Evaluating vegetation communities and elevation capital in some of the San Francisco Bay's oldest restoration projects and comparison with west coast results

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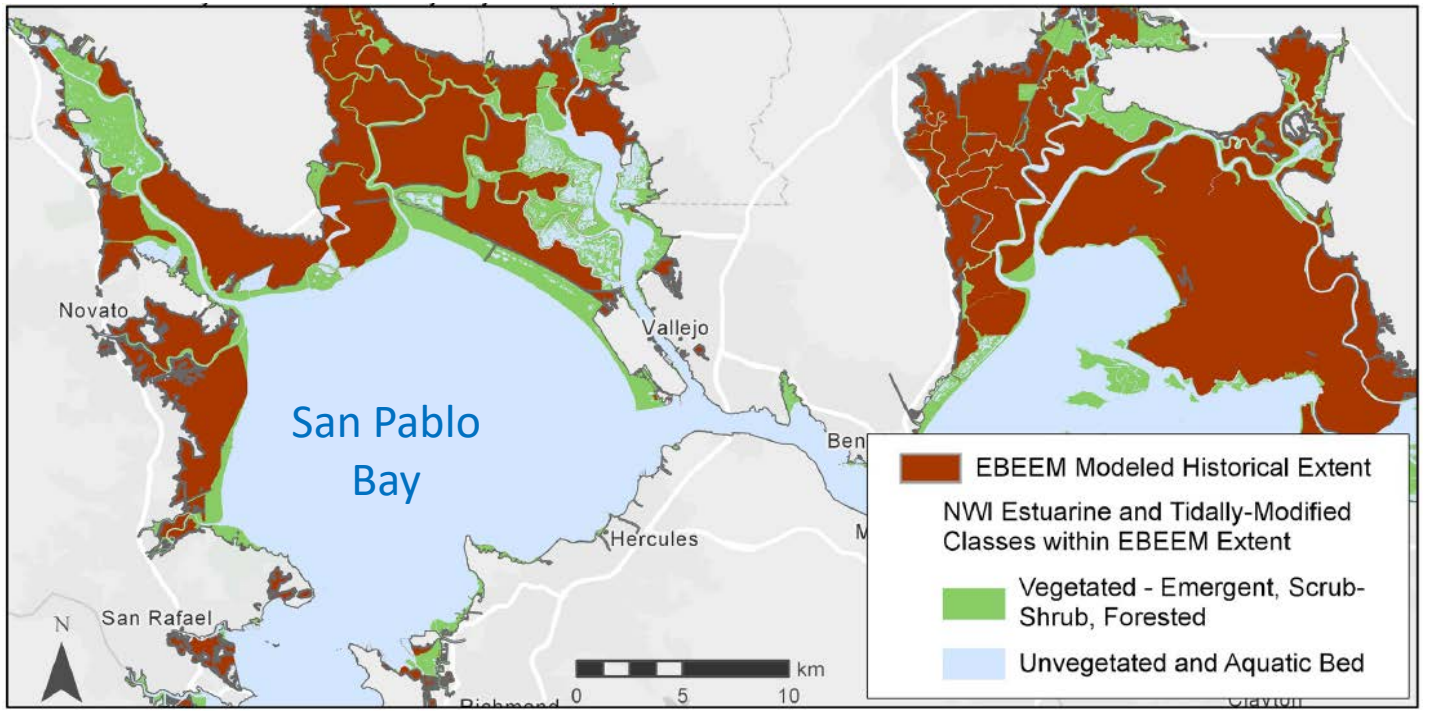
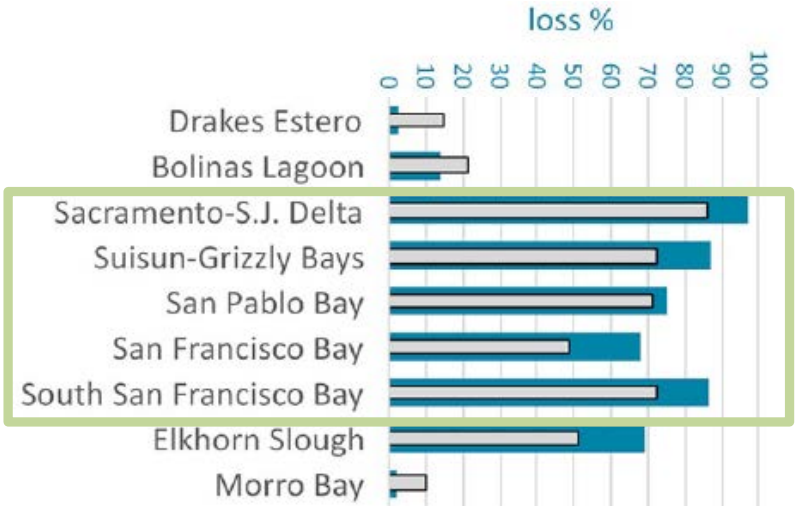
State of the Estuary, May 2024

Tidal wetland loss and recovery

- Substantial estuarine wetland loss
  - 68-98% loss of marsh in SF Bay/Delta
  - 85% loss of tidal wetlands across US west coast
- Marsh restoration dates back to mid 1900s
- Restoration accelerating
- Need to assess long-term outcomes of projects



Brophy et al. (2019) PLoS 1



National Estuarine Research Reserve System Science Collaborative

Goal: Evaluate three inter-related tidal wetland attributes – elevation capital, vegetation development, and carbon sequestration – in a set of the oldest tidal marsh restoration projects along the west coast of the US.

