Building coastal resilience to acidification and rising seas

High-resolution geographic data gives local planners power to act

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GlobalOceanHealth.org

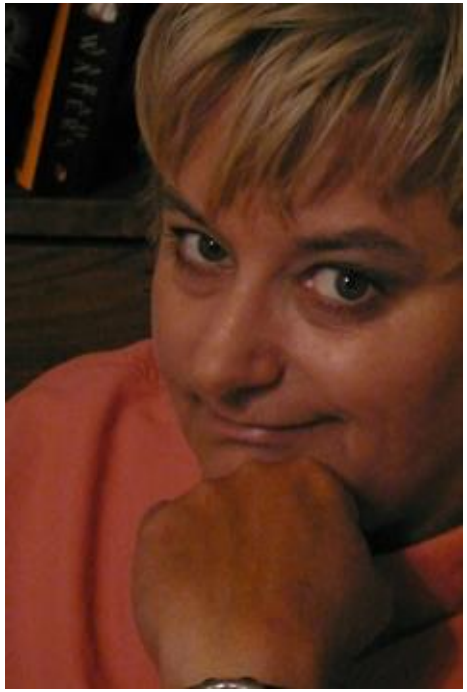
Marine Conservation Institute

Summary

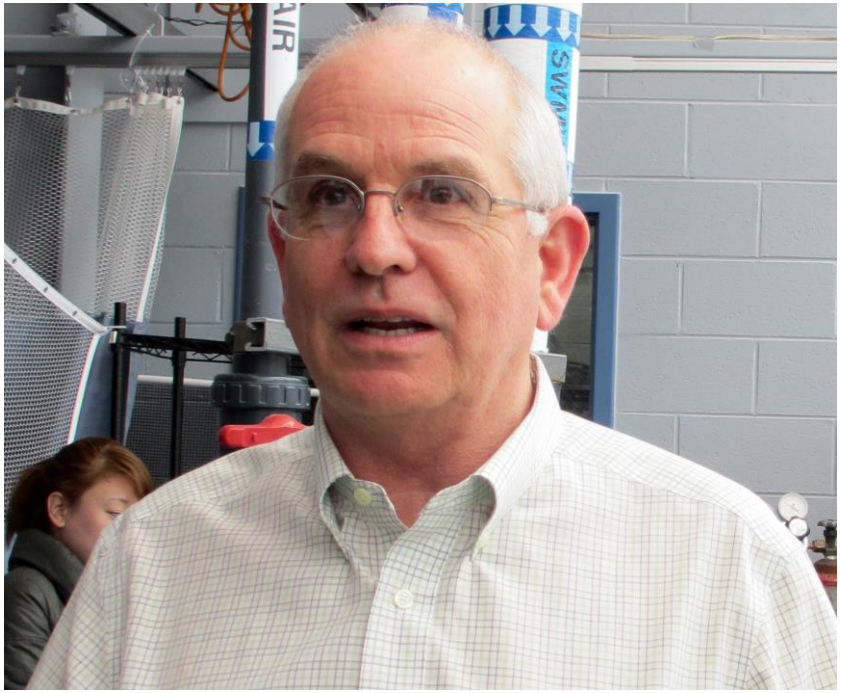
1. **Local planners** have key role in response to OA, as well as SLR and other climate impacts.
2. Restoration and resilience planning can be strengthened by providing high-res Lidar elevation models to local planners
3. Can advance vegetation based remediation (Action 6.1.1), OA refuges (Action 6.3.2), planning to reduce nutrients and organic carbon loads (Action 5.1.2).
4. Letter from MRAC to Ecology and Governor's office can encourage providing data to strengthen local planning.
5. Draft in works, will provide for review and revision.

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.

