West of Orkney Windfarm

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West of Orkney Windfarm

Offshore Ornithology Additional Information

Appendix 1 – EIA and HRA: Baseline Site Characterisation Technical Report

Date:	20 August 2024
Tel:	0141 342 5404
Web:	www.macarthurgreen.com
Address:	93 South Woodside Road |Glasgow | G20 6NT

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1 INTRODUCTION

1.1 Project summary

1. Offshore Wind Power Limited (OWPL) ('the Applicant') is proposing the development of the West of Orkney Windfarm ('the Project'), an Offshore Wind Farm (OWF), located at least 23 kilometres (km) from the north coast of Scotland and 28 km from the west coast of Hoy, Orkney (**Figure 1-1**).

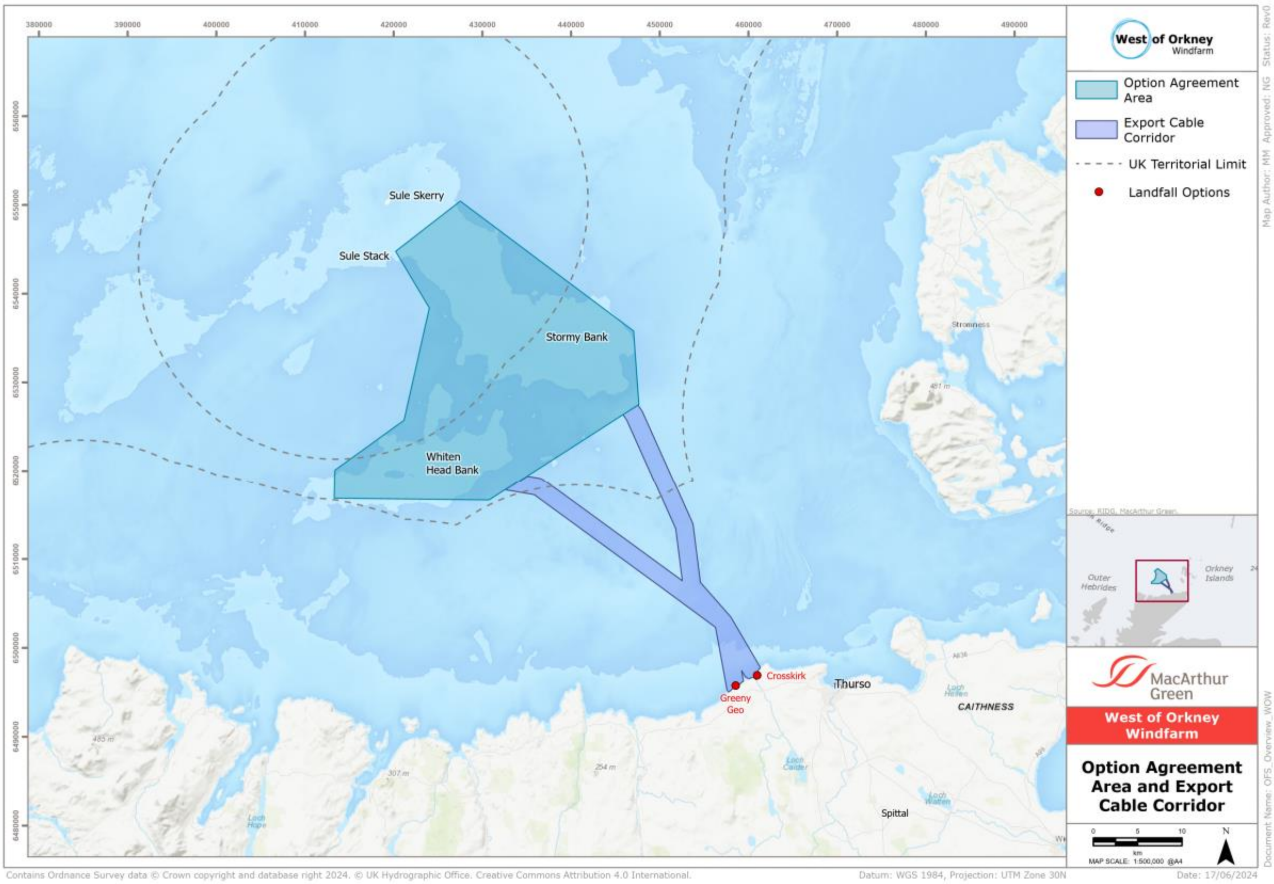

Figure 1-1. Map showing location of the West of Orkney Windfarm Option Agreement Area (OAA) and Export Cable Corridor (ECC) which together, comprise the Offshore Project Area.

2. The Offshore Project will comprise up to 125 wind turbine generators (WTGs) with fixed-bottom foundations and up to five Offshore Substation Platforms (OSPs). The area within which the WTGs, OSPs and associated infrastructure will be located is the Option Agreement Area (OAA). The OAA covers an area of 657 km^2. The export cables will be located within the Export Cable Corridor (ECC), with landfall options at Greeny Geo and/or Crosskirk in Caithness (**Figure 1-1**). The OAA and ECC together comprise the offshore Project area.

3. The Applicant submitted an application for consent under Section 36 of the Electricity Act 1989 and Marine Licences under Part 4 of the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009 to Scottish Ministers in September 2023 for the offshore components of the Project seaward of Mean High Water Springs (MHWS).

4. In accordance with relevant EIA Regulations[1], an Offshore Environmental Impact Assessment (EIA) Report was submitted to Marine Directorate – Licensing Operations Team (MD-LOT) as part of the Applicant's consent application (the 'Offshore EIA Report'). A Report to Information Appropriate Assessment (RIAA) was also submitted as part of the Offshore Application to provide the Competent Authority (MD-LOT) with the information required to assist them in undertaking an Appropriate Assessment (AA) for the offshore Project as required under the Conservation (Natural Habitats & c.) Regulations 1994 (as amended), the Conservation of Marine Habitats and Species Regulations 2017 and The Conservation of Habitats and Species Regulations 2017 (as amended) (hereafter referred to as the 'Habitats Regulations').

5. Following the review of the Applicant's application, and upon receipt of representations from consultees, MD-LOT issued a request for Additional Information on offshore ornithology. This report is part of the Ornithology Additional Information (OAI).

1.2 Relationship between the original application and the OAI

6. The Ornithology Additional Information (OAI) (see **Introduction to the Additional Ornithology Information** for structure of OAI and list of all reports) includes:

- an **Addendum to the Offshore EIA Report** in the form of a revised EIA chapter for Offshore and Intertidal Ornithology. All ornithology information in this report should be read in place of information in the original EIA chapter;
- an **Addendum to the RIAA**. All ornithology information in this report should be read in place of information in the original RIAA (with the exception of information on pre-application consultation);
- a set of nine technical appendices. This **Appendix 1 - EIA and HRA: Baseline Site Characterisation Technical Report** is one of the nine technical appendices. These reports entirely replace the original Supporting Study 12: Offshore Ornithology Technical Supporting Study.

7. NatureScot's pre- and post-application Project-specific advice and online guidance notes[2] were followed throughout the OAI. To demonstrate this, reference to NatureScot's guidance and advice is made throughout the OAI, either in the text or in separate text boxes.

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[1] *The relevant EIA Regulations include the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, the Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017, and the Marine Works (Environmental Impact Assessment) Regulations 2007.*

[2] Guidance Note 1: Guidance to support Offshore Wind Applications: Marine Ornithology - Overview | NatureScot

1.3 Purpose of this report

8. This **Appendix 1 - EIA and HRA: Baseline Site Characterisation Technical Report** provides detailed information on the marine ornithology interests in the and around the offshore Project area, providing a baseline site characterisation prior to any development in the area. This baseline ornithology information was also used to inform the EIA and HRA assessments.

9. Site characterisation was informed by 27 digital aerial surveys (DAS) that took place between July 2020 and September 2022, plus a review of other information of relevance to baseline characterisation of the area.

10. This report provides the following information:

- Numbers and maps of raw observations of all marine birds recorded during each of the 27 DAS are presented for all species;
- Mean density and abundance estimates of birds recorded more frequently in the offshore Project area;
- Mean density of birds in flight to inform collision risk modelling;
- Mean Seasonal Peak (MSP) estimates to inform predictions of displacement mortality.

11. This report includes the following Annexes:

- Annex 1A: Digital video aerial surveys of seabirds and marine mammals at West of Orkney Windfarm: 27-Month Report July 2020 to September 2022;
- Annex 1B: Design-based abundance estimates from each survey of all birds (sitting and flying);
- Annex 1C: Design-based abundance estimates from each survey of flying birds;
- Annex 1D: Design-based analysis abundance estimates from each survey of sitting birds;
- Annex 1E: Design-based analysis density estimates from each survey of all birds (sitting and flying);
- Annex 1F: Design-based density estimates from each survey recorded of flying birds;
- Annex 1G: Design-based density estimates from each survey recorded of sitting birds;
- Annex 1H: Design-based mean abundance estimates from each calendar month of all birds (sitting and flying);
- Annex 1I: Design-based mean abundance estimates from each calendar month of flying birds;
- Annex 1J: Design-based mean abundance estimates from each calendar month of sitting birds;
- Annex 1K: Design-based mean density estimates from each calendar month of all birds (sitting and flying);

- Annex 1L: Design-based mean density estimates from each calendar month of flying birds;
- Annex 1M: Design-based mean density estimates from each calendar month of sitting birds;
- Annex 1N: Number of birds present in transect segments;
- Annex 1O: MRSea model summaries and diagnostics;
- Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review;
- Annex 1Q: Rarely recorded species information;
- Annex 1R: Comparison of design- and model-based abundance estimates;
- Annex 1S: Regional population estimates.

12. It is important to note that this report is intended to describe the baseline conditions, which are those that exist in the absence of the Project (CIEEM, 2018[3]). The impact assessments, which are provided in separate reports, determine how the baseline is predicted to change, during Project construction, operation and decommissioning.

1.4 Terminology

13. The following terminology is used in this report:

- The Option Agreement Area (OAA) this is the area within which WTGs and other offshore Project infrastructure will be installed;
- The Export Cable Corridor (ECC) is the area from the OAA to the landfall site in which the export cable will be placed;
- The Offshore Project Area comprises the OAA and ECC;
- The OAA plus 2 km buffer is a 2 km wide boundary surrounding the OAA;
- The OAA plus 4 km buffer is a 4 km wide boundary surrounding the OAA;
- 'Flying birds' are birds recorded in flight from DAS; and,
- 'Sitting birds' are birds recorded sitting on the surface of the water from DAS;
- WTG: Wind Turbine Generator.

1.5 Offshore ornithology study area

14. Bird abundance and density was estimated over three spatial scales in this report:

- OAA only: this is the area within which WTGs and other offshore Project infrastructure will be installed. Densities of birds in flight in the OAA only were used in collision risk modelling;

[3] *CIEEM (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.2. Chartered Institute of Ecology and Environmental Management, Winchester.*

- OAA plus 2 km buffer: this includes a 'zone of influence' around the OAA, allowing for changes in bird behaviour (e.g. disturbance/displacement) in the vicinity of the OAA. Bird abundance in the OAA plus 2 km buffer was used to estimate displacement mortality; and
- OAA plus 4 km buffer: The area within the OAA plus a 4 km buffer was used to characterise the baseline marine ornithology interests.

15. In addition, the area over which digital aerial surveys were carried out was slightly larger than the OAA plus 4 km buffer. This was to ensure that the OAA plus 4 km buffer was fully captured during surveys. See **Annex 1: Digital video aerial survey report** for details of area covered by digital aerial surveys.

NatureScot Guidance Note 2:

Consideration of the survey design area - we advise a minimum of a 4 km buffer for both digital aerial and boat surveys, with a wider buffer of 6km for commercial scale developments, to prevent influence of edge effects at 4 km when modelling marine bird distribution across a site. However, if sensitive species such as sea ducks and divers, in particular red-throated diver, are likely to be present a buffer of 10km will be required. When developers provide interim survey results, then potential issues with sensitive species will be considered and survey design adjusted if required. The reasons for designing a survey with a buffer of less than 6 km or with non-standard coverage or flight height must be included with any design statement issued prior to commencing surveys. If a previously agreed methodology is proposed then a reference to the agreed methodology should be provided and checked that it is still suitable to rely on if older than 12 months.

16. The OAA plus 4 km buffer area was surveyed to inform characterisation of the baseline for the site. Prior to commencing DAS, NatureScot advised the Applicant that surveys should cover a minimum of a 4 km buffer around the OAA (consultation meeting, November 2018). Subsequent guidance from NatureScot (Guidance Note 2[4]) advises that a 6 km buffer should be used for commercial scale developments, but the Project's survey programme was already underway when this advice was published (January 2023).

[4] *Guidance Note 2: Guidance to support Offshore Wind Applications: Advice for Marine Ornithology Baseline Characterisation Surveys and Reporting | NatureScot.*

2 INFORMATION TO INFORM BASELINE SITE CHARACTERISATION

17. A desk-based review of existing literature and data of relevance to the Project OAA was undertaken with the aim of providing temporal and spatial context on bird density, abundance and distribution, to the new data collected by the offshore Project.

18. New data on marine bird distribution, density and abundance was collected using DAS, to inform the baseline site characterisation and EIA and HRA assessments.

2.1 Key data sources

19. A desk-based review was undertaken of existing literature and data sources that were site-specific or relevant to the Offshore Ornithology Study Area. These are summarised in **Table 2-1** below.

Table 2-1 Summary of key information resources

Information source	Description	Year	Author
Offshore Project-specific DAS data – see **Annex 1: Digital video aerial survey report**	Presents HiDef digital aerial survey data recorded in each of the 27 months. These data are presented in Annex 1A: Digital video aerial surveys of seabirds and marine mammals at West of Orkney Windfarm: 27-Month Report July 2020 to September 2022.	2020 - 2022	HiDef
Seabirds Count	Latest census of breeding seabirds in Britain and Ireland. These census data are available in the Seabird Monitoring Programme (SMP) database.	2015-2021	Burnell *et al*., 2023
Seabird Monitoring Programme (SMP) database	Counts of breeding seabirds and, for some colonies, additional information, e.g. productivity, adult return rates. Data available at: https://app.bto.org/seabirds/public/data.jsp.	2000 – 2022	Programme coordinated and managed by BTO
PFOWF Environmental Impact Assessment Report	DAS data recorded between May 2015 to April 2016 for the PFOWF. EIA report available at: https://marine.gov.scot/node/22753.	2015-2016	Highland Wind Limited
Scientific paper entitled 'Distribution maps of cetacean and seabird populations in the North-East Atlantic'	Species Distribution Model (SDM) maps showing predicted densities of seabirds (including kittiwake, puffin, guillemot, fulmar, storm-petrel, great skua, gannet and razorbill) around the British Isles. Available online at: https://besjournals.onlinelibrary.wiley.com/doi/epdf/10.1111/1365-2664.13525.	1980 - 2018	Waggitt *et al*., 2020
Orkney Islands Council report entitled 'State of the Environment Assessment: A baseline	Summarises current status, pressures, and trends of seabird populations in Orkney. Report	2020	Orkney Islands Council

Information source	Description	Year	Author
assessment of the Orkney Islands Marine Region'	available online at: https://www.orkney.gov.uk/Files/Planning/Development-and-Marine-Planning/20210107-OIC-Report-V9-screen%20v2.pdf.		
RSPB webpage entitled 'Tracking the elusive Leach's storm-petrel on St Kilda'	Track of a Leach's storm-petrel from St Kilda available online at: https://community.rspb.org.uk/ourwork/b/science/posts/tracking-the-elusive-leach-s-storm-petrel-on-st-kilda.	2021	RSPB
Scientific paper entitled 'GPS tracking reveals highly consistent use of restricted foraging areas by European Storm-petrels *Hydrobates pelagicus* breeding at the largest UK colony: implications for conservation management'	Tracks of storm-petrels from Shetland, available online at: BCI_2000037 35.52 (cambridge.org).	2014 - 2017	Bolton 2021
BirdLife International Seabird Tracking Database	Seabird tracking data. Data available online at: http://www.seabirdtracking.org/.	2004 - present	Coordinated by BirdLife International
Scottish Marine and Freshwater Science report entitled 'Short-term behavioural responses of wintering waterbirds to marine activity in Orkney and Western Isles'	Study of the responses of inshore wintering waters birds in the North Orkney Special Protection Area (SPA) and Scapa Flow SPA to vessel traffic. Data available online at: https://data.marine.gov.scot/sites/default/files//SMFS%200907.pdf.	2016/17	Jarrett *et al.*, 2018
Scientific paper entitled 'Breeding density, fine-scale tracking, and large-scale modelling reveal the regional distribution of four seabird species'	Models showing distribution of four breeding seabird species (shag, kittiwake, guillemot and razorbill) around the British Isles. Paper available at: Ecological Applications, 27(7), pp.2074-2091, available online at:https://esajournals.onlinelibrary.wiley.com/doi/10.1002/eap.1591.	2017	Wakefield *et al.*, 2017
Mapping Seabird Sensitivity to Offshore Wind Farms.	Available online at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0106366	2014 (corrected in 2017)	Bradbury *et al.*, 2017
Combining habitat modelling and hotspot analysis to reveal the location of high density	Model predictions of seabird hotspot distributions around the UK. RSPB Research Report no. 63.	2018	Cleasby *et al.*, 2018

Information source	Description	Year	Author
seabird areas across the UK. Technical Report			
Marine Scotland Science Report 04/14: Statistical Modelling of Seabird and Cetacean data: Guidance Document	Guidance document focusing on statistical issues related to improving wildlife surveys in the measurement of distribution of animals in areas of near-shore and off-shore renewable energy development. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Mackenzie-et-al-2014.pdf.	2013	Mackenzie *et al.,* 2013
UK seabird colony counts in 2023 following the 2021-22 outbreak of Highly Pathogenic Avian Influenza (HPAI)	Colony counts and other surveys to ascertain the impact of HPAI on key species and colonies	2024	Tremlett *et al.* 2024
NatureScot Scientific Advisory Committee Sub-Group on Avian Influenza Report on the H5N1 outbreak in wild birds 2020-2023	An assessment of the current and emerging impact of HPAI on wild bird populations in Scotland, noting the wider geographical and biological context of these impacts, and the emerging evidence base is developing rapidly (and constrained due to restrictions on ringing and related activities in 2022) Available online at: NatureScot Scientific Advisory Committee Sub-Group on Avian Influenza Report on the H5N1 outbreak in wild birds 2020-2023 | NatureScot	2023	NatureScot *et al.* 2023

2.2 Review of additional bird data relevant to the baseline

2.2.1 Counts of seabird colonies

20. Through the Seabird Monitoring Programme (SMP), regular monitoring of 25 species of seabird that breed regularly in Britain and Ireland has been undertaken since 1986 to the present time. In addition to the annual counts at a sample of colonies provided through the SMP, periodic breeding seabird censuses have taken place to help identify where and why changes might be happening. The last complete count, the 'Seabirds Count' was undertaken between 2015 to 2021 (Burnell *et al.*, 2023), this last count is the fourth national seabird census to take place in Britain and Ireland, previous censuses have included:

- Operation Seafarer - count data collected between 1969 to 1970 (Cramp *et al.*, 1974);
- Seabird Colony Register (SCR) Census - count data collected between 1985 to 1988 (Lloyd *et al.*, 1991); and,
- Seabird 2000 - count data collected between 1998 to 2002 (Mitchell *et al.*, 2004).

21. Data from the Seabirds Count 2015–2021 census, which highlighted trends in colony counts for breeding birds, particularly since the previous census (Seabird 2000) were collated. This focused on breeding seabird colonies in the region around the offshore Project. This is provided in each species account in **Section 4.2.** The units of counts of breeding birds for each species were as follows:

- Apparently Occupied Nests (AON): Kittiwake, black-headed gull, common gull, great black-backed gull, herring gull, lesser black-backed gull, common tern, Arctic tern and shag;
- Apparently Occupied Territories (AOT): Great skua and Arctic skua;
- Individuals (IND): Guillemot, razorbill and black guillemot;
- Apparently Occupied Burrows (AOB): Puffin; and,
- Apparently Occupied Sites (AOS): European storm-petrel, fulmar, Manx shearwater and gannet.

22. Many of these species have been affected by HPAI, which has affected their colony sizes, including some of the colonies considered in this report. Details are provided in each species account in **Section 4.2.**

2.2.2 Post-census colony counts to assess HPAI impacts

23. HPAI is known to have killed many seabirds. Gannet and great skua populations were particularly impacted but also kittiwake, guillemot, gull and tern populations. Consequently, the RSPB coordinated counts of colonies of species known to be impacted by HPAI, during 2023, to assess changes in populations since the Seabirds Count census in 2015-2021. Results of these surveys are presented in Tremlett *et al.,* (2024).

2.2.3 Regional distribution of seabirds at sea

24. Aerial and vessel survey data have been presented in a range of studies to show spatial and temporal distributions of seabirds, including the key seabird species assessed in this report, around the UK (Waggitt *et al.*, 2020; Cleasby *et al.*, 2018; Bradbury *et al.*, 2014; Wakefield *et al.*, 2017; Kober *et al.*, 2010). These data have been used to predict densities of seabirds in the north-east Atlantic (Waggitt *et al.*, 2020), predict hotspots of distribution around Orkney and Caithness (Cleasby *et al.*, 2018), map seabird sensitivity to offshore windfarms in English territorial waters (Bradbury *et al.*, 2014) and identify possible SPAs in the marine environment (Kober *et al.*, 2010). These studies have provided background information on how seabirds utilise the sea in the region surrounding the offshore Project.

2.2.4 GPS tracking of seabirds

25. Tracking of key seabird species from colonies around the offshore Project are available from the BirdLife International Seabird Tracking Database (**Table 2-1**). These data provide additional context to pattern of abundance seen in the OAA plus 4 km buffer during the course of the digital aerial survey programme. Note, tracking data were not used to identify connectivity between the OAA and SPAs designated for breeding seabirds.

2.2.4.1 *Kittiwake*

26. On the western side of Orkney, a total of four kittiwakes have been tracked using GPS from the seabird colonies on Sule Skerry in 2011 and five birds from Cape Wrath in 2014. On the eastern side of Orkney, a total of 54 birds have been tracked from the island of Muckle Skerry, and 20 birds from the island of Copinsay. Further afield, tracking kittiwakes have been undertaken from Fair Isle, Bullers of Buchan, Whinnyfold, Fowlsheugh and the Isle of May.

27. The tracks from Sule Skerry indicated some overlap with the offshore Project, but there was no overlap from other tracked colonies. The sample size from Copinsay and the Pentland Firth islands on the eastern side of Orkney is likely sufficient to understand where these birds are foraging.

2.2.4.2 *Arctic tern*

28. There were no published tracking studies of Arctic terns in the region of the offshore Project. Key Arctic tern colonies with potential connectivity to the offshore Project are those on Sule Skerry and Hoy. The largest colonies in the region are on North Ronaldsay, Papa Westray, Swona and Stroma, but as Arctic terns generally forage in coastal locations within 3 to 10 km from the colony, although there are exceptions (Eglington & Perrow, 2014), it is unlikely to be a key species in the breeding season.

2.2.4.3 *Great skua*

29. Wade *et al.* (2014) tracked seven great skuas from Hoy in 2011. There was minimal overlap between the core area used by breeding birds and the offshore Project, although following breeding failure, the core area used by this species expanded and overlapped with the offshore Project. Wade *et al.* (2014) also tracked 10 great skuas from Foula in 2011; neither breeding birds nor birds that failed to breed overlapped with the offshore Project.

2.2.4.4 *Guillemot*

30. A total of nine birds were tracked with GPS from the colonies on the island of Copinsay between 2012 and 2014 by the RSPB. However, there has been no tracking of guillemots from breeding colonies at Sule Skerry and Sule Stack, Cape Wrath, the west coast of Orkney and the north Caithness coast. These are likely to be the colonies with potential connectivity to the offshore Project. The tracks from Copinsay showed no overlap with the offshore Project.

2.2.4.5 *Razorbill*

31. The RSPB tracked a total of 33 razorbills from the island of Muckle Skerry and 14 birds from Copinsay between 2010 and 2014. Key razorbill colonies with potential connectivity to the offshore Project include those from Cape Wrath and along the north coast of Caithness. The tracks from Muckle Skerry and Copinsay showed no overlap with the offshore Project.

2.2.4.6 *Puffin*

32. There were no published tracks available for puffin from colonies around the OAA.

2.2.4.7 *Gannet*

33. A total of 15 gannets were tracked from Sule Skerry in 2011. Due to the close proximity of Sule Skerry to the OAA, gannets from Sule Skerry are likely to be the main source of birds using the offshore Project. Wakefield *et al.* (2013) showed that there was very little overlap in the

foraging areas used between different gannet colonies. These results strongly indicated that the majority of birds within the offshore Project during the breeding season are likely to be from the colony on Sule Skerry.

34. Tracking from other colonies strongly indicates no, or little, connectivity in the breeding season with other gannet colonies (see Wakefield *et al*., 2013).

2.2.4.8 *European storm-petrel*

35. Bolton (2021) tracked breeding European storm-petrels from the largest UK colony on Mousa, Shetland, during incubation and chick rearing between 2014 and 2017 using GPS tags. Tracked birds used an area to the south of Shetland and did not overlap with the offshore Project. A further nine chick-rearing birds GPS-tracked from Mousa in 2018 travelled in a similar direction but remained closer to the colony than birds tracked in previous years (Deakin *et al*., 2022).

2.2.4.9 *Leach's petrel*

36. Leach's petrels were tracked during the breeding season in 2021 on the island of St Kilda by the RSPB (RSPB unpublished data). These tracking data confirmed this species use of deep waters (>1,000 m) around the Rosemary Bank seamount that were identified as hotspots by at-sea surveys (Deakin *et al*., 2022).

2.2.4.10 *Fulmar*

37. In Orkney, a total of 72 fulmars have been tracked with geolocators from the island of Eynhallow between 2006 and 2013. On the eastern side of Orkney, fulmars have been tracked with GPS tags from the island of Muckle Skerry in the Pentland Firth including 10 birds from between 2011 and 2014 and one bird from the island of Swona in 2012; 13 birds have also been tracked from the island of Copinsay between 2010 and 2013. The tracks from these colonies show little overlap with the offshore Project.

2.3 Highly Pathogenic Avian Influenza (HPAI)

38. Birds (wild and domestic) have long been exposed to Low Pathogenicity Avian Influenza (LPAI) which causes little or no illness in affected birds. However, the current H5N1 strain of the HPAI virus is a mutated strain of avian influenza that kills a high proportion of affected wild birds. It was first recorded in North Atlantic seabirds in the UK in the summer of 2021 in great skua populations and has since affected many species of UK wild bird populations (Falchieri *et al*. 2022; NatureScot 2023; Pearce-Higgins *et al*. 2023; Tremlett *et al*. 2024). An overview of HPAI impacts on seabirds is presented in Annex 1P: Seabirds and highly pathogenic avian influenza.

39. Mortality linked to the current HPAI virus outbreak was first reported among seabirds in great skuas breeding on Scottish islands, including the Orkney Isles, in July 2021 (Banyard *et al*. 2022). The first dead great skuas were recorded just before the end of June, HPAI virus infections were confirmed on 20 July 2021, and the last casualties of that year were found in autumn 2021 (Banyard *et al*. 2022; Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review).

40. In 2022 and 2023, the HPAI virus adversely affected survival and productivity within a range of different seabird colonies across the UK (NatureScot, 2023; Tremlett *et al.*, 2024). The HPAI virus has been found to affect a range of seabird species, particularly great skua and gannet. Baseline DAS (**Section 3**) for the offshore Project were mostly undertaken prior to the widespread effects of HPAI within most seabird populations in the north of Scotland before June 2022.

41. NatureScot advised (meeting 28 May 2024) that additional qualitative contextual information on the effects of HPAI on relevant seabird breeding colonies should be provided, where counts are available. Natural England (2022) have stated that, "We expect seabird data collected prior to summer 2022 (June) to remain a valid representation of 'typical' seabird distribution and density, as this was before mass mortality events began to take place". If this advice was also applied in Scotland only the last three, or four, months of DAS data collected for the offshore Project could potentially not be representative of typical seabird distribution and density prior to HPAI impacts. The NatureScot Scientific Advisory Committee Sub-Group on Avian Influenza report (NatureScot, 2023) noted that, during the period 4th April to 11th September 2022, 20,500 dead seabirds were reported with gannets and great skuas being the most badly affected species but also guillemots, kittiwakes, terns and large gulls. Great skua were detected early on as having HPAI, whereas kittiwake and fulmar were not reported until later in the season.

42. Given that HPAI was noted in great skuas on Orkney in 2021, with the first mortalities occurring in June 2021 (Banyard *et al*. 2022), and also given the substantial mortality rate (NatureScot, 2023) and declines in great skua populations (Tremlett *et al*. 2024), it is likely that DAS of the Project OAA plus 4 km buffer in 2021 and 2022 were representative of great skua abundance and density in the presence of HPAI impacts. For other species, for which impacts were more obvious in 2022, particularly later in that breeding season (NatureScot, 2023), it is likely that the Project DAS are more representative of pre-HPAI seabird distributions, densities and abundances.

43. A recent report published by the RSPB compared UK seabird colony counts in 2023 following the 2021-22 outbreak of HPAI (Tremlett *et al.* 2024). The species included in the study were prioritised based on three criteria: conservation concern: UK responsibility, ability to detect an HPAI related impact, and feasibility of implementation. High priority species were kittiwake, herring gull sandwich tern, roseate tern, common tern, Arctic tern, great skua, guillemot and gannet; medium priority species were black-headed gull and great black-backed gull; and low priority species were lesser black-backed gull and Arctic skua. Baseline colony count data (i.e. pre-HPAI) was obtained either fully or in part from the Seabirds Count dataset, with remaining counts taken from the SMP database.

44. Tremlett *et al*. (2024) compared baseline colony population sizes with colony counts for the same species and colonies counted in 2023 (i.e. once colonies may have been impacted by HPAI). Counts were obtained for 2023 either through the annual SMP database or through additional surveys organised and undertaken by the RSPB to fill gaps in survey coverage in 2023. An overview of the change in colony sizes (baseline pre-HPAI colony size compared with 2023) for breeding seabird colonies surrounding the offshore Project for each species listed in the bullet points above is provided in **Section 4**.

45. During baseline DAS (**Section 3**), records of dead birds occurred for three species within the OAA plus 4 km buffer over the 27 surveys. A total of 31 dead gannets and one dead great skua and one fulmar were recorded. It is possible that other dead seabirds were present but not detected, or not detectable as dead birds. These three species are large and easily identified, which may explain why other species were not detected. For gannet and great skua, the number of dead birds recorded in each survey were compared with the number of birds recorded alive:

- **Figure 2-1** shows the number of individual alive and dead gannets recorded in each survey within the OAA plus 4 km buffer; dead gannets were recorded much more frequently in August and September 2022 than in any other month. Prior to October 2021, no dead birds were recorded during baseline aerial surveys. Fewer alive gannets were recorded in August and September 2022 compared with the same months in 2021 and 2020.
- **Figure 2-2** shows the number of individual alive and dead great skuas recorded in each survey within the Offshore Ornithology Survey Area; the number of skuas recorded each month was highly variable between years with no clear decline in 2022. However, data were sparse and it is difficult to reach a strong conclusion from these observations.

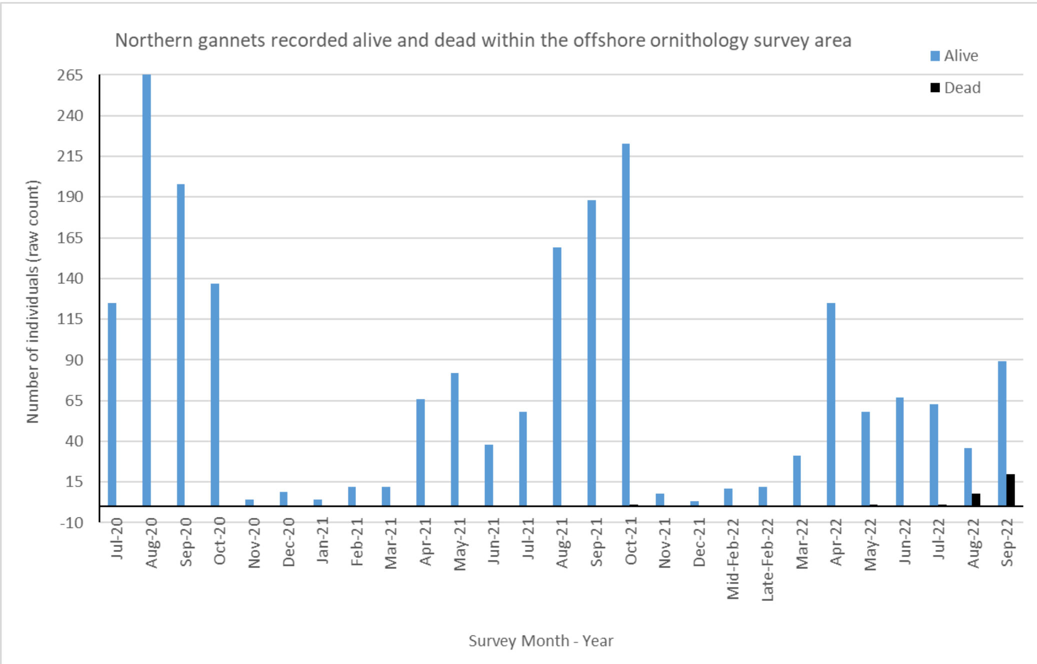

Figure 2-1 Gannet raw count data showing the number of individual alive and dead birds recorded in each survey within the OAA plus 4 km buffer.

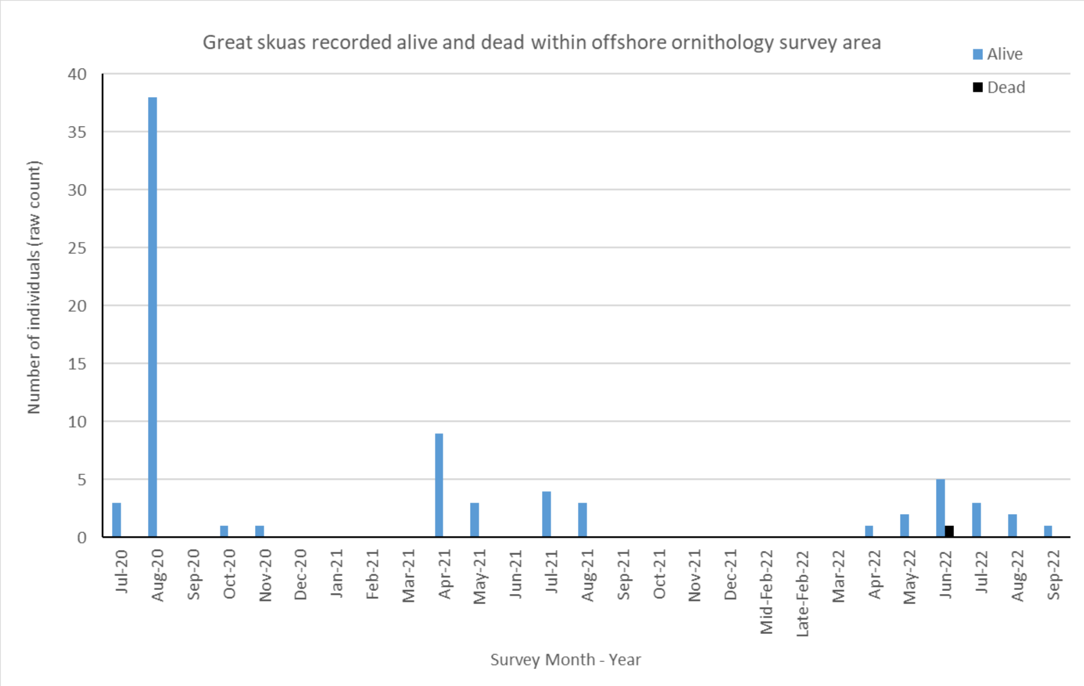

Figure 2-2 Great skua raw count data showing the number of individual alive and dead birds recorded in each survey within the OAA plus 4 km buffer.

46. HPAI impacts are discussed in more detail in the **Addendum to the RIAA** where specific consideration is given to individual SPA colonies and how HPAI may have impacted the colony.

3 ESTIMATING BIRD DENSITY AND ABUNDANCE

3.1 Digital Aerial Survey methodology

47. Dedicated digital video aerial surveys conducted by HiDef Aerial Surveying Limited (hereafter "HiDef") were deployed for ornithological and marine mammal monitoring over the OAA plus 4 km buffer (refer to **Section 3.1.1**) using methods described in Buckland *et al.* (2012), Weiß *et al.* (2016) and Webb and Nehls (2019).

48. Methods used to collect and process DAS data are summarised here in this section. Further details can be found in the Digital video aerial surveys of seabirds and marine mammals at West of Orkney Windfarm: 27-Month Report (July 2020 to September 2022) in **Annex 1A: Digital video aerial survey report.**

3.1.1 Offshore Ornithology Survey Area - Modification to the area surveyed between January to February 2021

49. Project monthly DAS were commissioned between July 2020 to September 2022, (see **Section 3** and **Annex 1A: Digital video aerial surveys report**).

50. The area that was surveyed changed slightly during the DAS programme (between January and February 2021). This was because DAS commenced in July 2020 ahead of the ScotWind leasing round which meant that the Offshore Ornithology Survey Area was defined as the expected OAA within the N1 Plan Option, rather than a refined OAA.

51. In February 2021, the area that was surveyed was modified slightly in the south-east corner to reflect the refinement of the OAA from the initial Windfarm Development Area (WDA) that had been defined based on initial constraints analysis work undertaken by OWPL. This boundary modification slightly increased the area that was surveyed; a total area of 1,290 km^2 was covered in each survey completed between July 2020 to January 2021, and a total area of 1,321 km^2 was covered in each survey completed between February 2021 to September 2021.

52. The difference between the two survey areas (31.1 km^2) is shown in **Figure 3-1;** the 'original' (green) area that was surveyed between July 2020 to January 2021, the 'updated' (yellow) area that was surveyed between February 2021 to September 2021 and the additional area surveyed between February 2021 to September 2022 is illustrated by red hatching. This change in the area was both absolutely small (31.1 km^2) as well as being a relatively very small part of the overall survey area (2.4%) or the OAA + 4km buffer (4%). Despite the refined OAA omitting an area in the west, the area was retained during the remaining surveys.

53. The OAA plus a 2 km buffer fell within both the 'original' and the 'updated' aerial survey areas. Since the impact assessments presented in the Additional Information are based on the OAA plus a 2 km buffer, the alteration to the Offshore Ornithology Survey Area after the January 2021 did not affect the data used in the impact assessment. The additional aerial survey area shown in **Figure 3-1** was only inside the OAA plus 4 km buffer, which was only used for the baseline characterisation and *not* the impact assessment.

54. The refinement of the area that was surveyed was discussed with NatureScot at a consultation meeting (18 May 2023) and a letter sent to NatureScot following this meeting to give the background to the survey area and to explain why OWPL did not consider the change in area to influence the Ornithology impact assessment (letter Ref. WO1-WOW-HSE-EV-LT-0017). NatureScot responded (by email on 5 June 2023) indicating no further information on this was required ahead of application.

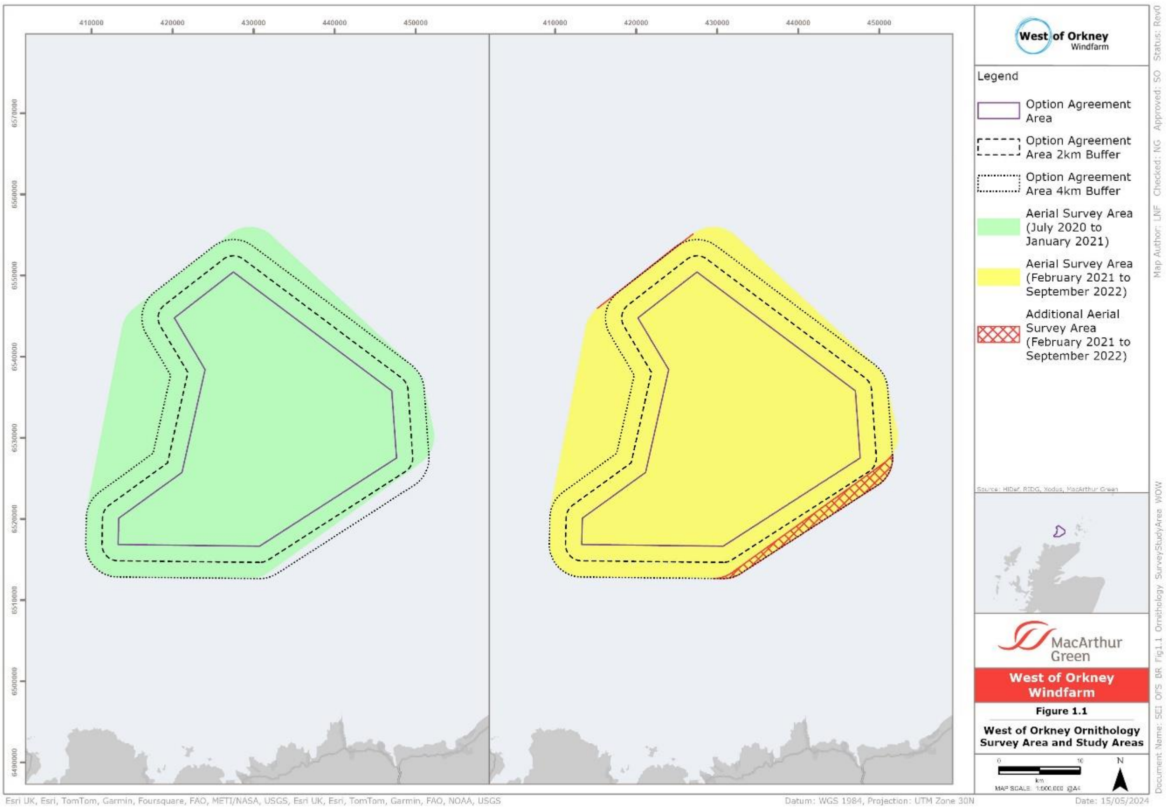

Figure 3-1 Map showing the location of the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer. The green aerial survey area covered the WDA plus a 4 km buffer and was surveyed between July 2020 to January 2021. Once the OAA was finalised, the aerial survey area was increased to ensure a 4 km buffer around the OAA was surveyed. This updated aerial survey area is indicated in yellow and was covered between February 2021 to September 2022. The hatched red area shows the additional area covered in the aerial surveys between February 2021 to September 2022 (i.e. the difference between the 'original' and 'updated' survey areas).

3.1.2 Data collection

55. Digital video aerial surveys were undertaken by HiDef using an aircraft equipped with four HiDef Gen II video cameras flown along 21 transects placed 2 km apart across the OAA and a 4 km buffer (see **Annex 1A: Digital video aerial survey report** for the location of transect lines). The transect orientation was approximately north to south, which was perpendicular to the depth contours along the coast to ensure that each transect sampled a similar range of habitats (primarily relating to water depth) and reduced the variation as much as possible in bird and mammal abundance estimates between transects.

56. Each camera captured images with a 2 cm Ground Sample Distance (GSD) and sampled a strip of 125 m wide, separated from the next camera by ~25 m, thus providing a combined sampled width of 500 m within a 575 m overall strip. The surveys were flown at a height of approximately 550 m above sea level (ASL; ~1800 feet) which eliminated the risk of flushing species that are easily disturbed by aircraft noise (Thaxter *et al.*, 2016).

57. Position data for the aircraft was captured from a Garmin GPSMap 296 receiver with differential GPS enabled to give 1 m accuracy for the positions and recording updates in location at one second intervals for later matching to bird and marine mammal observations.

58. Data from two out of the four cameras was processed to achieve a minimum target of 12.5% coverage of the site, following survey best practice. Remaining unprocessed data were archived. The survey design and coverage allowed for a robust data analysis to estimate species density and abundance.

59. The aircraft flight altitude of approximately 550 m, and other technical parameters of the adopted method conform with the recommended minimum aircraft altitude from Thaxter and Burton (2009) and updated in Thaxter *et al.* (2016).

3.1.3 Survey programme

NatureScot Guidance Note 2:

We advise that baseline characterisation should comprise two years of monthly surveys. Surveys should commence either at the start of the breeding season or the non-breeding season but not mid-way through a season, (i.e. surveys should commence in either March or October).

60. Following NatureScot advice, the DAS programme comprised monthly surveys for a period of more than two years. The survey programme started in July 2020 and ended in September 2022. Contrary to NatureScot guidance, the survey programme started mid-way through a season, due to NatureScot online guidance being published in January 2023, after the survey programme began. NatureScot advice was sought on when to use the full 27 months of survey and when to discard the first three months (July-September 2020) and restrict the dataset to the advised 24 months. NatureScot's advice on this is presented in the relevant report (i.e. Screening, Collision and Displacement Technical Appendices). In summary, following NatureScot's advice, the full 27 months of digital aerial survey was used in baseline site characterisation, HRA screening and displacement mortality estimation. The restricted dataset of 24 months (October 2020 to September 2022) was used to inform collision risk modelling.

61. The date, flight times, number of transects and survey effort (i.e. length of transects) of DAS undertaken between July 2020 and September 2022 are shown in **Table 3-1**.

Table 3-1 Survey effort and flight information for the 27 surveys of the Offshore Ornithology Survey Area

Survey ID	Date	Start time	End time	Area covered (km²)	Coverage of the site (%)
1	22/07/2020*	09:18:30.	14:31:32	160.84	12.46
2	06/08/2020*	10:58:12	14:52:53	160.76	12.45
3	24/09/2020*	09:01:48	12:45:57	160.94	12.47
4	22/10/2020*	10:12:56	13:46:45	160.73	12.45

Survey ID	Date	Start time	End time	Area covered (km²)	Coverage of the site (%)
5	28/11/2020*	11:06:12	14:42:58	160.73	12.45
6	15/12/2020*	11:08:54	14:50:01	160.88	12.46
7	04/01/2021*	10:30:52	14:35:26	160.97	12.47
8	27/02/2021	10:38:27	14:10:13	164.19	12.42
9	15/03/2021	11:12:21	14:53:14	164.69	12.46
10	21/04/2021	10:55:21	14:36:38	164.55	12.45
11	20/05/2021	10:17:29	13:51:27	164.73	12.46
12	11/06/2021	10:47:25	14:50:32	164.21	12.42
13	02/07/2021	10:24:41	14:29:39	164.43	12.44
14	30/08/2021	10:23:00	14:05:06	164.81	12.47
15	08/09/2021	10:36:16	14:05:12	164.8	12.46
16	12/10/2021	09:34:37	13:07:49	164.67	12.45
17	15/11/2021	10:25:39	14:04:33	164.41	12.47
18	28/12/2021	10:30:58	14:14:46	165.04	12.48
19	18/02/2022	09:39:59	14:12:16	164.65	12.45
20	26/02/2022	10:34:16	14:12:16	164.34	12.43
21	11/03/2022	08:55:17	12:48:16	164.62	12.45
22	14/04/2022	09:59:26	13:33:58	164.49	12.44
23	15/05/2022	10:17:59	13:46:57	164.13	12.41
24	05/06/2022	10:08:35	13:45:45	164.85	12.47
25	22/07/2022	09:09:24	12:29:05	164.48	12.45
26	17/08/2022	10:13:53	13:54:17	163.99	12.41
27	02/09/2022	11:13:32	15:15:12	162.35	12.29

*WDA (refer to **section 3.1.1**)

62. DAS were flown in almost every calendar month from July 2020 to September 2022, (**Table 3-2**). Generally, one survey was conducted each calendar month, except in January 2022 when adverse weather conditions prevented the survey taking place. Two surveys were conducted in February 2022 to account for the missing January 2022 survey.

