Managing for uncertainty- Maximizing resilience of plant and animal populations in the face of climate change and other stressors

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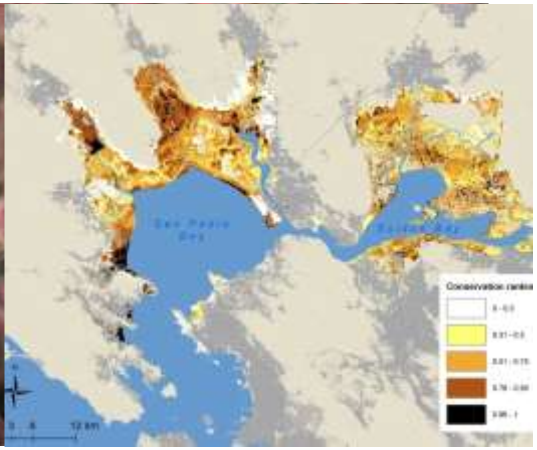
Bay Delta Science Conference, October 2014





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Conservation science for a healthy planet.

Objectives

- Today's talk summarizes findings of the "Risks to Wildlife" Workgroup
- Chapter 6 of the Final Report (and in Science Summary).

Our charge:

- How will populations of plants and animals in bayland habitats be affected by climate change?
- Which management actions can be most effective in keeping populations healthy and/or restoring population health, given anticipated climate change impacts?

Overarching Questions

- Question #1: Effects of climate change:
- **Long-term trends**
- Changes in habitat, landscapes.
    - Extent of habitat, patch size, and connectivity
- Temperature, salinity, depth, elevation

Overarching Questions

- Question #1: Effects of climate change:
- **Long-term trends**
- Changes in habitat, landscapes**.**
    - Extent of habitat, patch size, and connectivity
- Temperature, salinity, depth, elevation
- **Extreme events (transient, unpredictable):**
- Storms, droughts, flooding, extreme temperature
    - Magnitude, timing, duration and frequency
- Will affect survival, reproductive success

Overarching Questions, continued

- Question #2: Which management actions can be most effective in keeping populations healthy and/or restoring population health?
- Answer: management that maximizes **population resilience**, in a connected, dynamic landscape.

Overarching Questions, continued

- Question #2: Which management actions can be most effective in keeping populations healthy and/or restoring population health?
- Answer: management that maximizes **population resilience**, in a connected, dynamic landscape.
- **How?**
- Maximize **survival**, **reproductive success**, and **effective dispersal**.
- Not only with respect to the effects of climate change,

  but also need to consider **other stressors**
  and the **interaction** of climate change drivers and these stressors.

Profound Acknowledgments

- Bruce Herbold, co-Chair, Risks to Wildlife Working Group

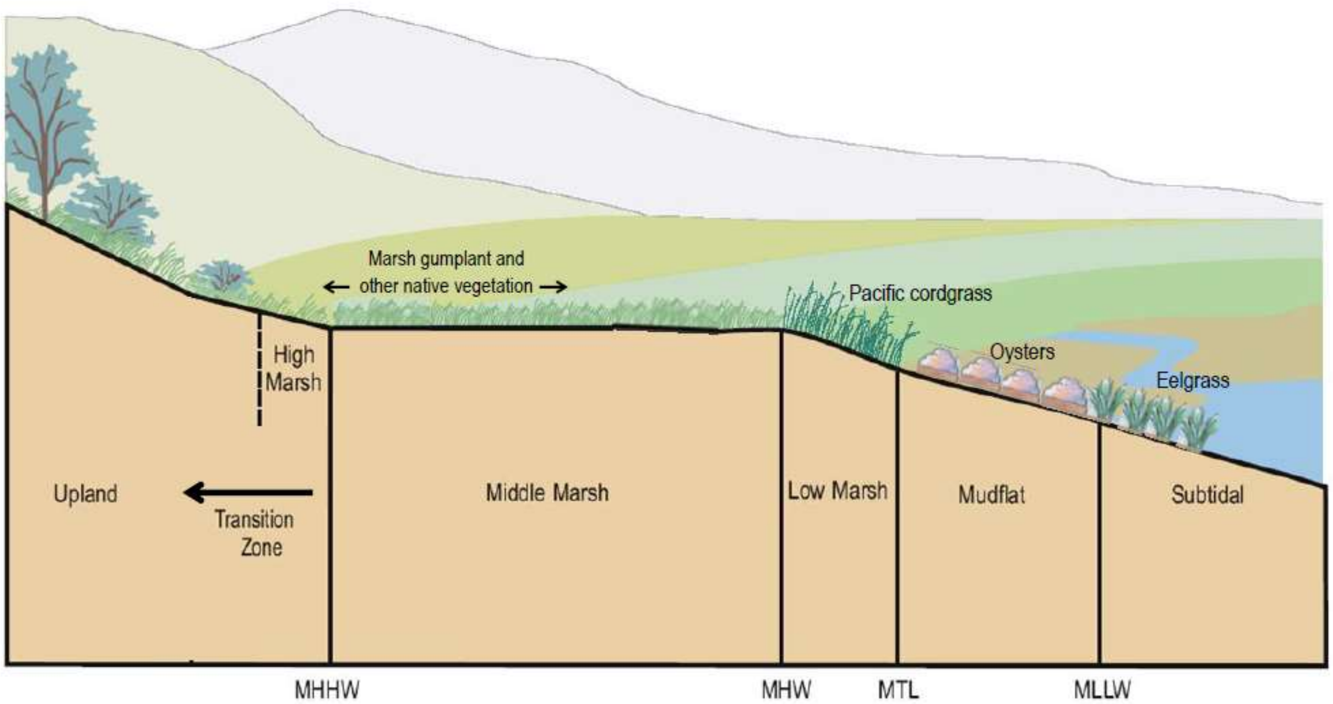
Members of the Risks to Wildlife Working Group, especially:

