Five Years in the Life of Kala Point's Retreating Bluffs

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Puget Sound and its bluffs form one of the most geologically active regions in the world. That is what makes them intriguing to a long-time geologist like me. James Hutton, an 18th century founding scientist of geology, as he looked out over the Scottish lowlands, realized that cycles of accumulation and erosion had shaped the vistas around him, but that landscape changed very little from year to year. Whatever forces were affecting it, must be very slow and geological time very long. Seeing geology at work would require a lifespan far beyond that of a human.

Our local bluffs are an exception to this generalization. Because of the setting, action is greatly accelerated and you can see them changing over years to decades rather than centuries to millennia. This led me to start a systematic recording of the bluffs from Kala Point to Fort Townsend State Park, which I have been doing for 5 years now. The results are maps, photos and videos showing geological dynamics at work. For me, it is part of an effort to predict how the bluffs will respond to the

likely 3+ feet rise in sea-level that will happen in this century due to global warming.

The fate of the bluffs rests with the wind and the waves, and the effect of these depends on what the bluff is made of. The waves are the primary eroding agent, chewing at the foot of the bluff, undercutting them and increasing their angle, thus heightening erosion as gravity draws everything downward. The tides play a role since the reach of the waves on the bluff depends on sea-level. How powerful those waves are depends on the strength and direction of the wind when tides are high.

The geology of the bluffs dictates how resistant they are. Along the shore from Kala Point to Fort Townsend State Park, the bluff is constructed of four layers with quite different mechanical properties. These layers are variable in thickness and rise gently in altitude towards the north. The lowest (and oldest) unit is a well sorted, easily eroded, sandstone. It is subsurface at Kala Point and appears at beach level about where Baycliff Dr. points out to the bay. Above the sandstone there is a more consolidated siltstone which resists erosion better, making for a noticeable vertical face on the lower bluff as you walk north along the beach from Kala Point. Over this there is a thick unit of loosely consolidated pebbly sand which thins as you go towards the Park. The unit face has an angled surface which is vegetated unless it is scarred and erosion is cutting into it. Maintenance of the slope clearly depends on the plant cover. Finally, the top layer on the bluff, seen towards the Park end of the beach line, is a glacial deposit called Till. This is an admixture of all particles from mud to boulders and is moderately well cemented, so it resists erosion and makes up a vertical face on the bluff.

The variable layering from south to north means that the bluff response to erosion changes along the beach line. All the layers are impacted by wave and wind action, but the bottom and middle sandstone units are particularly vulnerable. The units are important because the lower one makes up the foot of the bluff along most of the beach line, and the upper one makes up the bulk of the bluff face until superseded by the Till within Ft. Townsend State Park.

To see how the bluffs respond to wind and waves I have made bi-weekly to monthly photos of set locations along the coast line for more than 5 years now. Additionally, I have mapped the bluffs and recorded bluff changes using the maps and GPS locating. To go with this, I have compiled a continuous five+ year record of the local tide and winds (strength and direction). The results have shown me how bluff retreat proceeds and documented that the extent of active erosion on the bluff line has increased significantly over the past half decade.

The main way erosion proceeds on the bluff is through the opening of scars, mostly created by tree uprootings, and mostly in the layer 3 pebbly sandstone, the unit sitting on top of the distinctive siltstone (unit 2). The scar allows gravity to get

