SEAGRASS ECOLOGY AND PHYSIOLOGY IN A LOCALLY AND GLOBALLY CHANGING ENVIRONMENT

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Cover Image: A short-spined sea-urchin (*Amblypneustes pallidus*) within a seagrass meadow (*Posidonia* sp.). Photo credit: Owen Burnell

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THESIS ABSTRACT

Human beings can modify the abiotic conditions and biotic interactions that shape natural ecosystems. The primary aim of my thesis was to elucidate local- and global-scale anthropogenic changes of importance in shaping seagrass habitats, by examining how a number of both established and forecasted conditions can modify biotic interactions between seagrass and their consumers (i.e. grazing herbivores), as well as interactions between seagrass and their competitors (i.e. algal epiphytes). I approached this from both a top-down (i.e. consumer driven) and bottom-up (i.e. resource limitation) perspective.

I begin by examining how urchin-epiphyte-seagrass interactions can modify habitat loss in local seagrass beds. This was motivated by the observation that the seagrass species *Amphibolis antarctica* appeared to suffer disproportionately under the influence of herbivore expansions. To this end, I found the recovery rate of the seagrass *Amphibolis antarctica* was much slower following grazing damage than contiguous meadows of *Posidonia sinuosa,* which appeared to result from the distinct morphological differences between these two seagrasses (i.e. elevated vs. basal meristems, respectively). Given these emerging urchin effects and the legacy of seagrass loss from nutrient enrichment, next I investigated how these processes (i.e. top-down vs. bottom-up) might interact to shape the maintenance or loss of seagrass habitats. I found that the independent negative effects of urchins and nutrients do not combine in an intuitive manner, but rather eutrophic conditions reduce the *per capita* grazing of urchins on seagrass, as they appear to acquire greater nutrition from increasing food quality.

After documenting these emerging local changes to seagrass, I examined how forecasted global changes, in particular increases in dissolved CO_2 could modify future seagrass meadows. From a resource limitation perspective I examined the carbon physiology of three seagrass species, consistently finding they were reliant on energetically costly bicarbonate acquisition under contemporary CO_2 conditions. Subsequent growth experiments at enriched CO_2 uncovered this contemporary limitation could translate to greater growth for seagrass under future CO_2 due to lower energetic requirements for photosynthesis. However, I also examined the implications of changing CO_2 resources on epiphyte-seagrass interactions, finding under certain abiotic conditions, such as high light, opportunistic epiphytes are strong competitors that could inhibit future seagrass growth. Finally using urchin-seagrass interactions as a simplified model ecosystem, I found global increases in both temperature and CO_2 could increase top-down grazing control on seagrass meadows, as it appears the physiological demands on some grazing herbivores (i.e. ectotherms) could be greater in a high CO_2 world.

In conclusion, I add to the growing evidence for top-down grazer effects on seagrass, highlighting population expansions of urchins can drive strong, but variable, effects on seagrass, dependent upon species vulnerability and nutrient status of meadows. In reference to global change, I highlight the importance of biotic interactions in modifying the response of seagrass habitats to forecasted CO_2 levels. Thus, the future of habitat-forming producers should not be inferred or assumed *a priori*, but requires rigorous tests of how anthropogenic change modifies the interactions between organisms across all trophic levels.

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