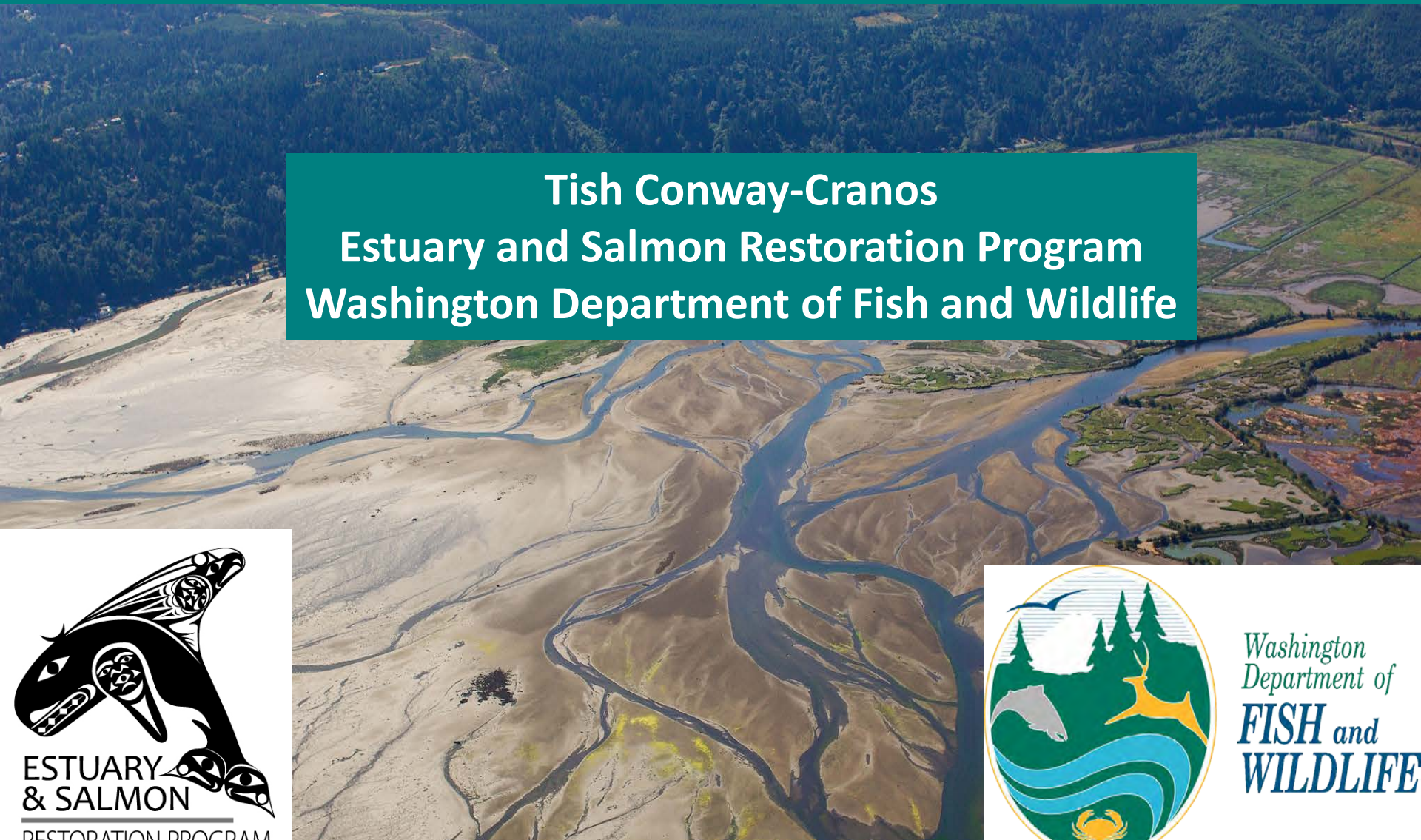
Habitat loss and restoration of ecosystem processes in Puget Sound

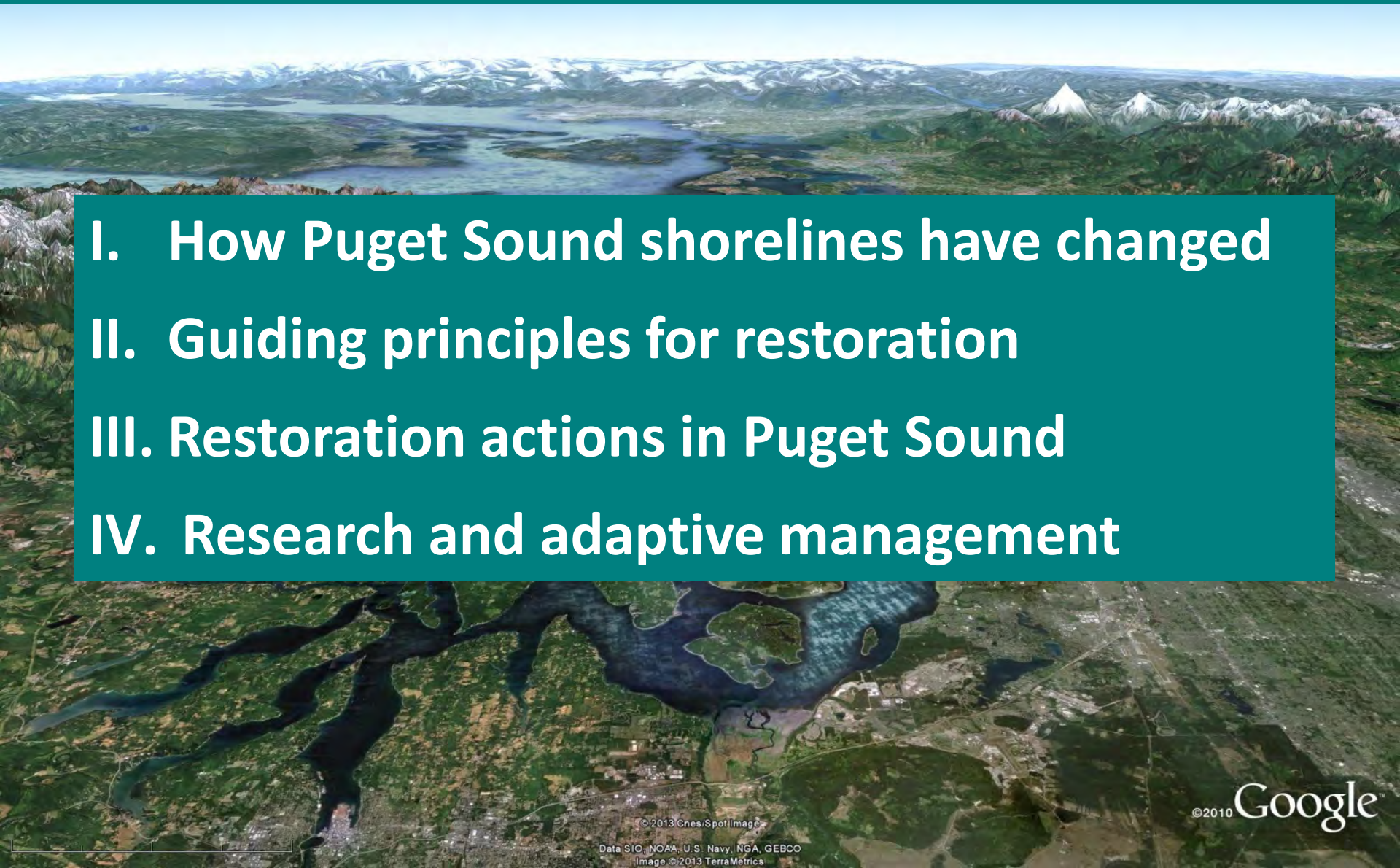


Tish Conway-Cranos
Estuary and Salmon Restoration Program
Washington Department of Fish and Wildlife

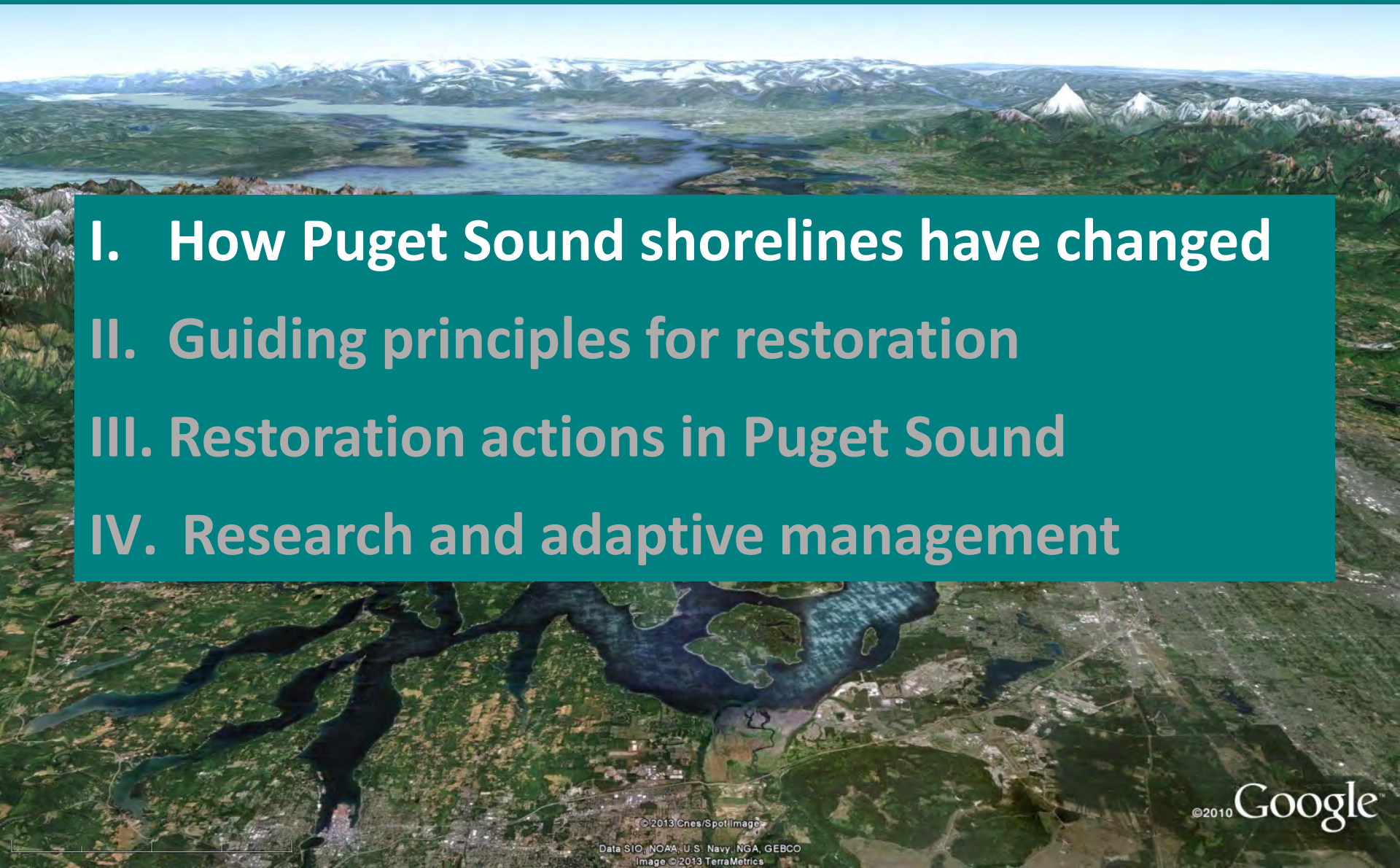
ESTUARY & SALMON RESTORATION PROGRAM

Washington Department of FISH and WILDLIFE

Habitat loss and restoration of ecosystem processes in Puget Sound



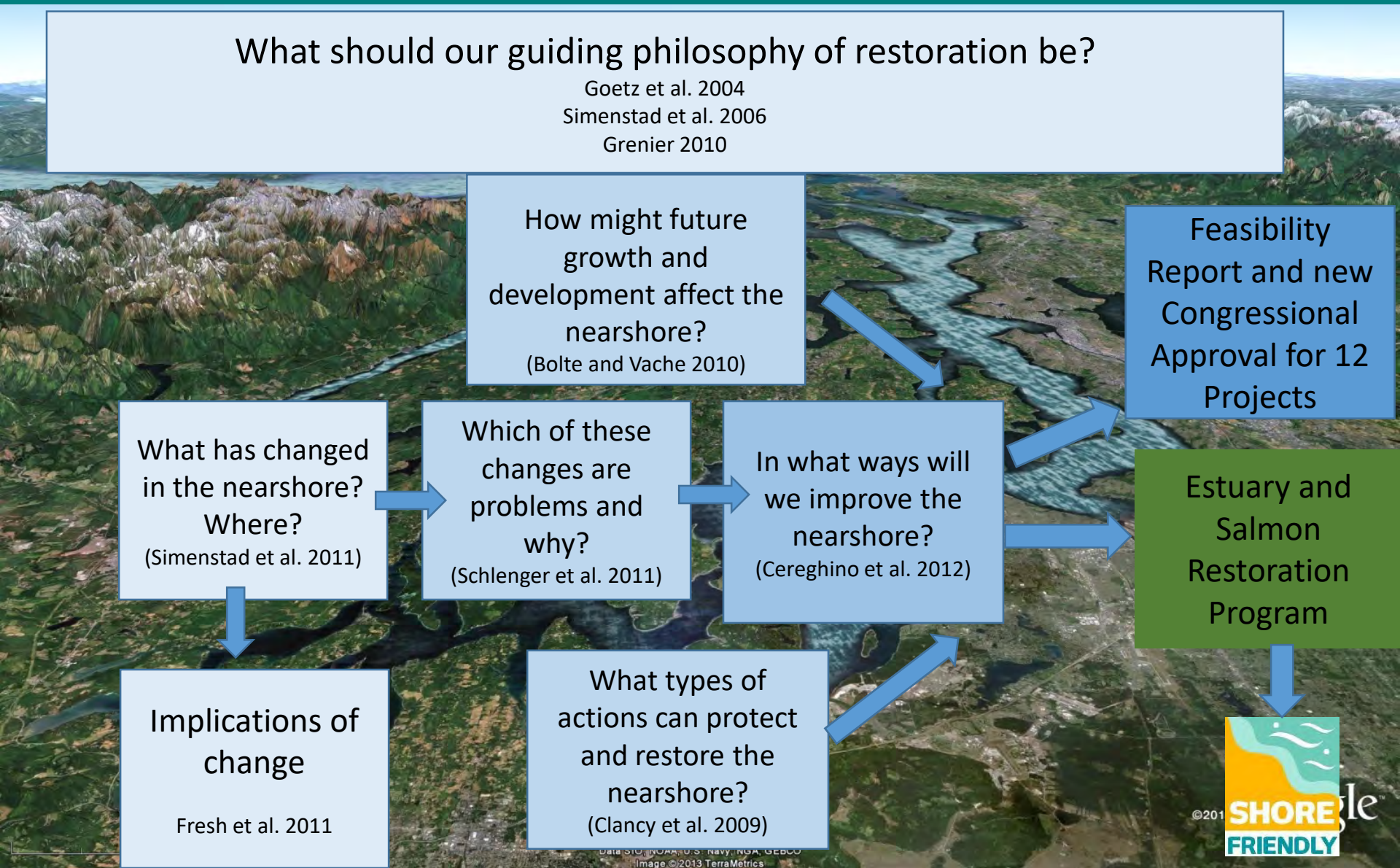
Habitat loss and restoration of ecosystem processes in Puget Sound



Puget Sound


We are here
How to approach restoration at the Puget Sound scale?
© 2013 Cnes/Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2013 TerraMetrics
©2010 Google

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)



Puget Sound

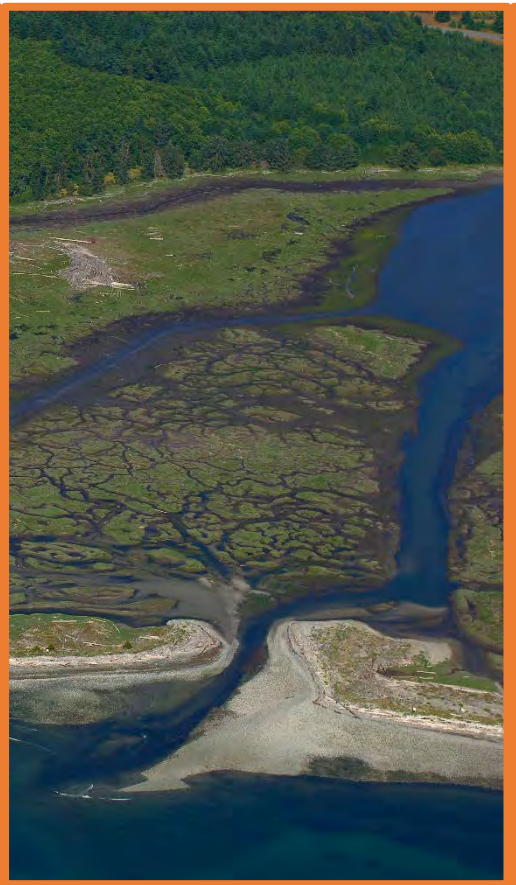

We are here
How to approach restoration at the Puget Sound scale?
© 2013 Cnes/Spot Image
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2013 TerraMetrics
©2010 Google

We organize the landscape by shoreform

Deltas

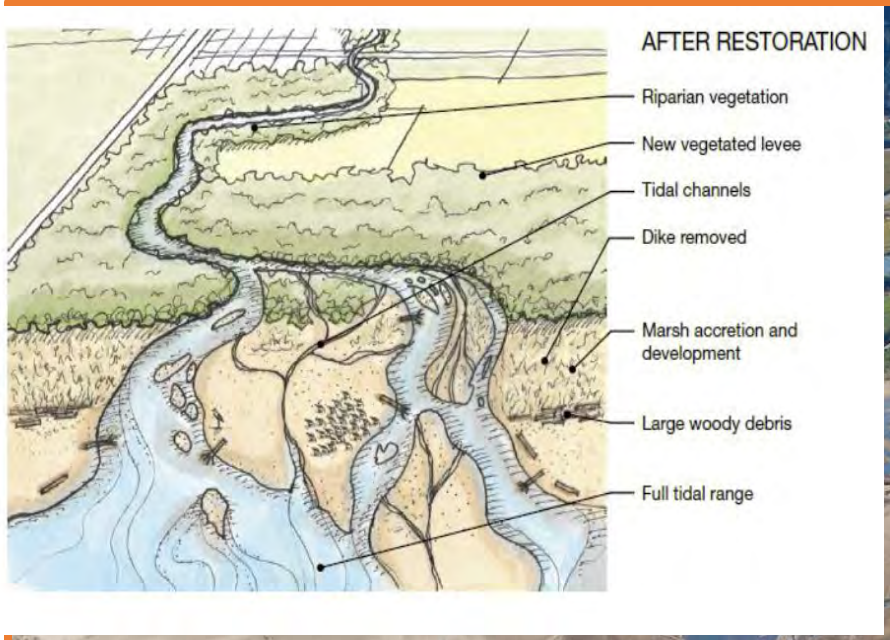
Coastal Inlets

Barrier Embayments



Beaches

Deltas

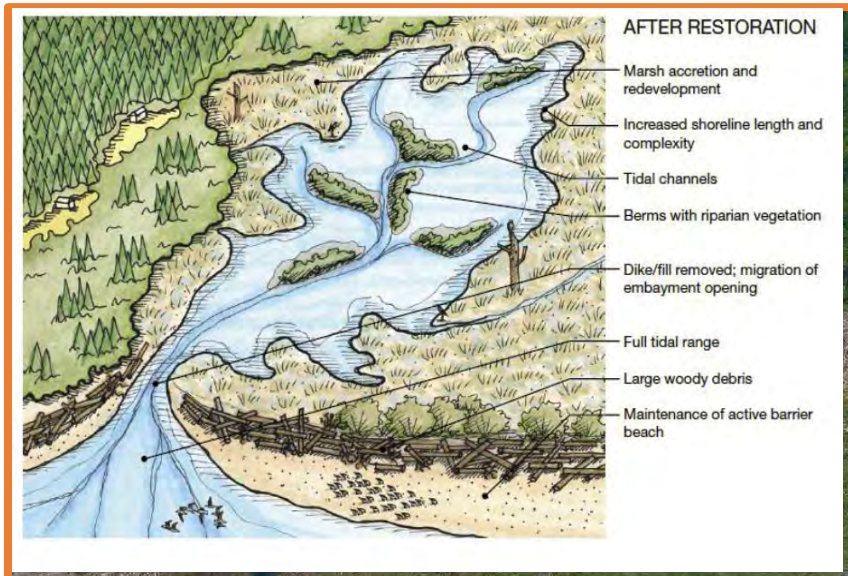


Shipman 2008,
Schlenger et al. 2011
Brandon et al. 2013

Coastal Inlets

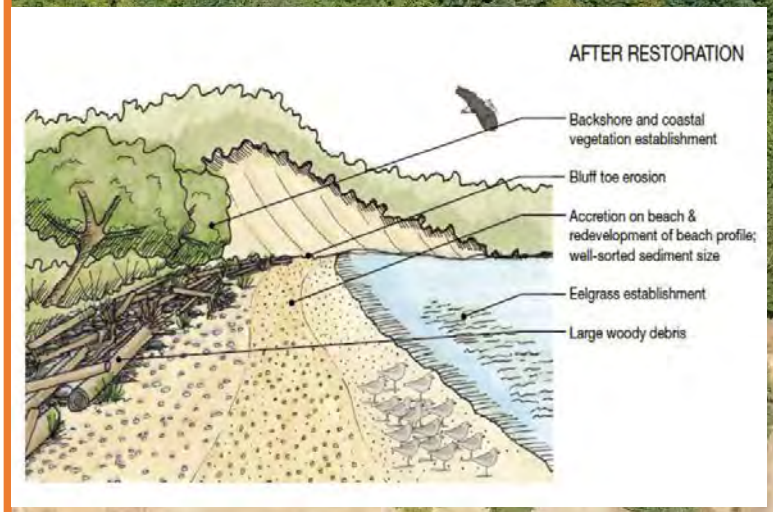
Shipman 2008,
Schlenger et al. 2011
Brandon et al. 2013

