Adapting to Rising Tides

Natural Shorelines Vulnerability and Risk Profile

There is a variety of natural, wetland shorelines in the ART project area, ranging from tidal marsh that is fully exposed to the bay (e.g., Emeryville Crescent); to those that transition from mudflat, to tidal marsh, to managed marsh (e.g., the confluence of San Lorenzo Creek and the Bay); and those that are a complex of tidal marsh, managed marsh and managed pond (e.g., within the Hayward Regional Shoreline). These natural wetland shorelines are generally managed to preserve or restore ecosystem service benefits such as flood risk reduction, water quality improvement, habitat for target species, and carbon sequestration.

The vulnerability and risk of twelve tidal and five managed marshes in the ART project areas was evaluated in collaboration with PRBO Conservation Science using their online decision support tool (www.prbo.org/sfbayslr). This approach was taken because wetlands are dynamic nearshore systems, and their response to changes in mean sea level rise will depend on a number of physical and biological factors including the rate of sea level rise, their current elevation relative to the tidal frame, mineral sediment availability either from the Bay or nearby tributaries, and the rate of organic matter accumulation.

Key Issues

Historically, tidal marshes in the Bay have kept pace with sea level rise by accumulating mineral sediment; however, the rate of sea level rise is accelerating and the concentration of suspended sediment in the Bay is declining. Furthermore, many tidal marshes around the Bay are restricted by inland barriers that limit opportunities for landward migration. Tidal marshes in the ART project area are vulnerable to sea level rise and may not be able to keep pace. Model projections indicate that while there will be a significant down-shifting of habitat at mid-century, e.g., from mid to low marsh, by the end-of-century many of the tidal marshes will convert to mudflat or subtidal habitat without significant intervention and management to promote marsh accretion. In addition, there are limited opportunities for landward migration of tidal marshes in the southern part of the ART project area and very few in the northern portion. Managed marsh systems are particularly sensitive to sea level rise because many of the levees and berms that protect them from wave and tidal action are already in need of repair, and higher water levels could overtop and erode these structures further. In addition, managed marshes tend to be at lower starting elevations than fully tidal marshes due to subsidence, and typically do not support the vegetation found in fully tidal marshes. These challenges will only be compounded by rising sea levels and declining sediment supplies.

Vulnerabilities

Timing

- By mid-century marsh habitat will downshift, e.g., from mid to low marsh.
- By end-of-century marshes will convert to mudflat.

Consequences

Scale

- Site to international, depending on the ecosystem service benefits lost.

People

- The complete or partial loss of tidal or managed marsh systems will increase the reliance on structural shoreline protection, and will place shoreline residents at a greater risk of flooding.
- Tidal and managed marshes offer opportunities to view wildlife, provide access to the Bay shoreline, and offer scenic and aesthetic benefits that other areas cannot. The loss of these functions will have consequences for the people that use these areas for outdoor enjoyment or recreation, and will ultimately diminish the value of the Bay Area as a desirable place to live.

Vulnerabilities

Physical and Functional Qualities

- Tidal marshes will struggle to maintain elevation relative to the tidal frame solely through vertical accretion, especially in light of the Bay's declining suspended sediment supply.
- Marshes are vulnerable to "coastal squeeze" since migration opportunities are limited by adjacent development and by uplands that are not at an appropriate elevation to support future marsh habitat.
- Inland barriers and shoreline land uses limit opportunities for marsh migration landward, particularly in the northern portion of the ART project area.
- Some tidal marshes are already "squeezed" against adjacent land uses, with inundation at high tide displacing birds and wildlife. More frequent or permanent inundation due to sea level rise will exacerbate this situation, forcing birds and wildlife to forage and nest closer to people and infrastructure such as roads and highways.
- Tide control structures or gates used to maintain managed marsh water surface elevation are sensitive to higher Bay water levels, and may become difficult to operate or maintain if the frequency or intensity of storms increases.
- Managed systems that are restored to full tidal action will be vulnerable to sea level rise and storm events given that they are at fairly low starting elevations and vegetation will be sensitive to changes in tidal regime or high-energy storm events during the colonization phase.

Management Control

- Development and implementation of restoration or enhancement actions for larger projects requires coordination of multiple agencies to prioritize, plan, fund, implement, monitor and manage the actions.
- Managed marshes can have complex operations, require additional management, and have permit compliance requirements (e.g., at the Hayward Marsh). There is limited capacity to simply, easily or in a low cost manner change the operations or management of the levees, berms and water control structures protecting managed marshes to accommodate sea level rise or storm events.
- Many marshes are protected by levees or berms that are already in need of repair; however improving these structures requires the action of multiple agencies to obtain environmental reviews, permits and financing.

Consequences

Economy

- Many of the tidal marshes in the ART project area have been restored, representing a significant financial investment. There will be direct economic consequences if sea level rise increased the cost of restoration, including the cost to maintain or improve restoration projects.
- There are multiple utilities that transect tidal and managed marshes in the ART project area, including power, wastewater and gas pipelines (some which are abandoned). There will be direct costs in repairing or relocating utilities that are currently located within natural, wetland shorelines.
- Tidal marshes and mudflats protect shoreline structures from wind waves and tidal energy, the loss of marsh and mudflat wave attenuation benefits will increase the cost of maintaining, repairing and upgrading these already expensive assets.

Ecosystem Services

- Downshifts and loss of marsh habitat would be significant for a number of species of conservation concern, including state-listed or federally threatened and endangered species such as Clapper Rail, Black Rail and Salt Marsh Harvest Mouse, which rely on tidal marsh for breeding, foraging, and high tide refugia.
- Loss of tidal marsh and tidal flat habitat in the Bay will affect the success of migrating and wintering bird, which could be significant as the Bay is on the Pacific Flyway, a major north-south travel route for migratory birds extending from Alaska to Patagonia.
- Loss of tidal marsh will decreases the potential for carbon sequestration (greenhouse gas mitigation) and water quality improvement.
- Changes in marsh habitat will affect the flood risk management benefits they provide by attenuating the energy of incoming waves. This may resulting in the overtopping of shoreline protection or catastrophic levee failures, placing shoreline communities at greater risk of flooding.