

Marine Institute Seabird Monitoring

During the Western European Shelf
Pelagic Acoustic Survey (WESPAS).

June - July 2019

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Executive Summary

Irish waters represent one of the most important marine habitats for seabirds in Europe and are utilized by a wide range of seabird species. However, the at-sea abundance and distribution of many of the seabird species occurring in Irish waters remains poorly understood. Under the EU Birds Directive, there is a requirement on member states to conduct surveillance of seabirds occurring within their waters. The Department of Arts, Heritage and the Gaeltacht (DAHG), through the Marine Institute, commissioned a seabird survey from the MRV Celtic Explorer during the annual Western European Shelf Pelagic Acoustic Survey (WESPAS), running from 13th of June to 4th of July and the 4th to 24th July 2019.

A standard line transect survey methodology was employed by the seabird survey team with additional visual point sampling at fishing locations and oceanographic sampling stations. Survey transects were undertaken at speeds of 5-10 knots, with fishing activity being conducted at speeds of 2-3 knots. The seabird observer's survey effort was maximized and optimized during periods of sea state less than or equal to sea state 6 and with visibility of greater than 300m. A total of 225 hours and 40 minutes of survey effort was conducted over the course of the WESPAS 2019 survey, 125 hours and 3 minutes of survey effort was conducted on Leg 1, while 100 hours and 37 minutes of survey effort was conducted on Leg 2 of the survey. In total, 187 hours and 36 minutes of survey effort were conducted using a line transect methodology, while 38 hours and 4 minutes of effort were conducted using the point sampling methodology.

A total of 4528 seabird sightings were recorded throughout the survey, totalling 24866 individuals, with flock size ranging from 1 up to 2000 for some species. In total, 7074 seabirds were recorded as 'in-transect' during line transect survey effort. A total of 25 species of seabird were encountered during the survey. A further 23 sightings of terrestrial birds were also recorded, comprising of 56 individuals belonging to 10 species'.

Introduction

Irish waters represent one of the most important marine habitats for seabirds in Europe and are utilized by a wide range of seabird species (Mackey, *et al.*, 2004; Mitchell, *et al.*, 2004; Pollock, *et al.*, 1997). The waters of the Irish EEZ consist of an area high in biological productivity within the North-East Atlantic and include widespread areas over shallower continental shelf, deep oceanic waters and waters overlying the continental slope (DEHLG, 2009), providing diverse habitats for a range of seabirds. Ireland's rugged and exposed coastline provide ample and diverse nesting habitats for a range of seabirds, and Ireland's coast hosts a number of large seabird colonies of significance at a European level (Mackey, *et al.*, 2004). At present, there are twenty-four species of seabirds known to breed in Ireland (Mitchell, *et al.*, 2004; *Table 1*).

In 1930, legal protection for birds, including most seabird species, in Ireland began with the enactment of the Wild Birds (Protection) Act. The 1976 Wildlife Act provides a legal framework for the conservation of Irish wildlife and their habitats, conferring specific protection on all bird species, including seabirds, from death, injury or disturbance at nest sites.

Seabirds in Ireland are also protected under EC Council Directive (2009/147/EEC) on the conservation of birds commonly referred to as the EU Birds Directive. The Birds Directive relates to the conservation of all wild bird species occurring in EU member states, it covers the protection and management of the birds, their nests, eggs and habitat, and mandates the creation of Special Protection Areas (SPAs) (Article 3, EC Council Directive 2009/147/EEC). A number of seabirds are listed under Annex I of the Birds Directive as species requiring special conservation measures concerning their habitat in order to ensure their survival in their natural range (Article 4, EC Council Directive 2009/147/EEC). Since 1993 the EU has funded Species Action Plans for species listed in Annex 1 of the Birds Directive, including the Balearic shearwater (*Puffinus mauretanicus*) and roseate tern (*Sterna dougallii*), providing key information on the status, ecology and threats to species as well as key steps to ensure their conservation. Seabirds gain further protection under the EC Council Directive (92/43/EEC) on the conservation of natural habitats, and of wild flora and fauna, commonly referred to as the EU Habitats Directive, through the establishment of the 'Natura 2000' network; a coherent network of SPAs and Special Areas of Conservation (SACs). Article 6 of the Habitats Directive defines how Natura 2000 sites are managed and protected, and establishes the requirement to conduct appropriate assessments in Natura 2000 sites before plans or projects likely to impact the site are conducted.

Ireland is also a signatory to the Bern convention on the conservation of European wildlife and natural habitats, the Bonn convention on the conservation of migratory species of wild animals, and the OSPAR convention for the protection of the marine environment in the North-East Atlantic, each affording further protection to seabirds.

Despite the importance Ireland holds for nesting and feeding seabirds, quantitative data on the population status and distribution, particularly the at sea distribution, of many of the seabird species occurring in Ireland remains poorly understood (Mackey, *et al.*, 2004). Under the EU Birds Directive, there is a requirement on member states to identify and classify habitats for the establishment of SPAs for seabirds, including foraging habitats within their waters.

Table 1: Breeding seabird numbers in Ireland and Britain 1998-2002 as recorded during the Seabird 2000 census and percentage change in numbers since The Seabird Colony Register (SCR) 1985-1988 (Source: Mitchell, et al., 2004).

<i>Species</i>	<i>Latin name</i>	<i>Northern Ireland</i>	<i>Republic of Ireland</i>	<i>All- Ireland total</i>	<i>GB & Ireland Total</i>	<i>Percentage change since SCR Census (1985-88)¹</i>
Fulmar	<i>Fulmarus glacialis</i>	5,992	32,918	38,910	537,991	0%
Manx Shearwater ²	<i>Puffinus puffinus</i>	4,633	32,545	37,178	332,267	
European Storm petrel ²	<i>Hydrobates pelagicus</i>	0	99,065	99,065	124,775	
Leach's Storm petrel ²	<i>Oceanodroma leucorhoa</i>	0	310	310	48,357	
Gannet	<i>Sula bassana</i>	0	32,758	32,758	259,311	39%
Cormorant	<i>Phalacrocorax carbo</i>	663	4,548	5,211	13,681	7%
Shag	<i>Phalacrocorax aristotelis</i>	301	3,426	3,727	32,306	-25%
Arctic Skua	<i>Stercorarius parasiticus</i>	0	0	0	2,136	-37%
Great Skua	<i>Stercorarius skua</i>	0	1	1	9,635	26%
Mediterranean Gull	<i>Larus melanocephalus</i>	2	3	5	113	
Black-headed Gull	<i>Larus ridibundus</i>	10,107	3,876	13,983	141,890	2%
Common Gull	<i>Larus canus</i>	557	1,060	1,617	49,780	39%
Lesser Black-backed Gull	<i>Larus fuscus</i>	1,973	2,876	4,849	116,684	42%
Herring Gull	<i>Larus argentatus</i>	714	5,521	6,235	149,177	-17%
Great Black-backed Gull	<i>Larus marinus</i>	76	2,243	2,319	19,713	-6%
Kittiwake	<i>Rissa tridactyla</i>	13,060	36,100	49,160	415,995	-23%
Sandwich Tern	<i>Sterna sandvicensis</i>	1,954	1,762	3,716	14,252	-11%
Roseate Tern	<i>Sterna dougallii</i>	4	734	738	790	44%
Common Tern	<i>Sterna hirundo</i>	1,704	2,485	4,189	14,497	-2%
Arctic Tern	<i>Sterna paradisaea</i>	767	2,735	3,502	56,123	-29%
Little Tern	<i>Sterna albifrons</i>	0	206	206	2,153	-25%
Guillemot	<i>Uria aalge</i>	98,546	138,108	236,654	1,559,484	32%
Razorbill ³	<i>Alea torda</i>	24,084	27,446	51,530	216,087	23%
Black Guillemot ⁴	<i>Cephus grylle</i>	1,174	3,367	4,541	42,683	
Atlantic Puffin	<i>Fratercula arctica</i>	1,610	19,641	21,251	600,751	19%

¹ inland colonies were not surveyed during the SCR Census (1985-88)

² not surveyed during the SCR Census (1985-88)

³ counts of individuals

⁴ counts of pre-breeding adults; pre-breeding surveys were not conducted in the Republic of Ireland during the SCR Census (1985-88).

Since 1994, a number of dedicated studies on seabirds have been conducted in Ireland, providing data on the presence, distribution and abundance of the numerous seabird species in coastal and offshore waters (e.g. Pollock et al. 1997; Mackey, et al., 2004; O'Brien, et al., 2016). In recent years, the Marine Institute has facilitated the surveillance of seabirds in Irish waters by providing berths for seabird observers on-board the national research vessels, MRV Celtic Explorer and MRV Celtic Voyager, during oceanographic and fisheries surveys (O'Donnell, et al., 2016; 2017; 2018). Fisheries acoustic surveys are particularly suited to the conduction of seabird surveys as the vessel spends the majority of the survey travelling at a steady speed along pre-determined survey tracks.

The WESPAS is an acoustic survey undertaken by the Fisheries Ecosystems Advisory Services (FEAS) department of the Marine Institute of Ireland. The survey has been undertaken annually since 2016 with the present survey being the fourth survey in the series. Prior to 2016, the survey was organised as two separate surveys; the Malin Shelf acoustic survey and the boarfish survey. The Malin Shelf acoustic survey has been carried out annually since 2008 and reports on the annual abundance of summer feeding aggregations of herring to the west of Scotland and to the north and west of Ireland from 54°N to 58°30'N (O'Donnell, et al., 2018). The boarfish survey was carried out from 2011 using a chartered fishing vessel and reports on the abundance of spawning aggregations of boarfish from 47°N to 57°N (O'Donnell, et al., 2018). Since 2016, these surveys were combined and undertaken on-board the RV *Celtic Explorer* over a 42 day period during the summer months under the unified Western European Shelf Pelagic Acoustic Survey title. WESPAS provides stratified relative stock abundance estimates of herring (*Clupea harengus*), boarfish (*Capros aper*) and horse mackerel (*Trachurus trachurus*) as part of a national stock assessment (O'Donnell, et al., 2018).

