EMFF Operational Programme 2014-2020

Marine Biodiversity Scheme

Marine Institute Seabird Monitoring

During the Celtic Sea Herring Acoustic Survey

4th- 24th October 2020

Lead Agency: Marine Institute

Lead Partners: National Parks and Wildlife Service,

Authors: Emerald Marine

Citation: Connaughton, P. and Power, J. (2020). Seabird Monitoring undertaken during the Celtic Sea Herring Acoustic Survey (CSHAS) 4th- 24th October 2020

Ireland's EU Structural and Investment Funds Programmes 2014 - 2020
Co-funded by the Irish Government and the European Union

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

EMFF

Operational Programme	European Maritime and Fisheries Fund (EMFF) Operational Programme 2014-2020
Priority	Union Priority 1 Sustainable Development of Fisheries Union Priority 6 Fostering the implementation of the Integrated Maritime Policy
Thematic Objective	TO 6 - Preserving and protecting the environment and promoting resource efficiency
Specific Objective	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
Measure	Marine Biodiversity Scheme
Project No.	MB/2019/09
EMFF Certifying Body	Finance Division, Department of Agriculture, Food and the Marine
Managing Authority	Marine Agencies & Programmes Division, Department of Agriculture, Food and Marine
Specified Public Beneficiary Body	Marine Institute
Grant Rate	100%
EU Co-Financing Rate	50%
Legal Basis	Article 29, 40 & 80 EMFF
Details	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

Ireland's EU Structural and Investment Funds Programmes 2014 - 2020
Co-funded by the Irish Government and the European Union

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

EMFF

Stradbally, Castlegregory, Tralee, Co. Kerry

Email: enquiries@emeraldmarine.eu

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 Celtic Sea Herring Acoustic Survey (CSHAS), running from the 4th to the 24th of October 2020.

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 117 hours and 34 minutes of survey effort was conducted over the course of the CSHAS 2020 survey. In total, 99 hours and 50 minutes of survey effort were conducted using a line transect methodology, while 14 hours and 45 minutes of effort were conducted using the point sampling methodology. A further 2 hours and 58 minutes of effort were conducted as a casual watch.

A total of 3764 seabird sightings were recorded throughout the survey, totalling 35639 individuals. In total, 11624 seabirds were recorded as "in transect", while 24012 were recorded "off transect". The species encountered included 27 species from 9 families. A further 74 sightings of terrestrial birds were also recorded, comprising of 287 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 roseatte 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).

Species	*Latin name*	*Northern Ireland*	*Republic of Ireland*	*All- Ireland total*	*GB & Ireland Total*	*Percentage change since SCR Census (1985-88)*[1]
Fulmar	*Fulmarus glacialis*	5,992	32,918	38,910	537,991	0%
Manx Shearwater[2]	*Puffinus puffinus*	4,633	32,545	37,178	332,267	
European Storm petrel[2]	*Hydrobates pelagicus*	0	99,065	99,065	124,775	
Leach's Storm petrel[2]	*Oceanodroma leucorhoa*	0	310	310	48,357	
Gannet	*Morus bassana*	0	32,758	32,758	259,311	39%
Cormorant	*Phalacrocorax carbo*	663	4,548	5,211	13,681	7%
Shag	*Phalacrocorax aristotelis*	301	3,426	3,727	32,306	-25%
Arctic Skua	*Stercoratius parasiticus*	0	0	0	2,136	-37%
Great Skua	*Stercoratius skua*	0	1	1	9,635	26%
Mediterranean Gull	*Larus melanocephalus*	2	3	5	113	
Black-headed Gull	*Larus ridibundus*	10,107	3,876	13,983	141,890	2%
Common Gull	*Larus canus*	557	1,060	1,617	49,780	39%
Lesser Black-backed Gull	*Larus fuscus*	1,973	2,876	4,849	116,684	42%
Herring Gull	*Larus argentatus*	714	5,521	6,235	149,177	-17%
Great Black-backed Gull	*Larus marinus*	76	2,243	2,319	19,713	-6%
Kittiwake	*Rissa tridactyla*	13,060	36,100	49,160	415,995	-23%
Sandwich Tern	*Sterna sandvicensis*	1,954	1,762	3,716	14,252	-11%
Roseate Tern	*Sterna dougallii*	4	734	738	790	44%
Common Tern	*Sterna hirundo*	1,704	2,485	4,189	14,497	-2%
Arctic Tern	*Sterna paradisaea*	767	2,735	3,502	56,123	-29%
Little Tern	*Sterna albifrons*	0	206	206	2,153	-25%
Guillemot	*Uria aalge*	98,546	138,108	236,654	1,559,484	32%
Razorbill[3]	*Alea torda*	24,084	27,446	51,530	216,087	23%
Black Guillemot[4]	*Cepphus grylle*	1,174	3,367	4,541	42,683	
Atlantic Puffin	*Fratercula arctica*	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 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 (O'Donnell, et al., 2016; 2017; 2018; 2019). 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 CSHAS is an acoustic survey undertaken by the Fisheries Ecosystems Advisory Services (FEAS) department of the Marine Institute of Ireland to determine an age stratified relative abundance of herring (*Clupea harengus*) within the survey area as part of a national stock assessment. CSHAS also aims to determine estimates of biomass and abundance of sprat (*Sprattus sprattus*) within the survey area (O'Donnell, et al., 2019).

The survey has been undertaken annually since 1989 and since 2004 has been fixed in October and carried out on the *RV Celtic Explorer*. Since 2016 the CSHAS survey has used an updated survey design, covering an extended area of the Celtic sea with each survey employing parallel transects spaced equally at 8 nautical miles, beginning in an east-west fashion for an initial pass of the survey area before a second pass is conducted in a west-east fashion at a 4 nautical mile offset. The survey also incorporates secondary high resolution adaptive surveys focusing on areas of high abundance (O'Donnell, et al., 2016; 2017; 2018; 2019).

The CSHAS provides a unique opportunity for surveillance of the autumn distribution of seabirds in shelf water habitats along Ireland's Celtic sea 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 *RV Celtic Explorer* during the annual Celtic Sea Herring Acoustic Survey (CSHAS), running from the 4th to the 24th of October 2020.

Methodology

The seabird survey was conducted from the 05/10/20 to the 23/10/20 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 2018 survey (*Figure 1)*, a standard line transect survey methodology was determined to be most suitable and was employed by the seabird survey team. Survey transect were undertaken at speeds of 5-10 knots, with fishing activity being conducted at speeds of 2-3 knots.

