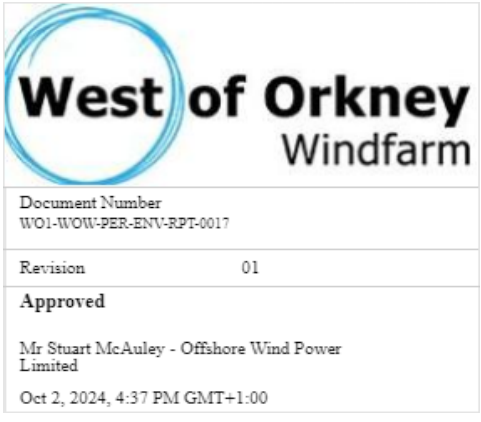
Digital video aerial surveys of seabirds and marine mammals at West of Orkney Windfarm: 27-Month Report July 2020 to September 2022



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Executive summary

In July 2020, Offshore Wind Power Limited commissioned HiDef Aerial Surveying Limited (HiDef) to undertake a programme of high-resolution digital video aerial surveys for marine megafauna, ornithological and human activity over the proposed West of Orkney Windfarm. The proposed West of Orkney Windfarm is located approximately 23km from the north coast of Scotland.

A total of 27 monthly surveys were flown between July 2020 and September 2022. HiDef designed a survey that placed 2km-spaced transects across the development area plus a 4km surrounding buffer ('the survey area'), creating a total survey area of 1,290km^2. From February 2021 the development area was changed to reflect the Option Agreement Area (OAA) awarded by Crown Estate Scotland, increasing by 31km^2, giving an updated total survey area of 1,321km^2 for the remaining surveys.

Surveys were undertaken using an aircraft equipped with four HiDef Gen II cameras with sensors set to a resolution of 2cm Ground Sample Distance (GSD). Each camera sampled a strip of 125m width, separated from the next camera by ~25m, to provide a combined sampled width of 500m within a 575m overall strip. Two of the four cameras were analysed, achieving approximately 12.5% coverage of the survey area in each flight. The remaining footage is available for analysis at a later stage if required.

Data analysis followed a two-stage process in which video footage was reviewed (with a 20% random sample used for audit) and detected objects were identified to species or species group level (again with 20% selected at random for audit). The audit of both stages requires 90% agreement to be achieved.

Density and abundance estimates were calculated using strip transect analysis and kernel density estimation (KDE) was used to create density surface maps. In addition, known diving rates of four species were used to estimate the proportion of diving animals that would be underwater at the time of survey for the correction of abundance and density estimates.

The surveys recorded a total of 27,244 birds of 32 species and 414 non-avian animals of 12 species, in addition to 34 dead birds and one dead non-avian animal. A further 915 birds and 77 non-avian animals were recorded which were not assigned to a species. In addition, one unidentified bird was observed as dead. An identification rate to species level of 96.99% was achieved throughout the 27-month period.

The primary observations from the surveys were:

- Kittiwakes (*Rissa tridactyla*) were present in relatively high densities during the spring migration and post-breeding migration periods (1.79 birds/km^2 (95% CI 0.91– 2.83) peak density; July 2022). The majority of birds were recorded as flying, suggesting the area may be primarily used for passage to other areas;
- Great black-backed gulls (*Larus marinus*) were most abundant during the non-breeding season, peaking in December 2021 (0.41 birds/km^2 (95% CI 0.32 – 0.51)). The relatively high proportion of birds recorded sitting on the water suggests the area may be used for foraging, likely by birds migrating offshore to over-wintering areas;
- Guillemots (*Uria aalge*) were the most abundant species, with peaks generally occurring during the autumn post-moult dispersal period (8.18 birds/km^2 (95% CI 5.44 – 11.62) peak estimate; July 2022);
- Razorbills (*Alca torda*) were recorded intermittently, peaking towards the end of the breeding season 0.37 birds/km^2 (95% CI 0.16 – 0.64) peak estimate; September 2022);

- Puffins (*Fratercula arctica*) were most abundant during the breeding season and the start of the non-breeding season (6.24 birds/km^2 (95% CI 4.22 – 8.45) peak density; June 2022), before decreasing for the remainder of the winter period;
- Fulmar (*Fulmarus glacialis*) were primarily present during the non-breeding winter period (3.44 birds/km^2 (95% CI 01.93 – 5.65) peak estimate; December 2020). A total of one dead bird was observed;
- Gannets (*Morus bassanus*) were primarily recorded towards the end of the breeding season and into the post-breeding migration period (1.65 birds/km^2 (95% CI 0.36 – 4.12) peak estimate; August 2020). A total of 32 dead birds were recorded over the survey period. Similar proportions of flying and sitting birds indicates the survey area is utilised for both passage and foraging;
- Harbour porpoise (*Phocoena phocoena*) were the most abundant marine mammal species present, peaking in September 2021, with an absolute density of 0.75 animals/km^2 (95% CI 0.25 – 1.51).
- White-beaked dolphin (*Lagenorhynchus albirostris*) were the second most abundant non-avian animal species, with peak densities recorded in February 2022 at 0.15 animals/km^2 (95% CI 0.01 – 0.34);

Distribution maps for all bird species showed higher densities in the east and southeast of the survey area especially between November 2020 and February 2021. Although species-specific variations were recorded, birds were generally recorded in higher densities towards the development area boundary and in the 4km buffer area. The distribution of non-avian animals was more widespread.

The work undertaken by HiDef collected monthly survey data over a continuous 27-month period. The data collected works towards satisfying the survey requirements for the contract. This report follows, and supersedes, data presented in the Two-Year Report (Document Reference: HP00126-702-02), submitted in September 2022.

1 Introduction

1 West of Orkney Windfarm (hereafter 'WOW') is a proposed offshore wind farm, located approximately 23km off the coast of Scotland. In July 2020, OWPL commissioned HiDef Aerial Surveying Limited ('HiDef') to undertake a programme of high-resolution digital video aerial surveys of marine megafauna (defined within this report as cetaceans, pinnipeds or other large, non-avian marine fauna), ornithological and human activity in support of the development proposal. The survey design consisted of 2km-spaced transects of the WOW development area plus a 4km surrounding buffer, together referred to as the 'survey area'.

2 Between July 2020 and January 2021, the survey area was 1,290km^2, which increased to 1,321km^2 for the remaining surveys after the development area was modified ahead of the ScotWind bid application (section 2.2).

3 HiDef designed the survey methodology to provide data suitable to support OWPL proposed development at WOW for which baseline surveys and an accurate assessment of abundance and distribution of seabirds and marine mammals is required to inform the Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA).

4 There are multiple sites designated as Special Protection Areas (SPA) under the European Council (EC) Directive 2009/147/EC on the Conservation of Wild Birds ('the Birds Directive') are located in the vicinity of the survey area.

5 Within 30km of the development area, numerous SPAs are designated for internationally important concentrations and breeding assemblages of guillemots (*Uria aalge*); razorbills (*Alca torda*); puffins (*Fratercula arctica*); kittiwakes (*Rissa tridactyla*) and fulmars (*Fulmarus glacialis*) such as the Cape Wrath and North Caithness Cliffs SPAs (JNCC, 2015a; 2018a).

6 The Sule Skerry and Sule Stack SPA (overlapping with the survey area) and the Hoy SPA (25km east of the survey area) are also designated for the aforementioned species as well as for nationally important concentrations of European storm petrels (*Hydrobates pelagicus*), Leach's storm-petrels (*Oceanodroma leucorhoa*) and shags (*Gulosus aristotelis*) for the former (JNCC, 2015b), and important concentrations of nesting and breeding great skuas (*Stercorarius skua*); red-throated divers (*Gavia stellata*); great black-backed gulls (*Larus marinus*); and Arctic skuas (*S. parasiticus*) for the latter (JNCC, 2015c). Additionally, a large gannet (*Morus bassanus*) colony is known to breed on Sule Stack, with a growing overspill on Sule Skerry.

7 The Caithness and Sutherland Peatlands SPA (approximately 24km south of the development area) are designated for numerous duck, diver and wader species such as red-throated and black-throated divers (*G. arctica*); common scoters (*Melanitta nigra*) and golden plovers (*Pluvialis apricaria*) (JNCC, 2018a).

8 European storm petrels are qualifying species for Auskerry SPA and both European and Leach's storm-petrels are also qualifying species for North Rona and Sula Sgeir SPA (both approximately 78km away; JNCC, 2015d; 2015e), along with other breeding seabird species mentioned previously.

9 In addition to being designated for guillemots; puffins; razorbills; kittiwakes; fulmars and great black-backed gulls, the further afield Pentland Firth Islands, Rousay, and West Westray SPAs (all between 50 and 60km from the survey area) are also designated to protect Arctic terns (*Sterna paradisaea*) and Arctic skuas for the two latter sites (JNCC, 2015f; 2015g; 2019a).

10 Other SPAs can be found further afield, such as Handa SPA (58km); Copinsay SPA (67km); Fair Isle SPA (140km) and Foula SPA (160km). These sites are designated for numerous seabird species known to have large foraging ranges, such as guillemots; kittiwakes; puffins; gannets; petrels and great skua (Woodward *et al.*, 2019; JNCC, 2015h; 2015i; 2015j; 2015k). Seabirds are likely to use the surrounding waters for feeding and post-breeding dispersal, with many species foraging long distances from their breeding colonies. As examples, the mean max foraging range for gannet is 315km ±194 SD and for kittiwake 156km ±44.5 SD (Woodward *et al.*, 2019); as such, seabirds from a number of other UK SPAs may travel to the WOW area to feed.

11 Nesting seabirds are known to occur in a wide area around their breeding colonies, including in the survey area, with the highest densities occurring in the spring, summer and early autumn. Other migratory and transient bird species are also likely to be present intermittently (Xodus, 2022).

12 Marine mammals are also likely to occur year-round within the survey area, with harbour porpoise (*Phocoena phocoena*), minke whales (*Balaenoptera acutorostrata*), grey seals (*Halichoerus grypus*) and white-beaked dolphins (*Lagenorhynchus albirostris*) likely to be the most numerous (Evans *et al.,* 2011; Hammond *et al.,* 2021). The closest Special Area of Conservation (SAC) designated for the protection of harbour porpoises is the Inner Hebrides and Minches SAC (approximately 90km south; JNCC, 2019b). There are several SACs designated for grey seals on the Orkney Islands and to the west, at North Rona SAC and Faray and Holm of Faray SAC (JNCC, 2015l; 2015m). The Sanday SAC (approximately 87km north-east) is designated for the protection of harbour seals (*Phoca vitulina*; JNCC, 2015n), and further south-east of the survey area, bottlenose dolphins (*Tursiops truncatus*) are protected by the Moray Firth SAC (JNCC, 2015o). Minke whale is a qualifying feature of the Sea of Hebrides Marine Protected Area (MPA) and the Southern Trench MPA in the Moray Firth.

13 This report ('the 27-month report') provides the results from 27 surveys undertaken between July 2020 and September 2022. Observations and survey effort are summarised, and results presented as density surface distribution maps and density estimates with 95% confidence intervals (CIs). Summarised data on behaviour, age and flight direction for seabirds are also presented. A discussion is provided as to the representativeness of the results in relation to the wider region.

2 Methods

2.1 Survey flights

14 A series of strip transects were flown on a monthly basis between July 2020 and September 2022 except in January 2022 (an additional survey was flown in February 2022), following the protocol agreed in July 2020 (HP00126-001; HiDef, 2021).

15 HiDef designed the survey methodology to provide information suitable to support OWPL proposal to develop WOW for which an accurate assessment of abundance and distribution of seabirds and marine mammals is required to support the EIA.

16 The survey design consisted of 2km-spaced transects across the WOW development area (799km^2 February 2020 to January 2021; 825km^2 February 2021 to June 2022)[1] and a surrounding 4km buffer. This created overall survey areas of 1,290km^2 and 1,321km^2 for the periods July 2020 to January 2021 and February 2021 to September 2022 respectively (Figure 1).

17 The survey design consisted of 21 strip transects extending roughly north to south, perpendicular to the depth contours along the coast. The objective of such a design is for each transect to sample varying habitats (primarily relating to water depth) therefore reducing the variation in bird and mammal abundance estimates between transects.

18 Surveys were undertaken using an aircraft equipped with four HiDef Gen II cameras with sensors set to a resolution of 2cm Ground Sample Distance (GSD). Each camera sampled a strip of 125m width, separated from the next camera by ~25m, thus providing a combined sampled width of 500m within a 575m overall strip.

19 A minimum target of 12.5% site coverage was agreed, with data from two out of the four cameras being processed. This ensured a survey with sufficient coverage and number of transects for precise abundance estimation, with the remaining unprocessed data archived.

20 The surveys were flown along the transect pattern shown in Figure 1 at a height of approximately 550m (~1800') above sea level (ASL). Flying at this height ensures that there is no risk of flushing species that are easily disturbed by aircraft noise. Thaxter *et al.* (2016) recommends a minimum flight altitude of 460 – 500m ASL.

21 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.

[1] The WOW development area, as defined for the DAS included a deeper water area to the west of the final boundary of the Option Agreement Area (OAA), awarded by Crown Estate Scotland (CES). Hence why the development area referenced here is larger compared to the final OAA which is 657 km^2.

2.2 DAS area adjustment

22 The survey area changed slightly over the survey programme. OWPL commenced DAS ahead of the ScotWind leasing round which meant that the survey area was defined as the expected development area within the N1 Plan Option, rather than a refined Option Agreement Area (OAA). Therefore, between July 2020 and January 2021 the survey area was 1,290km^2 comprising the expected development area and a 4km buffer.

23 From February 2021 to September 2022, the survey area was modified slightly to reflect the refinement of the preferred OAA (ahead of the ScotWind bid application). This increased the survey area to 1,321km^2 (development area + 4 km buffer) due to a revision of the boundary in the south-east corner. This change in area was both absolutely small (31.1 km^2) as well as being a relatively very small part of the overall survey area (2.4%) or the OAA + 4 km buffer (4%). Despite the refined OAA omitting an area in the west, the area was retained during the remaining surveys (Figure 2).

24 The refinement of the survey area during the DAS was discussed with NatureScot at a consultation meeting (18th April 2023) and a letter sent to NatureScot following this meeting to give the background to the survey area and explain why OWPL did not consider the change in area to influence the Ornithology impact assessment. NatureScot responded (5th June 2023) indicating no further information was required ahead of application.

Figure 1 WOW survey design with 4km buffer and 2km-spaced transects flown between July 2020 - January 2021 and February 2021 - September 2022

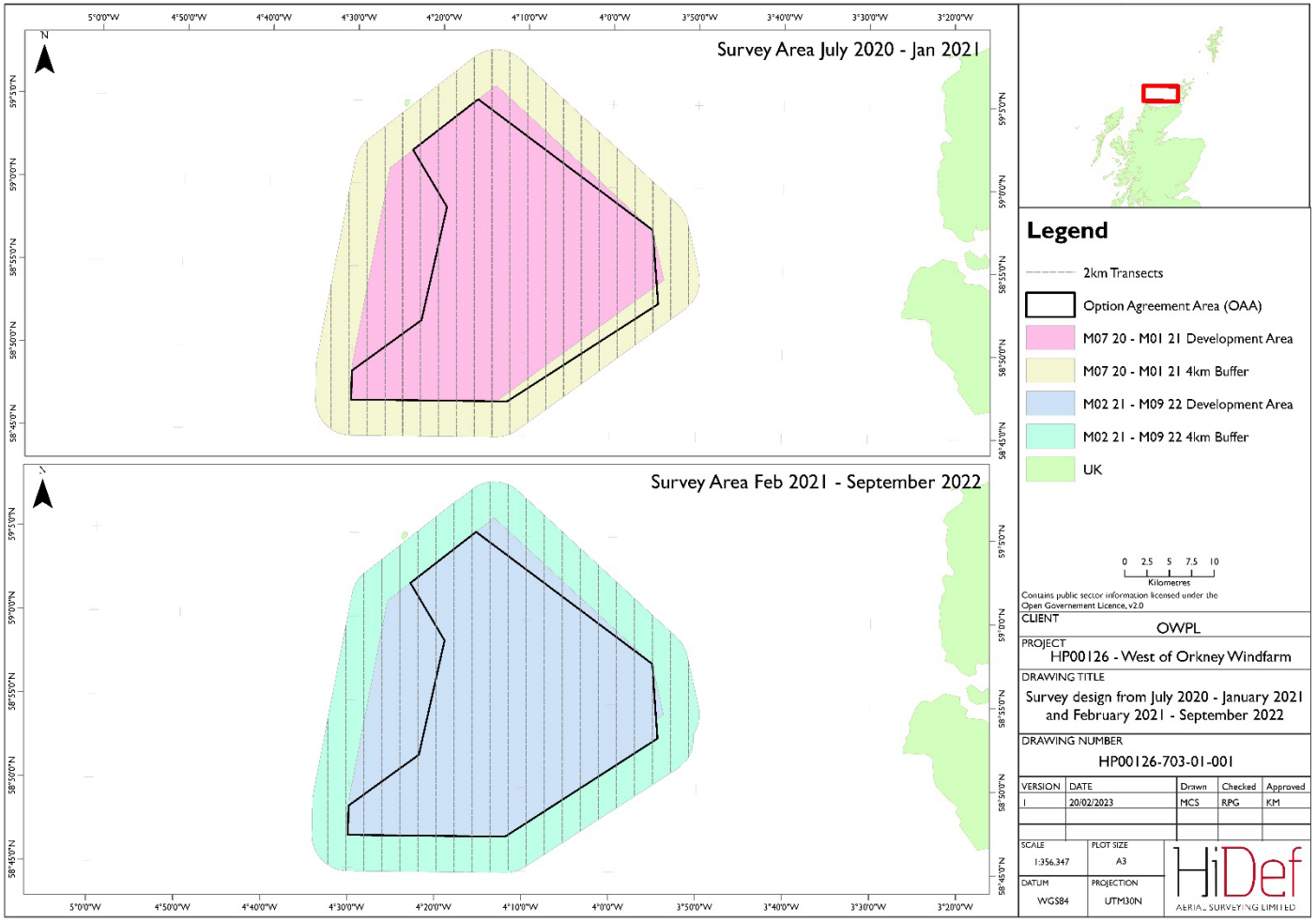
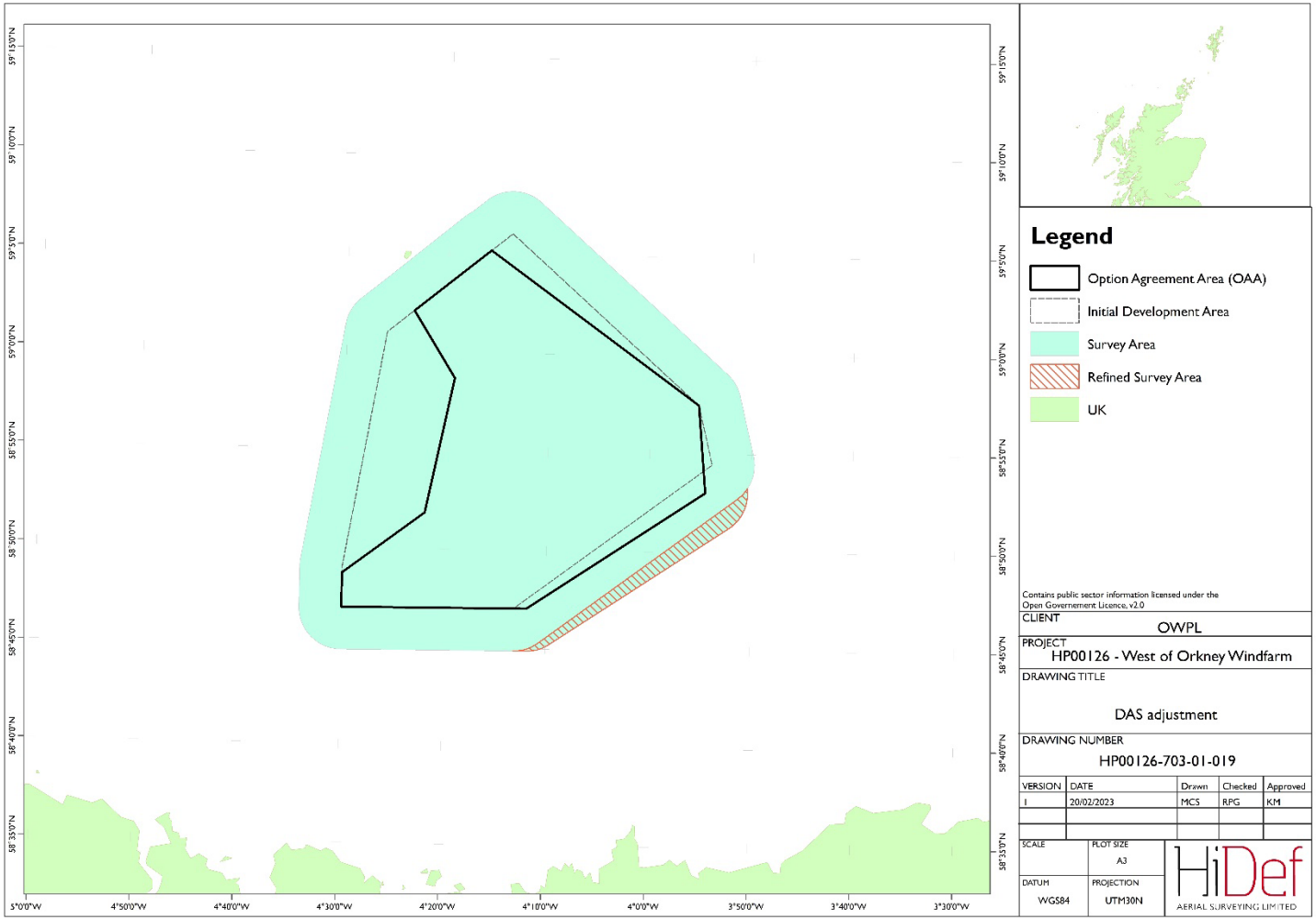


Figure 2 **WOW Survey Area with site revisions February 2021 - September 2022**



2.3 Data review and object detection

26 Data were viewed by trained reviewers who marked any objects in the footage as requiring further analysis, as well as determining which were birds, marine megafauna (defined within this report as cetaceans, pinnipeds or other large, non-avian marine fauna) or anthropogenic objects such as ships or buoys.

27 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.

28 Objects were only recorded where they reached a reference line (known as '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 where the survey craft is buffeted by airflow) were eliminated.

2.4 Object identification

29 Images marked as requiring further analysis were reviewed by the ID Team; ornithologists[2] and marine mammal specialists[3] for identification to the lowest taxonomic level possible and for assessment of the approximate age and sex of each animal, as well as any behaviour traits visible from the imagery.

30 At least 20% of all objects 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/marine mammal specialist for a final decision. The level of agreement within the QA process was calculated as the final number of agreements as a percentage of all identifications subjected for QA for the entire survey.

31 All objects were assigned to a species group and where possible, each of these then further identified to species level. The species identifications were given a confidence rating of 'possible', 'probable' or 'definite'[4].

32 It is important to note that confidence ratings are not standardised. The likelihood of achieving a definite or probable identification is not consistent for all component members of a species group. For example, someone undertaking identification of a large auk will find it easier to be confident of guillemot identification than razorbill. Confidence scores should not be used to filter or weight the probability of 'large auk' being one species or another in any analysis, as this will lead to biased results, particularly if the identification rate is low.

33 Any animals that could not be identified to species level were assigned to a category 'No ID' and only identified to group level. If, on occasion, the unidentified bird is suspected of belonging to two possible

[2] HiDef currently employs four of the ten current members of the British Birds Rarities Committee ('BBRC') as expert ornithologists

[3] HiDef staff have long-standing experience in marine mammal identification, regularly undertaking boat surveys as part of ESAS (European Seabirds At Sea Partnership) and other programmes. They process thousands of cetacean images, hold regular internal training sessions and have access to marine specialists within our wider company BioConsult SH.

[4] Definite: as certain as reasonably possible. Probable: very likely to be this species or species group. Possible: more likely to be this species or species group than anything else.

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 (*Puffinus puffinus)*, or to 'Large Auk species' if identified as a guillemot. However, if the bird has the potential to be either, then it would be assigned to a wider group category 'Shearwater / Auk species' and the species level recorded as 'No ID'.

34 In the case of birds, additional information was recorded on basic behaviour (i.e. whether the bird was sitting; loafing on land or other objects; flying; diving or taking off). Detail was recorded where possible on foraging behaviour, approximate age, sex and any other details of interest. Aging of birds was based on moults and was conducted where possible on species which show seasonal variation in plumage.

35 Marine mammals and other marine megafauna were recorded using the same process. Animals were first assigned to a species group (e.g. 'cetacean species') and then given a species level identification (e.g. 'harbour porpoise', 'minke whale' or 'No ID'). If a precise species group could not be ascertained, then the record was assigned to a broader group category (e.g. 'seal or small cetacean species') and the species level recorded as 'No ID'.

36 In the case of marine mammals, surfacing behaviour was also recorded as either 'surfacing', 'surfacing at red line', 'submerged' or 'unknown'. 'Surfacing at red line' (or snapshot surfacing) was defined as the animal's dorsal fin being above the water in the frame nearest to the 'red line' on the operator's screen and is required for calculation of availability bias (Section 2.5.3). 'Surfacing' was defined as any other surfacing behaviour that was not snapshot surfacing and included any part of the animal's body breaking the surface of the water in any frame. Sexing and aging of marine mammals was carried out where possible.

37 Anthropogenic activity was recorded as either 'man-made object', 'fishing boat' or 'other boat'. Further details were noted, including further specifying the type of object (e.g. 'fishing buoy', 'marker buoy', 'wind turbine').

2.5 Final processing

38 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.

2.6 Data analysis

2.6.1 Data treatment

39 Raw count data were trimmed to the survey area prior to presentation in this report. After basic presentation, data were processed to remove dead animals and estimate density, abundance and distribution of key species and species groups.

40 Records identified to species level were separated out from records of individuals identified to group level, and the following analyses undertaken on both datasets. All confidence levels of species identifications were used in the analysis.

41 Apportioning of 'unidentified' birds and marine mammals 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 in a survey, then 80% of unidentified birds would be assigned to guillemot and 20% assigned to razorbill.

2.6.2 Population estimates

42 Population estimates were calculated for the WOW survey area (development area plus a 4km buffer).

43 Each strip transect was treated as a statistically independent random sample from the site. The length and breadth (i.e. the width of the field of view of the camera) of each transect were multiplied to give the transect area; dividing the number of observations for each species on each 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 by multiplying by the area of the site), the standard deviation, the 95% confidence intervals (CIs) and coefficient of variance (CV) were then estimated using a non-parametric block bootstrap method with replacement (Buckland *et al.,* 2001), to ensure equal transect effort was sampled across each bootstrap iteration. This was done by using transect ID as the sampling unit with replacement. A group of transects were randomly sampled until their total length equalled approximately the same length as the total survey length.

44 A total of 1,000 bootstrap iterations were performed from which the mean and standard deviation of the sampled means were calculated, as well as the relative standard deviation (or CV) as defined by the standard deviation divided by the mean multiplied by 100. Data were processed in the R programming language (version 4.1.1) and code can be provided on request.

45 The density estimate is expressed as the average number of animals per square km in the whole survey area. The population estimate is expressed as the estimated number of animals within the whole survey area. The upper and lower confidence limits (CLs) 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.

46 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. In Section 2.5.3 we describe our method for taking account of species availability to generate estimates of absolute abundance for auks and harbour porpoise.

2.6.3 Availability bias

47 In wildlife surveys, a proportion of seabirds or marine mammals that spend any time underwater, especially while feeding, will not be detectable at the surface. This 'availability bias' leads to an under-estimate of their abundance during surveys. For species that make long dives underwater, this bias might be significant (for example, guillemot).

48 There are two main approaches to account for availability bias: by using double platform surveys (for example Borchers *et al.,* 2002) which can be logistically difficult to achieve and relatively expensive; and by using known data on time spent underwater to apply correction factors to abundance estimates (for example Barlow *et al.,* 1988).

49 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.

50 Due to a lack of diving rate data for many species, availability bias corrections were only conducted on four species: guillemots, razorbills, puffins and harbour porpoise. When considering population

estimates calculated for other diving species, it should be noted that population estimates for the survey area are likely to be underestimated.

2.6.3.1 Seabirds

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

52 For guillemots and razorbills, data obtained during the breeding season using data loggers were 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.

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

54 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.

55 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 the species.

2.6.3.2 Marine mammals

56 Harbour porpoise abundance is also affected by availability bias, and further complicated because detections of animals are possible while they are submerged. The approach to correct for availability bias for this species applies a correction factor to the density of animals that were recorded surfacing only using data on the surfacing rates from tagged animals; or to apply a correction factor to the density of all animals.

57 Teilmann *et al.* (2013) provides detailed information which accommodates variation in time of year, geographical location and time of day in the proportion of time spent breaking the surface. All of these metrics relate to model outputs in Teilmann *et al.* (2013) and are used to refine the predicted amount of time that harbour porpoise spend surfacing in the outputs.

58 The tagging study of Teilmann *et al.* (2013) did not extend to the area of the northeast Atlantic/North Sea surrounding this project but no other data are available on surfacing behaviour for this species in the relevant area. For our analysis, we assumed that diving behaviour in the survey area was comparable to that of the North Sea data collection area of Teilmann *et al.* (2013).

59 To estimate the density of surfacing harbour porpoise, we first calculated the proportion of animals snapshot surfacing. Snapshot surfacing indicates where the dorsal fin is clear of the water surface in the middle frame of the sequence in which the animal is present. By using the snapshot surfacing detections, we subsample the data to mimic the surfacing behaviour category in Teilmann *et al.* (2013) which corresponds to periods when the transmitter on the dorsal fin of tagged animals is completely clear of the water. This was done using data combined from all surveys because sample sizes were too small to be accurate when calculating the surfacing proportions in individual surveys. We then multiplied the calculated density of all harbour porpoise by the proportion of snapshot surfacing encounters in our surveys to estimate the density of surfacing harbour porpoises. Finally, this was then divided by the proportion surfacing from Teilmann *et al.* (2013) in Table 1, to derive the estimates of absolute density and abundance.

Table 1 Correction factors used to account for availability bias for harbour porpoise at different times of the year and at different times of the day (after Teilmann *et al.*, 2013)

Month	Surface behaviour	
	09:00 – 15:00	15:00 – 21:00
January	0.0490	0.0476
February	0.0398	0.0384
March	0.0543	0.0529
April	0.0646	0.0632
May	0.0563	0.0549
June	0.0518	0.0503
July	0.0493	0.0479
August	0.0530	0.0516
September	0.0420	0.0406
October	0.0413	0.0399
November	0.0406	0.0392
December	0.0429	0.0415

2.6.4 Distribution mapping

60 Maps of the distribution of key species, selected on the basis of their relatively high abundance or their significance at nearby SPAs/SACs were generated using a Watson-Nadaraya type kernel density estimation (KDE) technique (Simonoff, 1996). For diving species (guillemot, razorbill, puffin and harbour porpoise), the KDE mapping represents a relative estimate of density and does not take account of availability bias.

61 In KDE, a small 'window' function (the kernel) was used to calculate a local density at each point in the survey area. To evaluate the density at a given point, the kernel was centred on that point and all the observations within the window were summed to obtain a local count. The total area of the transect(s) intersecting the window was then summed to obtain a local measure of effort. By dividing the local count by the local effort, a local density estimate was obtained. To build a density map, the survey area was covered with a fine mesh of study points and the density was calculated at each point in the mesh in turn.

62 Kernel techniques are robust and not as complex as other density estimation techniques because they have few parameters; as a result, they are arguably the easiest density surface technique to reproduce independently. The only variables are the size and shape of the kernel or window function. For these analyses, we have used a Gaussian window function, which has the advantages of being smooth,

rotationally symmetric and easy to compute. The shape of the Gaussian is determined by a single width parameter; the selection of this parameter is the only variable in the computation of the density maps.

63 Rather than set the width parameter arbitrarily, we have used a leave-one-out cross validation method. Cross validation estimates the predictive power of a model by removing some of the data from the data set and using the remainder of the data and the model to predict the values for the data that was removed. The closer the predicted values represent the removed data, the better the model performance and the width parameter used in the model.

64 To apply cross validation to the survey area, each transect is subdivided into km long segments. To evaluate a particular choice of kernel width, each segment is removed in turn, using the kernel and the remaining data to predict the density of the missing segment and subtract the known value from the prediction to obtain an error score. This process is repeated for every segment and the error scores for all segments are squared and summed to give a total performance score for that particular choice of kernel width. The kernel width is then varied and the process repeated; if the new score is lower than the old, the new kernel width is a better choice than the previous value. An exhaustive search over all kernel widths is then used to identify the best global choice. The result of the process is a smooth density estimate which has been derived without any manual parameter selection. The whole process is repeated from scratch for each map, as different kernel sizes are appropriate for different species.

65 It should be noted that several of the KDE maps are effectively 'flat' (i.e. they appear uniform in colour). These correspond to distributions where the density surface as obtained from a small local kernel was not effective at predicting missing data; this can happen with evenly distributed birds but can also happen for very sparse distributions. In the case of sparse distributions, the 'flat' map does not necessarily mean that the true underlying distribution is 'flat'; it could mean that the data doesn't contain enough evidence to determine what the underlying distribution is. It is therefore useful to refer back to the population estimates for the corresponding map when looking at these 'flat' densities; we have also overlaid the relevant observations as dots to help with interpretation of the maps. In extreme cases, the maps were not included in the results section, and the data presented as dot maps.

66 For less abundant bird and non-avian species, as well as those identified to group level, distribution is illustrated by dot maps only.

2.6.5 Flight direction of seabirds

67 Wind rose diagrams were created to present the flying direction of seabirds, where each cardinal point (N, E, S, W) and intercardinal point (NE, SE, SW, NW) indicates the total number of birds recorded flying in that direction in each survey.

3 Results

3.1 Survey effort

68 The date, number of transects and survey effort (i.e. length of transects) undertaken between July 2020 and September 2022 are shown in Table 2. The number of transects and the total length of transects are those used in subsequent analysis (see Figure 3 to Figure 5 for the aircraft flight pattern). Variation in presentation of track data is due to differing GPS records in the equipment; frequency of the GPS records can occasionally vary for the flight pattern. This does not affect location data for the observations recorded.

69 The same transect lines were used for each survey, although effort may have differed slightly between surveys. This can be caused by minor differences in the start and stop times for transects and minor deviations of the aircraft from the transect line. In a model-based sampling framework, minor variations in coverage between surveys can be accommodated.

Table 2 Survey effort across the WOW survey area between July 2020 and September 2022 inclusive

Survey date	Survey number	Number of transects analysed	Total length of transects analysed (km)	Area covered (km²)	Area covered (%)
22 July 2020*	1	21	643.38	160.84	12.46
06 August 2020*	2	21	643.04	160.76	12.45
24 September 2020*	3	21	643.75	160.94	12.47
22 October 2020*	4	21	642.92	160.73	12.45
28 November 2020*	5	21	642.91	160.73	12.45
15 December 2020*	6	21	643.52	160.88	12.46
04 January 2021*	7	21	643.88	160.97	12.47
27 February 2021	8	21	656.76	164.19	12.42
15 March 2021	9	21	658.77	164.69	12.46
21 April 2021	10	21	658.20	164.55	12.45
20 May 2021	11	21	658.96	164.73	12.46
11 June 2021	12	21	656.84	164.21	12.42
02 July 2021	13	21	657.73	164.43	12.44
30 August 2021	14	21	659.25	164.81	12.47
08 September 2021	15	21	659.19	164.80	12.46
12 October 2021	16	21	658.68	164.67	12.45
15 November 2021	17	21	659.37	164.41	12.47
28 December 2021	18	21	660.15	165.04	12.48
18 February 2022	19	21	658.61	164.65	12.45
26 February 2022	20	21	657.35	164.34	12.43
11 March 2022	21	21	658.48	164.62	12.45
14 April 2022	22	21	657.96	164.49	12.44
15 May 2022	23	21	656.51	164.13	12.41
06 June 2022	24	21	659.39	164.85	12.47
22 July 2022	25	21	657.90	164.48	12.45
17 August 2022	26	21	655.95	163.99	12.41
02 September 2022	27	21	649.39	162.35	12.29

**Initial survey area – see Figure 1and Figure 2*

Figure 3 Flight pattern for surveys flown between July 2020 and June 2021 over the WOW survey area

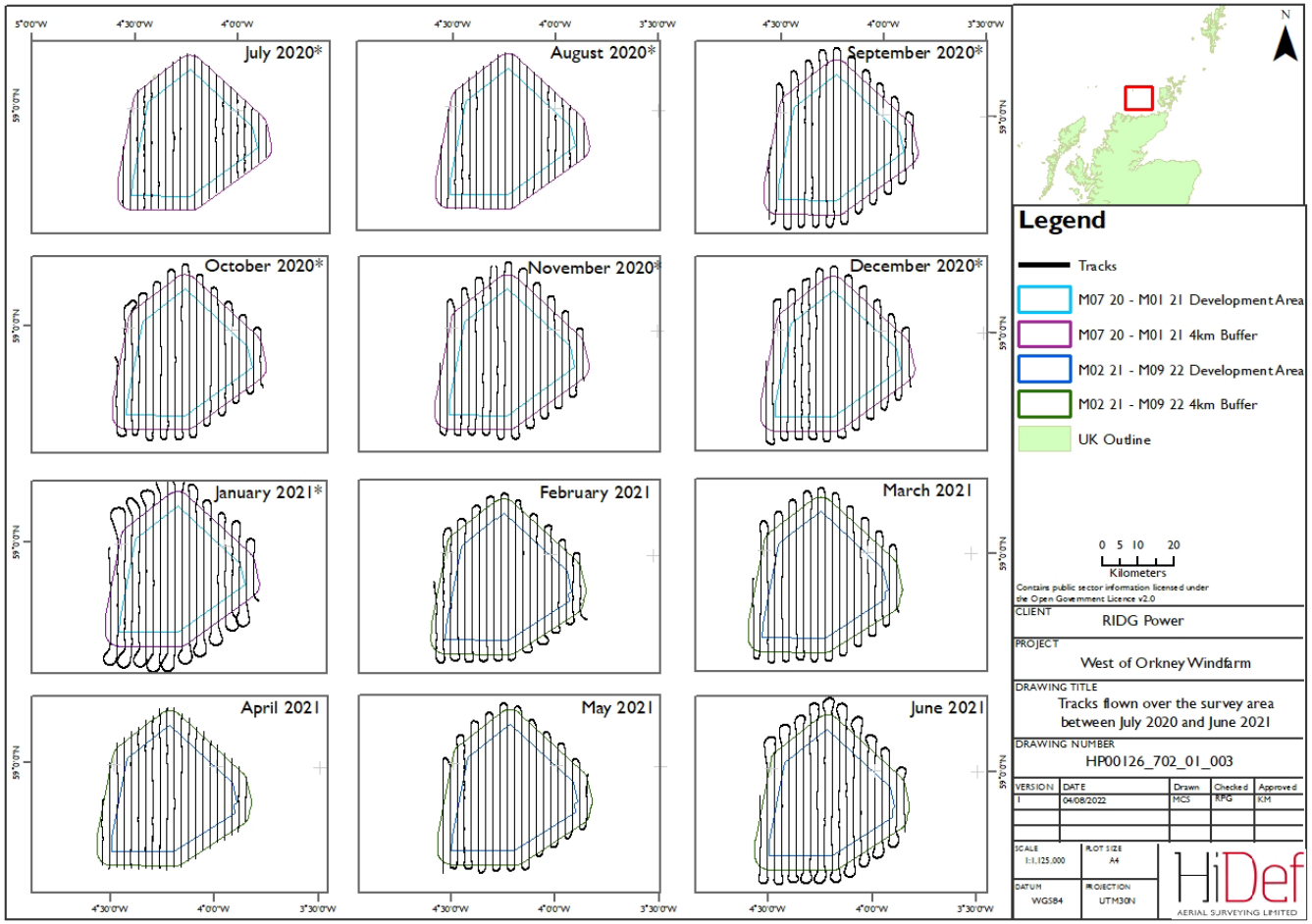


Figure 4 **Flight pattern for surveys flown between July 2021 and June 2022 over the WOW survey area**

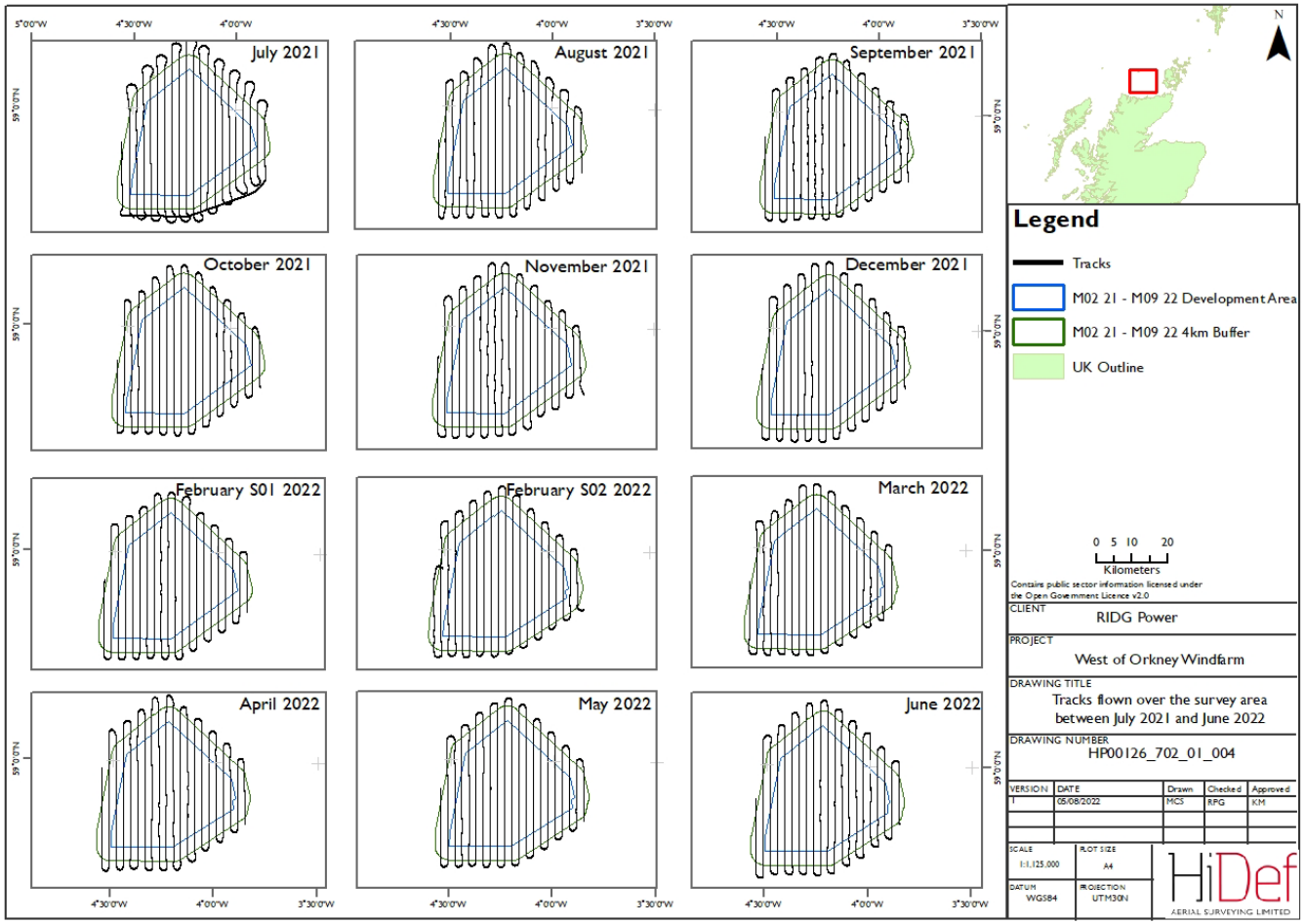
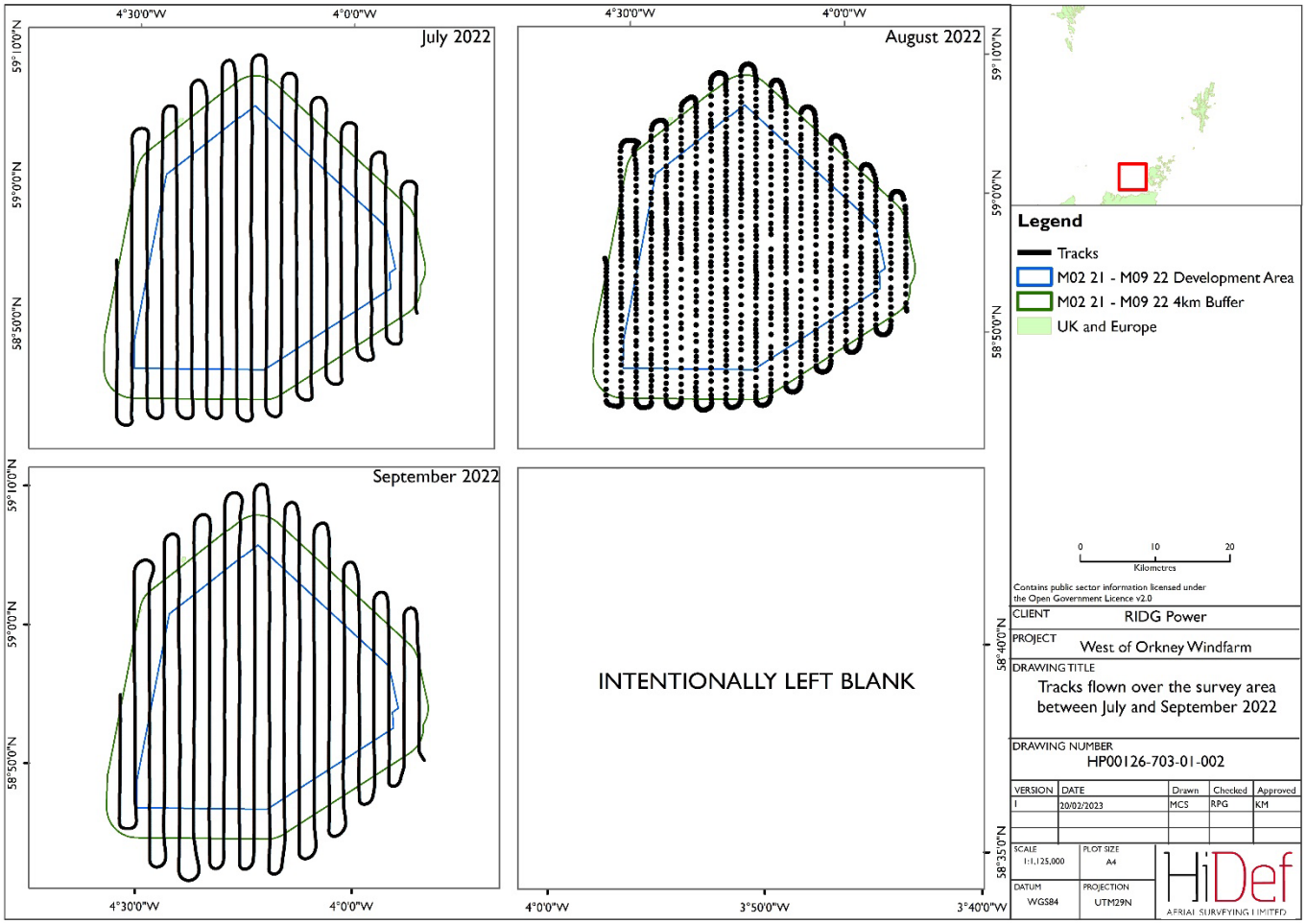


Figure 5 **Flight pattern for surveys flown between July and September 2022 over the WOW survey area**



3.2 Survey results

70 Each animal was assigned to a species group, and where possible these were also assigned a species identification with confidence levels of 'Possible', 'Probable' or 'Definite'. Any animals that could not be identified to species level were assigned to a category 'No ID'. The analysis of data to species level uses all levels of identification confidence. The overall identification rate of birds and non-avian animals to species level (not including 'No ID's) for the 27 surveys are given in Table 3.

71 The total number of objects detected in each survey flight, as well as numbers of species and species groups are presented in Table 4 to Table 9.

Table 3 WOW survey identification rates for birds and non-avian animals between July 2020 and September 2022 inclusive

Survey date	ID rate (%)
22 July 2020*	93.39
06 August 2020*	98.00
24 September 2020*	98.89
22 October 2020*	98.37
28 November 2020*	95.14
15 December 2020*	97.65
04 January 2021*	96.73
27 February 2021	96.53
15 March 2021	97.47
21 April 2021	94.71
20 May 2021	97.12
11 June 2021	98.50
02 July 2021	98.80
30 August 2021	96.76
08 September 2021	97.32
12 October 2021	98.71
15 November 2021	95.29
28 December 2021	95.59
18 February 2022	98.28
26 February 2022	96.51
11 March 2022	95.69
14 April 2022	98.01
15 May 2022	98.00
06 June 2022	98.01
22 July 2022	96.12
17 August 2022	98.67
02 September 2022	94.56
Average	**96.99**

**Initial survey area – see Figure 1 and Figure 2*

Table 4 Number of objects detected during each survey assigned to species level for Year 1 in the WOW survey area between July 2020 and June 2021. Survey dates presented in Table 3.

Species	Scientific name	Month												Total
		Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	
Greylag goose	*Anser anser*	0	0	0	0	0	0	0	0	0	0	0	0	0
Pink-footed goose	*Anser brachyrhynchus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Golden plover	*Pluvialis apricaria*	0	0	5	0	0	0	0	0	0	0	0	0	5
Whimbrel	*Numenius phaeopus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Curlew	*Numenius arquata*	0	0	0	0	0	0	0	0	0	0	0	0	0
Kittiwake	*Rissa tridactyla*	40	46	5	202	32	18	15	37	208	87	10	24	724
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Little gull	*Hydrocoloeus minutus*	0	0	1	0	0	0	0	0	0	0	0	0	1
Common gull	*Larus canus*	0	0	0	0	0	0	0	0	0	1	0	0	1
Great black-backed gull	*Larus marinus*	0	0	0	4	19	10	11	31	6	0	0	4	85
Herring gull	*Larus argentatus*	0	0	0	0	4	0	2	1	1	0	2	0	10
Lesser black-backed gull	*Larus fuscus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Common tern	*Sterna hirundo*	0	2	0	0	0	0	0	0	0	0	0	0	2
Arctic tern	*Sterna paradisaea*	0	0	0	0	0	0	0	0	0	0	0	23	23

Species	Scientific name	Month												Total
		Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	
Great skua	*Stercorarius skua*	3	39	0	1	1	0	0	0	0	9	3	0	56
Arctic skua	*Stercorarius parasiticus*	1	0	0	0	0	0	0	0	0	0	0	0	1
Long-tailed skua	*Stercorarius longicaudus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Little auk	*Alle alle*	0	0	0	0	0	0	0	1	0	0	0	0	1
Guillemot	*Uria aalge*	523	193	606	501	74	126	195	337	467	1004	84	163	4273
Razorbill	*Alca torda*	2	3	13	0	1	0	0	10	12	21	3	17	82
Black guillemot	*Cepphus grylle*	0	0	0	0	0	0	0	0	0	0	0	0	0
Puffin	*Fratercula arctica*	375	316	25	18	2	0	1	1	0	204	62	747	1751
Red-throated diver	*Gavia stellata*	0	0	0	1	0	0	0	0	0	0	0	0	1
Great northern diver	*Gavia immer*	0	0	0	1	0	0	0	0	0	0	1	0	2
European storm petrel	*Hydrobates pelagicus*	0	1	11	0	0	0	0	0	0	0	0	0	12
Fulmar	*Fulmarus glacialis*	226	247	442	471	259	560	369	62	190	68	32	1	2927
Cory's shearwater	*Calonectris borealis*	0	0	0	0	0	0	0	0	0	0	0	0	0
Sooty shearwater	*Ardenna grisea*	0	0	0	0	0	0	0	0	0	0	0	0	0
Great shearwater	*Ardenna gravis*	0	0	0	0	0	0	0	0	0	0	0	0	0
Manx shearwater	*Puffinus puffinus*	0	0	2	0	0	0	0	0	0	0	0	2	4
Gannet	*Morus bassanus*	143	273	232	144	6	9	4	14	20	83	106	65	1099

Species	Scientific name	Month												Total
		Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	
Shag	*Gulosus aristotelis*	0	0	0	0	0	0	0	0	0	3	0	0	3
Barrel jellyfish	*Rhizostoma pulmo*	0	1	0	0	0	0	0	0	1	1	0	0	3
Lion's mane jellyfish	*Cyanea capillata*	24	5	5	1	0	0	0	0	0	0	0	0	35
Basking shark	*Cetorhinus maximus*	0	0	0	0	0	0	0	0	1	0	0	0	1
Ocean sunfish	*Mola mola*	0	0	1	0	0	0	0	0	0	0	0	0	1
Porbeagle shark	*Lamna nasus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey seal	*Halichoerus grypus*	0	0	1	1	0	1	0	1	0	1	0	0	5
Minke whale	*Balaenoptera acutorostrata*	0	0	0	0	0	0	0	0	0	2	0	0	2
Common dolphin	*Delphinus delphis*	0	0	4	8	0	0	0	0	0	0	0	0	12
Risso's dolphin	*Grampus griseus*	0	0	5	2	0	0	0	0	0	5	0	0	12
White-beaked dolphin	*Lagenorhynchus albirostris*	0	0	0	0	0	4	1	0	3	0	0	0	8
Bottlenose dolphin	*Tursiops truncatus*	0	0	1	0	0	0	0	0	0	0	0	0	1
Harbour porpoise	*Phocoena phocoena*	2	5	4	0	1	0	1	4	5	22	1	1	46
Total		**1339**	**1131**	**1363**	**1355**	**399**	**728**	**599**	**499**	**914**	**1511**	**304**	**1047**	**11189**

Table 5 Number of objects detected during each survey assigned to species level for Year 2 in the WOW survey area between July 2021 and June 2022. Survey dates presented in Table 3.

