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Inventory and Assessment of Current and Historic Beach Feeding Sources/Erosion and Accretion Areas for the Marine Shorelines of WRIA 8 & 9

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With historic Accretion Shoreform mapping by **Aundrea McBride**
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Purpose

- Field map current sediment sources (feeder bluffs), accretion shoreforms, transport zones and modified shores throughout study area

- Research and map historic sediment sources (feeder bluffs), accretion shoreforms, transport zones

- Based on results of comparison of current and historic sediment process data: prioritize restoration & conservation areas based on degree of loss/intact nearshore habitat forming processes

- Results for understanding processes, salmon recovery planning and implementation, permit and siting issues, SMP updates and much more...

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Conceptual Model

Sediment

↓

Beaches

Conceptual Processes

Sediment

Erosion/ Mass Wasting

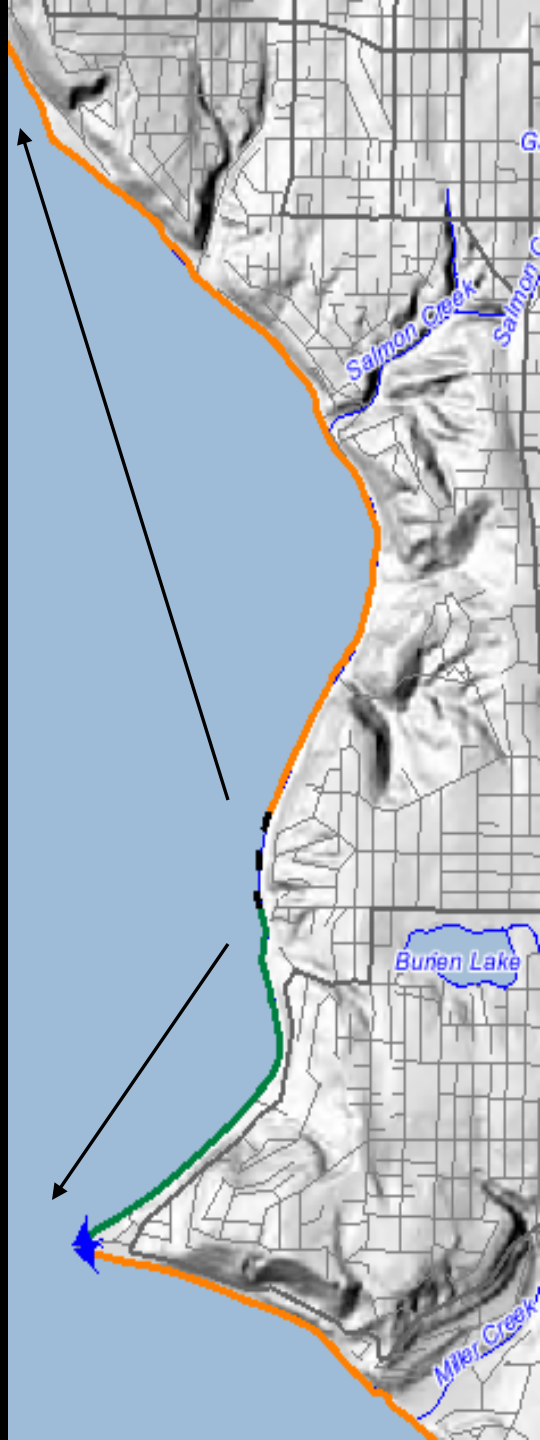
Bluffs (~90%??)

