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Marine protected areas show low overlap with projected distributions of seabird populations in Britain and Ireland

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ABSTRACT

Marine Protected Areas (MPAs) are an important tool for the conservation of seabirds. However, mapping seabird distributions using at-sea surveys or tracking data to inform the designation of MPAs is costly and time-consuming, particularly for far-ranging pelagic species. Here we explore the potential for using predictive distribution models to examine the effectiveness of current MPAs for the conservation of seabirds, using Britain and Ireland as a case study. A distance-weighted foraging radius approach was used to project distributions at sea for an entire seabird community during the breeding season, identifying hotspots of highest density and species richness. The percentage overlap between distributions at sea and MPAs was calculated at the level of individual species, family group, foraging range group (coastal or pelagic foragers), and conservation status. On average, 32.5% of coastal populations and 13.2% of pelagic populations overlapped with MPAs indicating that pelagic species, many of which are threatened, are likely to have significantly less coverage from protected areas. We suggest that a foraging radius approach provides a pragmatic and rapid method of assessing overlap with MPA networks for central place foragers. It can also act as an initial tool to identify important areas for potential designation. This would be particularly useful for regions throughout the world with limited data on seabird distributions at sea and limited resources to collect this data. Future assessment for marine conservation management should account for the disparity between coastal and pelagic foraging species to ensure that wider-ranging seabirds are afforded adequate levels of protection.

1. Introduction

Even though most of the world's oceans continue to be impacted by humans (Game et al., 2009; Halpern et al., 2008), just over 4% of their area is currently protected (UNEP-WCMC and IUCN, 2016). There is an urgent need to speed up the identification and designation of Marine Protected Areas (MPAs) given that one of the Aichi targets is to protect 10% of the oceans by 2020 (Secretariat of the Convention on Biological Diversity, 2014; Watson et al., 2014). Seabirds provide an important focus for the development of protected areas. As is true for all marine top-predators, they are threatened by a suite of impacts, particularly from fisheries and pollution, and are in urgent need of protection in many parts of the world (Croxall et al., 2012). The use of Important Bird Areas (IBAs) to delineate candidate MPAs for the conservation of seabirds globally has been encouraged by conservation bodies (BirdLife International, 2010; Lascelles et al., 2012). In the European Union (EU), as of 2014, 59% of areas identified as marine IBAs have been designated as either Special Protected Areas (SPAs) or Special Areas of Conservation (SACs) (BirdLife International, 2014). However, only 3.9% of the total EU marine area is designated for marine SPAs, similar to global levels of coverage, and much lower than the 12.5% designated for terrestrial SPAs (Ramirez et al., 2017). One of the reasons that designation of MPAs in Europe and elsewhere has been slow is that the costs and challenges of identifying biodiversity hotspots are prohibitive for many marine regions. In this paper we develop a simple modelling approach that can be used to quickly identify areas of importance for seabird communities, and assess coverage by existing protected areas.

Protected areas for seabirds usually focus on the locations of important breeding colonies, either at the nesting sites themselves or through seaward extensions in the waters immediately surrounding the

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Table 1
Summary for each species of the number of colonies in Britain and Ireland; total population size (individuals) from most recent colony counts; European conservation status; proportion of the European population contained in Britain and Ireland; maximum foraging range (km); and foraging range group (pelagic or coastal). European conservation status is taken from the IUCN Red List of Threatened Species (Choudhury et al., 2016). European population size was taken as the maximum estimate from the IUCN (Choudhury et al., 2016). The proportion estimated is therefore the minimum potential percentage of the biogeographical population contained in Britain and Ireland. Maximum foraging range was taken from a review by Thaxter et al. (2012) with a few exceptions, see table footnotes. Species with a maximum foraging range of < 75 km were defined as coastal and those with a maximum foraging range of 75 km or greater were defined as pelagic.

