Digital video aerial surveys of seabirds and marine mammals at Arklow Bank:

Two-year survey report March 2018 - February 2020 survey programme (plus April 2020)

Population and density estimates

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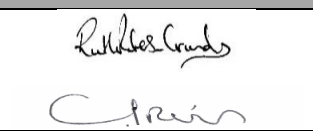
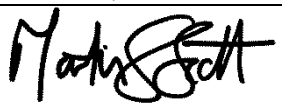
Prepared by	Ruth Peters-Grundy Catherine Irwin		02/06/2020
Checked by	Martin Scott		04/06/2020
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Executive Summary

1 In March 2018, SSE commissioned HiDef Aerial Surveying Limited (HiDef) to undertake a programme of high-resolution digital video aerial marine megafauna, ornithological and human activity surveys in an extension around the Arklow Bank offshore windfarm.

2 Arklow Bank is located approximately 10km off the Wicklow coast in the western Irish Sea.

3 Monthly surveys were commissioned from March 2018 to February 2020. HiDef designed a survey that placed transects at 2 km apart across Arklow Bank ('the survey area'). Due to weather and contract conditions in April 2019, the survey could not be flown. Instead two surveys were undertaken in July 2019. A later survey was additionally undertaken in April 2020, to provide data for that calendar month, resulting in twenty-five (25) months of combined data.

4 The HiDef surveys were undertaken using an aircraft equipped with four (4) HiDef Gen II cameras with sensors set to a resolution of 2 centimetres ('cm') Ground Sample Distance ('GSD'). Each camera sampled a strip of 125 m width, separated from the next camera by ~25 m, which provides a potential combined sampled width of 500 m within a 575 m overall strip. Footage from 1.6 of the four (4) cameras was processed yielding a strip width of 200 m. This was achieved by reviewing two part-cameras, each 100 m wide, giving 9.9% site coverage. The remaining footage is available for analysis at a later stage if required.

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

6 Surveys were successful in characterising the bird and mammal species present in the Arklow Bank survey area, recording a total of 31,291 birds of 37 species and 305 marine mammals of five (5) species, plus basking shark *Cetorhinus maximus* and barrel jellyfish *Rhizostoma pulmo*, in twenty-five (25) months. An average identification rate to species level of 92.85% was achieved across the survey programme.

7 This report presents the results of population and density estimates and density mapping. The primary observations were that:

- Guillemots *Uria aalge* and razorbills *Alca torda*, were the first and third most abundant species, found in high densities across the entire survey area including the proposed development site;
- Kittiwakes *Rissa tridactyla*, the second most abundant species, showed a strong attraction to the Arklow Bank area;
- Herring gulls *Larus argentatus* and Sandwich terns *Sterna sandvicensis* were recorded in low numbers;
- Red-throated divers *Gavia stellata* and gannets *Morus bassanus* were found in relatively low numbers but were recorded within the site near to the existing turbines;
- Manx shearwaters *Puffinus puffinus* were found in high densities across Arklow Bank in the breeding season;
- Arctic terns *Sterna paradisaea* and common terns *Sterna hirundo* were recorded in high numbers in 2018/19, with high densities across the site and turbines;

- Harbour porpoise *Phocoena phocoena* were found in consistent numbers across the survey period, with common dolphin *Delphinus delphis*, bottlenose dolphin *Tursiops truncatus*, grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* found in much lower numbers.

8 The work undertaken by HiDef collected twenty-five (25) months of continuous data towards satisfying the survey recommendations for the consent application.

1 Introduction

1 Arklow Bank offshore windfarm is a consented and part-operational project located approximately 10 km off the Irish Wicklow coast. The Foreshore Leaves, awarded to Sure Partners Ltd. (100% owned by SSE Renewables) in 2002, allows for the construction of up to 200 turbines in relatively shallow waters (less than 20 m deep) in four phases. The consented turbines allow for the blade tip to be a minimum height of 20 m above sea level and no higher than 100 m in height above sea level. Seven 3.6MW turbines have been operational since 2004 in Phase 1.

2 The EIS for the Arklow Bank project identified red throated diver and little gull as the most sensitive species at this location. Monitoring of the seabirds using the survey area around the wind farm following construction was undertaken on an annual basis up to June 2010. The monitoring programme followed boat based transect survey methods a standard as well as monitoring numbers and productivity of the nearest seabird breeding colony of note at Wicklow Head (Ecology Ireland 2013)

3 In March 2018, SSE Renewables commissioned HiDef Aerial Surveying Limited (HiDef) to undertake a programme of high-resolution digital video aerial surveys of marine megafauna, ornithological and human activity in support of the extension development proposals for Arklow Bank.

4 HiDef designed the survey to provide suitable information in support of SSE's proposal for an extension to the offshore wind farm at Arklow Bank. This requires an accurate assessment of abundance and distribution of seabirds and marine mammals to enable environmental impact assessment to take place.

5 The site is located within close proximity to two important bird sites, classified as Special Protection Areas ('SPAs') under the European Council ('EC') Directive 2009/147/EC on the Conservation of Wild Birds ('the Birds Directive'). Wicklow Head SPA (IE004127), designated for the protection of kittiwake *Rissa tridactyla*, lies within the north-west corner of the survey area; approximately 7km from the Arklow Bank consented site boundary (NPWS, 2020c). The Murrough SPA (IE004186), designated for the protection of red-throated diver *Gavia stellata*, black-headed gull *Chroicocephalus ridibundus*, herring gull *Larus argentatus*, little tern *Sterna albrifrons* and a number of duck and geese species, lies just outside of the survey area; approximately 15km north-west of the consented site (NPWS, 2020b). Approximately 40km north of the consented site, lie the Dalkey Islands SPA (IE004172), designated for the protection of roseate tern *Sterna dougalli*, common tern *S. hirundo* and Arctic tern *S. paradisaea* (NPWS, 2020a).

6 Nesting seabirds are known to occur in a wide area around their breeding colonies, with the highest densities occurring in the spring, summer and early autumn. Seabirds are capable of travelling long distances to feed and forage, as well as breed, and so designated sites further afield, for example, around the wider Irish Sea are likely to use the features of waters in and around the project area for feeding and transit. Comprehensive data on important offshore sites for breeding and migratory birds in Ireland is still lacking (Burke, 2018), therefore the need to conduct year-round surveys to characterise abundance is all the more significant.

7 Marine mammals are also likely to occur year-round within the survey area, with harbour porpoise *Phocoena phocoena* being the most numerous. The Rockabill to Dalkey Island Special Area of Conservation ('SAC') (IE003000), situated less than 40km north of the consented site, is designated to protect this species (NPWS, 2013).

8 This two-year population and density estimate report provides the results from twenty-four (24) surveys undertaken between March 2018 and February 2020, with the addition of a further month: April 2020. It presents both population abundance and density estimates of seabirds and non-avian animals occurring during this period, in the form of abundance tables and Kernel Density Estimate

('KDE') maps. It should be viewed in conjunction with the preceding 'two-year observation report' (HP00091-703-01) which presents the raw, unanalysed data, and additional flight height data report.

9 Commentary has also been provided as to the representativeness of the results.

2 Methods

2.1 Survey flights

10 A series of strip transects were flown on a monthly basis between March 2018 and February 2020, following the protocol agreed in March 2018 (document reference: HP00091-001). Two surveys were undertaken in July 2019 to mitigate for a lack of survey effort in April 2019, arising from poor weather conditions. An additional survey was flown in April 2020 to ensure data reflected seasonal species distributions robustly.

11 HiDef designed the survey to provide suitable information in support of SSE's proposal for an extension to the offshore wind farm at Arklow Bank. This requires an accurate assessment of abundance and distribution of seabirds and marine mammals to enable future environmental impact assessments to take place. Irish guidance on offshore pre-construction baseline surveys suggests the inclusion of a 4km buffer around sites >10km^2 for monitoring birds, and a 10km buffer for monitoring cetaceans, specifically basking sharks *Cetorhinus maximus* (DCCAE, 2018). In this case, agreement with SSE was for the former. For this reason, HiDef designed a survey that placed transects at 2 km apart across the survey area, which included a 4 km buffer around the consented site boundary but also took the survey area to the coast (Figure 1).

12 The strip transects were placed approximately perpendicular to the depth contours from the coast. Such a design helped to ensure that each transect sampled a similar range of habitats (primarily relating to water depth) which reduces the difference in bird and mammal abundance estimates between each transect.

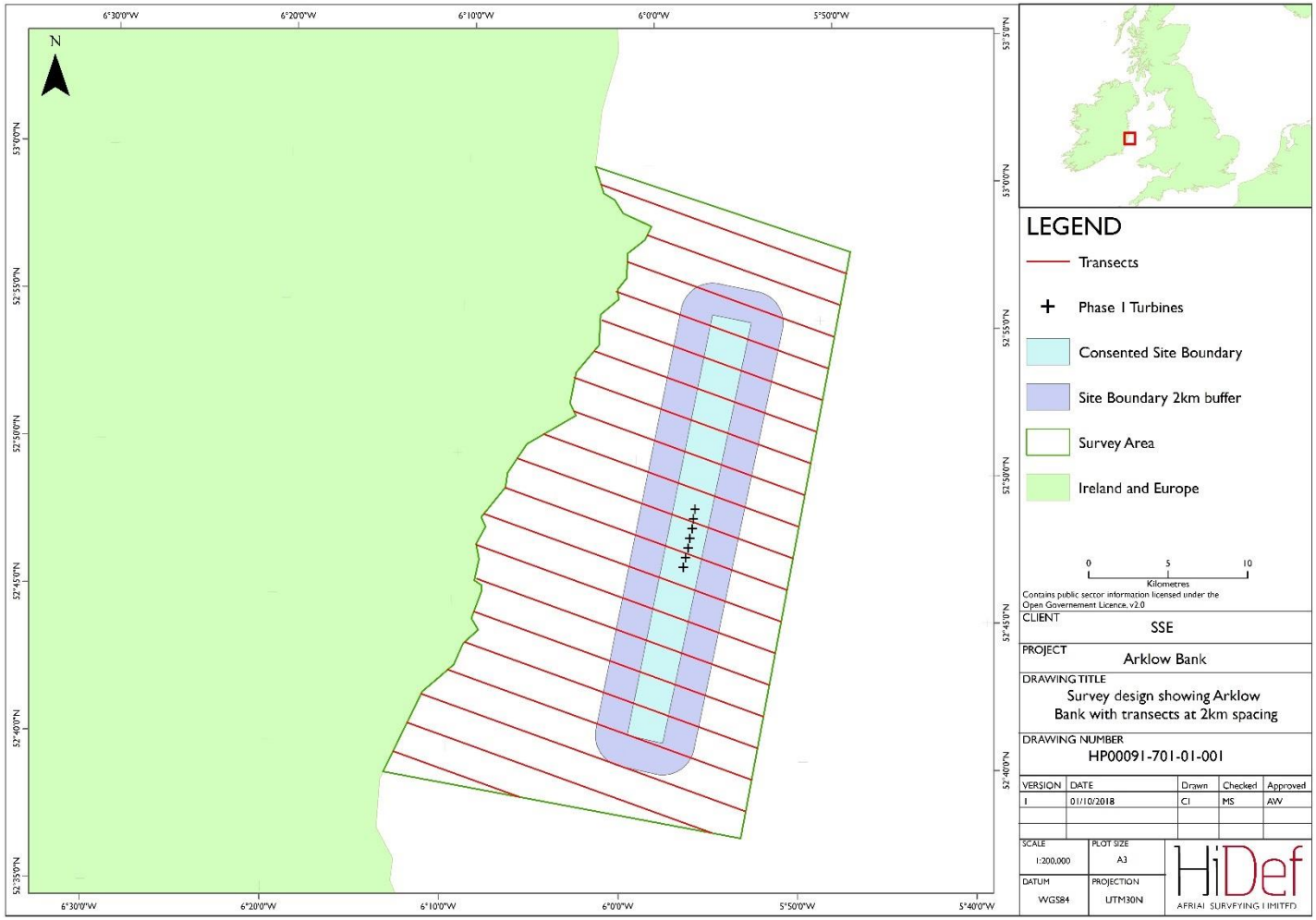
13 Surveys were undertaken using an aircraft equipped with four (4) HiDef Gen II cameras with sensors set to a resolution of 2 centimetres ('cm') Ground Sample Distance ('GSD'). Each camera sampled a strip of 125 m width, separated from the next camera by ~25 m, thus providing a combined potential sampled width of 500 m within a 575 m overall strip.

14 To allow a 10% site coverage, while ensuring an adequate number of transects, HiDef agreed with SSE that only data from two partial cameras (100m strip width) would be processed. This ensures that SSE have a survey designed with sufficient coverage and number of transects. It also offers the potential for the subsequent review and identification of additional data without undertaking additional surveys, should unusual observations be made, or should additional data be required.

