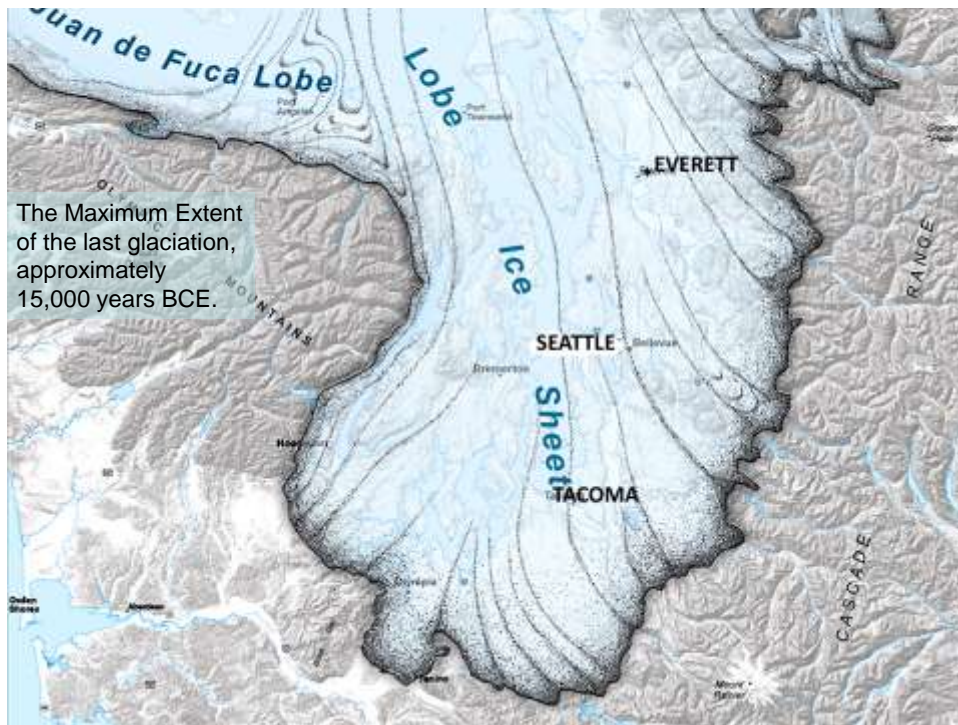


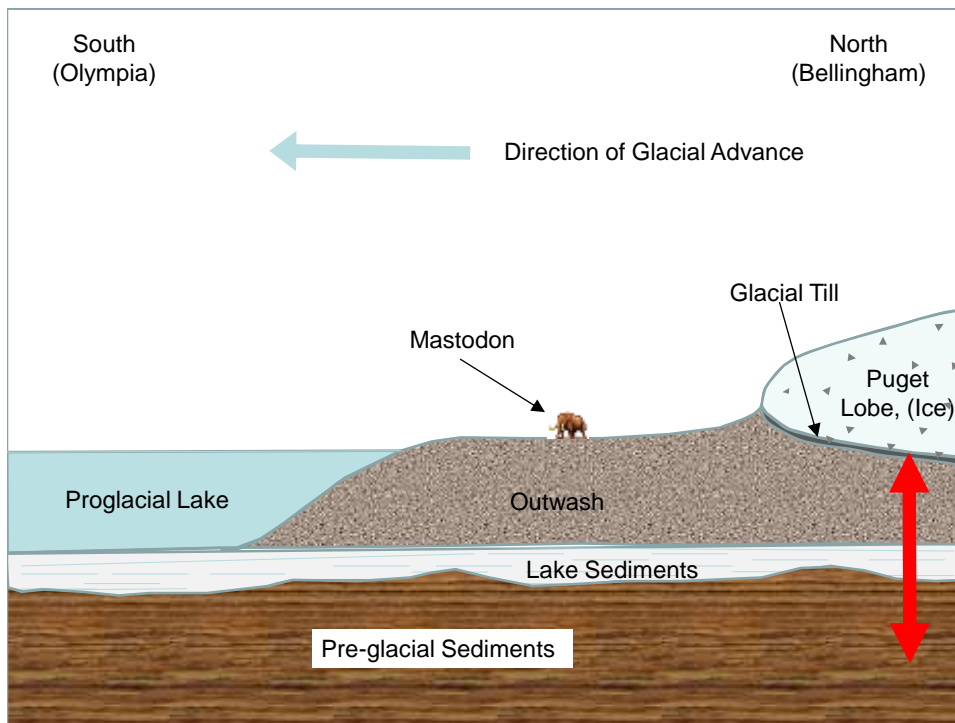
# **Where the Land Meets the Water**

**KCD SHORELINE LANDOWNERS  
WORKSHOP  
Vashon Island  
July 13, 2019**

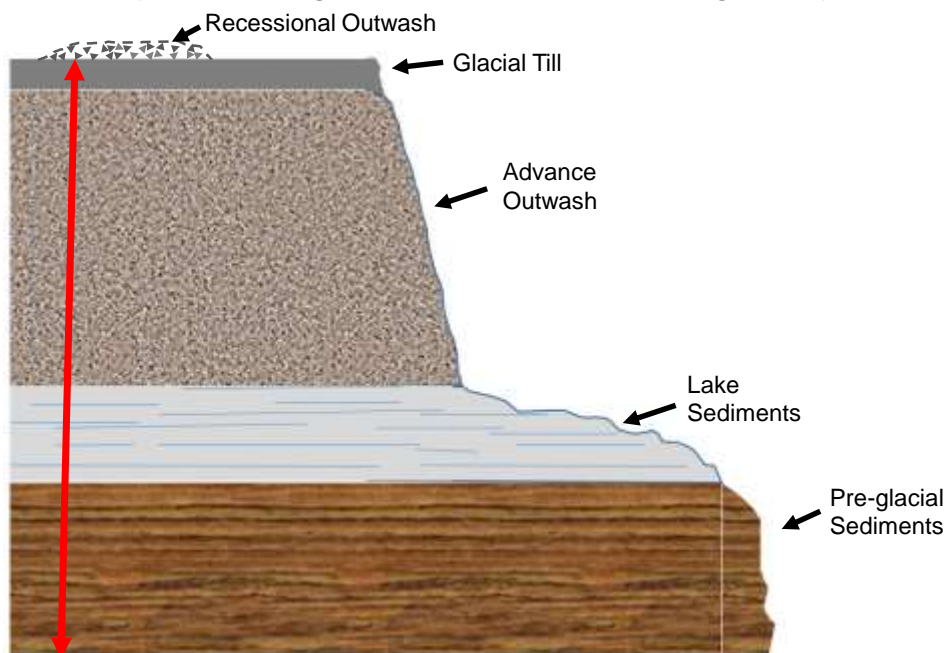
## **Geologic History Of Puget Sound Shorelines**



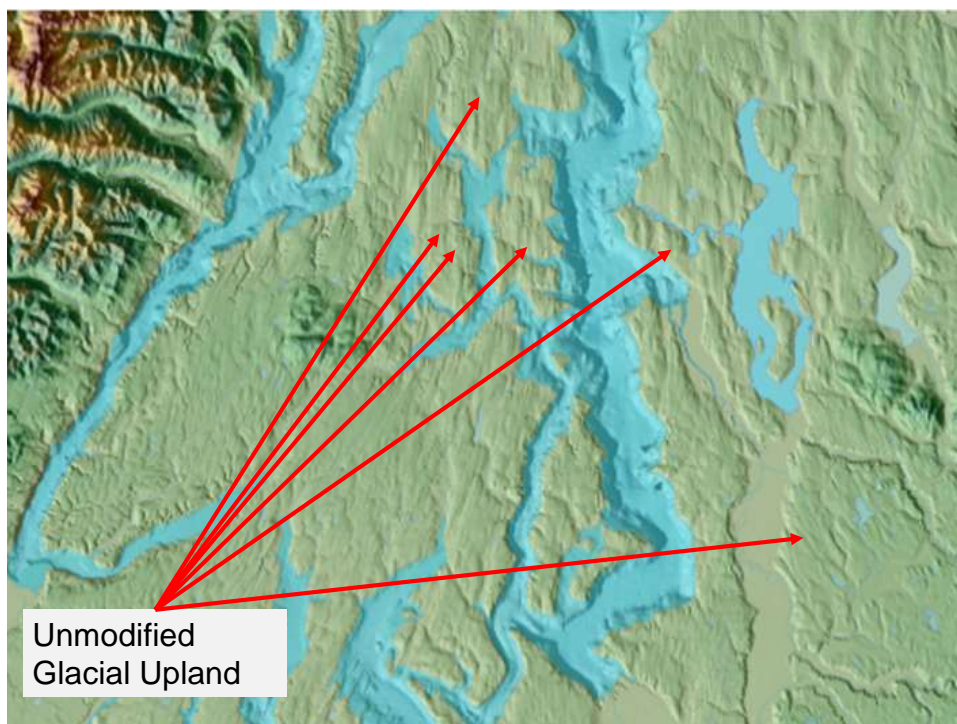
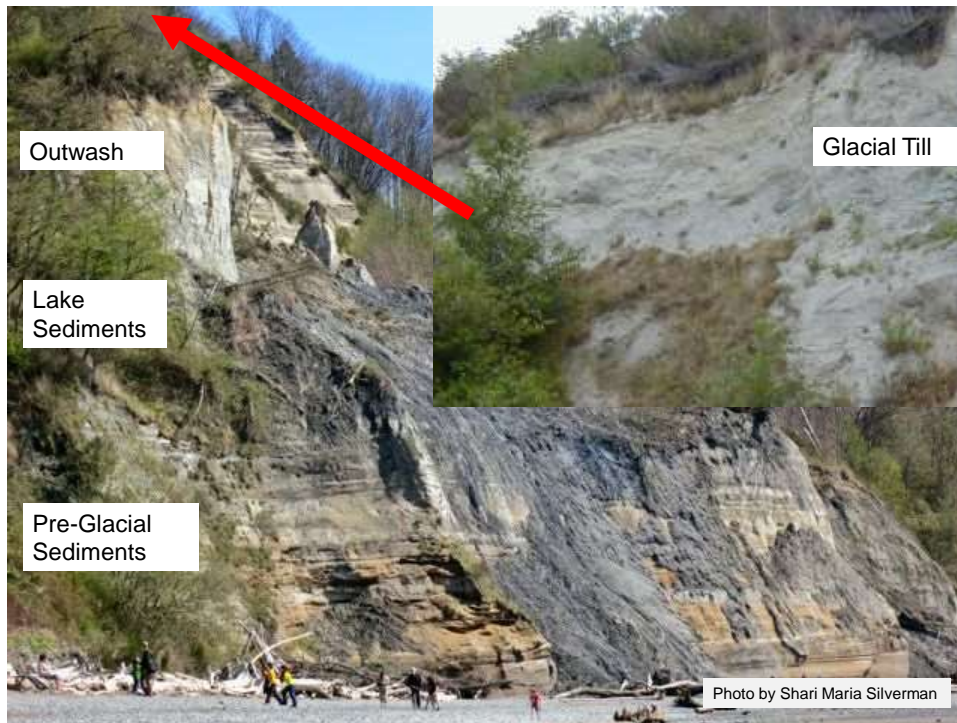


