From Floodplains to Coral Reefs:
Restoration to Generate Impact And Get To Scale

<u>Using science for decision making</u>

James Byrne Maximizing the benefits of reef restoration.
Chad Wiggins Science & Traditional Management- Community-based MPA, HI.
Matthea Yepsen Measuring the ecological uplift of restoration, adaptation to CC and reducing risk and vulnerability of human coastal communities.

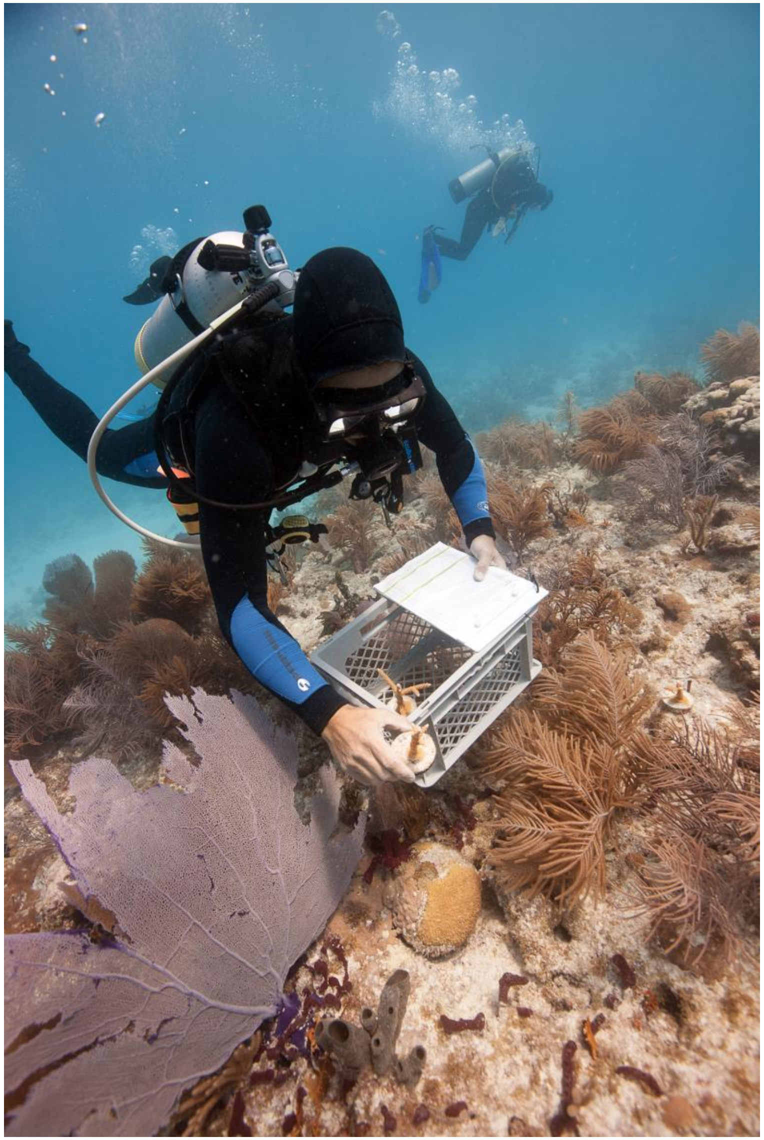
<u>Translating science to generate credibility</u>

Amanda Wrona-Meadows Lessons from monitoring, large scale ARRA restoration.
Kemitt-Amon Lewis Reef resilience and coral restoration in the USVI.
Christine Pickens Hydrologic and oyster restoration through the Albemarle-Pamlico Climate Change Adaptation Project.

<u>Convening diverse partners and stakeholders</u>

Jenny Baker Restoring floodplains and estuaries in Puget Sound
Eric Conklin HAWAI‘I SUCKS -- and we are darn good at it! Invasive algae remediation using the Supersucker.

Restoration by Design: Utilizing Science in Coral Restoration



James Byrne

Main Questions

- Can we grow Coral and Outplant Successfully?
- Can it be done on Ecologically Significant Scale?
- Why are we restoring Reefs?
- What Does Success look like?

Maximizing the Benefits from Coral Restoration

- Restoring Individual Reefs
- Enhancing Tourism
- Enhancing Fisheries
- Population Enhancement/Recovery
- Coastal Protection
- Improved Mitigation

Site Restoration

COMMUNICATIONS

ARTICLE

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DOI: 10.1038/ncomms2409

Caribbean-wide decline in carbonate production threatens coral reef growth

Chris T. Perry[1], Gary N. Murphy[1], Paul S. Kench[2], Scott G. Smithers[3], Evan N. Edinger[4], Robert S. Steneck[5] & Peter J. Mumby[6]

Global-scale deteriorations in coral reef health have caused major shifts in species composition. One projected consequence is a lowering of reef carbonate production rates, potentially impairing reef growth, compromising ecosystem functionality and ultimately leading to net reef erosion. Here, using measures of gross and net carbonate production and erosion from 19 Caribbean reefs, we show that contemporary carbonate production rates are now substantially below historical (mid- to late-Holocene) values. On average, current production rates are reduced by at least 50%, and 37% of surveyed sites were net erosional. Calculated accretion rates (mm year^{-1}) for shallow fore-reef habitats are also close to an order of magnitude lower than Holocene averages. A live coral cover threshold of ~10% appears critical to maintaining positive production states. Below this ecological threshold carbonate budgets typically become net negative and threaten reef accretion. Collectively, these data suggest that recent ecological declines are now suppressing Caribbean reef growth potential.

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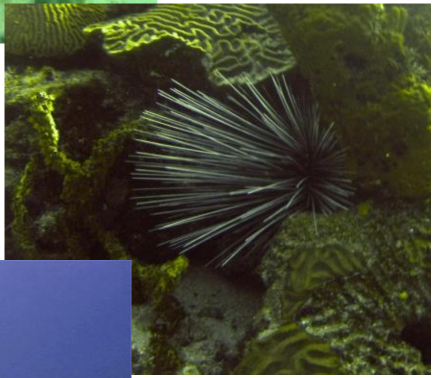
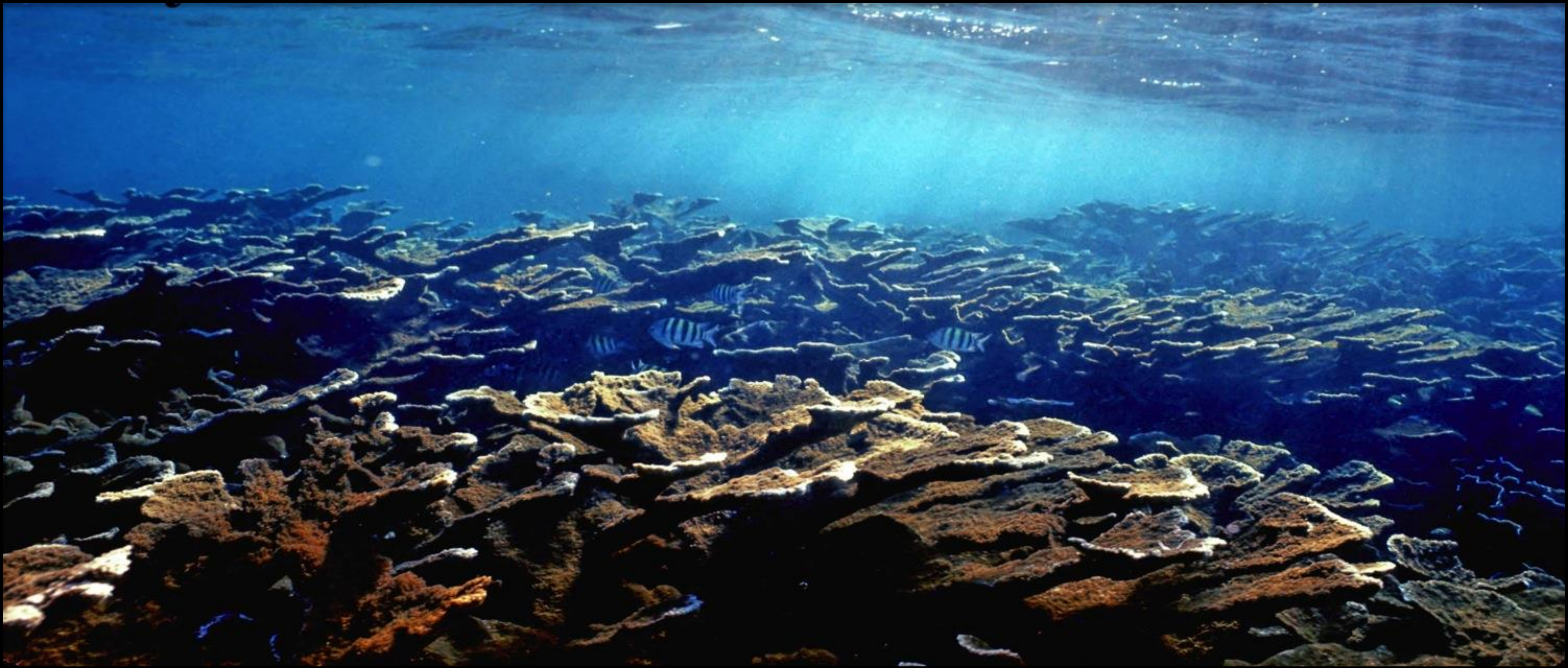


