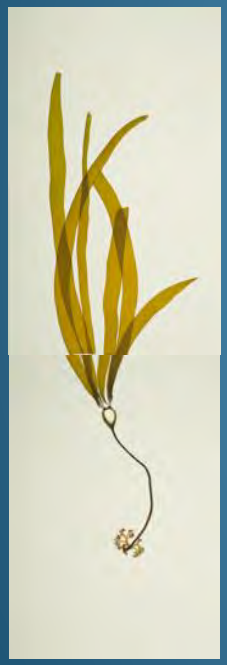
Ocean Acidification – Action at a Local Level

June 28, 2016

Northwest Maritime Center, Port Townsend

Investigating Kelp Cultivation in Jefferson County to Mitigate Ocean Acidification



Betsy Peabody
Executive Director, Puget Sound Restoration Fund
Former Member, Blue Ribbon Panel on Ocean Acidification

PUGET SOUND
RESTORATION FUND

Ocean Acidification - the Basics

Global, Regional, and Local Factors:

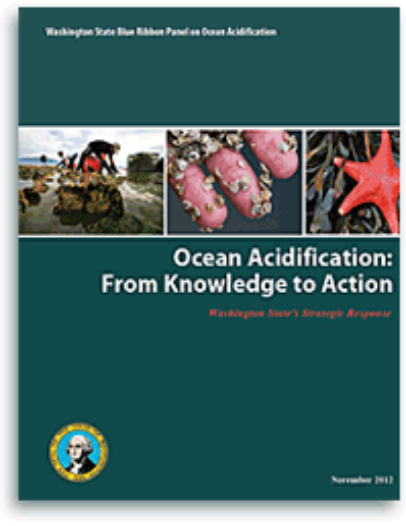
- Global: 25% of the CO_2 we emit is absorbed by the world's oceans.
- Regional: Water upwelled off Washington's coast is loaded with more CO_2 than anywhere else in the world (10% higher than Atlantic).
- Local: Nutrient pollution in local waters increase CO_2 levels in seawater

What Does this Mean?

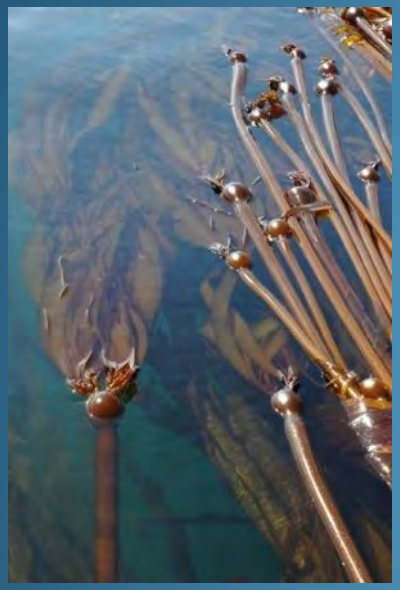
- Increased CO_2 from all these sources triggers chemical reactions in seawater that make carbonate less available for shell-building.
- Rising CO_2 decreases pH. Oceans are 30% more acidic today than in pre-industrial times.
- The combination of decreasing carbonate ions & increasing acidity causes mortality in calcium dependent critters (shellfish, plankton, corals, algae)
- 30% of species in Washington are calcifiers, so this is not just about shellfish.

Blue Ribbon Panel Report (Action 6.1.1): Investigate Phytoremediation Strategies

- Cultivate and harvest kelp & seaweeds in order to remove carbon from the marine system.



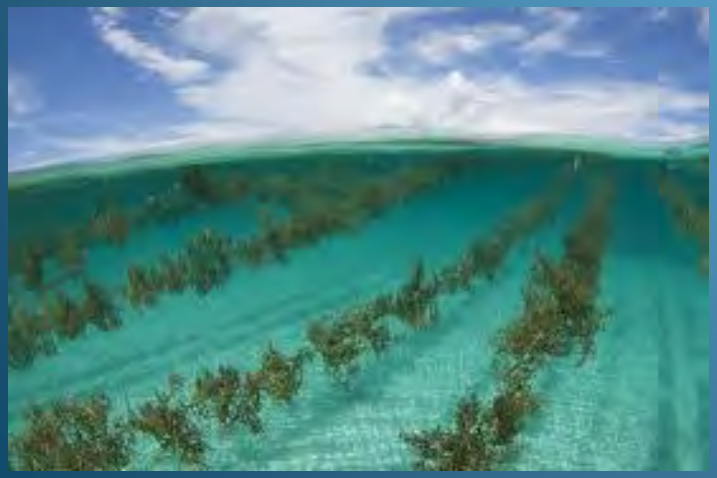
Kelp Superpowers



- Seaweeds are an enormous & diverse biological resource.
- Kelp can draw down CO_2 & increase pH.
- Seaweeds thrive in acidifying waters.

Incredible Facts:

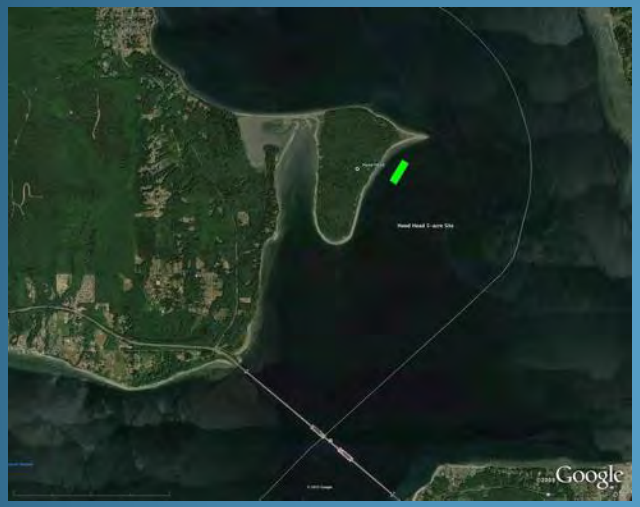
- China leads world in farming seaweeds; 8 tons carbon removed (dry weight) for every 20 metric tons harvested (per year/hectare).
- Seaweed can be transformed into food, fertilizer, fuel, feed.
- Unlike other food production, no fertilizer or irrigation is needed.



Paul Allen Ocean Challenge

Cultivating seaweeds to mitigate OA and generate habitat, fertilizer, food, fuel.