Barrier Embayments



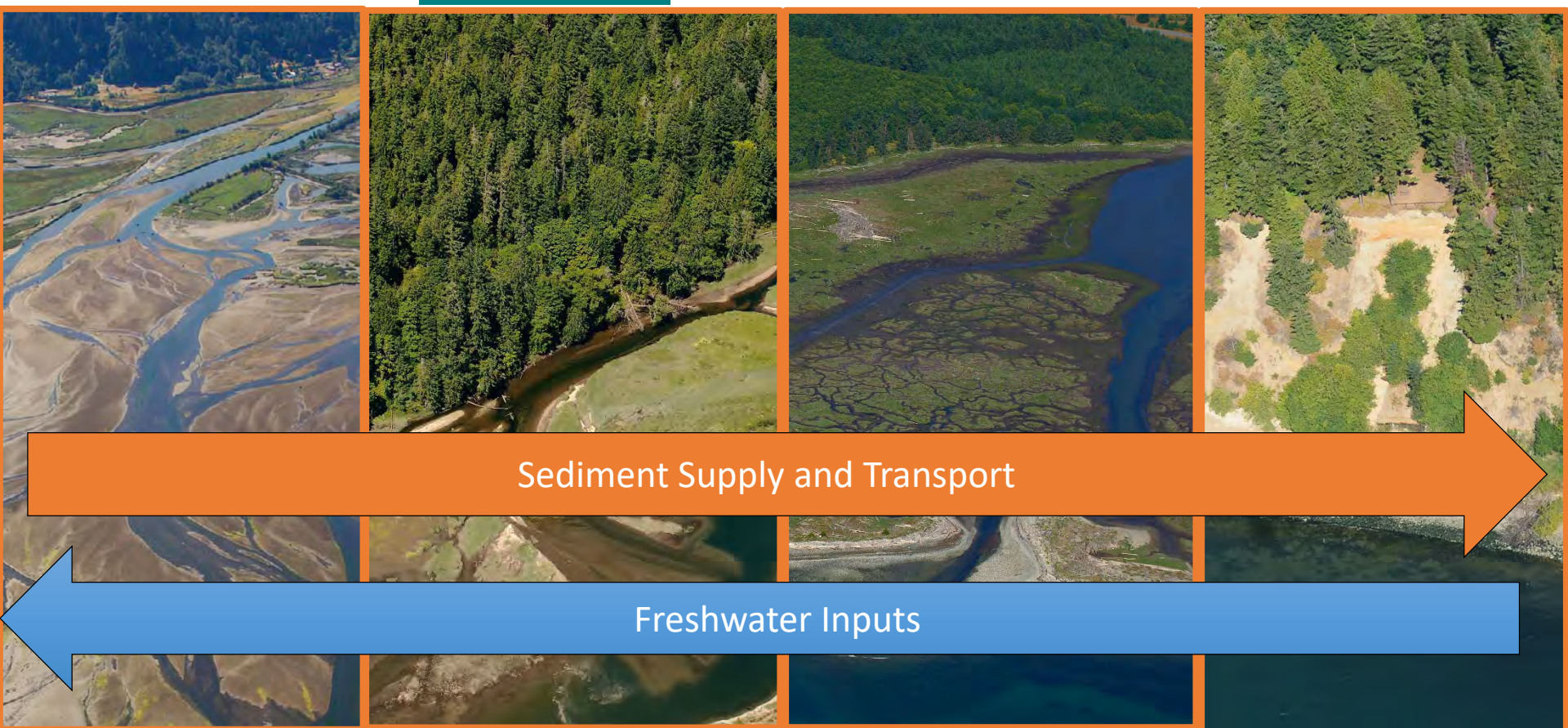
Shipman 2008,
Schlenger et al. 2011
Brandon et al. 2013

Beaches

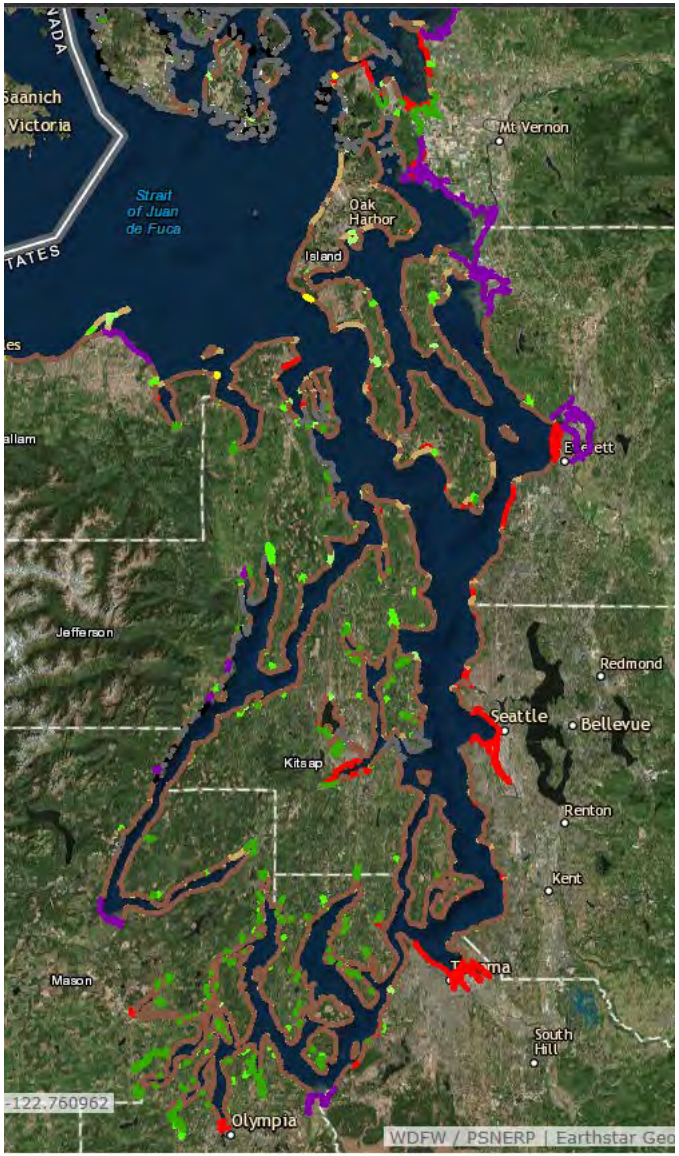


Shipman 2008,
Schlenger et al. 2011
Brandon et al. 2013

Shaped by different processes



Categorize Puget Sound by shoreform



- Delta
- Bluff Backed Beach
- Barrier Beach
- Open Coastal Inlet
- Barrier Estuary
- Barrier Lagoon
- Closed Lagoon Marsh
- Plunging Rocky
- Rocky Platform
- Pocket Beach
- Artificial

River Delta

Beaches

Open Coastal Inlet

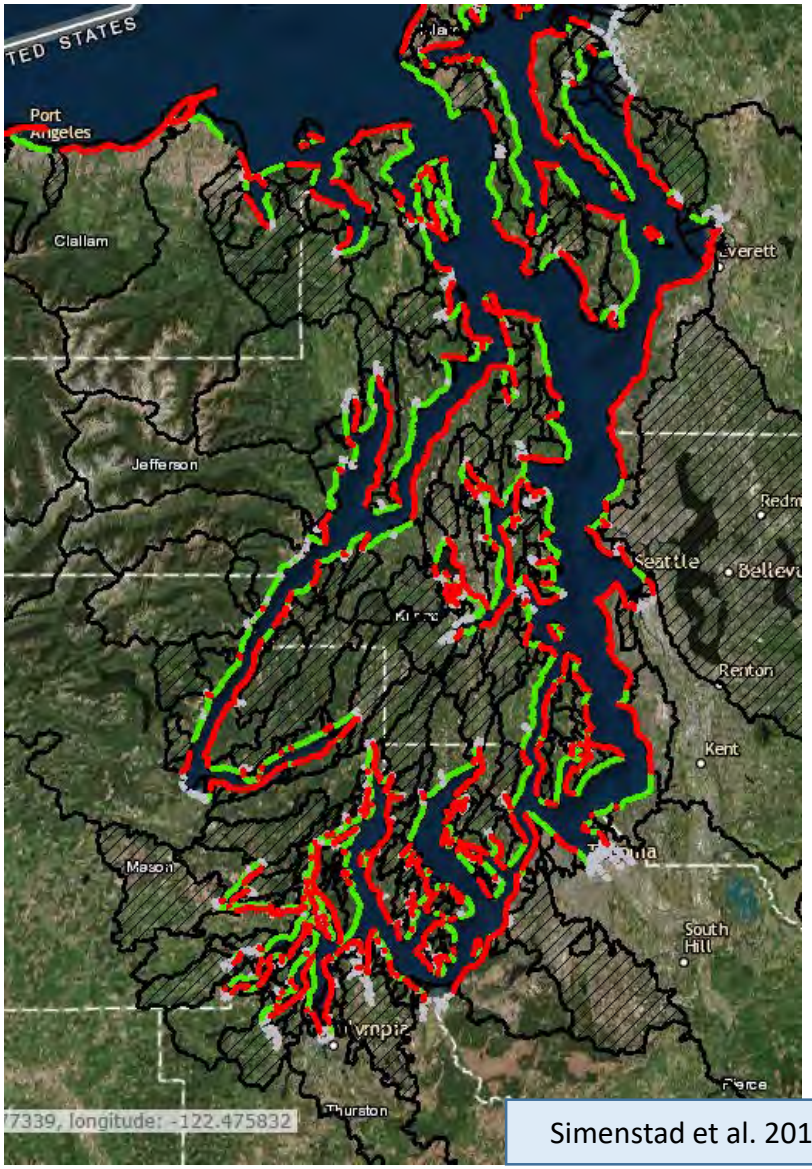
Barrier Embayments

Nearshore Process Units

Nearshore Process Unit

- **Watershed**
- **Adjacent Upland**
- **Shoreforms**

- 812 Shoreline Process Units (SPU)
- 16 Delta Process Units (DPU)
- SPU's defined by **net sediment drift**

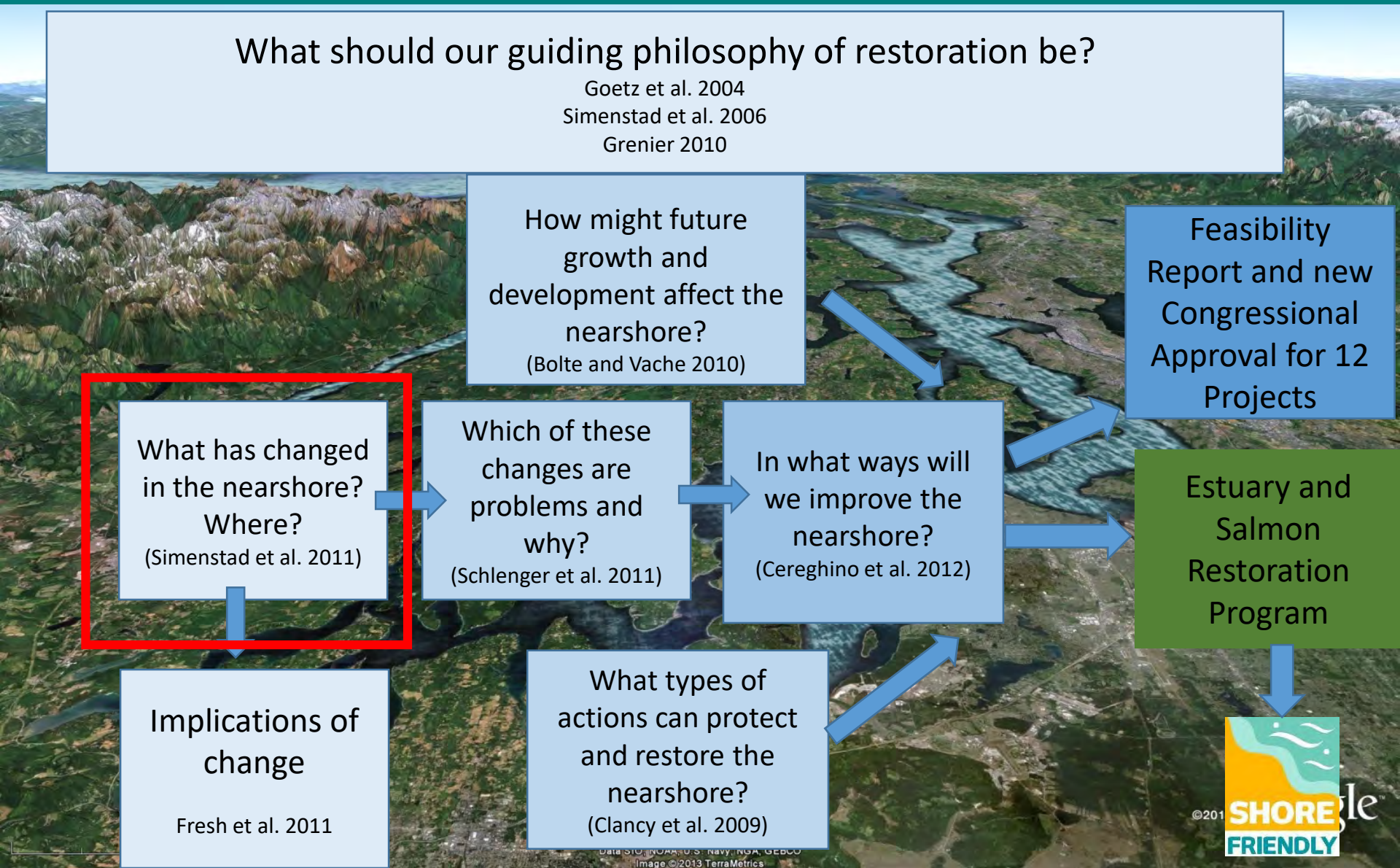


Simenstad et al. 2011

How sediment moves through drift cells

SHORE FRIENDLY

The Puget Sound Ecosystem Restoration Project (PSNERP)

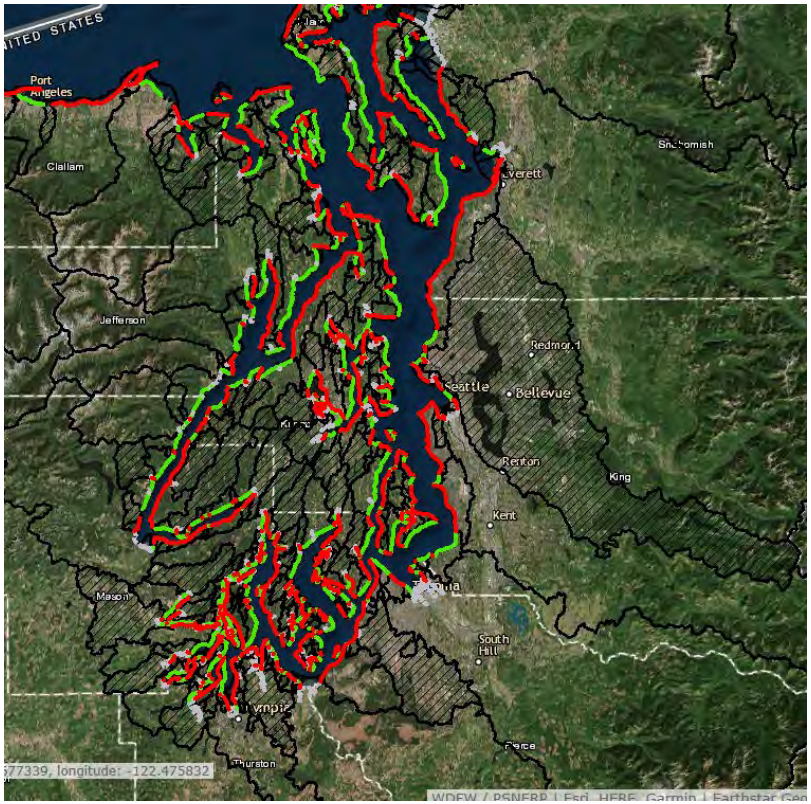


Assessing change at multiple spatial scales

1852-1926 to 2000-2006

Nearshore Process Unit

- Watershed
- Adjacent Upland
- Shoreforms



Big Data Compilation Effort!

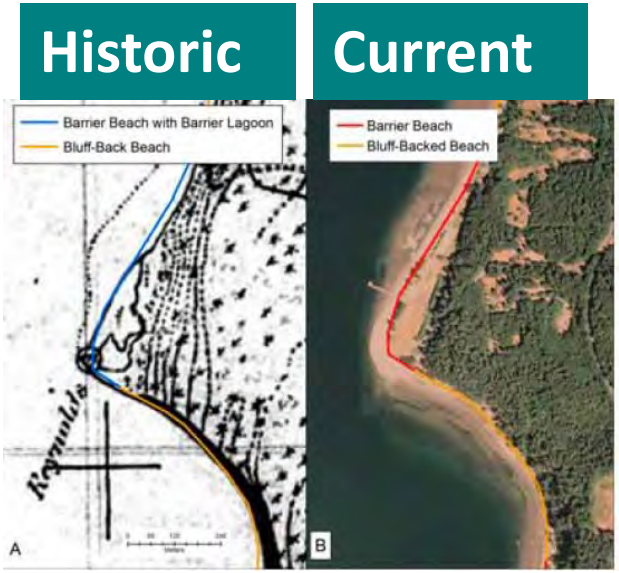
Simenstad et al. 2011

Assessing change at multiple spatial scales

1852-1926 to 2000-2006

Nearshore Process Unit

- Watershed
- Adjacent Upland
- Shoreforms



Big Data Compilation Effort!

Simenstad et al. 2011

Assessing change at multiple spatial scales

1852-1926 to 2000-2006

Nearshore Process Unit

- Watershed
- Adjacent Upland
- Shoreforms

→

- Roads
- Railroads
- Land Cover
- Impervious Surfaces
- Stream Crossings

Big Data Compilation Effort!

Simenstad et al. 2011

Assessing change at multiple spatial scales

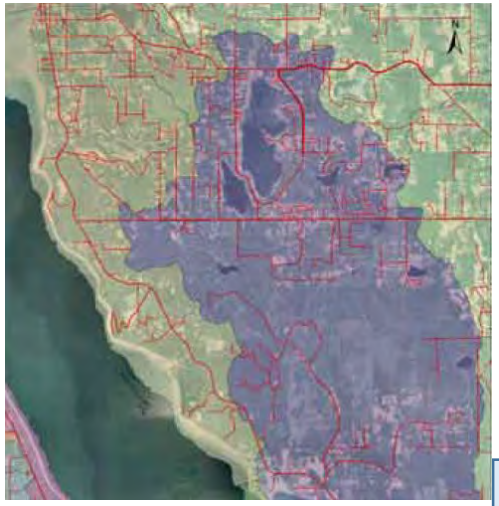
1852-1926 to 2000-2006

Nearshore Process Unit

- Watershed
- Adjacent Upland
- Shoreforms

→

- Roads
- Railroads
- Land Cover
- Impervious Surfaces
- Stream Crossings
- Drainage Area
- Impoundment by dams



Big Data Compilation Effort!

Simenstad et al. 2011

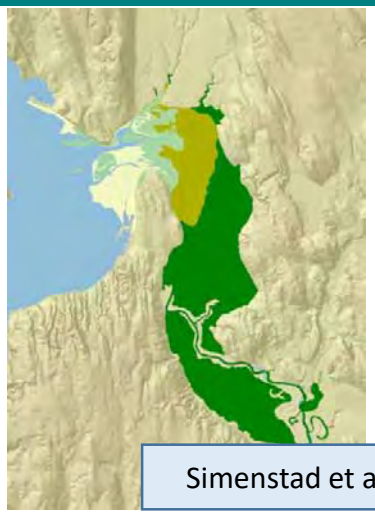
Assessing change at multiple spatial scales

1852-1926 to 2000-2006

Nearshore Process Unit

- Watershed
- Adjacent Upland
- Shoreforms

Loss/gain of intertidal wetlands
Armoring
Tidal Barriers
Breakwaters/jetties
Overwater structures
Nearshore Fill
Marinas



Simenstad et al. 2011

Big Data Compilation Effort!

