

# Nature based coastal defence: an NGO perspective



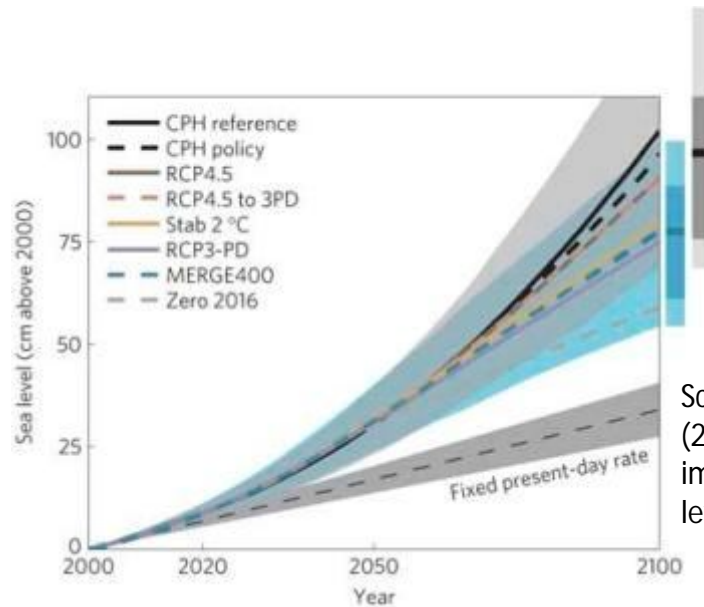
Mark Spalding

The Nature Conservancy

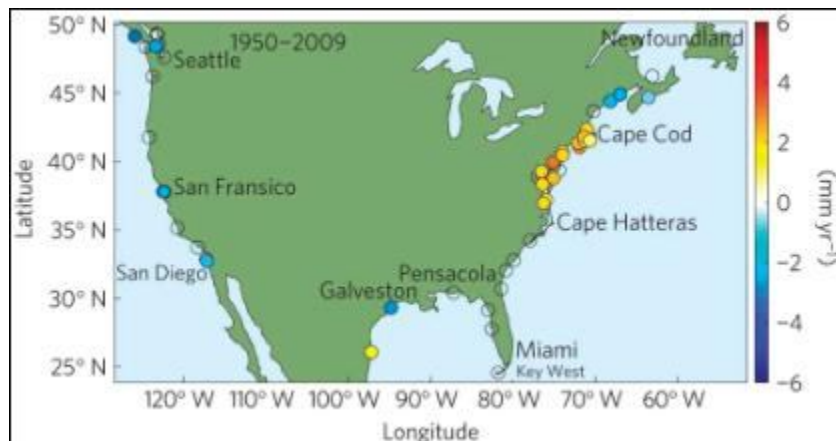
Protecting nature. Preserving life.™



# The issues: growing risks?



Schaeffer, M., W. Hare, et al. (2012). "Long-term sea-level rise implied by 1.5°C and 2°C warming levels." *Nature Clim. Change*.



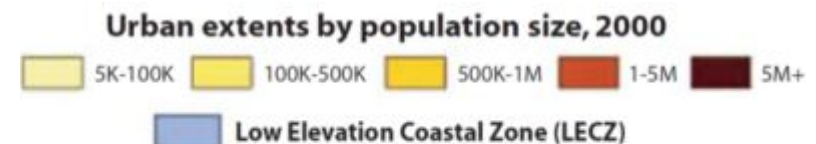
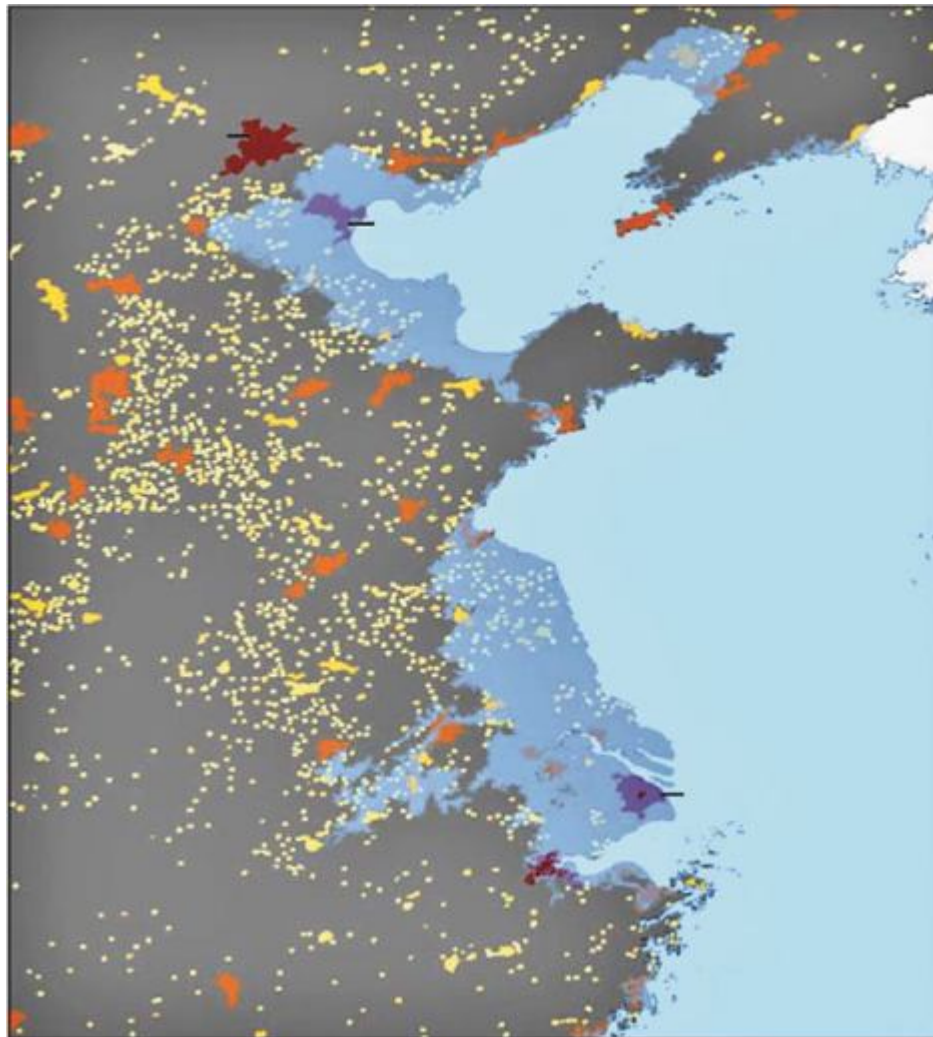
Sallenger, A. H., K. S. Doran, et al. (2012). "Hotspot of accelerated sea-level rise on the Atlantic coast of North America." *Nature Clim. Change*



Terra and Aqua/MODIS – 2012/240, 08/27/2012, 02:40 UTC. Typhoons Tembin (15W) and Bolaven (16W) in the Philippine Sea

