Offshore Wind Power Limited

West of Orkney Offshore EIA Report

Volume 2, Supporting Study 8: Digital Video Aerial Survey Methodology and Marine Mammal Survey Results

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West of Orkney Windfarm digital video aerial survey methodology and marine mammal and other megafauna results: 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.

1 Introduction

1 West of Orkney Windfarm (hereafter 'WOW') is a proposed offshore windfarm, located approximately 23km off the coast of Scotland.

2 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'.

3 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).

4 HiDef designed the survey methodology to provide data suitable to support OWPL's 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).

5 This report ('the 27-month report') provides the results from 27 surveys undertaken between July 2020 and September 2022. Observations of marine mammals and other non-avian megafauna and survey effort are summarised, and results presented as density surface distribution maps and density estimates with 95% confidence intervals (CIs). Estimates of density and abundance for seabirds are presented in the Supporting Study 12 (SS12): Offshore ornithology technical supporting study. A discussion is provided as to the representativeness of the results in relation to the wider region.

2 Methods

2.1 Survey flights

6 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).

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

8 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).

9 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.

10 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.

11 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.

12 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.

13 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

14 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.

15 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 awarded OAA omitting an area in the west, the area was retained during the remaining surveys (Figure 2).

16 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

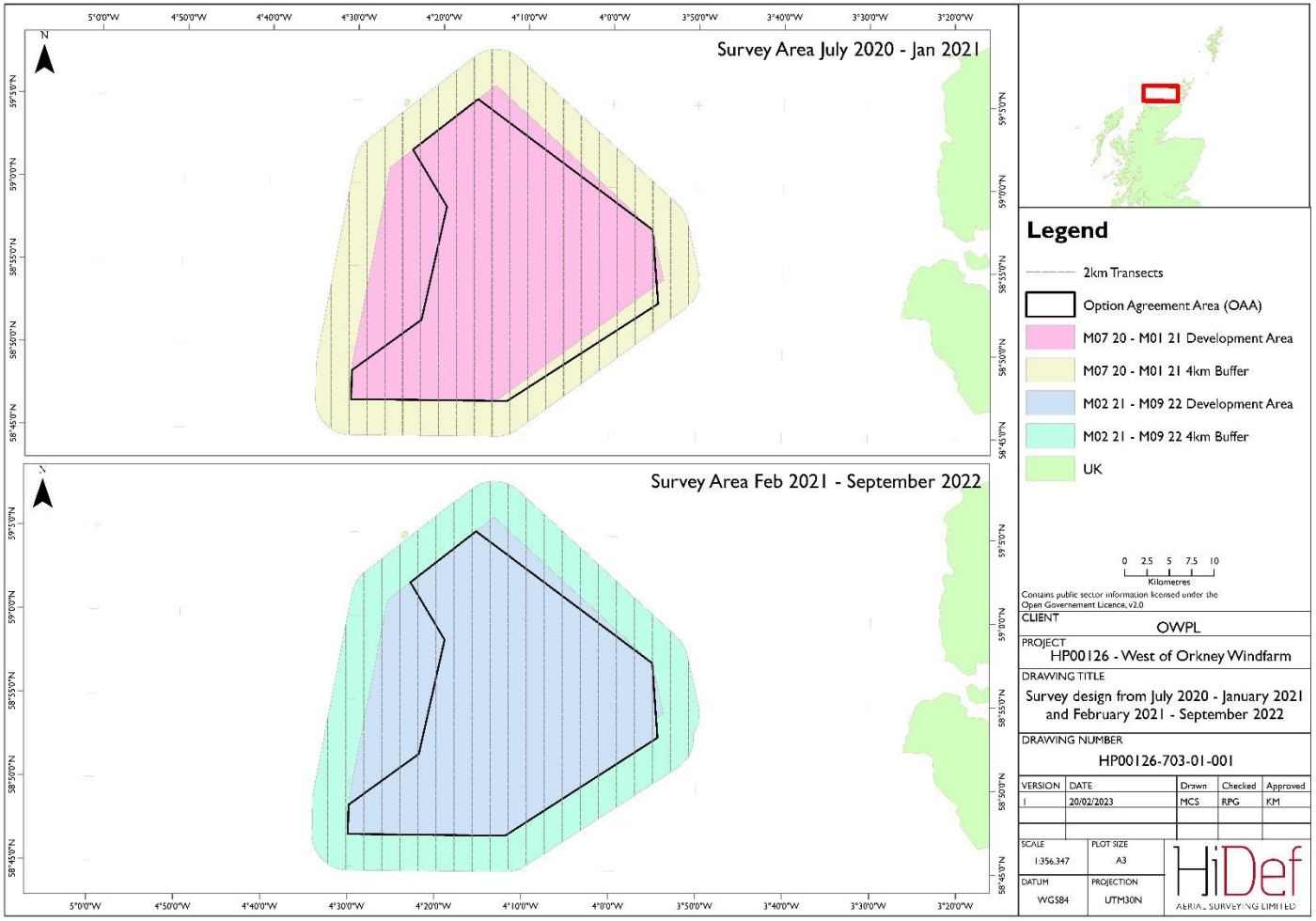
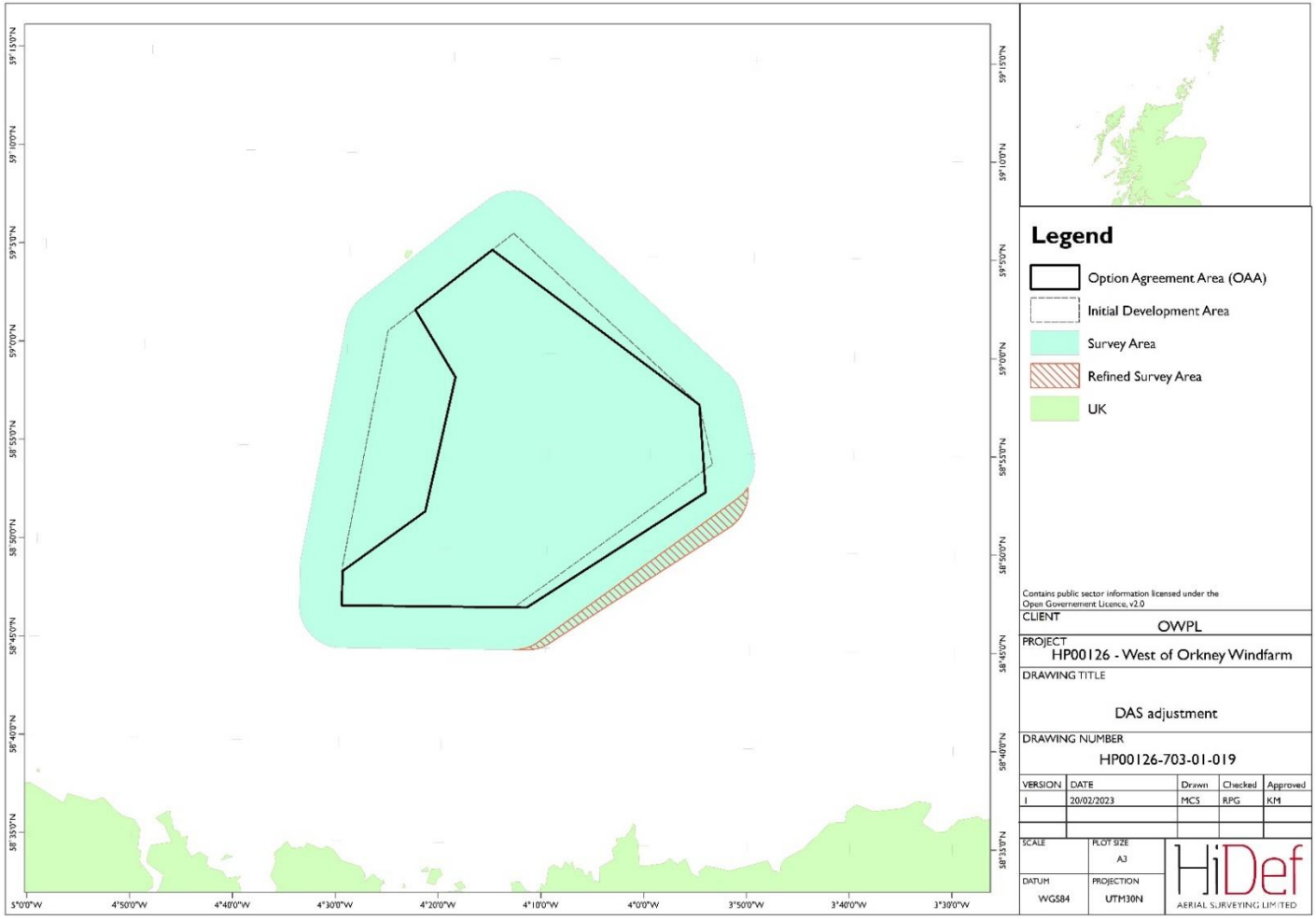


Figure 2 **WOW Survey Area with site revisions February 2021 - September 2022**



2.3 Data review and object detection

18 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.

19 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.

20 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

21 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.

22 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.

23 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].

24 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.

25 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'.

26 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.

27 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'.

28 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.

29 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

30 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

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

32 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.

33 Apportioning of marine mammals to species level was also undertaken for the purposes of calculating population estimates. This means that the number of unidentified marine mammals in each species group were assigned to species where appropriate, based on their respective abundance ratios in the data for those identified species. For example, if identified common dolphin and bottlenose dolphin occurred in a 4:1 ratio in a survey, then 80% of unidentified small cetaceans would be assigned to common dolphin and 20% assigned to bottlenose dolphin.

2.6.2 Population estimates

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

35 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.

36 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.

37 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.

38 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

39 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, harbour porpoise).

40 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).

41 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.

42 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

43 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).

44 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.

45 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.

46 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.

47 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

48 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.

49 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.

50 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).

51 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

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

53 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.

54 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.

55 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.

56 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.

57 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 marine mammals 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.

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

3 Results

3.1 Survey effort

58 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.

59 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 1 and Figure 2*

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

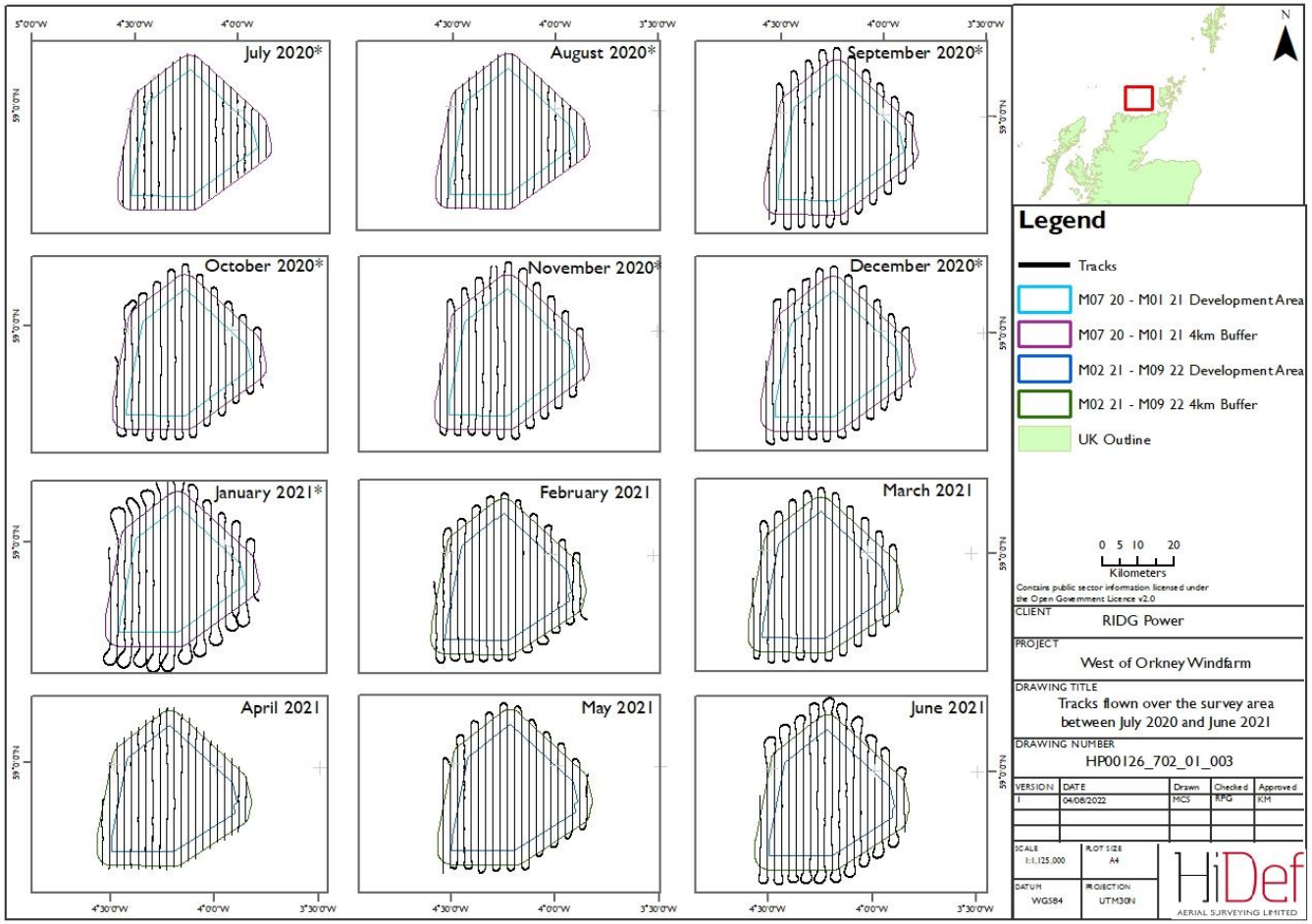


Figure 4 **Flight pattern for surveys flown between July 2021 and June 2022 over the WOW survey area**

