Modeling Sea-level Rise Effects on Tidal Wetland Distributions in the San Francisco Bay Estuary

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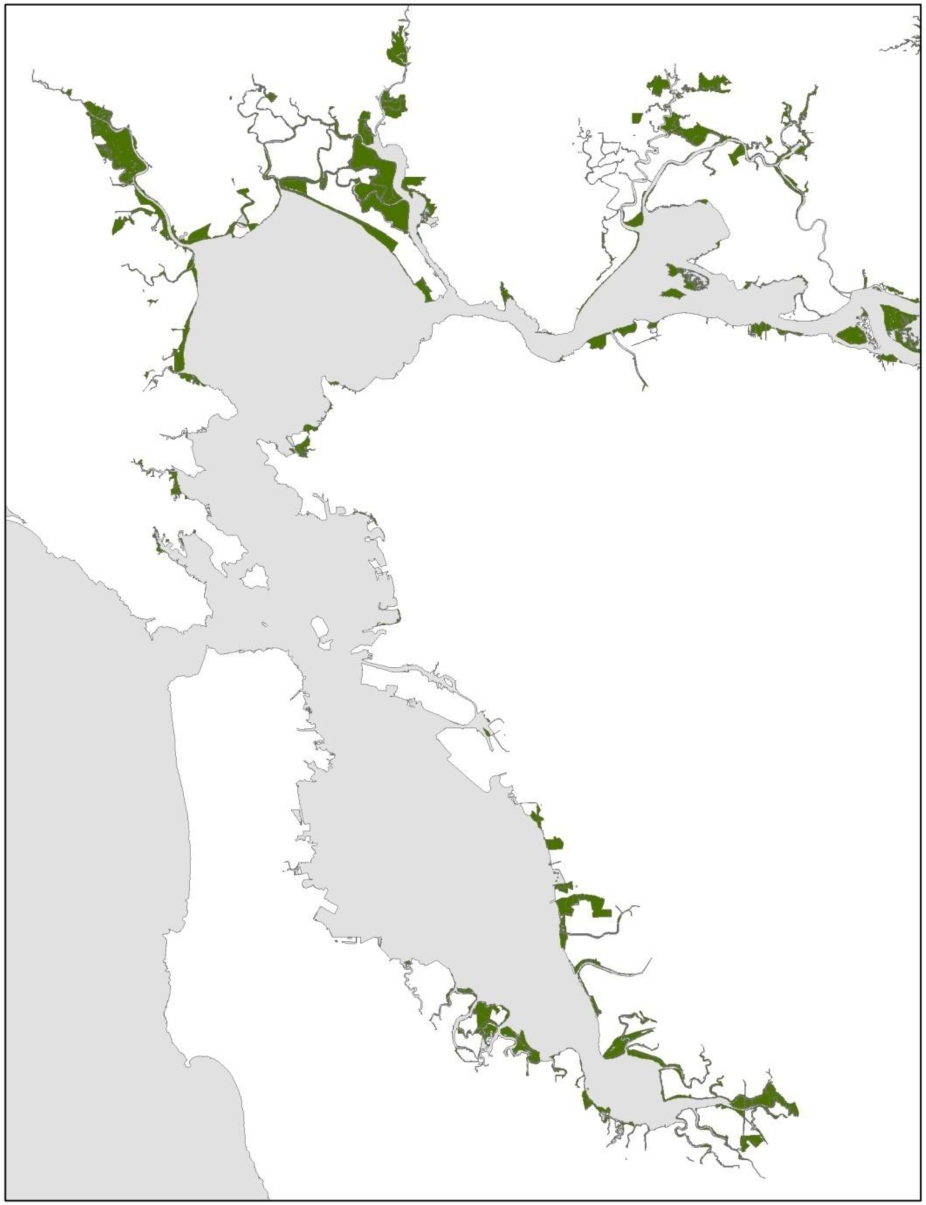
CALFED BAY-DELTA PROGRAM

Pre 1850

Current

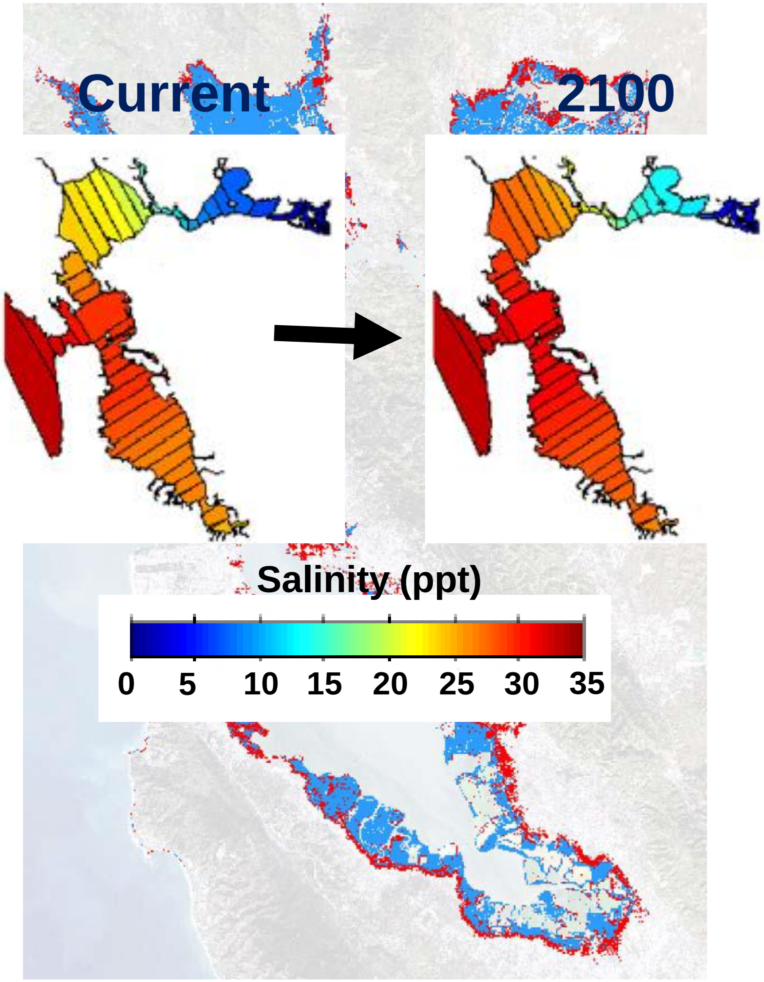


How might wetland distributions change with predicted climate change?






