



U.S. ARMY

## USING ENGINEERING WITH NATURE<sup>®</sup> TECHNIQUES TO RESTORE TIDAL SALT MARSHES IN SUBSIDED FORMER BAYLANDS IN SAN FRANCISCO BAY, CA.

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Wetlands and Coastal Ecology Branch, Environmental Lab
- 9<sup>th</sup> National Summit on Coastal and Estuarine Restoration and Management
- December 12, 2018

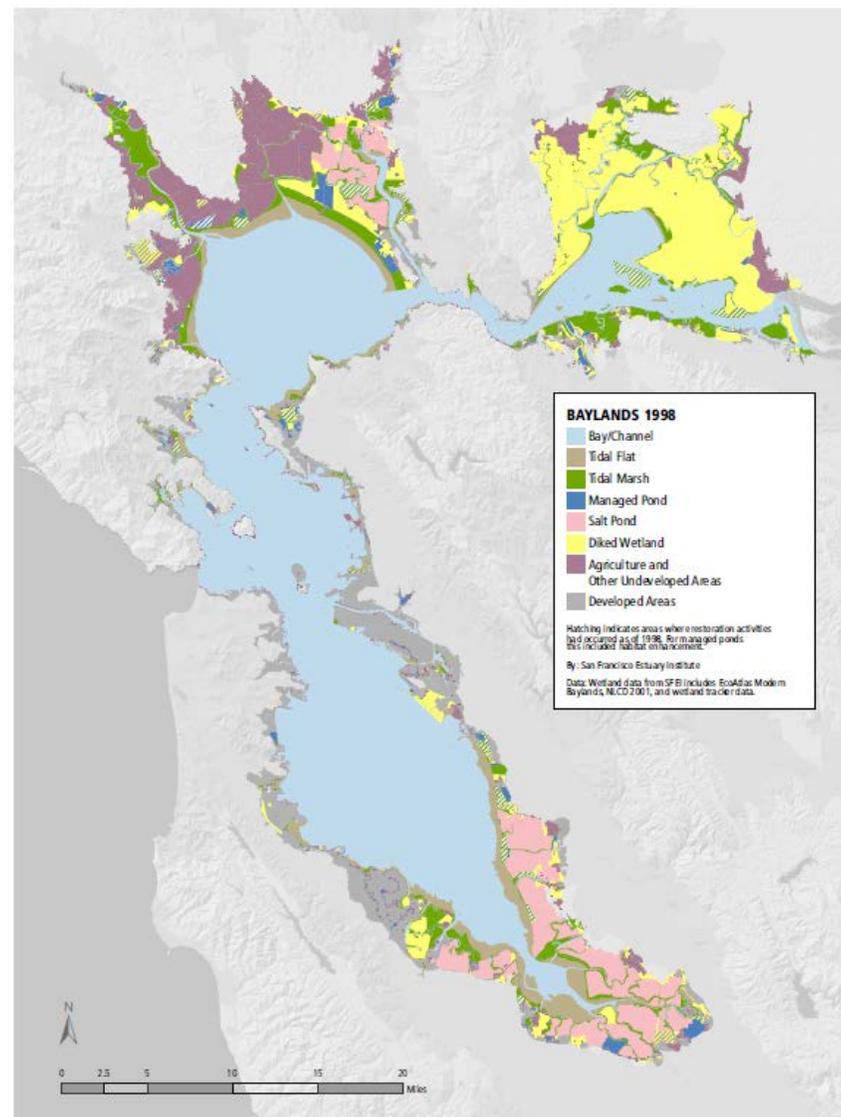
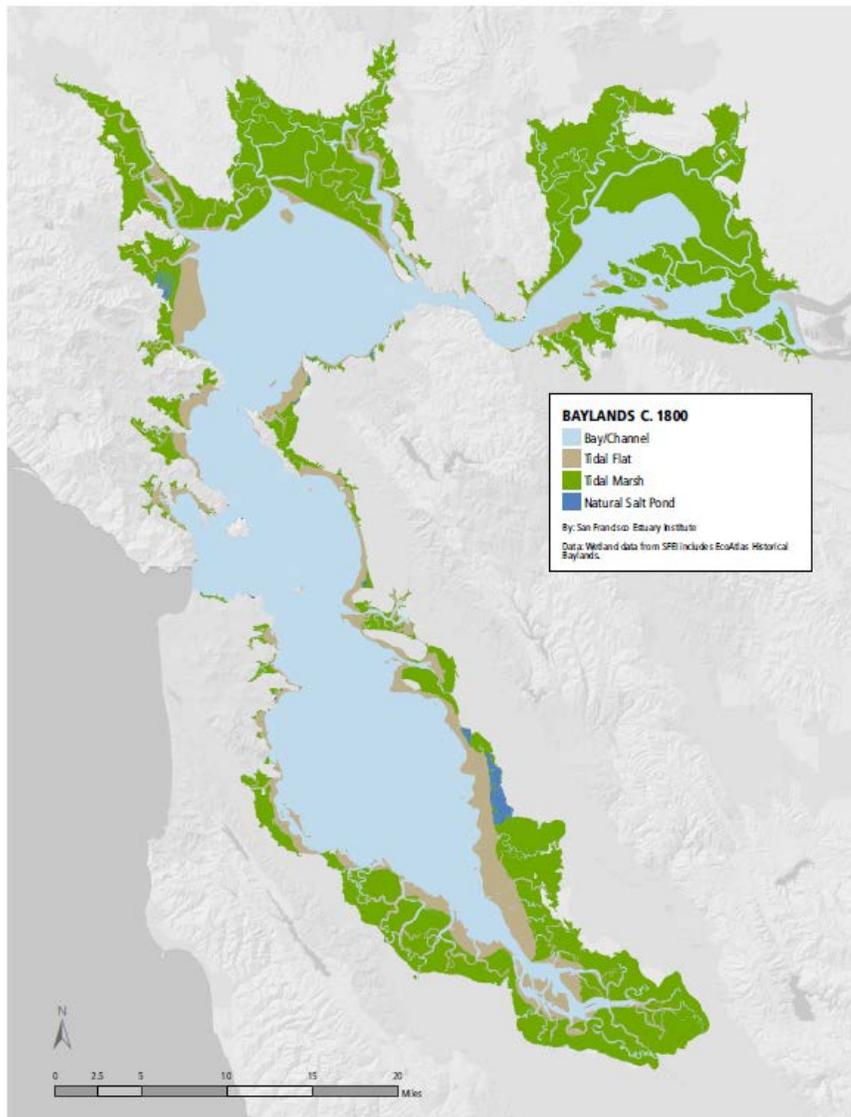


