BERWICK BANK WIND FARM
OFFSHORE ENVIRONMENTAL IMPACT ASSESSMENT

APPENDIX 11.1: BASELINE ORNITHOLOGY TECHNICAL REPORT

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1. INTRODUCTION

1.1. PROJECT BACKGROUND

1. Berwick Bank Wind Farm Limited (BBWFL) is a wholly owned subsidiary of SSE Renewables Limited and will hereafter be referred to as 'the Applicant'. The Applicant is developing the Berwick Bank Wind Farm (hereafter referred to as 'the Project') located in the outer Forth and Tay region (Figure 1.1).

2. The Project is located adjacent to the consented Forth and Tay offshore wind farms (OWFs) consisting of Seagreen to the north, Inch Cape to the northwest and Neart na Gaoithe to the west (Figure 1.1).

3. The Project will, if consented, provide an estimated 4.1 GW of renewable energy, making it one of the largest OWFs in the world. Given the anticipated operational life span of 35 years, the development will make a critical contribution to Scotland's renewable energy target of 11 GW of new offshore wind by 2030. Initially, pre-July 2021, the area was named as two separate sites, Marr Bank and Berwick Bank, but these have now been merged to a single site, Berwick Bank Wind Farm.

4. Turbine capacity is yet to be confirmed but will be between 14 – 24 MW, with a maximum number of turbines on site to be 179 - 307. Importantly, the minimum lower blade tip height is 37 m (above LAT) for all turbine options as an engineering design measure to reduce collision risk to seabirds.

5. The site boundary of the Project balances maximising the potential for renewable energy generation whilst reducing environmental impacts.

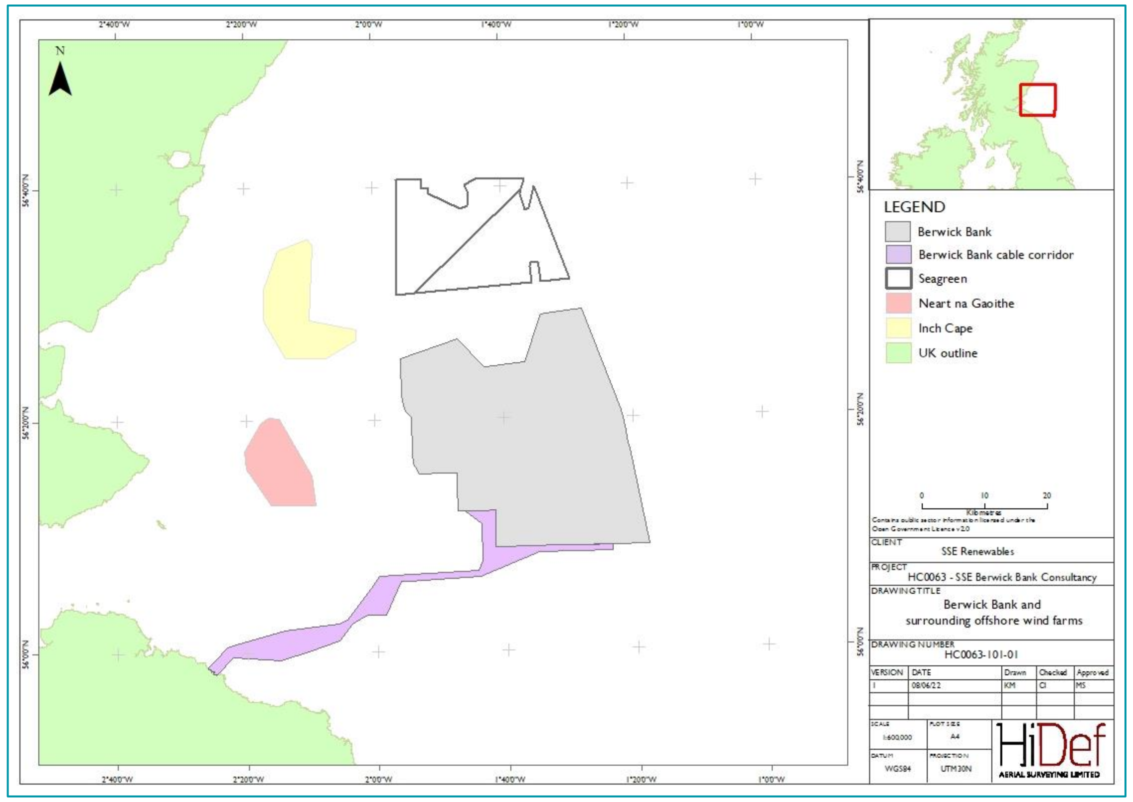


Figure 1.1: Site boundaries for all consented and proposed wind farms currently within the Outer Firth of Forth

1.2. STUDY AREA

6. Three study areas are defined in the Berwick Bank Wind Farm Offshore Scoping Report (October 2021):

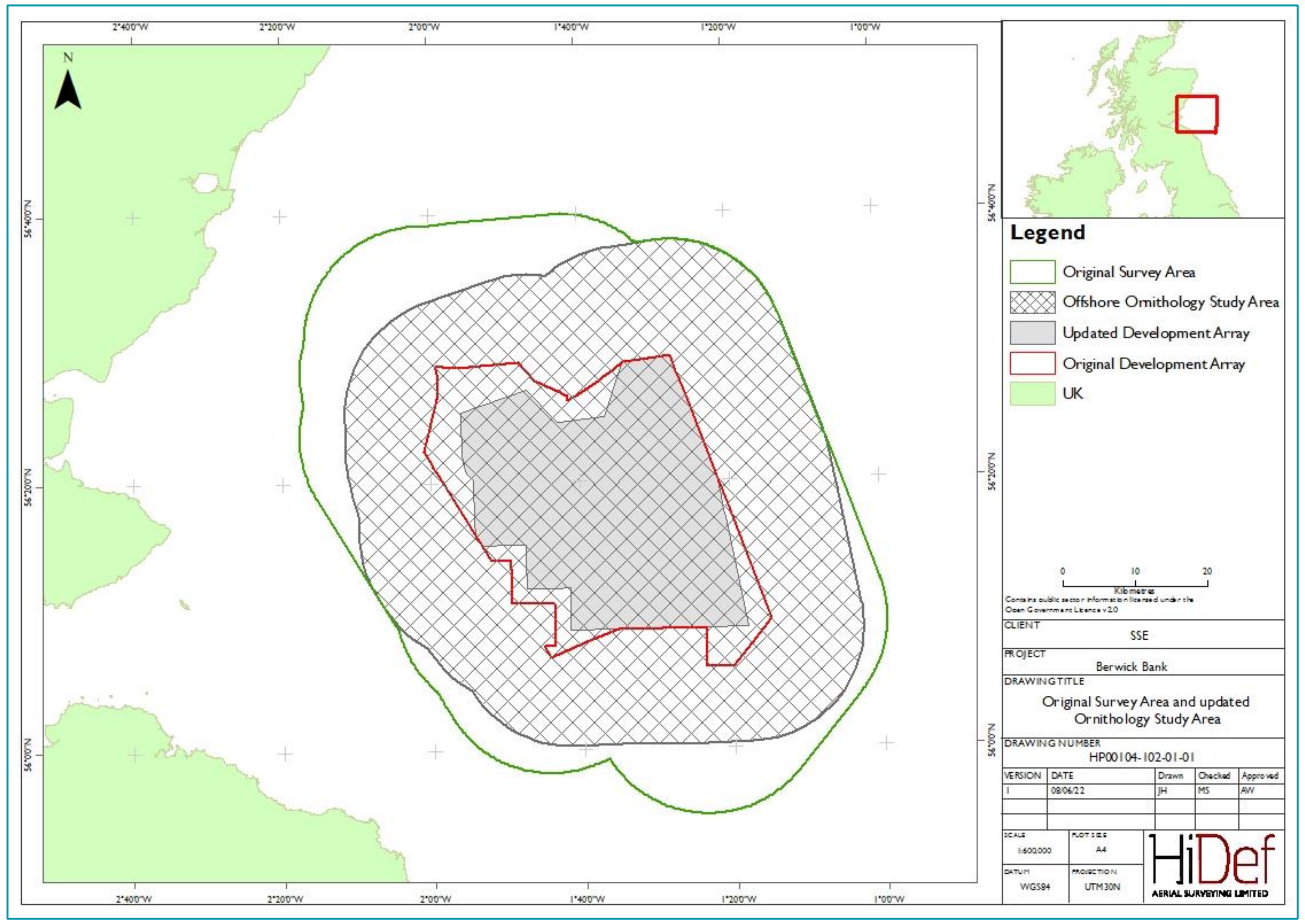
- Offshore Ornithology Regional Study Area
- Offshore Ornithology Study Area; and
- Intertidal Ornithology Study Area (reported separately in Appendix 11.2, Intertidal Survey report).

7. The Offshore Ornithology Study Area is the focus of this technical report and is located within the survey area of the commissioned digital video aerial surveys, used to provide robust data to define baseline characteristics. The Offshore Ornithology Study Area encompasses the proposed Berwick Bank Development Array and a 16km buffer.

8. Since digital aerial video surveys were commissioned, the Berwick Bank Development Array boundary has reduced (see Chapter 4), and the Offshore Ornithology Study Area was adjusted to reflect this. Differences between the two study areas are indicated in Figure 1.2. For the purposes of this report and all other reports for this submission which pertain to offshore ornithology, the original Development Array boundary and 16km buffer flown during digital aerial surveys will be referred to as 'the survey area' and the updated Development Array plus 16 km buffer will be referred to as the 'Offshore Ornithology Study Area'. Since the entirety of the Offshore Ornithology Study Area falls within the survey area, no additional data collection was necessary; the survey design for digital aerial surveys within the Offshore Ornithology Study Area is indicated in Figure 1.3. Total areas for the survey area, Offshore Ornithology Study Area and Development Array area were calculated at 4.981 km^2, 3,975 km^2 and 1010 km^2 respectively. Information from digital aerial surveys will also contribute to the characterisation for the proposed export cable corridor, as outlined in Chapter 11.

9. The Offshore Regional Study Area is considered in the Offshore Environmental Impact Assessment Report (EIAR). Its area is defined by the mean-maximum breeding season foraging range (plus one standard deviation (SD)) of gannet, which has the largest foraging range of the key species considered in the ornithology assessment (315.2 km ± 194.2 km (Woodward *et al*., 2019)). Consequently, the maximum extent of the Offshore Ornithology Regional Study Area was calculated as 509.4 km from the Project.

10. Within the Offshore Ornithology Regional Study Area, there are many designated protected sites for seabirds in both breeding and non-breeding seasons. Those closest to the Project include the Forth Islands SPA; Fowlsheugh SPA; St Abb's Head to Fast Castle SPA; and Outer Firth of Forth and St Andrew's Bay Complex SPA.



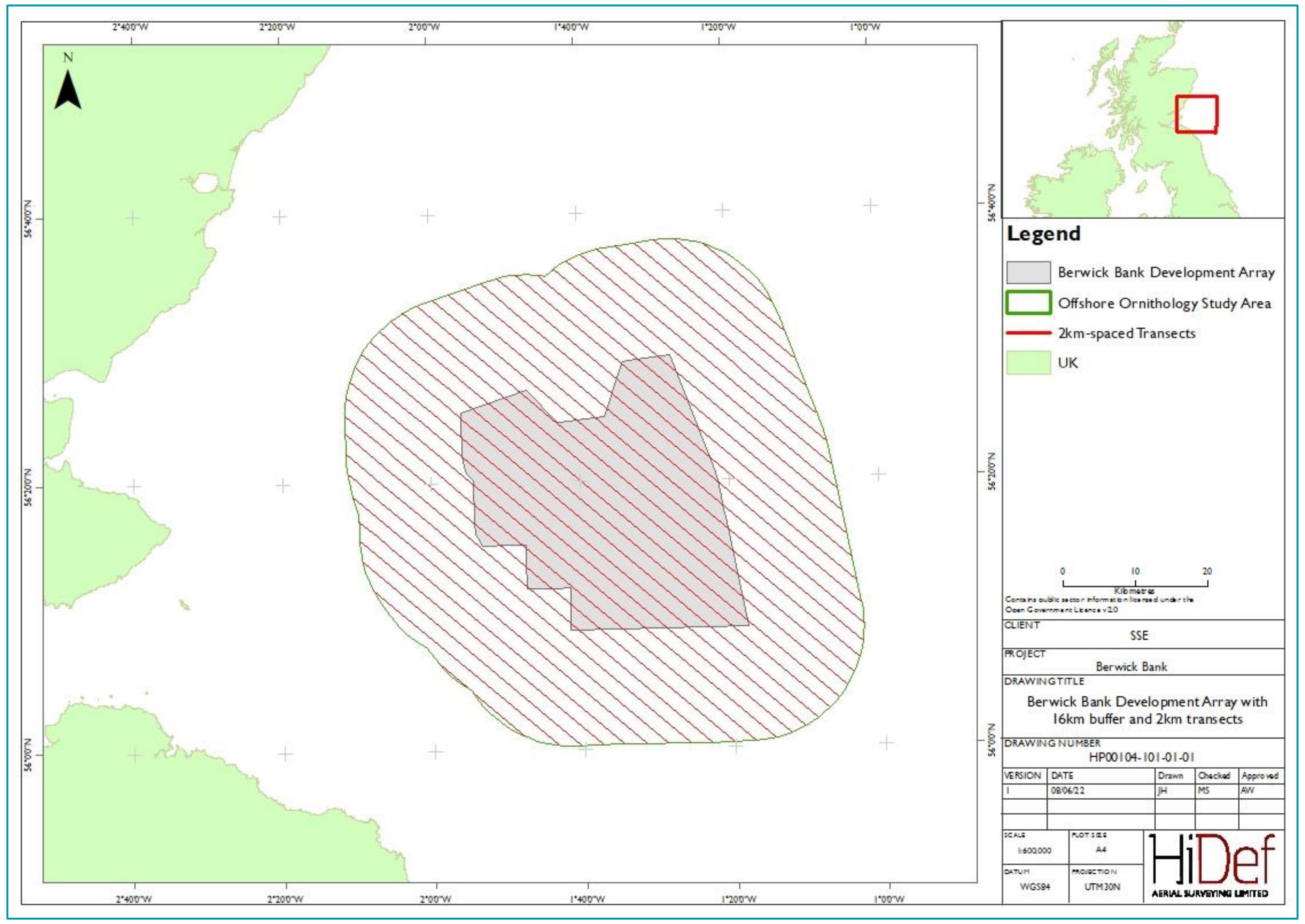


Figure 1.2: Original Berwick Bank Development Array plus 16km buffer ('the survey area') flown during digital aerial surveys and updated Berwick Bank Development Array and 16 km buffer (the 'Offshore Ornithology Study Area')

Figure 1.3: The 'Offshore Ornithology Study Area' comprising the updated Berwick Bank Development Array and 16km buffer. The area was surveyed using digital video aerial surveys of 2 km spaced transects

1.3. PURPOSE OF THE REPORT

11. This technical report provides the baseline ornithological characterisation for the Offshore Ornithology Study Area (Figure 1.2).

12. The report provides baseline information on the seasonal distribution, density, and abundance of seabirds based on:

- available reports and literature (“Desktop study” Section 2), and
- analysis of data from a series of digital aerial surveys undertaken in the period 2019 - 2021 (“Berwick Bank digital aerial surveys” Section 3).

13. Additional Annexes (A – K) provided separately to this report, detail analytical outputs on species monthly density and abundance estimates.

14. The species density and abundance estimates presented in this report (Section 4) underpin further technical reports regarding the collision risk, displacement, and population-level effects of the Project on the seabird community present within the Offshore Ornithology Regional Study Area. All technical reports provide information to support the production of the Berwick Bank Wind Farm Offshore EIAR and Habitats Regulation Appraisal (HRA).

2. DESKTOP STUDY

2.1. KEY DATA SOURCES

15. 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 desktop reports

Title	Source	Year	Author
Boat-based surveys	Berwick Bank	2020-2021	RPS
Boat-based surveys	Seagreen	2009-2011	Seagreen
Boat-based surveys	IMPRESS Final Report	1997-2003	Camphuysen 2005
Boat-based surveys	Mainstream	2009 - 2012	Fijn *et al.* 2013
Digital aerial surveys	Seagreen Phase 1	2019 - 2020	HiDef Aerial Surveying
Digital aerial surveys	R3 Zone Aerial Surveys	2010	APEM Ltd
Aerial surveys	Aerial Surveys of Waterbirds in the UK: 2007/08 Final Report	2009	WWT
Colony specific data	Seabird Monitoring Programme (SMP)	Various dates	Joint Nature Conservation Committee (JNCC)
Colony specific data	Isle of May long-term study (IMLOTS) seabird annual breeding success	1982 - present	NatureScot and JNCC
Designated sites	NatureScot SiteLink	Various dates	NatureScot
Non-estuarine coastal waterbird survey	British Trust for Ornithology (BTO) Research Report	2015/16	BTO
Existing offshore wind farm grey literature associated with wind farms in the vicinity of Berwick Bank. E.g., Kincardine, Seagreen 1, Neart na Gaoithe and Inch Cape	Available on marine.gov.scot	Various dates	Atkins Limited/Kincardine Offshore Windfarm Limited, Seagreen Wind Energy Ltd, NnG (Neart na Gaoithe) Offshore Wind Ltd, Inch Cape Offshore Ltd
Impacts of the presence of offshore wind farms on seabird populations	Open access reports and peer reviewed literature	2007 - 2020	Maclean et al., 2007; Furness et al., 2013; Busch et al., 2013; Bradbury et al., 2014; Johnston et al., 2014; Scott et al., 2014; Cleasby et al., 2015; Cazenave et al., 2016; Green et al., 2016; Statutory Nature Conservation Bodies (SNCB), 2017; Jarrett et al., 2018; Heinanen et al., 2020; Lane et al., 2020
Seabird distributions	Open access reports and peer reviewed literature	1995 - 2020	Stone et al., 1995; Ollason et al., 1997; Mitchell et al., 2004; Kober et al., 2010; Kober et al., 2012; Wakefield et al., 2017; Cleasby et al., 2020
Seabird population estimates and demographics	Open access reports and peer reviewed literature	2000 - 2020	Camphuysen and Garthe, 2000; Mitchell et al., 2004; Frederiksen et al., 2008; Banks et al., 2009; Horswill and Robinson, 2015; Horswill et al., 2017; Horswill et al., 2020; Ruffino et al., 2020
Seabird migration and foraging movements	Open access reports and peer reviewed literature	1998 - 2021	Wanless et al., 1998; Furness and Tasker, 2000; Mitchell et al., 2004; Maclean et al., 2007; Scott et al., 2010; Embling et al., 2012; Thaxter et al., 2012; Cox et al., 2013; Furness et al., 2018; Waggitt et al., 2018.
Seabird breeding ecology	Open access reports and peer reviewed literature		Dunnet et al., 1990; Erikstad et al., 1998; Mitchell et al., 2004; Crespin et al., 2006; Durant et al., 2006; Parsons et al., 2008; Wanless et al., 2009; Cook et al., 2014; Newell et al., 2015; Keogan et al., 2020

2.2. REVIEW OF ADDITIONAL BIRD DATA RELEVANT TO THE BASELINE

2.2.1. BERWICK BANK BOAT-BASED SEABIRD SURVEYS (2020 – 2021)

16. Site-specific boat-based surveys were undertaken across the Berwick Bank Development array during July-August 2020 and April-June 2021. The surveys were designed to collect flight height data to potentially inform collision risk monitoring for the Project, and to trial measurement techniques. The use of the generic flight height data of Johnston *et al*. (2014) is currently the advised source for collision risk modelling, but the flight height data on kittiwake collected visually and with the use of a laser rangefinder were analysed and presented to provide additional context in Appendix 11.3: Ornithology Collision Risk Modelling Technical Report.

17. Sampling blocks were repeatedly sampled along a continuous transect route broadly following methods as described by Embling *et al.* (2012; Figure 2.1). Where possible the surveys recorded detailed information on the species' age and plumage of each bird encountered, along with flight height, flight direction, behaviour, interaction with other birds, incidental marine mammal sightings, vessels, and association with other features of interest such as tidal fronts, upwellings, current, detritus or flotsam etc.

18. Flight height recording followed the previous boat-based survey method used for Seagreen in 2017 (Harwood *et al*., 2018), with flight heights visually estimated in 5m bands. Surveyors also used laser rangefinders when not surveying the line transect or when very few birds were present. Rangefinder data formed the basis of the flight height distribution dataset with visual flight heights used for comparison. To increase data collected using rangefinders additional rangefinders were used opportunistically by other observers. The survey methods for the boat-based surveys undertaken in 2020 and 2021 were agreed with ornithological advisors at Marine Scotland, NatureScot and RSPB.

19. A total of 47,777 birds were recorded of 37 identified species. Five key species accounted for ~89% of the observations: guillemot (32.09%), kittiwake (23.67%), gannet (16.12%), razorbill (9.68%) and puffin (7.26%). Flight height data were not able to be recorded for every bird. For example, at periods where birds 'swamped' the sampling platform, species which could be easily targeted with rangefinders (e.g. gannet) were preferentially selected. For gannet and kittiwake, flight height data were collected for 88% and 70% of total observations (visual estimation plus laser rangefinder data), respectively. Gannet and kittiwake rangefinder data recorded flight heights between 0-78.8 m and 0.6-68.6 m respectively, collected from 1,229 observations. Further details are given in Appendix 11.7, Boat-based Survey Report.

2.2.2. SEAGREEN BOAT-BASED TRANSECT SURVEYS (2009 TO 2011)

20. Boat-based surveys were carried out for the first phase of baseline data collection for the former Firth of Forth Round 3 Zone across the Seagreen (Alpha – northwest, and Bravo – southeast) site between December 2009 and November 2011. The surveys were designed to characterise baseline ornithology to inform EIA.

21. As this dataset is now over ten years old and the abundance of seabirds has likely changed since the data were collected, it provides contextual information to support the primary baseline data source, which are the digital aerial surveys of the survey area undertaken between March 2019 and April 2021.

22. A total of 23 monthly boat-based transect surveys were undertaken between December 2009 and November 2011, covering the former Firth of Forth Round 3 Zone, which includes the Project and the Seagreen site. Transects were spaced 3km apart and oriented northwest to southeast to intercept the likely predominant flight lines from major breeding colonies in the Firth of Forth.

23. A total of 24,206 birds of 39 species and 20,436 birds of 37 species were recorded at the Alpha and Bravo sites respectively. Within the Alpha site, guillemot (28.10%), kittiwake (24.80%), and gannet (16.10%) were the predominant species recorded. For the Bravo site, guillemot (29.30%), kittiwake (21.60%), and gannet (16.60%) were the most frequently recorded species.

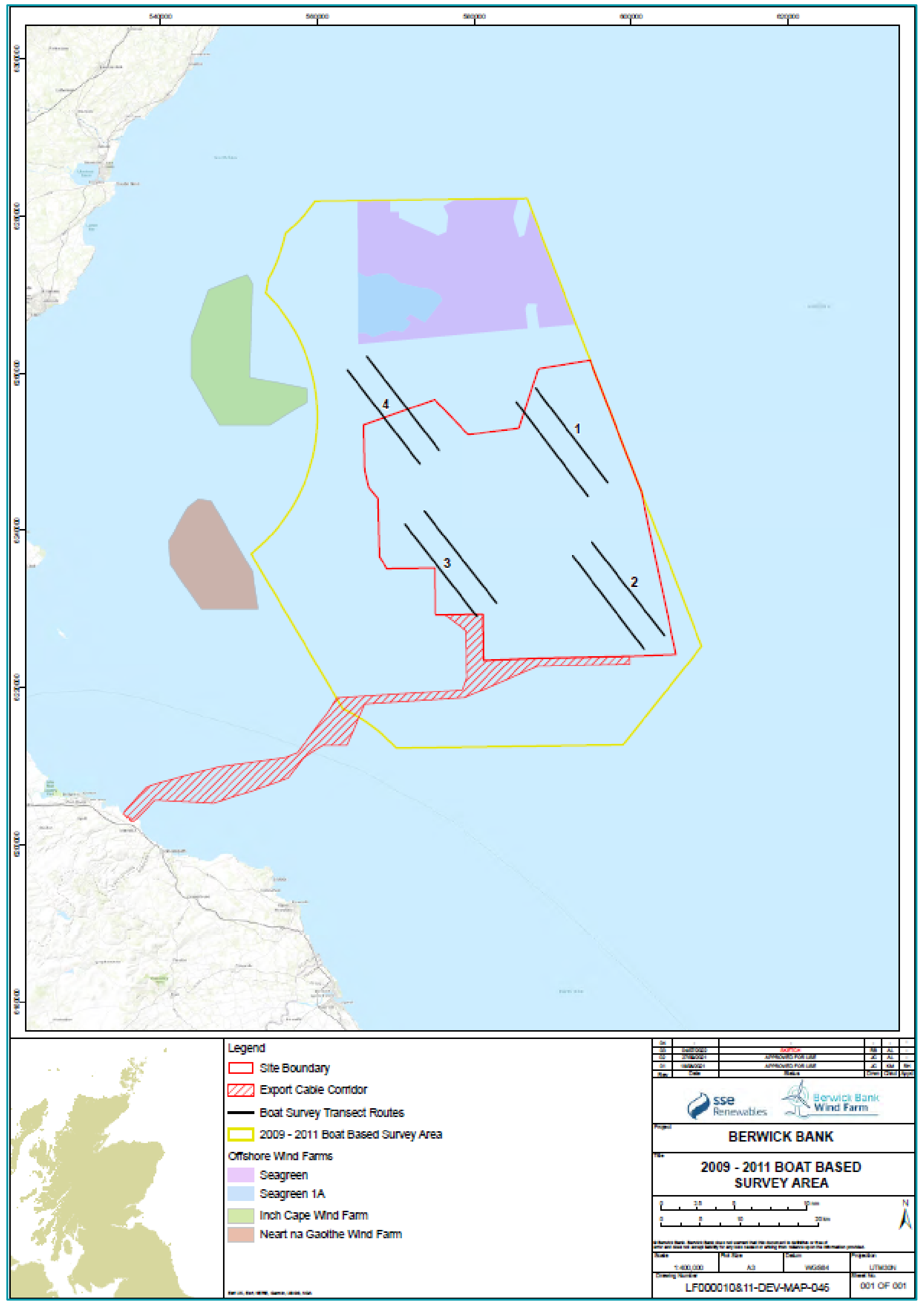


Figure 2.1: Boat based surveys undertaken by ECON and RPS during July-August 2020 and April-June 2021

2.2.3. SEAGREEN PRE-CONSTRUCTION MONITORING SURVEYS

24. Dedicated digital aerial surveys of the Seagreen site were commissioned between March 2019 and September 2020 to provide data for pre-construction monitoring.

25. Twenty-six strip transects were flown on a roughly monthly basis over the site plus a 12 km buffer. Two kilometre transect spacing was used, with transects orientated roughly perpendicular to the main environmental gradients, such as depth. The proximity of the Seagreen site to the Offshore Ornithology Study Area resulted in approximately 25% overlap of the Seagreen pre-construction monitoring area with the Offshore Ornithology Study Area, equating to nearly 2,000 km^2. Preliminary evaluation of the data suggested the presence of several seabird species of importance, including:

- Qualifying species for nearby SPAs:
  - Guillemot, Arctic tern, Sandwich tern, gannet, kittiwake, herring gull, lesser black-backed gull, puffin, little gull, red-throated diver, Manx shearwater, and razorbill.
- European Union (EU) Bird Directive Annex 1 species:
  - Guillemot, red-throated diver, Manx shearwater, Sandwich tern, and Arctic tern.
- Species present in regionally important abundance:
  - Guillemot, gannet, kittiwake, razorbill, and puffin.

26. Baseline data collected during the surveys suggest that kittiwakes, gannets, guillemots and puffins use the area during the breeding season, occurring in relatively high abundance. Relatively high numbers of Arctic terns were also observed in the breeding season. These data suggest that the Seagreen site is used frequently during post-breeding migration by lesser black-backed gulls, guillemots and razorbills. During return migration in the spring, kittiwakes were regularly observed. It is likely that a small population of puffins also utilises the area during the non-breeding season.

2.2.4. JNCC SEABIRDS AT SEA DATA: EFFORT RELATED SEABIRD OBSERVATION DATA COLLECTED FROM BOATS USING EUROPEAN SEABIRDS AT SEA (ESAS) METHODOLOGY

27. The European Seabirds at Sea (ESAS) database holds the most comprehensive data on the abundance and distribution of northwest European seabirds, spanning over 30 years. Camphuysen *et al*. (2004) developed methods to assess bird distribution and abundance at sea to evaluate impacts of OWFs on bird populations. Line transect distance sampling methodology was the recommended census technique for boat-based surveys, using distance bands and detection functions to correct for the uncertain detection at increasing distances from the survey vessel.

28. The summed counts from the 84 boat-based ESAS surveys (1980 and 1996) trimmed to the Offshore Ornithology Study Area are presented in Table 2.2. Data were downloaded from https://hub.jncc.gov.uk/assets/5c7d5eca-9b5f-4781-809f-f27c94d94661. These data provide contextual information regarding the species and relative abundance of species likely to be present within the Offshore Ornithology Study Area.

Table 2.2: Total birds identified within the Offshore Ornithology Study Area from ESAS boat-based survey data between 1980 and 1996

Species	Total individuals present	Species	Total individuals present
Arctic skua	119	Kittiwake	1631
Arctic tern	5	Lesser black-backed gull	50
Black guillemot	1	Little auk	62
Black-headed gull	2	Little gull	17
Common gull	14	Long-tailed duck	1
Common scoter	2	Long-tailed skua	5
Common tern	4	Manx shearwater	18
Cormorant	2	Pomarine skua	13
Fulmar	1472	Puffin	781
Gannet	1645	Razorbill	820
Glaucous gull	1	Red-throated diver	2
Goldeneye	1	Sandwich tern	1
Great black-backed gull	139	Shag	4
Great skua	68	Sooty shearwater	39
Grey pharalope	3	Storm petrel	5
Guillemot	4142		
Herring gull	116		

Grand Total 11066

2.2.5. ANALYSIS OF EUROPEAN SEABIRDS AT SEA (ESAS) DATA TO IDENTIFY SUITABLE LOCATIONS FOR MARINE SPA'S WITHIN THE BRITISH FISHERY LIMIT

29. The ESAS database was used to determine the location of seabird assemblages and identify areas of high seabird densities to ultimately inform the designation of marine SPAs within national waters. Analyses conducted by Kober *et al*. (2010; 2012) used data from boat-based platforms of opportunity, with those relating to the North Sea region of relevance to the Offshore Ornithology Study Area. Data concerning sitting and flying birds between 1980 and 2004 were collected using line transects and the snapshot method respectively, as described by Camphuysen *et al*. (2004) and Tasker *et al.* (1984) and analysed using distance sampling.

30. The Outer Firth of Forth/Wee Bankie/Marr Bank region and the Inner Firth of Forth region were highlighted as important areas for multiple seabird species, such as breeding gannets, puffins and guillemots as well as wintering kittiwakes and puffins. Hotspot analyses identifying the presence of high densities of seabird species within the area supported the classification of the Outer Firth of Forth and St Andrews Bay Complex SPA which is in close proximity to the Offshore Ornithology Study Area.

2.2.6. IMPRESS FINAL REPORT: INTERACTIONS BETWEEN THE MARINE ENVIRONMENT, PREDATORS AND PREY, IMPLICATIONS FOR SUSTAINABLE SANDEEL FISHERIES – CAMPHUYSEN *ET AL*., 2004

31. The IMPRESS project aimed to quantify the relationships between sandeel populations, hydrography and foraging success and breeding performance of gannets, shags *Gulosus aristotelis*, kittiwakes and guillemots across the Wee Bankie/Marr Bank complex in the Outer Firth of Forth.

32. The IMPRESS study reported high abundance of kittiwakes, guillemots and gannets within the Berwick Bank development zone during the breeding season. These data will not be used during this assessment but are included to indicate which species are likely to be present in important numbers within the Berwick Bank Offshore Ornithology Study Area.

33. Colony-based studies of seabird breeding populations were conducted, one on the Isle of May considering shags, guillemots and kittiwakes annually between 1997 and 2003, and for gannets on Bass Rock in 1994 and 2004. Colony counts suggested breeding success for gannets and shags in contrast to that for guillemots where declines in breeding success were observed. Kittiwake breeding success was more variable.

34. Boat-based line transect surveys studying seabird distribution, abundance and behaviour were conducted throughout the Outer Firth of Forth region between 2001 and 2004. Data were collected using standard ESAS methods (Tasker *et al*., 1984). Surveys identified 37 seabird species, the most abundant of which were guillemot (49%), puffin (21%), kittiwake (12%), razorbill (11%) and gannet (6%). Distribution patterns indicated gannets ranged far from colonies, with guillemots and kittiwakes concentrated in the west of the region and shags distributed in coastal regions.

2.2.7. ISLE OF MAY LONG-TERM STUDY (IMLOTS)

35. The Isle of May long-term study (IMLOTS) aims to assess the impacts of environmental change on seabirds and their surrounding ecosystems on the Isle of May, in the outer Firth of Forth. As part of the Seabird Monitoring Programme (SMP), hosted by BTO and managed by JNCC, data concerning seabird breeding success has been continuously collected since 1982 for puffin, guillemot and razorbill, and since 1987 for shag, kittiwake and fulmar. Seabird breeding success is monitored by collecting data on the number of active nests and the number of chicks fledged per active nest.

36. Data collected through IMLOTS will not be directly applied to this report but are instead provided for context regarding which species are likely to be encountered.

2.2.8. SEABIRD TAGGING DATA

37. GPS loggers are used to track fine scale movements of many seabird species within the marine environment, the results of which are used in a variety of micro, meso and macro scale applications.

38. Wakefield *et al*. (2017) tracked 1,313 seabirds from 29 UK colonies using GPS loggers to determine coarse-scale breeding seabird distributions. Foraging ranges were variable between species with shags staying close to nest sites (median 3.4 km, interquartile range (IQR) 1.6–7.5) and kittiwakes (11.9 km, IQR 4.2–30.9), razorbills (13.2 km, IQR 5.1–26.2) and guillemots (10.5 km, IQR 3.2–19.1) travelling further afield. The study also predicted that breeding shags, kittiwakes, guillemots and razorbills primarily foraged within 100km of the coast in Scotland. Tagging data from the Isle of May was included in the analyses, however site-specific data were not presented.

39. Cleasby *et al.* (2018) built on Wakefield *et al*. (2017) using seabird telemetry data collected between 2010 and 2015 to create species distribution models and identify seabird hotspots at the UK- and SPA-level. Four species were considered: shag, kittiwake, guillemot and razorbill. SPA-level hotspots for kittiwake identified the east of Scotland as being of importance to the species, in particular those associated with Fowlsheugh SPA to the northeast of the Offshore Ornithology Study Area. Hotspots at the SPA-level of relevance to the Project were also identified for shags at the Forth Islands SPA.

40. Lane *et al*. (2020) collected telemetry data from 154 Bass Rock gannets during the breeding season between 2015 and 2019 to assess the risk of consented and proposed offshore wind farms within foraging range. Gannets generally flew northeast and southeast from the colony with males and females spending more time within proposed offshore wind farm sites during chick rearing than during pre-hatching. The potential collision risk was estimated to be eight times higher during this period, and also to be three times higher for females than males due to their higher flight heights, longer trip duration and increased time spent within proposed wind farm sites. The highest recorded densities of gannets from telemetry data overlapped with proposed wind farm sites within the outer Firth of Forth, with 99% of predicted collisions during the breeding season occurring in this region, compared to other wind farm sites which are within the foraging range of Bass Rock gannets but which are considerably more distant. Additional telemetry data have since been gathered from the breeding gannet colony on the Bass Rock since this study was published, which demonstrate a high degree of inter-annual variation in these patterns (Lane and Hamer, 2021).

41. Indeed, Lane and Hamer (2021) undertook additional tracking work from the Bass Rock, funded by developers from proposed and consented wind farms within the Forth of Tay (Neart na Gaoithe, Seagreen, and the Project), to determine the impacts of offshore wind farms on adult gannet foraging, survival and population dynamics. Tracks from both sexes overlapped with planned OWF sites in the outer Firth of Forth, although the proportion of tracks falling within these areas was higher in males (rather than females as found by Lane *et al*. 2020). Distance travelled and foraging trip duration were shorter compared to Lane *et al.* (2020). Trip duration, distance travelled and distance of displacement from the colony was consistent between sexes. Sex-specific survival was likely to be variable, although no trends could be determined.

42. Bogdanova *et al*. (in prep.) presents the results of GPS tracking of adult guillemots, razorbills and puffins breeding on the Isle of May, and of kittiwakes breeding on the Isle of May, St Abb's Head and Fowlsheugh in June and July 2021. An assessment of connectivity with three OWF sites in the outer Firth of Forth (Neart na Gaoithe, Seagreen and the Project) was conducted. Locational data were obtained from 23 guillemots, 11 razorbills, 24 puffins and 50 kittiwakes on the Isle of May, 40 kittiwakes at Fowlsheugh and 37 kittiwakes at St Abb's Head.

2.2.9. WWT WATERBIRD SURVEYS

43. Waterbirds and seabirds in inshore waters were monitored regularly by WWT Consulting between 2004 and 2009, to provide a comprehensive and robust assessment of UK inshore environments (e.g., Calbrade *et al*. 2009; Austin *et al*. 2007). Visual aerial surveys were conducted, using transects spaced at 2 km intervals orientated north to south. Survey methodology and distance sampling protocol from Buckland *et al.* (2001) and Camphuysen *et al*. (2004) was adopted.

44. Although the study did not cover the region considered for the Project, it gave reliable population estimates for waterbird species in the wider vicinity of the Project and indicates which species are likely to be present.

45. The "NE1" sampling block is closest to the Offshore Ornithology Study Area, located approximately 20 km from the southwest boundary of the buffer. Auks and gannets were identified as the most abundant species, with 6,199 birds recorded in the survey block overall. However, only non-breeding season surveys were targeted, and it is likely other species of interest may be present at other times.

3. BERWICK BANK DIGITAL AERIAL SURVEYS

3.1. OVERVIEW OF SURVEY FLIGHTS

46. Dedicated digital video aerial surveys conducted by HiDef Aerial Surveying Limited (hereafter "HiDef") were deployed for ornithological monitoring over the Offshore Ornithology Study Area using methods described in Buckland *et al*. (2012), Weiss *et al*. (2016) and Webb and Nehls (2019).

47. The aircraft flight altitude, >500 m, and other technical parameters of the adopted method conform with the guidance of Thaxter and Burton (2009) and updated in Thaxter *et al*. (2016). To complete the survey coverage in a single day and obtain a suitable snapshot, HiDef deployed two to four aircraft on each occasion to survey the area simultaneously with each aircraft surveying unique subsets of survey transects (Figure 3.1).

48. The survey programme ran from March 2019 to April 2021 and aimed to survey the Offshore Ornithology Study Area at monthly intervals or as close to this as possible. A total of 25 surveys were successfully flown, with a summary of survey flights presented in Table 3.1.

49. The COVID-19 pandemic halted all non-essential survey activity during April 2020, however surveys resumed in May 2020 based on updated risk assessments and stringent COVID-19 mitigation measures. Due to this and further complications (e.g., industrial action of airport personnel), complete coverage was not achieved in all months.

50. The April 2019 survey was missed due to bad weather, the January 2020 survey was flown at the beginning of February 2020, and two surveys were undertaken in May 2020 due to the April 2020 survey being cancelled. For the analysis of the data, some flights were assigned to different months where there was no survey to ensure coverage of all months in both seasons for a two-year period (see section 3.2.8). The Applicant discussed this allocation during the Ornithology Road Map process (RM4) and followed subsequent joint advice from Marine Scotland and NatureScot received through email on 14 January 2022.

51. For all surveys between July 2019 and January 2020, varying proportions of the intended transects were not flown. However, the target coverage for the site (~12.5%) was achieved by increasing the number of cameras from which the imagery was processed. Whilst this increased overall coverage, there remained limited "gaps" spatially where transects could not be surveyed (e.g., December 2019; Figure 3.2). Despite differences in survey coverage in some months, the survey results are of sufficient quality to provide robust baseline characterisation of the Offshore Ornithology Study Area.

52. Flight times for each survey are presented in Table 3.2.

53. HiDef's survey times are targeted at times of day that exclude 1.5 hours of sunrise and sunset in summer and winter. The dawn and dusk periods are excluded because the sun angle and light levels are too low for digital imagery at these times of the day. Dawn and dusk periods are also often out with airport opening hours.

54. Additional environmental information, such as time of sunset and high tide times, is also presented in Table 3.2.

55. The extent of the survey programme ensured that sampling occurred over a range of tidal states. Tidal state can influence the activity and habitat use of many bird species (Gilbert *et al.*, 1998) but given the offshore location of the Project, the influence of tidal state on seabird densities is also likely lower than in coastal areas.

56. Aircraft flight patterns are displayed in Figure 3.2, Figure 3.3 and Figure 3.4. Variation in presentation of track data is due to differing GPS equipment used in some surveys. The same transect lines were intended to be flown in each survey, however, effort differed between surveys due to slight differences in start and stop times and minor deviations of the aircraft from the transect line. It is important to note that aircraft flight patterns follow the original survey design covering the survey area (contractually agreed with the Applicant in September 2019) and extend beyond the Offshore Ornithology Study Area. The survey design was presented to Consultees through at the first meeting of the offshore Ornithology Road Map process (Technical Appendix 11.8).

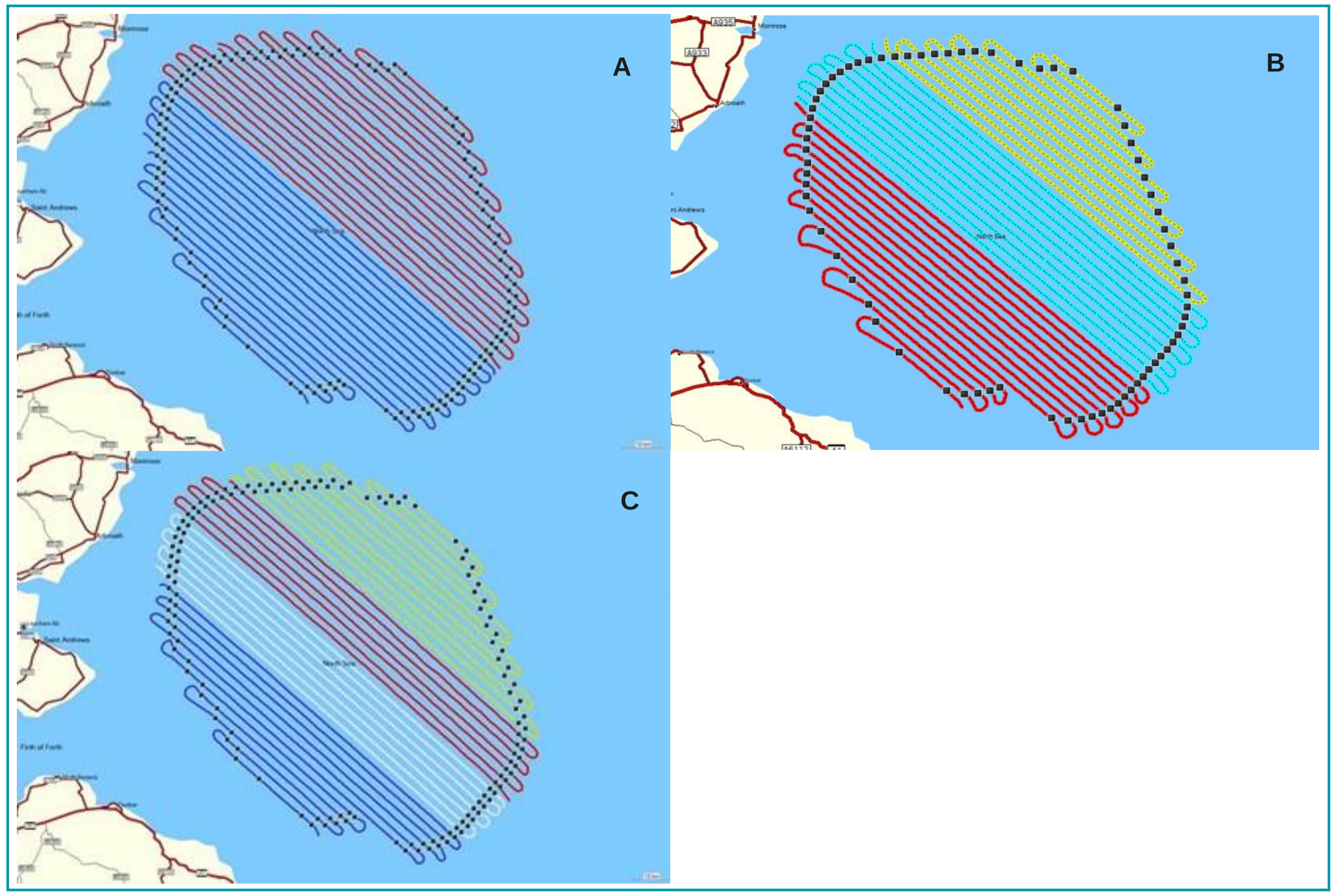


Figure 3.1: Transect splits between aircraft during summer months (April – September) A) 2 aircraft B) 3 aircraft and C) 4 aircraft, during autumn and early spring months (October – March) over the survey area. Note: flight paths follow original survey design (agreed in September 2019)

Table 3.1: **Survey effort and flight information for the 25 surveys of the survey area (original Berwick Bank Development Array plus 16 km buffer)**

Survey	Survey Date	Survey Number	Flight Times	Number of transects analysed	Total length of transects analysed (km)	Area covered (km^2)	Area covered (%)
March 2019	28/03/2019	1	09:20	35	2300.95	825.28	16.57%
May 2019[1]	14/05/2019	2	10:10	37	2492.69	623.17	12.51%
June 2019	21/06/2019	3	08:45	37	2488.60	622.15	12.49%
July 2019	23/07/2019	4	10:15	28	2095.22	621.15	12.47%
August 2019	06/08/2019	5	08:40	34	2307.80	618.96	12.43%
September 2019	15/09/2019	6	09:40	37	2489.89	622.47	12.50%
October 2019	17/10/2019	7	10:10	25	1890.50	655.70	13.17%
November 2019	19/11/2019	8	12:45	33	2188.78	633.47	12.72%
December 2019	07/12/2019	9	10:20	30	2247.63	663.21	13.32%
January 2020[2]	05/02/2020	10	08:55	32	2050.50	597.44	12.00%
February 2020	19/02/2020	11	09:40	37	2487.25	621.81	12.49%
March 2020	21/03/2020	12	10:25	36	2393.62	598.41	12.02%
May 2020 (S01)[3]	05/05/2020	13	10:20	29	1758.89	704.53	14.15%
May 2020 (S02)[3]	16/05/2020	14	07:55	37	2488.90	622.23	12.49%
June 2020	09/06/2020	15	08:15	37	2485.35	621.34	12.48%
July 2020	12/07/2020	16	08:30	37	2484.53	621.13	12.47%
August 2020	09/08/2020	17	09:00	37	2485.30	621.33	12.48%
September 2020	06/09/2020	18	08:40	37	2487.12	621.78	12.48%
October 2020	16/10/2020	19	08:40	37	2485.51	621.38	12.48%
November 2020	05/11/2020	20	10:50	37	2486.10	621.52	12.48%
December 2020	01/12/2020	21	10:15	37	2486.86	621.72	12.48%
January 2021	19/01/2021	22	10:50	37	2486.71	621.68	12.48%
February 2021	16/02/2021	23	10:00	37	2482.62	620.66	12.46%
April 2021 (S01)[4]	12/04/2021	24	08:40	37	2489.56	622.39	12.50%
April 2021 (S02)[4]	24/04/2021	25	08:55	37	2487.17	621.79	12.48%

[1]*April 2019 missed due to bad weather*

[2]*January 2020 survey undertaken on 05/02/2020.*

[3]*April 2020 survey suspended due to Coronavirus. Two surveys undertaken in May 2020 instead.*

[4]*Two surveys flown in April 2021 to ensure representative samples of "April" were available.*

For all surveys between July 2019 and January 2020, extra cameras were reviewed to achieve required coverage and to compensate for missed transects.

Table 3.2: **Survey summary of flight dates, flight times and tidal states over the survey area (original Berwick Bank Development Array plus 16 km buffer)**

Flight Date	Sunrise	Survey start time	Survey completion time	Sunset	First high tide time Arbroath	Second high tide time Arbroath
28/03/2019	05:49	09:20	18:10	18:40	07:17	20:08
14/05/2019	04:55	10:10	14:30	21:18	11:05	N/A
21/06/2019	04:19	08:45	17:05	22:05	04:40	17:10
23/07/2019	04:55	10:15	18:35	21:38	06:54	19:19
06/08/2019	05:21	08:40	19:30	21:10	06:29	19:11
15/09/2019	06:42	09:40	17:35	19:28	03:34	16:01
17/10/2019	07:47	10:10	15:05	18:06	04:36	16:58
19/11/2019	07:58	12:45	14:10	15:53	06:31	18:46
07/12/2019	08:30	10:20	14:30	15:33	11:02	23:03
05/02/2020	07:58	08:55	15:40	16:47	11:07	23:30
19/02/2020	07:27	09:40	13:50	17:18	11:20	N/A
21/03/2020	06:07	10:25	19:00	18:24	00:48	12:52
05/05/2020	05:15	10:20	17:30	20:56	01:14	13:25
16/05/2020	04:50	07:55	13:35	21:18	04:10	17:04
09/06/2020	04:21	08:15	14:25	21:57	05:05	17:47
12/07/2020	04:37	08:30	14:20	21:53	07:30	20:24
09/08/2020	05:26	09:00	14:30	21:01	06:07	18:46
06/09/2020	06:21	08:40	13:45	19:49	05:02	17:31
16/10/2020	07:42	08:40	12:50	18:04	02:10	14:42
05/11/2020	07:26	10:50	16:05	16:18	04:21	16:33
01/12/2020	08:18	10:15	15:40	16:24	02:24	14:40
19/01/2021	07:56	10:50	14:50	16:27	06:12	18:09
16/02/2021	07:13	10:00	16:10	17:18	04:53	16:52
12/04/2021	06:12	08:40	15:35	19:52	03:25	15:28
26/04/2021	05:42	08:55	14:55	20:15	02:21	14:29

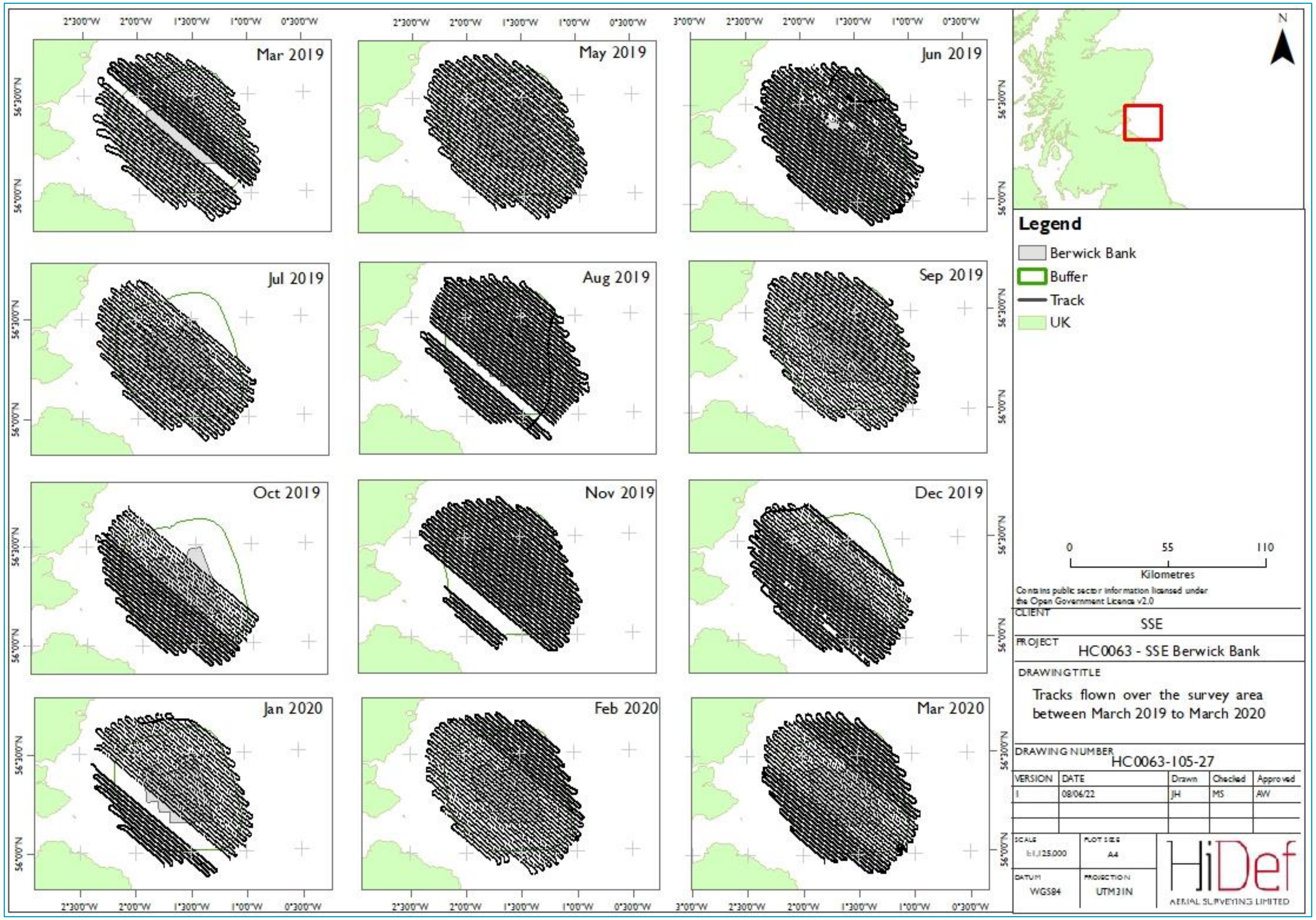


Figure 3.2: **Aerial survey transect coverage for each survey over the survey area (original Berwick Bank Development Array plus 16 km buffer) between March 2019 and March 2020**

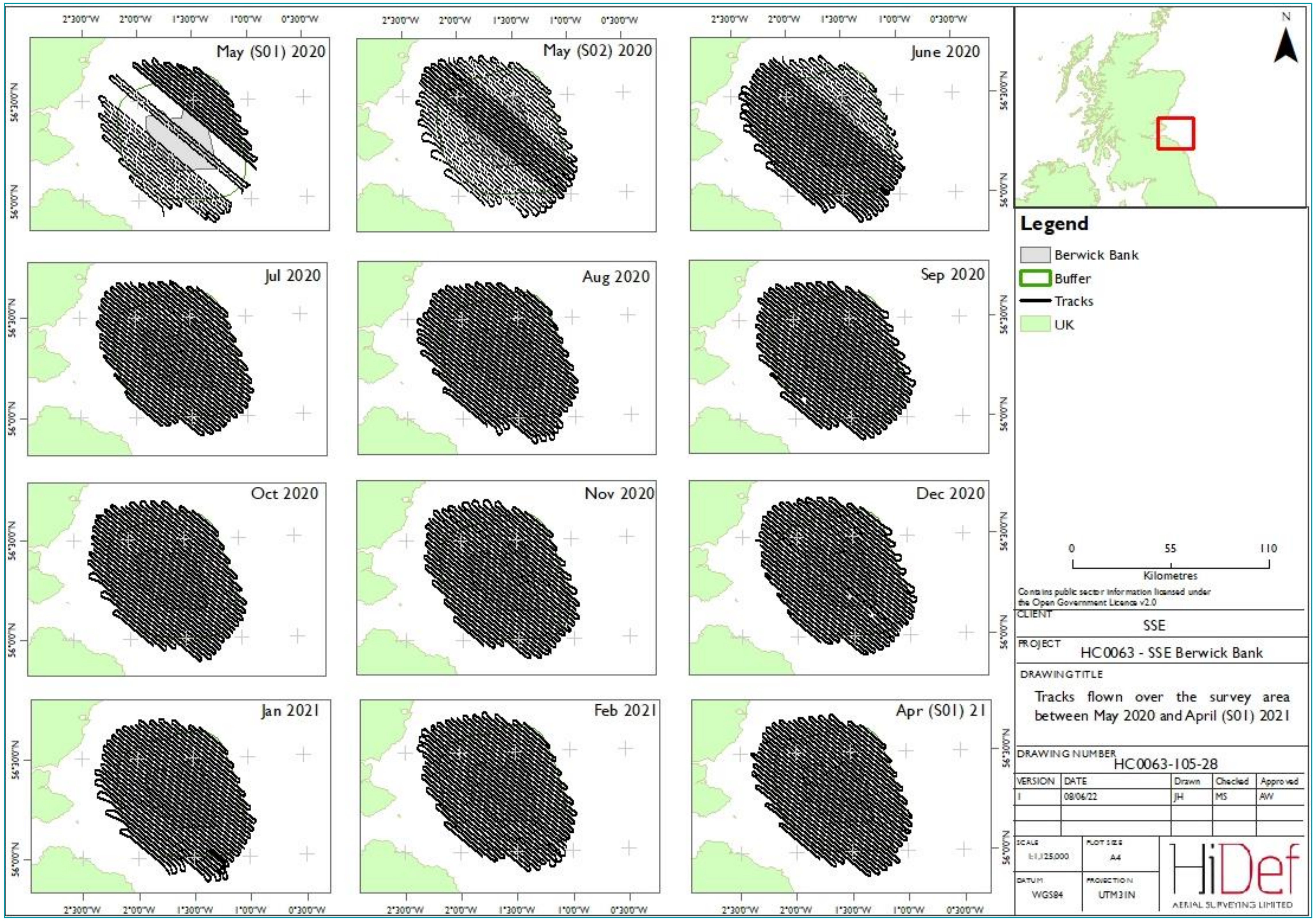


Figure 3.3: Aerial survey transect coverage for each survey over the survey area (original Berwick Bank Development Array plus 16 km buffer) between May 2020 and April (S01) 2021

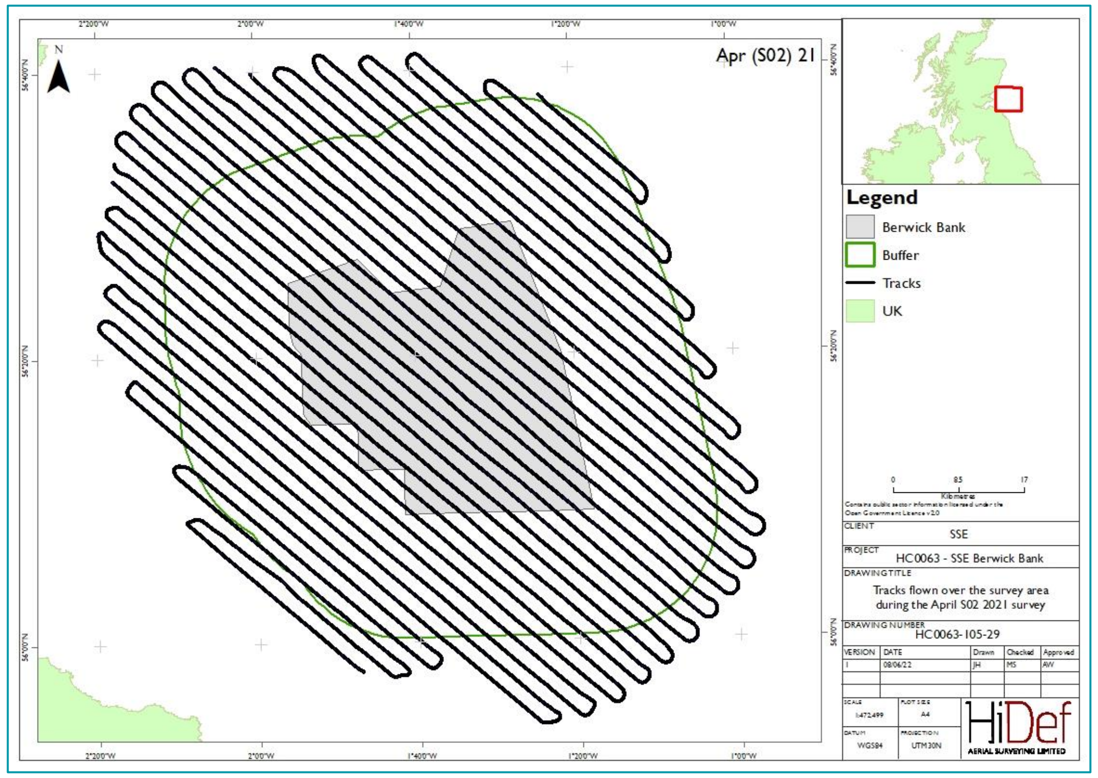


Figure 3.4: Aerial survey transect coverage over the survey area (original Berwick Bank Development Array plus 16 km buffer) during April (S02) 2021

3.2. METHODOLOGY

57. A series of strip transects were flown across the survey area, extending beyond the Offshore Ornithology Study Area, between March 2019 and April 2021.

58. The survey design consisted of 37 strip transects extending roughly north-west to south-east, perpendicular to the depth contours along the coast. Such a placement helped to ensure that each transect sampled a range of habitats (primarily relating to water depth), to reduce variation in bird and marine mammal abundance estimates between transects.

59. Transects were placed at 2 km apart across the survey area, resulting in an overall survey area of approximately 4,981 km^2. The Offshore Ornithology Study Area covers 3,975 km^2 and is entirely within the survey area.

60. Surveys were undertaken using an aircraft equipped with four HiDef Gen II cameras with sensors set to a resolution of 2 cm Ground Sample Distance (GSD). Each camera sampled a strip of 125 m width, separated from the next camera by ~20 m, providing a combined sampled width of 500 m within a 575 m overall strip (Figure 3.5).

61. Surveys were flown along the transect pattern shown in Figure 3.2 for example, and at a height of approximately 550 m above sea level (ASL) (~1800'). Flying at this height ensures that there is no risk of flushing those species easily disturbed by aircraft noise. Thaxter *et al.* (2016) recommends a minimum flight altitude of 460-500 m ASL.

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

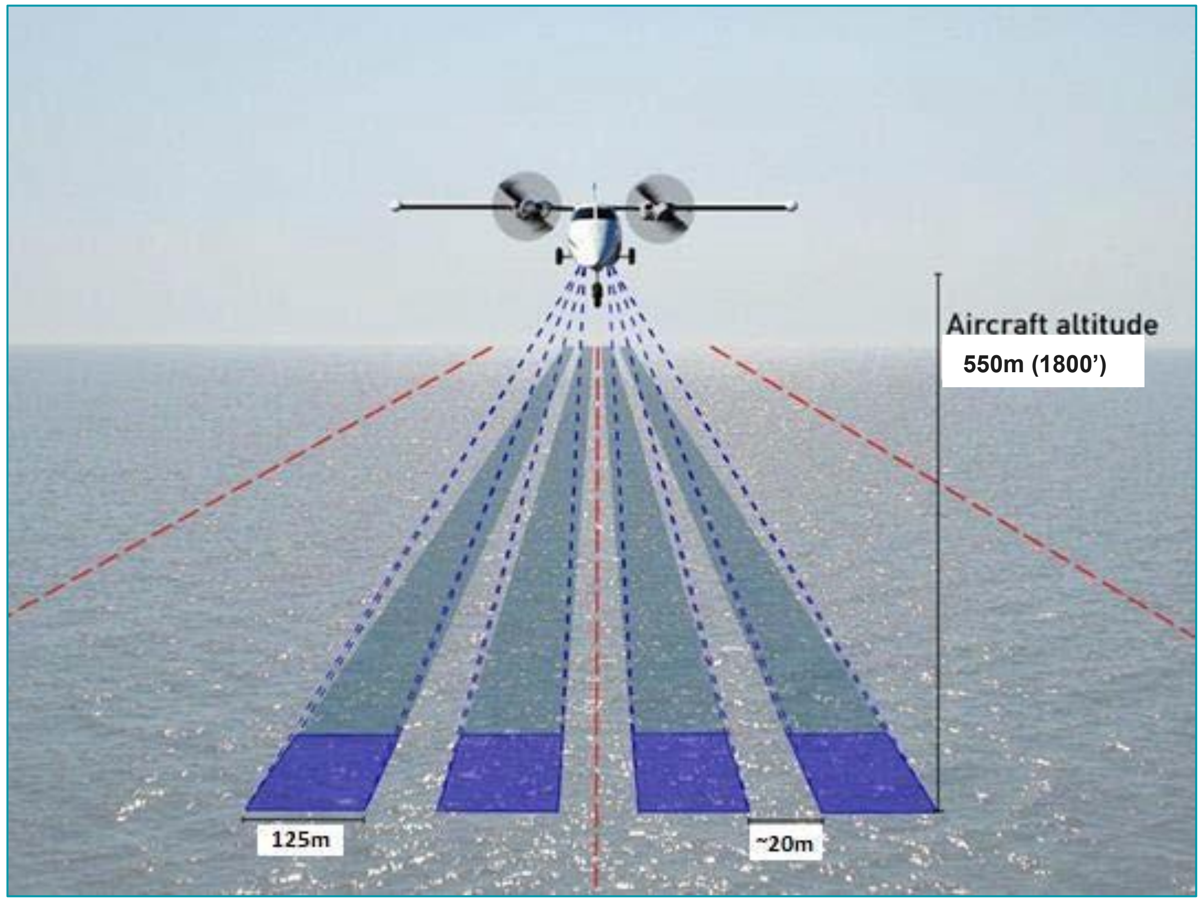


Figure 3.5: Schematic depicting the digital video aerial survey methodology

63. For most surveys, data from two out of the four cameras were processed to achieve a minimum target of 12.5% site coverage. This ensured sufficient coverage and number of transects, whilst allowing the remaining unprocessed data to be archived.

64. Where survey transects had been compromised, additional cameras were processed to achieve the 12.5% target. This was necessary for surveys from July 2019 to January 2020 inclusive.

3.2.2. IMAGE PROCESSING

65. Data were viewed by trained reviewers who marked any objects in the footage as requiring further analysis by the Identification (ID) Team, separating them into broad categories of birds, marine megafauna or anthropogenic objects.

66. An object was only recorded where it reached a reference line ('the red line') which defined the true transect width of 125m for each camera. By excluding objects that do not cross the red line, biases to abundance estimates caused by flux (movement of objects in the video footage relative to the aircraft, such as 'wing wobble') are eliminated.

67. As part of HiDef's quality assurance (QA) process, an additional 'blind' review of 20% of the raw data was carried out and the results compared with those of the original review. If 90% agreement was not attained during the QA process, then corrective action was initiated: the remaining data set was reviewed and where appropriate, the failed reviewer's data discarded and all the data re-reviewed. Additional training was then given to the reviewer to improve performance.

3.2.3. SPECIES IDENTIFICATION

68. Images marked as requiring further analysis were reviewed by specialist ornithologists for identification to the lowest taxonomic level possible and for assessment of the approximate age and the sex of each animal, as well as any behaviour traits visible from the imagery.

69. At least 20% of all birds were selected at random and subjected to a separate 'blind' QA process. If less than 90% agreement was attained for any individual camera then corrective action was initiated: if appropriate, the failed identifier's data were discarded, and the data re-identified. Any disputed identifications were passed to a third-party expert ornithologist for a final decision.

70. All birds were assigned to a species group and where possible, each of these were then further identified to species level. Identifications were given a confidence rating of 'possible', 'probable' or 'definite'.

71. Any birds that could not be identified to species level were assigned as 'No ID'. If, on occasion, the unidentified bird is suspected of belonging to two possible genera, then a broader group category may be used. For example, a bird would usually be assigned to the group category 'Shearwater species' if identified as a Manx shearwater, or to 'Auk species' if identified as a guillemot. However, if the bird has the potential to be either, then it would be assigned to the group category 'Shearwater / Auk species' and the species level recorded as 'No ID'.

72. A list of scientific names and taxonomic groupings used in the study are presented in Annex A.

3.2.4. AGE, SEX AND BEHAVIOUR

73. Where possible, birds were assessed for approximate age and sex. Aging of birds was based on moults and was therefore conducted only on flying individuals and species which show seasonal variation in plumage.

74. The behaviour of each bird was recorded. The direction of travel was also noted in the case of flying birds.

3.2.5. GEO-REFERENCING

75. All data were geo-referenced, taking into account the offset from the transect line of the cameras, and compiled into a single output; Geographical Information System (GIS) files for the Observation and Track data are issued in ArcGIS shapefile format, using UTM30N projection, WGS84 datum.

3.2.6. BIRD ABUNDANCE AND DENSITY ESTIMATION

76. The abundance of each species observed was estimated separately using a design-based strip transect analysis. During analysis, survey area data were trimmed to the Offshore Ornithology Study Area. All subsequent data within this report refer only to the updated Berwick Bank Development Array and corresponding 16km buffer (the Offshore Ornithology Study Area), although the various annexes also provide estimates for the Development Array, see Table 5.1 for description of Annexes.

77. Each transect is treated as an independent analysis unit, and the assumption is made that transects can be treated as statistically independent random samples from the site. The length of each transect and its breadth (i.e. the width of the field of view of the camera) multiplied together give the transect area; dividing the number of observations on that transect by the transect area gives a point estimate of the density of that species for the transect. The density of animals at the site (and hence the population size), the standard deviation, the 95% Confidence Intervals (CIs) and coefficient of variance (CV) are then estimated using a non-parametric bootstrap method with replacement (Buckland *et al*., 2001).

78. The upper and lower 95% confidence intervals were performed by way of a blocked bootstrapping technique to ensure equal transect effort was sampled across each iteration. This was done by using transect ID as the sampling unit with replacement, and then randomly sampling until the total length of the sampled transects equalled approximately the same length as the total survey length. A total of 500 bootstrap iterations were performed from which mean and standard deviation of the sampled means were calculated, as well as the relative standard error as defined by the standard deviation divided by the mean (or the "Coefficient of Variation", CV). Data were processed in the R programming language (version 4.0.4).

79. The density estimate is expressed as the average number of animals per square km surveyed over the whole site, and the population estimate is then calculated as the average density multiplied by the area of the whole site. The standard deviation is a measure of the variance of the population estimate, standardised by the number of samples (transects). The upper and lower CI define the range that the population estimate falls within with 95% certainty. The CV is a measure of the precision of the population and density estimates.

80. For most species these abundance estimates relate to absolute abundance, but for diving species (such as auks) the abundance relates to relative abundance due to a proportion of animals being submerged at the time of survey.

81. Density and abundance can also be derived using model-based methods. These methods tend to result in similar estimates as from design-based methods, and this was verified by completing model-based density and abundance estimates for five focal species to compare with the design-based estimates: kittiwake, guillemot, razorbill, puffin and gannet. HiDef undertook density surface modelling using the Marine Renewables Strategic Environmental Assessment (MRSea Windows Package package) in R (Scott-Hayward *et al.,* 2013). HiDef adapted and customised some of the MRSea code so that the modelling approach could cope with the specific nuances of the Berwick Bank data (code can be made available on request). This work was undertaken through consultation with the package author (Scott-Hayward) and was reported to consultees during the Road Map consultation process. The methodology and in depth-results are reported in Annex L to this report. The outputs that allow comparison to the design-based estimates are presented in Section 4.1.