Climate change impact on wetlands



- Increased inundation due to sea-level rise
- Increased salinity during growing season
- Key uncertainties
  - ability to maintain elevation with SLR
  - ability to migrate upland

N. Knowles

1. Sea-level Rise Field Experiment

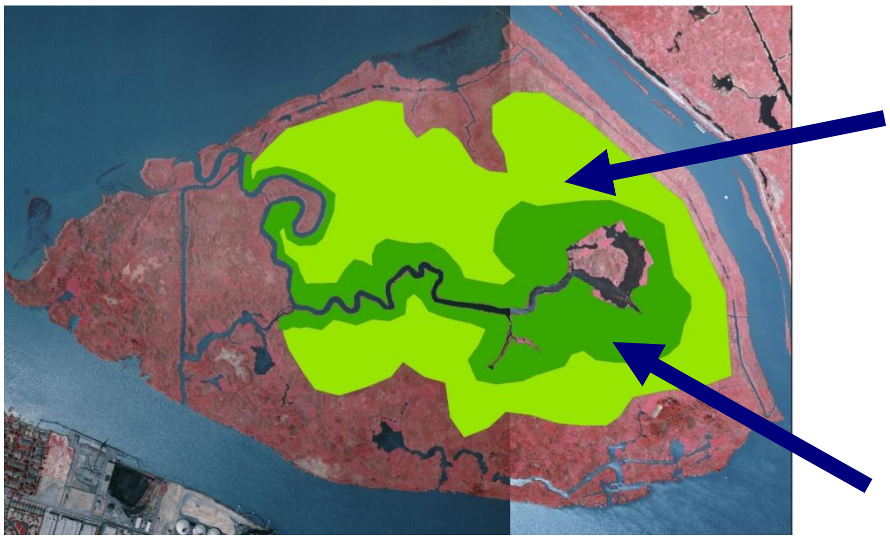
2. Modeling Marsh Accretion with Sea-level Rise

Sea-level Rise Experiment

- Examine how simulated SLR affects above- and below-ground productivity of two dominant plant species
- Main questions
  - How do species respond to increased inundation?
  - How do biotic interactions change with increased inundation?