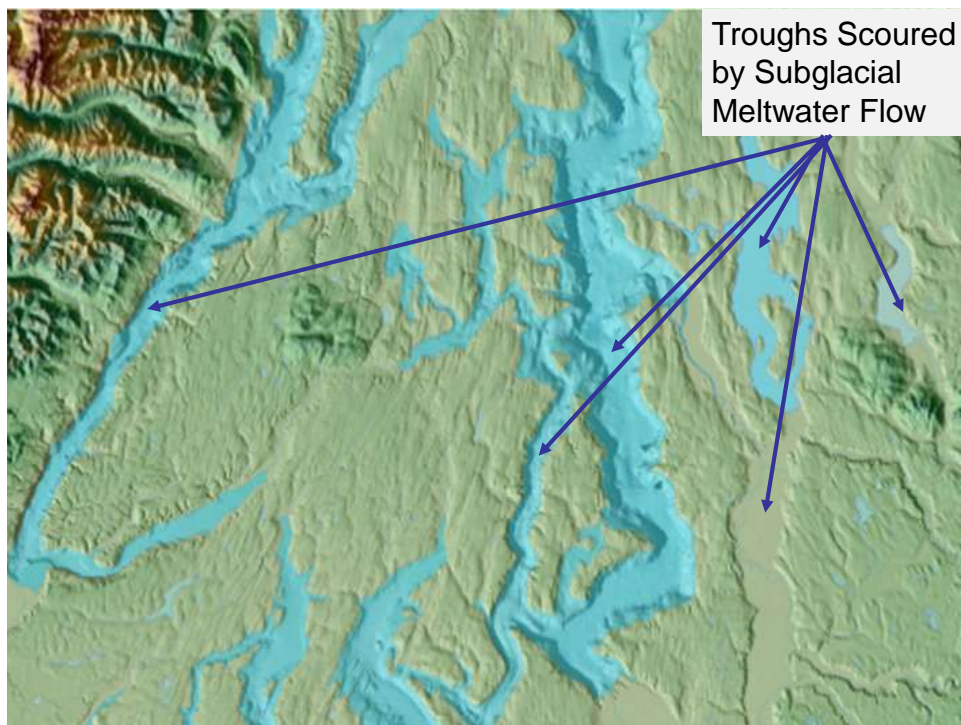


## Typical Puget Sound Bluff Stratigraphy

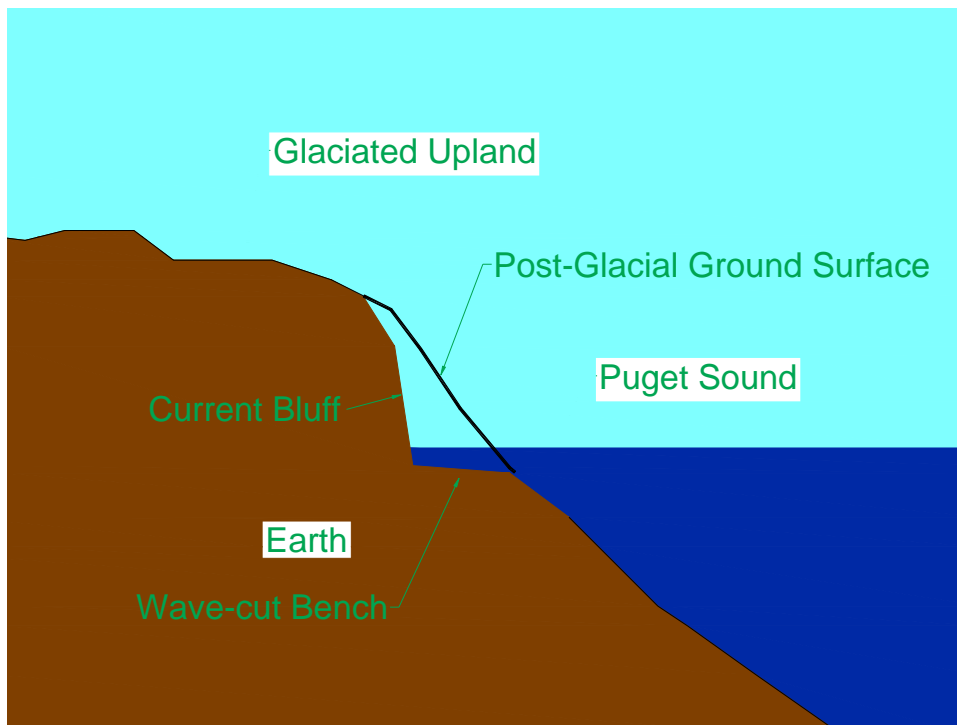


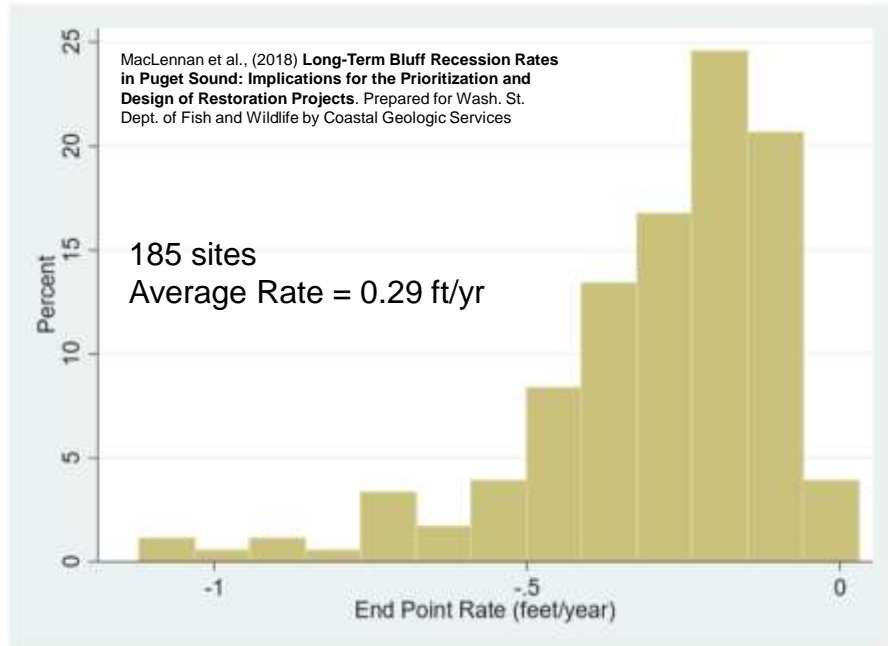








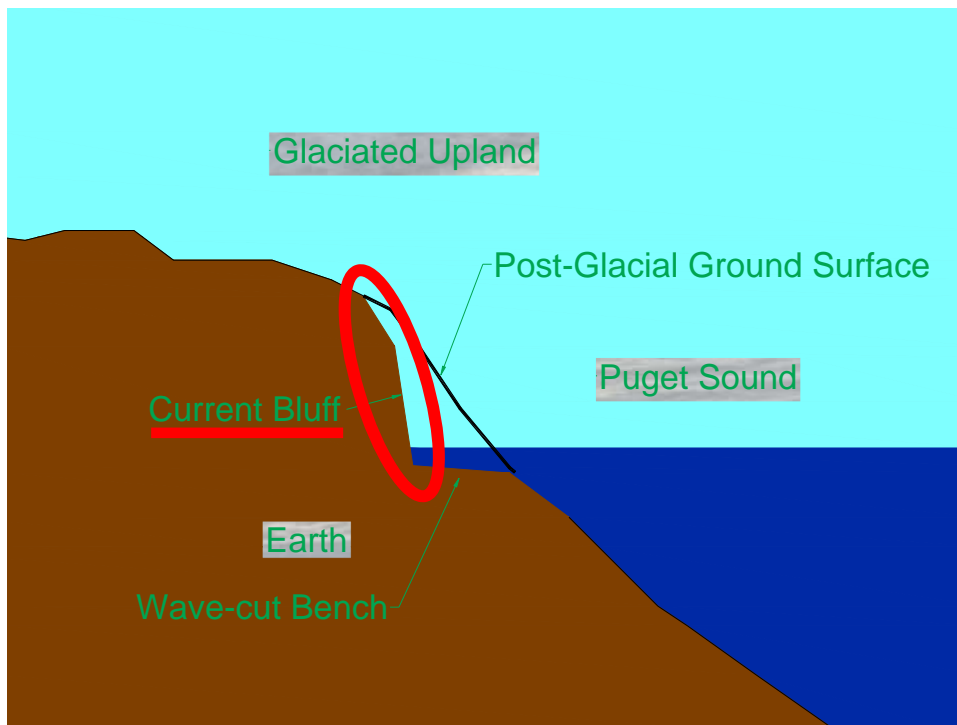




**Figure 16.** Frequency distribution of all long-term bluff recession rates, reported as End Point Rate (feet/year).

## COASTAL BLUFF PROCESSES





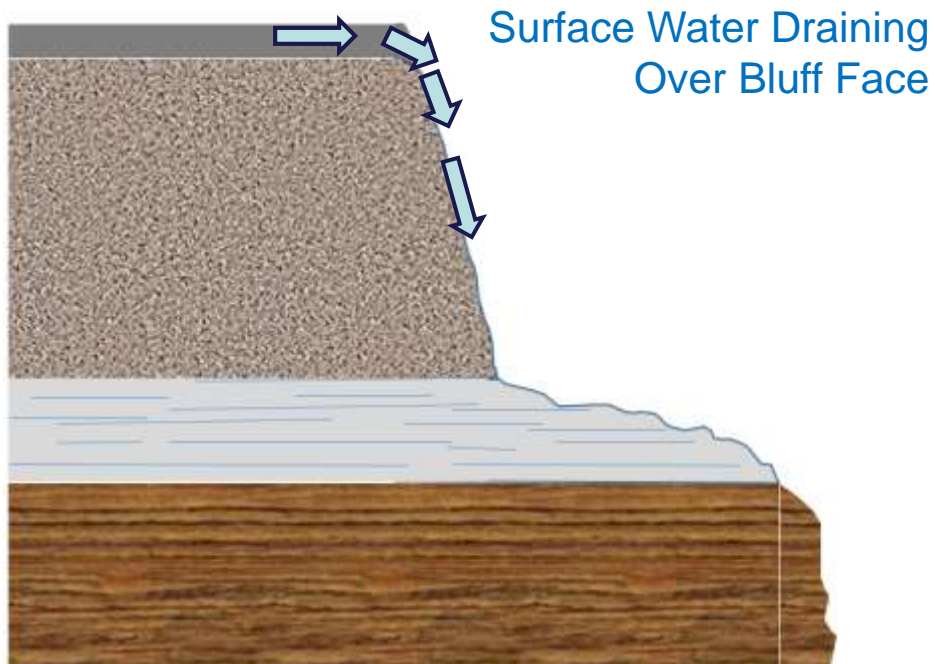


Erosion by Flowing Water



Shallow Landslides





Burlington  
Northern-Santa  
Fe Freight  
Train, Everett to  
Seattle,  
December 2018





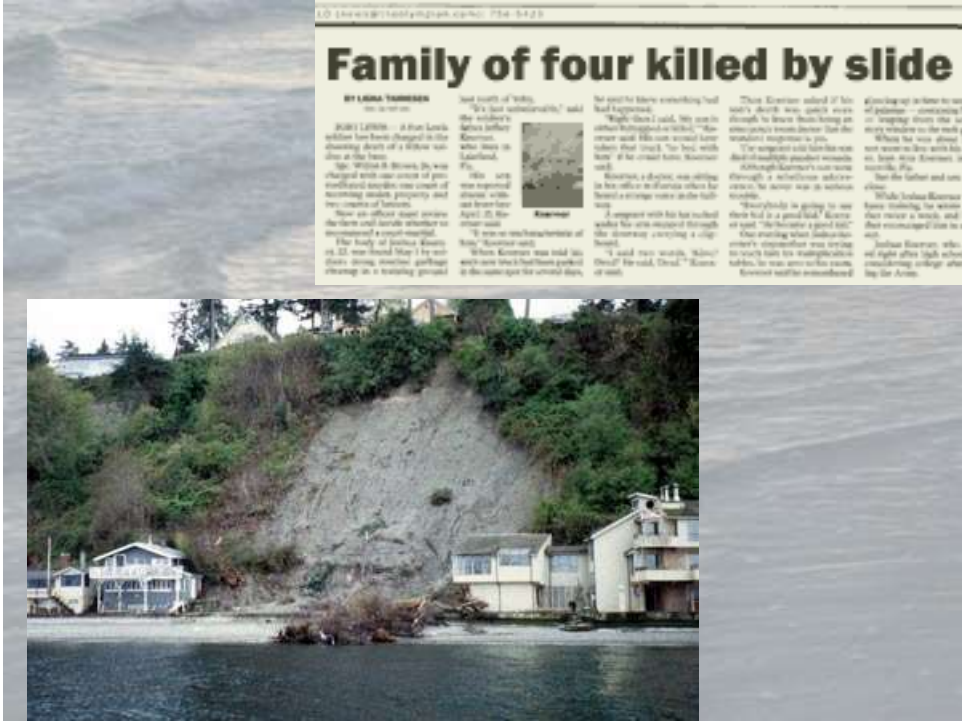
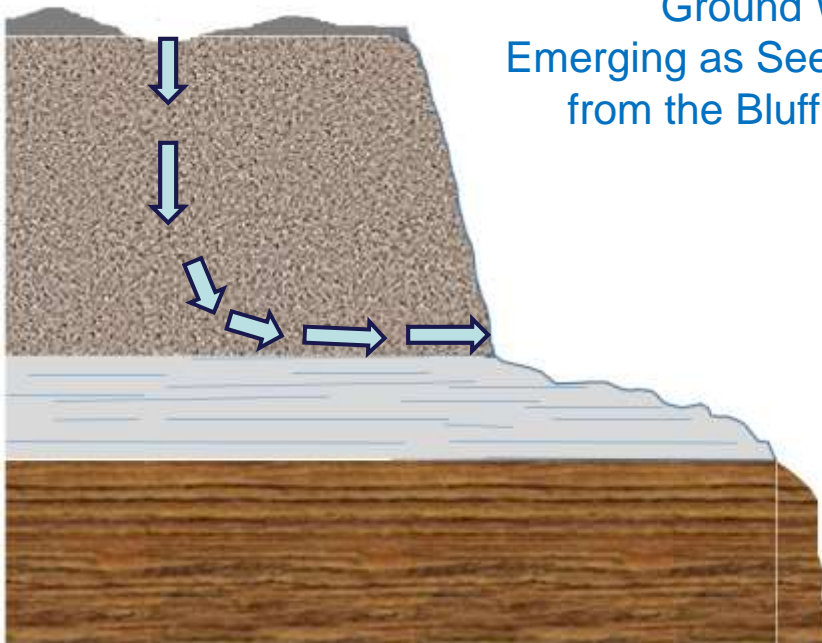
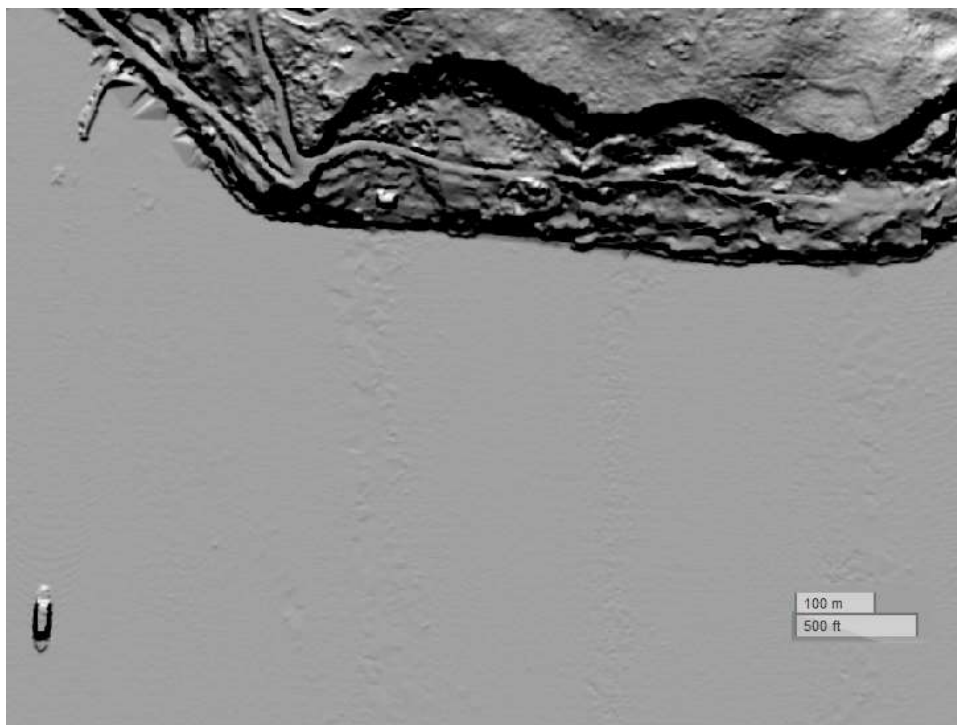


