# Tidal Wetland Habitats & Wildlife

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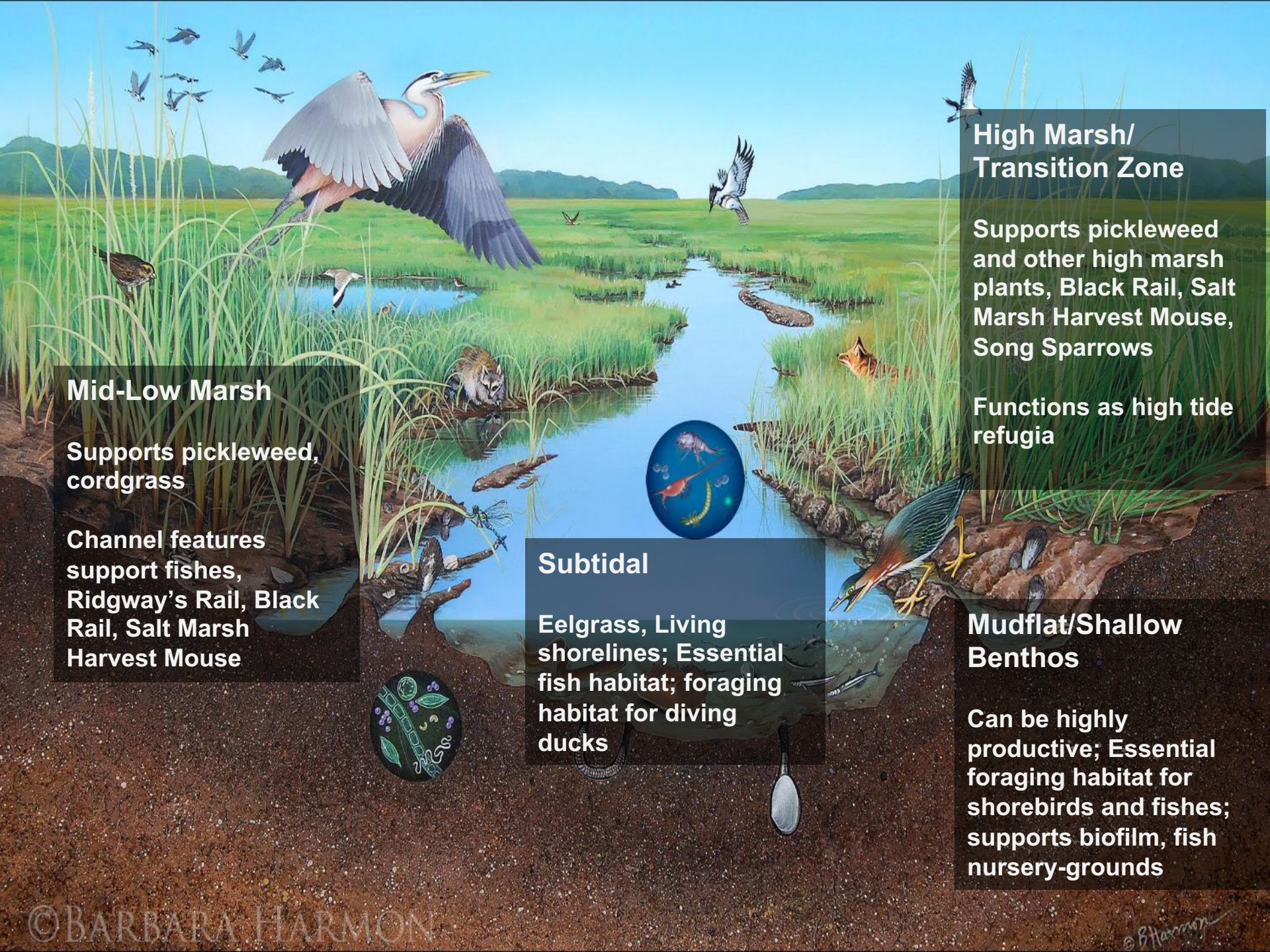
High Marsh/
Transition Zone
Supports pickleweed and other high marsh plants, Black Rail, Salt Marsh Harvest Mouse, Song Sparrows
Functions as high tide refugia
Mid-Low Marsh
Supports pickleweed, cordgrass
Channel features support fishes, Ridgway's Rail, Black Rail, Salt Marsh Harvest Mouse
Subtidal
Eelgrass, Living shorelines; Essential fish habitat; foraging habitat for diving ducks
Mudflat/Shallow Benthos
Can be highly productive; Essential foraging habitat for shorebirds and fishes; supports biofilm, fish nursery-grounds
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# SFBE Supports a Myriad of Wildlife

