Shoreline Erosion Rates

When geologists speak of coastal erosion rates, they usually mean long-term average rates of shoreline retreat. When property owners speak of coastal erosion rates, they usually mean the amount of bluff that slid during the previous winter. Both of these rates are important, and it is critical to understand the distinction.

Shoreline retreat is the rate at which the toe of the bluff moves landward and must be documented over a long enough period so as not to be influenced by short-term variations. Short-term erosion typically refers to slope failures such as landslides, slumps, or simply the sloughing of a layer of soil and vegetation. In the case of slope failures, it is useful to know the frequency and the maximum extent of such an event.

High rates of bluff retreat occur when:

- Wave energy is high. Long fetches in the direction of predominant winds, coupled with deep water close to shore, allow large waves to develop and to reach the toe of the bluff. Energetic waves can break apart rocks more easily and can rapidly remove eroded material from the base of the bluff, exposing fresh material.
- Bluff materials are weak. Many factors affect the resistance of rock to erosion, including rock type, fractures, and groundwater saturation. The glacial sediments typical of Puget Sound bluffs may erode several inches per year, whereas massive bedrock such as that in the San Juans may erode only a faction of an inch per year.
- Beaches are narrow. Beaches provide excellent natural protection, dissipating wave energy over a broad area and limiting the frequency with which waves actually reach the base of the bluff.

These three conditions are most often met on classic feeder bluffs such as Birch Point in Whatcom County, Scatchett Head on south Whidbey Island, and Green Point south of Gig Harbor. As one moves downdrift within a coastal drift sector, beaches generally become wider, and erosion rates may diminish.

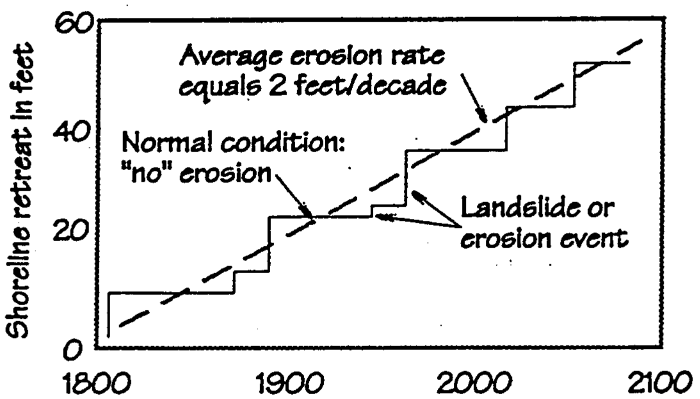

Figure 1. Long term erosion rates are an average of many landslide or erosion events over a period of decades to centuries.

Ralph Keuler, with the U.S. Geological Survey, measured long-term shoreline erosion in much of northern Puget Sound. The fastest rates are over 1 foot per year at Point Partridge on the exposed west side of Whidbey Island, but this rate is unusually high for Puget Sound. Even on exposed feeder bluffs such as Forbes Point near Oak Harbor, the north end of Marrowstone Island, or Yellow Bluff on Guemes Island, retreat rates are in the 4- to 8-inch per year range. On less exposed shorelines, the erosion rates are often much less than 4 inches per year.

Coastal erosion is highly episodic. Long periods during which erosion is negligible are interrupted by short, impressive slumps and landslides. These slope failures are triggered by saturated soils, tree blowdown, or the combination of storm waves and high tides. Although these events may cause the top of the bank to retreat several feet, and may appear even worse since they strip away mature vegetation, the long-term rate at the location may still be very slow. It may be many decades before that portion of the bank slides again.

Shoreline property owners often accelerate erosion rates by weakening the bluff or causing the beach to diminish. The former is easily done by clearing upland vegetation and changing bluff hydrology by misdirecting storm runoff or placing sewage drain fields too close to the bluff.

The latter is best done by armoring the shoreline updrift, effectively starving the beach of needed sediment.

There is a tendency around Puget Sound to exaggerate the rate of long-term shoreline erosion, yet ignore the potential for short-term bluff failure. When developing near marine bluffs, we need to recognize that both slope stability and chronic shoreline erosion affect the safety of the property but that, if the geology of the site is known and the structure is adequately set back, problems will be unlikely.

–Hugh Shipman (1993)

Table 3-1
Shoreline Armoring Impact Categories

IMPACTS TO PHYSICAL PROCESSES

1. Direct Impacts
   a. Temporary Construction Impacts
   b. Permanent Impacts
      - Placement of Structures/Loss of Beach Area
      - Impoundment (Loss) of Sediment Source Behind Structures
2. Indirect Permanent Impacts
   a. Downdrift Impacts from Sediment Impoundment
   b. Modifications of Groundwater Regime
   c. Hydraulic Impacts from Armoring
      - Increased Energy Seaward of Armoring
      - Reflected Wave Energy From Other Structures
      - Dry Beach Narrowing/End Wall Effects
      - Substrate Winnowing/Coarsening
      - Beach Profile Lowering/Steepening
      - Potential "During Storm" Impacts
      - Sediment Storage Capacity Changes
      - Loss of Organic Debris (inc. LOD)
      - Downdrift Impacts of the Above
3. Cumulative Impacts
   a. Incremental Increases in All Impacts
   b. Impacts to Single Drift Sectors
      - Downdrift Sediment Starvation
   c. Potential Threshold Effects

IMPACT LINKS TO BIOLOGICAL PROCESSES

1. Direct Impacts
   a. Temporary Construction Impacts
   b. Permanent Impacts
      - Habitat (Substrate) Burial or Removal
      - Change Vegetative Cover/Organic Inputs
2. Indirect Permanent Impacts
   a. Modification of Groundwater Regime
   b. Changes to Shoreline Environment Due to Hydraulic Impacts
      - Loss Spawning/Foraging/Rearing Habitat for Fish
      - Loss Migratory Corridor for Fish
      - Substrate Changes Reflected in Benthos
      - Effects on Shellfish
3. Cumulative Impacts
   a. Incremental Increases in All Impacts
   b. Potential Threshold Effects

Macdonald, Keith, David Simpson, Bradley Paulsen, Jack Cox, and Jane Gendron. 1994. *Shoreline Armoring Effects on Physical Coastal Processes in Puget Sound, Washington. Coastal Erosion Management Studies Volume 5.* Shorelands and Water Resources Program, Washington Department of Ecology, Olympia. * DOE - REPORT 94-78 *