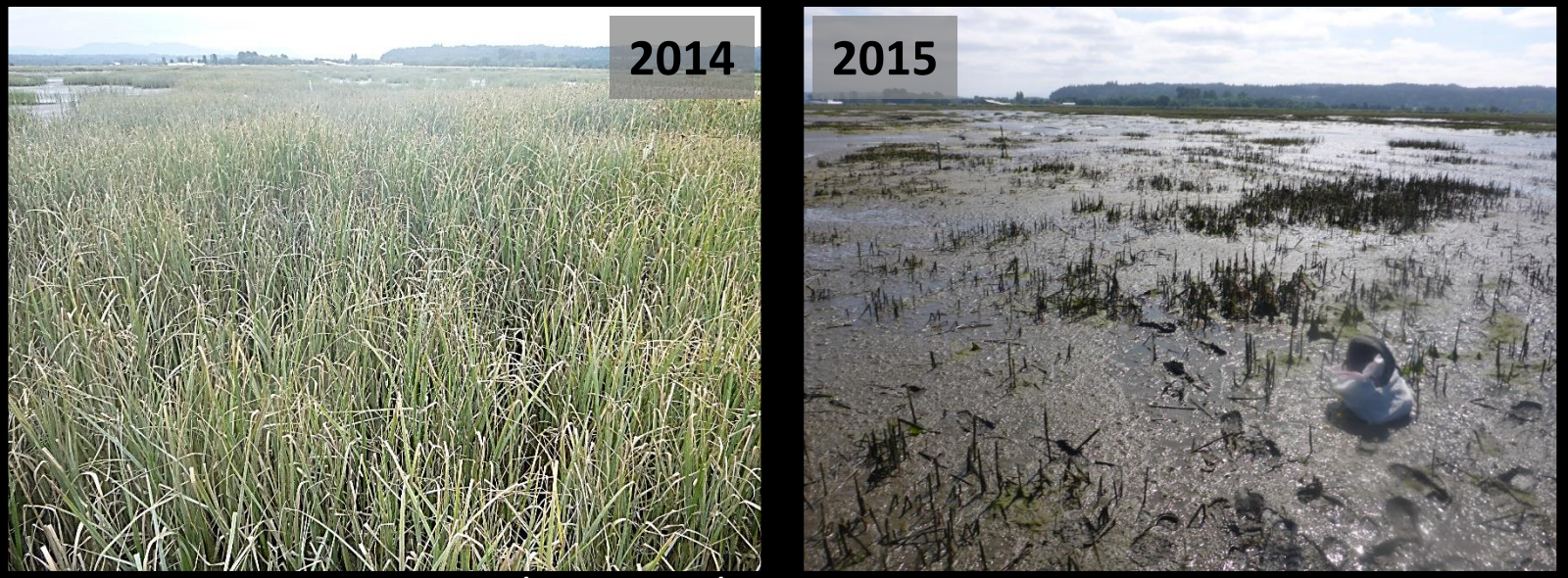
Variable marsh resilience to stress offers clues to climate change adaptive management



The same plot, one year apart

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John Rybczyk, WWU
Eric Grossman, USGS
Chad Stellern, WWU

The Take-Home Messages

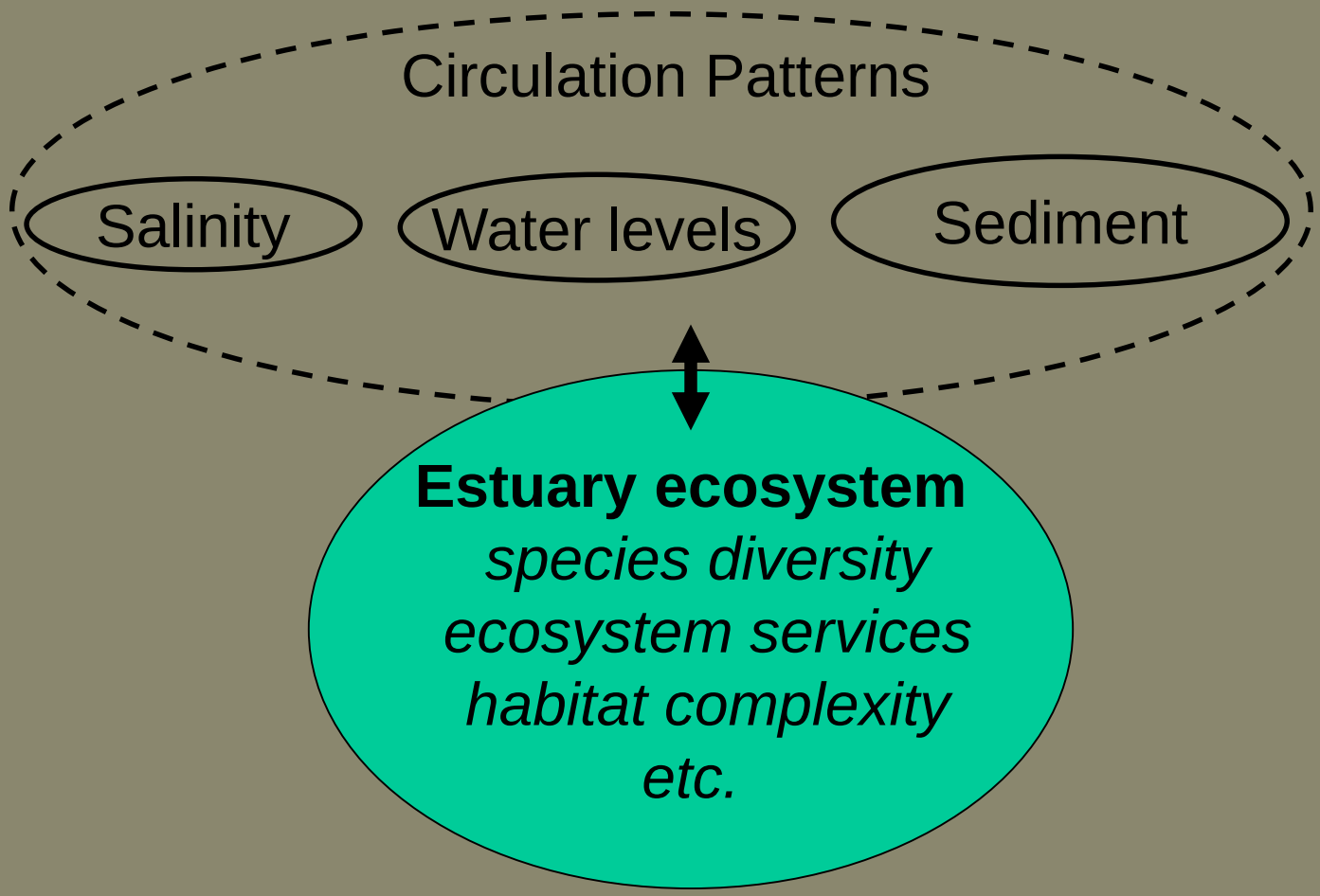
1. Climate change interacts with existing sources of stress, and changes the rules and the timeline of response.