# The issues: growing vulnerability

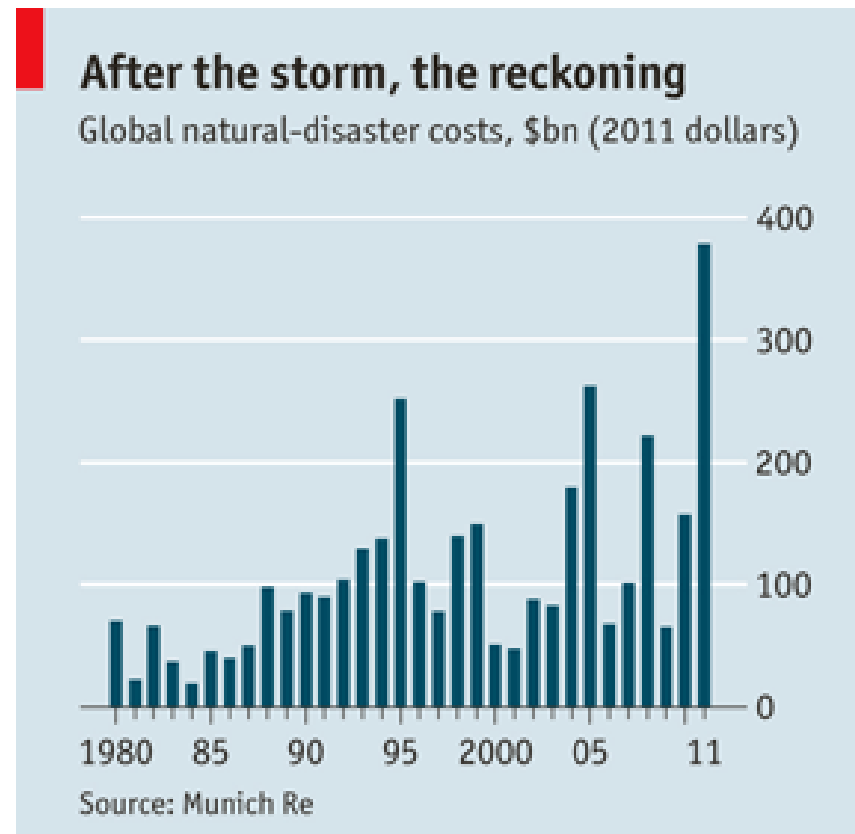
(coastal migration, infrastructure development, land claim)



NOTE: LECZ layer has been made semi-transparent to show the underlying layers. Thus the blue colour is not uniform.

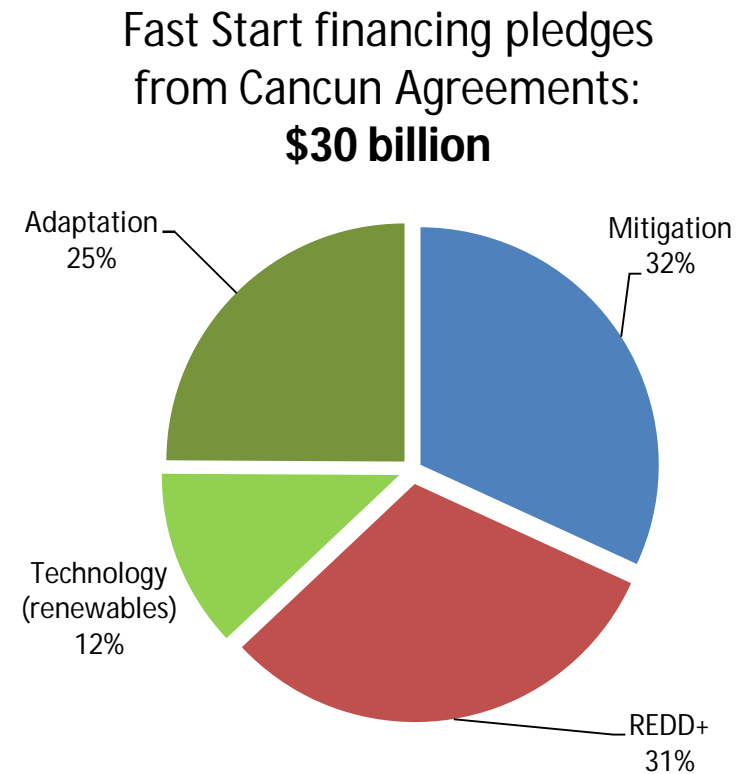
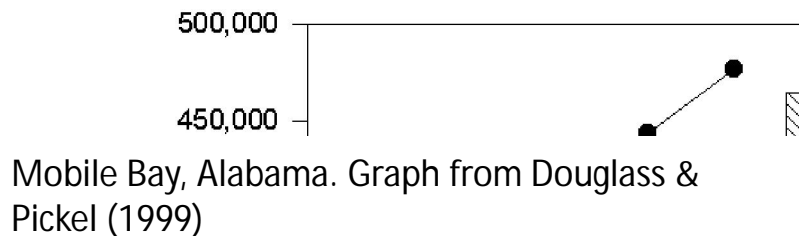
McGranahan et al 2007. Environment and Urbanization, v. 19, no. 1, p. 17-37.

# The issues: Growing costs engineering, insurance



# ...and the responses

- Increasing coastal defence
- Adaptation funds



# NGO interest



- Concern at the loss of natural systems
- Aware that ecosystems can play a role in coastal defence, but that this may be being overlooked
- Want to emphasise the additional ecosystem benefits





# NGO involvement

- Action on the ground
- Planning tools/Decision support
- Science - building the case
- Policy - making the case



# Action on the ground: mangroves



Photos: Shigeyuki Baba and Mami Kainuma



# Action on the ground: coral reefs



St Vincent Grenadines



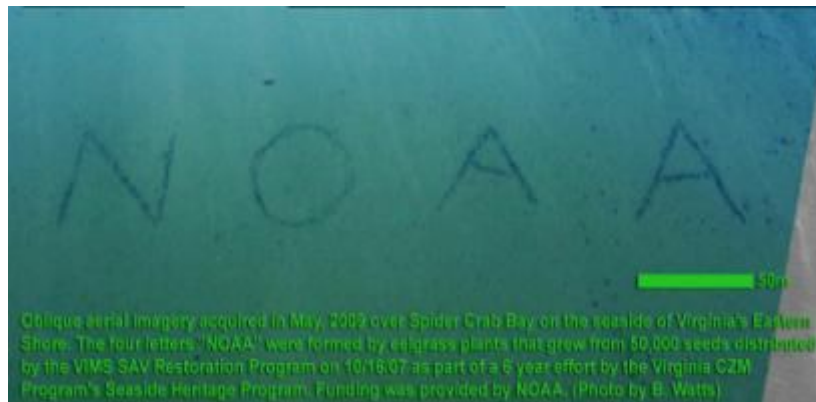
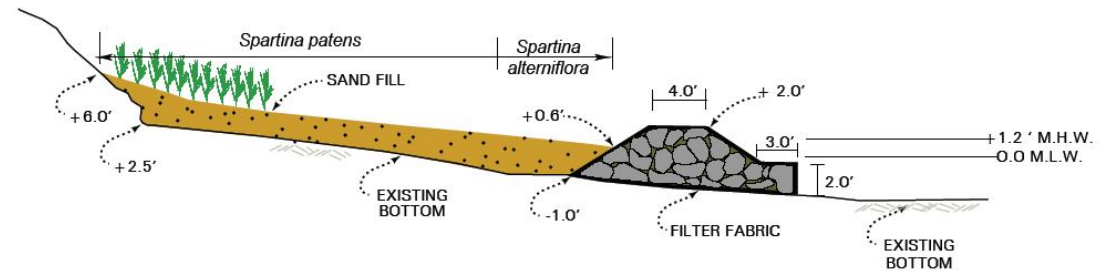
Marriott, Grand Cayman



