

The Influence of Climate on
Vegetation Change Over 15 years at
China Camp and Muzzi Marsh

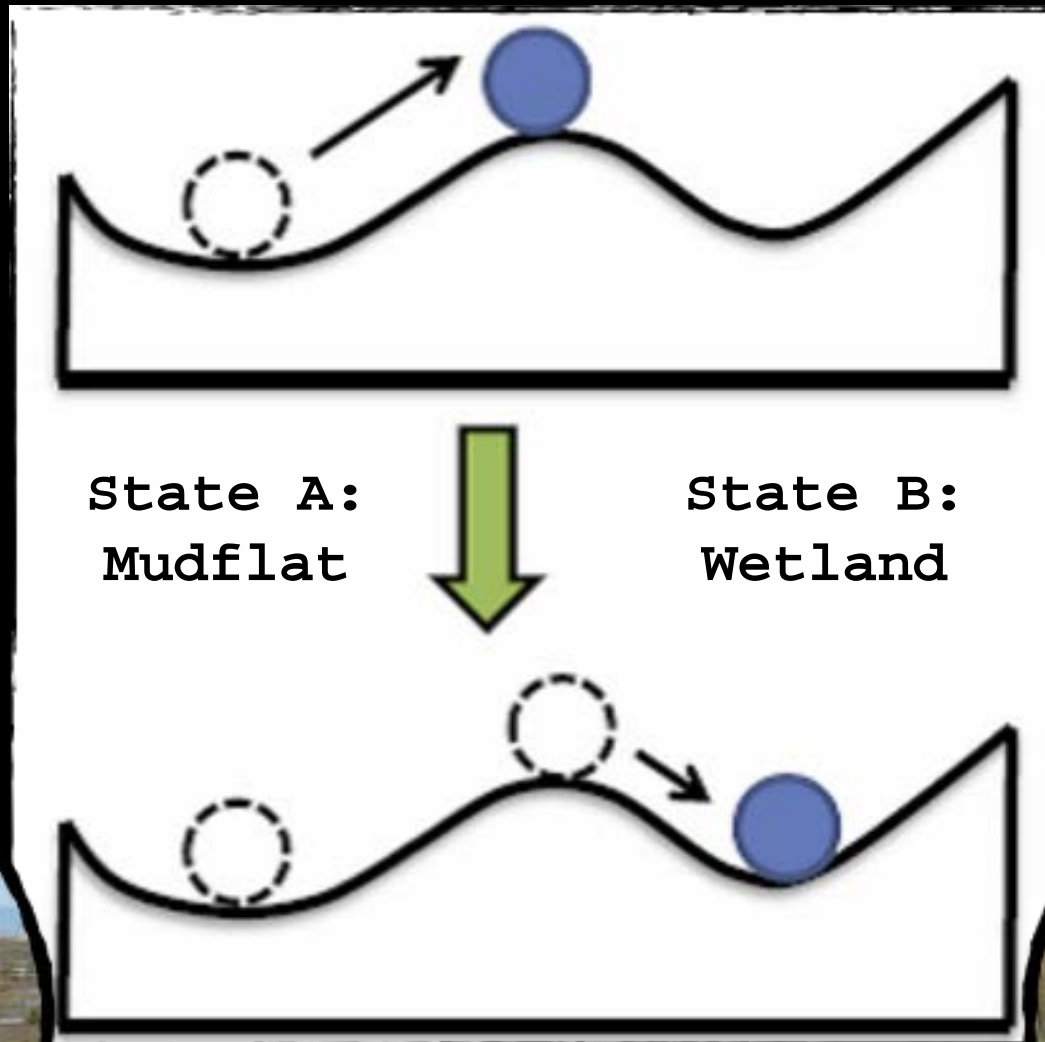
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Merenlender

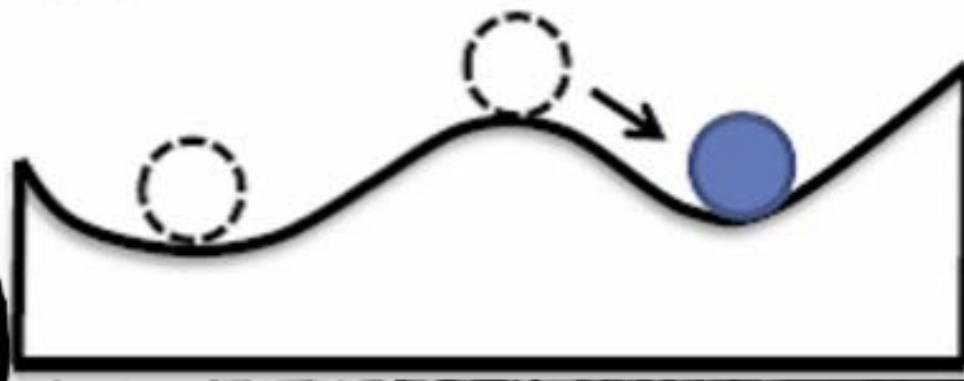
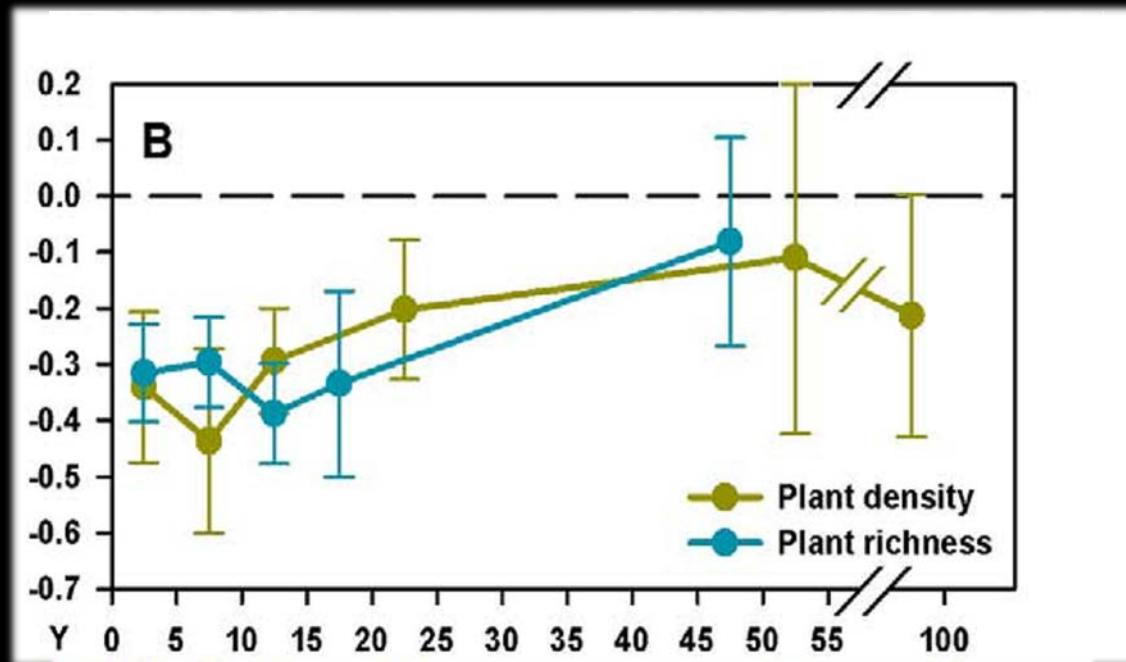
11/16/2016

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How and why do ecosystems transition between states?



How long does it take and what does the pathway look like?



Beisner et al. (2003)

Moreno-Mateos et al. (2012)



SF Bay

~190,000 acres
historic tidal marsh



Image: San Francisco Estuary Institute
Source: Baylands Goals Update 2015

¹. Adapted from: San Francisco Estuary Institute (SFEI). 1998.
"Bay Area EcoAtlas V1.50b4 1998: Geographic Information System
of wetland habitats past and present."

SF Bay

~190,000 acres historic
tidal marsh

1850-1998:

~150,000 acres lost

1970-2009:

~17,000 acres restored



Image: San Francisco Estuary Institute
Source: Baylands Goals Update 2015

1. Adapted from: Goals Project. 2015. The Baylands and Climate Change: What We Can Do.
2. Tidal marsh that has persisted for ~100 years or more
3. Includes completed marsh restoration.
4. Includes restored managed ponds and diked wetlands and marsh restoration in progress.