  - Peter Baye
  - Karen Thorne
  - Cory Overton
  - Susan De La Cruz
  - Kyle Spragens
  - Sarah Allen
  - Elizabeth Brusati
  - Patrick Kleeman
  - Jen McBroom

- The BEHGU Implementation Team (especially Letitia Grenier, Trisha Hickey, Matt Gerhart)
- BEHGU Steering Committee and BEHGU Science Review Panel
- Point Blue Colleagues: Sam Veloz, Julian Wood
- Funding by State Coastal Conservancy and CA LCC

Process

- Working Group: over 30 biologists active in the process
- Plant and Animal; all bayland habitats, tidal and non-tidal (managed marsh; managed ponds, other ponds).
- Met monthly to develop case studies and recommendations;



32 Case Studies: Plants and Animals:
Terrestrial vertebrates

General Category	Species	Sub-category, i.e., what is it indicative of	habitat
Marsh Birds	Clapper Rail	tidal-marsh dependent birds	tidal marsh
	Song Sparrow	tidal-marsh dependent birds	tidal marsh
	Black Rail	tidal-marsh dependent birds	tidal marsh
	Northern Harrier	marsh predator	multi-habitat
Water Birds	Avocets, western sandpipers	shorebirds	marsh; mudflats; managed pond
	Least Tern and Forster's Tern	piscivorous waterbirds	beaches, marshes, islands
	dabbling ducks: 6 species	dabbling ducks	diked bayland and tidal marsh; managed ponds
	diving ducks: 6 species	diving ducks	diked bayland; open water; managed ponds
Mammals 	salt marsh harvest mouse	marsh (tidal and non-tidal) small mammal	tidal marsh; diked bayland
	Suisun shrew, salt marsh wandering shrew	marsh (tidal and non-tidal) small mammal	tidal marsh; diked bayland
	river otter	aquatic mammal (creeks and rivers)	creeks and rivers
	harbor seal	aquatic mammal, bay and mudflat	mudflat, sandbar, rocky inter-tidal
Herps	California Toad	wetland-herp	wetlands
	California Red-legged Frog	wetland-herp	wetlands

32 Case Studies, continued, Terrestrial and Aquatic

General Category	Species	Sub-category, i.e., what is it indicative of	habitat
Invertebrates	Marsh and mudflat Inverts	multiple species	tidal marsh
Vernal Pool	plants, crustaceans, other inverts, plants	multiple taxa	freshwater, ephemeral pools
Plants	Low tidal marsh graminoids	multiple species	tidal marsh
	High tidal marsh plants (4 case studies)	annual forbs & graminoids; subshrubs; perennial forbs & graminoids	tidal marsh
	terrestrial ecotone/high marsh	terrestrial ecotone graminoids & psammophyte	terrestrial ecotone (transition zone)
	Submerged aquatic vegetation	multiple species	open water
	Spartina	invasive and native Spartina	tidal marsh
"Aquatic" Species			
Macro Invert	Dungeness crab	nursery value of baylands	shallow aquatic, eelgrass
Fish	Pacific herring	subtidal	shallow aquatic
	delta smelt	upstream part of estuary	open water
	longfin smelt	pelagic throughout Estuary	open water
	longjaw mudsucker	marsh fish	pickleweed marsh
	tidewater goby	small estuaries	estuarine lagoon
	grunion	recovered native	sandy beach
	chinook salmon and steelhead	migratory fish	vegetated marsh edge

