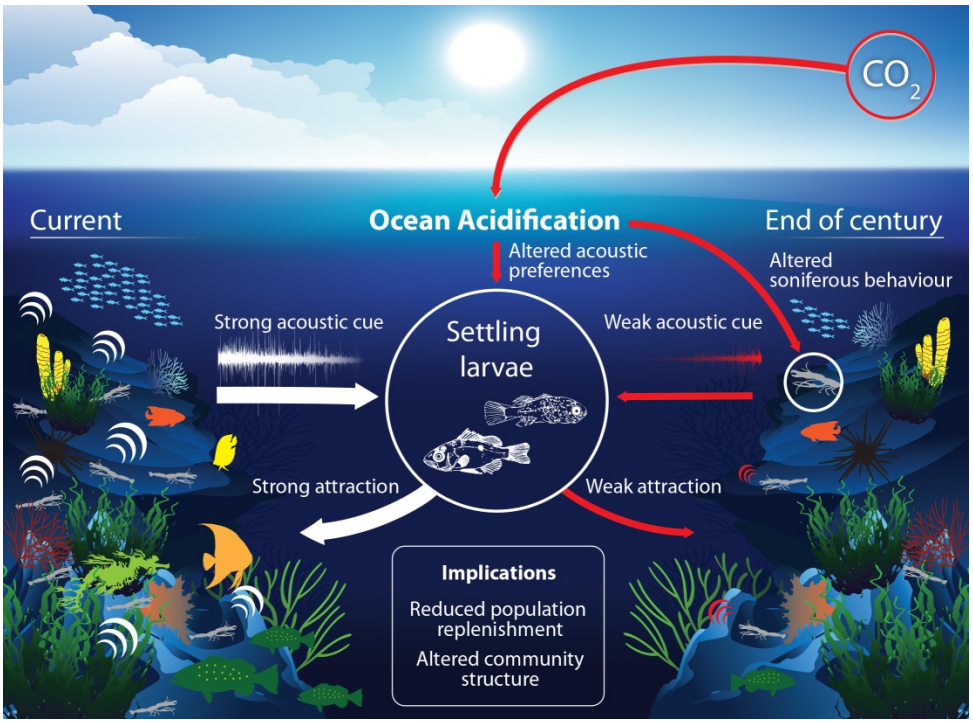
THE EFFECTS OF OCEAN ACIDIFICATION ON SOUND PRODUCTION AND RECEPTION IN MARINE ANIMALS



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Cover Image: Conceptual diagram showing the direct and indirect effects of ocean acidification on settlement-stage larvae in relation to marine sounds and hearing. Ocean acidification will directly impact settling fish larvae by altering their auditory preferences and indirectly by weakening the quantity and quality of the biological soundscape which is used as a long-distance cue for orientation by oceanic larvae of many species.

Artwork credit: Tullio Rossi

DECLARATION

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CHAPTER 2

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CHAPTER 3

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CHAPTER 4

This study was supported by Australian Research Council (ARC) Future Fellowship to Ivan Nagelkerken (grant no. FT120100183) and Sean D Connell (grant no. FT0991953), and a grant from the Environment Institute (The University of Adelaide). Figure 4 credit: Tullio Rossi and IAN University of Maryland Centre for Environmental Science.

CHAPTER 5

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ABSTRACT

The dispersal of larvae and their settlement is fundamental to replenishment of marine populations and their connectivity. During their ontogeny, larvae progressively develop behavioural and physiological capabilities that allow them to effectively identify, locate and reach suitable settlement habitats making the settlement process far from being a stochastic event. This process typically involves multiple senses, including audition, olfaction and vision. Sound propagates well in water with little attenuation and plays a critical part of this process because the larval stages of many species use it as a long distance cue for orientation towards suitable settlement habitat. Because marine coastal soundscapes are largely of biological origin, they not only carry information about the location and proximity of potential habitat, but also information about the quality of habitat. Ocean acidification has profound effects on marine life, but its effect on biological sound production and its reception by navigating oceanic larvae remains largely unknown. In this thesis I show that ocean acidification can profoundly decrease the total acoustic output of coastal habitats as measured at natural CO_2 vents. This change is largely due to the negative effect of ocean acidification on the soniferous behaviour and potentially the abundance of the noisiest invertebrate in the ocean, the snapping shrimp. Laboratory experiments showed that a quieter soundscape indirectly penalizes oceanic larvae by being a less attractive settlement cue. Remarkably, ocean acidification also caused a switch in role of preferred soundscape cues from attractor to repellent in the auditory preferences of fish larvae of two economically important species, barramundi and mulloway. Furthermore, ocean acidification boosted larval development but made fish larvae swim slower. This thesis reveals an increased risk to the complex process of larval settlement through a combination of direct and indirect effects driven by ocean acidification. Such alterations will likely have far-reaching consequences for the population

replenishment of marine organisms that utilize soundscapes orientation as part of their life history strategy.