Figure Curtesy Don Tubbs





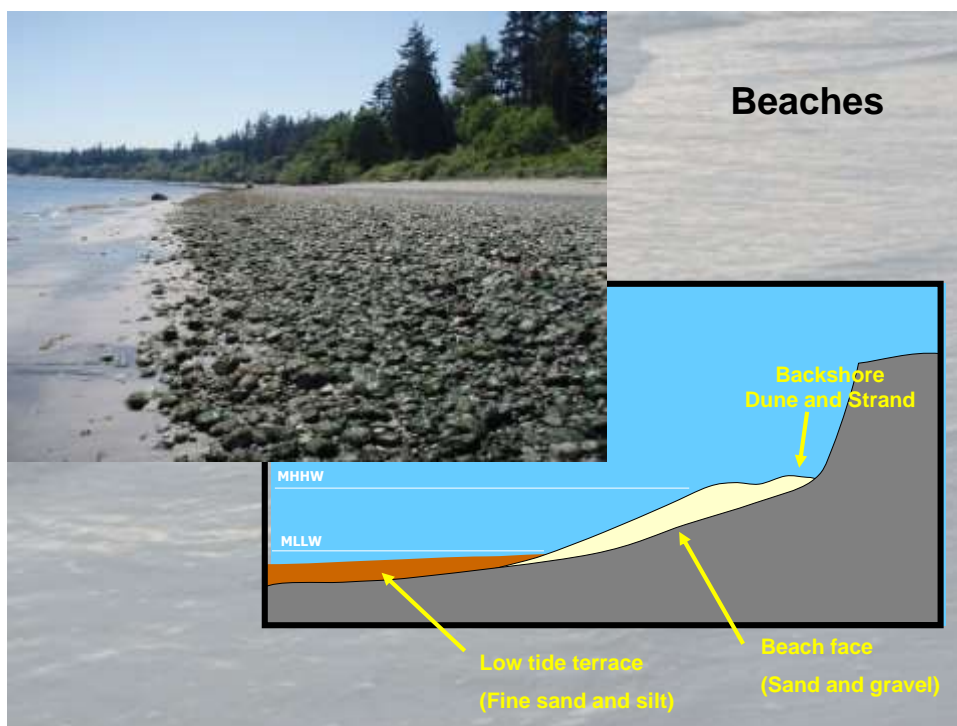
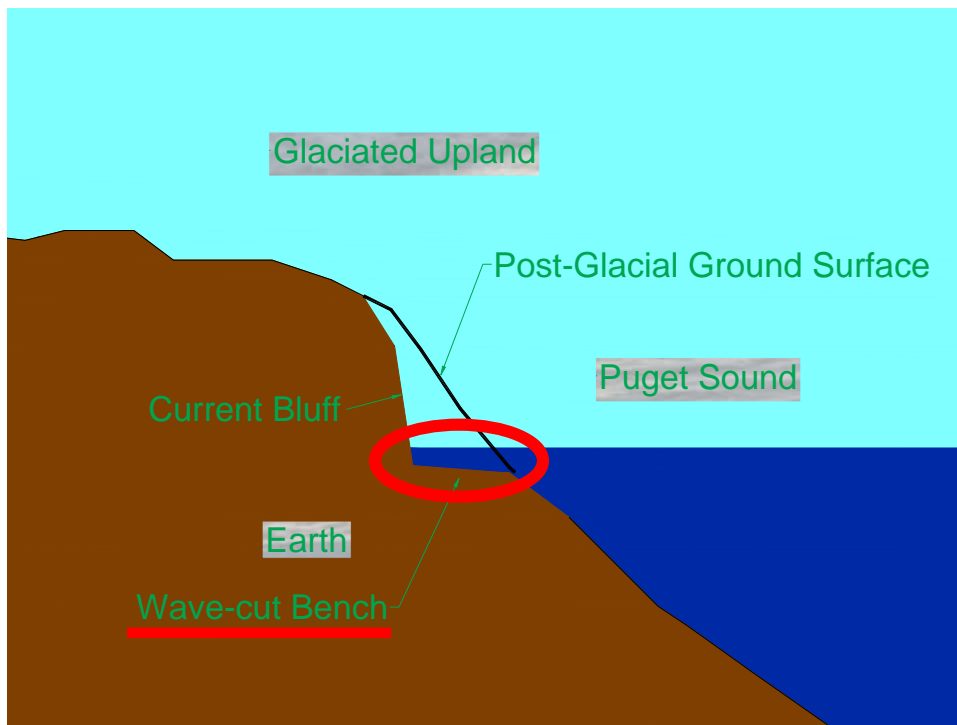