Species	Scientific name	Month												Total
		Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb S01-22	Feb S02-22	Mar-22	Apr-22	May-22	Jun-22	
Greylag goose	*Anser anser*	0	0	0	11	0	0	0	0	0	0	0	0	11
Pink-footed goose	*Anser brachyrhynchus*	0	0	0	2	0	0	0	0	0	0	0	0	2
Golden plover	*Pluvialis apricaria*	0	0	0	0	0	0	0	0	0	0	0	0	0
Whimbrel	*Numenius phaeopus*	0	0	0	0	0	0	0	0	0	2	0	0	2
Curlew	*Numenius arquata*	1	0	0	0	0	0	0	0	0	0	0	0	1
Kittiwake	*Rissa tridactyla*	17	0	20	119	20	8	17	69	273	33	17	11	604
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	0	0	0	0	0	1	0	0	1
Little gull	*Hydrocoloeus minutus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Common gull	*Larus canus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Great black-backed gull	*Larus marinus*	0	0	0	0	32	68	14	24	6	0	1	0	145
Herring gull	*Larus argentatus*	0	0	0	0	1	0	0	2	1	0	0	0	4
Lesser black-backed gull	*Larus fuscus*	0	2	0	0	0	0	0	0	0	0	0	0	2
Common tern	*Sterna hirundo*	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic tern	*Sterna paradisaea*	0	3	0	0	0	0	0	0	0	0	1	0	4

Species	Scientific name	Month												Total
		Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb S01-22	Feb S02-22	Mar-22	Apr-22	May-22	Jun-22	
Great skua	*Stercorarius skua*	4	3	0	0	0	0	0	0	0	1	2	6	16
Arctic skua	*Stercorarius parasiticus*	0	0	0	0	0	0	0	0	0	0	0	1	1
Long-tailed skua	*Stercorarius longicaudus*	0	0	0	1	0	0	0	0	0	0	0	0	1
Little auk	*Alle alle*	0	0	0	0	6	0	2	0	0	0	0	0	8
Guillemot	*Uria aalge*	236	486	611	494	172	228	54	72	51	267	360	299	3330
Razorbill	*Alca torda*	0	17	14	7	2	3	0	6	23	0	1	0	73
Black guillemot	*Cepphus grylle*	1	0	0	1	0	0	0	0	0	0	0	0	2
Puffin	*Fratercula arctica*	492	339	366	30	1	2	0	0	0	193	866	866	3155
Red-throated diver	*Gavia stellata*	0	0	0	0	1	0	0	0	0	0	1	0	2
Great northern diver	*Gavia immer*	0	0	0	0	0	0	0	0	0	0	2	0	2
European storm petrel	*Hydrobates pelagicus*	0	39	17	0	0	0	0	0	0	0	0	0	56
Fulmar	*Fulmarus glacialis*	49	237	145	306	277	334	217	295	389	98	45	30	2422
Cory's shearwater	*Calonectris borealis*	0	1	0	0	0	0	0	0	0	0	0	0	1
Sooty shearwater	*Ardenna grisea*	0	2	1	0	0	0	0	0	0	0	0	0	3
Great shearwater	*Ardenna gravis*	0	0	0	0	0	0	0	0	0	0	0	0	0
Manx shearwater	*Puffinus puffinus*	0	1	0	1	0	0	0	0	0	0	0	0	2
Gannet	*Morus bassanus*	86	172	209	238	8	3	17	19	43	136	81	87	1099

Species	Scientific name	Month												Total
		Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb S01-22	Feb S02-22	Mar-22	Apr-22	May-22	Jun-22	
Shag	*Gulosus aristotelis*	0	0	0	0	0	0	1	0	0	0	0	0	1
Barrel jellyfish	*Rhizostoma pulmo*	0	0	0	0	0	0	0	0	0	0	0	0	0
Lion's mane jellyfish	*Cyanea capillata*	0	11	26	22	0	0	0	0	0	0	0	0	59
Basking shark	*Cetorhinus maximus*	1	0	0	1	0	0	0	0	0	0	0	1	3
Ocean sunfish	*Mola mola*	0	1	2	0	0	0	0	0	0	0	0	0	3
Porbeagle shark	*Lamna nasus*	0	1	0	0	0	0	0	0	0	0	0	0	1
Grey seal	*Halichoerus grypus*	0	0	1	4	0	0	0	0	0	0	3	0	8
Minke whale	*Balaenoptera acutorostrata*	0	0	0	0	0	0	0	0	0	1	0	0	1
Common dolphin	*Delphinus delphis*	0	0	0	0	0	30	0	0	0	0	0	0	30
Risso's dolphin	*Grampus griseus*	4	2	0	1	0	0	0	0	0	0	0	0	7
White-beaked dolphin	*Lagenorhynchus albirostris*	2	24	0	20	0	8	3	25	6	0	0	0	88
Bottlenose dolphin	*Tursiops truncatus*	0	0	0	0	0	0	0	0	0	0	0	0	0
Harbour porpoise	*Phocoena phocoena*	4	5	20	8	0	5	1	8	2	0	12	13	78
Total		**897**	**1346**	**1432**	**1266**	**520**	**689**	**326**	**520**	**794**	**732**	**1392**	**1314**	**11228**

Table 6 **Number of objects detected during each survey assigned to species level in the WOW survey area between July and September 2022. Survey dates presented in Table 3.**

Species	Scientific name	Month			Total for last 3 survey months	Total for entire survey period (Jul-20 to Sep-22)	Year 1	Year 2	Year 3
		Jul-22	Aug-22	Sep-22					
Greylag goose	*Anser anser*	0	0	0	0	11		✓	
Pink-footed goose	*Anser brachyrhynchus*	0	0	0	0	2		✓	
Golden plover	*Pluvialis apricaria*	0	0	0	0	5	✓		
Whimbrel	*Numenius phaeopus*	0	0	0	0	2		✓	
Curlew	*Numenius arquata*	0	0	0	0	1		✓	
Kittiwake	*Rissa tridactyla*	294	10	6	310	1638	✓	✓	✓
Black-headed gull	*Chroicocephalus ridibundus*	0	0	0	0	1		✓	
Little gull	*Hydrocoloeus minutus*	0	0	0	0	1	✓		
Common gull	*Larus canus*	0	0	0	0	1	✓		
Great black-backed gull	*Larus marinus*	0	0	0	0	230	✓	✓	
Herring gull	*Larus argentatus*	0	0	0	0	14	✓	✓	
Lesser black-backed gull	*Larus fuscus*	0	0	0	0	2		✓	
Common tern	*Sterna hirundo*	0	0	0	0	2	✓		
Arctic tern	*Sterna paradisaea*	6	11	0	17	44	✓	✓	✓
Great skua	*Stercorarius skua*	3	2	1	6	78	✓	✓	✓
Arctic skua	*Stercorarius parasiticus*	6	0	0	6	8	✓	✓	✓
Long-tailed skua	*Stercorarius longicaudus*	0	0	0	0	1		✓	

Species	Scientific name	Month			Total for last 3 survey months	Total for entire survey period (Jul-20 to Sep-22)	Year 1	Year 2	Year 3
		Jul-22	Aug-22	Sep-22					
Little auk	*Alle alle*	0	0	0	0	9	✓	✓	
Guillemot	*Uria aalge*	1016	782	610	2408	10011	✓	✓	✓
Razorbill	*Alca torda*	24	5	44	73	228	✓	✓	✓
Black guillemot	*Cepphus grylle*	0	0	0	0	2		✓	
Puffin	*Fratercula arctica*	829	741	98	1668	6574	✓	✓	✓
Red-throated diver	*Gavia stellata*	0	0	0	0	3	✓	✓	
Great northern diver	*Gavia immer*	0	0	0	0	4	✓	✓	
European storm petrel	*Hydrobates pelagicus*	0	0	0	0	68	✓	✓	
Fulmar	*Fulmarus glacialis*	75	96	323	494	5843	✓	✓	✓
Cory's shearwater	*Calonectris borealis*	0	0	0	0	1		✓	
Sooty shearwater	*Ardenna grisea*	0	0	0	0	3		✓	
Great shearwater	*Ardenna gravis*	0	0	1	1	1			✓
Manx shearwater	*Puffinus puffinus*	3	2	4	9	15	✓	✓	✓
Gannet	*Morus bassanus*	79	47	113	239	2437	✓	✓	✓
Shag	*Gulosus aristotelis*	0	0	0	0	4	✓	✓	
Barrel jellyfish	*Rhizostoma pulmo*	0	0	0	0	3	✓		
Lion's mane jellyfish	*Cyanea capillata*	0	0	0	0	94	✓	✓	
Basking shark	*Cetorhinus maximus*	0	0	1	1	5	✓	✓	✓
Ocean sunfish	*Mola mola*	0	0	0	0	4	✓	✓	
Porbeagle shark	*Lamna nasus*	0	0	0	0	1		✓	

Species	Scientific name	Month			Total for last 3 survey months	Total for entire survey period (Jul-20 to Sep-22)	Year 1	Year 2	Year 3
		Jul-22	Aug-22	Sep-22					
Grey seal	*Halichoerus grypus*	1	1	2	4	17	✓	✓	✓
Minke whale	*Balaenoptera acutorostrata*	0	0	0	0	3	✓	✓	
Common dolphin	*Delphinus delphis*	0	0	0	0	42	✓	✓	
Risso's dolphin	*Grampus griseus*	0	0	0	0	19	✓	✓	
White-beaked dolphin	*Lagenorhynchus albirostris*	0	4	0	4	100	✓	✓	✓
Bottlenose dolphin	*Tursiops truncatus*	0	0	0	0	1	✓		
Harbour porpoise	*Phocoena phocoena*	0	1	0	1	125	✓	✓	✓
Total		**2336**	**1702**	**1203**	**5241**	**27658**			

Table 7 **Number of objects with no species ID detected during each survey assigned to species group in Year 1 in the WOW survey area between July 2020 and June 2021. Survey dates presented in Table 3.**

Species group (No ID)	Month												Total
	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	
Wader species	0	0	0	0	0	0	0	0	0	0	4	0	4
Small gull species	0	0	1	0	0	0	0	0	0	0	0	0	1
Large gull species	0	0	0	0	0	0	0	3	0	0	0	0	3
Gull species	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic / common tern	0	0	0	0	0	0	0	0	0	0	0	8	8
Tern / small gull	0	2	0	0	0	0	0	0	0	0	0	0	2
Skua species	0	0	0	0	0	0	0	0	0	0	0	0	0
Large auk	1	5	9	12	6	13	10	9	14	24	1	3	107
Small auk	0	0	0	0	0	0	0	1	0	0	0	0	1
Auk species	96	21	6	11	10	1	16	4	7	58	3	4	237
Auk / small gull	0	0	0	2	0	0	0	0	1	1	0	0	4
Large auk / diver species	0	0	0	0	0	0	0	2	0	1	0	0	3
Auk / shearwater species	0	1	0	0	0	0	0	0	0	0	0	1	2
Fulmar / gull species	2	2	0	4	2	4	0	0	2	2	0	0	18
Jellyfish	0	4	9	1	0	0	0	0	0	0	0	0	14
Seal species	3	0	1	0	0	0	2	0	0	3	0	0	9
Dolphin species	0	0	1	0	1	0	0	0	0	0	0	0	2

Species group (No ID)	Month												Total
	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	
Cetacean species	0	0	0	0	0	0	0	0	1	0	0	0	1
Seal / small cetacean species	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	**102**	**35**	**27**	**30**	**20**	**18**	**28**	**19**	**25**	**89**	**8**	**16**	**417**

Table 8 **Number of objects with no species ID detected during each survey assigned to species group in Year 2 in the WOW survey area between July 2020 and June 2021. Survey dates presented in Table 3.**

Species group (No ID)	Month												Total
	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb S01-22	Feb S02-22	Mar-22	Apr-22	May-22	Jun-22	
Wader species	0	2	5	0	0	0	0	0	0	1	0	2	10
Small gull species	0	0	0	0	0	0	0	0	0	0	0	0	0
Large gull species	0	0	0	0	2	0	0	0	0	0	0	0	2
Gull species	0	0	0	0	1	0	0	0	0	0	0	0	1
Arctic / common tern	1	0	0	0	0	0	0	0	0	0	1	2	4
Tern / small gull	0	0	0	0	0	0	0	0	0	0	0	0	0
Skua species	0	0	0	0	0	0	0	0	0	0	1	1	2
Large auk	1	2	12	25	9	21	8	12	20	3	6	2	121
Small auk	0	0	0	0	0	0	0	0	0	0	0	0	0
Auk species	8	40	26	14	13	12	1	2	1	10	21	21	169
Auk / small gull	0	0	0	2	2	0	0	1	1	0	0	0	6
Large auk / diver species	0	0	0	0	0	0	0	0	0	0	0	0	0
Auk / shearwater species	0	0	0	0	0	0	0	0	0	0	0	0	0
Fulmar / gull species	1	1	0	0	1	1	1	3	14	1	0	0	23
Jellyfish	0	2	1	7	0	0	0	0	0	0	0	0	10
Seal species	0	3	4	7	0	0	0	2	0	0	6	4	26
Dolphin species	0	1	0	0	0	0	0	0	0	0	0	0	1

Species group (No ID)	Month												Total
	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Feb S01-22	Feb S02-22	Mar-22	Apr-22	May-22	Jun-22	
Cetacean species	0	1	0	0	0	0	0	0	0	0	1	0	2
Seal / small cetacean species	0	0	0	2	0	0	0	0	0	0	0	2	4
Total	**11**	**52**	**48**	**57**	**28**	**34**	**10**	**20**	**36**	**15**	**36**	**34**	**381**

Table 9 **Number of objects with no species ID detected during each survey assigned to species group in the WOW survey area between July and September 2022. Survey dates presented in Table 3.**

Species group (No ID)	Month			Total	Total Jul-20 to Sep-22
	Jul-22	Aug-22	Sep-22		
Wader species	0	0	0	0	14
Small gull species	0	0	0	0	1
Large gull species	0	0	0	0	5
Gull species	1	0	0	1	2
Arctic / common tern	6	9	0	15	27
Tern / small gull	0	0	0	0	2
Skua species	0	0	0	0	2
Large auk	19	4	16	39	267
Small auk	0	0	0	0	1
Auk species	60	7	30	97	503
Auk / small gull	4	1	0	5	15
Large auk / diver species	0	0	0	0	3
Auk / shearwater species	3	0	24	27	29
Fulmar / gull species	2	1	0	3	44
Jellyfish	0	0	0	0	24
Seal species	0	2	0	2	37
Dolphin species	0	0	0	0	3
Cetacean species	0	5	0	5	8

Species group (No ID)	Month			Total	Total Jul-20 to Sep-22
	Jul-22	Aug-22	Sep-22		
Seal / small cetacean species	0	0	0	0	5
Total	**95**	**30**	**70**	**194**	**992**

3.3 Distribution patterns and seasonal abundance

72 The density, total estimated population and upper and lower 95% CLs are presented for key species only in this section. Estimates, including standard deviation and CV, for all species and species groups are presented in Appendix I. An explanation of these parameters is presented in Table 10.

73 For certain diving species (guillemot, razorbill, puffin and harbour porpoise), estimates were adjusted to account for availability bias (Section 2.5.3) and estimate absolute abundance. The adjusted (absolute) density and abundances provide the best estimates at the time of survey. No calculation of availability bias was carried out for any other diving species due to a lack of information on dive times, and so estimates for such species should be considered low. Absolute density and abundance estimates for the relevant key species are presented within this result section, alongside the corresponding relative estimates.

74 Distribution patterns of the most abundant species are presented as density maps, in which a density surface depicts the estimated number of individuals per km². Distributions of less abundant species, unidentified species and anthropogenic activity are presented as dot maps only.

75 References to species-specific seasonality may be made throughout the report and are based on the biologically defined minimum population scale (BDMPS) report of Furness (2015) and the breeding seasons provided by NatureScot (2020) (Table 11).

Table 10 Terms used in population analysis

Term	Definition
Density estimate *(animals/km^2)*	The average number of animals per square km surveyed over the whole area.
Population estimate *(number)*	The mean number of animals estimated within the survey area.
95% confidence interval *(CI)*	A measure of uncertainty in the mean value. If the analysis was repeated, 95% of the time the mean population estimate would fall within this range. The smaller the CI range the more confident we can be that the mean estimate is an accurate reflection of the true population size.
Confidence limit *(CL)*	The upper and lower values that define the range of the 95% confidence interval.
Standard deviation *(SD)* of population estimate	The amount of variation or dispersion of a set of values. A low SD indicates that the bootstrap values tend to be close to the mean of the set.
CV (%)	The coefficient of variation is a standard measure that describes the dispersion of data points around the mean. The lower the CV the more precise the estimate. It is calculated as the SD / mean.
Relative abundance	In the case of diving birds and mammals, this is the estimated population size based on animals recorded on or above the sea surface and does not account for any that may be diving and thus submerged at the time of survey.
Absolute abundance	The most accurate estimate of population size. In the case of diving birds and mammals, this includes an estimate for the number that are believed to be submerged at the time of survey.

Table 11 Seasonality for the presented key seabird species (based on Furness, 2015 and NatureScot, 2020)

Species	Breeding season (NatureScot, 2020)	Non-breeding season (Furness, 2015)		
		Post-breeding migration (autumn)	Non-breeding	Return migration (spring)
Kittiwake	mid Apr – Aug	Aug – Dec	Sep – Feb	Jan – Apr
Great black-backed gull	Apr - Aug	Aug – Nov	Sep – Mar	Jan – Apr
Guillemot	Apr – mid Aug	Jul – Oct	Aug – Feb	Dec – Feb
Razorbill	Apr – mid Aug	Aug – Oct	Aug – Mar	Jan – Mar
Puffin	Apr – mid Aug	late Jul – Aug	mid Aug – Mar	Mar – Apr
Fulmar	Apr – mid Sep	Sep – Oct	Sep – Dec	Dec – Mar
Gannet	mid Mar – Sep	Sep – Nov	Oct – Feb	Dec – Mar

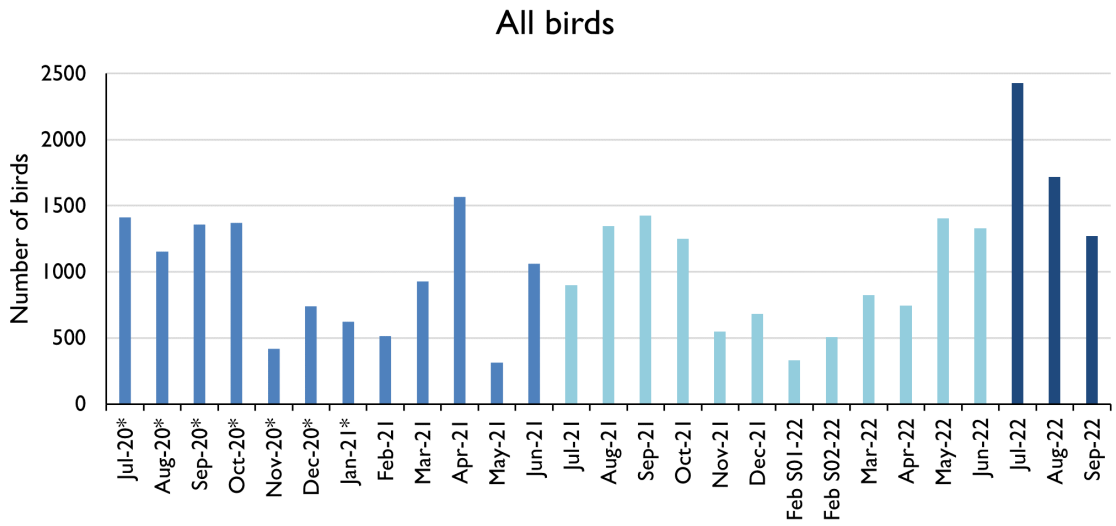
3.3.1 All bird species

76 The total number of birds recorded across the WOW survey area is presented in Figure 6, whilst the distributions and densities of birds throughout the survey period are presented in Figure 7 to Figure 9. The total number of birds varied between surveys, peaking in July 2022. Low numbers of birds were recorded in May 2021 and February S01 2022. It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

77 A total of 35 dead birds were observed, presented in Table 12.

78 Birds were found in relatively high densities across the survey area, such as in April and August 2021. A higher number of birds were distributed to the east and southeast of the survey area during the winter months such as between November 2020 and February 2021 (Figure 7 and Figure 9).

Figure 6 Total number of birds recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)



Initial survey area – see Figure 1 and Figure 2

Table 12 Dead birds recorded during the survey period

Species	Apr - 21	Oct - 21	May - 22	Jun - 22	Jul - 22	Aug - 22	Sep - 22	Total
Fulmar	0	0	0	0	0	0	1	**1**
Gannet	0	1	1	0	1	8	21	**32**
Great skua	0	0	0	1	0	0	0	**1**
No ID tern / small gull	0	0	0	0	0	1	0	**1**
Total	**0**	**1**	**1**	**1**	**1**	**9**	**22**	**35**

Figure 7 Density of all birds (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021.

Note: An increase in the development and survey area from February 2021 to September 2022.

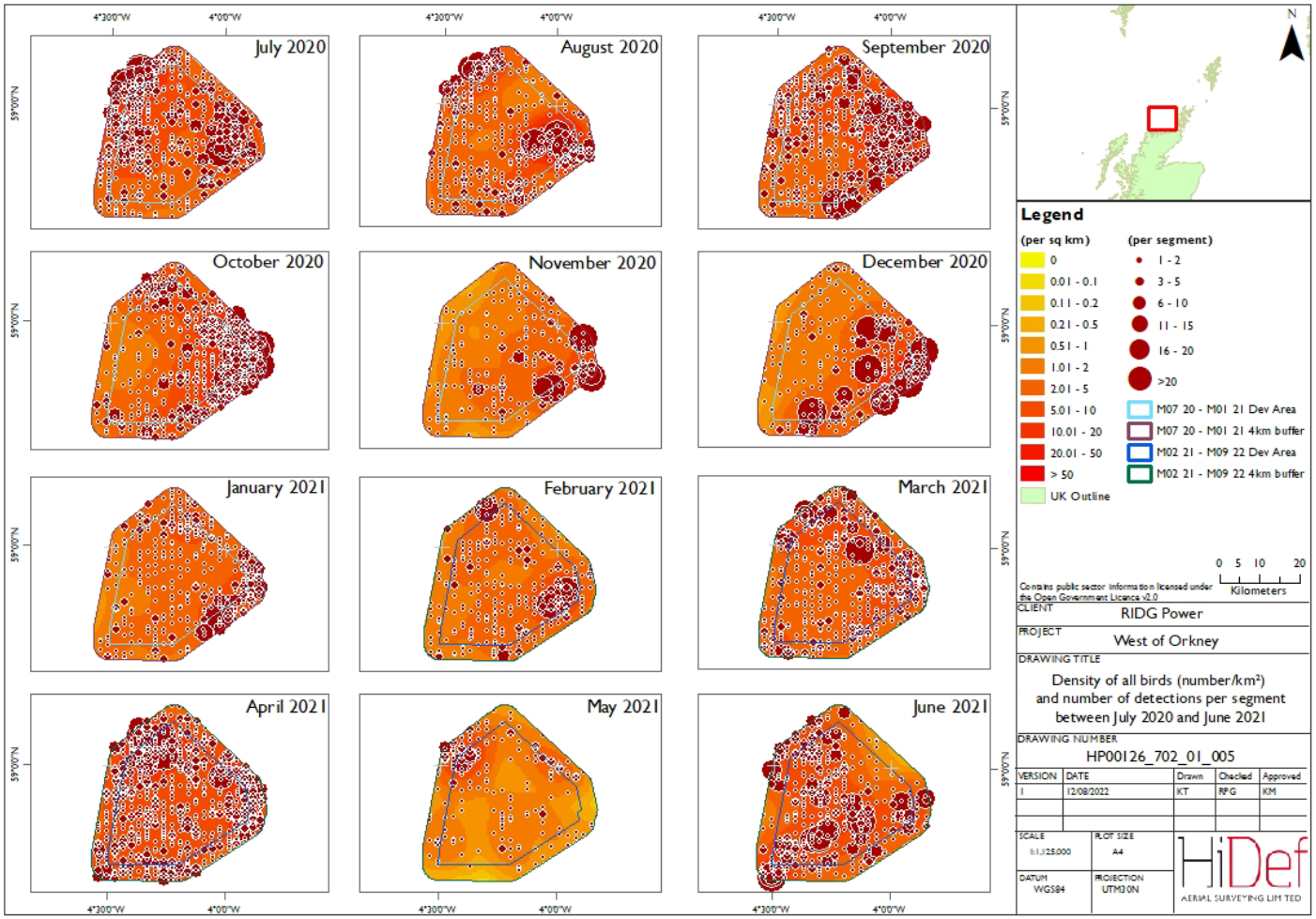


Figure 8 **Density of all birds (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.**

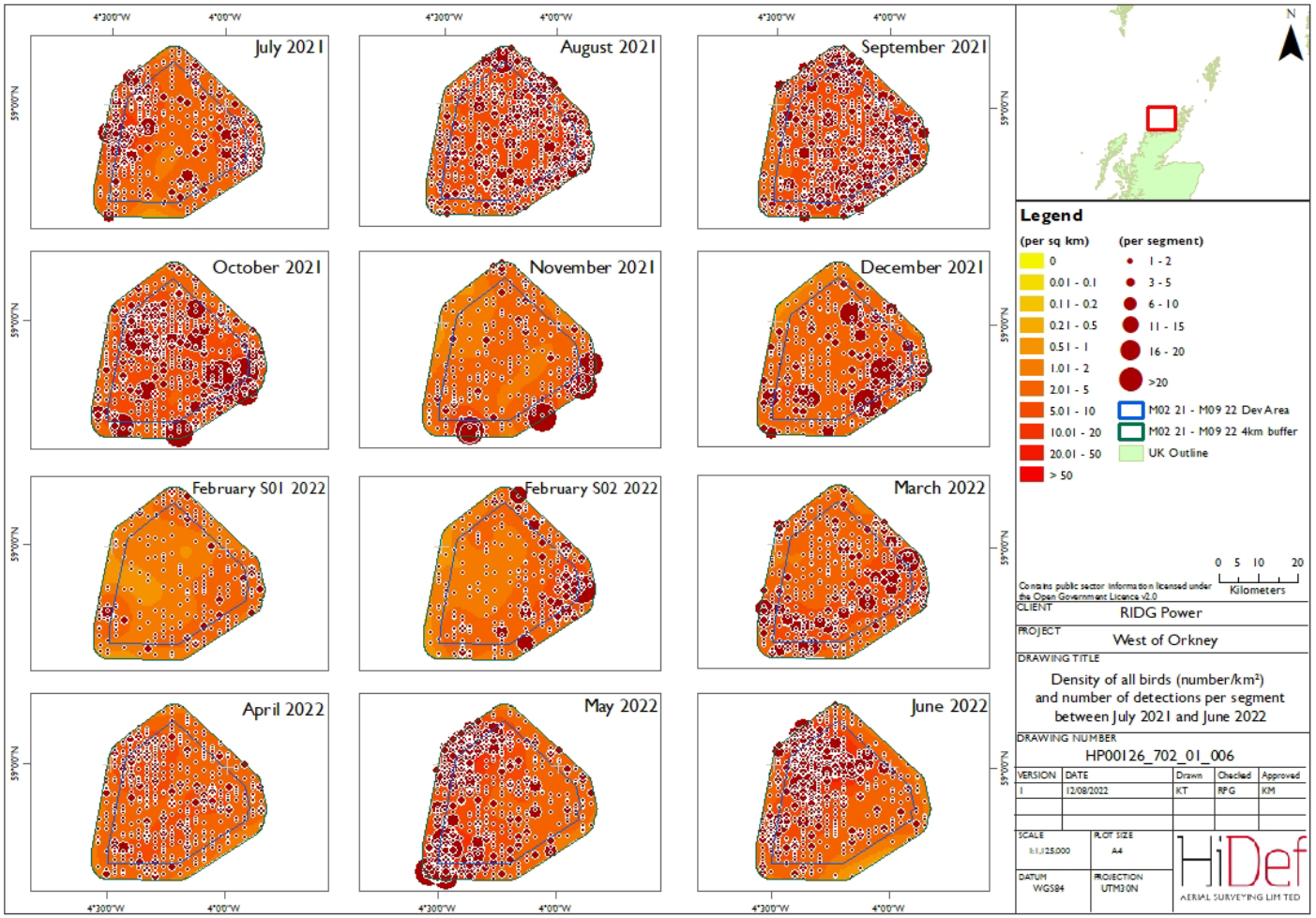
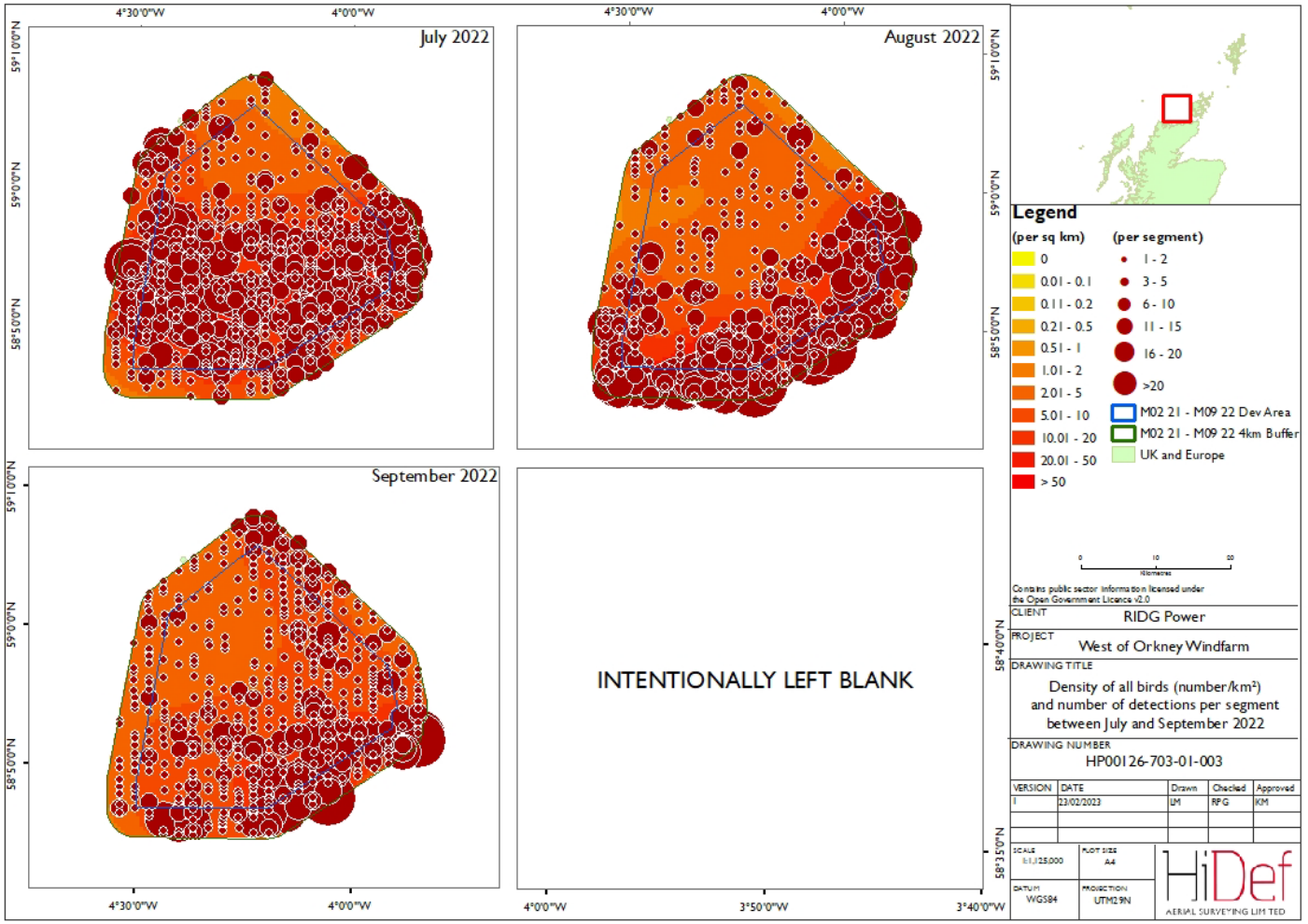


Figure 9 Density of all birds (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.



3.3.2 Kittiwake

79 Kittiwakes were observed in every survey, except August 2021 (Figure 10). The species was recorded in relatively low numbers during the breeding season, with peaks observed coinciding with the autumn post-breeding and spring return migration, such as October 2020 and March 2021 and 2022. Numbers peaked in July 2022 with 294 birds recorded It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

80 Density estimates for the species ranged between 0.04 birds/km^2 (95% CI 0.01 – 0.07) in September 2020 and 1.79 birds/km^2 (95% CI 0.91 – 2.83) in July 2022 (Figure 11; Table 13), equating to a population estimate of 50 birds (95% CI 8 – 96) and 2,362 birds (95% CI 1,203 – 3737) respectively.

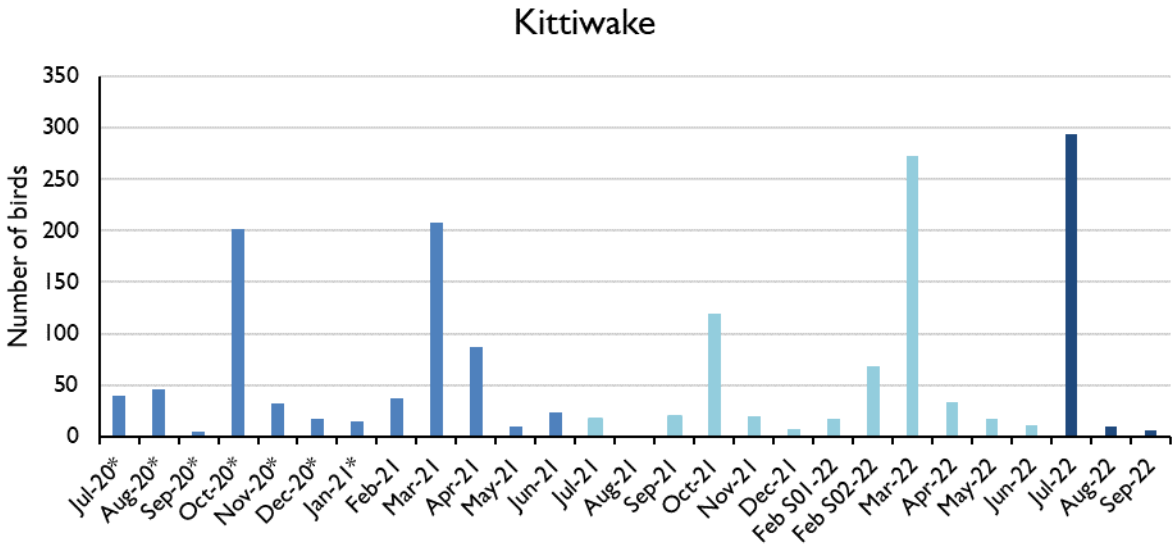
81 Kittiwakes were found throughout the survey area, with higher densities generally observed within the development area. In March and July 2022 when records peaked, the highest density of birds were estimated in the south and east of the development area and 4km buffer, while in other months, observations were more evenly spread (Figure 12 to Figure 14).

82 Of the birds that could be aged, 91% were recorded as adults. Relatively high numbers of immature and juvenile birds were recorded in March 2022 and October 2020 respectively (Table 14).

83 Over the survey period, 73% of birds were recorded flying, with a large proportion of birds recorded as sitting on the water in June 2021 and July 2022 (Table 15).

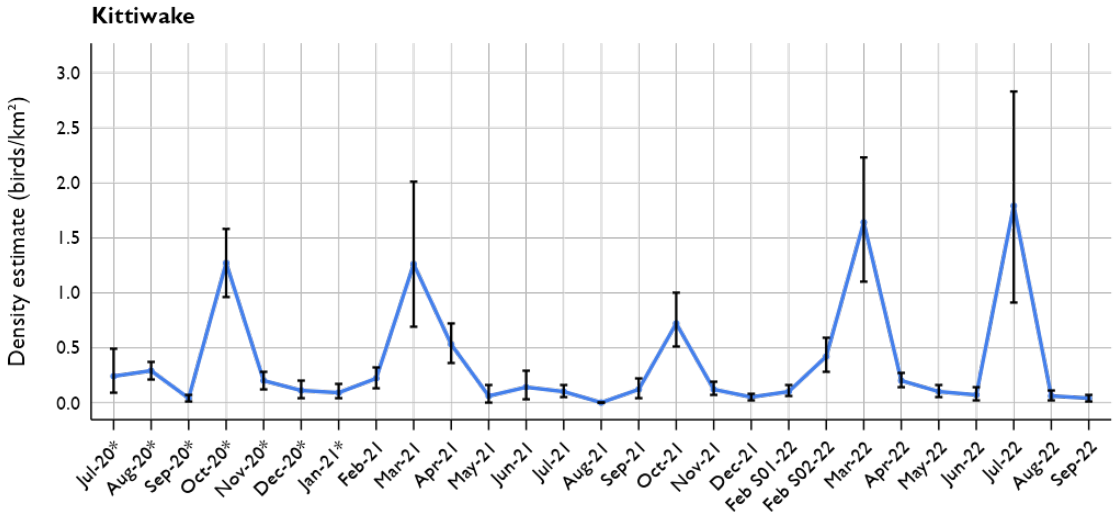
84 There were survey months in which no data regarding flight direction were available. To allow for clear interpretation of results, only surveys which contained flight direction data are displayed (Figure 15). In July 2022, when numbers peaked, birds were mainly heading west and northwest while in March 2022, birds were mainly flying northwest and southeast.

Figure 10 Number of kittiwakes recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)



**Initial survey area – see Figure 1 and Figure 2*

Figure 11 Kittiwake density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022



**Initial survey area – see Figure 1 and Figure 2*

Table 13 Density and population estimates of kittiwake in the WOW survey area between July 2020 and September 2022

Survey date	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
22 July 2020*	0.24	314	115	631	144	45.92
06 August 2020*	0.29	370	266	477	56	14.98
24 September 2020*	0.04	50	8	96	23	46.22
22 October 2020*	1.27	1625	1233	2033	208	12.79
28 November 2020*	0.20	253	159	355	51	19.87
15 December 2020*	0.11	145	56	254	51	35.02
04 January 2021*	0.09	120	48	214	44	36.63
27 February 2021	0.22	293	175	421	66	22.44
15 March 2021	1.26	1660	906	2645	447	26.90
21 April 2021	0.53	700	482	948	118	16.73
20 May 2021	0.06	80	0	209	61	75.88
11 June 2021	0.14	191	46	380	90	47.08
02 July 2021	0.10	137	72	215	37	27.04
30 August 2021	0.00	0	0	0	0	0.00
08 September 2021	0.12	162	47	296	67	41.23
12 October 2021	0.72	956	677	1321	166	17.38
15 November 2021	0.12	162	86	256	45	27.30
28 December 2021	0.05	65	24	109	22	33.51
18 February 2022	0.10	136	77	207	36	26.42
26 February 2022	0.42	551	365	776	106	19.21
11 March 2022	1.64	2155	1453	2930	372	17.23
14 April 2022	0.20	265	182	360	47	17.69
15 May 2022	0.10	137	64	217	41	29.53
06 June 2022	0.07	91	24	191	46	50.69
22 July 2022	1.79	2362	1203	3737	643	27.20
17 August 2022	0.06	80	25	148	31	38.66
02 September 2022	0.04	50	16	93	20	39.95

**Initial survey area – see Figure 1 and Figure 2*

Table 14 Summary of kittiwake ages in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded as adult	Number recorded as immature	Number recorded as juvenile	Number recorded as unknown	% Adult (from aged birds)	Total
22 July 2020*	26	0	0	14	100	40
06 August 2020*	32	0	1	13	97	46
24 September 2020*	1	0	2	2	33	5
22 October 2020*	112	0	27	63	81	202
28 November 2020*	29	1	2	0	91	32
15 December 2020*	15	1	1	1	88	18
04 January 2021*	15	0	0	0	100	15
27 February 2021	29	2	0	6	94	37
15 March 2021	97	6	0	105	94	208
21 April 2021	82	3	0	2	96	87
20 May 2021	10	0	0	0	100	10
11 June 2021	23	1	0	0	96	24
02 July 2021	13	0	0	4	100	17
30 August 2021	0	0	0	0	-	0
08 September 2021	16	0	4	0	80	20
12 October 2021	76	9	15	19	76	119
15 November 2021	20	0	0	0	100	20
28 December 2021	8	0	0	0	100	8
18 February 2022	17	0	0	0	100	17
26 February 2022	65	2	0	2	97	69
11 March 2022	173	12	0	88	94	273
14 April 2022	27	0	0	6	100	33
15 May 2022	7	9	0	1	44	17
06 June 2022	4	1	0	6	80	11
22 July 2022	194	2	1	97	98	294
17 August 2022	4	0	2	4	67	10
02 September 2022	3	0	2	1	60	6
Total	**1098**	**49**	**57**	**434**	**91**	**1638**

**Initial survey area – see Figure 1 and Figure 2*

Table 15 Summary of kittiwake behaviours in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded diving	Number recorded flying	Number recorded sitting	Number recorded taking off	% Flying	Total	Number recorded as dead
22 July 2020*	0	28	12	0	70	40	0
06 August 2020*	0	35	11	0	76	46	0
24 September 2020*	0	3	2	0	60	5	0
22 October 2020*	0	126	76	0	62	202	0
28 November 2020*	0	30	0	2	94	32	0
15 December 2020*	0	12	6	0	67	18	0
04 January 2021*	0	12	3	0	80	15	0
27 February 2021	0	23	14	0	62	37	0
15 March 2021	0	103	104	1	50	208	0
21 April 2021	0	84	3	0	97	87	0
20 May 2021	0	10	0	0	100	10	0
11 June 2021	0	8	16	0	33	24	0
02 July 2021	0	17	0	0	100	17	0
30 August 2021	0	0	0	0	-	0	0
08 September 2021	0	20	0	0	100	20	0
12 October 2021	0	117	2	0	98	119	0
15 November 2021	0	20	0	0	100	20	0
28 December 2021	0	8	0	0	100	8	0
18 February 2022	0	17	0	0	100	17	0
26 February 2022	0	61	8	0	88	69	0
11 March 2022	0	188	85	0	69	273	0
14 April 2022	0	33	0	0	100	33	0
15 May 2022	0	16	1	0	94	17	0
06 June 2022	0	4	7	0	36	11	0
22 July 2022	0	204	86	4	69	294	0
17 August 2022	0	6	4	0	60	10	0
02 September 2022	0	5	1	0	83	6	0
Total	**0**	**1190**	**441**	**7**	**73**	**1638**	**0**

**Initial survey area – see Figure 1 and Figure 2*

Figure 12 Density of kittiwakes (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

An increase in the development and survey area from February 2021 to September 2022.

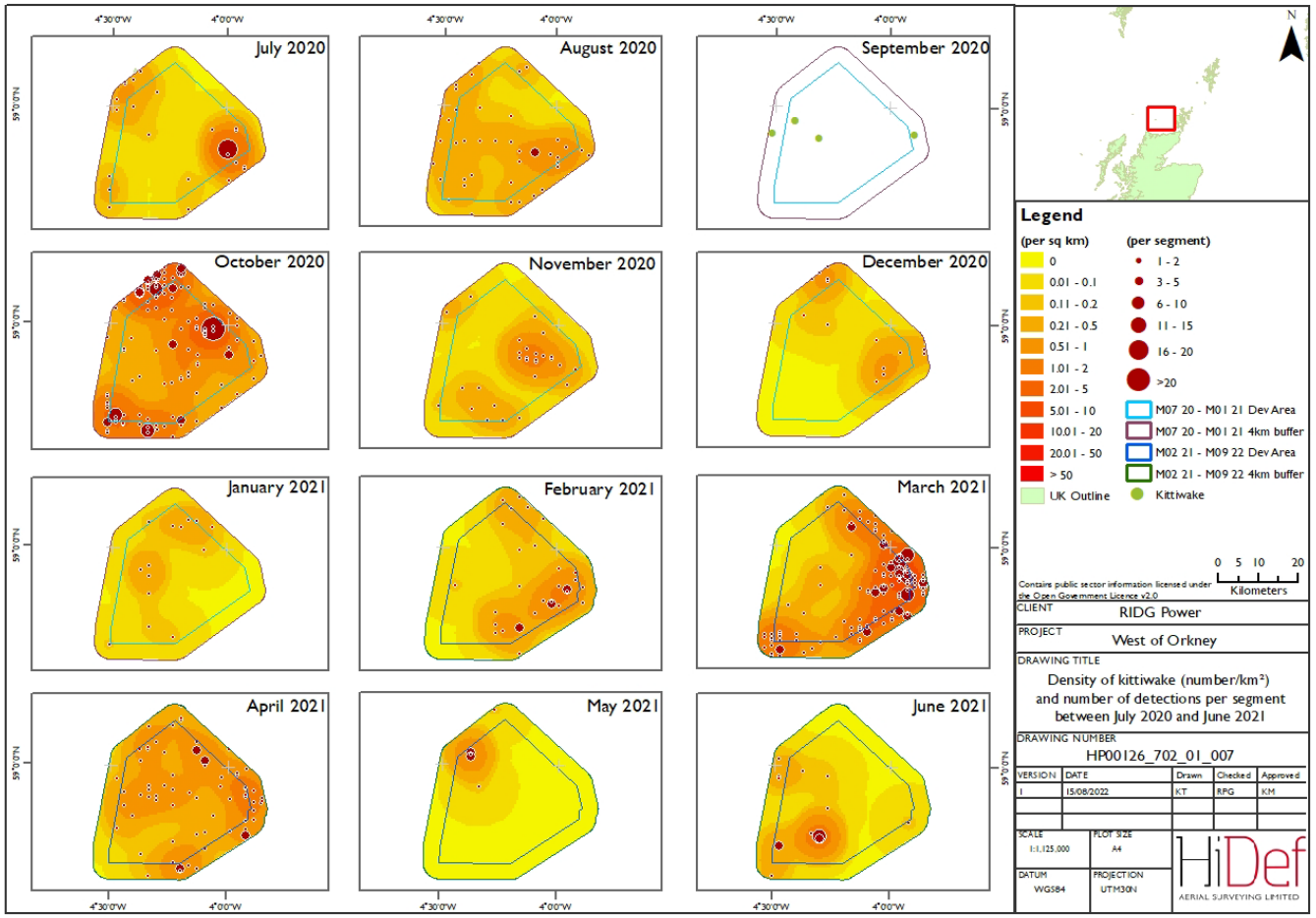


Figure 13 Density of kittiwakes (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

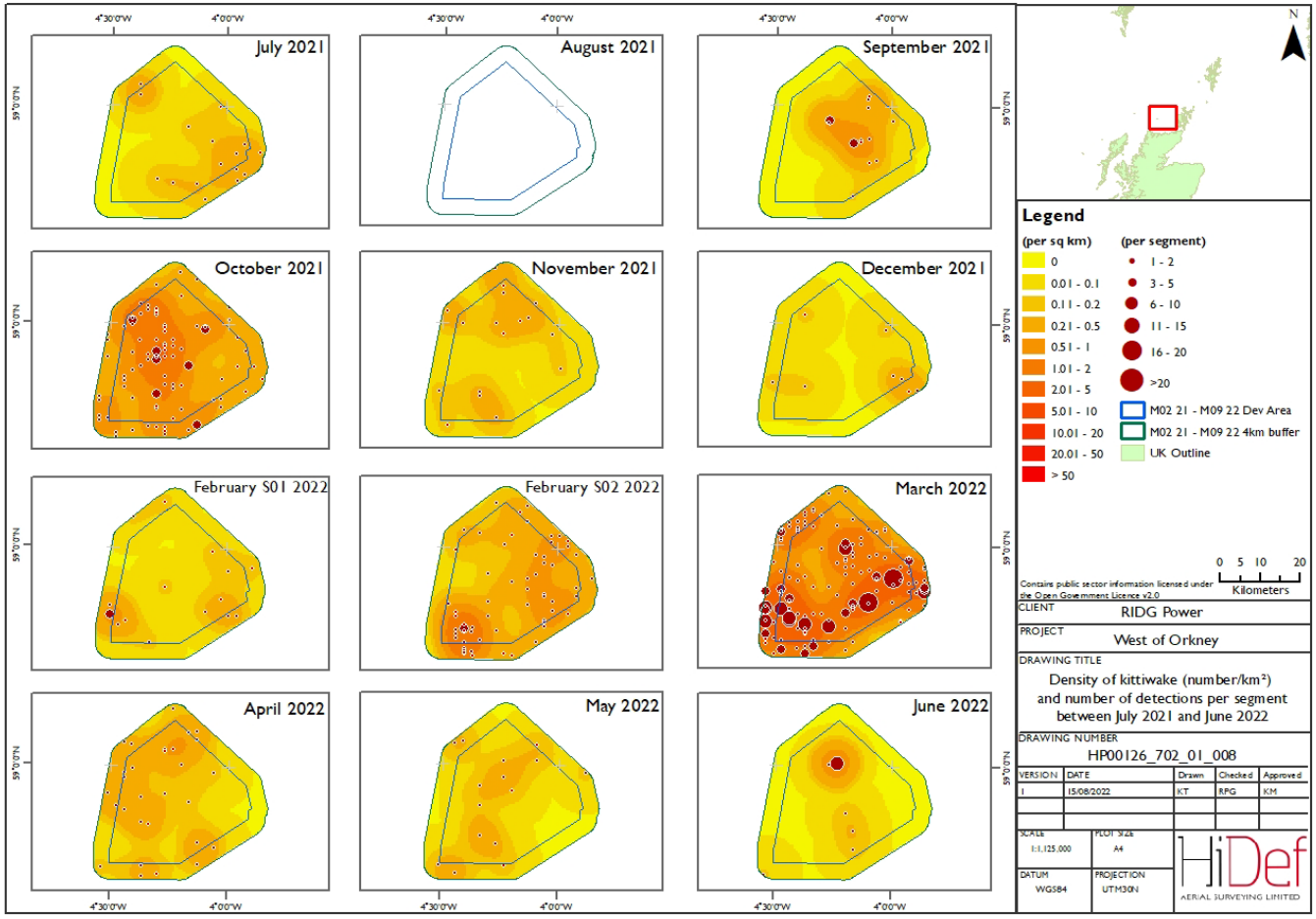


Figure 14 Density of kittiwakes (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.

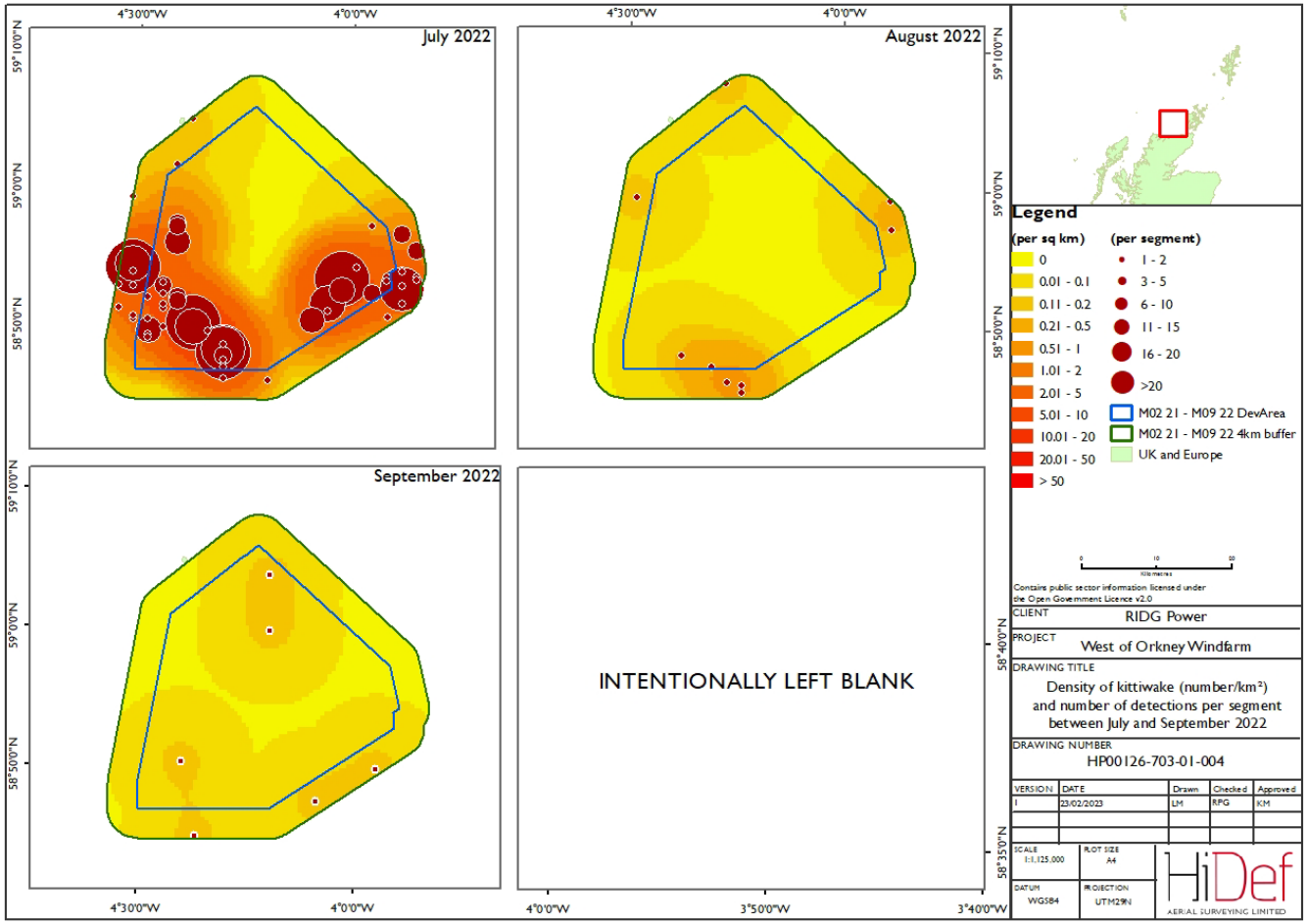
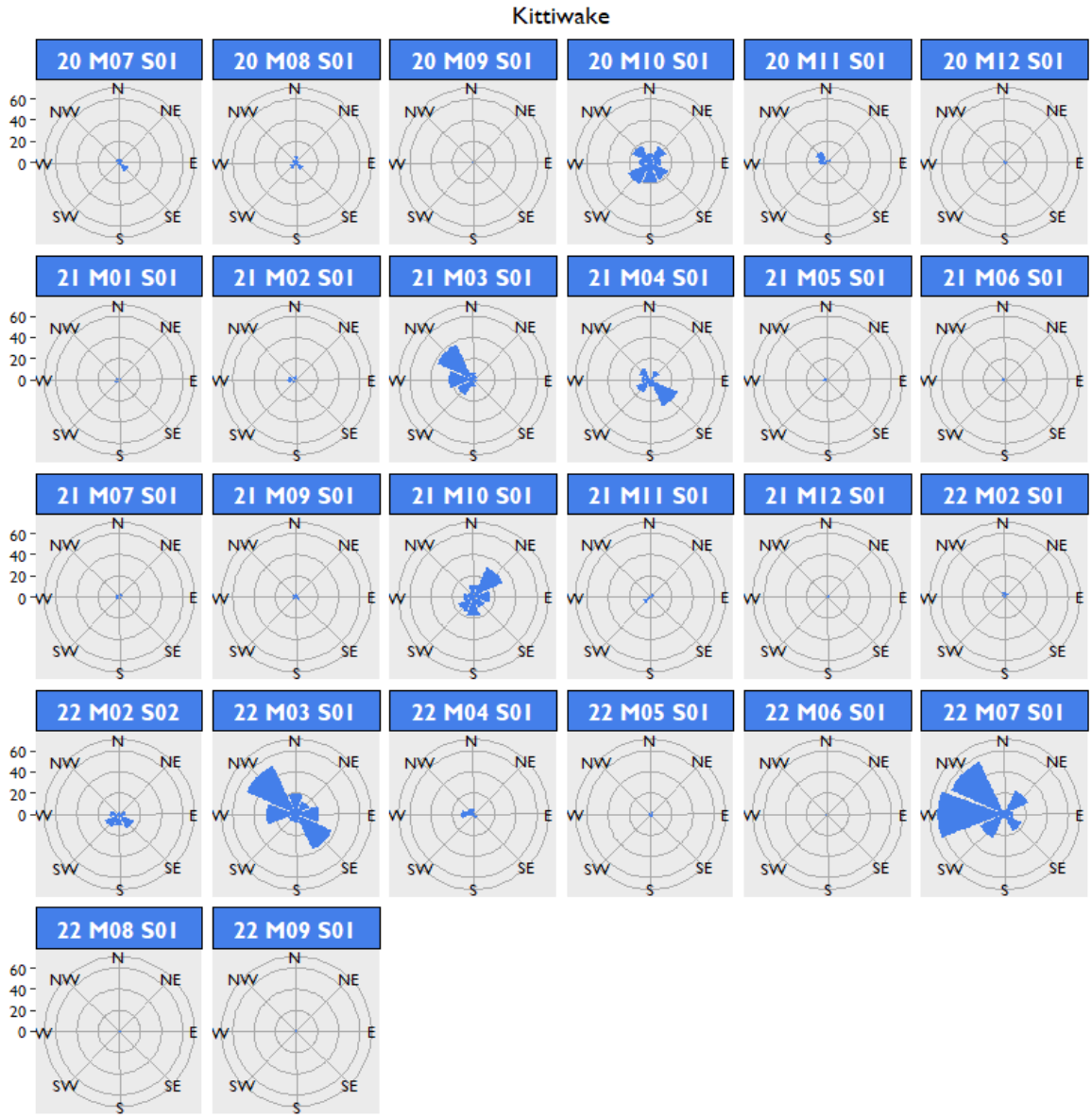


Figure 15 Summarised direction of movement of flying kittiwakes in the WOW survey area between July 2020 and September 2022

Note: All plots are visualised on the same scale to match the month with the highest values, therefore plots for months with fewer flying individuals may be harder to interpret or in extreme cases appear blank.



3.3.3 Great black-backed gull

85 Records of great black-backed gull peaked in December 2021, at 68 birds, during the non-breeding season (Figure 16). Few birds were recorded during the breeding season in Year 1 and Year 2. It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

86 Density estimates for the species ranged between 0.01 birds/km^2 in May 2022 (95% CI 0.00 – 0.02), and 0.41 birds/km^2 (95% CI 0.32 – 0.51) in December 2021 (Figure 17; Table 16), equating to 8 birds (95% CI 0 – 25) and 544 birds (95% CI 417 - 669) respectively.