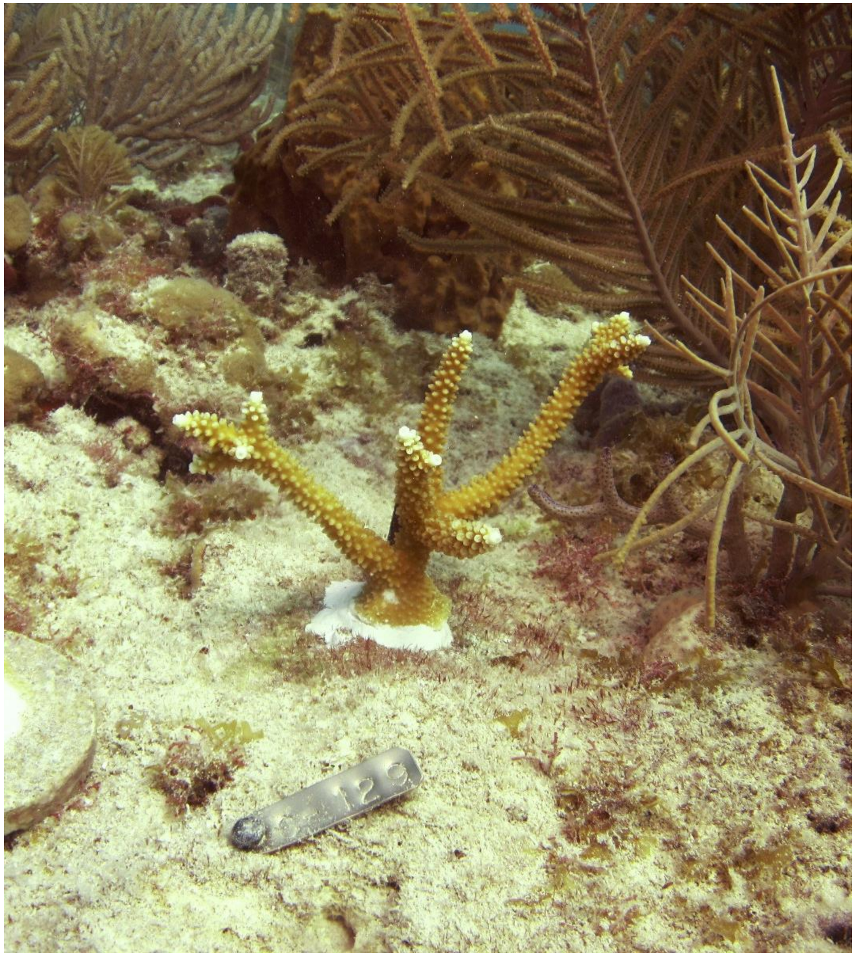


Engaging the Dive Industry

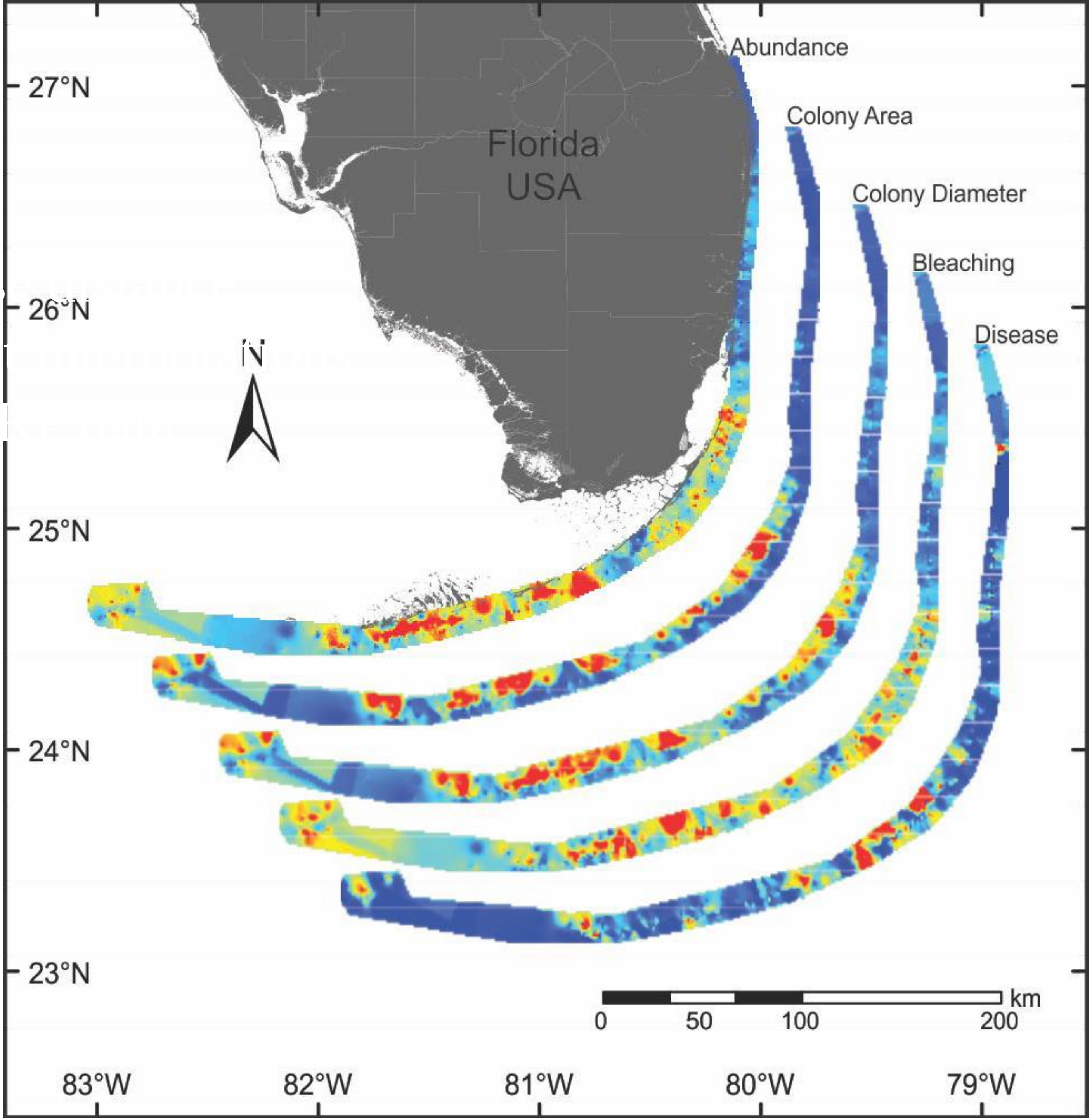
PADI®

Recreational	Scientific
• Assisting with assembling of nursery apparatus • Assisting with nursery set-up • Removing algae and other epiphytes from nursery structures/corals • Affixing newly fragmented corals to nursery apparatus • Fixing broken fragments or fragments that fall off the tree or block… epoxying or securing them back into place, or if origin is unknown, moving them to an "unknown" tree or block • Differentiating healthy vs. unhealthy • Estimating percentage affected tissue • Measuring corals • Affixing corals to predetermined nursery apparatus or outplant sites • Removing predators (snails, fireworms) from the nursery • Basic underwater repair of blocks, trees (ie. Epoxying a puck back onto a pedestal; securing a new monofilament line on a tree to replace one that broke) • Photography	• Coral health assessment (differentiating between paling, bleaching, and disease etc.) • Nursery site selection, design, and set-up • Determination of viable corals to be used in nurseries • Collection of viable fragments of opportunity • Fragmentating of corals • Outplant site (and coral) selection • Ouplant site mapping and monitoring • Coral nursery and restoration experimental design, data collection, and analysis • Collection of coral tissue for genetic analysis.

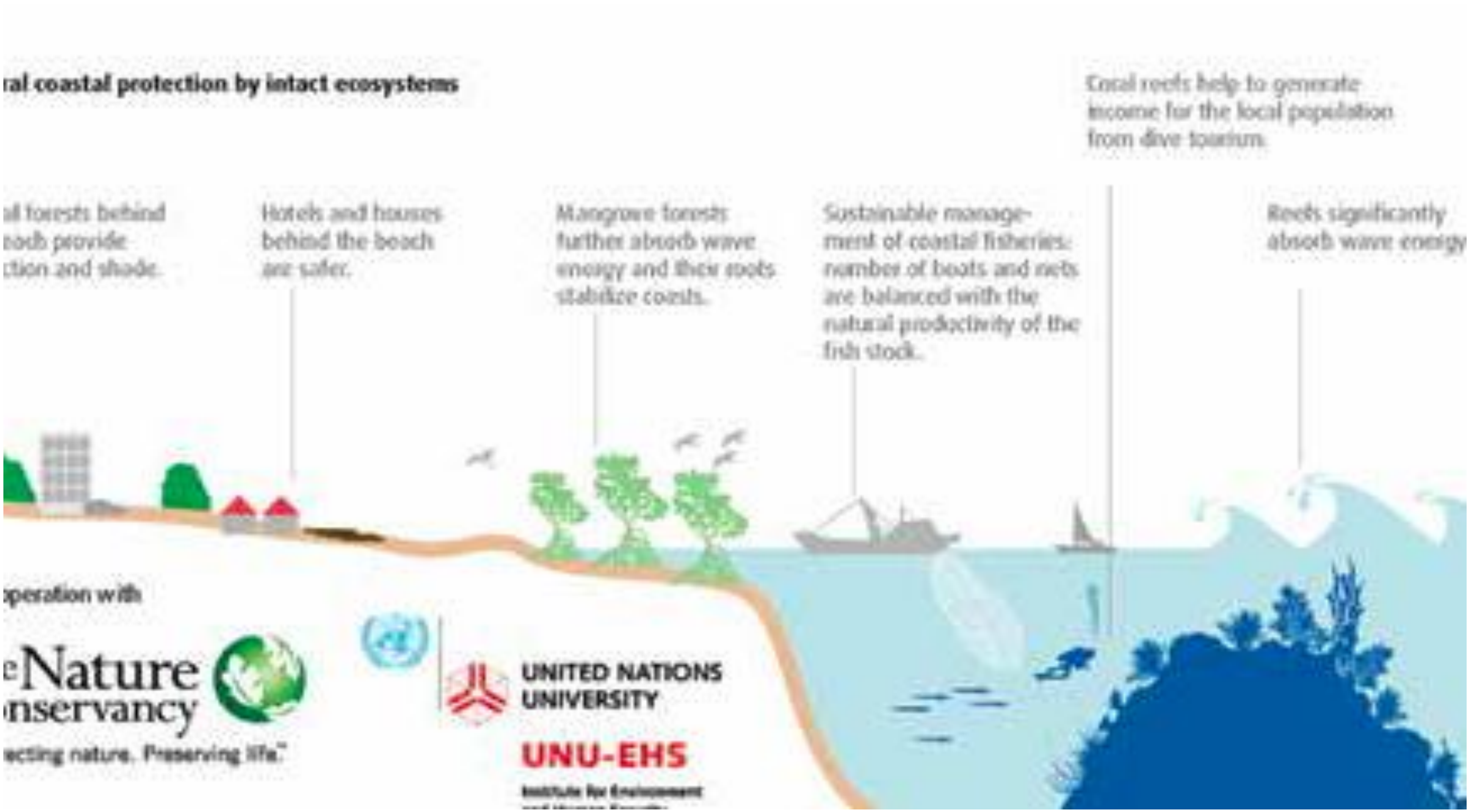
Enhancing Fisheries



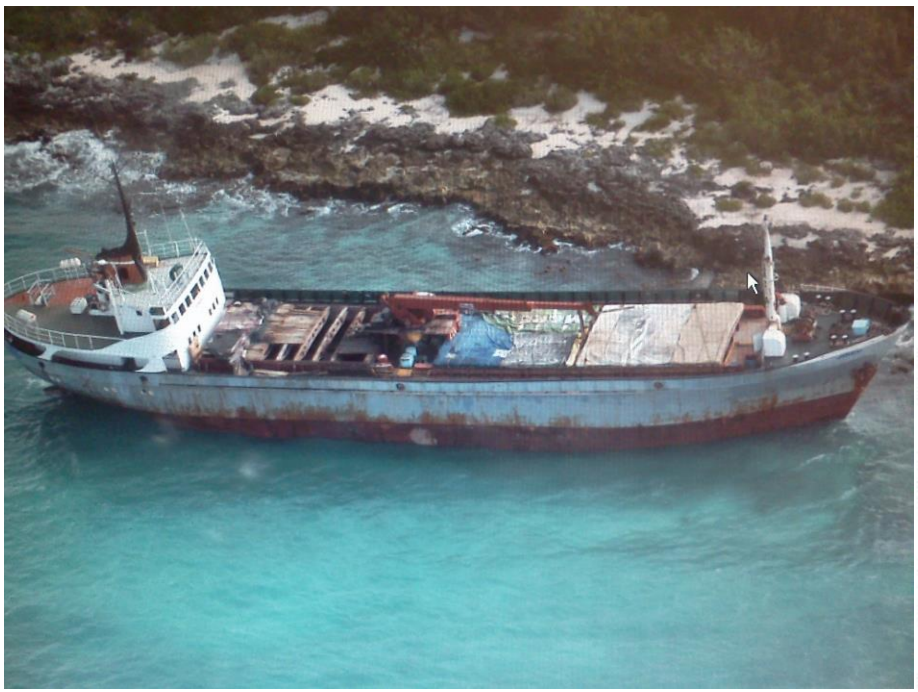
Enhancing Populations/Recovery

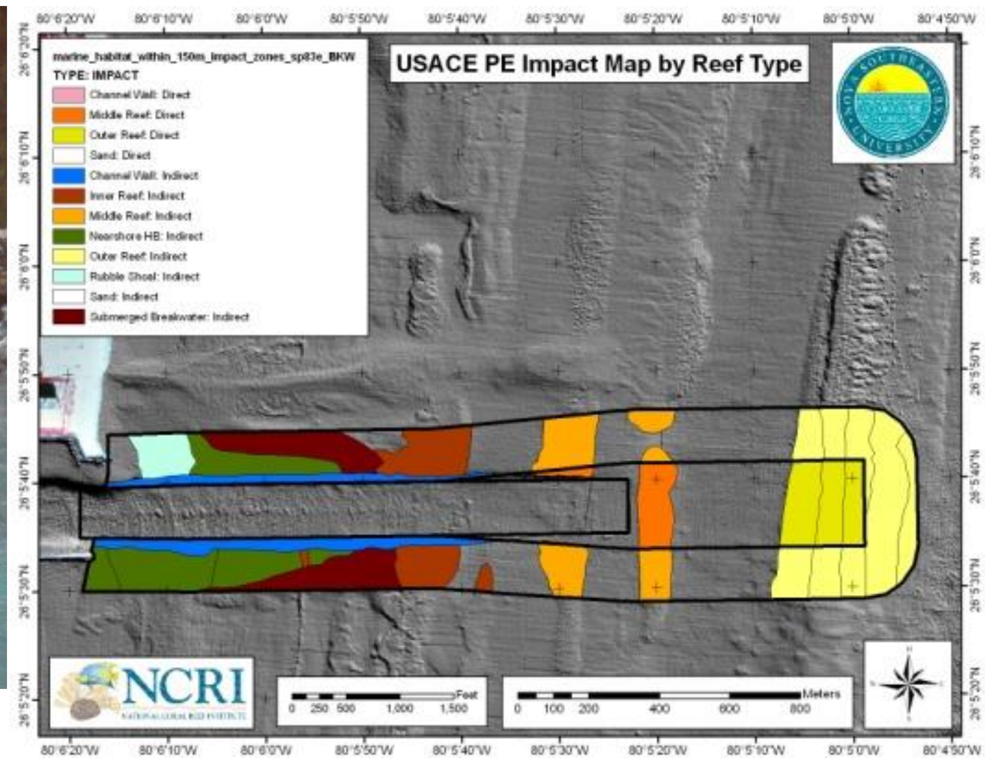

Abundance
Colony Area
Colony Diameter
Bleaching
Disease
Florida
USA
N
27°N
26°N
25°N
24°N
23°N
83°W
82°W
81°W
80°W
79°W
km
0
50
100
200

Enhancing Coastal Protection



Improving Mitigation





Bringing Together Science and Traditional Managem
to Support a Community-based MPA in West Hawa

Chad Wiggins

Hawaiian Newspaper Translation Project – 1923

"….fisheries management appears to have been carried out at a local level….."

