Coastal Geomorphology and Coastal Geology Analysis of Proposed Henderson Inlet [Taylor/Lockhart, Arcadia/Thiesen, Arcadia/McClure], and Eld Inlet [Xia/NetVenture] Geoduck and Clam Farms, Thurston County, WA

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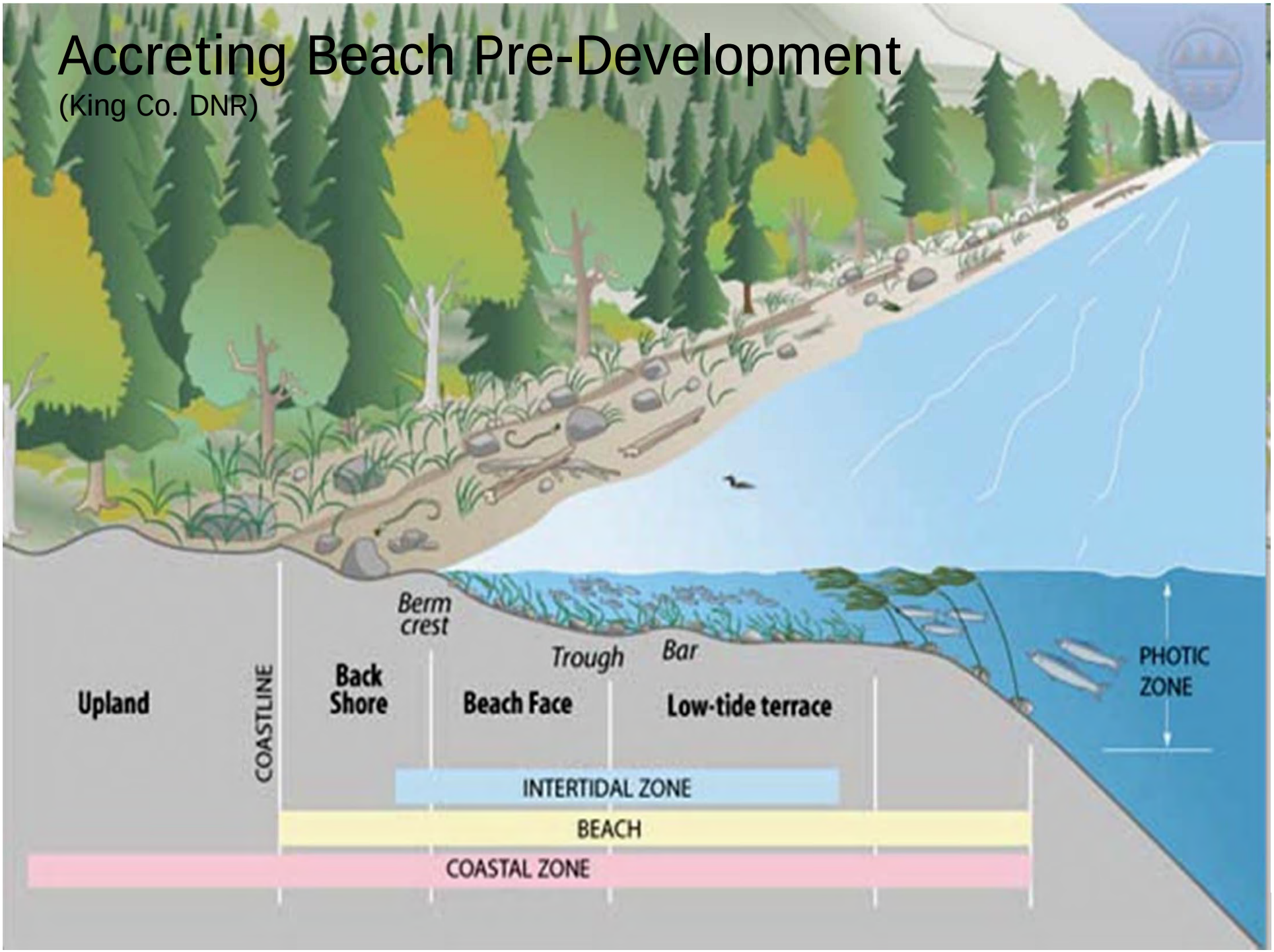
Accreting Beach Pre-Development

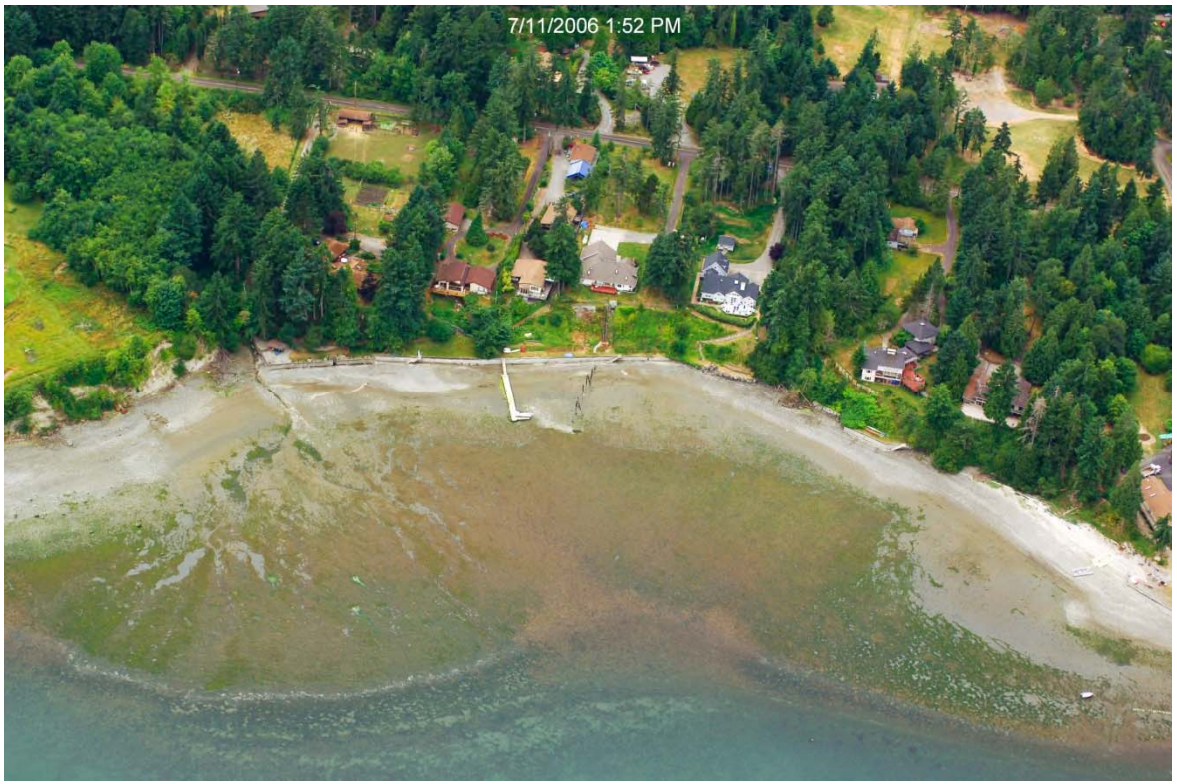
(King Co. DNR)



