

# Estuary-Nearshore Climate Change Effects and Relationship to Migratory and Listed Species



J. Y. Takekawa, K. M. Thorne, C. T. Overton, M. L. Casazza, T. Rohmer, N. D. Athearn, and S. W. De La Cruz

*U. S. Geological Survey- Western Ecological Research Center, Vallejo  
and Dixon, California*

*University of California, Davis, California*

# Acknowledgments

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East Bay Regional Parks

Calfed Ecosystem Restoration Program

# Climate Change Research

Global  
Climate  
Models

Ecosystem  
Response  
California

Regional  
Habitat  
Response  
San Francisco Bay

Habitat  
Requirement  
Response  
Food  
Cover  
reproduction

**Species or Population Response**  
**Site specific answers**

Downscaling

# Avian Response in San Francisco Bay

Shoal Habitats – Migratory Birds

Tidal Marshes – Endemic Species

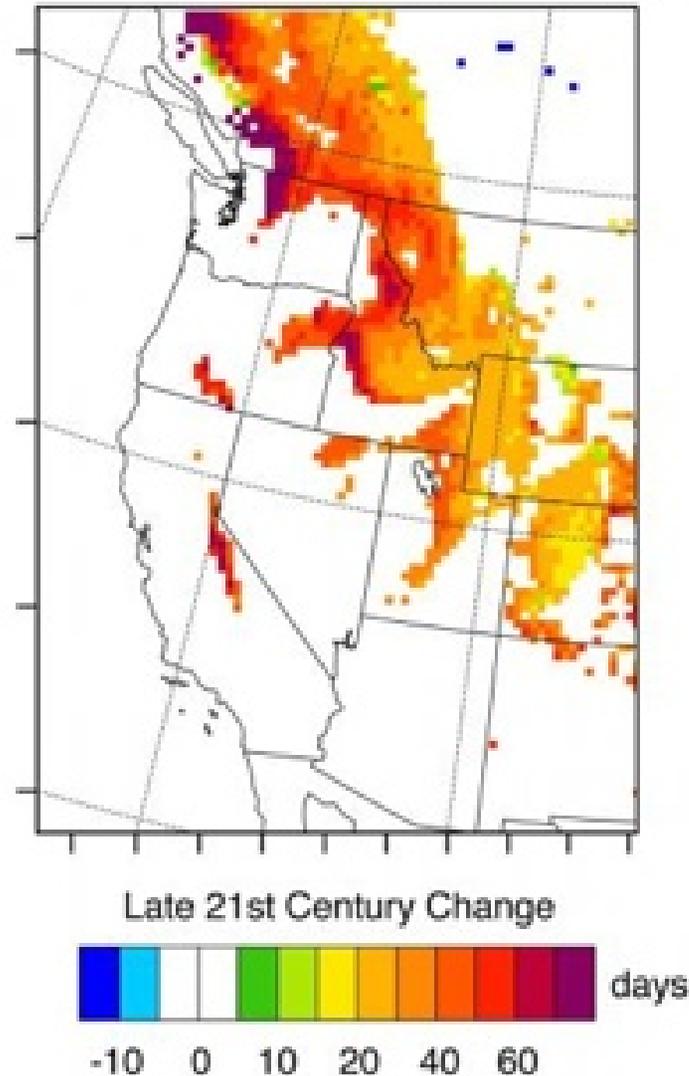
*Sea level rise will inundate low elevation areas unprotected by levees and erode existing levees*



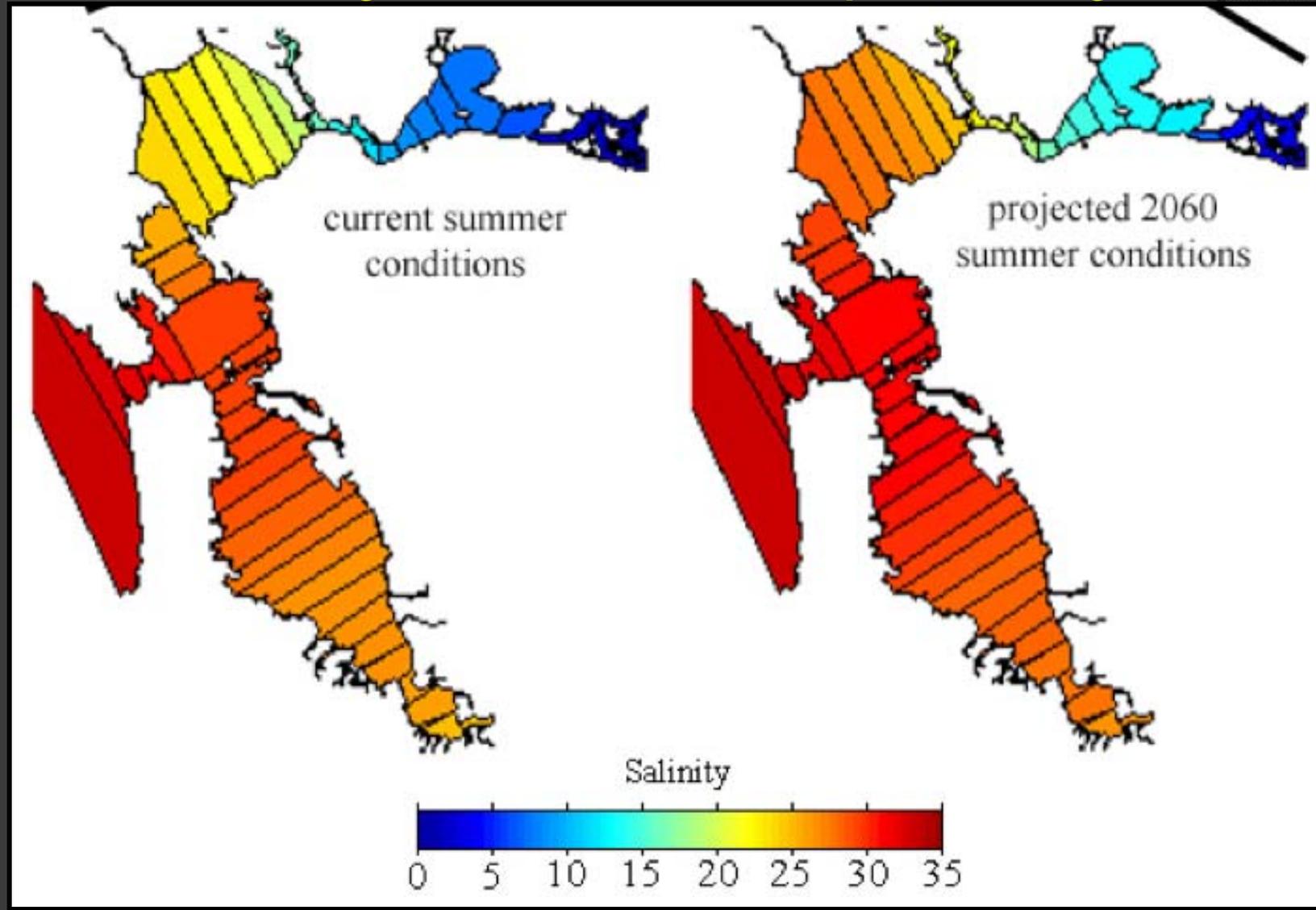
(SLR = 1 m)