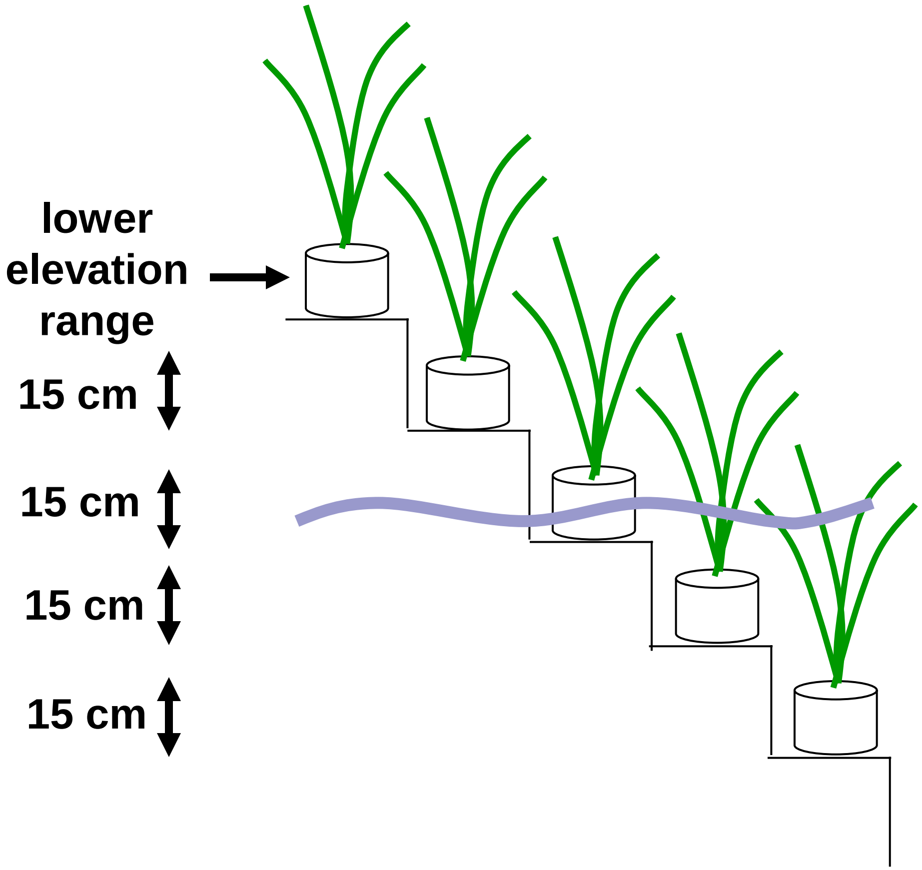
Sea-level Rise Experiment

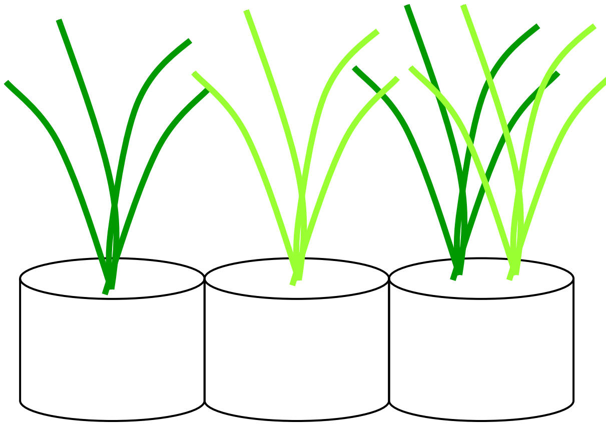


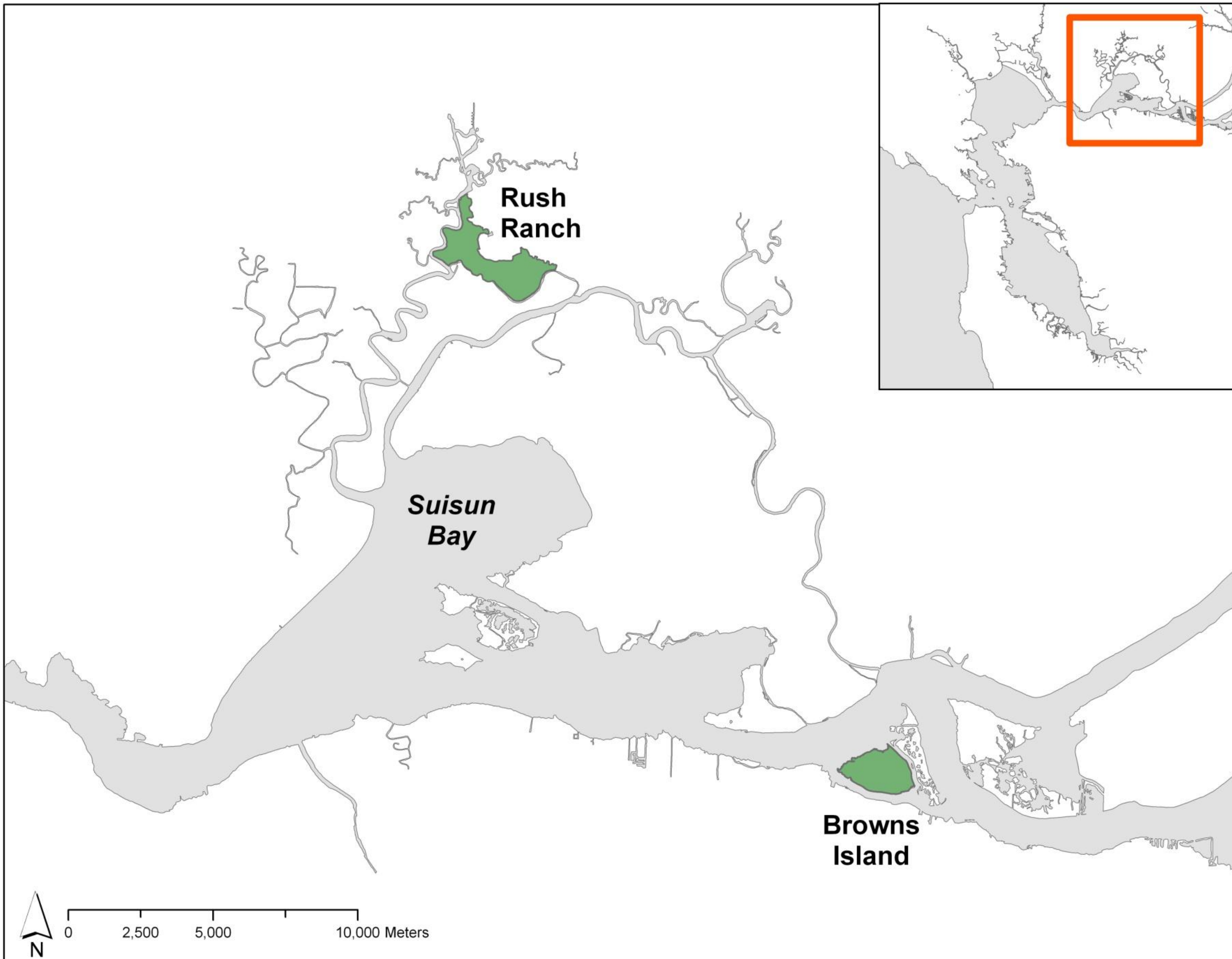
Schoenoplectus americanus

Schoenoplectus acutus

Marsh Organ

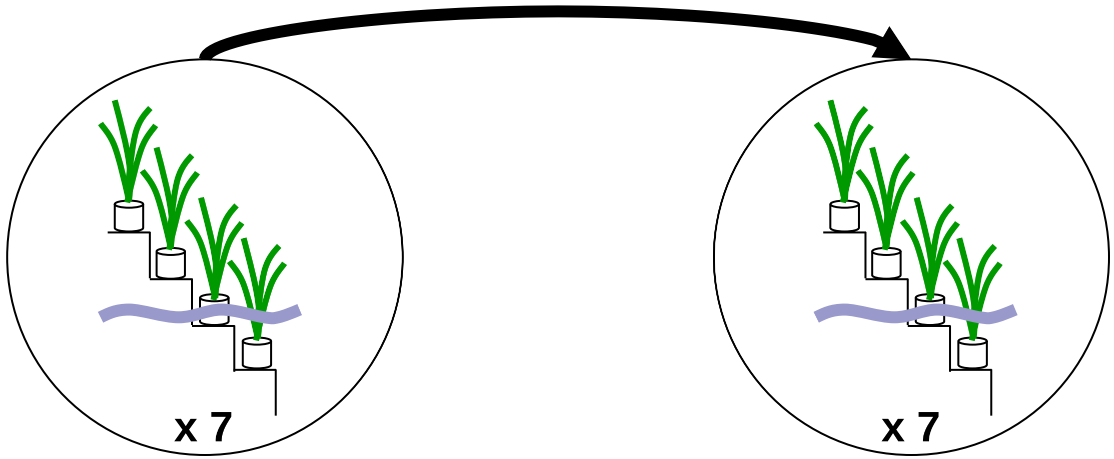




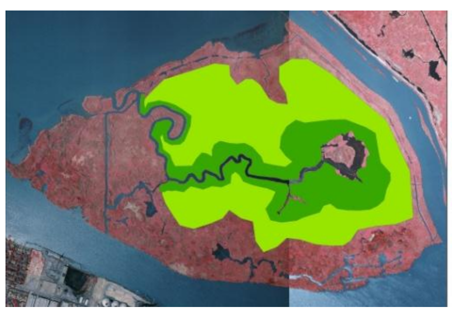

Rush Ranch
Suisun Bay