Funding Provided By:
Paul G. Allen Family Foundation & U.S. Navy



The Kelp Team

Co-PIs: Joth Davis & Betsy Peabody, PSRF

Assessment, Modeling, Lab

- Dick Feely, NOAA PMEL
- Simone Alin, NOAA PMEL
- Jan Newton, UW APL, WOAC
- John Mickett, UW APL
- Nina Bednarsek, UW SMEA
- Dale Kiefer, SSA
- Jack Rensel, SSA
- Frank O'Brien, SSA
- Cinde Donoghue, WA DNR
- John Colt, NMFS
- Ron Johnson, NMFS
- Dan Tonnes, NMFS
- Port Gamble S'Klallam Tribe

Kelp Cultivation, Outreach, PM

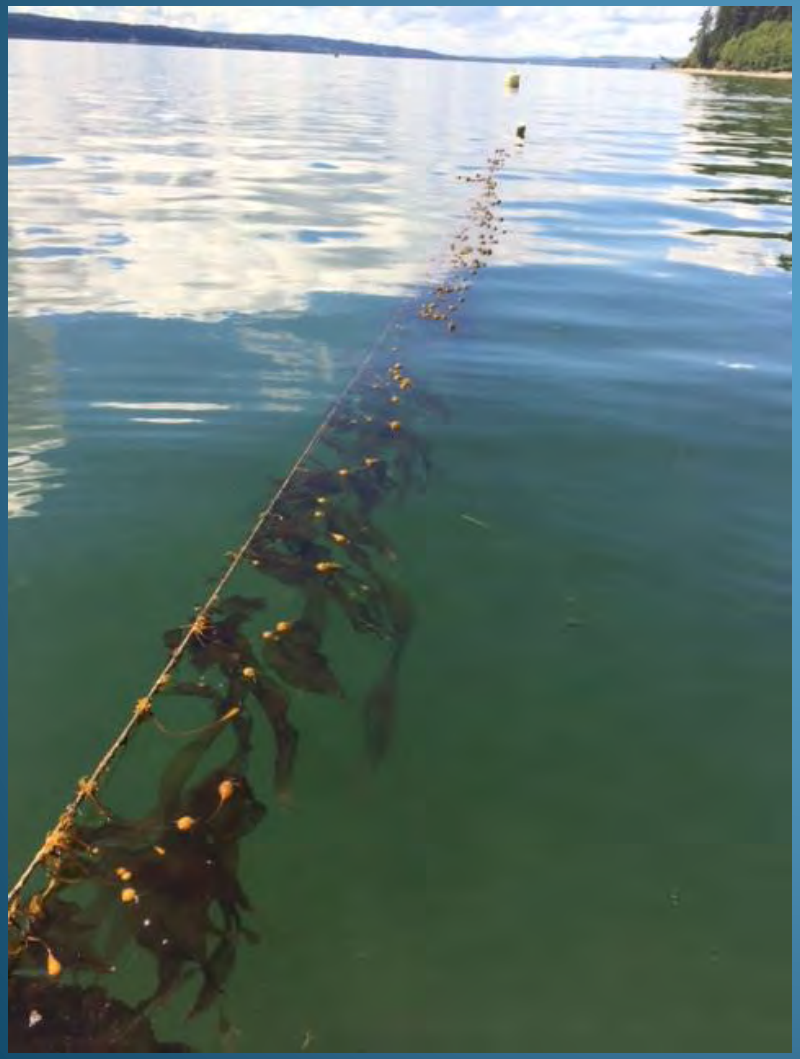
- Walt Dickhoff, NMFS
- Mike Rust, NOAA Aquaculture
- Tom Mumford, Marine Agronomics
- David Gillingham, Anchor QEA
- Louie Druehl, CKR
- Terrie Klinger, UW SMEA, WOAC
- John Forster, Forster Consulting
- Connie Mahnken, WA F&W Comm.
- Meg Chadsey, WA Sea Grant
- Eric Scigliano, WA Sea Grant
- Brian Allen, PSRF

Kelp Headquarters: Manchester Shellfish Hatchery

Kelp Propagation

30-day sugar kelp culture, seeded line, juvenile bull kelp sporophytes

Pilot Kelp Cultivation at Hood Head



Critical Steps Ahead

Obtain a Jefferson County shoreline development permit to install scientific buoys upstream & downstream of kelp.

All other permits/leases for mariculture operation are in hand from Army Corps, DNR. The mariculture array itself fell under the definition of “existing aquaculture” in SMP.

Project Timeline

- Full cultivation and scientific assessment will occur in 2017 and 2018.
- Kelp (sugar and bull) will be propagated at Manchester in October 2016/2017 and outplanted at Hood Head November/December 2016/2017.
- Peak growth period will occur February – June 2017 and 2018.

Jefferson County project is on the cusp of a much bigger phenomenon

Seaweed Might Have The Power To Make The Oceans Less Acidic
Huffington Post, April 28, 2015

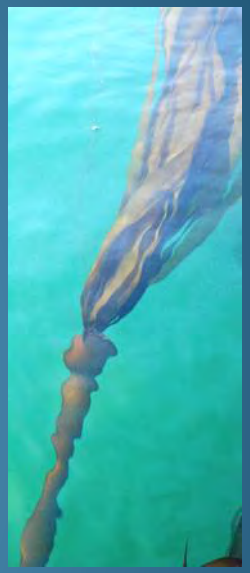
MOVE OVER KALE, The New Super Vegetable Comes From The Sea.
Scientific American, July 11, 2014

“Eat Kelp. It's chock-full of nutrients, it mitigates climate change by sequestering carbon, improves oceans by soaking up excess nitrogen and phosphorus, and has potential as a valuable fertilizer and biofuel.”

A NEW LEAF:
Seaweed could be a miracle food—if we can figure out how to make it taste good.
The New Yorker, November 2, 2015

IN THE WEEDS
Seaweed could save the world’s oceans from becoming too acidic
Quartz, Nov 4, 2015

Harness the power of seaweeds to protect important resources



- Create refuges and protect sensitive species;
- Deploy them as a potential mitigation tool; and
- Produce food at the same time.

Keep an Eye on Global and Local Scales

photo credit - Dr. Nina Bednarsek

While we figure out the global carbon problem….

Seaweeds might help us hold onto species locally that are fundamental to ecosystem health.