"…. biological processes that were the basis for management decisions often occurred on small geographical scales…"

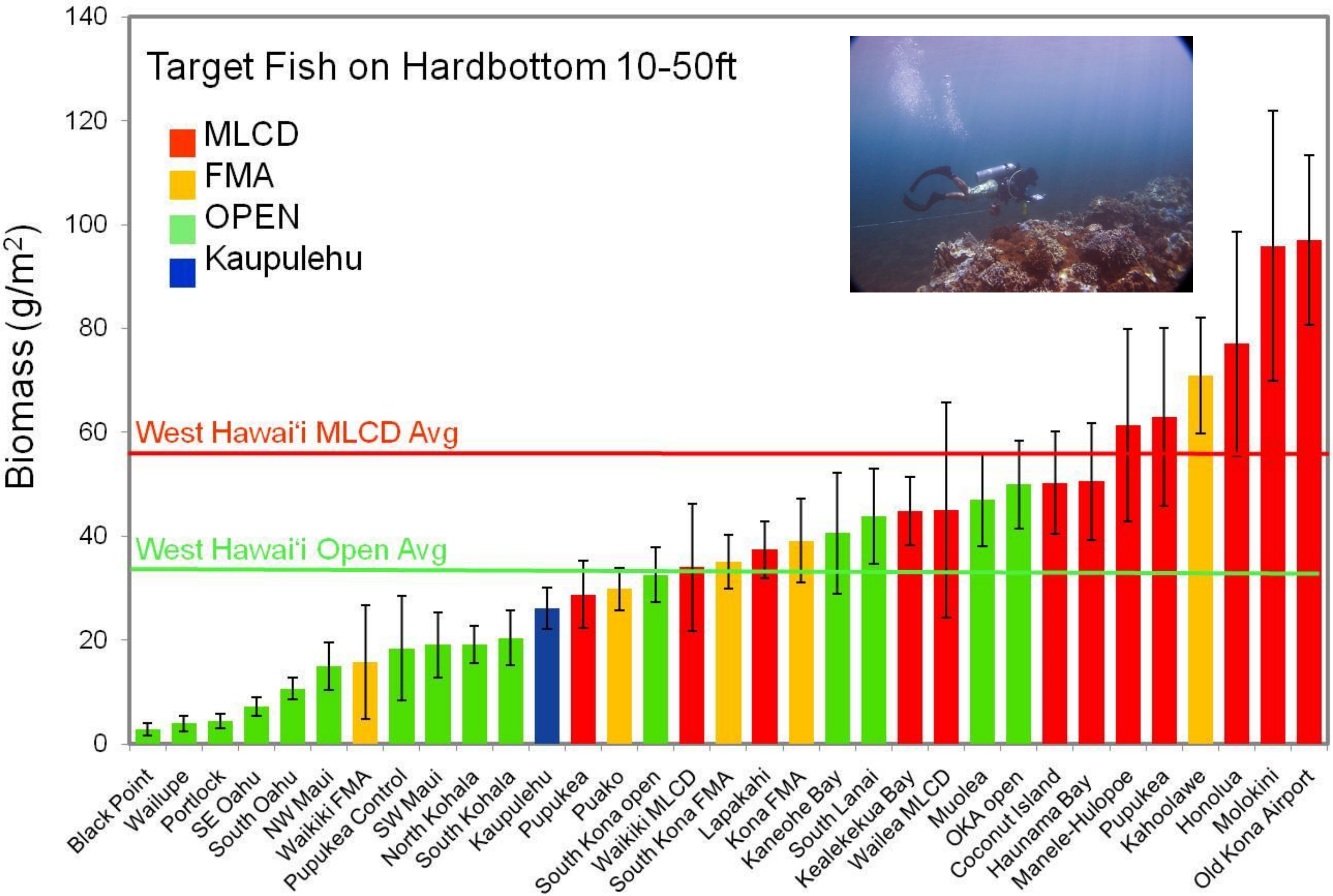
"…… individuals responsible for these decisions were the priests and kapu were put into place by the chiefs..."

"…. the priests had considerable knowledge of spawning seasons …for many important aquatic species important as food to the people...

"…..Much of this information has been lost in modern times …."

Ka ho 'opakele 'ana i nai 'a
From *Ka Nupepa Kuokoa*, March 8, 1923



Target Fish on Hardbottom 10-50ft
MLCD
FMA
OPEN
Kaupulehu
Biomass (g/m2)
140
120
100
80
60
40
20
0
West Hawai'i MLCD Avg
West Hawai'i Open Avg
Black Point
Wailupe
Portlock
SE Oahu
South Oahu
NW Maui
Waikiki FMA
Pupukea Control
SW Maui
North Kohala
South Kohala
Kaupulehu
Pupukea
Puako
South Kona open
Waikiki MLCD
South Kona FMA
Lapakahi
Kona FMA
Kaneohe Bay
South Lanai
Kealekekua Bay
Wailea MLCD
Muolea
OKA open
Coconut Island
Haunama Bay
Manele-Hulopoe
Pupukea
Kahoolawe
Honolua
Molokini
Old Kona Airport

SOUND SCIENCE AS A CRITICAL COMPONENT OF TAKING HABITAT RESTORATION TO SCALE

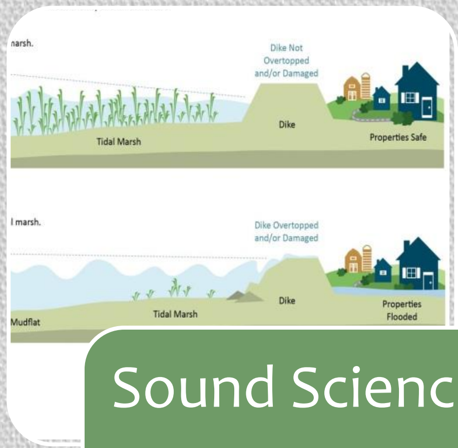
Metthea Yepsen

NJ Chapter

Superstorm Sandy Funding

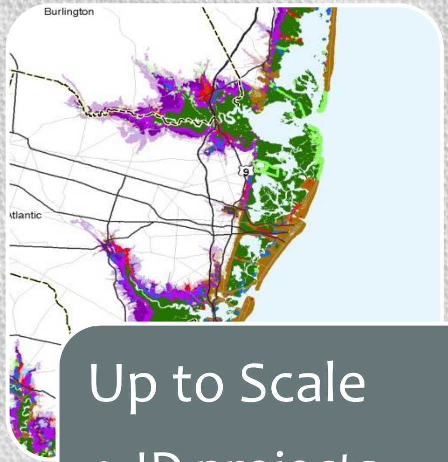
Pilot Sites

- Multiple methods
- Multiple locations



Sound Science

- Do no harm
- Ecology
- Ecosystem services



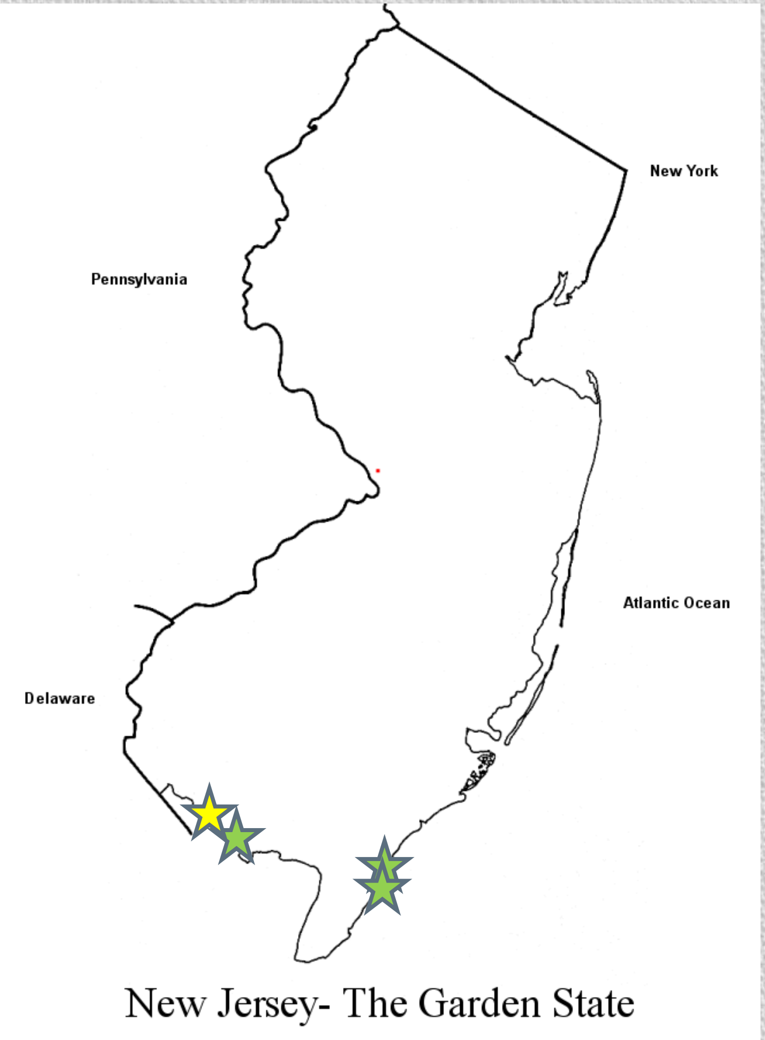
Up to Scale

- ID projects
- Lessons learned
- Promote

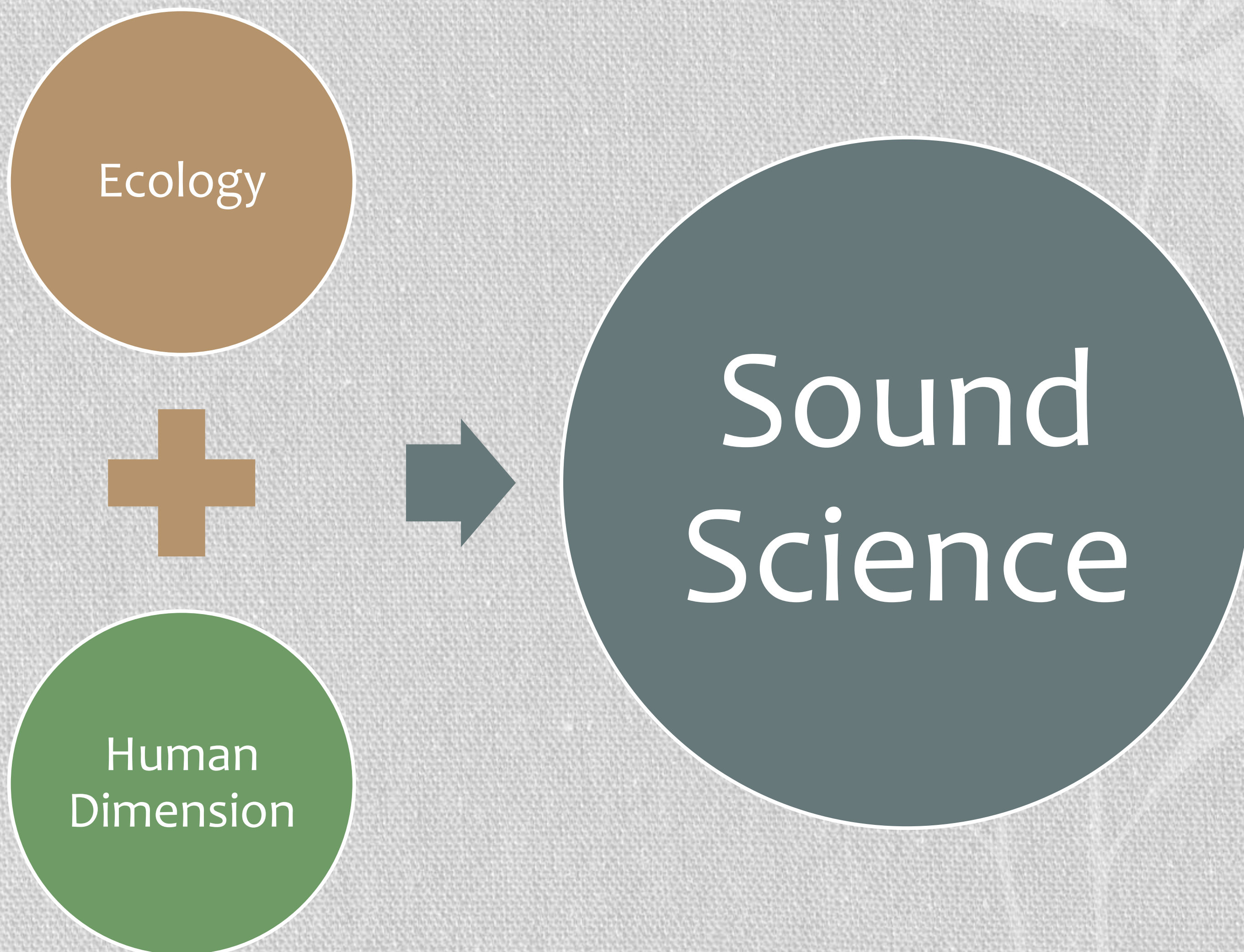
Pilot Sites

Current Methods

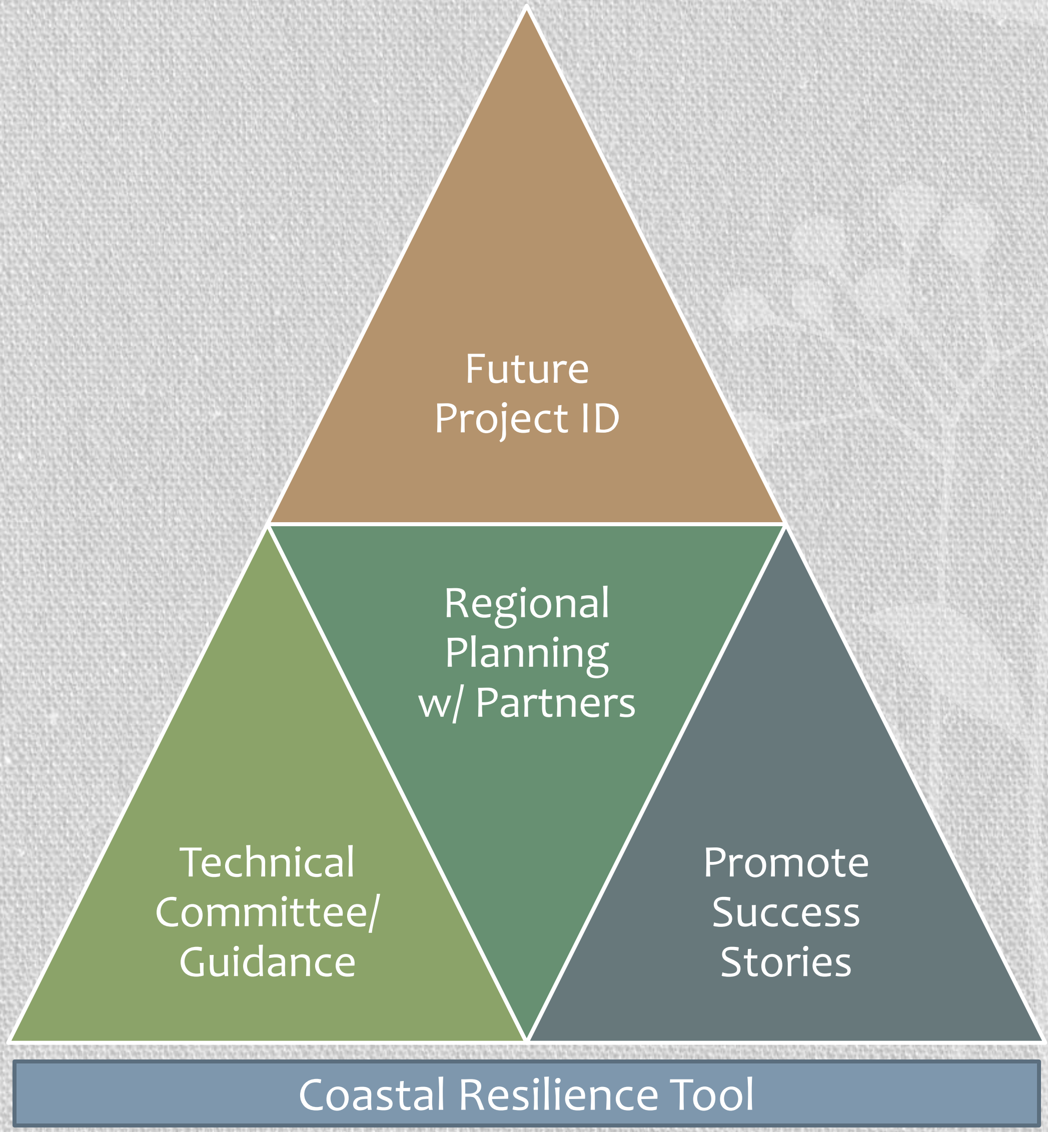
- Oyster reef breakwaters
- Beneficial use of dredge material
  - Thin-layer placement
  - Marsh edge restoration