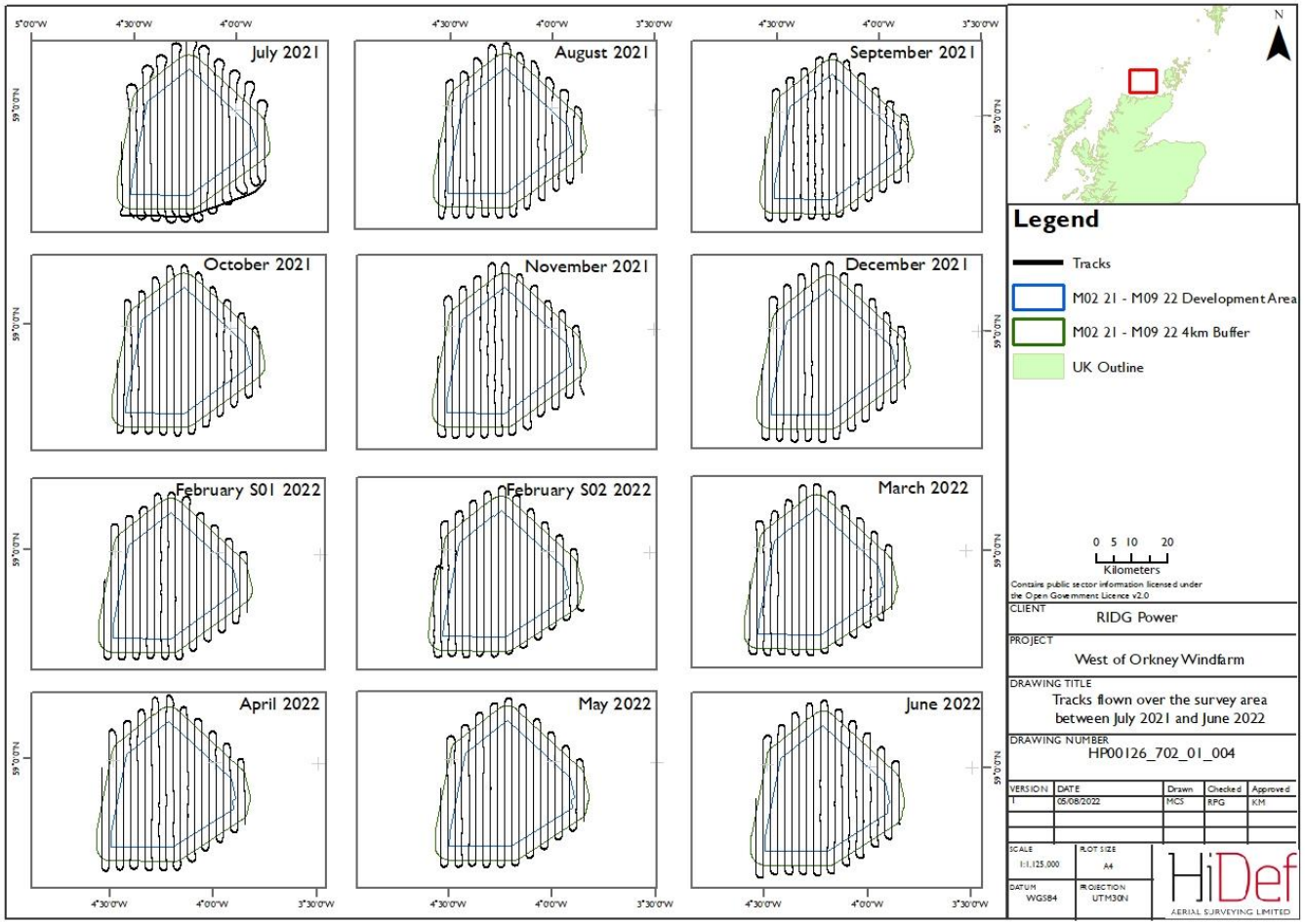
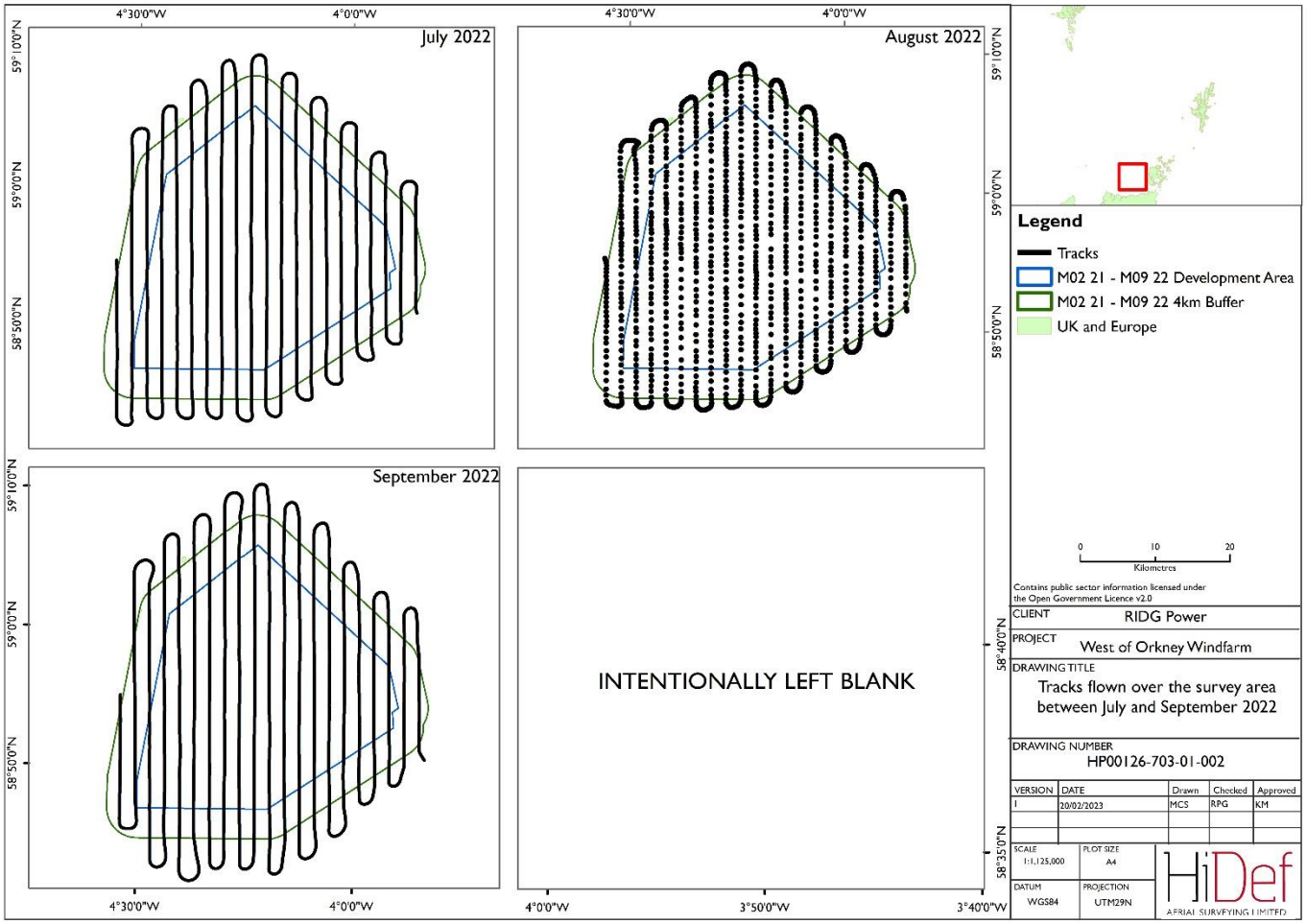


Figure 5 **Flight pattern for surveys flown between July and September 2022 over the WOW survey area**



3.2 Survey results

60 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.

61 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 non-avian animals 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	
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	6	0	0	13
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**	**1512**	**304**	**1047**	**11190**

Table 5 **Number of non-avian animals 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	
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**	**1267**	**520**	**689**	**326**	**520**	**794**	**732**	**1393**	**1315**	**11231**

Table 6 **Number of non-avian animals 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					
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		✓	
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	20	✓	✓	
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		**2337**	**1710**	**1225**	**5272**	**27693**			

Table 7 **Number of non-avian animals 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	
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
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 non-avian animals 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	
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
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 non-avian animals 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		
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
Seal / small cetacean species	0	0	0	0	5
Total	**95**	**30**	**70**	**195**	**993**

3.3 Distribution patterns and seasonal abundance

62 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.

63 For 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.

64 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.

Table 10 Terms used in population analysis

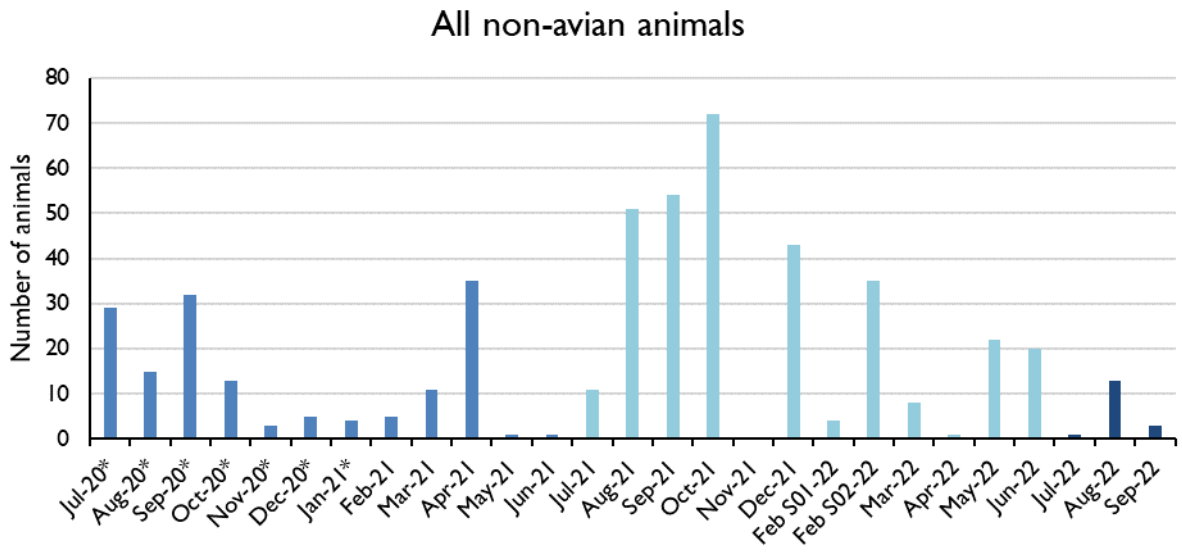
Term	Definition
Density estimate *(animals/km²)*	The average number of animals per square km surveyed over the whole area.
Population estimate *(number)*	The mean number of animals estimated within the survey area.
95% confidence interval *(CI)*	A measure of uncertainty in the mean value. If the analysis 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 marine 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 marine mammals, this includes an estimate for the number that are believed to be submerged at the time of survey.

3.3.1 All non-avian animals

65 Non-avian animals were recorded intermittently, with the highest numbers recorded between August and October 2021 (Figure 6). 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...

66 Surfacing rates of species and unidentified animals can be found in Table 11. The densities of all non-avian animals are presented in Figure 7 to Figure 9.

Figure 6 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)



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

Table 11 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
Barrel jellyfish	3	0	0	0	0	3
Basking shark	5	0	0	0	0	5
Bottlenose dolphin	0	1	0	0	0	1
Common dolphin	40	2	0	0	0	42
Grey seal	1	3	13	76	0	17
Harbour porpoise	83	5	33	26	4	125
Lion's mane jellyfish	93	1	0	0	0	94
Minke whale	2	0	1	33	0	3
Ocean sunfish	4	0	0	0	0	4
Porbeagle shark	1	0	0	0	0	1
Risso's dolphin	10	1	6	30	3	20
White-beaked dolphin	87	4	9	9	0	100
No ID						
Cetacean species	6	2	0	0	0	8
Dolphin species	2	0	1	33	0	3
Jellyfish	24	0	0	0	0	24
Seal / small cetacean species	3	0	1	20	1	5
Seal species	5	2	29	78	1	37
Total	**369**	**21**	**93**	**19**	**9**	**492**

Figure 7 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.

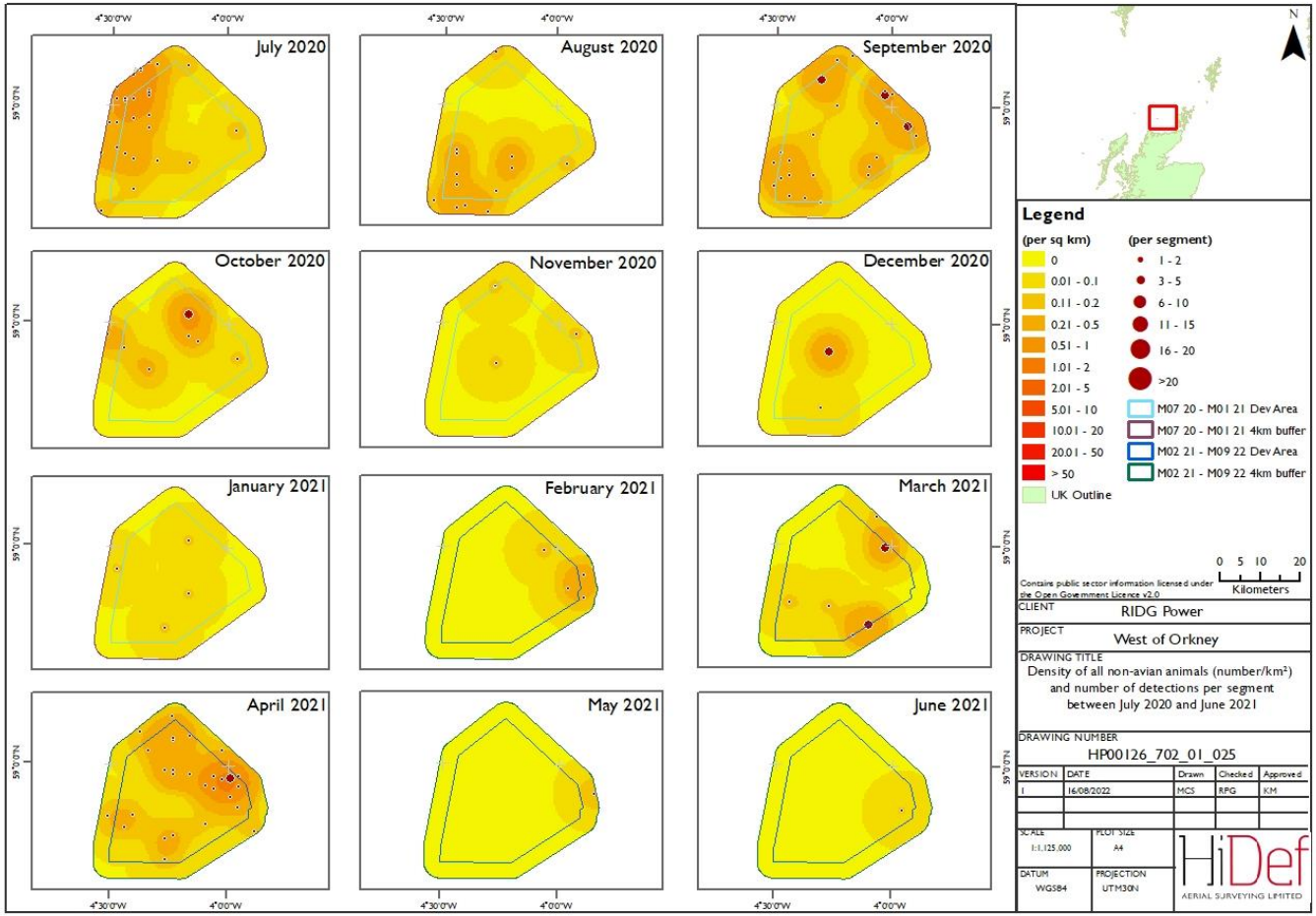


Figure 8 Density of all non-avian animals (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