Waves

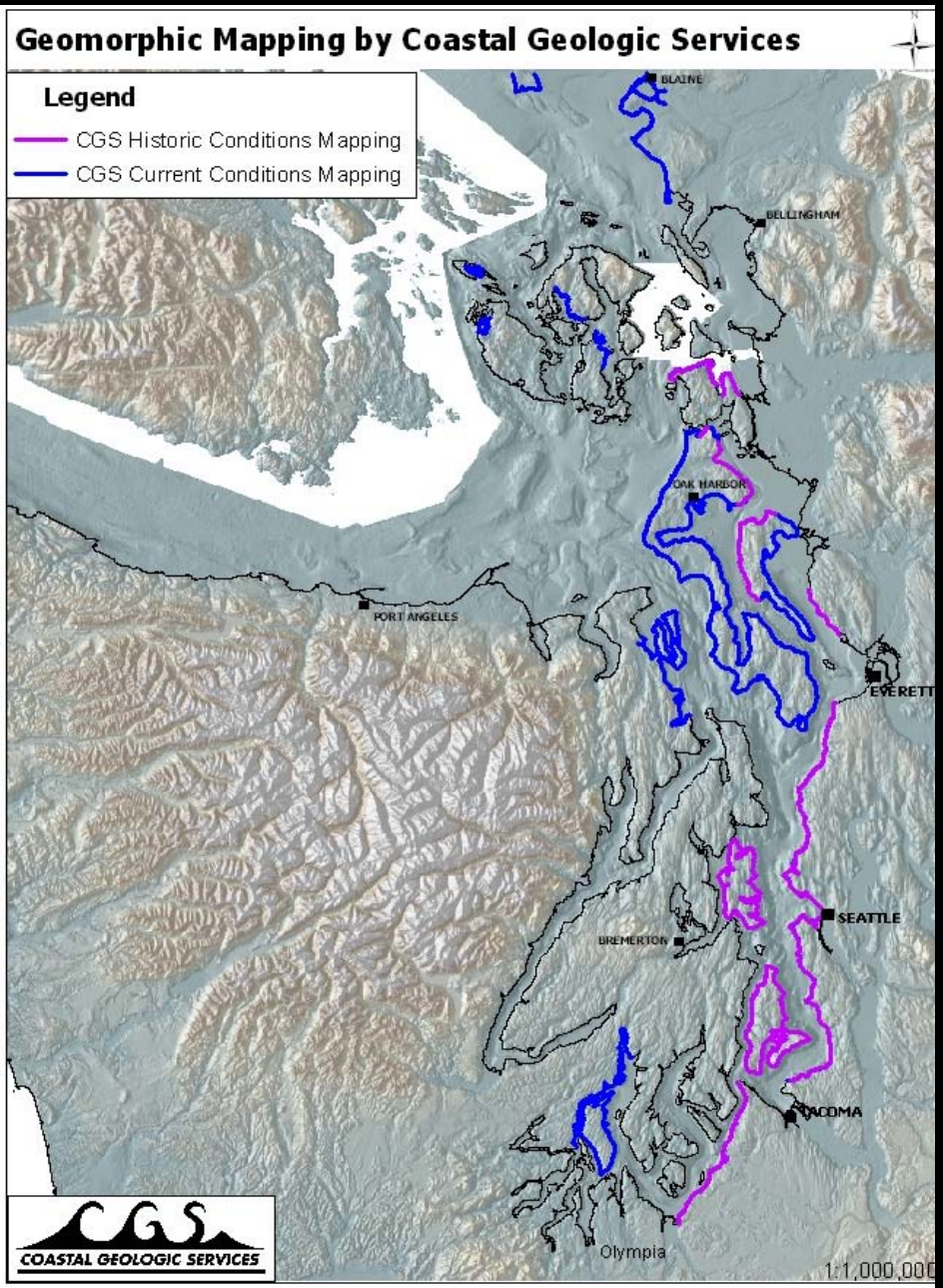
Littoral Drift/ Net Shore-drift cells

Beaches

Deposition > Habitats



Previous Feeder Bluff/Accretion Shoreform Mapping by CGS



1999-2009:

Current conditions mapping has been completed for over 680 miles of PS shore

Historic conditions mapping has been completed for over 250 miles of PS shore

Additional mapping in 2009:

Current conditions 200-400 miles

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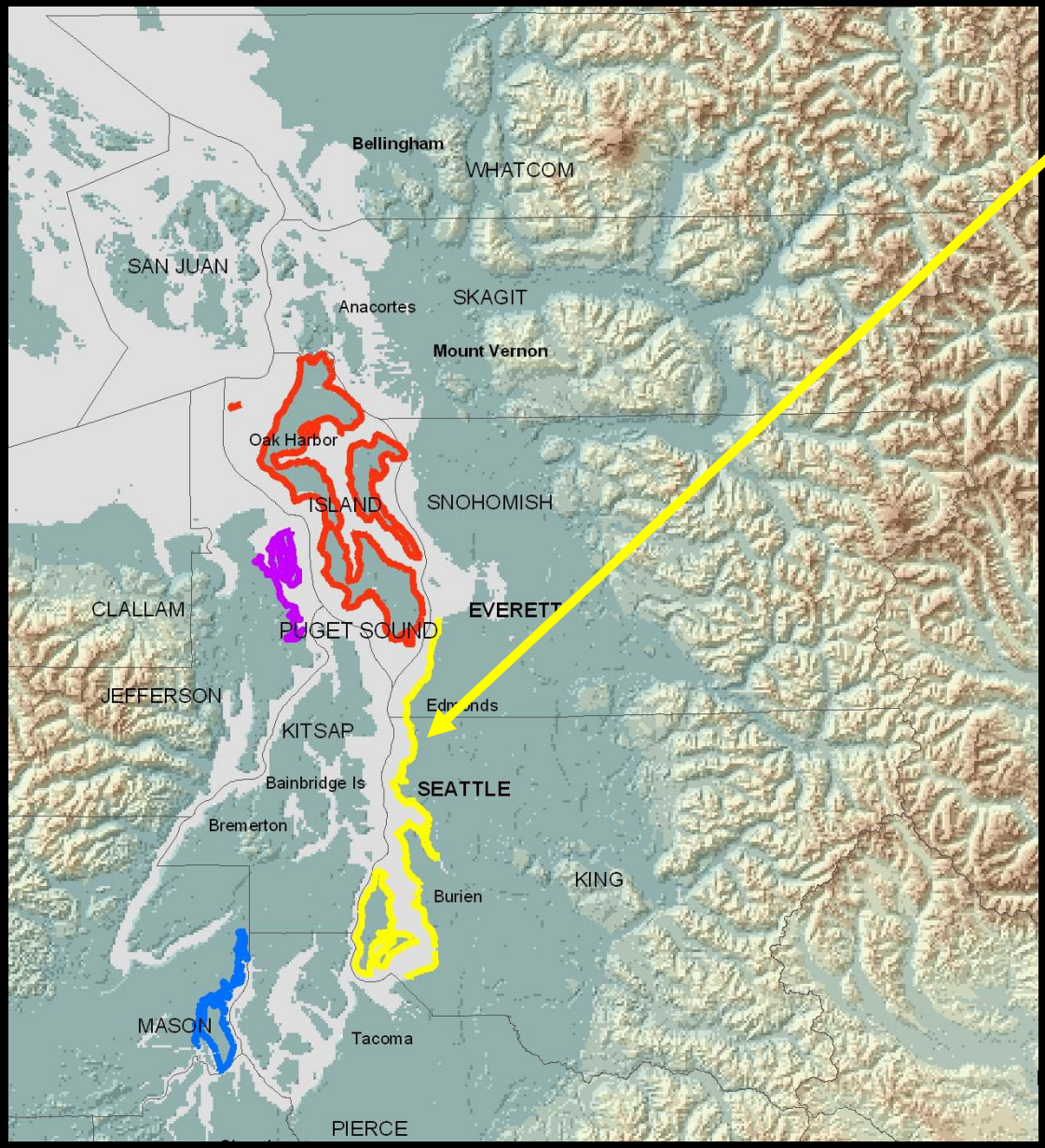
Study Area