*Snowpack runoff  
will decrease and  
advance by up to  
60 days*

## Snow-Dominated Runoff



# *Salinity will increase up estuary*



# Assumptions: Climate Change in SFB

1. Sea level will rise 30-90 cm in 21<sup>st</sup> century (Dettinger et al. 2003), and 39% of intertidal habitats (70% in South Bay) may become subtidal by 2100 (Galbraith et al., 2002).
2. Water temperatures and salinity will increase (Malamud-Roam 2002, Cayan et al. 2005).
3. High and low tide events will become more extreme. A 30cm increase will reduce 100-yr storm events to 10 yrs.
5. Western snowpack will decline and has decreased 10-40% since 1950 (Barnett et al. 2008).
6. Snowpack runoff will be earlier and shorter (Difffenbaugh et al. 2008).

# Avian Response to Climate Change: Shoals and Migratory Birds



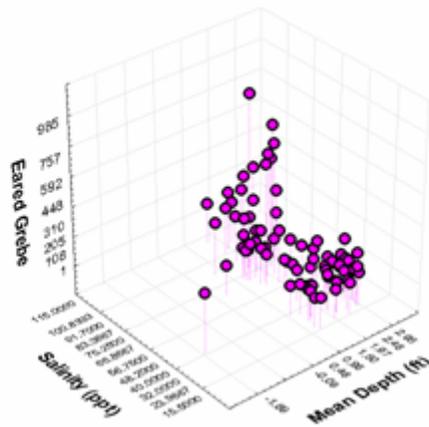
# Assumptions: Shoals and Migratory Birds

1. Water depth will increase over existing shoals and will inundate baylands without levees
2. Salinity, temperature, and depth changes will affect the macroinvertebrate community
3. Change varies with species mobility: local, regional, or continental migrants
4. Migration routes and phenology of some will be affected

# Food Abundance – determined by salinity, temp, depth and other conditions

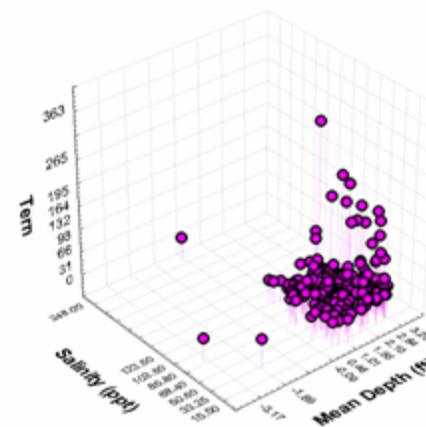


Baumberg Salt Ponds: Eared Grebe Occurrence by Mean Depth and Salinity



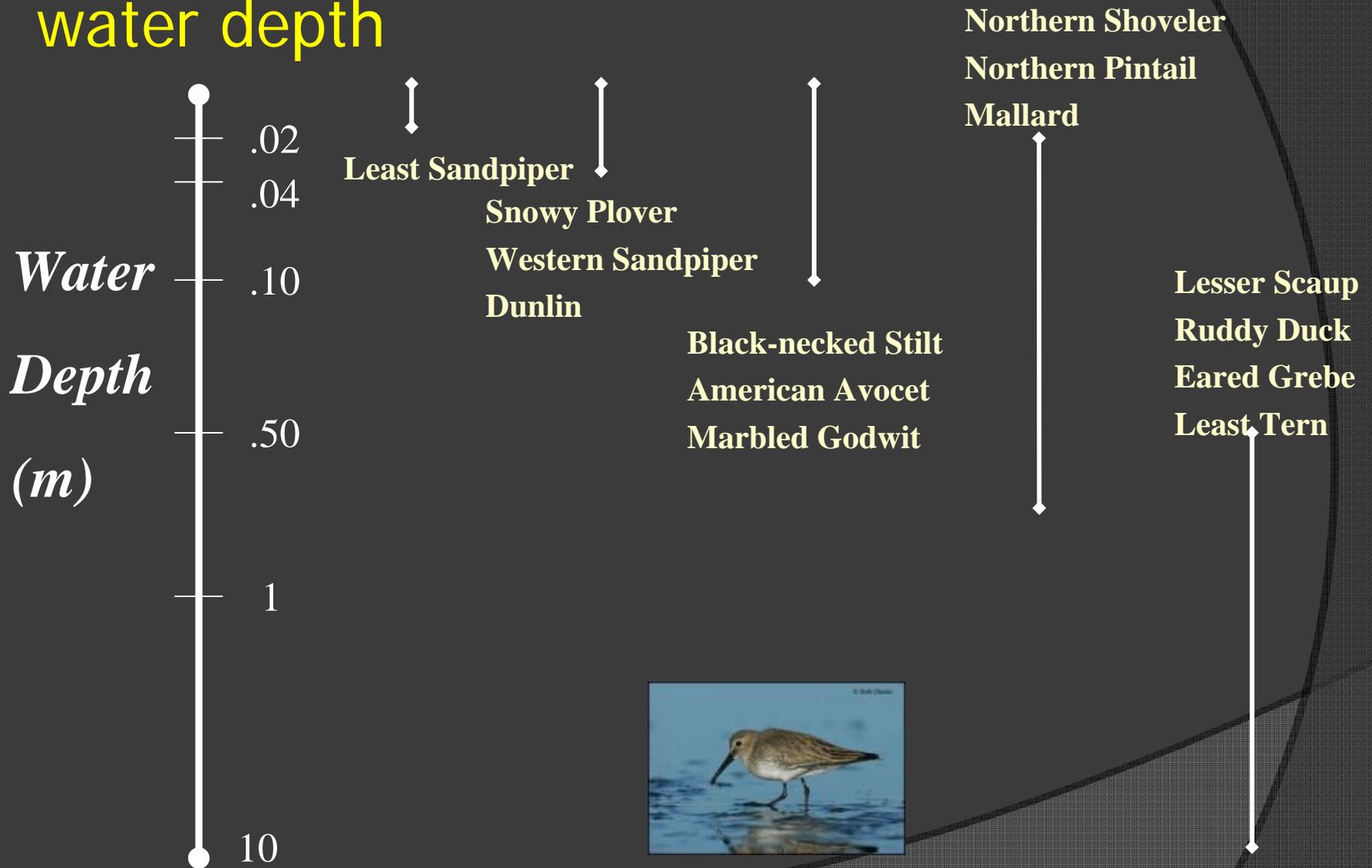
Eared grebes correlated with higher salinity

