**The Seabird Prey Database**

This database was created as part of the Marine Ecosystem Research Programme (MERP), funded by the Natural Environment Research Council (NERC) and the Department for Environment, Food and Rural Affairs (Defra) and aiming to integrate existing and new marine data sets with current models of marine ecosystem services to further our knowledge and understanding of the UK marine ecosystems. The aim of the Seabird Prey Database was to collate a new dataset from all known information on prey consumed by seabirds breeding in the British Isles.

For the predators, we have focused on the 10 most common seabird species by total biomass during the breeding season (Table 1). As the focus of the MERP programme was an assessment of the marine ecosystem, we only selected seabird species where the majority of their consumed prey was marine. Among the top-ten British seabird species by biomass are two gull species (Herring Gull (*Larus argentatus*) and Lesser Black-backed Gulls (*L. fuscus*)). However, they show a very different diet from the other seabirds, forage to a substantial amount on terrestrial habitat (Garthe et al., 2016; Götmark, 1984) and if they consume marine prey its taxonomy is usually poorly resolved. Therefore, they were excluded from this dataset and we concentrated instead on the Northern Gannet (*Morus bassanus*), Common Guillemot (*Uria aalge*), Northern Fulmar (*Fulmarus glacialis*), Atlantic Puffin (*Fratercula arctica*), Black-legged Kittiwake (*Rissa tridactyla*), Razorbill (*Alca torda*), Manx Shearwater (*Puffinus puffinus*), and European Shag (*Phalacrocorax aristotelis*). Together, these birds accounted for 95% of biomass of seabirds consuming a marine diet in 2000 (Grandgeorge et al., 2008; Mitchell, Newton, Ratcliffe, & Dunn, 2004) and thus their prey will reflect the majority of marine prey consumed by seabirds in British waters.

Information was gathered from the primary literature by searching the Web of Science for titles, abstract or keywords containing ‘diet’, ‘food’, and species name. Individual publications returned by the search were then inspected for relevant diet information and/or references to earlier studies that could contain further information. The process was repeated with any further identified studies until no new references could be identified. We also contacted researchers known to collect or to have been collecting seabird diet information. This sometimes lead to the sourcing of unpublished information if the source agreed to the inclusion of that information into the database.

The minimum requirements for inclusion of a study in the database were: the provision of quantitative information on the diet (see below), a sampling location (site name, latitude and longitude) and sampling date (year of data collection or at least a range of years over which the diet information was collected). We also collected a range of other information if present (see metadata included with the database).

We distinguished between sampling during the predator species’ breeding season (although whether a particular sample come from a breeding adult was not necessarily known) and the non-breeding season; there is much less information for the latter season. We recorded this distinction because diets may change due to seasonal variation in prey availability and between breeding and non-breeding requirements. Diets may also vary between different breeding stages but often the exact breeding stage was not known. Moreover, even in the breeding season typically chicks or birds with chicks are sampled, but there are also non-breeding birds; individuals with chicks can bring in food that is higher in energetic density than the food taken by birds without chicks (Noordhuis & Spaans 1992, Brown & Ewins 1996, Ojowski et al. 2001). We also recorded whether the diet sample was obtained from the parent bird or the nestling, as chick food can differ from the food eaten by adults (e.g. Ydenberg 1994, Mehlum, 2001, Dierschke & Hüppop 2003). In some cases, a sample could have come from either of them as this was recorded as ‘Adult & Chick’.

For the prey taxon, we first recorded the prey type as given in the original study. However, some taxa names have changed over time and in order to use a consistent taxonomic terminology we matched each prey type to the corresponding lowest possible valid taxonomic level in WoRMS (<http://www.marinespecies.org/>) using the r package worrms (Chamberlain, 2019) . The quantitative information on how common a prey item was in a particular location and year (location-year) can be expressed in one of three currencies commonly used in seabird dietary studies (Duffy & Jackson 1986, Barrett et al. 2007): frequency of occurrence, numerical frequency and biomass frequency. We recorded the metrics that were provided by the original study per year and location (location-year) with a separate record entered for each prey taxon. So, if for a seabird predator n prey taxa were identified in the samples for a particular year and location, then there are n rows in the database representing that information. If there was diet information for separate years, we recorded the information separately, otherwise we give the start and end year over which information was collected. We recorded any information on the size of a prey taxon if provided (typically prey length); if a number of lengths was given, we recorded the median value. For each location and year, the number of samples recorded. This is the number of different samples collected at a particular location and year and we cannot exclude the possibility that occasionally multiple samples may have been sourced from the same individual. We have included all available information irrespective of sample sizes, but this may be filtered by a minimal sample size required to provide a representative picture of the birds’ diet which may vary between different sample types and diet diversity.