WRIA 9 & 8

~121 miles

(2004-2005)

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Current Conditions Mapping

Field Mapping Classification-1

Feeder Bluff Exceptional - Magnolia Bluff

- Rapidly eroding, abundant sediment load
- Recent landslide scarps
- Lack of vegetation cover, some fallen trees
- Presence of colluvium, boulder/cobble lag

Feeder Bluff - Normandy Park

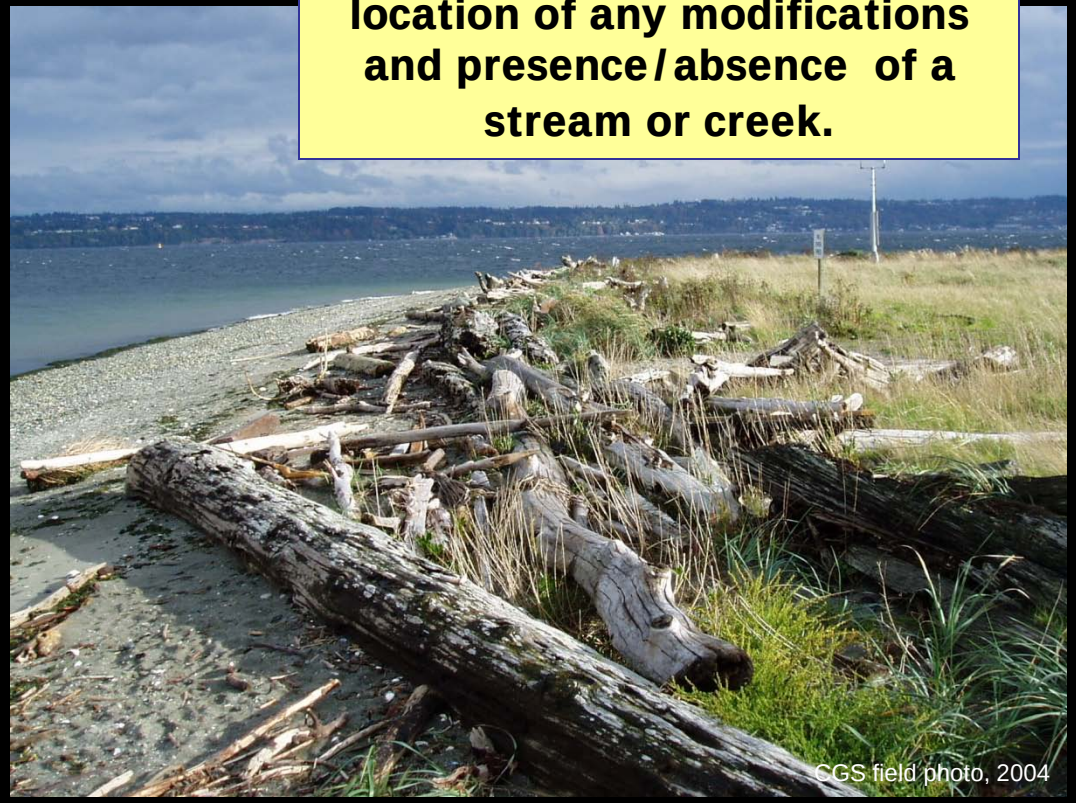
- Periodic sediment input; longer recurrence interval than FBE
- Presents of historic scarps, lack of mature vegetation and intermittent bank erosion.

Current Conditions Mapping.
Field Mapping Classification-2

AS(es) were classified into 5 sub-categories to capture their contrasting condition. Categories including the location of any modifications and presence/absence of a stream or creek.

Transport Zone – South Vashon Island

- Lack of visible indicators of erosion or accretion.
- Mature vegetation e.g. conifers.
- Occasional toe erosion.