Shoreforms: then and now

Historic

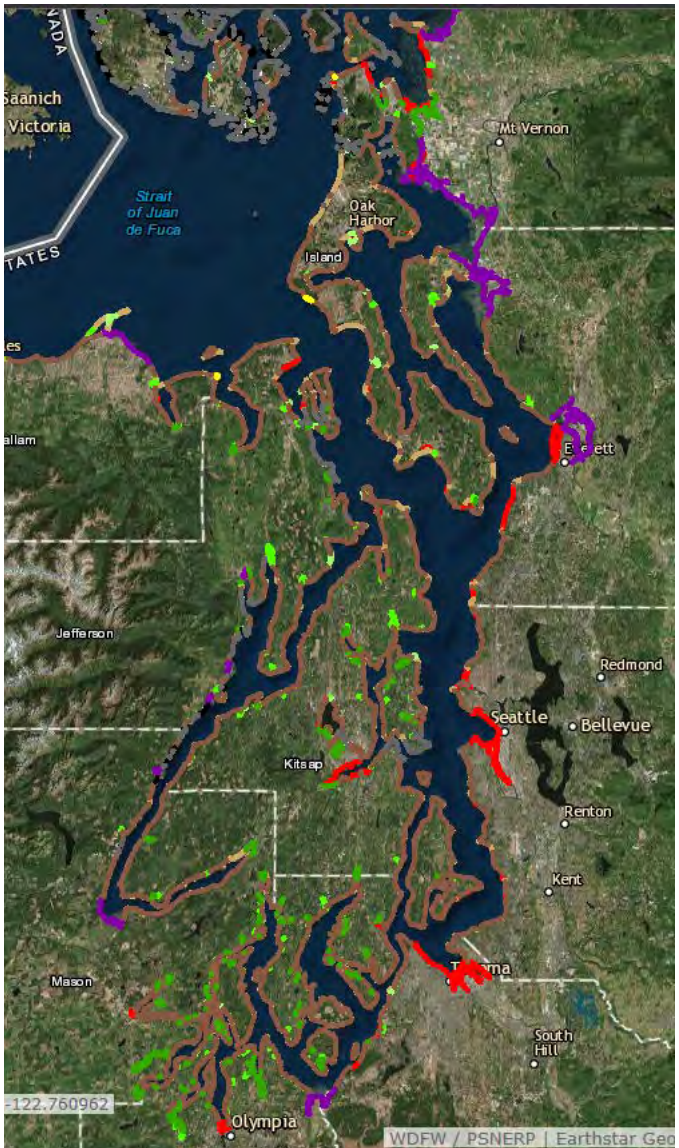
- Delta
- Bluff Backed Beach
- Barrier Beach
- Open Coastal Inlet
- Barrier Estuary
- Barrier Lagoon
- Closed Lagoon Marsh
- Plunging Rocky
- Rocky Platform
- Pocket Beach
- Artificial

Simenstad et al. 2011

Shoreforms: then and now

Historic

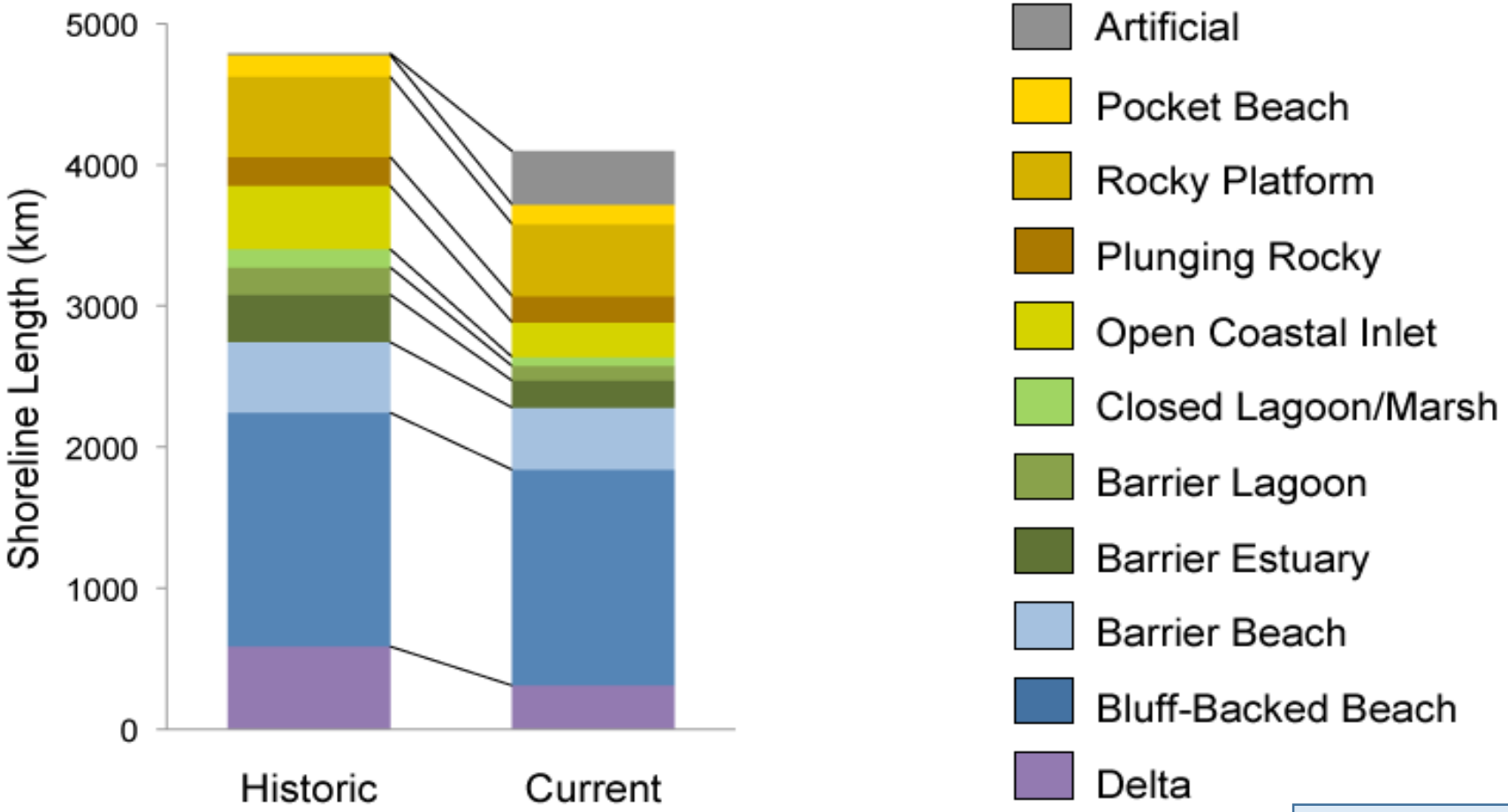
Current



- Delta
- Bluff Backed Beach
- Barrier Beach
- Open Coastal Inlet
- Barrier Estuary
- Barrier Lagoon
- Closed Lagoon Marsh
- Plunging Rocky
- Rocky Platform
- Pocket Beach
- Artificial

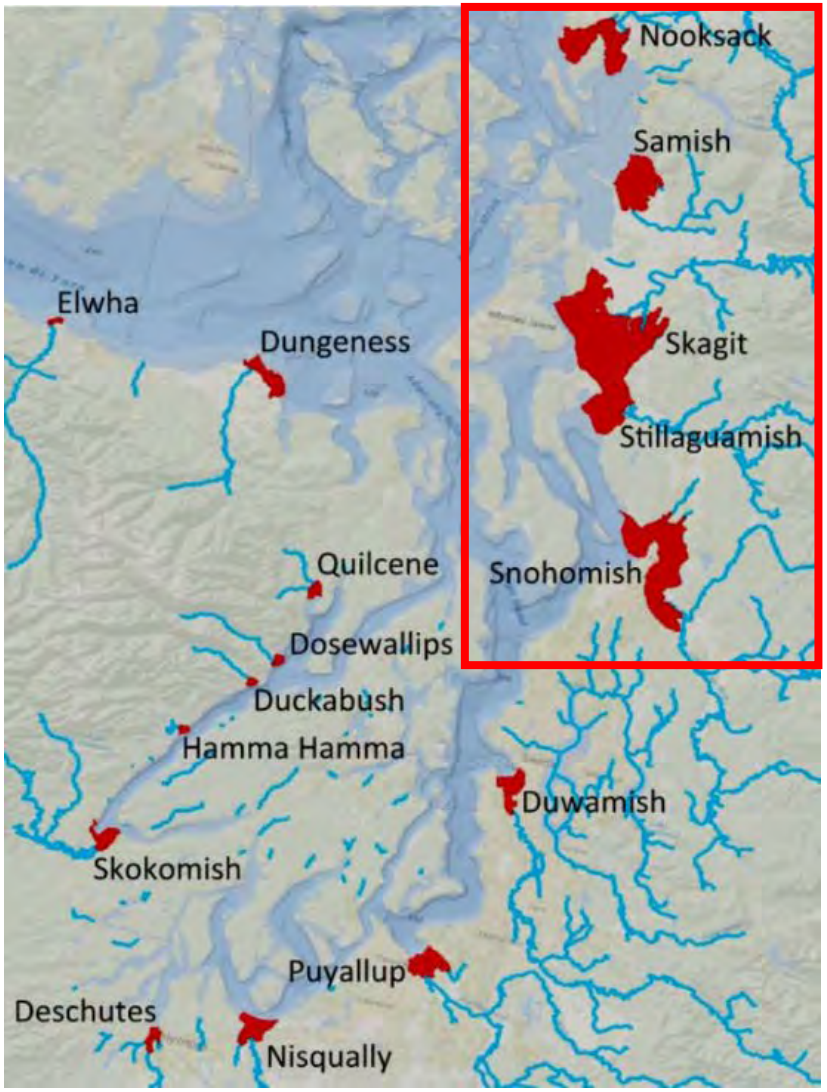
Simenstad et al. 2011

Shorter, simpler, more artificial shorelines



Simenstad et al. 2011

Loss of tidal wetlands in Puget Sound



77% loss of vegetated wetlands from 16 largest river deltas


PLOS ONE

Insights into estuary habitat loss in the western United States using a new method for mapping maximum extent of tidal wetlands

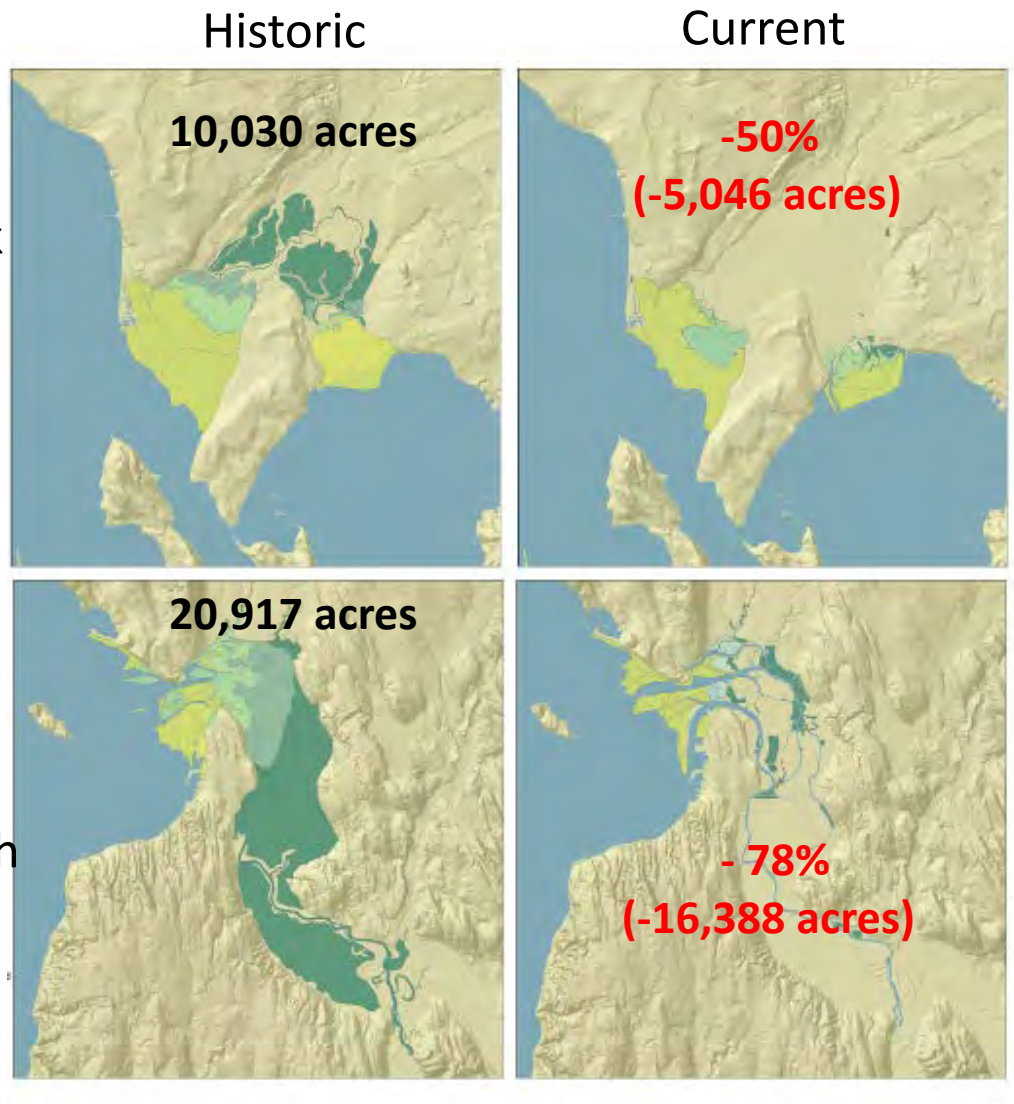
Abstract

Recent paper→ Brophy et al. 2019, similar results

PMEP
PACIFIC MARINE & ESTUARINE FISH HABITAT PARTNERSHIP

Simenstad et al. 2011

Loss of tidal wetlands in Puget Sound



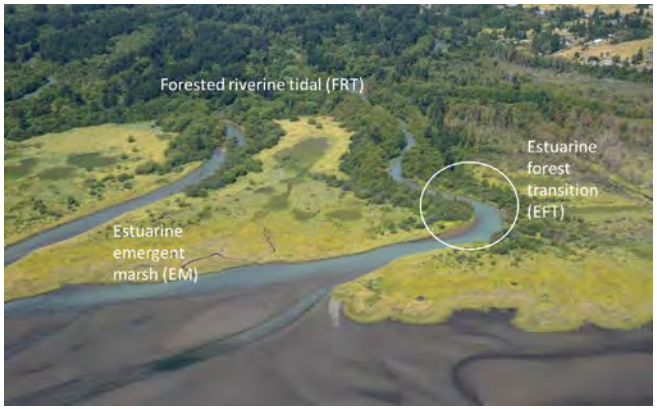
Euryhaline unvegetated

Estuarine mixing

Oligohaline transition

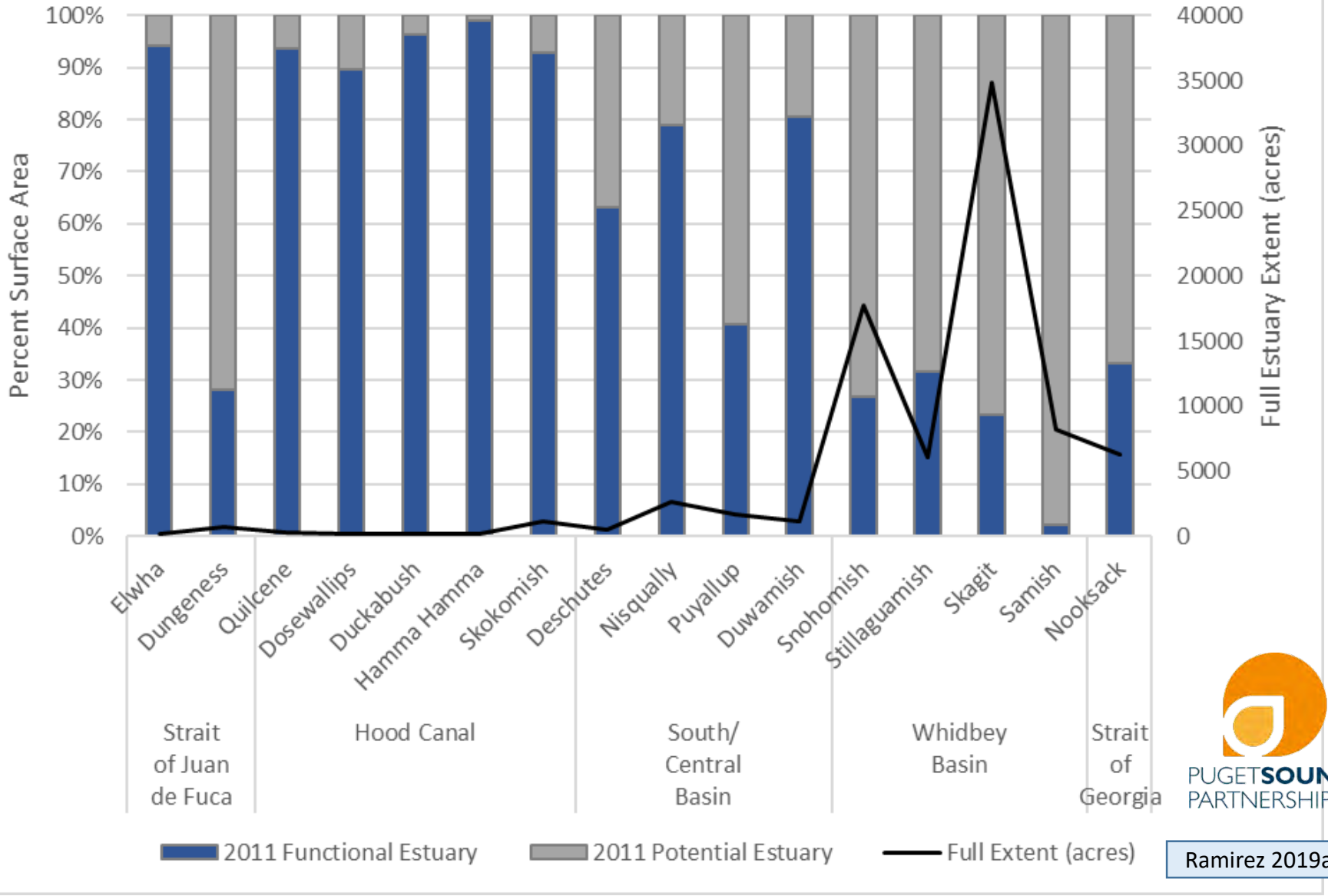
Tidal freshwater

Disproportionate loss of some habitats → Tidal Freshwater



Simenstad et al. 2011

Recent Puget Sound Analysis



PUGETSOUND PARTNERSHIP

Ramirez 2019a, b

Nearshore habitat degradation in Puget Sound

~77% of large river estuaries are diked or filled ~1/3 of beaches are armored

Riprap on Ediz Hook in Port Angeles

Elliott Bay Marina and Magnolia neighborhood in Seattle

Aerial of Purdy Spit and Purdy Lagoon

Highway across Purdy Spit

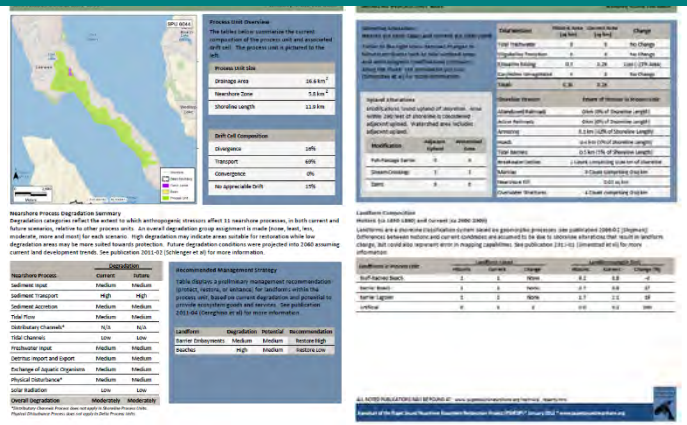
Pier at Redondo Beach

Railroad grade and isolated tidal wetland in Woodway, south o

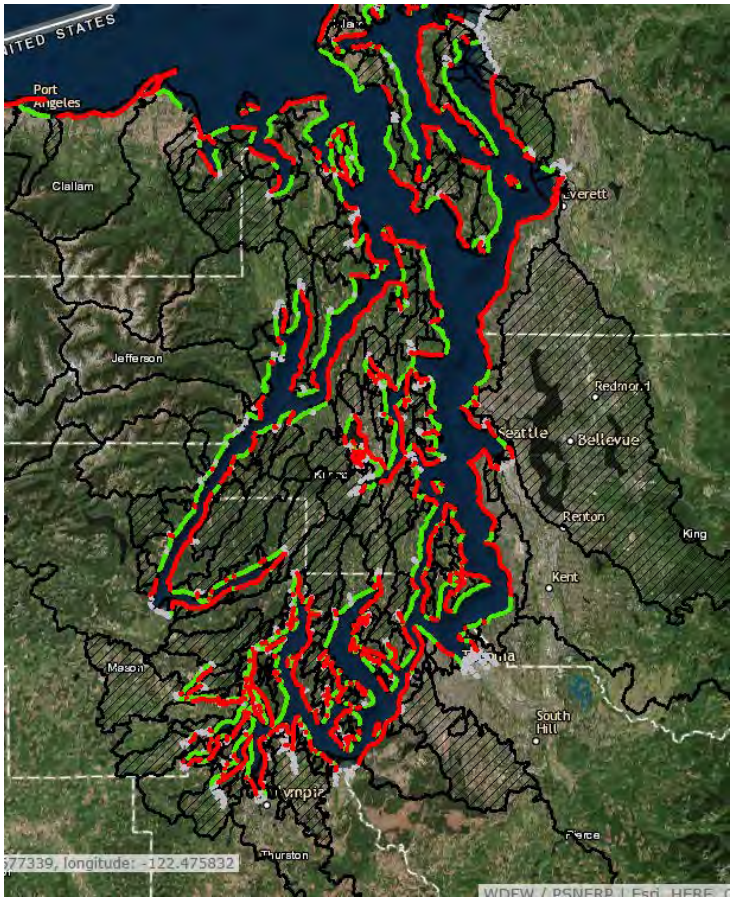
Drift logs accumulated on beach at Elger Bay, Camano Island