Table 3-2 Months when DAS were conducted (X) at the offshore Project between July 2020 to September 2022. Months with no survey area indicated by a '-' and the month of two surveys by 'XX'. Shaded cells are out with the survey programme.

Month	2020	2021	2022
January	-	X	-
February	-	X	XX
March	-	X	X

Month	2020	2021	2022
April	-	X	X
May	-	X	X
June	-	X	X
July	X	X	X
August	X	X	X
September	X	X	X
October	X	X	-
November	X	X	-
December	X	X	-

3.1.4 Data review, object identification and initial processing

63. Images were viewed by trained reviewers who identified birds, other marine megafauna and all other objects in the footage. An additional 'blind' review of 20% of the raw footage was carried out as part of the QA process.

64. Birds were identified to the lowest taxonomic level possible. The approximate age and sex of each animal, as well as any behaviour (sitting on the water, flying, etc) visible from the imagery, were also recorded, where possible. Aging of birds was based on plumage characteristics and was conducted, where possible, on species which show age variation in plumage.

65. Raw data from DAS were supplied as observation logs, containing details of all objects (seabird, marine mammal, vessel, etc.) as well as latitude and longitude coordinates for each object. All data were geo-referenced, taking into account the offset from the transect line of the cameras, and compiled into a single output. All non-bird records were removed prior to analysis.

3.2 Consideration of biological seasons

NatureScot Guidance Note 2:

For interim and baseline site characterisation reports the following should be presented:
- Presentation of seasonal/monthly population estimates to allow impact assessments to be conducted on the relevant population scale (i.e. breeding, over wintering etc.) The seasons should reflect our recommended periods [see NatureScot Guidance Note 9 for breeding and non-breeding season definitions]

66. Bird abundance and distribution varies greatly throughout the year, dictated largely by season and bird biology and phenology. This report uses biologically distinct seasons, which

aid in understanding the importance of the OAA plus 4 km buffer for each species at different points during a yearly cycle.

67. Following NatureScot Guidance Note 2, this report presents density and abundance data (refer to **section 3.3**) in accordance with the breeding and non-breeding seasons presented in NatureScot 2023 Guidance Note 9[5]. These seasons are presented for each species recorded in the Offshore Ornithology Survey Area in **Table 3-3**.

68. NatureScot Short Guidance Note 9 defines breeding and non-breeding seasons as:

- Breeding season: birds are strongly associated with a nest site, including nesting, egg-laying and provisioning young.
- Non-breeding season: period of time where no breeding takes place, which may encompass birds over-wintering in an area and migration periods between breeding and wintering sites, dependent on the species.

69. NatureScot Short Guidance Note 9 defines some months as being split between the breeding and non-breeding seasons, e.g. for kittiwake, the first half of April is considered to be part of the non-breeding season and the second half of April is part of the breeding season (**Table 3-3**).

70. Almost all seabirds are migratory, meaning distributions and abundances of birds around the UK change with season. The at-sea populations of birds that breed in the UK are also supplemented by birds that have bred in other countries. Furness (2015) captured these seasonal changes in seabird populations by identifying Biologically Defined Minimum Population Scales (BDMPS) for each species. Furness (2015) identified key seasons in which seabird populations were migratory and estimated the size of the population in each season, separating out the UK component and the overseas component.

71. Density and abundance data are presented in this report for the non-breeding seasons as defined in Furness (2015). For those species where the autumn and spring passage and winter periods are defined within the non-breeding season, these BDMPS seasons are also summarised in **Table 3-3**.

Table 3-3 Species specific seasonal definitions for all species recorded during DAS, taken from NatureScot (2023, Guidance Note 9) and the BDMPS report (Furness, 2015).

Species	NatureScot (2023)		Furness (2015)		
	Breeding season	Non-breeding season	Spring migration	Autumn migration	Winter
Kittiwake	mid-April to August	September to mid-April	January to April	August to December	-

[5] *NatureScot (2020). Guidance Note 9 - Guidance to support Offshore Wind Applications: Seasonal periods for Birds in the Scottish Marine Environment. Available online at: https://www.nature.scot/doc/guidance-note-9-guidance-support-offshore-wind-applications-seasonal-periods-birds-scottish-marine.*

Species	NatureScot (2023)		Furness (2015)		
	Breeding season	Non-breeding season	Spring migration	Autumn migration	Winter
Black-headed gull[3]	April to August	September to March	-	-	-
Little gull[3]	mid-April to July[1]	August to mid-April	-	-	-
Common gull[3]	April to August	September to March	-	-	-
Great black-backed gull	April to August	September to March	September to March (single non-breeding BDMPS season)		
Herring gull	April to August	September to March	September to March (single non-breeding BDMPS season)		
Lesser black-backed gull	mid-March to August	September to mid-March[1]	March to April	August to October	November to February
Common tern	May to mid-September	mid-September to April[1]	April to May	Late July to September	-
Arctic tern	May to August	September to April[1]	Late April to May	July to early September	-
Great skua	mid-April to mid-September	mid-September to mid-April[1]	March to April	August to October	November to February
Arctic skua	May to August	September to April[1]	April to May	August to October	-
Long tailed skua[2, 3]	Not a breeding species in the UK	Not present in significant numbers	-	-	-
Little auk[2, 3]	Not a breeding species in the UK	Not present in significant numbers	-	-	-
Guillemot	April to mid-August	mid-August to March	Single non-breeding season: August to February		
Razorbill	April to mid-August	mid-August to March	January to March	August to October	November to December
Black guillemot	April to August	September to March	-	-	-
Puffin	April to mid-August	mid-August to March	Single non-breeding season: mid-August to March		

Species	NatureScot (2023)		Furness (2015)		
	Breeding season	Non-breeding season	Spring migration	Autumn migration	Winter
Red-throated diver	May to mid-September	mid-September to April	February to April	September to November	December to January
Great northern diver	Mid-May to September1	October to mid-May	-	-	-
European storm-petrel[3]	mid-May to October	November to mid-May[1]	-	-	-
Fulmar	April to mid-September	mid-September to March	December to March	September to October	November
Cory's shearwater[3]	Not a breeding species in the UK	Not present in significant numbers	-	-	-
Sooty shearwater[3]	Not a breeding species in the UK	Not present in significant numbers	-	-	-
Great shearwater[3]	Not a breeding species in the UK	Not present in significant numbers	-	-	-
Manx shearwater	April to mid-October	mid-Oct to March	Late March to May	August to early October	-
Gannet	mid-March to September	October to mid-March	December to March	September to November	-
Shag	March to September	October to February	-	-	-

1: Not present in significant numbers in Scottish marine areas.
2: Breeding and non-breeding season date range not provided in NatureScot (2023) guidance.
3: Species not included in Furness, 2015.

3.3 Methods for estimating bird density and abundance: model- vs design-based

NatureScot Guidance Note 2:

For interim and baseline site characterisation reports the following should be presented:
- Presentation and discussion of species densities and distributions for the entire study site, broken down into the development site and buffer area. Consideration should be given to potential explanatory factors around estimated density and distribution, such as water depth, distance from the coast, and attraction to fishing boats.
- Densities should be presented for birds on the water and in flight, with a combination of the two to give the mean density and overall population.

72. Density estimates of birds in flight within the OAA and abundance estimates of birds in flight and sat on the water within the OAA plus 2 and 4 km buffers were calculated from raw bird observations recorded during the baseline DAS surveys (**section 3.1).**

73. Density and abundance estimates within the OAA and the OAA plus 2 and 4 km buffers were calculated for all bird species recorded between July 2020 and September 2022 (refer to **section 4.2**).

NatureScot Guidance Note 2:

MRSea should be used for density modelling approaches and users should check GitHub for the most up to date versions. Mackenzie, et al. (2013) should be followed for presentations of outputs and model fit. However, if the number of data points for a species is less than 10, or the species are present in a uniform distribution it may not be possible to run the spatial element of MRSea. If this applies we will require this explanation to be set out for any relevant species and design based estimates can be used.

74. Two methods were used to estimate bird densities and abundances: design-based and model-based. Design-based methods extrapolate bird density estimated from observations from within the strip transects, across the OAA, OAA plus 2 km buffer, and OAA plus 4 km buffer. Model-based methods fit environmental covariates to bird observations and use these relationships to predict bird density in a grid across the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer. Each method is described in more detail below.

75. The impact assessment presented in the **Addendum to the Offshore EIA Report** and the **Addendum to the RIAA** is based on collision and displacement impacts derived from design-based density and abundance estimates.

76. The Project Applicant sought agreement from NatureScot, in a consultation meeting, that only design-based and not model-based estimates should be used in the impact assessment. This was due to the low numbers of counts of many species on many surveys meaning the models were unable to produce plausible estimates of density and abundance, particularly

when considering only birds in flight or on the water. This meant that only design-based estimates were available and no model-based estimates for many surveys. Information from multiple surveys needs to be combined to then be used in collision risk modelling and displacement matrix tables, to estimate collision and displacement mortality. Combining information from a mix of design- and model-based estimates was problematic, due to the underpinning assumptions that the estimates rely on.

77. NatureScot agreed that model-based estimates did not need to be used to inform the impact assessment in a consultation meeting (30 April 2024). However, NatureScot requested that a comparison between design-based and model-based density and abundance estimates was undertaken and presented (Consultation Meeting, 30 April 2024). A comparison of design- and model-based estimates is presented in Annex 1R: Comparison of design- and model-based abundance estimates.

78. NatureScot also agreed, in a subsequent comment to the note of the 30 April 2024 Consultation Meeting, that all model diagnostics and density surface maps could be presented in annexes to the **Appendix 1 - EIA and HRA: Baseline Site Characterisation Technical Report**, to reduce the volume of information in the main technical report. All model diagnostics and density surface maps are presented in **Annex 1O: MRSea model summaries and diagnostic**s. For the same reason, the comparison of model and design-based abundance estimates is presented in an annex (**Annex 1R: Comparison of design- and model-based abundance estimates**).

3.3.1 Design-based analysis methods

3.3.1.1 Abundance and density estimates per survey

79. Design-based densities (birds/km^2) and abundances were estimated from baseline DAS bird observations for all species recorded in each of the 27 surveys using the 'R' Project statistical program (R Development Core Team 2012[6]).

80. Density estimates for each species from each survey were calculated as the raw observation counts divided by the area surveyed. Abundance estimates were calculated as the density multiplied by the total area over which the abundance was to be estimated (e.g. the OAA or the OAA plus 2 km and OAA plus 4 km buffers). This is a simple extrapolation, that assumes similar densities were present in the un-surveyed space between transects. These calculations were conducted for the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer.

81. This method to calculate density and abundance for each species in each survey assumes that the surveyed area is representative of the un-surveyed region, thus the design of the survey is important (hence the name 'design based').

[6] R Development Core Team 2012. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/

3.3.1.2 Using a 'bootstrap' approach to estimate variance around abundance and density estimates

82. The simple extrapolation approach described above does not have any measure of uncertainty associated with it. To quantify uncertainty around density and abundance estimates, a bootstrap approach was used.

83. A non-parametric bootstrap with 1,000 iterations with resampling method was used to estimate standard deviation (SD), lower 95% bootstrap confidence intervals (lci), upper 95% bootstrap confidence intervals (uci) and coefficient of variation (CV) as follows:

- All 21 transect lines tracked during each survey were divided into 500 m segments;
- The observations for each species in each survey were resampled using a time-series bootstrap function (R library 'boot' function 'tsboot') with a blocking structure defined as 10 sequential segments along each transect, with each segment 500 m in length. Thus, a 40 km transect would comprise 8 blocks of 5 km, each block comprising 10 x 500 m segments. This approach was adopted to avoid the risk of autocorrelation between blocks and the consequent risk of underestimating variance;
- Following the bootstrap procedure, for each species a table with 27 columns (surveys) and 1,000 rows (resamples) was obtained. Each bootstrap iteration provided a re-estimated number of observations which were analysed to obtain mean abundance or density. To derive variances from the bootstrap samples, the SD, lci and uci (which are the 25^{th} and 975^{th} value in the ranked bootstraps) and the coefficient of variation (CV) were extracted to provide measures of uncertainty; and
- This resampling process was conducted separately for birds recorded in flight, sat on the water and for both birds in flight and sitting combined.

84. Abundance estimates and SD (SD calculated from 1000 bootstrap values) for all birds (flying and sitting) within the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer are presented for each species in **section 4.2**. The abundance estimates and SD as well as the lci, uci and CV calculated from 1000 bootstrap values are also presented for each species in each survey in the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer for:

- All flying and sitting birds (Annex 1B: abundance estimates from each survey recorded for all birds (sitting and flying));
- Flying birds only (Annex 1C: abundance estimates from each survey recorded for flying birds); and,
- Sitting birds only (Annex 1D: Design-based analysis abundance estimates from each survey recorded for sitting birds).
- Density estimates and SD (SD calculated from 1000 bootstrap values) for flying birds within the OAA are presented for each species in **section 4.2**, where baseline DAS survey data were sufficient. The density estimates and SD as well as the lci, uci and CV calculated from bootstrap values are also presented for each species in each survey in the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer for:

- All flying and sitting birds (Annex 1E: Design-based analysis density estimates per survey recorded for all birds (sitting and flying));
- Flying birds only (Annex 1F: Design-based analysis density estimates per survey recorded for flying birds); and,
- Sitting birds only (Annex 1G: Design-based analysis density estimates per survey recorded for sitting birds).

85. For auks (guillemot, razorbill and puffin), once density and abundance estimates had been calculated for each of the 27 months as described above, additional data analyses was carried out to apportion unidentified auks (**section 3.3.2**) and to correct for availability bias (**section 3.3.3**).

3.3.1.3 Mean density per calendar month

NatureScot Guidance Note 2:

We advise that baseline characterisation should comprise two years of monthly surveys. Surveys should commence either at the start of the breeding season or the non-breeding season but not mid-way through a season, (i.e. surveys should commence in either March or October).

NatureScot letter (27 March 2024)

We agree with the approach to only use the 24 months of data collected from the start of the 2020 non-breeding season [for assessment of collisions].

86. The DAS programme ran from July 2020 to September 2022, covering 27 months. NatureScot advise only surveying for 24 months, starting in October or March (NatureScot Guidance Note 2). NatureScot advised on and agreed to the selection of 24 months or 27 months survey data used for various purposes. **Table 3-4** summarises the datasets used at various stages of the impact assessment process.

Table 3-4. Details of the DAS data used in different stages of the assessment, with justification for the choice and evidence of NatureScot agreement with the decision.

Stage	Survey data used	Justification	Date of NatureScot advice/agreement
HRA Screening	27 months (July 2020 – September 2022)	The DAS data were used to identify species using the OAA and surrounding area to ensure SPAs with those species as qualifying features were screened in. Using the shorter 24 months of survey data risked overlooking (i.e. screening out) species that use the OAA less frequently.	Consultation Meeting 25th June 2024
Baseline site characterisation	27 months (July 2020 – September 2022)	The digital aerial survey data were used to describe the species regularly using the OAA and surrounding area, including their abundance, density and distribution. Including the full 27 months of survey data available	Consultation Meeting 25th June 2024

Stage	Survey data used	Justification	Date of NatureScot advice/agreement
		ensures the fullest picture of how seabirds use the OAA and surrounding area.	
Collision risk modelling	24 months (October 2020 – September 2022)	NatureScot advised using 24 months of survey data for collision risk modelling to ensure a consistent approach across projects.	NatureScot letter dated 27 March 2024
Displacement	27 months (July 2020 – September 2022)	NatureScot advised using the 27 months of survey data for displacement, acknowledging that this includes additional data that were not used for collision risk modelling. This was advised to allow a peak abundance estimate to be selected from complete seasons for all NatureScot and BDMPS seasons (see **Table 3-3**).	NatureScot letter dated 3 June 2024

87. Mean density estimates of birds in flight in the OAA in each calendar month are a key input into collision risk modelling which estimates the number of collisions for each calendar month (**Appendix 3 - EIA and HRA: Collision Risk Modelling Technical Report**).

88. DAS were carried out monthly over 27 months (**section 3.1.3**). However, NatureScot advised to only use data from complete seasons, starting in March or October, over a two year period, i.e. 24 months of data. Consequently, mean density estimates for each calendar month of birds in flight in the OAA were calculated using DAS data from October 2020 to September 2022. The 24 survey months were used to calculate the mean density (plus SD) of birds in flight for each of the 12 calendar months in **Appendix 3 - EIA and HRA: Collision Risk Modelling Technical Report**. In this report the densities of birds in flight were calculated for each of the 27 surveys and are presented in **Section 4.2** for each species.

89. Mean densities (plus SD) per calendar month for birds in flight, the upper and lower bootstrap confidence intervals (C.I.) and coefficient of variation (CV) values are presented in **Annex 1L: Design-based analysis mean density estimates from each calendar month of flying birds**. As additional information, SD, lci, uci and CV calculated from bootstrap values are also presented for each species in each survey in the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer for:

- All flying and sitting birds (Annex 1K: Design-based analysis mean density estimates from each calendar month recorded of all birds (sitting and flying));
- Flying birds only (Annex 1L: Design-based analysis mean density estimates from each calendar month of flying birds); and,
- Sitting birds only (Annex 1M: Design-based analysis mean density estimates from each calendar month of sitting birds).

3.3.1.4 Mean seasonal peak abundance estimates.

NatureScot Guidance Note 8 (2023):

Data should be provided in a format that allows the calculation of mean seasonal peak population estimates based on the minimum two years of baseline data. For example, for a species with a breeding season from April to July, this requires the average of the peak population estimates between April and July in year one and two. This may require the counts to originate from different months in the two years (e.g. May in the first year and June in the second year).

NatureScot Letter (3 June 2024):
Displacement – seasonal mean peak:
The DAS campaign for West of Orkney Windfarm started in July 2020, part way through the breeding season and was completed in September 2022, covering a period of 27 months. In line with guidance note 8, we advise complete (in-year) seasons are used to calculate the mean seasonal peak to ensure the peak is fully representative. We acknowledge, due to the start date of the DAS campaign, that this may require exclusion of slightly different months, depending on the species to account for species-specific breeding seasons e.g. guillemot will differ from gannet. This approach needs to be fully documented in the Additional Information assessment and we suggest that monthly values are provided during the next meeting for agreement.

90. Mean Seasonal Peak (MSP) abundance estimates per season of all birds (flying and sitting) in the OAA plus 2 km buffer are a key data input into the displacement impact assessment (**Appendix 4 - EIA and HRA: Displacement Technical Report**). Abundance estimates within the OAA, OAA plus 2 km buffer, and OAA plus 4 km buffer were used to calculate MSPs for each species in **section 4.2**.

91. Based on NatureScot Guidance Note 8[7], MSP abundance estimates were calculated as the peak abundance for each complete season, with seasonal peaks from each of the two years of survey then averaged. Following NatureScot advice (letter dated 3 June 2024), only complete seasons were used to calculate MSPs. To obtain complete seasons, aerial survey data collected in August and September 2020 were also used to calculate MSPs for some species in some seasons because these months were part of a complete season (e.g. August and September were included for the kittiwake autumn migration period, refer to **Table 4-7**).

92. For guillemot, razorbill and puffin, unidentified birds recorded in non-species-specific categories during DAS (e.g. 'auk species' or 'large auk') have been apportioned to a species based on the relative abundance ratios of identified species within the category (i.e.

[7] *NatureScot (2023). Guidance Note 8: Guidance to support Offshore Wind Applications: Marine Ornithology Advice for assessing the distributional responses, displacement and barrier effects of Marine birds. Available online at: https://www.nature.scot/doc/guidance-note-8-guidance-support-offshore-wind-applications-marine-ornithology-advice-assessing.*

guillemot, razorbill or puffin). See **section 3.3.2** for more details. Therefore, abundance estimates for these auk species used to calculate MSP included guillemots, razorbills and puffins recorded in non-species-specific categories. Guillemot, razorbill and puffin abundance estimates were also adjusted for availability bias to account for birds likely to be diving under the surface of the sea at the time of each aerial survey.

93. For all other bird species recorded during DAS, apportioning of unidentified birds and accounting for availability bias was not required. This was because there were very few records of birds, apart from auks, not identified to species (refer to **Table 4-2**).

94. Abundance estimates and MSPs are presented in **section 4.2** for each species where birds were recorded in the OAA plus 2 km buffer. Abundance estimates are colour coded to highlight different biological seasons for each species. When a month was split between breeding and non-breeding seasons, as defined in the NatureScot Guidance Note 9, it was assumed that the abundance in that month was appropriate for consideration for either season when identifying the seasonal peak.

3.3.2 Assignment of unidentified auks to species

95. For some auk observations (i.e. birds belonging to the auk family) recorded during aerial surveys, it was not possible to classify the observation to an individual species (i.e. guillemot, razorbill or puffin) and the observation was assigned as either an 'auk species' (i.e. the species was a guillemot, razorbill or puffin) or a 'large auk' (i.e. the species was either a guillemot or a razorbill).

96. The abundance and density estimates for unidentified auks were apportioned to each of the three auk species according to the ratios in which they were recorded during surveys. For example, if the relative percentages of observations of guillemot, razorbill and puffin were 60%, 30% and 10%, respectively, 10 unidentified auk observations would be classed as 6 guillemots, 3 razorbills and 1 puffin. This was conducted separately for each individual survey, since the relative proportions of each species varied across surveys.

3.3.3 Availability bias of guillemots, razorbills and puffins

97. Auks spend a proportion of their time foraging beneath the water surface and therefore a proportion of individuals present in an area will be missed during the period the survey plane passes over. Density and abundance estimates were adjusted to account for these missed individuals by multiplying the number of birds recorded on the sea (birds in flight are not adjusted) with species-specific correction factors. The adjustment rates used were 1.311 for guillemot and 1.211 for razorbill (i.e. this assumes 24% of guillemots and 17% of razorbills are underwater at any given time; Thaxter *et al*., 2013) and 1.165 for puffin (i.e. 14% of puffins were assumed to be underwater at any time; Spencer, 2012).

3.3.4 Model-based analysis method

98. Model-based analysis seeks to identify variables which explain spatial variations in observations, which can then be used to predict abundance in areas which have not been surveyed. In the context of wind farm baseline surveys, this means fitting models to the transect data and using the results to estimate abundance between transects.

99. This analysis implemented the methods outlined in (Scott-Hayward *et al.*, 2014) and (Mackenzie *et al.*, 2013), using the R package 'MRSea' (v1.4, December 2023) to construct generalised additive models with spatially adaptive one-dimensional and two-dimensional covariates.

100. Since the modelling methods require a moderately high number of observations, not all species and surveys could be successfully modelled in this manner. Modelling was conducted for each species on each survey separately but following NatureScot Guidance Note 2, modelling was only attempted for instances with at least 10 observations of a species on any given survey. Bathymetry, minimum distance to coast and seabed slope were included as one-dimensional covariates and an x-y spatial term was modelled as a two-dimensional covariate.

101. The stages for modelling were as follows: first the observations along each transect were assigned a segment ID, with segments defined as 500 m sequential lengths. Values for the one-dimensional covariates were added to the observations. An initial generalised linear model (GLM) was fitted to the data for use as the basis for subsequent steps. Next a generalised additive model (GAM) with a spatially adaptive smoothing algorithm applied to the one-dimensional covariates, was fitted to the data, with inbuilt cross-validation used to determine which variables to retain. The final stage was fitting the full two-dimensional GAM applying a smoothing algorithm to a synthetic x-y two-dimensional covariate. If any of the one-dimensional covariates were retained in the one-dimensional GAM, this was used as the basis for the two-dimensional GAM, otherwise the initial GLM was used as the model basis. The quasi-Bayesian Information Criteria (Q-BIS) was used for model selection throughout. A quasi-poisson error distribution was used throughout since initial investigations identified high levels of over-dispersion (residual deviance was much higher than degrees of freedom).

102. Modelling was conducted separately for birds in flight, on the sea and for all combined. Model coefficients were used with a continuous prediction grid of cells which extended beyond the surveyed area, for which every cell had values for the covariate values used, to generate model predicted estimates of abundance in each cell. The cell values were summed for areas of interest (OAA, OAA plus 2 km buffer, and OAA plus 4 km buffer) to provide model-based abundance and density estimates.

103. The model formulation used for each survey and species combination that met the minimum data requirements was:

response ~ s(depth) + s(distance) + s(slope) + s(x.pos, y.pos) + offset(log(segment_area_sq_km))

where:

- response is count of birds per segment (image area is (roughly 0.09 sq km);
- s(depth) is a smooth function of depth (m);
- s(distance) is a smooth function of minimum distance to shore (km);
- s(slope) is smooth function of seabed slope (degrees);
- s(x.pos, y.pos) is a two-dimensional smooth function of spatial coordinates; and

- offset(log(segment_area_sq_km)) accounts for the small amount of variation in segment area and ensures consistent counts per unit area.

104. Some models did not converge (i.e. the models failed to fit) or generated unreliable predictions with upper confidence limits approaching infinity (typically due to models being trained on small sample sizes of data that are disparate from new prediction data), resulting in unrealistically large predictions. Such outputs were omitted on the grounds of unrealistic results.

3.3.4.1 Justification for use of design-based estimates and not model-based estimates in the impact assessment

105. NatureScot advice is to use model-based approaches in MRSea (Scott-Hayward *et al.* 2021) for estimating bird abundance and distribution (NatureScot Guidance Note 2; NatureScot letter dated 27 March 2024). However, for many species, an insufficient number of individuals were recorded on a survey to allow the model-based approach to successfully describe bird distribution across the OAA plus 2 and 4 km buffer. The design-based approach, which extrapolates from the percentage of a site covered to the total area of interest and relies on very simple assumptions, is not subject to these sample size limitations and can produce an estimate of abundance from even a single observation.

106. The attraction of deriving seabird abundance estimates from model-based analysis of transect data is the ability to incorporate explanatory variables in a predictive model which can be used to interpolate to areas between transects and thereby predict abundance for un-surveyed areas. However, to successfully fit a spatial model, using methods such as MRSea, it is necessary to have enough observations, distributed across a representative range of the covariates being used, for the model coefficients to be reliably estimated and with reasonable levels of precision. This often precludes model fitting for less abundant species on many or even all surveys. There is the option to pool survey data (e.g. across surveys) for model fitting, and then use the coefficients from the pooled model to generate outputs for individual surveys. However, the pooled model will be based on merged seabird distributions collected on different occasions and if used to obtain survey level outputs these will share the same spatial pattern, differing only in the predicted relative abundances. Thus, with the exception of species present in large numbers in every month, it is highly unlikely that it will be possible to fit spatial models to every survey and species combination, and even less likely that all such models will be considered robust. It is also worth noting that the motivation for the development of MRSea, and spatial modelling more generally, is to investigate changes in spatial distributions and use statistical methods to identify explanatory factors related to such changes. The methods were not intended for producing the single survey spatial models required for baseline site characterisation and are not well suited to this task.

107. Since design-based estimates are straightforward to obtain for all survey and species combinations there may be a temptation to combine the two approaches, with model-based estimates replaced with design-based ones where the former has been unsuccessful. However, this will result in different species having different combinations of model and design-based results (e.g. both years model based, both years design based and a mixture), adding considerable complication to an assessment. While design-based extrapolation can

be easily verified, as this is just a multiplication of observations by the ratio of surveyed area to total area, there are several aspects of fitting a spatial model which can be adjusted (e.g. error distribution, knot placement, etc.) and under some circumstances the results obtained can be quite sensitive to the settings used. To be confident that model-based results are robust it would be necessary to closely examine the model outputs for each survey and agree with the methods used on each occasion. Furthermore, consideration of the results obtained from spatial models reveals that they are often very similar to those obtained from the equivalent design-based analysis, and therefore there is limited benefit from the extra complication of spatial modelling.

108. Given these considerations the Applicant discussed with NatureScot the most appropriate means for obtaining the baseline site characterisation. NatureScot agreed to the use of estimates obtained using design-based approaches for the West of Orkney Windfarm ornithology impact assessment (Consultation Meeting, 30 April 2024). NatureScot also requested that model-based estimates were presented and compared with design-based estimates. In a subsequent consultation meeting (7 May 2024), NatureScot agreed that all model-based diagnostics and density surface maps could be provided in an annex, rather than in the baseline site characterisation technical appendix. Annex 1O: MRSea model summaries and diagnostics has all the model summaries, diagnostic information and density surfaces for each species and survey for which model-based approaches produced a plausible abundance estimate. NatureScot, in their online Guidance Note 2[8], list information that should be provided to support model-based estimates. All of these can be found in Annex 1O: MRSea model summaries and diagnostics.

109. The model and design-based approaches comparison for species and surveys with a sufficient number of observations to support the model-based approach are provided in **Annex 1R: Comparison of design- and model-based abundance estimates**.

[8] *Guidance Note 2: Guidance to support Offshore Wind Applications: Advice for Marine Ornithology Baseline Characterisation Surveys and Reporting | NatureScot.*

4 RESULTS

4.1 Raw counts

111. The total number of birds recorded during the 27 surveys in the OAA plus 4 km buffer (the area used for baseline site characterisation) are presented in Table 4-1. Birds which could not be identified to species level ('unidentified') but were assigned to a broader species group are presented in **Table 4-2**. The DAS report (see **Annex 1A: Digital video aerial survey report**) presents the total number of raw observations of birds within the whole survey area (i.e. an area larger than the OAA plus 4 km buffer), across all 27 surveys.

112. For comparative purposes between survey years, all species and species groups recorded within the OAA plus 4 km buffer are presented in **Table 4-1** and **Table 4-2**, even if there was only one bird within one survey recorded. Long-tailed skua is not a listed species in **Table 4-1** because this species was only recorded outside of the OAA plus 4 km buffer.

113. Birds categorised as 'Auk species' and 'Large auk' were apportioned to individual species groups of guillemot, razorbill and puffin (as described in **section 3.3.2**). As can be seen in **Table 4-2**, very small numbers of birds were categorised into other 'unidentified' groups, therefore groups apart from 'Auk species' and 'Large auk' were not apportioned to individual species.

114. Altogether, 25,328 birds were recorded in the OAA plus 4 km buffer, across the 27 surveys. Common guillemot was the most frequently recorded species, with a total of 9,027 records. Puffin were also recorded frequently in the OAA plus 4 km buffer, with a total of 5,818 records across all 27 surveys. There were also 660 records of 'Auk species' and 'Large auk species'. Fulmar were recorded in similar numbers to puffin, with 5,485 records. Gannet and kittiwake, present in lower numbers (2,114 and 1,458 records, respectively). Other species were all recorded much less frequently (**Table 4-1**).

115. A total of 14 species were recorded in trivial numbers, i.e. fewer than 10 records across all surveys (**Table 4-1**). Among these, five species were only recorded once and a further three only twice. For all these species, details of their ecology, seasonality, and density and abundance estimates are provided in **Annex 1Q: Rarely recorded species information** and are not considered further here.

116. Leach's petrel were not recorded on any digital aerial survey, within the OAA plus 4 km buffer, nor elsewhere within the entire survey area. Whilst Leach's petrel are a qualifying feature of Sule Skerry and Sule Stack SPA, the boundary of which is 1.7 km from the OAA, the citation population for this feature is only 5 pairs. More recently, at least one individual was heard calling in flight in 2021, but the site was not fully surveyed during the Seabirds Count census (Burnell *et al.* 2023). Given that this species is thought to have undergone an 80% decline in breeding abundance since Seabird 2000, it may be that birds no longer breed on Sule Skerry and Sule Stack SPA.

Table 4-1 Raw counts of all birds (in flight and sat on the water) recorded to species level for each of the 27 DAS within the OAA plus 4 km buffer between July 2020 to September 2022.

Species	2020						2021												2022								
	July-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb	Feb	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
Guillemot	441	168	533	489	64	110	178	313	389	904	77	139	216	428	541	431	142	209	37	69	42	228	335	290	968	721	565
Puffin	322	284	26	16	1	-	1	1	-	174	52	713	348	296	357	27	-	2	-	-	-	175	762	789	705	681	86
Fulmar	173	223	434	465	247	585	361	54	179	60	32	-	44	214	134	300	262	301	203	268	364	87	37	27	69	82	280
Gannet	125	265	198	137	4	9	4	12	12	66	82	38	58	159	188	224	8	3	11	12	31	125	59	67	64	44	109
Kittiwake	37	39	2	186	30	16	15	33	205	81	10	21	17	-	20	107	16	7	16	65	231	26	17	11	237	7	6
Great black-backed gull	-	-	-	4	16	11	11	30	4	-	-	2	-	-	-	-	31	60	14	22	5	-	-	-	-	-	-
Razorbill	2	2	12	0	1	-	-	10	9	21	3	12	-	16	10	3	1	3	-	5	18	-	1	-	23	5	44
Great skua	3	38	-	1	1	-	-	-	-	9	3	-	4	3	-	-	-	-	-	-	-	1	2	6	3	2	1
European storm-petrel	-	1	11	-	-	-	-	-	-	-	-	-	-	36	5	-	-	-	-	-	-	-	-	-	-	-	-
Arctic tern	-	-	-	-	-	-	-	-	-	-	-	23	-	3	-	-	-	-	-	-	-	-	1	-	6	11	-
Herring gull	-	-	-	-	4	-	2	1	1	-	2	-	-	-	-	-	1	-	-	2	1	-	-	-	-	-	-

Species	2020						2021												2022								
	July-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb	Feb	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
Manx shearwater	-	-	1	-	-	-	-	-	-	-	-	2	-	1	-	1	-	-	-	-	-	-	-	-	3	2	2
Little auk	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	5	-	2	-	-	-	-	-	-	-	-
Arctic skua	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-
Shag	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Great northern diver	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Red-throated diver	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-
Sooty shearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-
Common tern	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black guillemot	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Lesser black-backed gull	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Little gull	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Common gull	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Species	2020						2021												2022								
	July-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb	Feb	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
Cory's shearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Black-headed gull	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Great shearwater	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

-: Aerial survey took place, but the species was not seen in the OAA plus 4 km buffer.

Table 4-2 Raw counts of birds not assigned to a species for each digital aerial survey within the OAA plus 4 km buffer between July 2020 to September 2022. Unidentified bird groups including 'Auk species' and 'Large auk' were apportioned to individual species groups of guillemot, razorbill and puffin. All other unidentified bird groups were not apportioned to individual species groups.

Species	2020						2021												2022								
	July-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb 18th -22	Feb 26th-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
Auk species	70	20	5	10	9	1	16	4	6	50	2	2	7	35	25	12	12	11	1	2	1	9	20	20	55	6	22
Fulmar / gull species	2	2	-	4	2	4	-	-	2	2	-	-	1	1	-	-	1	1	1	3	13	1	-	-	2	1	-
Auk / shearwater species	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Large auk	-	5	7	12	5	10	10	9	14	21	1	1	1	2	11	21	8	19	6	11	12	3	6	2	18	-	12
Tern / small gull	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Small gull species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Auk / small gull	-	-	-	2	-	-	-	-	1	1	-	-	-	-	-	2	2	-	-	1	1	-	-	-	4	1	-
Large auk / diver species	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Large gull species	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Small auk	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wader species	-	-	-	-	-	-	-	-	-	-	4	-	-	2	5	-	-	-	-	-	-	1	-	2	-	-	-
Arctic / common tern	-	-	-	-	-	-	-	-	-	-	-	8	1	-	-	-	-	-	-	-	-	-	-	2	6	7	-

Species	2020						2021												2022								
	July-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb 18th -22	Feb 26th-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
Skua species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Gull species	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

-: Aerial surveys took place, but no observations of the unidentified species group were recorded.

4.2 Species Accounts

117. Species accounts are presented in section 4.2.1 to section 4.2.12 for the following species:

- Black-legged kittiwake, *Rissa tridactyla*;
- Great black-backed gull, *Larus marinus*;
- Herring gull, Larus argentatus;
- Arctic tern, Sterna paradisaea;
- Great skua, Stercorarius skua;
- Common guillemot, *Uria aalge*;
- Razorbill, *Alca torda*;
- Atlantic puffin, *Fratercula arctica*;
- European storm-petrel, *Hydrobates pelagicus*;
- Northern fulmar, *Fulmarus glacialis*;
- Manx shearwater, *Puffinus puffinus*; and
- Northern gannet, *Morus bassanus*.

118. Each species account includes the following information:

- the ecology and status of the species and a comparison between the latest Seabirds Count data (refer to **section 2.2.1**) for colonies surrounding the Project and colony populations pre-HPAI (i.e. 2020/21) with during/post HPAI, i.e. 2023 (refer to **section 2.3**);
- a table illustrating species-specific seasons, where this information is available, for the breeding and non-breeding seasons (as defined in NatureScot Guidance Note 9) and for the BDMPS non-breeding seasons (spring migration, autumn migration and winter) as defined in Furness (2015);
- Figures of all raw observations recorded in each DAS survey – these observations include birds recorded inside and outside of the OAA plus 4 km buffer. Figures show the spatial distribution of all observations recorded;
- A summary table presenting the number of raw observations of birds recorded in the OAA in flight and sat on the water as well as the proportion of birds recorded in flight within the OAA. These are provided for the OAA and not the buffers as these proportions inform the assessment of potential collisions;
- A summary table comparing design-based density estimates for birds in flight, and a second table of densities of birds in flight and sat on the water, in the OAA and OAA plus 4 km buffer on each of the 27 surveys for each species. Standard deviation (S.D.) and upper and lower C.I. calculated using the 'bootstrap method' (**section 3.3.1**) are also presented. Densities of birds in flight present in the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer are presented in **Annex 1F: Design-based analysis density estimates from each survey of flying birds**. In addition, density estimates for each

species in each survey of all birds (sitting and flying), and density estimates for only birds sat on the water, in the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer, are presented in **Annex 1E: Design-based analysis density estimates from each survey of all birds (sitting and flying)** and **Annex 1G: Design-based analysis density estimates from each survey of sitting birds**, respectively**.**

- A summary table presenting design-based abundance estimates for all birds (flying and sitting) in the OAA plus 2 km buffer in each of the 27 surveys for each species where data is available. Standard deviation and upper and lower C.I. calculated using the 'bootstrap method' (**section 3.3.1**) are also presented. Abundance estimates are colour coded to highlight different biological seasons for each species. Abundance estimates are only presented for all birds (sitting and flying) within the OAA plus 2 km buffer; the reason for this, is that only abundance data for all birds in the OAA plus 2 km buffer was used in the impact assessment (for the displacement assessment, refer to **Appendix 4 - EIA and HRA: Displacement Technical Report**). For species where there were no birds (sitting or flying) recorded in the OAA plus 2 km buffer in any month, no abundance data is presented in this report, however, for additional information, abundance estimates of all birds present in the OAA plus 4 km buffer as well as the OAA alone are presented in **Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).** In addition, abundance estimates for each species in each survey for birds in flight and birds sat on the water in the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer are presented in **Annex 1C: abundance estimates per survey recorded for flying birds** and **Annex 1D: Design-based analysis abundance estimates from each survey recorded of sitting birds**, respectively;
- For each species abundance estimates from each survey are shown and an MSP abundance was calculated for each season (refer to **section 3.3.1.4**). Estimates are provided for all birds (sitting and flying) at relevant spatial scales. For all species, the abundance within the OAA plus 4 km buffer is provided to describe the baseline conditions. For those species that require displacement impacts to be assessed (see **Appendix 4 - EIA and HRA: Displacement Technical Report**) the predicted abundances and MSP values are also provided with in the OAA and OAA plus 2 km buffer; and,
- A figure comparing abundance estimates and upper and lower C.I. values recorded in each survey for all birds (sitting and flying) in the OAA plus 2 km buffer in each survey year.

119. Information regarding flight direction of each species recorded in the Offshore Ornithology Survey Area is presented in **Annex 1A: Digital video aerial survey report**.

4.2.1 Kittiwake

4.2.1.1 *Ecology and status*

120. Kittiwake is a numerous gull species which forms large colonies around the UK during the breeding season, before dispersing offshore for the rest of the year during the non-breeding season (Mitchell *et al*., 2004; Coulson, 2011). Many large colonies are located along the north and east coasts of mainland Scotland as well as around the coast of the Orkney Isles. Outside the breeding season, the kittiwake is the most pelagic of the gulls distributed across the North Atlantic Ocean, with only small numbers seen along the coastline of Britain and Ireland at this time (Wernham *et al*., 2002).

121. The kittiwake is currently a Red-listed Bird of Conservation Concern in the UK (Stanbury *et al*., 2021) and classed as Vulnerable by the IUCN (IUCN, 2024). The kittiwake population grew during the first half of the 20th century which was linked to reduced persecution (Coulson, 2011). It continued to grow between the first seabird census, Operation Seafarer (1969-70) to the second SCR Census (1985-88), which estimated the population at 447,967 and 539,645 AON, respectively (Burnell *et al*. 2023). However, the last seabird census, Seabirds Count (2015-2021), indicated that Britain and Ireland's kittiwake breeding population was the lowest ever recorded in the four seabird censuses. A kittiwake population of 241,321 AON was recorded in Seabirds Count which was a decline of 42% since Seabird 2000 (1988-2002, 418,780 AON) and 55% since the SCR Census (1985-88; Burnell *et al*. 2023). The overall decline was predominantly due to the significant decrease in the Scottish kittiwake population (57%) whose contribution to the British and Irish total fell from 68% in Seabird 2000 to 50% in Seabirds Count (Burnell *et al.* 2023). Some of the most severe declines have occurred in Orkney and Shetland where the majority of kittiwake colonies have decreased in size (Burnell *et al*. 2023).

122. Since the Seabirds Count was conducted, the HPAI virus (refer to section 2.3) is known to have impacted kittiwake abundance at some breeding colonies around the UK between 2021 to 2023 (Tremlett *et al*. 2024). Tremlett *et al.* (2024) considered kittiwake to be a high priority target species for colony counts in 2023, in part due to moderate levels of observed HPAI related mortalities in 2022. HPAI mortalities did not occur at all kittiwake colonies around the UK, and where the virus did occur, it did not impact all colonies equally. Tremlett *et al*. (2024) assessed the impact of the HPAI virus on breeding kittiwake numbers at UK SPAs. In Orkney, the largest decrease in colony size was within the Copinsay SPA (67.2 km from the OAA), where the number of breeding kittiwakes decreased from 955 AON pre-HPAI (2015 - 2021) to 296 AON in 2023, which represented a decrease of 69%. Elsewhere in Orkney, the number of breeding kittiwakes decreased by 18% at West Westray SPA (60.2 km from the OAA), but at Marwick Head SPA (35 km from the OAA), occupied nests increased by 59% between the baseline pre-HPAI years (2015 - 2021; 906 AON) to 2023 (1,439 AON). On the north coast mainland of Scotland, the number of breeding kittiwake also increased between the baseline pre-HPAI years (2015-2021) and 2023, including within the Cape Wrath SPA at 25.9 km from the OAA (191% increase) and North Caithness Cliffs SPA at 27.2 km from the OAA (41% increase; Tremlett *et al*. 2024). The Project OAA is within foraging range of all of these kittiwake colonies and so these changes in colony status could affect the numbers of kittiwakes recorded in the OAA. However, given that some colonies increased while others declined, it

is difficult to attribute any observed patterns in kittiwake numbers in the OAA to HPAI impacts at nearby colonies.

123. Kittiwakes feed on the surface of the sea and during the breeding season their diet is mainly composed of sandeels, although other small fish, such as sprat, may be taken. Foraging trips from breeding colonies typically cover tens of kilometres (Daunt *et al*. 2002; Wakefield *et al.* 2017; Trevail *et al.* 2019) with a mean maximum foraging range plus one standard deviation of 156.1 + 144.5 km, i.e. 300.6 km (Woodward *et al* 2019). Kittiwakes are particularly vulnerable to changes in sandeel availability (Frederiksen *et al*., 2005) which in turn are sensitive to changes in sea surface temperature and fishing pressure, therefore climate change and fisheries management are an important and likely cause of changes to kittiwake population size.

4.2.1.2 *Seasons*

124. Kittiwake seasons (breeding season, non-breeding season, BDMPS spring and autumn migration) are illustrated in **Table 4-3**. April is defined as being split between the breeding and non-breeding seasons for kittiwake (NatureScot Guidance Note 9).

Table 4-3 Kittiwake seasons taken from NatureScot 2023 (Guidance Note 9) and Furness (2015). Green cells are breeding months, blue cells are non-breeding months, yellow cells are spring migration and orange cells are autumn migration.

Season	Jan	Feb	Mar	Apr*	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season												
Non -breeding												
BDMPS Spring migration												
BDMPS Autumn migration												

*April is a split-month including both breeding and non-breeding seasons (NatureScot Guidance Note 9)

4.2.1.3 *Raw observations*

125. Raw observations of kittiwakes are presented for each survey in **Figure 4-1** to **Figure 4-3**. Kittiwakes were recorded within the OAA plus 4 km buffer in 26 out of 27 surveys. There was one survey (August 2021) during which kittiwakes were only recorded outside the 4 km buffer. Numbers of kittiwake observations fluctuated between surveys, with more observations recorded in early spring and late autumn months and relatively low numbers of observations recorded at other times of the year. The exception to this was July 2022 when a large number of kittiwakes were recorded in the OAA and 4 km buffer. The relatively few observations of kittiwakes in the breeding season (with the exception of July 2022) suggests that the OAA and 4 km buffer tends to be used more by birds on spring or autumn passage rather than breeding birds.

126. Kittiwakes displayed a relatively weak spatial pattern across the Offshore Ornithology Survey Area, this species was recorded scattered across the Offshore Ornithology Survey Area particularly during March/April and October which coincided with part of the spring and autumn migration seasons, respectively. The highest kittiwake activity tended to be along

the eastern edge of the OAA and to a lesser extent, on the south-western edge of the OAA, although areas of high activity varied between months. Fewer kittiwake observations were recorded in northern part of the OAA in each survey.

127. The number of raw observations of kittiwakes recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-4**. The proportion of birds in flight is only provided for the OAA as this is the spatial scale used in collision risk modelling. In most surveys, the majority of kittiwakes were recorded in flight in the OAA. Notable exceptions were the June 2021 and June 2022 surveys when the majority of kittiwakes were recorded sat on the water.