Accretion Shoreform – East Maury Island

- Broad backshore area (greater than 10 ft).
- Backshore vegetation community.
- Spit and/or lagoon landward of a spit.
- Relatively fine-grained sediment and very old drift logs in the backshore.

Current Conditions Mapping
Field Mapping Classification-3

CGS field photo, 2004

CGS field photo, 2004

DOE oblique, 2001

Modified –

- Bulkheaded or otherwise altered.
- Natural geomorphic character of shore is (largely) concealed.
- Potential sediment sources lost.

Modified – by BNSF Railway

- Modified by BNSF railway causeway.

No Appreciable Drift

- Modified to the degree that net shore-drift is precluded.
- Typically also consists of fill areas.
- Common in marinas and Port facilities.

Current Conditions Results

- mapped at 1:24,000
- typical segment length 300-700 ft
- 858 shore segments

Shoretype	Number of Units	Min Length (ft)	Max Length (ft)	Mean Length (ft)	% of Study Area
Feeder Bluff Exceptional	29	61	2,861	709	3.30%
Feeder Bluff	184	23	3,560	517	15.10%
Transport Zone	95	19	1,808	274	4.10%
Accretion Shoreform	247	5	2,930	473	18.50%
Modified	287	21	29,986	1,004	45.60%
Modified - RR	16	829	17,247	5,293	13.40%
Sum	858				100.00%

Mod + Mod-RR + AS-mods = 69% MODIFIED

22 drift cells had NO INTACT SEDIMENT SOURCE
(61 cells total)

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Current Conditions Results

Legend

- Feeder bluff Exceptional
- Feeder bluff
- Transport zone
- Accretion shoreform
- Modified
- Modified - by BNSF RR
- No Appreciable Drift
- Landslides
- Toe erosion
- Subarea boundaries
- ▲ Drift cell boundaries

Data sources: All mapping by Coastal Geologic Services, Inc., Bellingham, WA, 2005.

Base map - Finlayson D.P., Haugerud R.A., Greenberg, H. and Logsdon, M.G. (2000) Puget Sound Digital Elevation Model.

Historic Conditions Methods

- Current Conditions mapping was starting point

  > researched historic condition of currently modified shores only

- Relied on concurrence between available data sets

Media	Year	Source	Coverage & Applicability, Misc.
Vertical aerial photography	1936	Walker & Assoc.	Historic conditions, landslide mapping
			WRIA 9 only, stereo pairs
	1940	US ACOE	Photo mosaics – WRIA8 & 9 – not georeferenced
	1947	Snoho Cty	Historic conditions, landslide mapping, WRIA8 only
	1977/78	DOE & SC	Color and 1:6000
	1990	DNR	B&W orthos – 3 ft resolution
	2002	USGS	Coastal areas only - 1ft pixel
Oblique aerial photos	2000/01	DOE	King and Snohomish County (no scale)
Maps	1841	US Ex.	West Point to Alki Point (Wilkes map)
	1841	NOAA	Puget Sound Admiralty Inlet (Wilkes map)
	1850+	GLO	Cadastral GLO Survey Maps – some digitized in S. end,
	1854	USCS	Reconnaissance of Seattle Harbor and Duwamish Bay
	1855-56	Anonymous	Plan of Seattle 1855-56
	1878	Koch, A.	Bird's Eye View of Seattle and Environs (Kroll) perspective
	1878	Glover, E.	Birds Eye View of City of Seattle (Kroll) perspective drawing
	1879	NOAA	Seattle Harbor, Puget Sound
	1884	Kroll	City of Seattle –downtown perspective drawing
	1891	NOAA	Seattle to Olympia & Vashon/Maury Islands
	1890	City of Seattle	Seattle Tidelands, many maps, filed by subarea.
	1891	Kroll	Bird's eye view of Seattle, incl. Smith Cove to Alki
	1866/99	USC&GS	All WRIA8&9 T-sheets plus descriptive reports 1899;
	1905	NOAA	Admiralty Inlet & Puget Sound
	1991	USGS	Geology of Vashon & Maury Islands (landslide and beach
	1893-34	M. Stixrud	Map of part of Seattle Harbor showing Soundings
	1854	US Coast Survey	Preliminary survey of Duwamish Bay, Washington Territory
B. Collins data	2004	T-sheets	Aquatic/tidal wetland habitat loss – Elliott Bay (Green/Duw)
	2005	T-sheets	Cartographic symbol mapping

Vector data	Year	Source	Theme	Notes
	2004	DNR-geology	Surface Geology	Mapped Qb, Qls
	1975	DOE-CZA	Slope stability	Recent landslides
	1975	DOE-CZA	Slope stability	Historic landslides
	2004	KC-DNR&P	1933-60 landslides	WRIA9 shoreline
	2004	KC-DNR&P	1996-97 landslides	WRIA9 shoreline
	2004	BNSF/WRIA8	1996-97 landslides	WRIA8 shoreline
Shoretype	2004	CGS	Geomorphic character	FBE, FB, TZ, AS, Mod
Landslides	2004	CGS	Recent landslides	In previous 2-3 yrs
Toe erosion	2004	CGS	Recent toe erosion	In previous 2-3 yrs