Simenstad et al. 2011

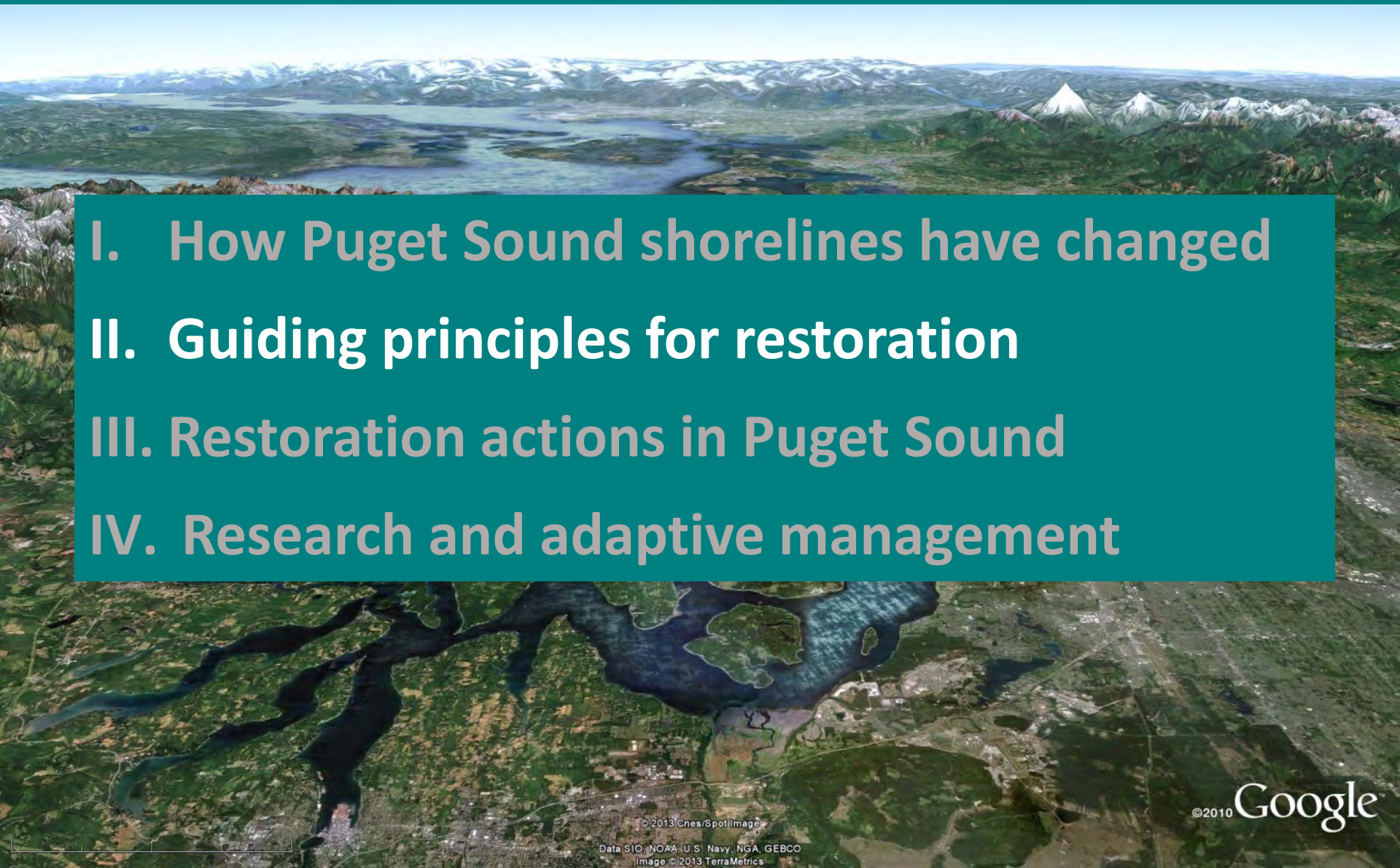
PSNERP Process Unit 2 Pagers



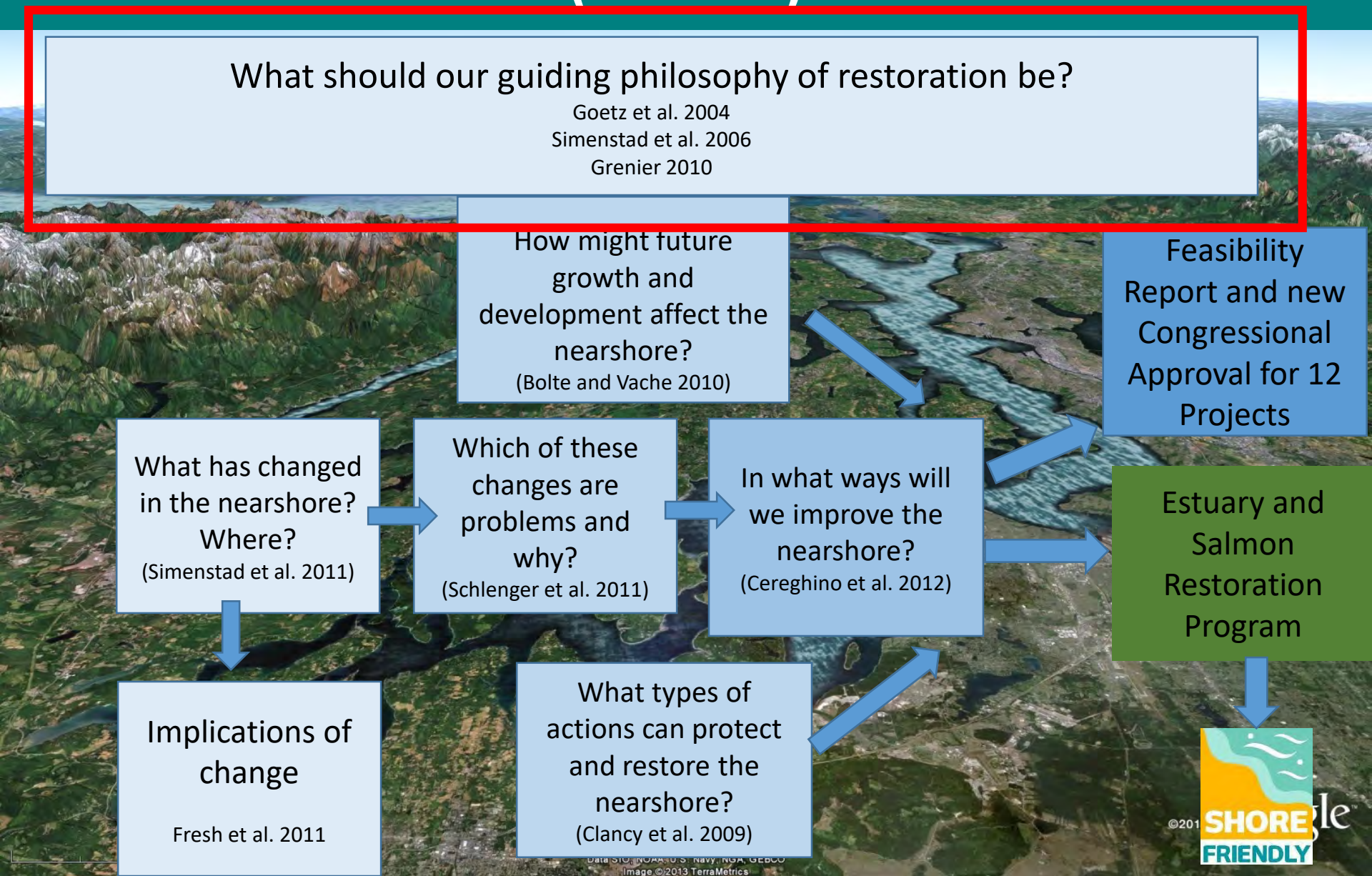
- Sediment dynamics
- Process degradation
- Shoreforms present
- Upland and watershed features
- Shoreline modifications
- Wetland loss/gain



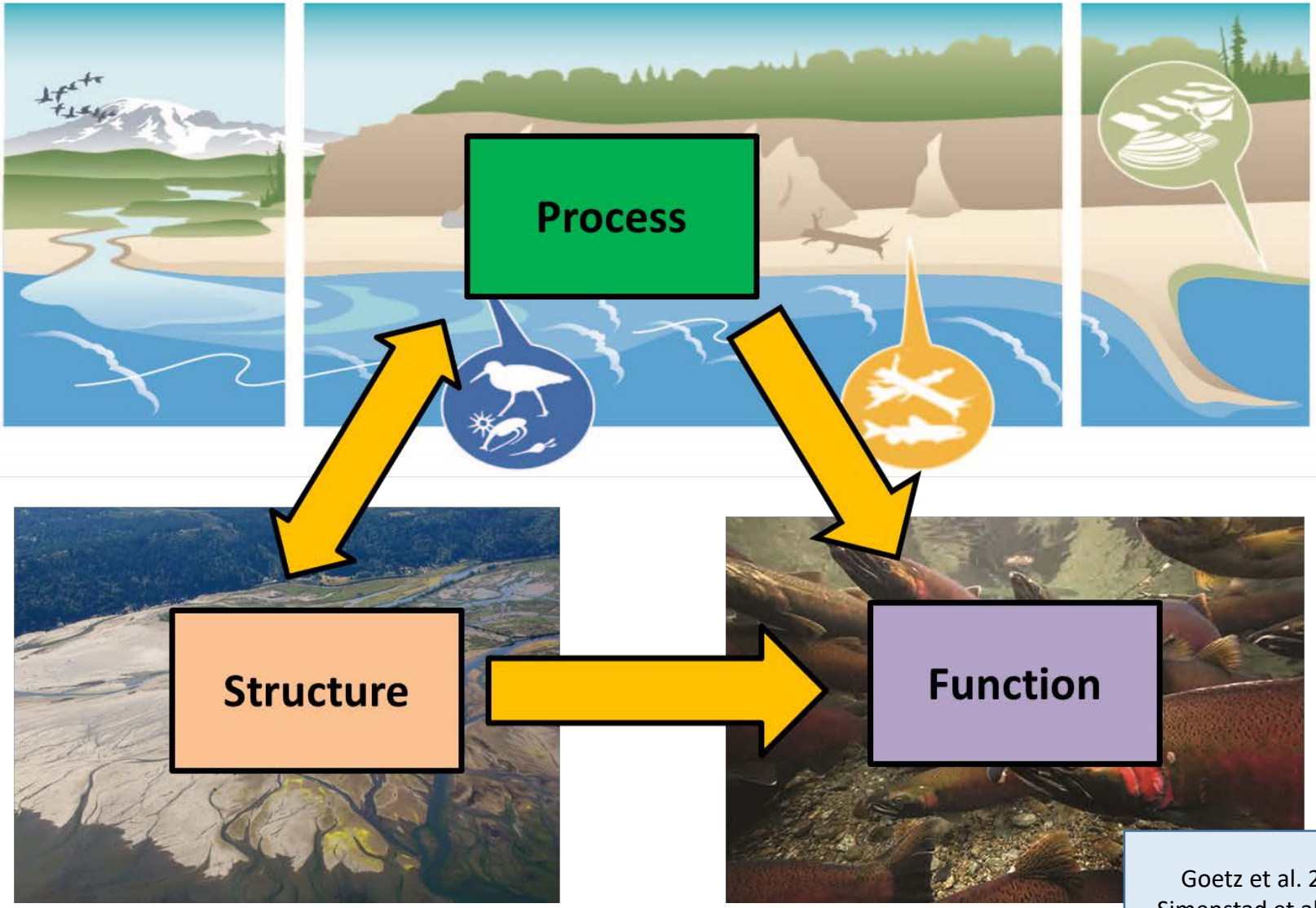
Habitat loss and restoration of ecosystem processes in Puget Sound



The Puget Sound Ecosystem Restoration Project (PSNERP)

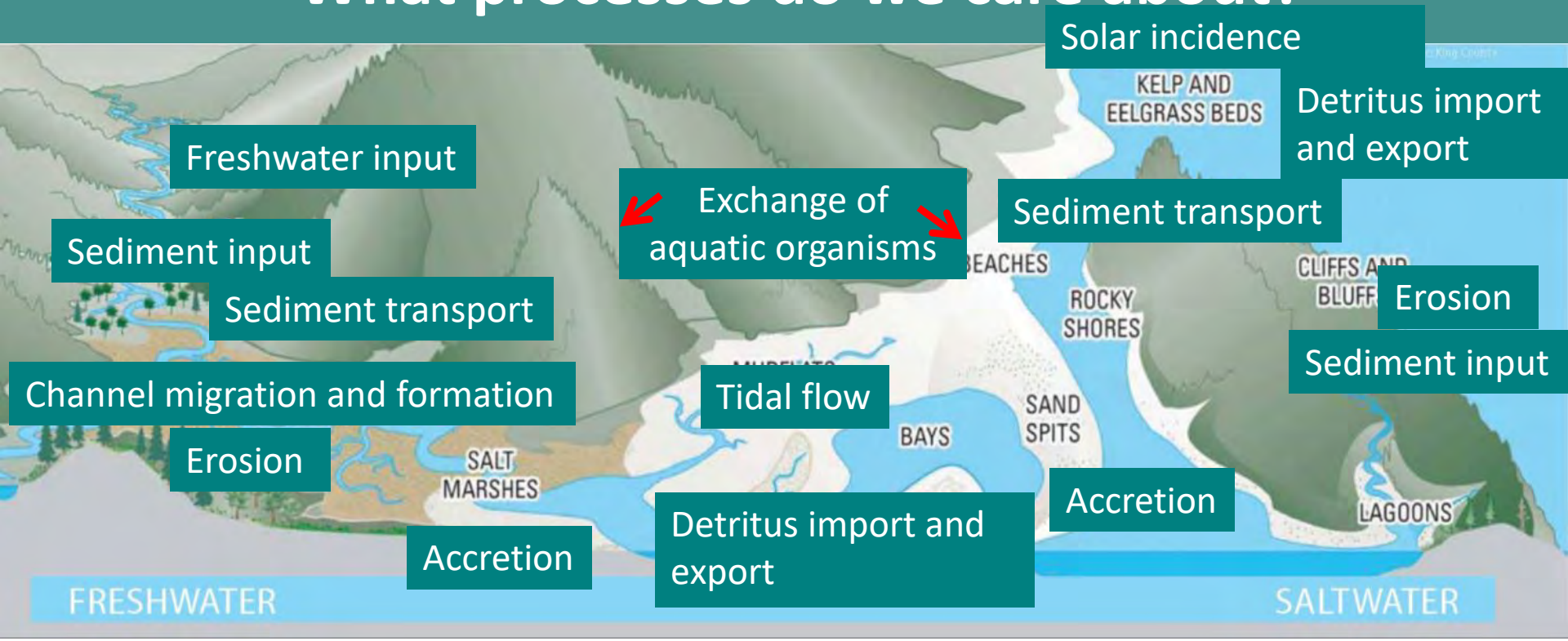


Process-based restoration



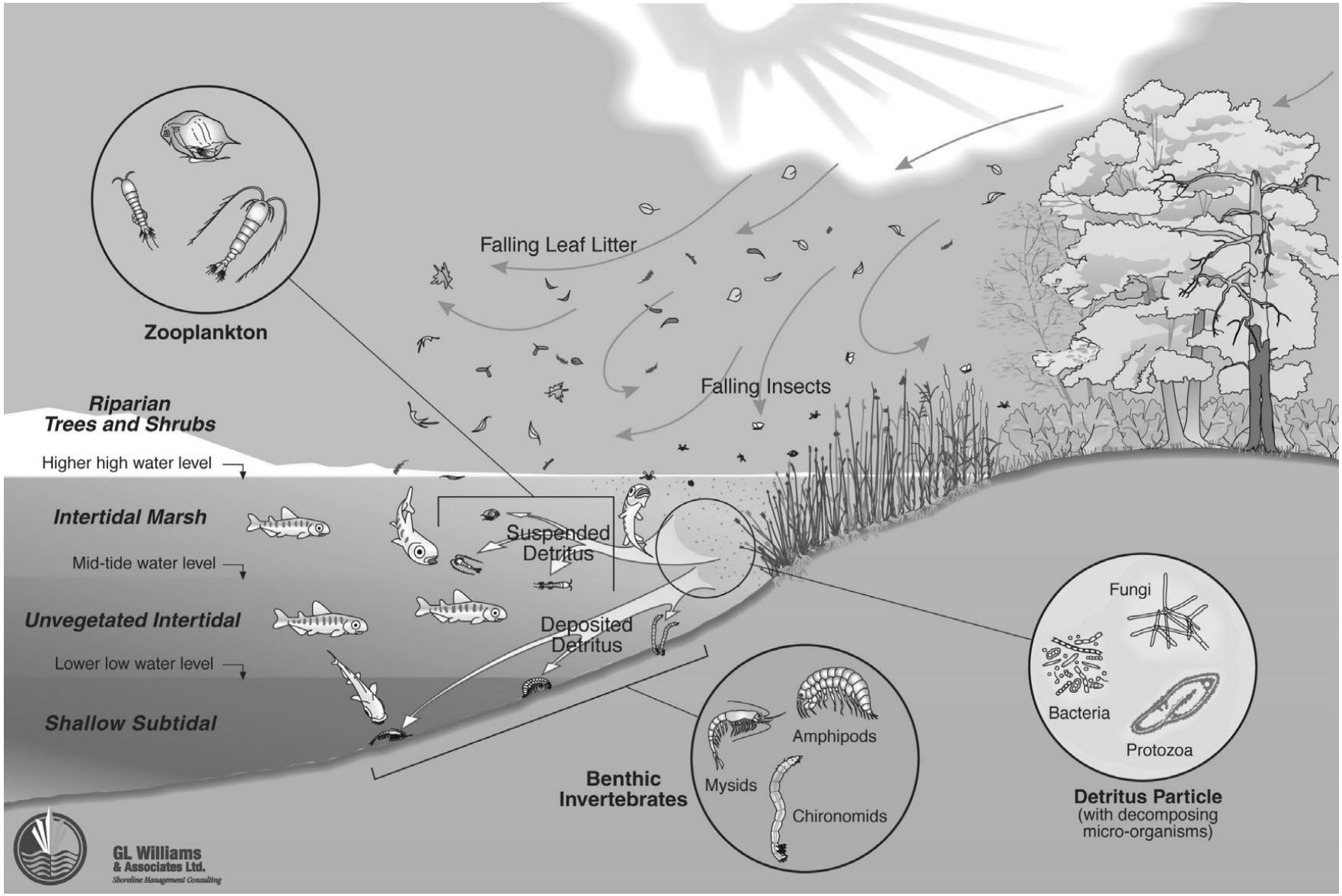
Goetz et al. 2004
Simenstad et al. 2006
Grenier 2010

What processes do we care about?



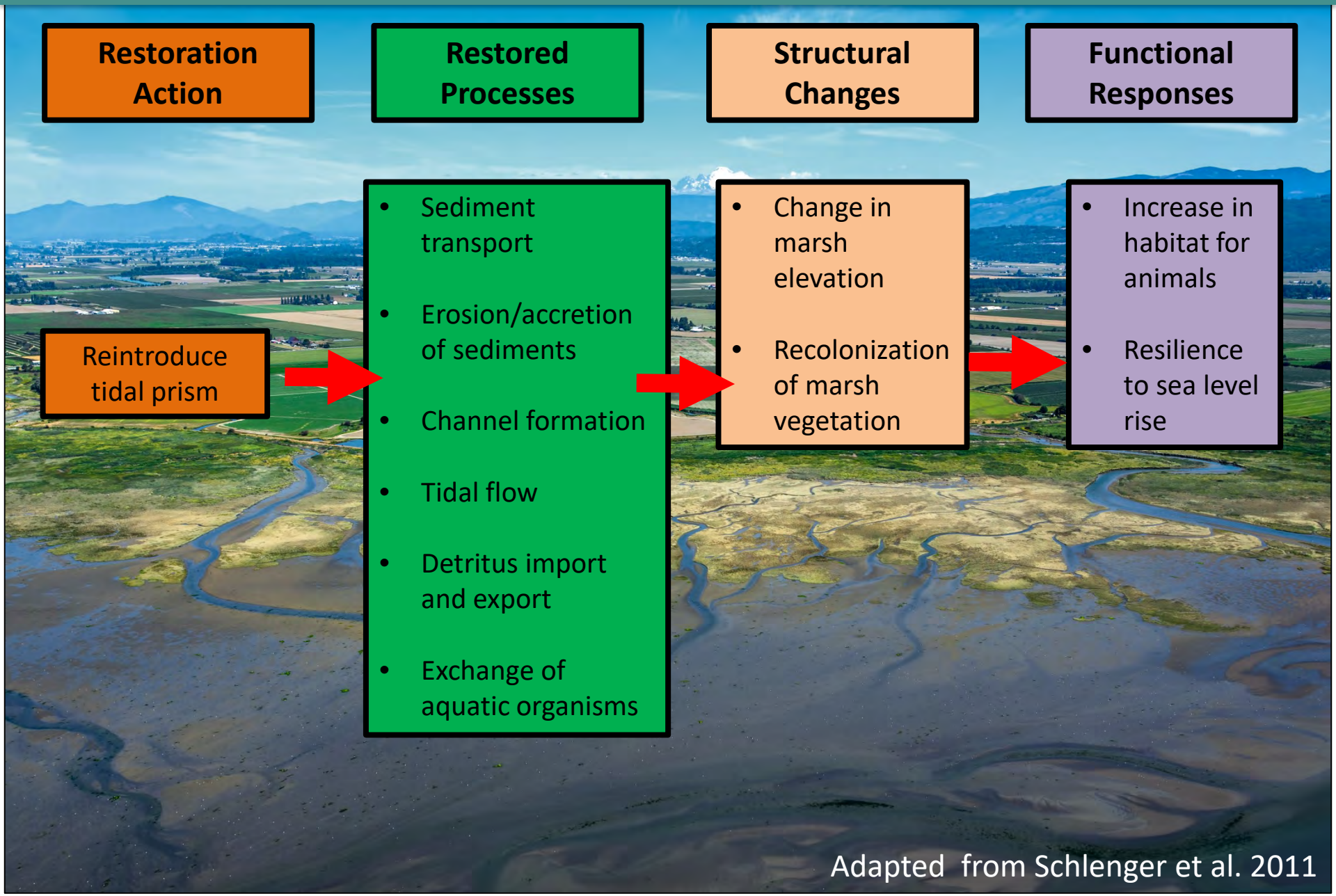
What processes maintain this physical landscape?

Detrital inputs to marine systems



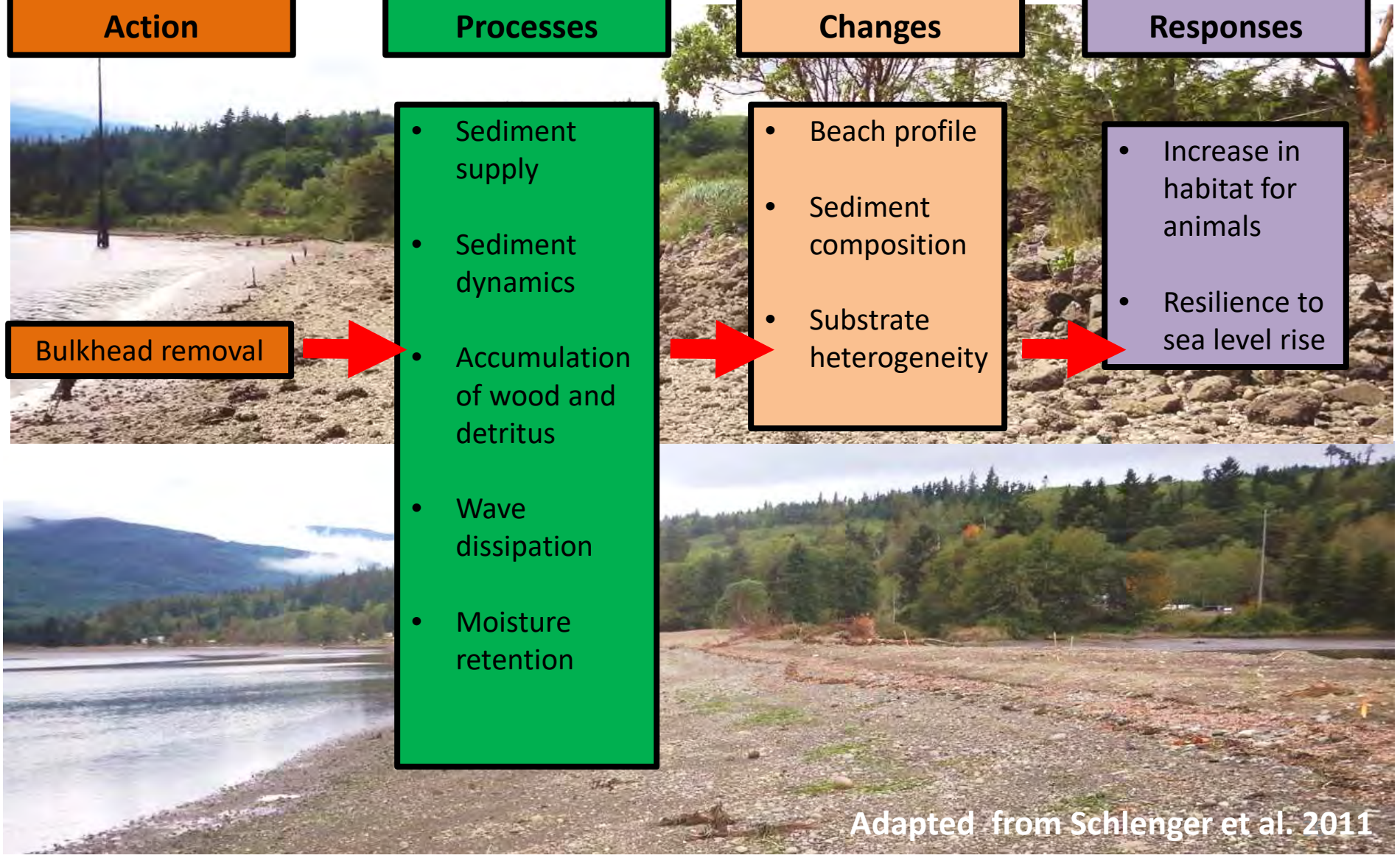
Graphic courtesy of GL Williams & Associates, Coquitlam, BC

Example for delta restoration



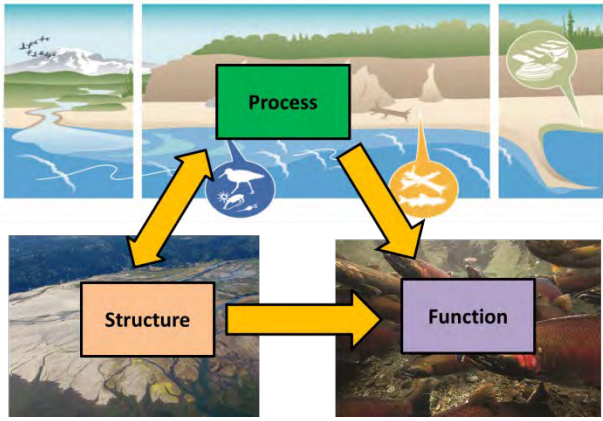
Adapted from Schlenger et al. 2011

Example for beach restoration



PSNERP Guiding Principles for restoration

Derived from landscape, conservation, and estuarine ecology



- Conserve **what is intact**
- **Ecosystem-based** approach
- **Physical processes**
- **Habitat heterogeneity**
- **Landscape context**
- **Connectivity**
- **Large areas**
- **Rare or vulnerable** components of the ecosystem
- **Ecological importance**
- **Cumulative** impacts

ESTUARY & SALMON RESTORATION PROGRAM

Goetz et al. 2004
Simenstad et al. 2006
Grenier 2010

The Puget Sound Ecosystem Restoration Project (PSNERP)

What should our guiding philosophy of restoration be?

