Effects of regional wetland restoration on shoals of the South San Francisco Bay: migratory bird ecology, food webs, sediment supply, and mercury contamination

Principal Investigators: John Y. Takekawa, Josh T. Ackerman (Western Ecological Research Center); David H. Schoellhamer (California Water Science Center); Bruce E. Jaffe (Pacific Science Center)

Introduction

The ongoing restoration of salt ponds in the South Bay Salt Pond Restoration Project, the largest tidal marsh restoration on the Pacific coast, will increase sediment demand to the ponds, but the effect of that change on the adjacent shoals and sloughs is unknown. The shoals are very sensitive habitats that drive regional primary productivity and are used as the principal foraging resource by over a million migratory birds. If sediment supply is insufficient, erosion of existing mud flat habitats may result in changes in food webs, reducing their value for migratory birds. Based on previous studies, we expect that sediment will deposit on mud flats during the wet season when supply from the watershed is the greatest, and mud flats will erode during the dry season, mostly due to wind-wave resuspension. In the lower South Bay, the relative contribution of sediment coming from the watershed or from San Francisco Bay through the Dumbarton Narrows is unknown. Additionally, legacy mercury contamination from historic mining operations, currently resides in sediments of ponds, sloughs, and tidal mud flats throughout the region. Thus, there is concern that wetland restoration actions that mobilize sediments may also increase the availability of mercury and increase contamination in fish and waterbirds above current levels that already exceed toxicity thresholds. Sediment supply, the response of migratory birds, and the remobilization and bioaccumulation of mercury contaminated sediments are key uncertainties identified for the South Bay Salt Pond Restoration Project. Phase I restoration projects will include restoring Ponds SF2 to a shallow water pond, A6 to full tidal flow, and A8 to muted tidal flow in FY2010-FY2011. Our studies are focused on these ponds as well as the adjacent shoals and sloughs to collect baseline information and post-restoration data. These studies will directly address the largest uncertainties facing the restoration program.

We propose to test the following hypotheses in this multi-year study:

- Mud flats accrete due to sediment supply from the watershed
- Mud flats accrete due to sediment supply from South San Francisco Bay
- Mud flats erode due to wind-wave resuspension
- Shallows and channels accrete and erode in phase with the mud flats
- Sediment grain size changes seasonally in response to supply and wind-wave energy
- Primary productivity and food resources respond to accretion or erosion of the shoals
- Seasonal changes in shoals result in changes in macroinvertebrates and their consumption by migratory birds
- Migratory bird populations depend on mud flat food resources for foraging, and availability of those resources varies with elevation, inundation, and slope
- Remobilization of mercury-laden sediments and changes in water management will reduce mercury bioaccumulation in restored ponds and increase mercury bioaccumulation in nearby tidal shoals and sloughs.

Approach

This interdisciplinary study will be led by 3 USGS centers in the Western Region including the California Water Science Center (CWSC), Marine and Coastal Geology Pacific Science Center (PSC), and Biological Resources Western Ecological Research Center (WERC).

- Measure sediment supply from Coyote Creek so that sediment supply in all major lower South Bay tributaries is gaged.
- Measure sediment flux at the Dumbarton Bridge to measure sediment supply to lower (or loss) South Bay from the rest of South San Francisco Bay
- Continuously measure wind waves, sediment concentration, bed elevation, salinity, and temperature on a mudflat
- Use land-based LIDAR to measure the morphology of selected mud flats to quantify seasonal and interannual variations
- Perform bathymetric surveys of shallows and channels adjacent to selected mud flats to quantify seasonal and interannual variations
- Measure seasonal variability of sediment grain size on mud flats and adjacent shallows and channels
- Conduct bird surveys and behavior observations on selected shoals with known elevations
- Determine presence and abundance of migratory bird and fish food resources with changes in shoal characteristics.
- Examine avian consumption and carrying capacity on mud flats with energetic modeling and exclosure experiments.
- Measure mercury bioaccumulation in resident fish and waterbirds in mud flat, slough, and restored salt pond habitats to determine effect of restoration on mercury contamination.

In FY2010, we will initiate tasks including to:

- Augment studies initiated on the Dumbarton shoals adjacent to SF2 with studies on the Alviso shoals adjacent to A6 and the sloughs downstream from Pond A8. Ponds SF2, A6, and A8 are proposed to be restored in FY2010-FY2011.
- Continue measurement of sediment supply from Coyote Creek
- Continue regular visits to maintain the sediment flux measurement station at the Dumbarton Bridge
- Continuously measure wind waves, sediment concentration, salinity, and temperature on both Dumbarton and Alviso shoals
- Conduct 3-4 surveys of the Dumbarton and Alviso mud flats with land-based LIDAR
- Conduct 3-4 surveys of the Dumbarton and Alviso mud flats with a side-scan interferometer (R/V Snavely)
- Bathymetric surveys of Alviso Slough, which connects Pond A8 to mudflats.
- Collect sediment composition samples of mud flats, shallows, and channels
- Conduct bird surveys and behavior observations
- Conduct monthly sampling of invertebrate resources and estimate biomass of biofilm
- Initiate carrying capacity modeling, movement studies, and exclosure approaches
- Sample benthic, sediment-dwelling biosentinel fish in shoals, sloughs, and restored salt pond habitats and determine mercury concentrations before and after restoration, and in relation to toxicity thresholds.
- Sample waterbirds and determine their mercury concentrations in relation to restoration actions and known toxicity thresholds.
- Publish initial papers and make presentations at scientific conferences.

Budgets:

Takekawa FY2010 Biology, Western Ecological Research Center budget:
TOTAL for Takekawa WERC: $221K

Ackerman and Eagles-Smith FY2010 Biology, Western Ecological Research Center budget:
TOTAL for Ackerman and Eagles-Smith WERC: $219K

Schoellhamer FY2010 Hydrology, California Water Science Center budget:
CAWSC TOTAL: $359k

Jaffe FY2010 Coastal and Marine Geology, Pacific Science Center budget:
TOTAL for Jaffe PSC: $201K