Dynamics and resilience of a system of shallow coastal bays, Virginia, USA

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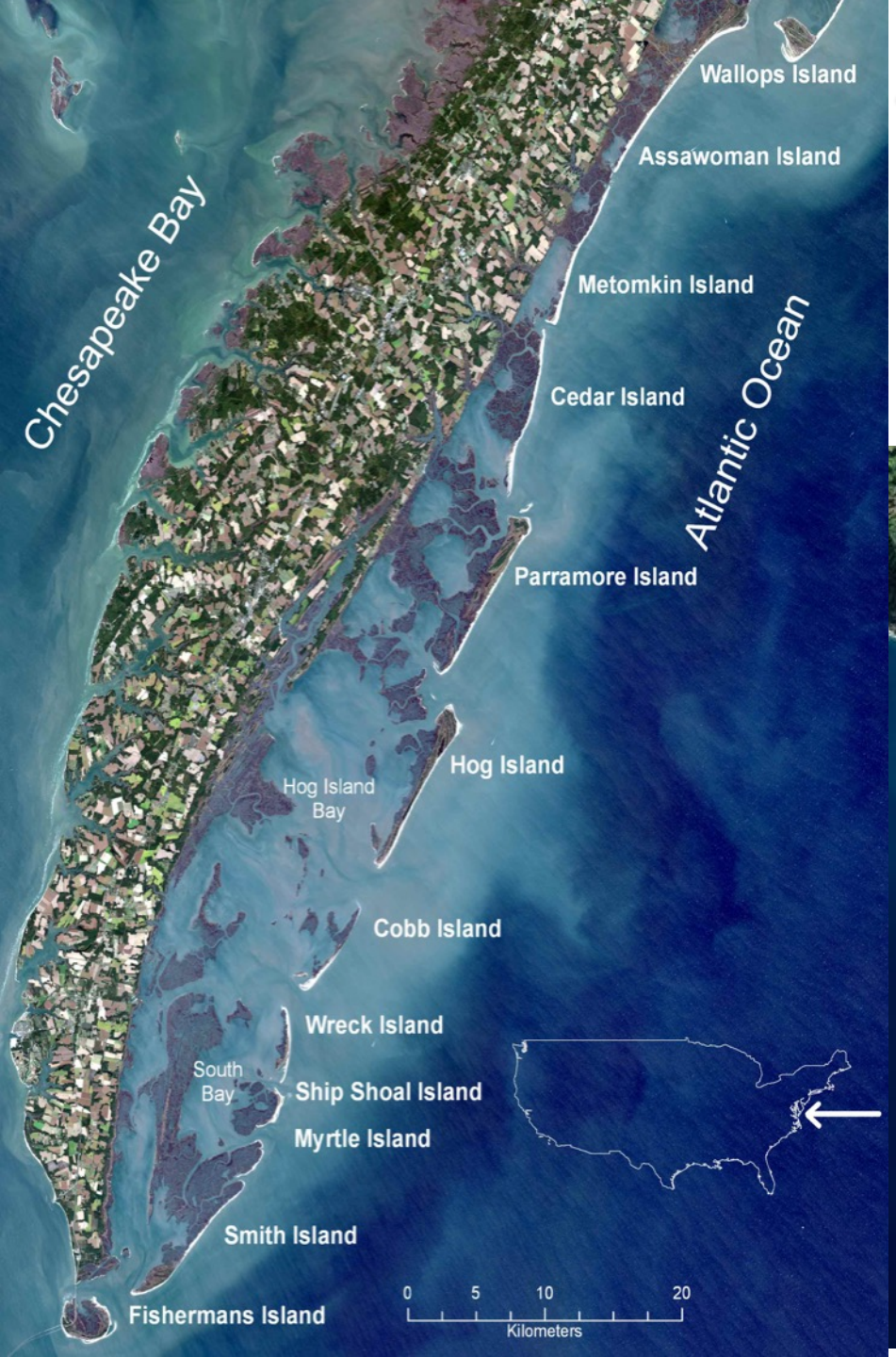
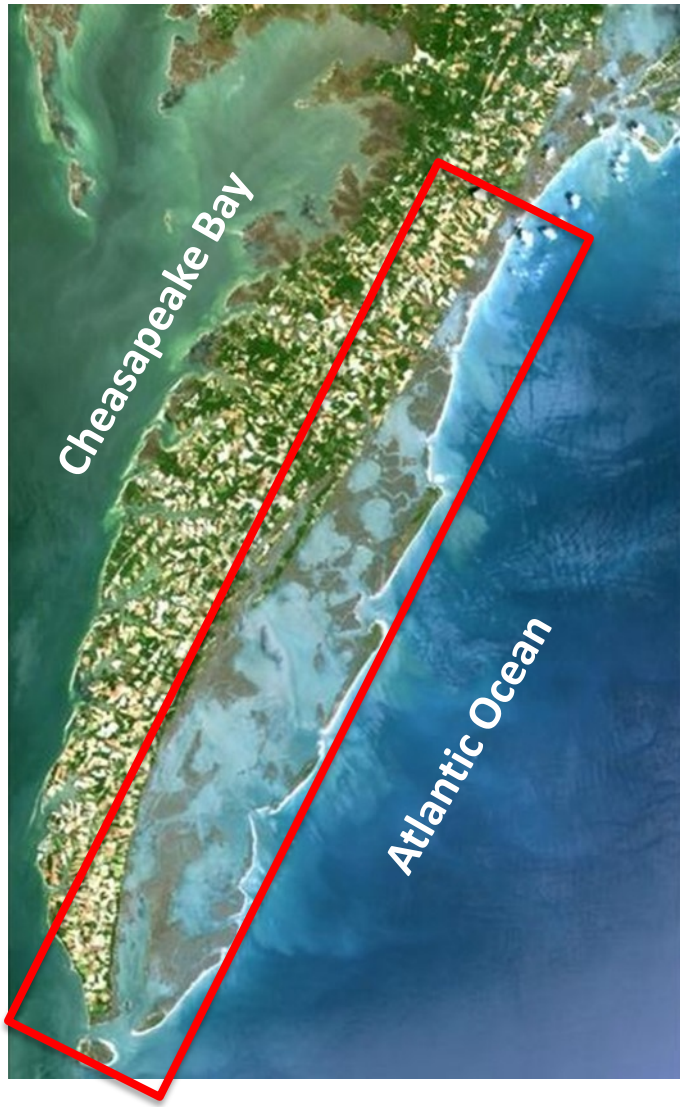
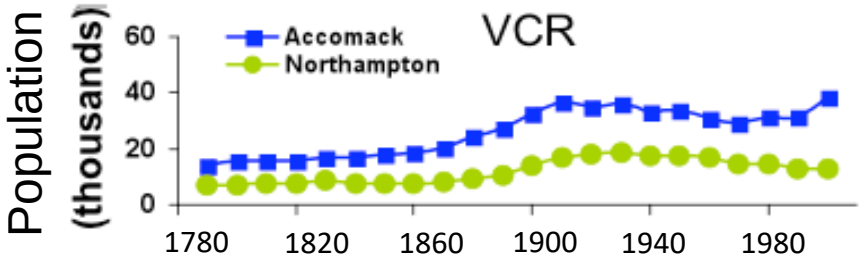