The WESPAS provides a unique opportunity for surveillance of the summer distribution of seabirds in shelf water habitats along Ireland's Atlantic margins which can be difficult to reach by other means. The waters of Ireland's Atlantic margin are highly productive owing to the upwelling of nutrient rich oceanic waters, and support large and diverse species' assemblages (Mackey et al., 2004). The availability and distribution of prey is a key factor affecting the distribution of seabirds, and the complex bathymetry and hydrology of the Atlantic margin maintain a heterogeneous marine environment, making it a key habitat for seabirds (Mackey et al., 2004).

In order to contribute to its current monitoring regime, the Department of Arts, Heritage and the Gaeltacht (DAHG), through the Marine Institute, commissioned the conduction of a seabird survey from the MRV Celtic Explorer during the annual Western European Shelf Pelagic Acoustic Survey (WESPAS), running from 13th of June to 4th of July and the 4th to 24th July 2019.

Methodology

The seabird survey was conducted from the 14/06/19 to the 24/07/19 using a team of two seabird surveyors per survey leg. The lead seabird observer conducted visual survey effort, while the other seabird observer was responsible for data collection and recording. Given the presented survey transects (*Figure 1*), a standard line transect survey methodology was determined to be most suitable and was employed by the seabird survey team. Survey transects were undertaken at speeds of 5-10 knots, with fishing activity being conducted at speeds of 2-3 knots.

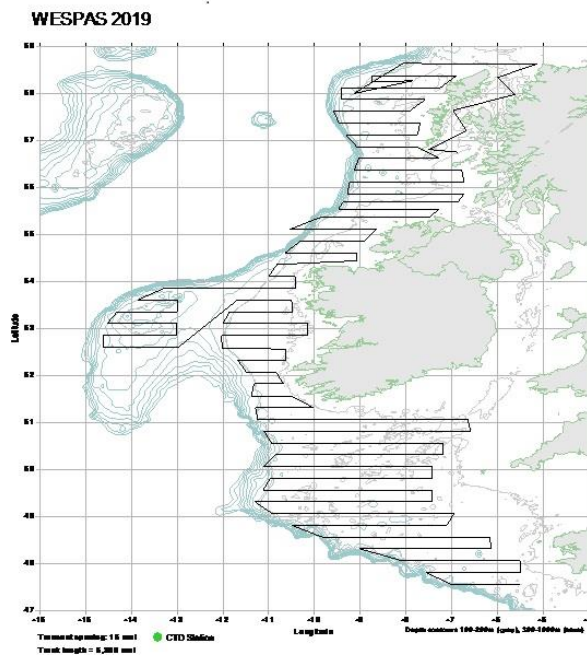


Figure 1: The planned WESPAS 2019 cruise track (Source: Marine Institute, 2017).

Visual survey watches were conducted using a standard line transect survey design while the vessel was travelling at a consistent speed and heading. Additional visual point sampling (e.g., at oceanographic sampling stations or fishing stations) was also employed, however line transect survey effort was prioritised by the observer. The observer's survey effort was maximized and optimized during periods of sea state less than or equal to sea state 6 and with visibility of greater than 300m. Regular breaks were taken by the observer to avoid observer fatigue and its associated negative consequences.

Observations for seabirds were conducted from the monkey island (deck height 12 m above sea level) or the bridge (deck height 10 m above sea level). Observations were conducted from the monkey island preferably, however, as in previous surveys aboard the R.V. Celtic Explorer, access to the monkey island was dependent on weather conditions.

Line transect survey methodology

The line transect data collection methodology was based on that originally proposed by Tasker *et al.* (1984) with later adaptations applied to allow correction factors to be applied for missed birds (Camphuysen *et al.*, 2004). The method employed used a single platform line transect survey design with sub-bands to survey birds associated with the water, while flying birds were surveyed using a 'snapshot' technique. Observer effort was concentrated in a bow-beam arc of 90° to one side (i.e., to port or starboard) of the vessel's track-line, however, all seabirds observed outside this area were also recorded.

Survey effort for seabirds associating with the water were concentrated within a survey strip of 300m running parallel and adjacent to the vessels track-line and extending to the horizon. All birds surveyed within this region were recorded as 'in-transect' and assigned to one of four distance sub-bands (A: 0-50m, B: 50-100m, C: 100-200m, D: 200-300m) according to their perpendicular distance from the track-line. This approach allows for the evaluation of biases caused by specific differences in detection probability with increasing distance from the trackline (Camphuysen *et al.* 2004). Seabirds occurring outside of this survey strip were recorded as 'off-transect' and assigned to a separate sub-band (E: >300m). The perpendicular distance to an animal was estimated using a fixed interval range finder (Heinemann, 1981), ensuring each animal was allocated to the correct distance sub-band.

Flying birds were surveyed using 'snapshots', where instantaneous counts of flying birds within a survey quadrant of 300m x 300m were conducted. The periodicity of these 'snapshots' was vessel speed dependent but timed to allow counts to occur as the vessel passes from one survey quadrant to the next. This method minimises biases in counts of flying birds relative to the movement of the vessel (Pollock *et al.*, 2000, Camphuysen *et al.* 2004).

Seabirds remaining with the vessel for more than 2 minutes were deemed to be associating with the vessel (Camphuysen *et al.* 2004) and were recorded as such. Seabirds seen associating with other vessels (i.e. fishing vessels) were also recorded as such.

Searching for seabirds was done with the naked eye, however, Leika Ultravid 8x42 HD binoculars were used to confirm parameters such as species identification, age, moult, group size and behaviour (Mackey *et al.* 2004). A Canon EOS 7D Mark II DSLR camera with a Canon EF 100-400mm F4.5-5.6 IS II USM telephoto lens was used to visually document other information of scientific interest. Data was also collected on all migratory/ transient waterfowl and terrestrial birds encountered.

Data collection and recording

The Cybertracker (<https://cybertracker.org>) data collection software package (Version 3.501) was configured for optimum use on the survey. Cybertracker was used to record all positional, environmental and sightings data. Using a portable GPS receiver with USB connection, the Cybertracker software automatically recorded the ships position directly into a Microsoft Access database every 5 seconds.

Environmental data was regularly recorded using Cybertracker, including at the start of each seabird survey transect, and included data such as; wind speed, wind direction, sea state, swell, visibility, cloud cover and precipitation. The data was time stamped with GPS data by Cybertracker and saved

in the Access database. If environmental conditions changed at any point, the seabird observers recorded an environmental update of the above listed data. Each line transect was assigned a unique transect number, and a new transect was started anytime the vessel activity changed (i.e. changing from on-transect to inter-transect). Each subsequent sighting was also assigned to this unique transect number. Ancillary information (such as line changes, changes in survey activity, other vessel activity, etc.) were also recorded on Cybertracker.

The GPS position of each seabird sighting was time stamped and digitally marked using Cybertracker. Sighting data such as; species identification, distance band, group size, composition, heading, age, moult, behaviour and any associations with cetaceans or other vessels were also recorded on the time stamped Cybertracker sighting record page. Where species identification could not be confirmed, sightings were recorded at an appropriate taxonomic level (i.e. large gull sp., *Larus sp.*, commic tern, etc.).

Additional visual point sampling was conducted at oceanographic sampling stations and fishing shoot/haul locations. Point sampling survey effort for seabirds was conducted in 360° arc around the vessel. Data recording methodology remained similar for both point sampling and line transect methods.

Results

Effort

A total of 225 hours and 40 minutes of survey effort was conducted over the course of the WESPAS 2019 survey, 125 hours and 3 minutes of survey effort was conducted on Leg 1, while 100 hours and 37 minutes of survey effort was conducted on Leg 2 of the survey. In total, 187 hours and 36 minutes of survey effort were conducted using a line transect methodology, while 38 hours and 4 minutes of effort were conducted using the point sampling methodology.

The observer's survey effort was maximized and optimized during the prevailing hours of daylight. The maximum recorded daily survey effort was 9 hours and 19 minutes while the average daily survey effort was 6 hours and 6 minutes. No effort watches were conducted on the 4th or 5th of July due to a crew change followed by calibration of the vessels acoustic survey equipment in Killary harbour. Seabird survey effort was greatly reduced on the 27th of June, and on the 21st and 22nd of July, due to weather conditions exceeding the specified weather limits for observations. Poor weather conditions also resulted in reduced visual survey effort on a number of occasions over the course of the survey. During these periods of unsuitable environmental conditions, a number casual watches were conducted by the observers. Seabird survey effort was also restricted on the 14th of June due to transiting from port. A graph of daily effort is provided in *Figure 2* below.

