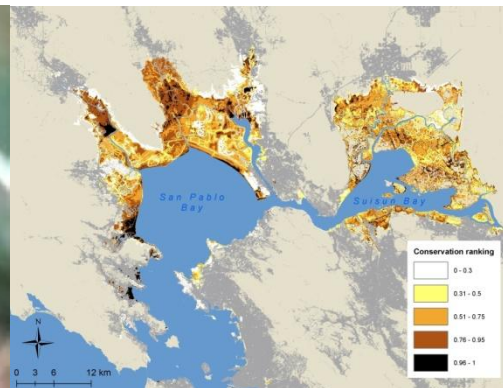




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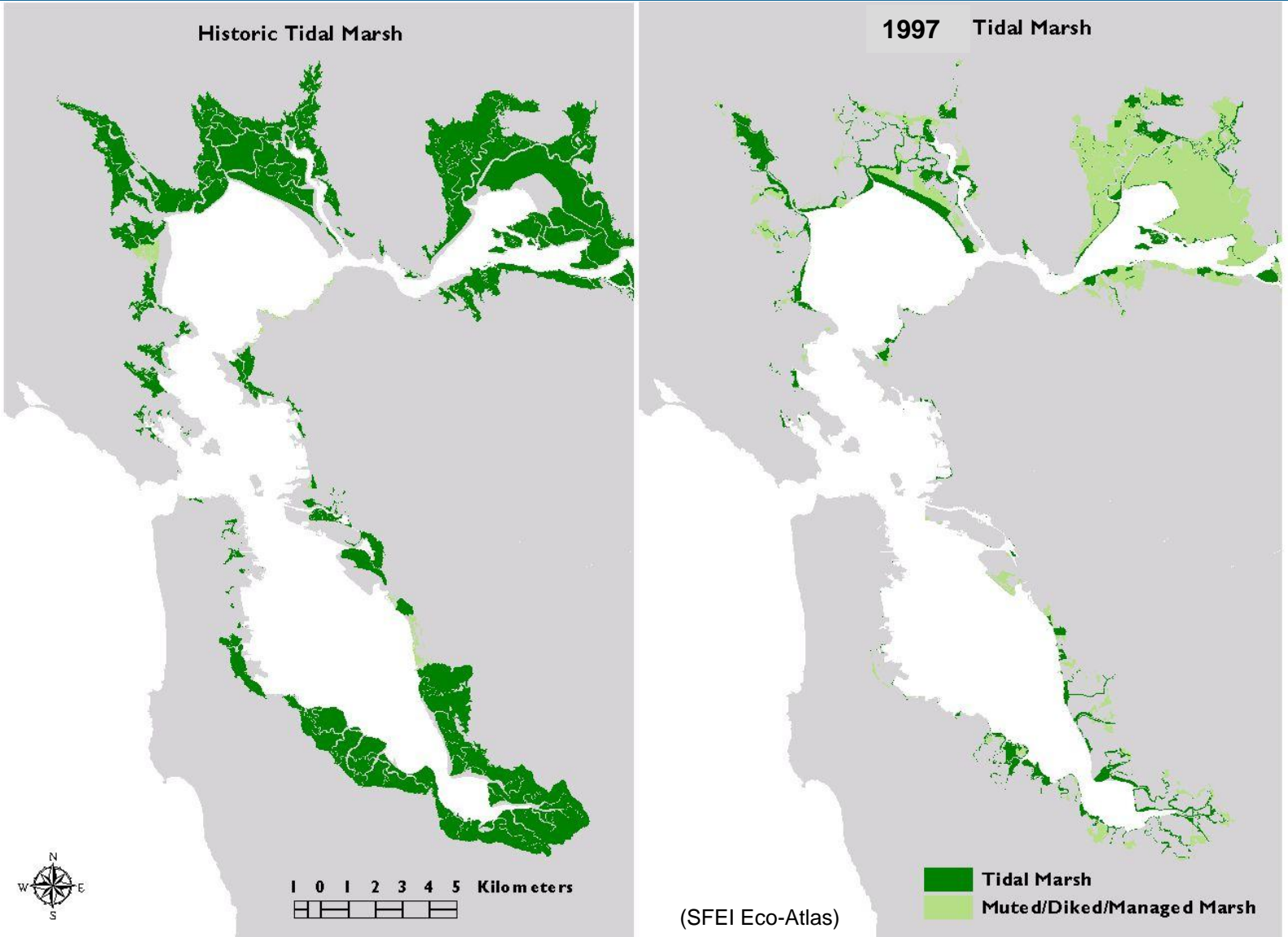


# Can we improve coastal adaptation planning by using models of tidal marsh accretion in response to sea level rise?

Sam Veloz, Diana Stralberg, Leo Salas, Nadav Nur, Julian Wood, Dennis Jongsomjit, Len Liu  
Grant Ballard PRBO Conservation Science;

Lisa Schile UCB; John Callaway USF; Tom Parker SFSU, Steve Crooks PWA

# Background- 90% Loss of Tidal Marsh in SF Bay



## Background- Changing Landscape

- **Historic marshes were diked off**
  - **Agriculture, salt production, development**
- **Levees now breached to restore tidal marsh**