Keep an eye on kelp in the hope that it can carry us into a bright future

Jefferson County
Marine Resources Committee

Community Projects for Ocean Acidification Remediation

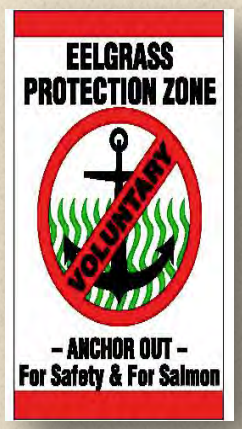
Nam Siu
District 1 Representative

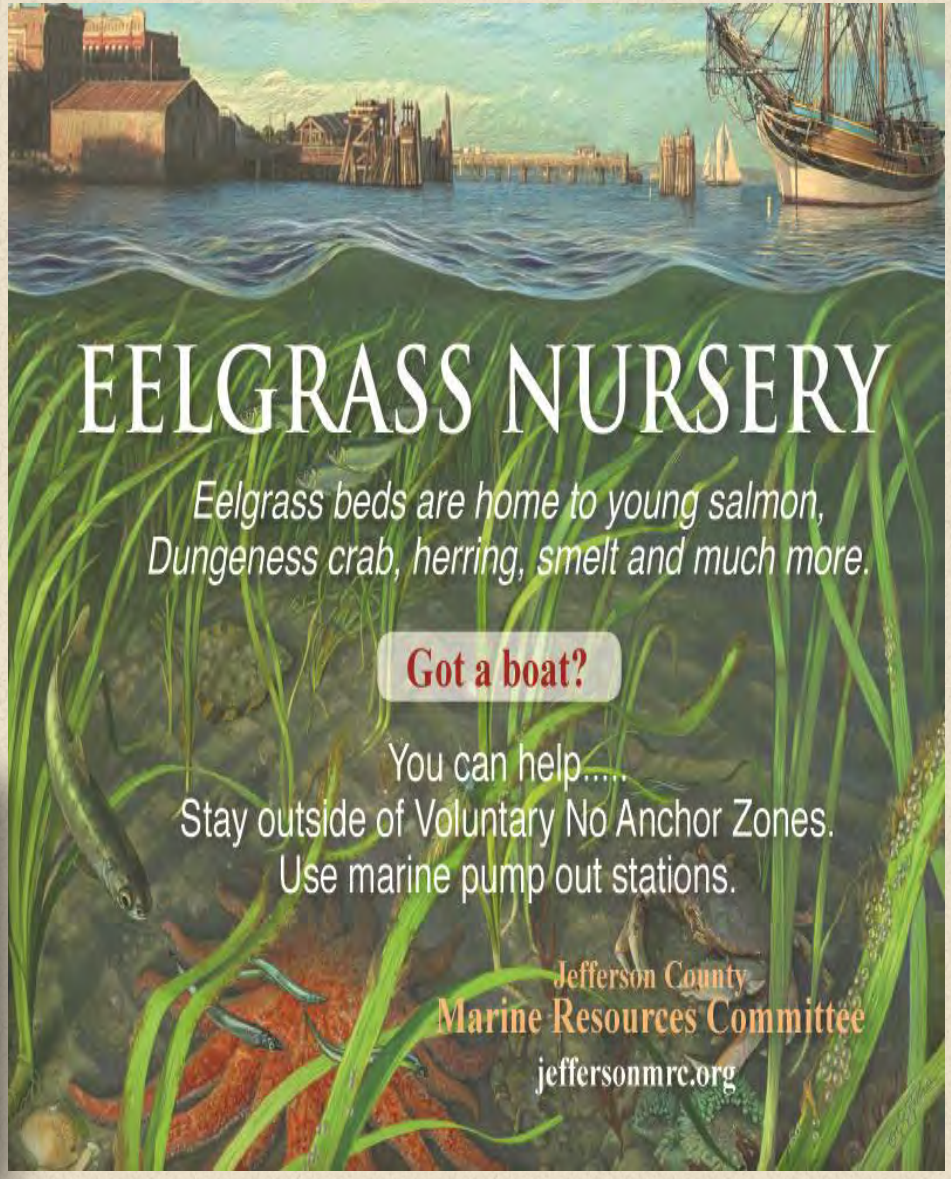
Jefferson County
Marine Resources Committee

Northwest Straits INITIATIVE
partners in marine conservation

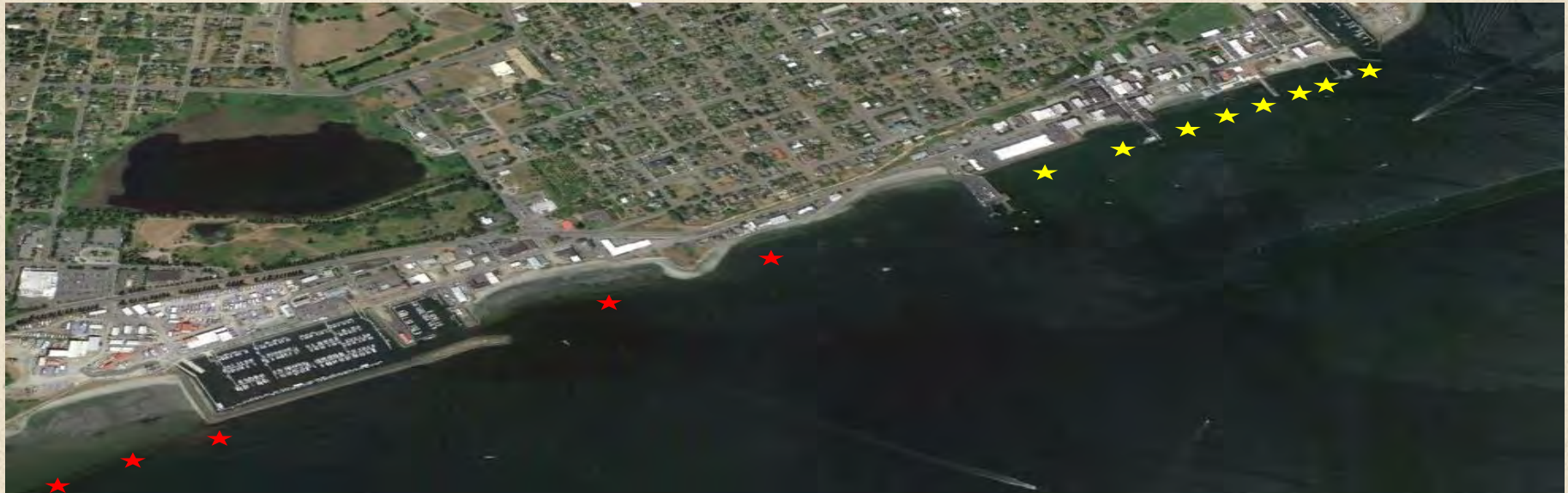
PugetSoundPartnership
LEADING PUGET SOUND RECOVERY