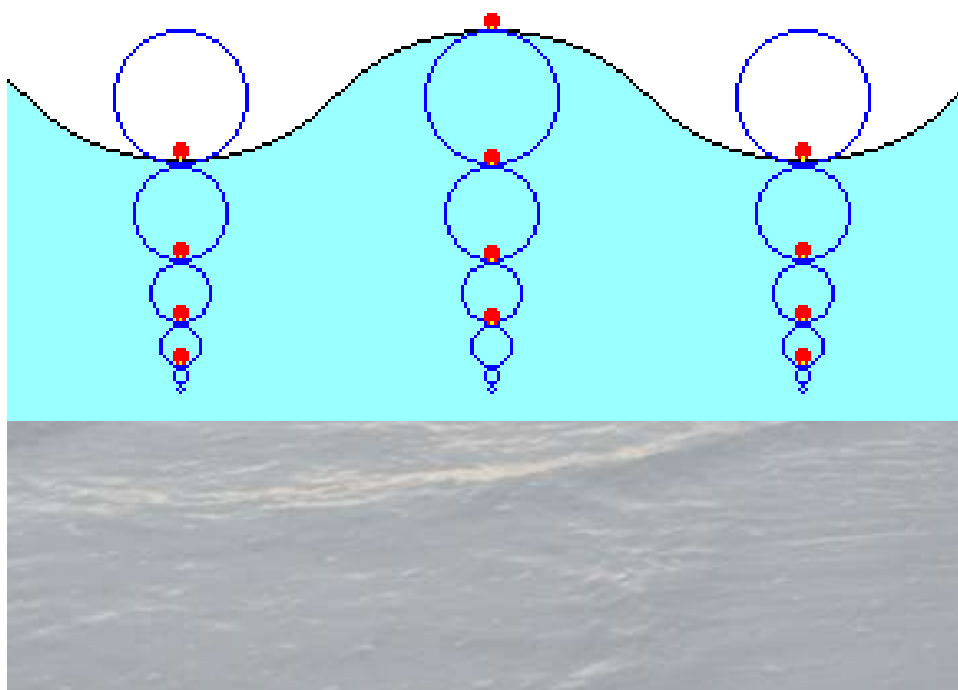


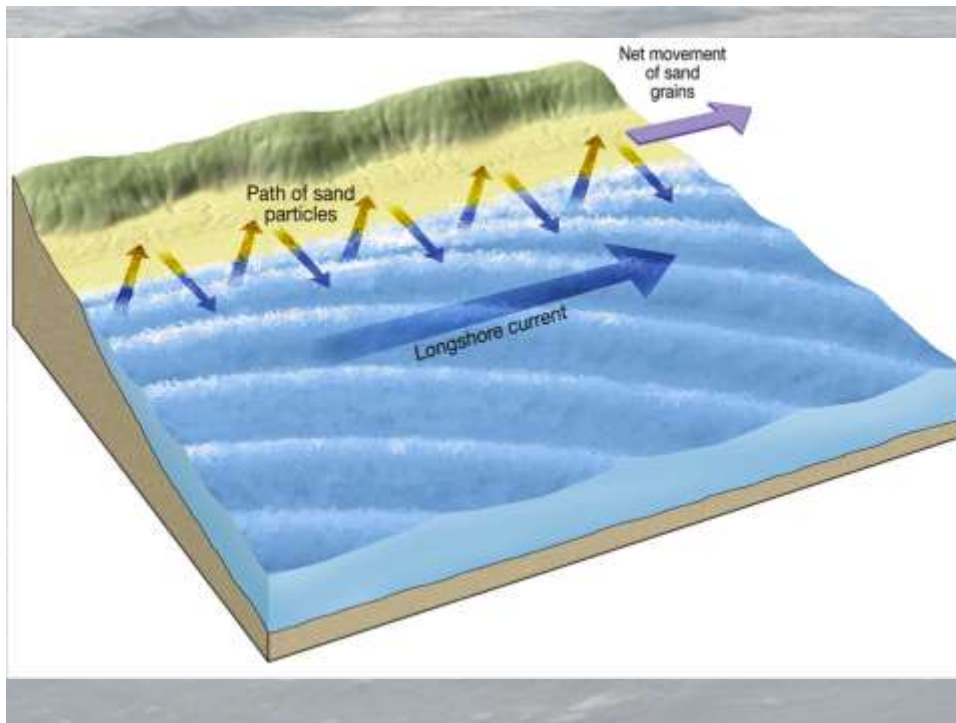
## Beach Formation and Longshore Drift







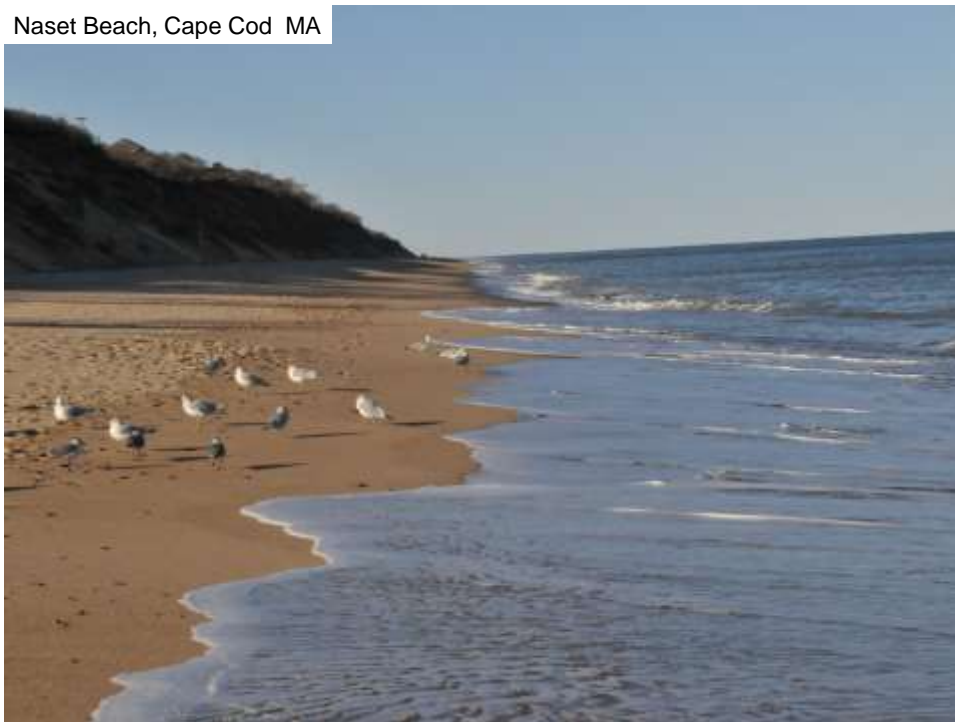








Naset Beach, Cape Cod MA



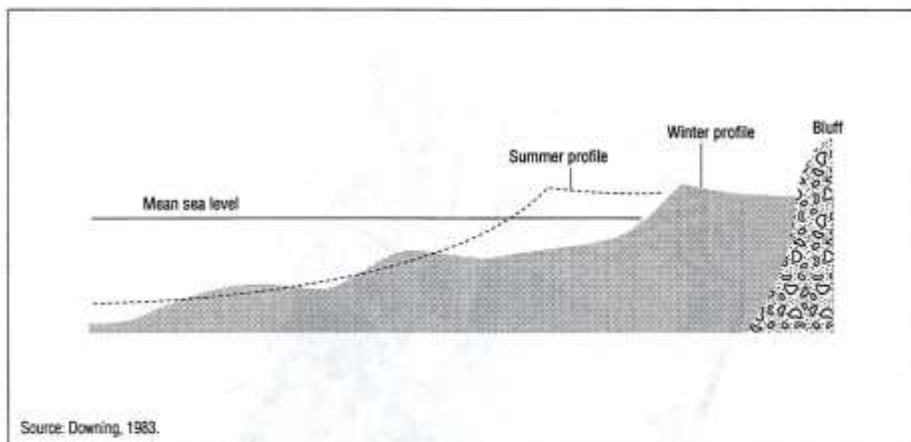
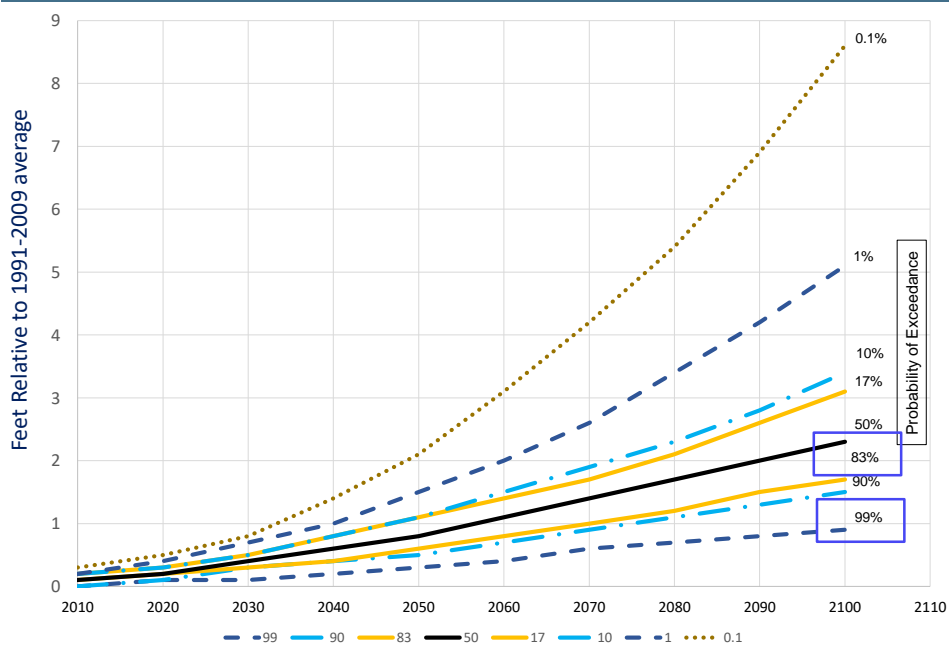


Figure 2-3  
Seasonal Beach Profiles



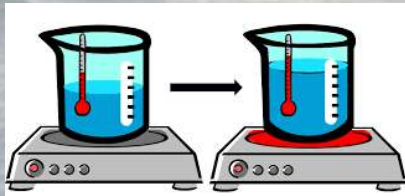


### Projected Sea Level Rise (Seattle)



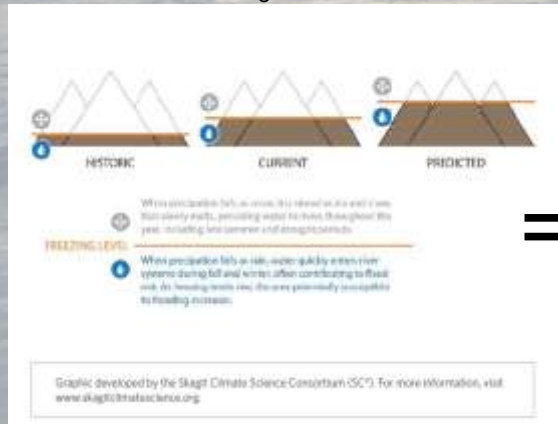


## Thermal Expansion



= 35%

## Glaciers/land ice melting



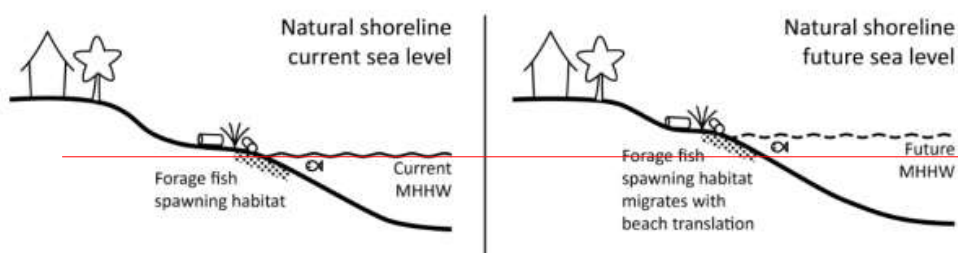
= 40-50%


A 1 foot rise in sea level =  
100-year flood event occurring every 2 years






### The Coastal Squeeze





Questions?



# Nearshore Ecology





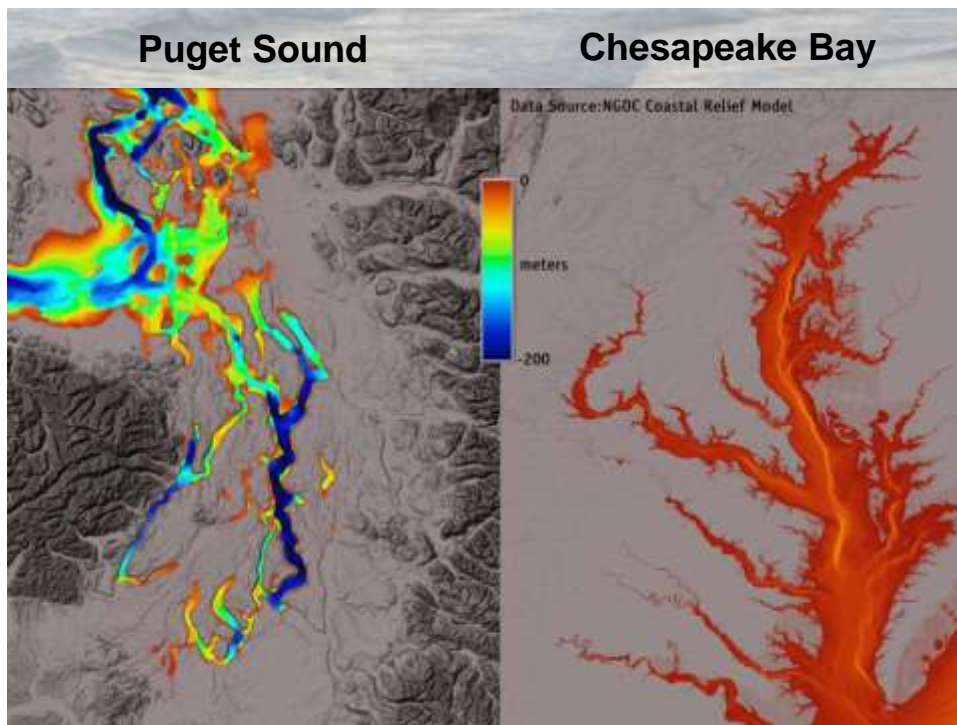


## Puget Sound Nearshore Ecosystem



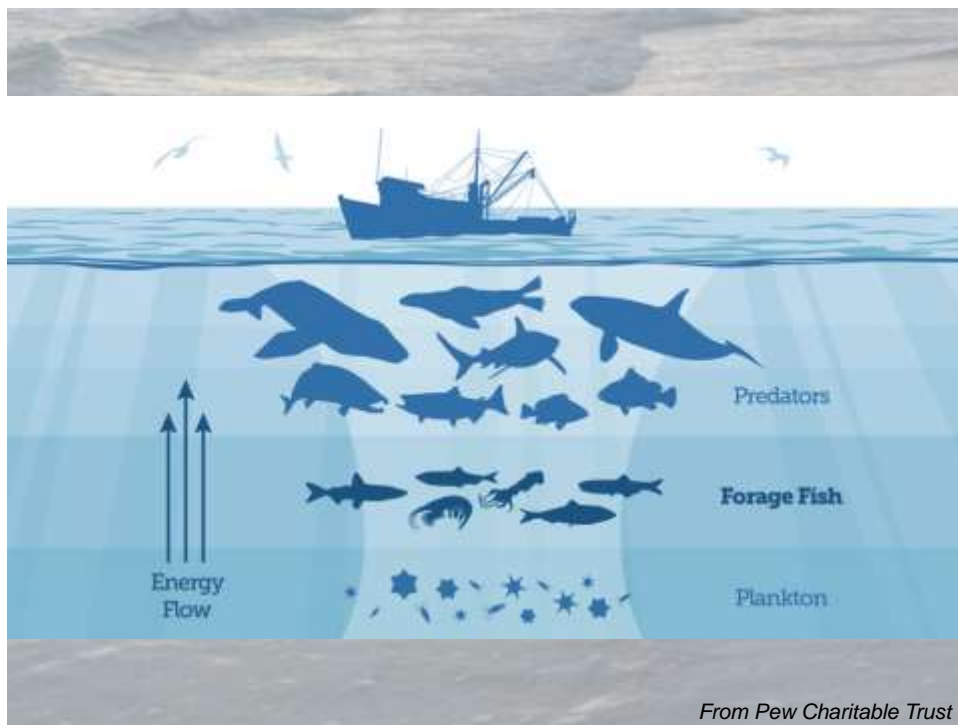
### Semi-Enclosed Coastal Sea

- Steep coastline with narrow nearshore zone
- Mixed sand/gravel beaches
- Strong regional gradients
- Tides-Twice a day
- Ecology strongly linked to geology and physical processes
- Rich biological resources

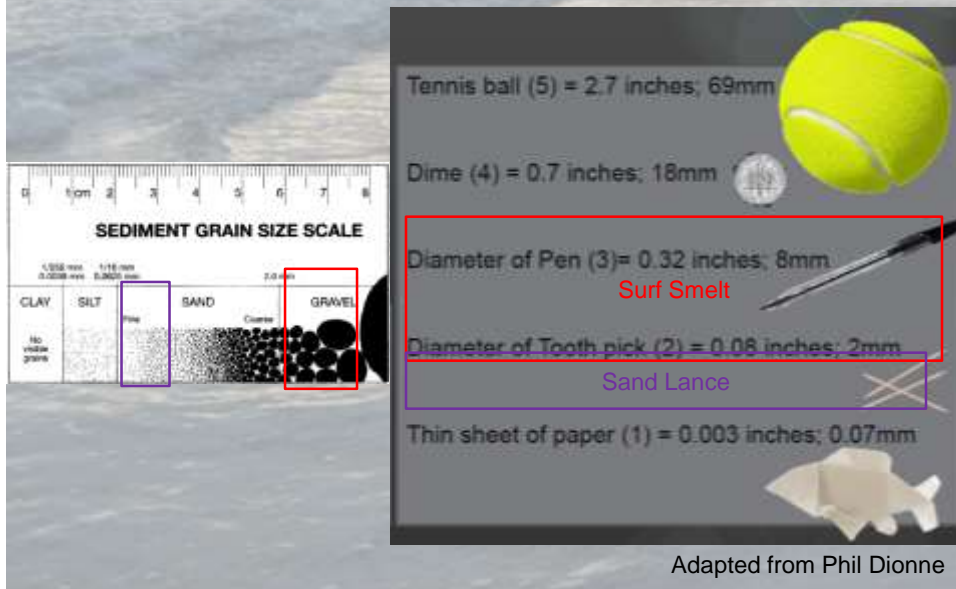








# What size gravel do they spawn in?





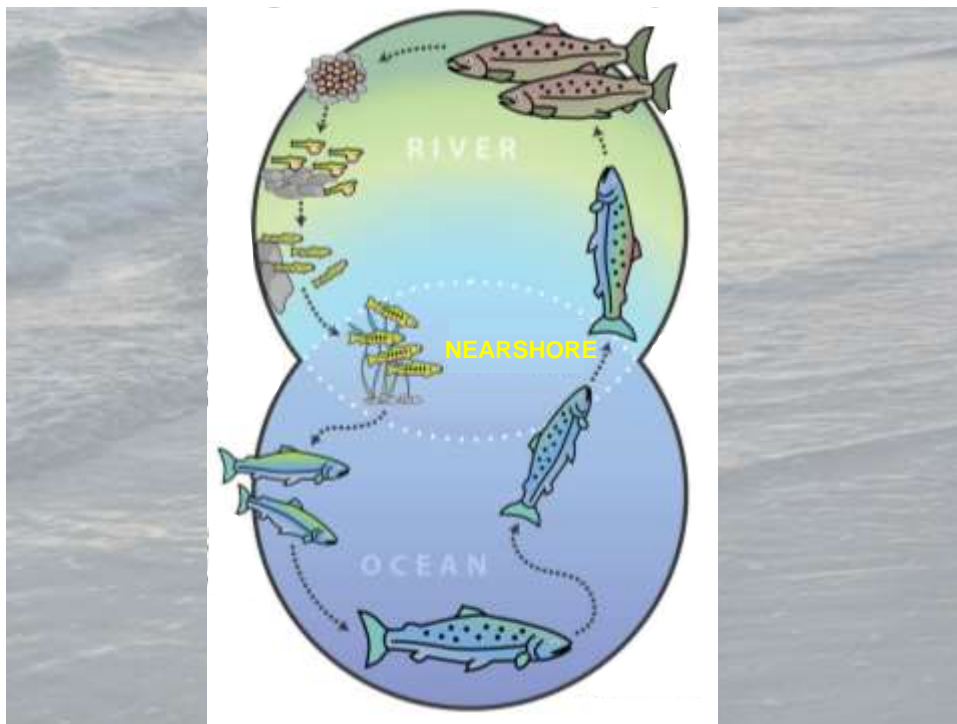
## Eelgrass



## Kelp/Algae



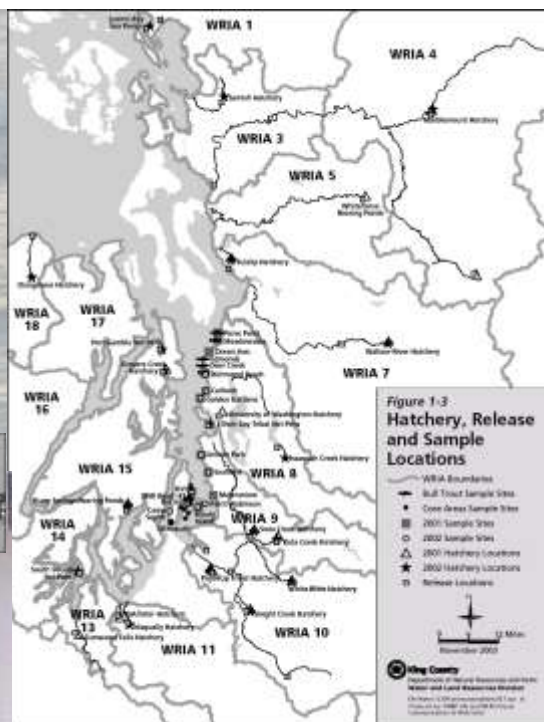
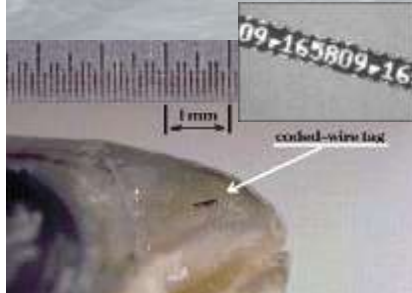
# PACIFIC SALMON ARE MARINE FISHES



## General Functions of Shallow Nearshore Habitats for Juvenile Salmon

- Feeding
- Migration
- Refuge from predators
- Physiological transition from freshwater to saltwater.

