The role of seabirds in Marine Protected Area identification, delineation, and monitoring: Introduction and synthesis

Robert A. Ronconi a,*, Ben G. Lascelles b, Gary M. Langham c, James B. Reid d, Daniel Oro e

a Department of Biology, Dalhousie University, 1355 Oxford St., Halifax, NS, Canada B3H 4J1
b Global Seabird Programme, BirdLife International, Wellbrook Court, Citron Road, Cambridge CB3 0QA, UK
c National Audubon Society, 1150 Connecticut Ave., Suite 600, Washington, DC 20036, United States
d Joint Nature Conservation Committee, Inverdee House, Baxter St., Aberdeen AB11 9QA, UK
e Population Ecology Group, Institut Mediterrani d’Estudis Avançats IMEDEA (CSIC–UIB), Miquel Marques 21, 07190 Es porles, Spain

A R T I C L E   I N   P R E S S

Abstract

Currently less than 1% of the world’s seas are under any form of protected area designation, thus, there is an important and immediate need for tools to identify and delineate a network of ecologically representative Marine Protected Areas (MPAs). Although the role of seabirds in MPA identification and the importance of MPAs to seabird conservation have been discussed for more than a decade, the actual designation of MPAs using seabird data has lagged far behind. To synthesize the current state of knowledge regarding seabirds and the designation of MPAs, this special issue presents 14 papers resulting from the 1st World Seabird Conference, held in Canada in 2010. These papers present examples from around the world that show the important role seabirds can play in the identification, design, implementation, and monitoring of MPAs. Approaches to seabird MPA site identification consider single- versus multiple-species approaches, mapping of marine biological “hotspots”, and assessment of overlap with risks and threats. The delineation of MPA boundaries may further be refined with information on seabird foraging ranges, at-sea density estimates, and tools for ranking areas based on conservation priorities. Seabirds can also be used to evaluate the effectiveness of MPAs as conservation tools by monitoring changes in seabird foraging ranges, patterns of distribution and abundance, and population dynamics. To date, very few MPAs have been established specifically for the benefit of seabirds, however, many of the papers in this special issue suggest that this should become a growing trend in seabird conservation and marine spatial planning.

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The ocean is not just a bowl of all-the-same water but a glittering, swirling mosaic of grand proportions. – Carl Safina, The Eye of the Albatross: Visions of Hope and Survival, 2002.

1. Introduction

The oceans cover 71% of the surface of planet Earth with a mosaic of distant, deep and dynamic ecosystems and habitats. These habitats support enormous amounts of biomass and biodiversity that we rely on for many aspects of our lives; the oceans hold 97% of the world’s water, create at least 50% of our oxygen, and play a vital role in regulating our climate. As scientists, managers, policy makers, and citizens, we are just beginning to understand and appreciate how important the oceans are, and how much we rely upon them in our day-to-day lives. Although humans are land mammals by nature, we have exploited marine ecosystems for millennia and two-thirds of the world’s population now lives within 60 km of the coast, with many relying directly on the resources the oceans provide. However, the ecological integrity of the marine environment is becoming increasingly degraded due to the compounding effects of various human activities (Rogers and Laffoley, 2011), and there are few corners of the world’s oceans that remain unaffected (Halpern et al., 2008).

Currently less than 1% of the world’s seas are under any form of protected area designation, in stark contrast to the progress that has been made on land where protected areas cover 11% of the earth’s land surface (Toropova et al., 2010). Governments of the world, through the Convention on Biological Diversity, have pledged to increase the marine figure dramatically, with a target of designating 10% of the world’s oceans as protected areas by 2020 (CBD, 2010).

Although the role of seabirds in MPA identification and the importance of MPAs to seabird conservation have been discussed...
in science arenas for more than a decade (Gilman, 2001; Hyrenbach et al., 2000), the actual legal designation of MPAs using seabird data has lagged far behind. To synthesize the current state of knowledge regarding seabirds and the designation of MPAs, a special symposium on “Spatial ecology at sea: Opportunities and challenges for seabird marine protected areas” was held during the 1st World Seabird Conference in Victoria, BC, Canada from 7 to 11 September 2010. This symposium was complemented by a number of other invited and contributed papers, poster presentations and a workshop during the conference programme, all aimed at sharing experiences and gaining a common understanding of how seabirds can inform the designation of MPAs.