Historic Conditions Methods

Historic Bluff Conditions

University of Washington Special Collections Libraries. Negative No. UW 1682

HSSI = Historic Sediment Source Index

Reach topography, surface geology, landslide history, landscape and net shore-drift context, T-sheets, historic air photos (1936/47)

Index scores convey the relative likelihood that unit was a source of littoral sediment

(Prior to scoring units – modified shores were delineated into segments of homogenous geomorphic character)

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Historic Conditions Methods: Historic Sediment Supply Index (HSSI)

- 35 shore segments from current conditions mapping were scored for index calibration

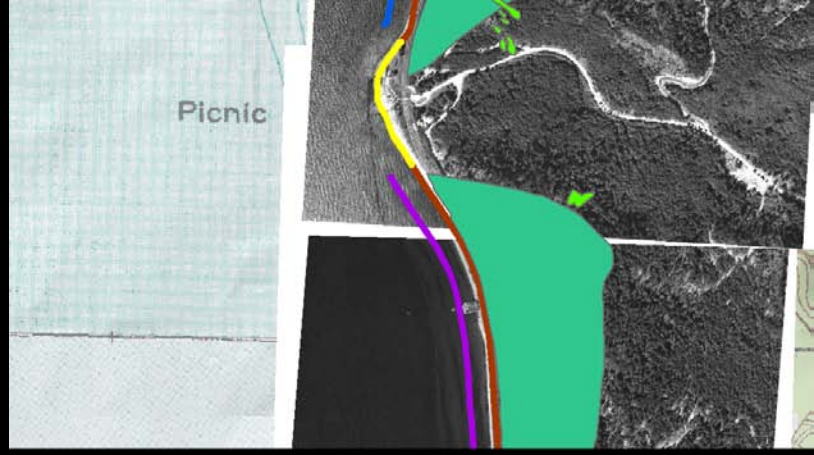
- Following scoring all mod units – data were compared with calibration data and shoretype categories were delineated:

Score	HSSI Shoretype
0 – 19	Not Feeder Bluff
20 – 29	Potential Feeder Bluff
30 – 45	Modified Feeder Bluff
46 +	Modified Feeder Bluff Exceptional

Score	Question	Source
0-2-4-6	Relative fetch: longest fetch distance measured in GIS (0=0-<5 mi., 2=5-<10, 4=10-<15-, 6=15+) .	USGS 7.5" topo maps, DNR shoreline
0-3-6-9-12	Typical bluff height. First contour must be within 100 ft of Shorezone shoreline 0=0-80 ft, 3=81-120, 6=121-160, 9=161-200, 12=200+ ft.	USGS 7.5" topo maps
0-6	Surface Geology: dominant unit in segment. Unit scores reflect relative quantity of beach-forming material (coarse sand and gravel). 6=Qva; 3=Qls, Qsgo; 2=Qpom, Qtb, Qob, Qvt , 0=Other units**	WA DNR-Geology
10	Mapped as Rocky/Eroding/Bluff in T-sheet interpretations by B. Collins? (Rocky bluff and Bluff were represent same shore features just referred to earlier/later products)	B Collins, 2005, University of Washington, Rivers History Group
10	1936/47 visual evidence of eroding bluff; including slides, slumping, scarps, trees in intertidal etc.?	Walker and Assoc., KCDNR&P and Snohomish County
5	Recent landslides within 500ft of segment?	City of Seattle, KC DNR&P BNSF
5	Older slides (Qls or Uos) within 500 ft of segment?	Qls=DNR surface geology; Uos=DOE, CZ Atlas
5	Landslides mapped by CGS within 500 ft of segment?	CGS current conditions mapping.
5	Adjacent to Feeder Bluff in CGS current conditions mapping; or Historic Feeder Bluffs?	CGS current conditions mapping
2	Within 500 ft of divergent zone?	DOE with CGS edits, WA net shore drift
2	Within 1500 ft of divergent zone?	Net shore drift mapping by DOE (with CGS edits)
1	Absence of low elevation backshore?	USGS 7.5" topo

Historic Conditions Results

Historic Bluff Conditions



Property of Museum of History & Industry, Seattle

Legend

- BNSF slides (96-97)
- 96-97 slides
- 33-60 slides
- Old slide
- Recent slide
- Feeder bluff Exceptional
- Feeder bluff
- Potential Feeder bluff
- NOT Feeder bluff
- Feeder bluff Exceptional
- Feeder bluff
- Transport zone
- Accretion shoreform
- Modified
- Modified - by BNSF RR
- No Appreciable Drift

Data sources: All mapping by Coastal Geologic Services, Inc., Bellingham, WA, 2005.

Base map - Finlayson D.P., Haugerud R.A., Greenberg, H. and Logsdon, M.G. (2000)
Puget Sound Digital Elevation Model.

Historic Conditions Results
Historic Bluff Conditions

Legend 1:24,000

- Drift Cell Boundaries
- Subarea Boundaries

Current Conditions Shoretypes

- Feeder Bluff Exceptional
- Feeder Bluff
- Transport Zone
- Accretion Shoreform
- Modified
- Modified - by BNSF RR
- No Appreciable Drift

Historic Conditions Shoretypes (offshore

- Feeder Bluff Exceptional
- Feeder Bluff
- Potential Feeder Bluff
- NOT Feeder Bluff

Data sources: All mapping by Coastal Geologic Services, Inc., Bellingham, WA, 2005.