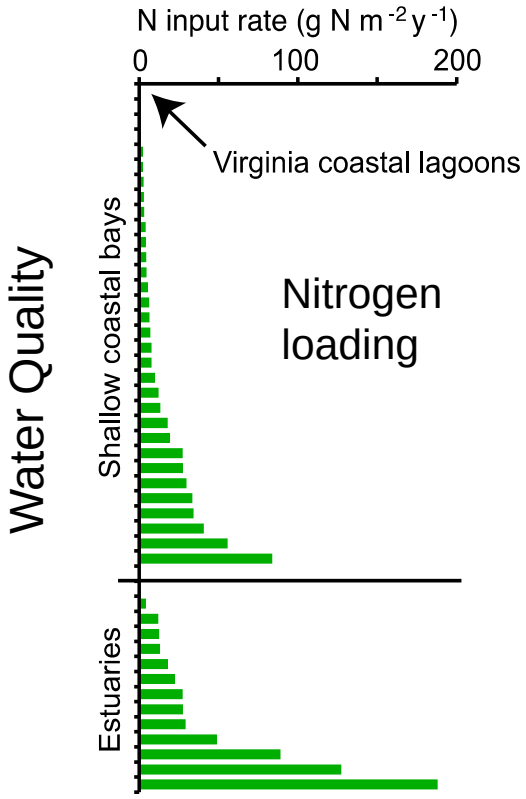
Virginia Coast Reserve

San Francisco Bay

Virginia Coast Reserve







- no significant terrestrial sediment sources
- mean tidal range ~1.2m
- mean depth ~1.0m MLW
- sea-level rise ~4-5mm/y

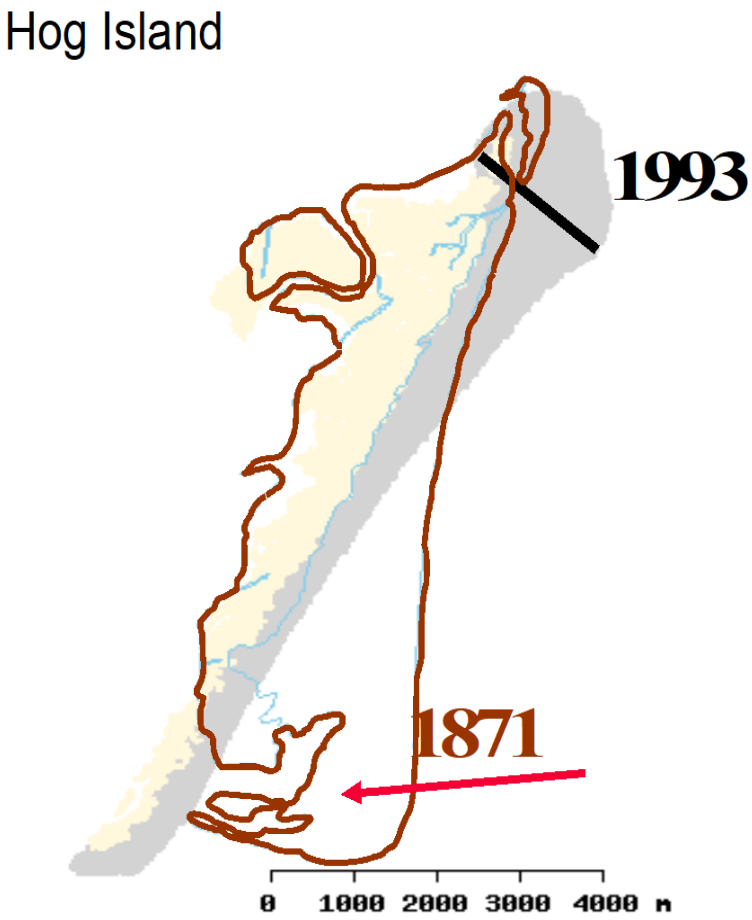
Why is population so low?

In the early 1900s, the Virginia coastal barrier system supported one of the most prosperous farming and fishing economies in the country.