Puget Sound Coastal Systems

Interconnected Components:

- Bluff
- Beach
- Waves
- Stream
- Subtidal
- Spit
- Lagoon/Salt marsh
- People



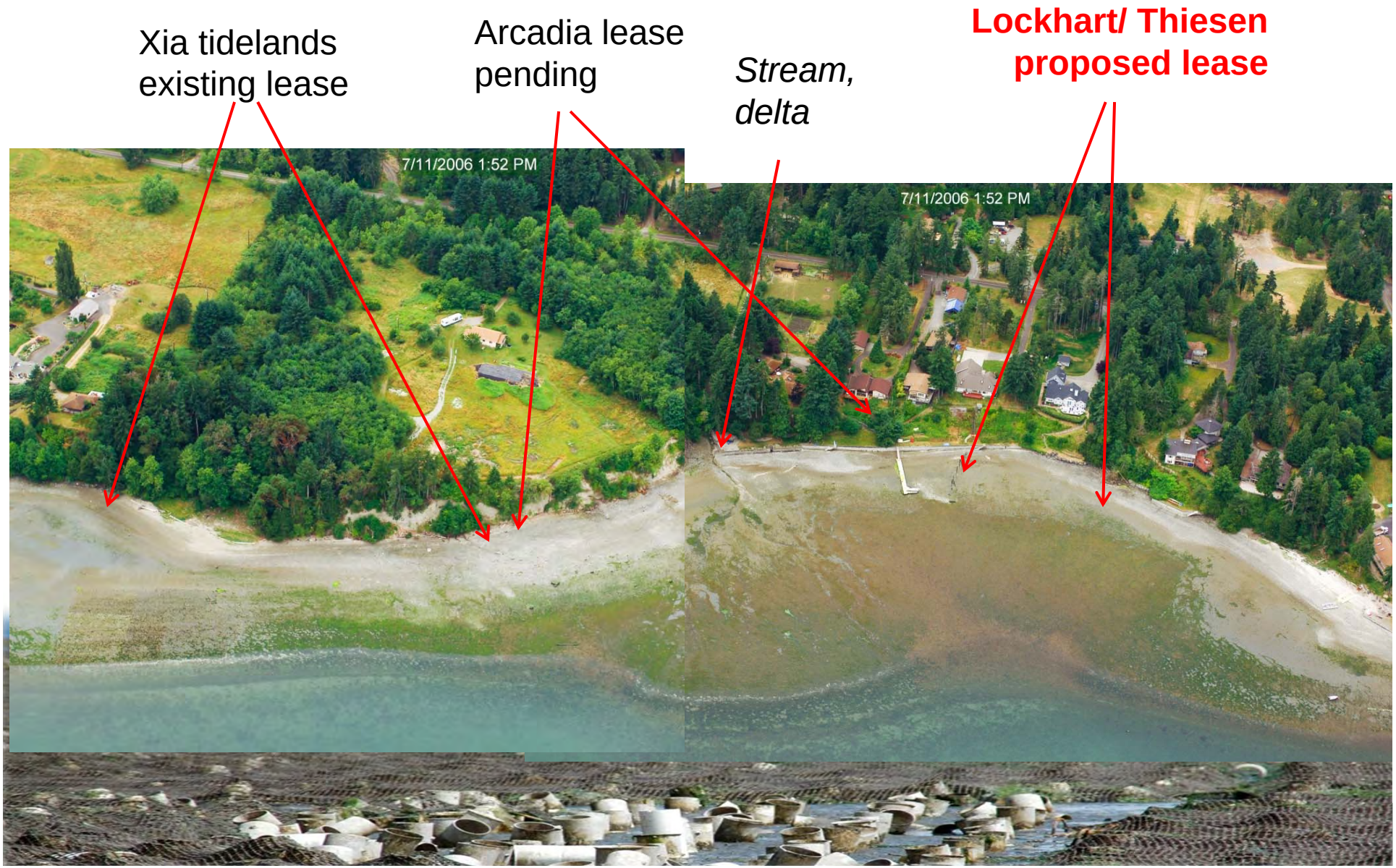
Physical processes acting on *sediment builds & maintain habitats*

