

## Marine Institute Seabird Monitoring

During the Western European Shelf Pelagic  
Acoustic Survey

10th June – 19th July 2021

**Lead Agency:** Marine Institute

**Lead Partners:** National Parks and Wildlife Service,

**Authors:** Emerald Marine

**Citation:** Power, J., Connaughton, P. and Keogh N.T. (2021). Seabird Monitoring undertaken during the Western European Shelf Pelagic Acoustic Survey (WESPAS)

10th June- 19th July 2021.

<b>Operational Programme</b>	European Maritime and Fisheries Fund (EMFF) Operational Programme 2014-2020
<b>Priority</b>	Union Priority 1 Sustainable Development of Fisheries Union Priority 6 Fostering the implementation of the Integrated Maritime Policy
<b>Thematic Objective</b>	TO 6 - Preserving and protecting the environment and promoting resource efficiency
<b>Specific Objective</b>	UP1 SO1 - Reduction of the impact of fisheries and aquaculture on the marine environment, including the avoidance and reduction, as far as possible, of unwanted catch.  UP1 SO2 - Protection and restoration of aquatic biodiversity and ecosystems.  UP6 SO1 - Development and implementation of the Integrated Maritime Policy
<b>Measure</b>	Marine Biodiversity Scheme
<b>Project No.</b>	MB/2019/09
<b>EMFF Certifying Body</b>	Finance Division, Department of Agriculture, Food and the Marine
<b>Managing Authority</b>	Marine Agencies & Programmes Division, Department of Agriculture, Food and Marine
<b>Specified Public Beneficiary Body</b>	Marine Institute
<b>Grant Rate</b>	100%
<b>EU Co-Financing Rate</b>	50%
<b>Legal Basis</b>	Article 29, 40 & 80 EMFF
<b>Details</b>	Report to the Marine Institute Emerald marine

This project or operation is part supported by the Irish government and the European Maritime & Fisheries Fund as part of the EMFF Operational Programme for 2014-2020



An Roinn Talmhaíochta,  
Bia agus Mara  
Department of Agriculture,  
Food and the Marine



EUROPEAN UNION  
This measure is part-financed  
by the European Maritime  
and Fisheries Fund



Foras na Mara  
Marine Institute



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#### DOCUMENT CONTROL SHEET

<b>Client</b>	<b>National Parks and Wildlife Service</b>
<b>Project Title</b>	Seabird monitoring during Marine Institute's annual fisheries acoustic surveys
<b>Document Title</b>	Seabird Monitoring undertaken during the Western European Shelf Pelagic Acoustic Survey (WESPAS) 10 <sup>th</sup> June- 19 <sup>th</sup> July 2021

<b>Rev. No</b>	<b>Date</b>	<b>Status</b>	<b>Authored</b>	<b>Checked</b>
<b>Rev 1</b>	28/08/2021	Final	JP	PC



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*Citation: Power, J., Connaughton, P. and Keogh N.T. (2021). Seabird Monitoring undertaken during the Western European Shelf Pelagic Acoustic Survey (WESPAS) 10th June- 19th July 2021.*

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## Executive Summary

Irish waters represent one of the most important marine habitats for seabirds in Europe, 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 Housing, Local Government and Heritage (DHLGH), 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 10<sup>th</sup> June- 19<sup>th</sup> July 2021.

A standard line transect survey methodology was employed by the seabird observer 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 262 hours and 40 minutes of survey effort was conducted over the course of WESPAS 2021. In total, 218 hours and 48 minutes of survey effort were conducted using a line transect methodology, while 42 hours and 20 minutes of effort were conducted using the point sampling methodology. A further 1 hour and 32 minutes of effort were conducted as a casual watch.

A total of 7210 seabird observations were recorded throughout the survey, totalling 32229 individuals. In total, 12391 seabirds were recorded as "in transect", while 19838 were recorded "off transect". The species encountered included 26 species from eight families. A further 21 observations of terrestrial/migratory birds were also recorded, comprising of 79 individuals.

## 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 affect 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 &amp; Ireland Total</i>	<i>Percentage change since SCR Census (1985-88)<sup>1</sup></i>
Fulmar	<i>Fulmarus glacialis</i>	5,992	32,918	38,910	537,991	0%
Manx Shearwater <sup>2</sup>	<i>Puffinus puffinus</i>	4,633	32,545	37,178	332,267	
European Storm petrel <sup>2</sup>	<i>Hydrobates pelagicus</i>	0	99,065	99,065	124,775	
Leach's Storm petrel <sup>2</sup>	<i>Oceanodroma leucorhoa</i>	0	310	310	48,357	
Gannet	<i>Morus bassanus</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 <sup>3</sup>	<i>Alea torda</i>	24,084	27,446	51,530	216,087	23%
Black Guillemot <sup>4</sup>	<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%

<sup>1</sup> inland colonies were not surveyed during the SCR Census (1985-88)

<sup>2</sup> not surveyed during the SCR Census (1985-88)

<sup>3</sup> counts of individuals

<sup>4</sup> 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 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, *RV Celtic Explorer* and *RV Celtic Voyager*, during oceanographic and fisheries surveys (e.g. O'Donnell, *et al.*, 2016; 2017; 2018; 2019; 2020). 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.

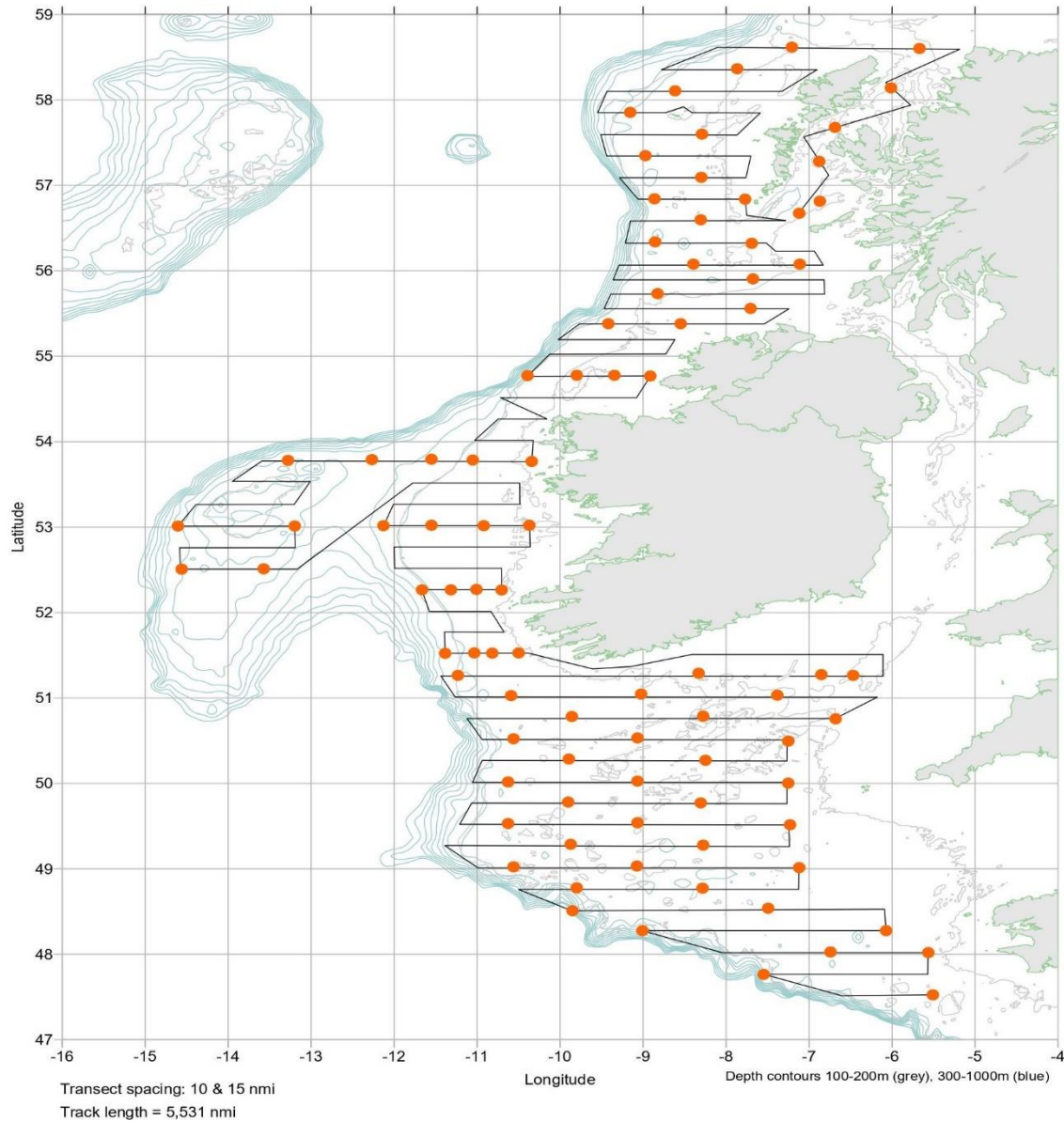
The WESPAS is an acoustic survey undertaken by the Fisheries Ecosystems Advisory Services (FEAS) department of the Marine Institute of Ireland. The survey has been undertaken annually since 2016 with the present survey being the sixth survey in the series. Prior to 2016, the survey was organised as two 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.*, 2020). 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.*, 2020). Since 2016, these surveys were combined and undertaken across two survey legs 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.*, 2020).

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 Housing, Local Government and Heritage (DHLGH), through the Marine Institute, commissioned a seabird survey from the *RV Celtic Explorer* during the annual Western European Shelf Pelagic Acoustic Survey (WESPAS), running from 10<sup>th</sup> June- 19<sup>th</sup> July 2021.

