

Methods for restoring a native saltmarsh dominant



Coastal
Conservancy



Olofson Environmental, Inc.



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¹San Francisco State University¹ and Coastal Conservancy's Invasive Spartina Project²

Talk Outline

- Ecological Restoration in the context of the Bay
 - Horticulture versus Field of Dreams
- Spartina
- Project and Research Aims
- Restoration recommendations





What is Ecological Restoration?

Intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability. (SER 2013)

Restoration in Tidal Salt Marshes



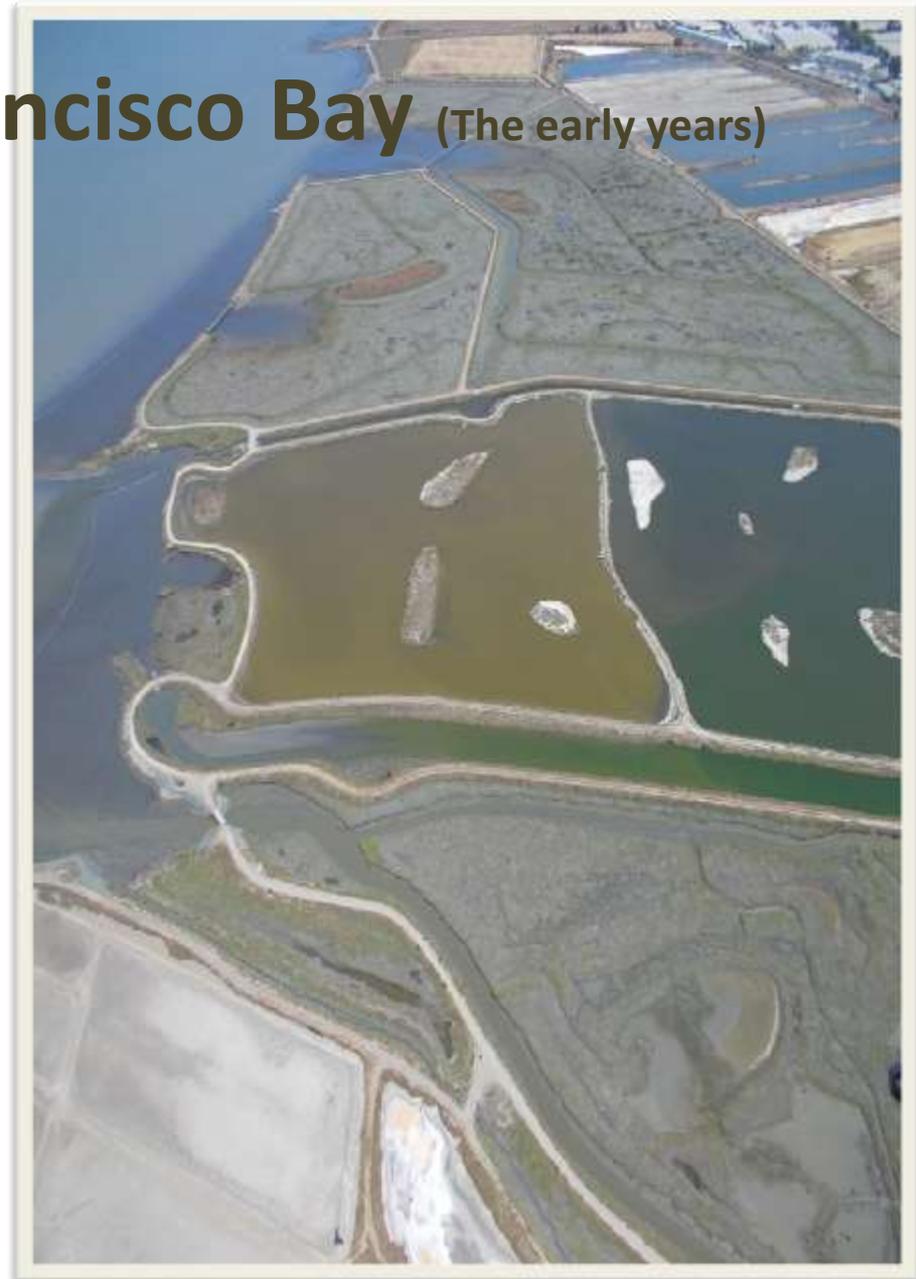
Mowry Marsh, Centennial Marsh



Inundation + Salt water + Complicated landscape factors = Tidal Salt Marsh!

Restoration in San Francisco Bay (The early years)

- Experimentation
 - (Zedler 1982, HT Harvey 1983)
- Beneficial reuse of dredge material
 - (USACE 1975, 1976)
- Shoreline stabilization/Erosion Control
 - (Josselyn 1984. USACE 1978)
- “Green” barren soils
 - (Knutson 1973)
- Endangered Species Habitat
 - (Harvey et al. 1982)
- Rapid establishment of vegetation for **mitigation**
 - (BCDC 1988)



Spartina

Spartina foliosa Trin.

- Low marsh dominant
- Colonizes unvegetated substrate
- Erosion control
- Endangered Species Habitat

(Hinde 1954, Goals 1999)



A21: 2006 Restoration



Planting efforts occurred
with many early
restoration/mitigation
projects.....



Knutson
et al,
1975



Newcombe et al, 1978

Salt Marsh Restoration Experience in San Francisco Bay

Philip Williams and Phyllis Faber

In 1983, Margaret Race completed a critical review of these projects showing how more than 90% of *Spartina* plantings had died out and suggesting tidal restoration projects were failures because they did not meet their stated goals (RACE, 1983). Although *Spartina* did subse-



Failure

By the early 1980s, it was recognized that plantings were unnecessary because of the large seed source in San Francisco Bay that established naturally over time.



Thought to be unnecessary

From mitigation to restoration...

- Time scale
- Connectivity
- Approach to establishing vegetation



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Restoration
Mistakes



Spartina densiflora, collected from Humboldt Bay was planted. At that time, *S. densiflora* was mistakenly considered to be the native *S. foliosa*. In the Pond 3 restoration, the exotic *Spartina alterniflora* was imported from Maryland as an experiment to compare planting by broadcasting seed or by planting plugs. (Both of these exotics are now invading adjacent marshes displacing both the native *S. foliosa* and other wetland species.)

The other *Spartina*
(*Spartina alterniflora*)



Callaway and Josselyn 1992, Ayres et al 2004,
Grosholz and Levin 2002

Cargill Mitigation Photo Point (2005 and 2012)





Salt Marsh Restoration Experience in San Francisco Bay

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Restoration Mistakes

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Goals of Planting Efforts

Self-sustaining populations of native cordgrass

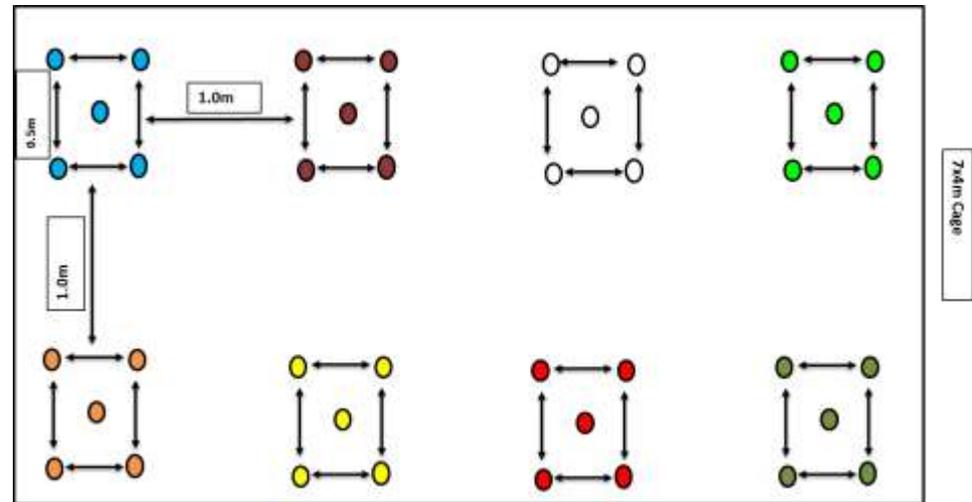
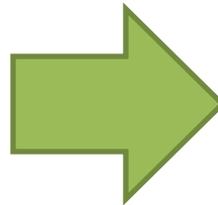
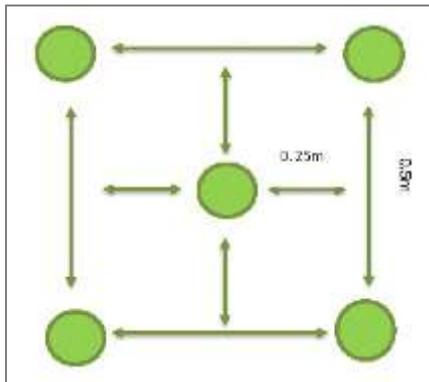
Usable data

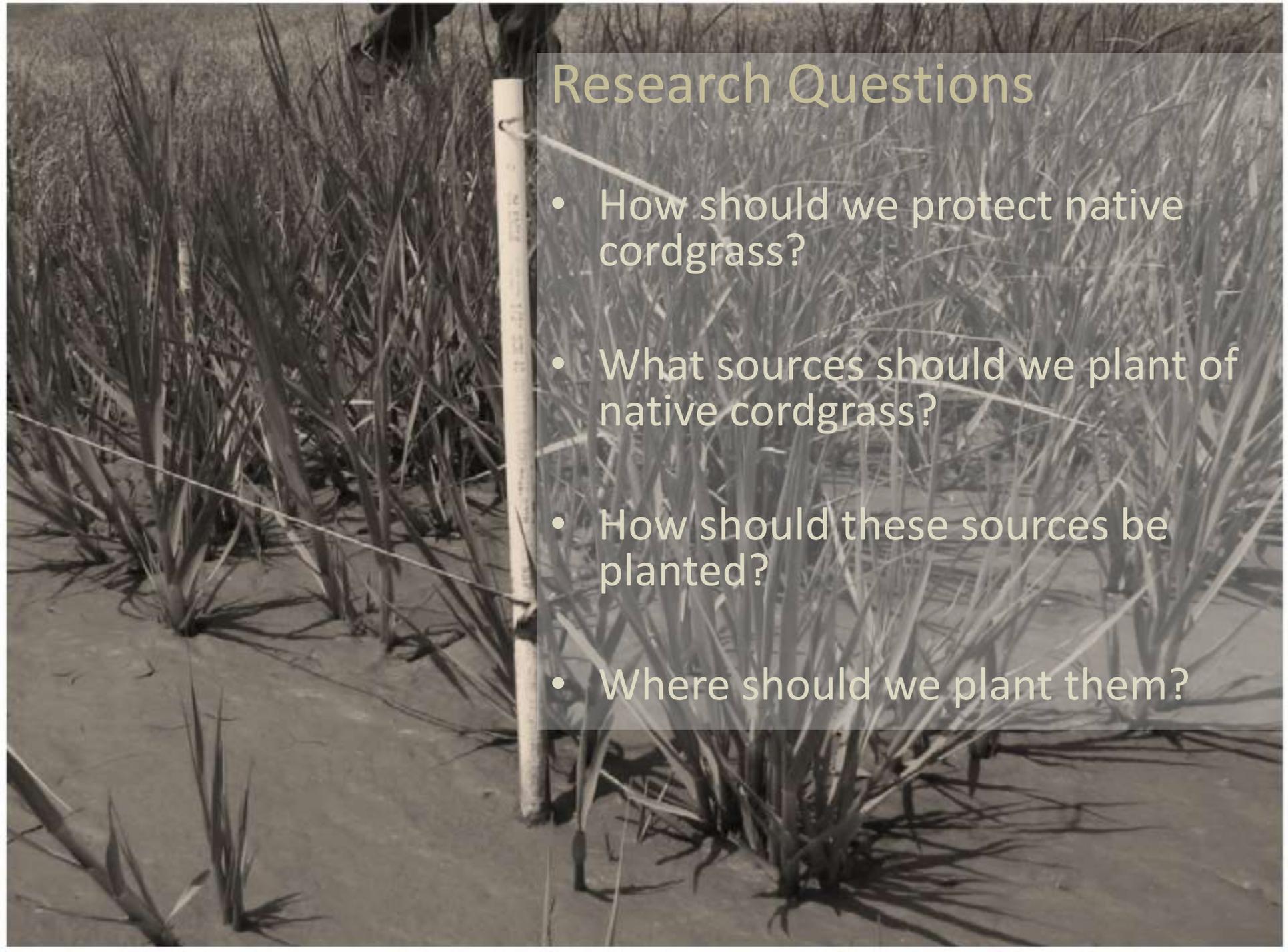
Provide replication across sites

Provide endangered species habitat



Planting Design



A photograph of a cordgrass field with a wooden stake and a string marking a research plot. The grass is dark green and growing in sandy soil. A wooden stake is planted in the ground, and a string is tied around it, forming a rectangular plot. The background shows more of the same grass field.

Research Questions

- How should we protect native cordgrass?
- What sources should we plant of native cordgrass?
- How should these sources be planted?
- Where should we plant them?