Photos: TNC



# Action on the ground: seagrasses and saltmarshes



# Action on the ground: oyster reefs



Mark Spalding





Erika Nortemann/TNC





Photos: TNC

# Federal efforts

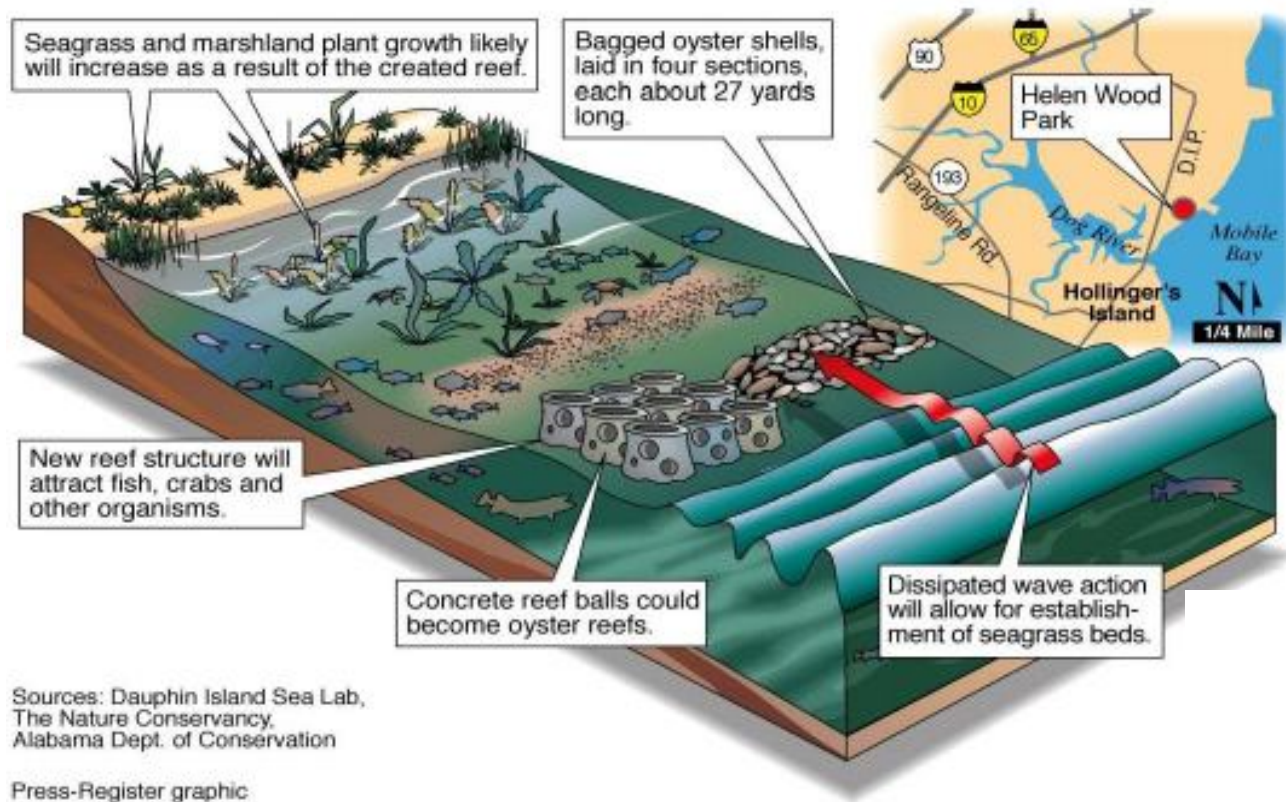
## NOAA Restoration Center – 2009-2011 only

|   | #projects  | Hectares      | NOAA funding         | Total funding        |
|---|------------|---------------|----------------------|----------------------|
| Community-based Restoration Program (CRP)               | 201        | 127.9         | \$ 9,602,929         | \$ 27,914,609        |
| American Recovery and Reinvestment Act (ARRA)           | 6          |               | \$ 18,066,812        | \$ 18,066,812        |
| Damage Assessment, Remediation, and Restoration Program | 13         | 20.6          | \$ -                 | \$ 5,908,868         |
| Appropriations  | 166        | 682.7         | \$ 1,220,853         | \$ 1,804,974         |
| Emergency Support                                       | 4          | 459.7         | \$ 9,000,000         | \$ 9,006,876         |
| <b>Total</b>  | <b>391</b> | <b>1404.7</b> | <b>\$ 28,848,782</b> | <b>\$ 53,660,327</b> |

## US Army Corps of Engineers - Chesapeake

| State                         | Period    | Hectares   | Cost                |
|-------------------------------|-----------|------------|---------------------|
| Maryland                      | 1996-2011 | 182        | \$6,726,000         |
| Virginia                      | 2000-2011 | 162        | \$12,800,000        |
| <b>Total USACE Chesapeake</b> |           | <b>344</b> | <b>\$19,526,000</b> |

# Oyster reefs as coastal defence



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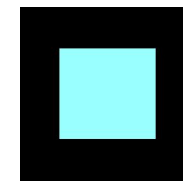
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# Oyster reefs as coastal defence



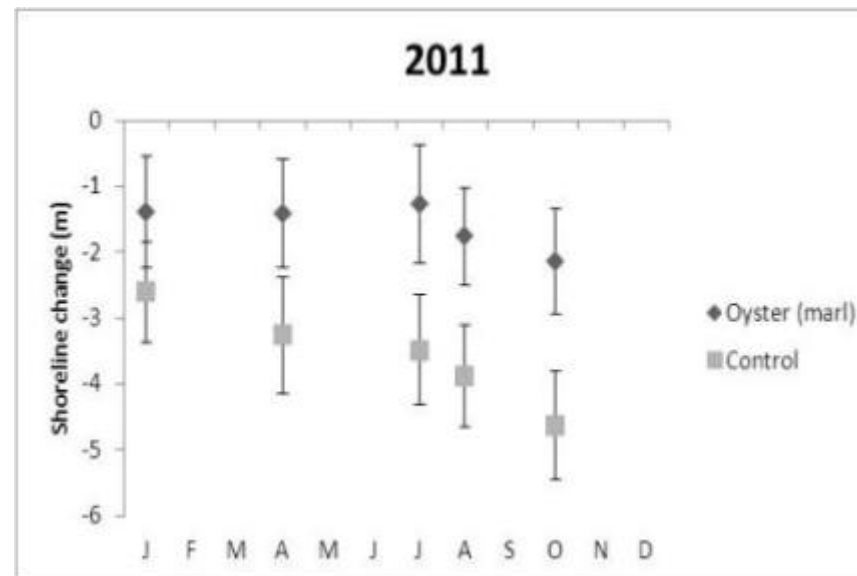
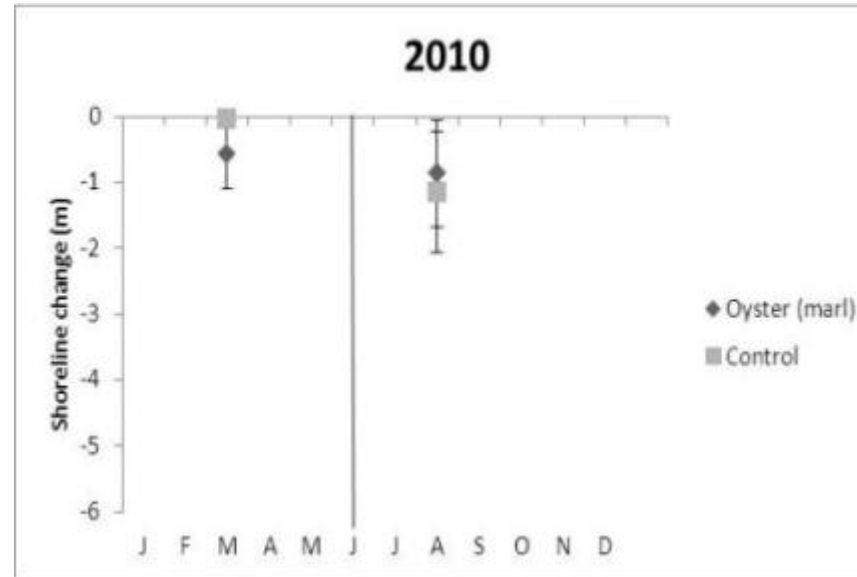
Photos: TNC



