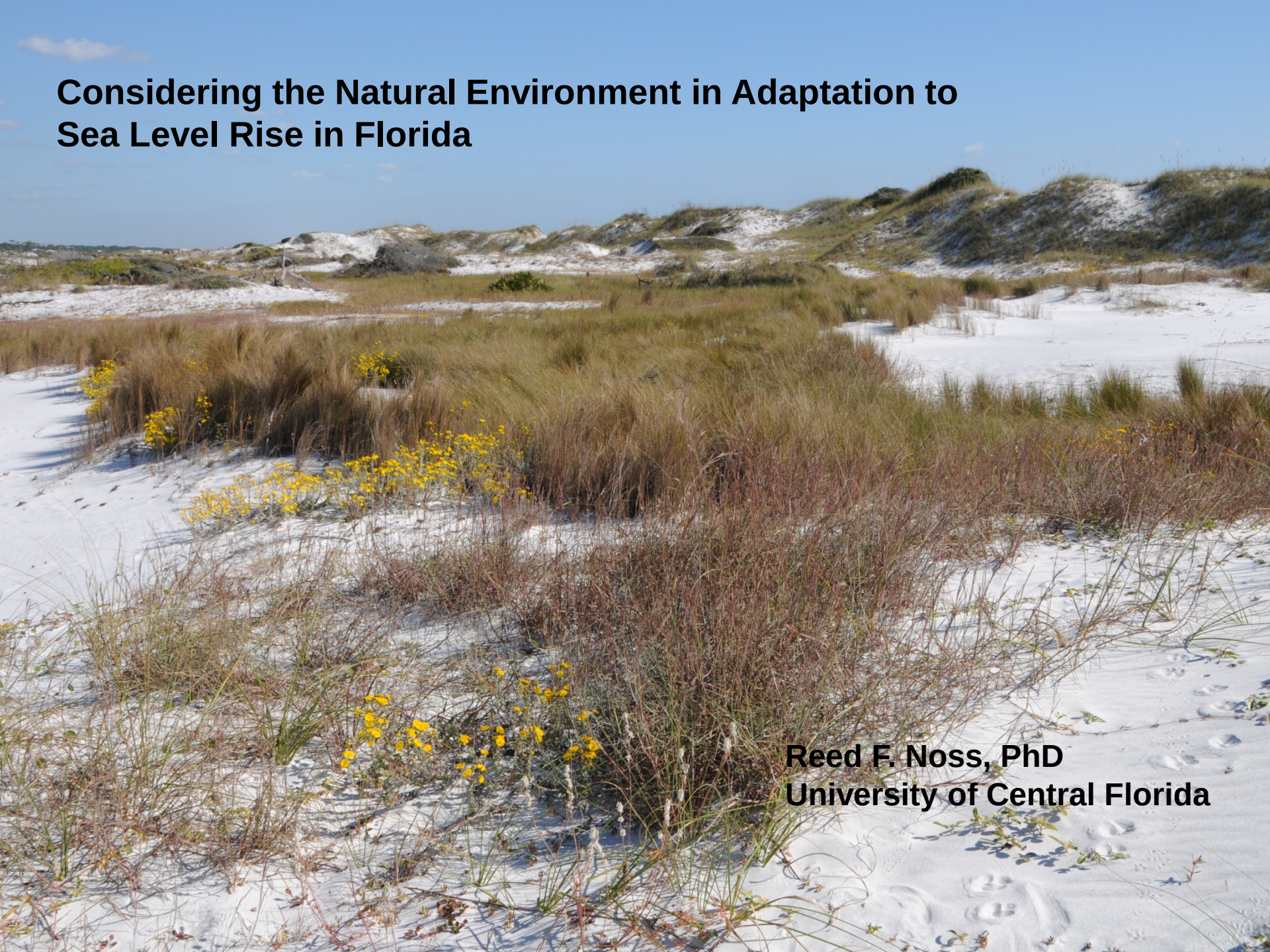
Considering the Natural Environment in Adaptation to Sea Level Rise in Florida