US Army Corps  
of Engineers<sup>®</sup>



DISCOVER | DEVELOP | DELIVER

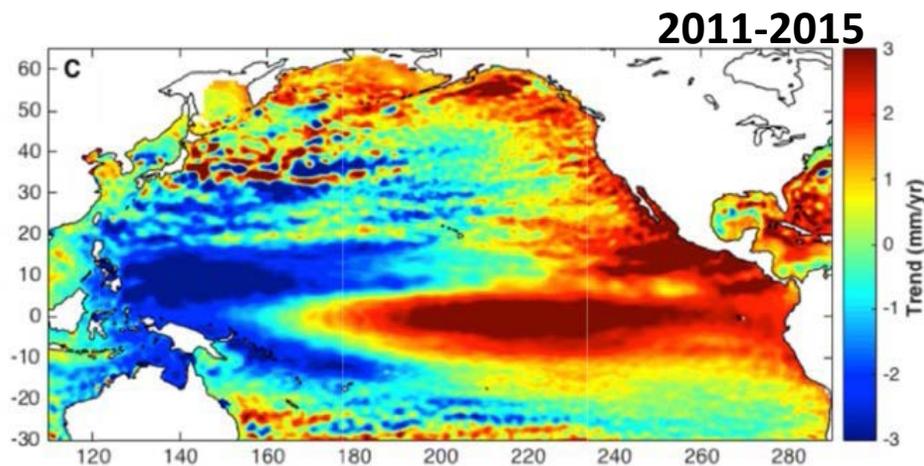
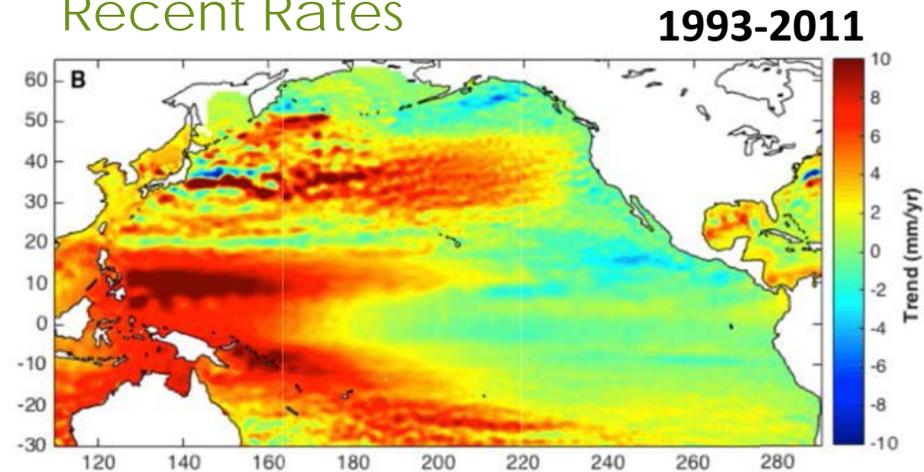
# Historic Marsh Losses



Goals Project, 2015.