## Methodology

The seabird survey was conducted across two survey legs from the 10<sup>th</sup> - 29<sup>th</sup> June and the 1<sup>st</sup> - 19<sup>th</sup> July 2021, using a single seabird observer per survey leg. The seabird observer conducted visual survey effort while also recording all survey data. Given the presented survey transects for the 2021 survey (*Figure 1*), a standard line transect survey methodology was determined to be most suitable and was employed by the seabird surveyor. Survey transects were undertaken at speeds of 5-10 knots, with fishing activity being conducted at speeds of 2-3 knots.



*Figure 1: Representative cruise track of the Western European Shelf Pelagic Acoustic Survey (Source: Marine Institute, 2021).*

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 13 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 were conducted within a survey quadrant of 300m x 300m. 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 or Swarovski EL 8x32 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 or Canon EOS 7D Mark I DSLR camera with a Sigma EF 100-400mm F5-6.3 DG DN OS telephoto lens were used to visually document other information of scientific

interest. Data were 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 3.515) was configured for optimum use on the survey. Cybertracker was used to record positional, environmental and seabird observation 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 observer 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 seabird observation 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 record was time stamped and digitally marked using Cybertracker. Observational 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, observations 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.

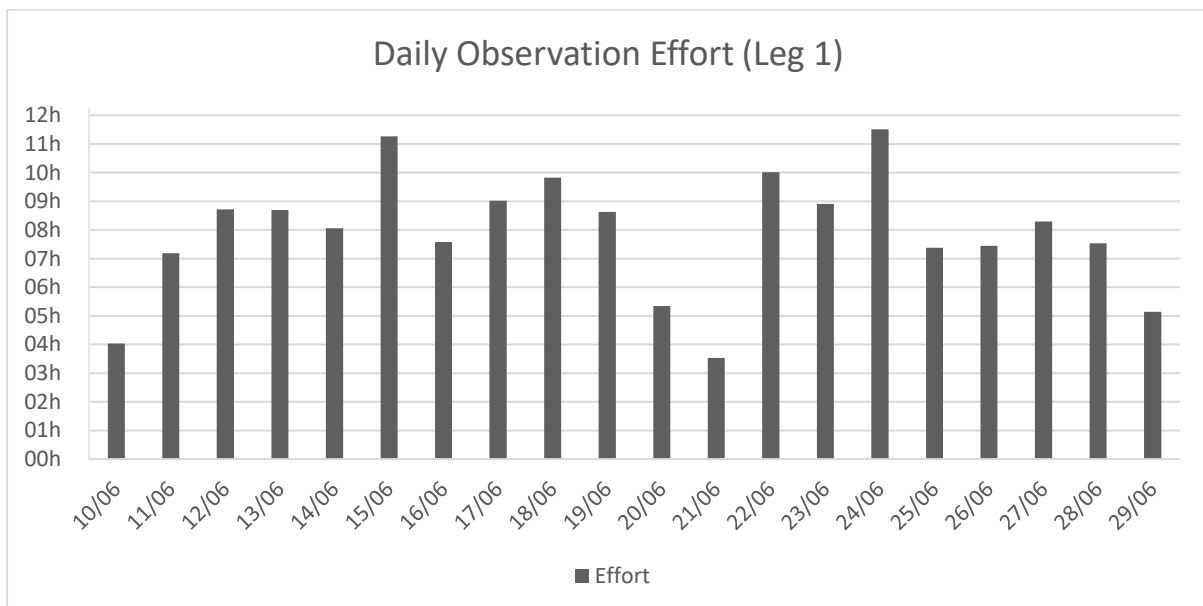
## Results

### Effort

A total of 262 hours and 40 minutes of survey effort was conducted over the course of WESPAS 2021. 158 hours and 5 minutes of survey effort was conducted on Leg 1, while 104 hours and 35 minutes of survey effort was conducted on Leg 2 of the survey. In total, 218 hours and 48 minutes of survey effort were conducted using a line transect methodology, while 42 hours and 20 minutes of effort were conducted using the point sampling methodology. A further 1 hour and 32 minutes of effort were conducted as a casual watch.

The observer's survey effort was maximized and optimized during the prevailing hours of daylight. The maximum daily survey effort recorded on Leg 1 was 11 hours and 30 minutes while the average daily survey effort was 7 hours and 54 minutes. On Leg 2, the maximum daily survey effort recorded was 8 hours and 4 minutes while the average daily survey effort was 5 hours and 30 minutes.

No effort watches were conducted on the 1<sup>st</sup> of July due to a port call for crew change between survey legs. Seabird survey effort was greatly reduced on the 20<sup>th</sup> and 21<sup>st</sup> of June and the 14<sup>th</sup> and 17<sup>th</sup> July due to weather conditions exceeding the specified weather limits for observations. Survey effort was also reduced on the 10<sup>th</sup> of June due to technical issues with the data collection software and on the 29<sup>th</sup> June due to transit to port. A graph of daily effort is provided in *Figure 2* below.



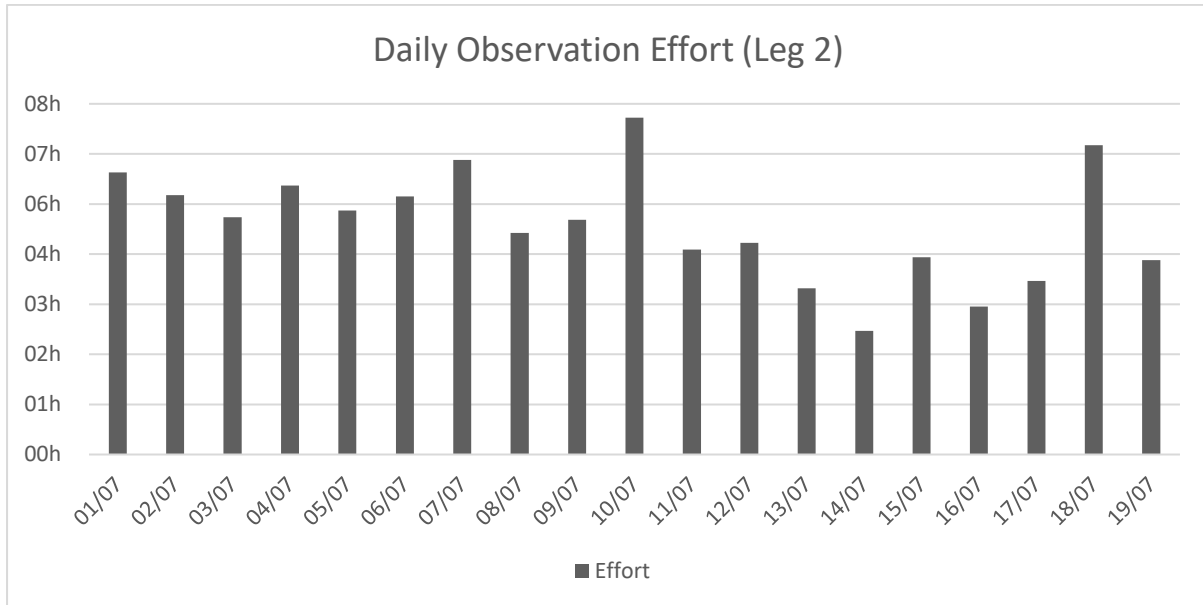


Figure 2: Daily visual effort undertaken during a) Leg 1, and b) Leg 2 of the survey.

### Environmental Conditions

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

### Sea State

Sea state was recorded both in terms of the World Meteorological Organisation (WMO) sea state scale and the Beaufort scale. The WMO sea state was judged based on the total state of agitation of the sea, taking into account the effect of wind, swell and currents (WMO, 2011) on the sea conditions, with wave height in meters used as an additional guide. Beaufort wind force/ sea state and was judged based on the effect of the wind on the sea surface.

Sea states 2, 3 and 4 were the most common sea states recorded. The most frequently recorded WMO sea state was 4, accounting almost 91 hours (35%) of observation effort, while WMO sea state 3 accounted for over 73 hours (28%). WMO sea state 2 accounted for 58.5 hours (22%) of observation effort (Fig. 3a).

The most frequently recorded Beaufort wind force/ sea state was a sea state 4, accounting for 61 hours (23%) of survey effort. Beaufort wind force/ sea state 3 was recorded over almost 71 hours (27%) of observation effort, while Beaufort wind force/ sea state 2 accounted for almost 51 hours (19%) of observation effort (Fig. 3b).

### Swell

A swell height of 0.1-1 meter was most frequently recorded throughout the survey, being recorded over almost 152 hours (58%) of survey effort. A swell height of 1.1-2 meters was recorded across 87 survey hours (33%), while swell of over 2 meters was recorded during over 13 hours (5%) of survey effort. No swell was also recorded across 9 hours (4%) of survey effort (*Fig. 3c*).

### Visibility

Visibility was generally very good during seabird survey effort; however, a number of periods of heavy fog were also recorded. The most frequently recorded visibility was 11-15km, being recorded for over 200 hours (76%) of survey effort. Visibility of 6-10km was recorded on over 35 hours (14%) of survey effort, while visibility of 1-5km was recorded for 18 hours (7%) of survey effort. Visibility of less than 1km was recorded during 4 hours (2%) of survey effort, however, survey effort generally ceased if visibility reduced below 300m (*Fig. 3d*).