Diked Baylands



Restored marsh



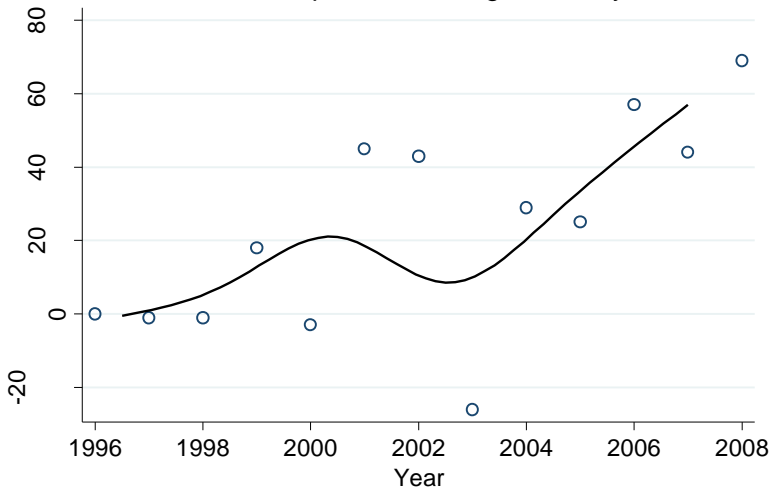
# Project Motivation

## How will changing climate affect tidal marsh birds?

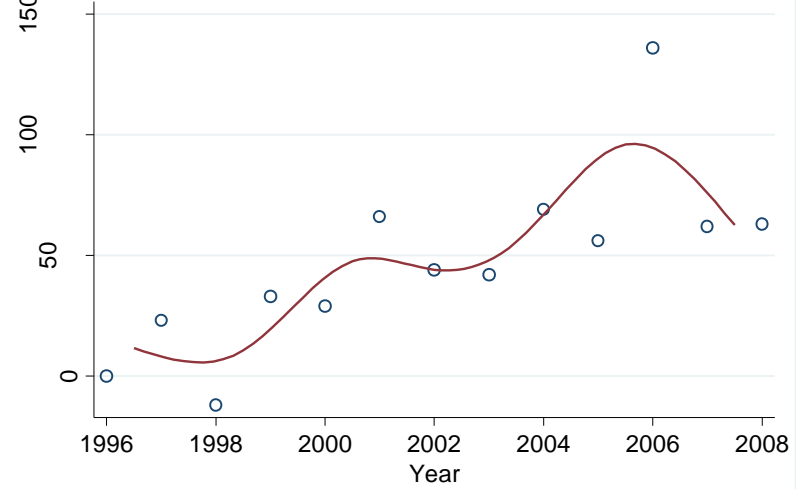


Nur and Wood, unpublished

Black Rail Population Change, Estuary-wide



Common Yellowthroat Population Change, Estuary-wide

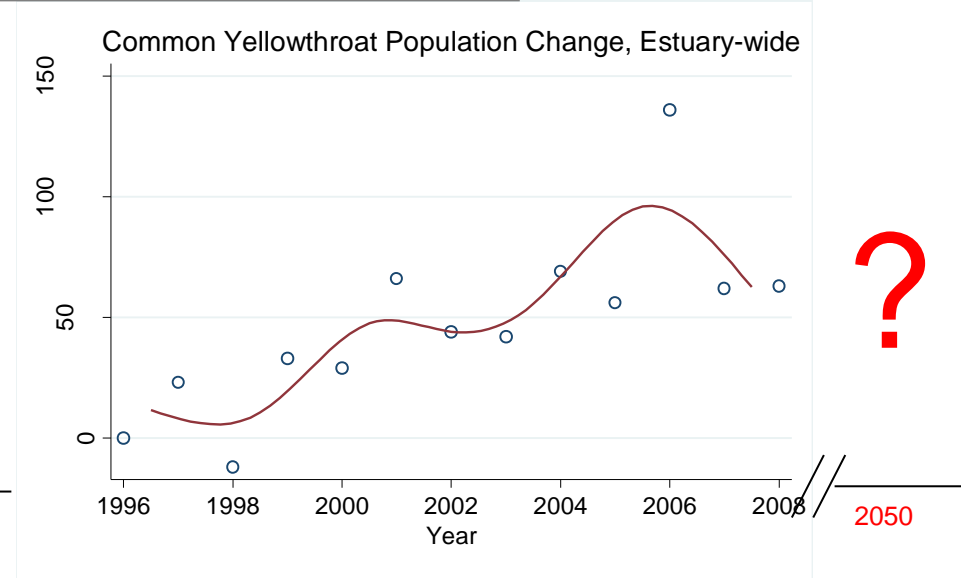
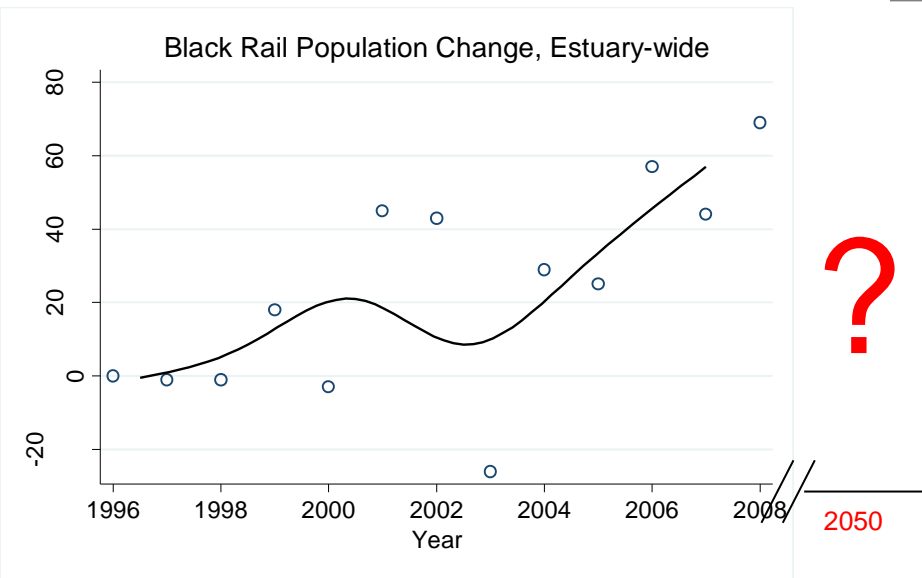


# Project Motivation

## How will changing climate affect tidal marsh birds?



Nur and Wood, unpublished

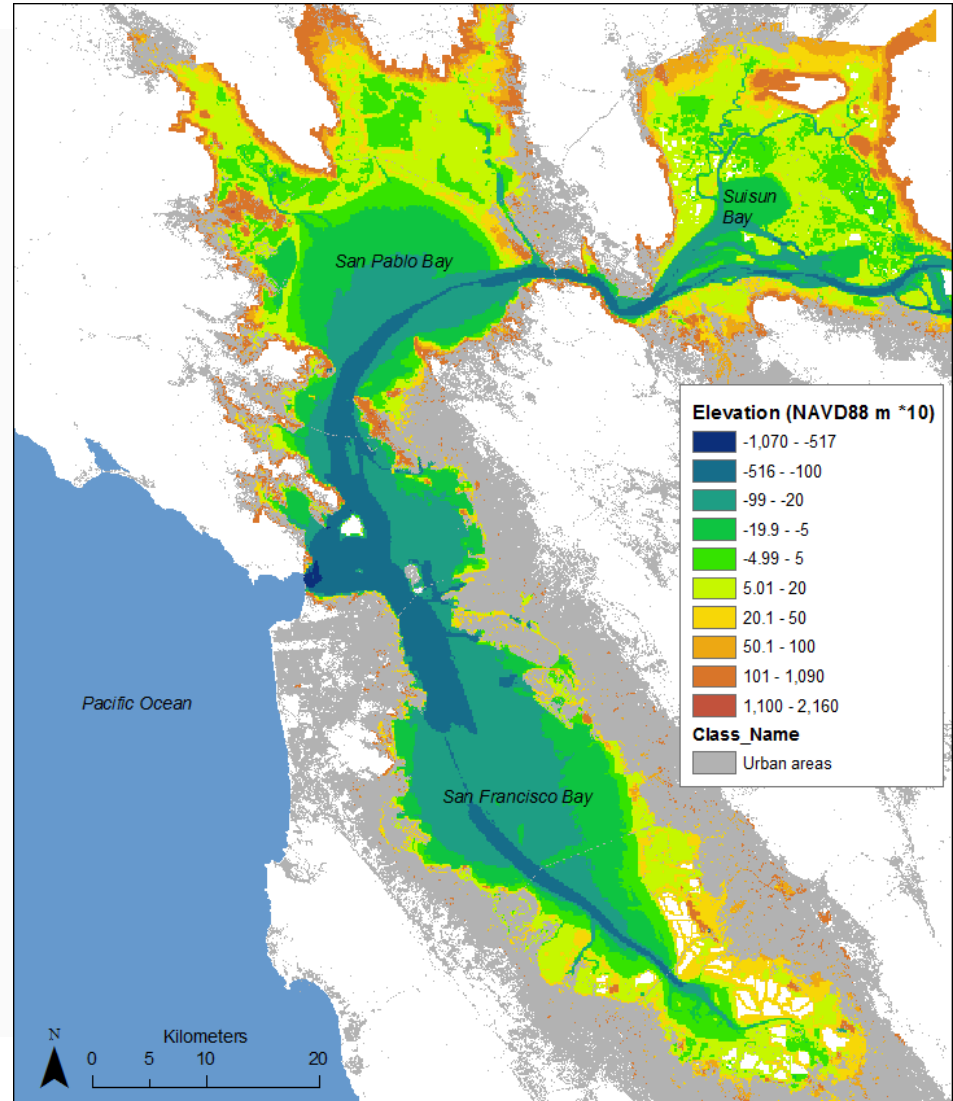


# Adapting planning for rising sea levels and climate change

- **Will tidal marsh habitat persist with sea level rise?**
- **Are tidal marsh bird species in the San Francisco Estuary vulnerable to sea-level rise and climate change?**
- **How can we use future projections to inform adaptation planning?**

