Coastal Geomorphology and Coastal Geology Analysis of Proposed Haley (Taylor Shellfish, Seattle Shellfish) Geoduck Farm, Pierce County, WA

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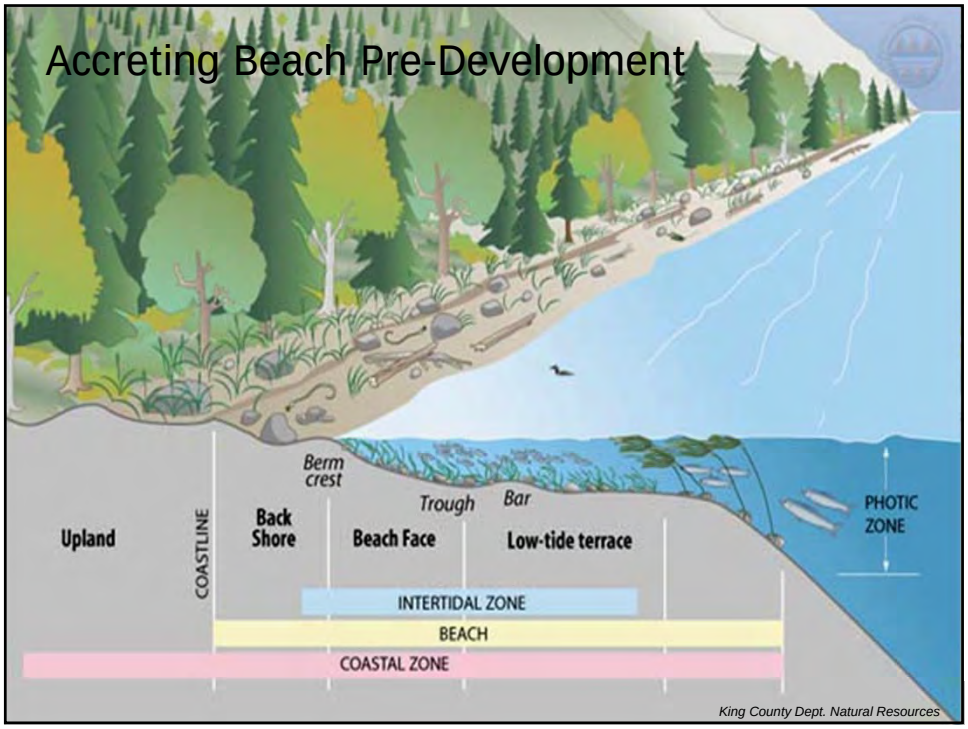
Location Map – S. Puget Sound; Haley Site

Accreting Beach Pre-Development



King County Dept. Natural Resources

Puget Sound Coastal Systems

Interconnected Components:

Bluff
Beach
Tide flat
Subtidal
Waves
Streams
Spit
Lagoon/Salt marsh
People

Physical processes build & maintain habitats

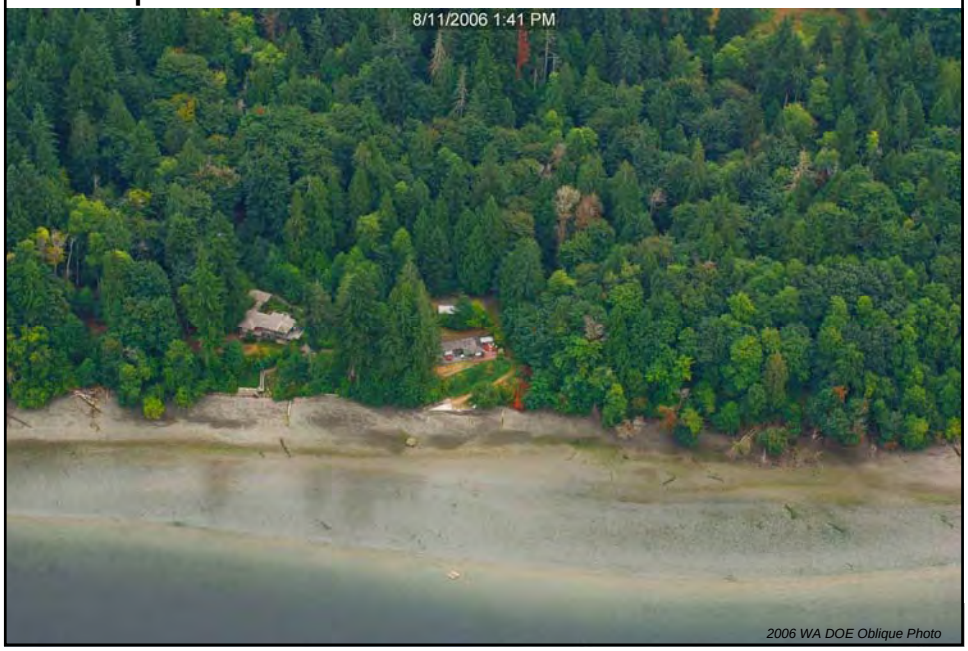
Proposed Haley geoduck farm site, Jim Johannessen photo, 8/9/14