15 The surveys were flown along the transect pattern shown in Figure 1 at a height of approximately 550 m above sea level (ASL) (~1800'). Flying at this height ensured that there was no risk of flushing those species which have been shown to be easily disturbed by aircraft e.g. scoter (Thaxter *et al.* (2016) recommend a minimum flight altitude of 500 m ASL).

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

Figure 1 Survey design showing Arklow Bank with planned transects at 2 km spacing



2.2 Data Review and Object Detection

17 Data were viewed by trained reviewers who marked any objects in the footage as requiring further analyses, 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.

18 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. In addition, additional training was then given to the reviewer to improve performance. No re-reviews were required for this data set.

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

2.3 Object Identification

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

21 At least 20% of all objects were subjected to an external QA process. If more than 10% disagreement was attained, then corrective action was initiated. If appropriate, the failed reviewer's data was discarded and the data re-reviewed. Any disputed identifications were passed to a third-party expert ornithologist for a final decision[1].

22 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 using the following definitions:

- 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.

It is important that people analysing the data results of these identifications don't fall into a trap of thinking that this is ever going to be a standardised assessment or if you can apply any form of probability to the identification reliability. The key thing is that the likelihood of achieving a definite or probable identification is not consistent for all component members of a species group. So, for example, someone undertaking ID of a large auk species is going to find it easier to be confident of guillemot identification than razorbill. If these confidence scores are used to filter or weight the probability of large auk being one species or another in any analysis, then this will lead to biased results, particularly if the identification

[1] HiDef currently employ three (3) of the ten (10) current members of the British Birds Rarities Committee ('BBRC') as expert ornithologists

rate is low. This is why it is better to use the assessment of the person who is looking at the images rather than making assumptions based on biased data with high confidence identifications

23 Additional information was recorded for each bird on their basic behaviour: whether the bird was sitting, loafing on land or other objects or flying. In the latter case the direction of travel was also recorded. More detail was recorded where possible on foraging behaviour, approximate age and sex and any other details of interest.

24 In the case of marine mammals, surfacing behaviour was recorded as either 'surfacing', 'surfacing at red line', 'submerged' or 'unknown'. Surfacing behaviour was defined as any surfacing behaviour that occurred while the non-avian animal was visible. However, for the purposes of calculating availability bias, harbour porpoise surfacing behaviour was also classified as if the animal's dorsal fin was above the water in the frame nearest to the 'red line' on the operator's screen.

2.4 Final processing

25 All data were geo-referenced, taking into account the offset from the transect line of the cameras which gives a higher degree of positional accuracy to each geo-referenced object and compiled into a single output. Geographical Information System ('GIS') files for the Observation and Track data were issued in ArcGIS shapefile format, using UTM30N projection, WGS84 datum.

2.5 Data analysis

2.5.1 Data treatment

26 After baseline numbers were established, data were processed for estimating abundance and distribution of the key species and species groups. Confidence levels, giving high and low extremes, were produced for each species as part of statistical working. All confidence levels of species identifications were used in the analysis. In the analysis of species groups, rationalisation of the full list of species groups was carried out in order to simplify the interpretation. Where identification to species was not possible analysis was carried out at species group level.

27 For species groups which include different genus, species level identification is used to assign to species group. Where identification to species level is not possible, a broader species group category is used instead for that record. For example, birds originally assigned to the category 'Shearwater / auk species' might be assigned to 'Shearwater species' if they were identified as a Manx shearwater *Puffinus puffinus*; and to 'Auk species' if identified as a guillemot, or remain as 'Shearwater / auk species' if no species level identification was recorded.

2.5.2 Abundance estimates

28 The abundance of each species observed was estimated separately using a design-based strip transect analysis with variance and confidence intervals ('CI') derived through 5,000 bootstraps. The bootstrapping technique uses the total length of each survey transect to limit selection rather than total number of transects. This method has a particular advantage when transects are of unequal length and provides better precision estimates. For most species these abundance estimates relate to absolute abundance, but for diving species (auks and marine mammals) the abundance relates to relative abundance. In Section 2.6.4 we describe our method for taking account of availability, which provides a reasonable measure of absolute abundance.

29 In a strip transect analysis, each transect is treated as an independent analysis unit, and the assumption is made that transects can be treated as statistically independent random samples from the site. The

length of each transect and its breadth (i.e. the width of the field of view of the camera) multiplied together give the transect area; dividing the number of observations on that transect by the transect area gives a point estimate of the density of that species for the site. The density of animals at the site (and hence the population size), the standard deviation, 95% confidence intervals ('CI') and coefficient of variance ('CV') are then estimated using a non-parametric bootstrap method with replacement (Buckland et al., 2001).

30 The upper and lower 95% confidence intervals were performed by way of a blocked bootstrapping technique in order to ensure equal transect effort was sampled across each iteration. This was done by using transect ID as the sampling unit with replacement, and then randomly sampling until the total length of the sampled transects equalled approximately the same length as the total survey length. A total of 5,000 bootstrap iterations were performed from which we calculated the mean and standard deviation of the sampled means, as well as the relative standard error as defined by the standard deviation divided by the mean. Data were processed in the R programming language (version 3.4.3) and code can be provided on request.

31 The density estimate is expressed as the average number of animals per square km surveyed over the whole study area or the project area, and the population estimate is then calculated as the density multiplied up to the area of the whole project area or the study area (project area with 4 km buffer). The upper and lower CI define the range that the population estimate falls within with 95% certainty. The CV, also referred to as the relative standard error, is a measure of the precision of the population and density estimates.

2.5.3 Density mapping

32 The density maps have been derived using a Watson-Nadaraya type kernel density estimation ('KDE') technique (Simonoff, 1996). In KDE, a small 'window' function (the kernel) is used to calculate a local density at each point in the study area. To evaluate the density at a given point, the kernel is centred on that point and all the observations within the window are summed to obtain a local count. The total area of the transect(s) intersecting the window is then summed to obtain a local measure of effort. By dividing the local count by the local effort, a local density estimate is obtained. To build a density map, the study area is covered with a fine mesh of study points and the density is calculated at each point in the mesh in turn.

33 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 window is determined by a single width parameter; the selection of this parameter is the only variable in the computation of the density maps.

34 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.

35 To apply cross validation to the survey area, each transect is subdivided into 1km long segments. To evaluate a particular choice of kernel width, each segment is removed in turn, use 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 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.

36 It should be noted that several of the KDE maps are effectively flat. 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 mainly happens 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 does not 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.

2.5.4 Availability bias

37 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 may lead to an under-estimate of their abundance during surveys, which is known as availability bias. For species that make long dives underwater, this bias might be significant (for example, razorbill *Alca torda*).

38 There are two main approaches to accounting for availability bias: by using double platform surveys (for example Borchers et al. 2002) which is 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).

Barlow used an equation to determine the proportion of time that an animal is not available in equation 1:

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

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

40 All available data for seabirds relate to diving behaviour obtained by direct observation, or in the case of guillemots and razorbills, to data obtained during the breeding season using data loggers. Thaxter et al. (2010) give average times for these species engaged in flying, feeding and spent underwater during the chick-rearing period. We have used the mean time spent underwater (1.9 and 0.8 hours for guillemots *Uria aalge* and razorbills respectively) as a percentage of the mean time spent at sea not flying (8.0 and 4.6 hours respectively). Thus, the percentage time spent underwater for guillemots is 23.75% and for razorbills is 17.4%. For puffins *Fratercula arctica*, data from data loggers were used from Spencer (2012), which estimated that puffins spend 14.16% of daylight time underwater.

41 These figures can only be applied to estimates of relative abundance of birds sitting on the sea and should be added to the true abundance of flying birds to give an estimate of true abundance for the species. For this reason, it was necessary to calculate the percentage of birds as a total of all observations and applying these to the estimates of abundance for the two species. Because of low sample sizes of guillemots and razorbills in many months, we used the percentage of sitting birds to calculate the

correction factors for abundance estimates within the proposed development area. For some species, too few observations were available to assess the ratio of sitting to flying birds with confidence and consequently, a ratio was used that pooled data for certain species. We have used these percentage figures to scale up the relative abundance estimate of guillemots, razorbills and puffins sitting on the sea by factors of 1.2375, 1.174 and 1.1416 respectively, and then added these corrected abundance estimates for sitting birds to the abundance estimate of flying birds (see discussion for shortcomings of this method). A scaling factor was also applied for large auks and auk species in proportion to the ratio of the estimated abundance of sitting guillemots, razorbills and puffins to each other and to other species within each of the mapped grid cells.

42 Harbour porpoise abundance is also affected by availability bias, and further complicated because detections of animals are also possible while they are submerged. There are two approaches to using known diving rates to correct for availability bias for this species: to apply 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 using the proportion of time spent at known depths by tagged animals.

43 The depth above which animals are available for detection is not known and is likely to vary according to the turbidity of the water, and perhaps other factors, but has been estimated to be 2m by Teilmann et al. (2013) when correcting for availability bias during visual aerial surveys of harbour porpoise.

44 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 in the surface 2m of the water column and 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. The tagging study of Teilmann et al. (2013) did not extend to the Irish Sea, and no other data are available on surfacing behaviour for this species in the relative area. For our analysis, we assumed that diving behaviour in the eastern Irish Sea was similar to that of the similar depth North Sea and used the model outputs from the North Sea in our calculations. In order to estimate the density of surfacing harbour porpoise, it was necessary for us to use the density of all detectable animals and calculate the proportion where the dorsal fin was snapshot surfacing. Snapshot surfacing indicates where the head of a seal or dorsal fin of a cetacean are clear of the water surface in the middle frame of the sequence in which the animal is present. This was done using data from all months combined because sample sizes were too small to be accurate when calculating the surfacing proportions in individual months. We multiplied the calculated density of harbour porpoise by the proportion of snapshot surfacing encounters in our surveys and divided this by the proportion of surfacing behaviour from Teilmann et al. (2013) in Table 1, to derive the estimates of absolute density and abundance used in Table 57.

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	Behaviour			
	Surface		0 – 2 m	
	09:00 – 15:00	15:00 – 21:00	09:00 – 15:00	15:00 – 21:00
January	0.0490	0.0476	0.4381	0.418614
February	0.0398	0.0384	0.3748	0.355348
March	0.0543	0.0529	0.4637	0.444271
April	0.0646	0.0632	0.5708	0.551331
May	0.0563	0.0549	0.5262	0.506735
June	0.0518	0.0503	0.5093	0.489809
July	0.0493	0.0479	0.5116	0.492099
August	0.0530	0.0516	0.4508	0.431293
September	0.0420	0.0406	0.4468	0.427348
October	0.0413	0.0399	0.4422	0.42276
November	0.0406	0.0392	0.4439	0.424431
December	0.0429	0.0415	0.4790	0.459555

3 Results

3.1 Survey effort

45 The date, number of transects and survey effort (as expressed by length of transects) undertaken between March 2018 and February 2020, plus April 2020, are shown in **Error! Not a valid bookmark self-reference.**. The number of transects and the total length of transects are those used in subsequent analyses.

46 The same transect lines were used for each survey, although effort differed slightly between surveys. This was caused by minor differences in start and stop times for transects and minor deviations of the aircraft from the transect line.

Table 2 Survey effort across Arklow Bank between March 2018 and February 2020 inclusive, plus April 2020

Survey date	Number of transects analysed	Total length of transects analysed (km)	Area covered (km²)
27 March 2018	20	341.47	68.29
23 April 2018	20	342.32	68.46
10 May 2018	20	341.74	68.35
21 June 2018	20	341.29	68.26
3 July 2018	20	342.08	68.42
25 August 2018	20	341.18	68.24
7 September 2018	20	342.65	68.53
1 October 2018	20	341.93	68.39
22 November 2018	20	342.15	68.43
18 December 2018	20	341.71	68.34
28 January 2019	20	342.19	68.44
11 February 2019	20	342.14	68.43
17 March 2019	20	342.71	68.54
4 May 2019	20	343.77	68.75
13 June 2019	20	341.61	68.32
2 July 2019	20	341.97	68.39
27 July 2019	20	341.47	68.29
13 August 2019	20	343.16	68.63

Survey date	Number of transects analysed	Total length of transects analysed (km)	Area covered (km²)
5 September 2019	20	343.75	68.75
6 October 2019	20	339.90	67.98
10 November 2019	20	341.13	68.23
9 December 2019	20	342.35	68.47
10 January 2020	20	342.15	68.43
12 February 2020	20	343.76	68.75
25 April 2020	20	342.78	68.56

3.2 Identification rates

47 Each animal was assigned to at least a species group, and where possible these were also assigned a species identification with confidence levels of 'Possible', 'Probable' or 'Definite'.