SF Bay

~190,000 acres historic tidal marsh

1800-1998:

~150,000 acres lost

1970-2009:

~17,000 acres restored

2009-2030:

~30,000 PLANNED

Goal: to Improve understanding of systems over time

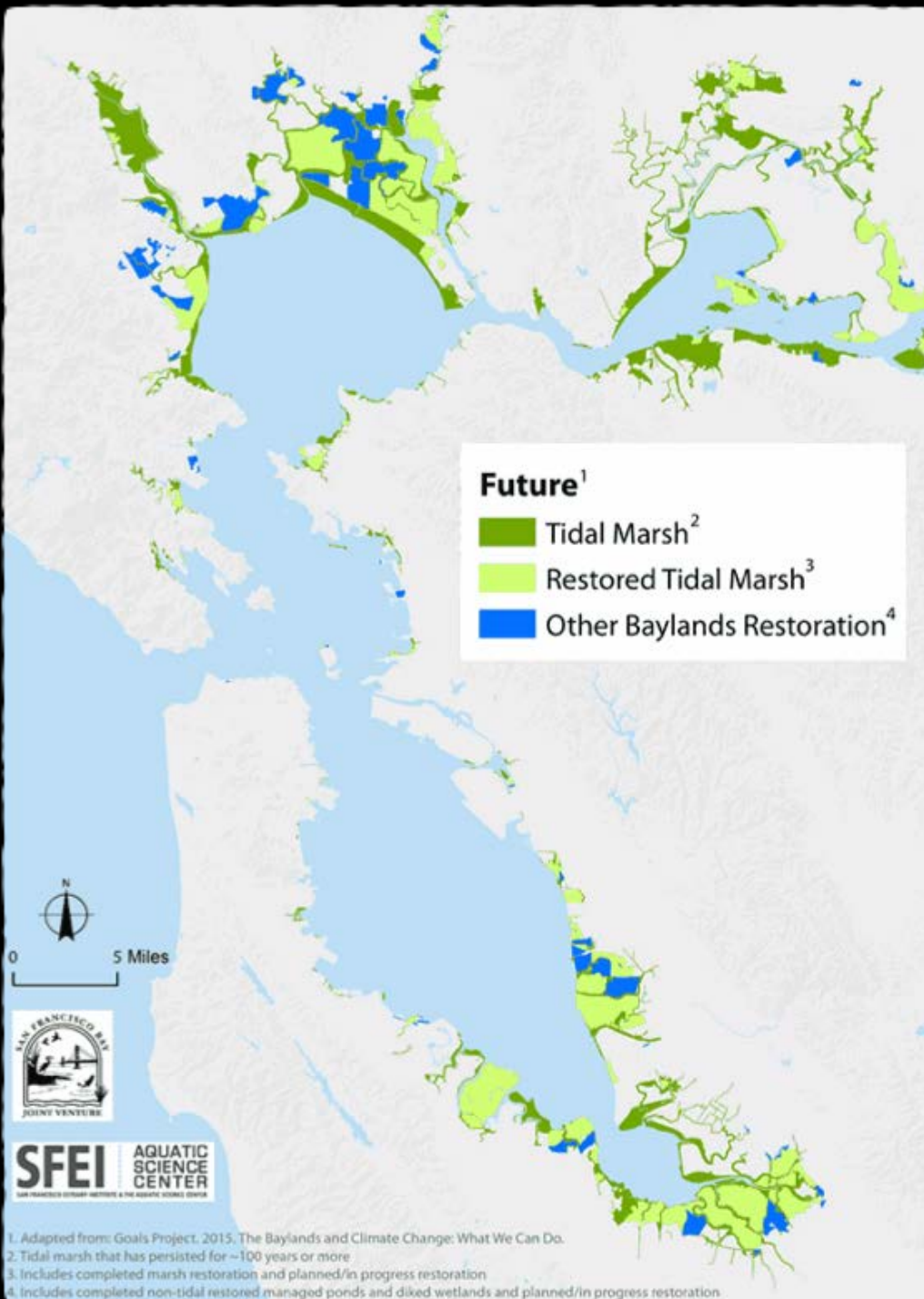
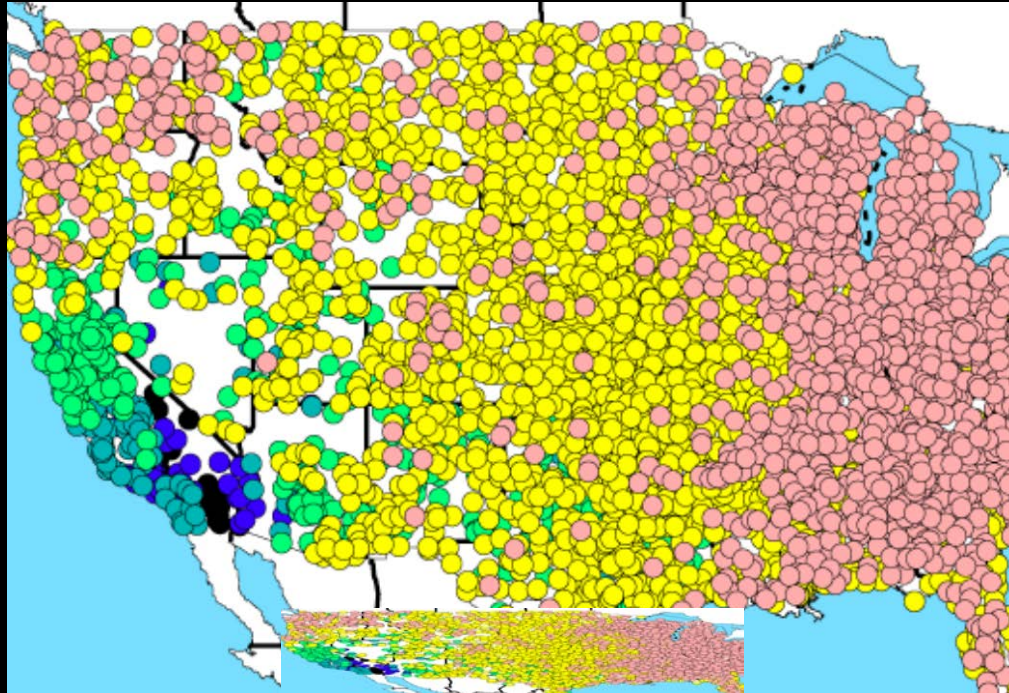


Image: San Francisco Estuary Institute
Source: Baylands Goals Update 2015

1. Adapted from: Goals Project. 2015. The Baylands and Climate Change: What We Can Do.
2. Tidal marsh that has persisted for ~100 years or more
3. Includes completed marsh restoration and planned/in progress restoration
4. Includes completed non-tidal restored managed ponds and diked wetlands and planned/in progress restoration

Mediterranean Climate Variability

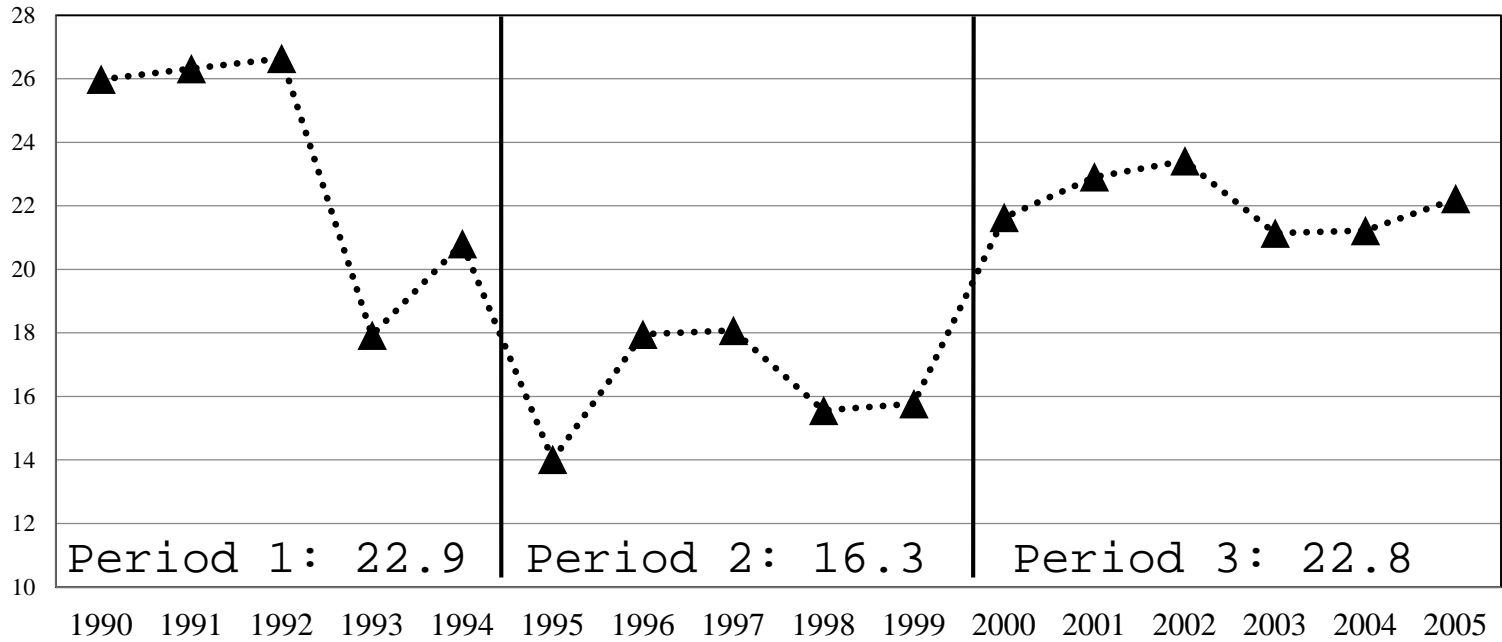


*Low -> High
Coefficient of Variation*



Mediterranean Climate Variability

Salinity (ppt)