Baumberg Salt Ponds: Tern Occurrence by Mean Depth and Salinity

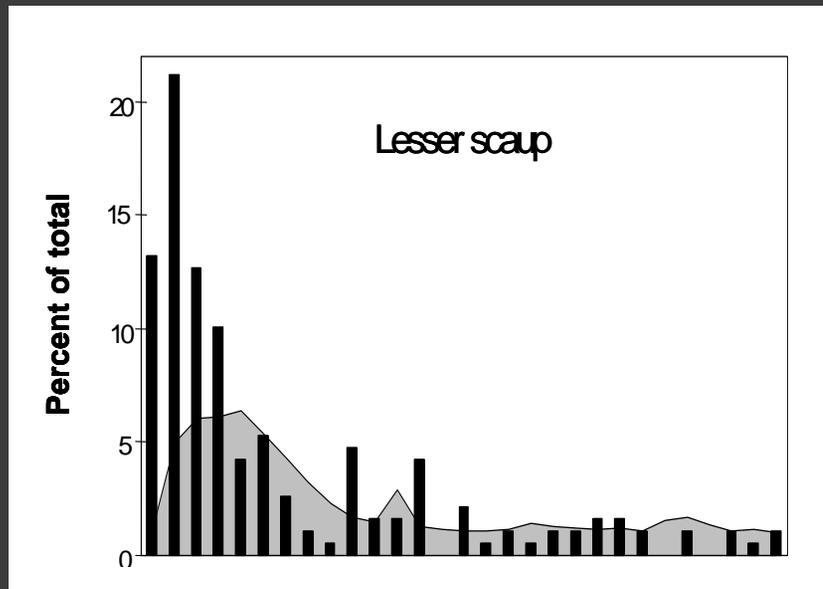


Terns correlated with lower salinity, higher dissolved oxygen (fish eaters)

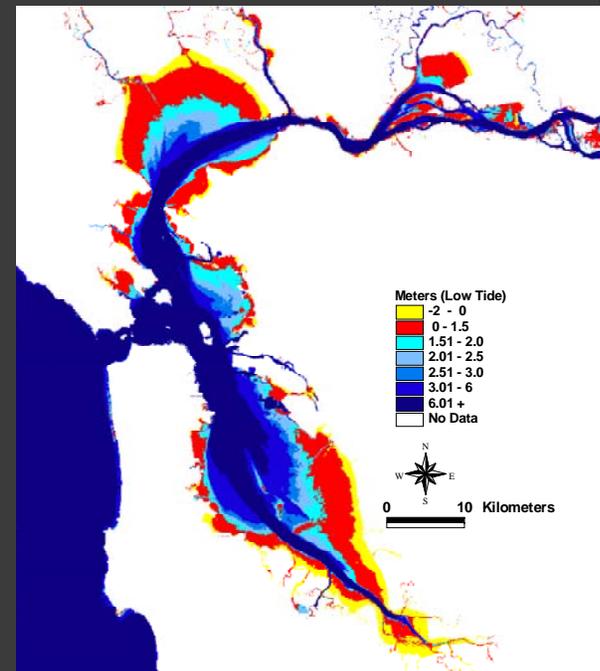
# Food Availability -- determined by water depth



# Preferred Foraging Depths

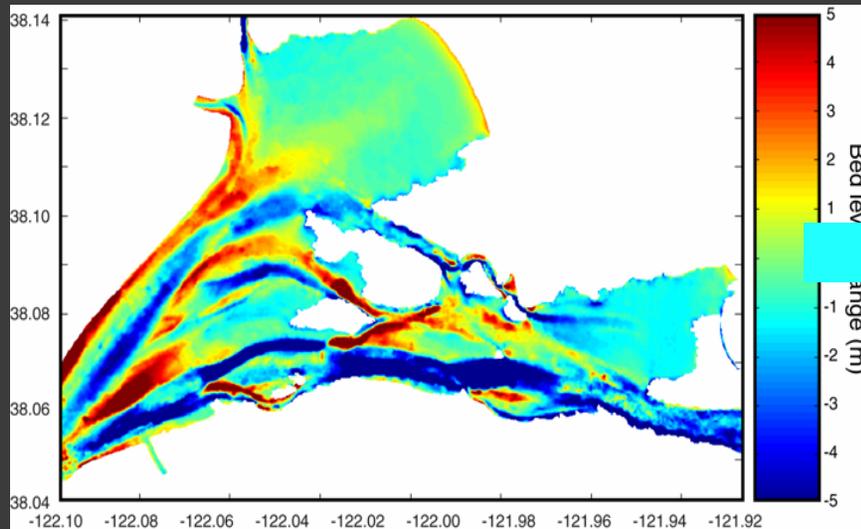


Preference (bars) of scaup species for shallow foraging habitats compared with available habitats.

