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Conservation benefits of a network of marine reserves and partially protected areas

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ABSTRACT

Marine biodiversity is becoming increasingly threatened worldwide. To help address this, networks of no take marine reserves are being promoted as a means of conserving biodiversity and managing coastal resources. Many studies have demonstrated the effectiveness of individual marine reserves and metaanalyses have shown that marine reserves provide positive outcomes for marine conservation. Few studies, however, have examined the effects of marine reserves with different levels of protection or examined shallow subtidal areas (1–3 m depth). Here, we examine changes within a network of "no take" marine reserves relative to partially protected "take" areas after 5 years of operation. We also examine similar open areas outside the boundaries of the marine reserve network. We show that some targeted species including red morwong (*Cheilodactylus fuscus*) and abalone (*Haliotis rubra*) were more abundant in marine reserves than elsewhere. Fish assemblages inside the marine reserve network differed from those outside the boundaries of the reserve network. This result was driven by habitat differences; abundant, schooling species of fish were more commonly encountered outside the marine reserve where urchin barrens dominated. The combination of large spatio-temporal variation in reef assemblages and variable effects of early reserve protection in shallow subtidal habitats made it challenging to detect other changes among zones. Careful consideration of variation in the design and analysis of shallow subtidal reef monitoring is necessary to ensure such programs can best inform adaptive management processes.

1. Introduction

No take marine reserves (MRs) are promoted as a means of managing coastal resources and protecting marine biodiversity (e.g. Pauly et al., 2002; Lubchenco et al., 2003). The culmination of three decades of research and hundreds of published studies worldwide has prompted peak scientific bodies in Australia, Europe and the United States to strongly promote the formation of networks of MRs to ensure long term conservation of biodiversity. Further, there is a growing body of evidence for benefits to fisheries when appropriate consideration is given to fishing effort when designing MR networks (e.g. Gell and Roberts, 2003; Gaines et al., 2010; Roberts, 2012).

Although many studies have shown changes in biodiversity for individual MRs (e.g. Lester et al., 2009), there are often large differences in recovery trajectories of individual MRs and those within a single network can often show varying responses to protection (McCook et al., 2010). This can partly be explained by differences in activities that are permissible in MRs, with the efficacy of MRs with differing levels of protection being much less well understood (Lester and Halpern, 2008). This is further complicated by the recent trend to establish marine parks that contain multiple areas designed for high (strict no take MRs) to lower (Partially Protected Areas, PPAs) conservation protection interspersed or abutted by areas with little or no protection ("open" areas).

We evaluate changes in fish, invertebrate and algal assemblages within a network of no take sanctuary zones (hereafter called marine reserves, MRs and PPAs in the Batemans Marine Park (BMP) on the southeast coast of New South Wales (NSW), Australia. The zoning plan for BMP was established in June of 2007 and included the implementation of a network of MRs throughout the park's 85,000 ha (approximately 100 km of coastline) representing approximately 19.1% of this area. Interspersed with MRs are various types of "take" zones (hereafter called partially protected areas, PPAs) where some fishing and harvesting activities are allowed. However, some forms of commercial fishing (e.g.

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demersal trawling, dredging and long lining) have been excluded from the entire marine park (see Read and West 2011 and NSW Marine Park (Zoning Plan) regulation 1999 for details).

BMP represents an ideal system in which to test for changes among MRs, PPAs and open areas because (a) there are multiple, spatially independent, no take MRs and PPAs throughout the parks extent, (b) this marine park is abutted by open areas which serve as "reference" locations and (c) all areas are within the same bioregion minimising confounding effects of habitat, geography and species distributions (Lester and Halpern, 2008). Prior to the marine park's establishment, planners only had very limited information about rocky reef community structure throughout the Batemans Shelf Bioregion (Breen et al., 2005). Rather than focusing on areas with the most diverse communities, the location of the marine park in the bioregion and the locations of MRs and PPAs in the marine park were primarily driven by CAR principles (i.e. to have comprehensive, adequate and representative reserves) based on broad habitat types (e.g. rocky reef, soft-sediment, seagrass and depth strata), consideration of existing use by key stakeholders (e.g. commercial and recreational fishers) and the distribution of threatened species (e.g. grey nurse sharks). In terms of marine community structure, there were no robust data to suggest the MRs were placed in superior locations to PPAs or areas outside the marine park. In fact, there are data to suggest that fish were less abundant in MRs compared to PPAs (Edgar and Stuart-Smith, 2009), as well as some sites outside the marine park (MA Coleman, unpublished data). A consequence of this park planning process is that it was possible to establish replicated sites at random places within the different zones (MRs, PPAs and areas outside the marine park) that were representative of the reefs in the bioregion prior to the park's establishment.