Browns Island
N
0
2,500
5,000
10,000 Meters

Sea-Level Rise Experiment

Inundation



Browns Island

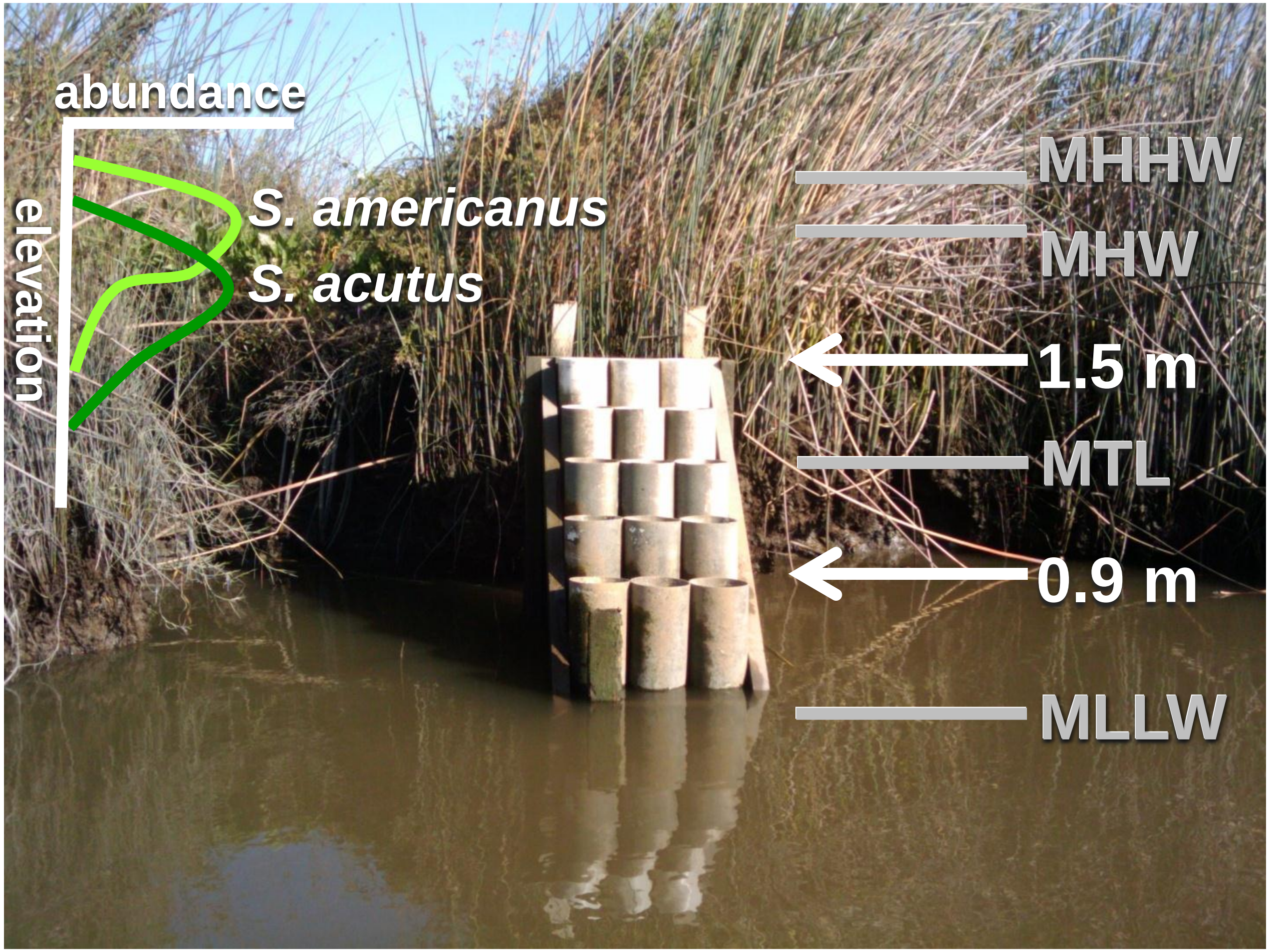


Rush Ranch

Salinity

0-1 ppt

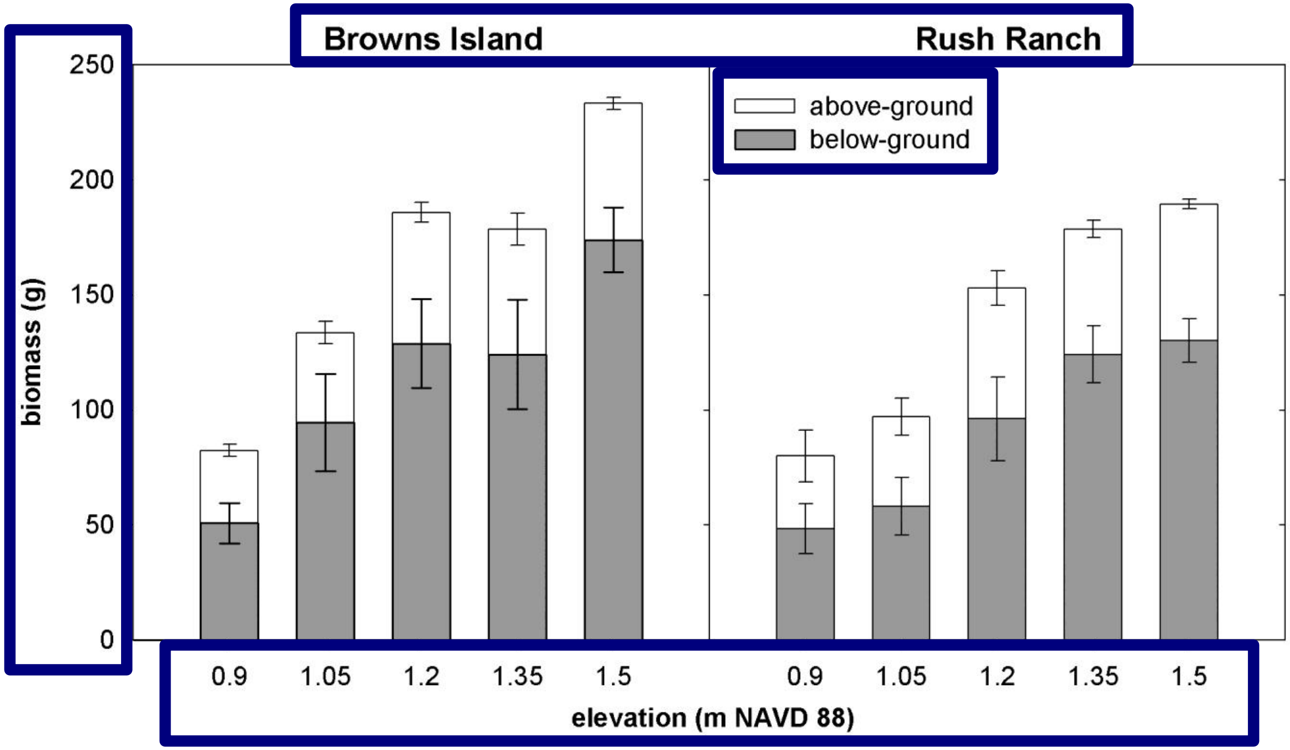
3-5 ppt


abundance
elevation
S. americanus
S. acutus
MHHW
MHW
1.5 m
MTL
0.9 m
MLLW

Marsh Organ

Total Biomass

