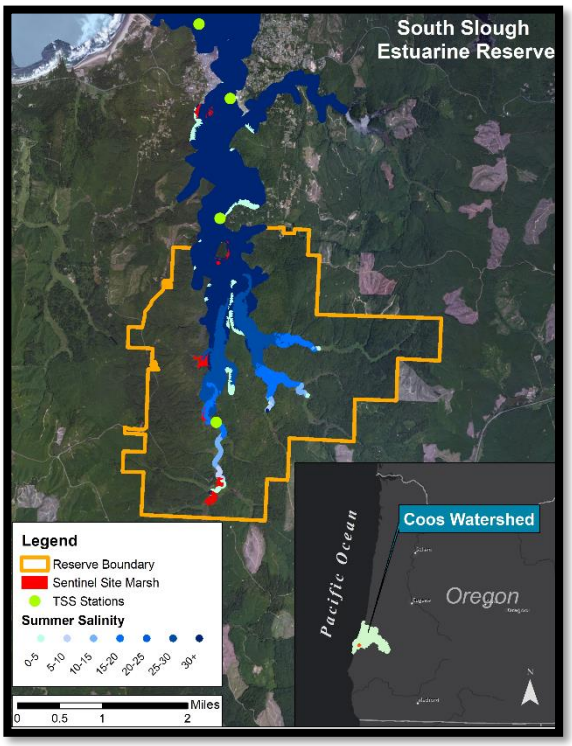
Sentinel Site Story

Welcome to South Slough



This is South Slough National Estuarine Research Reserve in Charleston, Oregon. It's one of 29 **estuary** reserves around the country, which use science and research to inform people and decision-makers about estuaries. One focus of the scientists at South Slough is monitoring marshes. To keep track of changes, there are Sentinel Sites set up in the reserve which are sampled every few years.

What's a marsh?

Marshes are areas of land that are periodically covered in water, where herbaceous plants (like grasses and flowers) grow. Marsh communities provide valuable ecosystem services:

- Filtering toxins out of water which runs off into the ocean
- Absorbing water like a sponge to prevent flooding
- **Sequestering carbon**
- Providing habitat for economically important species like juvenile Dungeness crab and salmon

Estuary: An aquatic system where a river flows into the sea, and freshwater mixes with saltwater.

Carbon sequestration: The process by which carbon is taken out of the carbon cycle and stored for a long period of time. In marshes, CO_2 is taken from the atmosphere by plants for photosynthesis. When they die they decompose very slowly because of the wet soil, so carbon is retained.

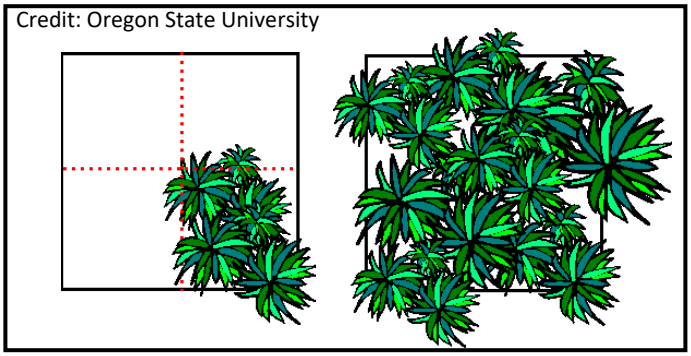
Valino Island marsh, located in South Slough Reserve.

Currently, climate change and sea level rise are threatening marshes around the world. As global temperatures rise, the water in the ocean expands, and melting ice adds water to the ocean. This is causing average water levels to increase around the world. The current rate of sea level rise in Charleston is 1.12 mm/year. In the future this is expected to drown some marshes, which will be underwater so often that plants can no longer grow. Other marshes could migrate inland or grow in elevation and keep up with sea level rise. The science team at South Slough monitors marshes to track changes related to these processes. Let's look at two of the things they measure: plant diversity, and marsh elevation.