1. How does the elevation capital of older restored sites compare with reference wetlands?
2. To what extent do vegetation communities in older projects resemble least-disturbed reference wetlands?
3. What is the carbon sequestration capacity of restored tidal wetlands along the Pacific coast and does sequestration capacity vary with restored wetland age or other factors in ways that can inform restoration prioritization and implementation?

Study design

- Pairs of restored and reference wetlands
  - Selected with end-user input & access/data considerations
  - 16 pairs in 9 estuaries
  - Age = 19-62 yr
  - 2 west coast climate regions
- New field data collection and existing data

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San Francisco Bay sites

- Faber restoration, South SF Bay
- Levee breached, 1969
- Elevation manipulated with fill

San Francisco Bay sites

- Muzzi marsh restoration, Marin Co.
- Restored 1976
- Elevation manipulated with fill

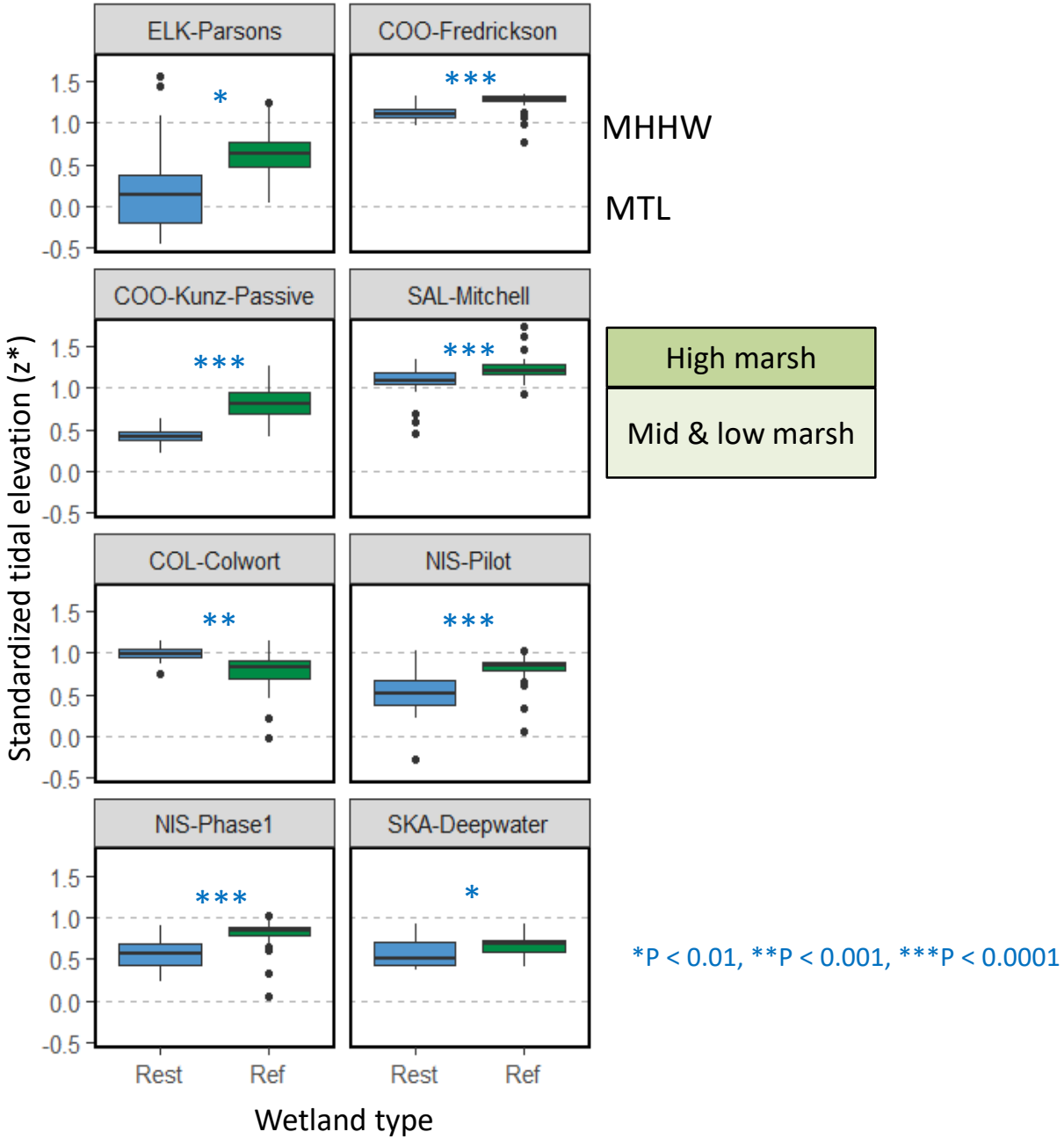
San Francisco Bay sites

- Sonoma Baylands restoration
- Restored 1996
- Elevation manipulated with fill

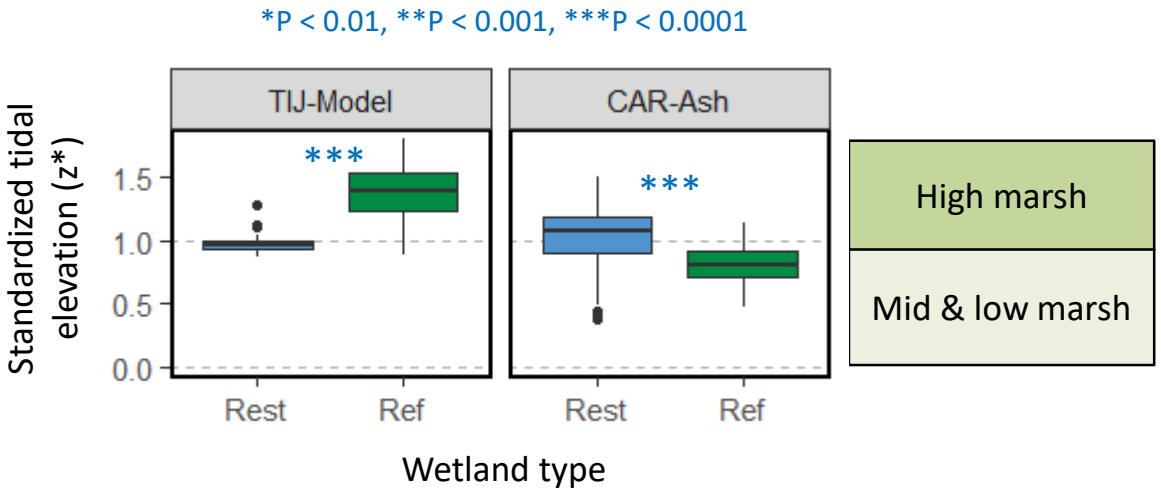
Methods – restoration condition assessment

- Marsh surface elevation
  - RTK-GNSS along transects
- Vegetation cover, composition, diversity
  - Veg transects, aerial imagery
- Soil pore water salinity
- Soil accretion, carbon density, C sequestration

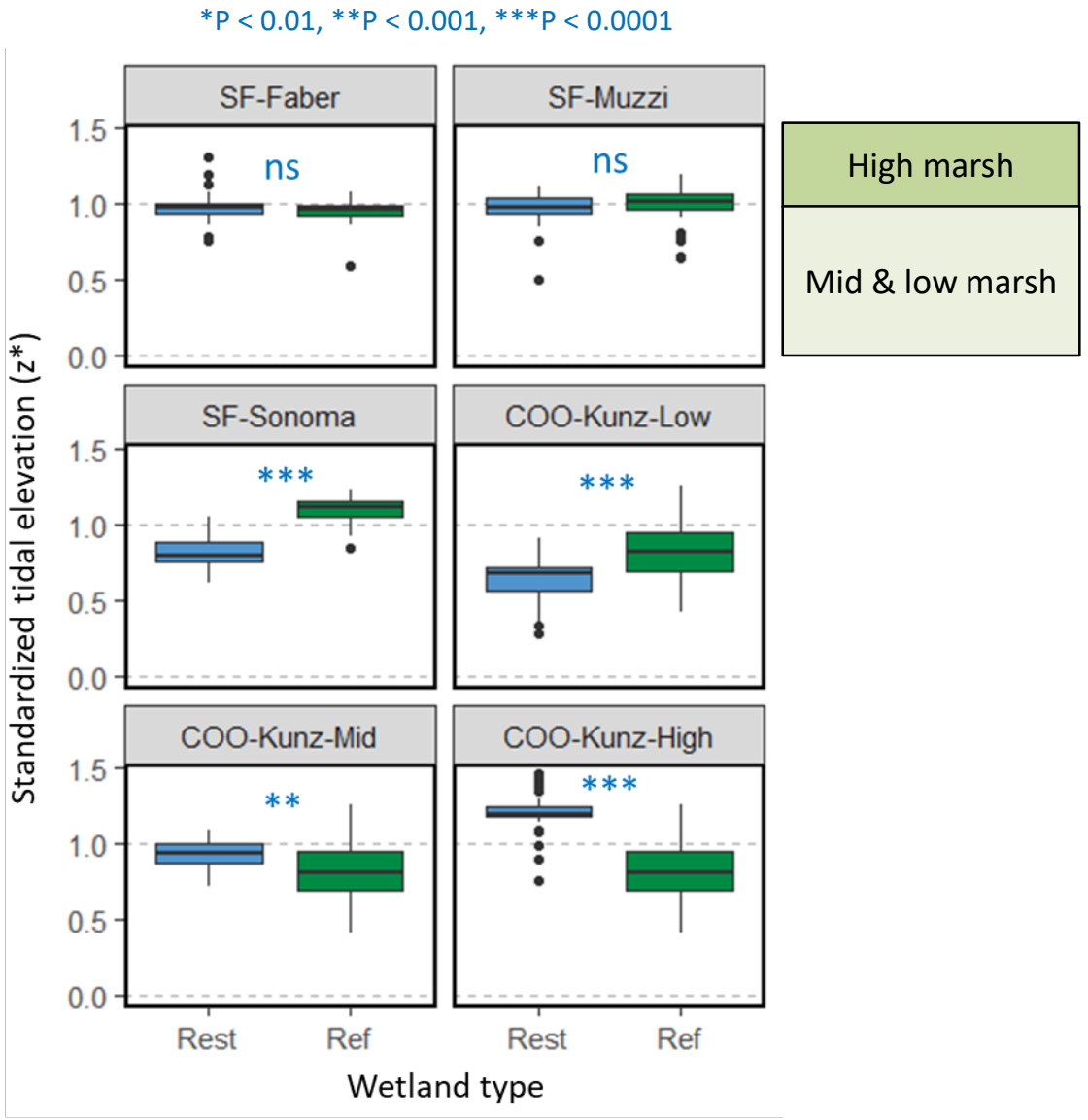
- A. Sites where elevation was un-manipulated
- In 7/8 sites, restored site elevation was lower
- Parsons mostly too low to support vascular plants



- B. Sites with fill removed
- Both sites have good elevation capital
- Tijuana has an ample sediment supply from the watershed



