Presented at Puget Sound Shorelines and the Impacts of Armoring Workshop,
May 12-14 2009.
This presentation not peer reviewed.

Shoreline erosion on Puget Sound: Implications for the construction and potential impacts of erosion control structures

Puget Sound Shoreline Armoring Workshop
12-14 May 2009

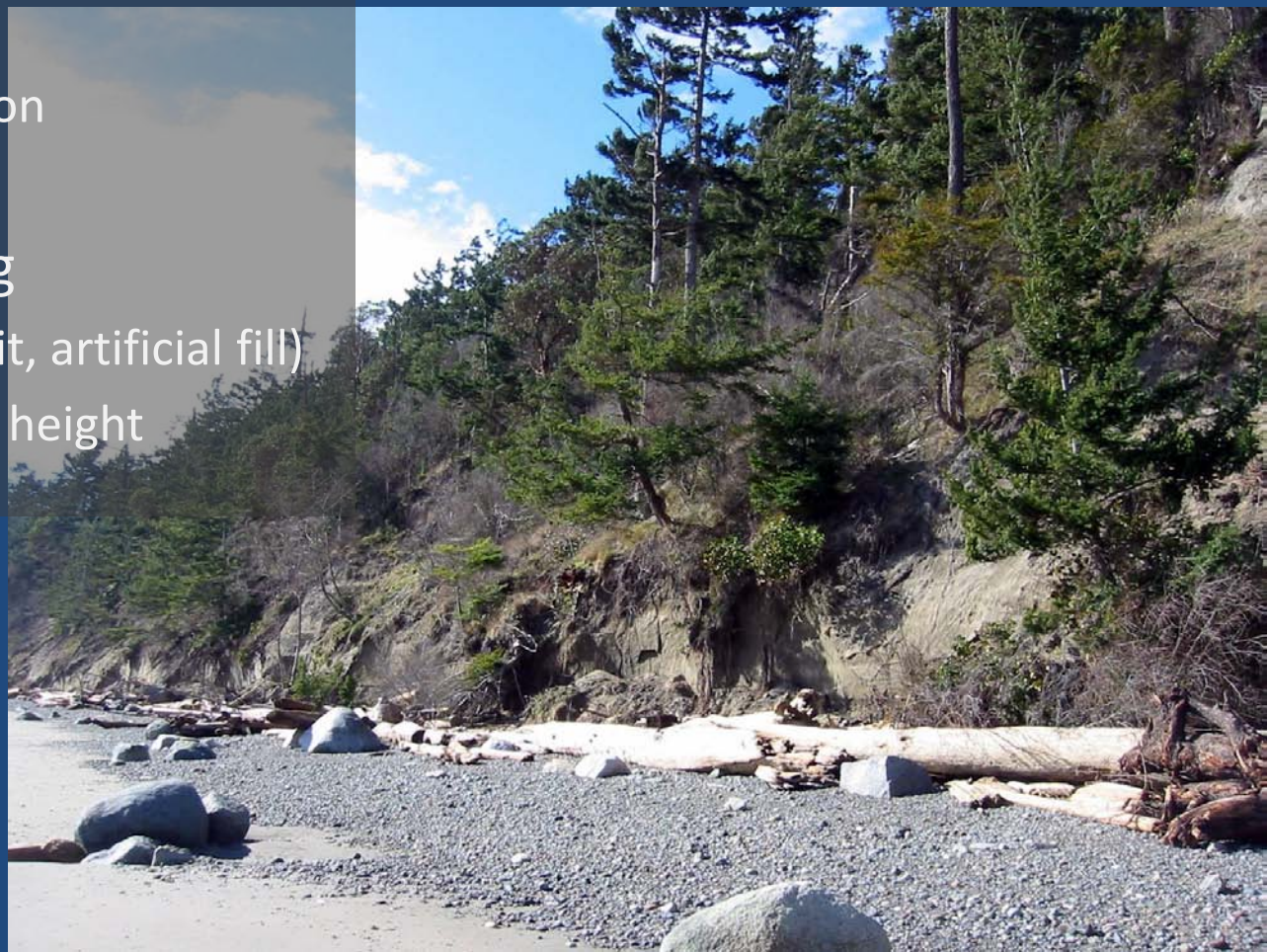
Hugh Shipman
WA Department of Ecology

Overview

- Nature of erosion on Puget Sound
- Typical erosion control measures
- Potential impacts of armoring structures