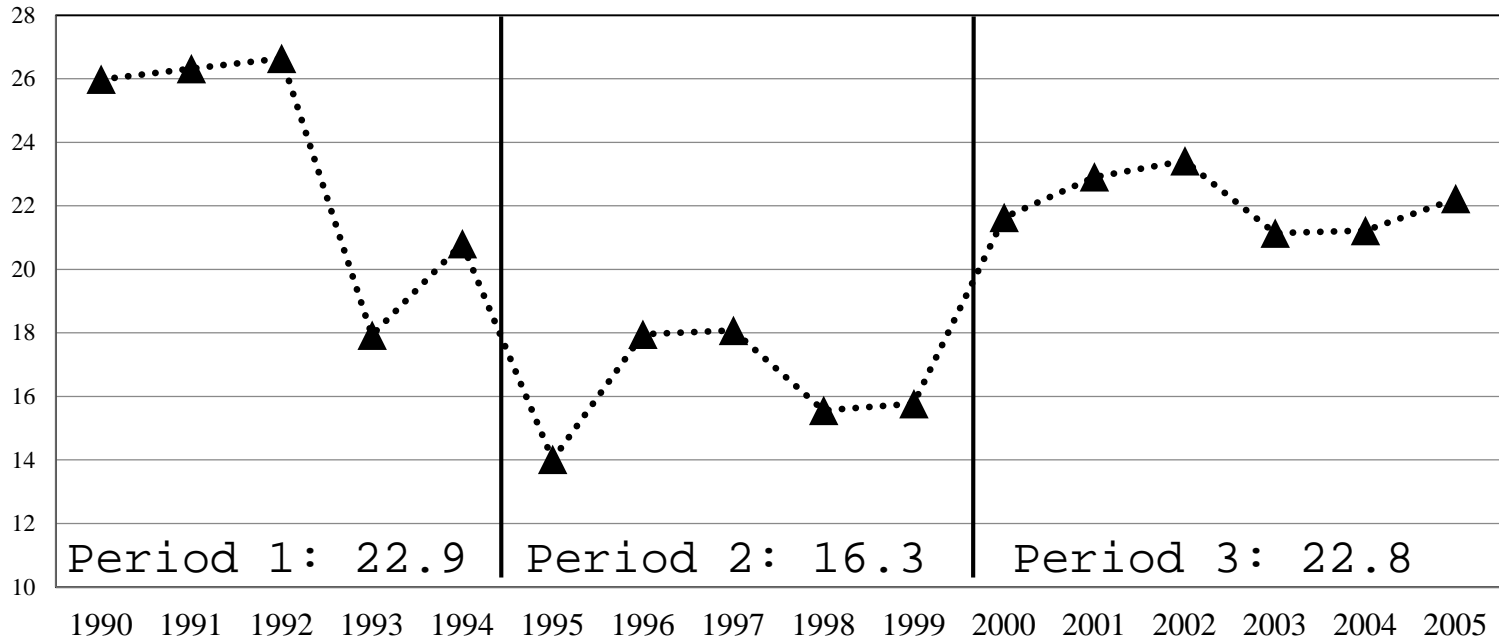


Year



How does climate variability influence plant communities?

Salinity (ppt)



Year



Muzzi Marsh and China Camp



Muzzi Marsh: Restoration Site



Initiated in 1976

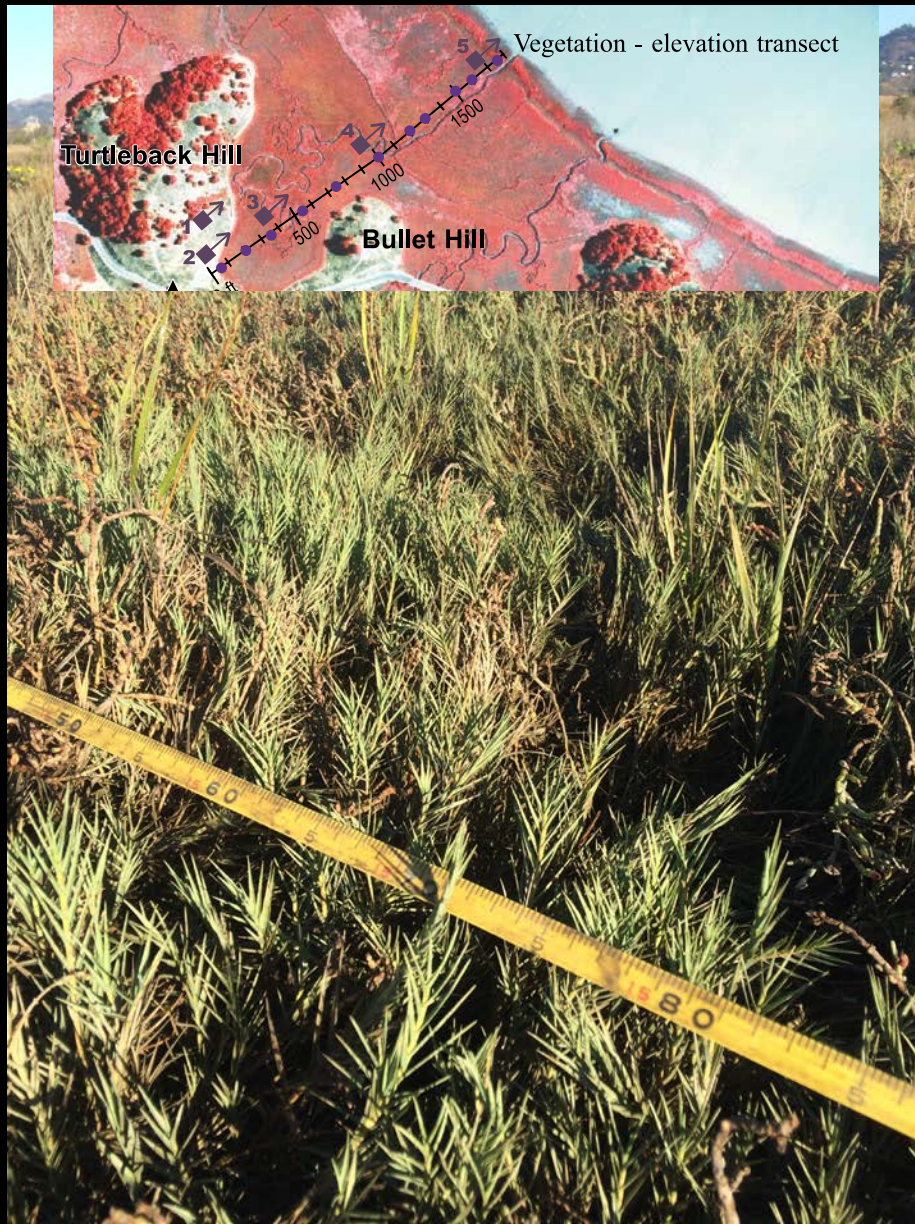
Mitigation for Corte Madera ferry service

Site divided into two to prevent dredge fill

China Camp: Reference Site



Field Data Collection Methods



Focus on vegetation data

Percent cover along 15.2m linear transect

Annual visits most years during July

Muzzi Marsh: n=45

China Camp: n=37

Channel density collected for each plot

Climate Data Collection Methods



Salinity data collected from USGS Water Quality Cruise, Station 15

Rainfall data collected from NOAA Muir Woods weather station

Monthly means used to determine water year (October-September) means

<http://sfbay.wr.usgs.gov/access/wqdata/overview/wherewhen/where.html>

Question 1:

How do vegetation communities change over time in relation to climate?