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

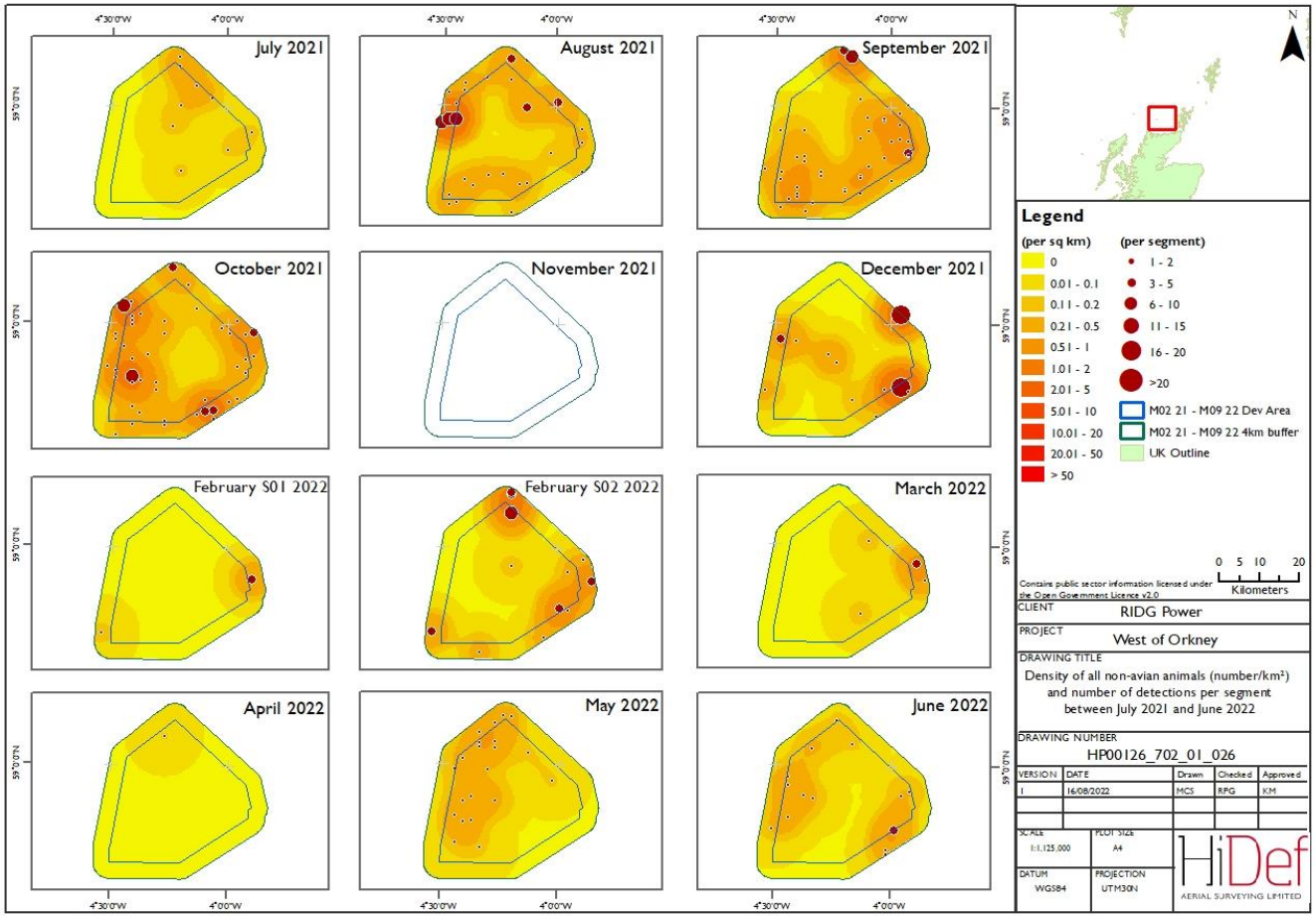
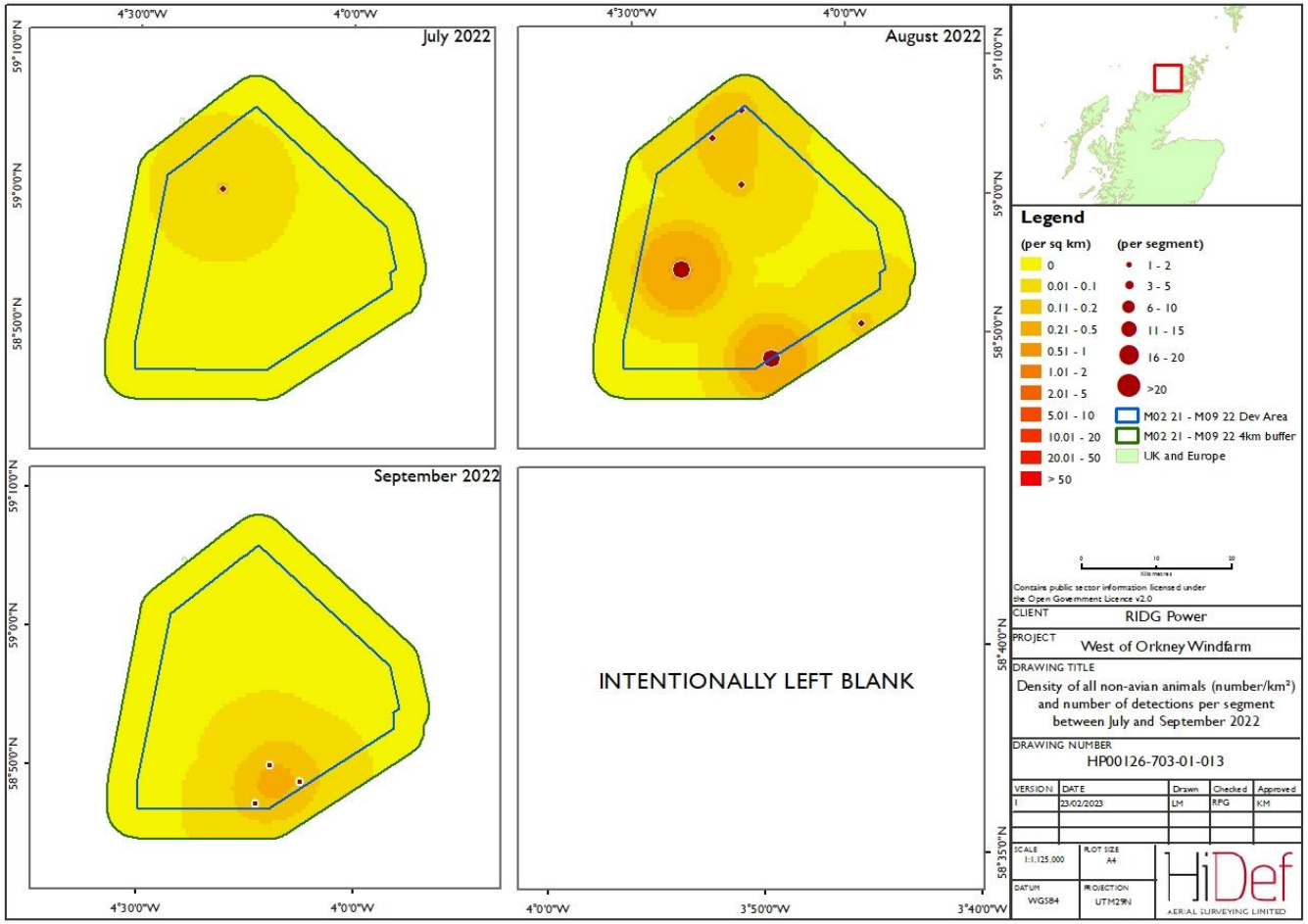


Figure 9 **Density of all non-avian animals (number/km²) and number of detections per segment in the WOW survey area between July and September 2022.**



3.3.2 Harbour porpoise

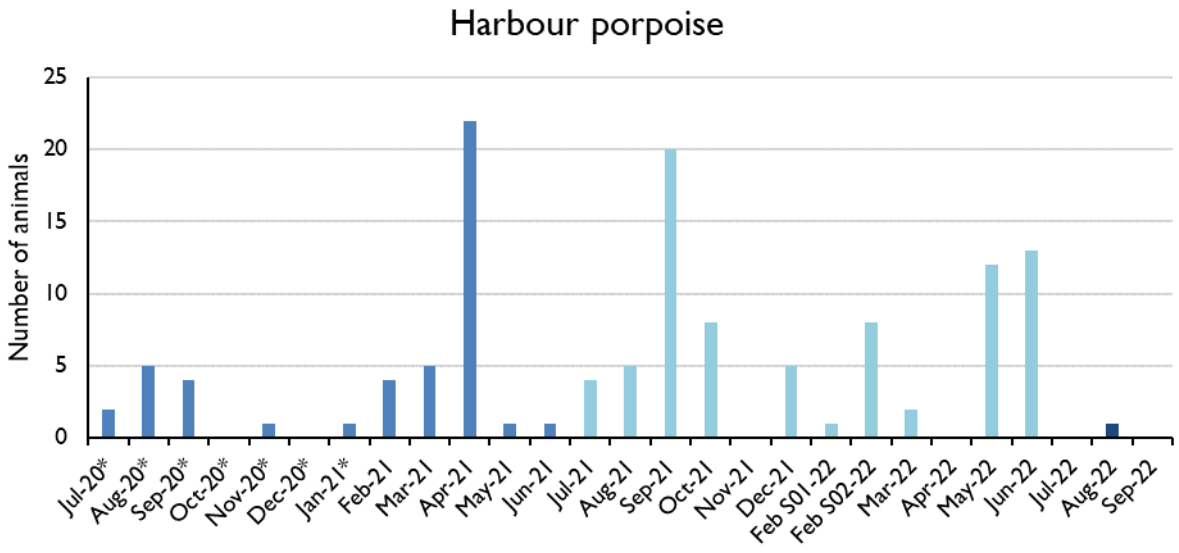
67 Harbour porpoise were recorded relatively frequently, with records peaking in April 2021 with 22 animals (Figure 10). It should be noted that counts may not be directly comparable between surveys of the initial and revised survey area, however, density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

68 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 12 to Figure 14), equating to a peak population estimate for the survey area of 1,009 animals (95% CI 250 – 1,900).

69 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 12 to Figure 14). 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.

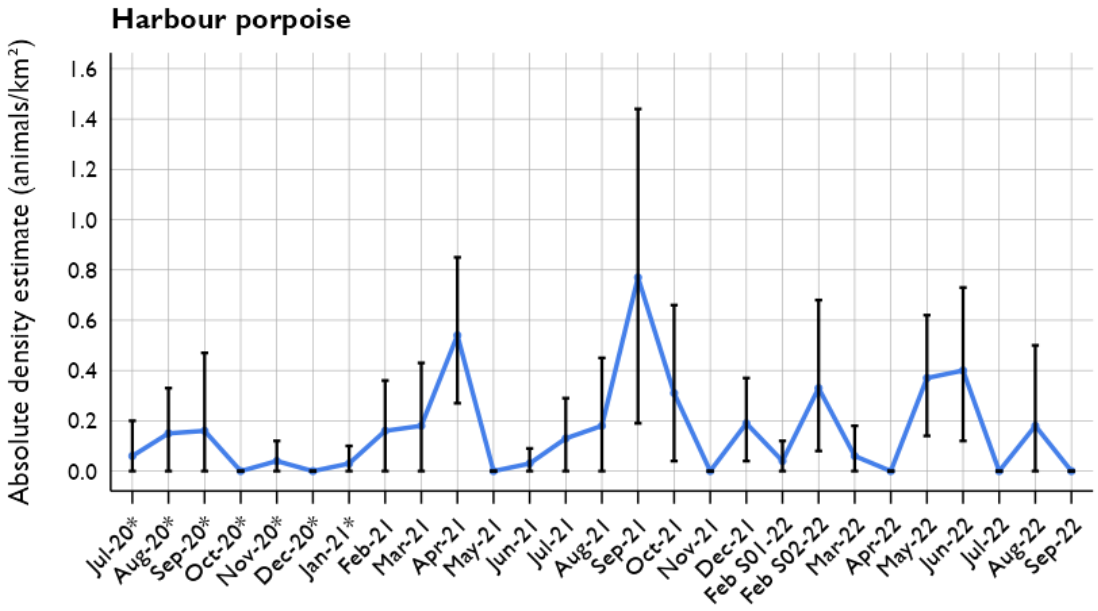
70 Proportions of surfacing animals can be found in Table 11; 67% of individuals were recorded as submerged.

Figure 10 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)



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

Figure 11 Harbour porpoise 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 12 **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
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
08 September 2021	0.12	163	47	313	70	43.02	0.77	1009	250	1900

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
12 October 2021	0.05	64	8	134	33	51.14	0.31	404	50	867
15 November 2021	0.00	0	0	0	0	0.00	0.00	0	0	0
28 December 2021	0.03	41	8	80	19	45.03	0.19	245	49	483
18 February 2022	0.01	9	0	24	8	98.69	0.04	53	0	159
26 February 2022	0.05	66	15	136	33	49.50	0.33	431	102	898
11 March 2022	0.01	17	0	49	16	96.77	0.06	76	0	235
14 April 2022	0.00	0	0	0	0	0.00	0.00	0	0	0
15 May 2022	0.08	104	40	183	36	33.95	0.37	483	186	819
06 June 2022	0.08	104	38	190	41	38.73	0.40	524	161	965
22 July 2022	0.00	0	0	0	0	0.00	0.00	0	0	0
17 August 2022	0.04	48	0	129	37	77.63	0.18	235	0	655
02 September 2022	0.00	0	0	0	0	0.00	0.00	0	0	0

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

Figure 12 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.