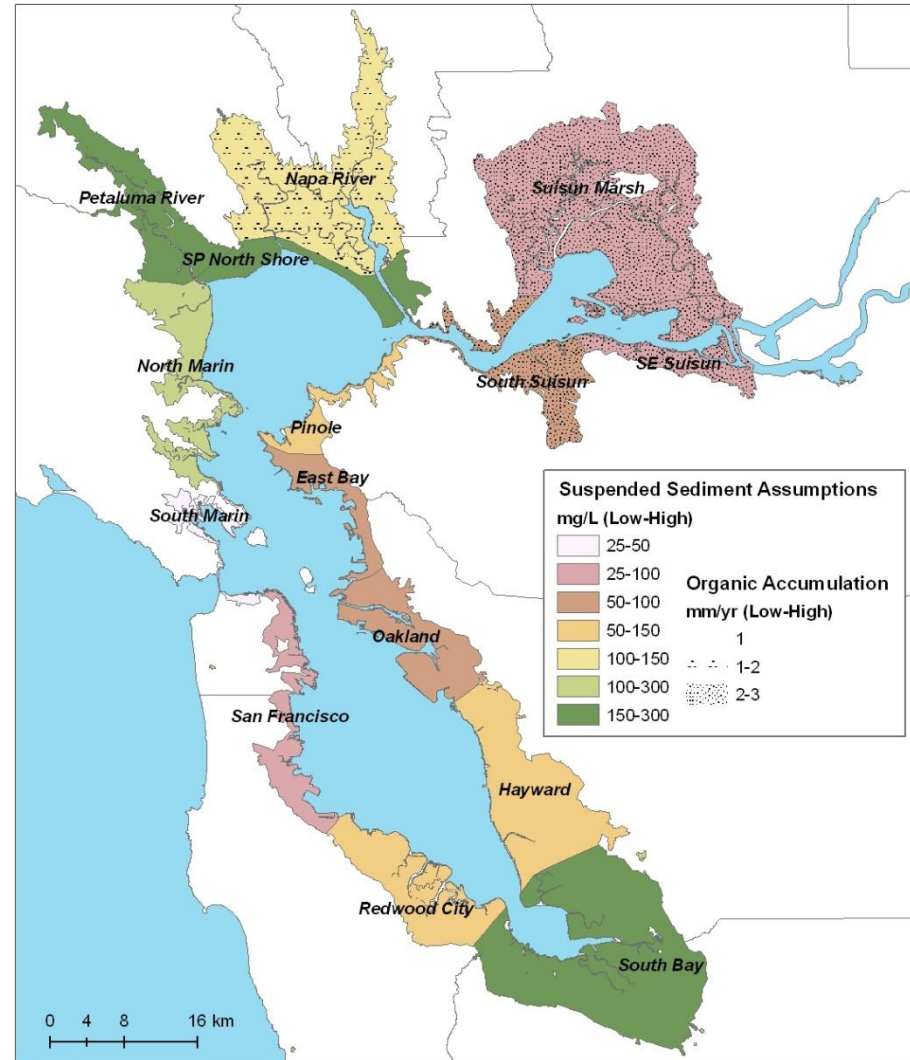
# Project Steps

- Elevation



# Project Steps

- Elevation
- Subregional scenarios
  - Suspended sediment
  - Organic accumulation

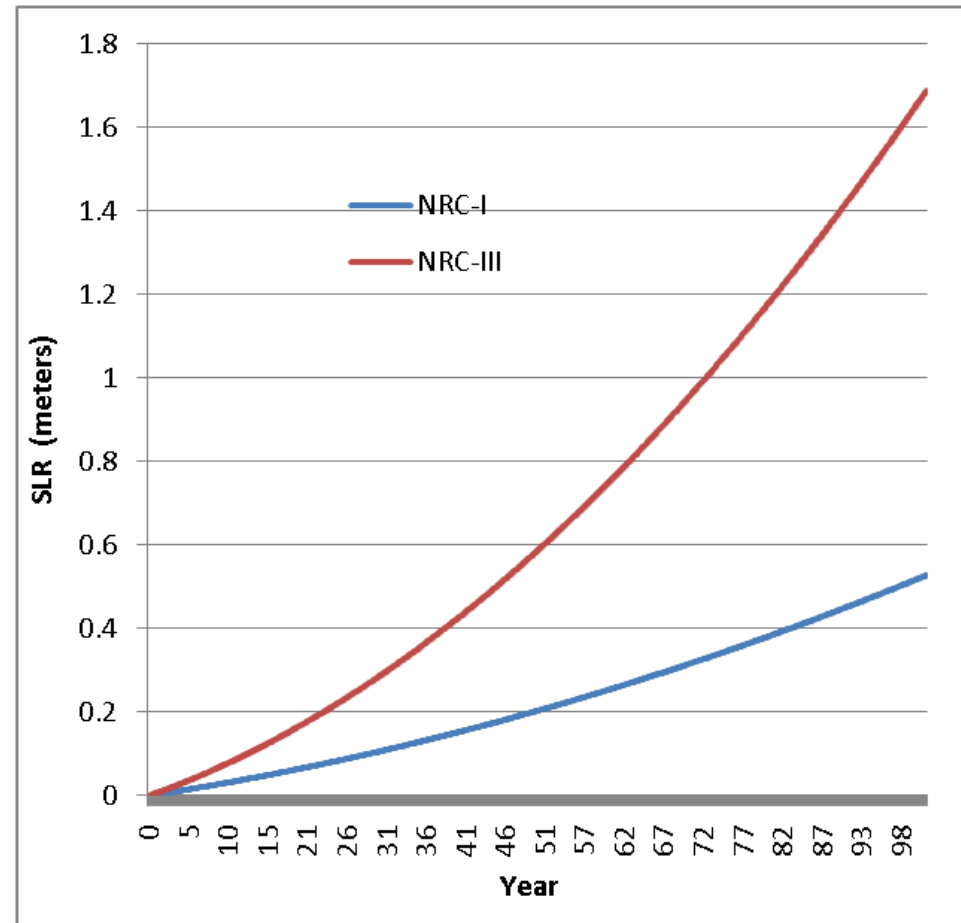




# Project Steps

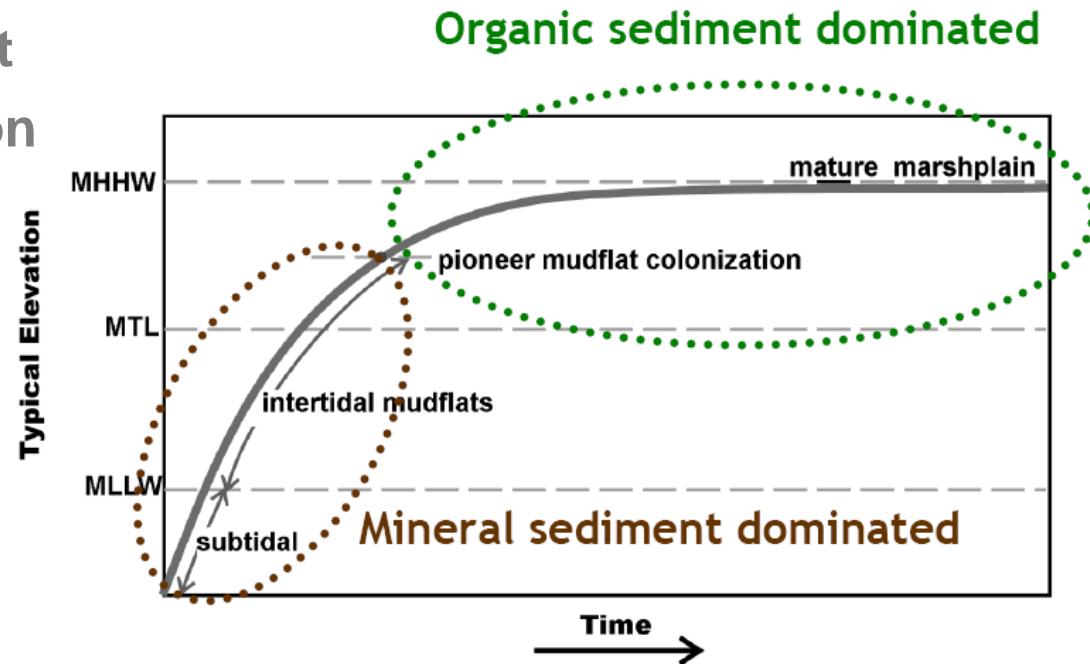
- **Elevation**
- **Subregional scenarios**
  - **Suspended sediment**
  - **Organic accumulation**
- **Sea-level rise**

From National Research Council, adopted by ACOE



# Project Steps

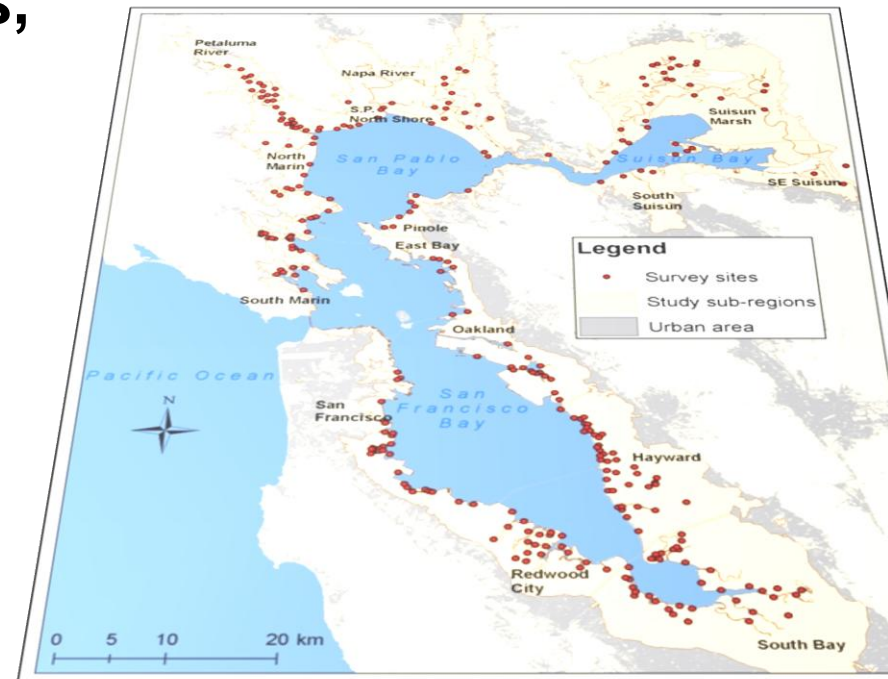
- Elevation
- Subregional scenarios
  - Suspended sediment
  - Organic accumulation
- Sea-level rise
- **Marsh 98 Accretion Model**