- SFBE supports >500 spp of fish, amphibians, reptiles, birds, and mammals, and ~500 spp of invertebrates (Goals Project 2000)
- 147 species of birds use tidal wetland habitat (upland transition, tidal marsh, channels, mudflats, ponds; Takekawa et al. 2011)
- **Tidal Marsh** endemics: Endangered Salt Marsh Harvest Mouse, Ridgway's Rail, etc. (Tidal Marsh Recovery Plan 2013)
- **Intertidal Mudflats** dependent wildlife: Mudflats are essential foraging habitat for shorebirds, and demersal fishes, yet are understudied in this region
  - Site of Hemispheric Importance (WHSRN) > 1/2 million shorebirds
  - Worldwide loss of intertidal flats associated with declining shorebird populations (Zöckler et al. 2003, Boere and Piersma 2012, Iwamura et al. 2013)
- **Subtidal:** Essential Fish Habitat (Magnuson-Stevens Act 1996), Subtidal aquatic vegetation (Subtidal Goals Project 2010)

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# Benthic invertebrates prey resources for fishes

- Demersal fishes also forage in mudflat habitats, functional foraging perspective (De La Cruz, in prep)

| | | | Prey Size Class (mm) | | | | | Mean Prey Biomass (mg/m2) | |
|---|---|---|---|---|---|---|---|---|---|
| Foraging Depth in Sediment | Fish Species | Life Stage | 0-4 | 4-12 | 12-24 | 24-50 | 50-100 | Dredged | Undgredged |
| Shallow 0-4 cm | Pacific Sardine | Juvenile | x | | | | | 168.71 | 299.23 |
| | | Adult | x | x | x | | | 1475.03 | 2272.84 |
| | Longfin Smelt | Juvenile | x | | | | | 168.71 | 299.23 |
| | | Adult | x | x | x | | | 1475.03 | 2272.84 |
| | Northern Anchovy | Juvenile | x | | | | | 168.71 | 38001.58 |
| | | Adult | x | x | x | x | x | 1664.76 | 2707.56 |
| | English Sole | Juvenile | x | x | | | | 329.72 | 667.81 |
| | | Adult | x | x | x | x | | 1664.76 | 2707.56 |
| | Starry Flounder | Juvenile | x | x | | | | 329.72 | 667.81 |
| | | Adult | x | x | x | x | x | 1664.76 | 2707.56 |
| | Brown Rockfish | Juvenile* | x | | | | | 168.71 | 299.23 |
| | | Adult | x | x | x | x | x | 1664.76 | 2707.56 |
| | California Halibut | Juvenile | x | x | x | x | | 1664.76 | 2707.56 |
| | | Adult | x | x | x | x | x | 1664.76 | 2707.56 |
| Deep 0-10 cm | Dungeness Crab | Juvenile | x | x | x | x | x | 1853.12 | 3156.87 |
| | | Adult | x | x | x | x | x | 1853.12 | 3156.87 |
| | Big Skate | Juvenile | x | x | x | x | x | 1853.12 | 3156.87 |
| | | Adult | x | x | x | x | x | 1853.12 | 3156.87 |
| | Green Sturgeon | Juvenile | x | x | x | x | x | 1853.12 | 3156.87 |
| | | Adult | x | x | x | x | x | 1853.12 | 3156.87 |
| | White Sturgeon | Juvenile | x | x | x | x | x | 1853.12 | 3156.87 |
| | | Adult | x | x | x | x | x | 1853.12 | 3156.87 |
| | Leopard Shark | Juvenile | x | x | x | x | x | 1853.12 | 3156.87 |
| | | Adult | x | x | x | x | x | 1853.12 | 3156.87 |

