



## Spatial mismatch between marine protected areas and dugongs in New Caledonia



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### ABSTRACT

Marine protected areas (MPAs) are a powerful tool for conserving marine biodiversity when designed using ecological information and conservation goals and targets. Dugongs (*Dugong dugon*) were not an explicit target in the design of the network of MPAs in New Caledonia, despite being one of the region's World Heritage values. Our study retrospectively assessed the capacity of the New Caledonia MPA network to protect dugongs from anthropogenic threats. We developed a spatially explicit model of dugong distribution and relative density based on information collected from ~10 years of aerial surveys. We quantified the amount of overlap between areas supporting high densities of dugongs and MPAs. We found that most of the important dugong habitats of New Caledonia had a low coverage of MPAs that provide high levels of restriction on anthropogenic activities. We identified several important dugong habitats along the west and the north-east coast that were not covered by MPAs and should be a priority for future management. The spatial mismatch between MPAs and dugongs was likely caused by weaknesses in the planning process, including the: (1) lack of explicit conservation goals and targets; (2) omission of spatial information on species' distribution; (3) mismatch of spatial scales; (4) cost considerations; and (5) incorrect application of the IUCN protected area categories. We provide guidance on how these shortcomings can be avoided for marine species of conservation concern in New Caledonia and other regions.

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### 1. Introduction

Marine protected areas (MPAs) are a powerful tool for the conservation and management of marine resources (Agardy et al., 2011; Gaines et al., 2010; Lockwood et al., 2012). The levels of protection provided by MPAs range from restrictions on one or more human activities (e.g., fishing, Pauly et al., 2002; and tourism, Eagles et al., 2002), to the comprehensive protection of an area from all anthropogenic impacts. Systematically designed MPAs use goals and targets to ensure the representation and persistence of biodiversity features and ecological processes at multiple spatial and temporal scales (Lourie and Vincent, 2004; Margules and Pressey, 2000). MPAs designed for the preservation of ecosystems

are widely advocated over single-species approaches as the ecosystem approach provides conservation benefits for more species at a comparable cost (Pomeroy and Douvère, 2008). Nonetheless, ecosystem-based MPAs need to incorporate ecological information and targets to ensure the protection of species and habitats of conservation concern (Hooker and Gerber, 2004; e.g., Dobbs et al., 2008; Fernandes et al., 2005).

The MPAs of New Caledonia (southwest Pacific; Fig. 2) were designed to mitigate the adverse effects of human activities on marine biodiversity and the World Heritage listed lagoonal ecosystem. An explicit reason for the 2008 World Heritage inscription of the lagoons was their globally important dugong (*Dugong dugon*) population (UNESCO, 2009). New Caledonia is critical to the persistence of dugongs at the eastern edge of its range and globally (Marsh et al., 2011) because dugongs are in decline or extinct in at least one third of their range (Marsh, 2008). Protecting the dugong as a charismatic 'umbrella' species is also beneficial to other coastal species that utilise seagrass habitats, which are threatened by multiple human activities (Jones et al., 1995; Marsh et al.,

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