Estimated foraging ranges of the breeding seabirds of Ireland's marine Special Protected Area network

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Version 1

Introduction

Ireland's Special Protection Area (SPA) network lists 20 species of breeding seabirds. Coastal SPA boundaries for seabirds typically encompass the terrestrial breeding colonies of the listed species and the immediately adjacent marine waters (ranging between 200 – 500m). The rationale for these marine extensions to the terrestrial SPAs was to encompass areas considered to be of importance for non-foraging maintenance behaviours of the seabirds linked to the breeding colonies. The current SPA network does not include all relevant and important foraging areas ecologically linked to those listed seabird colonies included within the network. Seabirds are central-place foragers with a fixed geographical breeding location and a foraging range predominantly extending out to sea. The maintenance of the foraging resources of seabirds is important for breeding success (Critchley et al., 2018; Thaxter et al., 2012). The breeding season foraging range of pelagic seabird species in Ireland ranges considerably (10s – 1000s kms), greatly exceeding the current SPA boundaries.

Feeding strategies and foraging behaviour of seabirds are complex and can vary markedly between species, colonies, years and even between individuals of the same species (Stauss et al., 2012; Suryan et al., 2000; Thaxter et al., 2012). Identifying discreet important foraging areas is challenging without site and species specific long term data on foraging behaviour as well as information on environmental variables. A colony specific approach identifying foraging areas based exclusively on colony specific data is not currently feasible given the number of SPAs and species involved and the lack of datasets currently available. Recent advancements in seabird tracking technology alongside traditional survey methods can provide representative maximum and mean foraging range values for different seabird species (Woodward et al., 2019). This approach has direct applicability across Ireland's network of SPAs and could highlight the potential importance of marine waters for the protection of seabird populations during the breeding season.

Methods

Thaxter et al. (2012) reviewed the foraging range of 25 seabird species in the United Kingdom based on a total of 304 studies including direct tracking of birds, estimates based on flight speeds and time activity, survey observations and speculative estimates. This comprehensive review has been intermittently updated with the latest review covering 27 species (Woodward et al., 2019). All Irish breeding seabird species, triggering SPA selection, are covered in this review. Foraging range metrics used include the mean, mean maximum and the maximum (see Table 1 below). The maximum foraging ranges are included to show all potential usage areas of foraging seabirds. However, the maximum foraging range of birds of the same species is likely to vary between colonies so the mean maximum is also provided. This is the maximum range reported for each colony, averaged across all colonies. It should be noted that the density of birds at the edge of maximum foraging ranges is likely to be low and for certain species there is limited information available. A GIS based analysis was used to map locations of colonies of listed breeding seabird species in SPAs in Ireland overlayed with foraging ranges from Woodward et al., (2019). A single centre point for each species was selected within each SPA to represent the approximate area of the highest species abundance. There are 71 Special Protected Areas (SPA) in Ireland where breeding seabirds are listed as a Special Conservation Interest, 12 of these were not selected for this study. A total of eight inland sites were excluded as

they are not close to marine areas. This foraging radii approach was not deemed to be suitable for a further four sites, which were primarily defined for the conservation of Chough *Pyrrhocorax pyrrhocorax* and included very long stretches of coastline. These particular sites hold seabird populations with low-density/dispersed coastal distributions. Sites excluded are highlighted in the accompanying Excel file.

Results

Individual foraging range shapefiles were produced for 20 breeding seabirds species that are SCI in Ireland's marine SPA network (Table 1). It should be noted that for Common Gull *Larus canus*, Storm Petrel *Hydrobates pelagicus* and Leach's Petrel *H. eucorhous* in Woodward et al. (2019) information on foraging ranges is relatively poor and some foraging range values were not available. For the purposes of the GIS map creation, missing values were filled with existing foraging range values from other fields. This is highlighted in Table 1 below.

Table 1: The foraging range (km) of breeding seabirds that are Species of Conservation Interest (SCI) in Ireland's marine Special Protected Area (SPA) network. Values (km) based on a review by Woodward et al. (2019). * = values not available in Woodward et al. (2019), missing values were substituted for existing values from neighbouring fields.

Seabird species	Mean foraging radius (kms)	Mean - max foraging radius (kms)	Max foraging radius (kms)	Confidence
Northern Fulmar *Fulmarus glacialis*	134.6	542.3	2736	Good
Manx Shearwater *Puffinus puffinus*	136.1	1346.8	2890	Moderate
Storm Petrel *Hydrobates pelagicus*	336*	336	336	Poor
Leach's Petrel *Oceanodroma leucorhoa*	657	657*	657*	Moderate
Northern Gannet *Morus bassanus*	120.4	315.2	709	Highest
Cormorant *Phalacrocorax carbo*	7.1	25.6	35	Moderate
Shag *Phalacrocorax aristotelis*	9.2	13.2	46	Highest
Kittiwake *Rissa tridactyla*	54.7	156.1	770	Good
Black-headed Gull *Chroicocephalus ridibundus*	7	18.5	18.5	Uncertain
Common Gull *Larus canus*	50*	50	50	Poor
Lesser black-backed Gull *Laurus fuscus*	43.3	127	533	Highest
Herring Gull *Larus argentatus*	14.9	58.8	92	Good
Little Tern *Sternula albifrons*	3.5	5	5	Moderate
Sandwich Tern *Sterna sandvicensis*	9	34.3	80	Moderate
Common Tern *Sterna hirundo*	6.4	18	30	Good
Arctic Tern *Sterna paradisea*	6.1	25.7	46	Good
Roseate Tern *Sterna dougallii*	4.1	12.6	24	Moderate
Common Guillemot *Uria aalge*	33.1	73.2	338	Highest
Razorbill *Alca torda*	61.3	88.7	313	Good
Puffin *Fratercula arctica*	62.4	137.1	383	Good

GIS

The spreadsheet 'Foraging ranges.xls' was imported into ArcGIS Pro. The geographic location of the single centre points for each species selected within each SPA was provided in the geographic coordinate system Irish Transverse Mercator in this table. The x and y coordinates were added to a map creating a point shapefile 'SBRF21_SPA_centroids.shp'. These points were projected to the geographic coordinate system WGS1984 and the excluded sites highlighted in the foraging ranges Excel spreadsheet deleted from the attribute table.

Separate point shapefiles representing the SPA centroids of each of the listed seabird species were created from the 'SBRF21_SPA_centroids.shp'using attribution and the data exported as feature classes. These points representing the SPA centroids for each bird species were fed into a simple

model created in Model builder that automated the process for the creation of mean, mean-max and max foraging radii buffers. Given the large foraging ranges of a number of seabird species, geodesic buffering was used to create the foraging radii polygons to account for the curvature of the earth's surface. Three foraging radii polygon shapefiles were created for each of the twenty listed seabird species. These shapefiles were merged to create the single shapefile 'All_seabird_foraging_radii.shp'.

Discussion

The shapefile of representative foraging ranges of seabirds provided here likely includes a significant amount of the colony specific foraging areas for Ireland's SPA network of breeding seabirds. This approach also shows where foraging ranges may overlap, highlighting the theoretical connectivity of Ireland's marine SPA network. This work is an important preliminary tool for identifying seabird foraging ranges, which is of utility for the conservation management of these species. It should be noted that information on the foraging range of some species is relatively poor (see Woodward et al., 2019 for further information). It is likely more detailed information on all species will become available given the increase in tracking studies being conducted worldwide.

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