Photos from
"The Barrier Islands"
by Badger and Kellam

Why is population so low? -> morphodynamics

Longest stretch of undeveloped barrier islands in the global temperate zone



No jetties, seawalls

Ecosystem dynamics also played a role

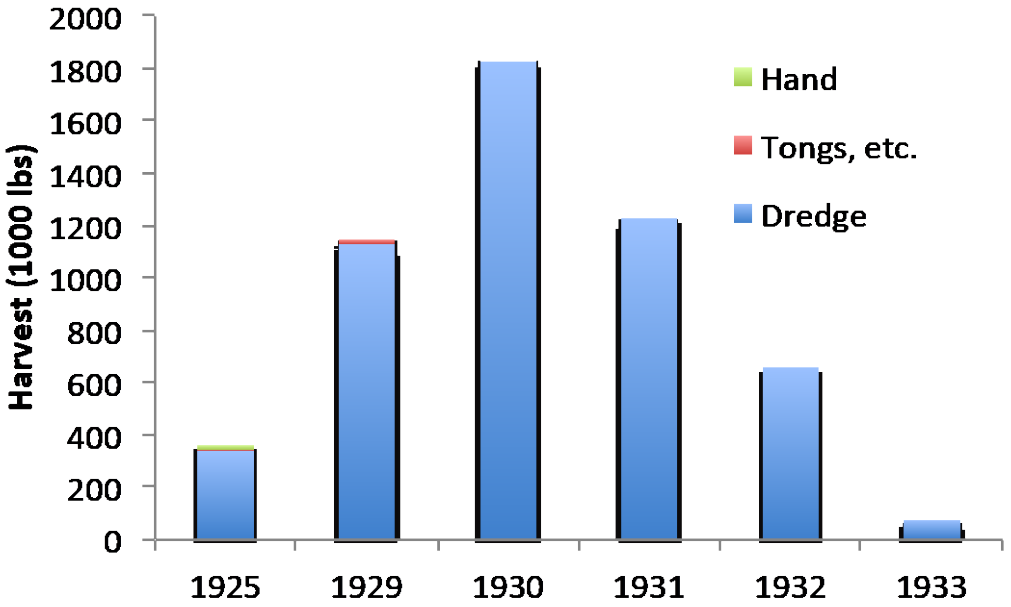
Dramatic ecosystem change in ~ 1933

A scallop ‘scrape’ (dredge)

Separating scallops and eelgrass
Field et al. 1910

Seagrass became locally extinct due to pandemic “wasting disease” and “Great Storm” of 1933

Scallop industry crashed



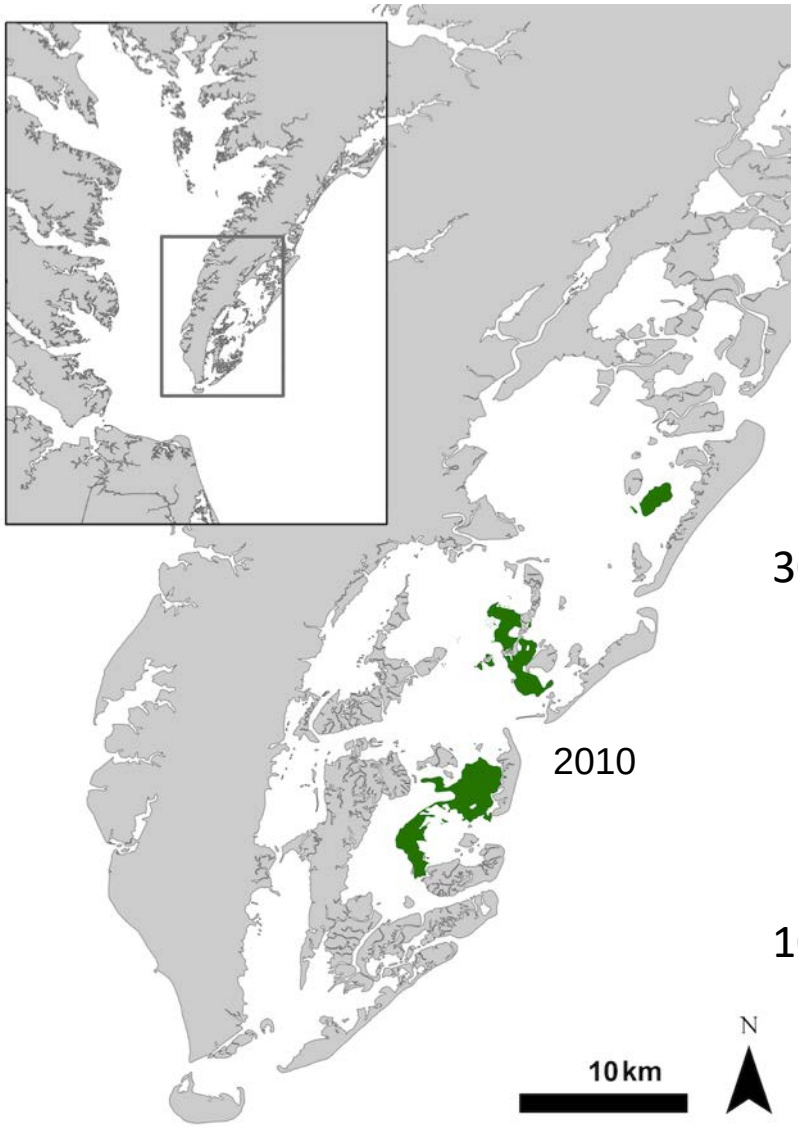
Data from VA Comm Fisheries harvest records

M. Oreska

Impacts, restoration and resilience in VCR

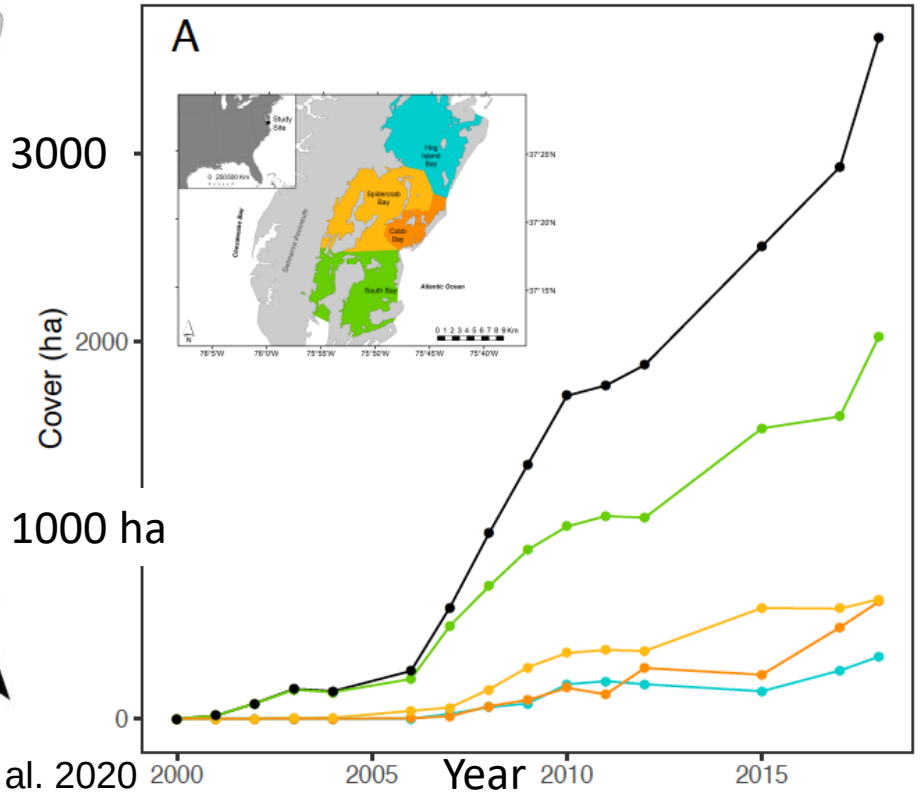
1. Seagrass restoration
2. Oyster reef restoration and marsh protection
3. Impacts of sea-level rise and warming ocean temperatures