SAV
fresh/brackish

Low marsh
graminoid

T-zone/high marsh perennial forbs

T-zone/high marsh annual forbs

Plant Guilds = 8 case studies

Plant Guilds = Ecological "functional groups"

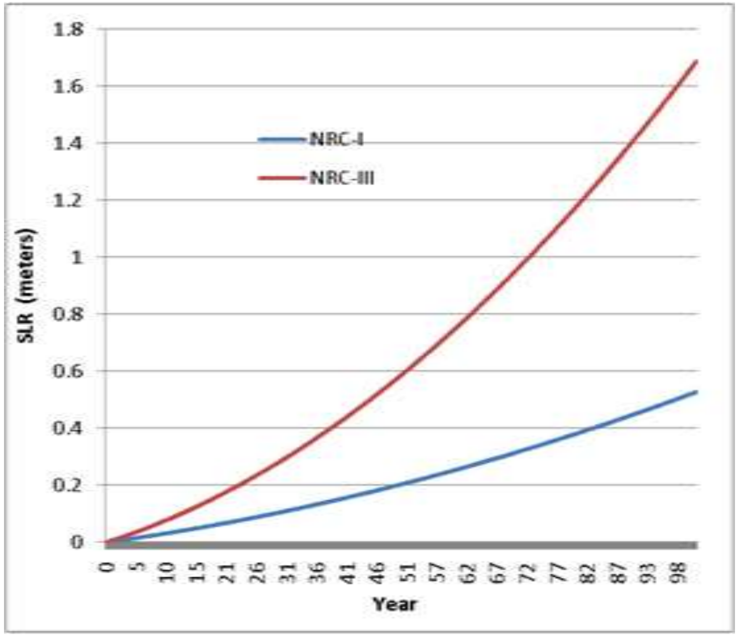
- **Objectives:**
  - *Distinct population trends within & among groups in response to climate change impacts*
  - *Related by management, conservation measures*

Differ with respect to:

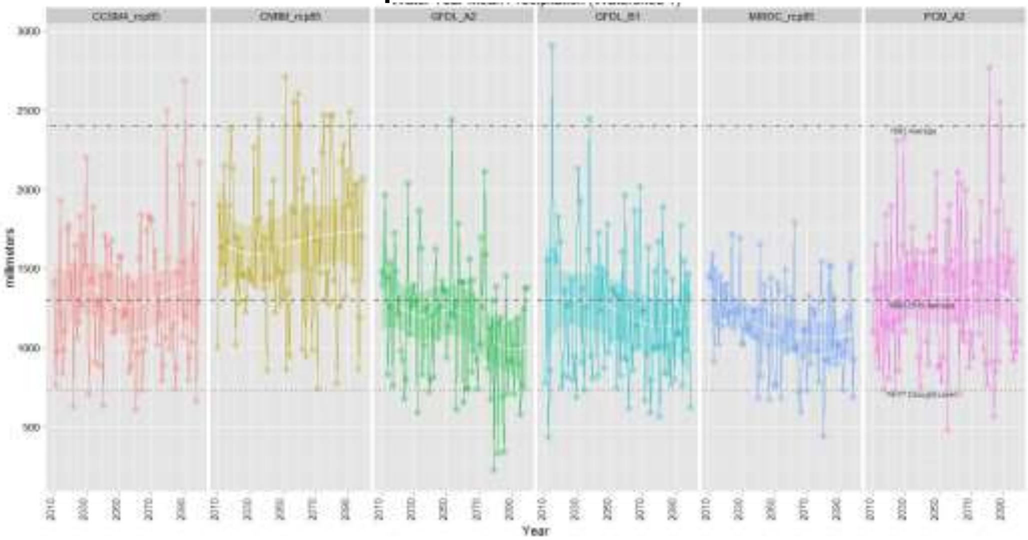
- **Sensitivity to climate change drivers**:
  - Salinity tolerance
  - Submergence tolerance
  - Sediment type, supply
  - Wave energy, erosion
- **Morphology, life-form**
- **Reproduction, life-history traits**
- **Ecological engineers, keystone species**
- **Endemism, rarity**

Climate Change Impacts: Trends

- Expect changes in habitat suitability, suitability for successful breeding, etc., due to SLR, changes in salinity, temperature, precipitation.