Plant Diversity

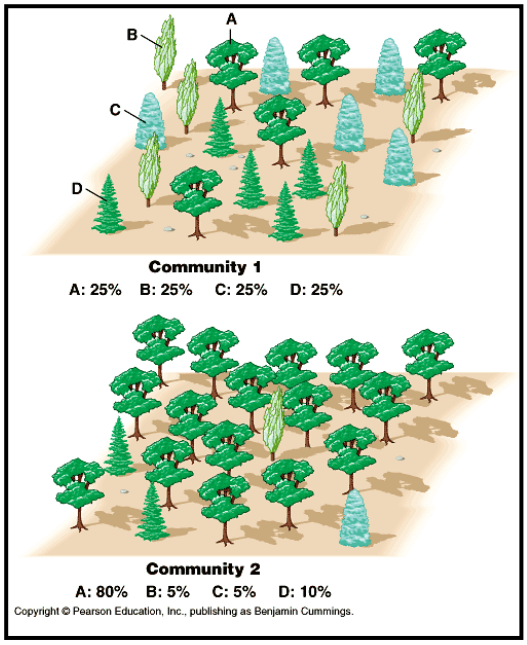
The South Slough marshes are on a salinity gradient, meaning that some are in very salty water, while others are freshwater or even somewhere in between (brackish water). Metcalf Marsh is closest to the ocean, making it very salty; Hidden Creek is considered brackish. Both of these are Sentinel Sites.

When they study these sites, researchers identify all of the plant species they find in a 1m x 1m plot, as well as the **percent cover** of each species.



Percent cover *is the area in a plot covered by a plant species. The plot on the left has ~ 25% cover; the right plot has ~95%.*

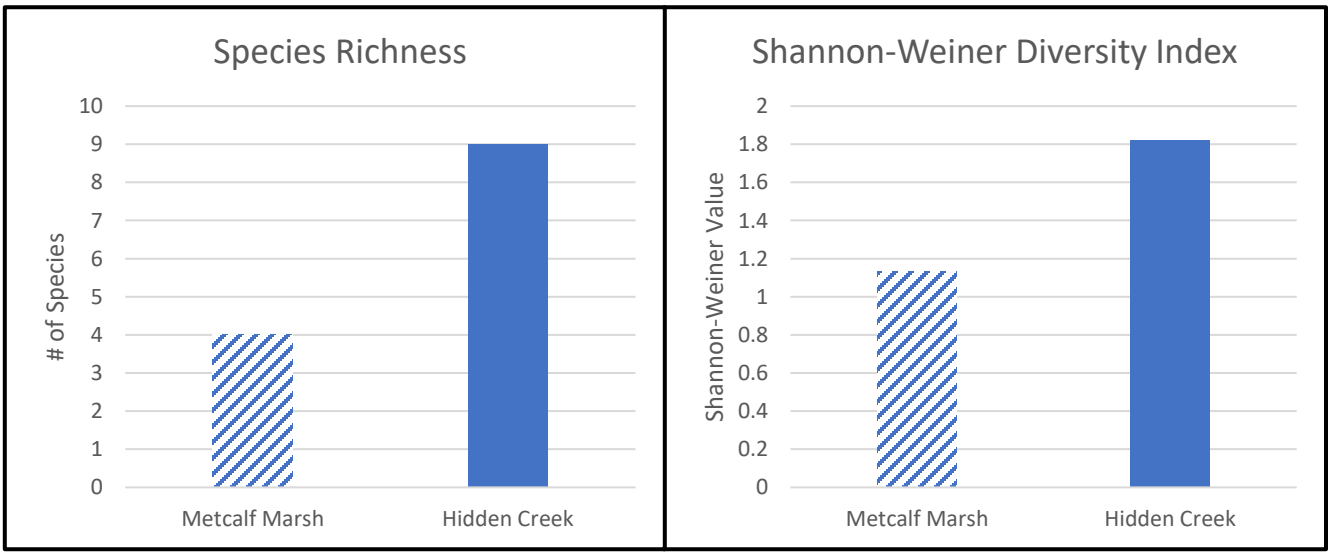
The number of species present is called the **species richness**, a measure of biodiversity. Another way to quantify diversity is with the Shannon-Weiner Diversity Index, which uses both the species richness and **evenness**.