Restoring seagrass to Virginia coastal bays



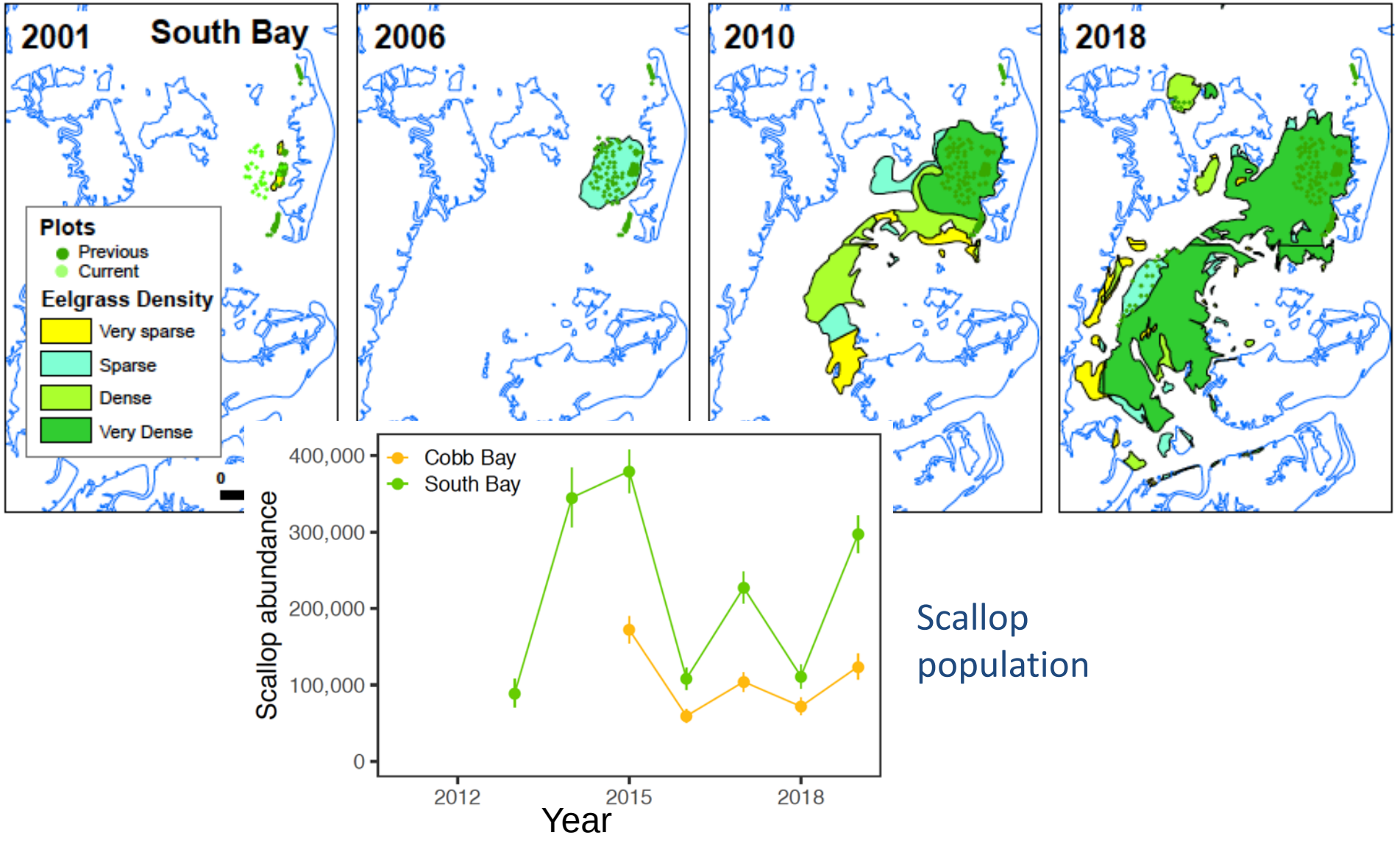
seeds

Orth Lab, VIMS



Orth et al. 2020

Seagrass restoration trajectory in South Bay

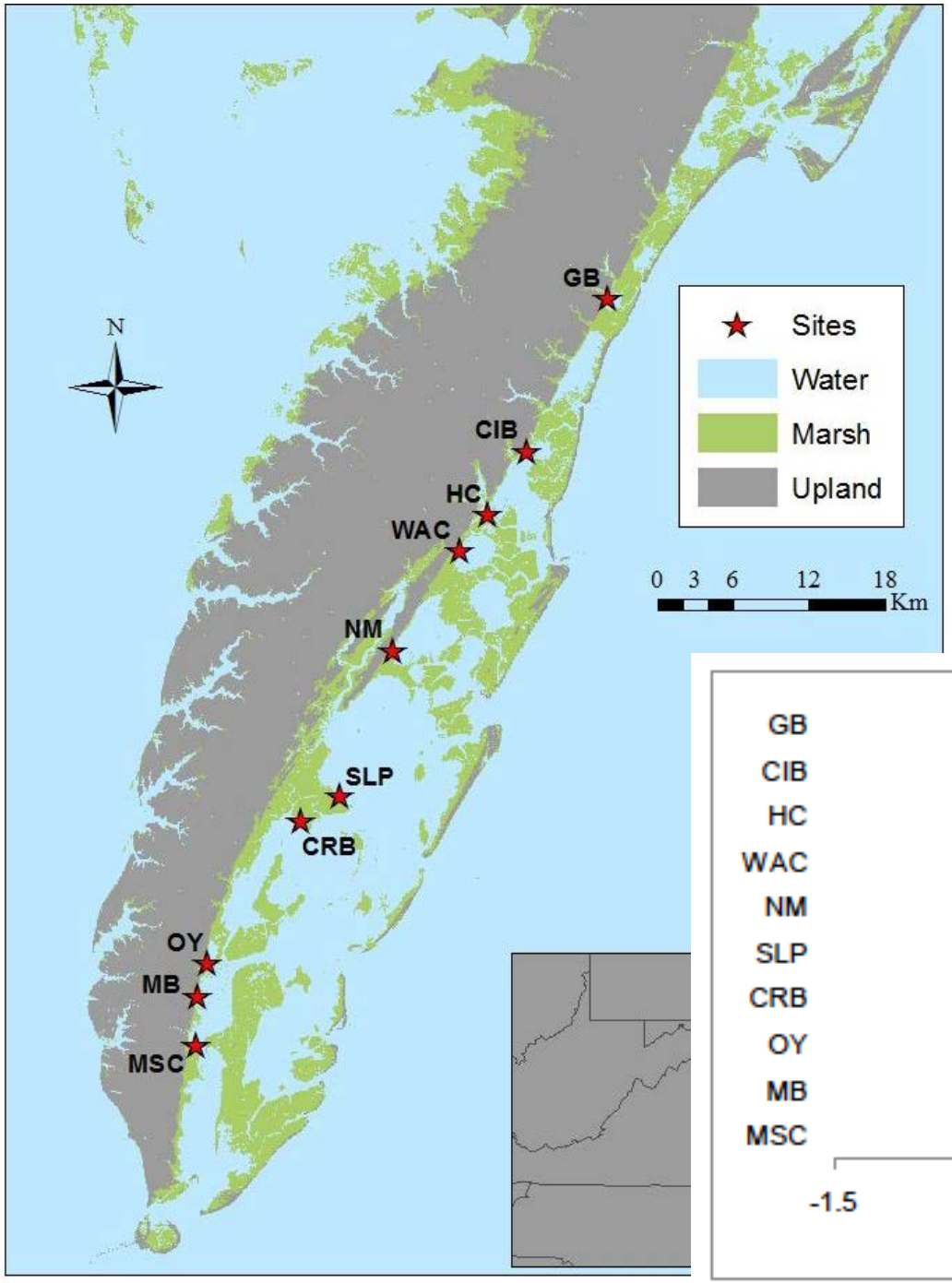


