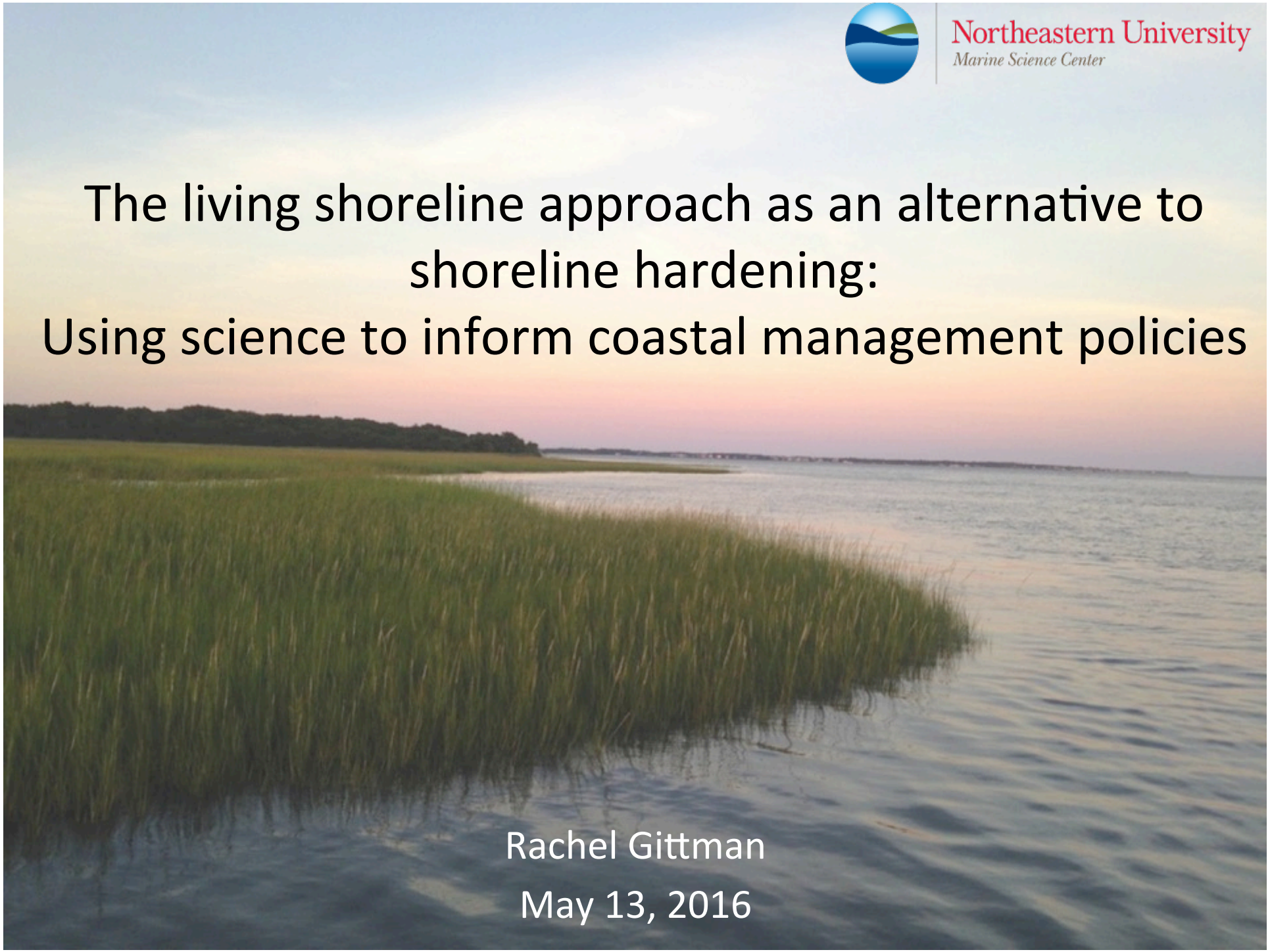


Northeastern University
Marine Science Center

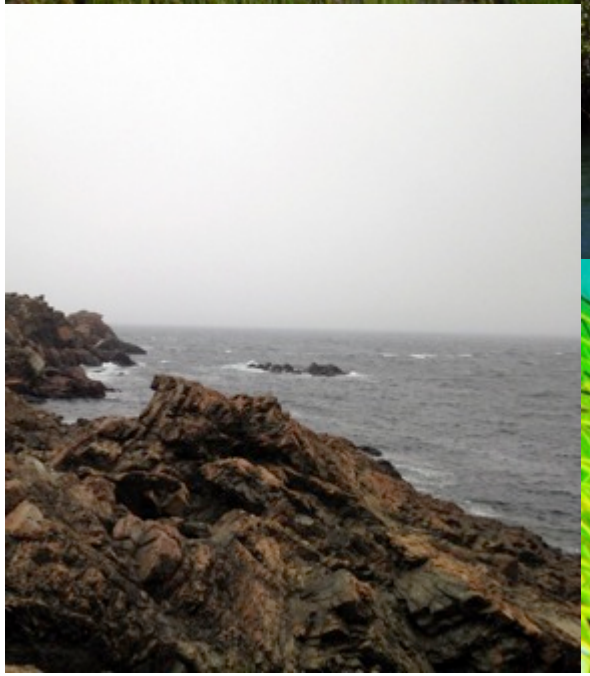
The living shoreline approach as an alternative to shoreline hardening: Using science to inform coastal management policies