Species richness *is the number of species in an area.*
Species evenness *is the distribution of plants between the species – are there an equal number of each type of plant, or do a few species dominate?*

Both communities here have the same richness (4), but Community 1 has a higher evenness, and is considered more diverse. The Shannon-Weiner Index uses both richness and evenness to calculate diversity, so it gives more information than species richness alone. A community with a higher Shannon-Weiner value is more diverse.

Take a look at the two diversity indices compared between sites:



Compare the diversity data between Metcalf Marsh and Hidden Creek.

Metcalf Marsh has both fewer species, and a lower Shannon-Weiner value than Hidden Creek. This means that Metcalf has a lower plant diversity. Salt marshes tend to have lower plant diversity because of the high salinity and low oxygen – plants that live here must be adapted to the stressful conditions.

Marsh elevation

Marsh elevation is the main factor which determines whether a marsh will survive sea level rise in the future. Marshes which don't increase in elevation as fast as sea levels rise could drown and turn into mudflats, which don't provide the same benefits as marshes. Marshes at South Slough are monitored using deep rod Surface Elevation Tables (RSET), so any changes in the height of the marsh can be tracked over time.

Surface Elevation Tables are anchored deep in the ground, with an arm held above the marsh. The distance between the arm and the ground is measured periodically, and if this distance changes, this means that the marsh elevation has changed.

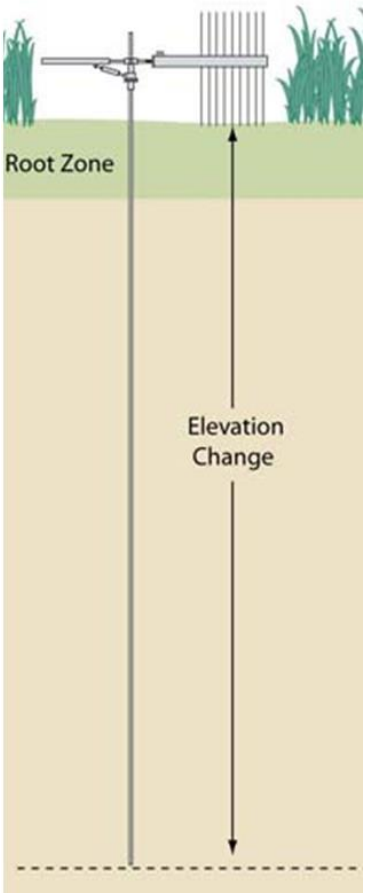
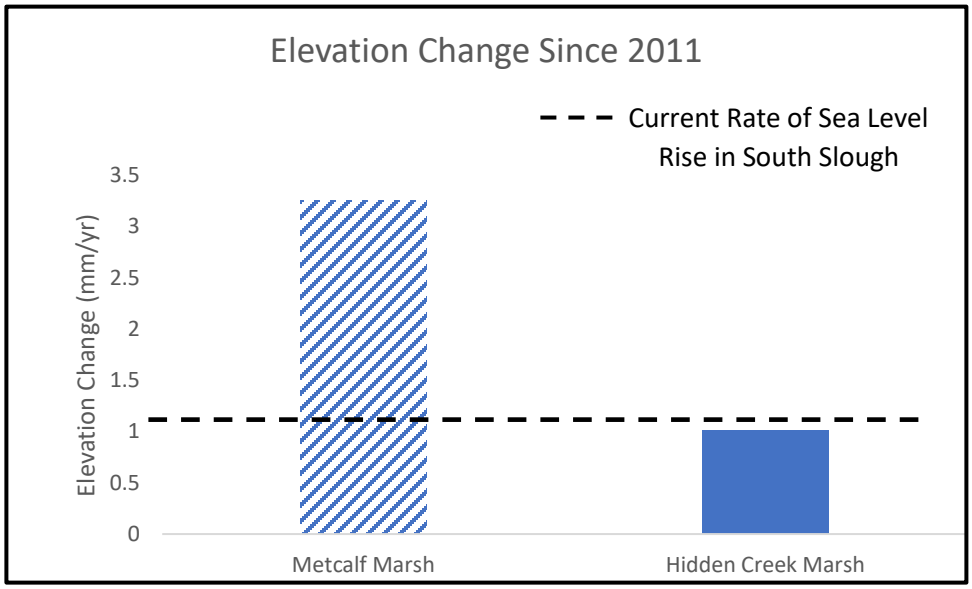


Diagram of a Surface Elevation Table. The RSET stays in place as the marsh surface rises or sinks, so any elevation change relative to the RSET can be measured.