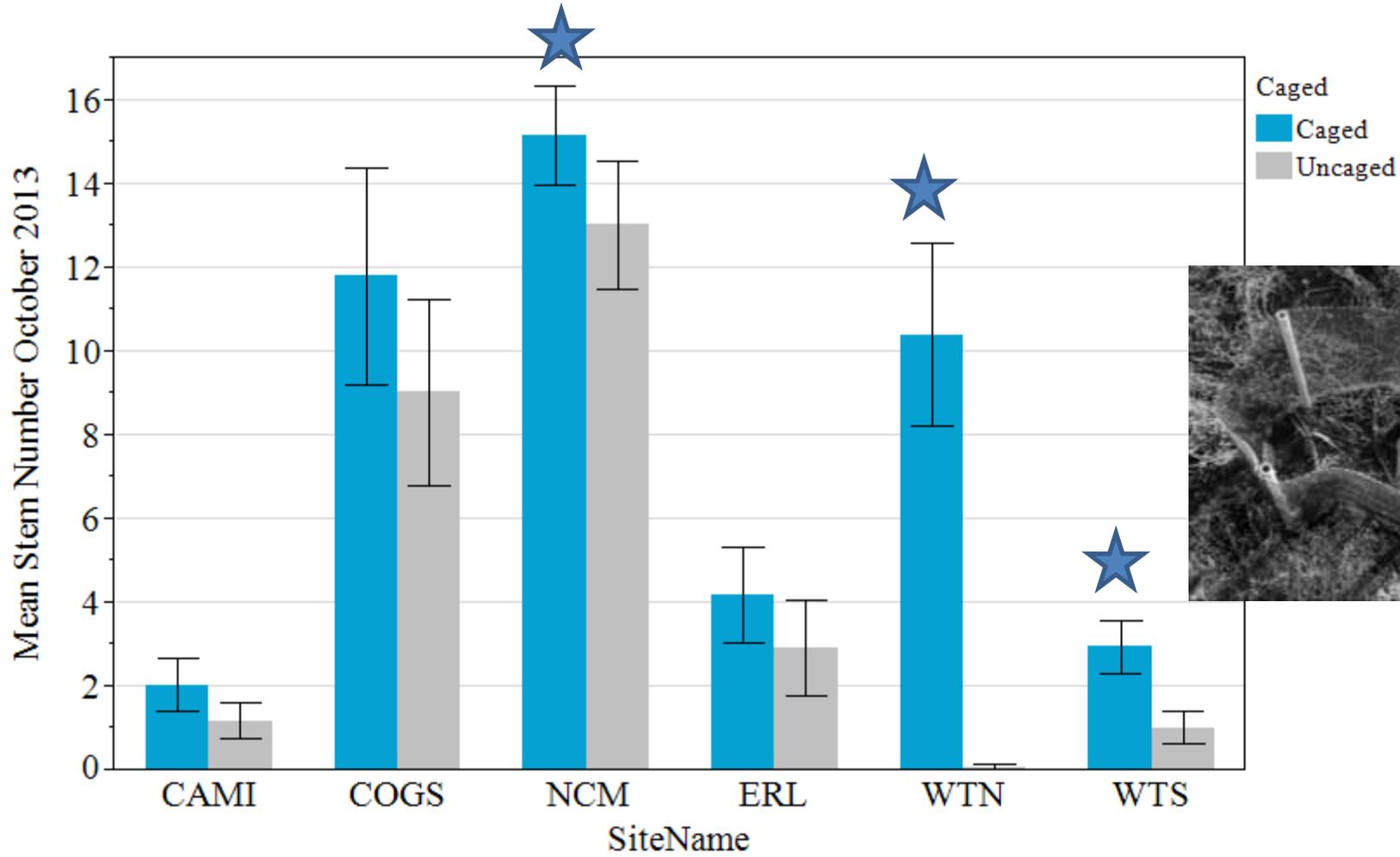
How should we protect native cordgrass?

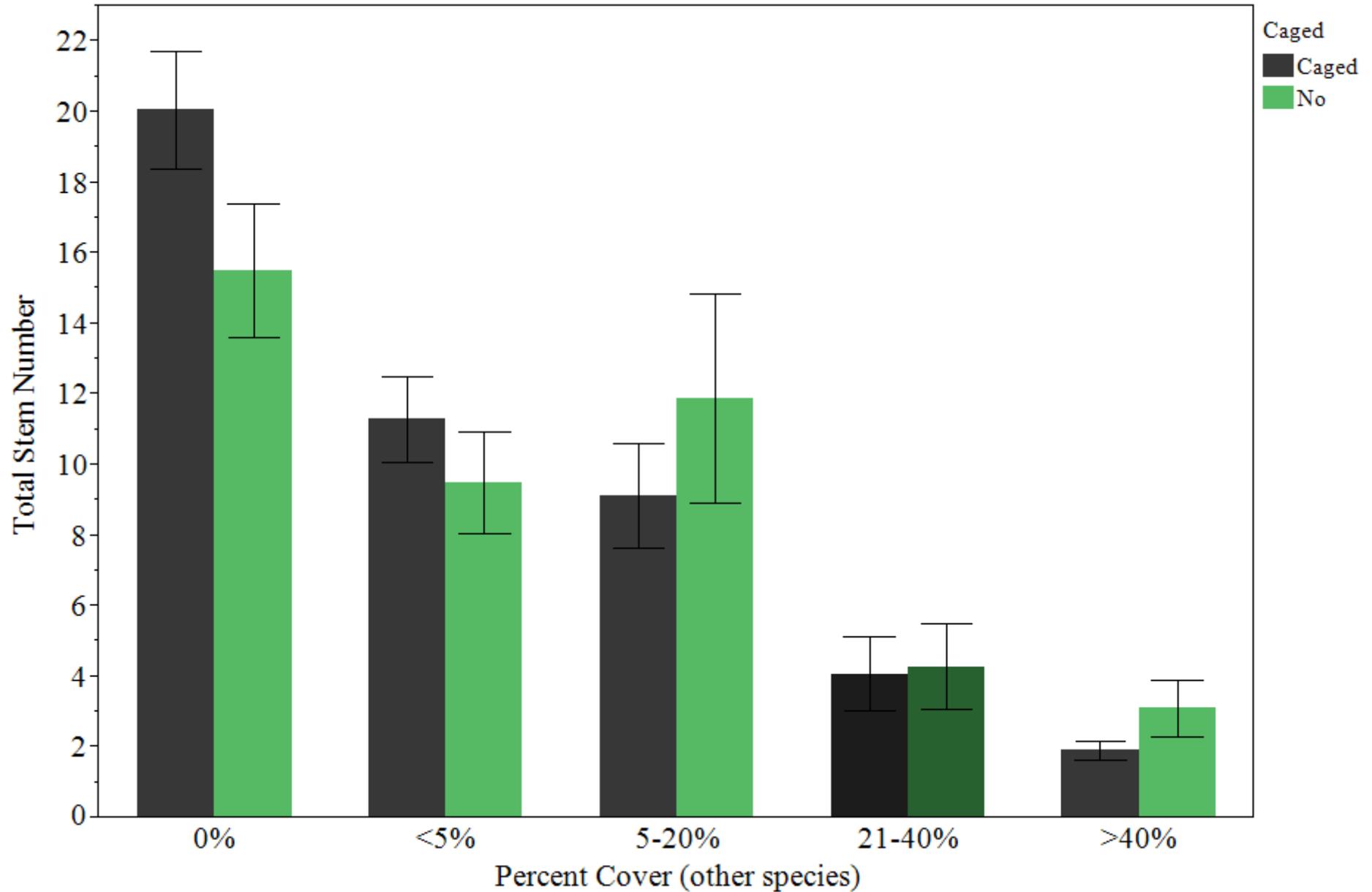


How should we protect native cordgrass?



The effect of rope and plastic mesh caging all sites: 2012 planting





Each error bar is created as 95% confidence interval from the mean

How should we protect native cordgrass?

The effect of rope caging North Creek Marsh (2012 planting)



Each error bar is created as 95% confidence interval from the mean

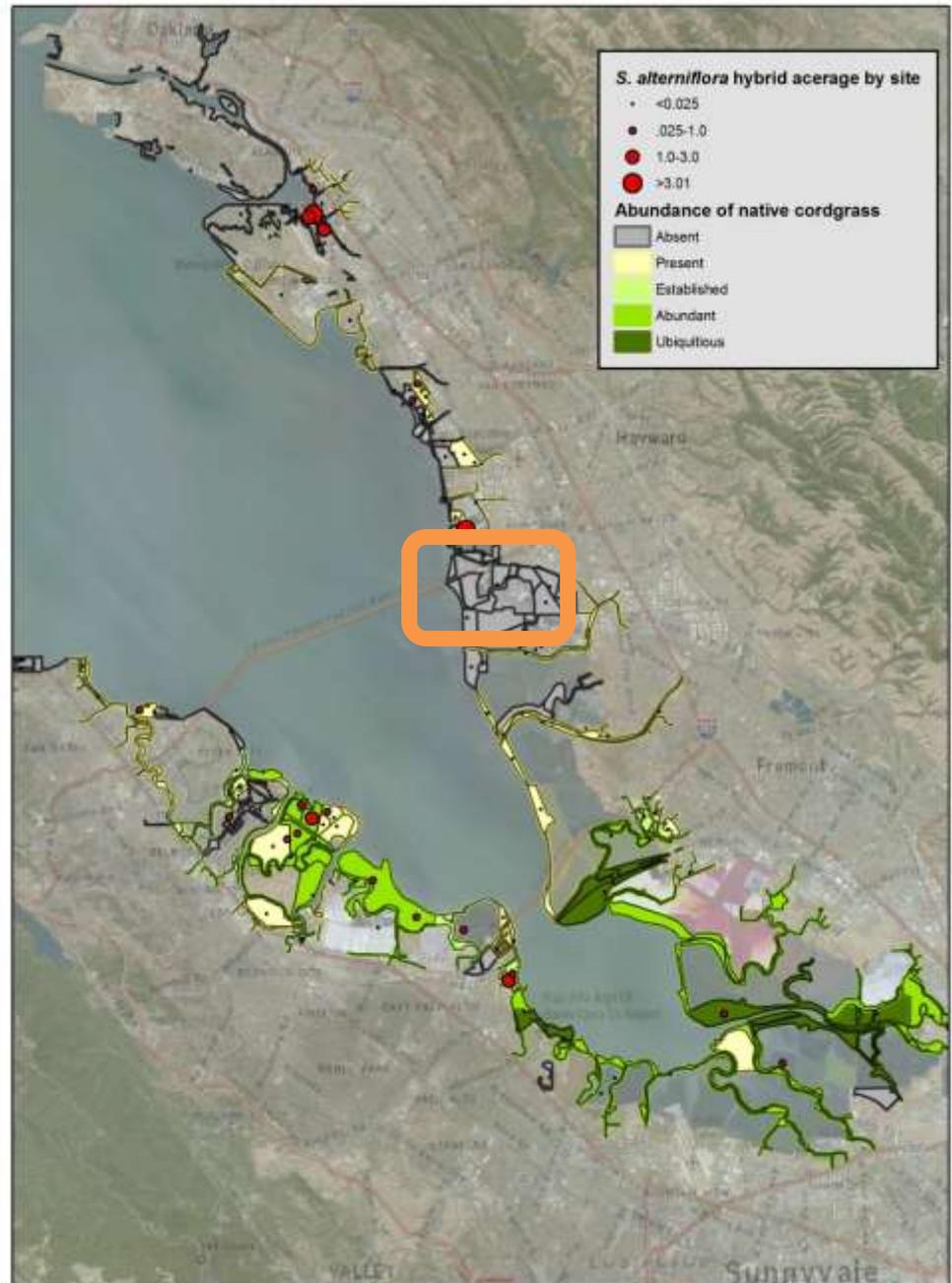
A photograph of a cordgrass field. A wooden stake is planted in the ground, with a string tied around it to mark a plot. The grasses are tall and thin, growing in sandy soil. The background is slightly blurred, showing more of the field.

Research Questions

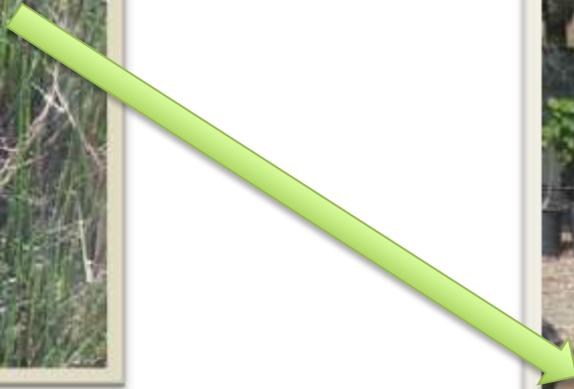
- How should we protect native cordgrass?
- **What sources should we plant of native cordgrass?**
- How should these sources be planted?
- Where should we plant them?

It is hard to find a good parent....