Proposed Project Setting
Net shore-drift

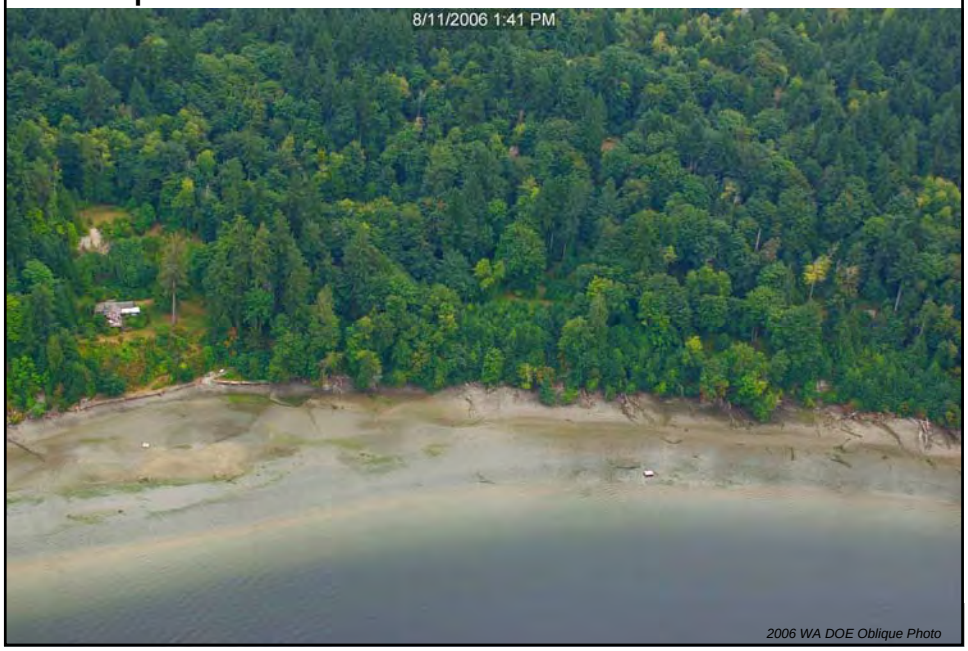
- *Broad, low slope in intertidal and subtidal*
- *Fronting bluff*
- *Intermittent backshore present*
- *Within drift cell PI-15-3, which is approx. 3 miles long*
- *Low level of development*
- *Complex of beach habitats*

Drift Cell-Oblique Aerial View 1 of 10 (S->N)

Oblique Aerial View 2



Oblique Aerial View 3



Oblique Aerial View 4 – **Proposed Farm Site**

Oblique Aerial View 5

Oblique Aerial View 6-”Haley” Lagoon

Oblique Aerial View 7- ”Haley” Lagoon Channel

Oblique Aerial View 8

Oblique Aerial View 9 of 9-Dutchers Cove

Proposed Farm Site-North end looking into Case Inlet

CGS/Johannessen Photo taken 8/9/2014, At Haley site, South area

Proposed Farm Site-Below 0 ft MLLW-South

CGS/Johannessen Photo taken 8/9/2014, At Haley site, South area

Proposed Farm Site-Below 0 ft MLLW-Central

CGS/Johannessen Photo taken 8/9/3214, At Haley site, Central area

Proposed Farm Site- 0 to +2ft MLLW-North

CGS/Johannessen Photo taken 8/9/2014, At Haley site, South area

Proposed Farm Site- 2 to +2ft MLLW-Substrate

CGS/Johannessen Photos taken 8/9/2014, At Haley site

Proposed Farm Site- 0 to +2ft MLLW-Central

CGS/Johannessen Photo taken 98//2014, At Haley site, South area

Geoduck Operations - Clearing a Beach

Jim Johannessen Photo taken 5/14/2014, ***East Totten Inlet***

Clearing a Beach

Jim Johannessen Photo taken 5/14/2014, East Totten Inlet

Thousands of PVC tubes

Jim Johannessen Photo taken 5/14/2014, Totten Inlet

Thousands of PVC tubes

Jim Johannessen Photo taken 5/14/2014, Totten Inlet

Canopy Netting

Jim Johannessen Photo taken 5/14/2014, West Totten Inlet

Canopy Netting

Jim Johannessen Photo taken 5/14/2014, West Totten Inlet

“Stomping in” PVC tubes

Jim Johannessen Photo taken 5/14/2014, Totten Inlet

Many Missing PVC tubes

Jim Johannessen Photo taken 5/14/2014, West Totten Inlet

Staging Areas for Geoduck Farms

Jim Johannessen Photos
taken 5/14/2014, Totten Inlet

Harvest in lower intertidal/shallow subtidal-video-1

West shore Totten Inlet 5/16/14, by Jim Johannessen

IMG_4925.MOV

Harvest in lower intertidal/shallow subtidal-video-2

West shore Totten Inlet 5/16/14, by Jim Johannessen

IMG_4927.MOV

Harvest in lower intertidal/shallow-subtidal

Jim Johannessen Photo taken 5/14/2014, West Totten Inlet

Harvest in lower intertidal/shallow-subtidal

Jim Johannessen Photo taken 5/14/2014, West Totten Inlet

Harvest in lower intertidal/ shallow subtidal

Sediment disturbance & suspension (loss of natural compaction)