Rachel Gittman

May 13, 2016





Coastal ecosystem services

Habitat

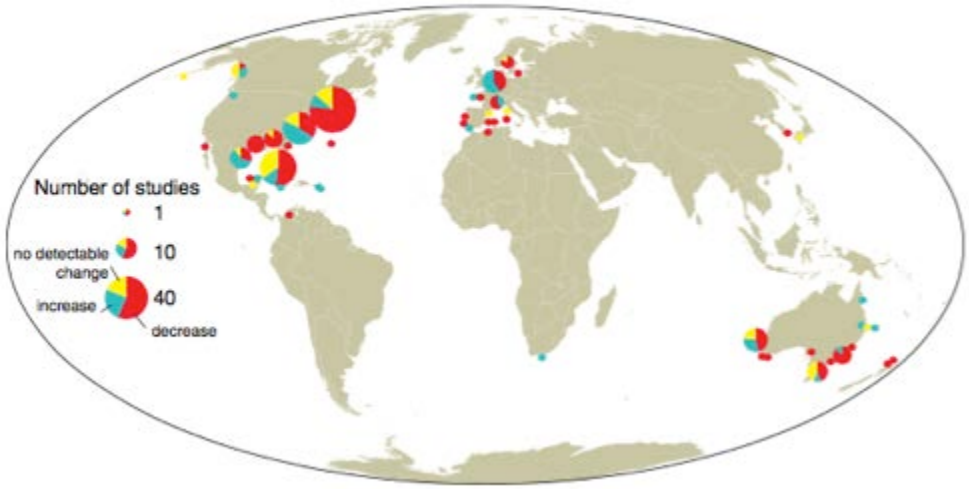
Sediment Stabilization

Tourism, Recreation, Aesthetics

Carbon storage

Habitat Degradation & Loss

Seagrass Losses >30%

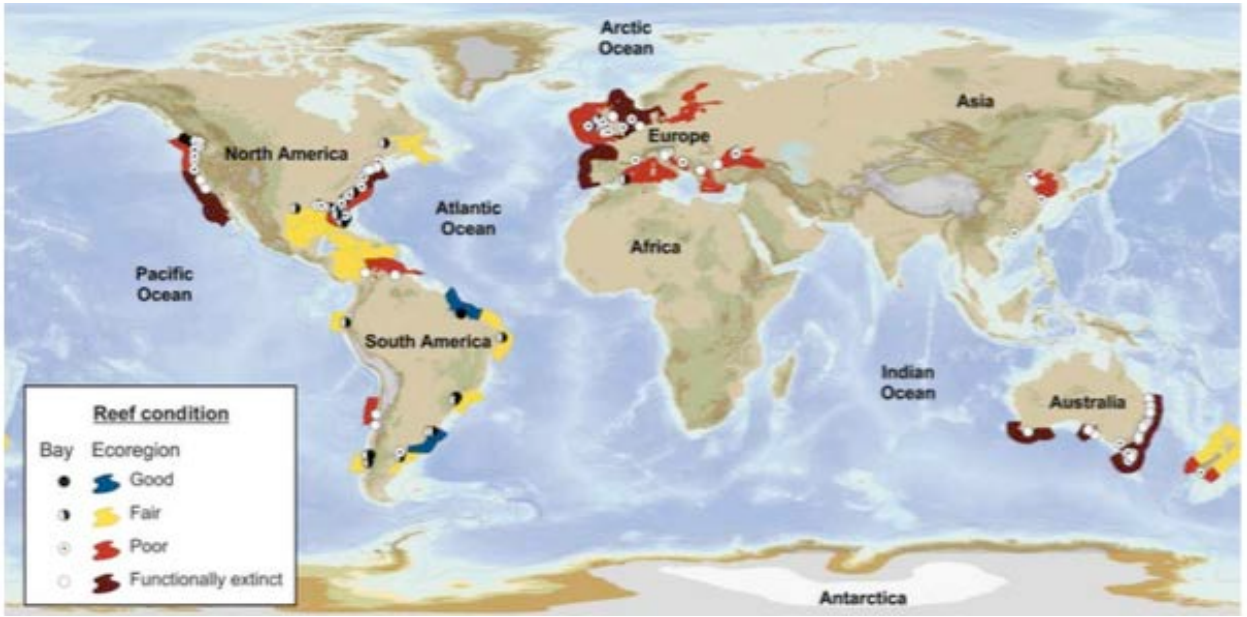


Waycott et al. 2009

> 40% decline of North American salt marshes

Gedan and Silliman 2009

Oyster Losses – 65-85%



Beck et al. 2011

35% of mangrove area has been lost since 1980s

Valiela et al. 2001

Coastal development

nature International weekly journal of science

NATURE | NEWS

Gulf ecology hit by coastal development

Dubai's artificial islands are affecting marine ecosystems.

Daniel Cressey

16 November 2011

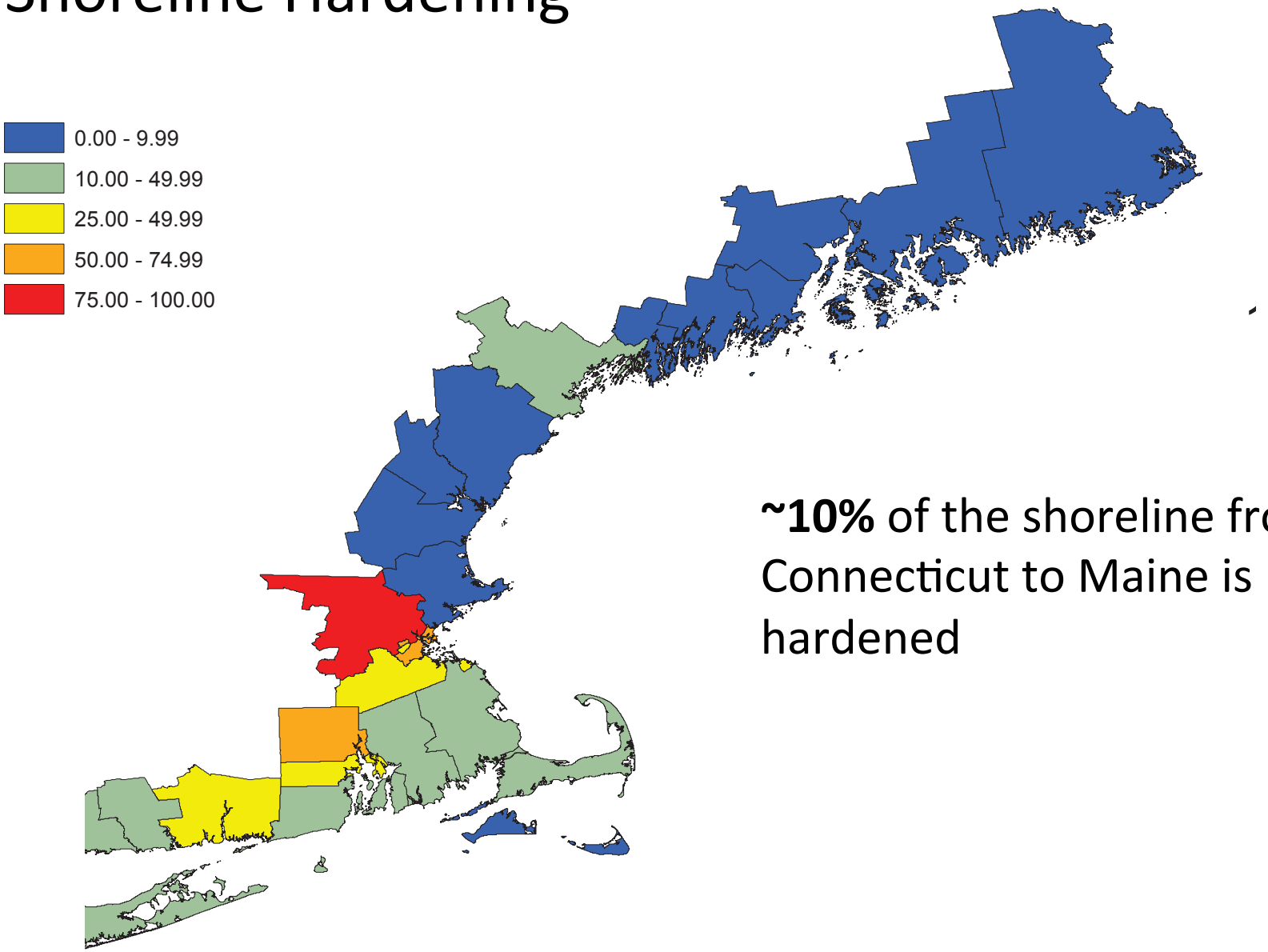
M. SEIFERT/REUTERS

Coastal erosion

Causes:

- Ambient wave energy
- Storm events
- Disruption in sediment supply
- Changes in shoreline topography
- Removal of vegetation
- Boat wakes

Shoreline Hardening



~10% of the shoreline from Connecticut to Maine is hardened

Gittman et al. 2015. *Frontiers in Ecology and the Environment*

U.S. Shoreline Hardening Conclusions

- 14% of the total U.S. shoreline is hardened (~22,000 km)
- Housing density best predictor on Atlantic sheltered and Gulf coasts
- South Atlantic and Gulf coasts projected to see largest increases in coastal population

Gittman et al. 2015. *Frontiers in Ecology and the Environment*

What are the Ecological Effects of Shoreline Hardening?

Seawalls/Bulkheads

Riprap revetments

Breakwaters

Gittman et al. *In revision*. *BioScience*

Meta-analysis methods

Metric	Structure Type	No. Studies	No. Responses
Biodiversity	Seawall	11	20
	Riprap	8	14
	Breakwater	5	11
Abundance	Seawall	22	67
	Riprap	7	22
	Breakwater	8	36

Nekton

Flora

Epibiota

Birds

Benthic infauna

Gittman et al. *In revision*. *BioScience*

Affected flora and fauna

- Benthic infauna (e.g., Seitz et al. 2006):
  - Polychaetes, amphipods
  - Clam (*Macoma balthica*)

- Shore birds (e.g., Dugan et al. 2006, 2008):
  - Spotted sandpiper (*Actitis macularius*)
  - Sanderling (*Calidris alba*)
  - Willet (*Tringa semipalmata*)
  - Killdeer (*Charadrius vociferus*)

- Nekton (Peterson et al. 2000, Gittman et al. 2016, Seitz et al. 2006)
  - Blue crabs (*Callinectes sapidus*)
  - Mummichogs (*Fundulus heteroclitus*)
  - Penaeid shrimp
  - Spot (*Leiostomus xanthurus*)

Shoreline hardening

What is lost?