Community Change



Bray-Curtis
dissimilarity

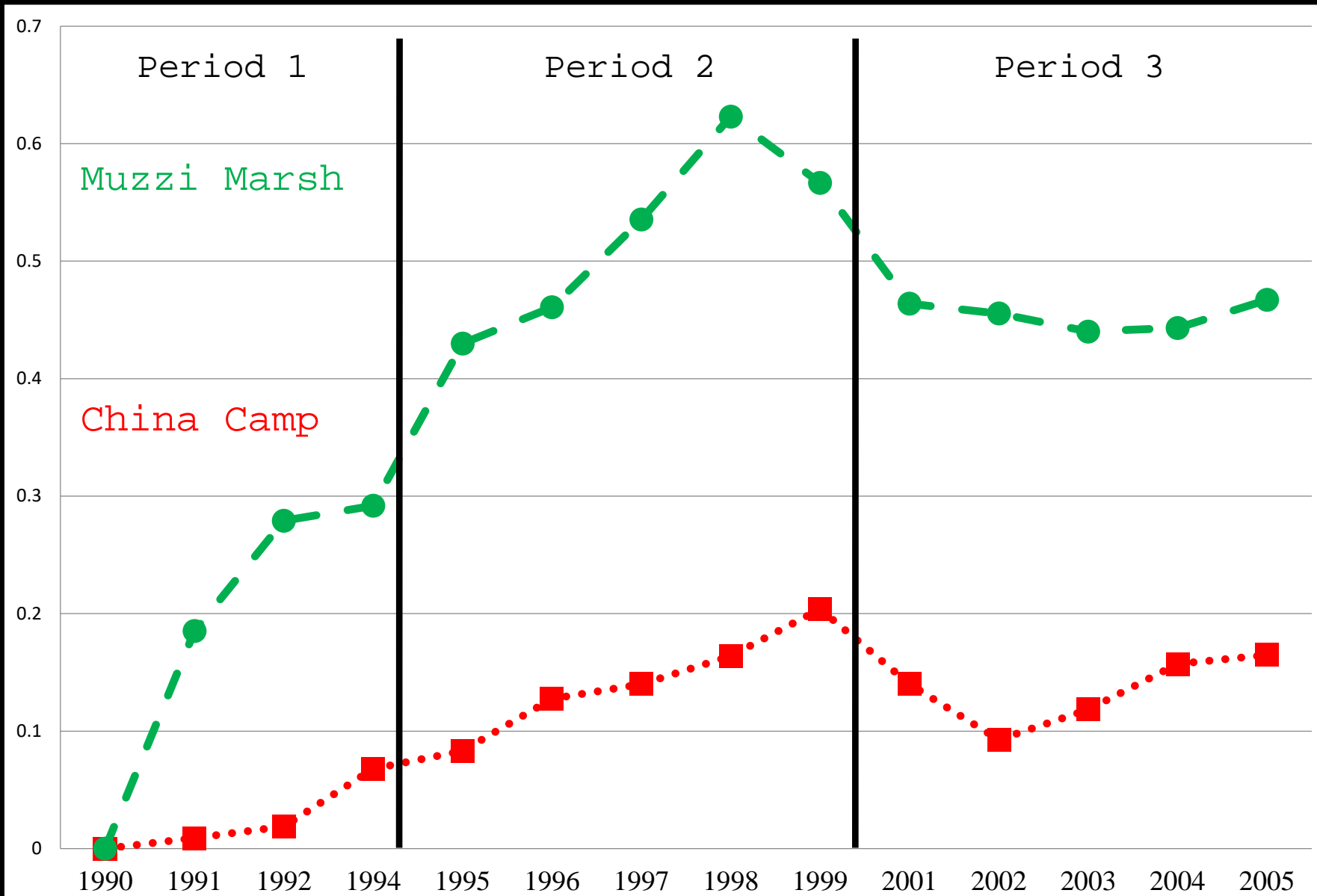
Measure of how
similar plant
communities are over
time

Scale: 0 (same) to
1 (different)