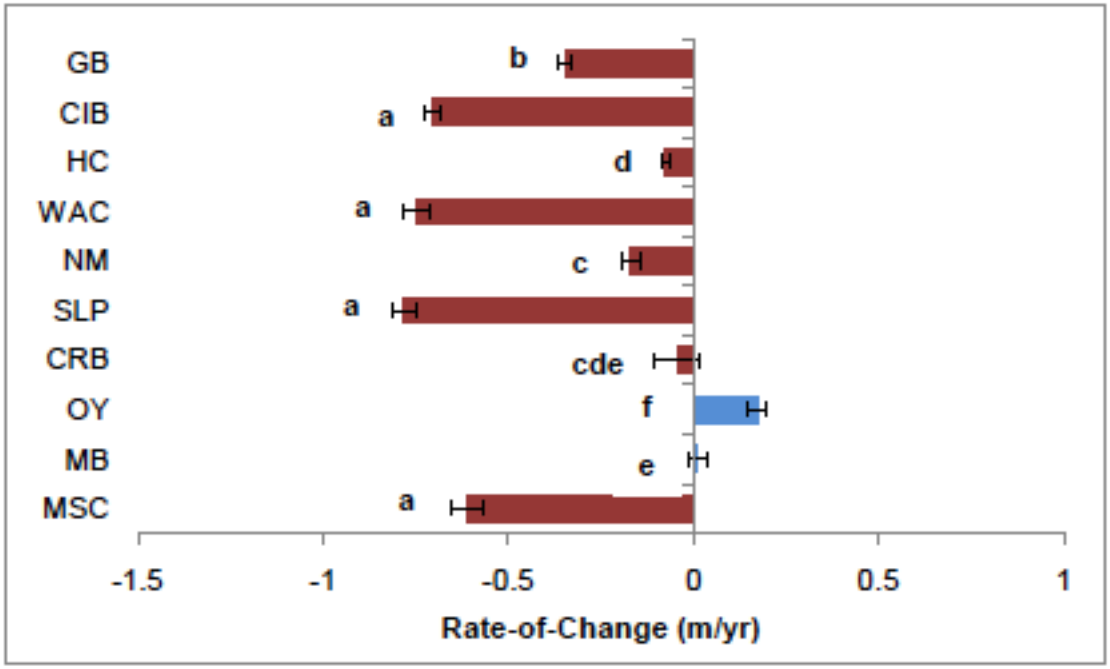
Scallop population

Marsh edge erosion

Marsh edges are eroding throughout most of the bays.

Some of the loss is compensated by marshes moving further inland.