48 All records relating to definite, probable and possible are presented. Non-identifications are presented separately.

49 Any animals that could not be identified to species level were assigned to a category 'No ID' in the species column. The analysis of data to species level uses all levels of identification confidence; the overall identification rates of birds and non-avian animals to species level for the twenty-five (25) surveys were:

Table 3 Survey identification rates of species at Arklow Bank between March 2018 and February 2019 inclusive, plus April 2020

Survey date	ID rate (%)
27 March 2018	94.26
23 April 2018	93.56
10 May 2018	94.97
21 June 2018	91.85
3 July 2018	93.28
25 August 2018	93.45
7 September 2018	94.07
1 October 2018	92.06
22 November 2018	92.79
18 December 2018	93.93
28 January 2019	93.93
11 February 2019	91.63
17 March 2019	98.52
4 May 2019	86.93
13 June 2019	95.30
2 July 2019	94.43
27 July 2019	93.10
13 August 2019	90.44
5 September 2019	89.51

Survey date	ID rate (%)
6 October 2019	97.37
10 November 2019	92.22
9 December 2019	92.39
10 January 2020	89.78
12 February 2020	92.38
25 April 2020	89.22
Average	**92.85**

3.3 Abundance estimates

50 The density, total estimated population, upper and lower 95% CI, standard deviation and CV for each species and species group have been calculated using strip transect analysis and are presented in Table 4 to

51 Table **53**. Figures relate to the survey area as a whole. Highlights only, for the key species observed, are described in this section

52 Kittiwakes were recorded in all surveys and were the second most abundant species present. Density estimates, in line with abundance estimates, varied across the twenty-five (25) month period. In the first year of surveying (2018/2019), kittiwake density estimates for the survey area ranged between 0.03 birds/km^2 and 8.4 birds/km^2. In March 2018, kittiwake density was estimated at 1.38 birds/km^2, equating to an estimated abundance of 944 birds (±95% CI 677 – 1249). In April 2018, density was estimated at 1.73 birds/km^2, equating to an estimated 1189 birds (±95% CI 896 – 1512). In May, June and July 2018, density was estimated at 3.68, 0.94 and 1.99 birds/km^2, equating to 2519 (±95% CI 1378 – 3924), 643 (±95% CI 189 – 1435) and 1361 (±95% CI 636 – 2269) birds respectively. In August, September, October and November 2018, density was estimated at 3.43, 0.36, 0.57 and 0.58 birds/km^2, equating to 2350 (±95% CI 1010 – 4223), 249 (±95% CI 127 – 409), 390 (±95% CI 220 – 594) and 400 (±95% CI 204 – 610) birds respectively. In December 2018, kittiwakes were recorded at their highest estimated density in the first year of surveying (8.4 birds/km^2), equating to an estimated 5755 birds (±95% CI 791 – 14,358). In January 2019 and February 2019, kittiwake density was estimated at 0.03 and 2.11 birds/km^2, equating to an estimated abundance of 21 (±95% CI 0 – 50) and 1444 (±95% CI 228 – 2871) birds respectively.

53 In the second year of surveying (March 2019 to February 2020), kittiwake density estimates for the survey area were higher, ranging between 0.42 birds/km^2 and 20.35 birds/km^2. In March, May, June and July (S01) 2019, kittiwake density was estimated at 1.68, 2.71, 0.48 and 1.11 birds/km^2, equating to an estimated abundance of 1154 (±95% CI 667 – 1847), 1860 (±95% CI 1292 – 2484), 331 (±95% CI 184 – 508) and 763 (±95% CI 455 – 1094) birds respectively. In July (S02), August, September and October 2019, kittiwake density was estimated at 0.54, 0.45, 0.42 and 2.88 birds/km^2, equating to an estimated abundance of 372 (±95% CI 155 – 656), 308 (±95% CI 98 – 593), 290 (±95% CI 120 – 504) and 1977 (±95% CI 139 – 5407) birds respectively. In November and December 2019, kittiwake density was estimated at 12.31 and 2.26 birds/km^2, equating to an estimated abundance of 8433 (±95% CI 2149 – 16525) and 1546 (±95% CI 495 – 3390) birds respectively. In January and February 2020, kittiwakes reached their highest recorded density and abundance of the 25-month survey period, with estimated densities of 16.63 and 20.35 birds/km^2, equating to an estimated 11,394 (±95% CI 4252 – 20253) and 13,946 (±95% CI 4497 – 25442) birds respectively. In April 2020, kittiwake density was estimated at 5.58 birds/km^2, equating to 3822 birds (±95% CI 1468 – 6844). This was at least three times higher than the estimate for April 2018, and higher than the similar period in 2019.

54 Herring gulls were recorded in every survey in the 25-month period, at varying numbers, with little difference apparent between years. In the first year of surveying (2018/19), herring gulls were recorded at their highest estimated density for the whole survey area in March 2018 (0.41 birds/km^2), equating to 283 birds (±95% CI 129 – 466), and their lowest estimated density in July 2018 (0.06 birds/km^2), equating to 40 birds (±95% CI 0 – 89). In the second year of surveying (2019/20), herring gulls were recorded at their highest estimated density in January 2020 (0.36 birds/km^2), an abundance estimate of 250 birds (±95% CI 59 – 525), and at their lowest estimated density in May 2019 (30 birds/km^2), an abundance estimate of 30 birds (±95% CI 0 – 79). In April 2020, birds were recorded at reasonably high numbers, with an estimated density of 0.33 birds/km^2 and an estimated abundance of 230 birds (±95% CI 76 – 421) across the whole survey area.

55 Sandwich terns *Sterna sandvicensis* were recorded in relatively low abundances in eleven (11) surveys. In the first year of surveying (2018/19), birds were recorded between March and September 2018, with no birds recorded in June or July. Estimated density was lowest in March, at 0.01 birds/km^2, equating to an estimated abundance of 10 birds (±95% CI 0 – 30), and highest in May, at 0.2 birds/km^2, equating to an estimated abundance of 139 birds (±95% CI 39 - 260). In the second year of surveying (2019/20),

birds were recorded between May and September 2019 in relatively lower abundances than the first year, with no birds recorded in August 2019. Estimated density was lowest in September, at 0.01 birds/km^2, equating to an estimated abundance of 10 birds (±95% CI 0 – 30), and highest in both May and July (S02), at 0.07 birds/km^2, equating to an estimated abundance of 50 birds in each survey (±95% CI 10 – 100 and 10 – 98 respectively). In April 2020, Sandwich tern abundance was still low in comparison to April of the first year, with an estimated density of only 0.04 birds/km^2, equating to an estimated 31 birds (±95% CI 0 – 68).

56 Common terns were recorded in eight (8) surveys across the 25-month period, in varying numbers. In the first year of surveying (2018/19), common terns were recorded in particularly high numbers between April and September 2018, with no birds recorded in June or July 2018. Estimated density was lowest in May 2018, at 0.01 birds/km^2, equating to an estimated abundance of 10 birds (±95% CI 0 – 30), and highest in August 2018, at 1.9 birds/km^2, equating to an estimated abundance of 1303 birds (±95% CI 794 - 1920). However, numbers of common tern dropped significantly in the second year of surveying (2019/20), when birds were only recorded in May, June and July (S02) 2019. During this period, estimated density was at its lowest in May and June 2019, at 0.01 birds/km^2, equating to an estimated 10 birds (±95% CI 0 – 30) per survey, and at its highest in July (S02) 2019 at only 0.04 birds/km^2, equating to 30 birds (±95% CI 0 – 78). In April 2020, estimated density of common terns was 0.03 birds/km^2, equating to an estimated abundance of 20 birds (±95% CI 0 – 49); still significantly lower than April 2018.

57 Arctic terns were recorded in nine (9) surveys across the 25-month period, and again, were significantly more abundant in the first year of surveying (2018/19) than the second year, in even higher numbers than their 'common' counterparts. In 2018/19, Arctic terns were recorded between April and October 2018, with no birds recorded in June or July 2018. Estimated density was highest in August 2018, at 5.5 birds/km^2, equating to an estimated abundance of 3769 birds (±95% CI 1219 - 6861) and lowest in October 2018, at 0.01 birds/km^2, equating to an estimated abundance of 11 birds (±95% CI 0 – 30). In the second year of surveying (2019/20), Arctic terns were only recorded in May, September, and October 2019, at much lower abundances. Estimated density was highest in May and October 2019, at 0.06 birds/km^2, equating to an estimated abundance of 40 (±95% CI 0 - 119) and 41 (±95% CI 0 - 109) birds respectively, and lowest in September 2019, at 0.01 birds/km^2, equating to an estimated abundance of 11 birds (±95% CI 0 – 30). In April 2020, Arctic tern numbers had increased, with an estimated density of 0.45 birds/km^2, equating to 307 birds (±95% CI 20 - 819); comparable to the number of birds recorded in April 2018.

58 Guillemots were the most abundant species, present in all surveys across the 25-month period and at particularly high abundances in the breeding season. Whilst figures varied across months, they were relatively comparable across both years. In the first year of surveying (2018/19), guillemots were recorded in their highest numbers in May and between August and November 2018. During this period, estimated density was highest in May and August, at 17.29 birds/km^2 and 15.48 birds/km^2, equating to an estimated abundance of 11848 (±95% CI 6412 - 18553) and 10608 (±95% CI 8612 - 12560) birds respectively, and lowest in March at 0.18 birds/km^2, equating to an estimated abundance of 121 birds (±95% CI 59 – 185). In the second year of surveying (2019/20), guillemots were recorded in their highest numbers in July, August, and November 2019 and January 2020. Estimated density was highest in July (S02) 2019, at 18.19 birds/km^2, equating to an estimated abundance of 12466 birds (±95% CI 7330 - 18176), and lowest again in March, at 0.2 birds/km^2, equating to an estimated abundance of 140 birds (±95% CI 60 – 240). In April 2020, guillemots were estimated at a density of 2.33 birds/km^2, equating to 1596 birds (±95% CI 729 - 3088); lower than January and February 2020, but higher than April 2018.

59 Razorbills were recorded in every survey across the 25-month period, with a higher total estimated abundance and average estimated density in the first year of surveying (2018/19) than the second (2019/20). In 2018/19, razorbills were recorded in their highest numbers in August and September 2018, at estimated densities of 9.82 birds/km^2 and 12.79 birds/km^2, equating to an estimated abundance of 6730 (±95% CI 4763 - 8928) and 8766 (±95% CI 6152 - 11839) birds respectively. Birds were recorded in their lowest estimated density in June 2018, at 0.12 birds/km^2, equating to an estimated abundance of 80 birds (±95% CI 0 - 240). In the second year of surveying (2019/20), razorbills were recorded in their highest numbers in November 2019 and January 2020, at estimated densities of 6.62 birds/km^2 and 8.31 birds/km^2, equating to an estimated abundance of 4539 (±95% CI 2207 - 7352) and 5697 (±95% CI 2131 - 10115) birds respectively. Birds were recorded in their lowest estimated density that year in July (S01) 2019, at 0.16 birds/km^2, equating to an estimated abundance of 111 birds (±95% CI 40 - 194).

60 Red-throated divers were recorded in seventeen (17) surveys across the 25-month period. This was primarily in the non-breeding season across the winter, with birds recorded in greater numbers in winter 2019/20. In the first year (2018/19), birds were recorded at relatively low numbers, peaking in November 2018 at an estimated density of 0.48 birds/km^2, equating to an estimated abundance of 332 (±95% CI 177 - 503), however figures were relatively consistent from October 2018 to February 2019. During this year, birds were recorded in their lowest estimated densities in April and May 2018, at 0.06 birds/km^2, equating to an estimated abundance of 41 birds per survey (±95% CI 10 – 77 and 0 – 79 respectively). In the second survey year (2019/20), there was a sharp rise in red-throated diver numbers in the winter, peaking in December 2019 and January 2020 at an estimated density of 1.39 birds/km^2 and 0.93 birds/km^2, equating to estimated abundances of 952 birds (±95% CI 514 - 1429) and 637 birds (±95% CI 127 - 1517) respectively. Birds were recorded in their lowest estimated density in September 2019, at 0.03 birds/km^2, equating to an estimated abundance of just 20 birds (±95% CI 0 - 49). In April 2020, red-throated divers were recorded at an estimated 0.15 birds/km^2, equating to an estimated 100 birds (±95% CI 39 – 189); more than double the estimated number of birds of April 2018.

61 Manx shearwaters were recorded in twelve (12) surveys across the 25-month period. Birds were observed between March and September, with significantly more birds recorded in the 2018 breeding season than the 2019 breeding season. In the first survey year (2018/19), Manx shearwater numbers peaked significantly in May 2018, at an estimated density of 13.76 birds/km^2, equating to an estimated 9426 birds (±95% CI 4446 - 15053) across the whole survey area. Birds were recorded at their lowest density estimate in March 2018 at 0.01 birds/km^2, equating to an estimated 11 birds (±95% CI 0 – 30). In the second survey year (2019/20), Manx shearwater numbers were highest in July (S01) 2019, at an estimated density of 4.84 birds/km^2, equating to an estimated 3317 birds (±95% CI 1086 - 5853). Birds were recorded at their lowest density estimate in September 2018, at 0.36 birds/km^2, equating to an estimated 249 birds (±95% CI 59 - 501). In April 2020, Manx shearwaters were recorded at an estimated density of 1.26 birds/km^2, equating to an estimated 862 birds (±95% CI 467 – 1310); less than April 2018.