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# Tidal Marsh Ecosystems are Vulnerable to Climate Change

1. How will populations of plants and animals in bayland habitats be affected by climate change? Baylands Ecosystem Habitat Goals Science Update 2016
2. Which management actions can be most effective in keeping populations healthy and/or restoring population health, given anticipated climate change impacts? Baylands Ecosystem Habitat Goals Science Update 2016
   - Requires best available science from #1
   - Pilot projects, flexibility

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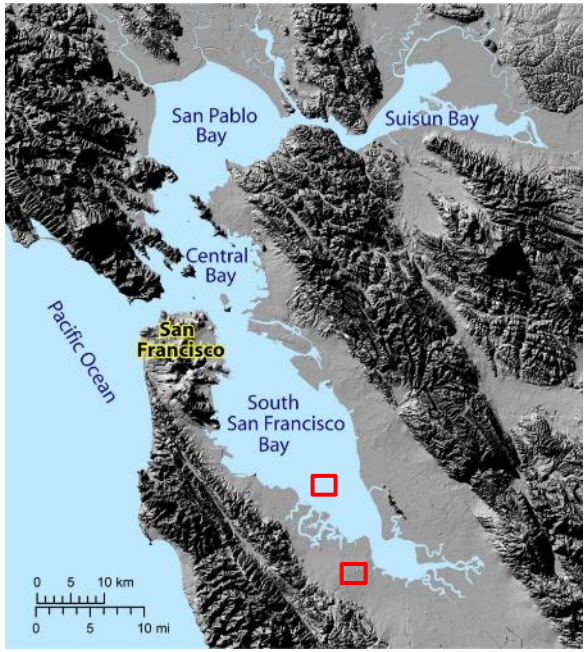
# How will wildlife be impacted by SLR?

1. How will SLR impact the tidal marsh-mudflat-subtidal continuum?
2. And how will changes in inundation impact access to habitat?
3. How will changes in inundation impact prey resources for foraging shorebirds and other wildlife?

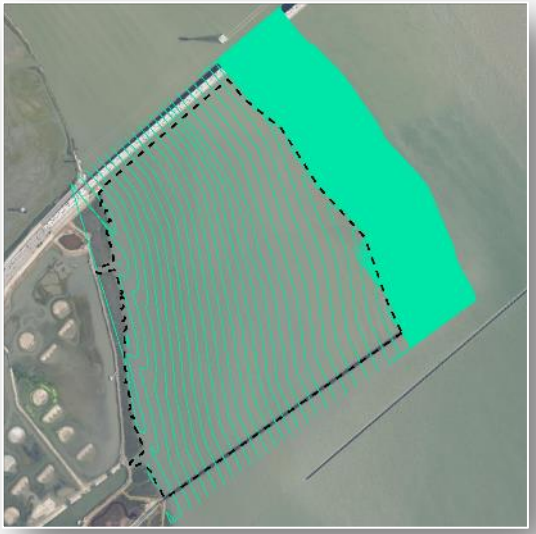



# Modeling Mudflat Surface

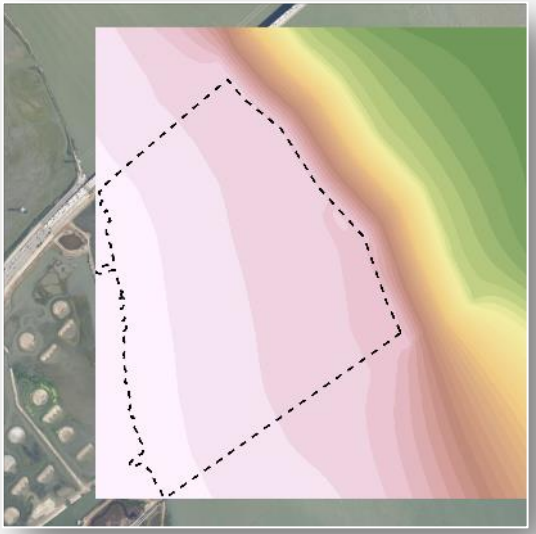
- Obtained elevations for points on 5 transects at each site from USGS topobathy (Foxgrover and Jaffe 2005)
- Modeled yearly elevations for all point on each transect using 1-D model (van der Wegen et al. 2017) under scenario of 167 cm SLR by 2100
- Used model results to generate surface profiles for 2005, 2030, 2050, and 2100 using steps below