- CWT Chinook were caught from 22 different hatcheries representing 13 different Watersheds

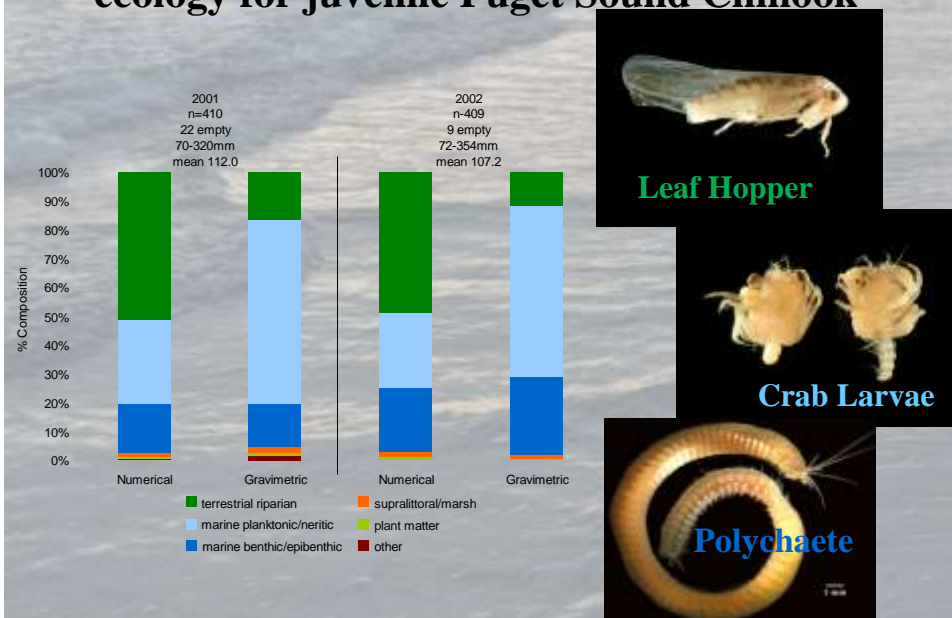


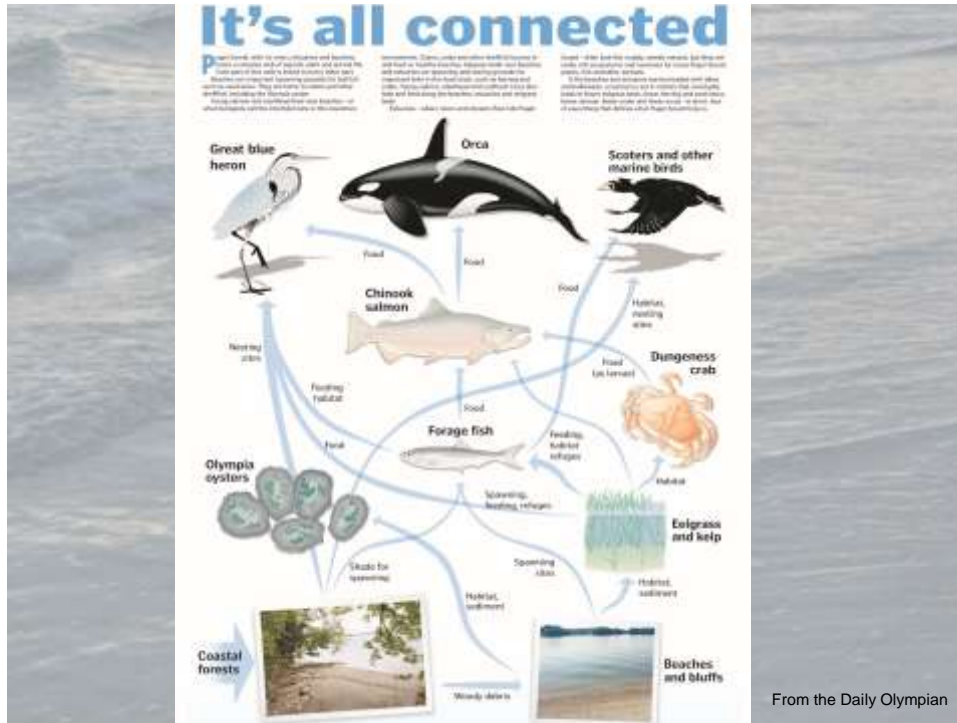


## Diet



## Overall diet composition based on prey ecology for juvenile Puget Sound Chinook





BREAK

## Switching Gears



69

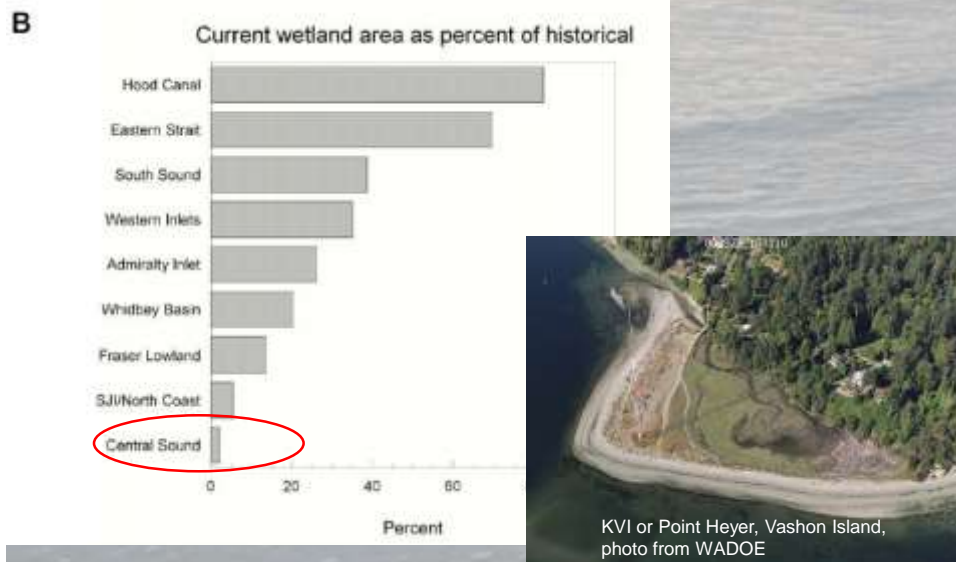
## Human Influences

- Armoring
- Filling
- Dredging
- Pollution

- Overwater Structures
- Clearing and Grading
- Non-native species



Currently, King County has less than 2% of its historic estuarine wetlands left



Historic Elliot Bay Shoreline



## Filling

- Loss of shallow water habitat
- Loss of riparian functions
- Changes in hydrology
- Elimination of spawning, rearing and refuge habitat



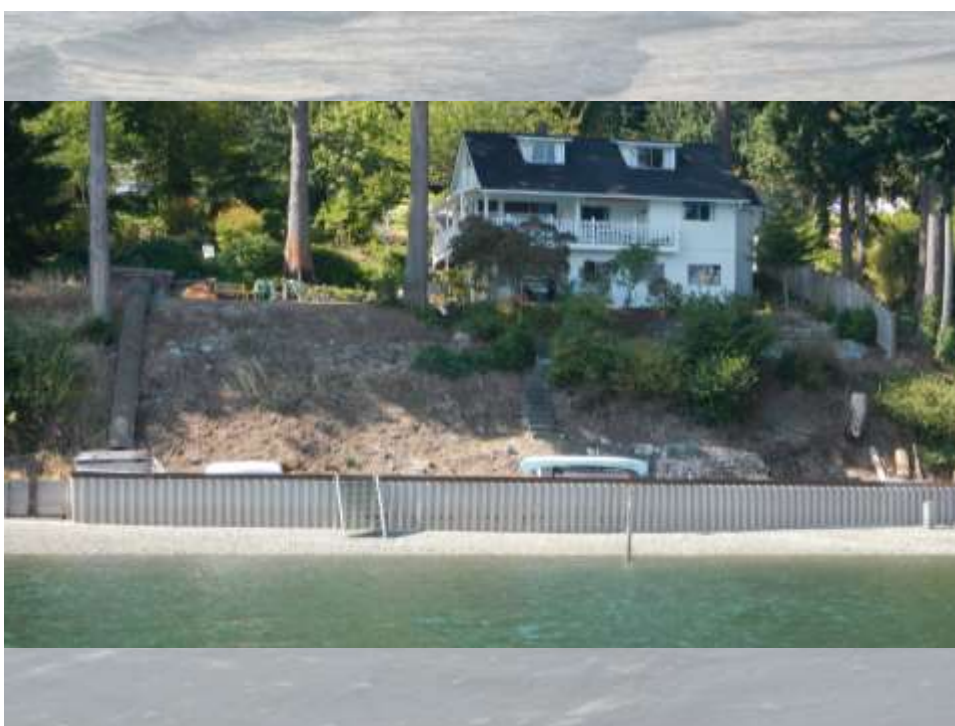
## Overwater Structures



## What is Shoreline Armoring?















## Shoreline Armoring in the Green-Duwamish Watershed

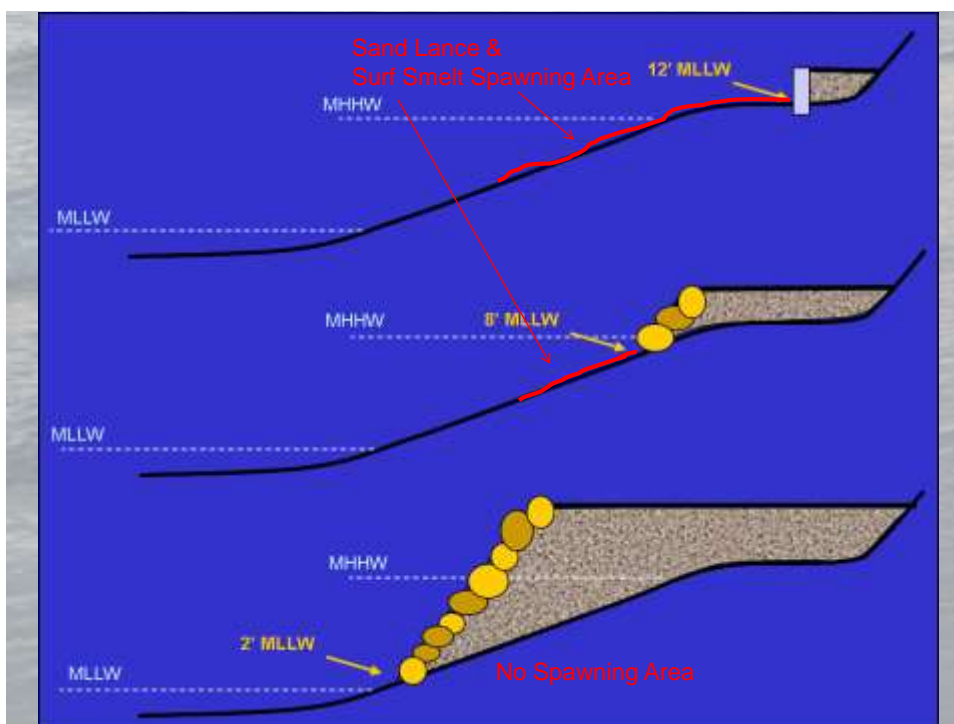
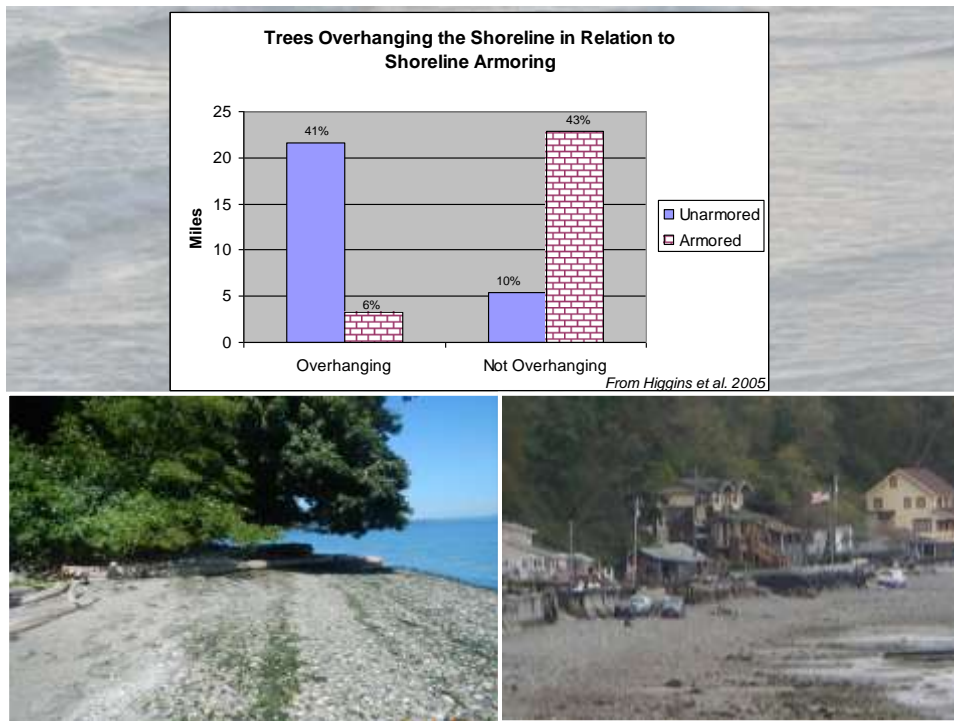
- 92 miles shoreline
- Total=63% is armored
  - Mainland is 80%
  - Islands are 50%



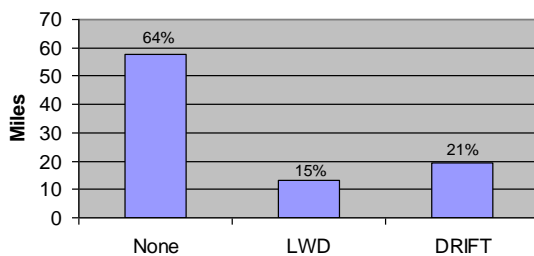
Why do we  
care?