62 Gannets *Morus bassanus* were recorded in twenty (20) surveys across the 25-month period, with abundance estimates determining a steady but relatively low population. In the first year of surveying (2018/19), gannet estimated density was highest in August and October 2018, at 0.19 and 0.15 birds/km^2, equating to an estimated abundance of 131 (±95% CI 48 - 231) and 100 (±95% CI 40 - 172) birds respectively. Gannets were at their lowest estimated density in January 2019, at 0.01 birds/km^2, equating to an estimated 10 birds (±95% CI 0 – 30). In the second year of surveying (2019/20), gannets were recorded at their highest estimated density in September 2019, at 0.12 birds/km^2, equating to an estimated 81 birds (±95% CI 29 - 140), and lowest in May, at 0.01 birds/km^2, equating to an estimated abundance of 10 birds (±95% CI 0 – 30). In April 2020, the highest number of gannets were recorded

across the 25-month survey period. This created a substantial increase in the population estimate, with an estimated density of 0.25 birds/km^2, equating to 171 birds (±95% CI 39 - 356).

63 Harbour porpoises were recorded in low numbers in every survey across the 25-month period, apart from June 2018 and June 2019. Figures (including density and abundance estimates for the whole site) were similar between years. For the first year of surveying (2018/19), density estimates for harbour porpoises across the whole survey area ranged between 0.03 animals/km^2 (April 2018) and 0.4 animals/km^2 (August 2018). This equated to abundance estimates ranging between 21 animals (±95% CI 0 – 50) and 271 animals ((±95% CI 149 – 408) respectively. For the second year (2019/20), density estimates ranged between 0.04 animals/km^2 (March 2018) and 0.29 animals/km^2 (July S02 2019). This equated to abundance estimates ranging between 31 animals (±95% CI 0 – 68) and 202 animals ((±95% CI 110 - 307) respectively. In April 2020, harbour porpoises were recorded at an estimated density of 0.09 animals/km^2, comparative to an estimated 61 animals (±95% CI 20 – 110) within the survey area.

Table 4 Abundance and density estimates of species groups in the survey area during Survey 1 on 27 March 2018

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	2094	1655	2573	236	11.23%
All non-avian animals	0.1	71	20	131	29	41.08%
Species group						
Duck species	0.12	81	0	240	77	95.16%
Diver species	0.07	50	10	100	23	45.95%
Fulmar / gull species	0.01	10	0	30	10	95.76%
Shearwater species	0.01	11	0	30	10	94.03%
Gannet species	0.04	30	0	67	16	52.35%
Cormorant species	0.04	30	0	68	17	54.22%
Small gull species	1.75	1197	927	1495	147	12.29%
Black-backed gull species	0.04	31	0	67	16	52.08%
Large gull species	0.44	302	126	499	97	32.05%
Gull species	0.01	11	0	30	10	95.34%
Tern species	0.01	10	0	30	10	98.24%
Large auk	0.44	300	157	475	83	27.49%
Auk species	0.03	21	0	49	14	64.98%

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 (%)
Auk / shearwater species	0.01	10	0	30	10	96.23%
Small bird species	0.01	11	0	30	10	95.45%
Cetacean species	0.09	61	10	119	28	45.27%
Seal / small cetacean species	0.01	11	0	30	10	95.52%

Table 5 Abundance and density estimates of species in the survey area during Survey 1 on 27 March 2018

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 scoter	0.12	80	0	240	77	96.21%
Red-throated diver	0.07	51	10	100	24	46.39%
Manx shearwater	0.01	11	0	30	10	96.48%
Gannet	0.04	30	0	61	16	52.67%
Cormorant	0.03	21	0	50	14	68.15%
Kittiwake	1.38	944	677	1249	147	15.49%
Black-headed gull	0.15	101	0	237	62	61.49%
Common gull	0.19	131	68	199	35	26.34%
Lesser black-backed gull	0.01	10	0	30	10	97.33%
Herring gull	0.41	283	129	466	86	30.29%
Great black-backed gull	0.06	41	10	79	19	44.59%
Sandwich tern	0.01	10	0	30	10	101.01%
Guillemot	0.18	121	59	185	33	26.87%
Razorbill	0.22	150	39	331	78	51.60%
Harbour porpoise	0.09	60	10	119	28	46%

Table 6 Abundance and density estimates of species groups in the survey area during Survey 2 on 23 April 2018

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	9.02	6183	4491	8076	925	14.95%
All non-avian animals	0.06	40	10	78	17	42.47%
Species group						
Swan species	0.06	39	0	120	38	97.90%
Diver species	0.06	40	10	78	18	42.78%
Fulmar / gull species	0.01	11	0	30	10	94.44%
Shearwater species	3.95	2705	1545	4056	649	23.97%
Wader species	0.06	40	0	120	38	95.50%
Skua species	0.01	10	0	30	10	97.86%
Small gull species	1.77	1214	912	1544	163	13.36%
Large gull species	0.17	120	20	271	67	55.31%
Gull species	0.04	30	0	79	22	71.53%
Arctic / common tern	1.09	750	466	1077	157	20.85%
Tern species	0.15	101	40	166	32	31.39%
Large auk	1.27	868	608	1169	143	16.46%
Auk species	0.01	10	0	30	10	97.39%

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 (%)
Auk / small gull	0.01	11	0	30	10	95.78%
Large auk / diver species	0.01	10	0	30	10	95.28%
Auk / shearwater species	0.35	239	118	390	71	29.51%
Small bird species	0.01	10	0	30	10	96.44%
Seal species	0.03	21	0	49	13	64.22%
Cetacean species	0.03	21	0	49	14	64.59%

Table 7 Abundance and density estimates of species in the survey area during Survey 2 on 23 April 2018

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						
Mute swan	0.06	42	0	119	39	93.46%
Red-throated diver	0.06	41	10	77	18	42.27%
Fulmar	0.01	11	0	30	10	94.12%
Manx shearwater	3.98	2728	1584	4094	648	23.73%
Curlew	0.06	40	0	120	39	96.66%
Arctic skua	0.01	10	0	30	10	96.65%
Kittiwake	1.73	1189	896	1512	159	13.35%
Common gull	0.01	10	0	30	10	96.27%
Herring gull	0.22	150	30	323	75	50.19%
Sandwich tern	0.13	91	39	149	29	31.03%
Common tern	0.46	319	177	481	79	24.61%
Arctic tern	0.45	311	161	479	82	26.31%
Guillemot	0.78	532	341	737	102	19.14%
Razorbill	0.45	311	182	453	70	22.51%
Grey seal	0.01	10	0	30	10	95.61%
Harbour porpoise	0.03	21	0	50	14	64.37%

Table 8 Abundance and density estimates of species groups in the survey area during Survey 3 on 10 May 2018

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	39.35	26960	17286	37898	5251	19.48%
All non-avian animals	0.2	140	78	213	35	24.90%
Species group						
Diver species	0.07	51	19	90	20	39.26%
Shearwater species	13.61	9323	4490	14869	2678	28.72%
Gannet species	0.1	71	29	120	25	34.68%
Cormorant species	0.06	41	0	96	24	57.74%
Wader species	0.06	41	0	99	28	67.38%
Small gull species	3.71	2543	1390	3943	661	25.99%
Black-backed gull species	0.01	11	0	30	10	95.14%
Large gull species	0.19	130	38	253	57	43.51%
Gull species	0.04	30	0	68	16	53.06%
Arctic / common tern	1.61	1104	481	1826	352	31.90%
Tern species	0.26	182	70	307	61	33.09%
Large auk	18.37	12584	6952	19407	3155	25.07%
Auk species	0.03	21	0	49	14	65.31%

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 (%)
Auk / shearwater species	1.17	803	491	1177	176	21.84%
Seal species	0.06	40	10	78	18	43.16%
Cetacean species	0.15	101	40	175	35	34.63%

Table 9 Abundance and density estimates of species in the survey area during Survey 3 on 10 May 2018

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						
Red-throated diver	0.06	41	10	79	18	44.62%
Manx shearwater	13.76	9426	4446	15053	2734	29%
Gannet	0.1	71	29	120	26	35.74%
Shag	0.06	40	0	90	23	57.16%
Bar-tailed godwit	0.01	11	0	30	10	98.53%
Kittiwake	3.68	2519	1378	3924	667	26.45%
Common gull	0.01	10	0	30	10	98.03%
Herring gull	0.16	111	30	199	43	38.57%
Sandwich tern	0.2	139	39	260	58	41.37%
Common tern	0.01	10	0	30	10	98.48%
Arctic tern	1.07	737	229	1413	310	42.08%
Guillemot	17.29	11848	6412	18553	3159	26.66%
Razorbill	0.93	637	313	1025	182	28.52%
Grey seal	0.06	41	10	78	18	43.23%
Harbour porpoise	0.15	101	39	174	35	34.69%

Table 10 Abundance and density estimates of species groups in the survey area during Survey 4 on 21 June 2018

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	3.65	2503	409	6490	1925	76.90%
All non-avian animals	0.01	11	0	30	10	93.79%
Species group						
Shearwater species	0.03	21	0	50	14	67.75%
Gannet species	0.07	51	10	101	24	47.41%
Cormorant species	0.01	11	0	30	10	95.98%
Wader species	0.01	11	0	30	10	96.70%
Small gull species	0.91	623	185	1384	351	56.32%
Large gull species	0.01	11	0	30	10	96.72%
Gull species	0.03	20	0	60	20	95.77%
Large auk	2.56	1752	117	4837	1510	86.15%
Auk species	0.04	31	0	91	30	97.79%
Small bird species	0.02	11	0	30	10	95.34%
Seal species	0.01	10	0	30	10	96.13%

Table 11 Abundance and density estimates of species in the survey area during Survey 4 on 21 June 2018

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						
Manx shearwater	0.03	21	0	50	14	65.90%
Gannet	0.07	51	10	100	24	46.89%
Shag	0.01	10	0	30	10	97.62%
Kittiwake	0.94	643	189	1435	363	56.33%
Great black-backed gull	0.01	11	0	30	10	94.86%
Guillemot	2.34	1603	117	4408	1381	86.18%
Razorbill	0.12	80	0	240	78	98.44%

Table 12 Abundance and density estimates of species groups in the survey area during Survey 5 on 3 July 2018

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	6.97	4775	2803	7651	1265	26.48%
All non-avian animals	0.23	161	78	253	45	27.93%
Species group						
Fulmar / gull species	0.03	21	0	50	14	66.40%
Shearwater species	0.56	385	30	988	283	73.60%
Gannet species	0.07	51	10	99	24	45.77%
Cormorant species	0.01	11	0	30	10	93.10%
Small gull species	2.04	1397	686	2294	417	29.79%
Black-backed gull species	0.03	20	0	50	14	66.64%
Large gull species	0.07	50	10	99	24	47.13%
Gull species	0.03	20	0	60	19	96.90%
Tern / small gull species	0.01	10	0	30	10	94.93%
Large auk	4.02	2754	1497	4730	899	32.64%
Auk species	0.07	50	0	135	39	78.16%
Auk / shearwater species	0.03	20	0	49	14	66.56%
Cetacean species	0.21	142	69	220	39	27.42%
Seal / small cetacean species	0.03	20	0	49	14	66.59%

Table 13 Abundance and density estimates of species in the survey area during Survey 5 on 3 July 2018

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						
Fulmar	0.03	21	0	50	14	65.60%
Manx shearwater	0.55	378	30	990	280	74.13%
Gannet	0.07	50	10	99	24	46.80%
Cormorant	0.01	10	0	30	10	95.29%
Kittiwake	1.99	1361	636	2269	415	30.47%
Black-headed gull	0.03	20	0	50	14	66.41%
Common gull	0.01	11	0	30	10	94.83%
Lesser black-backed gull	0.01	10	0	30	10	96.76%
Herring gull	0.06	40	0	89	23	55.57%
Guillemot	3.47	2376	1365	3907	677	28.46%
Razorbill	0.21	142	0	415	120	84.33%
Puffin	0.03	21	0	60	20	94.80%
Harbour porpoise	0.21	141	69	219	39	27.39%
Fulmar	0.03	21	0	50	14	65.60%

Table 14 Abundance and density estimates of species groups in the survey area during Survey 6 on 25 August 2018

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	45.86	31423	22676	41132	4693	14.93%
All non-avian animals	0.47	323	193	463	70	21.67%
Species group						
Fulmar / gull species	0.04	30	0	60	16	52.61%
Shearwater species	3.73	2555	774	4863	1061	41.49%
Gannet species	0.19	132	49	234	49	36.93%
Cormorant species	0.06	41	0	116	31	77.10%
Small gull species	3.6	2469	1113	4298	836	33.83%
Black-backed gull species	0.01	11	0	31	10	94.94%
Large gull species	0.1	70	20	147	34	47.77%
Gull species	0.06	41	10	79	18	44.20%
Arctic / common tern	8.79	6022	2743	10253	1918	31.85%
Tern species	0.48	333	173	521	91	27.09%
Tern / small gull species	0.6	413	173	690	136	32.76%
Large auk	21.24	14552	11462	17648	1588	10.91%
Auk species	0.19	130	39	240	52	39.74%
Auk / small gull	0.13	91	30	167	36	39.11%