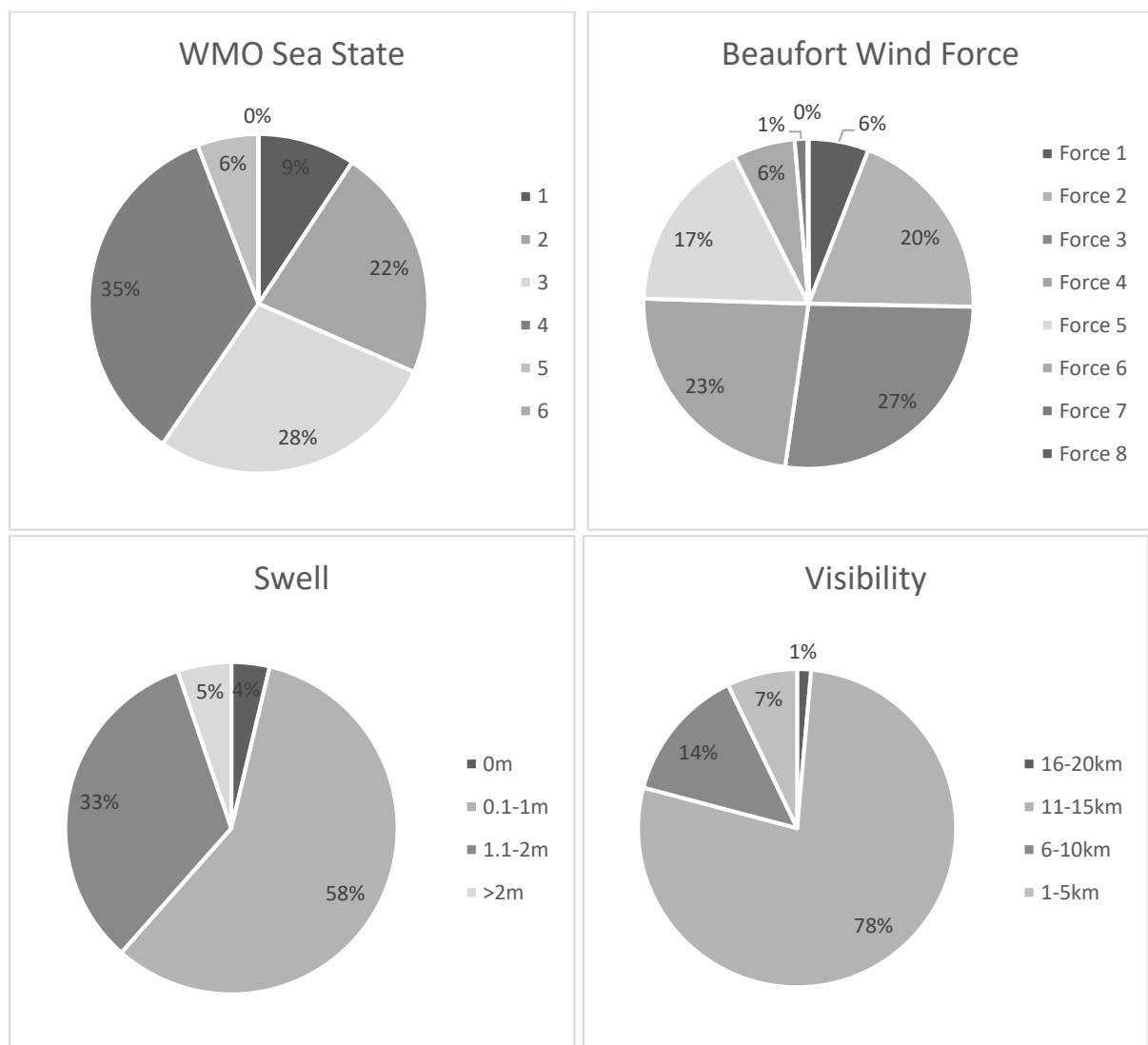


Figure 3: Summary of environmental conditions recorded on the WESPAS 2021; a) WMO sea state, b) Beaufort sea state/ wind force, c) Swell height (meters), d) Visibility (kilometres).

### *Seabird records*

In total, 7210 seabird observations were recorded throughout the survey, totalling 32229 individuals, with flock size ranging from one up to 2000 for some species (*Table 2*). In total, 12391 seabirds were recorded as “in transect”, while 19838 were recorded “off transect”. A summary of all seabirds recorded on the survey is presented in *Table 2* and includes birds recorded during both line transect and point sampling watches. A total of 26 species from eight families were encountered during the survey.

Of the 7210 seabird observations recorded during the survey, 6983 were recorded during line transect effort. All of the 26 seabird species recorded during the survey were recorded during line transect survey effort, while 11 species were recorded during point counts. In total, 28109 seabirds were recorded during line transect effort, with 12391 of these recorded as ‘in-transect’. The remaining 15718 seabirds were recorded as ‘off-transect’. A breakdown of all species encountered during line transect effort watches is presented in *Table 3*.

The distribution of all observations of seabird species recorded as ‘in-transect’ during line transect survey effort is presented in *Figures 4- 7*. For clarity, and brevity, seabirds recorded during point sampling watches, or those recorded as ‘off-transect’ are not displayed.

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

<b>Common Name</b>	<b>Species name</b>	<b>No. of records</b>	<b>No. of Seabirds</b>	<b>Flock size</b>
<b>Fulmar</b>	<i>Fulmarus glacialis</i>	1677	4431	1-350
<b>Great Shearwater</b>	<i>Puffinus graves</i>	1	1	1
<b>Sooty Shearwater</b>	<i>Puffinus griseus</i>	16	20	1-2
<b>Manx Shearwater</b>	<i>Puffinus puffinus</i>	961	14488	1-2000
<b>Wilson's Petrel</b>	<i>Oceanites oceanicus</i>	8	8	1
<b>Storm Petrel</b>	<i>Hydrobates pelagicus</i>	556	2018	1-250
<b>Petrel sp.</b>	<i>Hydrobatidae sp.</i>	1	1	1
<b>Gannet</b>	<i>Morus bassanus</i>	2208	5307	1-200
<b>Pomarine Skua</b>	<i>Stercorarius pomarinus</i>	4	4	1
<b>Arctic Skua</b>	<i>Stercorarius parasiticus</i>	3	3	1
<b>Long-tailed Skua</b>	<i>Stercorarius longicaudus</i>	4	4	1
<b>Great Skua</b>	<i>Stercorarius skua</i>	109	143	1-11
<b>Small skua sp.</b>	<i>Stercorarius parasiticus/ longicaudus</i>	3	8	1-6
<b>Skua sp.</b>	<i>Stercorarius sp.</i>	1	1	1
<b>Common Gull</b>	<i>Larus canus</i>	1	1	1
<b>Black-headed Gull</b>	<i>Larus ridibundus</i>	1	3	3
<b>Lesser Black-backed Gull</b>	<i>Larus fuscus</i>	215	1344	1-62
<b>Herring Gull</b>	<i>Larus argentatus</i>	18	41	1-8
<b>Yellow-legged gull</b>	<i>Larus michahellis</i>	1	1	1
<b>Great Black-backed Gull</b>	<i>Larus marinus</i>	31	60	1-14
<b>Kittiwake</b>	<i>Rissa tridactyla</i>	276	479	1-30
<b>Common Tern</b>	<i>Sterna hirundo</i>	1	2	2
<b>Arctic Tern</b>	<i>Sterna paradisaea</i>	11	17	1-4
<b>Guillemot</b>	<i>Uria aalge</i>	464	1826	1-50
<b>Black guillemot</b>	<i>Cepphus grylle</i>	1	2	2
<b>Razorbill</b>	<i>Alea torda</i>	192	531	1-22
<b>Razorbill / Guillemot</b>	<i>Alea torda / Uria aalge</i>	27	686	1-150
<b>Puffin</b>	<i>Fratercula arctica</i>	412	777	1-16
<b>Shag</b>	<i>Phalacrocorax aristotelis</i>	6	21	1-14
<b>Cormorant</b>	<i>Phalacrocorax carbo</i>	1	1	1
	<b>Total</b>	<b>7210</b>	<b>32229</b>	

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

<b>Common Name</b>	<b>Species name</b>	<b>No. of records</b>	<b>No. of Seabirds</b>	<b>In Transect</b>	<b>Off Transect</b>
Fulmar	<i>Fulmarus glacialis</i>	1627	3790	800	2990
Great Shearwater	<i>Puffinus graves</i>	1	1	1	0
Sooty Shearwater	<i>Puffinus griseus</i>	16	20	2	18
Manx Shearwater	<i>Puffinus puffinus</i>	947	13454	7368	6086
Wilson's Petrel	<i>Oceanites oceanicus</i>	8	8	3	5
Storm Petrel	<i>Hydrobates pelagicus</i>	534	1414	692	722
Petrel sp.	<i>Hydrobatidae sp.</i>	1	1	0	1
Gannet	<i>Morus bassanus</i>	2133	4155	1059	3096
Pomarine Skua	<i>Stercoratius pomarinus</i>	4	4	2	2
Arctic Skua	<i>Stercoratius parasiticus</i>	3	3	0	3
Long-tailed Skua	<i>Stercoratius longicaudus</i>	4	4	0	4
Great Skua	<i>Stercoratius skua</i>	90	115	38	77
Small skua sp.	<i>Stercoratius parasiticus/ longicaudus</i>	3	8	0	8
Common Gull	<i>Larus canus</i>	1	1	0	1
Black-headed Gull	<i>Larus ridibundus</i>	1	3	0	3
Lesser Black-backed Gull	<i>Larus fuscus</i>	183	735	102	633
Herring Gull	<i>Larus argentatus</i>	13	24	9	15
Yellow-legged gull	<i>Larus michahellis</i>	1	1	0	1
Great Black-backed Gull	<i>Larus marinus</i>	26	34	2	32
Kittiwake	<i>Rissa tridactyla</i>	276	479	188	291
Common Tern	<i>Sterna hirundo</i>	1	2	2	0
Arctic Tern	<i>Sterna paradisaea</i>	10	16	10	6
Guillemot	<i>Uria aalge</i>	463	1825	1322	503
Black guillemot	<i>Cepphus grylle</i>	1	2	0	2
Razorbill	<i>Alea torda</i>	192	531	376	155
Razorbill / Guillemot	<i>Alea torda / Uria aalge</i>	27	686	92	594
Puffin	<i>Fratercula arctica</i>	410	771	306	465
Shag	<i>Phalacrocorax aristotelis</i>	6	21	17	4
Cormorant	<i>Phalacrocorax carbo</i>	1	1	0	1
	<b>Total</b>	<b>6983</b>	<b>28109</b>	<b>12391</b>	<b>15718</b>