# Oyster reefs as coastal defence



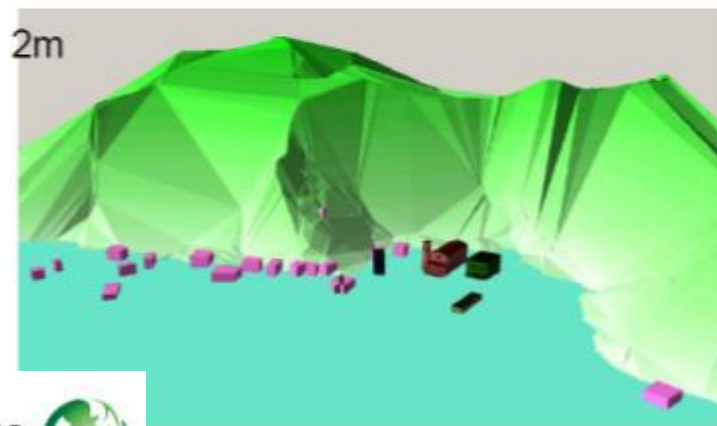
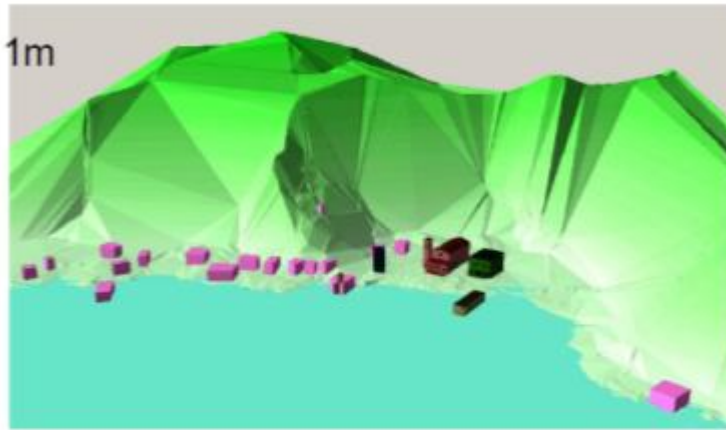
Photos: TNC



TNC unpublished data

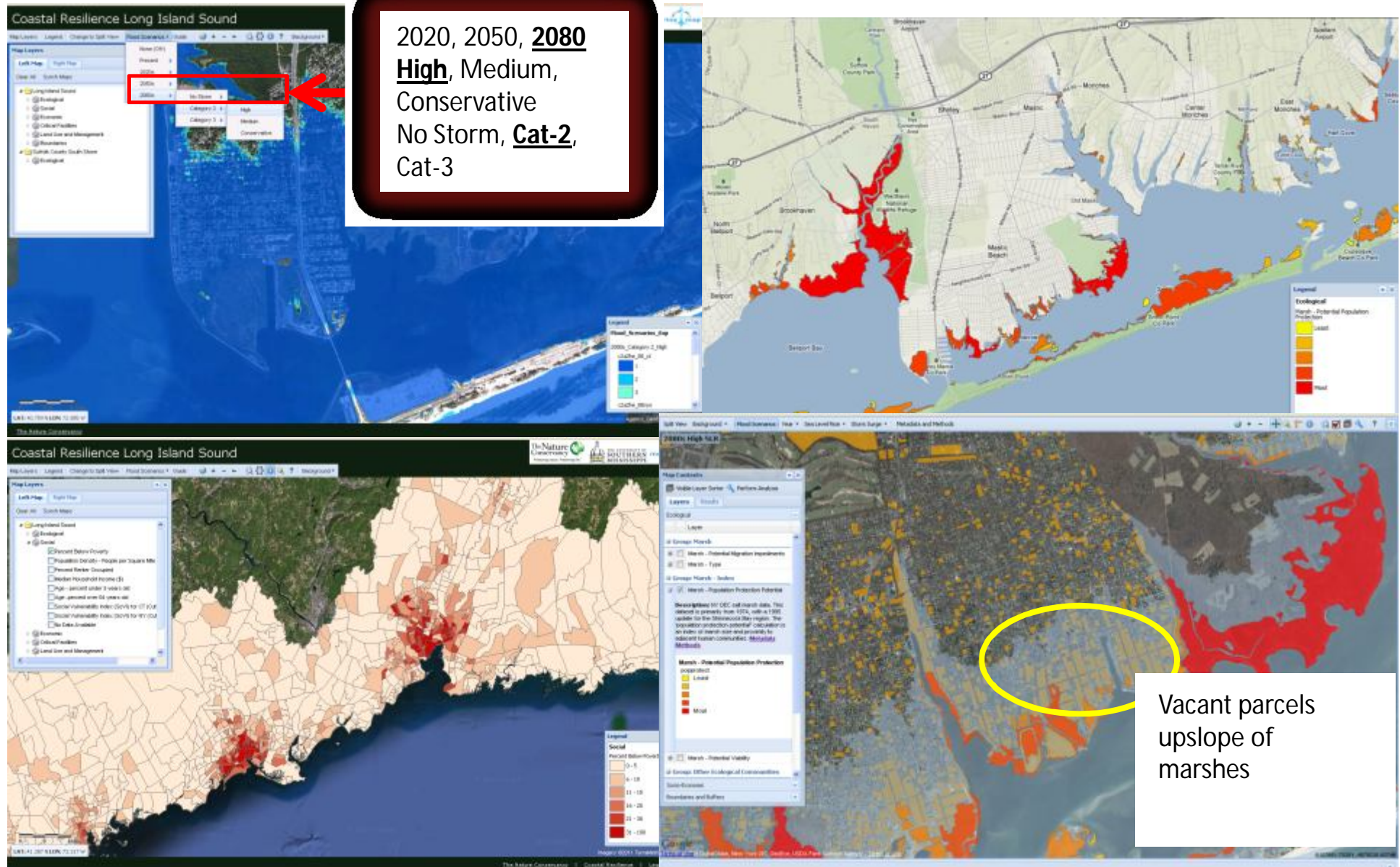
# Planning tools and decision support:

Participatory 3D modelling, Choiseul, Solomons (AusAID)





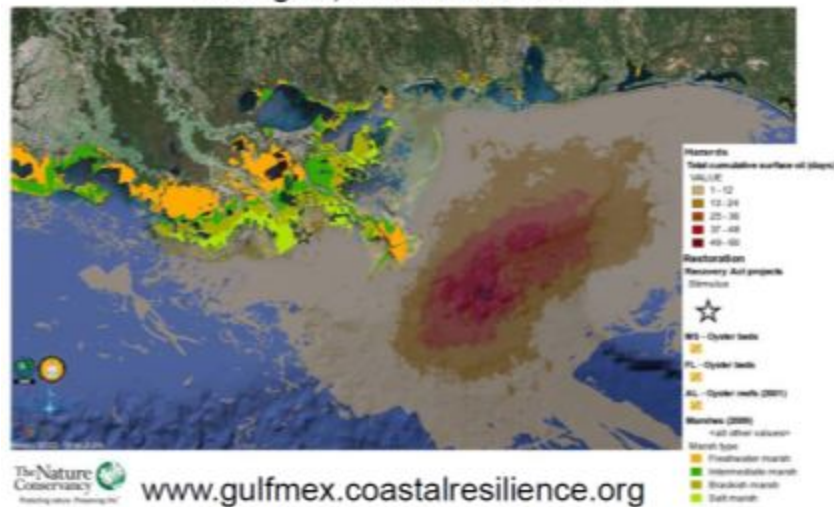
# Planning tools and decision support: sea-level rise and storm surge scenarios