# Accelerated Sea Level Rise in East Pacific

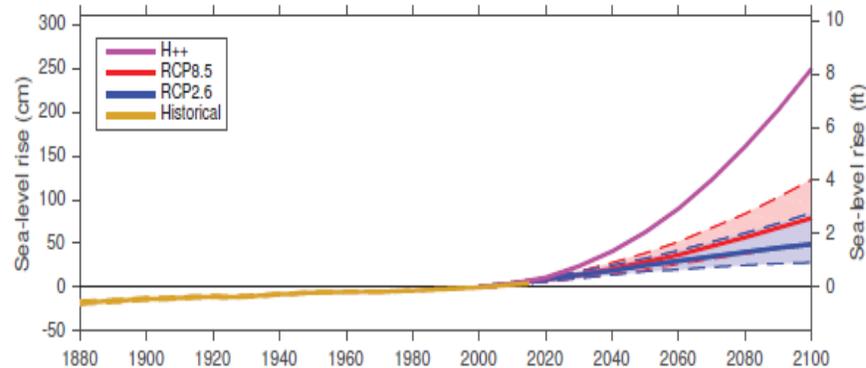
## Recent Rates



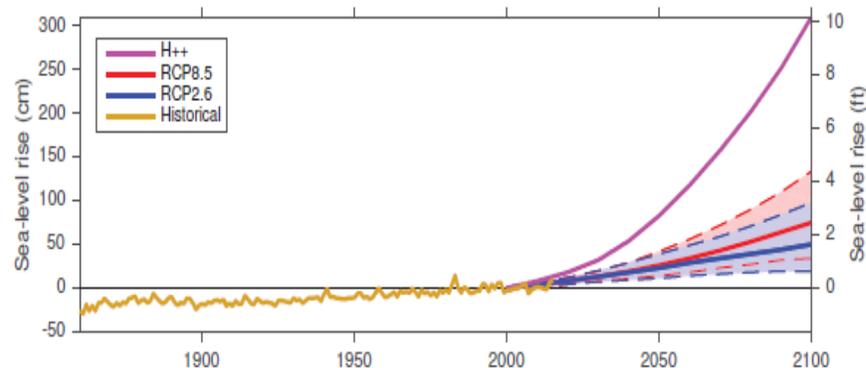
*Hamlington et al. 2016*

## Projections

(a) Global mean sea level



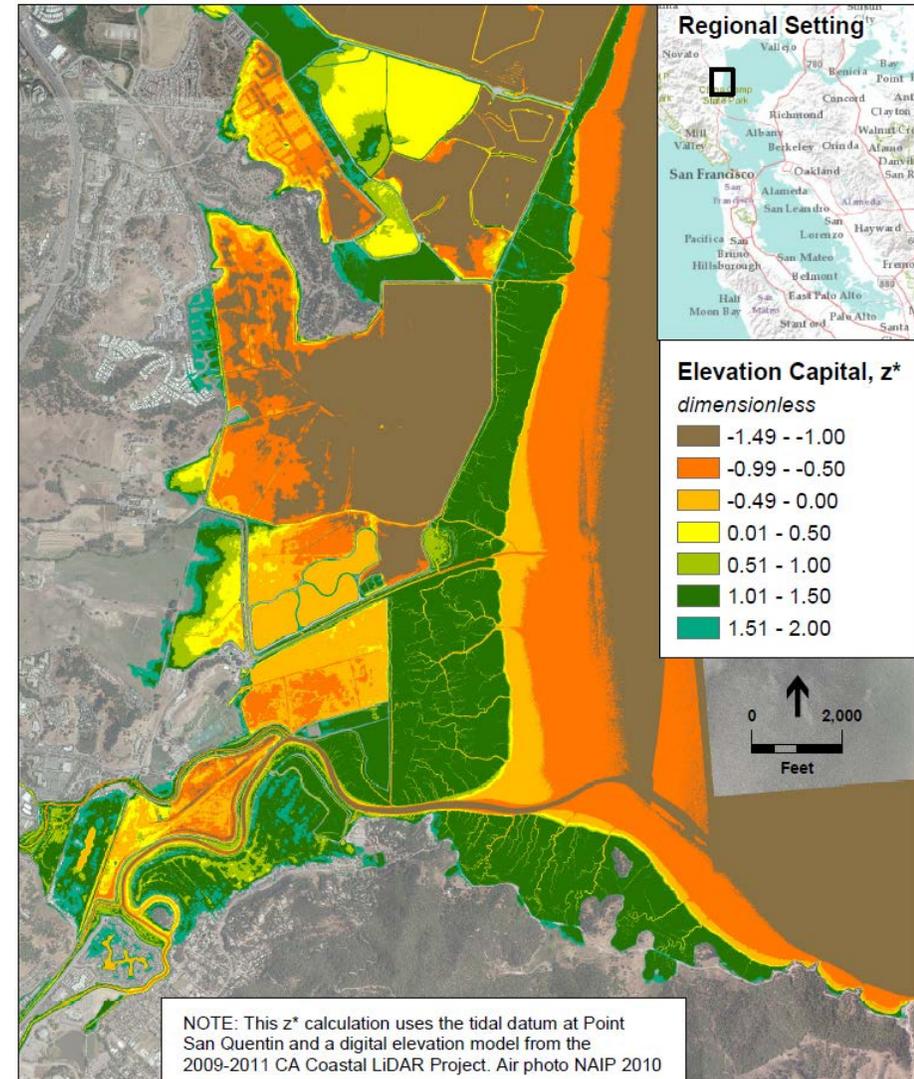
(b) Relative sea level in San Francisco, California



*Griggs et al., 2017*

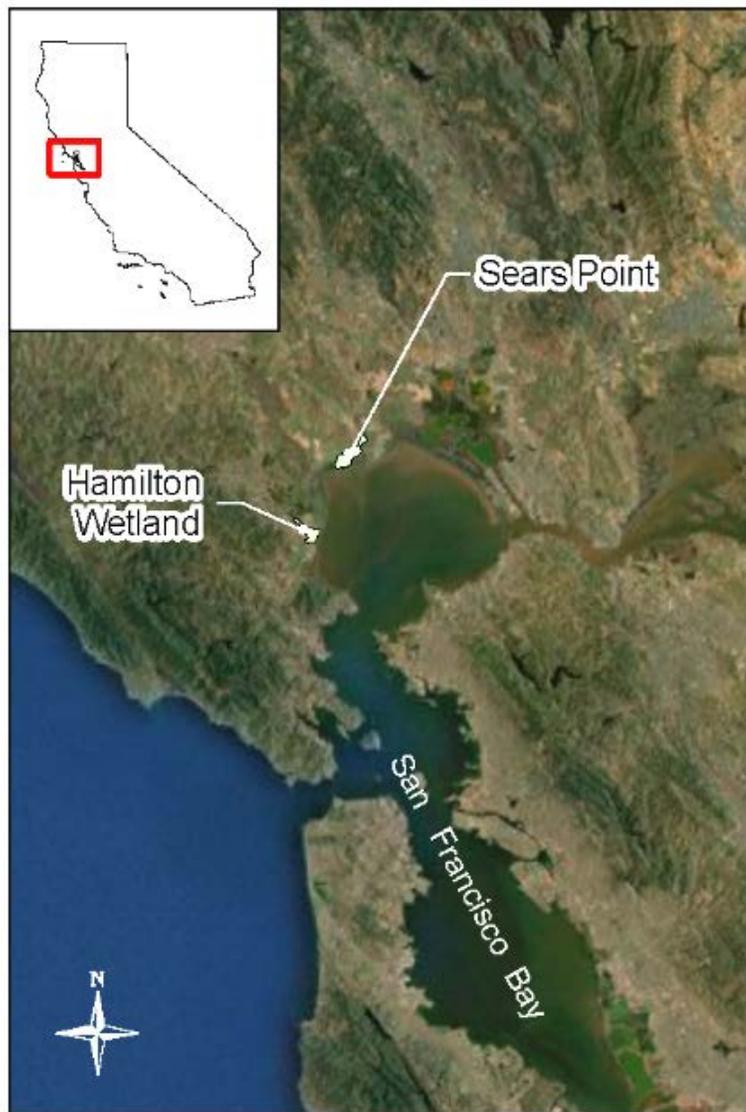
# Sediment and Subsidence

- Sediment supply reduced
- Diked baylands have subsided 1-2 m
- Dark green are marsh elevations.
- Yellow, orange and brown are below marsh elevation.
- In order to restore these baylands, sediment needs to be brought in or encouraged to accrete.