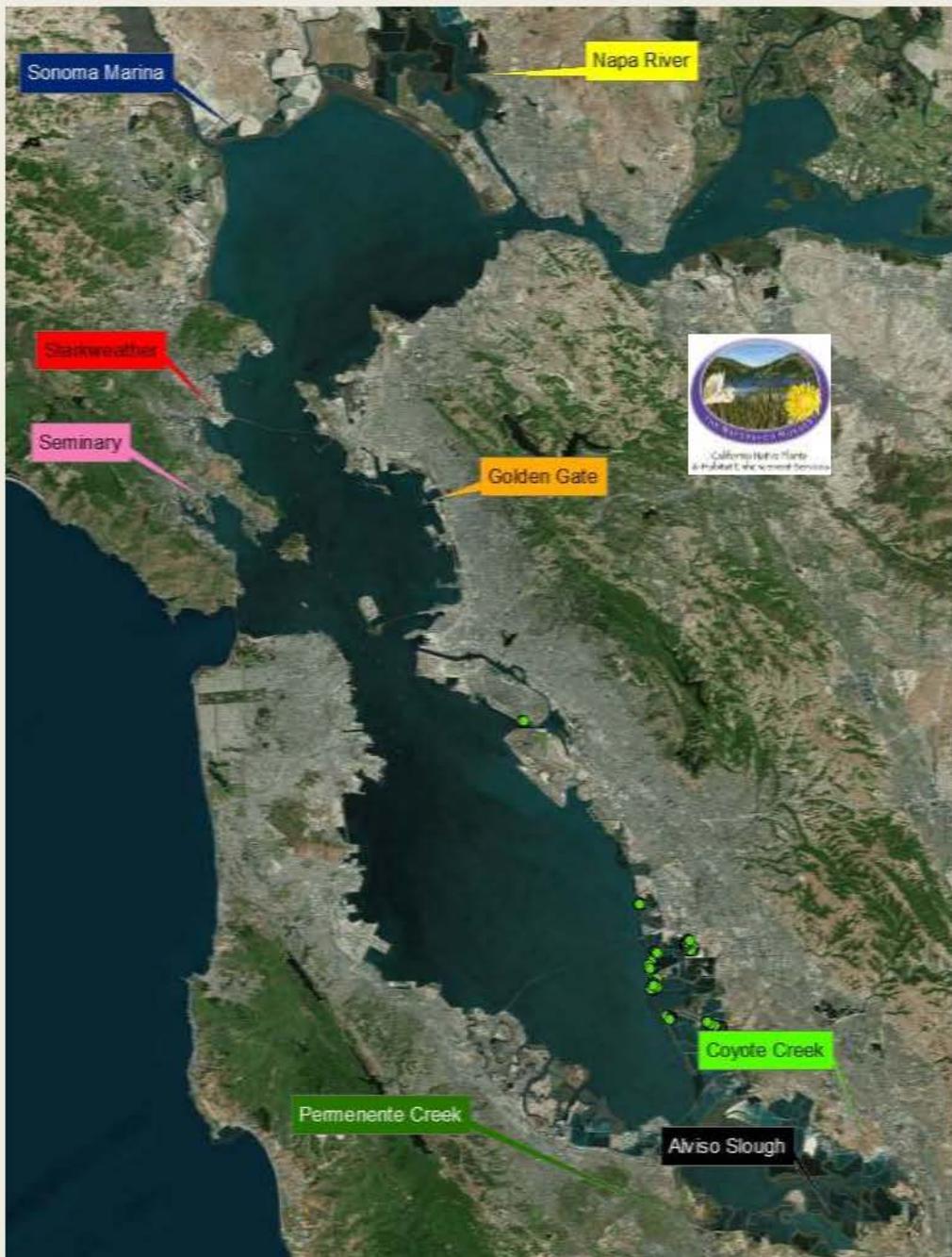
1. Free of hybrid
2. Robust populations of native cordgrass
3. Not Ridgeway's Rail nesting habitat



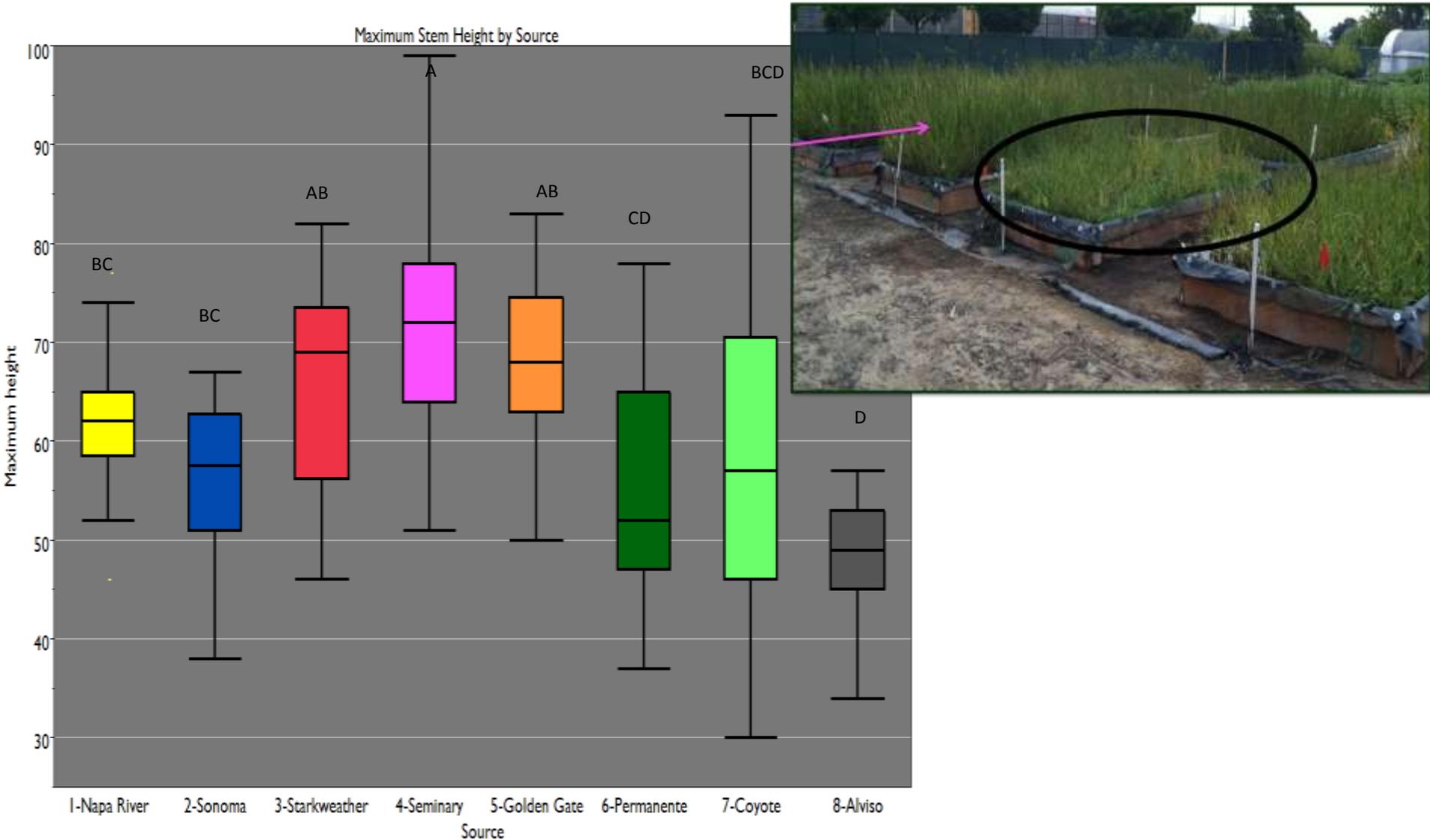
What sources should we plant of native cordgrass?



What sources should we plant of native cordgrass?



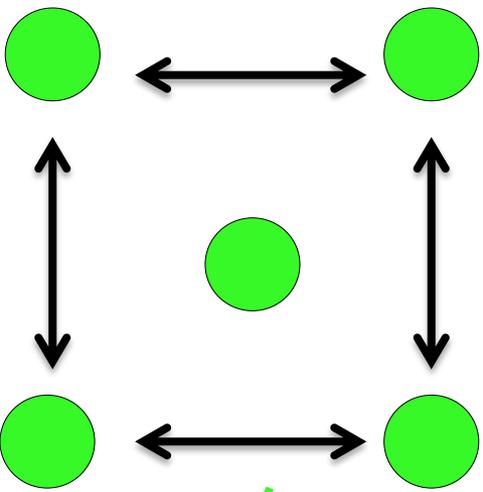
Maximum stem height by source in November 2012



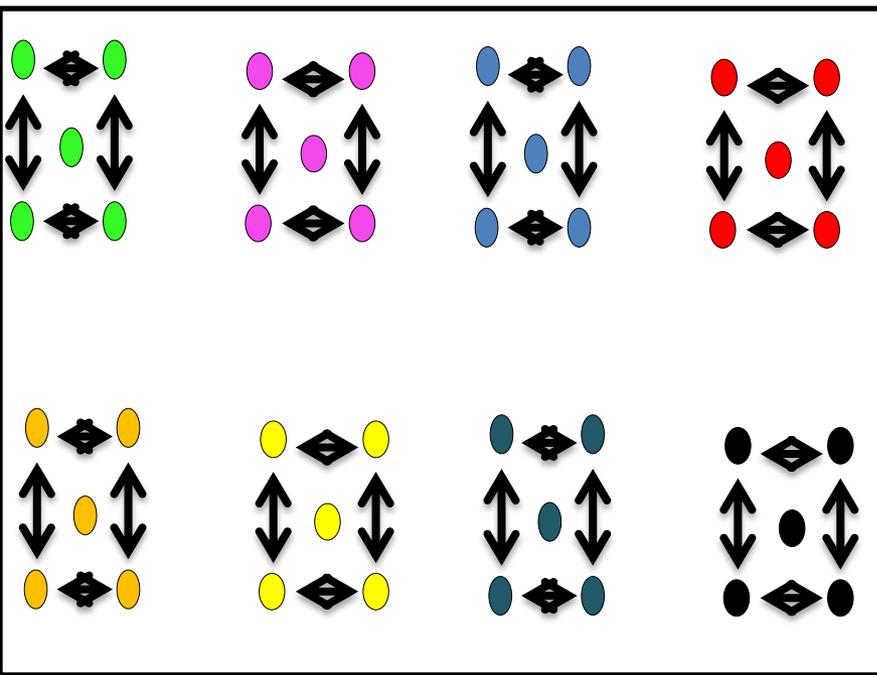
Each error bar is constructed using a 95% confidence interval of the mean.

What sources should we plant of native cordgrass?