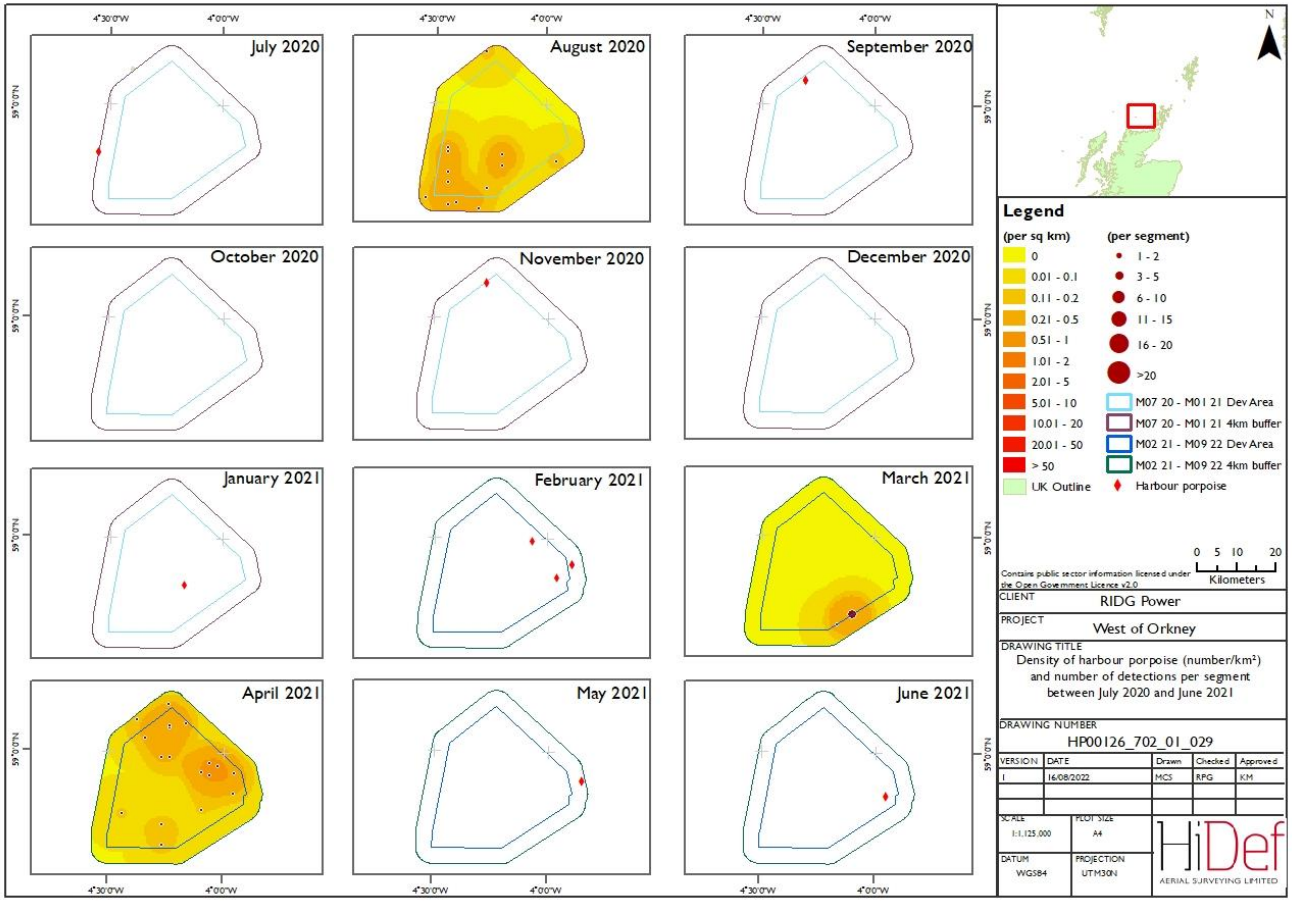


Figure 13 **Density of harbour porpoise (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.**

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

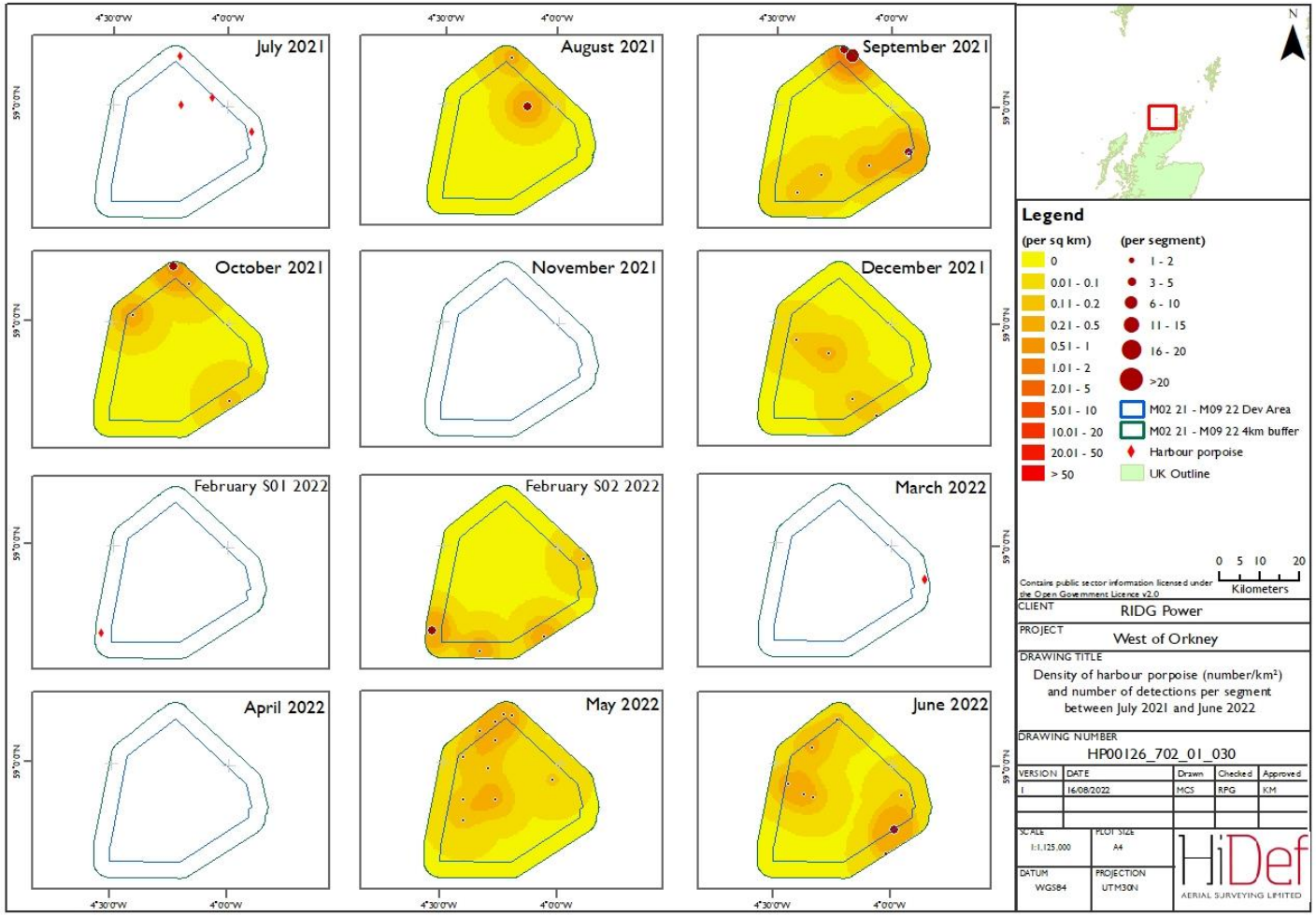
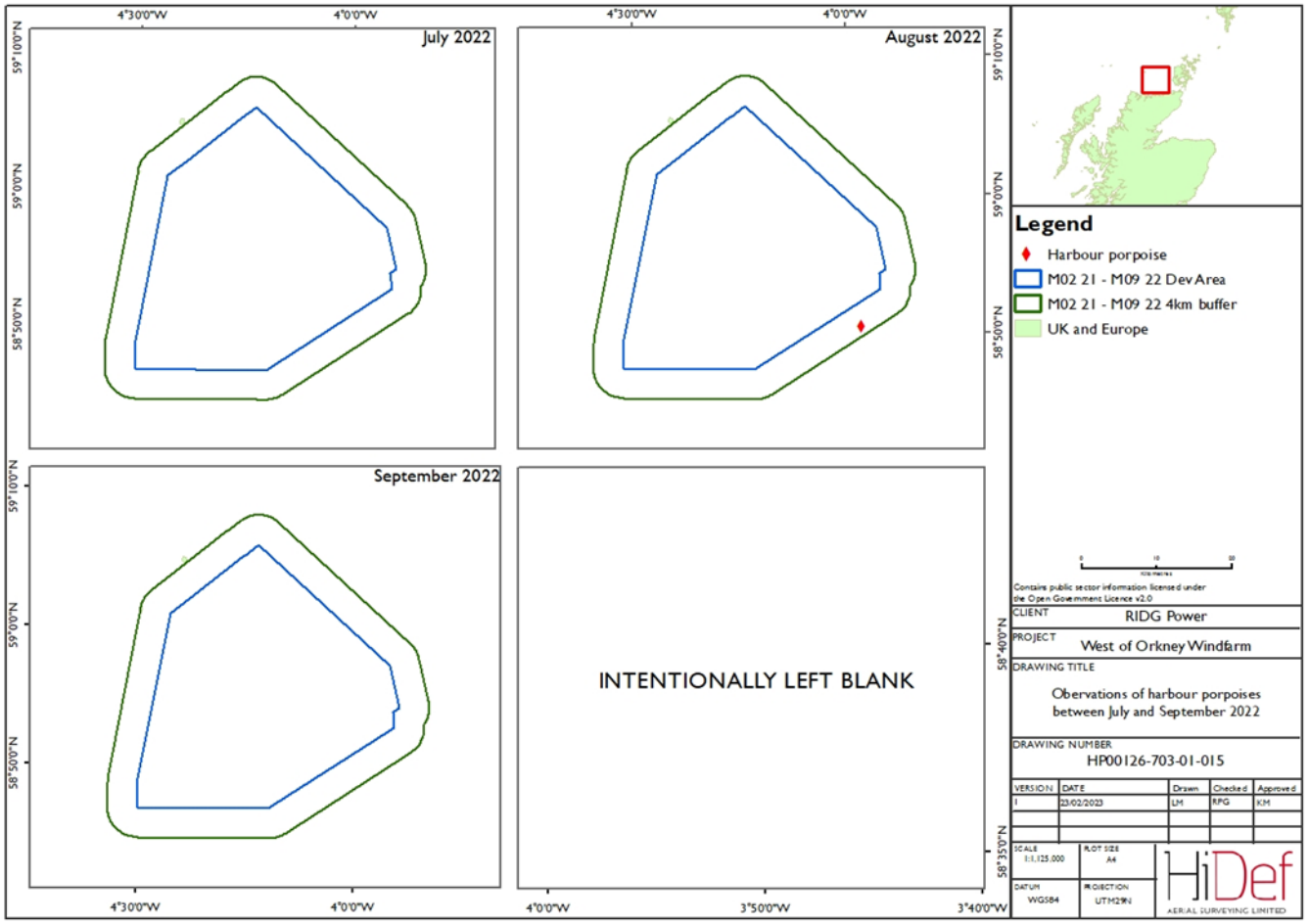


Figure 14 Detections of harbour porpoises in the WOW survey area between July and September 2022.

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



3.3.3 White-beaked dolphin

71 White-beaked dolphins were recorded intermittently, with more animals recorded during Year 2 compared to Year 1 (Figure 15). 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.

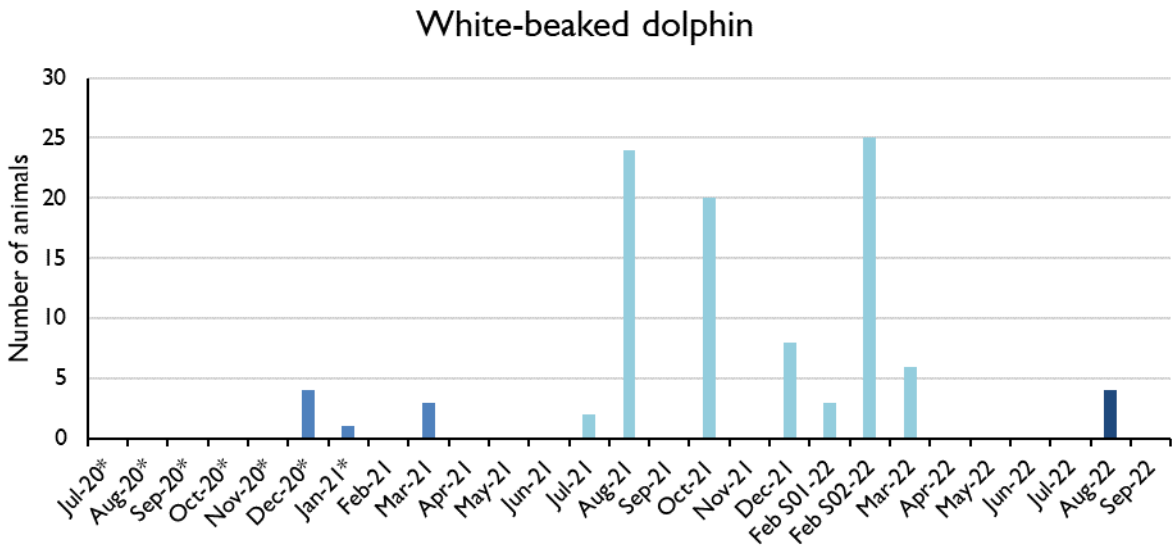
72 When observed, density estimates for the species ranged between 0.01 animals/km^2 (95% CI 0.00 – 0.02) in January 2021 and 0.15 animals/km^2 (95% CI 0.01 – 0.34) in February 2022 (Figure 16; Table 13), equating to 9 animals (95% CI 0 - 24) and 203 animals (95% CI 16 - 446) respectively.

73 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 17 to Figure 19).

