Evaluating the Effects of Projected Sea-level Rise on Tidal Marsh Habitats Along the Pacific Coast; an Interdisciplinary Approach

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Background

- The 2007 Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report designated coastal areas as high risk zones from climate change impacts, in particular sea-level rise and storms.
- The 2007 IPPC global average sea-level rise (SLR) projections range between 18 – 60 cm for 1990 to 2100. More recent projections range from 1.3 m to 1.9 m (Grinsted *et al.* 2009, Vermeer and Rahmstorf 2009).
- Climate change and sea-level rise, coupled with habitat loss and urbanization, are the greatest threats to salt marsh biodiversity. However, downscaled global or regional models are difficult to use for local adaptation planning

Program Objectives

- Investigate how sea-level rise and changes in storm frequency and intensity alters salt marsh habitats and wildlife populations along the Pacific coast with a bottom-up approach.
- Improve decision-making tools for coastal land managers and stakeholders by providing parcel-specific information.
- Incorporate tidal cycles, local weather, sediment availability, and habitat response into modeling approach.

Main Findings

- Variation in elevations relative to tides at marshes along coastal gradient indicate differential risk to SLR at a landscape scale (fig. 3).
- Increase in tidal range and inundation frequency due to storm events of a salt marsh may present a greater short-term risk to wildlife and their habitats than mean sea-level rise.
- Projections from the WARMER accretion models indicate a conversion from salt marsh to mudflat by 2080 at San Pablo Bay NWR (fig. 3). At 12 sites around San Francisco Bay, WARMER projects > 95% of the marsh area is *unlikely* to keep pace with SLR to 2100 (Takekawa *et al.* in prep).

Elevation surveys conducted using a RTK GPS

Vegetation was surveyed with 0.25 m^2 quadrats

Data loggers monitored tidal cycles to develop tidal datums and was used to monitor storms

Wildlife responses are considered in sea level rise habitat response models (California black rail)

Bottom-Up Conceptual Model

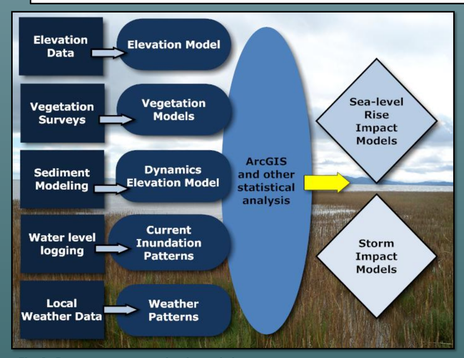

Fig 1. Program conceptual model

We collected detailed parcel-specific data (fig. 1). This is incorporated into bottom-up ecological climate change impact models for salt marshes along the Pacific coast (fig. 2).

Model inputs include:
-High resolution elevation data collected with RTK GPS (+/- 2.5 cm)
-Bathymetric data (fig. 5)
-Vegetation surveys
- Local accretion rates (WARMER model, fig. 4)
-Tidal inundation patterns
-Local weather data

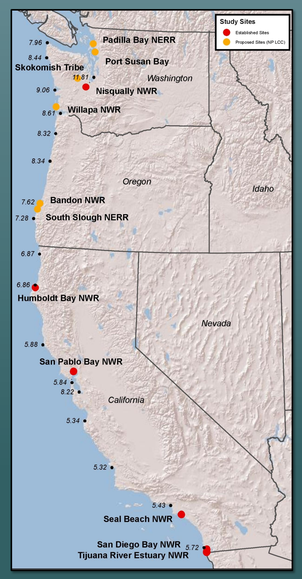

Fig 2. Location of field sites along the west coast with mean tidal range in feet (NOAA tides and currents). Establishing study sites along the tidal range gradient will allow us to compare salt marsh risk to sea-level rise against an important variable in marsh accretion processes.

Elevation Models

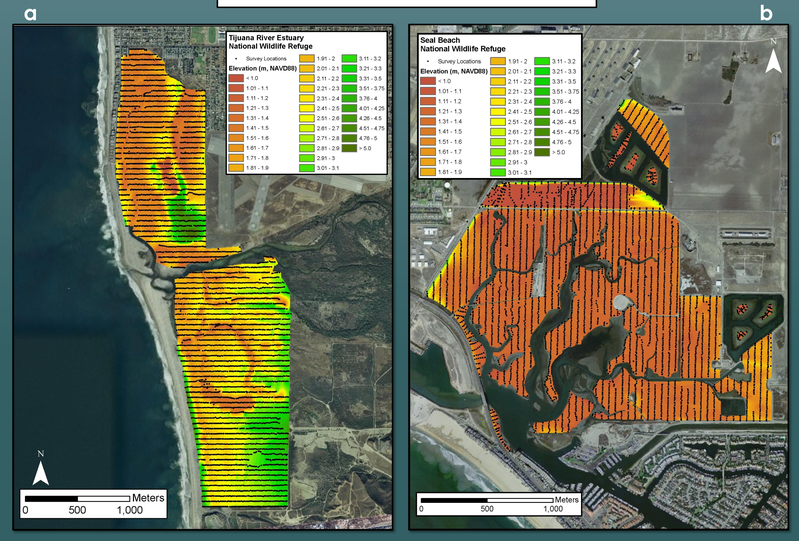

Fig 3. Elevation models created with Kriging interpolation in ArcGIS at (a) Tijuana River Estuary National Wildlife Refuge with 5853 RTK GPS survey points to develop the model and (b) Seal Beach National Wildlife Refuge with 4757 survey locations to develop the model. At each site, vegetation was surveyed concurrently and will be incorporated into SLR projections. Water loggers are deployed at each site; after one year of data collection site specific tidal datums will be determined.

Sea-Level Rise Model

Fig 4. Results from a sea-level rise model (WARMER) for a portion of San Pablo Bay National Wildlife Refuge in San Francisco Bay, CA. WARMER is a 1-D model for marsh processes and considers organic and inorganic matter input, compaction, and decay in projections of relative sea-level (Takekawa *et al.* in prep).

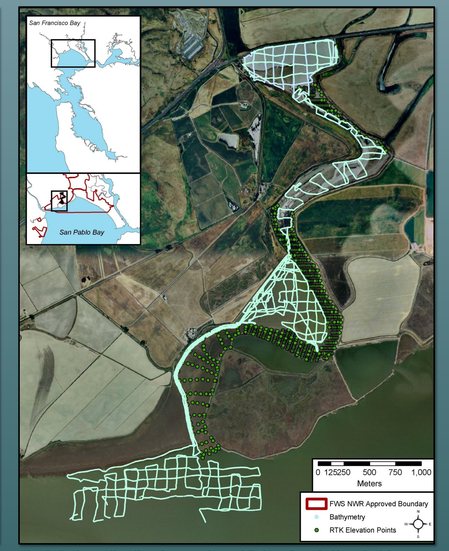

Fig 5. Data collection is ongoing at Tolay Creek (San Pablo Bay NWR). RTK elevation points, bathymetry, and LiDAR of the surrounding uplands will be synthesized into a continuous elevation model for SLR modeling (WARMER).

Next Steps

- Field surveys at Humboldt Bay NWR are planned for April 2012
- Develop sea-level rise models for remaining coastal refuges
- Continue collaboration with land managers to identify data gaps for developing habitat and wildlife risk assessments to SLR and storms
- Currently applying for LCC funds to examine the response of wildlife populations to rising sea levels and storm events

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