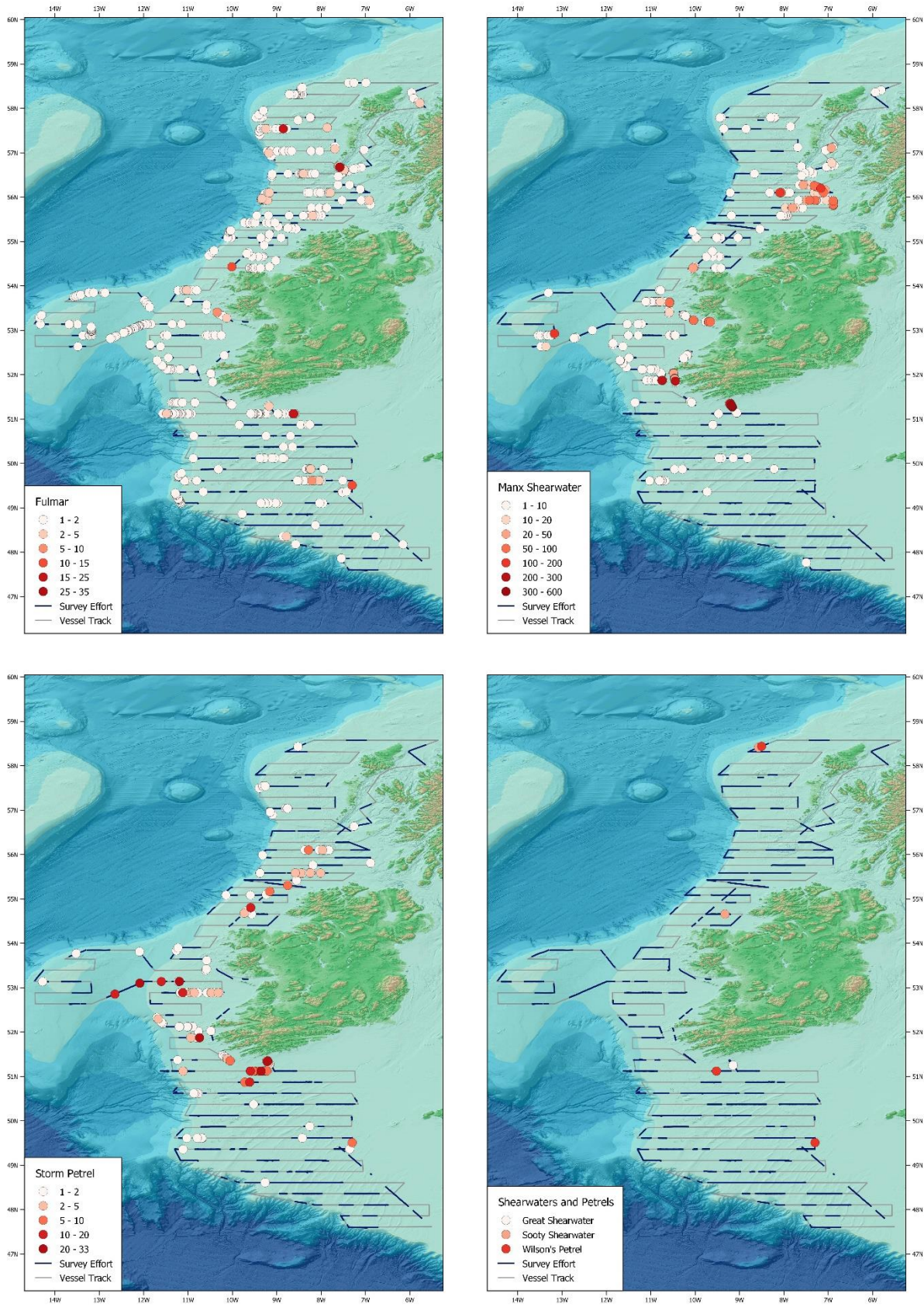


Figure 4: Distribution of a) fulmar, b) Manx shearwaters, c) European storm petrel and d) shearwaters and petrels recorded as 'in-transect' during line transect survey effort.

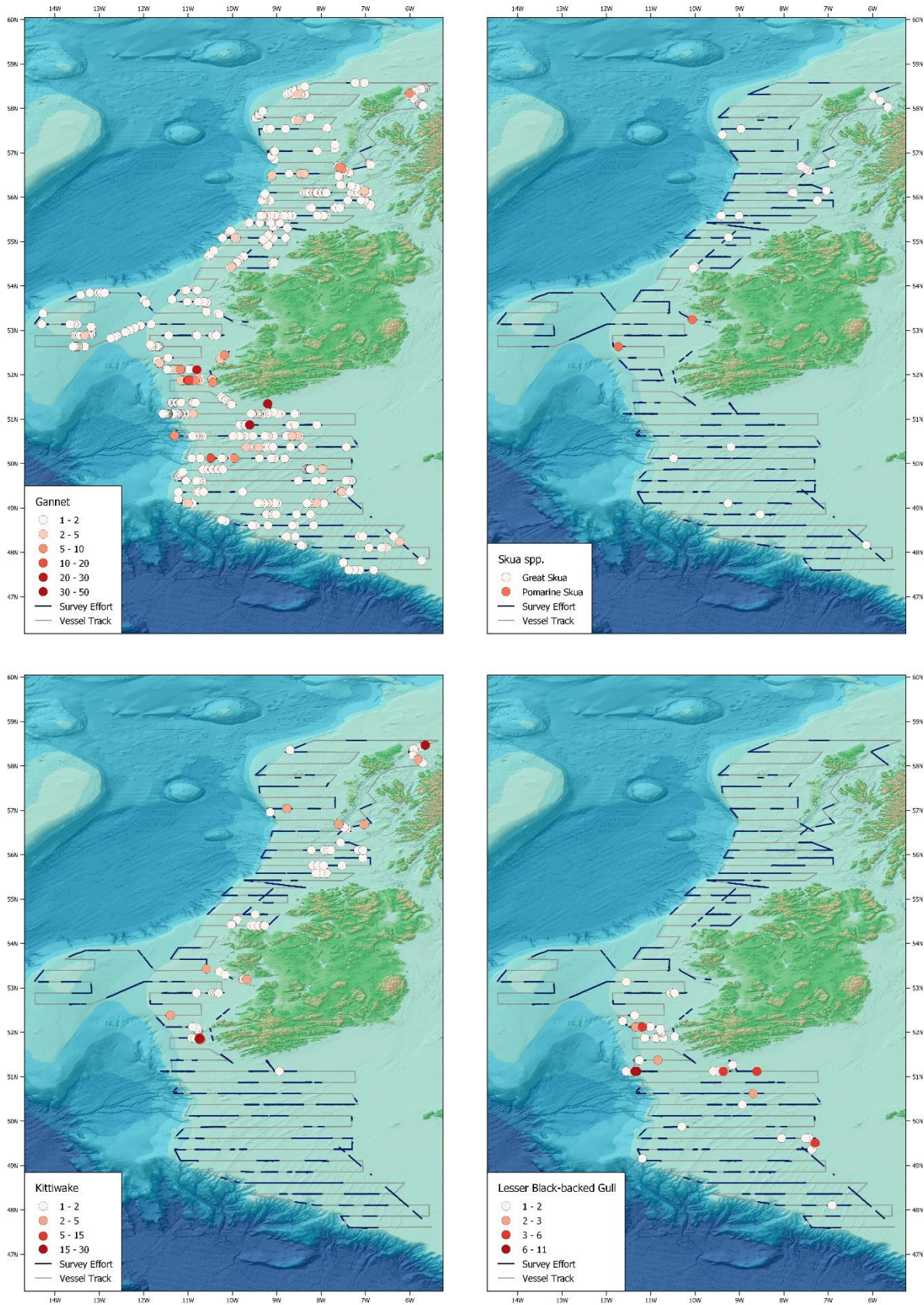


Figure 5: Distribution of a) gannet, b) skua spp., c) kittiwake and d) lesser black-backed gull recorded as 'in-transect' during line transect survey effort.