74 Proportions of surfacing animals can be found in Table 11; 87% of individuals were recorded as submerged.

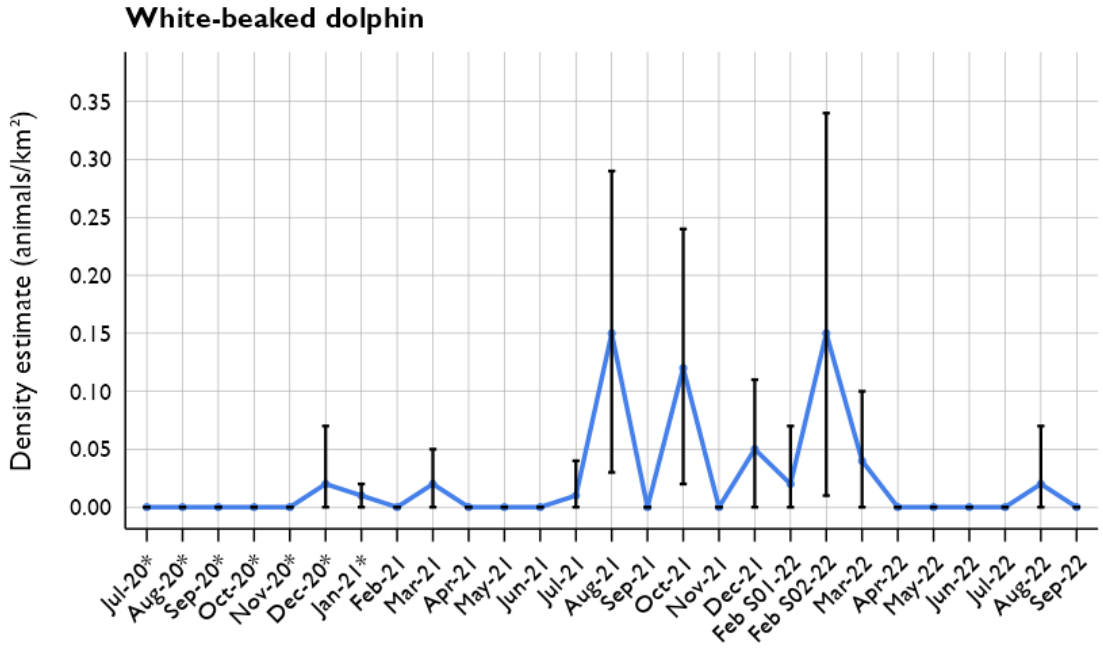
75 Throughout the survey period, a total of six adult-juvenile pairs were recorded; two in August 2021 and four in October 2021.

Figure 15 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)



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

Figure 16 White-beaked dolphin 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 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

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

Figure 17 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.

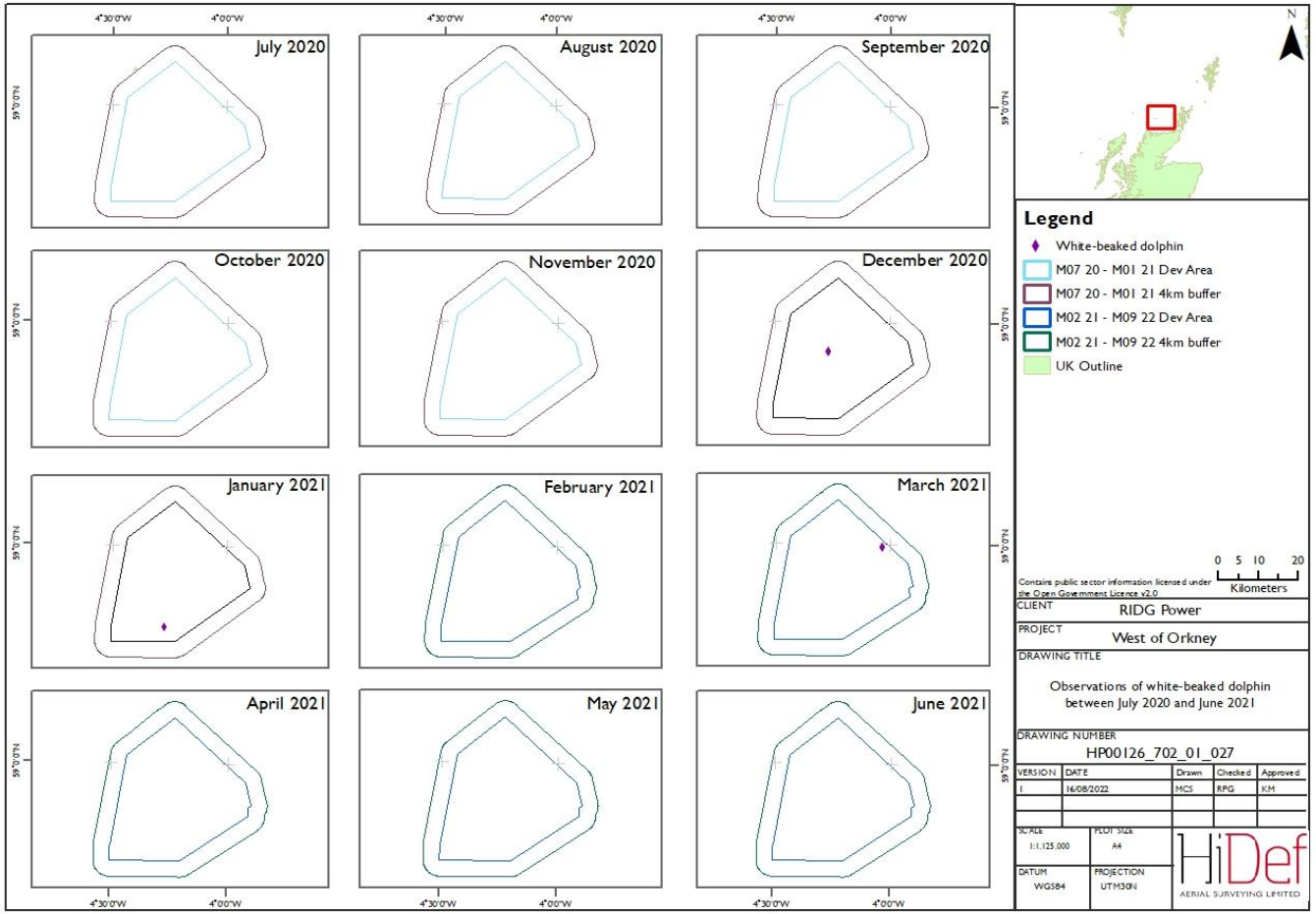


Figure 18 Density of white-beaked dolphins (number/km²) and number of detections per segment in the WOW survey area between July 2021 and June 2022.

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

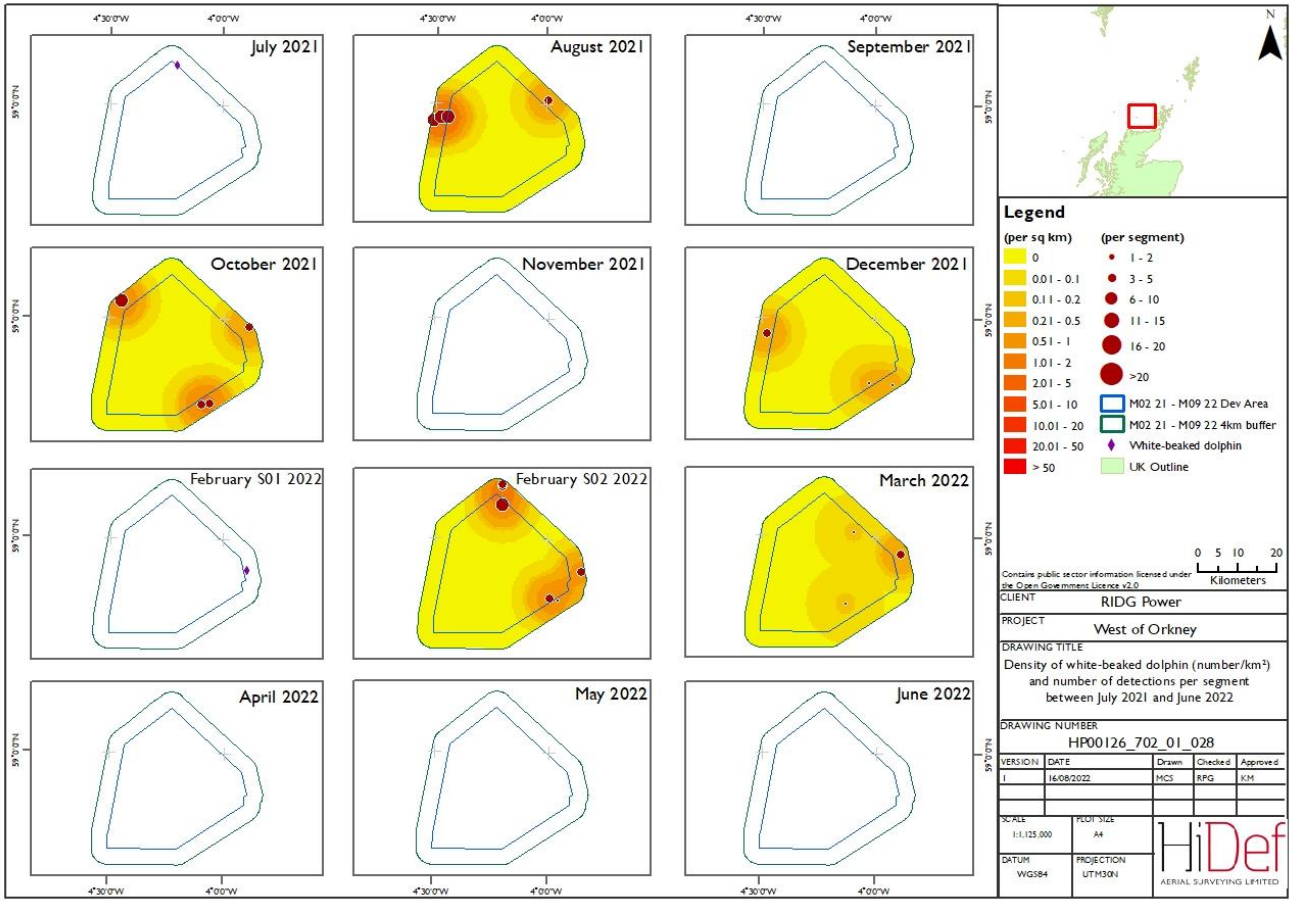


Figure 19 Detections of white-beaked dolphins in the WOW survey area between July and September 2022.

3.3.4 Less abundant non-avian animal species

76 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 20; Figure 21).

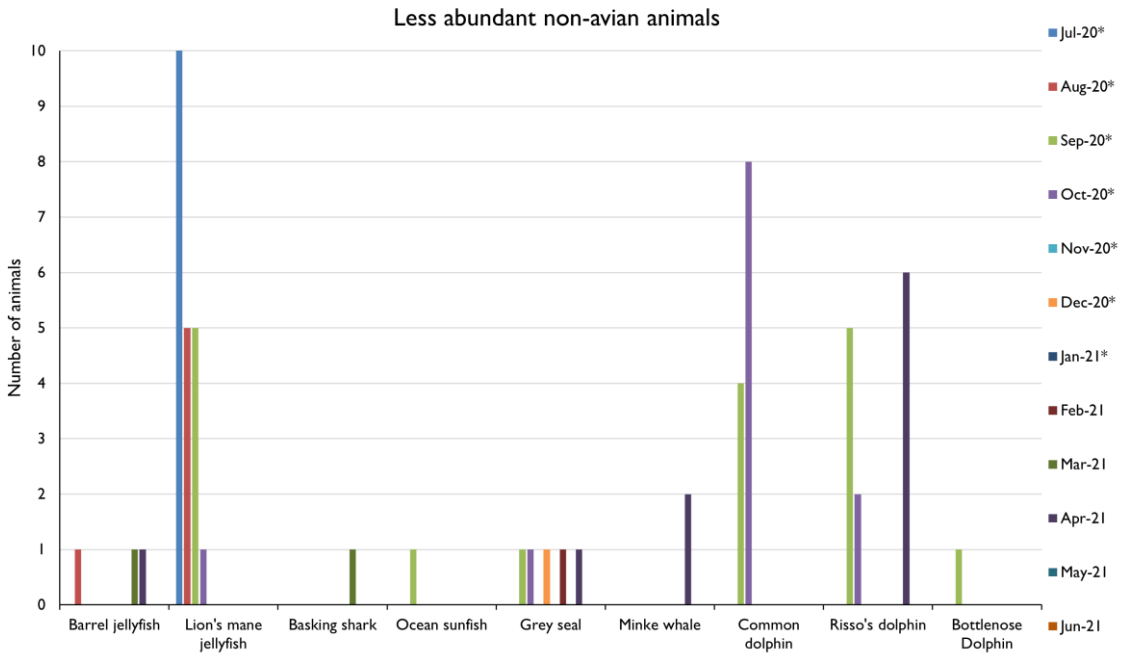
77 Common dolphins (*Delphinus delphis*) and Risso's dolphins (*Grampus griseus*) were the next most abundant marine mammals with 42 and 20 records respectively. Risso's dolphins were recorded in low numbers, with the majority of common dolphins (71%) recorded during the December 2021 survey. Risso's dolphin densities were generally higher in the north of the survey area, while common dolphins were distributed throughout both the development area and the 4km buffer (Figure 22 to Figure 24).

78 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.

79 It should be noted a different survey area was flown for the first seven surveys, which means raw counts may not be directly comparable. However, the change in area was very small and density estimates can provide this direct comparison because the counts are standardised per unit area sampled.

Figure 20 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 1 and Figure 2*

Figure 21 Number of less abundant non-avian animals recorded within the WOW survey area between July 2021 and September 2022

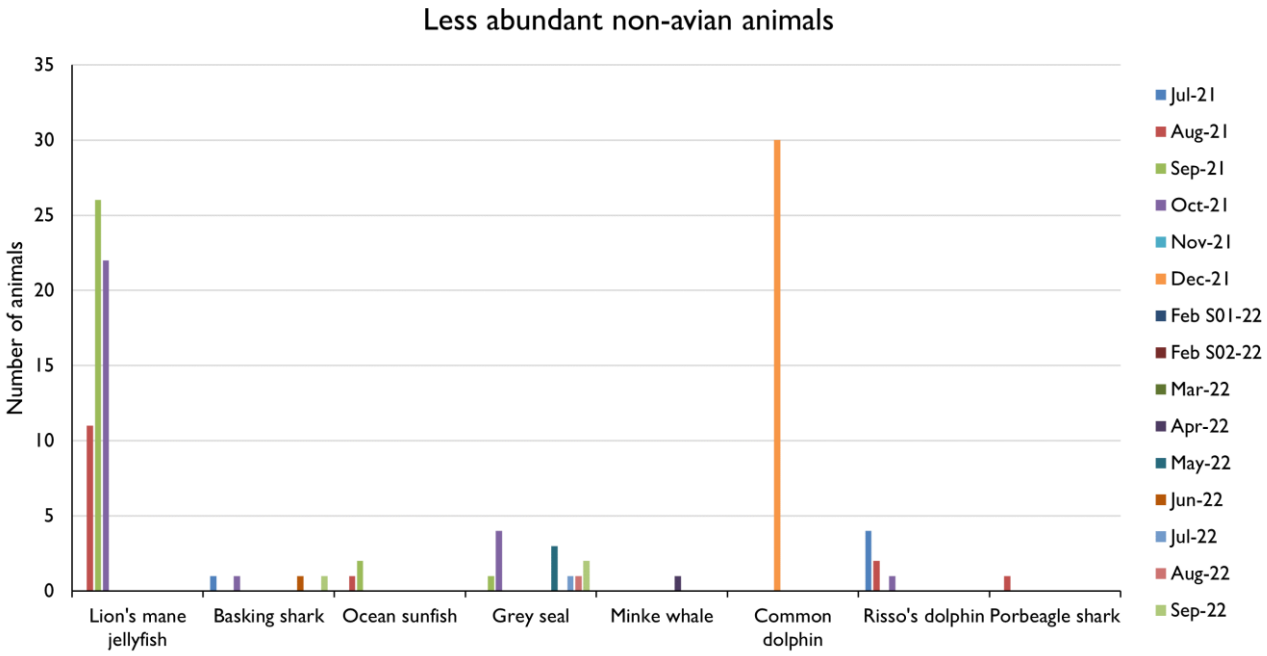


Figure 22 Detections of less abundant non-avian animal species in the WOW survey area between July 2020 and June 2021.