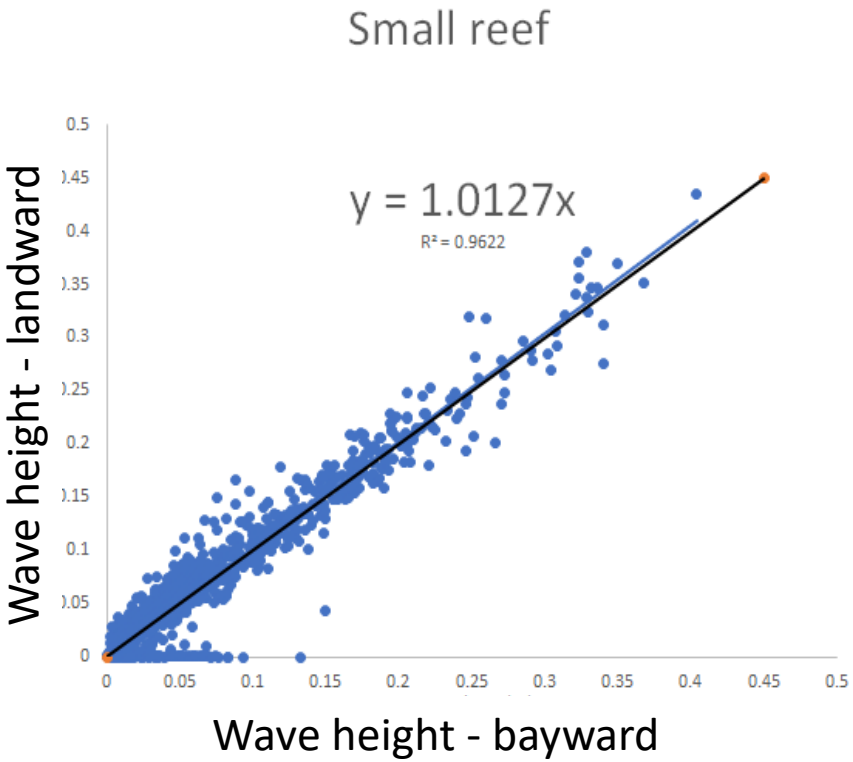
Reefs constructed of oyster castles

Living shoreline designed for oyster habitat and reduction of wave energy reaching the marsh edge.

4 reefs designs are being tested for oyster growth and wave attenuation

Findings to date

- Rapid oyster colonization
- Small reefs have no effect on wave energy
- Larger reefs reduce wave energy, especially for depths < mean water depth



After 3 years

Hogan 2020

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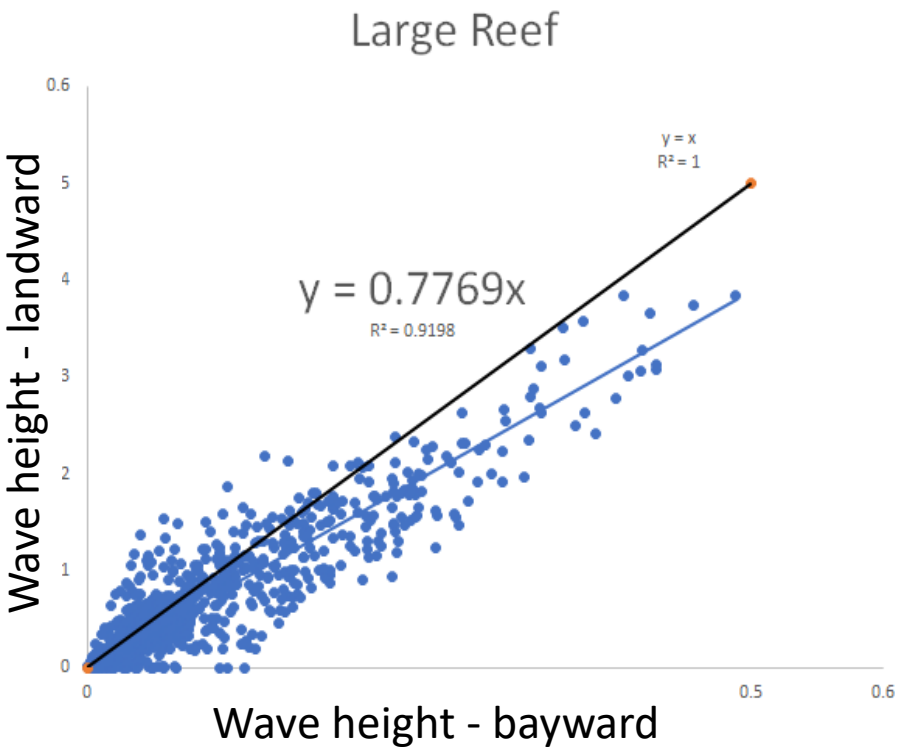
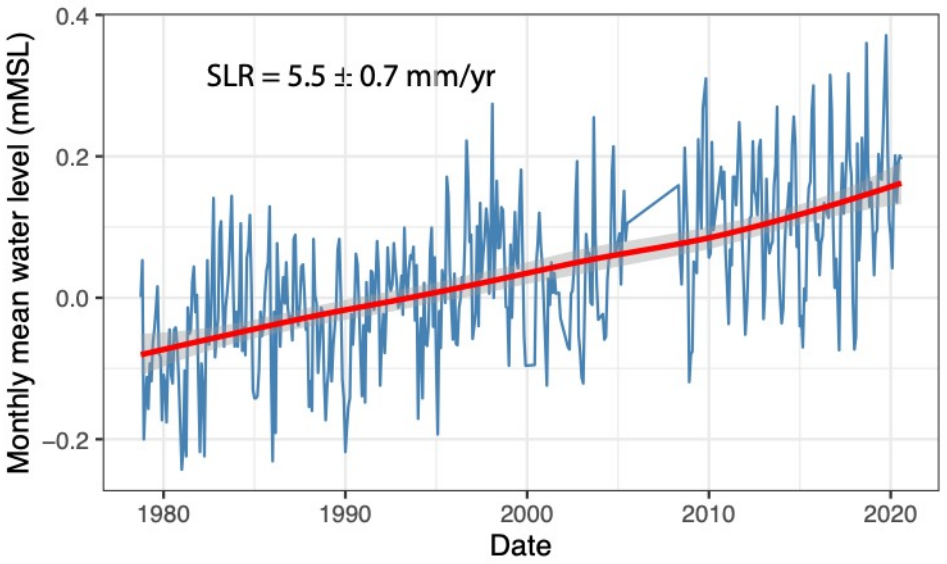