Base map - Finlayson D.P., Haugerud R.A., Greenberg, H. and Logsdon, M.G. (2000) Puget Sound Digital Elevation Model.

Historic Conditions Results
Historic Bluff Conditions

Legend 1:24,000

- ▲ Drift Cell Boundaries
- Subarea Boundaries

Current Conditions Shoretypes

- Feeder Bluff Exceptional
- Feeder Bluff
- Transport Zone
- Accretion Shoreform
- Modified
- Modified - by BNSF RR
- No Appreciable Drift

Historic Conditions Shoretypes (offshore)

- Feeder Bluff Exceptional
- Feeder Bluff
- Potential Feeder Bluff
- NOT Feeder Bluff

Data sources: All mapping by Coastal Geologic Services, Inc., Bellingham, WA, 2005.

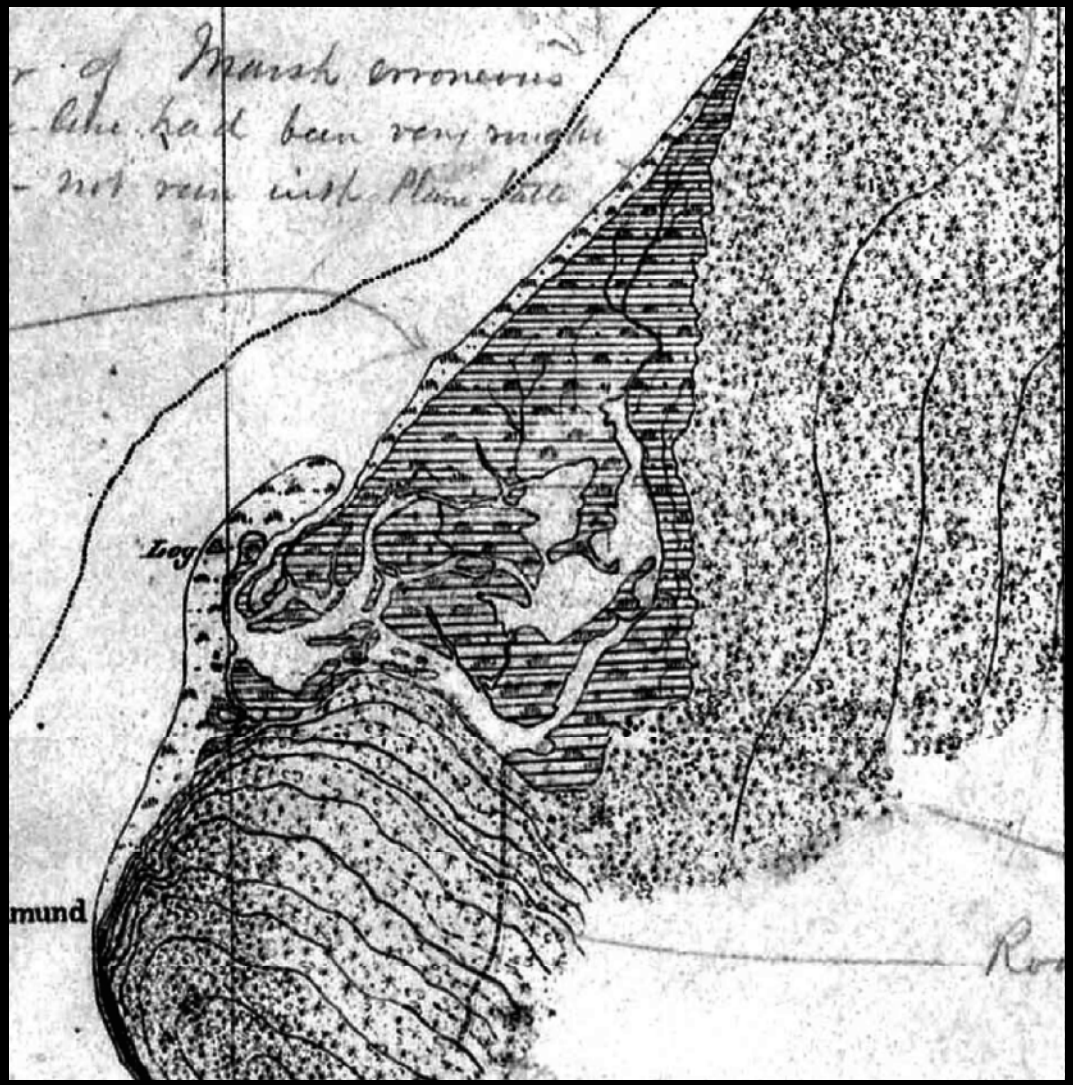
Base map - Finlayson D.P., Haugerud R.A., Greenberg, H. and Logsdon, M.G. (2000) Puget Sound Digital Elevation Model.