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 (%)
Auk / shearwater species	6.5	4456	2732	6335	921	20.65%
Seal species	0.06	41	0	89	23	54.44%
Cetacean species	0.4	271	155	403	64	23.61%
Seal / small cetacean species	0.01	10	0	30	10	97.05%

Table 15 Abundance and density estimates of species in the survey area during Survey 6 on 25 August 2018

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						
Fulmar	0.04	31	0	68	16	52.99%
Manx shearwater	5.64	3866	1484	6670	1309	33.85%
Gannet	0.19	131	48	231	48	36.42%
Shag	0.06	41	0	109	31	75.40%
Kittiwake	3.43	2350	1010	4223	828	35.24%
Little gull	0.13	90	10	207	51	56.25%
Black-headed gull	0.16	111	11	236	58	52.10%
Common gull	0.01	10	0	30	10	98.77%
Lesser black-backed gull	0.03	21	0	49	13	63.54%
Herring gull	0.09	61	10	139	34	55.68%
Sandwich tern	0.15	101	30	196	44	42.69%
Common tern	1.9	1303	794	1920	291	22.33%
Arctic tern	5.5	3769	1219	6861	1452	38.52%
Guillemot	15.48	10608	8612	12560	1020	9.61%
Razorbill	9.82	6730	4763	8928	1060	15.74%
Puffin	0.06	41	0	89	23	55.30%

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 (%)
Grey seal	0.01	10	0	30	10	97.44%
Harbour seal	0.03	21	0	50	14	66.43%
Harbour porpoise	0.4	271	149	408	66	24.28%

Table 16 Abundance and density estimates of species groups in the survey area during Survey 7 on 7 September 2018

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	32.85	22505	17425	28437	2832	12.58%
All non-avian animals	0.48	330	218	453	62	18.58%
Species group						
Duck species	1.66	1138	0	3393	1084	95.28%
Fulmar / gull species	0.01	11	0	30	10	93.34%
Shearwater species	0.1	71	10	165	41	57.56%
Gannet species	0.06	40	0	119	38	96.18%
Cormorant species	0.04	31	0	67	16	52.33%
Wader species	0.01	10	0	30	10	99.62%
Skua species	0.01	10	0	30	10	95.70%
Small gull species	0.95	654	203	1363	316	48.32%
Black-backed gull species	0.07	50	10	89	20	39.04%
Large gull species	0.16	112	10	250	63	55.85%
Gull species	0.03	20	0	60	19	96.02%
Arctic / common tern	2.33	1598	405	3467	854	53.43%
Tern species	0.2	140	60	228	43	30.19%
Tern / small gull species	1.14	779	258	1437	304	39.02%

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 (%)
Large auk	22.55	15448	12744	18336	1431	9.26%
Auk species	0.03	20	0	50	14	66.43%
Auk / shearwater species	3.62	2478	1011	4466	911	36.73%
Seal species	0.13	90	20	186	44	48.14%
Cetacean species	0.35	240	140	353	55	22.88%

Table 17 Abundance and density estimates of species in the survey area during Survey 7 on 7 September 2018

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 scoter	1.69	1161	0	3403	1097	94.41%
Manx shearwater	0.49	334	70	706	166	49.53%
Gannet	0.06	41	0	119	38	94.43%
Cormorant	0.04	31	0	61	16	52.94%
Arctic skua	0.01	11	0	30	10	94.35%
Kittiwake	0.36	249	127	409	73	29.05%
Little gull	0.88	604	60	1504	411	68%
Black-headed gull	0.01	10	0	30	10	95.63%
Lesser black-backed gull	0.09	61	10	126	30	48.59%
Herring gull	0.16	110	10	249	63	57.50%
Great black-backed gull	0.03	21	0	50	14	66.60%
Sandwich tern	0.09	61	0	136	34	55.45%
Common tern	1.28	875	130	2109	591	67.52%
Arctic tern	0.6	409	109	769	169	41.18%
Guillemot	12.56	8608	6556	10672	1033	12%
Razorbill	12.79	8766	6152	11839	1481	16.89%

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 (%)
Grey seal	0.07	51	0	128	35	69.27%
Harbour porpoise	0.35	240	139	354	55	22.99%

Table 18 Abundance and density estimates of species groups in the survey area during Survey 8 on 1 October 2018

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	14.56	9973	8102	11881	957	9.59%
All non-avian animals	0.21	141	70	231	42	29.23%
Species group						
Duck species	0.6	411	0	1204	380	92.33%
Diver species	0.37	251	150	351	52	20.55%
Fulmar / gull species	0.07	51	0	150	49	95.63%
Gannet species	0.15	101	40	175	35	34.67%
Cormorant species	0.09	60	10	131	32	52.83%
Small gull species	2.3	1574	741	2670	502	31.89%
Black-backed gull species	0.09	61	20	110	25	40.62%
Large gull species	0.22	151	0	400	116	76.25%
Gull species	0.09	61	0	157	43	69.10%
Arctic / common tern	0.01	11	0	30	10	94.86%
Large auk	10.3	7058	5749	8581	721	10.21%
Auk species	0.07	51	10	100	24	46.44%
Auk / small gull	0.1	71	11	140	33	46.79%
Large auk / diver species	0.03	21	0	49	14	64.64%

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 (%)
Passerine species	0.06	41	0	120	39	95.40%
Seal species	0.01	10	0	30	10	95.94%
Cetacean species	0.18	121	50	210	42	34.50%
Seal / small cetacean species	0.01	10	0	30	10	96.50%

Table 19 Abundance and density estimates of species in the survey area during Survey 8 on 1 October 2018

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 scoter	0.59	406	0	1200	375	92.43%
Red-throated diver	0.37	251	156	352	51	20.20%
Gannet	0.15	100	40	172	35	34.25%
Cormorant	0.03	21	0	50	14	64.59%
Shag	0.03	21	0	50	14	66.53%
Kittiwake	0.57	390	220	594	95	24.38%
Little gull	1.29	882	174	1900	456	51.73%
Black-headed gull	0.35	241	109	395	75	31%
Common gull	0.01	10	0	30	10	95.85%
Lesser black-backed gull	0.04	30	0	79	22	71.32%
Herring gull	0.17	120	0	306	86	71.55%
Great black-backed gull	0.04	31	0	61	16	51.01%
Arctic tern	0.01	11	0	30	10	94.55%
Guillemot	7.59	5198	3917	6665	711	13.66%
Razorbill	2.12	1454	1068	1884	209	14.35%
Snow bunting	0.06	39	0	119	38	97.28%

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 (%)
Grey seal	0.01	11	0	30	10	93.76%
Harbour porpoise	0.18	121	49	214	44	36.24%

Table 20 Abundance and density estimates of species groups in the survey area during Survey 9 on 22 November 2018

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	20.78	14241	10191	18786	2207	15.49%
All non-avian animals	0.19	131	49	224	47	35.43%
Species group						
Duck species	0.15	101	0	266	72	71.05%
Diver species	0.47	320	174	479	80	24.75%
Gannet species	0.04	31	0	67	16	52.88%
Cormorant species	0.01	11	0	30	10	95.19%
Wader species	0.03	21	0	60	20	96.90%
Small gull species	3.59	2462	1527	3590	532	21.60%
Black-backed gull species	0.04	31	0	67	16	51.44%
Large gull species	0.29	199	88	345	66	33.10%
Gull species	0.06	41	0	108	31	74.78%
Large auk	15.8	10823	7288	14855	1957	18.08%
Auk species	0.23	161	98	226	33	20.35%
Auk / small gull	0.06	40	10	78	18	44.13%
Large auk / diver species	0.04	31	0	90	29	95.49%
Seal species	0.04	31	0	79	22	72.04%

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 (%)
Cetacean species	0.1	70	10	144	35	49.18%
Seal / small cetacean species	0.04	31	0	68	17	52.97%

Table 21 Abundance and density estimates of species in the survey area during Survey 9 on 22 November 2018

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 scoter	0.13	90	0	248	71	78.94%
Red-throated diver	0.48	332	177	503	85	25.54%
Gannet	0.04	31	0	68	16	52.84%
Shag	0.01	11	0	30	10	96.90%
Kittiwake	0.58	400	204	610	105	26.14%
Little gull	0.94	645	262	1129	226	34.92%
Black-headed gull	0.67	462	20	1110	290	62.75%
Common gull	1.2	822	401	1336	243	29.50%
Lesser black-backed gull	0.01	11	0	30	10	95.79%
Herring gull	0.29	201	89	343	66	32.53%
Great black-backed gull	0.01	11	0	30	10	93.89%
Guillemot	13.61	9328	6266	12784	1682	18.02%
Razorbill	1.34	918	514	1369	219	23.85%
Puffin	0.01	11	0	30	10	97.68%
Grey seal	0.01	10	0	30	10	100.13%
Harbour porpoise	0.1	71	10	146	35	49.76%

Table 22 Abundance and density estimates of species groups in the survey area during Survey 10 on 18 December 2018

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	15.13	10369	2548	22715	5417	52.24%
All non-avian animals	0.17	120	40	219	46	38.39%
Species group						
Duck species	0.1	71	10	148	36	49.58%
Diver species	0.31	212	99	338	63	29.60%
Gannet species	0.12	80	20	147	33	40.23%
Cormorant species	0.06	40	0	89	23	55.85%
Small gull species	9.93	6807	1063	16317	4306	63.25%
Black-backed gull species	0.01	10	0	30	10	96.15%
Large gull species	0.1	71	0	158	41	56.91%
Large auk	4.53	3101	870	5960	1316	42.43%
Auk / small gull	0.01	10	0	30	10	96.72%
Large auk / diver species	0.04	30	0	79	22	71.49%
Cetacean species	0.16	110	40	193	39	35.32%
Seal / small cetacean species	0.01	11	0	30	10	94.32%

Table 23 Abundance and density estimates of species in the survey area during Survey 10 on 18 December 2018

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						
Wigeon	0.01	11	0	30	10	94.68%
Common scoter	0.09	60	0	137	35	57.40%
Red-throated diver	0.32	222	108	353	64	28.53%
Great northern diver	0.01	10	0	30	10	96.09%
Gannet	0.12	81	20	148	33	39.90%
Shag	0.06	41	0	89	23	55.37%
Kittiwake	8.4	5755	791	14358	3869	67.23%
Little gull	1.13	772	39	1812	472	61.05%
Black-headed gull	0.1	71	29	125	25	35.36%
Common gull	0.15	100	30	191	43	42.70%
Herring gull	0.1	70	0	157	40	56.61%
Great black-backed gull	0.01	10	0	30	10	95.23%
Guillemot	1.24	851	414	1486	282	33.08%
Razorbill	2.68	1838	326	3782	900	48.93%
Harbour porpoise	0.16	110	39	191	40	35.80%

Table 24 Abundance and density estimates of species groups in the survey area during Survey 11 on 28 January 2019

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	6.91	4738	2107	8560	1692	35.71%
All non-avian animals	0.28	190	105	284	47	24.47%
Species group						
Duck species	0.38	261	0	776	248	95.14%
Diver species	0.48	330	243	424	47	13.96%
Gannet species	0.01	11	0	30	10	93.67%
Cormorant species	0.09	61	20	110	25	39.88%
Small gull species	3.66	2506	334	6043	1598	63.74%
Large gull species	0.19	131	39	242	53	40.47%
Gull species	0.1	70	20	128	28	40.05%
Large auk	1.94	1329	469	2782	661	49.69%
Auk species	0.04	31	0	60	16	52.30%
Auk / small gull	0.01	10	0	30	10	98.23%
Large auk / diver species	0.01	10	0	30	10	98.66%
Seal species	0.03	21	0	50	14	65.72%
Cetacean species	0.23	161	78	253	45	28.06%
Seal / small cetacean species	0.01	10	0	30	10	97.51%

Table 25 Abundance and density estimates of species in the survey area during Survey 11 on 28 January 2019

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 scoter	0.38	260	0	778	253	97.20%
Red-throated diver	0.44	300	201	414	54	18.03%
Great northern diver	0.04	30	0	79	21	70.23%
Gannet	0.01	10	0	30	10	95.94%
Cormorant	0.03	20	0	49	13	64.28%
Shag	0.06	40	0	89	23	55.87%
Kittiwake	0.03	21	0	50	14	65.21%
Little gull	0.07	52	0	138	40	77.18%
Black-headed gull	1.3	891	167	1936	470	52.71%
Common gull	2.15	1472	126	3766	1064	72.31%
Herring gull	0.19	131	49	233	49	36.85%
Guillemot	0.76	524	239	920	179	34.05%
Razorbill	1.07	735	120	1756	480	65.34%
Harbour porpoise	0.23	160	77	257	46	28.71%