Linear mixed effects
models at each site

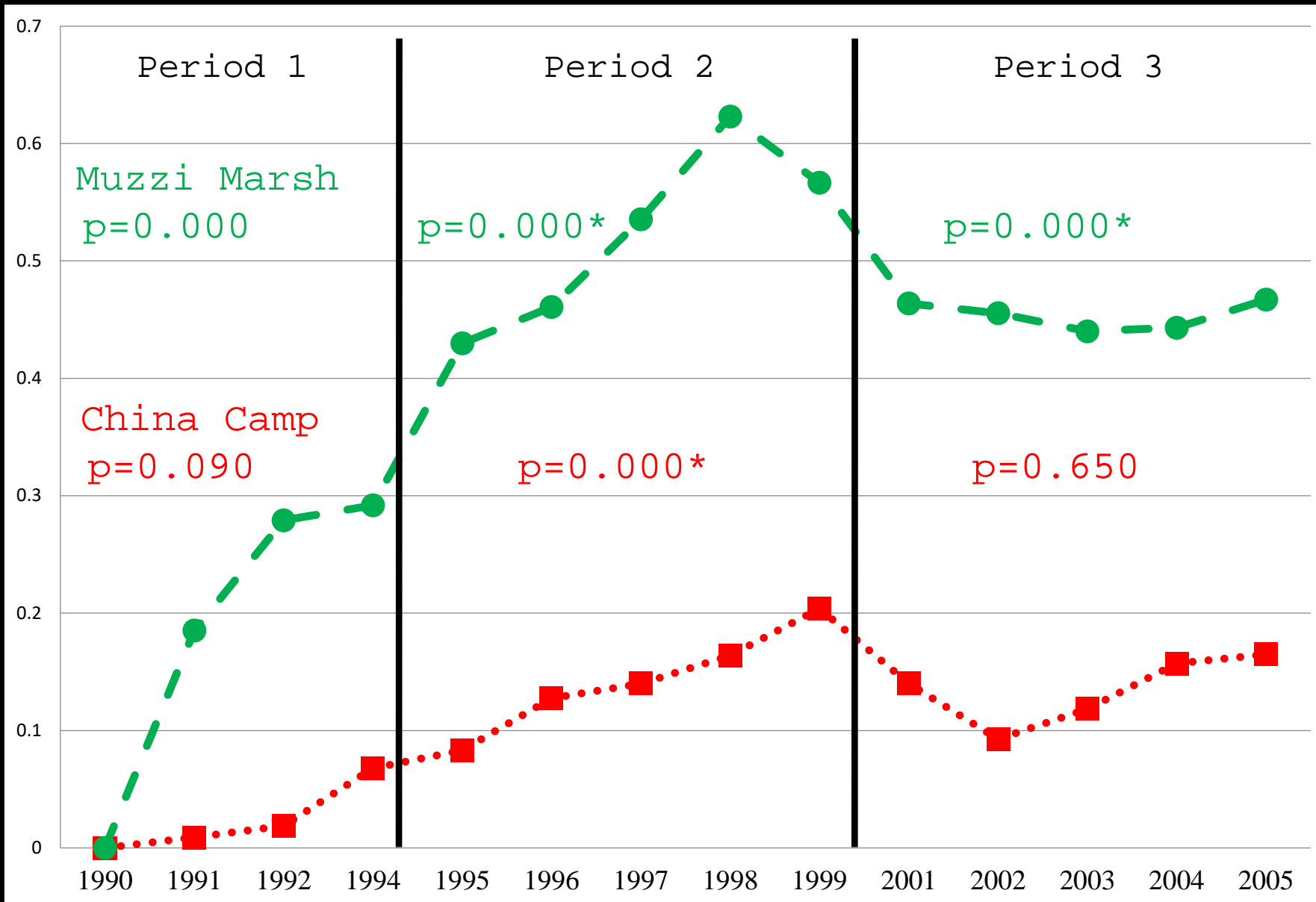
Community Change

Dissimilarity from 1990

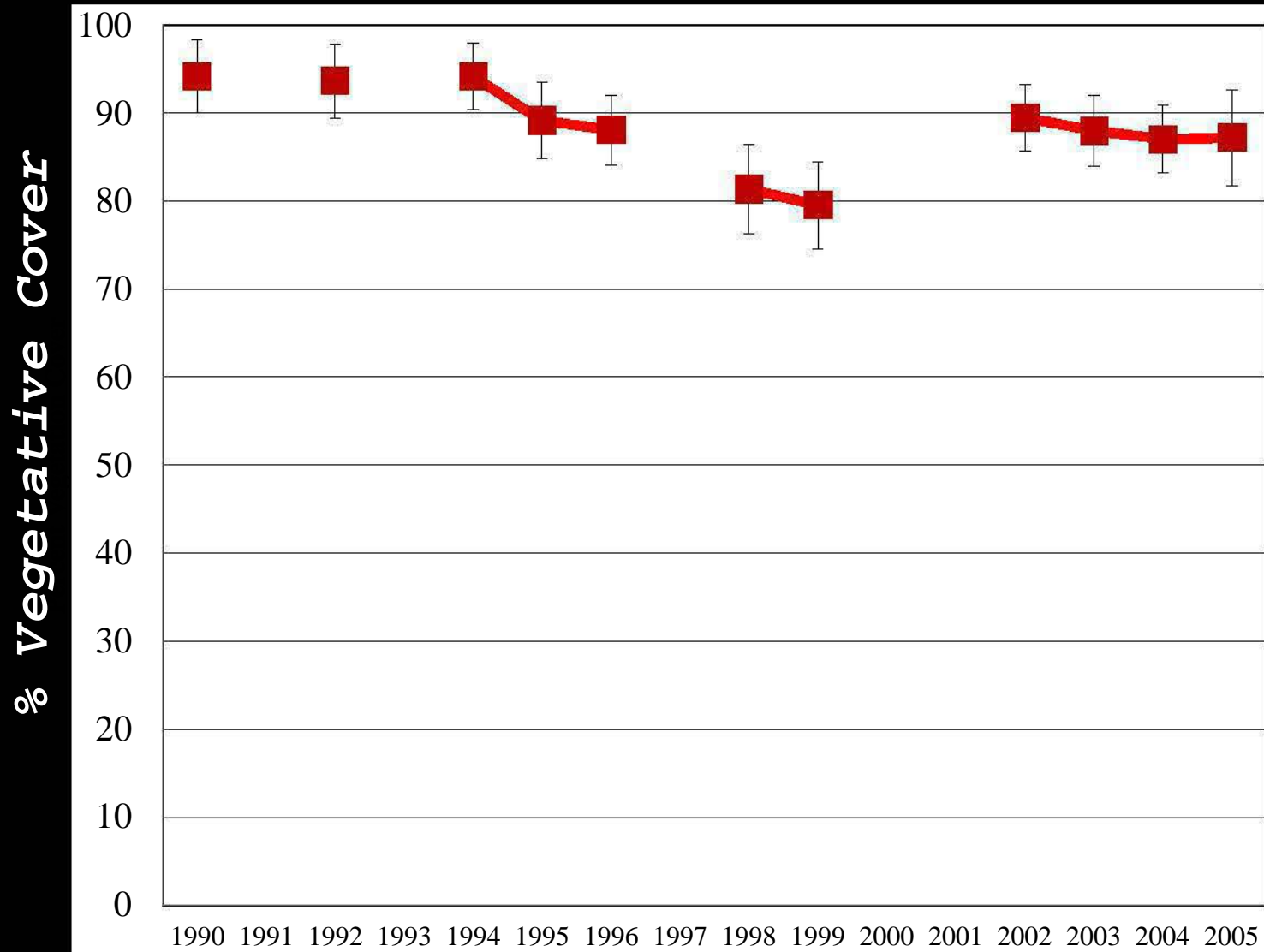


Overall Community Change

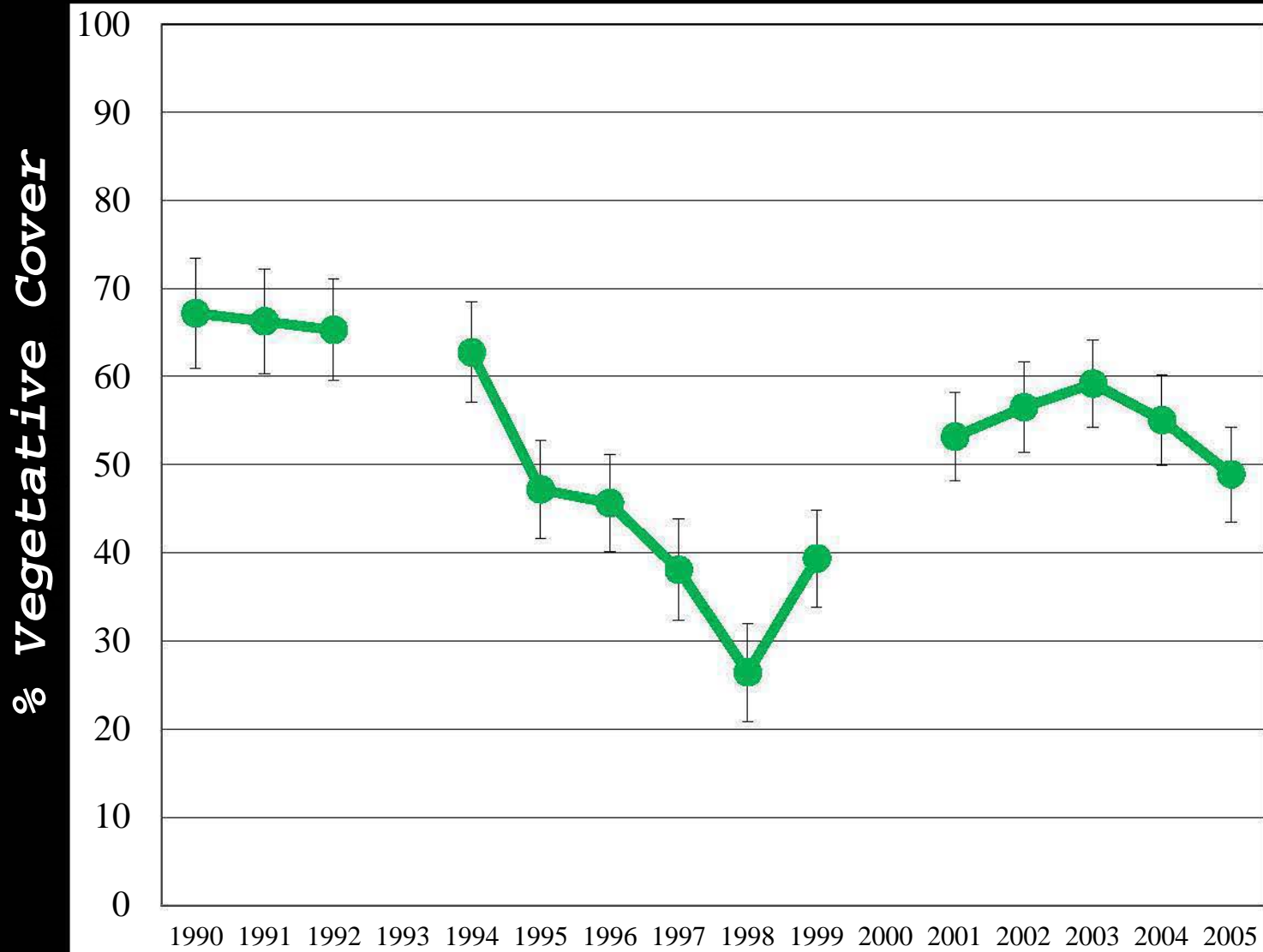