- C. Sites with fill added
- Faber and Muzzi are very similar to reference marshes
- Sonoma Baylands has a modest elevation deficit



Results – vegetation communities

- At least 85 plant taxa present in the dataset for the west coast
- Macroalgae: Chlorophyta, *Vaucheria*, *Fucus*

Results – vegetation communities

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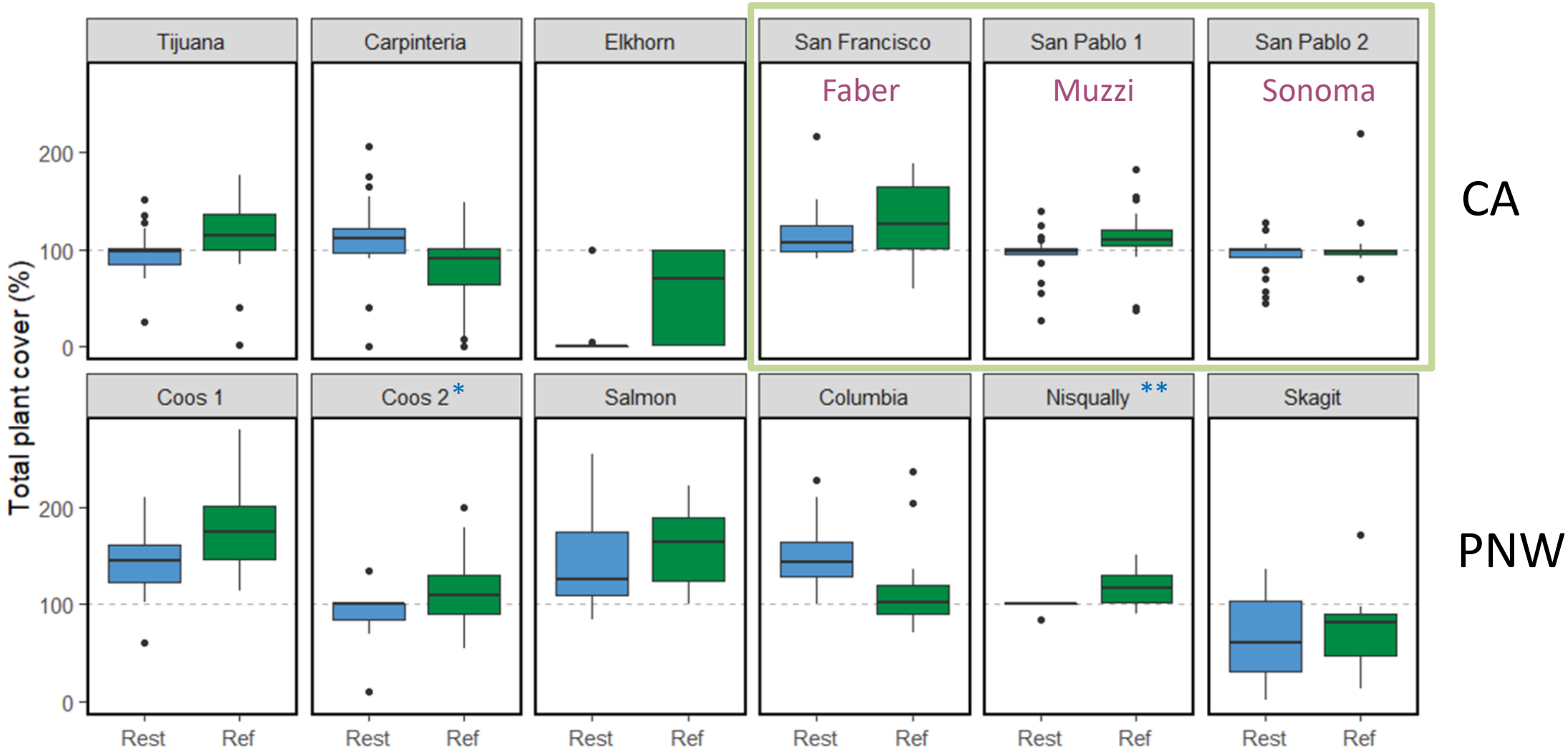
Plant cover

