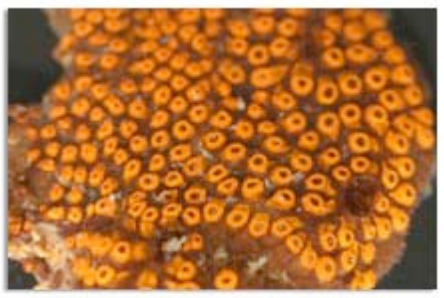
Keeping out Marine Hitchhikers

Hal Hughes

In California's coastal and nearshore waters, areas known for exceptional species abundance and biodiversity are rapidly being turned into virtual monocultures by alien species from as far away as Asia. Most of these invasive organisms arrive in ballast water carried by ships, but many also ride in or are spread by attaching to hulls. The state is attempting to curtail further invasions, but some battles may already be lost.



An Asian seasquirt colony (*Batrylloides diegensis*) found in San Francisco Bay

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The first step, in 1999, was to adopt legislation that prohibits oceangoing vessels from dumping or taking in ballast water within state waters. "The rules [established] boil down to ships being required to discharge ballast water at least 200 nautical miles from shore," according to Andy Cohen, environmental scientist at the San Francisco Estuary Institute. Next, in 2003, the Legislature passed the Marine Invasive Species Act, which renewed the 1999 law and expanded the initial program to include shipping within California waters, and also required a study of "fouling species," organisms that attach to hulls.

Ballast water is seawater that vessels take on board as they leave port, to help maintain balance and trim. Some ships dump this water before entering a port, to reduce the depth of the vessel's draft. Before the return journey, they take in more water. These operations, which had often been performed in or near ports, are now prohibited in state waters.

Because seawater, especially along the coast, is a living soup of tiny plants and animals and their spores, eggs, and larvae, multitudes of organisms are transported from port to port in ballast water, and this can have calamitous consequences for local ecosystems.

Non-indigenous species occur everywhere along the California coast, but the greatest numbers are found in large ports that handle international shipping. Well over 250 alien species have become established in San Francisco Bay, along with many others whose point of origin has not been determined, according to Cohen. In surveys he conducted in 2004 and 2005, he found that in some parts of the bay, nonindigenous species have completely taken over.

Ocean life has always been transported by travelers, but modern shipping has greatly increased the problem. Studies show that from 1850 to 1960 about one new species became established in San Francisco Bay every year. Since 1960 that rate has quadrupled.

Some imported species fail to survive, others fit into a new ecosystem with little effect. Some, however, explode in numbers, usually because the predators, competitors, and diseases that kept their populations in check where they came from are absent in their new habitat. Such highly successful invaders can alter entire ecosystems, devouring natives and driving them to extinction, disrupting food webs, or even changing environmental conditions on which natives rely for survival.

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Manila clams (*Venerupis phillipinarum*) dug from beneath intertidal rocks in San Francisco Bay

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Mitten crabs from Asia and green crabs from Europe, clams from Asia and the East Coast, South American water hyacinth and Atlantic cordgrass are among the most damaging invaders in San Francisco Bay. The Asian clam *Corbula amurensis* has not only taken over huge parts of the bay bottom, it also seems to have altered the entire ecosystem. According to Cohen, since the Asian clam was first found in the North Bay in 1986, annual blooms of phytoplankton that were the basis of key food webs have ceased, and the zooplankton and tiny shrimp they supported have disappeared from most of the bay. The niche the plankton had occupied in the food web has since been dominated by a series of 15 Japanese zooplankton, which one after another have been devoured by the voracious filter-feeding Asian clams. "Over the last three years the pelagic fish that were supported by the native plankton have also gone into dramatic decline," said Cohen. Ecosystems are too complex for us to readily pin the blame for changes on a single species, he cautions, but these declines correspond almost exactly with the establishment of the Asian clam.

Cohen's 2004 and 2005 surveys, funded by the Coastal Conservancy, showed that invasives dramatically outnumbered natives in most areas. In sites near the mouth of the bay, 30 to 50 percent of the 80-110 species identified were aliens; near tributaries to the bay, only 20-30 species were found, and 70-80 percent were exotics; in parts of the South Bay, 90-100 percent of species identified were nonnatives.

