USGS science for a changing world

USGS Western Ecological Research Center

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Climate change and sea-level rise modeling to assess impacts to marsh wildlife

Tidal extremes and tidal prism changes

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Program Summary:

Data was collected at 13 salt marshes around the San Francisco Estuary. Site specific information is used to understand daily tidal inundation patterns and flooding from storms at the local level. Using detailed elevation models with data collected from ground surveys using RTK GPS units, comprehensive vegetation surveys, and tidal inundation patterns; with local weather data we are able to understand current inundation patterns over tidal cycles, seasonal differences in inundation and storm event flooding. All elevation data is converted into tidal datum using water logging data for analysis. Work has recently been expanded to the San Diego and Humboldt estuary.

Conceptual Model

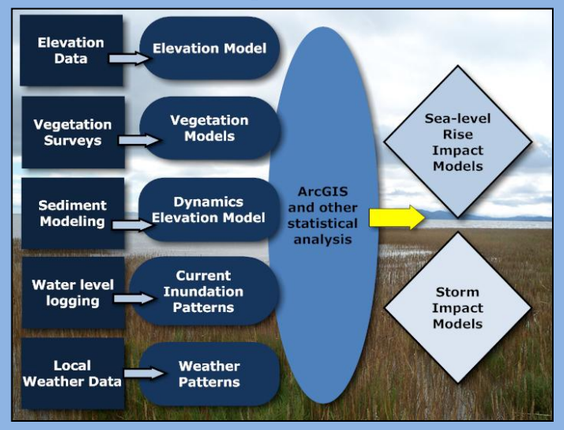

Fig. 1 Tidal and storm inundation model inputs include: elevation and vegetation data, water level monitoring and local weather data.

- We believe that mean sea-level rise scenarios do not always evaluate the risk to wildlife species completely, that tidal cycles and storm events need to be incorporated into monitoring and climate change impact models (fig 2).
- Increase in tidal range flooding and inundation frequency of a marsh presents a greater risk to wildlife and their habitats than just evaluating mean sea-level rise (fig 2 & 3).
- Marsh inundation during high tides and storm episodes present elevated periods of predation and drowning risk during the winter and nest failure during the summer (fig 4 & 5).
- Location and tidal range of salt marsh matters-- vulnerability differs because of variation in current and future inundation frequency with sea-level rise (fig 3).

Incorporating tidal cycles into sea-level rise modeling to assess vulnerability of wildlife

Many salt marsh wildlife species rely on the marsh vegetation for cover, feeding, and breeding sites. When this vegetated habitat is not available they are at risk of drowning and predation events. To assess future risk to endangered wildlife populations, incorporating the tidal cycle into sea-level rise modeling is important to identify critical tidal depths and times of the year.

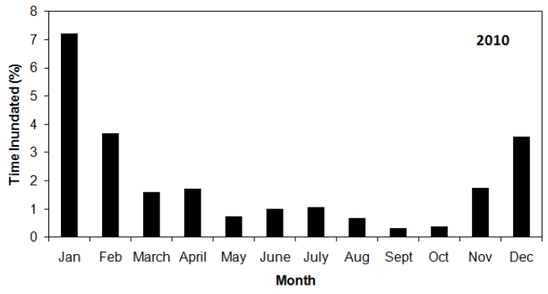

Fig. 2 Using water level monitoring and an elevation model we are able to record the percentage of time the marsh surface of San Pablo Bay NWR was inundated in 2010 (*Thorne et al. in prep*). This is valuable baseline data that can be used to identify vulnerability and future change from sea-level rise.

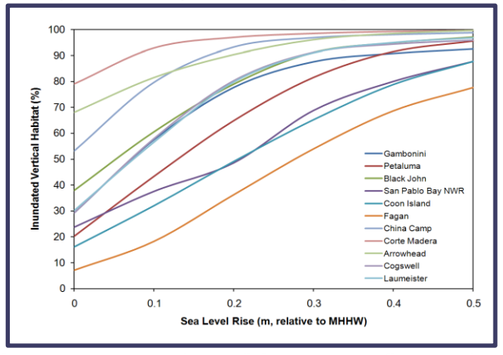

Fig 3. This illustrates a comparison of the percent of vegetative structure inundated with sea-level rise for marsh parcels in. Vertical structure is used as a indicator for available habitat*(Takekawa et al. In prep*).

Modeling storm impacts on marsh habitats

Storms may pose the most significant impact on many marsh wildlife populations over the short-term under climate change projections. By developing baseline models for sites we are able to monitor water depth and duration on the marsh surface during storm episodes and evaluate impacts to wildlife populations.

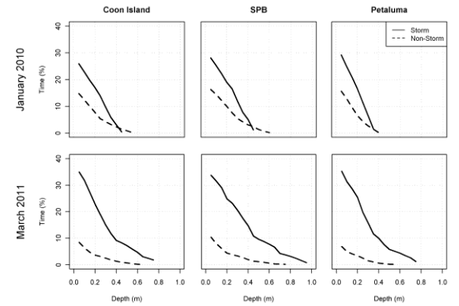

Fig 4. During two storm events in 2010 and 2011 the percentage of time the marshes were inundated was greater then during non-storm days in the same months. This has implications for both vegetation and wildlife over the short and long-term. (*Thorne et al. submitted*)

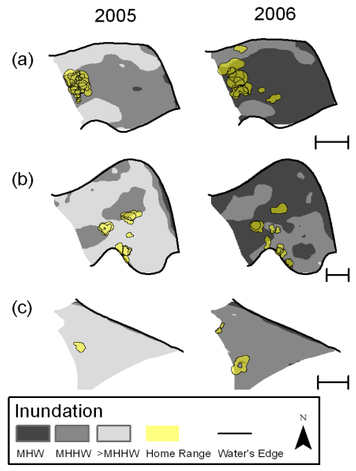

Fig 5. Using elevation models and water level monitoring we were able to assess the impact to black rail breeding home ranges during a 2006 storm event at three salt marshes on the Petaluma River. The increase in water inundation during 2006 flooded nesting habitat and home ranges (*Spragens et al. in prep*). It is important to monitor the frequency, intensity and impacts from storm events that may increase in the future from climate change.