Blocks *feeder  
bluffs* from  
feeding beaches





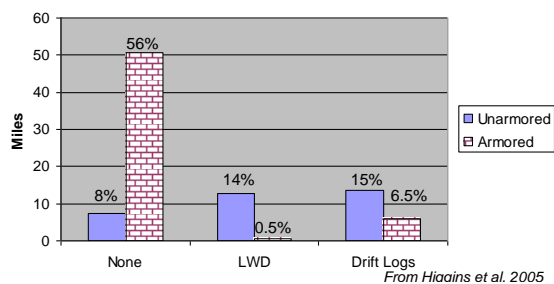
### Wood Distribution Along Marine Shorelines of King County



Unarmored-Drift logs



### Wood Distribution in Relation to Shoreline Armoring



### Recent UW Study





## Recent UW Study



## From recent UW Study



From recent UW Study

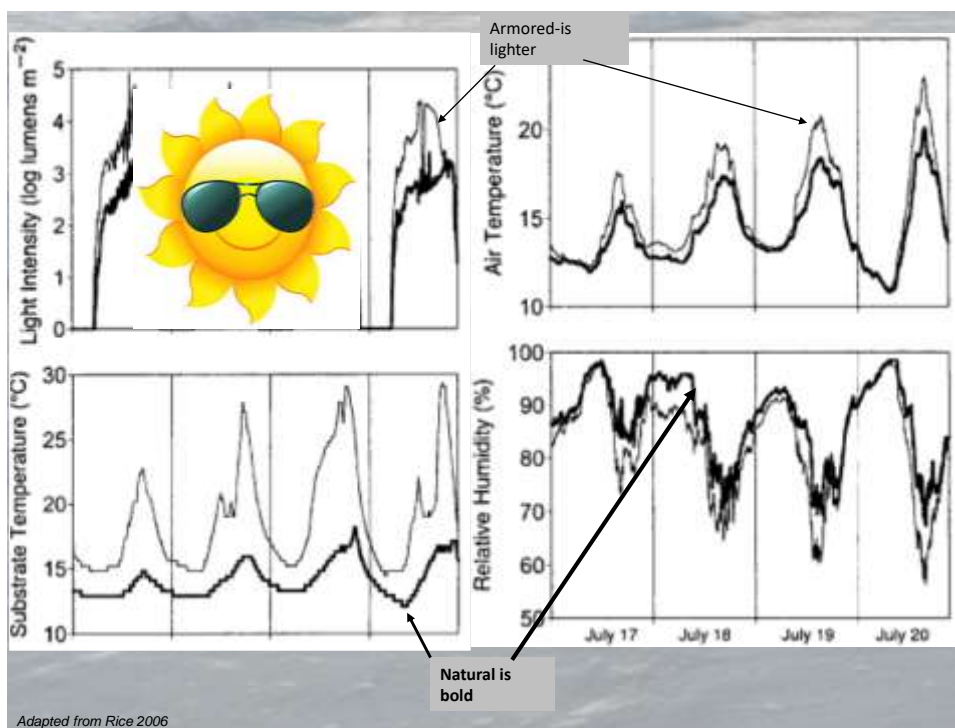
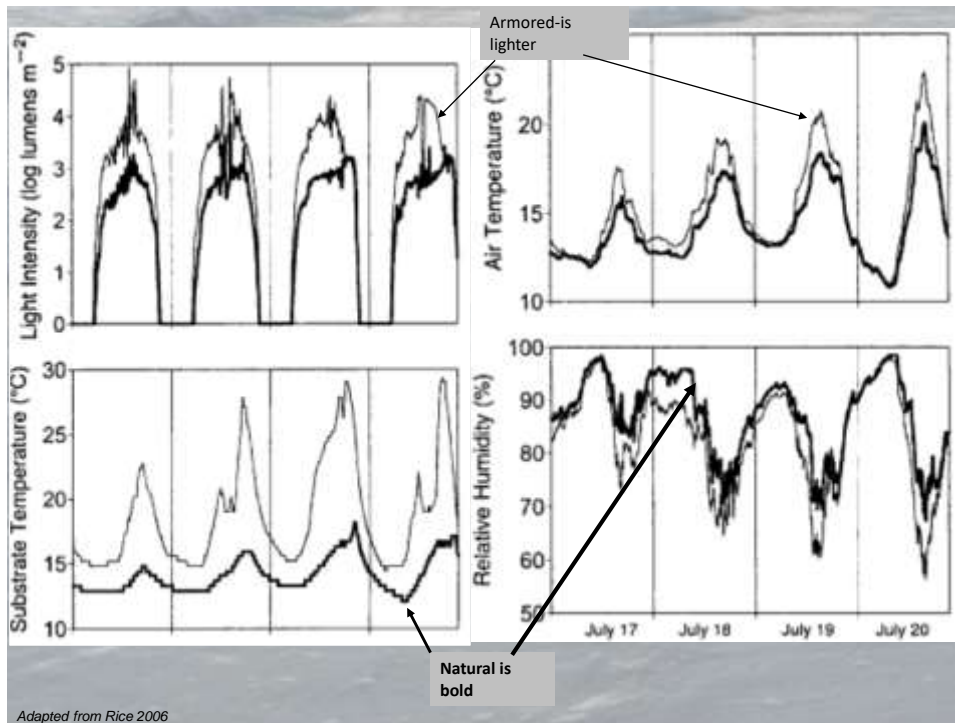


92

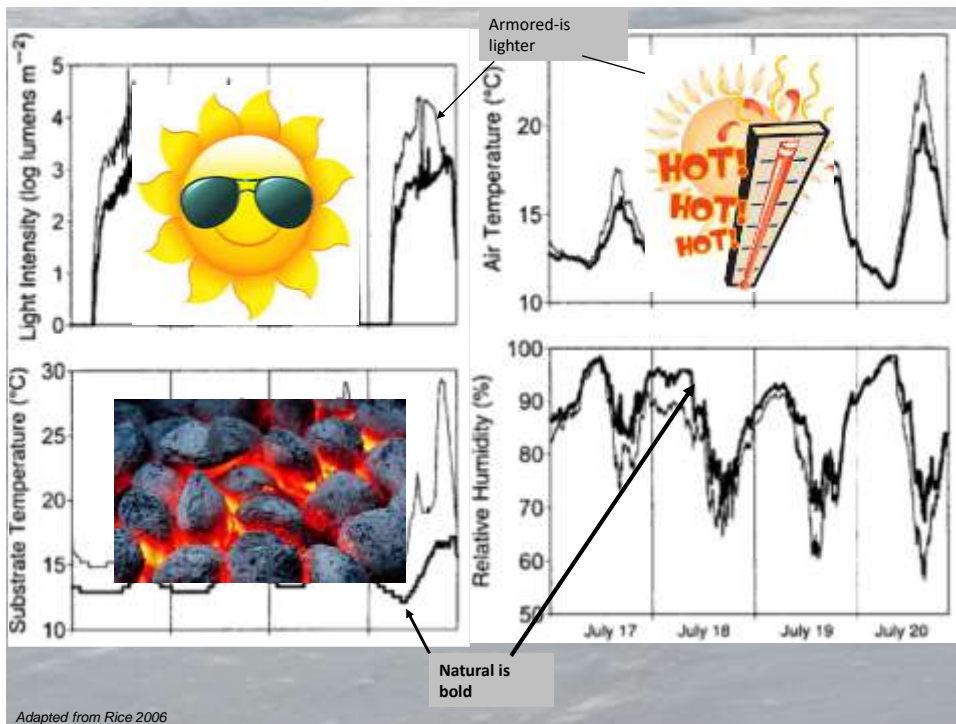
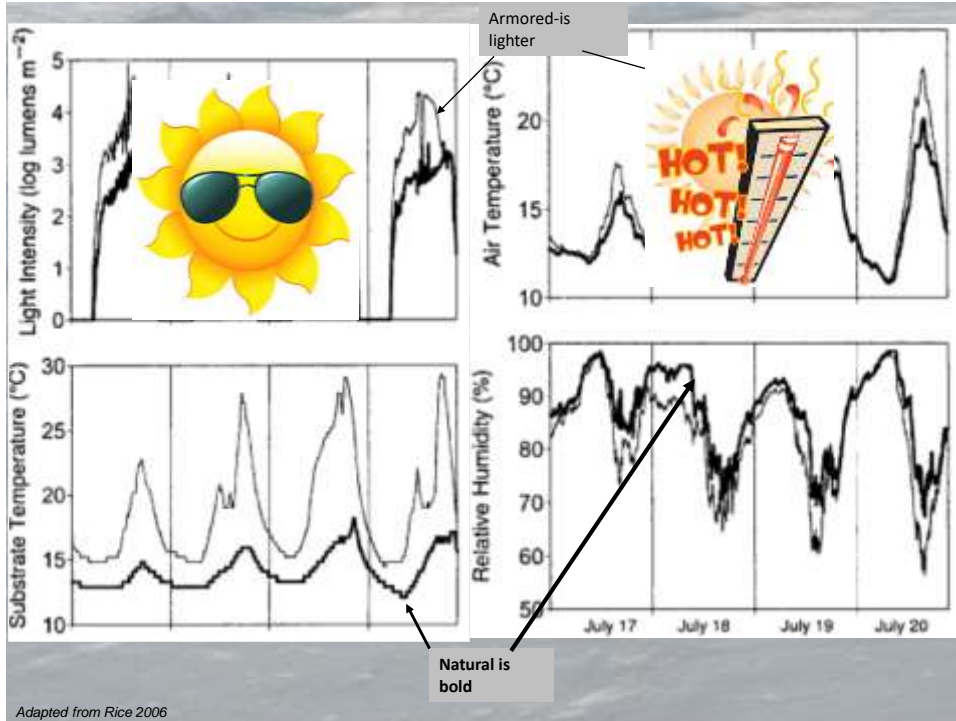
From recent UW Study