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

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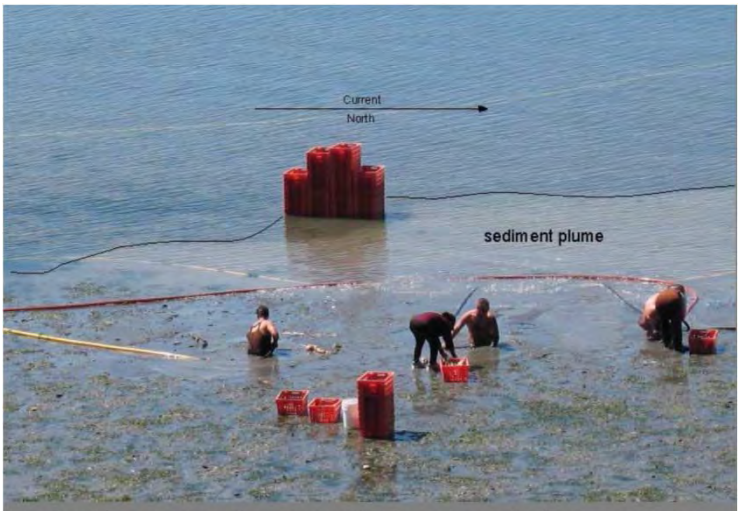
taken by Coalition to Protect Puget Sound Habitat

Harvest in lower intertidal/ shallow subtidal

Plume; later available for resuspension & bedload transport



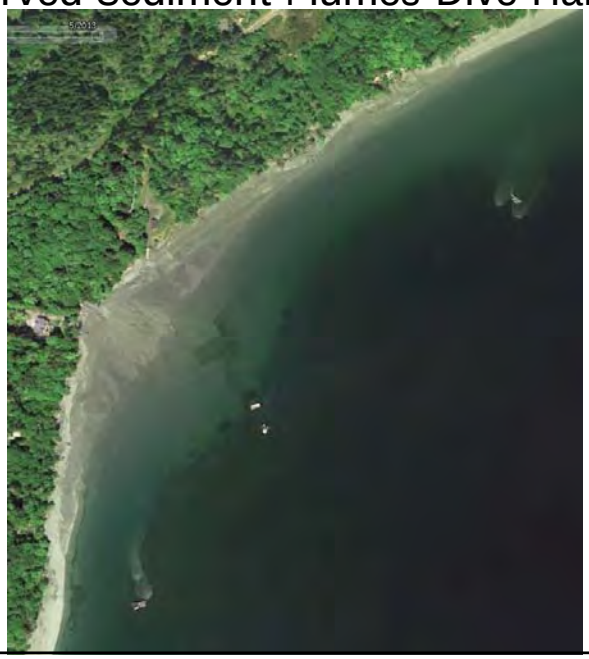
Taylor Foss operation water jet harvest, obvious sediment plume, northern edge of Foss property. 8/14/07