Altering one component *affects others*

Cumulative impacts need to be considered

Location Map – North Henderson Inlet in South Puget Sound

Henderson Inlet sites I – from north to south



Henderson Inlet sites – II continuing south

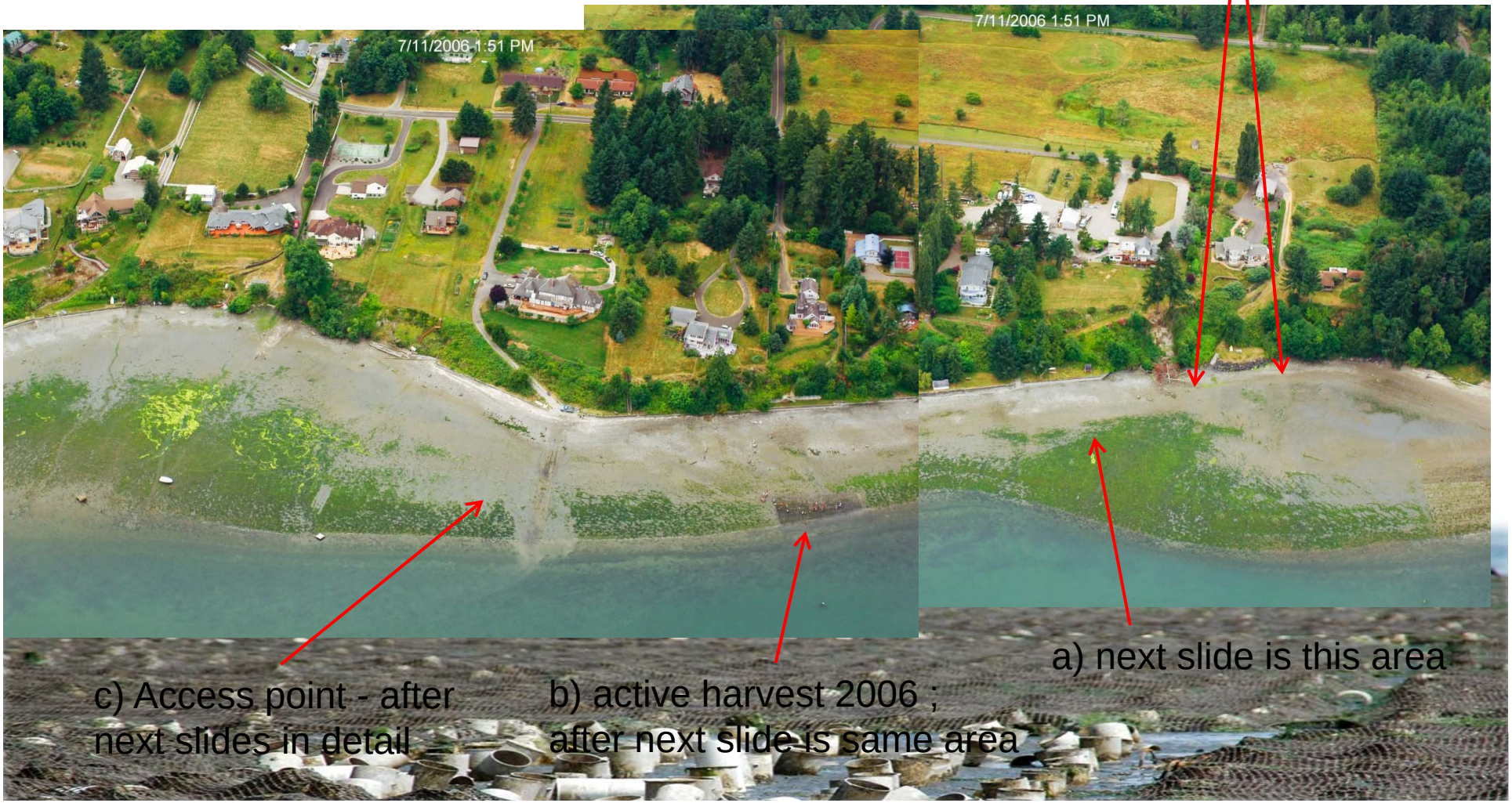
McClure adjacent to continuous line of lease areas:

Existing - - - - - - - - - - - - - - - - - -Arcadia

Existing Rising tide

Existing Arcadia

McClure Proposed



c) Access point - after next slides in detail

b) active harvest 2006 ; after next slide is same area

a) next slide is this area

a) Shellfish aquaculture Storage on the Beach, circa 2012

b) South of Proposed McClure, Dense net cover - 2011

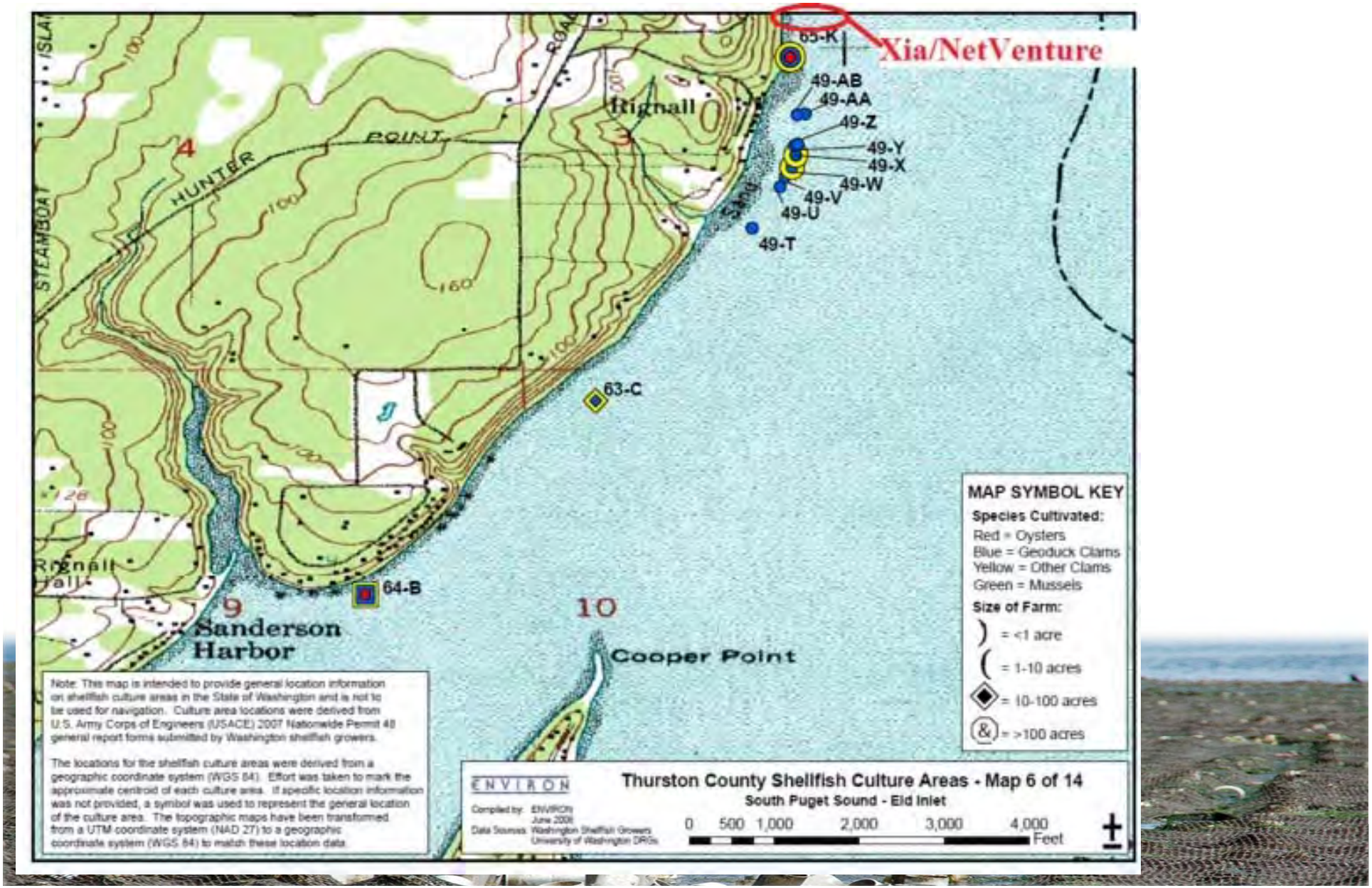
Net density approaches that studied in Exhibit 79 by Bendell and Wan (2010) in Journal of Coastal Conservation, from Baynes Sound in BC.

Exhibit 77 by Bendell (2006) in *Environmental Conservation* journal, quote from abstract:
“Beaches that were actively farmed also had greater accumulations of organic matter and silt. Simplification of the intertidal benthic community, coupled with accumulations of organic matter and increased siltation, may have altered the ecology of the foreshore region used for intense shellfish harvesting.”

c) South of Proposed McClure, Detail - 2006

Henderson Inlet sites – spit at drift cell terminus

North Eld Inlet site – Xia Net Venture



North Eld Inlet site –

Effects – Summary

Probable Significant Impacts:

- Proposal Altered sediment transport due to netting, PVC tubes, and water jet harvest

- **Sediment accretion - temporary**
- **Sediment release during and after harvest**
- **Sediment resuspension**

- **Lack of sediment compaction**
- **Possibly altering southern spit**
- **Possibly altering forage fish spawn**

Lack of Scientific Sampling and Study

Cumulative Impacts – Significant

- Many harvest sites, adjacent, more proposed
- Clear significant impacts to sediment, water quality, habitats

Water jet harvest – sediment transport initiated

Causes sediment suspension and turbidity in lower intertidal/ shallow subtidal, Immediately adjacent to tidal waters

Sediment Firmness

A Field Method for Determining the Firmness of Colonized Sediment Substrates

Murray K. Gingras and S. George Pemberton.

Beginning of Abstract:

"Substrate firmness influences the erodibility, remobilization, and topography expression of that substrate. Sediment distribution patterns, remobilization of sediment, and the architecture of biogenic sedimentary structures are strongly affected by the firmness and cohesiveness of the sediment." (Page 1)

"Substrate firmness is a physical characteristic that strongly affects the erodibility and remobilization of sediment."

