As good as the concept is, there are difficulties with implementing it. Many dentists prefer not to use this equipment, according to Okada, simply because of the high cost. In addition, there is the ethical issue of leaving a major medical decision to a computer program. “In medicine, doctors are God,” Okada begins on this delicate topic, “They are trained to make a decision of what to do,” he says. “We designed (dental CADs) to be a tool only to be used by these medical specialists. It doesn’t make a decision - the process must be that a doctor does his own diagnosis as he usually does but also lets the computer do that, then he compares them. The doctor is still the person to make the last decision to what is going to happen.”

The project is funded externally by CSUPERB (California State University Program for Education and Research in Biotechnology.) Okada personally proposed this research and was funded, helping to compensate the students who work for him and the equipment he needed to buy. Okada works with two graduate students who use PC computers located at the Center for Computing for Life Science (CCLS), a research center in the College of Science and Engineering. A colleague at USC provided patient data.

Okada spent close to two decades studying computer facial recognition but has discovered that his interest lies with medical imaging. One might think why spend so much time in one field just to cross over to another? This doesn’t bother Okada. “When I saw the opportunity of applying my knowledge into a set of programs that can save people’s lives, I just didn’t think twice. I just jumped into it,” he says.

If you look out on San Francisco Bay’s shallows and tidal flats during herring spawning season at low tide, you are likely to see a glistening expanse of sand or mud speckled with flat, green patches being eagerly picked over by shorebirds. Those patches are the exposed green blades of eelgrass, or Zostera marina, a mostly subtidal flowering plant found in shallow bays and estuaries, which provides key shelter, feeding and nursery habitat for a variety of organisms.

Illustration from Bilder ur Nordens Flora by C. A. M. Lindman (1856-1928), Swedish botanist.
Increasing eelgrass beds in the bay will benefit the area both economically by improving herring spawning habitat and ecologically by increasing biodiversity.

"It’s not just a slimy thing on the bottom of the bay," said Laura Reynolds, Boyer’s research technician. "Eelgrass clears the water column while providing great habitat for invertebrates and juvenile fish." Boyer said that "within individual eelgrass beds, suspended sediment is lower, providing more light to fuel eelgrass growth."

Boyer has a history of working on projects to understand and restore environmentally sensitive habitats, from restoring California salt marshes to studying pollution’s effects on coral reefs in the tropics. Boyer came to SF State in 2004 and set up her lab in the Romberg Tiburon Center, the university’s marine field station, which the school purchased from the federal government for a dollar. It is the only marine lab located on San Francisco Bay.

Upon Boyer’s arrival, she quickly made contacts within the local restoration community, forming a working relationship with Save the Bay, an Oakland nonprofit devoted to restoration, which works with and educates more than 8,000 volunteers and students a year. Some of these volunteers are working on the eelgrass restoration project.

Marilyn Latta, Save the Bay’s habitat restoration director, said the organization’s goal is to “connect restoration stakeholders to community volunteers.” She explained: “Historically, there has been a divide between academic programs and volunteers. Projects like this allow us to change that.”

Boyer believes that projects involving volunteers are important because they get people interested in the bay and “maybe even into the water.” When Boyer was a child, she first became interested in marine biology through summer programs sponsored by the Chesapeake Bay Foundation.

Today eelgrass covers less than one percent of the bay. Scientists believe mining activities during the Gold Rush, which occurred from 1846 to 1849, deposited sediments into the bay, reduced light levels and caused extensive eelgrass habitat to be lost. Recent biophysical modeling and studies showing a reduction in sediment loads suggest conditions have greatly improved, and may be conducive to restoration of thousands of acres of eelgrass.

San Francisco State University’s Katharyn Boyer, Ph.D., has been conducting eelgrass restoration experiments to test a newly developed technique to disperse seeds. Boyer speculate that eelgrass seeds may not be reaching areas suitable for recolonization. The National Oceanic and Atmospheric Administration (NOAA) and the California Coastal Conservancy have provided grants totaling over $700,000 for Boyer’s eelgrass restoration projects, which if successful will provide habitat for myriad species, including the commercially important herring. The bay’s herring fishery, worth $2 million a year, is the largest fishery south of British Columbia, according to the California Department of Fish and Game.

The current projects, begun in 2005, will continue at least through 2009. Boyer and her team of graduate students have been analyzing seed donor sites, collecting seeds, and deploying dispersal units (“seed buoys”) at selected restoration sites around the bay. In 2006 the team began experimenting with transplanting whole plants as well. Beginning in 2007 the team began to assess if eelgrass is growing in the new areas. With the help of SF State’s Sarah Cohen, Ph.D., the team will analyze the donor and restored populations to evaluate genetic diversity.