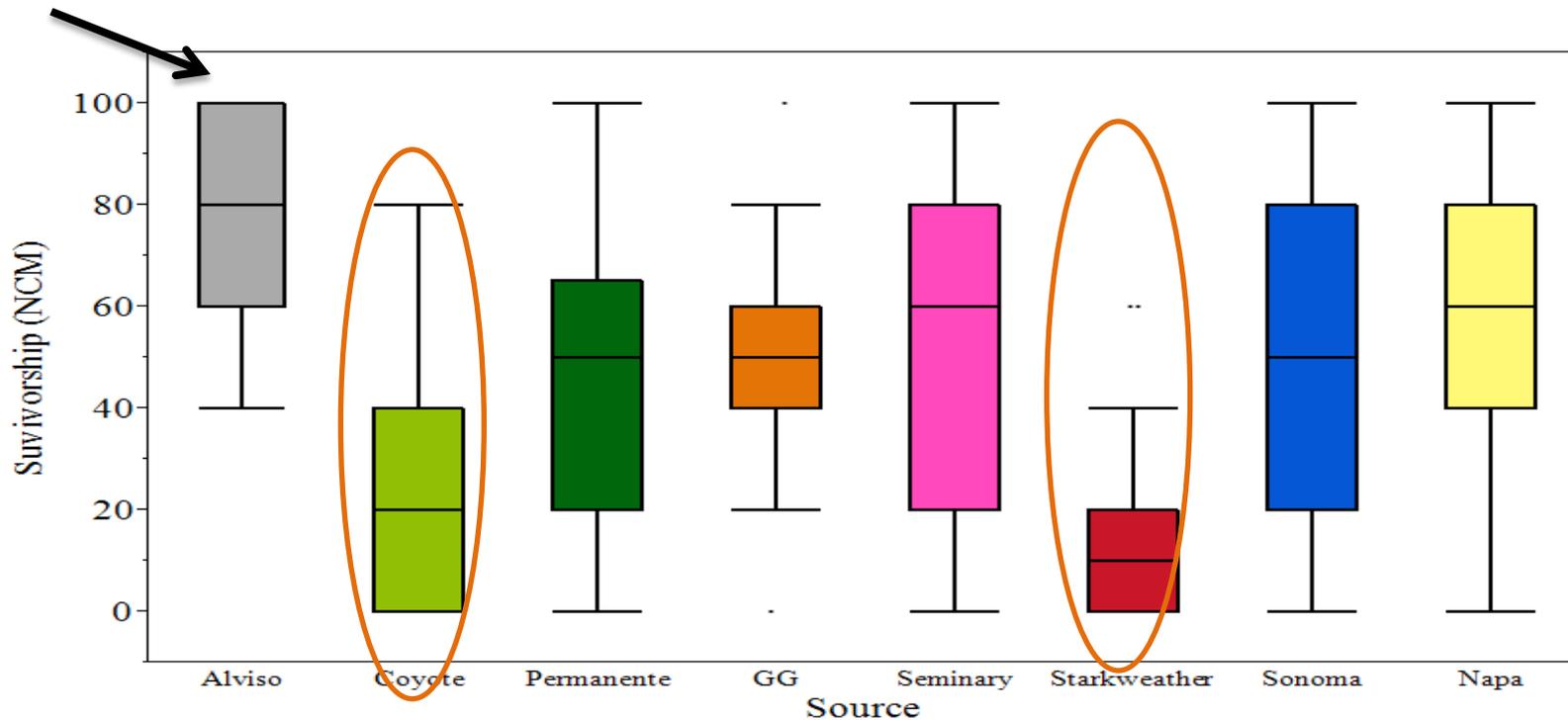
Field Planting



5 plugs x 8 sources x 30 replicates x 2 sites =
2400 plugs

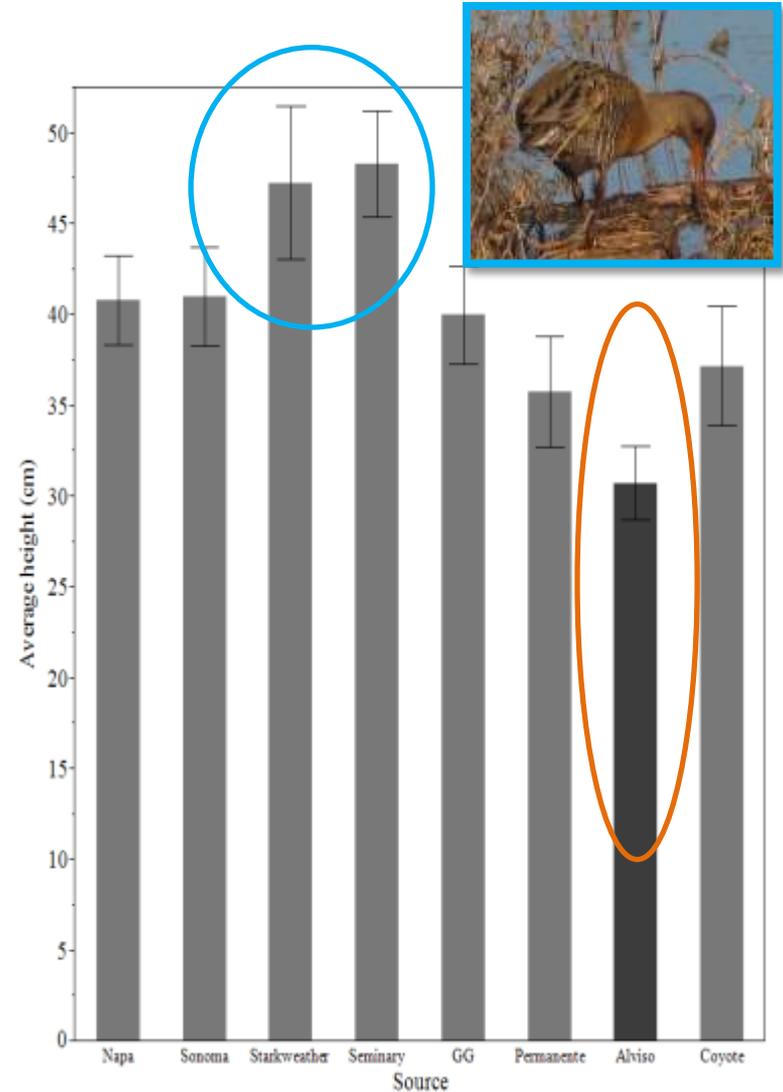
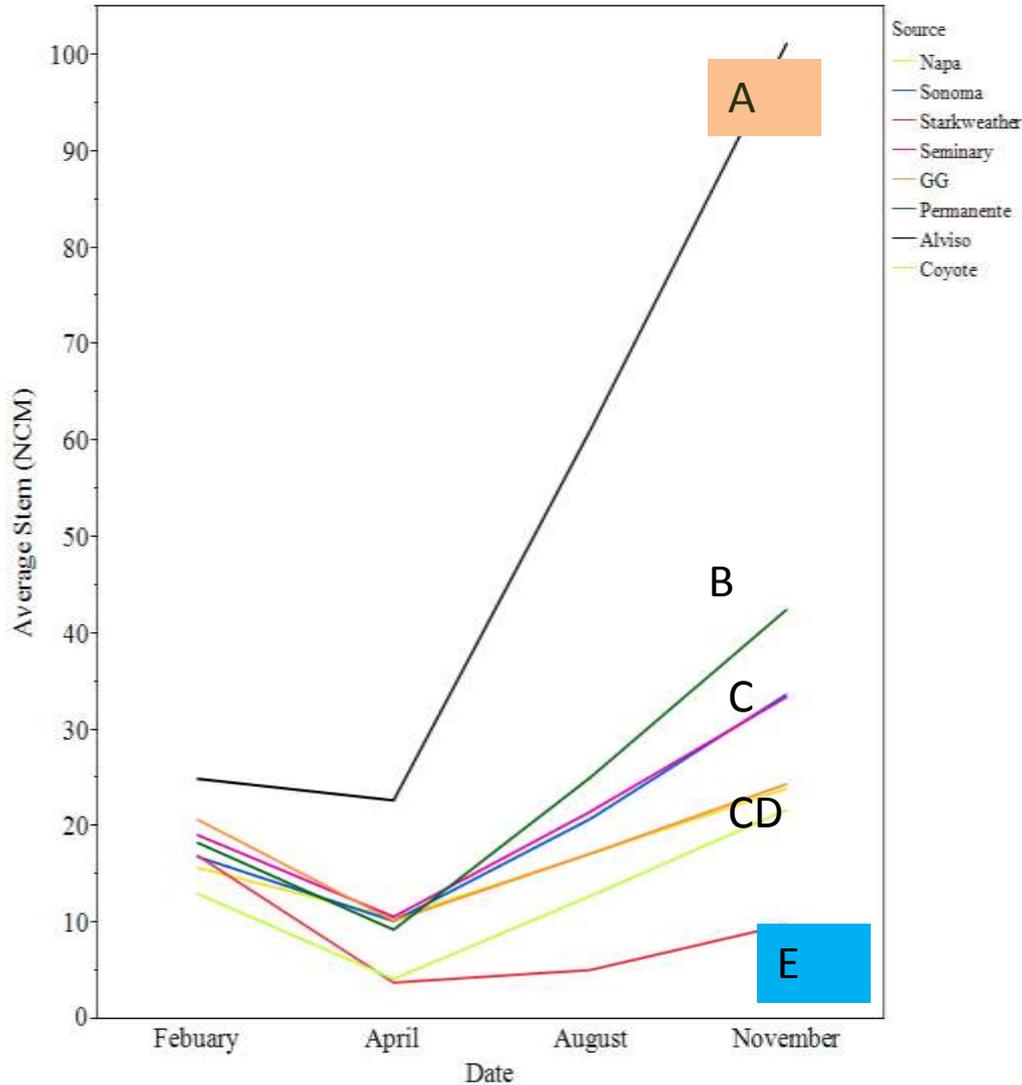


The effect of source on survivorship North Creek Marsh (2012 planting)



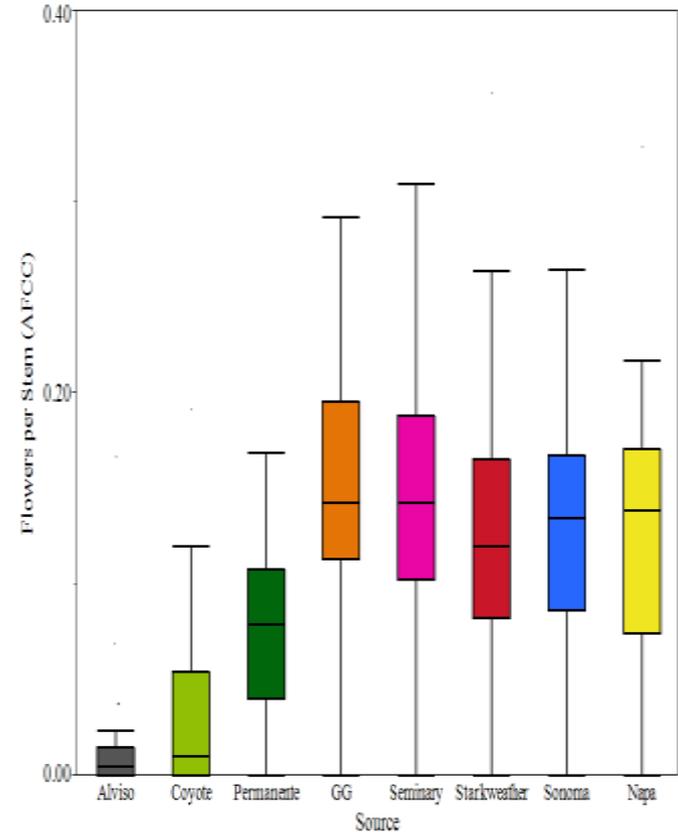
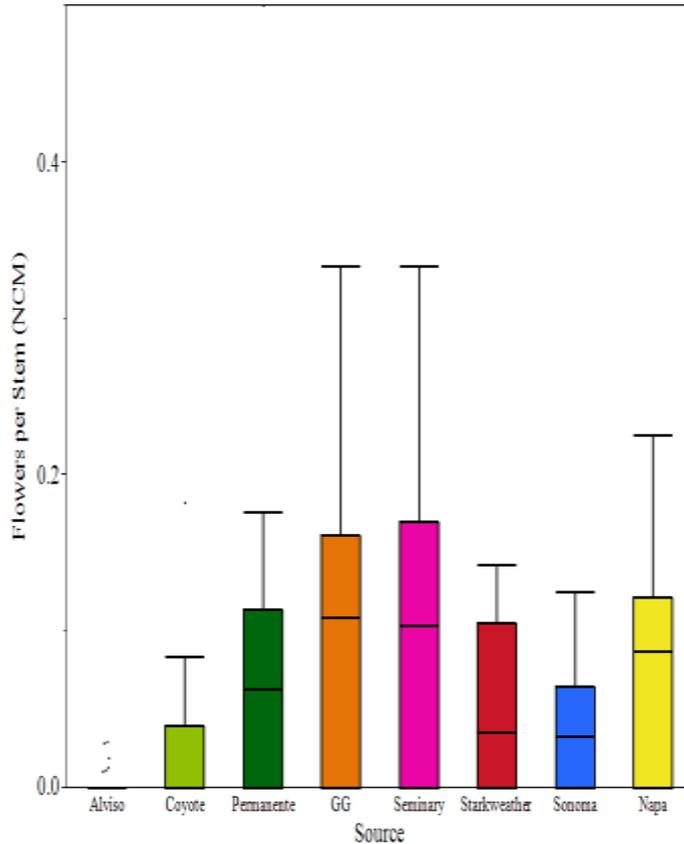
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The effect of source on growth rate and height North Creek Marsh (2012 planting)

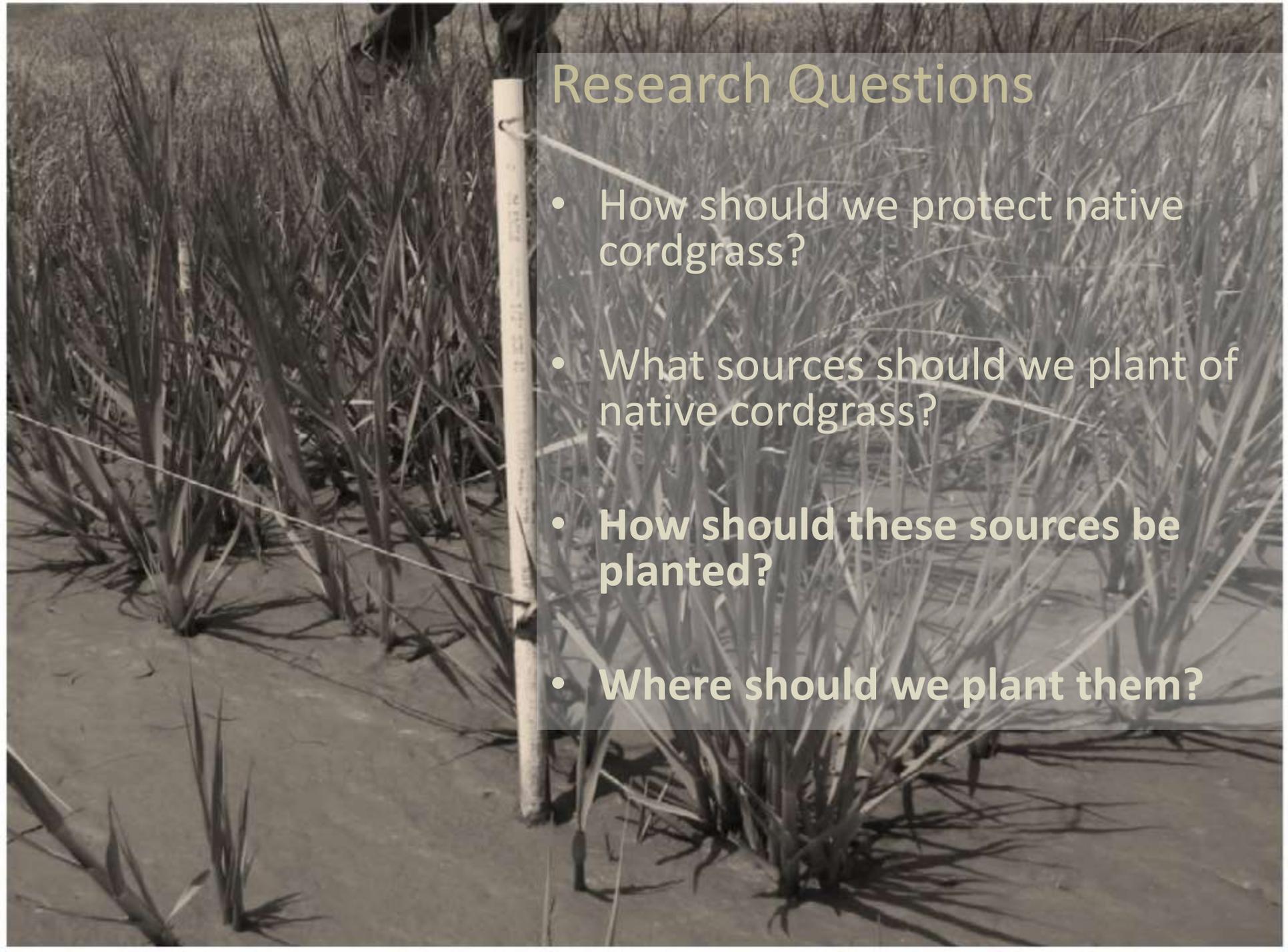


The effect of source on flowering rates

North Creek Marsh and AFCC (2012 planting)