Dissimilarity from 1990



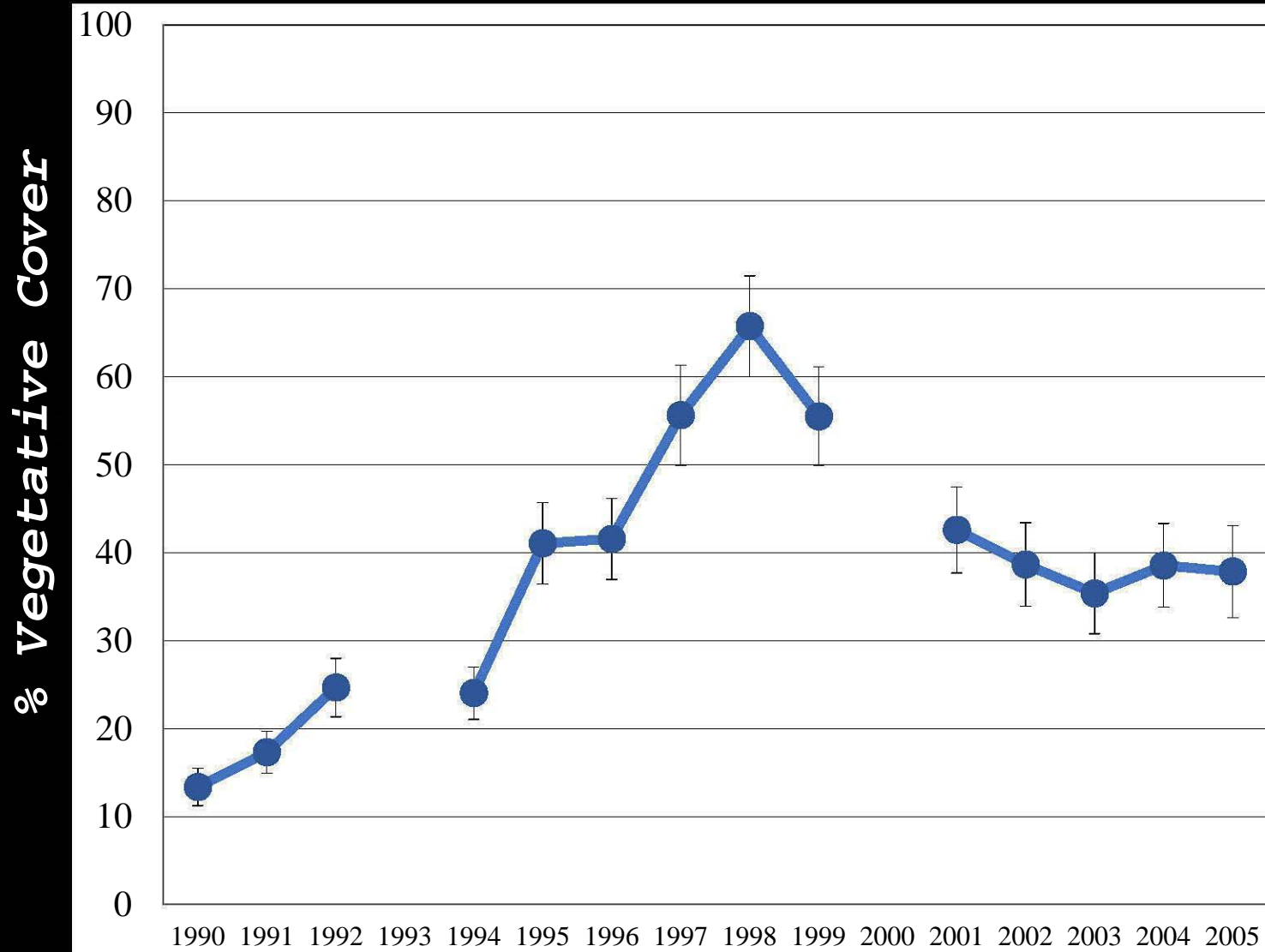
Salicornia pacifica: China Camp



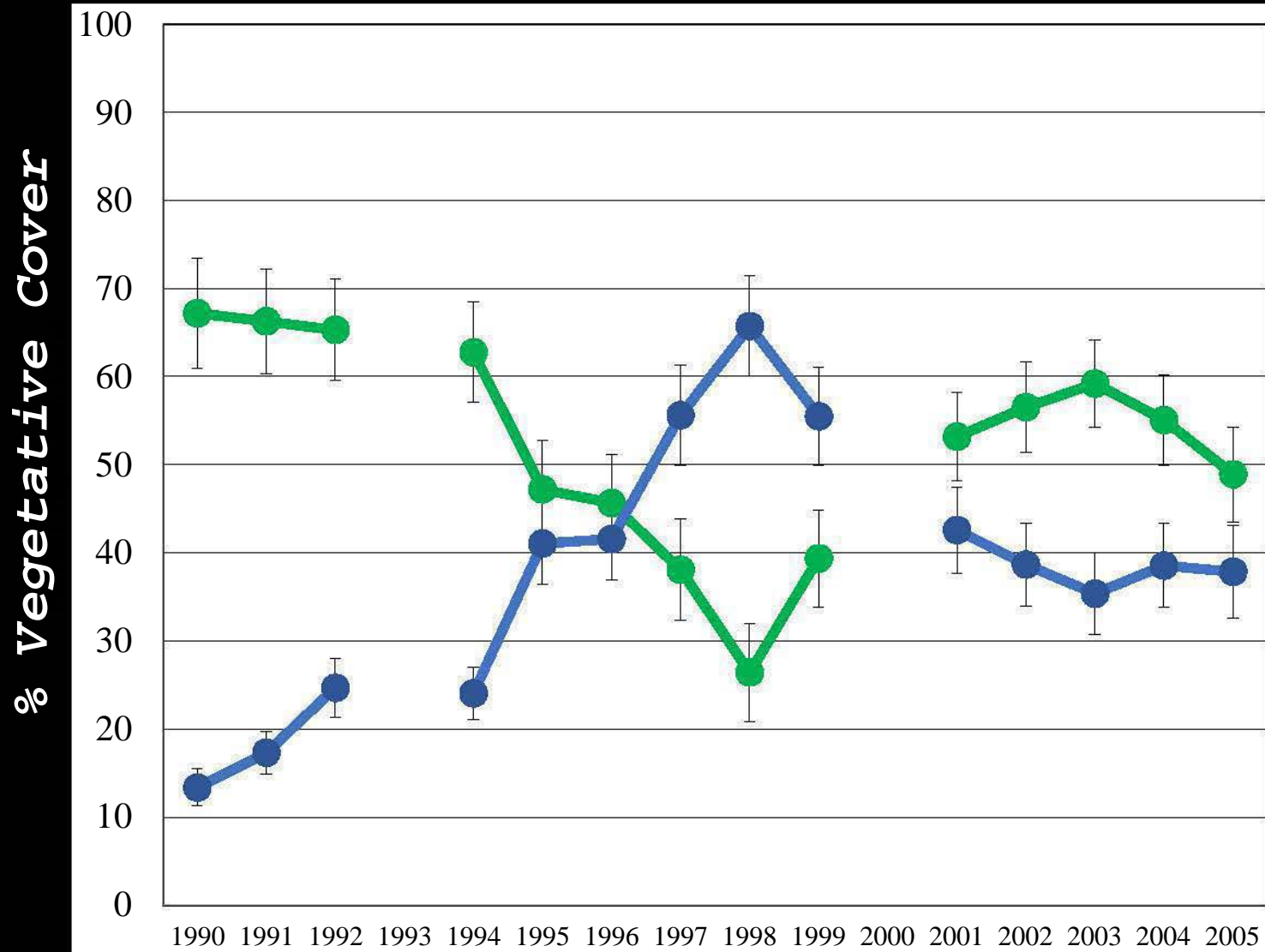
Salicornia pacifica: Muzzi Marsh



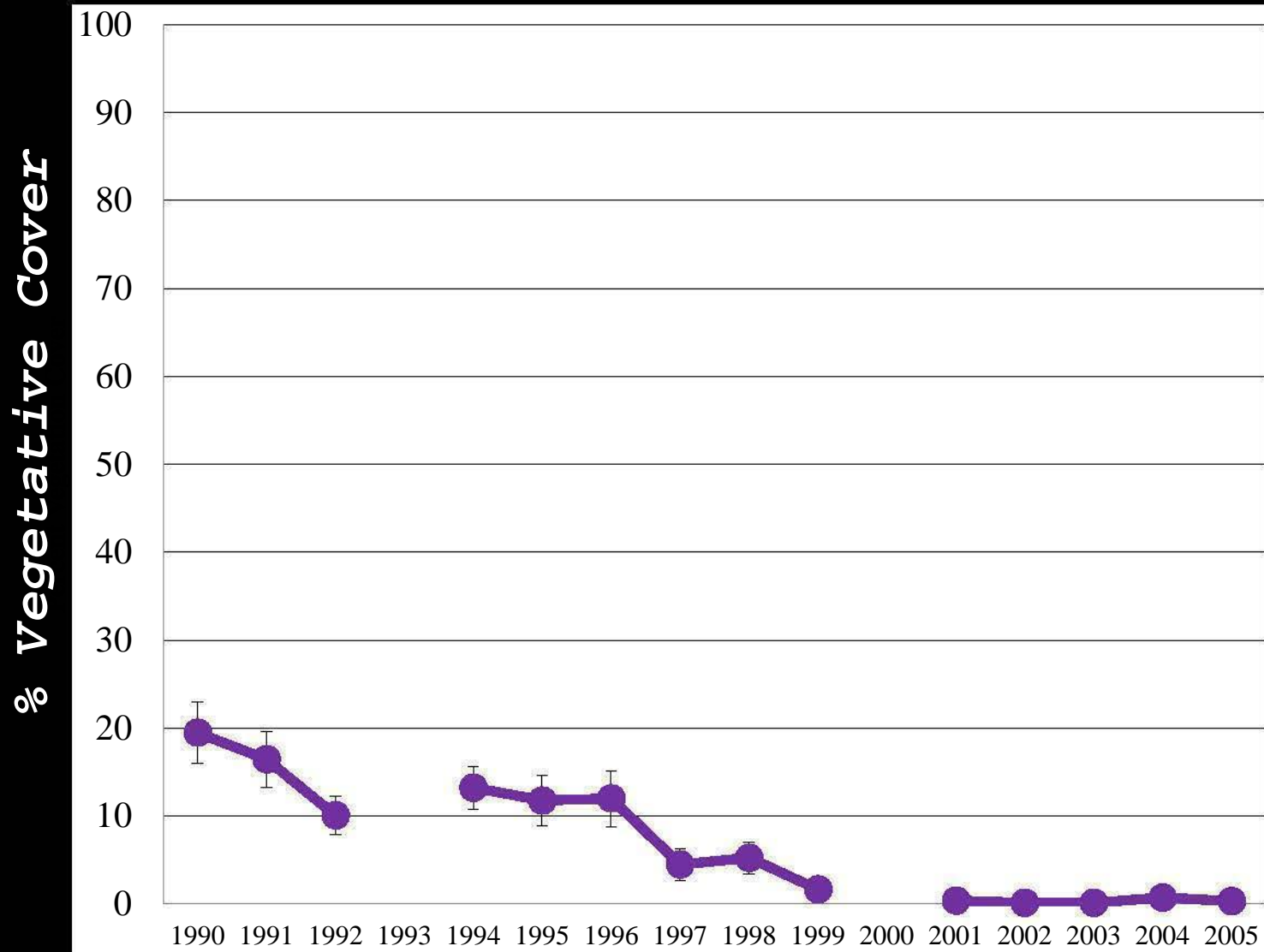