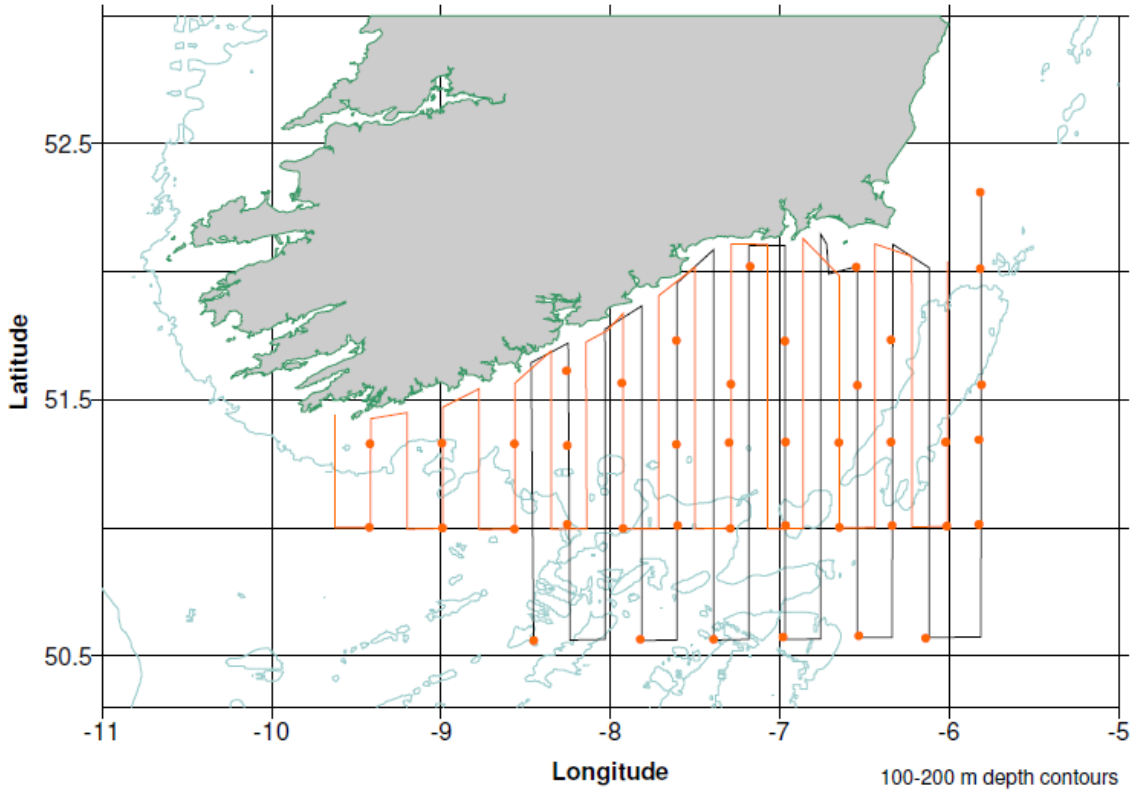

Figure 1: The CSHAS 2018 cruise track (Source: Marine Institute, 2019).

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).

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^{o} 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 3.514) 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 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 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 ^{o} arc around the vessel. Data recording methodology remained similar for both point sampling and line transect methods.

Results

Effort

A total of 117 hours and 34 minutes of survey effort was conducted over the course of CSHAS 2020. In total, 99 hours and 50 minutes of survey effort were conducted using a line transect methodology, while 14 hours and 45 minutes of effort were conducted using the point sampling methodology. A further 2 hours and 58 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 recorded daily survey effort was 8 hours and 18 minutes while the average daily survey effort was 6 hours and 11 minutes. Seabird survey effort was greatly reduced on the 4th, 14th and 23rd of October due to transiting to/from the survey area. During these transits a number of casual watches were conducted by the observer. No effort watches were conducted on the 20th of October and seabird survey effort was greatly reduced on the 19th of October due to weather conditions exceeding the specified weather limits for observations. A graph of daily effort is provided in *Figure 2 b*elow.

On a number of occasions throughout the survey, the vessel conducted intensive mini surveys over key herring habitats. During these mini surveys the seabird survey methodology was adjusted to accommodate the shorter and more closely spaced transect lines by conducting single continuous watch during the mini survey.

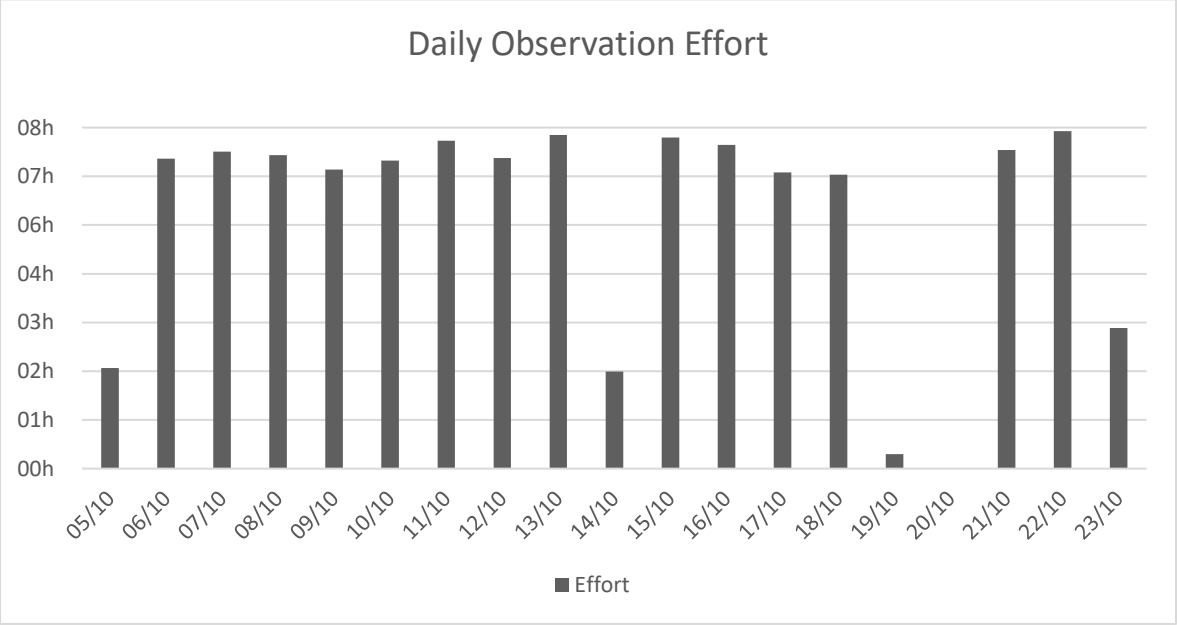

Figure 2: Daily visual effort undertaken during the survey.

Environmental Conditions

Environmental conditions were generally moderate to poor 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 was judged in terms of the total state of agitation of the sea with wave height in meters used as an additional guide. Beaufort sea state was recorded in terms of Beaufort wind force and was judged based on the effect of the wind on the sea surface.