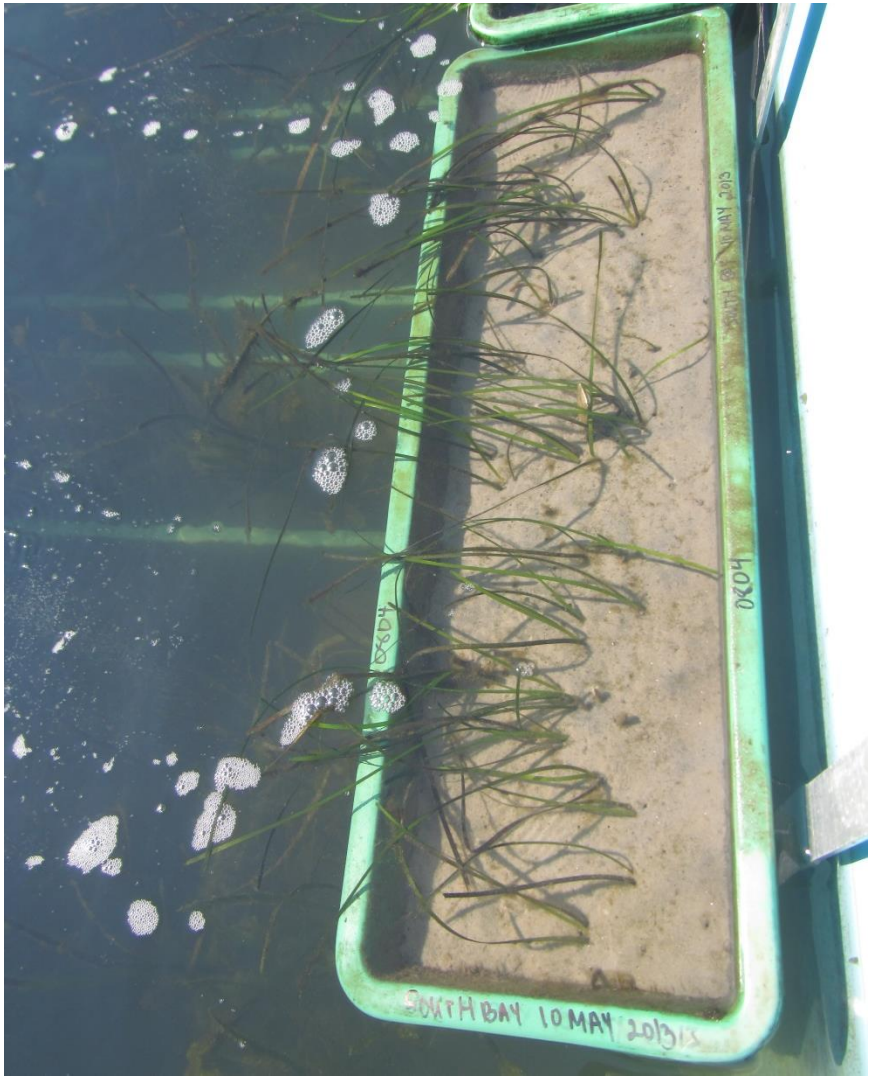


Richard Zimmerman, Old Dominion University: with colleagues, he documented CO_2 consumption by eelgrasses, showing a high-CO_2 ocean may speed growth. Some carbon can be stored in mud beneath the eelgrass beds (varies by species, place, etc)