SFEI 2015

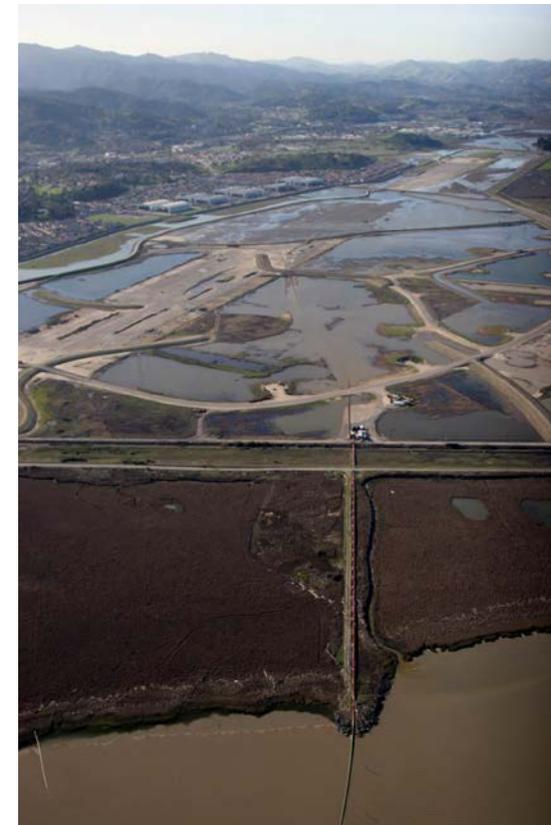
# Sears Point and Hamilton Wetlands



- Both in San Pablo Bay
- Both formerly diked, subsided baylands
- Both large
- Both involved multiple partners
  - SP: Sonoma Land Trust, Ducks Unlimited, CDFW, USFWS, WWR, plus 17 funders
  - HW: Corps of Engineers San Francisco District, California Coastal Conservancy, Port of Oakland (for dredged material), NOAA, BCDC
- Both designed to benefit species, including endangered species
- Both designs utilized natural processes, what we now call Engineering With Nature®
- Both subject to local constraints
- Both designs informed by Sonoma Baylands, a Corps project completed 20 years ago

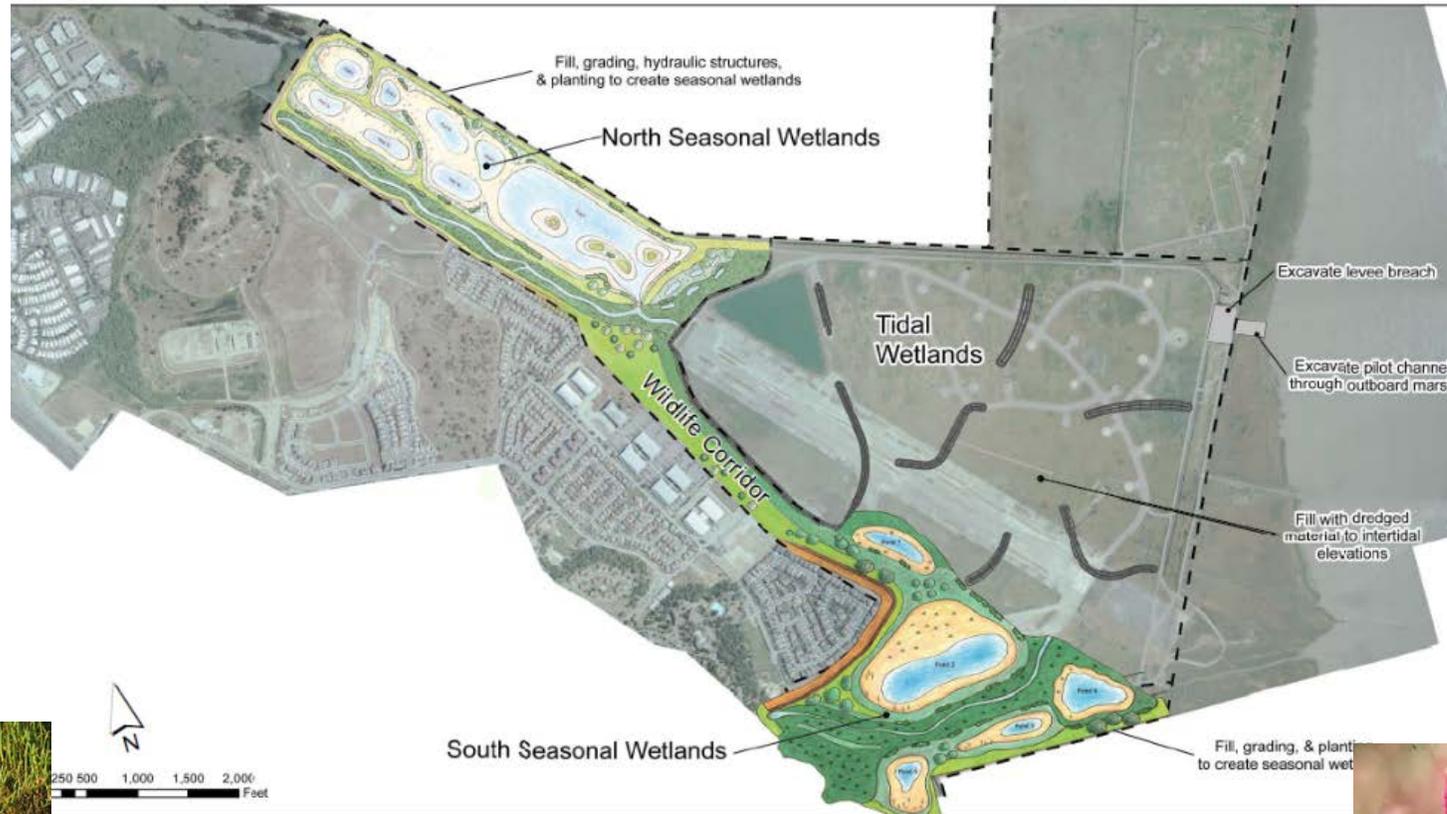
# Hamilton Wetlands

- Site diked ~150 yr ago for ag use
- Became an Army Airfield in 1930s
- Slated for restoration in 2003
- Significant subsidence ~ 2m
- 650-acre wetland restoration
- Beneficial use of 5.8 M yd<sup>3</sup> of dredged material brought tidal areas within feet of target elevations
- Berms used as fetch reduction to promote accretion of sediment to achieve remaining elevation gains
- Breached levee on 4/25/14