1. Modeled transects 1D Delft 3D

2. Generate surface contours from TIN



3. Generate surface from contours

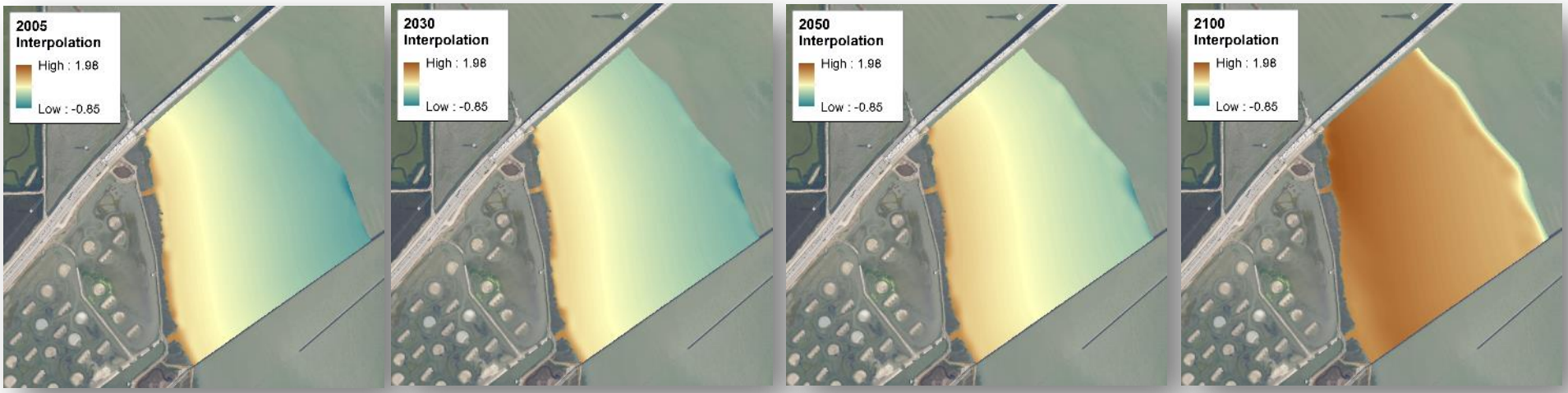


UNESCO-IHE Institute for Water Education

UNESCO-IHE, Institute for Water Education, Delft, The Netherlands and USGS Partnership