taken by Coalition to Protect Puget Sound Habitat

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

taken by Coalition to Protect Puget Sound Habitat

Observed Sediment Plumes-Dive Harvest-1



Google Earth 5/3/2013 image

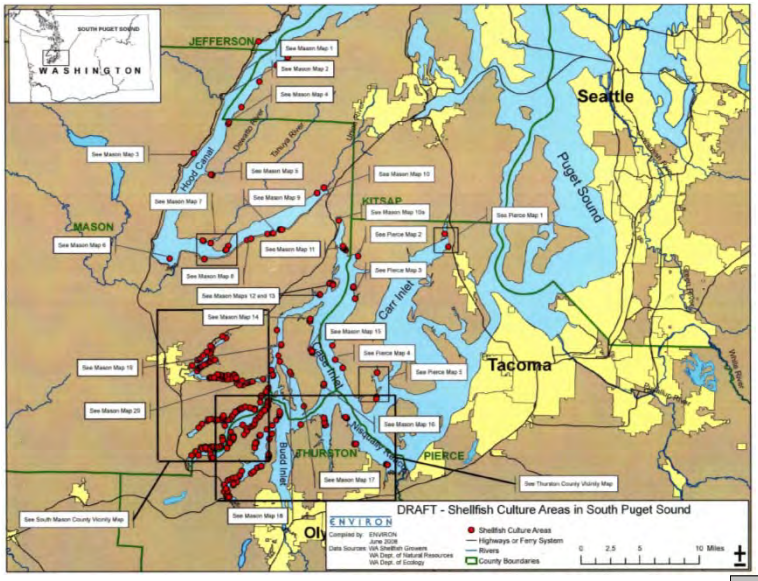
Observed Sediment Plumes-Dive Harvest-2

Google Earth 5/3/2013 image

Observed Sediment Plumes-Dive Harvest-3

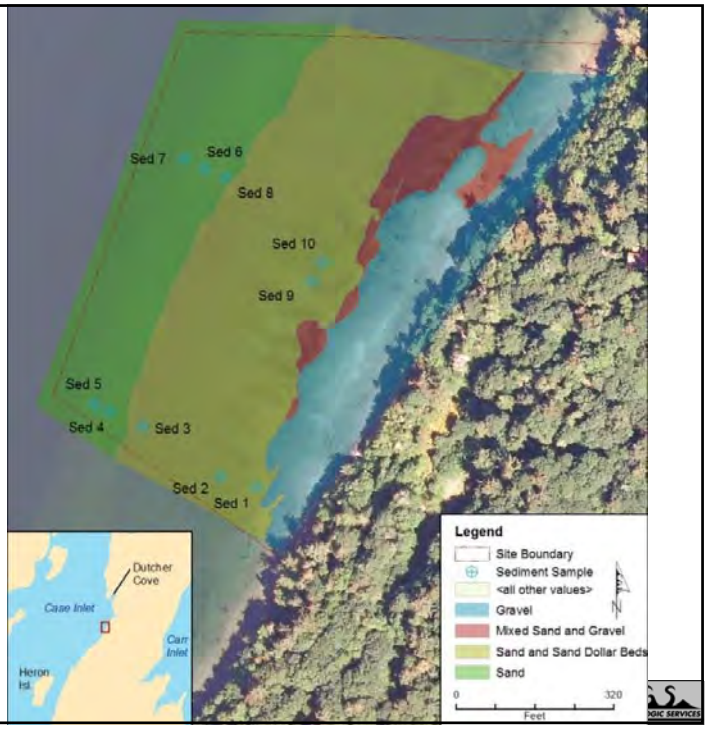
Google Earth 5/3/2013 image

Known Shellfish Aquaculture Areas-2008

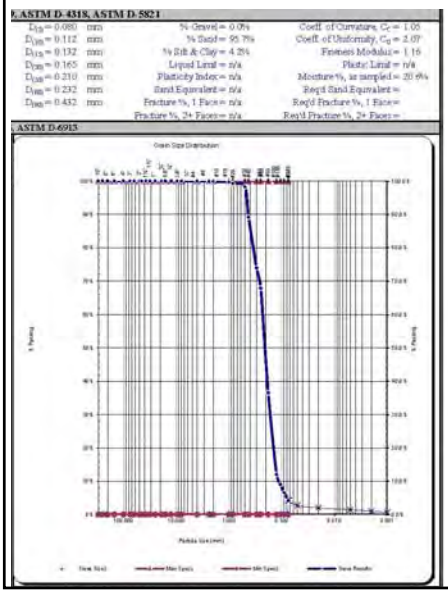


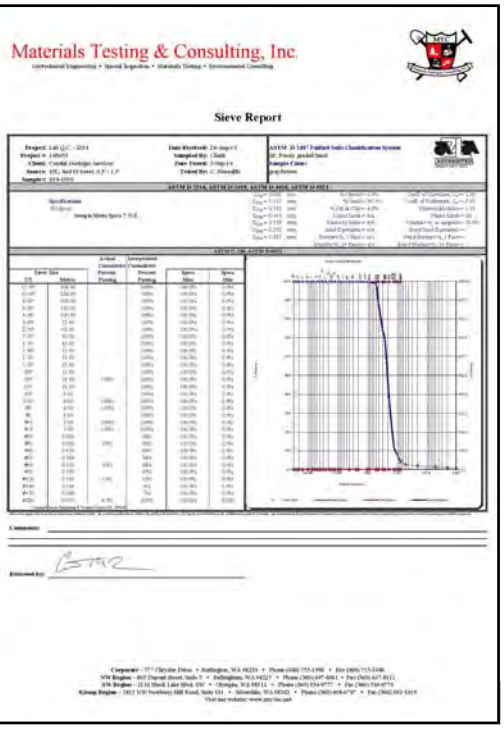
Beach Sediment Complexity

Mapped sediment polygon distribution and sediment samples, by CGS 8/9/2014 at proposed geoduck farm

