Photo by Gordon Leppig

Photo by Susan Schlosser

EEL GRA

Beneath the Surface

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Story by
Adam Frimodig
and Kirsten Ramey

It started out as an ordinary June morning for John Mello, a Department of Fish and Game biologist, who spends a great deal of time in the field working with the plants and wildlife in Humboldt Bay. Along with other scientists that morning back in 2002, Mello was slogging through mudflats on the southwest end of Indian Island in the central bay to sample eelgrass (Zostera marina), California's most common type of seagrass. Mello spotted what looked like young, newly developing individual eelgrass plants, commonly referred to as shoots. He assumed they were from native eelgrass since Humboldt Bay historically had been home to only one species of eelgrass. Nevertheless, he carried samples back to the laboratory to make sure.

Overleaf: At left, a patch of the invasive dwarf eelgrass floats on mudflats in northern Humboldt Bay. At right, dozens of volunteers slogged through ankle-deep mud in the first-of-its-kind effort to eliminate the non-native species after it was discovered in 2003 inside Humboldt Bay. A cooperative effort between the Department of Fish and Game, and researchers and students funded through the California Sea Grant continues to guard against the species taking ahold again. This page: Closeup of the invasive dwarf eelgrass (circled in white) intermixed with native eelgrass (circled in red) on a mudflat on Indian Island, Humboldt Bay in 2003.

It turned out what Mello found weren't the shoots of native eelgrass species—which dominates the bay—but rather shoots of dwarf eelgrass (Zostera japonica) from Asia. Native eelgrass is a marine flowering plant with long, ribbon- or strap-like leaves that inhabits shallow coastal waters. Although similar in appearance, the leaves of the non-native dwarf eelgrass are shorter and narrower. Dwarf eelgrass can quickly take over intertidal mudflat areas and sometimes dramatically alter the natural habitat once it has settled.

DFG confirmed identification of the newly found invasive species with botanists from Harvard, University of British Columbia, University of Washington and Humboldt State University. Less than six months later, eelgrass researchers from the Humboldt Bay area, representing DFG, California Sea Grant, and Humboldt State University, gathered with more than 50 experts at a seagrass colloquium in Newport, Ore. to discuss the implications of the dwarf eelgrass discovery.

What came out of that colloquium was the first attempt anywhere to physically remove the invasive species from the Humboldt Bay ecosystem. More than 30 volunteers waded through mud to perform the work. Follow-up research showed their efforts proved successful (see research spotlight).

Dwarf eelgrass was first detected on the Pacific Northwest coast in 1957, in Willapa Bay, Wash. However, experts agree it likely arrived as many as 30 years earlier with oyster shipments from Japan.

The natural habitat range of dwarf eelgrass extends along most of the eastern coast of Asia, from the severely cold Kamchatka Peninsula on the Bering Sea, to the sub-tropical coast of Vietnam. On the shores of western North America, dwarf eelgrass spread rapidly, reaching from the Powell River in British Columbia down to—until 2002—Oregon.

Mello's discovery of dwarf eelgrass in Humboldt Bay was the first encountered in California waters. Humboldt Bay had been the only known location in California until last year.

In April 2008, DFG's Kirsten Ramey discovered dwarf eelgrass in McNulty Slough, a northern arm of the Eel River estuary approximately five miles south of Humboldt Bay. The new discovery in the estuary marks the southernmost extent of its range along western North America.

Some might question the concern over the invasive dwarf eelgrass inhabiting Humboldt Bay. Further inquiry might ask why it's considered an "invasive species" in California waters.

Introduced species, known as non-native or exotic, have an increasingly growing impact on California's environment. Introduced species are those

Although the shipping industry has received most of the attention as a transporter for marine invasive species, non-shipping mechanisms have emerged as sources for non-native species that plague the state's aquatic habitats. Experts are learning now that non-shipping mechanisms such as recreational boats, aquaculture, seafood, bait and the industry surrounding aquariums must share some of the burden for allowing the incursion.

established from outside their naturally occurring range, either intentionally or inadvertently, as a result of human activities. Invasive species are introduced species that have the potential to cause economic or ecological harm, and compete with native species for the resources necessary to exist.

The first step leading to a biological assault by an invasive species is transportation from its place of origin. The most widely acknowledged form for marine invasive species comes through ballast water carried in commercial ships. "Fouling" communities also make the journey on the exterior surfaces of ships. It can happen after cargo ships unload their commercial supplies and then take up ballast water in bays, estuaries and inland waterways to compensate for the lost weight. The new ballast is released later, when the vessel loads cargo in another port—often in another bay or estuary in a different part of the world. This transfer of water between similar habitats around the world has resulted in the introduction of

Research Spotlight: Dwarf Eelgrass

By Susan Schlosser and Annie Eicher

If researchers of Humboldt Bay's non-native dwarf eelgrass have learned anything about this invasive species, it's that the aquatic plant can move so swiftly that marine biologists can never lower their guard.