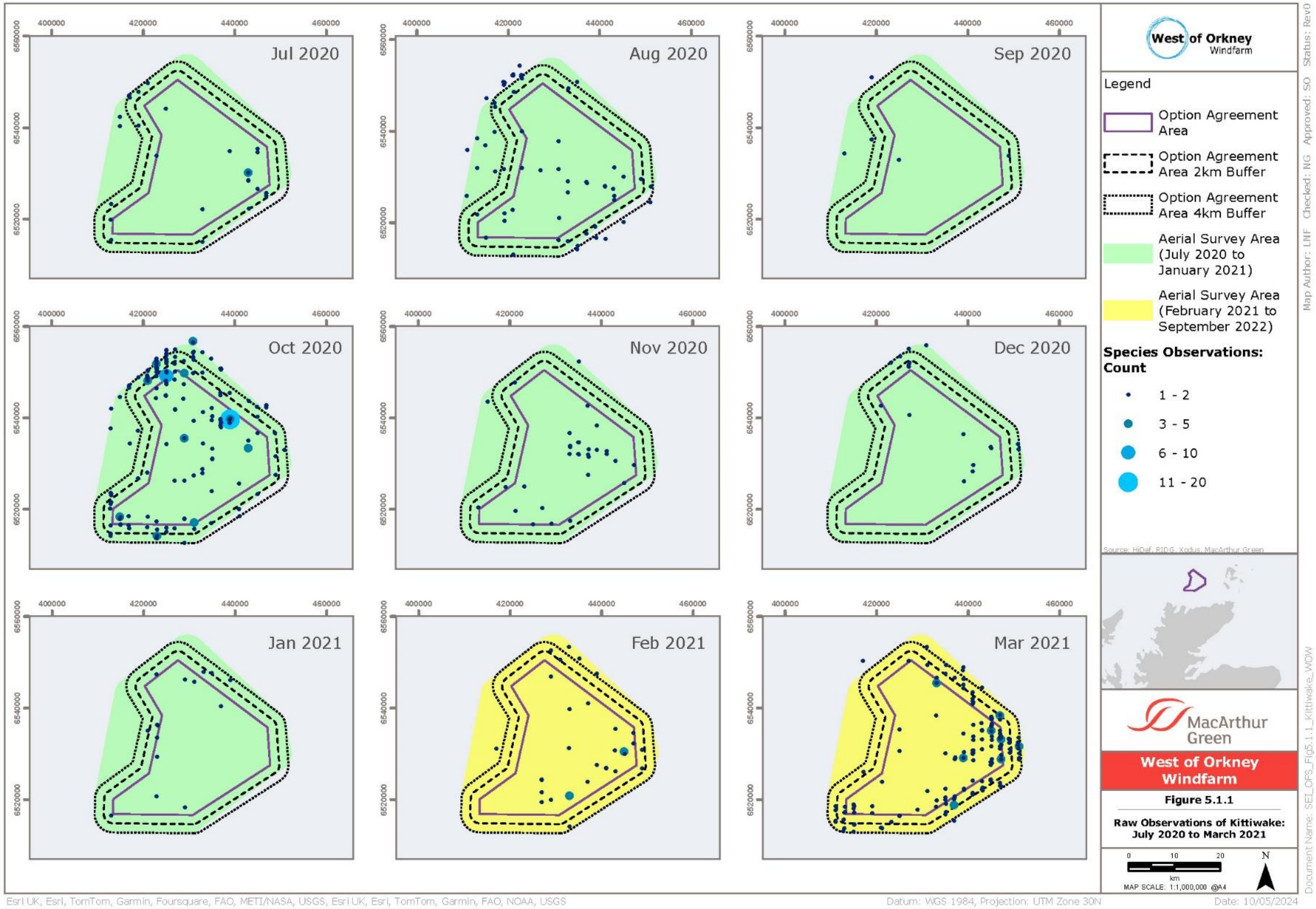

Figure 4-1 Raw observations of kittiwake: July 2020 to March 2021

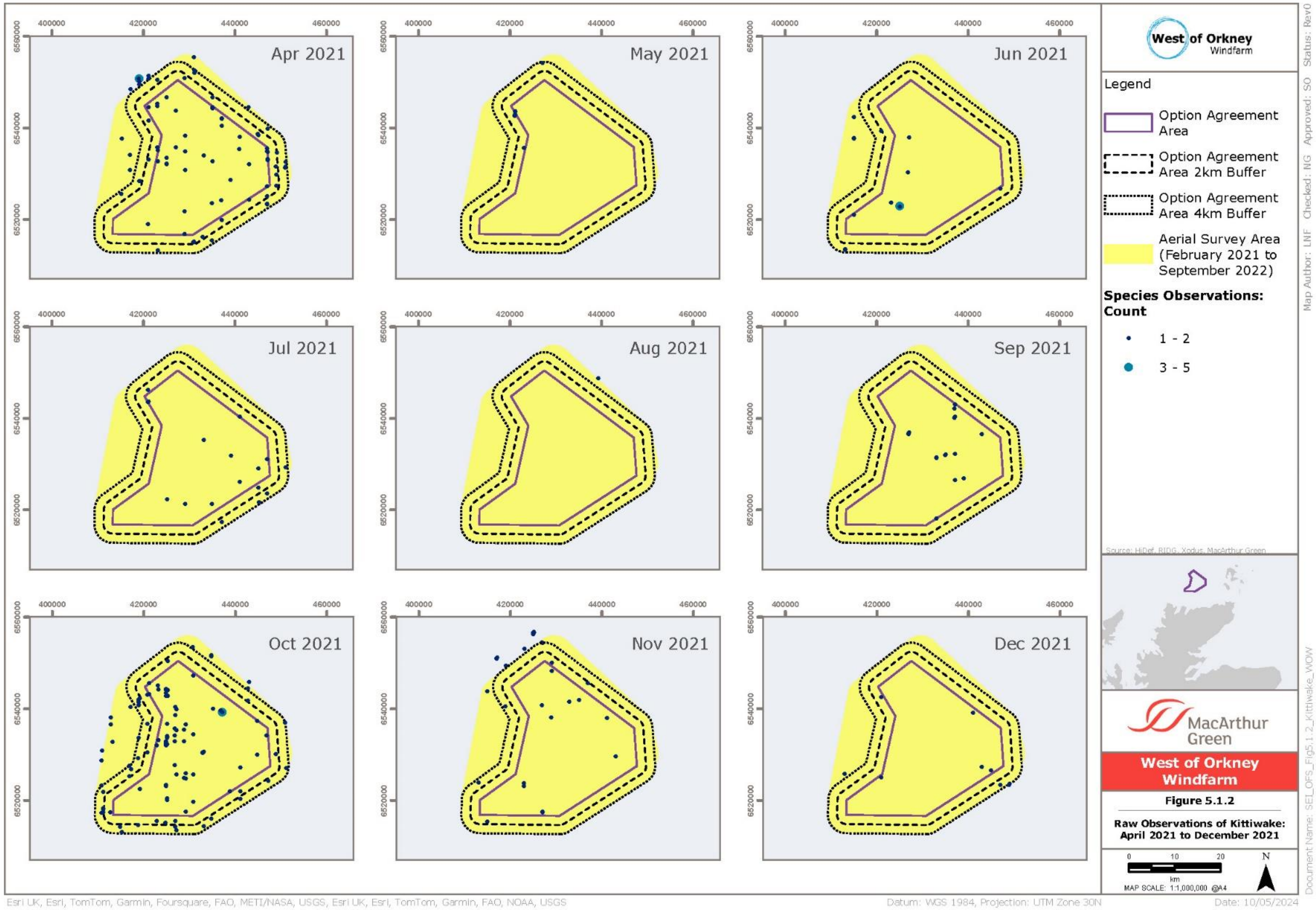

Figure 4-2 Raw observations of kittiwake: April 2021 to December 2021.

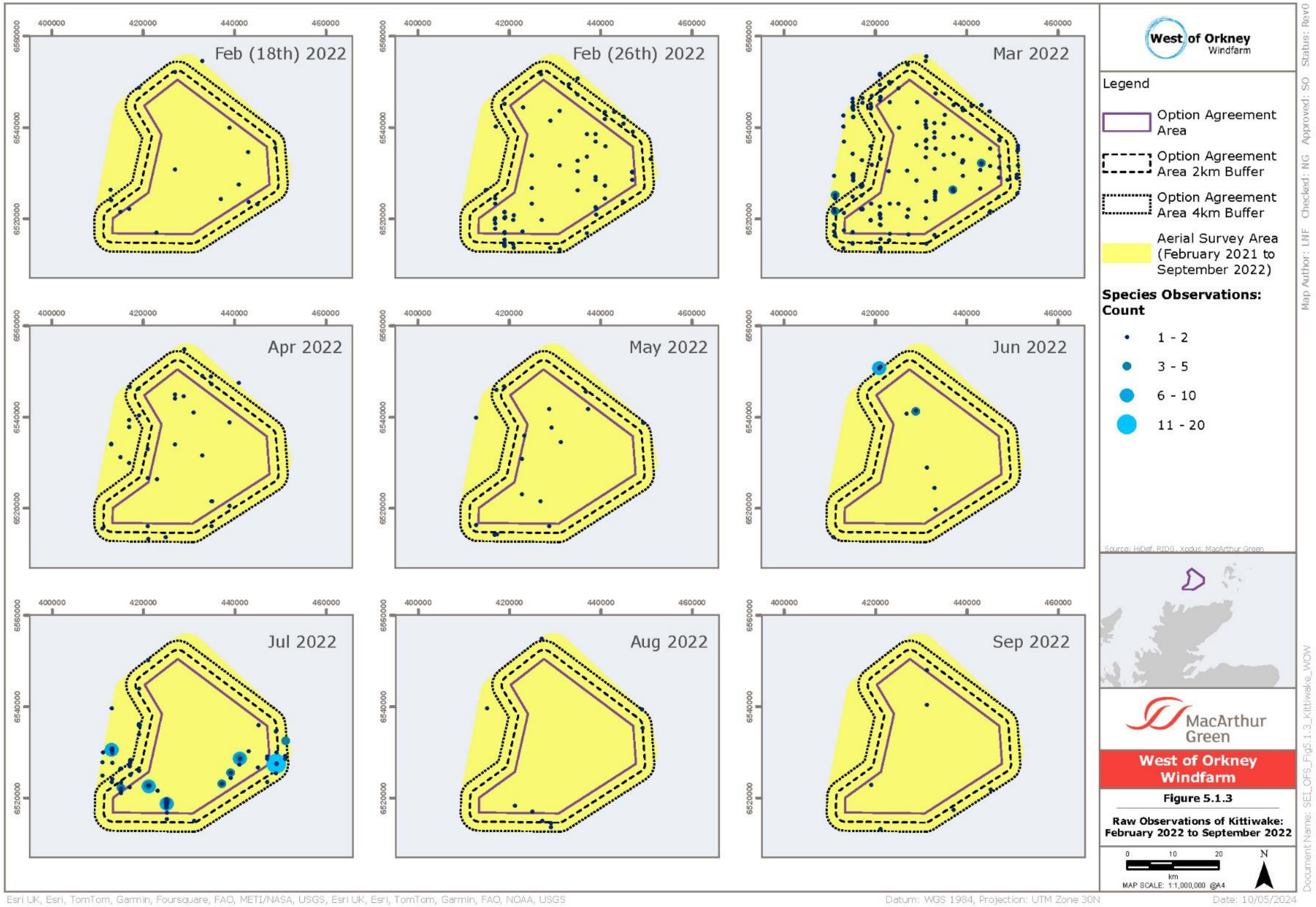

Figure 4-3 Raw observations of kittiwake: February 2022 to September 2022

Table 4-4 Kittiwake raw counts of flying birds, sitting birds and proportion of birds in flight per survey in the OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	15	8	0.65
Aug-2020	17	6	0.74
Sep-2020	1	0	1.00
Oct-2020	43	43	0.50
Nov-2020	25	0	1.00
Dec-2020	4	5	0.44
Jan-2021	6	0	1.00
Feb-2021	16	12	0.57
Mar-2021	56	53	0.51
Apr-2021	36	3	0.92
May-2021	5	0	1.00
Jun-2021	4	13	0.24
Jul-2021	10	0	1.00
Aug-2021	-	-	N/A
Sep-2021	20	0	1.00
Oct-2021	64	1	0.98
Nov-2021	11	0	1.00
Dec-2021	4	0	1.00
Feb (18)-22	7	0	1.00
Feb (26)-22	36	4	0.90
Mar-2022	91	38	0.71
Apr-2022	12	0	1.00
May-2022	8	0	1.00
Jun-2022	3	7	0.30
Jul-2022	105	71	0.60
Aug-2022	1	1	0.50
Sep-2022	1	1	0.50

4.2.1.4 Design-based density estimates

128. Design-based density estimates of kittiwakes, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and the OAA plus 4 km buffer in each survey are presented in **Table 4-5**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds**.

129. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in (**Table 4-6)** The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying)**.

130. Density estimates were relatively small. In most months densities were smaller than one bird/km^2, and never exceeded two birds/km^2. Densities greater than one bird/km^2 only occurred in two months (March and July) in one year (2022).

Table 4-5 Kittiwake density estimates, SDs & 95% C.I. derived from birds recorded only in flight in each survey within the OAA and the OAA plus 4 km buffer. Seasons are the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0.07 (0.03)	0.02-0.13	0.08 (0.03)	0.04-0.14	-	-	0.08 (0.02)	0.05-0.13	0.11 (0.03)	0.06-0.16
Feb*		-	-	0.19 (0.05)	0.11-0.29	0.42 (0.09)	0.28-0.6	-	-	0.13 (0.03)	0.08-0.19	0.38 (0.06)	0.27-0.5
Mar		-	-	0.65 (0.13)	0.4-0.91	1.08 (0.24)	0.66-1.58	-	-	0.67 (0.08)	0.52-0.84	1.09 (0.14)	0.81-1.39
Apr		-	-	0.43 (0.09)	0.26-0.6	0.14 (0.05)	0.06-0.25	-	-	0.52 (0.08)	0.38-0.68	0.17 (0.04)	0.11-0.25
May		-	-	0.06 (0.05)	0-0.18	0.09 (0.04)	0.04-0.18	-	-	0.07 (0.05)	0-0.17	0.11 (0.03)	0.05-0.17
Jun		-	-	0.05 (0.02)	0.01-0.08	0.04 (0.02)	0-0.07	-	-	0.03 (0.01)	0.01-0.06	0.03 (0.01)	0.01-0.05
Jul		0.18 (0.12)	0.02-0.46	0.12 (0.04)	0.05-0.19	1.22 (0.63)	0.19-2.57	0.17 (0.07)	0.07-0.33	0.11 (0.03)	0.07-0.17	1.01 (0.38)	0.4-1.85
Aug		0.21 (0.06)	0.11-0.33	0 (0)	0-0	0.01 (0.01)	0-0.04	0.2 (0.04)	0.12-0.28	0 (0)	0-0	0.02 (0.01)	0-0.04
Sep		0.01 (0.01)	0-0.04	0.24 (0.08)	0.09-0.41	0.01 (0.01)	0-0.04	0.01 (0.01)	0-0.02	0.13 (0.05)	0.05-0.23	0.03 (0.01)	0.01-0.06
Oct		0.51 (0.11)	0.32-0.73	0.76 (0.14)	0.51-1.04	-	-	0.74 (0.11)	0.56-0.98	0.7 (0.09)	0.53-0.9	-	-
Nov		0.27 (0.07)	0.15-0.43	0.13 (0.04)	0.05-0.21	-	-	0.19 (0.04)	0.11-0.27	0.11 (0.03)	0.06-0.17	-	-
Dec		0.05 (0.02)	0.01-0.09	0.05 (0.02)	0.01-0.09	-	-	0.07 (0.02)	0.03-0.11	0.05 (0.02)	0.02-0.08	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-6 Kittiwake density estimates, SDs & 95% C.I. derived from birds recorded in flight and on the sea in each survey within the OAA and the OAA plus 4 km buffer. Seasons are the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0.07 (0.03)	0.02-0.12	0.08 (0.03)	0.04-0.14	-	-	0.1 (0.02)	0.05-0.15	0.11 (0.03)	0.05-0.16
Feb*		-	-	0.33 (0.08)	0.18-0.51	0.47 (0.1)	0.28-0.68	-	-	0.22 (0.05)	0.13-0.31	0.44 (0.07)	0.31-0.58
Mar		-	-	1.29 (0.28)	0.77-1.85	1.52 (0.33)	0.92-2.22	-	-	1.37 (0.16)	1.06-1.69	1.55 (0.21)	1.17-1.98
Apr		-	-	0.46 (0.09)	0.3-0.65	0.14 (0.05)	0.06-0.24	-	-	0.54 (0.08)	0.4-0.7	0.17 (0.03)	0.11-0.24
May		-	-	0.06 (0.06)	0-0.18	0.09 (0.04)	0.04-0.17	-	-	0.07 (0.05)	0-0.17	0.11 (0.03)	0.06-0.17
Jun		-	-	0.2 (0.12)	0.02-0.48	0.12 (0.07)	0.02-0.27	-	-	0.14 (0.08)	0.03-0.31	0.07 (0.04)	0.02-0.17
Jul		0.28 (0.18)	0.04-0.68	0.12 (0.04)	0.05-0.19	2.13 (0.9)	0.58-4.06	0.26 (0.1)	0.1-0.49	0.11 (0.03)	0.07-0.17	1.62 (0.55)	0.68-2.8
Aug		0.28 (0.07)	0.16-0.42	0 (0)	0-0	0.02 (0.02)	0-0.06	0.27 (0.05)	0.18-0.36	0 (0)	0-0	0.05 (0.02)	0.01-0.09
Sep		0.01 (0.01)	0-0.04	0.24 (0.08)	0.09-0.42	0.02 (0.02)	0-0.06	0.01 (0.01)	0-0.03	0.13 (0.05)	0.05-0.23	0.04 (0.01)	0.01-0.07
Oct		1.02 (0.25)	0.57-1.56	0.77 (0.15)	0.48-1.08	-	-	1.25 (0.22)	0.9-1.75	0.72 (0.1)	0.52-0.92	-	-
Nov		0.3 (0.07)	0.15-0.44	0.13 (0.04)	0.06-0.22	-	-	0.2 (0.04)	0.13-0.29	0.11 (0.03)	0.05-0.16	-	-
Dec		0.11 (0.05)	0.02-0.2	0.05 (0.02)	0.01-0.09	-	-	0.11 (0.03)	0.05-0.17	0.05 (0.02)	0.02-0.07	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.1.5 *Design-based abundance estimates*

131. Design-based abundance estimates of kittiwake, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 4 km buffer in each survey are presented for each season in **Table 4-7**. This provides contextual information on the overall abundance of kittiwakes in the OAA and surrounding waters. This information for the OAA and OAA plus 2 km buffer, which are used in the assessment of displacement impacts, are shown in **Table 4-8**. The bootstrap means and CV values for these abundance estimates are presented in **Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying)**.

132. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-4.** Generally, abundance estimates were similar between corresponding months in each survey year as indicated by the overlapping confidence intervals. One exception was the abundance for July 2022 which was higher than the abundances in July in 2020 and 2021, which were similar to each other. These data indicate that abundance estimates of kittiwakes in the offshore Project were not strongly affected by HPAI in 2022 (Tremlett *et al*. 2024). The abundance of kittiwakes was a little higher in 2022 compared with pre-HPAI years (2020 and 2021), perhaps as a result of birds leaving their colonies. The colonies surrounding the OAA, on the north mainland coast and on Orkney, showed varying population trends in 2023, compared with counts undertaken pre-HPAI (see section 4.2.1.1).

133. Kittiwake MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-7** and **Table 4-8** for the OAA, OAA plus 2 km buffer and OAA plus 4 km buffer. The highest MSP abundance in the OAA plus 2 km buffer (1216.78 birds) was recorded in the non-breeding season, including the BDMPS spring migration period. The breeding season MSP abundance estimate in the OAA plus 2 km buffer was slightly lower (1112.72 birds), with the lowest estimate recorded in the BDMPS autumn migration period (798.66 birds).

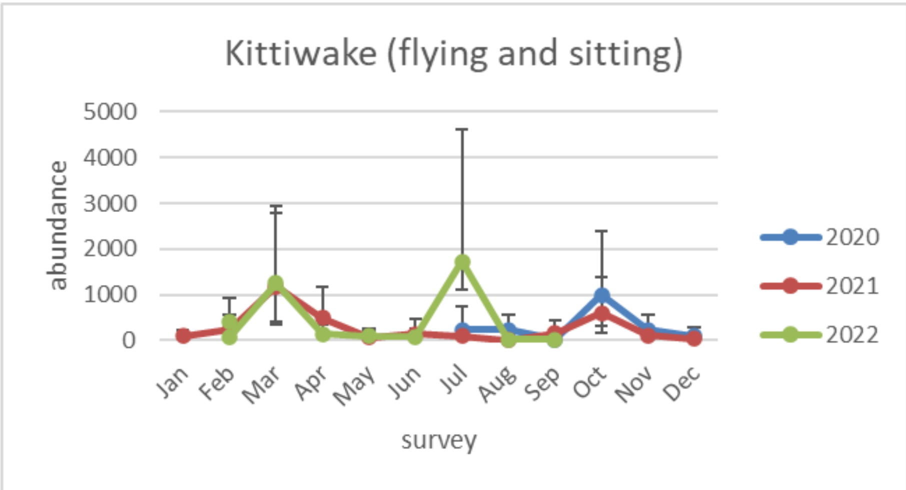

Figure 4-4 Estimated abundance and 95% C.I. of all kittiwakes (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis

Table 4-7 Kittiwake abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

			Peak seasonal abundance			
Survey	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Jul-20	296.76 (119.83)	120.31-561.63				
Aug-20	310.51 (54.16)	207-414.01				1442.24 (250.87)
Sep-20	15.49 (9.91)	0-38.74		1587.78 (183.95)		
Oct-20	1442.24 (250.87)	1046.59-2023.98				
Nov-20	232.65 (50.01)	147.35-333.66				
Dec-20	123.99 (38.43)	54.24-201.48				
Jan-21	116.22 (27.28)	61.98-170.46			1587.78 (183.95)	
Feb-21	255.59 (56.49)	147.16-364.02				
Mar-21	1587.78 (183.95)	1231.5-1959.56				
Apr-21	628.24 (89.54)	465.36-814.38	628.24 (89.54)			
May-21	77.5 (54.94)	0-201.71				
Jun-21	162.78 (87.41)	38.76-364.32				
Jul-21	131.78 (30.49)	77.52-193.79				
Aug-21	0 (0)	0-0				829.68 (115.34)
Sep-21	154.96 (52.94)	61.98-263.63		1791.37 (245.46)		

Survey	Estimate (S.D.)	95% c.i.	Peak seasonal abundance			
			Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Oct-21	829.68 (115.34)	604.81-1070.06				
Nov-21	123.85 (31.54)	61.92-185.77				
Dec-21	54.25 (17.74)	23.25-85.25				
Feb (18)-22	124 (30.59)	62-186				
Feb (26) 22	503.5 (80.36)	356.32-673.92			1791.37 (245.46)	
Mar-22	1791.37 (245.46)	1357.1-2287.69				
Apr-22	201.14 (39.29)	123.78-278.7				
May-22	131.99 (33.84)	69.87-201.86				
Jun-22	85.17 (46.39)	23.23-193.58	1879.75 (634.39)			
Jul-22	1879.75 (634.39)	785.01-3239				
Aug-22	54.62 (25.41)	15.61-109.25				
Sep-22	47.43 (17.15)	15.81-79.05				
MSP Abundance			**1254.00**	**1689.58**	**1689.58**	**1135.96**

Table 4-8 Kittiwake abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA and OAA plus 2 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

	OAA plus 2 km buffer						OAA					
			Seasonal peak abundance						Seasonal peak abundance			
Season	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Jul-20	240.61 (119.42)	64.16-513.31					184.47 (115.23)	24.06-449.15				
Aug-20	230.89 (47.42)	135.35-334.39					183.12 (44.9)	103.5-278.66				
Sep-20	15.49 (9.85)	0-38.74					7.75 (7.37)	0-23.24				
Oct-20	1000.26 (186.59)	682.35-1403.47				1000.26 (186.59)	666.84 (165.29)	372.19-1023.52				666.84 (165.29)
Nov-20	232.65 (46.66)	147.35-333.47					193.88 (47.03)	100.82-286.94				
Dec-20	100.74 (36.69)	31-178.23		1185.03 (198.02)			69.74 (30.57)	15.5-131.74		844.24 (186.69)		
Jan-21	92.98 (25.21)	46.49-147.21					46.49 (16.44)	15.5-77.67				
Feb-21	232.35 (57.35)	131.67-340.78			1185.03 (198.02)		216.86 (55.71)	116.18-333.23			844.24 (186.69)	
Mar-21	1185.03 (198.02)	828.75-1587.98					844.24 (186.69)	503.44-1216.2				
Apr-21	496.39 (83.56)	341.27-667.21					302.49 (57.92)	193.9-426.58				
May-21	69.75 (54.11)	0-193.76	496.39 (83.56)				38.75 (37.06)	0-116.26	302.49 (57.92)			
Jun-21	139.53 (84.48)	23.25-325.57					131.78 (81.93)	15.5-317.81				

MacArthur Green

	OAA plus 2 km buffer						OAA					
Aug-21	0 (0)	0-0					0 (0)	0-0				
Sep-21	154.96 (53.31)	61.98-271.18					154.96 (54.3)	61.98-278.93				
Oct-21	597.06 (95.71)	418.72-783.16				597.06 (95.71)	504.01 (100.83)	317.92-705.81				504.01 (100.83)
Nov-21	108.37 (30.83)	53.99-170.29					85.14 (27.2)	38.7-147.07				
Dec-21	38.75 (14.91)	15.5-69.75		1248.53 (217.97)			31 (14.34)	7.75-62		1000.38 (215.83)		
Feb (18)-22	85.25 (22.7)	46.5-131.75					54.25 (18.63)	23.25-93				
Feb (26) 22	395.05 (69.8)	263.18-534.68			1248.53 (217.97)		309.85 (64.83)	185.91-449.28			1000.38 (215.83)	
Mar-22	1248.53 (217.97)	837.53-1698.51					1000.38 (215.83)	604.88-1457.92				
Apr-22	139.25 (34.72)	69.63-208.88					92.84 (31.03)	38.68-154.73				
May-22	93.17 (26.14)	46.58-147.51					62.11 (23.24)	23.29-108.69				
Jun-22	77.43 (46.6)	7.74-185.83	1729.05 (606.65)				77.43 (45.37)	15.49-178.09	1395.93 (587.81)			
Jul-22	1729.05 (606.65)	610.32-2879.31					1395.93 (587.81)	380.71-2665.16				
Aug-22	23.41 (12.38)	0-46.82					15.61 (10.44)	0-39.02				
Sep-22	23.71 (12.15)	0-47.43					15.81 (10.79)	0-39.52				
MSP Abundance			**1,112.72**	**1,216.78**	**1,216.78**	**798.66**			**849.21**	**922.31**	**922.31**	**585.43**

4.2.2 Great black-backed gull

4.2.2.1 *Ecology and status*

134. Great black-backed gull is predominantly a coastal breeding species with a strong preference for rocky coastlines and islets, although small numbers now nest on rooftops in urban areas (Burnell *et al*. 2023). Scotland has 48% of the British and Irish population. In Scotland, some of the highest density breeding colonies are present on Orkney (Burnell *et al*. 2023). Great black-backed gull populations are dispersive. In the non-breeding season this species occurs on the coast as well as at inland and lowland sites (Balmer *et al*. 2013).

135. Great black-backed gull is an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al*., 2021) and classed as Least Concern by the IUCN (IUCN, 2024). Since Seabird 2000 (1998-2002), the population of great black-backed gulls in Britain has fallen by 43%. The greatest declines have been recorded in Scotland. Between Seabird 2000 and Seabirds Count, the Scottish population dropped to 5,404 AON which is a decline of 63%. Some of the steepest declines have been observed in the Northern Isles that host the highest density of breeding great black-backed gulls (Burnell *et al*. 2023).

136. The HPAI virus (refer to section 2.3) is now known to have impacted great black-backed gull numbers at some breeding colonies around the UK between 2021 to 2023 (Tremlett *et al*. 2024). In a study of UK seabird colony counts following the 2021-22 outbreak of HPAI, Tremlett *et al*. (2024) considered great black-backed gull to be a medium priority target species for additional colony monitoring, in part due to moderate levels of observed HPAI related mortalities in 2022. HPAI mortalities did not occur at all great black-backed gull colonies around the UK, and where the virus did occur, it did not impact all colonies equally. In Orkney, many colonies decreased in size between the baseline pre-HPAI years (2015-2021) to 2023. Within the Hoy SPA (24.7 km from the OAA) and Copinsay SPA (67.2 km from the OAA), both with breeding great-black-backed gull qualifying features, the number of breeding great black-backed gulls decreased from 9 AON pre-HPAI (2015-2021) to 5 AON in 2023 (44% decrease) and 67 AON pre-HPAI (2015-2021) to 49 AON in 2023 (27% decrease) in each SPA, respectively (Tremlett *et al.* 2024). However, at colonies in Caithness and Sutherland, decreases in the number of breeding great black-backed gulls were less severe or colonies increased in size between baseline pre-HPAI years (2015-2021) to 2023 (Tremlett *et al*. 2024). Elsewhere in the UK, some breeding black-headed gull colonies decreased in size, while other colonies increased between pre-HPAI years (2018-2021) to 2023 The highest decreases were recorded at some colonies on the south-west coast of England (Tremlett *et al.* 2024).

137. Great black-backed gulls are kleptoparasites (i.e. they deliberately take food from other animals, e.g. fish from auks), but their di*et al*so includes marine invertebrates and shellfish and they will also feed at inland refuge tips. This species has a mean maximum foraging range of 73 km (Woodward *et al.* 2019). There are many threats and pressures that could be driving Britain's great black-backed gull breeding population decline. It is possible that changes in fishery practices (e.g. reductions in the tonnage of fish landed), increased predation from white-tailed eagles and human disturbance all contribute to the decline (Burnell *et al.* 2023).

4.2.2.2 *Seasons*

138. Great black-backed gull seasons (breeding season and non-breeding) are illustrated in **Table 4-9**.

Table 4-9 Great black-backed gull season taken from NatureScot (2023, Guidance Note 9). Green cells are breeding months, blue cells are non-breeding months.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season												
Non -breeding												

4.2.2.3 *Raw observations*

139. Raw observations of great black-backed gulls are presented for each survey in **Figure 4-5** and **Figure 4-6**. Great black-backed gulls were recorded within the OAA plus 4 km buffer in 12 out of 27 surveys. In only one survey (May 2022) were great black-backed gulls recorded only outside the 4 km buffer. Numbers of great black-backed gull observations fluctuated between surveys, with most observations during the winter months, and very low numbers or a complete absence of observations during the spring and summer months.

140. Great black-backed gulls displayed a weak spatial pattern across the Offshore Ornithology Survey Area, with observations scattered across the Offshore Ornithology Survey Area during winter months.

141. The number of raw observations of great black-backed gulls recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-10**. The proportion of birds in flight is only provided for the OAA as this is the spatial scale used in collision risk modelling. In the majority of surveys, less than half of great black-backed gulls were recorded in flight in the OAA. Notable exceptions were the October 2020, June 2021 and March 2022 surveys when all birds were recorded in flight, but in these surveys only 1 to 2 birds were recorded in the OAA.

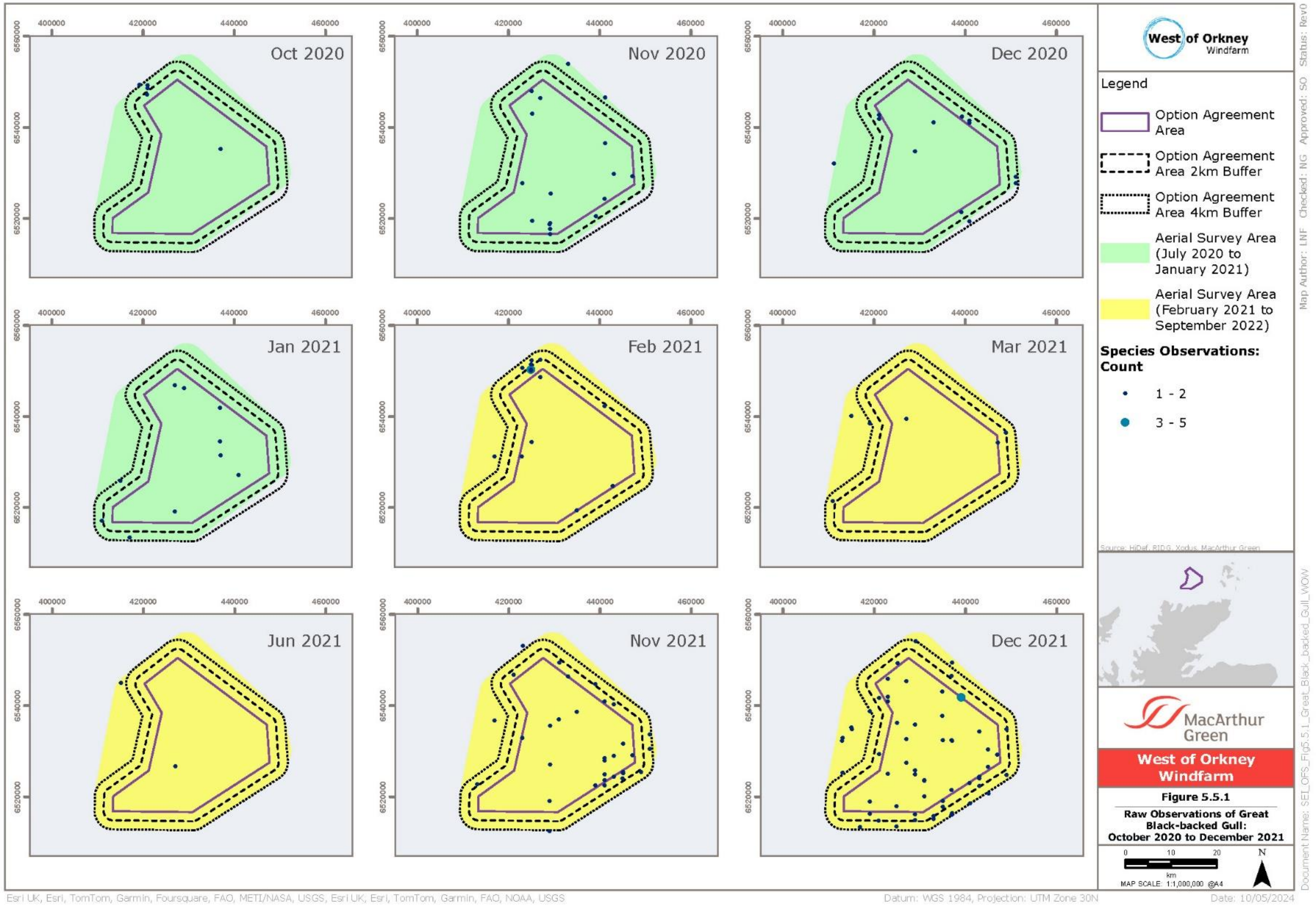

Figure 4-5 Raw observations of great black-backed gull: October 2020 to December 2021.

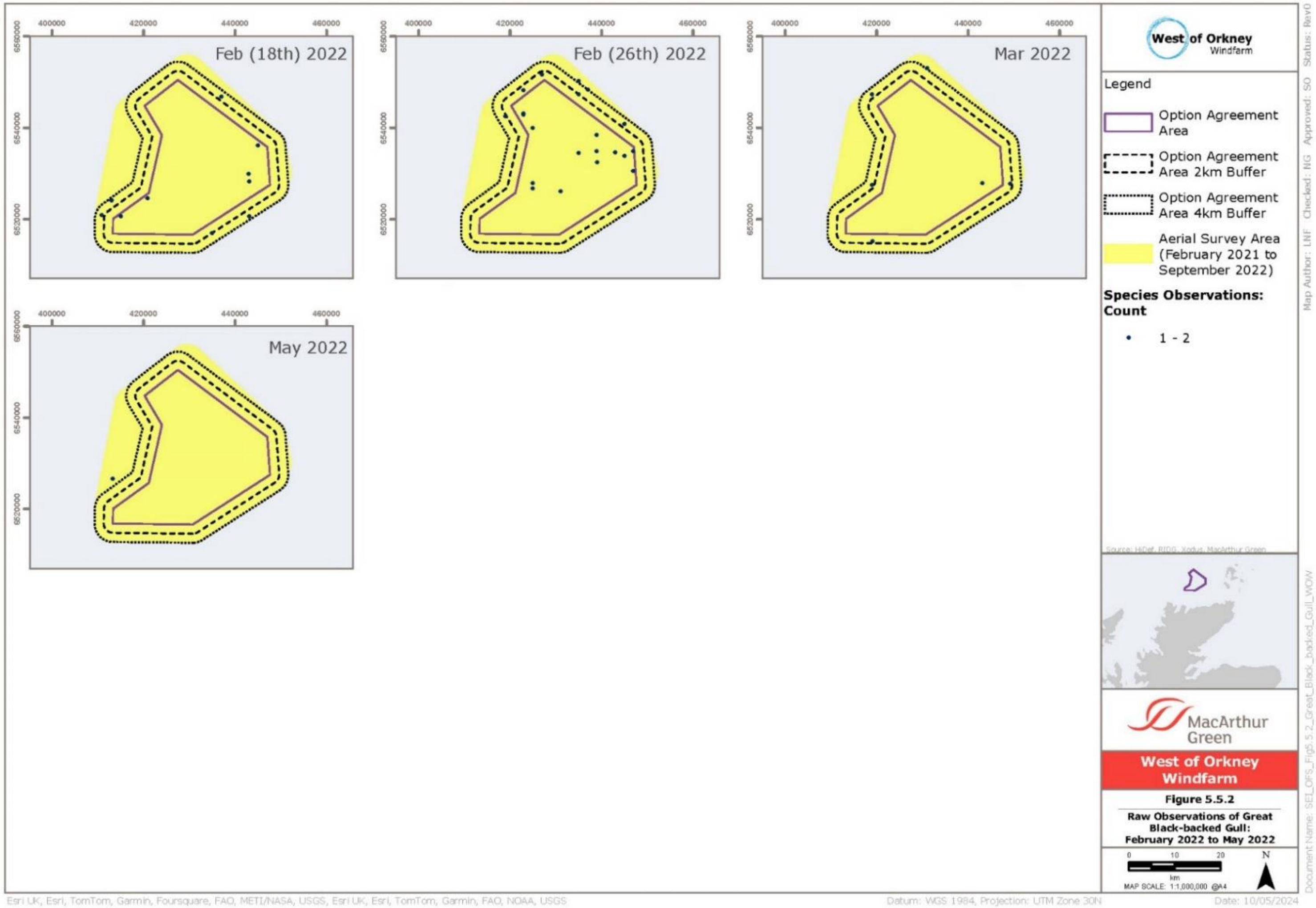

Figure 4-6 Raw observations of great black-backed gull: February 2022 to May 2022.

Table 4-10 Great black-backed gull raw counts of flying birds, sitting birds and proportion of birds in flight per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	-	-	N/A
Aug-2020	-	-	N/A
Sep-2020	-	-	N/A
Oct-2020	1	-	1.00
Nov-2020	9	5	0.64
Dec-2020	1	1	0.50
Jan-2021	3	5	0.38
Feb-2021	2	3	0.40
Mar-2021	0	2	0.00
Apr-2021	-	-	N/A
May-2021	-	-	N/A
Jun-2021	2	0	1.00
Jul-2021	-	-	N/A
Aug-2021	-	-	N/A
Sep-2021	-	-	N/A
Oct-2021	-	-	N/A
Nov-2021	2	14	0.13
Dec-2021	14	20	0.41
Feb (18th)-2022	1	5	0.17
Feb (26th)-2022	6	11	0.35
Mar-2022	1	0	1.00
Apr-2022	-	-	N/A
May-2022	-	-	N/A
Jun-2022	-	-	N/A
Jul-2022	-	-	N/A
Aug-2022	-	-	N/A
Sep-2022	-	-	N/A

4.2.2.4 Design-based density estimates

142. Design-based density estimates of great black-backed gulls, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-11**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds**.

143. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-12**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying)**.

144. Densities of birds in flight were very small, with values only exceeding 0.1 birds/km^2 in one survey (December 2021), in either the OAA or the OAA plus 4 km buffer (**Table 4-11**). Densities of all birds (in flight and on the sea) were also very small (**Table 4-12**). Densities of all birds were seldom greater than 0.1 birds/km^2, peaking at 0.4 birds/km^2 in December 2021. Great black-backed gulls were largely a winter feature of the area.

Table 4-11 Great black-backed gull density estimates, SDs & 95% c.i. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*	Non-breeding	-	-	0.04 (0.02)	0-0.08	0.01 (0.01)	0-0.04	-	-	0.02 (0.01)	0-0.05	0.03 (0.01)	0.01-0.05
Feb*	Non-breeding	-	-	0.02 (0.02)	0-0.06	0.07 (0.03)	0.02-0.12	-	-	0.06 (0.03)	0.01-0.13	0.06 (0.02)	0.03-0.09
Mar	Non-breeding	-	-	0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0.01 (0)	0-0.01	0.02 (0.01)	0-0.04
Apr	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
May	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jun	Breeding	-	-	0.02 (0.02)	0-0.07	0 (0)	0-0	-	-	0.01 (0.01)	0-0.04	0 (0)	0-0
Jul	Breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Aug	Breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Sep	Non-breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Oct	Non-breeding	0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.02 (0.01)	0-0.05	0 (0)	0-0	-	-
Nov	Non-breeding	0.09 (0.03)	0.04-0.15	0.02 (0.02)	0-0.06	-	-	0.07 (0.02)	0.03-0.11	0.06 (0.02)	0.03-0.09	-	-
Dec	Non-breeding	0.01 (0.01)	0-0.04	0.17 (0.05)	0.08-0.27	-	-	0.03 (0.02)	0.01-0.07	0.16 (0.03)	0.1-0.23	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-12 Great black-backed gull density estimates, SDs & 95% c.i. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km^2)						OAA plus 4 km buffer (birds/km^2)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0.09 (0.03)	0.04-0.17	0.07 (0.03)	0.01-0.14	-	-	0.07 (0.02)	0.04-0.12	0.09 (0.03)	0.04-0.15
Feb*		-	-	0.06 (0.03)	0.01-0.12	0.2 (0.05)	0.11-0.31	-	-	0.2 (0.12)	0.03-0.47	0.15 (0.03)	0.09-0.21
Mar		-	-	0.02 (0.02)	0-0.06	0.01 (0.01)	0-0.04	-	-	0.03 (0.01)	0.01-0.05	0.03 (0.01)	0.01-0.06
Apr		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
May		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jun		-	-	0.02 (0.02)	0-0.07	0 (0)	0-0	-	-	0.01 (0.01)	0-0.04	0 (0)	0-0
Jul		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Aug		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Sep		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Oct		0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.03 (0.02)	0-0.07	0 (0)	0-0	-	-
Nov		0.17 (0.05)	0.07-0.26	0.19 (0.05)	0.09-0.3	-	-	0.11 (0.03)	0.05-0.17	0.21 (0.04)	0.14-0.28	-	-
Dec		0.02 (0.02)	0-0.06	0.4 (0.09)	0.25-0.59	-	-	0.07 (0.02)	0.03-0.13	0.4 (0.06)	0.29-0.52	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.2.5 *Design-based abundance estimates*

145. Design-based abundance estimates of great black-backed gulls, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 4 km buffer in each survey are presented for each season in **Table 4-13**.

146. The bootstrap means and CV values for these abundance estimates are presented in Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).

147. As great black-backed gull were generally recorded in low numbers across the surveys, it is difficult to discern any decrease in abundance that could be attributed to HPAI impacts that occurred in 2022 (Tremlett *et al.* 2024). Given the scarcity of great black-backed gull records during the breeding season, across all three summers of the survey programme, it is unlikely that actively breeding individuals from colonies in Orkney or northern mainland Scotland use the OAA plus 4 km buffer.

148. Great black-backed gull MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-13**.

149. The largest MSP abundance (348.67 birds) was recorded in the non-breeding season. The breeding season MSP abundance estimate was much smaller (7.75 birds). Note that great black-backed gull is not assessed for displacement impacts. The abundance in the OAA plus 4 km buffer is only provided for context.

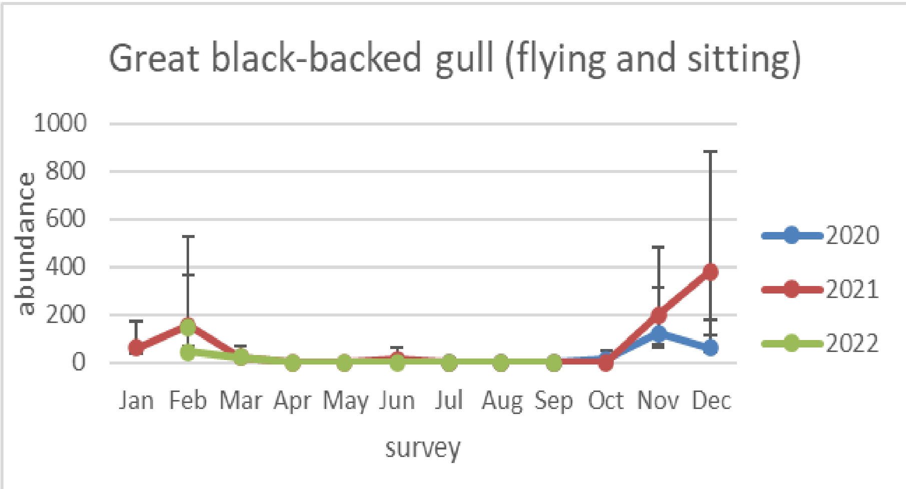

Figure 4-7 Estimated abundance and 95% confidence intervals of all great black-backed gulls (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis.

Table 4-13 Great black-backed gull abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green) and non-breeding season (blue).

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	Non-breeding season (NatureScot)
Jul-20	0 (0)	0-0		
Aug-20	0 (0)	0-0		232.35 (137.46)
Sep-20	0 (0)	0-0		
Oct-20	31.02 (20.9)	0-77.54		
Nov-20	124.08 (35.64)	62.04-201.63		
Dec-20	85.24 (28.4)	38.75-147.23		
Jan-21	85.23 (23.2)	46.49-139.47		
Feb-21	232.35 (137.46)	38.73-542.35		
Mar-21	30.98 (13.2)	7.75-61.96		
Apr-21	0 (0)	0-0	15.5 (13.79)	
May-21	0 (0)	0-0		
Jun-21	15.5 (13.79)	0-46.51		
Jul-21	0 (0)	0-0		
Aug-21	0 (0)	0-0		464.98 (70.3)
Sep-21	0 (0)	0-0		
Oct-21	0 (0)	0-0		
Nov-21	239.95 (44.36)	162.55-325.1		
Dec-21	464.98 (70.3)	340.98-604.47		
Feb (18)-22	108.5 (31.81)	46.5-170.5		
Feb (26)-22	170.42 (38.18)	100.7-247.88		
Mar-22	38.77 (14.76)	15.51-69.79		

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**
Apr-22	0 (0)	0-0	0 (0)	
May-22	0 (0)	0-0		
Jun-22	0 (0)	0-0		
Jul-22	0 (0)	0-0		
Aug-22	0 (0)	0-0		
Sep-22	0 (0)	0-0		
MSP Abundance			**7.75**	**348.67**

4.2.3 Herring gull

4.2.3.1 Ecology and status

150. Herring gulls are commonly found breeding at inland sites, although the highest numbers still tend to occur on the coast (Keller *et al.* 2020). Many moderate and large-sized colonies are located along the north and east coasts of mainland Scotland as well as around the coast of the Orkney Isles. Herring gull populations are dispersive, in the non-breeding season this species is more coastal in its distribution in Scotland (Balmer *et al.* 2013).

151. Herring gull is a Red-listed Bird of Conservation Concern in the UK (Stanbury *et al.*, 2021) and classed as Least Concern by the IUCN (IUCN, 2024). Estimates from Seabirds Count (2015-2021) suggest that the natural-nesting (i.e. coastal) herring gull population in Britain and Ireland is 74,926 AON which represents a decrease of 41% since Seabird 2000 (1998-2002). Approximately half of the herring gull population breeds in Scotland. Some of the steepest declines in colony size have been recorded on the west coast of Scotland (Burnell *et al.* 2023).

152. The HPAI virus (refer to section 2.3) is now known to have impacted herring gull numbers at some breeding colonies around the UK between 2021 to 2023 (Tremlett *et al.* 2024). In a study of UK seabird colony counts following the 2021-22 outbreak of HPAI, Tremlett *et al.* (2024) considered herring gull to be a high priority target species for additional colony monitoring, in part due to moderate levels of observed HPAI related mortalities in 2022. HPAI mortalities did not occur at all herring gull colonies around the UK, and where the virus did occur, it did not impact all colonies equally. In Orkney, the number of breeding herring gulls decreased by 11% to >100% at some colonies between the baseline pre-HPAI years (2015-2021) to 2023 (Tremlett *et al.* 2024). However, at colonies in Caithness and Sutherland, decreases in the number of breeding herring gulls were less severe or colonies increased in size between baseline pre-HPAI years (2015-2021) to 2023 (Tremlett *et al.* 2024). Elsewhere in the Scotland, decreases in SPAs with breeding herring gull qualifying features were greatest at the Canna and Sanday SPA (221.9 km from the OAA, 33% decrease), Forth Islands SPA (301.9 km from the OAA, 34% decrease) and Fowlsheugh SPA (236.8 km from the OAA, 25% decrease).