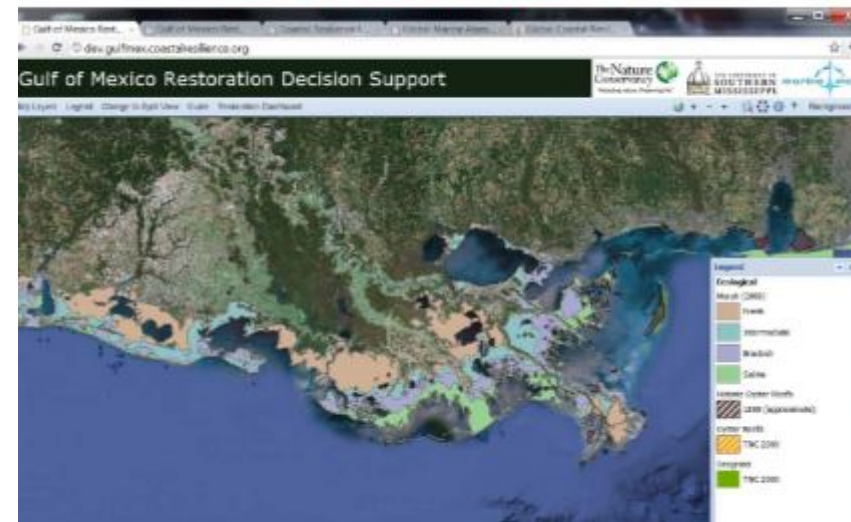
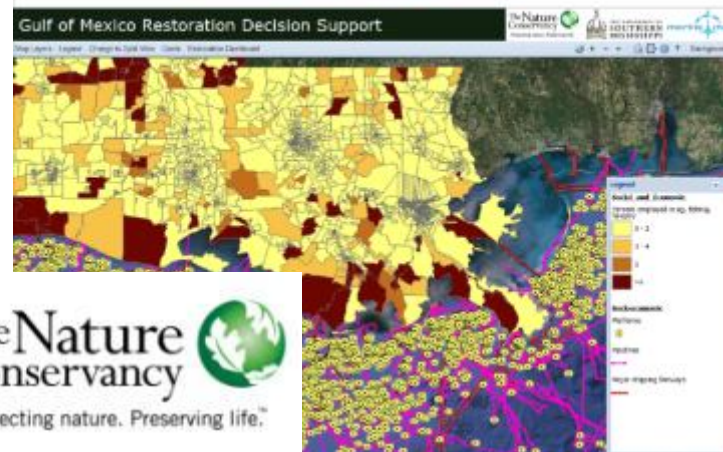


# Planning tools and decision support: Gulf of Mexico

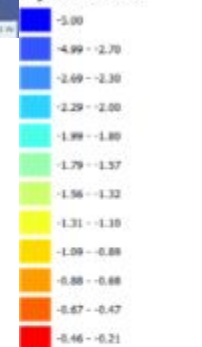
Restoration Decision Support  
Ecological, Social and Economic



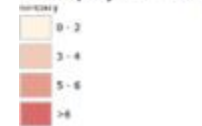
Ecological, Social and Economic

Ecological, Social and Economic  
Decision Support Application

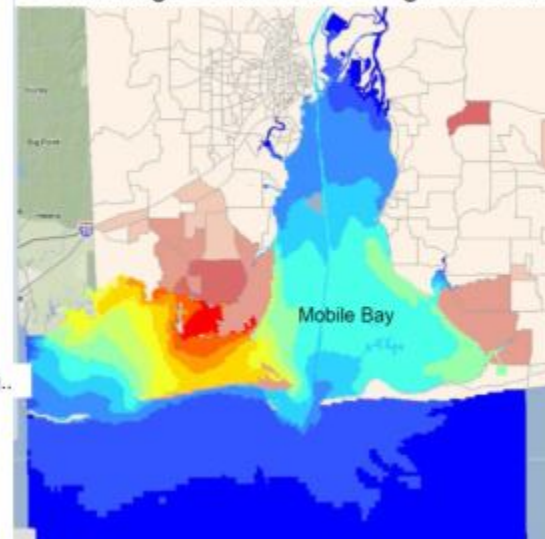
### Oyster Larvae



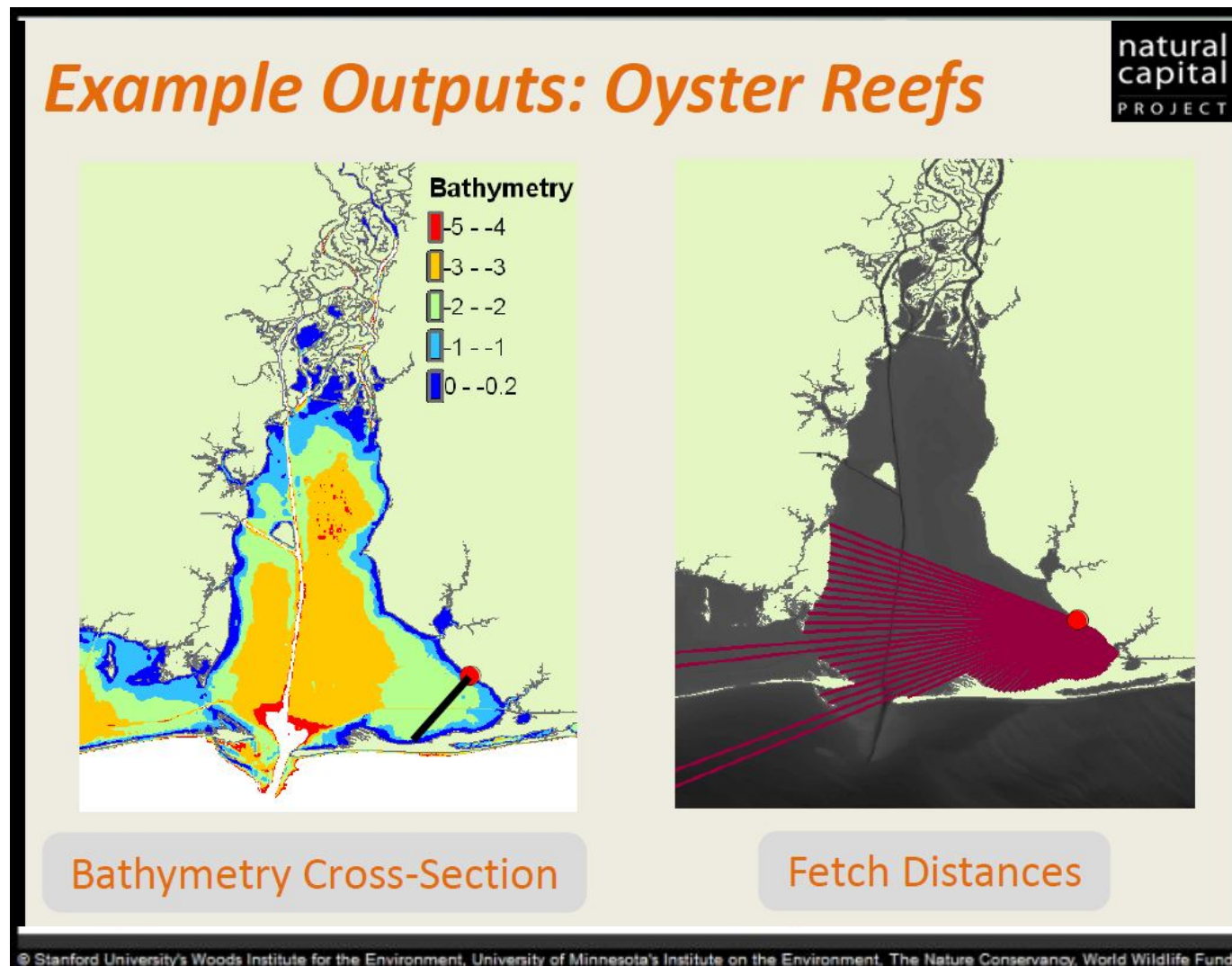
% employed – Fish, Ag..