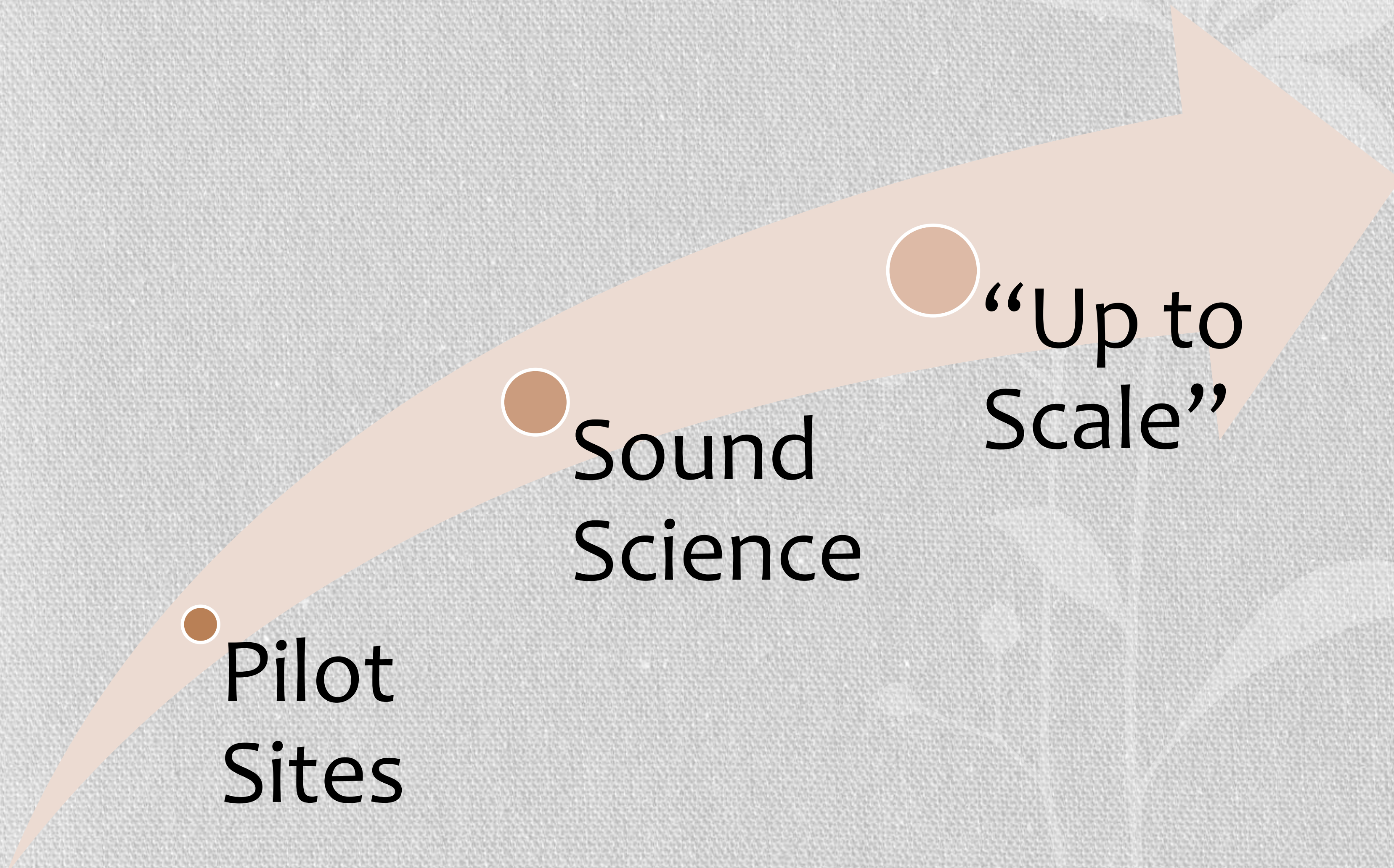
http://www.netstate.com/states/maps/images/nj_outlinebord.gif


Ecology
Human Dimension
Sound Science

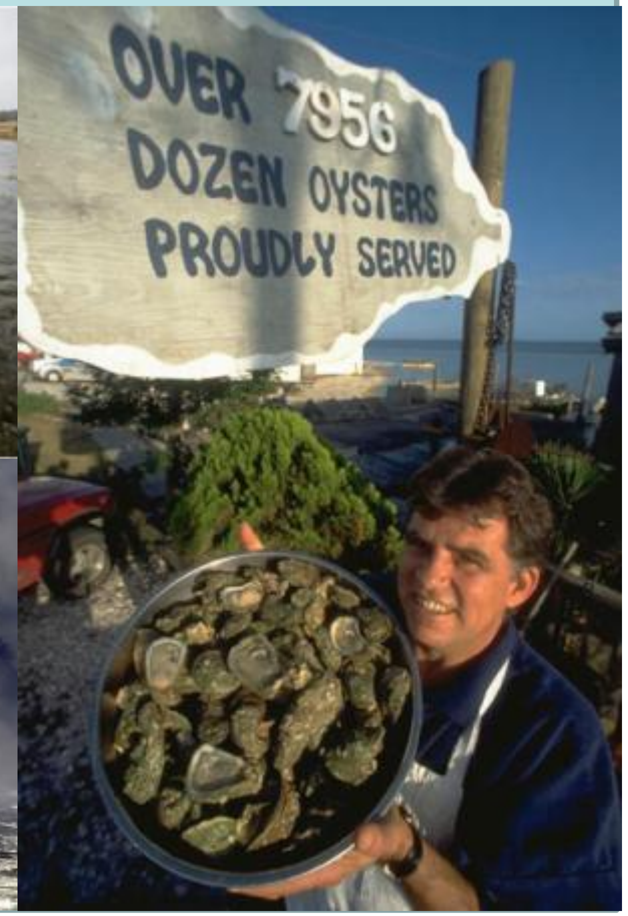
Taking Natural Infrastructure “Up To Scale”



Summary



Coastal and Marine Restoration: Benefits for Humans and Habitats



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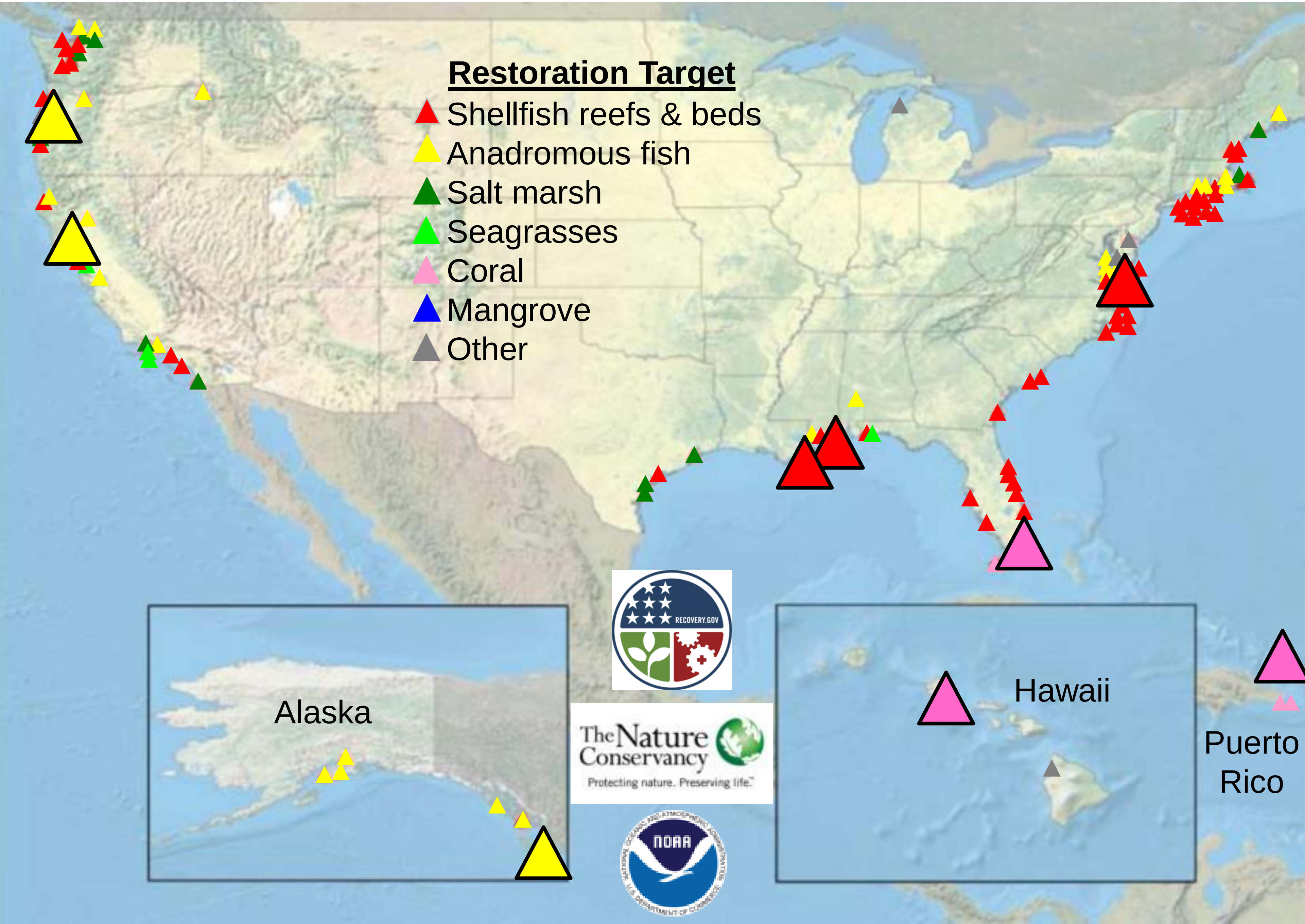
RECOVERY.GOV

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Recovery Act Projects 2009-2012

2009 -2012 American Recovery and Reinvestment



Alabama Breakwater and Estuary Restoration

Goals: Restore and enhance shoreline habitat with a long-term goal of boosting the economy of coastal Alabama

1.5 miles submerged breakwater, 3 acres oyster reef, and 30 acres seagrass beds over 10,000 feet of shoreline.