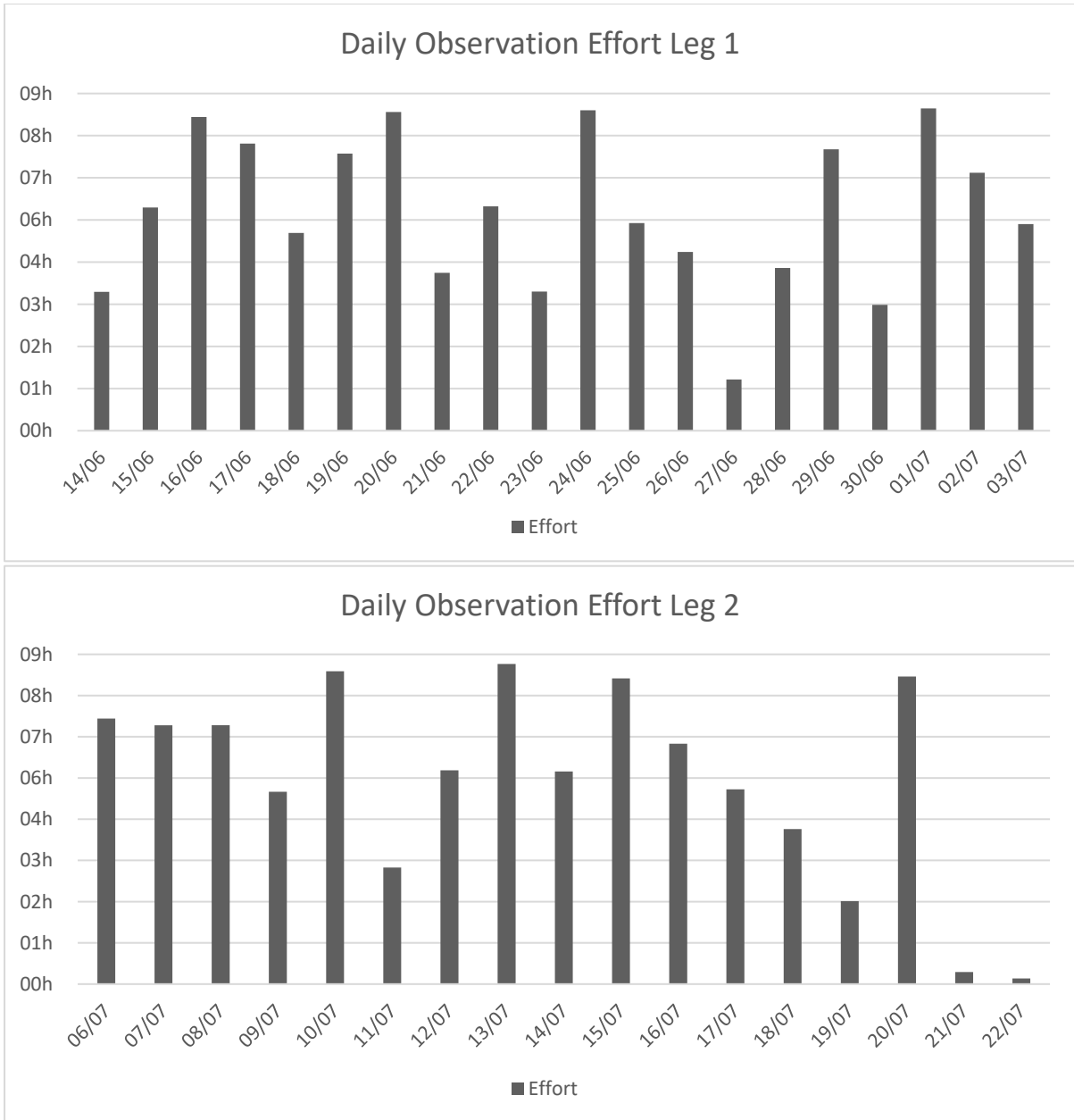


Figure 2: Daily visual effort undertaken during the survey.

Environmental Conditions

Environmental conditions were generally moderate to good throughout the survey, however, on a number of occasions seabird survey effort was restricted due to environmental conditions. A breakdown of key environmental factors recorded during the survey is provided hereunder.

Sea State

Sea state was recorded using both the World Meteorological Organisation (WMO) sea state scale and the Beaufort scale. The WMO scale takes account of the effect of wind, swell and currents (WMO, 2011) on the sea conditions and is judged in terms of wave height in meters. Beaufort sea state was recorded in terms of Beaufort wind force and was judged based on the effect of the wind and currents on the sea surface.

WMO sea states 3, 4 and 5 were the most common sea states recorded. The most frequently recorded WMO sea state was 3, accounting for over 69 hours (31%) of observation effort. WMO sea state 4 accounted for over 68 hours (30%) of observation effort, while WMO sea state 2 accounted for over 67 hours (30%) (*Fig. 3a*).

The most frequently recorded Beaufort sea state was also a sea state 3, accounting for over 71 hours (32%) of survey effort, while sea state 4 and 5 each approximately accounted for 45 hours (20%) of survey effort. Sea state 2 was also frequently recorded, accounting for 40 hours (18%) of survey effort (*Fig. 3b*).

Swell

A swell height of 0.1-1 meter was most frequently recorded throughout the survey, being recorded on over 120 hours (53%) of survey effort. A swell height of 1.1-2 meters accounted for the majority of the remaining survey hours (80 hours / 35%) (*Fig. 3c*).

Visibility

Visibility was generally very good during seabird survey effort. The most frequently recorded visibility was 11-15km, being recorded over 139 hours (62%) of survey effort, while visibility of 6-10km was recorded over 45 hours (20%) of survey effort (*Fig. 3d*).

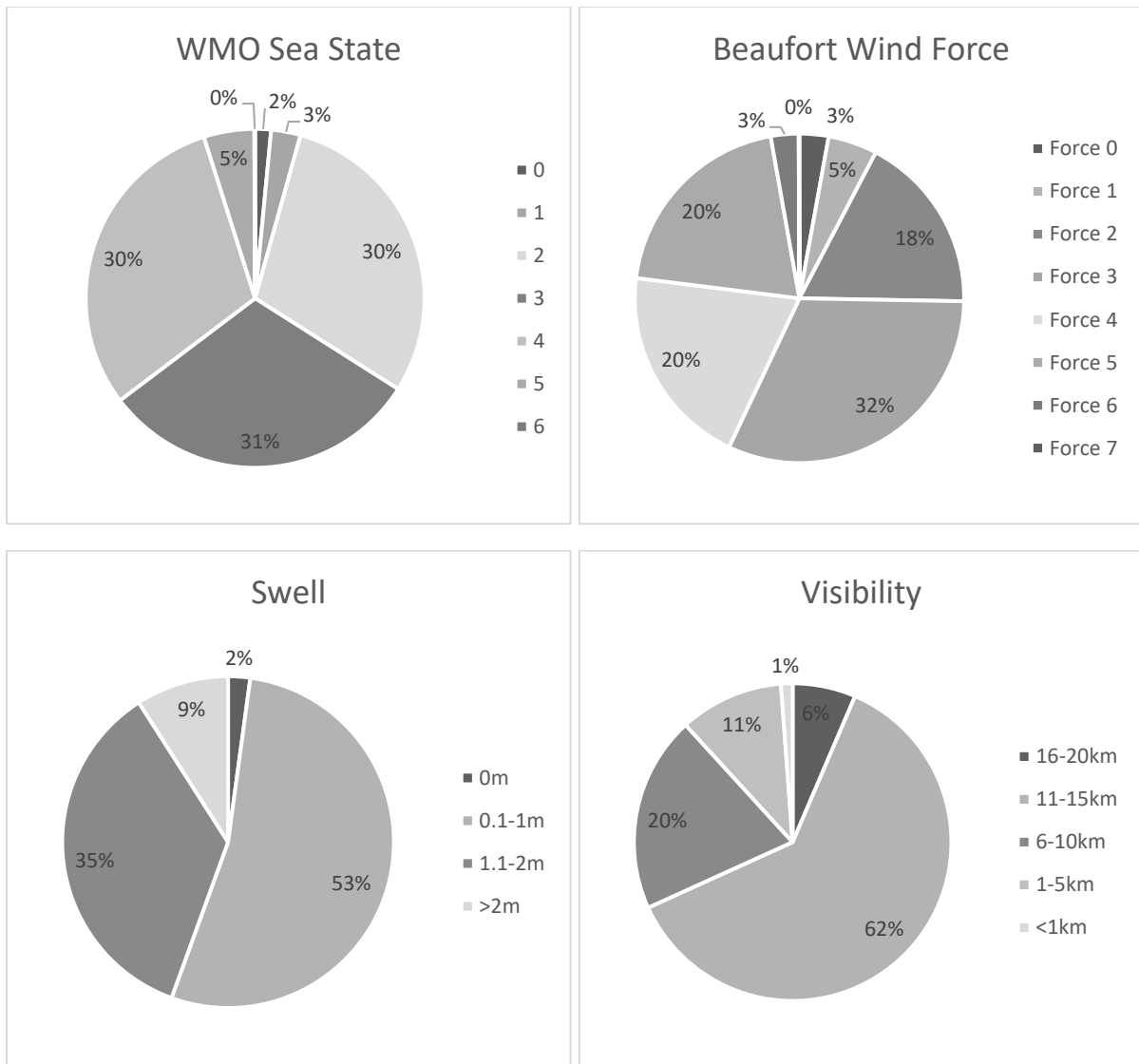


Figure 3: Summary of environmental conditions recorded on the WESPAS 2019; a) WMO sea state, b) Beaufort sea state/ wind force, c) Swell height (meters), d) Visibility (kilometres).

Sightings

A total of 4528 seabird sightings were recorded throughout the survey, totalling 24866 individuals, with flock size ranging from 1 up to 2000 for some species (*Table 2*). In total, 7074 seabirds were recorded as “in transect” during line transect survey effort. A summary of all sightings recorded on the survey is presented in *Table 2* and includes sightings recorded during both line transect and point sampling watches. A total of 25 species of seabird were encountered during the survey. A further 23 sightings of terrestrial birds were also recorded, comprising of 56 individuals belonging to 10 species’.

Table 2: Summary of all seabird sightings recorded on the survey during both line transect and point sampling watches.