Annual Precipitation: Six climate models



Climate Change Impacts: Trends

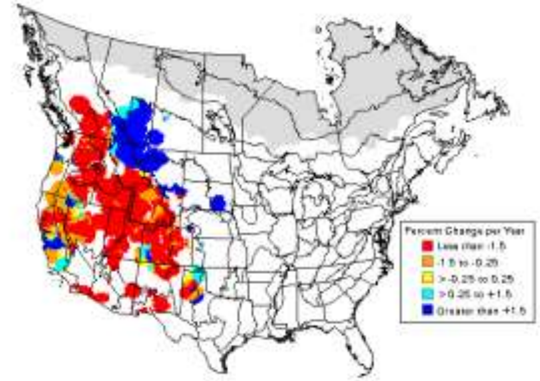
Harbor Seal

- Sea Level Rise
  - Habitat loss: haul-out for pupping
  - Potential new habitat
- Ocean condition
  - Acidity
  - Change in upwelling
  - More frequent and intense ENSOs
  - Indirect effects on prey

Longjaw mudsucker (*Gillichthys mirabilis*)

Sentinel species on west coast
Now rare in Estuary, low numbers
Pickleweed dependent, loss of habitat a concern
low mobility (need for translocation?)

Dabbling Duck: Cinnamon Teal



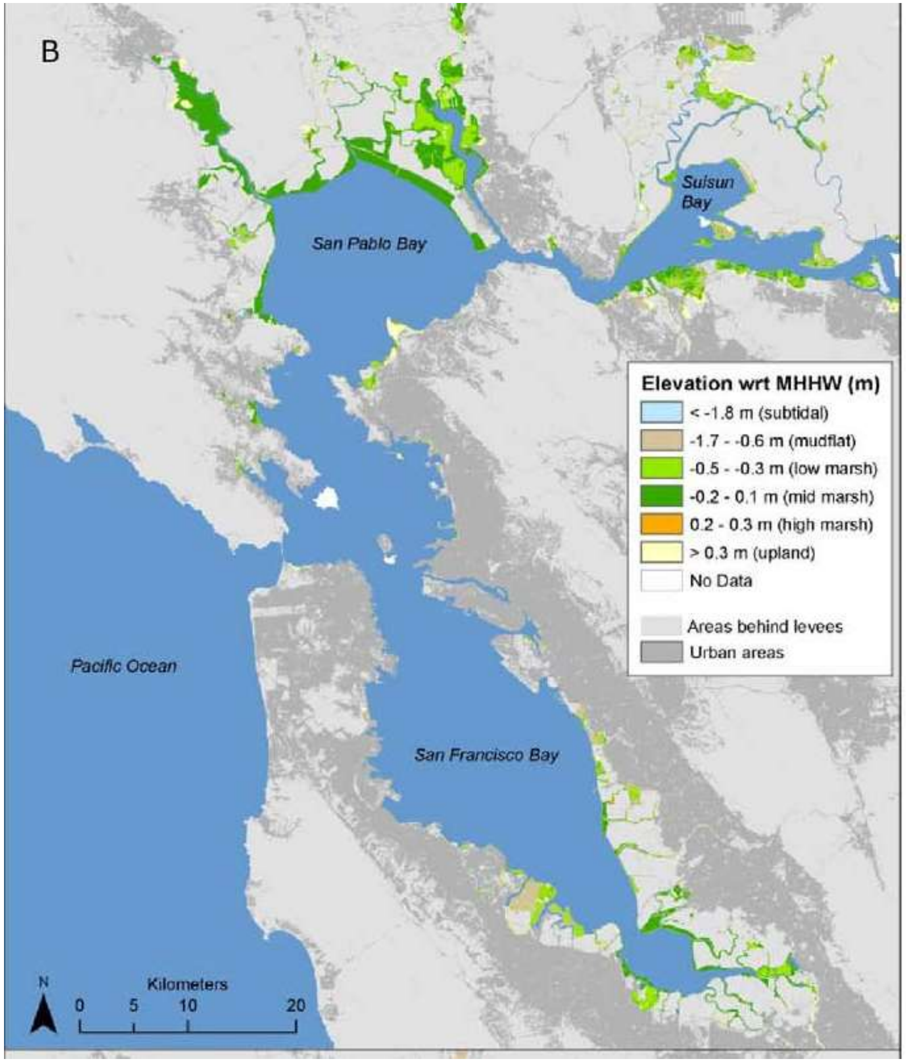
Affected by:

- Landward migration of saltwater marshes and habitats.
- Decrease in freshwater inputs; precipitation, runoff.
- Temperature change altering growth periods of vegetation for nesting cover, food availability.
- Long-distance migrant, mismatch in migration cues and breeding habitat availability.