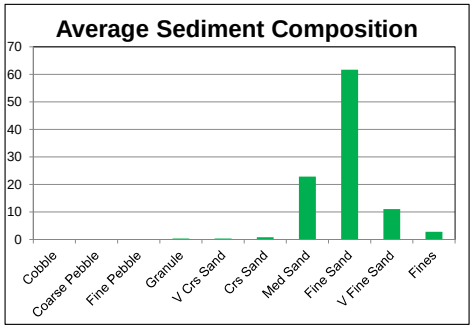


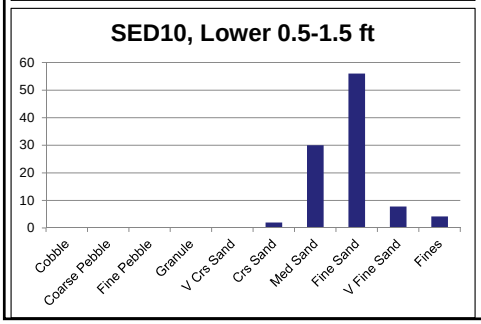
Sediment Results

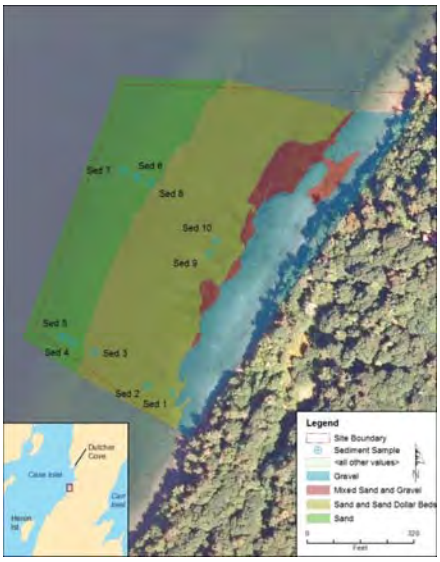




Beach Sediment- 6 samples from approx. -2 to +2 ft MLLW





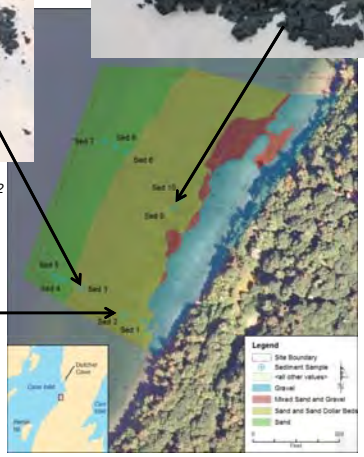


Beach Sediment Samples

SED3 *CGS Photo Taken 9/3/2014 of Sediment Sample SED3*
Upper 0-0.5 ft

SED9 *CGS Photo Taken 9/3/2014 of Sediment Sample SED9*
Upper 0-0.5 ft

SED2 *CGS Photo Taken 9/3/2014 of Sediment Sample SED2*
Upper 0-0.5 ft



Map of Sediment Samples Taken 8/9/2014 at proposed geoduck farm

Beach Sediment-low intertidal below +2 ft MLLW

CGS/Johannessen Photos taken 8/9/2014, At Haley site, South end

Beach Sediment-low intertidal below +2 ft MLLW

CGS/Johannessen Photo taken 8/9/2014, At Haley site, South end

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

CGS Ground Photo Taken 8/9/2014 At proposed geoduck farm site

CGS Ground Photo Taken 8/9/2014 At proposed geoduck farm site

Puget Sound Literature

The Potential Impacts of the Commercial Geoduck (Panope generosa) Hydraulic Harvest Method on Organisms in the Sediment and at the Water-Sediment Interface in Puget Sound.

By Georgina B. Willner, 2006

"Released contaminants, pollutants and dissolved metals into the water column become potentially available for bioaccumulation…"

"The disturbed sediment loses stability and grain size distribution is changed with resuspension. The resuspended sediment settles in an unconsolidated form and may be susceptible to resuspension and erosion by currents and waves."

Testimony of Dr. Jeff Parsons in Foss Geoduck 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

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."

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."

"An on-going study through the University of Washington (Ruesink 2008, unpublished) has found measureable, but not necessarily significant, differences in grain size and beach elevation."

Samples from the Eld Inlet site (Figure 5-2) differed somewhat from that found at the Case Inlet site, but the experimental design also differed. At the Eld inlet site, where sampling was conducted only

0121657 86 ENVIRON

Net shore-drift/ Littoral Drift off-site

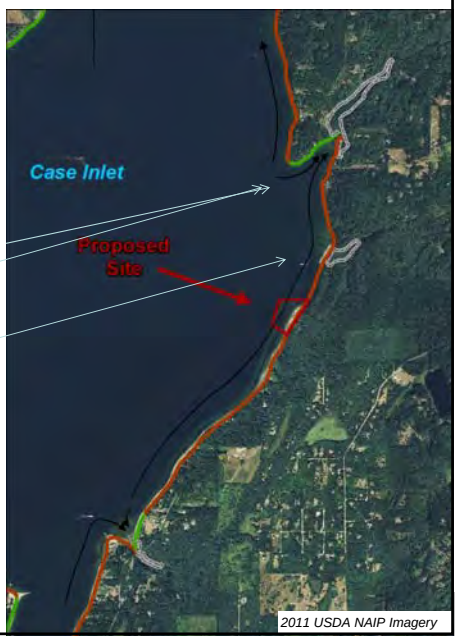
Probable altered sediment transport at adjacent estuaries

- Sediment release during and after harvest
- Likely re-suspension
- Transport to:

Dutchers Cove 1.0 miles down-drift of proposed harvest site:

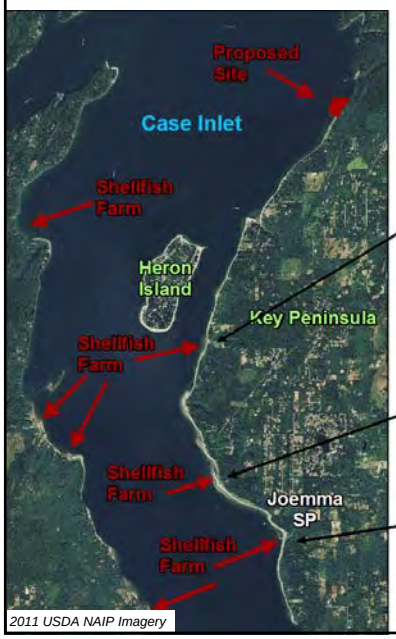
Haley Lagoon - 0.25 miles down-drift of proposed harvest site:

CGS/Johannessen Photos taken 8/9/2014



2011 USDA NAIP Imagery

Cumulative Impacts; Threshold?



2011 USDA NAIP Imagery

2006 WA DOE Oblique Photo

2006 WA DOE Oblique Photo

2006 WA DOE Oblique Photo

Lack of Science

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

One study rehashes the next;
not always in context

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

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

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*"

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

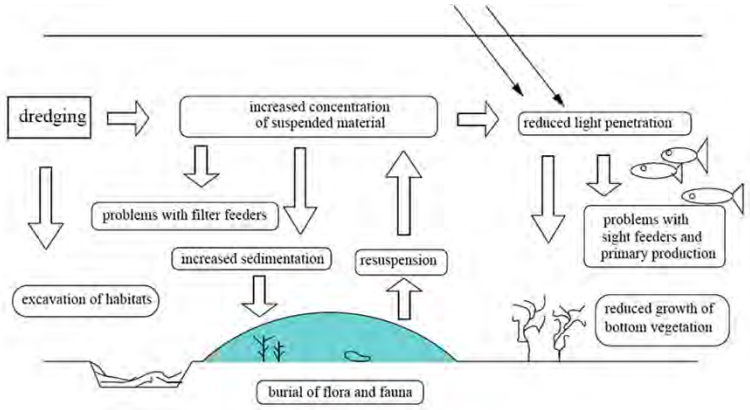


Figure 6.1: Impact of dredging on ecology

Management Measures for Protecting and Restoring the Puget Sound Nearshore. Technical Report 2009-01, (2009) for WDFW; From Introduction:

"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?"

Johannessen, J. et al - 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
- To attempt to recover lost nearshore habitats, salmon, and many other species

Probable Significant Impacts – Summary

Probable Significant Impacts:

- Modification of diverse natural and productive beach
- Proposal will alter sediment transport
  - Sediment accretion - temporary
  - Release during and after harvest
  - Re-suspension
- Lack of sediment compaction
- Likely impacting Haley Lagoon (0.25 mi distant) and Dutchers Cove (1.0 mi distant), which are important estuaries

Lack of Scientific Study:

Cumulative Impacts – Significant

- Many harvest sites, more proposed
- Numerous farm sites in Case Inlet
- Clear significant impacts

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EDUCATION

MS Degree in Geology *— Western Washington University, Bellingham, WA, 3/93.*
Masters Thesis: Mapped long-term littoral drift cells in all of San Juan County and parts of northern Puget Sound. Graduate study concentrated on coastal geomorphology and hydrogeology.

Research: Monitored sites to assess the cumulative impact of seawalls and bulkheads on coastal sectors for the Washington Dept. of Ecology.

BS in Geology and Oceanography *— Univ. of Rhode Island, Kingston, RI, 5/84.*

Licensed Engineering Geologist and **Licensed Geologist** in the State of Washington

EXPERIENCE

PRINCIPAL COASTAL GEOMORPHOLGIST - Coastal Geologic Services, Inc, Bellingham, WA

Provides consulting services on coastal and estuarine processes, coastal bluff geologic processes and coastal management. Qualified and experienced in site assessment, design suitability determination, beach restoration/enhancement design, monitoring, and other technical studies for coastal projects. Clients include private, commercial, government, and tribes. Also provides advice on shoreline management plans and develops educational programs on coastal processes and issues.

Specific areas of expertise include:

- Littoral drift assessment/ drift cell analysis with recommendations for management of coastal reaches
- Nearshore assessments focusing on salmon and nearshore ecosystem recovery
- Shoreline change/ historical reconstruction using GIS
- Beach nourishment design for erosion control and habitat restoration
- Alternative shoreline erosion control methods using large woody debris and vegetation
- Beach and estuarine processes technical support for biological and ecological management efforts
- Inlet stability analysis and design
- Assessment of coastal dynamics with regard to planning and management of coastal property
- Assessment of on- and off-site impacts for proposed coastal projects
- Reconnaissance geologic mapping of glacial deposits at coastal areas and bluff management
- Development of workshops and programs on coastal geology, bluff and beach processes

Recent project experience includes:

Beaches and Bluffs of Puget Sound and the Northern Straits: A Valued Ecosystem Component.
The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) through the US Army Corps of Engineers contracted this "white paper". The paper characterized beach and coastal bluff processes throughout Puget Sound and the Northwest Straits and discussed processes, trends, impacts and restoration. Sea Grant is publishing the paper (for the Corps) as part of a series of "valued ecosystem component" documents to aid in restoration planning throughout the region.