Table 26 Abundance and density estimates of species groups in the survey area during Survey 12 on 11 February 2019

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	11.03	7558	2570	13413	2744	36.30%
All non-avian animals	0.14	100	30	192	43	43.16%
Species group						
Diver species	0.41	283	162	415	64	22.62%
Cormorant species	0.09	61	20	117	26	43.04%
Small gull species	7.46	5109	839	9976	2279	44.60%
Black-backed gull species	0.04	31	0	79	22	70.49%
Large gull species	0.33	224	40	487	115	51.28%
Gull species	0.15	100	48	167	32	31.34%
Large auk	2.28	1560	811	2553	451	28.90%
Auk species	0.1	71	20	139	32	45.49%
Auk / small gull	0.04	30	0	61	16	52.05%
Large auk / diver species	0.03	21	0	50	13	64.68%
Small bird species	0.03	20	0	50	14	69.92%
Jellyfish	0.01	11	0	30	10	94.77%
Seal species	0.01	10	0	30	10	97.52%
Cetacean species	0.1	71	10	147	35	49.40%

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	10	0	30	10	96.55%

Table 27 Abundance and density estimates of species in the survey area during Survey 12 on 11 February 2019

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						
Red-throated diver	0.41	281	166	409	63	22.45%
Cormorant	0.01	10	0	30	10	98.33%
Shag	0.07	50	19	90	20	39.68%
Kittiwake	2.11	1444	228	2871	660	45.68%
Little gull	1.12	770	67	2026	586	76.13%
Black-headed gull	1.36	932	238	1842	416	44.55%
Common gull	2.3	1577	337	3222	749	47.51%
Lesser black-backed gull	0.01	11	0	30	10	99.02%
Herring gull	0.32	220	59	448	103	46.51%
Great black-backed gull	0.04	31	0	80	23	72.28%
Guillemot	1.46	1003	666	1388	187	18.59%
Razorbill	0.76	518	100	1109	266	51.18%
Puffin	0.01	11	0	30	10	95.07%
Barrel jellyfish	0.01	10	0	30	10	96.99%
Harbour porpoise	0.1	71	10	148	36	50.76%

Table 28 Abundance and density estimates of species groups in the survey area during Survey 13 on 17 March 2019

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	3.91	2681	1972	3510	392	14.60%
All non-avian animals	0.04	31	0	68	17	53.73%
Species group						
Diver species	0.12	81	29	148	32	39.26%
Fulmar / gull species	0.01	10	0	30	10	97.95%
Cormorant species	0.04	30	0	67	16	53.26%
Small gull species	2.46	1685	1031	2473	380	22.53%
Black-backed gull species	0.1	70	0	180	49	70.22%
Large gull species	0.19	131	58	220	43	32.37%
Gull species	0.1	71	10	160	41	56.97%
Large auk	0.71	489	298	693	101	20.56%
Small auk	0.1	71	10	147	35	48.19%
Auk species	0.07	50	0	120	34	67.26%
Cetacean species	0.04	31	0	68	17	53.72%

Table 29 Abundance and density estimates of species in the survey area during Survey 13 on 17 March 2019

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						
Red-throated diver	0.12	81	29	149	32	39.39%
Cormorant	0.03	20	0	49	14	65.57%
Shag	0.01	10	0	30	10	97.46%
Kittiwake	1.68	1154	667	1847	308	26.64%
Little gull	0.65	449	185	760	146	32.52%
Common gull	0.19	130	49	228	46	34.80%
Lesser black-backed gull	0.09	60	0	155	41	66.95%
Herring gull	0.24	162	59	290	60	36.68%
Great black-backed gull	0.01	10	0	30	10	98.41%
Guillemot	0.2	140	60	240	47	33.14%
Razorbill	0.54	370	239	519	72	19.35%
Puffin	0.1	71	10	145	35	48.58%
Harbour porpoise	0.04	31	0	68	17	53.73%

Table 30 Abundance and density estimates of species groups in the survey area during Survey 14 on 4 May 2019

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	10.73	7354	5386	9712	1107	15.05%
All non-avian animals	0.07	50	19	88	19	36.91%
Species group						
Diver species	0.07	50	0	108	28	54.69%
Fulmar / gull species	0.03	20	0	60	19	95.07%
Shearwater species	1.51	1034	266	2203	517	49.94%
Gannet species	0.01	11	0	30	10	96.57%
Cormorant species	0.03	20	0	50	14	66.66%
Small gull species	2.85	1950	1369	2593	312	15.96%
Large gull species	0.04	30	0	78	21	70.38%
Arctic / common tern	0.48	328	57	743	180	54.77%
Tern species	0.07	50	10	99	24	46.50%
Large auk	4.73	3239	2377	4255	484	14.92%
Small auk	0.03	20	0	60	20	97.38%
Auk species	0.15	101	49	157	28	27.89%
Auk / small gull	0.06	40	0	107	30	73.77%
Large auk / diver species	0.01	10	0	30	10	97.61%

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 (%)
Auk / shearwater species	0.64	437	135	912	213	48.66%
Seal species	0.01	10	0	30	10	95.08%
Cetacean species	0.06	41	10	78	18	42.60%

Table 31 Abundance and density estimates of species in the survey area during Survey 14 on 4 May 2019

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						
Red-throated diver	0.09	60	10	120	29	46.99%
Fulmar	0.03	21	0	60	20	95.26%
Manx shearwater	1.74	1190	378	2340	520	43.67%
Gannet	0.01	10	0	30	10	98.48%
Shag	0.01	10	0	30	10	96.95%
Kittiwake	2.71	1860	1292	2484	303	16.28%
Common gull	0.04	30	0	89	29	94.97%
Herring gull	0.04	30	0	79	22	71.02%
Sandwich tern	0.07	50	10	98	23	45.92%
Common tern	0.01	10	0	30	10	97.23%
Arctic tern	0.06	40	0	119	38	95.56%
Guillemot	3.98	2726	1987	3591	409	14.97%
Razorbill	0.5	340	203	498	76	22.24%
Puffin	0.01	10	0	30	10	96.05%
Harbour porpoise	0.06	41	10	77	18	42.53%

Table 32 Abundance and density estimates of species groups in the survey area during Survey 15 on 13 June 2019

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	4.35	2984	1792	4404	674	22.56%
All non-avian animals	NA	NA	NA	NA	NA	NA
Species group						
Duck species	0.01	11	0	30	10	94.27%
Diver species	0.01	11	0	30	10	95.41%
Fulmar / gull species	0.01	11	0	30	10	96.04%
Shearwater species	1.49	1022	234	2095	489	47.88%
Gannet species	0.16	111	30	219	50	44.73%
Cormorant species	0.03	20	0	50	14	66.74%
Small gull species	0.54	372	204	566	94	25.22%
Large gull species	0.15	100	20	213	51	50.53%
Tern species	0.04	30	0	78	21	69.10%
Large auk	1.19	813	428	1363	241	29.55%
Small auk	0.03	20	0	60	20	97.72%
Auk species	0.59	404	181	659	125	30.78%
Auk / shearwater species	0.1	71	0	186	51	71.48%

Table 33 Abundance and density estimates of species in the survey area during Survey 15 on 13 June 2019

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 scoter	0.01	11	0	30	10	95.46%
Great northern diver	0.01	11	0	30	10	94.07%
Fulmar	0.01	10	0	30	10	97.14%
Manx shearwater	1.56	1068	257	2114	487	45.57%
Gannet	0.16	111	30	220	50	44.91%
Cormorant	0.03	21	0	50	14	65.19%
Kittiwake	0.48	331	184	508	83	24.96%
Common gull	0.04	30	0	90	29	95.65%
Herring gull	0.12	80	10	175	44	54.03%
Great black-backed gull	0.01	11	0	30	10	95.34%
Sandwich tern	0.03	21	0	60	20	94.37%
Common tern	0.01	10	0	30	10	96.08%
Guillemot	1.27	870	547	1279	188	21.53%
Razorbill	0.33	229	87	405	83	36.08%
Puffin	0.04	31	0	79	22	69.98%

Table 34 Abundance and density estimates of species groups in the survey area during Survey 16 on 2 July 2019

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	19.39	13286	8599	18206	2439	18.36%
All non-avian animals	0.31	210	87	343	66	31.36%
Species group						
Fulmar / gull species	0.03	21	0	50	14	66.02%
Shearwater species	4.88	3341	1077	6048	1276	38.18%
Gannet species	0.1	70	29	126	26	36.87%
Cormorant species	0.01	11	0	30	10	98.06%
Wader species	0.01	11	0	30	10	95.47%
Small gull species	1.1	753	446	1093	166	21.96%
Black-backed gull species	0.04	31	0	80	23	73.18%
Large gull species	0.16	110	30	213	47	42.52%
Gull species	0.04	31	0	78	21	69.12%
Tern species	0.06	40	0	120	39	96.75%
Tern / small gull species	0.03	21	0	49	14	65.15%
Large auk	12.15	8323	5673	11055	1387	16.65%
Small auk	0.01	10	0	30	10	97.13%
Auk species	0.68	466	229	750	135	29.01%

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 (%)
Auk / small gull	0.02	11	0	30	10	93.94%
Auk / shearwater species	0.12	79	20	143	32	39.46%
Passerine species	0.02	11	0	30	10	94.14%
Jellyfish	0.03	21	0	49	13	64.14%
Seal species	0.04	30	0	60	16	50.46%
Cetacean species	0.24	162	68	272	53	32.77%

Table 35 Abundance and density estimates of species in the survey area during Survey 16 on 2 July 2019

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						
Fulmar	0.01	10	0	30	10	97.04%
Manx shearwater	4.84	3317	1086	5853	1250	37.68%
Gannet	0.1	71	29	124	26	36.30%
Shag	0.01	10	0	30	10	99.88%
Oystercatcher	0.01	10	0	30	10	98.56%
Kittiwake	1.11	763	455	1094	164	21.41%
Little gull	0.01	10	0	30	10	96.52%
Lesser black-backed gull	0.01	11	0	30	10	96.52%
Herring gull	0.15	100	20	203	48	47.31%
Great black-backed gull	0.03	21	0	50	14	67.84%
Sandwich tern	0.04	31	0	90	29	93.56%
Guillemot	11.71	8026	5382	10715	1385	17.26%
Razorbill	0.16	111	40	194	40	35.67%
Puffin	0.04	31	0	60	16	50.91%
Feral pigeon	0.01	10	0	30	10	97.30%
Barrel jellyfish	0.03	21	0	50	14	65.64%

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 (%)
Grey seal	0.01	10	0	30	10	95.25%
Harbour porpoise	0.23	160	60	269	54	33.27%

Table 36 Abundance and density estimates of species groups in the survey area during Survey 17 on 27 July 2019

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	24.06	16483	10098	23308	3415	20.72%
All non-avian animals	0.4	272	167	383	56	20.28%
Species group						
Fulmar / gull species	0.01	11	0	30	10	94.26%
Shearwater species	0.55	377	49	926	254	67.32%
Gannet species	0.1	70	10	149	36	51.47%
Cormorant species	0.01	11	0	30	10	94.75%
Wader species	0.16	107	0	308	93	86.78%
Small gull species	0.82	561	259	937	178	31.70%
Black-backed gull species	0.03	21	0	50	14	65.56%
Large gull species	0.25	171	87	271	49	28.36%
Gull species	0.03	21	0	60	20	96.26%
Arctic / common tern	0.34	232	70	467	106	45.61%
Tern species	0.12	81	20	157	36	44.07%
Tern / small gull species	0.04	31	0	78	21	67.77%
Large auk	20.18	13830	8216	19877	2989	21.61%
Small auk	0.19	131	10	326	88	66.63%

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 (%)
Auk species	0.36	250	146	370	59	23.53%
Auk / small gull	0.01	11	0	30	10	95.23%
Auk / shearwater species	0.13	92	30	164	34	37.02%
Passerine species	0.63	430	0	1284	406	94.45%
Small bird species	0.01	11	0	30	10	95.70%
Shark species	0.01	11	0	31	10	97.13%
Seal species	0.09	60	20	101	21	34.13%
Cetacean species	0.29	200	107	303	51	25.40%

Table 37 Abundance and density estimates of species in the survey area during Survey 17 on 27 July 2019

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						
Fulmar	0.01	10	0	30	10	95.77%
Manx shearwater	0.59	405	61	966	258	63.54%
Gannet	0.1	71	10	151	37	52.32%
Shag	0.02	11	0	31	10	96.57%
Oystercatcher	0.03	20	0	60	19	95.58%
Kittiwake	0.54	372	155	656	130	34.83%
Little gull	0.06	40	0	109	30	74.87%
Black-headed gull	0.18	122	49	210	42	34.34%
Common gull	0.04	30	0	78	21	68.84%
Lesser black-backed gull	0.03	20	0	60	20	96.44%
Herring gull	0.16	110	40	189	39	34.90%
Great black-backed gull	0.03	21	0	50	14	65.39%
Little tern	0.04	30	0	90	29	95.24%
Sandwich tern	0.07	50	10	100	24	47.29%
Common tern	0.04	30	0	78	21	67.97%
Guillemot	18.19	12466	7330	18176	2771	22.23%