Eelgrass Protection





Eelgrass Protection



Eelgrass Protection

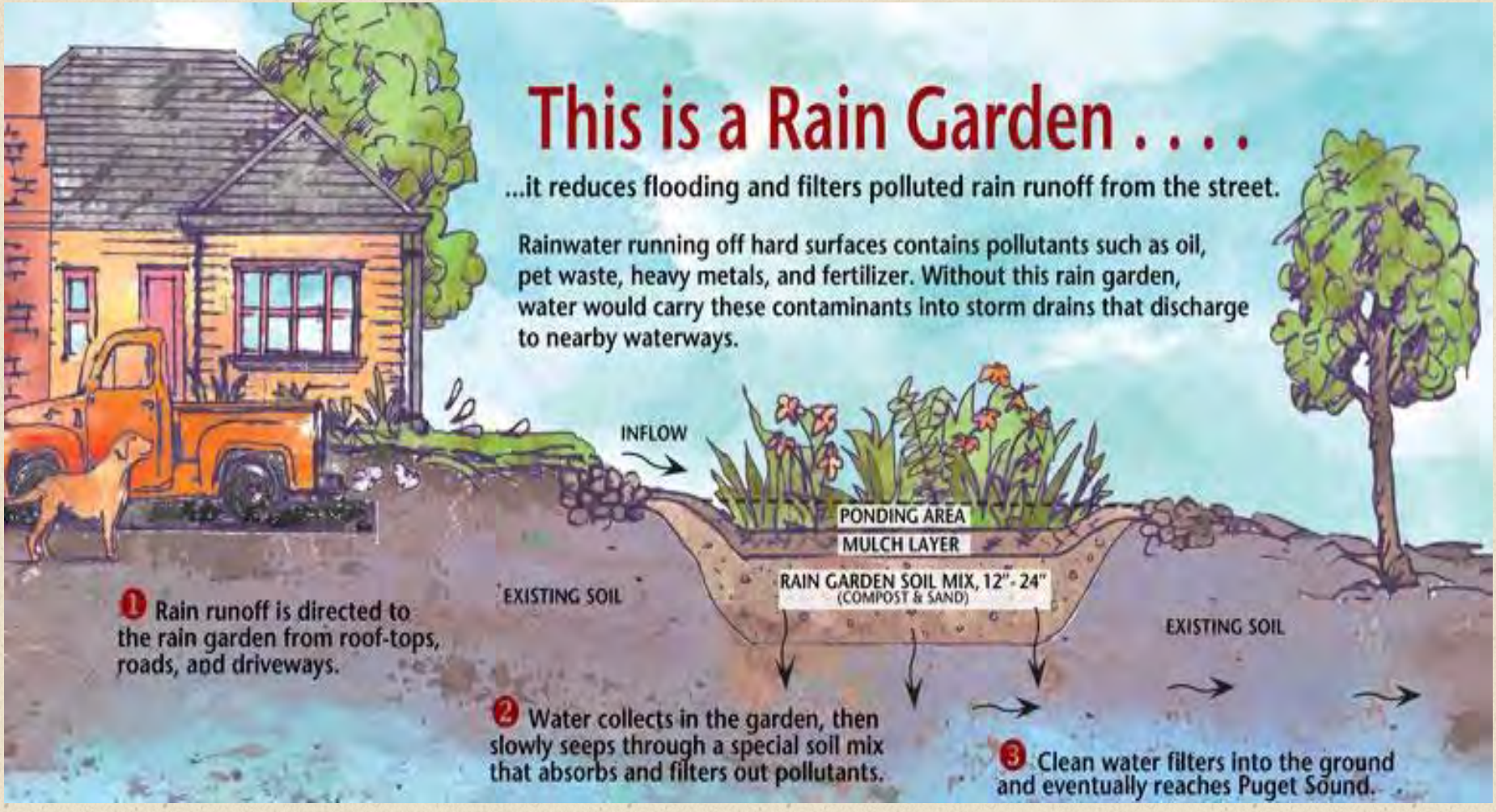
Kelp Monitoring

Kelp Monitoring

Olympia Oyster Restoration

Olympia Oyster Restoration

Raingarden and Stormwater Remediation



Raingarden and Stormwater Remediation

Jefferson County
Marine Resources Committee

How can we help each other?

- Advisory and communication
- Community partnership and collaborations
- Outreach and education

Support our projects!

Building coastal resilience to acidification and rising seas

High-resolution geographic data gives local planners power to act

(via shoreline master plans, state policy)

By Brad Warren, Julia Sanders, and John Guinotte

GlobalOceanHealth.org

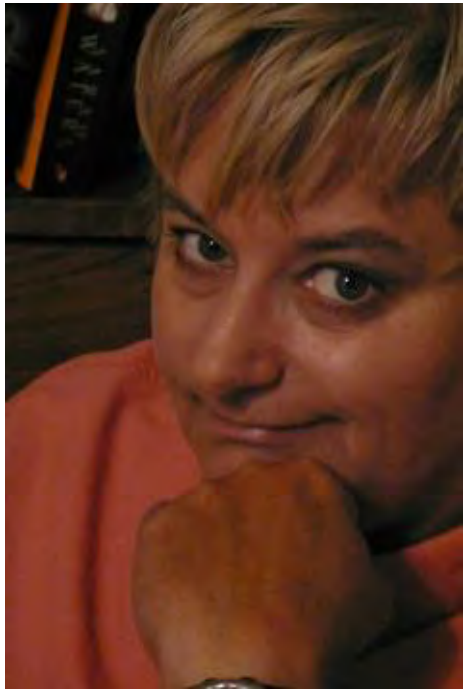
MARINE CONSERVATION INSTITUTE

Summary

1. **Local planners** have key role in response to OA, as well as SLR and other climate impacts.
2. Restoration and resilience planning can be strengthened by providing high-res Lidar elevation models and sea level rise scenario models to local Shoreline Master Plan planners.
3. High-res modeling can help communities build local resilience to OA along with other climate-change impacts (enabling durable benefit as the shoreline changes)
4. Key to long-term success of several Blue Ribbon Panel recommendations: vegetation based remediation (Action 6.1.1), OA refuges (Action 6.3.2), and planning to reduce nutrients and organic carbon loads (Action 5.1.2).

Inspiration from research…

I.K. Chung, Pusan Nat'l University: kelp as CO_2 sink: created "Coastal CO_2 Removal Belt" in Korea. Showed *Ecklonia* brown algae can draw 10t/yr per hectare.



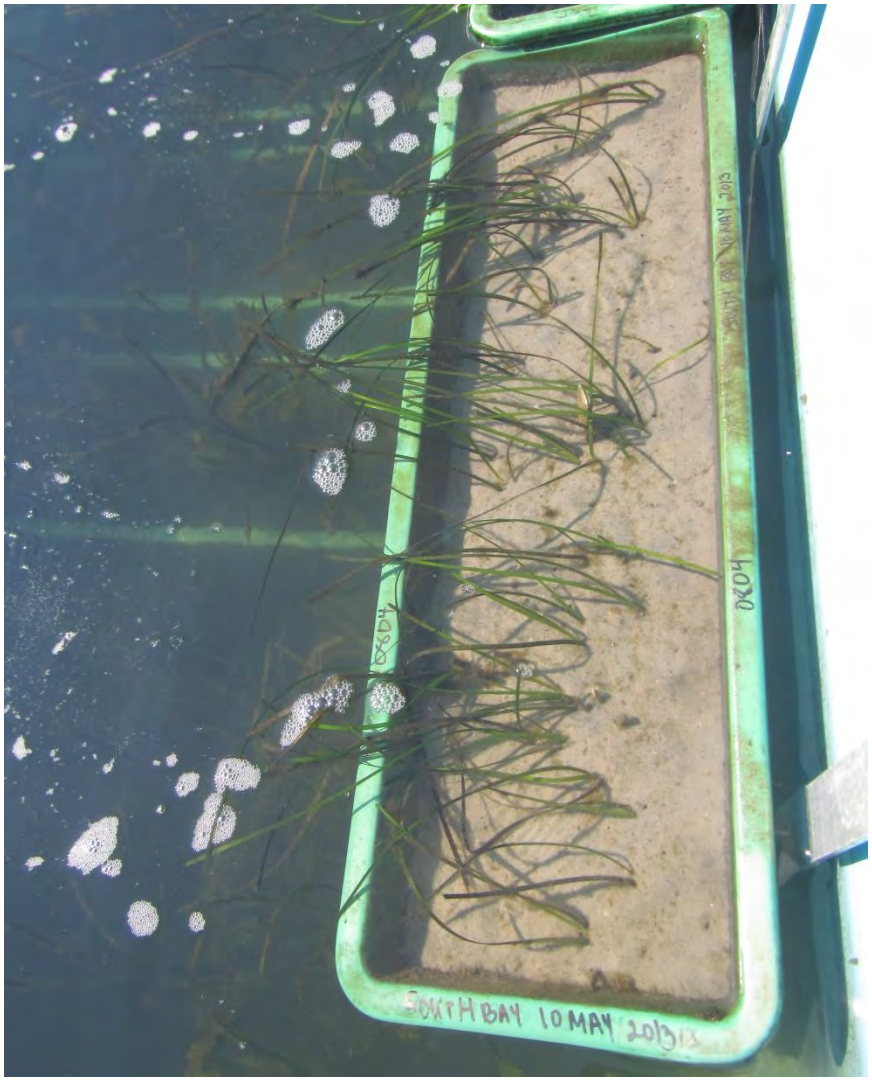
Gail Chmura, McGill University: Highlighted need for precise elevations to plan restoration. Noted "millions wasted" restoring marshes doomed by SLR.