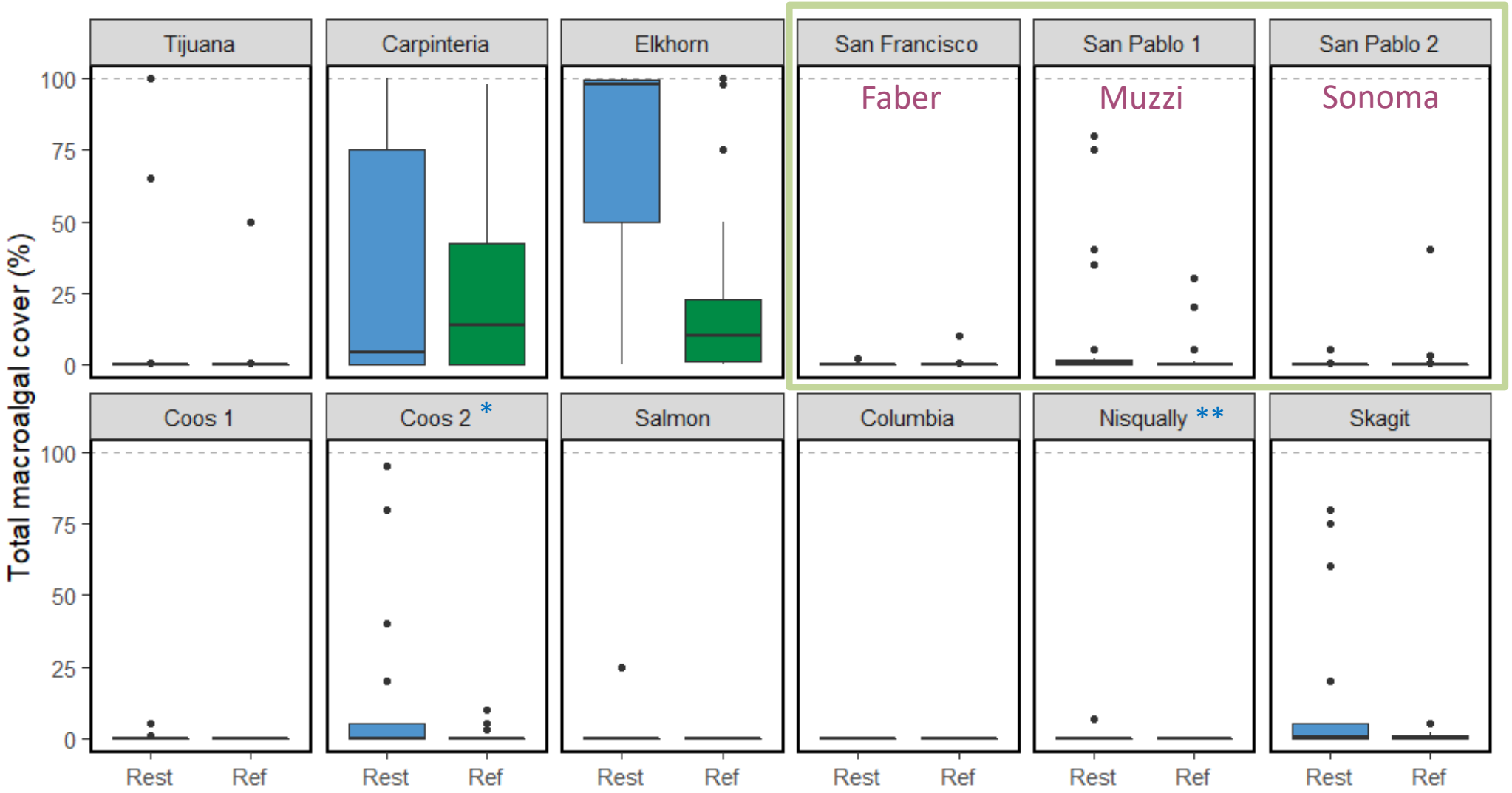
- Most restored sites had relatively high total plant cover



*Parts of Kunz low and Kunz passive cells only; ** Phase 1 site

Macroalgal cover

- Patchy macroalgal occurrence.



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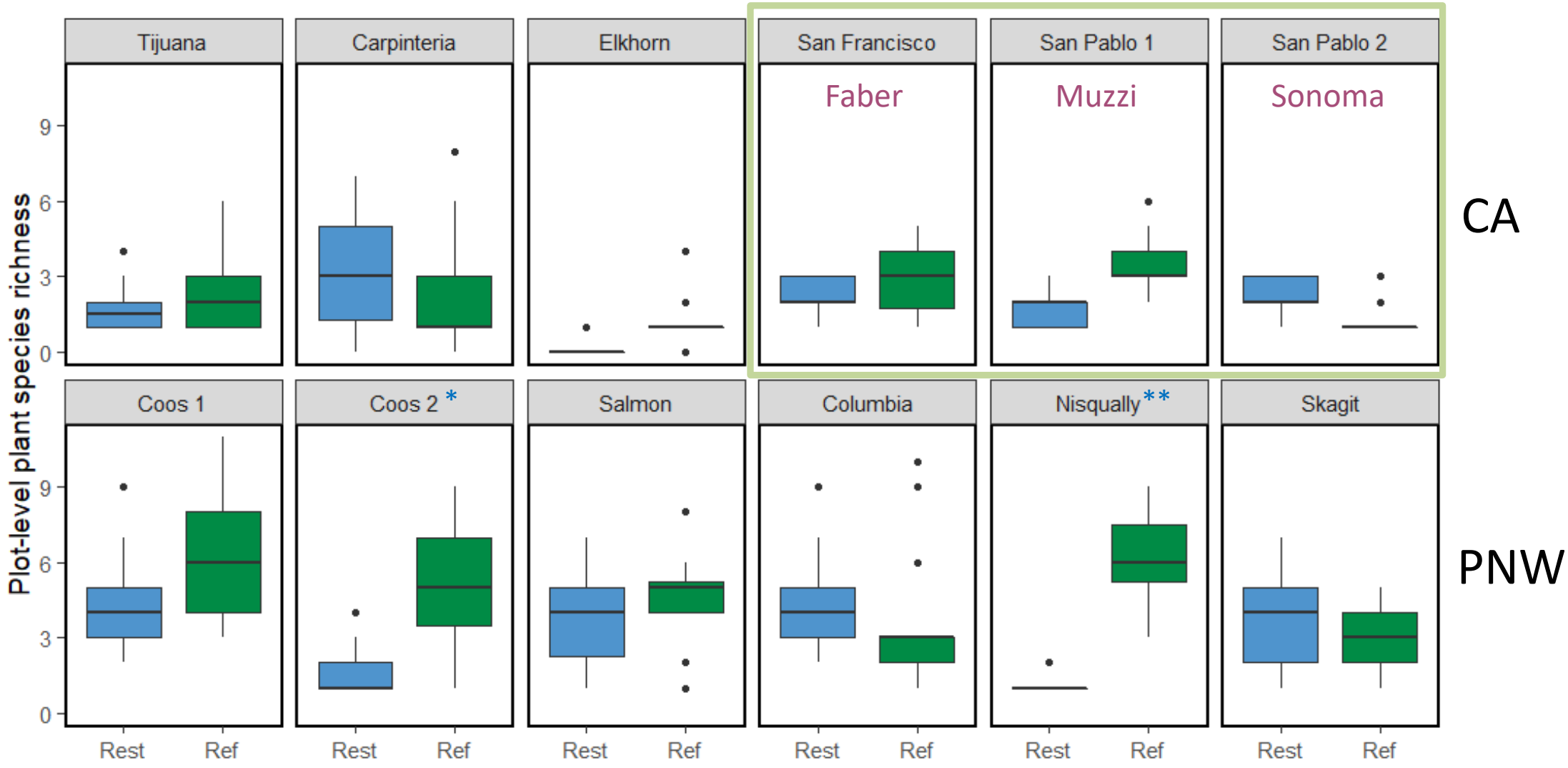
Plant diversity