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 (%)
Razorbill	1.41	968	501	1492	257	26.49%
Puffin	0.2	141	20	335	87	61.84%
Feral pigeon	0.63	434	0	1283	409	94.17%
Grey seal	0.01	11	0	30	10	95.45%
Harbour porpoise	0.29	202	110	307	51	24.92%

Table 38 Abundance and density estimates of species groups in the survey area during Survey 18 on 13 August 2019

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	17.66	12098	7851	18106	2729	22.55%
All non-avian animals	0.16	111	59	167	29	25.66%
Species group						
Duck species	0.07	50	0	137	40	79.28%
Shearwater species	2.71	1855	188	4755	1310	70.59%
Gannet species	0.1	69	0	195	57	82.12%
Wader species	0.07	50	0	137	39	77.84%
Small gull species	0.53	360	159	640	127	35.24%
Black-backed gull species	0.03	21	0	49	13	64.32%
Large gull species	0.07	51	10	100	24	47.67%
Arctic / common tern	0.2	139	59	227	43	30.91%
Tern / small gull species	0.01	10	0	30	10	96.07%
Large auk	13.1	8979	6454	11980	1404	15.64%
Small auk	0.04	31	0	90	29	94.39%
Auk species	0.03	21	0	50	14	66.69%
Auk / shearwater species	0.55	374	79	849	213	56.73%
Small bird species	0.01	11	0	30	10	95.61%

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 species	0.01	10	0	30	10	95.10%
Cetacean species	0.15	101	57	150	25	24.83%

Table 39 Abundance and density estimates of species in the survey area during Survey 18 on 13 August 2019

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 scoter	0.07	50	0	130	38	76.58%
Manx shearwater	2.81	1928	219	4835	1346	69.80%
Gannet	0.1	72	0	200	59	82.31%
Oystercatcher	0.01	10	0	30	10	98.71%
Kittiwake	0.45	308	98	593	128	41.48%
Little gull	0.01	10	0	30	10	98.55%
Black-headed gull	0.01	10	0	30	10	94.42%
Common gull	0.01	11	0	30	10	94.28%
Lesser black-backed gull	0.01	11	0	30	10	93.99%
Herring gull	0.06	41	0	90	24	57.53%
Great black-backed gull	0.01	10	0	30	10	96.32%
Guillemot	11.92	8166	5739	11002	1353	16.56%
Razorbill	0.32	219	70	393	83	37.77%
Puffin	0.04	30	0	90	29	95.50%
Harbour porpoise	0.15	100	57	150	25	24.88%

Table 40 Abundance and density estimates of species groups in the survey area during Survey 19 on 5 September 2019

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	10.02	6863	4505	9447	1270	18.50%
All non-avian animals	0.2	139	59	227	43	30.86%
Species group						
Duck species	0.03	21	0	50	14	66.89%
Diver species	0.01	10	0	30	10	96.98%
Fulmar / gull species	0.01	11	0	30	10	95.03%
Shearwater species	0.28	191	39	425	102	53.34%
Gannet species	0.12	80	29	140	30	36.77%
Cormorant species	0.03	20	0	50	14	66.39%
Small gull species	0.73	499	213	858	166	33.16%
Black-backed gull species	0.12	80	0	215	59	73.92%
Large gull species	0.07	50	0	123	34	66.48%
Gull species	0.06	40	0	107	30	73.90%
Arctic / common tern	0.16	110	39	193	40	35.91%
Tern species	0.01	10	0	30	10	95.43%
Tern / small gull species	0.01	10	0	30	10	96.06%
Large auk	7.68	5264	3412	7318	1003	19.05%

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 (%)
Auk species	0.28	192	40	410	97	50.30%
Large auk / diver species	0.09	61	0	178	58	95.72%
Auk / shearwater species	0.31	210	57	412	92	43.79%
Seal species	0.01	10	0	30	10	94.89%
Cetacean species	0.19	130	50	222	45	34.18%

Table 41 Abundance and density estimates of species in the survey area during Survey 19 on 5 September 2019

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 scoter	0.03	20	0	49	14	66.18%
Red-throated diver	0.03	20	0	49	14	65.24%
Fulmar	0.01	10	0	30	10	96.92%
Manx shearwater	0.36	249	59	501	115	46.15%
Gannet	0.12	81	29	140	30	36.78%
Cormorant	0.01	10	0	30	10	95.52%
Shag	0.01	10	0	30	10	98.80%
Kittiwake	0.42	290	120	504	98	33.74%
Little gull	0.06	40	0	89	23	55.46%
Black-headed gull	0.03	20	0	49	13	64.91%
Common gull	0.19	130	0	344	97	74.19%
Herring gull	0.09	61	0	136	34	55.60%
Great black-backed gull	0.13	91	0	242	68	74.62%
Sandwich tern	0.01	10	0	30	10	94.32%
Arctic tern	0.01	11	0	30	10	94.31%
Guillemot	5.74	3936	2406	5727	837	21.26%

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 (%)
Razorbill	1.66	1136	709	1596	228	20.02%
Puffin	0.01	10	0	30	10	96.07%
Harbour porpoise	0.19	129	49	222	44	34.21%

Table 42 Abundance and density estimates of species groups in the survey area during Survey 20 on 6 October 2019

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	12.89	8832	4744	14098	2448	27.72%
All non-avian animals	0.15	101	49	161	30	29.69%
Species group						
Duck species	0.24	162	10	371	94	57.97%
Diver species	0.09	61	10	131	32	52.20%
Fulmar / gull species	0.01	10	0	30	10	97%
Gannet species	0.09	60	10	129	32	51.93%
Cormorant species	0.5	344	20	918	268	77.84%
Grebe species	0.01	10	0	31	10	95.78%
Skua species excluding great	0.01	11	0	31	10	95.66%
Small gull species	5.55	3800	383	8737	2193	57.72%
Large gull species	0.17	120	0	332	96	79.93%
Gull species	0.16	111	10	253	65	58.03%
Arctic / common tern	0.06	42	0	110	31	73.26%
Large auk	5.9	4041	2872	5243	610	15.09%
Auk species	0.04	30	0	91	29	96.79%
Auk / small gull	0.01	11	0	31	10	95.29%

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 (%)
Small bird species	0.03	21	0	50	14	65.29%
Shark species	0.01	10	0	31	10	96.60%
Seal species	0.01	11	0	31	10	97.45%
Cetacean species	0.12	82	29	145	31	37.04%

Table 43 Abundance and density estimates of species in the survey area during Survey 20 on 6 October 2019

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 scoter	0.19	131	10	294	74	56.65%
Goldeneye	0.04	31	0	91	29	95.12%
Red-throated diver	0.09	61	10	131	32	51.63%
Fulmar	0.01	10	0	31	10	98.73%
Gannet	0.09	61	10	130	32	51.13%
Cormorant	0.04	30	0	79	22	70.43%
Shag	0.45	308	10	873	268	87.17%
Great crested grebe	0.01	10	0	30	10	97%
Pomarine skua	0.01	11	0	31	10	97.23%
Kittiwake	2.88	1977	139	5407	1615	81.71%
Little gull	0.65	443	61	932	223	50.32%
Black-headed gull	0.15	102	10	218	53	52%
Common gull	1.86	1275	29	3646	1137	89.23%
Lesser black-backed gull	0.12	83	0	241	78	94.42%
Herring gull	0.06	41	0	90	23	56.20%
Great black-backed gull	0.04	31	0	79	22	70.52%

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 (%)
Arctic tern	0.06	41	0	109	30	74.12%
Guillemot	5.44	3727	2660	4846	558	14.96%
Razorbill	0.28	192	40	390	93	48.48%
Puffin	0.04	31	0	91	30	96.22%
Basking shark	0.01	11	0	31	10	96.83%
Harbour porpoise	0.12	81	30	145	30	36.66%

Table 44 Abundance and density estimates of species groups in the survey area during Survey 21 on 10 November 2019

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	43.83	30031	16110	45313	7475	24.89%
All non-avian animals	0.19	132	20	286	70	53.11%
Species group						
Duck species	2.52	1725	0	4990	1573	91.21%
Diver species	0.18	121	59	193	35	28.52%
Fulmar / gull species	0.01	10	0	31	10	97.60%
Cormorant species	0.23	161	0	443	133	82.68%
Wader species	0.01	11	0	30	10	95.32%
Small gull species	23.37	16012	6004	28520	5814	36.31%
Large gull species	0.16	111	40	195	40	35.84%
Gull species	1.11	759	289	1334	268	35.22%
Large auk	15.4	10550	6759	14970	2118	20.07%
Auk species	0.72	492	221	810	151	30.61%
Auk / small gull	0.26	180	58	330	71	39.38%
Large auk / diver species	0.03	21	0	50	14	65.45%
Small bird species	0.01	10	0	30	10	96.38%
Dolphin species	0.09	60	0	180	58	96.53%

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 (%)
Cetacean species	0.1	71	20	140	32	44.36%

Table 45 Abundance and density estimates of species in the survey area during Survey 21 on 10 November 2019

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 scoter	2.43	1668	0	4968	1584	94.97%
Red-breasted merganser	0.01	11	0	30	10	94.93%
Red-throated diver	0.18	122	59	196	35	28.80%
Cormorant	0.22	149	0	431	132	88.14%
Shag	0.01	11	0	30	10	95.59%
Oystercatcher	0.01	10	0	30	10	95.45%
Kittiwake	12.31	8433	2149	16525	3718	44.08%
Little gull	2.45	1676	648	2865	576	34.37%
Black-headed gull	4.55	3116	1030	5591	1171	37.57%
Common gull	3.13	2144	1026	3506	643	29.96%
Herring gull	0.17	120	50	211	42	34.66%
Great black-backed gull	0.04	30	0	90	30	98.42%
Guillemot	8.12	5566	3362	8706	1413	25.37%
Razorbill	6.62	4539	2207	7352	1337	29.45%
Puffin	0.02	11	0	30	10	95.71%
Common dolphin	0.04	31	0	90	29	93.95%

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 (%)
Bottlenose dolphin	0.05	32	0	90	30	94.08%
Harbour porpoise	0.1	70	20	138	31	44.20%

Table 46 Abundance and density estimates of species groups in the survey area during Survey 22 on 9 December 2019

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	22.47	15397	7499	26121	4848	31.48%
All non-avian animals	0.26	180	70	310	61	33.92%
Species group						
Duck species	4.58	3139	0	9246	3005	95.72%
Diver species	1.35	924	494	1387	228	24.64%
Gannet species	0.04	31	0	67	16	51.47%
Cormorant species	0.29	201	20	524	153	75.74%
Crow species	0.01	10	0	30	10	96.89%
Grebe species	0.03	20	0	50	14	67.29%
Small gull species	8.63	5915	1940	12827	3299	55.77%
Black-backed gull species	0.01	10	0	30	10	95.68%
Large gull species	0.24	162	30	333	77	47.57%
Gull species	1.81	1242	274	2956	793	63.80%
Large auk	4.8	3292	2533	4083	400	12.15%
Auk species	0.63	430	210	707	128	29.71%
Auk / small gull	0.12	81	30	144	30	36.23%
Large auk / diver species	0.12	80	20	158	36	43.94%

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 (%)
Cetacean species	0.15	101	38	188	41	40.65%
Seal / small cetacean species	0.12	80	10	167	40	49.35%

Table 47 Abundance and density estimates of species in the survey area during Survey 22 on 9 December 2019

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 scoter	4.45	3050	0	9210	2918	95.68%
Red-throated diver	1.39	952	514	1429	235	24.65%
Gannet	0.04	31	0	60	16	50.81%
Cormorant	0.23	160	0	478	154	96.51%
Shag	0.04	30	0	68	17	55.52%
Great crested grebe	0.01	10	0	30	10	99.34%
Slavonian grebe	0.01	10	0	30	10	97.11%
Kittiwake	2.26	1546	495	3390	871	56.34%
Little gull	2.93	2008	48	5433	1550	77.19%
Black-headed gull	1.69	1161	258	2687	709	61.02%
Common gull	2.71	1859	744	3688	839	45.13%
Herring gull	0.33	229	49	469	109	47.63%
Great black-backed gull	0.03	21	0	50	14	66.85%
Guillemot	3.16	2165	1500	2905	361	16.65%
Razorbill	1.48	1016	680	1358	173	17.03%
Corvid	0.01	10	0	30	10	96.34%

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 (%)
Harbour porpoise	0.25	170	60	300	62	36.02%