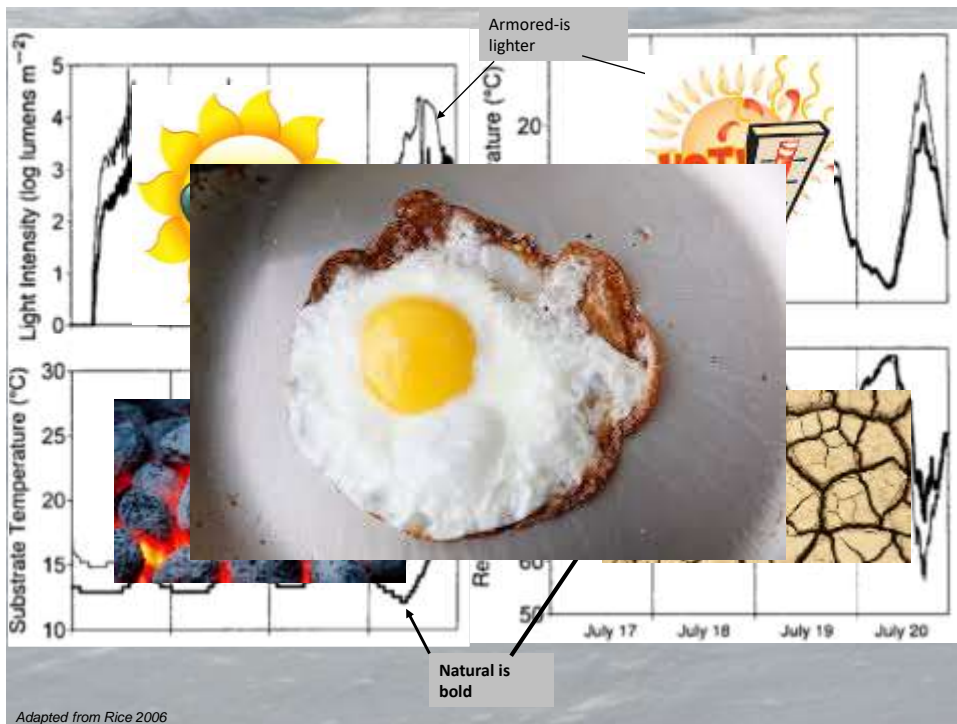
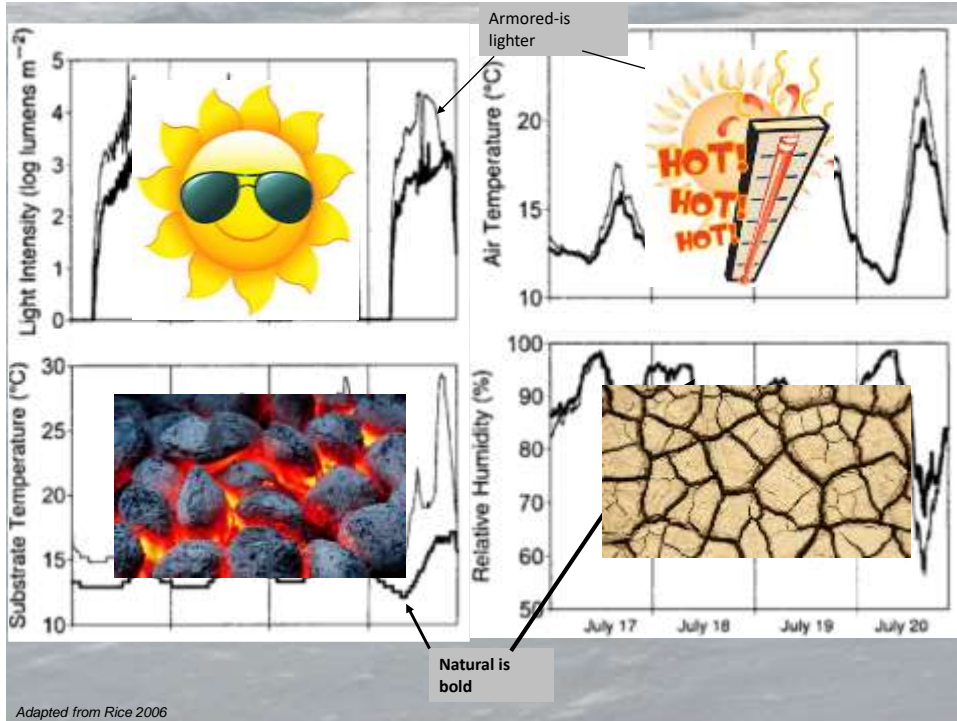


93









# ARE THERE ALTERNATIVES FOR HARD SHORELINE ARMORING?



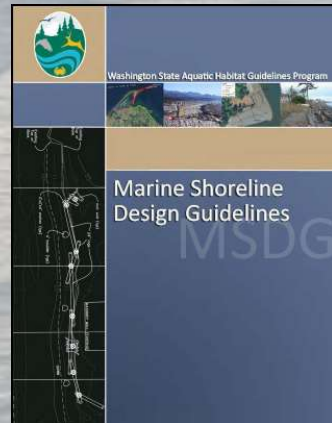


# Marine Shoreline Design Guidelines

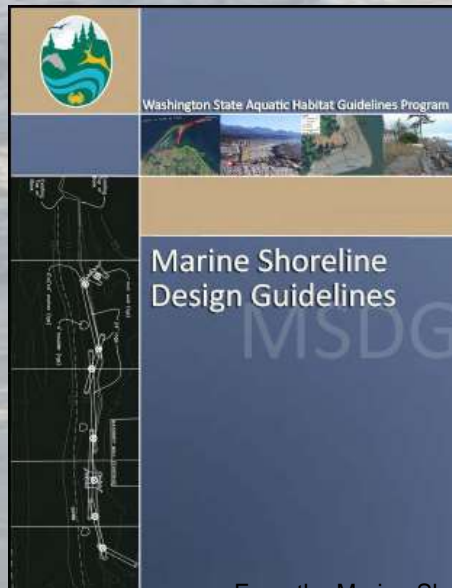
Includes lots of useful info

- Basic Puget Sound Geology
- Site assessment
- Risk assessment
- Coastal Processes Assessment
- Alternatives to bulkheads

User Friendly Version in Back

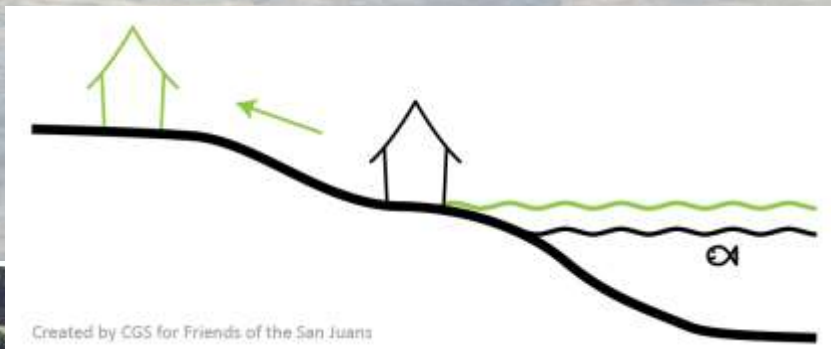


## Bulkhead Alternatives?



From the Marine Shoreline Design Guidelines

## Relocate-back



From the Marine Shoreline Design Guidelines

## Relocate--up



## Wood Placement











## Samish Beach- *before nourishment*





Beach Nourishment with sill  
Seahurst Park, Burien



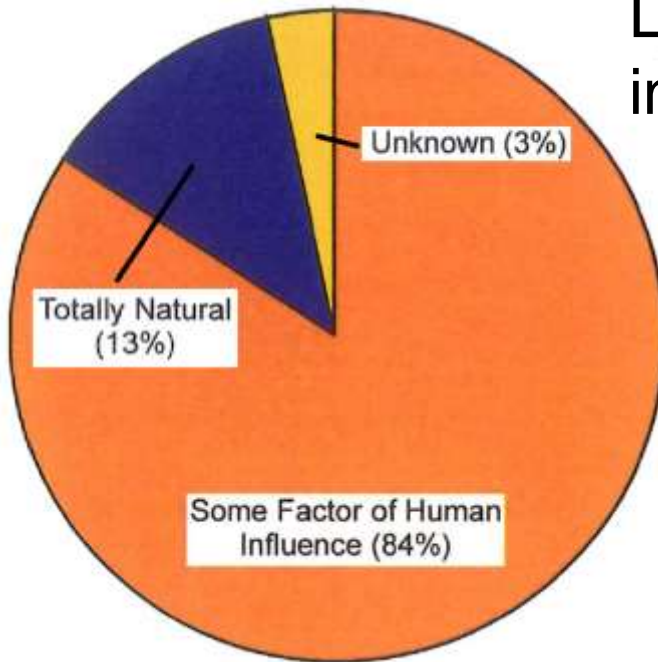
Pocket beach  
Olympic Sculpture Park



# QUESTIONS?



## Landslides in Seattle



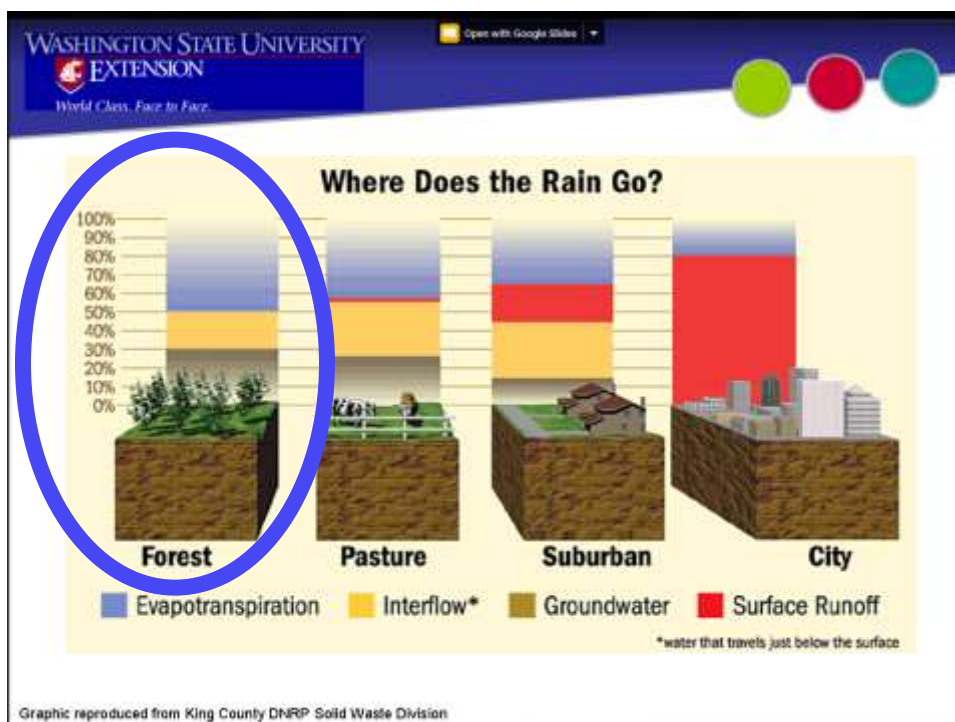
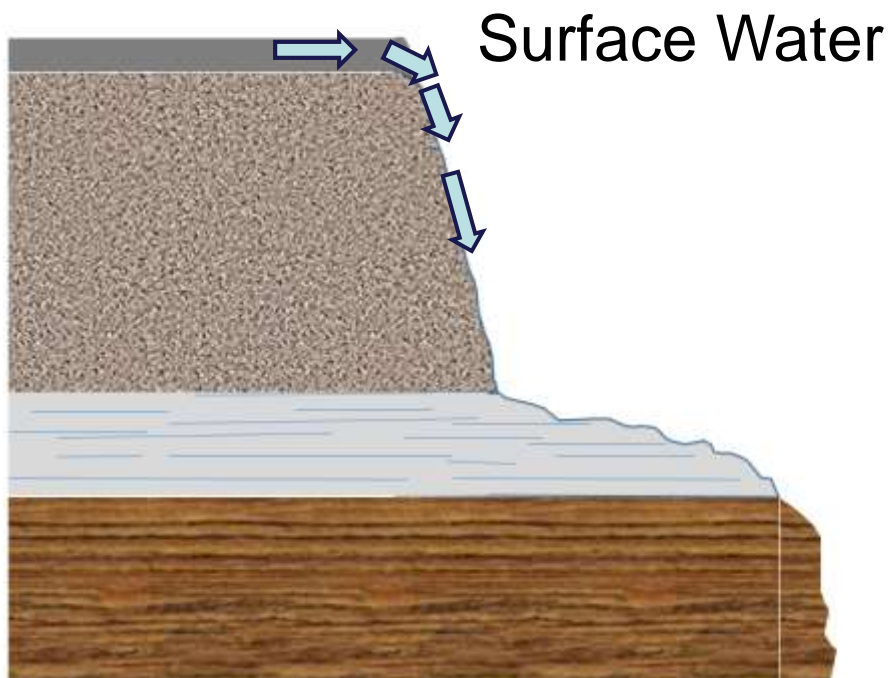
Shannon and Wilson  
Landslide Study for the  
City of Seattle, 2000

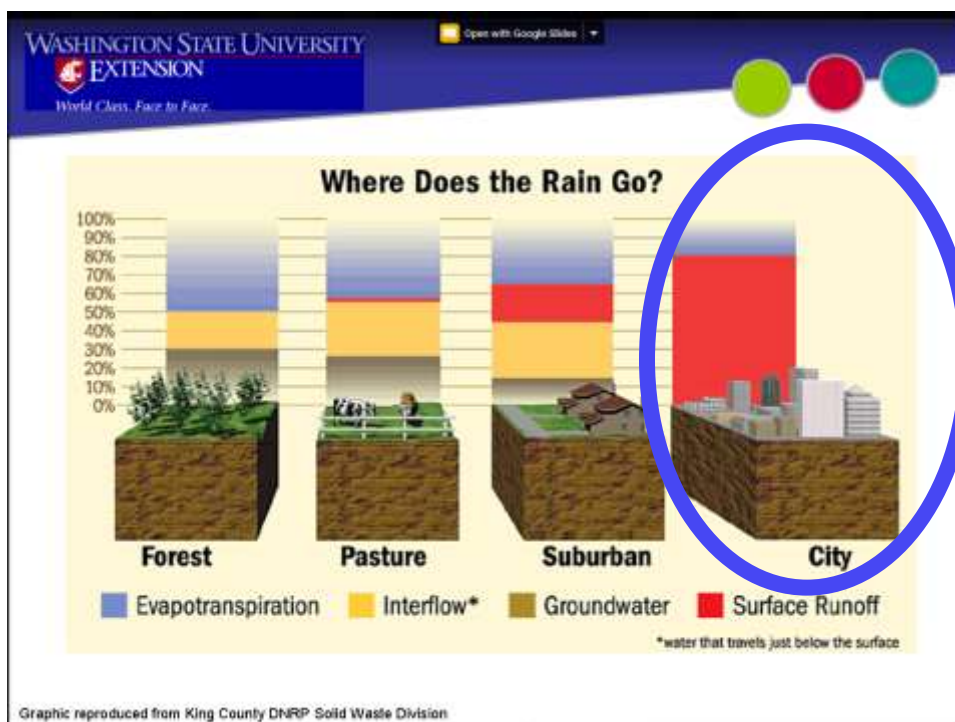
Most common human contributions to landslides:

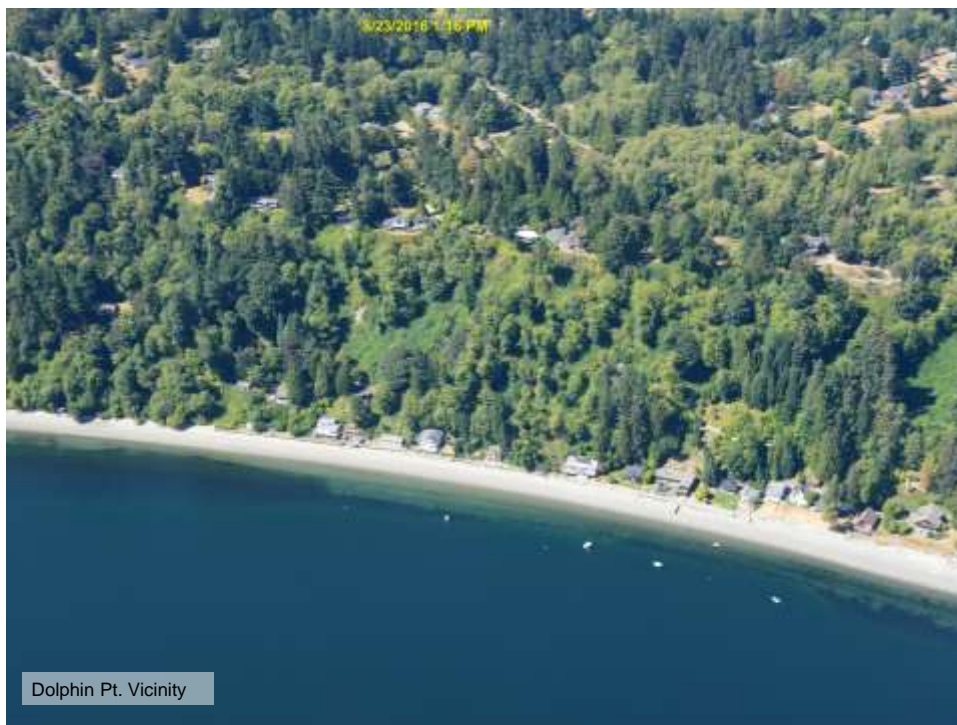
- Inappropriate vegetation management
- Inappropriate water management
- Inappropriate fill/debris placement















**\$73<sup>72</sup>** /roll



4 in. x 100 ft. Corex Drain Pipe





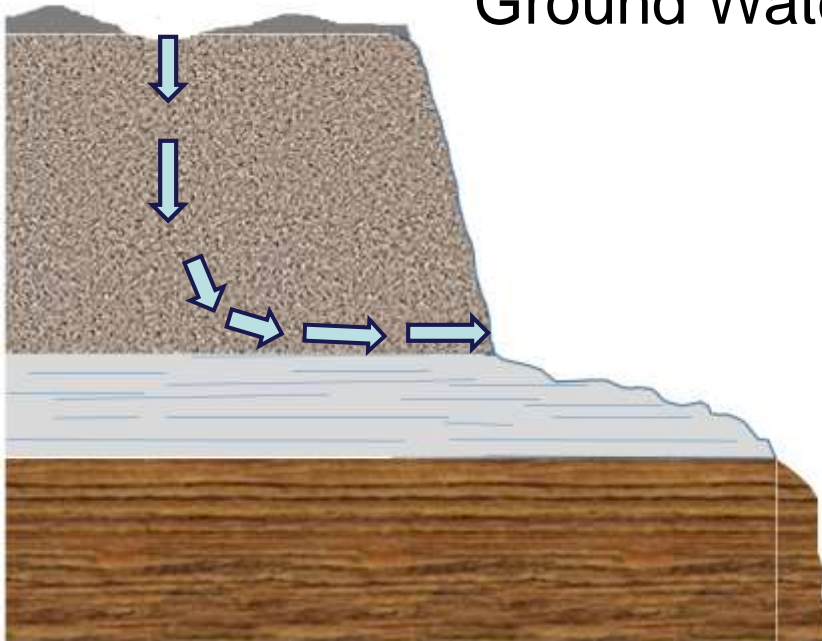








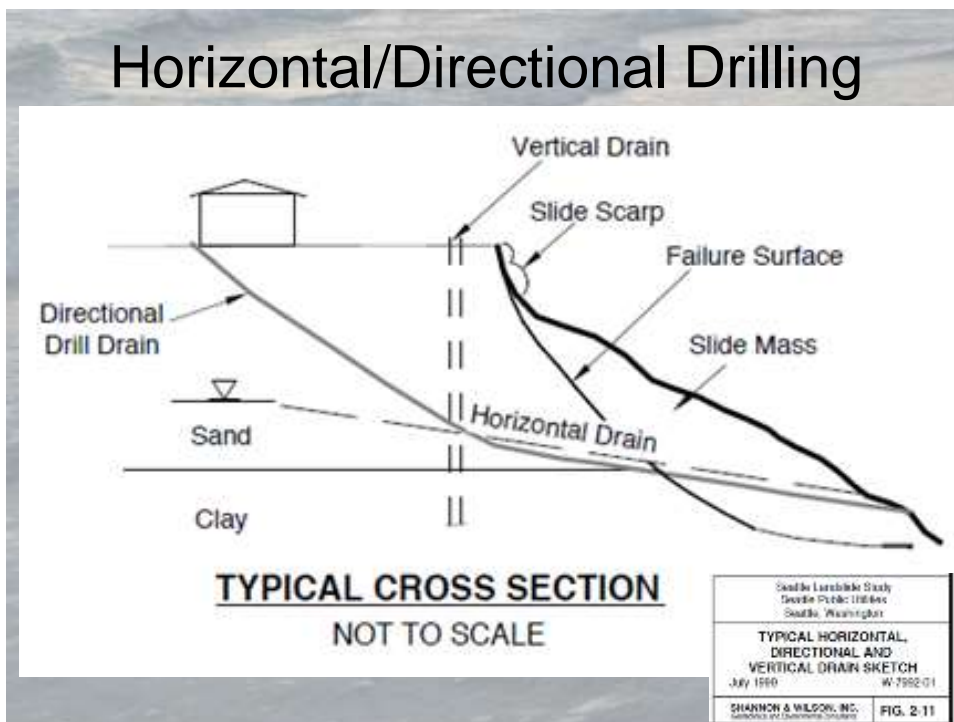
## Ground Water



## Interceptor Trenches



## Horizontal/Directional Drilling





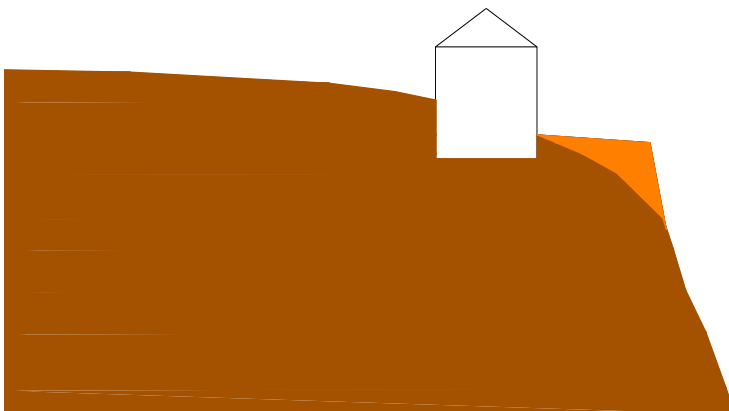
Rain garden, an Element of “Low Impact Development” (LID).  
Photo courtesy WA DOE

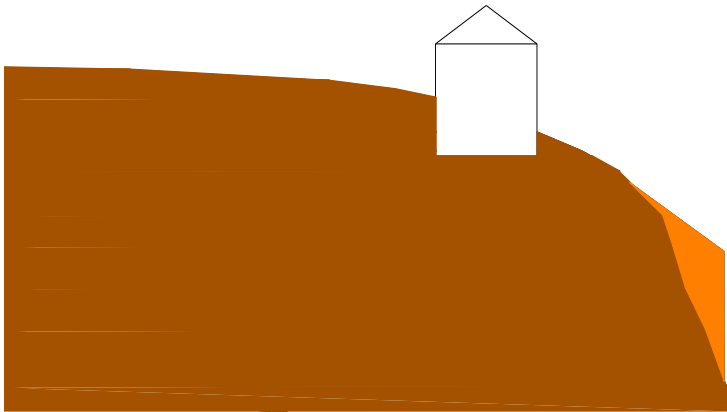




## A FEW WORDS ABOUT FILL AND DEBRIS PLACEMENT

Fill placement on slopes.



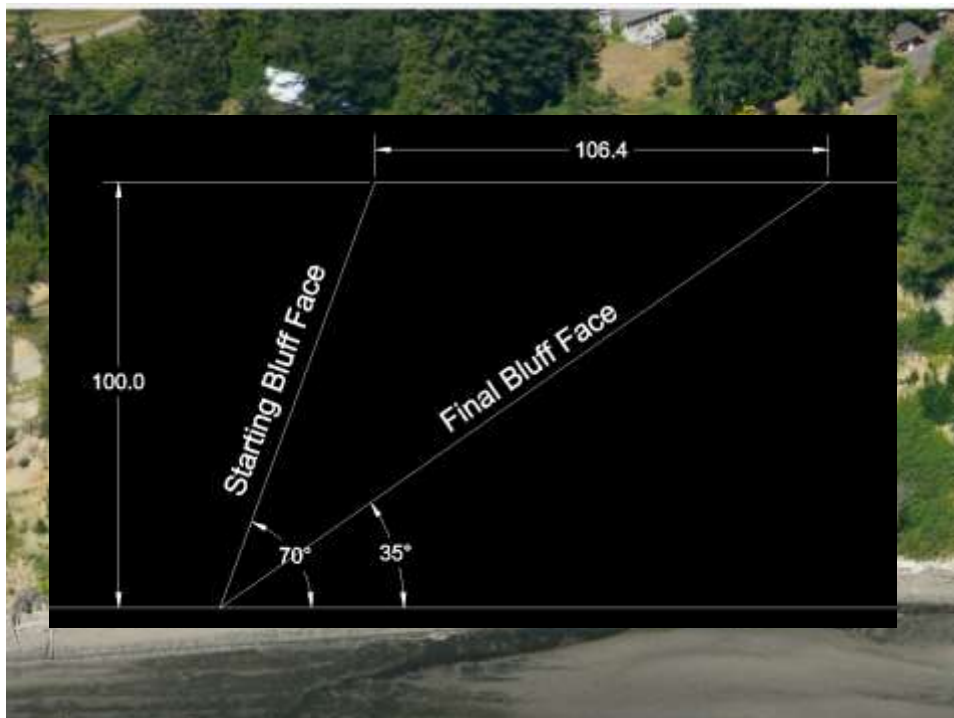
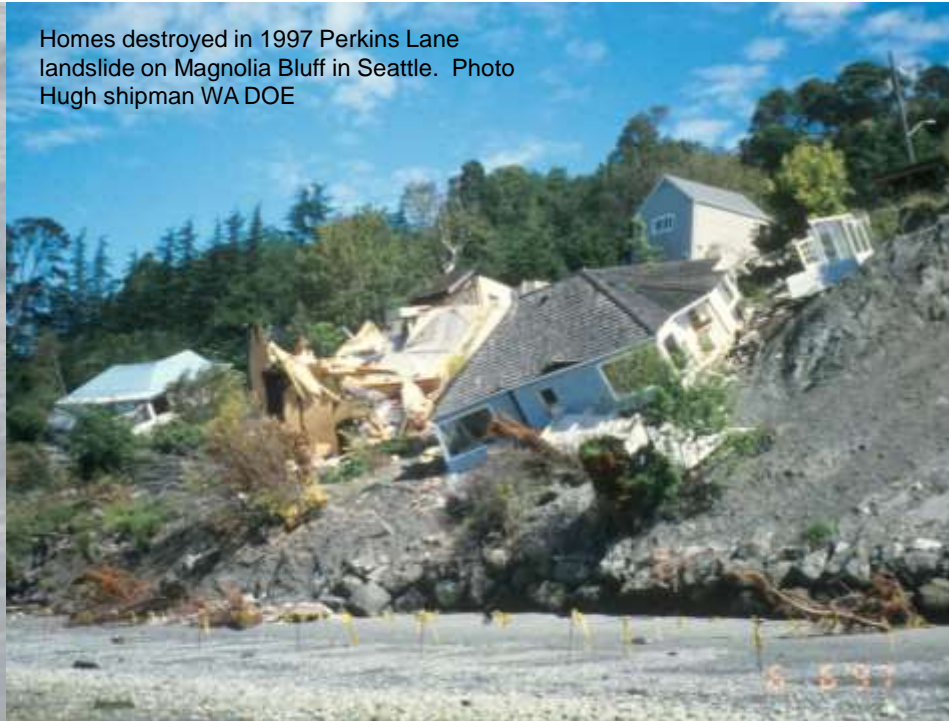




## A FEW WORDS ABOUT BULKHEADS AND SLOPE STABILITY



Homes destroyed in 1997 Perkins Lane landslide on Magnolia Bluff in Seattle. Photo Hugh shipman WA DOE



Great Northern Seawall  
Construction, 1906





## Bluffs and erosion

- Bluffs are inherently unstable
- Humans can reduce or increase that instability:
  - Surface and groundwater
  - Adding fill/debris
  - Shoreline armoring
  - Changes to vegetation