

# ILLUSTRATIVE EXAMPLE 1: RESTORE



Healthy re-generated crayweed forests at low tide  
Source: Patagonia Once lost Now returned Photo Justin Gilligan.

## Location and spatial patterns

Crayweed (*Phyllospora Comosa*) is a species of brown macroalgae growing up to 2.5 metres in length in dense underwater beds, also referred to as forests, to depths of 5–18 metres.

The crayweed found on the temperate rocky reefs from Port Macquarie to Tasmania are a part of Australia's Great Southern Reef.

## Characteristics

Crayweed ecosystems support high levels of biodiversity including fish and invertebrates such as abalone and crayfish. As well as providing food and habitat, crayweed provides detritus (decaying plant matter) to adjacent ecosystems and soft sediment habitats such as seagrasses. Crayweed supports a unique biodiversity not found in places dominated by other seaweed species. For example, crayweed supports 7–10 times more abalone than other seaweed species in the region and has a diversity of microbes on its surface, not found on other seaweed species.

## Forest lost

The once abundant crayweed on Sydney's rocky reefs began disappearing in the 1980s but went unnoticed and unreported until 2008 by which time the loss, attributed to sewage pollution, extended for 70 km along the Sydney coastline.

*'The local disappearance of crayweed from the most urbanised stretch of coastline on the Australian continent was linked to the high volumes of poorly treated sewage that used to flow onto Sydney's shores before the construction of deep ocean outfalls in the 1990s. These outfalls and improvements in wastewater treatment practises have vastly increased water quality around Sydney since the 1980s, but despite this, crayweed has failed to recover.'*

Source: <http://www.operationcrayweed.com>

## OPERATION CRAYWEED

The aims of Operation Crayweed are **RESTORATION** and **SUSTAINABILITY**. This means restoring crayweed to bare surfaces where healthy forests once grew to a level when reproduction and growth are self-sustaining. Restoration began in 2011 as the signature project of the Sydney Institute of Marine Science (SIMS).

The method developed by scientists involves transplanting healthy, fertile adults from places north and south of Sydney where populations are plentiful, by attaching them to rocks on biodegradable mesh frames. Volunteers play an important role in Operation Crayweed restoration projects at many sites and, in 2021, the Gamay Indigenous Rangers worked with scientists at Kurnell.

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**WATCH** the following short videos to learn more about the restoration process:

- The Operation Crayweed Story at <https://vimeo.com/228955452>
- Marine Explorer Operation Crayweed <https://vimeo.com/186118316>
- Sixty Second Docs <https://www.facebook.com/60SecDocs/videos/1629220030612813>



Aerial and submarine photographs showing restoration in action (left & centre), 'Craybies' are evidence of successful recruitment, at Kurnell, 2021 (right)  
Photos: Operation Crayweed Facebook Group, diver and craybies John Turnbull; Aerial view Haig Gilchrist

**The desired outcome** – to produce 'craybies' in the transplanted patches that would then attach themselves to the rocky reef surfaces to form new, self-sustaining populations that would expand to cover the bare rocky reef over time. Once the Crayweed habitat is re-established biodiversity would return.

**Funding** – was provided by government and non-government organisations, businesses, and individuals. These include the NSW Department of Primary Industries, the Australian Research Council, the John T Reid Foundation, the Evolution & Ecology Research Centre of UNSW Sydney and the Sim-Lutton and Breen Initiatives. Restoration at Newport in March 2021 for example, was funded by Patagonia and the site at Freshwater, originally planted in 2016 was extended in 2020 with the support of local government through the Warringah Communities Environment grant. A full list of supporters is on the Operation Crayweed website [here](#).

## Locations

Transplanting has taken place at eleven locations along 70 km of the Sydney coastline including Cabbage Tree Bay, Freshwater, Kurnell, Long Bay and Little Bay, North and South Bondi, Coogee and Newport.

## Evaluation

The success of Operation Crayweed has been evaluated using visual observations, scientific monitoring, and a criteria-based tool created by the Society for Ecological Restoration. Video productions, websites and academic articles illustrate the success of Operation Crayweed in kelp forest restoration at all sites on the Sydney coastline.

The transplanted crayweed in the first trials (2011) and subsequent plantings have had survival rates of around 70%, much the same as those in natural populations and surprisingly, higher reproduction and birth rates.