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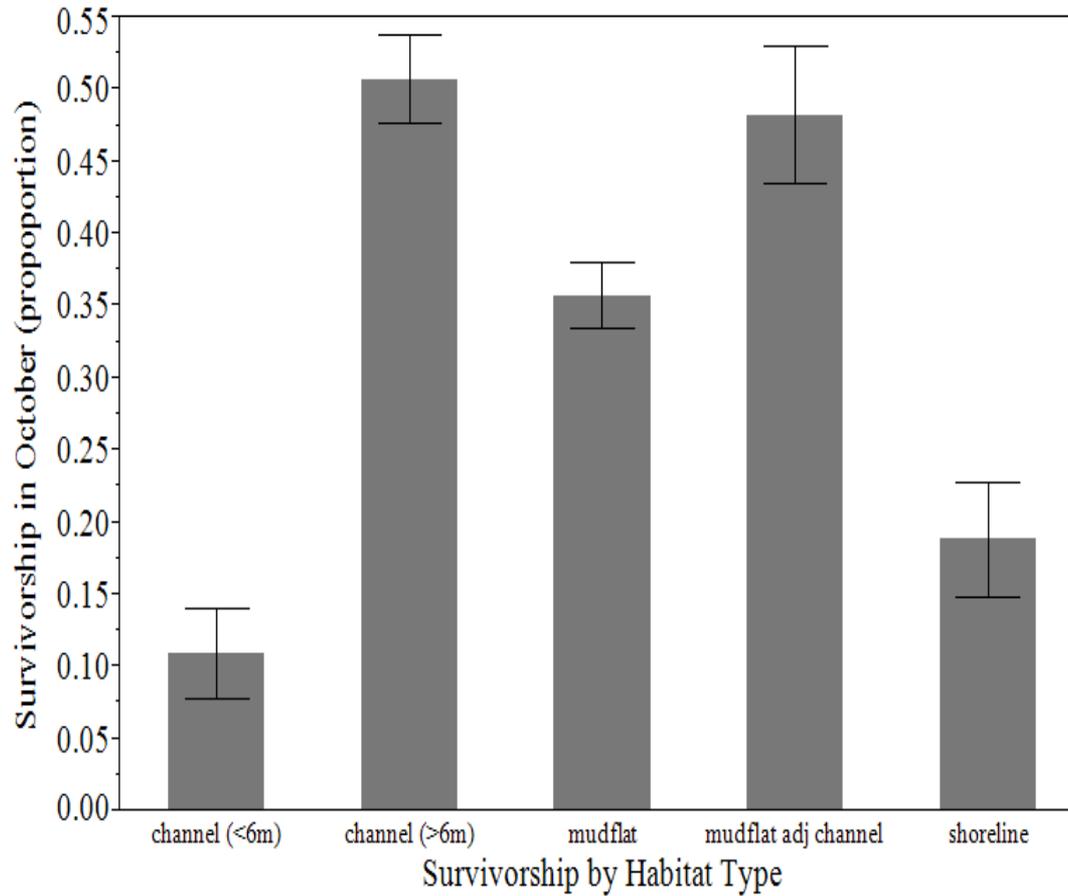
A photograph of a cordgrass field. A wooden stake is planted in the ground, and a string is tied around it, forming a rectangular plot. The grass is tall and thin, growing in sandy soil. The background shows more of the field and some trees.

Research Questions

- How should we protect native cordgrass?
- What sources should we plant of native cordgrass?
- **How should these sources be planted?**
- **Where should we plant them?**

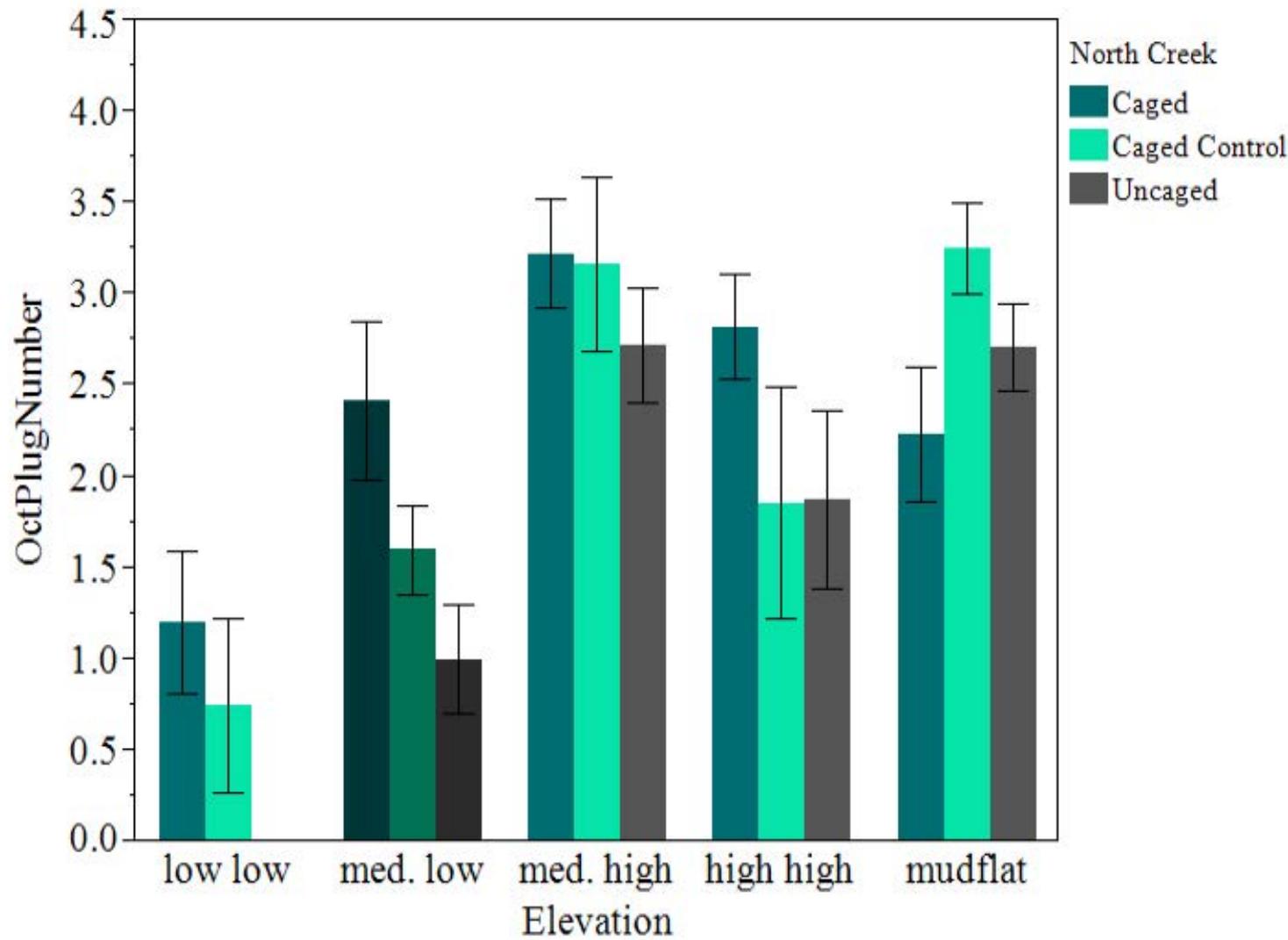
How and where do we plant?

The effect of habitat type on survivorship
(All 2012-2013 plantings)



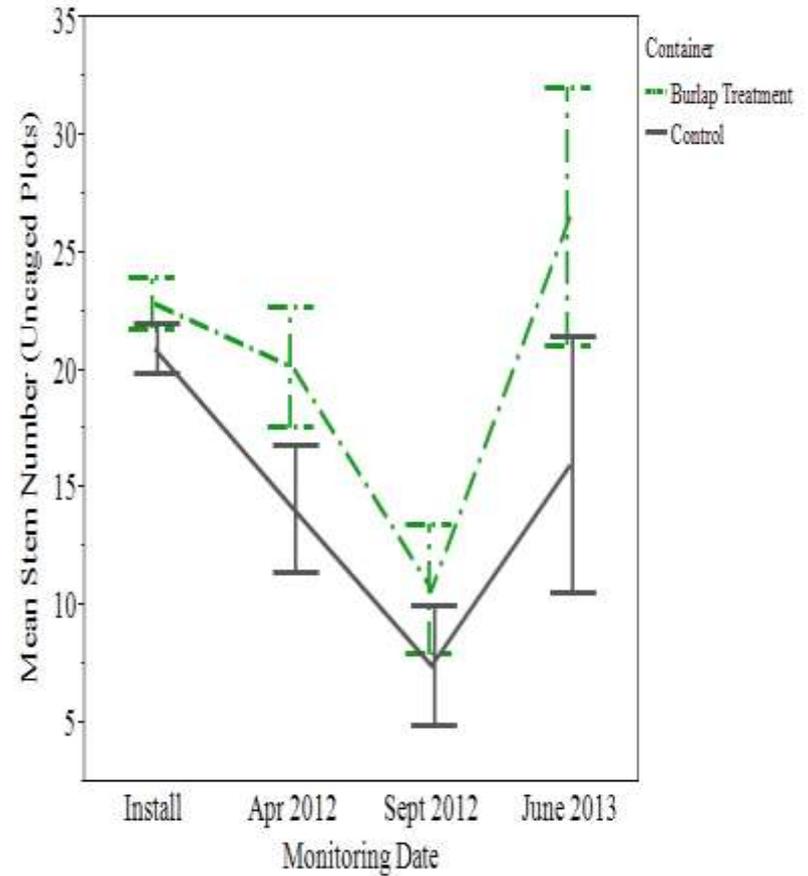
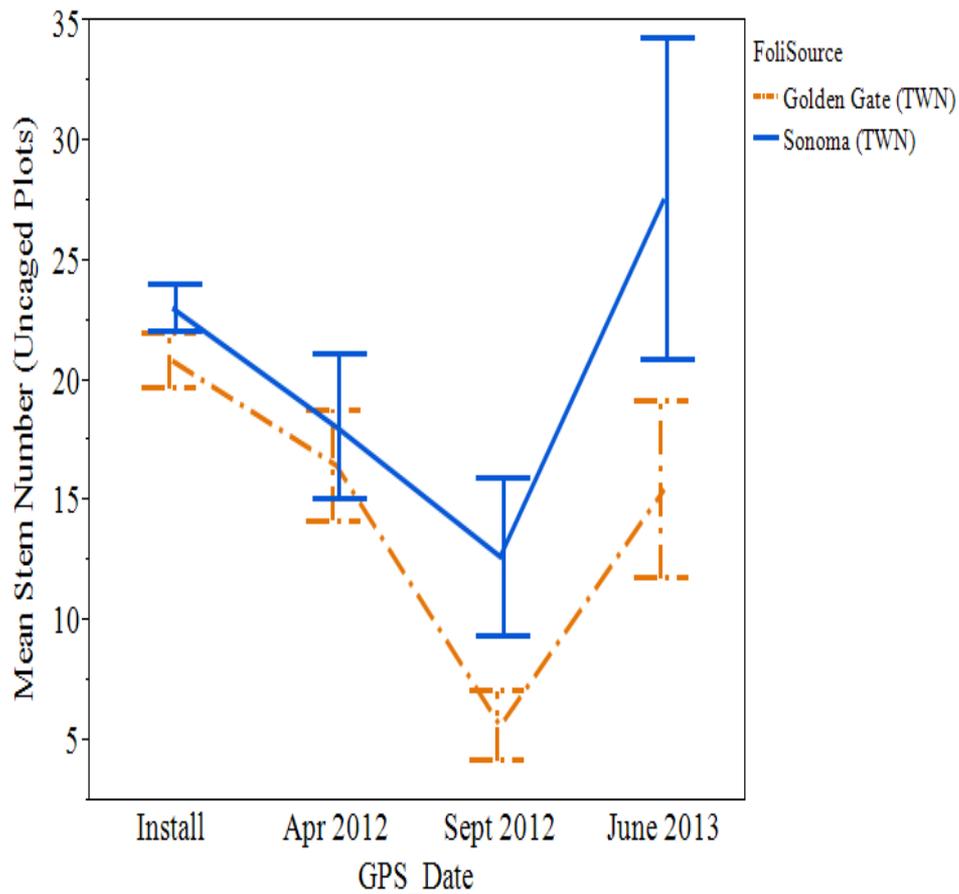