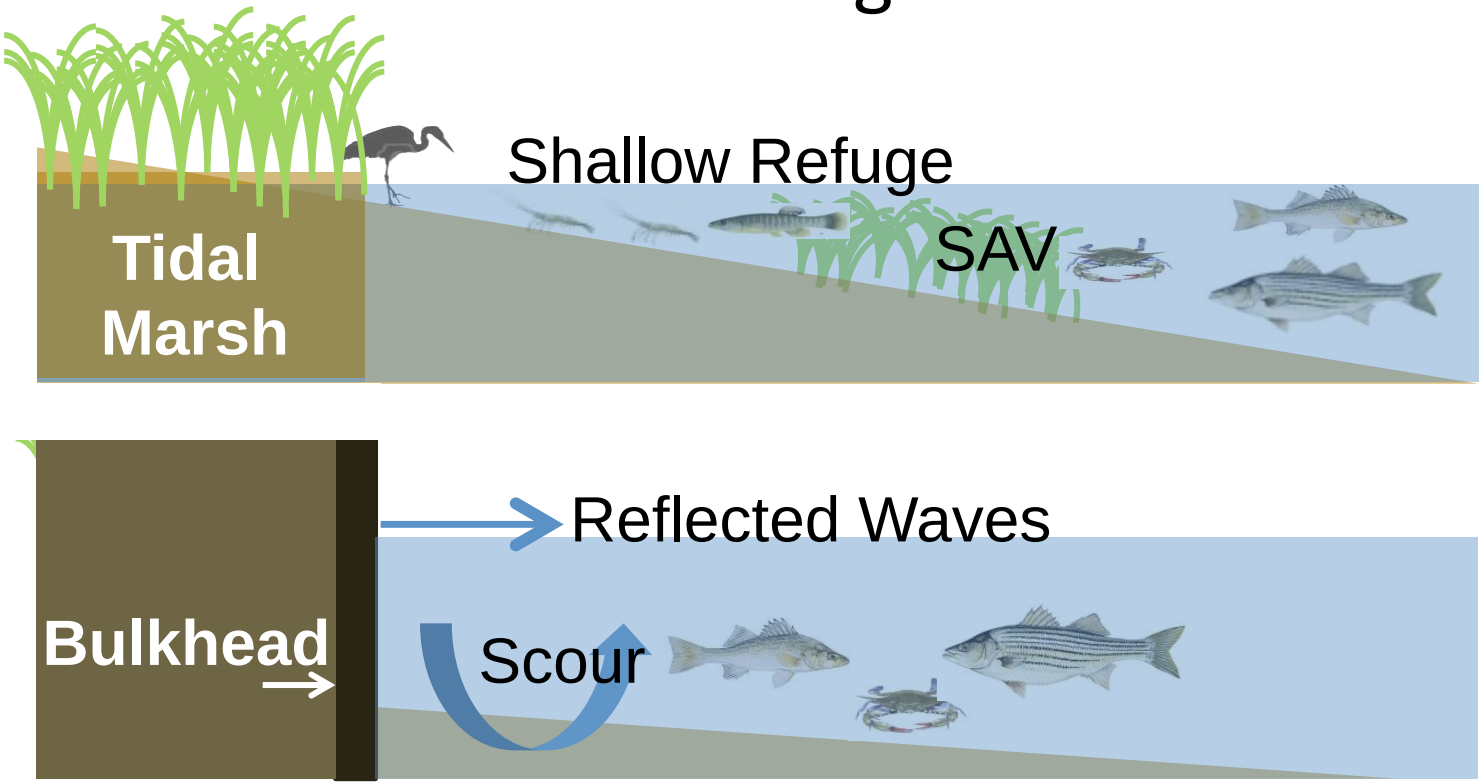


Fig. courtesy T. Jordan

Changes occur **BELOW** the MHW line:

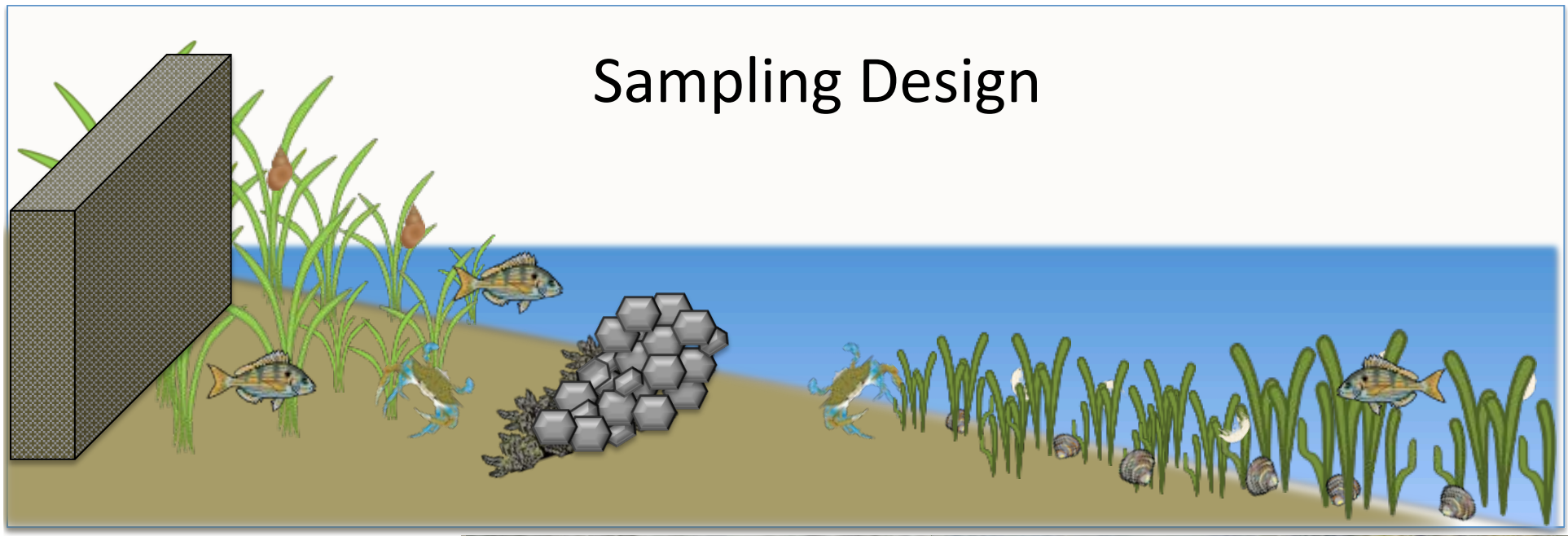
- Sediment transport & particle-size change
- Vegetation loss
- Benthic Fauna, Birds, Fish abundance reduced
- Denitrification capacity reduced