2. Resilience to stress differs spatially across the estuary.
   (and each estuary is different)

3. Understanding why resilience varies, allows you to identify strategies to enhance resilience now.

The Stillaguamish Estuary

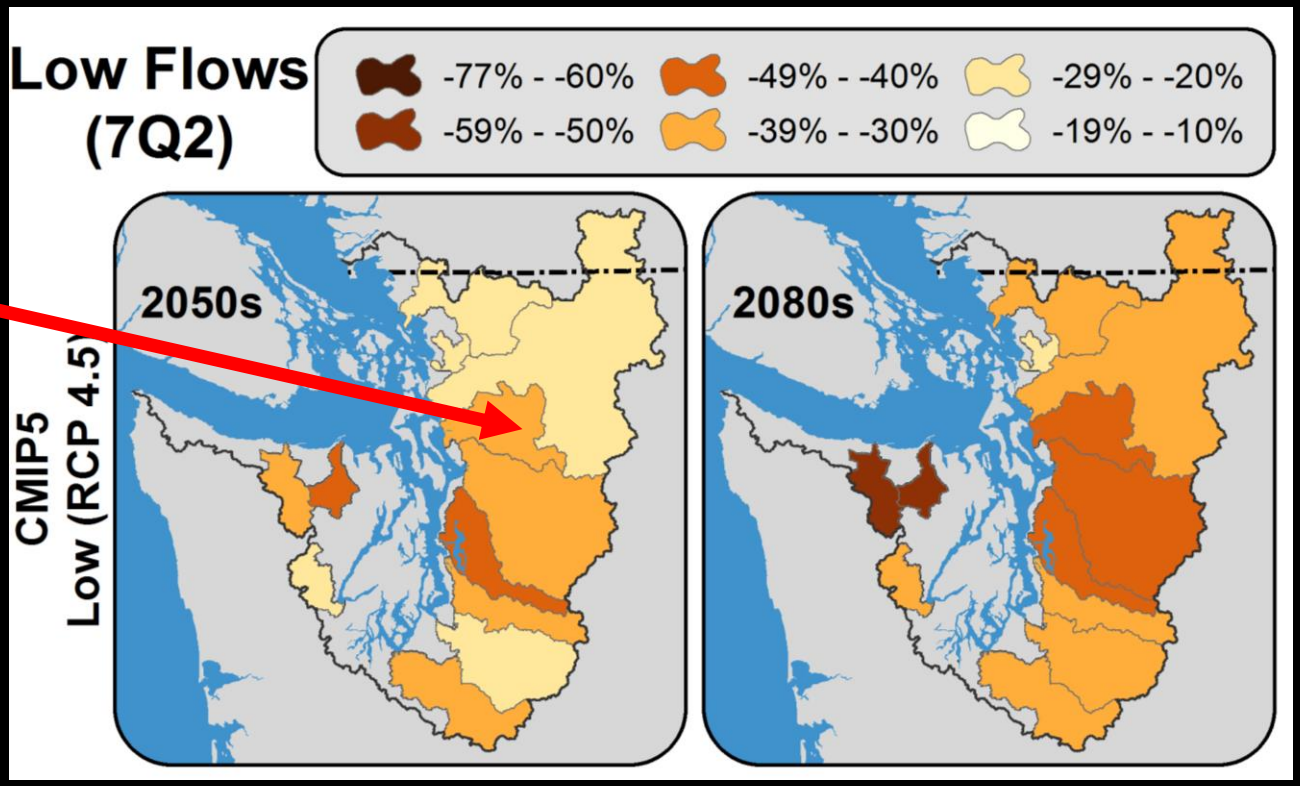
Habitat Drivers (resilience factors)