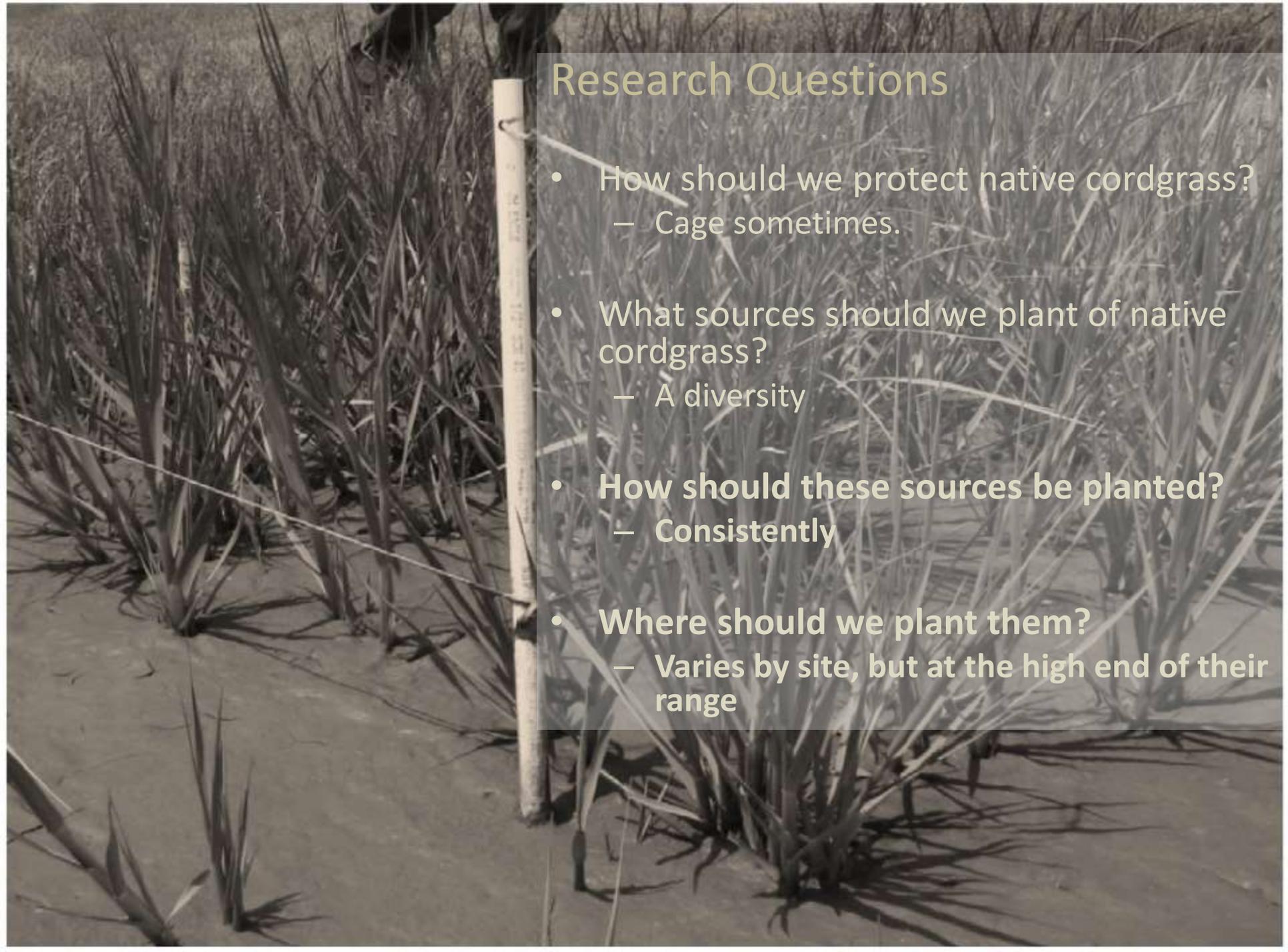
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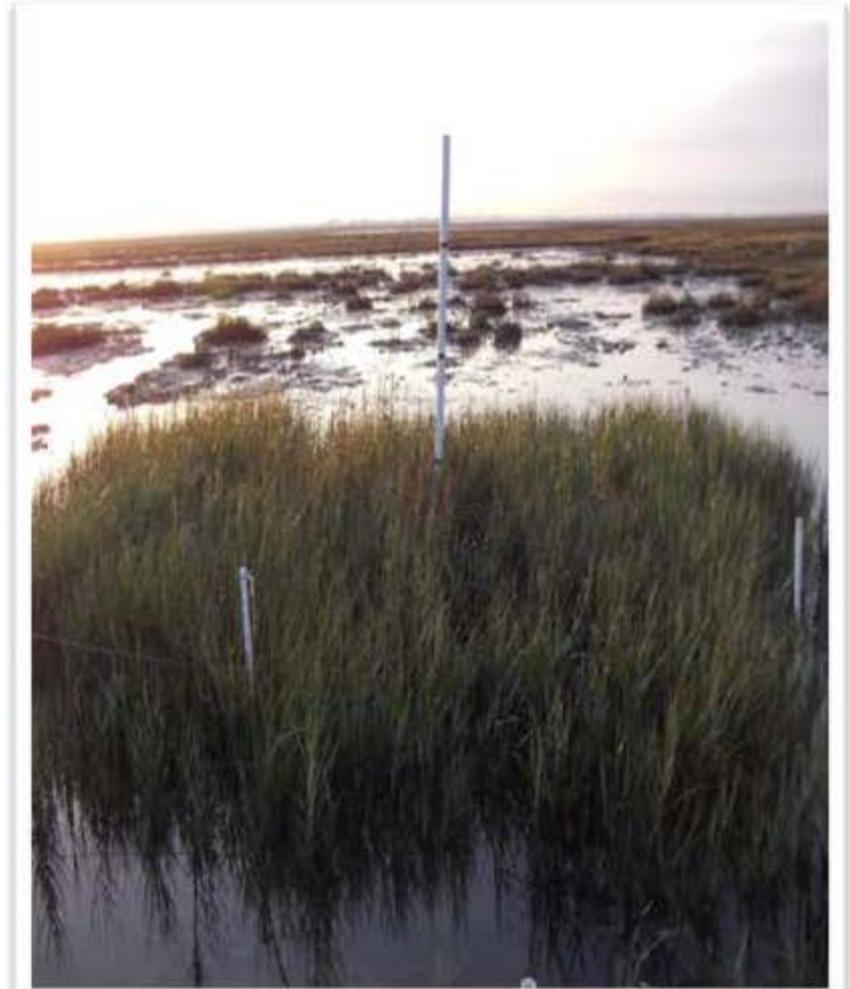
Uncaged (Source and Burlap)



A photograph of a cordgrass field. A wooden stake is planted in the sand, with a string tied around it to mark a plot. The grasses are tall and thin, growing in clumps. The background shows more of the field and some trees.

Research Questions

- How should we protect native cordgrass?
 - Cage sometimes.
- What sources should we plant of native cordgrass?
 - A diversity
- **How should these sources be planted?**
 - **Consistently**
- **Where should we plant them?**
 - **Varies by site, but at the high end of their range**





So many people to thank!



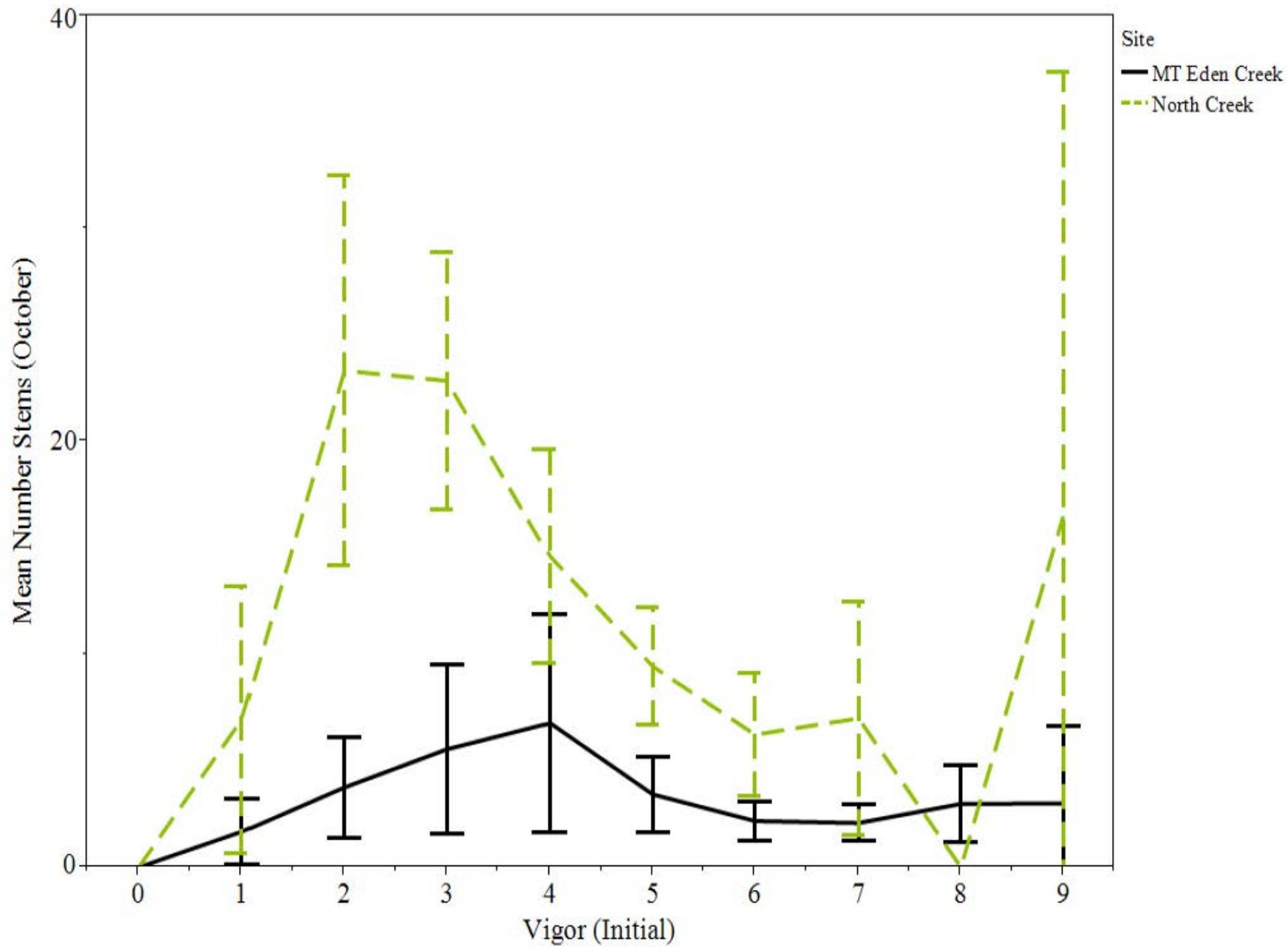
- Boyer Lab at San Francisco State University
- Olofson Environmental/ ISP Staff
- The Watershed Nursery
- The Grosholz Lab and Laura Feinstein
- The plethora of people that I have borrowed equipment from, grilled incessantly, hounded, and annoyed. (USGS WERC, John Callaway, Tom Parker, Mike Vasey, Peter Baye, Laura Feinstein, UCLA Human Genomics Lab)



