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Sea-weeding and coral IVF – ecological, biological, and genetic effects of reef restoration

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The Great Barrier Reef (GBR) supports a diverse ecosystem that provides economic benefits through industries such as tourisms and fisheries. However, coral cover on the GBR has halved in recent decades[1,2]. The drivers of coral decline urgently need to be addressed; however, active interventions offer avenues for increasing local-scale reef resilience[3,4].

Macroalgae flourish under conditions of high terrestrial runoff, increased sedimentation and nutrient loading; conditions characteristic of several inshore GBR reefs[5]. These conditions can prompt a shift from coral dominance to a less desirable macroalgae-dominated community, with the return of coral dominance rare once macroalgae communities have established[6]. Removal of macroalgae is proposed as one local-scale measure to promote reef recovery through increasing growth of existing coral colonies and enhancing available space for coral recruitment. However, one intervention by itself is unlikely to be sufficient for lasting benefits. Larval capture during mass coral spawning followed by targeted release can enhance recruitment, proving effective at re-establishing breeding populations on degraded reefs[7]. Used in consort, macroalgal removal and larval release have potential to shift algal dominated reefs back to a coral dominated state. The outcomes of my work will provide critical information for managers to make decisions regarding active reef interventions globally.

The objective of my research is to develop approaches to reverse reef health decline on the GBR and provide solutions to successfully manage them into the future. I will quantify the ecological, biological, and genetic impacts of two restoration techniques: macroalgae removal and enhanced recruitment. Case studies show success of these approaches though they have not been rigorously tested on the GBR, nor have their potential benefits been assessed together. Importantly, the potential for genetic bottleneck using any restoration technique is poorly understood. Using a fully crossed experimental field design and a highly interdisciplinary approach, I will test if macroalgal removal and larval capture and release increase coral juvenile settlement and survival and thus increase benthic coral cover, and develop best practice recommendations to maintain genetic diversity.

Three bays around Magnetic Island (Arthur, Florence, Geoffrey Bay) have been selected with twelve 5x5m quadrats established in each bay consisting of three replicate plots for each of four treatments: 1) macroalgae removal only; 2) larval enhancement only; 3) macroalgae removal and larval enhancement; and 4) control (monitor only) (Figure 1). Baseline abundance of coral, macroalgae, fish and other species within each plot will be established for all sites prior to any intervention. A wide range of parameters will be monitored in each plot throughout the study, including: benthic cover and species composition (assessed using photographs, point intercept transects, and cryptic crawls), algal biomass (a measure of number of holdfast and canopy height), algal growth/regrowth rate, number and species of fish present (assessed using visual surveys and field collections using enclosed clove-oil stations), sediment dynamics (suspended sediments and deposition rates), water quality (chlorophyll, suspended matter, particulate nutrients, dissolved nutrients), coral photobiology (assessed using Pulse Amplitude Fluorometer), and recruitment rate of juvenile corals (assessed using coral settlement tiles). Algae will be removed by hand by citizen scientist SCUBA divers and biomass weighed.

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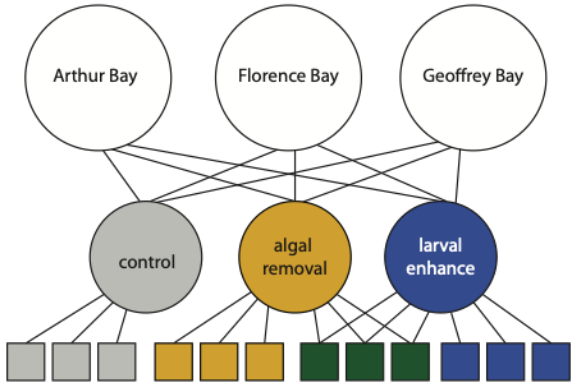

Figure 1. Experimental design schematic.

For the larval enhancement component gravid adult coral colonies are collected prior to spawning from sites at Magnetic Island and transported to the National SeaSimulator (SeaSim) at AIMS to spawn. Spawned gametes are allowed to fertilise and embryos and larvae cultured. When larvae become competent to settle they are transported back to Magnetic Island and released within fine mesh enclosures to ensure they settle within the established treatment plots.

To determine if the two restoration approaches have the potential to enhance coral cover, settlement plates will be established in each experimental plot. Ten plates will be deployed in each plot, and will be examined under a specialised microscope to identify and count juvenile corals at 48 hours post spawning, 2 weeks post spawning, and every 3 months thereafter. The number of recruits will be analysed to determine the restoration potential of each method.

The genetic diversity of the current (i.e. pre-restoration) Magnetic Island coral population will be assessed by collecting up to 50 tissue samples of each of 3 representative species (*Acropora tenuis, Montipora aequituberculata, Porites lutea*) in each bay. The parent colonies for the larval enhancement component described above will also be sampled. Tissue samples will be stored in liquid nitrogen to allow for a wide variety of assays (DNA, RNA, microbiome, proteome). Prior to the spawning event each year, all juvenile corals in each plot will be sampled for DNA. The genetic diversity of newly settled juveniles each year will be compared to the original population genetic diversity, and data will be analysed to determine the parentage of successful settlers (i.e. captive parent, wild Magnetic Island parent, migrant from other reef).

The project has already commenced in a pilot phase, and thus continuing financial support is critical to secure consumables associated with the project and additional field expenses for ongoing monitoring efforts. The project is expected to run for at least 5 years, with intensive field work occurring in the spawning season each year (October/November). A proposed budget for start-up costs and the first year of monitoring is below.

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total project cost (first year)	$158,828.8
total already funded	$119,142
remainder outstanding	$39,686.8

References:

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