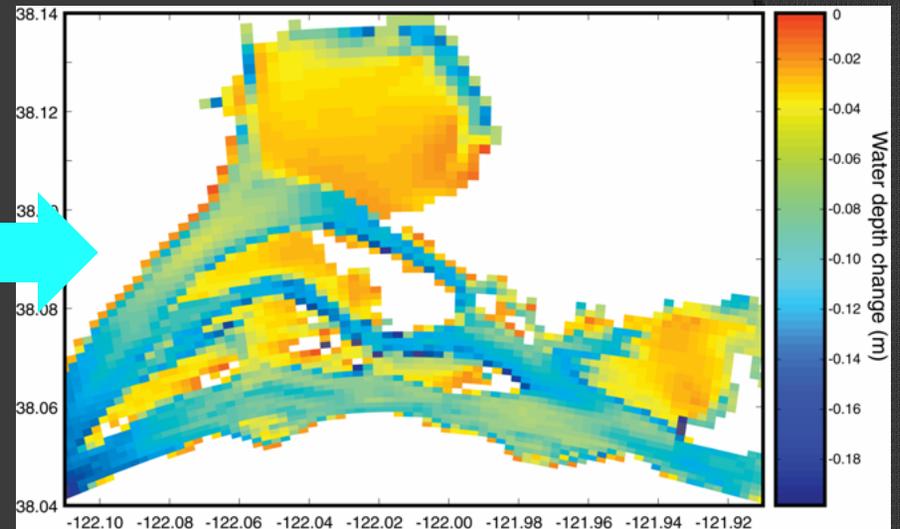


Current shoal habitats preferred by foraging scaup (red).

# Predicted Changes in Shoal Depths, Suisun Bay



Bed level changes in Suisun Bay between 1867 and 1990 (Cappiella et al., 1999). Positive values indicate deposition; negative values, erosion.



Predicted changes by 2030 with changes in bed and water level with warming, sea-level rise, and decreased watershed sediment supply.

# Length of stay at migration stopover areas

Western Sandpiper  $2.3 \pm 1.7d$ ,  $n = 233$

Dunlin  $2.6 \pm 1.5d$ ,  $n = 40$

Long-billed Dowitcher  $3.0 \pm 1.9d$ ,  $n = 20$

Short-billed Dowitcher  $3.2 \pm 2.3d$ ,  $n = 41$

*(Warnock et al. 2004, Bishop et al. 2006)*



# Research Directions: Shoals and Migratory Birds

- Determine macroinvertebrate abundance in relation to benthic conditions
- Identify migratory birds most at-risk of population effects
- Relate changing food resources to migration and wintering demands
- Predict resource change along migration routes



# Management Considerations: Shoals and Migratory Birds

- Reduce disturbance on shoals to maximize foraging – consider protected areas
- Protect bay edge areas without levees that can become mud flats
- Protect shallow nontidal estuarine areas (ponds) as alternative foraging areas



# Avian Response to Climate Change: Tidal Marshes and Endemics



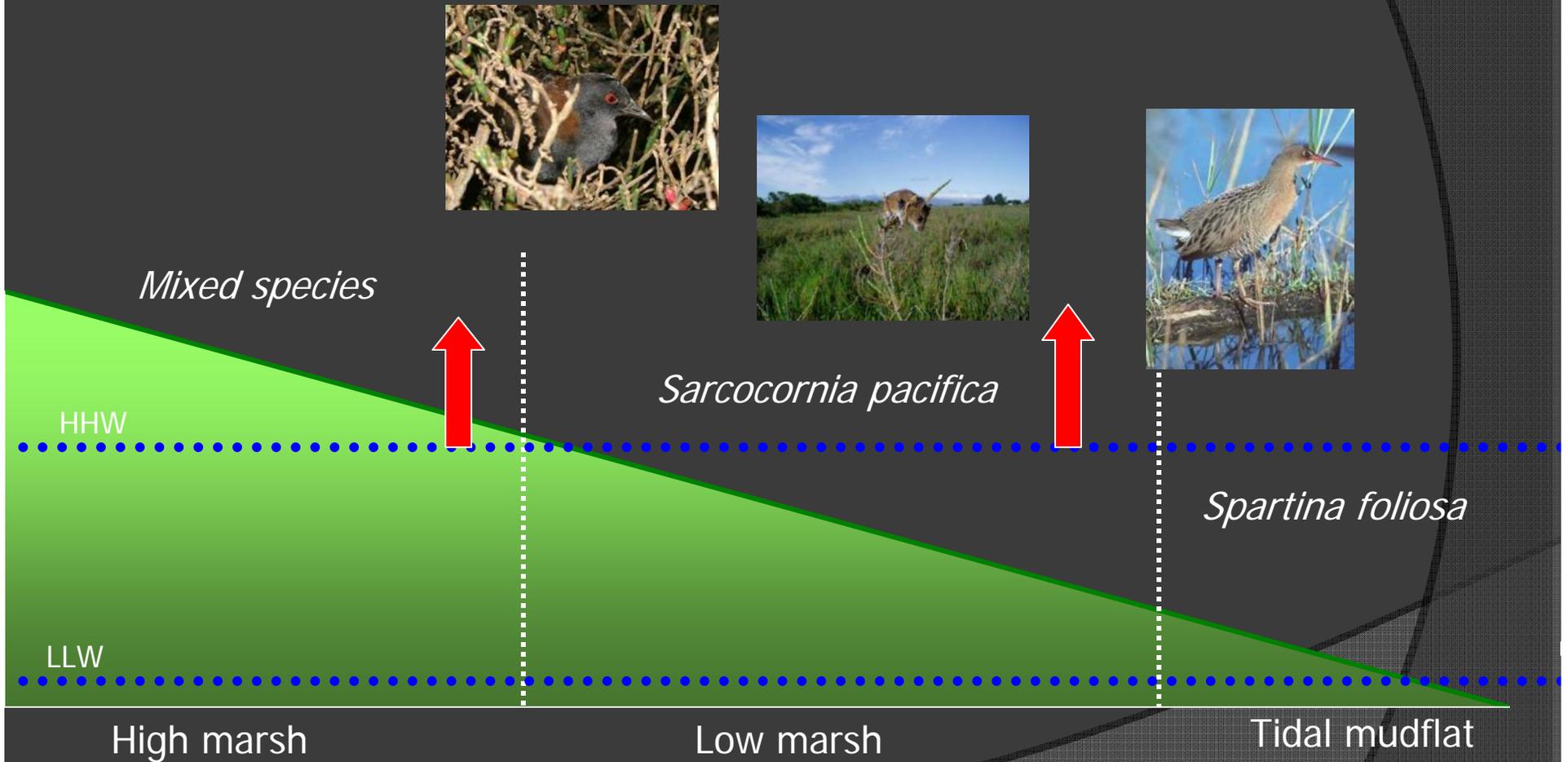
# Assumptions: Tidal Marshes and Endemics

1. Endemics are limited by habitat availability
2. Sea level rise will outpace sediment accretion
3. Habitat response is limited by levees
4. Predation will increase with fewer refugia



# Salt Marsh Elevation Gradient

Will sea level rise occur too fast for a vegetation response upslope?