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

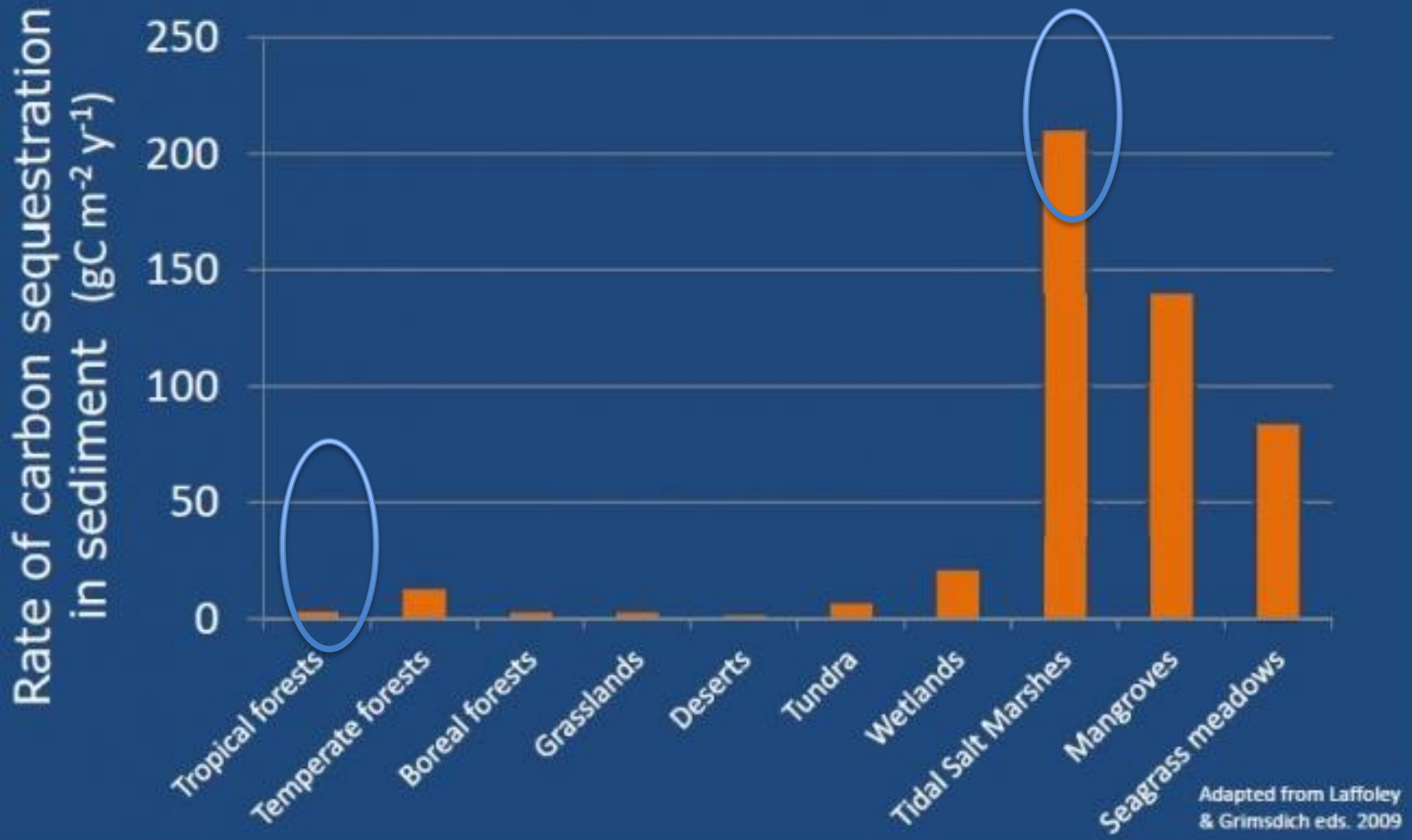
Crooks, Rybczyk, O'Connell, Devier, Poppe, and Emmett-Mattox, Restore America's Estuaries, 2014