Apportioning of unidentified birds

82. Apportioning of 'unidentified' birds to species level was also undertaken for the purposes of calculating population estimates. The number of unidentified birds in each species group were assigned to species where appropriate, based on their respective abundance ratios. For example, if identified guillemots and razorbills occurred in a 4:1 ratio, then 80% of unidentified birds would be assigned to guillemot and 20% assigned to razorbill. Apportioned estimates are presented in text, with apportioned and unapportioned estimates presented in the Annexes for reference.

Centcount maps

83. Cent-count maps were created to show the distribution of species. To account for varying survey effort for visualization, design-based population estimates, and statistical modelling, observations were run through a HiDef data aggregation tool which organized those data into regularly spaced bins along transect lines. This tool works by interpolating GPS tracks from the aircraft and locating points along those tracks which are approximately 500 m apart (i.e., centroids of 500 m bins). These 500 m bins then use a nearest neighbour technique to aggregate observations into those centroid locations (i.e., observations are aggregated into the nearest centroid point along the line). To calculate the area surveyed for each bin, the length of the bin is multiplied by the strip width of the cameras (125 m x *n* cameras, where *n* is the number of cameras used in that transect). The circles represent the number of birds in each 500 m bin. The larger the circle, the greater the number of birds present.

84. Where more than 40% of the surveys had observations, all surveys have been displayed in centcount maps, including those with no observations. This is with the exception of Survey April (S02) 2021 which was only mapped where observations were present. Where less than 40% of surveys had observations, only surveys with observations have been displayed in maps.

Correction for availability bias

85. In wildlife surveys, a proportion of seabirds that spend time underwater, especially while feeding, will not be detectable at the surface. This “availability bias” leads to an under-estimate of their abundance.

86. Barlow *et al*. (1988) produced a method to estimate true abundance by using correction factors based on species-specific data on time spent underwater.

87. Following Barlow *et al*. (1988) the probability that an animal is available at the surface is calculated as:

$$\Pr(being\ visible) = \frac{(s+t)}{(s+d)}$$

Where s is the average time spent at the surface, t is the window of time that the animal is within view and d is the average time below the surface. In the case of digital video surveys, the value of t is negligibly small and is treated as 0.

88. Using Barlow’s method, we calculated the proportion of time that an animal was available at the surface (Pr (visible)) for guillemot and razorbill. Absolute density, corrected for availability, was then obtained by dividing the density of birds observed by the Pr(visible).

89. For guillemots and razorbills, data obtained during the breeding season using data loggers was used to estimate availability bias. Thaxter *et al*. (2010) give mean times for these species engaged in flying, feeding and underwater per trip during the chick-rearing period.

90. Thus, the proportion of time that guillemots and razorbills were available at the surface (Pr(visible)) was estimated at 0.7595 and 0.8182, respectively.

91. For puffins the results from a study using data loggers reported in Spencer (2012) were used. The results show that puffins spend 14.16% of daylight time underwater. This infers that the proportion of time that puffins were available at the surface (Pr(visible)) was 0.8584.

92. The estimates of Pr(visible) for guillemots, razorbills and puffins were used to correct relative abundance estimates of birds sitting on the sea. These corrected abundance estimates for sitting birds were then added to the abundance estimate of flying birds to give an overall absolute abundance for each species.

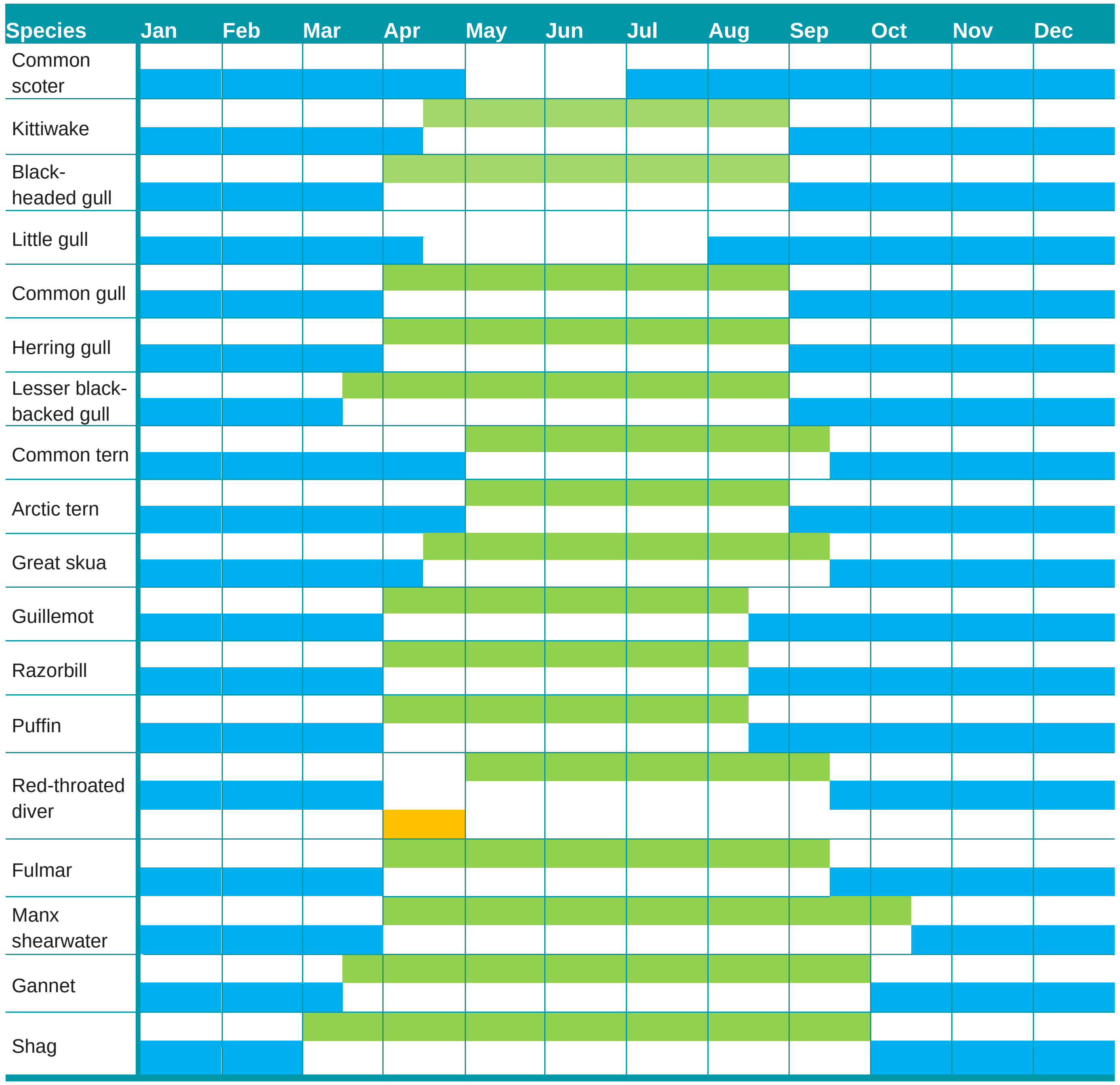
93. Correction for availability bias was not undertaken for any other species due to a lack of information about diving patterns.

3.2.7. CONSIDERATION OF BIOLOGICAL SEASONS

94. Bird abundance and distribution varies greatly throughout the year, dictated largely by season and bird biology. This report recognises two main biologically distinct ‘bio-seasons’, which aid in understanding the importance of the site for each species during a yearly cycle. We have used the seasonal definitions outlined in NatureScot guidance (2020a), as agreed during the Ornithology Road Map process. Seasonality is complex and periods differ between species based on life history traits, with timings an approximation. Figures collated for each species are summarised in Figure 3.6. Bio-seasons used within this technical baseline report are:

- **Breeding season:** birds are strongly associated with a nest site, including nesting, egg-laying and provisioning young.
- **Non-breeding season:** period 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.

Figure 3.6: Gantt chart of species-specific bio-seasons used in this report, adapted from NatureScot (2020a) including the breeding season (green), non-breeding (blue) and pre-breeding (orange)



3.2.8. CALCULATION OF MEAN SEASONAL PEAKS

95. Mean seasonal peak (MSP) population estimates were calculated for each species in each bio-season, taken as an average over the two years of surveying (March 2019 – April 2021). For example, the MSP population estimate for the breeding season was calculated as the average of the peak count in the breeding season in year one and the peak count in the breeding season in year two.

96. Surveys were generally assigned to a season based on the day of the month that the survey was flown. For seasons starting or ending halfway through the month, the 15/16 was used as a mid-month cut off. This

was necessary to avoid the same monthly estimate potentially being used in both the breeding and non-breeding season.

97. To account for months where there was no survey, some flights were assigned to different months or years to ensure coverage of all months in both seasons for a two-year period (Table 3.2). The Applicant discussed this allocation during the Ornithology Road Map process (RM4) and followed subsequent joint advice from Marine Scotland and NatureScot received through email on 14 January 2022.

98. This treatment of surveys was only conducted for calculation of mean-seasonal peaks and age class proportions, with all other data presented in this technical report by the date that the surveys were flown.

Table 3.2: Treatment of rescheduled surveys for calculation of mean seasonal peaks (MSPs) and age proportions per season

Survey name	Date flown	Used to represent	Date used in analysis
Jan-20	05/02/20	January 2020	30/01/20
Feb-20	19/02/20	February 2020	19/02/20
May S01 20	05/05/20	April 2020	30/04/20
May S02 20	16/05/20	May 2020	16/05/20
Apr S02 21	24/04/21	April 2019	24/04/19

99. MSP population estimates are presented for the offshore Ornithology Study area for context. MSPs for the for the Development array plus a 2km buffer, which are required for relevant species for displacement modelling and assessment are also reported. MSPs for the array area only are reported separately in the Appendix 11:4: Ornithology Displacement Technical Report.

3.2.9. CALCULATION OF AGE CLASS PROPORTIONS

100. To assess the proportion of birds in each age class (adult, immature, juvenile), the average or mean number of birds recorded in each class was calculated across all surveys that occurred in each season. For example, if there were four surveys in the breeding season in year one and four surveys in the breeding season in year two, then the average number of adult birds was calculated across eight surveys in total. This was conducted using all data within the 16 km boundary. Surveys were assigned to a season based on the day that the survey was flown, with the exceptions listed in Table 3.2. For seasons starting or ending halfway through the month, the 15/16 was used as a mid-month cut off.

101. The resulting proportion in each class was calculated as a proportion of the sum of the average number in each age class. This is presented for species where aging was possible, namely gulls, gannets and terns.

4. RESULTS

102. The total number of birds observed during the 25 surveys in the Offshore Ornithology Study Area and subsequently identified to species level are presented in Table 4.1 and Table 4.2. Species addressed in greater detail within this report are highlighted in grey. Birds which could not be identified to species level but were assigned to a broader species group are presented in Table 4.3 and Table 4.4. For comparative purposes between survey years, all species recorded are presented in Table 4.1 and Table 4.2, even if only recorded in one year.

103. Scientific names of species and taxonomic groupings are presented in Annex A.

Table 4.1: Raw counts of birds detected and assigned to species level in Year 1 of surveying at Offshore Ornithology Study Area: March 2019 to February 2020

Species	Mar	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Pink-footed goose	0	0	0	0	0	17	0	0	0	0	0
Teal	0	0	0	0	0	0	2	0	0	0	0
Tufted duck	0	0	0	0	0	0	0	0	0	0	0
Common scoter	0	0	2	0	0	0	0	0	0	1	0
Goosander	0	0	0	0	0	0	1	0	0	0	0
Rock dove	0	0	0	1	0	0	0	0	0	0	0
Wood pigeon	1	1	0	0	0	0	0	0	0	0	0
Red-necked grebe	1	0	0	0	0	0	0	0	0	0	0
Oystercatcher	0	0	0	0	0	0	0	0	0	0	0
Lapwing	0	0	0	0	0	0	0	0	0	0	0
Golden plover	15	0	0	0	0	40	0	0	0	0	0
Curlew	1	0	0	0	1	0	0	0	0	0	0
Woodcock	0	0	0	0	0	0	0	0	0	0	0
Kittiwake	7496	1259	1018	1807	4067	790	696	230	281	988	658
Black-headed gull	0	0	0	0	0	0	0	0	0	0	0
Little gull	0	0	0	5	8	0	0	2	0	1	3
Common gull	5	1	0	4	3	0	16	50	37	6	11
Great black-backed gull	2	0	15	4	1	1	0	34	8	0	2
Herring gull	3	2	235	103	97	1	1	193	87	5	2
Lesser black-backed gull	0	2	18	32	16	2	0	0	0	0	0
Sandwich tern	0	0	1	0	8	0	0	0	0	0	0
Common tern	0	0	0	3	4	0	0	0	0	0	0
Arctic tern	0	1	0	40	33	0	0	0	0	0	0
Great skua	0	1	0	4	0	2	0	0	0	0	0
Pomarine skua	0	0	0	0	0	0	0	0	0	0	0
Arctic skua	0	1	1	0	0	0	2	0	0	0	0
Little auk	2	0	0	0	0	0	3	8	2	16	14
Guillemot	3631	9663	2074	8475	14250	1813	2260	733	1373	4058	2415
Razorbill	599	507	133	795	907	516	1139	161	296	460	293
Puffin	659	709	541	1102	865	393	97	9	0	7	21
Red-throated diver	0	5	2	0	0	0	1	1	0	0	1
Great northern diver	0	0	0	0	0	0	0	0	0	0	0
European storm-petrel	0	0	0	0	0	0	0	0	0	0	0
Fulmar	102	36	22	27	28	23	7	67	66	60	21
Sooty shearwater	0	0	0	0	0	0	0	0	0	0	0
Manx shearwater	0	0	9	0	1	3	0	0	0	0	0
Gannet	161	338	593	1542	1995	1145	687	133	13	4	2
Shag	0	0	3	0	0	0	0	0	0	0	0
Redwing	0	0	0	0	0	0	34	0	0	0	0
Redstart	0	0	0	0	0	0	0	0	0	0	0
Total	12678	12526	4667	13944	22284	4746	4946	1621	2163	5606	3443

Table 4.2: Raw counts of birds detected and assigned to species level in Year 2 of surveying at Offshore Ornithology Study Area: March 2020 to April 2021

Species	Mar	May S01	May S02	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Apr S01	Apr S02
Pink-footed goose	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teal	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tufted duck	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Common scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goosander	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Rock dove	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood pigeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-necked grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oystercatcher	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Lapwing	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Golden plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curlew	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Woodcock	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Kittiwake	2531	1507	2841	2497	3114	4619	6868	856	1775	1188	2112	503	3419	4241
Black-headed gull	0	0	0	0	0	0	1	0	0	1	0	0	0	0
Little gull	0	0	0	0	4	32	5	1	0	5	3	0	0	4
Common gull	1	0	1	0	3	22	3	0	3	115	23	0	3	14
Great black-backed gull	1	0	0	1	9	2	0	0	5	50	28	1	0	0
Herring gull	1	1	1	25	544	79	27	3	11	629	72	5	2	7
Lesser black-backed gull	0	3	0	6	108	31	0	0	0	1	0	0	1	0
Sandwich tern	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Common tern	0	1	1	0	7	34	22	0	0	0	0	0	0	4
Arctic tern	0	1	8	6	11	23	12	0	0	0	0	0	0	8
Great skua	1	0	0	1	0	2	3	5	7	4	0	0	0	0
Pomarine skua	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Arctic skua	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Little auk	0	0	0	0	0	0	0	0	15	72	45	6	0	0
Guillemot	7756	12415	8842	10417	3598	11899	17021	3843	2853	6917	3386	1611	9230	22527
Razorbill	1483	506	329	287	699	1209	5353	452	143	487	959	324	1306	591
Puffin	188	423	136	223	525	624	3281	43	52	7	8	95	442	1279
Red-throated diver	0	0	4	0	0	0	0	0	12	4	4	1	0	1
Great northern diver	0	0	0	0	0	0	0	0	0	0	0	1	0	0
European storm-petrel	0	0	0	0	0	0	6	0	0	0	0	0	0	0
Fulmar	39	25	16	34	23	44	341	120	0	181	56	61	16	53
Sooty shearwater	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Manx shearwater	0	0	0	7	5	8	0	0	0	0	0	0	0	0
Gannet	97	331	548	657	1622	915	912	421	555	176	46	25	257	698
Shag	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Redwing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Redstart	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	12098	15214	12727	14161	10272	19545	33859	5744	5436	9838	6742	2634	14676	29430

Table 4.3: Raw counts of birds with no species ID, assigned to species groups, in Year 1 of surveying at Offshore Ornithology Study Area: March 2019 to February 2020

Species	Mar	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Wader species	3	0	0	3	28	6	0	0	0	0	0
Small gull species	1	3	1	1	4	3	3	17	6	9	13
Black-backed gull species	0	0	1	0	0	0	0	0	0	0	0
Large gull species	0	0	8	6	5	0	0	7	2	0	0
Gull species	0	0	15	10	10	2	3	28	15	5	2
Arctic / common tern	0	12	12	758	1326	8	0	0	0	0	0
Tern species	0	0	1	8	26	0	0	0	0	0	0
Tern / small gull species	0	0	1	14	27	0	0	1	0	0	0
Skua species	0	0	0	0	0	0	0	0	0	0	0
Large auk	230	257	90	814	790	511	427	121	120	520	259
Small auk	0	2	1	0	0	1	0	1	1	6	1
Auk species	293	267	167	592	632	307	214	53	106	247	118
Auk / small gull	11	36	14	6	21	5	15	9	4	10	59
Large auk / diver species	0	4	0	2	0	0	0	0	1	0	2
Auk / shearwater species	0	3	1	0	2	2	4	1	0	0	0
Diver species	0	0	0	0	0	0	0	0	0	2	0
Fulmar / gull species	3	2	15	10	8	3	2	10	8	6	4
Shearwater species	0	0	0	0	0	0	0	0	0	0	0
Passerine species	2	0	0	0	0	0	6	0	0	0	0
Small bird species	0	2	0	0	14	1	9	0	1	7	3
Total	543	588	327	2224	2893	849	683	248	264	812	461

Table 4.4: Raw counts of birds with no species ID, assigned to species groups, in Year 2 of surveying at Offshore Ornithology Study Area: March 2020 to April 2021

Species	Mar	May S01	May S02	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Apr S01	Apr S02
Wader species	0	0	14	0	0	0	0	0	0	0	0	0	0	0
Small gull species	17	1	1	0	3	6	4	4	0	26	9	0	6	11
Black-backed gull species	0	0	0	0	2	0	0	0	0	0	0	0	0	1
Large gull species	0	1	0	0	16	4	1	0	0	5	0	0	0	0
Gull species	4	1	0	1	14	11	13	1	1	23	4	2	1	3
Arctic / common tern	0	6	75	2	24	905	138	0	0	0	0	0	0	11
Tern species	0	0	1	0	0	20	2	0	0	0	0	0	0	0
Tern / small gull species	0	0	2	1	0	30	10	0	0	0	0	0	0	3
Skua species	0	0	0	0	0	0	1	0	2	0	0	0	0	0
Large auk	692	486	296	202	313	544	996	212	104	287	409	240	562	470
Small auk	1	0	0	0	0	0	0	0	5	0	0	2	0	0
Auk species	167	375	171	177	171	443	595	216	112	235	251	123	326	503
Auk / small gull	9	60	35	14	13	19	73	11	16	17	18	20	30	68
Large auk / diver species	1	0	0	1	0	0	1	0	16	0	1	0	1	0
Auk / shearwater species	0	0	0	12	1	13	13	0	0	0	0	0	0	1
Diver species	0	0	0	0	0	1	0	1	1	0	1	0	0	0
Fulmar / gull species	7	12	1	2	6	6	38	6	1	6	3	8	4	12
Shearwater species	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Passerine species	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Small bird species	0	0	0	0	1	0	1	0	3	0	0	4	2	0
Total	898	942	596	412	564	2002	1886	453	264	599	696	399	932	1083

4.1. ABUNDANCE ESTIMATES: COMPARISON OF DESIGN- AND MODEL-BASED

104. Plots of density and associated 95% confidence intervals for each survey for kittiwake, guillemot, razorbill, puffin and gannet enable comparison between estimates generated from design and model-based methods.

105. Kittiwake estimates were relatively similar from the two methods throughout the study period (Figure 4.1). Likewise, for razorbill and puffin, the estimates from the two methods were effectively the same, as demonstrated by the overlapping confidence intervals (Figure 4.3 and Figure 4.4 respectively).

106. Estimates produced by both methods for gannets were similar apart from December 2019 and February 2020, where MRSea produced much larger population estimates. This was due to the model being unable to resolve the spatio-temporal relationship in the survey gaps, leading to unrealistic estimates.

107. The estimates using design-based and MRSea methods for guillemots were relatively similar. However, in October 2019 MRSea produced a significantly higher estimate than those produced by the design-based method. There was also less variation in the two methods outputs in Year 2 (2020/21) (Figure 4.2).

108. MRSea results cannot be replicated despite reruns with the same code and input parameters as the stochasticity in the bootstrapping used to produce estimates will lead to different values on every run and due to the selection of spatial knots.

109. The use of density-based estimates was more appropriate for downstream processes due to the instability of MRSea across several metrics. First, confidence limits of model-based population estimates were wider than design-based in most cases, particularly in October 2019 surveys. An often-cited desirable trait of model-based estimates is the ability to generate tighter confidence limits around population estimates. However, design-based estimates provided tighter confidence limits compared to model-based estimates in this case. Another reason for the selection of design-based over model-based population estimates was related to stochasticity in the MRSea process which generated vastly different results when running the same set of code with no changes in data or parameters (Table 4.5 and Table 4.6). This seemed to be related to the random selection of spatial knots combined with large gaps in the survey areas. This stochasticity meant that the MRSea results were unreliable (in April S02 of the 2021 surveys, there was a difference of 2,438 individuals between both model runs, while in October 2019, due to large gaps in survey effort, in one model, the mean estimate was unrealistically high, while in the next run, estimates were in line with other months). Although the estimates fall within respective confidence limits between runs, the differences would invariably impact MSPs used for displacement and, for other species, density estimates for collision risk modelling.

110. On a technical point, another reason for using design-based estimates rather than the MRSea outputs was because of the inability to save output files from MRSea to allow for re-examination of model outputs. File sizes of the outputs were on the order of 20 GB (due to the size of the dataset) and were unable to be re-read into the R interface, meaning re-visiting models was not possible. This issue was raised at the Marine Scotland Ornithology Impact Assessment Workshop on the 22 February 2022, and it was confirmed that there are currently no plans to change output file format. The possibility of modelling at a monthly scale (as opposed to a seasonal scale; suggested by Scott-Hayward during the Marine Scotland Ornithology Impact Assessment Workshop) to help overcome issues with data gaps was not considered because downstream processes required population estimates at the survey-level scale to aggregate data.

111. Annex L provides monthly population estimates by species from the MRSea analyses and spatial maps of the mean densities and uncertainty (95% CIs and CVs) around those estimates.

Table 4.5: Exemplar abundance outputs from two runs of MRSea for guillemot from March 2019 to February 2020. Input data and model parameters were identical with the only difference being between location of the spatial knots

Model run	Mar	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
1	10767	22782	5999	23594	32768	4580	448304	690	1680	13410	8448
2	11195	23088	5543	23037	34106	4211	2615	779	1556	14460	9536
Difference	428	306	-456	-557	1338	-369	-445689	89	-124	1050	1088

Table 4.6: Exemplar abundance outputs from two runs of MRSea for guillemot from March 2020 to April 2021. Input data and model parameters were identical with the only difference being between location of the spatial knots

Model run	Mar	May S01	May S02	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Apr S01	Apr S02
1	30666	20701	14462	34072	8950	24006	27928	4102	2914	11900	9536	5277	22554	51986
2	31292	22044	14524	33596	9218	23316	28390	3765	2978	12788	9242	5636	21003	49548
Difference	626	1343	62	-476	268	-690	462	-337	64	888	-294	359	-1551	-2438

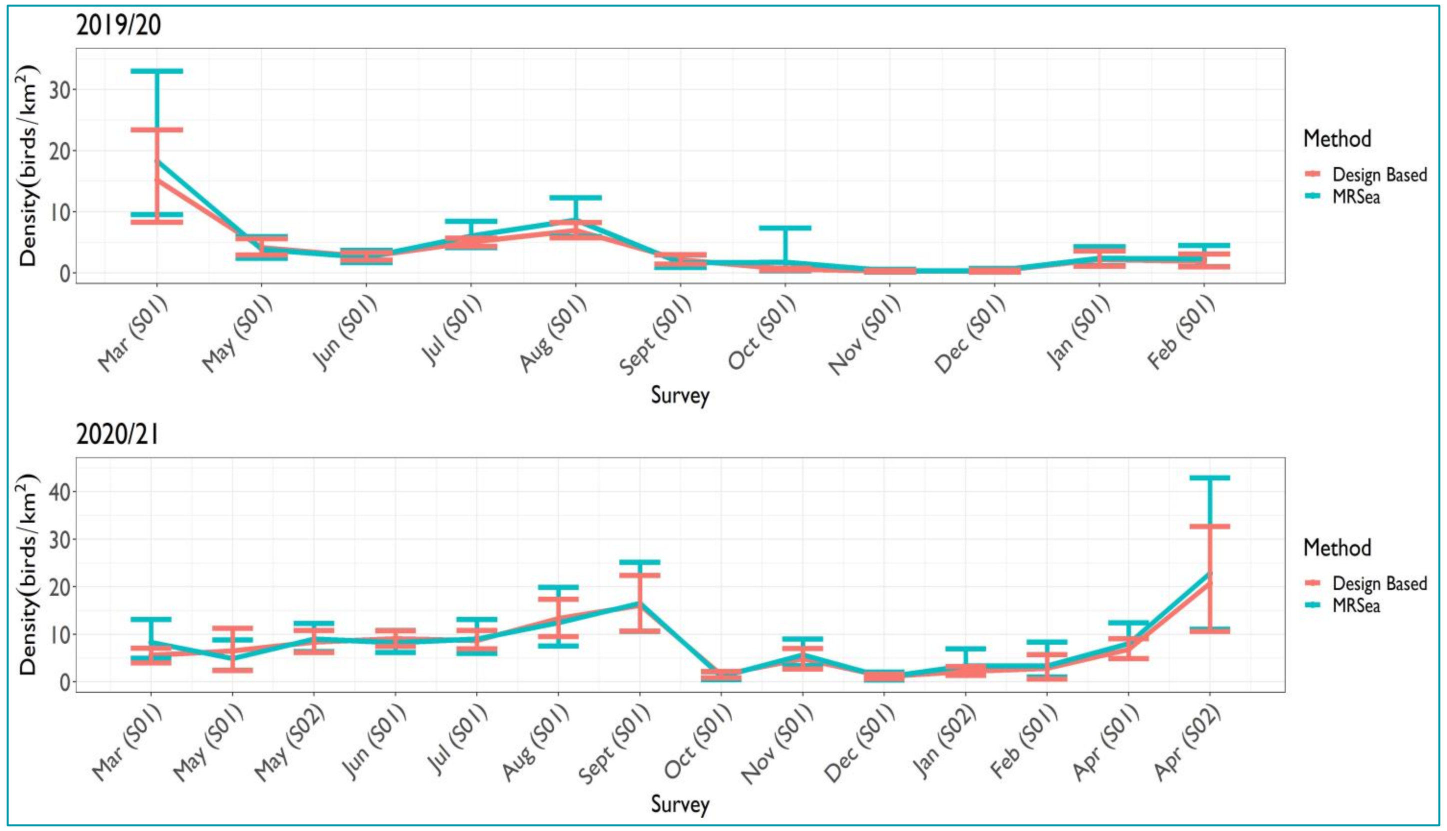


Figure 4.1: Comparison of the density estimates produced using design-based and MRSea methods for kittiwakes

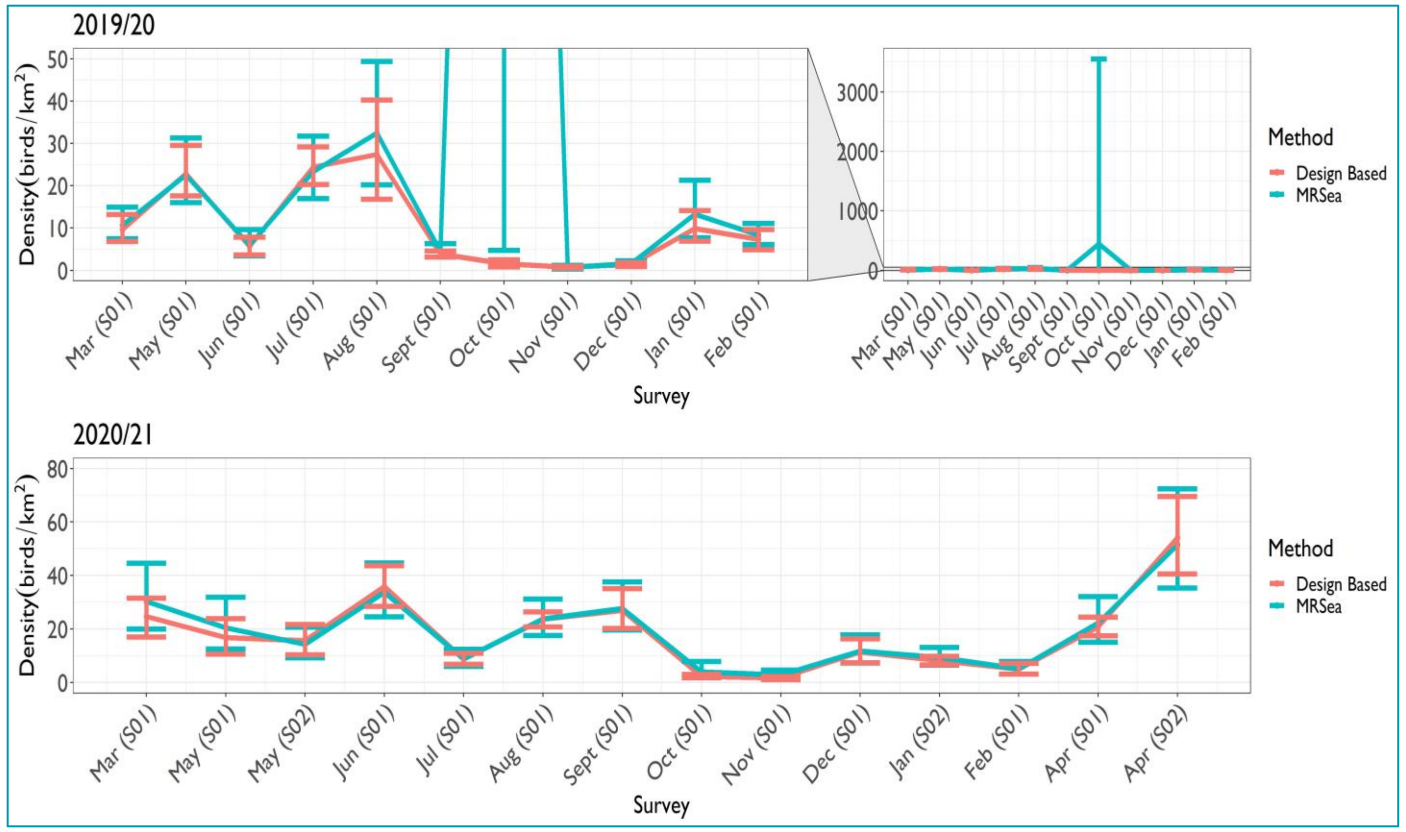


Figure 4.2: Comparison of the density estimates produced using design-based and MRSea methods for guillemots

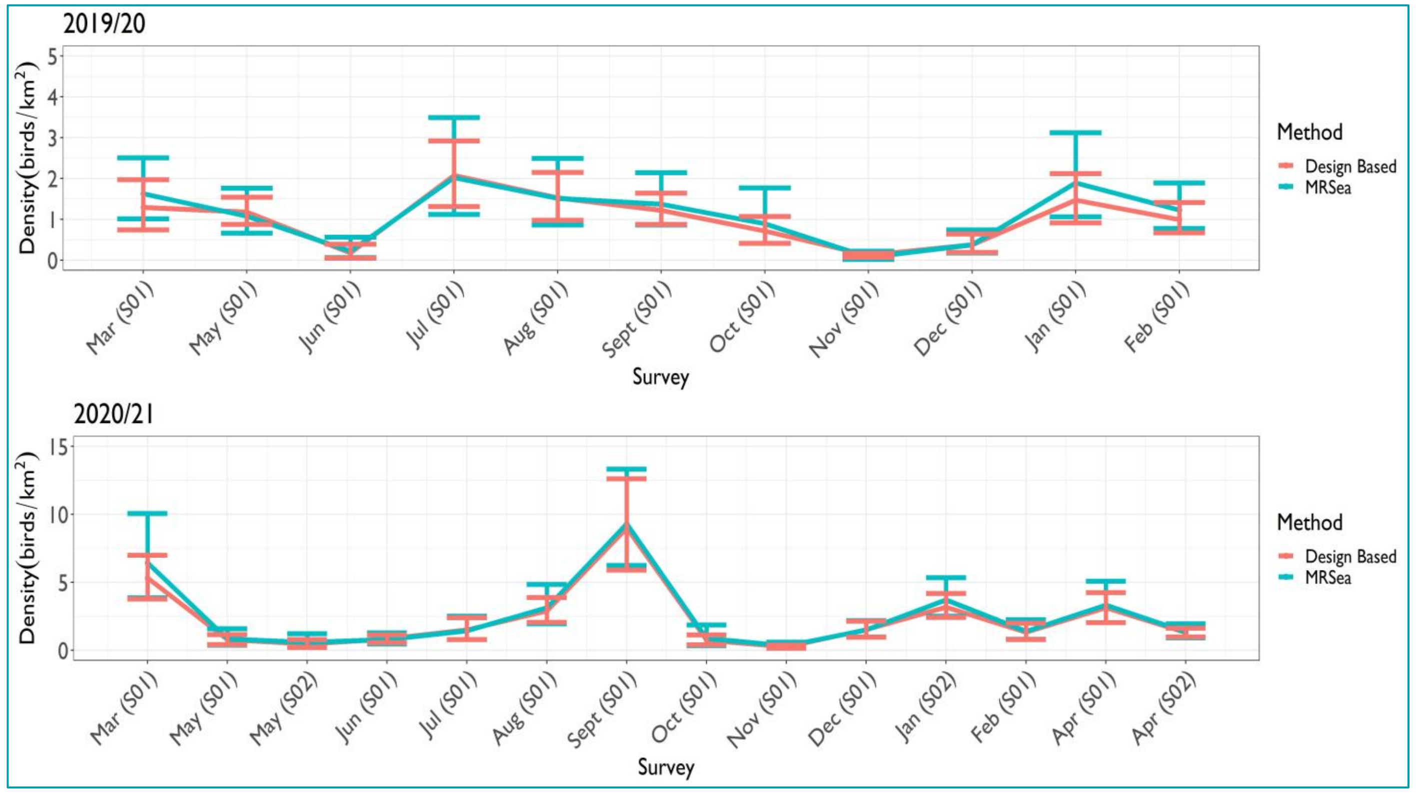


Figure 4.3: Comparison of the density estimates produced using design-based and MRSea methods for razorbills

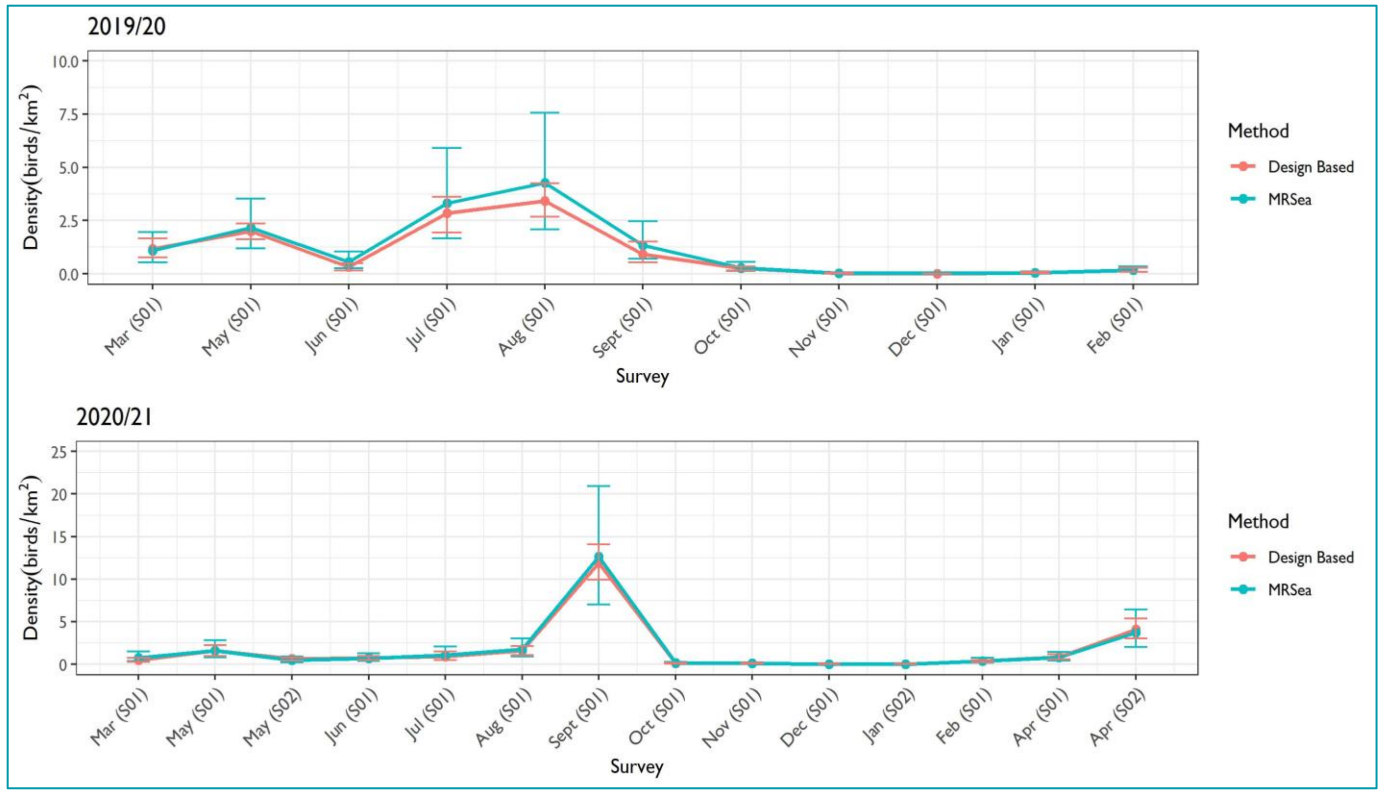


Figure 4.4: Comparison of the density estimates produced using design-based and MRSea methods for puffins

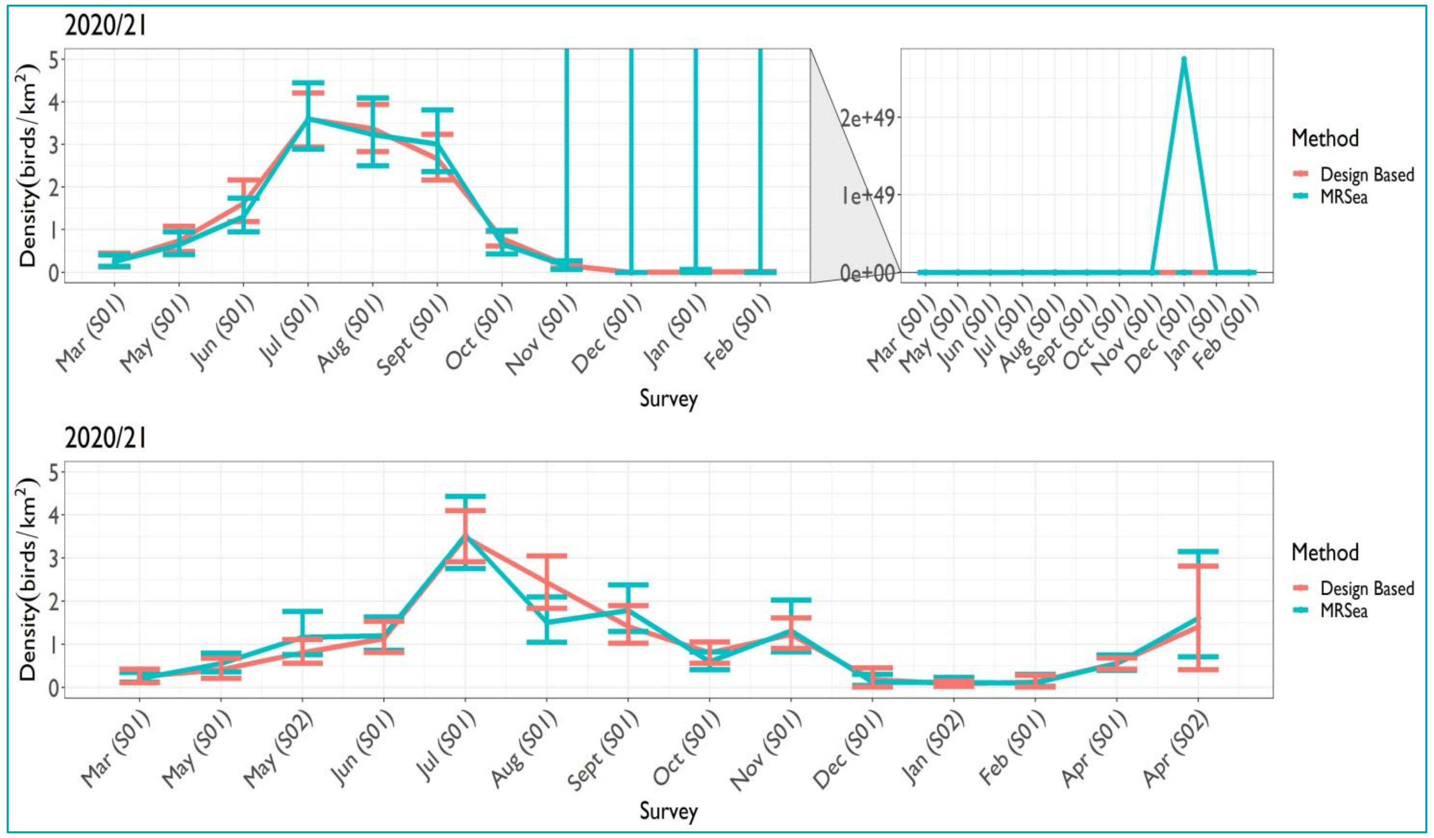


Figure 4.5: Comparison of The Density Estimates Produced Using Design-Based and Mrsea Methods for Gannets

5. SPECIES ACCOUNTS

112. Eighteen species are the focus of the species accounts and discussed in greater detail below:

- common scoter;
- kittiwake;
- black-headed gull;
- little gull;
- common gull;
- herring gull;
- lesser black-backed gull;
- common tern;
- arctic tern;
- great skua;
- guillemot;
- razorbill;
- puffin;
- gannet;
- red-throated diver;
- fulmar;
- manx shearwater; and
- shag.

113. These species were identified taking account of the Berwick Bank Scoping and HRA Screening Reports, and ensure relevant information is provided for Environmental Impact Assessment.

114. For each species account, estimates are provided for the Offshore Ornithology Study Area, apportioned for unidentified birds and adjusted for availability bias where appropriate. Unapportioned estimates, and those for the Project only, are provided in the attached annexes (see Table 5.1). Population estimates for a 2 km buffer around the Project are presented separately in Appendix 11.4: Ornithology Displacement Technical Report.

115. Low densities may appear as 0.00 birds/km² yet still have low population estimates presented. This is simply a result of rounding very low densities to 2 decimal places. Similarly, some upper confidence limits presented in graphs may appear to sit at the mean; this is also an issue of rounding.

Table 5.1: Summary of content of Annexes A to L. Dev array= Development array. 'Apportioned?' Refers to whether the estimates are for all birds, including those detections assigned to a species group but latterly assigned to a species

Annex	Analysis		Boundary		Apportioning of unidentified birds		Availability bias		Behaviour		
	Design-based	Model-based	16km Buffer	Dev Array	Yes	No	Yes	No	All birds	Flying	Sitting
A	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
B*	✓		✓		✓	✓		✓	✓		
C	✓		✓			✓		✓	✓		
D	✓		✓			✓		✓		✓	
E	✓		✓			✓		✓			✓
F	✓		✓			✓	✓		✓		✓
G*	✓			✓	✓	✓		✓	✓		
H	✓			✓	✓	✓		✓	✓		
I	✓			✓	✓	✓		✓		✓	
J	✓			✓	✓	✓		✓			✓
K	✓			✓	✓	✓	✓		✓		✓
L		✓	✓	✓	✓	✓					

**Estimates presented on a survey-by-survey basis, rather than grouped by species*

5.1. KITTIWAKE

116. The most abundant gull species globally, kittiwakes are small coastal seabirds which form large colonies during the breeding season, before dispersing offshore for the non-breeding season (Mitchell *et al*., 2004; Coulson, 2011). Many large colonies are located along the east coast of Scotland, although some are also present on man-made structures such as buildings and oil rigs (Mitchell *et al*., 2004). The species is currently Red-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

117. Kittiwake productivity (defined by mean fledged chicks per nest) increased along the east coast of Scotland between 2009 and 2019. Although sea surface temperature (SST) increased in the Firth of Forth 1980-2010, the following decade saw a decrease in sea surface temperature (SST) in the region and this is thought to have had a positive effect on productivity (Wanless *et al*., 2018; JNCC, 2021). Consequently, abundance and breeding success have shown a degree of stability over the period 2011 – 2018 for many of the key species, including kittiwake (Scotland's Marine Assessment, 2020).

118. It is likely that decreases in SST positively influence sandeel abundances, increasing the availability of this food source to kittiwakes within the region (Arnott and Ruxton, 2002). Kittiwakes are particularly vulnerable to changes in sandeel availability (Frederiksen *et al*., 2005), as birds can only feed at or near the sea surface, thus having less access to a greater range of species in the water column. Kittiwake productivity and survival was previously affected by a sandeel fishery in south-east Scotland, which ceased operation in 2000 (Frederiksen *et al*., 2004).

119. Estimated apportioned densities from design-based analysis ranged between 0.48 (November 2019) and 13.86 (September 2020) birds/km^2, equating to population estimates for the Offshore Ornithology Study Area ranging between 1,903 birds (95%CI 1,031 – 3,128; November 2019) and 55,139 birds (95%CI 41,872 – 71,811; September 2020) (Table 5.3).

120. High abundances of kittiwakes within the Offshore Ornithology Study Area in summer months, such as August 2019 and 2020 (Table 5.3), are consistent with Berwick Bank and Seagreen boat-based seabird surveys, where kittiwakes accounted for a high proportion of the total birds present, calculated at 23.67%, 24.80% and 21.60% of all detections respectively. Analysis of ESAS data by Kober *et al*. (2010, 2012) indicated the outer Firth of Forth is likely to be most important for kittiwakes during the breeding season. The total count of kittiwakes within the foraging range (mean max distance +1 sd from Woodward et al. 2019) of the Project approximates the regional population and is estimated at 319,126 breeding adults.

121. Egg-laying typically occurs between May and early June (Coulson, 2011); and this is reflected in decreased kittiwake abundance in the Offshore Ornithology Study Area as adult birds are in attendance at colonies. Chicks hatch through June and July and rearing continues until juveniles fledge six weeks later. Use of the Offshore Ornithology Study Area whilst foraging may occur during chick-rearing, but generally the highest abundances were recorded in late summer, such as in August 2019 and August/September 2020, coupled with high proportions of juvenile birds at this time (Table 5.3; Table 5.8). These results indicate that the Offshore Ornithology Study Area is primarily used by post-fledging kittiwakes before dispersal to wintering areas. High incidence of kittiwakes within the breeding season is also consistent with data collected during the IMPRESS project (Camphuysen, 2005). Relatively high abundance recorded in March 2019 may be attributed to the movement of birds to breeding colonies prior to egg laying.

122. Mean seasonal peak population estimates indicate the Offshore Ornithology Study Area is important for the species during the non-breeding season, with design-based analysis estimating approximately 50,958 birds (95%CI 35,530 – 69,349) (Table 5.6). Mean-peak estimates for the breeding season remain high, calculated at 36,189 birds (95%CI 24,774 – 49,254). Relatively high abundances right after the breeding season (e.g. September 2020) are likely to have led to the non-breeding mean seasonal peak, with abundance being generally low throughout this period until the start of the breeding season.

123. Behaviour differed between seasons (Figure 5.6), with the largest proportions of flying birds generally occurring between April and June, and October and December dependent on year. These peaks in flying activity generally coincided with the start and end of the breeding season, with a peak of 86% (197 birds) recorded flying in November 2019. Large proportions of birds were recorded as sitting on the water in most surveys, indicative of recent feeding activity, suggesting the Offshore Ornithology Study Area is used for foraging year-round. The highest proportions of sitting birds generally occurred in spring and mid to late summer, coinciding with the breeding season. This reaffirms the possibility that birds are congregating in the area prior to the breeding season and may be feeding in the area during or after chick-rearing. High proportions of sitting birds (75%) were also recorded in February 2021.

124. The largest average proportion of juveniles (11% of aged birds) coincided with the non-breeding period; the same was true for immature birds (7% of aged birds; Table 5.8).

125. Flight direction varied considerably between months and bio-seasons (Figure 5.5). In September 2020, when the highest densities of kittiwakes were estimated, birds primarily flew southwest, however, in March 2019 when high densities were also present, many kittiwakes also flew southwards. In April S01 2021, many birds flew north and south, with few birds flying east or west.

Table 5.2: Kittiwake bio-seasons taken from NatureScot (2020a)

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

Table 5.3: **Monthly density and population estimates of all kittiwakes across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species**

All Kittiwake	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	11.76	7.34	16.82	46777	29188	66887	9961	21.29%
May-19	2.55	1.91	3.12	10128	7603	12405	1210	11.95%
Jun-19	2.09	1.65	2.65	8302	6577	10534	1029	12.39%
Jul-19	3.72	3.12	4.43	14796	12415	17614	1311	8.86%
Aug-19	8.29	7.03	9.59	32962	27947	38159	2735	8.3%
Sep-19	1.60	1.20	2.03	6368	4775	8070	884	13.88%
Oct-19	1.34	0.70	2.34	5325	2792	9326	1806	33.91%
Nov-19	0.48	0.26	0.79	1903	1031	3128	558	29.31%
Dec-19	0.54	0.26	0.91	2140	1025	3621	705	32.95%
Jan-20	2.08	1.39	2.95	8270	5538	11718	1540	18.62%
Feb-20	1.46	1.10	1.92	5807	4356	7627	849	14.62%
Mar-20	5.36	3.58	7.50	21334	14228	29836	4021	18.85%
May S01 20	2.87	1.57	4.27	11416	6259	16984	2657	23.27%
May S02 20	5.76	4.81	6.83	22928	19141	27153	2066	9.01%
Jun-20	5.07	4.32	5.74	20178	17191	22825	1485	7.36%
Jul-20	6.30	5.03	7.63	25057	19988	30351	2648	10.57%
Aug-20	9.34	7.53	11.26	37148	29930	44771	3948	10.63%
Sep-20	13.86	10.53	18.06	55139	41872	71811	7069	12.82%
Oct-20	1.75	1.12	2.53	6967	4450	10049	1439	20.65%
Nov-20	3.61	2.70	4.44	14375	10739	17642	1738	12.08%
Dec-20	2.42	1.20	4.31	9637	4784	17147	3195	33.15%
Jan-21	4.33	2.11	7.32	17226	8407	29105	5392	31.3%
Feb-21	1.02	0.37	1.99	4062	1475	7934	1665	40.97%
Apr S01 21	6.90	5.68	8.24	27435	22592	32787	2587	9.43%
Apr S02 21	8.86	4.93	13.51	35230	19618	53737	8834	25.07%

Table 5.4: **Monthly density and population estimates of flying kittiwakes only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species**

Flying Kittiwake	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	2.88	1.96	4.06	11445	7793	16163	2113	18.46%
May-19	1.79	1.37	2.22	7121	5438	8817	854	11.99%
Jun-19	0.77	0.61	0.97	3064	2410	3864	397	12.95%
Jul-19	1.71	1.45	2.10	6797	5776	8341	676	9.94%
Aug-19	2.87	2.34	3.43	11422	9310	13647	1138	9.96%
Sep-19	0.47	0.35	0.59	1878	1403	2364	270	14.33%
Oct-19	0.65	0.36	1.02	2596	1450	4070	699	26.91%
Nov-19	0.38	0.19	0.64	1526	745	2543	474	31.03%
Dec-19	0.24	0.17	0.34	973	657	1360	176	18.09%
Jan-20	1.03	0.68	1.39	4092	2718	5546	710	17.33%
Feb-20	0.55	0.43	0.70	2194	1717	2775	265	12.05%
Mar-20	2.37	1.50	3.32	9439	5972	13224	1895	20.07%
May S01 20	1.61	1.08	2.18	6387	4315	8653	1161	18.18%
May S02 20	4.23	3.51	5.12	16812	13971	20350	1605	9.55%
Jun-20	4.30	3.67	4.92	17096	14585	19551	1332	7.79%
Jul-20	1.81	1.43	2.22	7205	5699	8842	806	11.18%
Aug-20	3.27	2.67	3.91	12989	10638	15535	1277	9.83%
Sep-20	3.24	2.72	3.89	12884	10806	15469	1177	9.13%
Oct-20	1.19	0.85	1.59	4731	3370	6325	746	15.76%
Nov-20	2.55	1.90	3.22	10147	7549	12792	1343	13.23%
Dec-20	1.67	0.96	2.69	6654	3806	10703	1786	26.83%
Jan-21	1.66	1.18	2.25	6600	4676	8964	1117	16.91%
Feb-21	0.25	0.15	0.35	988	607	1392	199	20.07%
Apr S01 21	3.76	3.00	4.57	14968	11916	18170	1635	10.92%
Apr S02 21	3.56	2.43	5.24	14177	9665	20828	2976	20.99%

Table 5.5: **Monthly density and population estimates of sitting kittiwakes only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species**

Sitting Kittiwake	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	8.77	4.99	13.41	34895	19830	53329	8899	25.5%
May-19	0.73	0.50	0.98	2914	2002	3884	489	16.78%
Jun-19	1.29	0.99	1.64	5139	3921	6515	695	13.52%
Jul-19	1.98	1.62	2.40	7873	6454	9564	843	10.71%
Aug-19	5.40	4.34	6.51	21477	17268	25902	2333	10.86%
Sep-19	1.12	0.75	1.48	4437	2981	5894	723	16.29%
Oct-19	0.73	0.28	1.37	2891	1100	5442	1206	41.72%
Nov-19	0.09	0.04	0.14	358	175	560	105	29.23%
Dec-19	0.29	0.09	0.56	1146	369	2219	475	41.44%
Jan-20	1.09	0.50	1.79	4353	1994	7134	1329	30.52%
Feb-20	0.92	0.62	1.26	3652	2451	5032	692	18.93%
Mar-20	2.88	1.69	4.41	11467	6735	17556	2766	24.12%
May S01 20	1.19	0.60	1.99	4751	2404	7898	1391	29.28%
May S02 20	1.50	1.13	1.91	5963	4496	7588	820	13.75%
Jun-20	0.77	0.64	0.94	3049	2548	3734	297	9.73%
Jul-20	4.44	3.32	5.66	17661	13190	22530	2411	13.65%
Aug-20	6.04	4.63	7.47	24035	18416	29701	2995	12.46%
Sep-20	10.58	7.31	14.49	42074	29093	57645	7417	17.63%
Oct-20	0.55	0.20	1.10	2177	799	4365	931	42.77%
Nov-20	1.05	0.70	1.46	4191	2771	5823	781	18.64%
Dec-20	0.80	0.21	1.91	3176	835	7590	1893	59.6%
Jan-21	2.63	0.88	4.98	10447	3518	19799	4366	41.79%
Feb-21	0.79	0.22	1.61	3161	860	6414	1511	47.79%
Apr S01 21	3.19	2.54	3.86	12700	10120	15354	1377	10.84%
Apr S02 21	5.00	2.46	8.47	19897	9791	33702	6361	31.97%

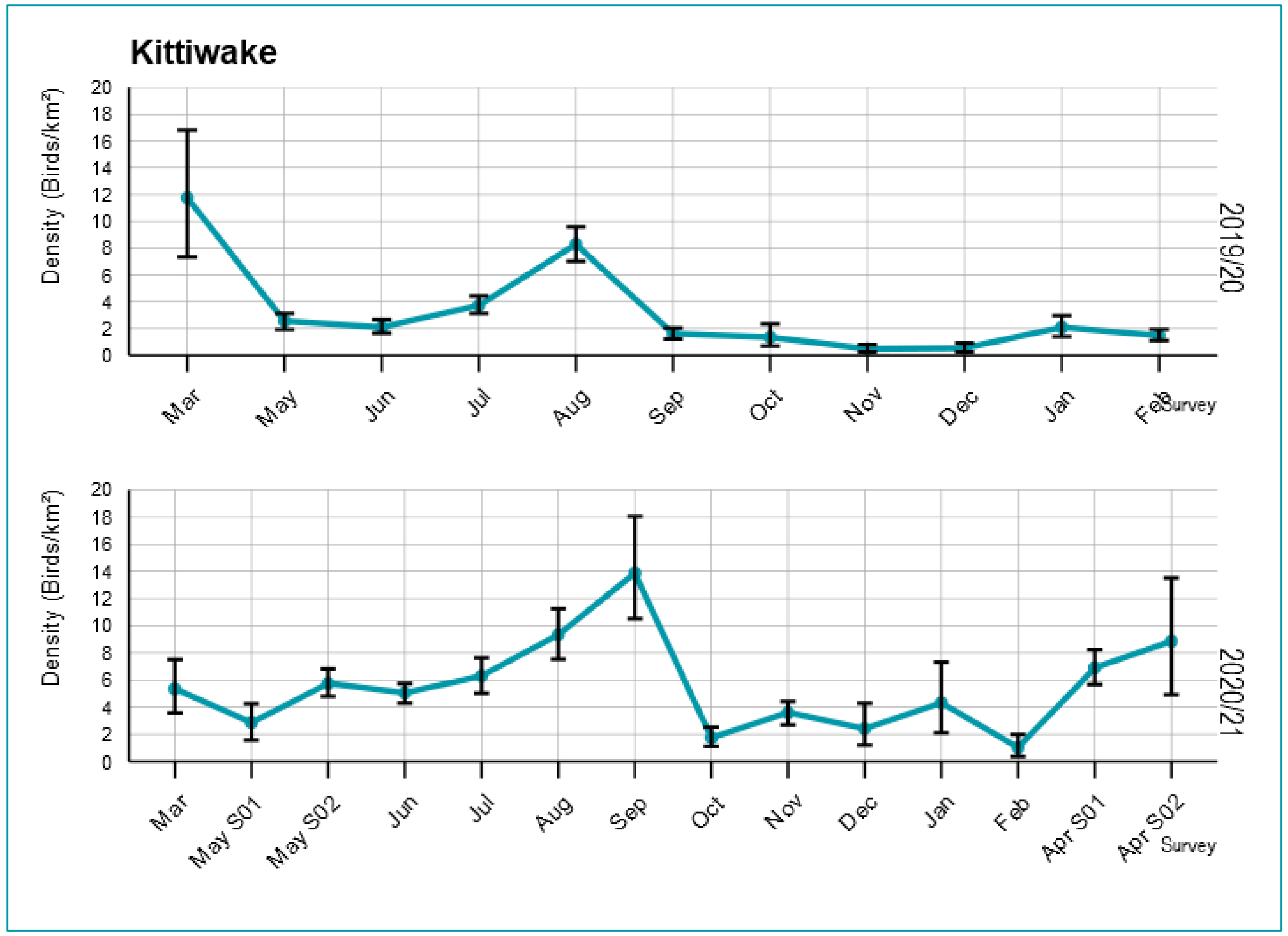


Figure 5.1: Estimated densities (birds/km²) of all kittiwakes across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.6: Mean seasonal peak (MSP) population and density (birds/km²) of all kittiwakes in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

Kittiwake								
Bio-season	**Peak population**	**Peak density**	**MSP Population**	**Lower 95% CI**	**Upper 95% CI**	**MSP Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	35,230 (Yr1); 37,148 (Yr2)	8.86 (Yr1); 9.34 (Yr2)	36189	24774	49254	9.10	6.23	12.38
Non-breeding	46,777 (Yr1); 55,139 (Yr2)	11.76 (Yr1); 13.86 (Yr2)	50958	35530	69349	12.81	8.93	17.44

Table 5.7: Mean seasonal peak (MSP) population and density (birds/km²) of all kittiwakes in the Berwick Bank Development Array plus 2km buffer across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

Kittiwake								
Bio-season	**Peak population**	**Peak density**	**MSP Population**	**Lower 95% CI**	**Upper 95% CI**	**MSP Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	24,949 (Yr1); 17,333 (Yr2)	19.06 (Yr1); 13.24 (Yr2)	21141	12477	30819	16.15	9.54	23.55
Non-breeding	17,174 (Yr1); 19,383 (Yr2)	13.12 (Yr1); 14.81 (Yr2)	18279	10864	27131	13.96	8.3	20.74

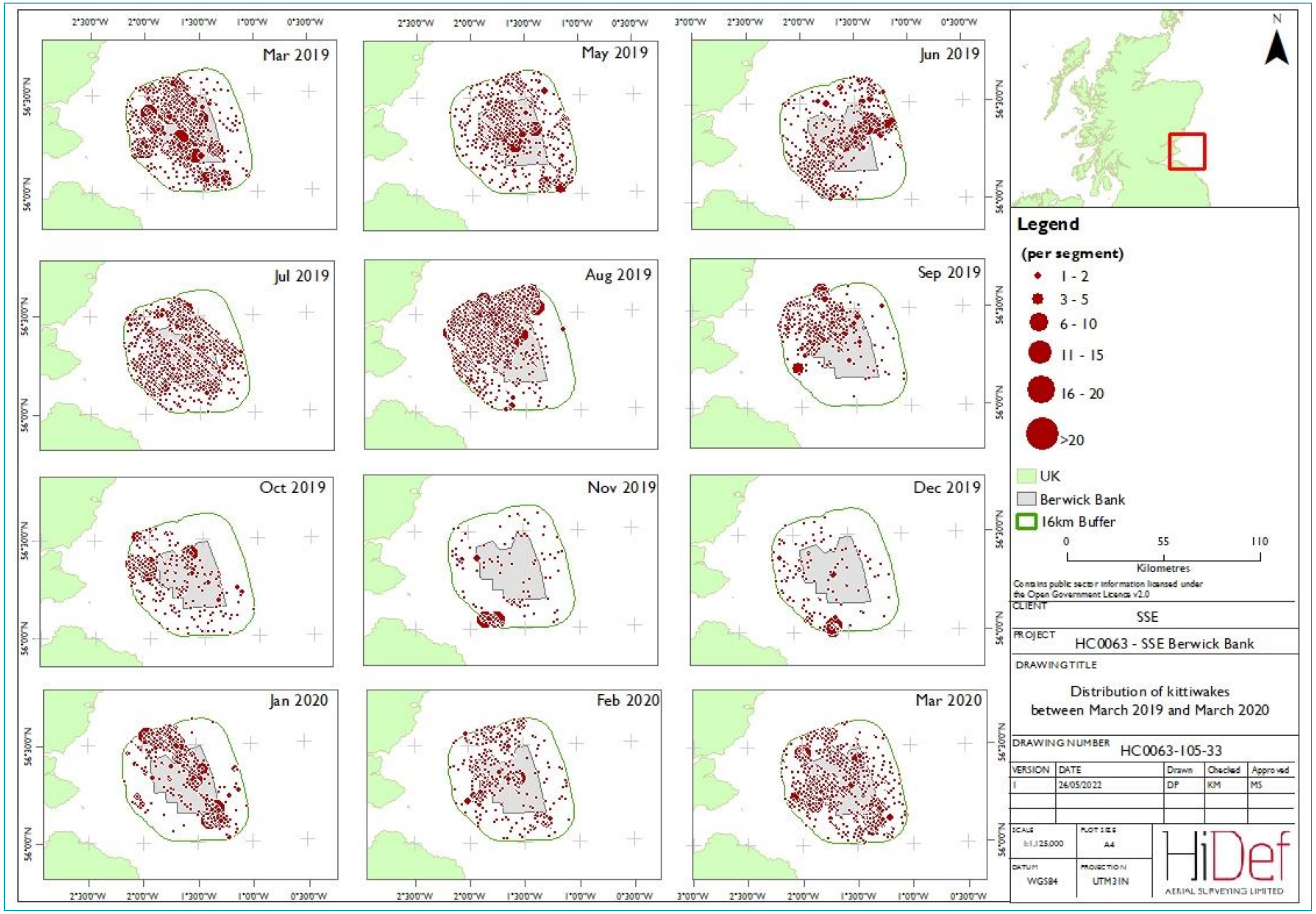


Figure 5.2: **Distribution of kittiwakes across the Offshore Ornithology Study Area between March 2019 and March 2020**

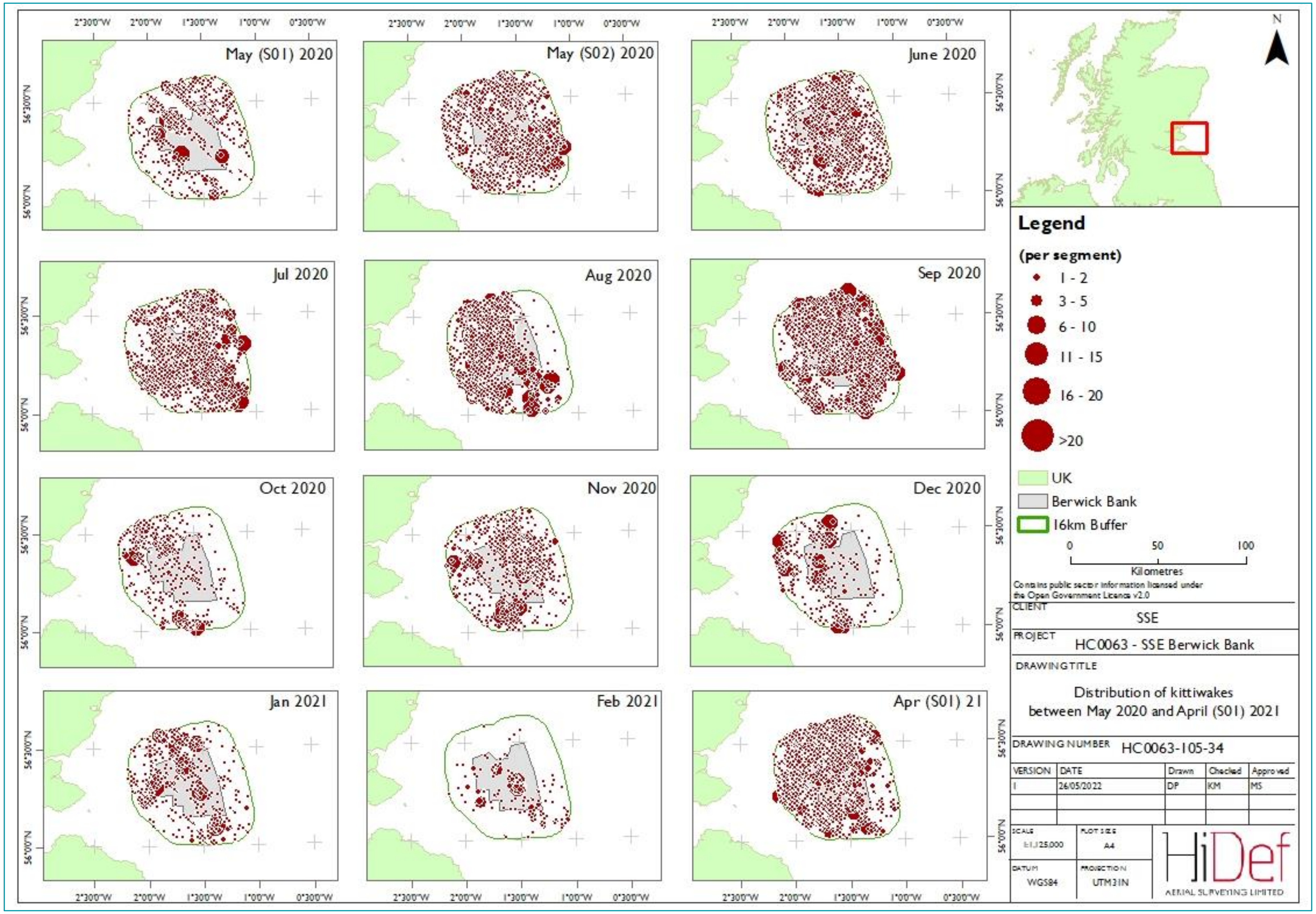


Figure 5.3 **Distribution of kittiwakes across the Offshore Ornithology Study Area between May S01 2020 and April S01 2021**

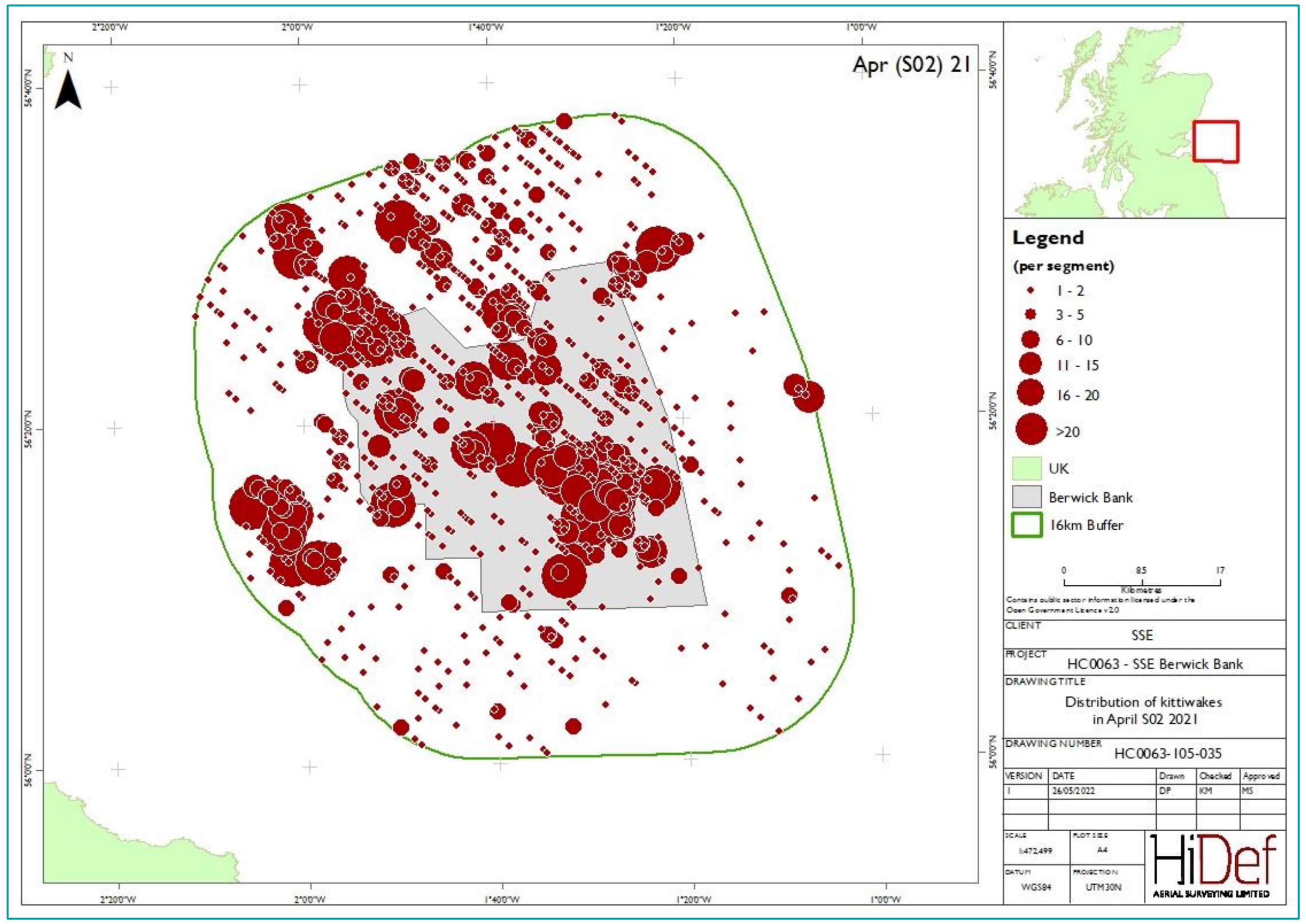


Figure 5.4: Distribution of kittiwakes across the Offshore Ornithology Study Area in April S02 2021

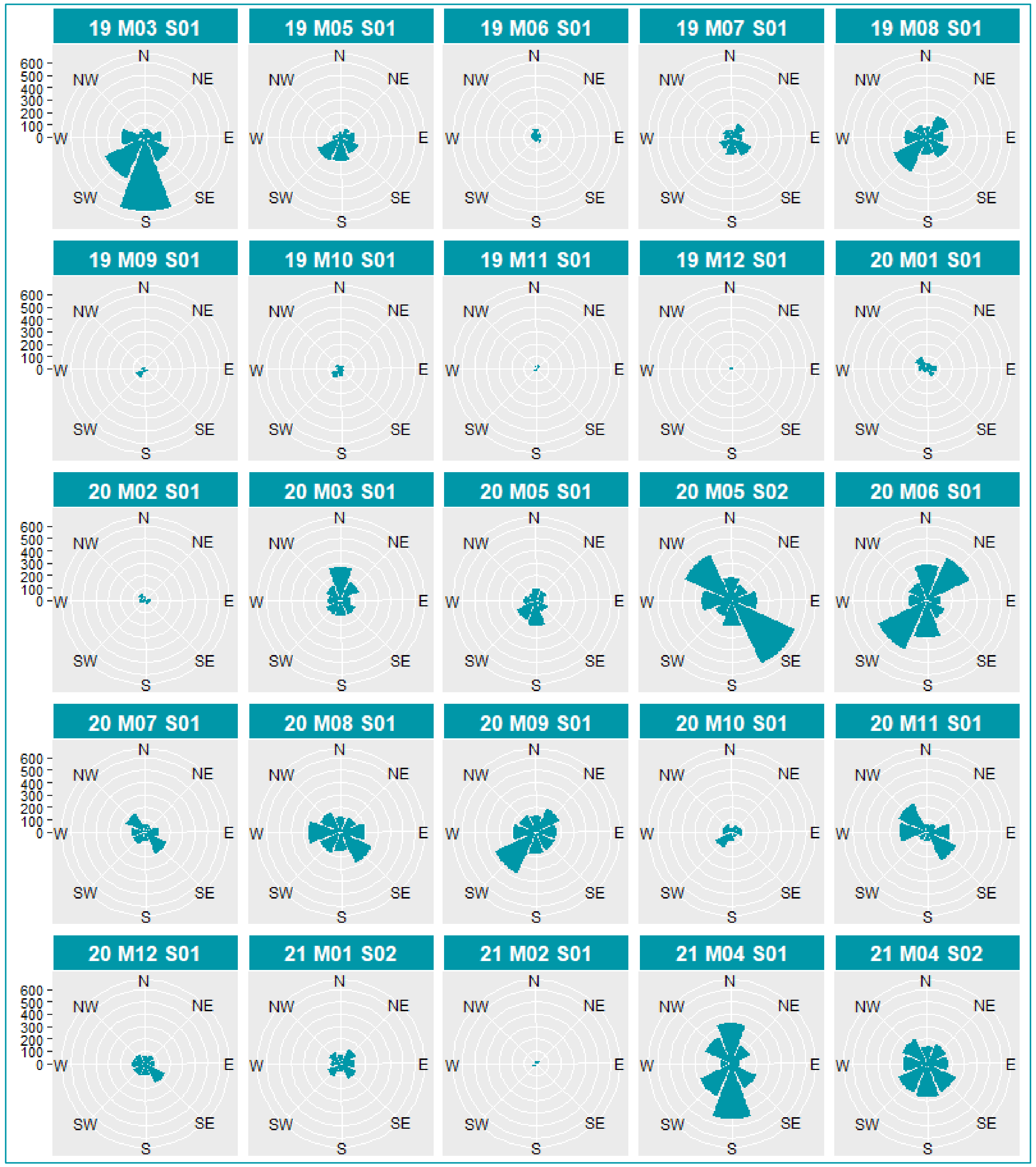


Figure 5.5: Summarised flight direction of kittiwakes across the Offshore Ornithology Study Area

Table 5.8: Mean count, SD and proportion of kittiwakes in each age class averaged across bio-season

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	SD	Prop	Mean	SD	Prop	Mean	SD	Prop	Mean	SD
Breeding season	1414	626	0.97	33	36	0.02	13	34	0.01	1747	1339
Non-breeding	839	659	0.82	71	111	0.07	114	168	0.11	1556	1931

Figure 5.6: **Percentage of flying kittiwakes per survey across the Offshore Ornithology Study Area**

5.2. GUILLEMOT

126. One of the most abundant seabird species in the northern hemisphere, in the breeding season, guillemots are generally found in coastal colonies consisting of up to tens of thousands of individual birds (Mitchell *et al*., 2004). Typically, only coming to coastal areas to breed, most birds move offshore during the non-breeding season (Wernham *et al*., 2002). As pursuit divers, guillemots generally feed on schooling fish such as cod and sprat (Gaston and Jones 1998), however this is likely to differ depending on local feeding conditions (Merkel, 2019). Large breeding colonies in proximity to the Offshore Ornithology Study Area are present on the Isle of May and St Abb's Head with approximately 18,705 and 42,905 individuals recorded in 2018 respectively (SMP, 2021). The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

127. Guillemots were the most abundant species recorded in the Offshore Ornithology Study Area during the survey programme, with birds recorded most frequently between April and May and August and/or September in both years, coinciding with the start of the breeding season and the post-breeding flightless moult stage (Table 5.10). Evidence suggests guillemots may be present in large aggregations post-breeding along the east coasts of Scotland and England, coinciding with high local prey abundance (Furness, 2015). Aggregations are likely to be highly dependent on prey availability, lasting only two to three weeks. Movement down the east coast of Scotland from the northern North Sea during post-breeding migration and dispersal has also been indicated (Figure 21.3; Furness, 2015), with spring migration expected to occur in the opposite direction (movement of breeding birds northwards along the Scottish east coast). Density estimates produced using design-based methods ranged between 2.12 birds/km^2 (95%CI 1.35 – 3.22; November 2019) and 60.88 birds/km^2 (95%CI 47.69 – 76.93; April S02 2021) over the entire survey period, when adjusted for availability bias.