- Many, but not all, restored sites had lower richness



*Parts of Kunz low and Kunz passive cells only; ** Phase 1 site

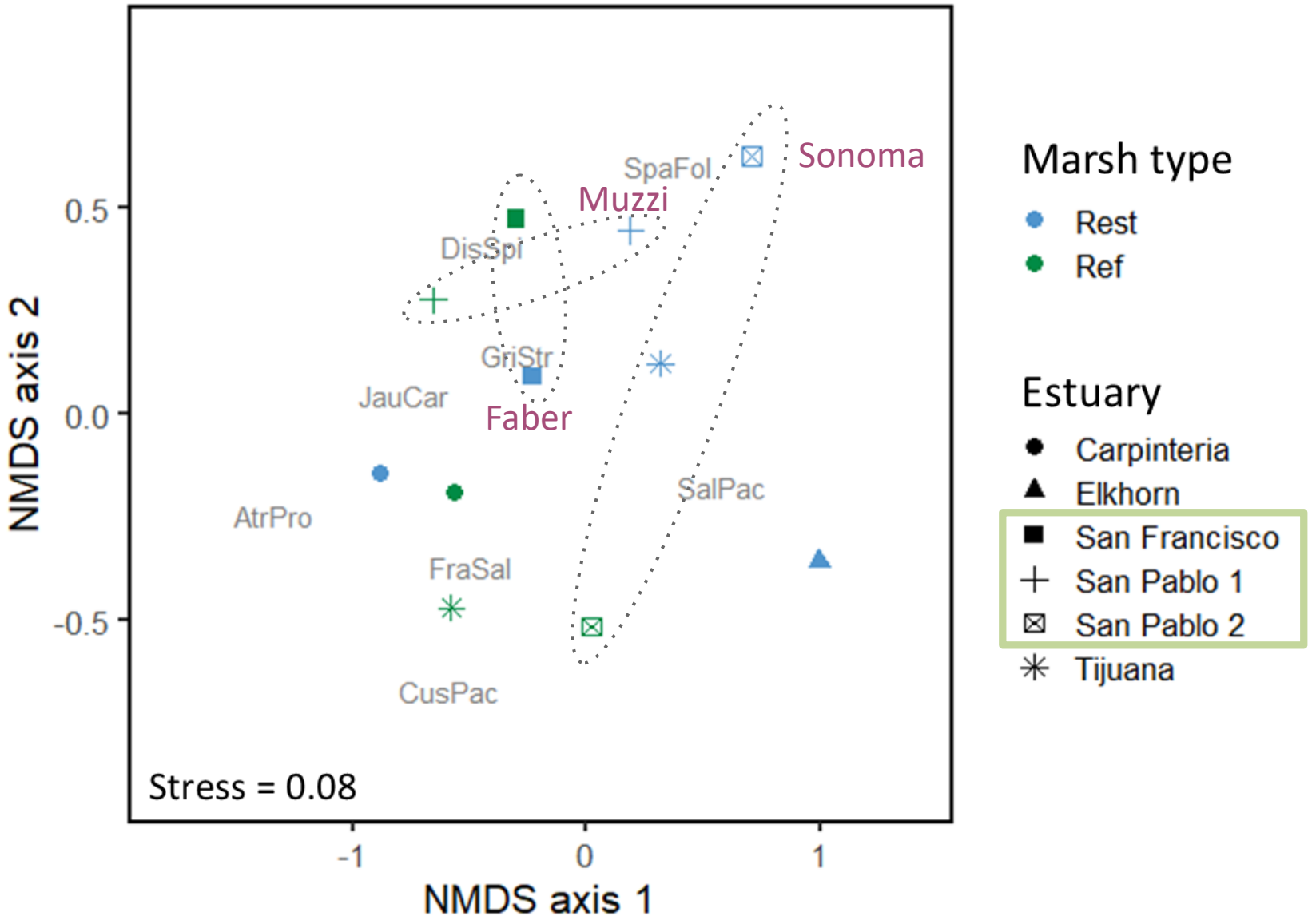
Results – diversity

- Restored sites sometimes lacked rarer species found in reference sites
- Example: Salt marsh birds beak at Heerdt marsh, absent from Muzzi

Chloropyron maritimum ssp. *palustre*

Results – species composition

California - average site cover by species



Results – non-native plants

- Non-native species also present
- Prevalence may be driven more by salinity than restoration status (tdb)

