

# Operation Crayweed



Marine ecologist **John Turnbull** celebrates an inspiring restoration project.

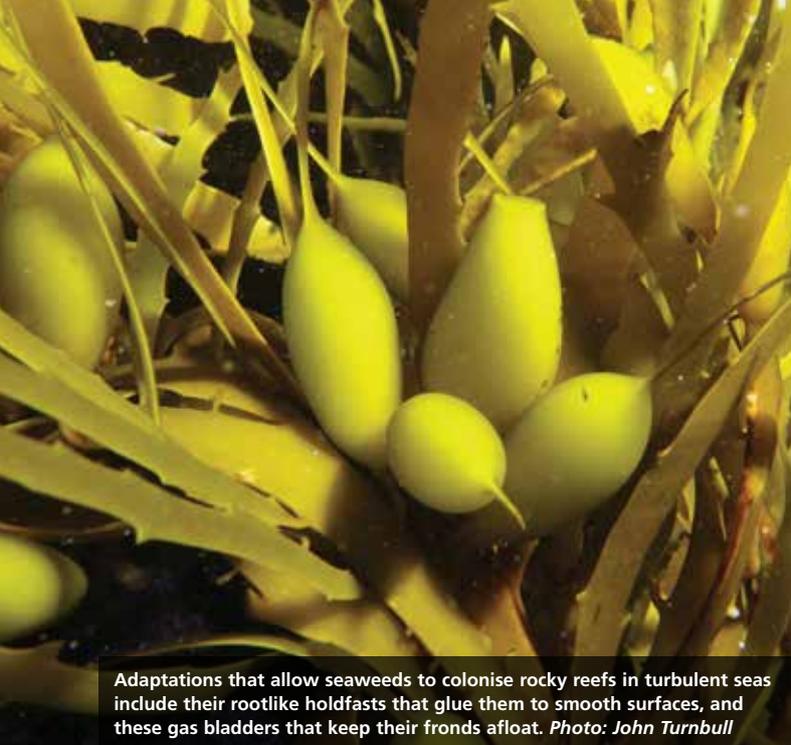
It's dark below the forest canopy, yet vibrant with activity. Abalone and crayfish move around the rocky spaces between stems, and young fish dart out in search of food then back into the safety of the forest. The canopy sways to and fro in a turbulent sea.

The forest consists of crayweed (*Phyllospora comosa*), a brown seaweed with large serrated fronds held aloft by gas-filled bladders. It grows densely on shallow, wave-buffed rocky reefs along the southern and eastern coastline from Robe in South Australia to Port Macquarie, New South Wales, and around Tasmania. But like other large seaweeds in southern Australia, it is declining in many parts.

## A valuable community disappears

Crayweed forests were once common around Sydney but disappeared during the 1970s and 80s, at a time when Sydney's sewage was discharged with only primary treatment into coastal waters. Although we can't say definitely what caused the decline, crayweed embryos are highly sensitive to pollutants commonly

Crayweed is the basis of extensive forests on shallow rocky reefs around southeastern Australia. This brown algae grows up to 2.5 metres tall and provides shelter and food for hundreds of species. Many large seaweeds are declining in southeastern Australia, for reasons including increasing flows of warm, nutrient-poor water travelling south on a strengthening East Australian Current, and the proliferation of black urchins, which eat regenerating seaweed. *Photo: John Turnbull*



Adaptations that allow seaweeds to colonise rocky reefs in turbulent seas include their rootlike holdfasts that glue them to smooth surfaces, and these gas bladders that keep their fronds afloat. Photo: John Turnbull



Marine restoration projects are much rarer than those on land.

By eating algae, black urchins (*Centrostephanus rodgersii*) create bare areas called barrens. It is very difficult for new algae to recolonise these barrens. Photo: John Turnbull

found in sewage. Despite many improvements since then to sewage treatment, including establishing deep ocean outfalls, crayweed has not returned. Recent surveys found not a single crayweed along a 70 kilometre stretch of coastline.

Many of the former forests are now urchin barrens, where black urchins – often at densities of 5 to 10 per square metre – have replaced crayweed as the dominant species. There are also many tent shells, patches of encrusting algae, some barnacles or limpets, and lots of bare rock. The abalone and crayfish have gone, and any young fishes have few places to hide other than rock crevices.

The loss of large seaweeds like crayweed from temperate reefs is akin to losing corals from tropical reefs. Seaweeds are the main primary producers and provide the infrastructure for highly diverse ecological communities. Crayweed forests provide shelter and food for hundreds of species, including many of economic importance, and dislodged and decaying crayweed (wrack) is an important food source for abalone and is part of detrital food webs that support species such as mulloway and bream.

