Research article

Development and testing of a new framework for rapidly assessing legal and managerial protection afforded by marine protected areas: Mediterranean Sea case study

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ABSTRACT

Aim: The Convention on Biological Diversity (CBD) states the need to effectively conserve at least 10% of coastal and marine areas of particular importance for biodiversity by 2020. Here, a new indicator-based methodological framework to assess biodiversity protection afforded by marine protected areas' (MPA) was developed as a quick surrogate for MPAs' potential conservation effectiveness: the Marine Protected Area Protection Assessment Framework (MaPAF). The MaPAF consists of a limited number of headline indicators that are integrated in two indexes: *Legal protection* and *Management effort*, which eventually integrate in the overall MPA *Protection* super-index. The MaPAF was then tested in the Mediterranean MPA network as a case study. Spatial analyses were performed at three meaningful scales: the whole Mediterranean Sea, Mediterranean ecoregions and countries. The results of this study suggest that: 1) The MaPAF can serve as a useful tool for consistent, adaptive, quick and cost-effective MPA effectiveness assessments of MPAs and MPA networks in virtually any marine region, as the headline indicators used are commonly compiled and easy to retrieve; 2) The MaPAF proved usable and potentially relevant in the Mediterranean Sea where most indicators in the framework can be publicly accessed through the MAPAMED database and are planned to be regularly updated; 3) *Protection* afforded by MPAs is low across the whole Mediterranean, with only few MPAs having relatively high legal and managerial protection; and 4) Most Mediterranean countries need to devote substantially more work to improve MPA effectiveness mainly through increased management effort.

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1. Introduction

A protected area (PA) on land or at sea is 'a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values' (Dudley, 2008). MPAs are regarded as important tools for marine and coastal biodiversity conservation (Day et al., 2012). The CBD states the need to conserve at least 10% of the coastal and marine environment of particular importance for biodiversity and ecosystem services through effectively managed systems of protected areas by 2020 (CBD, 2010). MPA coverage targets on their own are controversial as they do not necessarily mean those areas are in the most valuable places for biodiversity (Juffe-Bignoli et al., 2014) or effectively protected (de Santo, 2013). Besides, increasing coverage by PAs may detract scarce conservation resources from existing PAs and compromise their effective conservation (Wells et al., 2007). Thus, increasing the amount of coastal and marine area protected should be coupled with effectively conserving protected biodiversity in those areas.

It is broadly assumed that merely legally designating PAs (*i.e.* 'paper parks') is ineffective at conserving biodiversity and that, in order to render positive outcomes, PAs, both terrestrial and marine, also need to be managed effectively (Hockings et al., 2006; Davis, 2012). However, both assumptions have rarely been empirically tested and remain a research challenge (Juffe-Bignoli et al., 2014). PA management effectiveness has been largely assessed through opinion-based systems, such as the Rapid Assessment and Prioritization of Protected Area Management (RAPPAM), the

Management Effectiveness Tracking Tool (METT), or other score-card systems (Leverington et al., 2010). Current global efforts try to propose and use demonstrable metrics and monitoring methods to evaluate conservation outcomes (IUCN, 2014). However, well-designed, evidence-based monitoring and evaluation systems are still scarce and resource-demanding (Addison, 2011). Some factors are deemed important for the ecological outcomes of MPAs: size, isolation, age, enforcement and regulations (Edgar et al. 2014). The relationships between MPA size and age, and ecological effective-ness have been studied previously (Halpern, 2003; Claudet et al., 2008). The effect of regulations and management on MPA conser-vation outcomes is a more recent concern (Coleman et al., 2013; Rodríguez-Rodríguez et al. 2015a).

There is a good case and some evidence for assuming that both legal designation and management are likely to enhance MPAs' conservation outcomes (Edgar et al., 2014; IUCN, 2014). On the one hand, sectorial regulations impose different restrictions on devel-opment, resource extraction and/or waste deposition in MPAs (Lester et al., 2009; Montefalcone et al., 2009). These restrictions are likely to deter some offenders by fear of sanctions or voluntary compliance associated with civic behaviour (Stern, 2008). Moreover, advanced nature protection regulations require adequate environ-mental assessments prior to the authorisation of any potentially damaging activity. A paradigmatic example of this is Environmental Impact Assessment (EIA) regulations, which impose harder devel-opment restrictions on environmentally sensitive areas such as MPAs (EU, 1985; EU, 2001). In addition to EIAs and broader landscape or seascape regulations (e.g. territorial planning, integrated coastal zone management or maritime spatial planning) where these exist, legal provisions designating MPAs normally prohibit, restrict or regulate other activities that may conflict with conservation objec-tives within MPA boundaries (Al-Abdulrazzak and Trombulak, 2012; ELI, 2015). Thus, environmental regulations are intended and likely to have positive ecological effects on MPAs, although legal desig-nation on its own is probably not enough to warrant effective con-servation in most cases (Montefalcone et al., 2009).