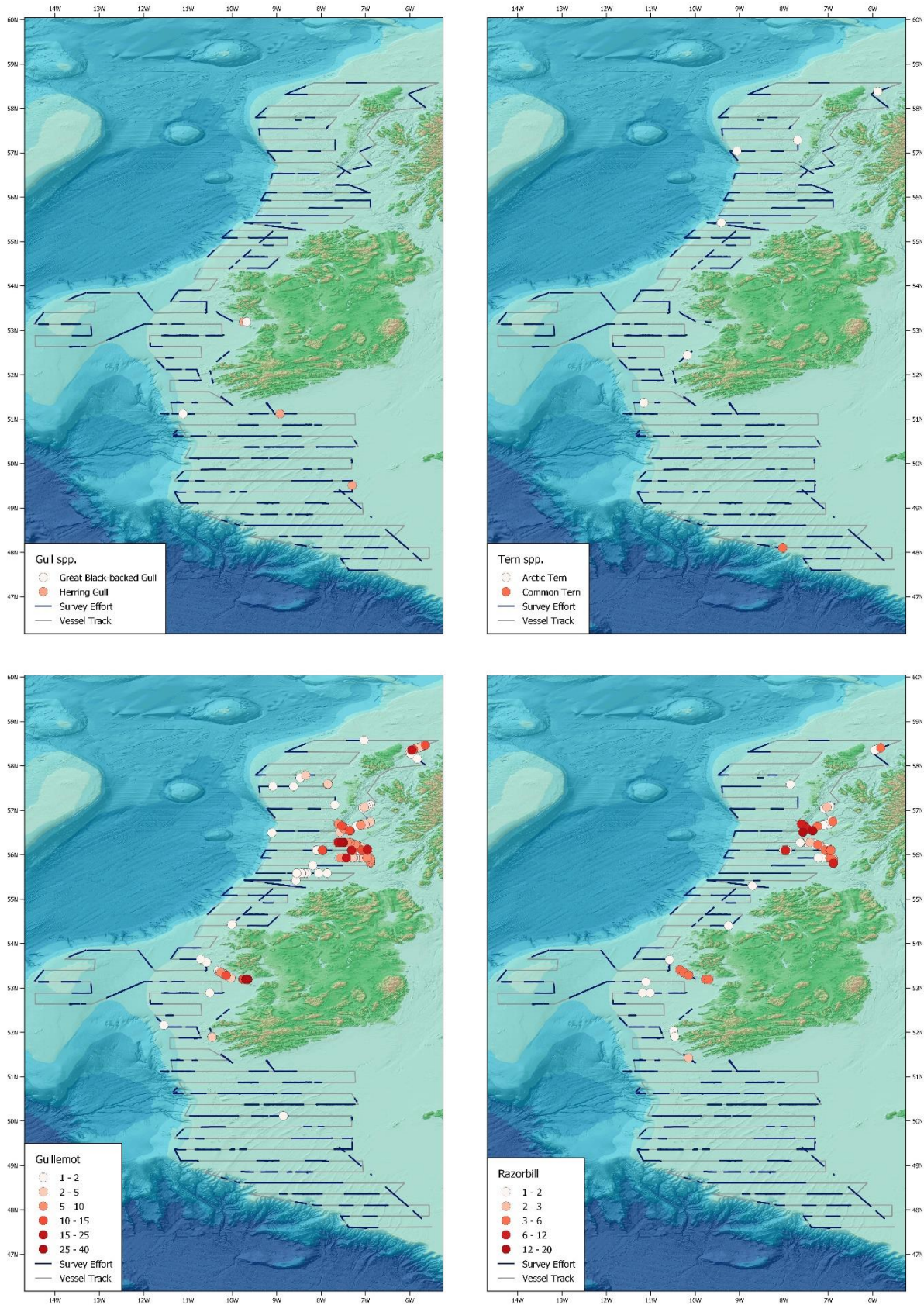


Figure 6: Distribution of a) gull spp., b) tern spp., c) guillemot and d) razorbill recorded as 'in-transect' during line transect survey effort.

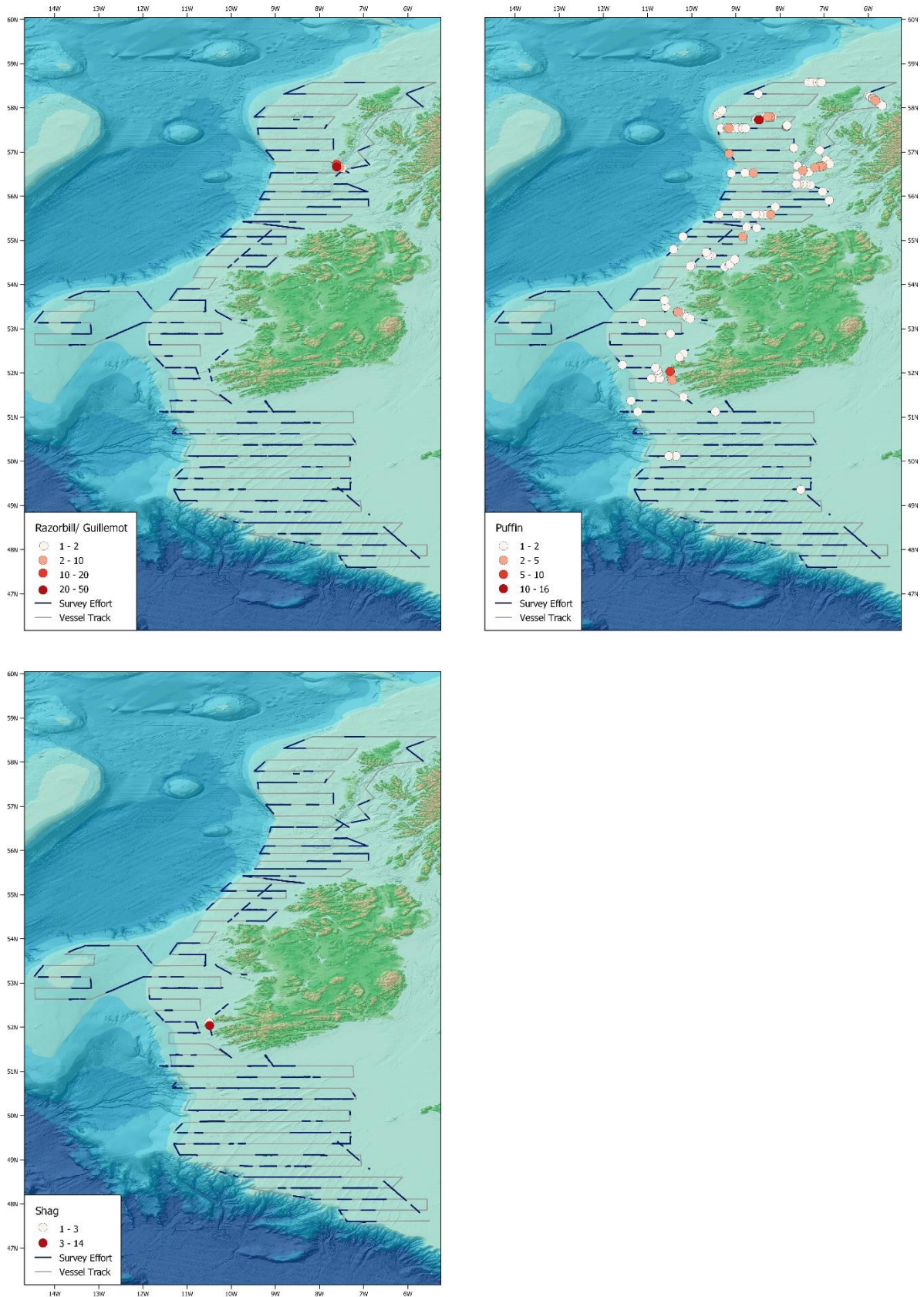


Figure 7: Distribution of a) razorbill/ guillemot, b) puffin and c) shag recorded as 'in-transect' during line transect survey effort.

Forty-five point counts were conducted at oceanographic or fishing stations. A total of 215 seabird observations were recorded during point sampling effort, comprising 3955 individuals from 11 species (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.

<i>Common Name</i>	<i>Species name</i>	<i>No. of records</i>	<i>Off transect</i>
<b>Fulmar</b>	<i>Fulmarus glacialis</i>	49	627
<b>Manx Shearwater</b>	<i>Puffinus puffinus</i>	12	1031
<b>Storm Petrel</b>	<i>Hydrobates pelagicus</i>	21	596
<b>Gannet</b>	<i>Morus bassanus</i>	72	1076
<b>Great Skua</b>	<i>Stercorarius skua</i>	19	28
<b>Skua sp.</b>	<i>Stercorarius sp.</i>	1	1
<b>Lesser Black-backed Gull</b>	<i>Larus fuscus</i>	29	552
<b>Herring Gull</b>	<i>Larus argentatus</i>	4	15
<b>Great Black-backed Gull</b>	<i>Larus marinus</i>	4	21
<b>Arctic Tern</b>	<i>Sterna paradisaea</i>	1	1
<b>Guillemot</b>	<i>Uria aalge</i>	1	1
<b>Puffin</b>	<i>Fratercula arctica</i>	2	6
	<b>Total</b>	<b>215</b>	<b>3955</b>

### *Fulmar*

Northern fulmar (*Fulmarus glacialis*) were the second most frequently encountered seabird species on the survey, being recorded on 1677 occasions and totalling 4431 individuals. In total, 1627 observations of 3790 individuals were recorded during line transect watches, with 800 individual birds recorded as 'in-transect', making fulmars one of the most abundant species recorded during line transect effort.

Fulmar were found to be broadly distributed in low numbers across much of the survey area however, they were also found to display a somewhat patchy distribution with higher abundances in areas such as south of the Seven Heads, off Erris Head, south of Barra, south of St. Kilda, and the Hebridean shelf slopes. Fulmar were not as common or broadly distributed in the Celtic Sea when compared to the more northerly survey transects, showing a more patchy distribution, however some large aggregations were still recorded.

### *Shearwaters*

Three species of shearwater were encountered on the survey: great shearwater (*Puffinus graves*), sooty shearwater (*Puffinus griseus*) and Manx shearwater (*Puffinus puffinus*). All three species were recorded during line transect effort, however, only Manx shearwater were recorded point sampling watches.

Manx shearwater were recorded on 961 occasions, totalling 14488 individuals. Manx shearwater were recorded on 947 occasions (13454 individuals) during line transect effort with 7368 individuals recorded as 'in-transect', making Manx shearwater the most abundant and third most frequently encountered species on the survey.

Manx shearwater were recorded across much of the survey area, however they were less frequently encountered in the Celtic Sea. Manx shearwater showed a highly patchy distribution pattern with very large aggregations recorded in areas such as off Toe Head, the Skelligs, along the south Connemara coast and over the Stanton Bank.