WMO sea states 3 and 4 were the most common sea states recorded. The most frequently recorded WMO sea state was 4 (moderate), accounting for over 68 hours (58%) of observation effort, while WMO sea state 3 accounted for over 33 hours (29%). WMO sea state 2 accounted for just 9 hours (8%) of observation effort (*Fig. 3a*).

The most frequently recorded Beaufort sea state was a sea state 6, accounting for 40.5 hours (34%) of survey effort. Beaufort sea state 4 and 5 each accounted for between 19-20 hours (17%) of recorded effort while sea state 3 accounted for over 12 hours (10%) of survey effort (*Fig. 3b*).

Swell

A swell height of 1.1-2 meter was most frequently recorded throughout the survey, being recorded on over 69 hours (59%) of survey effort. A swell height of 0.1-1 meters was recorded over almost 31 survey hours (26%), while swell of over 2 meters was recorded during almost 17 hours (14%) of survey effort (*Fig. 3c*).

Visibility

Visibility was generally very good during seabird survey effort. The most frequently recorded visibility was 11-15km, being recorded over 107 hours (91%) of survey effort, while visibility of 16-20km was recorded over 4 hours (8%) of survey effort (*Fig. 3d*).

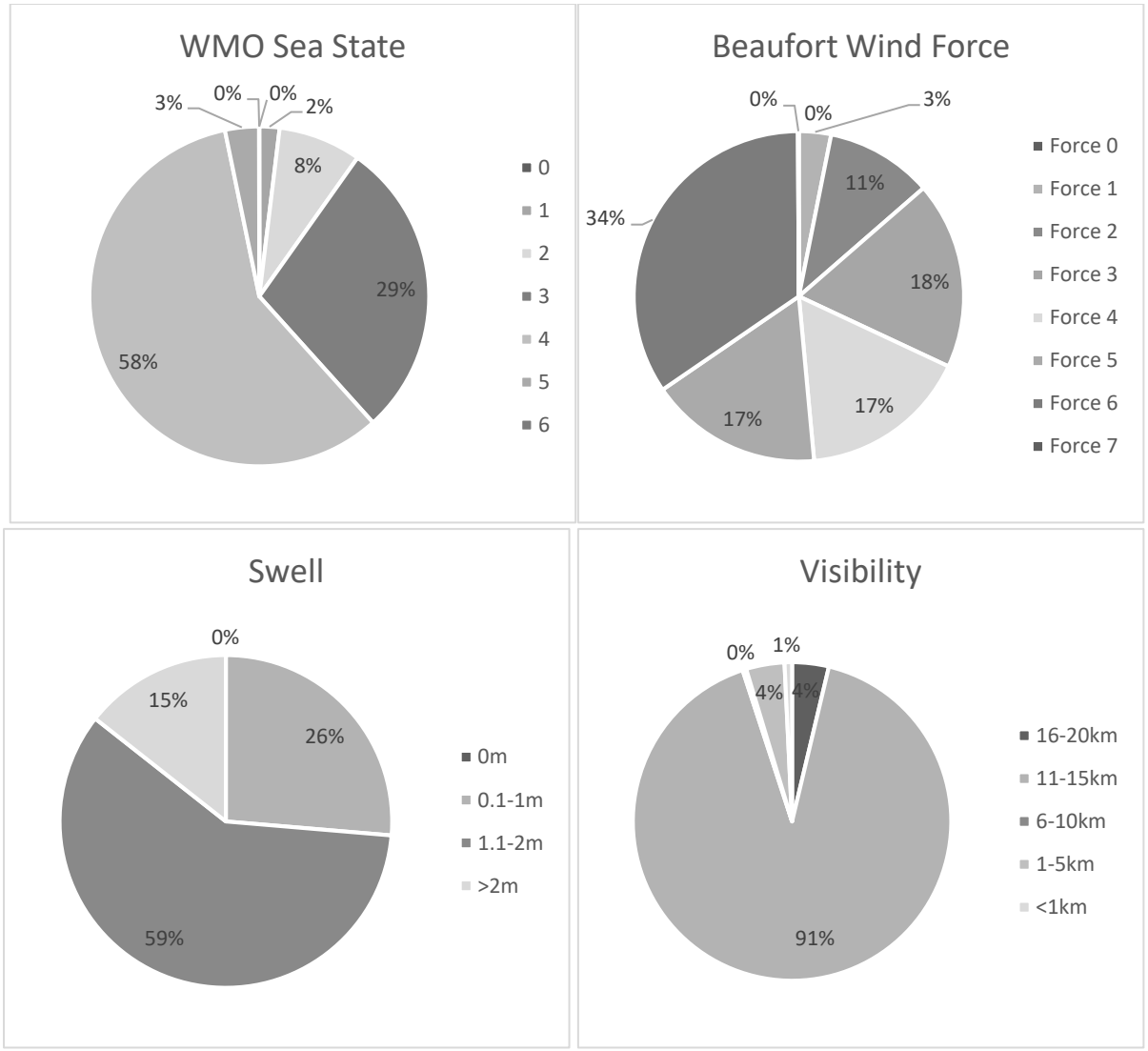

Figure 3: Summary of environmental conditions recorded on the CSHAS 2020; a) WMO sea state, b) Beaufort sea state/ wind force, c) Swell height (meters), d) Visibility (kilometres).

Sightings

A total of 3764 seabird sightings were recorded throughout the survey, totalling 35639 individuals, with flock size ranging from 1 up to 1500 for some species (*Table 2*).In total, 11624 seabirds were recorded as “in transect”, while 24012 were recorded “off transect”. 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 26 species of seabird were encountered during the survey. A further 74 sightings of terrestrial birds were also recorded, comprising of 287 individuals belonging to 19 species.

Of the 3764 sightings recorded during the survey, 3501 were recorded during line transect effort. Of the 29 seabird species recorded during the survey, 27 species were recorded during line transect survey effort. In total, 26500 seabirds were recorded during line transect effort, with 8576 of these recorded as ‘in-transect’. The remaining 17924 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 sightings of seabird species recorded during line transect survey effort can be seen in *Figures 4* to *6*.