Factors influencing erosion

- Waves and water levels
  - Exposure (fetch, bathymetry)
  - Tides, Sea level, El Nino
- Geology
  - Resistance to erosion
  - Bluff stability
- Geomorphic setting
  - Landform (bluff, spit, artificial fill)
  - Beach width, berm height



Bluff Erosion

- Wave-induced toe erosion
  - High tide events and storms
- Hillslope mass-wasting
  - Heavy rainfall

Barrier Erosion

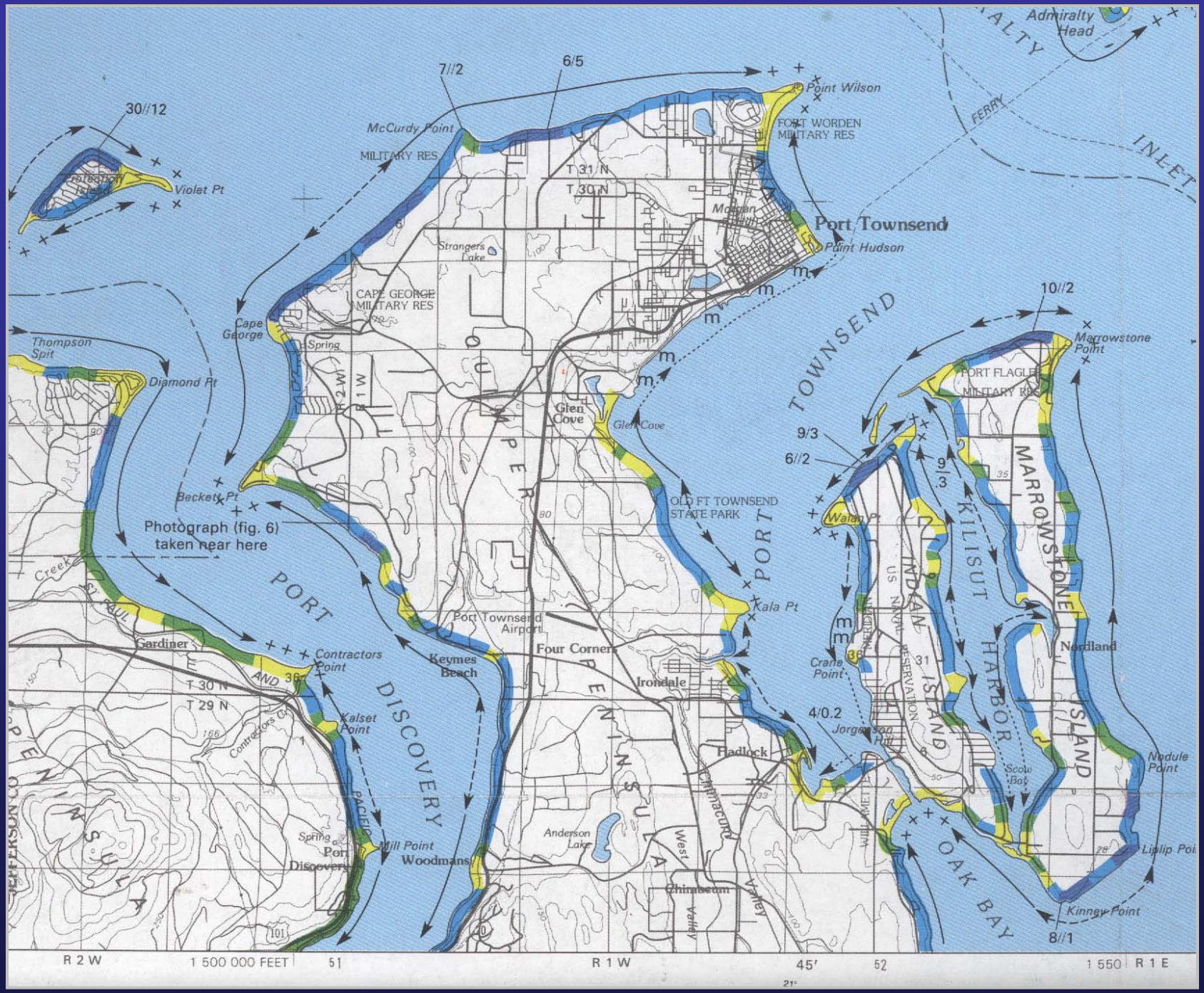
- Beach erosion and narrowing
- Overwash and barrier migration