Reed F. Noss, PhD
University of Central Florida

Florida's coastal ecosystems are between the devil and the deep blue sea - squeezed between development and rising sea level

Impacts of SLR on the Natural and the Built Environment in Florida

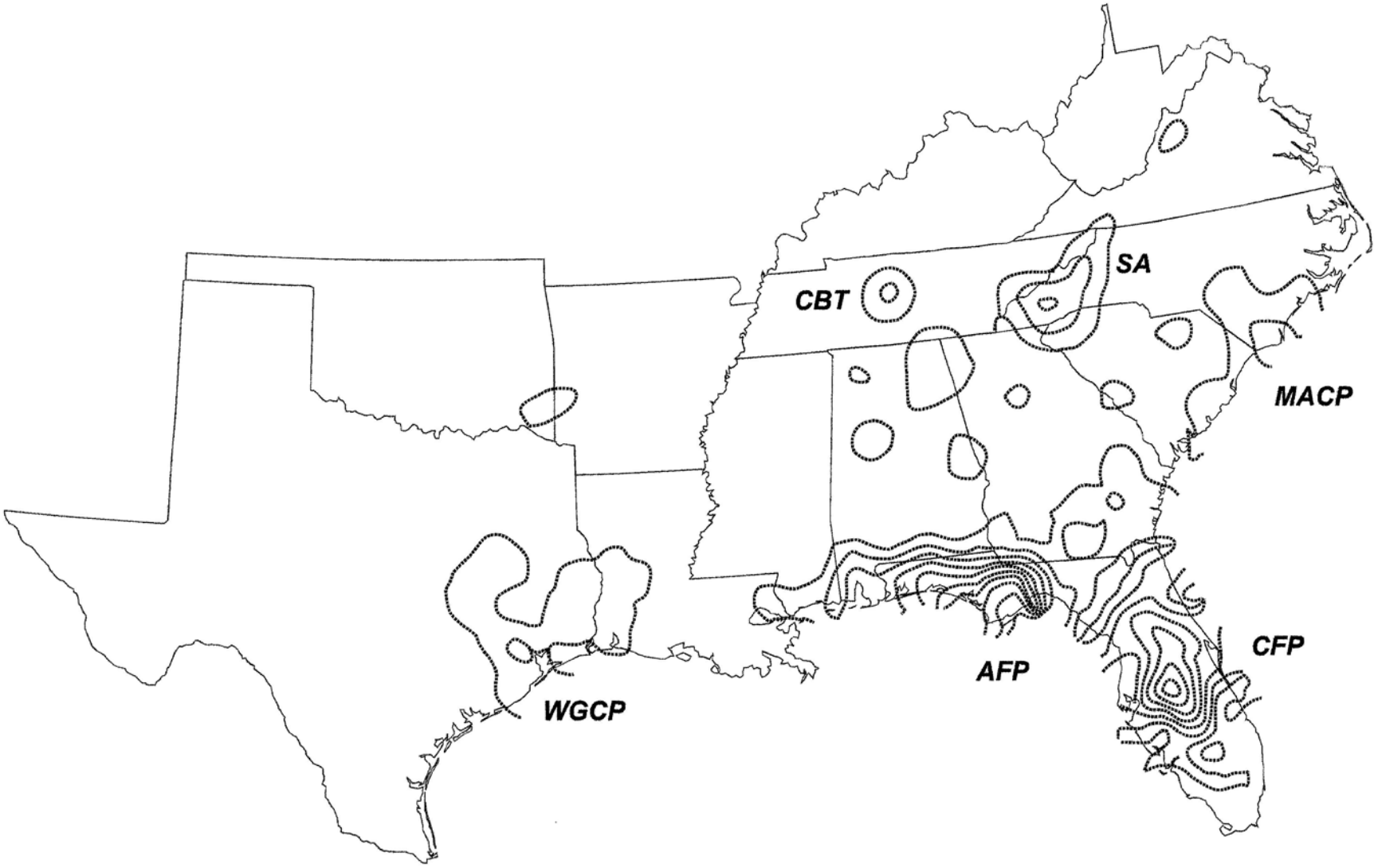
- Both natural ecosystems and human-created ecosystems (e.g., cities) in Florida are highly vulnerable to sea level rise and storm surge
- Risks to the built environment are receiving more attention, which is understandable because this is where people live
- **Nevertheless, an exclusive focus on protecting people and the built environment is counter-productive and self-defeating for several reasons**

