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Strengthened enforcement enhances marine sanctuary performance

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HIGHLIGHTS

- We used a BACI design to test whether greater enforcement improved marine sanctuary performance.
- New enforcement initiatives resulted in a 201% increase in annual fine rate.
- Greater enforcement resulted in more target fish in the marine sanctuary compared to fished areas.
- Strengthened enforcement can help underperforming marine sanctuaries meet conservation goals.

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ABSTRACT

Marine sanctuaries are areas where the extraction of biota is not permitted. Although most marine sanctuaries have a positive influence on biotic communities, not all sanctuaries are meeting their conservation objectives. Amidst possible explanations (e.g., size, age and isolation), insufficient enforcement is often speculated to be a key driver of marine sanctuary underperformance. Despite this, there are few studies directly linking quantitative enforcement data to changes in biotic communities within marine sanctuaries. Here, we used an asymmetrical-BACI experimental design from 2006–2012 to test whether new enforcement initiatives enhanced abundances of target fishes and threatened species in an existing large sub-tropical marine sanctuary relative to areas open to fishing. Implementation of the new enforcement initiatives in 2010 was associated with a 201% increase in annual fine rate and a significant increase in target fish and elasmobranch abundance, as well as sightings of a critically-endangered shark, in the marine sanctuary relative to areas open to fishing. Overall, these results demonstrate that strengthening enforcement can have a rapid positive influence on target fish and perhaps threatened species in a subtropical marine sanctuary. From this, we contend that increased enforcement guided by risk-based compliance planning and operations may be a useful first step for improving underperforming marine sanctuaries.

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1. Introduction

Global concern for marine conservation has driven an unprecedented increase in the establishment of marine protected areas (MPAs) (Edgar et al., 2014; Halpern et al., 2010). A small percentage of these MPAs are marine sanctuaries (or marine reserves), in which the extraction of living resources is not permitted (Gaines et al., 2010). Marine sanctuaries have an important role in conserving biodiversity (Edgar et al., 2014), and may also contribute to sustainable fisheries (e.g., Harrison et al., 2012). Although marine sanctuaries generally have a positive influence on marine environments, not all sanctuaries meet their conservation objectives (Guidetti et al., 2008).

In order to maximize the conservation benefit of marine sanctuaries, researchers have distilled a number of key attributes associated with positive environmental outcomes (e.g., size and degree of isolation, Edgar et al., 2014, or habitat quality, intensity of surrounding exploitation, Roberts, 2000). There is, however, growing recognition of the necessity of compliance with regulations to ensure long-term conservation benefits (Byers and Noonburg, 2007; Guidetti et al., 2008; Kelaher et al., 2014). It has been postulated that enforcement and compliance is essential to ensure positive ecological outcomes; otherwise an MPA may be protected in name only (Claudet and Guidetti, 2010; McCook et al., 2010).

An essential goal of effective marine sanctuary management is, therefore, to maximize compliance with regulations. Stakeholder incentives, careful planning, education and outreach programs contribute to this goal (Read et al., 2011). However, it is the deterrent created by effective legislation and enforcement that often drives high levels of compliance (Shimshack, 2007). Effective enforcement of marine sanctuary regulations routinely involves risk-based prioritization of illegal activities and tactical enforcement strategies aimed at optimal deployment of available resources (e.g., NSW Marine Parks Authority, 2009). Ultimately, the deterrent effect relies on those being regulated believing that there is a reasonable probability of being apprehended and, if caught, that the penalty will outweigh the benefits of non-compliance (Rossiter and Levine, 2014; Shimshack, 2007).

We evaluated the influence of strengthened enforcement of the Cape Byron Marine Park (CBMP) (22,000 hectare multi-use marine park on the North Coast of New South Wales (NSW), Australia) on the performance of the largest marine sanctuary (Cape Pinnacle sanctuary, IUCN Protected Area Categories II) inside the park. The zoning plan for the CBMP commenced on the 1st of May 2006, after which activities within the park (e.g. fishing, commercial use, development and recreational activities) were regulated by the *NSW Marine Parks (Zoning Plans) Regulation 1999*, as well as previously existing legislation (Kelaher et al., 2014). At that time, the compliance team in the CBMP included a specialist compliance officer supported by two rangers (with broader responsibilities) guided by a risk-based tactical compliance plan; a level of enforcement that would be considered high on a global scale (see Edgar et al., 2014).

In June 2009, a state-wide compliance plan was introduced that aimed to create an effective deterrent against illegal activities in marine sanctuaries and prioritize operations accordingly (NSW Marine Parks Authority, 2009). By mid-2010, this plan led to an additional specialized compliance officer for the CBMP, standardized guidance to ensure consistent enforcement responses against illegal fishing in a marine sanctuary and the reporting of all enforcement actions to a state-wide database for analysis and review. The standardized enforcement guidelines removed the discretion of officers to issue verbal cautions by ensuring that the minimum penalty for fishing in a sanctuary was a $500AUD fine or, given defined extenuating circumstances, an official written caution. Together with risk-based compliance planning, these new enforcement initiatives resulted in improved enforcement across the CBMP, including the Cape Pinnacle sanctuary.

Given that enforcement of the CBMP was already relatively high, it was not clear whether the new compliance initiatives would improve sanctuary performance. To address this, we used an asymmetrical before-after-control-impact (BACI) comparison to test the hypothesis that strengthened marine park enforcement would significantly increase the abundance of target fishes in the Cape Pinnacle sanctuary relative to reference locations, but have less of an effect on species richness and non-target species. Furthermore, we evaluated whether strengthened enforcement would also have a detectable influence on threatened species. Our study represents one of the first rigorous demonstrations of how strengthened enforcement of an existing marine sanctuary can improve conservation outcomes.

2. Materials and methods

2.1. Study site and experimental design

Three locations were sampled to test the hypothesis that abundances of target fish and threatened species in the marine sanctuary at Cape Pinnacle (28° 37′ 12″S, 153° 38′ 24″E) were enhanced relative to fished areas after the implementation of new enforcement initiatives. The locations were established in the only areas with substantial deep reef habitat (25–40 m in depth) in the Cape Byron region (Jordan et al., 2010). As well as the Cape Pinnacle sanctuary, two reference locations were sampled in areas open to fishing (Billinudgel (28° 30′ 36″S, 153° 34′ 12″E) and North Julian reefs (28° 35′ 24″S, 28° 35′ 24.00″S)). At each location the fish assemblages were sampled six times from 2006 to 2009 (3 May 06–12 June 06, 11 Dec 06–17 Jan 07, 7 Dec 07–14 Mar 08, 9 Aug 08–2 Sep 08, 19 Jan 09–06 Feb 09 and 29 Oct 09–15 Dec 09). By mid-2010, the new enforcement initiatives had taken effect, after which the fish assemblages in each location were re-sampled twice more (27 Jun 11–01 Sep 11 and 01 Aug 12–11 Sep 12).

The combination of a marine sanctuary and two reference locations sampled before and after the new enforcement initiatives allowed for an asymmetrical BACI comparison to evaluate the influence of strengthened enforcement on fish