Sooty shearwater were recorded on 16 occasions with 20 individual birds recorded. Of these records. All sooty shearwater were recorded during line transect effort, with two birds recorded as 'in-transect'.

A single record of a lone great shearwater was recorded during line transect effort off Toe Head in Co. Cork.

### *Storm Petrels*

Two species of storm petrel were recorded during the survey: European storm petrel (*Hydrobates pelagicus*) and Wilson's storm petrel (*Oceanites oceanicus*).

European storm petrel were the third most frequently encountered and the fourth most abundant species, being recorded on 556 occasions and comprising of 2018 individuals in total. In total, 534 records occurred during line transect watch, numbering 1414 birds. Of these, 692 storm petrels were recorded as 'in transect'. European storm petrel were regularly recorded across the survey area with a number of areas of particularly high density noted such as; the west Cork coast, west of the Skelligs, west of the Arans and the Irish north western shelf waters.

Wilson's storm petrel were recorded on 8 occasions with each record consisting of a solitary bird. All eight encounters were recorded during line transect effort with three individuals recorded as 'in-transect'. Wilson's storm petrel were recorded sporadically across the breadth of the survey area from the southern Celtic Sea, to the Porcupine Bank and the Hebridean shelf slopes.

### *Gannet*

Overall, Gannet (*Morus bassanus*) were the most frequently observed seabird species on the survey, being recorded on 2208 occasions and totalling 5307 individuals. In total, 2133 observations of 4155 birds were recorded during line transect watches, with 1059 gannets recorded as 'in-transect', making gannet the second most abundant species recorded during line transect effort.

Gannet were found to be broadly distributed in low numbers across the entire survey area, although, as with many other species, a number of large aggregations were also recorded. These larger aggregations were observed in areas such as: off Toe Head, west of the Skelligs, and Stanton Bank.

### *Skuas*

Four species of skua were encountered on the survey including great skua (*Stercoratius skua*), pomarine skua (*Stercoratius pomarinus*), Arctic skua (*Stercoratius parasiticus*) and long-tailed skua (*Stercoratius longicaudus*). All skua species were recorded during line transect survey effort, however, only great skua and pomarine skua were recorded as 'in-transect'. Of the four species, great skua were the only species recorded during point counts. A number of skuas were encountered which could not be positively identified to species level, these were recorded as skua spp. or small skua spp.

Great skua were regularly encountered in low numbers throughout the survey (109 records of 1443 individual birds). During line transect survey effort, great skua were encountered on 90 occasions, totalling 115 individual birds. Of these, 39 great skua were recorded as 'in-transect'. Great skua were patchily distributed across much of the survey area in low numbers, however, the waters south of Barra and the Hebridean shelf edge held some higher numbers.

Four records of solitary pomarine skua were noted during line transect effort on the survey; with two pomarine skua recorded as 'in-transect', both in Irish western shelf waters.

Four records of solitary long-tailed skua were also noted during line transect effort on the survey, with all long-tailed skua recorded as 'off-transect'. They were recorded on the Porcupine Bank, outer Donegal Bay and the Hebridean shelf edge. Three records of solitary Arctic skua were noted during line transect effort on the survey, each being recorded as 'off-transect' also. Arctic skua were recorded on the Stanton Bank and at the north of the Minch.

### *Gulls*

Seven species of gull were encountered on the survey including common gull (*Larus canus*), black-headed gull (*Larus ridibundus*), lesser black-backed gull (*Larus fuscus*), herring gull (*Larus argentatus*), yellow-legged gull (*Larus michahellis*), greater black-backed gull (*Larus marinus*) and black-legged kittiwake (*Rissa tridactyla*). Of these seven species, all but common gull, black-headed gull and yellow-legged gull were recorded as 'in-transect' during line transect survey effort.

Kittiwake were the most frequently encountered and the second most abundant gull species on the survey with a total of 479 individuals recorded during 276 observations, each occurring during line transect effort. Of these, 188 birds were recorded as 'in-transect'.

Kittiwake were found to be broadly distributed in low numbers along both Ireland's and Scotland's western shelf waters, however they were almost completely absent from the Celtic Sea and the Porcupine Bank. Kittiwake were also found to display a somewhat patchy distribution with higher abundances recorded in areas such as west of the Skelligs and the northern Minch. Kittiwake were well represented on Stanton Bank, however the majority of these encounters were recorded as 'off-transect'.

Lesser black-backed gull were the second most frequently encountered gull species on the survey with a total of 1344 individuals recorded during 215 observations. Lesser black-backed gull were the most abundant species of gull recorded, being recorded 183 occasions during line transect effort. Of these, 735 birds were recorded as 'in-transect'.

Lesser black-backed gull were broadly distributed in low numbers across the survey area, although more frequently encountered on southern transects, including in the Celtic Sea. A large proportion of lesser black-backed gulls were recorded as 'off-transect' meaning the above map does not quite capture the extent of their distribution.

Although less common overall, herring gull (9 birds 'in-transect') and greater black-backed gull (2 birds 'in-transect') were occasionally recorded during line transect effort. Herring gull and greater black-backed gull were patchily distributed in low numbers across Irish shelf waters, with some records in Scottish waters also. However, the majority of herring gull and greater black-backed observations were recorded as 'off-transect'.

Common gull (1 bird 'off-transect'), black-headed gull (3 birds 'off-transect') and yellow-legged gull (1 bird 'off-transect') were each encountered on one occasion during line transect effort only, however each record was of birds 'off-transect'. A flock of three black-headed gulls and a solitary common gull were recorded off Inis Mor, while the lone yellow-legged gull was recorded in the Celtic Sea near the Labadie Bank.

### *Terns*

Two species of tern were encountered over the course of the survey: Arctic tern (*Sterna paradisaea*) and common tern (*Sterna hirundo*).

Arctic tern were recorded on 11 occasions during the survey, totalling 17 birds. Of these 10 records of 16 individual birds were obtained during line transect effort, with 10 birds being recorded as 'in-transect'. A single Arctic tern was also recorded during a point sampling effort. Arctic tern were recorded irregularly across the western Irish and Scottish shelf waters.

A single record of a pair of common tern were recorded over the Celtic shelf slopes during line transect effort; this observation was recorded as 'in-transect'.

### *Auks*

Four of the five species of auk known to occur in Irish waters were encountered on the survey. These were guillemot (*Uria aalge*), black guillemot (*Cepphus grylle*), razorbill (*Alea torda*) and Atlantic puffin (*Fratercula arctica*). All auk species were recorded during line transect effort, while guillemot and puffin were also recorded during point sampling survey effort. Guillemot, razorbill and puffin were also recorded as 'in-transect' during line transect watches. A number of observations of auks identified only as guillemot/razorbill were also recorded during line transect survey effort.

Guillemot were the most frequently encountered of the auk species with all but one record of loan guillemot recorded during line transect survey effort. In total, 463 observations of 1825 individuals were recorded during line transect watches, with 1322 birds recorded as 'in-transect'. Guillemot were recorded almost exclusively in coastal waters and were all but absent from offshore waters, particularly in the Celtic Sea and the Porcupine Bank. Some sporadic encounters of guillemot were recorded on the Hebridean continental shelf edge, however these were all recorded as 'off-transect'. Guillemot were recorded in highest numbers along the south Connemara coast, Stanton Bank, south of Barra and the northern Minch.

Puffin were the second most frequently encountered of the auk species (412 records of 777 individual birds). In total, 410 sightings of 771 puffin were recorded during line transect watches, with 306 birds recorded as 'in-transect', making Puffin the second most abundant auk species. Two records of puffin, totalling six birds were also recorded during point sampling effort while the vessel was engaged in fishing activity. Puffin also were almost recorded exclusively in coastal waters and were all but absent from offshore waters, particularly in the Celtic Sea and the Porcupine Bank. Puffin were recorded in highest numbers west of the Skelligs, south of Barra, around St. Kilda and the north of the Minch.

Razorbill were less frequently encountered during the survey and were recorded during line transect effort only. In total, 192 observations of 531 individuals were recorded during line transect watches, with 376 individuals recorded as 'in-transect'. Although less abundant, razorbill showed a very similar distribution pattern to that of guillemot with highest numbers recorded along the south Connemara coast, Stanton Bank, south of Barra and the northern Minch.

Black guillemot were recorded off Inis Mor as a single observations of a pair of birds made during line transect watches, both were recorded as 'off-transect'.

#### *Cormorant and Shag*

Both cormorant and shag were recorded during this years' WESPAS. Both species were recorded during line transect effort only, however, only shag were recorded as 'in-transect'.

Shag were recorded on 6 occasions totalling 21 birds, of these 17 shag were recorded as 'in-transect'. Shag were recorded off the west Kerry coast, north of Inis Mor and in the north of the Minch, however only the records obtained off the Kerry coast were recorded as 'in-transect'.

A single cormorant was recorded on the survey. The cormorant was also encountered off the coast of Inis Mor.

*Terrestrial/ migratory birds*

A number of terrestrial/ migratory birds were encountered during the survey. A total of 21 observations of terrestrial/ migratory bird species were recorded during the survey (*Table 2*). These observations comprised of 79 individuals from 12 species' or species groups. Species recorded included a ringed plover (*Charadrius hiaticula*), a quail (*Coturnix coturnix*), a collared dove (*Streptopelia decaocto*) and a flock of 45 whimbrel (*Numenius phaeopus*).