<i>Common Name</i>	<i>Species name</i>	<i>No. of Sightings</i>	<i>No. of Individuals</i>	<i>Group Size</i>
Fulmar	<i>Fulmarus glacialis</i>	965	8159	1-2000
Balearic Shearwater	<i>Puffinus mauretanicus</i>	1	1	1
Great Shearwater	<i>Puffinus graves</i>	1	1	1
Manx Shearwater	<i>Puffinus puffinus</i>	561	3010	1-500
Sooty Shearwater	<i>Puffinus griseus</i>	8	8	1
European Storm Petrel	<i>Hydrobates pelagicus</i>	524	3425	1-1000
Leach's Petrel	<i>Oceanodroma leucorhoa</i>	3	3	1
Wilson's Petrel	<i>Oceanites oceanicus</i>	4	6	1-3
Gannet	<i>Morus bassanus</i>	1265	6087	1-900
Shag	<i>Phalacrocorax aristotelis</i>	1	3	1
Arctic Skua	<i>Stercoratius parasiticus</i>	2	2	1
Great Skua	<i>Stercoratius skua</i>	108	135	0-5
Long-tailed Skua	<i>Stercoratius longicaudus</i>	1	1	1
Pomarine Skua	<i>Stercoratius pomarinus</i>	4	4	1
South Polar Skua	<i>Stercorarius maccormicki</i>	1	1	1
Kittiwake	<i>Rissa tridactyla</i>	225	1061	1-300
Herring Gull	<i>Larus argentatus</i>	13	23	1-7
Great Black-backed Gull	<i>Larus marinus</i>	31	43	1-5
Lesser Black-backed Gull	<i>Larus fuscus</i>	133	541	1-100
Little Tern	<i>Sterna albifrons</i>	1	3	1
Commic tern sp.	<i>Sterna hirundo / Sterna paradisaea</i>	1	15	15
Common Tern	<i>Sterna hirundo</i>	7	9	1-3
Arctic Tern	<i>Sterna paradisaea</i>	13	20	1-5
Auk sp.	<i>Alcidae sp.</i>	13	371	1-200
Guillemot	<i>Uria aalge</i>	299	1149	1-50
Razorbill	<i>Alea torda</i>	114	340	1-18
Atlantic Puffin	<i>Fratercula arctica</i>	229	445	1-44
	Total	4528	24866	

Of the 4528 sightings recorded during the survey, 4093 were recorded during line transect effort. All 25 seabird species recorded during the survey were recorded during line transect survey effort. In total, 15892 seabirds were recorded during line transect effort, with 7074 of these recorded as 'in-transect'. The remaining 8818 seabirds were recorded as 'off-transect'. A breakdown of all species encountered during line transect effort watches is presented in *Table 3*.

Table 3: Summary of all seabird sightings recorded during line transect effort on the survey.

<i>Common Name</i>	<i>Species name</i>	<i>No. of Sightings</i>	<i>No. of Seabirds</i>	<i>In Transect</i>	<i>Off Transect</i>
Fulmar	<i>Fulmarus glacialis</i>	864	3708	1002	2706
Balearic Shearwater	<i>Puffinus mauretanicus</i>	1	1	0	1
Great Shearwater	<i>Puffinus graves</i>	1	1	0	1
Manx Shearwater	<i>Puffinus puffinus</i>	525	2761	1902	859
Sooty Shearwater	<i>Puffinus griseus</i>	6	6	1	5
European Storm Petrel	<i>Hydrobates pelagicus</i>	486	1972	847	1125
Leach's Petrel	<i>Oceanodroma leucorhoa</i>	3	3	2	1
Wilson's Petrel	<i>Oceanites oceanicus</i>	3	5	1	4
Gannet	<i>Morus bassanus</i>	1137	3860	821	3039
Shag	<i>Phalacrocorax aristotelis</i>	1	3	3	0
Arctic Skua	<i>Stercoratius parasiticus</i>	1	1	0	1
Great Skua	<i>Stercoratius skua</i>	91	106	50	56
Long-tailed Skua	<i>Stercoratius longicaudus</i>	1	1	0	1
Pomarine Skua	<i>Stercoratius pomarinus</i>	3	3	0	3
South Polar Skua	<i>Stercorarius maccormicki</i>	1	1	0	1
Kittiwake	<i>Rissa tridactyla</i>	198	845	629	216
Herring Gull	<i>Larus argentatus</i>	9	18	2	16
Lesser Black-backed Gull	<i>Larus fuscus</i>	107	316	27	289
Great Black-backed Gull	<i>Larus marinus</i>	28	33	7	26
Arctic Tern	<i>Sterna paradisaea</i>	11	17	9	8
Commic tern sp.	<i>Sterna hirundo / Sterna paradisaea</i>	1	15	0	15
Common Tern	<i>Sterna hirundo</i>	6	8	3	5
Little Tern	<i>Sterna albifrons</i>	1	3	3	0
Auk sp.	<i>Alcidae sp.</i>	12	357	212	145
Razorbill	<i>Alea torda</i>	108	320	273	47
Guillemot	<i>Uria aalge</i>	281	1120	1043	77
Atlantic Puffin	<i>Fratercula arctica</i>	207	408	237	171
	Total	4093	15892	7074	8818

The distribution of all sightings of seabird species recorded during line transect survey effort can be seen in *Figures 4 to 6*.

Point sampling was conducted at 45 oceanographic and/or fishing stations (Figure 9). A total of 435 sightings were recorded during point sampling effort, comprising 8974 individuals belonging to 19 species or species groups (Table 4). All sightings recorded during point sampling watches were recorded as 'off transect'.

Table 4: Summary of all sightings recorded during point sampling effort on the survey.

Common Name	Species name	No. of Sightings	No. of Individuals 'Off Transect'
Fulmar	<i>Fulmarus glacialis</i>	101	4451
Manx Shearwater	<i>Puffinus puffinus</i>	36	249
Sooty Shearwater	<i>Puffinus griseus</i>	2	2
Storm Petrel	<i>Hydrobates pelagicus</i>	38	1453
Wilson's Petrel	<i>Oceanites oceanicus</i>	1	1
Gannet	<i>Morus bassanus</i>	128	2227
Arctic Skua	<i>Stercorarius parasiticus</i>	1	1
Great Skua	<i>Stercorarius skua</i>	17	29
Pomarine Skua	<i>Stercorarius pomarinus</i>	1	1
Kittiwake	<i>Rissa tridactyla</i>	27	216
Herring Gull	<i>Larus argentatus</i>	4	5
Lesser Black-backed Gull	<i>Larus fuscus</i>	26	225
Great Black-backed Gull	<i>Larus marinus</i>	3	10
Arctic Tern	<i>Sterna paradisaea</i>	2	3
Common Tern	<i>Sterna hirundo</i>	1	1
Auk sp.	<i>Alcidae sp.</i>	1	14
Guillemot	<i>Uria aalge</i>	18	29
Razorbill	<i>Alea torda</i>	6	20
Atlantic Puffin	<i>Fratercula arctica</i>	22	37
	Total	435	8974

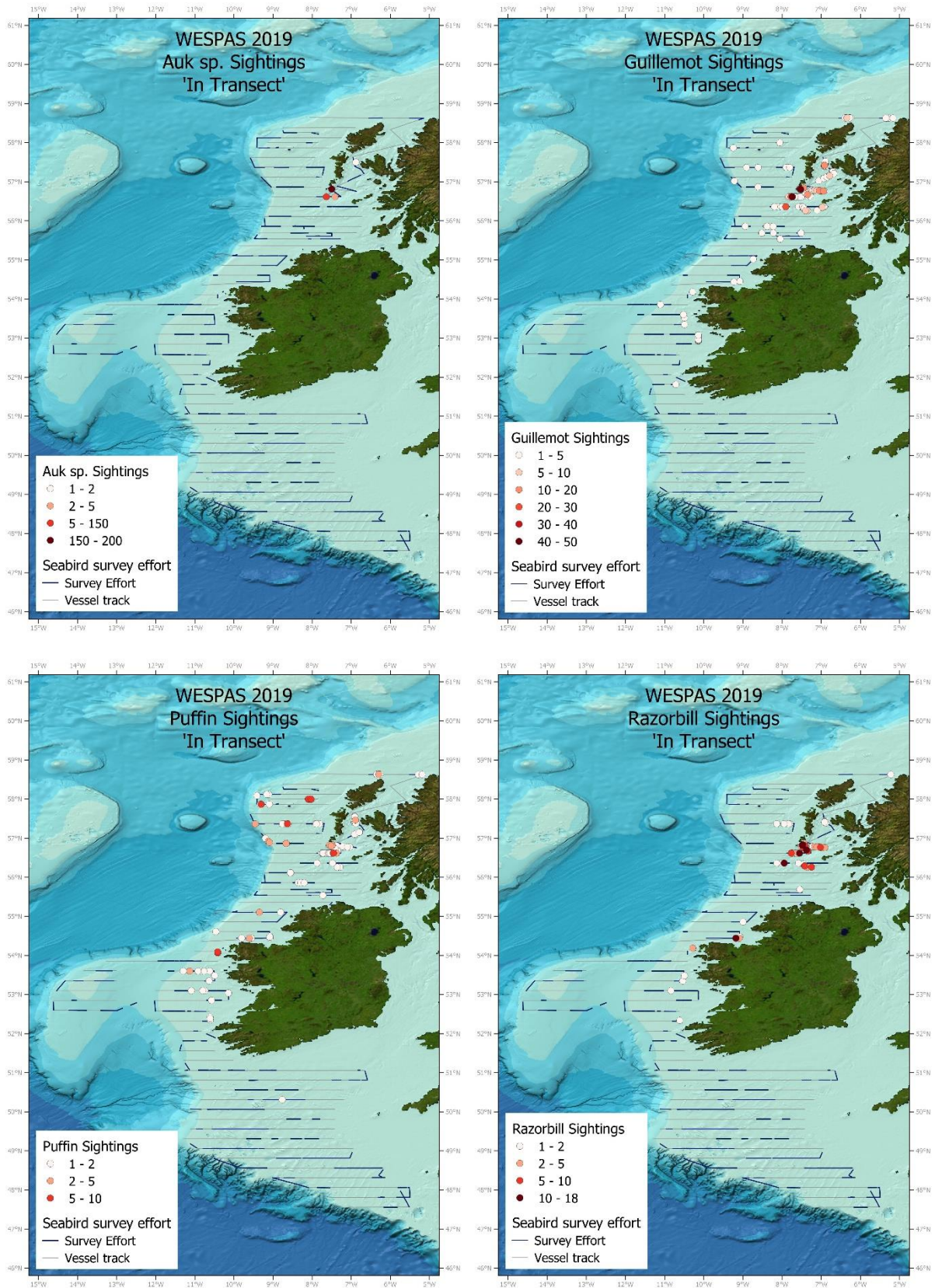


Figure 4: Distribution and abundance of auk species' sightings recorded as 'In transect' during line transect effort on the survey; a) unidentified auk sp., b) guillemot, c) puffin, d) razorbill. Seabird survey effort transects are overlaid on the survey track line.