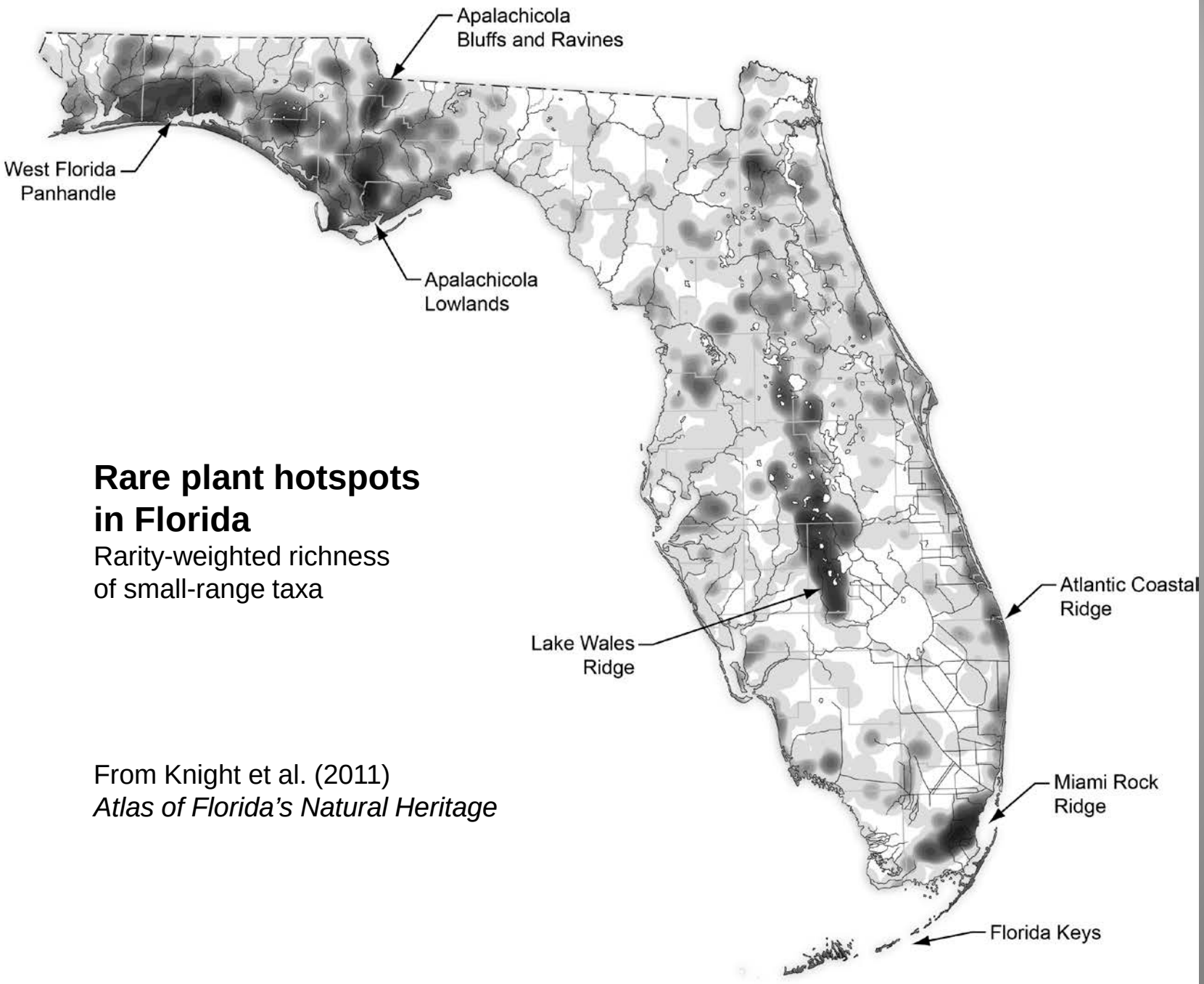
Why Consider Natural Ecosystems?

