Quantitative Marine Science

Thesis Abstract

# Climate change and a range-extending sea urchin: catastrophic-shifts and resilience in a temperate reef ecosystem

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The barrens-forming sea urchin *Centrostephanus rodgersii* (Diadematidae) has undergone recent poleward range-extension to eastern Tasmania. Coincident with the arrival and expansion of the sea urchin population is a warming coastal regime driven by increased southward penetration of the East Australian Current (EAC). Underlying the climate-driven incursion of the sea urchin is a temperate ecosystem that has been heavily exploited. This thesis provides a case study of recent catastrophic-shift from seaweed dominated reefs to sea urchin dominated barrens and identifies two processes acting to alter this temperate reef system: 1. Climate change - resulting in the poleward migration of a habitat-modifying species; and 2. Fishing - resulting in reduced ecosystem resilience.

Examination of *C. rodgersii* population dynamics across the extension-region reveals that recent warming has led to a coastal regime where sea temperature is suitable for *C. rodgersii* larval development (>12 ºC) during its' major winter spawning. Furthermore, the timing of the sea urchins' arrival, age-structure and spatial distribution across the extension-region is consistent with patterns in sea temperature and dispersal potential driven by the EAC. As in the species historic range, *C. rodgersii* in eastern Tasmania is now found in association with barrens habitat; and field experimentation reveals that creation of barrens by this sea urchin results in local losses of approximately 150 taxa that associate with Tasmanian seaweed beds. Furthermore, seaweed-sea urchin dynamics are observed to be broadly consistent with that observed from within the sea urchins' historical range suggesting that the ecological importance of *C. rodgersii* will be similar across the extension-region.

Field experiments identify the spiny lobster (Palinuridae) as the chief predator of *C. rodgersii* within the extension-region and trials inside/ outside Marine Protected Areas (where size and abundance of lobsters has recovered following cessation of fishing) demonstrate that *C. rodgersii* survival is decreased in the presence of large predatory lobsters. Indeed, the predatory interaction between lobsters and *C. rodgersii* is highly size-specific with only lobsters well above the harvested size-limit physically capable of predating on *C. rodgersii*. Importantly, such predatory capable lobsters have been functionally extirpated from much of the Tasmanian coastline due to intensive fishing for well over a century. The culmination of this thesis is that fishing, by removing large predators, equates to a reduction in seaweed bed resilience and therefore increased risk of catastrophic overgrazing by *C. rodgersii* in the face of warming climate.