Goetz et al. 2004
Simenstad et al. 2006
Grenier 2010

How might future growth and development affect the nearshore?
(Bolte and Vache 2010)

What has changed in the nearshore? Where?
(Simenstad et al. 2011)

Which of these changes are problems and why?
(Schlenger et al. 2011)

In what ways will we improve the nearshore?
(Cereghino et al. 2012)

What types of actions can protect and restore the nearshore?
(Clancy et al. 2009)

Implications of change

Fresh et al. 2011

Feasibility Report and new Congressional Approval for 12 Projects

Estuary and Salmon Restoration Program

Methods for deriving strategies

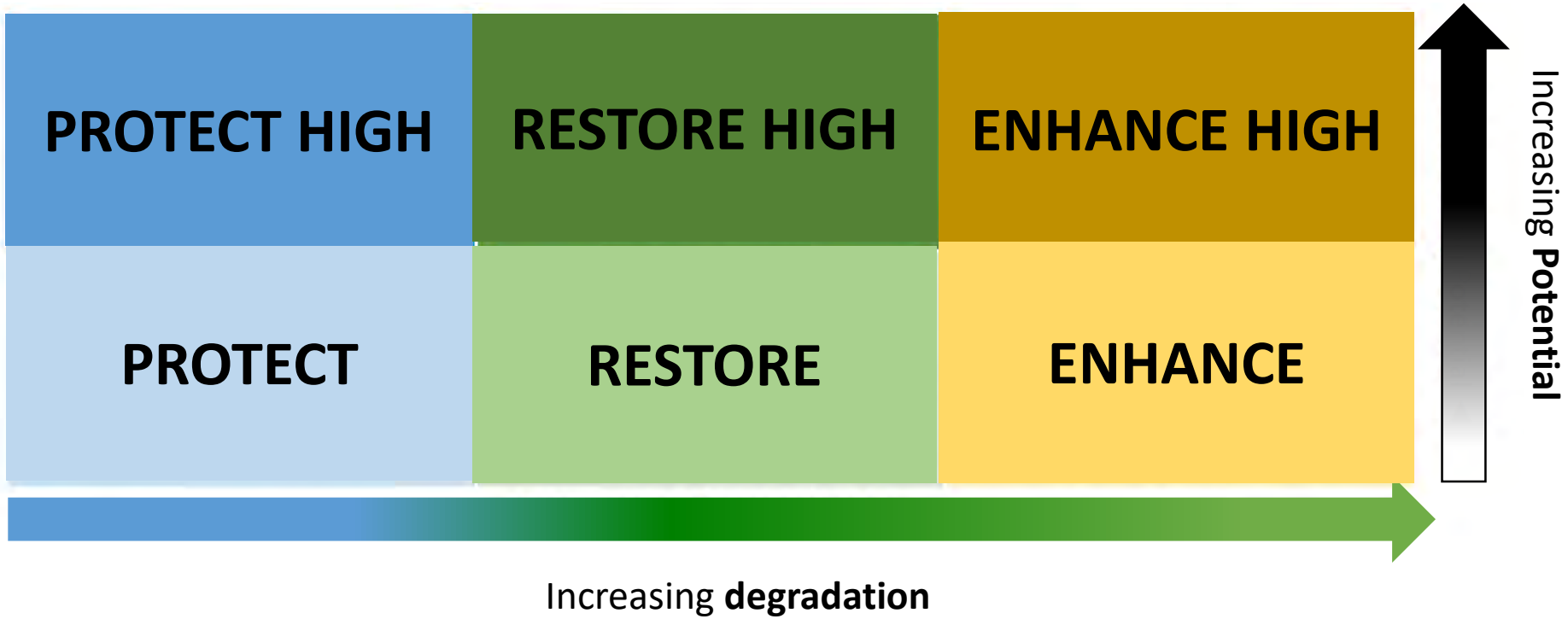
I. Calculate **Anthropogenic Degradation and Restoration Potential** for each process unit

II. Assign a strategy (**Protect, Restore, Enhance**) based on **Degradation**

III. Assign category of High/Low for based on **Potential**

Cereghino et al. 2012

Methods for deriving restoration strategies



Cereghino et al. 2012

Deriving restoration strategies: Deltas

Restoration Potential

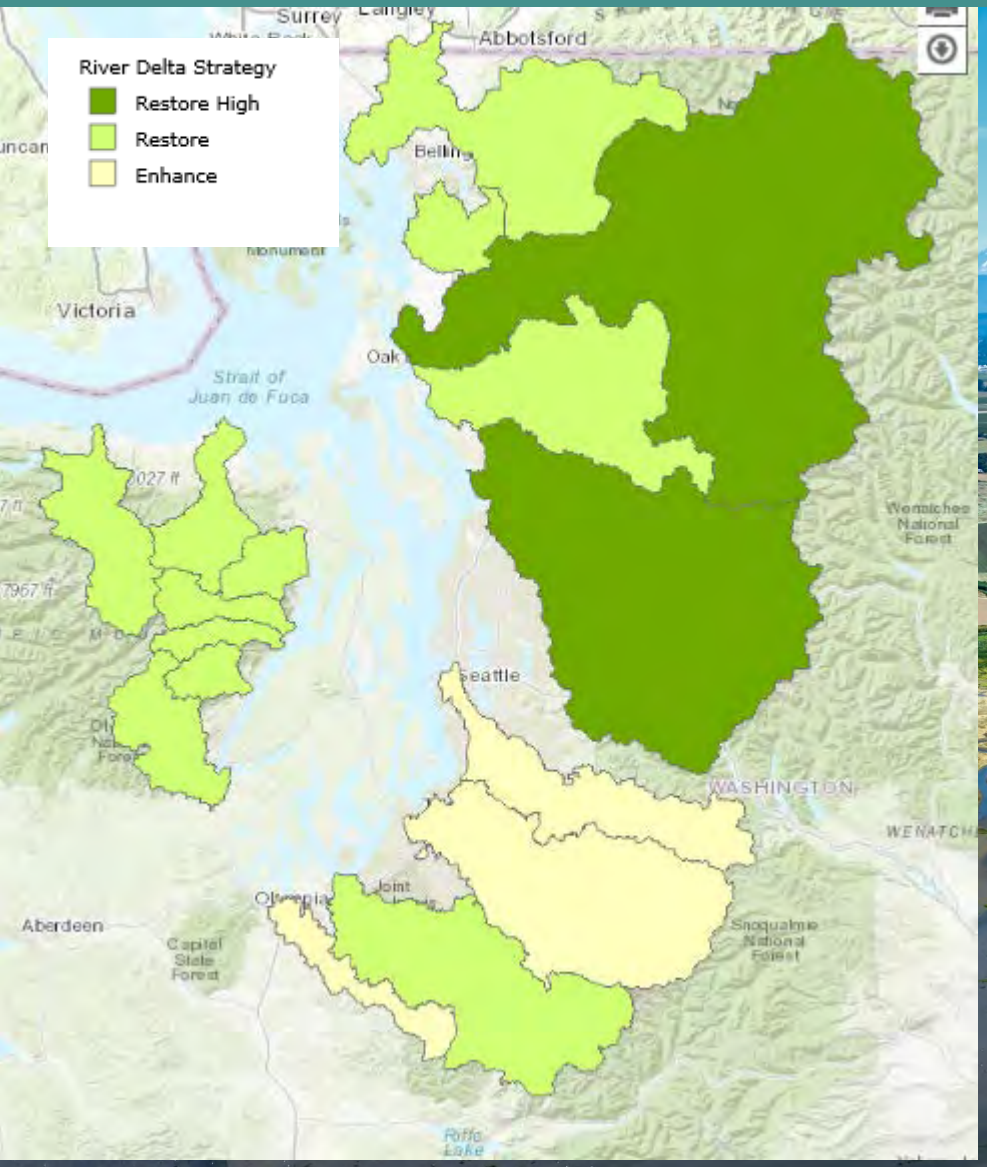
- Size
- Complexity
- Diversity of habitats

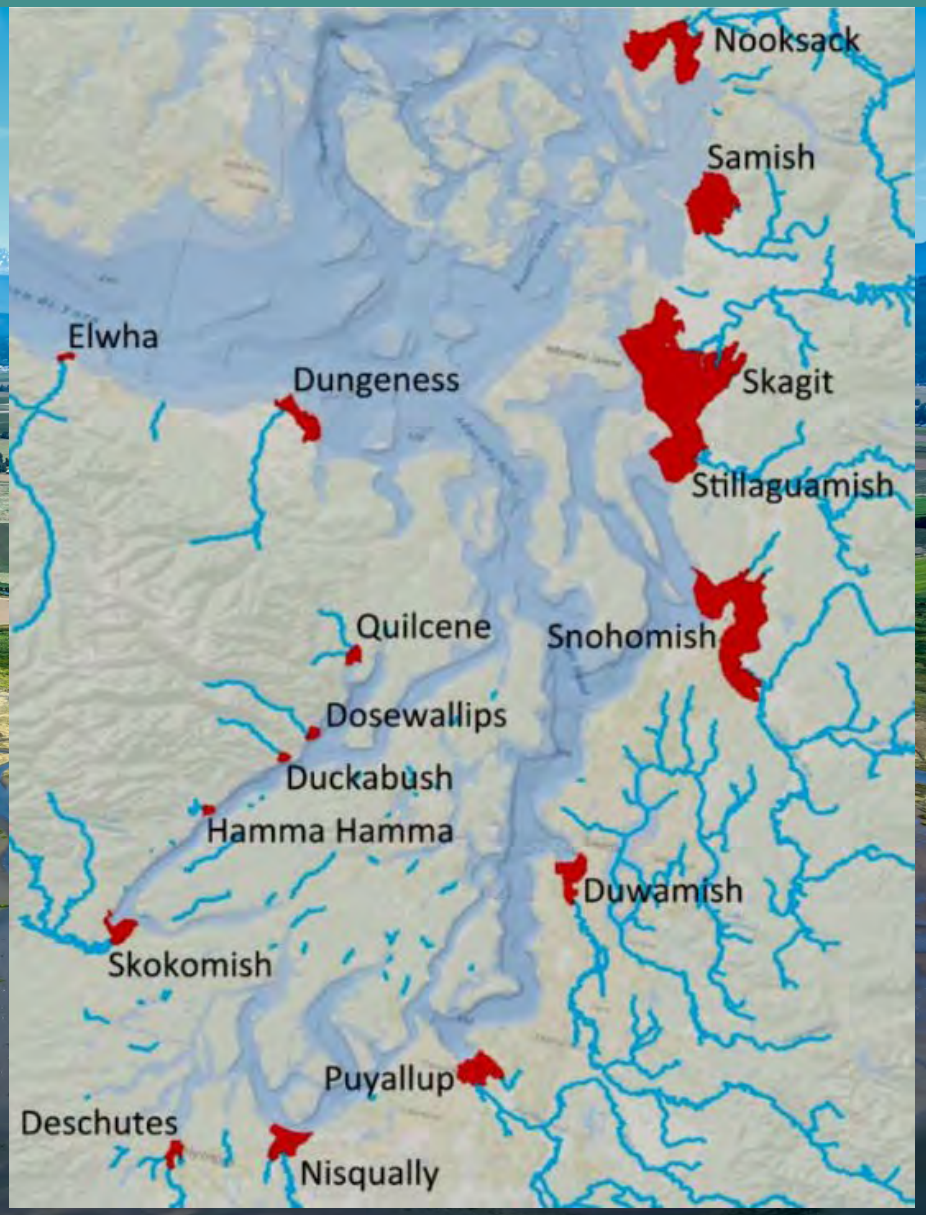
Degradation

- Habitat Loss
- Impervious surface

Cereghino et al. 2012

River delta strategy recommendations across Puget Sound

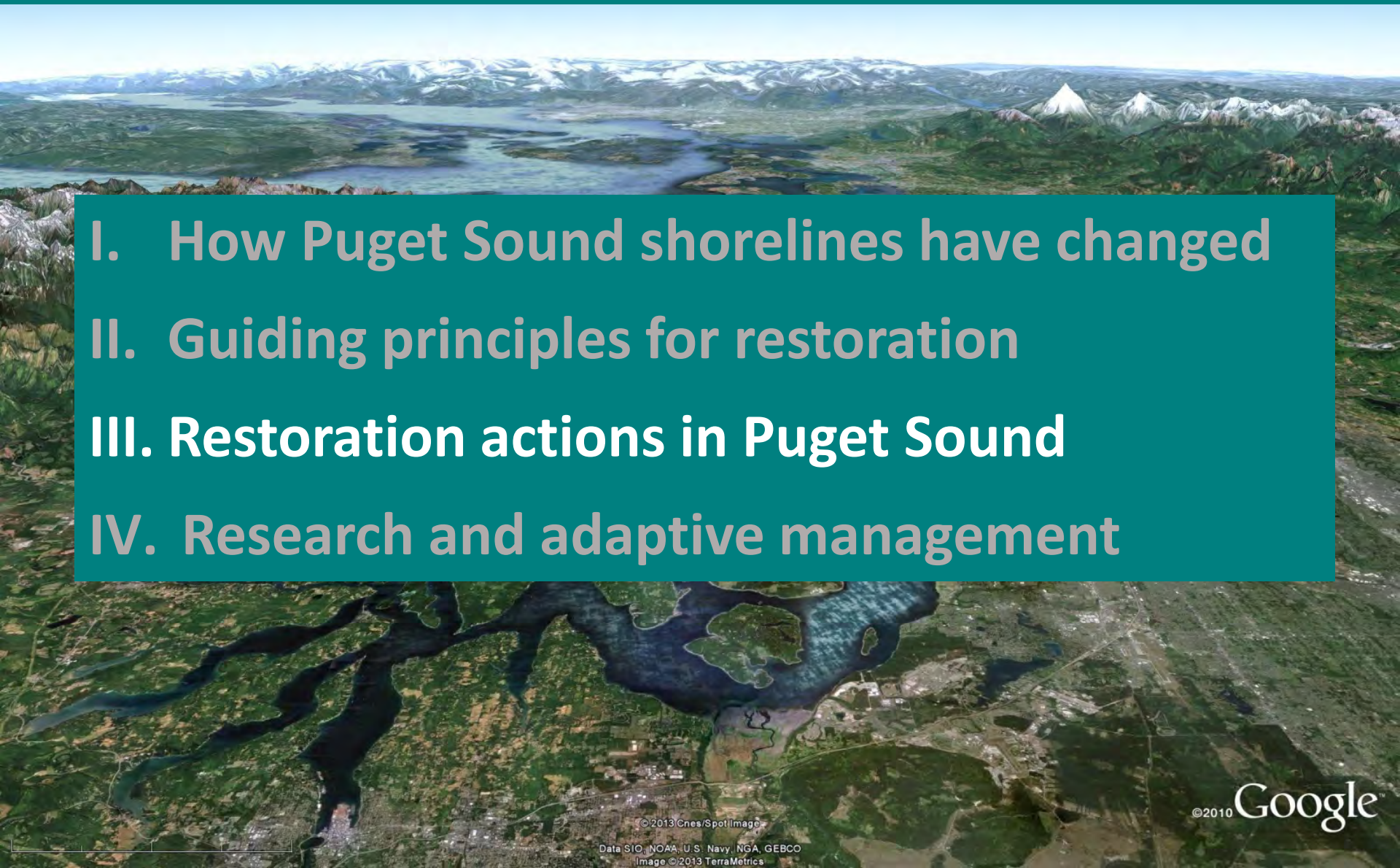




Beach strategy recommendations across Puget Sound

Coming in 2020!
New Beach Strategies based on updated data

Habitat loss and restoration of ecosystem processes in Puget Sound



Restoration Programs in Puget Sound

PUGET SOUND PARTNERSHIP

PSAR FUND
Puget Sound Acquisition and Restoration

DEPARTMENT OF ECOLOGY
State of Washington

Floodplains by Design
· REDUCING RISK, RESTORING RIVERS ·

ESTUARY & SALMON RESTORATION PROGRAM

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Salmon Recovery Funding Board

Washington Department of FISH and WILDLIFE

NOAA FISHERIES

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Estuary restoration in Puget Sound

2020 Target: 7,038 acres

3,178 acres

Area Restored (acres)

8000
7000
6000
5000
4000
3000
2000
1000
0

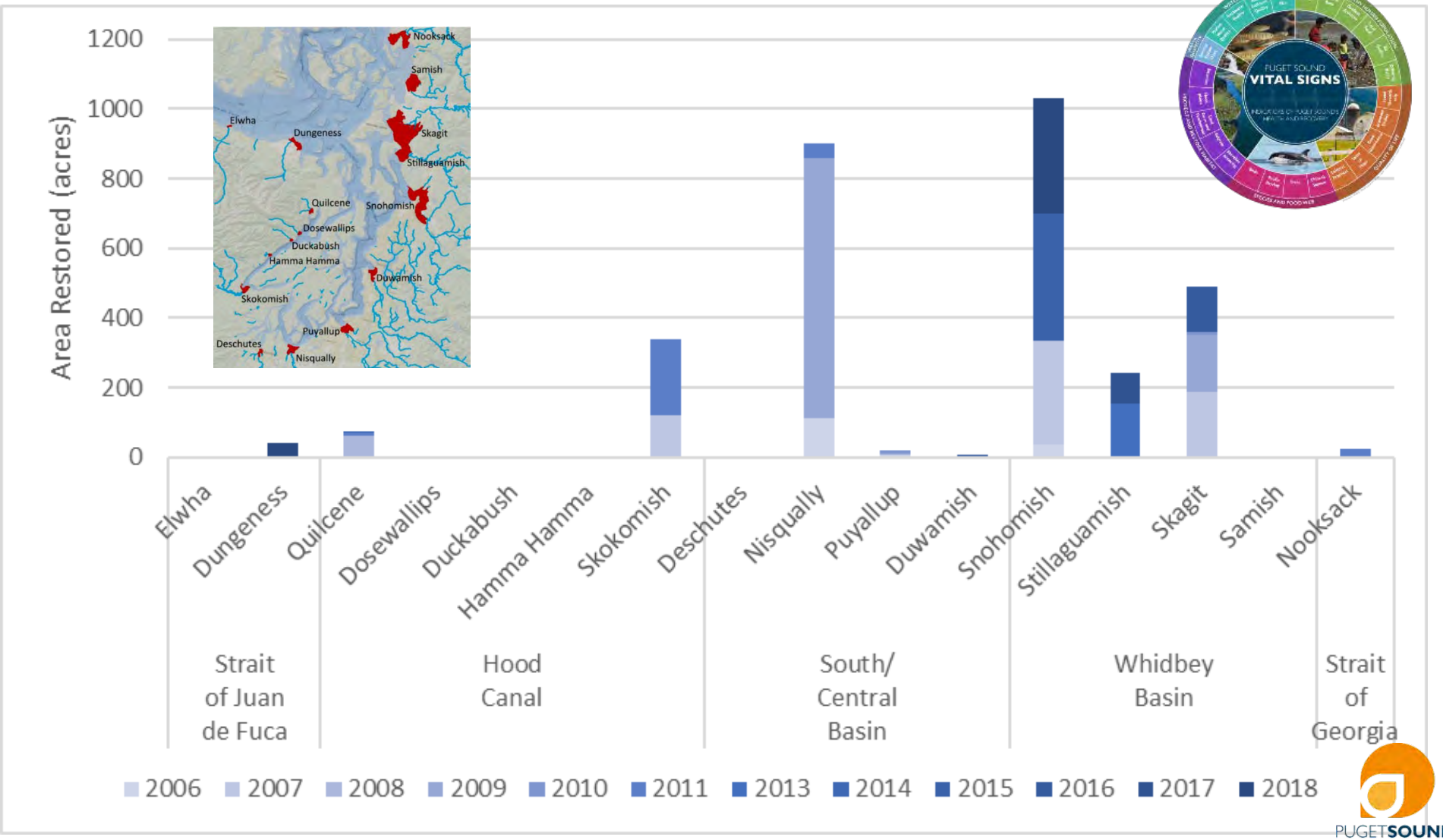
2006 2007 2008 2009 2010 2011 2013 2014 2015 2016 2017 2018 2019 2020