Schoenoplectus acutus

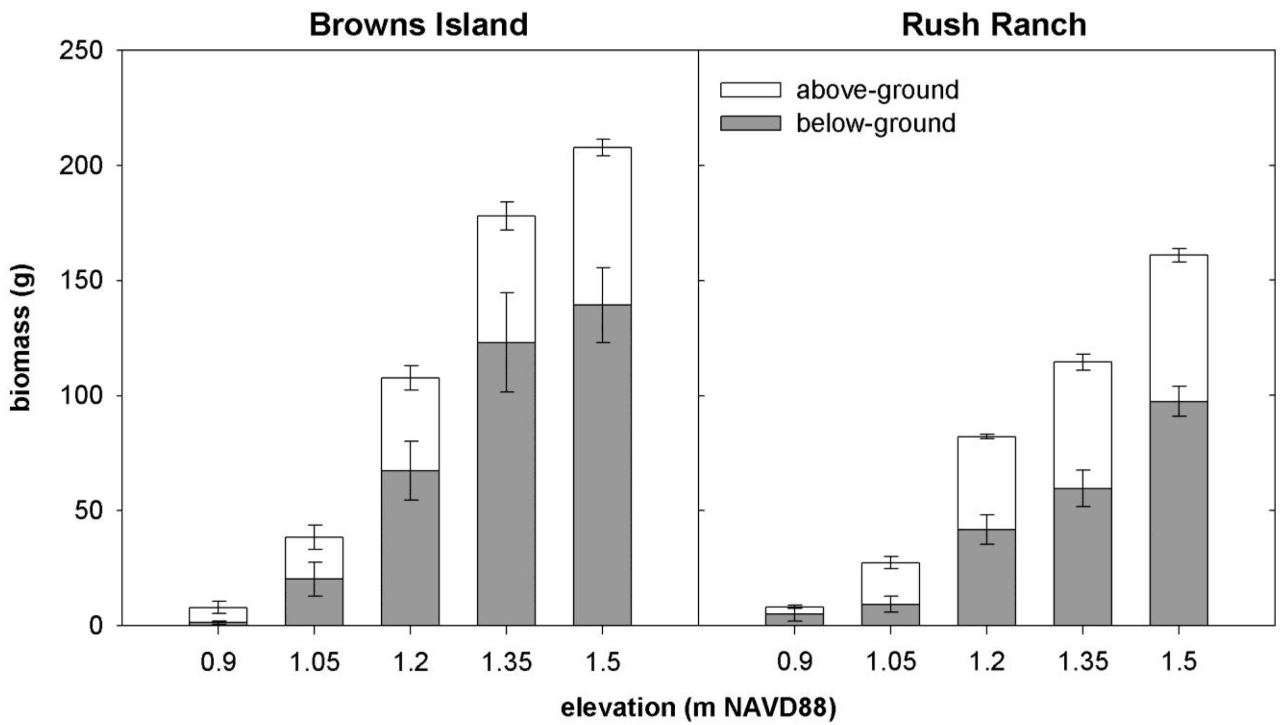


Similar trends with above- and below-ground biomass

60% distribution in biomass with increased inundation

Total Biomass

Schoenoplectus americanus



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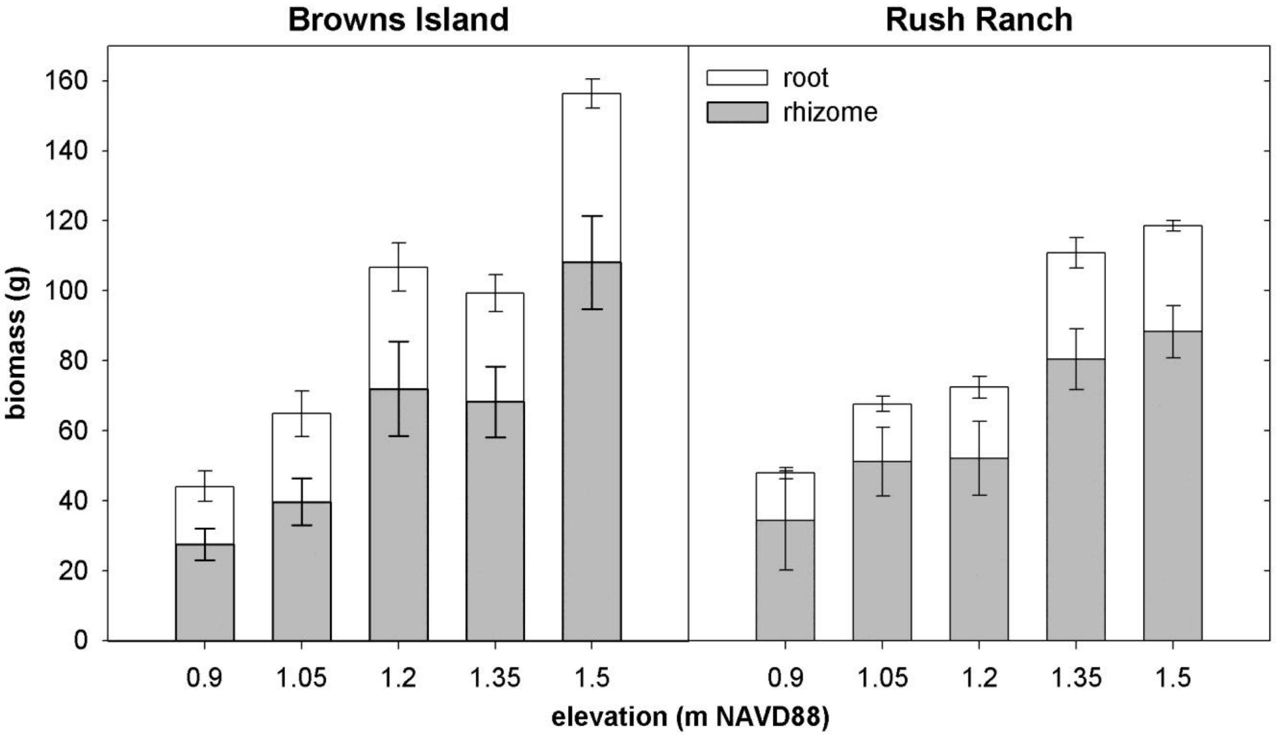
Below-ground Biomass

