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Controlling Undaria and Invasive Kelps through Management of the Gametophyte

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Controlling *Undaria* and Invasive Kelps through Management of the Gametophyte

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Background

Undaria pinnatifida is an edible brown kelp cultured off the coasts of Korea, China and Japan. While its proliferation is encouraged and indeed nurtured in these places, in others "wakame" is seen as a terrible nuisance species, a threat to the health of native kelps and therefore the focus of containment and eradication efforts. California is one place where the kelp's presence is unwanted.

Undaria was first discovered in California in the Los Angeles/Long Beach Harbor in 2000 where it was probably introduced on the hulls of commercial ships. It is possible that a piece of the Japanese kelp broke loose from a hull and started a new population, or the tiny gametophyte stage was transported in ballast water. Local ship and boat traffic could then have easily spread it to Santa Barbara Harbor, where it was found in 2001. The kelp has since been identified in waters as far north as Monterey Bay and as far south as Ensenada, Mexico.

Resource managers, fishers and others for whom the kelp may be problematic are eager to minimize its spread. However, efforts to eradicate it by physically removing large plants have not proven effective in Australia, France and elsewhere. This difficulty reflects the kelp's reproductive cycle: *Undaria* reproduces both sexually and asexually.

Large stands of *Undaria*—what we think of when people refer to the kelp—represent the asexual stage of its life cycle. These sporophytes asexually produce millions of minute spores. Each spore is capable of developing into a new phase called the gametophyte, a tiny filament usually about a millimeter or so in length. This is the sexual stage during which eggs and sperm are produced. These fuse, producing a zygote, which in turn grows into another sporophyte, *ad infinitum*. Unless spores are removed, which is virtually impossible because they are microscopic, a treated area is likely to be re-colonized with new plants. This explains the tremendous difficulty in eradicating *Undaria* once it is established.

A large, mature *Undaria* sporophyte. Photo: Marla Ranelletti

Research Goals

California Sea Grant recently funded biology professor David Chapman of UC Santa Barbara to study basic biological questions about *Undaria* so that scientists will be better able to assess its ability to proliferate and out-compete native biota such as *Macrocystis pyrifera* (giant kelp) and *Egregia menziesii* (feather boa kelp).

For reasons already mentioned, the main focus of the research is to better understand the kelp's reproduction. More specifically, Chapman and his graduate student Marla Ranelletti are conducting experiments to assess the degree to which:

- the kelp's gametophyte stage acts as a perennial "seed stock;"
- the kelp can reproduce parthenogenically, i.e., clone itself, and whether
- the kelp can hybridize with local, native kelps.

They are also examining the degree to which the presence of gametophytes or spores of one type of kelp affects the reproductive capability of the gametophytes or spores of other kelps.

Findings

Preliminary laboratory experiments have corroborated the idea that *Undaria* gametophytes from spores act as a "seed stock."

"The gametophytes are like dandelion seeds left in the ground over winter," Chapman said. "They come back and reproduce in spring."

Experiments with *Undaria*, *Macrocystis* and *Egregia* have also shown the following:

1) *Undaria* gametophytes are capable of growing vegetatively (without

Sea Grant Trainee Marla Ranelletti holds a large, mature *Undaria* sporophyte and a smaller *Undaria* sporophyte juvenile. Photo: Marta de Jesus

sexual reproduction) for many years and can then be induced to produce many sporophytes. Under the same laboratory conditions, cultures of *Egregia* and *Macrocystis* produce very few sporophytes, if any at all. Only older *Undaria* gametophytes seem to be successful at producing large numbers of sporophytes.

"This suggests that continuing spore production could produce a continually increasing build-up of seed stock gametophytes that would continue to produce new crops of sporophytes despite efforts at removal," Chapman said.

2) *Undaria* gametophytes increase their reproductive output in the presence of *Egregia* and *Macrocystis* gametophytes, suggesting that gametophytes of different kelps interact in different ways with each other and with other kelp gametophytes and spores. Older gametophytes elicit a different response than younger gametophytes.

Implications

"I would anticipate one of two things will come out of this research," Chapman said. "Because *Undaria* has now been found at Catalina Island and Ensenada, realistically, eradication is out of the question. That is certainly the experience in Australia, France, Argentina and elsewhere."

"What can we do," he said, "if we fully understand the biology of its seed stock, is predict how *Undaria* will influence, interact with, or affect existing kelp beds in this area. Once we know that, then I anticipate one of two things will happen. If we show *Undaria* will not have a major affect—it will be there but it won't be a significant player in kelp beds—my feeling is we will leave it alone while still making efforts to remove new invasions. However, if it proves to be a major competitor, we can anticipate that there may well be an interest to consider harvesting it commercially. This is what is being done in France, and this may also happen in Australia and New Zealand."

Some research, unrelated to this California Sea Grant project, has shown that *Undaria* contains interesting antiviral and other compounds that produce anti-hypertensive effects in rats. Such potential pharmaceutical use could put pressure on the idea of culturing *Undaria* commercially.

Outreach

Another component of this project will be to prepare a brochure illustrating *Undaria*, explaining its dangers and suggesting ways for reducing its spread. Harbor masters, marina managers, park officials and others, including California Sea Grant, will help distribute the brochure to the public.

Collaborations

California Department of Fish and Game
Santa Barbara Harbor staff

Trainees

Marla Ranelletti

Presentations

M. Ranelletti, M. 2004. Competition among kelp gametophytes, round 1: Invasive *Undaria pinnatifida* vs. native *Egregia menziesii*. Annual meeting, Western Society of Naturalists, Sonoma, California, November 11–14, 2004.

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