## Methods- Data layers and modeling

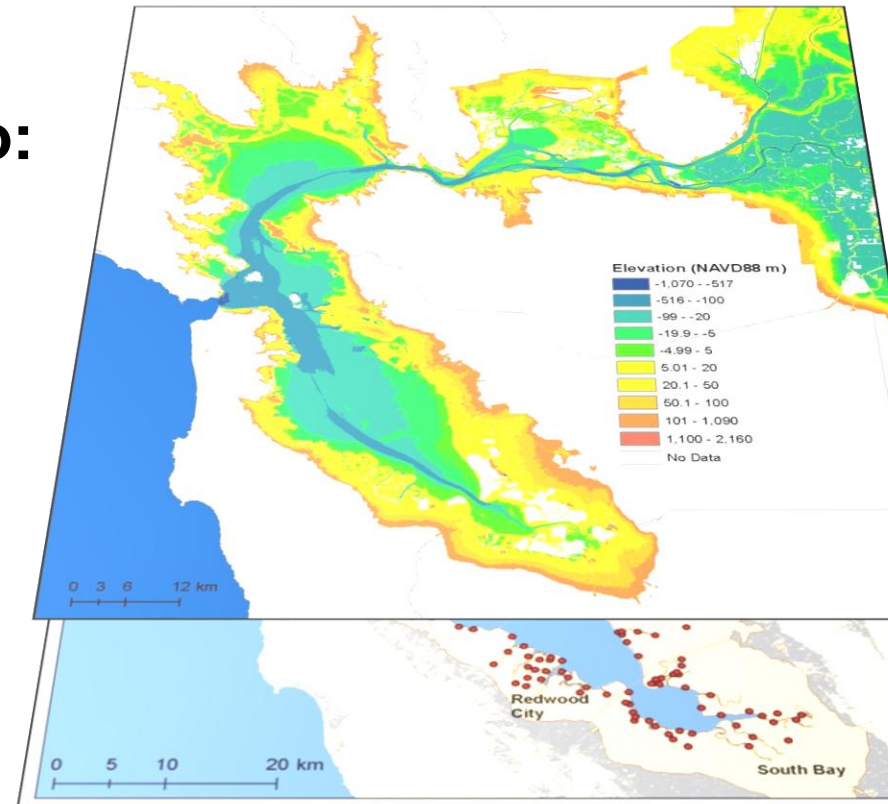
- **Observation data for birds and vegetation, >600 locations**

**Five species: Black Rails,  
Clapper Rails, Common  
Yellowthroats, Marsh Wrens,  
Song Sparrows**



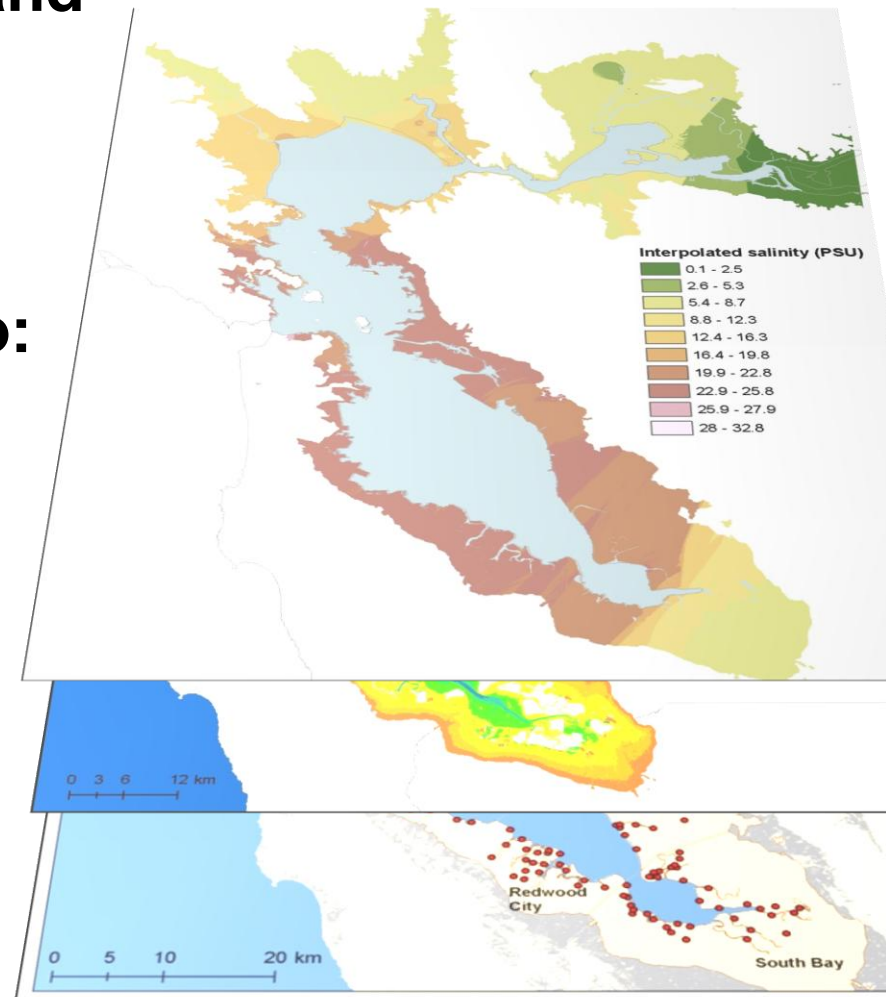
## Methods- Data layers and modeling

- **Observation data for birds and vegetation, >600 locations**
- **Correlated observations to physical variables related to:**
  - **elevation, salinity, tidal range, distance metrics**