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

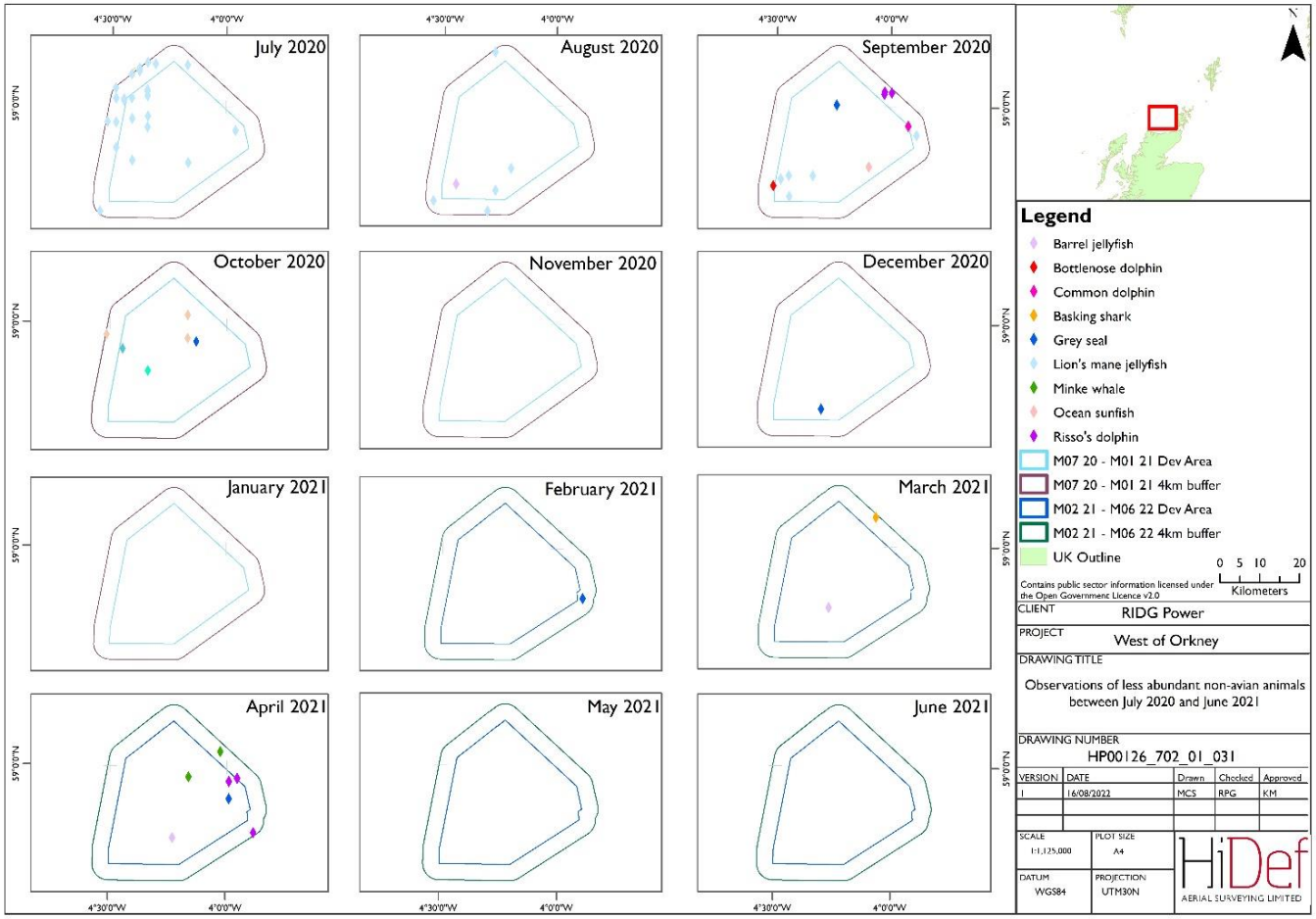


Figure 23 Detections of less abundant non-avian animal species in the WOW survey area between July 2021 and June 2022.

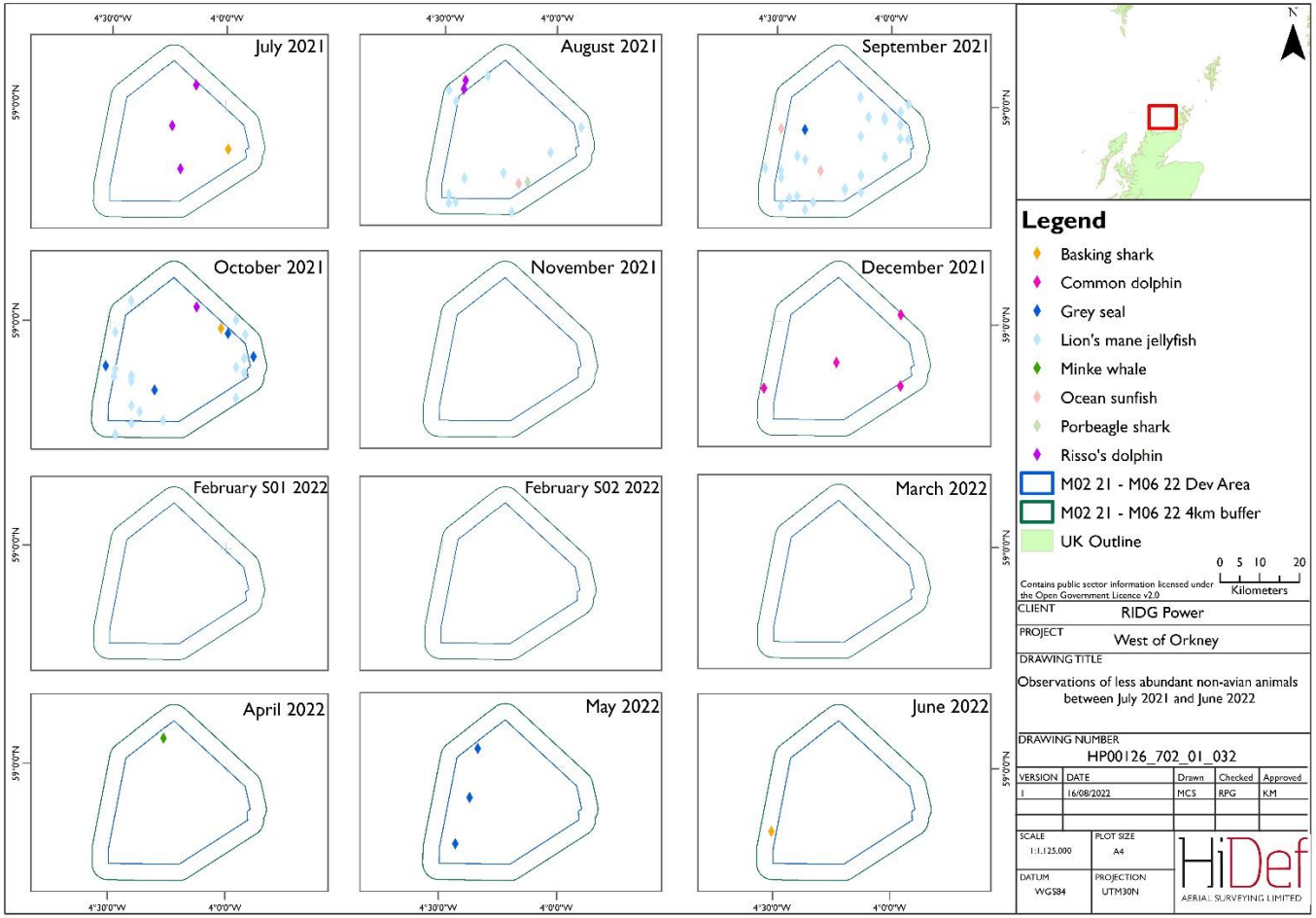
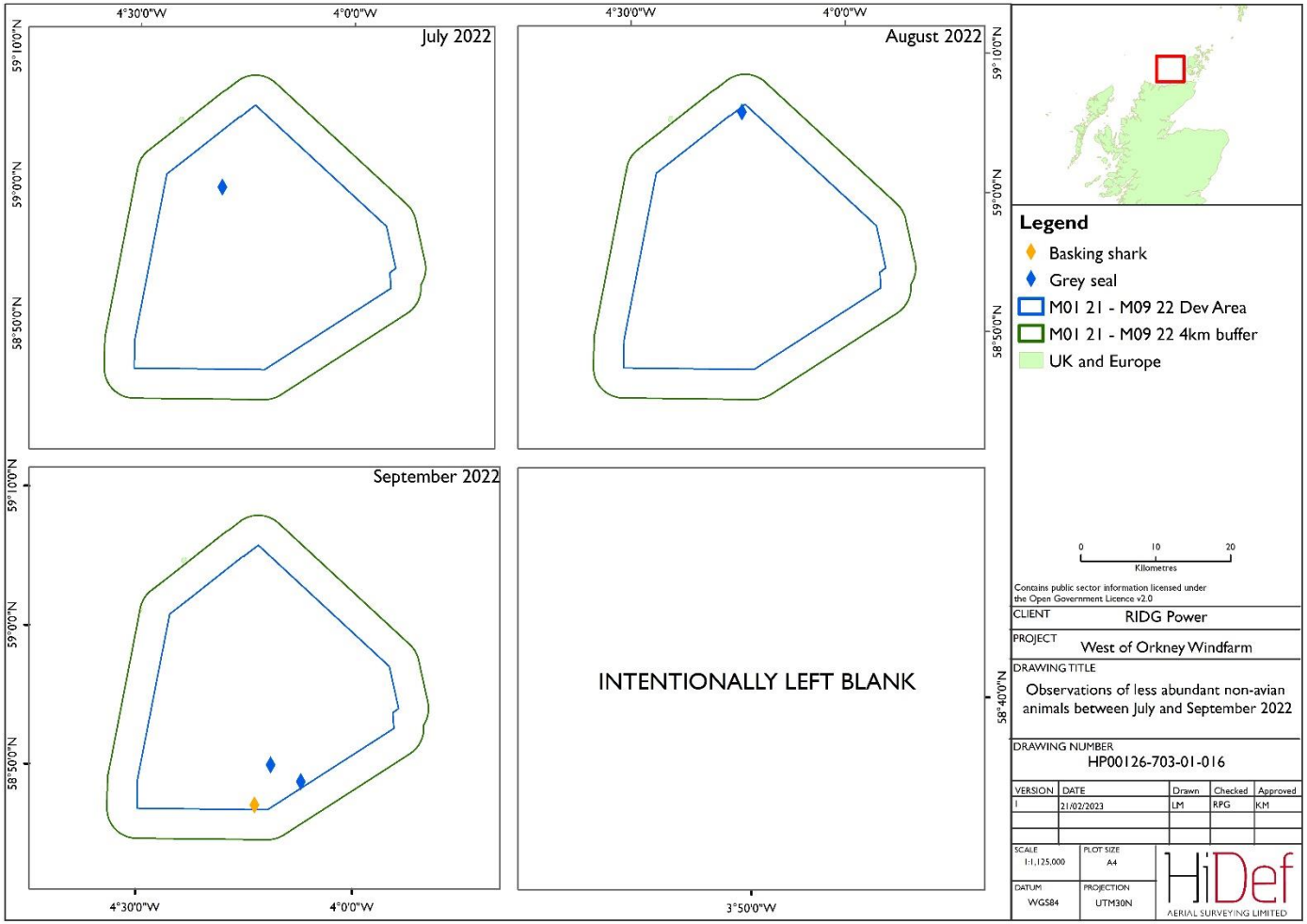


Figure 24 Detections of less abundant non-avian animal species in the WOW survey area between July and September 2022.



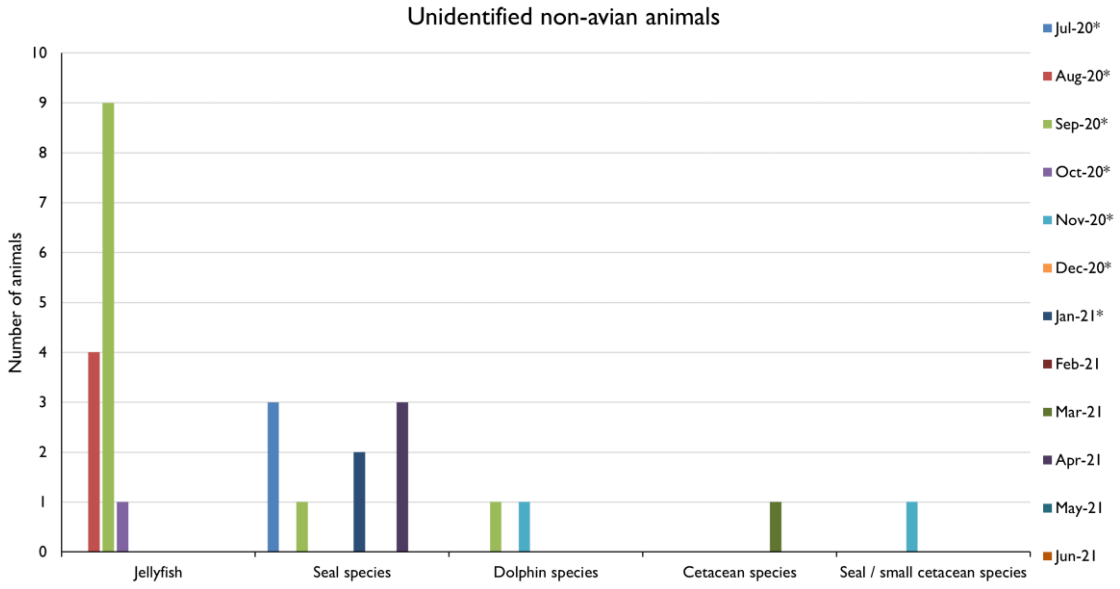
3.3.5 Unidentified non-avian animals

80 Several unidentified non-avian animals were recorded through the survey period, with peaks in non-identification related to seal species (Figure 25; Figure 26). 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.