# RTK GPS Network

- Rover unit communicates with a network of permanent reference stations to determine x,y,z position



- Stop and go kinematic accuracy:

Horizontal = 1-2 cm

Vertical = 1-3 cm

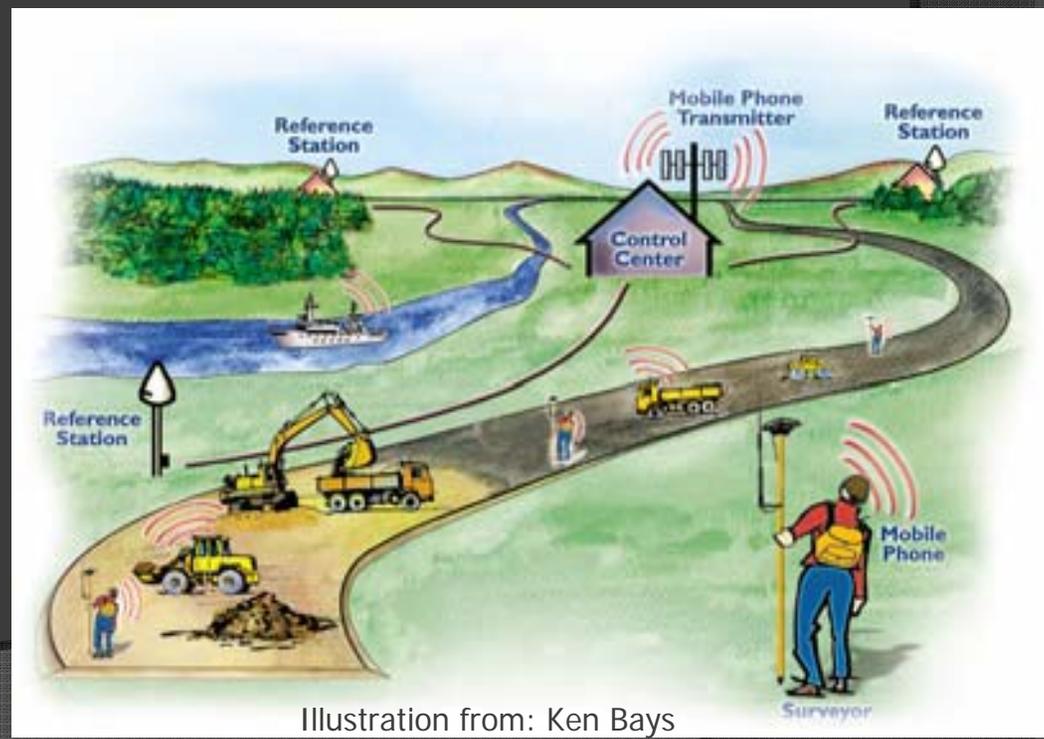


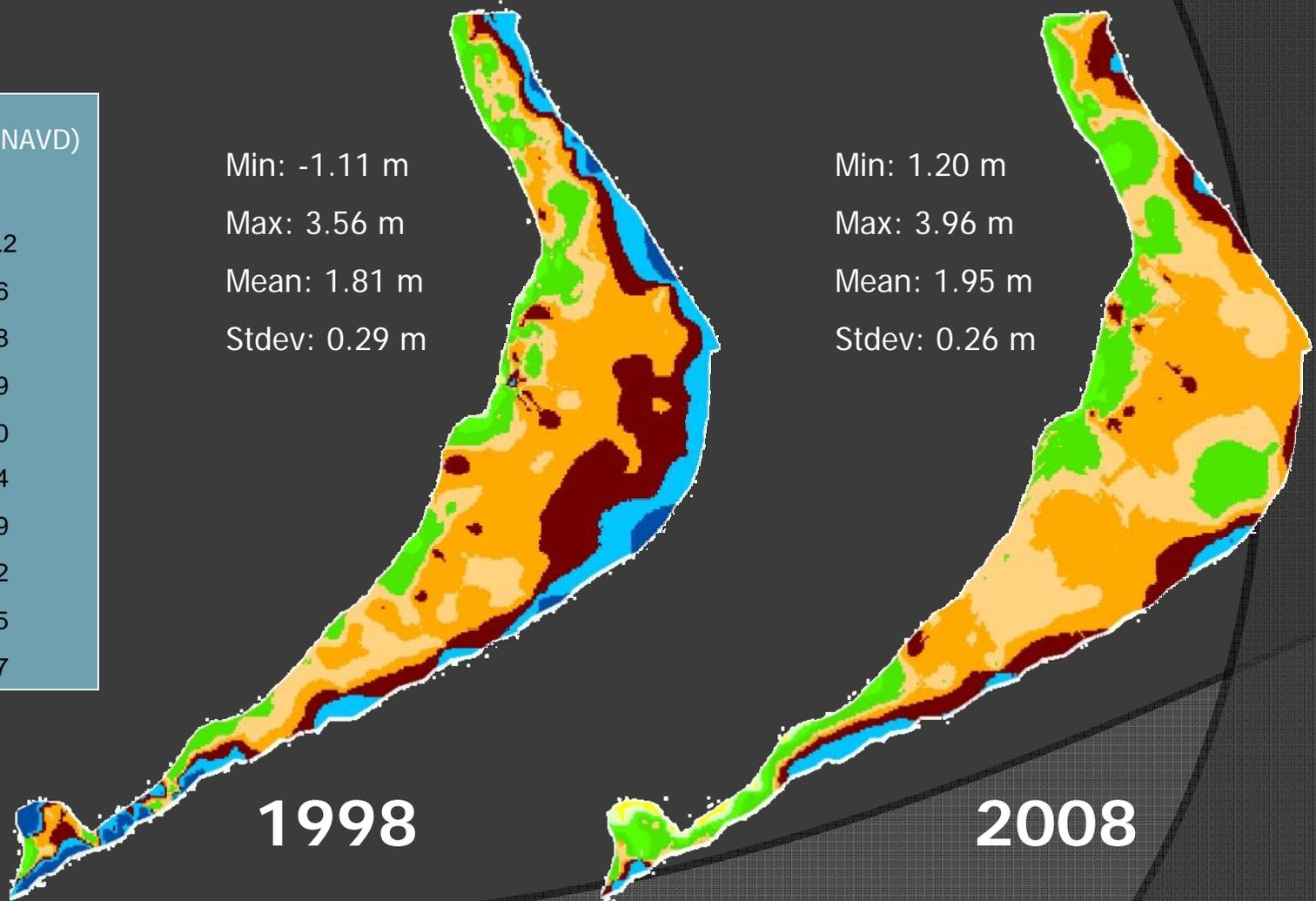
Illustration from: Ken Bays

# Tracking Elevation Change – San Pablo Bay NWR



Min: -1.11 m  
Max: 3.56 m  
Mean: 1.81 m  