Species	Number of colonies	Population size (individuals)	European conservation status	Proportion of European population (%)	Maximum foraging range (km)	Foraging range group
Arctic skua *Stercorarius parasiticus*	643	4740	Least concern	4.23	75	Pelagic
Arctic tern *Sterna paradisaea*	959	116,472	Least concern	6.43	30	Coastal
Atlantic puffin *Fratercula arctica*	405	869,690	Endangered	7.50	200	Pelagic
Black guillemot *Cepphus grylle*	1323	38,529	Least concern	5.19	15[c]	Coastal
Black-headed gull[a] *Larus ridibundus*	415	184,240	Least concern	7.44	40	Coastal
Black-legged kittiwake *Rissa tridactyla*	538	704,028	Vulnerable	15.96	120	Pelagic
Common guillemot *Uria aalge*	506	1,271,624	Near threatened	41.56	135	Pelagic
Common gull[a] *Larus canus*	1330	48,110	Least concern	4.76	50	Coastal
Common tern[b] *Sterna hirundo*	376	35,468	Least concern	3.11	30	Coastal
European shag *Phalacrocorax aristotelis*	1238	61,798	Least concern	39.36	17	Coastal
European storm-petrel *Hydrobates pelagicus*	107	178,138	Least concern	17.29	336[d]	Pelagic
Great black-backed gull *Larus marinus*	2010	36,528	Least concern	13.73	60[c]	Coastal
Great cormorant[b] *Phalacrocorax carbo*	290	27,084	Least concern	3.00	35	Coastal
Great skua *Stercorarius skua*	700	16,016	Least concern	46.42	219	Pelagic
Herring gull[a] *Larus argentatus*	2633	278,340	Near threatened	17.82	92	Pelagic
Leach's storm-petrel *Oceanodroma leucorhoa*	16	96,714	Least concern	17.68	120	Pelagic
Lesser black-backed gull[a] *Larus fuscus*	907	180,790	Least concern	26.79	181	Pelagic
Little tern *Sterna albifrons*	63	3424	Least concern	3.23	11	Coastal
Manx shearwater *Puffinus puffinus*	43	658,798	Least concern	83.92	330	Pelagic
Mediterranean gull[a] *Larus melanocephalus*	16	1026	Least concern	0.16	20	Coastal
Northern fulmar *Fulmarus glacialis*	2643	1,075,514	Endangered	15.36	580	Pelagic
Northern gannet *Morus bassanus*	27	576,088	Least concern	42.05	709[e]	Pelagic
Razorbill *Alca torda*	679	178,773	Near threatened	17.53	95	Pelagic
Roseate tern *Sterna dougallii*	5	3060	Least concern	52.76	30	Coastal
Sandwich tern *Sterna sandvicensis*	64	34,166	Least concern	11.58	54	Coastal

[a] Gull colonies that were located at a distance of > 5 km from the coast were classified as inland, following criteria set out by Mitchell et al. (2004) and excluded from analysis.
[b] For common tern and great cormorant a number of colonies were located at a distance greater than the maximum foraging range; these were excluded from analysis.
[c] Maximum foraging range taken from review by Jovani et al. (2016).
[d] Maximum foraging range taken from unpublished GPS tracking data from High Island, Co. Galway, Ireland (Kane, A., Pers. Comm.)
[e] Maximum foraging range taken from Wakefield et al. (2013).

colony (BirdLife International, 2010). The use of IBAs based on short-range colony extensions works well for coastal foragers (McSorley et al., 2003; Wilson et al., 2009) – especially when individual colonies hold a high proportion of the total population – as the designated protected areas often encompass the majority of the colony's range. These coastal MPAs, however, are less effective for protecting pelagic species, whose ranges cover large areas, often crossing national boundaries (Game et al., 2009; Grémillet and Boulinier, 2009; Hyrenbach et al., 2000). At the same time, pelagic species are more threatened than coastal species, and many of the greatest threats, such as by-catch, occur in feeding grounds offshore (Croxall et al., 2012). Designation of MPAs in these areas, using a multi-species and multi-colony approach, can help ensure appropriate conservation management practices are put in place (Ballard et al., 2012; Nur et al., 2011; Ronconi et al., 2012).