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

Common Name	***Species name***	***No. of Sightings***	***No. of Individuals***	***Group Size***
Fulmar	*Fulmarus glacialis*	305	2068	1-600
Sooty Shearwater	*Puffinus griseus*	22	55	1-25
Manx Shearwater	*Puffinus puffinus*	25	76	1-20
Storm Petrel	*Hydrobates pelagicus*	13	34	1-11
Leach's Petrel	*Oceanodroma leucorhoa*	2	2	1
Gannet	*Morus bassanus*	1165	12690	1-800
Pomarine Skua	*Stercoratius pomarinus*	1	1	1
Arctic Skua	*Stercoratius parasiticus*	4	6	1-2
Long-tailed Skua	*Stercoratius longicaudus*	1	1	1
Great Skua	*Stercoratius skua*	60	75	1-6
Mediterranean gull	*Larus melanocephalus*	3	6	1-4
Common Gull	*Larus canus*	40	135	1-60
Little gull	*Larus minutus*	3	4	1-2
Sabine's gull	*Larus sabini*	1	1	1
Black-headed Gull	*Larus ridibundus*	6	47	1-40
Lesser Black-backed Gull	*Larus fuscus*	99	688	1-45
Herring Gull	*Larus argentatus*	43	499	1-200
Yellow-legged gull	*Larus michahellis*	3	3	1
Great Black-backed Gull	*Larus marinus*	111	310	1-25
Kittiwake	*Rissa tridactyla*	554	9594	1-1000
Gull sp.	*Laridae sp.*	3	1620	60-1500
Guillemot	*Uria aalge*	1057	4377	1-200
Razorbill	*Alea torda*	192	706	1-60
Puffin	*Fratercula arctica*	15	24	1-3
Auk sp.	*Alcidae sp.*	26	2603	1-800
Shag	*Phalacrocorax aristotelis*	7	9	1-2
Cormorant	*Phalacrocorax carbo*	1	1	1
Great Northern Diver	*Gavia immer*	1	1	1
Common scoter	*Melanitta nigra*	1	3	3
	Total	**3764**	**35639**	

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

Common Name	***Species name***	***No. of Sightings***	***No. of Seabirds***	***In Transect***	***Off Transect***
Fulmar	*Fulmarus glacialis*	279	1081	420	661
Sooty Shearwater	*Puffinus griseus*	18	51	20	31
Manx Shearwater	*Puffinus puffinus*	24	75	56	19
Storm Petrel	*Hydrobates pelagicus*	11	32	22	10
Leach's Petrel	*Oceanodroma leucorhoa*	2	2	1	1
Gannet	*Morus bassanus*	1085	9260	2328	6932
Pomarine Skua	*Stercoratius pomarinus*	1	1	1	0
Arctic Skua	*Stercoratius parasiticus*	4	6	2	4
Long-tailed Skua	*Stercoratius longicaudus*	1	1	1	0
Great Skua	*Stercoratius skua*	48	60	23	37
Mediterranean gull	*Larus melanocephalus*	3	6	6	0
Common Gull	*Larus canus*	33	61	32	29
Little gull	*Larus minutus*	1	1	1	0
Sabine's gull	*Larus sabini*	1	1	1	0
Black-headed Gull	*Larus ridibundus*	3	3	2	1
Lesser Black-backed Gull	*Larus fuscus*	81	472	132	340
Herring Gull	*Larus argentatus*	35	175	24	151
Yellow-legged gull	*Larus michahellis*	3	3	1	2
Great Black-backed Gull	*Larus marinus*	95	233	100	133
Kittiwake	*Rissa tridactyla*	508	7528	1514	6014
Gull sp.	*Laridae sp.*	3	1620	0	1620
Guillemot	*Uria aalge*	1033	3965	3170	795
Razorbill	*Alea torda*	183	627	457	170
Puffin	*Fratercula arctica*	15	24	14	10
Auk sp.	*Alcidae sp.*	24	1203	243	960
Shag	*Phalacrocorax aristotelis*	6	8	5	3
Great Northern Diver	*Gavia immer*	1	1	0	1
	Total	**3501**	**26500**	**8576**	**17924**

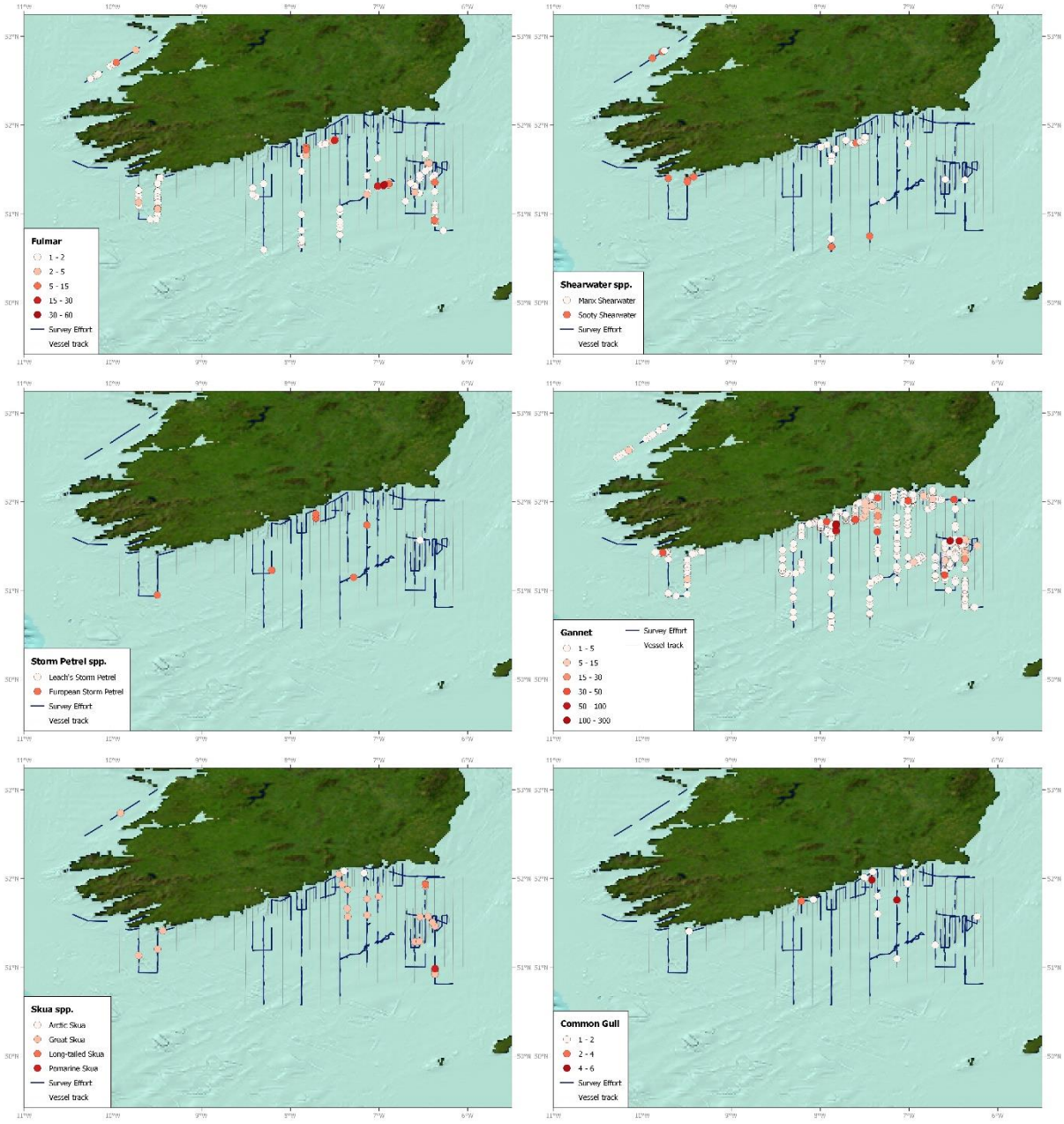

Figure 4: Distribution and abundance of seabird sightings recorded as 'In transect' during line transect effort on the survey; a) fulmar, b) shearwater spp., c) storm petrel spp., d) gannet, e) skua spp., f) common gull. Seabird survey effort transects are overlaid on the survey track line.

