Sediment Accretion and Sea Level Rise Assessment for Sitka Sedge SNA Dike Scenarios

Erin Peck (Oregon state University) and Noel Bacheller (Oregon Parks and Recreation Department)

November 6, 2019

There is no currently-available local sediment accretion and sea level rise data available for the Sitka Sedge planning area; however, the Netarts estuary appears to be a suitable analog in terms of sea level rise, watershed size, freshwater inputs, and sediment inputs. Sediment accretion rates and relative sea level rise have been well characterized for the Netarts estuary in Erin Peck's research. While sediment cores from Whalen Island are available to improve understanding of the Sand Lake estuary, the cores have not yet been analyzed. OSU and OPRD are investigating options for funding and completing the analysis of sediment accretion rates from these cores. If funding can be found, analysis could take several months. In the absence of the data from these cores, it is still possible to make general speculations about sediment and sea level rise resilience for each of the dike scenarios under consideration using the Netarts estuary as a model. Because of the differences between the estuaries, these speculations are qualitative rather than quantitative, but should provide a useful basis for general comparison of sediment and sea level rise characteristics of each alternative relative to the to the others. If the Whalen island cores are analyzed, it will be possible to compare and contrast the alternatives in more quantitative terms.

Erin's research indicates that sediment accretion rates in Netarts Bay are keeping up with sea level rise. Based on analysis of the simultaneous uplift of the shoreline from tectonic action and sea level rise, Netarts Bay is experiencing a net sea level rise of 1.5mm per year. This is the rate of increase of the elevation of the ocean surface in relationship to the land surface. Sediment accumulation can, in some cases, build up the surface of the land at a pace that keeps up with the rise in ocean levels. This is the case at Netarts Bay based on the sediment accretion rates measures from the sediment cores taken in the marsh at the southern end of the bay. Sediment accretion in some other estuaries in Oregon is not keeping up – which results in "drowned" marshes in which the land surface becomes deeper and deeper underwater each year until marsh vegetation is no longer possible and the surface becomes mud flats or aquatic beds. Based on the location of Sand Lake, the similarity in freshwater inputs, the localized rate of tectonic uplift, predictions of sedimentation rates from the SPARROW model, and the similarity of the tide elevations, the elevation of Sand Lake's marsh surfaces are probably mostly keeping up with sea level rise as they are at Netarts. It should be noted that this sediment accretion matching of sea level rise is measured for the marsh, not upland or dune environments. Upland areas may not build up soils quickly enough to remain uplands. Marshes will presumably colonize formerly upland low areas as sea levels rise until tide water reaches terrain that rises steeply.

Each of the alternatives being discussed for the Sitka Sedge property is described below in terms of general sediment and sea level rise effects with a short statement of comparison to the other alternatives:

<u>Existing condition</u>

The existing dike and tide gate allow substantial tidal influx because of the broken tide gate flap. This influx may be allowing sediment deposition in Beltz Marsh, but there is some question about this

because of the sediment dynamics around constrictions in flow. Flow constrictions can cause sediment to drop out of suspension without penetrating deeply into the marsh.

Some sediment in Beltz Marsh is provided by Beltz Creek, Reneke Creek, No-Name Creek and various ditches and overland flow, but these sediment sources are likely less important than sediment from the estuary outside the dike, which is sourced from mixed larger flows around the estuary. Pooling of freshwater behind the existing dike and tide gate is unlikely to supply sufficient sediment to keep up with sea level rise. Compared to the other alternatives, the existing dike and tide gate probably provides more sediment than the modern tide gate scenario, and less than the breach or setback dike (in the area north of the setback dike). Limited periods of inundation during average tidal conditions will likely result in continued subsidence as organic peaty soils decay (since peaty soils require prolonged low-oxygen inundation to prevent rotting away). Sea level rise will eventually overtop the existing dike and result in sediment accretion similar to a breach.