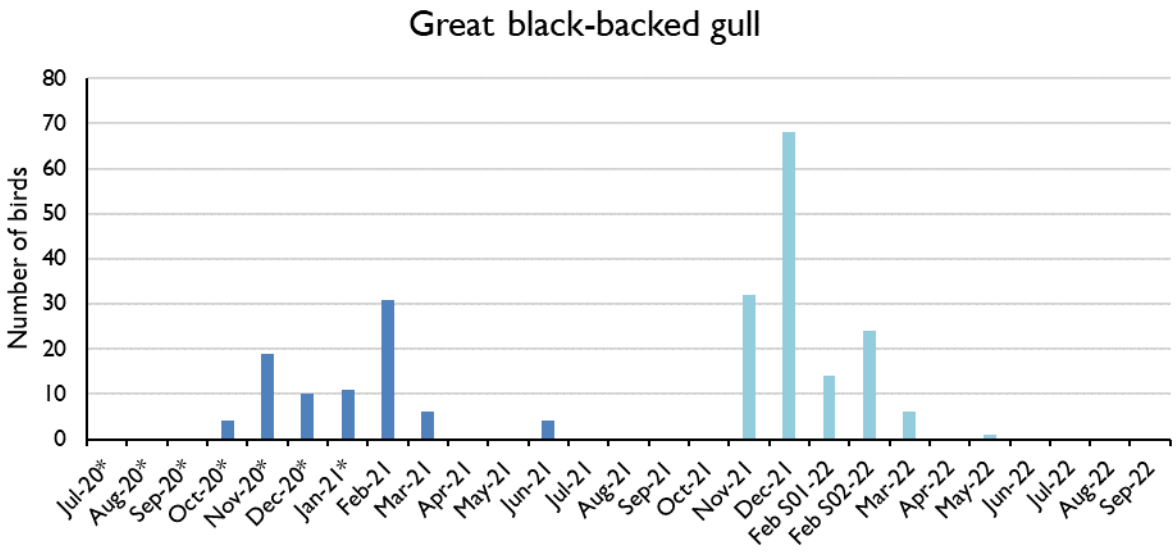
87 Great black-backed gulls were found throughout the survey area, with the highest densities tending to be found in the 4km buffer, such as in November 2021. In December 2021 when records peaked, density was highest in the east and southeast of the survey area, in comparison to February 2021 where density was concentrated in the northwest buffer (Figure 18 to Figure 20).

88 Of the birds that could be aged, 66% were recorded as adults, with the largest proportion of immature (67%) and juvenile (9%) birds recorded in October 2020 and December 2021 respectively (Table 17).

89 Over the survey period, 38% of birds were recorded flying. Relatively high proportions of birds were recorded sitting on the water between December 2020 and March 2021 (Table 18).

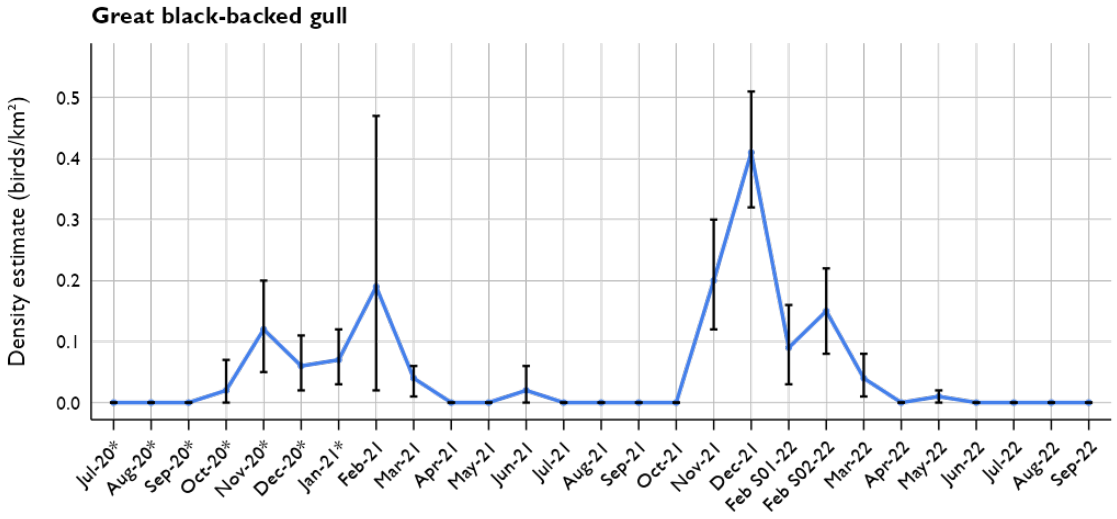
90 There were survey months in which no data regarding flight direction were available. To allow for clear interpretation of results, only surveys which contained flight direction data are displayed (Figure 21). In December 2021, when numbers peaked, birds were observed flying in all directions, but with many flying northwest.

Figure 16 Number of great black-backed gulls recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)



**Initial survey area – see Figure 1 and Figure 2*

Figure 17 Great black-backed gull density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022



**Initial survey area – see Figure 1 and Figure 2*

Table 16 **Density and population estimates of great black-backed gulls in the WOW survey area between July 2020 and September 2022**

Survey date	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
22 July 2020*	0.00	0	0	0	0	0.00
06 August 2020*	0.00	0	0	0	0	0.00
24 September 2020*	0.00	0	0	0	0	0.00
22 October 2020*	0.02	32	0	86	25	76.97
28 November 2020*	0.12	153	63	258	50	32.43
15 December 2020*	0.06	81	24	144	30	37.20
04 January 2021*	0.07	89	38	155	32	35.46
27 February 2021	0.19	250	32	617	175	69.92
15 March 2021	0.04	48	16	86	18	36.24
21 April 2021	0.00	0	0	0	0	0.00
20 May 2021	0.00	0	0	0	0	0.00
11 June 2021	0.02	33	0	79	21	63.81
02 July 2021	0.00	0	0	0	0	0.00
30 August 2021	0.00	0	0	0	0	0.00
08 September 2021	0.00	0	0	0	0	0.00
12 October 2021	0.00	0	0	0	0	0.00
15 November 2021	0.20	270	160	401	62	22.72
28 December 2021	0.41	544	417	669	65	11.90
18 February 2022	0.09	112	46	206	42	36.89
26 February 2022	0.15	196	102	294	50	25.19
11 March 2022	0.04	48	8	104	27	55.37
14 April 2022	0.00	0	0	0	0	0.00
15 May 2022	0.01	8	0	25	8	101.83
06 June 2022	0.00	0	0	0	0	0.00
22 July 2022	0.00	0	0	0	0	0.00
17 August 2022	0.00	0	0	0	0	0.00
02 September 2022	0.00	0	0	0	0	0.00

Table 17 Summary of great black-backed gull ages in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded as adult	Number recorded as immature	Number recorded as juvenile	Number recorded as unknown	% Adult (from aged birds)	Total
22 July 2020*	0	0	0	0	-	0
06 August 2020*	0	0	0	0	-	0
24 September 2020*	0	0	0	0	-	0
22 October 2020*	1	2	0	1	33	4
28 November 2020*	12	7	0	0	63	19
15 December 2020*	7	3	0	0	70	10
04 January 2021*	10	1	0	0	91	11
27 February 2021	18	9	0	4	67	31
15 March 2021	1	0	0	5	100	6
21 April 2021	0	0	0	0	-	0
20 May 2021	0	0	0	0	-	0
11 June 2021	4	0	0	0	100	4
02 July 2021	0	0	0	0	-	0
30 August 2021	0	0	0	0	-	0
08 September 2021	0	0	0	0	-	0
12 October 2021	0	0	0	0	-	0
15 November 2021	13	16	2	1	42	32
28 December 2021	44	18	6	0	65	68
18 February 2022	8	0	0	6	100	14
26 February 2022	17	6	0	1	74	24
11 March 2022	3	1	0	2	75	6
14 April 2022	0	0	0	0	-	0
15 May 2022	1	0	0	0	100	1
06 June 2022	0	0	0	0	-	0
22 July 2022	0	0	0	0	-	0
17 August 2022	0	0	0	0	-	0
02 September 2022	0	0	0	0	-	0
Total	**139**	**63**	**8**	**20**	**66**	**230**

**Initial survey area – see Figure 1 and Figure 2*

Table 18 Summary of great black-backed gull behaviours in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded diving	Number recorded flying	Number recorded sitting	Number recorded taking off	% Flying	Total	Number recorded as dead
22 July 2020*	0	0	0	0	-	0	0
06 August 2020*	0	0	0	0	-	0	0
24 September 2020*	0	0	0	0	-	0	0
22 October 2020*	0	3	1	0	75	4	0
28 November 2020*	0	11	7	1	58	19	0
15 December 2020*	0	4	6	0	40	10	0
04 January 2021*	0	3	8	0	27	11	0
27 February 2021	0	9	22	0	29	31	0
15 March 2021	0	1	5	0	17	6	0
21 April 2021	0	0	0	0	-	0	0
20 May 2021	0	0	0	0	-	0	0
11 June 2021	0	4	0	0	100	4	0
02 July 2021	0	0	0	0	-	0	0
30 August 2021	0	0	0	0	-	0	0
08 September 2021	0	0	0	0	-	0	0
12 October 2021	0	0	0	0	-	0	0
15 November 2021	0	9	23	0	28	32	0
28 December 2021	0	25	43	0	37	68	0
18 February 2022	1	4	9	0	29	14	0
26 February 2022	0	10	14	0	42	24	0
11 March 2022	0	4	2	0	67	6	0
14 April 2022	0	0	0	0	-	0	0
15 May 2022	0	1	0	0	100	1	0
06 June 2022	0	0	0	0	-	0	0
22 July 2022	0	0	0	0	-	0	0
17 August 2022	0	0	0	0	-	0	0
02 September 2022	0	0	0	0	-	0	0
Total	**1**	**88**	**140**	**1**	**38**	**230**	**0**

**Initial survey area – see Figure 1 and Figure 2*

Figure 18 Density of great black-backed gulls (number/km²) and number of detections per segment in the

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

An increase in the development and survey area from February 2021 to September 2022.

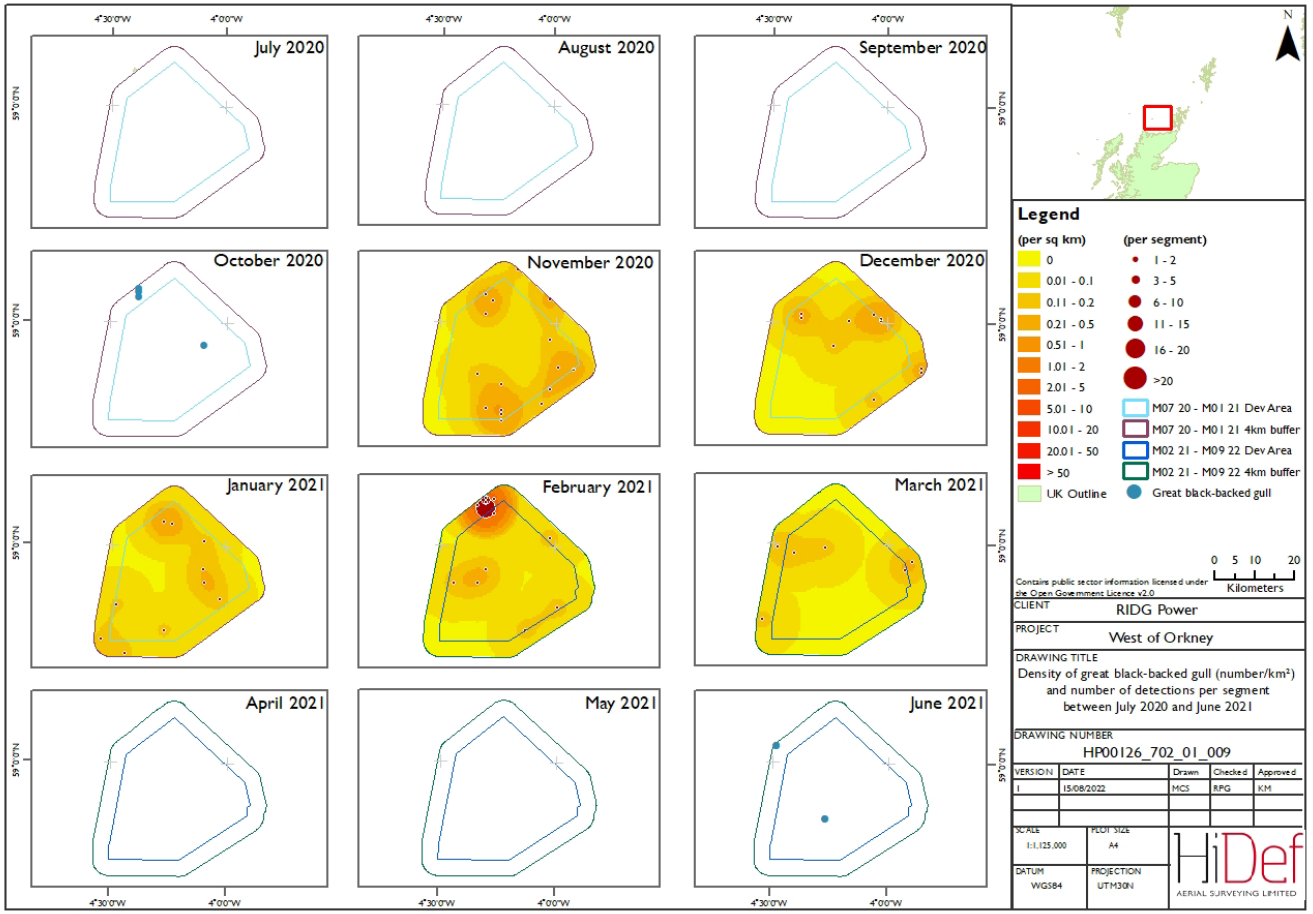


Figure 19 Density of great black-backed gulls (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

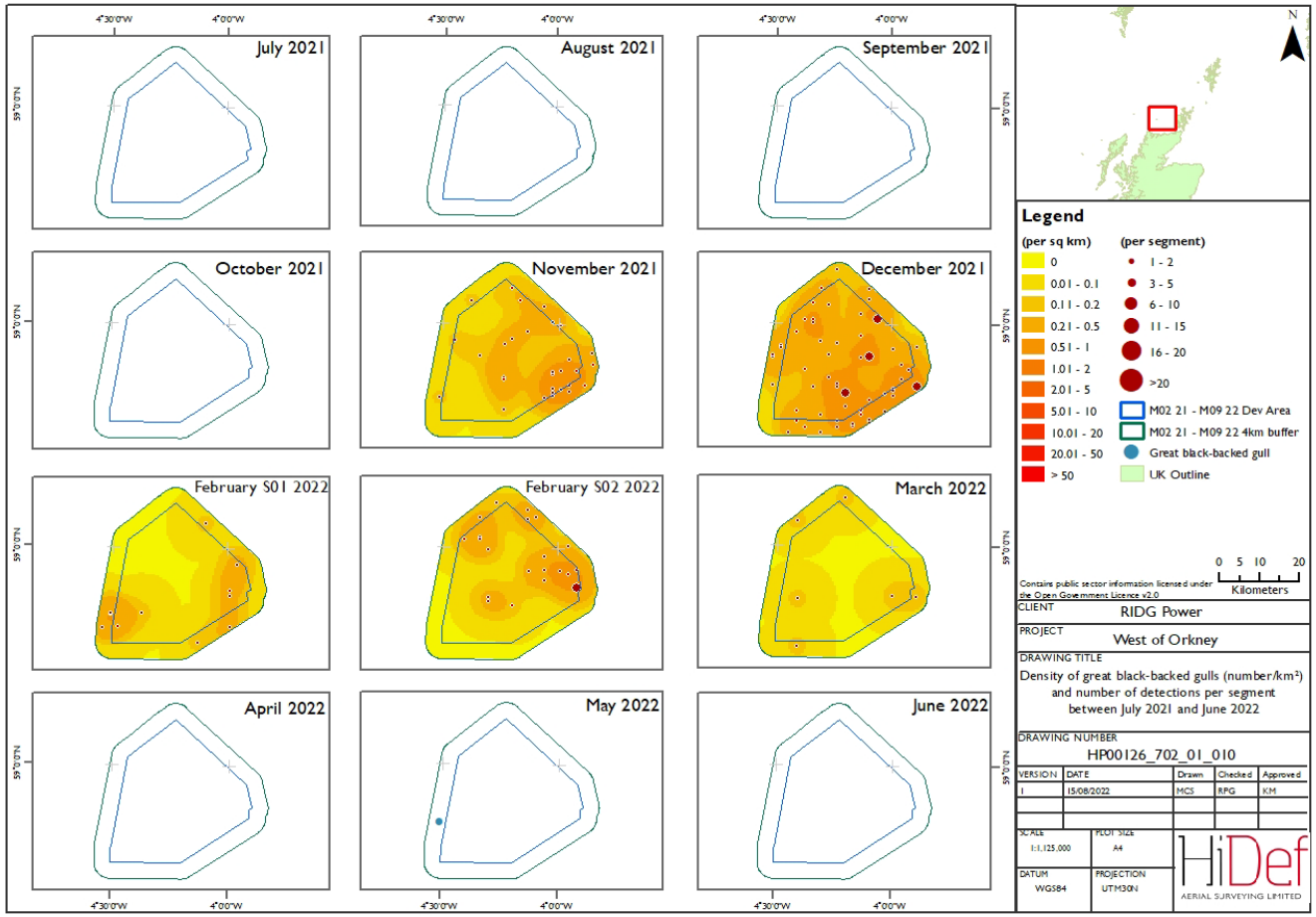


Figure 20 Detections of great black-backed gulls in the WOW survey area between July and September 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

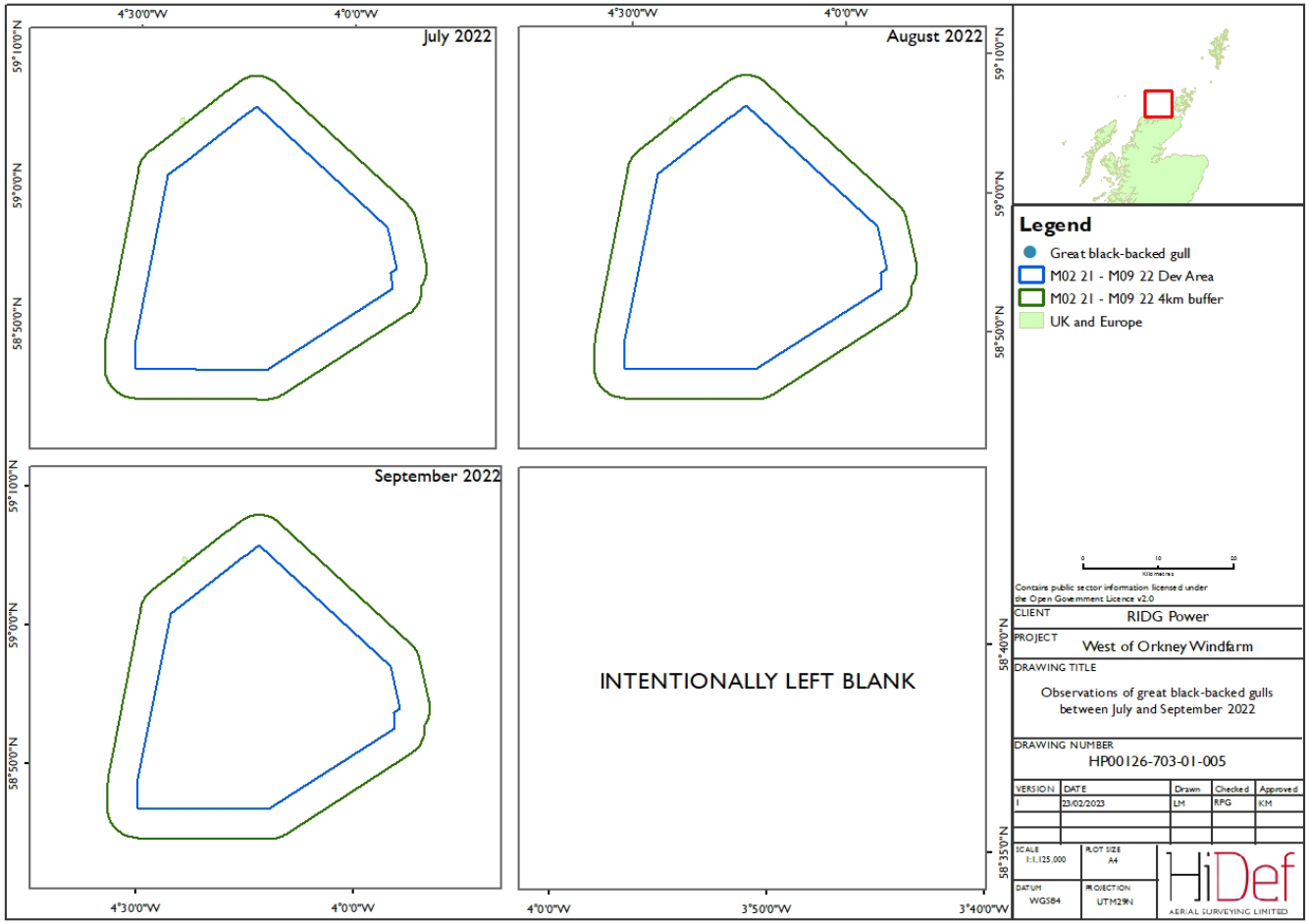
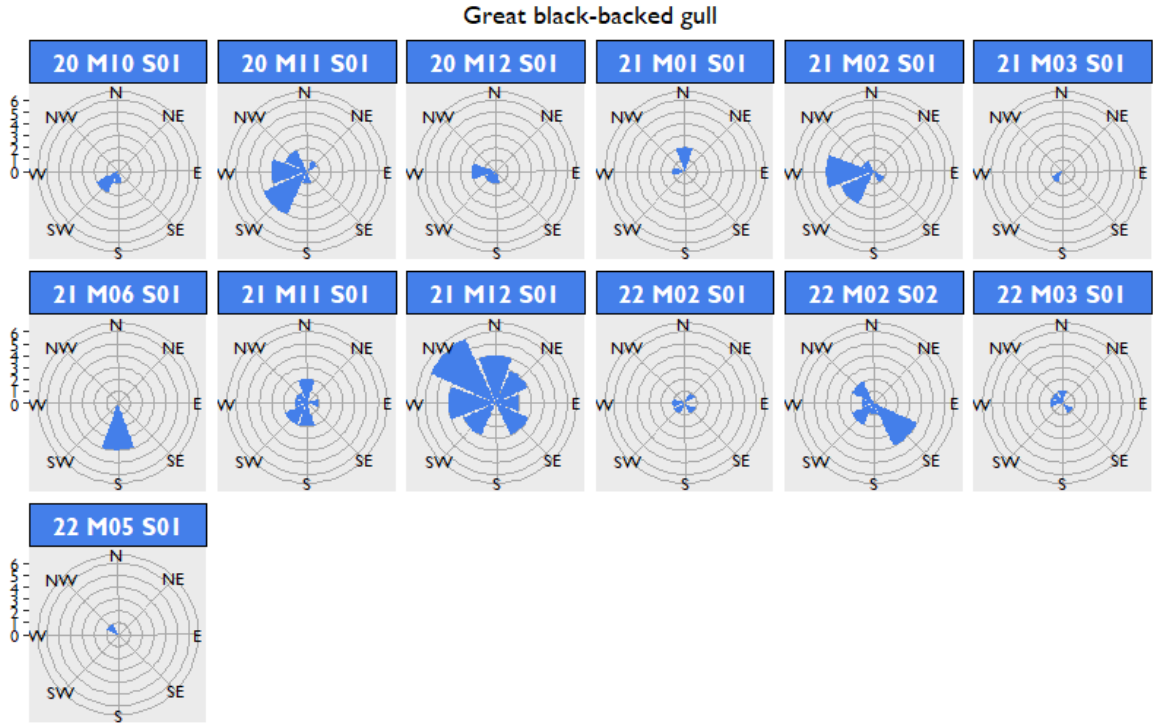


Figure 21 Summarised direction of movement of flying great black-backed gulls in the WOW survey area between July 2020 and September 2022

Note: All plots are visualised on the same scale to match the month with the highest values, therefore plots for months with fewer flying individuals may be harder to interpret or in extreme cases appear blank.



3.3.4 Guillemot

91 Guillemots were the most abundant species recorded, with peaks in detections generally occurring during the autumn post-moult dispersal (e.g. July 2022), as well as a large peak in April 2021 at the beginning of the breeding season (Figure 22). It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

92 Absolute density estimates for the species ranged between 0.50 birds/km^2 (95% CI 0.34 – 0.63) in February 2022 and 8.18 birds/km^2 (95% CI 5.44 – 11.62) in July 2022 (Figure 23; Table 19), equating to estimated abundance of 653 birds (95% CI 445 – 840) and 10,814 birds (95% CI 7,195 – 15,357) respectively.

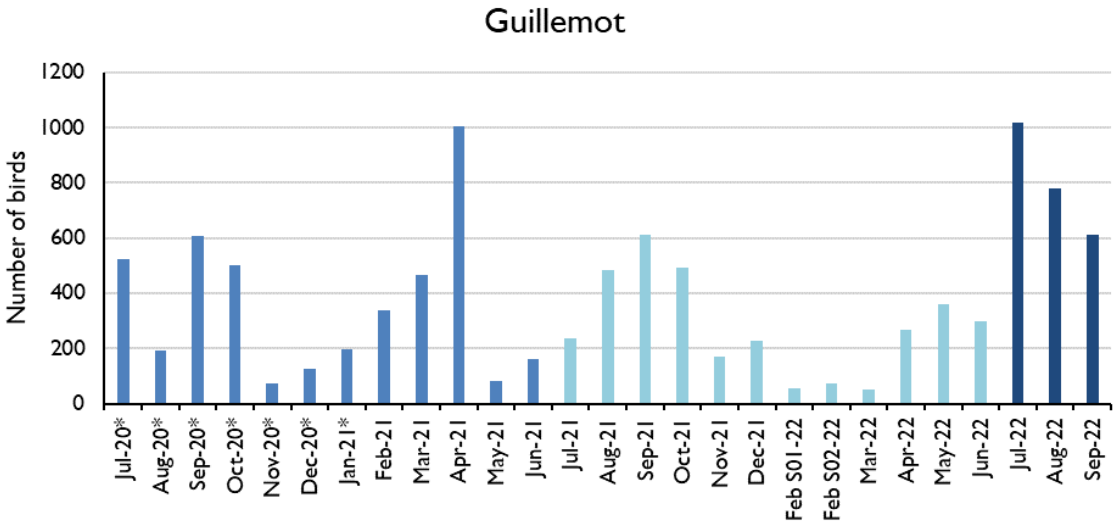
93 Guillemots were found throughout the survey area, with high densities observed within the development area and 4km buffer. In July 2022 when records peaked, birds were mainly in the east and southeast of the survey area in comparison to May and June 2021 where density was highest in the north-west of the survey area (Figure 24 to Figure 26).

94 Age data for guillemots are not presented 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. Throughout the 27-month period, 118 adult-chick pairs were recorded.

95 As expected for the species, only 6% of birds were recorded flying, with the most birds recorded as sitting on the water, such as in April 2021 and July 2022 (Table 20).

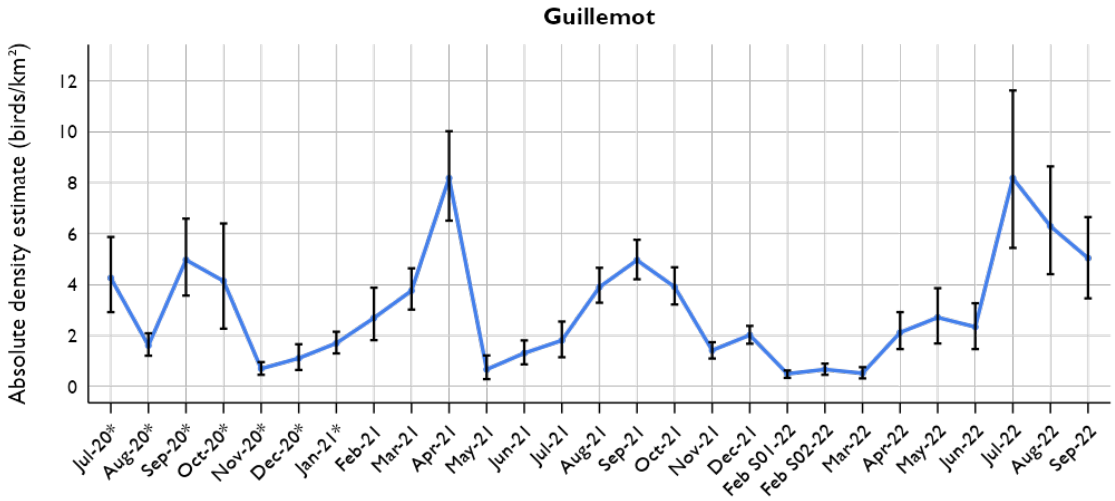
96 There were survey months in which no data regarding flight direction were available. To allow for clear interpretation of results, only surveys which contained flight direction data are displayed (Figure 27). In October 2021, birds were mainly heading in southerly directions, while in May 2022, most birds were flying in easterly directions.

Figure 22 Number of guillemots recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)



**Initial survey area – see Figure 1 and Figure 2*

Figure 23 Guillemot absolute density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022



**Initial survey area – see Figure 1 and Figure 2*

Table 19 Absolute monthly density and population estimates for guillemot in the WOW survey area between July 2020 and September 2022, accounting for the potential number of birds estimated as being unavailable for detection.

Survey Date	Relative population estimates						Absolute population estimates					
	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
22 July 2020*	3.26	4182	2985	5790	719	17.18	4.26	5468	3744	7551	1025	18.75
06 August 2020*	1.23	1584	1227	2026	205	12.90	1.61	2075	1550	2696	291	14.02
24 September 2020*	3.82	4906	3638	6552	751	15.30	4.97	6372	4585	8453	1059	16.62
22 October 2020*	3.16	4059	2224	6182	1009	24.85	4.14	5307	2913	8206	1409	26.55
28 November 2020*	0.54	692	496	938	111	15.95	0.70	899	598	1230	158	17.58
15 December 2020*	0.87	1120	715	1579	223	19.89	1.11	1417	838	2136	317	22.37
04 January 2021*	1.32	1696	1332	2090	190	11.15	1.70	2189	1663	2768	267	12.20
27 February 2021	2.11	2771	1973	3829	491	17.69	2.69	3526	2389	5102	690	19.57
15 March 2021	2.93	3848	3182	4576	355	9.20	3.76	4960	3958	6099	522	10.52
21 April 2021	6.21	8200	6639	10058	860	10.48	8.18	10807	8597	13237	1213	11.22
20 May 2021	0.52	680	318	1201	229	33.68	0.67	885	379	1613	322	36.38
11 June 2021	1.00	1321	924	1768	219	16.56	1.31	1723	1155	2371	312	18.11
02 July 2021	1.44	1892	1295	2547	322	17.00	1.81	2375	1511	3348	429	18.06
30 August 2021	2.96	3917	3351	4573	326	0.08	3.90	5161	4349	6159	476	9.22

Survey Date	Relative population estimates						Absolute population estimates					
	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
08 September 2021	3.77	4961	4245	5732	389	7.83	4.96	6520	5545	7588	547	8.39
12 October 2021	3.16	4174	3485	4860	355	8.49	3.91	5175	4266	6186	411	7.94
15 November 2021	1.10	1448	1179	1756	150	10.32	1.42	1866	1451	2291	209	11.20
28 December 2021	1.55	2033	1695	2380	172	8.44	2.02	2657	2211	3124	243	9.15
18 February 2022	0.37	492	341	641	76	15.32	0.50	653	445	840	110	16.85
26 February 2022	0.51	668	428	898	119	17.76	0.67	878	607	1187	163	18.56
11 March 2022	0.40	530	322	776	115	21.60	0.52	692	424	993	156	22.54
14 April 2022	1.64	2159	1579	2761	316	14.63	2.12	2786	1933	3856	452	16.22
15 May 2022	2.26	2980	2070	4056	526	17.65	2.71	3586	2238	5101	701	19.55
06 June 2022	1.83	2412	1649	3265	411	17.03	2.34	3094	1932	4319	585	18.91
22 July 2022	6.30	8328	5493	12270	1706	20.48	8.18	10814	7195	15357	2336	21.60
17 August 2022	4.79	6335	4413	8749	1118	17.65	6.29	8315	5834	11411	1550	18.64
02 September 2022	3.89	5146	3648	6895	842	16.36	5.04	6662	4577	8781	1186	17.80

**Initial survey area – see Figure 1 and Figure 2*

Table 20 Summary of guillemot behaviours in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded diving	Number recorded flying	Number recorded sitting	Number recorded taking off	% Flying	Total	Number recorded as dead
22 July 2020*	0	11	512	0	2	523	0
06 August 2020*	0	7	186	0	4	193	0
24 September 2020*	1	9	596	0	1	606	0
22 October 2020*	0	18	483	0	4	501	0
28 November 2020*	0	5	69	0	7	74	0
15 December 2020*	0	13	113	0	10	126	0
04 January 2021*	0	12	183	0	6	195	0
27 February 2021	0	44	293	0	13	337	0
15 March 2021	0	30	437	0	6	467	0
21 April 2021	0	14	990	0	1	1004	0
20 May 2021	0	4	80	0	5	84	0
11 June 2021	0	12	151	0	7	163	0
02 July 2021	0	51	185	0	22	236	0
30 August 2021	0	0	486	0	0	486	0
08 September 2021	0	5	606	0	1	611	0
12 October 2021	0	113	380	1	23	494	0
15 November 2021	0	15	157	0	9	172	0
28 December 2021	0	2	225	1	1	228	0
18 February 2022	0	0	54	0	0	54	0
26 February 2022	0	1	71	0	1	72	0
11 March 2022	0	1	50	0	2	51	0
14 April 2022	0	24	243	0	9	267	0
15 May 2022	1	98	261	0	27	360	0
06 June 2022	0	31	268	0	10	299	0
22 July 2022	1	35	979	1	3	1016	0
17 August 2022	0	0	782	0	0	782	0
02 September 2022	1	3	606	0	0	610	0
Total	**4**	**558**	**9446**	**3**	**6**	**10011**	**0**

**Initial survey area – see Figure 1 and Figure 2*

Figure 24 Density of guillemots (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021.

Note: An increase in the development and survey area from February 2021 to September 2022.

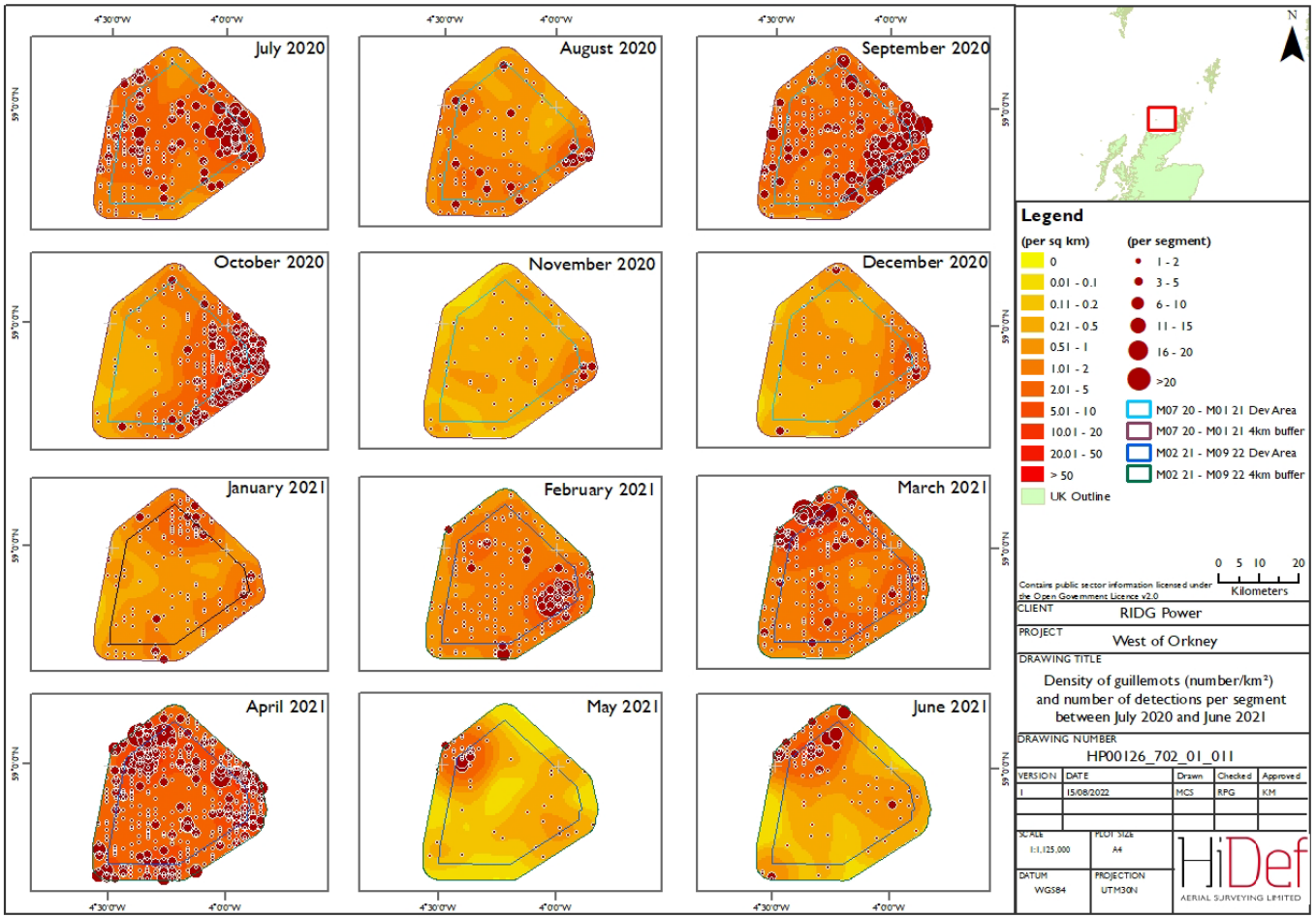


Figure 25 Density of guillemots (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

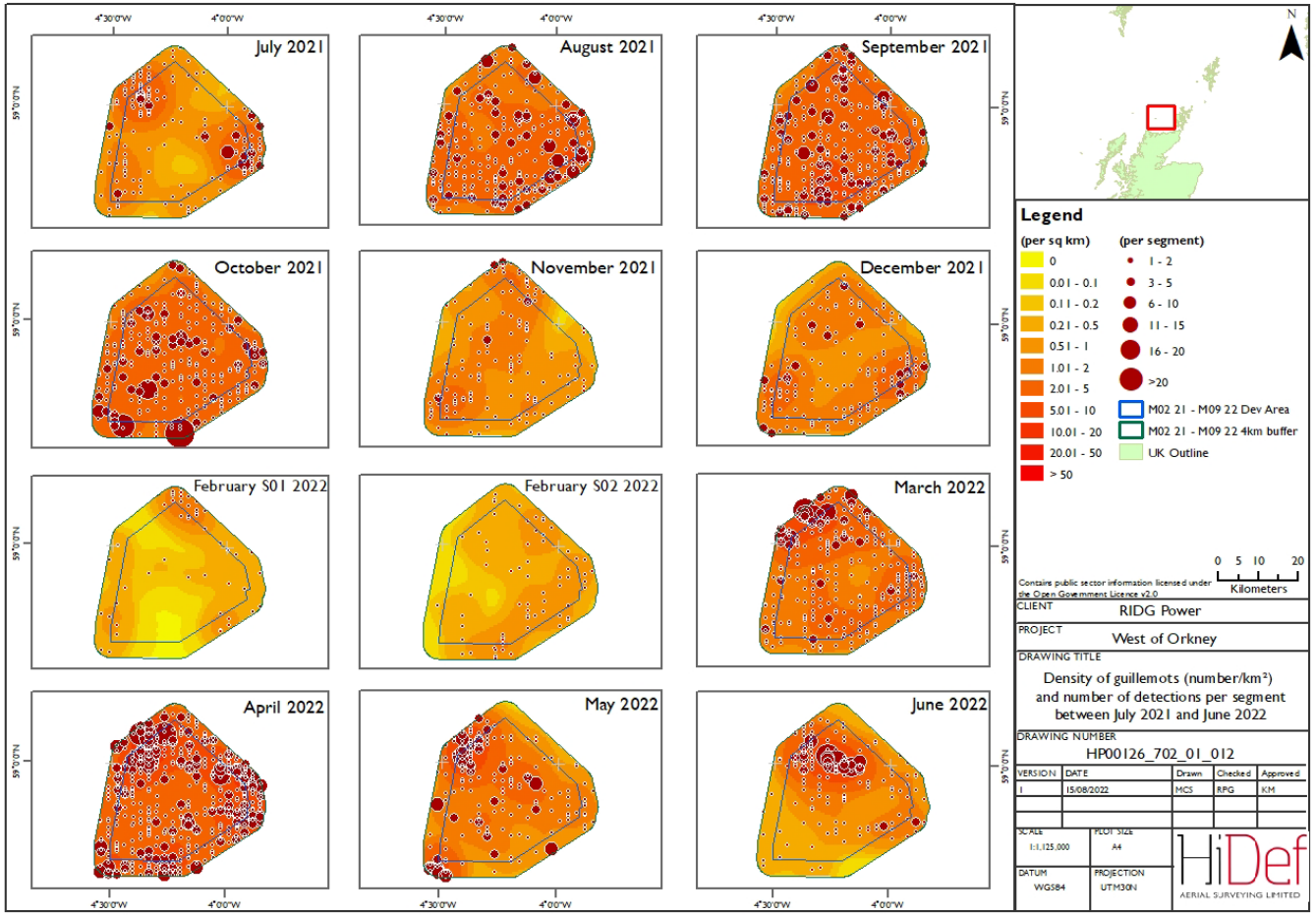


Figure 26 Density of guillemots (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.

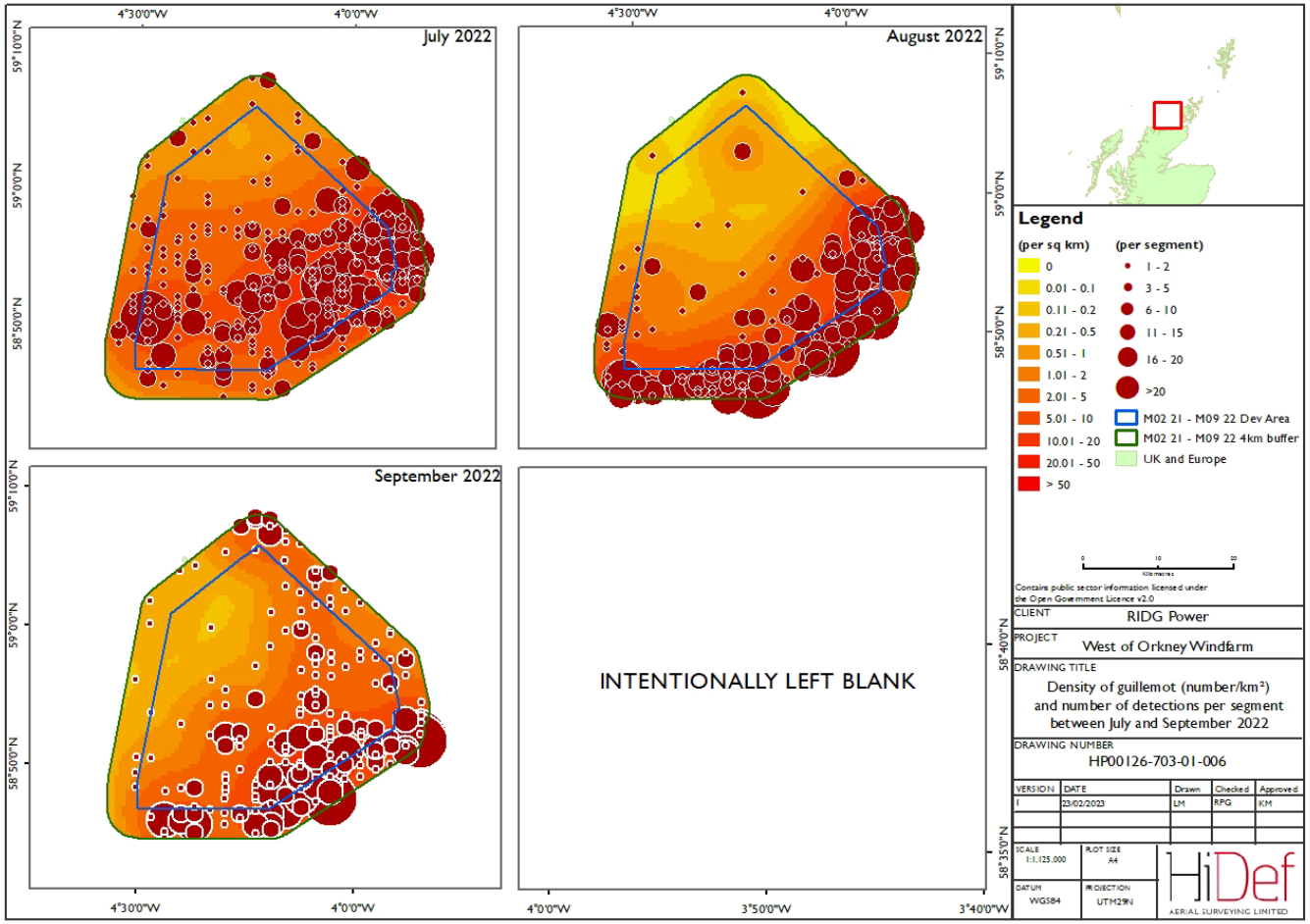
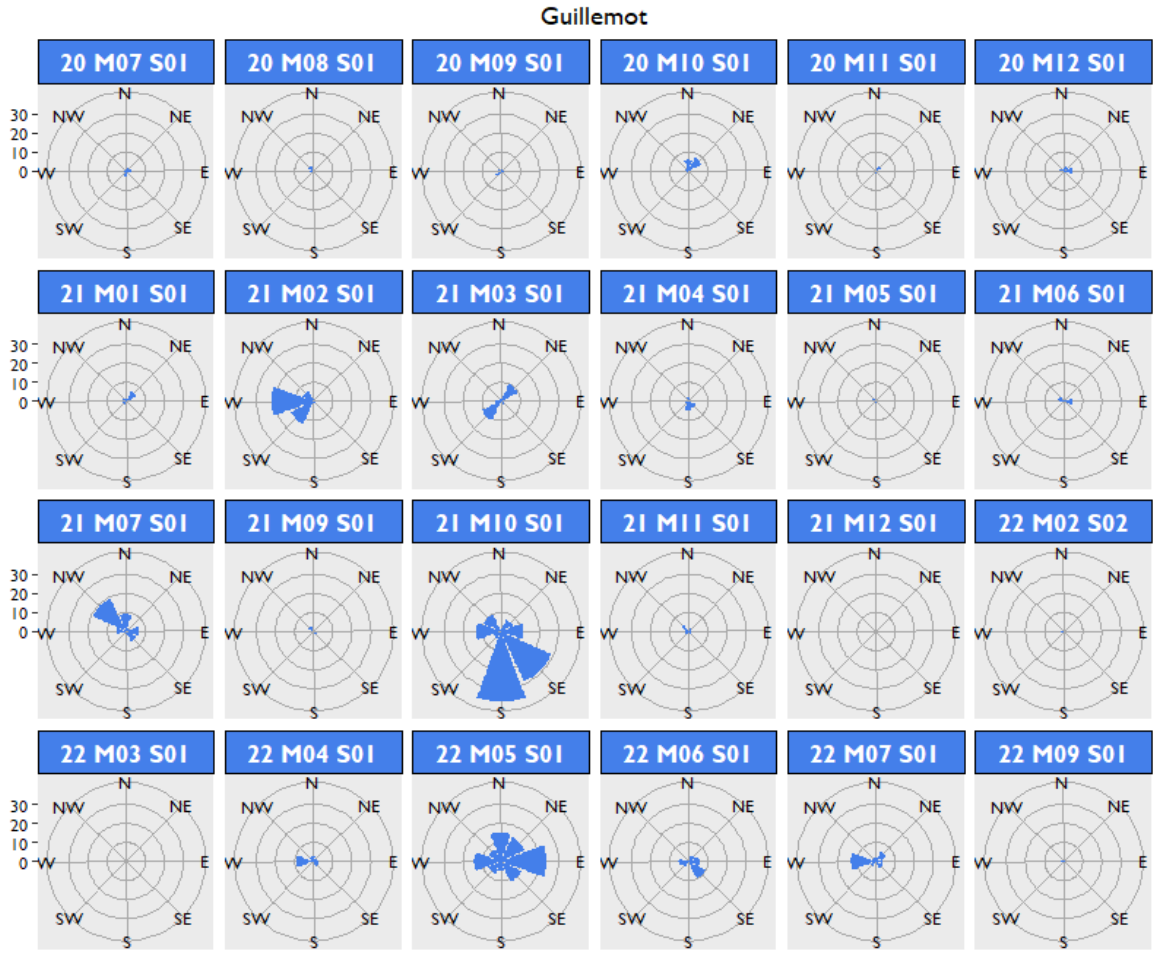


Figure 27 Summarised direction of movement of flying guillemots in the WOW survey area between July 2020 and September 2022

Note: All plots are visualised on the same scale to match the month with the highest values, therefore plots for months with fewer flying individuals may be harder to interpret or in extreme cases appear blank.



3.3.5 Razorbill

97 Razorbills were recorded intermittently throughout the survey period, peaking in September 2022, with 44 records (Figure 28). It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

98 Absolute density estimates for the species ranged between 0.01 birds/km^2 (95% CI 0.00 – 0.02) in May 2022 and 0.37 birds/km^2 (95% CI 0.16 – 0.64) in September 2022 (Figure 29; Table 21), equating to a 11 birds (95% CI 0 – 31) and 475 birds (95% CI 202 – 831) respectively.

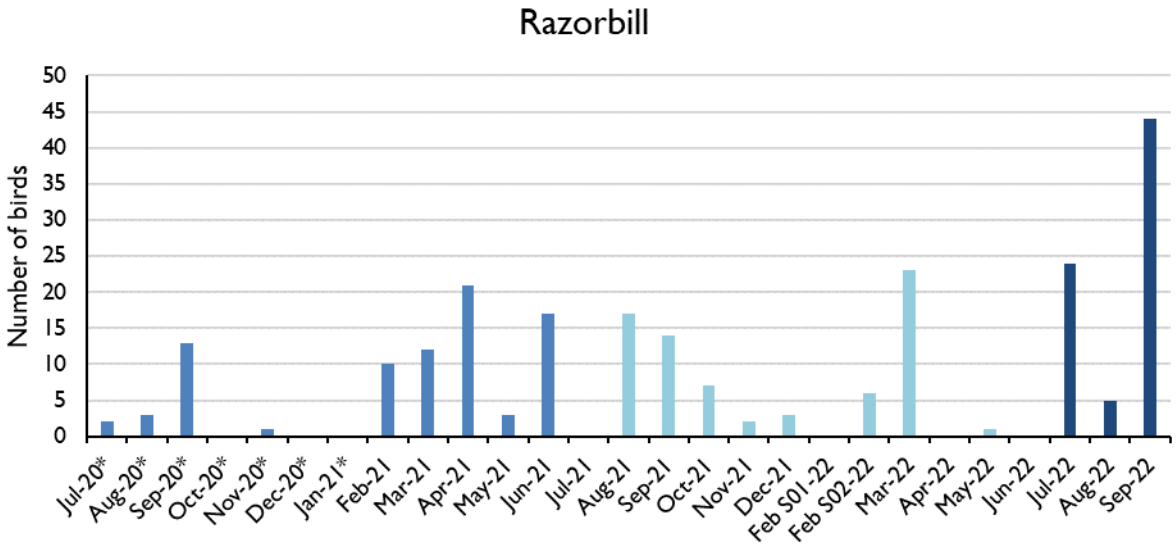
99 Distribution of razorbill varied between surveys with the species generally widespread throughout the survey area. In September 2022 when numbers peaked, more birds were distributed in the south and southeast of the 4km buffer area as in July 2022 while in other months, birds were more widespread (Figure 30 to Figure 32).

100 Age data for razorbills are not presented 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. Throughout the 27-month period four adult-chick pairs were recorded.

101 As expected for the species, only 5% of birds were recorded flying, with the most birds recorded as sitting on the water, such as in July and September 2022 (Table 22).

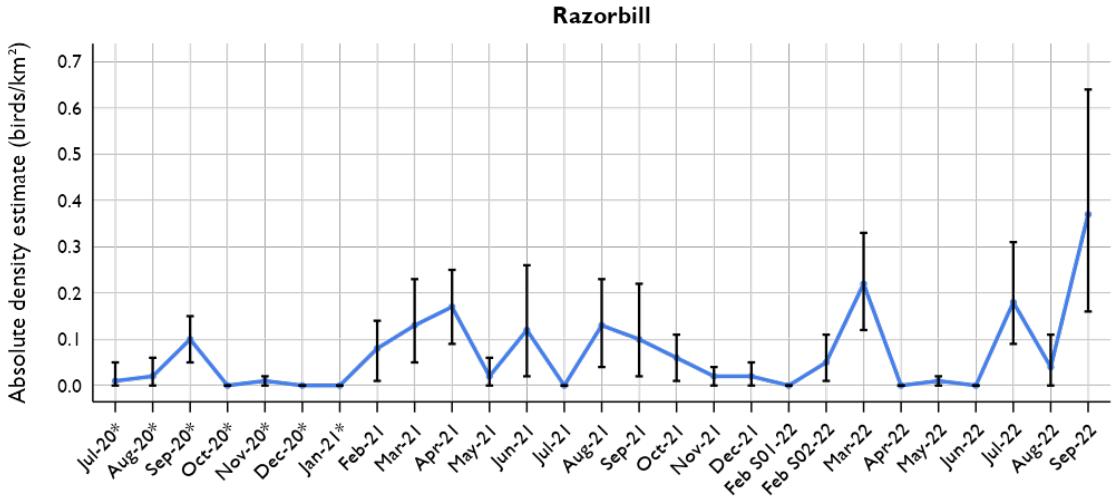
102 There were survey months in which no data regarding flight direction were available. To allow for clear interpretation of results, only surveys which contained flight direction data are displayed (Figure 33). No clear patterns in flight direction could be determined.

Figure 28 Number of razorbills recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)



**Initial survey area – see Figure 1 and Figure 2*

Figure 29 Razorbill absolute density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022



**Initial survey area – see Figure 1 and Figure 2*

Table 21 Absolute monthly density and population estimates for razorbill in the WOW survey area between July 2020 and September 2022, accounting for the potential number of birds estimated as being unavailable for detection.