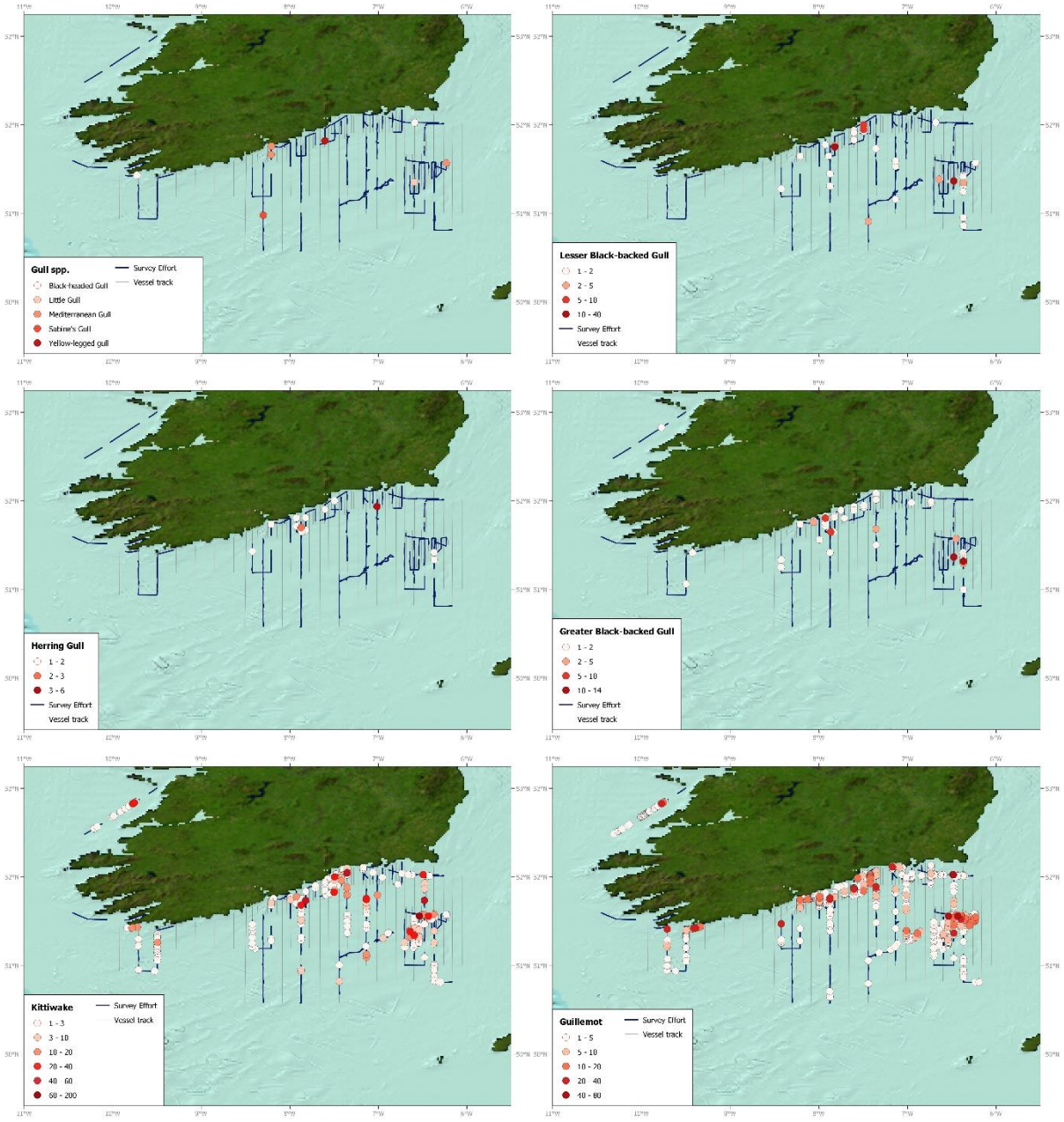

Figure 5: Distribution and abundance of seabird sightings recorded as 'In transect' during line transect effort on the survey; a) gull spp., b) lesser black-backed gull, c) herring gull, d) greater black-backed gull, e) kittiwake, f) guillemot. Seabird survey effort transects are overlaid on the survey track line.