..and have negative impact on public trust resources

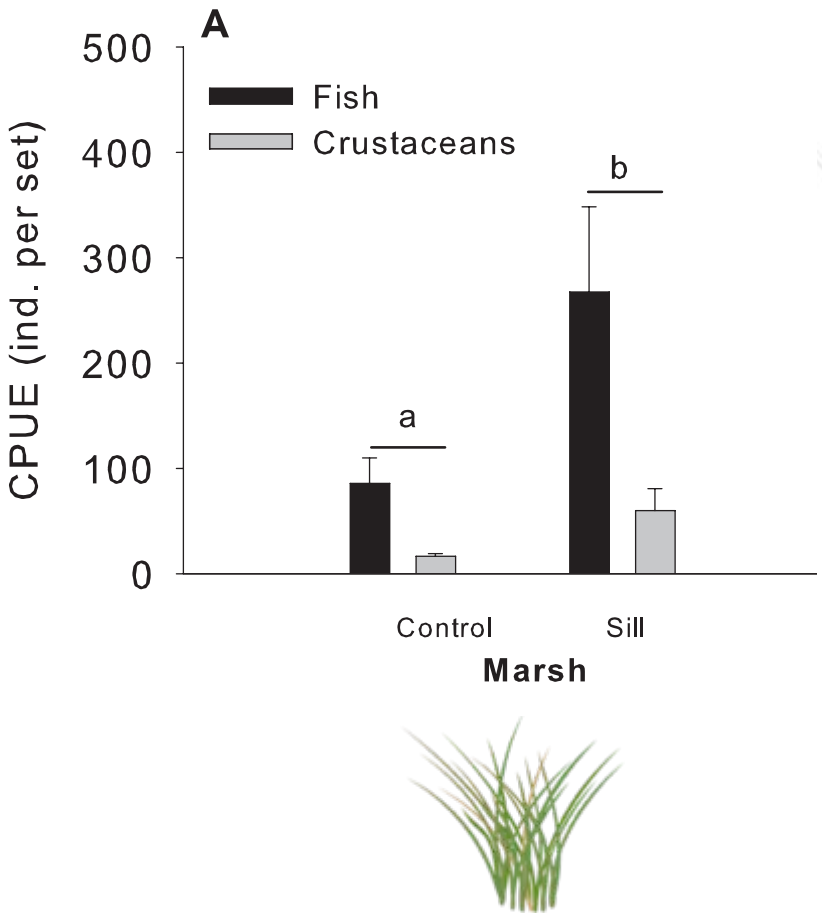
What are the alternatives?

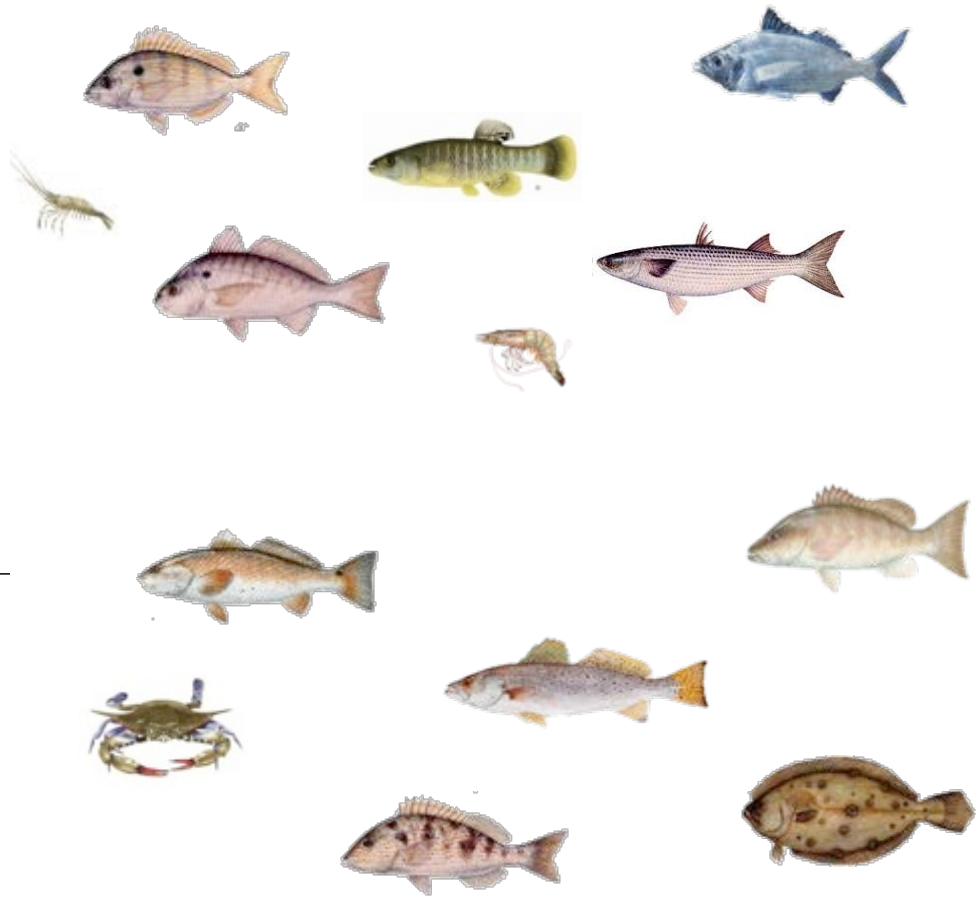
Living shorelines "A living shoreline incorporates vegetation or other 'soft' elements alone or in combination with some type of harder shoreline structure (e.g. oyster reefs or rock sills) for added stability. Living shorelines maintain continuity of the natural land - water continuum and reduce erosion while providing habitat value and enhancing coastal resiliency. (NOAA 2015).

Sampling Design



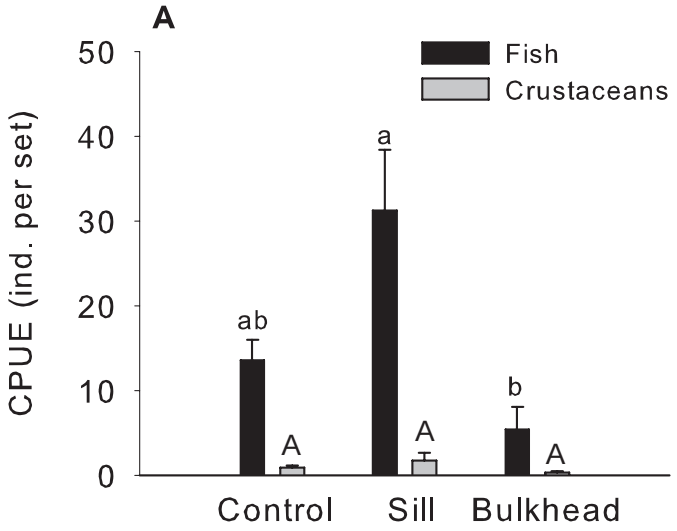
Comparison of marshes with and without sills