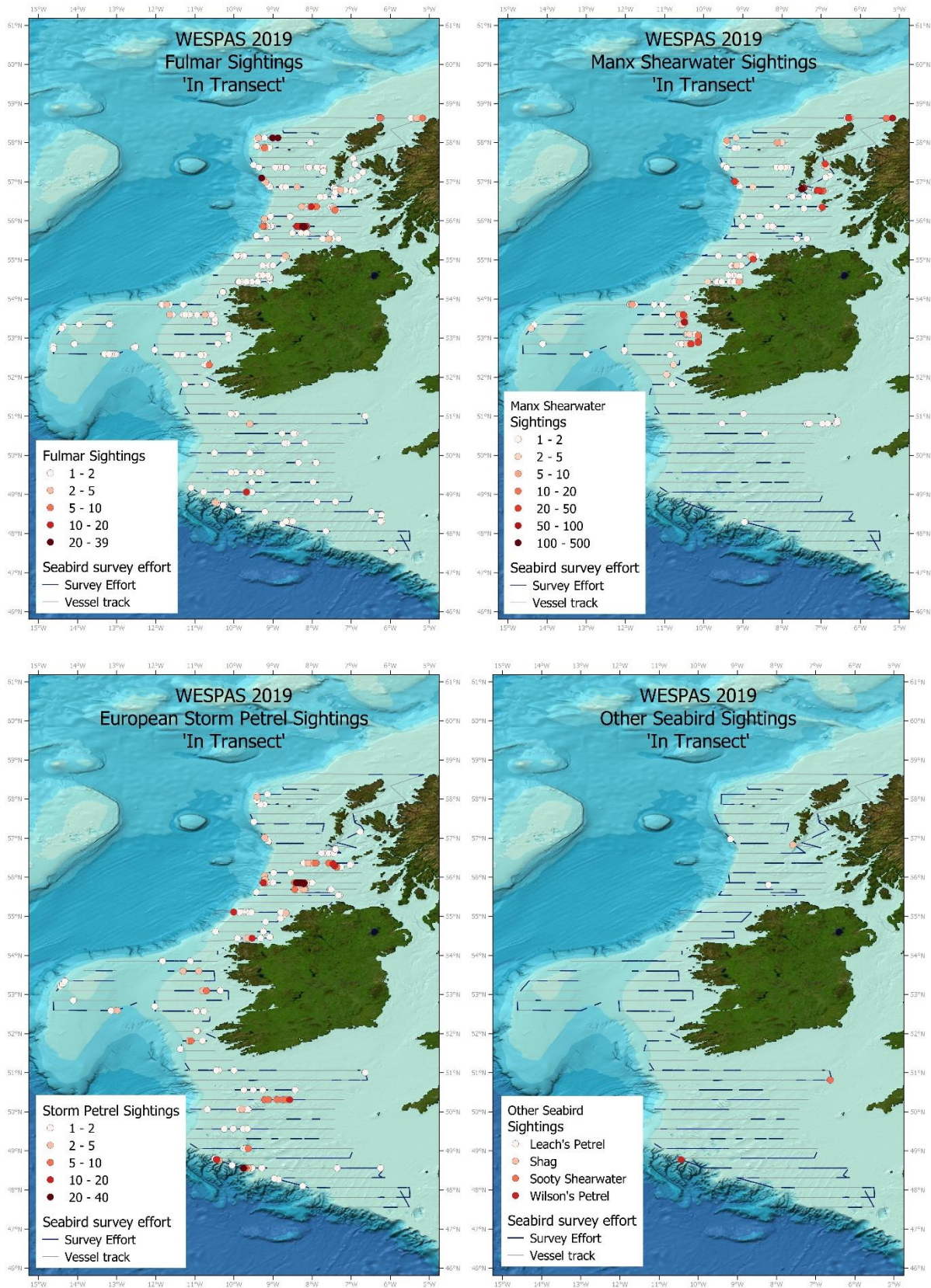


Figure 5: Distribution and abundance of seabird sightings recorded as 'In transect' during line transect effort on the survey; a) fulmar, b) Manx shearwater, c) European storm petrel, d) other seabird spp. Seabird survey effort transects are overlaid on the survey track line.

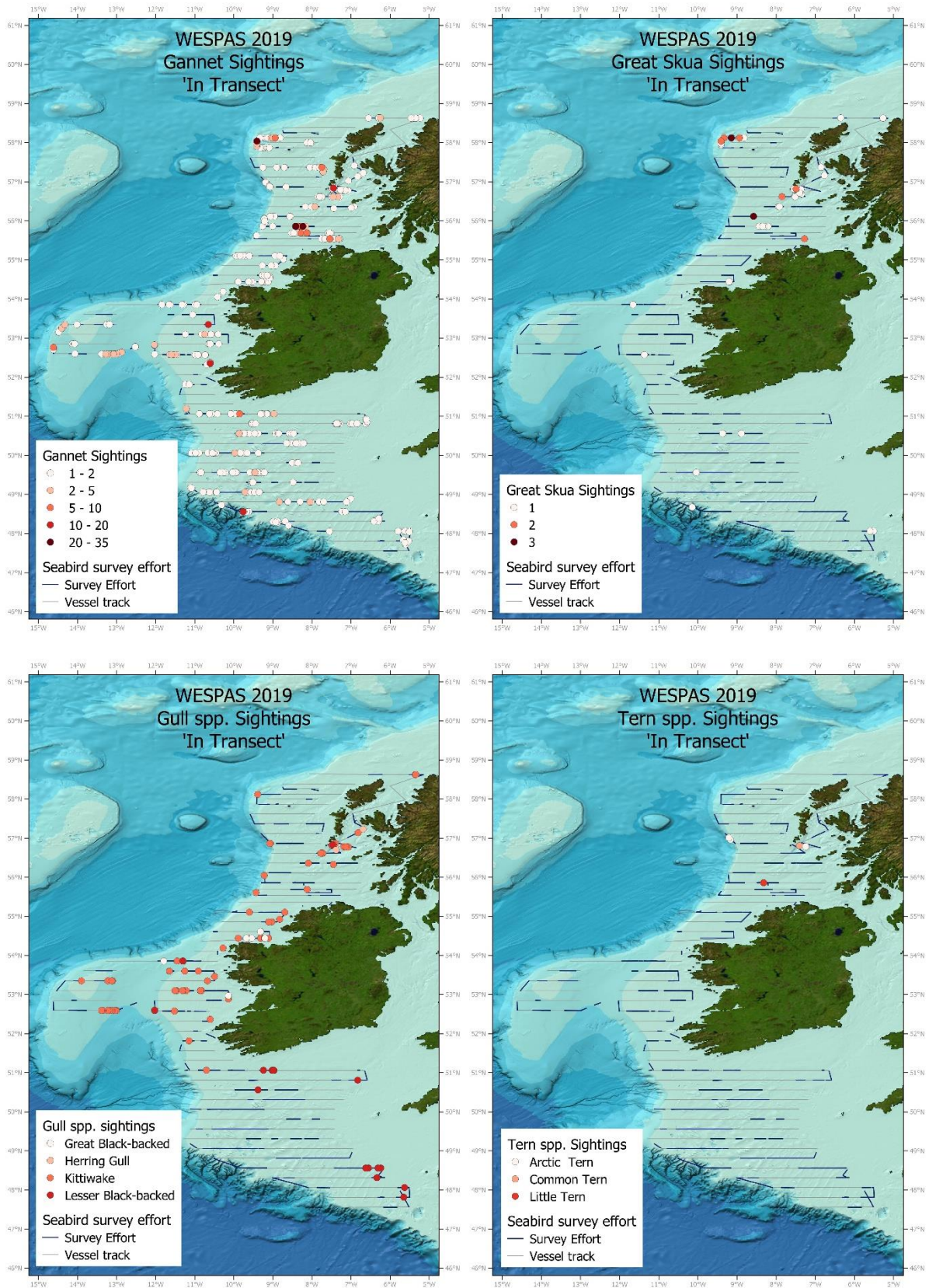


Figure 6: Distribution and abundance of seabird sightings recorded as 'In transect' during line transect effort on the survey; a) gannet, b) great skua, c) gull spp., d) tern spp. Seabird survey effort transects are overlaid on the survey track line.

Gannet

Overall, Gannet (*Morus bassanus*) were the most frequently encountered seabird species on the survey, being recorded on 1265 occasions and totalling 6087 individuals. In total, 1137 sightings of 3860 individuals were recorded during line transect watches, with 821 individuals recorded as 'in-transect', making gannets one of the most abundant species recorded during line transect effort. Gannets were found to be broadly distributed in low numbers across the entire survey area, although they were found to display a somewhat patchy distribution with high abundances recorded in a number of locations such as; west of the Blasket Islands, west of Slyne head, Stanton bank and around St. Kilda and the Scottish continental shelf slopes.