- Florida is a global biodiversity hotspot, and much of this biological richness is coastal
- Floridians have shown strong bipartisan support over several decades for protecting natural areas
- State and federal laws (e.g., the Endangered Species Act) apply to many coastal species threatened by sea level rise
- Natural ecosystems such as salt marshes, mangrove swamps, and oyster reefs provide substantial protection to human communities and infrastructure from sea level rise and storm surges
- These ecosystems provide other economic benefits, for example from fisheries and nature-based tourism

Context: Centers of plant endemism in the Southeastern U.S.

The major centers of endemism are in Florida From Estill and Cruzan (2001)





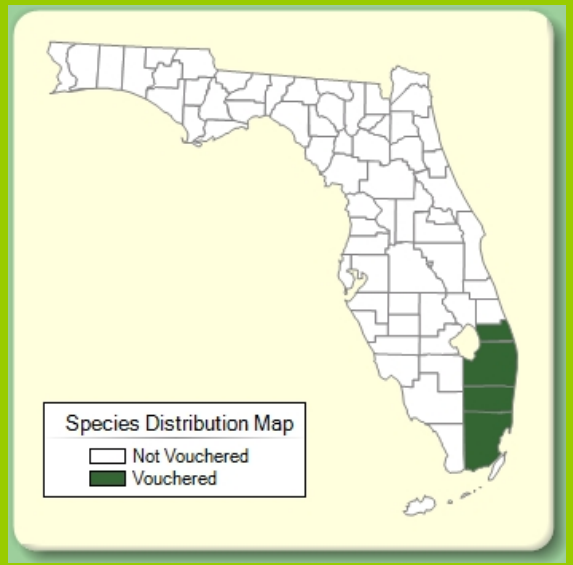
Rare plant hotspots in Florida

Rarity-weighted richness of small-range taxa

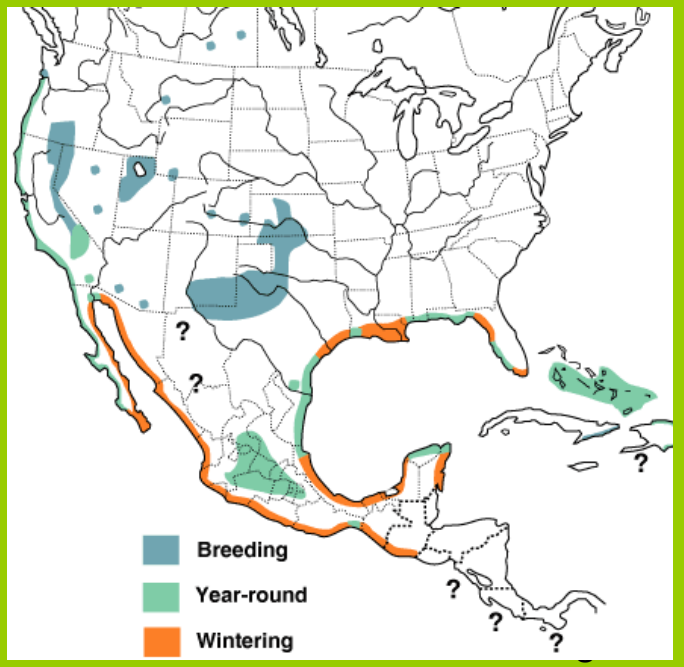
From Knight et al. (2011)
Atlas of Florida's Natural Heritage

Jacquemontia reclinata
Beach jacquemontia

Listed Endangered



Charadrius nivosus
Snowy Plover



Caretta caretta
Loggerhead
Listed Endangered

Also Green, Hawksbill, Leatherback, and Kemp's Ridley nest in Florida

Biological Impacts of Sea Level Rise in Florida are Already Apparent

Study traces tree deaths to sea-level rise

The Associated Press

A 1992 aerial photo shows dead trees on a salt marsh island surrounding surviving cabbage palms in the Waccasassa Bay State Preserve in Levy County on Florida's Gulf Coast. A seven-year University of Florida study shows rising sea levels are the cause behind the dying trees.