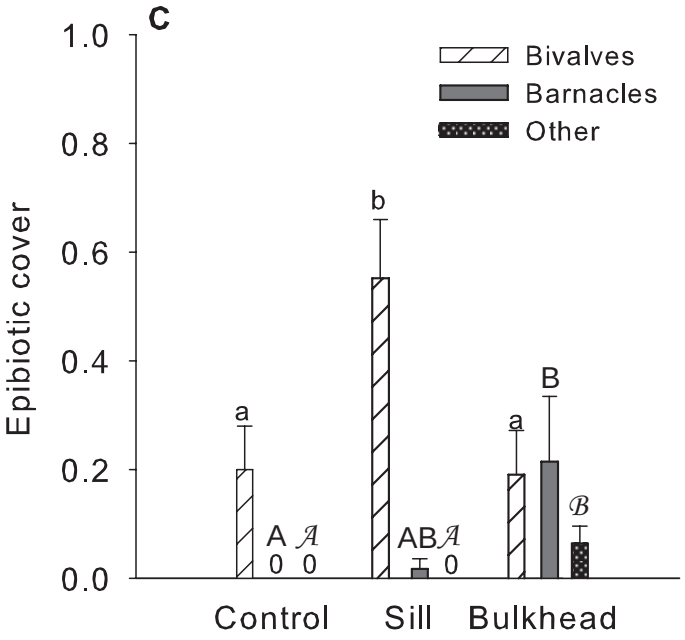


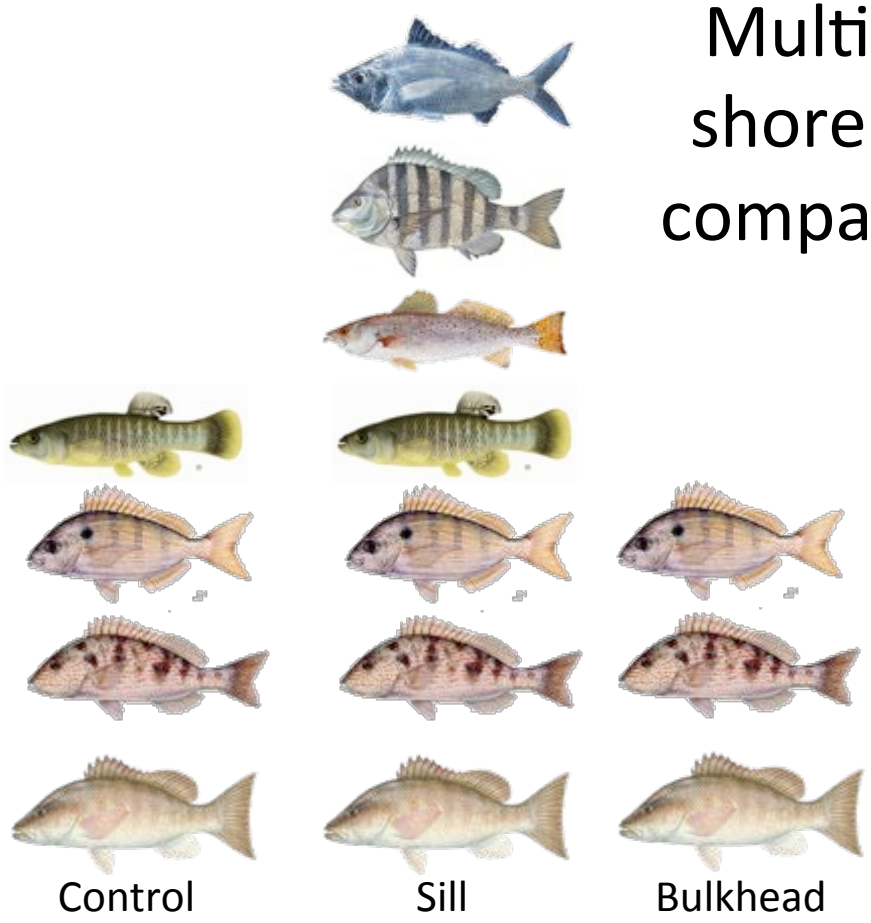


Gittman et al. 2016 *Ecological Applications*

Multiple shoreline comparison







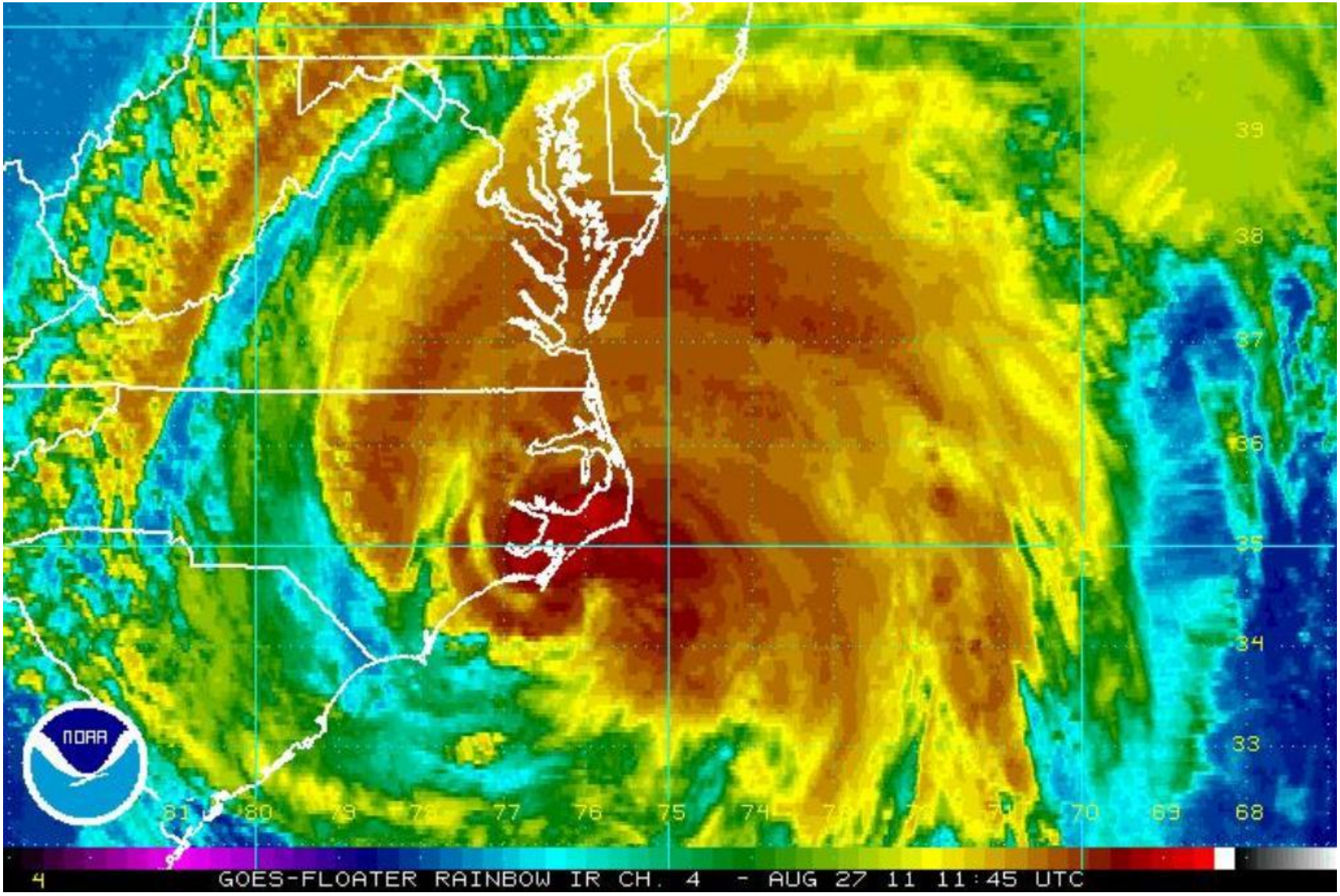
Gittman et al. 2016 *Ecological Applications*

Habitat provision conclusions

- Living shorelines can serve as better habitat than bulkheads

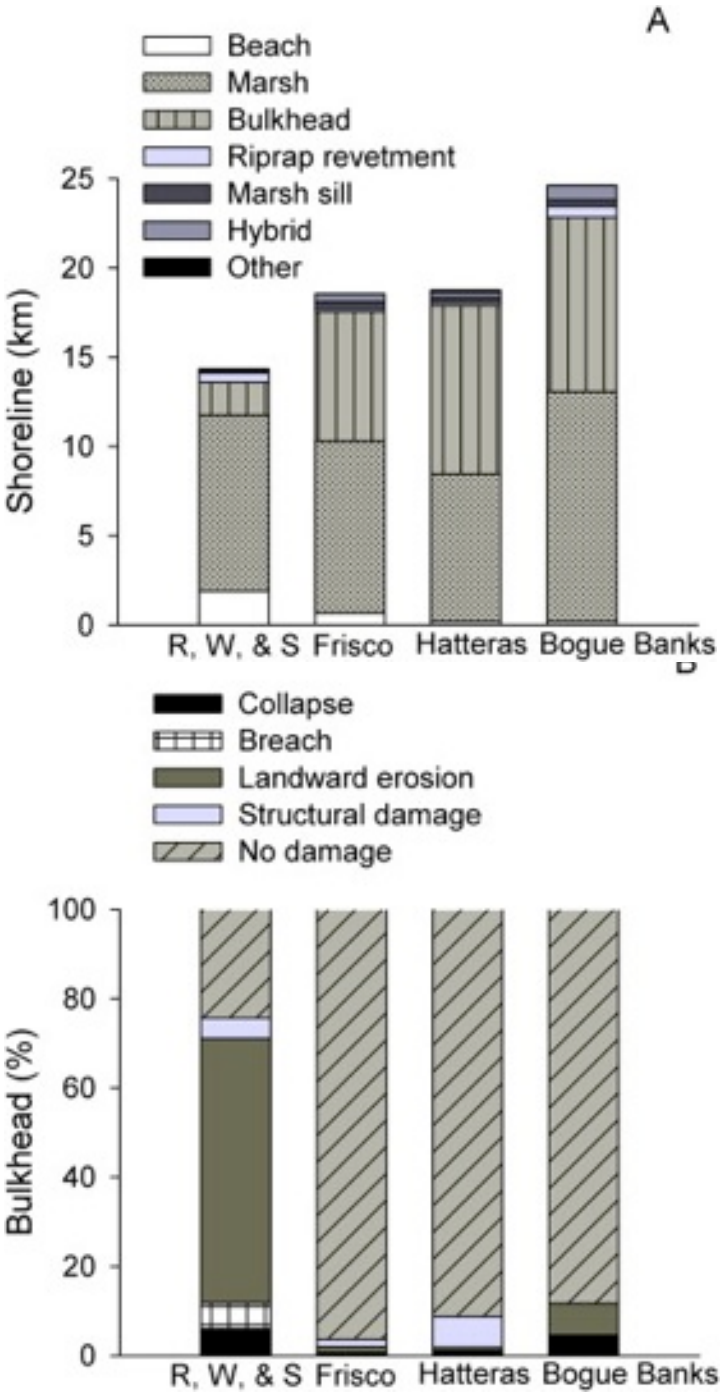
- Sills may function similar to oyster reefs in terms of providing refuge and foraging opportunities