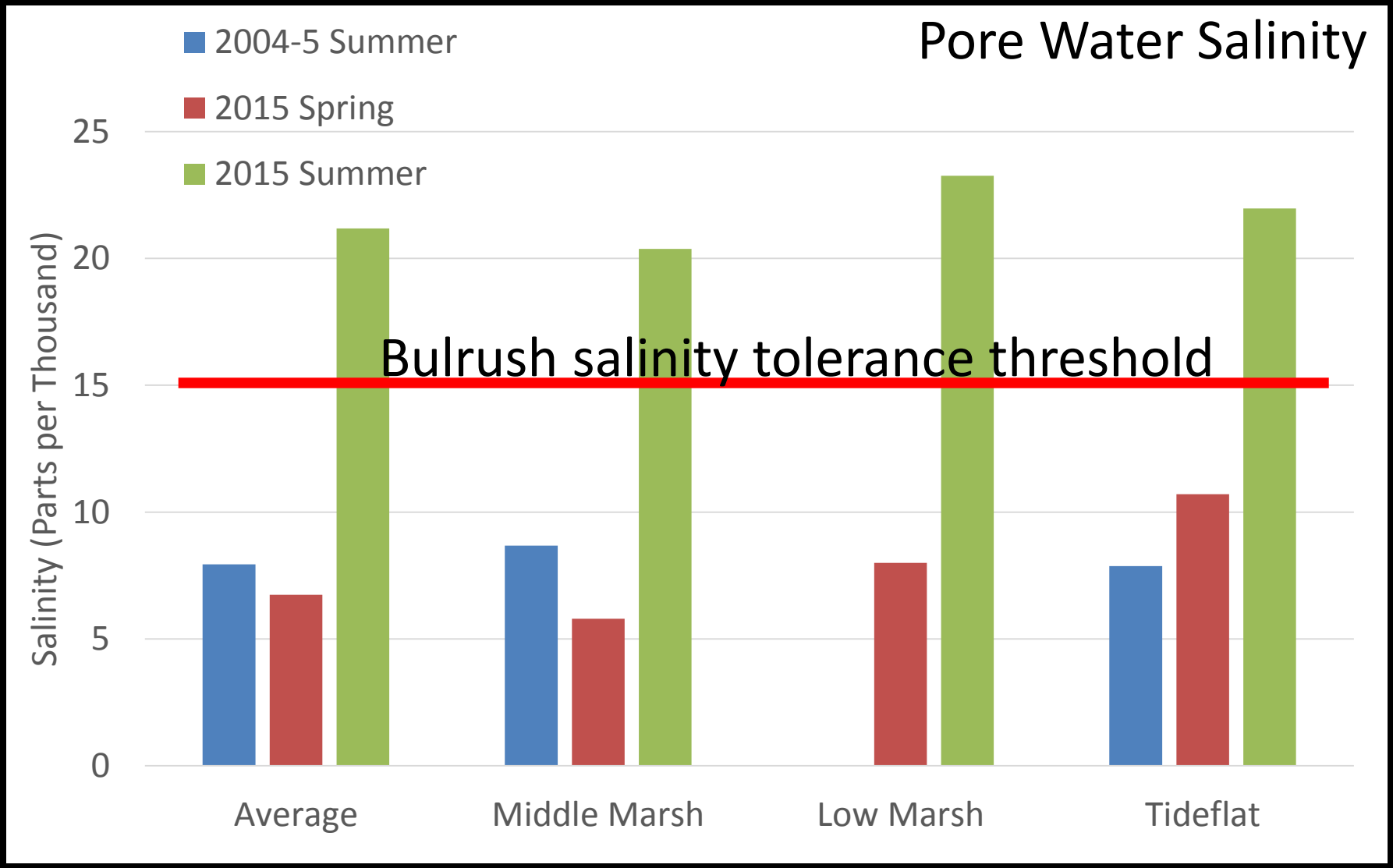
Climate change stress

Salinity

2050's Projection for 2-year low flow: 30-40% decline



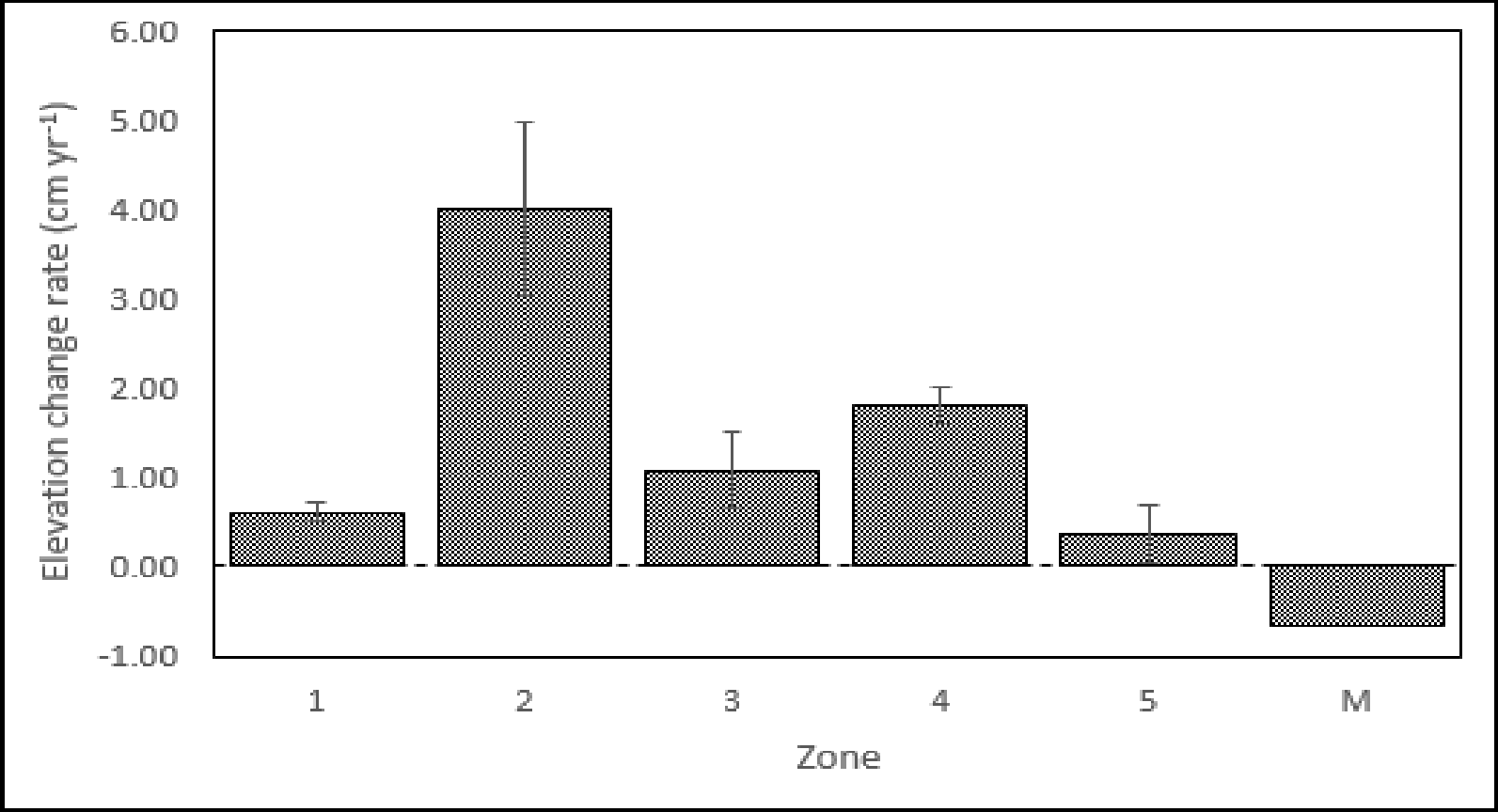
Summer 2015: same as 2050's average condition



Climate Change Stress
Sea level rise and Accretion

Elevation Change (cm/yr)