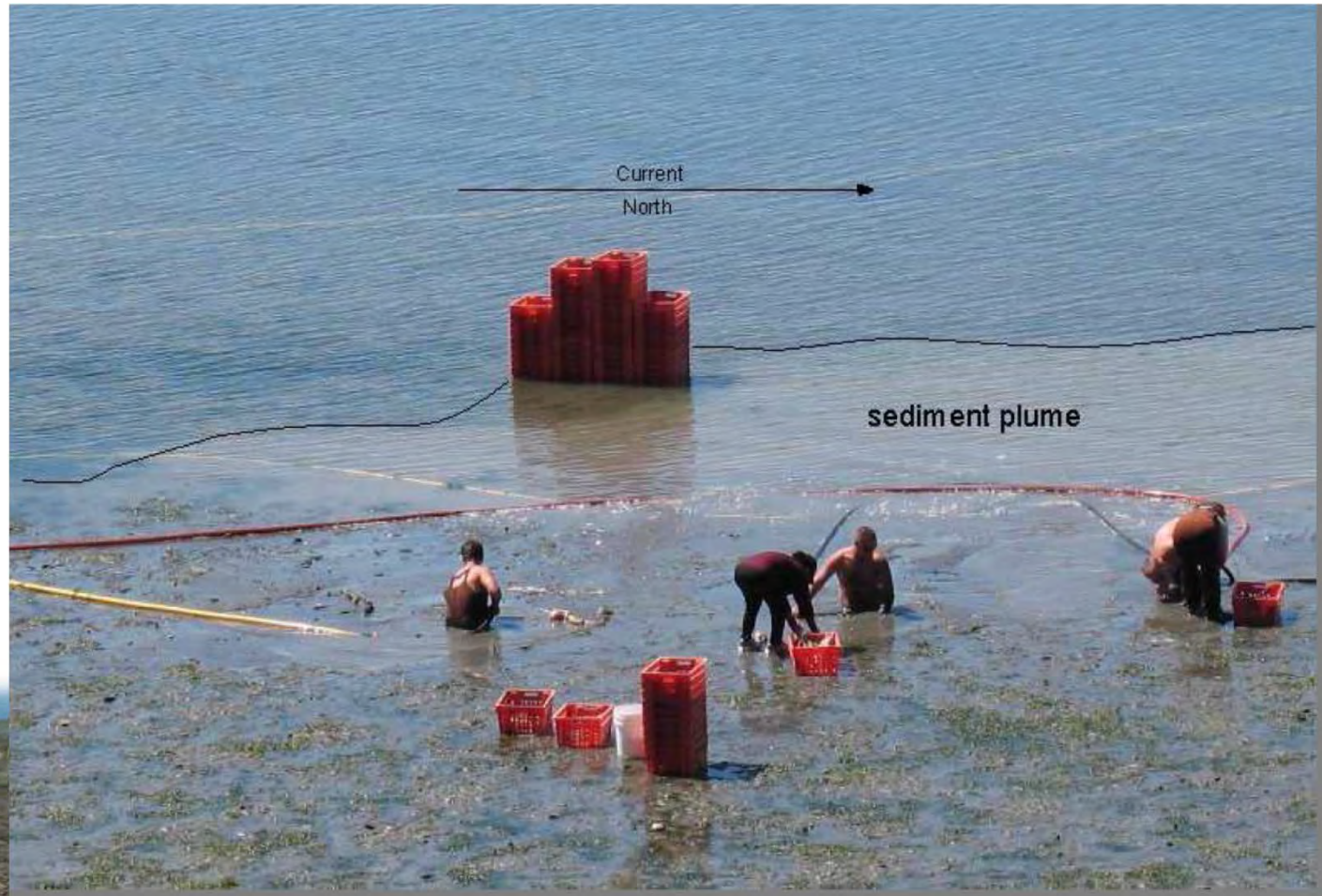
Harvest in lower intertidal/ shallow subtidal

Sediment disturbance & suspension (loss of natural compaction); increased turbidity

Taylor Foss operation harvest. Close up of two harvesters “in the hole.” 8/14/07

Harvest in lower intertidal/ shallow subtidal

Plume; later available for resuspension & bedload transport



Taylor Foss operation water jet harvest, obvious sediment plume, northern edge of Foss property. 8/14/07

Testimony of Dr. Jeff Parsons in Foss Site Hearing

Administrative Appeal AA16-07

Q: And in terms of the composition of the beach, were there any areas that seem unusually hard or unusually soft? (page 162)

A: There was one area that was extremely soft on both of my visits, and that was about 100 to 150 feet of the beach immediately in front of John McCormick's property"

And it was extremely loose and, just in walking over it, I sunk in about somewhere between six to 10 inches, so covering – enough to cover my feet, go up a few inches on my shin. At it was very distinct area, and it was also the same area that I was informed, by John McCormick, as the area that had been harvested earlier this year. (page 162-163)

Testimony of Dr. Jeff Parsons in Foss Site Hearing

Administrative Appeal AA16-07

Q: My question was whether you'd developed an opinion regarding the cause of that soft area. (page 164)

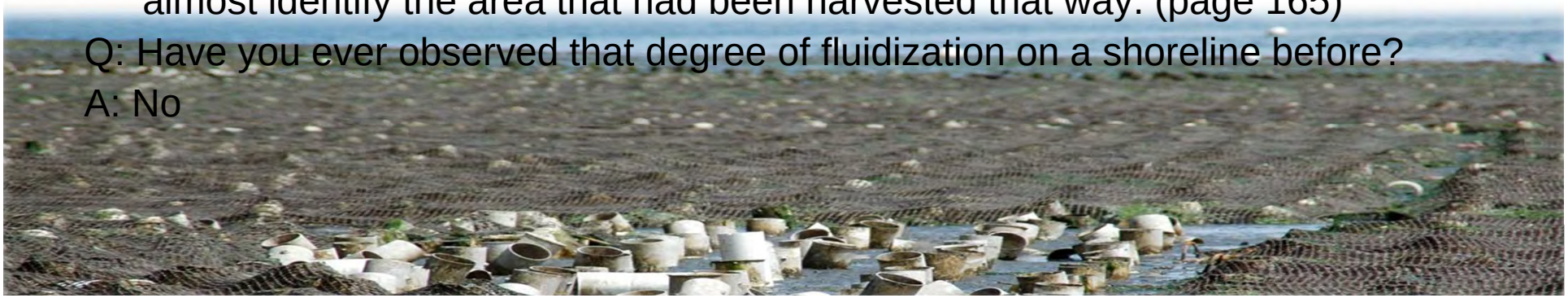
A: What I realized was that this was– it looked to be liquefied, and looked liquefied– it most likely related to the fact that there was a large quantity of water seeping out of the beach.

A: there could be a number of causes of the volume of water coming out, one of which is that it could be a natural phenomenon, However, there were a number of other places where I did notice seeps along the beach, and none of them were fluidized to the same degree as particularly in front of John McCormick's property.

A: even though it was marked, you didn't need to know where the edge of the harvesting area was, because, when you could walk on the ground as if it was normal, you knew where it was, because it stopped. So you could almost identify the area that had been harvested that way. (page 165)

Q: Have you ever observed that degree of fluidization on a shoreline before?