Jobs: 35 to 40 new jobs

Virginia Seaside Bays Restoration

- Oyster reef structure and function
- Functional eel grass meadows
- Evaluate potential techniques for bay scallop restoration
- Conduct water quality monitoring

Goal	Objective	Parameter	Technique & Method	Baseline	Reference	Target	Pre-restoration	Post-restoration
Restore oyster reef structure and function	Restore reef structure with fossil shell	Acres of planted shells	Dredge local fossil shell and import fossil shell to restoration for shell planting	Benthos devoid of oysters	N/A	24 acres of functional substrate	Pre-project survey	One GPS survey per reef of substrate footprint
		Increased vertical topography	Photograph and measure topography of restored reefs with chain method	Flat	Average topography of reference reef	Average topography of reference reef (TBD)	N/A	Annual sample at each reef; 3 transects per acre
	Restore functional oyster reefs	Length of growing oysters	Measurement of oyster shell length	N/A	Average size of oysters on reference reefs - value?	Mixed-size (age) oysters	N/A	Minimum of 3 - 1/16 m^2 quadrat samples at each reef annually
		Number of oysters per square meter (density)	Average number of oysters per 1/16 m^2 quadrat	N/A	Average density of oysters on reference reefs - value?	Average density of oysters on reference reefs (TBD)	N/A	Minimum 3 - 1/16 m^2 quadrat samples at each reef annually
		Create biomass reference for oysters in VA Seaside Bays	Ash free dry weight and length	N/A	N/A	TBD	N/A	Subsample of 10 oysters from each 1/16m^2 quadrat and determine ash free dry weight
		Percent Coverage of Macroalgae	Visual observation estimate	N/A	N/A	N/A	N/A	Minimum annually at time of sampling in the fall
		Number and kinds of other fauna present	Count, identify, and measure length	N/A	N/A	N/A	N/A	Minimum of 3–1/16m^2 quadrant samples at each reef annually
Restore functional eelgrass meadows	Collect eelgrass seeds	Number of eelgrass seeds	Hand and machine collections	N/A	N/A	10 million seeds per year	N/A	N/A
	Planting eelgrass seeds	Number of acres	Hand broadcast of seeds at a rate of 50,000 - 150,000 per 1-acre plot	N/A	N/A	100 acres planted	Pre-project survey and trial planting	Seedling success monitored each spring with diver transect surveys
	Establishment and spread of eelgrass	Increasing acreage of eelgrass in the coastal bays	Vertical aerial photography	0 acres	N/A	100 acres planted and spreading	Pre-project survey and trial planting	Vertical aerial photography at 2,000 and 12,000 feet and standard mapping procedures
Evaluate potential techniques for bay scallop restoration	Evaluating spawning potential	Number of larvae spawned	Count number of eyed larvae in a subsample per spawning attempt	N/A	N/A	TBD	N/A	TBD
	Evaluate growth potential	Length of growing bay scallops	Measurement of bay scallop shell length	N/A	N/A	TBD	N/A	TBD
	Establish survival rates in the nursery and at the field site	Number of living bay scallops	Number of living scallops in the nursery; Number of living scallops per cage and on bottom plots	N/A	N/A	TBD	N/A	TBD
	Evaluate the costs associated with each approach	Measure cost per viable bay scallop in the field	Determine cost associated with each approach	N/A	N/A	TBD	N/A	TBD
Conduct water quality monitoring	Assess eelgrass plot performance	Turbidity, chlorophyll fluorescence, temperature, salinity, pH, dissolved oxygen, depth	Discreet measurements with flow-through system from boat and fixed stations sampling using sensor arrays	N/A	N/A	Suitable water quality for restoration and growth - values?	Pre-restoration survey (July-November 2009)	Conduct Dataflow cruises throughout the SAV growing season (March - November) and to deploy the fixed stations for a minimum of 14-day intervals bi-monthly throughout this same period.
	Evaluate habitat suitability for eelgrass and bay scallops							

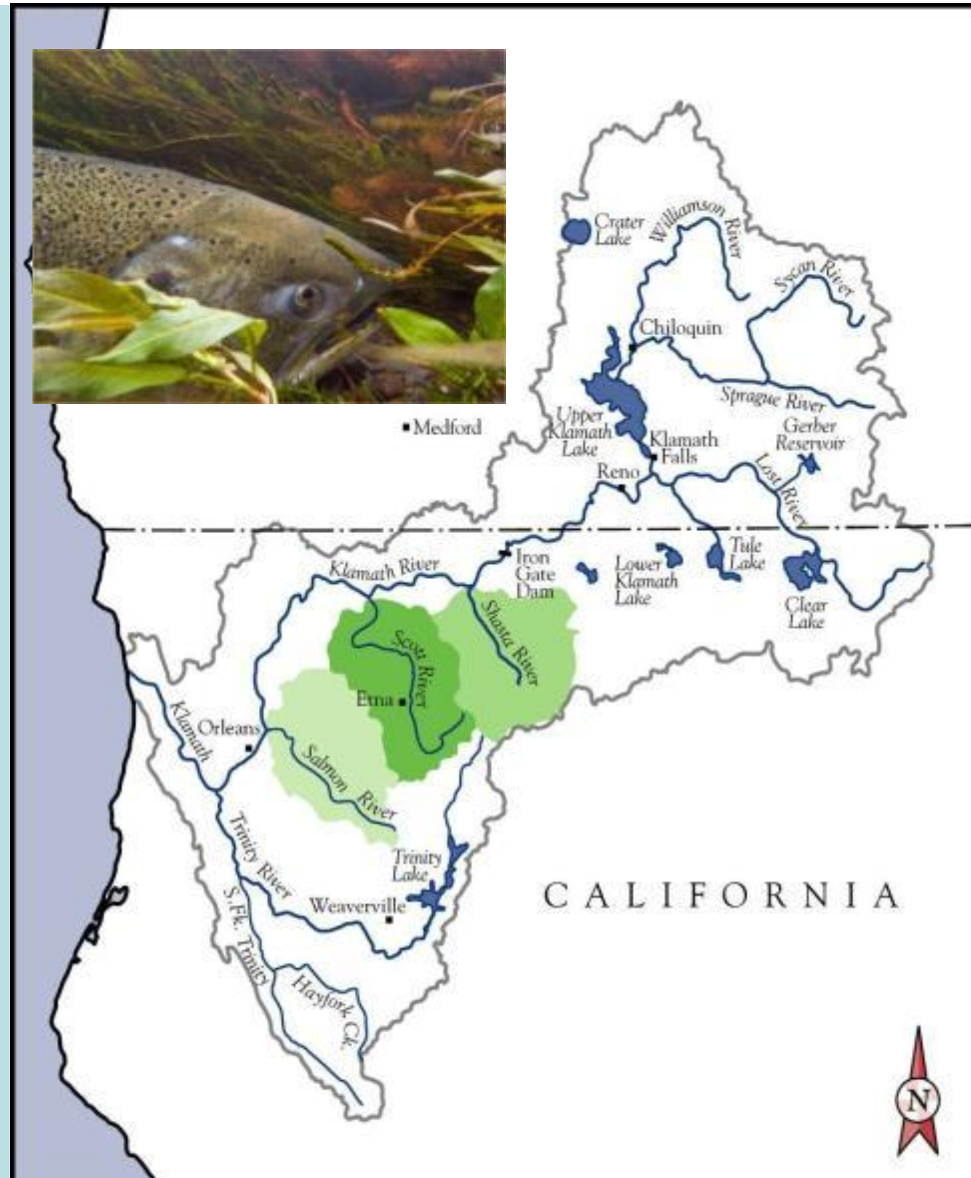
TNC Recovery Act Projects

Project	Monitoring	% Invested Monitoring	Right amount?
Alabama	$750,000	**25.4**	Just Right
California	$330,000	**20**	Just Right
Virginia	$295,000	**13.6**	Just Right
Hawaii	$250,000	**7.4**	Just Right
Alaska	$35,000	**3.4**	Too low
Louisiana	$140,000	**3.0**	Just Right
Washington	$95,800	**1.6**	Too High

CA – Big Springs Creek Shasta River habitat restoration

Goals: Restore degraded salmon habitat and demonstrating agricultural practices that benefit both people and fish.

Jobs: 54 jobs and 18,741 labor hours of employment



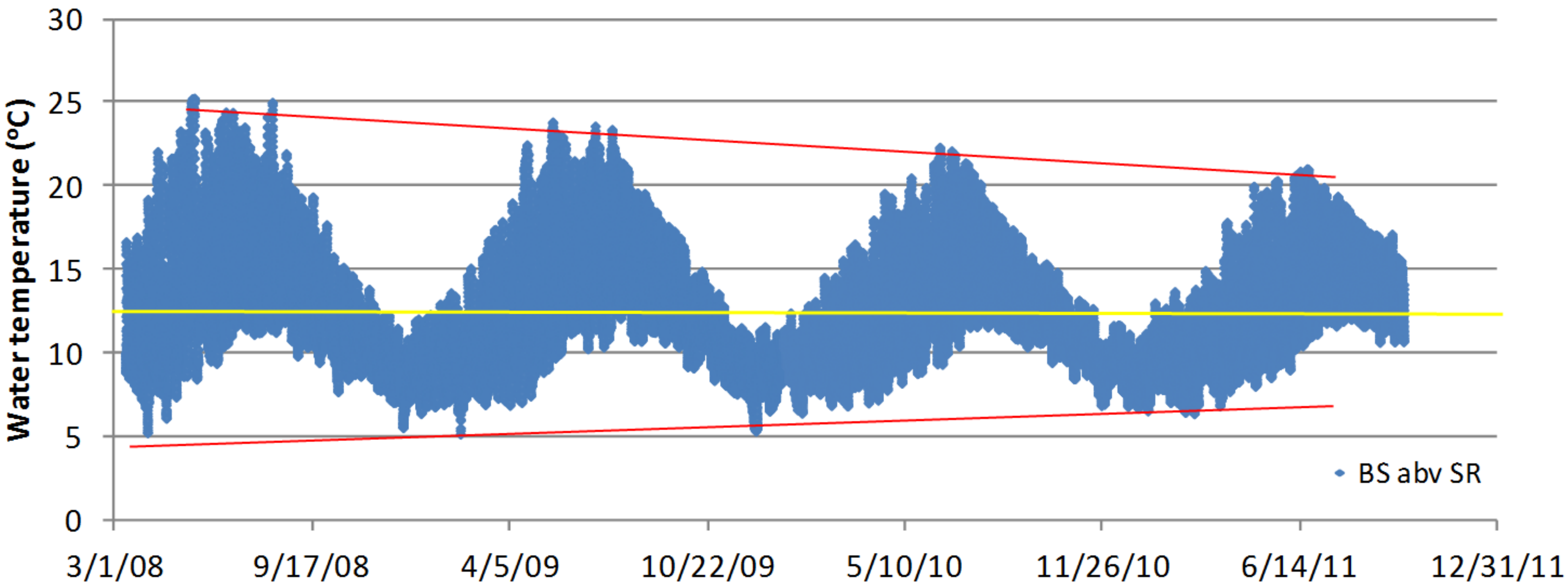
Problem: Loss of CA Salmon Habitat

Irrigation return

Cattle in streams and creeks

Large irrigation diversions

Monitoring Water Temperature




BEFORE 2008


AFTER
2010

SE Alaska – Hydrological Reconnection Salmon Habitat

Goals: Improve salmon habitat to restore fisheries to historic levels to meet the needs of local residents and others.

460 acres of seagrass estuary and 65 miles of stream habitat

Jobs: 20 jobs and an estimated 10,800 hours

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The Solution: Hydrologic Reconnection

Fish Passage Captured on Video

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The Problem: Extensive invasive algae covers shallow reef


May 2011
Aerial imagery collection and processing by Resource Mapping Hawaii

VA Seaside Bays Restoration

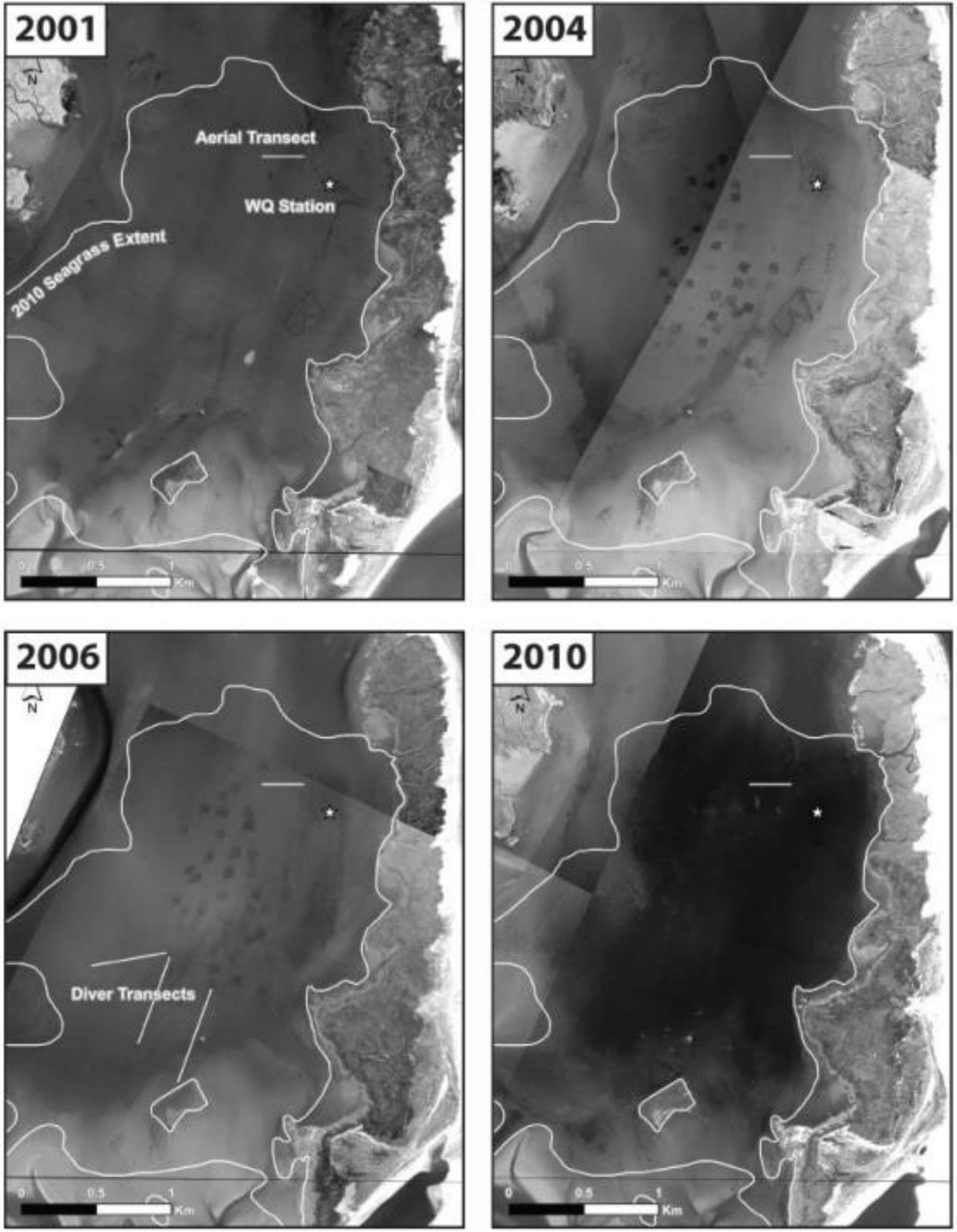
Goals: **Twenty-four acres** oyster reefs at 12 sites and **262 acres of seagrass** planted. Test the re-introduction of Bay Scallops

Jobs: 57 jobs with 59,927 labor hours

Since 1999:
38 million seeds, 369 plots

Monitored: aerial photos, sediment, genetics, water quality (seven years)

Source: Bob Orth VIMS




NOAA

A Million and One Answers to the Questions about Caribbean Coral Reef Restoration

Kemit-Amon Lewis
Caribbean Coral Conservation Manager

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Caribbean Coral Reef Restoration FAQs

How will coral restoration make a difference with on-going climate issues?

