

FREQUENTLY ASKED QUESTIONS REGARDING THE *UNDARIA* INVASION OF MONTEREY BAY

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What is *Undaria pinnatifida*?

Undaria pinnatifida is a brown seaweed native to Japan, northern China, and Korea. It is currently listed as an invasive species by state and federal agencies.

What is an invasive species?

Invasive species are those species that have spread, often with the direct or indirect assistance of humans, beyond their native range and into new habitats. These species often cause significant economic or ecological damage to native ecosystems.

When did *Undaria* invade Monterey Harbor?

It was detected in Monterey Harbor in August 2001.

How did *Undaria* get into Monterey Harbor?

We cannot determine the actual cause, but like many marine invasive species, it is very likely that it arrived with vessel traffic. *Undaria* releases microscopic spores that can become entrained in ballast water; however, these spores remain in the water column for only 5-6 hr before they settle on hard surfaces. Once settled, the spores divide to produce a second microscopic stage (gametophytes) that will eventually release eggs and sperm. Microscopic gametophytes can likely persist on vessel hulls for days to weeks. We suspect vessels from southern California that were coated with gametophytes acted as the vectors of transmission, inoculating harbors to the north, including Monterey Harbor.

Has *Undaria* invaded other parts of the world?

Over the past 30 years, *Undaria* has spread to New Zealand, Australia, Tasmania, Argentina, Baja California, the Mediterranean, Spain, France, and to the shores of England. In March 2000 it was detected in southern California, first in Los Angeles Harbor, then spreading to other southern California ports over the next 13 months.

Has *Undaria* spread to other Monterey Bay harbors?

In December 2002 cursory surveys were conducted at Moss Landing and Santa Cruz Harbors, but not *Undaria* were observed. However, it is possible that these harbors will be invaded in the near future.

Has *Undaria* spread beyond the harbor?

Currently we have not detected *Undaria* past the Coast Guard Breakwater. But given its recent spread from the center of the harbor to adjacent areas, it is likely that spores are being carried beyond the confines of the harbor. It is not clear if *Undaria* will be able to compete with native algae in a natural kelp forest community and become established.

What will *Undaria* do to native species?

It is not known how *Undaria* will affect native species in Monterey Bay. This will require further research and monitoring to detect changes, if any, to native communities. In New Zealand and Argentina, *Undaria* can reach high densities, carpeting the seafloor and shading native algae. This can alter the native community of algae, which can in turn change the behavior and distribution of fishes and invertebrates that use native seaweeds for food and shelter. In spite of the paucity of information examining the ecological effects of *Undaria* on native species, there is enough information that the Global Invasive Species Database (<http://issg.appfa.auckland.ac.nz/database/welcome/>) has listed *Undaria* among the top 100 worst invasive species.

Are there native species that can eat *Undaria* and perhaps acts as a biological control agent?

Undaria is very edible—in fact it is commercially grown in many parts of the world. More commonly known as wakame, *Undaria* is a typical ingredient of miso soup. In Monterey, native herbivores (e.g., kelp crab *Pugettia producta*) have been observed feeding on the blade tissue, but not on reproductive tissue (called sporophylls). In Santa Barbara, *Pugettia* has strong negative impacts on the density of *Undaria*. However, it is not clear if this grazing negatively impacts the quantity and timing of spore production for adults that retain the sporophyll.

Can people harvest and use *Undaria*?

Because it is an invasive species, handling of *Undaria* falls under the purview of the California Department of Fish and Game. It has been proposed that *Undaria* can be harvested in the winter and early spring, when it is most abundant, and used as feed for local abalone farms. During the winter months, the densities of native algae are naturally low, but at the same time *Undaria*, a winter annual, is just beginning to recruit. If the reproductive portions were removed, the blades could be used to feed abalone and the risk of spreading *Undaria* would be negligible. And while Monterey Harbor tends to have relatively clean water, it is not clear if *Undaria* harvested from the harbor would be fit for human consumption.

How much *Undaria* is in Monterey Harbor?

Since its initial introduction in 2001, *Undaria* has increased its distribution and abundance throughout the harbor. It is likely that by winter 2003 most of the 400+ slips will have several *Undaria* growing on them. In addition, the cement pier pilings can have dozens of individuals on the upper portions.

What can be done to remove *Undaria*?

An eradication effort was initiated in fall 2002 through a joint effort by Monterey Harbor staff, City of Monterey volunteers, and Monterey Bay National Marine Sanctuary staff. After one year of effort, it is evident that eradication is unlikely. And even if all individuals could be removed, the issue of future invasions from infested vessels cannot be easily resolved. Instead, current removal efforts are assessing what can be done to slow the spread of *Undaria* and reduce the standing biomass. In addition, we are monitoring its spread into areas that are not dominated by man-made structures and artificial substrates.

What kind of scientific research is being done?

In addition to the information being collected by this project, researchers from Moss Landing Marine Laboratories are conducting field and laboratory experiments to understand the basic biology of *Undaria* in Monterey Harbor. Topics include: timing and cues for spore production; growth rates; rate of spread; and competitive ability. Research on *Undaria* is also underway in other parts of the world. For example, geneticists in France are investigating the origin and mechanisms of the introduction of *Undaria* by analyzing mitochondrial DNA polymorphisms. Scientists in Tasmania have reported that disturbance to native algal assemblages is critical to the establishment of *Undaria*, but they also found that *Undaria* declined as canopy-forming native species recovered within the disturbed area.

Where can I read some of the peer-reviewed scientific literature on *Undaria*?

The following references can be obtained at a local university library:

Silva, P.C. et al. 2002. First report of the Asian kelp *Undaria pinnatifida* in the northeastern Pacific Ocean. *Biological Invasions* **4**: 333–338.

J.P. Valentine and C.R. Johnson. 2003. Establishment of the introduced kelp *Undaria pinnatifida* in Tasmania depends on disturbance to native algal assemblages. *Journal of Experimental Biology and Ecology* **295**: 63-90.

Thornber, C.S. et al. 2004. Population ecology of the invasive kelp *Undaria pinnatifida* in California: environmental and biological controls on demography. *Marine Ecology Progress Series* **268**: 69-80.

For more information and pictures of *Undaria*, visit the SIMoN website:

<http://www.mbnms-simon.org/other/moreLinks/invasives.php> and

http://www.mbnms-simon.org/sections/rockyShores/project_info.php?pid=100184&sec=rs



Photo: Judith Calson, San Jose Mercury News, March 8, 2004. Dive volunteer Pete Harvey holds up a large adult, showing the holdfast (at bottom) and sporophyll (upper part).