A: No



Sediment Transport

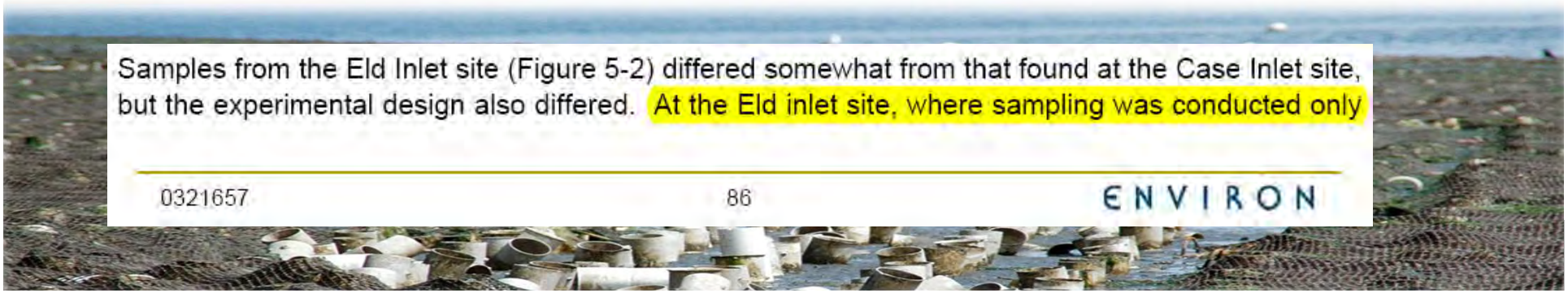
BOTH in Suspension and as Bedload (along the bottom)

Breaking waves add significant turbulence
Sands typically transported as bedload (“Waves effectively move sediment”)
Tidal asymmetry does not preclude this (“submerged”)
Silt often transported in suspension

Environ 2009

Page 86-87

“At the Eld inlet site, where sampling was conducted only a day after a harvest (versus approximately two months following harvest at the Case Inlet site) significant reductions in the very coarse sand (> 2mm [not pictured in Figure 5-2]) and silt components of the sediment (40-63 mm), and significant increases in the medium and fine grained sand (0.125 to 0.5 mm) components, were recorded after harvest.”



Uneven bed left after harvest

Beach two days after Taylor Shellfish harvest, Foss operation, tube abandoned on beach. 4/22/07

Beach after Taylor Shellfish geoduck harvest, Foss operation, 6/2/07

Exhibit 129

Nittrouer, and Sternberg – The Fate of a Fine Grained Dredged Spoils of Deposit in a Tidal Channel of Puget Sound, Washington (1975)

Sediment was dredged from Olympia and deposited in Dana Passage. Monitoring, diving, sampling revealed that:

Fines were removed from deposits (silt to fine sand)

Grain size of deposits became more coarse

Due to "*greater susceptibility for suspension during disposal and also for resuspension during erosion of loosely consolidated sediment from the spoils deposit*"

Exhibit 131

Danker, P.J.T. - The behavior of fines released due to dredging – a literature review, Hydraulic Engineering Section, Faculty of Civil Engineering and Geosciences, Delft University of Technology (2002)

