San Francisco Bay Living Shorelines: Near-shore Linkages Project
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April 2015 Key messages, Lessons Learned and Next Steps

Key Messages for the project include:

- Oyster and eelgrass habitats are important features of the San Francisco Bay ecosystem and provide critical habitat for a wide variety of fish, invertebrates, and wildlife.

- Constructed Living Shorelines with oyster and eelgrass reefs are providing valuable benefits, including increased ecosystem functions (such as nesting, breeding, food resources) and increased ecosystem services (such as wave attenuation, sediment accretion, shoreline protection).

As referenced in the recently released report "Living Shorelines: From Barriers to Opportunities" by Restore America's Estuaries, these recommendations also hold apply to San Francisco Bay. Please see full report at https://www.estuaries.org/first-national-report-on-living-shorelines-institutional-barriers-released

- There is a regional need to develop a broad and common understanding of the efficacy, impacts, and benefits of living shorelines as well as hardened structures. Collecting reliable information, making it generally available, and providing education and training to the various constituencies affected by shoreline management decisions is necessary to overcoming each of the identified barriers and promoting the wider use of living shorelines.

- To successfully implement comprehensive regulatory reform and wider use of living shorelines, the capacity of the major constituencies must be improved and expanded. The current availability of designers, engineers, builders, and regulators sufficiently knowledgeable of living shoreline techniques is not adequate and must be increased, primarily through specialized training.

Lessons Learned and Future Design Criteria:

To date, our project team is able to draw the following conclusions toward future designs:

- This project and several others (Boyer, unpublished data) suggest that eelgrass should be restored early in the growing season; we did not have success in establishing eelgrass at either site in late July and early August 2012. Our second planting in April and early May 2013 led to successful establishment at both sites (although the Hayward site ultimately failed to support eelgrass by fall/winter 2013).

- We can eliminate two of the baycrete element designs: layer cakes and small reef ball stacks. Neither stand up well over time, and layer cakes have fewer oysters compared with other configurations.

- Key stressors for oysters vary with location within San Francisco Bay. Shell bags potentially offer protection from heat and desiccation stress and provide a lot of complex surface area for oysters and other organisms to attach to and live in, but surfaces that are at higher tidal elevations and more stressful in terms of exposure may provide oysters with some measure of protection from marine predators and non-native fouling species.

- Additional protection from oyster predators and cover of fouling species might be gained by encouraging larger mobile predators (such as crabs) and mesograzers to settle on restoration substrates. Future designs might include developing substrate types and/or configurations that attract large crabs and fish.

- We tentatively suggest that restoration projects incorporating both oyster reef and eelgrass together should be considered; although neither species appears to be benefiting from the other so far, the preliminary evidence that differences in the two habitats lead to distinct invertebrate and fish communities suggests that their co-location will maximize habitat value.

- Oyster reef designs should consider the fact that the lower portion of substrates will experience sediment burial. Future designs could be elevated on materials that are less difficult to source than bags of clean Pacific oyster half shells, which will be less available in the future.

- Wave energy reduction measured in our San Rafael project is encouraging, but we recommend many additional sites should be used for similar projects and measurements in order to determine optimal design and the need for site-specific differences in reef configuration.

Future work:

In January 2015, the Coastal Conservancy successfully secured a new grant through the USFWS North American Wetland Conservation Act, to build upon the information and lessons learned from this project and construct an additional set of Living Shoreline reefs at an additional site in San Francisco Bay. This "Phase Two" effort titled the San Francisco Bay Multi-Habitat Enhancement Project will include additional tidal marsh habitat (Pacific cordgrass, marsh gumplant), linking a more diverse set of habitat types up the slope that can have cumulative benefits with further integration of habitat linkages and increased wave attenuation potential.

Our approach is to actively enhance four native foundation species: Pacific cordgrass (*Spartina foliosa*), marsh gumplant (*Grindelia stricta*), native Olympia oysters (*Ostrea lurida)*, and native eelgrass (*Zostera marina*). Pacific cordgrass, which provides critical habitat cover and food resources in the lower tidal marsh zone, was recently locally extirpated and replaced by introduced non-native cordgrass. After several years of aggressive, coordinated control, the introduced cordgrass is now nearly 96% eradicated from most of the Bay (see www.spartina.org for 2014 ISP Treatment and Monitoring Report). Marsh gumplant is an important native shrub that occurs along channels in tidal marshes and provides food resources and vertical cover and habitat refugia for multiple species at high tides.

The Coastal Conservancy's current San Francisco Bay Living Shorelines Project was constructed in 2012, and to date over two million oysters have settled on reef structures and this habitat has

provided substantial food and nesting resources, increased wave attenuation rates by 30-50%, and resulted in increased use by invertebrate, fish, and bird populations that are utilizing the reefs.

These four foundation species are critical components of estuarine intertidal emergent wetlands, estuarine intertidal reefs, and estuarine subtidal aquatic beds, and thoughtful linkages through restoration can increase cumulative habitat and shoreline protection values in the face of an estimated 5’ of sea level rise over the next century and other climate changes. All four species have the potential to provide needed ecosystem services and functions in San Francisco Bay, including sedimentation stabilization, wave attenuation, food chain productivity; and serve as protective cover, nesting, and productive foraging habitat for a multi-trophic level suite of estuary-dependent species.