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Marine Invasives

California's coastal and marine ecosystems are valuable resources, both in terms of the natural environment, as well as in their importance to the state's economy. They are home to diverse marine life, host a variety of recreational uses, and support a number of industries.

Many of these beneficial uses have the potential to introduce non-native organisms, and if this occurs in an area with suitable conditions, the organism has the potential to become established and result in environmental or economic harm – the threshold for being considered "invasive." Impacts in the coastal and marine environments may include displacement of native species, alteration of habitat such that associated species are unable to utilize it, and heavy colonization of man-made structures necessitating an increase in maintenance.

Not only do California's coastal and marine environments have a variety of uses, but they also have a number of agencies entrusted with managing their use and protection of their resources.

These include federal agencies like the US Fish and Wildlife Service, National Oceanic and Atmospheric Administration Fisheries Service, and Coast Guard, state agencies including the California Department of Fish and Game, Parks and Recreation, Coastal Commission, State Lands Commission, Coastal Conservancy, and Ocean Protection Council, and local agencies (cities and counties). Some of these agencies are explicitly tasked with addressing invasive species issues, while for others

invasive species fall under their umbrella missions of protecting the coastal and/or marine environments. Many of these agencies partner on efforts, as well as enlist the expertise and manpower of non-government organizations, academia, and the public.

Often these agencies attempt to address the threat of marine invasive species relative to their mode of introduction, referred to as "vector" or "pathway," be it ship ballast water, hull fouling, aquaculture, intentional release, or the emerging Japanese tsunami marine debris. With a combination of prevention, outreach and education, and early detection monitoring, these agencies work to protect the state's coastal and marine ecosystems.

In this issue of Eye On Invasives we are introduced to some of the organizations working together to prevent the introduction of invasive species, monitoring for new introductions, and a few of the species California is confronted with.



Mendocino headlands, DFG File Photo

Estuaries Under Invasion

Karen Bigham, Office of Spill Prevention and Response

California's estuaries and marine habitats are threatened by non-native aquatic species (NAS), brought to California in ballast water or attached to hulls of commercial vessels, often referred to as "hull fouling." Although vessel traffic to California has been decreasing because of the downturn in the economy, the rate of NAS discovery continues to increase. As of December 2011, 257 invertebrates and algae have established populations in California. The most invaded estuary in the West Coast is San Francisco Bay. Only two other regions in the world, the eastern Mediterranean and the Hawaiian Islands, have comparable numbers of reported marine invasions.

DFG's Marine Invasive Species Program (MISP), part of the Office of Spill Prevention and Response (OSPR), works with Moss Landing Marine Laboratories to determine the level of NAS invasions in California coasts and estuaries. Since 2000, they have conducted numerous large-scale surveys of bays and harbors, including San Francisco Bay, and the outer coast. The most recent surveys are the "2011 Bays and Harbors" survey, which is currently in progress, and the "2010 San Francisco Bay" survey. Details and results of all recent and past surveys can be found on the [MISP](#) website. The 2010 San Francisco Bay survey revealed four new introduced species:



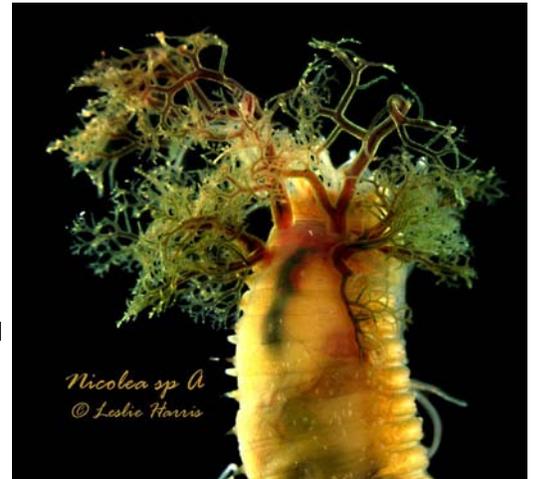
Caprella simia. Photo by Gail Ashton, Encyclopedia of Life.

Caprella simia, a caprellid, also known as skeleton shrimp, was first discovered in Long Beach Harbor in 2000. It is native to Japan and is believed to have been introduced to California by fouling or ballast water. It is now widespread in San Francisco Bay.

Grateloupia lanceolata, red algae, was found in the Port of Oakland and in Richardson

Bay. It was first discovered in 2003 on Santa Catalina Island. Its successful introduction to three very different environments, Mediterranean, southern California, and Central California, suggests that this species is a "weed" that can aggressively grow and reproduce while tolerating a broad range of physical conditions. *G. lanceolata* was likely introduced to California through imports of oysters for mariculture. Other possible vectors are ballast water, hull fouling of shipping vessels, and floating plastic debris.