This special issue presents 14 papers from the conference, representing work undertaken in the Pacific, Atlantic, Indian and Southern Oceans that investigate the important role of seabirds towards the identification, design, implementation, management, and monitoring of Marine Protected Areas.

2. Identification of sites for MPAs

The immense proportions, dynamic biological processes, and complex political boundaries of our oceans mean that total protection of our seas is both impractical and undesirable from an economic and socio-political point of view. Therefore, there is an important need to identify the highest priority sites where MPAs could and should be established. Whether to meet the requirements of existing legislation or simply to identify ecologically significant “hotspots” from first principles, data on seabird distribution, abundance and diversity can form a sound scientific basis for the identification of candidate sites for MPAs (Lascelles et al., 2012). However, as this special issue illustrates, there is no single catch-all approach that can be applied; approaches to MPA site identification will be dependent on the availability of robust data, political and legislative requirements, and the nuances of the particular species and ecosystems in question. Nevertheless, some commonality of approach for all regions, including consideration of single- versus multiple-species approaches, methods for identification of seabird “hotspots”, and assessment of environmental risks, is desirable to provide a level of consistency, transparency, and repeatability.

Single- versus multi-species approaches to conservation planning has been a long-standing debate among scientists and managers. While the ultimate goal is often to protect biomass and biodiversity within landscapes, sometimes designing protected areas for indicator, or “umbrella” species may provide adequate protection for large areas and, by extension, a diversity of species within them. This approach is the essence of designing MPAs for marine top predators, including seabirds; to protect them outright and also to protect the habitats and ecosystems essential for their survival (Hooker et al., 2011). Seabirds in general are considered to be excellent indicators of the health of marine ecosystems, but with ca. 350 species worldwide, there is clearly a bewildering array of "indicators" to choose from the identification of candidate MPAs. The best choice of single- or multiple-species will be contingent on the context and purpose of the MPA.

Several studies have used a single species in the identification of candidate MPAs. At a local scale, in the United Kingdom Special Protection Areas at sea have been designated where high concentrations of wintering birds occur (O'Brien et al., 2012) and, in South Africa, fisheries exclusion areas have been established to protect individual colonies of certain threatened species (Pichegru et al., 2010, 2012). At a regional scale, Oppel et al. (2012) adopted a single-species approach focusing on the wide-ranging and critically endangered Balearic Shearwater (Puffinus mauretanicus) to identify important Bird Areas (IBAs), where improved management of fisheries activities could have direct conservation benefit by reducing bycatch of this species (and others) around Spain and Portugal. Alternatively, Arcos et al. (2012) suggested that some species show higher predictability than others at in-sea distributions and may be better for IBA identification, therefore, they used three “representative” pelagic species to model seabird hotspots.

Although in some cases “umbrella” species may be useful in designation of MPAs to address species or site-specific conservation objectives (e.g. Louza et al., 2006; Oppel et al., 2012; Pichegru et al., 2012), a multi-species approach based on abundance and biodiversity indices may, generally, be preferable for MPA identification at larger foraging-range (Montevecchi et al., 2012; Thaxter et al., 2012) and ecosystem scales (Ballard et al., 2012; Le Corre et al., 2012; Nur et al., 2011).

Regardless of the number of species involved in the MPA identification process, most approaches focus on seabird “hotspot” identification. Marine biological “hotspots” may be defined as “sites of critical ecosystem linkages between trophic levels” (Sydeman et al., 2006) and analysis of seabird abundance and distribution data have been widely used to identify these important areas for the purposes of candidate MPA identification. Both aerial and vessel-based surveys provide datasets from which it is possible to map areas of high seabird abundance. Where survey effort is incomplete, spatial modeling can provide a powerful tool to predict patterns of species occurrence (Ballard et al., 2012; Garthe et al., 2012; O’Brien et al., 2012; Oppel et al., 2012). Alternatively, tracking data from individual species and colonies have identified seabird hotspots in remote regions of the world that are typically not accessible or amenable to surveys, thus, providing extremely valuable data for conservation planning, particularly in international waters (Le Corre et al., 2012; Montevecchi et al., 2012).

