

Spatially-explicit Conservation in the Alborán Sea: Predictive Habitat Models and Gap Analysis Guide Pelagic Protected Area Designs

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INTRODUCTION

Networks of marine protected areas (MPAs) are increasingly being used to protect threatened species and habitats around the globe. Although most MPAs have focused on protecting sessile and sedentary taxa, there is a growing interest in applying spatially-explicit management approaches - including MPAs - to protect the foraging grounds and migration corridors of highly-mobile marine vertebrates, especially in the high seas beyond national jurisdictions (Hooker et al. 2004, Hoyt 2005, Norse et al. 2005). Because marine vertebrates often aggregate at specific bathymetric and hydrographic features, they are - in principle - amenable to spatially explicit conservation (Hyrenbach et al. 2000, Cañadas et al. 2005). However, it is unclear whether traditional MPA concepts can accommodate the dynamic nature of pelagic habitats. Herein, we showcase a new project, under the auspices of a Pew Foundation fellowship for marine conservation, to evaluate the feasibility and effectiveness of spatially-explicit protective measures for highly-mobile marine vertebrates in the Alborán Sea, a dynamic transition zone between the Mediterranean Sea and the Atlantic Ocean (<http://www.AlboranSeaConservation.org>).

METHODS

The Alborán Sea is a bathymetrically and hydrographically complicated area. The input of Atlantic surface water into the Mediterranean gives rise to strong currents and persistent meso-scale eddies. The local bathymetry steers these currents and enhances mixing, making this area one of the most productive regions of the Mediterranean (Parrilla and Kinder 1987). An impressive assemblage and density of oceanic species reproduce and forage in the Alborán Sea, and migrate through the area seasonally, including: (i) a highly-diverse cetacean community of epi-pelagic dolphins, deep-diving toothed whales (sperm and pilot whales, Risso's dolphins, beaked whales), and baleen whales (largely fin whales); (ii) seabirds (most notably shearwaters) dispersing into the Atlantic Ocean after the breeding season, and (iii) highly-migratory loggerhead turtles (e.g., Ristow et al. 2000, Hoyt 2005, Cañadas 2006, Revelles et al. 2007).

This three-year project (2007-2010) addresses two main research questions: (i) how does oceanographic variability influence the distribution of marine vertebrates (cetaceans, birds, turtles) in a dynamic seascape, and (ii) how do these habitat associations influence the design and efficacy of pelagic MPAs. This project will follow a three-step approach.

First, we will develop and improve predictive habitat models (Cañadas et al. 2005, Louzao et al. 2006) for the full complement of marine vertebrates in the study area using local (study area) and regional (basin-wide) environmental datasets (Fig. 1). Building upon these modeling results, we will undertake a gap analysis to identify priority areas for the conservation of multiple species. More specifically, we will use “decision-support” GIS tools to prioritize areas for conservation, by integrating the species-specific modeling results into a comprehensive perspective of the areas and habitats where marine vertebrates overlap and concentrate. Finally, to evaluate the feasibility of potential dynamic MPA designs, we will quantify the spatial and temporal predictability of the oceanographic features identified through wildlife modeling and gap analysis.

DISCUSSION

The European Union recognizes two main MPA designations for protecting threatened species and habitats: special areas for conservation (SACs) and special protected areas of Mediterranean Importance (SPAMIs) (<http://www.fao.org/fi/glossary>). Alnitak, World Wildlife Fund and Birdlife International are already working to identify potential MPA sites in the Alborán Sea (Cañadas et al. 2005, WWF 2006, Arcos et al. 2007). In particular, several conservation steps have been taken under the auspices of the EU Habitat Directives. A dolphin SAC already exists in Murcia, and three additional sites have been proposed within a larger regional SPAMI in Andalucía. In addition, a proposed “oceanic area” would protect cetacean aggregations and safe-guard dolphin movements between disjunct SACs. As part of this project, we will assess the effectiveness of these MPA proposals for multiple marine vertebrates.

This project will make two main conservation contributions. Regionally, we will evaluate the effectiveness of existing and proposed MPAs for marine vertebrates in the Alborán Sea. On a broader scale, our approach will establish a methodological and analytical framework for developing place-based conservation measures in other areas of the Mediterranean Sea. In particular, it is our hope that this research will help to refine the conceptual and analytical frameworks needed to design MPA networks, when multiple species are considered simultaneously.

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Figure 1. Spatial and temporal scales considered in this study.