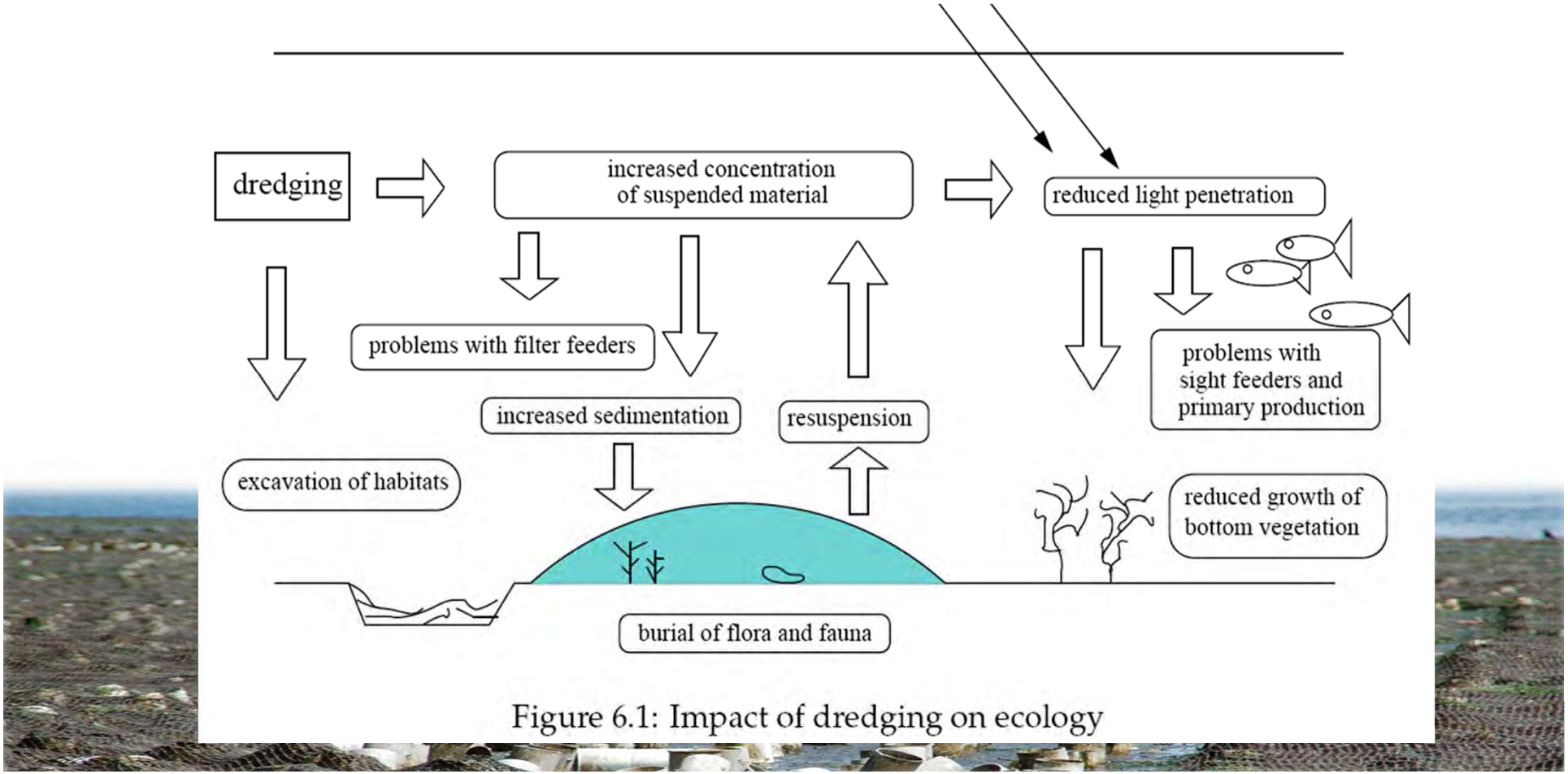


Figure 6.1: Impact of dredging on ecology

Canopy nets and PVC tubes:

Causes increased sedimentation, gathers organic and debris

Excess debris in nearshore system

Extensive net cover

Netting –

Decreases wave energy, may alter sediment distribution (bird skeleton)

Thousands of Small Impacts

Plastic tubes and nets

Netting –

Traps rock crab, may trap marine mammals

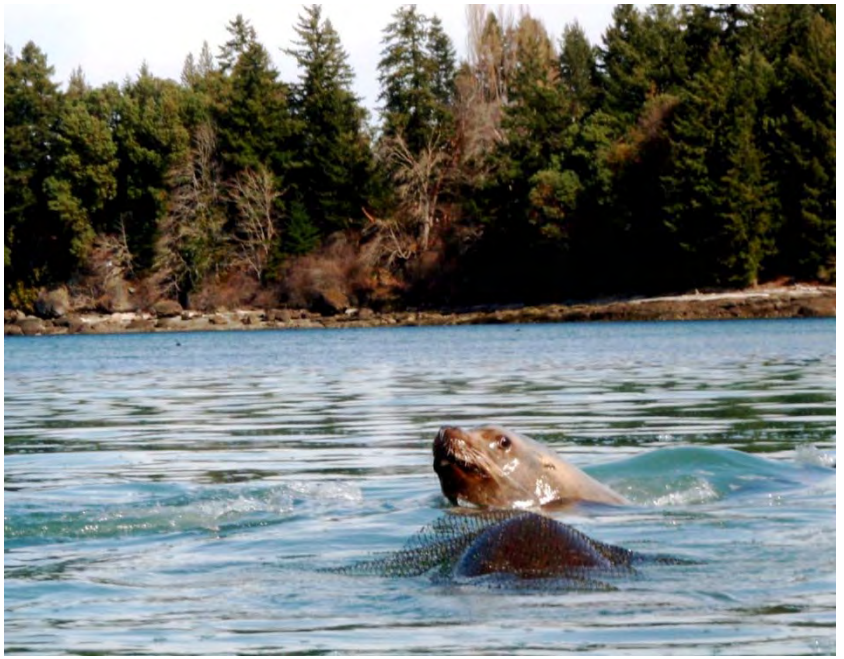
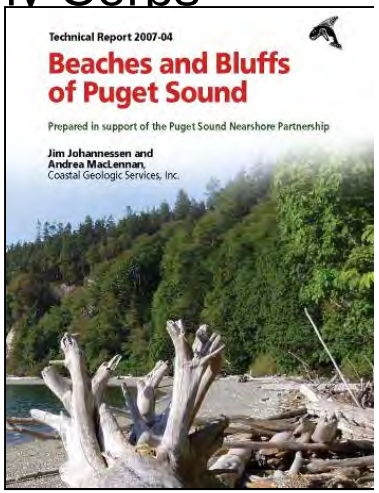


Exhibit 128

Johannessen, J. and MacLennan, 2007. Beaches and Bluffs of Puget Sound, Puget Sound Nearshore Ecosystem Restoration Project Report No 2007-04, Published by Seattle District, U.S. Army Corps of Engineers, Seattle Washington



- Conservation is far cheaper than restoration
- Even so, more and more restoration is being undertaken in Puget Sound, at great expense
- Purpose is to *attempt* to recover impacted and lost nearshore habitats, salmon, and many other species

Note: WDNR is spending hundreds of thousands of public dollars on site restoration at a small site in nearby Henderson Inlet at Woodard Bay for nearshore habitat.

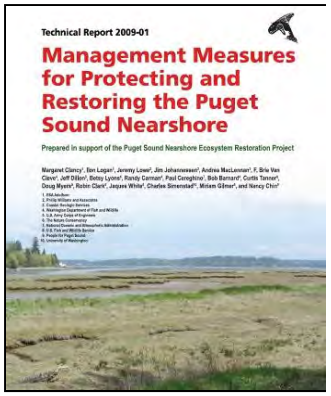
Similar sums will likely be spent for another restoration site just south of the Xia Net Ventures site for restoration.

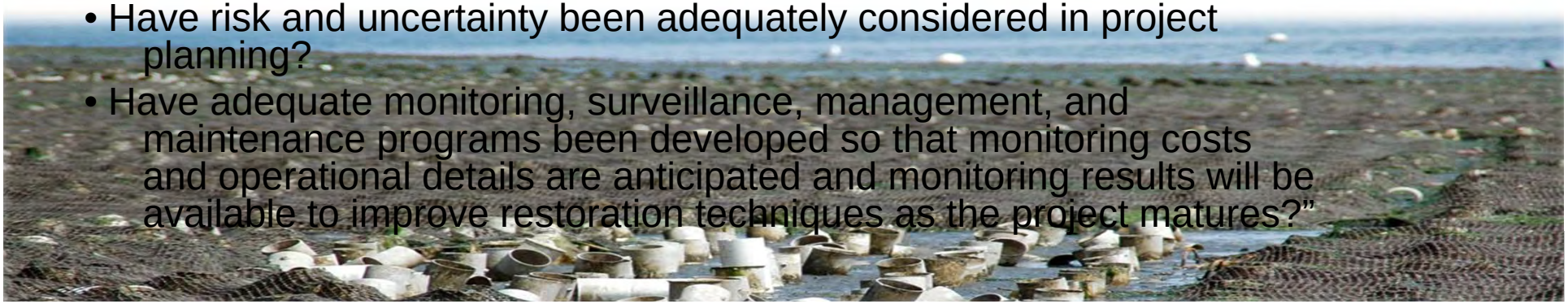
Exhibit 134, Management Measures for Protecting and Restoring the Puget Sound Nearshore. Technical Report 2009-01, (2009) for WDFW; Is analysis of permitted shellfish aquaculture sites this careful?