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



Adapted from Laffoley & Grimsdich eds. 2009

Salt marsh

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

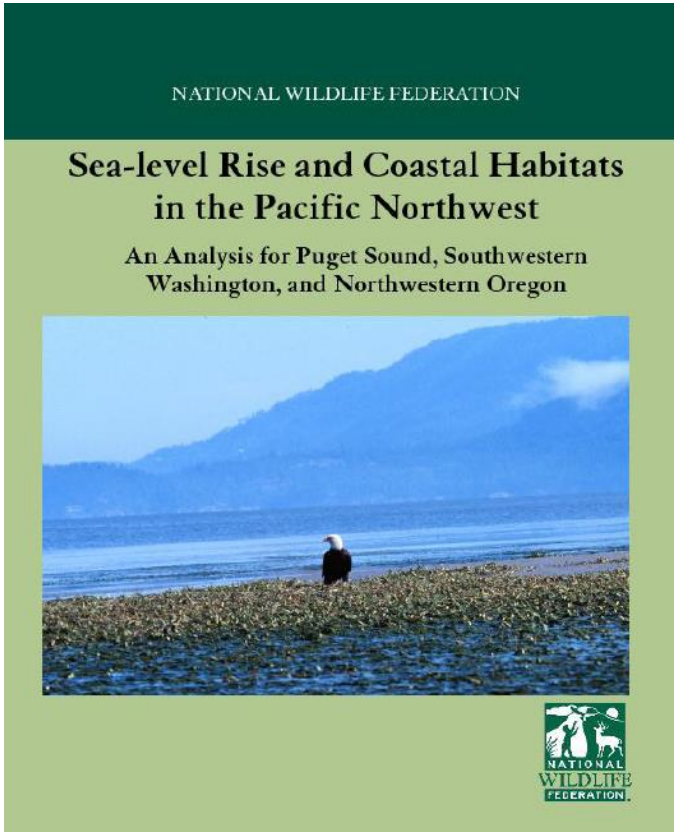
COASTAL PLANNING & RESTORATION

- 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

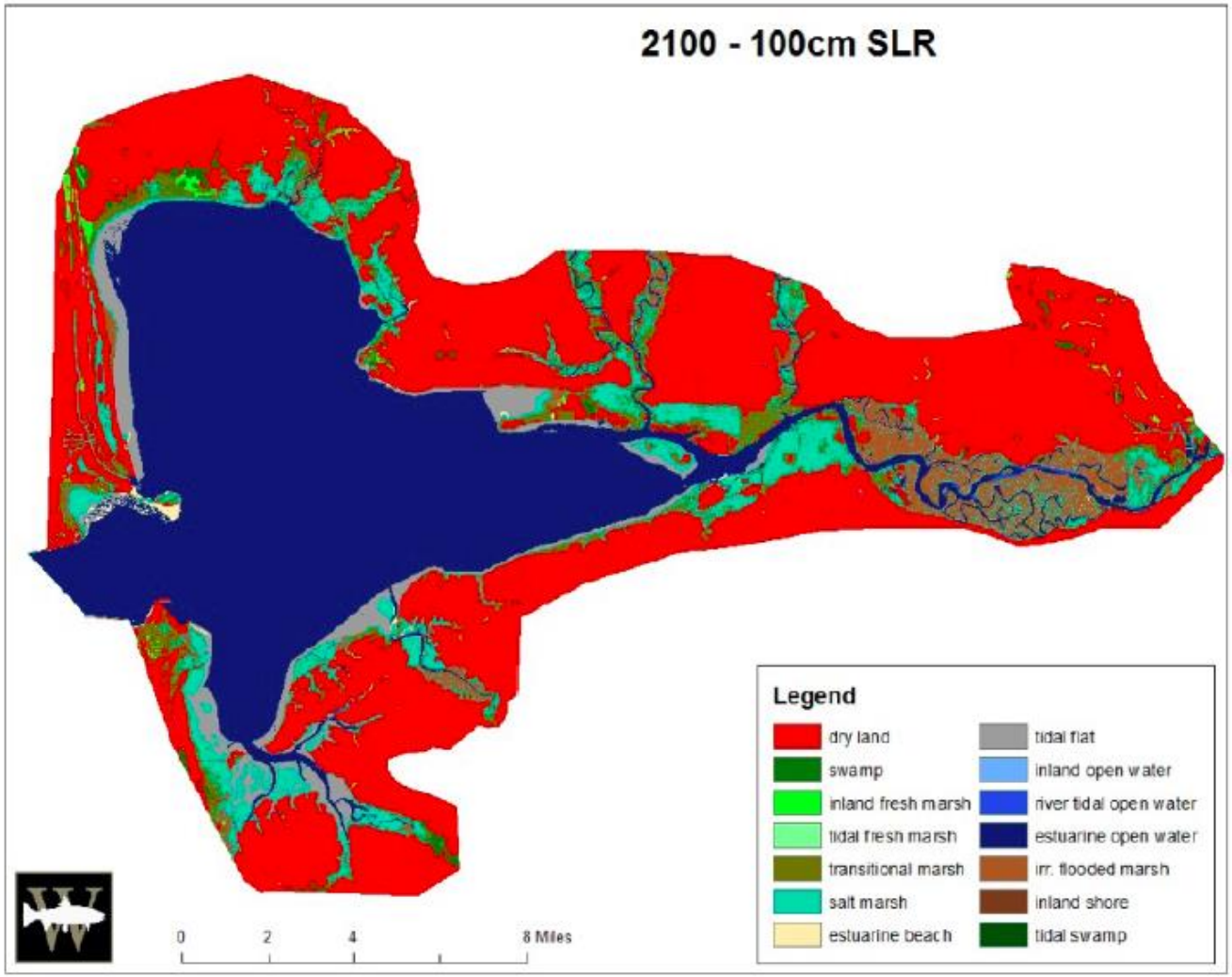
1. Given the data, can communities begin to anticipate SLR effects and use scenarios for planning?
2. Can we really expect a huge increase in saltmarsh etc?