153. Herring gulls are opportunistic feeders, with diets ranging from fish and crustaceans to human refuse and occasionally other birds (Snow & Perrins 1998). This species has a mean maximum foraging range plus one standard deviation of 58.8 + 26.8 (Woodward *et al.* 2019). The drivers of the herring gull population decline in the UK are unclear, although decreases in the availability of scavenged food sources from refuge tips and fishery discards are thought to have played a role (Burnell *et al.* 2023; Mitchell *et al.* 2004; Foster *et al.* 2017).

4.2.3.2 Seasons

154. Herring gull seasons (breeding season and non-breeding) are illustrated in **Table** 4-14.

Table 4-14 Herring gull season taken from NatureScot 2023 (2023, Guidance Note 9). Green cells are breeding months, blue cells are non-breeding months.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season				■	■	■	■	■				
Non -breeding	■	■	■						■	■	■	■

4.2.3.3 *Raw observations*

155. Raw observations of herring gulls are presented for each survey in **Figure 4-8**. Herring gulls were recorded within the OAA plus 4 km buffer in 8 out of 27 surveys. Low numbers of herring gull observations were recorded during the winter months, with no observations during the spring and summer months. This pattern is similar to the more frequently recorded great black-backed gull.

156. Herring gulls displayed a weak spatial pattern across the Offshore Ornithology Survey Area, with observations scattered across the Offshore Ornithology Survey Area during winter months.

157. The number of raw observations of herring gulls recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-15**. The proportion of birds in flight is only provided for the OAA as this is the spatial scale used in collision risk modelling. The majority of herring gulls were recorded in flight in the OAA.

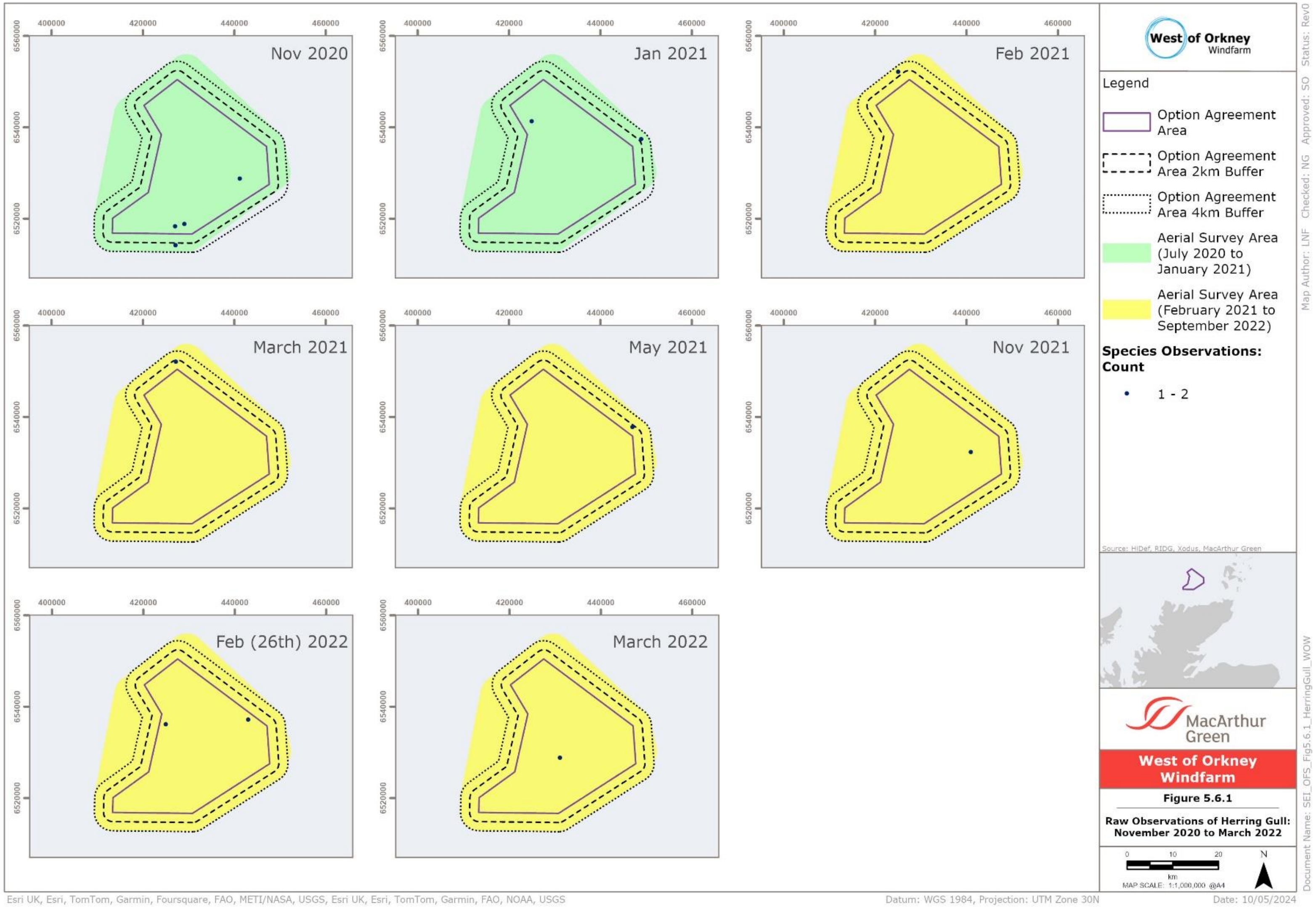

Figure 4-8 Raw observations of herring gull: November 2020 to March 2022.

Table 4-15 Herring gull raw counts of flying birds, sitting birds and proportion of birds in flight per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	-	-	N/A
Aug-2020	-	-	N/A
Sep-2020	-	-	N/A
Oct-2020	-	-	N/A
Nov-2020	2	1	0.67
Dec-2020	-	-	N/A
Jan-2021	1	0	1.00
Feb-2021	-	-	N/A
Mar-2021	-	-	N/A
Apr-2021	-	-	N/A
May-2021	-	-	N/A
Jun-2021	-	-	N/A
Jul-2021	-	-	N/A
Aug-2021	-	-	N/A
Sep-2021	-	-	N/A
Oct-2021	-	-	N/A
Nov-2021	0	1	0.00
Dec-2021	-	-	N/A
Feb (18^{th})-2022	-	-	N/A
Feb (26^{th})-2022	2	0	1.00
Mar-2022	0	1	0.00
Apr-2022	-	-	N/A
May-2022	-	-	N/A
Jun-2022	-	-	N/A
Jul-2022	-	-	N/A
Aug-2022	-	-	N/A
Sep-2022	-	-	N/A

4.2.3.4 Design-based density estimates

158. Design-based density estimates of herring gull, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-16**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds**.

159. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-17**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying).**

160. Density estimates of flying herring gulls in the OAA and OAA plus 4 km buffer are presented in **Table 4-16**. Densities were very small, with no birds recorded in most months. In months where herring gulls were present, densities were well below 0.1 birds/km^2. No herring gulls were recorded in flight during the breeding season. Densities of all birds were also very small, and also did not exceed 0.1 birds/km^2. Herring gulls were recorded from one survey in the breeding season (May 2021), albeit at very low densities (0.01 birds/km^2). Note, due to these very low densities, herring gulls were screened out of the HRA assessment. However, this species was assessed in the EIA.

Table 4-16 Herring gull density estimates, SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*	Non-breeding	-	-	0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.01 (0.01)	0-0.03	0 (0)	0-0
Feb*	Non-breeding	-	-	0 (0)	0-0	0.02 (0.02)	0-0.06	-	-	0.01 (0.01)	0-0.02	0.01 (0.01)	0-0.03
Mar	Non-breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0
Apr	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
May	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jun	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jul	Breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Aug	Breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Sep	Non-breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Oct	Non-breeding	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Nov	Non-breeding	0.02 (0.02)	0-0.06	0 (0)	0-0	-	-	0.02 (0.01)	0-0.05	0 (0)	0-0	-	-
Dec	Non-breeding	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-17 Herring gull density estimates, SDs & 95% C.I. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*	Non-breeding	-	-	0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.01 (0.01)	0-0.03	0 (0)	0-0
Feb*	Non-breeding	-	-	0 (0)	0-0	0.02 (0.02)	0-0.06	-	-	0.01 (0.01)	0-0.02	0.01 (0.01)	0-0.03
Mar	Non-breeding	-	-	0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0.01 (0.01)	0-0.02	0.01 (0.01)	0-0.02
Apr	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
May	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0.01 (0.01)	0-0.04	0 (0)	0-0
Jun	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jul	Breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Aug	Breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Sep	Non-breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Oct	Non-breeding	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Nov	Non-breeding	0.04 (0.02)	0-0.07	0.01 (0.01)	0-0.04	-	-	0.03 (0.01)	0.01-0.05	0.01 (0.01)	0-0.02	-	-
Dec	Non-breeding	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.3.5 Design-based abundance estimates

161. Design-based abundance estimates of herring gulls, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 4 km buffer in each survey are presented for each season in **Table 4-18**.

162. The bootstrap means and CV values for these abundance estimates are presented in Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).

163. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-9**. Generally, abundance estimates were similar between corresponding months in each survey year as indicated by the overlapping confidence intervals, although the estimate recorded in May 2021 was high compared with May 2022 because herring gull was not recorded in May 2022. As abundance estimates were very low for all surveys, it was not possible to discern any HPAI impact on herring gull abundance in the OAA.

164. Herring gull MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-18**.

165. The highest MSP abundance (23.36 birds) was recorded in the non-breeding season. The breeding season MSP abundance estimate was lower (7.75 birds).

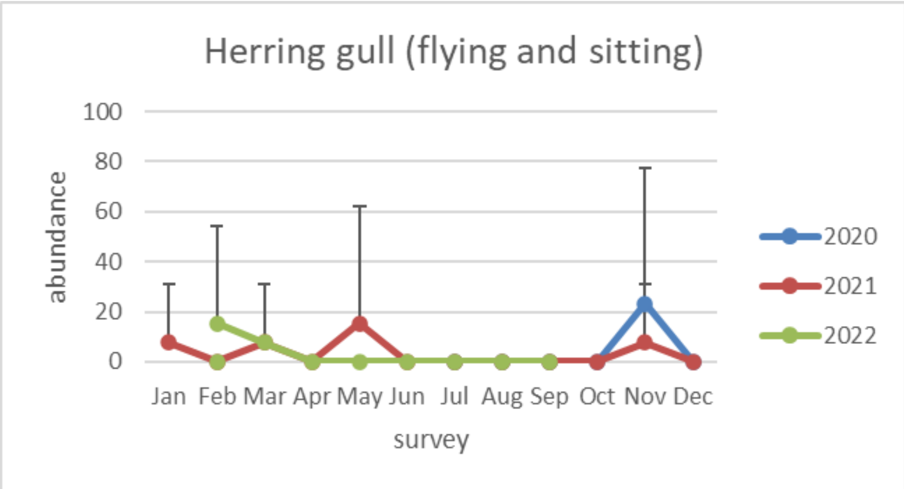

Figure 4-9 Estimated abundance and 95% C.I. of all herring gulls (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis.

Table 4-18 Herring gull abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green) and non-breeding season (blue).

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	Non-breeding season (NatureScot)
Jul-20	0 (0)	0-0		
Aug-20	0 (0)	0-0		
Sep-20	0 (0)	0-0		
Oct-20	0 (0)	0-0		
Nov-20	31.02 (15.12)	7.76-62.04		31.02 (15.12)
Dec-20	0 (0)	0-0		
Jan-21	15.5 (9.85)	0-38.74		
Feb-21	7.75 (7.22)	0-23.24		
Mar-21	7.75 (7.1)	0-23.24		
Apr-21	0 (0)	0-0		
May-21	15.5 (13.62)	0-46.5		
Jun-21	0 (0)	0-0	15.5 (13.34)	
Jul-21	0 (0)	0-0		
Aug-21	0 (0)	0-0		
Sep-21	0 (0)	0-0		
Oct-21	0 (0)	0-0		
Nov-21	7.74 (6.86)	0-23.22		15.49 (9.91)
Dec-21	0 (0)	0-0		
Feb (18)-22	0 (0)	0-0		
Feb (26)-22	15.49 (9.96)	0-38.73		
Mar-22	7.75 (7.18)	0-23.26		
Apr-22	0 (0)	0-0		
May-22	0 (0)	0-0		
Jun-22	0 (0)	0-0	0 (0)	
Jul-22	0 (0)	0-0		
Aug-22	0 (0)	0-0		

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	Non-breeding season (NatureScot)
Sep-22	0 (0)	0-0		
MSP Abundance			7.75	23.36

4.2.4 Arctic tern

4.2.4.1 *Ecology and status*

166. Arctic terns breed almost exclusively in coastal habitats on marine islands or beaches (Balmer *et al.* 2013). Orkney is an important area for breeding Arctic terns in Britain (Burnell *et al.* 2023; Wernham *et al*. 2002). Arctic tern is a migratory species, and during the non-breeding season this species migrates to spend the winter in Antarctic seas (Wernham *et al.* 2002).

167. Arctic tern is an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al*., 2021) and classed as Least Concern by the IUCN (IUCN, 2024). The last seabird census, Seabirds Count (2015-2021), estimated Britain and Ireland's Arctic tern breeding population to be 33,215 AON of which approximately 59% were in Scotland (Burnell *et al*. 2023). The Seabirds Count census reported a decline of approximately 35% in the UK Arctic tern population since Seabird 2000 (1998-2002). The population of Arctic terns in Orkney fell by 63% between Seabird 2000 and Seabirds Count.

168. The HPAI virus (refer to section 2.3) is now known to have affected Arctic tern abundance at breeding colonies around the UK between 2021 to 2023 (Tremlett *et al*. 2024). In a study of UK seabird colony counts following the 2021-22 outbreak of HPAI, Tremlett *et al.* (2024) considered Arctic tern to be a high priority target species for additional colony monitoring, in part due to high levels of observed HPAI related mortalities in 2022. HPAI mortalities did not occur at all Arctic tern colonies around the UK, and where the virus did occur, it did not impact all colonies equally. Closest to the offshore Project, numbers of breeding Arctic terns at some colonies in Orkney as well as at a colony in Caithness decreased between 11% to 50% between the baseline pre-HPAI years (2018-2021) to 2023 (Tremlett *et al.* 2024). Within the Papa Westray (North Hill and Holm) SPA on Orkney, which is 74.1 km from the OAA, the Arctic tern colony had 237 AON in the baseline pre-HPAI years (2018-2021), but by 2023 the colony had only 47 AON, a decrease of 80%. Elsewhere, colony decreases were recorded in Shetland, Gordon, Western Isles, Argyll and Bute and Northern Ireland (Tremlett *et al.* 2024).

169. In Britain, Arctic terns forage for sandeel primarily, as well as juvenile herring and cod, by plunge-diving to depths of up to 50 cm (Snow & Perrins 1998). The mean maximum foraging range plus one standard deviation is 25.7 + 14.8 km (Woodward *et al.* 2019). There are many threats and pressures that could be driving Britain's Arctic tern breeding population, including changes in sandeel availability, mammalian predation pressures and human disturbance (Burnell *et al.* 2023).

4.2.4.2 *Seasons*

170. Arctic tern seasons (breeding season, non-breeding season, BDMPS spring and autumn migration) are illustrated in **Table 4-19.**

Table 4-19 Arctic tern seasons taken from NatureScot (2023, Guidance Note 9) and Furness (2015). Green cells are breeding months, blue cells are non-breeding months, yellow cells are spring migration and orange cells are autumn migration.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season												
Non -breeding												
BDMPS Spring migration												
BDMPS Autumn migration												

4.2.4.3 *Raw observations*

171. Raw observations of Arctic terns are presented for each survey in **Figure 4-10**. Arctic terns were recorded within the OAA plus 4 km buffer in 6 out of 27 surveys. Small numbers of Arctic terns were recorded during the summer months between May to August. No Arctic terns were recorded in the OAA plus 4 km buffer during September to April.

172. Arctic terns displayed a weak spatial pattern across the Offshore Ornithology Survey Area, with observations scattered across the Offshore Ornithology Survey Area during summer months.

173. The number of raw observations of Arctic terns recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-20**. The proportion of birds in flight is only provided for the OAA as this is the spatial scale used in collision risk modelling. In the majority of surveys, most Arctic terns were recorded in flight in the OAA. A notable exception was August 2022 when eight birds were recorded sat on the water.

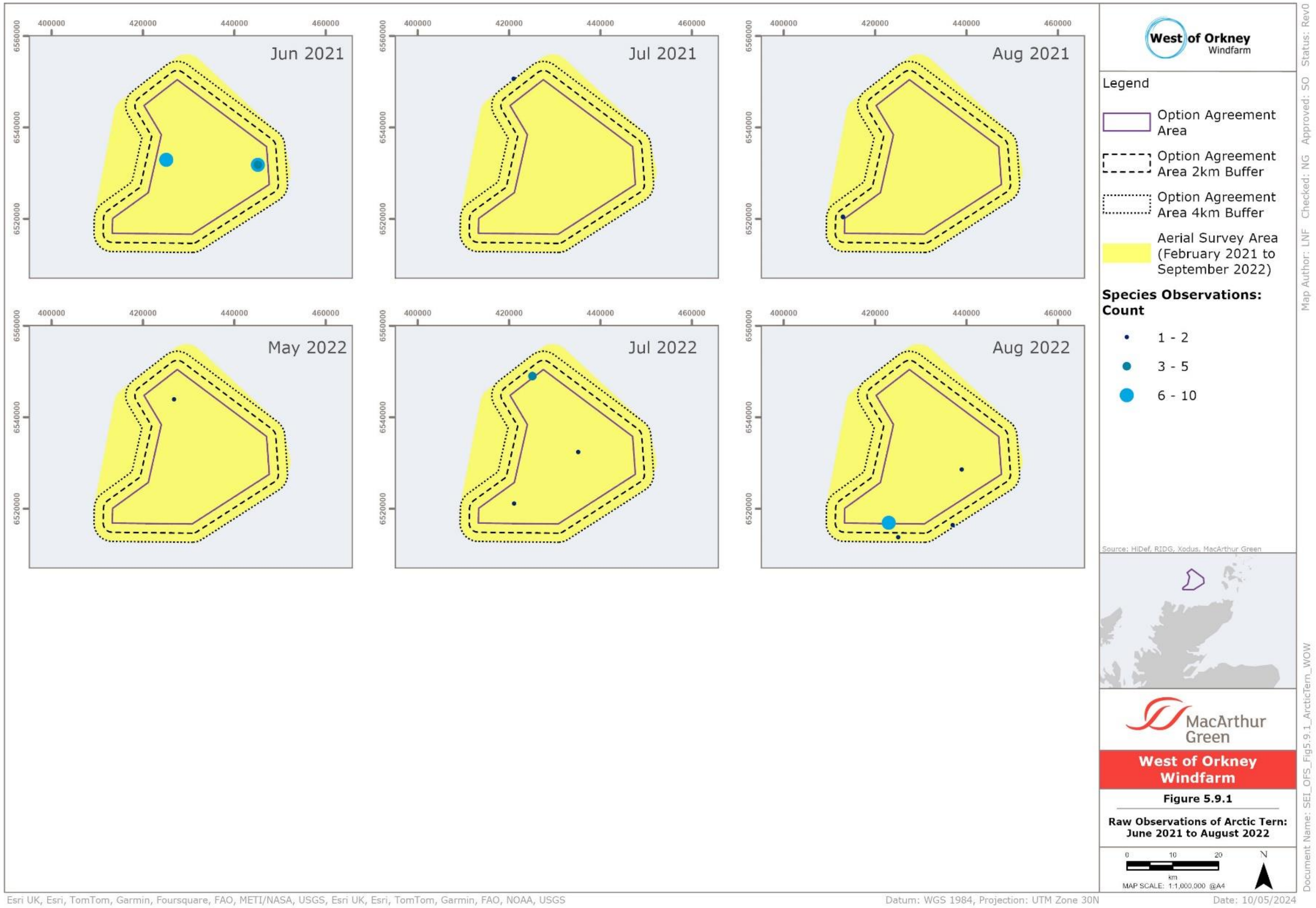

Figure 4-10 Raw observations of Arctic tern: June 2021 to August 2022.

Table 4-20 Arctic tern raw counts of flying birds, sitting birds and proportion of birds in flight per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	-	-	N/A
Aug-2020	-	-	N/A
Sep-2020	-	-	N/A
Oct-2020	-	-	N/A
Nov-2020	-	-	N/A
Dec-2020	-	-	N/A
Jan-2021	-	-	N/A
Feb-2021	-	-	N/A
Mar-2021	-	-	N/A
Apr-2021	-	-	N/A
May-2021	-	-	N/A
Jun-2021	13	10	0.57
Jul-2021	-	-	N/A
Aug-2021	-	-	N/A
Sep-2021	-	-	N/A
Oct-2021	-	-	N/A
Nov-2021	-	-	N/A
Dec-2021	-	-	N/A
Feb (18^{th})-2022	-	-	N/A
Feb (26^{th})-2022	-	-	N/A
Mar-2022	-	-	N/A
Apr-2022	-	-	N/A
May-2022	1	0	1.00
Jun-2022	-	-	N/A
Jul-2022	2	0	1.00
Aug-2022	1	8	0.11
Sep-2022	-	-	N/A

4.2.4.4 *Design-based density estimates*

174. Design-based density estimates of Arctic terns, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-21**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds**.

175. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-22**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying)**.

176. Density estimates of flying Arctic terns in the OAA and OAA plus 4 km buffer are presented in **Table 4-21** were very small. Birds were only recorded in the breeding season, when densities were mostly smaller than 0.1 birds/km^2. Densities only exceeded this in one survey (June 2021 in the OAA), though densities remained small (0.15 birds/km^2). Densities of all birds (in flight and on the sea) were similarly small and restricted to the breeding season (**Table 4-22**).

Table 4-21 Arctic tern density estimates, SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Mar		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Apr		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
May		-	-	0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0 (0)	0-0	0.01 (0.01)	0-0.02
Jun		-	-	0.15 (0.14)	0-0.46	0 (0)	0-0	-	-	0.09 (0.08)	0-0.26	0 (0)	0-0
Jul		0 (0)	0-0	0 (0)	0-0	0.02 (0.02)	0-0.06	0 (0)	0-0	0 (0)	0-0	0.04 (0.03)	0-0.1
Aug		0 (0)	0-0	0 (0)	0-0	0.01 (0.01)	0-0.04	0 (0)	0-0	0.02 (0.02)	0-0.04	0.01 (0.01)	0-0.03
Sep		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Oct		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Nov		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Dec		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-22 Arctic tern density estimates, SDs & 95% C.I. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Mar		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Apr		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
May		-	-	0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0 (0)	0-0	0.01 (0.01)	0-0.02
Jun		-	-	0.27 (0.17)	0-0.66	0 (0)	0-0	-	-	0.15 (0.1)	0-0.38	0 (0)	0-0
Jul		0 (0)	0-0	0 (0)	0-0	0.02 (0.02)	0-0.06	0 (0)	0-0	0 (0)	0-0	0.04 (0.03)	0-0.1
Aug		0 (0)	0-0	0 (0)	0-0	0.11 (0.09)	0-0.31	0 (0)	0-0	0.02 (0.02)	0-0.06	0.07 (0.05)	0.01-0.19
Sep		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Oct		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Nov		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Dec		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.4.5 *Design-based abundance estimates*

177. Design-based abundance estimates of Arctic tern, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 4 km buffer in each survey are presented for each season in **Table 4-23**.

178. The bootstrap means and CV values for these abundance estimates are presented in Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).

179. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-11**. Abundance estimates were generally similar between corresponding months in each survey year, although the estimate recorded in June 2021 was larger than in June 2022 as this species was not recorded in June in the latter year. Due to the paucity of Arctic tern records in the Offshore Ornithology Survey Area, it is not possible to draw any conclusions on whether the lack of Arctic terns recorded in June 2022 was due to the impact of HPAI in 2022 (Tremlett *et al*. 2024) or simply due to their absence in the Offshore Ornithology Survey Area on the day of the survey in June 2022. It is more likely to be the latter cause, as Arctic terns were recorded in the OAA in July and August 2022 in slightly larger numbers than they were in the same months in 2021.

180. Arctic tern MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-23** for the OAA plus 4 km buffer and **Table 4-24** for the OAA and OAA plus 2 km buffer. The highest MSP abundance in the OAA plus 2 km buffer (124.3 birds) was recorded in the breeding season followed by the lower BDMPS autumn migration period (46.7 birds) and BDMPS spring migration (3.9 birds). Arctic terns were not observed in the OAA plus 4 km buffer in the non-breeding season.

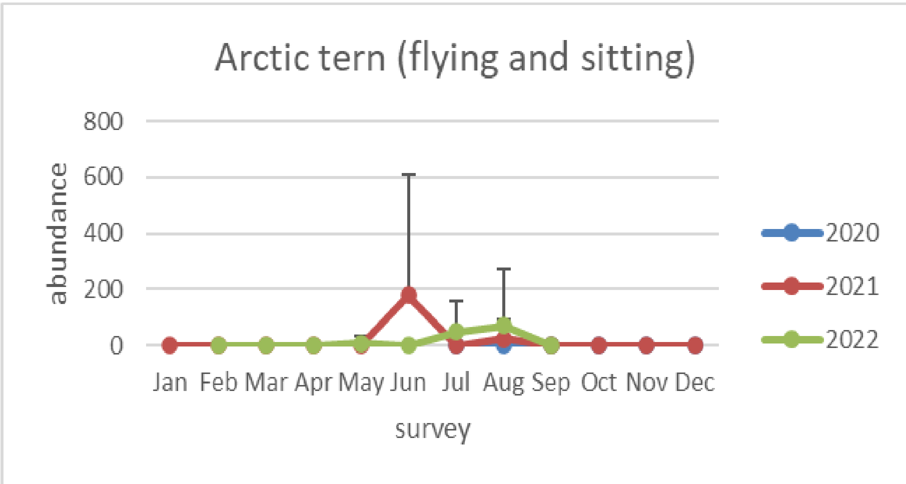

Figure 4-11 Estimated abundance and 95% confidence intervals of all Arctic terns (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis.

Table 4-23 Arctic tern abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance			
			Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Jul-20	0 (0)	0-0				
Aug-20	0 (0)	0-0				
Sep-20	0 (0)	0-0				
Oct-20	0 (0)	0-0				
Nov-20	0 (0)	0-0				
Dec-20	0 (0)	0-0		0 (0)		
Jan-21	0 (0)	0-0				
Feb-21	0 (0)	0-0				
Mar-21	0 (0)	0-0				
Apr-21	0 (0)	0-0			0 (0)	
May-21	0 (0)	0-0				
Jun-21	178.29 (114.62)	0-434.09	178.29 (114.62)			
Jul-21	0 (0)	0-0				
Aug-21	23.23 (18.13)	0-69.69				23.23 (18.13)
Sep-21	0 (0)	0-0				
Oct-21	0 (0)	0-0				
Nov-21	0 (0)	0-0				
Dec-21	0 (0)	0-0		0 (0)		
Feb (18)-22	0 (0)	0-0				
Feb (26)-22	0 (0)	0-0				
Mar-22	0 (0)	0-0				

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance			
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**	**Spring migration (BDMPS)**	**Autumn migration (BDMPS)**
Apr-22	0 (0)	0-0			7.76 (7.28)	
May-22	7.76 (7.28)	0-23.29	85.84 (60.65)			
Jun-22	0 (0)	0-0				
Jul-22	47.59 (31.81)	0-118.97				85.84 (60.65)
Aug-22	85.84 (60.65)	7.8-218.49				
Sep-22	0 (0)	0-0				
MSP Abundance			**132.22**	**0.00**	**3.88**	**54.54**

Table 4-24 Arctic tern abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA and OAA plus 2 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Season	OAA plus 2 km buffer						OAA					
			Peak seasonal abundance						Peak seasonal abundance			
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Jul-20	0 (0)	0-0					0 (0)	0-0				
Aug-20	0 (0)	0-0					0 (0)	0-0				
Sep-20	0 (0)	0-0					0 (0)	0-0				
Oct-20	0 (0)	0-0					0 (0)	0-0				
Nov-20	0 (0)	0-0					0 (0)	0-0				
Dec-20	0 (0)	0-0					0 (0)	0-0				
Jan-21	0 (0)	0-0		0 (0)			0 (0)	0-0		0 (0)		
Feb-21	0 (0)	0-0					0 (0)	0-0				
Mar-21	0 (0)	0-0					0 (0)	0-0				
Apr-21	0 (0)	0-0			0 (0)		0 (0)	0-0			0 (0)	
May-21	0 (0)	0-0					0 (0)	0-0				
Jun-21	178.29 (116.91)	0-434.09					178.29 (112.71)	0-434.09				
Jul-21	0 (0)	0-0	178.29 (116.91)				0 (0)	0-0	178.29 (112.71)			
Aug-21	23.23 (18.62)	0-69.69				23.23 (18.62)	0 (0)	0-0				0 (0)

	OAA plus 2 km buffer						OAA					
			Peak seasonal abundance						Peak seasonal abundance			
Season	**Estimate (S.D.)**	**95% c.i.**	**Breeding season (NatureScot)**	**Non-breeding season (NatureScot)**	**Spring migration (BDMPS)**	**Autumn migration (BDMPS)**	**Estimate (S.D.)**	**95% c.i.**	**Breeding season (NatureScot)**	**Non-breeding season (NatureScot)**	**Spring migration (BDMPS)**	**Autumn migration (BDMPS)**
Sep-21	0 (0)	0-0					0 (0)	0-0				
Oct-21	0 (0)	0-0					0 (0)	0-0				
Nov-21	0 (0)	0-0					0 (0)	0-0				
Dec-21	0 (0)	0-0					0 (0)	0-0				
Feb (18)-22	0 (0)	0-0		0 (0)			0 (0)	0-0		0 (0)		
Feb (26)-22	0 (0)	0-0					0 (0)	0-0				
Mar-22	0 (0)	0-0					0 (0)	0-0				
Apr-22	0 (0)	0-0			7.76 (7.33)		0 (0)	0-0			7.76 (7.39)	
May-22	7.76 (7.33)	0-23.29					7.76 (7.39)	0-23.29				
Jun-22	0 (0)	0-0					0 (0)	0-0				
Jul-22	47.59 (29.9)	0-111.04	70.23 (58.57)				15.86 (10.4)	0-39.66	70.23 (58.83)			
Aug-22	70.23 (58.57)	0-202.89				70.23 (58.57)	70.23 (58.83)	0-202.89				70.23 (58.83)
Sep-22	0 (0)	0-0					0 (0)	0-0				
MSP Abundance			**124.26**	**0.00**	**3.88**	**46.73**			**124.26**	**0.00**	**3.88**	**35.12**

4.2.5 Great skua

4.2.5.1 *Ecology and status*

181. In Britain, great skuas breed only at coastal colonies in Scotland and Ireland (Burnell *et al.* 2023). Scotland held approximately 60% of the world's breeding great skuas in 1985-2000 (Mitchell *et al.* 2004) but range expansion could mean that the relative proportion of the world population breeding in Scotland has reduced (Burnell *et al.* 2023). Orkney is a stronghold for breeding great skua in the UK. One of the largest British populations breeds within the Hoy SPA (Burnell *et al.* 2023), which is the only SPA with great skua as a qualifying feature in Orkney. Great skua is a migratory species and in the non-breeding season this species makes a short migration to winter off the coasts of southern Europe (Wernham *et al.* 2002).

182. Great skua is an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al.,* 2021) and classed as Least Concern by the IUCN (IUCN, 2024). Seabirds Count recorded 10,971 AOT across 795 occupied sites in Britain and Ireland; this represented a 14% increase since Seabird 2000 (1998-2002), with 6% being recorded within apparently new sites (Burnell *et al.* 2023). This was a continuation of a positive population trend since Operation Seafarer (1969-70; Burnell *et al.* 2023).

183. However, since the Seabirds Count census was conducted, HPAI (refer to **section 2.3**) is known to have impacted great skua survival and productivity at Scottish breeding colonies. The virus was first reported in the Orkney population in July 2021. Breeding productivity at great skua colonies was very low in 2021, possibly as a consequence of the HPAI outbreak (see **Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review**). In 2022, HPAI was present at great skua colonies in Orkney. It is likely that during migration this species fed on dead gannets that had died from HPAI and were floating on the sea surface, spreading the virus to great skua breeding colonies (refer to **Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review**). In a study of UK seabird colony counts following the 2021-22 outbreak of HPAI, Tremlett *et al.* (2024) considered great skua to be a high priority target species for additional colony counts, in part due to the very high levels of observed HPAI related mortalities in 2022. In 2022, there was a minimum loss of 2,591 individual great skuas in Scotland (NatureScot, 2023), with 1,400 individuals reported lost from the largest Scottish colony, on Foula (Camphuysen *et al.* 2022). Within the Hoy SPA (24.7 km from the OAA), Tremlett *et al.* (2024) found that the number of great skua territories had declined to 257 AOT in 2023 from 1,404 AOT recorded during the pre-HPAI baseline (2015-2020), a decrease of 82%.

184. Great skuas use a variety of techniques to support a diverse diet. Declines in sandeel abundance and fishery discards mean that great skuas now more frequently predate on other seabirds including kittiwake, fulmar, common guillemot and puffin as well as small numbers of other bird species (Burnell *et al.* 2023). This species has a mean maximum foraging range plus one standard deviation of 443.3 + 487.9 km (Woodward *et al.* 2019). One of the primary pressures affecting great skua numbers, aside from HPAI, is likely to be food availability. However, their ability to switch prey resources is perhaps one of the key features that has contributed to the recent increase in great skuas breeding populations in the UK (Burnell *et al.* 2023), although feeding on dead birds has increased their exposure to HPAI.

4.2.5.2 *Seasons*

185. Great skua seasons (breeding season, non-breeding season, BDMPS spring and autumn migration and winter period) are illustrated in **Table 4-25**. April and September are defined as being split between the breeding and non-breeding seasons for great skua (NatureScot Guidance Note 9).

Table 4-25 Great skua seasons taken from NatureScot 2023 (Guidance Note 9) and Furness (2015). Green cells are breeding months, blue cells are non-breeding months, yellow cells are spring migration, orange cells are autumn migration, purple cells are winter.

Season	Jan	Feb	Mar	Apr*	May	Jun	Jul	Aug	Sep*	Oct	Nov	Dec
Breeding season												
Non -breeding												
BDMPS Spring migration												
BDMPS Autumn migration												
BDMPS Winter												

*April and September are split months including both breeding and non-breeding seasons (NatureScot Guidance Note 9).

4.2.5.3 *Raw observations*

186. Raw observations of all great skuas (sitting and flying) recorded in any location in each aerial survey are presented in **Figure 4-12** to **Figure 4-13**. Great skuas were recorded within the OAA plus 4 km buffer in 14 out of 27 surveys; for 13 out of 27 months this species was not observed during an aerial survey. Numbers of great skuas fluctuated between surveys, but for surveys where this species was recorded, the number of sightings were small and flock size was generally small (1 to 5 birds), although an unusually large flock of 30 birds was recorded once in August 2020.

187. Great skua observations were scattered across Offshore Ornithology Survey Area with no consistent spatial distribution pattern between survey months (**Figure 4-12** to **Figure 4-13**).

188. The number of raw observations of great skuas recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-26**. The proportion of birds in flight is only provided for the OAA as this is the spatial scale used in collision risk modelling. Very few observations of birds in flight were recorded within the OAA. The largest flock of great skuas observed was a group of 30 birds sat on the water in August 2020.

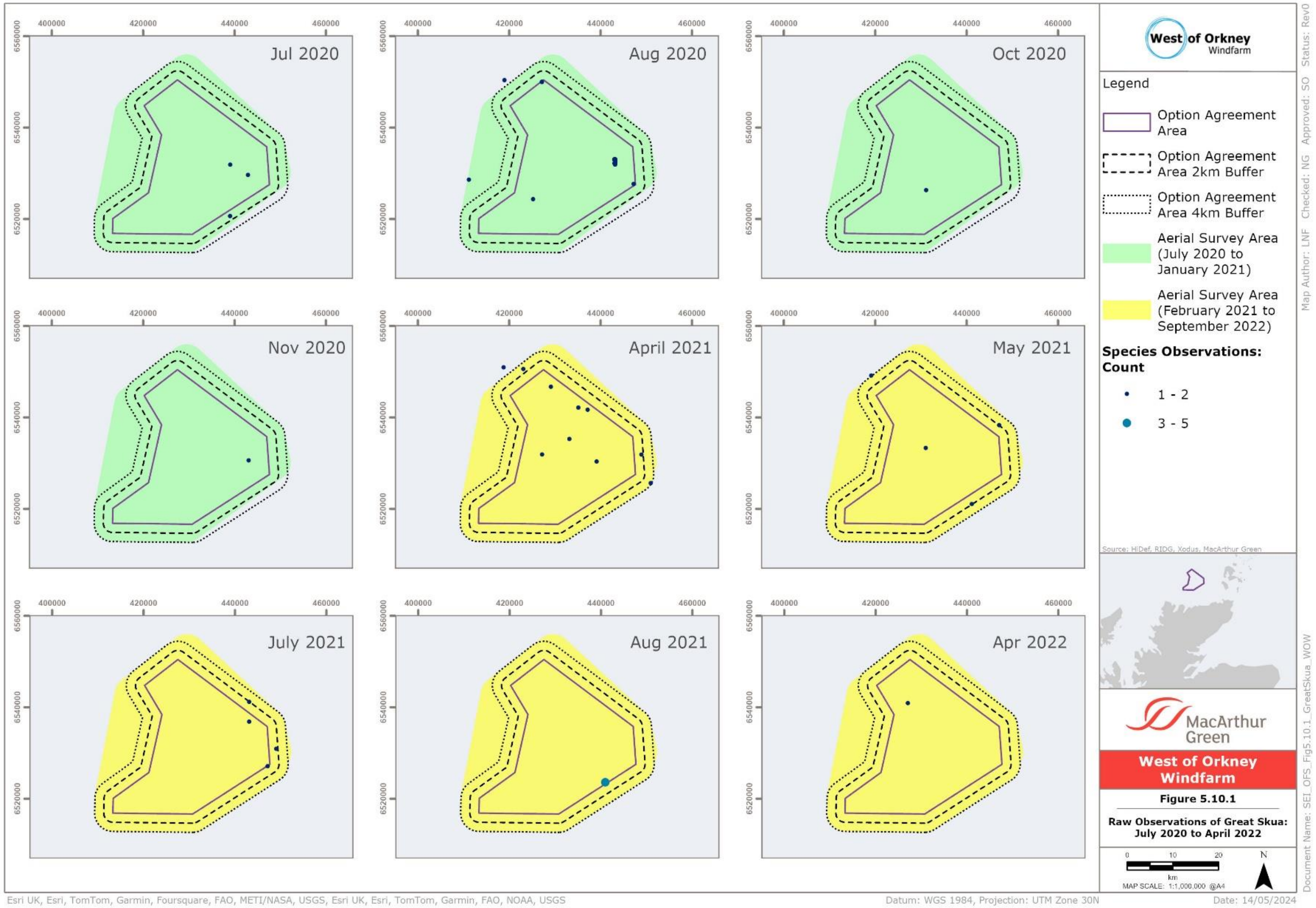

Figure 4-12 Raw observations of great skua: July 2020 to April 2022.

Figure 4-13 Raw observations of great skua: May 2022 to September 2022.

Table 4-26 Great skua raw observations of flying birds, sitting birds and proportion of birds in flight per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	1	1	0.50
Aug-2020	8	30	0.21
Sep-2020	-	-	N/A
Oct-2020	0	1	0.00
Nov-2020	0	1	0.00
Dec-2020	-	-	N/A
Jan-2021	-	-	N/A
Feb-2021	-	-	N/A
Mar-2021	-	-	N/A
Apr-2021	6	0	1.00
May-2021	0	1	0.00
Jun-2021	-	-	N/A
Jul-2021	1	0	1.00
Aug-2021	0	3	0.00
Sep-2021	-	-	N/A
Oct-2021	-	-	N/A
Nov-2021	-	-	N/A
Dec-2021	-	-	N/A
Feb (18th)-2022	-	-	N/A
Feb (26th)-2022	-	-	N/A
Mar-2022	-	-	0.00
Apr-2022	0	1	0.00
May-2022	-	-	N/A
Jun-2022	0	4	0.00
Jul-2022	-	-	N/A
Aug-2022	1	1	0.50
Sep-2022	-	-	N/A

4.2.5.4 Design-based density estimates

189. Design-based density estimates of great skua, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-27**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds**.

190. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in Table 4-28The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying)**.

191. Densities were of flying birds were generally very small (0.1 birds/km^2 or smaller; **Table 4-27**). Densities of all great skuas (flying and on the sea) were also very small (0.46 birds/km^2 or smaller; Densities of all great skuas (flying and on the sea) were also very small (0.46 birds/km^2 or smaller; **Table 4-28**). Birds were only recorded from the OAA or OAA plus 4 km buffer in the breeding season.

Table 4-27 Great skua density estimates, SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow), autumn migration (orange) and winter period (purple).

Month	Season	OAA (birds/km^2)						OAA plus 4 km buffer (birds/km^2)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*		-	-	0 (0)	0-0	0	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Mar		-	-	0 (0)	0-0	0.00	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Apr		-	-	0.06 (0.02)	0.01-0.12	0	0-0	-	-	0.03 (0.01)	0.01-0.06	0 (0)	0-0
May		-	-	0 (0)	0-0	0	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0
Jun		-	-	0 (0)	0-0	0	0-0	-	-	0 (0)	0-0	0.01 (0.01)	0-0.02
Jul		0.01 (0.01)	0-0.04	0.01 (0.01)	0-0.04	0.00	0-0	0.01 (0.01)	0-0.03	0.03 (0.01)	0.01-0.05	0.01 (0.01)	0-0.03
Aug		0.1 (0.05)	0.01-0.21	0 (0)	0-0	0.01	0-0.04	0.06 (0.03)	0.01-0.12	0 (0)	0-0	0.01 (0.01)	0-0.02
Sep		0 (0)	0-0	0 (0)	0-0	0	0-0	0 (0)	0-0	0 (0)	0-0	0.01 (0.01)	0-0.01
Oct		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Nov		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Dec		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-28 Great skua density estimates, SDs & 95% C.I. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow), autumn migration (orange) and winter period (purple).

Month	Season	OAA (birds/km^2)						OAA plus 4 km buffer (birds/km^2)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Mar		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Apr		-	-	0.07 (0.03)	0.02-0.12	0.01 (0.01)	0-0.04	-	-	0.06 (0.02)	0.03-0.09	0.01 (0.01)	0-0.02
May		-	-	0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.02 (0.01)	0-0.04	0.01 (0.01)	0-0.03
Jun		-	-	0 (0)	0-0	0.05 (0.02)	0.01-0.09	-	-	0 (0)	0-0	0.04 (0.01)	0.01-0.07
Jul		0.02 (0.02)	0-0.06	0.01 (0.01)	0-0.04	0 (0)	0-0	0.02 (0.01)	0.01-0.04	0.03 (0.01)	0.01-0.05	0.02 (0.01)	0-0.04
Aug		0.46 (0.35)	0.01-1.27	0.04 (0.03)	0-0.11	0.02 (0.02)	0-0.06	0.26 (0.2)	0.01-0.7	0.02 (0.02)	0-0.06	0.01 (0.01)	0-0.03
Sep		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0.01 (0.01)	0-0.01
Oct		0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0	-	-
Nov		0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0	-	-
Dec		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.5.5 Design-based abundance estimates

192. Design-based abundance estimates of great skuas, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 2 km buffer in each survey are presented for each appropriate season in **Table 4-29**.

193. The bootstrap means and CV values for these abundance estimates are presented in Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).

194. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-14**. Generally, abundance estimates were similar between corresponding months in each survey year. One exception was the estimated abundance in August 2020, which was higher than in August 2021 and 2022, which were similar to each other.

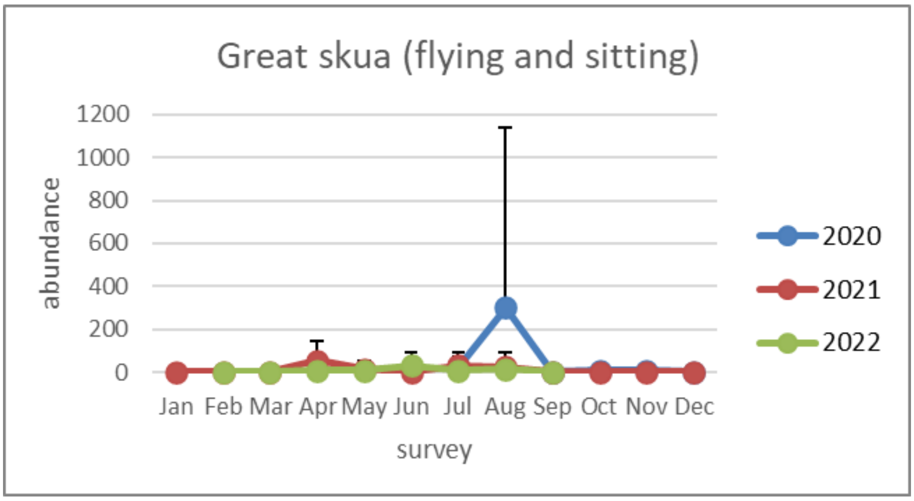

Figure 4-14 Estimated abundance and 95% C.I. of all great skuas (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis.

195. The HPAI virus was first detected in great skua colonies in Orkney in 2021 (Tremlett *et al.* 2024; Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review) and although it is possible that the HPAI outbreak in 2021 could explain the lower August 2021/22 abundances than August 2020, abundance of this species was generally low within the OAA plus 2 km and there was little evidence of an HPAI impact in other months. It is important to note that the August 2020 abundance estimate was not used to calculate the breeding season MSP (i.e. the MPS used in the displacement assessment for breeding birds did not include August 2020), as August 2020 was part of an incomplete breeding season. The August 2020 estimate was however used to calculate the MSP for great skua in the BDMPS autumn migration period.

196. Great skua MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-29**.

197. The highest MSP abundance (164.39 birds) was recorded in the BDMPS autumn migration period (which included August 2020, see above) followed by the breeding season (38.74

birds). The non-breeding season MSP abundance estimate was very similar (38.77 birds)., The BDMPS spring migration period (3.87 birds) and the BDMPS winter period (3.88 birds) MSP abundances were very small.

Table 4-29 Great skua abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow), autumn migration (orange) and winter period (purple).