US Army Corps of Engineers  
San Francisco District

# Hamilton Wetlands

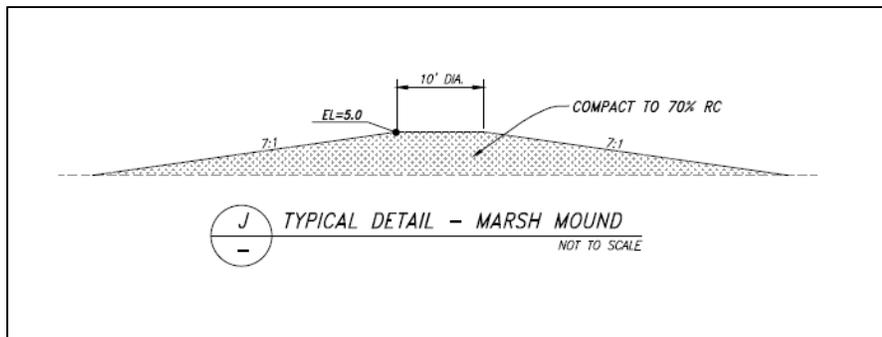
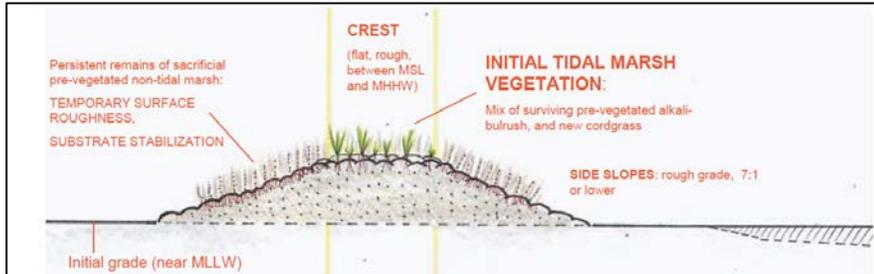


- Tidal Wetlands designed to support Endangered Ridgway Rail and Salt Marsh Harvest Mouse
- North Seasonal Wetlands can shift to Tidal Wetlands with SLR





# Sears Point

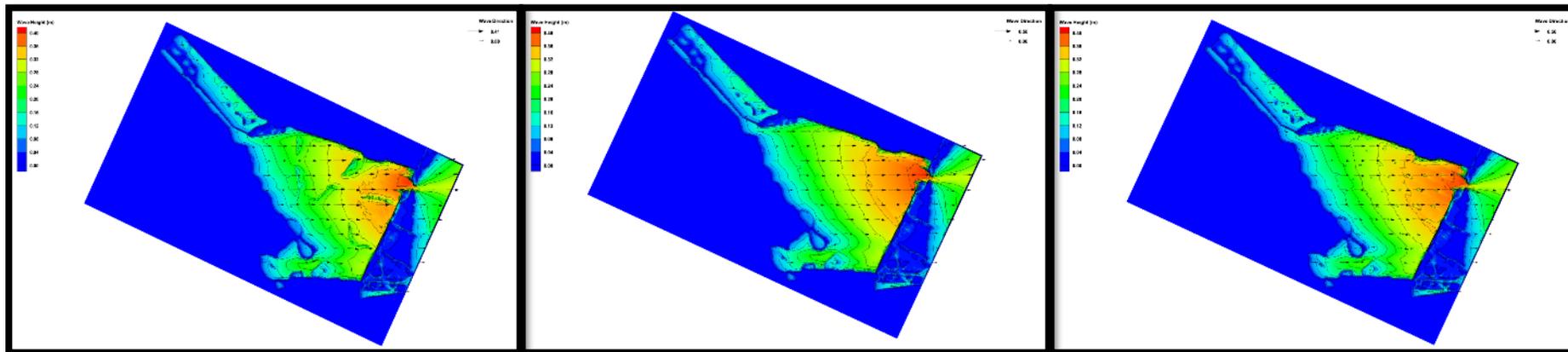


- 500 marsh mounds
- Reduce wind-wave energy
- Promote sediment accretion
- Serve as nuclei for vegetation

# Engineering With Nature®

## Research Into Harnessing Natural Processes

- At each site, use STWAVE to model wave height reduction from fetch reduction features
- Models validated based on data collected at each site for a year
- Models run on (1) As-Built, (2) Site stripped of features, and (3) Site with different features using same volume of material
- With and without Vegetation (parameters based on Corte Madera attenuation research)
- Models run for various wind directions and water heights



Linear Berms (As-Built)

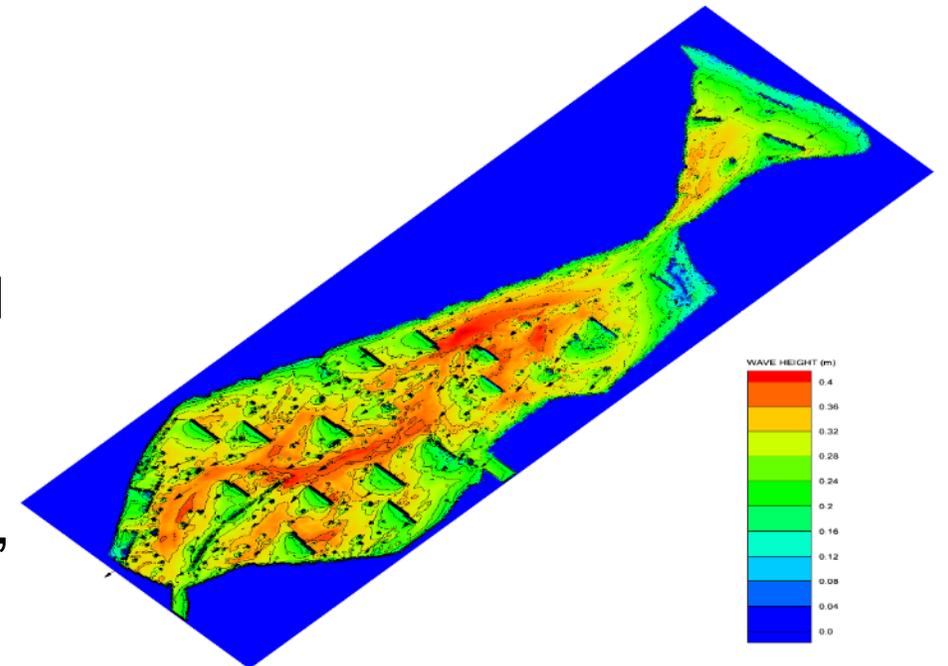
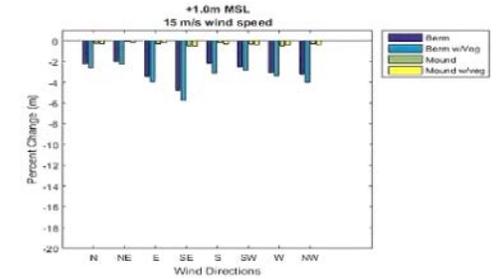
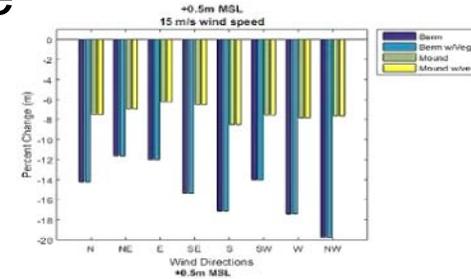
No Berms (Control)