Salsola soda

Limonium duriusculum

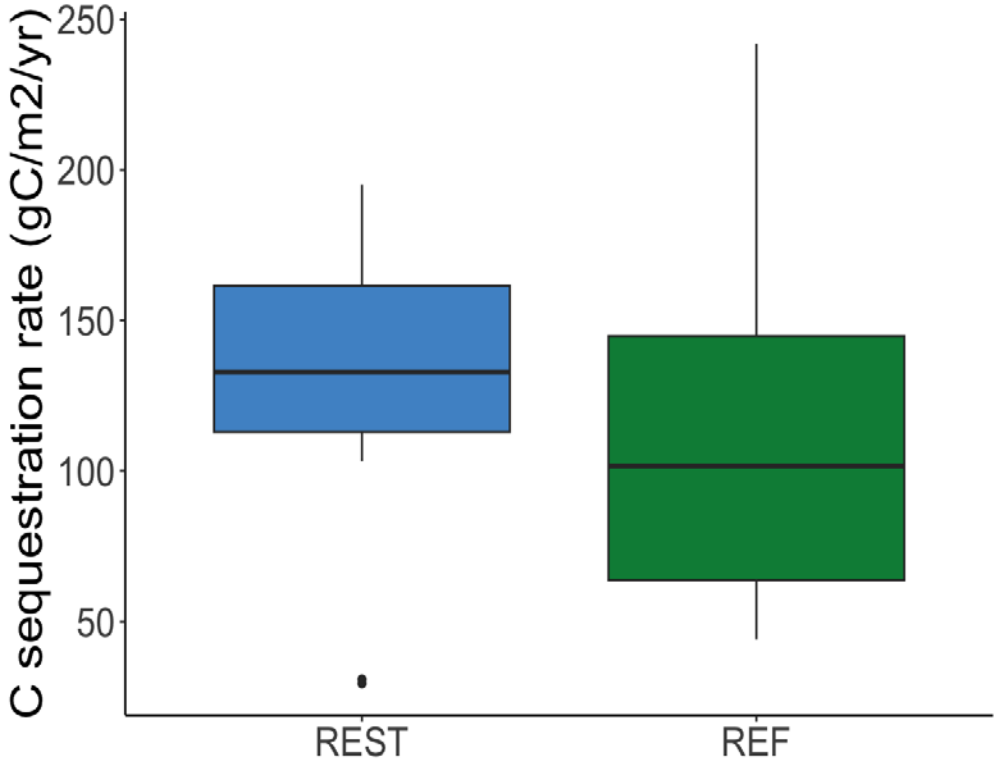
Results – carbon sequestration

- Core analysis on-going (WWU)
- C Seq = C density *x* accretion rate

Poppe, Schroeter, Rybczyk

Results – carbon sequestration

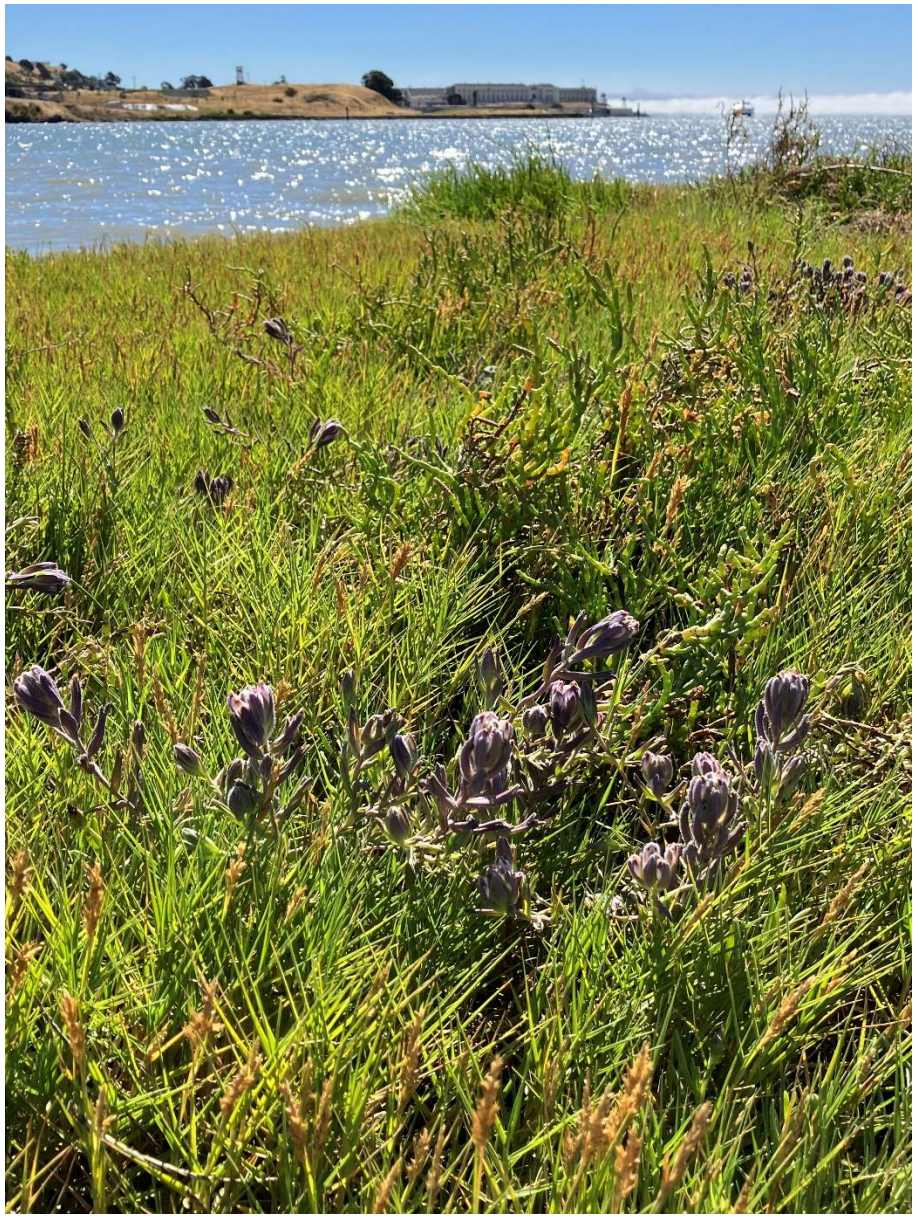
- Overall (preliminary) trend towards higher carbon sequestration in restored sites
- Carbon density similar, so sequestration appears to be driven by higher accretion rates in restored marshes