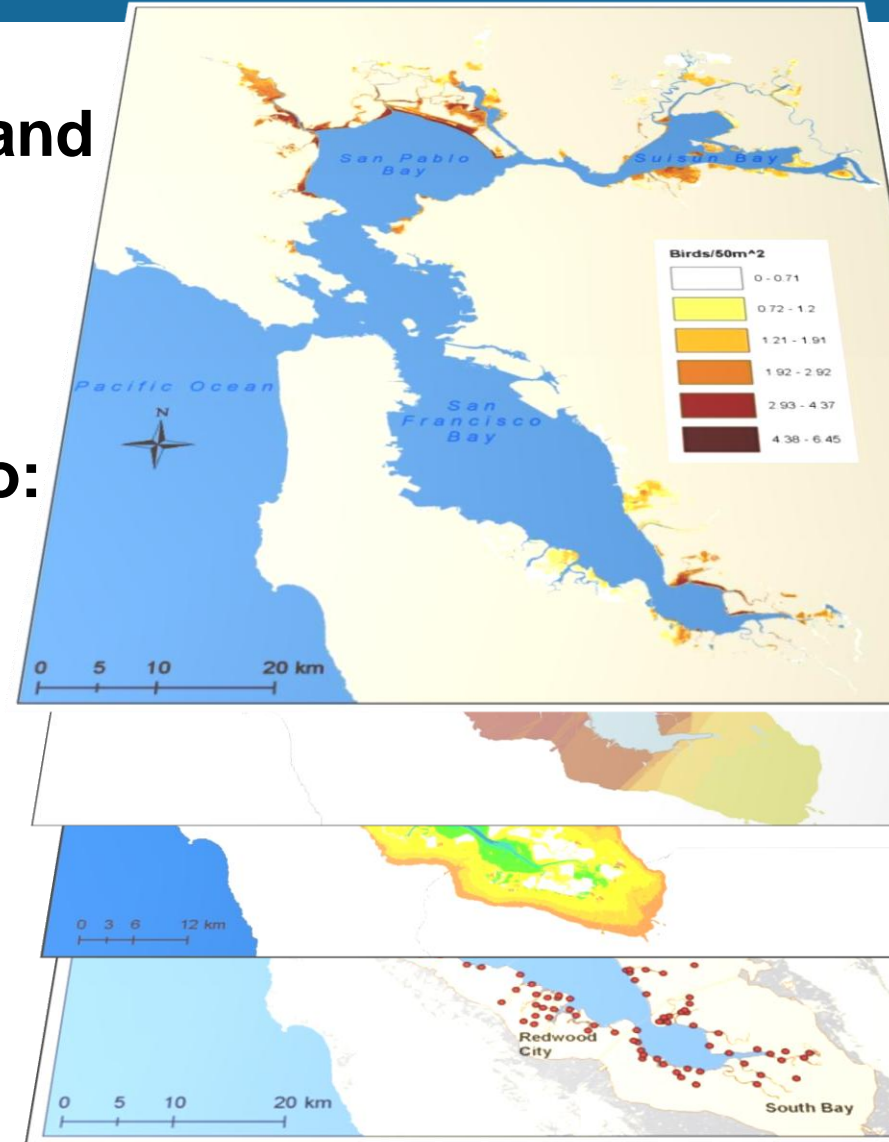
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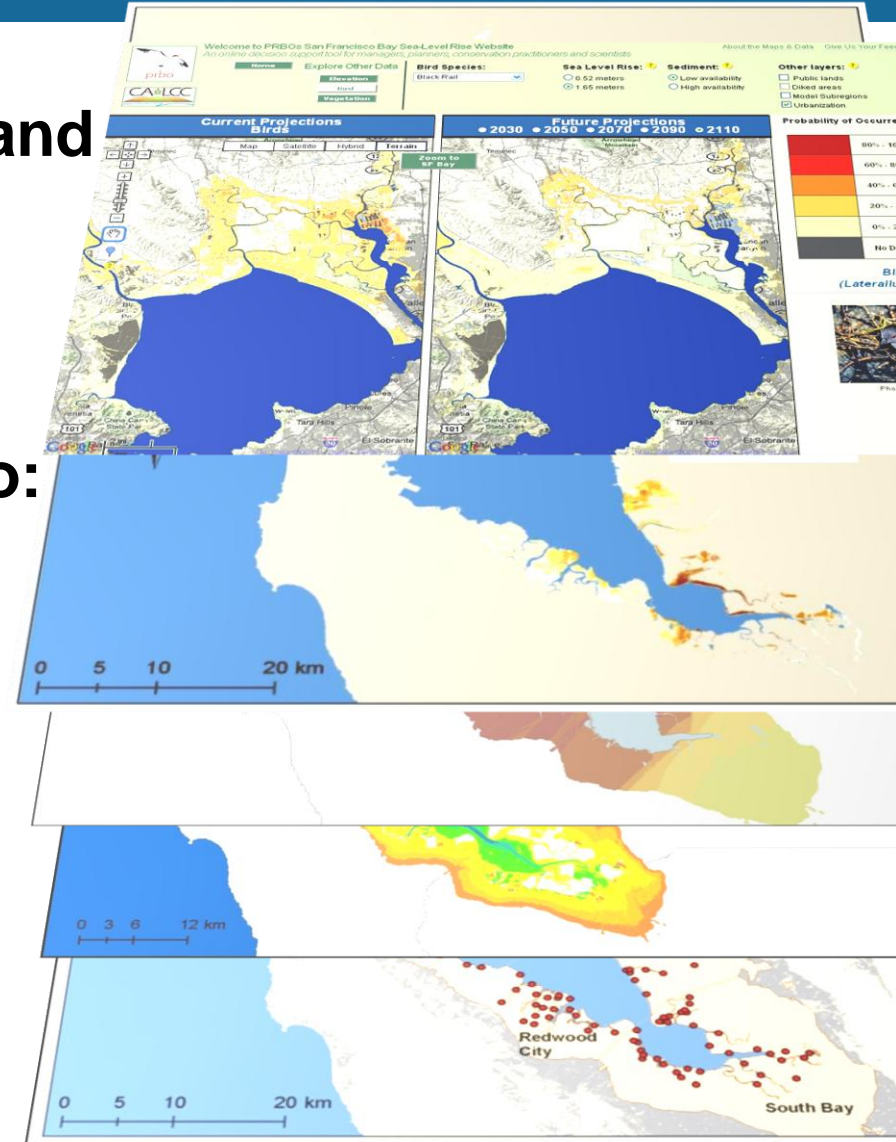
# Methods- Data layers, modeling, SLR Tool

- **Observation data for birds and vegetation, >600 locations**
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- **Maps predicted distribution**



# Methods- Data layers, modeling, SLR Tool

- Observation data for birds and vegetation, >600 locations
- Correlated observations to physical variables related to:
  - elevation, salinity, tidal range, distance metrics
- Maps predicted distribution
- SF Bay SLR Tool  
[www.prbo.org/sfbayslr](http://www.prbo.org/sfbayslr)

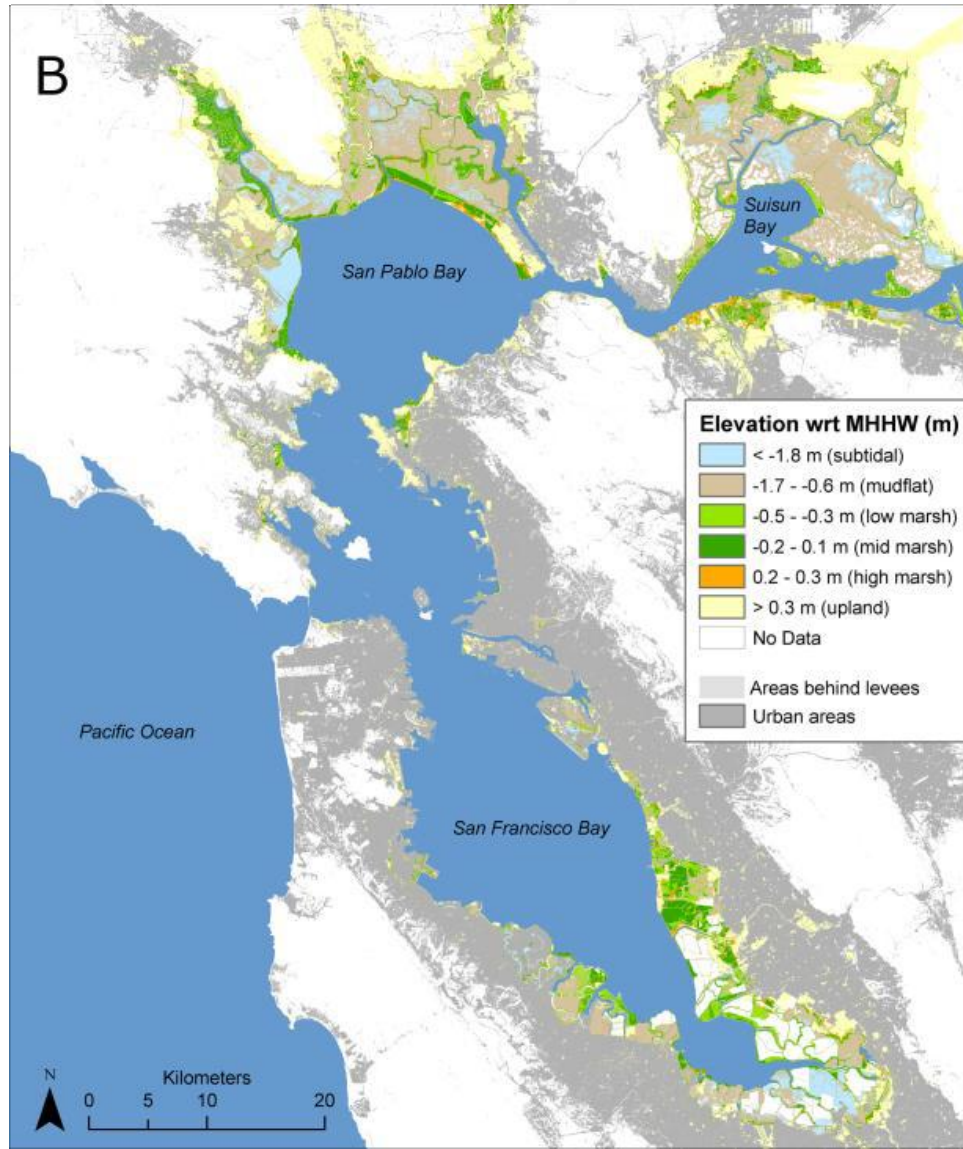


Can tidal marsh habitat persist  
with sea level rise?





# Current tidal marsh habitat and potential habitat with restoration (levee removal)



# Marsh sustainability is extremely sensitive to sediment availability and SLR scenario

## Projections for 2110

### Low sediment/ high SLR

Habitat Type ?

