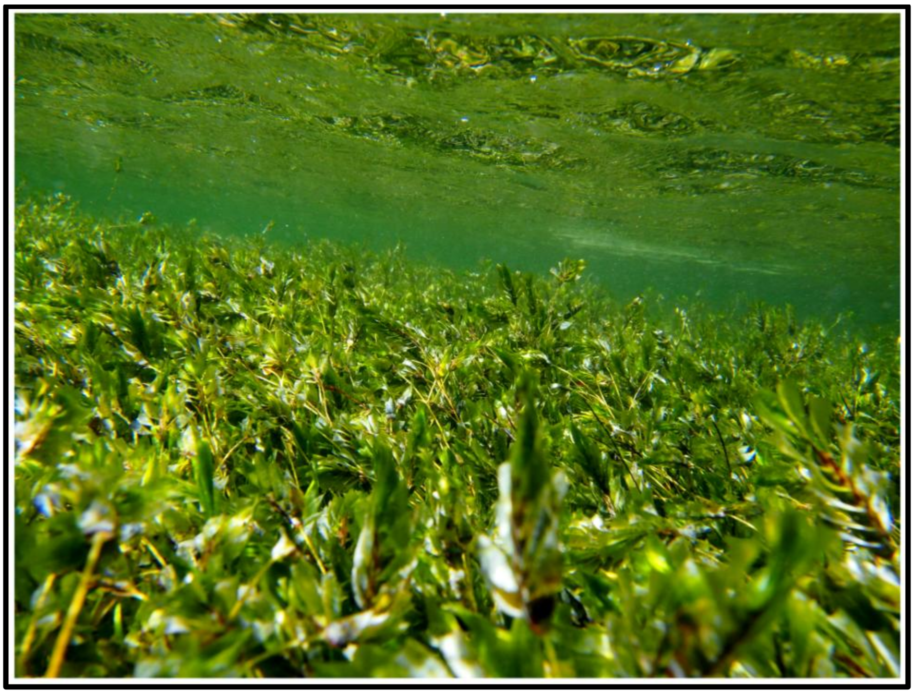
STABILITY AND RECOVERY OF COASTAL ECOSYSTEMS TO LOCAL AND GLOBAL RESOURCE ENHANCEMENT



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Cover Image: *Amphibolis Antarctica* meadow, Lady Bay, Fleurieu Peninsula, South Australia. Photo credit: Sam Langholz.

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ABSTRACT

Human modification of the abiotic environment can cause profound change to biological communities, yet many ecosystems that face intensive anthropogenic pressure can persist without undergoing major change. To understand the inherent stability of many systems facing human driven environmental change, we need an account of the mechanisms that allow ecosystems to withstand such change. Whilst it is well known that resource enhancement favours the growth of subordinate or weedy species over habitat-forming perennials, less is known about the inherent ability of herbivores to counter this increased growth. Throughout this thesis, I assessed whether such resource enhancement can encourage herbivores to compensate for the additional productivity of opportunistic algae that can cause the decline of seagrass habitats and the displacement of kelp forests.

Human activities can modify resource availability on local (e.g. nutrients) through to global scales (e.g. carbon dioxide). Anthropogenically derived nutrients can increase local resource availability in coastal zones, stimulating the overgrowth of seagrass by epiphytic algae, leading to the decline of seagrass habitats. By experimentally manipulating nutrient concentrations and herbivore abundance, I showed that herbivores are capable of reducing the effects of local nutrient addition in a seagrass ecosystem by consuming the increased production of epiphytic algae. Importantly, this work showed that although nutrient addition increased food availability, herbivore abundance did not increase in the grazed treatments, suggesting that the greater consumption of algae was due to an increase in *per capita* grazing and not grazer abundance.

Concurrent with the local enrichment of nutrients is the global accumulation of carbon dioxide (CO_2), which can act as a resource for photosynthetic organisms that are carbon limited. Indeed, I found that experimental enrichment of both nutrients and CO_2 proved to have a greater influence on the expansion of algal turf than the provision of either resource alone, but only in the absence of herbivores. Elevated nutrients and CO_2 increased herbivore consumption, which was proportional to an increase in herbivore metabolism.

Where resource enhancement is ongoing, however, the influence of such change can overwhelm countering forces (such as herbivory) to the extent that the production of opportunistic algae escapes regulation and perennial species may be lost (e.g. seagrass decline on urbanised coasts). As the global loss of seagrass continues, efforts are made to restore lost meadows with the principle aim of restoring ecosystem function (e.g. faunal recolonisation). I used experimental restoration plots of known ages (1, 3 and 5 years) to test the rate of recovery of epifaunal composition and seagrass structure to that in an adjacent natural seagrass meadow. I found that whilst seagrass structure and epifaunal composition took three years to become similar to the natural meadow, epifaunal richness and abundance took one year. These results have suggested that recovering habitats may support similar ecosystem function as natural habitats before the full recovery of seagrass meadows themselves.

Restoration success is generally measured as the recovery of aboveground seagrass structure; which ignores the important role of the belowground element of a seagrass meadow that may not recover at the same rate. After quantifying the recovery of the aboveground components of the seagrass restoration plots, I determined the recovery of belowground components. I quantified elements of infaunal composition (e.g. richness and abundance) and belowground seagrass structure of the same experimental restoration plots. I found that infaunal abundance and richness was similar to the natural seagrass after two years, the recovery of belowground biomass, however, took four to six years. These results have confirmed the suggestion that recovering habitats can support similar ecosystem function to natural habitats before the full recovery of seagrass *per se*.

In summary, compensatory mechanisms may play a pivotal role in enabling ecosystems to resist change and remain stable during periods of resource enhancement. Indeed, I demonstrated that compensatory responses were directly proportional to the magnitude of disturbance (or multiple disturbances) by resource enhancement. When ecosystems are lost as a result of resource enhancement, however, habitat restoration can be applied to re-establish ecosystem structure and function. I showed that recovering habitats may not need to be structurally similar to natural habitats in order to support similar ecosystem function. Recovering habitats may therefore have greater economic and social value than otherwise might have been expected.

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