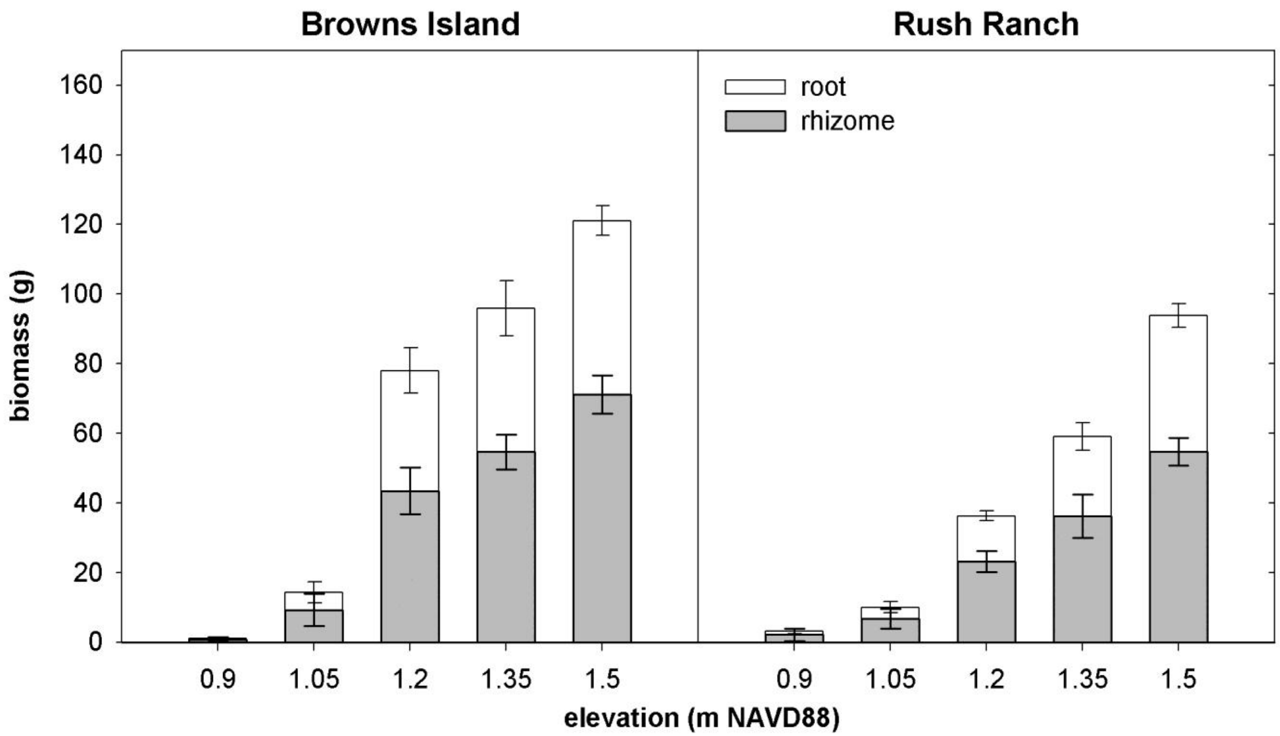
Schoenoplectus acutus



Proportional decrease in both roots and rhizomes with increased inundation

Below-ground Biomass

Schoenoplectus americanus

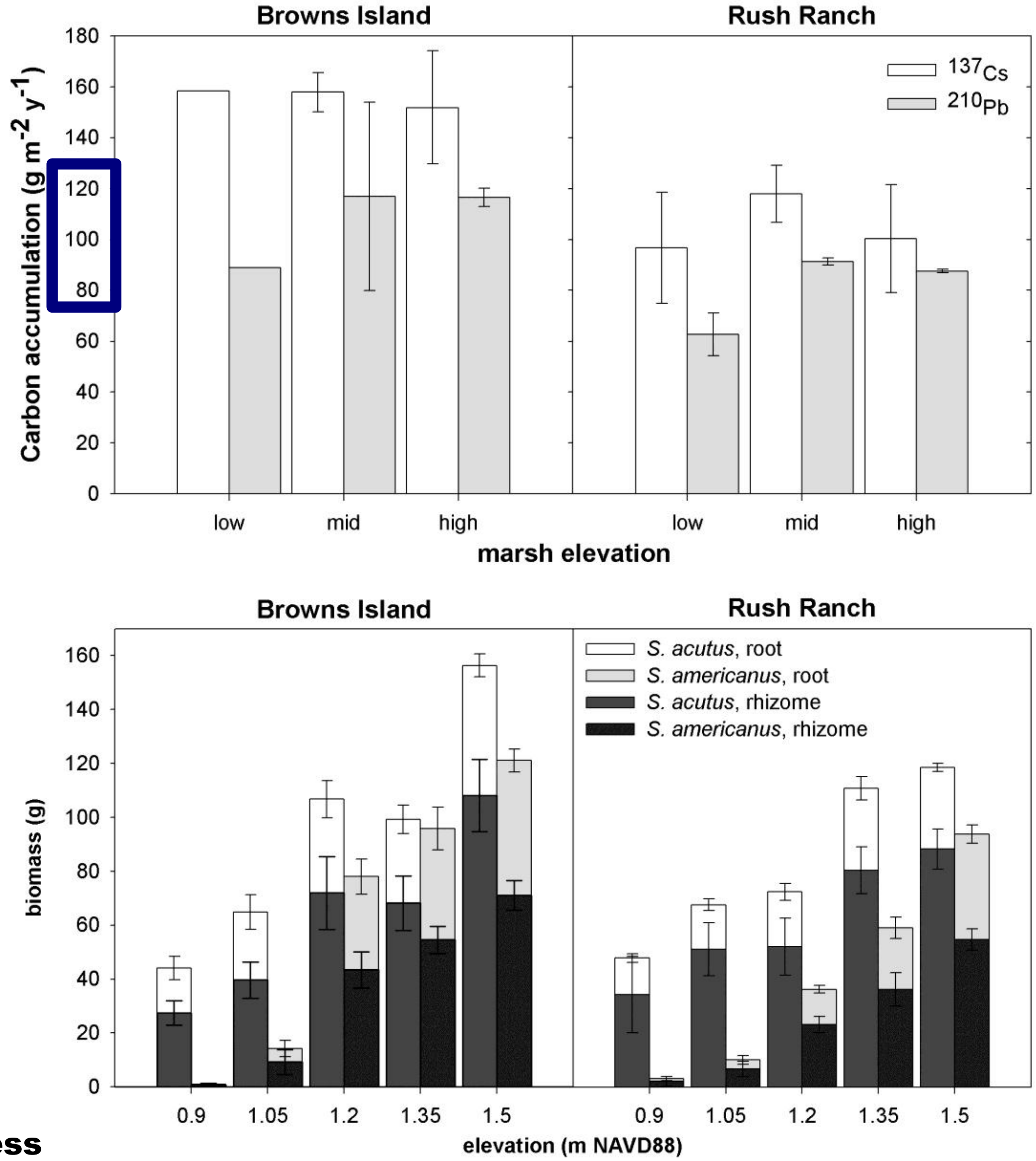


Marsh Organ Results

- Plant response to SLR
  - *S. acutus* biomass decreased with increased inundation, but not markedly
  - *S. americanus* biomass & survival decreased dramatically with increased inundation
    - sea level increase of ~80 cm kills most plants

S. acutus* is better adapted to inundation stress than *S. americanus

Carbon Storage



Callaway et al. in press

2. Modeling Marsh Accretion with Sea-level Rise






NCEAS Working Group
C Sequestration modeling in tidal wetlands

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- Steve Crooks, ESA PWA
- Pat Megonigal, Smithsonian Env. Res. Center
- Abe Doherty, CA Coastal Conservancy
- Rich Ambrose, UCLA
- Omar Aziz, FIU
- Lisa Marie Windham-Myers, USGS
- Chris Craft, Univ. of Indiana
- Steve Faulkner, USGS
- Jason Keller, Chapman Univ.
- Jim Morris, Univ. of South Carolina
- Enrique Reyes, East Carolina Univ.
- Lisa Schile, UC Berkeley

Options

- ☐ Simulate Restoration
- ☑ Use my biomass depth profile
- ☑ Biomass Seasonality

Physical Inputs

Century Sea Level Rise	24	cm
Mean High Water	186	cm NAVD
Mean Sea Level	105	cm NAVD
Initial Rate SLR	0.24	cm/yr
Suspended Sed. Conc.	100	mg/l
Marsh Elevation	173.8	cm NAVD

Biological Inputs

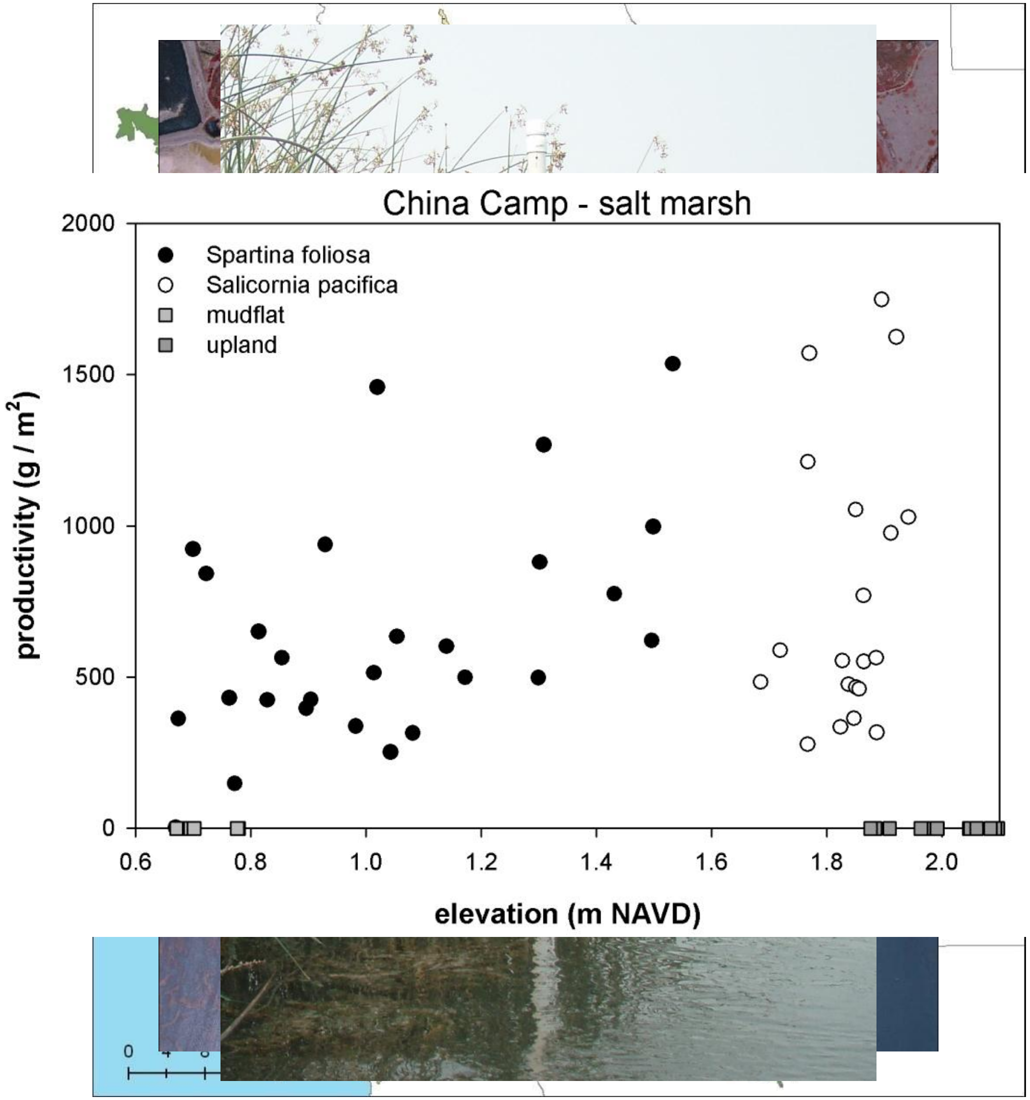
max elevation	194.0	cm
min elevation	60.0	cm
max peak biomass	1600	g/m2
OM decay rate	-0.8	1/year
BGBio to Shoot Ratio	3.4	g/g
Refrac. Fraction (kr)	0.05	g/g
BG turnover rate	1.5	1/year
Max (95%) Root Depth	20	cm