128. Peak population estimates in April S02 2021 equated to 242,168 birds (95%CI 190,509 – 305,941). The total count of guillemots at SPAs within foraging range (mean max distance +1 sd from Woodward et al. 2019) of the Project approximates the regional population and is estimated at 353,971 breeding adults. There are other large colonies, such as the 148,805 breeding adults at North Caithness Cliffs SPA, which may also frequent the Firth of Forth region based on modelled tagging data (Wakefield *et al*. 2017, 2019). The relatively high abundance estimated for the site in April S02 2021 is likely to be explained by a good breeding season in 2020 (supported by our data for September 2020 and NatureScot, 2021), which as a consequence will lead to a high number of birds returning to the area ahead of the following 2021 breeding season. As the most recent SPA counts used were from 2014 to 2019, except for Forth Islands SPA which includes counts up to 2021, the successful breeding season observed in 2020 will not be reflected in the SPA estimated totals for guillemot. A pattern emerges where the number of birds seen in March/April is predicated (to a large extent) by the success of the breeding season in the previous year; this pattern is seen in the Year 1 data, where the breeding/post breeding peak abundance estimates are lower (August 19) than the pre/breeding season return of guillemot to the area to access the colonies the following year (May SO1 20 as "April").

129. Data collected from boat-based surveys of the Berwick Bank and Seagreen in 2020 and 2021 also recorded an abundance of guillemots, with the species making up the largest proportion of all recorded birds (32.09%, 28.10% and 29.30% respectively). Camphuysen *et al*. (2004) reported a decline in breeding success within the outer Firth of Forth between 1997 and 2003. However, since 2007, this trend has reversed and breeding success recovered to a high level in the 2010s (Harris *et al.,* 2017).

130. Overall, guillemots were recorded in higher densities in Year 2 compared to Year 1, with design-based density estimates ranging between 2.12 birds/km^2 (95%CI 1.35 – 3.22) and 40.26 birds/km^2 (95%CI 27.91 – 54.40) in 2019/20 compared to 4.82 birds/km^2 (95%CI 3.74 – 5.92) and 60.88 birds/km^2 (95%CI 47.89 – 76.93) in 2020/21. After the post-breeding peak, abundance declines substantially, likely due to dispersal offshore to the North Sea after chick-rearing (Wernham *et al*., 2002; Forrester *et al*., 2007). When accounting for availability bias, estimates of density were higher during the breeding season, with mean peak densities for the region estimated at 46.91 birds/km^2 (95%CI 37.98 – 57.83), compared to 34.88 birds/km^2 (95%CI 27.41 – 43.02) during the non-breeding season (Table 5.13).

131. High guillemot abundance in the breeding season coincides with the onset of egg-laying and incubation (Harris and Wanless, 2004). During this time, most birds were recorded as sitting on the water, which is to be expected considering their feeding strategy of diving from the water surface. A high proportion of sitting birds were also observed during the secondary peaks between August and September, likely due to the presence of many flightless adult birds which moult after the chick-rearing period (Brown and Grice, 2005). As expected, extremely low percentages of flying birds were present within the population at this time (Figure 5.12) and consequently a lack of flight direction data for guillemots in August and September in both 2019 and 2020 (Figure 5.11).

132. Overall, flight direction data indicated guillemots generally flew in easterly and westerly directions such as in March 2019 and between March and May 2020, with May 2019 being the only month in which a large proportion of birds flew south (Figure 5.12). Movement east and west may be attributed to adult birds moving between nest sites to the west of the Offshore Ornithology Study Area such as the Isle of May and Craigleith and foraging grounds further offshore in the outer Firth of Forth and North Sea (Furness, 2015).

133. Ages of birds are not presented for this species since adults can only be aged when in the presence of a juvenile for size comparison, and they almost exclusively occur as single adult-chick pairs.

Table 5.9: Guillemot bio-seasons taken from NatureScot (2020a)

Bio-season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season				■	■	■	■	■ (part)				
Non-breeding	■	■	■					■ (part)	■	■	■	■

Table 5.10: Monthly absolute density and population estimates of all guillemots across the Offshore Ornithology Study Area using design-based analysis, adjusted for availability bias. Data include "no-identification" birds apportioned to species

All Guillemot	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	7.71	5.74	10.08	30659	22875	40130	4146	13.52%
May-19	25.91	21.22	31.35	103101	84382	124671	10462	10.15%
Jun-19	5.81	4.35	7.52	23120	17326	29923	3055	13.21%
Jul-19	24.93	18.59	30.76	99162	73918	122338	14236	14.36%
Aug-19	40.26	27.91	54.40	160108	111020	216369	30116	18.81%
Sep-19	5.96	5.13	6.78	23692	20415	26918	1692	7.14%
Oct-19	6.26	3.02	10.70	24916	11985	42529	8373	33.6%
Nov-19	2.12	1.35	3.22	8434	5391	12752	1727	20.48%
Dec-19	3.67	2.08	5.33	14590	8297	21215	3591	24.61%
Jan-20	12.77	9.36	16.83	50791	37188	66943	7843	15.44%
Feb-20	7.00	5.46	8.72	27840	21755	34710	3248	11.67%
Mar-20	22.52	17.69	28.20	89553	70349	112184	10996	12.28%
May S01 20	30.56	24.90	36.28	121590	99015	144289	12258	10.08%
May S02 20	23.69	19.13	28.60	94245	76058	113734	10190	10.81%
Jun-20	28.03	23.86	32.23	111489	94884	128216	8899	7.98%
Jul-20	10.23	8.25	12.23	40679	32794	48646	4025	9.89%
Aug-20	32.94	28.06	38.73	131004	111602	154017	11737	8.96%
Sep-20	47.25	37.13	57.84	187928	147687	230080	25115	13.36%
Oct-20	10.78	6.43	16.35	42822	25594	65059	10389	24.26%
Nov-20	7.80	5.09	10.87	31020	20257	43243	6519	21.02%
Dec-20	18.82	13.86	23.55	74882	55090	93685	10848	14.49%
Jan-21	9.91	8.66	11.33	39410	34438	45047	2767	7.02%
Feb-21	4.82	3.74	5.92	19139	14916	23508	2315	12.1%
Apr S01 21	25.60	20.85	31.77	101810	82951	126353	10895	10.7%
Apr S02 21	60.88	47.89	76.93	242168	190509	305941	29703	12.27%

Table 5.11: Monthly density and population estimates of all flying guillemots only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Guillemot	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.74	0.53	0.96	2959	2123	3823	433	14.61%
May-19	0.83	0.55	1.15	3321	2169	4556	635	19.1%
Jun-19	0.39	0.24	0.54	1558	972	2153	310	19.84%
Jul-19	0.07	0.05	0.10	276	187	383	49	17.74%
Aug-19	0.01	0.00	0.02	30	0	74	20	63.93%
Sep-19	0.05	0.01	0.10	191	48	391	92	47.89%
Oct-19	0.24	0.12	0.40	974	483	1594	295	30.29%
Nov-19	0.12	0.06	0.20	484	238	776	134	27.71%
Dec-19	0.01	0.00	0.02	50	14	96	21	41.24%
Jan-20	0.21	0.13	0.31	849	503	1218	187	21.97%
Feb-20	0.07	0.04	0.10	272	168	391	58	21.08%
Mar-20	1.16	0.72	1.71	4614	2868	6798	988	21.4%
May S01 20	0.86	0.62	1.16	3437	2466	4626	548	15.93%
May S02 20	0.77	0.55	1.03	3082	2187	4082	473	15.32%
Jun-20	0.55	0.38	0.74	2176	1512	2931	360	16.51%
Jul-20	0.20	0.11	0.31	800	431	1237	210	26.25%
Aug-20	0.01	0.00	0.02	32	0	71	19	59.09%
Sep-20	0.01	0.00	0.03	60	6	139	35	58.13%
Oct-20	0.23	0.14	0.33	901	559	1325	204	22.6%
Nov-20	0.16	0.09	0.26	647	369	1036	166	25.53%
Dec-20	0.43	0.27	0.59	1706	1068	2347	345	20.18%
Jan-21	0.14	0.09	0.20	546	342	777	115	20.93%
Feb-21	0.08	0.04	0.11	300	177	420	67	22.22%
Apr S01 21	1.07	0.73	1.42	4247	2919	5649	675	15.88%
Apr S02 21	0.75	0.45	1.09	3000	1807	4331	640	21.34%

Table 5.12: Monthly absolute density and population estimates of sitting guillemots only across the Offshore Ornithology Study Area using design-based analysis, adjusted for availability bias. Data include "no-identification" birds apportioned to species

Sitting Guillemot	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	6.97	5.21	9.12	27700	20752	36307	3248	11.73%
May-19	25.08	20.67	30.20	99780	82213	120115	8527	8.55%
Jun-19	5.42	4.11	6.98	21562	16354	27770	2473	11.47%
Jul-19	24.86	18.54	30.66	98886	73731	121955	11306	11.43%
Aug-19	40.25	27.91	54.38	160078	111020	216295	23697	14.80%
Sep-19	5.91	5.12	6.68	23501	20367	26527	1415	6.02%
Oct-19	6.02	2.90	10.30	23942	11502	40935	6605	27.59%
Nov-19	2.00	1.29	3.02	7950	5153	11976	1424	17.91%
Dec-19	3.66	2.08	5.31	14540	8283	21119	2919	20.08%
Jan-20	12.56	9.23	16.52	49942	36685	65725	6461	12.94%
Feb-20	6.93	5.42	8.62	27568	21587	34319	2745	9.96%
Mar-20	21.36	16.97	26.49	84939	67481	105386	8733	10.28%
May S01 20	29.70	24.28	35.12	118153	96549	139663	10047	8.50%
May S02 20	22.92	18.58	27.57	91163	73871	109652	8180	8.97%
Jun-20	27.48	23.48	31.49	109313	93372	125285	7149	6.54%
Jul-20	10.03	8.14	11.92	39879	32363	47409	3256	8.17%
Aug-20	32.93	28.06	38.71	130972	111602	153946	9485	7.24%
Sep-20	47.24	37.13	57.81	187868	147681	229941	18783	10.00%
Oct-20	10.55	6.29	16.02	41921	25035	63734	8440	20.13%
Nov-20	7.64	5.00	10.61	30373	19888	42207	5153	16.97%
Dec-20	18.39	13.59	22.96	73176	54022	91338	8481	11.59%
Jan-21	9.77	8.57	11.13	38864	34096	44270	2309	5.94%
Feb-21	4.74	3.70	5.81	18839	14739	23088	1851	9.82%
Apr S01 21	24.53	20.12	30.35	97563	80032	120704	9125	9.35%
Apr S02 21	60.13	47.44	75.84	239168	188702	301610	24947	10.43%

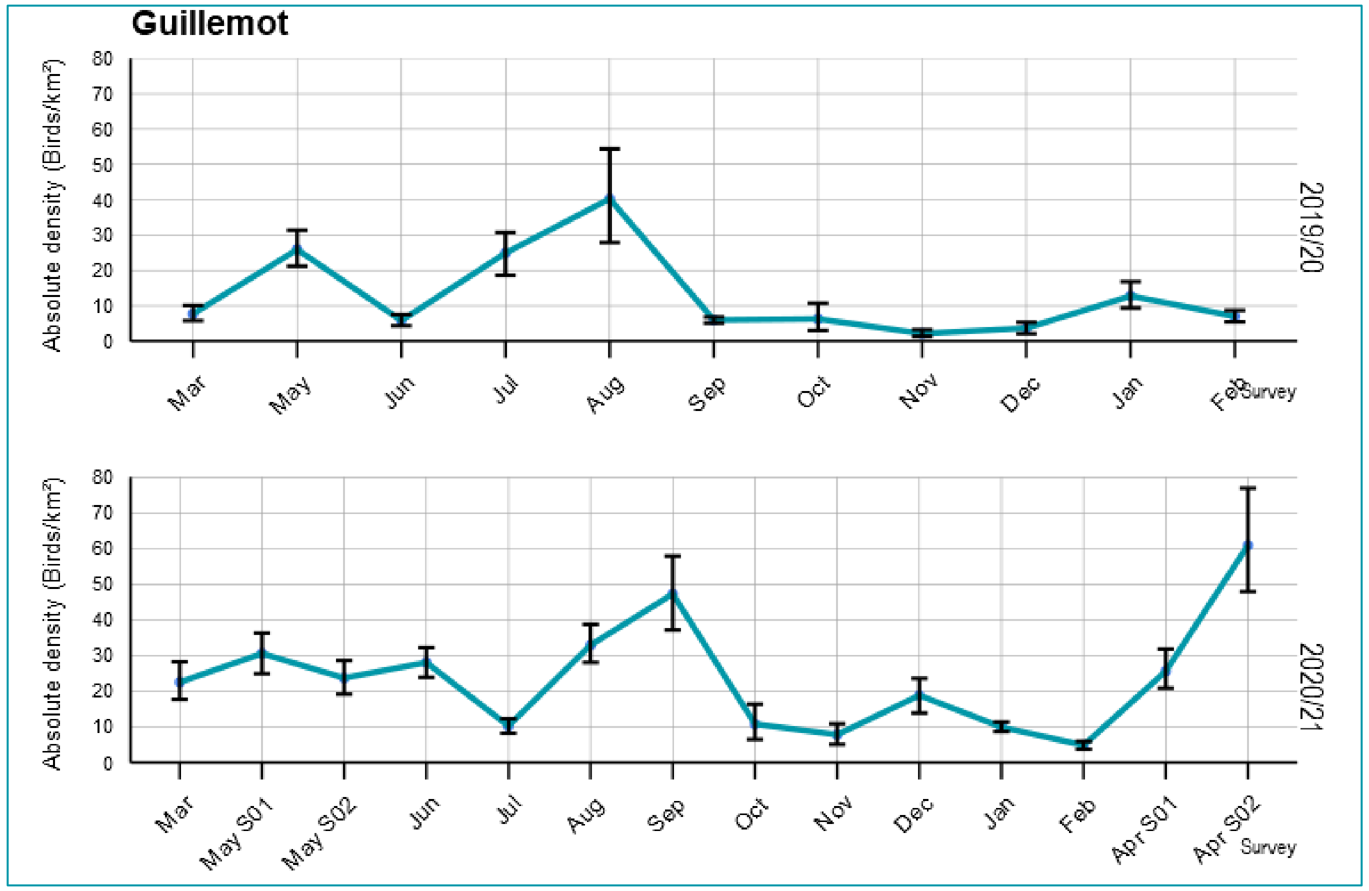


Figure 5.7: Estimated absolute densities (birds/km²) of all guillemots across the Offshore Ornithology Study Area using design-based analysis, accounting for availability bias. Data include "no-identification" birds apportioned to species

Table 5.13: Mean seasonal peak (MSP) population and density (birds/km²) of all guillemots in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis, with figures adjusted for availability bias. Data include "no-identification" birds apportioned to species

Guillemot									
Bio-season	**Peak population**	**Peak density**	**MSP Population**	**Lower 95% CI**	**Upper 95% CI**	**MSP Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	242168 (Yr1); 111489 (Yr2)	60.88 (Yr1); 28.03 (Yr2)	186586	151056	229980	46.91	37.98	57.83
Non-breeding	89553 (Yr1); 187928 (Yr2)	22.52 (Yr1); 47.25 (Yr2)	138741	109019	171133	34.88	27.41	43.02

Table 5.14: Mean seasonal peak (MSP) population and density (birds/km^2) of all guillemots in the Berwick Bank Development Array plus 2 km buffer across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis, with figures adjusted for availability bias. Data include "no-identification" birds apportioned to species.

Guillemot								
Bio-season	**Peak population**	**Peak density**	**MSP Population**	**Lower 95% CI**	**Upper 95% CI**	**MSP Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	94,806 (Yr1); 53,499(Yr2)	72.45 (Yr1); 40.87 (Yr2)	74154	53647	95911	56.66	40.98	73.29
Non-breeding	44,146 (Yr1); 44,194(Yr2)	33.77 (Yr1); 33.74 (Yr2)	44171	32120	57326	33.76	24.54	43.8

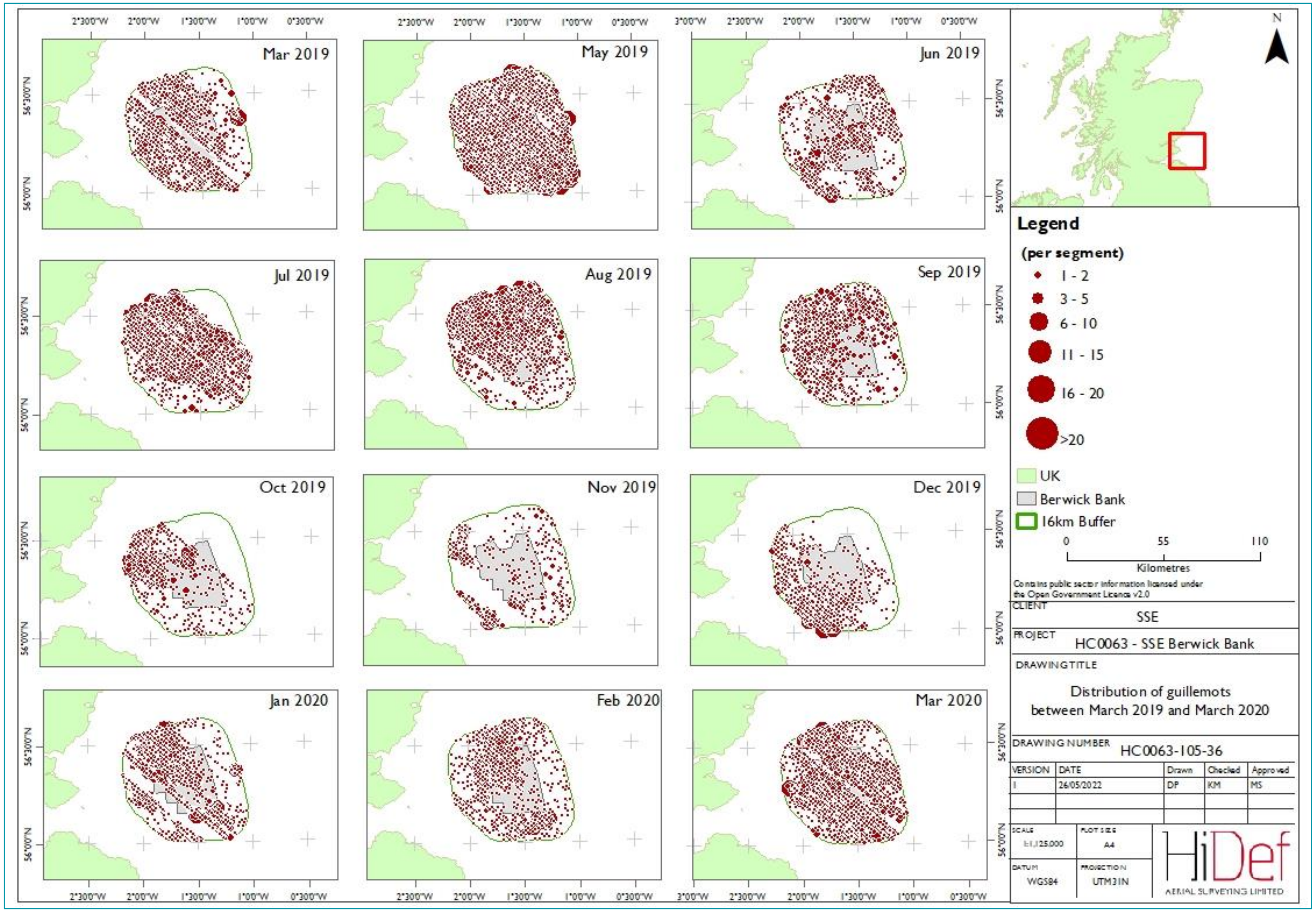


Figure 5.8: Distribution of guillemots across the Offshore Ornithology Study Area between March 2019 and March 2020

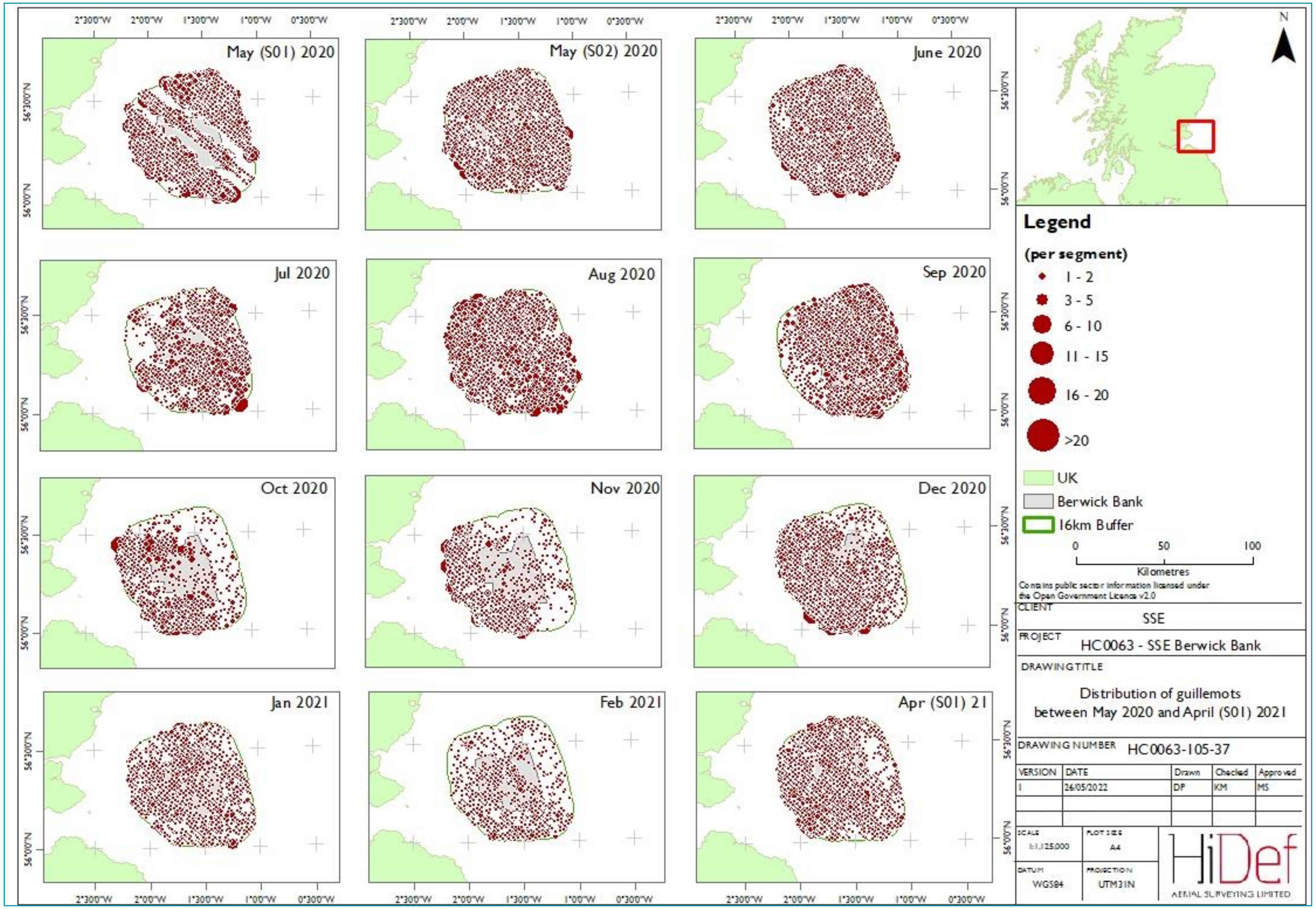


Figure 5.9: **Distribution of guillemots across the Offshore Ornithology Study Area between May S01 2020 and April S01 2021**

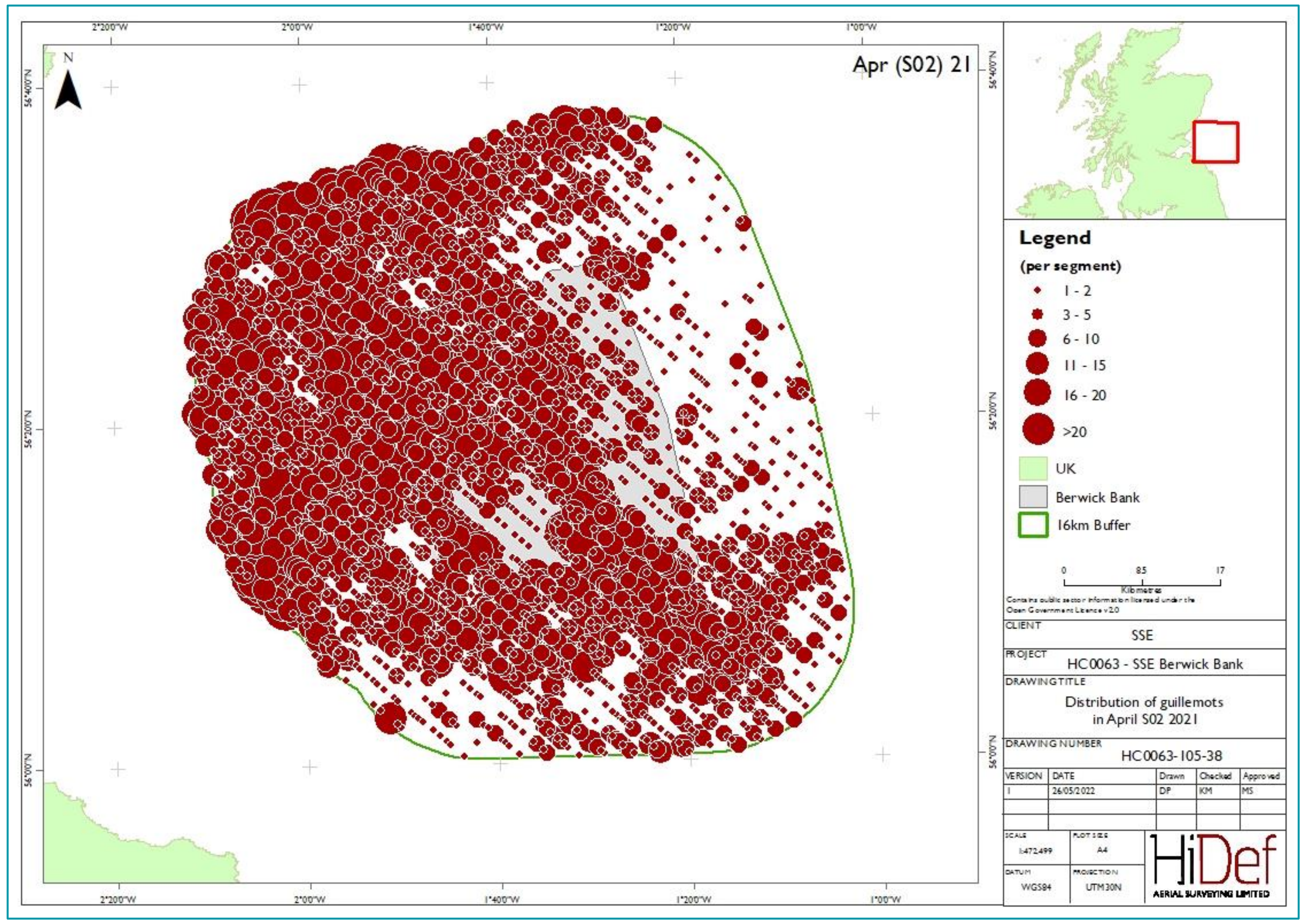


Figure 5.10: **Distribution of guillemots across the Offshore Ornithology Study Area in April S02 2021**

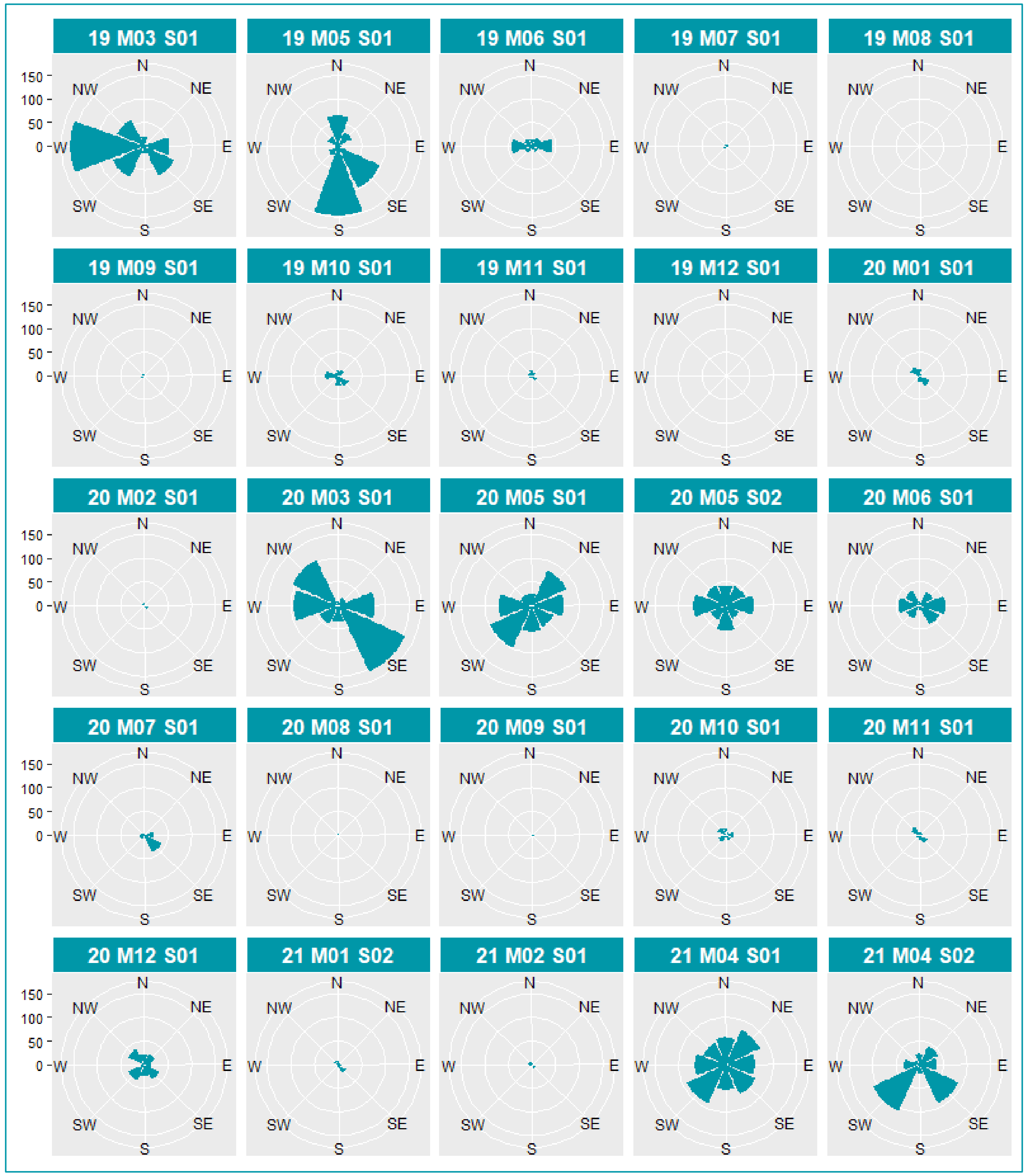


Figure 5.11: **Summarised flight direction of guillemots across the Offshore Ornithology Study Area**

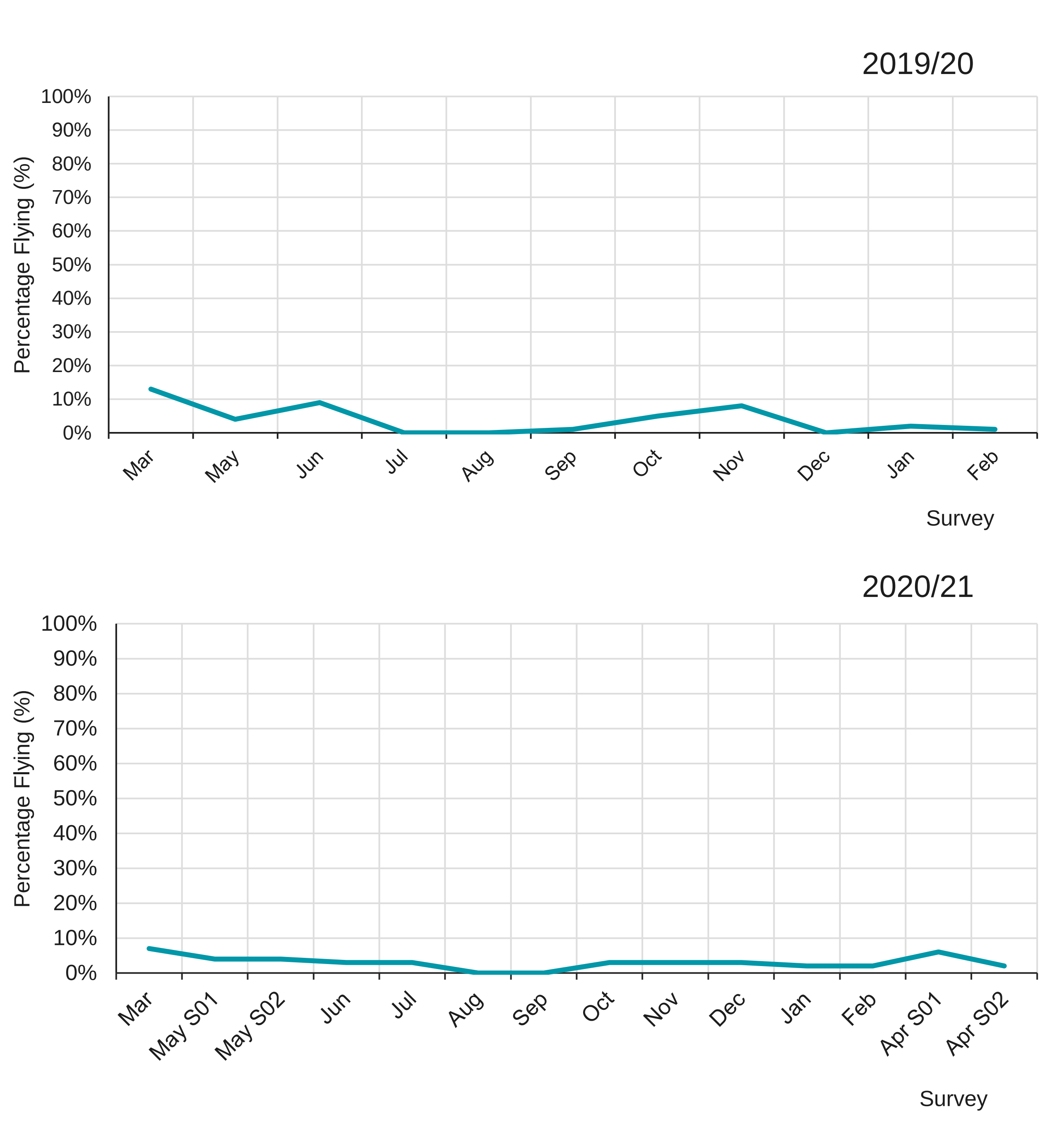


Figure 5.12: Percentage of flying guillemots per survey across the Offshore Ornithology Study Area

5.3. RAZORBILL

134. Common around the UK, razorbills are distributed at coastal colonies between April and August during the breeding season, usually found in mixed species assemblages with other seabirds such as guillemots and kittiwakes (Mitchell *et al*., 2004). The northwest North Sea provides important habitat for razorbills year-round, especially between July and September during the flightless moult period (Stone *et al*., 1995). Several large breeding colonies are present along the east coast of Scotland, such as the Isle of May, St Abb's Head and Fowlsheugh which respectively supported an estimated 4,867, 2,683 and 11,750 birds in 2018 (SMP, 2021). The total count of razorbills within the foraging range (mean max distance +1 sd from Woodward et al.2019) of the Project approximates the regional population and is estimated at 84,501 breeding adults. The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al.,* 2021).

135. Razorbills were present in relatively high abundances in the Offshore Ornithology Study Area, with birds recorded most frequently in October and September in Year 1 and Year 2 respectively, during the non-breeding season (Table 5.16). When accounting for availability bias. Design-based estimates gave densities ranging from 0.37 birds/km^2 (95%CI 0.22 – 0.56) to 3.21 birds/km^2 (95%CI 1.51 – 5.39) in 2019/20 and 0.50 birds/km^2 (95%CI 0.34 – 0.66) to 13.77 birds/km^2 (95%CI 9.66 – 17.91) in 2020/21 (Table 5.16).

136. Boat-based surveys of Berwick Bank in 2020-2021 identified razorbill as one of the key five species, which collectively accounted for 87% of all observations, of which razorbill accounted for 9.68% of all records. Data from the IMPRESS project (Camphuysen *et al*., 2004) reported that razorbills accounted for 11% of all observations. However, razorbills were not identified as a predominant species in Seagreen boat-based surveys.

137. Mean seasonal peaks were higher during the non-breeding period with an estimated population of 35,589 birds (95%CI 25,185 – 46,150;Figure 5.13). Estimates during the breeding season were much lower, calculated at 11,280 birds (95%CI 8,395 – 14,646). During the non-breeding season when abundance of razorbills peaked, their distribution was towards the west of the Offshore Ornithology Study Area (Figure 5.14 - Figure 5.16).

138. Low abundances during the summer suggests most birds at nearby colonies do not venture into the Offshore Ornithology Study Area to forage during chick-rearing but do disperse through the Offshore Ornithology Study Area in the post-breeding period, as indicated by increases in abundance towards the end of the breeding season, such as in August and September 2020 (Figure 5.13). Adults usually undergo a post-breeding moult around July and August, prior to movement offshore into the North Sea, which is estimated to support around 100,000 wintering razorbills (Furness, 2015). Younger age classes generally disperse further than older birds, with adults returning to colonies sooner than immature birds prior to the start of the breeding period (Furness, 2015).

139. Across all seasons, most razorbills were recorded as sitting on the water, with few birds recorded as flying during the 25 months of surveys. This is to be expected considering their feeding strategy which involves diving from the surface of the water (Shoji *et al.,* 2015). In Year 1, the highest percentage of flying birds was recorded in March during the return migration period, with a similar peak occurring in Year 2 (although to a lesser extent; Figure 5.18). In Year 2, the percentage of flying birds peaked in October and April S01, in the non-breeding and breeding seasons respectively.

140. The paucity of flying birds during the programme presented difficulties when assessing trends in flight direction, although many birds were recorded flying west in March 2019 and a large proportion also flew south in April S01 2021 (Figure 5.17). It is possible that this may be the migration of birds back to breeding colonies to the west and south of the survey area, such as the Isle of May and St. Abb's Head.

141. Ages of razorbills are not presented since adults can only be aged when in the presence of a juvenile for size comparison and they almost exclusively occur as single adult-chick pairs.

Table 5.15: Razorbill bio-seasons taken from NatureScot (2020a)

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

Table 5.16: Monthly absolute density and population estimates of all razorbills across the Offshore Ornithology Study Area using design-based analysis, adjusted for availability bias. Data include "no-identification" birds apportioned to species

All Razorbill	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	1.19	0.83	1.60	4723	3328	6403	765	16.2%
May-19	1.38	1.12	1.62	5450	4453	6445	598	10.97%
Jun-19	0.37	0.22	0.56	1480	841	2200	338	22.84%
Jul-19	2.16	1.16	3.04	8599	4640	12126	2379	27.67%
Aug-19	2.46	1.75	3.32	9785	6945	13229	1884	19.25%
Sep-19	1.53	1.30	1.80	6102	5139	7174	610	10%
Oct-19	3.21	1.51	5.39	12812	6025	21451	4728	36.9%
Nov-19	0.48	0.13	0.94	1917	530	3724	927	48.36%
Dec-19	0.94	0.53	1.40	3715	2113	5554	1060	28.53%
Jan-20	1.63	1.12	2.28	6476	4452	9050	1286	19.86%
Feb-20	0.79	0.59	1.00	3138	2339	3963	474	15.11%
Mar-20	4.13	3.00	5.28	16412	11960	21024	2561	15.6%
May S01 20	1.18	0.83	1.52	4686	3297	6039	762	16.26%
May S02 20	0.91	0.61	1.26	3603	2418	4981	674	18.71%
Jun-20	0.76	0.60	0.97	3038	2365	3835	392	12.9%
Jul-20	1.90	1.36	2.55	7562	5400	10172	1359	17.97%
Aug-20	3.21	2.47	4.03	12791	9844	16061	1816	14.2%
Sep-20	13.77	9.66	17.91	54763	38408	71275	10575	19.31%
Oct-20	1.45	0.84	2.11	5719	3383	8394	1325	23.17%
Nov-20	0.50	0.34	0.66	1972	1317	2640	365	18.51%
Dec-20	1.57	1.08	2.17	6282	4313	8657	1218	19.39%
Jan-21	2.87	2.25	3.63	11451	8985	14421	1557	13.6%
Feb-21	0.98	0.73	1.28	3937	2900	5139	637	16.18%
Apr S01 21	3.52	2.54	4.57	13981	10118	18211	2179	15.59%
Apr S02 21	1.58	1.31	1.90	6242	5218	7540	593	9.5%

Table 5.17: Monthly density and population estimates of flying razorbills only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species. Data include "no-identification" birds apportioned to species

Flying Razorbill	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.22	0.12	0.32	862	495	1281	207	23.97%
May-19	0.01	0.00	0.02	25	1	63	17	67.13%
Jun-19	0.03	0.01	0.07	133	33	266	62	46.06%
Jul-19	0.00	0.00	0.00	3	1	4	1	43.52%
Aug-19	0.00	0.00	0.01	18	0	43	12	67.63%
Sep-19	0.00	0.00	0.00	6	0	14	4	67.15%
Oct-19	0.17	0.08	0.29	684	325	1165	225	32.82%
Nov-19	0.02	0.00	0.04	67	2	145	37	54.72%
Dec-19	0.01	0.00	0.02	37	7	79	19	49.7%
Jan-20	0.05	0.02	0.09	207	100	353	64	30.59%
Feb-20	0.01	0.00	0.03	45	2	117	32	71.27%
Mar-20	0.30	0.21	0.39	1212	854	1559	192	15.77%
May S01 20	0.03	0.01	0.05	105	42	192	39	37.09%
May S02 20	0.04	0.01	0.07	143	48	262	57	39.91%
Jun-20	0.03	0.01	0.05	122	53	209	41	33.14%
Jul-20	0.01	0.00	0.02	50	17	89	19	36.93%
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.01	0.00	0.02	38	2	98	27	70.87%
Oct-20	0.20	0.11	0.29	784	447	1162	186	23.66%
Nov-20	0.02	0.01	0.05	93	26	194	45	47.79%
Dec-20	0.07	0.03	0.12	288	138	493	96	33.2%
Jan-21	0.05	0.03	0.09	218	116	341	59	26.98%
Feb-21	0.03	0.01	0.05	131	51	218	44	33.54%
Apr S01 21	0.29	0.17	0.44	1165	674	1770	288	24.7%
Apr S02 21	0.06	0.03	0.09	225	115	362	66	29.18%

Table 5.18: Monthly absolute density and population estimates of sitting razorbills only across the Offshore Ornithology Study Area using design-based analysis, adjusted for availability bias. Data include "no-identification" birds apportioned to species

Sitting Razorbill	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	0.97	0.71	1.28	3861	2833	5122	551	14.26%
May-19	1.37	1.12	1.60	5425	4452	6382	472	8.70%
Jun-19	0.34	0.21	0.49	1347	808	1934	254	18.88%
Jul-19	2.16	1.16	3.04	8596	4639	12122	1813	21.09%
Aug-19	2.46	1.75	3.31	9767	6945	13186	1464	14.99%
Sep-19	1.53	1.30	1.80	6096	5139	7160	475	7.80%
Oct-19	3.04	1.43	5.10	12128	5700	20286	3426	28.25%
Nov-19	0.46	0.13	0.90	1850	528	3579	727	39.31%
Dec-19	0.93	0.53	1.38	3678	2106	5475	797	21.67%
Jan-20	1.58	1.10	2.19	6269	4352	8697	997	15.91%
Feb-20	0.78	0.59	0.97	3093	2337	3846	367	11.87%
Mar-20	3.83	2.79	4.89	15200	11106	19465	1925	12.66%
May S01 20	1.15	0.82	1.47	4581	3255	5847	582	12.69%
May S02 20	0.87	0.60	1.19	3460	2370	4719	528	15.27%
Jun-20	0.73	0.59	0.92	2916	2312	3626	293	10.05%
Jul-20	1.89	1.36	2.53	7512	5383	10083	1092	14.54%
Aug-20	3.21	2.47	4.03	12791	9844	16061	1446	11.30%

Sitting Razorbill	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Sep-20	13.76	9.66	17.89	54725	38406	71177	7744	14.15%
Oct-20	1.25	0.73	1.82	4935	2936	7232	1025	20.77%
Nov-20	0.48	0.33	0.61	1879	1291	2446	272	14.48%
Dec-20	1.50	1.05	2.05	5994	4175	8164	922	15.38%
Jan-21	2.82	2.22	3.54	11233	8869	14080	1249	11.12%
Feb-21	0.95	0.72	1.23	3806	2849	4921	494	12.98%
Apr S01 21	3.23	2.37	4.13	12816	9444	16441	1665	12.99%
Apr S02 21	1.52	1.28	1.81	6017	5103	7178	472	7.85%

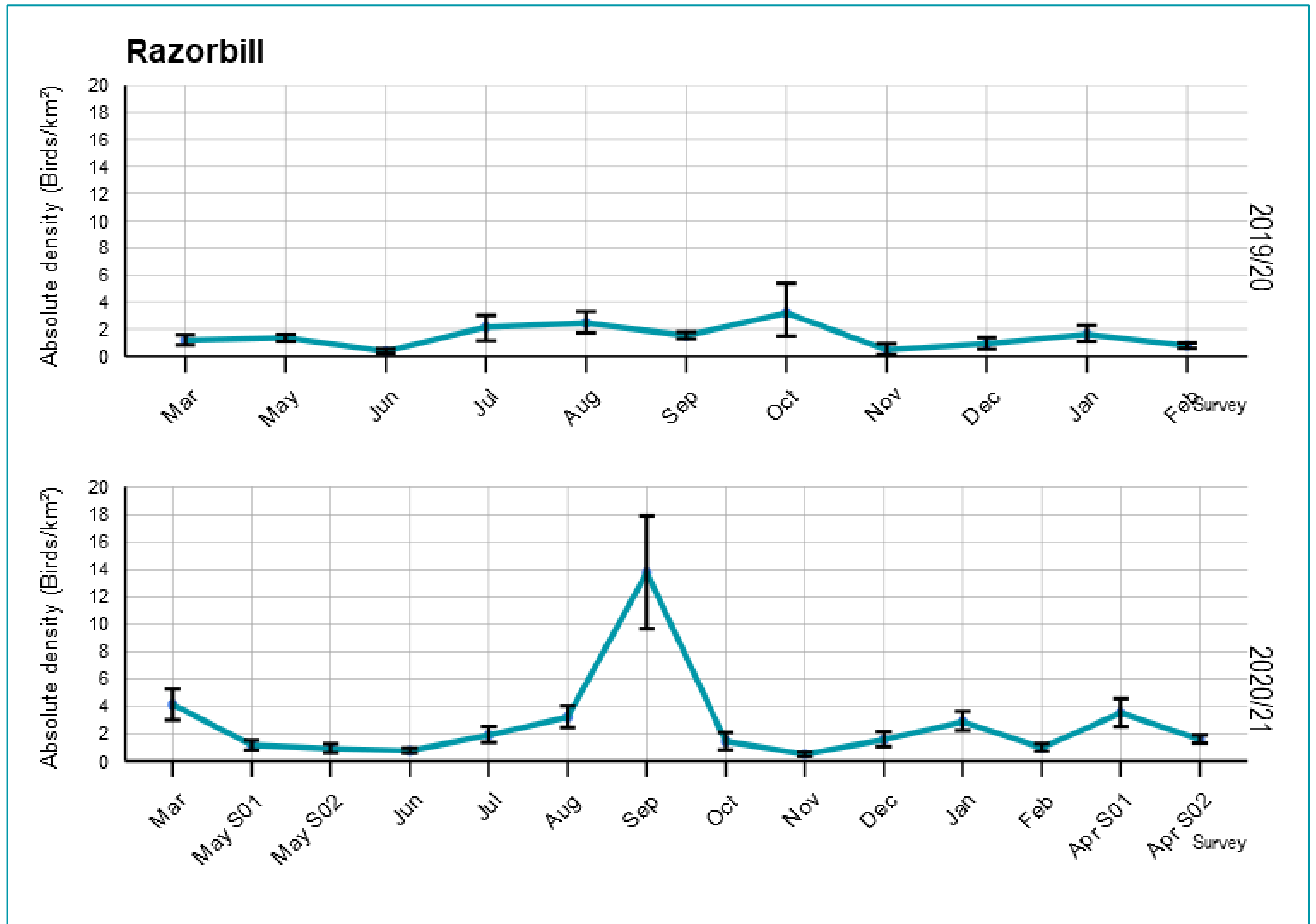


Figure 5.13: Estimated absolute densities (birds/km²) of all razorbills across the Offshore Ornithology Study Area using design-based analysis, accounting for availability bias. Data include "no-identification" birds apportioned to species

Table 5.19: Mean seasonal peak (MSP) population and density (birds/km²) of all razorbills in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis, with figures adjusted for availability bias. Data include "no-identification" birds apportioned to species

Razorbill								
Bio-season	**Peak population**	**Peak density**	**MSP Population**	**Lower 95% CI**	**Upper 95% CI**	**MSP Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	8599 (Yr1); 12791 (Yr2)	2.16 (Yr1); 3.21 (Yr2)	11289	8395	14646	2.84	2.11	3.67
Non-breeding	16412 (Yr1); 54763 (Yr2)	4.13 (Yr1); 13.77 (Yr2)	35589	25185	46150	8.95	6.33	11.59

Table 5.20: Mean seasonal peak (MSP) population and density (birds/km²) of all razorbills in the Berwick Bank Development Array plus 2 km buffer across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis, with figures adjusted for availability bias. Data include "no-identification" birds apportioned to species

Razorbill								
Bio-season	**Peak population**	**Peak density**	**MSP Population**	**Lower 95% CI**	**Upper 95% CI**	**MSP Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	3,258 (Yr1); 4,820 (Yr2)	2.49 (Yr1); 3.68 (Yr2)	4040	2754	5583	3.08	2.1	4.27
Non-breeding	9,130 (Yr1); 15,587 (Yr2)	6.98 (Yr1); 11.90 (Yr2)	12359	8294	16533	9.44	6.33	12.63

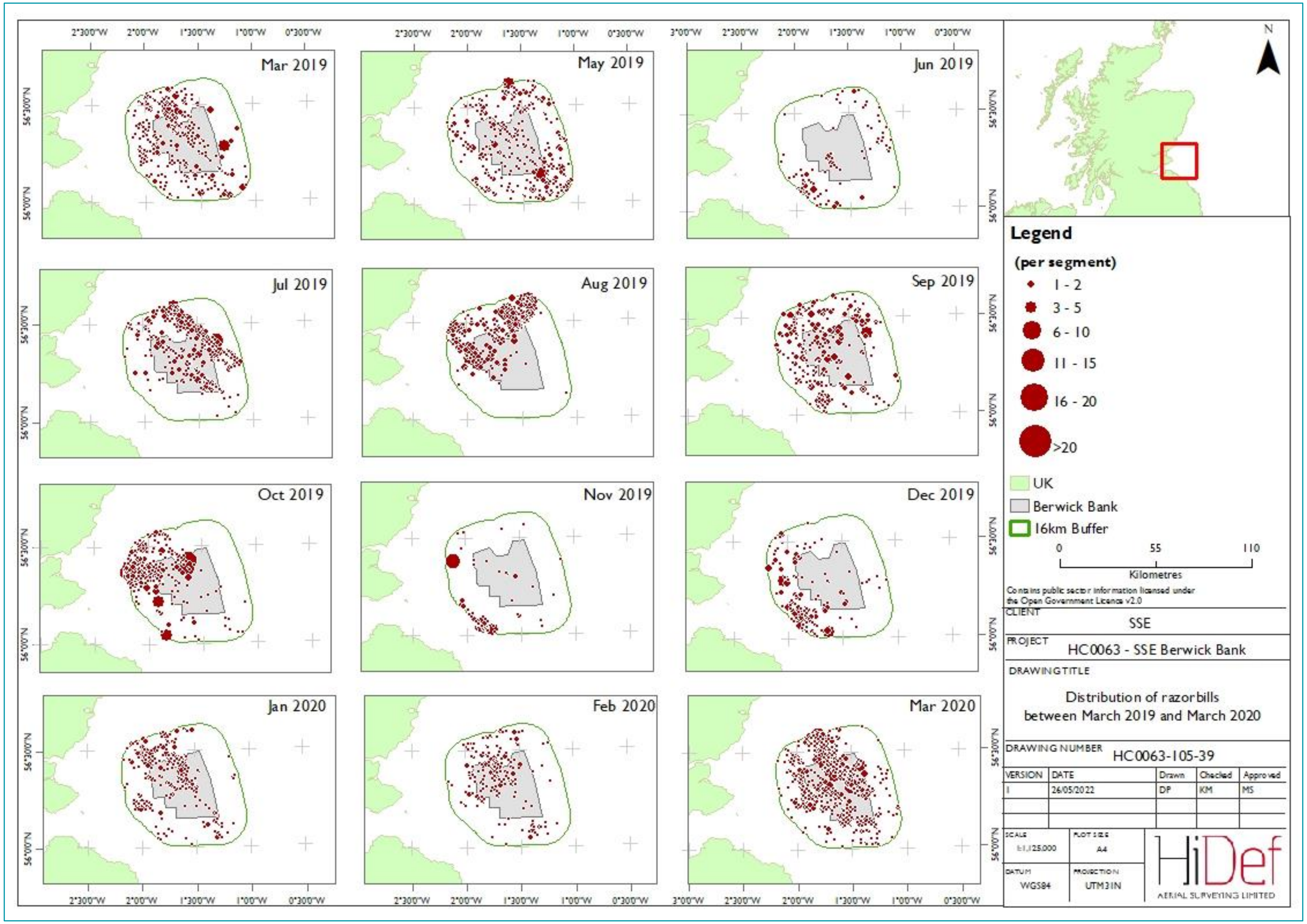


Figure 5.14: Distribution of razorbills across the Offshore Ornithology Study Area between March 2019 and March 2020

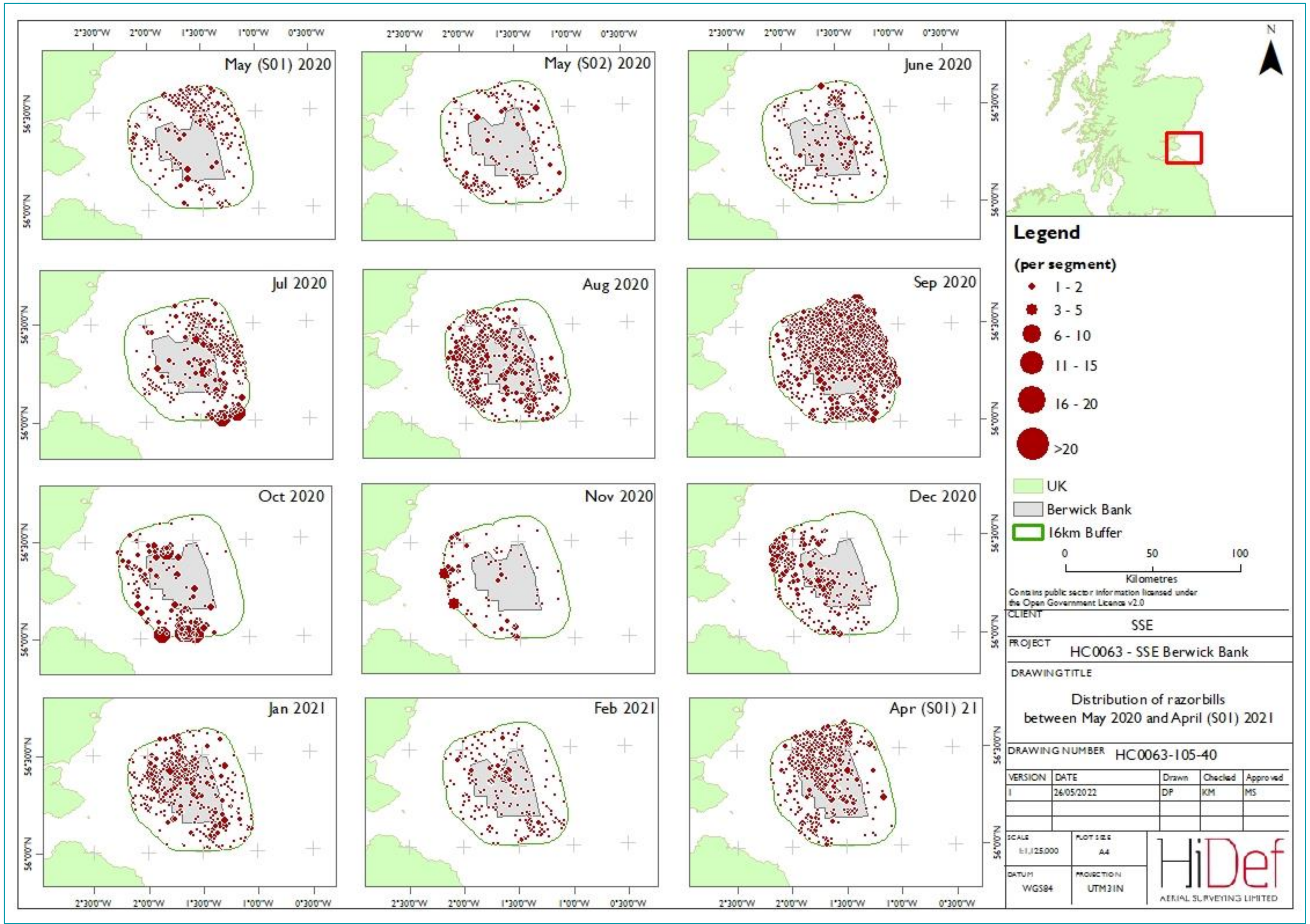


Figure 5.15: **Distribution of razorbills across the Offshore Ornithology Study Area between May S01 2020 and April S01 2021**

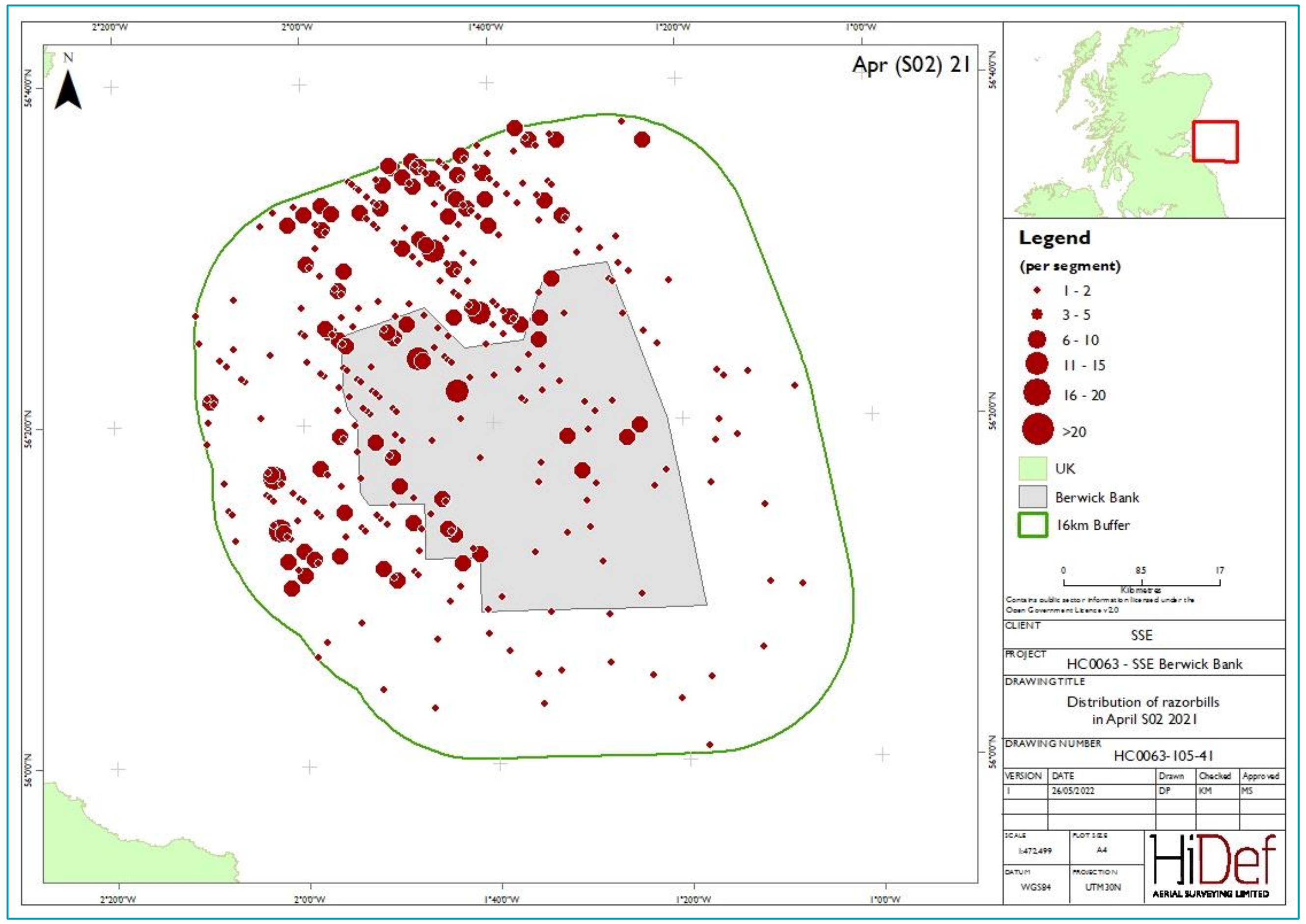


Figure 5.16: **Distribution of razorbills across the Offshore Ornithology Study Area in April S02 2021**

Figure 5.17: **Summarised flight direction of razorbills across the Offshore Ornithology Study Area**

2019/20

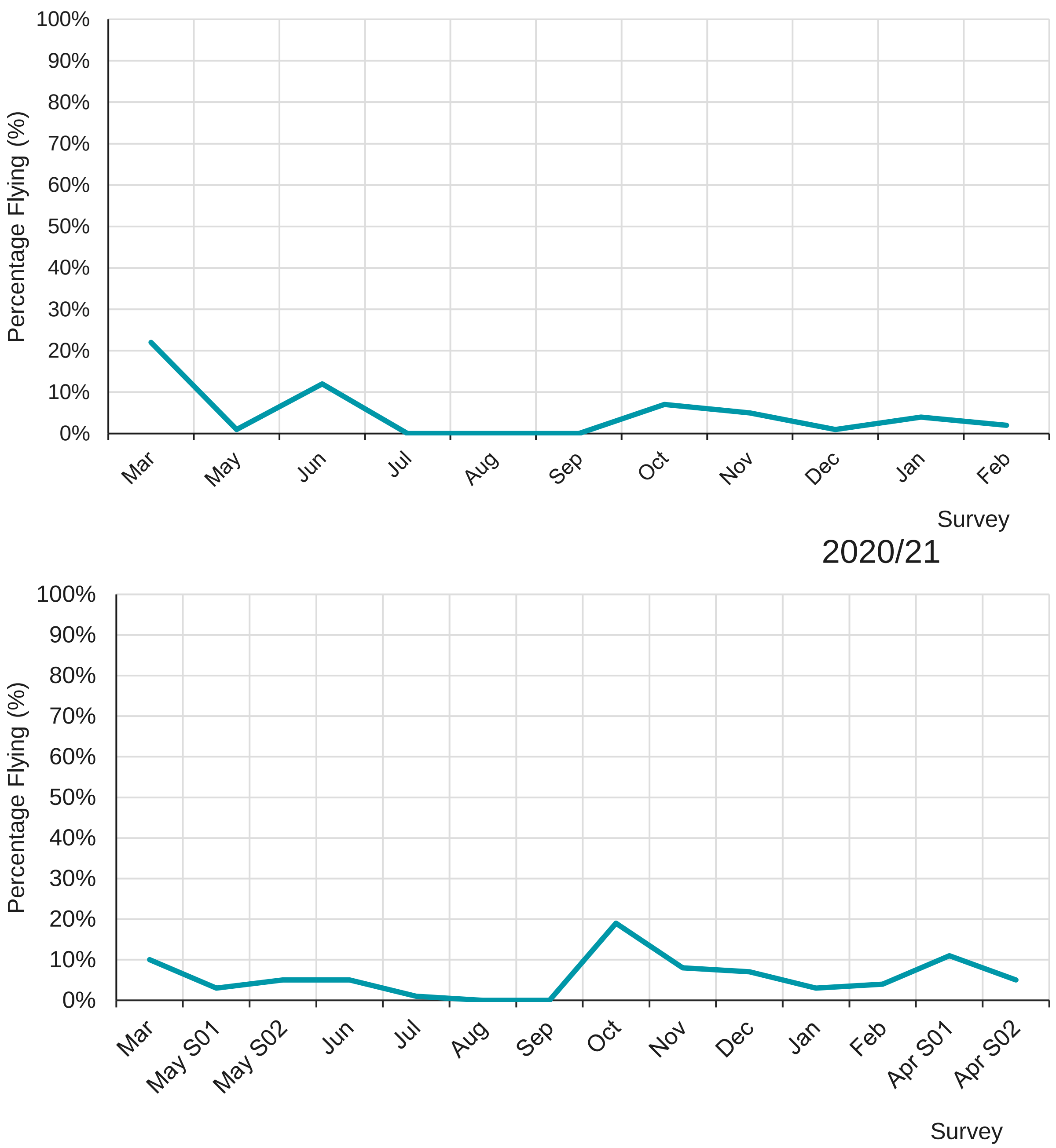


Figure 5.18: Percentage of flying razorbills per survey across the Offshore Ornithology Study Area

5.4. PUFFIN

142. A small auk species, puffins are most abundant in UK waters during the spring and summer, dispersing mainly westwards from early autumn into the winter. In the UK they nest in a few major colonies and are Red-listed on the UK Birds of Conservation Concern list (Stanbury *et al.,* 2021), following a listing as a vulnerable species on the ICUN Red List. A large breeding colony is present on the Isle of May, with the most recent count of 39,200 Apparently Occupied Burrows in 2017 (AOB's; SMP, 2021). Usually only present in coastal areas during the breeding season, puffins generally return to colonies between March and April, with egg laying occurring in April and May (Harris *et al.,* 2010). Typically, adult birds return to the same burrow year-on-year, raising one chick which generally fledges between July and August (Anker-Nilssen and Røstad, 1993; Finney *et al*., 2003).