Erosion Rates

Table 1. Erosion rates of coastal bluffs on Puget Sound

Location[1]	Rate (cm/yr)	Fetch (km)	Source
Baby Island, Whidbey Island	13	15	Keuler, 1988[2]
Maylor Point, Whidbey Island	15	15	Keuler, 1988
Penn Cove, Whidbey Island	6.5	5	Keuler, 1988
Mutiny Bay, Whidbey Island	11	10	Keuler, 1988
S. of Lake Hancock, Whidbey	4	20	Keuler, 1988
Rocky Point, Whidbey Island	14	>50	Keuler, 1988
Camano Island, west side	3	10	Keuler, 1988
Smith Island	69	>50	Keuler, 1988
North Beach, Quimper Peninsula	6	>50	Keuler, 1988
Shannon Point, Fidalgo Island	20	10	Schwartz, 1971
Skagit County (mean of 6 sites)[3]	7.6 (± 2.7)	---	Keuler, 1979
Skagit County (mean of 26 sites)[3]	4.9 (± 3.4)	---	Keuler, 1979
Port Williams	30	50	Ecker et al., 1979
Sequim Bay	6	< 5	Ecker et al., 1979
Port Angeles	90-150	>50	Galster and Schwartz, 1987
Point Grey, B.C.	30-50	>50	Van Osch, 1990
Cowichan Head, B.C.	60	>50	Van Osch, 1990

[1] Note that sites were selected based on available data, not on their representativeness of regional erosion rates. We suspect this sample is biased toward sites with rapid erosion.
[2] Sites from Keuler (1988) limited to those based on greater than 20 years of record.
[3] The larger set of sites (26) includes indirect measurements that may provide a low estimate of rates. The small subset of sites (6) may better reflect an average rate.



Admiralty Head
7//2
6/5
30//12
Point Wilson
McCurdy Point
FORT WORDEN MILITARY RES
MILITARY RES
Violet Pt
T 31 N
T 30 N
Port Townsend
Point Hudson
Strangers Lake
CAPE GEORGE MILITARY RES
Cape George
Spring
Thompson Spit
Diamond Pt
10//2
Marrowstone Point
FORT FLAGLER MILITARY RES
Glen Cove
9/3
6//2
Beckett Pt
Photograph (fig. 6) taken near here
OLD FT TOWNSEND STATE PARK
Walan Pt
Kala Pt
Port Townsend Airport
Gardiner
Contractors Point
Keymes Beach
Four Corners
Irondale
Crane Point
Nordland
T 30 N
T 29 N
Kalset Point
4/0.2
Jorgenson Hill
Hadlock
Nodule Point
Scow Bay
Anderson Lake
Mill Point
Woodmans
Port Discovery
Chimacum
Liplip Poi
Kinney Point
8//1
R 2 W
1 500 000 FEET
R 1 W
45′
1 550
R 1 E