Spartina foliosa: Muzzi Marsh



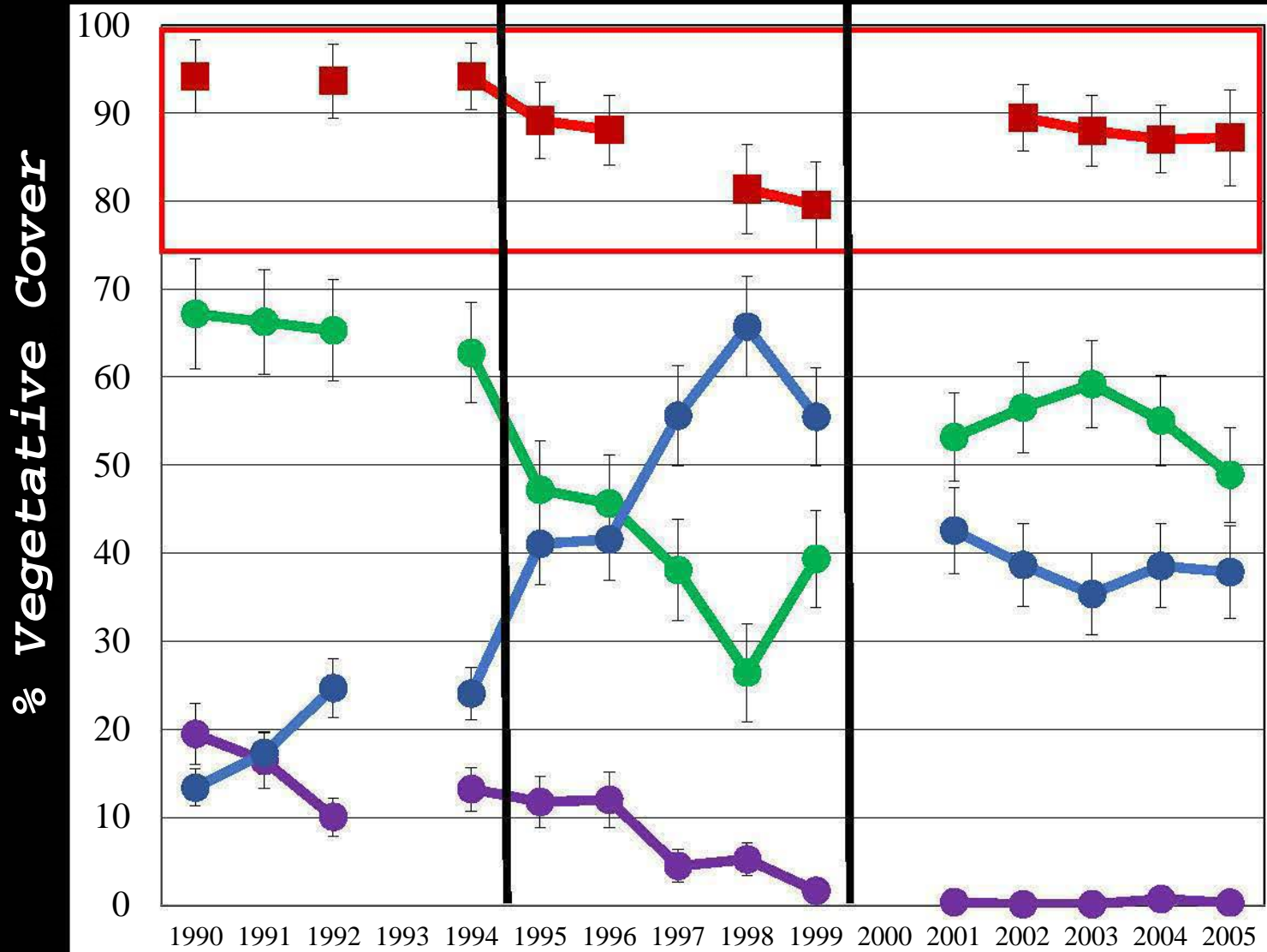
Salicornia vs. *Spartina*



Salicornia europaea: Muzzi Marsh



Overall Community Change



Question 2:

How does subdominant species abundance change over time?