WDFW Management Measures Technical Report
This project was a collaborative effort with ESA Adolfson, Philip Williams and Associates and Coastal Geologic Services for the WA Department of Fish and Wildlife (WDFW) as part of the larger PSNERP study. The report contained overviews of 21 management measures used in large-scale restoration efforts to provide common understanding among practitioners and aid in planning. Content for each measure included: scope, benefits and constraints, and guidance for assessing feasibility and project design/implementation. CGS was tasked with writing chapters on (MM1) Armor Removal and/or Modification, (MM2) Beach Nourishment, (MM10) Large Wood Placement and (MM17) Species Habitat Enhancement (MM17 was co-written with ESA-Adolfson).
Kayak Point County Park Restoration Feasibility Assessment and Design, Snohomish County, WA.

A geomorphic assessment of the shores encompassing Kayak Point County Park, located in Snohomish County, Washington, was preformed to determine the drivers of erosion along the park shores, the results of which were used to support restoration recommendations and designs. Four preliminary beach restoration/enhancement design options were provided that aimed to enhance nearshore habitats and prevent further storm damage to park infrastructure. The Second phase of the study has sea level rise component, which addressed each beach enhancement alternative under different (local) sea level rise scenarios.

Little Squalicum Beach Area Restoration Feasibility Assessment, Bellingham, WA.
CGS was contracted by the City of Bellingham to provide a feasibility assessment for beach/nearshore enhancement in the Little Squalicum Park beach to the southeast side of the filled area known as the Mount Baker Plywood Peninsula. The assessment included three designs for restoration and enhancement actions within the approximately 1,500 ft of shoreline and nearshore study area in northern Bellingham Bay. The study area has been altered by the BNSF railway bridge supports, trails, creek channelization and the culvert at the mouth of Little Squalicum Creek. The shore at the peninsula has been armored with concrete rubble and riprap, and contains large amounts of fill. Due to the level of alteration, the park and peninsula areas are in very poor condition in terms of nearshore habitats. The proposed designs incorporated local coastal processes, the scale of alteration, historic conditions, and opportunities for habitat improvement.

Oak Bay County Park Restoration Feasibility & Design, Jefferson County, WA.
CGS assessed coastal processes, the feasibility and constraints associated with restoring a reach of shore previously occupied by campsites and related park facilities. The stated vision for the Park was to provide public, non-vehicular access for enjoyment of the nearshore. Restoration designs included removal of the road, camping sites, and beach armoring. Two restoration options were proposed based on the results of the feasibility study.

San Juan Initiative Protection Assessment - Nearshore Case Study Area Characterization, San Juan County, WA. CGS was contracted by the San Juan Initiative, with a grant from the SurfRider Foundation to conduct this pilot project on behalf of the Puget Sound Partnership. The objective of this project was to assess what is known about existing and potential impacts of anthropogenic shore alterations, (including shore armoring, docks, mooring buoys, vegetation clearing, and development among others), and to quantify the extent to which these modifications occur in conjunction with priority habitats. New data from the field and GIS analysis was compiled with existing habitat data, and results were summarized and analyzed for 4 case study areas at the parcel unit scale. Results highlighted the vulnerability of certain geomorphic shoreforms, marine riparian cover and priority habitats to development patterns and other anthropogenic impacts in San Juan County.

South Discovery Bay Road Realignment Assessment, Jefferson County, WA.
CGS was contracted by the Jefferson County Public Works Department to assess geologic and coastal geologic conditions at a portion of South Discovery Bay Road. Recommendations regarding details for the planned road realignment were provided to inform management of appropriate actions in order to maintain safe usage of the road. The roadway has been at risk of failure due to ongoing slope failures along the Discovery Bay shore. CGS provided recommendations for road realignment and setback with 50 yr, 75 yr, and 100yr outlook based on geologic/geotechnical expertise, coastal processes, and shore change analysis.

Shoal Bay Tide Gate Removal, Lopez Island, WA.
The remains of a derelict tide gate were identified as a priority for removal from Shoal Bay on Lopez Island, WA. The tide gate is deteriorated, and now only the concrete remains. CGS was contracted by Friends of the San Juans to determine the feasibility of removing the structure in order to restore natural tidal flushing of the backshore lagoon. The history of the backshore lagoon and tide gate was examined through a historic analysis of aerial photographs. A topographic survey was performed to map the lagoon and vicinity for use in restoration design.