143. After adjusting for availability bias, density and population estimates suggest the species utilise the Offshore Ornithology Study Area predominantly between March and September which is largely coincident with the breeding season (Figure 5.19). When accounting for availability bias, design-based density estimates ranged from 0.00 birds/km2 to 3.84 birds/km2 (95%CI 2.93 – 4.92) in 2019/20 and 0.03 birds/km2 (95%CI 0.02 – 0.05) to 8.81 birds/km2 (95%CI 7.43 – 10.17) in 2020/21. Mean seasonal peak abundance was higher in the non-breeding season, with an estimated population 20,667 birds (95%CI 17,298 – 24,031) compared to 12,290 birds (95%CI 9,857 – 14,997) in the breeding season.

144. Data collected during boat-based surveys of Berwick Bank reported that puffins accounted for 7.26% of all observations. The IMPRESS project (Camphuysen *et al*., 2004) suggested puffins were likely to be numerous within the outer Firth of Forth, with the species accounting for 21% of all observations. The total count of puffins at SPAs within the foraging range (mean max distance +1 sd from Woodward et al. 2019) of the Project approximates the regional population and is estimated at 233,550 breeding adults.

145. High abundance during summer months suggests birds at nearby colonies use the Offshore Ornithology Study Area to forage during chick-rearing. Mapped observations indicate varied use of the Offshore Ornithology Study Area, but with a more westerly distribution in the Offshore Ornithology Study Area during the breeding season (Figure 5.20 - Figure 5.22). High densities in the west of the Offshore Ornithology Study Area in months such as June and July 2019, July 2020 and April 2021, suggest many birds use areas closer to colonies and chicks during this time. More widespread dispersal towards the end of the chick-rearing period, such as in September 2020, suggests movement of birds offshore, with elevated densities also observed to the east of the Offshore Ornithology Study Area in September 2019. Offshore movement of birds following the breeding season is expected, since the species usually overwinters at sea; the North Sea hosts significant concentrations of the species during winter months (Harris, 1984; Jessop *et al*., 2013).

146. Across all seasons, most birds were recorded as sitting on the water, with few birds recorded as flying during the 25 months of surveys (Table 5.23). In Year 1, peaks in flying birds were observed in June, with about 6% of birds recorded as flying, however in Year 2 peaks occurred in March and June, with approximately 29% and 17% of birds recorded as flying respectively (Figure 5.25). High proportions of sitting birds are to be expected considering the feeding strategy adopted by the species as pursuit-divers diving from the water surface (Cramp and Simmons, 1983). Typical prey species are small to mid-sized schooling pelagic fish, including sandeels and sprats, supplemented by crustaceans, molluscs and polychaetes during the breeding season (del Hoyo *et al.,* 1996). Considerable differences in diet between colonies and years has been identified, with sub-optimal prey species negatively affecting fledgling growth in some cases (Harris and Hislop, 1978).

147. The paucity of flying birds during the programme presented difficulties when assessing trends in flight direction, although many birds were recorded flying west in June 2019 and June and July 2020. Some birds were also recorded flying north and southeast in July 2019 and July 2020 respectively (Figure 5.23).

148. Ages of birds are not presented for the species since adults can only be aged when in the presence of a juvenile for size comparison and they occur almost always as single adult-chick pairs.

Table 5.21: Puffin bio-seasons taken from NatureScot (2020a)

Bio-season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season				✓	✓	✓	✓	✓				
Extended non-breeding	✓	✓	✓					✓	✓	✓	✓	✓

Table 5.22: Monthly absolute density and population estimates of all puffins across the Offshore Ornithology Study Area using design-based analysis, adjusted for availability bias. Data include "no-identification" birds apportioned to species

All Puffin	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	1.59	1.27	1.91	6297	5044	7593	740	11.75%
May-19	2.11	1.85	2.35	8378	7327	9373	597	7.13%
Jun-19	1.51	0.80	2.58	6031	3171	10223	2151	35.67%
Jul-19	3.84	2.93	4.92	15271	11667	19537	2351	15.4%
Aug-19	3.31	2.44	4.35	13154	9741	17290	2220	16.88%
Sep-19	1.52	1.10	2.02	6074	4359	8035	1180	19.43%
Oct-19	0.41	0.27	0.57	1594	1089	2232	357	22.4%
Nov-19	0.06	0.02	0.08	216	110	341	74	34.26%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.05	0.02	0.08	189	101	306	63	33.33%
Feb-20	0.20	0.15	0.26	797	607	1008	126	15.81%
Mar-20	0.71	0.48	0.97	2826	1910	3843	528	18.68%
May S01 20	1.66	1.23	2.10	6612	4895	8341	1094	16.55%
May S02 20	0.64	0.49	0.79	2531	1964	3127	334	13.2%
Jun-20	0.86	0.61	1.11	3390	2448	4425	493	14.54%
Jul-20	1.49	1.00	2.12	5936	3934	8448	1248	21.02%
Aug-20	2.17	1.75	2.68	8598	6949	10650	1144	13.31%
Sep-20	8.81	7.43	10.17	35035	29549	40467	3479	9.93%
Oct-20	0.20	0.14	0.27	813	578	1091	156	19.19%
Nov-20	0.20	0.12	0.29	761	473	1118	182	23.92%
Dec-20	0.03	0.02	0.05	127	80	178	33	25.98%
Jan-21	0.03	0.02	0.05	130	79	188	36	27.69%
Feb-21	0.36	0.24	0.53	1431	968	2095	349	24.39%
Apr S01 21	1.55	1.02	2.09	6193	4081	8316	1277	20.62%
Apr S02 21	4.01	3.21	4.86	15980	12763	19344	1977	12.37%

Table 5.23: Monthly density and population estimates of flying puffins only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Puffin	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.05	0.02	0.07	186	93	286	51	27.36%
May-19	0.05	0.03	0.07	188	108	278	44	22.99%
Jun-19	0.07	0.04	0.13	298	146	507	94	31.39%
Jul-19	0.04	0.02	0.07	161	78	269	51	31.65%
Aug-19	0.07	0.03	0.10	260	139	386	67	25.42%
Sep-19	0.02	0.00	0.04	79	8	167	42	51.96%
Oct-19	0.01	0.00	0.02	39	15	71	15	37.7%
Nov-19	0.00	0.00	0.00	2	0	5	2	93.87%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.13	0.08	0.19	521	334	738	103	19.72%
May S01 20	0.02	0.01	0.04	95	41	151	29	30.01%
May S02 20	0.01	0.00	0.02	33	0	72	20	59.33%
Jun-20	0.10	0.03	0.18	398	124	724	155	38.85%
Jul-20	0.09	0.04	0.15	363	154	600	117	32.28%
Aug-20	0.01	0.00	0.02	32	0	95	27	85.35%
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	8	1	20	6	66.5%
Nov-20	0.01	0.00	0.02	26	0	66	19	70.42%
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.01	9	0	32	9	100.71%
Apr S01 21	0.04	0.02	0.07	172	81	293	55	31.69%
Apr S02 21	0.04	0.02	0.07	165	70	284	57	34.3%

Table 5.24: Monthly absolute density and population estimates of sitting puffins only across the Offshore Ornithology Study Area using design-based analysis, adjusted for availability bias. Data include "no-identification" birds apportioned to species

Sitting Puffin	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Mar-19	1.54	1.25	1.84	6111	4951	7307	559	9.15%
May-19	2.06	1.82	2.28	8190	7219	9095	448	5.47%
Jun-19	1.44	0.76	2.45	5733	3025	9716	1610	28.09%
Jul-19	3.80	2.91	4.85	15110	11589	19268	1829	12.11%
Aug-19	3.24	2.41	4.25	12894	9602	16904	1693	13.13%
Sep-19	1.50	1.10	1.98	5995	4351	7868	893	14.89%
Oct-19	0.40	0.27	0.55	1555	1074	2161	264	17.00%
Nov-19	0.06	0.02	0.08	214	110	336	55	25.68%
Dec-19	0.00	0.00	0.00	0	0	0	0	0.00%
Jan-20	0.05	0.02	0.08	189	101	306	49	25.74%
Feb-20	0.20	0.15	0.26	797	607	1008	97	12.19%
Mar-20	0.58	0.40	0.78	2305	1576	3105	369	16.01%
May S01 20	1.64	1.22	2.06	6517	4854	8190	809	12.42%
May S02 20	0.63	0.49	0.77	2498	1964	3055	261	10.46%
Jun-20	0.76	0.58	0.93	2992	2324	3701	348	11.62%
Jul-20	1.40	0.96	1.97	5573	3780	7848	952	17.08%
Aug-20	2.16	1.75	2.66	8566	6949	10555	851	9.93%
Sep-20	8.81	7.43	10.17	35035	29549	40467	2648	7.56%

Sitting Puffin	Adjusted Density Estimate (birds/ km²)	Adjusted Lower 95% CI (birds/ km²)	Adjusted Upper 95% CI (birds/ km²)	Adjusted Population Estimate (number)	Adjusted Lower 95% CI (number)	Adjusted Upper 95% CI (number)	Adjusted SD	Adjusted CV (%)
Survey								
Oct-20	0.20	0.14	0.27	805	577	1071	120	14.88%
Nov-20	0.19	0.12	0.27	735	473	1052	136	18.50%
Dec-20	0.03	0.02	0.05	127	80	178	25	19.55%
Jan-21	0.03	0.02	0.05	130	79	188	28	21.51%
Feb-21	0.36	0.24	0.52	1422	968	2063	267	18.74%
Apr S01 21	1.51	1.00	2.02	6021	4000	8023	950	15.78%
Apr S02 21	3.97	3.19	4.79	15815	12693	19060	1559	9.85%

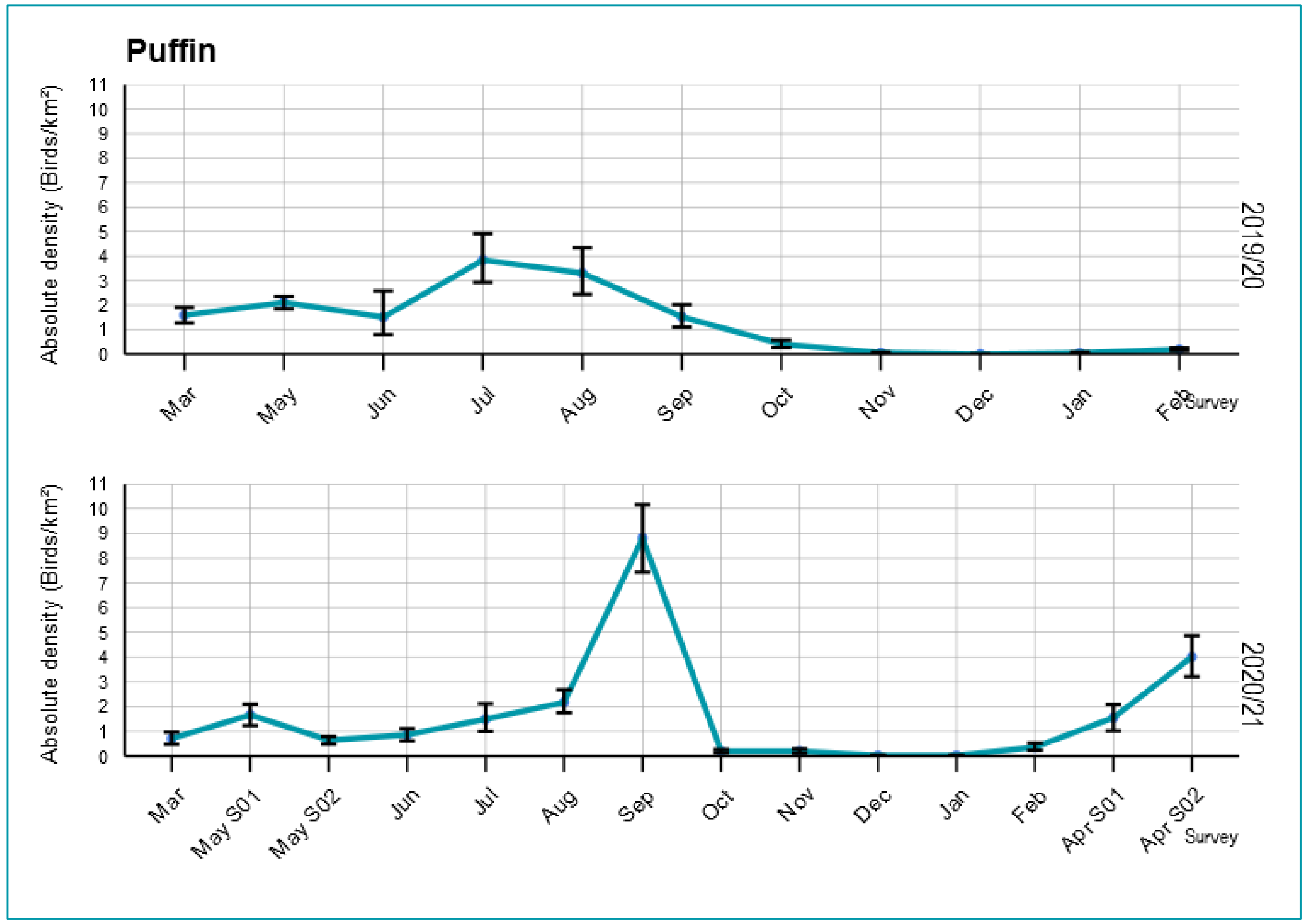


Figure 5.19: **Estimated absolute densities (birds/km²) of all puffins across the Offshore Ornithology Study Area using design-based analysis, accounting for availability bias. Data include "no-identification" birds apportioned to species**

Table 5.25: **Mean seasonal peak (MSP) population and density (birds/km²) of all puffins in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis, with figures adjusted for availability bias. Data include "no-identification" birds apportioned to species**

Puffin								
Bio-season	**Peak population**	**Peak density**	**MSP Population**	**Lower 95% CI**	**Upper 95% CI**	**MSP Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	15980 (Yr1); 8598 (Yr2)	4.01 (Yr1); 2.17 (Yr2)	12290	9857	14997	3.09	2.48	3.77
Non-breeding	6298 (Yr1); 35035 (Yr2)	1.59 (Yr1); 8.81 (Yr2)	20667	17298	24031	5.2	4.35	6.04

Table 5.26: **Mean seasonal peak (MSP) population and density (birds/km²) of all puffins in the Berwick Bank Development Array plus 2 km buffer across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis, with figures adjusted for availability bias. Data include "no-identification" birds apportioned to species. Non-breeding season data not displayed since they are not taken forward for displacement assessment**

Puffin								
Bio-season	**Peak population**	**Peak density**	**MSP Population**	**Lower 95% CI**	**Upper 95% CI**	**MSP Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	6280 (Yr1); 2745 (Yr2)	(Yr1); (Yr2)	4513	3367	5715	3.45	2.58	4.36

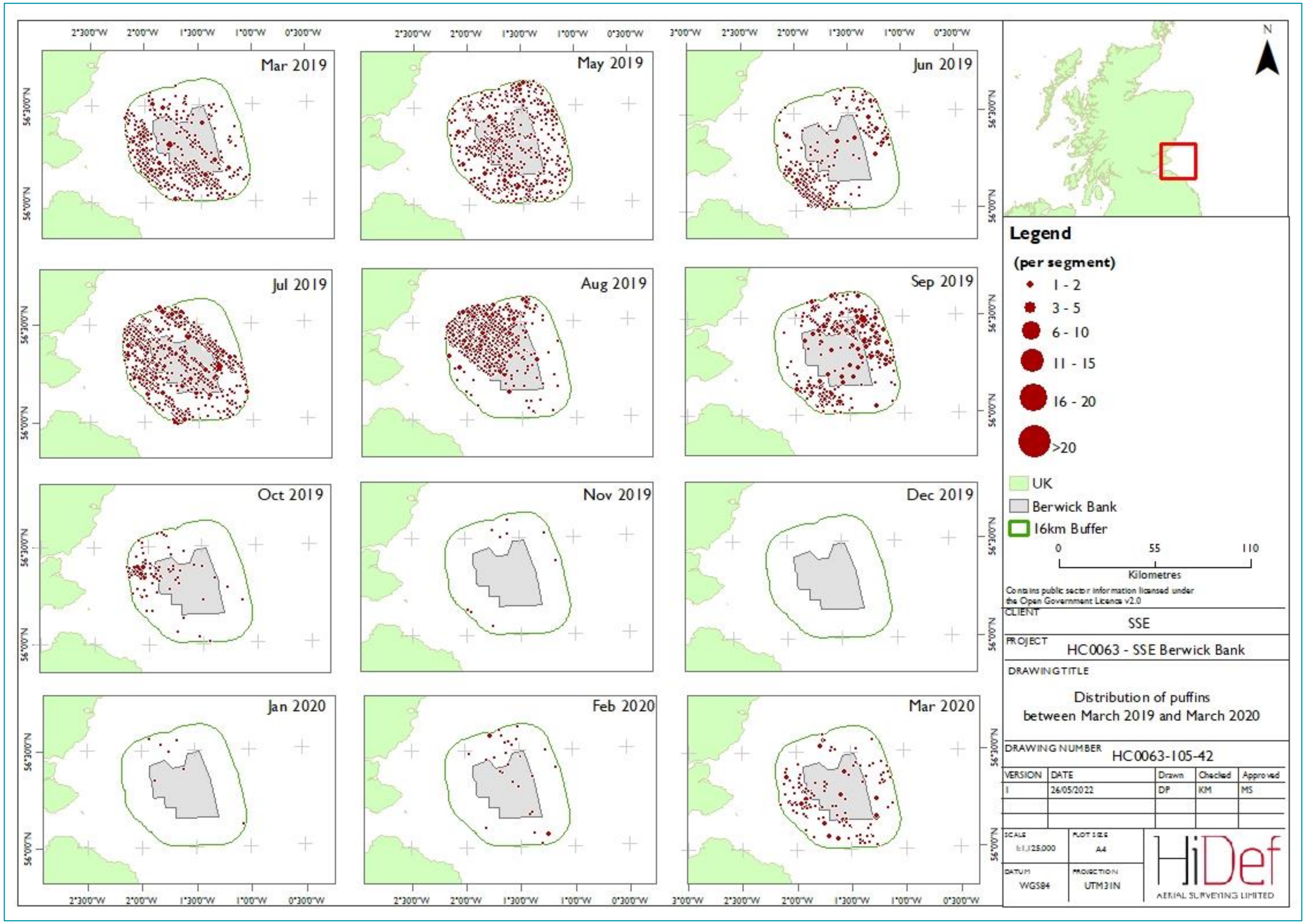


Figure 5.20: **Distribution of puffins across the Offshore Ornithology Study Area between March 2019 and March 2020**

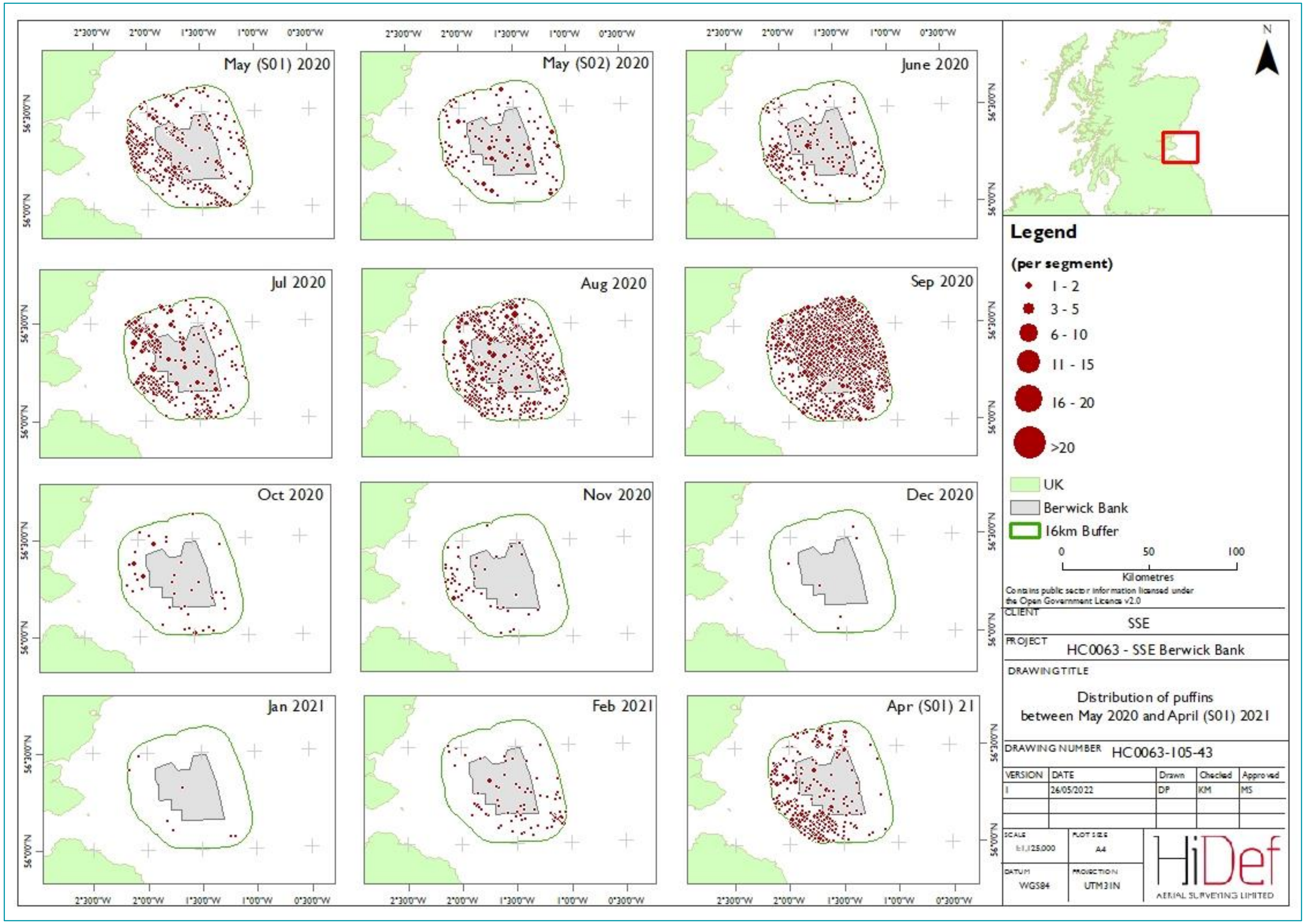


Figure 5.21: Distribution of puffins across the Offshore Ornithology Study Area between May S01 2020 and April S01 2021

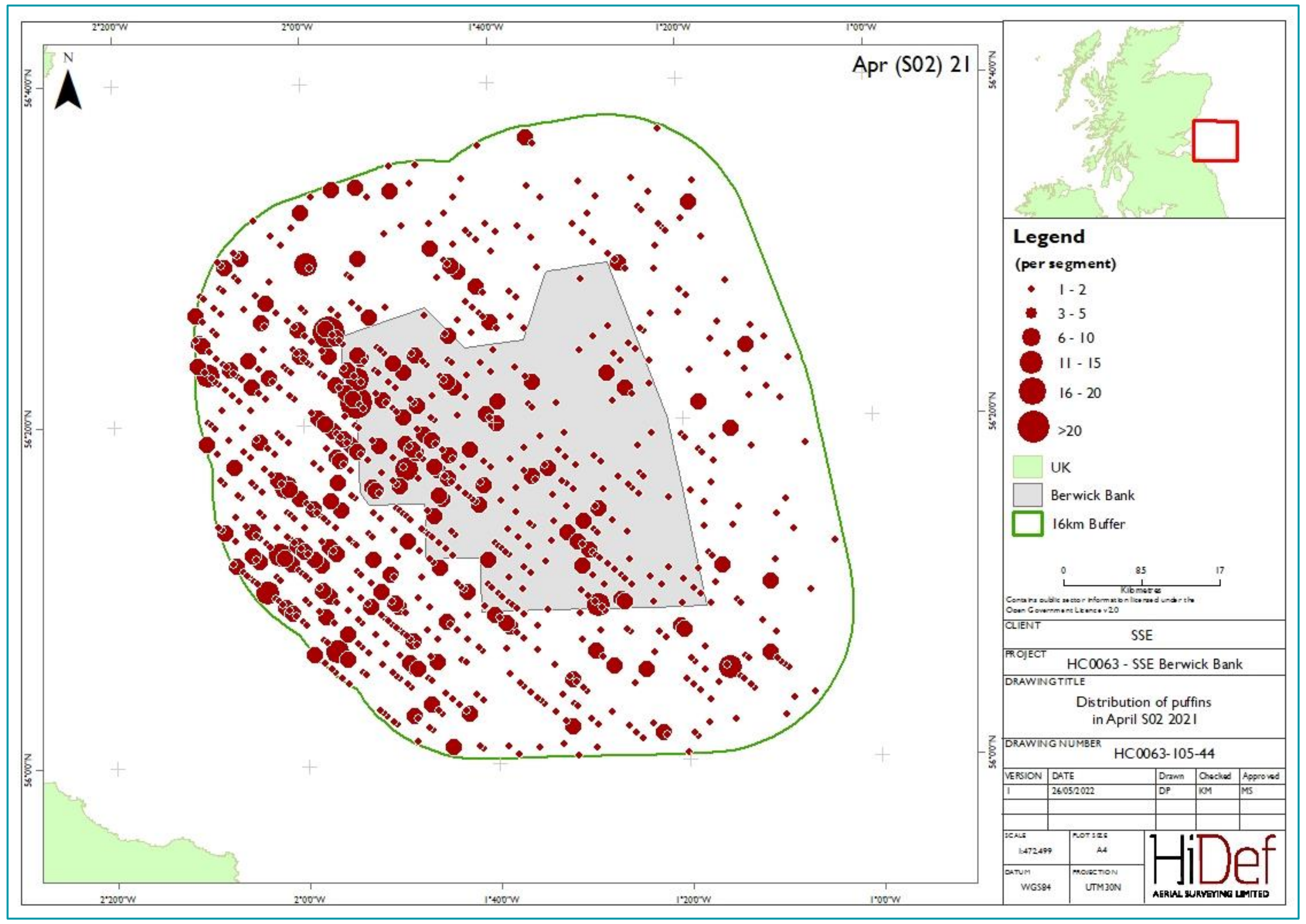


Figure 5.22: Distribution of puffins across the Offshore Ornithology Study Area in April S02 2021

Figure 5.23: Summarised flight direction of puffins across the Offshore Ornithology Study Area

2019/20

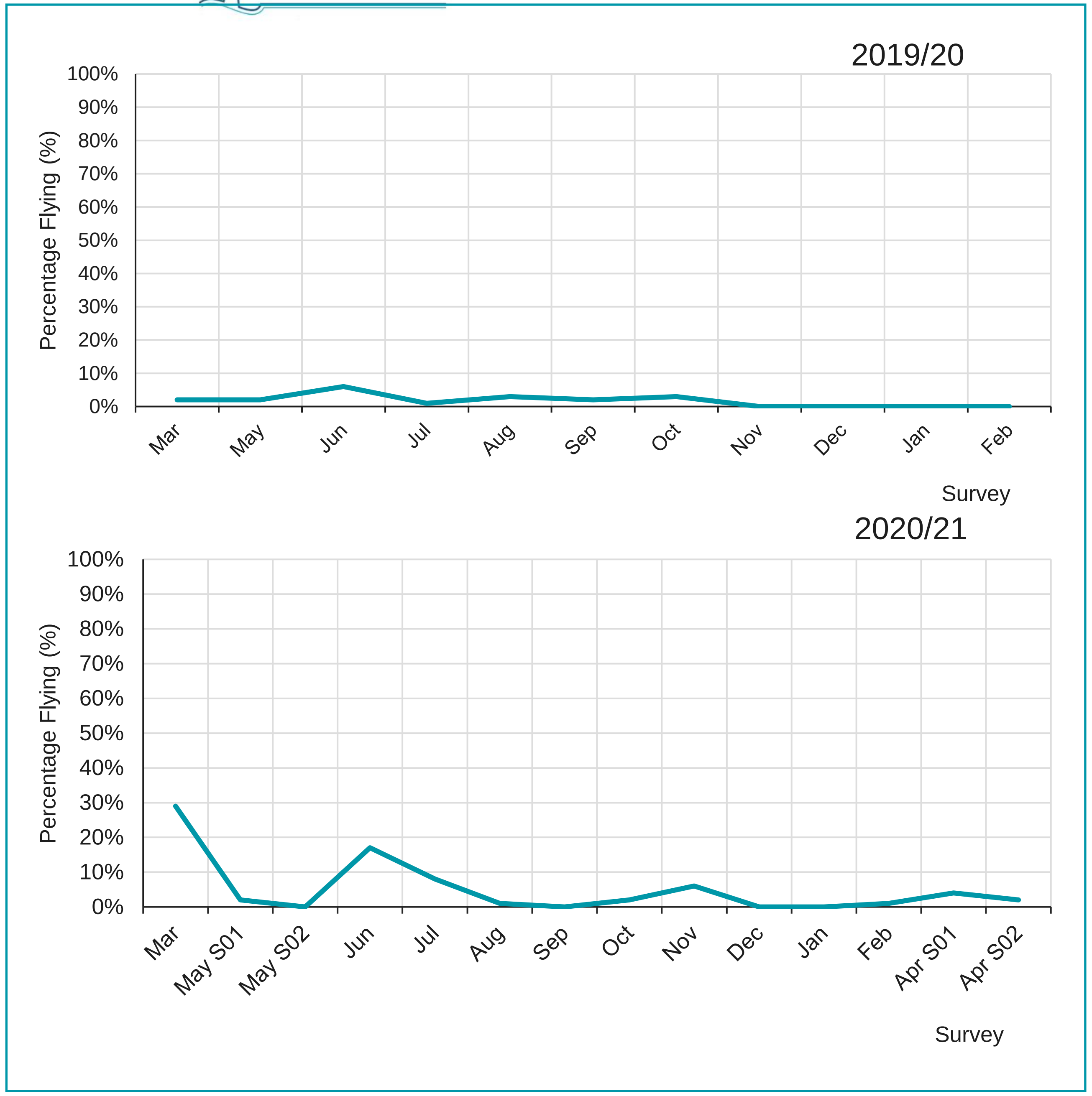


Figure 5.24: Percentage of flying puffins per survey across the Offshore Ornithology Study Area

5.5. GANNET

149. As the largest pelagic seabird in the North Atlantic, gannets have considerable influence on marine food chains, preying on various fish species and competing with other seabird species for discards from commercial fisheries (Hamer *et al*., 2000). It is likely that fisheries discards currently make up a much smaller percentage of the diet than previously, following the discard ban in 2015 which was fully implemented in 2019 (Ulhmann *et al*., 2019). Typical prey includes pelagic fish such as mackerel and sandeel, the latter species being abundant within the Firth of Forth and North Sea (Greenstreet *et al*., 2010). Gannet distribution and abundance is likely to be influenced by prey availability (Furness and Tasker, 1999) although its sensitivity to sandeel abundance is less than for other species such as kittiwake because of the greater variety of prey species it exploits (Daunt *et al.,* 2008; B. Furness, pers. comms., 2021). The nearest gannetry is the Bass Rock in the Firth of Forth, which is the world's largest colony with 75,259 Apparently Occupied Sites (AOS) recorded in 2014 (Murray *et al*., 2014; SMP, 2021). The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

150. Gannets were most abundant in the Offshore Ornithology Study Area in the breeding season. Design-based analysis estimated gannet density to range between 0.00 birds/km^2 (95%CI 0.00 – 0.01; February 2020) and 4.06 birds/km^2 (95%CI 3.42 – 4.79; August 2019) in 2019/20 and 0.05 birds/km^2 (95%CI 0.02 – 0.09; February 2021) and 3.27 birds/km^2 (95%CI 2.88 – 3.68; July 2020) in 2020/21. Densities peaked in August and July in Year 1 and Year 2 respectively, coinciding with the breeding season (Table 5.28).

151. Gannets were frequently encountered within the Offshore Ornithology Study Area and wider area during other studies of the outer Firth of Forth (Camphuysen *et al*., 2004; Kober *et al*. 2010, 2012; Lane *et al*. 2020). WWT Waterbird surveys also indicated high gannet abundance, although the survey block was located approximately 20km from the Offshore Ornithology Study Area. Gannets were identified as a key species during boat-based surveys of Seagreen between 2009-2011 (accounting for 16.10% and 16.60% of all observations respectively) and Berwick Bank between 2019-2020 (accounting for 16.12% of all observations). The total count of gannets within the foraging range (mean max distance +1 sd from woodward et al. 2019) of the Project is estimated at 323,836 breeding adults.

152. Mean seasonal peak density calculated for the breeding season was 3.66 birds/km^2 (95%CI 3.15 – 4.24), equating to a population of 14,581 birds (95%CI 12,528 – 16,840) (Table 5.31). High densities are to be expected within the Offshore Ornithology Study Area, due to the proximity to Bass Rock where breeding success of gannets has been consistently high, despite fluctuations in breeding success for other seabird species in the vicinity (Nelson, 2006; Hamer *et al*., 2007).

153. Following peaks in abundance in the breeding season, gannet abundance in the Offshore Ornithology Study Area declined steadily until December 2019 in Year 1 and until October and November 2020 in Year 2 (Table 5.28) Fluctuations in abundance later in the year may be attributed to fledgling birds leaving nests and spending time at sea (Nelson, 1966).

154. Distribution of gannets varied between months, with a tendency for a north-westerly distribution within the Offshore Ornithology Study Area during the breeding season (e.g., between August and September in both years). Generally, in both Year 1 and Year 2, it appeared that higher densities of gannets were more widespread throughout the Offshore Ornithology Study Area during the breeding season compared to the non-breeding season, such as in December 2019 and November 2020 specifically.

155. Of the birds that could be aged, most were recorded as adults (Table 5.33). Few young birds were observed in the Offshore Ornithology Study Area with the highest proportions of immature birds (2% of aged birds) and juvenile birds (2% of aged birds) occurring in the non-breeding period.

156. Within the breeding season, particularly between June and August, proportions of gannets recorded as flying and sitting on the water were broadly similar, suggesting the Offshore Ornithology Study Area is used during foraging and during passage to foraging grounds further afield. Peaks in the percentage of flying birds were observed in September in both survey years (). Flexibility in diet and foraging behaviour and duration is likely linked to the species success in the North Sea (Hamer *et al*., 2007). During the return migration period, proportions of sitting and flying birds were more variable.

157. Flight direction was variable, with many birds flying in easterly and westerly directions, such as in August 2019 and July 2020 (Figure 5.29). The presence of the Bass Rock to the southwest of the Offshore Ornithology Study Area may explain the abundance of eastwards and westwards flight, since many birds travel from this colony to foraging grounds further offshore in the North Sea.

Table 5.27: Gannet bio-seasons taken from NatureScot (2020a)

Bio-season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Breeding season			■ (part)	■	■	■	■	■	■			
Non-breeding	■	■	■ (part)							■	■	■

Table 5.28: Monthly density and population estimates of all gannets across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Gannet	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.25	0.17	0.34	999	683	1370	180	17.94%
May-19	0.68	0.50	0.87	2688	2002	3475	368	13.69%
Jun-19	1.19	1.00	1.44	4751	3982	5713	448	9.42%
Jul-19	3.15	2.83	3.50	12522	11274	13921	681	5.43%
Aug-19	4.06	3.42	4.79	16143	13600	19033	1376	8.52%
Sep-19	2.30	2.03	2.59	9159	8082	10299	565	6.17%
Oct-19	1.33	0.85	2.04	5275	3392	8119	1275	24.16%
Nov-19	0.26	0.14	0.41	1043	550	1614	276	26.43%
Dec-19	0.03	0.00	0.07	102	8	275	77	75.96%
Jan-20	0.01	0.00	0.02	34	0	72	18	52.7%
Feb-20	0.00	0.00	0.01	18	0	40	12	67.32%
Mar-20	0.20	0.14	0.26	781	554	1024	123	15.66%
May S01 20	0.60	0.48	0.76	2387	1928	3042	282	11.8%
May S02 20	1.10	0.89	1.34	4382	3530	5317	465	10.6%
Jun-20	1.32	1.09	1.64	5266	4326	6508	593	11.25%
Jul-20	3.27	2.88	3.68	13018	11455	14647	804	6.17%
Aug-20	1.82	1.48	2.22	7259	5876	8835	761	10.48%
Sep-20	1.83	1.54	2.15	7279	6143	8558	624	8.57%
Oct-20	0.84	0.66	1.08	3353	2611	4288	447	13.32%
Nov-20	1.11	0.84	1.41	4422	3359	5627	600	13.56%
Dec-20	0.34	0.18	0.53	1355	705	2093	360	26.53%
Jan-21	0.09	0.06	0.13	350	220	522	82	23.27%
Feb-21	0.05	0.02	0.09	200	64	378	80	39.8%
Apr S01 21	0.51	0.43	0.62	2045	1705	2448	197	9.59%
Apr S02 21	1.39	0.82	2.23	5543	3252	8887	1429	25.78%

Table 5.29: Monthly density and population estimates of flying gannets only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Gannet	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.19	0.13	0.27	772	515	1091	146	18.91%
May-19	0.54	0.39	0.71	2158	1543	2817	344	15.93%
Jun-19	0.71	0.55	0.91	2816	2187	3604	359	12.72%
Jul-19	1.66	1.41	1.94	6605	5600	7722	541	8.18%
Aug-19	1.95	1.67	2.27	7749	6631	9045	636	8.2%
Sep-19	2.00	1.72	2.32	7957	6843	9217	617	7.74%
Oct-19	0.68	0.49	0.92	2698	1936	3641	460	17.05%
Nov-19	0.13	0.09	0.16	500	350	650	78	15.56%
Dec-19	0.01	0.00	0.02	37	8	81	20	53.64%
Jan-20	0.01	0.00	0.02	33	0	73	19	56.31%
Feb-20	0.00	0.00	0.01	8	0	24	8	98.23%
Mar-20	0.17	0.12	0.22	678	495	878	100	14.65%
May S01 20	0.51	0.38	0.66	2024	1529	2635	293	14.46%
May S02 20	0.95	0.76	1.15	3760	3013	4574	411	10.91%
Jun-20	1.15	0.94	1.48	4578	3740	5888	575	12.55%
Jul-20	1.64	1.43	1.90	6536	5701	7577	502	7.67%
Aug-20	0.74	0.62	0.89	2932	2470	3553	286	9.73%
Sep-20	1.24	1.03	1.49	4945	4082	5908	491	9.91%
Oct-20	0.31	0.25	0.38	1242	999	1506	130	10.44%
Nov-20	0.61	0.46	0.76	2408	1815	3033	306	12.71%
Dec-20	0.11	0.07	0.16	434	265	654	104	23.8%
Jan-21	0.04	0.02	0.05	143	88	205	30	20.58%
Feb-21	0.02	0.01	0.04	97	32	168	35	35.57%
Apr S01 21	0.39	0.34	0.45	1567	1339	1810	126	8.02%
Apr S02 21	0.77	0.50	1.17	3066	1993	4654	693	22.59%

Table 5.30: Monthly density and population estimates of sitting gannets only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Gannet	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.05	0.02	0.10	210	73	398	91	43.28%
May-19	0.13	0.08	0.21	516	311	819	133	25.78%
Jun-19	0.48	0.39	0.59	1927	1554	2361	204	10.59%
Jul-19	1.47	1.23	1.69	5829	4911	6737	496	8.51%
Aug-19	2.11	1.61	2.66	8396	6403	10571	1107	13.19%
Sep-19	0.30	0.24	0.37	1202	953	1473	136	11.27%
Oct-19	0.66	0.33	1.19	2645	1310	4727	888	33.54%
Nov-19	0.13	0.03	0.26	523	110	1024	233	44.39%
Dec-19	0.01	0.00	0.05	59	0	194	61	103.07%
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.01	9	0	24	8	93.35%
Mar-20	0.03	0.01	0.05	111	41	206	43	38.72%
May S01 20	0.09	0.05	0.14	357	189	539	93	26.01%
May S02 20	0.16	0.11	0.20	619	438	809	98	15.72%
Jun-20	0.18	0.12	0.26	721	461	1036	149	20.59%
Jul-20	1.61	1.34	1.90	6405	5313	7552	575	8.97%
Aug-20	1.09	0.85	1.34	4345	3379	5349	514	11.83%
Sep-20	0.58	0.42	0.77	2326	1662	3061	371	15.93%
Oct-20	0.53	0.38	0.73	2108	1515	2891	349	16.54%
Nov-20	0.51	0.34	0.70	2019	1349	2765	362	17.9%
Dec-20	0.24	0.10	0.41	964	403	1640	319	33.02%
Jan-21	0.05	0.02	0.09	204	71	378	79	38.52%
Feb-21	0.03	0.00	0.06	107	8	241	61	56.52%
Apr S01 21	0.12	0.06	0.20	489	242	777	140	28.61%

Sitting Gannet	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Apr S02 21	0.60	0.25	1.00	2382	992	3961	790	33.13%

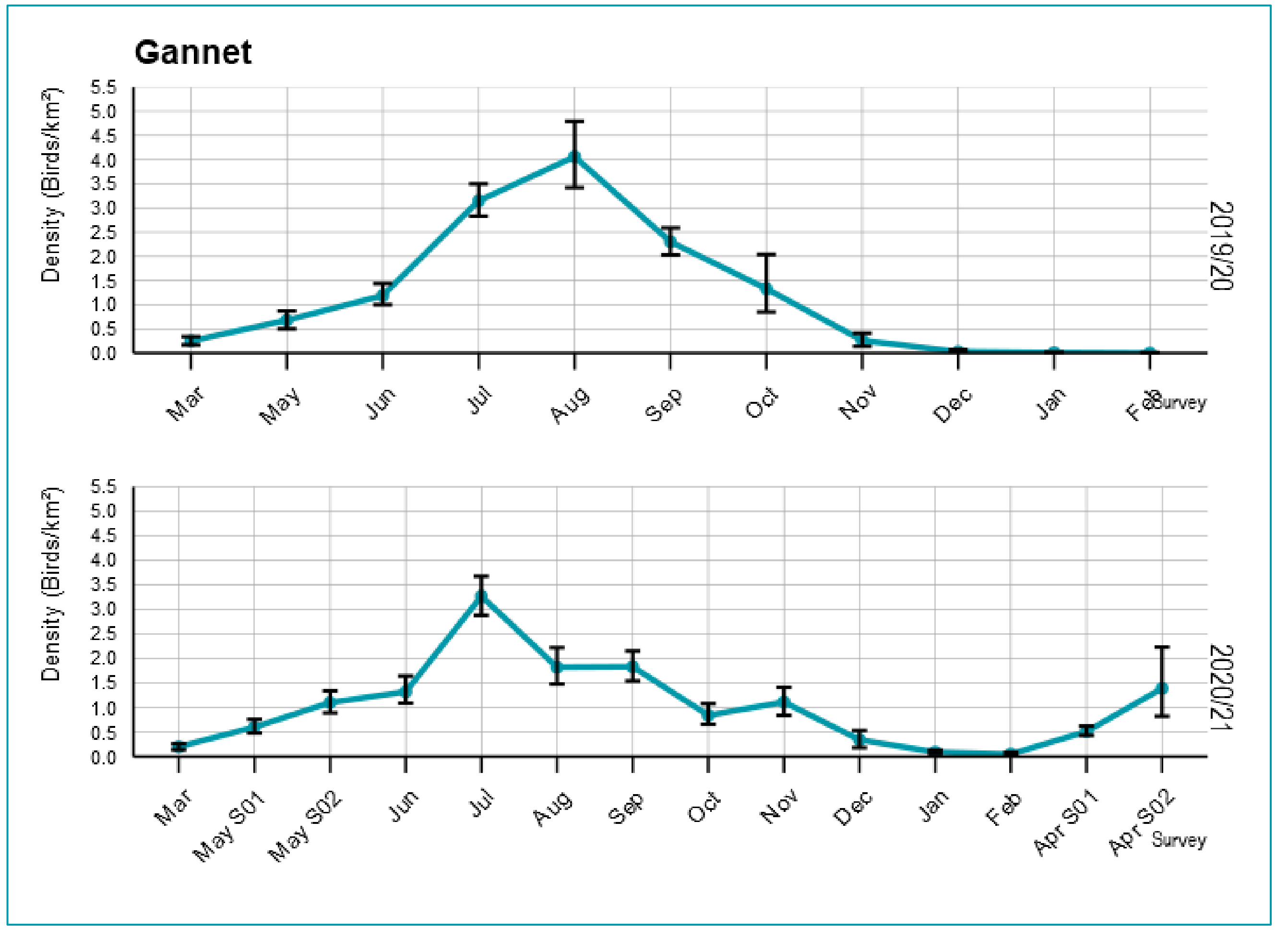


Figure 5.25: Estimated densities (birds/km²) of all gannets across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.31: Mean seasonal peak (MSP) population and density (birds/km²) of all gannets in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

Gannet								
Bio-season	Peak population	Peak density	Population	Lower 95% CI	Upper 95% CI	Density	Lower 95% CI	Upper 95% CI
Breeding season	16143 (Yr1); 13018 (Yr2)	4.06 (Yr1); 3.27 (Yr2)	14581	12528	16840	3.66	3.15	4.24
Non-breeding	5275 (Yr1); 4422 (Yr2)	1.33 (Yr1); 1.11 (Yr2)	4849	3376	6873	1.22	0.84	1.73

Table 5.32: Mean seasonal peak (MSP) population and density (birds/km²) of all gannets in the Berwick Bank Development Array plus 2 km buffer across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

Gannet								
Bio-season	Peak population	Peak density	Population	Lower 95% CI	Upper 95% CI	Density	Lower 95% CI	Upper 95% CI
Breeding season	5020 (Yr1); 4449 (Yr2)	3.84 (Yr1); 3.40 (Yr2)	4735	3881	5733	3.62	2.96	4.38
Non-breeding	1081 (Yr1); 1919 (Yr2)	0.83 (Yr1); 0.79 (Yr2)	1500	1110	1987	1.15	0.85	1.52

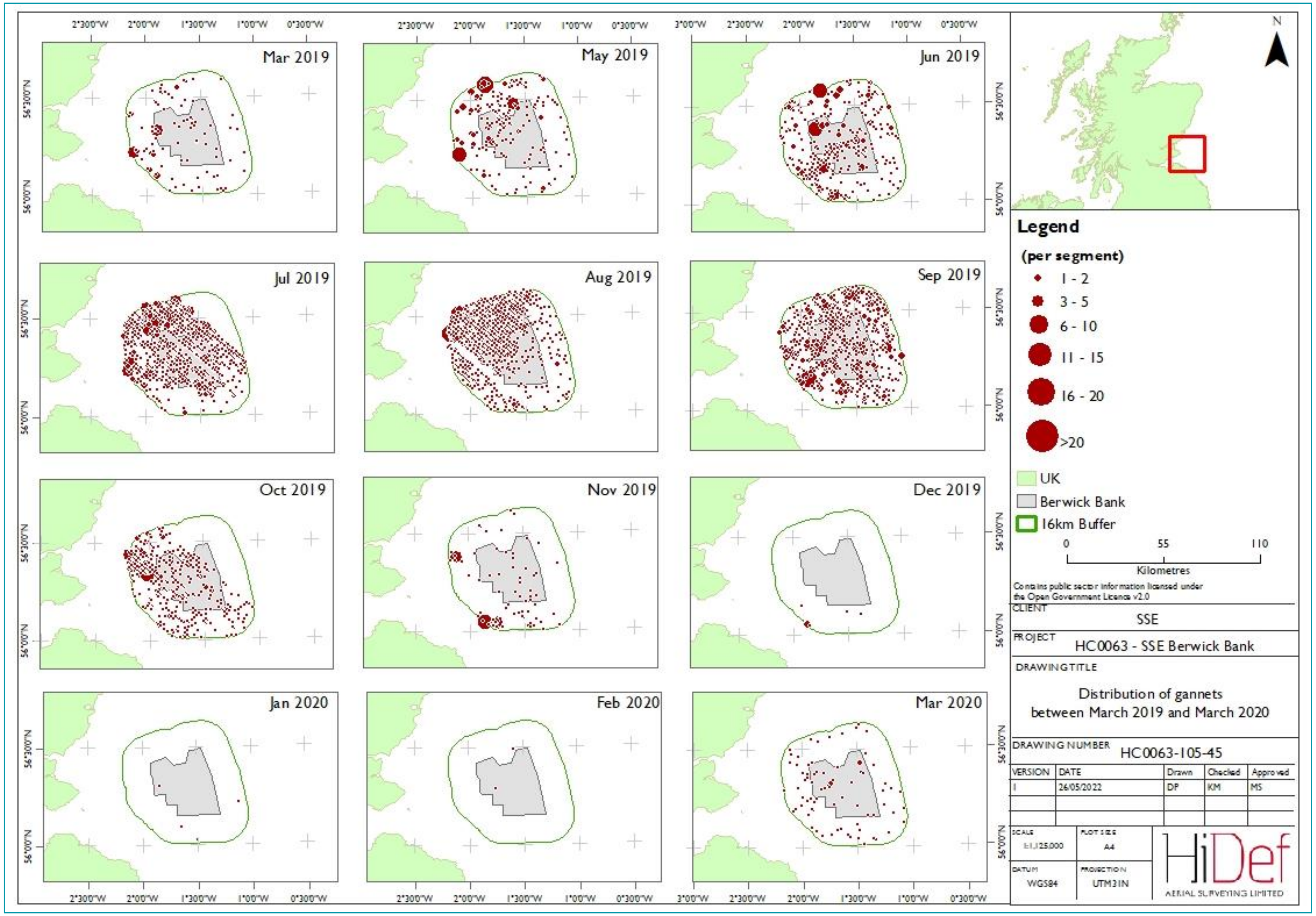


Figure 5.26: Distribution of gannets across the Offshore Ornithology Study Area between March 2019 and March 2020

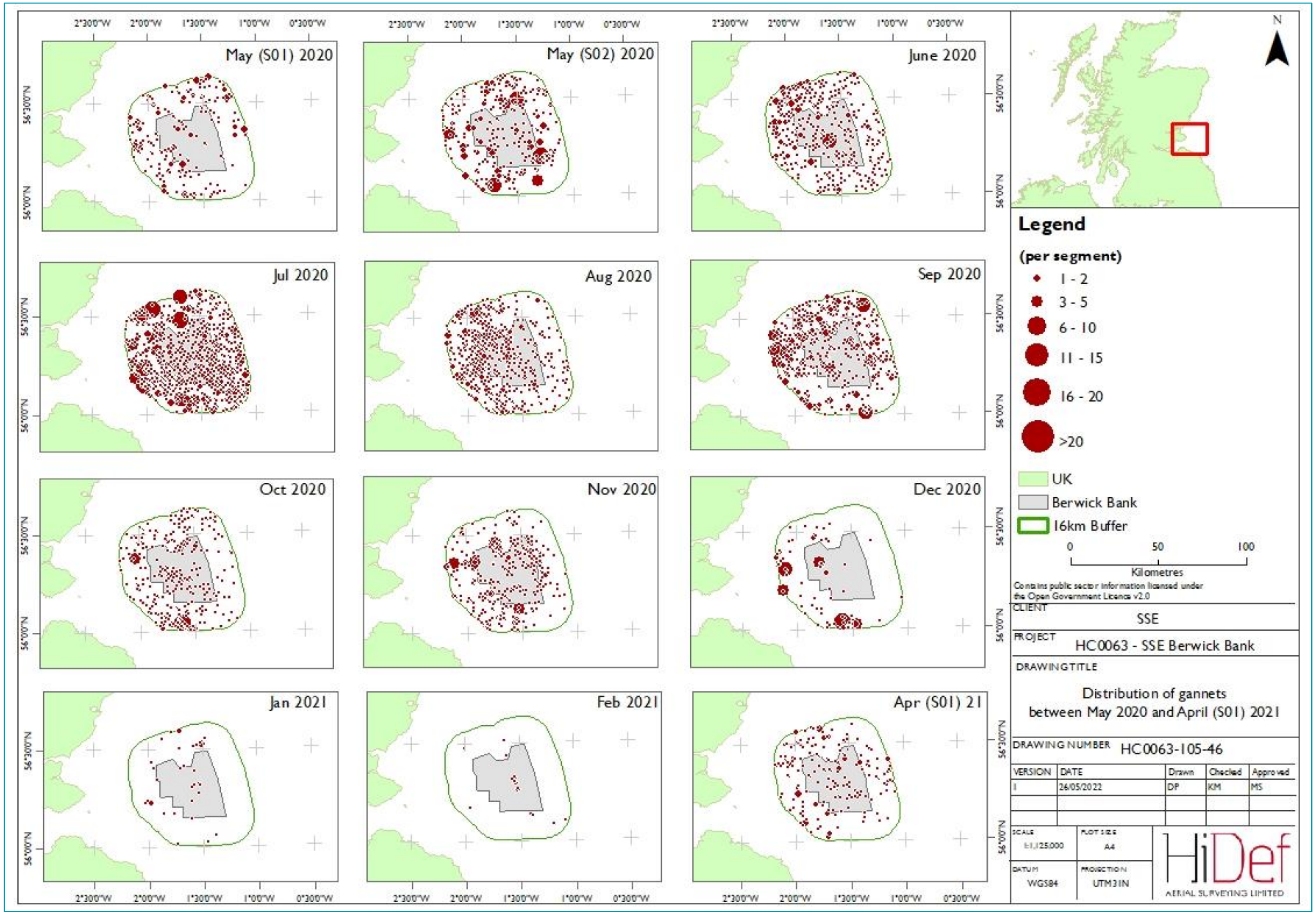


Figure 5.27: Distribution of gannets across the Offshore Ornithology Study Area between May S01 2020 and April S01 2021

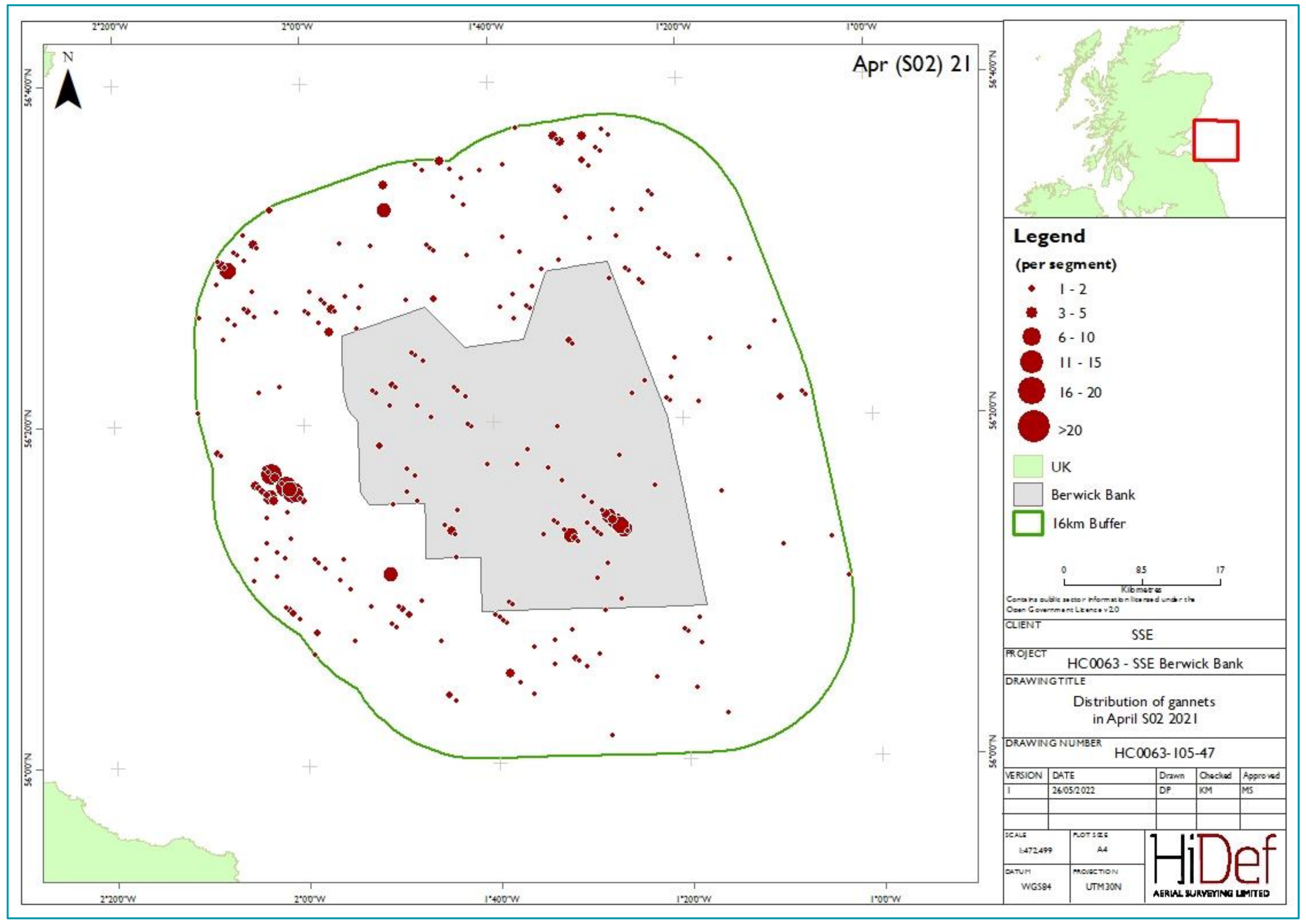


Figure 5.28: Distribution of gannets across the Offshore Ornithology Study Area in April S02 2021

Table 5.33: Mean count, SD and proportion of gannets in each age class averaged across bio-season

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	SD	Prop	Mean	SD	Prop	Mean	SD	Prop	Mean	SD
Breeding season	622	359	0.99	6	8	0.01	1	2	0	407	435
Non-breeding	138	187	0.96	3	4	0.02	3	4	0.02	176	226

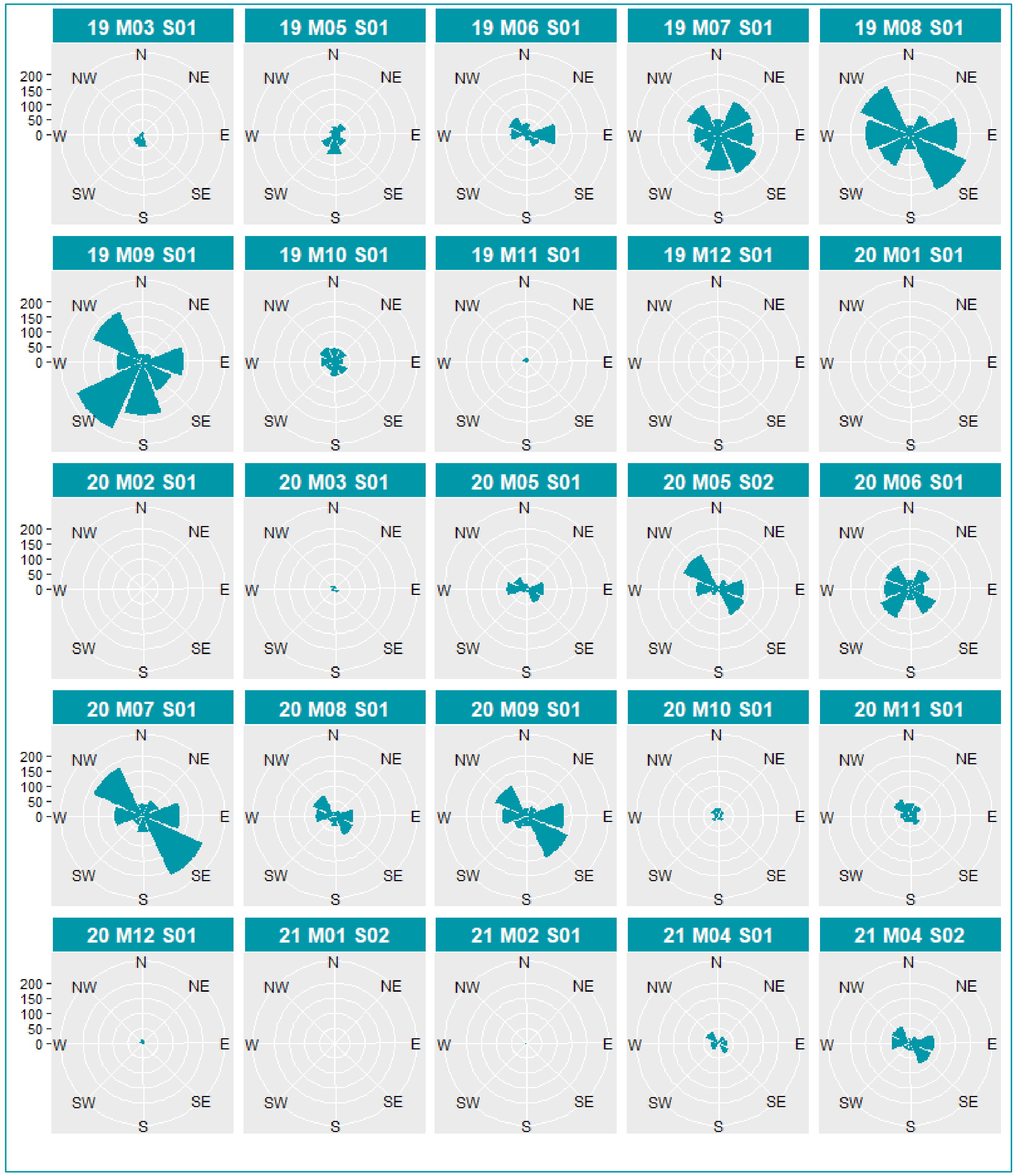


Figure 5.29: Summarised flight direction of gannets across the Offshore Ornithology Study Area

Figure 5.30: Percentage of flying gannets per survey across the Offshore Ornithology Study Area

5.6. COMMON SCOTER

158. Typically present in coastal environments, common scoters spend much of their time at sea in large flocks, migrating inland to freshwater environments to breed, such as those located in Caithness and Sutherland between May and July (del Hoyo *et al*., 1992). Outwith the breeding season, scoters typically utilise shallow marine environments, feeding on various invertebrate, mollusc and gastropod species (Fox, 2003). The species is currently Red-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

159. Common scoters were present in June 2019 (technically in the breeding period) and presumably non-breeding birds were encountered in January 2020 (Table 5.35;Figure 5.31). There are no breeding locations for common scoter within mean max foraging range of Berwick Bank. Estimated densities from design-based analysis were low, with population estimates for the Offshore Ornithology Study Area ranging between 9 birds (95%CI 0 – 28) in January 2020 and 16 birds (95%CI 0 – 48) in June 2019.

160. Within the two surveys in which common scoter were observed in the Offshore Ornithology Study Area, all birds were recorded as flying. In June 2019, all birds flew in a southeast direction while in January 2020 all birds flew north (Figure 5.33). It is likely that the species primarily pass through the Offshore Ornithology Study Area during passage to other areas.

161. Common scoters were detected in similar parts of the Offshore Ornithology Study Area, in the western buffer (Figure 5.32). Since the west of the Offshore Ornithology Study Area is closer to the coast, this distribution is not unexpected.

162. The apparent higher estimates for flying birds compared to all birds (see Table 5.35 and Table 5.36) are simply due to different iterations of the bootstrapping analysis process and rounding.