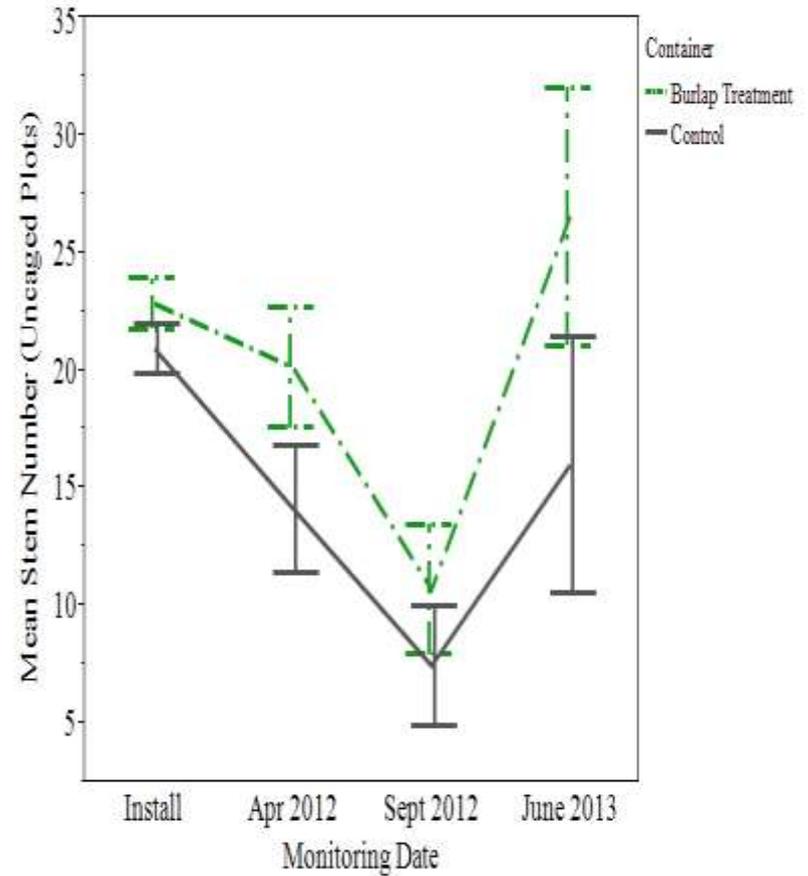
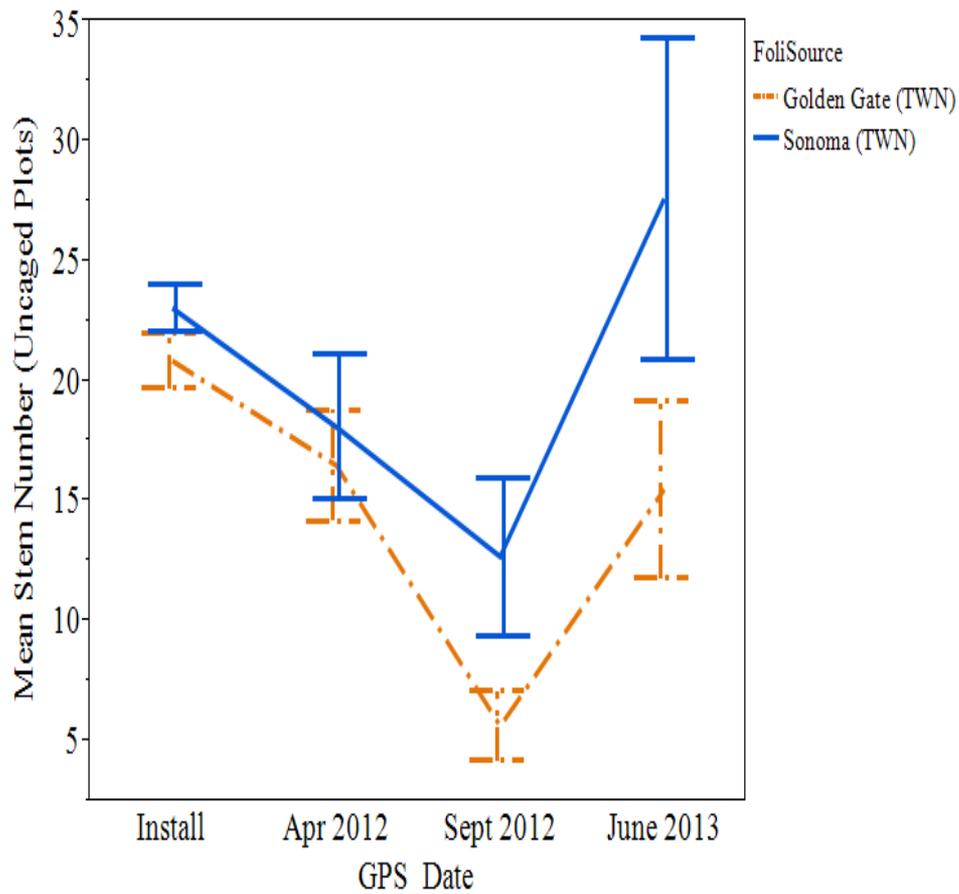
Conclusions

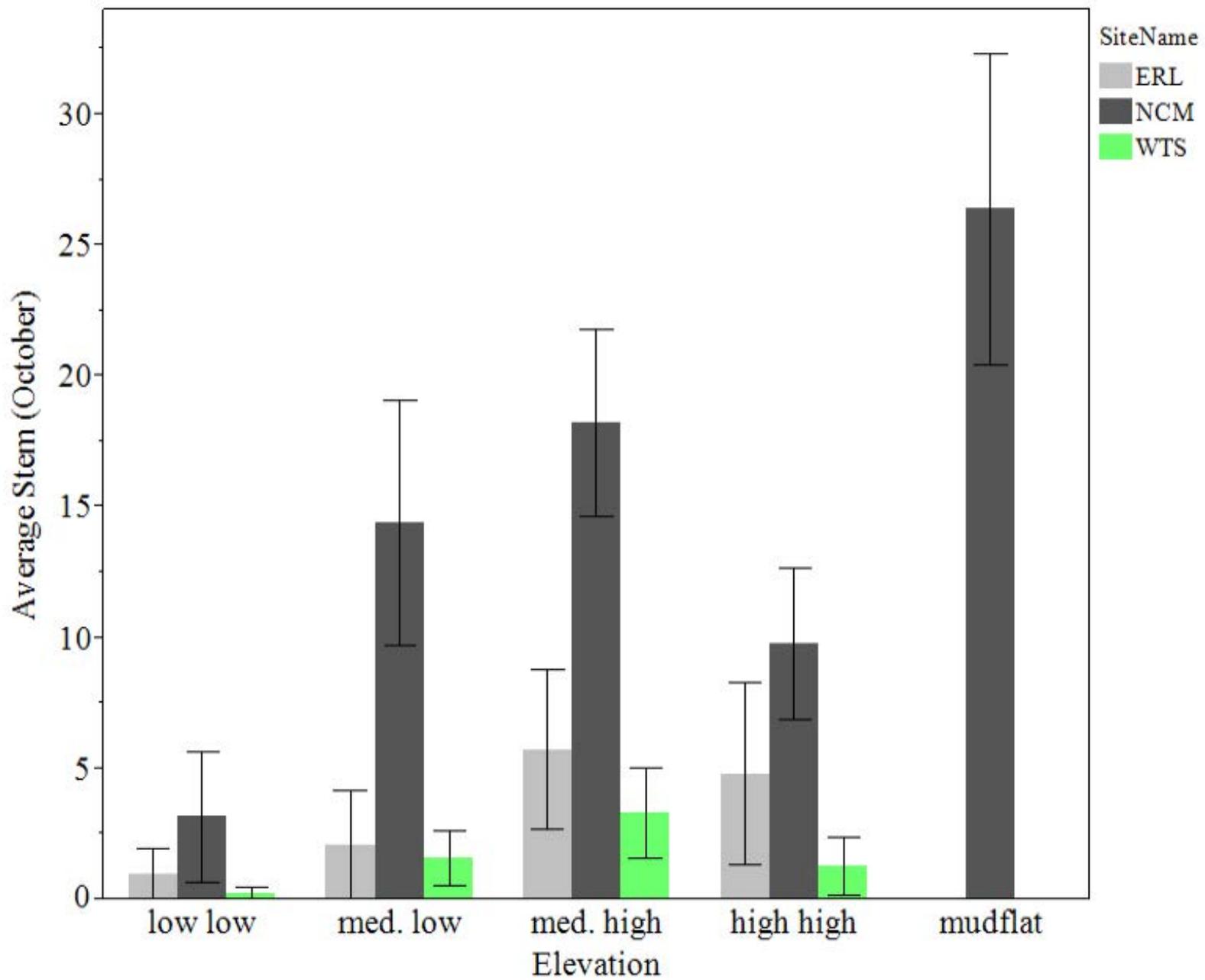
- “Restoration plantings” have been a vector for invasive species in the past.
- *Spartina foliosa* can be established, but restoration designs should be catered to site needs.
- There is a need for peer-reviewed literature on restoration methods in tidal salt marsh in the San Francisco Bay.

