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Using marine ecoengineering to mitigate biodiversity loss on modified structures in the Waitematā Harbour.

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Abstract

The construction of infrastructure on the foreshore is an unavoidable consequence of an ever-expanding human population. Traditionally, this infrastructure has replaced soft-substrates with hard substrates. Furthermore, even for native biota which occupy hard substrates, the flat, featureless construction of most marine infrastructure provides little habitat heterogeneity and results in depauperate communities with little biotic resistance against non-indigenous species. Marine ecoengineering provides a possible solution to this global phenomenon by using intelligent construction techniques that promote the accumulation of native biodiversity. Here, I used eco-engineered settlement plates to examine the effect of habitat complexity on the biodiversity of communities inhabiting existing. Additionally, we examined the effects of climate change driven increases in rainfall on the performance of ecoengineered substrates in the mid-intertidal zone. Last, we reviewed and synthesised the available literature on the species present in The Waitematā Harbour and, to the best of my knowledge, provide the most complete species lists to date.

In chapter two, we transplanted eco-engineered settlement plates seeded with local bivalve, *Perna canaliculus*, onto an existing seawall and monitored the accumulation of biodiversity. Overall, we show that both structural and biological habitat heterogeneity enhanced the biodiversity of the seawall community. Additionally, we found that the cemented pavement of volcanic rock that constituted the existing seawall, accumulated biodiversity faster than flat concrete settlement plates, supporting the use of this type of seawall construction over flat concrete seawalls. However, benefits to biodiversity could be further enhanced by explicitly adopting ecoengineering designs that provide crevices for intertidal organisms.

In chapter three, we examined the performance of ecoengineered substrates under the prediction that climate change will enhance rainfall by 20% in the Auckland region. While no effect of increased rainfall was observed for the mobile invertebrate community or the flat plates, increased rainfall did influence the biodiversity of the fouling community on the ridged plates, likely as a consequence of reduced desiccation stress. Although this was only a short-term experiment we predict that given time to develop, a distinct fouling community could influence the diversity mobile invertebrate community, shifting the whole community vertically up the seawall.

The review of the Waitematā taxonomy presented in chapter four, provides a reference for future studies of the biodiversity of the Waitematā harbour as well as identifying several gaps in our understanding, a cause for concern. Specifically, we show that non-indigenous species make up a considerable proportion of the fouling species listed for the Harbour and suggest that some of this could have been avoided by the adoption of ecoengineering techniques.

Overall, this thesis recognises that habitat heterogeneity, be it natural or man-made, is a vital driver of biodiversity. Each chapter provides additional insight, supporting the benefits of marine ecoengineering. These positive results within the Waitematā Harbour show potential for larger scale experimental trials and for the broader application of these techniques in other locations. By implementing intelligent design and eco-friendly materials in marine infrastructure, we can reduce the impact on local intertidal communities and indirectly reduce the spread of non-indigenous species.

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