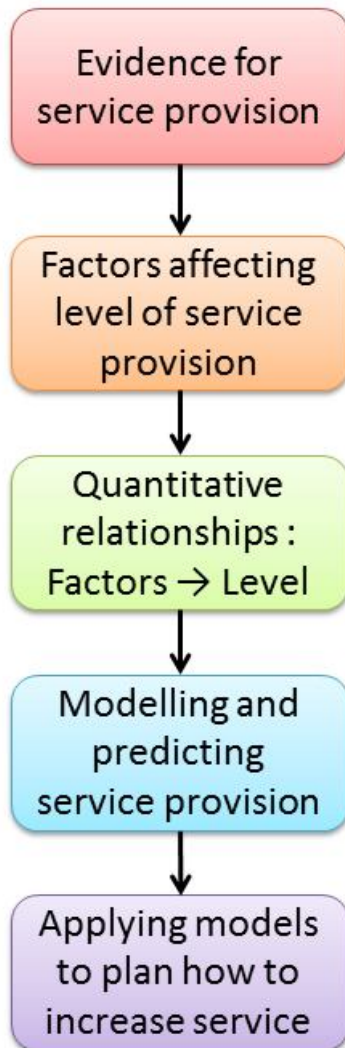
## Combining Social and Ecological Data



# Planning tools and decision support: Building numerical models



# Science - building the case

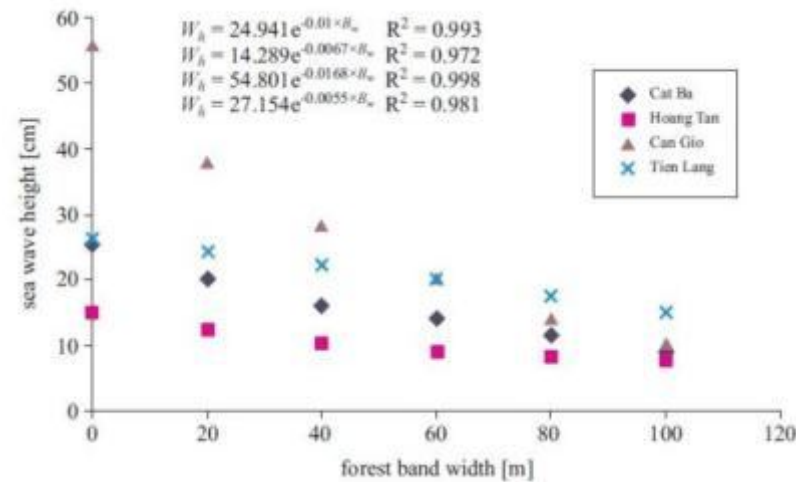
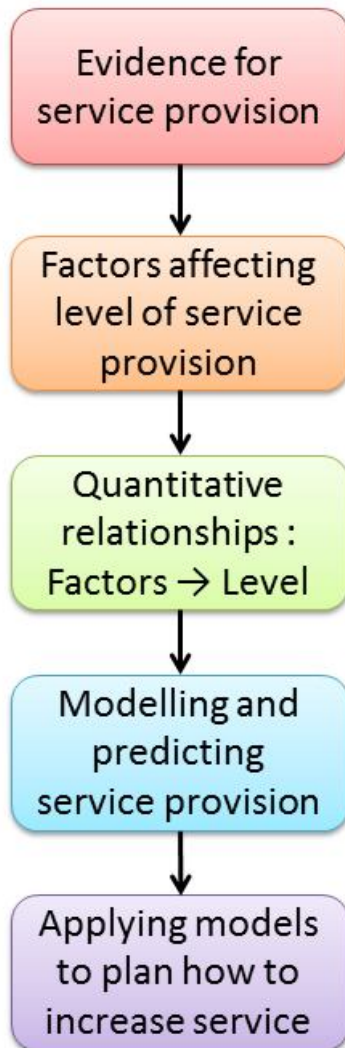


| Location                                    | Species                                       | Wave attenuation / transmission  | Source                       |
|---|---|--|------------------------------|
| Cocoa Creek, Australia                      | <i>Rhizophora stylosa</i>                     | Wave transmission factor 0 to 0.7  | Brinkman <i>et al.</i> 1997  |
| Iriomote Island, Japan                      | <i>Bruguiera</i> sp.                          | Wave transmission factor 0.2 to 0.8  | Brinkman <i>et al.</i> 1997  |
| Tong King Delta, Vietnam                    | <i>Kandelia candel</i>                        | Waves attenuated 20% per 100m  | Mazda <i>et al.</i> 1997     |
| Vinh Quang coast, northern Vietnam          | <i>Sonneratia</i> sp.                         | 45% / 100m when water 0.2m deep, 26% per 100m when water 0.6m deep ( <b>typhoon conditions</b> ) | Mazda <i>et al.</i> 2006     |
| Red River Delta, Vietnam                    | <i>Kandelia candel</i>                        | 0.002 to 0.011/m   | Quartel <i>et al.</i> 2007   |
| Nang Hai, Can Gio Mangrove Forest, Vietnam  | <i>Avicenia</i> sp. and <i>Rhizophora</i> sp. | 50-70% in first 20m (coinciding with 2m scarp)   | Vo-Luong & Massel 2006, 2008 |
| Red River Delta and Can Gio forest, Vietnam | as above                                      | mean 0.0043/m over 80m of forest   | Bao, 2011                    |

All studies reviewed show that mangroves are capable of reducing wave energy and height).

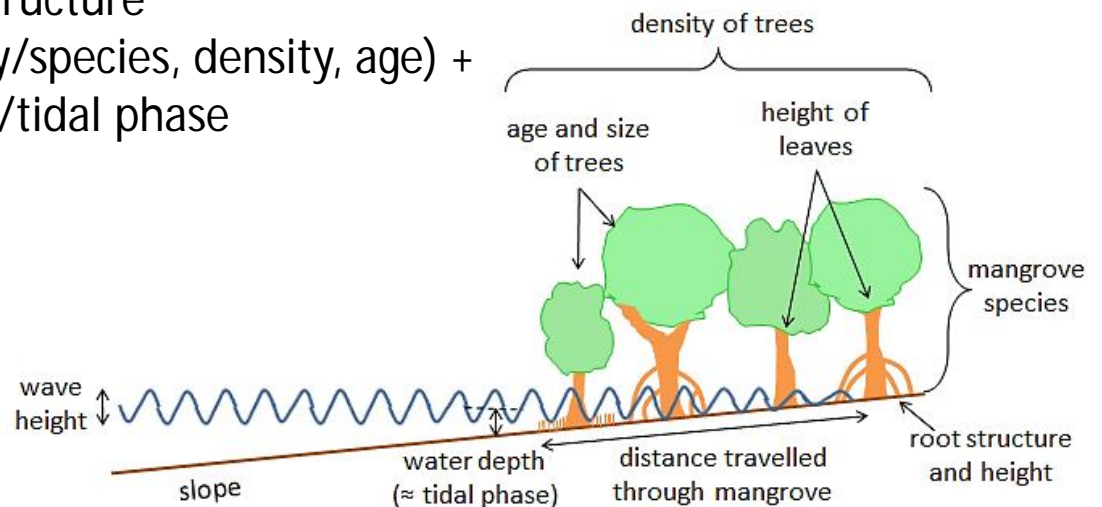


# Science - building the case



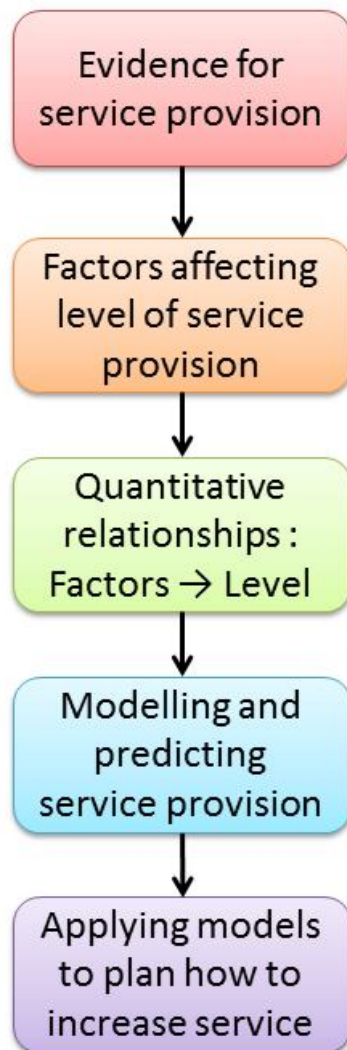
(from Bao, 2011)

- a) Distance travelled through mangrove
- b) Mangrove structure (morphology/species, density, age) + water depth/tidal phase
- c) Wave height
- d) Topography





# Science - building the case



Three models:

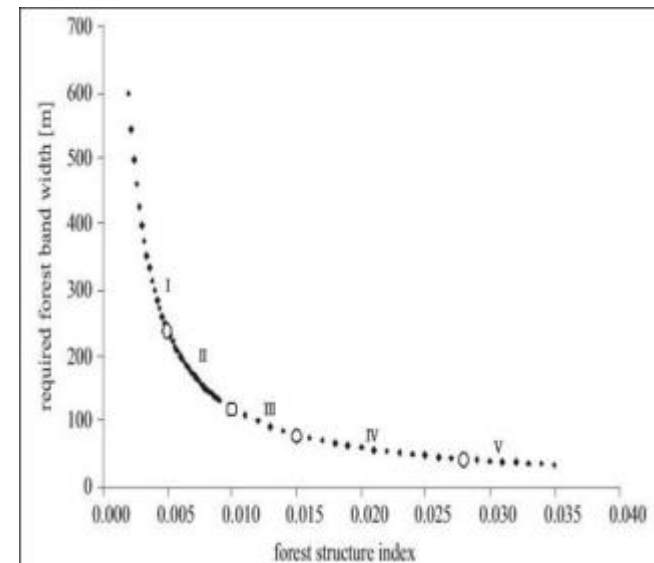
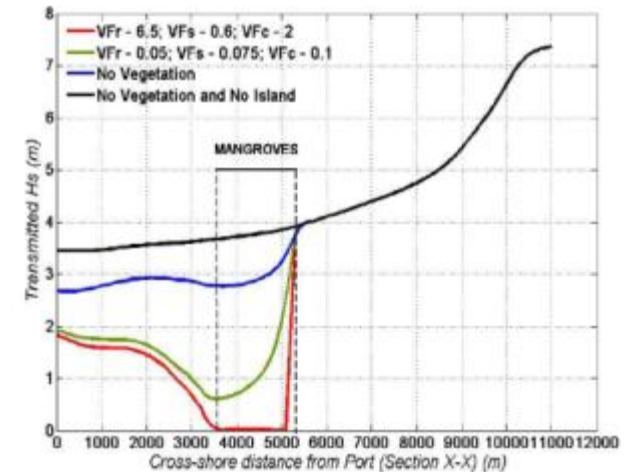
i. WAPROMAN (Vo-Luong and Massel, 2008)

ii. SWAN model (Suzuki *et al.*, 2011)

Used to estimate wave attenuation behind a mangrove island Dhamra Port, Orissa and to make case for expansion of mangroves

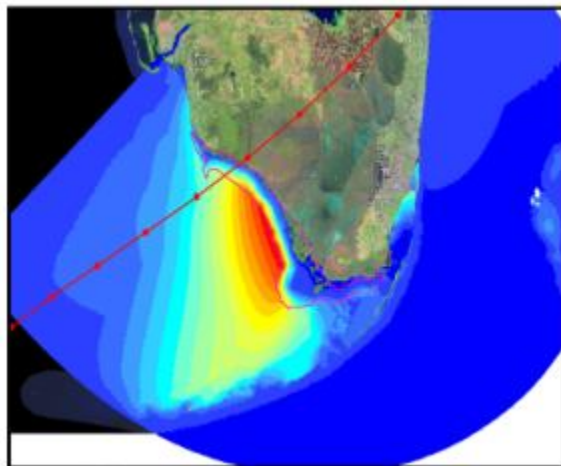
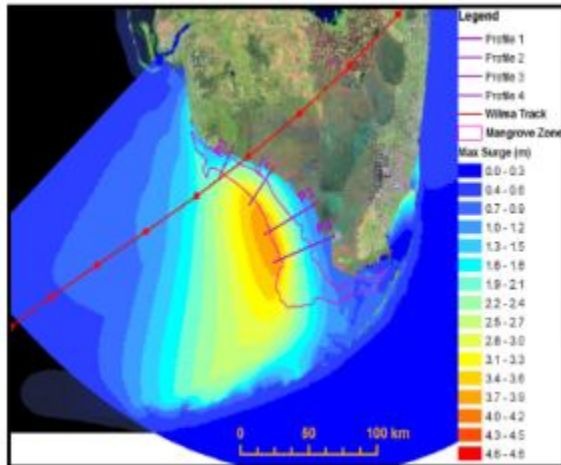
iii. Regression model based on forest structure data (Bao, 2011)

Used to work out the required band width of mangrove forests of different vegetation structure to reduce 3m waves to 0.3m for Vietnamese coasts