*Distichlis
spicata*



*Frankenia
salina*



*Grindelia
stricta*



*Jaumea
carnosa*



Data Analysis

1987

Subset data into 3 periods
based on El Niño Events in
1995 and 1998

Subset subdominant species

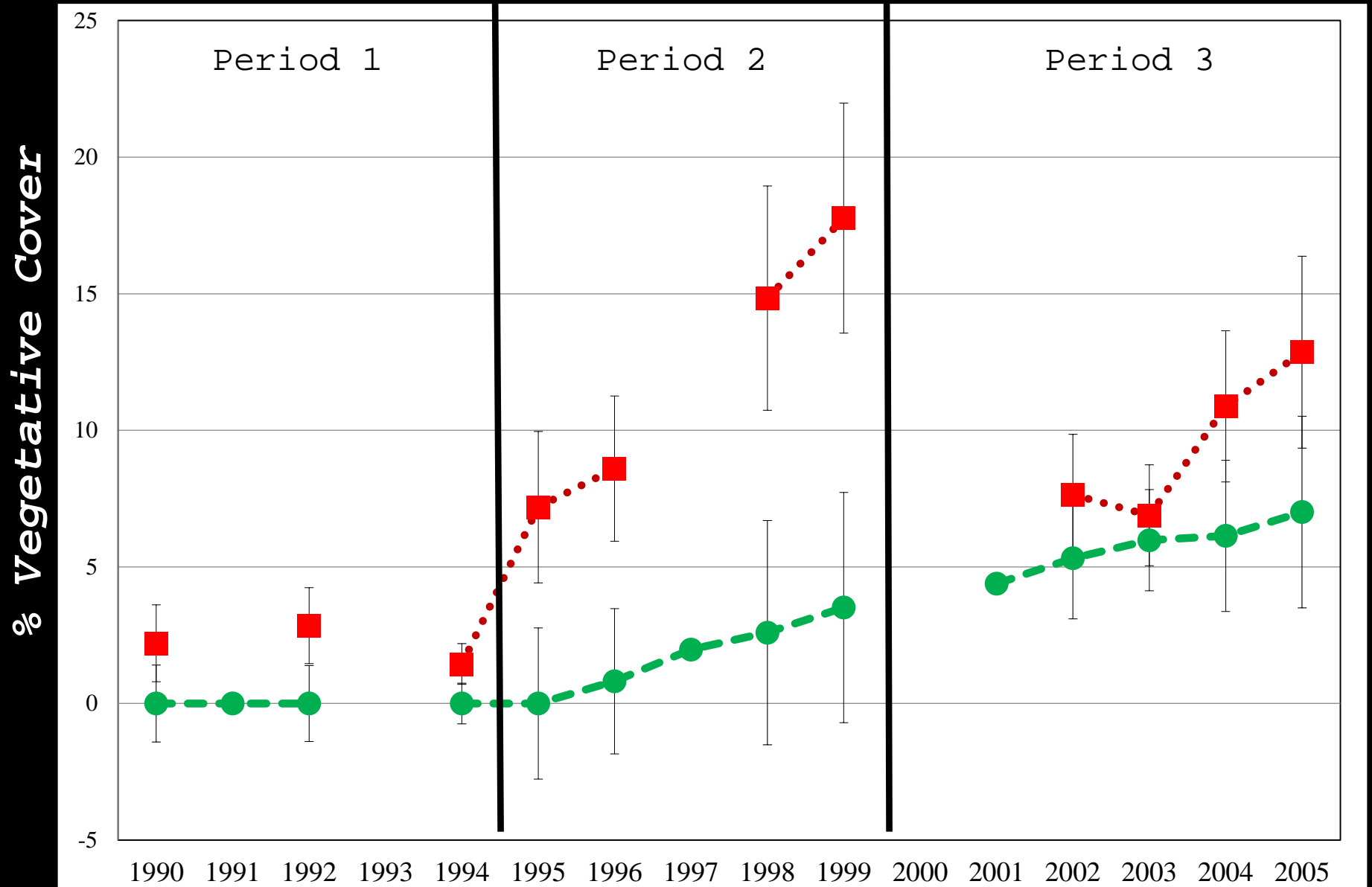
1999

Linear mixed effects models
at each site

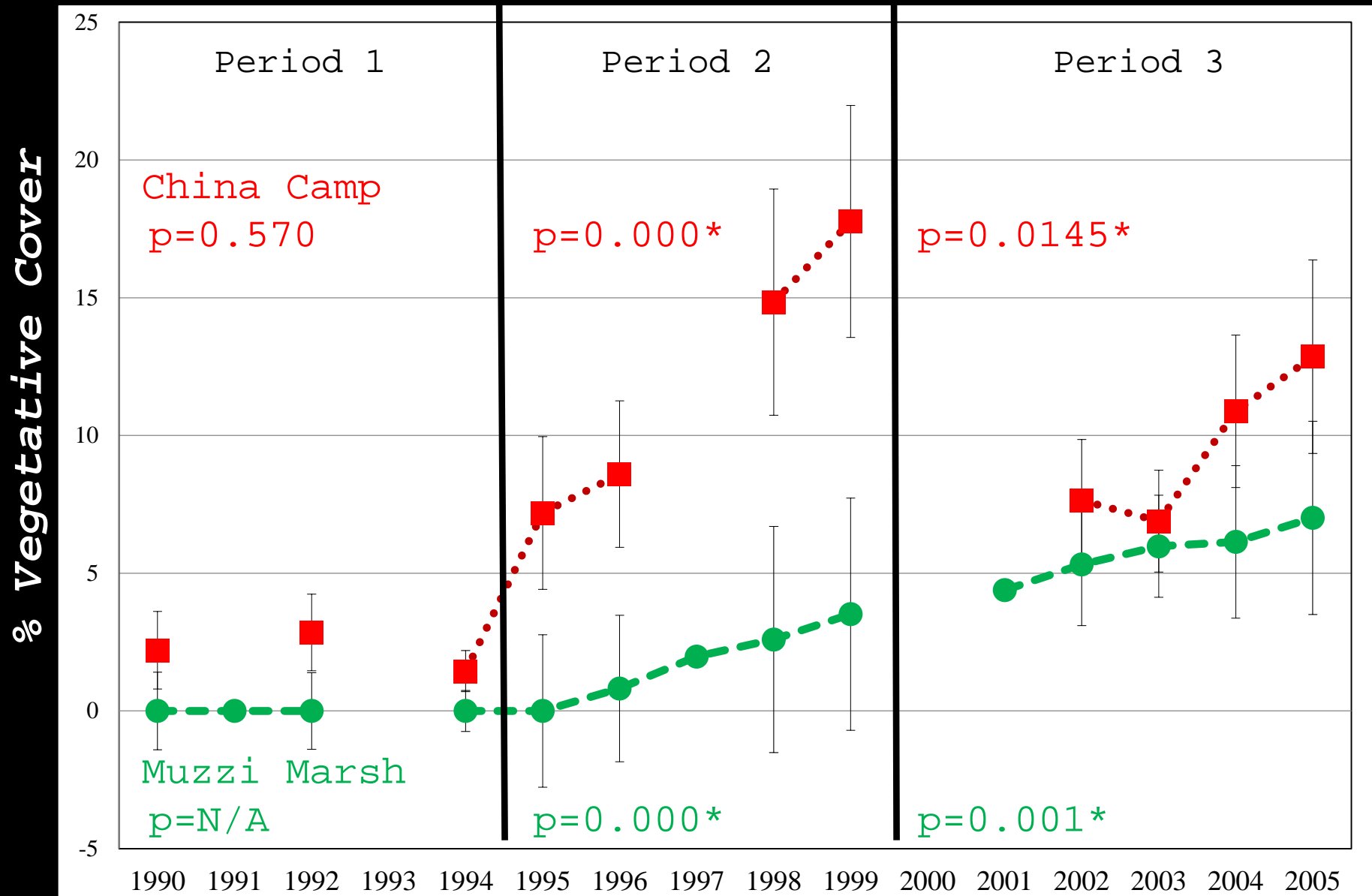
2003



Subdominant Abundance



Subdominant Abundance



Channels and Rainfall

1987

Channel: significant
predictor of subdominant
increase at both sites
($p < 0.01$)

1999

Annual rainfall NOT a
significant predictor of
subdominant change

2003



2015 Site Revisits



From 2005 to 2015:

Mean subdominant
abundance decreased
at China Camp:
12.86% to 5.56%

Stayed stable at
Muzzi Marsh:
7.01% to 7.33%

Overall greater mean
abundance may be due
to higher proportion
of channels at Muzzi

Conclusions

1987

Restoration trajectories are long and often non-linear—weather can influence

1999

Reference systems are also subject to significant variability over time

Matching restoration actions to climate conditions and adjusting timelines

2003



Revisiting a range of restoration projects of different ages

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Community Change



Bray-Curtis
dissimilarity

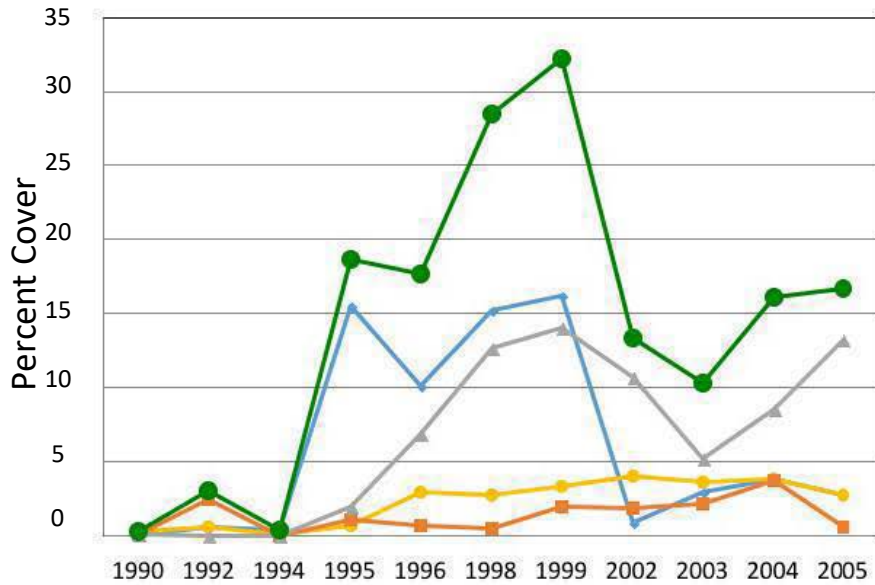
$$BC_{ij} = \sum \frac{|n_{ik} - n_{jk}|}{(n_{ik} + n_{jk})}$$

Measure of how
similar plant
communities are over
time

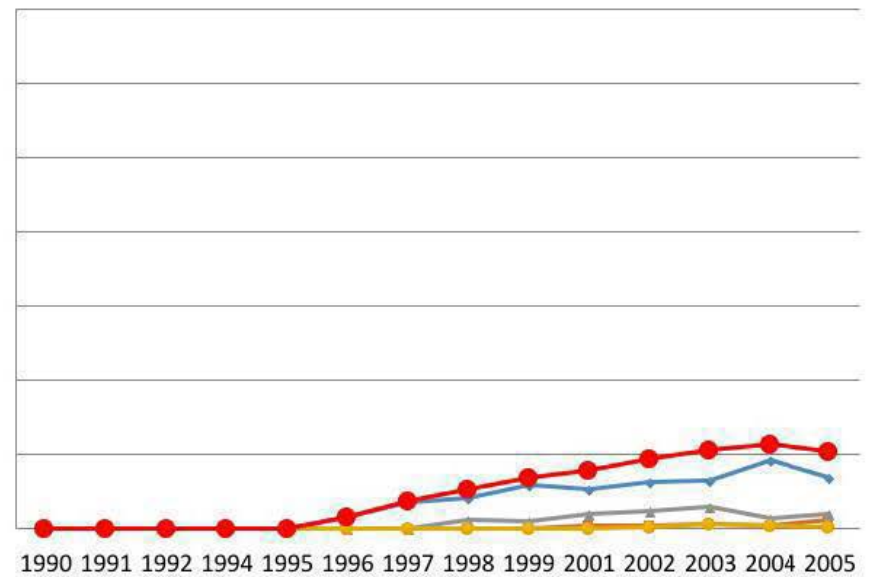
Divided into 3
periods based on El
Niño events in 1995
and 1998

Subdominant Species Abundance

Sub-Dominant Species Abundance, China Camp



Sub-Dominant Species Abundance, Muzzi Marsh



Legend

- ◆ Disticillis spicata

- Frankenia salina

- ▲ Grindelia stricta

- ◆ Jaumea carnosa


● Total "China Camp"
● Total Muzzi Marsh

Subdominant Species Abundance