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

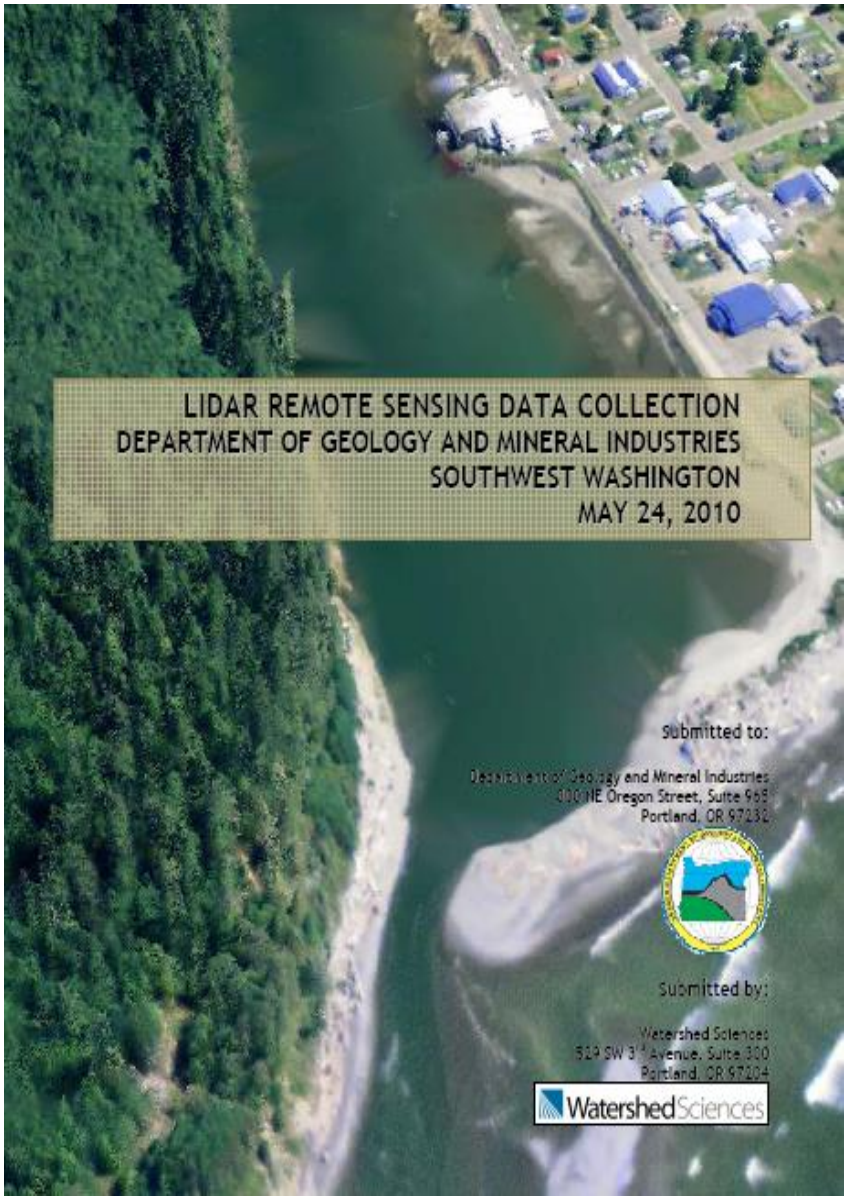
Projected Habitat Change

North Puget Sound

From Ducks Unlimited 2010

Habitat Type	Current Conditions	0.69 SLR Dikes in Place	0.69 SLR Dikes Removed	Decrease / Increase
Low Tidal	10,623	8,723	19,629	+46%
Saltmarsh	5,701	5,836	36,391	6.38x
Transitional	637	2,133	9,748	15.3x
Freshwater Tidal	1,569	937	716	—54%