Increasingly, however, we are seeing a more comprehensive approach that integrates a variety of techniques aimed at hotspot identification. These include modeling of various data types (Ballard et al., 2012), at-sea projections from colony-based data (Grecian et al., 2012) and the use of behavioral data that complement survey and tracking data (Camphuysen et al., 2012). Arcos et al. (2012) provides an example of this in which they integrate approaches of species–habitat modeling, assess the inter-annual stability of these areas, consider support from independent datasets, and use internationally applicable criteria to validate or reject the hotspots identified.

While identifying ecologically relevant areas should guide MPA placement, to identify areas in most immediate need of action it is necessary to assess threats and risks of interaction. In this special issue, two examples, from the Indian Ocean (Le Corre et al., 2012) and western North Atlantic (Montevecchi et al., 2012), demonstrate how multi-species tracking studies can be used to identify “population hotspots” at large marine ecosystem scales, and prioritize areas based on an overlap analysis with offshore industrial activities to determine where seabirds may be at greatest risk and hence where MPAs may be most desperately needed. In the Atlantic, Montevecchi et al. (2012) identified seabird hotspot overlap with areas of significant offshore hydrocarbon exploration and development, such as the Gulf of Mexico and the Grand Banks off Newfoundland. In the Indian Ocean, Le Corre et al. (2012) identify priority zones for the implementation of MPAs where seabirds overlap with industrial fisheries and major transportation corridors, which expose seabirds to chronic and catastrophic pollution. Together these studies provide useful examples of how managers may prioritize MPA placement to tackle threats.

3. Delineating MPA boundaries

Once candidate MPA sites have been identified, a next step in the process is deciding on the exact boundaries to delineate the

final extent of the MPA. While data may play a fundamental role in the identification of sites, the final delineation of MPA boundaries may be subject to complex political and legislative processes requiring a wide array of stakeholder participation (Lascelles et al., 2012). Nevertheless, seabird data can be used to inform potential boundaries and several papers in this special issue illustrate methods for doing so in both coastal and pelagic ecosystems.

In coastal areas, boundaries for seabird MPAs have often been delineated based on seaward extensions of known, and often already protected, terrestrial breeding areas (Yorio, 2009). Foraging ranges of breeding seabirds provide a simple and readily understandable tool for the preliminary assessment of candidate MPAs that may be particularly important to utilize in data poor situations. Indeed, foraging ranges of seabirds were one of the primary considerations in delineating the boundaries of Namibia’s first Marine Protected Area, totaling 10,000 km² and encompassing the foraging habitat of a globally endangered species, the African Penguin (Spheniscus demersus) (Ludynia et al., 2012). Likewise, boundaries of a fishery exclusion zone in South Africa were also determined based on penguin foraging ranges for specific colonies (Pichegru et al., 2012). For very well studied species, such as the Northern Gannet (Morus bassanus) in the United Kingdom, data on foraging ranges can be combined with other ecological data, such as colony size, foraging behavior, and indices of resource availability, to quickly and effectively produce accurate predictions of at-sea distributions which show strong validation with at-sea surveys (Grecian et al., 2012). For species where data already exist on foraging ranges and colony sizes, range-based mapping techniques may prove to be a valuable and inexpensive tool, relative to at-sea surveys and tracking studies, for identification of important marine foraging areas in coastal waters during breeding periods (Thaxter et al., 2012).

Outside of breeding seasons and away from colonies, MPA delineation for offshore regions will require approaches beyond the analysis of foraging ranges. O’Brien et al. (2012) use a relatively simple kernel density estimation method with maximum curvature to objectively delineate Special Protection Area boundaries for a single species at a single site during wintering periods. More often, however, scientists and managers will be required to select priority areas among multiple potential reserves which can be a difficult problem when many different conservation and resource utilization objectives are at stake. Thus, there is a need to adopt methods that objectively prioritize and delineate boundaries over large areas. Two examples from this special issue, one for a critically endangered species (Oppel et al., 2012) and another for multiple species (Ballard et al., 2012), included a “zonation” method (Moilanen et al., 2005) which prioritizes core conservation areas across large spatial scales. Nevertheless, even when the most sophisticated and scientifically sound analytical techniques are applied, the final delineation of MPA boundaries may also require expert opinion when “hotspots” were not so obvious (Arcos et al., 2012). Conversely, there is some suggestion that permanent boundaries may not always be necessary for seabird MPAs when spatial closures can be used to protect critical habitats that might be predictable seasonally or based on remote sensing data (e.g. Hyrenbach et al., 2000; Hooker et al., 2011).