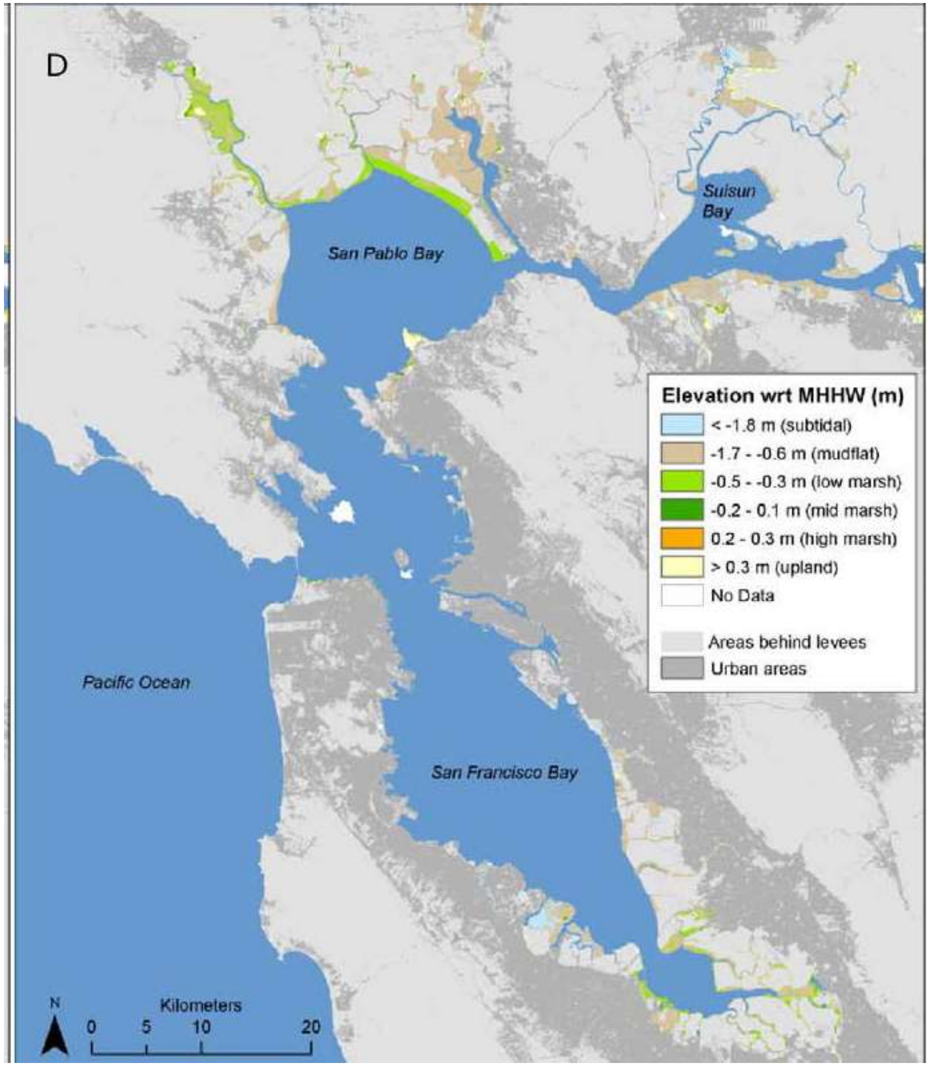
Modeled Marsh Accretion: Marsh elevation relative to Mean Higher High Water: 4 Scenarios: Low vs High Sea-Level Rise; Low vs High Sediment Availability