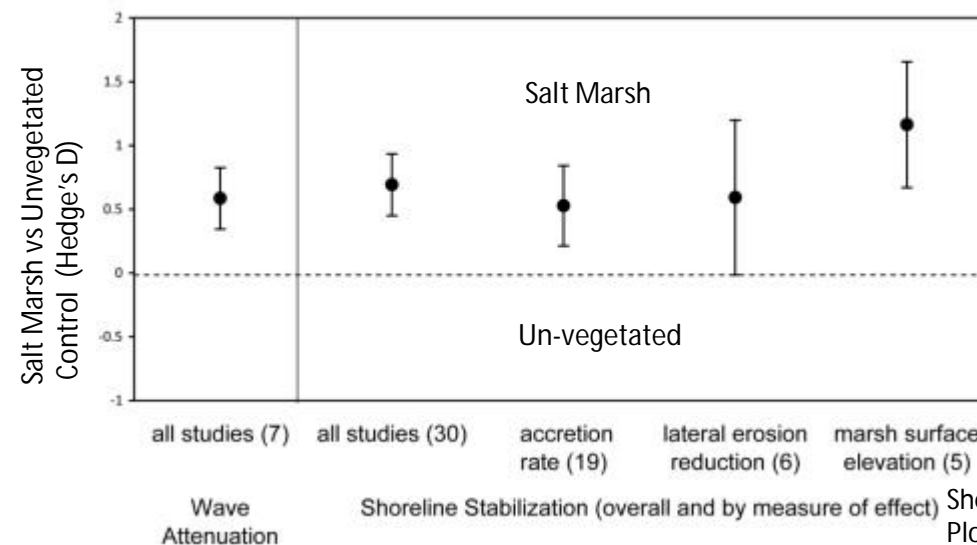
# Science - building the case

## Storm surge reduction in Florida

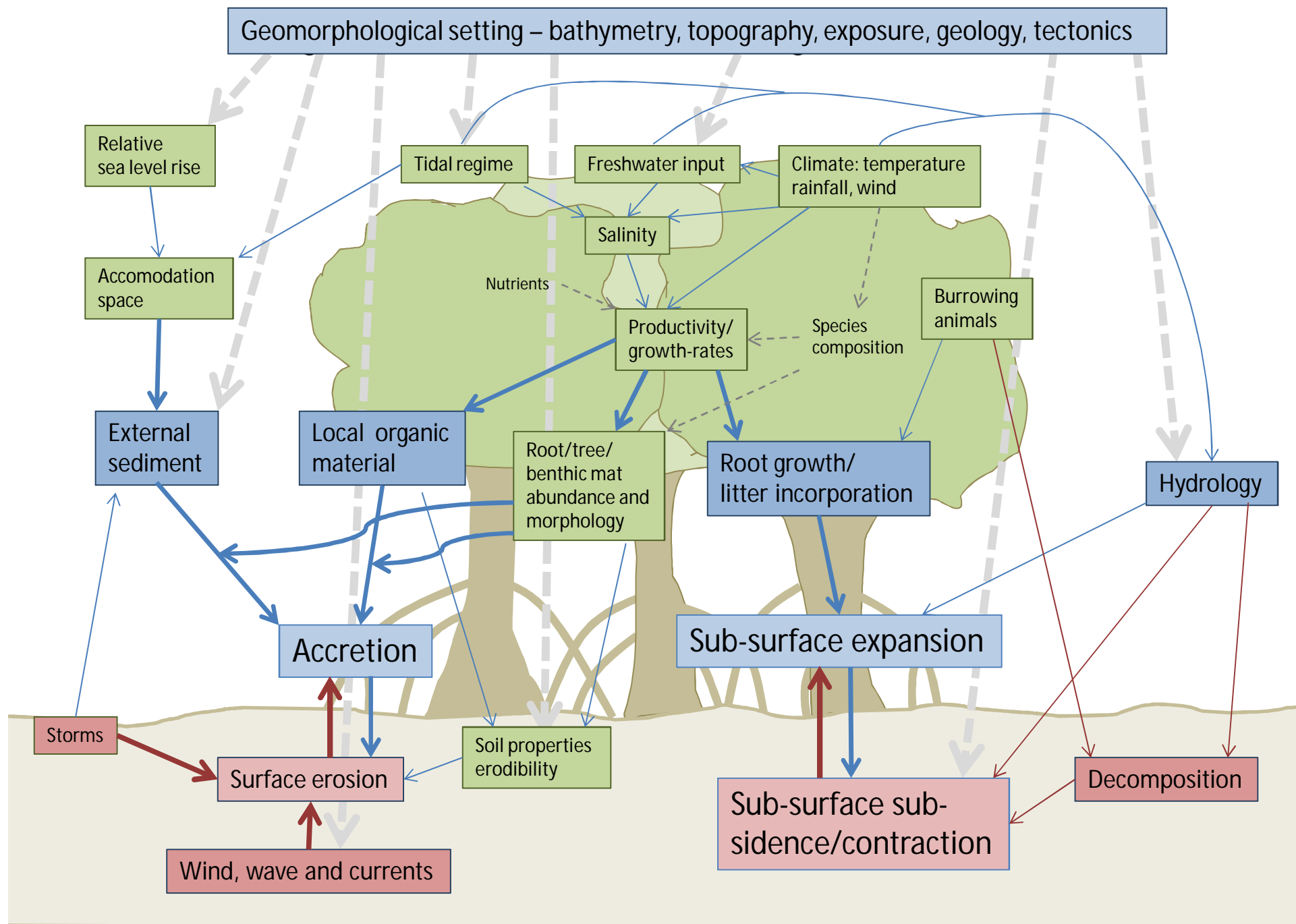


Zhang *et al.*, 2012

Ferrario *et al.*, In rev



Shepard *et al.* 2011.  
PloS One 6: e27374





# Building the economic case

5.8km of restored oyster reefs, Alabama, USA:

- **Fisheries:**
  - 3100 kg/year of additional fish and crab total economic output of \$39,000/year.
- **Coastal erosion:**
  - 51-90% reduction in wave height and 76-99% reduction in wave energy at the shore.
- **Nitrogen abatement:**
  - 130-1890kg of nitrogen per year removed from Bay waters.
- **Economic impacts from reef construction itself:**
  - \$8.4 million in local output, \$2.8 million in earnings and 88 jobs created.

# Communication and outreach

Natural Coastal Protection

conservonline.org/workspaces/naturalcoastalprotection/

**Natural Coastal Protection**  
Understanding the role of natural coastal protection

HOME MARSHES & MANGROVES: WATTENAUATION

**Natural Coastal Protection**  
The Natural Coastal Protection Series is a new journal of the Nature Conservancy, providing a platform for the scientific community to share their research on coastal protection. The series is a new journal of the Nature Conservancy, providing a platform for the scientific community to share their research on coastal protection.

**The Protective Role of Coastal Marshes: A Systematic Review and Meta-analysis**

Christine C. Shepard<sup>1\*</sup>, Caitlin M. Crain<sup>2</sup>, Michael W. Beck<sup>3</sup>

<sup>1</sup> Department of Ocean Science, University of California, Santa Cruz, California, United States of America, <sup>2</sup> The Nature Conservancy, Institute of Marine and Coastal Sciences, University of Maryland, Poolesville, Maryland, United States of America, <sup>3</sup> The Nature Conservancy, Institute of Marine and Coastal Sciences, University of Maryland, Poolesville, Maryland, United States of America

**Abstract**

**Background:** Salt marshes lie between many human communities and the ocean. They provide important ecosystem services, including wave attenuation, shoreline stabilization, and floodwater storage. However, the protective role of salt marshes has not been fully investigated. Here, we conducted a systematic review and meta-analysis of the literature to quantify the protective role of salt marshes. We found that salt marshes provide a significant positive effect on wave attenuation, shoreline stabilization, and floodwater storage. The magnitude of these effects varies with marsh type, location, and the specific hazard being studied. Our results show that salt marshes have value for coastal protection, and that the benefits of salt marshes are not fully understood. Because we do not yet fully understand the magnitude of this value, natural systems to maximize the benefits and ecosystem services provided by salt marshes are needed.

**Methodology/Principal Findings:** We conducted a thorough search and synthesis of the literature. We found that salt marshes provide a significant positive effect on wave attenuation, shoreline stabilization, and floodwater storage. The magnitude of these effects varies with marsh type, location, and the specific hazard being studied. Our results show that salt marshes have value for coastal protection, and that the benefits of salt marshes are not fully understood. Because we do not yet fully understand the magnitude of this value, natural systems to maximize the benefits and ecosystem services provided by salt marshes are needed.

**Conclusions/Significance:** Our results show that salt marshes have value for coastal protection. Because we do not yet fully understand the magnitude of this value, natural systems to maximize the benefits and ecosystem services provided by salt marshes are needed.

**Citation:** Shepard CC, Crain CM, Beck MW (2011) The Protective Role of Coastal Marshes: A Systematic Review and Meta-analysis. *PLoS ONE* 6(11): e27234. doi:10.1371/journal.pone.0027234

**Editor:** Julian Clifton, University of Western Australia, Australia

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**Competing Interests:** The authors have declared that no competing interests exist.

\* E-mail: cshepard@ucsc.edu

conservonline.org/workspaces/naturalcoastalprotection/doc

## Introduction

Salt marshes provide humans many vital benefits known as 'ecosystem services' and one of the most important may be their role as buffers in protecting coastlines. Our oceans face a variety of natural hazards including storms, hurricanes, and tsunamis. These hazards are natural processes that have always affected the coastal zone, however the impacts and associated costs of these hazards to humans have increased as the amount and value of coastal infrastructure have grown and continue to grow. The effects of climate change will further amplify these impacts and costs. Sea level rise and ocean warming will increase the frequency and magnitude of many coastal hazards [1] while at the same time threatening coastal ecosystems such as salt marshes that humans are highly dependent upon.

Historically, coastal protection plans have relied on hardened infrastructure solutions such as sea walls, jetties and groins while ignoring or even destroying coastal marshes that could provide

protective benefits. However, the protective role of salt marshes is not fully understood. Whereas the protective role of salt marshes is not fully understood, the magnitude of these effects varies with marsh type, location, and the specific hazard being studied. Our results show that salt marshes have value for coastal protection, and that the benefits of salt marshes are not fully understood. Because we do not yet fully understand the magnitude of this value, natural systems to maximize the benefits and ecosystem services provided by salt marshes are needed.

PLoS ONE | www.plosone.org

1

## Reduction of Wind and Swell Waves by Mangroves



Anna McIvor, Iris Möller, Tom Spencer and Mark Spalding

Natural Coastal Protection Series: Report 1  
Cambridge Coastal Research Unit Working Paper 40

The Nature Conservancy UNIVERSITY OF CAMBRIDGE WETLANDS INTERNATIONAL

Focus: Environmental degradation and disasters

**WorldRiskReport 2012**

UNIVERSITY OF CAMBRIDGE UNO-EHS The Nature Conservancy

Together for people in need.

# Shifting the needle

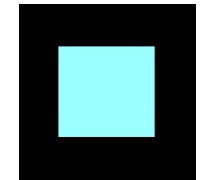
- Policy

- PEDRR
- World Bank
- CBD/UNFCCC/IUCN



- Partnerships

- NOAA, Restoration Center
- US Army Corps, SAGE – hybrid engineering
- Mangrove Capital Project (Wetlands Int, Deltares, Wageningen)



- Leverage







Thank you