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When a Shoot Needs a Meadow to Thrive

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The coastal seas are home to some of the most productive and diverse marine ecosystems on our planet. The health and ability of these ecosystems to function are primarily influenced by the presence of habitat-forming species, such as coral and shellfish reefs, seagrass meadows, and macroalgal forests.

The coast is also home to a large fraction of the human population. Historically, we have settled near the coast, and coastal regions continue to experience higher population growth and urbanisation rates compared to inland areas.

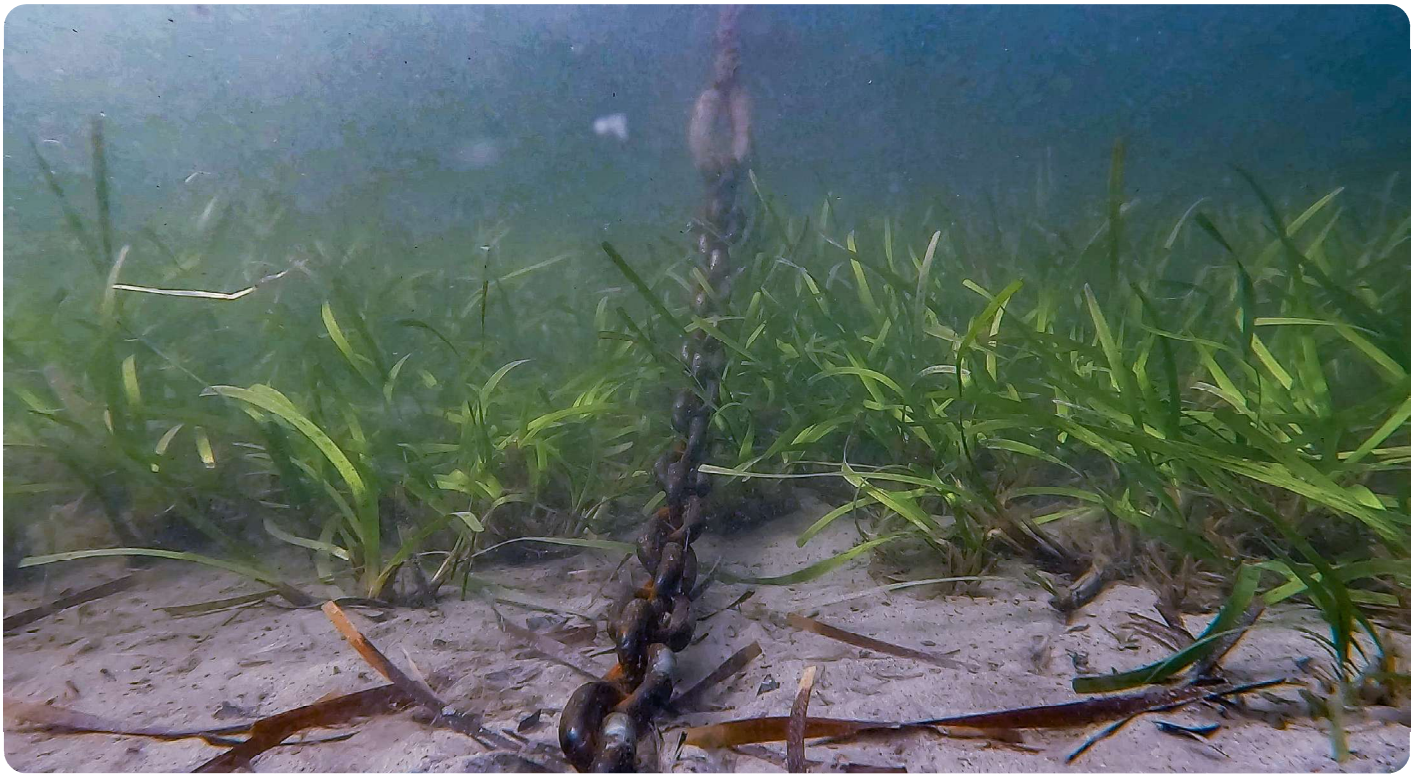
A Story of Severe Loss and Continued Decline

The spatial proximity of high human population density and marine biodiversity is not without consequences for the marine environment. The infrastructure we build, the waste we create, and our activities can adversely affect neighbouring marine habitat-forming species. As the human population grows, so does the pressure from anthropogenic stressors such as physical modification of coastal areas, water and sediment pollution, climate change, natural resource overexploitation, and introduction of non-native species. Nearly two-thirds of coastal regions are now under extreme or high anthropogenic pressure.

Consequently, the cover, complexity, and functioning of marine habitat-forming species have severely declined along with their associated biodiversity. Such is the case for seagrass meadows. While questions remain regarding their global cover and trajectories, their global declines are estimated at around twenty-nine to sixty-five percent lost, which are still declining today. Unfortunately, this is a significant loss of a habitat that is essential for ocean health and biodiversity. Seagrass meadows provide food, shelter, and act as a nursery for an abundance of other species. Their presence further stabilises marine sediments, attenuates waves, and improves water clarity – services that we benefit from and rely upon.

Getting Over the Restoration Hump

It is, therefore, essential that efforts are made to restore the meadows that have been lost. However, restoration of seagrasses is complex, and the success rates are generally low. One reason is that seagrass meadows affect the ecosystem by ameliorating environmental stressors, such as wave action, sediment movement, and sediment hypoxia. As such, a well-established meadow provides shelter from these stressors, thereby improving conditions for new seagrass shoots to establish. This process is called self-facilitation and is achieved only once the meadow reaches a specific size and density.