Shoreline Resilience



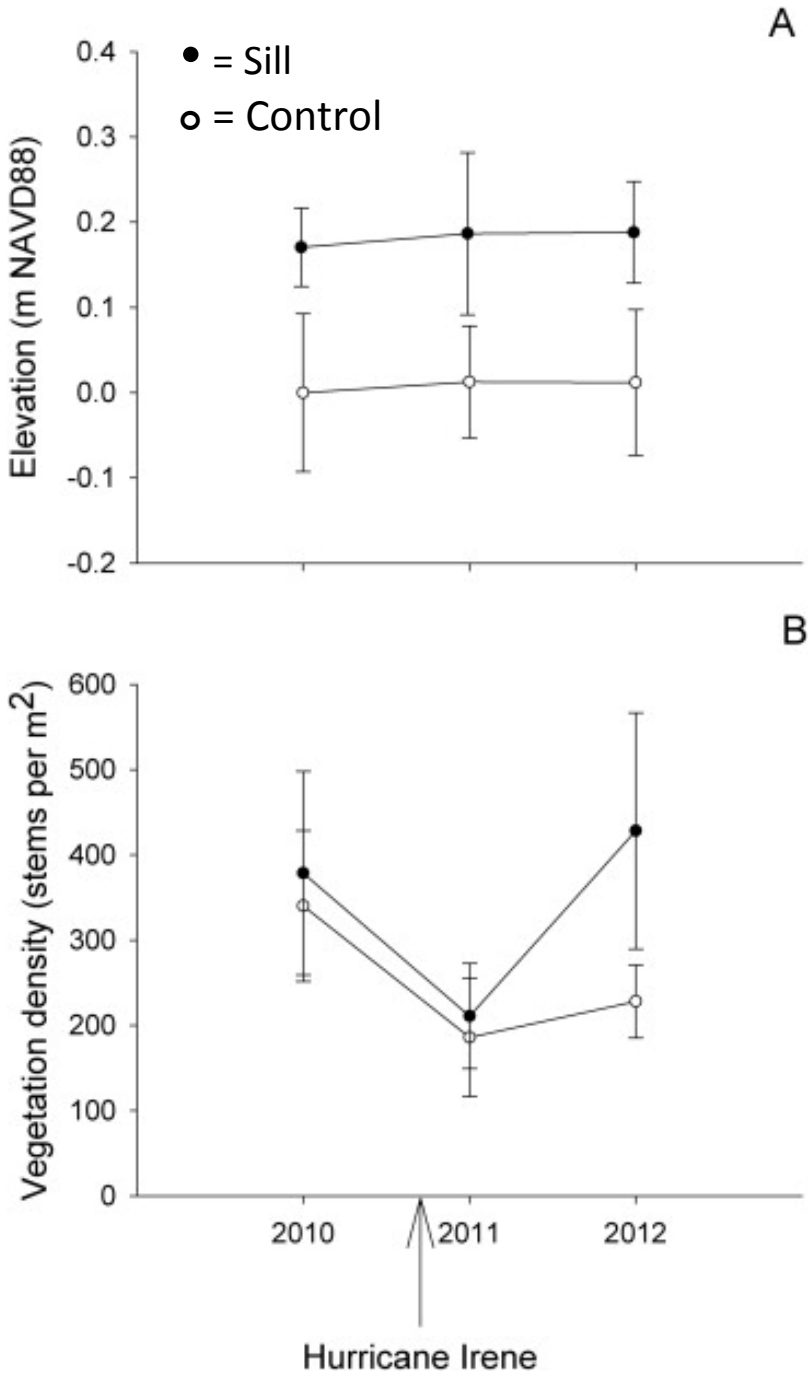
NOAA 2011

Post-hurricane survey results



Gittman et al. 2014. *Ocean & Coastal Management*

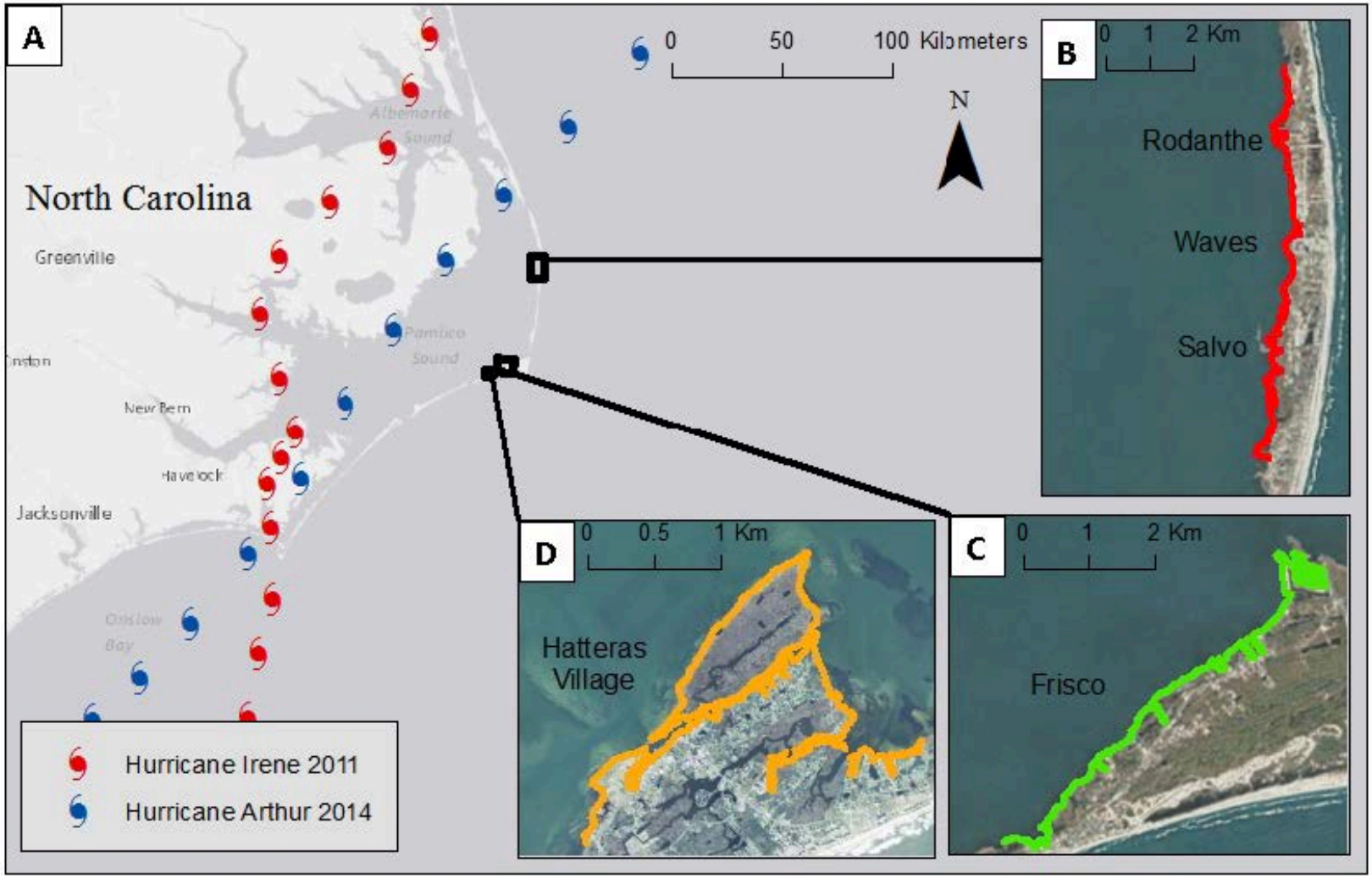
Shoreline Comparison



Gittman et al. 2014 *Ocean & Coastal Management*

Shoreline resilience

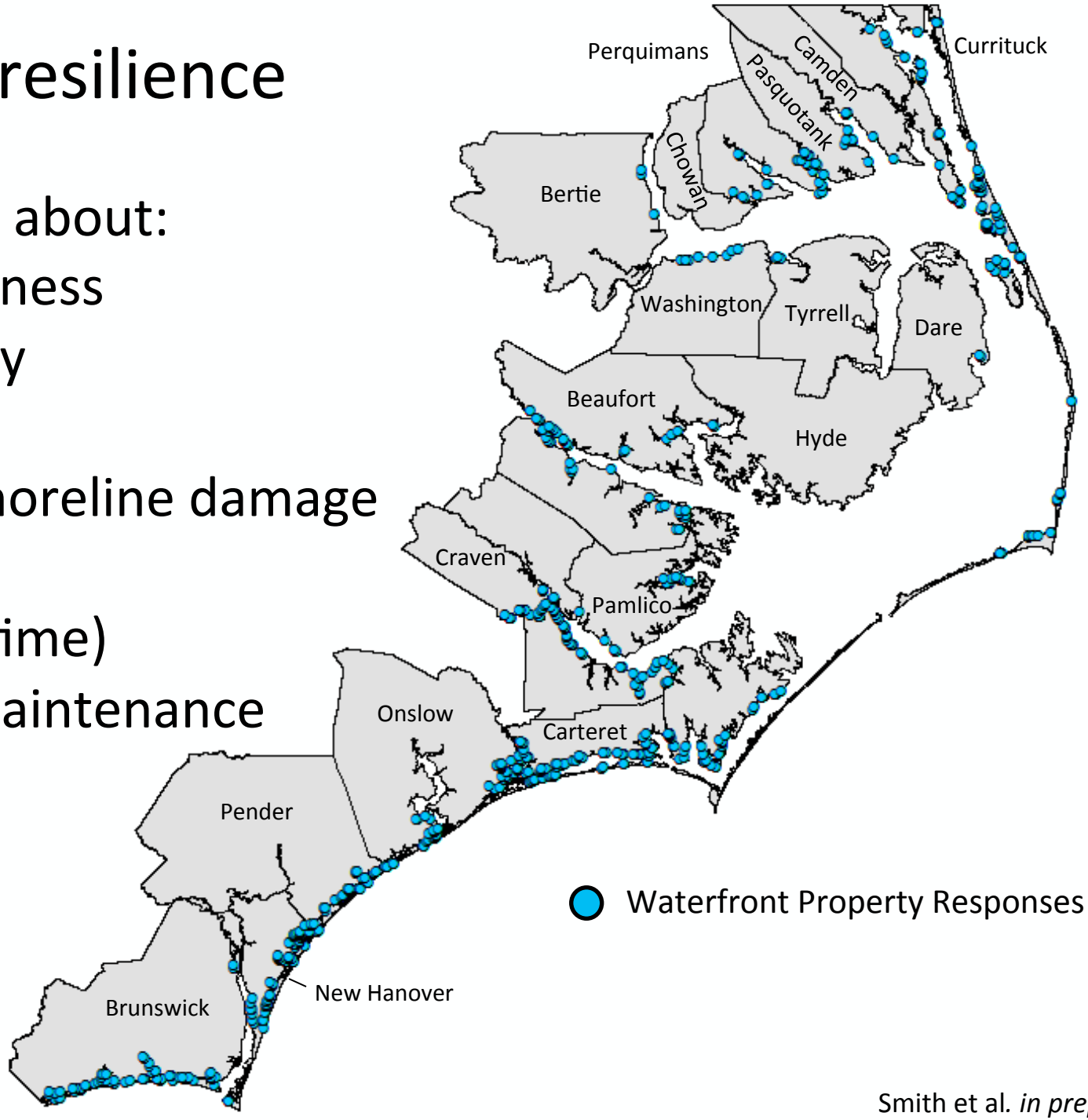
Shoreline resilience



Smith et al. *in prep*

Shoreline resilience

- Perceptions about:
  - Effectiveness
  - Durability
  - Cost
- Reported shoreline damage
  - Cause
  - Cost ($/time)
- Reported maintenance

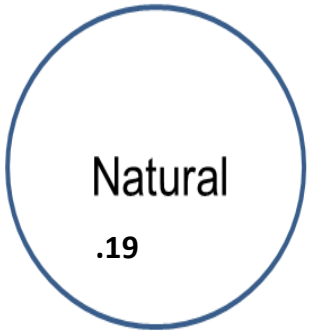


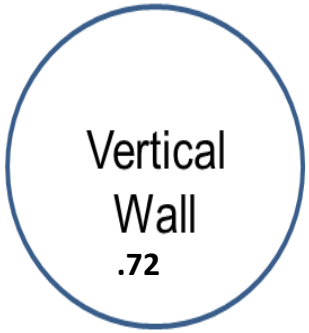
Smith et al. *in prep*

Which factors are the most powerful at predicting homeowner's current shoreline condition?

Classification Tree Analysis
Current Condition

Model Inputs
Perceived Environmental Condition
Priorities
Years at Current Residence
Years Residing on Mobile Bay
Adjacent Shoreline Condition
Age
Education
Income
Geographic Zone