Eelgrass is a foundation species that provides habitat for wildlife ranging from waterfowl to the cryptic bay pipefish, an elongated, beaky fish related to the sea horse. Increasing eelgrass beds in the bay will benefit the area both economically by improving herring spawning habitat and ecologically by increasing biodiversity.
Boyer, incredulously: “Many Bay Area residents have never even been on a boat in the bay. Most people think the bay is so polluted, cold, and dirty that they wouldn’t dream of getting into it or even visiting it.”

Boyer’s team has trained over 30 Save the Bay volunteers and staff, who have helped build seed buoys, load them with shoots, and install them at restoration sites. Some volunteers have also helped with the monitoring phase of the project, which is more difficult as it requires SCUBA and other specialized knowledge.

Restoration projects in the bay are challenging because of the very low water visibility. Laughing, Boyer recounts that when she is standing in less than one foot of water she often cannot see her own toes. Working on SCUBA requires doing everything by feel in the muddy water.

Previous eelgrass restoration projects in the bay were not very successful; however, all previous projects focused solely on planting shoots, rather than distributing seeds. Because water-born seeds from existing beds successfully implant themselves each year at various sites in the bay, Boyer speculated that a restoration technique using seeds might be more successful than planting.

Chris Pickerell, a restoration specialist for a county in New York, and Dr. Sandy Wyllie-Echeverria of the University of Washington originally developed the project’s seed buoys and used them in a successful eelgrass restoration project in the Pomme Estuary, New York. The buoys are made with mesh bags, which are attached to floats anchored to the seafloor by cinder blocks.

Boyer and her graduate students have now collected flowering shoots with maturing seeds from four different extant populations in the bay. Point San Pablo, located in the North Bay, is adjacent to the largest eelgrass bed in the bay—the perennial bed remains year-round. Point Molate and Keller Beach, in the Central Bay, also harbor perennial eelgrass beds. In addition, the team collects flowering shoots from Crown Beach, which has a largely annual eelgrass bed with very high genetic diversity. The Crown Beach site naturally regenerates each year from seeds.

Boyer’s team transports the flowering shoots to the shallow subtidal zones of restoration sites, primarily at two locations one near the Larkspur ferry landing at Point San Quentin and one in San Rafael at the Marin Rod and Gun Club. These sites were indicated by biophysical modeling as primarily at two locations: one near the Larkspur ferry landing at Point San Quentin and one in the Central Bay, also harbor perennial eelgrass beds. In addition, the team collects flowering shoots from Crown Beach, which has a largely annual eelgrass bed with very high genetic diversity. The Crown Beach site naturally regenerates each year from seeds.

As these initial projects have worked to establish plants at the two restoration sites, and plants are now spreading clonally through their rhizomes as well as flowering and producing new seedlings at the sites. Boyer’s graduate student Lindsey Carr is beginning to assess the habitat provided by the restored sites, focusing on the small shrimp-like amphipods and isopods that cling to eelgrass blades. While the established plants have made it through one winter, only time will tell whether the restoration sites will be self-sustaining in the long run. Although previous attempts to transplant whole shoots have not been very successful, Boyer’s team is also testing a planting frame that reduces two factors researchers think are responsible for previous projects focused solely on planting shoots, rather than distributing seeds. Because water-born seeds from existing beds successfully implant themselves each year at various sites in the bay, Boyer speculated that a restoration technique using seeds might be more successful than planting.

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Graduate student Brittany Huntington, who recently received a prestigious Environmental Protection Agency fellowship for her eelgrass research, has worked with Save the Bay before. “Many people like to keep their desk jobs and jump on the chance to work with Save the Bay and learn something about the natural environment,” she said.

“People who volunteer have never had the chance to see them.”

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Above: Eelgrass, a flowering plant, produces seeds that aid in bed maintenance and can be used in restoration.

Below right: Mesh bags of eelgrass flowers ready for deployment on seed buoys at a restoration site.

Stephanie Kiriakopolos, which uses bamboo stakes to hold eelgrass plants in place long enough to root. Early results show that while planting frames have not worked that well, the bamboo stake planting method has worked to establish small plots at numerous locations around the bay, and holds promise for larger scale restoration.

As these initial projects have worked to restore eelgrass in the bay, larger restoration projects should follow. Boyer hopes the partnership with Save the Bay will continue to involve the community in hands-on research, has worked with Save the Bay before. “Many people like to keep their desk jobs and jump on the chance to work with Save the Bay and learn something about the natural environment,” she said.

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