<u>From Introduction:</u>

"Pre-project implementation questions:

- Has the restoration been planned with adequate scope and expertise?
- Does the restoration design allow for midcourse corrections and adaptive management?
- Have sufficient baseline data been collected over a suitable period of time to facilitate before-and after comparisons?
- Has the project been designed to make the restored ecosystem as self-sustaining as possible to minimize maintenance requirements?
- What impact will the restoration have on processes and will the beneficial effects be outweighed by offsite factors (e.g., on site erosion control measures may not be effective if there are major activities/sources off site that deliver large sediment loads)?
- How long will the project need to be monitored before the restoration effort can be declared effective?
- Have risk and uncertainty been adequately considered in project planning?
- Have adequate monitoring, surveillance, management, and maintenance programs been developed so that monitoring costs and operational details are anticipated and monitoring results will be available to improve restoration techniques as the project matures?"





Lack of Science

Great lack of site-specific data
Significant lack of harvest monitoring
Lack of objectivity in some analyses

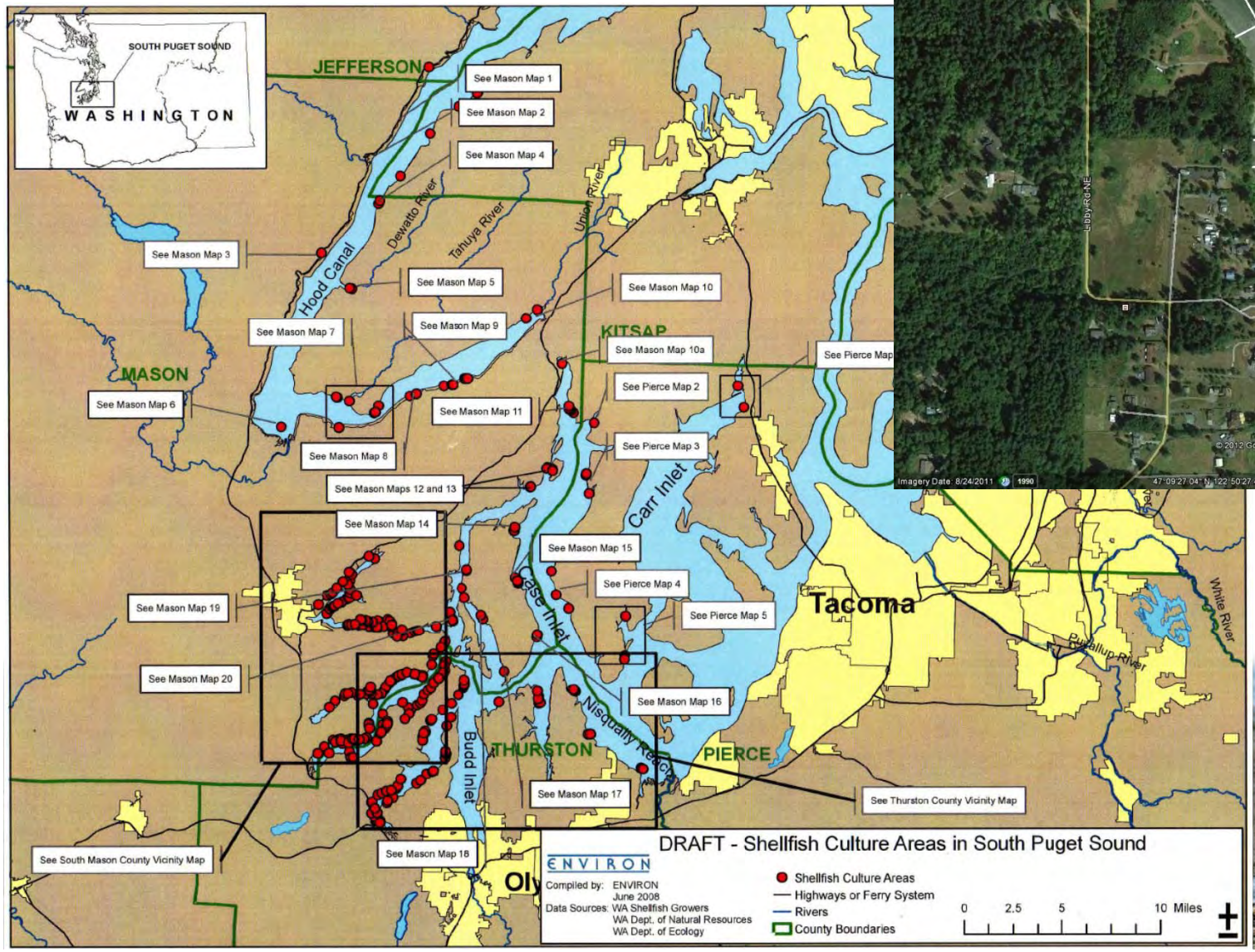
One study rehashes the next; all based on limited data and not always in context

Harvest sites vary and cannot be compared accurately
And cannot be considered in isolation

Harvest is localized dredging; for which more data and research exists:

Cumulative Impacts are Significant

Known Shellfish Aquaculture Areas-2008



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