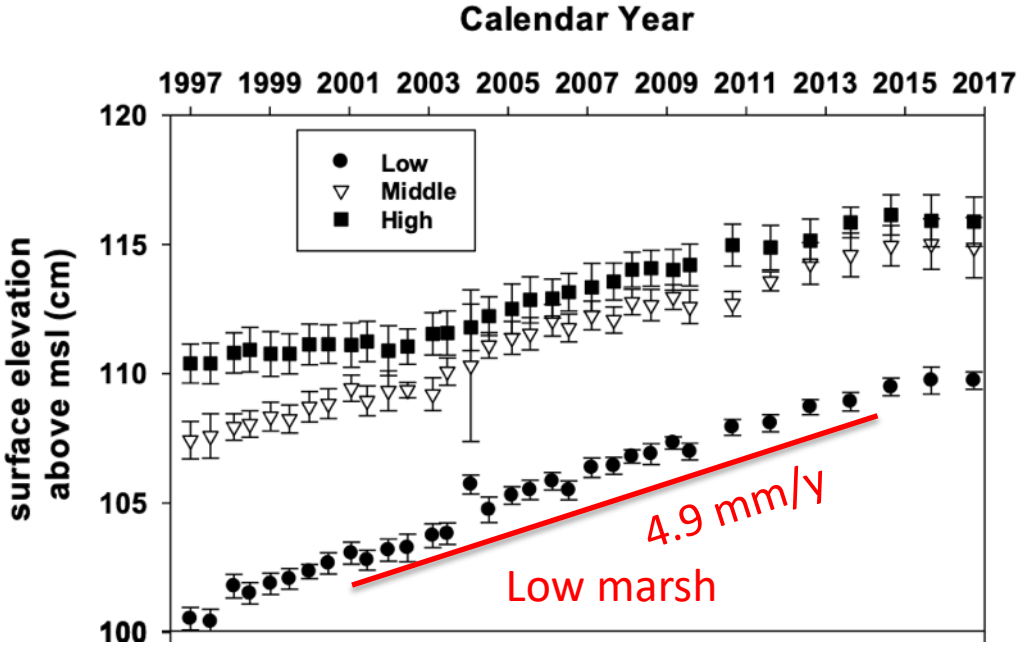
After 3 years

Hogan 2020

Sea-level rise

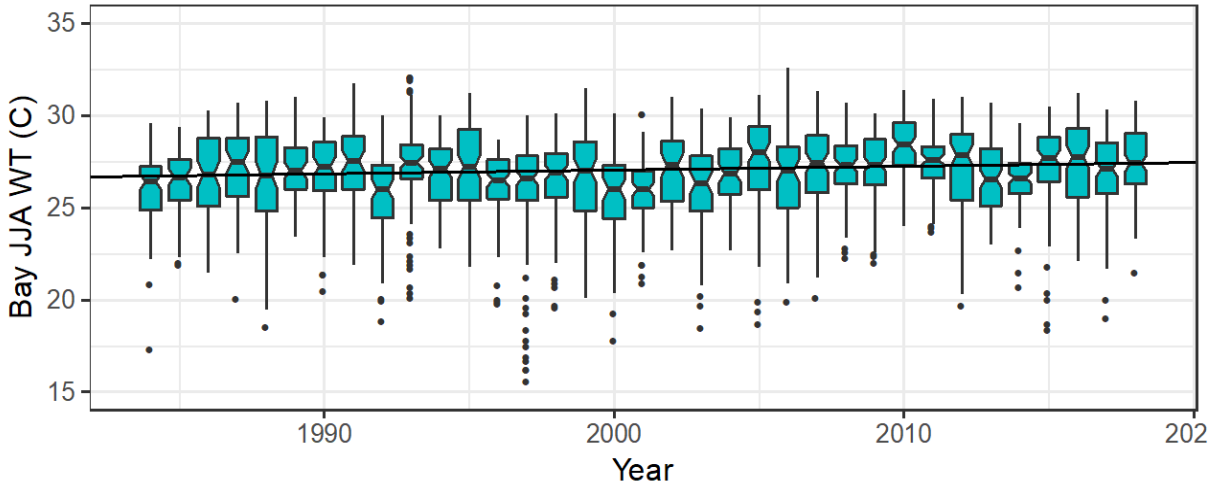
Current rates > 5 mm/y, but marshes are generally increasing in elevation at comparable rate.