Keuler, 1988

Seawalls and Bulkheads

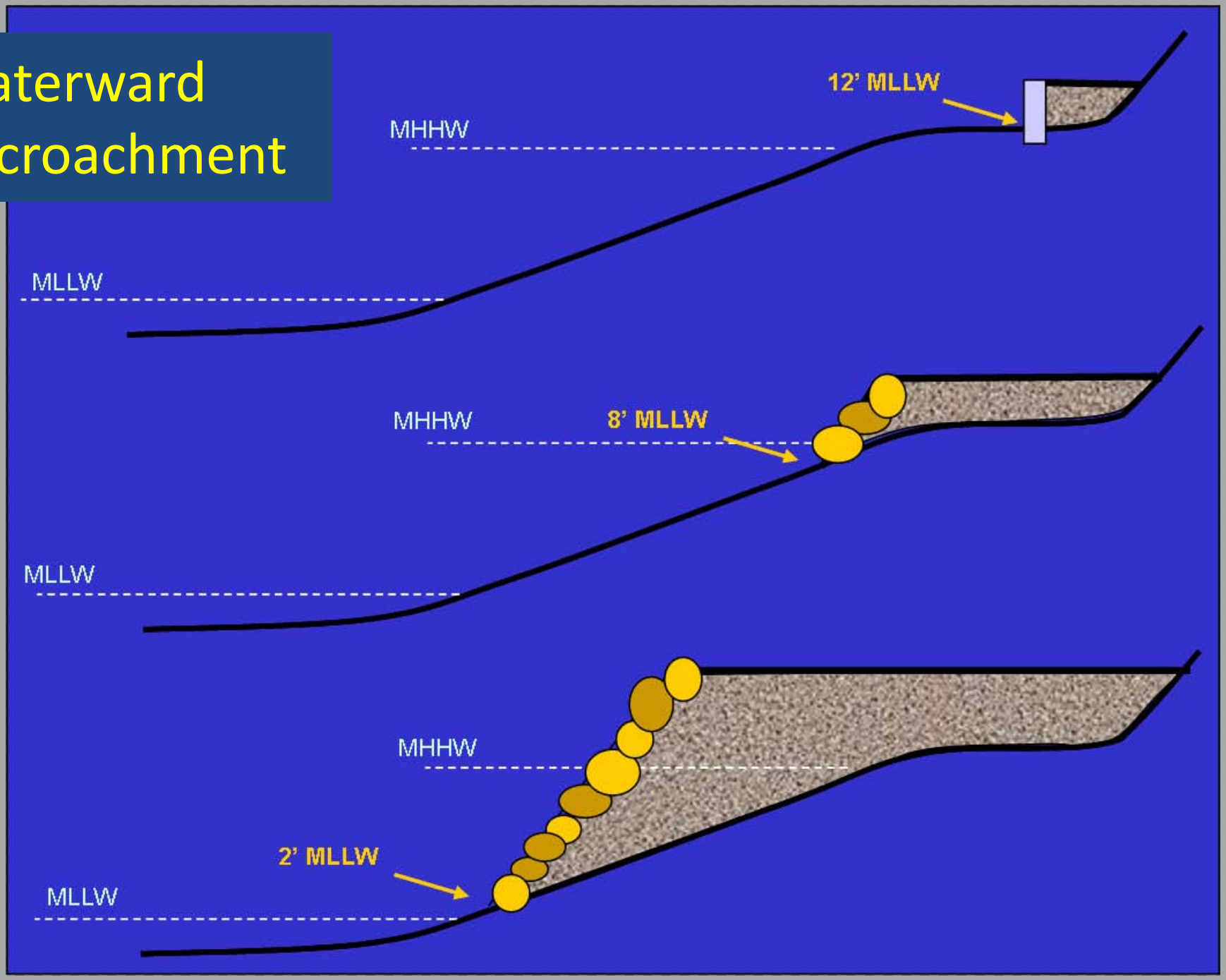
- **Purpose**
  - Protect bluff toe
  - Protect fill
  - Reduce storm damage
  - Slope stabilization