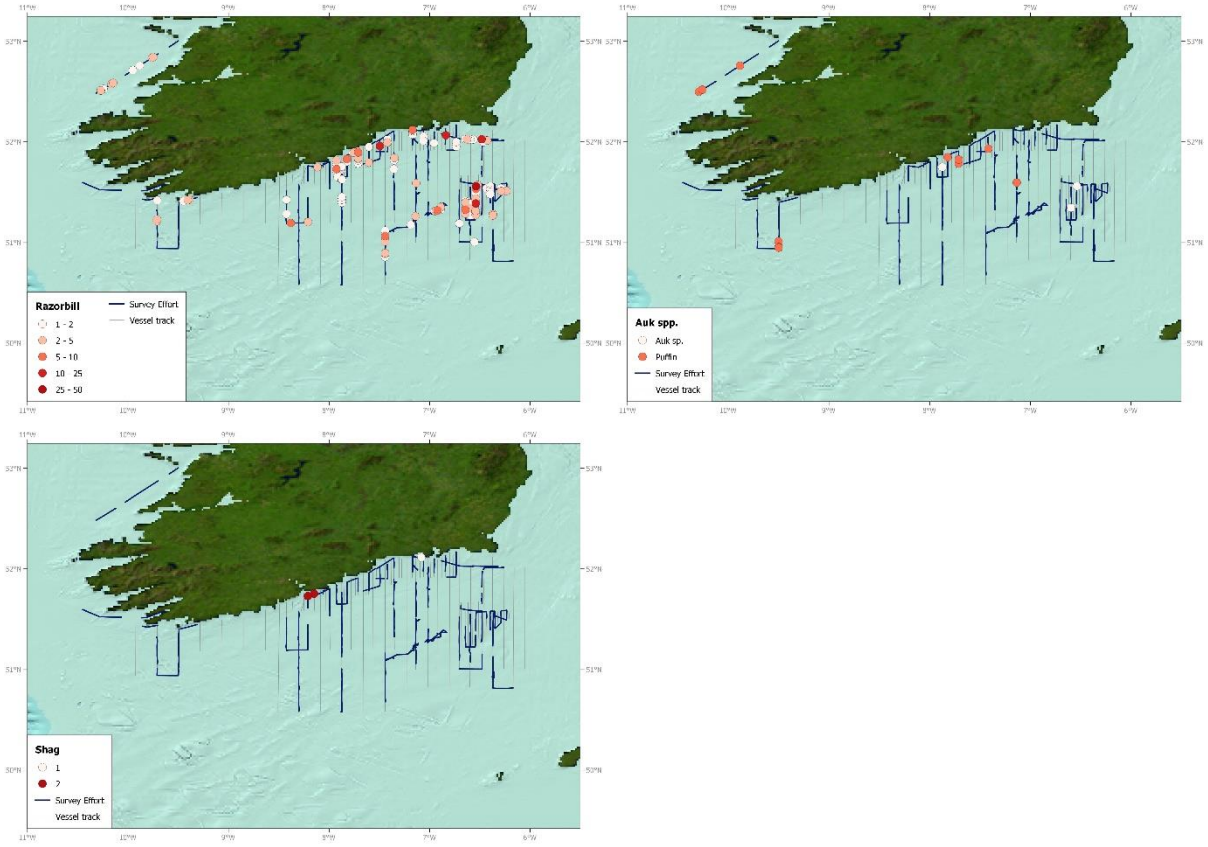

Figure 6: Distribution and abundance of seabird sightings recorded as 'In transect' during line transect effort on the survey; a) razorbill, b) auk spp., c) shag. Seabird survey effort transects are overlaid on the survey track line.

Point sampling was conducted at 20 oceanographic or fishing stations. A total of 178 sightings were recorded during point sampling effort, comprising 3816 individuals from 14 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.

Common Name	***Species name***	***No. of Sightings***	***No. of Individuals 'Off Transect'***
Fulmar	*Fulmarus glacialis*	21	82
Sooty Shearwater	*Puffinus griseus*	1	1
Manx Shearwater	*Puffinus puffinus*	1	1
Storm Petrel	*Hydrobates pelagicus*	1	1
Gannet	*Morus bassanus*	47	2012
Great Skua	*Stercoratius skua*	10	13
Common Gull	*Larus canus*	5	10
Black-headed Gull	*Larus ridibundus*	1	3
Lesser Black-backed Gull	*Larus fuscus*	17	213
Herring Gull	*Larus argentatus*	6	109
Great Black-backed Gull	*Larus marinus*	12	71
Kittiwake	*Rissa tridactyla*	38	1245
Guillemot	*Uria aalge*	11	38
Razorbill	*Alea torda*	7	17
	Total	**178**	**3816**

Fulmar

Northern fulmar (*Fulmarus glacialis*) were one of the most frequently encountered seabird species on the survey, being recorded on 305 occasions and totalling 2068 individuals. In total, 279 sightings of 1081 individuals were recorded during line transect watches, with 420 individuals recorded as 'in-transect', making fulmars the fourth most abundant species recorded during line transect effort.

Fulmar were found to be broadly distributed in low numbers across the entire survey area but were also found to display a somewhat patchy distribution with higher abundances recorded in areas such as the Smalls and Fastnet fishing grounds.

Shearwaters

Two species of shearwater were encountered on the survey; sooty shearwater (*Puffinus griseus*) and Manx shearwater (*Puffinus puffinus*). Both species were recorded during line transect survey effort and both were also recorded during point sampling watches.

Manx shearwater were recorded on 25 occasions, totalling 76 individuals. Manx shearwater were recorded on 24 occasions (75 individuals) during line transect effort with 56 individuals recorded as 'in-transect'. Sooty shearwater were recorded on 22 occasions, totalling 55 individuals. Sooty shearwater were recorded on 18 occasions (51 individuals) during line transect effort with 20 individuals recorded as 'in-transect'.

Both sooty and Manx shearwater were patchily distributed in low numbers across the Celtic sea, however, the distribution of Manx shearwater was largely clustered around fishing grounds such as Ballycotton, the Smalls and the Trench.

Storm petrels

Two species of storm petrel were recorded during the survey; European storm petrel (*Hydrobates pelagicus*) and Leach's storm petrel (*Oceanodroma leucorhoa*). The European storm petrel was recorded during both line transect and point sampling watches, while the Leach's petrel was recorded during a line transect watch.

European storm petrel were infrequently encountered on the survey, totalling 13 sightings of 34 individuals. In total, 12 sightings of 32 individuals were recorded during line transect watches, with 22 individuals recorded as 'in-transect'.

European storm petrel were also patchily distributed with all sightings recorded on the fishing grounds; Fastnet, the Rigs, the Trench and Ballycotton. The single Leach's petrel sighting was also recorded on a fishing ground; the Smalls.

Gannet

Overall, Gannet (*Morus bassanus*) were the most frequently observed seabird species on the survey, being recorded on 1165 occasions and totalling 12690 individuals. In total, 1085 sightings of 9260 individuals were recorded during line transect watches, with 2328 individuals recorded as 'in-transect', making gannet the most abundant species recorded during line transect effort.

Gannet were found to be broadly distributed in low numbers across the entire survey area, although a number of large aggregations were recorded in areas such as the Smalls and Ballycotton fishing grounds.

Skuas

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

Great skua were regularly encountered in low numbers throughout the survey (60 sightings of 75 individuals). During line transect survey effort, great skua were encountered on 48 occasions, totalling 60 individuals. Of these, 23 individuals were recorded as 'in-transect'.

Only a single individual pomarine skua and long-tailed skua were recorded during the survey, each being recorded as 'in-transect' during line transect effort. Arctic skua were recorded on 4 occasions, totalling 6 individuals, all of which were recorded during line transect effort, with 2 birds being recorded 'in-transect'.

The majority of skua records were observed towards the eastern extent of the survey area. The distribution of great skua showed some clustering around fishing grounds such as Fastnet, the Smalls and the Ballycotton.

Gulls

Ten species of gull were encountered on the survey including; Mediterranean gull (*Larus melanocephalus*), common gull (*Larus canus*), little gull (*Larus minutus*), Sabine's gull (*Larus sabini*), 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*). A number of individuals were also encountered which could not be identified to species level. All of the ten species successfully identified were recorded as 'in-transect' during line transect survey effort. Common gull, black-headed gull, lesser black backed gull, herring gull, greater black backed gull and kittiwake were also recorded during point sampling survey.

Kittiwake were the most frequently encountered gull species on the survey with a total of 9594 individuals recorded during 554 sighting events. They were also the most abundant species of gull and one of the most abundant seabird species with 7528 individuals recorded during 508 sightings while conducting line transect watches. Of these, 1514 birds were recorded as 'in-transect'.