Historic Conditions Results

Historic Accretion Shoreforms: Edmonds example

Using T-sheets

- Gravel or grasslands in backshore
- Spit or bar morphology
- Channels, impoundments and marsh behind beach berm
- Stream channels, deltas, or valleys



Historic Conditions Results

Historic Accretion Shoreforms: Edmonds example

Using Historic Photos

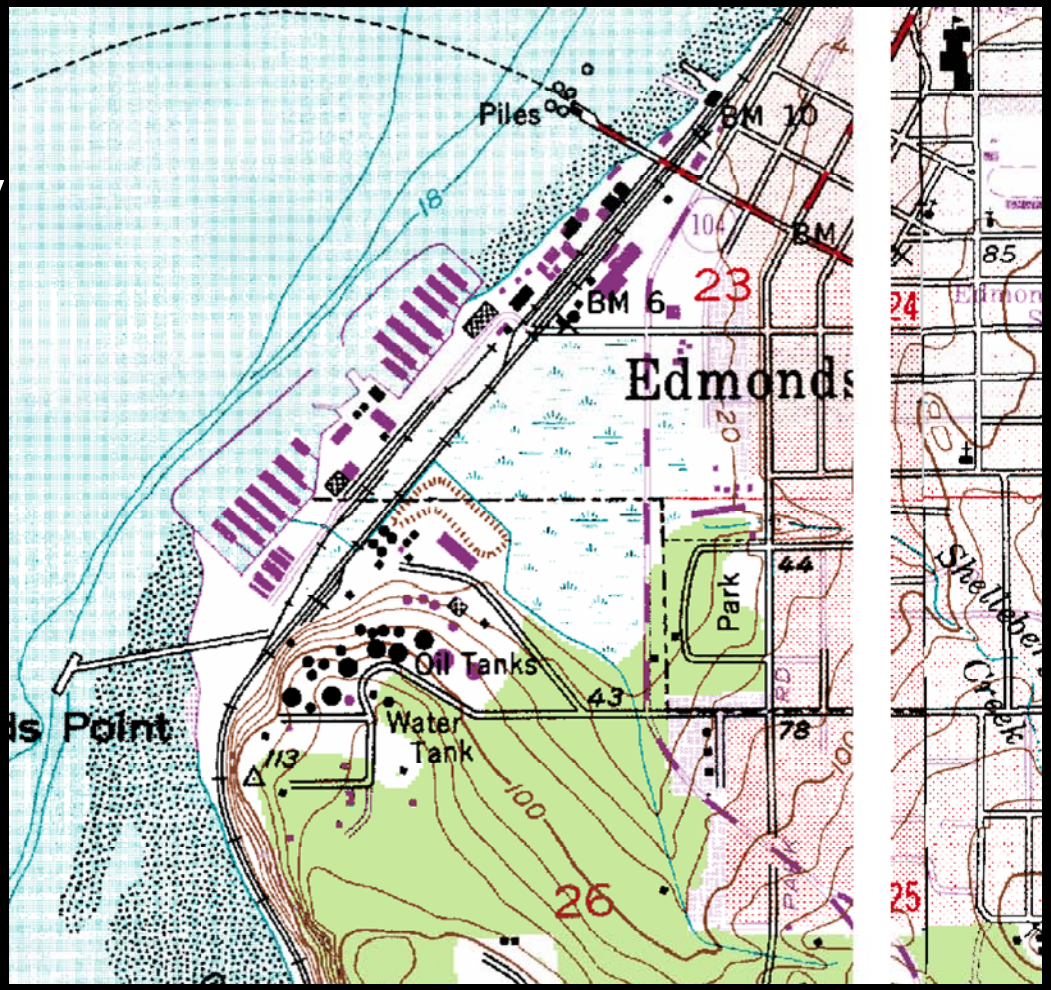
- Textures of backshore vegetation
- Channels, impoundments and marsh textures behind beach berm
- Stream channels or deltas
- Accumulations of drift logs >3 logs deep
- Spit or bar morphology

Historic Conditions Results

Historic Accretion Shoreforms: Edmonds example

Using Topo Maps

- Spit or bar morphology
- Backshore platform
- Channels, impoundments and marsh behind beach berm
- Stream channels, deltas, or valleys



Results of Current Conditions

Accretion Shoreforms

Compared to similar past mapping and classification methods on Vashon and Maury Islands.....

Source	Year	No. Units
ShoreZone	2001	21
CommEn Space	2005	20
CGS -this study	2005	59

CZA classified Accretion Shoreforms as NF=Not Feeding, F=Feeding, FS=Feeding Substantial

Comparing Current and Historic Conditions….

Most Common Shoretypes: Historic = FB: Current = MOD

Historically sediment sources accounted for 50.3% of study area, currently only 18.4%

This equates to a 63.4% loss of sediment sources; leaving only 36.6% of the historic sediment sources currently intact.

Historic Accretion Shoreforms were mapped ~40 miles of shore: Current conditions mapped ~22 miles of AS

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Restoration and Conservation Prioritization

Restoration and Conservation prioritization was performed at the unit, drift cell and landscape scale.

- All current and historic FBs and FBEs (and *Potential* FBs) were scored using the HSSI index.

- The highest scoring historic sediment sources (throughout the study area and in each drift cell) were identified as being of high RESTORATION POTENTIAL.

- The highest scoring current sediment sources (throughout the study area and in each drift cell) were identified as being of high CONSERVATION POTENTIAL.