<table>
<tr><th rowspan="2">Season</th><th rowspan="2">Estimate (S.D.)</th><th rowspan="2">95% c.i.</th><th colspan="5">Seasonal peak abundance</th></tr>
<tr><th>Breeding season (NatureScot)</th><th>Non-breeding season (NatureScot)</th><th>Spring migration (BDMPS)</th><th>Autumn migration (BDMPS)</th><th>Winter period (BDMPS)</th></tr>
<tr><td>Jul-20</td><td>24.06 (11.69)</td><td>8.02-48.12</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Aug-20</td><td>302.54 (227.97)</td><td>7.96-812.29</td><td></td><td></td><td></td><td rowspan="3">302.54 (227.97)</td><td></td></tr>
<tr><td>Sep-20</td><td>0 (0)</td><td>0-0</td><td></td><td rowspan="8">69.8 (19.8)</td><td></td><td></td></tr>
<tr><td>Oct-20</td><td>7.75 (7.52)</td><td>0-23.26</td><td></td><td></td><td></td></tr>
<tr><td>Nov-20</td><td>7.76 (6.92)</td><td>0-23.27</td><td></td><td></td><td></td><td rowspan="4">7.76 (6.92)</td></tr>
<tr><td>Dec-20</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Jan-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Feb-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Mar-21</td><td>0 (0)</td><td>0-0</td><td></td><td rowspan="2">0 (0)</td><td></td><td></td></tr>
<tr><td>Apr-21</td><td>69.8 (19.8)</td><td>31.02-108.58</td><td></td><td></td><td></td></tr>
<tr><td>May-21</td><td>23.25 (11.69)</td><td>0-46.5</td><td rowspan="4">31.01 (13.65)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Jun-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Jul-21</td><td>31.01 (13.65)</td><td>7.75-62.01</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Aug-21</td><td>23.23 (21.73)</td><td>0-69.69</td><td></td><td></td><td rowspan="3">23.23 (21.73)</td><td></td></tr>
<tr><td>Sep-21</td><td>0 (0)</td><td>0-0</td><td></td><td rowspan="3">7.74 (7.08)</td><td></td><td></td></tr>
<tr><td>Oct-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Nov-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td><td>0 (0)</td></tr>
</table>

Season	Estimate (S.D.)	95% c.i.	Seasonal peak abundance				
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**	**Spring migration (BDMPS)**	**Autumn migration (BDMPS)**	**Winter period (BDMPS)**
Dec-21	0 (0)	0-0					
Feb (18)-22	0 (0)	0-0					
Feb (26)-22	0 (0)	0-0					
Mar-22	0 (0)	0-0			7.74 (7.08)		
Apr-22	7.74 (7.08)	0-23.21					
May-22	15.53 (9.11)	0-31.06	46.46 (17.03)				
Jun-22	46.46 (17.03)	15.49-85.17					
Jul-22	23.79 (12.53)	0-47.59					
Aug-22	15.61 (10.38)	0-39.02					
Sep-22	7.9 (5.98)	0-15.81					
MSP Abundance			**38.74**	**38.77**	**3.87**	**164.39**	**3.88**

4.2.6 Guillemot

4.2.6.1 *Ecology and status*

198. The guillemot is one of the most widely distributed and abundant seabirds in the north temperate and Arctic zones (Snow & Perrins 1998). This species is a colonial breeder and pairs nest at very high densities along ledges around the coastline of northeastern and northwestern mainland Scotland as well as around the Orkney Isles (Burnell *et al.* 2023). This is a dispersive rather than a migratory species which spends the non-breeding season in the North Sea, often close to breeding colonies. Adults tend to remain further offshore from early August to the end of September which coincides with the main moult period, when they are flightless (Wernham *et al.* 2002; Buckingham *et al.* 2022).

199. Common guillemot is currently an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al.,* 2021) and classed as Least Concern by the IUCN (IUCN, 2024). A total of 1,449,589 individual common guillemots were counted in Britain and Ireland during Seabirds Count (2015-2021). This represented a decrease of approximately 8% since Seabird 2000 (1998-2002) despite an increase in the number of sites where breeding birds were present (Burnell *et al.* 2023). Scotland holds over half (56%) of the British and Irish breeding guillemot population. The greatest guillemot population decline was recorded in Scotland, where a total of 810,645 individuals were recorded by Seabirds Count which was down by 31% since Seabird 2000. Declines were most evident in the north of the country, e.g. in Orkney decreases were recorded at 42 out of 53 colonies and the population at Marwick Head SPA in Orkney (35 km from the OAA) decreased by 65% (Burnell *et al.* 2023). The only SPA in Orkney and Shetland to increase since Seabird 2000 was Calf of Eday SPA in Orkney (72.3 km from the OAA) which increased by 34% (883 individuals; Burnell *et al.* 2023).

200. The HPAI virus (refer to **section 2.3**) is now known to have impacted guillemot survival at some breeding colonies around the UK between 2021 to 2023 (Tremlett *et al.* 2024). In a study of UK seabird colony counts following the 2021-22 outbreak of HPAI, Tremlett *et al.* (2024) considered guillemot to be a high priority target species for additional colony monitoring, due to high levels of observed HPAI related mortalities in 2022. HPAI mortalities did not occur at all guillemot colonies around the UK, and where the virus did occur, it did not impact all colonies equally. Tremlett *et al.* (2024) assessed the impact of the HPAI virus on breeding guillemot within UK SPAs. In Orkney, the largest decrease in colony size was within the Copinsay SPA, which is 67.2 km from the OAA, where the number of breeding guillemots decreased from 18,472 individuals pre-HPAI (2015-2021) to 8,177 individuals in 2023, which represented a decrease of 56%. Elsewhere, in Orkney, breeding guillemots decreased by 20% at Marwick Head SPA, which is 35 km from the OAA, but at West Westray SPA, which is 60.2 km from the OAA, the colony increased by 7% between the baseline pre-HPAI years (2015-2021) to 2023. On the north coast mainland of Scotland, the number of breeding guillemots also increased between the baseline pre-HPAI years (2015-2021) and 2023, including within the Cape Wrath SPA, which is 25.9 km from the OAA (64% increase) and North Caithness Cliffs SPA which is 27.2 km from the OAA (33% increase; Tremlett *et al.* 2024).

201. Guillemots feed predominantly on sandeels, as well as sprat and small gadoids, by diving from the sea surface. Foraging trips from breeding colonies have a mean maximum foraging range plus one standard deviation of 33.1 + 36.5 km (Woodward *et al.* 2019). Foraging areas

closer to shore, nearer breeding colonies, are favoured during the breeding season where prey is available (Burnell *et al.* 2023). Guillemots are vulnerable to changes in sandeel availability, although less so than kittiwakes as they are able to dive below the surface to obtain prey deeper in the water column. They also readily switch to feeding on sprats when sandeels are scarce. Sandeels are sensitive to changes in sea temperatures and therefore climate change affects sandeel biomass. Recently, guillemots have suffered from two mass mortality events called 'wrecks'. These wrecks, in 2021 and 2023, occurred during the moult period and affected many adults as well as juveniles. The cause of these wrecks is not known. There are other factors that may influence Britain's guillemot breeding population decline including oil spills and, most recently, outbreaks of HPAI (as described above) (Burnell *et al.* 2023).

4.2.6.2 Seasons

202. Guillemot seasons (breeding season and non-breeding season) are illustrated in **Table 4-30**. August is defined as being split between the breeding and non-breeding seasons for guillemot (NatureScot Guidance Note 9).

Table 4-30 Guillemot seasons taken from NatureScot (2023, Guidance Note 9). Green cells are breeding months, blue cells are non-breeding months.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug*	Sep	Oct	Nov	Dec
Breeding season				(green)	(green)	(green)	(green)	(green)				
Non -breeding	(blue)	(blue)	(blue)					(blue)	(blue)	(blue)	(blue)	(blue)

*August is a split-month including both breeding and non-breeding seasons (NatureScot Guidance Note 9)

4.2.6.3 Raw observations

203. Raw observations of guillemots are presented for each survey in **Figure 4-15** to **Figure 4-17**. Guillemots were regularly recorded within the OAA plus 4 km buffer in all 27 surveys. Numbers of guillemot observations fluctuated between surveys, more observations were recorded in the early spring, mid-summer and autumn months and relatively low numbers of observations were recorded during the winter.

204. Guillemots displayed a weak spatial pattern across the Offshore Ornithology Survey Area. Overall, guillemot activity was recorded in all regions of the survey area, but within each survey, activity tended to be concentrated to one or two regions and there was considerable interannual variability. As a general trend, guillemots tended to be more dispersed across the OAA during the late summer/autumn and spring months when birds were likely passing to and from breeding colonies. Highest activity was generally recorded along the eastern edge of the OAA and to a lesser extent, on the north-western edge of the OAA, although areas of high activity varied between months. In the middle of the breeding season (May to July), guillemot activity tended to be more concentrated on the eastern and north-western edges of the OAA with less activity in the centre.

205. The number of raw observations of guillemots recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-31**. In most surveys, the majority of guillemots were recorded sat on the water.

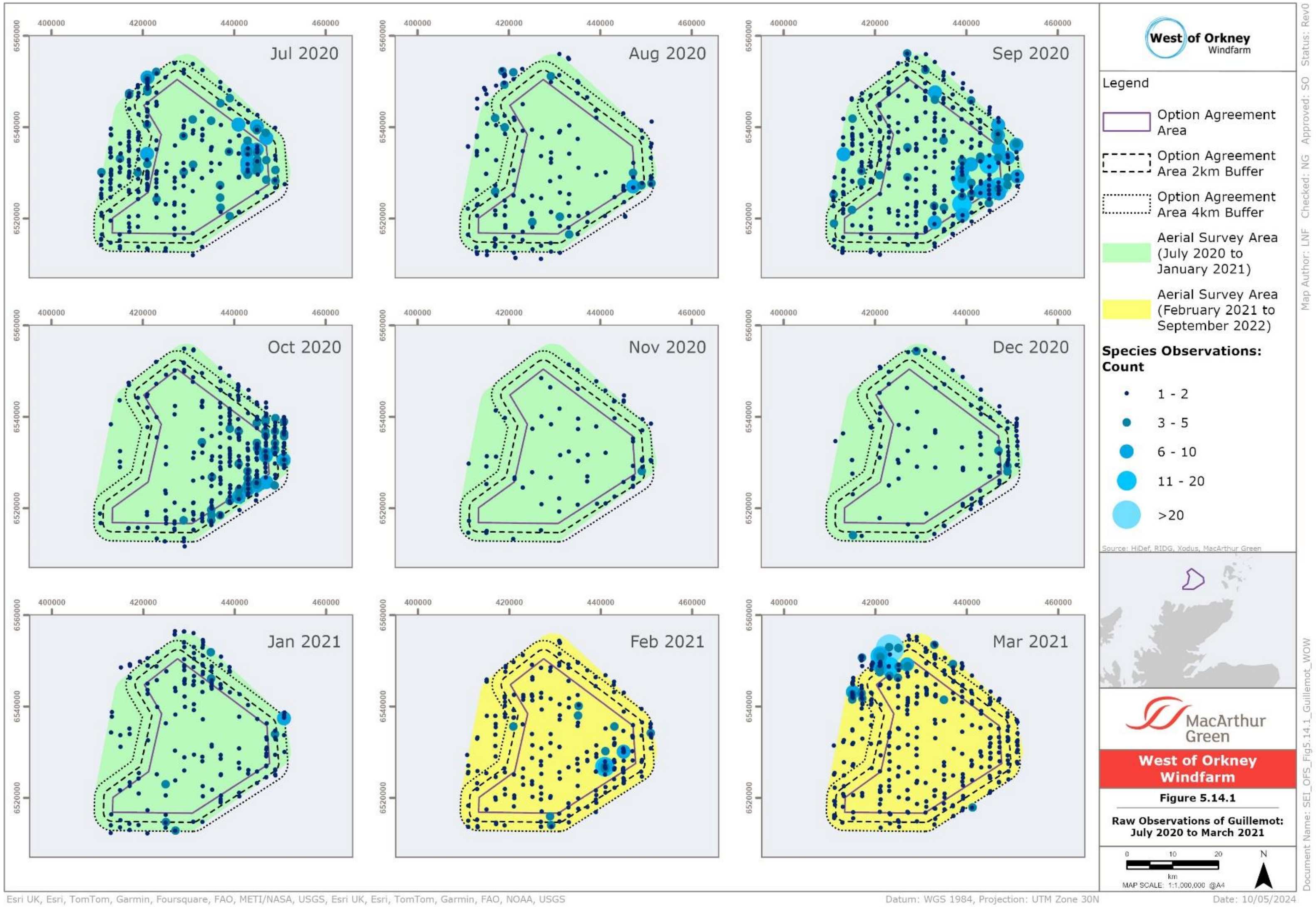

Figure 4-15 Raw observations of guillemot: July 20120 to March 2021.

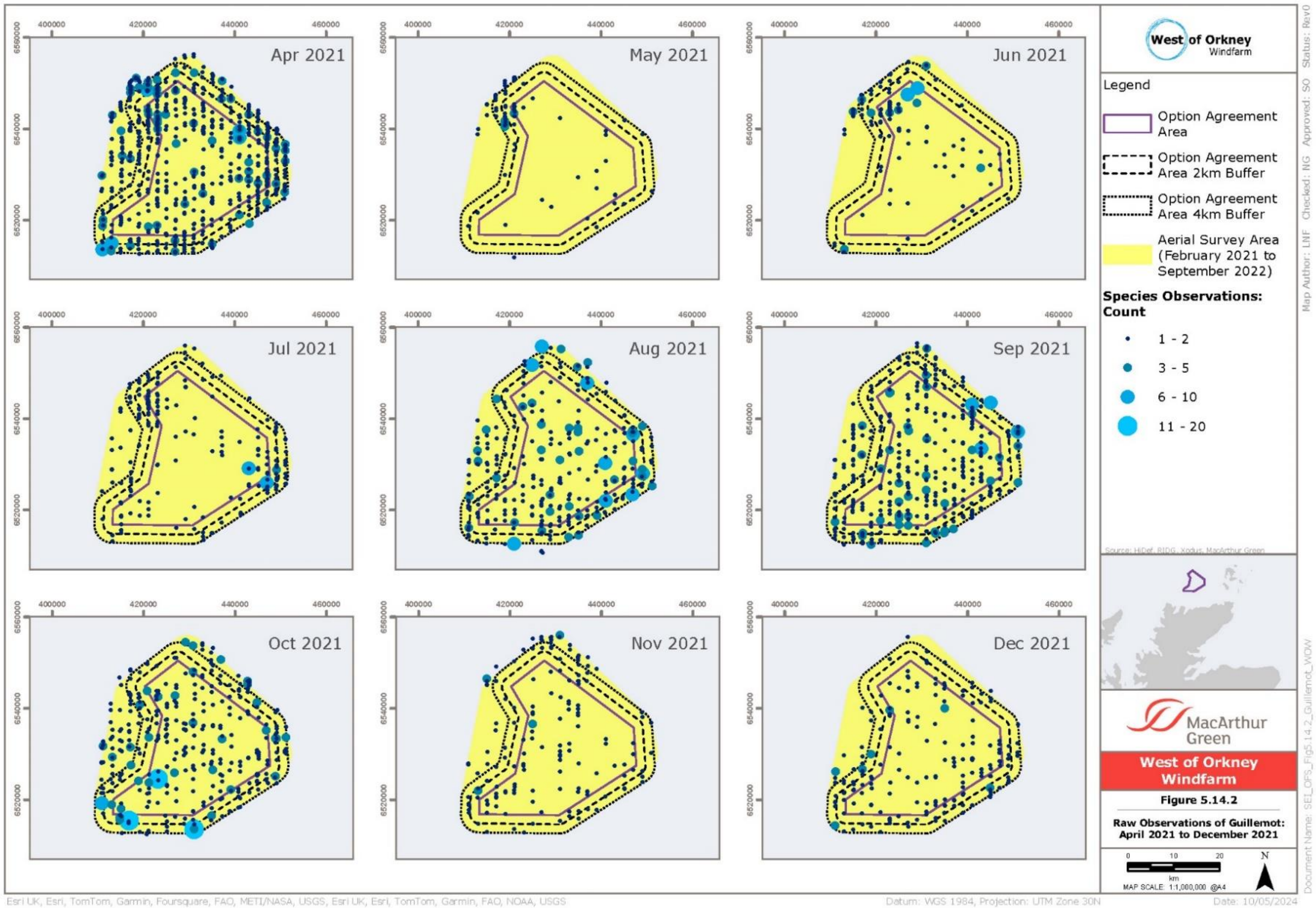

Figure 4-16 Raw observations of guillemot: April 2021 to December 2021.

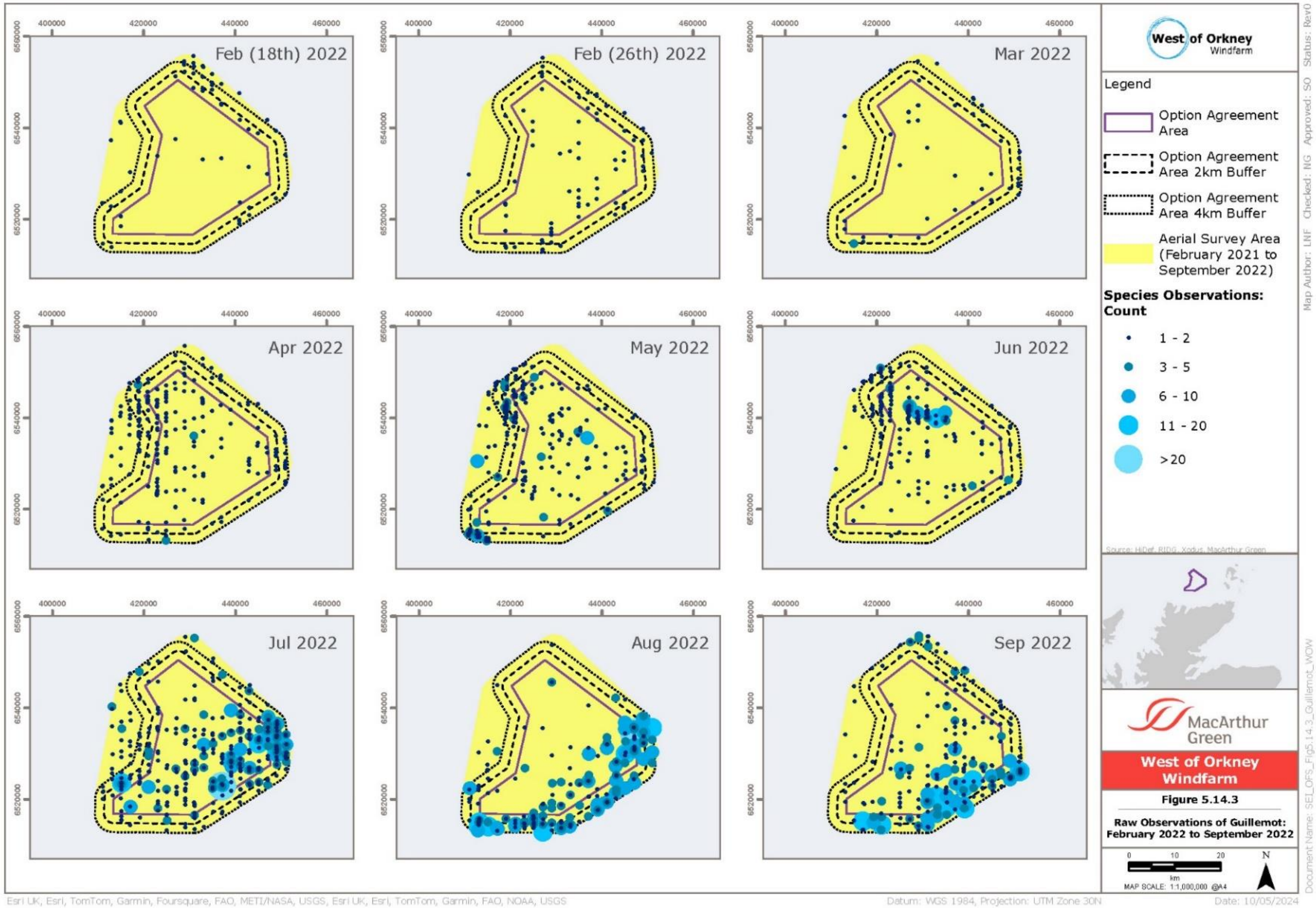

Figure 4-17 Raw observations of guillemot: February 2022 to September 2022.

Table 4-31 Guillemot raw counts of flying birds, sitting birds and proportion of birds in flight (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	5	250	0.00
Aug-2020	2	72	0.00
Sep-2020	4	295	0.00
Oct-2020	6	236	0.00
Nov-2020	3	23	0.12
Dec-2020	6	35	0.15
Jan-2021	9	70	0.11
Feb-2021	18	187	0.09
Mar-2021	20	164	0.11
Apr-2021	4	431	0.01
May-2021	3	21	0.13
Jun-2021	6	73	0.08
Jul-2021	24	62	0.28
Aug-2021	0	209	0.00
Sep-2021	3	303	0.01
Oct-2021	36	175	0.17
Nov-2021	5	75	0.06
Dec-2021	1	89	0.01
Feb (18^{th})-2022	0	9	0.00
Feb (26^{th})-2022	1	35	0.03
Mar-2022	0	17	0.00
Apr-2022	8	115	0.07
May-2022	51	88	0.37
Jun-2022	12	194	0.06
Jul-2022	22	515	0.04
Aug-2022	0	252	0.00
Sep-2022	4	238	0.02

4.2.6.4 Design-based density estimates

206. Design-based density estimates of guillemots, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-32**. Density estimates include auk spp and large auk spp (see **Section 3.3.2**). The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds.**

207. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-33**. Density estimates include auk spp and large auk spp (see **Section 3.3.2**). The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying).**

208. Density estimates of flying guillemots in the OAA and OAA plus 4 km buffer were relatively small (**Table 4-32**). Densities were less than 0.5 birds/km^2 in all surveys and for most surveys, densities were less than 0.1 birds/km^2. However, this was largely due to the small proportion of guillemots observed in flight. When the densities of all birds (i.e. including birds on the sea) are compared with birds in flight, values are much larger (**Table 4-33**).

Table 4-32 Guillemot density estimates (including unidentified auks apportioned using identified auk ratios), SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0.12 (0.06)	0.03-0.25	0 (0)	0-0	-	-	0.09 (0.04)	0.03-0.18	0 (0)	0-0
Feb*		-	-	0.26 (0.07)	0.13-0.42	0.01 (0.01)	0-0.04	-	-	0.3 (0.06)	0.19-0.42	0.01 (0.01)	0-0.02
Mar		-	-	0.24 (0.06)	0.12-0.38	0 (0)	0-0	-	-	0.2 (0.05)	0.12-0.3	0 (0)	0-0
Apr		-	-	0.07 (0.03)	0.02-0.14	0.11 (0.04)	0.03-0.19	-	-	0.11 (0.03)	0.05-0.17	0.16 (0.05)	0.08-0.25
May		-	-	0.04 (0.02)	0-0.08	0.62 (0.12)	0.39-0.86	-	-	0.03 (0.02)	0-0.06	0.6 (0.09)	0.43-0.79
Jun		-	-	0.07 (0.04)	0.01-0.14	0.14 (0.04)	0.06-0.22	-	-	0.07 (0.03)	0.03-0.13	0.21 (0.05)	0.12-0.31
Jul		0.07 (0.04)	0-0.16	0.28 (0.1)	0.11-0.51	0.27 (0.09)	0.11-0.48	0.08 (0.03)	0.03-0.14	0.33 (0.07)	0.19-0.48	0.25 (0.06)	0.15-0.38
Aug		0.02 (0.02)	0-0.06	0 (0)	0-0	0 (0)	0-0	0.03 (0.01)	0.01-0.06	0 (0)	0-0	0 (0)	0-0
Sep		0.04 (0.02)	0-0.08	0.06 (0.03)	0-0.12	0.05 (0.02)	0-0.1	0.07 (0.02)	0.03-0.11	0.04 (0.02)	0.01-0.08	0.03 (0.02)	0-0.07
Oct		0.08 (0.03)	0.03-0.15	0.46 (0.17)	0.17-0.79	-	-	0.12 (0.04)	0.05-0.2	0.77 (0.21)	0.4-1.22	-	-
Nov		0.04 (0.02)	0-0.07	0.07 (0.03)	0.03-0.13	-	-	0.03 (0.01)	0.01-0.06	0.09 (0.03)	0.05-0.14	-	-
Dec		0.08 (0.04)	0.01-0.17	0.04 (0.03)	0-0.11	-	-	0.08 (0.03)	0.04-0.13	0.03 (0.02)	0-0.07	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-33 Guillemot density estimates (including unidentified auks apportioned using identified auk ratios), SDs & 95% C.I. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	1.38 (0.23)	0.94-1.8	0.15 (0.05)	0.07-0.26	-	-	1.77 (0.19)	1.4-2.12	0.39 (0.06)	0.28-0.51
Feb*		-	-	3.26 (0.85)	1.91-5.08	0.65 (0.13)	0.41-0.92	-	-	2.77 (0.49)	1.98-3.84	0.71 (0.1)	0.53-0.92
Mar		-	-	2.97 (0.36)	2.29-3.7	0.33 (0.11)	0.14-0.56	-	-	3.52 (0.42)	2.73-4.4	0.45 (0.08)	0.31-0.61
Apr		-	-	7.26 (0.9)	5.57-9.19	1.94 (0.28)	1.41-2.55	-	-	8.46 (0.59)	7.3-9.57	2.02 (0.18)	1.68-2.42
May		-	-	0.38 (0.11)	0.19-0.63	2.02 (0.31)	1.44-2.68	-	-	0.68 (0.2)	0.35-1.1	2.86 (0.43)	2.06-3.74
Jun		-	-	1.22 (0.31)	0.66-1.89	3.22 (0.81)	1.89-4.93	-	-	1.21 (0.21)	0.87-1.66	2.54 (0.48)	1.7-3.62
Jul		4.45 (0.84)	2.9-6.05	1.26 (0.23)	0.84-1.75	8.82 (1.44)	6.26-11.91	4.35 (0.47)	3.41-5.26	1.83 (0.23)	1.38-2.29	9.06 (1.06)	7.05-11.09
Aug		1.26 (0.22)	0.87-1.71	3.44 (0.38)	2.74-4.19	3.96 (0.86)	2.4-5.77	1.61 (0.19)	1.25-1.97	3.95 (0.31)	3.32-4.52	6.43 (0.8)	4.84-8.01
Sep		4.73 (0.62)	3.53-5.97	5.01 (0.51)	4.06-6.05	4.02 (0.69)	2.79-5.57	4.76 (0.39)	4.01-5.49	4.97 (0.34)	4.34-5.67	5.31 (0.72)	4-6.71
Oct		3.92 (0.64)	2.72-5.19	3.36 (0.4)	2.61-4.12	-	-	4.45 (0.43)	3.7-5.42	3.82 (0.33)	3.21-4.48	-	-
Nov		0.5 (0.09)	0.32-0.69	1.43 (0.23)	0.98-1.87	-	-	0.67 (0.09)	0.51-0.86	1.39 (0.14)	1.12-1.68	-	-
Dec		0.67 (0.13)	0.44-0.94	1.66 (0.22)	1.24-2.13	-	-	1.04 (0.11)	0.83-1.26	2.09 (0.19)	1.74-2.48	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.6.5 Design-based abundance estimates

209. Design-based abundance estimates of guillemots, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 4 km buffer in each survey are presented for each appropriate season in **Table 4-34**. Abundance estimates include include auk spp and large auk spp and have been corrected for availability bias (see **Section 3.3.2** and **Section 3.3.3**). The bootstrap means and CV values for these abundance estimates, as well as abundance estimates for auk spp. and large auk spp. are presented in **Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).**

210. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-18**. Abundance estimates varied across the year and among years. The highest abundance across the 27 surveys was in July 2022, with an estimated 9,058 individuals (95% CI: 6,530 – 11,640). Generally, abundance in the OAA plus 4 km buffer was higher in late summer and autumn, suggesting that guillemots are using the area during the post-breeding moult period. At this time, adults are flightless, so are less able to move large distances. Abundances in May and June were lower, suggesting the OAA is less important during the incubation and colony-based chick rearing phases of the birds' annual cycle.

211. There was no discernible decrease in abundance in 2022 that could be attributed to HPAI impacts but abundance was variable among years and estimates had wide confidence intervals so smaller scale impacts would likely be undetectable. It is important to note that these surveys were not designed to detect small scale changes that may have been caused by HPAI, so small changes may not have been detectable.

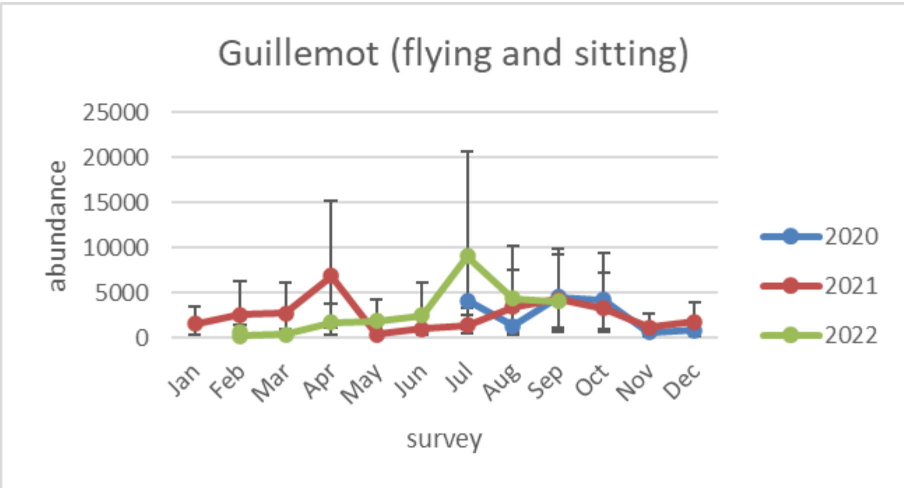

Figure 4-18 Estimated abundance and 95% C.I. of all guillemots (flying and sitting, including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in the OAA plus 4 km in each survey using design-based analysis.

212. Guillemot MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-34** for the OAA plus 4 km, and at the bottom of **Table 4-35** for the OAA and OAA plus 2 km buffer. The highest MSP abundance in the OAA plus 2 km buffer (the scale used for the

displacement impact assessment) (7972.52 birds) was recorded in the breeding season (**Table 4-35**). The non-breeding season (NatureScot 2020) MSP abundance estimate was (4392.93 birds, **Table 4-35**), which was identical to the non-breeding season (BDMPS) MSP abundance.

Table 4-34 Guillemot abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue) and BDMPS non-breeding season (yellow).

<table>
<tr><th rowspan="2">Season</th><th rowspan="2">Estimate (S.D.)</th><th rowspan="2">95% c.i.</th><th colspan="3">Peak seasonal abundance</th></tr>
<tr><th>Breeding season (NatureScot)</th><th>Non-breeding season (NatureScot)</th><th>Non-breeding (BDMPS)</th></tr>
<tr><td>Jul-20</td><td>5028.83 (548.71)</td><td>3945.53-6089.34</td><td></td><td></td><td></td></tr>
<tr><td>Aug-20</td><td>1863.03 (215.62)</td><td>1441.63-2284.44</td><td></td><td rowspan="8">5508.31 (448.03)</td><td rowspan="7">5508.31 (448.03)</td></tr>
<tr><td>Sep-20</td><td>5508.31 (448.03)</td><td>4639.95-6345.92</td><td></td></tr>
<tr><td>Oct-20</td><td>5148.63 (497.14)</td><td>4284.99-6275.22</td><td></td></tr>
<tr><td>Nov-20</td><td>775.51 (104.06)</td><td>593.45-993.62</td><td></td></tr>
<tr><td>Dec-20</td><td>1201.11 (131.31)</td><td>960.89-1463.17</td><td></td></tr>
<tr><td>Jan-21</td><td>2045.5 (214.92)</td><td>1620.31-2447.99</td><td></td></tr>
<tr><td>Feb-21</td><td>3206.47 (568.81)</td><td>2294.47-4446.03</td><td></td></tr>
<tr><td>Mar-21</td><td>4074.02 (487.96)</td><td>3162.86-5089.9</td><td></td><td></td></tr>
<tr><td>Apr-21</td><td>9788.1 (682.21)</td><td>8444.95-11076.58</td><td rowspan="5">9788.1 (682.21)</td><td></td><td></td></tr>
<tr><td>May-21</td><td>790.55 (230.78)</td><td>400.41-1273.09</td><td></td><td></td></tr>
<tr><td>Jun-21</td><td>1395.28 (238.65)</td><td>1003.8-1917.26</td><td></td><td></td></tr>
<tr><td>Jul-21</td><td>2116.24 (263.18)</td><td>1596.97-2645.54</td><td></td><td></td></tr>
<tr><td>Aug-21</td><td>4568.73 (353.04)</td><td>3842.33-5230.56</td><td rowspan="5">5749.08 (394.01)</td><td rowspan="5">5749.08 (394.01)</td></tr>
<tr><td>Sep-21</td><td>5749.08 (394.01)</td><td>5026.19-6556.71</td><td></td></tr>
<tr><td>Oct-21</td><td>4419.8 (383.35)</td><td>3711.96-5179.16</td><td></td></tr>
<tr><td>Nov-21</td><td>1610 (165.83)</td><td>1292.53-1938.8</td><td></td></tr>
<tr><td>Dec-21</td><td>2417.88 (221.91)</td><td>2012.69-2869.07</td><td></td></tr>
</table>

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance		
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**	**Non-breeding (BDMPS)**
Feb (18)-22	449.5 (68.64)	328.01-595.28			
Feb (26)-22	821.09 (113.91)	618.8-1059.09			
Mar-22	519.58 (88.39)	358.75-705.14			
Apr-22	2336.36 (211.24)	1946.97-2797.48	10477.41 (1225.8)		
May-22	3307.4 (491.93)	2379.1-4324.54			
Jun-22	2942.36 (560.15)	1968.08-4190.58			
Jul-22	10477.41 (1225.8)	8160.31-12826.44			
Aug-22	7444.34 (928.73)	5595.65-9272.13			
Sep-22	6141.95 (837.83)	4630.92-7761.96			
MSP Abundance			**10132.76**	**5628.70**	**5628.70**

Table 4-35 Guillemot abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in each survey in the OAA and OAA plus 2 km buffer. Peak seasonal abundance for the breeding season (green) and non-breeding season (blue).

Season	OAA plus 2 km buffer					OAA				
			Peak seasonal abundance					Peak seasonal abundance		
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Non-breeding (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Non-breeding (BDMPS)
Jul-20	4106.48 (542.56)	3133.91-5216.03				2919.45 (550.81)	1900.51-3973.03			
Aug-20	1337.56 (191.04)	950.66-1724.46				828.02 (142.38)	570.66-1119.22			
Sep-20	4516.66 (441.16)	3627.79-5374.51				3106.65 (404.31)	2317-3917.6			
Oct-20	4210.4 (516.15)	3298.32-5260.35				2574.31 (416.91)	1787.13-3404.32			
Nov-20	620.41 (102.54)	421.88-831.35		4516.66 (441.16)	4516.66 (441.16)	325.72 (61.59)	212.97-451.3		3106.65 (404.31)	3106.65 (404.31)
Dec-20	860.15 (128.54)	628.57-1125.09				441.7 (83.91)	290.88-614.07			
Jan-21	1541.87 (187.13)	1196.68-1921.59				906.53 (148.35)	619.37-1182.22			
Feb-21	2540.39 (528.93)	1669.4-3692.9				2137.65 (554.99)	1251.3-3337.33			
Mar-21	2772.81 (281.54)	2255.94-3363.22				1951.81 (235.27)	1506.29-2429.42			
Apr-21	6887.35 (656.33)	5715.96-8264.82	6887.35 (656.33)			4762.2 (591.8)	3656.49-6032.67	4762.2 (591.8)		
May-21	395.27 (128.88)	192.32-689.45				248.01 (74.37)	124.01-413.36			

Season	OAA plus 2 km buffer					OAA				
			Peak seasonal abundance					Peak seasonal abundance		
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Non-breeding (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Non-breeding (BDMPS)
Jun-21	999.95 (218.96)	609.97-1440.18				798.41 (205.26)	434.33-1243.1			
Jul-21	1418.58 (248.27)	964.78-1930.04				829.44 (149.3)	549.75-1147.71			
Aug-21	3399.45 (366.56)	2665.6-4144.09				2261.14 (248.25)	1795.66-2747.98			
Sep-21	4269.19 (370.78)	3585.59-5037.65				3285.19 (334.45)	2662.5-3972.28			
Oct-21	3248.94 (352.27)	2596.82-3952.79				2202.15 (262.1)	1711.62-2703.63			
Nov-21	1192.02 (155.38)	905.93-1490.02		4269.19 (370.78)	4269.19 (370.78)	936.58 (150.84)	643.9-1229.27		3285.19 (334.45)	3285.19 (334.45)
Dec-21	1782.41 (206.78)	1399.61-2177.18				1092.7 (145.36)	813.45-1396.22			
Feb (18)-22	217 (44.52)	125.63-308.37				100.75 (30.48)	44.78-167.91			
Feb (26)-22	650.68 (102.29)	454.25-859.39				426.04 (82.94)	272.19-603.56			
Mar-22	379.99 (80.7)	232.9-539.34				217.14 (73.13)	89.41-370.41			
Apr-22	1725.19 (179.54)	1384.03-2076.69				1276.49 (181.78)	923.64-1670.85			
May-22	1871.09 (260.22)	1391.08-2398.83	9057.69 (1352.44)			1327.62 (202.36)	945.57-1757.42	5789.94 (942.77)		
Jun-22	2462.29 (561.23)	1479.4-3638.97				2113.85 (534.22)	1241.63-3233.12			

Season	OAA plus 2 km buffer					OAA				
			Peak seasonal abundance					Peak seasonal abundance		
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Non-breeding (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Non-breeding (BDMPS)
Jul-22	9057.69 (1352.44)	6529.71-11639.99				5789.94 (942.77)	4107.68-7817.23			
Aug-22	4338.63 (731.75)	2905.9-5884.46				2598.5 (563.49)	1577.66-3784.32			
Sep-22	4039.3 (601.78)	2938.4-5272.28				2640.17 (455.75)	1832.57-3656.14			
MSP Abundance			**7972.52**	**4392.93**	**4392.93**			**5276.07**	**3195.92**	**3195.92**

4.2.7 Razorbill

4.2.7.1 Ecology and status

213. Razorbills breed along coastlines in the North Atlantic, North Sea and Irish Sea. This species is a colonial breeder and often breeds in similar areas to guillemots, although razorbills also nest in cracks and crevices along rocky coastlines and cliffs. High densities of razorbills breed along the coastline of north-east and north-west mainland Scotland as well as around the Orkney Isles (Burnell *et al.* 2023). This is a dispersive rather than a migratory species during the non-breeding season. Razorbills gradually move southwards from their breeding colonies and tend to aggregate in the southern North Sea (Buckingham *et al.* 2022). However, adult birds that breed in British and Irish colonies range as far as Bay of Biscay, coastal waters off Portugal and some as far as coastal waters off Iceland, Greenland and the Azores (Burnell *et al.* 2023; Wernham *et al.* 2002).

214. Razorbill is currently an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al*., 2021) and classed as Least Concern by the IUCN (IUCN, 2024). A total of 258,629 individual razorbills were counted in Britain and Ireland during Seabirds Count (2015-2021). This represented a steady increase during the whole census period: 18% rise since Seabird 2000 (1989-2002; 219,693 individuals), 47% rise since the SCR Census (1985-88; 176,135 individuals) and 54% since Operation Seafarer (1969-70; 167,683 individuals; Burnell *et al.* 2023). Scotland holds over half (54%) of the British and Irish breeding razorbill population. However, Scotland is one area (another area being the Isle of Man) where razorbills have declined slightly, particularly in northern colonies. Since the last census, there was a 2% decline in Scotland between Seabirds Count (138,828) and Seabird 2000 (142,216; Burnell *et al.* 2023). This contrasts with the period between Operation Seafarer and Seabird 2000 during which the Scottish razorbill population increased by approximately 28%.

215. Several colonies in Orkney and Shetland have experienced years of poor productivity since Seabird 2000. In SPAs with breeding razorbill qualifying features, there have been some large decreases between Seabird 2000 to Seabirds Count. The largest decreases have been within the Foula SPA (89%, 160.9 km from the OAA), North Rona and Sula Sgeir (76%, 79.7 km from the OAA), St Kilda (67%, 249.8 km from the OAA) and Handa (52%, 56.1 km from the OAA). Declines in Orkney and north mainland Scotland razorbill populations have either been less sever or some populations have increased, for example the razorbill population at East Caithness Cliffs SPA (70.1 km from the OAA) increased by 69% between Seabird 2000 to Seabirds Count (Burnell *et al.* 2023). It is unclear why northern razorbill populations have experienced greater population declines and poorer productivity than more southerly colonies over the past 20-25 years.

216. The HPAI virus (refer to section 2.3) is known to have affected some razorbill populations. Colonies at which razorbills tested positive for HPAI in the summer of 2022 included some at St Abb's and Golspie and Islay (refer to **Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review**). However, Tremlett *et al.* (2024) considered razorbill to have a low mortality from HPAI in comparison to other seabird species, and razorbill was not included in the study of UK seabird colony counts following the 2021-22 outbreak of HPAI (Tremlett *et al*. 2024).

217. Razorbills feed on small fish including sprat and juvenile herring as well as sandeels in the water column, by diving from the sea surface. Foraging trips from breeding colonies have a mean maximum foraging range plus one standard deviation of 61.3 + 33.4 km (Woodward *et al.* 2019). Razorbills are vulnerable to changes in pelagic fish availability meaning climate change is likely to be impacting the razorbill populations. Like guillemots, razorbills also suffered from a mass mortality event in 2021 that occurred during the post-breeding moult period. As with guillemots, the cause of this wreck is not known.

4.2.7.2 Seasons

218. Razorbill seasons (breeding season, non-breeding season, BDMPS spring and autumn migration, and BDMPS winter) are illustrated in **Table 4-36**. August is defined as being split between the breeding and non-breeding seasons for razorbill (NatureScot Guidance Note 9, 2023).

Table 4-36 Razorbill seasons taken from NatureScot (2023, Guidance Note 9). Green cells are breeding months, blue cells are non-breeding months, yellow cells are spring migration, orange cells are autumn migration, purple cells are winter.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug*	Sep	Oct	Nov	Dec
Breeding season												
Non -breeding												
BDMPS Migration seasons												
BDMPS winter												

*August is a split-month including both breeding and non-breeding seasons (NatureScot Guidance Note 9).

4.2.7.3 Raw observations

219. Raw observations of razorbills are presented for each survey in **Figure 4-19** to **Figure 4-21**. Razorbills were recorded within the OAA plus 4 km buffer in 21 out of 27 surveys. Numbers of razorbill observations fluctuated between surveys, with more observations in the early spring, summer and early autumn months and relatively low numbers of observations during the winter.

220. Razorbills displayed a weak spatial pattern across the survey area. Razorbill activity was generally low across the OAA, with highest activity tending to be concentrated on the eastern edge of the OAA.

221. The number of raw observations of razorbills recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-37**. In most surveys, the majority of razorbills were recorded on the sea.

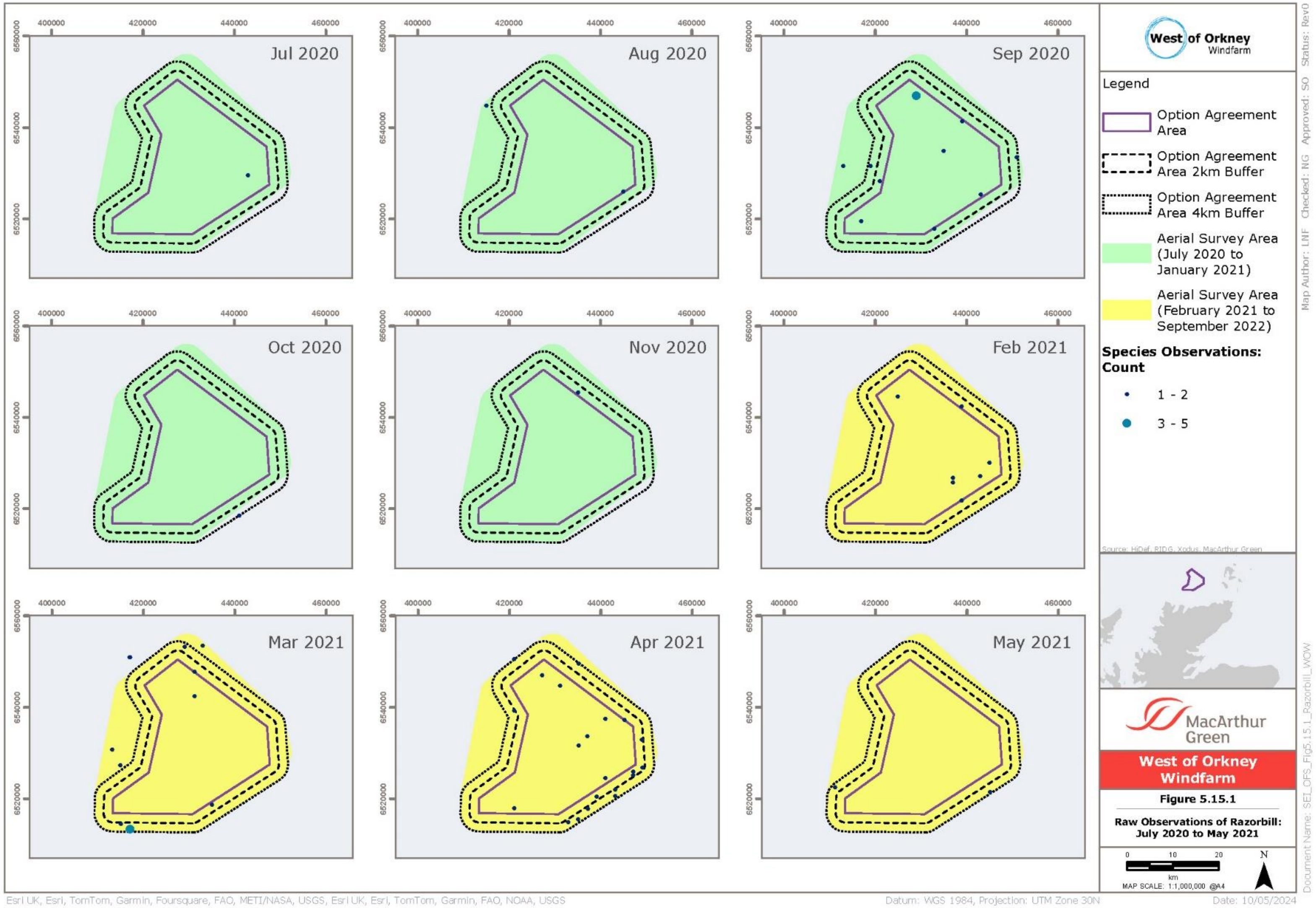

Figure 4-19 Raw observations of razorbill: July 2020 to May 2021.