Richard Zimmerman, Old Dominion University: with colleagues, he documented CO_2 consumption by eelgrasses, showing a high-CO_2 ocean may speed growth. Some carbon can be stored in mud beneath the eelgrass beds (varies by species, place, etc)

Every picture tells a story……

High Temperature, pH 6.5

High Temperature, pH 8



Slide: Richard Zimmerman, ODU

Ocean Acidification Refugia

Dwight Gledhill (NOAA OAP)
Joe Salisbury (UNH/NERACOOS)
Derek Manzello (NOAA AOML)

http://www.oceanacidification.noaa.gov/

Slide adapted from D Gledhill

Nature's carbon burial superstars?

COASTAL BLUE CARBON OPPORTUNITY ASSESSMENT
FOR THE SNOHOMISH ESTUARY
THE CLIMATE BENEFITS OF ESTUARY RESTORATION

RESTORE AMERICA'S ESTUARIES · ESA · WESTERN · EARTH CORPS

As it is now, Snohomish estuary will bury 2.55 million tons of carbon over 100 yrs:
500,000 cars

Fully restored, it could take out 8.9 million tons:
1.7 million cars

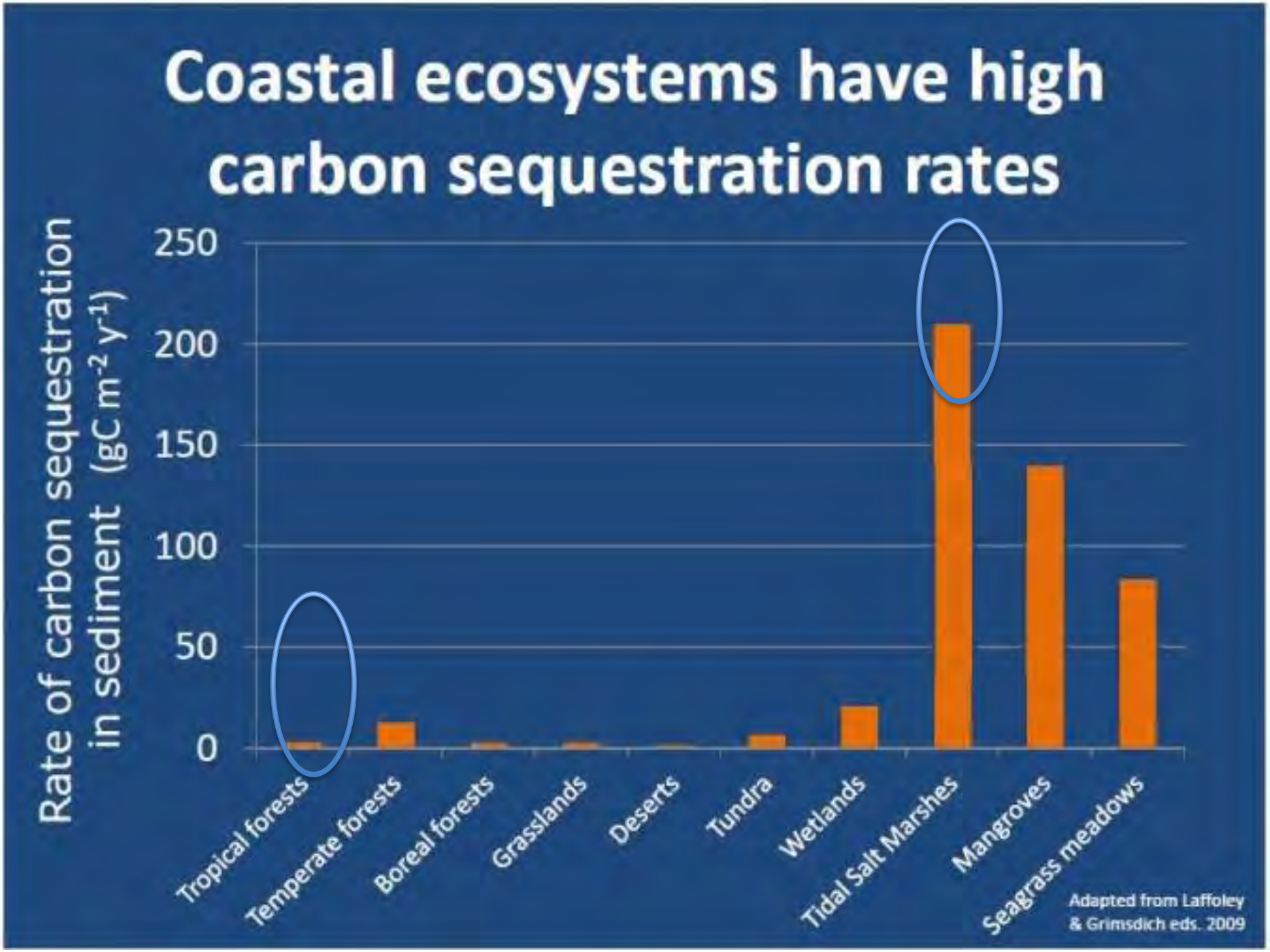
Crooks, Rybczyk, O'Connell, Devier, Poppe, and Emmett-Mattox, Restore America's Estuaries, 2014

Is there a silver lining?

1 meter of sea level rise…

- In U.S., inundated area = size of New Jersey
- Can we learn to manage this new coastal inundation zone?
- Huge potential to deliver
  - —flood protection
  - —fisheries & aquaculture
  - —acidification refuges
  - —carbon sequestration

Coastal ecosystems have high carbon sequestration rates



Salt marsh

Buries 10-17x more carbon per acre/year than Brazilian rainforest.

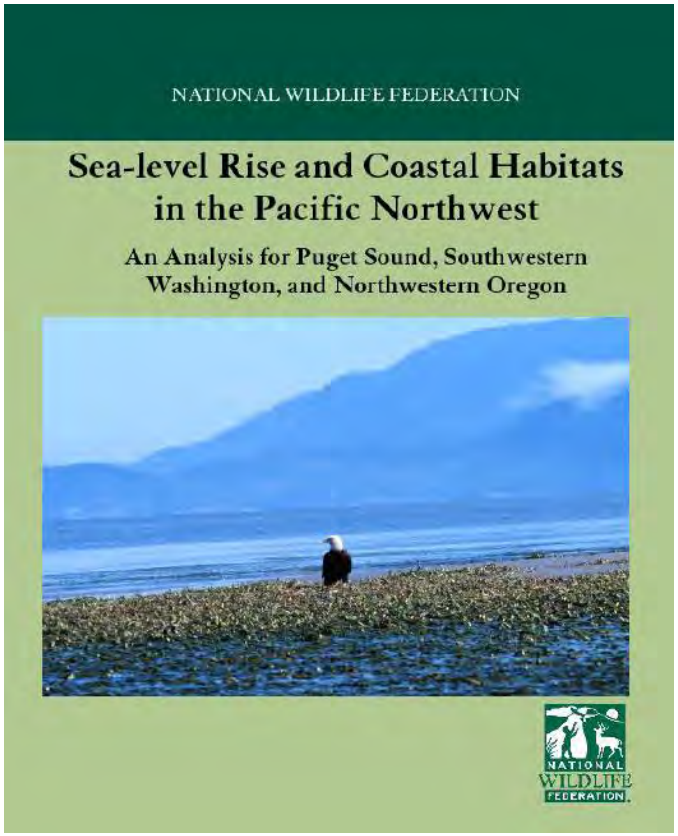
COASTAL PLANNING & RESTORATION

- Key decisions are local: SMPs, watershed groups, land trusts
- Good data leads to good planning: high-res elevations and GIS are needed to make decisions
- Many communities lack ready access to this data
- Planning for SLR is deemed “optional.” Addressing OA in planning? Barely imagined *(and addressing SLR is a prerequisite)*