Fulmar

Northern fulmar (*Fulmarus glacialis*) were the second most frequently encountered seabird species on the survey being recorded on 965 occasions and totalling 8159 individuals. In total, 864 sightings of 3708 individuals were recorded during line transect watches, with 1002 individuals recorded as 'in-transect', making fulmars the third most abundant species recorded during line transect effort. Similar to gannets, fulmars were found to be broadly distributed in low numbers across the entire survey area, although they were somewhat more northerly distributed than gannets, with fewer recorded in the Celtic sea. Fulmars were also found to display a somewhat patchy distribution with particularly high abundances recorded around Stanton bank and St. Kilda and the Scottish continental shelf slopes.

Storm petrels

Three species of storm petrel were encountered on the survey including; European storm petrel (*Hydrobates pelagicus*), Leach's storm petrel (*Oceanodroma leucorhoa*) and Wilson's storm petrel (*Oceanites oceanicus*). All three species were recorded as 'in-transect' during line transect survey effort. Both the European storm petrel and Wilson's storm petrel were also recorded during point sampling watches.

European storm petrels were the most frequently encountered species of storm petrel and one of the most commonly sighted seabirds on the survey, totalling 524 sightings of 3425 individuals. In total, 486 sightings of 1972 individuals were recorded during line transect watches, with 847 individuals recorded as 'in-transect', making storm petrels one of the most abundant species recorded during line transect effort.

European storm petrels were found to display a broad distribution across the survey area, however, they were often patchily distributed with particularly high abundances recorded in the waters over the Whittard canyon system, Labadie bank and Stanton bank.

A single sighting of a lone Wilson's storm petrel was recorded as 'in-transect' during line transect effort in the Whittard canyon area, while two sightings of lone Leach's storm petrels were recorded during line transect effort on the Stanton bank and along the Scottish continental shelf edge.

Shearwaters

Four species of shearwater were encountered on the survey including; Balearic shearwater (*Puffinus mauretanicus*), great shearwater (*Puffinus graves*), sooty shearwater (*Puffinus griseus*) and Manx shearwater (*Puffinus puffinus*). All four species were recorded during line transect survey effort, however, only the Manx shearwater and sooty shearwater were recorded as 'in-transect'. Both the Manx shearwater and sooty shearwater were also recorded during point sampling watches.

Manx shearwaters were the most frequently encountered shearwater species on the survey and one of the most frequently recorded species overall, with a total of 561 recorded sightings of 3010 individuals. Manx shearwaters were the most abundant species recorded during line transect effort with 1902 individuals recorded as 'in-transect'. In total, 525 sightings of 2761 individuals were recorded during line transect watches.

Manx shearwaters were infrequently encountered in the Celtic sea, and when they were sighted, they were recorded in low numbers. In contrast, the waters along Ireland's west coast were found to be much more plentiful with Manx shearwaters, particularly west of county's Clare and Galway. The waters of the Minch were also found to be rich with Manx shearwaters.

Auks

Three species of auk were encountered on the survey including; Atlantic puffin (*Fratercula arctica*), guillemot (*Uria aalge*) and razorbill (*Alea torda*). All three species were recorded during both line transect and point sampling survey effort. All three species were also recorded as 'in-transect' during line transect watches. A number of sightings of auks identified only as auk sp. (*Alcidae sp.*) were also recorded during both line transect and point sampling survey effort.

Auks were rarely encountered in the Celtic sea with only a single sighting of a puffin being recorded as 'in-transect'. Auks were more commonly encountered along Ireland's west coast but were found to be particularly abundant around the Minch, Outer Hebrides and Stanton bank areas.

Guillemots were the most frequently encountered of the three auk species and one of most frequently encountered species on the survey (299 sightings of 1149 individuals). In total, 281 sightings of 1120 individuals were recorded during line transect watches, with 1043 individuals recorded as 'in-transect', making guillemots the second most abundant species recorded during line transect effort. Guillemots occurred in very high numbers in the waters around the Isles of Barra.

Puffins were the second most frequently encountered of the three auk species and one of most frequently encountered species on the survey (229 sightings of 445 individuals). In total, 207 sightings of 408 individuals were recorded during line transect watches, with 237 individuals recorded as 'in-transect'. Puffins weren't as common as either guillemots or razorbills in the waters south of Barra. They were, however, more frequently recorded as 'in-transect' along the Scottish continental shelf margins and around St. Kilda than either of the other two auk species. The waters west of Achill, west of Slyne head and along the north Mayo coast were found to have abundant puffins.

Razorbills were the most infrequently encountered of the three auk species (114 sightings of 340 individuals). In total, 108 sightings of 320 individuals were recorded during line transect watches, with 273 individuals recorded as 'in-transect'. Similar to guillemots, razorbills occurred in very high

numbers in the waters around the Isles of Barra. As with puffins, razorbills were abundant in the waters west of Achill, west of Slyne head and along the north Mayo coast.

Skuas

Five species of skua were encountered on the survey including; Arctic skua (*Stercoratius parasiticus*), great skua (*Stercoratius skua*), long-tailed skua (*Stercoratius longicaudus*), pomarine skua (*Stercoratius pomarinus*) and south polar skua (*Stercorarius maccormicki*). All five species were recorded during line transect survey effort, however, only the great skua was recorded as 'in-transect'. Both the Arctic skua and great skua were also recorded during point sampling watches.

Great skuas were regularly encountered in low numbers throughout the survey (108 sightings of 135 individuals), however, they were recorded more frequently and in higher numbers around St. Kilda, south of Barra and Stanton bank. During line transect survey effort, great skuas were encountered on 91 occasions, totalling 106 individuals. Of these, 50 individuals were recorded as 'in-transect'.

Gulls

Four species of gull were encountered on the survey including; great black-backed gull (*Larus marinus*), herring gull (*Larus argentatus*), black-legged kittiwake (*Rissa tridactyla*) and lesser black backed gull (*Larus fuscus*). All four species were recorded during both line transect and point sampling survey effort. All four species were also recorded as 'in-transect' during line transect watches.

Kittiwakes were the most frequently encountered gull species on the survey with a total of 1061 individuals recorded during 225 sighting events. They were also the most abundant species of gull and one of the most abundant seabird species with 845 individuals recorded during 198 sightings while conducting line transect watches. Of these, 629 birds were recorded as 'in-transect'.

Kittiwakes were commonly encountered in the waters west of Ireland and west of Scotland where they enjoyed a broad distribution, however, they were much less common in the Celtic sea.

Although less common overall (27 birds 'in-transect') lesser black-backed gulls were more commonly recorded during line transect effort in the Celtic sea. Greater black-backed gulls were most commonly recorded during survey effort along the north Mayo coast (7 birds 'in-transect'), while herring gulls were only recorded as 'in-transect' on two occasions (2 birds 'in-transect'), both in the Minch.

Terns

Three species of tern were encountered on the survey including; Arctic tern (*Sterna paradisaea*), common tern (*Sterna hirundo*) and little tern (*Sterna albifrons*). All three species were recorded as 'in-transect' during line transect survey effort. A single sighting of 15 terns which could not be identified to species level were also recorded during line transect effort, these were recorded as common tern sp. (*Sterna hirundo* / *Sterna paradisaea*) and were 'off-transect'. Both Arctic tern and common tern were also recorded during point sampling watches.

Arctic terns were the most frequently encountered tern species, with 13 sightings of 20 individuals recorded over the course of the survey. They were also the most abundant tern species with 9 birds recorded as ‘in-transect’ during line transect effort. These sightings were recorded south of Barra and along the Scottish continental shelf edge.

Common terns were sighted on 7 occasions (9 individuals) over the course of the survey. They were recorded on 6 occasions during line transect effort, totalling 8 individuals. Of the 6 common tern sightings recorded during line transects, only 1 sighting of 3 common terns was recorded as ‘in-transect’. This sighting was also recorded just off Barra.

A single sighting of 3 little terns was also recorded as ‘in-transect’ during line transect effort. This sighting occurred in the Stanton bank area.

Shag

A single sighting of three shags (*Phalacrocorax aristotelis*) was also recorded as ‘in-transect’ during line transect effort south of Barra.

Terrestrial/ migratory birds

A number of terrestrial/ migratory birds were encountered during the survey. A total of 23 sightings of terrestrial/ migratory bird species were recorded during the survey (Table 5). These sightings comprised of 52 individuals from 10 species. Notable sightings included 7 sightings of common swift (*Apus apus*), totalling 12 individuals, a single spotted flycatcher (*Muscicapa striata*) and a pair of golden eagles (*Aquila chrysaetos*). Terrestrial bird sightings were clustered predominantly in the Celtic sea and around the Outer Hebrides (Fig. 8).

All terrestrial/ migratory bird species recorded during the survey were recorded as ‘off transect’ regardless of whether they were recorded during line transect or point sampling watches.

Table 5: Summary of all terrestrial/ migratory bird sightings recorded during the survey.