Restored full tidal Cumulative Acres Target

PUGETSOUND PARTNERSHIP

Ramirez 2019

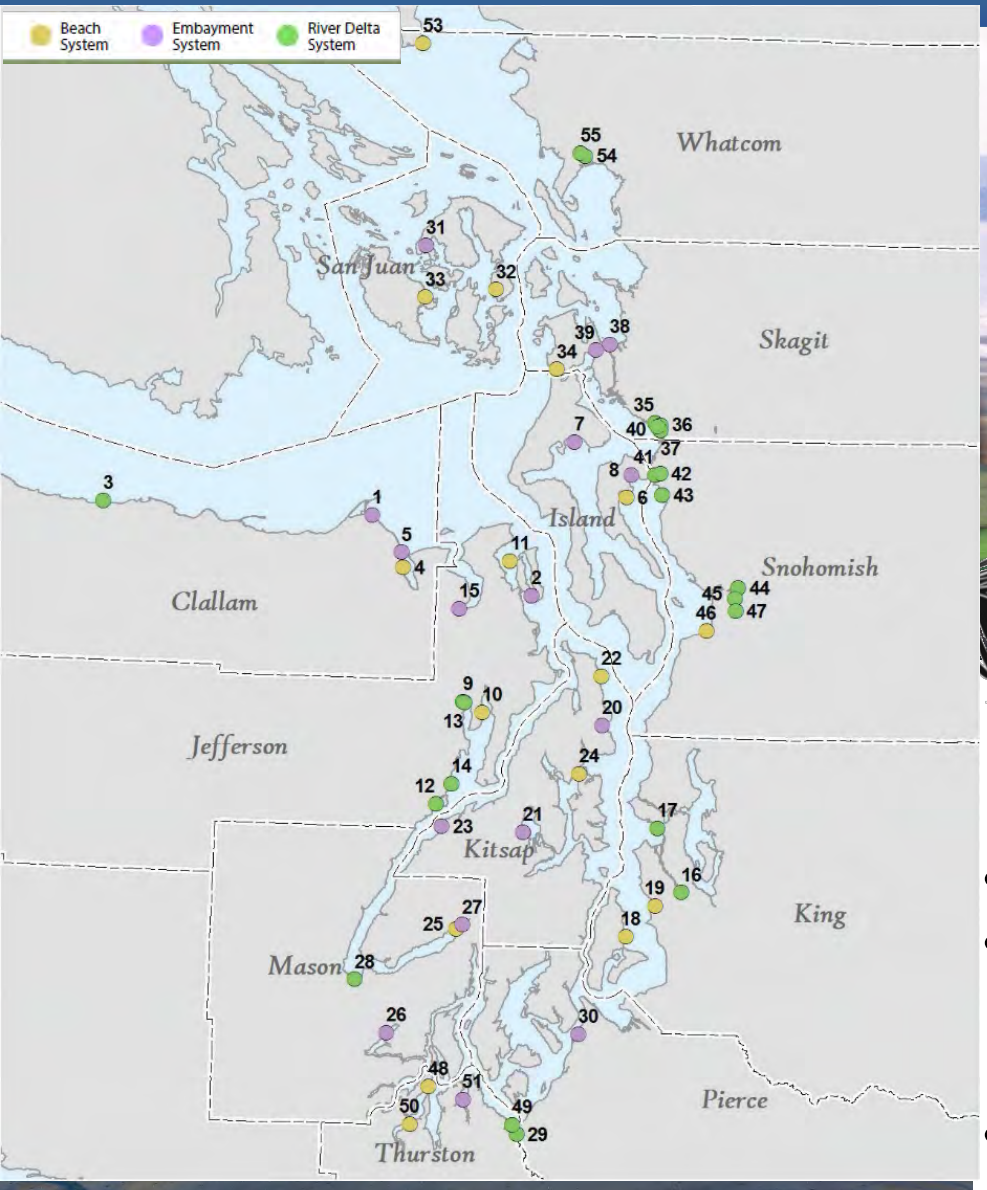
Estuary restoration in Puget Sound



PUGETSOUND PARTNERSHIP

Ramirez 2019

Estuary and Salmon Restoration Program



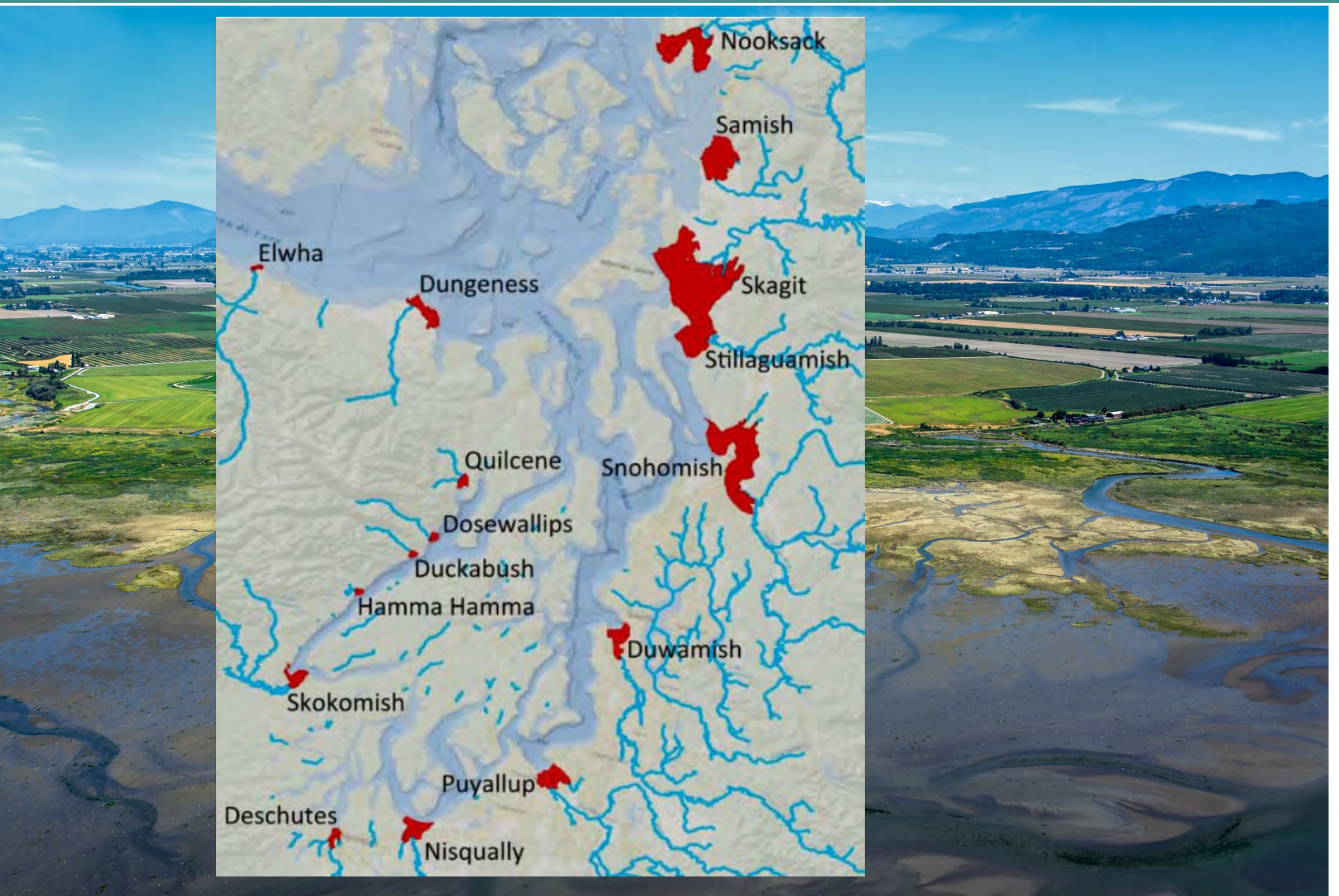
Estuary and Salmon Restoration Program

- Created in 2006
- Implementing nearshore ecosystem restoration projects ~100 completed to date
- Advancing adaptive management
- State capital budget appropriation
- $5-12.5 million for restoration projects

Estuary and Salmon Restoration Program (ESRP) Objectives

1. Restore and/or protect large river delta estuaries
2. Restore and/or protect coastal embayments
3. Restore and/or protect beaches and bluffs
4. Increase understanding of natural process restoration to improve effectiveness of project actions

Program Objective: Restore and protect river deltas



Project Example: Skokomish Estuary Restoration

Skokomish Estuary Restoration Sponsor: Skokomish Tribe & Mason Conservation District

Phase I (2007) - 108 acres completed
Phase II (2010) - 216 acres completed
Phase III (2011) - 525 acres completed
Phase IIIc(2014) - 330 acres underway

Total: 1,179 acres / 377 tidal acres $3.7 Million in ESRP

SKOKOMISH
INDIAN TRIBE
SqWuqWu'b3sh "People of the River"

Project Example: Leque Island Restoration

Skagit Bay

Camano Island

Stanwood

Stillaguamish River

Port Susan Bay

Washington Department of FISH and WILDLIFE

DUCKS UNLIMITED

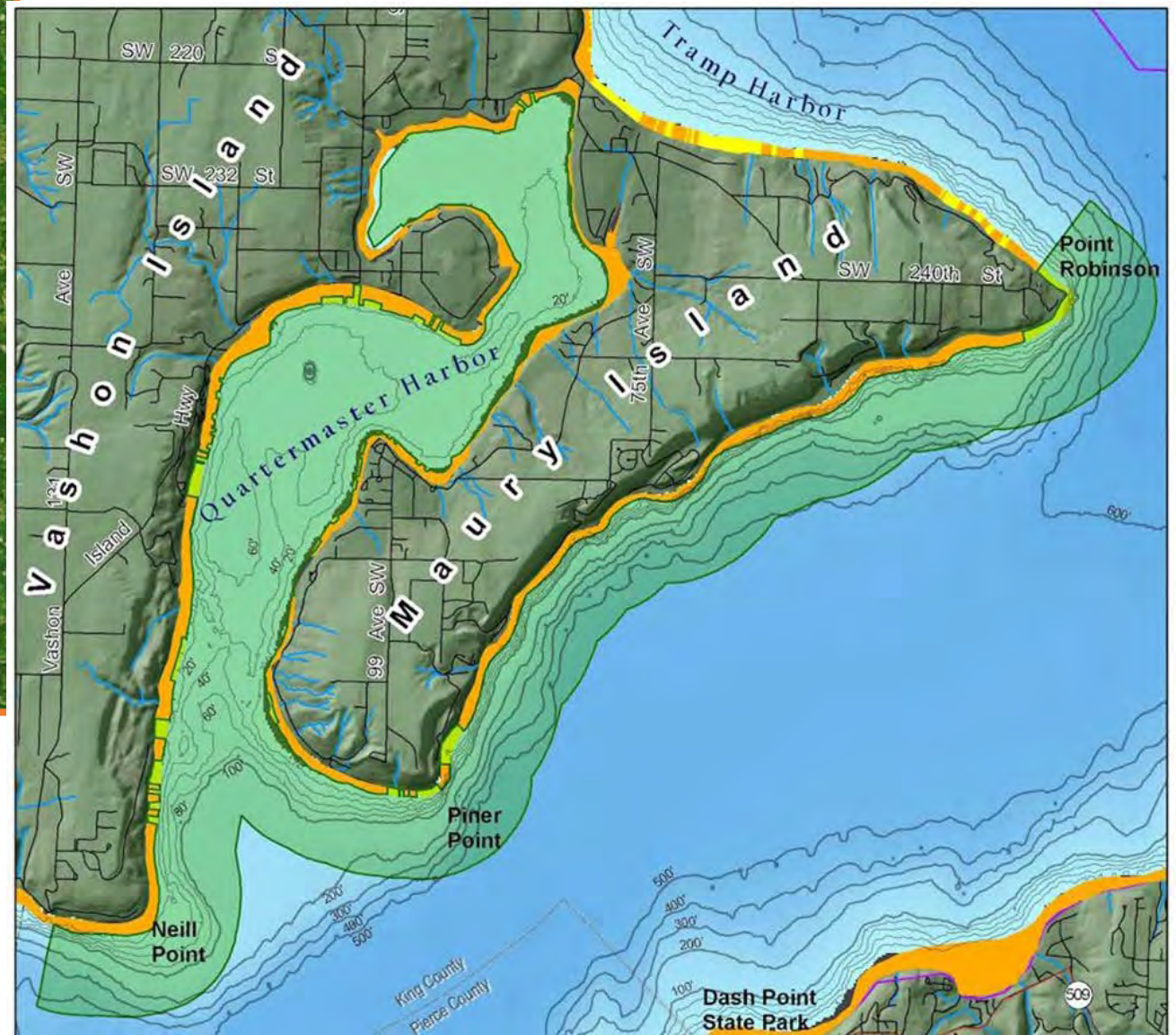
Program Objective: Restore and Protect Beaches and Embayments

Before

After

Project Example: Maury Island Aquatic Reserve

King County



Project Example: Maury Island Aquatic Reserve

King County

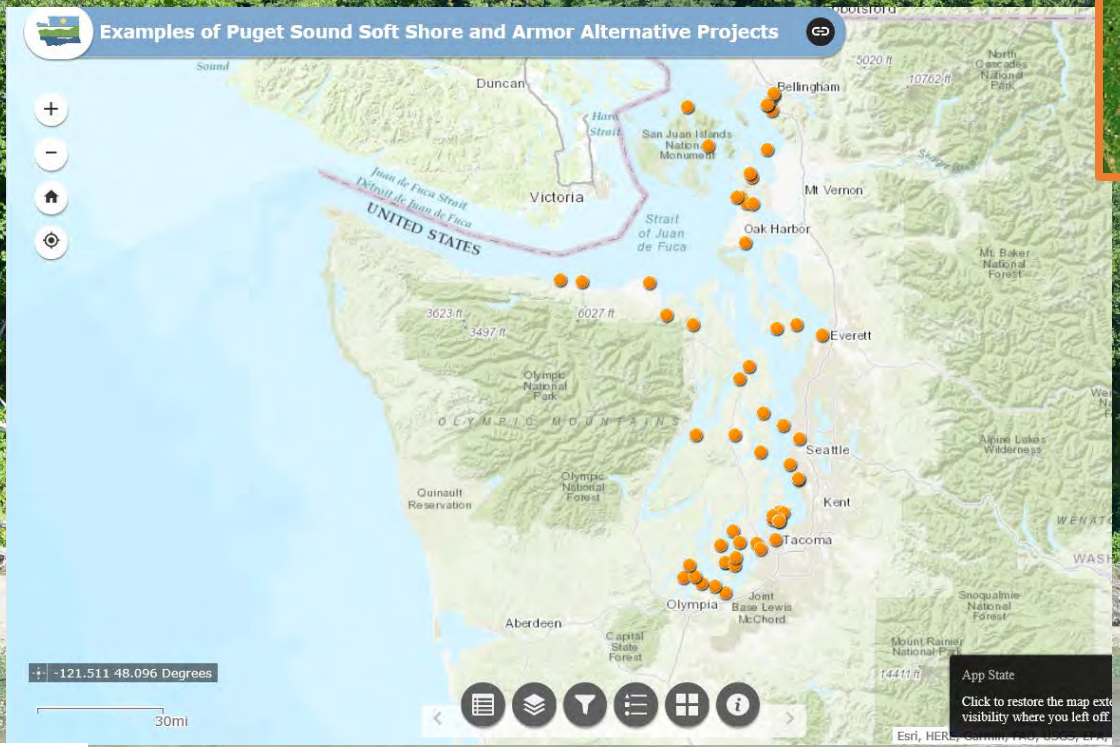
Project example: Edgewater Beach

SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

Image credit: George Kaminsky

Project example: Edgewater Beach

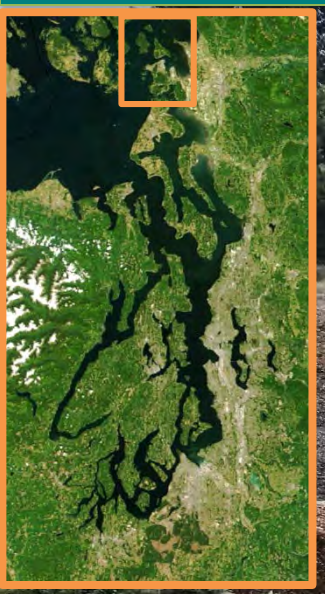
- New Tool!
- Department of Ecology Project cataloguing armor removal and soft shore projects in Puget Sound



SOUTH PUGET SOUND Salmon ENHANCEMENT GROUP

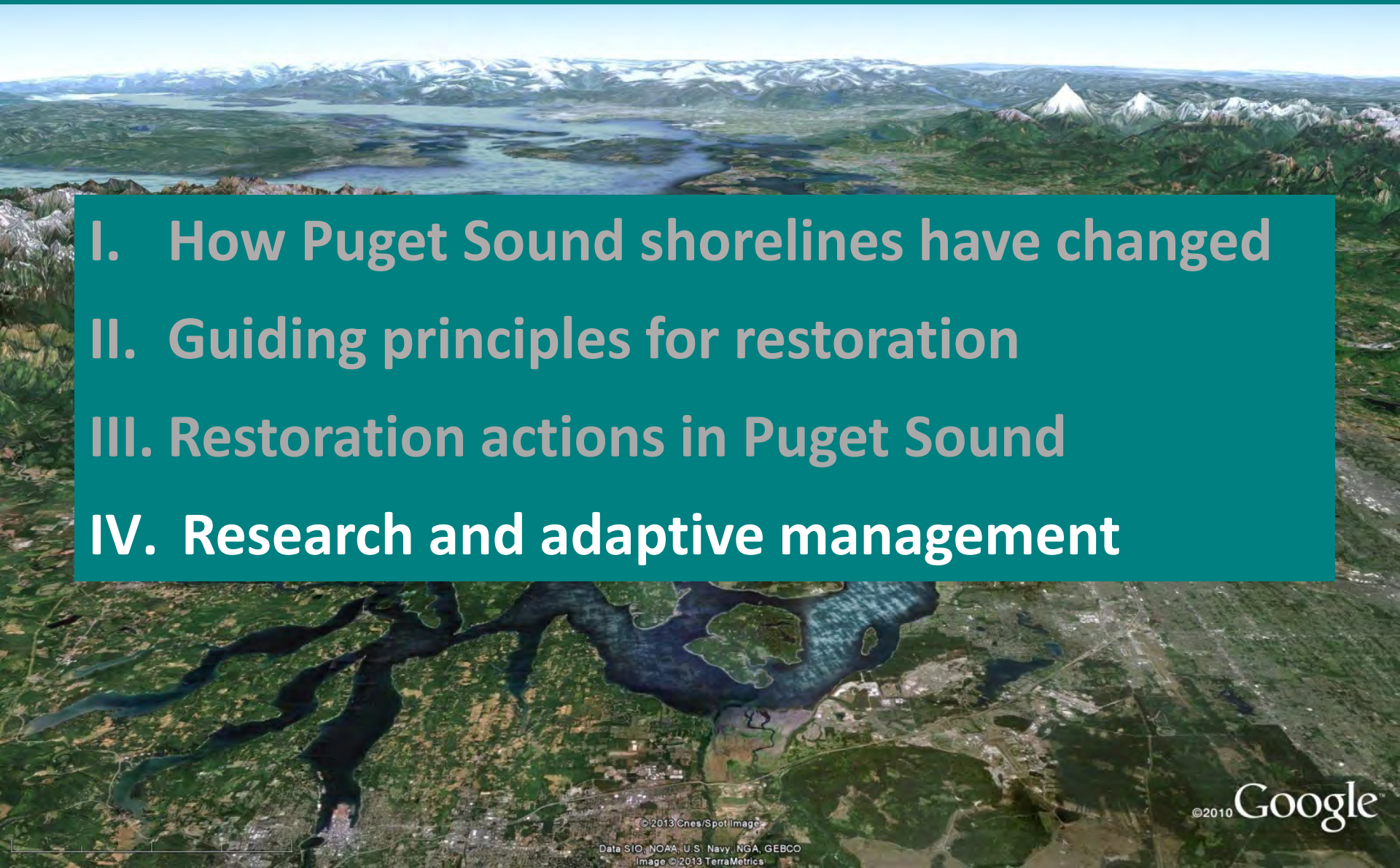
Image credit: George Kaminsky

Kelly's Point Feeder Bluff Protection



SKAGIT LAND TRUST
Saving Land for Tomorrow

Habitat loss and restoration of ecosystem processes in Puget Sound



Estuary and Salmon Restoration Program (ESRP) Objectives

1. Restore connectivity and size of large river deltas
2. Restore sediment input, transport and accretion processes
3. Restore shoreline complexity and length
4. Increase understanding of natural process restoration to improve effectiveness of project actions

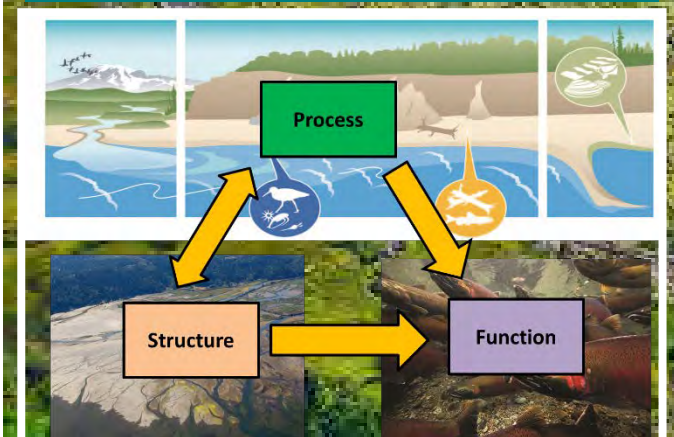
WDFW's Estuary and Salmon Restoration Program

Founded on scientific principles of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)

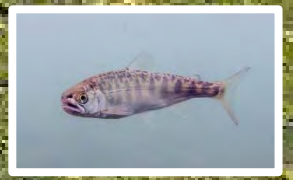
90%

10%

Process-based restoration in Puget Sound



Research projects to inform restoration



Project Example: Snohomish Beach Nourishment

Assessing ecosystem response to beach nourishment on shorelines occupied by railroad.