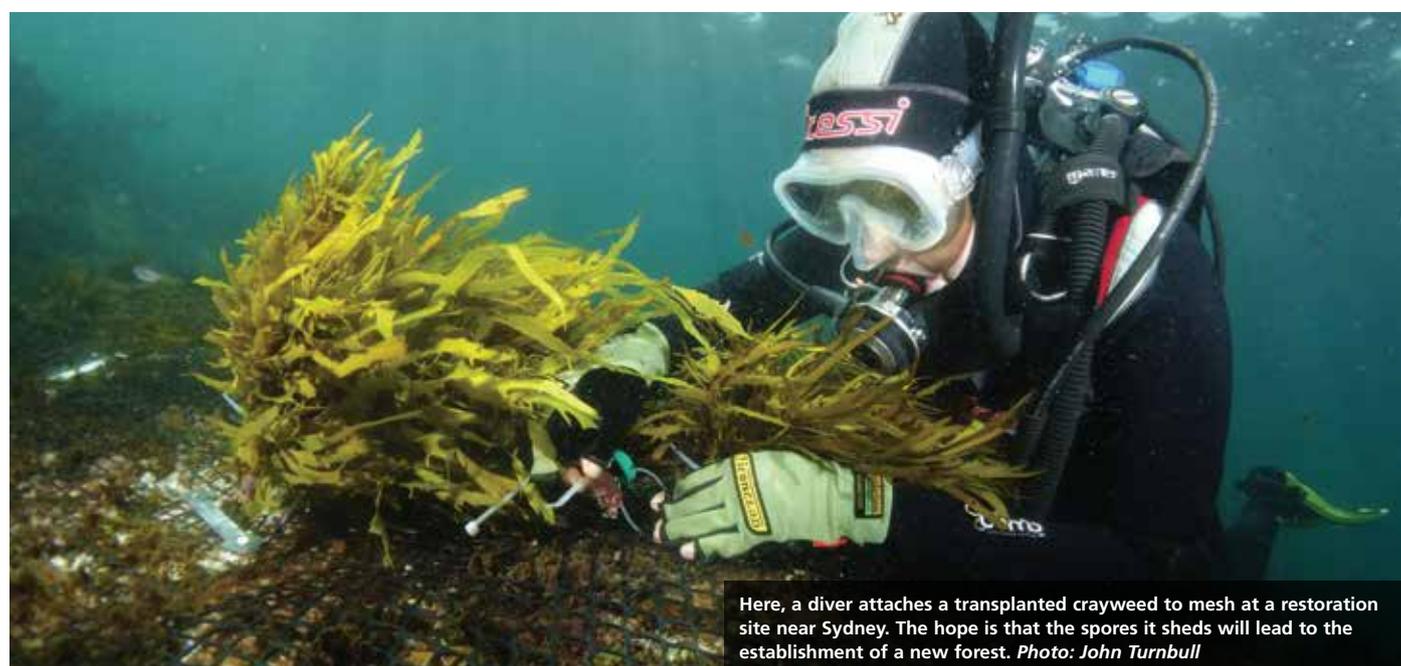
Extensive forests of kelp (*Ecklonia radiata*) also provide important habitat around Sydney and along the rocky coasts of

southeast Australian, but they differ in the species they support. Healthy crayweed beds, for example, can host 10 times more abalone than kelp forests and a more diverse array of urchins as well. Crayweed cannot be functionally replaced by another seaweed, for the ecological community it supports is unique.

### Trials bring hope

After reporting the crayweed problem in 2008, scientists at the University of New South Wales conducted a pilot study to investigate methods for restoration. With the help of volunteers, several crayweed restoration sites around Sydney were established and monitored. The results were mixed: some sites were lost, probably due to storm damage, and herbivores such as black urchins, but others survived, inspiring hope that we may be able to re-establish crayweed forests.

Marine restoration projects are much rarer than those on land, for the logistics are often daunting, particularly for seaweeds. Unlike plants, seaweeds do not have roots, and cling to rock using a holdfast. They must be mechanically anchored, and these anchors are often susceptible to damage by waves. It's also difficult to erect barriers to protect seaweeds from herbivores, ►



Here, a diver attaches a transplanted crayweed to mesh at a restoration site near Sydney. The hope is that the spores it sheds will lead to the establishment of a new forest. Photo: John Turnbull



Despite their ecological importance, seaweeds have nowhere near the public profile of corals. This installation at Sydney's Sculptures by the Sea 2016, created by Jennifer Turpin and Michaelie Crawford in collaboration with crayweed scientists, was very successful in raising awareness about the importance of seaweeds and the promise of crayweed restoration. Photo: Ian Hobbs Media

**Citizen science plays a central part in Operation Crayweed.**

particularly in areas subject to high energy waves. And we still have much to learn about ecological processes in the ocean that affect seaweeds, such as how their zygotes spread and establish, and the impacts of grazing by urchins.