Survey Date	Relative population estimates						Absolute population estimates					
	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
22 July 2020*	0.01	16	0	48	16	94.28	0.01	20	0	59	23	115.00
06 August 2020*	0.02	24	1	63	18	72.43	0.02	31	1	78	25	80.65
24 September 2020*	0.08	106	57	163	27	25.57	0.1	132	71	197	38	28.79
22 October 2020*	0.00	0	0	0	0	0.00	0	0	0	0	0	0.00
28 November 2020*	0.01	9	1	25	8	92.3	0.01	11	1	31	11	100.00
15 December 2020*	0.00	0	0	0	0	0.00	0	0	0	0	0	0.00
04 January 2021*	0.00	0	0	0	0	0.00	0	0	0	0	0	0.00
27 February 2021	0.06	82	25	155	35	42.02	0.08	100	21	193	46	46.00
15 March 2021	0.10	136	56	225	43	31.63	0.13	167	57	293	63	37.72
21 April 2021	0.13	178	104	266	42	23.57	0.17	214	116	333	57	26.64
20 May 2021	0.02	25	0	65	18	70.99	0.02	29	0	78	25	86.21
11 June 2021	0.11	140	36	277	63	44.6	0.12	165	40	343	85	51.52
02 July 2021	0.00	0	0	0	0	0.00	0	0	0	0	0	0.00
30 August 2021	0.10	138	56	230	46	0.3316	0.13	164	49	301	66	40.24

Survey Date	Relative population estimates						Absolute population estimates					
	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
08 September 2021	0.09	114	36	206	45	39.18	0.1	139	33	290	62	44.60
12 October 2021	0.05	61	26	106	21	33.98	0.06	71	22	144	30	42.25
15 November 2021	0.01	17	1	40	11	62.91	0.02	20	1	55	14	70.00
28 December 2021	0.02	26	2	51	13	50.23	0.02	33	2	70	19	57.58
18 February 2022	0.00	0	0	0	0	0.00	0	0	0	0	0	0.00
26 February 2022	0.04	57	7	121	30	51.97	0.05	67	15	147	42	62.69
11 March 2022	0.17	230	128	338	56	24.26	0.22	279	156	426	77	27.60
14 April 2022	0.00	0	0	0	0	0.00	0	0	0	0	0	0.00
15 May 2022	0.01	8	0	25	8	96.29	0.01	11	0	31	11	100.00
06 June 2022	0.00	0	0	0	0	0.00	0	0	0	0	0	0.00
22 July 2022	0.15	196	81	332	63	32.03	0.18	244	106	408	90	36.89
17 August 2022	0.03	41	1	125	34	82.68	0.04	51	1	150	48	94.12
02 September 2022	0.31	404	179	685	134	33.01	0.37	486	209	842	190	39.09

**Initial survey area – see Figure 1 and Figure 2*

Table 22 Summary of razorbill behaviours in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded diving	Number recorded flying	Number recorded sitting	Number recorded taking off	% Flying	Total	Number recorded as dead
22 July 2020*	0	0	2	0	0	2	0
06 August 2020*	0	0	3	0	0	3	0
24 September 2020*	0	0	13	0	0	13	0
22 October 2020*	0	0	0	0	-	0	0
28 November 2020*	0	0	1	0	0	1	0
15 December 2020*	0	0	0	0	-	0	0
04 January 2021*	0	0	0	0	-	0	0
27 February 2021	0	1	9	0	10	10	0
15 March 2021	0	1	11	0	8	12	0
21 April 2021	0	1	20	0	5	21	0
20 May 2021	0	0	3	0	0	3	0
11 June 2021	0	2	15	0	12	17	0
02 July 2021	0	0	0	0	-	0	0
30 August 2021	0	1	16	0	6	17	0
08 September 2021	0	2	12	0	14	14	0
12 October 2021	0	1	6	0	14	7	0
15 November 2021	0	1	1	0	50	2	0
28 December 2021	0	0	3	0	0	3	0
18 February 2022	0	0	0	0	-	0	0
26 February 2022	0	0	6	0	0	6	0
11 March 2022	0	1	22	0	4	23	0
14 April 2022	0	0	0	0	-	0	0
15 May 2022	0	0	1	0	0	1	0
06 June 2022	0	0	0	0	-	0	0
22 July 2022	0	0	24	0	0	24	0
17 August 2022	0	0	5	0	0	5	0
02 September 2022	0	0	44	0	0	44	0
Total	**0**	**11**	**217**	**0**	**5**	**228**	**0**

**Initial survey area – see Figure 1 and Figure 2*

Figure 30 Density of razorbills (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

An increase in the development and survey area from February 2021 to September 2022.

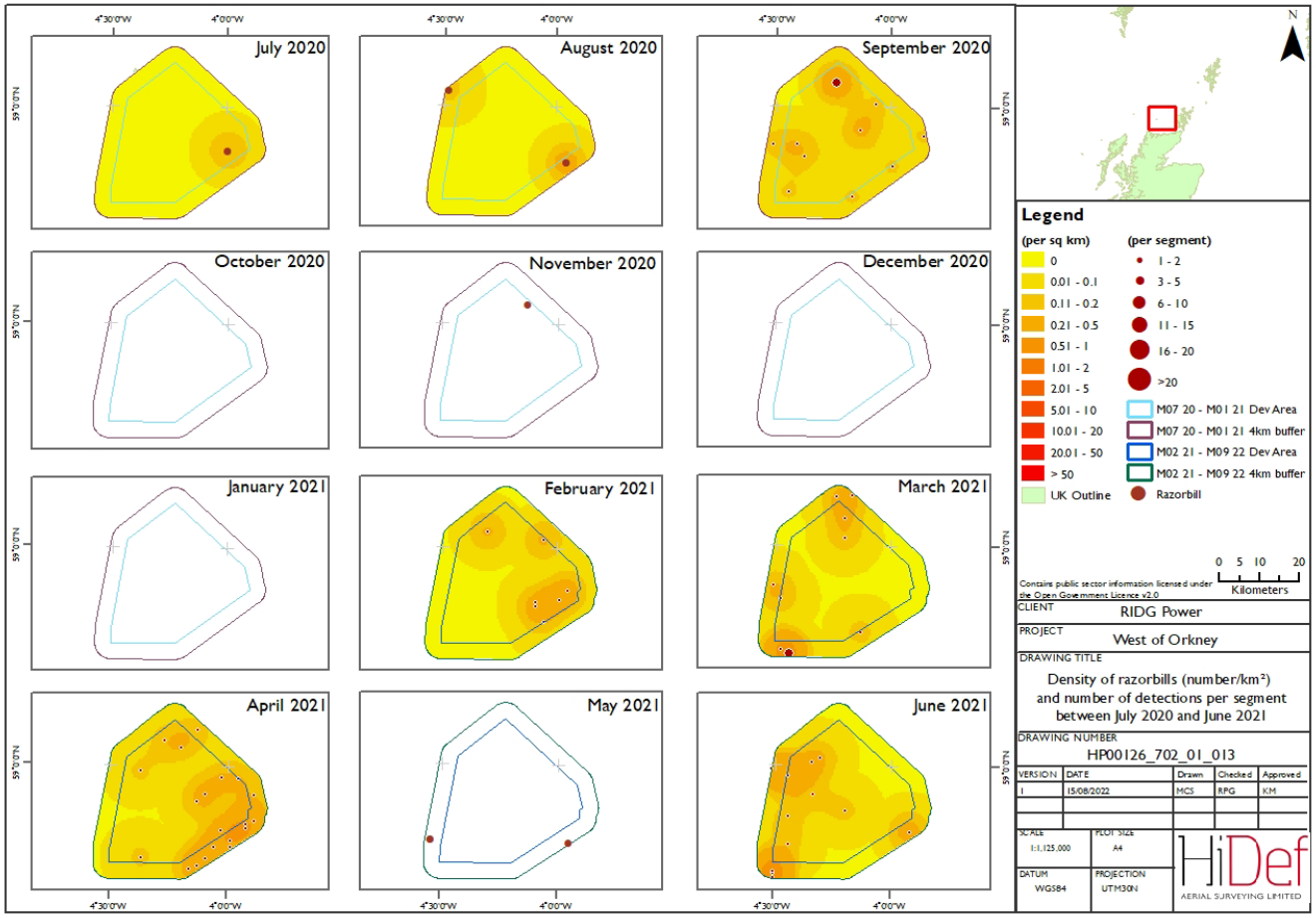


Figure 31 Density of razorbills (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

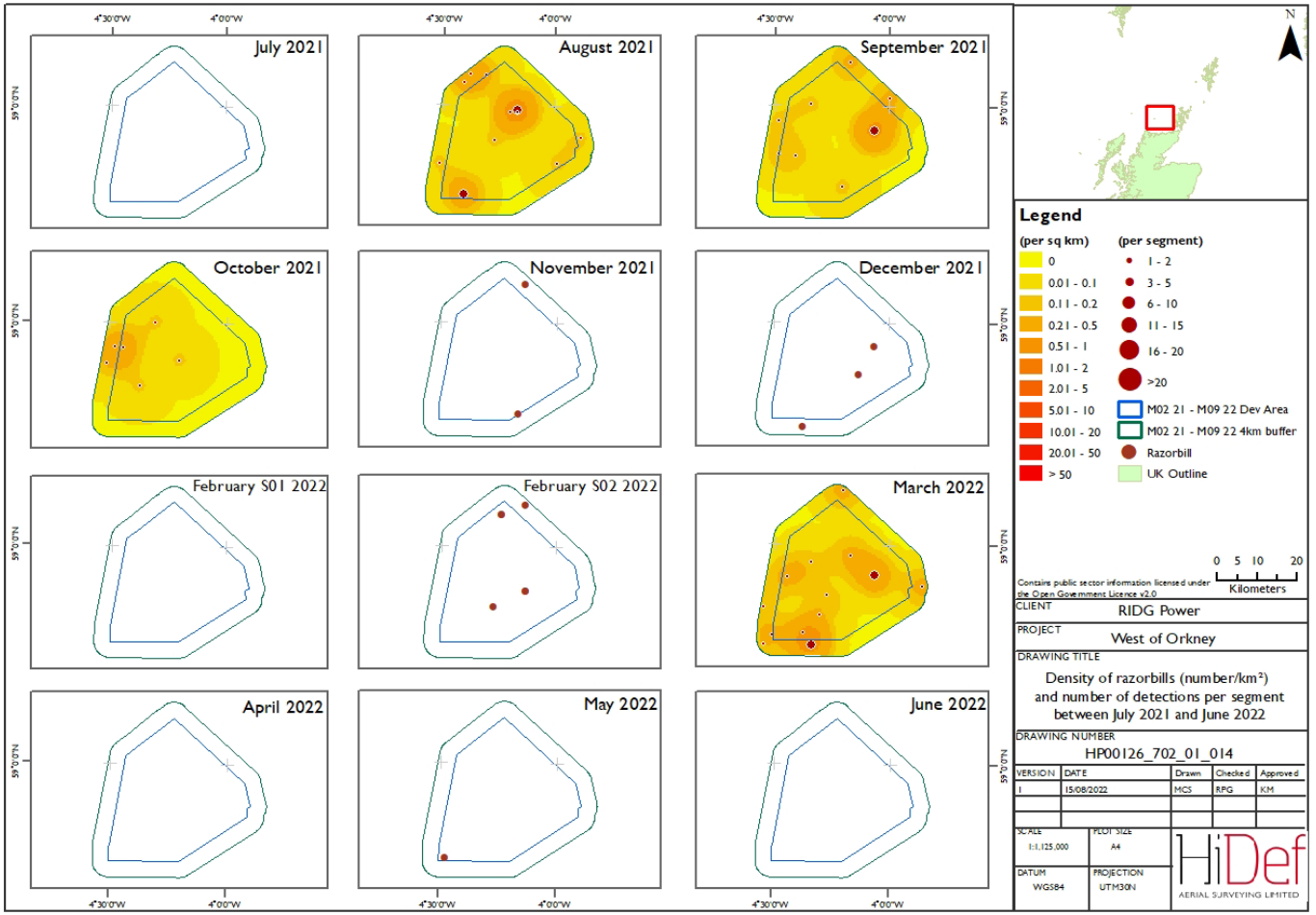


Figure 32 Density of razorbills (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.

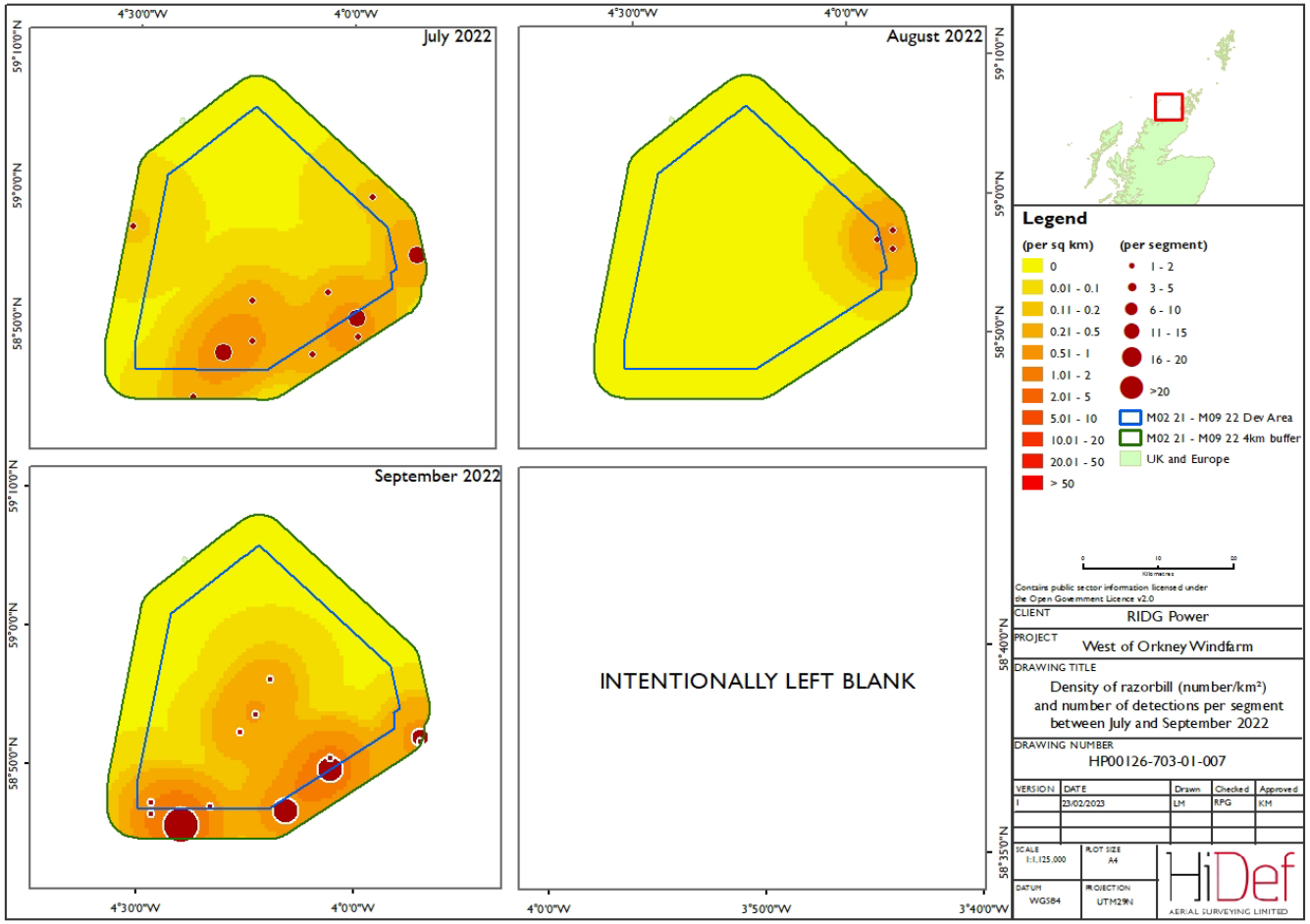
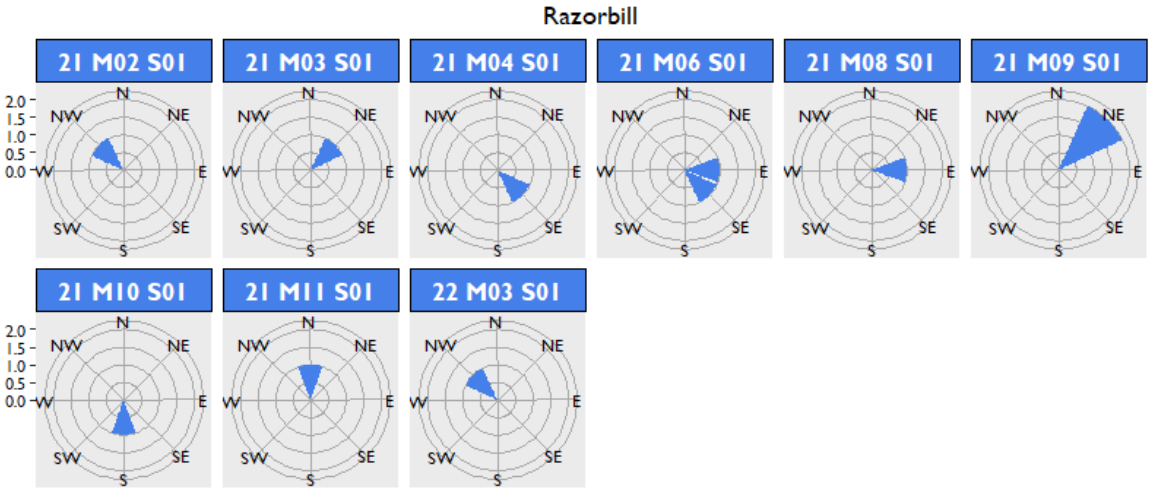


Figure 33 Summarised direction of movement of flying razorbills in the WOW survey area between July 2020 and September 2022

Note: All plots are visualised on the same scale to match the month with the highest values, therefore plots for months with fewer flying individuals may be harder to interpret or in extreme cases appear blank.



3.3.6 Puffin

103 Puffins were recorded intermittently, with relatively high numbers recorded during the breeding season and the start of the non-breeding season (Figure 34). It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

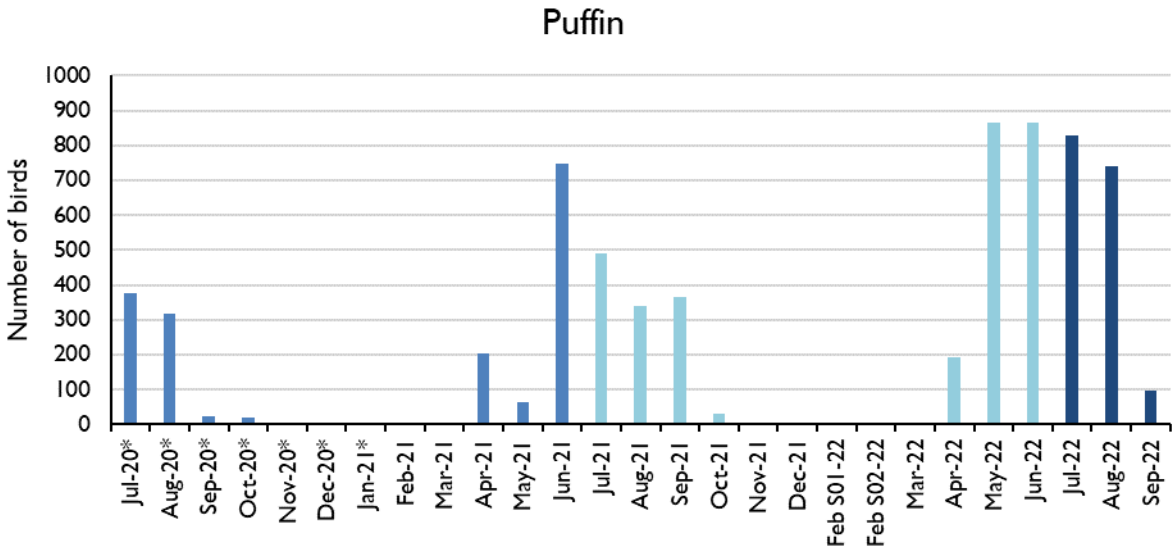
104 Absolute density estimates for the species ranged between 0.02 birds/km^2 (95% CI 0.01 – 0.03) November 2021, and 6.24 birds/km^2 (95% CI 4.22 – 8.45) in June 2022 (Figure 35; Table 23). This equates to an estimate of 27 birds (95% CI 9 – 47) and 8,255 birds (95% CI 5,585 – 11,160) respectively.

105 Puffins were found throughout the survey area, with the highest densities tending to be in the south and southwest, such as in June 2021 and August 2022. High densities were also recorded in the northwest of the survey area such as in July and August 2020 as well as July 2021 (Figure 36 to Figure 38).

106 As with guillemots and razorbills, only a small proportion of birds were recorded flying throughout the survey period (6%), with a large proportion of birds recorded as sitting on the water between April and September in both years (Table 24).

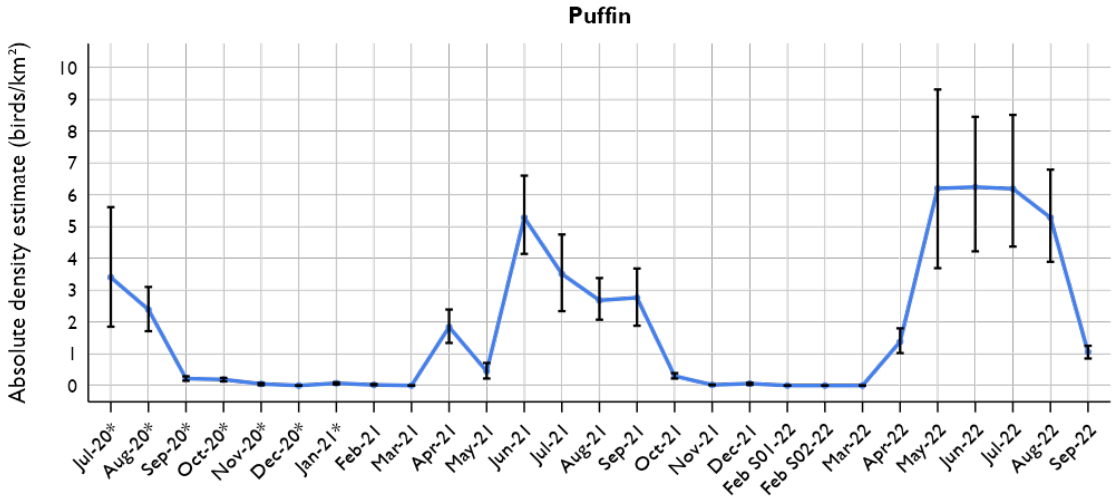
107 There were survey months in which no data regarding flight direction were available. To allow for clear interpretation of results, only surveys which contained flight direction data are displayed (Figure 39). In June 2021, when numbers peaked, birds were mainly heading northwest, while in July 2022 birds were primarily flying southeast.

Figure 34 Number of puffins recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)



**Initial survey area – see Figure 1 and Figure 2*

Figure 35 Puffin absolute density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022



**Initial survey area – see Figure 1 and Figure 2*

Table 23 **Absolute monthly density and population estimates for puffin in the WOW survey area between July 2020 and September 2022, accounting for the potential number of birds estimated as being unavailable for detection.**

Survey Date	Relative population estimates						Absolute population estimates					
	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
22 July 2020*	2.93	3764	2090	5934	1025	27.23	3.40	4363	2373	7208	1469	33.67
06 August 2020*	2.08	2677	1953	3407	365	13.64	2.39	3076	2194	3969	495	16.09
24 September 2020*	0.19	239	160	325	42	17.23	0.22	278	189	377	59	21.22
22 October 2020*	0.16	208	139	283	37	17.50	0.19	243	165	317	50	20.58
28 November 2020*	0.04	49	16	87	19	39.14	0.05	56	19	100	27	48.21
15 December 2020*	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
04 January 2021*	0.06	72	36	115	21	28.84	0.07	85	41	135	30	35.29
27 February 2021	0.02	25	4	48	12	45.61	0.02	29	9	55	16	55.17
15 March 2021	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
21 April 2021	1.60	2109	1556	2708	304	14.40	1.84	2424	1769	3163	421	17.37
20 May 2021	0.40	525	276	823	142	27.01	0.45	596	299	938	201	33.72
11 June 2021	4.59	6037	4981	7319	598	9.89	5.28	6947	5448	8680	853	12.28
02 July 2021	3.03	3986	2832	5240	635	15.92	3.51	4615	3080	6258	879	19.05
30 August 2021	2.28	3020	2288	3831	408	0.13	2.68	3541	2747	4463	566	15.98

Survey Date	Relative population estimates						Absolute population estimates					
	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
08 September 2021	2.37	3120	2129	4125	514	16.46	2.76	3632	2470	4843	718	19.77
12 October 2021	0.26	346	264	443	46	13.15	0.30	400	295	515	64	16.00
15 November 2021	0.02	23	8	41	9	35.77	0.02	27	9	47	13	48.15
28 December 2021	0.05	64	32	98	17	26.28	0.06	75	37	115	25	33.33
18 February 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
26 February 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
11 March 2022	0.00	0	0	0	0	0.00	0.00	0	0	0	0	0.00
14 April 2022	1.24	1628	1271	2006	189	11.57	1.38	1826	1331	2381	246	13.47
15 May 2022	5.44	7185	4626	10376	1518	21.11	6.20	8198	4876	12296	2101	25.63
06 June 2022	5.38	7104	4813	9652	1245	17.52	6.24	8255	5585	11160	1715	20.78
22 July 2022	5.37	7097	4885	9504	1156	16.29	6.19	8185	5778	11244	1476	18.03
17 August 2022	4.51	5957	4417	7710	857	14.38	5.28	6985	5140	8968	1179	16.88
02 September 2022	0.90	1185	984	1391	104	8.77	1.05	1374	1125	1652	149	10.84

**Initial survey area – see Figure 1and Figure 2*

Table 24 Summary of puffin behaviours in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded diving	Number recorded flying	Number recorded sitting	Number recorded taking off	% Flying	Total	Number recorded as dead
22 July 2020*	0	3	372	0	1	375	0
06 August 2020*	0	29	287	0	9	316	0
24 September 2020*	0	0	25	0	0	25	0
22 October 2020*	0	0	18	0	0	18	0
28 November 2020*	0	0	2	0	0	2	0
15 December 2020*	0	0	0	0	-	0	0
04 January 2021*	0	0	1	0	0	1	0
27 February 2021	0	0	1	0	0	1	0
15 March 2021	0	0	0	0	-	0	0
21 April 2021	1	2	201	0	1	204	0
20 May 2021	0	0	62	0	0	62	0
11 June 2021	0	81	666	0	11	747	0
02 July 2021	0	35	457	0	7	492	0
30 August 2021	0	0	339	0	0	339	0
08 September 2021	0	1	365	0	0	366	0
12 October 2021	0	1	29	0	3	30	0
15 November 2021	0	0	1	0	0	1	0
28 December 2021	0	0	2	0	0	2	0
18 February 2022	0	0	0	0	-	0	0
26 February 2022	0	0	0	0	-	0	0
11 March 2022	0	0	0	0	-	0	0
14 April 2022	0	46	147	0	24	193	0
15 May 2022	0	110	756	0	13	866	0
06 June 2022	0	23	843	0	3	866	0
22 July 2022	0	75	754	0	9	829	0
17 August 2022	0	5	736	0	1	741	0
02 September 2022	0	3	95	0	3	98	0
Total	**1**	**414**	**6159**	**0**	**6**	**6574**	**0**

**Initial survey area – see Figure 1 and Figure 2*

Figure 36 Density of puffins (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

An increase in the development and survey area from February 2021 to September 2022.

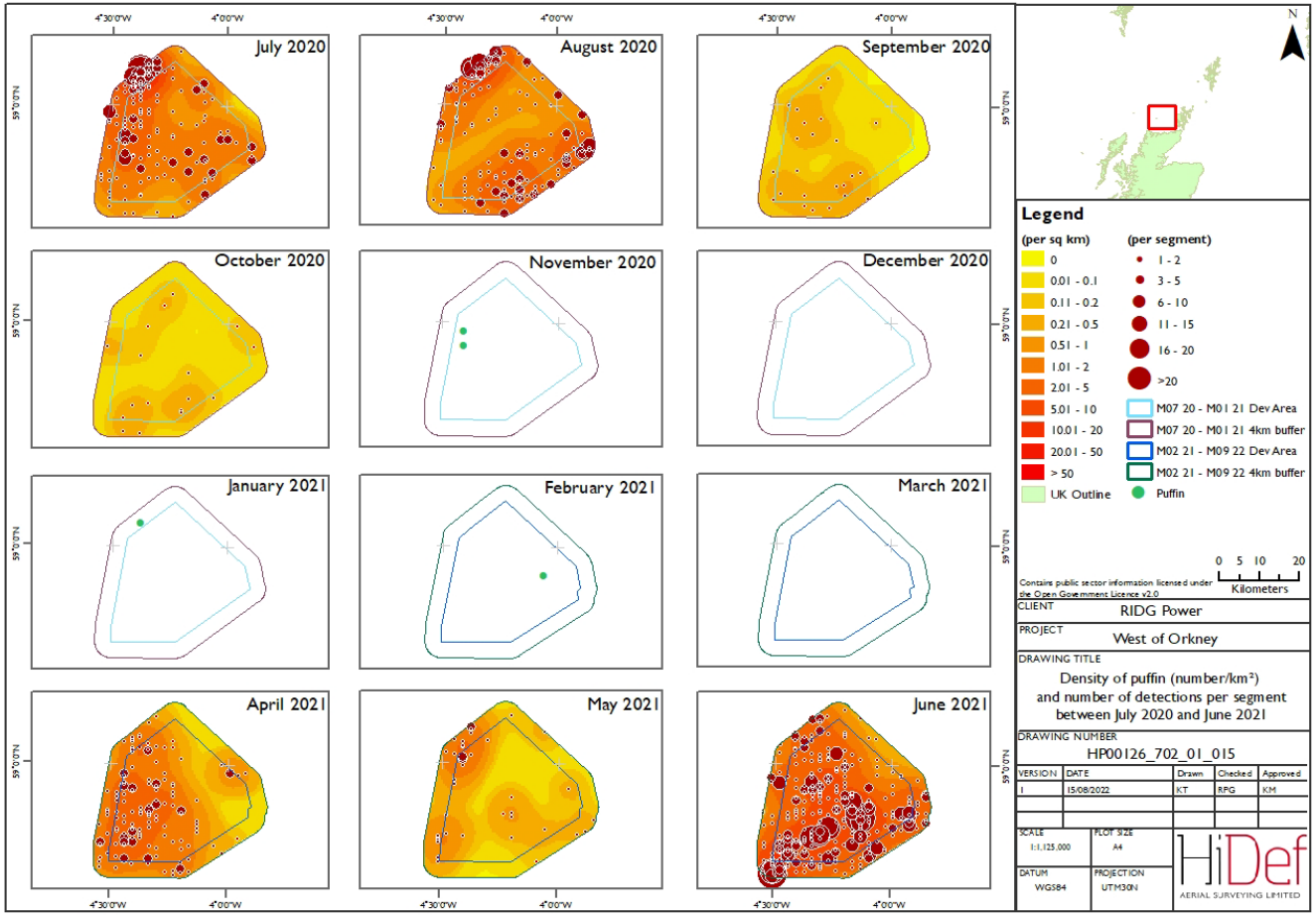


Figure 37 Density of puffins (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

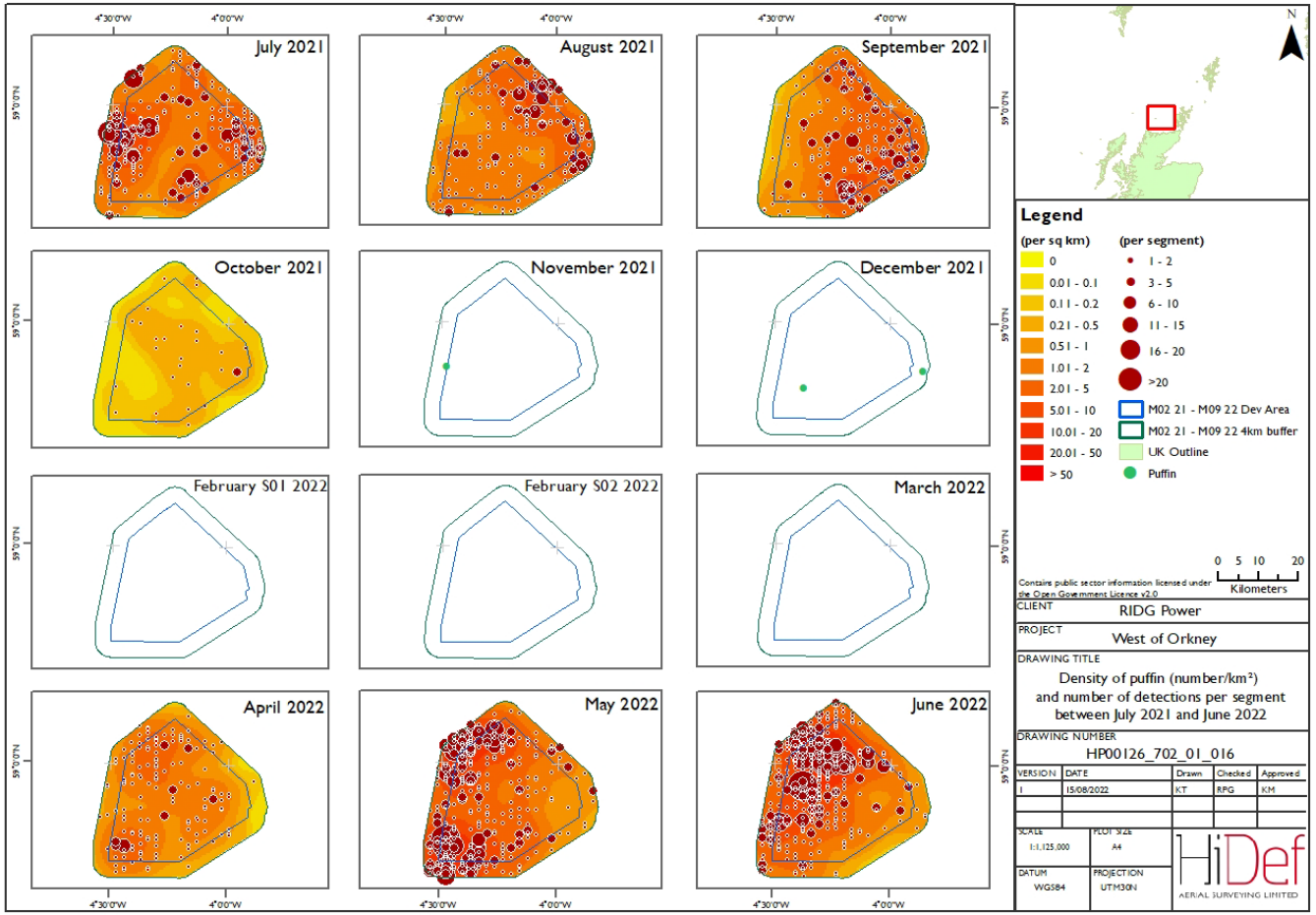


Figure 38 Density of puffins (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.

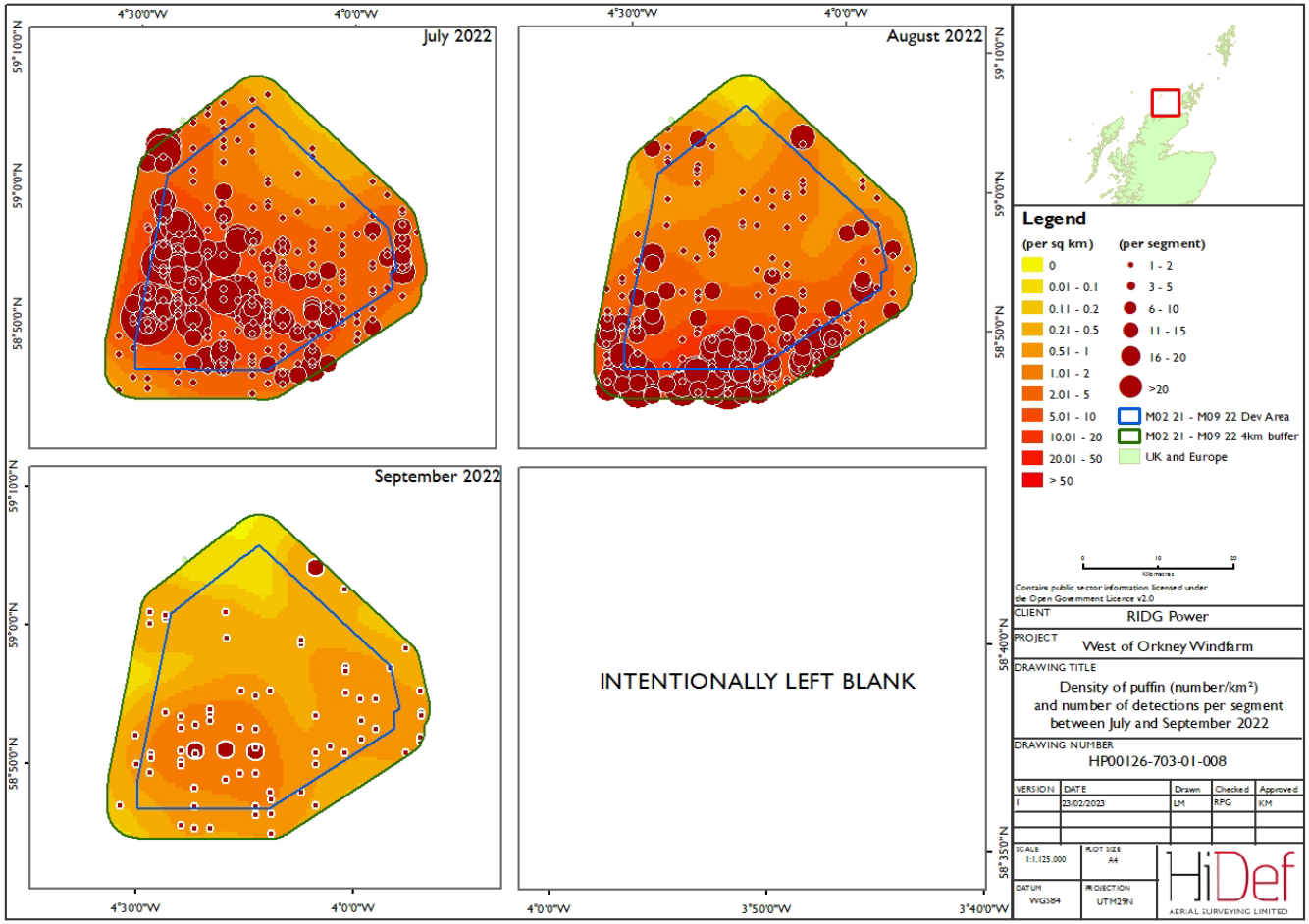
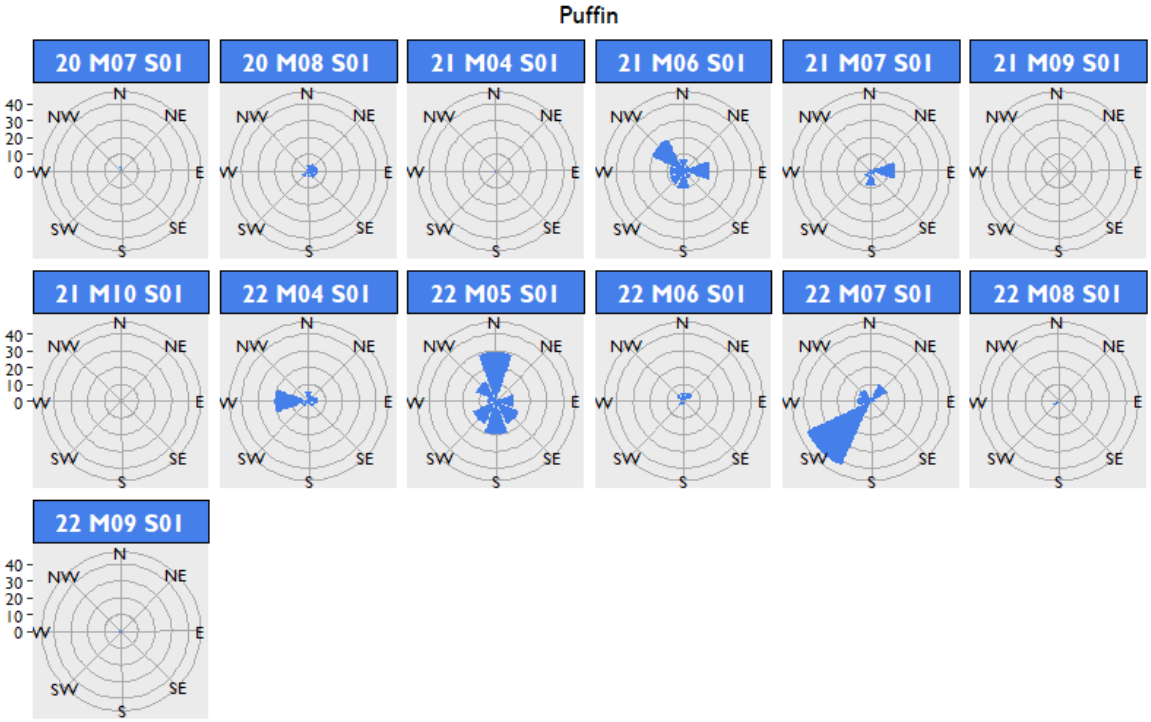


Figure 39 Summarised direction of movement of flying puffins in the WOW survey area between July 2020 and September 2022

Note: All plots are visualised on the same scale to match the month with the highest values, therefore plots for months with fewer flying individuals may be harder to interpret or in extreme cases appear blank.



3.3.7 Fulmar

108 Fulmars were recorded in all surveys, peaking in December 2020 with 560 birds (Figure 40). Records were generally highest during the non-breeding wintering period It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

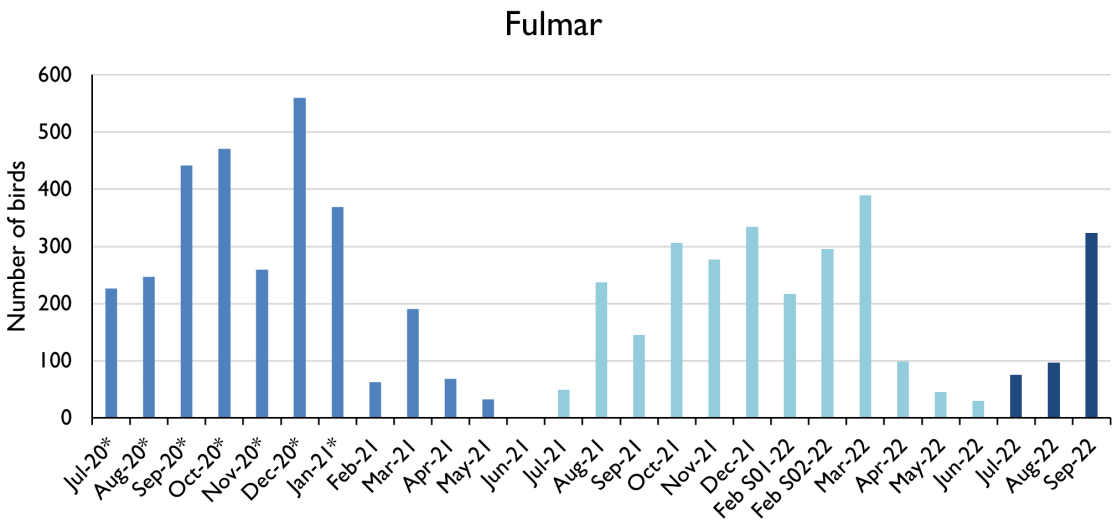
109 Density estimates for the species ranged between 0.01 birds/km^2 (95% CI 0.00 – 0.02) in June 2021 and 3.44 birds/km^2 (95% CI 01.93 – 5.65) in December 2020 (Figure 41; Table 25), equating to eight birds (95% CI 0 - 24) and 4,420 birds (95% CI 2,479 – 7,259) respectively.

110 Fulmars were found throughout the survey area, with the highest densities tending to be found in the east and southeast during the non-breeding and return migration periods. In other months, birds were generally more spread throughout the development and 4km buffer such as in May and June 2022 (Figure 42 to Figure 44).

111 Over the survey period, 57% of birds were recorded flying, with many birds recorded as sitting on the water in September and October 2020 (Table 26). One dead fulmar was recorded during the survey period.

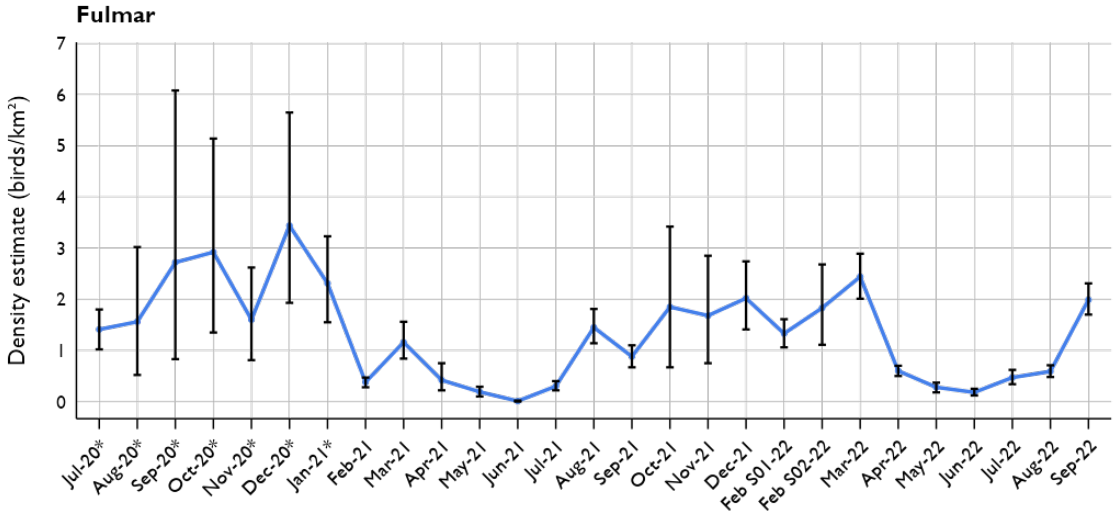
112 There were survey months in which no data regarding flight direction were available. To allow for clear interpretation of results, only surveys which contained flight direction data are displayed In December 2020 and March 2022 when relatively high numbers of birds were recorded, fulmars were flying in all directions, with no apparent patterns in flight direction (Figure 45).

Figure 40 Number of fulmars recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)



**Initial survey area – see Figure 1and Figure 2*

Figure 41 Fulmar density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022



**Initial survey area – see Figure 1 and Figure 2*

Table 25 Density and population estimates of fulmars in the WOW survey area between July 2020 and September 2022

Survey date	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
22 July 2020*	1.41	1816	1307	2311	263	14.44
06 August 2020*	1.56	2008	667	3876	833	41.45
24 September 2020*	2.72	3500	1071	7806	1901	54.32
22 October 2020*	2.92	3756	1738	6601	1310	34.86
28 November 2020*	1.60	2056	1043	3371	600	29.14
15 December 2020*	3.44	4420	2479	7259	1261	28.53
04 January 2021*	2.31	2962	1989	4145	555	18.74
27 February 2021	0.38	496	369	622	65	12.97
15 March 2021	1.16	1526	1109	2049	251	16.41
21 April 2021	0.42	558	288	988	187	33.47
20 May 2021	0.19	254	136	385	67	26.24
11 June 2021	0.01	8	0	24	8	101.46
02 July 2021	0.30	400	284	520	61	15.27
30 August 2021	1.45	1915	1512	2395	218	0.11
08 September 2021	0.88	1157	880	1444	144	12.37
12 October 2021	1.85	2445	890	4513	945	38.63
15 November 2021	1.68	2208	982	3754	714	32.31
28 December 2021	2.02	2662	1857	3603	448	16.83
18 February 2022	1.33	1745	1390	2119	187	10.71
26 February 2022	1.83	2403	1466	3528	512	21.30
11 March 2022	2.44	3216	2644	3804	298	9.26
14 April 2022	0.60	790	655	924	69	8.62
15 May 2022	0.28	364	245	490	64	17.57
06 June 2022	0.18	238	161	329	44	18.49
22 July 2022	0.47	619	451	815	94	15.15
17 August 2022	0.59	783	639	944	79	10.06
02 September 2022	1.99	2626	2242	3050	206	7.82

**Initial survey area – see Figure 1 and Figure 2*

Table 26 Summary of fulmar behaviours in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded diving	Number recorded flying	Number recorded sitting	Number recorded taking off	Other	% Flying	Total	Number recorded as dead
22 July 2020*	0	58	168	0	0	26	226	0
06 August 2020*	0	72	171	4	0	29	247	0
24 September 2020*	0	115	324	3	0	26	442	0
22 October 2020*	0	111	353	7	0	24	471	0
28 November 2020*	0	163	71	25	0	63	259	0
15 December 2020*	0	424	134	2	0	76	560	0
04 January 2021*	0	212	156	1	0	57	369	0
27 February 2021	0	44	18	0	0	71	62	0
15 March 2021	0	153	36	1	0	81	190	0
21 April 2021	0	31	34	3	0	46	68	0
20 May 2021	0	27	5	0	0	84	32	0
11 June 2021	0	1	0	0	0	100	1	0
02 July 2021	0	38	11	0	0	78	49	0
30 August 2021	0	71	165	1	0	30	237	0
08 September 2021	0	62	83	0	0	43	145	0
12 October 2021	0	159	127	20	0	52	306	0
15 November 2021	0	243	33	1	0	88	277	0
28 December 2021	0	215	106	13	0	64	334	0
18 February 2022	0	199	17	1	0	92	217	0
26 February 2022	0	254	40	1	0	86	295	0
11 March 2022	0	314	74	1	0	81	389	0
14 April 2022	0	91	7	0	0	93	98	0
15 May 2022	0	34	10	1	0	76	45	0
06 June 2022	0	23	7	0	0	77	30	0
22 July 2022	0	45	30	0	0	60	75	0
17 August 2022	0	79	17	0	0	82	96	0
02 September 2022	0	89	233	1	1	27	324	1
Total	**0**	**3327**	**2430**	**86**	**1**	**57**	**5844**	**1**

**Initial survey area – see Figure 1 and Figure 2*

Figure 42 Density of fulmars (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

An increase in the development and survey area from February 2021 to September 2022.

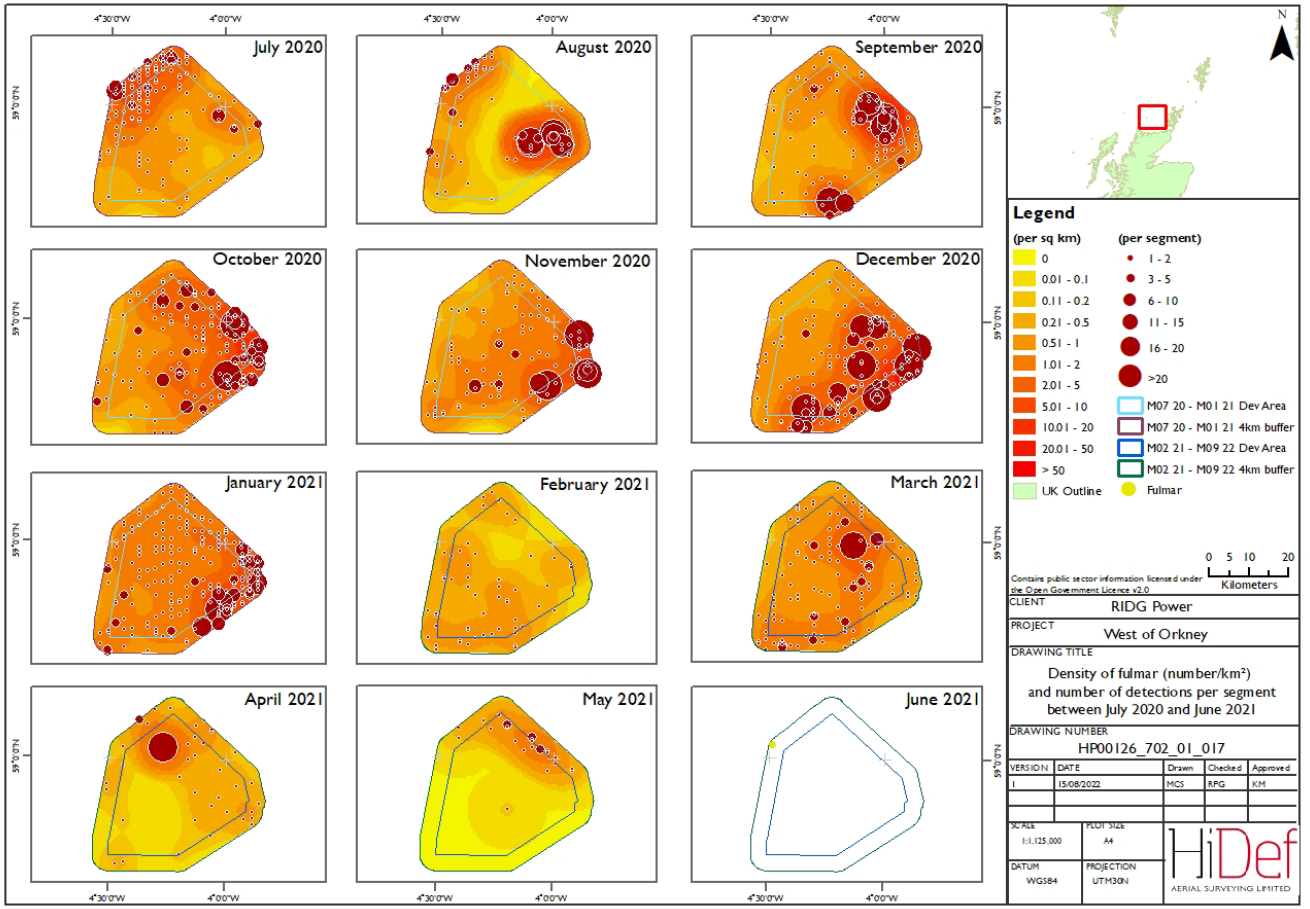


Figure 43 Density of fulmars (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

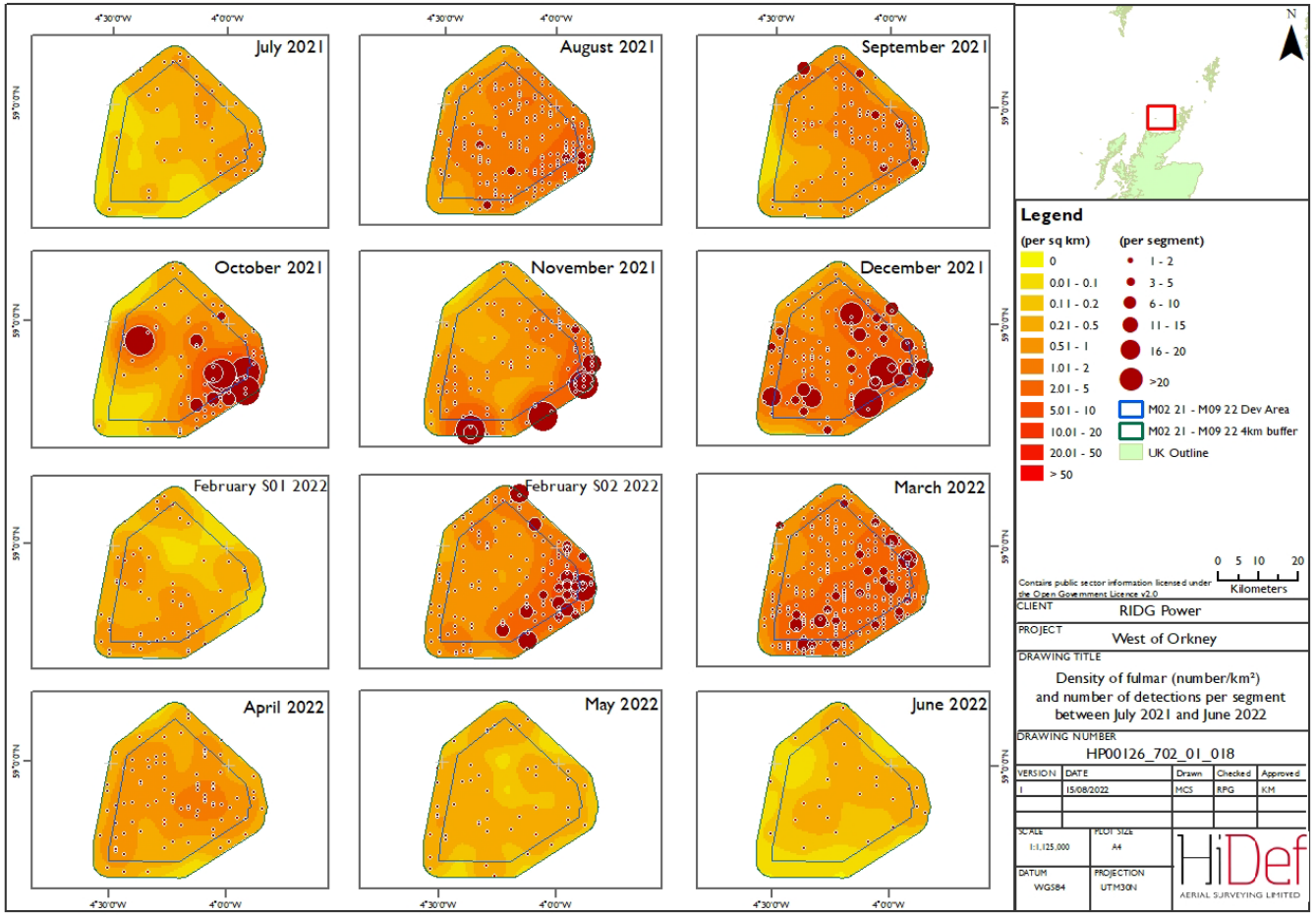


Figure 44 Density of fulmars (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.