Until dike is overtopped by sea level rise:

- More sediment accretion than modern tide gates
- Less sediment accretion than breach or setback dike (north of setback dike)
- Unlikely to keep up with sea level rise
- Subsidence probably lesser than modern tide gates but more than breach scenario.
- Storage basin capacity will likely persist

<u>Modern Tide Gates</u>

Modern tide gates are predicted to barely overtop the banks of current mudflats/tidal channels with either a 7-foot or 8-foot elevation closure point. Marsh areas receive the shortest period of inundation with estuary water under this alternative, and will therefore result in the least amount of sediment accumulation from estuary sources. Freshwater sources are largely confined to current channels and mudflat. The constriction at the tide gates may cause sediment to drop out without penetrating the marsh behind the dike. Compared to the other alternatives, modern tide gates are the most likely to result in a drowned marsh system with significant sea level rise (once the existing dike is overtopped). Since this alternative has the shortest period of inundation, it is the most likely to result in decomposition of organic/peaty soils and subsidence of the land surface. Over time and with significant sea level rise, current marsh habitats will shift downward and may drown. The amount of sea level rise it would take to drown the marsh, however, would overtop the dike and make the structure obsolete and ineffective. Once the dike is overtopped on a regular basis it will function more like a breach, and sedimentation rates will begin to match the breach scenario.

Up until dike is overtopped by sea level rise:

- Lowest sediment accretion
- Highest subsidence
- Storage basin capacity during tide gate closure will likely persist because of low sediment accretion and subsidence

After overtopping:

- Similar to breach

40’ bottom-width Breach

A limited-width breach would result in relatively stable sediment inputs over the long term and would likely result in sediment accretion rates that keep up with sea level rise, at least at the current rate of relative sea level rise. There is some question as to whether the 40’ wide breach would result in enough constriction to cause sediment to drop out of suspension and penetrate less deeply in to the marsh behind the dike. Over time, the land surface of the marsh would rise and provide for the persistence of marsh habitat unless an accelerating rate of relative sea level rise outpaces the accretion rate. There are numerous feedback cycles that may allow sediment accretion to match even accelerated rates of relative sea level rise, but this is currently uncertain. There would be no subsidence due to both frequent inundation preventing the decay of peat soils and because of the sediment accretion. The marsh boundary would expand into low lying areas as sea level rises, but could erode at the north edge as sea levels rise. Compared to the existing dike/tide gate and the modern tide gates scenario, this alternative is the most likely to keep up with sea level rise. It would result in earlier marsh migration into low lying areas (both immediately after breach due to unrestricted tide, and also as sea level rises); however, upon overtopping of the existing dike, marsh migration and marsh extent would be the same in all alternatives that make use of the existing dike. Compared with the setback dike alternative, the simple breach would function essentially the same in terms of sediment accretion north of the setback dike, but very differently in the area behind the setback dike as described below in the description of the effects for that option. Difference in sediment accretion in the areas north of the setback dike could occur depending on the specifics of breach sizing within the existing dike. If both had the same breach size, both would have very similar sediment accretion characteristics.

Setback Dike

Since the setback dike involves at least a breach of the existing dike, it would result in very similar results to the simple breach north of the setback dike… sediment accretion rates would be expected to keep up with sea level rise and provide for the persistence of the marsh habitat, at least at the current rate of relative sea level rise. The difference between this alternative and the simple breach is in the area behind the setback dike. Because the setback dike would include a modern tide gate, it would be expected to function similarly to the modern tide gate alternative in the area behind the setback dike. The area behind the setback dike would therefore be expected to accrete little sediment and would presumably not keep up with sea level rise. Subsidence would also be a likely consequence. Depending on the elevation of the setback dike, it might or might not be overtopped by sea level rise. If not overtopped, the area behind the setback dike would presumably continue to subside for a period of time. The marsh boundary south of the setback dike would not expand unless freshwater inputs were to increase.