### Driven by vision and science

Five years ago, Operation Crayweed was launched – with the aim, says Adriana Vergés, one of the lead project scientists, ‘to bring crayweed back to reefs where it once flourished, as well as raise awareness among the general public about the importance of seaweed forests in temperate reefs.’ The scientists anticipate that restoring crayweed will also bring the return of species like abalone and crayfish.

The project, headquartered at the Sydney Institute of Marine Science, is being funded by the NSW Environmental Trust, the Recreational Fishing Trust and the Habitat Action Grants program. Scientists took this ambitious project to the community, and extended the base funding through a crowdfunding campaign which attracted over 500 supporters and raised close to \$40,000, almost double the target.

Restoration starts with a careful survey to find the best sites. Crayweed likes waves, so a balance must be struck between sites with sufficient surge to support healthy plants but not so much as to make logistics too difficult and lead to damage or loss in a storm. To date, restoration sites have been established at Little Bay, Long Bay, Cape Banks, South Bondi and Kurnell, and another dozen are in preparation. On the chosen sites, a durable mesh is anchored to the rock at several depths. Mature crayweed plants are harvested from areas beyond Sydney where they are abundant, and brought to Sydney in large mesh bags. Divers – a mix of scientists and volunteers – attach the mature crayweeds to the anchored mesh. This is challenging, as each plant must be attached by cable ties while waves wash overhead.

Mature crayweeds cannot reattach their holdfasts, so long-term re-establishment depends on reproduction. Male and female plants release gametes that produce zygotes, which settle nearby. Protecting these juveniles in the early stages of their growth is important, particularly if they settle in urchin barrens, where they are likely to be eaten. How best to do this needs research. Erecting barriers to exclude urchins is difficult, and ‘weeding’ out black urchins is untested and labour intensive.

### With the help of friends

Citizen science plays a central part in Operation Crayweed. Volunteers are attracted to the idea of restoring underwater forests and have risen to the challenges posed by crayweed’s love of wave

surge. The project has also captured wider community attention through a growing concern about the plight of underwater ecosystems. Out of sight need not mean out of mind.

We saw this last year at Sculptures by the Sea, Australia’s largest annual outdoor sculpture exhibition. Artists Jennifer Turpin and Michaelie Crawford worked with the crayweed restoration team to create an ambitious installation along the shoreline of the south Bondi restoration site. It consisted of colourful crayweed-themed decorations stretching 500 metres, a viewing platform and marker buoy, all brought to life by school children dressed up in sculptures representing octopuses, crayfish and other crayweed forest residents. Thousands of visitors walked along the waterfront, and social science researchers found strong interest in marine conservation and support for crayweed restoration, exemplified by statements such as:

*Marine habitats are the biggest in the world; it’s extremely important to preserve these habitats. Coastal habitats are so important.*

*I’m still exploring all the marine life; it’s very different to what we see on land, so it’s very exciting.*

*Operation Crayweed is just amazing – it’s awesome that people like you are making a difference.*

By pioneering new techniques, engaging citizen scientists, and combining art with science, Operation Crayweed is pushing the boundaries of marine restoration. ■

**READING:** Marzinelli EM, Campbell AH, Vergés A, et al. 2014. Restoring seaweeds: does the declining furoid *Phyllospora comosa* support different biodiversity than other habitats? *Journal of Applied Phycology* 26(2):1089–96 ■ Coleman MA, Kelaher BP, Steinberg PD, Millar AJK. 2008 Absence of a large brown macroalga on urbanized rocky reefs around Sydney, Australia, and evidence for historical decline. *Journal of Phycology* 44(4):897–901 ■ Campbell AH, Marzinelli EM, Vergés A, et al. 2014. Towards restoration of missing underwater forests. *PLOS ONE* 9(1):e84106

**VIEWING:** Operation Crayweed: [vimeo.com/147158074](https://vimeo.com/147158074) ■ Restoration at south Bondi: [vimeo.com/186118316](https://vimeo.com/186118316) ■ Sculpture by the Sea: [youtu.be/QjM3mdCwVhM](https://youtu.be/QjM3mdCwVhM)

**JOHN TURNBULL** is a marine ecologist and social researcher at the University of New South Wales. He is president of the Underwater Research Group of NSW, a passionate marine photographer and founder of [www.marineexplorer.org](http://www.marineexplorer.org).