	Above +0.3m (Upland)
	0.2m to +0.3m (High Marsh)
	-0.2m to +0.1m (Mid Marsh)
	-0.5m to -0.3m (Low Marsh)
	-1.8m to -0.6m (Mudflat)
	-2.4 m to -1.8m (Subtidal)
	Bay water level
	No Data



## Results – summary of key findings

- **We project increases in tidal marsh habitat in all scenarios except for low sediment/ high sea level rise**
- **93% of mid and high tidal marsh in the Estuary could be lost by 2100 under the low sediment, high SLR scenario.**
- **Up to 7,500 ha (current) and ~32,500 ha (future sed high/slr low) of diked baylands have restoration potential.**
- **Up to 3,300 ha of uplands could become marsh by 2100.**
- **Sediment-rich areas have better prospects for long-term sustainability.**

Are tidal marsh bird species in  
the San Francisco Estuary  
vulnerable to sea-level rise  
and climate change?

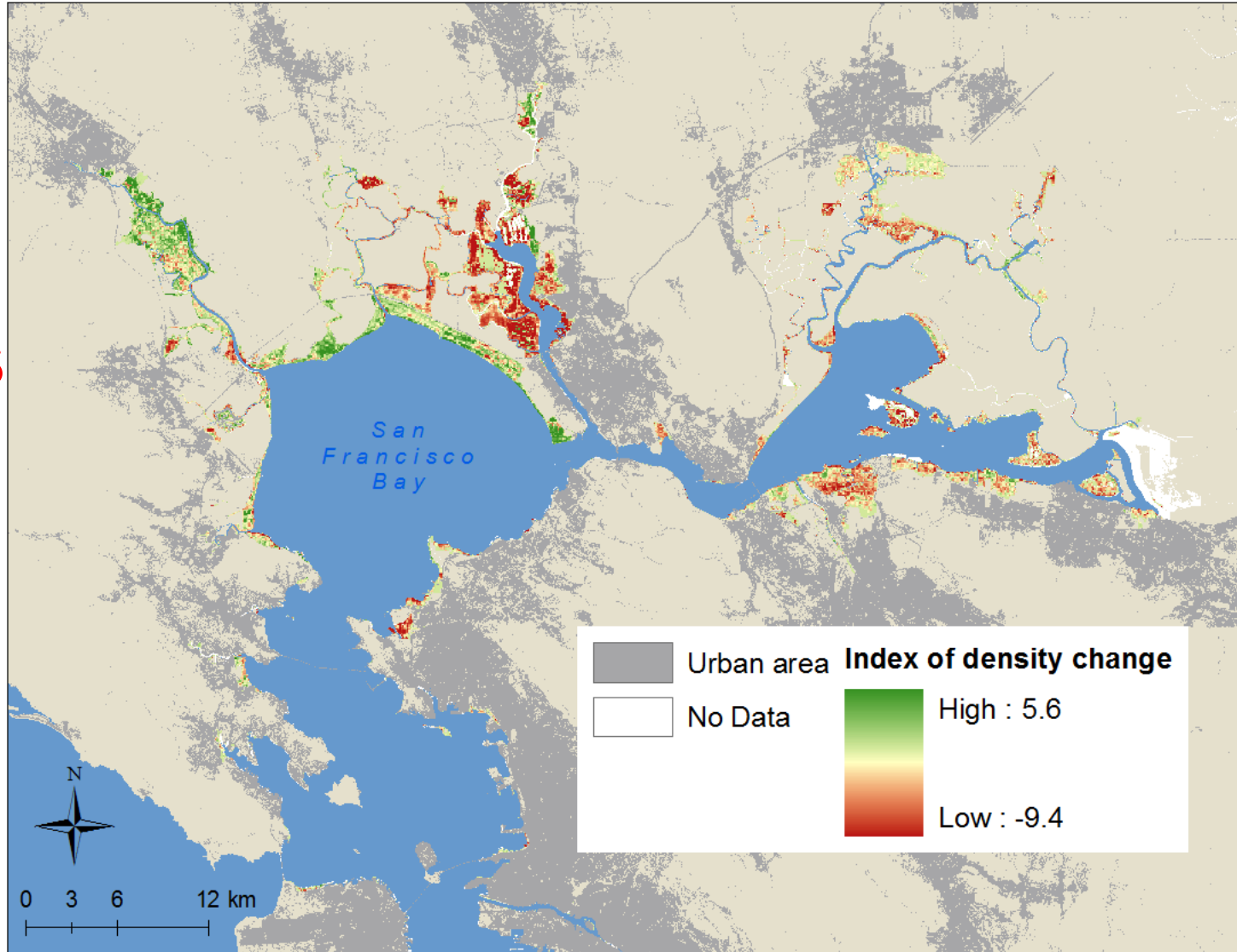
# Vulnerability vs. Resilience: Spatial variation for 5 tidal marsh birds



Future  
density  
decreases



Future  
density  
increases



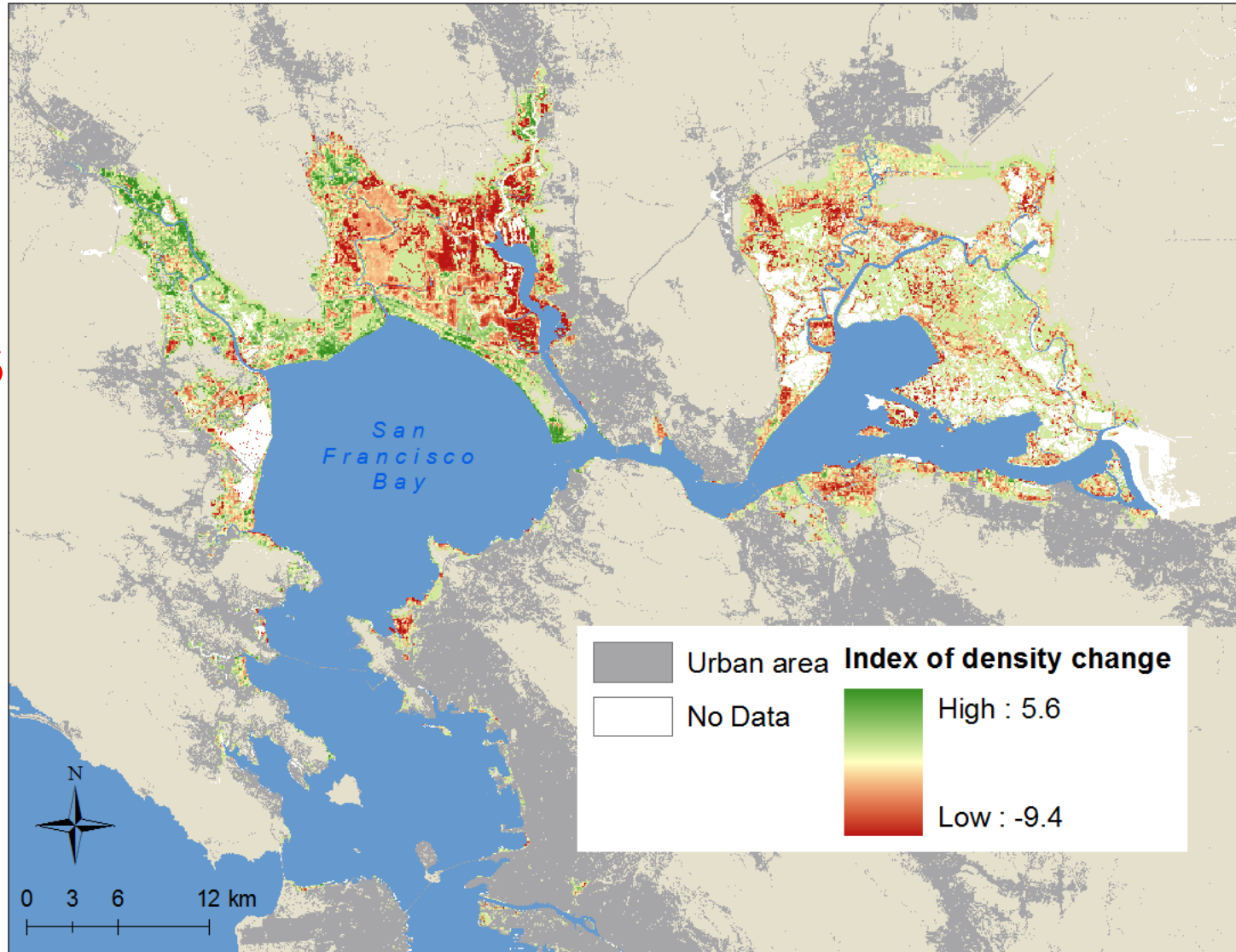
# Vulnerability vs. Resilience: Including potential restoration sites