■ The change exposes the trees to damaging salt water.

By BRIAN GELLER
Sun staff writer

Opening a photo album, Francis Putz turns to the images of dead trees.

Newspaper clippings and overhead black and white pictures show it: cabbage palm and cedar tree stands dying at Waccasassa Bay.

"We're losing these areas too rapidly," said Putz, a University of Florida botany professor.

Complaints about death in the once-thriving stands brought researchers to the area in the early 1990s. And after years of research, the team now believes that increased saltwater exposure caused by rising sea levels is the culprit in the deaths.

And global warming, Putz says, is speeding up the sea-level rise.

Five scientists worked on the tree study, which was published in the September issue of Ecology. After launching the project seven years ago, researchers divided forested islands with differing elevations into 400-square-meter plots.

Putz said many of the people who complained about the dying trees had not noticed that the seedlings had been dying for years before.

"These were the living dead," he said. "There was no regeneration."

In fact, one of the study's main findings was that the stands suffer the effects of rising seas before the death of the canopy makes those effects obvious, said Kimberlyn Williams, a former UF assistant professor of botany.

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Reporting on Williams et al. 1999 in *Ecology*

Gainesville Sun
October 20, 1999


Pine mortality on Big Pine Key
resulting from storm surge from
Hurricane Wilma in 2005, aggravated
by sea-level rise

Options for Responding to SLR:

- Coastal Hardening and Beach Nourishment: Apply traditional engineering approaches such as seawalls, levees, dikes, and beach nourishment – stop-gaps, but ecologically and economically unsustainable!
- Managed Retreat (Withdrawal): Allow for movement of species and ecosystems landward as sea level rises and abandon structures that cannot be moved. Relocate human communities and populations of other species, as needed.

- Hard armoring of shorelines in response to SLR may provide local protection, but often increases erosion of neighboring coastal areas
- Hard armoring often causes loss of coastal wetlands, which provide natural buffering from storms and play a key role in sequestering carbon
- Hard armoring can prevent coastal ecosystems from shifting landward in response to SLR

In addition, due to porous bedrock such as Miami oolite, hard armoring is ineffective in much of Florida – the water comes in from below!

