Scientists Set Seashells by the Seashore

By Aleta George

There's a new reef in the San Francisco Bay. It's not made of coral, but like the tropical variety this biological reef provides a structure where other creatures can hide, hunt, and huddle. A "reef" is what project partners call the native oyster and eelgrass restoration plots that make up the first phase of the San Francisco Bay Living Shorelines: Nearshore Linkages Project, or Living Shorelines for short.

The State Coastal Conservancy and its partners installed this one-acre pilot restoration project in 2012 in a shallow mudflat at San Rafael Bay between Point San Quentin and Point San Pedro. The long-term goal of the Living Shorelines project is to create biologically rich habitats in the subtidal and intertidal zones to improve the health of the estuary and to help its resiliency during sea level rise.


As part of the Living Shorelines project, scientists placed mesh bags full of oyster shells (pictured at distance on the left and in closeup on the right) off of the San Rafael coast.

photos courtesy of State Coastal Conservancy

"With climate change it's even more important to pay attention to that zone," said Marilyn Latta, the project manager with the Coastal Conservancy. "There are many areas of the current urbanized edge that are at risk of being inundated during sea level rise, and that's one reason we are testing these techniques to see if the natural habitats can help protect and buffer the adjacent shoreline edge."

The project at San Rafael has four treatment plots parallel to the shoreline, roughly 200 meters from shore. Each plot is 32 meters long and 10 meters wide. One plot has rows of mesh bags filled with empty Pacific oyster shells. Another plot has rows of eelgrass, a submerged aquatic plant native to the Bay. The third alternates with oyster bags and eelgrass like a checkerboard, and the fourth is a control plot with no treatment. Scientists are analyzing each plot to learn ideal techniques to restore these habitats and learn if biological reefs can protect shorelines. The lead scientist on the project is Katharyn Boyer, a coastal restoration specialist at San Francisco State University. Other partners include the University of California at Davis, USGS Western Ecological Research Center, ESA PWA, ENVIRON, and Isla Arena Consulting.

In addition to the treatment plots at San Rafael, they are analyzing small artificial substrates at both San Rafael and Hayward. The structures — which have entertaining names such as reef castle, reef ball, reef ball stack, and layer cake — are made of "baycrete," a cement-like material made of 20 percent Portland cement and 80 percent native sand or oyster shells. So far, the baby native oysters looking for a place to land seem to prefer the mesh bags filled with oyster shells.

In 2009, the state's Natural Resources Agency released the *California Climate Change Adaptation Strategy*, which projected a possible 12 to 18 inch sea level rise by 2050. The same report recommended natural shoreline enhancements as an alternative to hard shoreline protection as the waters rise. The Coastal Conservancy says that Living Shorelines can reinforce shorelines, minimize erosion, and create biological habitat. A healthy living shoreline around the San Francisco Bay would include sand beaches, rocky intertidal zones, seaweed beds, native oyster beds, and eelgrass meadows, and these habitats would work in concert with tidal wetlands and uplands. With this suite of healthy habitats, the twice-daily tidal exchange would bring life to all parts of the bay and the living creatures that depend on it.

Right now we can't boast of healthy living shorelines. Since the Gold Rush we have lost 90 percent of the bay's wetlands, and due to fill and development of its edges, the bay itself is one-third smaller. Eelgrass meadows and oyster beds once covered large portions of the subtidal zone. These habitats provide a physical structure for other species to use. "When we restore or conserve native oyster and eelgrass habitats, we also conserve and attract other species that use the habitats as a place to hide from predators, get food, and find a surface to attach to," said Boyer.

So far, scientists have collected one year's worth of data. During the summer, the lowest tides were at dawn. With headlamps switched on, the scientists scrambled over slippery riprap covered with oysters and mussels, and slogged across 600 feet of mud while pushing boogie boards full of gear. "It's a visceral experience to start in the dark when you can't see anything in the bay, and then arrive as the sun rises to see organisms crawling or swimming all over the structures," said Boyer. The scientists saw crabs, amphipods, bay shrimp, isopods, tunicates, serf perch, sea slugs, and bay pipefish. "It's just alive, stunning really to see all the activity that's present that wouldn't have been there otherwise," said Boyer.

Every Pacific oyster shell in the mesh bags has attracted about 20 native oysters, now of different ages, according to Boyer. Scientists will continue to monitor the site for another five years.

To test whether or not the reefs might slow the impact of waves, scientists from ESA PWA installed an acoustic Doppler current profiler to gather data of wave and current action. They have extended the reef data with computer modeling back in the office. Early results show that reefs do alter wave height by filtering out some of the wave directions. The next step is to model the ideal height and aspect of reefs. "The point is to find the sweet spot," said oceanographer Doug George. "If the Coastal Conservancy wants to build more of these, they will have a better idea of how high to build them and where to put them."

"It's really exciting to be able to document some of these ecosystem services," said Latta, who was also the project manager for the 2010 *San Francisco Bay Subtidal Habitat Goals Report*, an effort in which 75 agencies and scientists developed a 50-year conservation plan for the bay. The Living Shorelines project was developed with those goals in mind. "Our hope is that these techniques will be successful and result in healthy habitat that will improve conditions for fish, birds, and invertebrates in the bay, and help slow down wave action and prevent some erosion on the shoreline in the face of sea level rise," said Latta.

Looking forward, the Coastal Conservancy hopes to use this data to scale up and build more reefs, while also connecting habitats and restoration projects from the bay to the land. "We'd love to be able to integrate habitat types for multiple benefits, from the shallow subtidal and deep intertidal zone where we're now working, all the way up to tidal marsh and even the upland," said Boyer.

Their goal is to make the structures self-sustaining, and their wish is that after the species recruit and find other homes, they will continue to persist and result in further generations. ❖

Aleta George writes about nature and culture in California.

Burrowing in the Bay Area: The Scoop on Transportation Tunnels

By Beth Hillman

What's the most direct route from Point A to Point B? The proverbial crow has one answer, but when flying that straight line isn't an option, the lowly earthworm can suggest an alternative.

Of course, underground travel doesn't come without complications. In the Bay Area, ongoing and recently completed tunneling projects offer the promise of convenience, but their development is the result of years of specialized planning and often difficult excavations.

Tunneling presents challenges that are literally unseen. Youssef Hashash, a professor of civil and environmental engineering at the University of Illinois at Urbana-Champaign, said that engineers understand the geology they are working with by boring into the ground to take samples and collaborating with geologists to establish the connectivity between points.

"That's actually a very challenging task. In some cases, the changes in geology can be quite abrupt," Hashash said. "When you are dealing with tunnels for transportation, we are dealing with very longitudinal structures. There's a limited amount of holes we can put in the ground. Therefore, we have to make certain assumptions."

Making assumptions can result in surprises. "We're dealing with geology, which was given to us by Mother Nature," Hashash said. When she surprises construction crews with a change in rock texture, then they need to alter their tunneling techniques. Softer ground requires more support to prevent cave-ins during construction; rock is harder to excavate but requires less support.

The Devil's Slide Tunnels Project, which enables drivers to bypass an unstable area of Highway 1 in San Mateo County, faced such issues when the rock face was found to be too soft to bore into without risk of collapsing the tunnel. Such unexpected geological situations contributed to the project's delayed completion, a year and a half later than anticipated

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