SOURCE: M Petrie 2010 presentation from Ducks Unlimited work

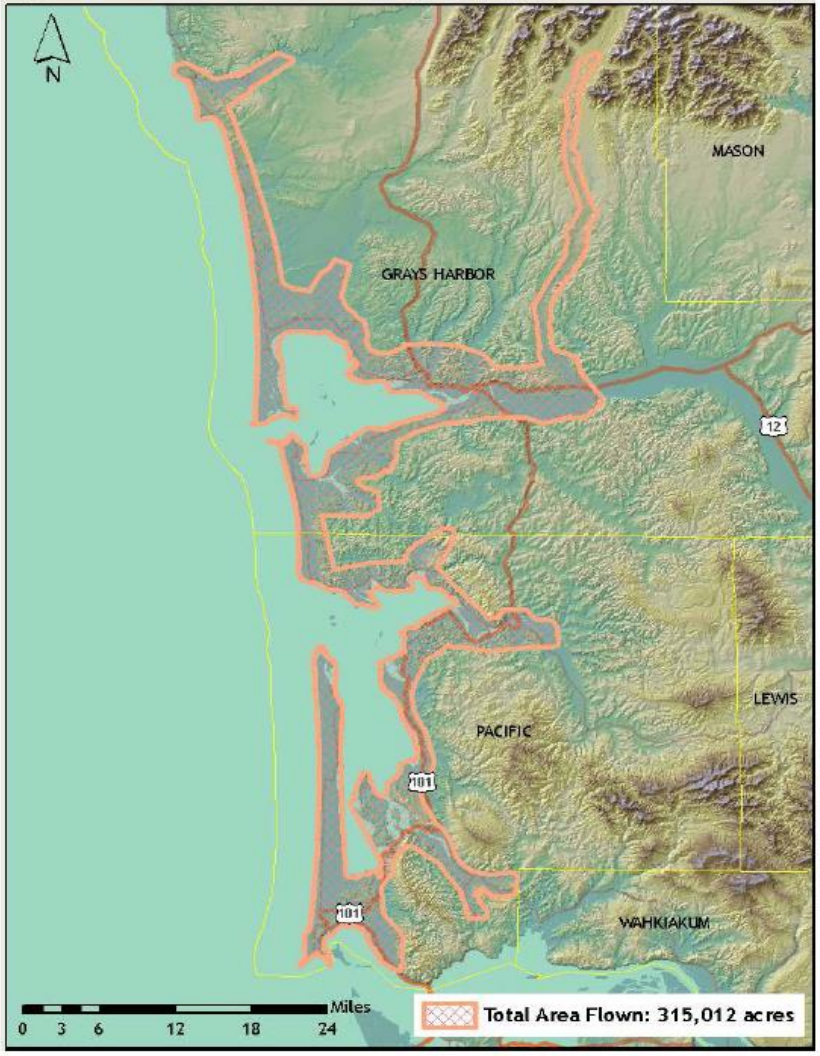


1. Overview

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.*



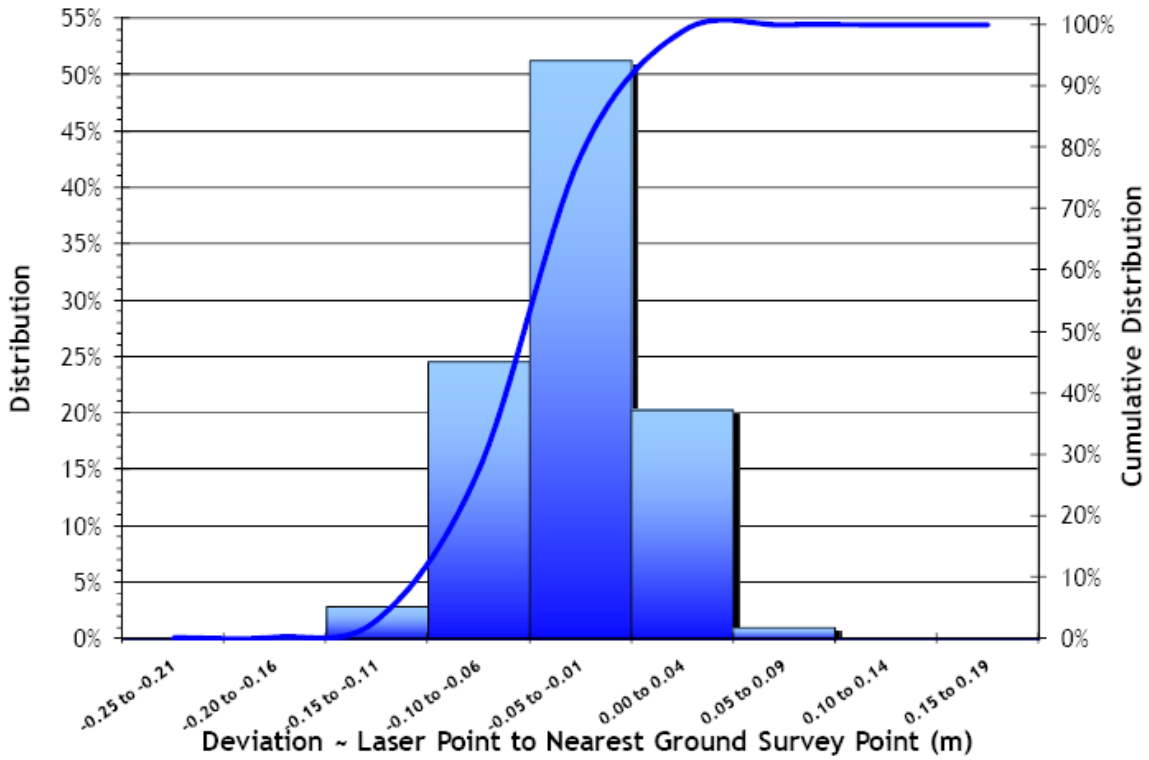
3.2 Absolute Accuracy

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

- Emergency Planning mindset is prevalent. High-res data can enable long-term planning, make SLR less “disaster-oriented”
- 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