plenty …of sediment for the marshes

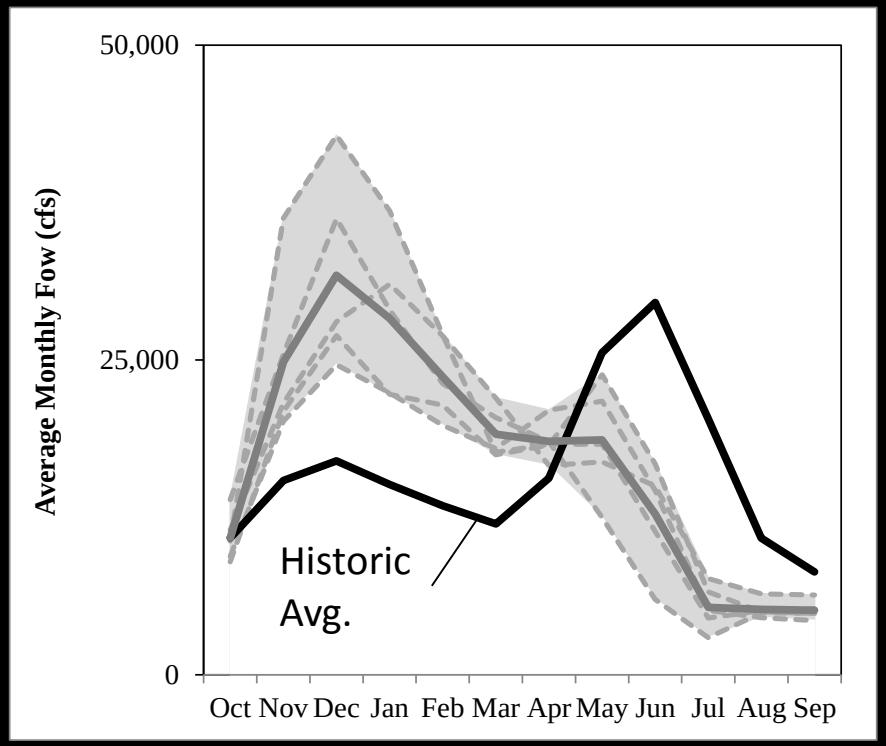


Rybczyk and Poppe

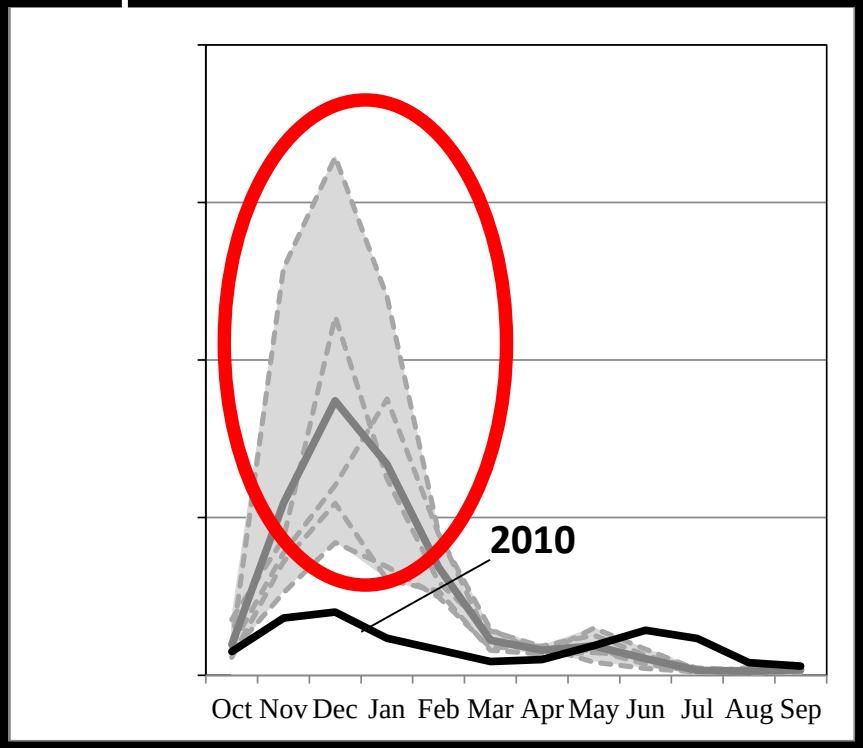
Sediment delivery in future?