<i>Common Name</i>	<i>Species name</i>	<i>No. of Sightings</i>	<i>No. of Individuals</i>
Collared Dove	<i>Streptopelia decaocto</i>	2	2
Common Scoter	<i>Melanitta nigra</i>	3	21
Dunlin	<i>Calidris alpina</i>	1	1
Feral/ racing pigeon	<i>Columba livia domestica</i>	4	5
Golden Eagle	<i>Aquila chrysaetos</i>	1	2
Pied Wagtail	<i>Motacilla alba</i>	1	1
Redshank	<i>Tringa totanus</i>	1	5
Spotted Flycatcher	<i>Muscicapa striata</i>	1	1
Swallow	<i>Hirundo rustica</i>	2	2
Swift	<i>Apus apus</i>	7	12
	Total	23	52

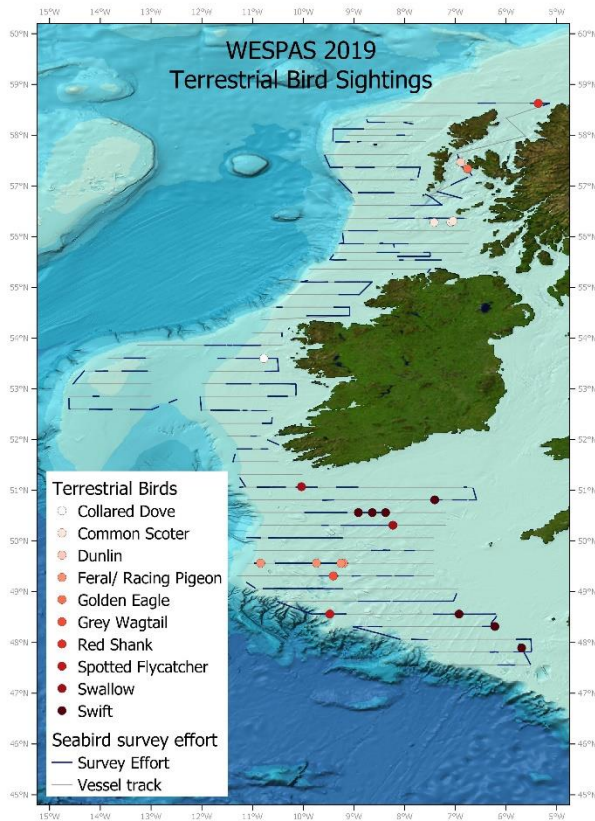


Figure 7: Distribution of terrestrial/ migratory bird sightings recorded on the survey.

Discussion

As in previous surveys, a large number of sightings, from a broad range of taxa and species groups, and a high abundance of seabirds were observed over the course of the survey. In total, 25 species of seabird and 10 species of terrestrial bird were recorded during the present survey. This is consistent with the species totals from previous seabird surveys during WESPAS. In 2018, 25 species of seabird and 5 species of terrestrial bird were recorded, in 2017, 23 species of seabird and 6 species of terrestrial bird were recorded, while in 2016, 26 species of seabird and 5 species of terrestrial bird were recorded.

Survey effort has varied across the time series of surveys. During the present survey a total of 225 hours and 40 minutes of survey effort was conducted, 187 hours and 36 minutes of survey effort were conducted using a line transect methodology, while 38 hours and 4 minutes of effort were conducted using the point sampling methodology. A total of 156 hours and 16 minutes of survey effort were recorded in 2018, and 95 hours and 51 minutes of survey effort were recorded in 2017, while 129 hours and 53 minutes of survey effort were recorded in 2016.

Table 6: Seabird sighting records from Western European Shelf Pelagic Acoustic Survey from 2016-2019 (O'Donnell et al., 2016; O'Donnell et al., 2017)¹.

Common Name	Species name	2019		2018		2017		2016	
		On-transect	Off-transect	On-transect	Off-transect	On-transect	Off-transect	On-transect	Off-transect
Fulmar	<i>Fulmarus glacialis</i>	1002	2706	336	1023	705	495	1216	792
Balearic Shearwater	<i>Puffinus mauretanicus</i>	0	1	-	-	1	0	-	-
Cory's Shearwater	<i>Calonectris diomedea</i>	-	-	4	2	11	2	282	360
Great Shearwater	<i>Puffinus graves</i>	0	1	3	3	3	1	70	45
Manx Shearwater	<i>Puffinus puffinus</i>	1902	859	374	394	2855	206	1111	826
Macaronesian Shearwater	<i>Puffinus baroli</i>	-	-	-	-	-	-	0	1
Sooty Shearwater	<i>Puffinus griseus</i>	1	5	3	10	22	8	15	43
Unidentified Shearwater sp.		-	-	1	0	-	-	-	-
European Storm Petrel	<i>Hydrobates pelagicus</i>	847	1125	60	296	1097	645	957	921
Leach's Petrel	<i>Oceanodroma leucorhoa</i>	2	1	-	-	2	0	3	0
Wilson's Petrel	<i>Oceanites oceanicus</i>	1	4	0	1	3	0	9	4
Unidentified Storm petrel		-	-	1	6	-	-	-	-
Cormorant	<i>Phalacrocorax carbo</i>	-	-	0	4	-	-	-	-
Shag	<i>Phalacrocorax aristotelis</i>	3	0	0	5	-	-	0	1
Great Northern Diver	<i>Gavia immer</i>	-	-	1	0	-	-	-	-
Gannet	<i>Morus bassanus</i>	821	3039	1032	3542	3157	1151	2345	941
Grey Phalarope	<i>Phalaropus fulicarius</i>	-	-	-	-	-	-	17	0
Arctic Skua	<i>Stercorarius parasiticus</i>	0	1	1	2	-	-	1	1
Great Skua	<i>Stercorarius skua</i>	50	56	23	43	11	6	16	22
Long-tailed Skua	<i>Stercorarius longicaudus</i>	0	1	-	-	-	-	3	3
Pomarine Skua	<i>Stercorarius pomarinus</i>	0	3	0	1	0	1	2	3
South Polar Skua	<i>Stercorarius maccormicki</i>	0	1	-	-	-	-	-	-
Black Headed Gull	<i>Chroicocephalus philadelphia</i>	-	-	-	-	0	1	-	-
Common Gull	<i>Larus canus</i>	-	-	2	10	-	-	-	-
Kittiwake	<i>Rissa tridactyla</i>	629	216	30	54	11	22	50	170
Sabine's Gull	<i>Xema sabini</i>	-	-	2	0	1	3	-	-
Herring Gull	<i>Larus argentatus</i>	2	16	2	33	1	15	0	6
Great Black-backed Gull	<i>Larus marinus</i>	7	26	6	35	1	36	6	77
Lesser Black-backed Gull	<i>Larus fuscus</i>	27	289	238	587	458	164	14	246
Yellow-legged Gull	<i>Larus michahellis</i>	-	-	-	-	-	-	0	1
Unidentified gull sp.	<i>Larus sp.</i>	-	-	0	2	-	-	-	-
Unidentified Large gull sp.	<i>Larus sp.</i>	-	-	21	4	150	0	-	-
Arctic Tern	<i>Sterna paradisaea</i>	9	8	0	3	3	1	16	9
Commic tern sp.	<i>Sterna hirundo / paradisaea</i>	0	15	-	-	-	-	-	-
Common Tern	<i>Sterna hirundo</i>	3	5	0	7	5	0	1	0
Little Tern	<i>Sterna albifrons</i>	3	0	-	-	-	-	-	-
Unidentified Sterna sp.	<i>Sterna sp.</i>	-	-	0	17	-	-	-	-
Auk sp.	<i>Alcidae sp.</i>	212	145	-	-	-	-	-	-
Guillemot	<i>Uria aalge</i>	1043	77	431	252	11	1	47	10
Razorbill	<i>Alea torda</i>	273	47	232	89	5	1	12	0
Unid. Razorbill/ Guillemot	<i>Alea torda/ Uria aalge</i>	-	-	552	651	-	-	-	-
Atlantic Puffin	<i>Fratercula arctica</i>	237	171	317	405	36	3	194	105
		7074	8818	3670	7481	8549	2762	6387	4533

¹ The survey timing, survey direction and number of seabird surveyors deployed has not remained constant annually.

Table 7: Terrestrial / migratory species recorded on WESPAS annually since 2016 (O'Donnell et al., 2016; O'Donnell et al., 2017)¹.

Common Name	Species name	2019	2018	2017	2016
Collared Dove	<i>Streptopelia decaocto</i>	2	6	-	-
Common Scoter	<i>Melanitta nigra</i>	21	-	-	-
Dunlin	<i>Calidris alpina</i>	1	25	-	17
Feral/ Racing Pigeon	<i>Columba livia domestica</i>	5	7	18	1
Golden Eagle	<i>Aquila chrysaetos</i>	2	-	-	-
Golden Plover	<i>Pluvialis apricaria</i>	-	-	1	-
Greenish Warbler	<i>Phylloscopus trochiloides</i>	-	-	1	-
Pied Wagtail	<i>Motacilla alba</i>	1	-	-	-
Oystercatcher	<i>Haematopus ostralegus</i>	-	-	2	-
Redshank	<i>Tringa totanus</i>	5	-	-	-
Spotted Flycatcher	<i>Muscicapa striata</i>	1	-	-	-
Swallow	<i>Hirundo rustica</i>	2	-	-	-
Swift	<i>Apus apus</i>	12	1	5	1
Turnstone	<i>Arenaria interpres</i>	-	-	-	1
Unidentified Passerine		-	1	-	-
Whimbrel	<i>Numenius phaeopus</i>	-	-	1	1
	Total	52	40	28	21

¹ The survey timing, survey direction and number of seabird surveyors deployed has not remained constant annually.

While each WESPAS survey has covered the same area of the European western shelf, and with each survey employing parallel transects spaced equally at 15 nautical miles and beginning at a randomly located point, it should be noted that the 2016 survey differs from all latter surveys in that it was undertaken in a north-south direction whereas all subsequent surveys were undertaken in a south-north fashion. It should also be noted that both the 2016 and 2017 seabird surveys did not run for the full duration of the WESPAS survey cruise. In 2016 seabird survey effort was undertaken from the 5th – 29th July covering the Celtic sea region, while in 2017 the seabird survey ran from the 9th-28th June in the Celtic sea. The 2018 seabird survey did run for the duration of WESPAS from the 10th-27th June and 4th-23rd July, as did the present survey. The number of seabird observers deployed has also varied through the years with a single observer deployed in both 2016 and 2018, and a team of two observers consisting of a primary observer and scribe/secondary observer deployed in both 2017 and 2019. As such, care should be taken when comparing species sighting and abundance results obtained across the surveys.