Researchers and students, funded through California Sea Grant, work with biologists from the Department of Fish and Game to maintain a vigil of the north coast's busiest commercial and recreational harbor. California Sea Grant sponsors marine research to support the management of the ocean for the benefit of current and future generations.

Led by the Humboldt Bay Cooperative Eelgrass Project, researchers are looking for ways to permanently remove and protect the bay from the destructive capabilities of dwarf eelgrass. The goals of the project are unerringly straightforward: detect new occurrences of the invasive species, eradicate it quickly and collect as much biological data of the populations as possible.

Research began back in 2001 into the state's native eelgrass, a common type of seagrass with ribbon-like leaves, which inhabits shallow coastal waters. The discovery of invasive dwarf eelgrass (see main story) sent those involved into alert mode.

During the eradication work, eelgrass project leaders tested several methods to rid the mudflats of central Humboldt Bay of the species. Critical information came from those early efforts as researchers found the Humboldt Bay dwarf eelgrass shared characteristics common to other populations in Pacific Northwest estuaries. Other information found included:

- Dwarf eelgrass prefers protected, mid-intertidal habitats with low wave energy.
- Dwarf eelgrass grows on sandy or muddy shorelines.
- Dwarf eelgrass growth was rapid between June and September.
- Reproductive plants are present between April and October.

In the early stages of discovery, when biologists tracked expansion of patches that had been marked, they found several had doubled in size between July and October. They learned the grass produces reproductive shoots during those months—and again during the following spring.

That finding of how fast eelgrass can spread spurred DFG in the spring of 2003 to launch efforts to eliminate the infestation. The unprecedented action involved more than 30 volunteers from state and federal agencies, as well as students and faculty from Humboldt State University and local residents.

Removing the flowering marine plant from the soggy bottom of the bay doesn't always guarantee triumph. While review of the effort indicated success at the initial detection site, the resilience of the invasive species was seen as new dwarf eelgrass populations were found.

Researchers are turning now to understanding how the invasive species came into the busy port, and how it spread. Samples of each detected population have been sent for genetic analysis to the U.S. Geological Survey Alaska Science Center. When answers come back, they hope to establish a link from dwarf eelgrass in Humboldt Bay to populations from other Pacific Northwest estuaries. That information could enable workers to determine the source and dispersal of dwarf eelgrass in the bay.

Susan Schlosser is a marine advisor and Annie Eicher is a staff research associate for the University of California Sea Grant Extension Program. They can be reached at scschlosser@ucdavis.edu and aeicher@ucdavis.edu.

scores of aquatic organisms outside their native range.

Although the shipping industry has received most of the attention as a transporter for marine invasive species, non-shipping mechanisms have emerged as other sources for non-native species to plague aquatic habitats. Experts are learning now that non-shipping mechanisms include things like recreational boats, aquaculture, seafood, bait and the industry surrounding aquariums.

For example, live seafood and bait trades unintentionally transport living marine species such as seaweeds, invertebrates, parasites and pathogens throughout the world. The movement increases the potential of biological invasions through different environments via release or escape. Similarly, the generally unregulated aquarium industry poses a serious threat to marine ecosystems. The menace comes when homeowners and business owners who had exotic fish aquariums decide to release these organisms into the wild.

Lastly, researchers from Oregon State University recently speculated that migratory waterfowl may be capable of transporting viable dwarf eelgrass seeds in their guts, thereby aiding its dispersal.