A South Slough intern measuring the distance between the RSET and the marsh surface using pins.

Let's look at the SET data from two of the Sentinel Sites, Metcalf Marsh and Hidden Creek Marsh:



What do you notice about the elevation data?

There is a visible difference in elevation change between the salt and brackish marshes – Metcalf is gaining elevation at a faster rate than Hidden Creek. The dashed line is also important – this represents the current rate of sea level rise in Charleston, Oregon. Hidden Creek is not gaining elevation at the same rate as sea levels are rising, so it's in danger of flooding in the future. Some marshes could move further inland as the oceans rise, but many marshes face barriers like cliffs or man-made structures which would prevent this marsh migration.

What conclusions can we draw from this data?

This data shows us that there are differences between the saltwater and brackish marshes. Hidden Creek marsh (brackish) has a higher number of species and greater biodiversity than Metcalf Marsh (salty). Hidden Creek also has a lower elevation change, and may not keep up with the predicted rate of sea level rise.

Another change which is expected with sea level rise is that saltwater will travel further into estuaries. This could cause a brackish marsh to eventually be in a saltwater zone, or even a freshwater marsh to become brackish. Since vegetation in freshwater marshes aren't usually adapted to the stress of saltwater, this could lead to either loss of these marshes, or transition to a salt marsh plant community.

What can we do about it?

If you were the manager of South Slough and you knew based on measured elevation changes that some of your marshes are likely to drown due to sea level rise, how could you either prevent the marsh drowning, or engineer a way to provide the same ecosystem services (like flood protection and providing habitat to species like young Dungeness crab and salmon) if a marsh disappears?

Some solutions which have been tried:

- Planting eel grass (could secure sediment and increase elevation gain)
- Adding a thin sediment layer on top of a marsh to artificially increase elevation
- Flood protection: sea walls, tide gates, adding sand to beaches (mostly short-term fixes)
- Habitat: building artificial habitat

Additional Resources

https://www.nationalgeographic.org/encyclopedia/marsh/ Detailed overview of marshes

https://www.vims.edu/research/units/centerspartners/map/education/profdev/VASEA/docs/SeaLevelRise/VASEASeaLevelRise.pdf A 1.5 1.5-hour lesson plan with a mock marsh activity demonstrating accretion and sea level rise

https://www.youtube.com/watch?v=8OCwgC6sb4A Musical parody video about marsh accretion and sea level rise

https://www.usgs.gov/media/videos/rapid-salt-marsh-erosion-grand-bay-mississippi Time lapse video of marsh erosion

https://www.globalchange.gov/browse/indicators/global-sea-level-rise Overview of sea level rise

https://ocean.si.edu/through-time/ancient-seas/sea-level-rise Detailed information on sea level rise

https://www.youtube.com/watch?v=msnOHuPep9I 1-minute description of sea level rise with illustrations

https://coast.noaa.gov/digitalcoast/tools/slr Mapping tool to visualize sea level rise in the US (can zoom to a specific coastal town, visualize marsh migration, alter sea level and accretion rate)

https://coast.noaa.gov/nerrs/research/ Overview of NERRS research, including publications & data reports

https://oceanservice.noaa.gov/news/june14/protect-estuaries.html List of steps that students can take to protect estuaries

https://www.ocregister.com/2014/09/27/even-a-marsh-can-drown/ Article about planting eelgrass to increase marsh accretion

https://www.unh.edu/unhtoday/2018/02/building-coastal-resiliency Article about adding sediment to marshes

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