This year saw the notable addition of south polar skua to the list of seabirds recorded during WESPAS. The record consisted of a single bird which approached the vessel and closely circled the mast for a brief period before moving off. This sighting has been added to the Irish Rare Birds Committee provisional list (IRBC, 2019) and, if confirmed, will be the first record of a south polar skua in Irish waters. This rare sighting demonstrates the value of conducting seabird surveys in offshore waters. Apart from the south polar skua, all four skua species occurring in Irish waters were also recorded on this year's survey. A sighting of three little terns was also recorded during this year's WESPAS, another species which had not been recorded on previous surveys. Cory's shearwater were not recorded during the present survey despite having been recorded on all

previous WESPASs. Cory's shearwater were recorded in low numbers in both 2018 and 2019 and were present in high numbers during the 2016 survey, however, this was most likely due to the differing survey schedule that year.

European storm petrels were one of the most commonly encountered and most abundant species recorded on the survey. In fact, all species of storm petrel frequenting Irish waters were recorded on this year's survey. The sighting rate, however, was found to be particularly weather dependant. With increasing sea state, the sightings of storm petrel were found to drop off dramatically, indicating the presence of a detection bias in higher sea states. It is therefore likely that the results obtained in this survey may substantially underestimate the true abundance of storm petrels. It would be recommended to apply a suitable correction factor, such as that proposed by Tasker *et al.*, (1984) and used in previous studies (e.g. Mackey, *et al.*, 2004; Pollock, *et al.*, 1997), to account for this detection bias. Similar biases may also exist for other inconspicuous species', particularly small petrels.

Manx shearwater, guillemot, fulmar, gannet and European storm petrel were the most abundant and widespread species' in the present survey, with fulmar and gannet being the most widely distributed. Despite their abundance and generally broad distribution, these species, along with many other species' recorded, displayed a somewhat patchy distribution. A number of areas of very high seabird density and diversity were observed over the course of the survey. These included sites such as; the Whittard canyon system, Labadie bank, west of the Blasket Islands, west of Slyne head, west of the Aran islands, west of Achill, the North Mayo coast, Stanton bank, the Minch, St. Kilda and the Scottish continental shelf slopes.

The high levels of seabird activity and feeding behaviour observed in these 'hotspots' suggests abundant feeding opportunities and high prey availability for seabirds. This was further confirmed on the survey by the presence of feeding cetaceans at some of these locations together with fish school 'marks' detected near the surface using the ships acoustic survey equipment. Many of the areas noted as holding a high diversity and abundance of seabirds are within foraging range of important seabird colonies. For instance, Inishtooskert hosts the largest population of European storm petrels in the British Isles, Little Skellig has the largest population of gannets in Ireland, and the cliffs of Moher hold the largest population of fulmars in Ireland (9% of the total population of Ireland and Britain) as well as having large colonies of both razorbill and guillemot, while Cruagh is home to a large population of Manx shearwaters. In Scotland, St. Kilda holds the largest gannet colony in the world as well as the largest colony of Leach's storm petrels in Europe, and the biggest colonies of Atlantic puffins and northern fulmars in the EU. At the southern end of the Outer Hebrides, Mingulay and Berneray are important nesting sites of auks, particularly razorbills, as well as kittiwakes and fulmars (Mitchell, *et al.*, 2004).

Given the outstanding international importance of the multi-species seabird colonies found in the British Isles (Kober, *et al.*, 2010), it is important to recognise the crucial role played by the foraging areas utilised by breeding seabirds that reside there. The availability and distribution of prey are known to be vital for the breeding success of many seabirds (Mackey, *et al.*, 2004). As such, the identification and management of key hotspots for foraging seabirds during the breeding season are important steps in guarding the long term health and stability of seabird colonies (Kober, *et al.*, 2010). Protecting seabirds in their offshore foraging habitats through the designation of SPAs would also further assist Ireland in meeting its obligation under the EU Birds Directive.

The WESPAS provides an excellent opportunity for the collection of data on the summer distribution, abundance and behaviour of seabirds in Irish shelf waters. However, the amount and quality of data

collected is confounded by factors such as environmental conditions and seabird survey design. Although the weather was quite good throughout the survey, poor weather did reduce the total number of seabird survey hours undertaken on a number of occasions. However, environmental conditions, particularly elevated sea states, likely affected the detection probability of certain inconspicuous species. The use of a larger dedicated seabird team on future surveys could improve data collection and contribute to a more robust dataset, to better inform policy decisions and advance the scientific understanding of the at-sea summer abundance and distribution of seabirds in Ireland's shelf water habitats.

Recommendations

An increase to the number of ESAS trained seabird observers on-board would be recommended for this survey. The present survey used a single ESAS trained seabird observer with a second, non-ESAS observer employed as scribe/ secondary observer. The ESAS survey methodology recommends the use of a minimum of two ESAS trained observers. The use of three ESAS seabird observers would allow a rotational system of two seabird observers on-effort (one observing, the other scribing) while the third observer takes a break. This approach would increase effort coverage of the survey area and minimise observer fatigue but would not be sufficient to cover all daylight hours. This approach could be used to conduct survey effort over a 10-12 hour period but with breaks in effort required during meal times.

To maximize the potential of the survey, a team of six seabird observers would be required. This would allow the survey to be conducted using two teams of three working on opposite shifts. This approach should allow full coverage of all survey areas during daylight hours. However, the authors appreciate the constraints on using such a large seabird survey team.

Both approaches outlined above would facilitate more sufficient coverage, which should increase the chances of detecting seabirds, particularly rare or scarce species, while also ensuring that all seabird observers get sufficient breaks/periods of rest. Sufficient breaks/periods of rest are highly important for seabird observers for maintaining full concentration during all effort times without suffering the ill effects of fatigue.

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References

Buckland, S.T., et al., (2001). *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford University Press, Oxford, UK.

Camphuysen, K., et-al (2004). *Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K.: a comparison of ship and aerial methods for marine birds, and their applicability to offshore wind farm development*. NIOZ report to COWRIE (BAM – 02-2002), Texel.

Cybertracker (2019). *Data collection software package (Version 3.501)*. <https://cybertracker.org>

Heinemann, D. (1981). *A Range Finder for Pelagic Bird Censusing*. *Journal of Wildlife Management* 45(2): 489-493.

IRBC (2019). *Irish Rare Birds Committee Provisional List*. Accessed online 15/08/19: <http://www.irbc.ie/provisional/list/A1A2July2019.pdf>.

Kober, K., et al., (2010). *An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs*. JNCC report No. 431.

Mackey, M., et al., (2004). *Cetaceans and Seabirds of Ireland's Atlantic Margin. Volume I – Seabird distribution, density & abundance*. Report on research carried out under the Irish Infrastructure Programme (PIP): Rockall Studies Group (RSG) projects 98/6 and 00/13, Porcupine Studies Group project P00/15 and Offshore Support Group (OSG) project 99/38. 95pp.

Marine Institute (2019). *Western European Shelf Pelagic Acoustic Survey Cruise plan*.

NPWS, (2013). *The Status of EU Protected Habitats and Species in Ireland*. Species Assessments Volume 3. Version 1.0. National Parks & Wildlife Services. Department of Arts, Heritage and the Gaeltacht, Dublin, Ireland. Available online: <http://www.npws.ie/publications/article17assessments/article172013assessmentdocuments/Article17PrintVol3reportspeciesv11.pdf>.

O'Brien, J., et al., (2014). *Cetaceans on the Frontier 6*. Final report to the Marine Institute, Rinville, Galway.

O'Donnell, C., et al., (2015). *Blue Whiting Acoustic Survey Cruise Report, 2015*. FSS Survey Series: 2015/01.

O'Donnell, C., et al., (2017). *Blue Whiting Acoustic Survey Cruise Report, 2017*. FSS Survey Series: 2017/01.

O'Donnell, C., et al., (2016). *Celtic Sea Herring Acoustic Survey Cruise Report, 2016*. (<http://oar.marine.ie/bitstream/10793/1194/1/CSHAS%20Cruise%20Report%202016.pdf>)

O'Donnell, C., et al., (2018). *Western European Shelf Pelagic Acoustic Survey Cruise Report, 2018*. (<http://oar.marine.ie/bitstream/10793/1380/1/WESPAS%20Cruise%20Report%202018.pdf>)

O'Donnell, C., et al., (2017). *Western European Shelf Pelagic Survey Cruise Report, 2017*. (<http://oar.marine.ie/bitstream/10793/1326/1/WESPAS%20Cruise%20Report%202017.pdf>)

O'Donnell, C., et al., (2016). *Western European Shelf Pelagic Survey Cruise Report, 2017*. (<http://oar.marine.ie/bitstream/10793/1179/1/WESPAS%20Cruise%20Report%202016.pdf>)

Pollock, C.M., et al., (1997). *The distribution of sea-birds and cetaceans in the waters around Ireland*. JNCC Report No. 267 .

Pollock, C.M., et al., (2000). *The distribution of seabirds and marine mammals in the Atlantic frontier, north and west of Scotland*. Joint Nature Conservation Committee, Scotland 92pp.

Tasker, M.L., et al., (1984). *Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardised approach*. Auk 101: 567-577.

WMO, 2011. *Manual on Codes, International Codes Volume I.1 Annex II to the WMO Technical Regulations, Part A – Alphanumeric Codes*, WMO-No. 306. Updated in 2017, 2011 edition

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