Besides legal designation, managerial activities such as moni-toring, surveillance, enforcement of sites' regulations and conser-vation planning are considered essential for MPA ecological effectiveness (Hockings et al., 2006; Day et al., 2012; Juffe-Bignoli et al., 2014) and have been demonstrated to affect some ecolog-ical variables such as density of large predatory fish (K.E. Gregor et al., unpublished data). Nevertheless, given the highly specific casuistic of each PA, legal and managerial requirements are neither always necessary nor always sufficient for effective conservation (Rodríguez-Rodríguez, 2012). The effectiveness of MPAs at conserving protected biodiversity is further contested due to the high connectivity of the marine environment, which determines a higher exposure to a number of unmanageable pressures relative to terrestrial PAs (Jameson et al., 2002; Mora and Sale, 2011). In a recent study, Rodríguez-Rodríguez et al. (2015a) found no correla-tion between management effort and conservation status in a small MPA sample in the English Channel. Whereas globally negative biodiversity trends (Butchart et al., 2010) would probably be worse without PAs, pressures on PAs are so numerous and intense that biodiversity in even well managed designated sites may degrade as a consequence (Hockings et al., 2006; Mora and Sale, 2011).

The terms MPA, park, marine reserve or reserve are often used indistinctively although different levels of legal stringency are sometimes implied or distinguished (Allison et al., 1998; de Santo, 2013). Some authors have studied the effect of different MPA reg-ulations (e.g. stringent no-take regulations vs flexible multiple-use regulations vs open, unregulated areas) on the ecological outcomes of MPAs through the construct 'level of protection' (Coleman et al., 2013; Rife et al., 2013; Guidetti et al., 2014; Sciberras et al., 2015).

Fine analyses discriminating activities regulated or prohibited in MPAs were done by surveying MPA managers (Rodríguez-Rodríguez et al., 2015a) or by analysing individual management plans (Portman et al., 2015). However, there is no consistency in the way 'level of protection' applied to MPAs has been used so far, leading to confusion and, sometimes, unfounded sense of marine conservation accomplishment (Al-Abdulrazzak and Trombulak, 2012). Some authors considered 'level of protection' to refer solely to the protection of MPAs afforded by legislation (Roberts et al., 2010; Sciberras et al., 2015), whereas some others used it as a synonym for MPA management or conservation categories (Al-Abdulrazzak and Trombulak, 2012), or implied legal protection (Coleman et al., 2013) or both legal and managerial inputs (Rife et al., 2013; Guidetti et al., 2014). There is thus the need for a consistent framework that allows standardisation and comparison of protection in MPAs. Rodríguez-Rodríguez et al. (2015a) recently proposed a simple conceptual framework to attribute effects of legal or managerial protection in MPAs more consistently. Such a framework can provide a rapid, operational, cost-effective and consistent assessment of protection as a surrogate for potential conservation outcomes, ecological effectiveness or environmental performance of MPAs or MPA networks.

The Mediterranean basin is a global marine biodiversity hotspot where high levels of endemicity coexist with intensive pressures from multiple marine and coastal human uses (Coll et al., 2010; Micheli et al., 2013). Thus, assessing protection afforded by MPAs in this region can be considered a conservation priority. In this study, we: 1) developed and made operational the conceptual framework by Rodríguez-Rodríguez et al. (2015a); and 2) adapted the new methodological framework and used it to assess potential conservation effectiveness of the Mediterranean MPA network as a case study at three complementary scales: the whole Mediterra-nean Sea, marine ecoregions and countries.

2. Methods

2.1. MPA protection assessment framework (MaPAF) development

Rodríguez-Rodríguez et al. (2015a) outlined a simple conceptual framework to discriminate MPA legal protection from managerial protection afforded to MPAs. Building upon that work, the MaPAF consists of three tiers related to the usual milestones of increasing protection complexity in MPA establishment processes (Government of Canada (2014)): tier 1 relates to basic protection afforded to MPAs by regulations through *legal designation categories* of variable *stringency* (*level of protection*, LoP) whereas tiers 2 and 3, which can occur sequentially or simultaneously to tier 1, refer to *management effort* in terms of *enforcement* of regulations and *man-agement planning*, respectively (*sub-level of protection*, SLoP). It can be easily argued that an MPA that is legally designated where reg-ulations are enforced and that has structured management (*i.e.*, where species' or habitat's conservation or restoration measures are implemented according to a management plan) is better protected and more likely to produce better conservation outcomes than another MPA with opposite characteristics (IUCN, 2014). In the proposed MaPAF, LoP and SLoP make two indices consisting in summing two headline indicators each: *legal designation* and *regu-lation stringency*, for LoP; and *enforcement* and *management plann-ning*, for SLoP. Both indices are then summed to produce an overall *Protection* super-index of the MPA.

2.2. Case study: quick assessment of biodiversity protection by Mediterranean MPAs

The MaPAF was used to assess the potential conservation