It's difficult to determine what impact California's ballast-water regulations have had on this problem. Maurya Falkner, manager of the Marine Invasive Species Program at the State Lands Commission, believes that they have helped to slow the rate of new invasions. "Only about 30 percent of commercial ships discharge ballast," she said, "and about 80 percent of those have been compliant. There have been a few problem vessels, about five percent, mostly those coming up the coast from Mexico and South America. Some of them discharge ballast, but only 50 to 100 nautical miles offshore. Container ships retain their ballast water." Cohen is less sanguine in his view of the program's effectiveness, pointing out that statistics are based on reports from the ships rather than on inspections.

Theoretically, commercial vessels also have the option of eliminating invaders by treating ballast water onboard or ashore. However, Falkner said that no system for such treatment is yet available. The Lands Commission helped to install experimental systems in two Matson vessels, she said, "but we don't know much about those yet. There aren't even any performance standards in place."

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An Edible Threat

A volunteer diver holds an adult *Undaria* removed from a pier in Monterey Bay.

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Among alarming recent arrivals in California waters is the Asian kelp *Undaria pinnafitida,* best known by its Japanese name, *wakame*. First found in Los Angeles Harbor in March 2000, by August 2001 it had been spotted as far north as Monterey Bay. Wakame is harvested as food in Japan, and is also eaten here. How *Undaria* came to California waters is uncertain--it is a fouling species, but its spores could have arrived in ballast water, or it may have been introduced deliberately for harvesting. A major concern is that it might interfere with, or even hybridize with, giant kelp *(Macrocystis pyrifera),* potentially devastating the coastal kelp forests, which are among the richest marine ecosystems. Scientists fear that if *Undaria* becomes established it will be impossible to control, as a single adult releases millions of spores that can lie dormant on the sea floor until conditions are right for it to grow. In Monterey Bay, boaters, divers, and other volunteers have been working to find and remove new-grown algae before they can reproduce. It may still be possible to control *Undaria* there, Cohen said, but he doubts that it can be eradicated in California.

Controlling ballast water may be difficult, but it's a breeze compared to trying to eliminate fouling species--plants, algae, and animals that attach themselves to boat hulls and hard substrates, natural or manmade, such as rocks and piers. "Ballast water is a solvable problem," said Cohen. "Organisms contained in a tank of water can be killed, but fouling species are in open water." It's next to impossible to police all the boat hulls in state waters, but he thinks the worst offenders are the small number of boats that stay in one place for a long time, then move slowly to another.

Boaters have always had to scrape barnacles, kelps, and other fouling species from hulls. More recently, they have also been using anti-fouling paints--based on copper and, until it was outlawed, TBT--that are toxic to these species. These paints, however, also leach toxins into the water, harming other marine life. The Department of Boating and Waterways has been encouraging boaters to find alternatives, but nothing quite as effective as copper has been found, so avoiding these paints means that more fouling species survive to wreak further damage.

Exotic species also get into coastal waters from other sources, including imported fish and seaweeds that are released from aquaria. Aquaculture operations have been a source of imported parasites and diseases that can be devastating if they escape into coastal waters. Most native abalone species are now threatened by withering disease or by a South African parasite, both introduced from abalone culture operations.

The Coastal Conservancy is now working with the Department of Fish and Game to develop a comprehensive aquatic invasive species management plan, funded by $110,000 from the California Ocean Protection Council, that will coordinate and define the roles of multiple agencies in combating invasive species in all California waters, including freshwater. This plan will be completed by May, and then open to public input during the summer. If the plan is approved by the governor and hoped-for federal funds are obtained, it should provide a much better coordinated effort that will facilitate early detection of aquatic invaders, rapid response to species that are of urgent concern, and improved monitoring of species and control efforts. It's encouraging that so many people are working to deal with marine invaders and the problems they cause, but the challenges are nearly as vast and complex as the oceans themselves.

Links for more information on marine invasive species, ballast water, *Undaria*, and antifouling paints. Click here.

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