PROJECT QUESTIONS

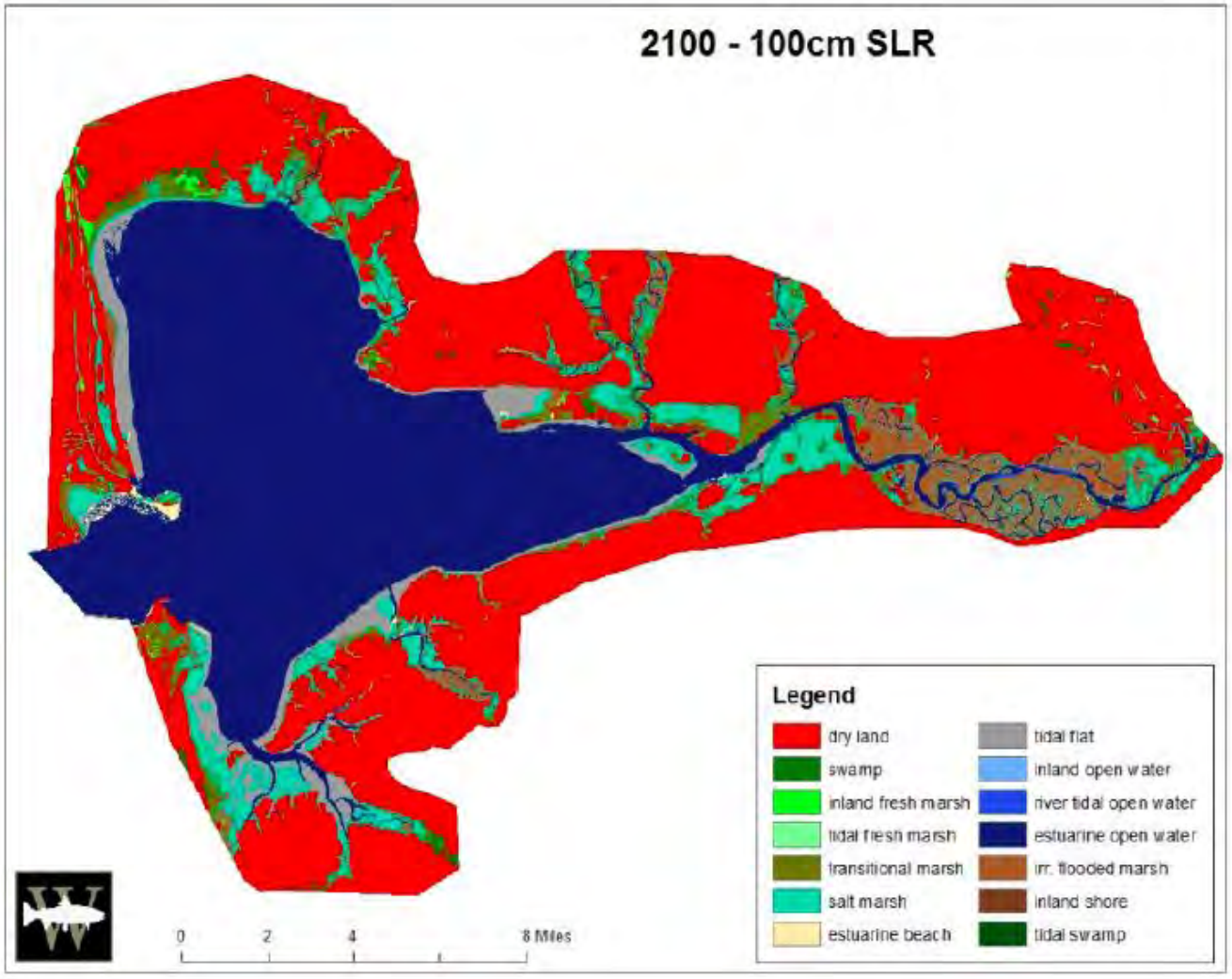
1. Given the data, can communities begin to anticipate SLR effects and use scenarios for planning?
2. Can we really expect a huge increase in saltmarsh etc?

PNW coastal habitat assessment: NWF 2007



- SLAMM (Sea Level Affecting Marshes Model) 5.0; noted some missing dike info
- 2001 SLR scenarios from IPCC: **max 0.69m by 2100**
- **used 10m DEMs**, so high uncertainty in low-relief areas

WFC study of Grays Harbor Estuary



- **Projected 4x increase in saltmarsh**
- **199x transitional marsh**

Sandell T, and A McAninch, Climate Change in the Chehalis River and Grays Harbor Estuary, Wild Fish Conservancy 2013 (prepared for Chehalis Basin Habitat Work Group)

Chehalis and Grays Harbor study, WFC 2013

- Detailed watershed assessment of climate impacts for salmon; examines multiple stresses in this system.

- SLAMM sampled DEMs from 2009 data at **5m resolution** (2x the NWF horizontal res). Result: up to ~2m in vertical errors

Grays Harbor habitat change

Wild Fish Conservancy 2013

Amount of change		Sea Level Rise		
NWI habitat categories	Our Habitat Category	A1B	75cm	1m
Dry Land	Dry Land	88%	87%	86%
Nontidal Swamp	Forest	43%	41%	34%
Inland Fresh Marsh	Scrub/Shrub Cover	45%	44%	39%
Tidal Fresh Marsh	High Emergent Marsh	11%	10%	6%
Transitional Marsh / Scrub Shrub	Scrub/Shrub Cover	265x	263x	199x
Regularly Flooded Marsh (Saltmarsh)	High Emergent Marsh	2.4x	2.6x	4.1x
Estuarine Beach	Cobble/gravel/Sand beach	67.7%	66.7%	49.5%
Tidal Flat	Mud Flat/Sand Flat	16.6%	16.7%	17.1%
Inland Open Water	Open Water	53.1%	51.9%	48.6%
Riverine Tidal Open Water	Open Water	7.5%	7.4%	7.0%
Estuarine Open Water	**Aquatic Vegetation Beds?**	2.5x	2.6x	2.6x
Irregularly Flooded Marsh	High Emergent Marsh	6x	6.1x	5.8x
Inland Shore		91.2%	90.4%	77.7%
Tidal Swamp	Forest	3.1%	2.7%	1.6%

Sandell & McAninch, 2013: Climate Change in the Chehalis River and Grays Harbor Estuary