Mounds (ala Sears Pt.)

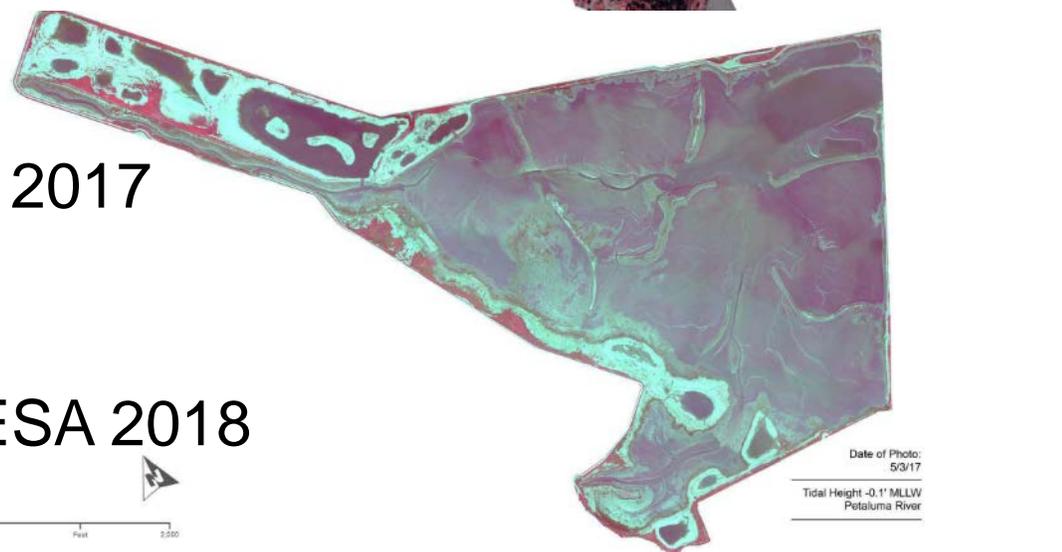
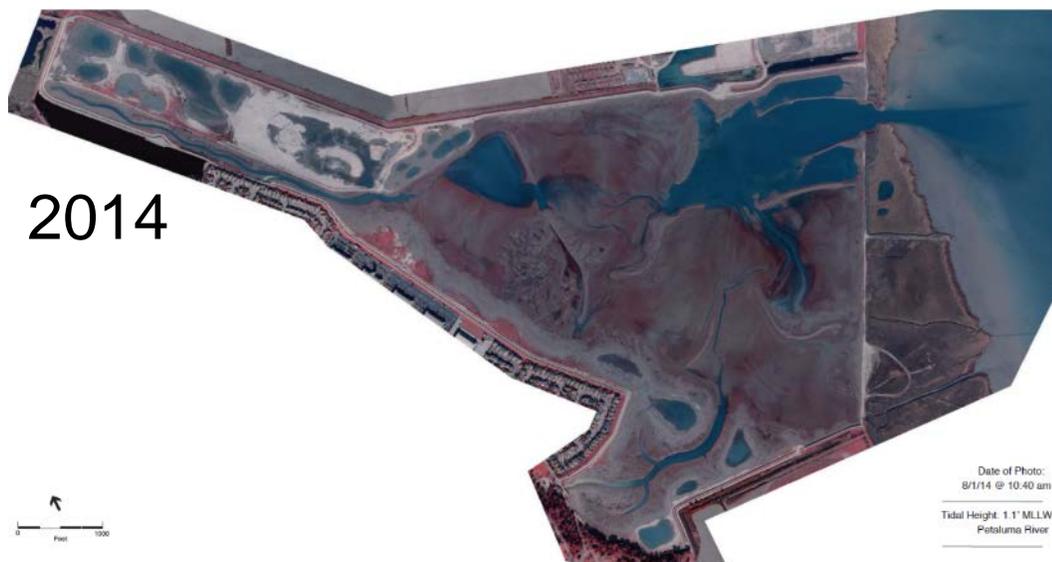
# Engineering With Nature®

## Research Into Harnessing Natural Processes

- At Hamilton, berms performed better (generally twice as well) but vegetation made a greater additional impact with the mounds
- Effect of both features diminishes as water levels increase
- At Sears Point, berms could not be placed in certain areas because of the narrow nature of the site and the excavated channel
- A combination of vegetated berms and mounds offered the most reduction in the model at Sears Point, and might help provide more vegetation loci at any site
- Submitted to Geomorphology (Sally Dillon, Jane Smith, Jarrell Smith, Elizabeth Murray)



# Hamilton Wetlands



ESA 2018

## 3-years of Monitoring

- Deepest parts of site filling in
- Highest levels of sedimentation occurring below 3.5 ft NADV where tidal inundation is currently > 50% frequency
- Native vegetation (pickleweed and cordgrass) has established on berm tops and site margins