Combining Ecology and Engineering for Coastal Adaptation

nature climate change

PERSPECTIVE

PUBLISHED ONLINE: 28 AUGUST 2013 | DOI: 10.1038/NCLIMATE1854

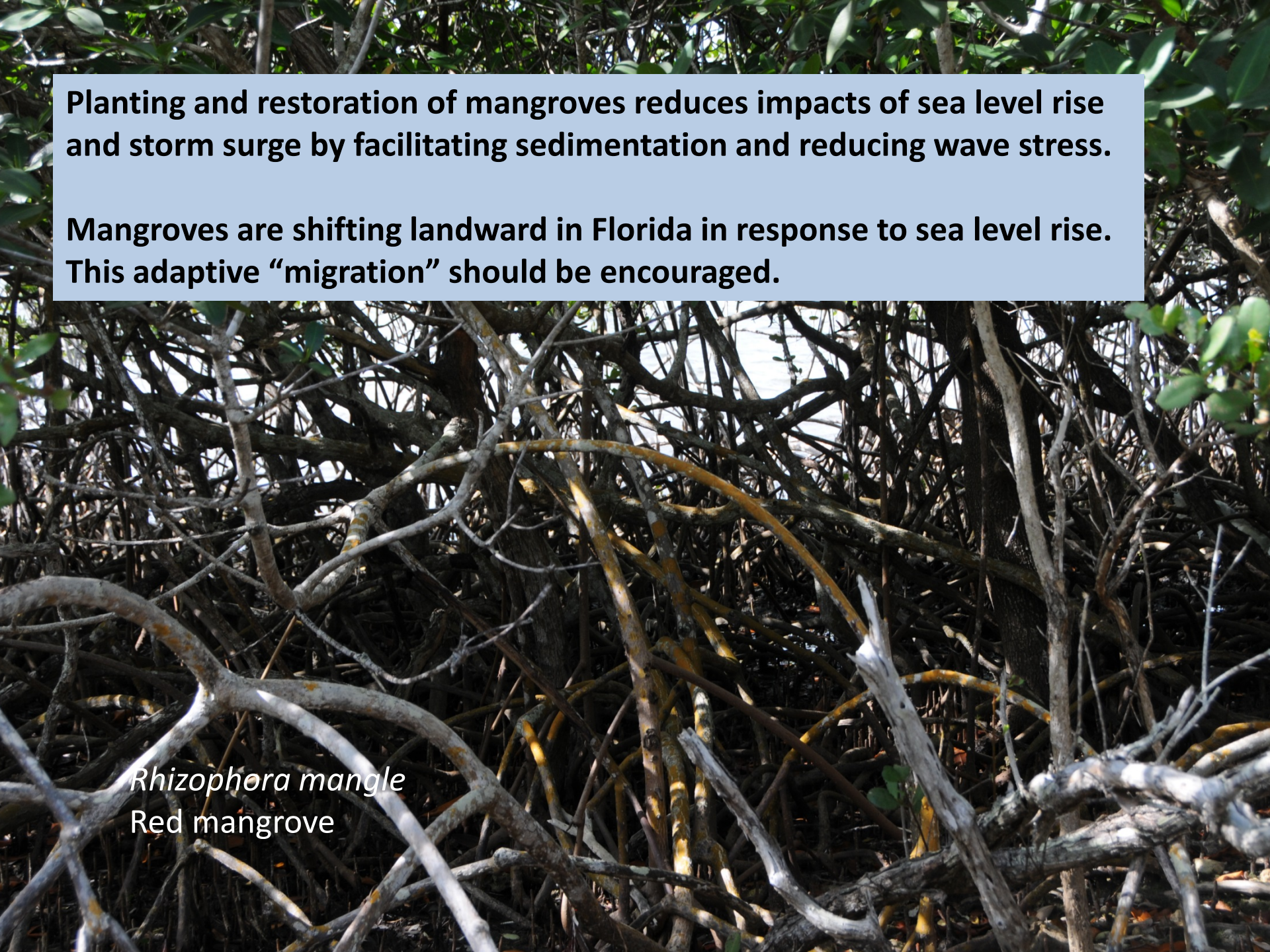
Coastal adaptation with ecological engineering

So-Min Cheong[1*], Brian Silliman[2], Poh Poh Wong[3], Bregje van Wesenbeeck[4], Choong-Ki Kim[5,6] and Greg Guannel[6]

The use of combined approaches to coastal adaptation in lieu of a single strategy, such as sea-wall construction, allows for better preparation for a highly uncertain and dynamic coastal environment. Although general principles such as mainstreaming and no- or low-regret options exist to guide coastal adaptation and provide the framework in which combined approaches operate, few have examined the interactions, synergistic effects and benefits of combined approaches to adaptation. This Perspective provides three examples of ecological engineering — marshes, mangroves and oyster reefs — and illustrates how the combination of ecology and engineering works.

Conservation and restoration of salt marshes facilitate deposition of sediments and accretion of organic matter, which can raise the marsh surface and, at least for a while, keep pace with sea level rise