2080s, Skagit River

River Flow



Suspended sediment



Hamlet et al. (2016)

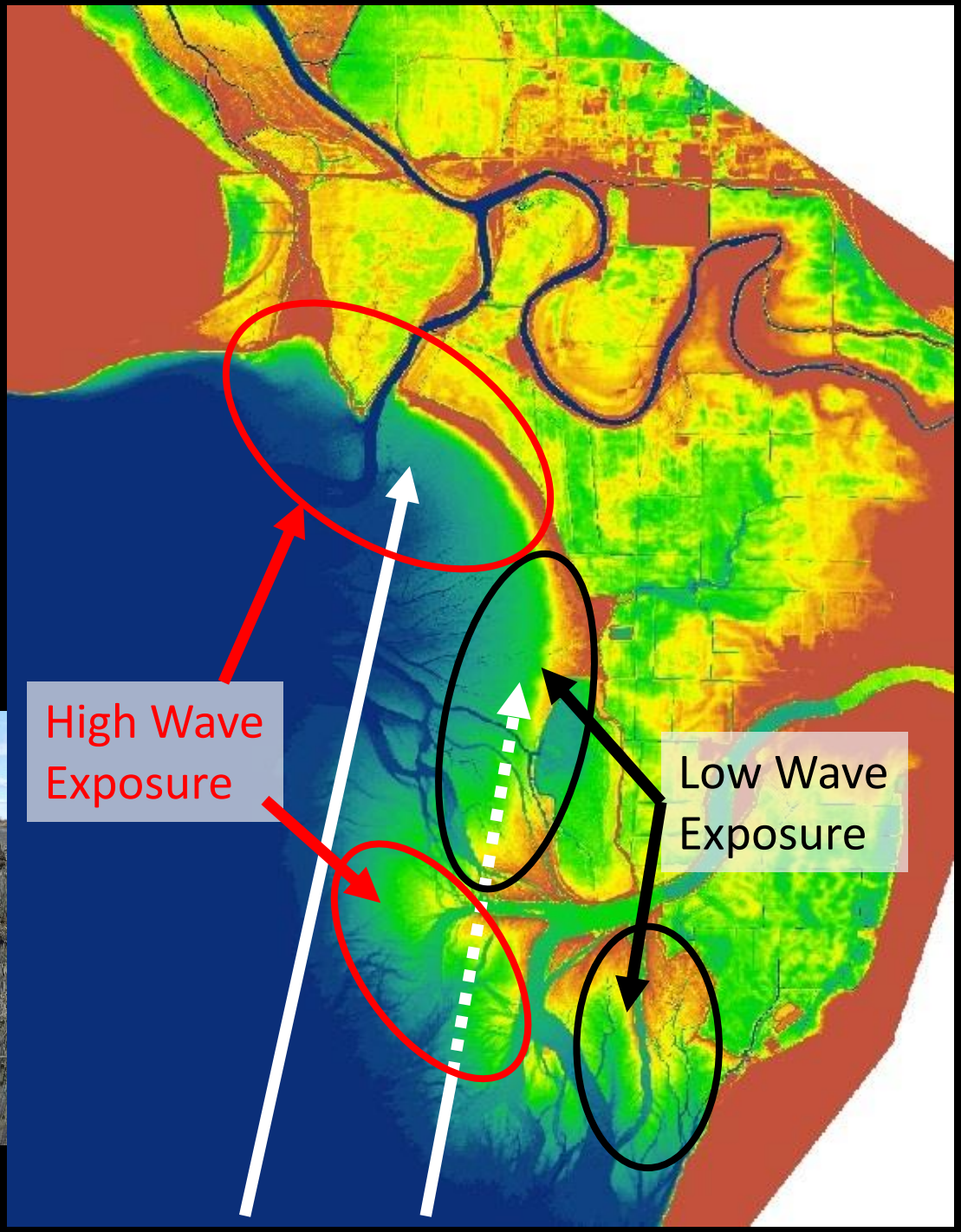
Other sources of stress that interact with climate change