A chain from a block-and-chain mooring drags along the seabed, clearing all seagrass within its reach and creating a bare path of sediment in the meadow. Image: Ann Flemming Nielsen.

The reliance of seagrasses in self-facilitation processes is partly what makes their restoration difficult because once a meadow is lost, so is the shelter it provides. Consequently, conditions may remain unsuitable for establishing new shoots, even when the original driver of seagrass decline has been removed.

Without the meadow, the site may shift into an alternative state that is stabilised by these emergent environmental stressors, as any new shoots are likely to succumb to them, resulting in a restoration threshold – a particular scale and density restoration efforts must exceed for the ecosystem to shift back. However, this might not be possible due to limited funds, resources, or availability of donor material. And with seagrass meadows continuously declining, it might increasingly be the case that restoration is needed in areas where no natural meadow remains to shelter new shoots.

Fake It Till the Shoots Make It

This challenge gives rise to the following question, which is the research question of my PhD project: can the restoration of seagrass be improved by introducing an engineered structure that mimics the role that a natural meadow would otherwise play? This restoration approach aims to artificially ameliorate environmental stressors and shelter new seagrass shoots, allowing them to take hold and grow until they are established well enough for self-facilitation to occur. Such an engineering measure may thus reduce the amount of donor material needed to reach the restoration threshold and increase the likelihood of shifting the ecosystem back from bare sediment to a thriving meadow.

Several studies have seen promising results using this approach for restoring marine habitat-forming species, but its potential has not yet been fully investigated for native seagrasses in Australian waters.

Seagrass Restoration in Lake Macquarie, New South Wales

Australia is home to the endemic seagrass species ribbon weed (*Posidonia australis*). It is a slow-growing species with broad leaves and a dense root system. In New South Wales, it has suffered severe declines and is today listed as an endangered species. In Lake Macquarie, its decline has partly been caused by traditional block-and-chain boat moorings. When the wind and waves move the boat around, the chain drags along the seafloor, ripping up the seagrass and creating a bare patch in the meadow – a so-called scar. Monitoring these scars has shown that even when the mooring is removed or replaced by an environmentally friendly mooring, the scars are unlikely to recover by themselves. This result is partly due to the slow-growing nature of *Posidonia australis* and the increased sediment movement within the scar, as the meadow is no longer there to stabilise it. Therefore, emergent shoots risk getting buried before they can be adequately established.

A dense meadow of ribbon weed (*Posidonia australis*) is found in the shallow waters of the sheltered bays within Lake Macquarie. Image: Ann Flemming Nielsen.

In this case, structures that mimic the root-stabilising ability of the seagrass meadow might ameliorate this stressor, thus increasing the chance of survival for new shoots. This project aims to test this hypothesis in different scars in Lake Macquarie that are subject to various stress levels. By transplanting seagrass shoots onto a sediment-stabilising and biodegradable structure, we aim to achieve a higher restoration success rate with a reduced need for donor material. As *Posidonia australis* continues to decline, methods aimed at increasing restoration success may be essential to help turn the tide.

Acknowledgements

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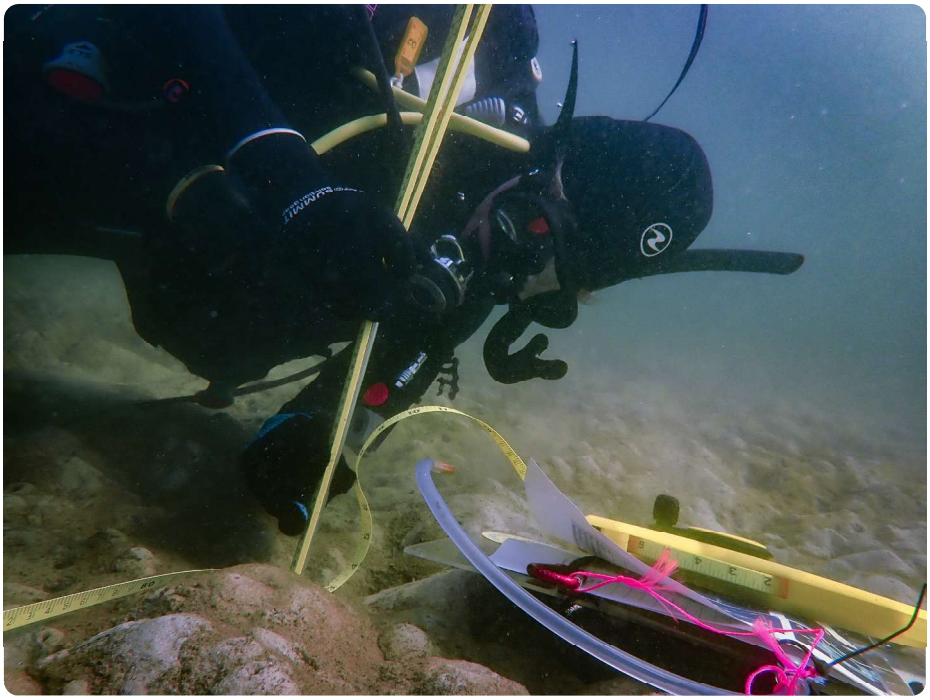
Funds provided by the Australian Wildlife Society covered the cost of biodegradable EcoSystem restoration Elements – biodegradable lattice structures used for ecosystem restoration that help reduce local currents and waves, provide stability and shelter, and settling opportunities for organisms.



Rods are placed in transects across the seagrass scars and measured to estimate the magnitude and direction of sediment movement. Image: Chanelle Webster.