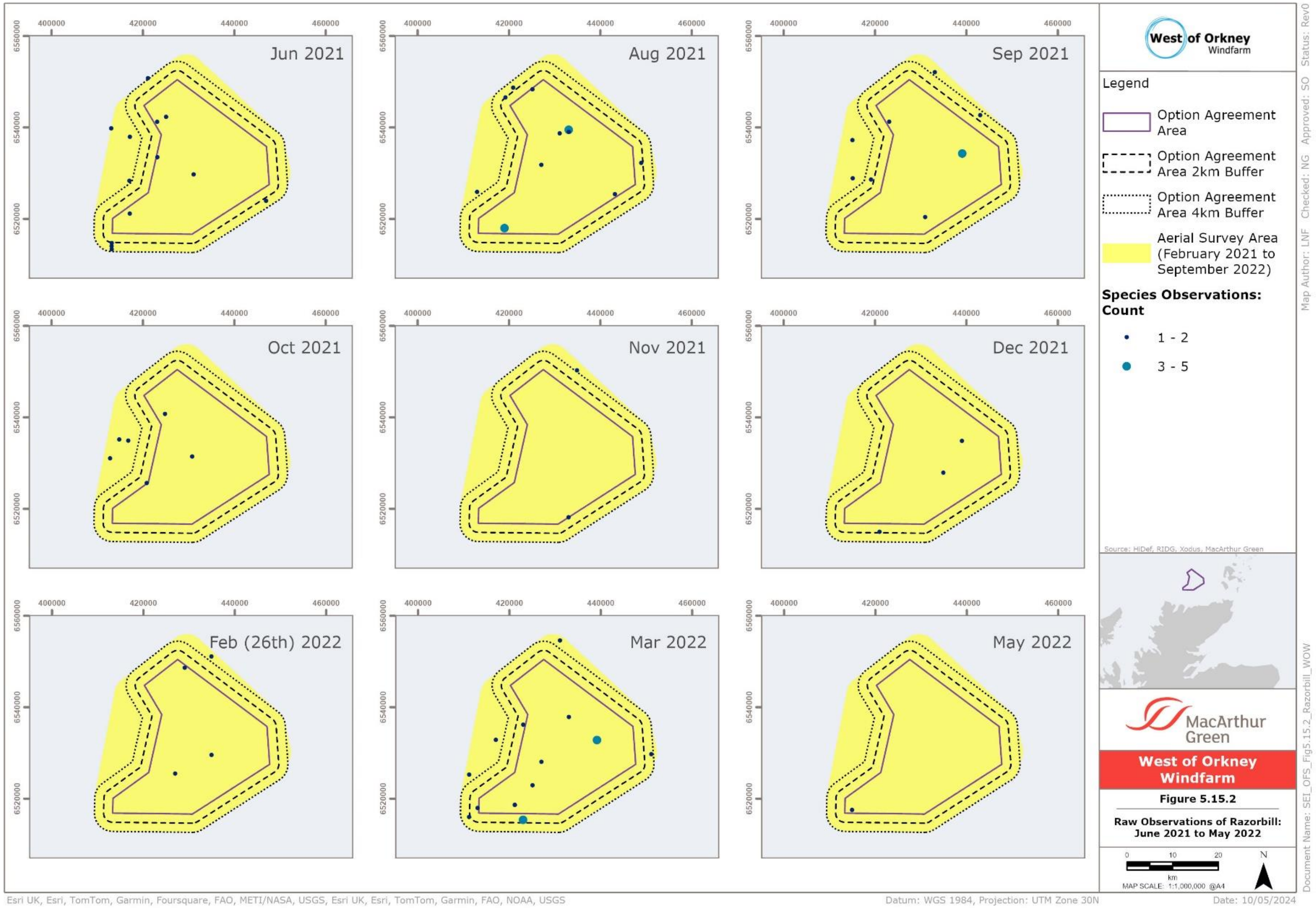

Figure 4-20 Raw observations of razorbill: June 2021 to May 2022.

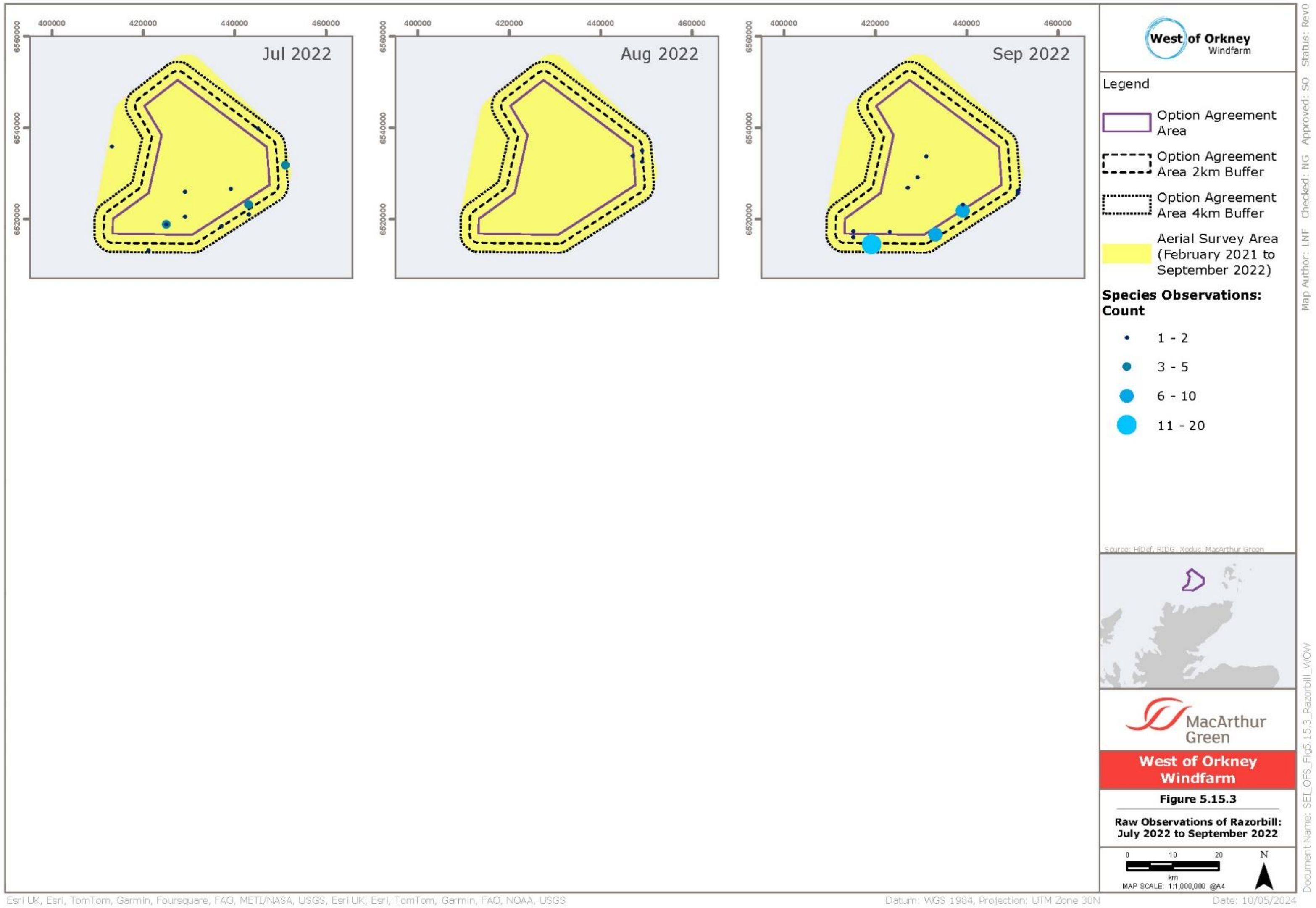

Figure 4-21 Raw observations of razorbill: July 2022 to September 2022.

Table 4-37 Razorbill raw counts of flying birds, sitting birds and proportion of birds in flight (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	0	2	0.00
Aug-2020	0	2	0.00
Sep-2020	0	8	0.00
Oct-2020	-	-	N/A
Nov-2020	-	-	N/A
Dec-2020	-	-	N/A
Jan-2021	-	-	N/A
Feb-2021	0	7	0.00
Mar-2021	0	1	0.00
Apr-2021	1	6	0.14
May-2021	-	-	N/A
Jun-2021	1	4	0.20
Jul-2021	-	-	N/A
Aug-2021	1	11	0.08
Sep-2021	0	7	0.00
Oct-2021	0	2	0.00
Nov-2021	1	0	1.00
Dec-2021	0	2	0.00
Feb (18)-22	-	-	N/A
Feb (26)-22	0	5	0.00
Mar-2022	0	9	0.00
Apr-2022	-	-	0.00
May-2022	0	1	0.00
Jun-2022	-	-	0.00
Jul-2022	0	10	0.00
Aug-2022	0	1	0.00
Sep-2022	0	10	0.00

4.2.7.4 Design-based density estimates

222. Design-based density estimates of razorbills, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-38**. Density estimates include auk spp and large auk spp (see **Section 3.3.2**). The bootstrap means and CV values for these density estimates recorded in each survey are presented in Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds.

223. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-39**. Density estimates include auk spp and large auk spp (see **Section 3.3.2**). The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying).**

224. Density estimates of flying razorbills in the OAA and OAA plus 4 km buffer were very low with no densities exceeding 0.01 birds/km^2 (**Table 4-38**). However, densities were larger for all razorbills (in flight and on the sea) in the OAA and OAA plus 4 km buffer (**Table 4-39**). Densities of all birds were mostly smaller than 0.1 birds/km^2, although densities did occasional exceed this, particularly when the OAA plus 4 km buffer is considered.

Table 4-38 Razorbill density estimates (including unidentified auks apportioned using identified auk ratios), SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0
Mar		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0.01 (0)	0-0.01
Apr		-	-	0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0
May		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jun		-	-	0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0
Jul		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Aug		0 (0)	0-0	0.01 (0.01)	0-0.04	0 (0)	0-0	0 (0)	0-0	0.01 (0.01)	0-0.04	0 (0)	0-0
Sep		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Oct		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0.01 (0.01)	0-0.02	-	-
Nov		0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0 (0)	0-0	0.01 (0.01)	0-0.02	-	-
Dec		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-39 Razorbill density estimates (including unidentified auks apportioned using identified auk ratios), SDs & 95% C.I. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*		-	-	0.09 (0.05)	0.01-0.19	0.08 (0.05)	0-0.18	-	-	0.08 (0.03)	0.02-0.14	0.05 (0.03)	0-0.11
Mar		-	-	0.01 (0.01)	0-0.04	0.15 (0.07)	0.05-0.29	-	-	0.07 (0.03)	0.02-0.14	0.17 (0.06)	0.08-0.29
Apr		-	-	0.09 (0.03)	0.04-0.16	0 (0)	0-0	-	-	0.17 (0.04)	0.1-0.25	0 (0)	0-0
May		-	-	0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0.03 (0.02)	0-0.05	0.01 (0.01)	0-0.02
Jun		-	-	0.07 (0.03)	0.03-0.13	0 (0)	0-0	-	-	0.09 (0.04)	0.03-0.17	0 (0)	0-0
Jul		0.02 (0.02)	0-0.07	0 (0)	0-0	0.15 (0.09)	0.01-0.33	0.01 (0.01)	0-0.04	0 (0)	0-0	0.2 (0.07)	0.08-0.35
Aug		0.02 (0.02)	0-0.07	0.19 (0.09)	0.05-0.38	0.01 (0.01)	0-0.04	0.01 (0.01)	0-0.04	0.13 (0.05)	0.05-0.23	0.04 (0.02)	0-0.09
Sep		0.12 (0.06)	0.03-0.24	0.09 (0.06)	0-0.23	0.14 (0.06)	0.04-0.26	0.1 (0.03)	0.04-0.18	0.08 (0.04)	0.01-0.16	0.38 (0.14)	0.13-0.69
Oct		0 (0)	0-0	0.02 (0.01)	0-0.06	-	-	0.01 (0.01)	0-0.04	0.02 (0.01)	0-0.04	-	-
Nov		0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0.01 (0.01)	0-0.02	0.01 (0.01)	0-0.02	-	-
Dec		0 (0)	0-0	0.02 (0.01)	0-0.06	-	-	0 (0)	0-0	0.03 (0.01)	0-0.05	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.7.5 Design-based abundance estimates

225. Design-based abundance estimates of razorbills, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 2 km buffer in each survey are presented for each appropriate season in **Table 4-40**. Abundance estimates include include auk spp and large auk spp and have been corrected for availability bias (see **Section 3.3.2** and **Section 3.3.3**). The bootstrap means and CV values for these abundance estimates, as well as abundance estimates for auk spp. and large auk spp. are presented in **Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).**

226. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-22**.

227. Abundance estimates varied substantially across the year and among years. A peak abundance of 171 birds was estimated for March 2022. Generally, abundances were higher in spring and autumn, and were lower in May and June and in winter. This is a similar pattern to guillemot abundances in the OAA plus 4 km buffer. This suggests the OAA is important for razorbills in the post-breeding period, when they are moulting and are flightless but is less important during incubation and colony-based chick rearing. Abundance is low in winter as razorbills will have moved away into non-breeding areas such as the southern North Sea.

228. These data do not indicate that abundance estimates of razorbills were impacted by HPAI virus in 2022 (Tremlett *et al.* 2024). Rather, the data indicate that, if anything, abundance of razorbills was higher in 2022 compared with pre-HPAI years (2020 and 2021). However, the high interannual variability in abundance and wide confidence intervals mean that detecting any HPAI impacts on numbers of razorbills using the OAA plus 4 km buffer is challenging.

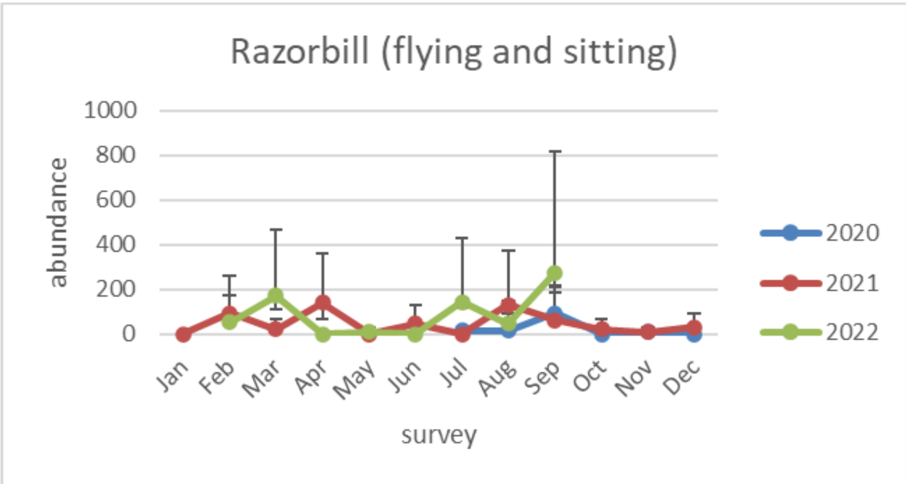

Figure 4-22 Estimated abundance and 95% C.I. of all razorbills (flying and sitting, including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in the OAA plus 2 km in each survey using design-based analysis.

229. Razorbill MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of

Table 4-40 for the OAA plus 4 km buffer and at the bottom of **Table 4-41** for the OAA and OAA plus 2 km buffer. The highest MSP abundance in the OAA plus 2 km buffer (the scale used for the displacement impact assessment) was recorded in the breeding season (141.19 birds, **Table 4-41**). The non-breeding season MSP abundance estimate was slightly lower (131.79 birds, **Table 4-41**) although this latter MSP was driven by high abundance estimates in spring and autumn and mid-winter abundance was much lower.

Table 4-40 Razorbill abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), BDMPS migration seasons (spring = yellow, autumn = amber) and BDMPS winter (purple).

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance				
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**	**Spring migration (BDMPS)**	**Autumn migration (BDMPS)**	**Winter (BDMPS)**
Jul-20	16.04 (14.46)	0-48.12					
Aug-20	15.92 (14.03)	0-47.77					
Sep-20	116.21 (40.36)	48.42-203.37				116.21 (40.36)	
Oct-20	15.51 (14.22)	0-46.52					
Nov-20	7.76 (7.18)	0-23.27		116.21 (40.36)			7.76 (7.18)
Dec-20	0 (0)	0-0					
Jan-21	0 (0)	0-0					
Feb-21	92.94 (34.57)	27.88-167.29			92.94 (34.57)		
Mar-21	85.2 (34.86)	18.93-160.93					
Apr-21	201.66 (44.94)	115.23-288.08					
May-21	31 (17.46)	0-62					
Jun-21	108.52 (41.83)	36.17-198.96	201.66 (44.94)				
Jul-21	0 (0)	0-0					
Aug-21	154.87 (56.17)	58.08-271.03					
Sep-21	92.98 (47.46)	9.3-185.95		201.63 (64.29)		154.87 (56.17)	
Oct-21	23.26 (12.45)	0-46.52					
Nov-21	7.74 (7.26)	0-23.22					31 (16.69)

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance				
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**	**Spring migration (BDMPS)**	**Autumn migration (BDMPS)**	**Winter (BDMPS)**
Dec-21	31 (16.69)	0-62					
Feb (18)-22	0 (0)	0-0					
Feb (26)-22	54.22 (31.36)	0-130.14			201.63 (64.29)		
Mar-22	201.63 (64.29)	89.61-336.04					
Apr-22	0 (0)	0-0					
May-22	7.76 (6.3)	0-23.29					
Jun-22	0 (0)	0-0	230.01 (80.89)				
Jul-22	230.01 (80.89)	90-400.02					
Aug-22	46.82 (26.06)	0-103					
Sep-22	442.66 (166.44)	150.91-794.78					
MSP Abundance			**215.84**	**158.92**	**147.29**	**135.54**	**19.38**

Table 4-41 Razorbill abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in each survey in the OAA and OAA plus 2 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), BDMPS migration seasons (spring = yellow, autumn = amber) and BDMPS winter (purple).

	OAA plus 2 km buffer		Peak seasonal abundance					OAA		Peak seasonal abundance				
Season	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter (BDMPS)
Jul-20	16.04 (14.25)	0-48.12						16.04 (14.86)	0-48.12					
Aug-20	15.92 (14.34)	0-47.77						15.92 (13.68)	0-47.77					
Sep-20	92.97 (35.66)	37.19-167.34				92.97 (35.66)		77.47 (36.24)	19.37-154.95				77.47 (36.24)	
Oct-20	0 (0)	0-0						0 (0)	0-0					
Nov-20	7.76 (7.01)	0-23.27		92.97 (35.66)			7.76 (7.01)	0 (0)	0-0		77.47 (36.24)			0 (0)
Dec-20	0 (0)	0-0						0 (0)	0-0					
Jan-21	0 (0)	0-0						0 (0)	0-0					
Feb-21	92.94 (35.7)	37.18-167.29			92.94 (35.7)			61.96 (29.63)	8.85-123.92			61.96 (29.63)		
Mar-21	23.24 (11.9)	0-46.47						7.75 (7.69)	0-23.24					
Apr-21	139.61 (38.82)	69.8-219.38						62.05 (20.71)	26.59-106.37					
May-21	0 (0)	0-0	139.61 (38.82)					0 (0)	0-0	123.9 (58.77)				
Jun-21	46.51 (18.51)	9.3-83.72						46.51 (18.76)	18.6-83.72					
Jul-21	0 (0)	0-0						0 (0)	0-0					

	OAA plus 2 km buffer							OAA						
			Peak seasonal abundance							Peak seasonal abundance				
Season	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter (BDMPS)
Aug-21	131.64 (54.43)	40.51-243.03						123.9 (58.77)	30.97-247.8					
Sep-21	61.98 (40.65)	0-150.53				131.64 (54.43)		61.98 (41.01)	0-150.76				123.9 (58.77)	
Oct-21	23.26 (12.32)	0-46.52						15.51 (9.66)	0-38.77					
Nov-21	7.74 (7.26)	0-23.22		170.61 (62.8)			31 (16.9)	7.74 (7.14)	0-23.22		123.9 (58.77)			15.5 (9.76)
Dec-21	31 (16.9)	0-62.26						15.5 (9.76)	0-38.75					
Feb (18)-22	0 (0)	0-0						0 (0)	0-0					
Feb (26)-22	54.22 (31.04)	0-119.29			170.61 (62.8)			54.22 (30.4)	0-119.29			100.81 (42.68)		
Mar-22	170.61 (62.8)	56.87-295.72						100.81 (42.68)	33.32-190.43					
Apr-22	0 (0)	0-0						0 (0)	0-0					
May-22	7.76 (6.44)	0-23.29						7.76 (6.5)	0-23.29					
Jun-22	0 (0)	0-0	142.77 (66.63)					0 (0)	0-0	95.18 (56.77)				
Jul-22	142.77 (66.63)	28.55-285.53						95.18 (56.77)	9.52-219.15					
Aug-22	46.82 (26.51)	0-103						7.8 (6.79)	0-23.41					
Sep-22	276.66 (125.55)	61.48-543.34						94.86 (36.21)	28.46-170.74					

Season	OAA plus 2 km buffer		Peak seasonal abundance					OAA		Peak seasonal abundance				
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter (BDMPS)
MSP Abundance			141.19	131.79	131.8	112.3	19.38			109.54	100.69	81.38	100.69	7.75

4.2.8 Puffin

4.2.8.1 Ecology and status

230. Puffin is a colonial burrow-nesting species which breeds around the North Atlantic coasts, as well as the North Sea and Irish Sea. High densities of puffins breed on Orkney and north Scotland, as well as Shetland as well as other eastern and western areas of Britain and Ireland. This species is absent from south-east England (Burnell *et al.* 2023). During the non-breeding season, puffins disperse out from breeding colonies into the North Sea and Atlantic Ocean. This species is rarely recorded around the British Isles in the winter (Wernham *et al.* 2002).

231. Puffin is currently a Red-listed Bird of Conservation Concern in the UK (Stanbury *et al*., 2021) and classed as Vulnerable by the IUCN (IUCN, 2024). A total of 489,238 AOB (puffin burrows) were counted in Britain and Ireland during Seabirds Count (2015-2021). This represented a decrease of 15% since Seabird 2000 (1989-2002; 573,736 AOB; Burnell *et al.* 2023). Scotland holds the majority (75%) of the British and Irish breeding puffin population. The Scottish population has decreased by 21% since Seabird 2000. Seabirds Count found the largest puffin population to be in the Western Isles, particularly at the Flannan Isles SPA (183.9 km from the OAA) for which a 214% increase was recorded between Seabird 2000 to Seabirds Count (although this increase figure should be treated with some caution; Burnell *et al.* 2023). A large puffin breeding population is present in Shetland, although numbers fell by 63% between Seabird 2000 (81,154 AOB) to Seabirds Count (30,334 AOB). The smaller population in Orkney fell by 9% (61,674 to 56-017 AOB) and the Sutherland population fell by 53% over the same timeframe although numbers at Caithness increased by 52% between Seabird 2000 to Seabirds Count (Burnell *et al.* 2023)

232. The HPAI virus (refer to section 2.3) is known to have affected some puffin populations. Puffins tested positive for HPAI in the summer of 2022 at the Isle of May, St Kilda and Islay (refer to **Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review**). However, Tremlett *et al.* (2024) considered puffin to have a low mortality from HPAI in comparison to other seabird species, and puffin was not included in the study of UK seabird colony counts following the 2021-22 outbreak of HPAI (Tremlett *et al.* 2024).

233. Puffins feed on small fish, predominantly sandeels by diving from the sea surface. Foraging trips from breeding colonies have a mean maximum foraging range plus one standard deviation of 62.4 + 34.4 km (Woodward *et al.* 2019). Puffins are particularly vulnerable to changes in sandeel availability which in turn are sensitive to changes in sea temperature and therefore climate change. There are many other threats and pressures that may be driving Britain's breeding puffin population decline including invasive non-native predators and plants, and oil spills (Burnell *et al.* 2023).

4.2.8.2 Seasons

234. Puffin seasons (breeding season, non-breeding season, BDMPS spring and autumn migration) are illustrated in **Table 4-42**. August is defined as being split between the breeding and non-breeding seasons for puffin (NatureScot Guidance Note 9). NatureScot and BDMPS non-breeding seasons are identical so the BDMPS season is not considered further in this report.

Table 4-42 Puffin seasons taken from NatureScot (2023, Guidance Note 9) and Furness (2015). Green cells are breeding months, blue cells are non-breeding months, amber cells are BDMPS non-breeding months.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug*	Sep	Oct	Nov	Dec
Breeding season												
Non -breeding												
BDMPS non-breeding												

*August is a split-month including both breeding and non-breeding seasons (NatureScot Guidance Note 9).

4.2.8.3 *Raw observations*

235. Raw observations of puffins are presented for each survey in **Figure 4-23** to **Figure 4-25**. Puffins were regularly recorded within the OAA plus 4 km buffer in 23 out of 27 surveys. No puffins were recorded during aerial surveys in December 2020, March 2021, February 2022 and March 2022. Numbers of puffin observations fluctuated between surveys, with more observations in the late spring, summer and autumn months and smaller numbers of observations during the winter.

236. Puffins displayed a weak spatial pattern across the OAA plus 4 km buffer and were patchily distributed across the survey area. Within each survey, activity tended to be concentrated to one or two regions and there was considerable inter-annual variability. As a general trend, puffins tended to be more dispersed across the OAA during the autumn and spring months when birds were likely passing to and from breeding colonies, highest activity was generally concentrated on the south-western and north-western edge of the OAA. For the majority of the breeding season (May to July), puffins were less dispersed and activity was more concentrated on the western edge of the OAA with less activity in the centre.

237. The number of raw observations of puffins recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-43**. In most surveys, the majority of puffins were recorded sat on the water.

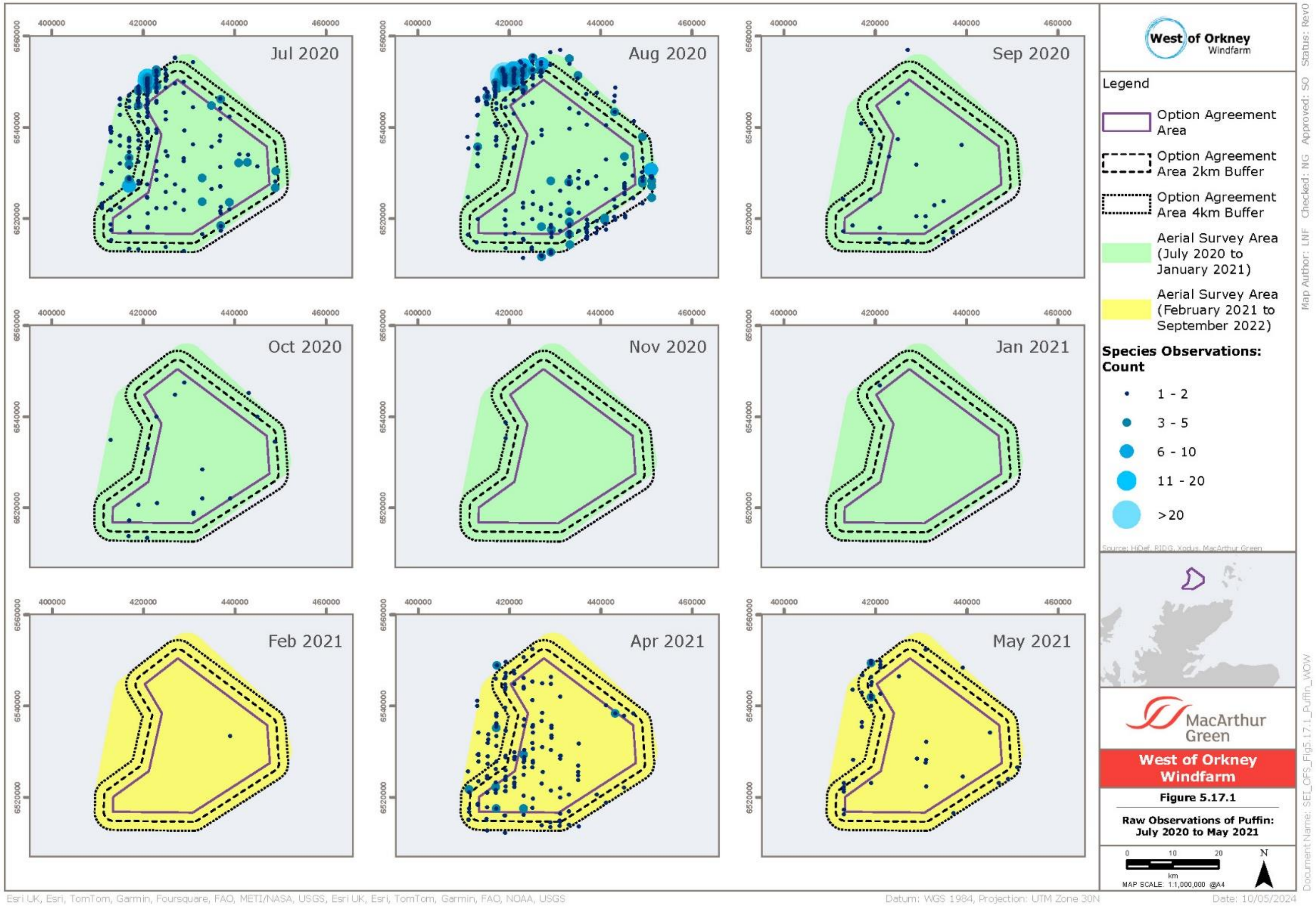

Figure 4-23 Raw observations of puffin: July 2020 to May 2021.

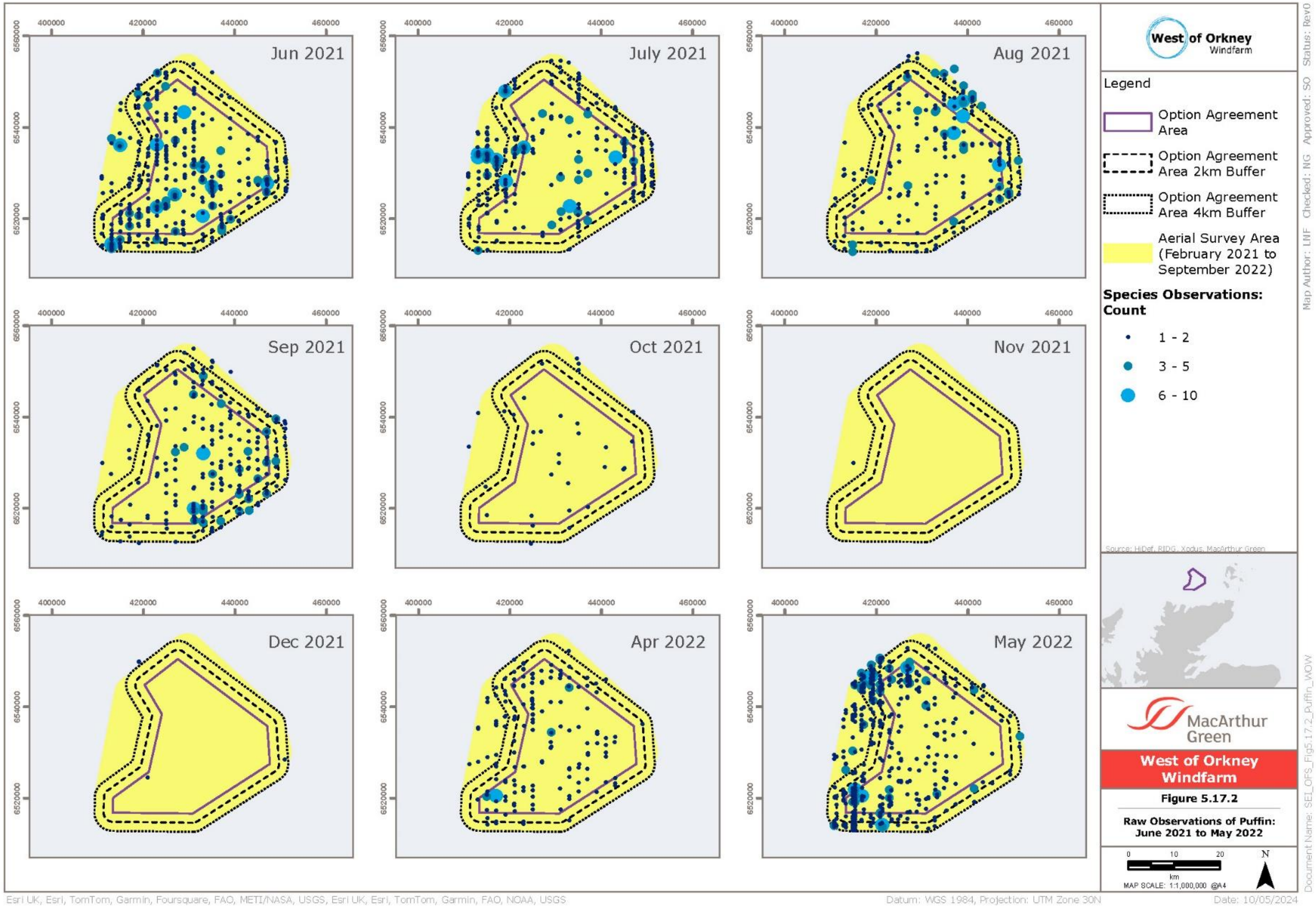

Figure 4-24 Raw observations of puffin: June 2021 to May 2022.

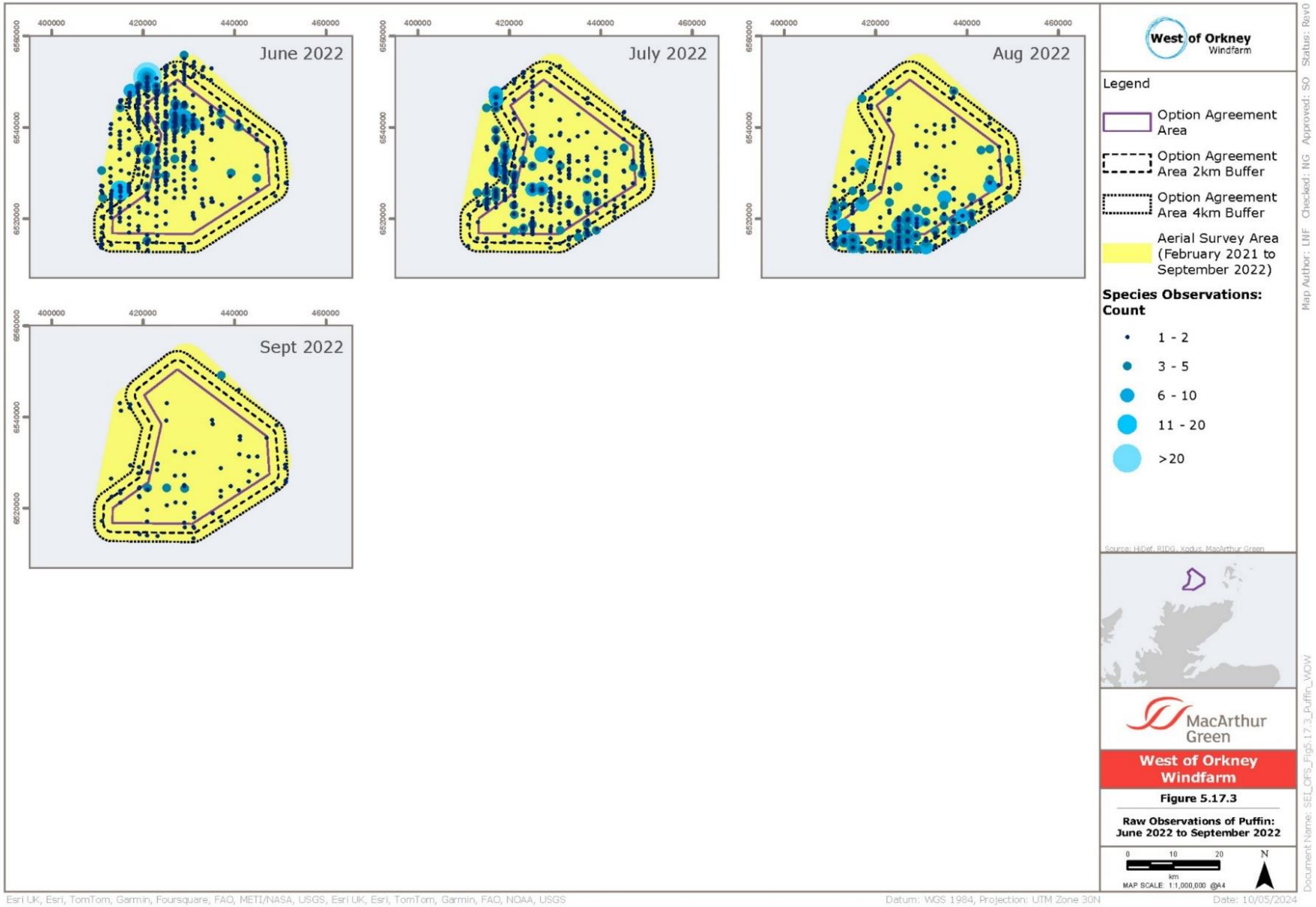

Figure 4-25 Raw observations of puffin: June 2022 to September 2022.

Table 4-43 Puffin raw counts of flying birds, sitting birds and proportion of birds in flight (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	0	90	0.00
Aug-2020	1	92	0.01
Sep-2020	0	14	0.00
Oct-2020	0	10	0.00
Nov-2020	-	-	N/A
Dec-2020	-	-	N/A
Jan-2021	-	-	N/A
Feb-2021	0	1	0.00
Mar-2021	-	-	N/A
Apr-2021	3	105	0.03
May-2021	0	13	0.00
Jun-2021	31	413	0.07
Jul-2021	13	139	0.09
Aug-2021		143	0.00
Sep-2021	1	232	0.00
Oct-2021	1	19	0.05
Nov-2021	-	-	N/A
Dec-2021	0	1	0.00
Feb (18)-22	-	-	N/A
Feb (26)-22	-	-	N/A
Mar-2022	-	-	N/A
Apr-2022	38	87	0.30
May-2022	37	292	0.11
Jun-2022	3	484	0.01
Jul-2022	10	349	0.03
Aug-2022	4	225	0.02
Sep-2022	1	57	0.02

4.2.8.4 *Design-based density estimates*

238. Design-based density estimates of puffins, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA in each survey are presented in **Table 4-44**. Density estimates include auk sp. (see **Section 3.3.2**). The bootstrap means and CV values for these density estimates recorded in each survey are presented in Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds.

239. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA in each survey are presented in **Table 4-45**. Density estimates include auk sp. (see **Section 3.3.2**). The bootstrap means and CV values for these density estimates recorded in each survey are presented in Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying).

240. Density estimates of flying puffins in the OAA were low (**Table 4-44**), particularly in the non-breeding season, where densities were less than 0.1 birds/km^2, except in one month (August 2022). Densities in the breeding season were less than 0.5 birds/km^2, except in one month (May 2022). Densities of all birds were relatively larger (**Table 4-45**), particularly in the breeding season when densities up to 6.8 birds/km^2 occurred.

241. It is important to note that the BDMPS non-breeding season definition is the same as the NatureScot definition, so has not been repeated here.

Table 4-44 Puffin density estimates (including unidentified auks apportioned using identified auk ratios), SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue). BDMPS non-breeding season covers the same months as the NatureScot non-breeding season.

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Mar		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Apr		-	-	0.02 (0.02)	0-0.06	0.48 (0.13)	0.25-0.76	-	-	0.01 (0.01)	0-0.03	0.31 (0.08)	0.19-0.46
May		-	-	0 (0)	0-0	0.44 (0.09)	0.27-0.6	-	-	0 (0)	0-0	0.66 (0.14)	0.42-0.98
Jun		-	-	0.37 (0.08)	0.2-0.53	0.04 (0.02)	0-0.09	-	-	0.48 (0.09)	0.31-0.66	0.13 (0.05)	0.04-0.24
Jul		0 (0)	0-0	0.15 (0.06)	0.05-0.27	0.12 (0.03)	0.06-0.19	0.01 (0.01)	0-0.03	0.21 (0.08)	0.09-0.4	0.28 (0.11)	0.11-0.53
Aug		0.01 (0.01)	0-0.04	0 (0)	0-0	0.05 (0.03)	0-0.12	0.16 (0.06)	0.05-0.29	0 (0)	0-0	0.03 (0.02)	0-0.06
Sep		0 (0)	0-0	0.01 (0.01)	0-0.04	0.01 (0.01)	0-0.04	0 (0)	0-0	0.01 (0.01)	0-0.02	0.01 (0.01)	0-0.03
Oct		0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0 (0)	0-0	0.01 (0.01)	0-0.02	-	-
Nov		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Dec		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-45 Puffin density estimates (including unidentified auks apportioned using identified auk ratios), SDs & 95% C.I. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue). BDMPS non-breeding season covers the same months as the NatureScot non-breeding season.

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0
Feb*		-	-	0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0
Mar		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Apr		-	-	1.55 (0.25)	1.12-2.05	1.7 (0.23)	1.28-2.17	-	-	1.42 (0.14)	1.14-1.71	1.34 (0.13)	1.09-1.61
May		-	-	0.18 (0.06)	0.08-0.31	4.52 (0.8)	3.12-6.22	-	-	0.42 (0.09)	0.25-0.61	5.96 (0.6)	4.93-7.17
Jun		-	-	6.06 (0.93)	4.35-7.96	6.77 (1.51)	4.1-10.01	-	-	5.5 (0.64)	4.34-6.79	6.24 (0.88)	4.72-8.09
Jul		1.39 (0.2)	1.02-1.83	2.08 (0.31)	1.52-2.75	5.22 (0.75)	3.69-6.65	2.84 (0.76)	1.69-4.55	2.71 (0.28)	2.19-3.24	5.77 (0.71)	4.39-7.19
Aug		1.36 (0.23)	0.93-1.81	2.08 (0.3)	1.5-2.64	3.19 (0.68)	1.93-4.65	2.35 (0.37)	1.67-3.09	2.42 (0.24)	1.98-2.9	5.37 (0.88)	3.73-7.13
Sep		0.19 (0.05)	0.09-0.31	3.28 (0.48)	2.39-4.27	0.86 (0.16)	0.55-1.14	0.2 (0.04)	0.13-0.28	2.86 (0.27)	2.38-3.43	0.7 (0.1)	0.52-0.92
Oct		0.14 (0.04)	0.07-0.24	0.27 (0.07)	0.15-0.39	-	-	0.13 (0.03)	0.07-0.19	0.21 (0.04)	0.14-0.3	-	-
Nov		0 (0)	0-0	0 (0)	0-0	-	-	0.01 (0.01)	0-0.02	0 (0)	0-0	-	-
Dec		0 (0)	0-0	0.01 (0.01)	0-0.04	-	-	0 (0)	0-0	0.01 (0.01)	0-0.03	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

MacArthur Green

4.2.8.5 Design-based abundance estimates

242. Design-based abundance estimates of puffin, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 4 km buffer in each survey are presented for each season in **Table 4-46** and in the OAA and OAA plus 2 km buffer in **Table 4-47**. Abundance estimates include auk spp and have been corrected for availability bias (see **Section 3.3.2** and **Section 3.3.3**). The bootstrap means and CV values for these abundance estimates, as well as abundance estimates for auk spp. are presented in **Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).**

243. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-26**. Whilst there was inter-annual variability in puffin abundance, it was consistently high in the breeding season and consistently very low or zero in winter. This suggests the OAA plus 4 km buffer is used by breeding puffins. Sule Skerry and Sule Stack SPA is on the edge of the OAA plus 4 km buffer (1.7 km from the OAA) and are likely to be contributing the majority of birds using the area. Cape Wrath SPA and Hoy SPA are 25.9 km and 24.7 km respectively from the OAA boundary and also have breeding puffin qualifying features so may also contribute birds to the area.

244. These data indicate that abundance estimates of puffins were not impacted by HPAI virus in 2022 (Tremlett *et al.* 2024) as the highest abundance estimates were obtained in 2022.

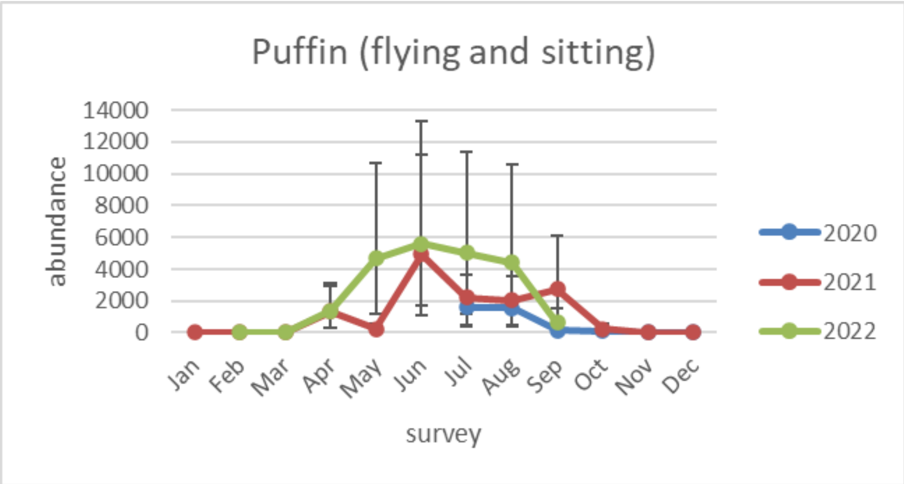

Figure 4-26 Estimated abundance and 95% C.I. of all puffins (flying and sitting, including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in the OAA plus 2 km in each survey using design-based analysis.

245. Puffin MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-46** for the OAA plus 4 km buffer and at the bottom of **Table 4-47** for the OAA and OAA plus 2 km buffer. The highest MSP abundance in the OAA plus 2 km buffer (the scale used for the displacement impact assessment) was recorded in the breeding season (5271.86 birds). The non-breeding season MSP abundance estimate was lower (2135.95 birds), but this

was driven by high abundance estimates in August and September and winter abundance was much lower.

Table 4-46 Puffin abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green) and non-breeding season (blue). BDMPS non-breeding season covers the same months as the NatureScot non-breeding season.

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	Non-breeding season (NatureScot + BDMPS)
Jul-20	3280.37 (881.24)	1955.74-5267.44		
Aug-20	2722.9 (422.68)	1927.12-3576.44		2722.9 (422.68)
Sep-20	232.42 (43.73)	151.97-321.81		
Oct-20	147.33 (34.01)	82.87-220.99		
Nov-20	7.76 (7.21)	0-23.27		
Dec-20	0 (0)	0-0		
Jan-21	7.75 (7.44)	0-23.24		
Feb-21	7.75 (6.83)	0-23.24		
Mar-21	0 (0)	0-0		
Apr-21	1644.28 (167.6)	1313.53-1975.02	6364.05 (736.44)	
May-21	480.53 (108.26)	286.47-702.31		
Jun-21	6364.05 (736.44)	5016.04-7855.09		
Jul-21	3139.47 (321.45)	2534.58-3753.16		
Aug-21	2795.44 (272.34)	2285.46-3352.64		3308.43 (307.41)
Sep-21	3308.43 (307.41)	2752.39-3966.41		
Oct-21	248.13 (48.46)	165.42-349.22		
Nov-21	0 (0)	0-0		
Dec-21	15.5 (9.25)	0-38.75		
Feb (18)-22	0 (0)	0-0		
Feb (26)-22	0 (0)	0-0		
Mar-22	0 (0)	0-0		

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	**Non-breeding season (NatureScot + BDMPS)**
Apr-22	1554.99 (153.38)	1261.77-1865.99	7224.27 (1018.06)	
May-22	6894.29 (693.98)	5699.78-8296.67		
Jun-22	7224.27 (1018.06)	5457.12-9357.67		
Jul-22	6670.33 (816.01)	5080.8-8317.33		
Aug-22	6211.42 (1014.85)	4314.02-8245.64		
Sep-22	814.18 (116.17)	605.67-1069.8		
MSP Abundance			**6794.16**	**3015.67**

Table 4-47 Puffin abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea (including unidentified auks apportioned using identified auk ratios and accounting for availability bias) in each survey in the OAA and OAA plus 2 km buffer. Peak seasonal abundance for the breeding season (green) and non-breeding season (blue). BDMPS non-breeding season covers the same months as the NatureScot non-breeding season.