Beach ecosystem response

- Beach wrack accumulation
- Invertebrates in wrack
- Forage fish eggs
- Sediment accumulation

Dethier et al. 2016, Estuarine, Coastal and Shelf Science

Nearshore Beach Nourishment
Figure 1

0 1,000 2,000
Feet

Snohomish County
PUBLIC WORKS
SURFACE WATER MANAGEMENT
(425) 388-3464

Project Example: Edgewater Beach

Ecosystem responses to restoration

- Sediment transport
- Beach wrack
- Beach profile
- Invertebrate community
- Fish and crab community

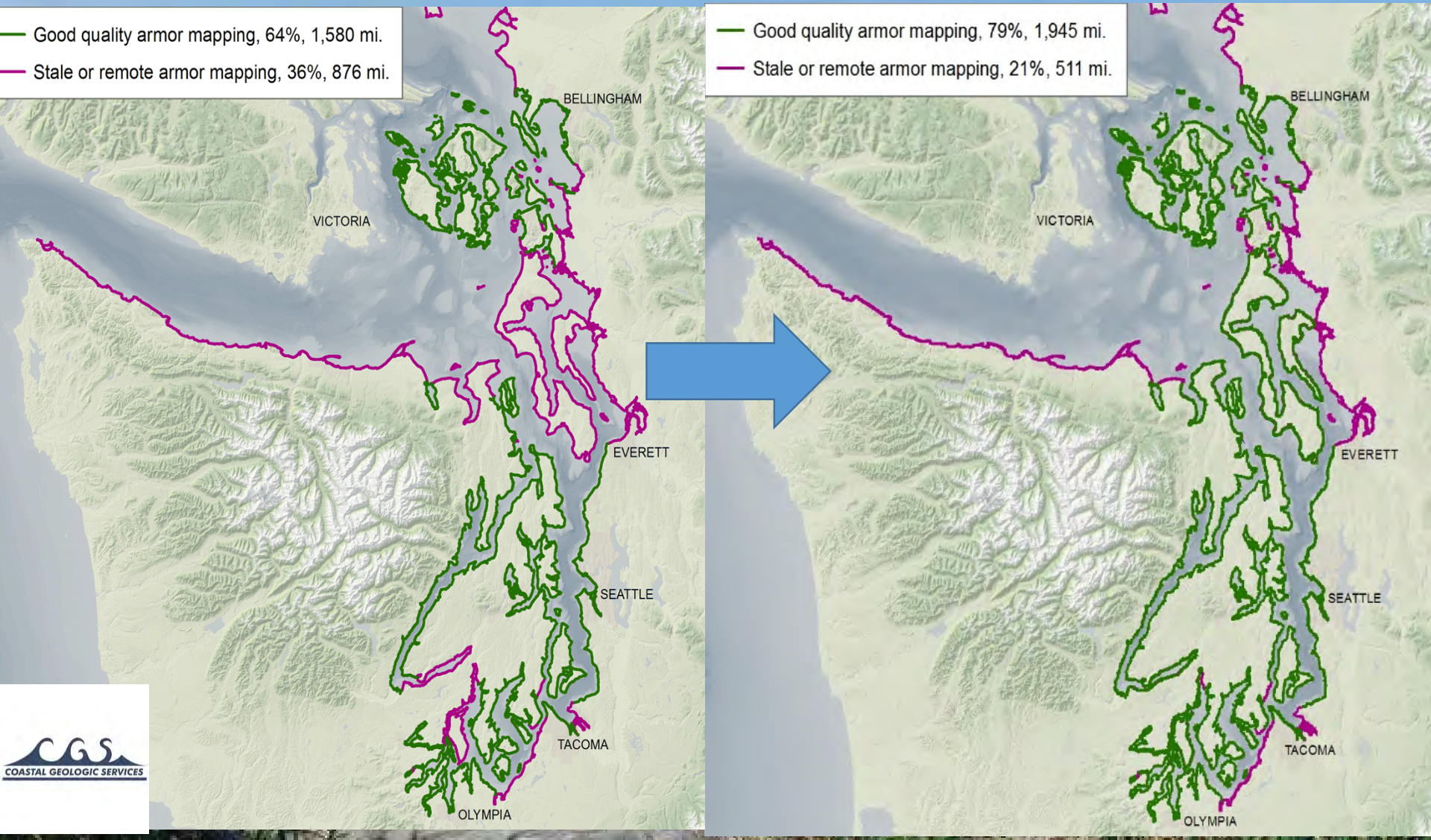
Project Example: Beach Strategies Project

1. Improve geospatial data for shorelines (armor extent/condition/feeder bluff mapping)

2. Develop new strategies based on new data

3. Incorporate into online interactive geodatabase

Project Example: Beach Strategies Project



COASTAL GEOLOGIC SERVICES

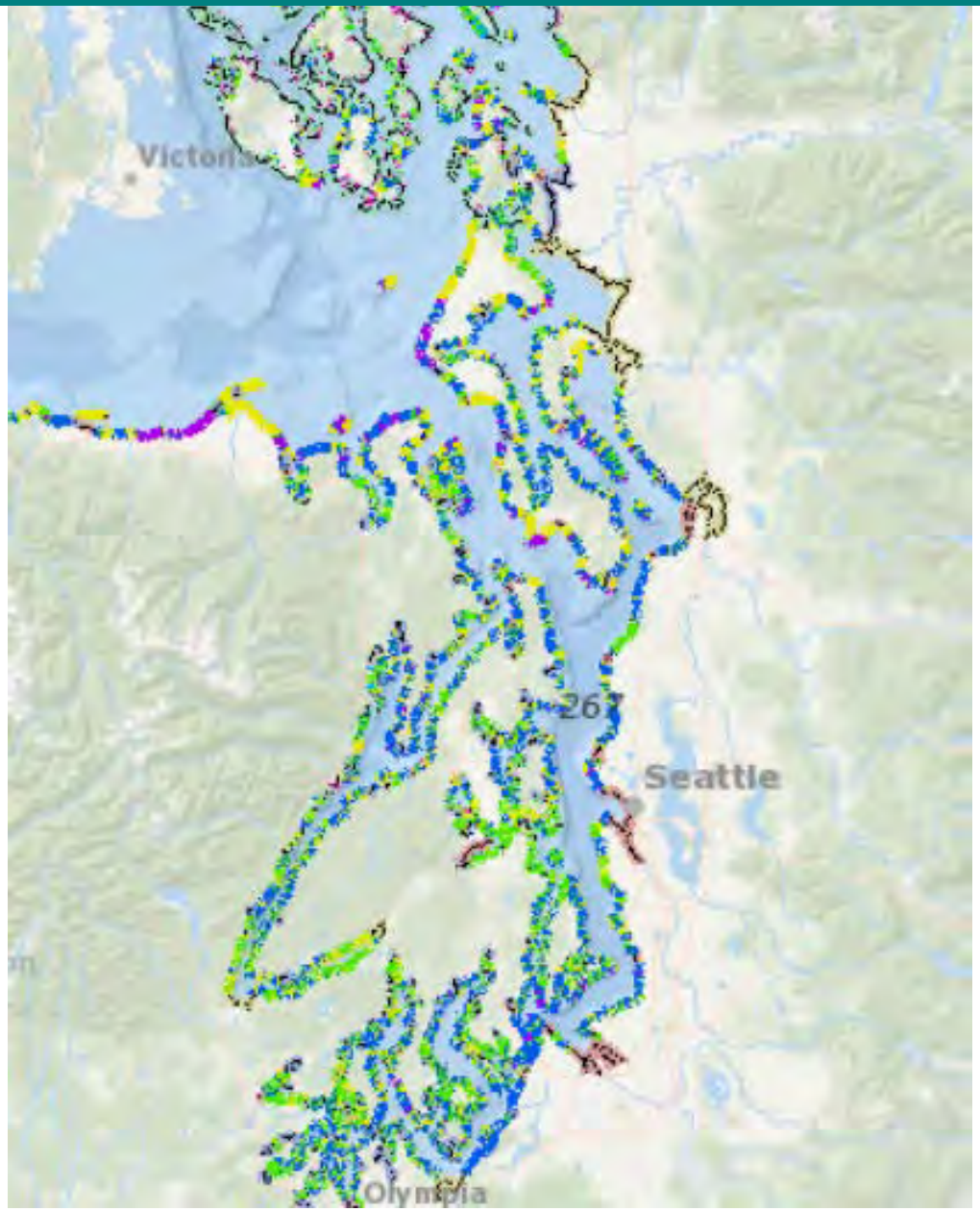
Project Example: Beach Strategies Project

New Shoretype Mapping

Beach Strategies

Shoretype

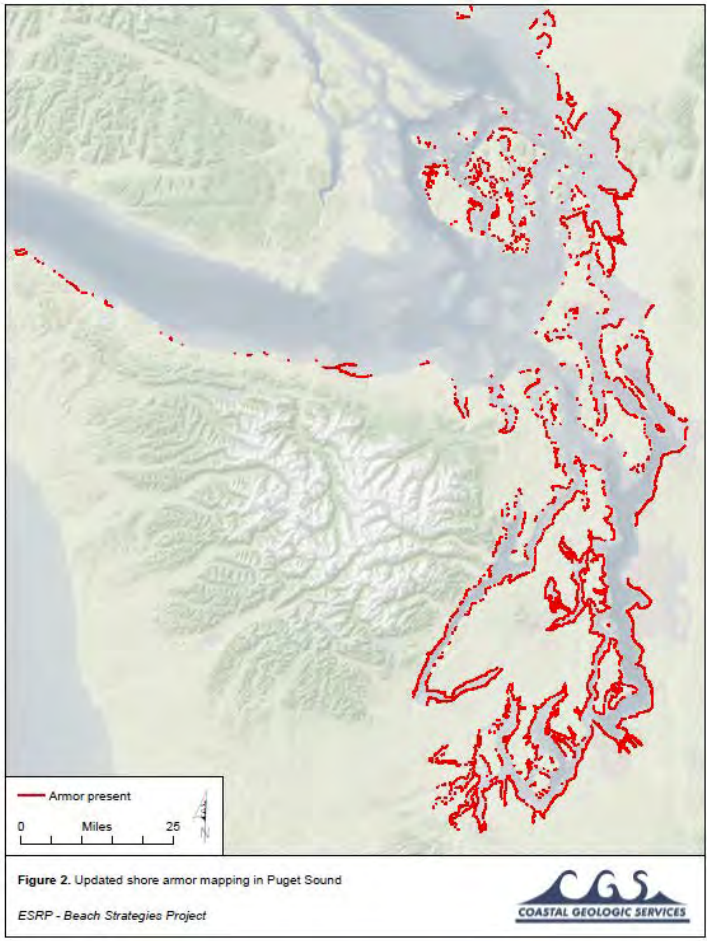
- Pocket Beach
- Pocket Beach - Artificial
- Feeder Bluff Exceptional
- Feeder Bluff
- Feeder Bluff, Tallus
- Transport Zone
- Accretion Shorform
- No Appreciable Drift - Artificial
- No Appreciable Drift - Bedrock
- No Appreciable Drift - Delta
- No Appreciable Drift - Low Energy



COASTAL GEOLOGIC SERVICES

Project Example: Beach Strategies Project

New Armor Mapping



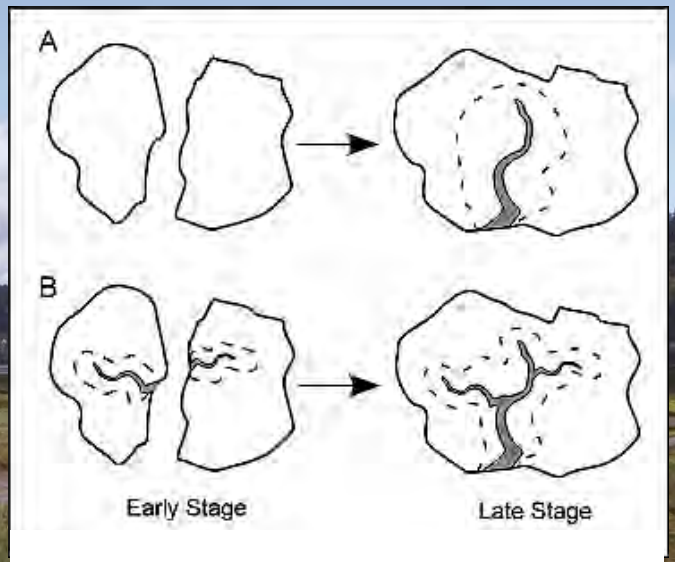
County	Unarmored, miles	Armored, miles	Total, miles	Percent Armored
Clallam	128	31	159	20
Island	163	54	217	25
Jefferson	173	28	202	14
King	56	67	123	55
Kitsap	132	122	254	48
Mason	158	74	232	32
Pierce	114	127	240	53
San Juan	382	26	408	6
Skagit	155	74	229	32
Snohomish	96	37	133	28
Thurston	71	45	116	39
Whatcom	115	31	146	21
Sound-wide	**1745**	**715**	**2,460**	**29**

Coming in 2020!
New Beach Strategies based on updated data

COASTAL GEOLOGIC SERVICES

Project example: Scaling tidal geometry with marsh island area for Puget Sound

Design Guidance:
Number of Channels
Number of Outlets
Channel Area

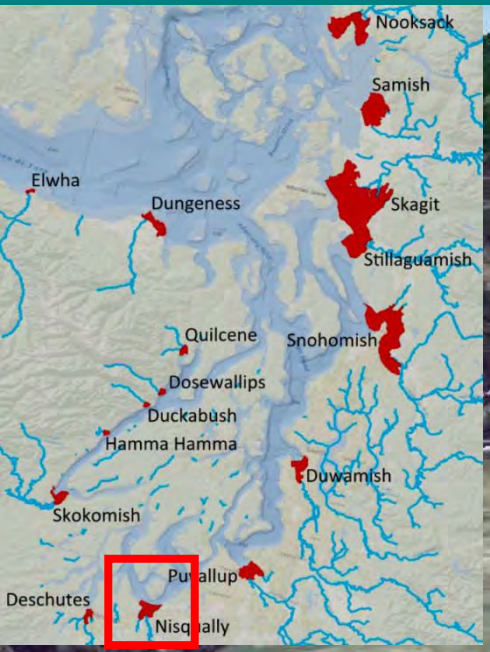


Hood 2007

SKAGIT RIVER SYSTEM COOPERATIVE

Hood 2007 Scaling tidal channel with marsh island area: A tool for habitat restoration, linked to channel formation processes. Water resources research
Hood 2015 Geographic variation in Puget Sound tidal channel planform. Geomorphology.230.98-108

Project example: Nisqually response to restoration



- Juvenile Chinook access to restored site
- Colonization by juvenile salmonid prey
- Habitat-specific prey energy density

Ellings et al. 2016
Davis et al. 2017
Davis et al. 2018
Woo et al. 2018
Woo et al. 2019

Adaptive Management Cycle

Learn

Ecosystem response

Tools

Communication

Nearshore Restoration Summit and Synthesis! Fall 2020

Reassess

Incorporation into restoration projects

Implement

Summary

- Puget Sound shorelines and estuaries have changed dramatically
- We are working to improve habitat function by restoring the processes that shape the landscape
- We are making good progress, but lots of work to do
- We are learning as we go

WDFW Conservation Initiative and Guiding Principles

- *"We practice conservation by managing, protecting and restoring ecosystems for the long term benefit of people, and for fish, wildlife and their habitat"*

Washington Department of FISH and WILDLIFE

Policy 5004, 5/2/2019

"There can be no purpose more enspiriting than to begin the age of restoration, reweaving the wondrous diversity of life that still surrounds us . . . The next century will, I believe, be the era of restoration in ecology. "

– E.O. Wilson, The Diversity of Life

"Science alone does not hold the power to achieve the goal of greater sustainability, but scientific knowledge and wisdom are needed to help inform decisions that will enable society to move toward that end."

– Jane Lubchenco

Acknowledgements

ESRP Team: Jay Krienitz, Kay Caromile, Jenna Jewett

PSNERP Nearshore Science Team

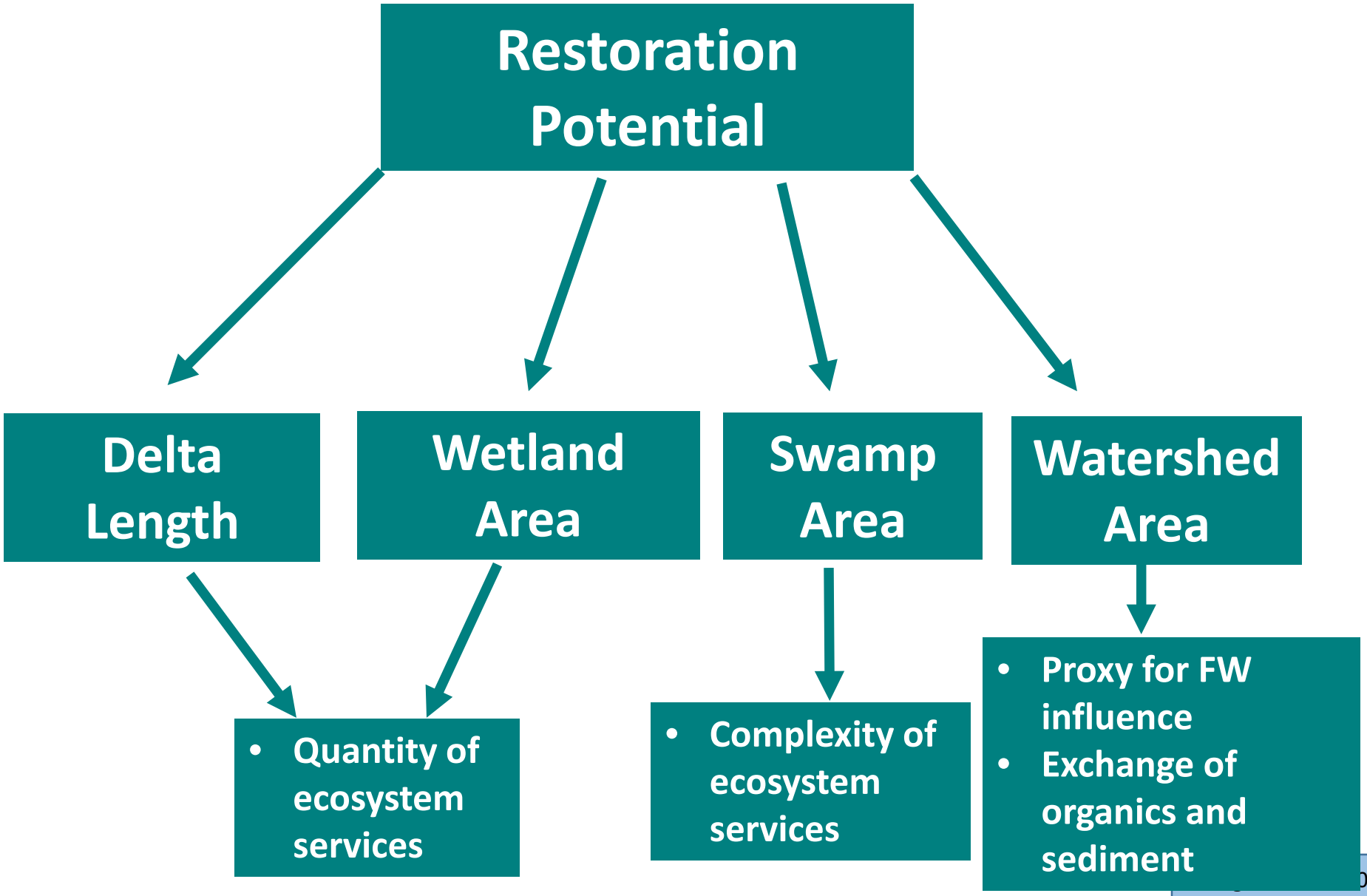
ESRP Learning Project Sponsors

Thank you!

