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Environmental factors that promote coral recovery following warm water bleaching

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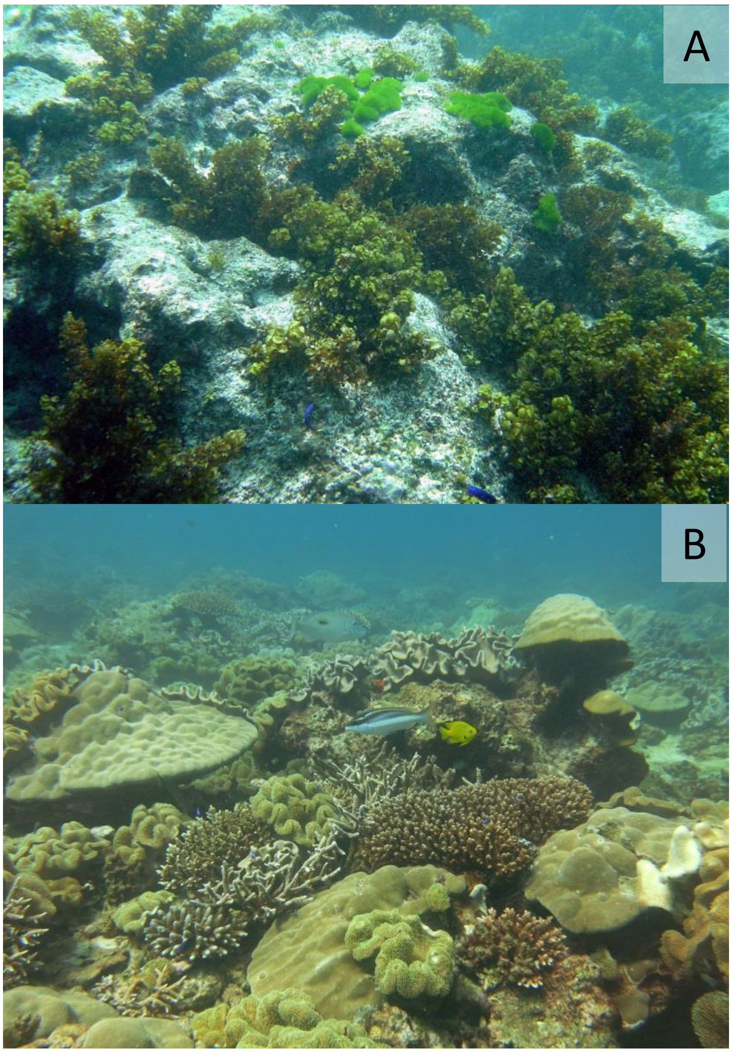
Background

Hard, or scleractinian, corals form the foundation of many tropical reefs which shelter coastlines from oceanic waves and provide habitat for fish and invertebrates of high conservation and/or commercial value. The health of corals is currently threatened by the increasing occurrence of abnormally warm water events or "heat waves". These events stress corals and break down their symbiotic relationship with the microscopic algae that live within their tissues and provide much of the colour and energy required for growth and survival. As a consequence corals appear "bleached" when heat stressed and will often die if the stress persists.

In 2011 and 2016 warm water anomalies caused extensive coral bleaching and mortality on many Western Australian reefs. Some reefs off the coast of Western Australia, are however inherently resilient to these warm water events and may recover to a similar state of coral cover within 10 years if conditions are favourable. Unfortunately, other reefs may not recover, becoming locked into alternate stable states where benthic communities are dominated by taxa such as fleshy macroalgae rather than hard corals. Under this scenario fish and invertebrate communities may be permanently altered, biodiversity reduced and ecosystem services such as coastal protection and fisheries compromised.



Coral reefs at the Seychelles Islands that have shifted to a macroalgal dominated state (A) or recovered with new coral growth (B) following bleaching in 1998.

Understanding how WA's important coral reefs at places like Ningaloo Marine Park recover from such disturbances can be informed by long-term studies at overseas locations where similar events have occurred. Importantly, such international studies can provide long-term data on reefs that have been exposed to coral bleaching under a range of different environmental conditions.

Parks and Wildlife marine scientist Dr Shaun Wilson is involved in a long-term study of coral reefs at the Seychelles Islands in the western Indian Ocean. Over seventeen years, these reefs, which were severely bleached in 1998, have provided insights into the recovery of corals, which can be directly applied to managing WA's marine parks and reserves.

Findings

The Seychelles study has identified five key factors that promote the recovery of coral and reduce the likelihood of disturbed reefs becoming covered in macroalgae.

1. Herbivorous fish remove algae and provide space for corals. Coral recovery is favoured when the biomass of herbivorous fish exceeds 177kg.ha^{-1}.

2. Nutrients in the water are rapidly taken-up by macroalgae and encourage their proliferation. Carbon/Nitrogen ratios in macroalgal fronds greater than 38 are indicative of good water quality that improves the probability of coral recovery.

3. Coral recovery is dependent on the supply of larvae and survival of juveniles. Recovery is favoured when the density of juvenile corals on the reef exceeds 6.2 per m^2.

4. Reefs deeper than 6.6 m are more likely to recover as they may be less suitable for macroalgal growth and less susceptible to additional bleaching impacts.

5. The structural complexity of reefs influences key ecological processes and complex reefs support a higher diversity of animals. Recovery of corals is more likely when there is widespread reef structure greater than 30-60 cm high.

Coral reefs with high numbers of herbivorous fishes (biomass >177kg.ha-^{1}) (above) and plentiful recruitment and survival of juvenile corals (abundance > 6.2 m-^{1}) (below) are more likely to recover following widespread coral bleaching and mortality.

Management Implications

Research on coral reefs in the Seychelles Islands and other tropical locations can provide critical management knowledge for WA's important coral reefs. The five key factors listed above can be easily measured on WA reefs and can provide managers with an indication of how disturbance events like coral bleaching will affect reefs and how they will recover.

Coral reefs at Ningaloo and the Rowley Shoals, for example, have steep reef slopes where deep water close to the reef can act as refuges from disturbance, while others areas have high levels of structural complexity that are also known to encourage coral recovery. Maintaining healthy populations of herbivorous fish and good water quality is also essential for high resilience on coral reefs. We can measure which reefs lack these features and are likely to exhibit low resilience when disturbance events occur.

This knowledge can be used in marine reserve planning, as measures like reef depth and complexity can be collected over large spatial scales, providing a basis for predicting which reefs are most likely to be resilient to climate disturbances. Coral recovery is also strongly linked to the reliable supply and survival of coral larvae, so knowledge of reef connectivity can be important when planning networks of marine reserves.

Further information: Graham NAJ, Jennings S, MacNeil MA, Mouillot D, Wilson SK (2015). Predicting climate-driven regime shifts versus rebound potential in coral reefs. **Nature** 518: 94-97.

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