Season	OAA plus 2 km buffer				OAA			
			Peak seasonal abundance				Peak seasonal abundance	
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot + BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot + BDMPS)
Jul-20	1604.09 (216.1)	1205.62-2043.43			914.33 (130.6)	670.51-1198.79		
Aug-20	1544.57 (232.56)	1122.21-1995.47		1544.57 (232.56)	891.71 (150.59)	613.65-1188.95		891.71 (150.59)
Sep-20	162.69 (39.2)	90.38-244.04			123.96 (35.71)	61.98-203.64		
Oct-20	116.31 (30.03)	62.63-178.94			93.05 (29.53)	46.52-158.18		
Nov-20	0 (0)	0-0			0 (0)	0-0		
Dec-20	0 (0)	0-0			0 (0)	0-0		
Jan-21	7.75 (7.26)	0-23.24			0 (0)	0-0		
Feb-21	7.75 (6.87)	0-23.24			7.75 (7.03)	0-23.24		
Mar-21	0 (0)	0-0			0 (0)	0-0		
Apr-21	1318.52 (164.47)	988.66-1638.74	4930 (627.86)		1016.04 (163.72)	733.81-1345.31	3976.56 (612.18)	
May-21	232.51 (56.55)	134.14-348.77			116.26 (41.03)	53.66-205.69		
Jun-21	4930 (627.86)	3822.54-6296.47			3976.56 (612.18)	2857.03-5221.47		
Jul-21	2201.51 (258.59)	1728.46-2720.04			1364.31 (201.42)	996.31-1804.13		

Season	OAA plus 2 km buffer				OAA			
			Peak seasonal abundance				Peak seasonal abundance	
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot + BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot + BDMPS)
Aug-21	2021.08 (218.98)	1573.01-2440.55		2727.32 (311.71)	1362.88 (193.7)	981.65-1734.57		2153.97 (316.14)
Sep-21	2727.32 (311.71)	2170.5-3385.96			2153.97 (316.14)	1571.33-2801.31		
Oct-21	224.87 (48.47)	140.54-318.8			178.34 (43.17)	98.09-258.82		
Nov-21	0 (0)	0-0			0 (0)	0-0		
Dec-21	7.75 (7.3)	0-23.25			7.75 (7.25)	0-23.25		
Feb (18)-22	0 (0)	0-0			0 (0)	0-0		
Feb (26)-22	0 (0)	0-0			0 (0)	0-0		
Mar-22	0 (0)	0-0			0 (0)	0-0		
Apr-22	1392.53 (157.36)	1090.96-1711.84	5613.71 (975.37)		1114.03 (151.09)	837.75-1425.95	4444.51 (992.18)	
May-22	4689.36 (624.12)	3503.21-5947.93			2965.79 (527.26)	2046.3-4083.82		
Jun-22	5613.71 (975.37)	3888.3-7713.38			4444.51 (992.18)	2692.26-6571.63		
Jul-22	5020.59 (637.74)	3866.61-6372.65			3426.38 (489.41)	2424.23-4361.95		
Aug-22	4424.47 (865.16)	2824.48-6125.24			2091.28 (446.1)	1269.38-3050.63		
Sep-22	640.28 (113.69)	430.04-860.32			561.23 (102.5)	358.03-745.33		

Season	OAA plus 2 km buffer				OAA			
			Peak seasonal abundance				Peak seasonal abundance	
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot + BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot + BDMPS)
MSP Abundance			5,271.86	2,135.95			4,210.54	1,522.84

4.2.9 European storm-petrel

4.2.9.1 *Ecology and status*

246. European storm-petrels breed mostly on uninhabited islands and skerries (de León *et al.* 2006) within burrows and crevices in colonies that sometimes number tens of thousands of pairs (Burnell *et al.* 2023). This species, which is only active nocturnally when attending nests during the breeding season, has breeding colonies mainly on the west coast of Britain and Ireland, including Orkney and Shetland (Burnell *et al.* 2023). The European storm-petrel is migratory, wintering off southwest and South Africa (Wernham *et al.* 2002).

247. European storm-petrel is an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al.*, 2021) and classed as Least Concern by the IUCN (IUCN, 2024). Seabirds Count (2015-2021) reported 147,500 AOS across 127 occupied sites in Britain and Ireland; this represented a 17% increase since Seabird 2000 (1998-2002; Burnell *et al.* 2023). Scotland has 23% of the British and Irish population, the Seabirds Count reported 33,358 AOS in Scotland, representing an increase of 48% since Seabird 2000. This apparent increase was driven mainly by population estimates doubling at Scotland's two largest colonies in the Mousa SPA (193.2 km from the OAA) and Treshnish Isles SPA (275.6 km from the OAA, Burnell *et al.* 2023). Seabirds Count reported approximately 2,300 AOS across 14 sites in Orkney (25% increase since Seabird 2000), including on outlying Sule Skerry. The two largest sites in Orkney, Auskerry SPA (77.6 km from the OAA) and Sule Skerry and Sule Stack SPA (1.7 km from the OAA) declined by 30% and 43% respectively between Seabird 2000 and Seabirds Count. The HPAI virus (refer to **section 2.3**) is not known to have affected European storm-petrel populations.

248. European storm-petrels feed off the sea surface and dive up to 5 m, their diet is composed mainly of small fish and zooplankton, they may also follow boats to feed off discarded fish offal (Burnell *et al.* 2023). This species has a mean maximum foraging range of 336 km (Woodward *et al.* 2019). One of the main threats to European storm-petrel is from mammalian and avian predation at breeding grounds (Burnell *et al.* 2023).

4.2.9.2 *Seasons*

249. European storm-petrel seasons (breeding season and non-breeding season) are illustrated in **Table 4-48**. May is defined as being split between the breeding and non-breeding seasons for European storm-petrel (NatureScot Guidance Note 9).

Table 4-48 European storm-petrel seasons taken from NatureScot 2023 (Guidance Note 9). Green cells are breeding months, blue cells are non-breeding months.

Season	Jan	Feb	Mar	Apr	May*	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season												
Non -breeding												

*May is a split-month including both breeding and non-breeding seasons (NatureScot Guidance Note 9).

4.2.9.3 Raw observations

250. Raw observations of European storm-petrels are presented for each survey in **Figure 4-27**. European storm-petrel was recorded within the OAA plus 4 km buffer in only 4 out of 27 surveys including August and September 2020 and 2021. This species was absent from the survey area at all other times of the year and was not recorded in any other survey.

251. All European storm-petrels recorded were in flight at the time of each survey.

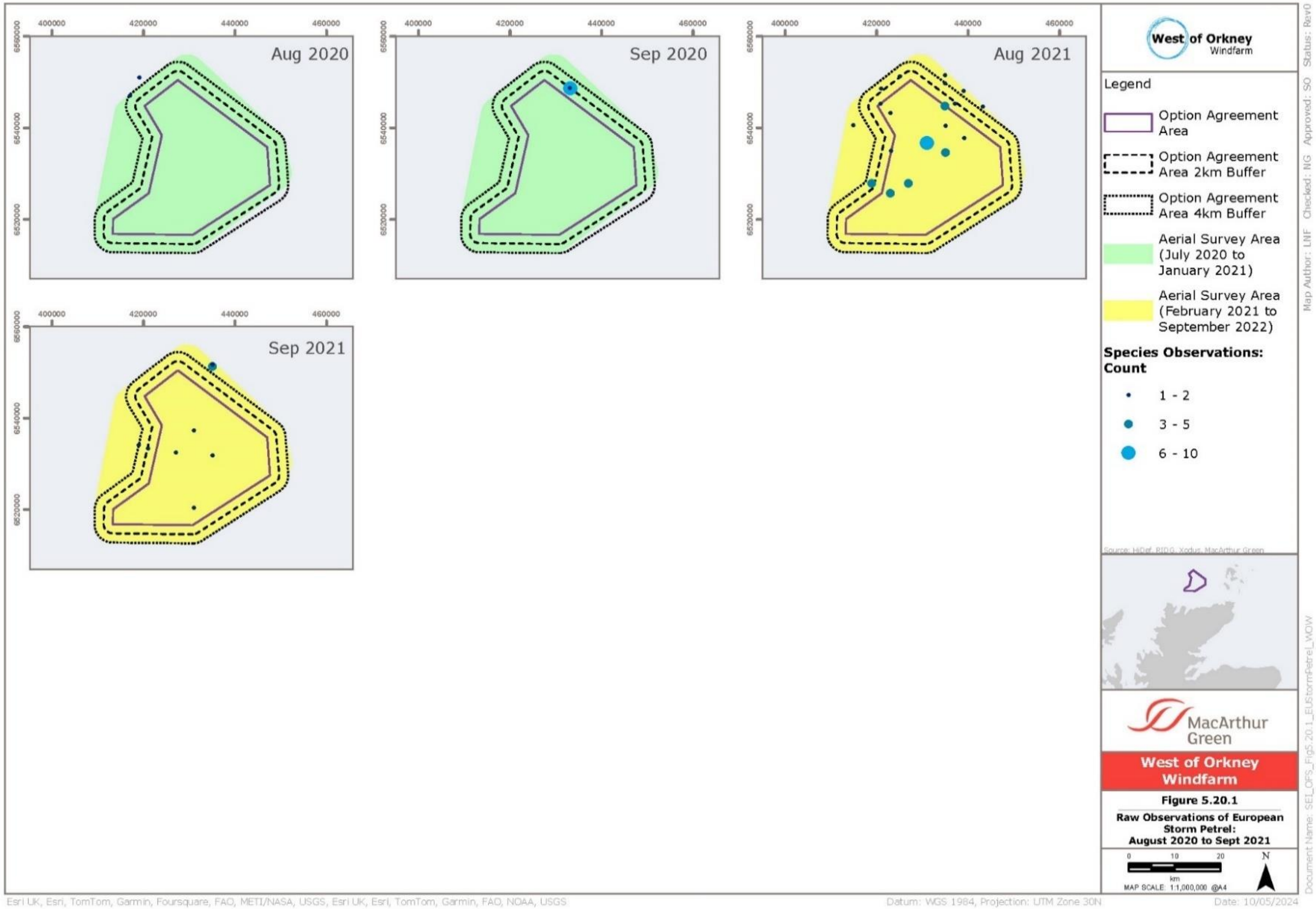

Figure 4-27 Raw observations of European storm-petrel: August 2020 to September 2021.

4.2.9.4 Design-based density estimates

252. Design-based density estimates of European storm-petrels, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-49**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey of flying birds**. As European storm-petrels were only observed in flight, no other density estimates were relevant to their baseline characterisation.

253. Density estimates of flying European storm-petrels in the OAA were low (**Table 4-49**), with densities in the breeding season only exceeding 0.1 birds/km^2 on one occasion (August 2021).

Table 4-49 European storm-petrel density estimates, SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green) and non-breeding season (blue).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*	Non-breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*	Non-breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Mar	Non-breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Apr	Non-breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
May	Breeding / Non-breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jun	Breeding	-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jul	Breeding	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0
Aug	Breeding	0 (0)	0-0	0.31 (0.11)	0.11-0.53	0 (0)	0-0	0.01 (0.01)	0-0.02	0.24 (0.07)	0.11-0.39	0 (0)	0-0
Sep	Breeding	0 (0)	0-0	0.05 (0.02)	0.01-0.09	0 (0)	0-0	0.07 (0.07)	0-0.22	0.03 (0.01)	0.01-0.06	0 (0)	0-0
Oct	Breeding	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Nov	Non-breeding	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Dec	Non-breeding	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

MacArthur Green

4.2.9.5 *Design-based abundance estimates*

254. Design-based abundance estimates of European storm-petrels, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying, though note all birds recorded were in flight) in the OAA plus 2 km buffer in each survey are presented for each appropriate season in **Figure 4-28**. However, it should be noted that all birds were recorded in flight.

255. The bootstrap means and CV values for these abundance estimates are presented in Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).

256. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in August and September 2021 are illustrated in **Figure 4-28**.

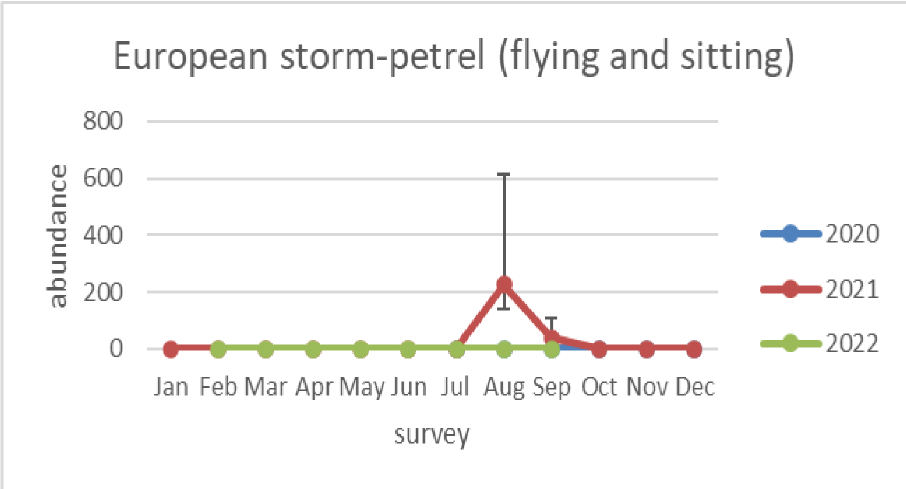

Figure 4-28 Estimated abundance and 95% C.I. of all European storm-petrels (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis.

257. European storm-petrel MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-50**Table 4-50). The highest MSP abundance 139.39 birds) was recorded in the breeding season and there were no records for the non-breeding season (**Table 4-50**).

Table 4-50 European storm-petrel abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green) and non-breeding season (blue).

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	Non-breeding season (NatureScot)
Jul-20	0 (0)	0-0		
Aug-20	7.96 (7.01)	0-23.89		

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**
Sep-20	85.22 (80.23)	0-255.66		
Oct-20	0 (0)	0-0		
Nov-20	0 (0)	0-0		0 (0)
Dec-20	0 (0)	0-0		
Jan-21	0 (0)	0-0		
Feb-21	0 (0)	0-0		
Mar-21	0 (0)	0-0		
Apr-21	0 (0)	0-0		
May-21	0 (0)	0-0	278.77 (81.43)	
Jun-21	0 (0)	0-0		
Jul-21	0 (0)	0-0		
Aug-21	278.77 (81.43)	139.39-456.87		
Sep-21	38.74 (15.98)	7.75-69.73		
Oct-21	0 (0)	0-0		
Nov-21	0 (0)	0-0		0 (0)
Dec-21	0 (0)	0-0		
Feb (18)-22	0 (0)	0-0		
Feb (26)-22	0 (0)	0-0		
Mar-22	0 (0)	0-0		
Apr-22	0 (0)	0-0		
May-22	0 (0)	0-0	0 (0)	
Jun-22	0 (0)	0-0		
Jul-22	0 (0)	0-0		
Aug-22	0 (0)	0-0		
Sep-22	0 (0)	0-0		

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance	
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**
MSP Abundance			**139.39**	**0.00**

4.2.10 Fulmar

4.2.10.1 *Ecology and status*

258. Fulmar is a widely distributed seabird which mostly breed along coastlines at northern latitudes in the Northern Hemisphere (Burg *et al.* 2003). Fulmars can nest in a variety of locations from cliffs, rocky beaches, sand dunes and buildings. Due to this flexibility in nesting habitat they can be more widely distributed than other more densely breeding species (e.g. kittiwake and auks; Burnell *et al.* 2023). Many large fulmar colonies are located in Orkney and Shetland as well as along the north, east and west coasts of mainland Scotland. After fledging, young fulmars may spend at least four years at sea without ever returning to land. Adults can also be distributed across the North Atlantic and North Pacific Oceans in the non-breeding season. However, they may regularly return to their breeding sites throughout the year (Wernham *et al.* 2002).

259. Fulmar is currently an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al.*, 2021) and classed as Least Concern by the IUCN (IUCN, 2024). In the early 2000s, fulmar was one of the commonest seabird species in Britain and Ireland, which held approximately 8% of its world breeding population (Mitchell *et al*. 2004). However, in recent years this species has experienced a population decline in the UK. During Seabirds Count, 352,995 AOS were counted across 2,553 surveyed sites, this represented a decrease of approximately 35% since Seabird 2000 (1998-2002; Burnell *et al*. 2023). Scotland holds the majority (88%) of the British and Irish breeding fulmar population, the largest colonies are in Scotland and some of the greatest population declines have also occurred in Scotland (as well as Isle of Man and Northern Ireland; Burnell *et al.* 2023). The Scottish breeding fulmar population recorded in Seabirds Count was 309,545 AOS, this represented a decline of 37% since Seabird 2000. Some of the largest declines were in north and west Scotland, for example the St Kilda SPA (249.8 km from the OAA) population decreased by 57% between Seabird 2000 to Seabirds Count. By contrast, breeding fulmars increased on Fair Isle by 59% between Seabird 2000 to Seabirds Count. Elsewhere on Orkney and northern mainland Scotland, some colonies have increased, but for the most part colonies have decreased in size over the last 20-25 years (Burnell *et al.* 2023).

260. The HPAI virus (refer to section 2.3) is known to have affected some fulmar populations. A small number of fulmars in Orkney tested positive for HPAI in the summer of 2022 (refer to **Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review**). However, Tremlett *et al.* (2024) considered fulmar to have a low mortality from HPAI in comparison to other seabird species, and fulmar was not included in the study of UK seabird colony counts following the 2021-22 outbreak of HPAI (Tremlett *et al.* 2024).

261. Fulmars feed on the surface of the sea, skimming the water for small crustaceans and fish (Garthe & Furness 2001), although birds will also follow boats for fishery discards. Foraging trips from breeding colonies have a mean maximum foraging range of 542.3 ± 657.9 km (Woodward *et al.* 2019). There are many factors that may affect the decline of breeding fulmars, including climate change impacts on prey distribution, invasive mammalian predators, fishery by-catch and the latest outbreak of HPAI (Burnell *et al.* 2023).

4.2.10.2 Seasons

262. Fulmar seasons (breeding season, non-breeding season, BDMPS spring and autumn migration and winter period) are illustrated in **Table 4-51**. September is defined as being split between the breeding and non-breeding seasons for fulmar (NatureScot Guidance Note 9).

Table 4-51 Fulmar seasons taken from NatureScot (2023, Guidance Note 9) and Furness (2015). Green cells are breeding months, blue cells are non-breeding months, yellow cells are spring migration, orange cells are autumn migration, purple cells are winter.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep*	Oct	Nov	Dec
Breeding season												
Non -breeding												
BDMPS Spring migration												
BDMPS Autumn migration												
BDMPS Winter												

*September is a split-month including both breeding and non-breeding seasons (NatureScot Guidance Note 9).

4.2.10.3 Raw observations

263. Raw observations of fulmars are presented for each survey in **Figure 4-29** to **Figure 4-31**. Fulmars were recorded regularly within the OAA plus 4 km buffer in 26 out of 27 surveys. An exception was in June 2021 when one fulmar observation was recorded outside of the 4 km buffer. Numbers of fulmars fluctuated between surveys, with more observations in higher numbers during the non-breeding season (mid-September to March) compared with the breeding season (April to mid-September).

264. Fulmars displayed a weak spatial pattern across the survey area. Fulmars appeared to be more widely distributed across the OAA during post breeding dispersal in September and October. During the breeding season, fulmars tended to be located on the eastern edge of the OAA and during the non-breeding season, the highest numbers were recorded on the eastern, southern and north-western edges of the OAA, although areas of highest activity varied between months.

265. The number of raw observations of fulmars recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-52**. Fulmars were recorded in flight as well as sat on the water in the OAA, in approximately a third of surveys, less than 50% of fulmars were recorded in flight.

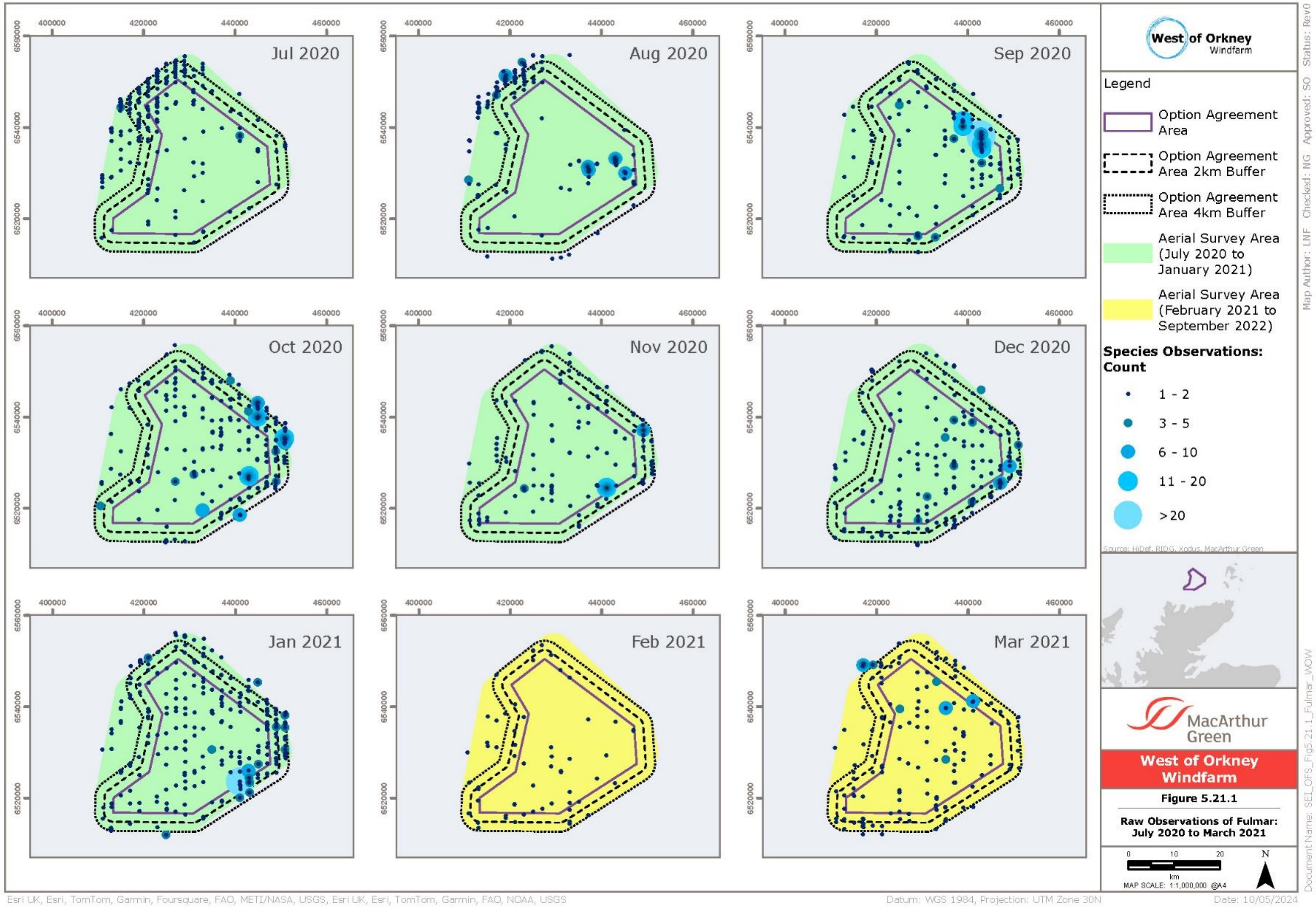

Figure 4-29 Raw observations of fulmar: July 2020 to March 2021.

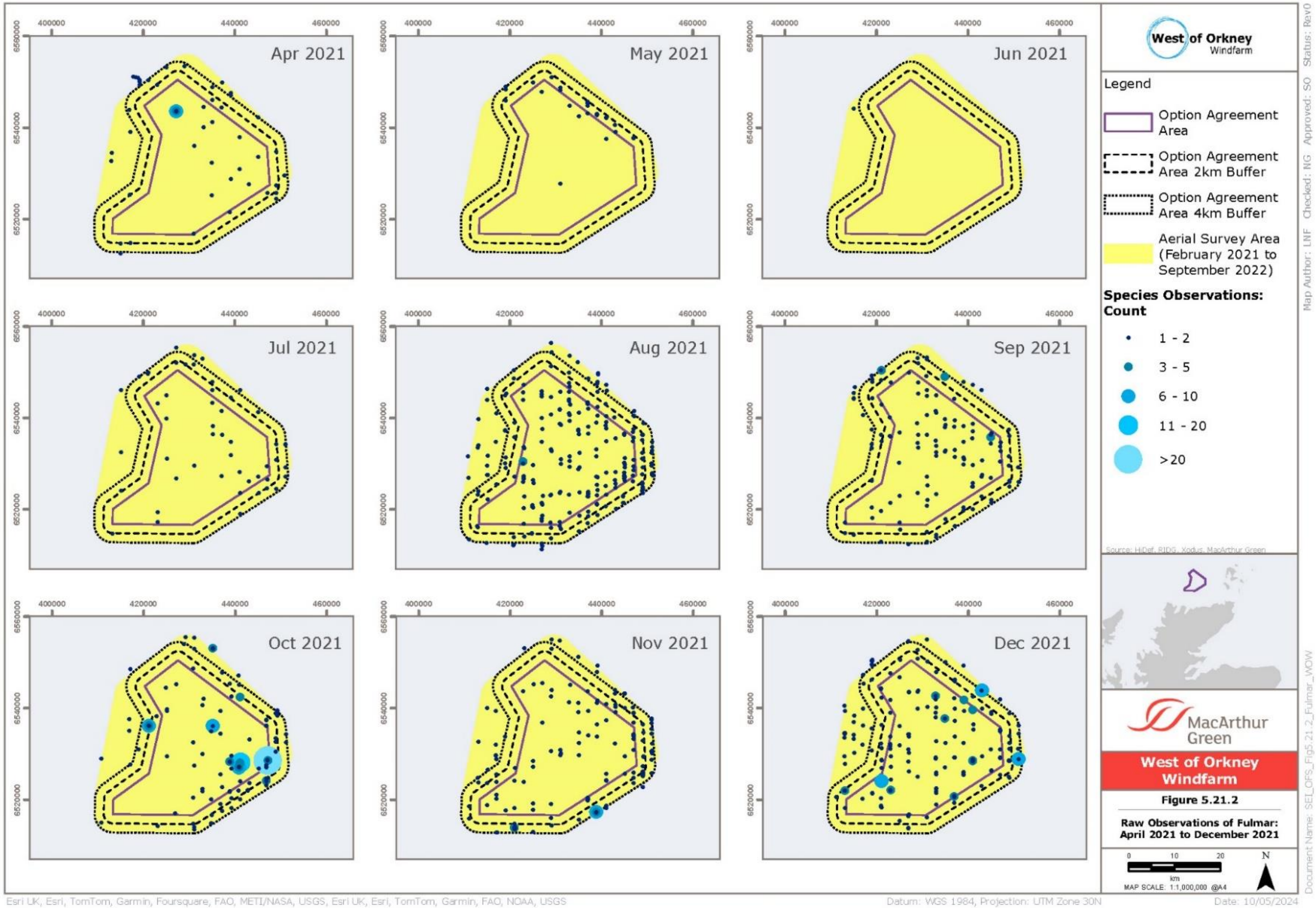

Figure 4-30 Raw observations of fulmar: April 2021 to December 2021

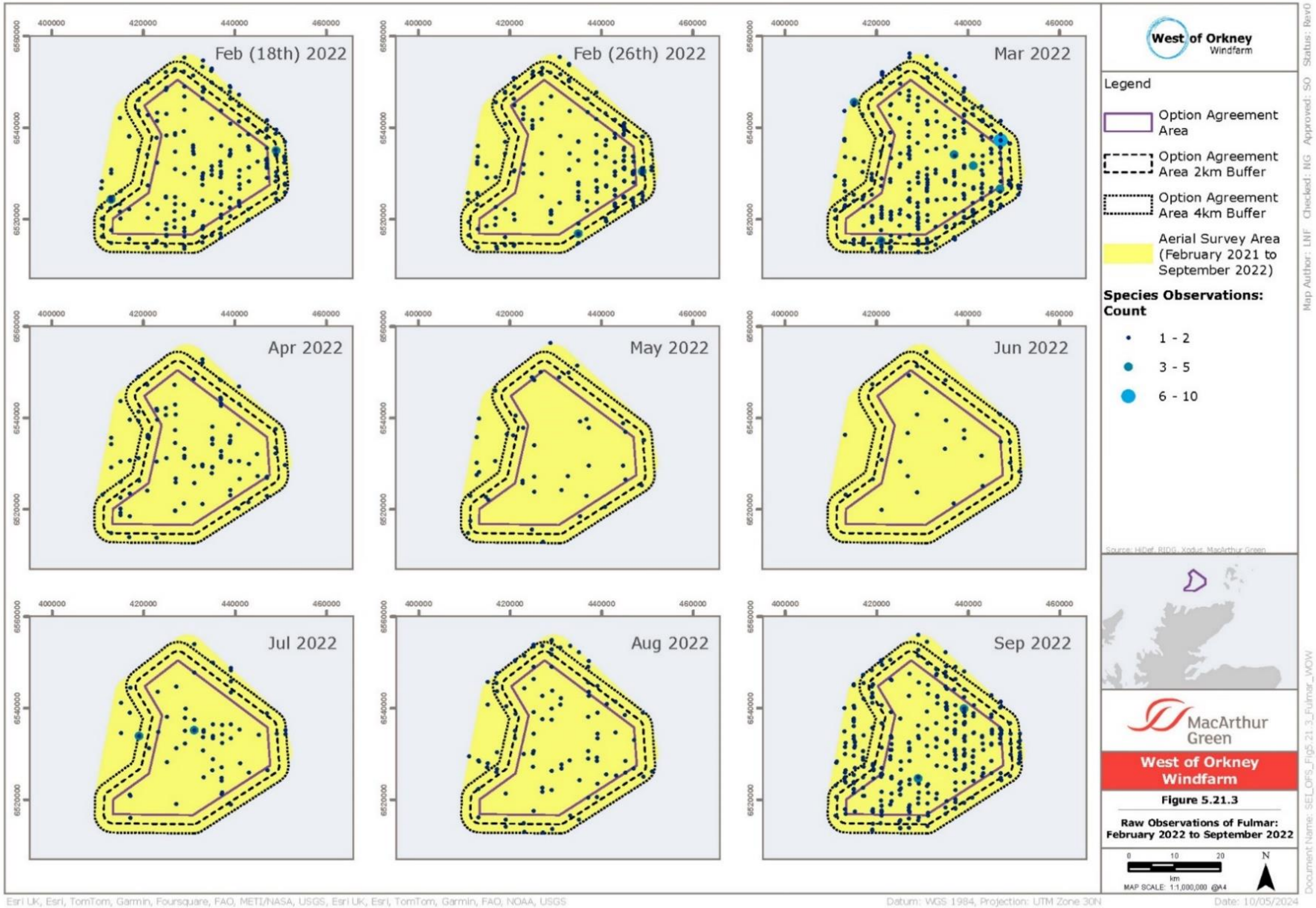

Figure 4-31 Raw observations of fulmar: February 2022 to September 2022.

Table 4-52 Fulmar raw counts of flying birds, sitting birds and proportion of birds in flight per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	17	42	0.29
Aug-2020	49	140	0.26
Sep-2020	57	297	0.16
Oct-2020	53	97	0.35
Nov-2020	90	27	0.77
Dec-2020	150	50	0.75
Jan-2021	88	74	0.54
Feb-2021	13	10	0.57
Mar-2021	88	15	0.85
Apr-2021	12	26	0.32
May-2021	6	0	1.00
Jun-2021	-	-	N/A
Jul-2021	18	3	0.86
Aug-2021	35	89	0.28
Sep-2021	29	47	0.38
Oct-2021	83	101	0.45
Nov-2021	40	6	0.87
Dec-2021	166	56	0.75
Feb (18)-22	90	7	0.93
Feb (26)-22	107	24	0.82
Mar-2022	172	32	0.84
Apr-2022	54	4	0.93
May-2022	13	3	0.81
Jun-2022	13	3	0.81
Jul-2022	30	19	0.61
Aug-2022	39	3	0.93
Sep-2022	43	130	0.25

4.2.10.4 Design-based density estimates

266. Design-based density estimates of fulmars, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-53**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds**.

267. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-54**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey recorded of all birds (sitting and flying)**.

268. Density estimates of flying fulmars in the OAA and OAA plus 4 km buffer were generally very small (**Table 4-53**). All the estimated densities of flying birds were less than 0.1 birds/km^2. Larger densities were estimated for all birds (flying and on the sea) with values often greater than one bird/km^2 and has high as 4.2 birds/km^2 (**Table 4-54**).

Table 4-53 Fulmar density estimates, SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow), autumn migration (orange) and winter period (purple).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	1.04 (0.13)	0.8-1.31	1.05 (0.14)	0.8-1.33	-	-	1.3 (0.1)	1.12-1.49	1.24 (0.1)	1.07-1.43
Feb*		-	-	0.15 (0.05)	0.07-0.26	1.26 (0.23)	0.84-1.73	-	-	0.24 (0.04)	0.17-0.31	1.53 (0.22)	1.12-1.96
Mar		-	-	1.04 (0.31)	0.58-1.76	2.02 (0.23)	1.6-2.47	-	-	0.96 (0.2)	0.64-1.39	1.97 (0.14)	1.7-2.27
Apr		-	-	0.13 (0.03)	0.07-0.2	0.64 (0.1)	0.46-0.84	-	-	0.18 (0.03)	0.13-0.25	0.54 (0.06)	0.42-0.68
May		-	-	0.07 (0.03)	0.02-0.13	0.15 (0.04)	0.08-0.24	-	-	0.18 (0.05)	0.09-0.28	0.19 (0.03)	0.13-0.26
Jun		-	-	0 (0)	0-0	0.15 (0.04)	0.07-0.24	-	-	0 (0)	0-0	0.13 (0.03)	0.08-0.19
Jul		0.21 (0.05)	0.11-0.31	0.21 (0.05)	0.13-0.31	0.36 (0.07)	0.22-0.51	0.32 (0.05)	0.23-0.42	0.23 (0.03)	0.16-0.29	0.29 (0.05)	0.21-0.38
Aug		0.55 (0.19)	0.22-0.95	0.41 (0.08)	0.27-0.58	0.46 (0.07)	0.33-0.58	0.43 (0.12)	0.21-0.68	0.41 (0.05)	0.31-0.52	0.45 (0.05)	0.36-0.55
Sep		0.64 (0.13)	0.39-0.91	0.34 (0.06)	0.22-0.46	0.51 (0.09)	0.34-0.67	0.73 (0.17)	0.47-1.13	0.38 (0.05)	0.28-0.46	0.47 (0.06)	0.36-0.59
Oct		0.61 (0.12)	0.39-0.87	0.98 (0.58)	0.2-2.29	-	-	0.72 (0.09)	0.55-0.91	1.03 (0.33)	0.42-1.72	-	-
Nov		0.79 (0.19)	0.44-1.21	0.47 (0.08)	0.32-0.65	-	-	1.03 (0.23)	0.58-1.43	1.55 (0.47)	0.74-2.52	-	-
Dec		1.76 (0.48)	0.98-2.77	1.89 (0.48)	1.04-2.87	-	-	3.01 (0.81)	1.63-4.63	1.29 (0.27)	0.82-1.86	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-54 Fulmar density estimates, SDs & 95% C.I. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow), autumn migration (orange) and winter period (purple).

Month	Season	OAA (birds/km^2)						OAA plus 4 km buffer (birds/km^2)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	1.91 (0.34)	1.33-2.62	1.15 (0.14)	0.9-1.42	-	-	2.42 (0.28)	1.92-2.99	1.36 (0.11)	1.15-1.59
Feb*		-	-	0.27 (0.07)	0.14-0.42	1.55 (0.29)	1-2.15	-	-	0.36 (0.05)	0.27-0.47	1.79 (0.24)	1.36-2.3
Mar		-	-	1.22 (0.32)	0.71-1.92	2.41 (0.27)	1.9-2.98	-	-	1.2 (0.19)	0.84-1.59	2.44 (0.19)	2.08-2.85
Apr		-	-	0.45 (0.29)	0.09-1.08	0.68 (0.1)	0.5-0.9	-	-	0.4 (0.17)	0.17-0.76	0.58 (0.07)	0.45-0.72
May		-	-	0.07 (0.03)	0.02-0.13	0.19 (0.04)	0.11-0.27	-	-	0.21 (0.06)	0.11-0.35	0.25 (0.04)	0.18-0.32
Jun		-	-	0 (0)	0-0	0.19 (0.05)	0.11-0.28	-	-	0 (0)	0-0	0.18 (0.03)	0.12-0.24
Jul		0.72 (0.17)	0.42-1.1	0.25 (0.05)	0.15-0.34	0.59 (0.13)	0.35-0.86	1.2 (0.17)	0.88-1.53	0.29 (0.04)	0.22-0.38	0.47 (0.08)	0.33-0.66
Aug		2.29 (1.17)	0.41-4.78	1.46 (0.18)	1.12-1.81	0.5 (0.07)	0.38-0.63	1.53 (0.67)	0.43-2.99	1.43 (0.1)	1.24-1.65	0.55 (0.05)	0.45-0.65
Sep		4.18 (2.14)	1.03-8.95	0.9 (0.14)	0.64-1.18	2.08 (0.22)	1.67-2.57	2.91 (1.23)	1-5.54	0.9 (0.09)	0.72-1.07	1.91 (0.13)	1.65-2.17
Oct		1.77 (0.44)	1-2.73	2.17 (0.98)	0.51-4.34	-	-	3.12 (0.68)	1.92-4.44	2.01 (0.57)	1.02-3.24	-	-
Nov		1.38 (0.47)	0.67-2.46	0.54 (0.09)	0.38-0.72	-	-	1.66 (0.38)	0.9-2.39	1.75 (0.52)	0.86-2.83	-	-
Dec		2.36 (0.52)	1.44-3.48	2.62 (0.57)	1.61-3.8	-	-	3.92 (0.93)	2.31-5.79	2.02 (0.33)	1.41-2.72	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.10.5 Design-based abundance estimates

269. Design-based abundance estimates of fulmars, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA plus 4 km buffer in each survey are presented for each season in **Table 4-55**. The bootstrap means and CV values for these abundance estimates are presented in **Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).**

270. Design-based abundance estimates, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying) in the OAA and OAA plus 2 km buffer in each survey are presented for each season in **Table 4-56**. The bootstrap means and CV values for these abundance estimates are presented in **Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).**

271. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-32.** Abundance estimates tended to be slightly higher in 2020 compared with 2021 and 2022. However, this difference was small enough to suggest that their populations were not impacted by HPAI in 2022 (Tremlett *et al.* 2024).

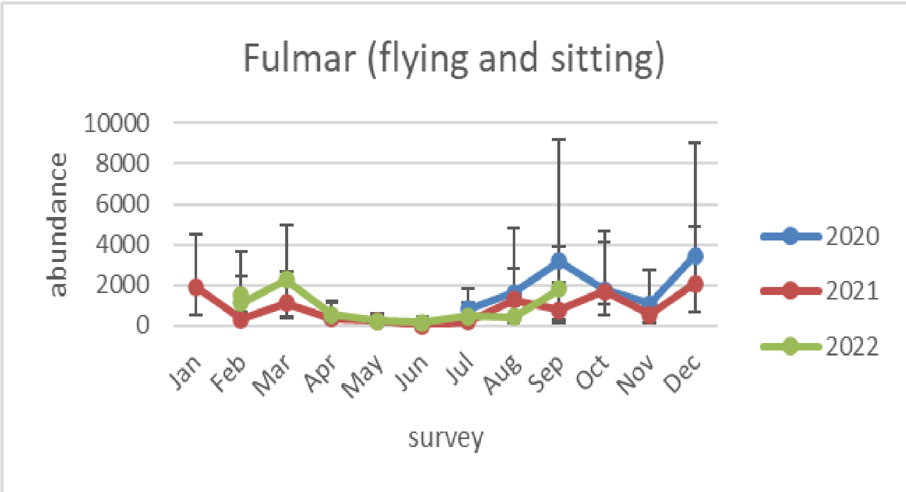

Figure 4-32 Estimated abundance and 95% C.I. of all fulmars (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis.

272. Fulmar MSP abundance estimates (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-55** for the OAA plus 4 km buffer and at the bottom of **Table 4-56** for the OAA and OAA plus 2 km buffer. The highest MSP abundance in the OAA plus 2 km buffer (the scale used for the displacement impact assessment) was recorded in the non-breeding season (2864.14 birds). The BDMPS spring migration period was identical to this. The BDMPS autumn migration period was 2,441.1 birds. The breeding season MSP abundance estimate was lower (1536.11 birds) with the lowest estimate recorded in the BDMPS winter period (813.78 birds).

Table 4-55 Fulmar abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow), autumn migration (orange) and winter period (purple).

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance				
			Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter period (BDMPS)
Jul-20	1387.54 (194.83)	1018.6-1764.5					
Aug-20	1775.46 (772.63)	493.62-3455.57					
Sep-20	3362.31 (1420.78)	1162.09-6407.18		4533.23 (1075.98)		3605.59 (786.47)	
Oct-20	3605.59 (786.47)	2217.63-5141.07					
Nov-20	1915.51 (439.73)	1039.19-2768.58					1915.51 (439.73)
Dec-20	4533.23 (1075.98)	2673.25-6695.82			4533.23 (1075.98)		
Jan-21	2797.07 (321.56)	2215.96-3463.6					
Feb-21	418.23 (60.86)	309.8-542.16					
Mar-21	1386.41 (225.55)	968.16-1843.38					
Apr-21	465.36 (193.4)	193.71-876.62	1657.13 (120.82)				
May-21	248.01 (70.69)	124.01-403.02					

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance				
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**	**Spring migration (BDMPS)**	**Autumn migration (BDMPS)**	**Winter period (BDMPS)**
Jun-21	0 (0)	0-0					
Jul-21	341.08 (45.24)	255.81-434.1					
Aug-21	1657.13 (120.82)	1440.31-1905.12					
Sep-21	1038.24 (102.59)	829.04-1239.89				2326.21 (654.07)	
Oct-21	2326.21 (654.07)	1178.42-3753.15					
Nov-21	2027.98 (598.11)	990.77-3274.37					2027.98 (598.11)
Dec-21	2332.64 (377.99)	1627.23-3146.54		2822.77 (222.73)			
Feb (18)-22	1573.23 (123.95)	1325.24-1836.73			2822.77 (222.73)		
Feb (26)-22	2075.97 (283.14)	1572.47-2656.93					
Mar-22	2822.77 (222.73)	2404.01-3295.82					
Apr-22	673.06 (77.23)	526.07-835.52					
May-22	287.26 (40.91)	209.62-364.9	2213.32 (155.61)				
Jun-22	209.06 (34.34)	139.37-278.75					

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance				
			Breeding season (NatureScot)	**Non-breeding season (NatureScot)**	**Spring migration (BDMPS)**	**Autumn migration (BDMPS)**	**Winter period (BDMPS)**
Jul-22	547.27 (96.85)	380.51-761.42					
Aug-22	639.87 (60.99)	522.82-756.92					
Sep-22	2213.32 (155.61)	1912.94-2513.69					
MSP Abundance			**1935.23**	**3678.00**	**3678.00**	**2965.90**	**1971.75**

Table 4-56 Fulmar abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA and OAA plus 2 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow), autumn migration (orange) and winter period (purple).

	OAA plus 2 km buffer							OAA						
			Peak seasonal abundance							Peak seasonal abundance				
Season	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter period (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter period (BDMPS)
Jul-20	794.03 (128.17)	561.43-1058.9						473.21 (110.43)	272.7-721.84					
Aug-20	1600.3 (749.27)	374.2-3201.39						1504.76 (767.31)	270.5-3137.3					
Sep-20	3191.87 (1340.86)	1068.93-5973.92				3191.87 (1340.86)		2742.53 (1405.37)	674.01-5872.62				2742.53 (1405.37)	
Oct-20	1752.39 (299.5)	1240.63-2396.55						1163.09 (286.98)	659.09-1791.55					
Nov-20	1085.72 (291.86)	620.41-1690.81					1085.72 (291.86)	907.35 (305.47)	442.04-1613.26					907.35 (305.47)
Dec-20	3463.86 (991.2)	1735.8-5548.56		3463.86 (991.2)				1549.82 (343.68)	945.2-2286.18		2742.53 (1405.37)			
Jan-21	1921.53 (300.47)	1394.66-2549.32			3463.86 (991.2)			1255.19 (222.27)	875.34-1720.27			1549.82 (343.68)		
Feb-21	302.06 (49.96)	209.12-402.74						178.14 (46.77)	92.94-278.82					
Mar-21	1099.83 (224.37)	712.57-1556.8						797.76 (207.75)	464.52-1262.48					
Apr-21	356.78 (190.31)	116.34-783.36						294.73 (190.35)	62.05-705.8					
May-21	240.26 (67.99)	116.26-372.22	1269.95 (120.58)					46.5 (18.09)	15.5-85.26	960.21 (116.42)				
Jun-21	0 (0)	0-0						0 (0)	0-0					

Season	OAA plus 2 km buffer							OAA						
			Peak seasonal abundance							Peak seasonal abundance				
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter period (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter period (BDMPS)
Jul-21	201.55 (37.12)	131.78-271.31						162.79 (32.22)	100.77-224.8					
Aug-21	1269.95 (120.58)	1029.9-1517.75						960.21 (116.42)	735.64-1184.77					
Sep-21	759.31 (92.27)	588.85-945.46				1690.38 (611.4)		588.85 (92.05)	418.4-774.81				1426.74 (643.87)	
Oct-21	1690.38 (611.4)	643.58-2939.36						1426.74 (643.87)	333.23-2845.73					
Nov-21	541.83 (65.05)	410.24-658.12					541.83 (65.05)	356.06 (57.28)	247.69-472.16					356.06 (57.28)
Dec-21	2084.65 (381.46)	1410.24-2844.31		2264.42 (211.5)				1720.42 (374.02)	1053.76-2495.38		1720.42 (374.02)			
Feb (18)-22	1108.24 (111.32)	898.99-1332.99			2264.42 (211.5)			751.74 (92.8)	588.8-929.99			1720.42 (374.02)		
Feb (26)-22	1518.25 (288.86)	1007-2114.9						1014.75 (189.06)	658.42-1409.8					
Mar-22	2264.42 (211.5)	1853.41-2667.67						1581.99 (180.38)	1248.34-1954.23					
Apr-22	541.54 (74.89)	394.55-688.53						448.7 (66.75)	324.92-587.96					
May-22	217.39 (36.9)	147.51-287.26	1802.27 (156.39)					124.22 (27.85)	69.87-178.57	1367.51 (147.43)				
Jun-22	170.35 (34.07)	108.4-240.03						123.89 (30.28)	69.69-185.83					
Jul-22	460.02 (89.19)	301.39-650.38						388.64 (88.22)	230.01-563.13					

Season	OAA plus 2 km buffer							OAA						
			Peak seasonal abundance							Peak seasonal abundance				
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter period (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Winter period (BDMPS)
Aug-22	444.79 (48.74)	351.15-546.23						327.74 (42.86)	249.71-413.57					
Sep-22	1802.27 (156.39)	1493.79-2110.55						1367.51 (147.43)	1098.75-1683.7					
MSP Abundance			1536.11	2864.14	2864.14	2441.13	813.78			1163.86	2231.48	1635.12	2084.64	631.71

4.2.11 Manx shearwater

4.2.11.1 Ecology and status

273. Manx shearwater breed in burrows or under rocks on predator free islands and are active at night around breeding colonies. In the Eastern Atlantic this species distribution ranges from islands off Iceland, the Faeroes, Britain, Ireland, Brittany, Maderia, the Canary Islands and the Azores (Wernham *et al.* 2002). This species does not breed in Orkney or off the north coast of Scotland. Manx shearwaters are transequatorial migrants, wintering off the Patagonian shelf, in the southern Atlantic Ocean (Burnell *et al*. 2023; Wernham *et al.* 2002).