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

<i>Common Name</i>	<i>Species name</i>	<i>No. of records</i>	<i>No. of individuals</i>
Collared Dove	<i>Streptopelia decaocto</i>	1	1
Curlew/Whimbrel	<i>Numenius arquata/ phaeopus</i>	1	1
Dunlin	<i>Calidris alpina</i>	2	3
Feral/ racing pigeon	<i>Columba livia domestica</i>	4	7
House Martin	<i>Delichon urbica</i>	1	1
Quail	<i>Coturnix</i>	1	1
Ringed Plover	<i>Charadrius hiaticula</i>	1	1
Small waders sp.	-	1	10
Swallow	<i>Hirundo rustica</i>	4	5
Swift	<i>Apus apus</i>	2	2
Turnstone	<i>Arenaria interpres</i>	1	1
Whimbrel	<i>Numenius phaeopus</i>	2	46
	<b>Total</b>	<b>21</b>	<b>79</b>

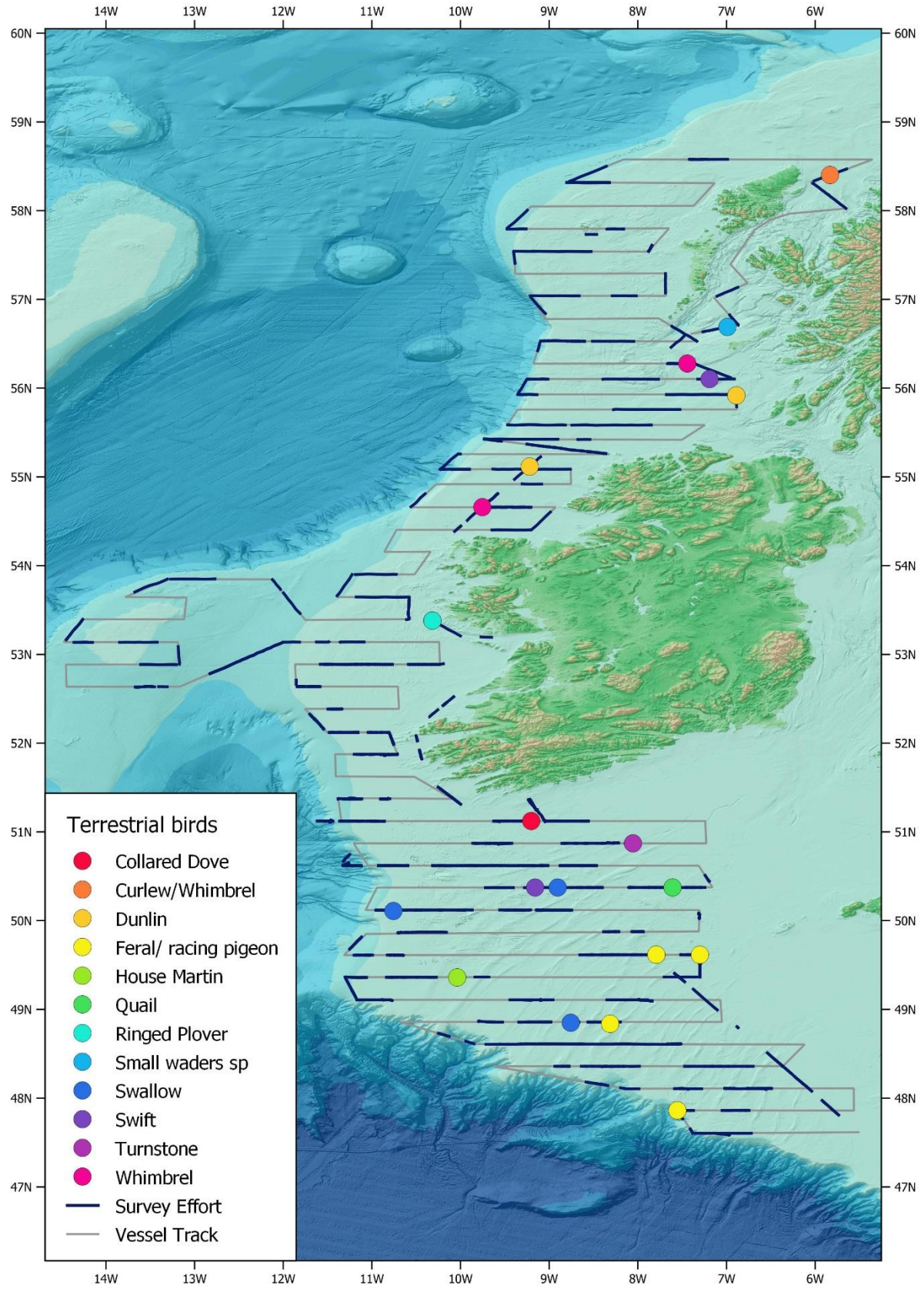


Figure 6: Distribution of terrestrial species recorded during survey effort.

## Discussion

The WESPAS has been undertaken annually aboard the *RV Celtic Explorer* since 2016 with seabird surveyors deployed on each survey (O'Donnell, *et al.*, 2016; 2017; 2018; 2019; 2020). However, the number of seabird surveyors deployed has varied across the time series of the WESPAS. Since 2019, the NPWS have commissioned a seabird survey during the WESPAS, with a single ESAS trained seabird surveyor deployed for each leg of the survey. The seabird survey during this year's survey was conducted using a single seabird surveyor, thus the level and detail of data collected was affected at times. The seabird observers' survey effort focused on the correct identification, enumeration, distance estimation and recording of species encountered while ancillary data such as age, moult stage and behaviour was de-prioritised, particularly during periods of high seabird activity.

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. WESPAS 2016 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 5<sup>th</sup> – 29<sup>th</sup> July covering the Celtic sea region, while in 2017 the seabird survey ran from the 9<sup>th</sup>- 28<sup>th</sup> June in the Celtic sea. The number of seabird observers deployed has also varied through the years with a single observer deployed on the present survey and also during WESPAS 2016, 2018 and 2020. Where as 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 survey effort and species observation and abundance results obtained across the surveys.

Survey effort has varied across the time series of surveys. During the present survey a total of 262 hours and 40 minutes of survey effort was conducted, 218 hours and 48 minutes of survey effort were conducted using a line transect methodology, while 42 hours and 20 minutes of effort were conducted using the point sampling methodology. In 2020, 271 hours and 5 minutes of survey effort were recorded. A total of 225 hours and 40 minutes of survey effort were recorded in 2019, and 156 hours and 16 minutes of survey effort were recorded in 2018. 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.

As in previous surveys, a large number of seabird records, 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, 26 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 2020, 31 species of seabird and 8 species of terrestrial bird were recorded during the present survey and in 2019, 25 species of seabird and 10 species of terrestrial bird were recorded, while 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. Tables containing all species of both seabird and terrestrial bird recorded since over the entire time series of WESPAS are provided in *Tables 6 & 7* within the Appendices.

There was a marked difference in the number of seabird records and the overall abundance and diversity of seabirds between leg 1 and leg 2 of the survey. Despite having more observer hours of effort recorded, leg 1 had considerably fewer records and a much lower abundance of seabirds when compared to leg 2. A number of species, particularly auks, were all but absent from Leg 1, especially

in the Celtic Sea. Leg 1 was characterised by common species such as gannet and fulmar, with few other species recorded over a number of days of effort.

Manx shearwater, guillemot, fulmar, gannet and European storm petrel were the most abundant and widespread species' overall in the present survey, with fulmar and gannet being the most widely distributed, while Manx shearwater were the most abundant. 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 south of Toe Head, south of the Seven Heads, west of the Skellig and Blasket Islands, the south Connemara coast, Erris Head, Stanton Bank, south of Barra, around St. Kilda, along the Hebridean shelf edge and the Minch.

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. Environmental conditions, particularly elevated sea states, likely affected the detection probability of certain species, particularly less conspicuous 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 is recommended for this survey. The present survey used a single ESAS trained seabird observer, however recent surveys have also 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, minimise observer fatigue and allow full coverage of all daylight hours. However, the authors appreciate the constraints on using such a large seabird survey team.

The approach 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 watches without suffering the ill effects of fatigue.

## Acknowledgments

The seabird observers would like to thank Captains Denis Rowan and Anthony Hobin, and chief scientists, Ciaran O'Donnell and Michael O'Malley, along with the crew of the Celtic Explorer for their support and professional conduct during the survey.

The seabird observers would also like to thank the marine, and galley crew, for their hospitality, and the marine crew for providing the seabird observers with access to the bridge.

Finally, the seabird observers wish the RV *Celtic Explorer*, the Explorer crew and the Marine Institute staff all the best for future surveys. Both, the Explorer crew and the Marine Institute staff have been a pleasure to work with and the seabird observer looks forward to future collaborations.

## 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.

Connaughton, P. and Power, J. (2020). *Seabird Monitoring undertaken during the Western European Shelf Pelagic Acoustic Survey (WESPAS) 1st June- 12th July 2020*. Report to the National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht.

Cybertracker, (2019). *Data collection software package (Version 3.515)*. <https://cybertracker.org>

Cummins, S., et al., (2019). *The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013–2018*. Irish Wildlife Manuals, No. 114. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

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

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, (2021). *Representative cruise track of the international co-ordinated survey program*.

Mitchell, I., et al., (Eds.) (2004). *Seabird Populations of Britain and Ireland: results of the Seabird 2000 census (1998-2002)*. Published by T and A.D. Poyser, London.

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., (2020). *Western European Shelf Pelagic Acoustic Survey Cruise Report (WESPAS) 3 June - 13 July, 2020*. FEAS Survey Series: 2020/03. Marine Institute.

O'Donnell, C., et al., (2019). *Western European Shelf Pelagic Acoustic Survey Cruise Report (WESPAS) 13 June - 24 July, 2019*. FEAS Survey Series: 2019/03. Marine Institute.

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, 2016*. (<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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Appendix 1

Table 6: Seabird sighting records from Western European Shelf Pelagic Acoustic Survey from 2016-2021 (Connaughton and Power, 2020)<sup>1</sup>.