Future  
density  
decreases



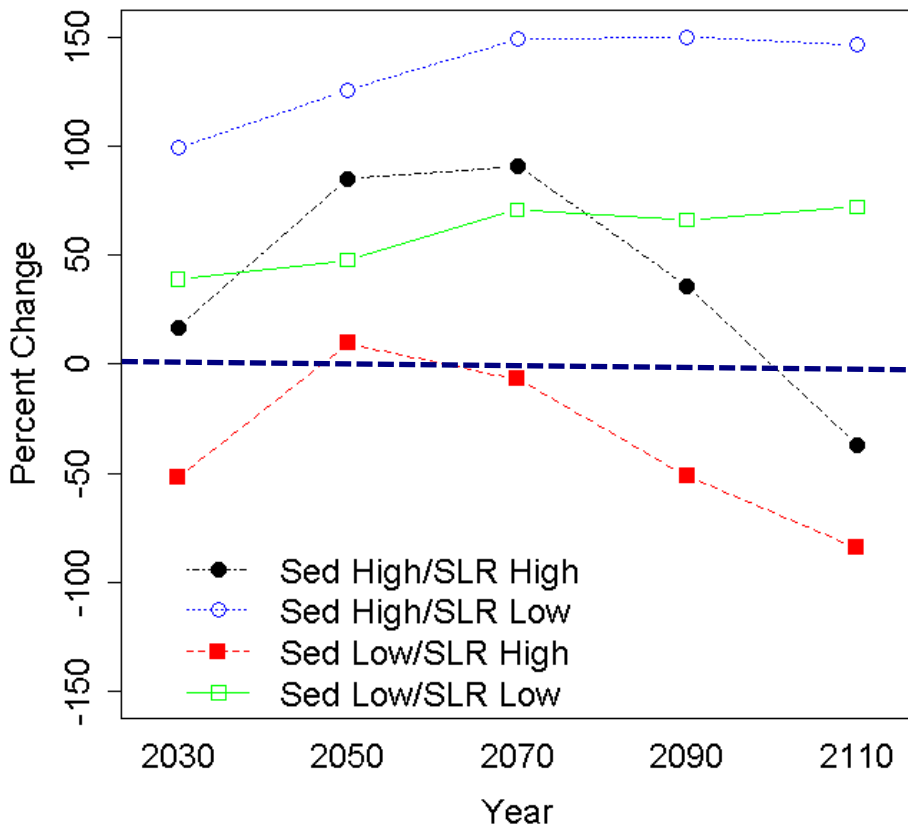
Future  
density  
increases



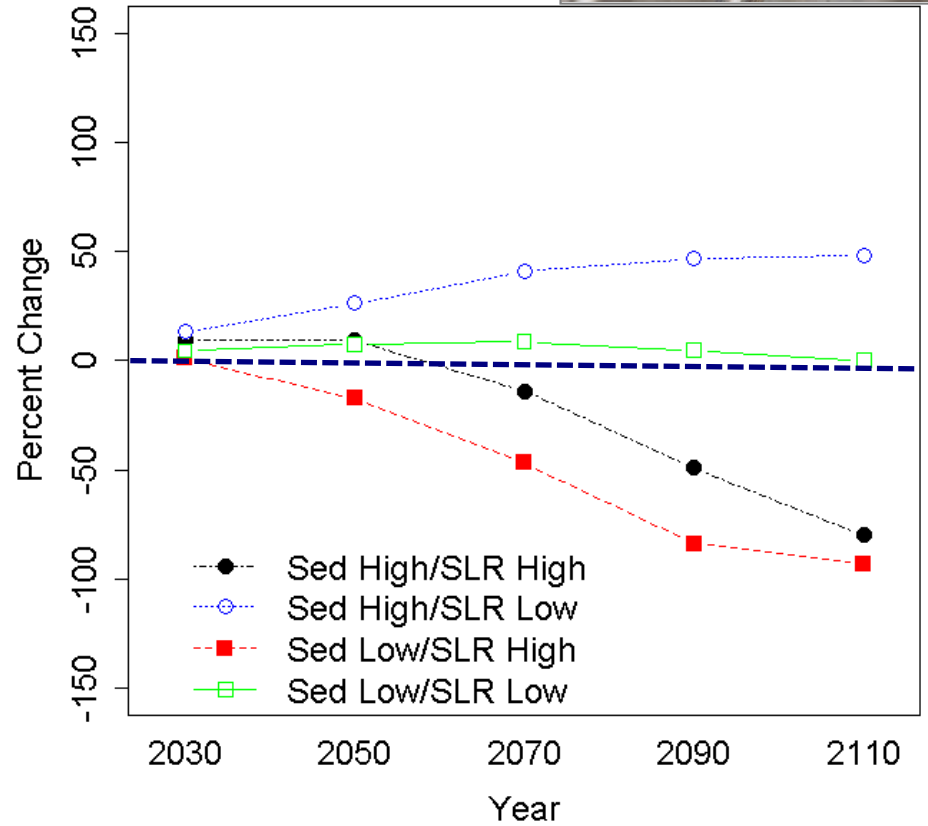
# Species have individualistic responses to future projections