Nicolea sp A Harris, a polychaete worm, was first found in San Diego Bay and Los Angeles/Long Beach Harbor in 2000. It was most likely introduced to San Francisco Bay by ballast water and fouling on ships or recreational boats.



Nicolea sp A Harris. Photo by Leslie Harris, Natural History Museum of Los Angeles County.



Amphibalanus eburneus. Photo by L. Holly Sweat, Smithsonian Marine Station at Fort Pierce.

Amphibalanus eburneus, also known as the ivory barnacle, has been found in Richmond and San Francisco marinas. Native to the North Atlantic, *A. eburneus* was first found in Colorado Lagoon (Long Beach) and Huntington Harbor. The

ivory barnacle was likely introduced to the bay through imports of oysters for mariculture.

Details on the newly introduced species in San Francisco Bay and all known NAS in California marine waters can be found in a database managed by MISP, the California Aquatic Non-native Organism Database (CANOD). CANOD was developed to record baseline information about NAS on the California coast. It continues to be a tool to help monitor new introductions and to understand the patterns associated with these introductions. To view CANOD, visit: the [Marine Invasive Species Program](#) website. For additional information about CANOD contact Karen Bigham at kbigham@ospr.dfg.ca.gov.

Partner Spotlight: Ballast Water Management

Chris Brown, California State Lands Commission

The introduction of non-native aquatic species into California through the discharge of ballast water from vessels continues to be a major concern. Once established, these species can become invasive and negatively impact the environment, public health and California's economy. The current approach of mid and coastal ocean ballast water exchange, while moderately effective in reducing the number of potentially invasive species in ballast tanks, does not completely remove the risk of new species introductions. Because of this, there has been a push throughout the world to utilize ballast water treatment. California has recently made progress towards a standardized approach for the management of ballast water discharges as a way to reduce these potential introductions.

Within the United States, ballast water management is under the jurisdiction of both the US Coast Guard (USCG) and the US Environmental Protection Agency (EPA). The USCG currently requires vessels arriving from outside of the US Exclusive Economic Zone to conduct ballast water exchange prior to discharging in US Waters. Earlier this year, USCG published regulations that establish federal discharge standards for living organisms in ships' ballast water discharged into US waters. These standards are numerically identical to those established by the International Maritime Organization (IMO) and will be



California State Lands Commission File Photo

implemented for new build vessels constructed on or after December 1, 2013. Existing vessels will need to meet the standards as of the first scheduled dry docking after January 1, 2014 or 2016, depending on vessel ballast capacity.

The EPA regulates ballast water and other discharges incidental to the normal operation of vessels under the Clean Water Act. In 2008, the EPA issued the "Vessel General Permit for Discharges Incidental to

the Normal Operation of Vessels" (VGP). The VGP regulates 26 discharges, including ballast water, incidental to normal vessel operations. The current VGP, which is set to expire on December 18, 2013, maintains the regulation of ballast water discharges by the USCG and does not include performance standards. The most recently released draft of the 2013 VGP, which will be implemented on December 19, 2013, does require vessels to meet performance standards for the discharge of ballast water. The discharge standards in the VGP are equivalent to the standards established by the USCG and IMO.

USCG and EPA regulations and permits do not relieve vessel owners/operators of the responsibility of complying with applicable state laws and/or regulations, such as those in place in California. California's Marine Invasive Species Act of 2003 directed the California State Lands Commission to recommend performance standards for the discharge of ballast water to the State Legislature in consultation with the USCG, State Water Resources Control Board, and a technical advisory panel consisting of regulators, research scientists, industry representatives and environmental organizations. The legislation mandated that the standards be based on the best technology economically achievable and should be designed to protect the beneficial uses of California's waters. In January 2006, after several meetings of the technical advisory panel, the Commission recommended numerical discharge standards. Later that year, the State Legislature passed the Coastal Ecosystems Protection Act, which adopted the discharge standards as statute and directed the Commission to implement them via regulations. (For specific details of the discharge standards and implementation schedule, please visit the [California State Lands Commission Marine Invasive Species Program](#) website).

Currently, staff of the California State Lands Commission is in the process of developing, with the aid of a technical advisory panel, protocols for the collection and analysis of ballast water samples in order to assess compliance with regulations. Currently no government agency or entity in the world has developed a comprehensive suite of compliance assessment protocols. Once finalized and implemented, these protocols will continue to keep California on the forefront of regulating the potential introduction of aquatic invasive species.