Salt marsh near Cedar Key



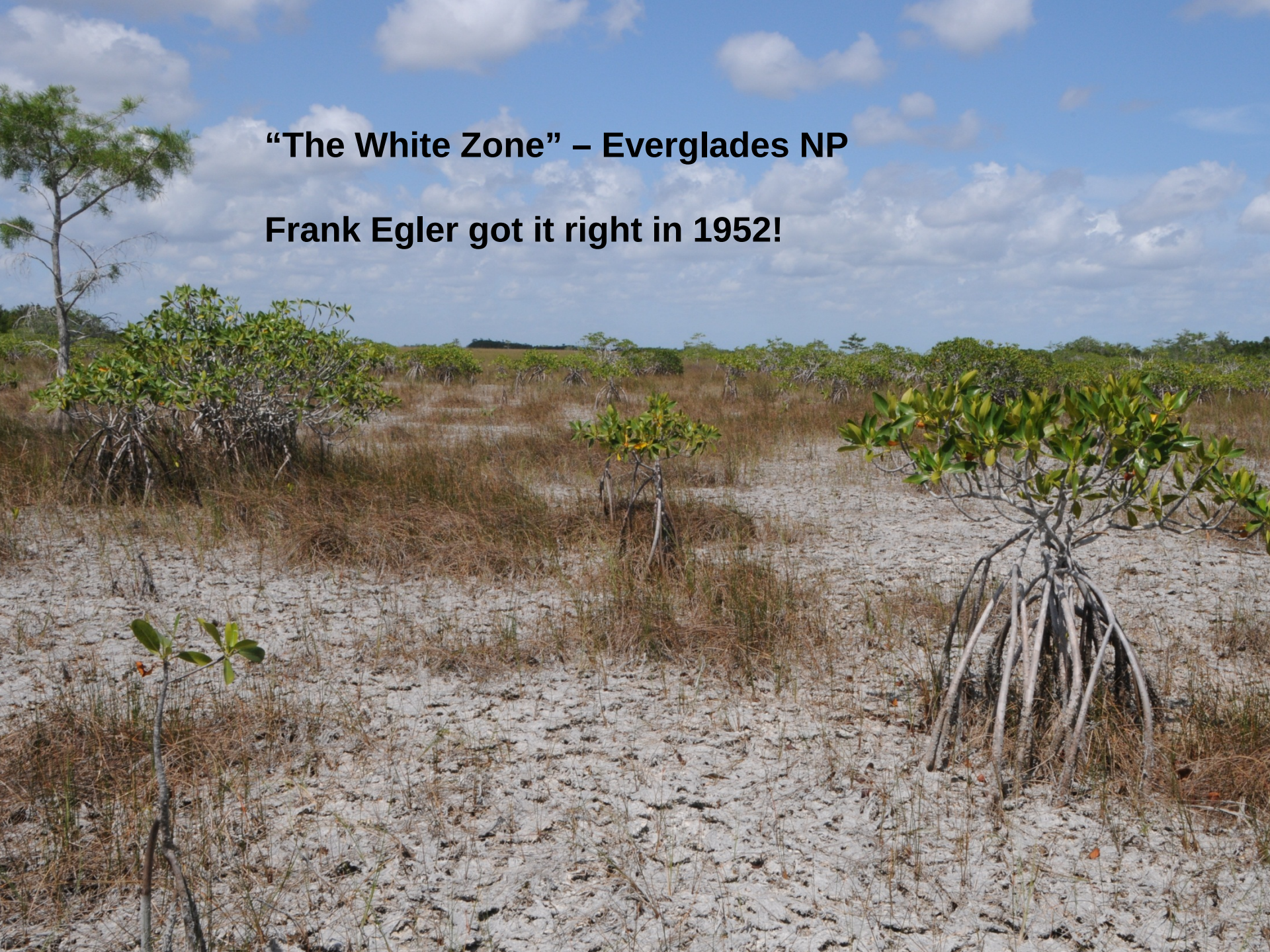
Planting and restoration of mangroves reduces impacts of sea level rise and storm surge by facilitating sedimentation and reducing wave stress.

Mangroves are shifting landward in Florida in response to sea level rise. This adaptive "migration" should be encouraged.

Rhizophora mangle
Red mangrove

Everglades National Park

(60% of the Everglades is below 3 feet)


“The White Zone” – Everglades NP
Frank Egler got it right in 1952!


The White Zone – wet season

Protecting and restoring natural coastal ecosystems – and allowing them to migrate landward – helps protect people and property from sea level rise and storm surge, and maintains the many other utilitarian and intrinsic values of these ecosystems

Coastal Grassland
Siesta Key, FL