Ducks Unlimited 2010

LiDAR, better ‘dike layer’ definition, separated major estuaries, simplified wetland classification, examined uncertainty in SLAMM; used SLAMM 6.0

SLR scenarios again use the 2001 IPCC projection of .69m

Ducks Unlimited slides adapted from 2010 presentation by Curt Mykut, Tom Dwyer, Mark Petrie, Ducks Unlimited Inc, Vancouver WA

Projected Habitat Change

North Puget Sound

From Ducks Unlimited 2010

Habitat Type	Current Conditions	0.69 SLR Dikes in Place	0.69 SLR Dikes Removed
Low Tidal	10,623	8,723	19,629
Saltmarsh	5,701	5,836	36,391
Transitional	637	2,133	9,748
Freshwater Tidal	1,569	937	716

Decrease
Increase

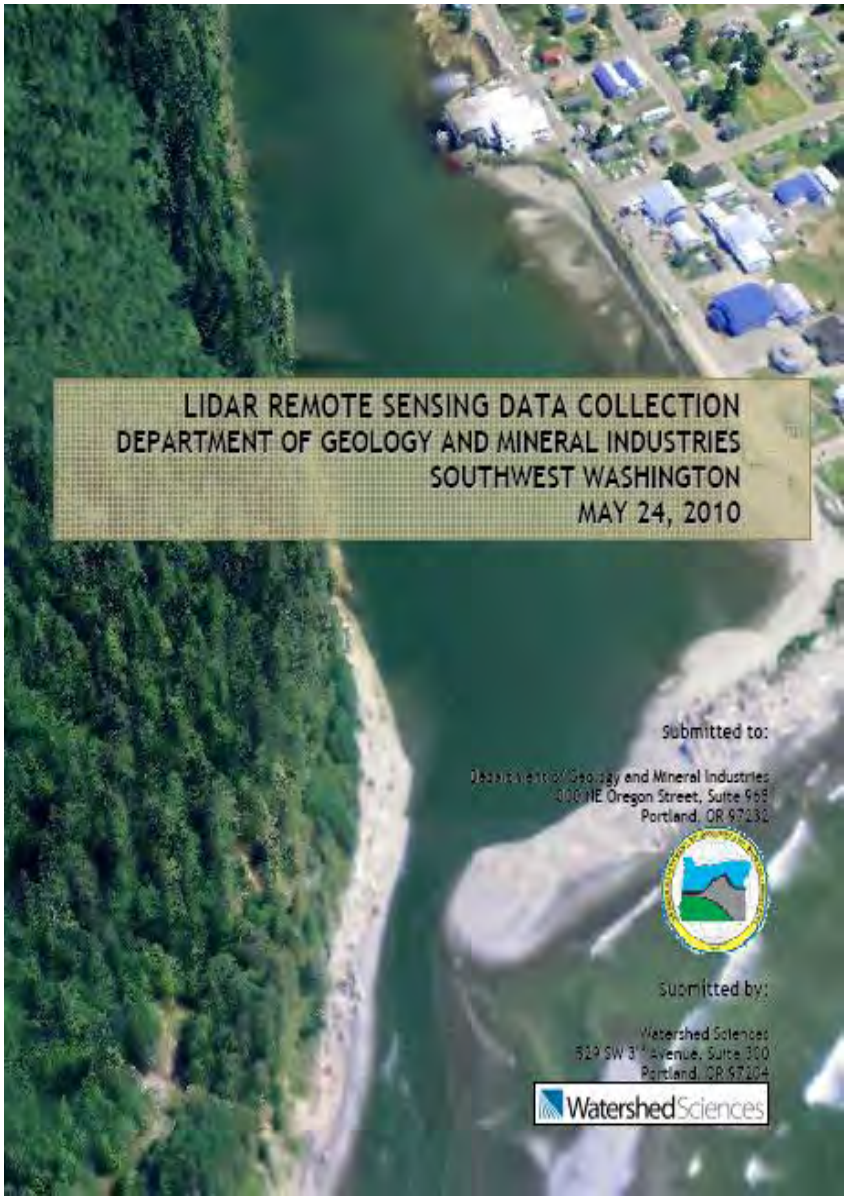
+46%

6.38x

15.3x

—54%

SOURCE: M Petrie 2010 presentation from Ducks Unlimited work



1. Overview

1.1 Study Area

Watershed Sciences, Inc. has collected Light Detection and Ranging (LiDAR) data of the Southwest Washington Study Area for the Oregon Department of Geology and Mineral Industries (DOGAMI). The area of interest (AOI) covers 463 square miles (296,307 acres) and the total area flown (TAF) covers 492 square miles (315,012 acres). The TAF acreage is greater than the original AOI acreage due to buffering and flight planning optimization (**Figure 1.1** below). The native projection for this LiDAR collection is UTM Zone 10; horizontal and vertical datum: NAD83 (CORS96)/NAVD88 (Geoid03); units: meters.

Figure 1.1. *DOGAMI Southwest Washington Study Area.*

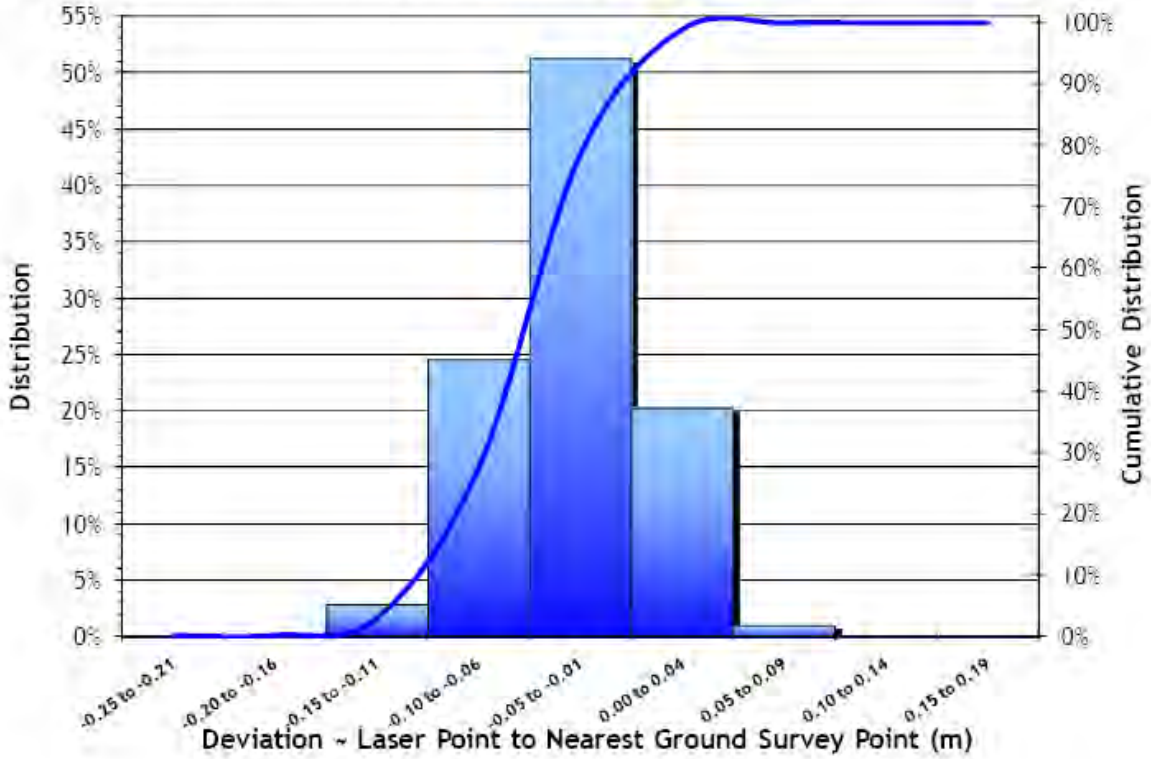
3.2 Absolute Accuracy

Absolute accuracy compares known RTK ground survey points to the closest laser point. For the Southwest Washington Study Area, a total of 9,187 RTK points were collected. Absolute accuracy is reported for the entire study area. Histogram and absolute deviation statistics are reported in **Figures 3.3 and 3.4.**