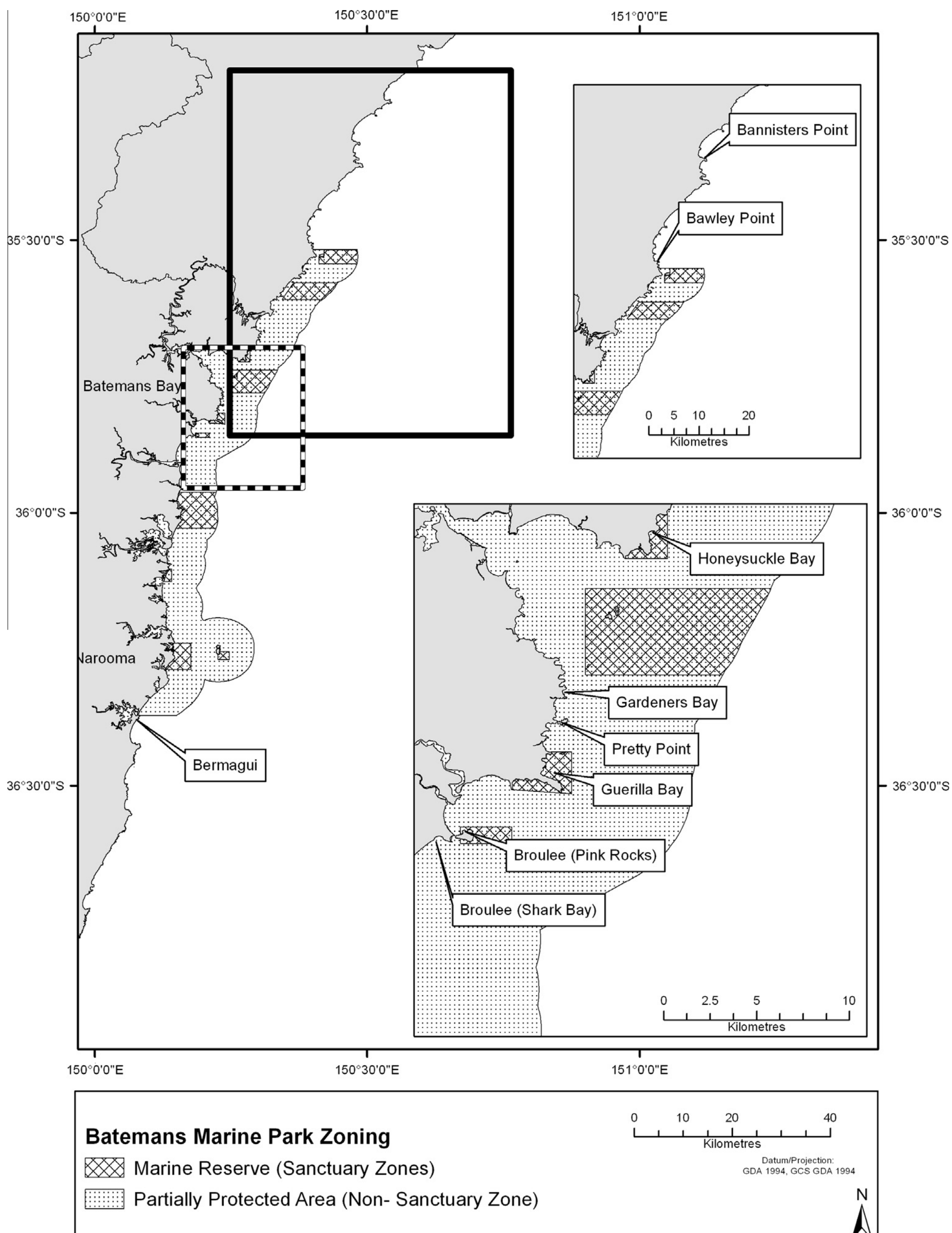

Fig. 1. Map of Batemans Marine Park showing zones (MRs and PPAs) and sites sampled. The boundary of the entire MPA network is also shown relative to open areas outside the marine park.