81 Unidentified non-avian animals were generally observed in the south-west of the survey area (Figure 27 to Figure 29).

82 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 25 Number of unidentified non-avian animals recorded within the WOW survey area between July 2020 and June 2021



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

Figure 26 **Number of unidentified non-avian animals recorded within the WOW survey area between July 2021 and September 2022**

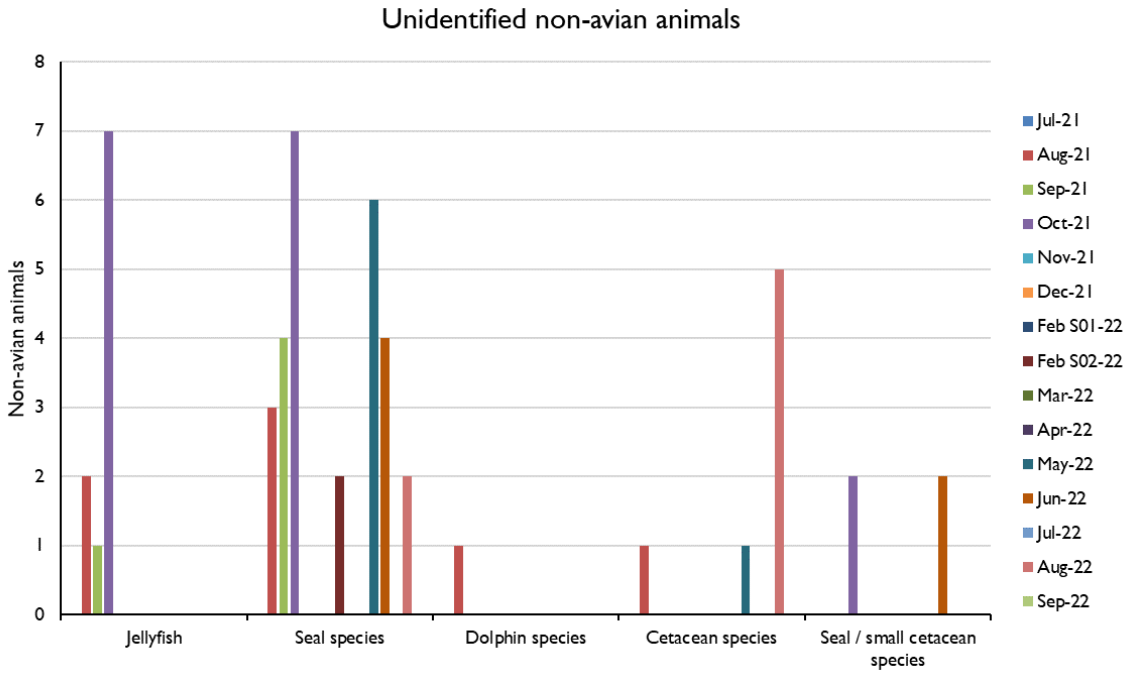


Figure 27 Detections of unidentified non-avian animal species in the WOW survey area between July 2020 and June 2021.

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

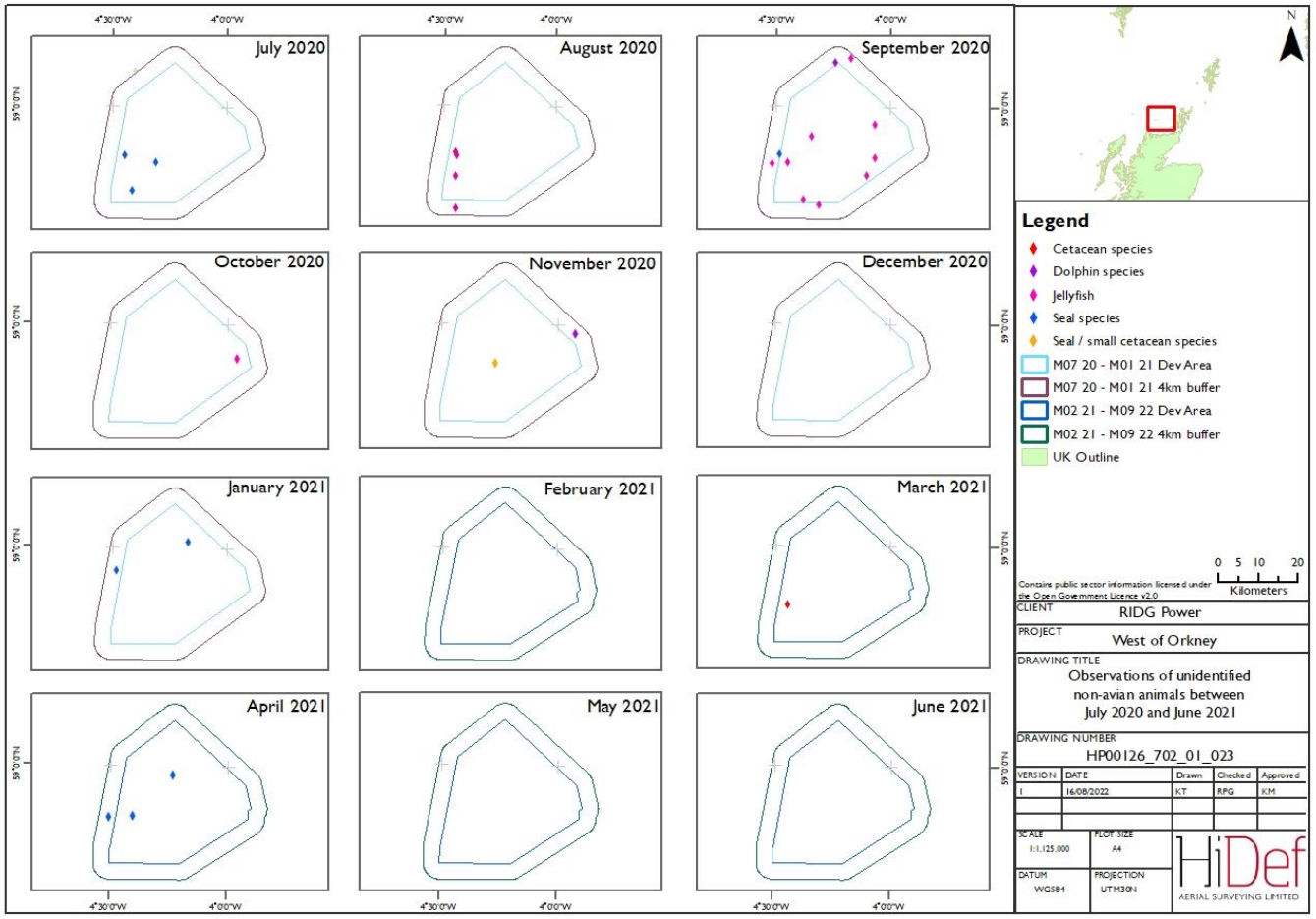


Figure 28 Detections of unidentified non-avian animal species in the WOW survey area between July 2021 and June 2022.

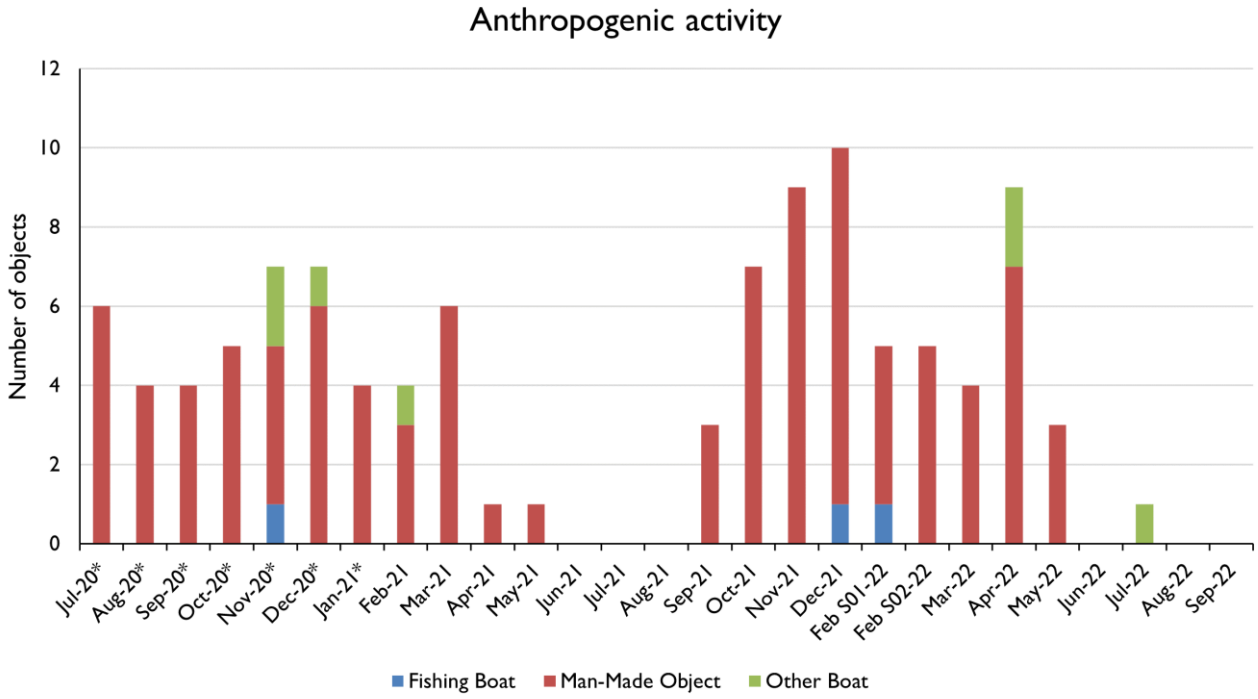
Figure 29 Detections of unidentified non-avian animal species in the WOW survey area between July and September 2022.

3.3.6 Anthropogenic activity

83 Anthropogenic activity was recorded throughout the survey period (Figure 30). Fishing boats were observed in November 2020, December 2021 and February S01 2022. 'Other boats' were also recorded intermittently.

84 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 31 to Figure 33). 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 30 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 31 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.

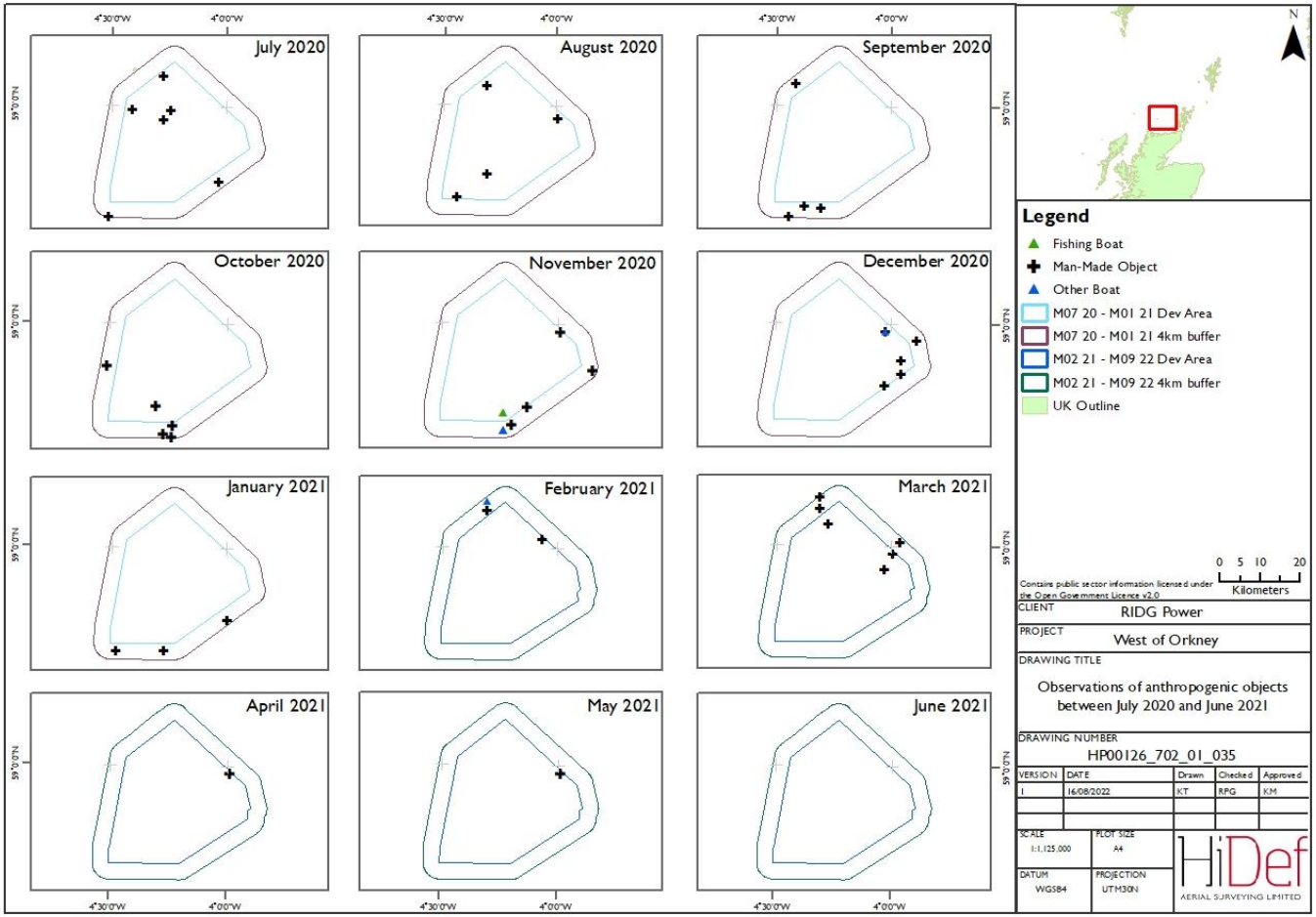


Figure 32 Detections of anthropogenic activity within the WOW survey area between July 2021 and June 2022.