Stralberg et al. 2011

Low Sea-Level Rise, Low Sediment, 2110



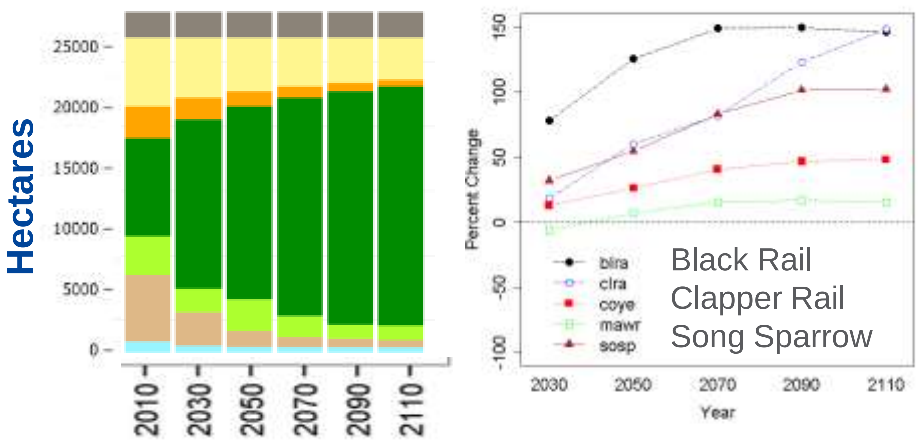
High Sea-Level Rise, Low Sediment, 2110



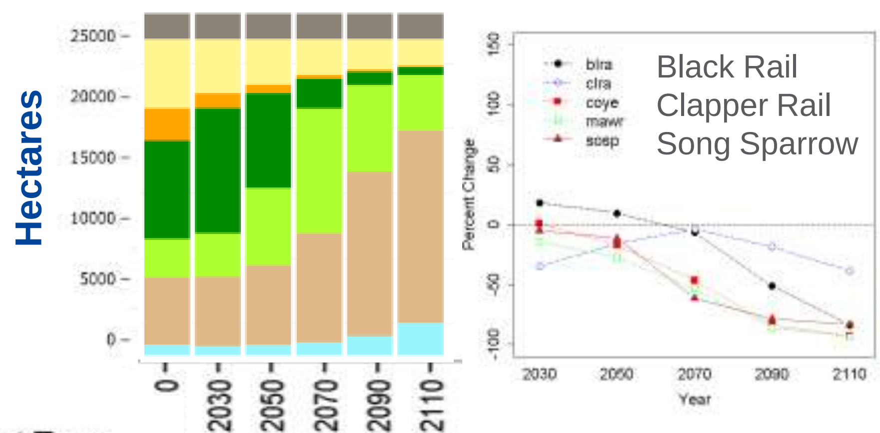
SLR Impacts on Tidal Marsh Birds:

Changes in Habitat Suitability due to SLR, Salinity

Veloz et al. 2012



High SLR/ Low Sediment



Low SLR/ High Sediment

Black Rail

Clapper Rail

Song Sparrow

40 to 80% decline

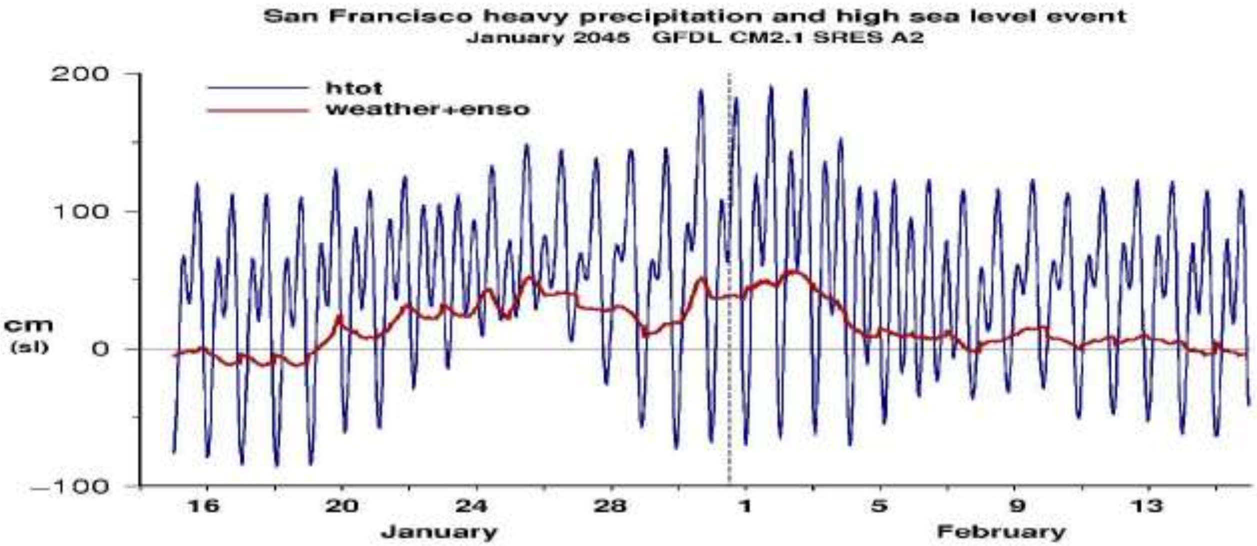
Climate Change Impacts: Extreme Events

Droughts; Extreme Temperature

Storms:

- direct effect,
- inundation of habitat (can be extended duration)

Winter storm event projection, 2045 (D. Cayan)



Water levels 20 to 50 cm higher than without the storm

Impact of January 2010 and March 2011 storms

Thorne et al. 2013

Site	January 2010			March 2011		
	MHHW Non-Storm	MHHW Storm	Max SLH Storm	MHHW Non-Storm	MHHW Storm	Max SLH Storm
Coon Island	40.88	55.95	65.41	7.46	80.94	93.59
Petaluma Marsh	46.58	73.90	78.52	15.55	92.85	97.78
SPB	54.27	65.46	72.23	23.45	90.00	95.85