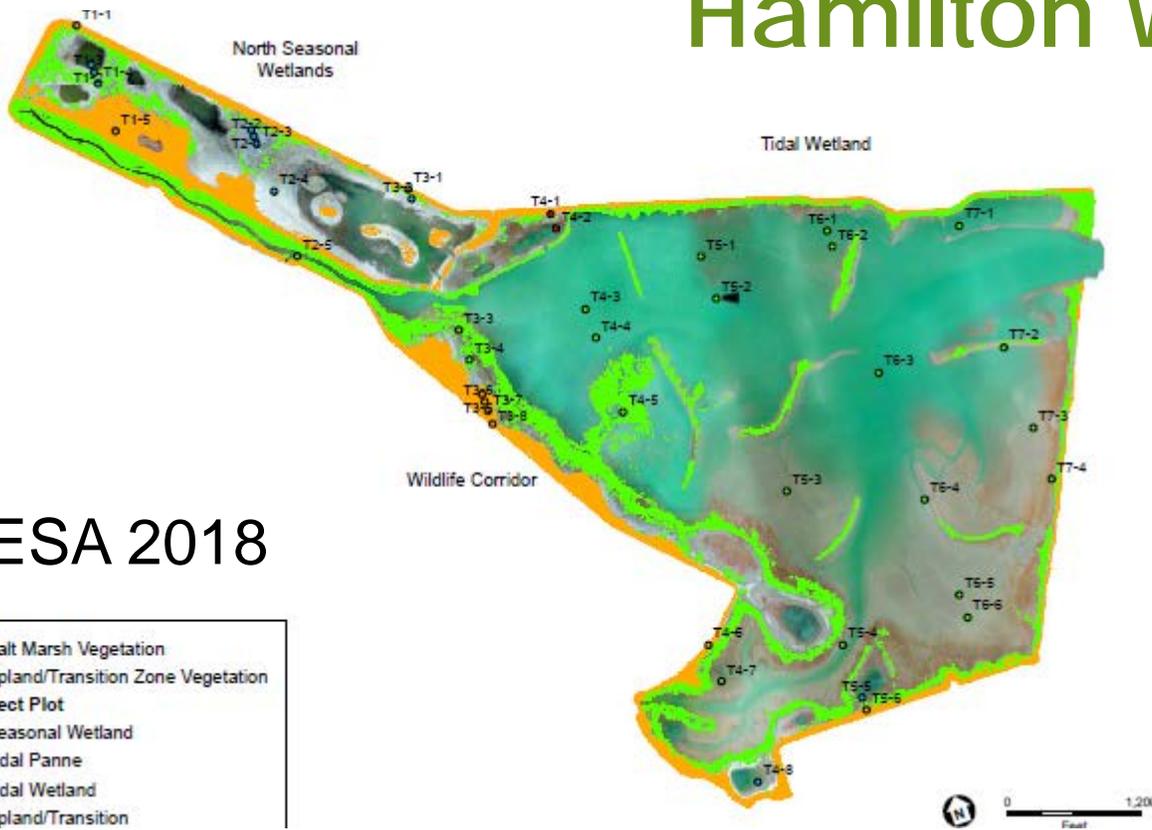
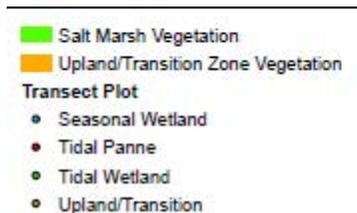
SPN

# Hamilton Wetlands

## 3-years of Monitoring

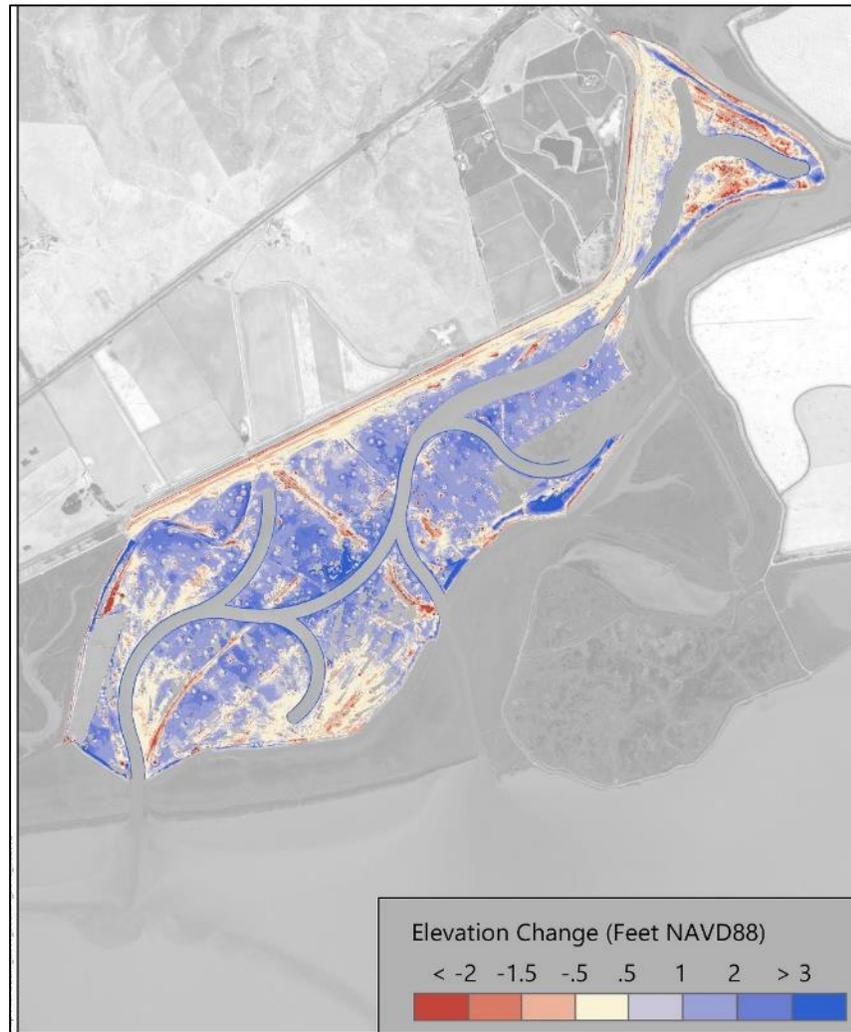
- 20% of tidal areas vegetated with natives
- Vegetation expanding into highest mudflat areas
- 20 different fish species; 70% native
- Abundant invertebrates in multiple age classes