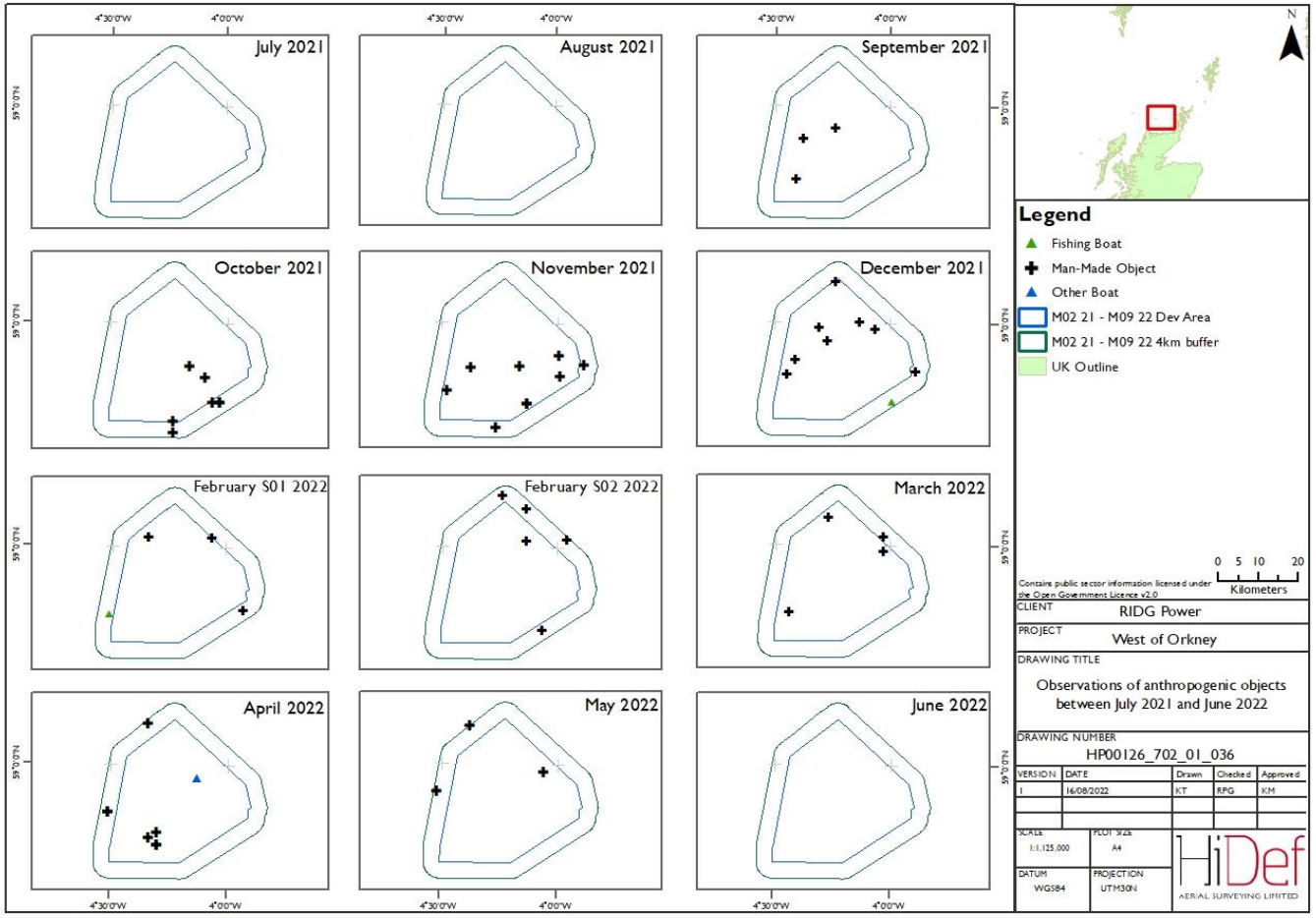
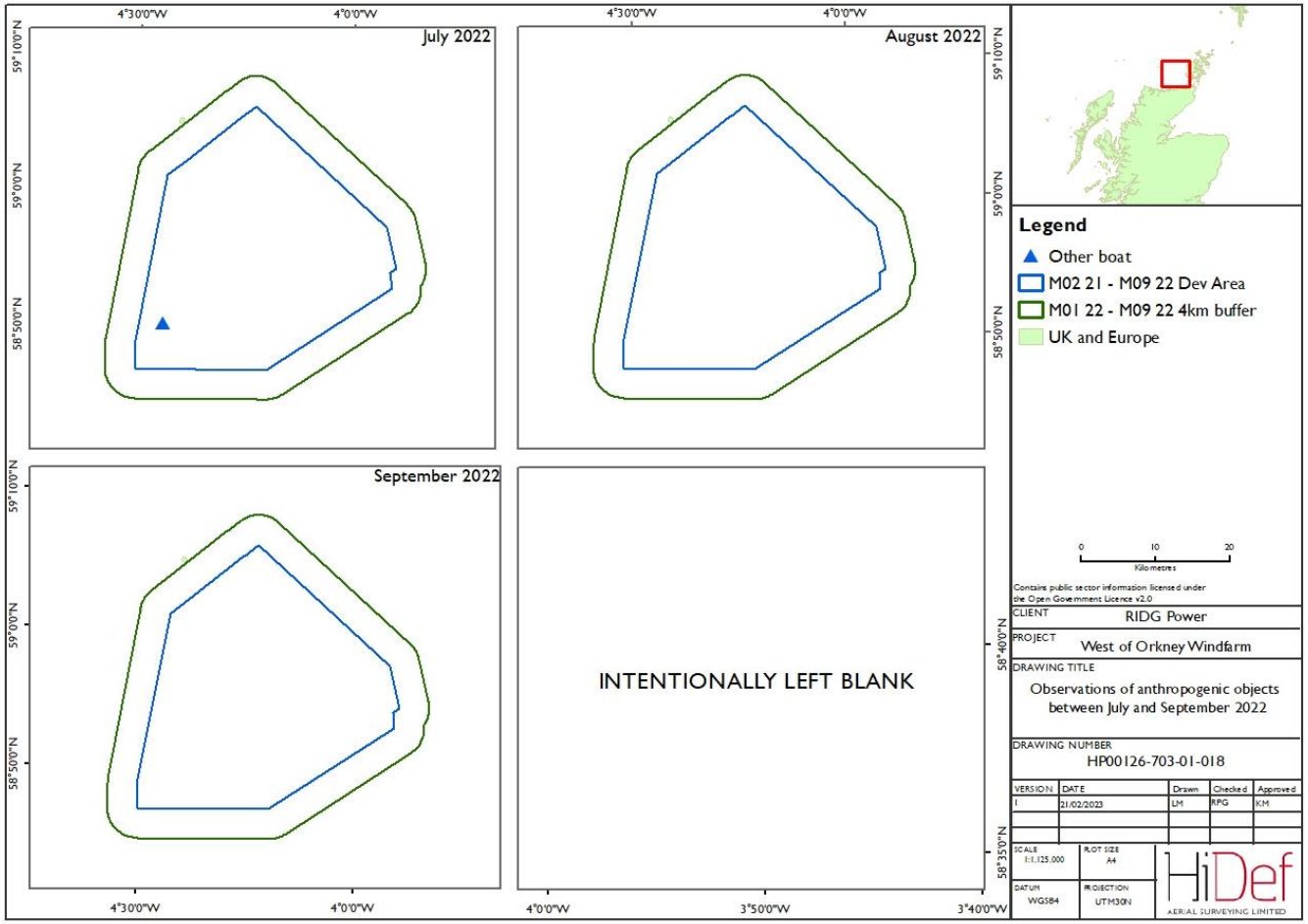


Figure 33 Detections of anthropogenic activity within the WOW survey area between July and September 2022.



4 Discussion

85 The surveys recorded a total of 415 non-avian animals of 12 species. A further 77 non-avian animals were recorded which were not assigned to a species. An identification rate to species level of 96.99% was achieved throughout the 27-month period.

86 Harbour porpoise were the most abundant marine mammal encountered, peaking in September 2021, with an estimated absolute density of 0.77 porpoise/km^2 (56.02% 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. 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).

87 An additional ten non-avian animal species were recorded during the survey period including 94 lion's mane jellyfish, 42 common dolphins and 20 Risso's dolphins. Anthropogenic activity was also recorded in the majority of surveys with fishing buoys being the most numerous.

5 Conclusions

88 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.

89 The surveys recorded a total 415 non-avian animals of 12 species. A further 77 non-avian animals were recorded which were not assigned to a species. Estimates of density and abundance for seabirds are presented in the SS12: Offshore ornithology technical supporting study. An identification rate to species level of 96.99% was achieved throughout the 27-month period.

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

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Appendix I: Density and population estimates

91 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 14 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 non-avian animals	0.18	231	118	359	64	27.56
Species group						
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 15 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						
Lion's mane jellyfish	0.15	193	88	310	57	29.22
Harbour porpoise	0.01	17	0	48	17	98.92

Table 16 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 non-avian animals	0.09	122	40	222	46	37.57
Species group						
Jellyfish	0.06	83	16	168	40	48.13
Cetacean species	0.03	34	0	78	21	61.55
Seal / small cetacean species	0.01	9	0	30	9	98.73

Table 17 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						
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 18 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 non-avian animals	0.33	428	283	593	81	18.77
Species group						
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 19 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						
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 20 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 non-avian animals	0.08	105	24	213	48	45.51
Species group						
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 21 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						
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 22 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 non-avian animals	0.02	25	0	63	17	69.69
Species group						
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 23 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						
Harbour porpoise	0.01	9	0	24	8	90.38

Table 24 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 non-avian animals	0.03	42	0	118	32	75.70
Species group						
Seal species	0.01	8	0	24	8	91.36
Dolphin species	0.02	31	0	94	29	92.47

Table 25 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						
Grey seal	0.01	8	0	24	8	92.28
White-beaked dolphin	0.02	32	0	95	31	94.14

Table 26 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 non-avian animals	0.03	33	0	71	18	54.59
Species group						
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 27 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						
White-beaked dolphin	0.01	9	0	24	8	91.64
Harbour porpoise	0.01	8	0	24	8	95.97

Table 28 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 non-avian animals	0.03	40	0	101	27	65.83
Species group						
Seal species	0.01	8	0	24	8	98.61
Cetacean species	0.02	33	0	77	19	58.98

Table 29 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						
Grey seal	0.01	8	0	24	8	101.51
Harbour porpoise	0.02	32	0	72	19	58.69

Table 30 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 non-avian animals	0.07	86	24	166	37	42.84
Species group						
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 31 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						
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 32 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 non-avian animals	0.21	278	161	416	66	23.54
Species group						
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 33 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						
Barrel jellyfish	0.01	8	0	24	8	96.07
Grey seal	0.02	33	8	62	15	43.64
Minke whale	0.01	16	0	39	11	67.89
Risso's dolphin	0.04	48	0	117	29	61.08
Harbour porpoise	0.13	173	79	277	50	28.78

Table 34 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 non-avian animals	0.01	8	0	24	8	100.32

Table 35 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 non-avian animals	0.01	8	0	24	8	100.58
Species group						
Cetacean species	0.01	8	0	24	8	101.64

Table 36 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						
Harbour porpoise	0.01	9	0	24	8	94.84

Table 37 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 non-avian animals	0.07	91	24	180	41	45.44
Species group						
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 38 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						
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 39 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 non-avian animals	0.31	409	220	616	105	25.58
Species group						
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
Dolphin species	0.16	215	64	406	87	40.30
Cetacean species	0.04	47	0	118	31	66.01

Table 40 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						
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 41 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 non-avian animals	0.33	428	283	593	81	18.77
Species group						
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 42 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						
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 43 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 non-avian animals	0.43	572	366	837	122	21.31
Species group						
Jellyfish	0.18	233	69	451	98	42.08
Shark species	0.01	8	0	24	8	97.94
Seal species	0.07	90	47	135	24	26.22
Dolphin species	0.13	171	40	324	76	44.20
Cetacean species	0.05	64	8	140	34	52.92
Seal / small cetacean species	0.01	16	0	40	11	67.44

Table 44 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						
Lion's mane jellyfish	0.18	235	72	467	104	43.92
Basking shark	0.01	8	0	24	8	97.42
Grey seal	0.07	88	40	135	24	27.09
Risso's dolphin	0.01	9	0	24	8	90.94
White-beaked dolphin	0.12	162	32	311	73	44.66
Harbour porpoise	0.05	64	8	134	33	51.14

Table 45 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 non-avian animals	0.27	352	86	929	223	63.41
Species group						
Dolphin species	0.23	302	39	741	210	69.50
Cetacean species	0.03	40	8	78	19	46.68

Table 46 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						
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 47 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 non-avian animals	0.02	31	0	87	25	81.53
Species group						
Dolphin species	0.02	26	0	72	25	97.44
Cetacean species	0.01	8	0	24	8	100.40

Table 48 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						
White-beaked dolphin	0.02	24	0	91	25	100.78
Harbour porpoise	0.01	9	0	24	8	98.69

Table 49 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 non-avian animals	0.22	289	85	568	122	42.06
Species group						
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 50 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						
White-beaked dolphin	0.15	203	16	446	113	55.50
Harbour porpoise	0.05	66	15	136	33	49.50

Table 51 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 non-avian animals	0.05	65	8	152	37	57.63
Species group						
Dolphin species	0.04	48	0	126	33	67.86
Cetacean species	0.01	17	0	48	17	98.77

Table 52 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						
White-beaked dolphin	0.04	48	0	127	34	70.76
Harbour porpoise	0.01	17	0	49	16	96.77

Table 53 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 non-avian animals	0.01	8	0	24	8	92.98
Species group						
Cetacean species	0.01	8	0	24	8	97.39

Table 54 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						
Minke whale	0.01	9	0	24	8	90.53

Table 55 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 non-avian animals	0.13	176	94	279	47	26.52
Species group						
Seal species	0.06	73	23	130	30	40.20
Cetacean species	0.08	104	40	182	37	35.03

Table 56 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						
Grey seal	0.05	65	16	125	28	42.04
Harbour porpoise	0.08	104	40	183	36	33.95

Table 57 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 non-avian animals	0.12	160	69	267	52	32.57
Species group						
Shark species	0.01	9	0	24	9	98.81
Seal species	0.02	33	8	63	15	45.03
Cetacean species	0.08	104	32	188	39	37.49
Seal / small cetacean species	0.01	16	0	48	16	98.90

Table 58 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						
Basking shark	0.01	8	0	24	8	100.61
Harbour porpoise	0.08	104	38	190	41	38.73

Table 59 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 non-avian animals	0.01	8	0	24	8	97.63
Species group						
Seal species	0.01	9	0	24	8	93.91

Table 60 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						
Grey seal	0.01	9	0	24	8	97.20

Table 61 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 non-avian animals	0.08	104	24	216	48	45.71
Species group						
Seal species	0.02	24	0	62	17	69.92
Dolphin species	0.02	33	0	96	30	93.42
Cetacean species	0.04	50	0	144	41	80.22

Table 62 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						
Grey seal	0.02	25	0	57	16	65.81
White-beaked dolphin	0.02	33	0	96	32	95.70
Harbour porpoise	0.04	48	0	129	37	77.63

Table 63 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 non-avian animals	0.02	24	0	49	13	50.87
Species group						
Shark species	0.01	8	0	25	8	97.01
Seal species	0.01	17	0	40	11	65.55

Table 64 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						
Basking shark	0.01	9	0	25	8	93.90
Grey seal	0.01	17	0	40	11	63.96