Marine protection enhances kelp forest stability

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Abstract

Ecosystem states:

- Urchin barrens
- Mixed algal forests
- Algal turfs
- Kelp forests

Shallow temperate reefs are typically dominated by macroalgal forests, but overfishing may shift these highly productive ecosystems to denuded urchin barrens. No-take marine reserves can restore predatory interactions that generate cascading effects that reverse the shift to urchin barrens. However, the long-term effects of protection on kelp (*Ecklonia radiata*) forest ecosystem stability and the role of reserves in reversing or preventing shifts to algal turf has not been examined. Using 20 years of monitoring data from New Zealand’s oldest marine reserve (Leigh; est. 1977), we explored temporal variation in ecosystem state under no-take protection and compared this to nearby fished reefs. Fished habitats fluctuated between urchin barren, algal turf, and occasionally algal forest states, while reserve sites were dominated by algal forests with a clear trajectory towards monospecific kelp forests. Protection increased the resilience and resistance of kelp forests through a net positive effect on
macroalgae, and a net negative effect on sea urchins and turfs. Stability was higher in the reserve, where fewer shifts occurred and ecosystem variation was smaller, compared to fished reefs. We conclude that long-term no-take protection is effective in promoting stable kelp forest ecosystems.

Keywords

Resilience / resistance, Phase shifts, Urchin barrens, Algal turfs