A Potential Tide of Invasives

California Department of Fish and Game Staff

The March 11, 2011 tsunami that struck the coast of Japan devastated approximately 1,300 miles of coastline and 217 square miles inland. As the tide receded, it carried millions of tons of debris from both inland and the coast. Much of the debris sunk into the ocean offshore of Japan, but not all, and recent reports of possible tsunami debris landing on the Pacific coast have attracted a good deal of media attention.

The remaining debris floating in the Pacific Ocean can be classified by its origin – either originating from land, such as appliances, lumber, trees, etc, or marine-origin, which includes ships, docks, buoys, etc. These objects, engineered to float, were in coastal environments and were likely to have been colonized by attaching and free-living marine organisms. The term “biofouled” is often used to describe the presence of marine organisms on surfaces below the waterline, such as those originating from the tsunami. Biofouling species found in harbors, ports, and estuaries of Japan are of particular concern because, if introduced to the Pacific Coast, may find those similar habitats suitable for establishment, or worse, optimal and proliferate.

It is important to recognize that marine debris is not isolated to those originating from the Japan tsunami. Marine debris includes trash blown into coastal environments and the rivers that flow into them, trash dumped overboard from boats in the ocean, and masses of fishing gear lost at sea. Ongoing efforts, including the National Oceanic and Atmospheric Administration’s (NOAA) Marine Debris Program, the US Army Corps of Engineers debris collection, and California efforts including the Adopt-A-Beach and annual Coastal Cleanup Day work to address this ongoing issue. However, the unique circumstance of the tsunami has added the invasive species component to the issue of marine debris.

Some scientists predicted that potential invaders on Japan tsunami marine debris would not survive a year long trans-Pacific voyage due to ultraviolet exposure and the paucity of food available in the open ocean, however this theory proved to be incorrect when a large dock from Japan washed ashore in Newport, Oregon in June of 2012. This dock, 66 feet long, 19 feet wide, and 7 feet high, was heavily biofouled and has thus far been documented to carry more than 90 Asian species of marine protists, invertebrates, algae, sponges, hydroids, sea anemones, polychaete worms, snails, clams, mussels, chitons, barnacles, crabs, sea stars, sea urchins, sea cucumbers, sea squirts, and seaweeds, including a number of species recognized as potentially serious invaders, including

Undaria (see “Species Spotlight” on page 6).

In response to the potential introduction of marine invasive species from Japan tsunami marine debris, DFG is coordinating with others, including NOAA. NOAA has taken the lead on coordinating a regional response to the threat of invasive species with states and federal agencies. Toward this goal DFG and several other state representatives participated in a meeting in Portland, Oregon in July 2012 for the purpose of developing a communications, reporting, assessment, and response framework to address biofouled tsunami debris. The final product of this workshop is anticipated to be complete in Fall 2012.

Concurrently, DFG has been working with partner state agencies including California Emergency Management Agency (CalEMA), Parks and Recreation, Coastal Commission, State Lands Commission, Coastal Conservancy, and the Ocean Protection Council on debris reporting, outreach to the public, and invasive species response. CalEMA is coordinating with local agencies to assist their response to all facets of the Japan tsunami marine debris, and has drafted a concept of operations to guide preparedness and response. Should biofouled Japan tsunami marine debris be discovered, DFG and the appropriate agencies will, to the best of their abilities, take action to prevent the introduction of invasive species. This may include containment and disposal of items biofouled with potentially invasive species.

To assist in this effort, anyone who has discovered marine debris should immediately report it to NOAA’s Marine Debris Program via email at DisasterDebris@noaa.gov. NOAA will forward the report to the appropriate authorities. It is possible debris could include hazardous material, therefore you should use caution around suspected debris. For more information on Japan Tsunami marine debris visit [NOAA’s Marine Debris Program](http://NOAA's Marine Debris Program) website.



A Japanese dock washed ashore on an Oregon beach following the March 2011 tsunami. The dock was covered in species that could become invasive. Photo courtesy Oregon Parks and Recreation Department.

Research Spotlight: Marine Invasives Redesign

Karen Bigham, Office of Spill Prevention and Response

San Francisco Bay is a dynamic ecosystem where there are growing numbers of new species. To keep up with San Francisco Bay's changing dynamics, the Department of Fish and Game's Marine Invasive Species Program (MISP) recently redesigned its monitoring program. The new design aims to measure changes in invasion patterns through space and time. To help develop this robust sampling approach, we made the following two main changes to our sampling design.