Stdev: 0.29 m

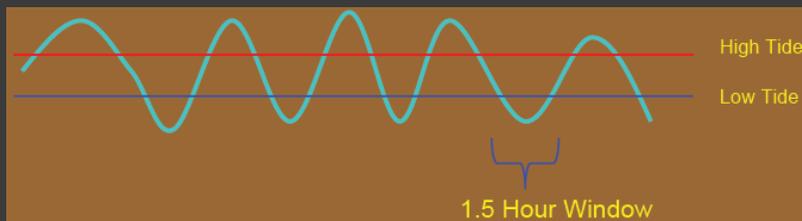
Min: 1.20 m  
Max: 3.96 m  
Mean: 1.95 m  
Stdev: 0.26 m



# California Clapper Rail Movements



- 3 South Bay marshes
- 29 Rails, >6000 locations
- Feb 2007-Feb 2008
- high and low tides



# Tidal Variation



Colma Creek Marsh



Cogswell Marsh

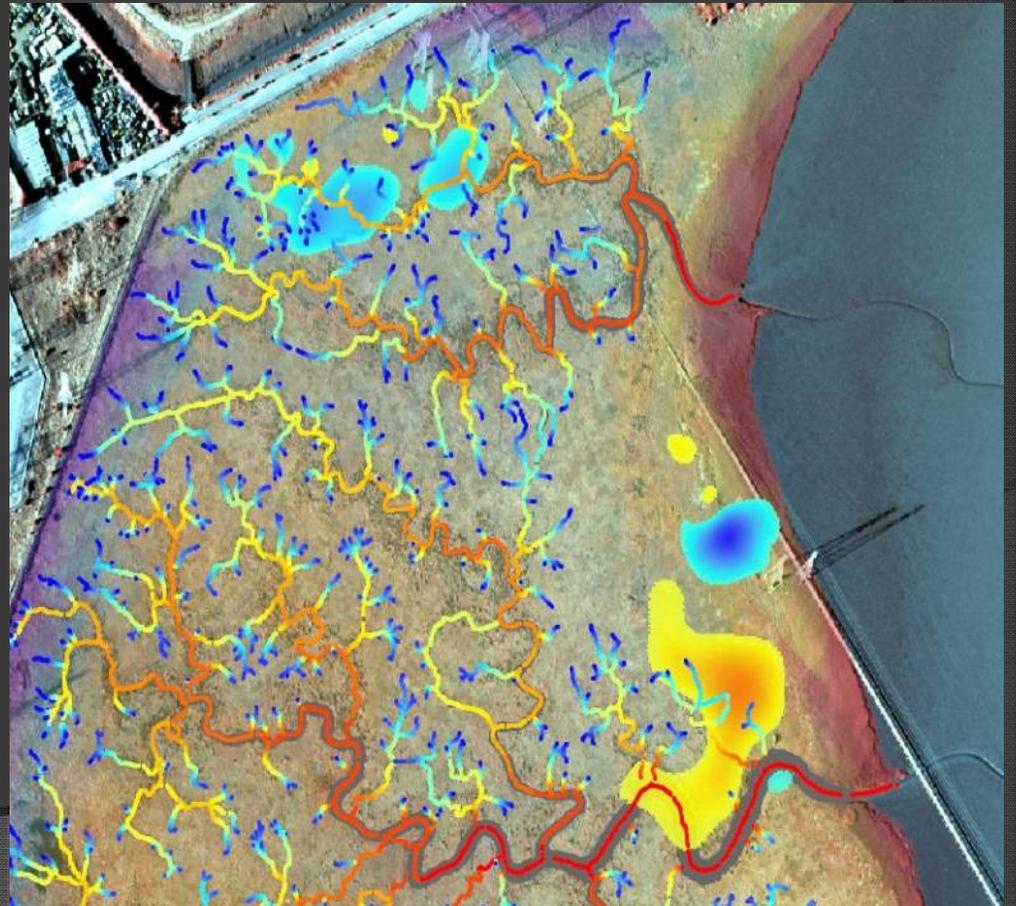
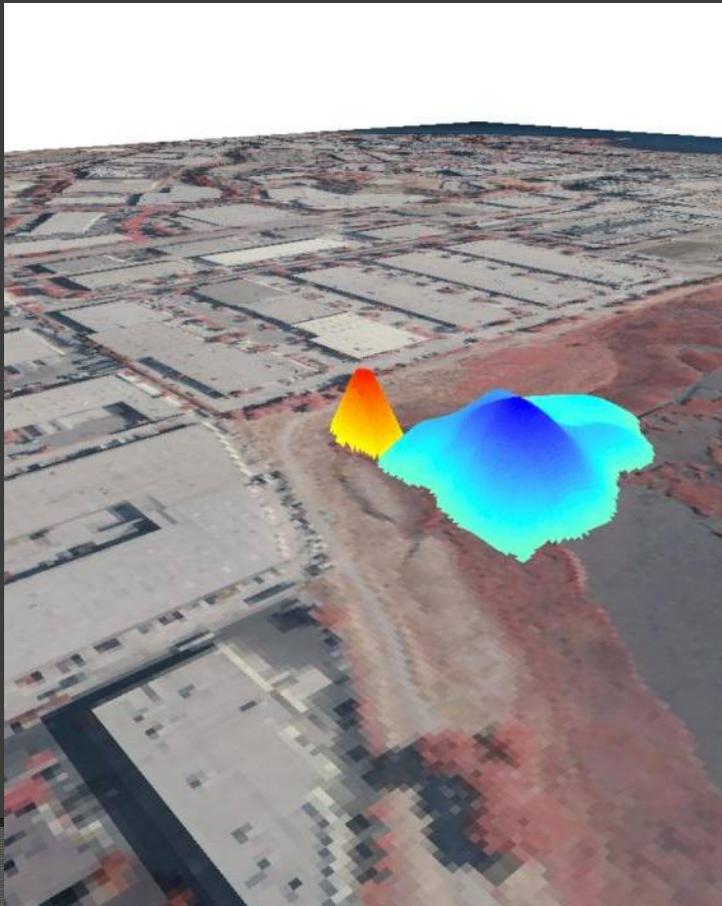
# Elevated Refugia