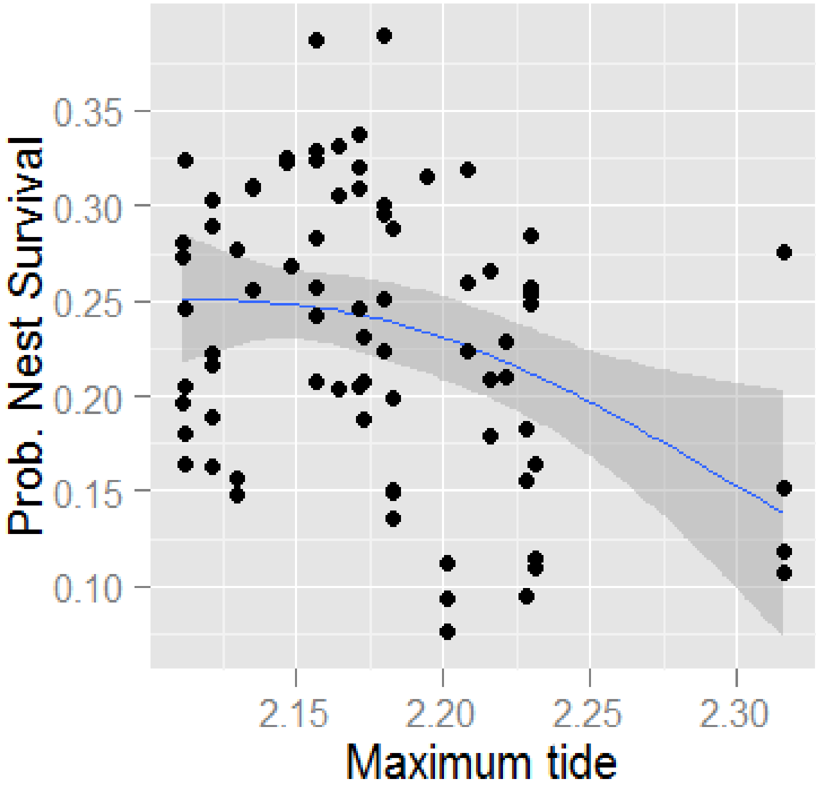
Percentage of vegetation under water

- **March 2011 storm had over 90% of the vegetation under water during the Max Sea Level Height**
- **March is breeding season for many marsh birds in San Francisco Bay**

(Thorne *et al.* 2013)

Tidal Marsh Song Sparrows:

Effects of climate change – Maximum high water during breeding season



Nur et al. 2012

Nest failure due to flooding varies from 3% to 55%, depending on year

The higher the maximum water level, the more nest failure due to flooding.

Nest survival declines as tide height increases

Recommendations:
Strategies for Enhancing Population Resilience

Ensure Suitable Habitat in the Future:

- Tidal (marsh, tidal flats); non-tidal (ponds, diked marsh).

Provide necessary habitat features, locally and across the landscape

- Refugia from predators; from flooding
- Enhance topographic relief ("complexity"); channel sinuosity

Maintain/augment resilience by addressing other stressors

- Predators, Invasive species, contaminants, disease

Increase recruitment/dispersal success and facilitate movement

- Remove barriers to dispersal, increase connectivity
- Translocate if needed

Manage for dynamic landscapes that will change in the future

- Anticipate future suitable habitat in planning, modeling
- Maintain genetic diversity

Manage for uncertainty, including extreme events, and the unforeseen

- Implement robust monitoring programs tied to adaptive management
- Develop thresholds/triggers to detect change, respond to extreme events.

Recommendations: Plants

- **Vertical high marsh conservation:** Build high marsh/t-zone platforms into tidal marsh restoration
- **Horizontal high marsh conservation: buffer wave erosion**: coarse sediment, high marsh berms
- **Experiment with facilitated dispersal, migration within Estuary** to conserve isolated populations of plant taxa limited by dispersal or colonization of suitable habitat (salinity gradient, high marsh)
- **Manage invasive non-native vegetation** if it conflicts with migration of native estuarine plant populations,
- **NORTH BAY AND SUISUN MARSH LOWLANDS**: key conservation opportunity for regional high marsh/t-zone transgression
  - lower development pressure in exurban terrestrial lowlands
  - low-intensity ag land use
  - freshwater-brackish gradients

Recommendations:
Reduce Impact of Predation:
Examples: Refugia from predation, extreme tides

Artificial floating islands, for clapper rails

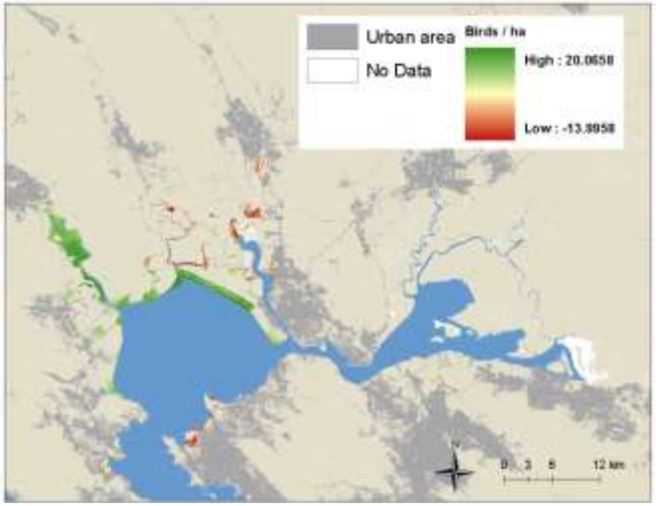
Bair Island – Earthen island 1 year after build