Stratified Random Sampling

Traditionally, we sampled sites with the highest probability of finding invasive species to create a baseline of non-native aquatic species populations. Now that we have a baseline, the new design will switch from non-random sampling, to one that is random within a bay. This will give us the ability to measure spatial, temporal, and taxonomic species diversity.

Increased Genetic Analysis

The MISP recently completed a joint pilot study in San Francisco Bay with Greg Ruiz from the Smithsonian Environmental Research Center (SERC) and Jon Geller from Moss Landing Marine Laboratories (MLML).

SERC set up artificial fouling plates made of PVC around San Francisco Bay for organisms to settle on and collected paired samples quarterly. Half of the paired samples were sent to specialized taxonomist's laboratories for traditional morphological identification. The second half went to MLML's genetics lab for molecular analysis. Recent advances in genetic analysis now allow millions of individual DNA sequences to be analyzed during a single run. This will allow us to sample whole community populations, such as plankton samples.



Artificial fouling plate with established species settling on it. Photo courtesy of MISP.

Although morphological analysis will always play a prominent role, it does have limiting factors. The process for identifying organisms from large-scale surveys can take up to a year. There are a lot of samples and the process of identifying individual organisms is slow. It can also be difficult, and in some cases, impossible to identify specimens that are damaged during collection because key morphologic characters may be lost. Other challenges include identifying juvenile specimens and distinguishing between morphologically identical species in the San Francisco Bay.



Side view of an artificial fouling plate with established species. Photo courtesy of MISP.

The genetic identification will provide DNA barcodes for every species sampled by the MISP surveys to add to a DNA Reference Library, which will save time and cost of future surveys.

The two new changes to the MISP sampling design will result in a cost-efficient, faster, and more accurate approach to identifying and monitoring non-native species.



Initial phase of the sorting process. Photo courtesy of MISP.

Do You Know This Is Invasive? Asian Kelp - *Undaria pinnatifida*

Did you know that the seaweed in your miso soup is an invasive species? That's right; it's called Asian kelp or *Undaria pinnatifida*, a marine species native to Japan, China, and Korea. Asian kelp is a type of brown seaweed found in near-shore coastal habitats.

Asian kelp can grow up to 9 feet and be found in waters as deep as 15 feet. It is usually golden brown in color with a single large blade attached to a midrib that grows the length of the kelp. Mature Asian kelp have a broad, crinkly blade with fingerlike projections, while young kelp have a smooth, undivided blade. In addition, mature Asian kelp have a ruffled reproductive structure at their base called a sporophyll. The sporophyll is one characteristic that distinguishes Asian kelp from native kelp.

Asian kelp is a threat to California's coast because it is fast growing and can form dense kelp forests in sheltered areas blocking out sunlight that native species need to survive. It can also attach to many different types of man-made and natural substrates, like boats, ropes, docks, shells, and rocks. If this occurs, boats and docks may require additional maintenance to remove the kelp. Today, Asian kelp can be found in several areas along the coast of California from southern California, north to Monterey. Its tendency to attach to vessels, along with its ability to produce many offspring, mean this invasive species has the ability to be spread and become established in new places.

In California, efforts are underway to remove Asian kelp from some coastal locations. Scientists from multiple agencies have been removing the kelp by hand from infested marinas and are always on the lookout for new populations. One way you can help is by inspecting and cleaning your boat and equipment so that attached kelp are not introduced to new areas. Visit the [Smithsonian Environmental Research Center's](#) website for more information on Asian kelp and how you can help.



Photo by: Marine Invasions
Research Laboratory at SERC

Upcoming Trainings and Conferences

Watercraft Inspection Trainings:

Level I: Contact your [local Regional Scientist](#) for training dates

Level II: October 16-17 and November 13-14. Sign up for the Lake Mead trainings on the [Aquatic Nuisance Species](#) website.

International Didymo Conference:

The Invasive Species Action Network and Northeast Panel on Aquatic Nuisance Species is hosting the International Didymo Conference in Rhode Island on March 12-13, 2013. Visit the [Invasive Species Action Network](#) website for more information.

18th International Conference on Aquatic Invasive Species:

The Invasive Species Centre is hosting the 18th International Conference on AIS in Niagara Falls, Ontario, Canada, April 21-25, 2013. Visit the [ICAIS](#) website for more information.

A Sneak Peek into the next issue of Eye On Invasives: Pesky Pets

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