4. Assessment and monitoring of MPA effectiveness

After MPAs have been established, there will be an important need to assess their effectiveness and monitor the benefits provided to seabirds and ecosystems. Ongoing monitoring is an integral part of an adaptive management strategy (McComb et al., 2010) which will, ultimately, allow us to improve the conservation value of MPAs through better management and potential refinement of MPA boundaries. Several papers in this special issue provide useful examples of seabird monitoring to assess the effectiveness of existing MPAs (Adams et al., 2012; Garthe et al., 2012; Ludynia et al., 2012; Pichegru et al., 2012).

In cases where MPAs were established explicitly for the conservation of seabirds, the monitoring of seabird activities, such as foraging ranges and effort, reproductive success, and distribution patterns, will provide essential data with which to evaluate MPA effectiveness. A crucial point would be to assess the impact of MPAs on the viability and population dynamics of vulnerable seabirds, particularly when these areas should be free of major negative impacts (e.g. longline fisheries). For the Namibian Islands’ Marine Protected Area, boundaries were established based on limited tracking data from a few seabird species and colonies, but additional tracking after the MPA establishment confirmed that the MPA’s design was adequate to encompass the foraging areas of several target species (Ludynia et al., 2012). Conversely, after the initial success of fisheries closures around a seabird breeding colony in South Africa (Pichegru et al., 2010), subsequent monitoring of penguin foraging effort and reproductive success highlights the limited benefit of “small” no-take zones, calling for larger protected areas, buffer zones, and reduced fishing quotas (Pichegru et al., 2012). In Germany, where Special Protection Areas were established for wintering populations of seabirds in offshore waters, continued collection of vessel and aerial survey data both during and after the MPA designation process were used to validate boundaries identified from original data analyses (Garthe et al., 2012). Together these studies highlight the importance of ongoing monitoring to confirm when seabird MPAs are functioning as intended and provide vital data for their future amendment if deemed necessary.

Seabirds may also be useful indicators to evaluate Marine Protected Areas that have been established for other purposes. Adams et al. (2012) conducted an analysis of Sooty Shearwater (Puffinus griseus) movements along the California Current Large Marine Ecosystem along the US west coast to document the use of five existing marine sanctuaries. By tracking more than 50 individuals during 2 years, their analysis revealed that these top predators use marine sanctuaries disproportionately to their availability; however, there are still vast areas of importance that fall outside of sanctuary boundaries and, thus, the establishment of “additional priority conservation areas outside sanctuaries may be warranted in the future.”

5. Towards a global network of seabird MPAs

To date very few MPAs have been established specifically for the benefit of seabirds, however, many of the papers in this special issue suggest that this should become a growing trend in seabird conservation and marine spatial planning more generally. Lascelles et al. (2012) provides an overview of existing regional and international policy mechanisms that require MPAs of some sort to be established, many of which can accommodate seabirds. Therefore, supplying data to these agreements will help ensure that the future establishment of a global network of MPAs is of benefit to seabirds and aid the recovery of these increasingly endangered species.

While overall progress towards seabird MPAs has been slow, there are some notable recent successes. Arcos et al. (2012) illustrate a process that has proposed the protection of 5% of Spanish waters based on one of the first national inventories of marine IBAs. Also, it has been recognized that protection should be afforded to some extremely large areas, such as the Ross Sea continental shelf and slope which function as an intact “natural history unit” to support a diverse community and high abundance of upper trophic-level predators (Ballard et al., 2012). Nevertheless, great challenges lie ahead for the conservation of marine habitats for
seabirds including urgently needed effective and enforceable management tools for established MPAs (Garthe et al., 2012), the identification and implementation of MPAs in international waters on the high seas (Hyrenbach et al., 2000), and the need for management beyond MPA boundaries (Yorio, 2009). To achieve this, governments, agencies, and scientists urgently “require the rapid development of new approaches, resources and partnerships” (Lascelles et al., 2012). It is our hope that the papers in this special issue inspire further progress and partnerships towards efforts already underway around the globe. Certainly, this provides optimism that we, as scientists, managers, and policy makers, are making valuable initial progress towards the implementation of a truly global network of MPAs – a network that will preserve the ecological integrity of our marine environments not only for future generations of humans to enjoy, but more importantly for the conservation and recovery of seabirds and other marine organisms worldwide.

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