Diets from different seabird species are typically collected using different methods, but often the majority of studies within a species use the same method. Each method has its limitation (see Barrett et al. 2007, Karnovsky et al. 2012). The most representative diet assessment is likely from stomach content. There is information from stomachs for most species and the predominant sampling method used for each species can be compared against stomach content to gain some insight into the limitations specific to the methods and locations collated here.

Finally, we also recorded whether the information was gathered from a peer reviewed publication (primary literature) or an unpublished record in the column Source.

Table 3 gives a summary of the number of locations and number of location-years that the database covers for each of the species included in the database. The number of locations varies between species depending on number of colonies in Britain and how readily diet information for this species can be collected. For Common Guillemots a total of 42 locations and 152 location-years all around the British coast were included. There was also a good number of locations (range 8=17 locations) and location-years (39-106 locations-years) for Atlantic Puffin, Black-legged Kittiwake, European Shag and Razorbill. There was information for five colonies for Northern Fulmar and Northern Gannet, the latter reflecting the smaller number of breeding locations in Britain than for the other species. Finally, diet information for Manx Shearwater was only available for one location from one year, although the species would breed at more locations in Britain. The geographical spread of the locations is skewed towards the northern and western parts of the British Isles as this is where the majority of breeding seabirds occur.

It is hoped that this information will provide an overview of the prey species the most common seabirds in British waters rely on and insights both in the function and structure of marine ecosystems and a basis for conservation management decisions, as many of British seabird populations are declining. As new information on the diets of British seabirds is published, we hope to continue to update the database, curating it as a repository for diet information of British Seabirds.

References

Barrett RT, Chapdelaine G, Anker-Nilsson T, Mosbech A, MontevecchiWA, Reid J, Veit RR (2006) Seabird numbers and prey consumption in the North Atlantic. ICES J Mar Sci 63:1145–1158

Robert T. Barrett, R.T., Camphuysen, C.J., Anker-Nilssen, T., Chardine, J.W, Furness, R.F., Garthe, S., Hüppop, O., Leopold, M.F., Montevecchi, W.A., Veit, R.A. 2007. Diet studies of seabirds: a review and recommendations. ICES Journal of Marine Science, 64:1675–1691.

Brown K. M., Ewins P. J. 1996. Technique-dependent biases in determination of diet composition: an example with ring-billed gulls. Condor , 98:34-41.

Cairns DK, Chapdelaine G, Montevecchi WA (1991) Prey exploitation by seabirds in the Gulf of St. Lawrence. In: Therriault JC (eds) The Gulf of St. Lawrence: Small ocean or big estuary? Canadian Special Publication of Fisheries and Aquatic Sciences, Mont-Joli, p 277–291 Camphuysen

Scott Chamberlain (2019). worrms: World Register of Marine Species (WoRMS) Client. R package version 0.3.2. https://CRAN.R-project.org/package=worrms

Dierschke, A-K., Hüppop, O. 2003. Langfristige Veränderungen in der Ernährung von Silbermöwen (*Larus argentatus*) auf Helgoland unter dem Einfluss der Fischerei mit Vergleichen zur Heringsmöwe (*Larus fuscus*). Seevögel, 24:3-15.

Duffy, D. & Jackson, S. 1986. Diet studies of seabirds: a review of methods. Colonial Waterbirds , 9:1-17.

Karnovsky, N., Hobson, K. & Iverson, S. 2012. From lavage to lipids: Estimating diets of seabirds. Marine Ecology Progress Series, 451: 263-284.

Mehlum, F. 2001. Crustaceans in the diet of adult common and Brünnich's guillemots *Uria aalge* and *U. lomvia* in the Barents Sea during the breeding period. Marine Ornithology , 29:19-22.

Noordhuis R. & Spaans A. L. 1992. Interspecific competition for food between herring *Larus argentatus* and lesser black-backed gulls *L. fuscus* in the Dutch Wadden Sea area. Ardea, 80:115-132.

Ojowski, U., Eidtmann, C., Furness, R. W. & Garthe S. 2001. Diet and nest attendance of incubating and chick-rearing northern fulmars (*Fulmarus glacialis*) in Shetland. Marine Biology, 139:1193-1200.

Ydenberg, R. 1994. The behavioural ecology of provisioning in birds. Ecoscience , 1:1-14.