The 'babies' of transplanted, fertile adults had firmly attached to rock up to hundreds of metres from originally restored patches and had themselves become reproductive.

*'... as of 2019, transplanted crayweed has reproduced in six locations such that multiple generations are now identifiable, often hundreds of meters from the original restored patches. These restored crayweed forests have become self-sustaining without the need for additional cost or maintenance, which is a rare result in marine restoration. This relatively small-scale intervention has translated into a large-scale impact/benefit, with crayweed populations continuing to expand and colonize substantial areas and beginning to function as natural forests.'*

Source: Kelp Forest Restoration in Australia <https://www.frontiersin.org/articles/10.3389/fmars.2020.00074/full>

In a study published in 2020, *Kelp Forest Restoration in Australia*, Operation Crayweed was judged the most successful marine restoration project in Australia to date, however the conclusion was also drawn that a longer time frame was needed to see if full restoration across all trophic levels is achieved.

The Society for Ecological Restoration (SER) assessment tool known as the '5-star recovery system' was applied to Operation Crayweed to evaluate its success. The system uses a set of criteria to assess key ecosystem attributes using indicators for kelp forest restoration such as transplant survival, growth rates, genetic diversity, and recruitment. Juvenile recruitment was identified one of the best indicators of successful restoration to build kelp forest resilience.



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*'For Operation Crayweed, the mean attribute score was 3.7, indicating that restoration of crayweed forests at the local of the initial loss is well under way, with high levels of recruitment and good progress toward development of associated communities and ecosystem functions that are on a self-sustaining trajectory.'*

Source: Kelp Forest Restoration in Australia <https://www.frontiersin.org/articles/10.3389/fmars.2020.00074/full>

## Challenges moving forward

- 1. Workload and cost** – initially, about 5 days is required at each site for site marking and preparation, securing mesh mats for crayweed attachment, collection of crayweed and transplanting. Estimated costs include:
  - \$US 6,850 per site for a 4-person team, boat and tow-vehicle, SCUBA tank fills, equipment and consumables.
  - \$US18,500 p.a. for project management and monitoring at multiple sites

Source: Kelp Forest Restoration in Australia <https://www.frontiersin.org/articles/10.3389/fmars.2020.00074/full>

- 2. Project scale** – restoration projects have been completed at a small to medium local scale with high levels of success. Scalability of kelp forest restoration to the seascape-scale at which crayweed losses have occurred remains a challenge.

## Education and emotional engagement: Bringing community on the journey

Educating the public about the value of kelp forests has become an important component of Operation Crayweed and the work of scientists involved in kelp restoration Australia wide. Volunteers have played an important role in replanting crayweed across sites in Sydney, but the challenge since the project began has been to make the public more aware of these important ecosystems and to care about their future.

In the words of marine ecologist and Associate Professor at UNSW Adriana Verges, *'education does not make people care'* and you need to emotionally engage people to get them to care. In 2019 Adriana won UNSW Sydney's Emerging Thought Leader prize for her ability to merge science, the arts and powerful storytelling to make issues visible and inspire the community to respond to environmental crises.

*"Art can be a particularly effective way to communicate science because it engages with people at an emotional level."*

Source: Adriana Verges [https://www.secondnature.org.au/bringing\\_back\\_our\\_underwater\\_forests\\_q\\_a\\_with\\_adriana\\_verg\\_s](https://www.secondnature.org.au/bringing_back_our_underwater_forests_q_a_with_adriana_verg_s)

Several successful initiatives aimed at engaging the public emotionally in Operation Crayweed include:

- 1. Operation Crayweed Artwork Installation, Bondi 2016** (At Sculptures by the Sea)

This project involved an environmental installation, participation activities and a performance developed to engage the community with the 'invisible' underwater restoration site at Bondi. Scientists and artists ran workshops with school children who created and paraded wearable sculptures of marine creatures that would return to the restored crayweed forests in the future. A local school band performed 'We All Live in the Yellow Crayweed' and a community swimming group performed a synchronised swim at the replanting site.



Right: Bondi public artwork installation and event.

One of three viewsopes above the site; Student parade and public performance. Source: <https://turpinclawfordstudio.com.au/work/operation-crayweed-art-work-site>

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## 2. Primary School restoration site visits.