Table 3.1. *Absolute Accuracy: deviation between laser points and RTK survey points.*

Sample Size (n): 9,187	
Root Mean Square Error (RMSE): 0.05m (0.15 ft)	
Standard Deviations	**Deviations**
sigma (σ): 0.05 m (0.15 ft)	**Minimum Δz:** -0.24 m (-0.79 ft)
2 sigma (σ): 0.09 m (0.30 ft)	**Maximum Δz:** 0.19 m (0.61 ft)
	Average Δz: 0.04 m (0.12 ft)

Figure 3.3. *Southwest Washington Study Area histogram statistics*

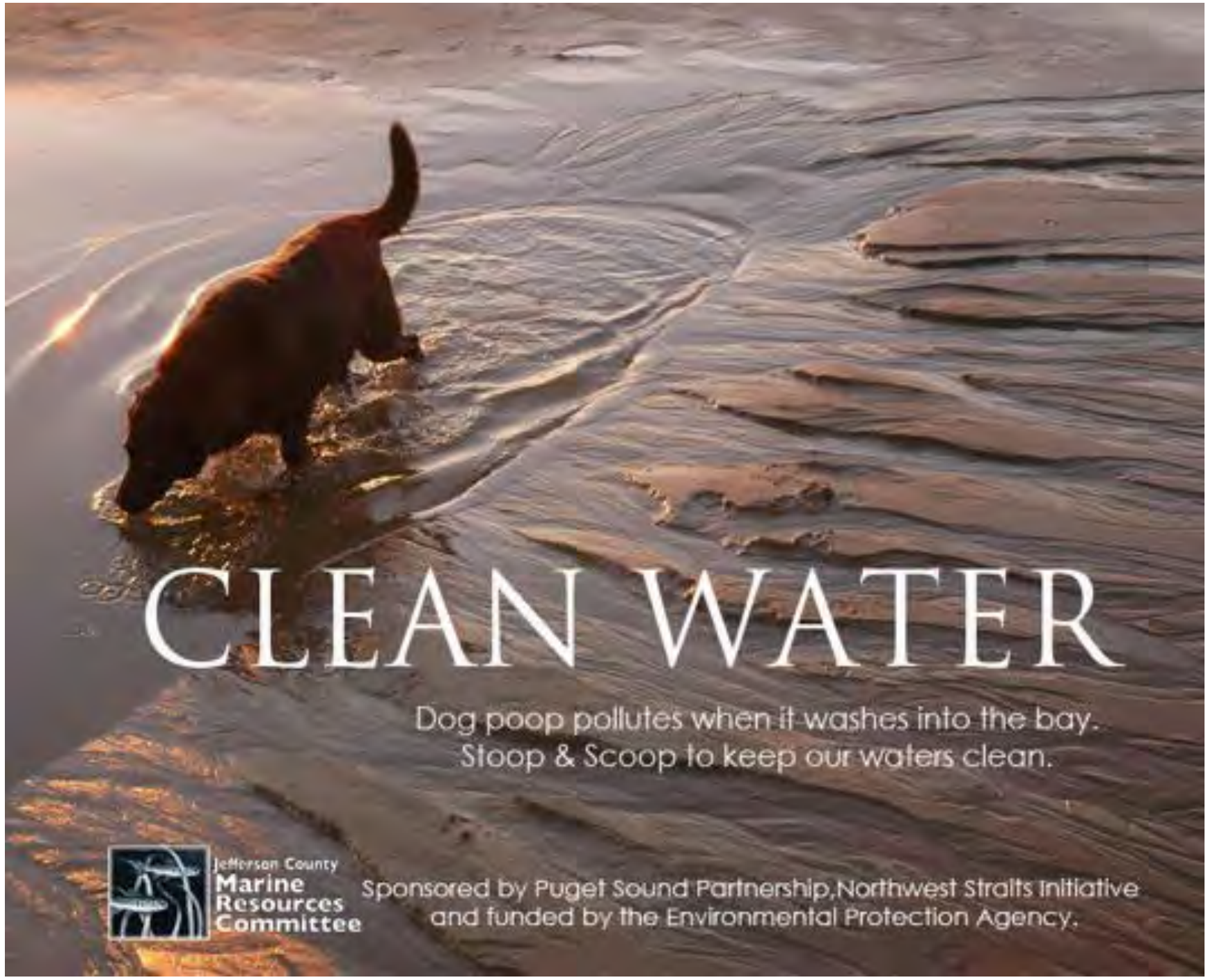


Some Initial Lessons

- Given good data, people can make good plans
- Community-driven: give communities what they need to get in front of problems, and they'll run with it
- Show people change and you find out where their priorities are

Thank you

Betsy, Brad, Nam
Jefferson MRC staff and
volunteer members


CLEAN WATER
Dog poop pollutes when it washes into the bay.
Stoop & Scoop to keep our waters clean.
Jefferson County
Marine
Resources
Committee
Sponsored by Puget Sound Partnership, Northwest Straits Initiative
and funded by the Environmental Protection Agency.


CLEAN WATER
Minimize use of lawn fertilizers.
Keep our waters clean.
Jefferson County
Marine
Resources
Committee
jeffersonmrc.org
Sponsored by Puget Sound Partnership Northwest Straits Initiative
and funded by the Environmental Protection Agency

What can we do?

Protect and restore plants and habitats that sequester carbon and buffer against acidification

Prevent nutrients and contaminants from getting into marine waters

Plant species that are OA tolerant

Stop adding to the carbon problem

We know that we can influence behavior:

PSE makes it easy to install high efficiency bulbs by giving away coupons for free bulbs

Parks provide bags for dog owners

Employers can encourage staff to tele-commute where feasible

Marinas can make it easy for boaters to find a pump out facility that works

Businesses can install bike racks for customers

Organizations can purchase high efficiency fleet vehicles

What role do you play?

Make sure that policies such as critical areas ordinances protect kelp, eelgrass

Make sure that restoration actions don't face huge regulatory hurdles

Consider improvements regarding sewage management – boats and buildings

Ensure strong enforcement of regulations –on-site septic systems, boat discharge

Green infrastructure

Land use planning/ Transit

Ocean Acidification – Action at a Local Level

June 28, 2016

Northwest Maritime Center, Port Townsend