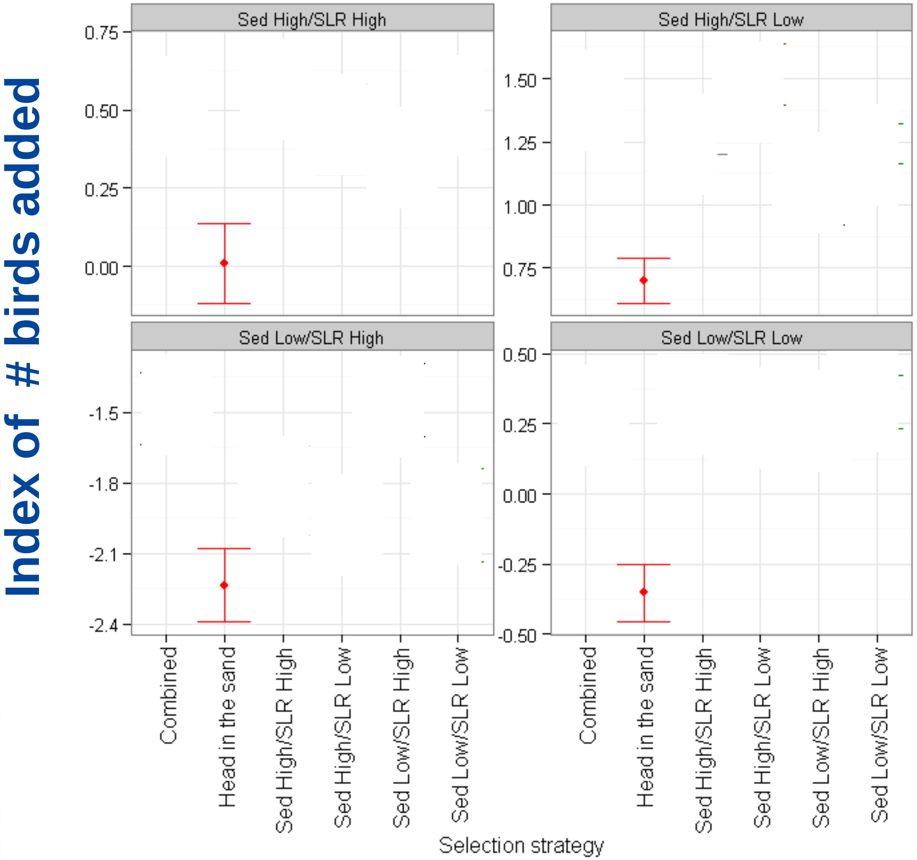
See Marilyn Latta's talk here, 1:35 p.m.

Addressing uncertainty:

Scenario planning – comparison of six strategies in the face of four climate change scenarios

The most robust strategy is the combined approach, which considers all scenarios simultaneously





Veloz et al. Ecosphere, 2013

Conclusions

- Areas that are currently suitable habitat will not be suitable/available in 20 to 100 yrs.
- Suitable habitat in the future will not be where it is now:
  wildlife need to be able to colonize/re-colonize.
- Expect changes in habitat features and landscape configuration (isolation).
- Extreme events will be unpredictable, and will affect survival, reproductive success. May lead to local extirpation.
- Can increase resilience by:
  - Minimizing mortality (reduce excessive predation, invasive species)
  - Reduce barriers to dispersal, on multiple time scales (daily, annual)
  - Maximizing dispersal success and increasing connectivity
- **Modeling** unpredictable future and **monitoring** environmental drivers and biological responses are important tools.

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Baylands Goals Update Regional Recommendations

1	**Restore estuary-watershed connections.**
2	**Design complexity and connectivity into the Baylands landscape.**
3	**Restore and conserve complete tidal wetlands systems.**
4	Restore Baylands to full tidal action prior to 2030.
5	**Plan for the Baylands to migrate.**
6	**Actively recover, conserve, and monitor wildlife populations.**
7	Develop and implement a comprehensive regional sediment management plan.
8	**Invest in planning, policy, research and monitoring.**
9	Develop a regional transition zone assessment program.
10	Improve carbon management.