Point Roberts Lighthouse Park Beach Restoration, Point Roberts, WA.
Lighthouse Park, located at the southwest corner of Point Roberts, WA, was the location of a mitigation action for the British Columbia Transmission Company when they replaced their existing transmissions lines at the Park. The project, under contract from Jones & Stokes, included the removal of an old transmission building and associated rock and soldier pile bulkhead and addition of beach nourishment sediment. CGS performed a site topographic survey for use in the restoration design. Restoration designs were created to include removal of the rock and soldier pile bulkhead along with placement of 900 cy of beach nourishment sediment. The rockery surrounding the Coast Guard light tower was also rebuilt during construction. CGS performed construction oversight during the removal and nourishment portions of the project as well as providing an as-built survey following completion.

Bulkhead Removal Feasibility Study, Central Puget Sound, WA.
This feasibility study analyzed removing some or all of the bulkheads fronting this historic nearshore sediment source without threatening a home atop the bluff. An analysis of current and historic bluff conditions was performed to identify the drivers of bluff erosion at the site, determine erosion rates and observe how the bluff has changed since bulkheading. Assessment methods included: surveying, GIS analyses, and geomorphic air photo analysis.

Inventory and Assessment of Current and Historic Beach Feeding Sources/ Erosion and Accretion Areas for WRIAs 8 and 9, Central Puget Sound, WA.
This 2004-2005 study included approximately 121 miles of shore in King and Snohomish counties. The project consisted of current conditions field mapping and historic reconstruction of key sediment source and accretion shoreform segments. Historic reconstruction was accomplished though analysis of all relevant historic maps, charts, air and ground photos, along with historic records of landslides and related topics. Based on quantitative comparison of current and historic conditions, recommendations for restoration and conservation of nearshore habitat base on sediment supply were formulated.

Lagoon and Estuary Restoration/Design - Inlet stability dynamics, tidal prism and hydrology analyzed, bathymetry surveyed, facilitated technical meetings, design alternatives developed and implemented at numerous Puget Sound area sites for beach rehabilitation or restoration. Completed projects are located in San Juan, Whatcom, and Jefferson Counties, although studies at the feasibility and/or design stage have been conducted in Skagit, Island, and Snohomish Counties. Many sites included baseline, as built, and post project quantitative monitoring by CGS.

Beach Rehabilitation/Restoration - Beach processes analyzed, beaches surveyed, technical meetings facilitated, designs developed and implemented at numerous Puget Sound area sites for beach rehabilitation or restoration. To date, completed projects are located in Skagit, San Juan, Island, Whatcom, Jefferson, King and Pierce Counties. Many sites included quantitative beach monitoring by CGS.

Beach Monitoring and Habitat Mitigation - Design and implementation of a long-term beach, detailed monitoring program and beach nourishment plan for the Lummi Indian Nation along 1.5 miles of the eroded Bellingham Bay shore. The program (1996-present) includes precision surveying, surf smelt spawning habitat mapping and mitigation through repeated beach nourishment, and road and revetment design modifications for the US Army Corps and tribal managers.

Coastal Processes Expert Witness - Served as coastal processes expert and expert witness for Rich Passage fast ferry lawsuit for the State of Washington. Involved extensive fieldwork, literature review, long-term coastal change trend analysis, and assessment of existing bulkheads and causes of erosion.

PROGRAM MANAGER - Norecol, Inc., Bellingham, WA; June - September 1992

Wrote most physical environment sections of an Environmental Impact Statement for a proposed large coastal transshipment facility near Cherry Point in Whatcom County. Responsibilities included field reconnaissance and assessment, writing, developing alternative designs, managing sub consultants, participating in meetings with regulatory agencies and proponent, and business development. Also finalized portions of an Environmental Impact Statement for a proposed Lilly Point (Point Roberts) golf course development.

PHYSICAL SCIENCE TEACHER - Zimbabwe, Africa; January 1989 - June 1990

Taught physics, chemistry, and physical science at one of the country's leading public high schools. Led field trips to the Zambezi River Valley to teach field methods for hydrology/geomorphology, conducted seminars on environmental issues and developed and implemented a computer education program.

GEOLOGIST - Ebasco Environmental, Bellevue, WA; July 1985 - Dec. 1988

Experience in surficial geology, hydrology, and sediment transport. (Company is now called Foster Wheeler). Designed, implemented, and managed programs to assess the impacts of development and to support biological sampling efforts. Selected experience includes:

- Impact assessment of oil structures on the stability of Arctic coast and barrier islands
- Program manger for river monitoring program on a major Arctic river
- Discipline manager for oceanographic monitoring program designed to quantify the effects of bridged segments of large offshore gravel causeway near Prudhoe Bay Alaska on fish habitat
- Participation in design, implementation and analysis for a multi-million dollar oceanographic monitoring project for three years, including extensive field logistics
- Site assessment of Cascade Mountain streams for small-scale hydroelectric development
- Water quality and sediment monitoring at Puget Sound sites near effluent outfalls
- Erosion control and mitigation plan development for small stream diversions

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