Table 5.34: Common scoter bio-seasons taken from NatureScot (2020a)

Bio-season	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Non-breeding (blue)												

Table 5.35: Monthly density and population estimates of all common scoter across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Common scoter	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.01	16	0	48	16	101.96%
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.01	9	0	28	9	98.41%
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.36: Monthly density and population estimates of flying common scoter only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Common scoter	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.01	17	0	48	16	97.83%
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.01	9	0	27	8	93.75%
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0

Flying Common scoter	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.37: Monthly density and population estimates of sitting common scoter only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Common scoter	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

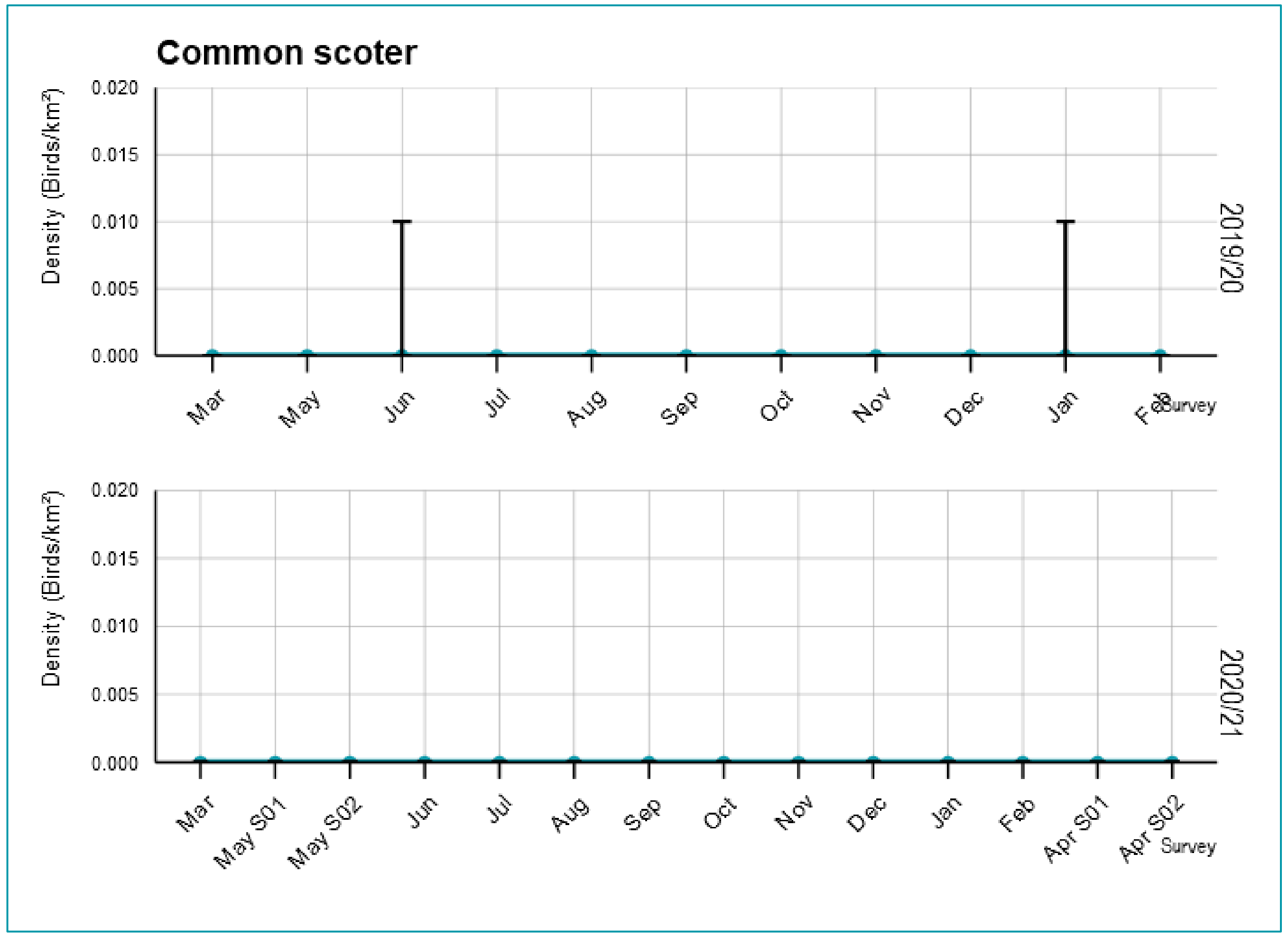


Figure 5.31: Estimated densities (birds/km²) of all common scoter across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

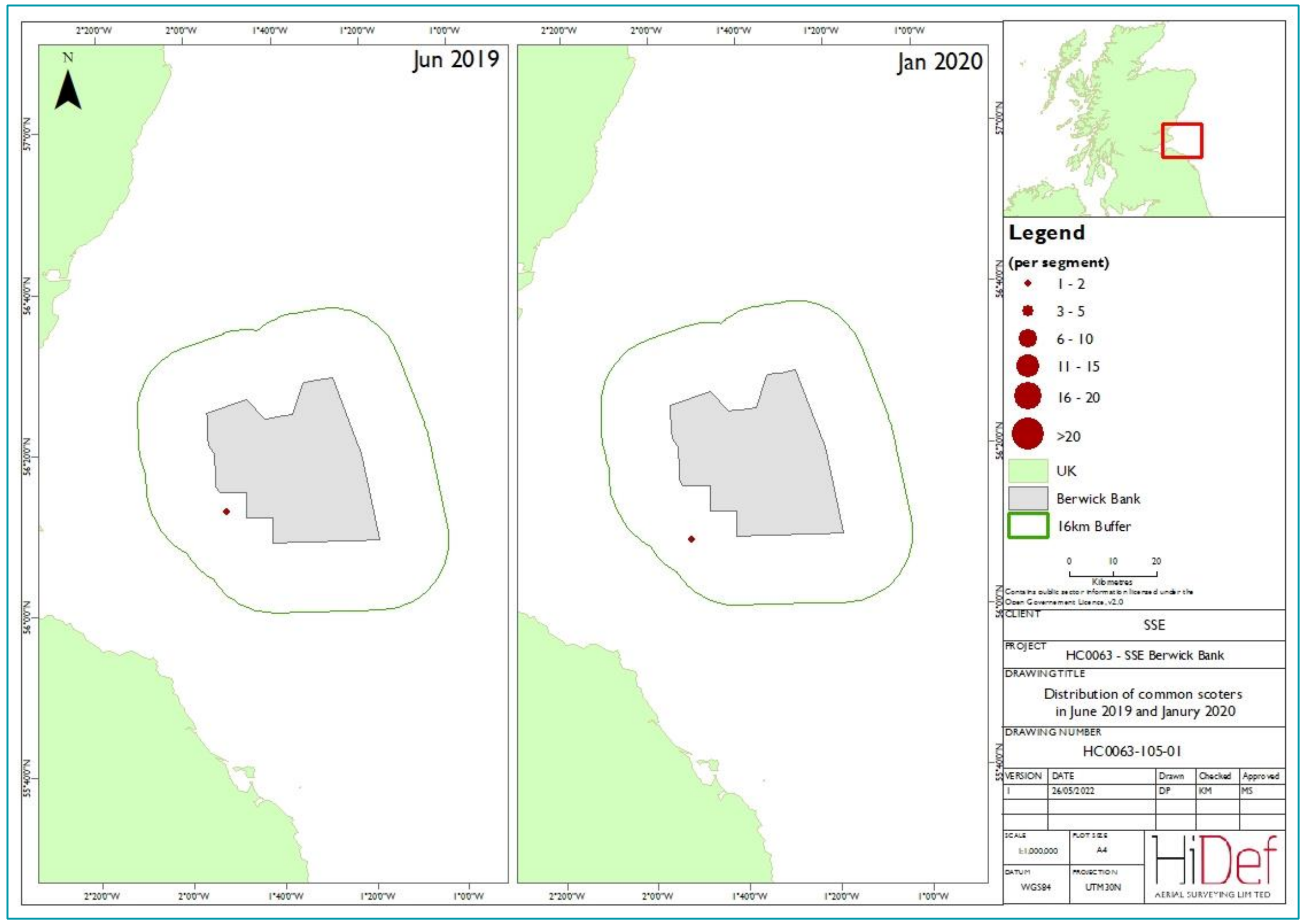


Figure 5.32: Distribution of common scoter across the Offshore Ornithology Study Area in June 2019 and January 2020

Table 5.38: Mean seasonal peak (MSP) population and density (birds/km²) of all common scoter in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

All Birds MSP						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	8	0	24	0	0	0
Non-breeding	5	0	14	0	0	0

Figure 5.33: Summarised flight direction of common scoter across the Offshore Ornithology Study Area

5.7. BLACK-HEADED GULL

163. Black-headed gulls are distributed throughout Scotland, primarily on the east and south-west coasts (Forrester *et al*., 2007). As well as birds arriving from elsewhere in the UK, many black-headed gulls migrate from northern and eastern Europe (Horton et al., 1983). Relatively large flocks of wintering birds have been observed within the Firth of Forth, such as at Skinflats and the Isle of May, located to the west of the survey area (Forrester *et al.,* 2007). The species is currently Amber-listed on the UK Birds of Conservation Concern.

164. Black-headed gulls were uncommon in Offshore Ornithology Study Area, and were only recorded during the non-breeding season (Table 5.40) with a mean seasonal peak population estimated at 9 birds (95%CI 1 – 24) and a density of 0.00 birds/km^2 (Table 5.43).

165. Digital aerial survey data presented here is consistent with existing data from the outer Firth of Forth region which suggests the species is typically present in low numbers in the non-breeding season. Data summed from ESAS surveys conducted between 1980 and 1996 clipped to the Offshore Ornithology Study Area recorded only two black-headed gulls in the 16-year period. In addition, boat-based surveys of Seagreen only recorded one individual.

166. Most black-headed gulls identified within the Offshore Ornithology Study Area were recorded as flying, with mean peak population estimates for the non-breeding season estimated at 8 birds (95%CI 0 – 20) and 2 birds (95%CI 0 – 4) for flying and sitting birds respectively (Table 5.41 and Table 5.42).

167. Black-headed gulls were distributed to the west of the Offshore Ornithology Study Area, in the south and west buffer in September and December 2020 respectively (Figure 5.35).

168. As so few birds were present in the Offshore Ornithology Study Area, it was difficult to draw reliable conclusions regarding flight direction (Figure 5.36)

Table 5.39: Black-headed gull bio-seasons taken from NatureScot (2020a)

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

Table 5.40: Monthly density and population estimates of all black-headed gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Black-headed gull	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.01	9	0	24	8	95.13%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.01	11	1	32	9	77.39%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.41: Monthly density and population estimates of flying black-headed gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Black-headed gull Survey	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	1	0	1	1	97.57%
Nov-19	0.00	0.00	0.00	1	0	1	1	54.42%
Dec-19	0.00	0.00	0.00	6	0	16	5	75.68%
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.01	9	0	24	9	96.93%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.01	9	1	25	8	85.08%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.42: Monthly density and population estimates of sitting black-headed gulls only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Black-headed gull Survey	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	1	0	1	1	64.68%
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	3	0	7	3	102.81%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

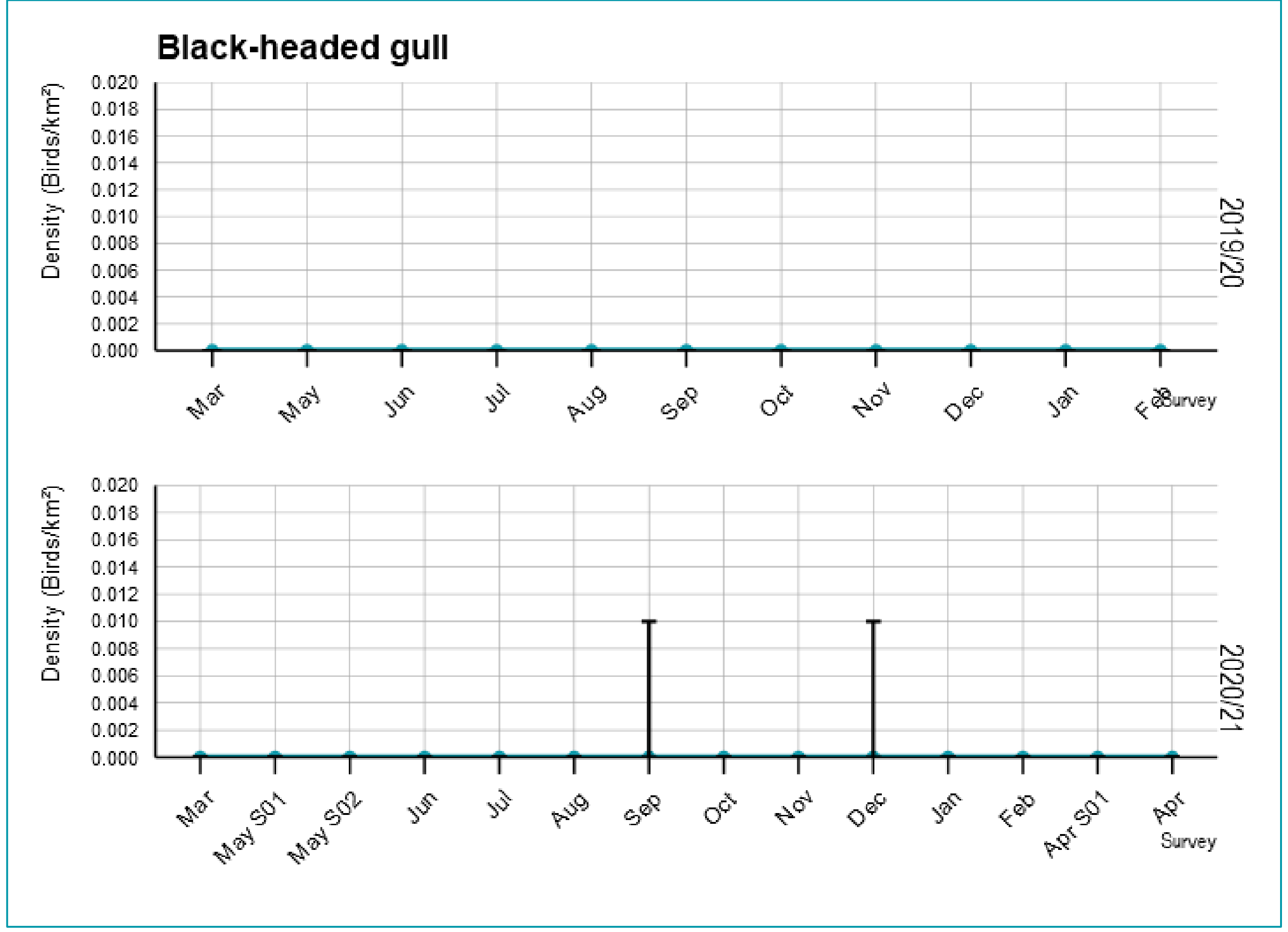


Figure 5.34: Estimated densities (birds/km^2) of all black-headed gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.43: Mean seasonal peak (MSP) population and density (birds/km^2) of all black-headed gulls in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

All Birds MSP						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	0	0	0	0	0	0
Non-breeding	9	1	24	0	0	0

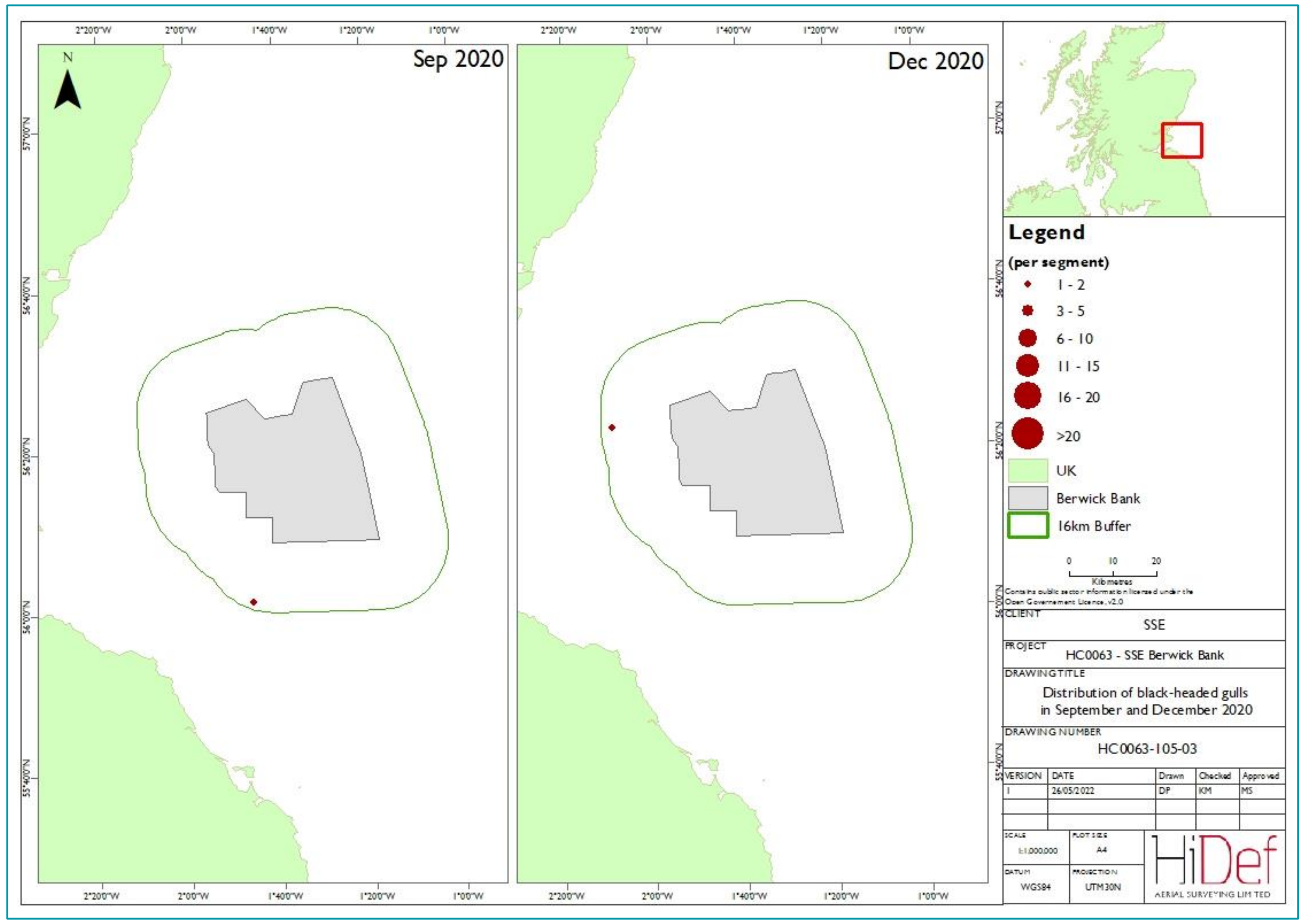


Figure 5.35: Distribution of black-headed gulls across the Offshore Ornithology Study Area in September and December 2020

Table 5.44: Mean count, SD and proportion of black-headed gulls in each age class averaged across bio-season

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	**SD**	**Prop**	**Mean**	**SD**	**Prop**	**Mean**	**SD**	**Prop**	**Mean**	**SD**
Breeding season	0	0	0	0	0	0	0	0	0	0	0
Non-breeding	1	1	0.9	0	0	0	0	0	0.1	0	2

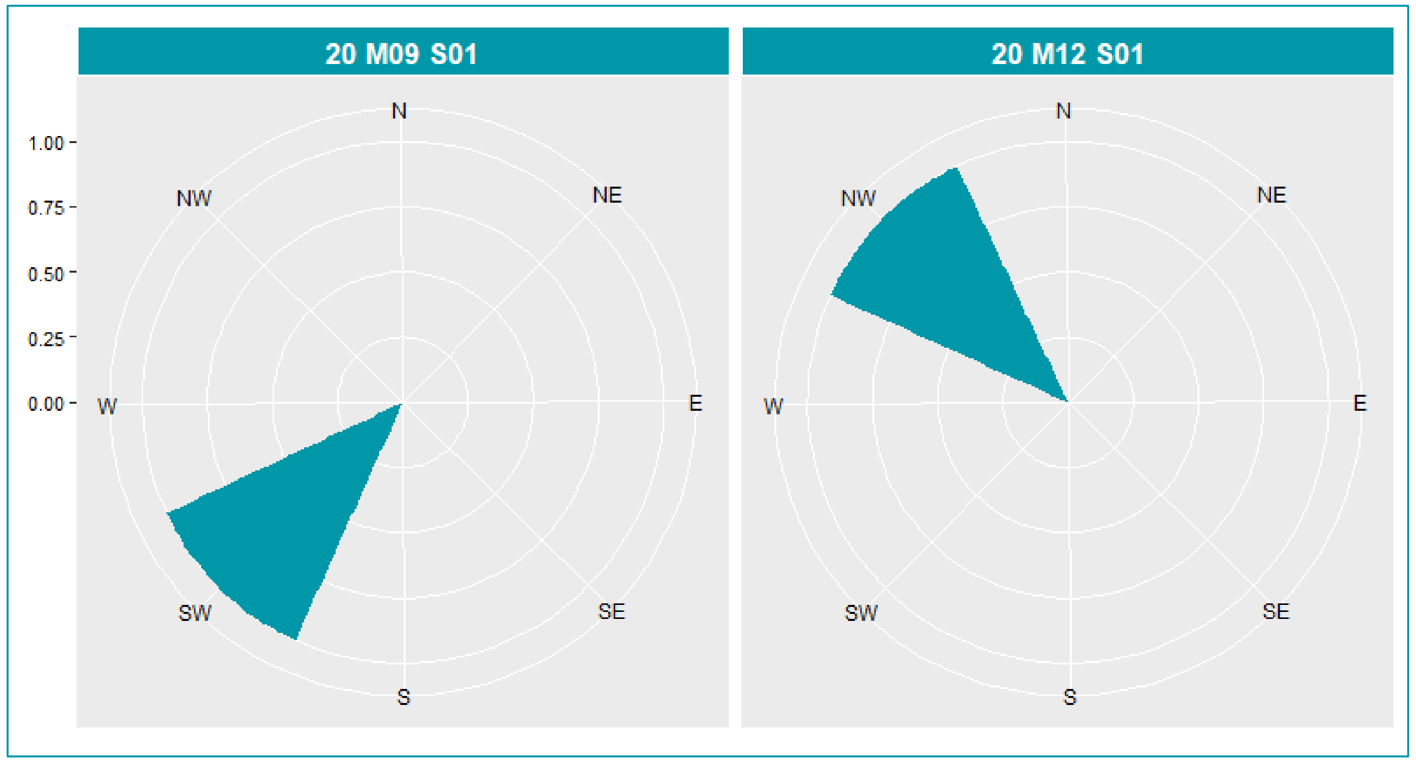


Figure 5.36: Summarised flight direction of black-headed gulls across the Offshore Ornithology Study Area

5.8. LITTLE GULL

169. As passage migrants, little gulls spend part of the year in UK waters as they move between summer and wintering grounds (Stone *et al*., 1995). The smallest gull species in the UK (Dunning, 1992), they generally migrate to UK coastal environments for the non-breeding period (Forrester *et al*., 2007). Post-breeding adult birds usually arrive in Scotland from Europe between late July and August, followed by juvenile birds, observed in the highest concentrations along the Angus and Dundee coast (Forrester *et al*., 2007), which is to the north of the Offshore Ornithology Study Area. A secondary influx generally occurs between October and November, mainly consisting of adult and first-winter birds (Forrester *et al*., 2007). The Outer Firth of Forth and St Andrews Bay Complex SPA, which overlaps the southwest corner of the Offshore Ornithology Study Area, was designated to support non-breeding populations of little gulls among other seabird species, suggesting the presence of suitable habitat within the SPA area.

170. Little gulls were observed in the Offshore Ornithology Study Area during the breeding and non-breeding seasons, with no records between March and June in either Year 1 or Year 2 (Table 5.46). Peak abundances were recorded in August 2019 and 2020 with a lesser peak occurring in both years, in February 2020 and December 2020 respectively. Design-based density estimates ranged between 0.00 birds/km^2 and 0.03 birds/km^2 (95%CI 0.01 – 0.06) in 2019/20 compared to 0.00 birds/km^2 and 0.11 birds/km^2 (95%CI 0.06 – 0.16) in 2020/21.

171. Boat-based surveys of Berwick Bank in 2019-2020 recorded one little gull, present in the June 2021 survey.

172. During the non-breeding season, most birds were recorded as flying, with only 15% of birds recorded as sitting on the water. Feeding strategy adopted by little gulls is variable, with individuals either feeding while inflight, or picking food items from the water's surface (Vittery, 2001). The presence of sitting birds within the Offshore Ornithology Study Area suggests the area may be utilised during foraging.

173. Little gulls were distributed throughout the Offshore Ornithology Study Area. In some months, birds were distributed only in the buffer, such as in July 2019 and September 2020 (Figure 5.38 to Figure 5.40). Many little gulls were recorded within the Proposed Development Array area in August 2020 and April S02 2021. Birds were recorded in the south of the Offshore Ornithology Study Area in September 2020 and January 2021 compared to the northwest in December 2020.

174. No flight direction data were available for this species.

Table 5.45: Little gull bio-seasons taken from NatureScot (2020a)

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

Table 5.46: Monthly density and population estimates of all little gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Little gull	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.01	0.00	0.02	42	12	73	16	37.29%
Aug-19	0.03	0.01	0.06	137	57	222	45	32.34%
Sep-19	0.00	0.00	0.00	1	0	1	1	72.36%
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.01	17	1	52	15	88.51%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.01	18	1	48	15	85.3%
Feb-20	0.01	0.00	0.02	25	0	64	18	69.56%
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.01	0.00	0.02	33	1	99	27	81.02%
Aug-20	0.11	0.06	0.16	420	242	629	100	23.72%
Sep-20	0.01	0.00	0.03	55	8	118	30	54.18%
Oct-20	0.00	0.00	0.01	8	1	24	8	95.91%
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.01	0.00	0.02	41	8	82	20	49.17%
Jan-21	0.01	0.00	0.02	26	1	72	24	92.41%
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.01	0.00	0.02	54	18	97	21	37.63%

Table 5.47: Monthly density and population estimates of flying little gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Little gull	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.01	0.00	0.02	33	9	63	14	41.89%
Aug-19	0.01	0.00	0.03	56	16	105	23	40.86%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.01	8	1	23	7	92.06%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.01	18	1	50	16	89.65%
Feb-20	0.01	0.00	0.02	24	0	71	18	74.86%
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.01	9	0	24	8	92.66%
Aug-20	0.10	0.06	0.15	400	237	601	93	23.09%
Sep-20	0.01	0.00	0.03	49	0	109	28	57.4%
Oct-20	0.00	0.00	0.00	1	0	1	1	69.16%
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.01	0.00	0.02	32	1	72	19	57.82%
Jan-21	0.00	0.00	0.01	8	1	24	8	96.66%
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.48: Monthly density and population estimates of sitting little gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Little gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.01	9	0	26	9	96.36%
Aug-19	0.02	0.00	0.04	79	17	160	36	45.41%
Sep-19	0.00	0.00	0.00	1	0	1	1	70.77%
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.01	10	1	29	8	85.69%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.01	0.00	0.02	24	1	72	24	100.36%
Aug-20	0.00	0.00	0.01	17	0	40	11	63.52%
Sep-20	0.00	0.00	0.01	9	0	24	8	91.2%
Oct-20	0.00	0.00	0.01	9	0	24	9	98.77%
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.01	8	1	25	8	100.81%
Jan-21	0.00	0.00	0.01	18	1	48	16	86.87%
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.01	0.00	0.02	52	19	94	20	38.21%

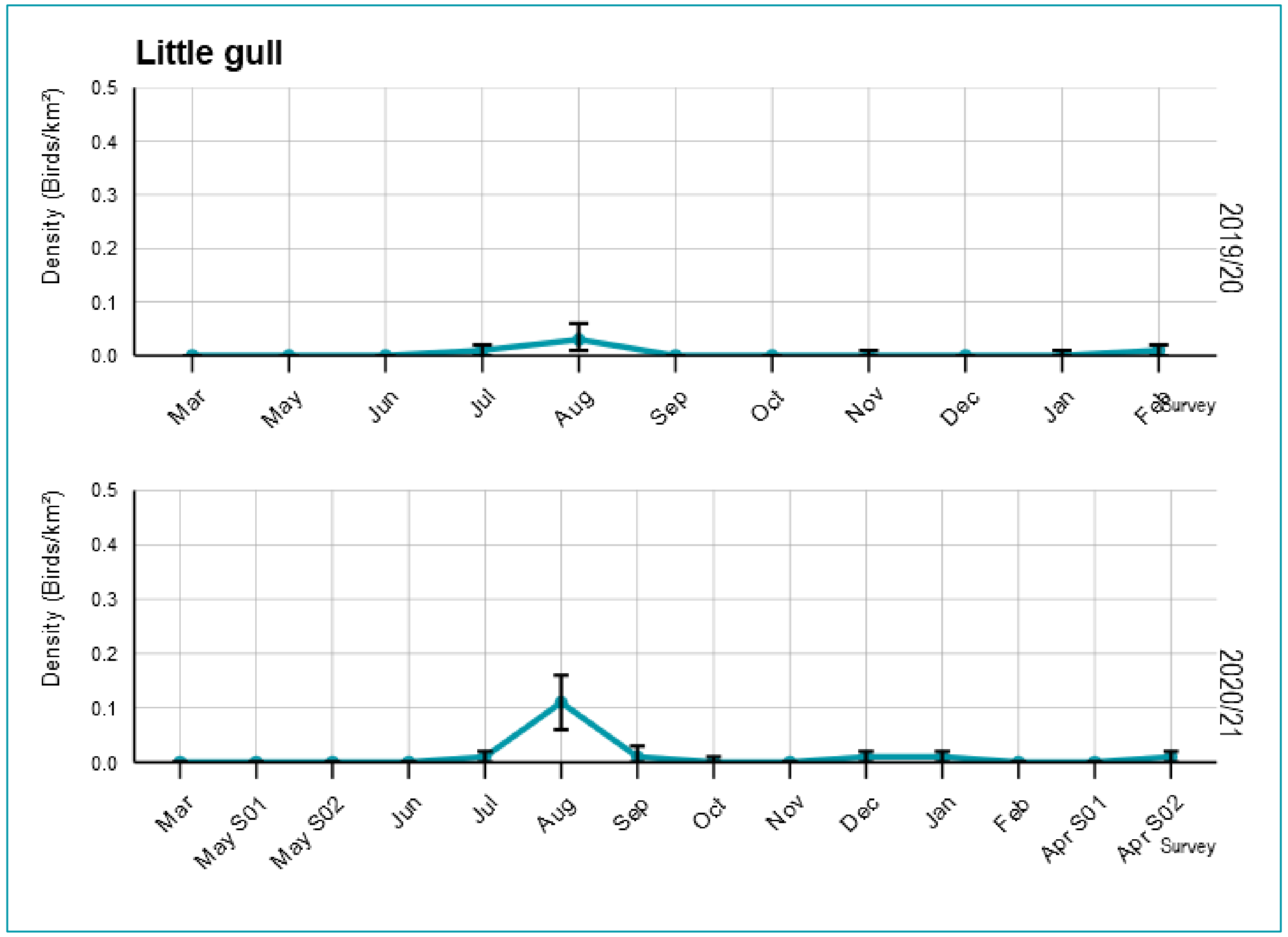


Figure 5.37: Estimated densities (birds/km²) of all little gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.49: Mean seasonal peak (MSP) population and density (birds/km²) of all little gulls in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

All Birds MSP						
Bio-season	Population	Lower 95% CI	Upper 95% CI	Density	Lower 95% CI	Upper 95% CI
Breeding season	44	10	98	0.01	0.00	0.02
Non-breeding	279	150	426	0.07	0.03	0.11

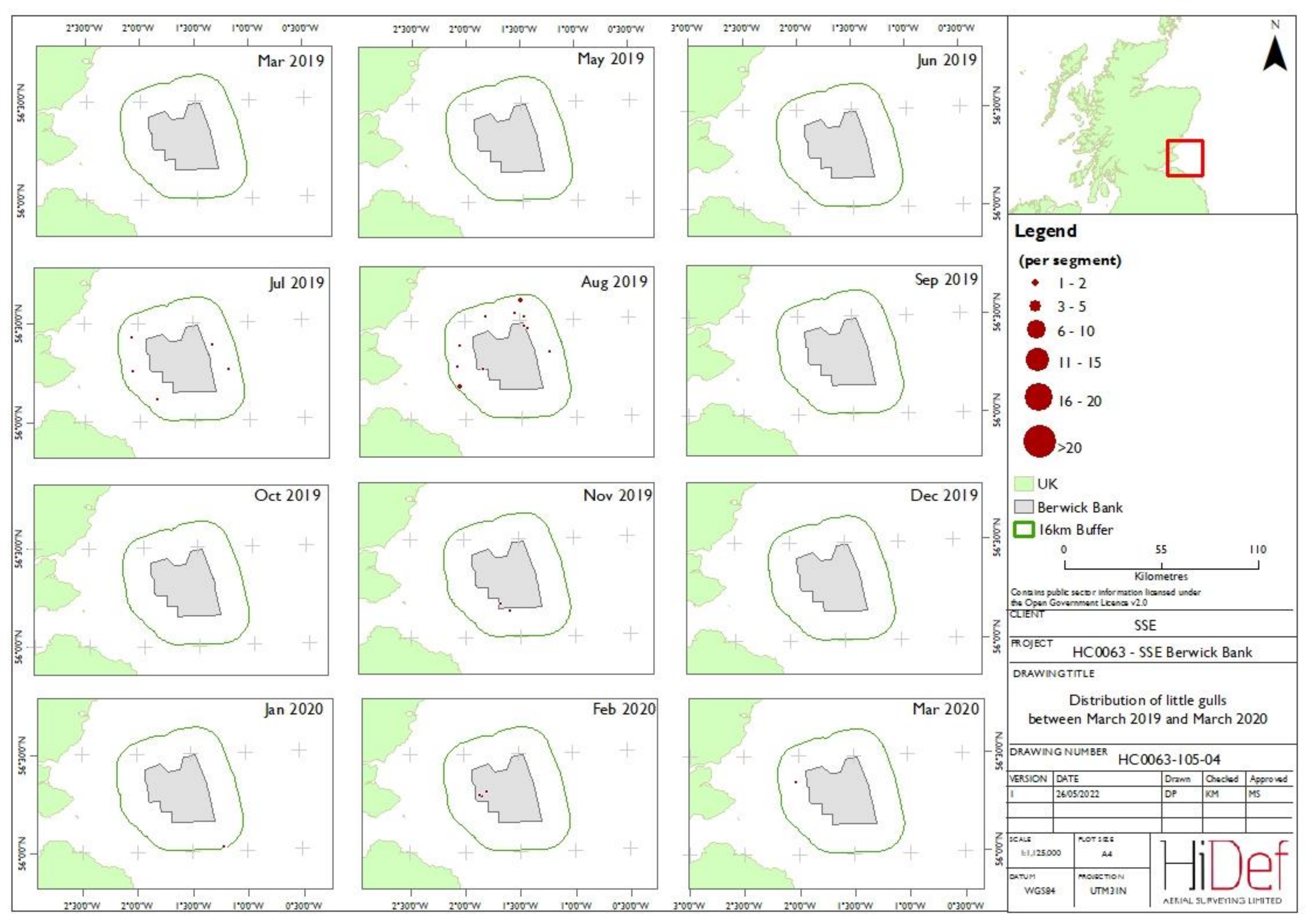


Figure 5.38: Distribution of little gulls across the Offshore Ornithology Study Area between March 2019 and March 2020

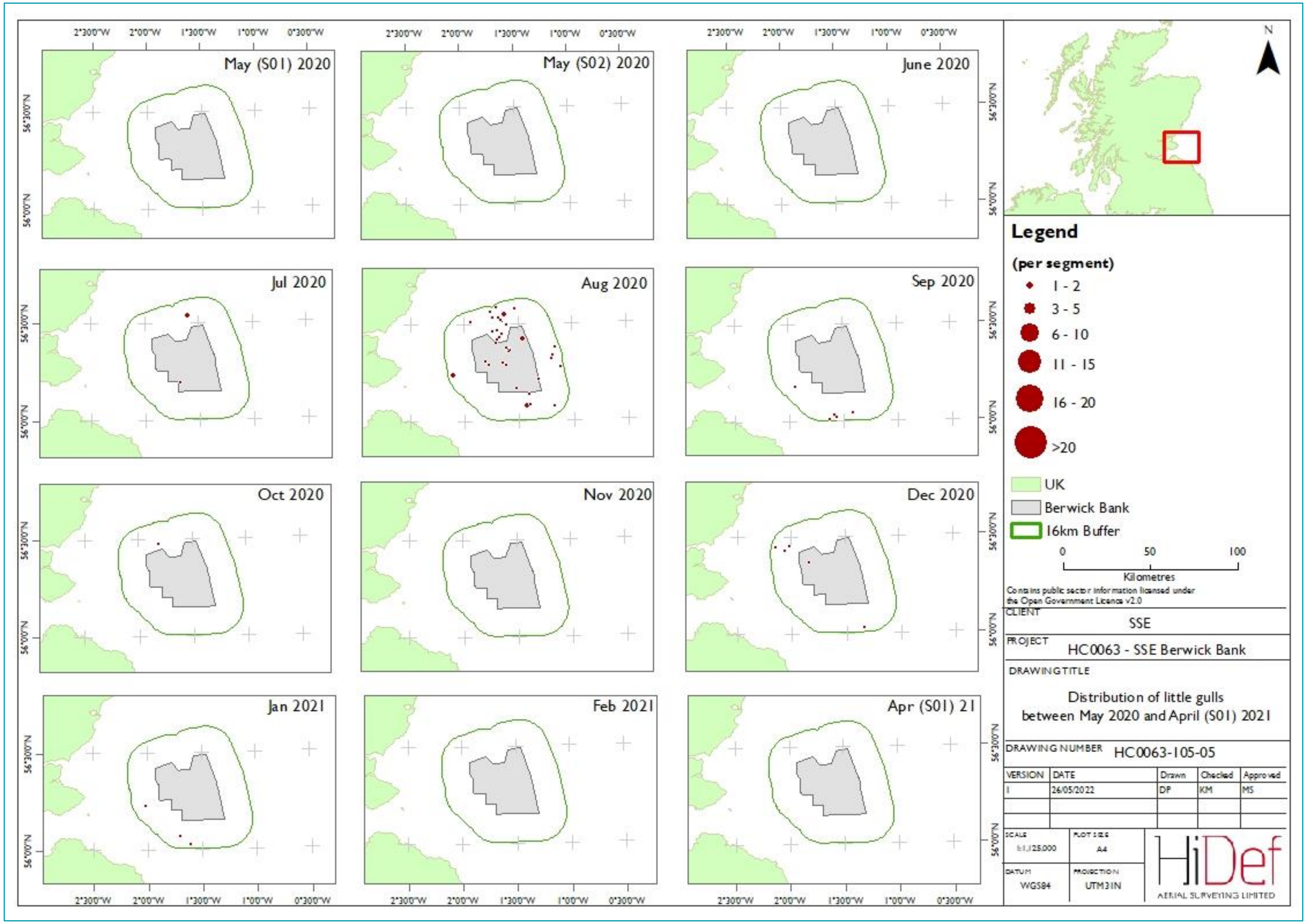


Figure 5.39: **Distribution of little gulls across the Offshore Ornithology Study Area between May S01 2020 and April S01 2021**

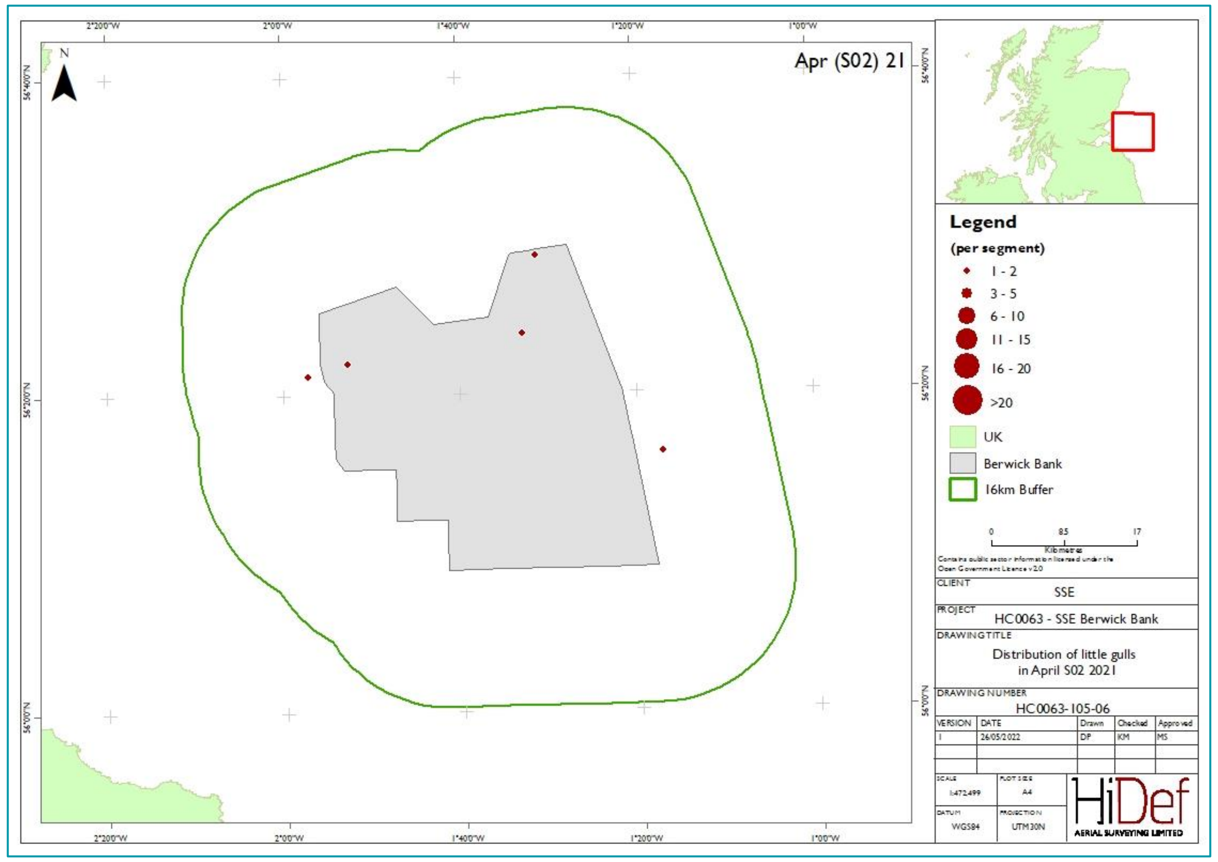


Figure 5.40: Distribution of little gulls across the Offshore Ornithology Study Area in April S02 2021

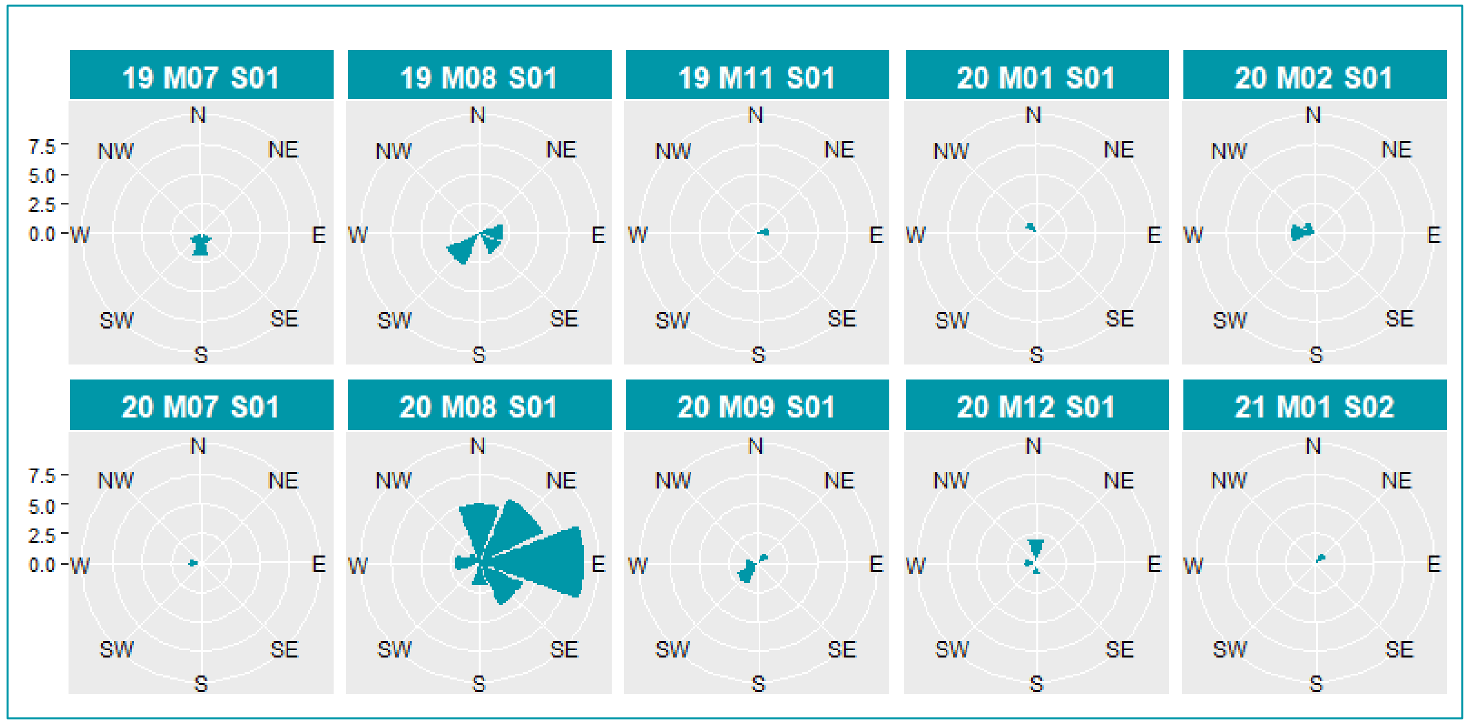


Figure 5.41: Summarised flight direction of little gull across Summarised flight direction of little gulls across

Table 5.50: Mean count, SD and proportion of little gulls in each age class averaged across bio-season

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	SD	Prop	Mean	SD	Prop	Mean	SD	Prop	Mean	SD
Breeding season	0	1	0.75	0	0	0.25	0	0	0	1	2
Non-breeding	2	3	0.59	1	1	0.2	1	2	0.2	3	6

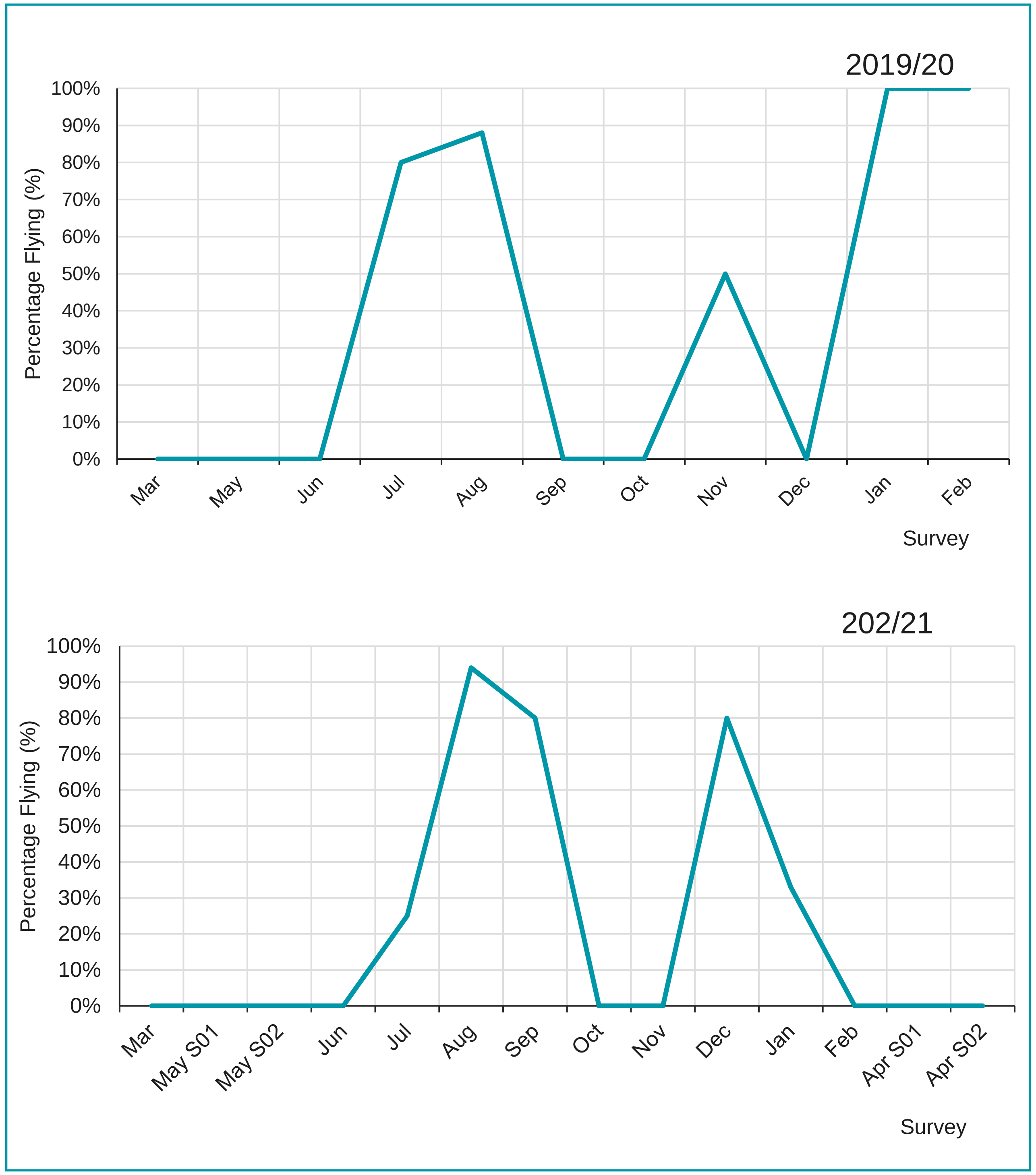


Figure 5.42: Percentage of flying little gulls per survey across the Offshore Ornithology Study Area

5.9. COMMON GULL

175. Common gulls are relatively abundant throughout Europe, with over 50% of the global breeding population concentrated in the northern regions of Europe (Tasker, 1994). Over winter, the UK hosts almost half the European population of common gulls (European Commission, 2009), with many of these birds occurring in Scottish coastal areas (Burton *et al.,* 2013). Generally, lower numbers of common gulls are present during the breeding period, distributed in inland areas (Bukaciński and Bukacińska, 2003). The species is generally long-lived, with recruits starting to breed after 2-5 years (Rattiste, 2006). The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

176. Common gulls were primarily recorded in the Offshore Ornithology Study Area during the non-breeding season in both years, with abundance peaking in December 2020 at 982 birds (95CI 232-1934) (Table 5.52). During the breeding season, abundance peaked in July 2019 and August 2020, equating to design-based population estimates for the Offshore Ornithology Study Area of 33 birds (95%CI 1 – 70) and 180 birds (95%CI 112 – 261) respectively (. Design-based density estimates ranged between 0.00 birds/km^2 and 0.13 birds/km^2 (95%CI 0.05 – 0.22) in 2019/20 compared to 0.00 birds/km^2 and 0.25 birds/km^2 (95%CI 0.06 – 0.49) in 2020/21.

177. Boat-based surveys of Berwick Bank recorded low numbers of common gulls between July and August 2019 and April and June 2020. The species was not highlighted as a key species in any of the other data sources included in the desktop study, with the species expected to be present in low numbers during the non-breeding season.

178. Although some birds were recorded in the Offshore Ornithology Study Area during the breeding season, this only comprised around 16% of the total common gulls recorded during the two-year period. This is to be expected, since the species is known to breed in inland areas such as moorland and heaths, utilising coastal areas during the winter (Tasker *et al*., 1991). Across the entire survey programme, most birds were recorded as flying, with only 23% of birds recorded as sitting on the water. In October 2019 and December 2020 when abundance peaked, 94% and 70% of birds were recorded as flying respectively. The relatively low proportion of birds recorded as sitting on the water suggests that the area is not utilised much during foraging, but instead used during passage to and from wintering areas.

179. Flight direction was variable, with birds recorded flying in easterly and westerly directions in November 2019 and December 2020 (Figure 5.47).

180. Generally, common gulls were distributed to the northwest of the Offshore Ornithology Study Area, with many birds in the western buffer, such as between October and December 2019. Very low abundances were also recorded within the Proposed Development array area. In December 2020, when abundances peaked, many birds were recorded in the northwest and west of the buffer, with a few also present in the south.

Table 5.51: Common gull bio-seasons taken from NatureScot (2020a)

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

Table 5.52: Monthly density and population estimates of all common gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Common gull	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.01	0.00	0.02	31	7	61	15	45.67%
May-19	0.00	0.00	0.01	9	0	25	9	94%
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.01	0.00	0.02	33	1	70	18	52.06%
Aug-19	0.01	0.00	0.01	25	0	55	14	55.19%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.03	0.01	0.07	123	31	266	58	46.92%
Nov-19	0.13	0.05	0.22	507	204	881	169	33.23%
Dec-19	0.08	0.02	0.16	299	97	624	136	45.21%
Jan-20	0.01	0.00	0.02	49	11	96	22	43.57%
Feb-20	0.03	0.01	0.05	125	55	216	41	32.25%
Mar-20	0.00	0.00	0.01	9	1	26	9	104.14%
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.01	8	0	24	8	100.92%
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.01	0.00	0.01	24	1	52	13	53.61%
Aug-20	0.05	0.03	0.07	180	112	261	39	21.32%
Sep-20	0.01	0.00	0.01	26	4	52	14	50.85%
Oct-20	0.00	0.00	0.00	1	0	1	1	59.98%
Nov-20	0.01	0.00	0.01	25	0	55	14	53.44%
Dec-20	0.25	0.06	0.49	982	232	1934	458	46.63%
Jan-21	0.05	0.03	0.07	188	112	264	37	19.47%
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.01	0.00	0.01	25	8	48	13	51.45%
Apr S02 21	0.03	0.01	0.04	111	49	175	32	28.37%

Table 5.53: Monthly density and population estimates of flying common gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Common gull	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.01	20	1	40	11	55.04%
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.01	0.00	0.01	25	0	50	12	48.13%
Aug-19	0.01	0.00	0.01	24	0	50	13	52.49%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.03	0.01	0.06	117	34	231	48	40.63%
Nov-19	0.10	0.04	0.16	386	170	641	121	31.18%
Dec-19	0.05	0.02	0.08	187	76	321	65	34.55%
Jan-20	0.01	0.00	0.02	51	13	98	23	44.09%
Feb-20	0.01	0.00	0.01	25	1	55	14	55.39%
Mar-20	0.00	0.00	0.01	9	1	25	8	95.67%
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.01	8	0	24	9	104.51%
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.01	17	0	40	12	69.71%
Aug-20	0.04	0.03	0.06	172	103	242	38	21.75%
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	1	0	1	1	66.66%
Nov-20	0.01	0.00	0.01	25	0	55	14	54.6%
Dec-20	0.17	0.05	0.34	683	186	1343	292	42.77%
Jan-21	0.04	0.03	0.06	170	105	237	35	20.24%
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.01	9	0	32	9	97.96%
Apr S02 21	0.02	0.01	0.04	98	40	162	31	31.21%

Table 5.54: Monthly density and population estimates of sitting common gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Common gull	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.01	12	0	38	12	99.6%
May-19	0.00	0.00	0.01	9	0	32	9	97.6%
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.01	9	0	28	9	92.19%
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.01	8	0	25	8	92.28%
Nov-19	0.03	0.01	0.06	125	33	250	60	47.86%
Dec-19	0.03	0.00	0.08	117	3	300	84	71.4%
Jan-20	0.00	0.00	0.00	1	0	1	1	60.55%
Feb-20	0.03	0.01	0.05	103	38	191	42	40.4%
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.01	9	0	25	9	95.37%
Aug-20	0.00	0.00	0.01	8	0	24	8	94.56%
Sep-20	0.01	0.00	0.01	25	1	56	14	54.52%
Oct-20	0.00	0.00	0.00	1	0	1	1	68.28%
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.08	0.00	0.20	315	18	813	211	66.9%
Jan-21	0.00	0.00	0.01	16	1	40	12	72.65%
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.01	16	1	40	11	64.6%
Apr S02 21	0.00	0.00	0.01	16	1	40	11	66.91%

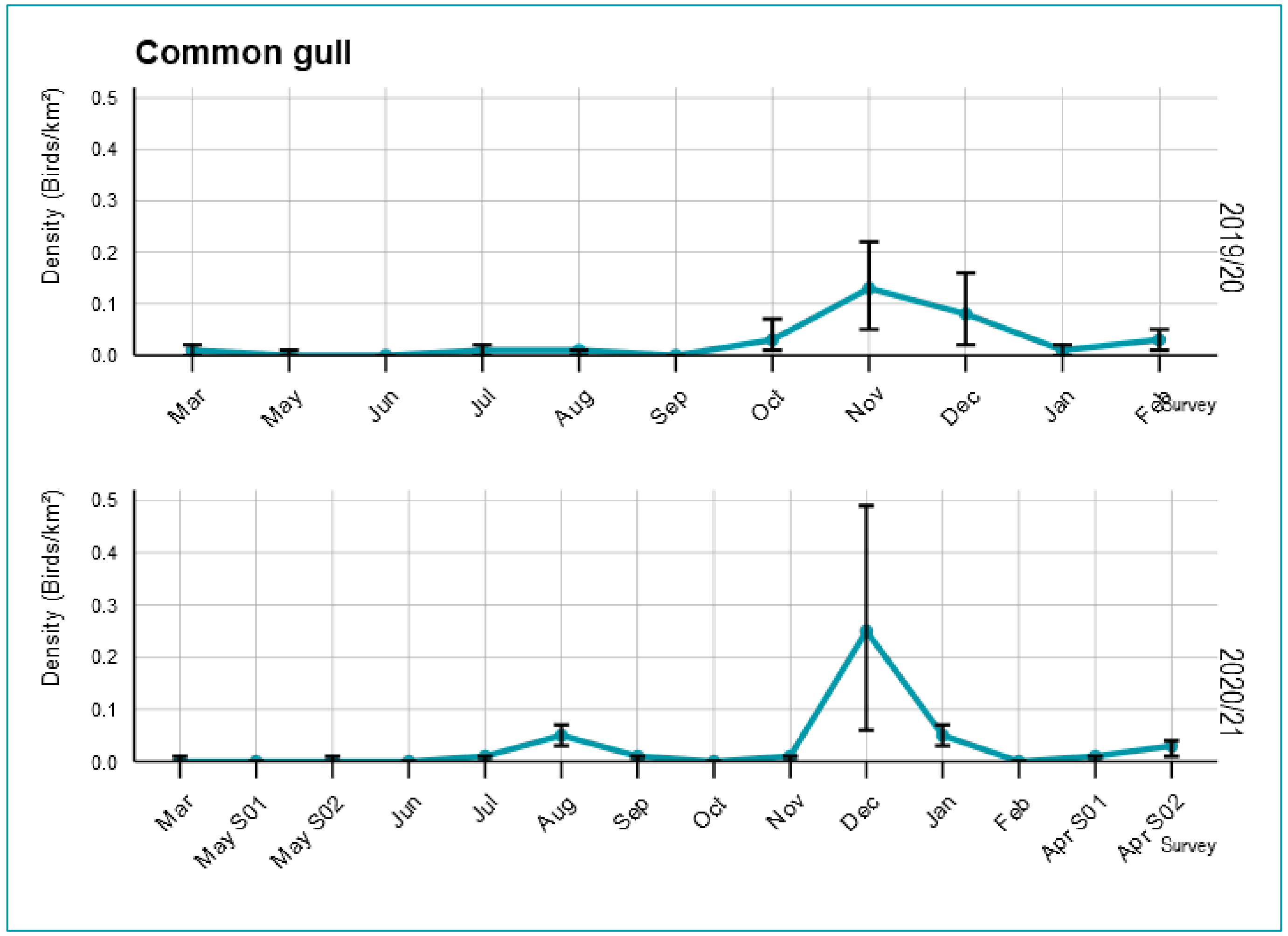


Figure 5.43: **Estimated densities (birds/km²) of all common gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species**

Table 5.55: **Mean seasonal peak (MSP) population and density (birds/km²) of all common gulls in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species**

All Birds MSP						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	146	81	218	0.04	0.02	0.06
Non-breeding	745	218	1408	0.19	0.06	0.36

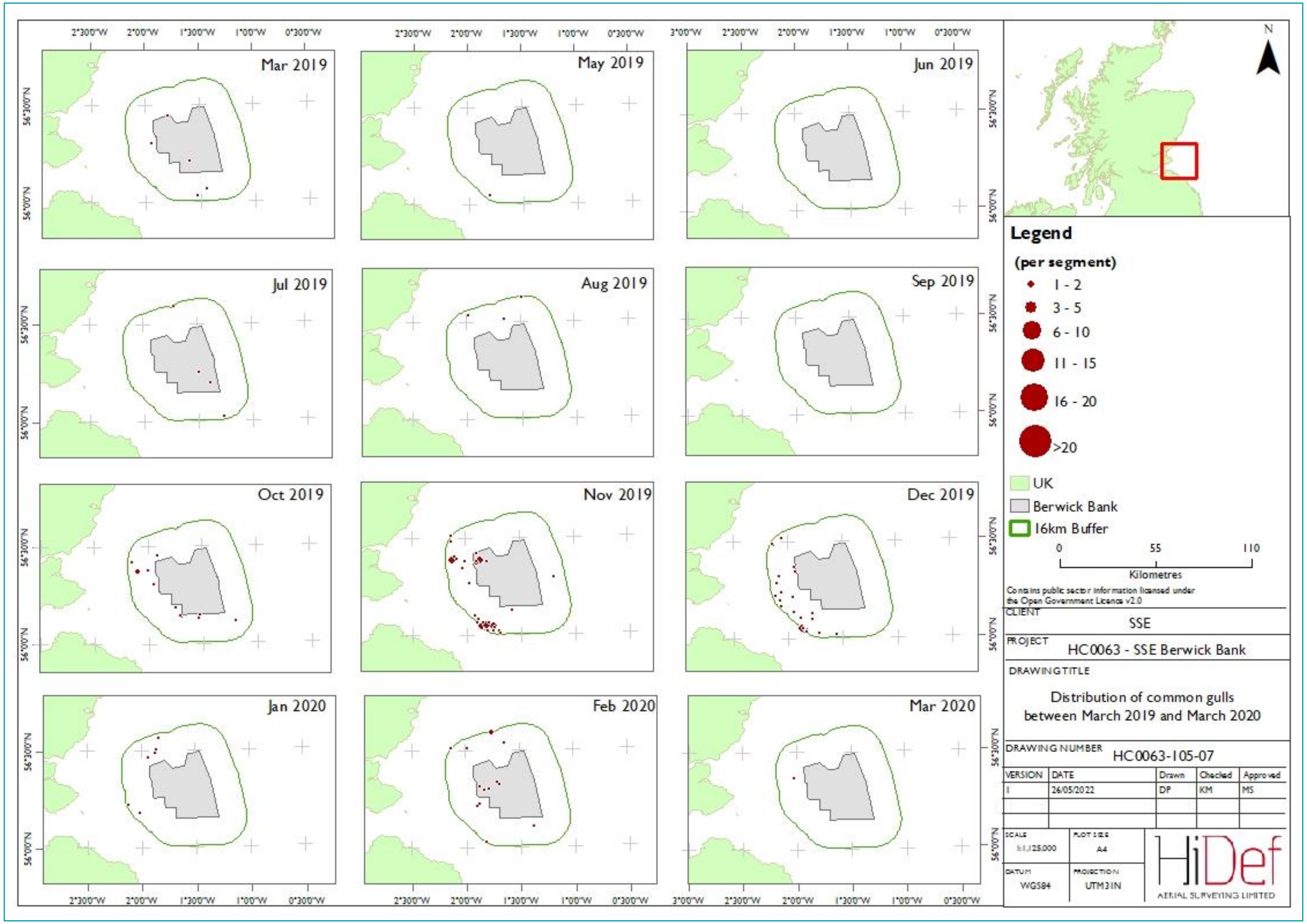


Figure 5.44: Distribution of common gulls across the Offshore Ornithology Study Area between March 2019 and March 2020

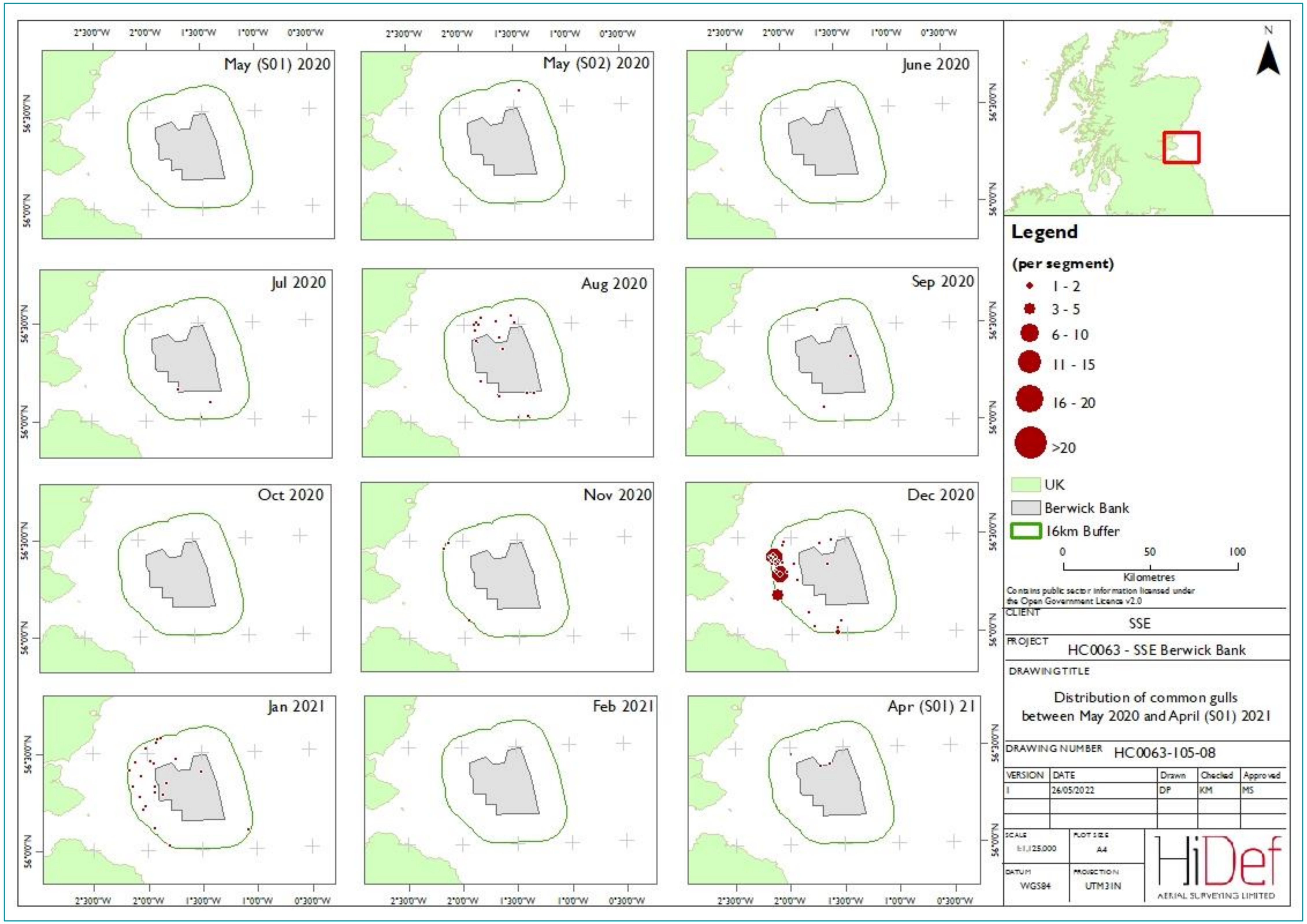


Figure 5.45: Distribution of common gulls across the Offshore Ornithology Study Area between May S01 2020 and April S01 2021

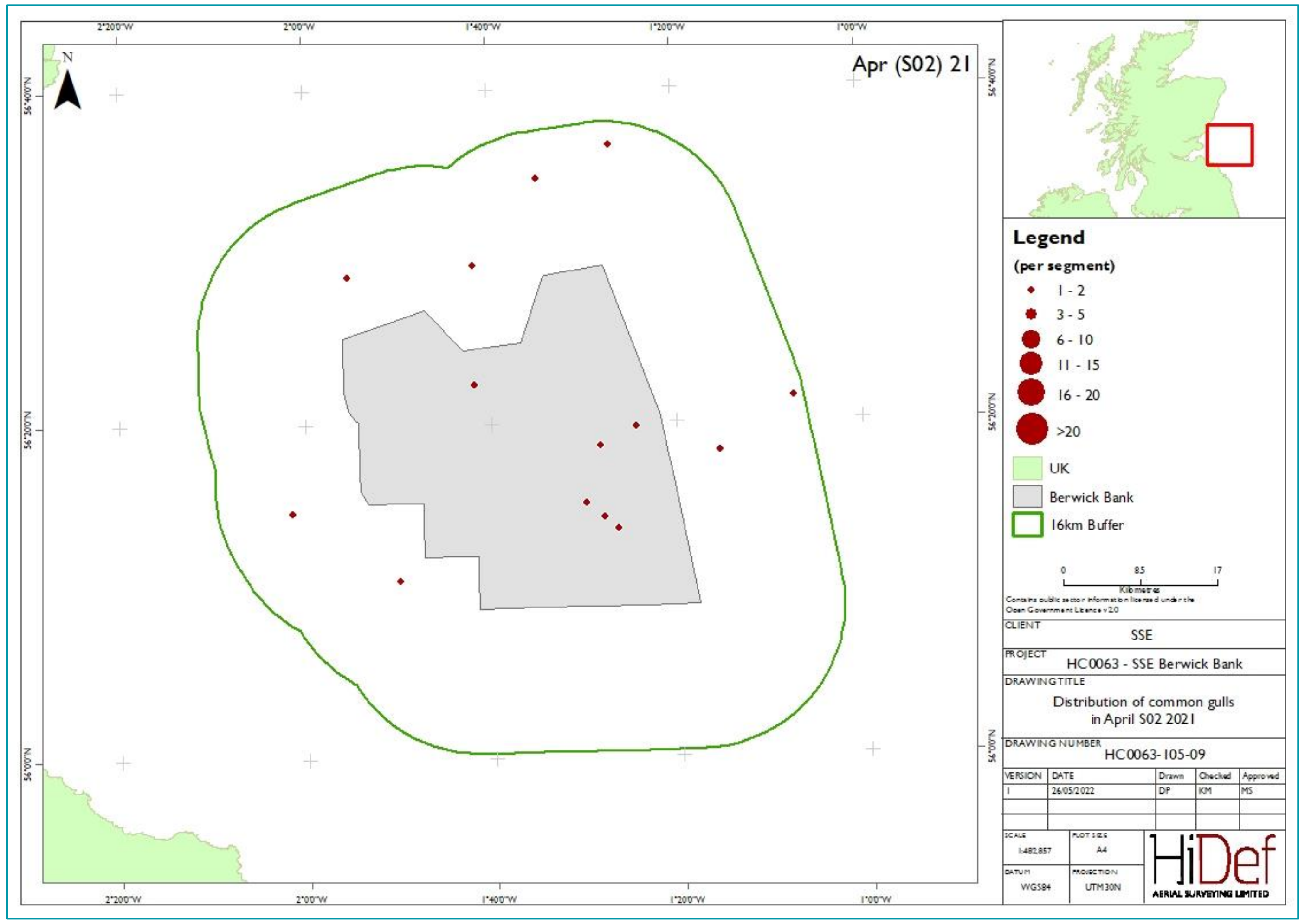


Figure 5.46: Distribution of common gulls across the Offshore Ornithology Study Area April S02 2021

Table 5.56: Mean count, SD and proportion of common gulls in each age class averaged across bio-season

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	SD	Prop	Mean	SD	Prop	Mean	SD	Prop	Mean	SD
Breeding season	4	7	0.98	0	0	0.02	0	0	0	2	2
Non-breeding	22	39	0.82	4	6	0.13	1	4	0.05	13	20

Figure 5.47: Summarised flight direction of common gulls across the Offshore Ornithology Study Area

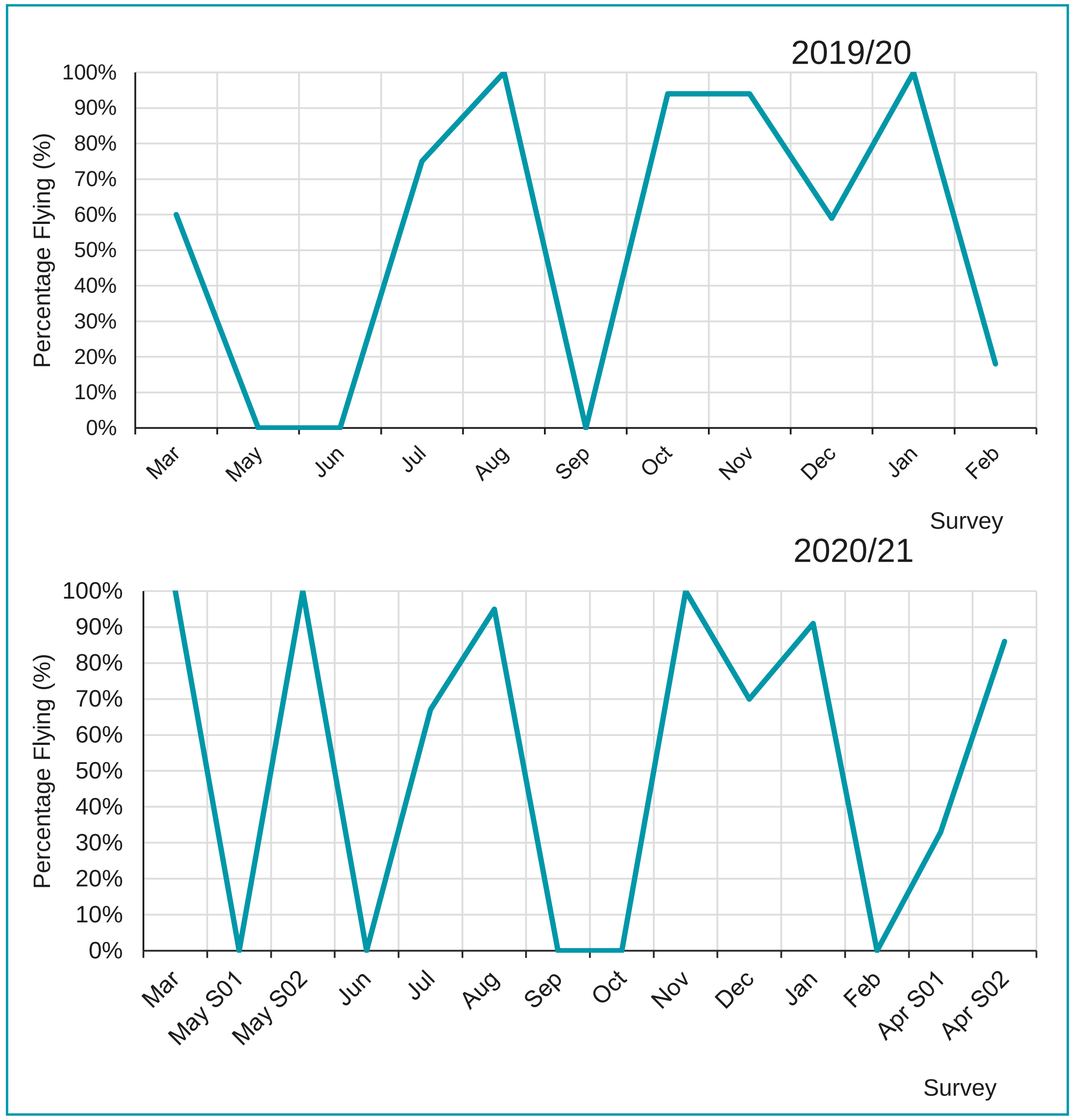


Figure 5.48: Percentage of flying common gulls per survey across the Offshore Ornithology Study Area

5.10. HERRING GULL

181. The Firth of Forth is known to support one of the largest coastal roosting populations of herring gulls in Scotland (NatureScot, 2020b). Many wintering herring gulls present along the east coast of Scotland are migrants from further afield, such as Norway and north Russia, boosting local populations between September and February (Wernham *et al*., 2002; Furness, 2015). Generally, the species uses inshore areas primarily for roosting, although foraging in intertidal areas is also likely to occur (Rome and Ellis, 2004). The species is currently Red-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

182. Herring gulls were the most abundant large gull species in the Offshore Ornithology Study Area during the survey period, present in relatively moderate densities from mid to late summer and again in winter. Few birds were present throughout the rest of the year. This pattern occurred in both years of surveys, with an overall greater abundance of birds in the second year. Design-based density estimates ranged between 0.00 birds/km^2 (95%CI 0.00 – 0.01) and 0.51 birds/km^2 (95%CI 0.34 – 0.73) in 2019/20 compared to 0.00 birds/km^2 (95%CI 0.00 – 0.01) and 1.28 birds/km^2 (95%CI 0.39 – 2.29) in 2020/21 (

183. Table 5.58). Mean-peak population estimates were similar in the non-breeding season, calculated at 3,382 birds (95%CI 957 – 6,294), compared to 3,356 (95%CI 2,246 – 4,733) birds in the breeding season (Table 5.61).