(Low Tide, High Tide)



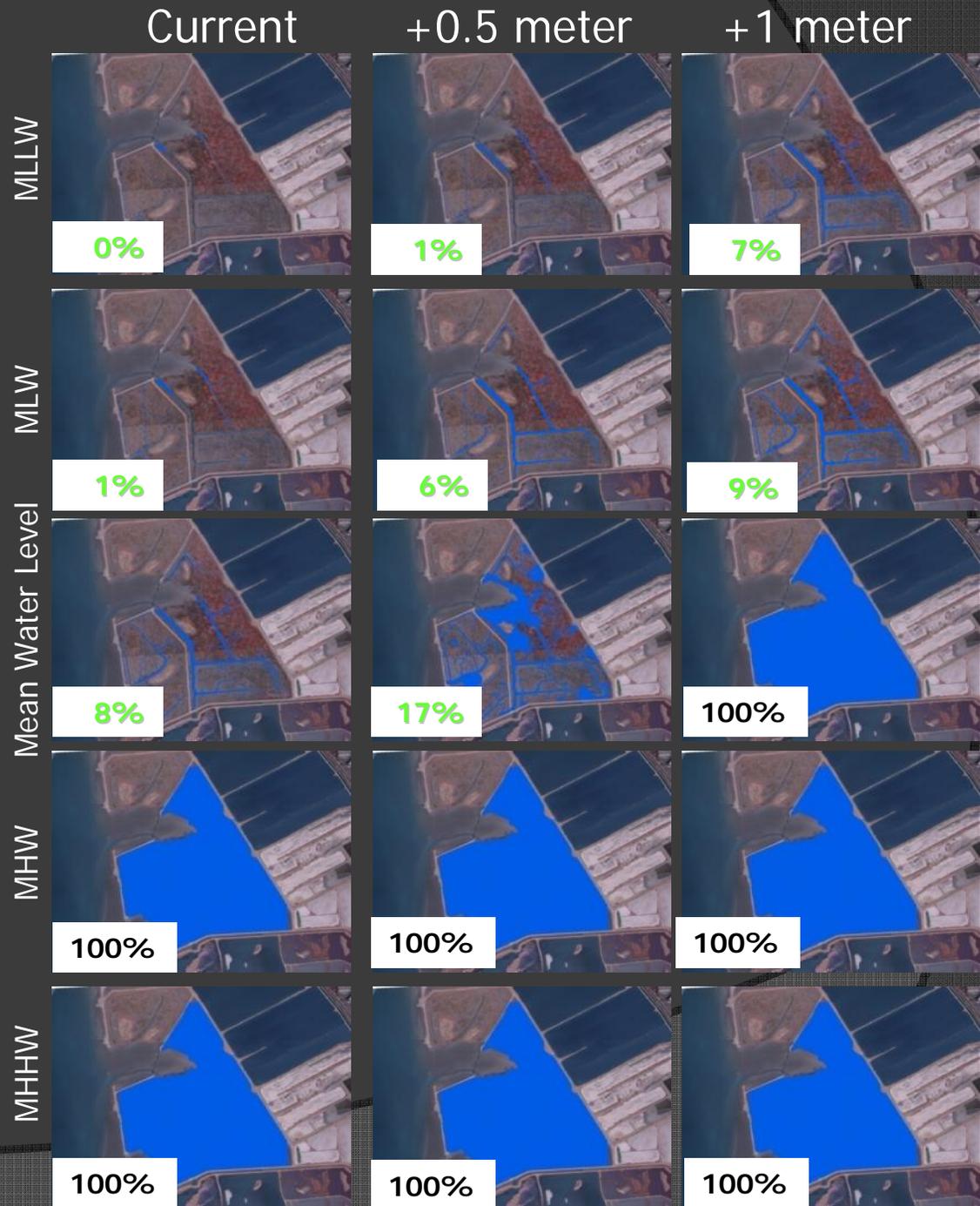
Colma Creek Marsh

Laumeister Marsh



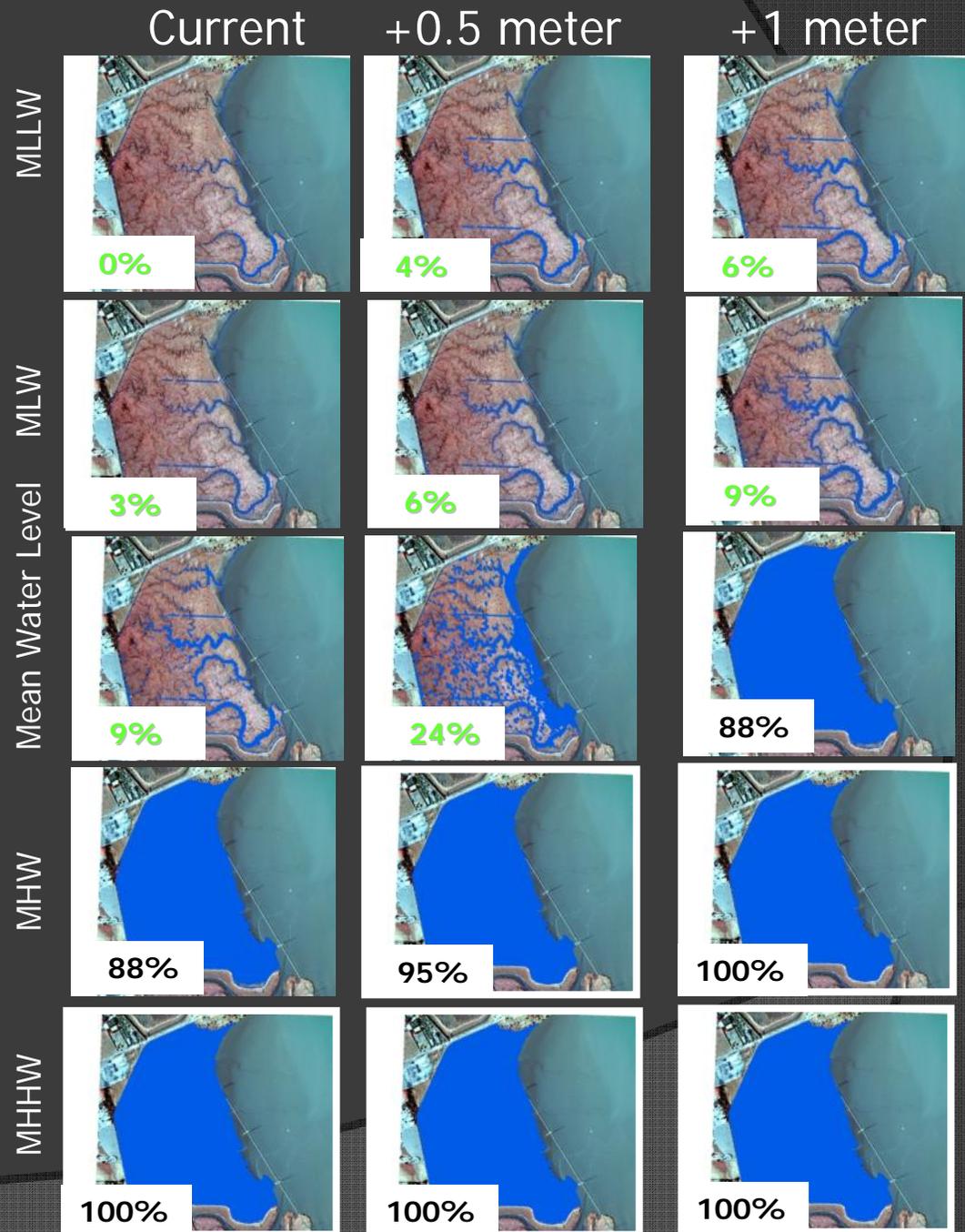
# Projected Tides at Cogswell

*More  
inundation  
results in less  
foraging time  
and more  
predation risks*



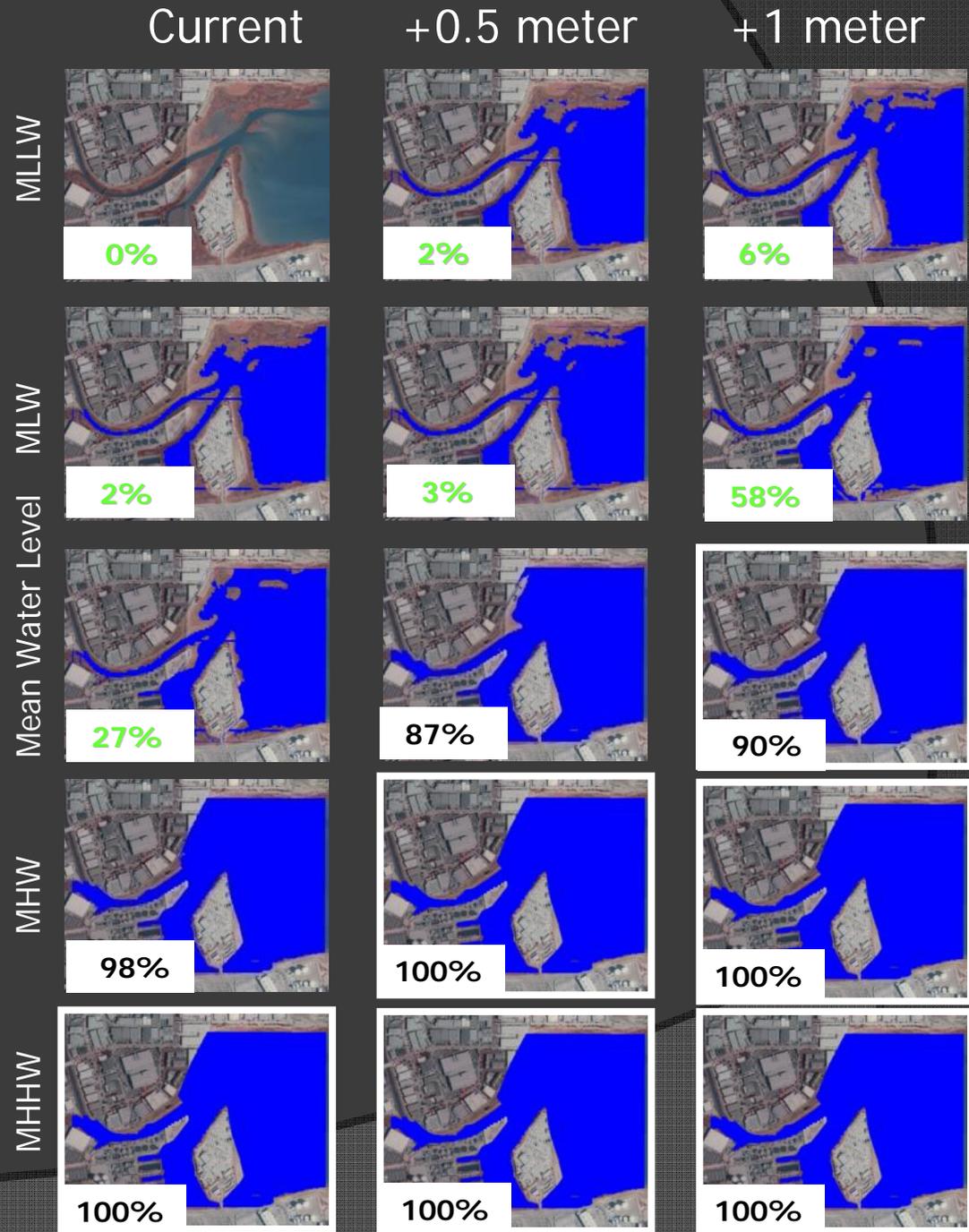
# Projected Tides at Laumeister

*Worse...*



# Projected Tides at Colma

*Even Worse....*



# Research Directions: Tidal Marshes and Endemics

- Identify endemics most at-risk and study movements and phenology
- Determine need for critical habitat elements such as channel edges and uplands
- Study predation risks and habitat conditions that reduce it



# Management Considerations: Tidal Marshes and Endemics

- Response will be site specific: create detailed elevation maps of areas
- Focus on areas with upland transitions and flexible land use (agriculture) for movement upslope
- Acquire or protect adjacent undeveloped uplands
- Prioritize acquisition or restoration in areas unconstrained by levees

