Seed-filled buoys may help restore diverse sea meadows in San Francisco Bay

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This shows Mesocosm tanks at RTC with seagrass raised for experiments on genetic diversity in restoration using seed buoys.These are offspring from the Crown Beach site that grew from seeds dropped from seed buoys in the tank. The seeds germinated in the tanks and grew eventually into large plants visible in this photo. Samples for genotyping were collected while plants were small and could be distinguished from each other. Tanks located at the RTC lab in an outdoor greenhouse are supplied by water pumped from the bay. Credit: Photo by Brian Ort.

A pearl net filled with seedpods, tethered by a rope anchored in the coastal mud but swaying with the tide, could be an especially effective way to restore disappearing marine meadows of eelgrass, according to a new study.

The resulting crop of eelgrass grown by SF State researchers is as genetically diverse as the natural eelgrass beds from which the seeds were harvested, said Sarah Cohen, an associate professor of biology at the Romberg Tiburon Center. As eelgrass meadows are threatened by a number of human activities, restoration plans that maintain diversity are more likely to succeed, she noted.

The emphasis on genetic diversity is a relatively new concern in ecosystem restoration projects, where there has been an understandable urgency to move plants and animals back into an area as quickly as possible. "It's taken a little longer for people to say, 'we need to know who we're moving,'" Cohen said, "and to explore how successful different genotypes are in different settings, so we can more strategically design the movement of individuals for restoration."

Eelgrass restoration projects are challenging because it's not easy to plant seedlings under the water, and seeds scattered over a large area could be washed away from the restoration site. Instead, RTC researchers tested the Buoy Deployed Seeding (BuDS) restoration technique. They first harvested eelgrass seedpods from several eelgrass beds in San Francisco Bay, then suspended the pods within floating nets over experimental tanks (called mesocosms) supplied with Bay water and with or without sediment from the original eelgrass areas. As the seeds inside each pod ripened, a few at a time, they dropped out of the nets and began to grow within the tanks.

The researchers then examined "genetic fingerprints" called microsatellites from the plants to measure the genetic diversity in each new crop. Genetic diversity can be measured in a number of ways, by looking at the number of different variants in a gene in a population, for instance, or by examining how these variants are mixed in an individual.

This shows Mesocosms in the greenhouse at SF State's Robert Tiburon Center for Environmental Studies. Mesocosm plants are growing inside tanks. Credit: Photo by Brian Ort.

Based on these measurements and others, the new crops were nearly as genetically diverse as their parent grass beds, Cohen and colleagues found. "These offspring impressively maintained the genetic diversity and distinctiveness of their source beds in their new mesocosm environments at the RTC-SFSU lab," said Cohen.

"I think it's impressive how well it worked for a relatively small scale design," she added, "and that's one of the things we wanted to point out in the paper, since a lot of eelgrass restoration projects are so small, up to a few acres."

Sea grass meadows are a key marine environment under siege. In their healthy state, they stabilize coastal sediment and provide a huge nursery for a variety of algae, fish, shellfish and birds. But a variety of human influences, from bridge building to runoff pollution to smothering loads of sediment, have threatened these grass beds globally.

They're often overlooked and misunderstood, Cohen said. For instance, many of the eelgrass beds in the San Francisco Bay are submerged. "If you were out kayaking at low tide, you might see these grasses in places like Richardson Bay, which is full of a big meadow," she said.

During low tides, beachcombers could walk to eelgrass beds at places like Crown Beach in Alameda or Keller Beach in Richmond. But for the most part, "people might see the green blades washed up on the beach, and not realize that these are flowering plants instead of a piece of algae."

In classes at the RTC, students are learning how to combine genetics and ecology for projects that build better strategies to preserve the surprisingly distinct eelgrass meadows of San Francisco Bay. Cohen said that differences in water salinity, wind, sunlight, a sandy or silty bottom, and the kinds of organisms that live with the eelgrass all might play a role in creating such genetically different meadows.

More information: "Conservation of Eelgrass (Zostera marina) Genetic Diversity in a Mesocosm-Based Restoration Experiment," by Cohen, Brian Ort, Katharyn Boyer, Laura Reynolds, Sheh May Tam and Sandy Wyllie Echeverria was published in the Feb. 21, 2014 issue of the journal *PLOS ONE*: dx.plos.org/10.1371/journal.pone.0089316.

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