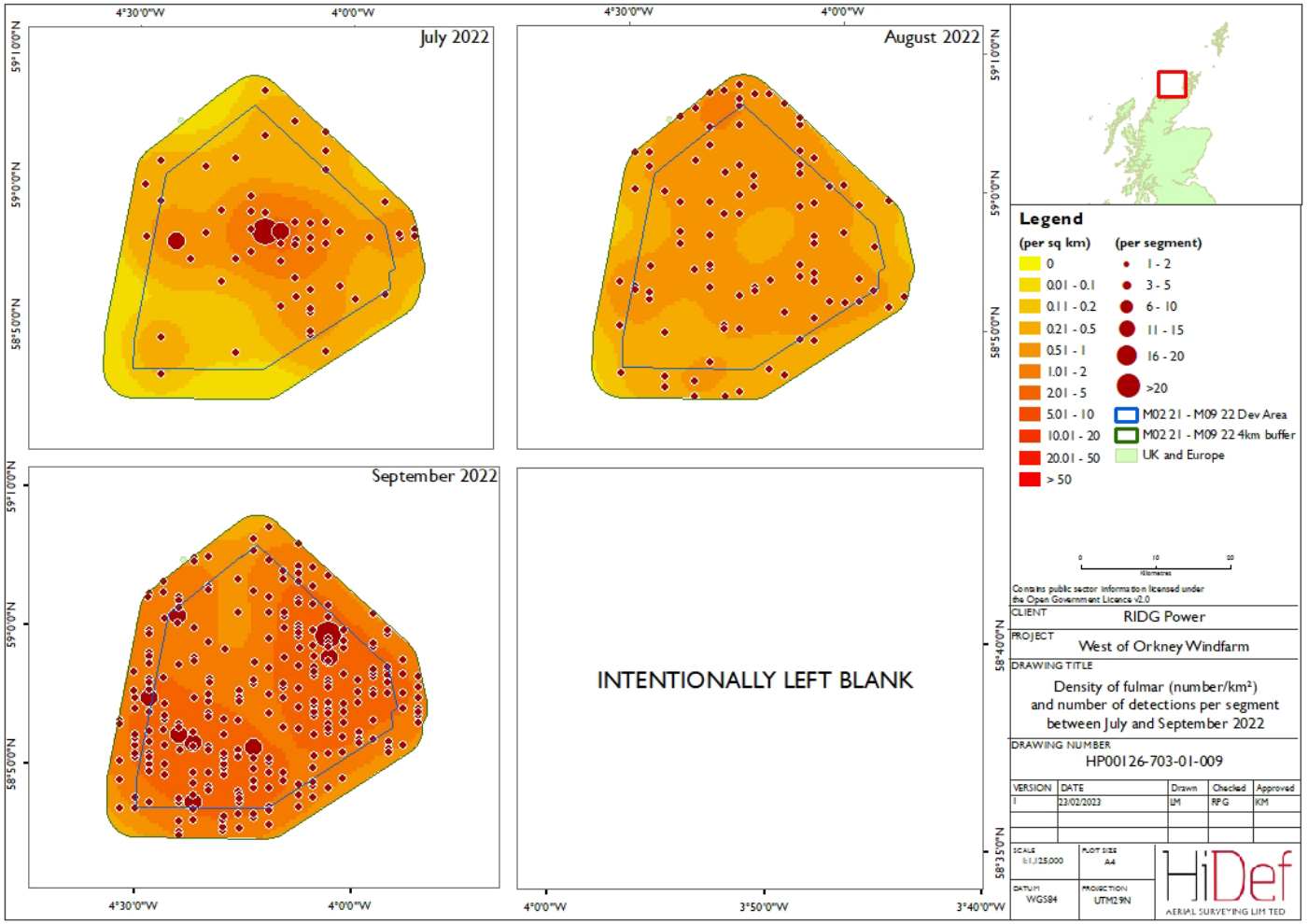
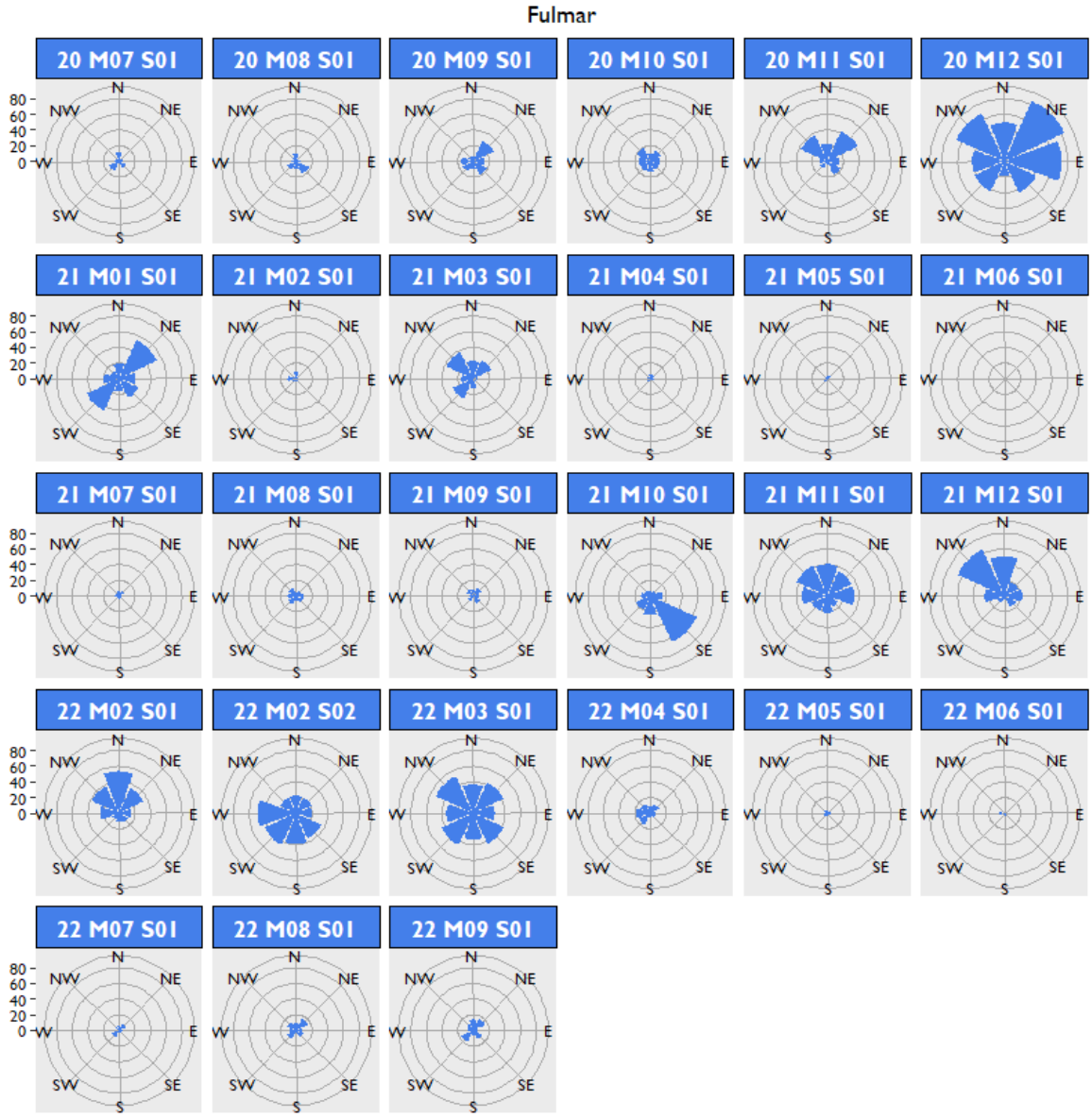


Figure 45 Summarised direction of movement of flying fulmars in the WOW survey area between July 2020 and September 2022

Note: All plots are visualised on the same scale to match the month with the highest values, therefore plots for months with fewer flying individuals may be harder to interpret or in extreme cases appear blank.



3.3.8 Gannet

113 Gannets were recorded throughout the survey period, with records peaking towards the end of the breeding season and into the post-breeding migration period (Figure 46). It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison.

114 Density estimates for the species ranged between 0.02 birds/km^2 (95% CI 0.00 – 0.04) in December 2021 and 1.65 birds/km^2 (95% CI 0.36 – 4.12) in August 2020 (Figure 47; Table 27), equating to population estimates of 25 birds (95% CI 0 - 55) and 2,113 birds (95% CI 465 – 5,290) respectively.

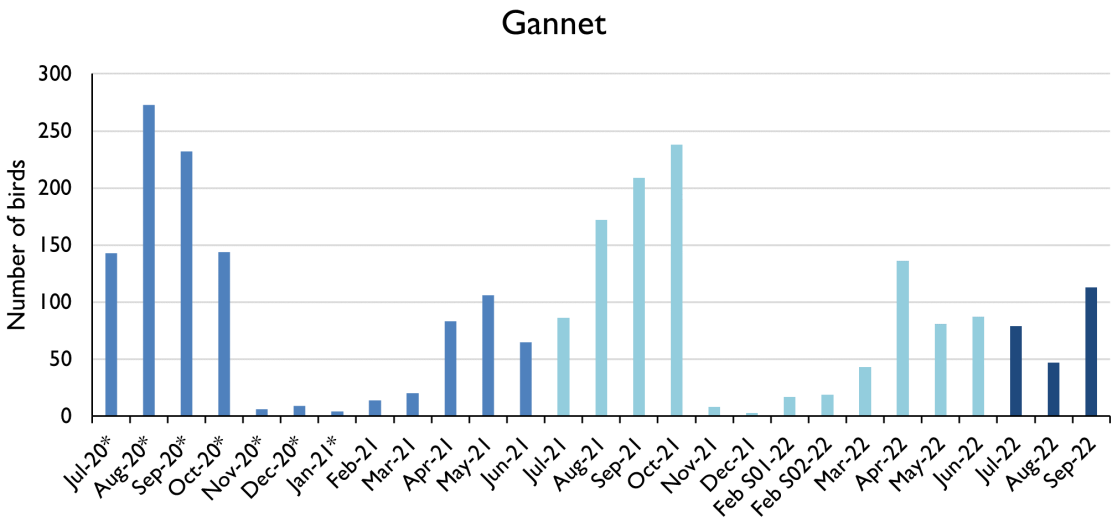
115 Gannets were present throughout the survey area, with the highest densities tending to be found in the north, such as in August and September 2021 (Figure 48 to Figure 50).

116 Of the birds that could be aged, 94% were recorded as adults, with the largest number of immature and juvenile birds recorded in September 2020 (Table 28).

117 Throughout the survey period, 54% of birds were recorded flying, with largest proportion of birds sitting on the water recorded in August 2020 (80%) (Table 29). Over the survey period, 32 dead birds were recorded.

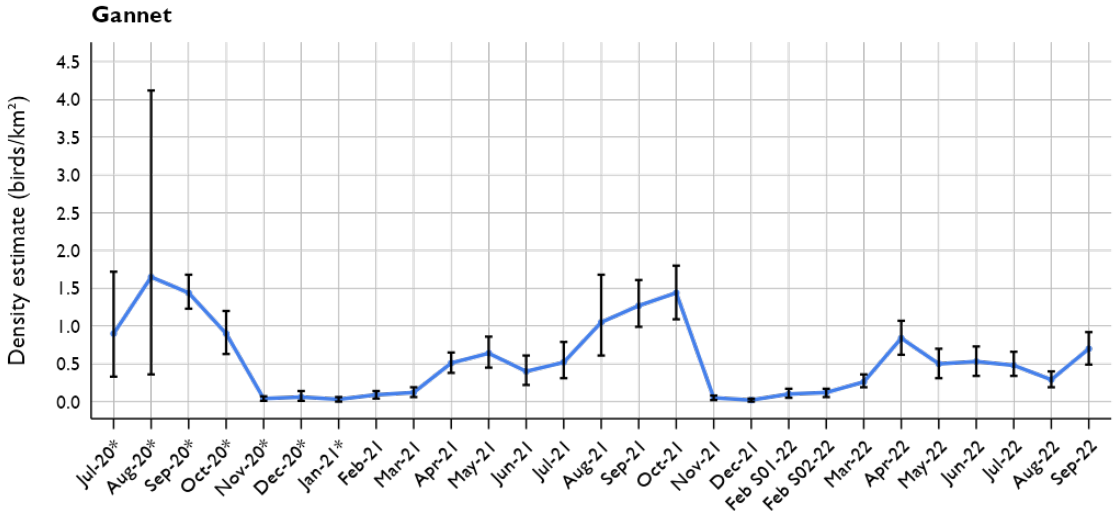
118 There were survey months in which no data regarding flight direction were available. To allow for clear interpretation of results, only surveys which contained flight direction data are displayed. In September 2020, birds generally flew in southerly and westerly directions, and in August 2021 a large proportion of birds were recorded flying east (Figure 51).

Figure 46 Number of gannets recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)



**Initial survey area – see Figure 1 and Figure 2*

Figure 47 Gannet density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022



**Initial survey area – see Figure 1 and Figure 2*

Table 27 Density and population estimates of gannets in the WOW survey area between July 2020 and September 2022

Survey date	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
22 July 2020*	0.90	1162	429	2212	472	40.57
06 August 2020*	1.65	2113	465	5290	1491	70.54
24 September 2020*	1.44	1855	1584	2152	149	8.01
22 October 2020*	0.90	1152	815	1539	186	16.13
28 November 2020*	0.04	49	16	88	20	40.32
15 December 2020*	0.06	74	8	175	44	59.43
04 January 2021*	0.03	33	0	72	18	53.79
27 February 2021	0.09	112	48	185	36	31.42
15 March 2021	0.12	160	80	245	43	26.47
21 April 2021	0.51	668	506	858	90	13.46
20 May 2021	0.64	847	586	1134	140	16.53
11 June 2021	0.40	522	284	797	130	24.90
02 July 2021	0.52	687	408	1038	168	24.34
30 August 2021	1.05	1393	807	2218	380	0.27
08 September 2021	1.27	1674	1297	2117	212	12.63
12 October 2021	1.44	1906	1445	2383	249	13.06
15 November 2021	0.05	64	30	103	20	30.55
28 December 2021	0.02	25	0	55	14	53.50
18 February 2022	0.10	137	62	224	41	29.52
26 February 2022	0.12	152	85	228	37	24.19
11 March 2022	0.26	344	246	477	63	18.22
14 April 2022	0.84	1102	812	1407	154	13.90
15 May 2022	0.50	655	408	930	138	20.94
06 June 2022	0.53	698	453	959	133	18.96
22 July 2022	0.48	632	454	879	109	17.25
17 August 2022	0.29	379	249	532	73	19.23
02 September 2022	0.70	923	649	1217	145	15.67

**Initial survey area – see Figure 1 and Figure 2*

Table 28 Summary of gannet ages in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded as adult	Number recorded as immature	Number recorded as juvenile	Number recorded as unknown	% Adult (from aged birds)	Total
22 July 2020*	108	2	0	33	98	143
06 August 2020*	61	2	0	210	97	273
24 September 2020*	129	12	24	67	78	232
22 October 2020*	89	11	4	40	86	144
28 November 2020*	5	0	0	1	100	6
15 December 2020*	7	1	0	1	88	9
04 January 2021*	4	0	0	0	100	4
27 February 2021	12	0	0	2	100	14
15 March 2021	16	0	0	4	100	20
21 April 2021	79	0	0	4	100	83
20 May 2021	88	0	0	18	100	106
11 June 2021	62	3	0	0	95	65
02 July 2021	80	4	0	2	95	86
30 August 2021	118	0	1	53	99	172
08 September 2021	189	10	9	1	91	209
12 October 2021	218	11	7	3	92	239
15 November 2021	7	0	0	1	100	8
28 December 2021	3	0	0	0	100	3
18 February 2022	17	0	0	0	100	17
26 February 2022	19	0	0	0	100	19
11 March 2022	42	0	0	1	100	43
14 April 2022	136	0	0	0	100	136
15 May 2022	81	1	0	0	99	82
06 June 2022	76	5	0	6	94	87
22 July 2022	52	4	0	24	93	80
17 August 2022	19	5	0	31	79	55
02 September 2022	74	4	0	56	95	134
Total	**1791**	**75**	**45**	**558**	**94**	**2469**

**Initial survey area – see Figure 1 and Figure 2*

Table 29 Summary of gannet behaviours in the WOW survey area between July 2020 and September 2022

Survey date	Number recorded diving	Number recorded flying	Number recorded sitting	Number recorded taking off	Other	% Flying	Total	Number recorded as dead
22 July 2020*	0	84	58	1	0	59	143	0
06 August 2020*	0	55	218	0	0	20	273	0
24 September 2020*	0	138	93	1	0	59	232	0
22 October 2020*	0	61	82	1	0	42	144	0
28 November 2020*	0	5	1	0	0	83	6	0
15 December 2020*	0	4	5	0	0	44	9	0
04 January 2021*	0	1	3	0	0	25	4	0
27 February 2021	0	13	1	0	0	93	14	0
15 March 2021	0	16	4	0	0	80	20	0
21 April 2021	1	50	32	0	0	60	83	0
20 May 2021	0	73	33	0	0	69	106	0
11 June 2021	0	45	20	0	0	69	65	0
02 July 2021	0	60	25	1	0	70	86	0
30 August 2021	0	150	22	0	0	87	172	0
08 September 2021	0	129	80	0	0	62	209	0
12 October 2021	0	81	156	1	1	34	239	1
15 November 2021	0	4	4	0	0	50	8	0
28 December 2021	0	3	0	0	0	100	3	0
18 February 2022	0	14	3	0	0	82	17	0
26 February 2022	0	16	3	0	0	84	19	0
11 March 2022	0	42	1	0	0	98	43	0
14 April 2022	0	53	83	0	0	39	136	0
15 May 2022	0	45	36	0	1	55	82	1
06 June 2022	0	22	63	2	0	25	87	0
22 July 2022	0	54	25	0	1	68	80	1
17 August 2022	0	23	22	2	8	42	55	8
02 September 2022	0	86	27	0	21	64	134	21
Total	**1**	**1327**	**1100**	**9**	**32**	**54**	**2469**	**32**

**Initial survey area – see Figure 1 and Figure 2*

Figure 48 Density of gannets (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

An increase in the development and survey area from February 2021 to September 2022.

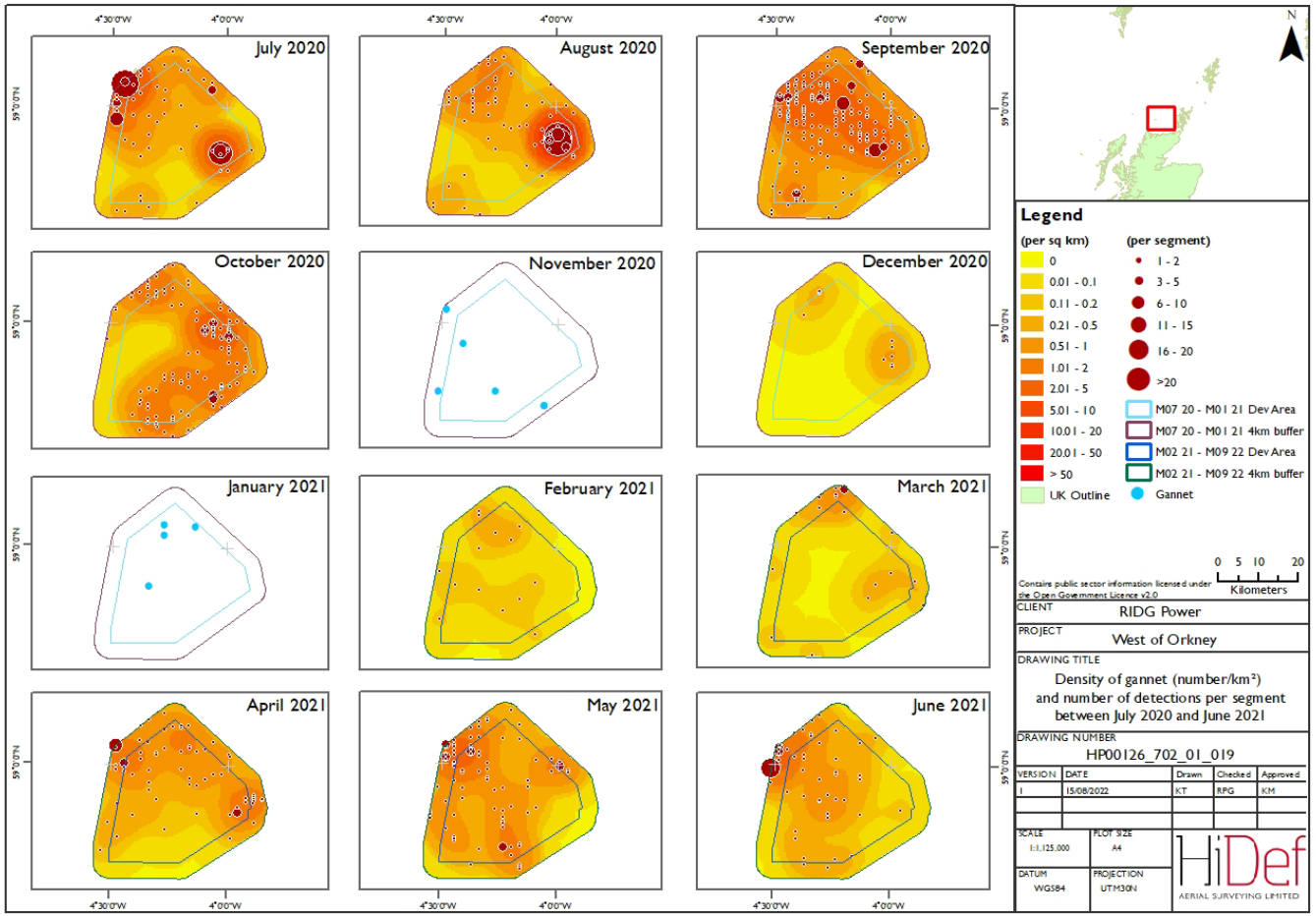


Figure 49 Density of gannets (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

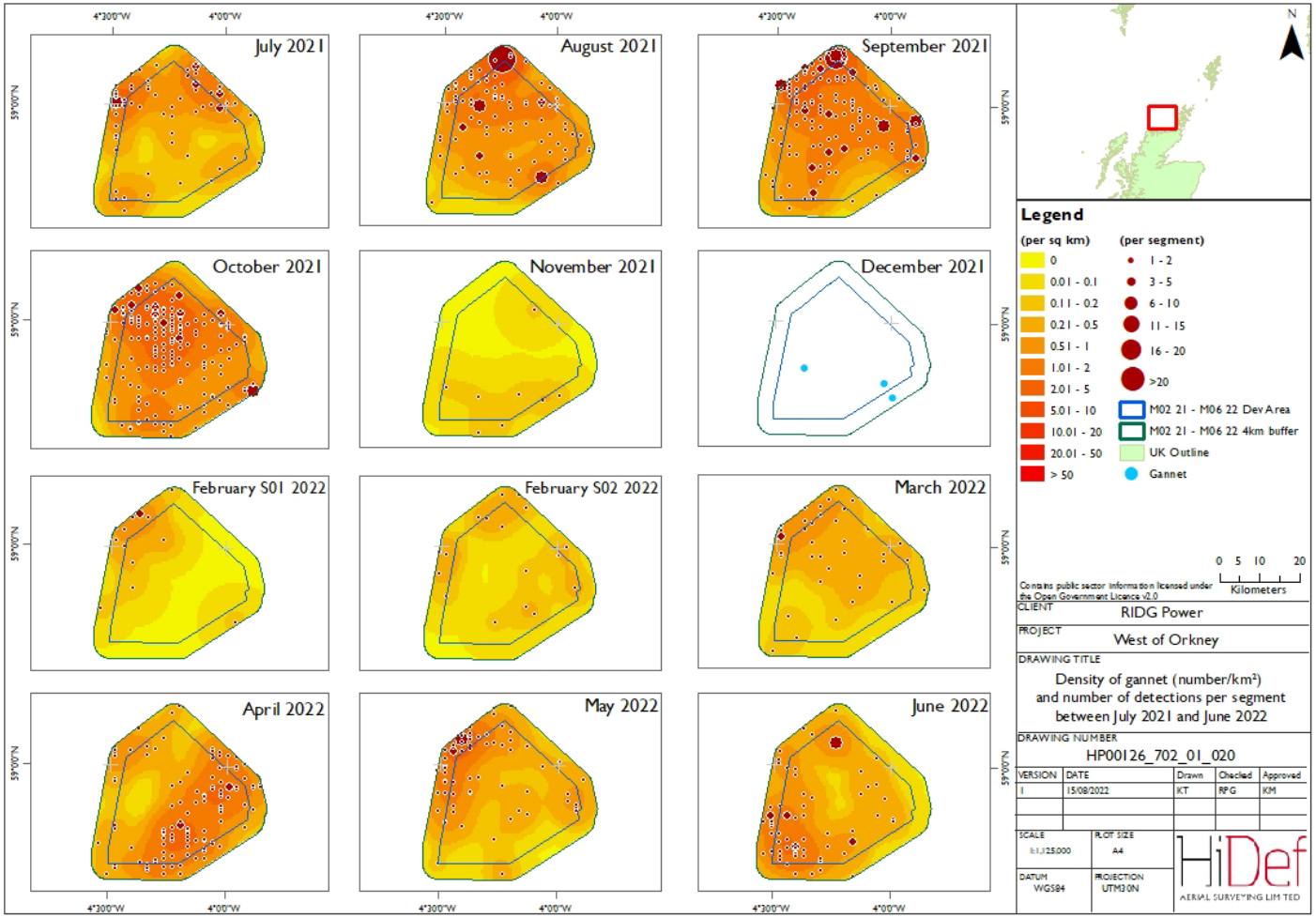


Figure 50 Density of gannets (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.

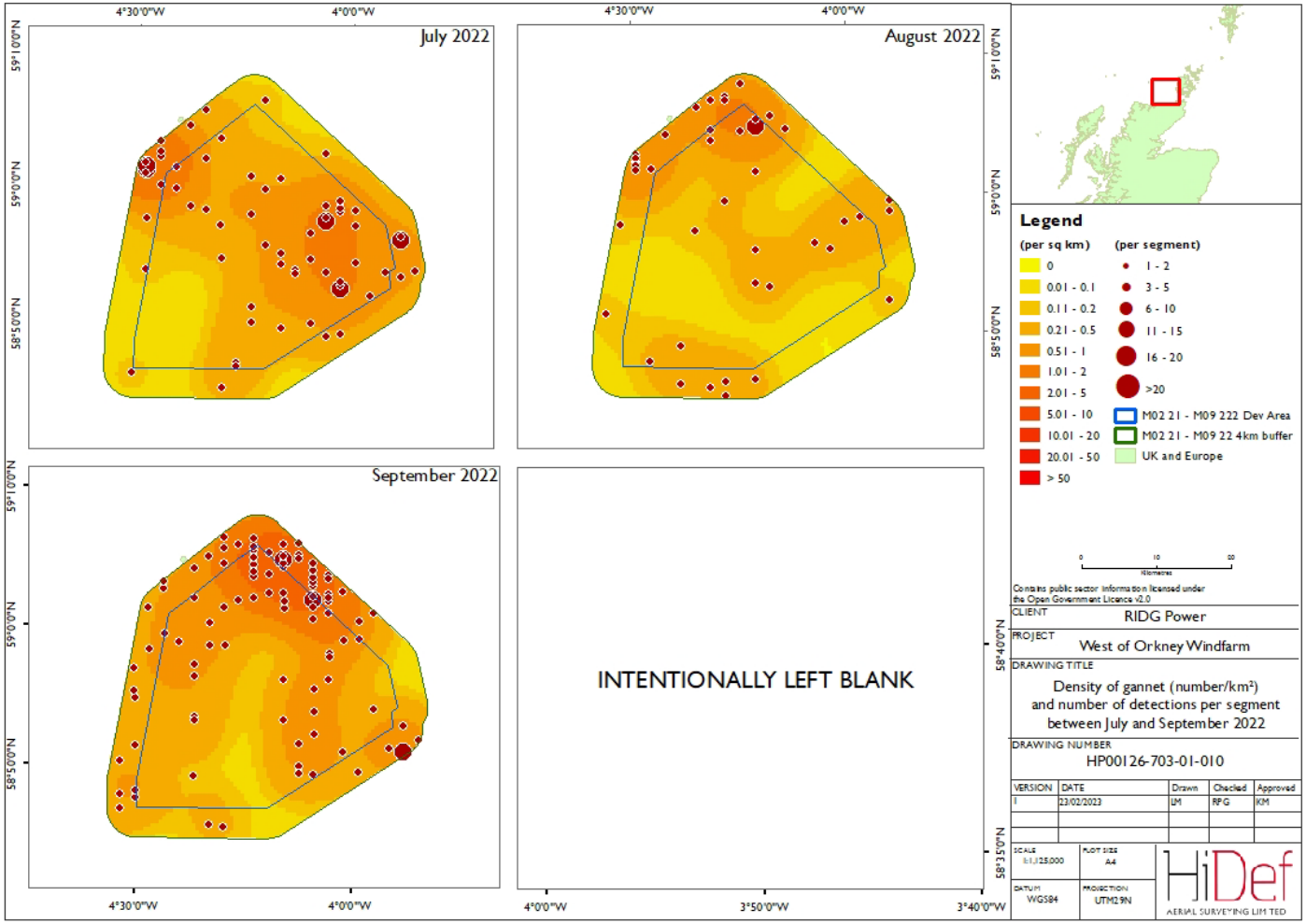
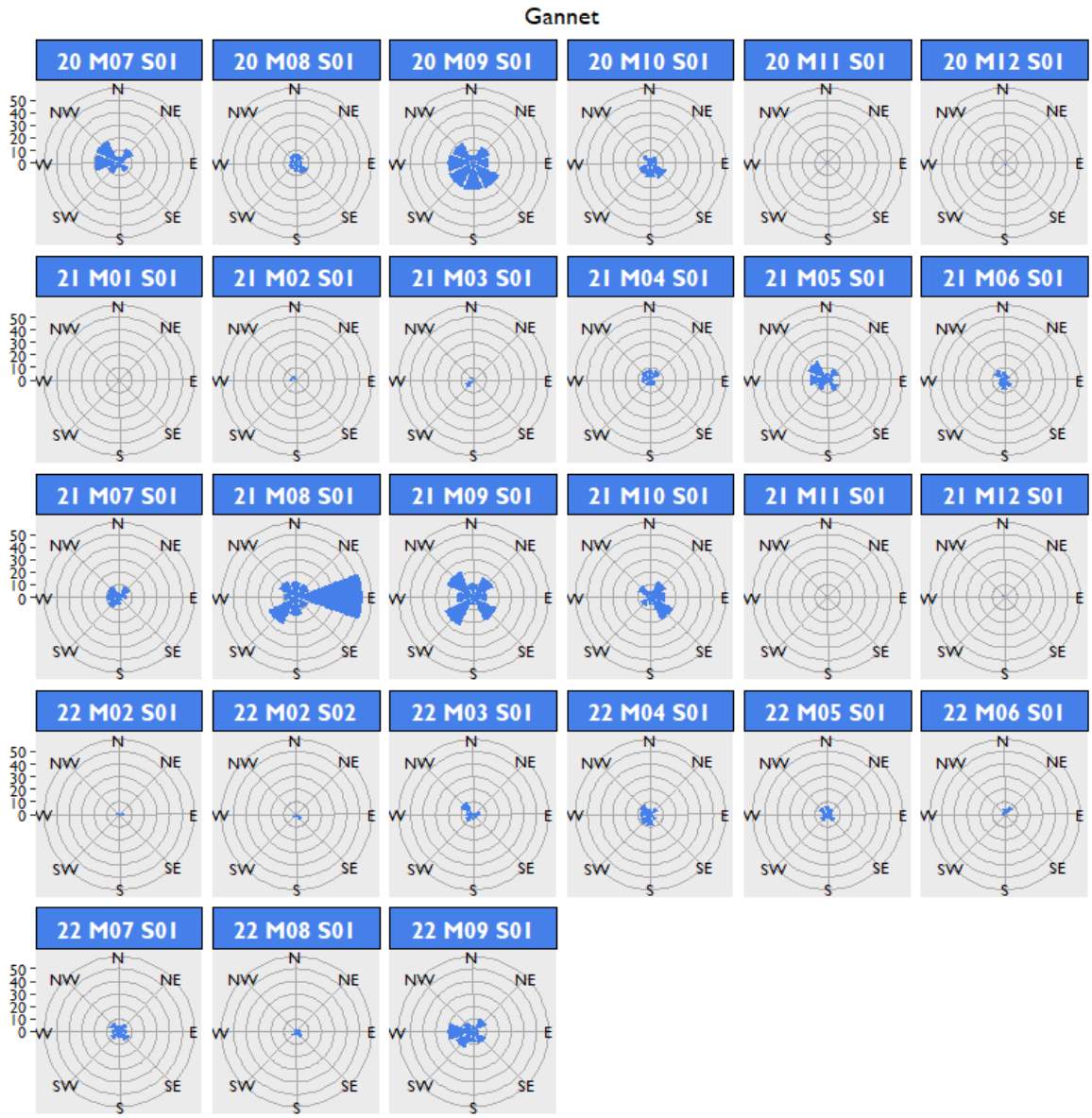


Figure 51 Summarised direction of movement of flying gannets in the WOW survey area between July 2020 and September 2022



3.3.9 Less abundant bird species

119 Twenty-five less abundant bird species were recorded throughout the survey period, the most numerous being great skua and European storm petrel, with 78 and 68 records (Figure 52; Figure 53). One great skua was recorded as dead during the survey period. Distributions are presented in Figure 54 to Figure 56 while population and density estimates for these species can be found in Appendix I. It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

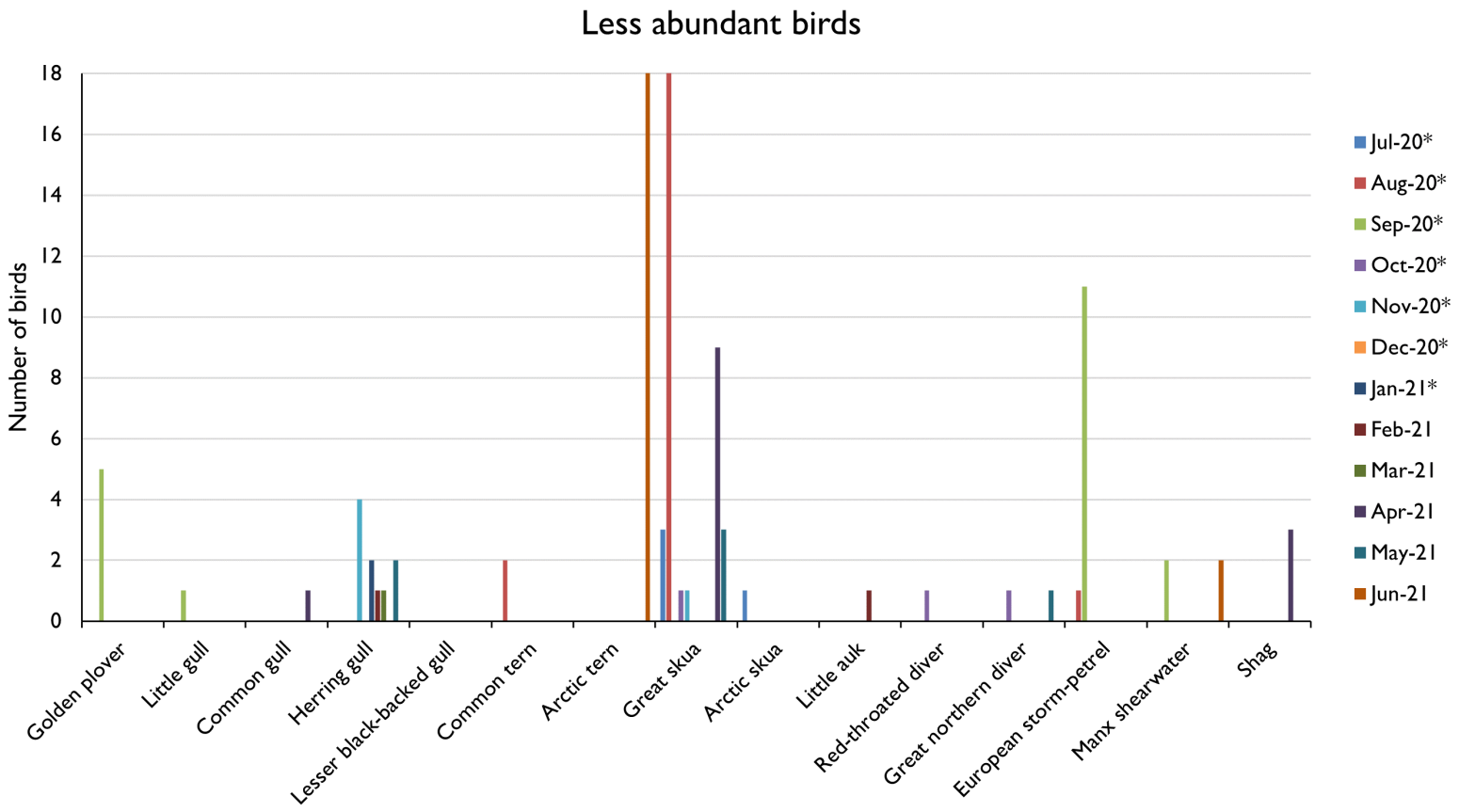
120 Although a relatively high number of great skuas were recorded over the 27 months, most of these (30%) were recorded in the August 2020 survey, during the breeding season. The same was true for European storm petrel, and despite a relatively high number of overall records, observations were primarily concentrated within a few months (e.g. August and September 2021; see Appendix I).

121 Arctic terns were recorded in moderate numbers during the breeding season, particularly in June 2021 and August 2022, distributed in the southeast and northwest of the 4km buffer. Herring gulls were also recorded intermittently, predominately occurring within the development area.

122 Over the survey period, 11 greylag geese (*Anser anser*) were recorded, all of these occurring during the October 2021 survey, distributed in the northwest.

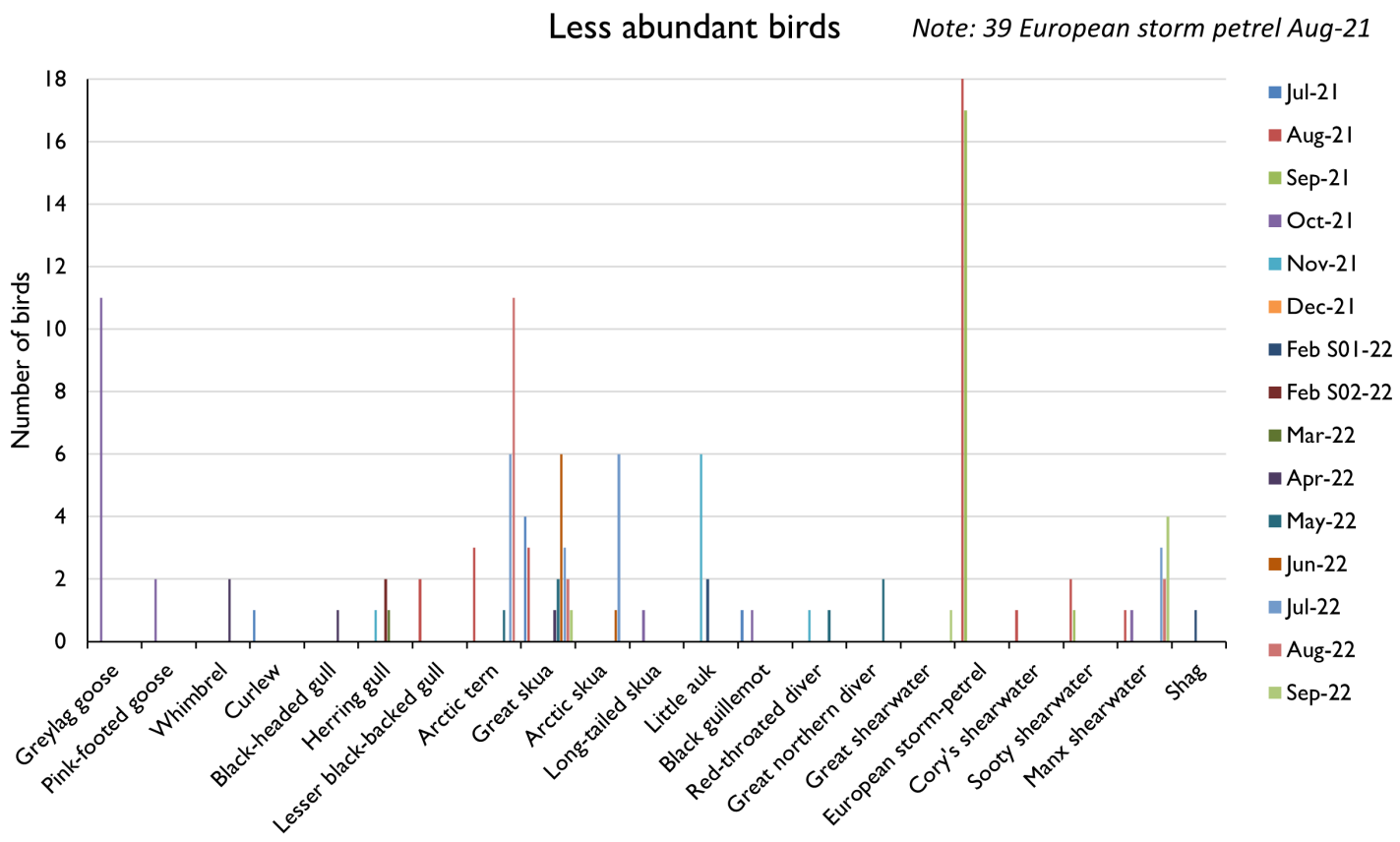
123 Other species of note, such as Cory's (*Calonectris diomedea*); sooty (*Puffinus griseus*) and Great shearwaters (*Ardenna gravis*), long-tailed skuas (*Stercorarius longicaudus*), black guillemots (*Cepphus grylle*), pink-footed geese (*Anser brachyrhynchus*), shags and lesser black-backed gulls (*Larus fuscus*) were recorded.

Figure 52 Numbers of less abundant bird species recorded within the WOW survey area between July 2020 and June 2021



**Initial survey area – see Figure 1 and Figure 2*

Figure 53 Numbers of less abundant bird species recorded within the WOW survey area between July 2021 and September 2022



**Initial survey area – see Figure 1 and Figure 2*

Figure 54 Detections of less abundant bird species in the WOW survey area between July 2020 and June 2021.

Note: An increase in the development and survey area from February 2021 to September 2022.

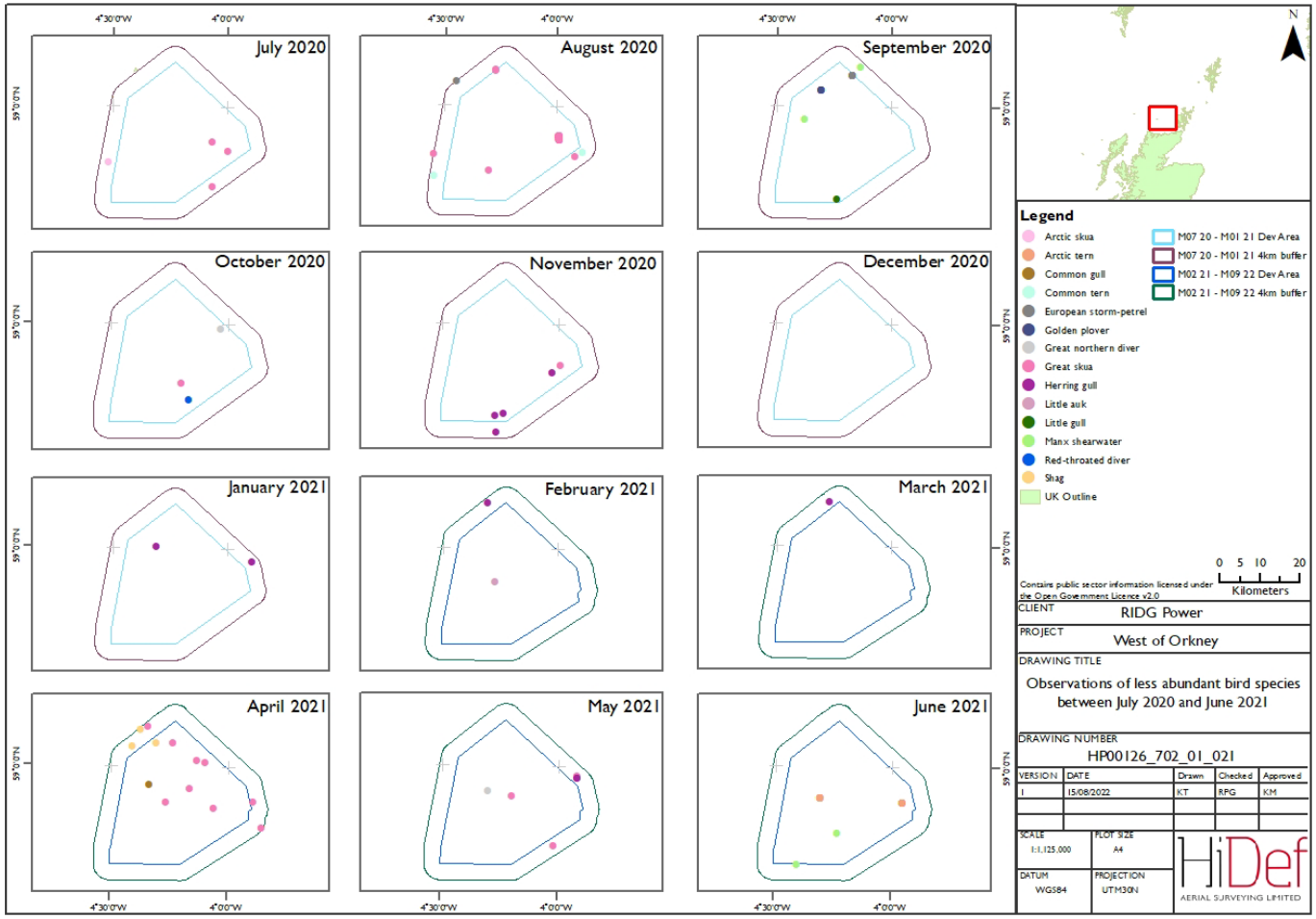


Figure 55 Detections of less abundant bird species in the WOW survey area between July 2021 and June 2022.

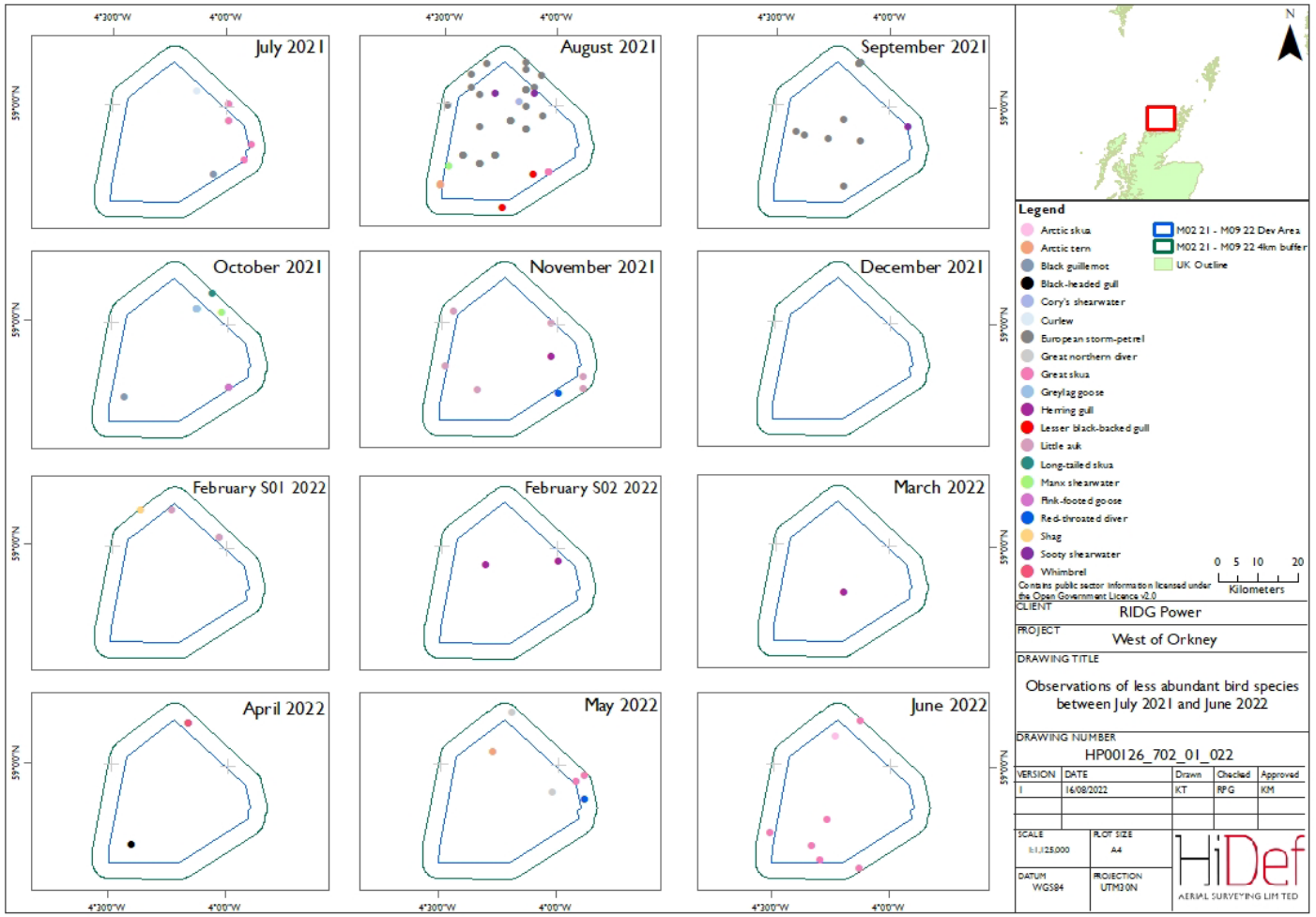


Figure 56 Detections of less abundant bird species in the WOW survey area between July 2021 and September 2022.

3.3.10 Unidentified bird species

124 Records of unidentified birds peaked in July 2020 and 2022 (Figure 57 to Figure 60). The spring and summer peaks of non-identification relate primarily to difficulties separating razorbill and guillemot and reflect the large number of birds present at that time. These are especially hard to distinguish when birds are in moult and accompanied by juveniles.

125 In addition, a total of one dead tern / small gull was observed and not assigned to species (Table 12).

126 Distributions of unidentified birds are displayed in Figure 61 to Figure 63. It should be noted a different survey area was flown for the first seven surveys, so counts may not be directly comparable with later surveys.