How do you define restoration success?

How can I help?

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Science + Conservation = AWESOME

CONSERVATION BY DESIGN

MEASURES

ADAPTIVE MANAGEMENT

SCIENCE THAT GUIDES CONSERVATION

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From 1 to 1,000 to 1,000,000,000

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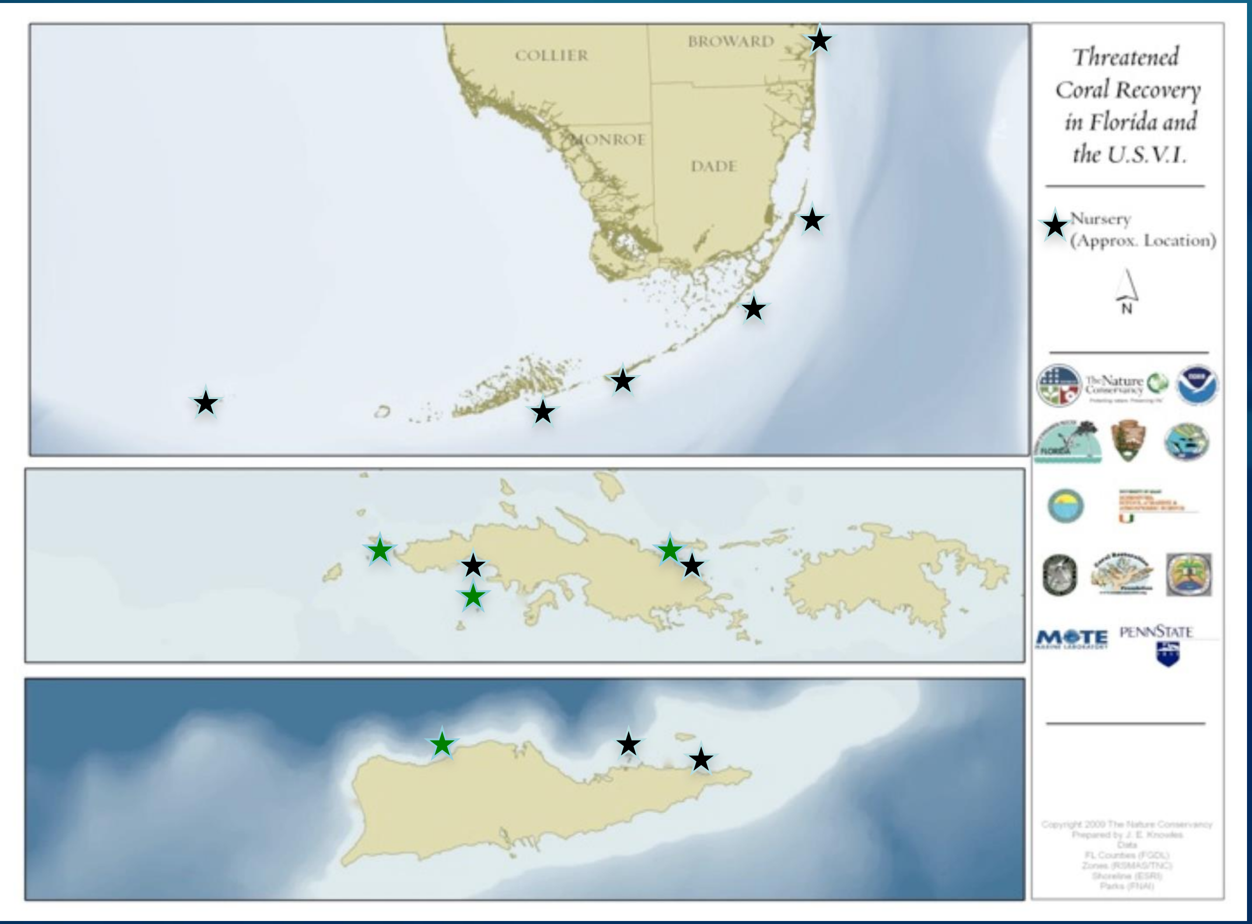
Love Your Partner(s)



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Understanding the Importance of and Enhancing Genetic Diversity

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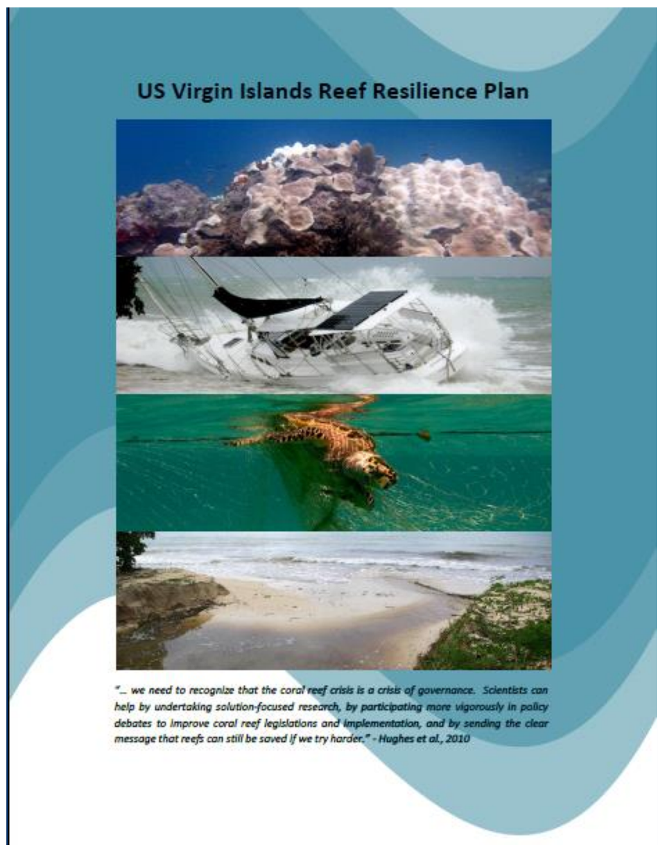
“If we control the things that we can, **we can make the world a better place** for those that can’t.”


US Virgin Islands Reef Resilience Plan

"... we need to recognize that the coral reef crisis is a crisis of governance. Scientists can help by undertaking solution-focused research, by participating more vigorously in policy debates to improve coral reef legislations and implementation, and by sending the clear message that reefs can still be saved if we try harder." - Hughes et al., 2010

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Focusing on Resilient Sites Towards a Higher Potential for Restoration Success

Positive Attributes	Negative Attributes
Good Water Quality	Excessive Macroalgae
Living Acroporids and Recruits	Hermodice
	Coralliophila
Flow and Flushing	Bleaching/Paling
Calcareous Algae	Disease
Diverse Coral Speciation	
Diadema	
Herbivorous Fishes	
Available Space	

Proposed Restoration Sites for TNC's USVI Coral Restoration Program Yr 1

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The above sites were chosen based on surveys conducted using modified AGRRA methodology to assess probability of restoration success based on water quality and flow dynamics, herbivore trophic structure, reef health, available space, and presence and health of living Acroporid corals.

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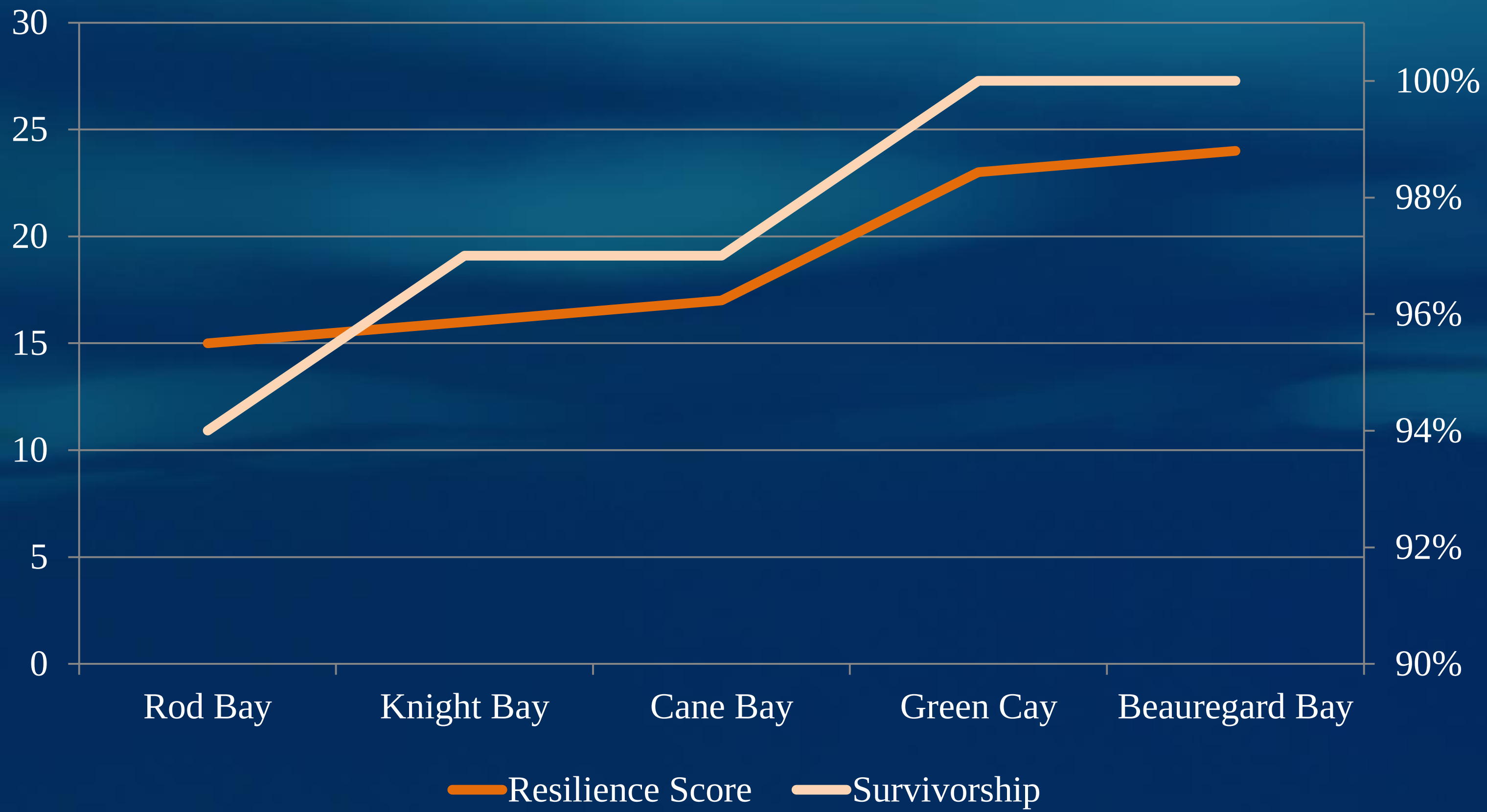
Out-Plant Site Resilience Score vs. Out-Planted Coral Survivorship



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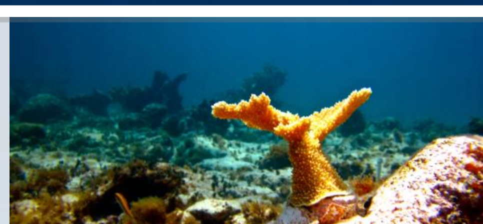

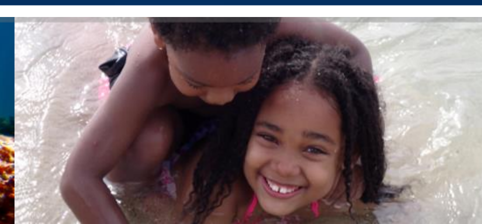

It Takes a Village to Raise ~~a Child~~ Corals

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VISION

"Thinking about or planning the future with imagination or wisdom."