- Biotic changes: herbivores, bioturbators and insects
- Waves
- Legacy stresses…levee configuration effects on delivery of freshwater and sediment

Disturbance - herbivory

Goose herbivory – overgrazing results in erosion and marsh loss

Herbivory interacts with Wave Exposure



Insect-mediated Marsh Dieback

2015: Stress + Insect = 50 acre dieback

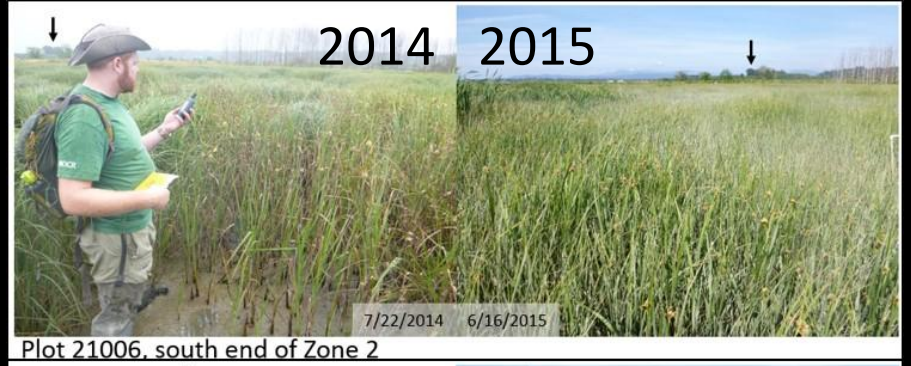
Preliminary ID:
Bactra sp. (Tortricidae)