Figure 57 **Number of unidentified birds, assigned to species group, recorded within the WOW survey area between July 2020 and June 2021. For clarity, unidentified auk species are presented separately.**

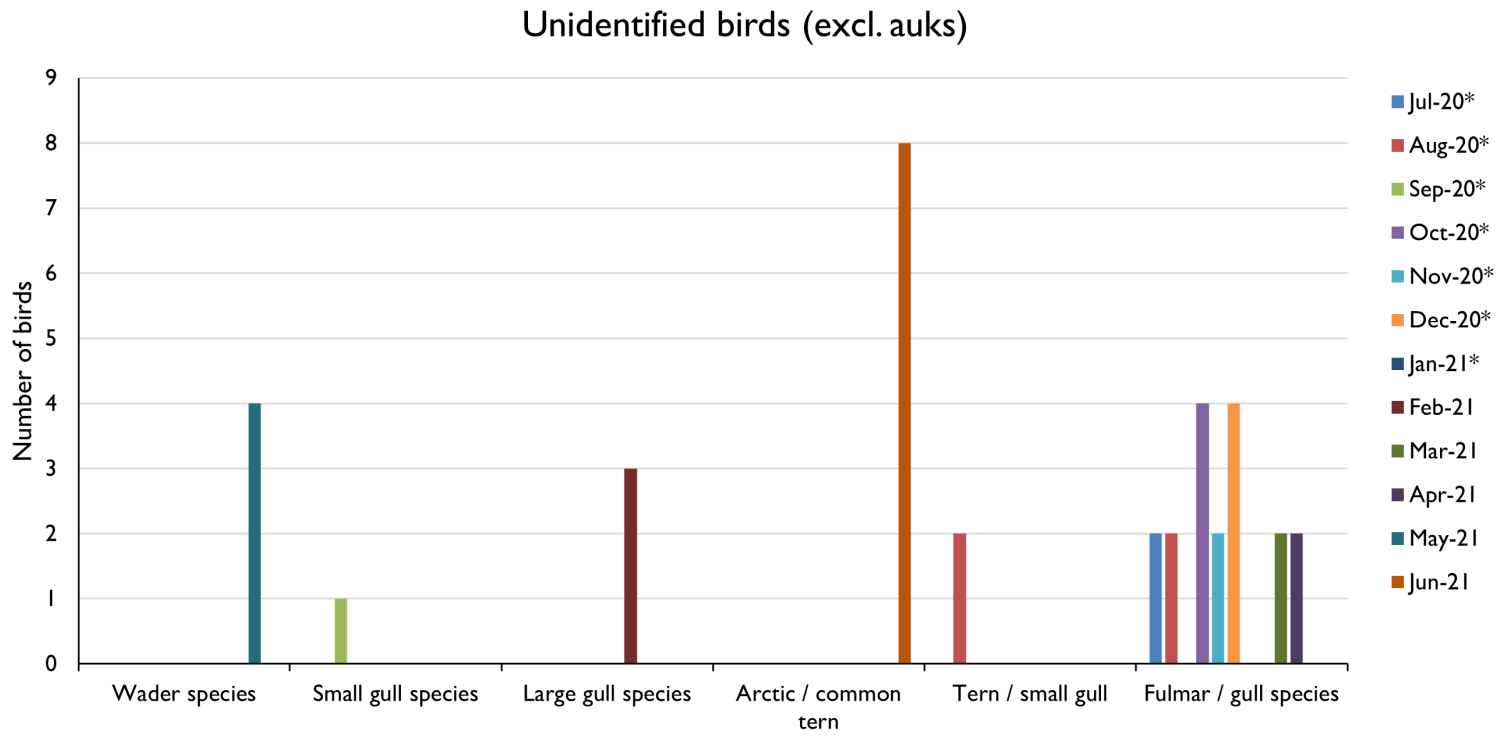


Figure 58 **Number of unidentified birds, assigned to species group, recorded within the WOW survey area between July 2021 and September 2022. For clarity, unidentified auk species are presented separately.**

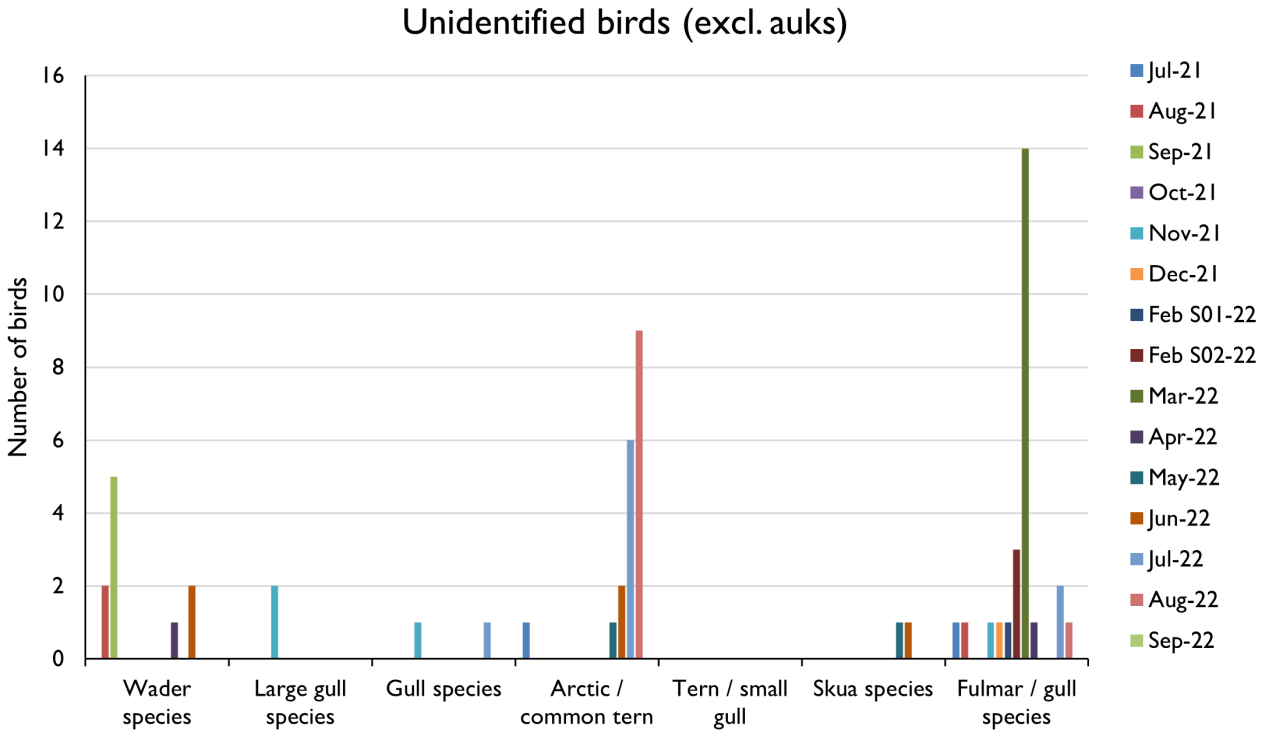
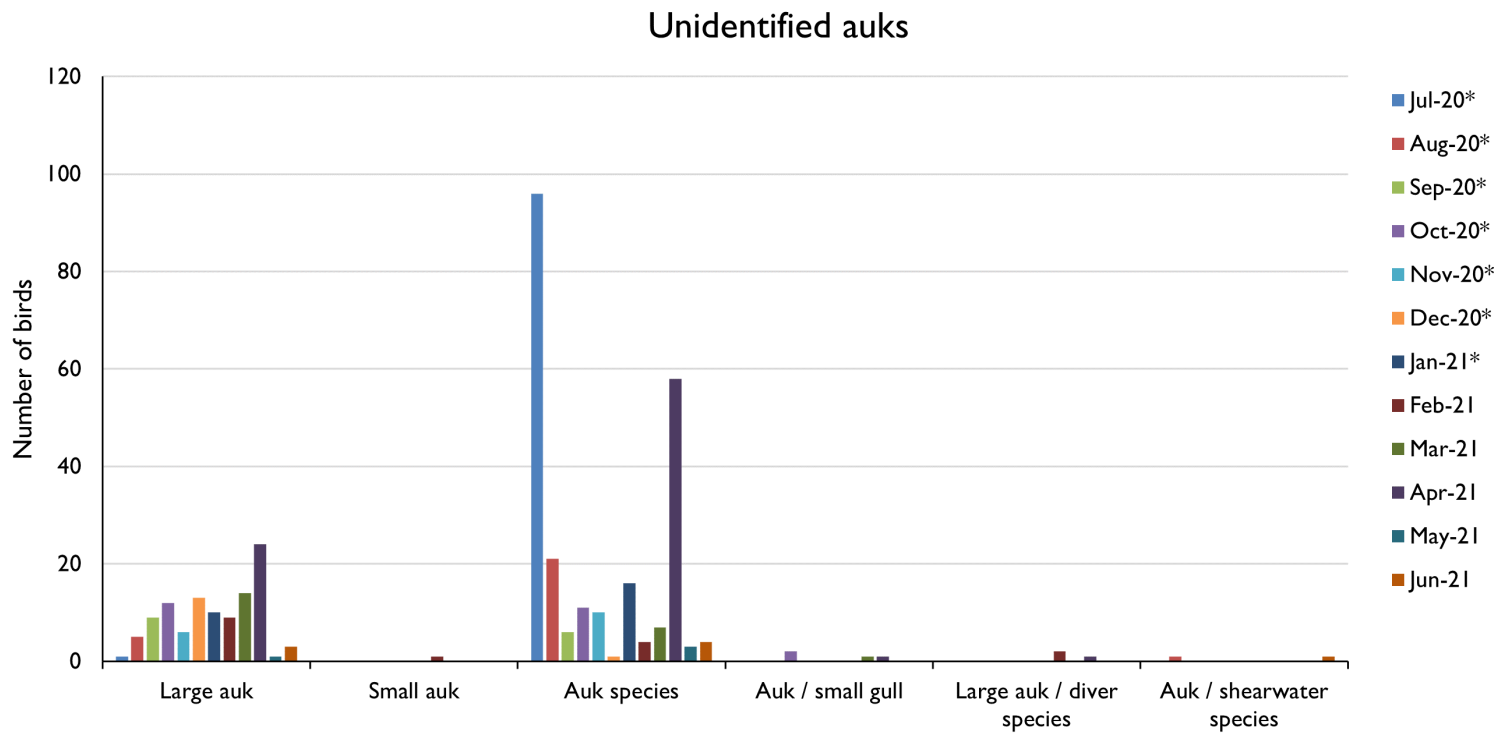


Figure 59 Number of unidentified auk species, recorded within the WOW survey area between July 2020 and June 2021



**smaller survey area, see Figure 1*

Figure 60 Number of unidentified auk species, recorded within the WOW survey area between July 2021 and September 2022

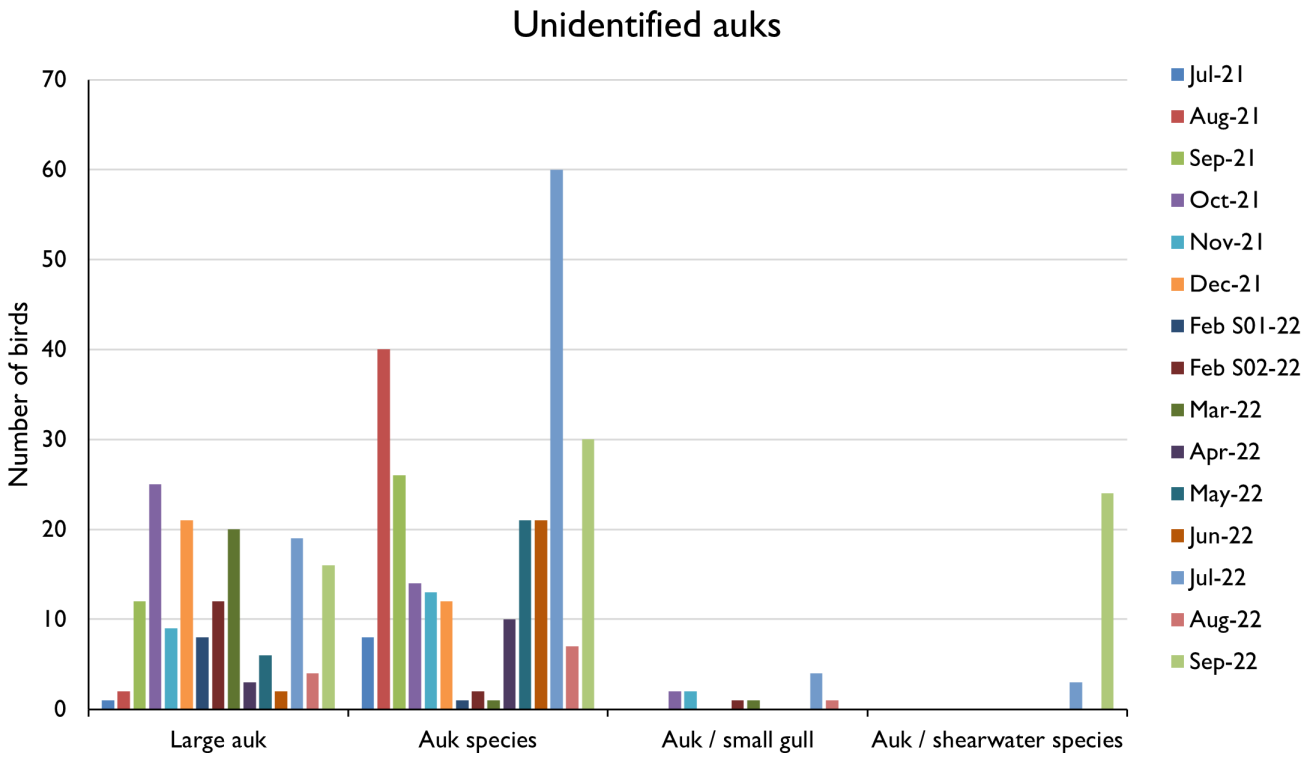


Figure 61 Detections of unidentified birds, assigned to species group in the WOW survey area between July 2020 and June 2021.

Note: An increase in the development and survey area from February 2021 to September 2022.

Figure 62 **Detections of unidentified birds, assigned to species group in the WOW survey area between July 2021 and June 2022.**

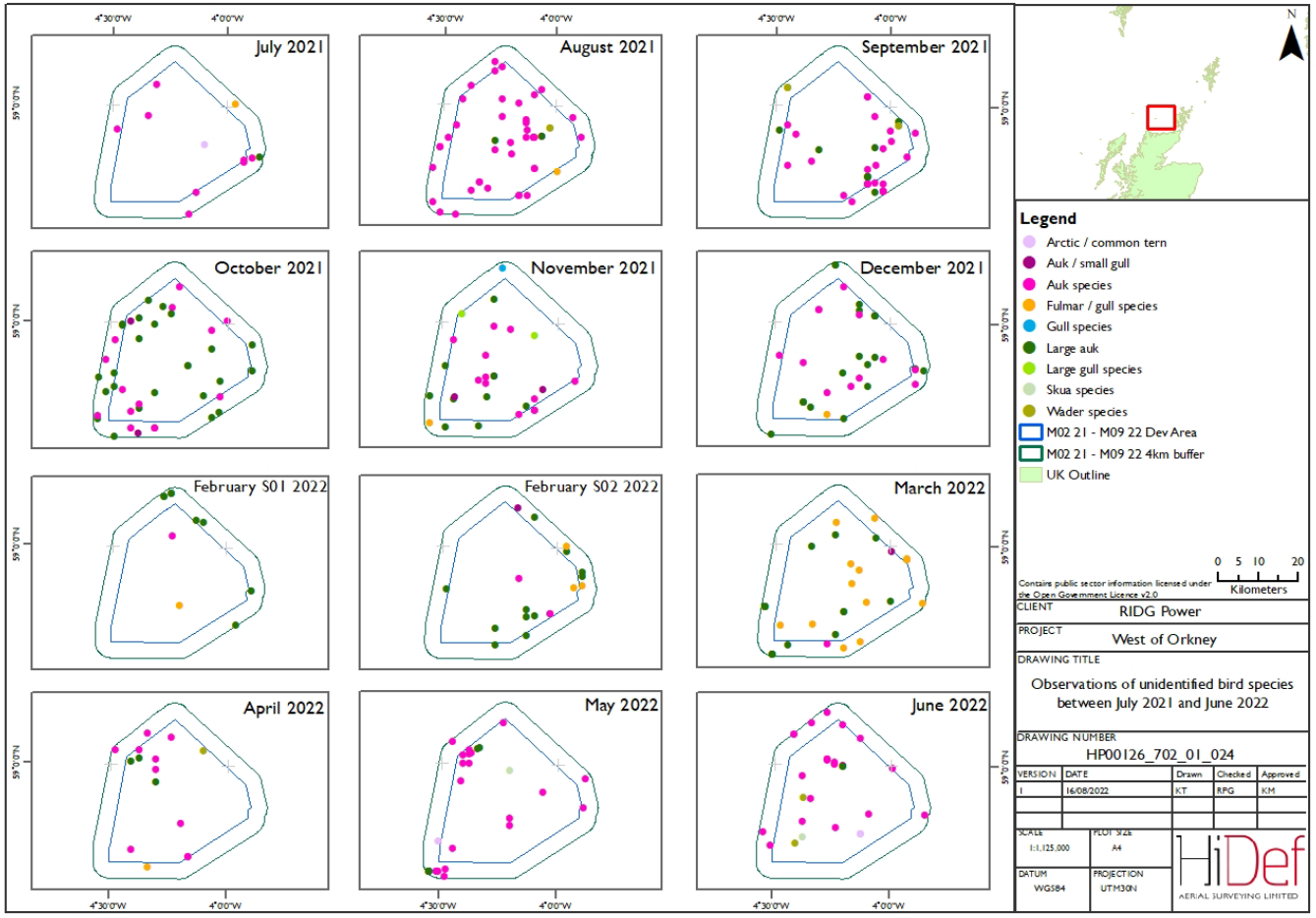
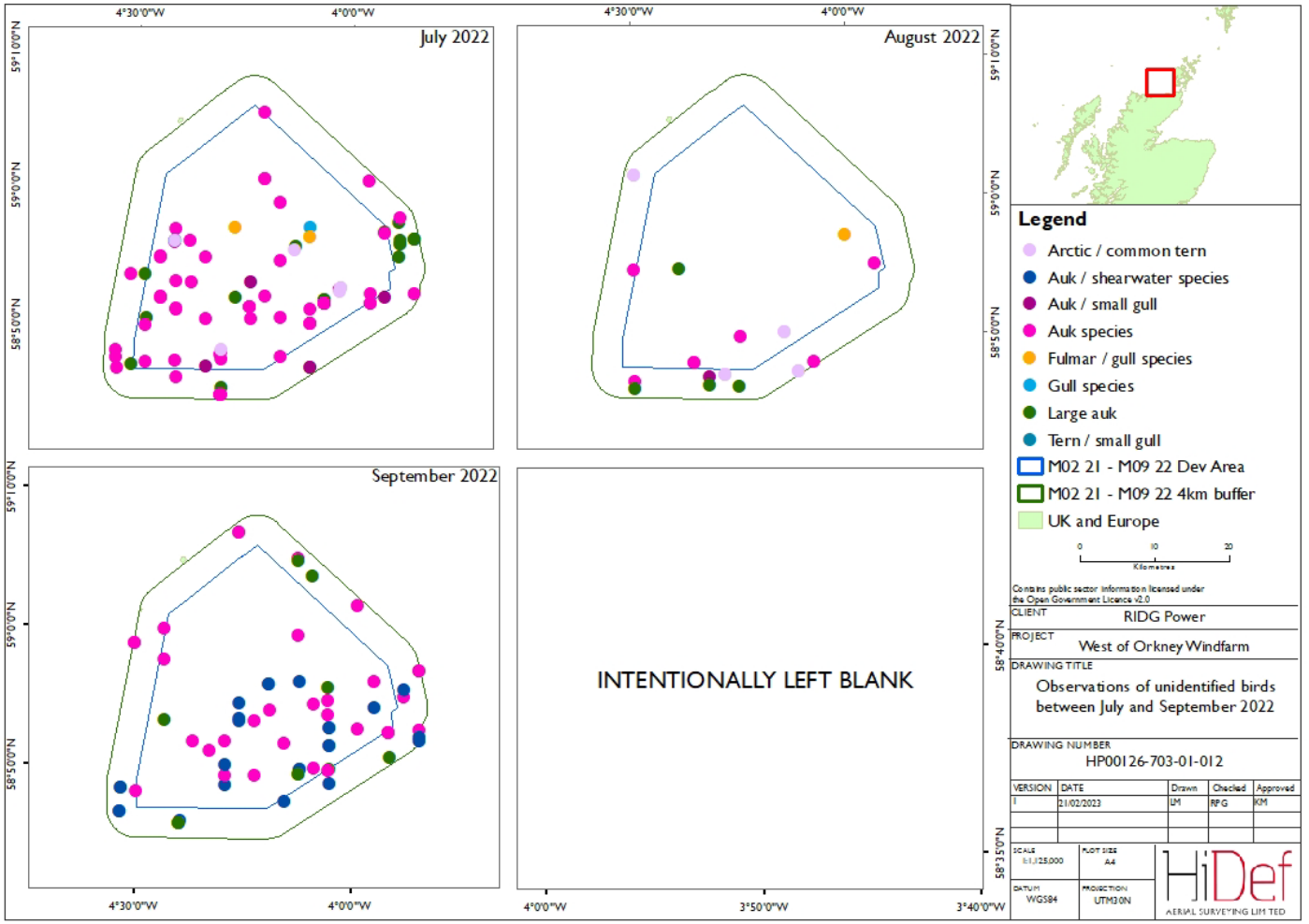


Figure 63 **Detections of unidentified birds, assigned to species group in the WOW survey area between July 2021 and September 2022.**



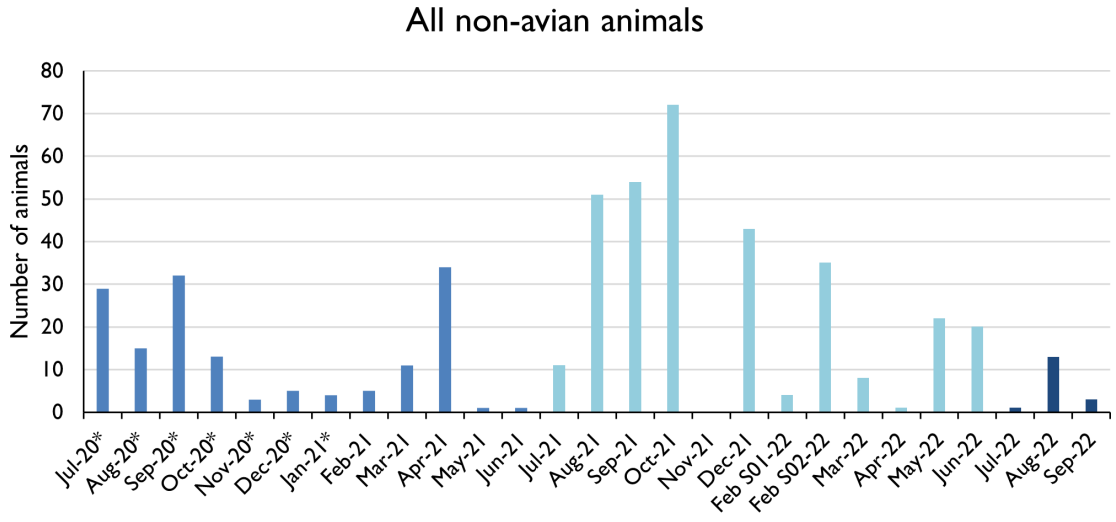
3.3.11 All non-avian animals

127 Non-avian animals were recorded intermittently, with the highest numbers recorded between August and October 2021 (Figure 64). It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

128 Surfacing rates of species and unidentified animals can be found in Table 30. One Risso's dolphin was recorded as dead during the survey period.

129 The densities of all non-avian animals are presented in Figure 65 to Figure 67.

Figure 64 Total number of non-avian animals recorded in the WOW survey area, between July 2020 and September 2022 (change in colour indicates the change in survey year)



**smaller survey area, see Figure 1*

Table 30 Summary of surfacing behaviour for all non-avian animals in the WOW survey area between July 2020 and September 2022

Species	Submerged	Surfacing	Surfacing at red line	% Surfacing at red line	Unknown behaviour	Total	Number recorded as dead
Barrel jellyfish	3	0	0	0	0	3	0
Basking shark	5	0	0	0	0	5	0
Bottlenose dolphin	0	1	0	0	0	1	0
Common dolphin	40	2	0	0	0	42	0
Grey seal	1	3	13	76	0	17	0
Harbour porpoise	83	5	33	26	4	125	0
Lion's mane jellyfish	93	1	0	0	0	94	0
Minke whale	2	0	1	33	0	3	0
Ocean sunfish	4	0	0	0	0	4	0
Porbeagle shark	1	0	0	0	0	1	0
Risso's dolphin	10	1	6	30	3	20	1
White-beaked dolphin	87	4	9	9	0	100	0
No ID							
Cetacean species	6	2	0	0	0	8	0
Dolphin species	2	0	1	33	0	3	0
Jellyfish	24	0	0	0	0	24	0
Seal / small cetacean species	3	0	1	20	1	5	0
Seal species	5	2	29	78	1	37	0
Total	**369**	**21**	**93**	**19**	**9**	**492**	**1**

Figure 65 Density of all non-avian animals (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021

Note: An increase in the development and survey area from February 2021 to September 2022.

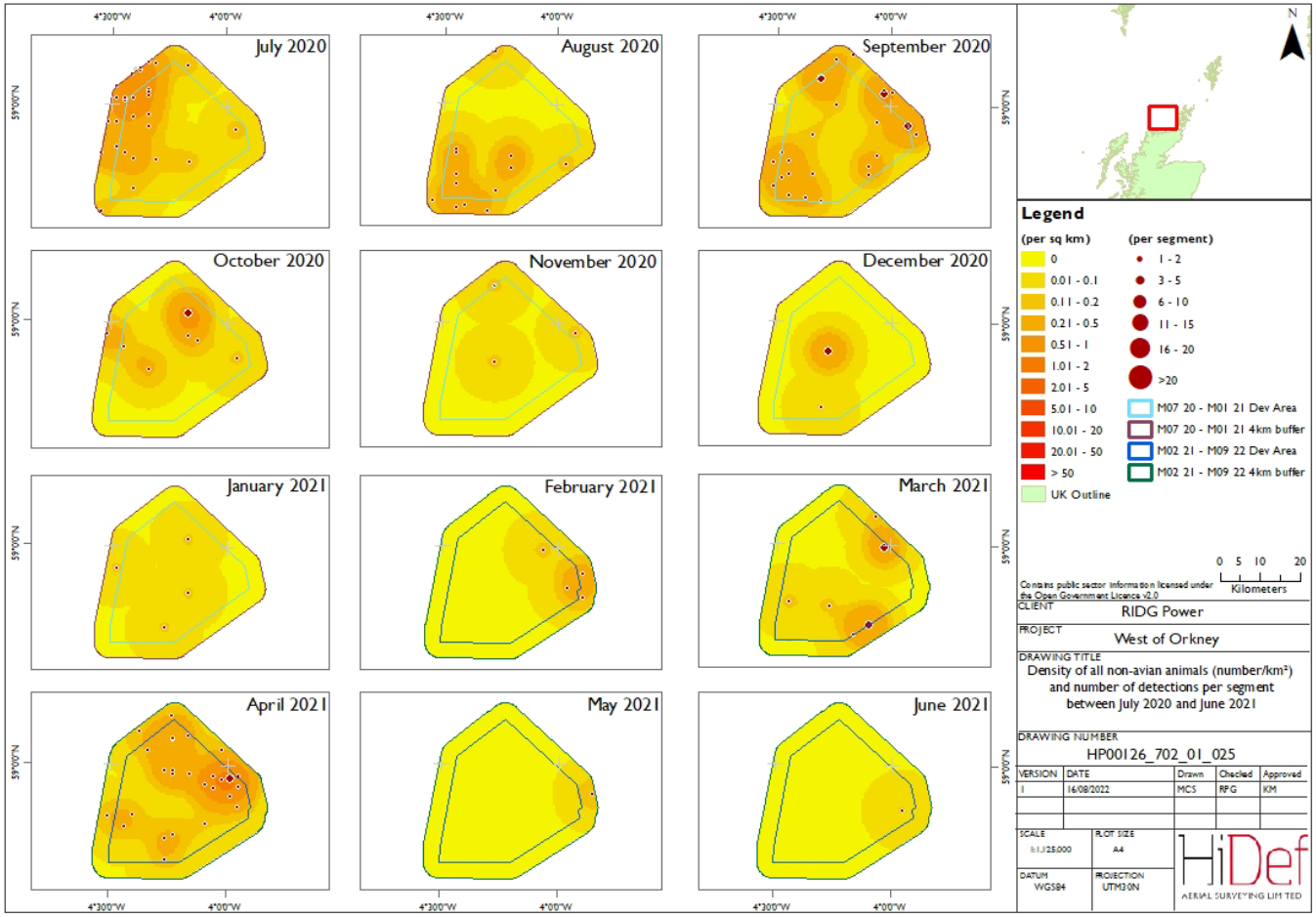


Figure 66 Density of all non-avian animals (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

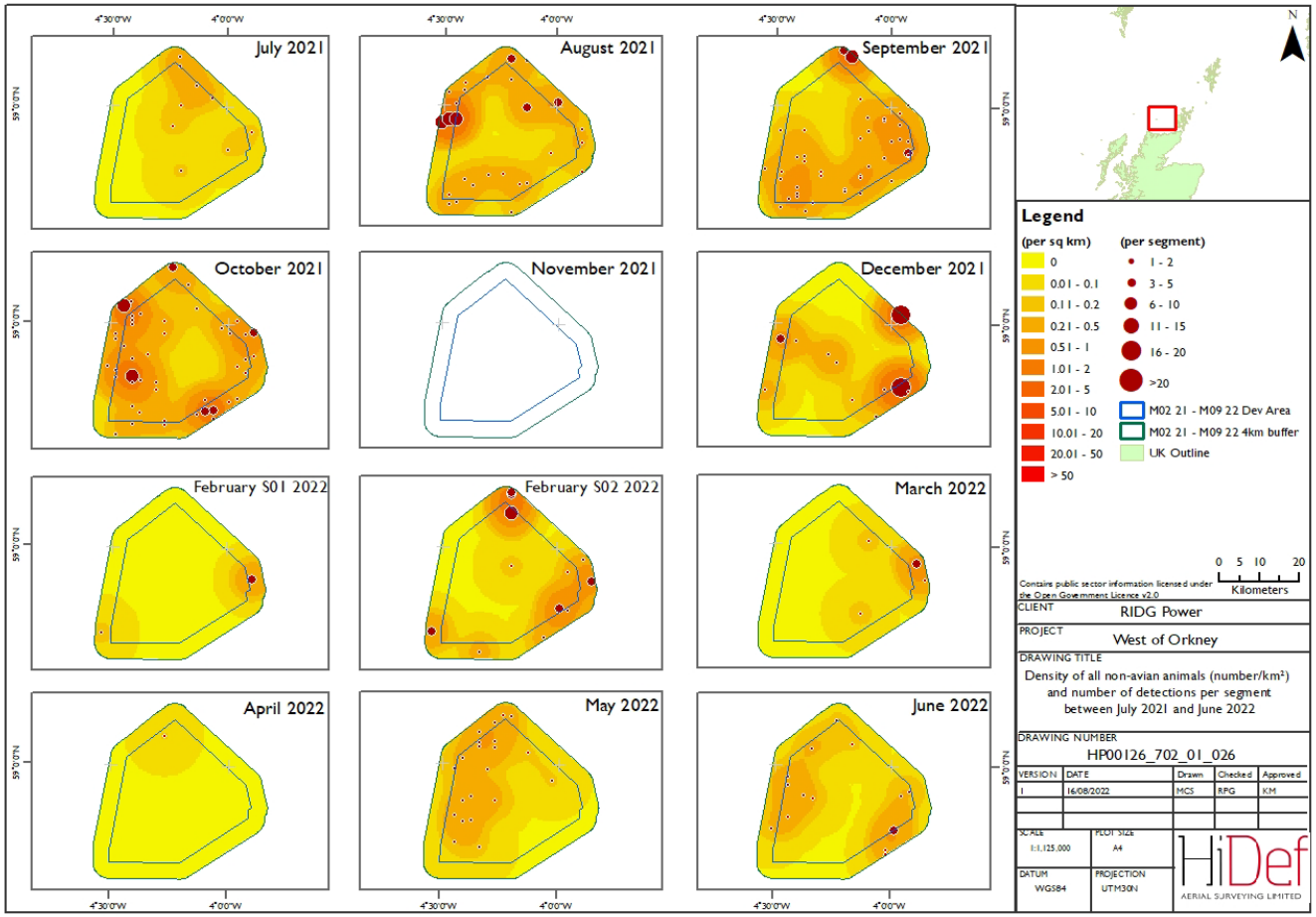
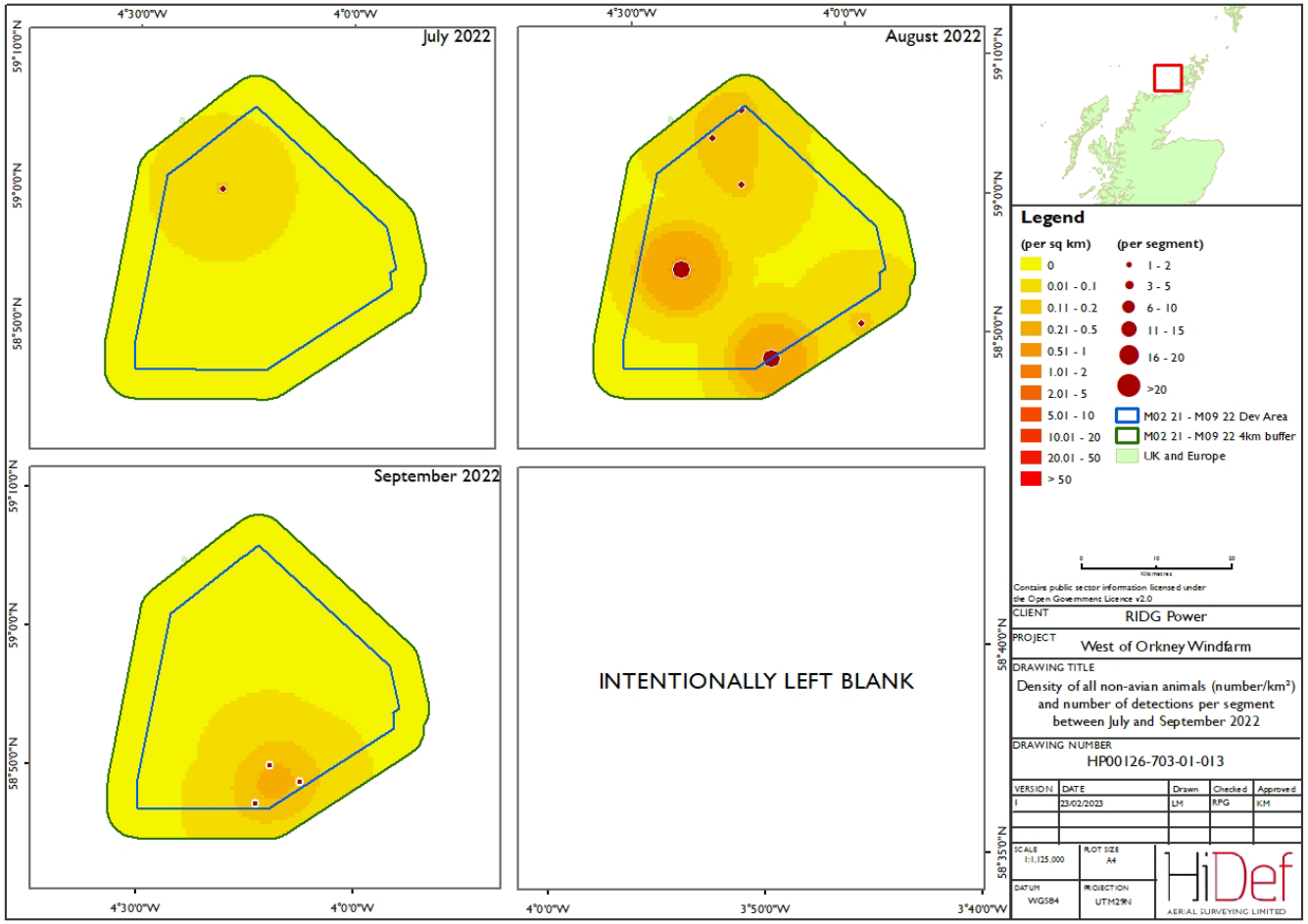


Figure 67 Density of all non-avian animals (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.



3.3.12 Harbour porpoise

130 Harbour porpoise were recorded relatively frequently, with records peaking in April 2021 with 22 animals (Figure 68). It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

131 When accounting for animals submerged at the time of the survey, absolute density estimates ranged between 0.00 animals/km^2, e.g. October 2020, and 0.77 animals/km^2 (95% CI 0.19 – 1.44) in September 2021 (Figure 70 to Figure 72), equating to a peak population estimate for the survey area of 1,009 animals (95% CI 250 – 1,900). Harbour porpoise were widespread across the survey area with higher densities generally observed within the 4km buffer such as in October 2021 and February 2022 (Figure 70 to Figure 72). In March 2021, density was concentrated in the southeast of the buffer while in September 2021, higher densities were primarily concentrated in the northern buffer.

132 Proportions of surfacing animals can be found in Table 30; 67% of individuals were recorded as submerged.

Figure 68 Number of harbour porpoise recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)

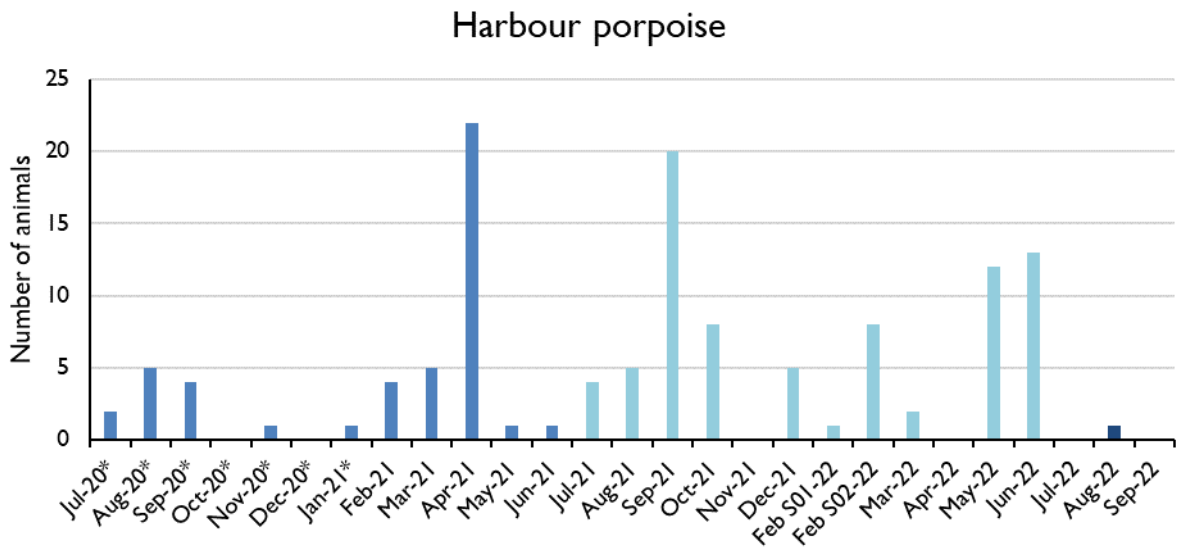
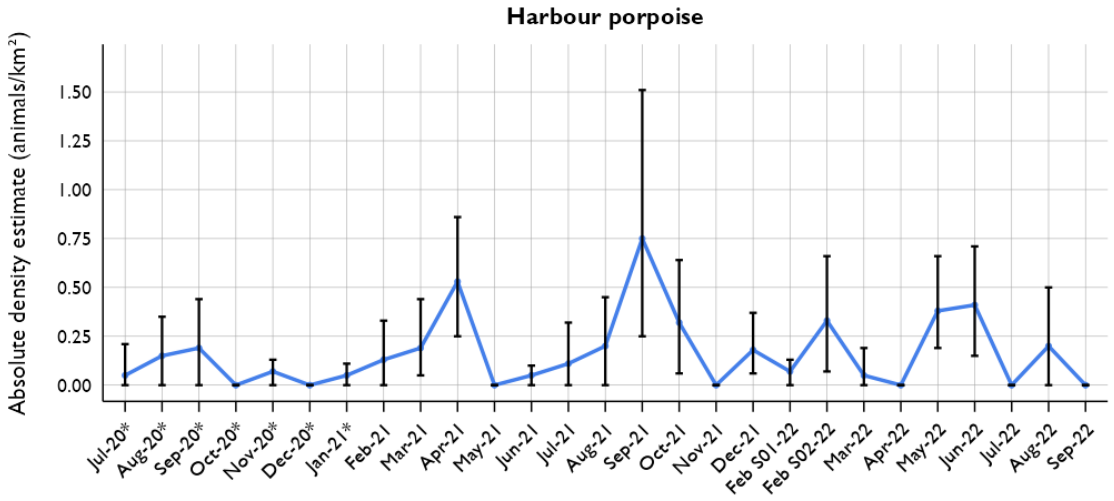


Figure 69 Harbour porpoise absolute density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022.



**smaller survey area, see Figure 1*

Table 31 **Relative and absolute monthly density and population estimates for harbour porpoise in the WOW survey area between July 2020 and September 2022, accounting for animals estimated as unavailable for detection.**

Survey Date	Relative population estimates						Absolute population estimates			
	Density estimate (n/km2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate (number)	CV (%)	Density estimate	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population
22 July 2020*	0.01	17	0	48	17	98.92	0.06	83	0	255
06 August 2020*	0.03	41	0	86	22	52.95	0.15	200	0	427
24 September 2020*	0.03	33	0	95	30	92.29	0.16	201	0	600
22 October 2020*	0.00	0	0	0	0	0.00	0.00	0	0	0
28 November 2020*	0.01	9	0	24	8	90.38	0.04	52	0	156
15 December 2020*	0.00	0	0	0	0	0.00	0.00	0	0	0
04 January 2021*	0.01	8	0	24	8	95.97	0.03	42	0	128
27 February 2021	0.02	32	0	72	19	58.69	0.16	214	0	473
15 March 2021	0.04	48	8	120	31	63.76	0.18	233	0	567
21 April 2021	0.13	173	79	277	50	28.78	0.54	716	349	1113
20 May 2021	0.00	0	0	0	0	0.00	0.00	0	0	0.00
11 June 2021	0.01	9	0	24	8	94.84	0.03	42	0	122
02 July 2021	0.02	33	0	76	20	60.05	0.13	177	0	386
30 August 2021	0.04	49	0	118	32	65.82	0.18	238	0	587

Survey Date	Relative population estimates						Absolute population estimates			
	Density estimate (n/km2)	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population	Standard deviation of population estimate (number)	CV (%)	Density estimate	Population estimate	Lower 95% confidence limit of population	Upper 95% confidence limit of population
08 September 2021	0.12	163	47	313	70	43.02	0.75	0.25	295	1967
12 October 2021	0.05	65	8	136	34	51.4	0.32	0.06	51	869
15 November 2021	0.00	0	0	0	0	0.00	0	0	0	0.00
28 December 2021	0.03	41	8	80	19	45.03	0.18	0.06	49	492
18 February 2022	0.01	9	0	24	8	98.69	0.07	0	0	159
26 February 2022	0.05	66	15	136	33	49.5	0.33	0.07	99	902
11 March 2022	0.01	17	0	49	16	96.77	0.05	0	0	238
14 April 2022	0.00	0	0	0	0	0.00	0	0	0	0.00
15 May 2022	0.08	106	47	184	36	33.45	0.38	0.19	220	863
06 June 2022	0.08	104	39	181	38	36.52	0.41	0.15	199	922
22 July 2022	0.00	0	0	0	0	0.00	0	0	0	0.00
17 August 2022	0.04	47	0	132	38	79.52	0.2	0	0	658
02 September 2022	0.00	0	0	0	0	0.00	0	0	0	0.00

**smaller survey area, see Figure 1*

Figure 70 **Density of harbour porpoise (number/km²) and number of detections per segment in the WOW survey area between July 2020 and June 2021.**

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

An increase in the development and survey area from February 2021 to September 2022.

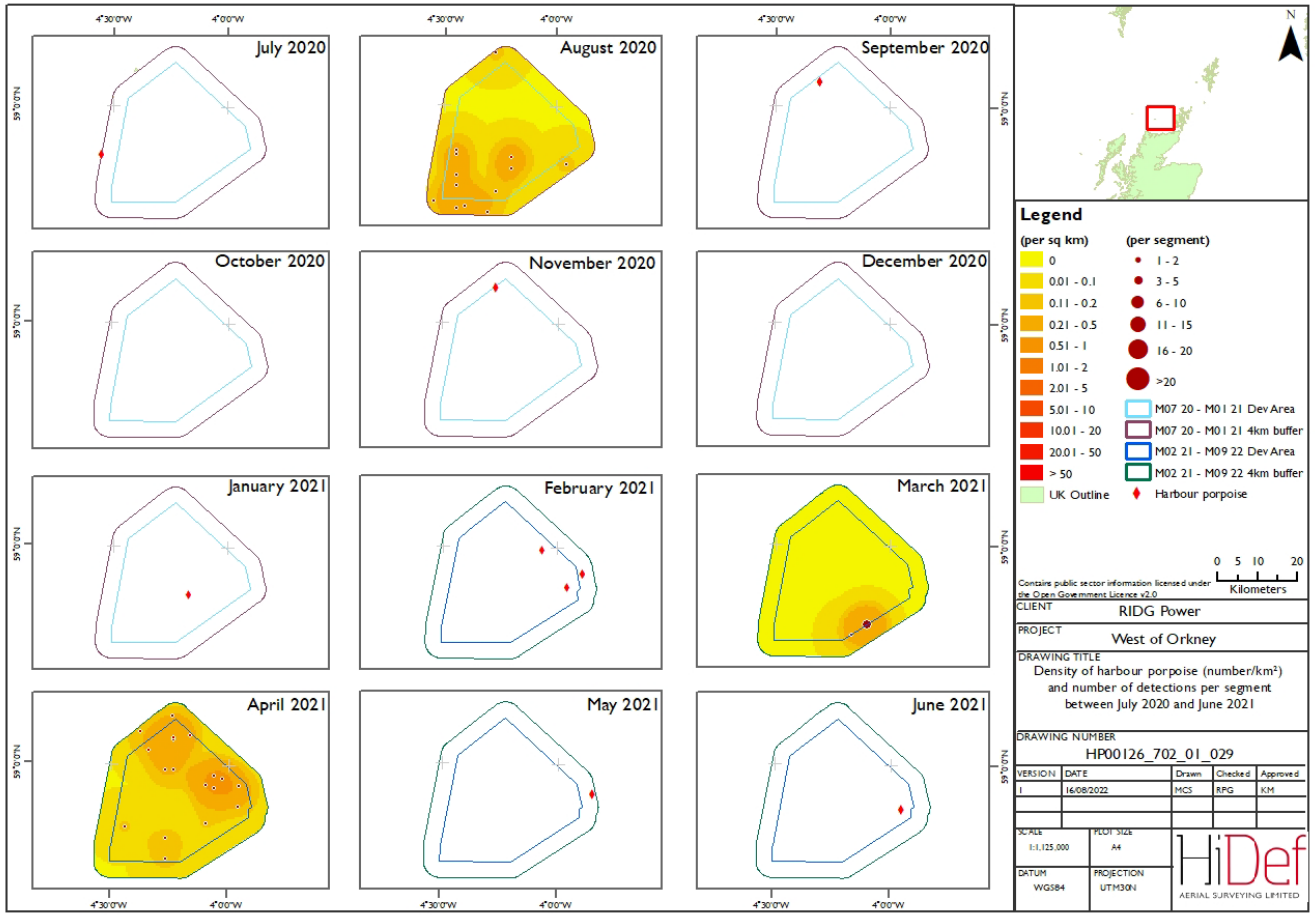


Figure 71 **Density of harbour porpoise (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.**

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

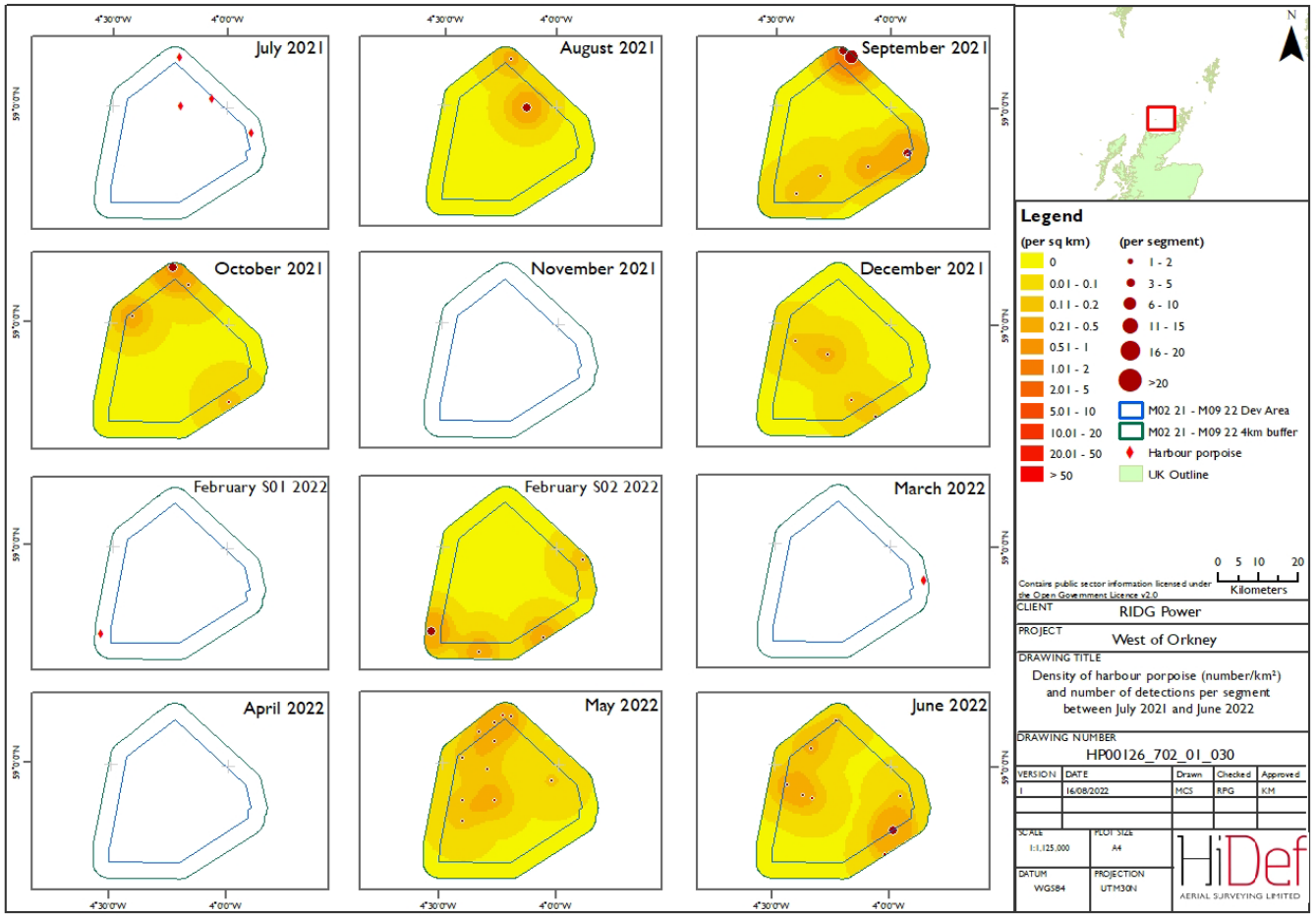
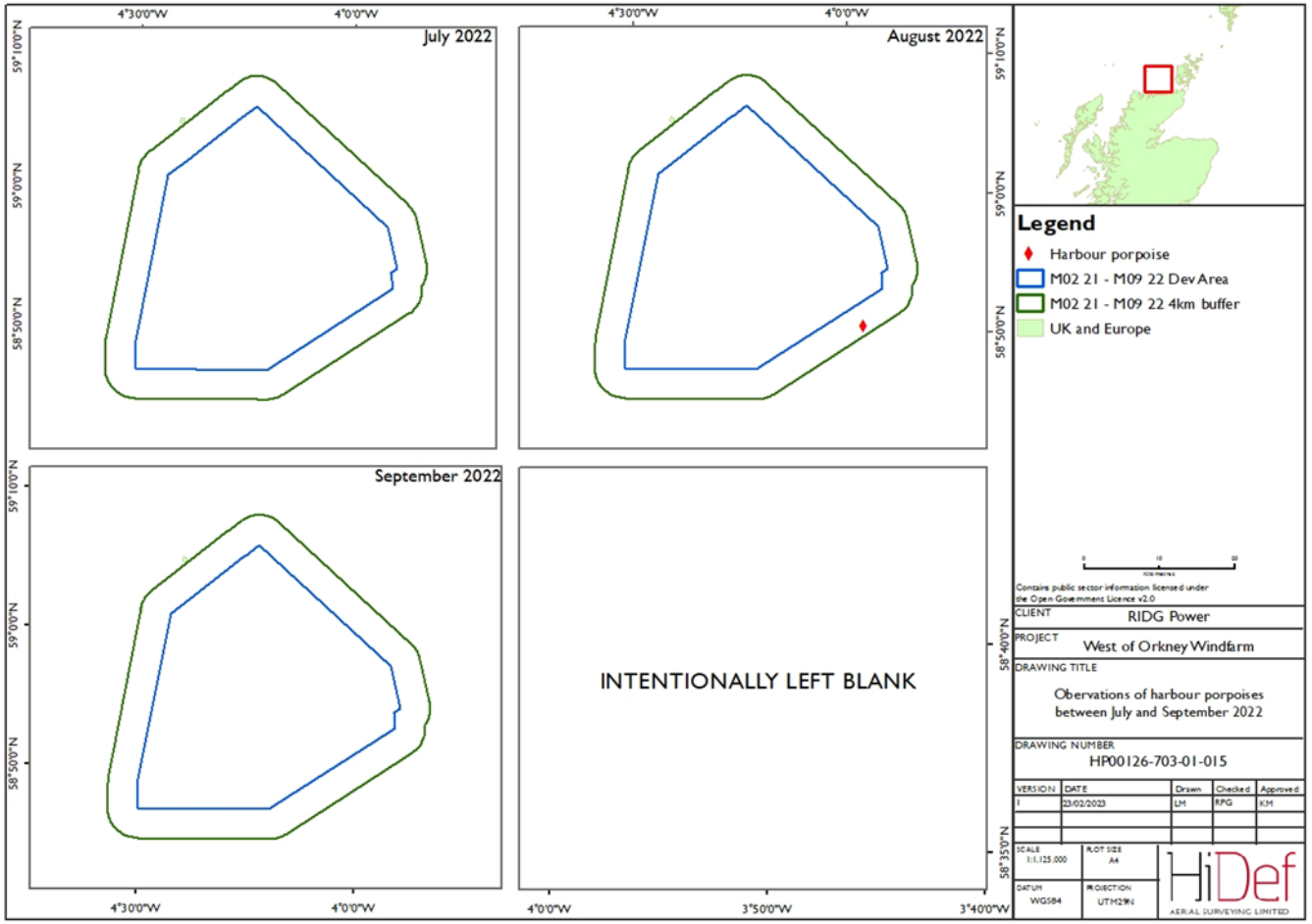


Figure 72 Detections of harbour porpoises in the WOW survey area between July and September 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.



3.3.13 White-beaked dolphin

133 White-beaked dolphins were recorded intermittently, with more animals recorded during Year 2 compared to Year 1 (Figure 73). It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

134 When observed, density estimates for the species ranged between 0.01 animals/km^2 (95% CI 0.00 – 0.02) in January 2021 and 0.15 animals/km^2 (95% CI 0.01 – 0.34) in February 2022 (Figure 74; Table 32), equating to 9 animals (95% CI 0 - 24) and 203 animals (95% CI 16 - 446) respectively.

135 White-beaked dolphins were mainly observed within the 4km buffer area, with higher densities observed in the west part of the survey area in August 2021 as well as south of the survey area, such as in October 2021 (Figure 75 to Figure 77).

136 Proportions of surfacing animals can be found in Table 30; 87% of individuals were recorded as submerged.

137 Throughout the survey period, a total of six adult-juvenile pairs were recorded; two in August 2021 and four in October 2021.

Figure 73 Number of white-beaked dolphins recorded between July 2020 and September 2022 in the WOW survey area (change in colour indicates the change in survey year)

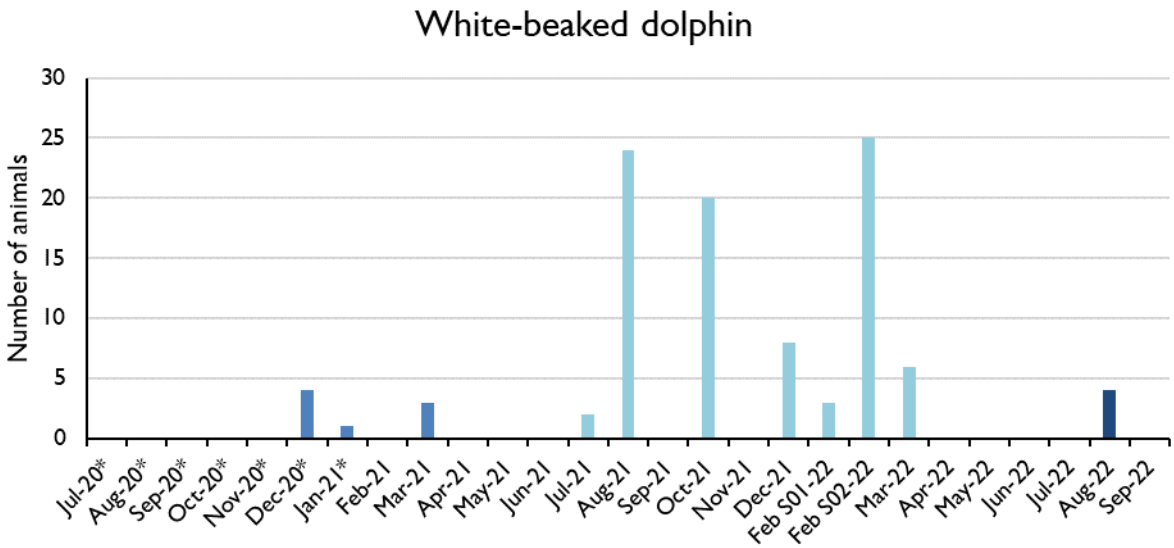
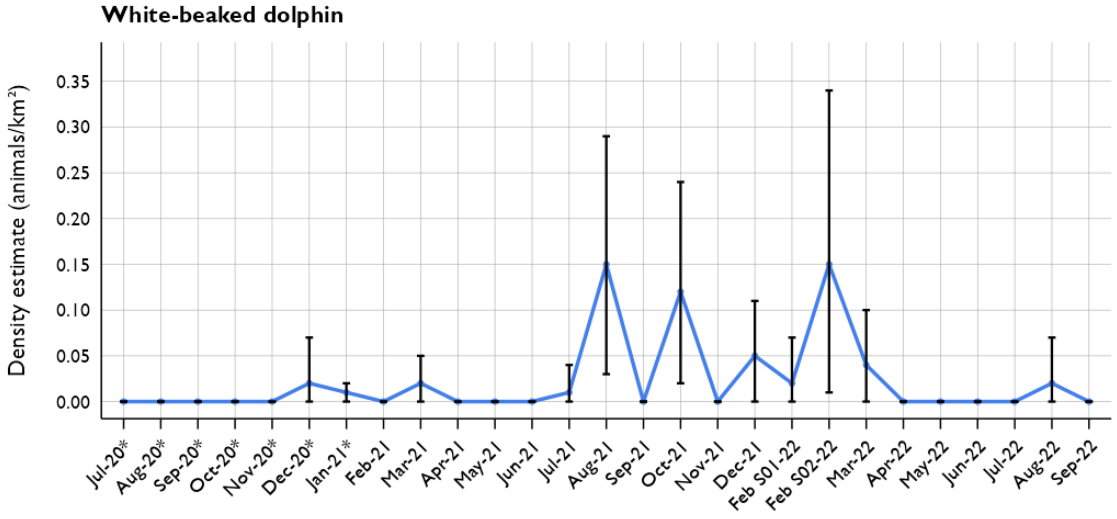


Figure 74 White-beaked dolphin density estimates, with 95% lower and upper confidence limits, in the WOW survey area between July 2020 and September 2022



**smaller survey area, see Figure 1*

Table 32 Density and population estimates of white-beaked dolphins in the WOW survey area between July 2020 and September 2022

Survey date	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
22 July 2020*	0.00	0	0	0	0	0.00
06 August 2020*	0.00	0	0	0	0	0.00
24 September 2020*	0.00	0	0	0	0	0.00
22 October 2020*	0.00	0	0	0	0	0.00
28 November 2020*	0.00	0	0	0	0	0.00
15 December 2020*	0.02	32	0	95	31	94.14
04 January 2021*	0.01	9	0	24	8	91.64
27 February 2021	0.00	0	0	0	0	0.00
15 March 2021	0.02	25	0	72	24	97.66
21 April 2021	0.00	0	0	0	0	0.00
20 May 2021	0.00	0	0	0	0	0.00
11 June 2021	0.00	0	0	0	0	0.00
02 July 2021	0.01	17	0	48	15	91.00
30 August 2021	0.15	196	45	382	86	43.98
08 September 2021	0.00	0	0	0	0	0.00
12 October 2021	0.12	162	32	311	73	44.66
15 November 2021	0.00	0	0	0	0	0.00
28 December 2021	0.05	65	0	141	37	56.33
18 February 2022	0.02	24	0	91	25	100.78
26 February 2022	0.15	203	16	446	113	55.50
11 March 2022	0.04	48	0	127	34	70.76
14 April 2022	0.00	0	0	0	0	0.00
15 May 2022	0.00	0	0	0	0	0.00
06 June 2022	0.00	0	0	0	0	0.00
22 July 2022	0.00	0	0	0	0	0.00
17 August 2022	0.02	33	0	96	32	95.70
02 September 2022	0.00	0	0	0	0	0.00

**smaller survey area, see Figure 1*

Figure 75 Detections of white beaked dolphins in the WOW survey area between July 2020 and June 2021.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps. An increase in the development and survey area from February 2021 to September 2022.