184. Boat-based surveys of Seagreen Alpha and Bravo recorded herring gulls within both sites in regionally important numbers in the breeding season, likely to be linked to nearby SPAs. Taking into account urban nesting birds[1]as well as those within SPAs, the total count of herring gulls within the foraging range (mean max distance +1 sd from Woodward et al. 2019) of the Project approximates the regional population and is estimated at 29,600 breeding adults. Generally, herring gulls were distributed to the west of the Offshore Ornithology Study Area with many birds distributed in the western buffer (e.g., November 2019 and December 2020), and in the northwest buffer, such as in July and August 2019. Generally, fewer birds were observed within the Project, except for June and July 2019 and July 2020.

185. Habitat use varied between seasons, with most birds recorded as sitting on the water during the breeding season, while during the non-breeding season the proportion of sitting and flying birds was relatively similar. Peaks in proportions of flying birds fluctuated within bio-seasons, such as the marked increase of flying birds between September and November 2020 (Figure 5.54). Herring gulls generally feed by making shallow dives from the surface of the water, and the high proportion of sitting birds during the breeding season suggests the use of the Offshore Ornithology Study Area during foraging. The increased proportion of flying birds during the non-breeding period may be explained by the passage of migrant birds from further afield or the movement of successful breeders away from the colony to other areas (Furness, 2015).

186. Of the birds that could be aged, most were recorded as adults. The highest average proportions of immature and juvenile birds occurred in the non-breeding season, at 32% and 2% respectively. The presence of more immature birds may be explained by increased movement of this life history stage compared to other demographics, since younger birds are known to disperse across larger distances compared to adults which generally remain closer to colonies (Wernham *et al*., 2002).

187. Flight direction varied between surveys, with many birds flying northwest and southeast in July 2020. In December 2020, when abundance of herring gulls peaked, birds flew in all directions, but a large proportion were recorded flying southwards. This may be attributed to movement to colonies to the south of the Offshore Ornithology Study Area such as those located at St. Abb's Head, which currently supports approximately 172 AON's (SMP, 2021).

[1] The proportion of urban gulls (roof nesting) was compared to the total population in Scotland from Seabird 2000. This resulted in a correction of 8% that was used to correct the total count of birds at SPAs. Information accessed from: Review of Urban Gulls and their Management in Scotland (www.gov.scot)

Table 5.57: Herring gull bio-seasons taken from NatureScot (2020a)

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

Table 5.58: Monthly density and population estimates of all herring gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Herring gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.01	19	0	39	10	52.95%
May-19	0.00	0.00	0.01	17	0	48	17	99.13%
Jun-19	0.51	0.34	0.73	2036	1344	2912	396	19.43%
Jul-19	0.23	0.17	0.31	910	657	1219	140	15.36%
Aug-19	0.22	0.12	0.34	876	472	1343	233	26.58%
Sep-19	0.00	0.00	0.01	8	0	28	9	105.49%
Oct-19	0.00	0.00	0.01	7	0	23	7	98.26%
Nov-19	0.42	0.09	0.87	1685	350	3464	840	49.85%
Dec-19	0.16	0.01	0.42	645	52	1672	460	71.26%
Jan-20	0.02	0.00	0.04	63	13	145	35	55.28%
Feb-20	0.01	0.00	0.02	35	10	71	15	42.77%
Mar-20	0.00	0.00	0.01	9	0	25	9	95.52%
May S01 20	0.00	0.00	0.01	14	0	36	10	70.53%
May S02 20	0.00	0.00	0.01	8	0	24	8	101.09%
Jun-20	0.05	0.01	0.10	200	56	398	90	44.86%
Jul-20	1.18	0.79	1.65	4675	3147	6553	862	18.43%
Aug-20	0.18	0.09	0.29	733	362	1168	212	28.86%
Sep-20	0.06	0.03	0.09	243	127	367	64	26.33%
Oct-20	0.01	0.00	0.01	25	1	50	13	52.02%
Nov-20	0.02	0.00	0.05	88	20	182	42	47.95%
Dec-20	1.28	0.39	2.29	5078	1563	9123	1998	39.34%
Jan-21	0.15	0.07	0.29	609	274	1148	236	38.66%
Feb-21	0.01	0.00	0.03	50	8	107	27	53.19%
Apr S01 21	0.00	0.00	0.01	19	0	40	11	57.82%
Apr S02 21	0.02	0.00	0.03	64	16	128	29	45.09%

Table 5.59: Monthly density and population estimates of flying herring gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Herring gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.01	19	0	39	10	50.88%
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.17	0.13	0.22	674	509	866	93	13.7%
Jul-19	0.10	0.07	0.14	396	285	540	66	16.46%
Aug-19	0.14	0.07	0.21	539	278	839	147	27.13%
Sep-19	0.00	0.00	0.01	9	0	24	9	95.59%
Oct-19	0.00	0.00	0.01	8	0	28	8	98.09%
Nov-19	0.21	0.04	0.40	834	164	1582	378	45.24%
Dec-19	0.06	0.01	0.15	245	34	606	155	63.17%
Jan-20	0.00	0.00	0.01	8	0	26	9	104.45%
Feb-20	0.00	0.00	0.01	8	0	24	8	98.31%
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.03	0.01	0.05	116	32	217	46	39.84%
Jul-20	0.29	0.20	0.37	1159	809	1485	176	15.12%
Aug-20	0.10	0.04	0.17	399	164	692	141	35.34%
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.01	9	0	25	8	93.23%
Nov-20	0.02	0.00	0.04	64	0	159	41	63.65%
Dec-20	0.83	0.27	1.66	3287	1083	6594	1454	44.22%
Jan-21	0.07	0.04	0.10	289	176	412	63	21.76%
Feb-21	0.00	0.00	0.01	8	0	24	8	102.38%
Apr S01 21	0.00	0.00	0.01	8	0	24	8	96.92%
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.60: Monthly density and population estimates of sitting herring gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Herring gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.02	17	0	62	17	95.76%
Jun-19	0.33	0.18	0.50	1305	723	1993	338	25.89%
Jul-19	0.13	0.08	0.19	521	323	747	111	21.17%
Aug-19	0.08	0.02	0.17	311	82	680	166	53.42%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.20	0.03	0.50	810	129	1980	541	66.81%
Dec-19	0.10	0.00	0.30	413	19	1189	348	84.21%
Jan-20	0.01	0.00	0.03	58	9	130	36	61.34%
Feb-20	0.01	0.00	0.01	27	6	52	13	48.9%
Mar-20	0.00	0.00	0.01	9	0	25	8	96.66%
May S01 20	0.00	0.00	0.01	15	0	37	11	68.54%
May S02 20	0.00	0.00	0.01	9	0	32	9	95.52%
Jun-20	0.02	0.00	0.05	90	8	212	56	62.02%
Jul-20	0.87	0.53	1.24	3449	2103	4932	737	21.34%
Aug-20	0.09	0.04	0.14	346	161	569	103	29.64%
Sep-20	0.06	0.03	0.09	237	130	374	64	27%
Oct-20	0.00	0.00	0.01	16	0	40	11	69.27%
Nov-20	0.01	0.00	0.01	25	0	55	14	54.17%
Dec-20	0.49	0.03	1.20	1930	102	4789	1218	63.12%
Jan-21	0.08	0.01	0.20	331	55	815	243	73.35%
Feb-21	0.01	0.00	0.02	42	4	93	25	58.81%

Sitting Herring gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Apr S01 21	0.00	0.00	0.01	11	0	27	8	71.96%
Apr S02 21	0.02	0.00	0.03	65	14	130	30	45.76%

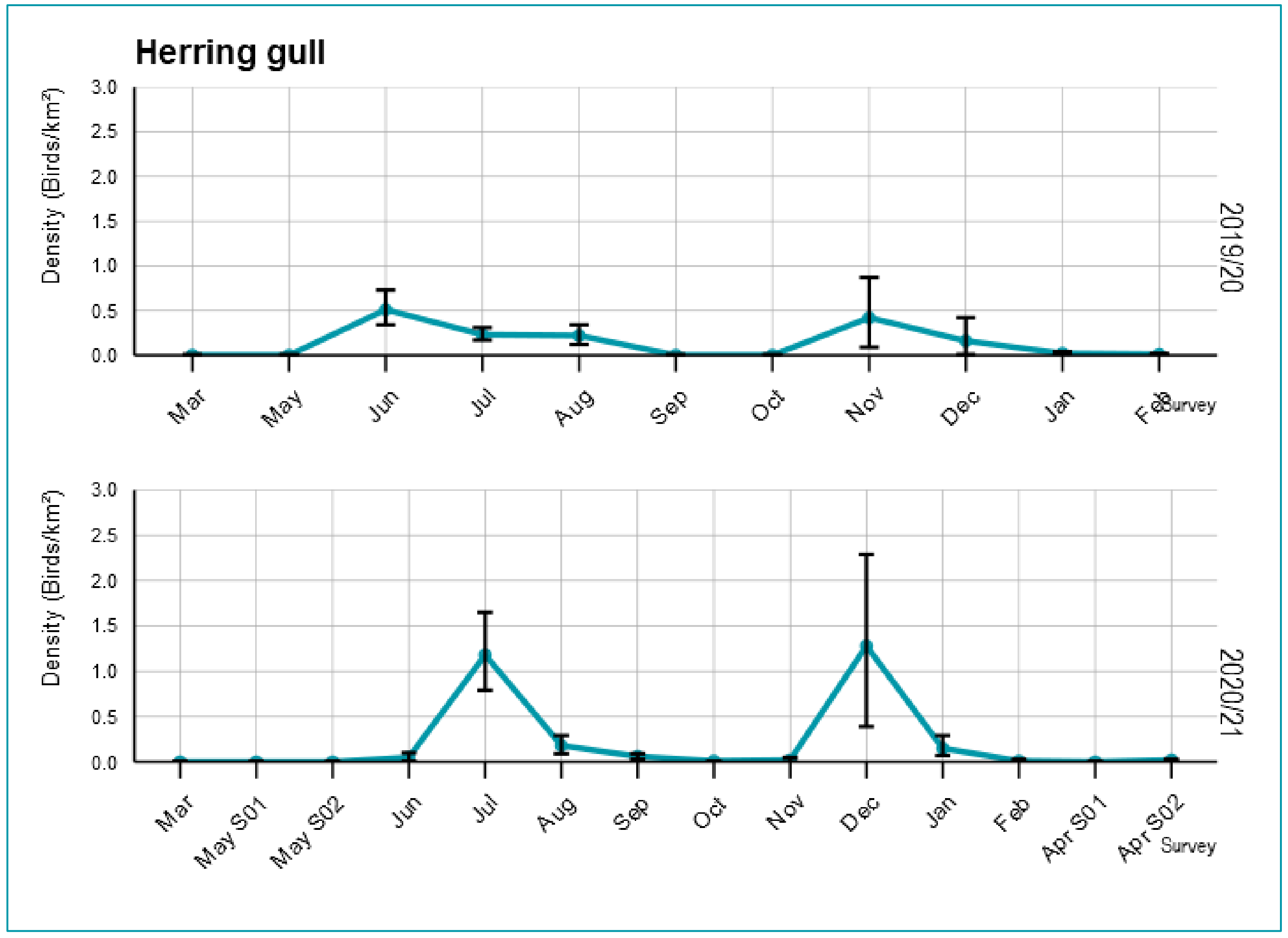


Figure 5.49: Estimated densities (birds/km2) of all herring gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.61: Mean seasonal peak (MSP) population and density (birds/km²) of all herring gulls in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

All Birds MSP						
Bio-season	Population	Lower 95% CI	Upper 95% CI	Density	Lower 95% CI	Upper 95% CI
Breeding season	3356	2246	4733	0.84	0.57	1.19
Non-breeding	3382	957	6294	0.85	0.24	1.58

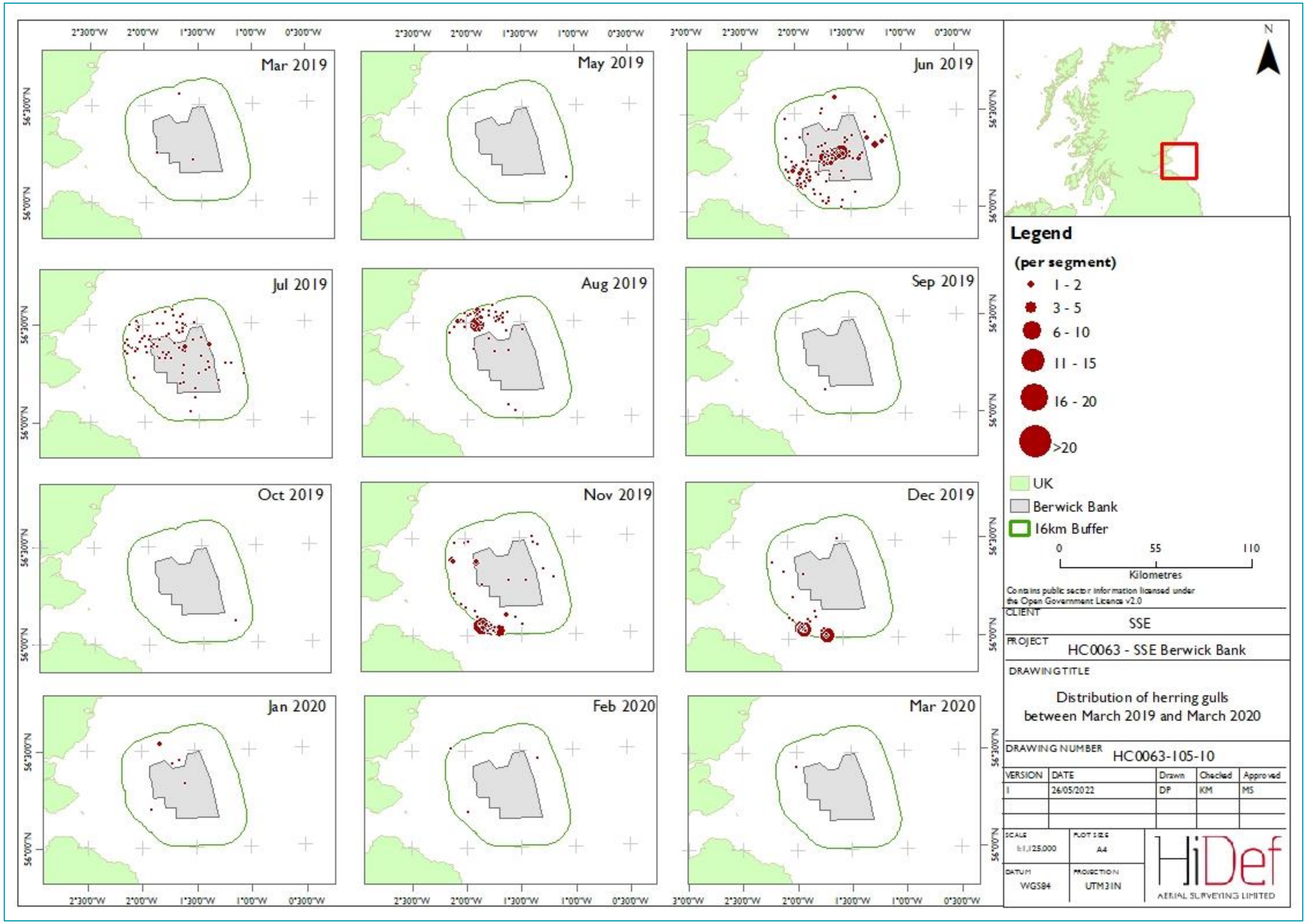


Figure 5.50: **Distribution of herring gulls across the Offshore Ornithology Study Area between March 2019 and March 2020**

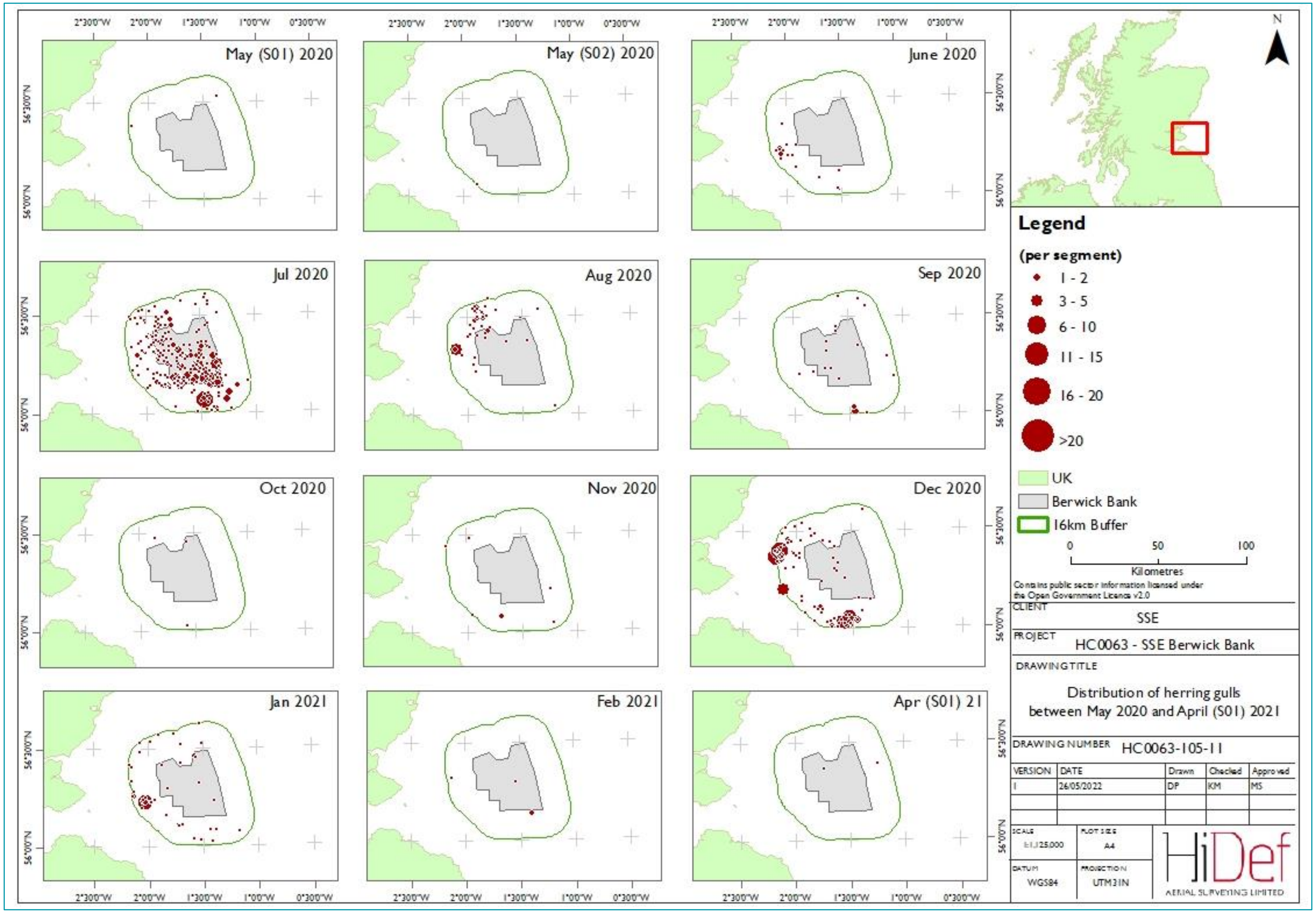


Figure 5.51: Distribution of herring gulls across the Offshore Ornithology Study Area between April 2020 and April (S01) 2021

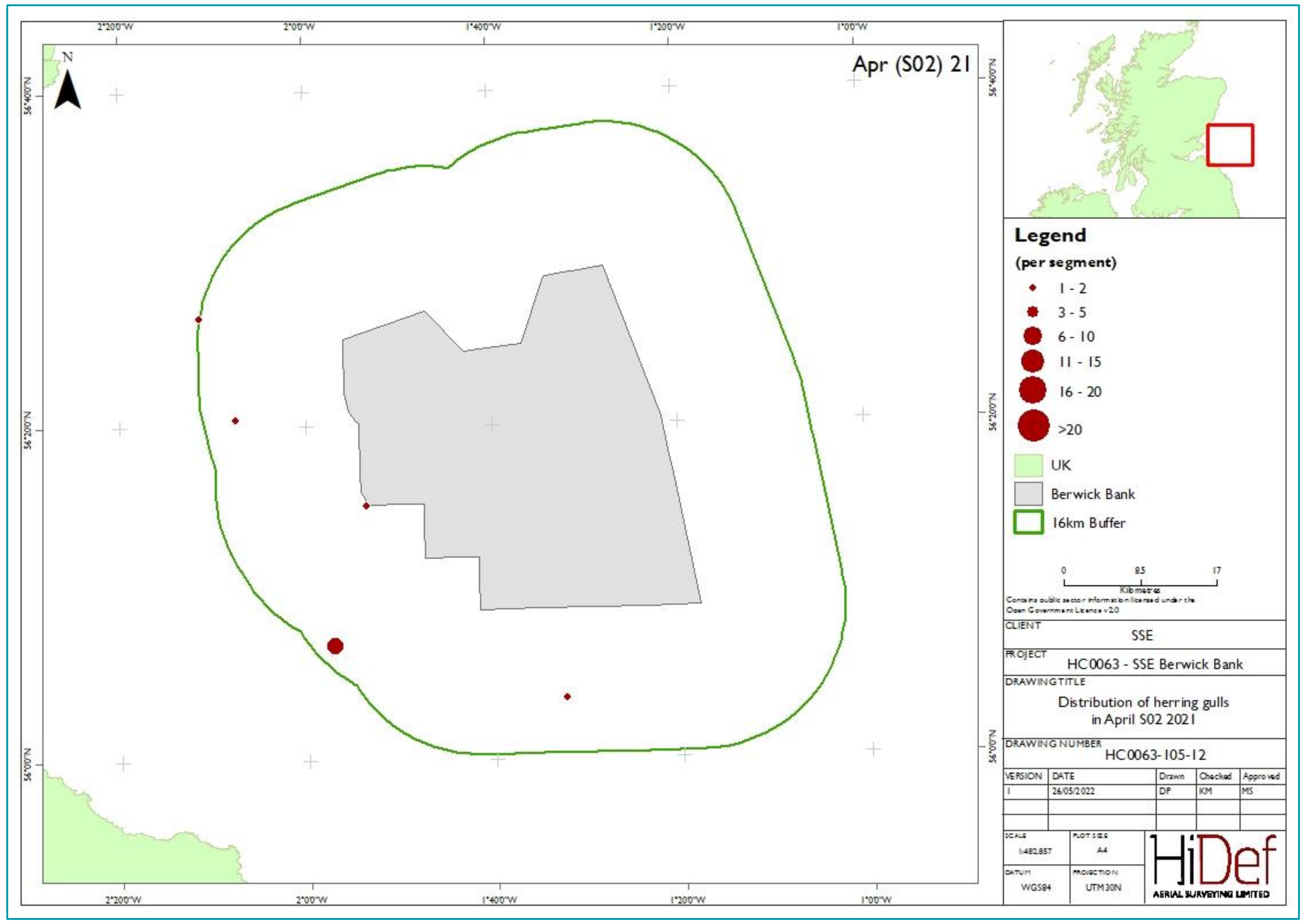


Figure 5.52: Distribution of herring gulls across the Offshore Ornithology Study Area in April (S02) 2021

Figure 5.53: Summarised flight direction of herring gulls across the Offshore Ornithology Study Area

Table 5.62: Mean count, SD and proportion of herring gulls in each age class averaged across bio-season

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	SD	Prop	Mean	SD	Prop	Mean	SD	Prop	Mean	SD
Breeding season	59	67	0.92	4	6	0.07	0	1	0.01	121	175
Non-breeding	53	159	0.66	26	72	0.32	2	3	0.02	91	266

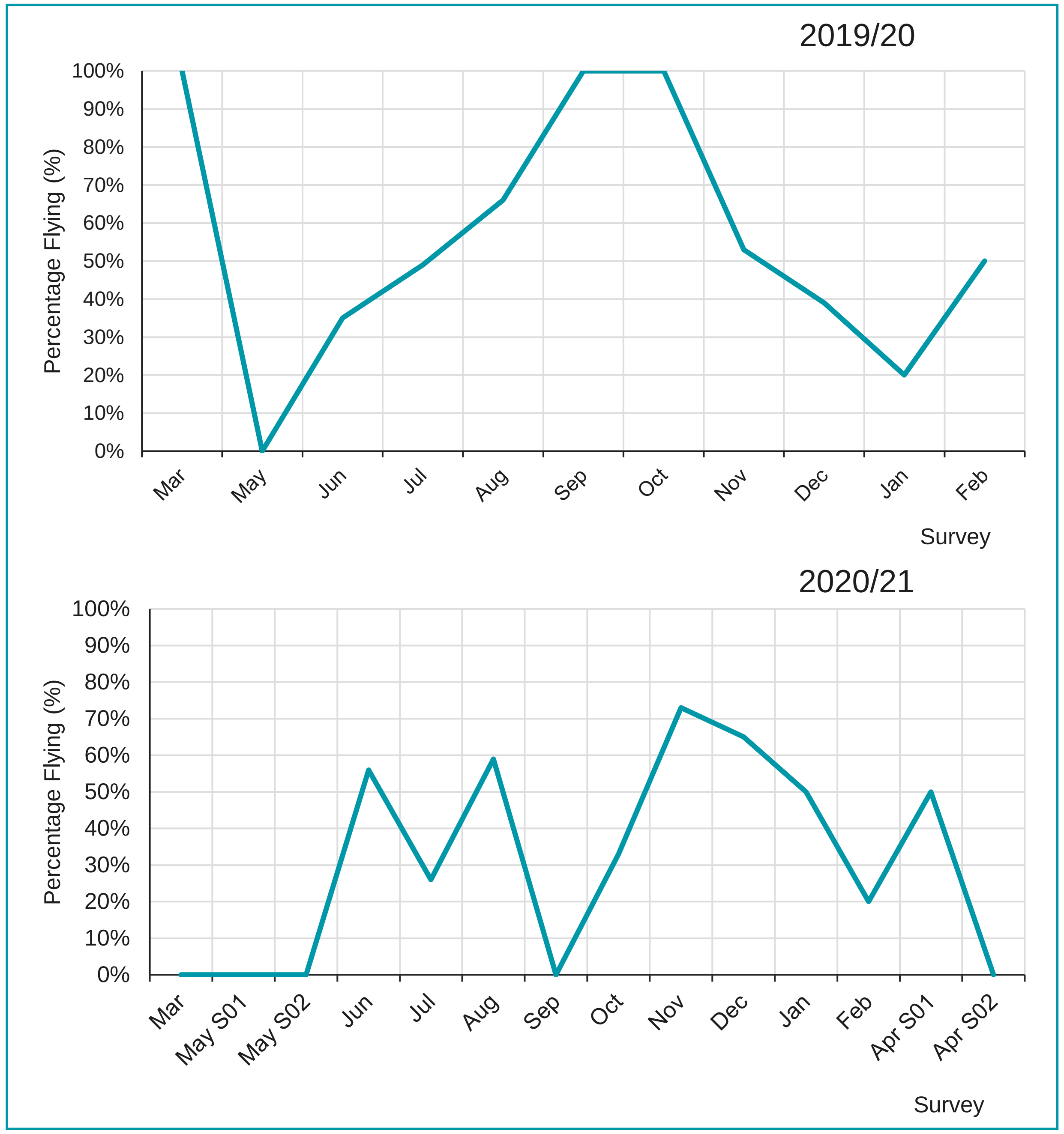


Figure 5.54: Percentage of flying herring gulls per survey across the Offshore Ornithology Study Area

5.11. LESSER BLACK-BACKED GULL

188. Lesser black-backed gulls are distributed throughout the UK, with breeding populations being a qualifying feature of ten UK SPAs (Stroud *et al*., 2001). National populations have fluctuated, with increases observed between the 1960s and early 2000s and decreases over the following decade (JNCC, 2014) which may be associated with redistribution of birds or changes to fishery discards policies (Ross-Smith *et al*., 2014; Furness *et al.*, 1992). Specific to the Offshore Ornithology Study Area, lesser black-backed gulls are a qualifying species for the Forth Islands SPA, with 1,684 AON, 131 AOT and 97 AOT in 2018 on the Isle of May, Fidra and Craigleith respectively (NatureScot, 2018; SMP, 2021). The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

189. Relatively high abundances observed throughout the aerial surveys may be due to the presence of several colonies in the vicinity of the survey area. Taking into urban nesting pairs[2], as well as those within SPA's, the total count of herring gulls within the foraging range (mean max distance +1 sd from Woodward et al. 2019) of the Project approximates the regional population and is estimated at 13,994 breeding adults.

190. Lesser black-backed gulls were recorded intermittently throughout the survey programme, mainly occurring during the breeding season, peaking in July 2019 and 2020 (Figure 5.55). Design-based density estimates ranged between 0.00 birds/km2 and 0.06 birds/km2 (95%CI 0.04 – 0.09) in 2019/20 compared to 0.00 birds/km2 and 0.23 birds/km2 (95%CI 0.17 – 0.29) in 2020/21 (Table 5.64). Between years, peaks in abundance varied substantially, with nearly three times as many birds recorded in July 2020 compared to July 2019. Much lower numbers of lesser black-backed gulls were recorded during the non-breeding season, with no birds between January and February in 2019 or 2020, as most birds move south for the winter months.

191. The mean seasonal peak estimated population in the Offshore Ornithology Study Area for the breeding season was 580 birds (95%CI 427 – 741; Table 5.67).

192. Boat-based surveys of Berwick Bank recorded 179 lesser black-backed gulls during the breeding season, similar to raw data collected during digital aerial surveys of the Offshore Ornithology Study Area. Lesser black-backed gulls were also recorded on Seagreen boat-based surveys and highlighted as a species likely to be present in regionally important numbers in the region, likely linked to breeding birds from the nearby Forth Islands SPA.

193. Birds were distributed throughout the Offshore Ornithology Study Area in June and July 2019 and July 2020 (Figure 5.56; Table 5.50). In 2019 and 2020, lesser black-backed gulls were widespread across the Offshore Ornithology Study Area, such as in July 2019, with a more concentrated distribution towards the northwest of the study area in August 2019. The species typically exhibits long foraging flights offshore, feeding on fish and discards from commercial fisheries (Camphuysen, 2013). It is likely that fisheries discards currently make up a much smaller percentage of diet than previously, following the discards ban at sea which was fully implemented in 2019 (Ulhmann *et al*., 2019). The species has, like many gulls, increased in urban areas feeding on human discards and litter.

194. Of the birds that could be aged, most were recorded as adults. The highest average proportion of immature birds was recorded in the breeding season, at 9% of all recorded birds (Table 5.83). No juvenile lesser black-backed gulls were recorded.

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[2] The proportion of urban gulls (roof nesting) was compared to the total population in Scotland from Seabird 2000. This resulted in a correction of 17% that was used to correct the total count of birds at SPAs. Information accessed from: Review of Urban Gulls and their Management in Scotland (www.gov.scot)

195. Flight direction was variable, with many birds flying east between June and August 2019 and July 2020 (Figure 5.58). Birds also flew west in July and August 2020.

Table 5.63: Lesser black-backed gull bio-seasons taken from NatureScot (2020a)

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

Table 5.64: Monthly density and population estimates of all lesser black-backed gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Lesser black-backed gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.01	15	0	40	12	74.05%
Jun-19	0.04	0.02	0.06	168	94	251	41	24.06%
Jul-19	0.06	0.04	0.09	258	178	341	43	16.6%
Aug-19	0.03	0.02	0.05	133	71	197	32	23.57%
Sep-19	0.01	0.00	0.02	25	0	61	17	68.37%
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	1	0	1	1	52.79%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.01	0.00	0.02	23	0	67	21	94.37%
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.01	0.00	0.03	48	8	110	28	57.33%
Jul-20	0.23	0.17	0.29	901	675	1141	119	13.11%
Aug-20	0.07	0.03	0.12	267	116	489	95	35.34%
Sep-20	0.00	0.00	0.00	1	0	2	1	95.6%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.01	9	1	24	9	100.38%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.01	9	0	28	8	99.38%
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.65: Monthly density and population estimates of flying lesser black-backed gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Lesser black-backed gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.01	8	0	24	8	102.21%
Jun-19	0.02	0.01	0.04	88	32	166	37	41.27%
Jul-19	0.04	0.02	0.06	159	100	229	33	20.68%
Aug-19	0.02	0.01	0.04	90	36	154	31	34.09%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	1	0	1	1	53.11%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.01	15	0	44	14	96.04%
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.01	0.00	0.02	34	0	76	20	58.07%
Jul-20	0.09	0.06	0.13	368	235	516	74	19.99%
Aug-20	0.04	0.02	0.07	156	71	267	52	33.41%
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.01	8	0	24	8	102.74%
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.66: Monthly density and population estimates of sitting lesser black-backed gulls only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Lesser black-backed gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.01	9	0	24	8	94.1%
Jun-19	0.02	0.01	0.03	83	33	139	27	32.05%
Jul-19	0.02	0.01	0.04	95	50	145	25	26.39%
Aug-19	0.01	0.00	0.02	40	9	83	19	47.26%
Sep-19	0.01	0.00	0.01	23	0	59	17	70.63%
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.01	8	0	22	7	90.84%

Sitting Lesser black-backed gull	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.01	16	0	40	12	72.97%
Jul-20	0.13	0.10	0.17	526	390	665	70	13.31%
Aug-20	0.03	0.01	0.05	105	39	196	42	39.46%
Sep-20	0.00	0.00	0.00	1	0	2	1	98.12%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.01	8	1	28	8	101.19%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

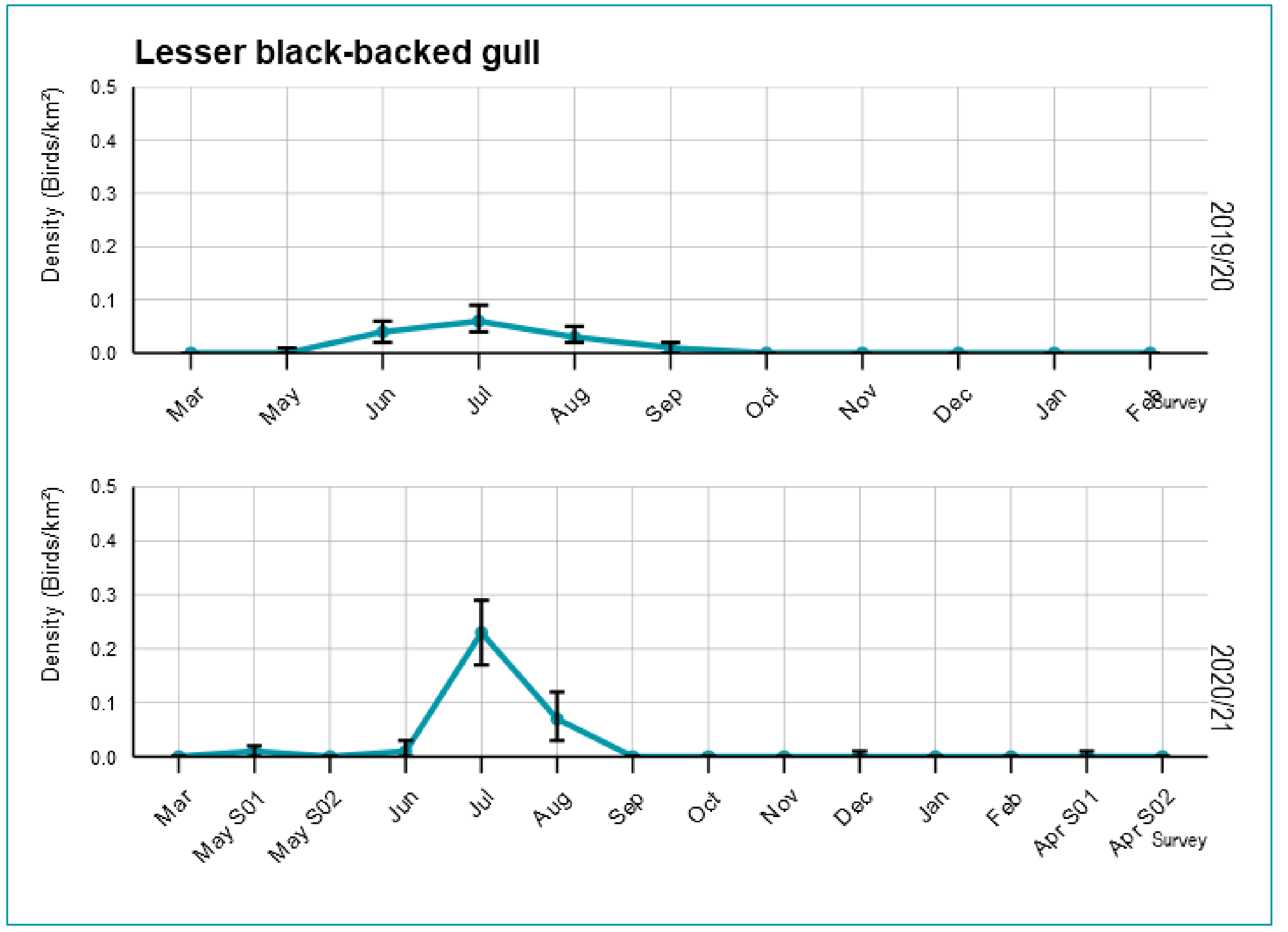

Figure 5.55: Estimated densities (birds/km²) of all lesser black-backed gulls across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.67: Mean seasonal peak (MSP) population and density (birds/km²) of all lesser black-backed gulls in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

All Birds MSP						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	580	427	741	0.15	0.11	0.19
Non-breeding	17	1	43	0.00	0.00	0.01

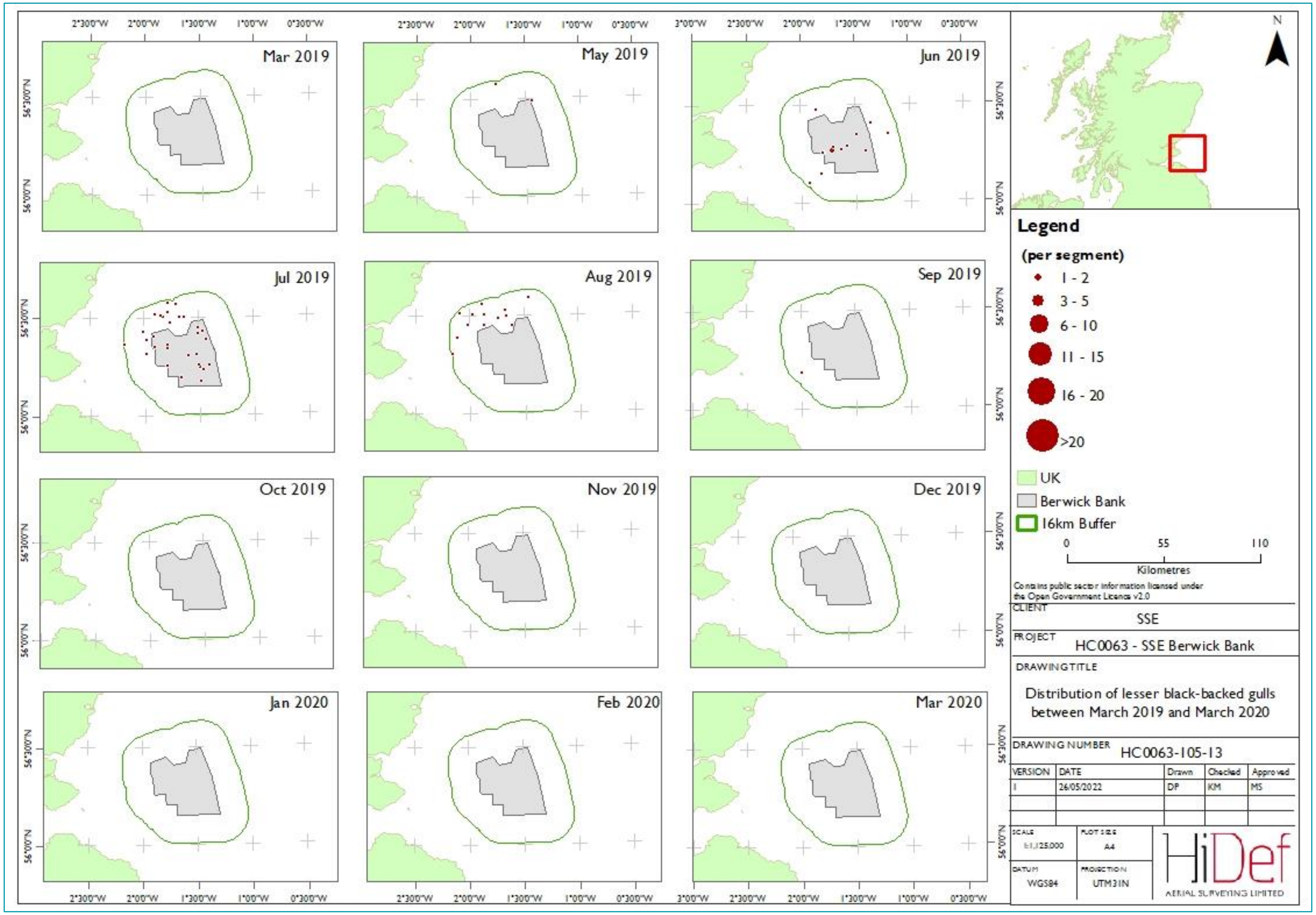

Figure 5.56: **Distribution of lesser black-backed gulls across the Offshore Ornithology Study Area between March 2019 and March 2020**

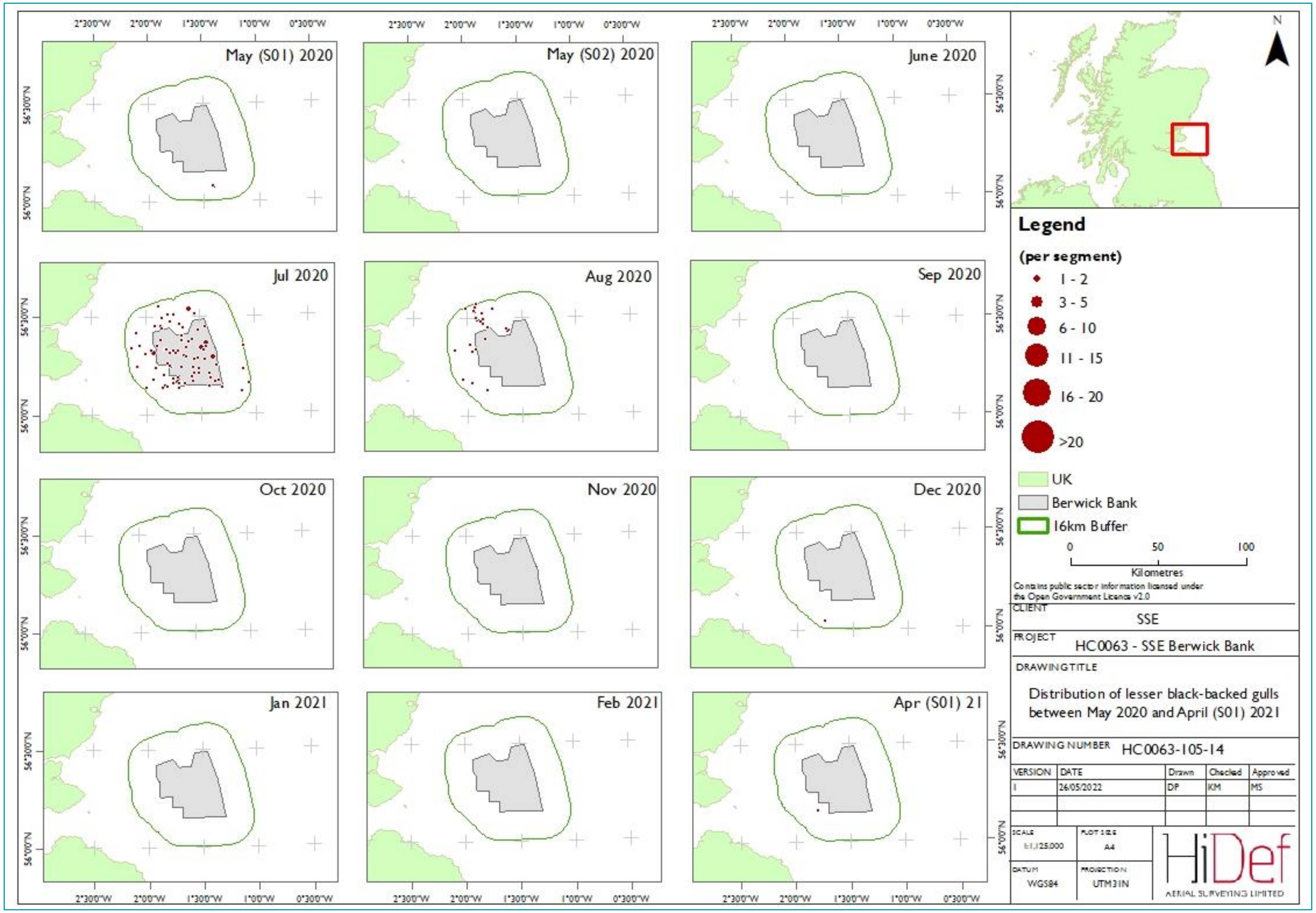

Figure 5.57: Distribution of lesser black-backed gulls across the Offshore Ornithology Study Area between May S01 2020 and April S01 2021

Table 5.68: Mean count, SD and proportion of lesser black-backed gulls in each age class averaged across bio-season

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	SD	Prop	Mean	SD	Prop	Mean	SD	Prop	Mean	SD
Breeding season	10	14	0.91	1	2	0.09	0	0	0	9	18
Non-breeding	0	0	1	0	0	0	0	0	0	0	1

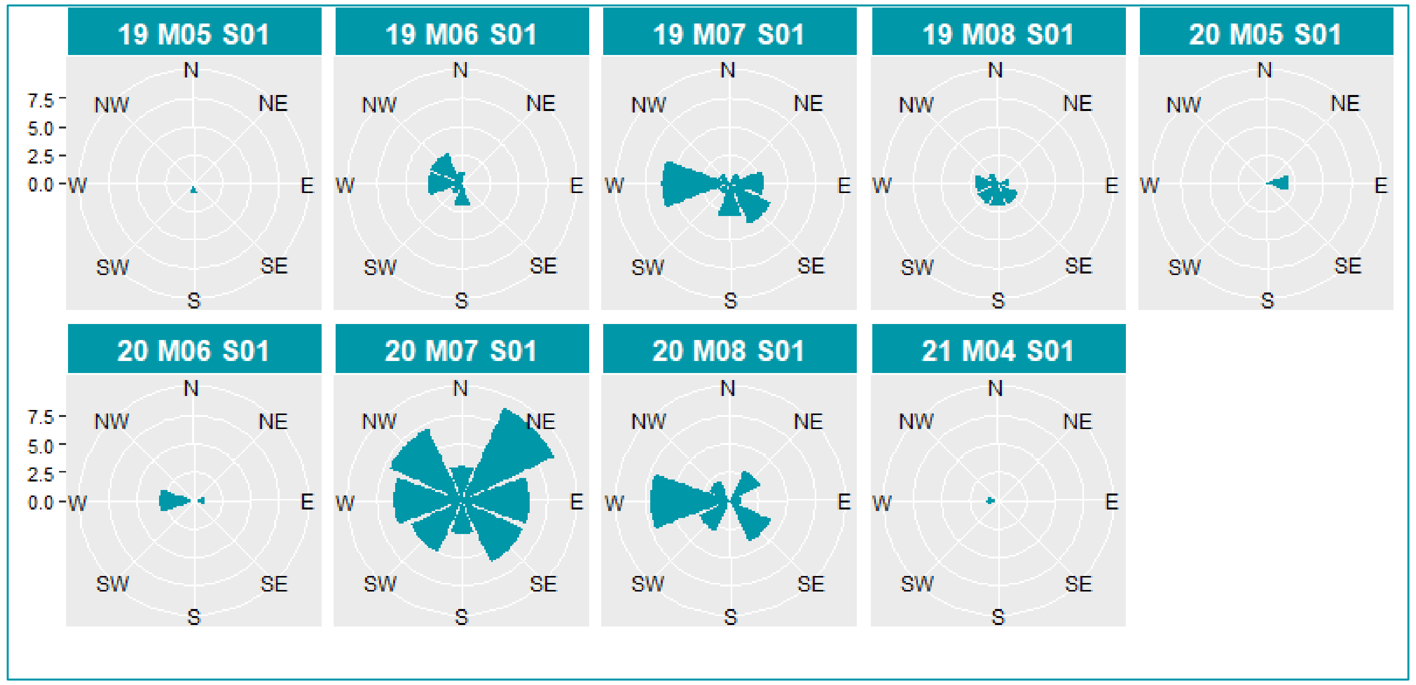

Figure 5.58: Summarised flight direction of lesser black-backed gulls across the Offshore Ornithology Study Area

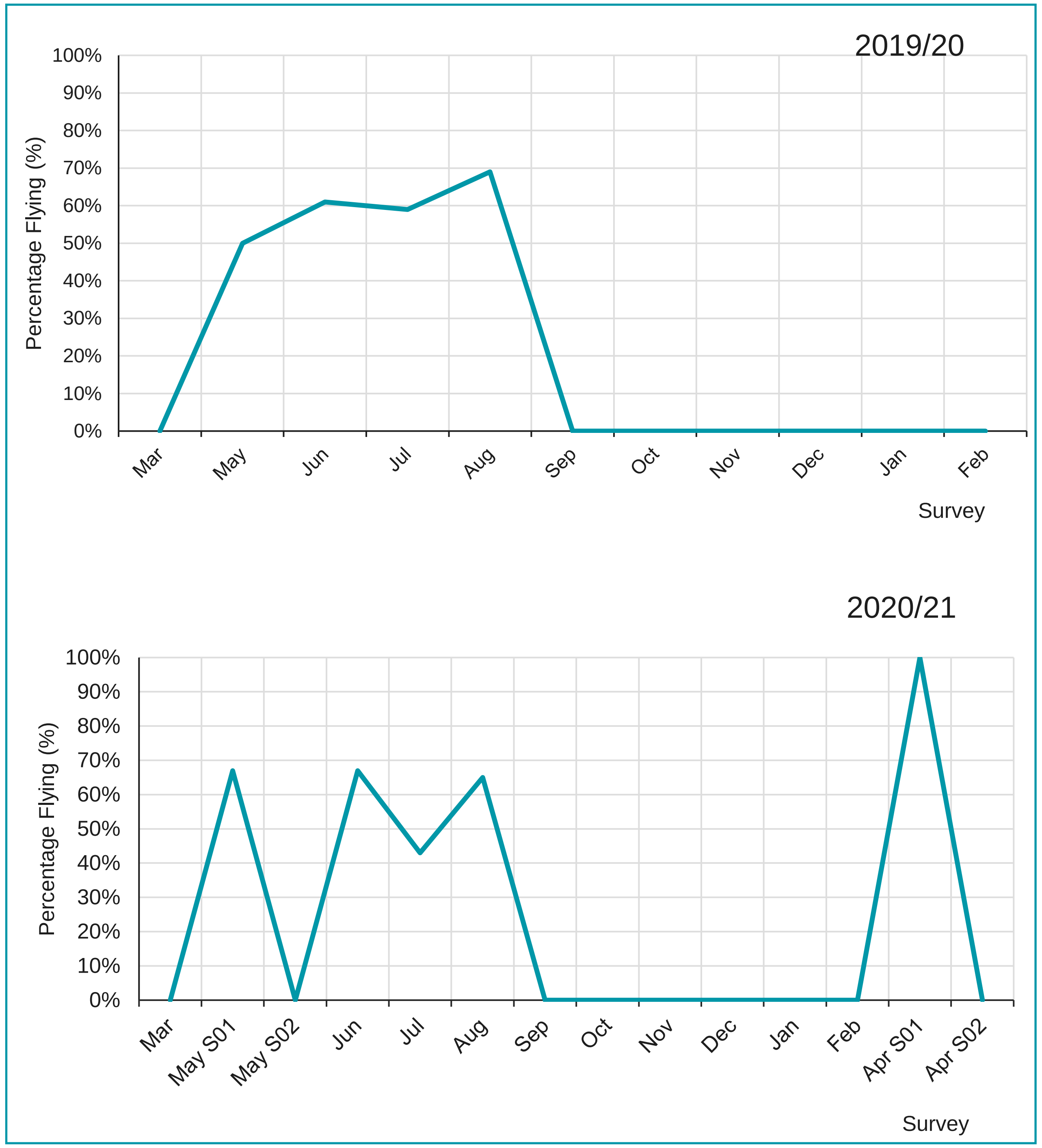

Figure 5.59: Percentage of flying lesser black-backed gulls per survey across the Offshore Ornithology Study Area

5.12. COMMON TERN

196. Located in both temperate and subtropical areas in the northern hemisphere, common terns are migratory seabirds found in coastal and inland areas (Mitchell *et al*., 2004). Within the UK, population trends have been relatively stable although regional fluctuations do occur, following changes in prey availability, nesting sites or predation (Mitchell *et al*., 2004). Common terns are a qualifying species for the nearby Forth Islands SPA, which is estimated to hold around 3% of the GB population, corresponding to 334 pairs (mean 1997 – 2001; NatureScot, 2018). Leith docks, located in Edinburgh also supports a large breeding population, estimated to be at around 514 and 246 AON in 2018 and 2019 respectively (SMP, 2021), although the Offshore Ornithology Study Area is out with the mean maximum foraging range (+1SD) for birds from this colony. The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

197. Common terns return to UK waters between April and September to breed (Table 5.69), spending their winters across the southern hemisphere. Birds were observed in both the 2019/20 and 2020/21 survey periods, with over 10 times more observations occurring in Year 2 compared to Year 1. Across all surveys, design-based density estimates ranged between 0.00 birds/km² and 0.13 birds/km² (95%CI 0.10 – 0.16) in 2019/20 compared to 0.00 birds/km² and 1.49 birds/km² (95%CI 1.02 – 2.02) in 2020/21 (Table 5.70).

198. Birds were primarily observed during the late breeding season, with peaks occurring in August 2019 and 2020 (Table 5.70). Peaks at this time can likely be attributed to post-breeding movements of adults and juveniles away from coastal breeding colonies. Mean seasonal peak abundance was highest in the breeding season, with a population estimate of 3,225 birds (95%CI 2,224 – 4,332) (Table 5.73). Lower abundance towards the start of the breeding season, such as between May and June can be attributed to birds beginning egg-laying and nest attendance, in which they are more closely associated with their nest sites until chicks have fledged.

199. Berwick Bank boat-based surveys recorded one common tern, present in the July 2020 survey, with boat-based surveys for Seagreen Alpha and Bravo recording the species in regionally important numbers in the Alpha site only. No individuals were recorded within the Bravo site. Data summed from ESAS surveys conducted between 1980 and 1996 clipped to the Offshore Ornithology Study Area recorded four common terns throughout the 16-year period.

200. Birds were widespread throughout the Offshore Ornithology Study Area, such as in August 2019 and 2020, located both within the Proposed Development Array area and the buffer. In August 2019 and 2020, there appeared to be no clear patterns in distribution, however in September 2020, common terns were concentrated to the south of the Offshore Ornithology Study Area.

201. Bar one individual, all birds were recorded as flying. Common terns feed almost exclusively while on the wing, predominantly by either plunge diving or contact dipping, hawking or even intraspecific kleptoparasitism (Garcia *et al*., 2011 and references therein), therefore flight behaviour cannot be used to distinguish between foraging and passage. Generally, common terns flew eastwards and westwards, with most birds flying west in August 2020 and east in September 2020. In many months, so few birds were recorded flying that no conclusions regarding flight direction could be determined.

Table 5.69: Common tern bio-seasons taken from NatureScot (2020a)

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

Table 5.70: Monthly density and population estimates of all common terns across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Common tern	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.07	0.04	0.09	264	176	364	48	18.16%
Aug-19	0.13	0.10	0.16	520	410	625	58	11.08%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.01	19	5	36	9	43.18%
May S02 20	0.01	0.00	0.01	31	17	53	10	31.88%
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.03	0.01	0.06	119	42	221	51	42.47%
Aug-20	1.49	1.02	2.02	5930	4038	8039	1108	18.69%
Sep-20	0.22	0.08	0.42	895	327	1663	351	39.23%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.03	0.00	0.07	120	16	263	65	54.4%

Table 5.71: Monthly density and population estimates of flying common terns only across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Common tern	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.07	0.05	0.09	265	180	363	49	18.28%
Aug-19	0.13	0.10	0.16	514	417	627	53	10.17%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.01	20	5	39	9	43.69%
May S02 20	0.01	0.00	0.01	31	14	54	11	33.45%
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.03	0.01	0.07	120	42	262	56	46.81%
Aug-20	0.58	0.41	0.79	2288	1629	3123	392	17.12%
Sep-20	0.22	0.09	0.44	879	356	1740	348	39.51%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.03	0.00	0.06	121	16	254	63	52.16%

Table 5.72: Monthly density and population estimates of sitting common terns only the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Common tern	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
Survey								
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.93	0.58	1.42	3708	2312	5659	845	22.79%
Sep-20	0.00	0.00	0.01	9	0	24	8	93.82%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

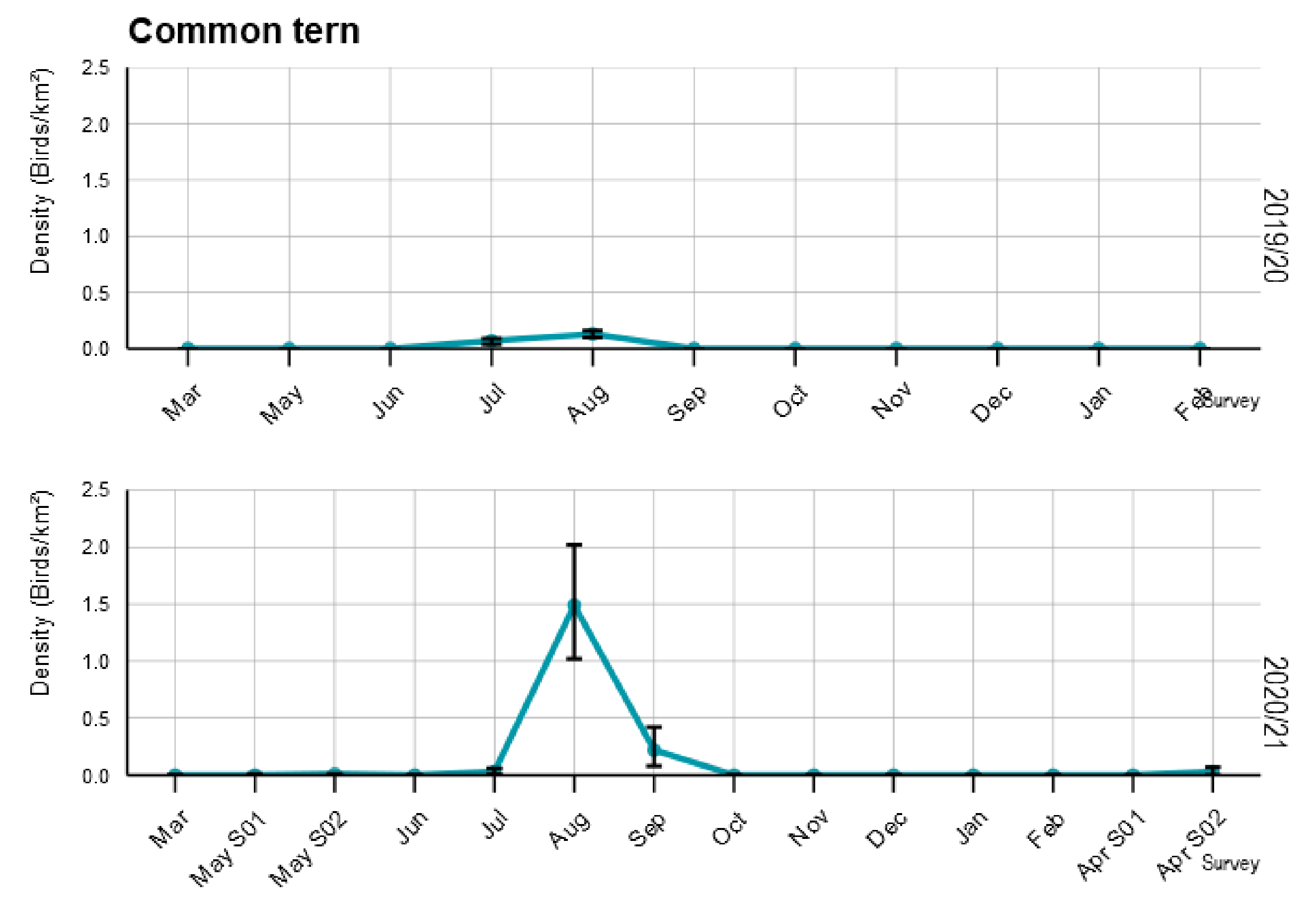

Figure 5.60: Estimated densities (birds/km²) of all common terns across the Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.73: Mean seasonal peak (MSP) population and density (birds/km²) of all common terns in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

	All Birds MSP					
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	3225	2224	4332	0.81	0.56	1.09
Non-breeding	70	11	150	0.01	0.00	0.04

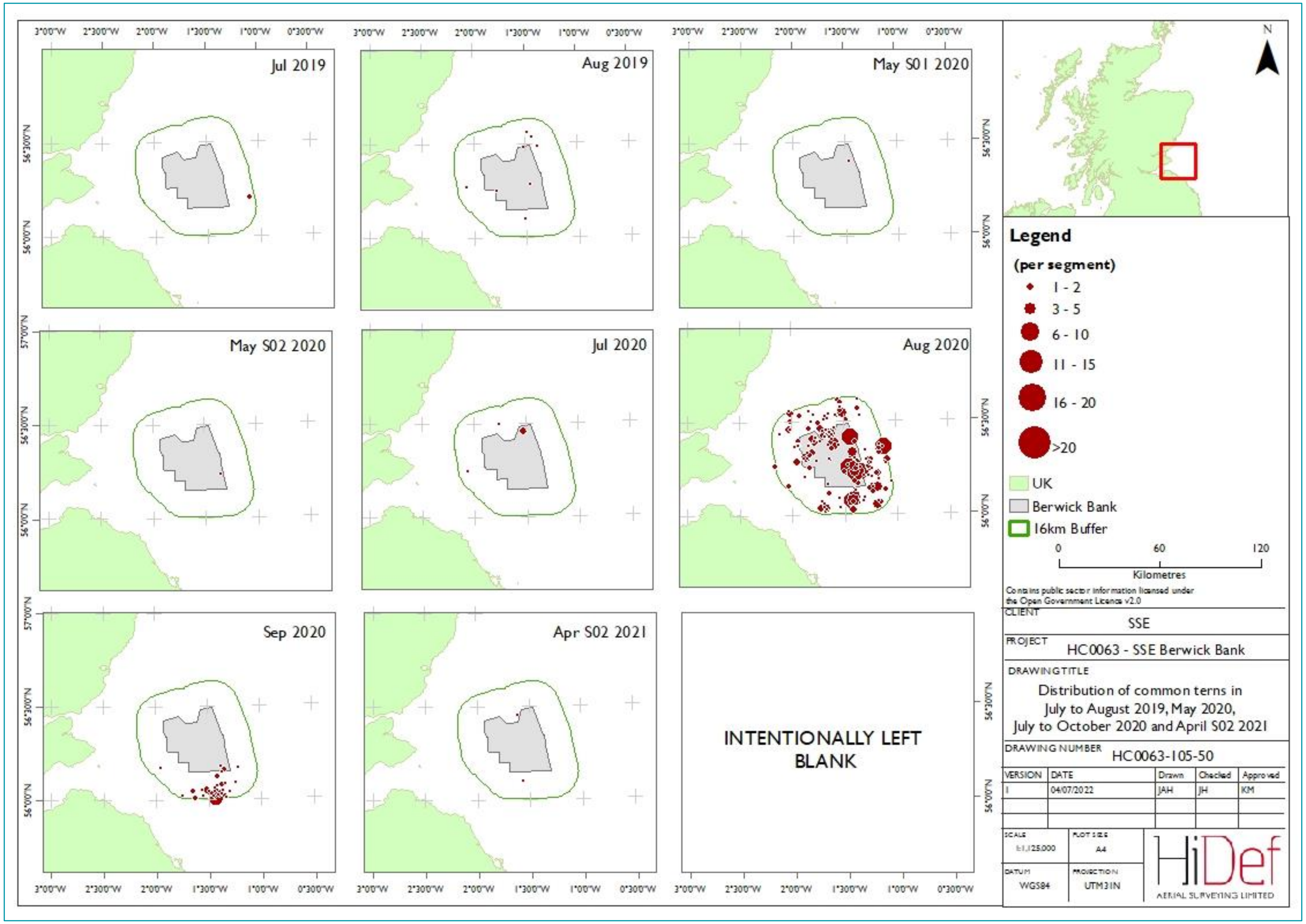

Figure 5.61: **Distribution of common terns across the Offshore Ornithology Study Area for all months with observations (July and August 2019, May S01 and S02 2020, July to October 2020 and April S02 2021)**

Table 5.74: **Mean count, SD and proportion of common terns in each age class averaged across bio-season**

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	SD	Prop	Mean	SD	Prop	Mean	SD	Prop	Mean	SD
Breeding season	5	10	0.88	0	0	0.02	1	2	0.1	6	11
Non-breeding	0	1	1	0	0	0	0	0	0	0	0

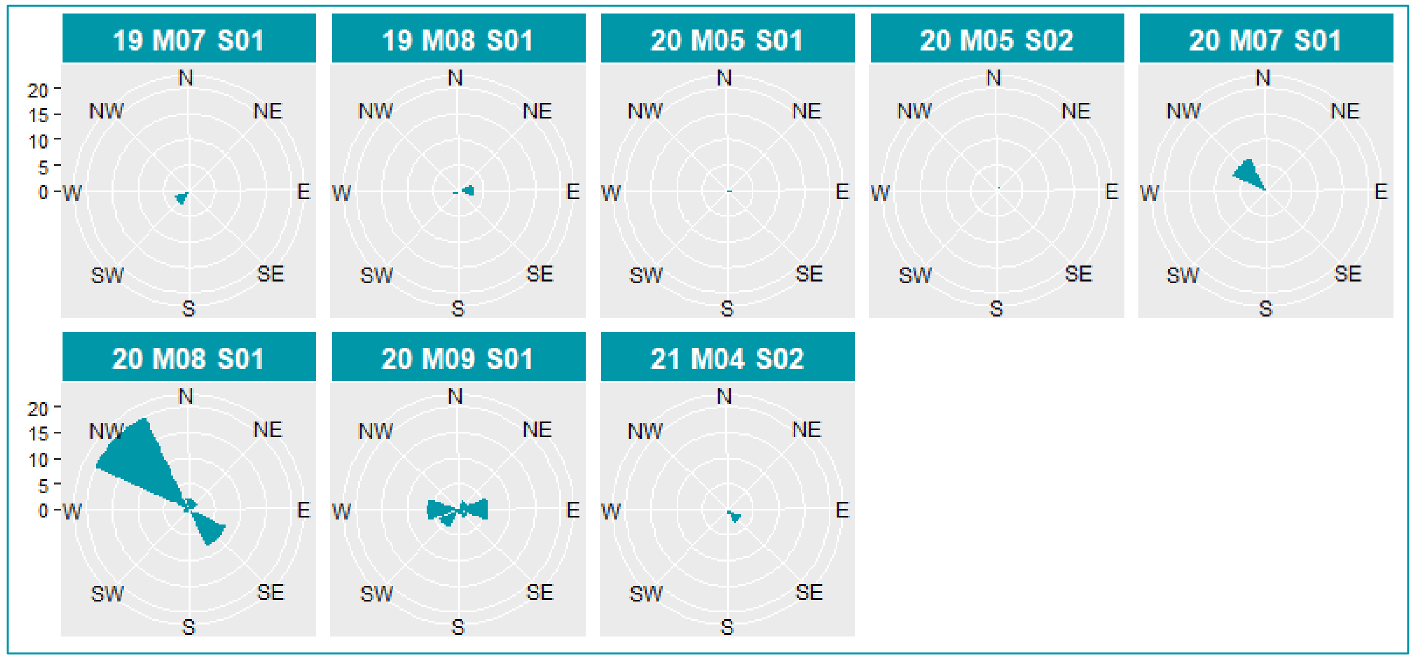

Figure 5.62: Summarised flight direction of common terns across Offshore Ornithology Study Area

5.13. ARCTIC TERN

202. The most common breeding tern species in the UK, Arctic terns are present over the summer breeding season, forming coastal breeding colonies on vegetated rock and sand (Mitchell *et al*., 2004; Forrester *et al.*, 2007). A significant proportion of Arctic terns breed in Scotland, which supports 84% of the British Isles breeding population and 10% of the world population (Forrester *et al*., 2007). Large variation in colony size between years is common, with some colonies only present for a few years at a time (Devlin *et al.,* 2008). Arctic terns are a qualifying species for the nearby Forth Islands SPA, which supports 1.2% of the population of Great Britain, equating to approximately 540 pairs at time of designation (mean 1992 – 1996; NatureScot, 2018), compared to 832 pairs in 2017 (SMP, 2021). Post breeding, Arctic terns migrate south through the North Sea and down the eastern seaboard of the Atlantic, with many juvenile birds wintering in western and southern Africa (Hatch, 2002). The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

203. Arctic terns spend a shorter period in UK waters than common terns, returning to UK shores to breed between late April and early September. Individuals were present during this period in both years of surveying. During the breeding season, the mean seasonal peak density was calculated at 1.03 birds/km^2, equating to a mean seasonal peak population estimate for the Offshore Ornithology Study Area of 4,074 birds (95%CI 3,188 – 5,088; Table 5.79).