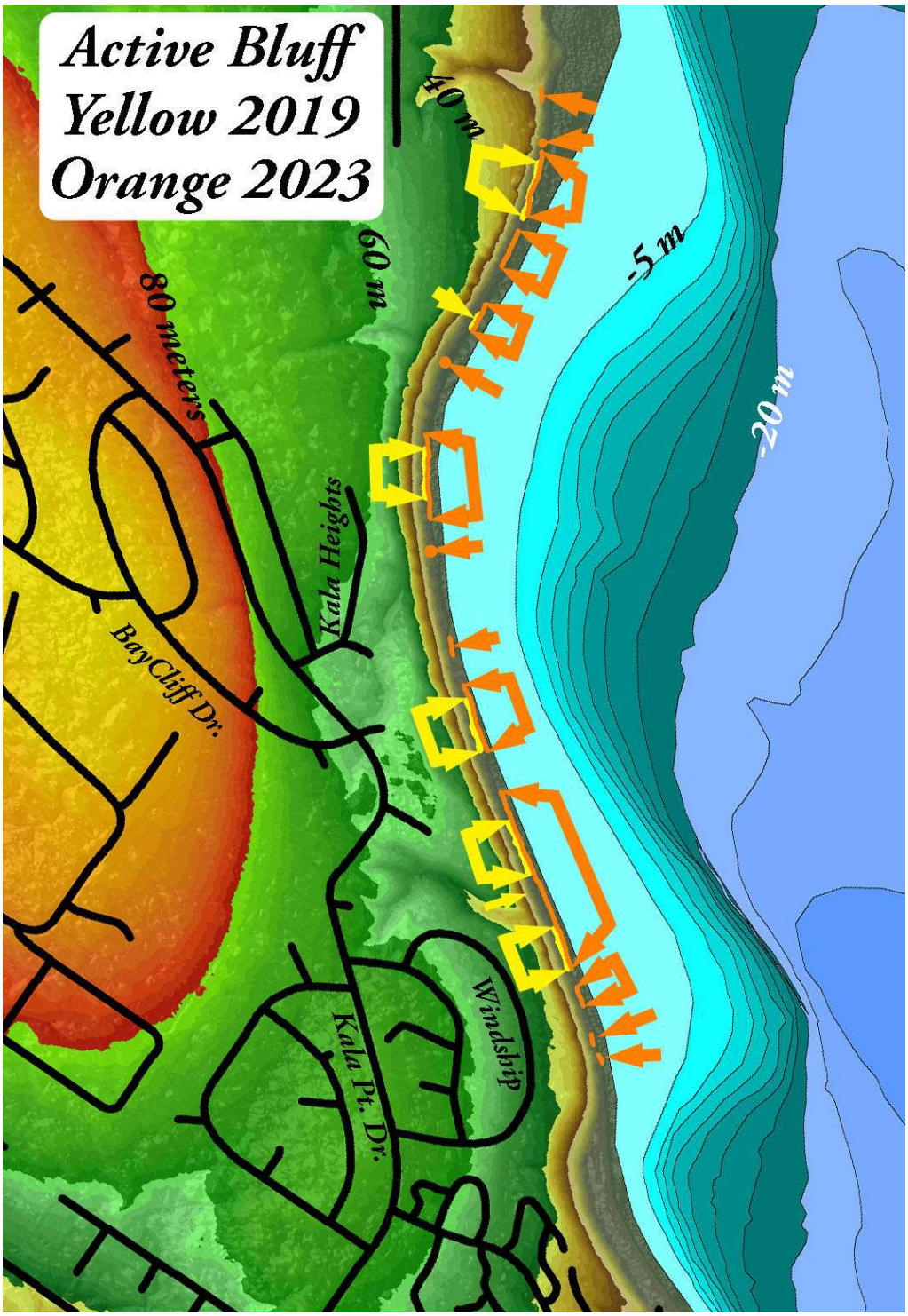
to work moving sediment downhill. The scars develop laterally fairly quickly and also excavate into the bluff side, making a scoop-like feature whose top rim is decorated by the hanging roots of trees upslope. As excavation continues, that rim is undercut and eventually trees topple over. So, active erosion on the bluff proceeds through side-ways growth of scars, merging over time, and also gradually expanding upslope through progressive undercutting.

Tree fall scaring and erosion excavation into the bluff face made of glacial sandstone. Sediment moving downhill bordered by colt's foot, horsetail and alders trying to hold place.

The most influential tree falls appear to be Douglas firs (seem to have a wide, shallow root system) and stands of alders. But, plants try to hold the bluff in place as well as serving as agents for its demolition. Almost any exposed surface in summer is rapidly invaded by coltsfoot, horsetail, blackberry and elderberry; the first two able to manage even moving surfaces. In addition, alders appear rapidly and seem able to root into the bluff, even at beach level where they have some superpower enabling them to avoid salt water poisoning. All of this pioneer vegetation attempts to keep the bluff unchanged, but observation shows that the plants are fighting the long defeat. Ultimately, territory is lost. You can see this in

two timelapse videos of the bluff opposite Windship and Nantucket drives which you can access at: https://tinyurl.com/KPbluffWindship and https://tinyurl.com/KPbluffNantucket.

An alder stand losing grip on the bluff opposite the north end of Kala Heights Dr.



Elevation map of the Kala Point area. Elevation is presented in color bands of 20 meter intervals with shades of color in the bands representing 2 meter intervals. Offshore depths in shades of blue.

Sections of the bluff with active erosion are compared for 2018 vs. 2023.

Over the five-plus years I have recorded the bluff line from Kala Point to the Fort Townsend State Park landing, I have observed the extent of active bluff erosion has increased significantly. I define an active erosion area as bluff face which is obviously shedding sediment with a clear path for that material to the beach. The beach is important to the process in that it accumulates bluff debris and there wave action clears that debris away, making room for more.

Mapping the extent of active erosion shows that it has increased by the progressive lateral expansion of existing scars on the bluff, and the development of new ones at a number of locations. There are probably multiple reasons for the increase in bluff activity, but one that I notice is that the bluff is retreating into a steep slope. This slope is the forested remains of a previous bluff which formed when sea-level was relatively higher

in the past during a time of landscape adjustment following the disappearance of the last glacial ice sheet. As the modern bluff cuts into its forebearer, the bluff rim rises in elevation and the bluff face steepens, promoting more instability and erosion.

Bluff erosion will be accelerated by rising sea-level, and maybe by changes in seasonal wind strength and direction as global climate warms. Over the past 5 years impacts on the bluff have been greatest from mid-December to April, as plant life recedes and wind storms from the South engender waves which batter the bluff base. When the storms coincide with high tides, the evidence of their action is immediately obvious. You can see the seasonal cycle in the videos referred to above.

In the long run, decades, bluff retreat will be energized by sea-level rise and the ever steepening face created as erosion cuts into the steep slope in which the bluff is set. Ultimately, gravity wins out in its relentless efforts to flatten the world, that is until the next ice age or tectonic upheaval resets the land surface once again.