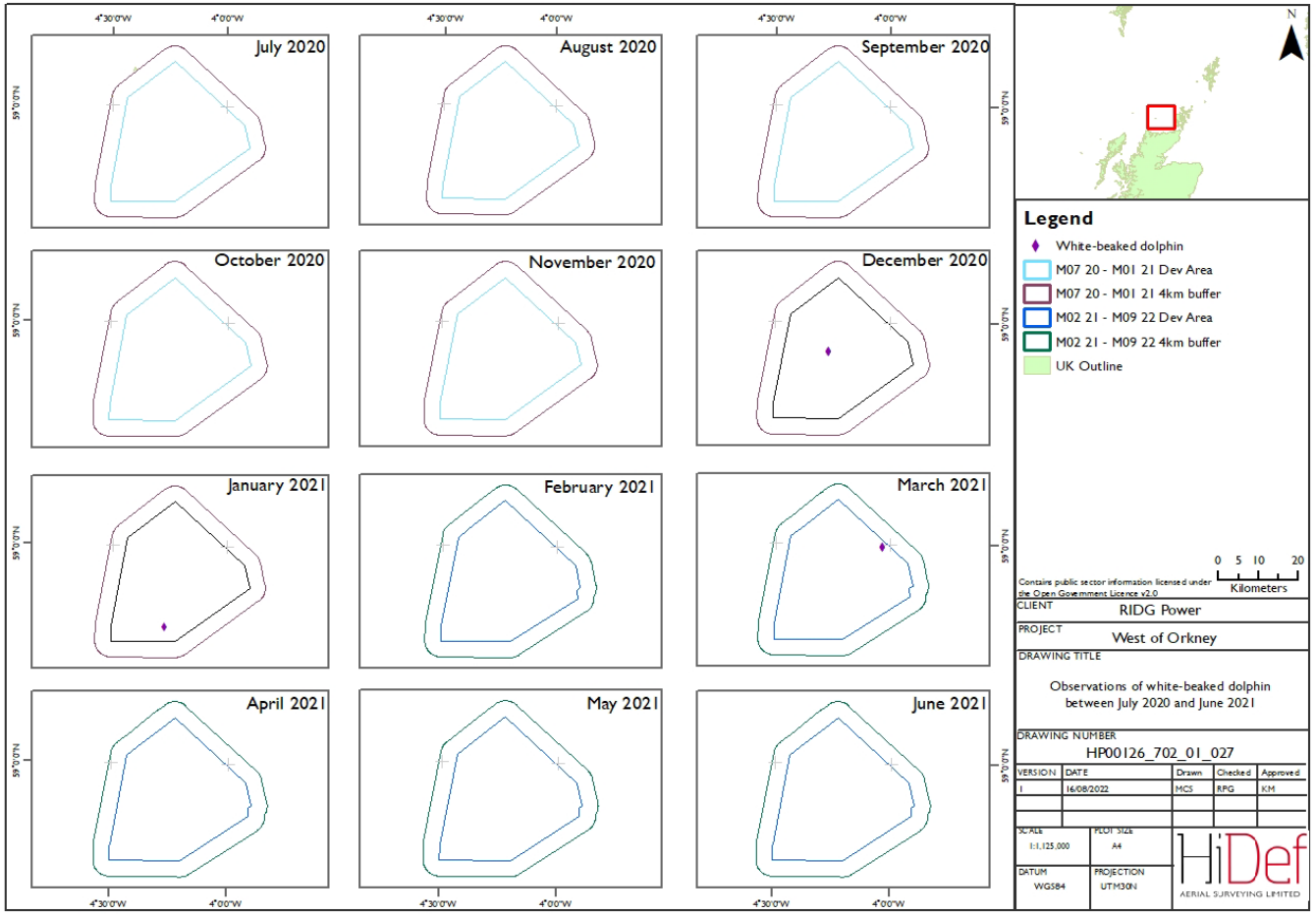


Figure 76 Density of white-beaked dolphins (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

Note: In cases where there are less than 5 observations, density maps are not included and the data presented as dot maps.

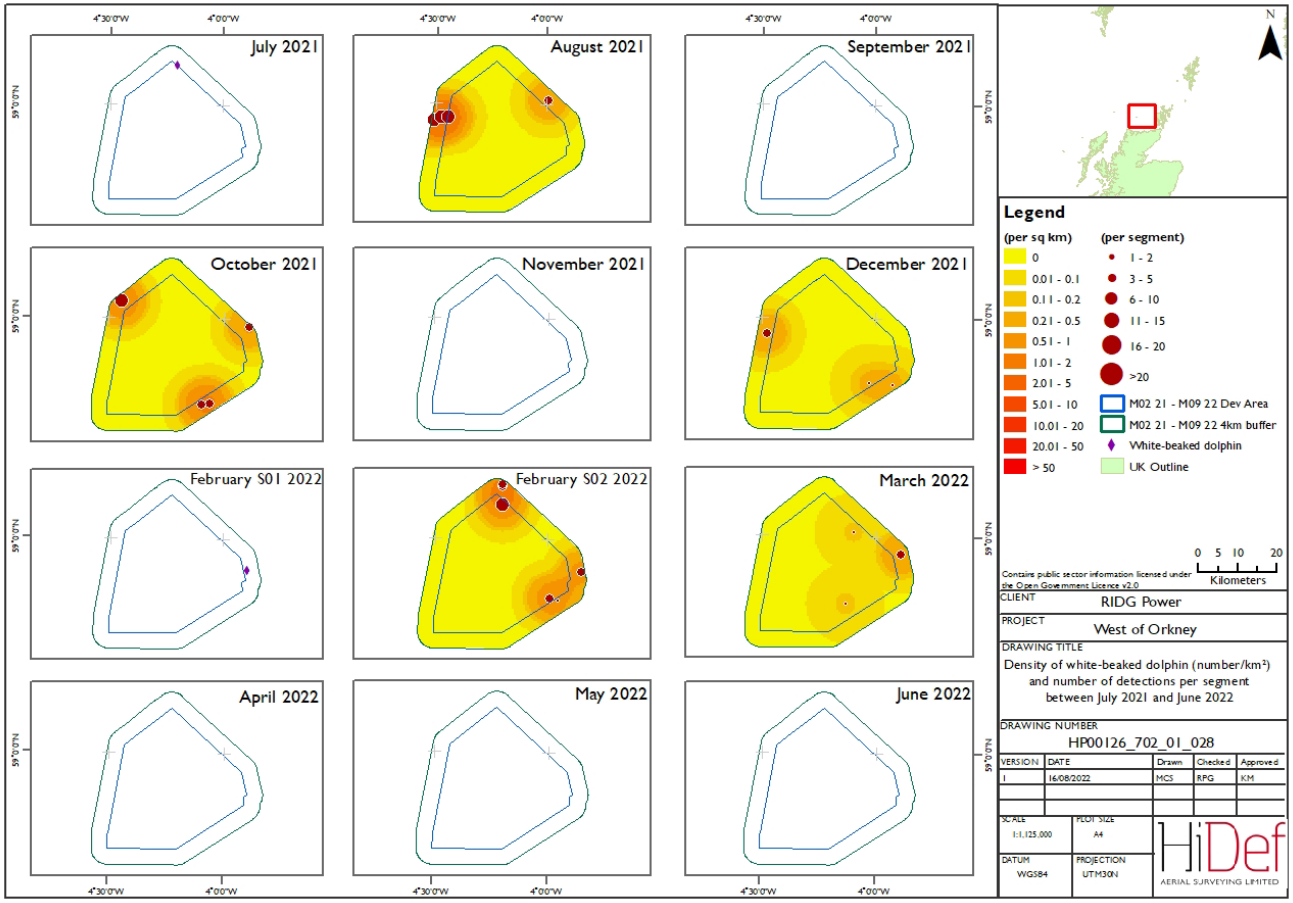


Figure 77 Detections of white-beaked dolphins in the WOW survey area between July and September 2022.

3.3.14 Less abundant non-avian animal species

138 Ten additional non-avian animal species were recorded throughout the survey period, of which lion's mane jellyfish (*Cyanea capillata*) were the most numerous, with 94 records, distributed throughout the survey area (Figure 78; Figure 79).

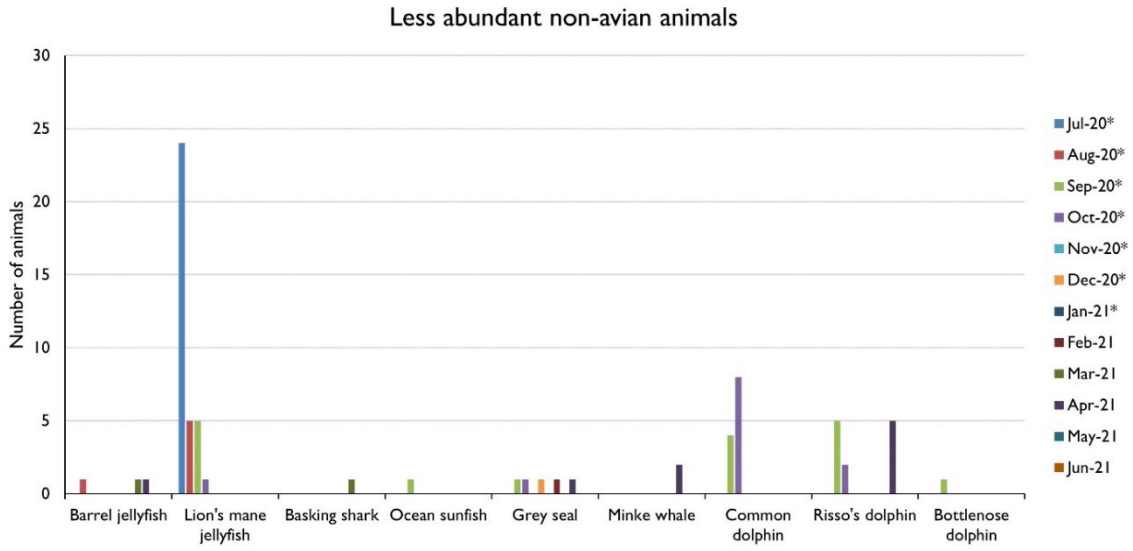
139 Common dolphins (*Delphinus delphis*) and Risso's dolphins (*Grampus griseus*) were the next most abundant marine mammals 42 and 20 recordings respectively. Risso's dolphins were recorded in low numbers with one found dead, with the majority of common dolphins (71%) recorded during the December 2021 survey. Risso's dolphin densities were generally higher in the north of the survey area, while common dolphins were distributed throughout both the development area and 4km buffer (Figure 80 to Figure 82).

140 Seventeen grey seals were recorded over the 27 surveys, with no clear patterns in distribution. Three minke whales were recorded, distributed in the north and northeast, in addition to five basking sharks (*Cetorhinus maximus*), and a single porbeagle shark (*Lamna nasus*), present in the southeast of the survey area in August 2021. Four ocean sunfish (*Mola mola*) were also recorded.

141 It should be noted a different survey area was flown for the first seven surveys, which may affect raw results.

Figure 78 Number of less abundant non-avian animals recorded within the WOW survey area between July 2020 and June 2021

Note: 24 lion's mane jellyfish Jul-20



**Initial survey area – see Figure 1and Figure 2*

Figure 79 Number of less abundant non-avian animals recorded within the WOW survey area between July 2021 and September 2022

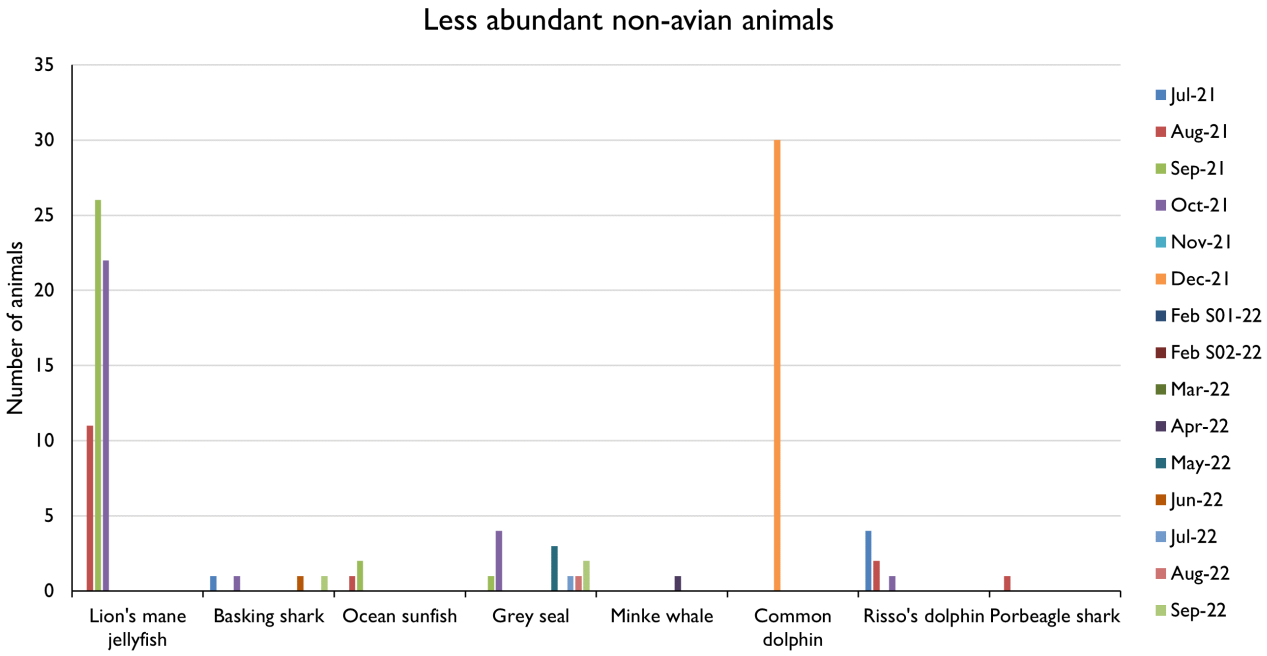


Figure 80 Detections of less abundant non-avian animal species in the WOW survey area between July 2020 and June 2021.

Note: An increase in the development and survey area from February 2021 to September 2022.

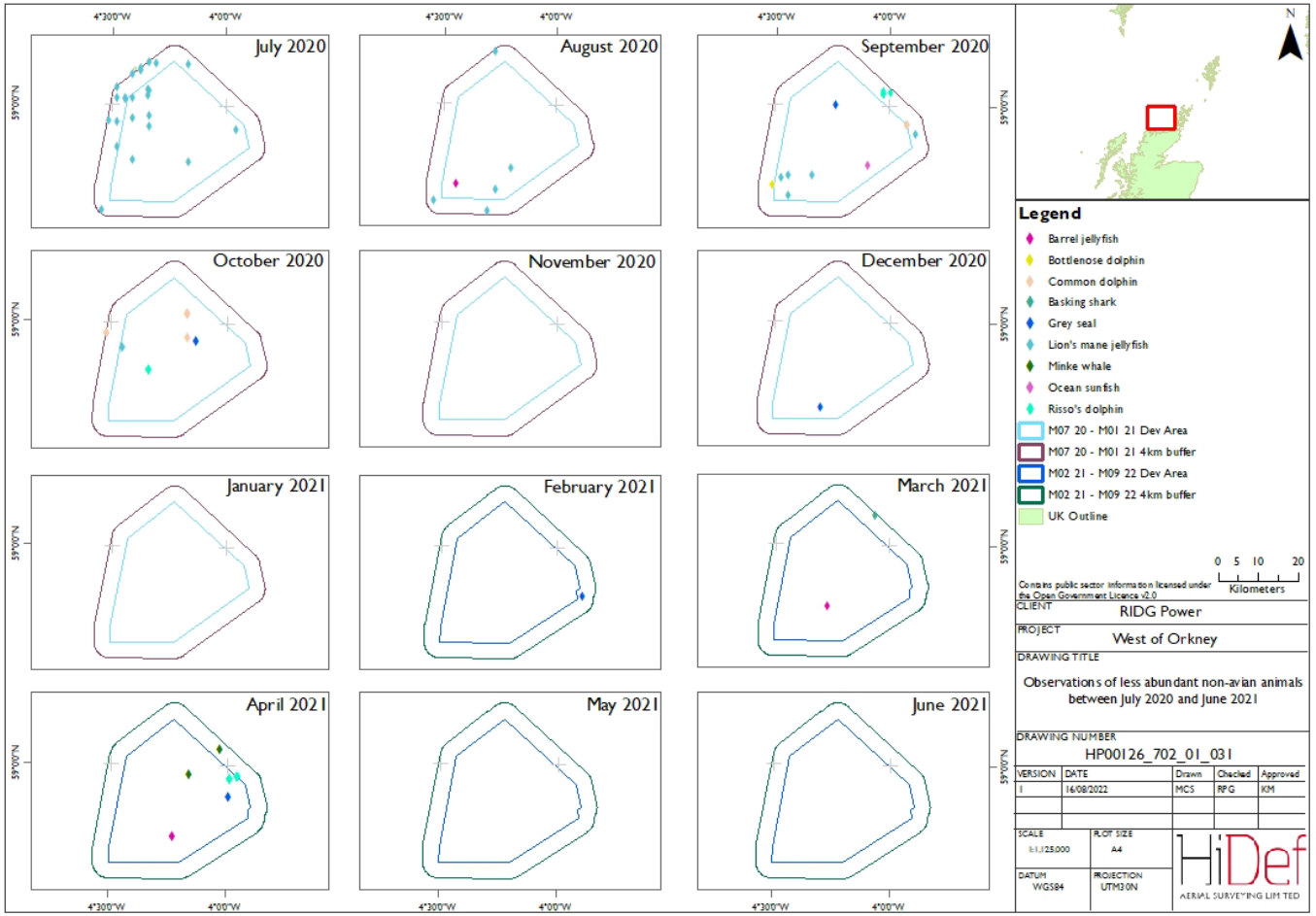


Figure 81 Detections of less abundant non-avian animal species in the WOW survey area between July 2021 and June 2022.

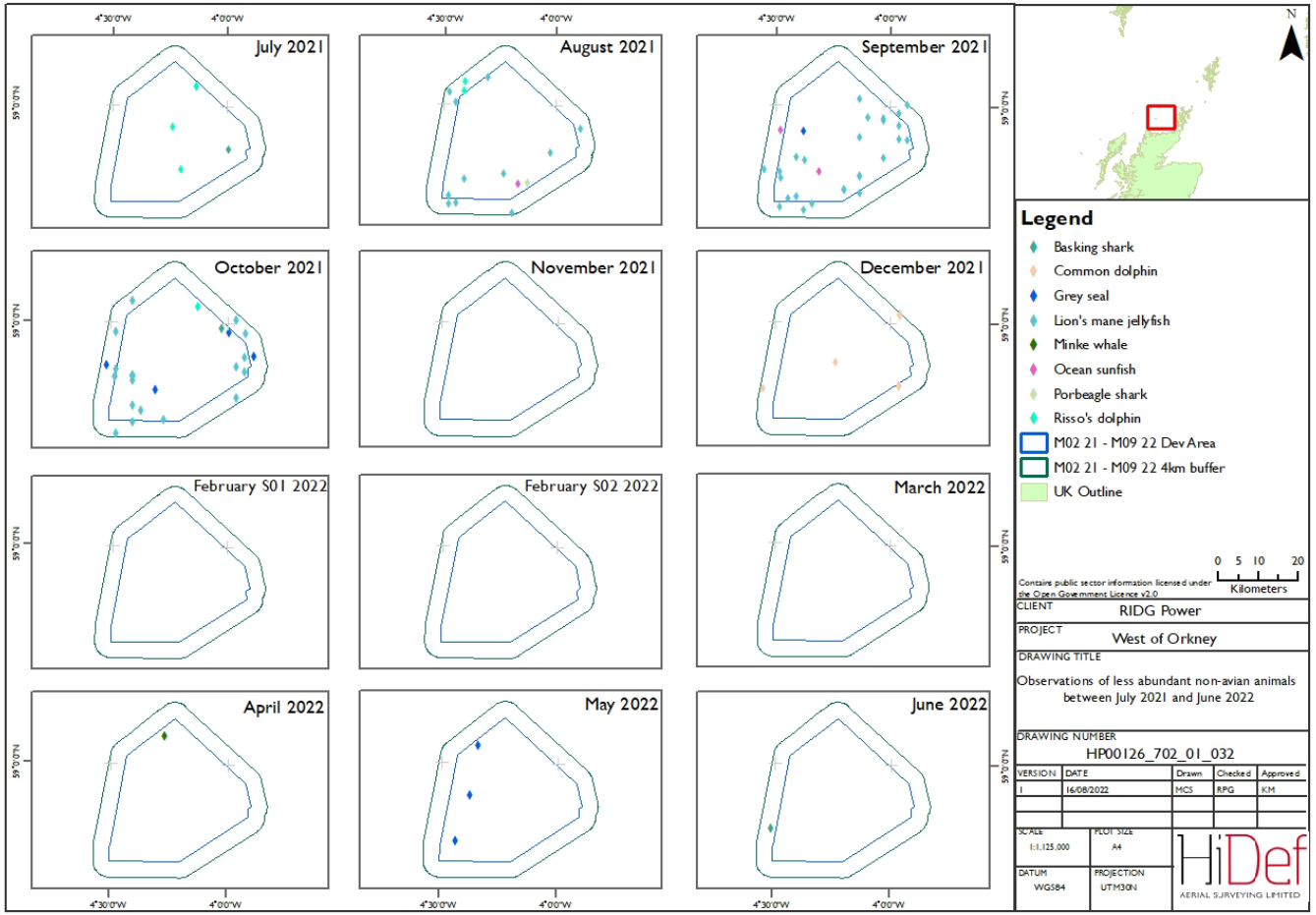
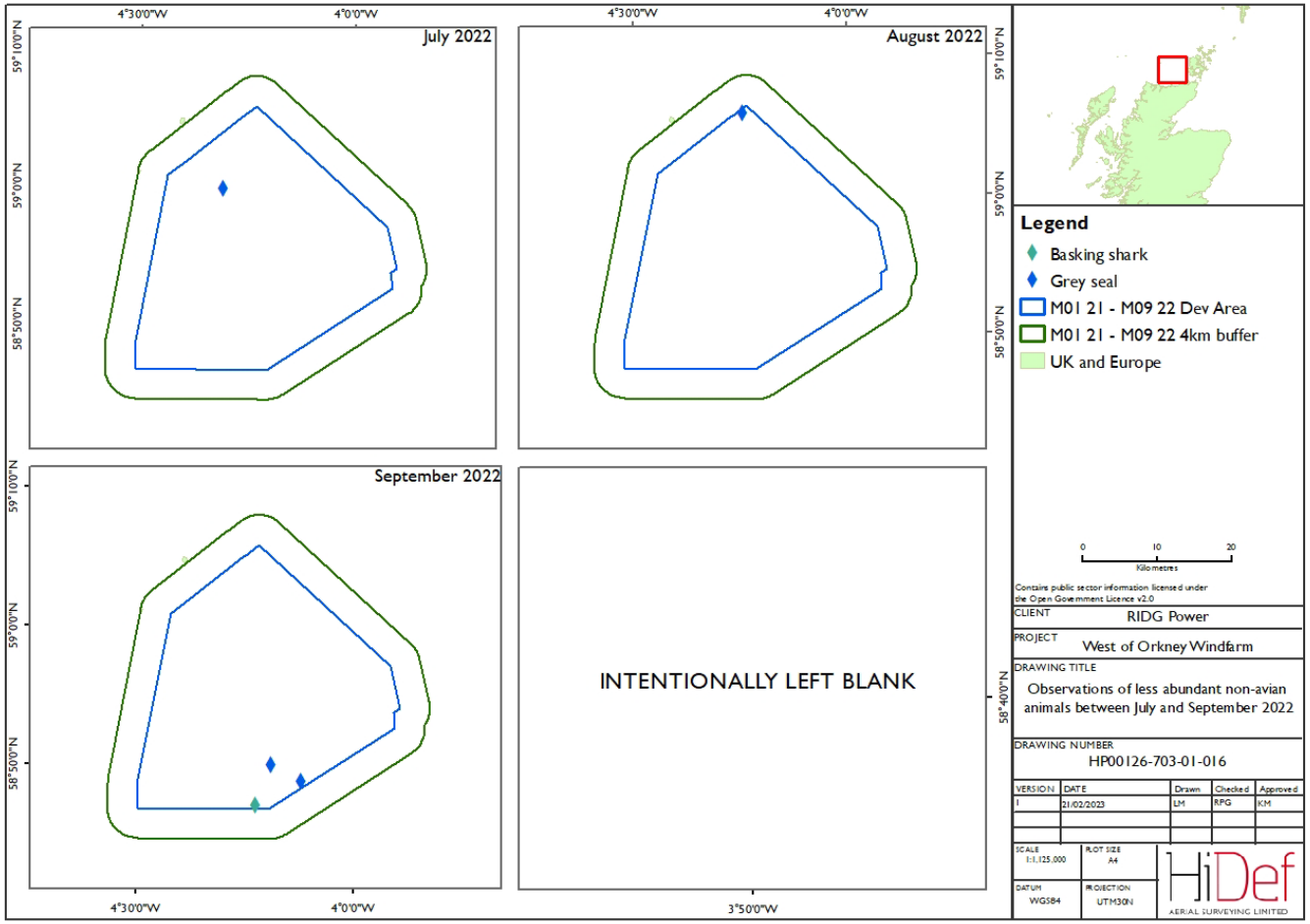


Figure 82 Detections of less abundant non-avian animal species in the WOW survey area between July and September 2022.



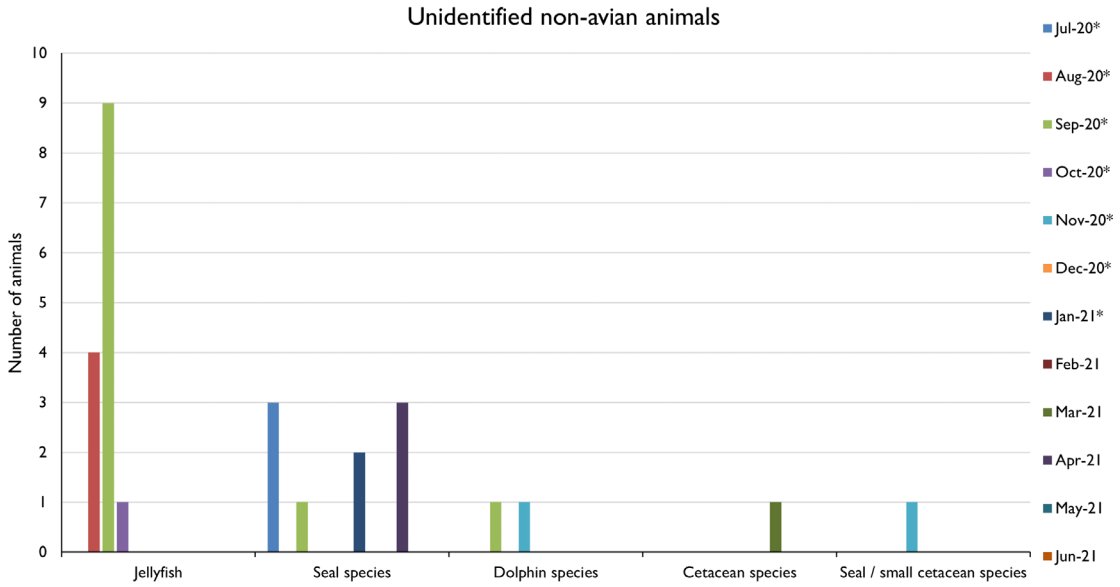
3.3.15 Unidentified non-avian animals

142 Several unidentified non-avian animals were recorded through the survey period, with peaks in non-identification related to seal species (Figure 83; Figure 84). This is primarily related to difficulties differentiating between harbour and grey seals, which can be problematic as females and juveniles of each species overlap in size.

143 Unidentified non-avian animals were generally observed in the south-west of the survey area (Figure 85 to Figure 87).

144 It should be noted a different survey area was flown for the first seven surveys, so counts may not be directly comparable with later surveys.

Figure 83 Number of unidentified non-avian animals recorded within the WOW survey area between July 2020 and June 2021



**Initial survey area – see Figure 1and Figure 2*

Figure 84 **Number of unidentified non-avian animals recorded within the WOW survey area between July 2021 and September 2022**

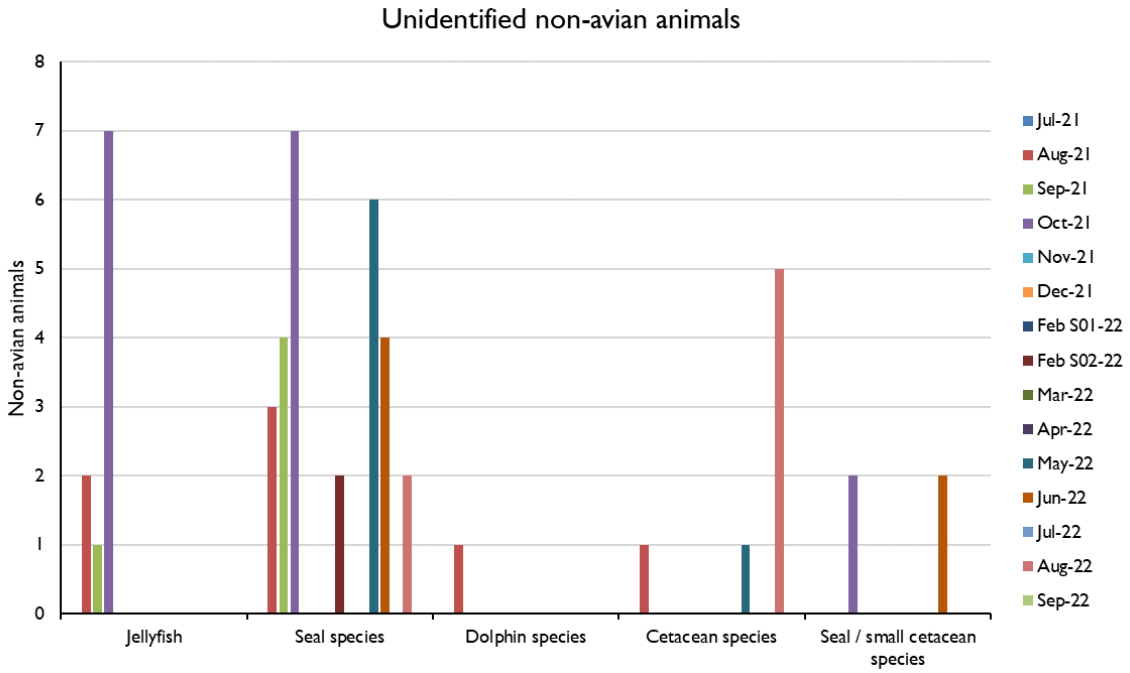


Figure 85 Detections of unidentified non-avian animal species in the WOW survey area between July 2020 and June 2021.

Note: An increase in the development and survey area from February 2021 to September 2022.

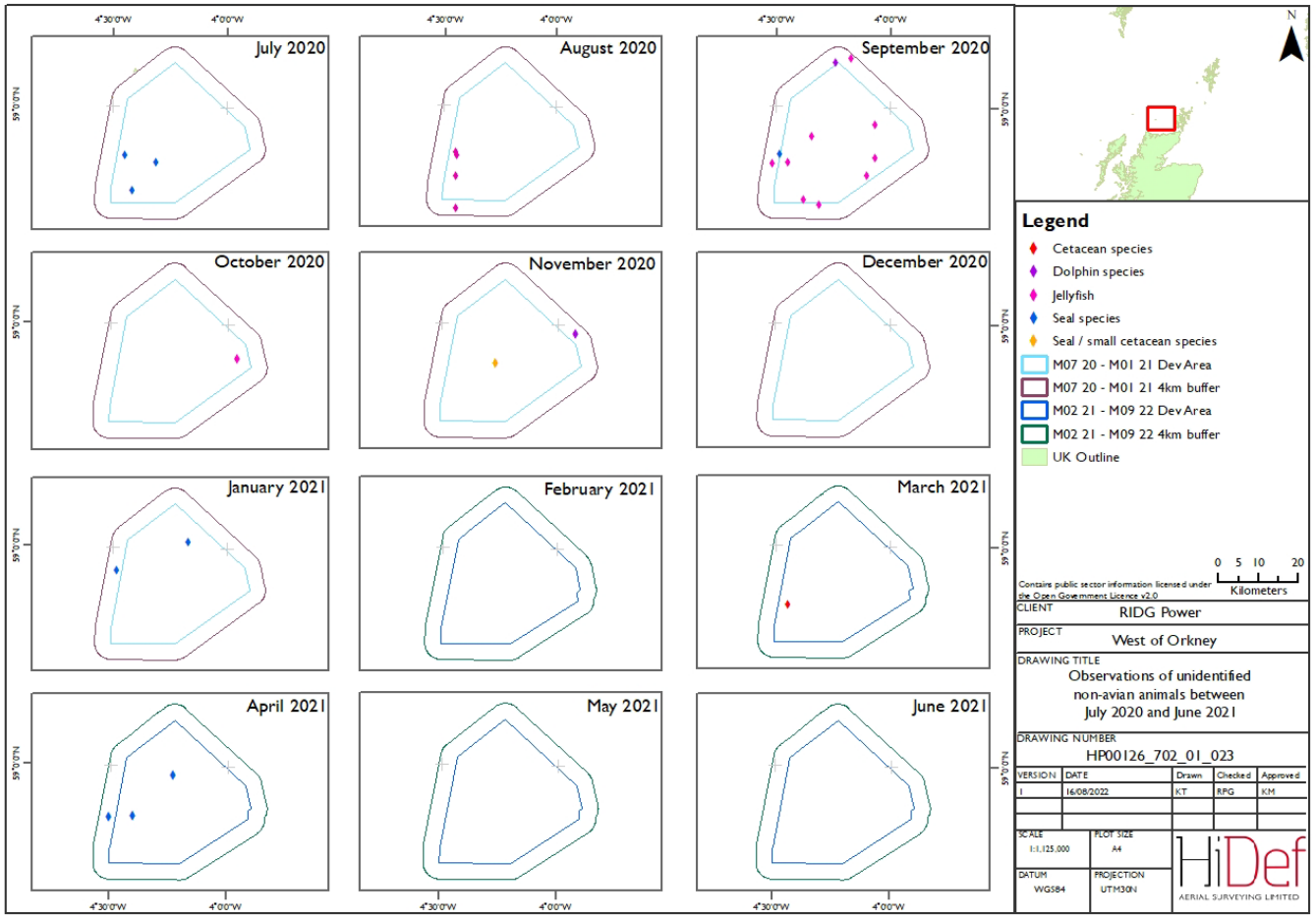
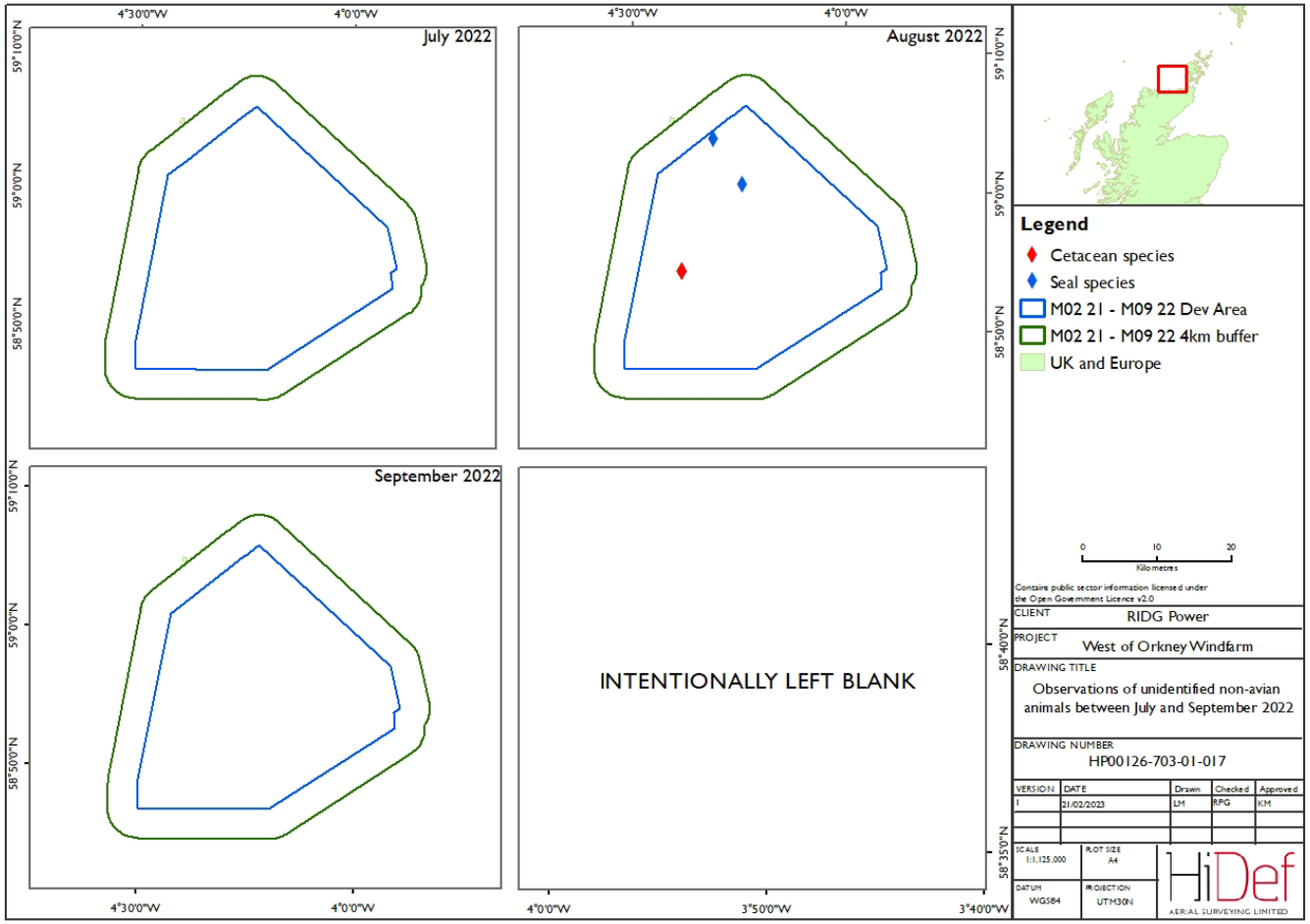


Figure 86 Detections of unidentified non-avian animal species in the WOW survey area between July 2021 and June 2022.

Figure 87 Detections of unidentified non-avian animal species in the WOW survey area between July and September 2022.

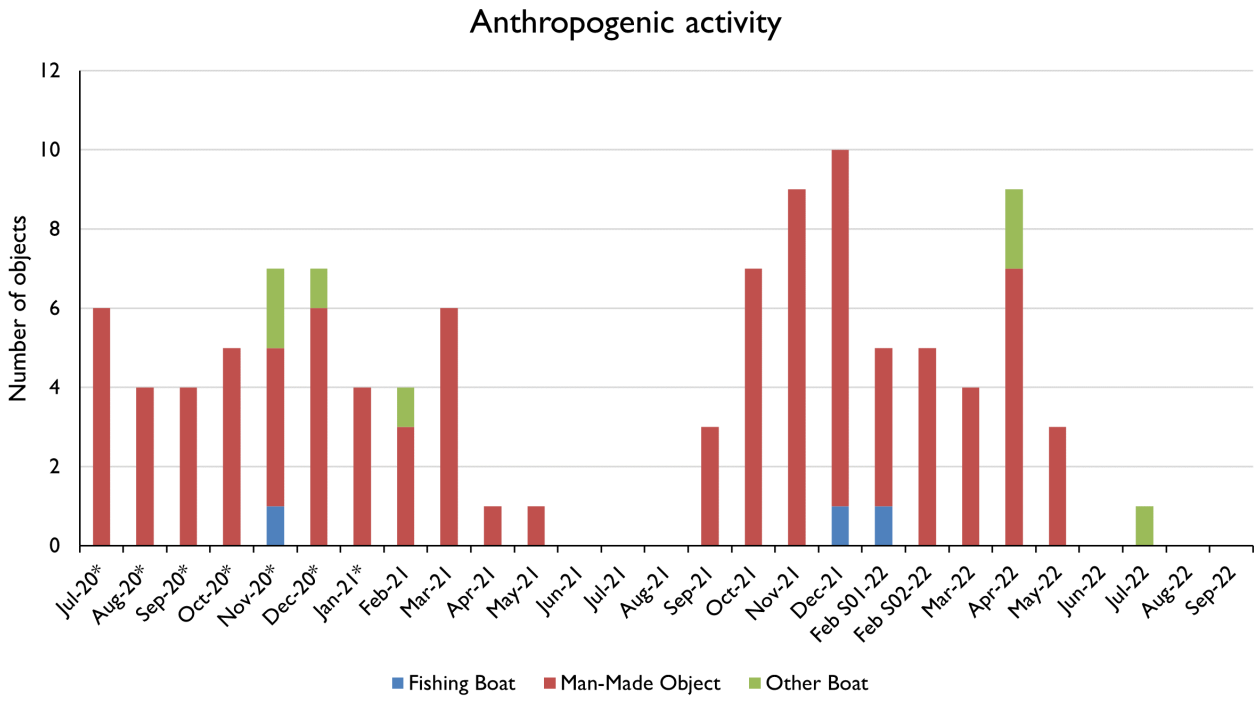


3.3.16 Anthropogenic activity

145 Anthropogenic activity was recorded throughout the survey period (Figure 88). Fishing boats were observed in November 2020, December 2021 and February 2022. 'Other boats' were also recorded intermittently.

146 A total of 95 man-made objects were recorded throughout the survey period, with fishing buoys being the most numerous. Anthropogenic objects were found in both the development area and 4km buffer (Figure 89 to Figure 91). It should be noted a different survey area was flown for the first seven surveys, so counts may not be directly comparable with later surveys.

Figure 88 Number of vessels and anthropogenic objects recorded within the WOW survey area between July 2020 and September 2022



Initial survey area – see Figure 1 and Figure 2

Figure 89 Detections of anthropogenic activity within the WOW survey area between July 2020 and June 2021.

Note: An increase in the development and survey area from February 2021 to September 2022.

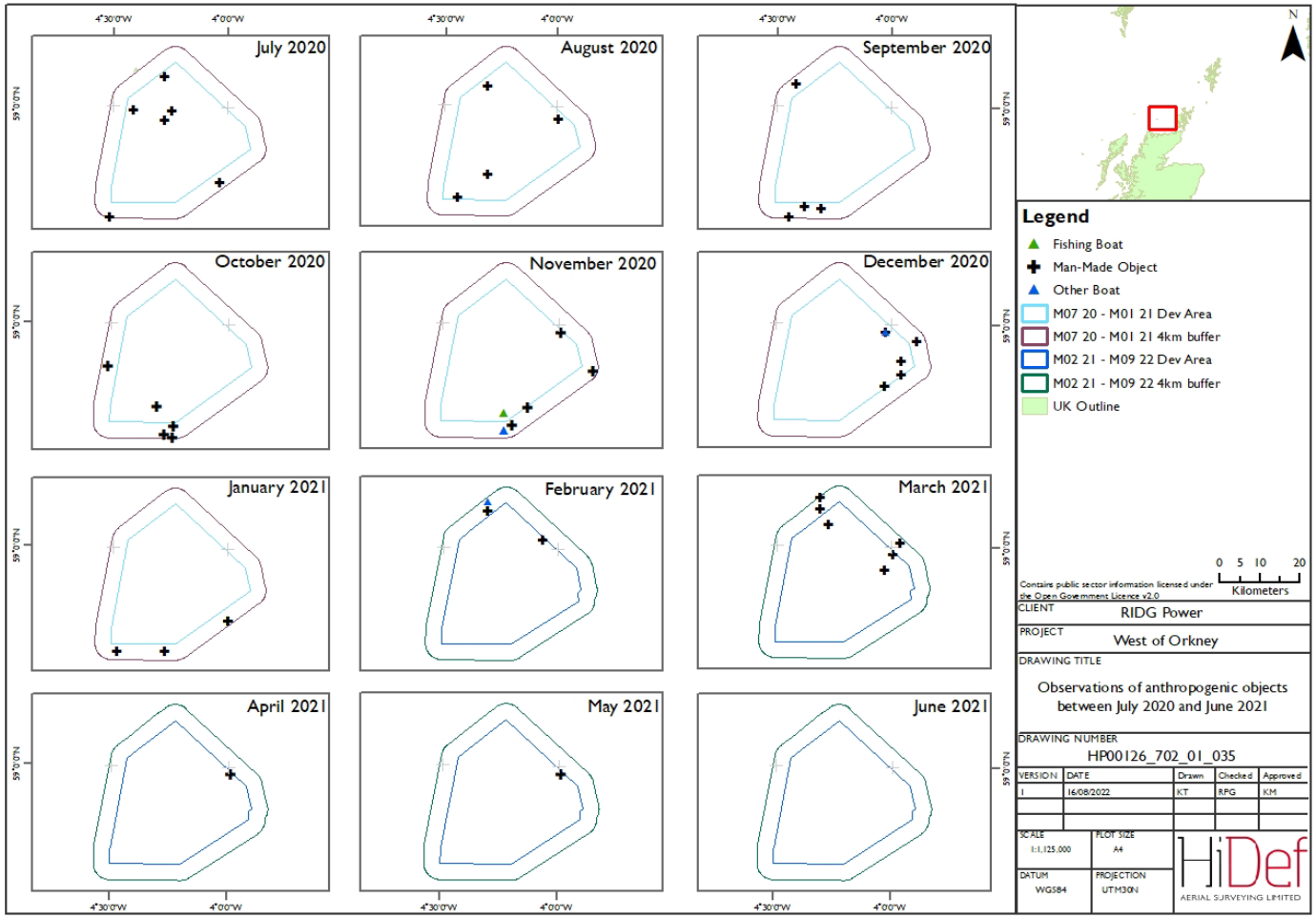


Figure 90 Detections of anthropogenic activity within the WOW survey area between July 2021 and June 2022.

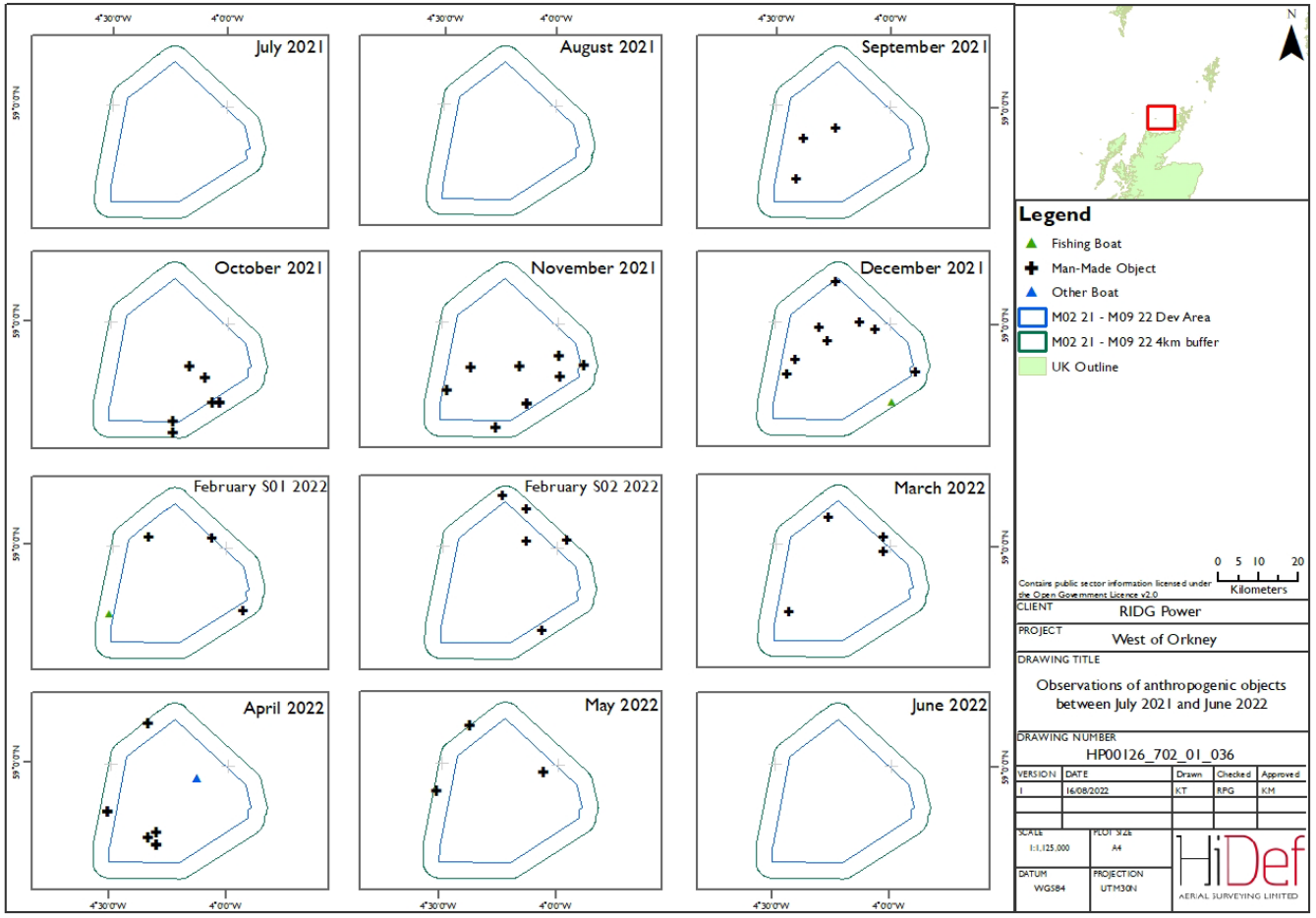
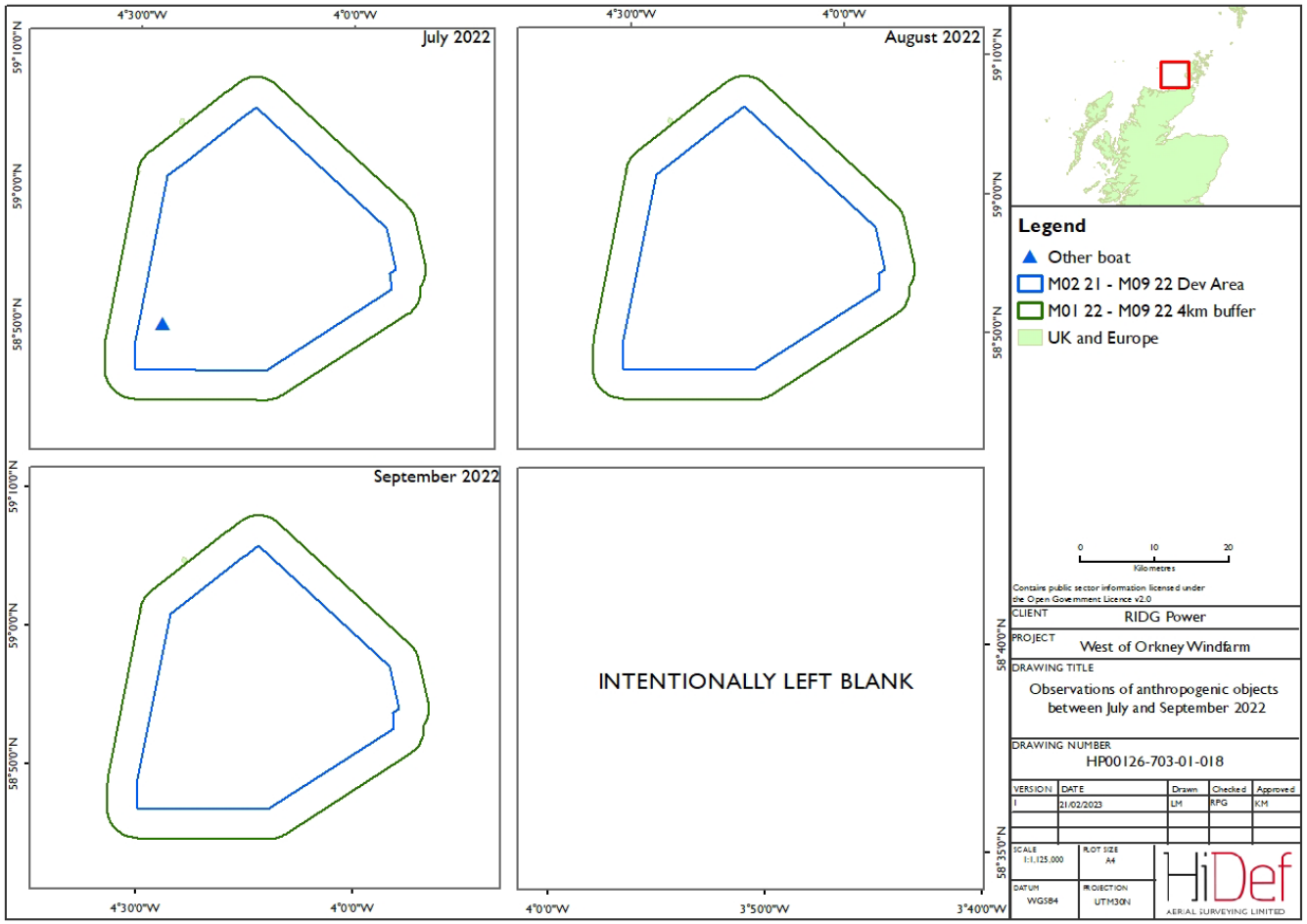


Figure 91 Detections of anthropogenic activity within the WOW survey area between July and September 2022.



4 Discussion

147 The surveys recorded a total of 27,244 birds of 32 species and 414 non-avian animals of 12 species, in addition to 34 dead birds and one dead non-avian animal. A further 915 birds and 77 non-avian animals were recorded which were not assigned to a species. In addition, one bird species was observed as dead. An identification rate to species level of 96.99% was achieved throughout the 27-month period.

148 Kittiwakes were recorded in relatively low numbers during the breeding season, with peaks observed in March and July 2022, coinciding with the autumn post-breeding and spring return migrations. Other peaks were observed in March 2020 and 2021 at the beginning of the breeding season before decreasing over winter. Typically, kittiwakes will be strongly associated with colonies between May and June (Coulson, 2011), with egg-laying occurring in late May, incubation lasting around 25-32 days and chicks fledging around 43 days later approximately at the end of July (Gilbert *et al.*, 2011). The decreasing presence of birds during the breeding season, and particularly the large proportion of flying adults recorded, suggests the area is not intensively used for foraging during incubation or chick-rearing but more heavily utilised by birds moving to their offshore wintering areas. Approximately ten breeding colonies are within the kittiwakes foraging range (mean max 156.1km ±144.5 SD; Woodward *et al.,* 2019), spread across the west of Scotland, northern Scottish coast and Orkney (Furness, 2015) the closest being Sule Skerry and Sule Stack SPA, which overlaps with the 4km buffer.

149 Great black-backed gulls were most abundant during the non-breeding. The species is a qualifying species for the nearby Hoy SPA, indicating the presence of breeding birds close to the survey area. It is possible that the birds recorded in the survey area over the winter period are birds from these colonies which have migrated offshore post-breeding to spend the winter offshore in addition to those migrating from higher latitudes.