204. Across all surveys, design-based density estimates ranged between 0.00 birds/km^2 to 1.61 birds/km^2 (95%CI 1.32 – 1.93) in 2019/20 compared to 0.00 birds/km^2 to 0.44 birds/km^2 (95%CI 0.29 – 0.63) in 2020/21 (Table 5.76). Arctic terns were distributed throughout the Offshore Ornithology Study Area (Figure 5.64 to Figure 5.66). In July 2019 and August 2020, birds were found congregated in the southeast of the Offshore Ornithology Study Area, while in August 2019, birds were spread between west and northeast.

205. Peak abundances were recorded in late summer, such as in August 2019 and 2020, which can likely be attributed to adults and juveniles moving through the Offshore Ornithology Study Area away from breeding colonies. The origins of these birds are unknown but are likely to be from nearby colonies as well as elsewhere in the country, such as Shetland.

206. Berwick Bank boat-based surveys in 2020-2021 recorded relatively high numbers of Arctic terns, recorded in all surveys apart from in April 2021. Boat-based surveys of Seagreen Alpha and Bravo estimated that regionally important numbers of the species were likely to be present within both sites with the species also recorded during pre-construction digital aerial surveys.

207. Flight direction varied between surveys, with a large proportion of birds flying east and west in July and August 2019, while in August 2020 a substantial number of birds flew north (Figure 5.67).

208. Very few birds were recorded as sitting on the water on surveys, with 90% of total birds recorded as flying. As with common terns, birds feed almost entirely whilst on the wing; surface feeding, plunge-diving or hawking in the air. Due to this, flight behaviour cannot be used to distinguish between those foraging and passing through the survey area.

Table 5.75: **Arctic tern bio-seasons taken from NatureScot (2020a)**

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

Table 5.76: **Monthly density and population estimates of all Arctic terns across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species**

Arctic tern	Density Estimate (birds/km^2)	Lower 95% CI (birds/km^2)	Upper 95% CI (birds/km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.02	0.00	0.04	78	16	170	43	55.53%
Jun-19	0.02	0.00	0.03	71	16	133	31	42.96%
Jul-19	0.95	0.71	1.26	3777	2825	4999	574	15.17%
Aug-19	1.61	1.32	1.93	6415	5239	7668	636	9.9%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.01	0.00	0.02	31	5	60	16	49.16%
May S02 20	0.08	0.05	0.12	320	194	466	71	22.18%

Arctic tern	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Jun-20	0.02	0.00	0.03	64	16	124	27	41.83%
Jul-20	0.05	0.03	0.09	216	110	357	64	29.2%
Aug-20	0.44	0.29	0.63	1733	1137	2507	357	20.55%
Sep-20	0.07	0.02	0.11	262	89	457	102	38.68%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.02	0.00	0.05	64	0	192	63	97.66%

Table 5.77: Monthly density and population estimates of flying Arctic terns only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Arctic tern	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.02	0.00	0.04	82	16	176	42	50.78%
Jun-19	0.02	0.00	0.03	73	16	135	32	43.74%
Jul-19	0.96	0.66	1.24	3823	2642	4921	595	15.54%
Aug-19	1.60	1.31	1.91	6368	5204	7597	615	9.65%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.01	0.00	0.02	31	5	60	15	48.87%
May S02 20	0.08	0.05	0.12	317	197	469	70	21.96%
Jun-20	0.01	0.00	0.03	59	16	108	25	41.29%
Jul-20	0.04	0.02	0.05	140	70	212	36	25.67%
Aug-20	0.44	0.28	0.67	1742	1101	2652	379	21.75%
Sep-20	0.06	0.02	0.12	255	96	465	97	37.76%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.78: Monthly density and population estimates of sitting Arctic terns only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Arctic tern	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.01	0.00	0.01	25	0	58	15	57.54%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.01	8	0	24	8	99.63%
Jul-20	0.02	0.00	0.05	81	0	187	50	61.1%
Aug-20	0.00	0.00	0.01	9	0	24	9	94.9%
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.02	0.00	0.05	65	0	190	60	91.49%

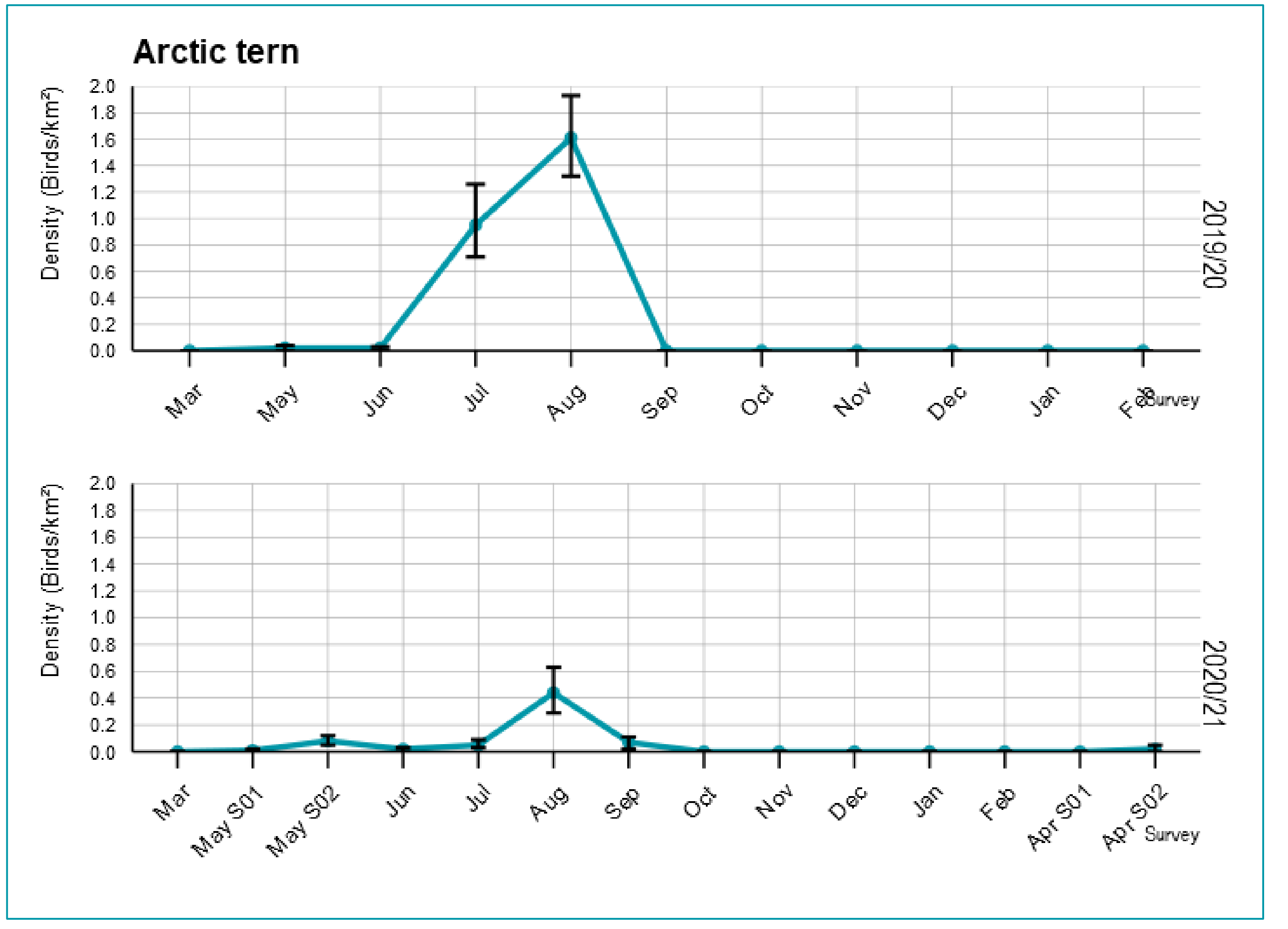

Figure 5.63: Estimated densities (birds/km²) of all Arctic terns across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.79: Mean seasonal peak (MSP) population and density (birds/km²) of all Arctic terns in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

All Birds MSP						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	4074	3188	5088	1.03	0.80	1.28
Non-breeding	163	45	325	0.05	0.01	0.08

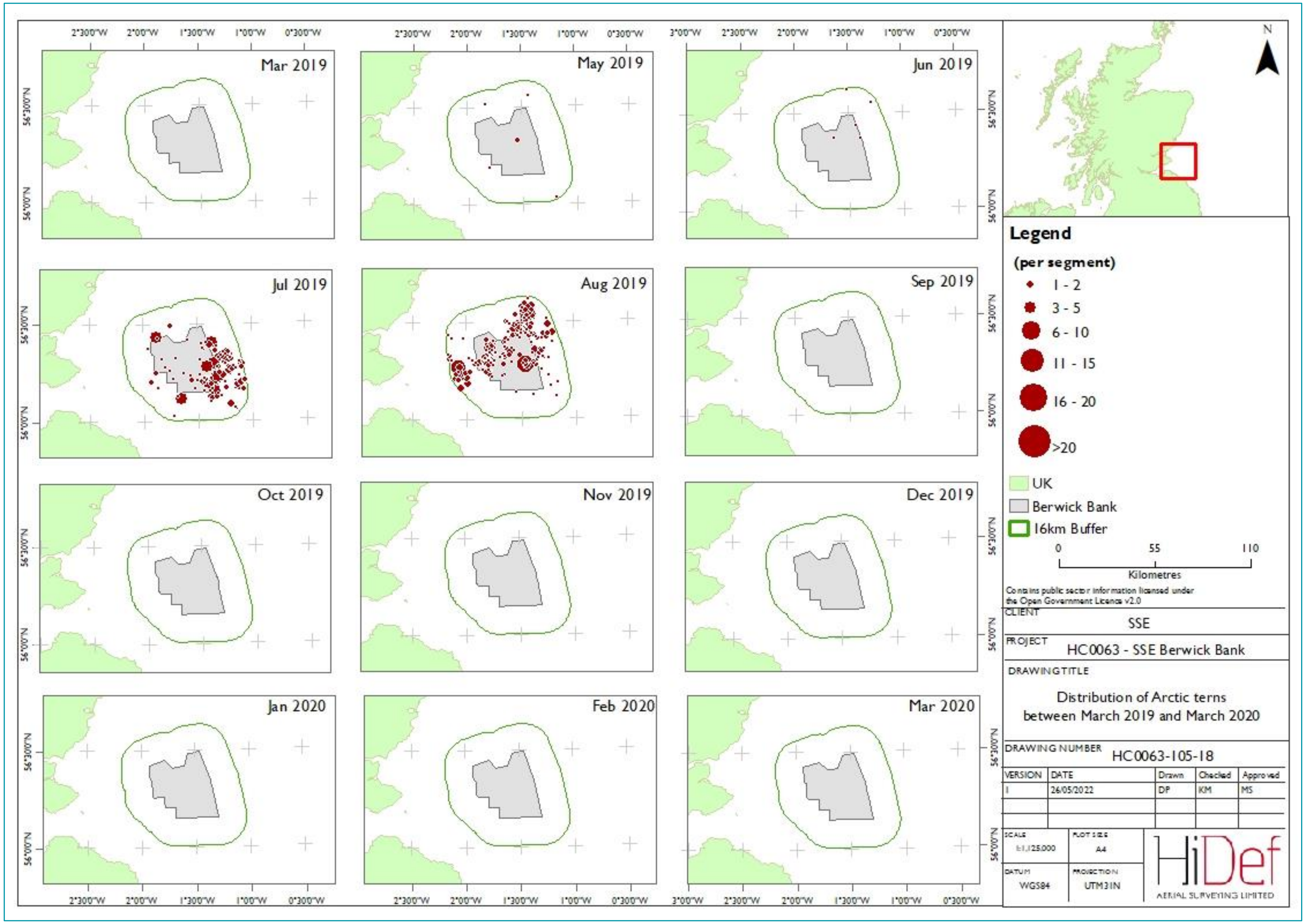

Figure 5.64: Distribution of Arctic terns across Offshore Ornithology Study Area between March 2019 and March 2020

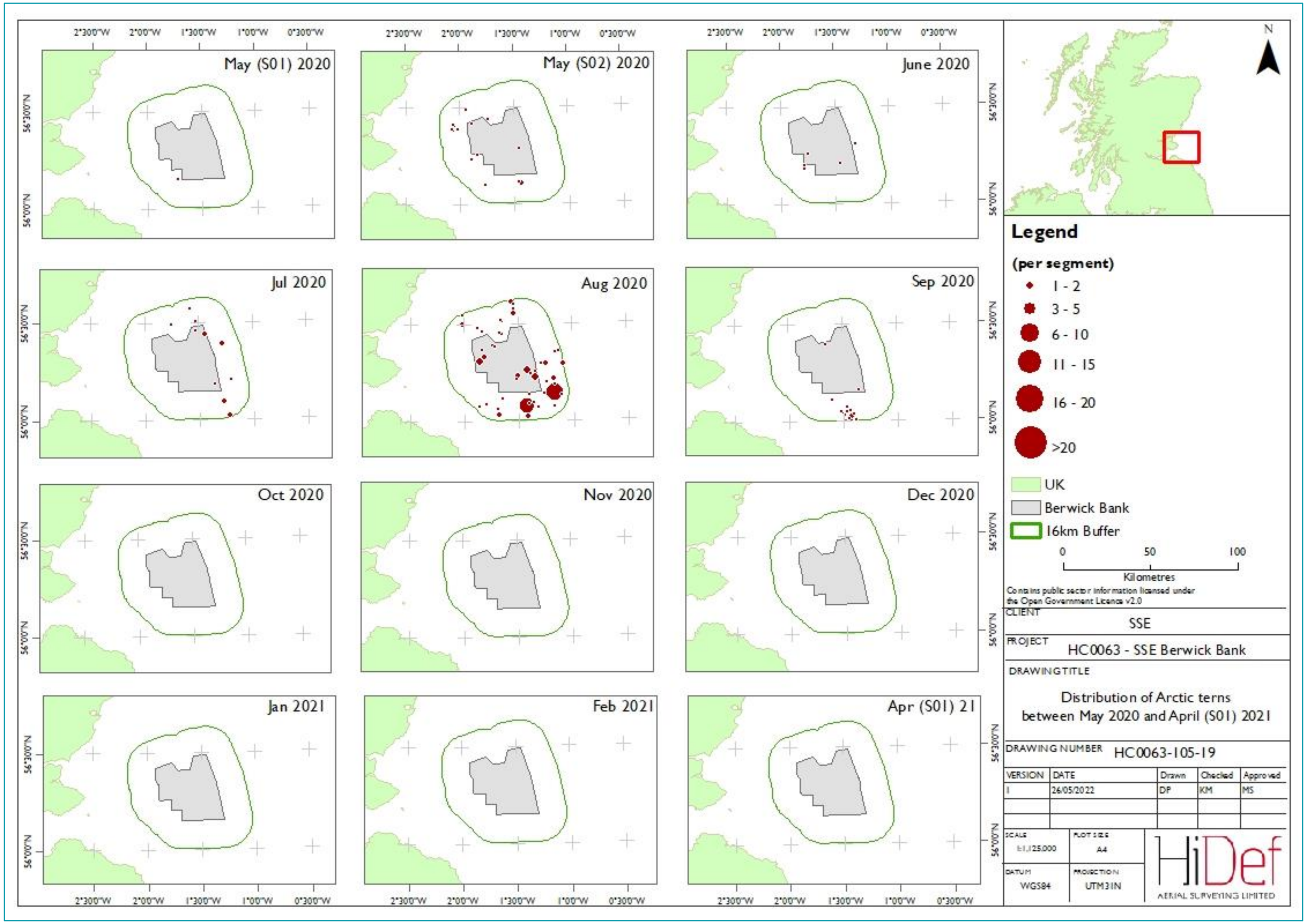

Figure 5.65: Distribution of Arctic terns across Offshore Ornithology Study Area between May S01 2020 and April S01 2021

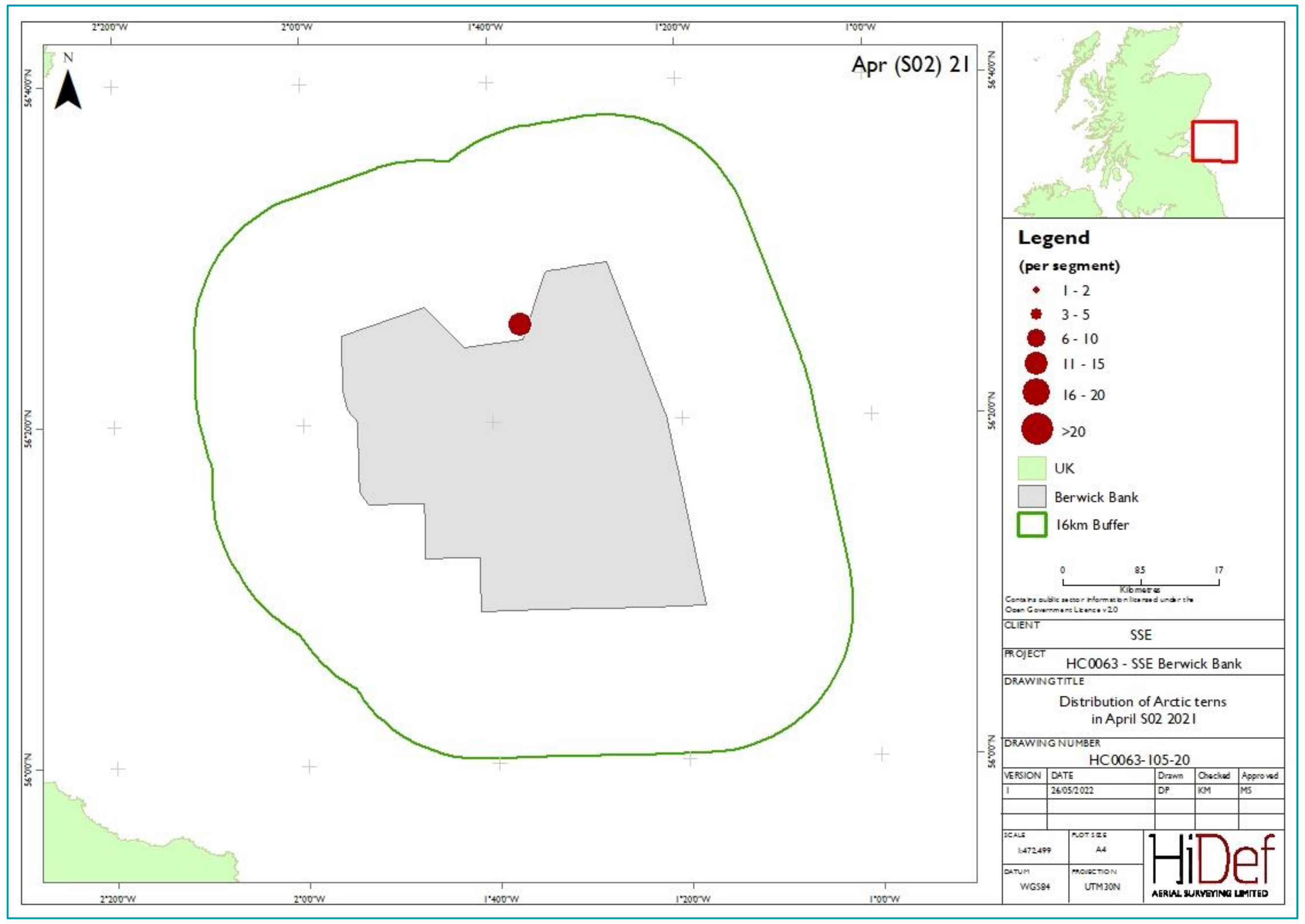

Figure 5.66: Distribution of Arctic terns across Offshore Ornithology Study Area April S02 2021

Table 5.80: Mean count, SD and proportion of Arctic terns in each age class averaged across bio-season

Bio-season	Adult			Immature			Juvenile			Unknown	
	Mean	SD	Prop	Mean	SD	Prop	Mean	SD	Prop	Mean	SD
Breeding season	11	10	0.92	0	0	0	1	2	0.08	6	6
Non-breeding	1	3	0.92	0	0	0	0	0	0.08	1	3

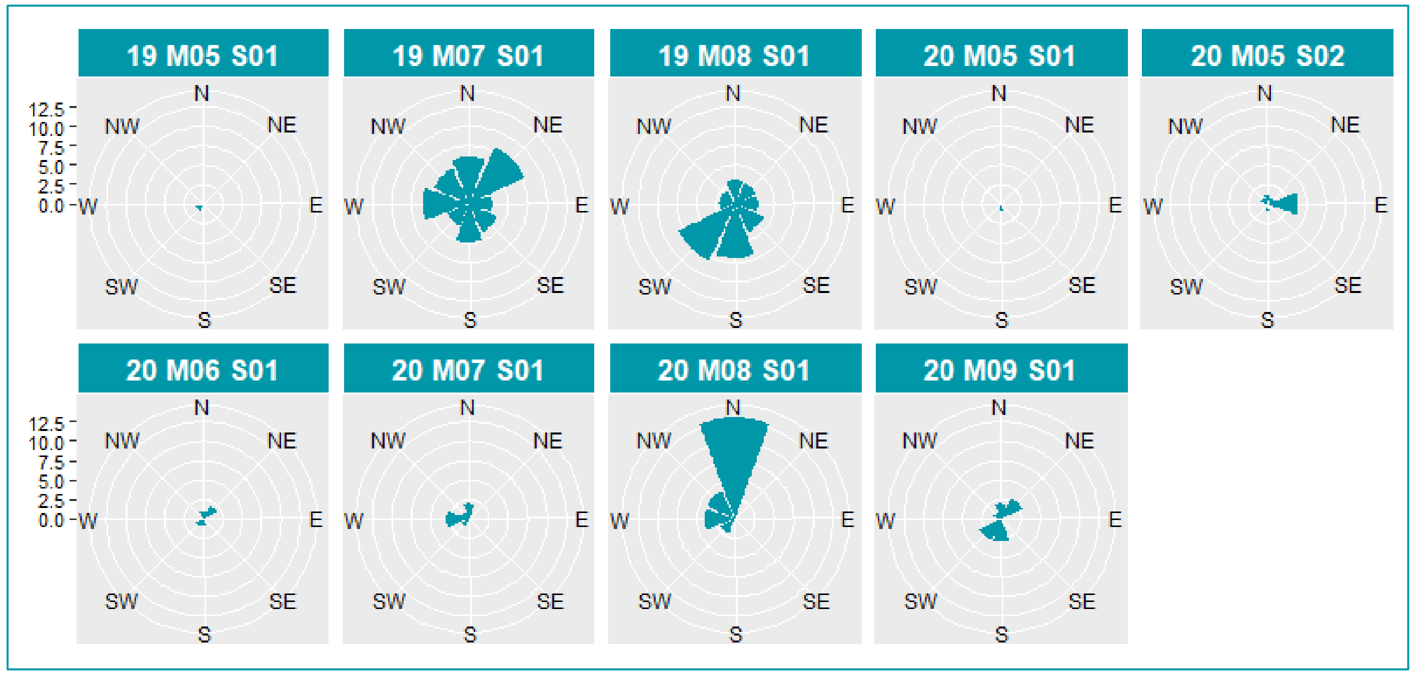

Figure 5.67: Summarised flight direction of Arctic terns across Offshore Ornithology Study Area

5.14. GREAT SKUA

209. Present only in the northeast Atlantic, there are approximately 16,000 breeding pairs of great skua worldwide, 60% of which are located in Scotland (Mitchell *et al*., 2004). Between 1900 and 1990, the Scottish population of great skuas doubled approximately every 12 years, with 80% of breeding birds located within SPAs (Mitchell *et al*., 2004). They feed on small fish species such as sandeels as well as klepto-parasitising other seabirds although previously they were also known to strongly associate with fishing vessels, preying on discards (Votier *et al*., 2004; Votier *et al*., 2008). It is likely that fisheries discards currently make up a much smaller percentage of diet than previously, following the banning of dumping discards at sea which was fully implemented in 2019 (Ulhmann *et al*., 2019). The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

210. Great skuas were recorded in low densities in the Offshore Ornithology Study Area, primarily between August and December. The peak estimated population was 72 birds (95%CI 32 – 119) in November 2020, attributed to the passage of birds through the Offshore Ornithology Study Area during southwards post-breeding migration (Table 5.82).

211. Berwick Bank Boat-based surveys in 2020-2021 recorded low numbers of great skuas. Most individuals were recorded in August 2020, and these birds were presumed to be birds passing through on their southwards post-breeding migration.

212. Great skua distribution was variable, with birds distributed in the east and west of the Offshore Ornithology Study Area, such as in July 2019 and October 2020 respectively (Figure 5.69 – Figure 5.70). Overall, most birds were recorded flying, with only 27% of birds recorded as sitting on the water.

213. Flight direction varied between surveys (Figure 5.71).

Table 5.81: Great skua bio-seasons taken from NatureScot (2020a)

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

Table 5.82: Monthly density and population estimates of all great skuas across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species.

All Great skua	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.01	8	0	24	8	93.54%
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.01	0.00	0.01	32	8	60	14	43.42%
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.01	16	0	40	12	69.91%
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.01	8	0	25	8	100.34%
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.01	8	0	25	8	102.74%
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.01	16	0	39	11	63.83%
Sep-20	0.01	0.00	0.02	33	8	63	15	44.12%
Oct-20	0.01	0.00	0.02	40	8	83	20	48.83%
Nov-20	0.02	0.01	0.03	72	32	119	23	32.02%
Dec-20	0.01	0.00	0.02	32	8	71	16	48.24%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.83: Monthly density and population estimates of flying great skuas only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Great skua	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.01	9	0	28	9	96.59%
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.01	0.00	0.01	24	0	48	13	53.34%
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.01	16	0	47	12	71.75%
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.01	10	0	25	9	92.42%
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.01	8	0	24	8	96.06%
Sep-20	0.00	0.00	0.01	17	0	40	11	66.09%
Oct-20	0.00	0.00	0.01	17	0	40	11	65.62%
Nov-20	0.01	0.00	0.02	32	8	63	15	45.9%
Dec-20	0.01	0.00	0.02	32	8	64	16	48.37%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.84: Monthly density and population estimates of sitting great skuas only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Great skua	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.01	9	0	25	8	94.63%
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.01	8	0	24	8	101.2%
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.01	8	0	24	8	100.13%
Sep-20	0.00	0.00	0.01	16	0	40	11	66.95%
Oct-20	0.00	0.00	0.01	8	0	24	8	99.89%
Nov-20	0.01	0.00	0.02	40	8	80	20	48.54%
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

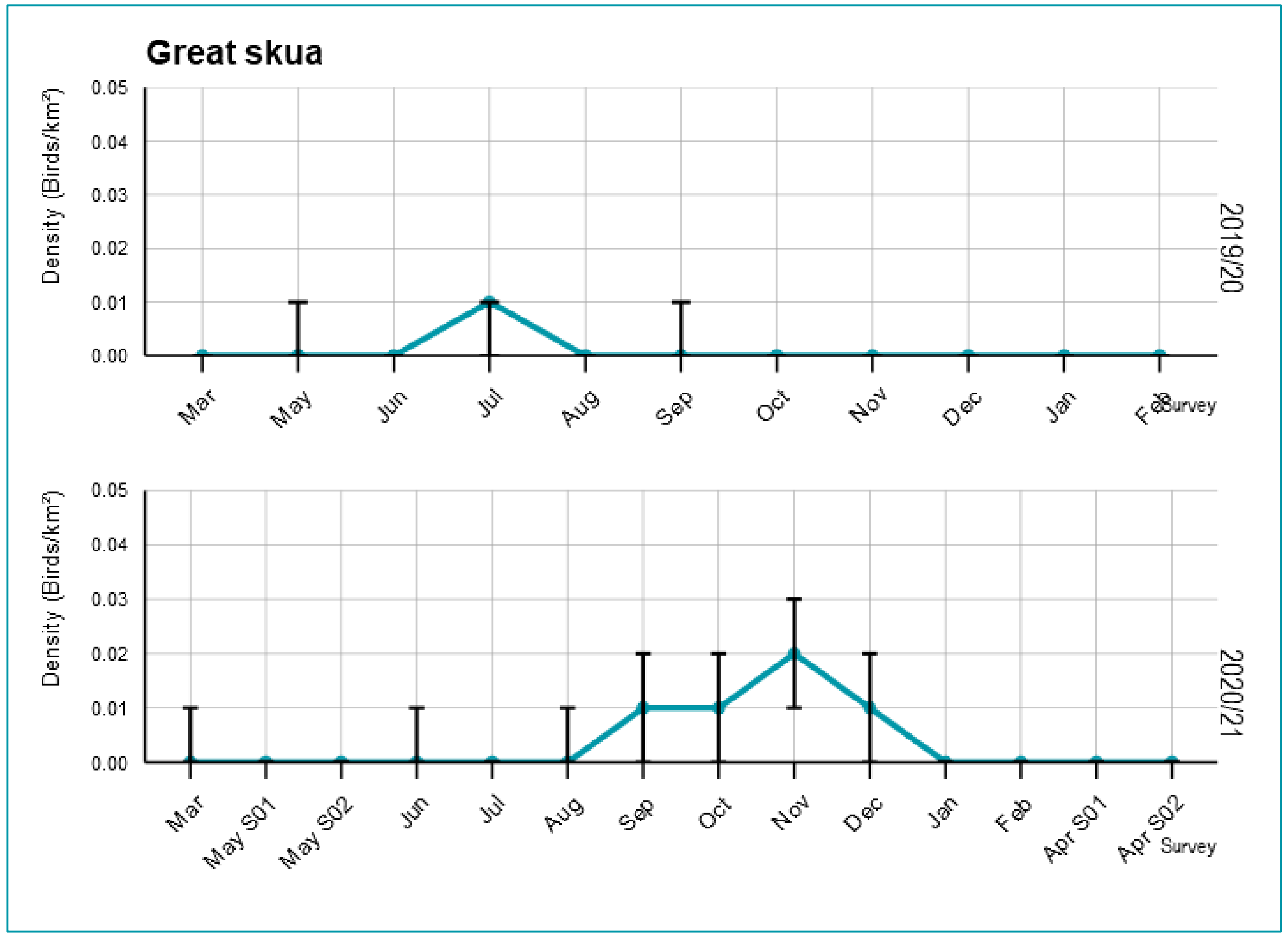

Figure 5.68: Estimated densities (birds/km²) of all great skuas across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.85: Mean seasonal peak (MSP) population and density (birds/km²) of all great skuas in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

All Birds						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	33	8	62	0.01	0.00	0.01
Non-breeding	40	16	72	0.01	0.00	0.02

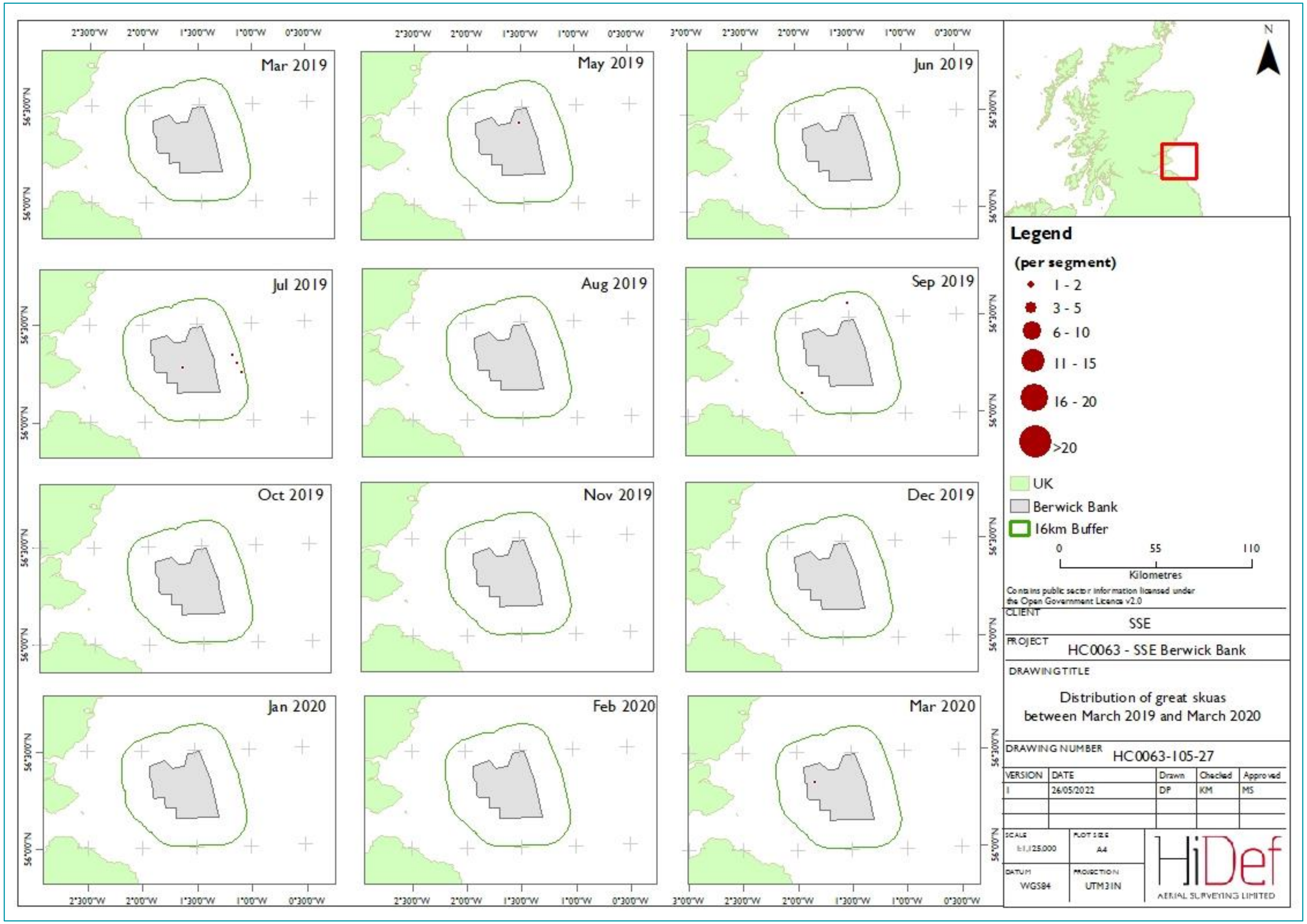

Figure 5.69: **Distribution of great skuas across Offshore Ornithology Study Area between March 2019 and March 2020**

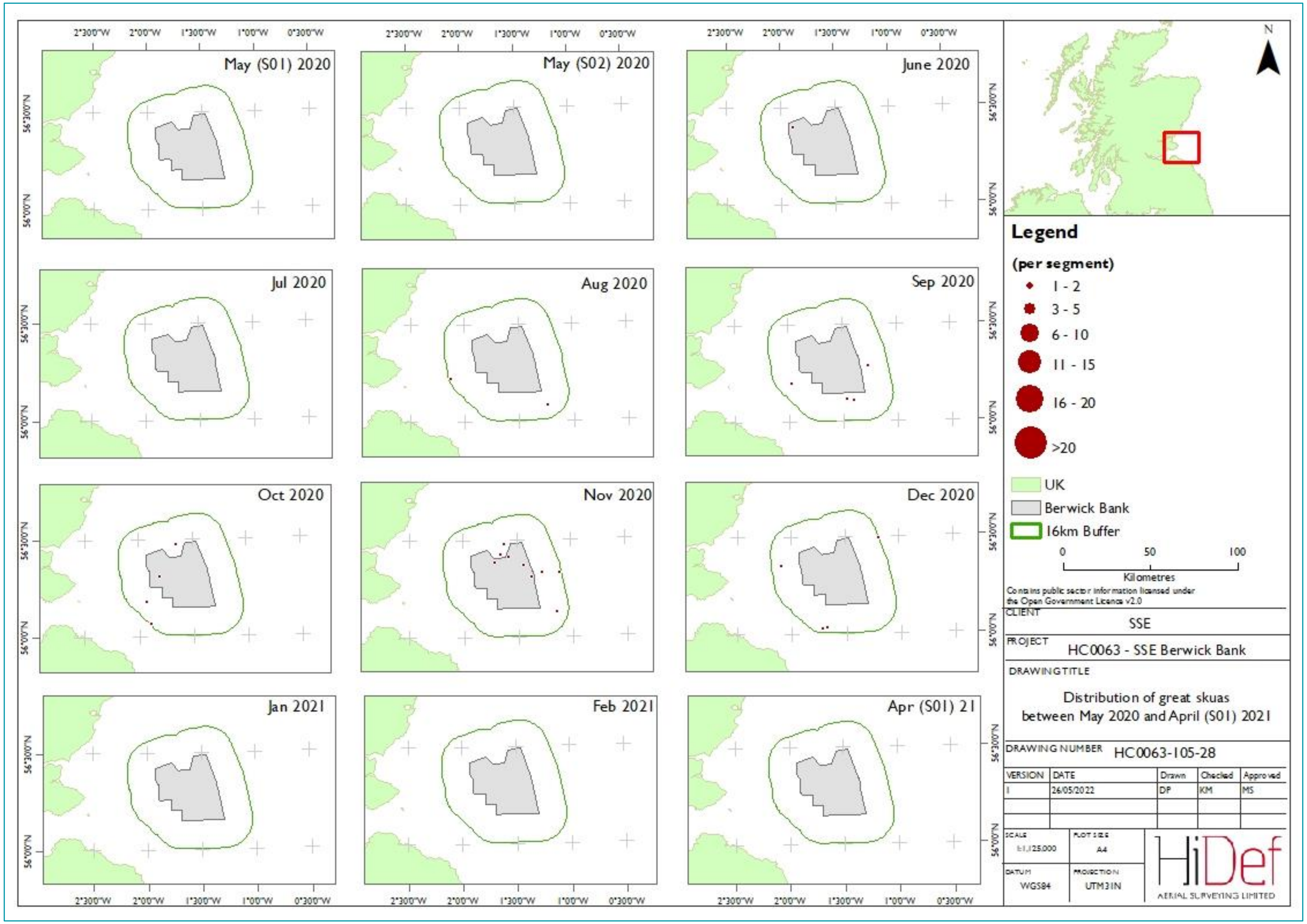

Figure 5.70: **Distribution of great skuas across Offshore Ornithology Study Area between May S01 2020 and April S01 2021**

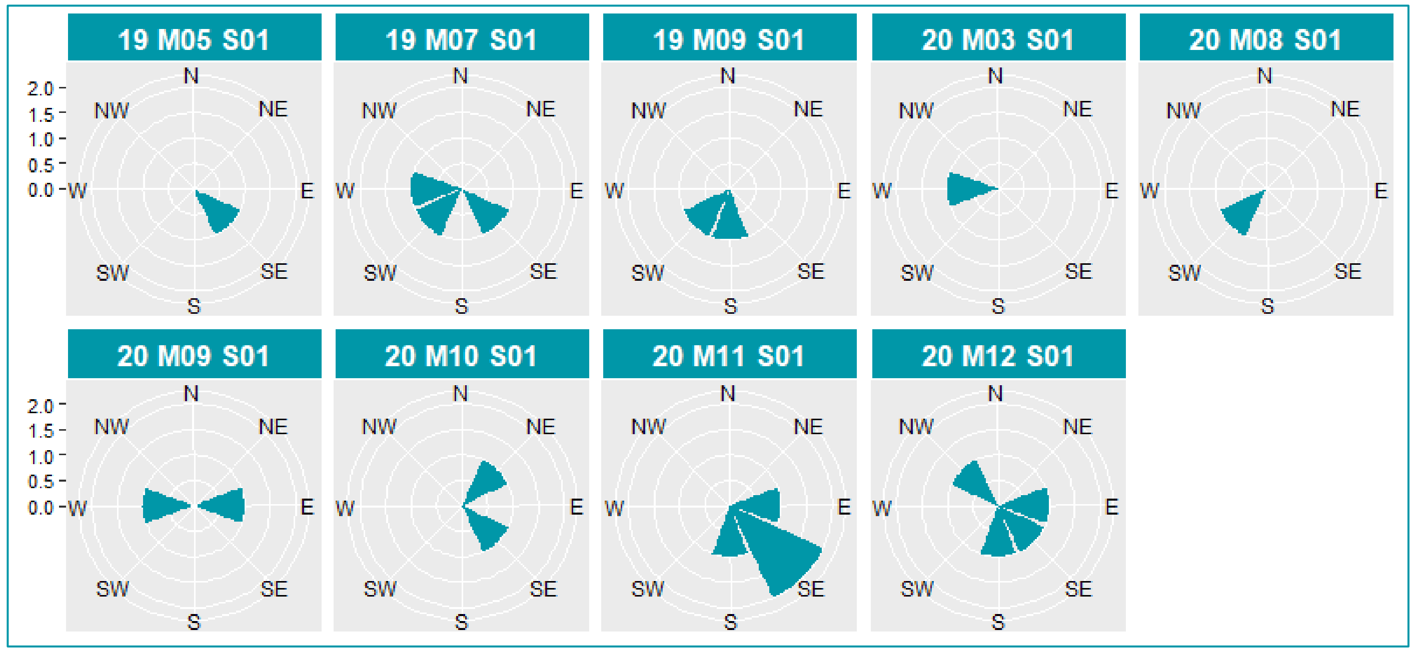

Figure 5.71: Summarised flight direction of great skuas across Offshore Ornithology Study Area

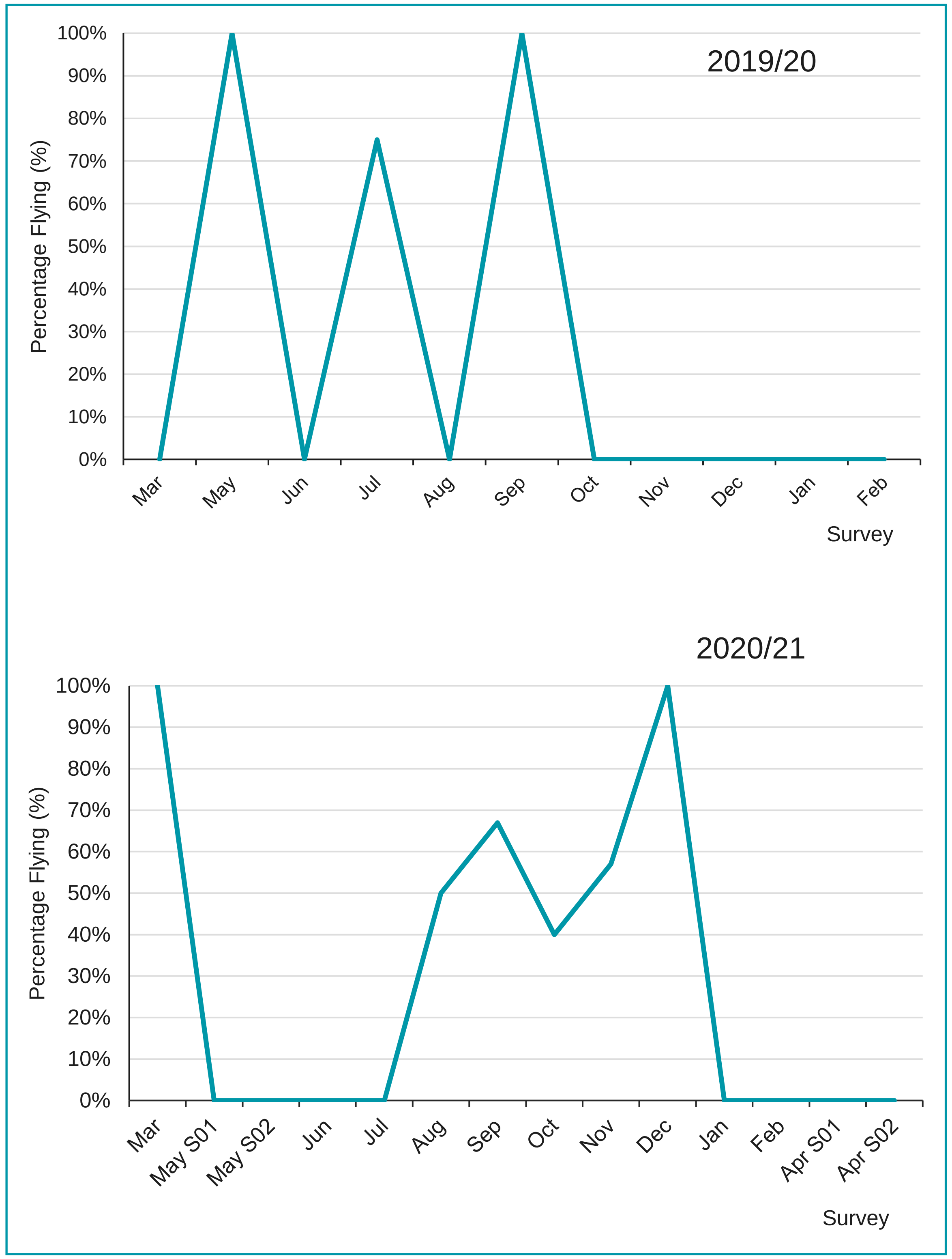

Figure 5.72: Percentage of flying great skuas per survey across Offshore Ornithology Study Area

5.15. RED-THROATED DIVER

214. Typically wintering in UK coastal waters, including estuaries and sandy bays, red-throated divers migrate to higher latitudes during the breeding season, breeding on lochs in Scotland (Campbell, 1993). Listed as an Annex 1 species in the EU Birds Directive, red-throated divers are a qualifying species for many UK SPAs in the non-breeding season, with the Outer Firth of Forth and St Andrews Bay Complex SPA being the closest to the Offshore Ornithology Study Area, supporting about 2% of the GB wintering population, estimated at 90 individuals (Scottish Natural Heritage, 2018). The species is currently Green-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

215. Red-throated divers were observed across the Offshore Ornithology Study Area in late spring and early winter, with peak density of 0.05 birds/km^2 (95%CI 0.02 – 0.09) occurring in November 2020 and equating to an estimated 200 birds (95%CI 72 – 375; Table 5.87). Spring peaks in abundance, such as those recorded in May 2019 and May S02 2020 (57 birds (95%CI 22 – 98) and 34 birds (95%CI 0 – 80) respectively), can be attributed to the presence of pre-breeding congregations of the species, which have previously been observed off the east coast of Scotland in late May. Data summed from ESAS surveys conducted between 1980 and 1996 clipped to the Offshore Ornithology Study Area recorded two birds over the 16-year period, with no birds recorded on either the Project or Seagreen boat-based surveys. No red-throated divers were recorded during the WWT waterbird surveys.

216. Generally, most observations occurred within the 16 km buffer, with birds recorded within the Project intermittently (Figure 5.74 to Figure 5.76). In November 2020, when abundance of red-throated divers peaked, most birds were recorded in the south and west buffer, with some birds distributed in the south of the Proposed Development Array area.

217. Most birds were recorded sitting on the water, but not in large groups; larger counts of birds within 500m transect segments were of 3-5 individuals only (Figure 5.74 - Figure 5.76). No birds were recorded flying.

Table 5.86: Red-throated diver bio-seasons taken from NatureScot (2020a)

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

Table 5.87: Monthly apportioned density and population estimates of all red-throated divers across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Red-throated diver	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.01	0.01	0.02	57	22	98	21	35.93%
Jun-19	0.00	0.00	0.01	18	0	40	12	66.88%
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.01	8	0	25	8	98.22%
Nov-19	0.00	0.00	0.01	8	0	25	8	98.22%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.01	8	0	24	8	97.82%
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.01	0.00	0.02	34	0	80	20	59.03%
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.01	9	0	24	8	93.81%
Nov-20	0.05	0.02	0.09	200	72	375	79	39.22%
Dec-20	0.01	0.00	0.02	33	0	71	18	55.87%
Jan-21	0.01	0.00	0.03	40	0	105	29	72.08%
Feb-21	0.00	0.00	0.01	9	0	24	8	96.39%
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.01	9	0	32	9	96.64%

Table 5.88: Monthly density and population estimates of flying red-throated divers only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Red-throated diver	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.89: **Monthly density and population estimates of sitting red-throated divers only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species**

Sitting Red-throated diver	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.01	0.00	0.02	56	20	99	21	37.29%
Jun-19	0.00	0.00	0.01	16	0	40	11	68.85%
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.01	8	0	25	8	97.34%
Nov-19	0.00	0.00	0.01	8	0	26	8	98.38%
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.01	8	0	24	8	98.91%
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.01	0.00	0.02	33	0	75	20	61.27%
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.01	8	0	24	8	98.93%
Nov-20	0.05	0.02	0.10	207	73	391	81	39.05%
Dec-20	0.01	0.00	0.02	33	0	72	19	57.15%
Jan-21	0.01	0.00	0.02	37	0	98	29	76.48%
Feb-21	0.00	0.00	0.01	9	0	24	8	94.52%
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.01	9	0	24	8	95.56%

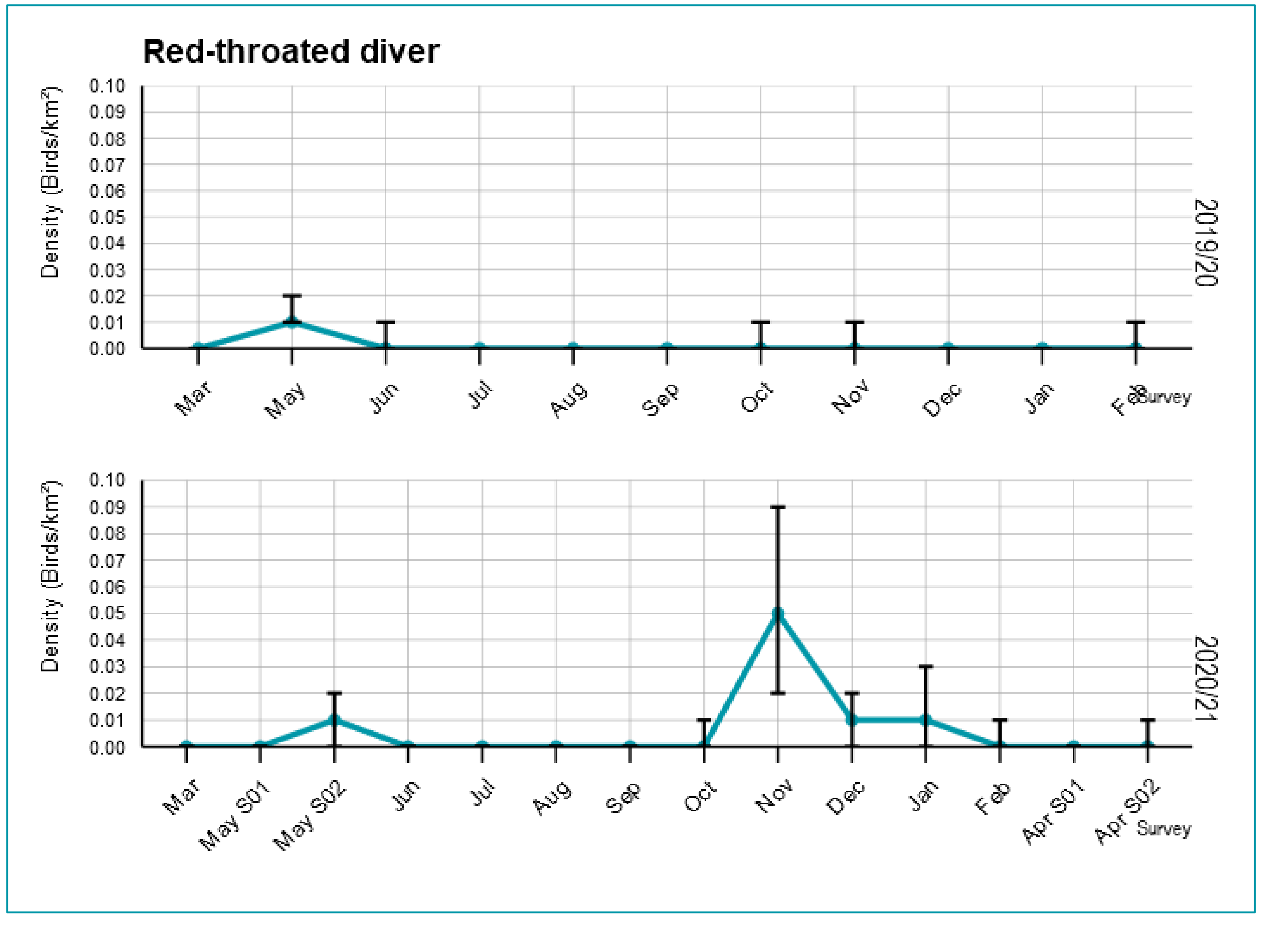

Figure 5.73: **Estimated densities (birds/km²) of all red-throated divers across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species**

Table 5.90: **Mean seasonal peak (MSP) population and density (birds/km²) of all red-throated divers in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis**

All Birds MSP						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	46	11	89	0.01	0.00	0.02
Non-breeding	105	36	204	0.03	0.01	0.05

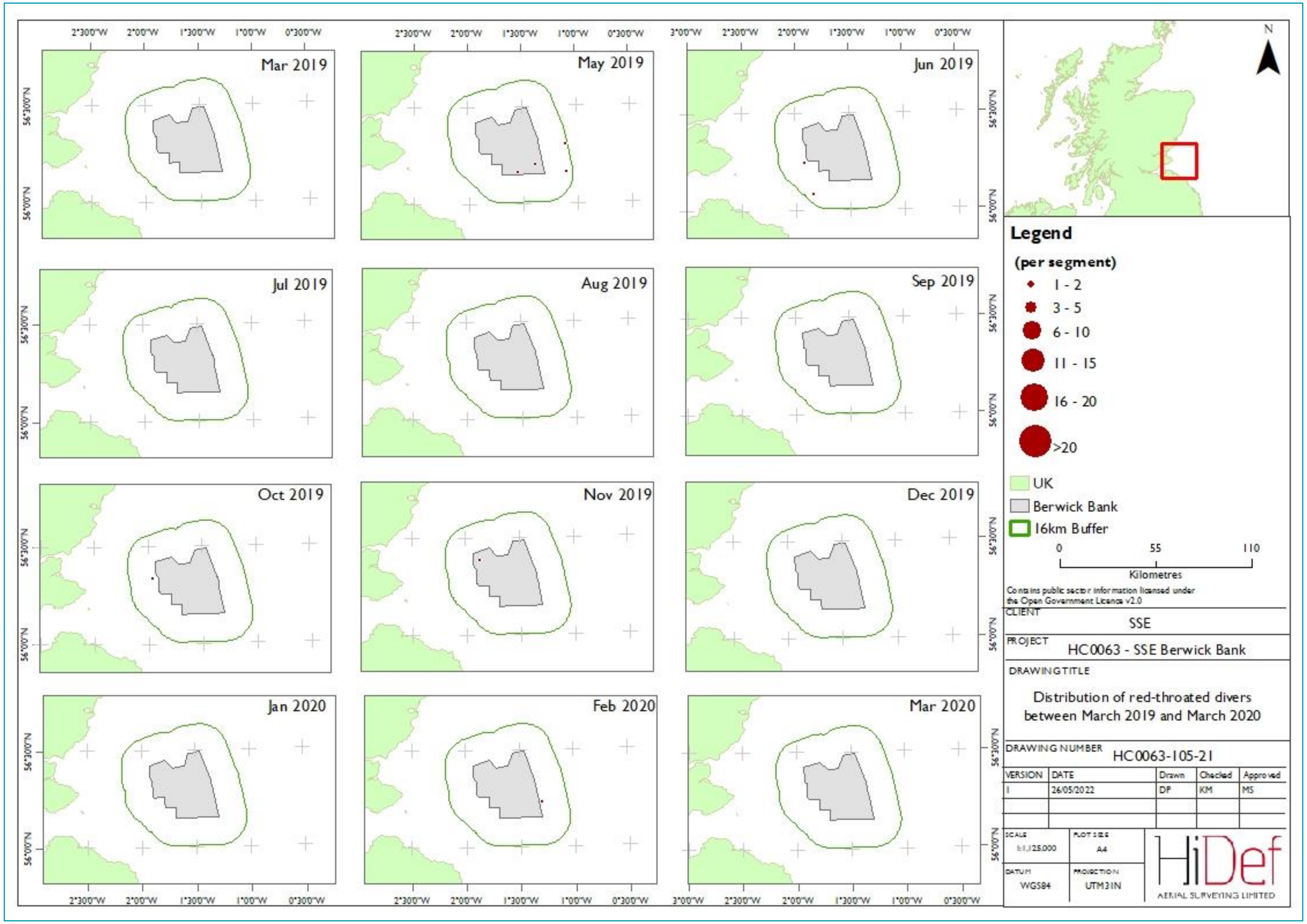

Figure 5.74: Distribution of red-throated divers across Offshore Ornithology Study Area between March 2019 and March 2020

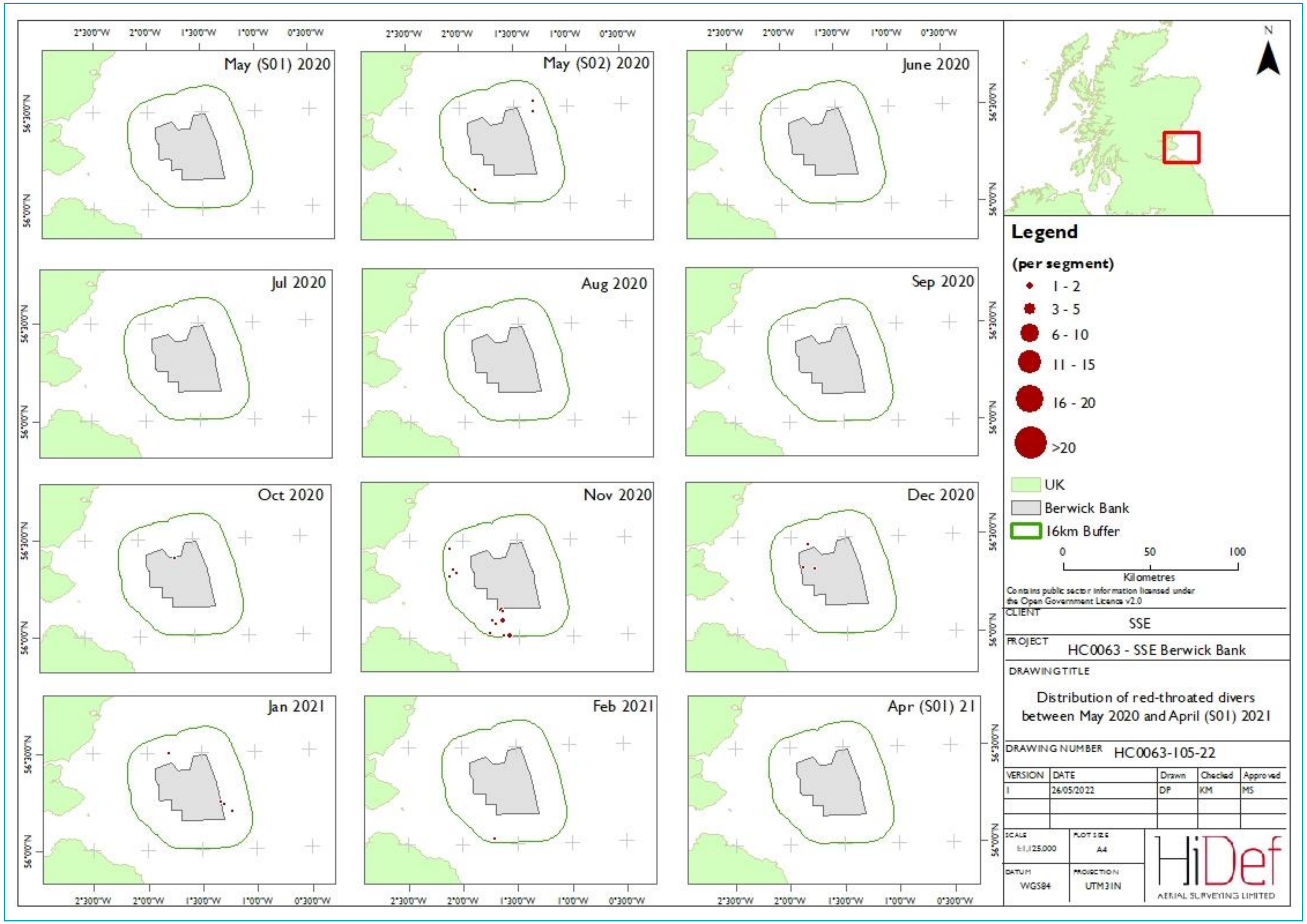

Figure 5.75: Distribution of red-throated divers across Offshore Ornithology Study Area between May S01 2020 and April S01 2021

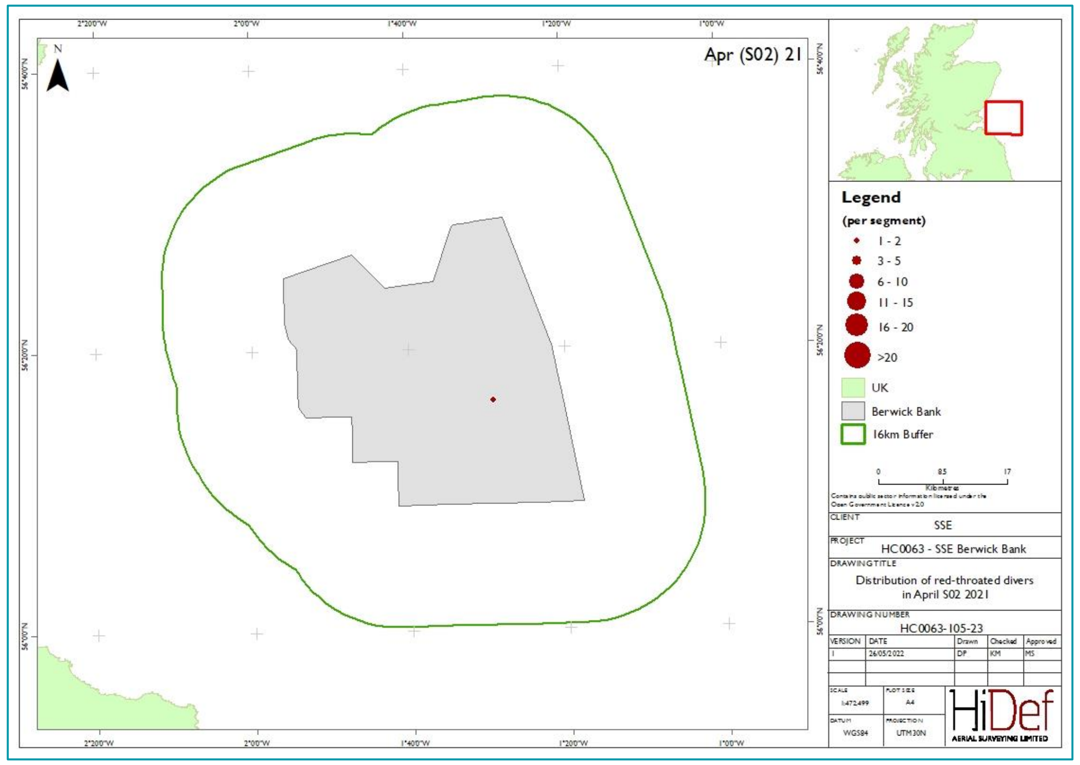

Figure 5.76: Distribution of red-throated divers across Offshore Ornithology Study Area April S02 2021

5.16. FULMAR

218. One of the most common seabird species found in the UK, fulmars typically breed on cliffs before moving offshore during the non-breeding period (Mitchell et al., 2004). Over the 20th Century fulmar populations dramatically increased (Fisher, 1952), however this has since stabilised, with declines experienced in some areas (Mitchell *et al*., 2004). Fulmars are generally long-lived with a low reproductive rate, making them particularly susceptible to environmental variations and anthropogenic impacts (Hatch 1987; Thompson, 2006). Fulmars are a qualifying species for the nearby Fowlsheugh SPA, which supports approximately 157 AOS (NatureScot, 2018; SMP, 2021). The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

219. Fulmar densities were relatively consistent throughout the first year of aerial survey is with slight increases in March 2019 and between November 2019 and January 2020 during the non-breeding season (Figure 5.77). In Year 2, two large peaks in densities were estimated, occurring in September and December 2020 at 0.77 birds/km^2 (95%CI 0.65 – 0.88) and 0.38 birds/km^2 (95%CI 0.28 – 0.48), during the breeding and non-breeding seasons (Table 5.92).

220. Fulmars were recorded during boat-based surveys of the Project and Seagreen Alpha and Bravo, occurring in regionally important numbers in the latter survey areas. Boat-based surveys conducted throughout the outer Firth of Forth as part of the IMPRESS project (Camphuysen *et al*., 2004), reported the species as present in low abundances, accounting for 0.6% of total observations. This was also true for WWT waterbird surveys, in which only 25 individuals were recorded.

221. The breeding season begins in April, with females exhibiting a pre-laying exodus from coastal colonies a month prior to laying, which may be visible in the slight increase in fulmar abundance in April S02 2021. Egg-laying begins in earnest in May, with birds closely associated to nest sites from May to mid-July. During these months, densities of fulmars were at their lowest in the Offshore Ornithology Study Area, as most birds would be in attendance at colonies. The highest mean seasonal peaks in density were observed during the breeding season (Table 5.95), with a large proportion of birds recorded as sitting on the water, suggesting use of the area for foraging. These results are largely influenced by the relatively high abundance calculated for September 2020, at the end of the breeding season, when birds are dispersing from colonies along the coast.

222. Outside of the breeding season, fulmars are highly pelagic, moving further offshore to spend the winter at sea. Few birds were recorded during the non-breeding season, such as in February 2019, suggesting birds are utilising the Offshore Ornithology Study Area most during dispersal periods between colonies and wintering areas (Table 5.95).

223. Distribution maps indicate widespread use of the Offshore Ornithology Study Area, with many birds recorded in the south and west during the breeding season, such as in June 2019 and May S01 2020 (Figure 5.78 to Figure 5.80).