Common Name	Species name	2021		2020		2019		2018		2017		2016	
		In-transect	Off-transect	In-transect	Off-transect	In-transect	Off-transect	In-transect	Off-transect	In-transect	Off-transect	In-transect	Off-transect
<b>Fulmar</b>	<i>Fulmarus glacialis</i>	800	3631	1893	7049	1002	2706	336	1023	705	495	1216	792
<b>Balearic Shearwater</b>	<i>Puffinus mauretanicus</i>	-	-	-	-	0	1	-	-	1	0	-	-
<b>Cory's Shearwater</b>	<i>Calonectris diomedea</i>	-	-	-	-	-	-	4	2	11	2	282	360
<b>Great Shearwater</b>	<i>Puffinus graves</i>	1	0	-	-	0	1	3	3	3	1	70	45
<b>Manx Shearwater</b>	<i>Puffinus</i>	7368	7120	7696	5808	1902	859	374	394	2855	206	1111	826
<b>Macaronesian Shearwater</b>	<i>Puffinus baroli</i>	-	-	-	-	-	-	-	-	-	-	0	1
<b>Sooty Shearwater</b>	<i>Puffinus griseus</i>	2	18	13	3	1	5	3	10	22	8	15	43
<b>Fea's type petrel</b>	<i>Pterodroma feae/ deserta</i>	-	-	1	0	-	-	-	-	-	-	-	-
<b>Unid. Shearwater sp.</b>		-	-	-	-	-	-	1	0	-	-	-	-
<b>European Storm Petrel</b>	<i>Hydrobates pelagicus</i>	692	1326	989	925	847	1125	60	296	1097	645	957	921
<b>Leach's Petrel</b>	<i>Oceanodroma leucorhoa</i>	-	-	1	0	2	1	-	-	2	0	3	0
<b>Wilson's Petrel</b>	<i>Oceanites oceanicus</i>	3	5	6	0	1	4	0	1	3	0	9	4
<b>Unid. Storm petrel</b>		0	1	1	-	-	-	1	6	-	-	-	-
<b>Cormorant</b>	<i>Phalacrocorax carbo</i>	0	1	-	-	-	-	0	4	-	-	-	-
<b>Shag</b>	<i>Phalacrocorax aristotelis</i>	17	4	9	0	3	0	0	5	-	-	0	1
<b>Great Northern Diver</b>	<i>Gavia immer</i>	-	-	1	0	-	-	1	0	-	-	-	-
<b>Gannet</b>	<i>Morus bassanus</i>	1059	4248	3726	7658	821	3039	1032	3542	3157	1151	2345	941
<b>Grey Phalarope</b>	<i>Phalaropus fulicarius</i>	-	-	-	-	-	-	-	-	-	-	17	0
<b>Arctic Skua</b>	<i>Stercorarius parasiticus</i>	0	3	7	2	0	1	1	2	-	-	1	1
<b>Great Skua</b>	<i>Stercorarius skua</i>	38	105	91	55	50	56	23	43	11	6	16	22
<b>Long-tailed Skua</b>	<i>Stercorarius longicaudus</i>	0	4	8	0	0	1	-	-	-	-	3	3
<b>Pomarine Skua</b>	<i>Stercorarius pomarinus</i>	2	2	5	2	0	3	0	1	0	1	2	3
<b>South Polar Skua</b>	<i>Stercorarius maccormicki</i>	-	-	-	-	0	1	-	-	-	-	-	-
<b>Small skua sp.</b>	<i>S. parasiticus/ longicaudus</i>	0	8	-	-	-	-	-	-	-	-	-	-
<b>Skua sp.</b>	<i>Stercorarius sp.</i>	0	1	-	-	-	-	-	-	-	-	-	-
<b>Black Headed Gull</b>	<i>Chroicocephalus philadelphia</i>	0	3	1	0	-	-	-	-	0	1	-	-



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Common Gull	<i>Larus canus</i>	0	1	1	0	-	-	2	10	-	-	-	-
Kittiwake	<i>Rissa tridactyla</i>	188	291	233	665	629	216	30	54	11	22	50	170
Sabine's Gull	<i>Xema sabini</i>	-	-	1	0	-	-	2	0	1	3	-	-
Herring Gull	<i>Larus argentatus</i>	9	32	22	7	2	16	2	33	1	15	0	6
Great Black-backed gull	<i>Larus marinus</i>	2	58	7	18	7	26	6	35	1	36	6	77
Lesser Black-backed gull	<i>Larus fuscus</i>	102	1242	156	441	27	289	238	587	458	164	14	246
Yellow-legged Gull	<i>Larus michahellis</i>	0	1	0	6	-	-	-	-	-	-	0	1
Unid. gull sp.	<i>Larus sp.</i>	-	-	-	-	-	-	0	2	-	-	-	-
Unid. large gull sp.	<i>Larus sp.</i>	-	-	-	-	-	-	21	4	150	0	-	-
Arctic Tern	<i>Sterna paradisaea</i>	10	7	10	4	9	8	0	3	3	1	16	9
Commic tern sp.	<i>Sterna hirundo / paradisaea</i>	-	-	17	0	0	15	-	-	-	-	-	-
Common Tern	<i>Sterna hirundo</i>	2	0	15	0	3	5	0	7	5	0	1	0
Little Tern	<i>Sterna albifrons</i>	-	-	-	-	3	0	-	-	-	-	-	-
Unid. Sterna sp.	<i>Sterna sp.</i>	-	-	-	-	-	-	0	17	-	-	-	-
Auk sp.	<i>Alcidae sp.</i>	-	-	-	-	212	145	-	-	-	-	-	-
Guillemot	<i>Uria aalge</i>	1322	504	745	123	1043	77	431	252	11	1	47	10
Black guillemot	<i>Cephus grylle</i>	0	2	-	-	-	-	-	-	-	-	-	-
Razorbill	<i>Alea torda</i>	376	155	98	13	273	47	232	89	5	1	12	0
Razorbill/ Guillemot	<i>Alea torda/ Uria aalge</i>	92	594	-	-	-	-	552	651	-	-	-	-
Atlantic Puffin	<i>Fratercula arctica</i>	306	471	525	237	237	171	317	405	36	3	194	105
		<b>12391</b>	<b>19838</b>	<b>16277</b>	<b>23016</b>	<b>7074</b>	<b>8818</b>	<b>3670</b>	<b>7481</b>	<b>8549</b>	<b>2762</b>	<b>6387</b>	<b>4533</b>

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

## Appendix 2

 Table 7: Terrestrial / migratory species recorded on WESPAS annually since 2016 (Connaughton and Power, 2020)<sup>1</sup>.

Common Name	Species name	2021	2020	2019	2018	2017	2016
Black Redstart	<i>Phoenicurus ochruros</i>	-	1	-	-	-	-
Black-tailed Godwit	<i>Limosa</i>	-	46	-	-	-	-
Collared Dove	<i>Streptopelia decaocto</i>	1	2	2	6	-	-
Common Scoter	<i>Melanitta nigra</i>	-	14	21	-	-	-
Curlew/Whimbrel	<i>Numenius arquata/ phaeopus</i>	1	-	-	-	-	-
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	-
House Martin	<i>Delichon urbica</i>	1	-	-	-	-	-
Quail	<i>Coturnix</i>	1	-	-	-	-	-
Pied Wagtail	<i>Motacilla alba</i>	-	-	1	-	-	-
Oystercatcher	<i>Haematopus ostralegus</i>	-	-	-	-	2	-
Redshank	<i>Tringa totanus</i>	-	-	5	-	-	-
Ringed Plover	<i>Charadrius hiaticula</i>	1	-	-	-	-	-
Small waders sp.	-	10	-	-	-	-	-
Spotted Flycatcher	<i>Muscicapa striata</i>	-	1	1	-	-	-
Swallow	<i>Hirundo rustica</i>	5	2	2	-	-	-
Swift	<i>Apus apus</i>	2	-	12	1	5	1
Tufted Duck	<i>Aythya fuligula</i>	-	4	-	-	-	-
Turnstone	<i>Arenaria interpres</i>	1	-	-	-	-	1
Unid. Passerine	-	-	-	-	1	-	-
Whimbrel	<i>Numenius phaeopus</i>	46	-	-	-	1	1
White-tailed Eagle	<i>Haliaeetus albicilla</i>	-	1	-	-	-	-
<b>Total</b>		<b>79</b>	<b>71</b>	<b>52</b>	<b>40</b>	<b>28</b>	<b>21</b>

Further details available on [www.emff.marine.ie](http://www.emff.marine.ie)

Managing Authority EMFF 2014-2020	Specified Public Beneficiary Body
<p data-bbox="252 853 740 927">Department of Agriculture Food &amp; the Marine</p> <p data-bbox="220 976 772 1008">Clogheen, Clonakilty, Co. Cork. P85 TX47</p> <p data-bbox="320 1055 671 1086">Tel: (+)353 (0)23 885 9500</p> <p data-bbox="316 1133 676 1164"><a href="http://www.agriculture.gov.ie/emff">www.agriculture.gov.ie/emff</a></p>	<p data-bbox="999 853 1203 884">Marine Institute</p> <p data-bbox="820 976 1382 1008">Rinville, Oranmore, Co. Galway, H91 R673</p> <p data-bbox="911 1055 1291 1086">Phone: (+)353 (0)91 38 7200</p> <p data-bbox="1002 1133 1198 1164"><a href="http://www.marine.ie">www.marine.ie</a></p>



This project or operation is part supported by the Irish government and the European Maritime & Fisheries Fund as part of the EMFF Operational Programme for 2014-2020



An Roinn Talmhaíochta,  
Bia agus Mara  
Department of Agriculture,  
Food and the Marine



EUROPEAN UNION  
This measure is part-financed  
by the European Maritime  
and Fisheries Fund



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