# Dumbarton

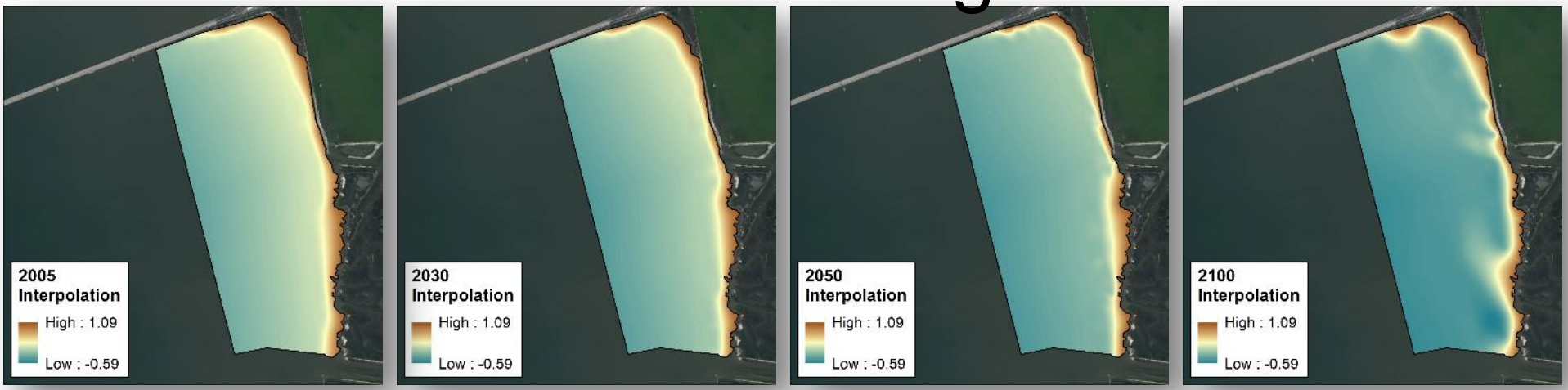
Surface Elevations




De La Cruz et al. in prep

# Eden Landing

Surface Elevations



# How do changes in mudflat geomorphology and thus inundation impact habitat availability for foraging shorebirds?

**Topography/ bathymetry**

↓

**Water Levels**

↓

**Foraging depths**

- Based on range of water depths used by foraging guilds (Isola et al. 2000)
  - Small shorebirds 0 – 5 cm
  - Large shorebirds 0 – 10 cm

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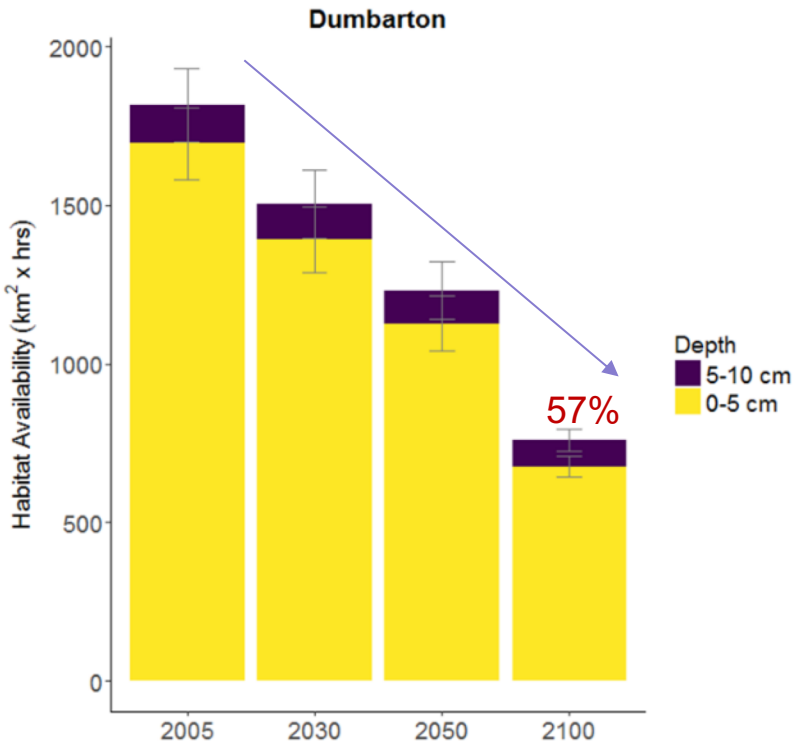
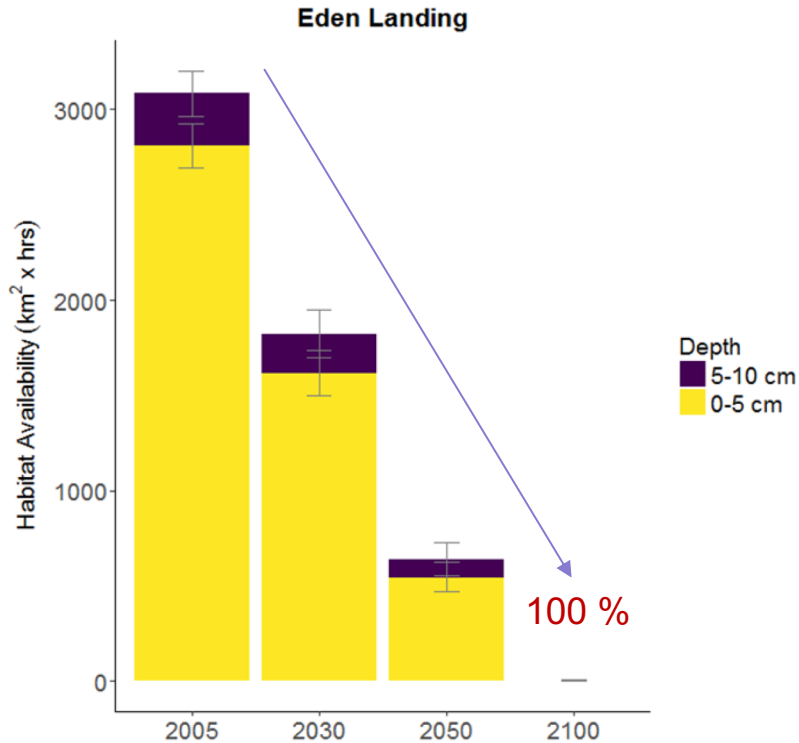
# Foraging Habitat Availability for small shorebirds