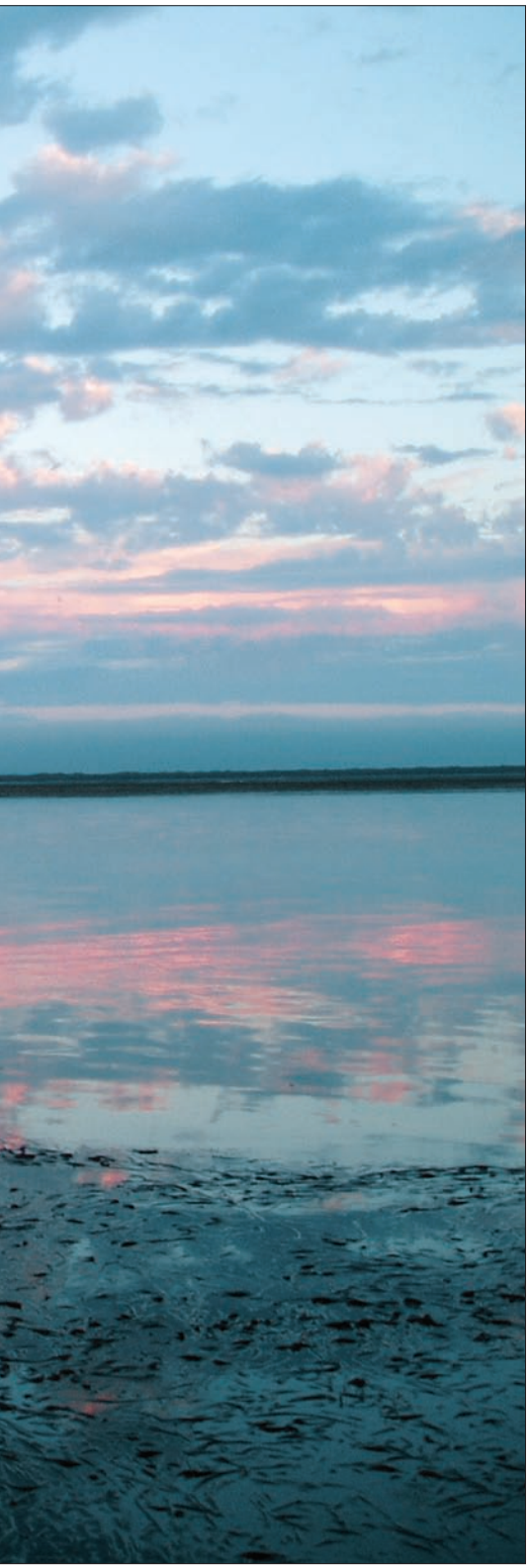
Seagrass communities, such as eelgrass meadows, aren't as colorful or mysteriously beautiful as the more vibrant coral reefs or kelp forests. But they are

DFG Photo by Adam Frimodig

At dusk in southern Humboldt Bay, a spring tide rolls in over an eelgrass meadow. Invasive species threaten the diversity or abundance of native species in several ways, including competition for resources interbreeding with native populations, transmitting diseases or causing physical or chemical changes to the invaded habitat.

one of the most productive and dynamic ecosystems on the face of the earth. Potential threats to these ecologically valuable communities should not be taken lightly or it could leave California open to huge problems in years to come.

Adam Frimodig is a marine biologist working on the Marine Protected Areas Science Project and Kirsten Ramey is an associate marine biologist working on the Aquaculture and Bay Management Project for DFG's Marine Region.



Reasons to Battle Dwarf Eelgrass

In California, the exotic dwarf eelgrass is considered an invasive species because it poses a serious threat to Humboldt Bay and to the rest of the coastal areas of the state due to three main reasons:

- Dwarf eelgrass rapidly colonizes intertidal mudflat areas, some of which were previously free from any form of vegetation. Once settled, dwarf eelgrass binds and accumulates sediments at a higher rate than native eelgrass, sometimes dramatically modifying the natural habitat. The settlement of dwarf eelgrass can also change the numbers and types of animal species living in the mud, as well as the feeding area and food content for many important shorebirds and waterfowl.
- The sediment accumulation resulting from the growth of dwarf eelgrass on mudflats could allow the invasive dense-flowered cordgrass (Spartina densiflora) to colonize additional habitat. This is of great concern because cordgrass can decrease bay and estuary edges, mudflats and important feeding areas for waterfowl and shorebirds.
- Estuaries and bays are centers for human activities, such as boating, shipping and aquaculture; providing multiple potential pathways for the dispersal of aquatic invasive species. California residents south of Humboldt County should be concerned about dwarf eelgrass continuing to spread further south.

State has History with Invasives

There have been several recent examples of invasive species having negative economic, environmental and recreational impacts in California's waterways.

Cases include the Zebra mussel (*Dreissena polymorpha*), Quagga mussel (*Dreissena bugensis*), Chinese mitten crab (*Eriocheir sinensis*), Asian clam (*Corbula amurensis*) and the "killer alga" Caulerpa taxifolia.

For example, Zebra and Quagga mussels are notorious for colonizing and accumulating on the pipes and equipment associated with industrial and treatment facilities, deteriorating docks and piers, and releasing toxins into the water column on the East Coast. Chinese mitten crabs undermine the stability of levees and shorelines through their burrowing activity and Asian clams have completely altered the food web in parts of San Francisco Bay. The tropical green Caulerpa taxifolia earns its "killer alga" nickname by having the ability to form a dense carpet on any surface which will then smother the native vegetation. It was introduced into Southern California through the aquarium trade, and cost the state approximately $7 million to eradicate.

In addition to their overarching economic and environmental impacts, invasive species can affect California citizens on a day-to-day basis.

Bill Gullickson is a retired carpenter who has owned a boat for nearly 30 years. He says he enjoys nothing more than spending his days aboard his vessel fishing, thinking of reeling in the big one. However, since the invasion of Zebra mussels, Gullickson constantly inspects and washes all exposed surfaces of his boat to prevent damage caused by the prolific fouling organism.

He says just the routine maintenance to keep his boat clean of the mussel has cost a great deal of money. Still, he knows that fixing damages caused by allowing the mussels to establish on his vessel would cost more.