Visit the Operation Crayweed Facebook page to learn more about how local schools such as Clovelly and Woollahra Public Schools are engaging with kelp forest learning and restoration – <https://www.facebook.com/OperationCrayweed>

3. *Manly Seaweed Forests Festival 2021* was a mix of science, art and food with panel discussions and workshops with scientists and leading thinkers and an art installation, 'Seaweed Arboretum'. Learn more about this successful community engagement festival and listen to the podcast series about Operation Crayweed and The Great Southern Reef at <https://www.seaweedforestsfestival.com/podcasts/>

For more details visit the Operation Crayweed website at <http://www.operationcrayweed.com> and follow Operation Crayweed on Facebook.

## References

Operation Crayweed, Sydney Institute of Marine Science <http://www.operationcrayweed.com>

*Kelp Forest Restoration in Australia* Cayne Layton, Melinda A. Coleman, Ezequiel M. Marzinelli, Peter D. Steinberg, Stephen E. Swearer, Adriana Vergés, Thomas Wernberg and Craig R. Johnson. Sourced July 20, 2021, from *Frontiers in Marine Science* at <https://www.frontiersin.org/articles/10.3389/fmars.2020.00074/full>

Adriana Vergés – <https://www.youtube.com/watch?v=Vnpepl2X8Uw&t=83s>

Bringing back our underwater forests: Q&A with Adriana Vergés – [https://www.secondnature.org.au/bringing\\_back\\_our\\_underwater\\_forests\\_q\\_a\\_with\\_adriana\\_verg\\_s](https://www.secondnature.org.au/bringing_back_our_underwater_forests_q_a_with_adriana_verg_s)

Project under way to bring rock lobsters and abalone back to Kurnell waters – [https://www.theleader.com.au/story/6853567/ocean-habitat-returns/?fbclid=IwAR1LusUFXHB5ivPTy\\_QVNwjQi3vaoibMukJNzXaZCyBu4I1ALby1pzCCusg](https://www.theleader.com.au/story/6853567/ocean-habitat-returns/?fbclid=IwAR1LusUFXHB5ivPTy_QVNwjQi3vaoibMukJNzXaZCyBu4I1ALby1pzCCusg)

Manly Seaweed Forests Festival – <https://www.seaweedforestsfestival.com>

Seaweed Forest Festival podcasts <https://www.seaweedforestsfestival.com/podcasts/>



Panel Discussion about Climate Change at the Manly Seaweed Forests Festival 2021. Source Manly Seaweed Forests Festival Website at <https://www.seaweedforestsfestival.com/resources/>

Operation Crayweed Facebook page – <https://www.facebook.com/OperationCrayweed>

Turpin Crawford Studio: Operation Crayweed Art-Work Site <https://turpincrawfordstudio.com.au/work/operation-crayweed-art-work-site> & <https://vimeo.com/299624551>

Reforestation of the Ocean from Reasons to be cheerful – <https://reasonstobecheerful.world/reforesting-the-ocean/?fbclid=IwAR3zly7-5jSpnWvSle0jqlhTxPwnzNbo1TFEJIJjXKQk5yKaMPcyornYaLo>

Australia's Ocean Odyssey <https://iview.abc.net.au/show/australia-s-ocean-odyssey-a-journey-down-the-east-australian-current>

Once lost Now returned – [https://www.patagonia.com.au/blogs/roaring-journals/operation-crayweed-once-lost-now-returned?fbclid=IwAR1z42cdtYegF603HB2TAexdQ1V9MA1rXk4nGDWa1B\\_oScnzY-OY-ov9fhw&utm\\_source=facebook&utm\\_medium=social&utm\\_campaign=w20\\_brand\\_enviro\\_eco\\_awareness](https://www.patagonia.com.au/blogs/roaring-journals/operation-crayweed-once-lost-now-returned?fbclid=IwAR1z42cdtYegF603HB2TAexdQ1V9MA1rXk4nGDWa1B_oScnzY-OY-ov9fhw&utm_source=facebook&utm_medium=social&utm_campaign=w20_brand_enviro_eco_awareness)

360 Degree image – <https://www.facebook.com/OperationCrayweed/photos/2634251320036252>

Operation Crayweed Balgowlah North PS – [https://www.youtube.com/watch?v=WmM\\_VT9iOes](https://www.youtube.com/watch?v=WmM_VT9iOes)