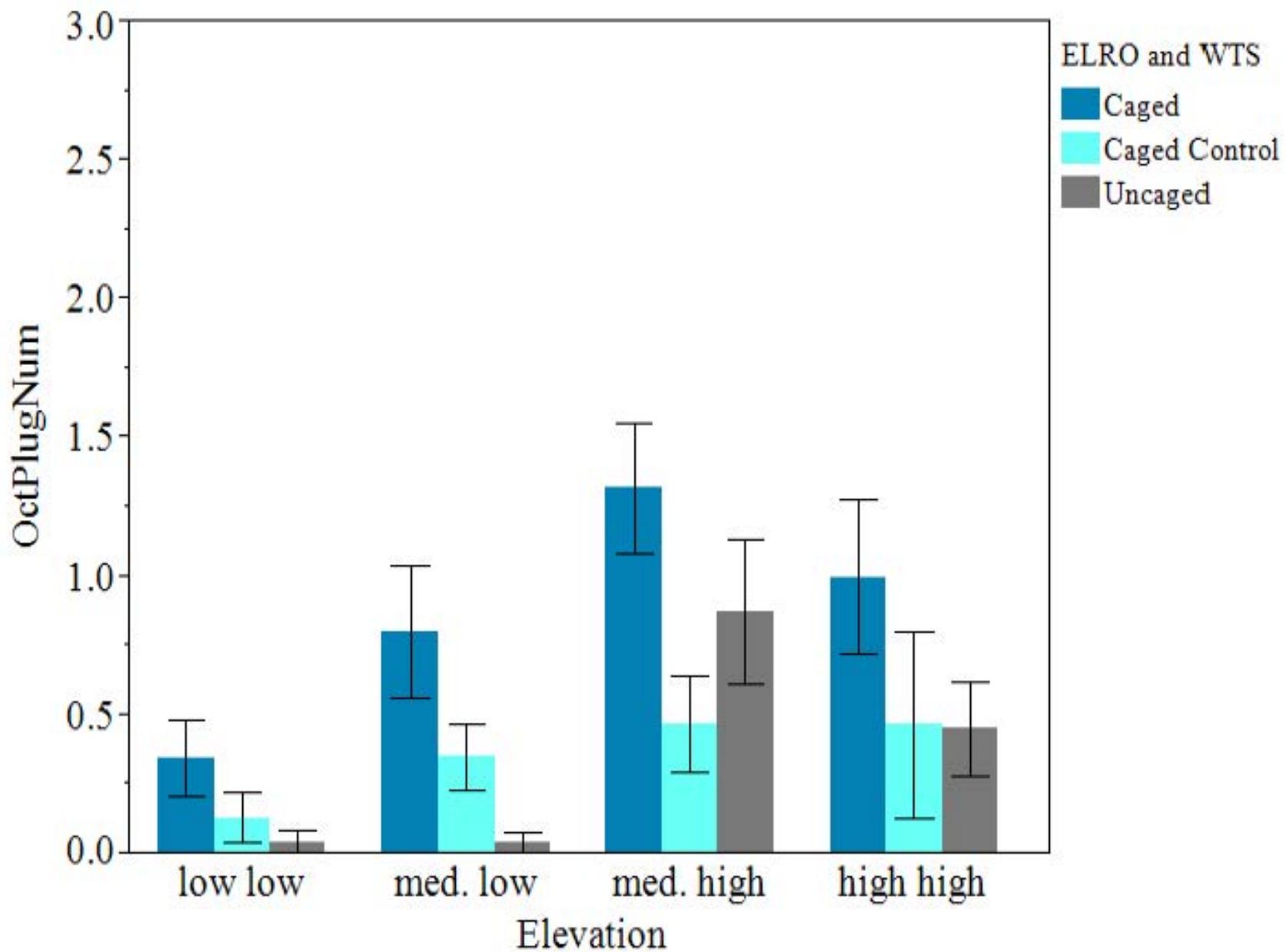


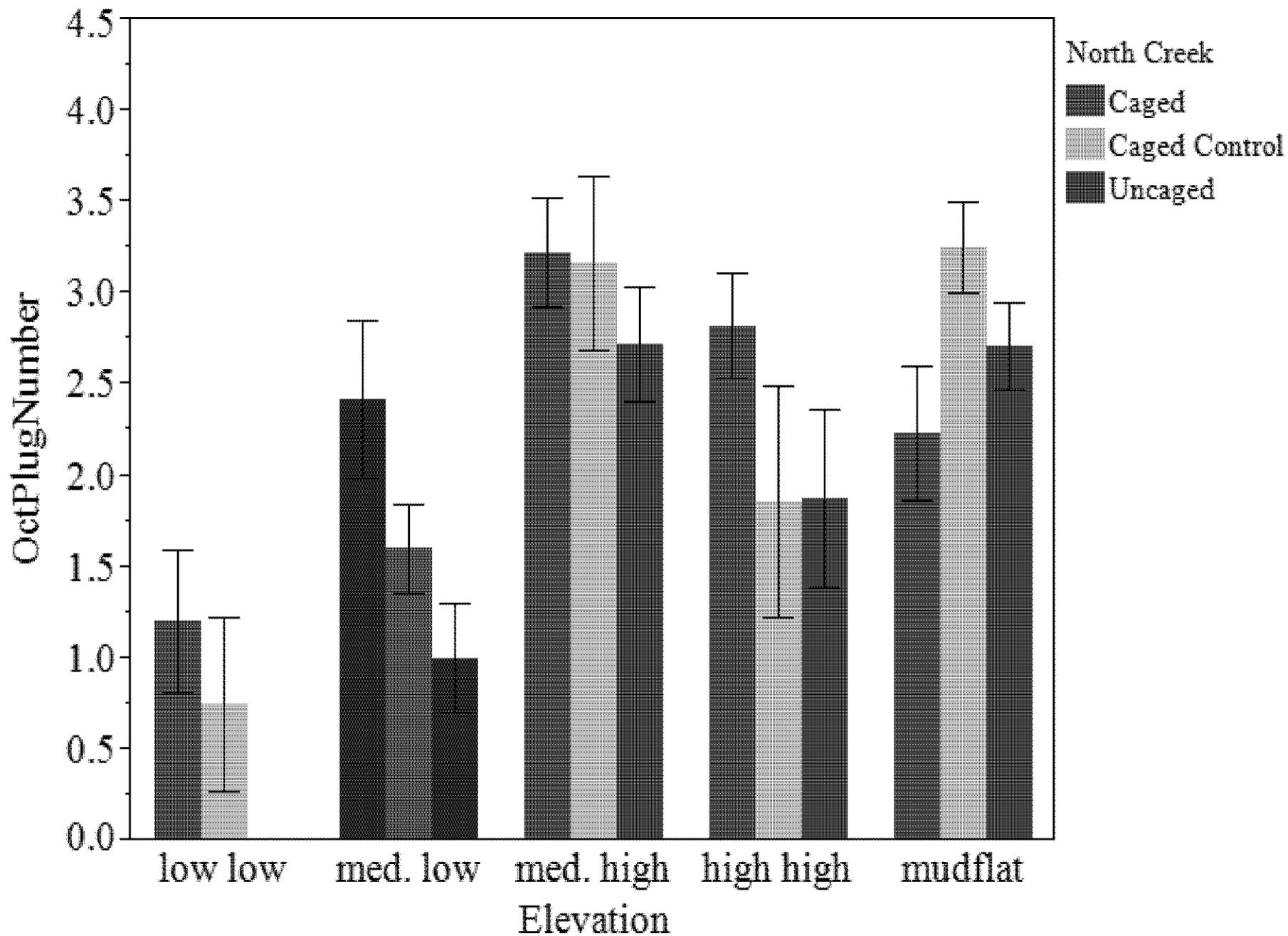


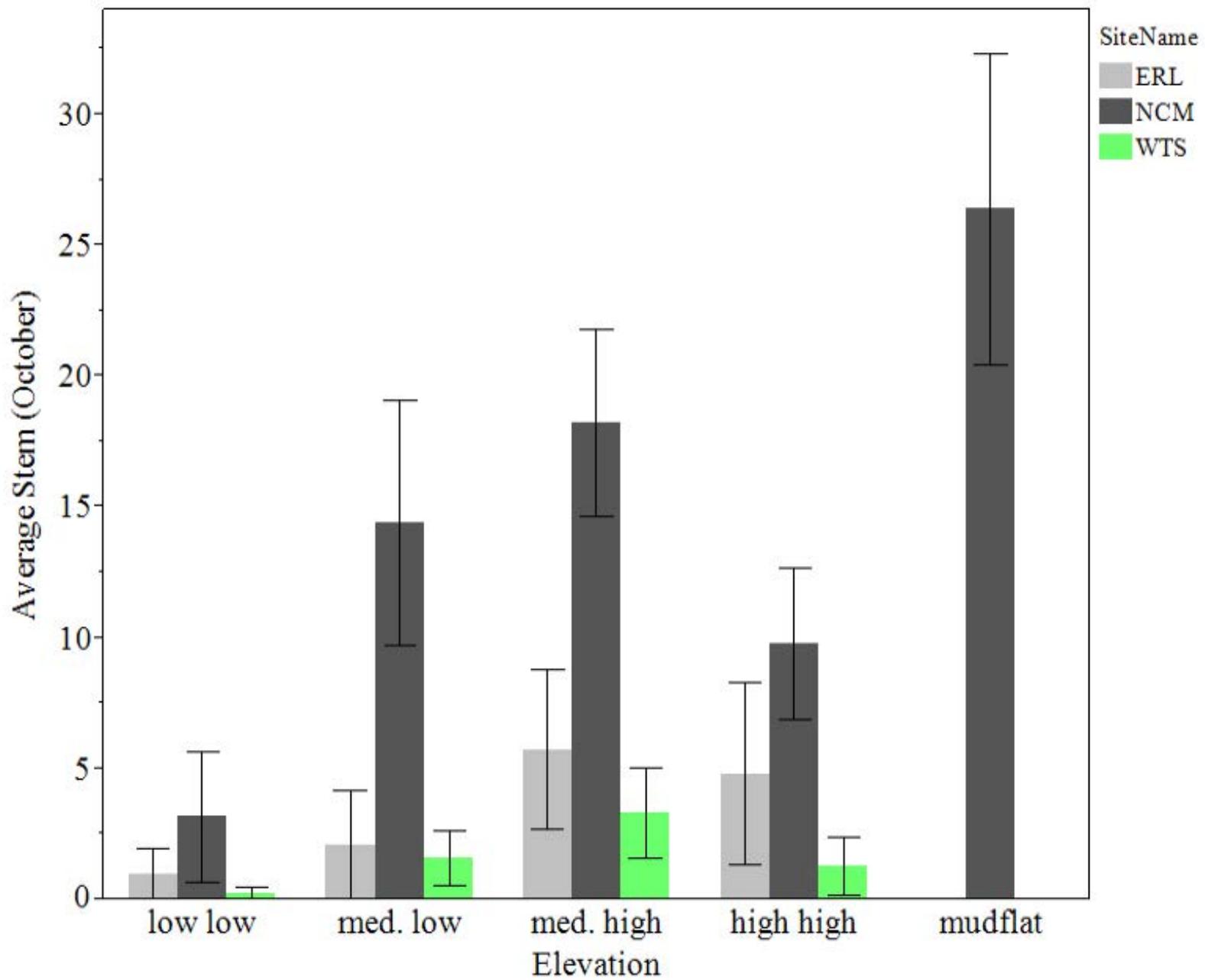
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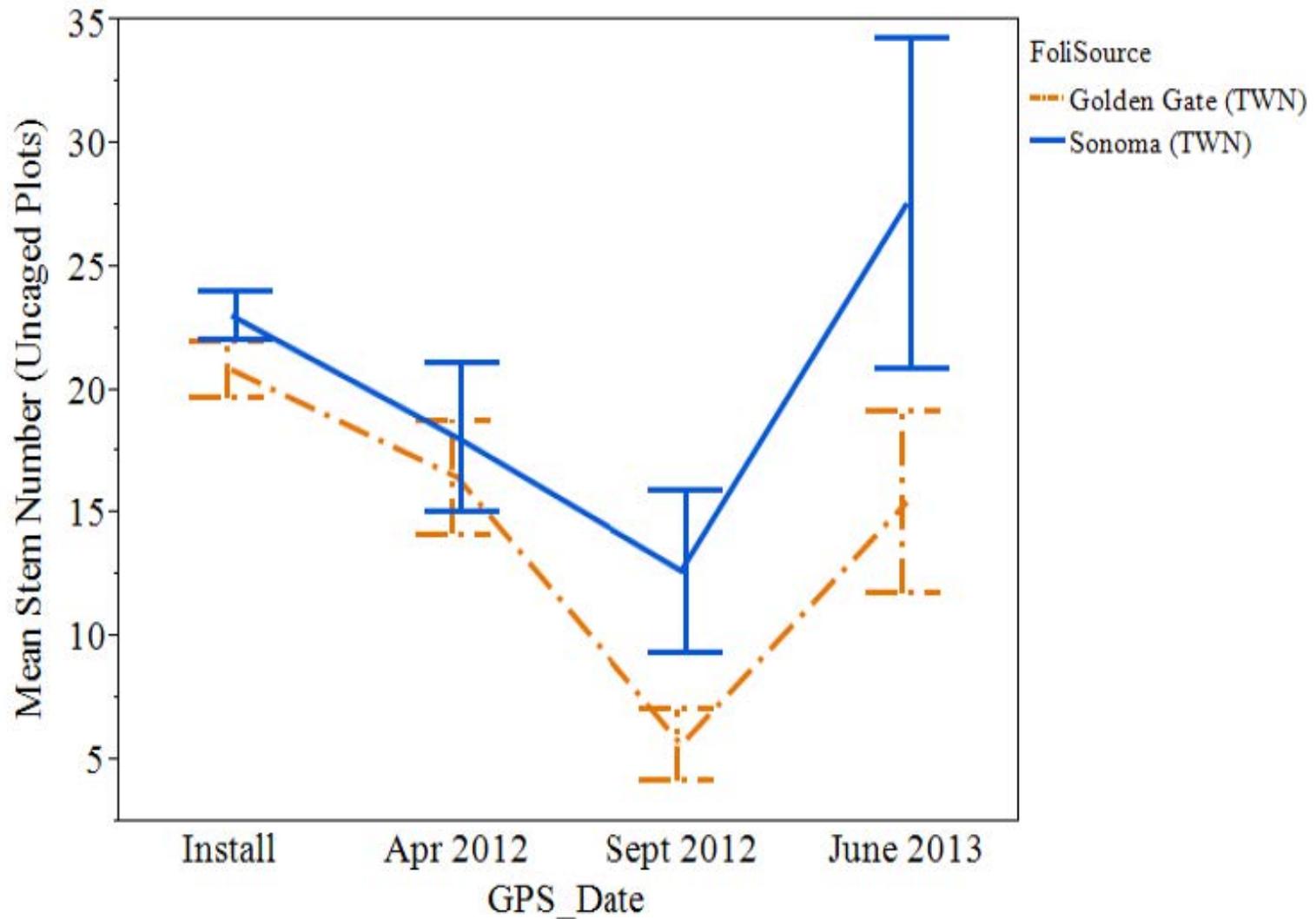








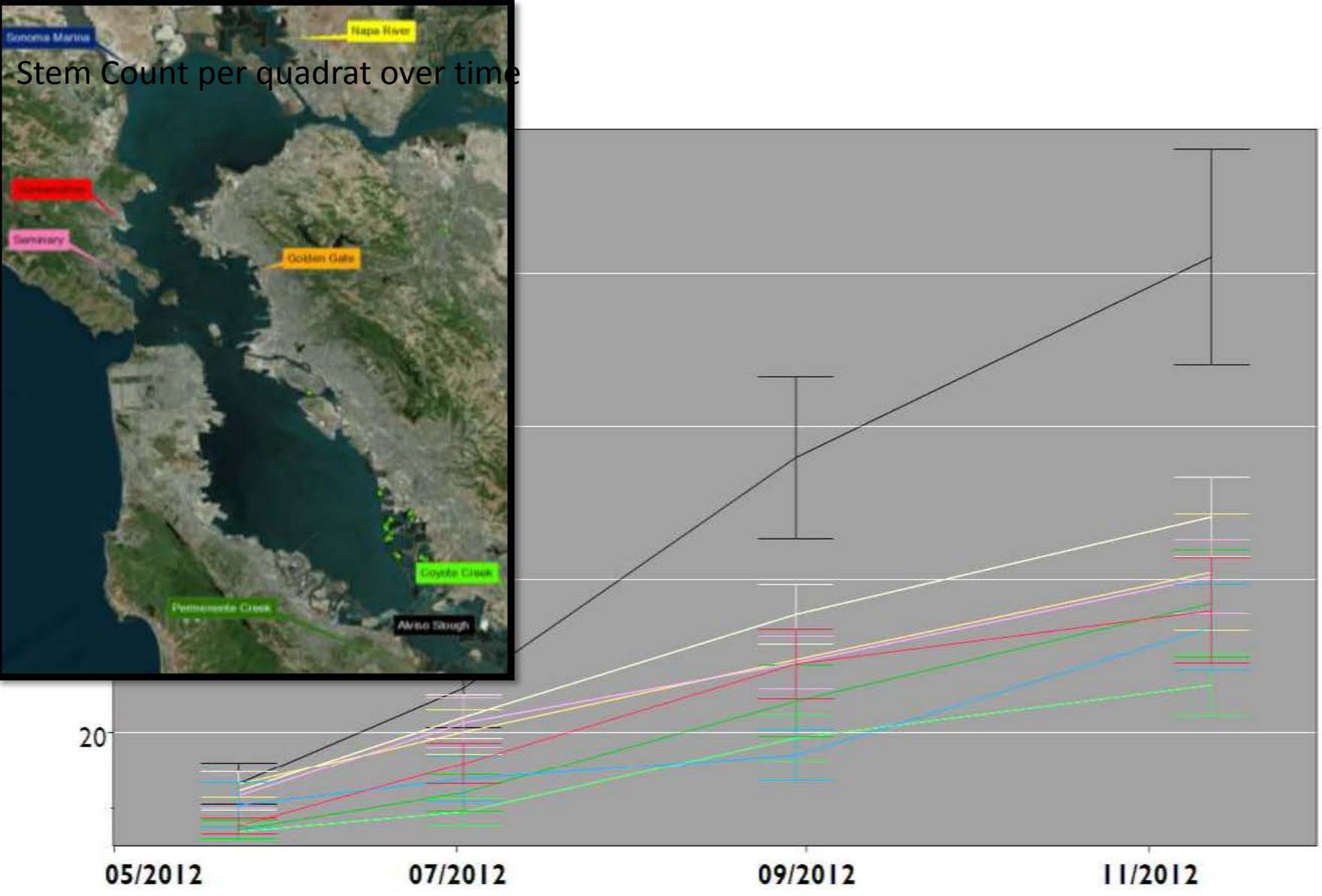
What sources should we plant of native cordgrass?



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Results: Does donor source influence growth patterns in nursery conditions?

Stem Count per quadrat over time



Each error bar is constructed using a 95% confidence interval of the mean.

Results: Does donor source influence growth patterns in nursery conditions?

Genetic results

- Genetic Structure
- Not based on geography