150 Guillemots were the most abundant species recorded, with peaks in records generally occurring during the autumn post-moult dispersal period, e.g. July 2022. Higher abundance estimates prior to the start of the breeding season in April 2021 may be attributed to the presence of birds returning to colonies after spending the winter offshore. The peak in July 2022 suggests the site is also utilised by birds beginning to disperse to their winter areas (post-moult dispersal). Multiple SPAs within 30km from the survey area are designated for the protection of breeding and migratory guillemots, including the overlapping Sule Skerry and Sule Stack SPA, which is used by more than 10,000 individuals (in 2018; BTO, 2022) and the North Caithness Cliffs SPA, estimated to hold 1% of the North Atlantic biogeographic population (11,100 individuals in 2016; BTO, 2022).

151 Razorbills were recorded intermittently throughout the 27-month period, peaking in September 2022, during the post-breeding migration. The relatively high density at this time, coupled with the relatively low number of adult-chick pairs, suggests the site is primarily used for post-breeding dispersal to over-wintering areas. Occurrence of the species within the survey area is to be expected since the North Caithness Cliffs SPA (approx. 30km from the survey area) holds approximately 3% of the GB population (NatureScot, 2018), indicating the presence of nearby suitable habitat. Other SPAs of note are Cape Wrath SPA (approx. 30km from the survey area) and further afield, North Rona and Sula Sgeir, West Westray, and Handa SPAs, the later holding 1.9% of the *A. t. islandica* biogeographic population with more than 16,000 individuals recorded using the site (JNCC, 2015h).

152 Puffins were relatively abundant, with relatively high abundance observed during the breeding season. Eggs are laid in mid-April, incubated for 36-45 days, with chicks fledging 38 days after hatching (Gilbert *et al.*, 2011). Marked increases in the number of puffins in May and June coincides with approximate

hatching and may suggest birds are utilising the site to forage during the chick-rearing period. Relatively high numbers from July to September coincide with post-breeding migration as birds disperse from their colonies. Puffins' relatively large foraging range (mean max 137.1km ±128.3 SD; Woodward *et al.,* 2019) means the birds observed are potentially coming from a range of breeding colonies in the North Sea. However, it is likely that many of these individuals are linked to the overlapping Sule Skerry and Sule Stack SPA, which holds more than 47,000 apparently occupied burrows (AOB) in 2018 (BTO, 2022) and 5% of the *F. a. grabae* biogeographic breeding population (JNCC, 2015b).

153 Fulmars were one of the most abundant species, with high abundance generally observed over the non-breeding wintering period. Generally, fulmars move further offshore to spend the winter at sea when there is less requirement to return to coastal breeding colonies as frequently, with many birds travelling back to coastal areas for the breeding season at the start of April (Edwards *et al.,* 2013). High abundance in March could indicate movement back into the area prior to the start of the breeding season. The presence of the species within the survey area is to be expected, with the nearby Hoy SPA supporting 6% of the GB population, in addition to the North Caithness Cliffs SPA which supports around 3% (SNH, 2009a; NatureScot 2018).

154 Gannets were recorded throughout the survey period, with records peaking towards the end of the usual breeding season and into the post-breeding migration period. A total of 32 birds were recorded as dead throughout the survey period. Similar proportions of flying and sitting birds indicates the survey area is utilised for both passage and foraging. Proximity of the survey area to the gannetry located at Sule Skerry and Sule Stack SPA is likely to influence abundance of the species in the survey area, with the area known to support nearly 6,000 pairs, 2.2% of the world biogeographic population (SNH, 2009b). Gannets are wide-ranging (mean max 315.2km ±194.2 SD; Woodward *et al.,* 2019), therefore the gannets observed could have travelled from the numerous breeding colonies present around the survey area, such as those at the North Rona and Sula Sgeir SPA; the Foula SPA; the Fair Isle SPA; or the West Westray SPA (Furness, 2015).

155 European storm petrels and great skuas were recorded intermittently during the breeding season. The Sule Skerry and Sule Stack SPA which overlaps the survey area supports between 1 and 6% of GB population of European storm petrel and the nearby Hoy SPA supports approximately 14% of world biogeographic population of great skua. respectively. Other species such as Arctic terns and great black-backed gulls (qualifying species for the nearby Hoy; Pentland Firth Islands; Rousay; West Westray; Handa and Copinsay SPAs), were recorded. Goose species were observed exclusively in October 2021, such as greylag and pink-footed geese. Multiple shearwater species were also recorded, including Cory's shearwater, Manx shearwater, Great shearwater and Sooty shearwater.

156 Harbour porpoise were the most abundant marine mammal encountered, peaking in September 2021, with an estimated absolute density of 0.75 porpoise/km^2 (43.02% CV). Relative density in July 2020 and July 2021 was estimated at 0.01 porpoise/km^2 and 0.02 porpoise/km^2 respectively, in comparison to a density of 0.308 porpoise/km^2 (27.3% CV) and 0.152 porpoise/km^2 (27.9% CV) from visual aerial surveys within the SCANS-III survey Blocks K and S surveyed in July 2016 (Hammond *et al.,* 2021). As the most common cetacean species present in the North Sea and wider UK waters (Hammond *et al.,* 2021), it is not unexpected that this species was the most abundant non-avian animal recorded.

157 White-beaked dolphins were the second most abundant marine mammal species recorded. Evans *et al.* (2011) noted that peak sightings of this species in northern Scotland occur between June and October, although they have been recorded year-round. Data from this report indicate the species is relatively abundant over winter, e.g. February 2022. During the survey period, the peak estimated density was 0.15 dolphins/km^2 (55.50% CV; February 2022). However, in July 2021, relative estimated density was

0.01 dolphins/km^2 (91% CV) compared to a mean density of 0.21 dolphins/km^2 (52.9% CV) and 0.02 dolphins/km^2 (69.0% CV) from visual aerial data collected in SCANS-III survey Blocks K and S respectively (which overlap the survey area), surveyed in July 2016 (Hammond *et al.*, 2021).

158 An additional ten non-avian animal species were recorded during the survey period including 94 lion's mane jellyfish, 42 common dolphins and 19 Risso's dolphins. Anthropogenic activity was also recorded in the majority of surveys with fishing buoys being the most numerous.

5 Conclusions

159 The provision of high-resolution digital aerial video surveys provided spatial distributions of marine birds, marine mammals and other marine megafauna in the WOW project area, off the west coast of Orkney, Scotland. The survey design allowed repeatable estimates of species abundance, and the digital aerial platform provided a unique, auditable record of species detections.

160 The surveys recorded a total of 27,244 birds of 32 species and 414 non-avian animals of 12 species, in addition to 34 dead birds and one dead non-avian animal. A further 915 birds and 77 non-avian animals were recorded which were not assigned to a species. In addition, one bird species was observed as dead. An identification rate to species level of 96.99% was achieved throughout the 27-month period.

161 The changes in the numbers of seabirds recorded across the wider avian breeding season is consistent with the project's proximity to seabird breeding colonies in along the islands and coastline of north Scotland, such as those at Sule Skerry and Sule Stack SPA and Hoy SPA. Several seabird species appear to also use the area during the non-breeding season including great black-backed gull and fulmar.

162 Marine mammal abundance of marine mammals varied, with white-beaked dolphin and harbour porpoise being the most numerous.

6 References

Barlow, J, Oliver, C.W., Jackson, T.D. and Taylor, B.L. (1988). Harbour porpoise *Phocoena phocoena*, abundance estimation for California, Oregon and Washington: II. *Fishery Bulletin*, 86, 433-444.

Borchers, D.L., Buckland, S.T. and Zucchini, W. (2002). *Estimating Animal Abundance: Closed Populations.* Springer, Berlin.

Buckland, S.T., Anderson, D.R., Burnham, K. P., Laake, J.L., Borchers, D.L. and Thomas, L. (2001). *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford University Press, Oxford.

Coulson, J.C. (2011). *The kittiwake.* London: T. & A.D. Poyser.

Edwards, E.W., Quinn, L.R., Wakefield, E.D., Miller, P.I. and Thompson, P.M. (2013_. Tracking a northern fulmar from a Scottish nesting site to the Charlie-Gibbs Fracture Zone: Evidence of linkage between coastal breeding seabirds and Mid-Atlantic Ridge feeding sites. *Deep Sea Research Part II: Topical Studies in Oceanography*, 98, 438-444.

Evans, P.G.H., Baines, M.E. and Coppock, J. (2011). *Abundance and behaviour of cetaceans and basking sharks in the Pentland Firth and Orkney Waters.* Scottish Natural Heritage Commissioned Report No.419.

Furness, R.W. (2015). *Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS).* Natural England Commissioned Reports, No.164.

Gilbert, G., Gibbons, D.W. and Evans, J. (2011). *Bird Monitoring Methods: A Manual of Techniques for UK Key Species*. The Royal Society for the protection of Birds, Sandy, Bedfordshire, England.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., *et al.* (2021). *Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys*. SCANS-III Report.

HiDef (2021) HiDef Transect Aerial Survey Method for Ornithological and Marine Mammal Surveys. HA10003_HiDef method_FINAL_v7.

JNCC. (2015a). *Natura 2000 - Stand Data Form – Cape Wrath SPA – UK9001231*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9001231.pdf. Accessed 29/04/2022.

JNCC. (2015b). *Natura 2000 - Stand Data Form – Sule Skerry and Sule Stack SPA – UK9002181*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9002181.pdf. Accessed 29/04/2022.

JNCC. (2015c). *Natura 2000 - Stand Data Form – Hoy SPA – UK9002141*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9002141.pdf. Accessed 29/04/2022.

JNCC. (2015d). *Natura 2000 - Stand Data Form – Auskerry SPA – UK9002381*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9002381.pdf. Accessed 29/04/2022.

JNCC. (2015e). *Natura 2000 - Stand Data Form – North Rona and Sula Sgeir SPA – UK9001011*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9001011.pdf. Accessed 29/04/2022.

JNCC. (2015f). *Natura 2000 - Stand Data Form – Pentland Firth Islands SPA – UK9001131*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9001131.pdf. Accessed 29/04/2022.

JNCC. (2015g). *Natura 2000 - Stand Data Form – West Westray SPA – UK9002101*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9002101.pdf. Accessed 29/04/2022.

JNCC. (2015h). *Natura 2000 - Stand Data Form – Handa SPA – UK9001241*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9001241.pdf. Accessed 29/04/2022.

JNCC. (2015i). *Natura 2000 - Stand Data Form – Copinsay SPA – UK9002151*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9002151.pdf. Accessed 29/04/2022.

JNCC. (2015j). *Natura 2000 - Stand Data Form – Fair Isle – UK9002091*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9002091.pdf. Accessed 29/04/2022.

JNCC. (2015k). *Natura 2000 - Stand Data Form – Foula SPA – UK9002061*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9002061.pdf. Accessed 29/04/2022.

JNCC. (2015l). *Natura 2000 - Stand Data Form – North Ronna SAC – UK0012696*. [Online]. https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0012696.pdf. Accessed 29/04/2022.

JNCC. (2015m). *Natura 2000 - Stand Data Form – Faray and Holm of Faray SAC – UK0017096*. [Online]. https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0017096.pdf. Accessed 29/04/2022.

JNCC. (2015n). *Natura 2000 - Stand Data Form – Sanday SAC – UK0030069*. [Online]. https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0030069.pdf. Accessed 29/04/2022.

JNCC. (2015o). *Natura 2000 - Stand Data Form – Moray Frith SAC – UK0019808*. [Online]. https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0019808.pdf. Accessed 29/04/2022.

JNCC. (2018a). *Natura 2000 - Stand Data Form – Caithness and Sutherland Peatlands SPA* – UK9001151. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9001151.pdf. Accessed 29/04/2022.

JNCC. (2019a). *Natura 2000 - Stand Data Form – Rousay SPA – UK9002371*. [Online]. https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9002371.pdf. Accessed 29/04/2022.

JNCC. (2019b). *Natura 2000 - Stand Data Form – Inner Hebrides and the Minches SAC – UK0030393*. [Online]. https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0030393.pdf. Accessed 29/04/2022.

NatureScot. (2018). *Citation For Special Protection Area (SPA) Site Description: North Caithness Cliffs (UK9001181) With Marine Extension*. NatureScot.

Scottish Natural Heritage (SNH). (2009a). *Citation For Special Protection Area (SPA) Site Description: Hoy (UK9002141) Including Marine Extension.* Scottish Natural Heritage.

Scottish Natural Heritage (SNH). (2009b). *Citation For Special Protection Area (SPA) Site Description: Sule Skerry and Sule Stack (UK9002181) Including Marine Extension.* Scottish Natural Heritage.

Simonoff, J. S. (1996). *Smoothing Methods in Statistics*. Springer, London.

Spencer, S.M. (2012). *Diving behavior and identification of sex of breeding Atlantic puffins (Fratercula arctica), and nest-site characteristics of Alcids on Petit Manan Island, Maine*. MS thesis, University of Massachusetts Amherst, Amherst, MA.

Teilmann, J., Christiansen, C.T., Kjellerup, S., Dietz, R. and Nachmann, G. (2013). Geographic, seasonal, and diurnal surface behavior of harbor porpoises. *Marine Mammal Science*, 29, 60-76.

Thaxter, C.B., Ross-Smith, V.H. and Cook, A.S.C.P. (2016). *How high do birds fly? A review of current datasets and an appraisal of current methodologies for collecting flight height data: Literature review.* BTO Research Report No. 666.

Thaxter, C.B., Wanless, S., Daunt, F., Harris, M.P., Benvenuti, S., Watanuki, Y., Grémillet, D. and Hamer, K.C. (2010). Influence of wing loading on the trade-off between pursuit-diving and flight in common guillemots and razorbills. *The Journal of Experimental Biology*, 213, 1018-1025.

Woodward, I., Thaxter, C. B., Owen, E. and Cook, A. S. C. P. (2019). *Desk-based revision of seabird foraging ranges used for HRA screening.* BTO research report No. 724.

Xodus. (2022). The West of Orkney Windfarm – Scoping Report. No: L-100632-S02-REPT-001.

Appendix I: Density and population estimates

163 The density, total estimated population, upper and lower 95% CLs, standard deviation and CV for each species and species group have been calculated using strip transect analysis and are presented here for each of the surveys undertaken.

Table 33 Density and population estimates of species groups in the WOW survey area during Survey 1 on 22 July 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	8.73	11210	8198	14856	1715	15.30
All non-avian animals	0.18	231	118	359	64	27.56
Species group						
Small gull species	0.25	324	119	688	149	45.82
Skua species	0.02	25	0	63	17	70.53
Skua species excluding great	0.01	9	0	24	9	94.04
Large auk	3.27	4198	2836	5893	780	18.58
Auk species	2.89	3710	2139	6032	1018	27.44
Fulmar / gull species	1.42	1820	1323	2351	264	14.50
Gannet species	0.88	1131	409	2193	471	41.61
Jellyfish	0.15	191	92	310	59	30.44
Seal species	0.02	25	0	48	13	50.97
Cetacean species	0.01	17	0	48	17	96.89

Table 34 Density and population estimates of species in the WOW survey area during Survey 1 on 22 July 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.24	314	115	631	144	45.92
Great skua	0.02	25	0	64	18	72.57
Arctic skua	0.01	9	0	31	8	94.82
Guillemot	3.26	4182	2985	5790	719	17.18
Razorbill	0.01	16	0	48	16	94.28
Puffin	2.93	3764	2090	5934	1025	27.23
Fulmar	1.41	1816	1307	2311	263	14.44
Gannet	0.90	1162	429	2212	472	40.57
Lion's mane jellyfish	0.15	193	88	310	57	29.22
Harbour porpoise	0.01	17	0	48	17	98.92

Table 35 Density and population estimates of species groups in the WOW survey area during Survey 2 on 06 August 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	7.26	9327	5890	14751	2343	25.11
All non-avian animals	0.09	122	40	222	46	37.57
Species group						
Small gull species	0.27	353	253	460	53	14.81
Gull species	0.01	8	0	24	8	95.57
Arctic / common tern	0.01	16	0	46	12	71.62
Tern / small gull species	0.01	16	0	40	11	66.56
Skua species	0.23	299	16	849	256	85.49
Large auk	1.19	1533	1151	1915	198	12.88
Small auk	0.01	8	0	24	8	98.88
Auk species	2.15	2758	2068	3498	368	13.32
Auk / shearwater species	0.01	8	0	24	8	100.84
Storm-petrel species	0.01	8	0	24	8	102.90
Fulmar / gull species	1.58	2025	728	3871	833	41.13
Gannet species	1.67	2147	467	5344	1522	70.87
Jellyfish	0.06	83	16	168	40	48.13
Cetacean species	0.03	34	0	78	21	61.55

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Seal / small cetacean species	0.01	9	0	30	9	98.73

Table 36 Density and population estimates of species in the WOW survey area during Survey 2 on 06 August 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.29	370	266	477	56	14.98
Common tern	0.01	16	0	47	12	75.76
Great skua	0.24	309	16	849	261	84.27
Guillemot	1.23	1584	1227	2026	205	12.90
Razorbill	0.02	24	1	63	18	72.43
Puffin	2.08	2677	1953	3407	365	13.64
European Storm-Petrel	0.01	8	0	24	8	94.26
Fulmar	1.56	2008	667	3876	833	41.45
Gannet	1.65	2113	465	5290	1491	70.54
Barrel jellyfish	0.01	13	0	38	13	98.34
Lion's mane jellyfish	0.05	68	16	130	30	43.93
Harbour porpoise	0.03	41	0	86	22	52.95

Table 37 Density and population estimates of species groups in the WOW survey area during Survey 3 on 24 September 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	8.67	11404	9893	13025	811	7.10
All non-avian animals	0.33	428	283	593	81	18.77
Species group						
Wader species	0.03	40	0	100	27	67.33
Small gull species	0.12	159	40	309	69	43.16
Large auk	3.85	5064	4331	5793	377	7.44
Auk species	2.42	3189	2191	4253	527	16.51
Storm-petrel species	0.10	134	16	331	89	66.38
Fulmar / gull species	0.88	1164	874	1456	149	12.76
Shearwater species	0.01	8	0	24	8	96.36
Gannet species	1.27	1669	1306	2119	213	12.72
Jellyfish	0.16	217	123	331	55	25.13
Fish species	0.01	16	0	39	11	67.44
Seal species	0.03	41	8	84	20	47.54
Cetacean species	0.12	157	40	308	69	43.60

Table 38 Density and population estimates of species in the WOW survey area during Survey 3 on 24 September 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Golden plover	0.03	39	0	119	38	98.65
Kittiwake	0.04	50	8	96	23	46.22
Little gull	0.01	9	0	24	8	92.59
Guillemot	3.82	4906	3638	6552	751	15.30
Razorbill	0.08	106	57	163	27	25.57
Puffin	0.19	239	160	325	42	17.23
European Storm-Petrel	0.07	85	0	262	87	102.12
Fulmar	2.72	3500	1071	7806	1901	54.32
Manx shearwater	0.01	16	0	39	11	66.64
Gannet	1.44	1855	1584	2152	149	8.01
Lion's mane jellyfish	0.09	111	61	179	31	27.91
Ocean sunfish	0.01	8	0	24	8	98.38
Grey seal	0.01	17	0	40	11	64.89
Common dolphin	0.03	33	0	100	30	91.43
Risso's dolphin	0.03	45	0	116	33	72.56
Bottlenose dolphin	0.01	9	0	31	8	90.41
Harbour porpoise	0.03	33	0	95	30	92.29

Table 39 Density and population estimates of species groups in the WOW survey area during Survey 4 on 22 October 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	8.55	10977	7405	15245	2072	18.87
All non-avian animals	0.08	105	24	213	48	45.51
Species group						
Small gull species	1.26	1623	1199	2075	225	13.82
Black-backed gull species	0.02	32	0	87	25	76.14
Skua species	0.01	8	0	24	8	94.23
Large auk	3.20	4107	2339	6312	1032	25.12
Auk species	0.21	268	171	383	55	20.39
Auk / small gull	0.01	16	0	48	17	103.97
Diver species	0.01	17	0	40	11	63.46
Fulmar / gull species	2.99	3837	1811	6788	1322	34.44
Gannet species	0.89	1144	830	1491	172	15.02
Jellyfish	0.01	16	0	39	11	65.22
Seal species	0.01	9	0	24	8	95.27
Dolphin species	0.06	78	0	184	48	62.05

Table 40 Density and population estimates of species in the WOW survey area during Survey 4 on 22 October 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	1.27	1625	1233	2033	208	12.79
Great black-backed gull	0.02	32	0	86	25	76.97
Great skua	0.01	9	0	24	8	93.34
Guillemot	3.16	4059	2224	6182	1009	24.85
Puffin	0.16	208	139	283	37	17.50
Red-throated diver	0.01	9	0	24	8	95.00
Great northern diver	0.01	8	0	24	8	100.06
Fulmar	2.92	3756	1738	6601	1310	34.86
Gannet	0.90	1152	815	1539	186	16.13
Lion's mane jellyfish	0.01	17	0	39	11	66.67
Grey seal	0.01	8	0	24	8	94.90
Common dolphin	0.05	67	0	174	49	72.55
Risso's dolphin	0.01	16	0	48	16	95.24

Table 41 Density and population estimates of species groups in the WOW survey area during Survey 5 on 28 November 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	2.59	3324	2148	4896	693	20.84
All non-avian animals	0.02	25	0	63	17	69.69
Species group						
Small gull species	0.20	254	162	358	49	19.26
Black-backed gull species	0.09	121	48	206	41	34.09
Large gull species	0.05	64	16	140	33	51.54
Skua species	0.01	8	0	24	8	97.70
Large auk	0.49	626	420	878	116	18.51
Auk species	0.09	122	54	201	40	32.14
Fulmar / gull species	1.61	2066	1080	3443	611	29.54
Gannet species	0.04	48	16	88	20	41.83
Dolphin species	0.01	9	0	24	8	95.71
Cetacean species	0.01	8	0	24	8	95.85
Seal / small cetacean species	0.01	9	0	24	8	92.98

Table 42 Density and population estimates of species in the WOW survey area during Survey 5 on 28 November 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.20	253	159	355	51	19.87
Great black-backed gull	0.12	153	63	258	50	32.43
Herring gull	0.02	33	0	71	19	56.21
Great skua	0.01	8	0	24	8	100.93
Guillemot	0.54	692	496	938	111	15.95
Razorbill	0.01	9	1	25	8	92.30
Puffin	0.04	49	16	87	19	39.14
Fulmar	1.60	2056	1043	3371	600	29.14
Gannet	0.04	49	16	88	20	40.32
Harbour porpoise	0.01	9	0	24	8	90.38

Table 43 Density and population estimates of species groups in the WOW survey area during Survey 6 on 15 December 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	4.64	5954	3524	9373	1494	25.08
All non-avian animals	0.03	42	0	118	32	75.70
Species group						
Small gull species	0.10	134	48	249	52	38.10
Black-backed gull species	0.06	82	31	149	31	37.29
Large auk	0.86	1104	711	1572	222	20.07
Auk species	0.01	8	0	24	8	97.13
Fulmar / gull species	3.50	4501	2235	7160	1299	28.85
Gannet species	0.06	72	8	172	44	60.34
Seal species	0.01	8	0	24	8	91.36
Dolphin species	0.02	31	0	94	29	92.47

Table 44 Density and population estimates of species in the WOW survey area during Survey 6 on 15 December 2020

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.11	145	56	254	51	35.02
Great black-backed gull	0.06	81	24	144	30	37.20
Guillemot	0.87	1120	715	1579	223	19.89
Fulmar	3.44	4420	2479	7259	1261	28.53
Gannet	0.06	74	8	175	44	59.43
Grey seal	0.01	8	0	24	8	92.28
White-beaked dolphin	0.02	32	0	95	31	94.14

Table 45 Density and population estimates of species groups in the WOW survey area during Survey 7 on 04 January 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	3.88	4978	3747	6411	672	13.49
All non-avian animals	0.03	33	0	71	18	54.59
Species group						
Small gull species	0.10	124	54	220	45	36.48
Black-backed gull species	0.07	87	31	156	32	36.15
Large gull species	0.01	16	0	40	11	69.8
Large auk	1.26	1620	1287	1991	186	11.44
Auk species	0.11	144	72	224	41	28.35
Fulmar / gull species	2.33	2986	1991	4126	554	18.53
Gannet species	0.02	33	0	71	18	54.83
Seal species	0.01	16	0	39	11	65.32
Dolphin species	0.01	8	0	24	8	96.34
Cetacean species	0.01	8	0	24	8	95.53

Table 46 Density and population estimates of species in the WOW survey area during Survey 7 on 04 January 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.09	120	48	214	44	36.63
Great black-backed gull	0.07	89	38	155	32	35.46
Herring gull	0.01	17	0	40	11	64.16
Guillemot	1.32	1696	1332	2090	190	11.15
Puffin	0.06	72	36	115	21	28.84
Fulmar	2.31	2962	1989	4145	555	18.74
Gannet	0.03	33	0	72	18	53.79
White-beaked dolphin	0.01	9	0	24	8	91.64
Harbour porpoise	0.01	8	0	24	8	95.97

Table 47 Density and population estimates of species groups in the WOW survey area during Survey 8 on 27 February 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	3.12	4098	3172	5189	537	13.10
All non-avian animals	0.03	40	0	101	27	65.83
Species group						
Small gull species	0.23	299	168	431	68	22.66
Black-backed gull species	0.17	225	24	586	161	71.53
Large gull species	0.03	40	0	120	39	97.49
Gull species	0.01	8	0	24	8	99.26
Large auk	2.16	2839	2045	3803	458	16.13
Small auk	0.01	8	0	24	8	97.34
Auk species	0.04	48	8	103	26	52.69
Large auk / diver species	0.01	16	0	40	11	65.16
Fulmar / gull species	0.38	497	368	624	65	13.01
Gannet species	0.08	111	48	181	36	31.66
Seal species	0.01	8	0	24	8	98.61
Cetacean species	0.02	33	0	77	19	58.98

Table 48 Density and population estimates of species in the WOW survey area during Survey 8 on 27 February 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.22	293	175	421	66	22.44
Great black-backed gull	0.19	250	32	617	175	69.92
Herring gull	0.01	9	0	24	8	92.93
Little auk	0.02	24	0	57	16	64.49
Guillemot	2.11	2771	1973	3829	491	17.69
Razorbill	0.06	82	25	155	35	42.02
Puffin	0.02	25	4	48	12	45.61
Fulmar	0.38	496	369	622	65	12.97
Gannet	0.09	112	48	185	36	31.42
Grey seal	0.01	8	0	24	8	101.51
Harbour porpoise	0.02	32	0	72	19	58.69

Table 49 Density and population estimates of species groups in the WOW survey area during Survey 9 on 15 March 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	5.64	7423	6340	8535	553	7.44
All non-avian animals	0.07	86	24	166	37	42.84
Species group						
Small gull species	1.22	1605	877	2497	427	26.59
Black-backed gull species	0.02	32	8	63	15	45.80
Large gull species	0.02	25	0	54	13	51.25
Large auk	2.98	3926	3268	4665	367	9.33
Auk species	0.05	72	15	152	36	50.07
Auk / small gull	0.01	16	0	39	11	67.33
Fulmar / gull species	1.20	1582	1144	2115	253	15.99
Gannet species	0.12	161	85	253	44	26.95
Jellyfish	0.01	8	0	24	8	96.16
Shark species	0.01	9	0	24	8	94.41
Dolphin species	0.02	23	0	71	22	95.09
Cetacean species	0.04	49	0	119	32	65.00

Table 50 Density and population estimates of species in the WOW survey area during Survey 9 on 15 March 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	1.26	1660	906	2645	447	26.90
Great black-backed gull	0.04	48	16	86	18	36.24
Herring gull	0.01	8	0	24	8	101.14
Guillemot	2.93	3848	3182	4576	355	9.20
Razorbill	0.10	136	56	225	43	31.63
Fulmar	1.16	1526	1109	2049	251	16.41
Gannet	0.12	160	80	245	43	26.47
Barrel jellyfish	0.01	9	0	24	8	92.38
Basking shark	0.01	8	0	24	8	95.77
White-beaked dolphin	0.02	25	0	72	24	97.66
Harbour porpoise	0.04	48	8	120	31	63.76

Table 51 Density and population estimates of species groups in the WOW survey area during Survey 10 on 21 April 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	9.51	12567	10684	14768	1085	8.63
All non-avian animals	0.21	272	157	416	69	25.36
Species group						
Small gull species	0.53	704	503	942	113	15.99
Skua species	0.05	72	39	111	19	25.08
Large auk	6.36	8406	6757	10197	884	10.51
Auk species	1.59	2104	1564	2725	304	14.42
Auk / small gull	0.01	9	0	31	9	97.21
Large auk / diver species	0.01	8	0	24	8	98.92
Fulmar / gull species	0.42	559	298	964	179	32.04
Gannet species	0.50	662	488	859	95	14.34
Cormorant / shag	0.02	25	0	48	13	50.76
Jellyfish	0.01	9	0	24	8	93.82
Seal species	0.02	33	8	63	15	43.91
Dolphin species	0.04	48	0	112	29	60.50
Cetacean species	0.14	190	95	291	51	26.68

Table 52 Density and population estimates of species in the WOW survey area during Survey 10 on 21 April 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.53	700	482	948	118	16.73
Common gull	0.01	8	0	25	8	99.80
Great skua	0.05	73	40	109	18	24.77
Guillemot	6.21	8200	6639	10058	860	10.48
Razorbill	0.13	178	104	266	42	23.57
Puffin	1.60	2109	1556	2708	304	14.40
Fulmar	0.42	558	288	988	187	33.47
Gannet	0.51	668	506	858	90	13.46
Shag	0.02	25	8	48	13	50.81
Barrel jellyfish	0.01	8	0	24	8	98.18
Grey seal	0.02	32	8	62	15	44.74
Minke whale	0.01	17	0	40	11	64.97
Risso's dolphin	0.03	41	0	101	27	66.14
Harbour porpoise	0.13	177	81	280	53	29.52

Table 53 Density and population estimates of species groups in the WOW survey area during Survey 11 on 20 May 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	1.88	2479	1795	3316	400	16.13
All non-avian animals	0.01	8	0	24	8	100.32
Species group						
Wader species	0.02	31	0	95	31	101.00
Small gull species	0.06	77	0	205	59	77.28
Large gull species	0.01	16	0	48	16	98.94
Skua species	0.02	24	0	54	13	53.41
Large auk	0.54	706	339	1166	219	31.00
Auk species	0.39	519	269	814	144	27.64
Diver species	0.01	9	0	24	8	92.41
Fulmar / gull species	0.19	255	133	398	68	26.45
Gannet species	0.65	849	578	1119	138	16.17

Table 54 Density and population estimates of species in the WOW survey area during Survey 11 on 20 May 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.06	80	0	209	61	75.88
Herring gull	0.01	17	0	48	16	93.83
Great skua	0.02	25	0	54	14	54.65
Guillemot	0.52	680	318	1201	229	33.68
Razorbill	0.02	25	0	65	18	70.99
Puffin	0.40	525	276	823	142	27.01
Great northern diver	0.01	8	0	24	8	92.06
Fulmar	0.19	254	136	385	67	26.24
Gannet	0.64	847	586	1134	140	16.53

Table 55 Density and population estimates of species groups in the WOW survey area during Survey 12 on 11 June 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	6.43	8463	6740	10328	937	11.06
All non-avian animals	0.01	8	0	24	8	100.58
Species group						
Small gull species	0.15	192	47	388	92	47.57
Large gull species	0.02	31	0	77	21	66.19
Arctic / common tern	0.19	252	0	544	136	54.07
Large auk	1.09	1438	1027	1969	242	16.78
Small auk	0.02	24	0	64	17	70.70
Auk species	4.56	5998	4854	7277	618	10.29
Auk / shearwater species	0.01	8	0	24	8	98.03
Fulmar / gull species	0.01	8	0	24	8	95.94
Shearwater species	0.01	16	0	39	10	63.20
Gannet species	0.39	516	298	783	122	23.55
Cetacean species	0.01	8	0	24	8	101.64

Table 56 Density and population estimates of species in the WOW survey area during Survey 12 on 11 June 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.14	191	46	380	90	47.08
Great black-backed gull	0.02	33	0	79	21	63.81
Arctic tern	0.19	249	0	548	140	56.12
Guillemot	1.00	1321	924	1768	219	16.56
Razorbill	0.11	140	36	277	63	44.60
Puffin	4.59	6037	4981	7319	598	9.89
Fulmar	0.01	8	0	24	8	101.46
Manx shearwater	0.01	17	0	40	11	65.95
Gannet	0.40	522	284	797	130	24.90
Harbour porpoise	0.01	9	0	24	8	94.84

Table 57 Density and population estimates of species groups in the WOW survey area during Survey 13 on 02 July 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	5.45	7167	5220	9084	992	13.83
All non-avian animals	0.07	91	24	180	41	45.44
Species group						
Wader species	0.01	8	0	24	8	100.41
Small gull species	0.10	136	69	211	37	26.97
Arctic / common tern	0.01	9	0	24	8	94.21
Skua species	0.02	33	0	72	19	57.23
Large auk	1.45	1913	1332	2588	323	16.88
Small auk	0.01	9	0	24	8	96.64
Auk species	3.05	4006	2803	5345	640	15.98
Fulmar / gull species	0.30	401	285	540	62	15.49
Gannet species	0.52	683	397	1050	167	24.37
Shark species	0.01	9	0	24	8	96.32
Dolphin species	0.04	48	0	101	27	54.70
Cetacean species	0.02	33	0	72	19	55.99

Table 58 Density and population estimates of species in the WOW survey area during Survey 13 on 02 July 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Curlew	0.01	8	0	24	8	99.84
Kittiwake	0.10	137	72	215	37	27.04
Great skua	0.02	33	0	72	19	57.47
Guillemot	1.44	1892	1295	2547	322	17.00
Black guillemot	0.01	9	1	24	8	91.01
Puffin	3.03	3986	2832	5240	635	15.92
Fulmar	0.30	400	284	520	61	15.27
Gannet	0.52	687	408	1038	168	24.34
Basking shark	0.01	8	0	24	8	95.65
Risso's dolphin	0.02	33	0	71	18	54.16
White-beaked dolphin	0.01	17	0	48	15	91.00
Harbour porpoise	0.02	33	0	76	20	60.05

Table 59 Density and population estimates of species groups in the WOW survey area during Survey 14 on 30 August 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	8.18	10764	9196	12558	834	7.74
All non-avian animals	0.31	409	220	616	105	25.58
Species group						
Wader species	0.01	17	0	61	16	94.37
Arctic / common tern	0.02	26	0	72	24	92.89
Skua species	0.02	25	0	72	24	98.11
Large auk	3.06	4025	3423	4685	337	8.37
Small auk	0.01	9	0	24	8	93.73
Auk species	2.31	3040	2290	3848	394	12.95
Storm-petrel species	0.24	310	146	500	94	30.14
Fulmar / gull species	1.45	1911	1511	2356	218	11.39
Shearwater species	0.02	32	8	62	14	43.14
Gannet species	1.05	1377	794	2257	391	28.37
Jellyfish	0.08	104	47	166	32	30.37
Fish species	0.01	9	0	24	8	90.91
Shark species	0.01	9	0	24	8	89.38
Seal species	0.02	25	0	48	13	50.78

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Dolphin species	0.16	215	64	406	87	40.30
Cetacean species	0.04	47	0	118	31	66.01

Table 60 Density and population estimates of species in the WOW survey area during Survey 14 on 30 August 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Lesser black-backed gull	0.01	16	0	40	11	66.28
Arctic tern	0.02	24	0	72	24	97.82
Great skua	0.02	25	0	72	24	96.92
Guillemot	2.96	3899	3285	4580	331	8.47
Razorbill	0.11	141	55	239	50	34.99
Puffin	2.29	3018	2298	3847	406	13.43
European Storm-Petrel	0.24	310	142	512	96	30.83
Fulmar	1.45	1901	1517	2357	217	11.37
Cory's shearwater	0.01	8	0	24	8	96.59
Sooty shearwater	0.01	17	0	39	11	64.19
Manx shearwater	0.01	9	0	24	8	94.68
Gannet	1.03	1358	821	2195	371	27.28
Lion's mane jellyfish	0.08	103	47	170	31	29.74
Porbeagle shrak	0.01	9	0	24	8	94.80
Ocean sunfish	0.01	9	0	24	8	94.24
Risso's dolphin	0.01	17	0	49	16	91.77
White-beaked dolphin	0.15	196	45	382	86	43.98

Harbour porpoise	0.04	49	0	118	32	65.82

Table 61 Density and population estimates of species groups in the WOW survey area during Survey 15 on 08 September 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	8.67	11404	9893	13025	811	7.10
All non-avian animals	0.33	428	283	593	81	18.77
Species group						
Wader species	0.03	40	0	100	27	67.33
Small gull species	0.12	159	40	309	69	43.16
Large auk	3.85	5064	4331	5793	377	7.44
Auk species	2.42	3189	2191	4253	527	16.51
Storm-petrel species	0.10	134	16	331	89	66.38
Fulmar / gull species	0.88	1164	874	1456	149	12.76
Shearwater species	0.01	8	0	24	8	96.36
Gannet species	1.27	1669	1306	2119	213	12.72
Jellyfish	0.16	217	123	331	55	25.13
Fish species	0.01	16	0	39	11	67.44
Seal species	0.03	41	8	84	20	47.54
Cetacean species	0.12	157	40	308	69	43.60

Table 62 Density and population estimates of species in the WOW survey area during Survey 15 on 08 September 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.12	162	47	296	67	41.23
Guillemot	3.77	4961	4245	5732	389	7.83
Razorbill	0.09	114	36	206	45	39.18
Puffin	2.37	3120	2129	4125	514	16.46
European Storm-Petrel	0.10	135	16	326	88	65.01
Fulmar	0.88	1157	880	1444	144	12.37
Sooty shearwater	0.01	9	0	24	8	96.26
Gannet	1.27	1674	1297	2117	212	12.63
Lion's mane jellyfish	0.16	214	117	320	54	25.05
Ocean sunfish	0.01	16	0	39	11	64.48
Grey seal	0.03	40	8	83	19	47.32
Harbour porpoise	0.12	163	47	313	70	43.02

Table 63 Density and population estimates of species groups in the WOW survey area during Survey 16 on 12 October 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	7.61	10056	8207	12305	1026	10.19
All non-avian animals	0.44	577	364	818	121	20.96
Species group						
Goose species	0.08	105	0	290	87	82.46
Small gull species	0.73	966	689	1332	165	17.04
Skua species	0.01	9	0	25	8	97.16
Large auk	3.20	4227	3536	4938	365	8.61
Auk species	0.28	367	279	459	46	12.35
Auk / small gull	0.01	17	0	39	10	60.03
Fulmar / gull species	1.83	2416	813	4731	976	40.39
Shearwater species	0.01	8	0	24	8	98.58
Gannet species	1.46	1924	1481	2416	246	12.76
Jellyfish	0.18	232	76	461	101	43.55
Shark species	0.01	9	0	25	8	96.13
Seal species	0.07	89	46	135	24	27.21
Dolphin species	0.13	171	40	327	72	42.12
Cetacean species	0.05	64	8	142	34	52.10

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Seal / small cetacean species	0.01	17	0	40	11	67.39

Table 64 Density and population estimates of species in the WOW survey area during Survey 16 on 12 October 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Greylag goose	0.07	89	0	264	87	97.72
Pink-footed goose	0.01	16	0	48	16	95.25
Kittiwake	0.72	956	677	1321	166	17.38
Long-tailed skua	0.01	9	0	25	8	97.09
Guillemot	3.16	4174	3485	4860	355	8.49
Razorbill	0.05	61	26	106	21	33.98
Black guillemot	0.01	11	0	29	8	74.23
Puffin	0.26	346	264	443	46	13.15
Fulmar	1.85	2445	890	4513	945	38.63
Manx shearwater	0.01	9	0	24	8	94.09
Gannet	1.44	1906	1445	2383	249	13.06
Lion's mane jellyfish	0.18	234	72	455	98	41.79
Basking shark	0.01	9	0	24	8	94.29
Grey seal	0.07	89	40	135	25	27.78
Risso's dolphin	0.01	9	0	24	8	95.93
White-beaked dolphin	0.12	161	32	320	72	44.77
Harbour porpoise	0.05	65	8	136	34	51.40

Table 65 Density and population estimates of species groups in the WOW survey area during Survey 17 on 15 November 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	3.32	4373	3207	5803	676	15.45
Species group						
Small gull species	0.12	159	85	244	43	26.49
Black-backed gull species	0.17	230	127	360	59	25.70
Large gull species	0.04	48	16	88	20	41.59
Gull species	0.01	8	0	24	8	93.85
Large auk	1.12	1469	1197	1794	156	10.61
Auk species	0.12	159	91	236	37	22.78
Auk / small gull	0.01	17	0	40	11	66.07
Diver species	0.01	8	0	24	8	98.75
Fulmar / gull species	1.70	2238	1005	3730	696	31.07
Gannet species	0.05	64	31	104	20	30.82

Table 66 Density and population estimates of species in the WOW survey area during Survey 17 on 15 November 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.12	162	86	256	45	27.30
Great black-backed gull	0.20	270	160	401	62	22.72
Herring gull	0.01	8	0	24	8	95.98
Little auk	0.10	137	76	199	32	22.83
Guillemot	1.10	1448	1179	1756	150	10.32
Razorbill	0.01	17	1	40	11	62.91
Puffin	0.02	23	8	41	9	35.77
Red-throated diver	0.01	8	0	24	8	97.97
Fulmar	1.68	2208	982	3754	714	32.31
Gannet	0.05	64	30	103	20	30.55

Table 67 Density and population estimates of species groups in the WOW survey area during Survey 18 on 28 December 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	4.11	5409	4416	6446	513	9.48
All non-avian animals	0.27	352	86	929	223	63.41
Species group						
Small gull species	0.05	63	23	110	23	35.62
Black-backed gull species	0.41	544	424	675	64	11.64
Large auk	1.50	1978	1622	2330	186	9.38
Auk species	0.11	142	80	206	32	22.26
Fulmar / gull species	2.02	2654	1815	3520	451	16.96
Gannet species	0.02	24	0	54	13	53.94
Dolphin species	0.23	302	39	741	210	69.50
Cetacean species	0.03	40	8	78	19	46.68

Table 68 Density and population estimates of species in the WOW survey area during Survey 18 on 28 December 2021

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.05	65	24	109	22	33.51
Great black-backed gull	0.41	544	417	669	65	11.90
Guillemot	1.55	2033	1695	2380	172	8.44
Razorbill	0.02	26	2	51	13	50.23
Puffin	0.05	64	32	98	17	26.28
Fulmar	2.02	2662	1857	3603	448	16.83
Gannet	0.02	25	0	55	14	53.50
Common dolphin	0.17	230	0	696	220	95.31
White-beaked dolphin	0.05	65	0	141	37	56.33
Harbour porpoise	0.03	41	8	80	19	45.03

Table 69 Density and population estimates of species groups in the WOW survey area during Survey 19 on 18 February 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	2.03	2673	2236	3161	238	8.90
All non-avian animals	0.02	31	0	87	25	81.53
Species group						
Small gull species	0.10	135	70	216	37	27.19
Black-backed gull species	0.08	112	40	198	43	37.76
Large auk	0.37	490	333	638	79	16.11
Auk species	0.02	25	0	61	17	68.41
Fulmar / gull species	1.32	1739	1396	2098	181	10.40
Gannet species	0.10	136	63	220	40	29.26
Cormorant / shag	0.01	8	0	24	8	94.79
Dolphin species	0.02	26	0	72	25	97.44
Cetacean species	0.01	8	0	24	8	100.40

Table 70 Density and population estimates of species in the WOW survey area during Survey 19 on 18 February 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.10	136	77	207	36	26.42
Great black-backed gull	0.09	112	46	206	42	36.89
Little auk	0.02	23	0	56	16	69.94
Guillemot	0.37	492	341	641	76	15.32
Fulmar	1.33	1745	1390	2119	187	10.71
Gannet	0.10	137	62	224	41	29.52
Shag	0.01	9	0	24	8	98.38
White-beaked dolphin	0.02	24	0	91	25	100.78
Harbour porpoise	0.01	9	0	24	8	98.69

Table 71 Density and population estimates of species groups in the WOW survey area during Survey 20 on 26 February 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	3.06	4020	2929	5310	629	15.63
All non-avian animals	0.22	289	85	568	122	42.06
Species group						
Small gull species	0.42	554	360	790	110	19.73
Black-backed gull species	0.15	193	102	298	51	26.10
Large gull species	0.01	17	0	40	11	63.81
Large auk	0.55	718	460	999	142	19.69
Auk species	0.01	17	0	40	11	64.36
Auk / small gull	0.01	8	0	24	8	98.99
Fulmar / gull species	1.82	2399	1545	3450	504	20.99
Gannet species	0.12	152	85	222	36	23.08
Seal species	0.01	16	0	40	11	69.08
Dolphin species	0.15	203	32	444	111	54.84
Cetacean species	0.05	63	8	128	32	49.81

Table 72 Density and population estimates of species in the WOW survey area during Survey 20 on 26 February 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.42	551	365	776	106	19.21
Great black-backed gull	0.15	196	102	294	50	25.19
Herring gull	0.01	17	0	40	11	66.35
Guillemot	0.51	668	428	898	119	17.76
Razorbill	0.04	57	7	121	30	51.97
Fulmar	1.83	2403	1466	3528	512	21.30
Gannet	0.12	152	85	228	37	24.19
White-beaked dolphin	0.15	203	16	446	113	55.50
Harbour porpoise	0.05	66	15	136	33	49.50

Table 73 Density and population estimates of species groups in the WOW survey area during Survey 21 on 11 March 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	4.98	6552	5549	7601	524	8.00
All non-avian animals	0.05	65	8	152	37	57.63
Species group						
Small gull species	1.63	2139	1475	2915	370	17.26
Black-backed gull species	0.02	32	0	85	24	74.54
Large gull species	0.02	24	0	49	13	52.93
Large auk	0.57	747	514	1031	132	17.56
Auk species	0.01	16	0	39	11	62.97
Auk / small gull	0.01	9	0	24	8	95.31
Fulmar / gull species	2.46	3241	2710	3878	305	9.38
Gannet species	0.26	342	241	480	63	18.22
Dolphin species	0.04	48	0	126	33	67.86
Cetacean species	0.01	17	0	48	17	98.77

Table 74 Density and population estimates of species in the WOW survey area during Survey 21 on 11 March 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	1.64	2155	1453	2930	372	17.23
Great black-backed gull	0.04	48	8	104	27	55.37
Herring gull	0.01	9	0	24	8	94.61
Guillemot	0.40	530	322	776	115	21.60
Razorbill	0.17	230	128	338	56	24.26
Fulmar	2.44	3216	2644	3804	298	9.26
Gannet	0.26	344	246	477	63	18.22
White-beaked dolphin	0.04	48	0	127	34	70.76
Harbour porpoise	0.01	17	0	49	16	96.77

Table 75 Density and population estimates of species groups in the WOW survey area during Survey 22 on 14 April 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	4.55	5979	5262	6774	377	6.29
All non-avian animals	0.01	8	0	24	8	92.98
Species group						
Wader species	0.02	24	0	61	17	68.58
Small gull species	0.19	251	160	342	49	19.29
Gull species	0.01	8	0	24	8	94.71
Skua species	0.01	9	0	24	8	93.21
Large auk	1.58	2082	1530	2694	304	14.59
Small auk	0.03	40	0	88	22	54.16
Auk species	1.24	1637	1284	2007	186	11.33
Auk / small gull	0.02	24	0	72	23	98.66
Fulmar / gull species	0.61	805	678	928	66	8.15
Gannet species	0.83	1086	782	1379	149	13.68
Cetacean species	0.01	8	0	24	8	97.39

Table 76 Density and population estimates of species in the WOW survey area during Survey 22 on 14 April 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Whimbrel	0.02	24	0	61	16	68.54
Kittiwake	0.20	265	182	360	47	17.69
Black-headed gull	0.01	9	0	24	8	94.00
Great skua	0.01	9	0	24	8	91.53
Guillemot	1.64	2159	1579	2761	316	14.63
Puffin	1.24	1628	1271	2006	189	11.57
Fulmar	0.60	790	655	924	69	8.62
Gannet	0.84	1102	812	1407	154	13.90
Minke whale	0.01	9	0	24	8	90.53

Table 77 Density and population estimates of species groups in the WOW survey area during Survey 23 on 15 May 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	8.55	11300	7917	15033	1838	16.26
All non-avian animals	0.13	178	88	275	48	26.58
Species group						
Small gull species	0.10	136	64	221	40	28.92
Black-backed gull species	0.01	9	0	25	9	98.07
Arctic / common tern	0.01	16	0	40	11	67.05
Skua species	0.02	25	0	54	13	52.13
Large auk	2.20	2905	2003	3961	512	17.63
Auk species	5.46	7216	4645	10296	1475	20.44
Diver species	0.02	25	0	54	14	53.48
Fulmar / gull species	0.27	361	248	491	65	17.78
Gannet species	0.50	656	399	925	139	21.18
Seal species	0.06	74	23	133	29	39.34
Cetacean species	0.08	105	47	173	35	33.59

Table 78 Density and population estimates of species in the WOW survey area during Survey 23 on 15 May 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.10	137	64	217	41	29.53
Great black-backed gull	0.01	8	0	25	8	101.83
Arctic tern	0.01	17	0	39	10	61.51
Great skua	0.02	25	0	55	13	53.70
Guillemot	2.26	2980	2070	4056	526	17.65
Razorbill	0.01	8	0	25	8	96.29
Puffin	5.44	7185	4626	10376	1518	21.11
Red-throated diver	0.01	8	0	25	8	100.29
Great northern diver	0.01	16	0	40	11	65.50
Fulmar	0.28	364	245	490	64	17.57
Gannet	0.50	655	408	930	138	20.94
Grey seal	0.06	74	24	135	29	39.58
Harbour porpoise	0.08	106	47	184	36	33.45

Table 79 Density and population estimates of species groups in the WOW survey area during Survey 24 on 06 June 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	8.03	10615	7622	13704	1579	14.87
All non-avian animals	0.12	159	71	263	49	30.39
Species group						
Wader species	0.01	17	0	40	11	65.24
Small gull species	0.07	91	23	200	48	53.07
Arctic / common tern	0.01	17	0	49	16	97.52
Skua species	0.05	64	31	103	19	29.20
Large auk	1.79	2362	1620	3241	419	17.74
Auk species	5.40	7135	4910	9541	1189	16.66
Fulmar / gull species	0.18	241	159	329	44	18.13
Gannet species	0.53	702	474	985	133	18.94
Shark species	0.01	8	0	24	8	101.54
Seal species	0.02	32	8	62	15	45.85
Cetacean species	0.08	105	32	190	41	38.74
Seal / small cetacean species	0.01	17	0	48	16	91.56

Table 80 Density and population estimates of species in the WOW survey area during Survey 24 on 06 June 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.07	91	24	191	46	50.69
Great skua	0.04	57	24	95	19	33.72
Arctic skua	0.01	8	0	24	8	97.58
Guillemot	1.83	2412	1649	3265	411	17.03
Puffin	5.38	7104	4813	9652	1245	17.52
Fulmar	0.18	238	161	329	44	18.49
Gannet	0.53	698	453	959	133	18.96
Basking shark	0.01	8	0	24	8	102.29
Harbour porpoise	0.08	104	39	181	38	36.52

Table 81 Density and population estimates of species groups in the WOW survey area during Survey 25 on 22 July 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	14.81	19568	15422	24220	2315	11.83
All non-avian animals	0.01	8	0	24	8	94.45
Species group						
Small gull species	1.78	2354	1188	3633	632	26.82
Gull species	0.01	8	0	24	8	101.13
Arctic / common tern	0.07	96	16	196	46	47.66
Skua species	0.05	73	23	135	30	41.32
Large auk	6.25	8260	5521	12221	1663	20.13
Small auk	0.01	17	0	40	11	66.07
Auk species	5.61	7413	5359	9684	1142	15.40
Auk / small gull	0.03	41	16	73	16	37.74
Auk / shearwater species	0.02	23	0	72	23	98.77
Fulmar / gull species	0.47	617	435	805	96	15.53
Shearwater species	0.02	25	0	49	13	52.38
Gannet species	0.48	632	439	867	108	17.09
Seal species	0.01	9	0	24	8	94.06

Table 82 Density and population estimates of species in the WOW survey area during Survey 25 on 22 July 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	1.79	2362	1203	3737	643	27.20
Arctic tern	0.07	93	24	189	43	45.88
Great skua	0.02	25	0	48	13	51.87
Arctic skua	0.04	49	0	109	26	54.03
Guillemot	6.30	8328	5493	12270	1706	20.48
Razorbill	0.15	196	81	332	63	32.03
Puffin	5.37	7097	4885	9504	1156	16.29
Fulmar	0.47	619	451	815	94	15.15
Manx shearwater	0.02	24	0	55	14	55.65
Gannet	0.48	632	454	879	109	17.25
Grey seal	0.01	8	0	24	8	98.61

Table 83 Density and population estimates of species groups in the WOW survey area during Survey 26 on 17 August 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	10.50	13868	11136	16784	1403	10.11
All non-avian animals	0.08	104	24	208	49	46.96
Species group						
Small gull species	0.06	81	25	147	31	37.54
Arctic / common tern	0.07	90	31	168	36	39.73
Tern species	0.05	66	0	192	62	94.17
Tern / small gull species	0.01	9	0	24	8	90.72
Skua species	0.01	17	0	40	11	64.26
Large auk	4.76	6293	4381	8882	1144	18.17
Auk species	4.63	6120	4381	7988	904	14.76
Auk / small gull	0.01	9	0	24	8	92.07
Fulmar / gull species	0.59	779	634	935	79	10.10
Shearwater species	0.01	17	0	40	11	65.81
Gannet species	0.28	376	233	535	76	20.19
Seal species	0.02	25	0	62	17	67.81
Dolphin species	0.02	33	0	97	32	94.31
Cetacean species	0.04	49	0	131	39	79.53

Table 84 Density and population estimates of species in the WOW survey area during Survey 26 on 17 August 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.06	80	25	148	31	38.66
Arctic tern	0.12	160	49	299	64	39.93
Great skua	0.01	16	0	40	11	66.19
Guillemot	4.79	6335	4413	8749	1118	17.65
Razorbill	0.03	41	1	125	34	82.68
Puffin	4.51	5957	4417	7710	857	14.38
Fulmar	0.59	783	639	944	79	10.06
Manx shearwater	0.01	17	0	40	11	64.31
Gannet	0.29	379	249	532	73	19.23
Grey seal	0.02	25	0	64	18	70.59
White-beaked dolphin	0.02	32	0	96	31	95.64
Harbour porpoise	0.04	47	0	132	38	79.52

Table 85 Density and population estimates of species groups in the WOW survey area during Survey 27 on 02 September 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Broad category						
All birds	7.82	10331	8169	12688	1164	11.26
All non-avian animals	0.02	25	0	49	13	50.11
Species group						
Small gull species	0.04	49	16	89	20	39.45
Skua species	0.01	9	0	32	9	100.69
Large auk	4.10	5424	3812	7306	905	16.68
Auk species	0.74	979	771	1186	108	11.00
Auk / shearwater species	0.22	292	158	450	76	25.79
Fulmar / gull species	1.99	2633	2285	3053	200	7.57
Shearwater species	0.03	41	8	81	20	48.85
Gannet species	0.70	921	662	1222	149	16.11
Shark species	0.01	9	0	25	8	93.15
Seal species	0.01	17	0	41	11	67.61

Table 86 Density and population estimates of species in the WOW survey area during Survey 27 on 02 September 2022

Category	Density estimate (n/km²)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Standard deviation of population estimate (number)	CV (%)
Species						
Kittiwake	0.04	50	16	93	20	39.95
Great skua	0.01	8	0	25	8	102.07
Guillemot	3.89	5146	3648	6895	842	16.36
Razorbill	0.31	404	179	685	134	33.01
Puffin	0.90	1185	984	1391	104	8.77
Fulmar	1.99	2626	2242	3050	206	7.82
Great shearwater	0.01	8	0	25	8	96.41
Manx shearwater	0.03	34	0	72	19	56.46
Gannet	0.70	923	649	1217	145	15.67
Basking shark	0.01	9	0	25	8	90.78
Grey seal	0.01	18	0	41	11	62.28