Threatened plant translocation case study:

Posidonia australis (Strapweed), Posidoniaceae

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The species

- Species of seagrass, also known as marine flowering plants or angiosperms.
- Slow-growing and long-lived species.
- Endemic to temperate Australian waters, listed as Endangered in 2012 (*NSW Fisheries Management Act 1994*) and 'Threatened Ecological Community' in 2015 (*Australian Environment Protection and Biodiversity Conservation Act 1999*).
- Distributed sub-tidally on soft sedimentary environments in shallow and mostly sheltered waters.

Threatening processes

- Catchment disturbance and pollution.
- Coastal development.
- Dredging.
- Boat mooring and other boating-related activities.
- Invasive species.

Deciding to translocate

Posidonia australis meadows occur in six NSW estuaries (Port Hacking, Botany Bay, Sydney Harbour, Pittwater, Brisbane Waters and Lake Macquarie) have experienced large reductions in distribution since the mid-1900s. It is at risk of becoming locally extinct in some estuaries due to ongoing impacts.

One of the ongoing impacts for loss of *P. australis* in NSW estuaries is traditional swing moorings (Glasby and West 2018). These moorings are composed of a large concrete block connected to a heavy chain that drags along the seafloor as the boat swings on its axis due to shifting wind and tides, directly removing seagrass shoots (Demers *et al*. 2013). Swing moorings create bare patches or scars that destabilise the sediment and change hydrodynamic conditions, resulting in fragmented meadows (Figure 1).

Natural recolonisation of bare patches by *P. australis* is very slow, taking over 20 years for a single scar to be revegetated naturally (Meehan and West 2000). The present restoration project was therefore started to determine whether *P. australis* shoots can be transplanted to promote seagrass recovery in these bare patches.

Figure 1. Effects of boat moorings in Shoal Bay, Port Stephens, NSW. The remaining seagrass is visible as dark patches surrounded by some bare light-coloured sand where moorings scour the seafloor. Photo: Tim Glasby

Aim of the translocation

Seagrass restoration is still a young science; however, recent works have produced encouraging results (Bastyan and Cambridge 2008; McLeod *et al.* 2018). In NSW, an important limitation for *P. australis* restoration is the low level of sexual reproduction (Gobert *et al*. 2006) and the unsuitability of harvesting source shoots from declining protected meadows. This project aimed to find a solution: 'Operation Posidonia' asks citizen scientists to collect detached shoots washed up on the beach after storms, which are then used to revegetate damaged meadows.

Translocation working group and key stakeholders

'Operation Posidonia' is a team composed of investigators from the following institutions:

- Centre for Marine Science and Innovation, UNSW Sydney – responsible for planning, planting,

performing ongoing monitoring and maintenance of the transplanted site.

- NSW Department of Primary Industries, Fisheries – responsible for collection and maintenance of fragments in tanks prior to transplant, planting and involved in planning and development of restoration methods.
- School of Biological Sciences and Oceans Institute, University of Western Australia – providing guidance with regards to planning, improving techniques and planting.
- Citizen scientists are volunteers from the Port Stephens Community – assisting with on-shore collections of naturally detached fragments and including 18 community groups.
- Anchorage Marina – collection spot where volunteers can store freshly collected shoots and keep them submerged until collection by NSW DPI staff.

Biology and ecology

- *P. australis* has a large root system for anchorage and nutrient uptake from soft sediments, and a rhizome network for nutrient storage and translocation to aboveground shoots consisting of 2-5 leaves. Growth can be vertical (orthotropic rhizome), or horizontal (plagiotropic rhizome) by ramifying across the seafloor through vegetative reproduction. Although sexual reproduction (seeds born from fertilized flowers that develop within fruit) has been reported, it is rare in NSW populations (Gobert *et al*. 2006).
- *P. australis* creates extensive and structurally complex meadows that provide habitat for a wide variety of invertebrates and fishes.
- *P. australis* is slow to recover from physical damage and damaged meadows may take years to become re-established, even after the apparent cause of damage is removed.

Site selection

Port Stephens is near the central coast of NSW and has a large area of seagrass (14,000,000 m^2) but also numerous swing moorings within seagrass meadows (Glasby and West 2018). Boat moorings have been responsible for a loss of 30,556 m^2 of *P. australis* (Glasby and West 2018), making Port Stephens the second most impacted estuary by boat moorings in NSW. Port Stephens was selected to optimise restoration techniques because it is within a Marine Park where *P. australis* is a dominant species and is the headquarters of DPI Fisheries, who lead the development of the novel seagrass transplanting methods.