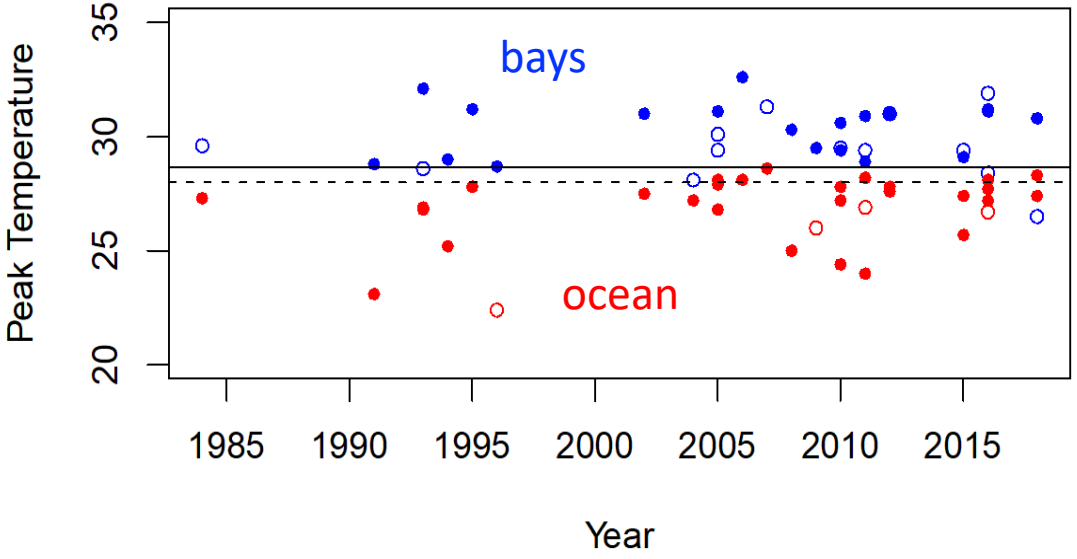


Blum et al. 2020

Impacts of warming water temperatures

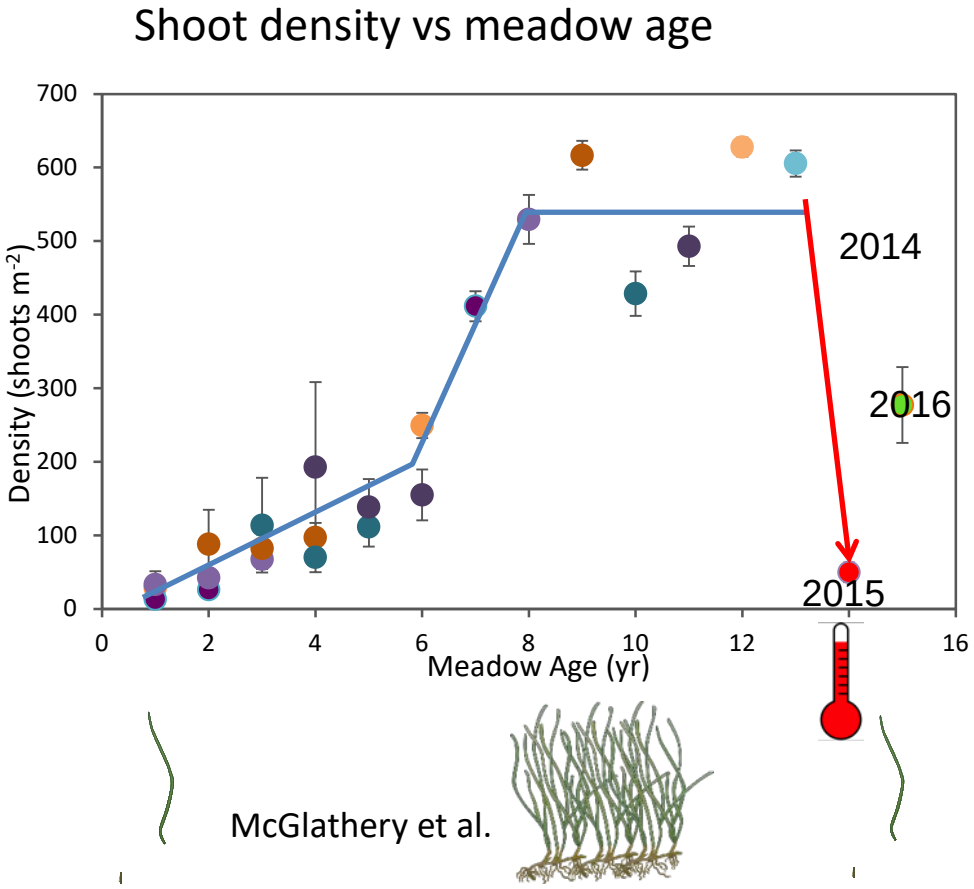


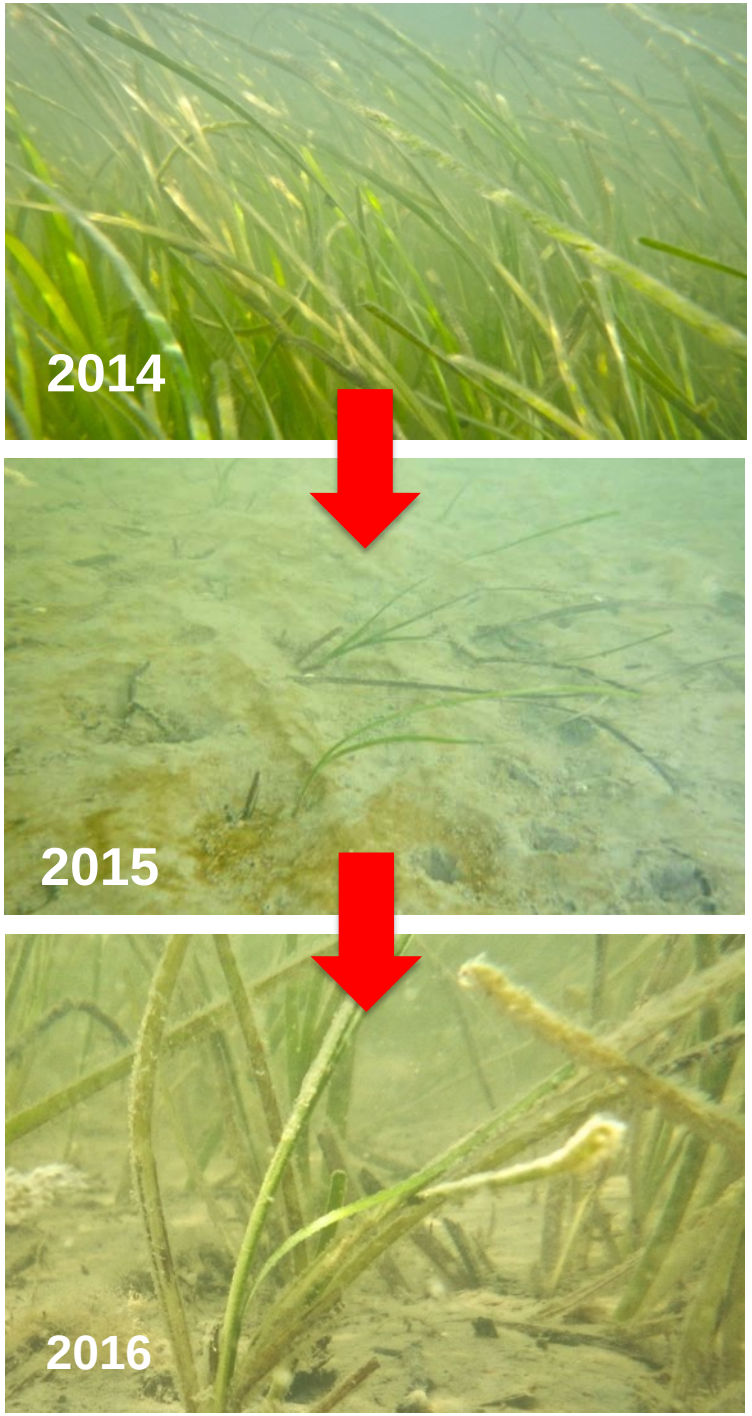
The bays are warming at a rate of 0.3°C/decade



Marine heatwaves are becoming more frequent in the bays and the adjacent ocean.

Heat waves can cause seagrass diebacks





Do seagrass diebacks release sediment trapped by the meadow?

Next step: building on this work to quantify the sediment budget for the bays to help anticipate future change

Complex interdependencies among bays, islands, seagrass, marshes (and other ecosystem) are a challenge.