Bore holes

Highest elevation marsh

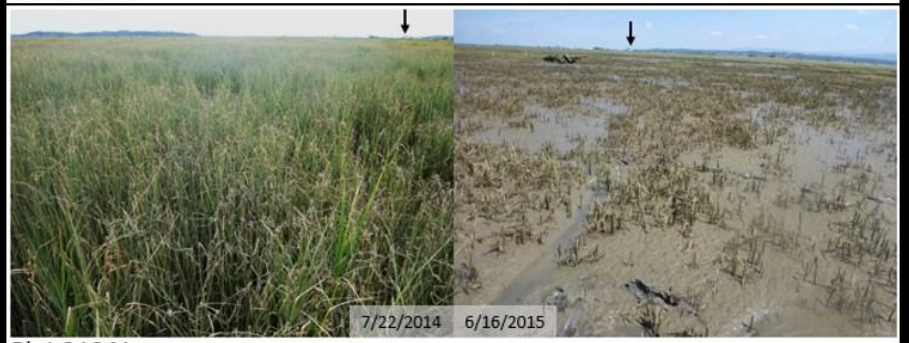
Interacting stresses kill marsh

Lowest elevation marsh



Plot 21006, south end of Zone 2

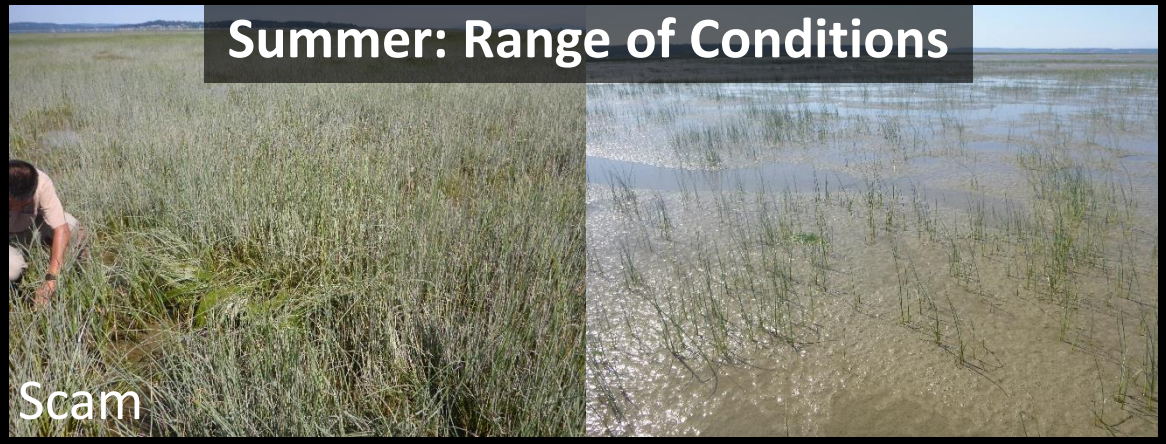
Plot 21016

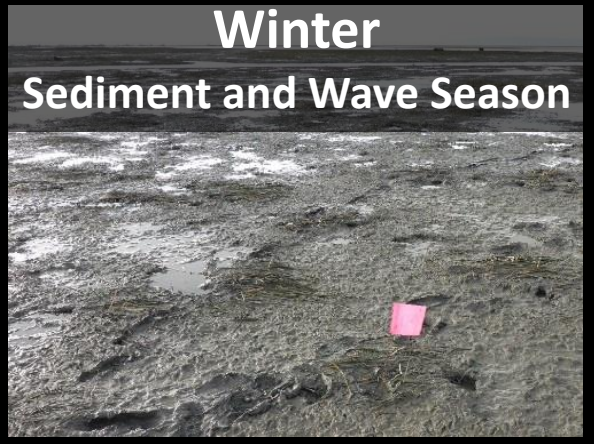


Plot 21041

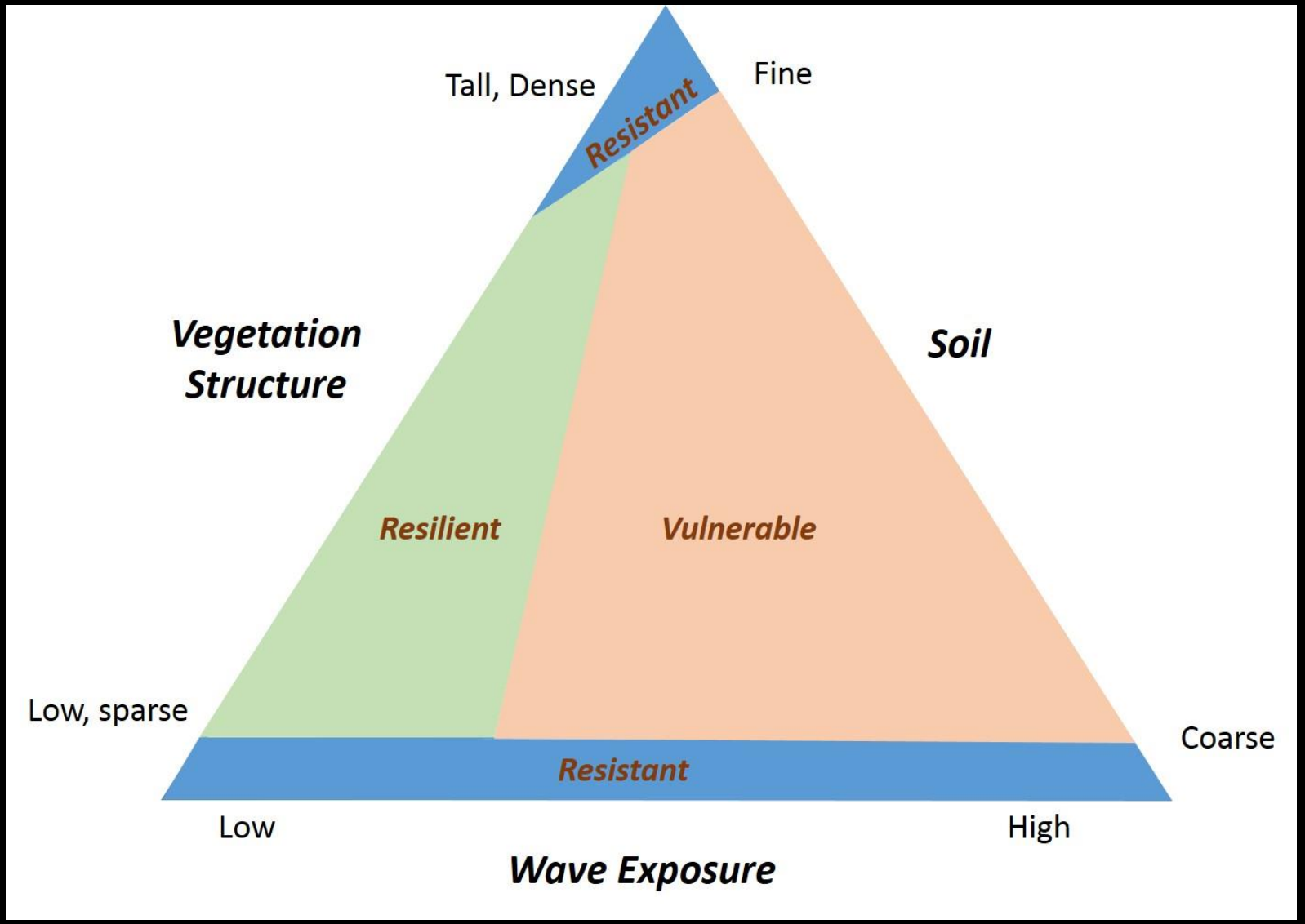
Plot 21050

Biophysical Interactions: Vegetation structure





Biophysical Interactions and Disturbance Resilience



Effects of high salinity on vegetation

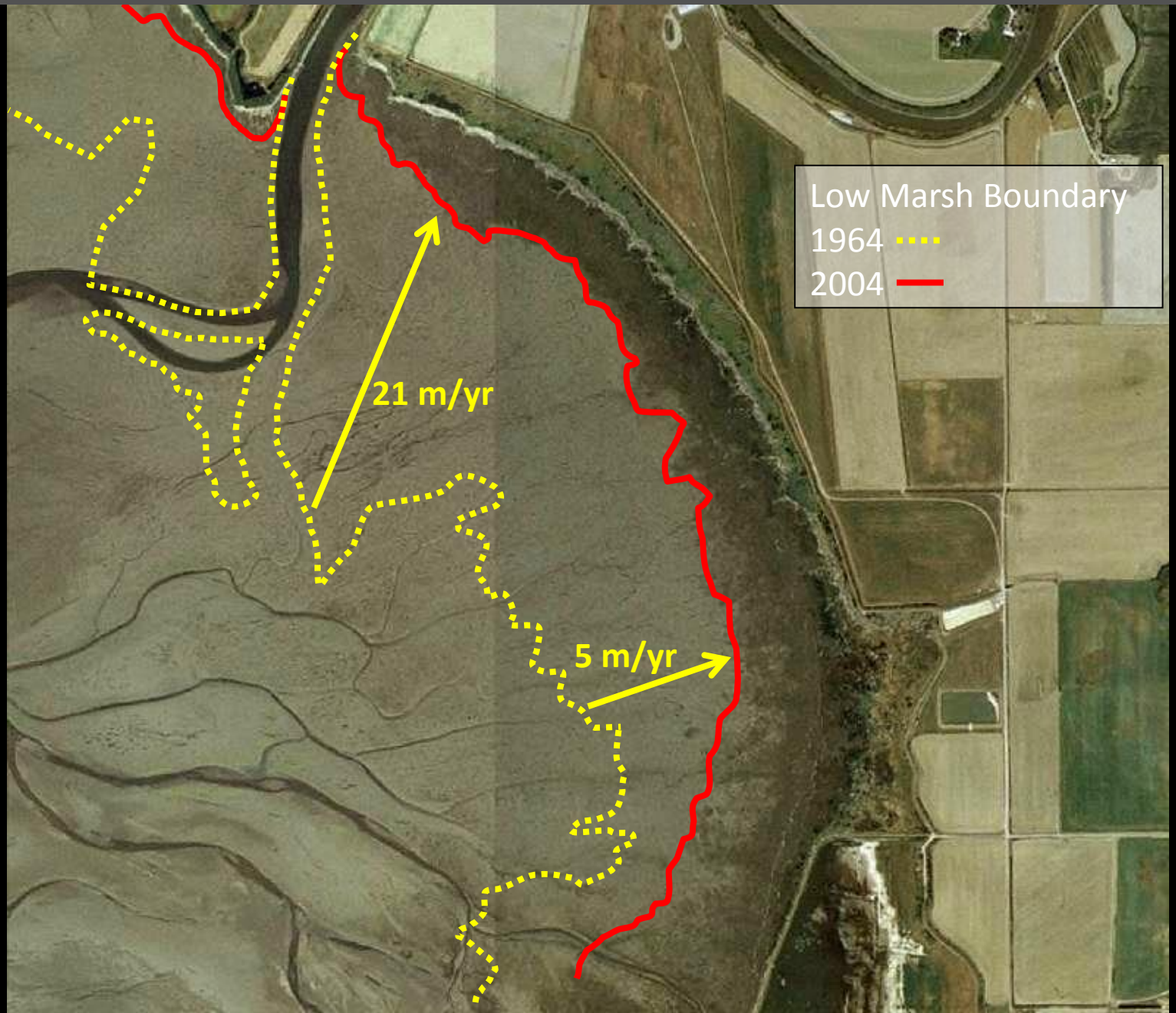
- early senescence
- decreased biomass
- reproductive failure

2015 % Reduction in vegetation height

Table 5. *Percent change in vegetation height between summers, 2014 and 2015.*

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Average
High Marsh	17		17	108		47
Middle Marsh	-27	-56	-40	-15	-34	-34
Low Marsh	-20		-41	-44	-67	-43

Marsh retreat…multiple interacting stressors



Summary

- Varied sources of stress, expect more in the future
- Climate changes effects interact with existing stresses
- Salinity is likely an earlier and bigger threat than SLR
- Understanding the biophysical interactions driving resilience allows spatially targeted strategies

Adaptation Action Examples

Salinity – earliest big threat from climate change

1. Restoration focus: freshwater and sediment delivery
    - *higher in estuary, close to river mouth, distributaries*

2. Maximize hydroconnectivity between restoration site and system

3. Fill and grade subsided restoration sites, target elevations and particle size to support resilient plant species
    - *e.g. Bolboschoenus fluviatilis, river bulrush*

4. Dredged sediment beneficial reuse

5. Engineered LWD jams: channel stabilizing, sediment capture, wave attenuation

6. Snow goose management, behavior modification

Monitoring Metrics to Understand Biophysical Interactions

- Pore water salinity (especially the next dry summer)
- Vegetation height and density (summer, winter)
- Common plant species
- Accretion (feldspar and grid horizons)
- Elevation change (Sediment Elevation Tables)
- Soil particle size distribution
- Disturbance index

Thanks!

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