Translocation proposal

This proposal was funded by the NSW Environmental Trust under its Restoration and Rehabilitation grants program. Key contributions from local volunteers were secured after extensive consultation with local stakeholders including scientists, boat mooring owners, local aquaculture managers, journalists specialising on marine matters and members of Community Groups from within the OCCI (Ocean and Coastal Care Initiatives) organisation.

'Operation Posidonia' (www.OperationPosidonia.com**)** was launched via a public event at the Anchorage Marina (the main collection point for detached *P. australis* fragments). Social media sites were used to attract volunteers and share updates. Short films were produced to explain the importance of *P. australis*, threats posed by boat moorings and to explain the life-cycle of the project. Public outreach also involved presenting to high school classes and giving presentations to local community groups.

Pre-translocation preparation, design, implementation and ongoing maintenance

'Operation Posidonia' outreach program has enabled the collection of more than 1000 *P. australis* fragments between October 2018 and April 2019. Fragments consist of shoots with attached rhizome. A pilot trial began in May 2018, replanting 267 fragments within two boat mooring scars (10 plots of 1 m x 2 m). Planting and monitoring were carried by SCUBA-divers (Figure 2). The fragments were anchored with wire pegs into old mooring scars consisting of either bare sediment (with or without stabilising jute-mats) or patches colonised by faster-growing seagrasses.

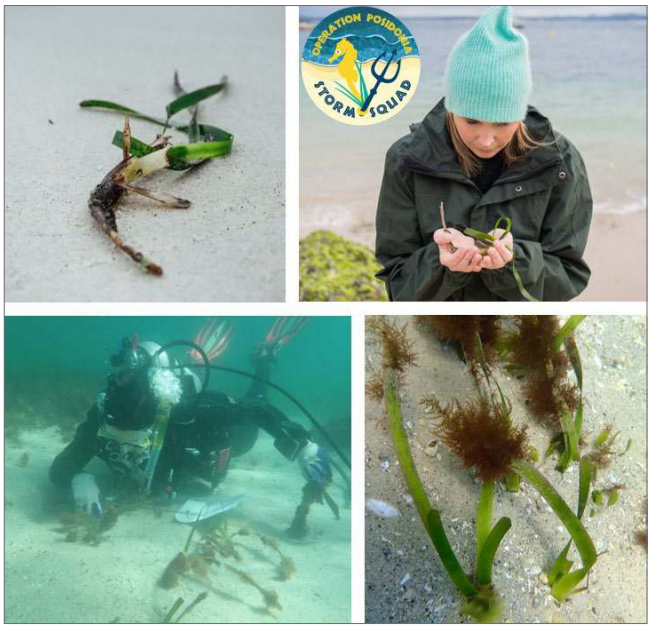

Figure 2. *Posidonia australis* transplantation sequence. Top left: Example of a fragment suitable for restoration; top right: beach collection by volunteers part of 'Operation Posidonia Storm Squad'; bottom left: Planting fragments into bare sand; bottom right: fragments nine months post planting. Photos: Harriet Spark, Adriana Vergés and Giulia Ferretto.

After 4 months, we recorded on average 55% shoot survival with plots with jute-mats reaching 70% survival. Nine months later, some fragments had grown new shoots, with overall shoot density increasing and approximating our starting shoot densities, indicating fragments had overcome initial transplant stress, and were now established and growing.

Subsequent actions

After encouraging results from the pilot trial, the first round of restoration began in January 2019, revegetating in four additional boat mooring scars. 432 fragments were planted in 18 plots of 1 m x 2 m using different techniques (restoring on bare sediment with or without stabilising jute-mats and on scars colonised by faster-growing seagrasses). Monitoring is currently taking place every two months. The morphological traits of all transplanted shoots were measured prior to planting, including leaf length and width, rhizome length and type of growth (horizontal/vertical). Fragments were also tagged with a unique ID that includes collection details such as location and date. This information will aid in identifying the factors that most influence restoration success.

Outcomes

Initial results indicate that fragments of *P. australis* collected from the shore and transplanted into a healthy and suitable environment can show high survival. After nine months, there is evidence that the fragments have overcome initial transplant stress and become established, producing new shoots to recover to initial planting shoot densities. Ongoing monitoring will determine whether individual traits of restored shoots or specific planting techniques (e.g., using jute mats to stabilise sediment) influence restoration success. This information will then be used to optimise future restoration programs.

What we learned

- Beach-collected detached fragments of *P. australis* can overcome transplant stress in less than a year.
- *P. australis* beach-collected fragments can establish within old boat mooring scars and grow.
- Beach-collected fragments are an effective, non-destructive source of planting units for use in restoration.
- Direct community engagement is an effective conservation and restoration tool that provides on-ground assistance and can raise awareness and community buy-in.

References and further reading

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