Kittiwake were found to be broadly distributed across the entire survey area, although they were found to display a somewhat patchy distribution with particularly high abundances recorded over the some of main fishing grounds in the Celtic sea.

Although less common overall, common gull (32 birds 'in-transect), lesser black-backed gull (132 birds 'in-transect') and greater black-backed gull (100 birds 'in-transect') were regularly recorded during line transect effort in the Celtic Sea. Each of these species showed a strong association with fishing grounds, particularly Ballycotton and the Smalls.

Terns

No tern species were recorded during this year's survey.

Auks

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

Guillemot were the most frequently encountered of the auk species and the second most frequently encountered species on the survey (1057 sightings of 4377 individuals). In total, 1033 sightings of 3965 individuals were recorded during line transect watches, with 3170 individuals recorded as 'in-transect', making guillemots the most abundant species recorded during line transect effort by a large margin. Guillemot were recorded in high numbers in the inshore waters along the breadth of Ireland's Celtic sea coast. Guillemot were also recorded in high numbers in the Smalls and Celtic Deep areas but were less common in much of the remaining offshore waters.

Razorbill were the second most infrequently encountered of the auk species (192 sightings of 706 individuals). In total, 183 sightings of 627 individuals were recorded during line transect watches, with 457 individuals recorded as 'in-transect'. Although less abundant, razorbill showed a similar distribution pattern to that of the guillemot.

Puffin were less frequently encountered during the survey and were recorded during line transect effort only. In total, 15 sightings of 24 individuals were recorded during line transect watches, with 14 individuals recorded as 'in-transect'. Puffin were observed around the Ballycotton and Fastnet fishing grounds and also along the west coast of Co. Clare during transit back to Galway.

Cormorants, Divers and Scoters

Shag were recorded on 7 occasions during the survey, amounting to a total of 9 individuals. Of these, 6 records of 8 individuals were recorded during line transect effort, with 5 birds being recorded as 'in-transect'. A single cormorant (*Phalacrocorax carbo*) was encountered during the survey, however, this was recorded during a casual watch.

A single great northern diver (*Gavia immer*) was also recorded, this individual was recorded as 'in-transect' during line transect effort.

A flock of 3 common scoter (*Melanitta nigra*) was also recorded during a casual watch.

Terrestrial/ migratory birds

A number of terrestrial/ migratory birds were encountered during the survey. A total of 74 sightings of terrestrial/ migratory bird species were recorded during the survey (*Table 5*). These sightings comprised of 287 individuals from 19 species. These sightings included 24 sightings (totalling 209 individuals) of swallow (*Sturnus vulgaris*), 23 sightings (totalling 42 individuals) of meadow pipit (*Anthus pratensis*), a jack snipe (*Lymnocryptes minimus*), and a pair of gadwall (*Anas strepera*).

All terrestrial/ migratory bird species recorded during the survey were recorded as 'off transect'. The distribution of these sightings can be seen in *Figure 7.*

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

Common Name	***Species name***	***No. of Sightings***	***No. of Individuals***
Black Redstart	*Phoenicurus ochruros*	1	1
Blackbird	*Turdus merula*	1	1
Blackcap	*Sylvia atricapilia*	3	4
Chaffinch	*Fringilla coelebs*	1	1
Chiffchaff	*Phylloscopus collybita*	1	1
Gadwall	*Anas strepera*	1	2
Goldcrest	*Regulus regulus*	1	1
Goldfinch	*Carduelis carduelis*	2	7
Grey Phalarope	*Phalaropus fulicarius*	1	1
House Martin	*Delichon urbica*	1	1
Jack Snipe	*Lymnocryptes minimus*	1	1
Meadow Pipit	*Anthus pratensis*	23	42
Pied Wagtail	*Motacilla alba*	4	4
Redwing	*Turdus iliacus*	1	1
Skylark	*Alauda arvensis*	1	1
Song Thrush	*Turdus philomelos*	1	1
Starling	*Sturnus vulgaris*	5	7
Swallow	*Hirundo rustica*	24	209
Yellow Wagtail	*Motacilla flava*	1	1
Total		**74**	**287**

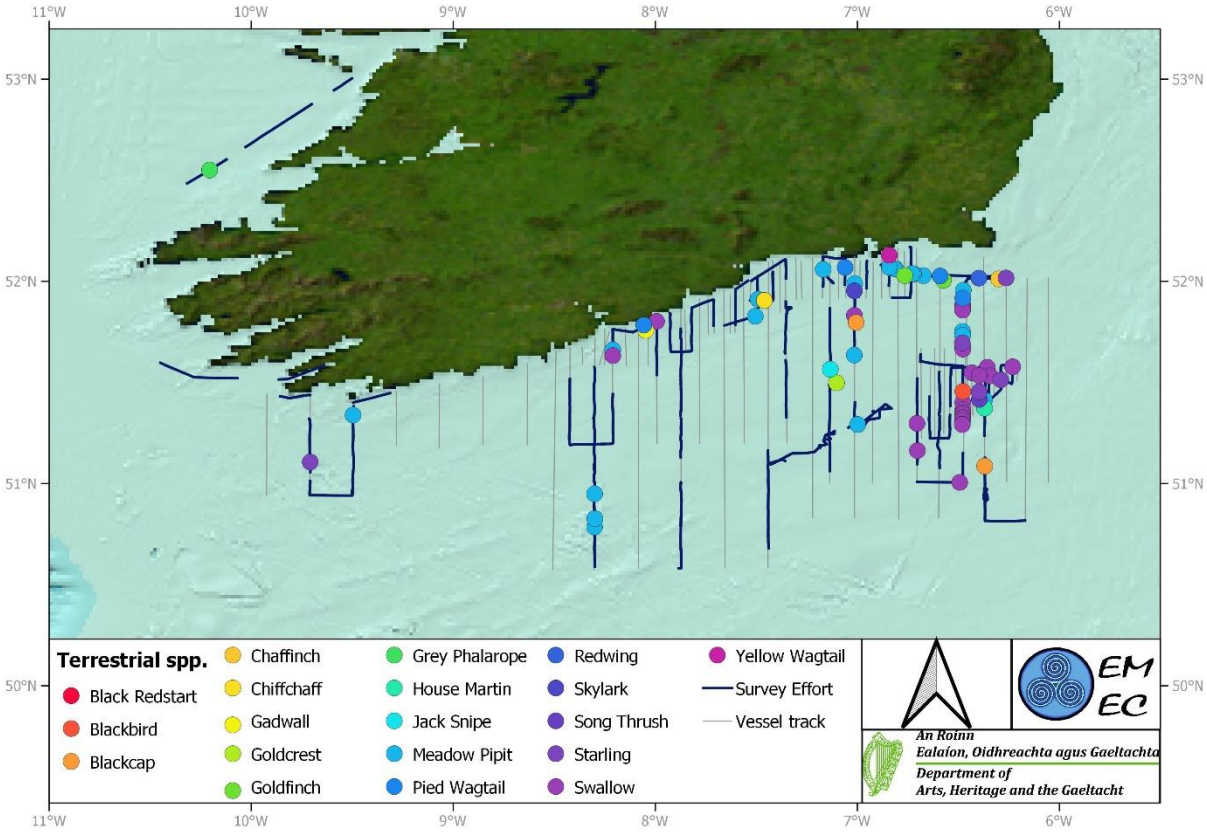

Figure 7: Distribution of terrestrial/ migratory bird sightings recorded on the survey.