224. Flight direction of fulmars varied between surveys (Figure 5.81).

Table 5.91: Fulmar bio-seasons taken from NatureScot (2020a)

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

Table 5.92: Monthly density and population estimates of all fulmars across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Fulmar	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.16	0.11	0.21	639	456	817	97	15.18%
May-19	0.08	0.05	0.11	303	200	429	61	19.96%
Jun-19	0.06	0.03	0.12	253	127	462	84	33.03%
Jul-19	0.07	0.05	0.09	265	194	347	40	14.75%
Aug-19	0.07	0.05	0.10	273	187	379	50	18.34%
Sep-19	0.05	0.03	0.07	209	130	296	44	20.66%
Oct-19	0.02	0.01	0.03	67	30	105	20	29.8%
Nov-19	0.15	0.11	0.20	605	420	809	102	16.83%
Dec-19	0.14	0.10	0.19	557	396	738	91	16.32%
Jan-20	0.14	0.10	0.18	539	392	703	83	15.41%
Feb-20	0.05	0.03	0.07	201	104	293	47	23.25%
Mar-20	0.10	0.06	0.14	379	243	540	81	21.29%
May S01 20	0.06	0.03	0.09	243	139	361	57	23.5%
May S02 20	0.03	0.02	0.06	138	64	225	40	28.8%
Jun-20	0.07	0.05	0.10	290	185	415	58	19.81%
Jul-20	0.05	0.03	0.07	199	123	281	41	20.56%
Aug-20	0.10	0.07	0.14	395	267	554	73	18.4%
Sep-20	0.77	0.65	0.88	3050	2602	3499	232	7.6%
Oct-20	0.26	0.18	0.33	1019	728	1323	158	15.5%
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.38	0.28	0.48	1502	1117	1913	201	13.34%
Jan-21	0.11	0.08	0.15	457	316	599	74	16.12%
Feb-21	0.14	0.09	0.20	553	374	783	107	19.25%
Apr S01 21	0.03	0.02	0.06	136	66	222	40	28.83%

All Fulmar	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Apr S02 21	0.13	0.08	0.18	502	335	701	89	17.65%

Table 5.93: Monthly density and population estimates of flying fulmars only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Fulmar	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.07	0.05	0.09	270	188	369	45	16.5%
May-19	0.03	0.01	0.04	112	56	167	29	25.94%
Jun-19	0.01	0.00	0.01	24	0	48	13	53.71%
Jul-19	0.03	0.01	0.04	108	57	175	30	27.06%
Aug-19	0.04	0.03	0.06	178	113	247	35	19.23%
Sep-19	0.03	0.02	0.05	130	71	201	35	26.42%
Oct-19	0.00	0.00	0.01	17	0	41	12	72.15%
Nov-19	0.08	0.06	0.11	328	226	430	55	16.56%
Dec-19	0.09	0.06	0.12	355	241	481	63	17.57%
Jan-20	0.10	0.06	0.14	402	252	553	76	18.91%
Feb-20	0.03	0.01	0.05	113	48	191	39	34.11%
Mar-20	0.07	0.05	0.10	294	194	405	56	19.04%
May S01 20	0.03	0.01	0.04	103	52	164	29	28.1%
May S02 20	0.03	0.01	0.04	103	52	166	31	29.5%
Jun-20	0.06	0.04	0.08	236	153	326	44	18.6%
Jul-20	0.03	0.02	0.05	137	71	203	33	23.69%
Aug-20	0.07	0.05	0.09	276	192	366	47	16.79%
Sep-20	0.30	0.24	0.37	1194	937	1454	137	11.47%
Oct-20	0.10	0.07	0.13	399	273	532	68	16.96%
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.23	0.18	0.29	924	700	1158	120	12.95%
Jan-21	0.06	0.04	0.08	239	152	336	47	19.62%
Feb-21	0.06	0.05	0.08	249	181	327	39	15.34%
Apr S01 21	0.02	0.01	0.04	94	40	169	34	36.04%
Apr S02 21	0.06	0.04	0.09	258	162	355	49	19%

Table 5.94: Monthly density and population estimates of sitting fulmars only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Fulmar	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.09	0.06	0.12	359	240	495	65	18%
May-19	0.05	0.03	0.07	194	109	298	48	24.42%
Jun-19	0.06	0.02	0.10	223	98	417	83	37.15%
Jul-19	0.04	0.03	0.06	159	106	226	32	20.14%
Aug-19	0.02	0.01	0.04	98	43	165	31	31.65%
Sep-19	0.02	0.01	0.03	80	32	127	25	30.61%

Sitting Fulmar	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Oct-19	0.01	0.00	0.02	46	15	86	20	41.96%
Nov-19	0.07	0.04	0.10	273	158	411	70	25.33%
Dec-19	0.05	0.02	0.09	209	97	373	70	33.21%
Jan-20	0.04	0.02	0.06	141	63	231	44	30.6%
Feb-20	0.02	0.01	0.04	89	32	159	33	37.09%
Mar-20	0.02	0.00	0.05	84	17	185	45	52.68%
May S01 20	0.04	0.02	0.05	140	65	218	40	28.17%
May S02 20	0.01	0.00	0.02	33	0	94	25	75.69%
Jun-20	0.01	0.00	0.03	48	8	105	26	54.02%
Jul-20	0.02	0.01	0.02	62	31	97	19	29.33%
Aug-20	0.03	0.01	0.05	115	45	206	41	35.32%
Sep-20	0.46	0.36	0.57	1837	1434	2254	210	11.38%
Oct-20	0.15	0.10	0.21	594	390	854	123	20.69%
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.14	0.08	0.21	552	310	836	135	24.32%
Jan-21	0.05	0.03	0.08	216	126	312	46	21.3%
Feb-21	0.07	0.04	0.12	297	142	485	88	29.44%
Apr S01 21	0.01	0.00	0.02	42	8	85	21	50.07%
Apr S02 21	0.06	0.04	0.10	252	152	387	61	23.91%

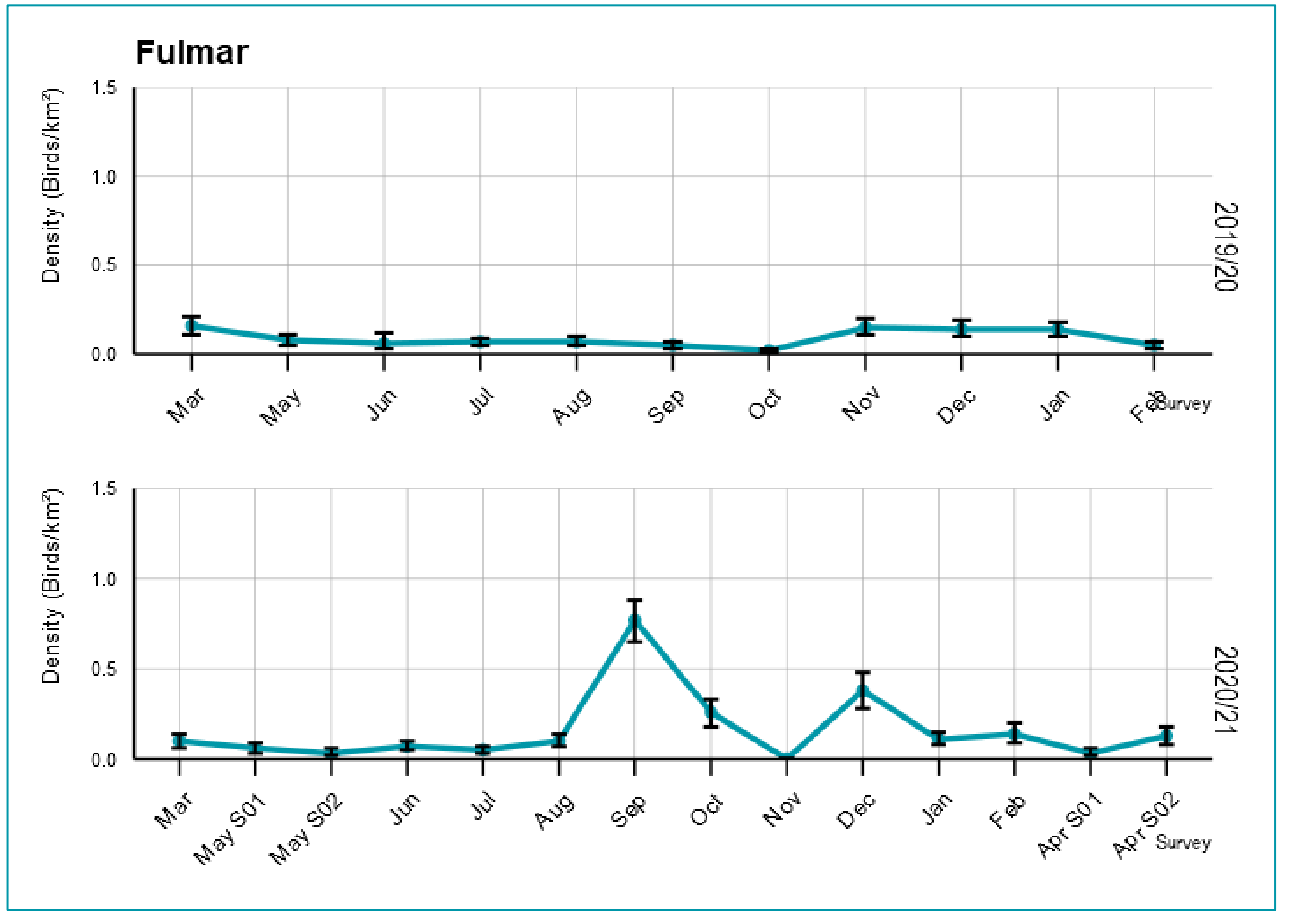

Figure 5.77: Estimated densities (birds/km²) of all fulmars across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.95: Mean seasonal peak (MSP) population and density (birds/km²) of all fulmars in the Offshore Ornithology Study Area in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis. Data include "no-identification" birds apportioned to species

All Birds MSP						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	1776	1469	2100	0.45	0.36	0.53
Non-breeding	1071	787	1365	0.27	0.20	0.34

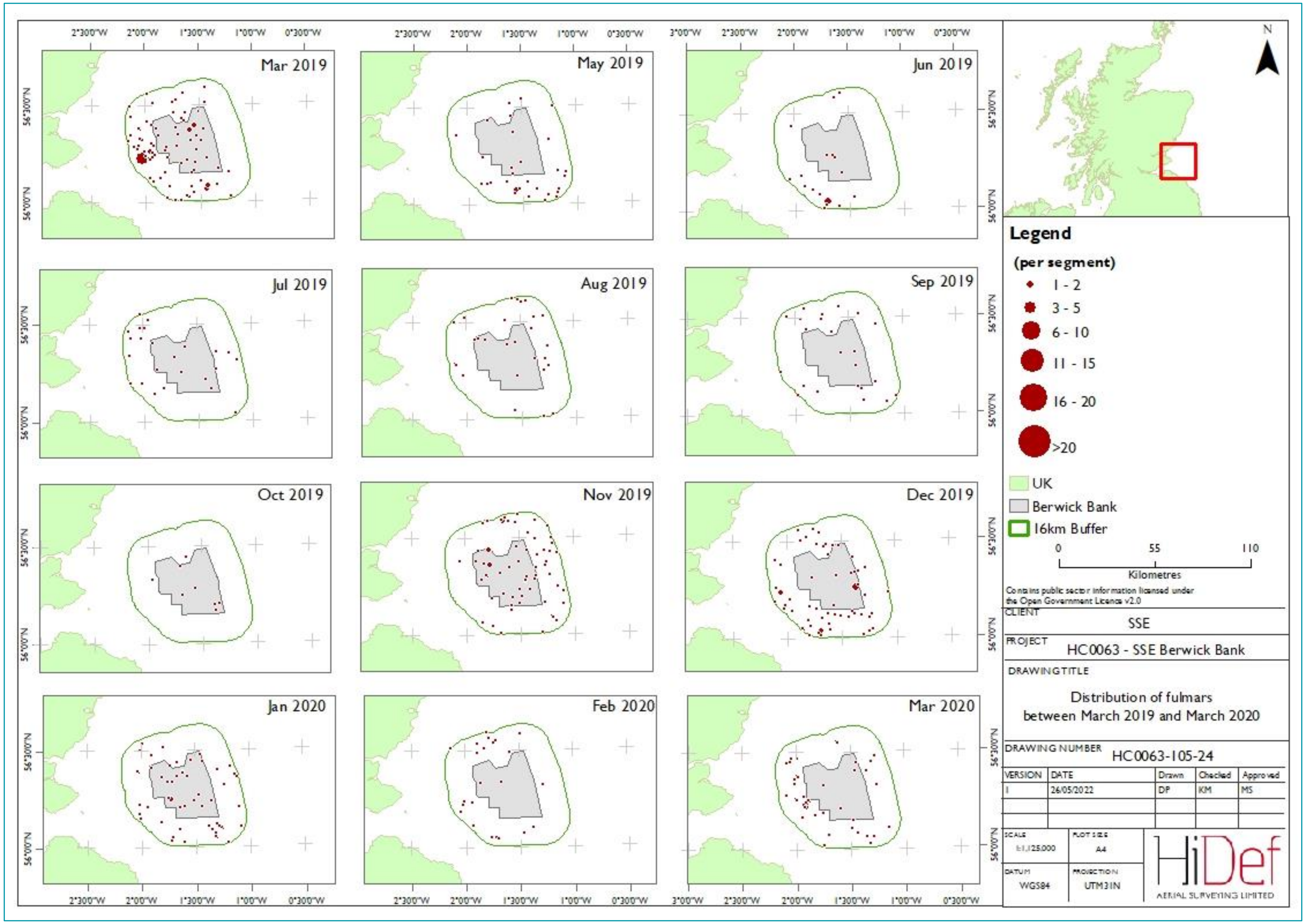

Figure 5.78: Distribution of fulmars across Offshore Ornithology Study Area between March 2019 and March 2020

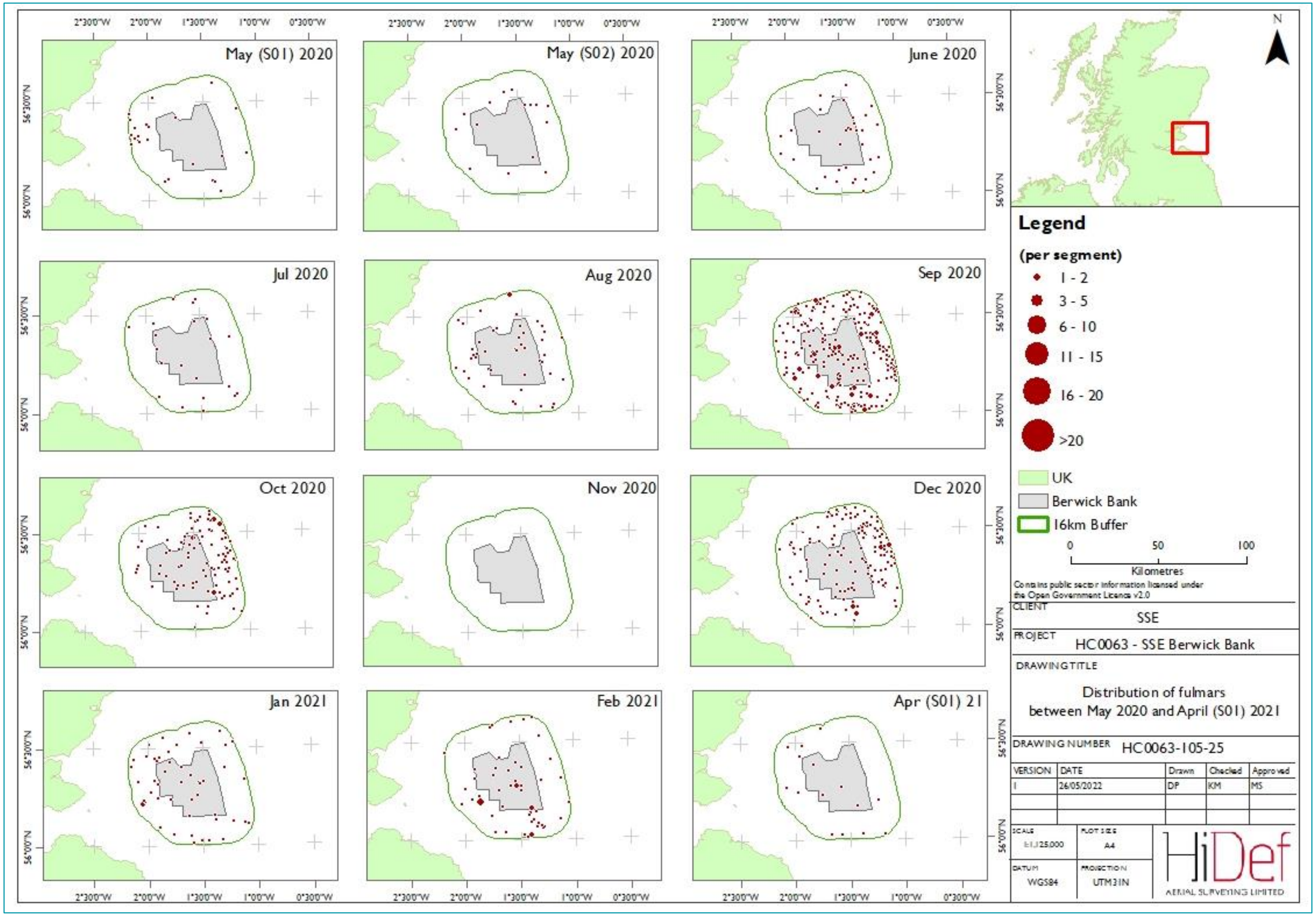

Figure 5.79: Distribution of fulmars across Offshore Ornithology Study Area between May S01 2020 and April S01 2021

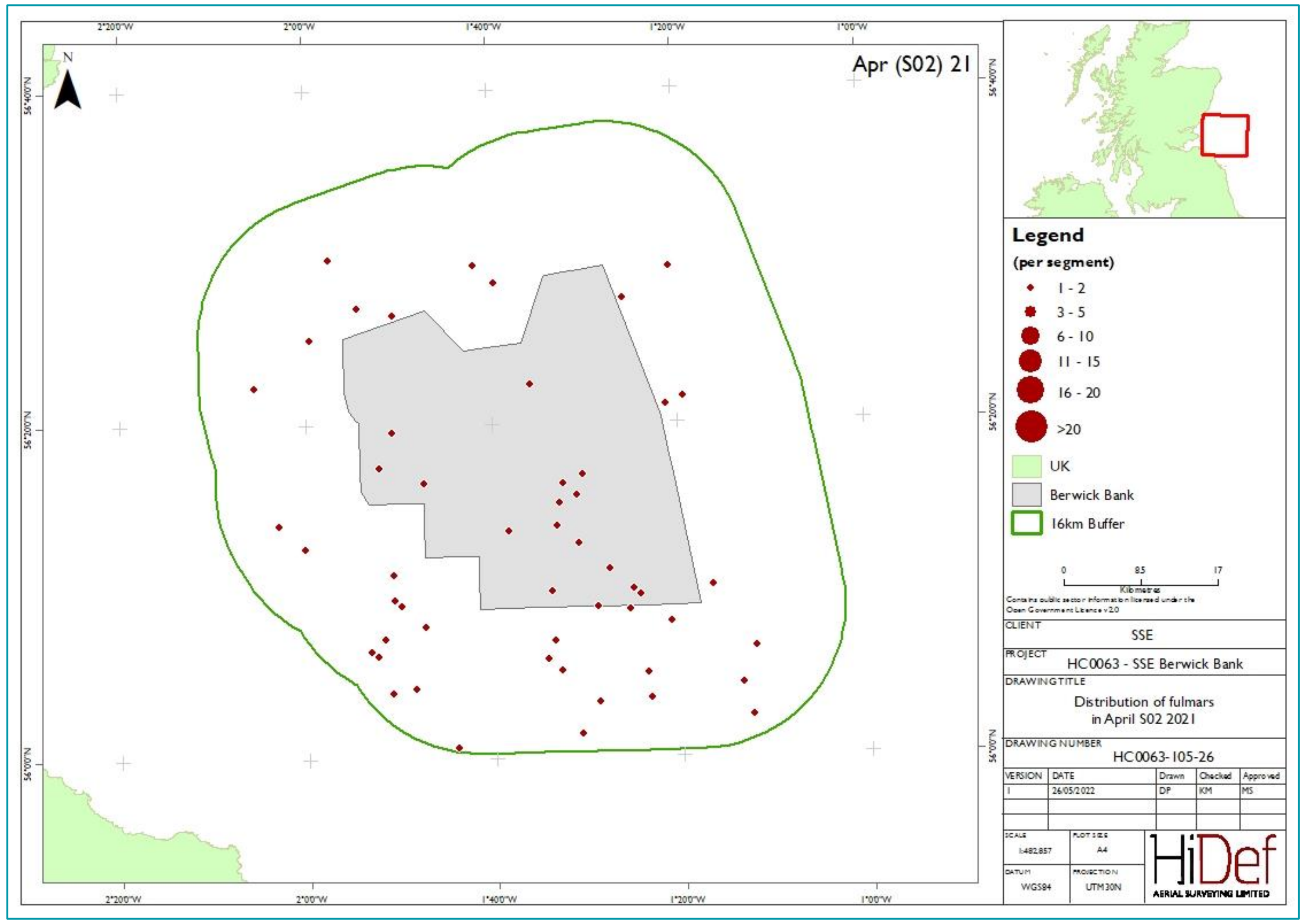

Figure 5.80: Distribution of fulmars across Offshore Ornithology Study Area April S02 2021

Figure 5.81: Summarised flight direction of fulmars across Offshore Ornithology Study Area

Figure 5.82: Percentage of flying fulmars per survey across Offshore Ornithology Study Area

5.17. MANX SHEARWATER

225. Manx shearwaters are highly pelagic and migratory, coming to coastal colonies to breed between April and October, before migrating south away from the UK during the non-breeding season (Guilford *et al*., 2009; NatureScot, 2020a). Approximately 89% of the world population breeds in Great Britain and Ireland (Mitchell *et al.,* 2004), with around 40% of these birds breeding on Rum, off the west coast of Scotland (Newton *et al.*, 2004). The species is vulnerable to predation by other seabird species such as great black-backed gulls and great skuas (Newton *et al.,* 2004). As pursuit divers, they mainly target small shoaling fish, molluscs and crustaceans (JNCC, 2016). The species is currently Amber-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

226. Manx shearwater densities were generally low with birds primarily observed during the breeding season, peaking in June in both Year 1 and Year 2 (Figure 5.84). In these months, peak densities were calculated at 0.02 birds/km^2 (95%CI 0.00 0.04) and 0.04 birds/km^2 (95%CI 0.02 – 0.07) respectively, equating to population estimates of 72 birds (95%CI 16 – 150) and 153 birds (95%CI 63 – 268; Table 5.97). Mean peak population estimates for both years of surveys were calculated at 113 birds (95%CI 40 – 209) during the breeding season (Table 5.100).

227. Berwick Bank boat-based surveys of in 2020-2021 recorded low numbers of Manx shearwaters across the survey period, with the species also not listed as a key species in the Seagreen Alpha or Bravo boat-based surveys. Site-specific digital aerial video pre-construction monitoring surveys of the same area suggested the species may be present in low numbers.

228. Distribution of Manx shearwaters was variable, with birds distributed to the south and west, such as in June 2019, and July and September 2020 (Figure 5.84 and Figure 5.85). In June 2020, many birds were also distributed in the northwest buffer.

229. Generally, Manx shearwater were mostly recorded in flight on surveys (67%). Higher proportions of sitting birds recorded during the breeding season may be due to the presence of rafting or foraging birds (Richards *et al*., 2019). The species is a qualifying species for the Outer Firth of Forth and St Andrews Bay Complex SPA since the area hosts one of only five known at-sea aggregations in Great Britain and the only east coast aggregation (JNCC, 2016).

230. Flight direction was variable (Figure 5.86).

Table 5.96: Manx shearwater bio-seasons taken from NatureScot (2020a)

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

Table 5.97: Monthly density and population estimates of all Manx shearwaters across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Manx shearwater	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.02	0.00	0.04	72	16	150	36	49.23%
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.01	18	0	45	13	71.87%
Sep-19	0.01	0.00	0.03	37	0	101	26	70.09%
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.04	0.02	0.07	153	63	268	52	33.88%
Jul-20	0.01	0.00	0.03	43	0	117	34	80.07%
Aug-20	0.02	0.00	0.05	68	0	191	64	94.13%
Sep-20	0.01	0.00	0.02	26	2	63	16	61.55%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.98: Monthly density and population estimates of flying Manx shearwaters only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Manx shearwater	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.02	0.00	0.03	66	8	138	35	53.14%
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.01	9	0	26	9	95.58%
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.02	0.01	0.05	98	32	198	43	43.79%
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.02	0.00	0.05	64	0	191	62	97.57%
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.99: Monthly density and population estimates of sitting Manx shearwaters only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Manx shearwater	Density Estimate (birds/ km^2)	Lower 95% CI (birds/ km^2)	Upper 95% CI (birds/ km^2)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.01	9	0	25	8	94.68%
Sep-19	0.01	0.00	0.02	39	3	100	25	65.53%
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.01	0.00	0.03	56	8	115	27	48.24%
Jul-20	0.01	0.00	0.03	39	0	103	34	88.32%
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.01	0.00	0.02	26	2	61	16	61.78%
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

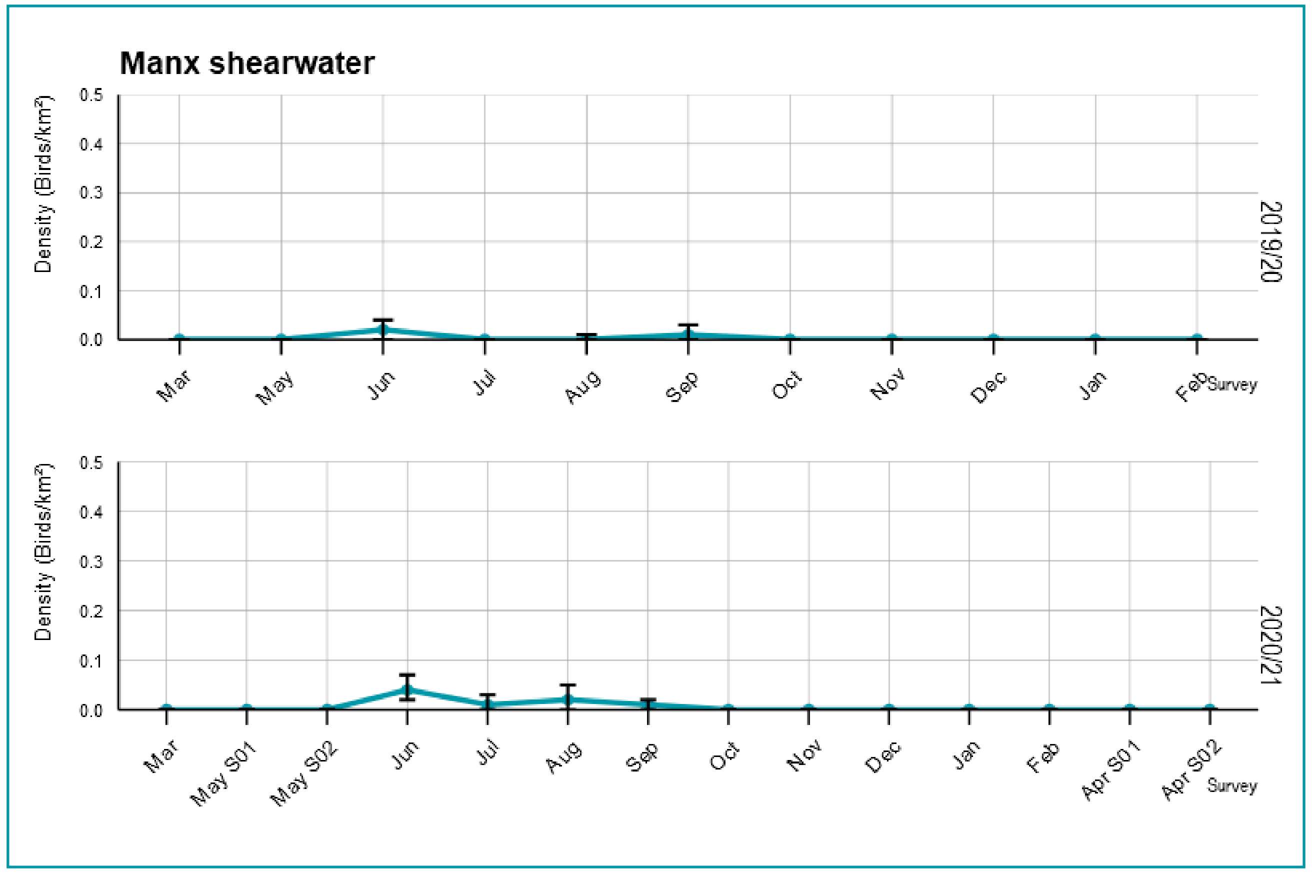

Figure 5.83: Estimated densities (birds/km²) of all Manx shearwaters across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.100: Mean seasonal peak (MSP) population and density (birds/km²) of all Manx shearwaters in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis

All Birds						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	113	40	209	0.03	0.01	0.06
Non-breeding	0	0	0	0.00	0.00	0

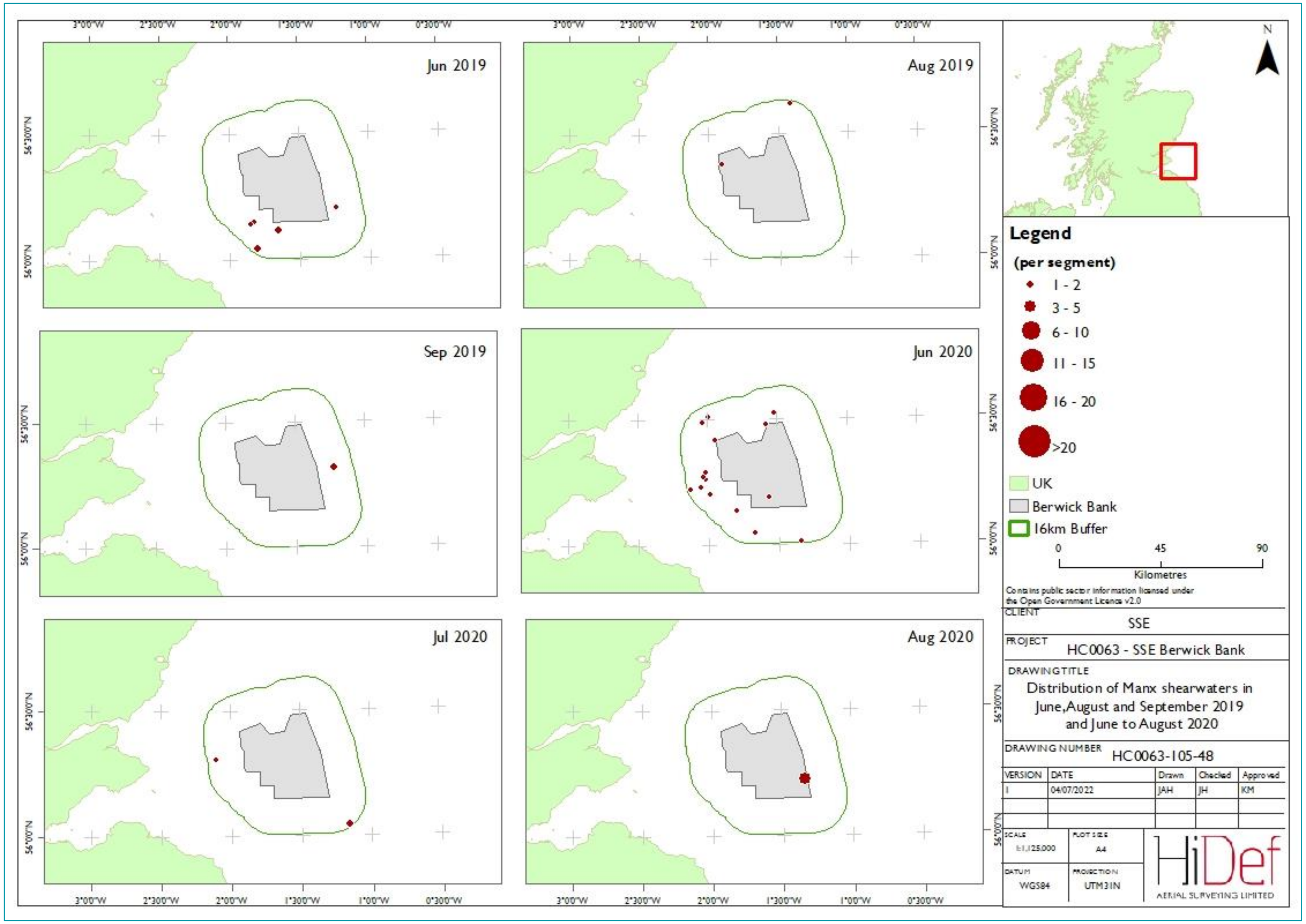

Figure 5.84: Distribution of Manx shearwaters across Offshore Ornithology Study Area in June, August and September 2019 and June to August in 2020

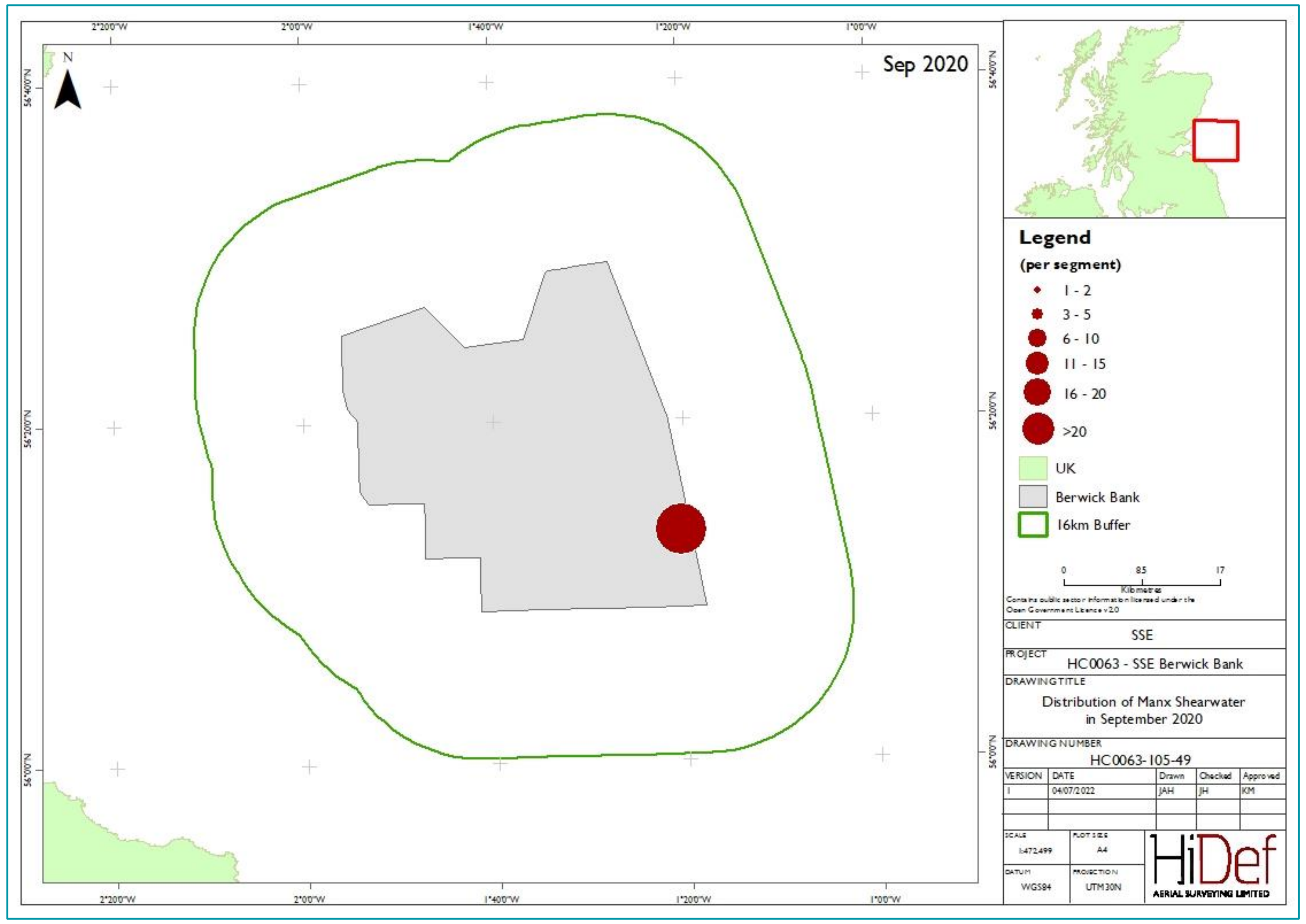

Figure 5.85: **Distribution of Manx shearwaters across Offshore Ornithology Study Area September 2020**

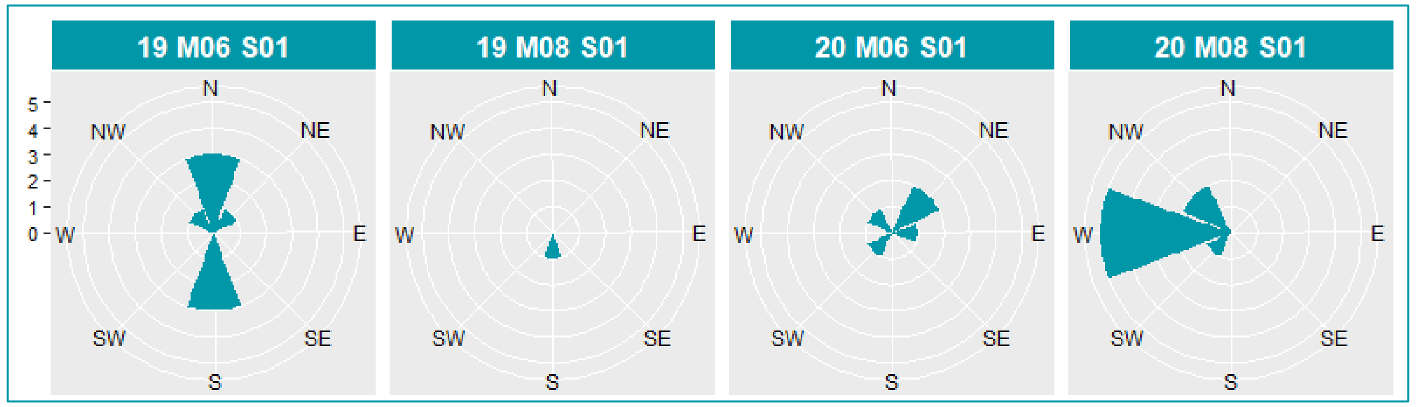

Figure 5.86: **Summarised flight direction of Manx shearwaters across Offshore Ornithology Study Area**

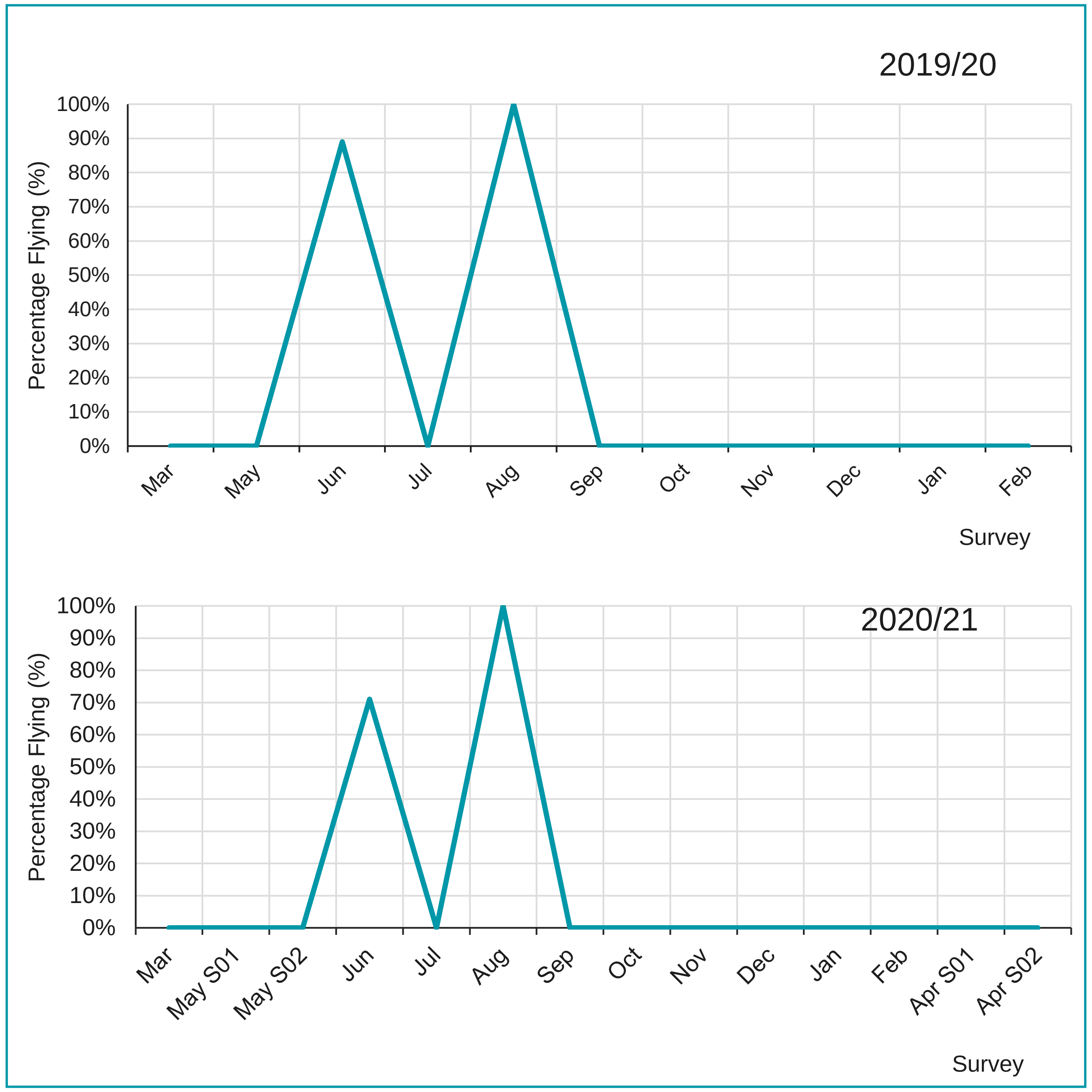

Figure 5.87: **Percentage of flying Manx shearwaters per survey across Offshore Ornithology Study Area**

5.18. SHAG

231. Distributed throughout the northeast Atlantic and Mediterranean, the UK supports approximately 34% of the global shag population (Wanless and Harris, 1997; JNCC 2016). Pursuit divers, they primarily feed on small fish species, such as saithe and sandeel (Harris and Wanless, 1991; Lorentsen *et al*., 2018). Shags are a qualifying species for the nearby Forth Islands, Outer Firth of Forth and St. Andrews Bay Complex and St. Abb's Head to Fast Castle SPA's. Colonies at the Isle of May and St. Abb's National Nature Reserve were estimated to support approximately 404 and 133 AON respectively in 2018 and 2015 (SMP, 2021). The species is currently Red-listed on the UK Birds of Conservation Concern List (Stanbury *et al*., 2021).

232. Shags were only recorded twice in the Offshore Ornithology Study Area, on the June 2019 and December 2020 surveys (Figure 5.88). Design-based density estimates for June 2019 were 0.01 birds/km2 (95%CI 0.00 – 0.02), equating to a population estimate of 25 birds (95% CI 0 –72). The mean seasonal peak population estimate for the breeding season was 12 birds (95% CI 0 – 36; Table 5.105) compared to the non-breeding season, where 5 birds (95%CI 0 – 12) were estimated to be present.

233. Shags were not an abundant species during the Berwick Bank boat-based surveys in 2020 and 2021 or on the Seagreen boat-based surveys.

234. Birds were distributed in the south of the Offshore Ornithology Study in both June 2019 and December 2020, present in the buffer. All shags were recorded flying northwest (Figure 5.91).

Table 5.101: Manx shearwater bio-seasons taken from NatureScot (2020a)

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

Table 5.102: Monthly density and population estimates of all shags across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

All Shag	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.01	0.00	0.02	23	0	72	24	106.55%
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.01	9	0	24	8	98.77%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.103: Monthly density and population estimates of flying shags only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Flying Shag	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.01	0.00	0.02	25	0	72	25	99.04%
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.00	0	0	0	0	0
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

Table 5.104: Monthly density and population estimates of sitting shags only across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Sitting Shag	Density Estimate (birds/ km²)	Lower 95% CI (birds/ km²)	Upper 95% CI (birds/ km²)	Population Estimate (number)	Lower 95% CI (number)	Upper 95% CI (number)	SD	CV (%)
Survey								
Mar-19	0.00	0.00	0.00	0	0	0	0	0
May-19	0.00	0.00	0.00	0	0	0	0	0
Jun-19	0.00	0.00	0.00	0	0	0	0	0
Jul-19	0.00	0.00	0.00	0	0	0	0	0
Aug-19	0.00	0.00	0.00	0	0	0	0	0
Sep-19	0.00	0.00	0.00	0	0	0	0	0
Oct-19	0.00	0.00	0.00	0	0	0	0	0
Nov-19	0.00	0.00	0.00	0	0	0	0	0
Dec-19	0.00	0.00	0.00	0	0	0	0	0
Jan-20	0.00	0.00	0.00	0	0	0	0	0
Feb-20	0.00	0.00	0.00	0	0	0	0	0
Mar-20	0.00	0.00	0.00	0	0	0	0	0
May S01 20	0.00	0.00	0.00	0	0	0	0	0
May S02 20	0.00	0.00	0.00	0	0	0	0	0
Jun-20	0.00	0.00	0.00	0	0	0	0	0
Jul-20	0.00	0.00	0.00	0	0	0	0	0
Aug-20	0.00	0.00	0.00	0	0	0	0	0
Sep-20	0.00	0.00	0.00	0	0	0	0	0
Oct-20	0.00	0.00	0.00	0	0	0	0	0
Nov-20	0.00	0.00	0.00	0	0	0	0	0
Dec-20	0.00	0.00	0.01	9	0	24	8	94.77%
Jan-21	0.00	0.00	0.00	0	0	0	0	0
Feb-21	0.00	0.00	0.00	0	0	0	0	0
Apr S01 21	0.00	0.00	0.00	0	0	0	0	0
Apr S02 21	0.00	0.00	0.00	0	0	0	0	0

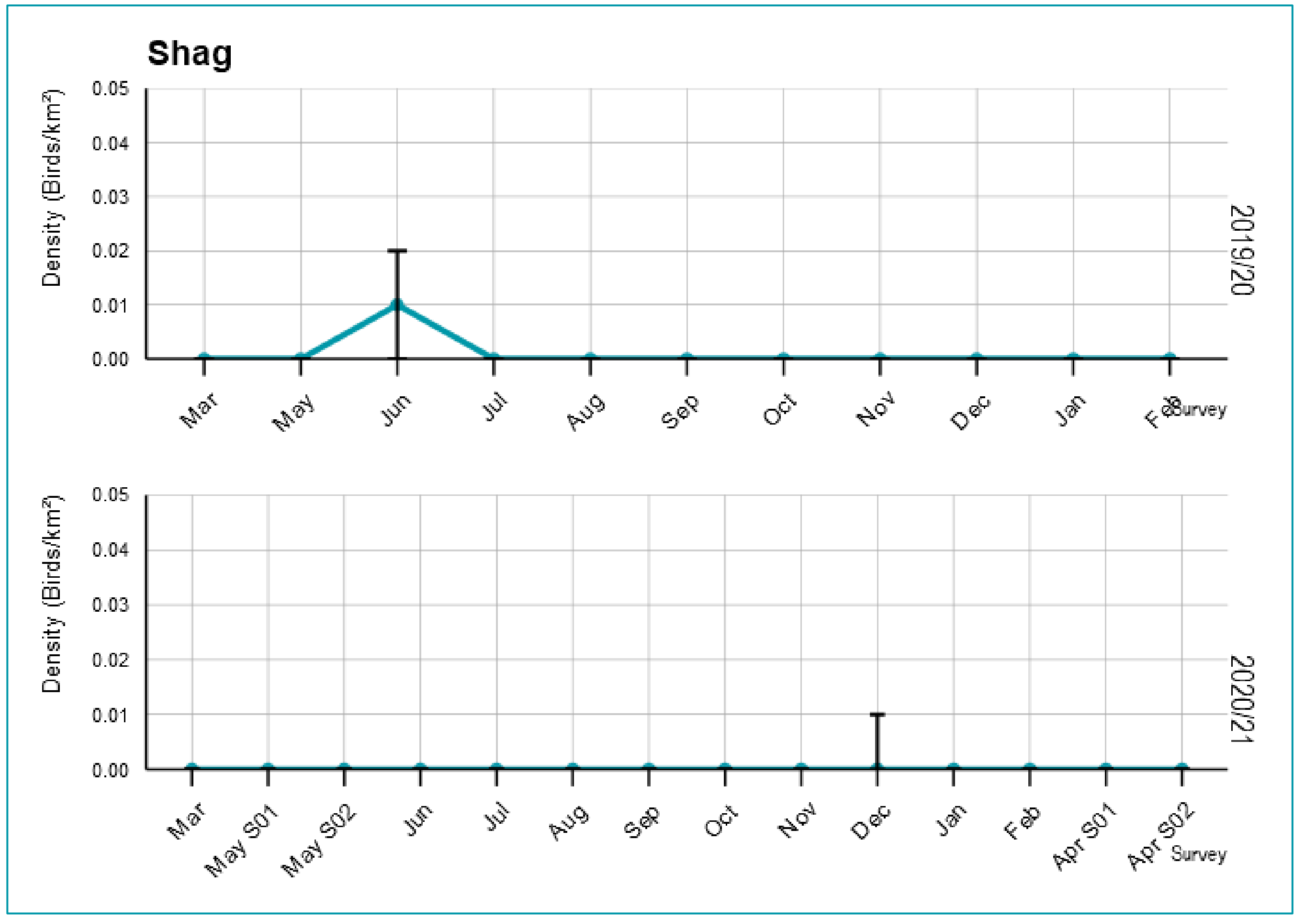

Figure 5.88: Estimated densities (birds/km²) of all shags across Offshore Ornithology Study Area using design-based analysis. Data include "no-identification" birds apportioned to species

Table 5.105: Mean seasonal peak (MSP) population and density (birds/km²) of all shags in the Offshore Ornithology Study Area across the two years of surveying (March 2019 to April 2021) estimated using design-based analysis

All Birds						
Bio-season	**Population**	**Lower 95% CI**	**Upper 95% CI**	**Density**	**Lower 95% CI**	**Upper 95% CI**
Breeding season	12	0	36	0.00	0.00	0.01
Non-breeding	5	0	12	0.00	0.00	0.00

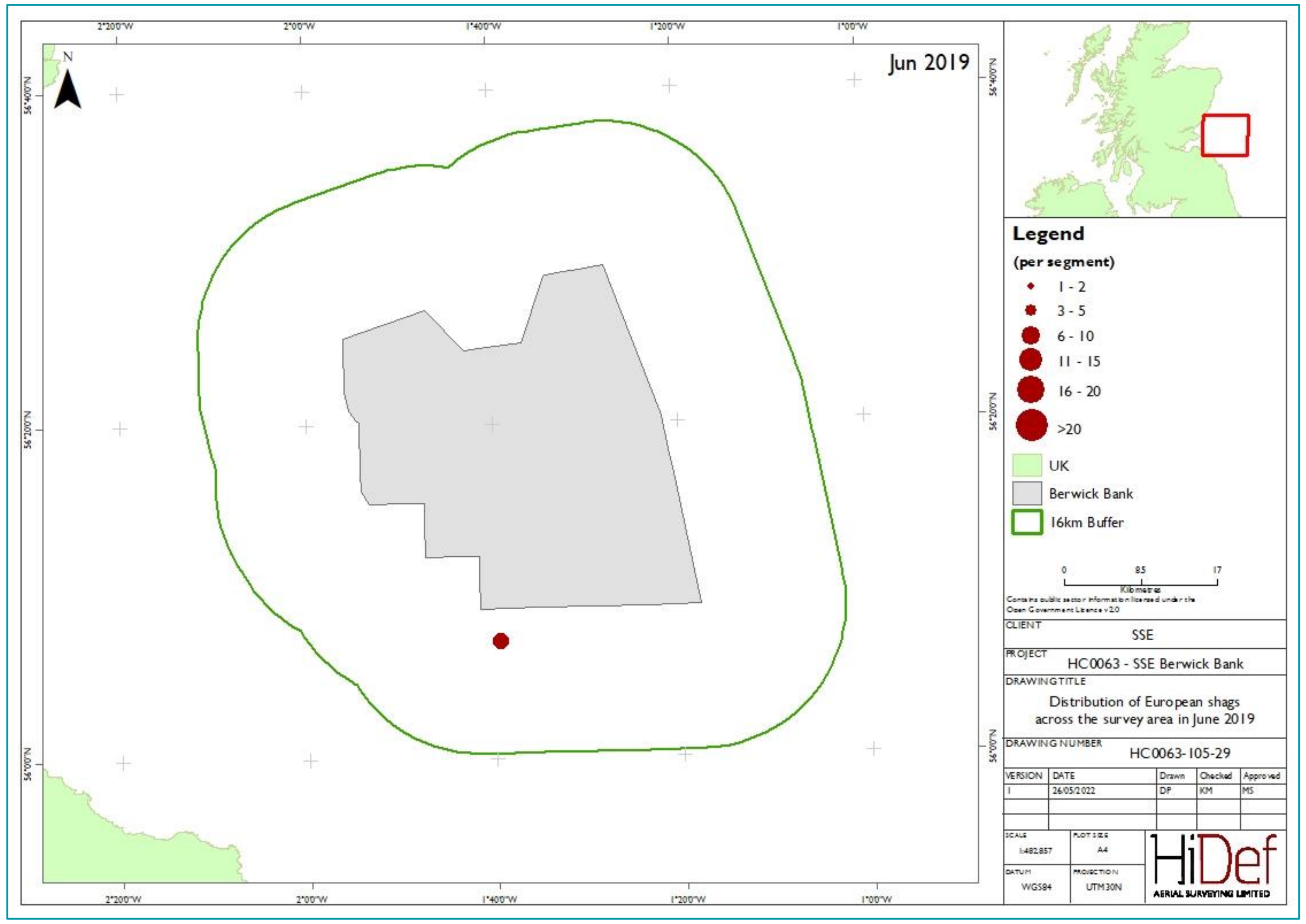

Figure 5.89: **Distribution of shags across Offshore Ornithology Study Area in June 2019**

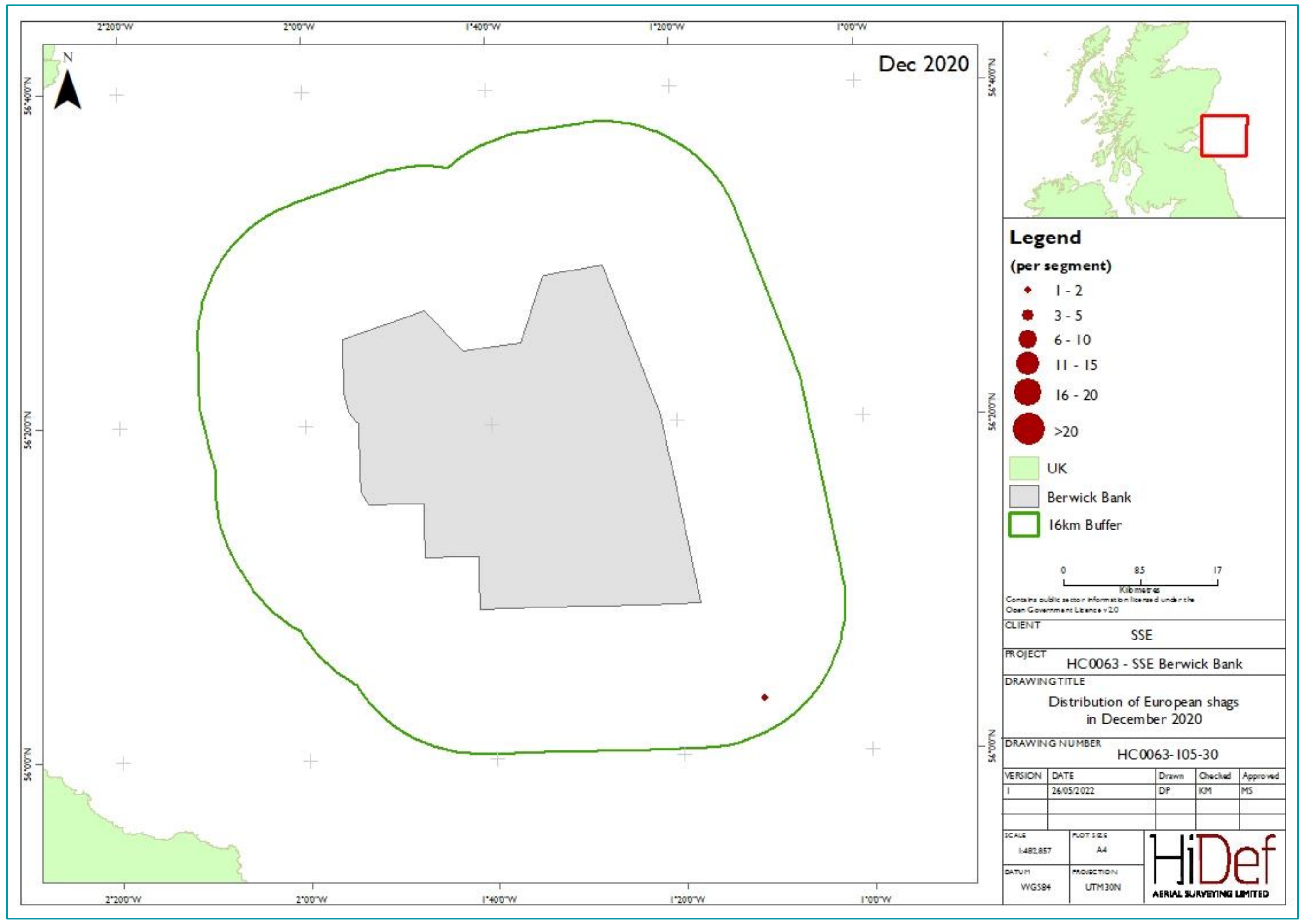

Figure 5.90: **Distribution of shags across Offshore Ornithology Study Area in December 2020**

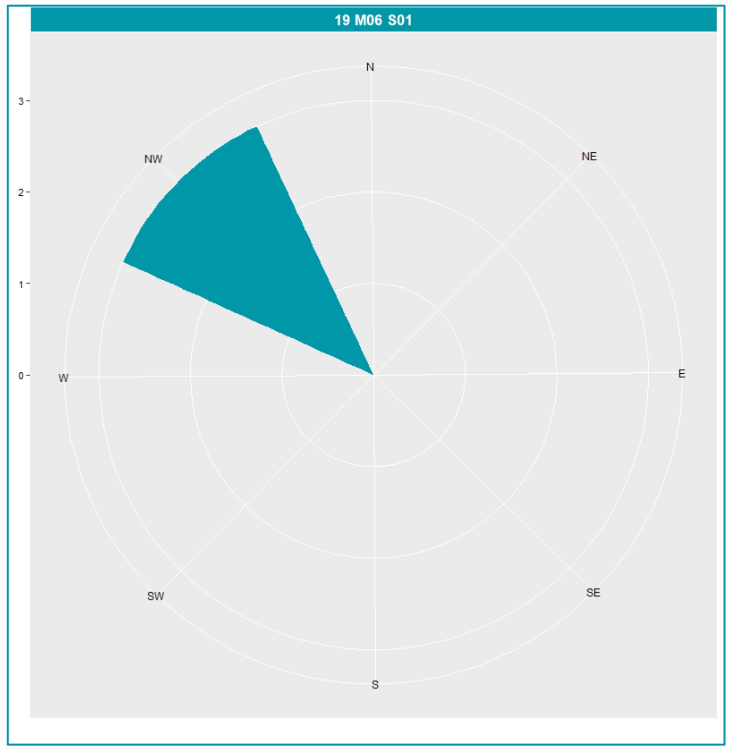

Figure 5.91: Summarised flight direction of shags across Offshore Ornithology Study Area

6 SUMMARY

235. The proposed Berwick Bank Wind Farm is located in the outer Firth of Forth, adjacent to the consented Firth of Forth offshore wind farms (OWFs) Seagreen, Inch Cape and Neart na Gaoithe. Berwick Bank is proposed for development by SSE Renewables.

236. The proposed Berwick Bank development will, if consented, provide an estimated 4.1 GW of renewable energy and turbine capacity may range from 14 – 24 MW with a maximum number of turbines on site ranging between 179 – 307. Importantly, the minimum lower blade tip height is 37 m (LAT) as an embedded design measure to reduce collision risk to seabirds.

237. This technical report, and its Annexes (A-L) provide the baseline ornithological characterisation for the Project. The report provides baseline information on the seasonal distribution, density, and abundance of seabirds in the Proposed Development Array area and a 16 km buffer (the Offshore Ornithology Study Area) based on:

- available reports and literature ("Desktop study" Section 22), and
- analysis of data from a series of digital aerial surveys 2019 – 2021 ("Berwick Bank digital aerial surveys" Section 33).

238. There are several at-sea seabird survey datasets relevant to the baseline of Berwick Bank, including boat-based surveys undertaken at the site, boat and aerial surveys at adjacent sites (e.g., Seagreen) and the studies on gannet and auk foraging, survival and population dynamics, based on telemetry data (Lane and Harmer, 2021; Bogdanova *et al*., in prep.). Other data related to research projects (e.g., Camphuysen, 2005) and broader scale monitoring programmes (e.g., WWT aerial surveys and ESAS boat-based surveys) are also available.

239. There are numerous breeding seabird colonies within the region, many of which are designated seabird Special Protection Areas (SPAs) that include the Forth Islands SPA, Fowlsheugh SPA, and St Abb's Head to Fast Castle SPA. The Seabird Monitoring Project provides the most up-to-date estimates of the abundance of breeding seabirds at UK colonies.

240. The Offshore Ornithology Study Area constituting an area of 3,975km^2 was surveyed between March 2019 and April 2021 to collect seabird and marine mammal data suitable for site characterisation. The survey design consisted of 35 strip transects, spaced 2km apart, extending roughly north-west to south-east, across the survey area.

241. The surveys were conducted by HiDef Digital Aerial Surveying Ltd. using aerial digital video methods. Survey aircraft were equipped with four HiDef Gen II cameras with sensors set to a resolution of 2 cm Ground Sample Distance (GSD). Each camera sampled a strip of 125m width, separated from the next camera by ~20m, providing a combined sampled width of 500m within a 575m overall strip.

242. Surveys were flown at a height of approximately 550 m above sea level to ensure the altitude of the aircraft is always above that recommended to avoid disturbance to seabirds. Thaxter *et al*. (2016) recommends a minimum flight altitude of 460-500 m Above Sea Level (ASL).

243. 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 observations.

244. Data from the cameras were processed to achieve a minimum target coverage of 12.5%. All camera data were viewed by HiDef's trained reviewers and further analysis by the identification team. At least 20% of all birds were selected at random and subjected to a separate 'blind' QA process. If less than 90% agreement was attained for any individual camera then corrective action was initiated: if appropriate, the failed identifier's data were discarded, and the data re-identified. Any disputed identifications were passed to a third-party expert ornithologist for a final decision. Birds were assessed for behaviour (flying, sitting) and, where possible, approximate age and sex.

245. Survey data were primarily analysed using design to generate estimates of density and abundance per species /species group within the Offshore Ornithology Study Area and the Proposed Development array area. This report provides estimates and accounts for 18 of the most abundant species.

246. The design-based analysis approach used a non-parametric bootstrap method with replacement (Buckland et al., 2001) on strip transect data to estimate the density of animals at the site, the standard deviation, the 95% Confidence Intervals (CIs) and coefficient of variance (CV). Estimates for guillemot, razorbill and puffin were corrected for availability bias following Barlow *et al*. (1988) to provide absolute abundance estimates. This could only be calculated for three auk species due to limited information currently available on diving rates of other seabird species. Monthly density and abundance estimate for flying birds, sitting birds and "all birds" were estimated. These estimates were used to generate mean-peak population estimates for all appropriate bio-seasons based on NatureScot guidance (2020a).

247. Distribution maps for all species from design-based analysis were created as cent-count maps. Observations were aggregated within 500 m bins of transect using a nearest neighbour technique. The aggregated observations were presented per unit area of each bin (500 m x surveyed strip width).

248. MRSea was used to generate model-based estimates of abundance. However, whilst the estimates were largely comparable to those from design-based estimates for many surveys, use of MRSea did not confer the expected advantage of greater precision of point estimates and for some surveys, estimates were unacceptably inflated. MRSea did not perform well in surveys where transects were missed. HiDef invested considerable time and work with the author of MRSea in order to be able to run it on the survey data. HiDef raised some of these issues during the Marine Scotland Ornithology Impact Assessment workshop in February 2022.

249. Over the 25-month survey period, 41 species were observed. During Year 1 of the survey programme (March 2019 to February 2020; comprised of 11 surveys), a total of 88,624 individuals of 31 species were recorded. In Year 2 (March 2020 to April 2021; comprised of 14 surveys), 32 species were recorded over 192,376 observations. A further 21,618 observations identified to species groups were made over the course of the surveys. The number of flights flown in Year 2 were greater and this contributes to the larger number of detections in this year compared to Year 1; however, as seabirds are mobile species, interannual variation in abundance of species is expected.

250. Guillemots were the most abundant species, with peaks present in April, May and August and/or September in both years, coinciding with the start of the breeding season and the post-breeding flightless moult stage. April/May peaks coincide with the onset of egg-laying and incubation (Harris and Wanless, 2004). During this time, most birds were recorded as sitting on the water, which is to be expected considering their feeding strategy, in which they dive for prey from the water surface. When accounting for animals diving at the time of the survey, estimates of density were higher during the breeding season, with mean peak densities for the region of 46.91 birds/km^2 (95%CI 37.98 – 57.83), compared to 34.88 birds/km^2 (95%CI 27.41 – 43.02) during the non-breeding season. Peak population estimates in April S02 2021 equated to 242,168 birds (95%CI 190,509 – 305,941). The local SPA total for guillemots is estimated at 280,972 breeding adults, with another 148,805 breeding adults at North Caithness Cliffs SPA also likely to have connectivity with the Project. The relatively high abundance estimated for the site in April S02 2021 is likely to be explained by a good breeding season in 2020 (supported by our data for September 2020 and NatureScot, 2021), which as a consequence will lead to a high number of birds returning to the area ahead of the following 2021 breeding season.

251. The highest mean seasonal peak of kittiwakes was estimated during the non-breeding season at approximately 50,958 birds (95%CI 35,530 – 69,349) likely attributed to the movement of birds between colonies and wintering areas. Behaviour differed between seasons with the largest proportions of flying birds generally occurring between April and June, and October and December dependent on year. Large proportions of birds were recorded as sitting on the water in all surveys, suggesting the Offshore Ornithology Study Area is used for foraging year-round.

252. Razorbills were present in relatively high abundances, with birds recorded most frequently in October and September in Year 1 and Year 2 respectively. Throughout the year, most birds were recorded as sitting on the water. This is to be expected when considering the feeding strategy adopted by the species, in which

they dive from the surface of the water for prey (Shoji *et al.,* 2015). The highest mean seasonal peak for all razorbills occurred during the non-breeding season, calculated at 35,589 birds (95%CI 25,185 – 46,150).

253. Puffins were relatively abundant throughout the Offshore Ornithology Study Area, with density and population estimates suggesting the species utilises the area most frequently between March and September during the breeding season. Mean seasonal peaks were estimated as 12,290 birds (95%CI 9,857 – 14,997) in the breeding season and 20,667 birds (95%CI 17,298 – 24,031) in the non-breeding season. High abundances between May and August suggest birds at nearby colonies use the Offshore Ornithology Study Area to forage during chick rearing, with widespread dispersal towards the end of this period suggesting movement offshore to at-sea wintering areas.

254. Gannets were most abundant in the breeding season with a mean seasonal peak for this period estimated at 14,581 birds (95%CI 12,528 – 16,840) and comprised in almost equal proportions of flying and sitting birds; suggesting the area is used during foraging and during passage to foraging grounds further afield. High densities are to be expected within the survey area, due to the proximity to Bass Rock where breeding success of gannets has been consistently high, despite fluctuations in breeding success for other seabird species in the vicinity (Nelson, 2006; Hamer *et al*., 2007).

255. Common scoter occurred in very low numbers, recorded during the June 2019 and January 2020 surveys only. All birds were recorded as flying, with abundance estimates for these months calculated at 16 birds (95%CI 0 - 48) and 9 birds (95%CI 0 - 28), respectively.

256. Black-headed gulls were only recorded within the Offshore Ornithology Study Area in the non-breeding season. The mean seasonal peak population estimate for the Offshore Ornithology Study Area was estimated at 9 birds (95%CI 1 - 24) during the non-breeding season.

257. Little gulls were observed during the non-breeding and breeding seasons. Low numbers of birds are known to be present along the Fife and Lothian coasts, with the Firth of Forth being one of the only areas where birds are consistently seen in low numbers between December and March (Forrester *et al*., 2007). The Outer Firth of Forth and St Andrews Bay Complex SPA, which overlaps the southwest corner of the Offshore Ornithology Study Area, was designated to support non-breeding populations of little gulls among other seabird species. The mean seasonal peak population occurred during the non-breeding season, calculated at 279 birds (95%CI 150 - 426).

258. Common gulls were primarily recorded during the non-breeding season in both years. Over winter, the UK hosts almost half the European population of common gulls (European Commission, 2009), with many of these birds occurring in Scottish coastal areas (Burton *et al*., 2013). The mean seasonal peak abundance estimates were 146 birds (95%CI 81 - 218) and 745 birds (95%CI 218 – 1,408) in the breeding and non-breeding season, respectively.

259. Herring gulls were the most abundant large gull species encountered during the survey period, present in greater numbers from mid to late summer and again in winter. Very few birds were present throughout the rest of the year. Mean-peak population estimates were highest in the non-breeding season estimated at 3,382 birds (95%CI 957 – 6,294), and the proportion of flying to sitting birds was similar. A mean-peak population of 3,356 birds (95%CI 2,246 – 4,733) was estimated in the breeding season.

260. Lesser black-backed gulls were recorded intermittently throughout the survey programme, mainly recorded during the breeding season. Specific to the Offshore Ornithology Study Area, lesser black-backed gulls are a qualifying species for the Forth Islands SPA, with 1,684 AON, 131 AOT and 97 AOT in 2018 on the Isle of May, Fidra and Craigleith respectively (NatureScot, 2018; SMP, 2021). Between years, peaks in abundance varied considerably, with nearly three times as many birds recorded in the July 2020 peak compared to that in July 2019. No birds were recorded in January and February in both years. The mean seasonal peak abundance during the breeding season was 580 birds (95%CI 427 – 741) compared to 17 (95%CI 1 - 43) during the non-breeding season.

261. Common terns return to UK waters between April and September to breed, spending their winters across the southern hemisphere. Birds were observed in both the 2019/20 and 2020/21 survey periods, with over 10 times more observations occurring in Year 2 compared to Year 1. In the breeding season, the mean seasonal peak abundance was estimated to be 3,225 birds (95%CI 2,224 – 4,332). Lower abundances at the start of the breeding season, such as between May and June can be attributed to birds beginning egg-laying and nest attendance, in which they are more closely associated with their nest sites until chicks have fledged. Densities of birds during these months in the survey area are expected to be low, as many birds remain close to colonies. A few birds were recorded during the non-breeding season.

262. Arctic terns spend a shorter period in UK waters than common terns, returning to the UK to breed between late April and early September. The species was present during the breeding period in both years of surveying. During the breeding and non-breeding seasons, the mean seasonal peak population was estimated to be 4,074 birds (95%CI 3,188 – 5,088) and 163 (95%CI 45 – 325) respectively.

263. Great skua were recorded in low densities in the Offshore Ornithology Study Area, primarily between August and December. The peak estimated population estimate was calculated at 72 birds (95%CI 32 – 119) in November 2020. It is likely this peak in abundance can be attributed to the passage of birds through the area during southwards post-breeding migration.

264. Red-throated diver were predominately detected within the buffer, with birds recorded within the Proposed Development Array intermittently. The highest mean seasonal peak was estimated during the non-breeding season at 105 birds (95%CI 36 – 204).

265. Fulmar densities were relatively consistent throughout the first year of surveying, with slight increases in March 2019 and between November 2019 and January 2020 during the non-breeding season. In Year 2, two large peaks in densities were estimated, occurring in September and December 2020 at 0.77 birds/km^2 (95%CI 0.65 – 0.88) and 0.38 birds/km2 (95%CI 0.28 – 0.48), during the breeding and non-breeding seasons. Mean seasonal peak abundance was highest during the breeding season with an estimated 1,776 birds (95%CI 1,469 – 2,100), although this was largely influenced by the September peak. The mean seasonal peak for the non-breeding period was estimated at 1,071 birds (95%CI 787 – 1,365).

266. Densities of Manx shearwaters were generally low, with birds primarily observed during the breeding season, peaking in June in Year 1 and Year 2. Mean peak estimates for both years of surveying of 113 birds (95%CI 40 – 209) in the breeding season, compared to 0 birds in the non-breeding season. A higher proportion of birds were recorded as flying compared to other behaviours (e.g. sitting or diving) however, higher proportions of sitting birds recorded during the breeding season may be due to the presence of rafting or foraging birds (Richards *et al*., 2019).

267. Shags were only recorded twice in the Offshore Ornithology Study Area, on the June 2019 and December 2020 surveys. The mean seasonal peak population estimate for the breeding season was calculated at 12 birds (95% CI 0 – 36). Birds were distributed in the south of the Offshore Ornithology Study Area in both June 2019 and December 2020, present in the buffer. All shags were recorded flying northwest.

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