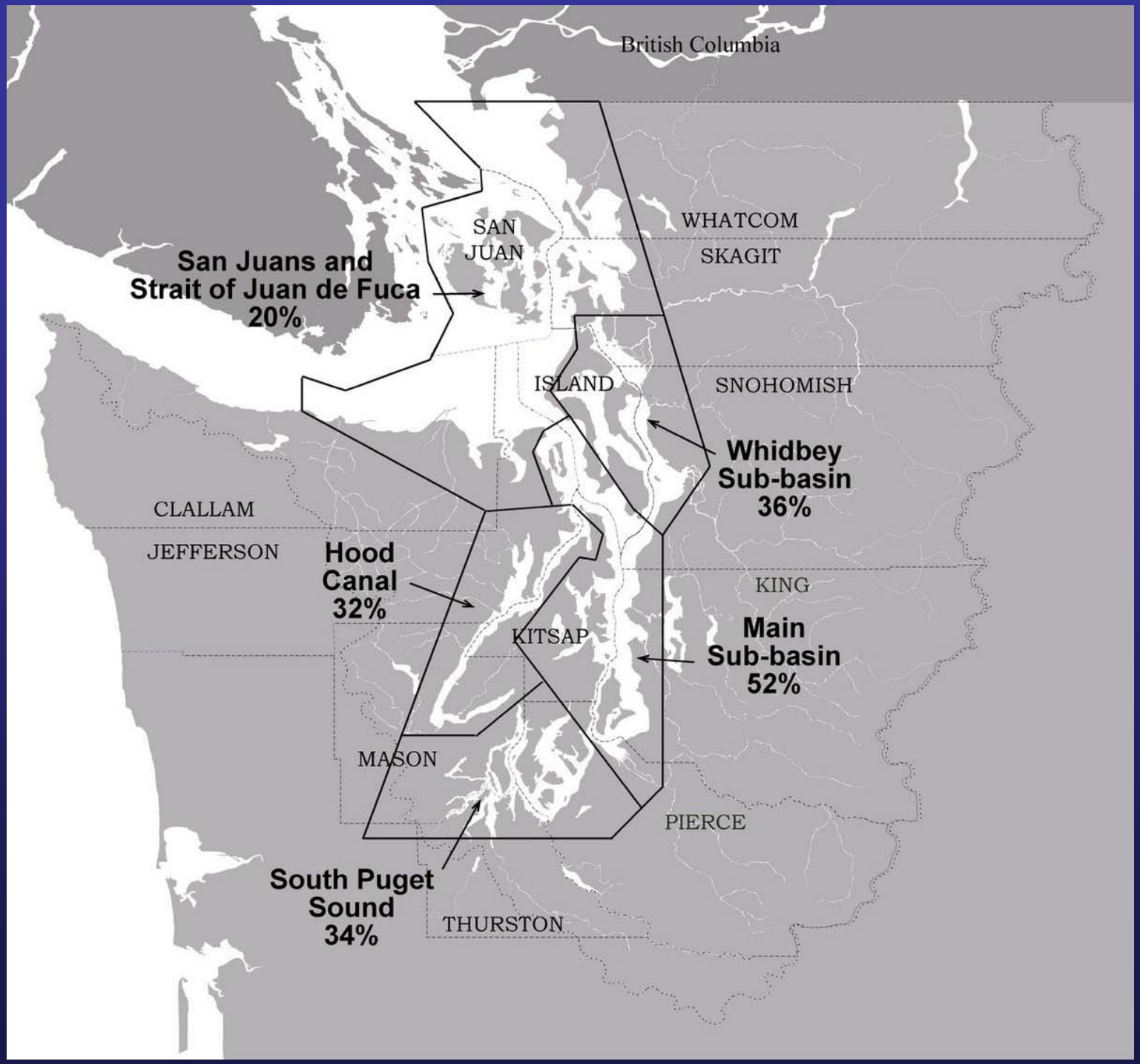
- Other functions:
  - Conversion to upland uses
  - Beach access
  - Landscaping
  - Storage and recreation

Armoring: Different Flavors

- Design
  - Material
  - Slope
- Setting
  - Bluff, Barrier, Artificial fill
  - Background erosion rate
  - Wave exposure, orientation
  - Beach substrate
- Waterward Position

Waterward encroachment




British Columbia
SAN JUAN
WHATCOM
SKAGIT
San Juans and Strait of Juan de Fuca 20%
ISLAND
SNOHOMISH
Whidbey Sub-basin 36%
CLALLAM
JEFFERSON
Hood Canal 32%
KING
KITSAP
Main Sub-basin 52%
MASON
PIERCE
South Puget Sound 34%
THURSTON

[DNR, 1998]

Potential impacts of armoring

- Burial or modification of upper beach
- Reduction in delivery of bluff sediment
- Reflection of wave energy, leading to
  - Change in sediment transport (cross-shore or longshore)
  - Change to beach substrate
- Hydrologic impacts
  - groundwater and surface water
- Loss of ecological connectivity
  - riparian vegetation, wildlife
  - detrital inputs
- Chronic beach loss
  - Passive erosion
  - Sea level rise
- Cumulative effects

Alternatives to Conventional Armoring

Creative engineering

Nourishment

Summary

- Erosion varies in rate and character
  - therefore potential impacts of erosion control also likely to vary
- Conflict between protecting environment and reducing hazards
  - particularly in the face of future sea level rise
- Increasing demand for stricter regulation, alternative approaches
- Limited scientific investigation, poor understanding of impacts