Scyphers et al. 2015. *Conservation Letters*

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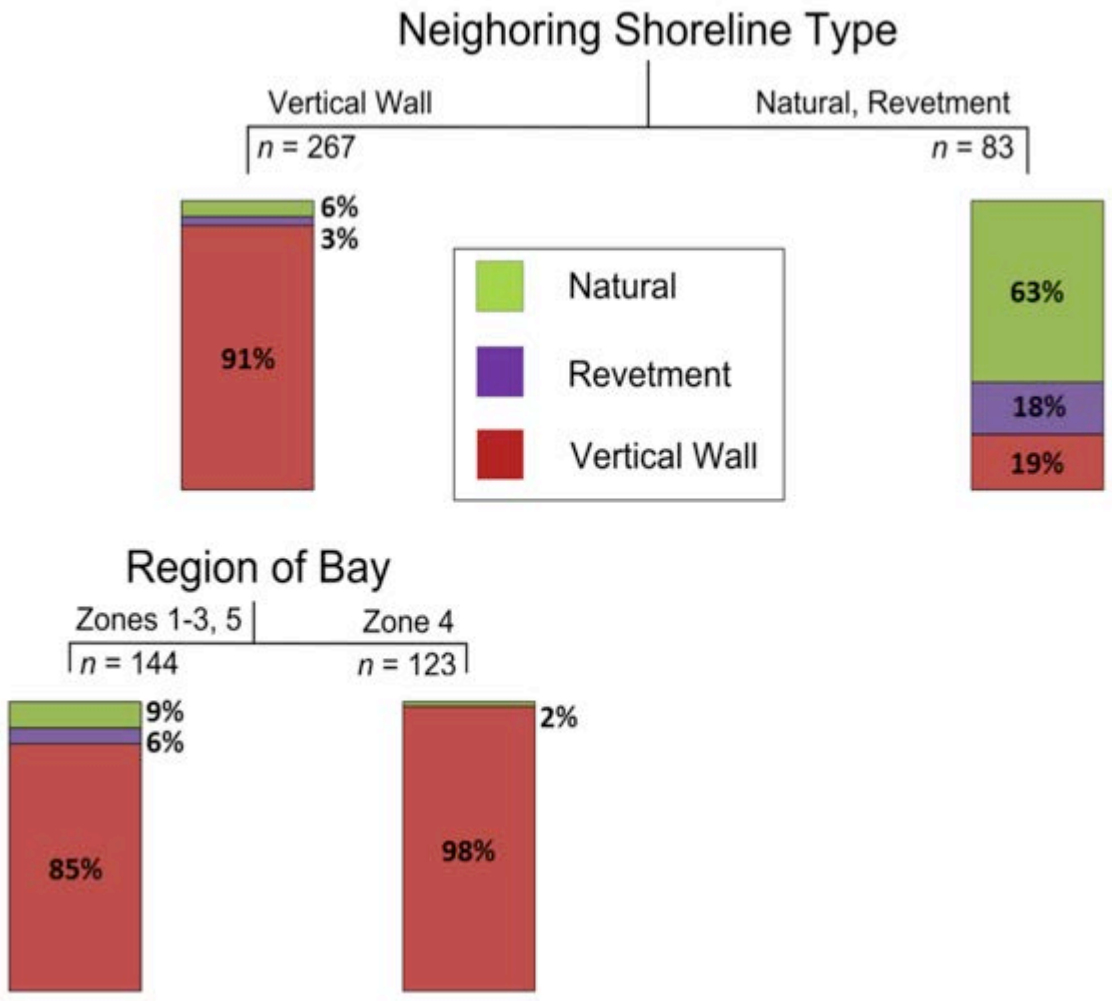
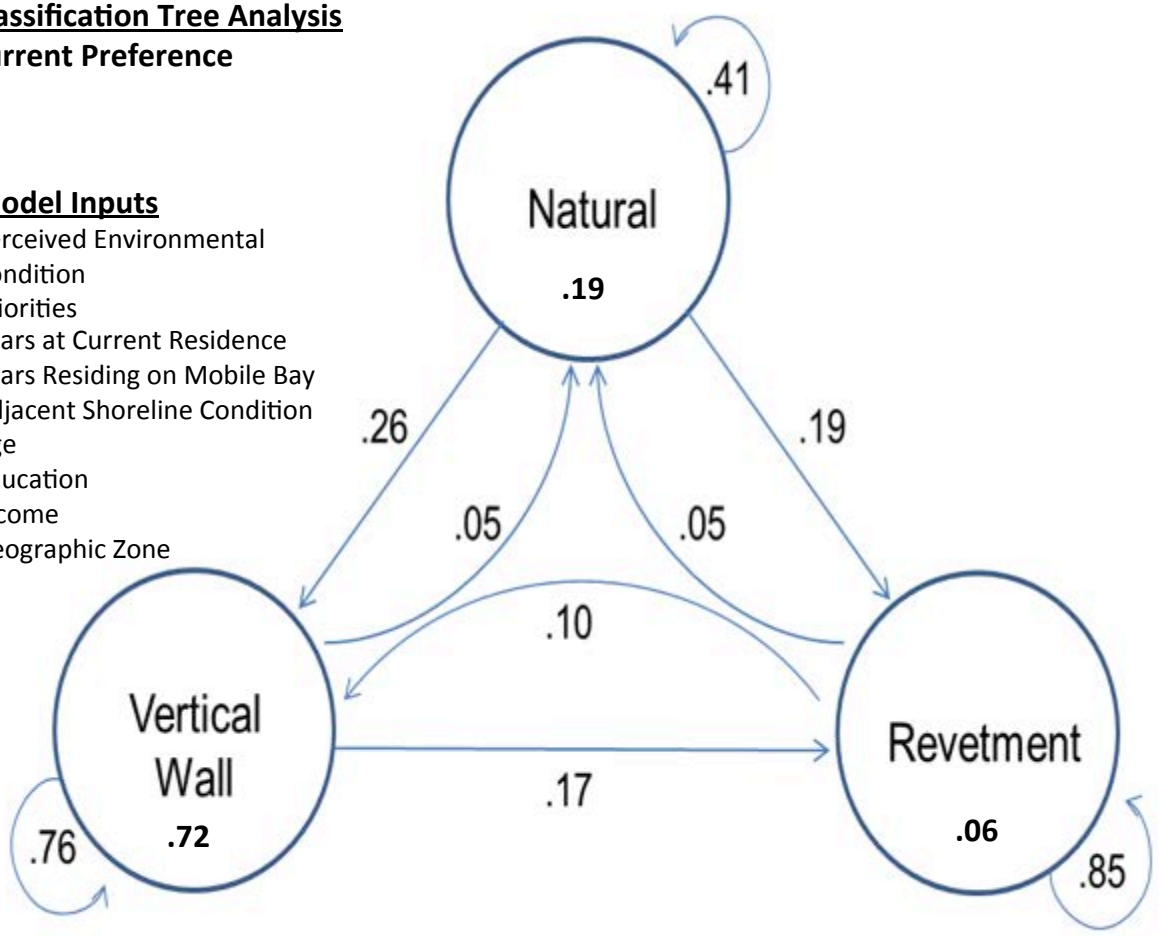


Scyphers et al. 2015. *Conservation Letters*

Which factors are the most powerful at predicting homeowner's current preference?

Classification Tree Analysis
Current Preference

Model Inputs
Perceived Environmental Condition
Priorities
Years at Current Residence
Years Residing on Mobile Bay
Adjacent Shoreline Condition
Age
Education
Income
Geographic Zone



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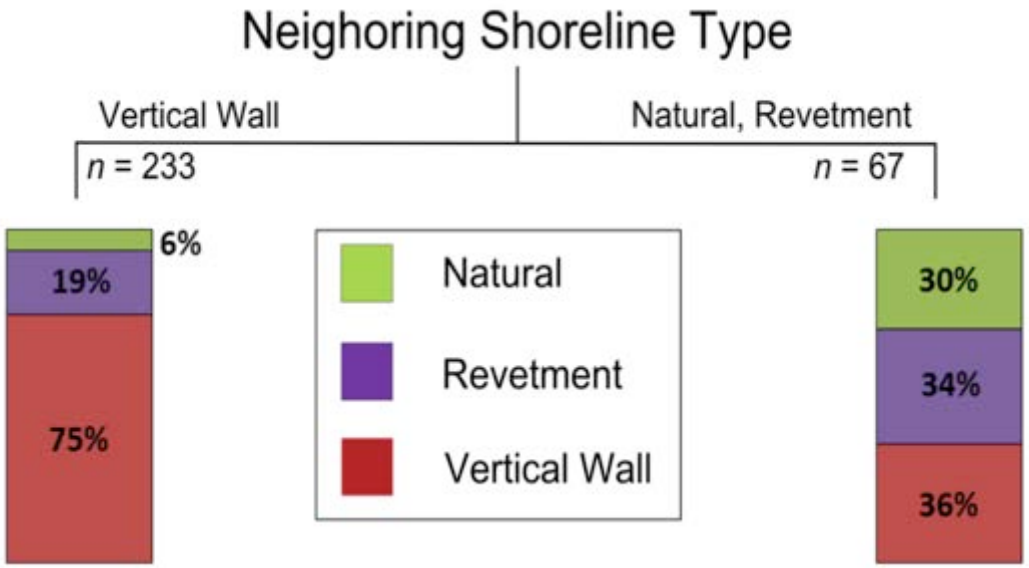

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Acknowledgements

Coauthors

John Bruno
Carolyn Currin
Joel Fodrie
Jon Grabowski
Danielle Keller
Isabelle Neylan
Pete Peterson
Michael Piehler
Alyssa Popowich
Steven Scyphers
Carter Smith

Technicians, grad students, agency staff, volunteers, and many more!

Email: r.gittman@neu.edu
Twitter: @GittmanR
Lab Webpage: http://www.northeastern.edu/grabowskilab/
Personal Webpage: http://www.northeastern.edu/gittman/