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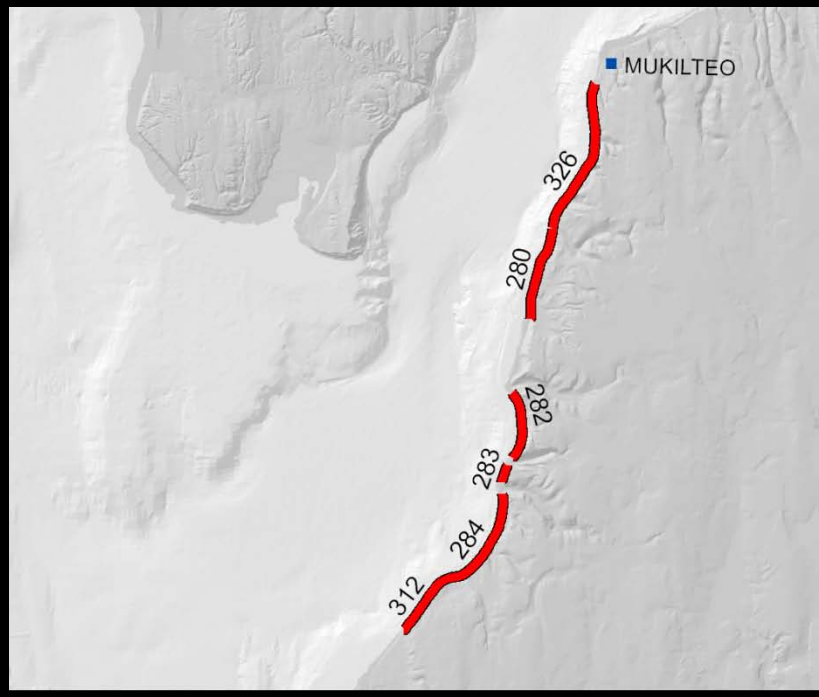
Restoration and Conservation Prioritization

Highest rated bluffs for *Restoration* in study area:

- Northern Railroad sub-area
- Magnolia Bluffs
- Normandy Park to Des Moines
- Southern Quartermaster Harbor
- East Vashon Island
- North of Three Tree Pt
- Inner Quartermaster Harbor
- North side Burton Peninsula



Legend 1:200,000

Bluffs of HIGH restoration priority
(By segment number)

Data sources: All mapping by Coastal Geologic Services, Inc., Bellingham, WA, 2005.
Base map - Finlayson D.P., Haugerud R.A., Greenberg, H. and Logsdon, M.G. (2000) Puget Snd Digital Elev Mod.

Restoration and Conservation Prioritization

Highest rated bluffs for *Conservation* throughout the study area:

- South Quartermaster Harbor
- Southeast Vashon Island
- Federal Way
- Magnolia Bluffs

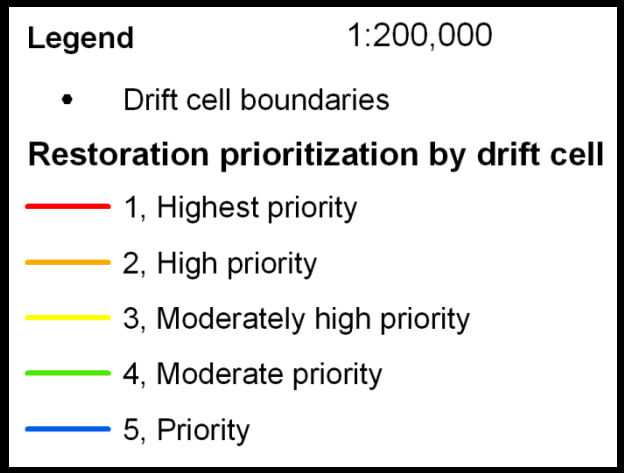
Legend 1:100,000

Bluffs of HIGH conservation priority
(By segment number)

Data sources: All mapping by Coastal Geologic Services, Inc., Bellingham, WA, 200
Base map - Finlayson D.P., Haugerud R.A., Greenberg, H. and Logsdon, M.G. (200

Restoration and Conservation Prioritization

Drift cells were ranked by calculating the percent of intact sediment sources (relative to historic conditions) in the cell, then weighting that number by the scores of the individual current and historic sediment source units that make up that drift cell.



Prioritization score =
(HFB score * % HFB of total pre-dev. sed source) + (CFB score * % of total pre-dev. sed source)
(CFB score * % of total pre-dev. sed source)

Where, CFB= Current Feeder Bluff, HFB=Historic Feeder Bluff.

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Conclusions

- Feeder bluff and accretion shoreform mapping along 121 miles of WRIA 8 & 9
- Current and Historic data
- Mapping provides process-based physical information that's been lacking
- Based primarily on new field data collection & not models
- Data useful for:
  - furthering GIS-based nearshore & salmon science
  - shoreline mgt (long-range & immediate)
  - restoration and conservation

Synthesis of data from 99 drift cells:

93 miles of historic sediment sources

42 miles of current sediment sources

= 55% loss of nearshore sediment sources

Average loss of (linear extent) of sediment supply: 42%

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