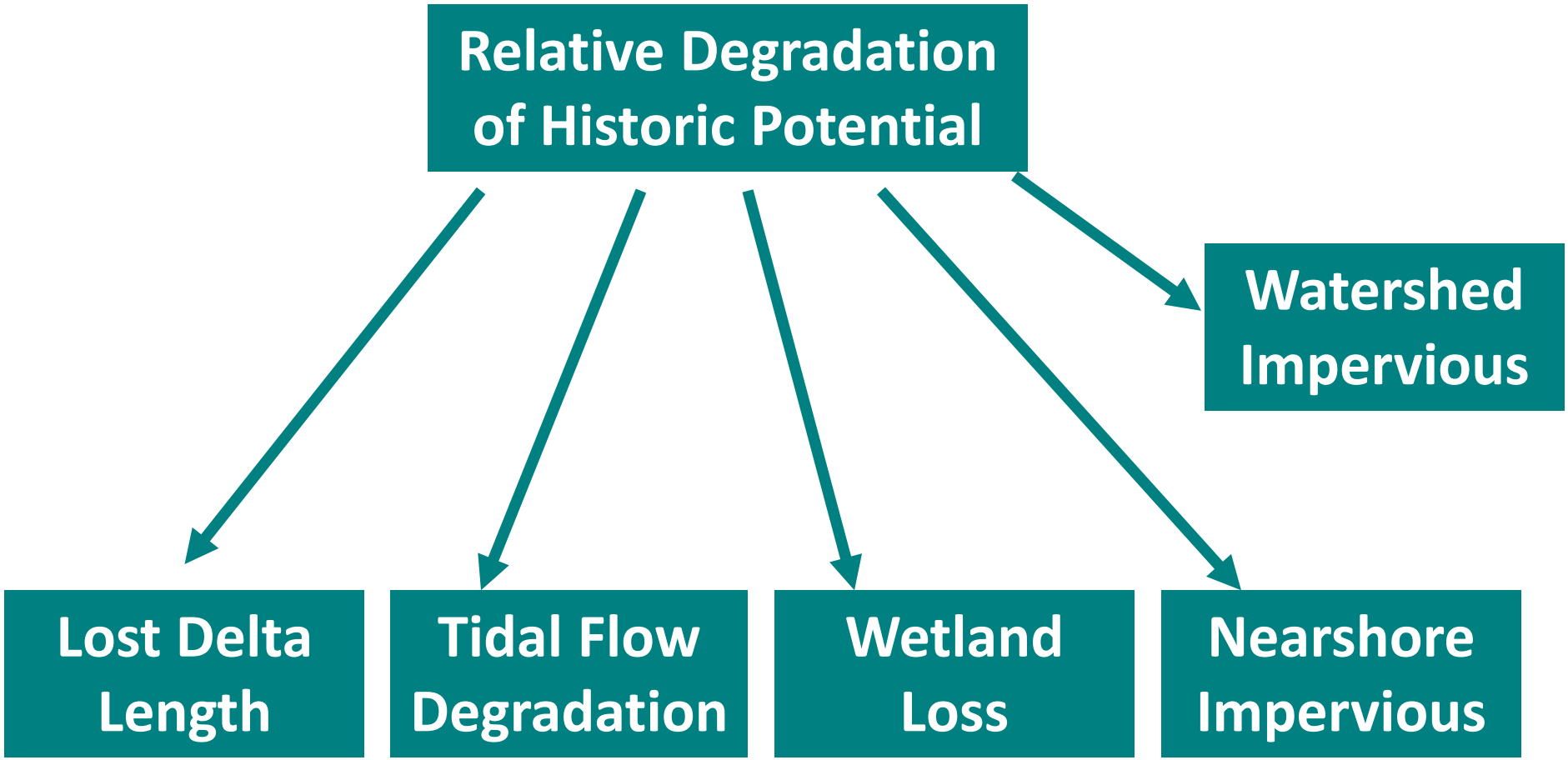
ESTUARY & SALMON RESTORATION PROGRAM

Washington Department of FISH and WILDLIFE

Calculation of Restoration Potential: Deltas

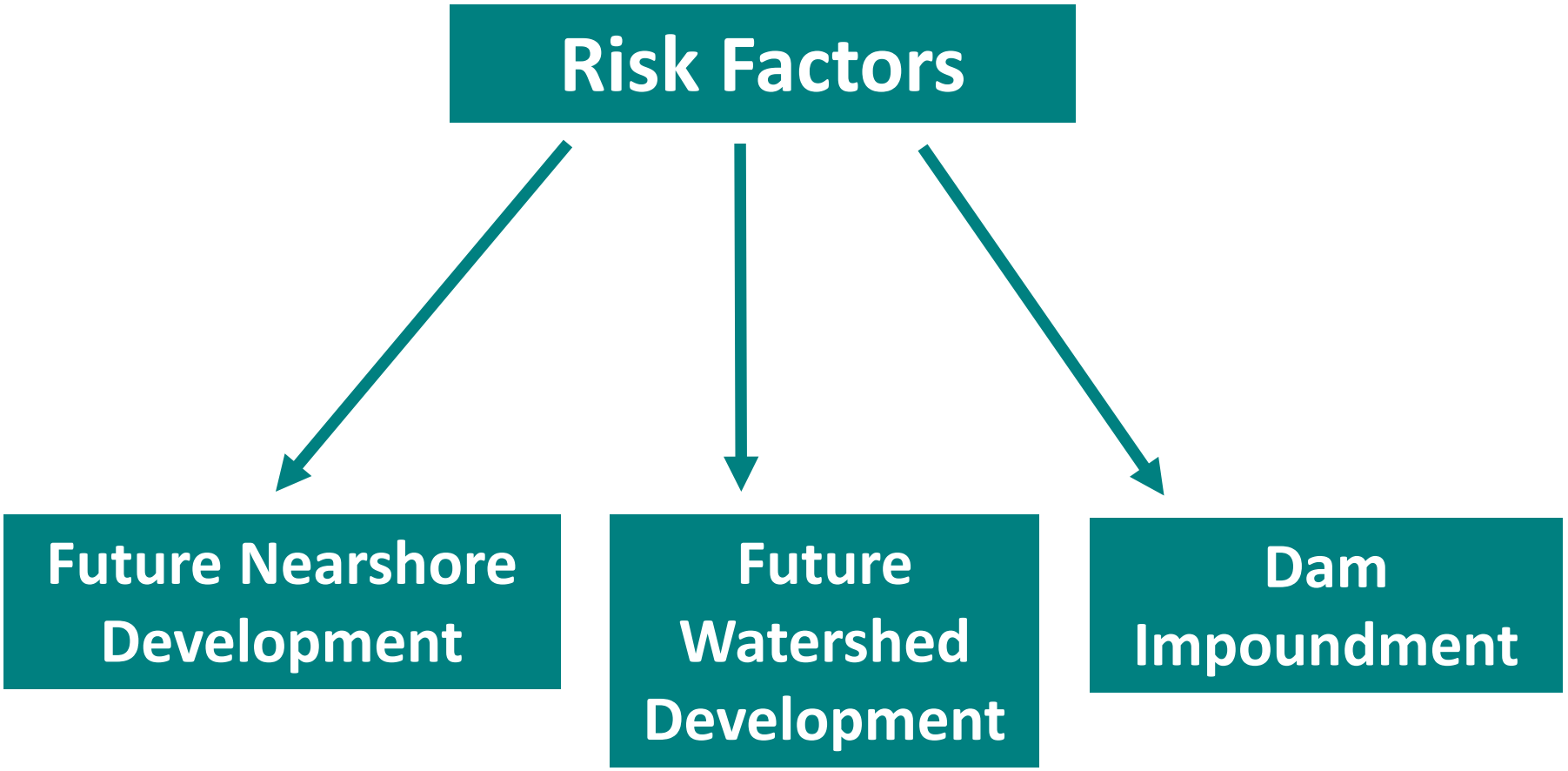


Calculation of Degradation: Deltas



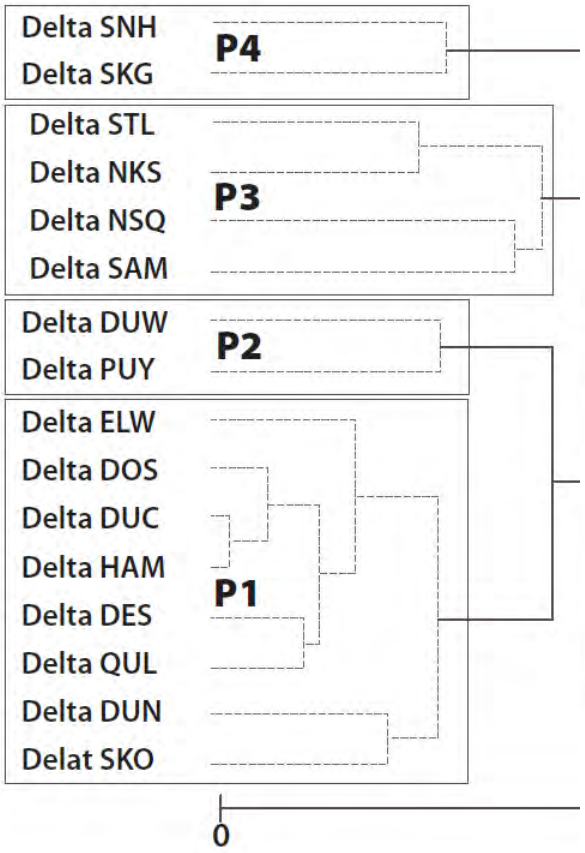
Cereghino et al. 2012

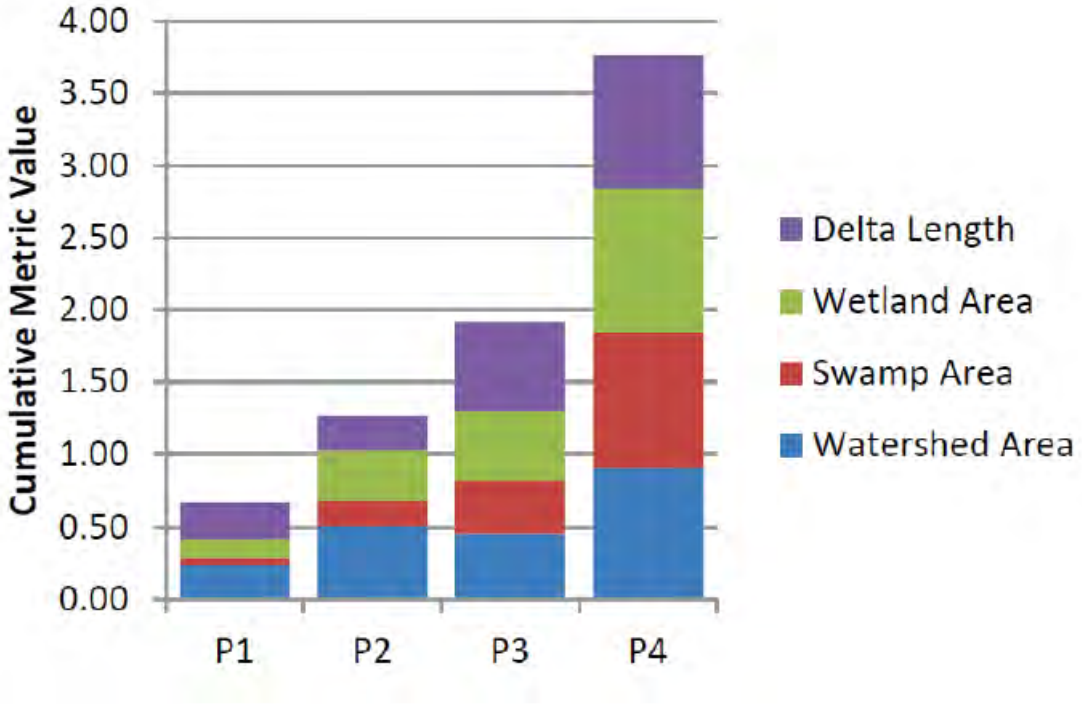
Risk Factors: Deltas



Cereghino et al. 2012

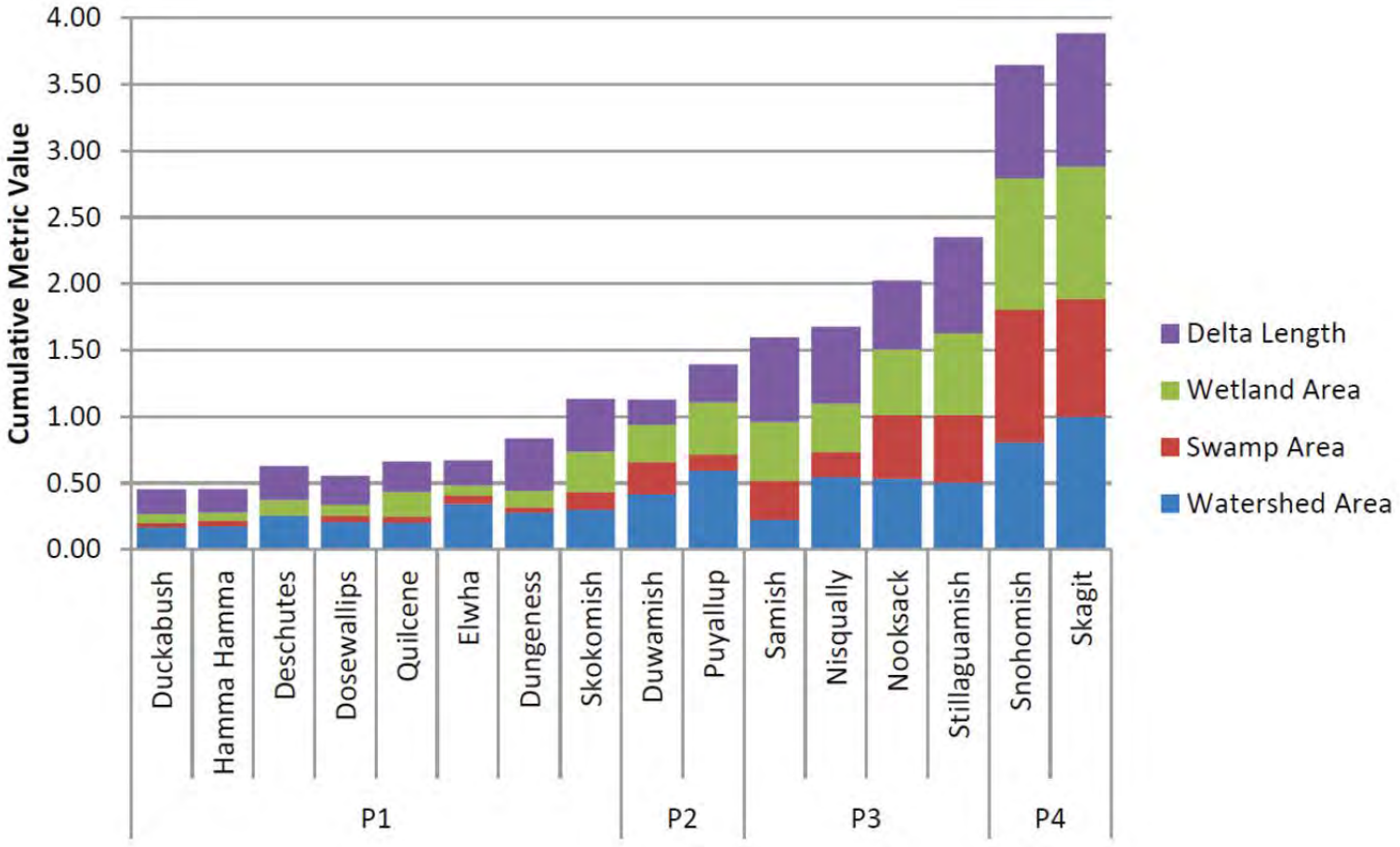
Delta Potential Groupings: Cluster analysis





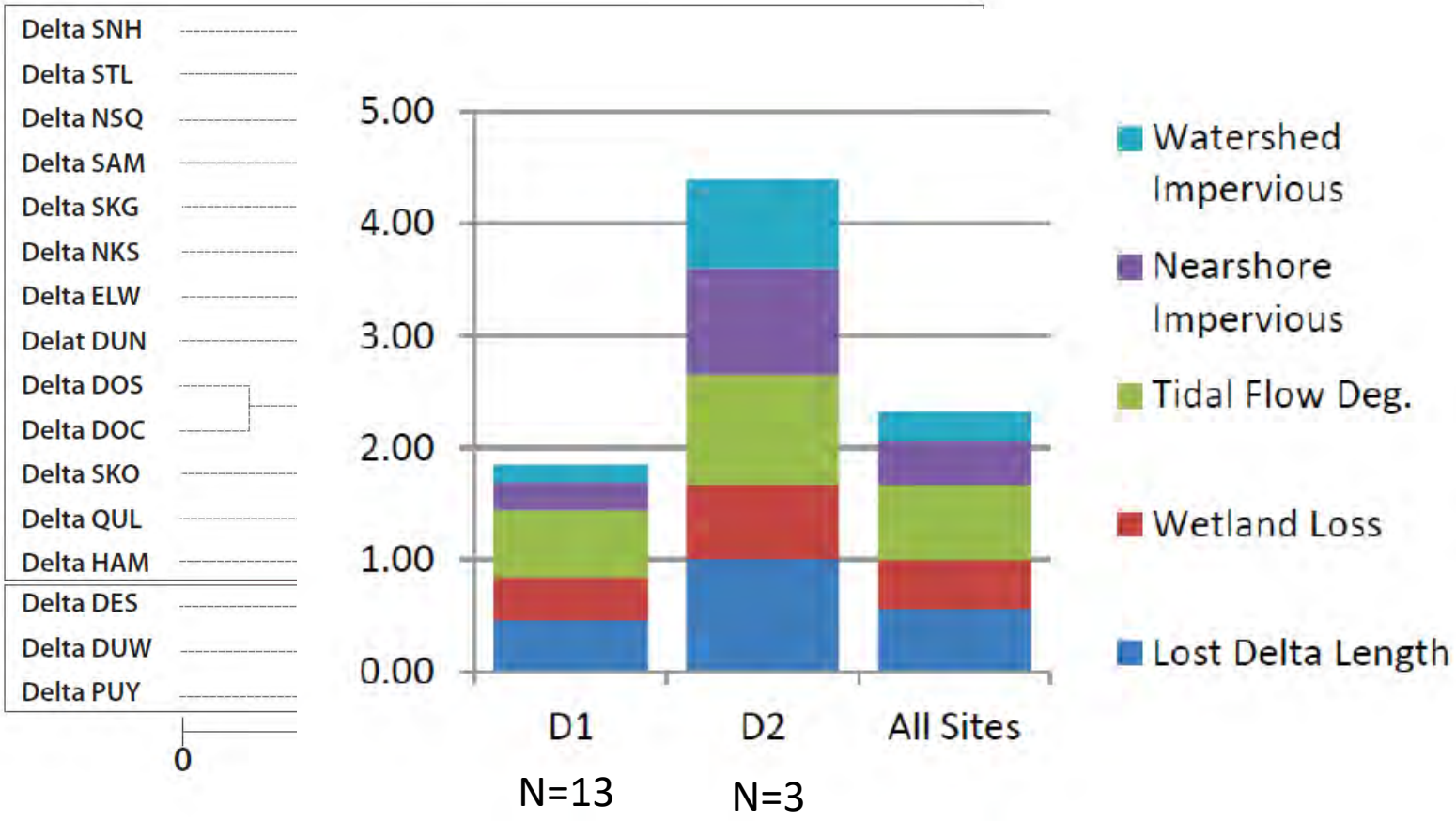
Cereghino et al. 2012

Features of Delta Potential Groups



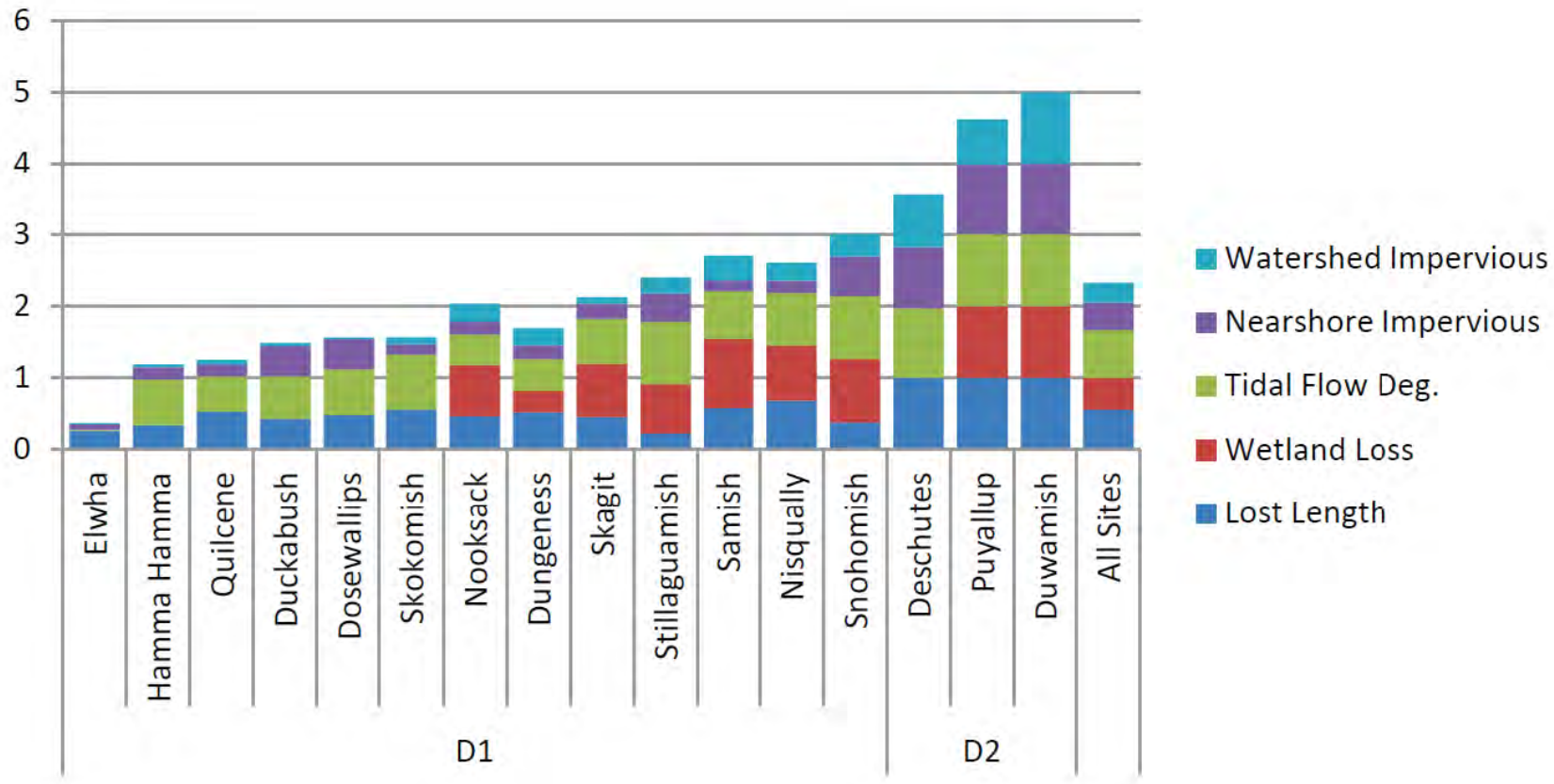
Cereghino et al. 2012

Delta Degradation Groupings: Cluster Analysis



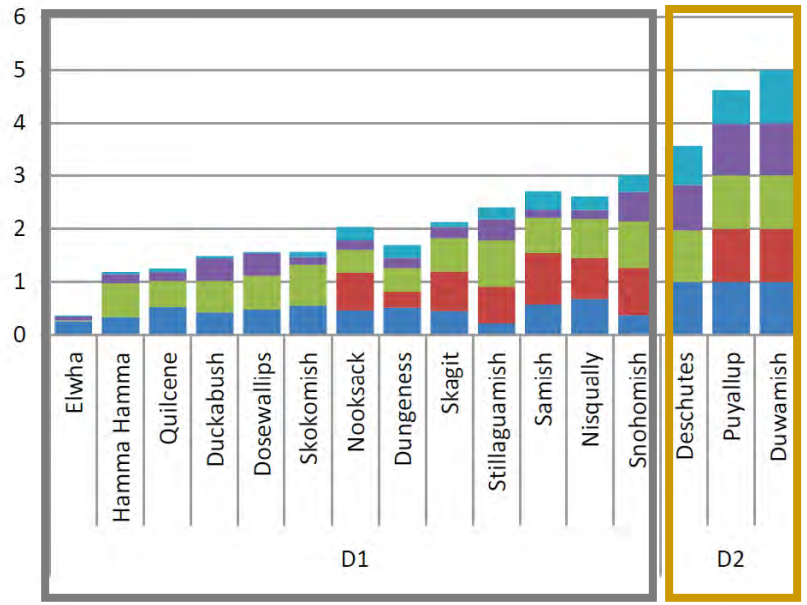
Cereghino et al. 2012

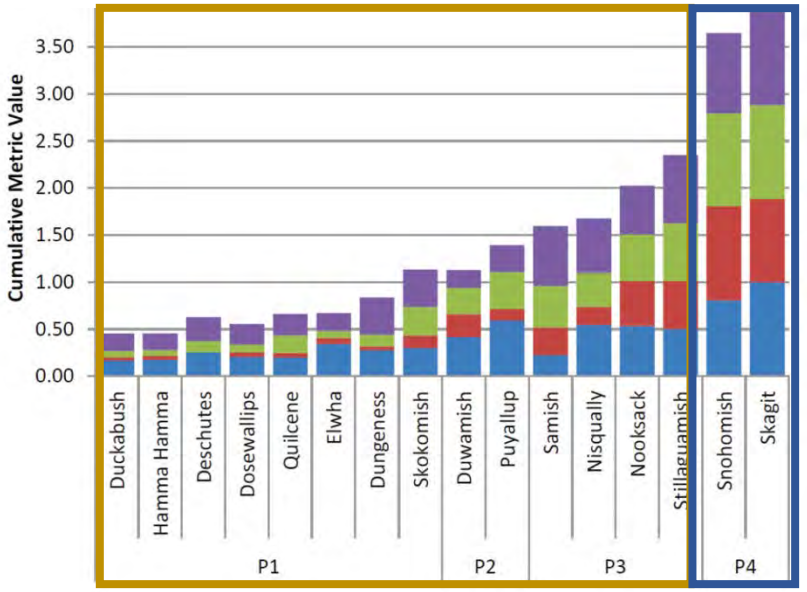
Features of Delta Degradation Groups



Cereghino et al. 2012

Delta Management Strategy





Group	D1	D2	Total
P1	7	1	8
P2		2	2
P3	4		4
P4	2		2
Total	13	3	16

Restore

Enhance

Low

High

Cereghino et al. 2012