Trapping Coef & Settling Velocity

ks	3.26E-02	$cm^{-1}\ yr^{-1}$
q	1.36E-03	$g\ cm^{-3}\ yr^{-1}$

Marsh Equilibrium Model

- Point-based
- Physical and biotic inputs
- Models marsh accretion with SLR over 100 years
- Apply the model to San Francisco Bay wetlands
- Map how marsh distributions change over time with SLR

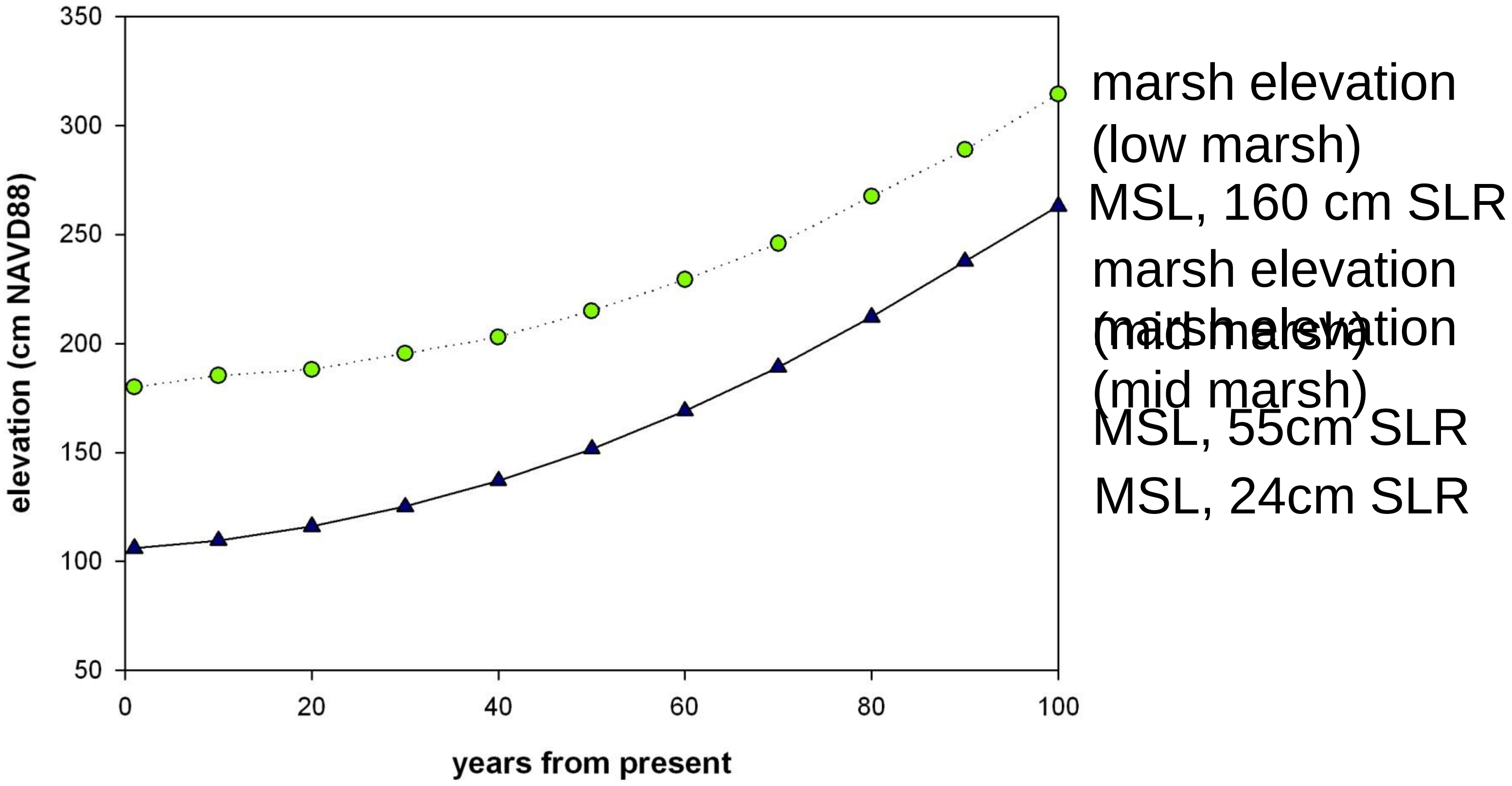


- Elevation ... marsh concentrations
  - LIDAR data

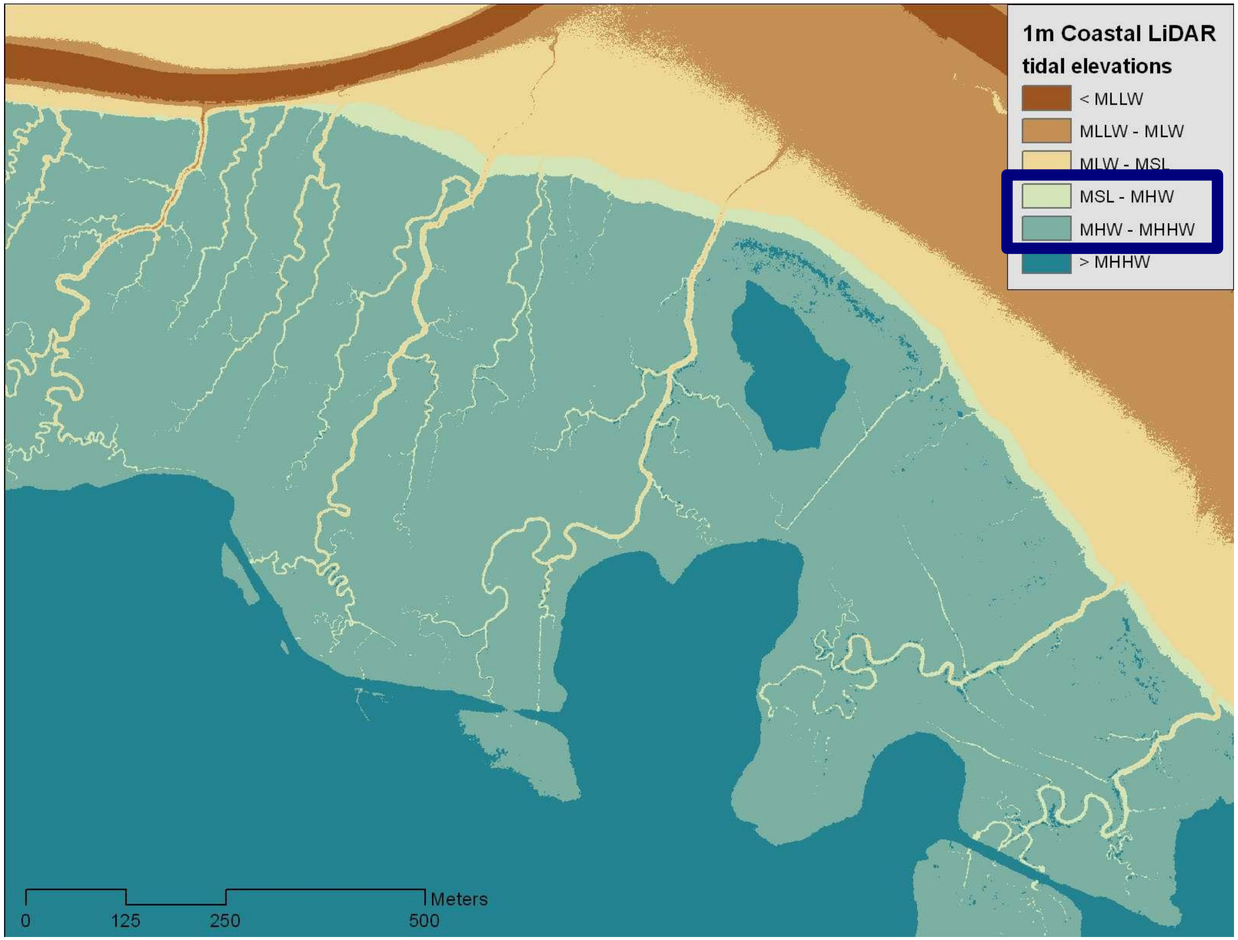
Stralberg et al. 2011


Petaluma River Marsh
Coon Island
Rush Ranch
San Pablo Bay
Suisun Bay
China Camp
Browns Island

MEM Results

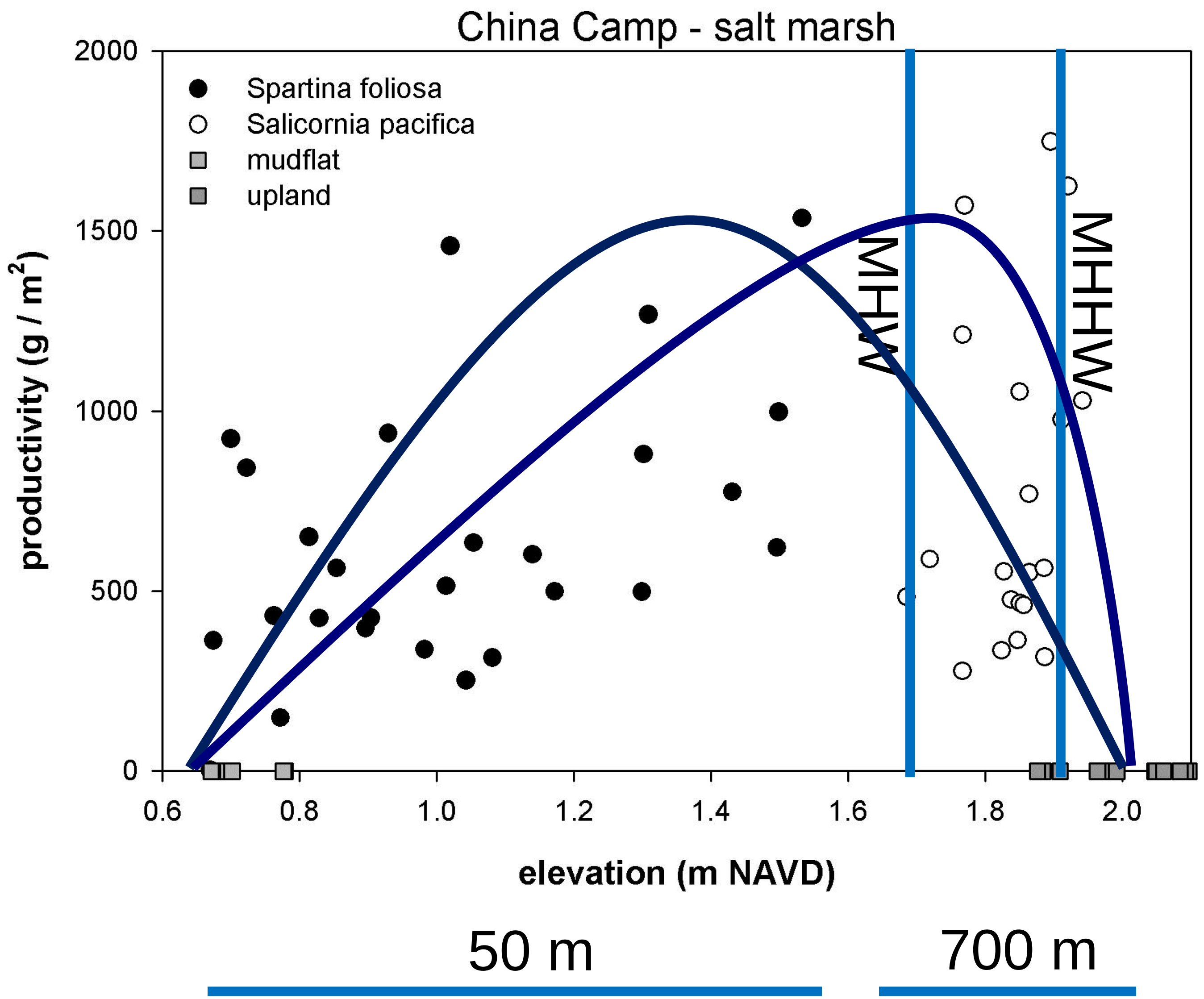


starting elevation: 180 cm (mid marsh)
suspended sediment concentration: 100 mg/l



Maps of Tidal Characteristics

MHW delineates *Spartina foliosa* and *Salicornia pacifica* boundary


China Camp - salt marsh
Spartina foliosa
Salicornia pacifica
mudflat
upland
MHW
MHHW
productivity (g / m²)
elevation (m NAVD)
2000
1500
1000
500
0
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
50 m
700 m

Broader Implications

- Reduction in both above- and below-ground biomass with increased inundation
- Changes in sea level and salinity likely will have negative effects on carbon sequestration and marsh distribution
- Highly urbanized estuary with little space for wetland migration
- Many large tidal wetland restoration opportunities in the Estuary
- With predicted climate change, need to rethink marsh management and where and how wetland restoration occurs

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