274. Manx shearwater is currently an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al*., 2021) and classed as Least Concern by the IUCN (IUCN, 2024). During Seabirds Count (2015-2021), the breeding population of Manx shearwater was estimated to be 921,618 AOS based on the assessment of 50 sites, this represented an increase of 174% since Seabird 2000 (1998-2002; 336,538 AOS) and an increase of 207-269% since the SCR Census (1985-88) estimate of 250,000-300,000 AOS, although these figures should be treated with caution due to changes in counting methods across these surveys (Burnell *et al*. 2023). Scotland holds 32% (295,194 AOS) of the British and Irish breeding Manx shearwater population. The largest colony in Scotland is on the island of Rum in western Scotland, which increased by 141% between Seabird 2000 and Seabirds Count, although the increased count may in part be a result of improved modelling techniques used in the latter census estimate (Burnell *et al*. 2023). Another large Manx shearwater colony is present on the island of Skomer; 70% of Britain and Ireland's Manx shearwater population breeds on Rum and Skomer (Burnell *et al*. 2023). In Scotland, a smaller, but notable Manx shearwater colony is present on St Kilda. The Seabirds Count census concluded that most of the very small Manx shearwater colonies that were once present in Shetland and Orkney are now extinct (Burnell *et al*. 2023).

275. The HPAI virus (refer to section 2.3) is known to have affected some Manx shearwater populations. A small number of Manx shearwaters on Rum tested positive for HPAI in the summer of 2022 (refer to Annex 1P: Seabirds and Highly Pathogenic Avian Influenza: a review). However, Tremlett *et al*. (2024) considered Manx shearwater to have a low mortality from HPAI in comparison to other seabird species, and Manx shearwater was not included in the study of UK seabird colony counts following the 2021-22 outbreak of HPAI (Tremlett *et al*. 2024).

276. The diet of Manx shearwater is not well understood but is thought to include a variety of squid and fish which they catch by diving into the sea up to 10 m (Burnell *et al*. 2023). Foraging trips from breeding colonies have a mean maximum foraging range of 1346.8 ± 1018.7 km (Woodward *et al.* 2019). Manx shearwater populations can be impacted by invasive mammalian predators and potentially climate change impacts on food distribution, although theoretically this species is less susceptible to changes in prey distribution due to their energy efficient flight and large foraging areas (Burnell *et al*. 2023).

4.2.11.2 Seasons

277. Manx shearwater seasons (breeding season, non-breeding season, BDMPS spring and autumn migration) are illustrated in **Table 4-57**. October is defined as being split between the breeding and non-breeding seasons for Manx shearwater (NatureScot Guidance Note 9).

Table 4-57 Manx shearwater seasons taken from NatureScot (2023, Guidance Note 9) and Furness (2015). Green cells are breeding months, blue cells are non-breeding months, yellow cells are spring migration and orange cells are autumn migration.

Season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct*	Nov	Dec
Breeding season												
Non -breeding												
BDMPS Spring migration												
BDMPS Autumn migration												

*October is a split-month including both breeding and non-breeding seasons (NatureScot Guidance Note 9)

4.2.11.3 Raw observations

278. Raw observations of Manx shearwaters are presented for each survey in **Figure 4-33**. Manx shearwaters were recorded within the OAA plus 4 km buffer in 7 out of 27 surveys. Low numbers of Manx shearwaters were recorded during the late summer months between June to October, in part coinciding with the autumn migration period.

279. Manx shearwater displayed a weak spatial pattern across the survey area, observations were scattered across the survey area.

280. All Manx shearwaters recorded were in flight at the time of each survey.

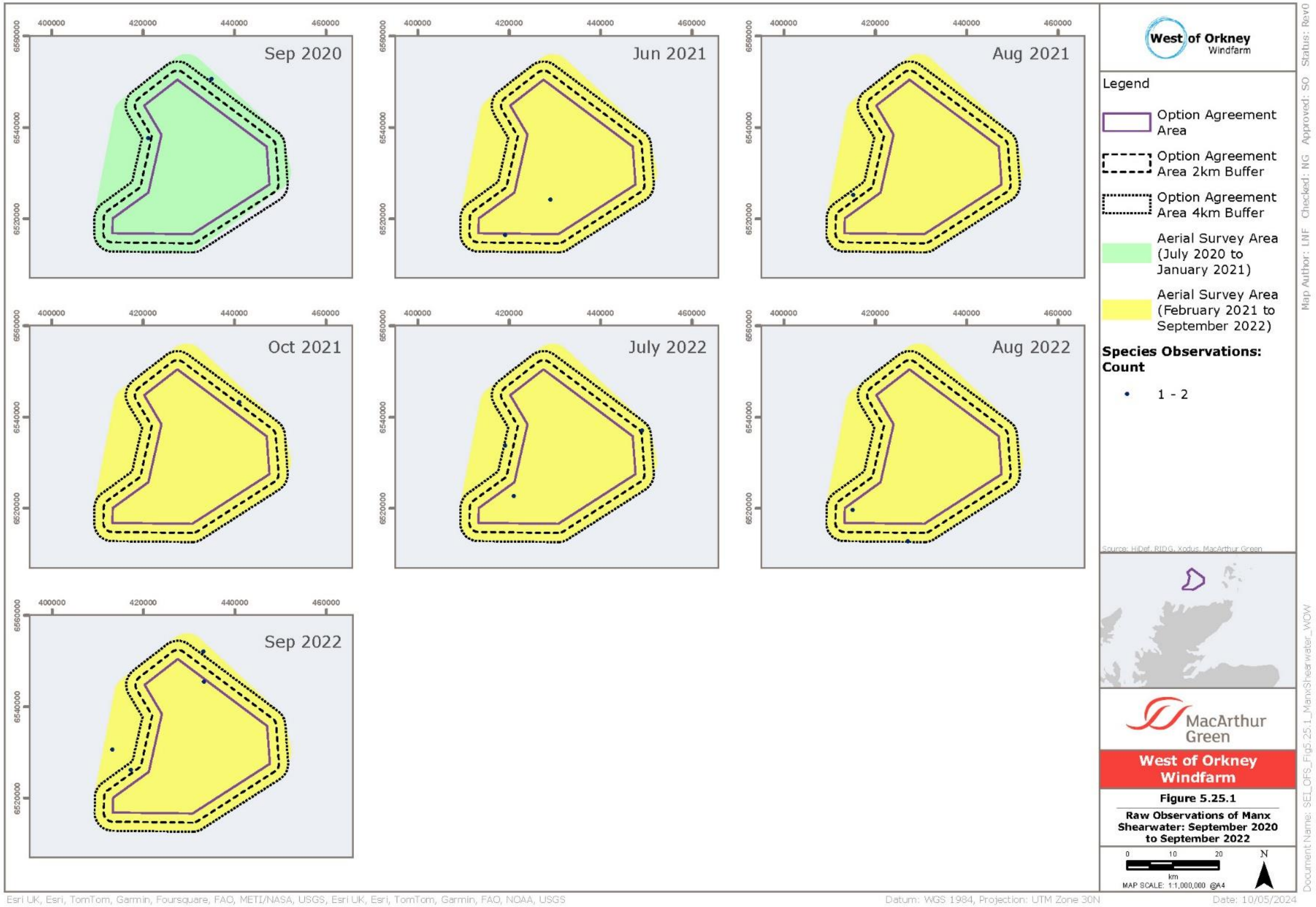

Figure 4-33 Raw observations of Manx shearwater: September 2020 to September 2022.

4.2.11.4 Design-based density estimates

281. Design-based density estimates of Manx shearwaters, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-58**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds**. Since all Manx shearwaters that were observed were flying, no estimation of densities of birds in flight and on the sea are necessary.

282. Density estimates of flying Manx shearwaters in the OAA were very low, with none exceeding 0.01 birds/km^2 (**Table 4-58**).

Table 4-58 Manx shearwater density estimates, SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Feb*		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Mar		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Apr		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
May		-	-	0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0
Jun		-	-	0.01 (0.01)	0-0.04	0 (0)	0-0	-	-	0.01 (0.01)	0-0.03	0 (0)	0-0
Jul		0 (0)	0-0	0 (0)	0-0	0.01 (0.01)	0-0.04	0 (0)	0-0	0 (0)	0-0	0.01 (0.01)	0-0.03
Aug		0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0 (0)	0-0	0.01 (0.01)	0-0.01	0 (0)	0-0
Sep		0 (0)	0-0	0 (0)	0-0	0.01 (0.01)	0-0.04	0.01 (0.01)	0-0.02	0 (0)	0-0	0.01 (0.01)	0-0.03
Oct		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0.01 (0.01)	0-0.02	-	-
Nov		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-
Dec		0 (0)	0-0	0 (0)	0-0	-	-	0 (0)	0-0	0 (0)	0-0	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.11.5 *Design-based abundance estimates*

283. Design-based abundance estimates of Manx shearwaters, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (sitting and flying, though note all birds recorded were in flight) in the OAA plus 4 km buffer in each survey are presented for each appropriate season in **Table 4-59**. The bootstrap means and CV values for these abundance estimates are presented in Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).

284. Abundance estimates with lower and upper C.I. recorded in the OAA plus 2 km buffer in June 2021 and July to September 2022 are illustrated in **Figure 4-34**. Manx shearwaters were not recorded in the survey area in 2020 and numbers in 2021 and 2022 were very small. These data indicate that abundance estimates of Manx shearwaters were not impacted by HPAI virus in 2022 (Tremlett *et al*. 2024).

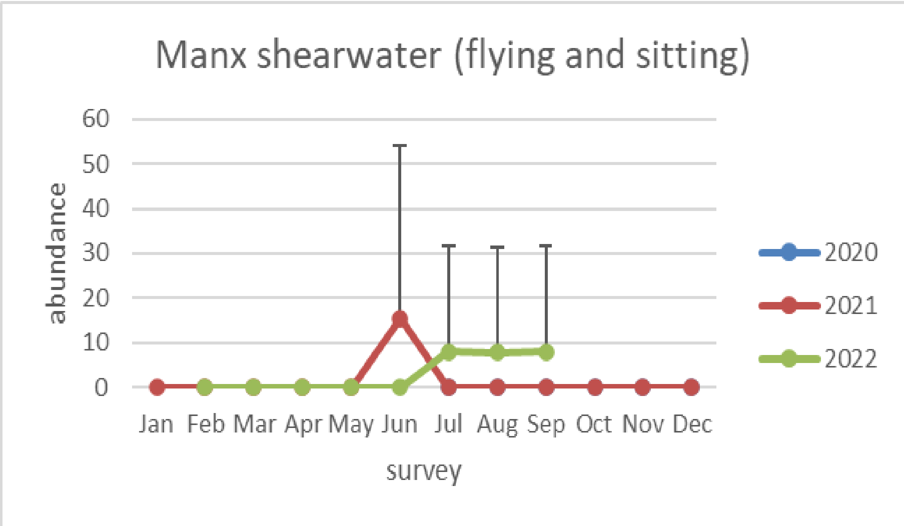

Figure 4-34 Estimated abundance and 95% C.I. of all Manx shearwaters (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis.

285. Manx shearwater was recorded only in NatureScot defined breeding season. This species was not recorded during the NatureScot defined non-breeding season, though was in the BDMPS autumn migration season. The MSP abundance in the OAA plus 4 km buffer of 15.66 birds for the breeding season (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete breeding season) is presented at the bottom of **Table 4-59**.

Table 4-59 Manx shearwater abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

<table>
<tr><th rowspan="2">Season</th><th rowspan="2">Estimate (S.D.)</th><th rowspan="2">95% c.i.</th><th colspan="4">Peak seasonal abundance</th></tr>
<tr><th>Breeding season (NatureScot)</th><th>Non-breeding season (NatureScot)</th><th>Spring migration (BDMPS)</th><th>Autumn migration (BDMPS)</th></tr>
<tr><td>Jul-20</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Aug-20</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td><td rowspan="3">7.75 (7.13)</td></tr>
<tr><td>Sep-20</td><td>7.75 (7.13)</td><td>0-23.24</td><td></td><td></td><td></td></tr>
<tr><td>Oct-20</td><td>0 (0)</td><td>0-0</td><td></td><td rowspan="6">0 (0)</td><td></td></tr>
<tr><td>Nov-20</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Dec-20</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Jan-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Feb-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Mar-21</td><td>0 (0)</td><td>0-0</td><td></td><td rowspan="3">0 (0)</td><td></td></tr>
<tr><td>Apr-21</td><td>0 (0)</td><td>0-0</td><td rowspan="7">15.5 (10.05)</td><td></td><td></td></tr>
<tr><td>May-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td></tr>
<tr><td>Jun-21</td><td>15.5 (10.05)</td><td>0-38.76</td><td></td><td></td><td></td></tr>
<tr><td>Jul-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Aug-21</td><td>7.74 (6.32)</td><td>0-23.23</td><td></td><td></td><td rowspan="3">7.75 (7.3)</td></tr>
<tr><td>Sep-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td></tr>
<tr><td>Oct-21</td><td>7.75 (7.3)</td><td>0-23.26</td><td rowspan="6">7.75 (7.3)</td><td></td></tr>
<tr><td>Nov-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Dec-21</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Feb (18)-22</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Feb (26)-22</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Mar-22</td><td>0 (0)</td><td>0-0</td><td></td><td rowspan="3">0 (0)</td><td></td></tr>
<tr><td>Apr-22</td><td>0 (0)</td><td>0-0</td><td rowspan="5">15.81 (10.09)</td><td></td><td></td></tr>
<tr><td>May-22</td><td>0 (0)</td><td>0-0</td><td></td><td></td></tr>
<tr><td>Jun-22</td><td>0 (0)</td><td>0-0</td><td></td><td></td><td></td></tr>
<tr><td>Jul-22</td><td>23.79 (12.3)</td><td>0-47.79</td><td></td><td></td><td></td></tr>
<tr><td>Aug-22</td><td>15.61 (9.4)</td><td>0-39.02</td><td></td><td></td><td></td></tr>
</table>

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance			
			Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Sep-22	15.81 (10.09)	0-39.52				
MSP Abundance			15.66	3.88	0.00	7.75

4.2.12 Gannet

4.2.12.1 *Ecology and status*

286. Northern gannet is a highly colonial species, most colonies are on offshore islands or on the edge of mainland cliffs where birds can avoid terrestrial predators (Burnell *et al*. 2023). Some large colonies, which are part of the North Atlantic gannet population, are present on islands surrounding the Orkney Isles and northern Scotland. Gannet is a migratory species and generally migrates south after the breeding season, wintering grounds are south of the Bay of Biscay, although most young birds travel further south to reach Morocco, Senegal and Guinea-Bissau (Wernham *et al.* 2002).

287. Gannet is currently an Amber-listed Bird of Conservation Concern in the UK (Stanbury *et al.*, 2021) and classed as Least Concern by the IUCN (IUCN, 2024). The gannet population grew during the 20th century, the world population increased ten-fold to over half a million pairs and there were large north wards and southwards extensions of its breeding range, Scotland has always been a stronghold (Burnell *et al*. 2023). A total of 360,748 AOS across 28 colonies were counted in Britain and Ireland during the Gannet Census (2013-2014) and Seabirds Count (2015-2021), this represented an increase of approximately 38% since the Gannet Census (2003-2005). The majority of the UK gannet population (71%) was recorded in Scotland, the largest colony is on the Bass Rock (75,259 AOS), but the largest colony closest to the offshore Project is on Sula Sgeir (12,271 AOS; part of the North Rona and Sula Sgeir SPA 79.7 km from the OAA). Other smaller gannet colonies in Orkney include colonies on Sule Skerry (4,515 AOS), Sule Stack (4,550 AOS) and Westray (1,384 AOS). A new colony of 9 AOS formed at Marwick Head SPA (35 km from the OAA) on Orkney in 2020 (Burnell *et al*. 2023). Other gannet colonies are present in Shetland as well as islands off the Western Isles and east and west mainland Scotland, but there are no colonies on the northern coast of mainland Scotland.

288. Since the Seabirds Count was conducted, the HPAI virus (refer to section 2.3) is now known to have impacted gannet survival at breeding colonies around the UK between 2021 to 2023 (Tremlett *et al*. 2024). In a study of UK seabird colony counts following the 2021-22 outbreak of HPAI, Tremlett *et al*. (2024) considered gannet to be a high priority target species due to very high levels of observed HPAI related mortalities in 2022. There was a minimum loss of 11,175 individual gannets in Scotland in 2022 (NatureScot, 2023) and an estimated 5,000 mortalities at RSPB Grassholm in Wales (Tremlett *et al*. 2024). During 2022, the first UK casualties observed were in Shetland and St Kilda in May. HPAI mortalities did not occur at all gannet colonies around the UK, and where the virus did occur, it did not impact all colonies equally. Tremlett *et al*. (2024) assessed the impact of the HPAI virus on breeding gannet within UK SPAs designated for breeding gannet, nearest the offshore Project, the largest decrease in colony size was within the North Rona and Sula Sgeir SPA (79.7 km from the OAA) where the number of breeding gannet decreased from 12,271 AOS pre-HPAI (2014-2021) to 9,495 AOS in 2023 (although the confidence in the count for 2023 is low), which represented a decrease of 23%. Large colony declines were recorded elsewhere, including a decrease of 23% at Hermaness, Saxa Vord and Valla Field SPA in Shetland (257.7 km from the OAA).

289. Gannets plunge-dive for fish, the commonest prey species being mackerel, herring and cod, although sandeels and fishery discards are taken when available (Burnell *et al*. 2023). Most

feeding takes place over the continental shelf well away from land, with concentrations in areas of high marine productivity (Wernham *et al.* 2002). Gannet therefore has a relatively large mean maximum foraging range of 315.2 ± 194.2 km (Woodward *et al.* 2019). Like all seabirds, gannets are vulnerable to climate change impacts on sea surface temperature and fish distribution, fishery by-catch and changes to fishing practices are also likely to impact gannets as well as the latest threat of HPAI virus.

4.2.12.2 Seasons

290. Gannet seasons (breeding season, non-breeding season, BDMPS spring and autumn migration) are illustrated in **Table 4-60**. March is defined as being split between the breeding and non-breeding seasons for gannet (NatureScot Guidance Note 9).

Table 4-60 Gannet seasons taken from NatureScot (2023, Guidance Note 9) and Furness (2015). Green cells are breeding months, blue cells are non-breeding months, yellow cells are spring migration and orange cells are autumn migration

Season	Jan	Feb	Mar*	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season			green	green	green	green	green	green	green			
Non -breeding	blue	blue	blue							blue	blue	blue
BDMPS Spring migration	yellow	yellow	yellow									yellow
BDMPS Autumn migration									orange	orange	orange	

*March is a split-month including both breeding and non-breeding seasons (NatureScot Guidance Note 9).

4.2.12.3 Raw observations

291. Raw observations of gannets are presented for each survey in **Figure 4-35** to **Figure 4-37**. Gannets were regularly recorded within the OAA plus 4 km buffer in all 27 surveys. Numbers of gannet observations fluctuated between surveys, more observations were recorded in spring and summer as well as mid-autumn and relatively low numbers of observations were recorded in the winter.

292. Gannets displayed a moderate spatial pattern across the survey area. Gannets tended to be more widely distributed across the survey area during post breeding dispersal between August to October. During the breeding season, gannets present in the survey area tended to be present on the southern, northern, and western edges of the OAA, although areas of the highest activity varied between months. Activity in the centre of the OAA was relatively low.

293. The number of raw observations of gannets recorded flying and sitting within the OAA as well as the proportion of birds recorded in flight within the OAA are presented in **Table 4-61**. The proportion of birds in flight is only provided for the OAA as this is the spatial scale used in collision risk modelling. In the majority of surveys more than 50% of gannets within the OAA were recorded in flight in the OAA.

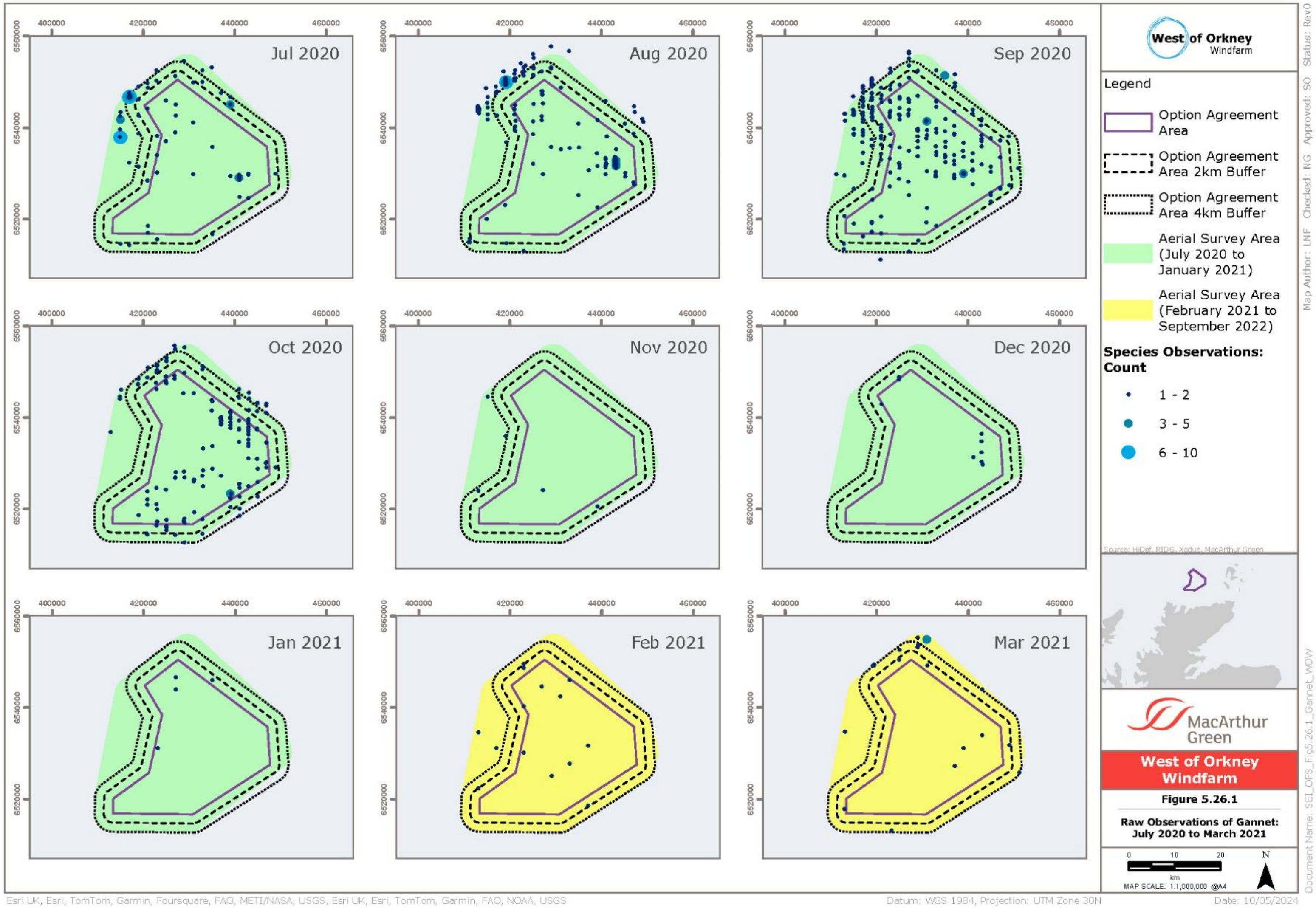

Figure 4-35 Raw observations of gannet: July 2020 to March 2021.

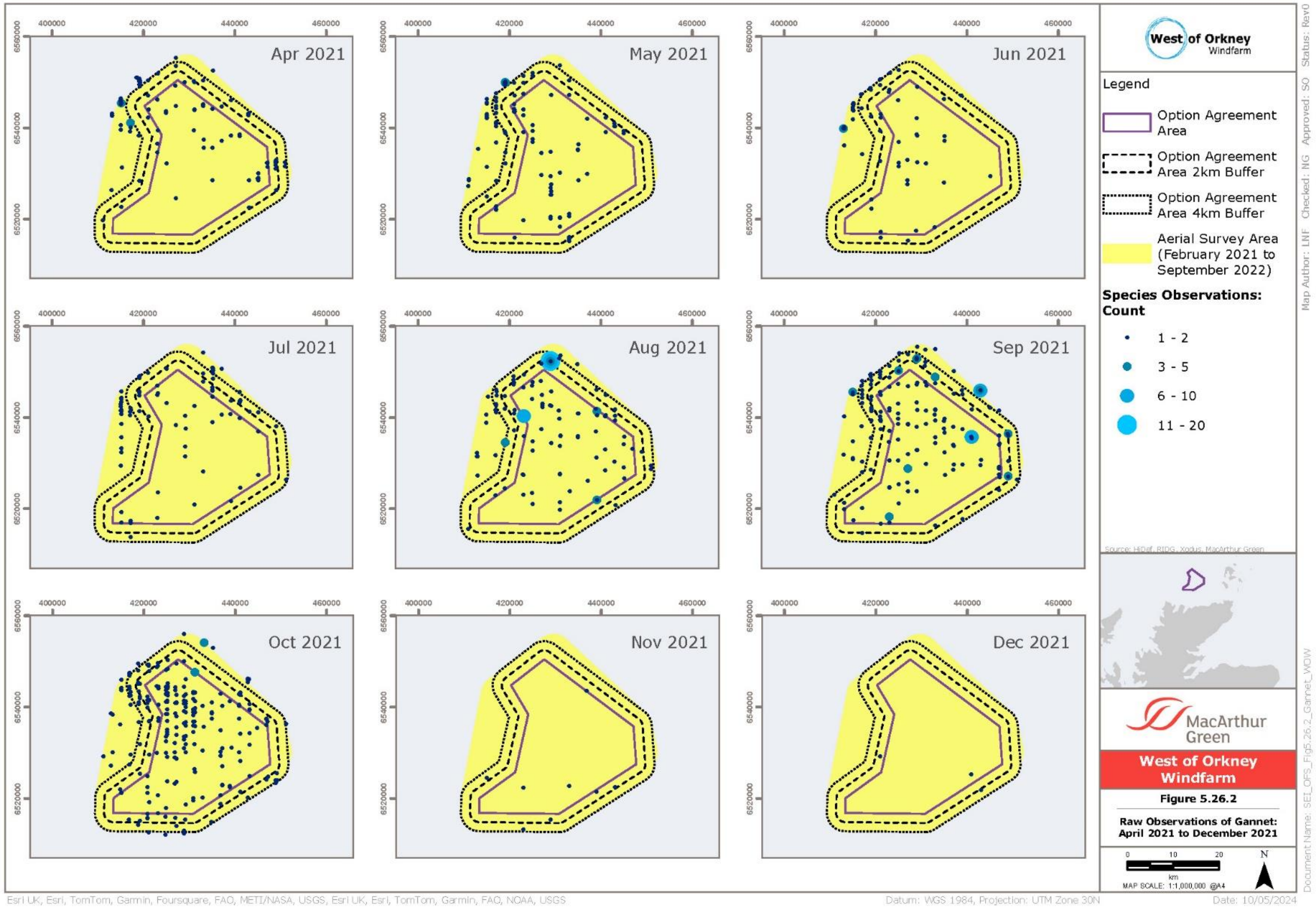

Figure 4-36 Raw observations of gannet: April 2021 to December 2021.

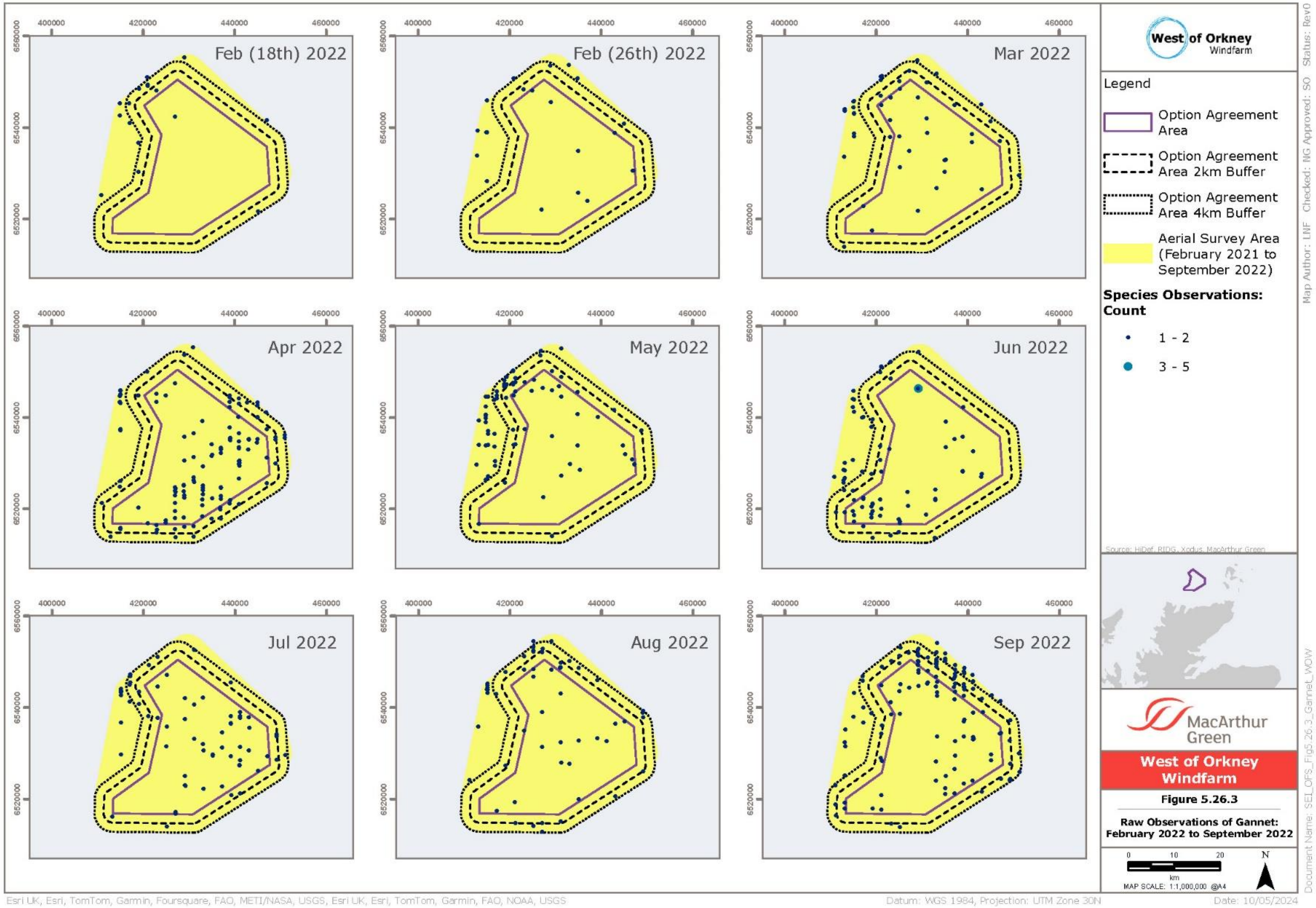

Figure 4-37 Raw observations of gannet: February 2022 to September 2022.

Table 4-61 Gannet raw counts of flying birds, sitting birds and proportion of birds in flight per survey in OAA.

Survey	Birds flying	Birds sitting	Proportion of birds in flight
Jul-2020	26	19	0.58
Aug-2020	32	210	0.13
Sep-2020	75	54	0.58
Oct-2020	47	51	0.48
Nov-2020	1	0	1.00
Dec-2020	4	3	0.57
Jan-2021	1	2	0.33
Feb-2021	7	1	0.88
Mar-2021	3	0	1.00
Apr-2021	25	9	0.74
May-2021	32	13	0.71
Jun-2021	21	1	0.95
Jul-2021	24	6	0.80
Aug-2021	51	13	0.80
Sep-2021	57	31	0.65
Oct-2021	53	91	0.37
Nov-2021	1	1	0.50
Dec-2021	1	0	1.00
Feb (18)-22	2	0	1.00
Feb (26)-22	8	1	0.89
Mar-2022	19	0	1.00
Apr-2022	27	54	0.33
May-2022	9	11	0.45
Jun-2022	16	30	0.35
Jul-2022	27	17	0.61
Aug-2022	7	10	0.41
Sep-2022	36	7	0.84

4.2.12.4 Design-based density estimates

294. Design-based density estimates of gannets, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight in the OAA in each survey are presented in **Table 4-62**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1F: Design-based analysis density estimates from each survey recorded of flying birds**.

295. Design-based density estimates, with S.D. and upper and lower C.I. values calculated using the 'bootstrap method' (section 3.3.1), for birds in flight and on the sea in the OAA and OAA plus 4 km buffer in each survey are presented in **Table 4-63**. The bootstrap means and CV values for these density estimates recorded in each survey are presented in **Annex 1E: Design-based analysis density estimates from each survey of all birds (sitting and flying).**

296. Density estimates of gannets in flight and on the sea in the OAA and OAA plus 4 km buffer were mostly less than 0.1 birds/km^2 (**Table 4-62**), though some larger densities occurred, with a peak of 2.9 birds/km^2 in the OAA in August 2020.

Table 4-62 Gannet density estimates, SDs & 95% C.I. of all birds recorded only in flight in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange)

Month	Season	OAA (birds/km^2)						OAA plus 4 km buffer (birds/km^2)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0.01 (0.01)	0-0.04	0.02 (0.02)	0-0.07	-	-	0.01 (0.01)	0-0.02	0.07 (0.03)	0.02-0.13
Feb*		-	-	0.08 (0.03)	0.02-0.14	0.09 (0.03)	0.04-0.15	-	-	0.07 (0.02)	0.03-0.11	0.07 (0.02)	0.03-0.11
Mar		-	-	0.04 (0.02)	0-0.07	0.22 (0.05)	0.13-0.33	-	-	0.07 (0.02)	0.03-0.11	0.21 (0.04)	0.14-0.28
Apr		-	-	0.28 (0.07)	0.17-0.44	0.32 (0.07)	0.19-0.47	-	-	0.28 (0.05)	0.19-0.39	0.3 (0.05)	0.21-0.4
May		-	-	0.38 (0.11)	0.18-0.61	0.09 (0.03)	0.04-0.15	-	-	0.36 (0.08)	0.21-0.52	0.19 (0.06)	0.1-0.33
Jun		-	-	0.25 (0.06)	0.13-0.37	0.18 (0.05)	0.08-0.29	-	-	0.22 (0.04)	0.15-0.29	0.1 (0.03)	0.04-0.16
Jul		0.32 (0.12)	0.13-0.57	0.28 (0.07)	0.15-0.43	0.31 (0.08)	0.17-0.46	0.46 (0.14)	0.21-0.77	0.27 (0.05)	0.19-0.39	0.27 (0.05)	0.19-0.37
Aug		0.39 (0.08)	0.23-0.57	0.6 (0.12)	0.4-0.83	0.05 (0.02)	0.01-0.1	0.34 (0.06)	0.23-0.45	0.94 (0.33)	0.48-1.69	0.13 (0.03)	0.07-0.2
Sep		0.89 (0.18)	0.57-1.26	0.67 (0.12)	0.46-0.92	0.29 (0.06)	0.18-0.42	0.77 (0.11)	0.57-1	0.75 (0.1)	0.58-0.94	0.46 (0.07)	0.33-0.61
Oct		0.56 (0.12)	0.34-0.8	0.6 (0.1)	0.4-0.8	-	-	0.4 (0.07)	0.26-0.56	0.52 (0.06)	0.4-0.64	-	-
Nov		0.01 (0.01)	0-0.04	0.01 (0.01)	0-0.04	-	-	0.03 (0.01)	0-0.05	0.03 (0.01)	0.01-0.05	-	-
Dec		0.05 (0.02)	0.01-0.09	0.01 (0.01)	0-0.04	-	-	0.03 (0.01)	0.01-0.05	0.02 (0.01)	0-0.04	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

Table 4-63 Gannet density estimates, SDs & 95% C.I. of all birds recorded in flight and on the sea in each survey within the OAA and OAA plus 4 km buffer in the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Month	Season	OAA (birds/km²)						OAA plus 4 km buffer (birds/km²)					
		2020		2021		2022		2020		2021		2022	
		Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.	Estimate (S.D.)	95% c.i.
Jan*		-	-	0.04 (0.02)	0-0.08	0.02 (0.02)	0-0.07	-	-	0.03 (0.01)	0.01-0.05	0.07 (0.03)	0.02-0.14
Feb*		-	-	0.09 (0.03)	0.05-0.15	0.11 (0.03)	0.05-0.18	-	-	0.08 (0.02)	0.04-0.12	0.08 (0.02)	0.04-0.12
Mar		-	-	0.04 (0.02)	0-0.07	0.22 (0.05)	0.13-0.33	-	-	0.08 (0.02)	0.04-0.13	0.21 (0.04)	0.13-0.28
Apr		-	-	0.4 (0.09)	0.25-0.59	0.95 (0.16)	0.64-1.28	-	-	0.44 (0.07)	0.32-0.58	0.84 (0.1)	0.65-1.04
May		-	-	0.53 (0.12)	0.31-0.79	0.24 (0.05)	0.14-0.34	-	-	0.55 (0.1)	0.36-0.75	0.4 (0.08)	0.24-0.55
Jun		-	-	0.26 (0.06)	0.17-0.39	0.54 (0.14)	0.29-0.84	-	-	0.25 (0.04)	0.18-0.34	0.45 (0.08)	0.29-0.62
Jul		0.55 (0.28)	0.16-1.21	0.35 (0.07)	0.21-0.51	0.53 (0.1)	0.34-0.73	0.87 (0.39)	0.26-1.73	0.39 (0.07)	0.25-0.54	0.44 (0.06)	0.32-0.56
Aug		2.94 (2.03)	0.4-7.61	0.76 (0.12)	0.53-1	0.2 (0.05)	0.12-0.3	1.82 (1.13)	0.39-4.53	1.06 (0.33)	0.6-1.77	0.3 (0.05)	0.22-0.39
Sep		1.52 (0.23)	1.07-1.94	1.04 (0.15)	0.77-1.33	0.52 (0.09)	0.35-0.69	1.33 (0.15)	1.04-1.65	1.26 (0.2)	0.92-1.69	0.74 (0.11)	0.55-0.96
Oct		1.16 (0.21)	0.79-1.58	1.7 (0.24)	1.28-2.21	-	-	0.92 (0.12)	0.71-1.17	1.5 (0.14)	1.23-1.76	-	-
Nov		0.01 (0.01)	0-0.04	0.02 (0.02)	0-0.06	-	-	0.03 (0.01)	0.01-0.06	0.05 (0.02)	0.02-0.09	-	-
Dec		0.08 (0.03)	0.02-0.15	0.01 (0.01)	0-0.04	-	-	0.06 (0.02)	0.02-0.11	0.02 (0.01)	0-0.04	-	-

*The survey on 18 February 2022 is used as for the sample for January 2022. The 26 February 2022 survey is used as the sample for February 2022.

4.2.12.5 Design-based abundance estimates

297. Design-based abundance estimates of gannets, with S.D. and lower and upper C.I. values calculated using the 'bootstrap method' (section 3.3.1), for all birds (flying and on the sea) in the OAA plus 4 km buffer in each survey are presented for each appropriate season in **Table 4-64** and in the OAA and OAA plus 2 km buffer in **Table 4-65**. The bootstrap means and CV values for these abundance estimates are presented in Annex 1B: abundance estimates from each survey recorded of all birds (sitting and flying).

298. Abundance estimates with lower and upper C.I. values recorded in the OAA plus 2 km buffer in each calendar month in each survey year (2020, 2021 and 2022) are illustrated in **Figure 4-38**. Although abundance estimates were higher in August 2020 compared with August 2021 and 2022, as C.I. overlapped between corresponding months, it is considered that these data do not strongly indicate that abundance estimates of gannets were impacted by HPAI virus in 2022 (Tremlett *et al*. 2024).

299. Gannet MSP abundance calculations (calculated as the mean of the peak DAS survey abundance estimate recorded in each complete season) are presented at the bottom of **Table 4-64** and at the bottom of **Table 4-65** for the OAA and OAA plus 2 km buffer. The highest MSP abundance (1368.03 birds) was recorded in the BDMPS autumn migration period followed by the non-breeding season (1170.85 birds). The breeding season MSP abundance estimate was slightly lower (851.67 birds) with the lowest estimate recorded in the BDMPS spring migration period (139.54 birds).

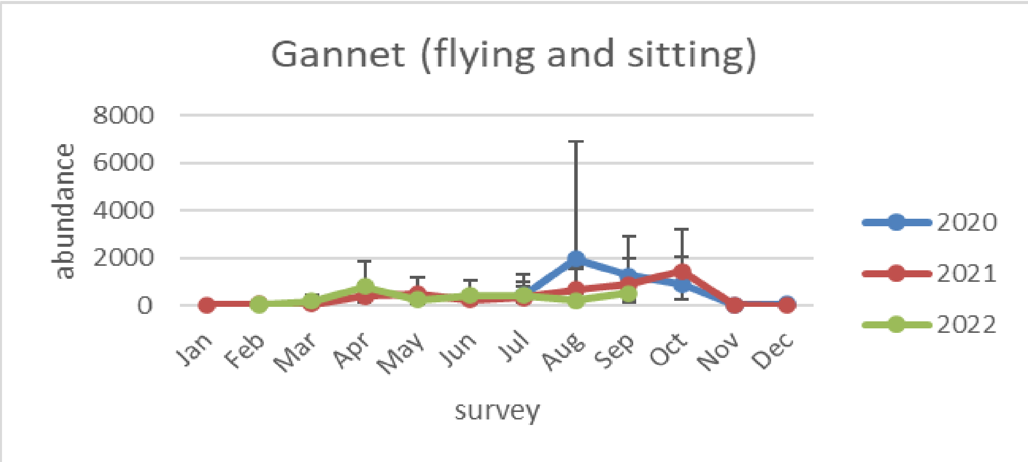

Figure 4-38 Estimated abundance and 95% C.I. of all gannets (flying and sitting) in the OAA plus 2 km in each survey using design-based analysis.

Table 4-64 Gannet abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA plus 4 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance			
			Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Jul-20	1002.56 (449.18)	304.78-2005.32				
Aug-20	2109.85 (1306.54)	445.66-5238.79				
Sep-20	1533.96 (176.7)	1200.83-1913.77				1533.96 (176.7)
Oct-20	1062.29 (139.19)	821.92-1356.94		1062.29 (139.19)		
Nov-20	31.02 (16.84)	7.56-69.8				
Dec-20	69.74 (26.47)	23.25-123.99			92.94 (26.86)	
Jan-21	30.99 (16.09)	7.75-62.18				
Feb-21	92.94 (24.16)	46.47-139.41				
Mar-21	92.94 (26.86)	46.47-147.16	1456.64 (227.57)			
Apr-21	511.9 (78.21)	364.53-674.77				
May-21	635.54 (112.58)	418.52-868.05				
Jun-21	294.56 (48.57)	209.1-387.58				

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance			
			Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Jul-21	449.6 (80.93)	294.57-620.14				
Aug-21	1231.23 (376.91)	696.93-2052.64				
Sep-21	1456.64 (227.57)	1069.24-1960.46				
Oct-21	1736.9 (164.46)	1426.74-2039.5				1736.9 (164.46)
Nov-21	61.92 (19.5)	23.22-100.62				
Dec-21	23.25 (12.5)	0-46.5		1736.9 (164.46)		
Feb (18)-22	85.25 (36.63)	23.25-162.75			240.4 (41.67)	
Feb (26)-22	92.95 (24.63)	46.48-139.62				
Mar-22	240.4 (41.67)	155.1-325.7				
Apr-22	967.04 (113.93)	750.42-1199.13				
May-22	458.07 (95.77)	279.3-636.63	967.04 (113.93)			
Jun-22	518.78 (96.24)	340.69-720.3				
Jul-22	507.61 (70.15)	372.78-650.38				
Aug-22	343.35 (53.18)	249.71-452.59				

Season	Estimate (S.D.)	95% c.i.	Peak seasonal abundance			
			Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Sep-22	861.61 (122.52)	640.08-1114.56				
MSP Abundance			1211.84	1399.60	166.67	1,635.43

Table 4-65 Gannet abundance estimates, SDs and lower and upper C.I. values of all birds recorded in flight and on the sea in each survey in the OAA and OAA plus 2 km buffer. Peak seasonal abundance for the breeding season (green), non-breeding season (blue), spring migration (yellow) and autumn migration (orange).

	OAA plus 2 km buffer						OAA					
			Peak seasonal abundance						Peak seasonal abundance			
Season	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Jul-20	433.11 (195.53)	152.39-898.49					360.92 (185.1)	104.27-794.03				
Aug-20	1974.5 (1332.67)	310.51-4912.36					1926.73 (1331.68)	262.74-4992.97				
Sep-20	1278.3 (158.33)	983.9-1626.93				1278.3 (158.33)	999.4 (147.81)	705-1270.75				999.4 (147.81)
Oct-20	883.95 (133.5)	627.88-1155.34		883.95 (133.5)			759.89 (135.96)	519.52-1039.03		759.89 (135.96)		
Nov-20	23.27 (15.87)	0-62.04					7.76 (7.52)	0-23.27				
Dec-20	69.74 (25.89)	23.25-123.99			77.45 (21.14)		54.24 (22.37)	15.5-100.74			61.96 (19.21)	
Jan-21	30.99 (15.84)	7.75-69.73					23.24 (14.35)	0-54.24				
Feb-21	77.45 (21.14)	38.73-116.18					61.96 (19.21)	30.79-100.69				
Mar-21	54.22 (17.77)	23.24-85.2	891.03 (110.62)				23.24 (12.05)	0-46.47	681.83 (97.17)			
Apr-21	395.56 (70.81)	271.46-535.17					263.7 (59.75)	162.68-387.8				

MacArthur Green

Season	OAA plus 2 km buffer						OAA					
			Peak seasonal abundance						Peak seasonal abundance			
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
May-21	496.03 (99.55)	310.02-697.54					348.77 (80.53)	201.51-519.28				
Jun-21	240.3 (46.29)	155.03-325.76					170.53 (37.64)	108.33-255.8				
Jul-21	341.08 (67.13)	224.61-480.61					232.55 (48.99)	139.53-333.33				
Aug-21	689.18 (102.78)	503.33-898.26					495.59 (79.82)	348.46-658.4				
Sep-21	891.03 (110.62)	689.58-1123.47					681.83 (97.17)	503.63-875.53				
Oct-21	1457.76 (146.11)	1201.88-1760.17				1457.76 (146.11)	1116.58 (156.49)	837.44-1450.2				1116.58 (156.49)
Nov-21	46.44 (16.93)	15.48-77.4					15.48 (9.92)	0-38.7				
Dec-21	15.5 (10.29)	0-38.75		1457.76 (146.11)			7.75 (7.36)	0-23.25		1116.58 (156.49)		
Feb (18)-22	23.25 (16.55)	0-62			201.63 (37.5)		15.5 (14.51)	0-46.5			147.34 (34.66)	
Feb (26)-22	77.46 (23.94)	30.98-131.68					69.72 (22.77)	30.98-116.19				
Mar-22	201.63 (37.5)	131.83-279.18	812.31 (110.18)				147.34 (34.66)	85.3-217.14	626.64 (107.96)			

MacArthur Green

Season	OAA plus 2 km buffer						OAA					
			Peak seasonal abundance						Peak seasonal abundance			
	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)	Estimate (S.D.)	95% c.i.	Breeding season (NatureScot)	Non-breeding season (NatureScot)	Spring migration (BDMPS)	Autumn migration (BDMPS)
Apr-22	812.31 (110.18)	611.17-1036.86					626.64 (107.96)	417.76-843.26				
May-22	256.21 (49.86)	163.04-357.14					155.28 (35.16)	93.17-225.35				
Jun-22	433.61 (97.29)	263.07-627.19					356.18 (92.1)	193.38-549.95				
Jul-22	428.3 (66.88)	301.2-563.13					348.98 (66.16)	222.08-476.08				
Aug-22	210.69 (39.34)	140.46-296.53					132.66 (29.65)	78.03-195.08				
Sep-22	537.52 (86.7)	395.23-719.33					339.9 (56.9)	229.24-450.57				
MSP Abundance			851.67	1170.86	139.54	1368.03			654.24	938.24	104.65	1057.99

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