## Black Rail



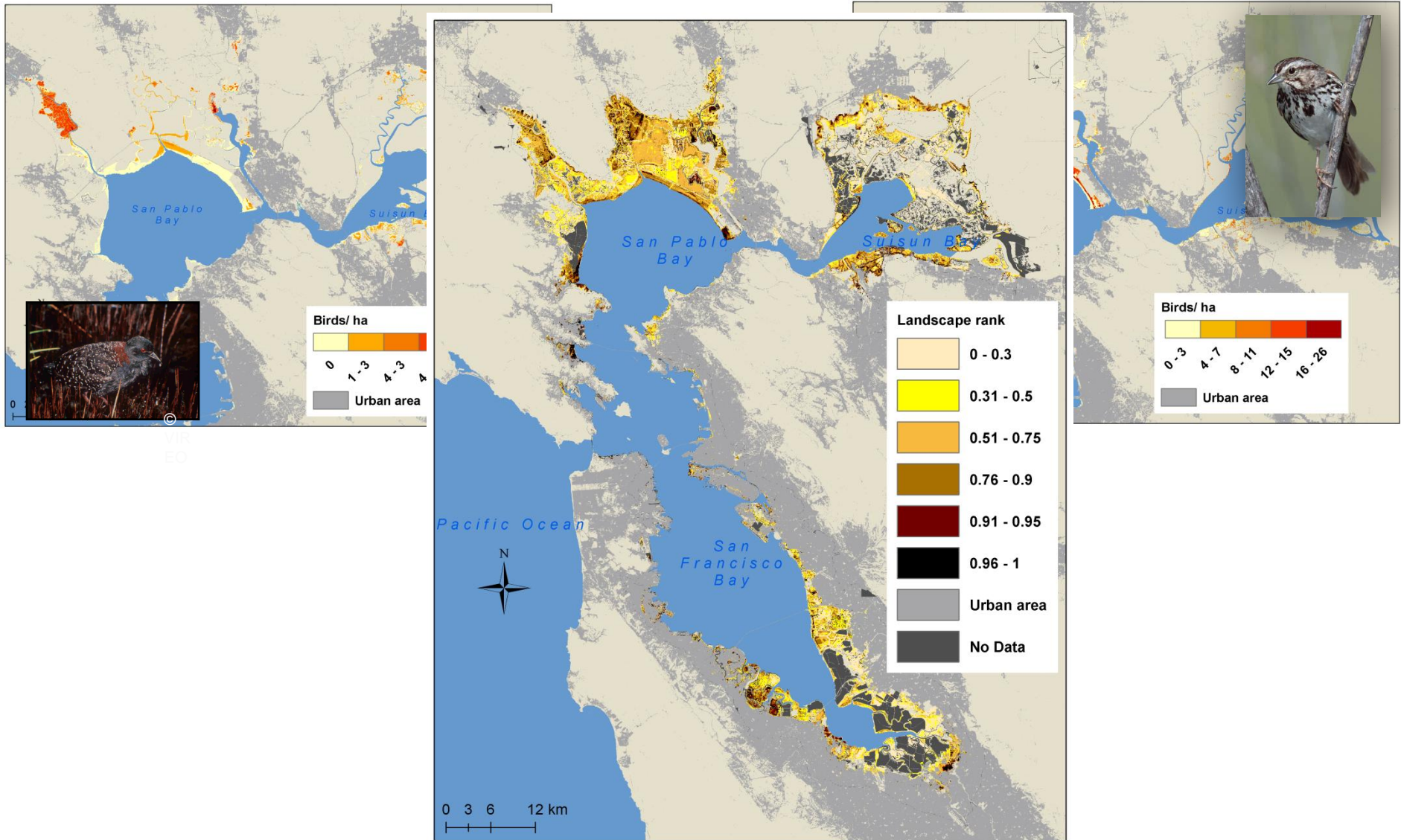
## Common Yellowthroat



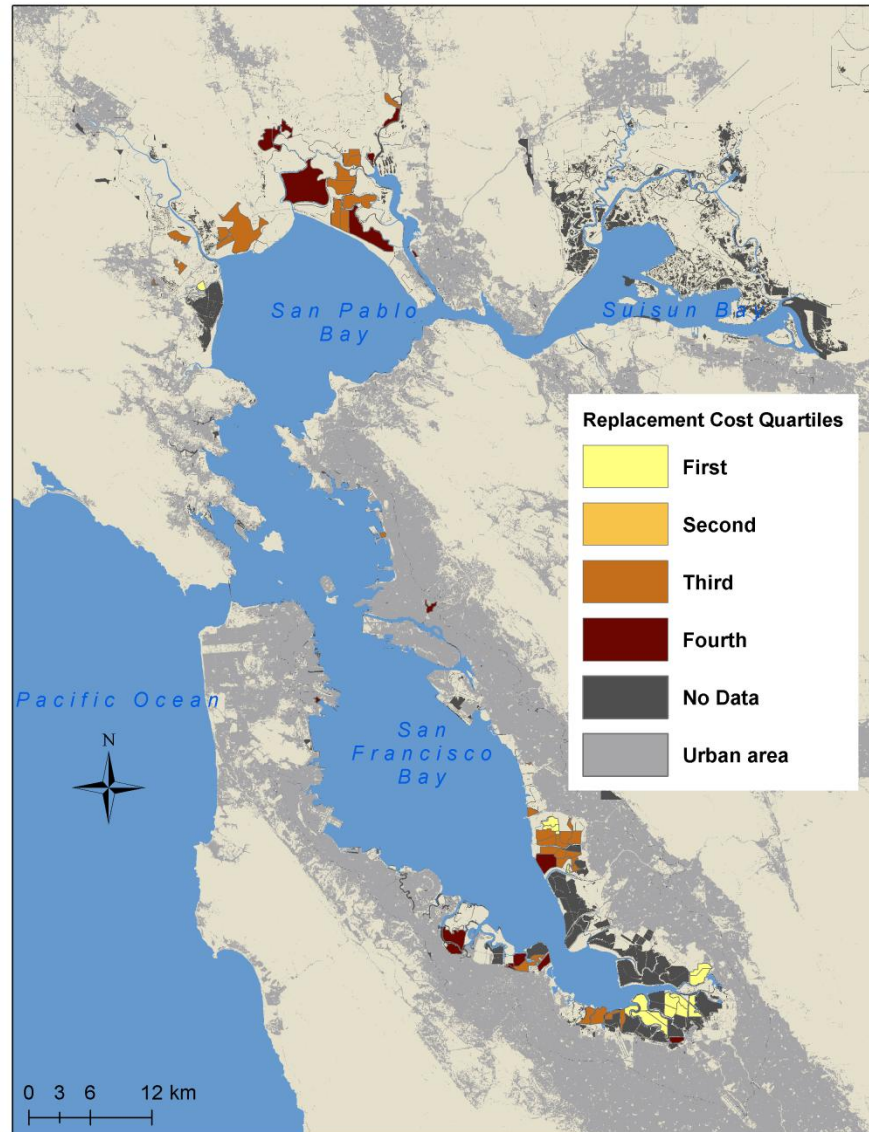


How can we use future  
projections to prioritize  
restoration planning?

# Zonation Conservation Planning Software (Moilanen, A. 2007)



# Using tidal marsh priority habitat to rank conservation/ restoration potential



# Conclusions

Will tidal marsh habitat persist with sea level rise?



Are tidal marsh bird species in the San Francisco Estuary vulnerable to sea-level rise and climate change?



Can we use future projections to prioritize restoration planning?



# Future Work

- Incorporate models for population viability
- Include habitat for shorebirds coupled with mudflat models
- Work with partners to develop new tools to evaluate the effects of floods and storm hazards (<http://data.prbo.org/apps/ocof/>)
- Engage stakeholders to at local levels to apply our tool in adaptation planning efforts

# Acknowledgments

**Funding:** Coastal Conservancy, CA LCC , Bay Fund of the San Francisco Foundation

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**Elevation Data:** Noah Knowles (USGS), FEMA, Joel Dudas (DWR), Stuart Siegel (WWR), Sonoma County

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[www.prbo.org/sfbayslr](http://www.prbo.org/sfbayslr)

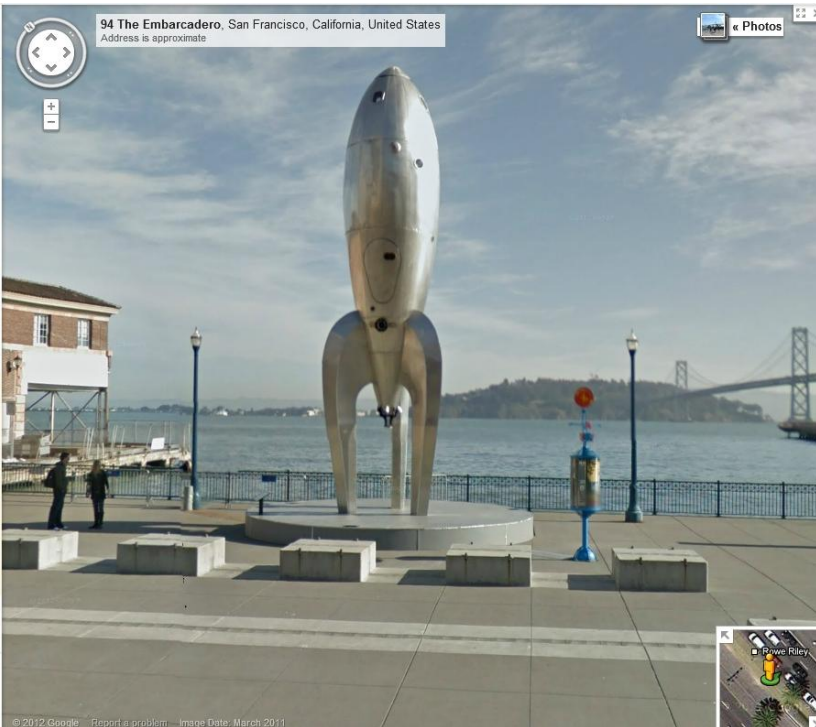


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PRBO Conservation Science

# Do we need adaptation plans for sea level rise?

## Embarcadero, San Francisco



Google maps street view

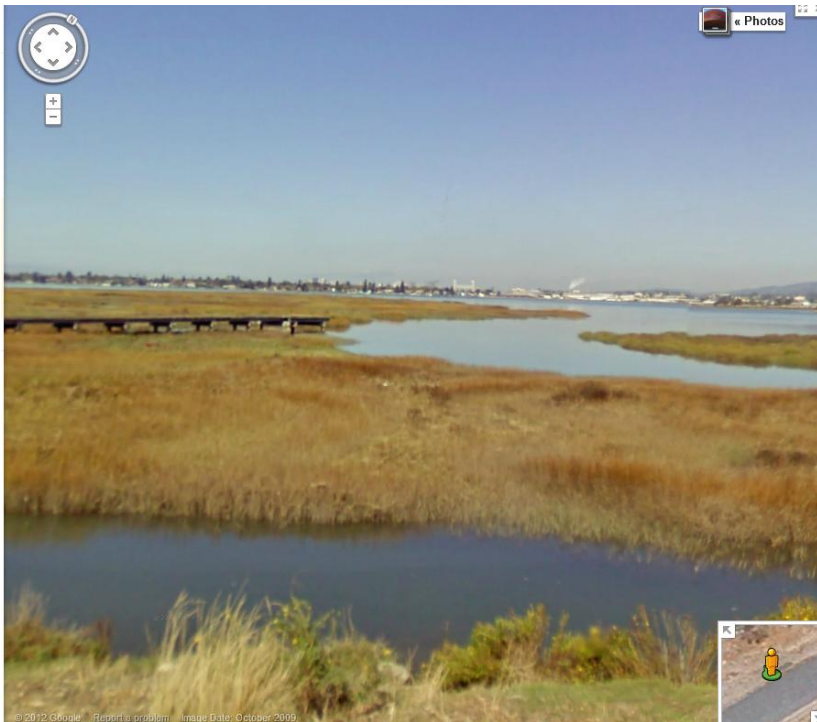


Heidi Nutters, 2/17/2012,  
California King Tide Project



# Tidal marshes and ecosystem services

## Arrowhead marsh



Google maps street view



Heidi Nutters, 1/21/2011, King tide Project