Archie Carr, Mahatma Gandhi, **Martin Luther King, Jr.**, Nelson Mandela, **George Washington Carver**, William J. Clinton, **General Buddhoe**, Barack Obama, **Matthew Gilligan**, Phil Kramer, **Ruth Blyther,** Jane Goodall, **Arthur Ashe,** Steve Jobs, **Jacques Cousteau,** John Audubon…

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Albemarle-Pamlico Climate Change Adaptation Project:

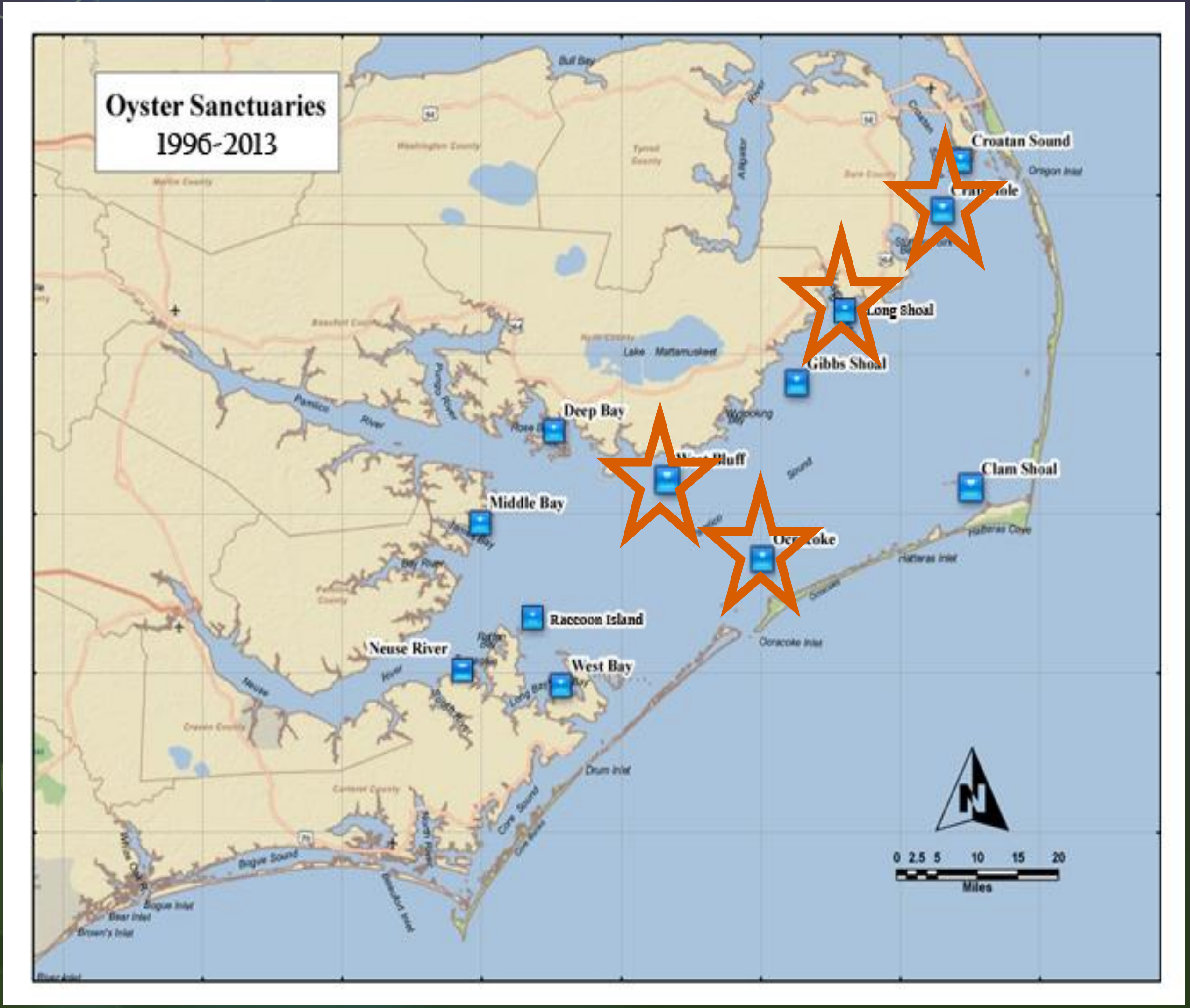
Oyster Habitat Creation

Christine Pickens

Coastal Restoration and Adaptation Specialist

The Nature Conservancy, North Carolina Chapter

TNC/NOAA CRP Partnership 2002-2006



- 4 Oyster Sanctuaries
- TNC starts oyster shell recycling with restaurants 2003-2006, 4000 bushels over 4 years
- NC starts a state-run program 2006-2013
- Remote setting spat on limestone marl
- Monitoring

A-P Climate Adaptation Project

Goal:
To develop, implement, and refine climate adaptation strategies for coastal wetlands such that ecosystem functions are preserved.

Carbon Sequestration

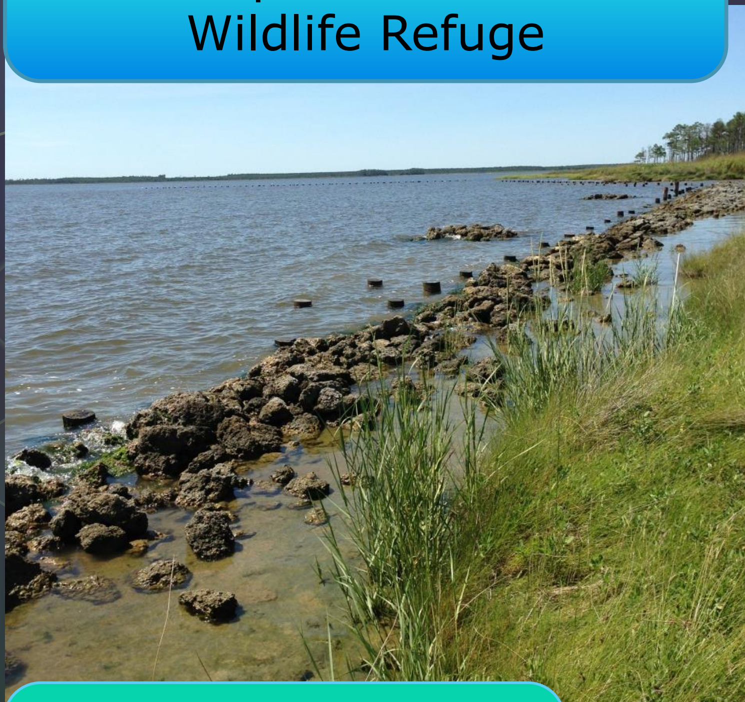
Ecosystem Services

Wetland Restoration
Facilitate Transition

Hydrologic Restoration

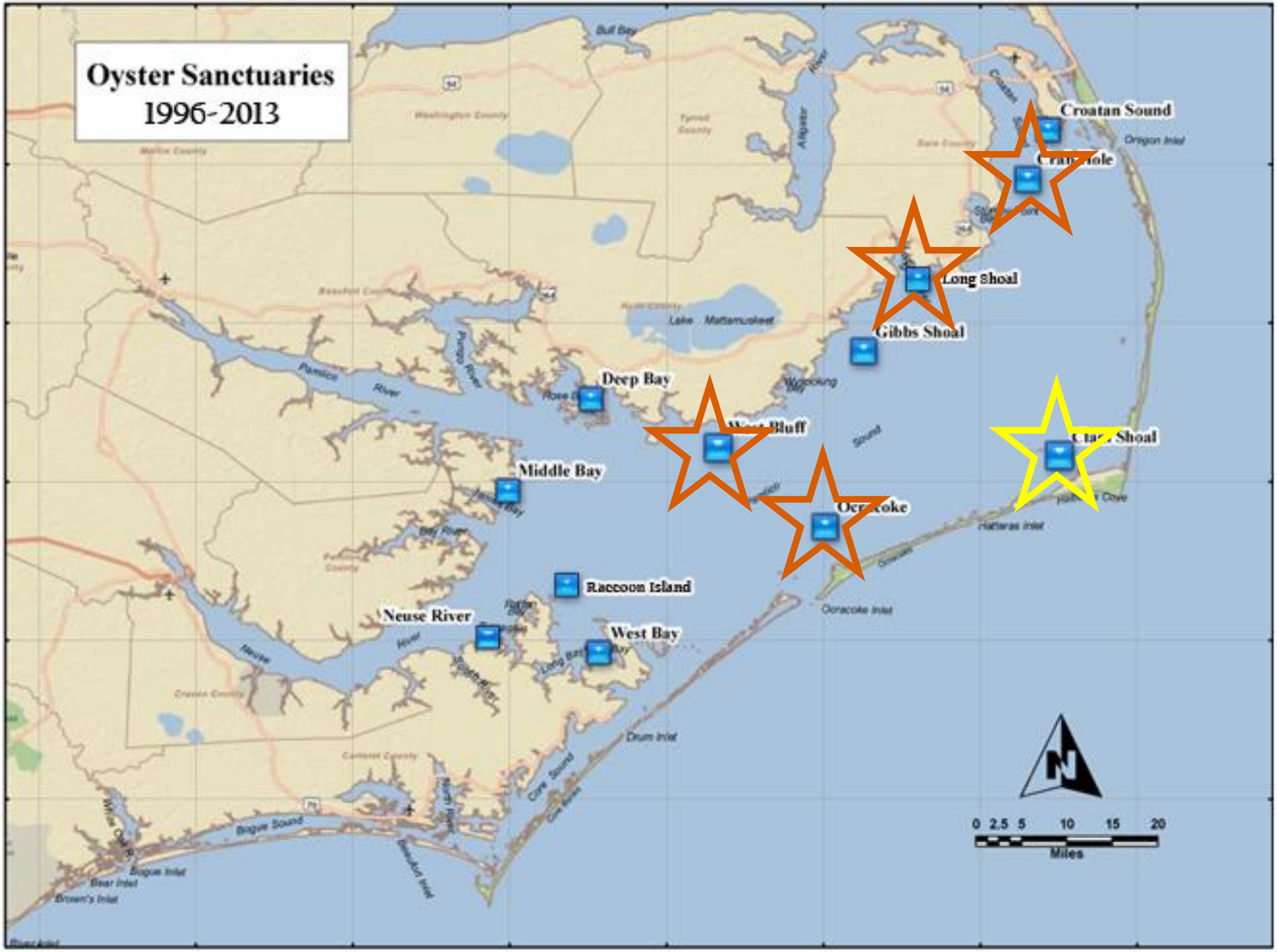
Oyster Habitat Creation

600′ of marl at Bell Island Swanquarter National Wildlife Refuge



1200′ of marl or shell bag at Alligator River National Wildlife Refuge

100′ of shell bag at Nag’s Head Woods Preserve


Oyster Sanctuaries
1996-2013
Croatan Sound
Long Shoal
Gibbs Shoal
Deep Bay
Middle Bay
Raccoon Island
Neuse River
West Bay
Lake Mattamuskeet
Pamlico River
Oregon Inlet
Hatteras Inlet
Ocracoke Inlet
Drum Inlet
Bogue Sound
Bogue Inlet
Bear Inlet
Brown's Inlet
Core Sound
0 2.5 5 10 15 20
Miles


OYSTER SANCTUARY
DANGER
SUBMERGED ROCKS


WEST BAY

Scientific Information → Credibility

- Monitoring component to oyster projects
- Partnerships
  - State Agencies
  - Academic Researchers
  - New Stakeholders
- Ability to leverage funding to achieve science-driven oyster habitat creation
- Communicate effectiveness and scale

Measuring biodiversity at reefs

Oyster dispersal research in Pamlico Sound

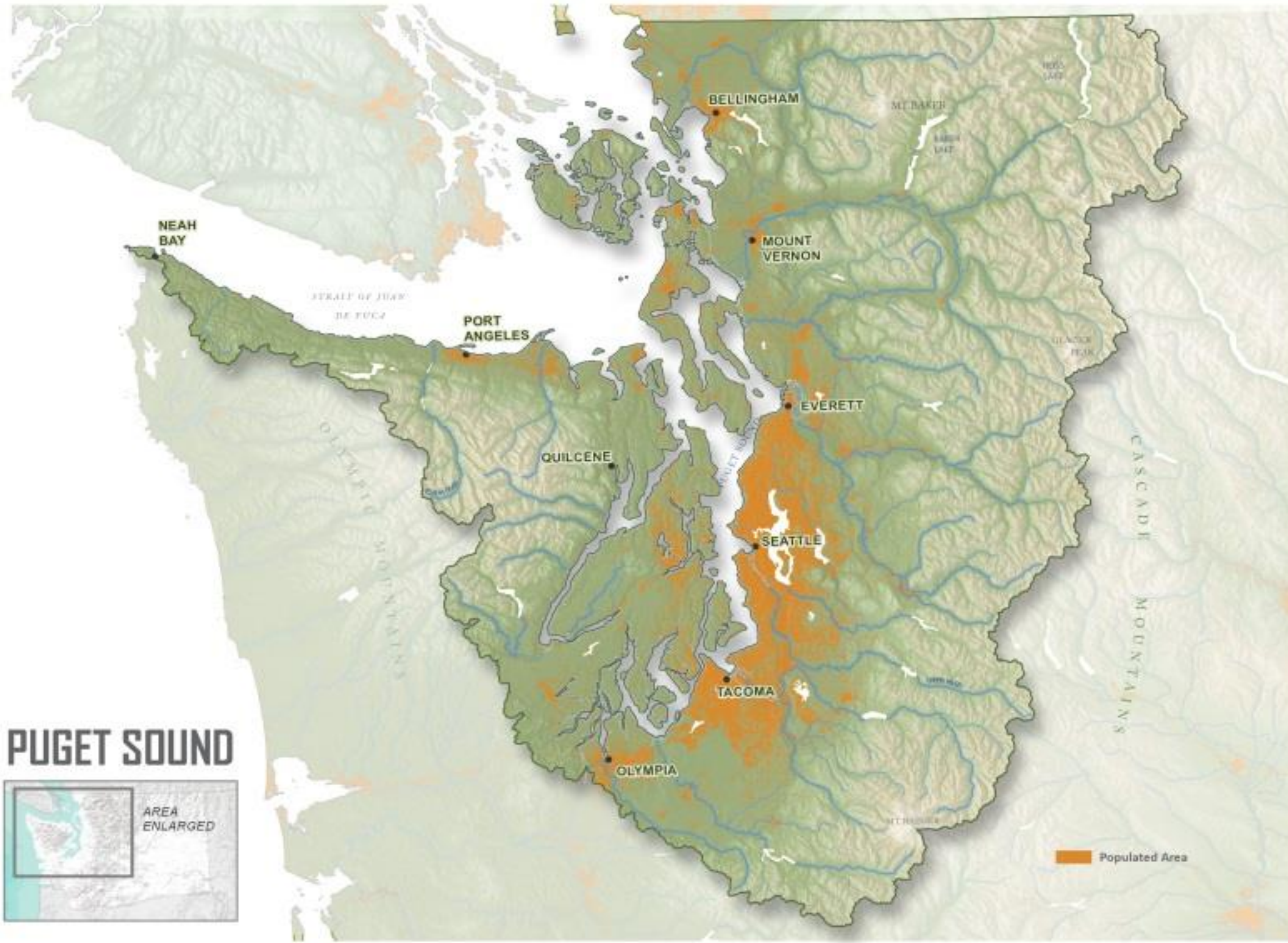

Control Site


800’ of Subtidal Reefs!