Discussion

Since 2016 the Celtic Sea Herring Acoustic Survey has used an updated survey design, covering an extended area of the Celtic sea employing parallel transects spaced equally at 8 nautical miles. The survey conducts two passes of the survey area offset at 4 nautical miles, while also conducting high resolution adaptive surveys within the bounds of the main survey area. A seabird survey has been conducted each year since the updated survey design was implemented. Seabird survey effort has varied across the time series of surveys since 2016. During the present survey a total of 117 hours and 34 minutes of survey effort was conducted, very close to the total survey effort of 117 hours and 33 minutes recorded in 2019. A total of 62 hours and 31 minutes of survey effort were recorded in 2018, and 66 hours and 14 minutes of survey effort were recorded in 2017, while 73 hours and 35 minutes of survey effort were recorded in 2016.

The seabird survey during this year's CSHAS differed from recent CSHAS seabird surveys in that only a single seabird surveyor was deployed for the duration of the survey. This was due to crewing restrictions put in place as a mitigation measure against the impacts of the COVID 19 pandemic. As a result the level of data collected was affected. Survey effort was 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.

As in previous surveys, a large number of sightings, from a broad range of taxa and species groups were observed over the course of the survey. In total, 27 species of seabird and 19 species of terrestrial bird were recorded during the present survey. This is broadly consistent with the species totals from previous seabird surveys during CSHAS. In 2019, 30 species of seabird and 16 species of terrestrial bird were recorded, and in 2018, 23 species of seabird and 12 species of terrestrial bird were recorded. During the 2017 survey, 26 species of seabird and 26 species of terrestrial bird were recorded, while in 2016, 26 species of seabird and 24 species of terrestrial bird were recorded.

Despite some inter-annual variation, the overall assemblage of seabird species recorded has remained relatively consistent over the years since 2016, with no seabird species recorded in the present survey which had not been previously encountered. There has been some variance in the reported occurrence of some species however it is not possible to directly compare species abundance without further analysis. A reduction in the numbers of birds recorded was evident for a number of species when compared to last year's survey. This was particularly evident for species such as guillemot, razorbill, fulmar and great skua. In contrast, the number of gannet recorded this year were substantially higher than recorded in 2019. This level of variation between years is not uncommon on the Celtic Sea herring acoustic survey, with 2017 also showing a reduced numbers of records for a number of species when compared to the preceding or following years. This variation may be down to any number of factors including; environmental conditions, survey design, observer effects or prey distribution.

This year did see the addition of a number of terrestrial birds which had not been reported in recent previous surveys, for example; blackbird, gadwall, house martin and yellow wagtail.

Guillemot, gannet, kittiwake, razorbill and fulmar were the most abundant and widespread species' in the present survey, with guillemot 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, usually in vicinity of commercial fishing grounds. These included areas such as; the Smalls, the Trench, Ballycotton and Fastnet grounds.

The high levels of seabird activity and feeding behaviour observed in these 'hotspots' suggests abundant feeding opportunities and high prey availability for seabirds in these locations. Many of the areas noted as holding a high diversity and abundance of seabirds are within foraging range of important seabird colonies. For instance, Little Skellig has the largest population of gannets in Ireland, and the Saltee islands are also home to some of Ireland's largest kittiwake, guillemot and razorbill colonies (Cummins, *et al., 2019;* 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 important role played by the winter foraging areas utilised by the seabirds that reside there. The availability and distribution of prey are known to be vital for the breeding success, and thus long term stability, of many seabird populations (Mackey, *et al*., 2004). As such, the identification and management of key hotspots for foraging seabirds, both during the breeding and non-breeding seasons, 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 CSHAS provides an excellent opportunity for the collection of data on the autumn distribution, abundance and behaviour of seabirds in the Celtic Sea. However, the amount and quality of data collected is confounded by factors such as environmental conditions and seabird survey design. Weather conditions throughout the survey were generally moderate to poor, with high wind speeds recorded persistently. The total number of seabird survey hours was reduced on a number of occasions due to conditions exceeding the environmental parameters for surveying. Environmental conditions, particularly elevated sea states, also likely affected the detection probability of certain inconspicuous species. The use of a larger ESAS qualified 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 autumn abundance and distribution of seabirds in Ireland's Celtic Sea 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 due to COVID 19 restrictions, 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 times without suffering the ill effects of fatigue.

Acknowledgments

The seabird observer would like to thank Captain Denis Rowan, and chief scientist, Ciaran O'Donnell, along with the crew of the Celtic Explorer for their support and professional conduct during the survey.

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

Finally, the seabird observer wishes 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.

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

Cummins, S., *et al*., (2019). *The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting2013–2018. 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, (2019). *Celtic Sea Herring Acoustic Survey Cruise plan*.

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/ article172013assessmentdocument s/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., (2019). *Celtic Sea Herring Acoustic Survey Cruise Report*, *2019*. (https://oar.marine.ie/bitstream/handle/10793/1494/CSHAS%20Cruise%20Report%202019_Final.pdf?sequence=1&isAllowed=y).

O'Donnell, C., et al., (2018). *Celtic Sea Herring Acoustic Survey Cruise Report*, *2018*. (https://oar.marine.ie/bitstream/handle/10793/1385/CSHAS%20Cruise%20Report%202018.pdf).

O'Donnell, C., et al., (2017). *Celtic Sea Herring Acoustic Survey Cruise Report*, *2017*. (https://oar.marine.ie/bitstream/handle/10793/1338/CSHAS Cruise Report 2017_Final.pdf).

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).

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.

Further details available on www.emff.marine.ie

Managing Authority EMFF 2014-2020	Specified Public Beneficiary Body
Department of Agriculture Food & the Marine Clogheen, Clonakilty, Co. Cork. P85 TX47 Tel: (+)353 (0)23 885 9500 www.agriculture.gov.ie/emff	Marine Institute Rinville, Oranmore, Co. Galway, H91 R673 Phone: (+)353 (0)91 38 7200 www.marine.ie

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

Ireland's EU Structural and Investment Funds Programmes 2014 - 2020
Co-funded by the Irish Government and the European Union

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