* Habitat availability expressed in millions of hours/year

Error bars represent the range of habitat availability if the entire interpolated surface was 1 RMSE higher or 1 RMSE lower

De La Cruz et al. in prep

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# How do invertebrate prey resources change with changes in inundation?

Input Data: Benthic invertebrates collected at Dumbarton site

- 3 transects, 9 locations along elevation gradient
- Monthly sampling Oct 2008 – Apr 2011
- Community composition, density, biomass (AFDW)

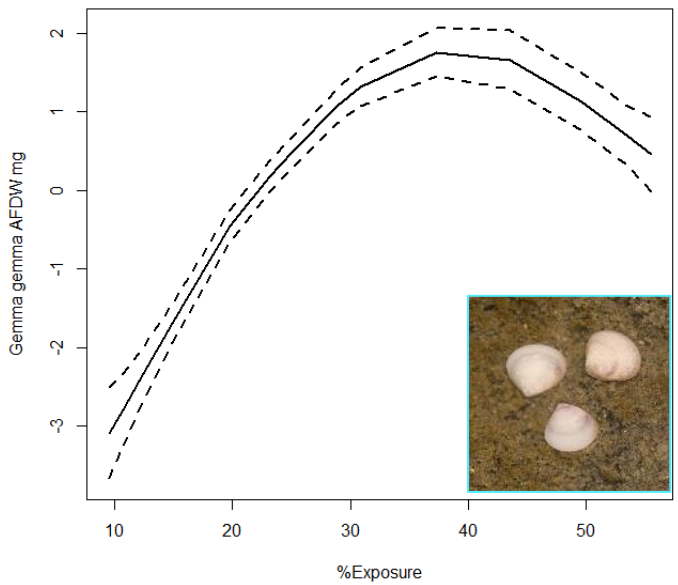
Modeling:

- Invert biomass as a function of % exposure (integrates elevation and SL)
- Generalized Additive Models (GAMs)
  - % exposure was modeled as a cubic spline
  - Transect, month included as fixed effects to account for spatial and temporal variation
- Used GAM results to generate biomass under SLR scenarios