Moving restoration to the whole-system scale in Puget Sound, Washington

By Jenny Baker

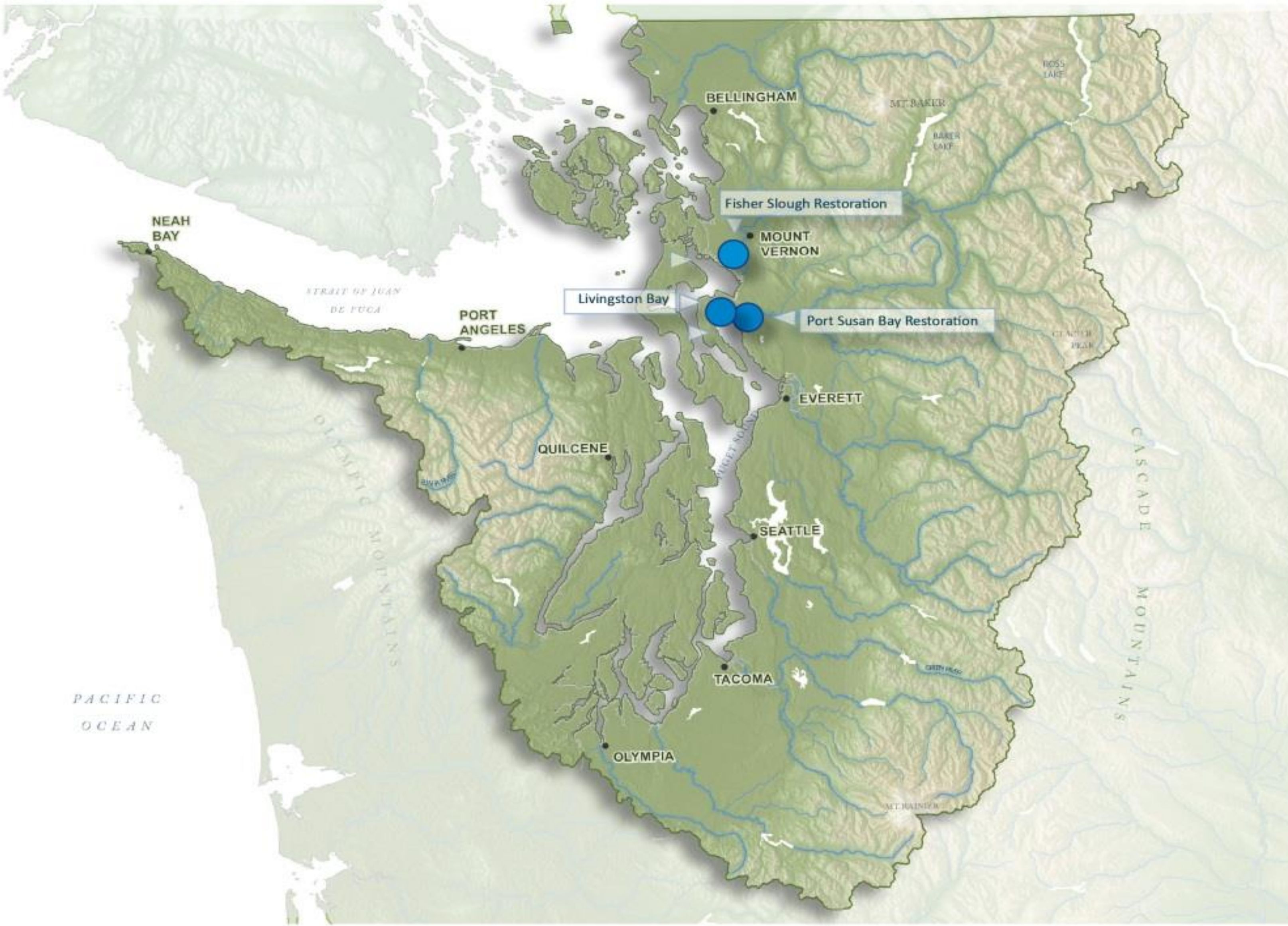
Marine Aggregation, Feb 2014



PUGET SOUND
AREA ENLARGED
BELLINGHAM
MT. BAKER
NEAH BAY
MOUNT VERNON
STRAIT OF JUAN DE FUCA
PORT ANGELES
EVERETT
QUILCENE
OLYMPIC MOUNTAINS
CASCADE MOUNTAINS
SEATTLE
TACOMA
OLYMPIA
Populated Area

WARNING
CONTAMINATED SHELLFISH
SHELLFISH FROM THIS BEACH ARE UNSAFE TO EAT
DUE TO BACTERIAL CONTAMINATION OF THESE WATERS

TNC-Owned and Managed Floodplain and Estuary Projects

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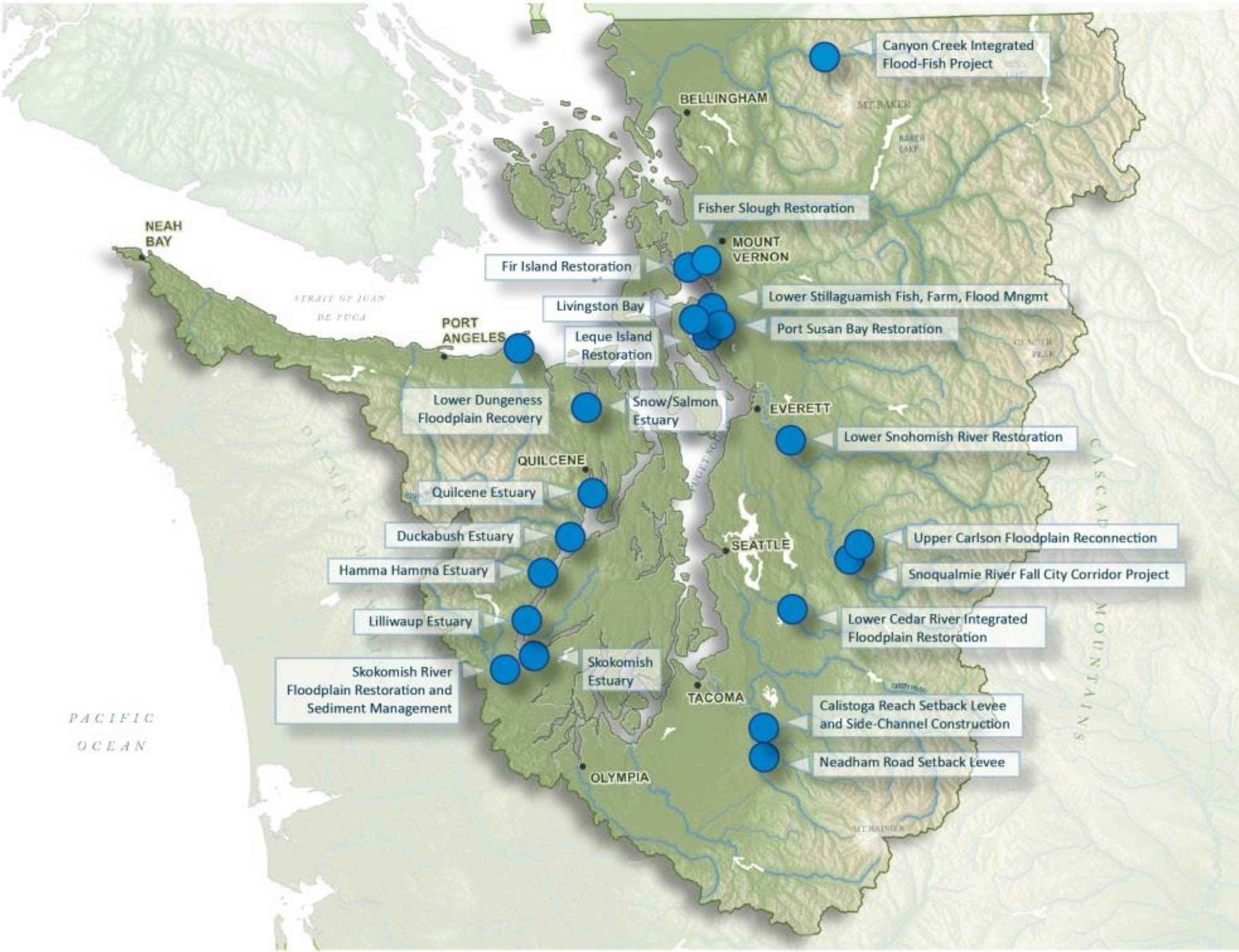
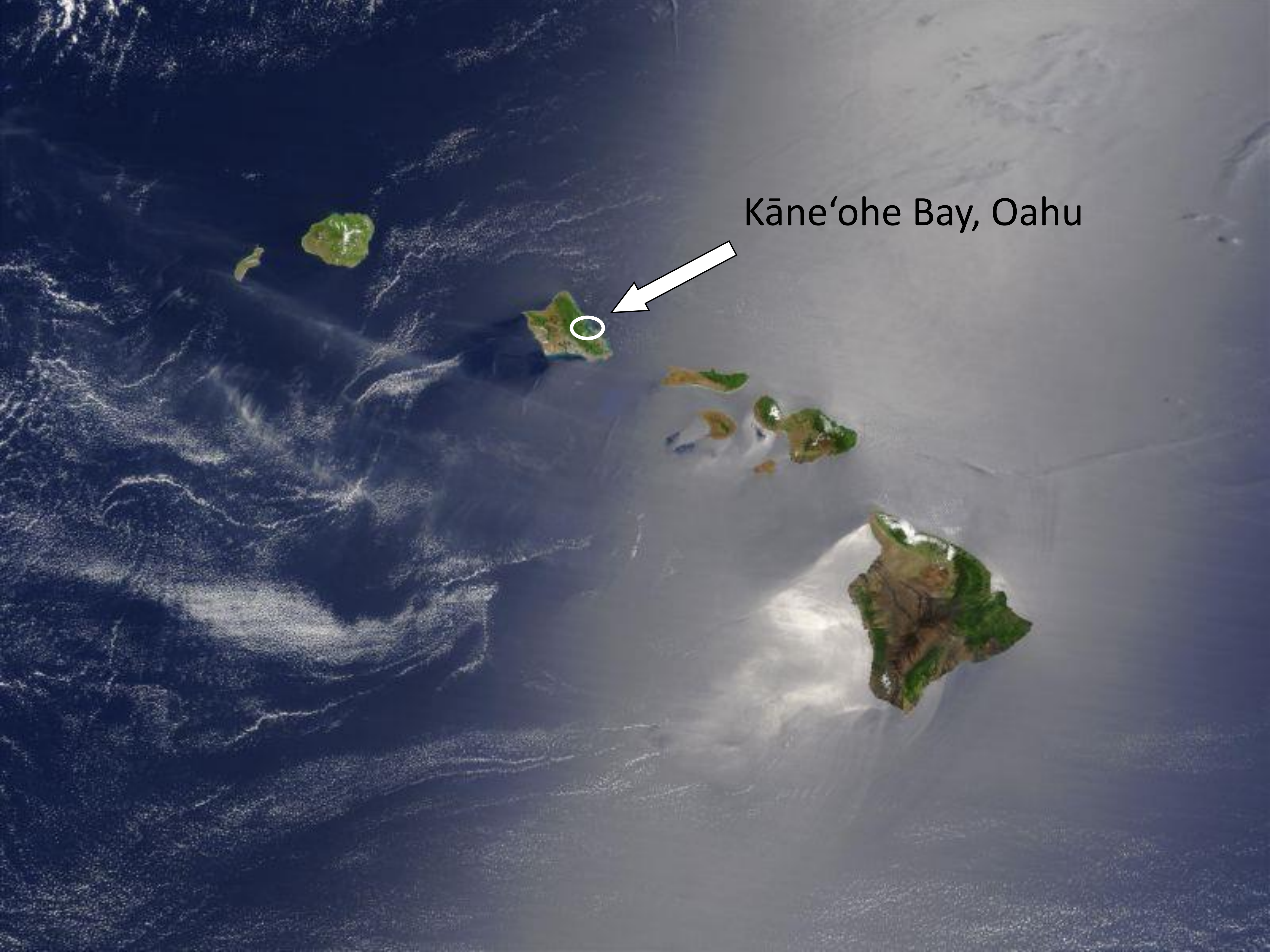
Applying Place-Based Lessons: Current Floodplain and Estuary Projects




Hawai‘i Sucks!
And we are darn good at it.
(And this title was NOT my idea….)
Eric Conklin
Hawai‘i Marine Science Director


Kāne‘ohe Bay, Oahu

Kāne‘ohe Bay

“A healthy, vibrant, sustainable Kane‘ohe Bay"

Strategies:

Short- to mid-term
- Supersucker
- Urchins

Mid- to long-term
- Better land-use practices
- Effective fisheries management

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UA MAU KE EA O KA 'ĀINA I KA PONO

Department of Land and Natural Resources
State of Hawaii


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Kākoʻo
ʻŌiwi

“A healthy, vibrant,
sustainable
Kane‘ohe Bay"