Poppe, Schroeter, Rybczyk

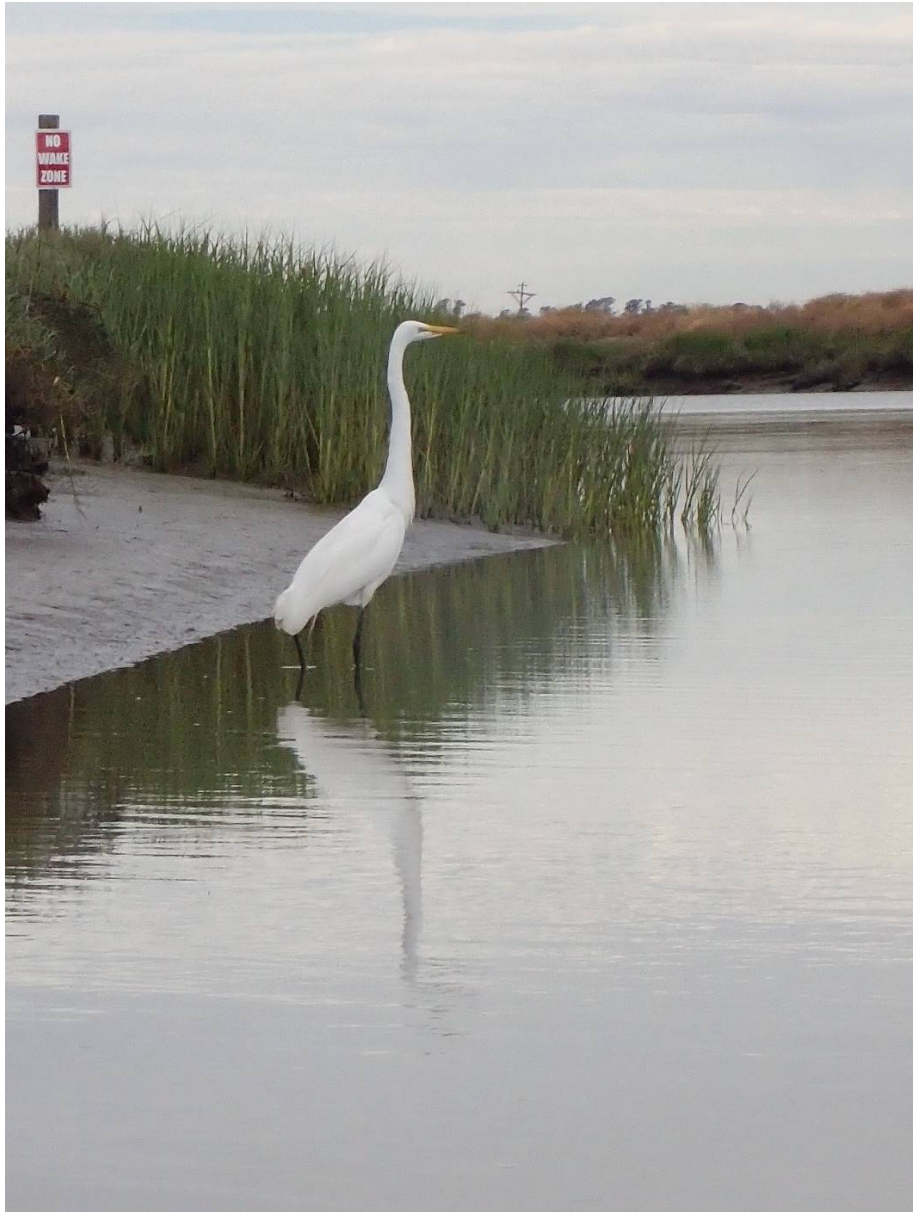
Summary of results

- Elevation:
  - Some sites have elevations similar to or higher than reference sites – promising for SLR resiliency
  - Sites tend to have higher elevation capital when elevation is manipulated
- Vegetation:
  - Overall, restored site plant cover is high
  - Composition and diversity may take decadal time scales to match reference sites
  - Non-native species: tbd
- Carbon sequestration:
  - In progress, but restoration may boost sequestration potential near-term



Implications

- Elevation is a key consideration in design with functional tradeoffs
  - Too low: vulnerable to SLR
  - Too high: poor channel development, lower C sequestration
- Restoration “recovery” is also site-specific
- Long-term monitoring is a critical component of restoration practice
  - Better understand successional trajectories
  - Determine SLR resilience
- Value in a regional approach to monitoring and measuring restoration patterns



Thank you!

National Estuarine Research Reserve System Science Collaborative

- US Fish and Wildlife Service, CA Dept Fish and Wildlife, National Estuarine Research Reserve System, National Park Service, US Forest Service, UC Natural Reserve System, Washington Dept of Fish and Wildlife, Port of Astoria

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