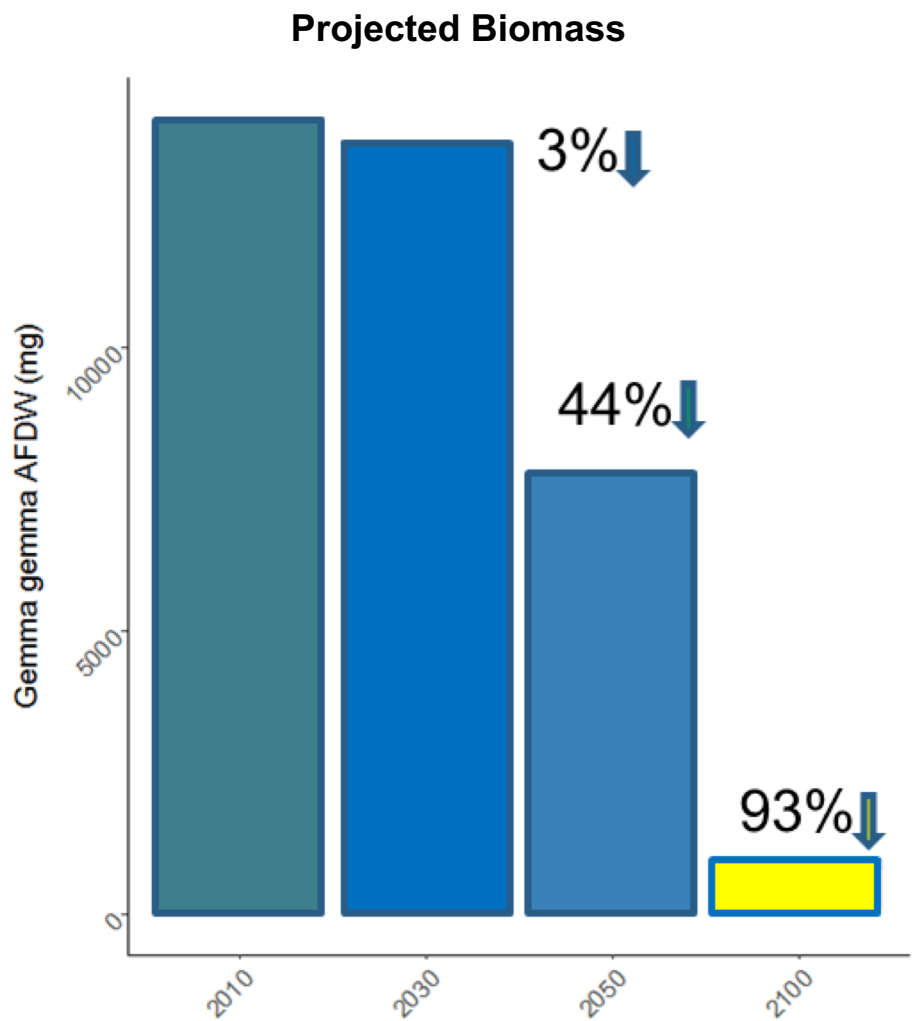
Flanagan et al. in review

# Bivalve Biomass Projections: *Gemma gemma*

- Highly abundant – density at Dumbarton site > 7000 ind/m2




Biomass peak when mudflat exposed 40% of the time




De La Cruz et al. in prep

# Summary and Implications

- Extensive loss of foraging habitat and key bivalve prey by 2100 indicates that carrying capacity for shorebirds may be greatly reduced

- Mudflat shape and slope are important factors in determining the rate and magnitude of habitat loss as sea level rises
  - How will other South Bay mudflats respond?

- Foraging habitat potentially could be recovered by
  - allowing landward migration through levee replacement
  - maintaining supratidal and intertidal foraging areas in managed ponds
  - Sediment augmentation

# Sediment Augmentation Questions

- 10-acre thin layer pilot project at Seal Beach 2016 (Seal Beach NWR, 2018 report)
  - ~10” sediment applied, more sandy than expected
  - Vegetation (native cordgrass) continues to re-establish, though slower than expected
  - Benthic invertebrate (abundance, diversity) declined and slowly increasing. Has not yet reached pre-augmentation levels
  - Shorebirds observed in abundance
  - Eelgrass declined and is recovering

- Benthic invertebrate “recovery” is not well defined in the literature (abundance) and few studies provide information relevant to foraging functions (biomass, size class)
- Closer linkage of wildlife response to physical changes
- Recommend Functional foraging assessments of “recovery”
  - Accessibility, biomass, and energetics

# Thank you!

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