ESA 2018

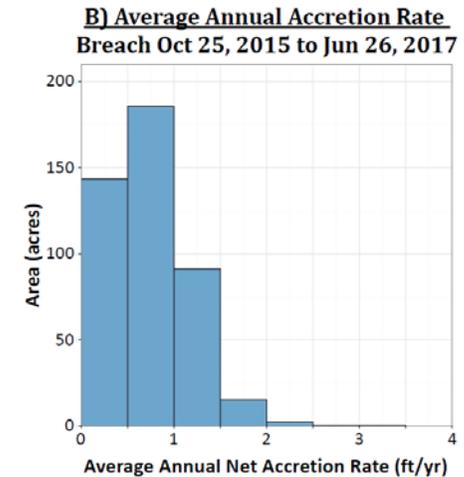
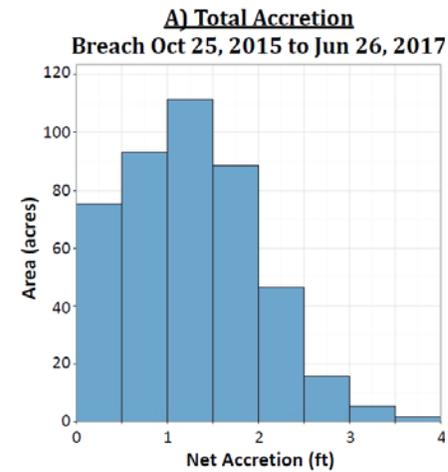


# Sears Point Sedimentation

Net sedimentation: Oct 25, 2015 to June 26, 2017



*Siegel et al., 2018*



After 21 months:

- Median accretion 1-1.5 ft
- Total net accretion nearly 4ft max

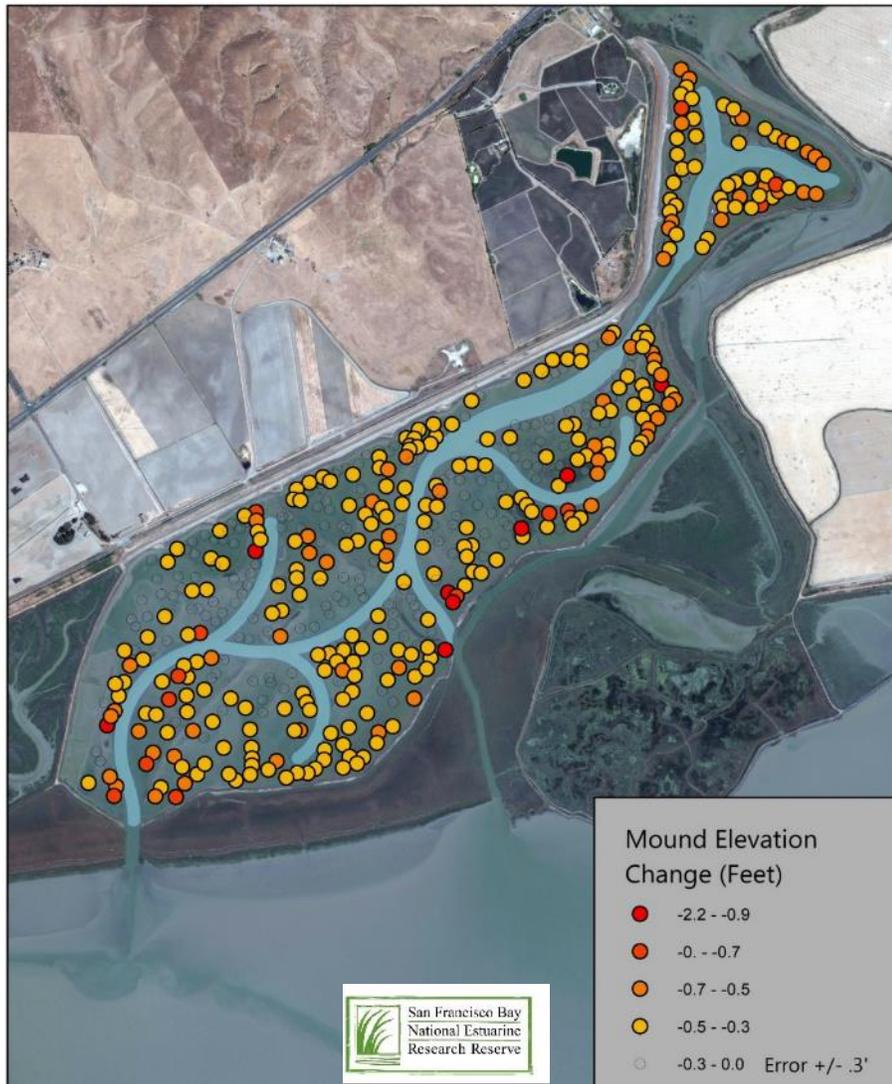
Annual rate:

- Average 0.5-1 ft/yr
- Maximum 3-3.5 ft/yr



# Are we losing our marsh mounds?

Marsh mound elevation change: June 2017 to June 2018



- Marsh mounds eroding up to 0.5m
- Planting cordgrass to stabilize mounds with suitable elevation



*Siegel et al., 2018*

# Sears Point and Hamilton Wetlands

- Both sites accreting and progressing toward marsh elevations
- Local sediment supply important consideration
- If using marsh mounds, compaction or pre-vegetation will promote persistence
- Cordgrass plantings can help to stabilize after the fact but the labor investment is significant
- Large breaches and multiple breaches facilitate tidal exchange and sediment accretion, but erosion must also be watched
- A combination of mound sand berms may maximize fetch reduction and vegetation loci
- Just as these projects adapted their designs from Sonoma Baylands, future projects may adapt methods from these projects, ever improving our approach to bayland restoration throughout the estuary.