Table 48 Abundance and density estimates of species groups in the survey area during Survey 23 on 10 January 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	61.95	42447	20563	67629	12110	28.53%
All non-avian animals	0.47	326	59	795	216	66.10%
Species group						
Duck species	5.45	3738	0	10621	3410	91.24%
Diver species	0.95	650	127	1556	420	64.61%
Fulmar / gull species	0.2	140	30	307	77	54.87%
Gannet species	0.03	20	0	49	14	65.75%
Cormorant species	0.07	50	0	136	39	78.07%
Small gull species	24.94	17091	5984	31793	6658	38.96%
Large gull species	0.42	292	99	556	123	42.15%
Gull species	5.8	3976	774	9224	2343	58.93%
Large auk	21.75	14903	6537	24547	4632	31.08%
Auk species	2.16	1480	231	2934	698	47.13%
Auk / small gull	0.48	328	77	648	146	44.26%
Large auk / diver species	0.03	21	0	60	20	96.01%
Small bird species	0.01	10	0	30	10	96.65%
Seal species	0.01	10	0	30	10	96.01%

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	0.23	161	0	478	152	94.32%
Cetacean species	0.24	162	49	312	69	42.53%

Table 49 Abundance and density estimates of species in the survey area during Survey 23 on 10 January 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						
Common scoter	5.25	3595	0	10603	3429	95.39%
Red-throated diver	0.93	637	127	1517	404	63.32%
Fulmar	0.04	30	0	78	21	70.08%
Gannet	0.03	20	0	49	13	64.96%
Cormorant	0.06	40	0	120	38	95.43%
Shag	0.01	11	0	30	10	95.02%
Kittiwake	16.63	11394	4252	20253	4079	35.80%
Little gull	2.22	1520	30	4395	1401	92.15%
Black-headed gull	1.92	1313	426	2565	565	42.98%
Common gull	8.01	5487	1379	11858	2800	51.03%
Lesser black-backed gull	0.01	10	0	30	10	95.69%
Herring gull	0.36	250	59	525	124	49.38%
Great black-backed gull	0.09	60	20	110	25	40.40%
Guillemot	12.06	8263	3970	13089	2372	28.70%
Razorbill	8.31	5697	2131	10115	2066	36.25%
Common dolphin	0.28	193	0	567	182	94.55%

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 (%)
Harbour porpoise	0.16	111	39	201	43	38.38%

Table 50 Abundance and density estimates of species groups in the survey area during Survey 24 on 12 February 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	36.26	24846	9105	45779	9336	37.57%
All non-avian animals	0.13	91	30	164	35	37.89%
Species group						
Swan species	0.03	21	0	60	20	97.25%
Diver species	0.45	310	80	619	142	45.71%
Fulmar / gull species	0.03	20	0	49	14	65.81%
Cormorant species	0.07	51	0	110	28	54.87%
Grebe species	0.01	10	0	30	10	94.77%
Small gull species	26.05	17846	5914	32790	6969	39.05%
Large gull species	0.26	181	60	339	73	40.08%
Gull species	0.13	89	0	195	49	54.26%
Large auk	7.71	5283	2134	9446	1902	36%
Auk species	0.76	518	107	1126	266	51.26%
Auk / small gull	0.72	491	88	1077	267	54.30%
Large auk / diver species	0.03	20	0	49	14	66.54%
Cetacean species	0.12	81	20	156	35	42.34%
Seal / small cetacean species	0.01	11	0	30	10	96.84%

Table 51 Abundance and density estimates of species in the survey area during Survey 24 12 February 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						
Mute swan	0.03	20	0	60	19	95.45%
Red-throated diver	0.39	268	69	575	136	50.91%
Great northern diver	0.01	11	0	30	10	96.54%
Cormorant	0.01	10	0	30	10	96.72%
Shag	0.06	41	0	89	23	56.20%
Great crested grebe	0.01	10	0	30	10	93.50%
Kittiwake	20.35	13946	4497	25442	5403	38.74%
Little gull	0.03	21	0	49	13	64.26%
Black-headed gull	0.66	450	106	897	206	45.67%
Common gull	4.73	3238	788	6772	1569	48.46%
Lesser black-backed gull	0.03	21	0	49	14	65.18%
Herring gull	0.1	70	20	138	32	45.94%
Guillemot	4.01	2747	1075	5210	1092	39.74%
Razorbill	3.19	2189	699	4112	873	39.85%
Harbour porpoise	0.12	80	20	150	34	41.74%

Table 52 Abundance and density estimates of species groups in the survey area during Survey 25 on 25 April 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	13.03	8926	5738	12931	1849	20.71%
All non-avian animals	0.13	91	39	150	30	32.87%
Species group						
Swan species	0.01	10	0	30	10	97.13%
Duck species	0.01	10	0	30	10	95.73%
Diver species	0.13	91	29	177	40	43.83%
Fulmar / gull species	0.07	51	20	89	19	37.52%
Shearwater species	1.16	797	384	1278	227	28.45%
Storm-petrel species	0.01	11	0	30	10	94.51%
Gannet species	0.25	170	40	364	83	48.89%
Cormorant species	0.09	61	0	136	35	58.27%
Small gull species	6.07	4163	1492	7537	1542	37.04%
Black-backed gull species	0.09	60	0	160	47	78.43%
Large gull species	0.35	240	80	430	90	37.21%
Gull species	0.03	21	0	60	20	93.81%
Arctic / common tern	1	685	50	1571	399	58.23%
Tern species	0.1	71	20	139	33	46.59%

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 (%)
Large auk	3.33	2282	1317	3906	742	32.49%
Small auk	0.01	10	0	30	10	95.87%
Auk species	0.04	30	0	61	16	51.75%
Large auk / diver species	0.01	10	0	30	10	95.84%
Auk / shearwater species	0.32	221	89	383	76	34.21%
Small bird species	0.01	11	0	30	10	96.09%
Seal species	0.04	30	0	67	16	53.81%
Cetacean species	0.09	61	20	110	25	39.83%

Table 53 Abundance and density estimates of species in the survey area during Survey 25 on 25 April 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						
Common scoter	0.01	10	0	30	10	95.73%
Red-throated diver	0.15	100	39	189	40	39.65%
Fulmar	0.07	51	20	89	19	37.37%
Manx shearwater	1.26	862	467	1310	217	25.13%
British storm-petrel	0.01	11	0	30	10	95.03%
Gannet	0.25	171	39	356	84	48.89%
Shag	0.07	50	0	120	32	63.28%
Kittiwake	5.58	3822	1468	6844	1400	36.61%
Common gull	0.18	121	20	239	55	45.48%
Lesser black-backed gull	0.03	20	0	60	20	95.68%
Herring gull	0.33	230	76	421	89	38.78%
Great black-backed gull	0.06	41	0	88	22	54.50%
Little tern	0.06	40	0	107	30	74.99%
Sandwich tern	0.04	31	0	68	17	53.33%
Common tern	0.03	20	0	49	14	67.25%
Arctic tern	0.45	307	20	819	236	76.89%

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 (%)
Guillemot	2.33	1596	729	3088	676	42.31%
Razorbill	0.77	531	338	746	106	19.89%
Puffin	0.01	11	0	30	10	95.07%
House martin	0.01	10	0	30	10	96.40%
Harbour porpoise	0.09	61	20	110	25	40.55%

3.4 Density maps

64 The distribution and density patterns of the key bird species (and harbour porpoise) across the twenty-five (25) month survey period are presented as density maps which depicts the estimated density of individuals per km² (**Error! Reference source not found.** to **Error! Reference source not found.**). The key species were guillemot, kittiwake and Manx shearwater.

65 A number of other species, although present during the surveys, are not presented in this report because of insufficient numbers during the surveys, such that the density maps appeared as 'flat' representations of the distribution for almost all of the months of survey.

66 Interpretation of the density maps is included within the discussion (Section 4)

67 Tables and graphs of raw data and individual observations are not repeated in this report but can be found within the preceding 'two-year observation report' (HP00091-703-01).

3.5 Distribution and seasonal abundance

3.5.1 Red-throated diver

68 The densities of red-throated diver (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in Figure 36 to Figure 40. Further interpretation is included within the discussion section.

69 Red-throated diver densities varied across the survey period. Low numbers of the species were recorded in March 2018 and May 2018 with no obvious distribution pattern. In April 2018, low numbers were concentrated in the south of the consented site boundary. From June to September 2018, none of the species was recorded. The species was concentrated from the south west to the north west of the survey area with a clear coastal bias in October and November 2018. The species was more widespread across the survey area from December 2018 to February 2019, with some concentration of the species in the south west, but an overall greater offshore distribution.

70 During March and May 2019, red-throated diver occurred in low numbers and distribution was concentrated in the west of the survey area and within the consented site boundary. From June to August 2019, the species was not recorded. The species distribution was concentrated in the south west of the survey area during September and October 2019. From November 2019 to January 2020, red-throated diver were again concentrated in the south west and north west of the survey area, with highest densities in coastal waters, and lower numbers in the consented site boundary. There was a similar distribution pattern recorded in February 2020, but with the species also concentrated in the south east of the survey area. During April 2020, red-throated diver distribution was concentrated in the offshore east and south east of the survey area as well as within the consented site boundary. No coastal records were recorded at this time.

Figure 2 **Densities of red-throated diver (number/km²) and number of detections per segment between March 2018 and August 2018**

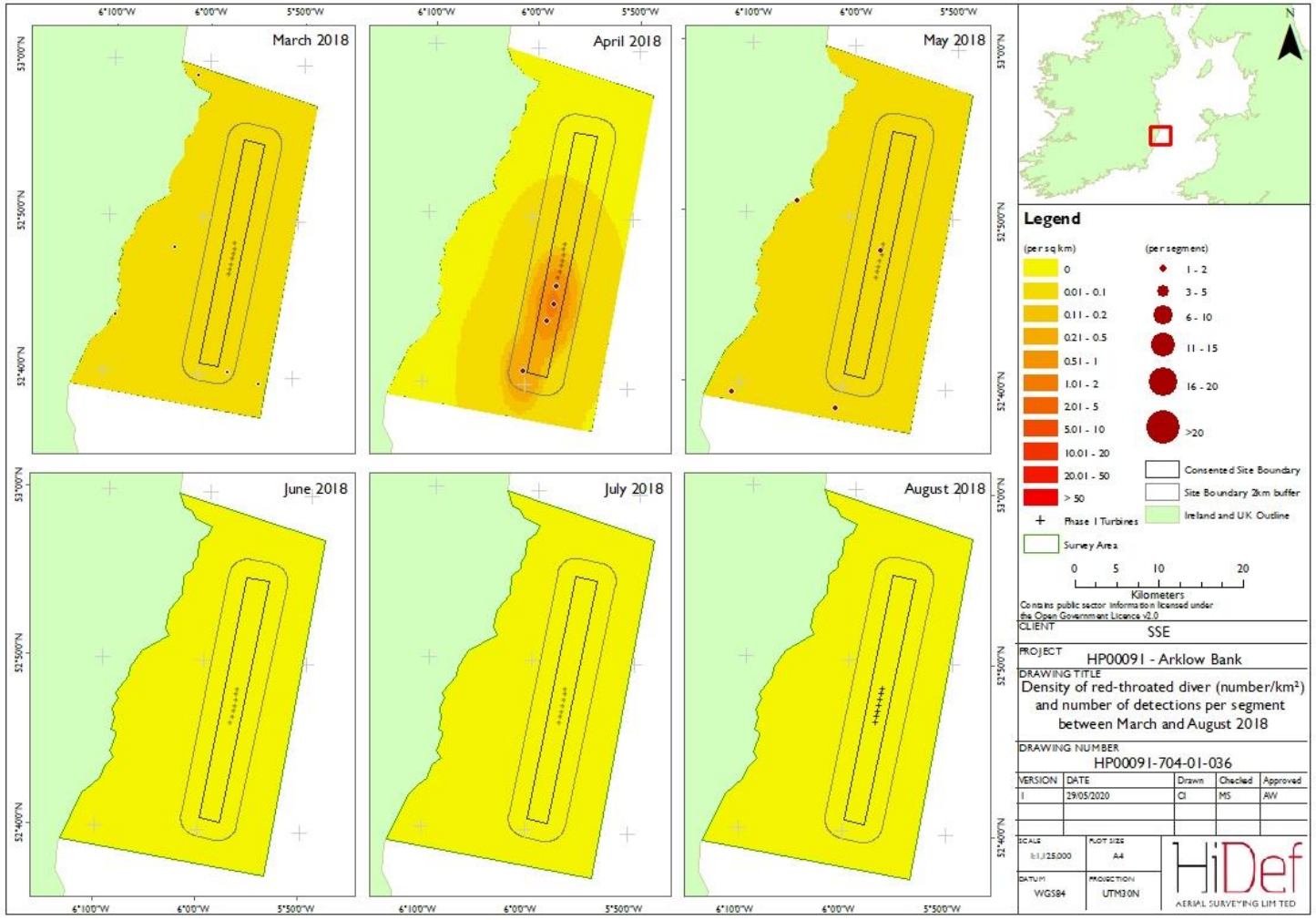


Figure 3 **Densities of red-throated diver (number/km²) and number of detections per segment between September 2018 and February 2019**

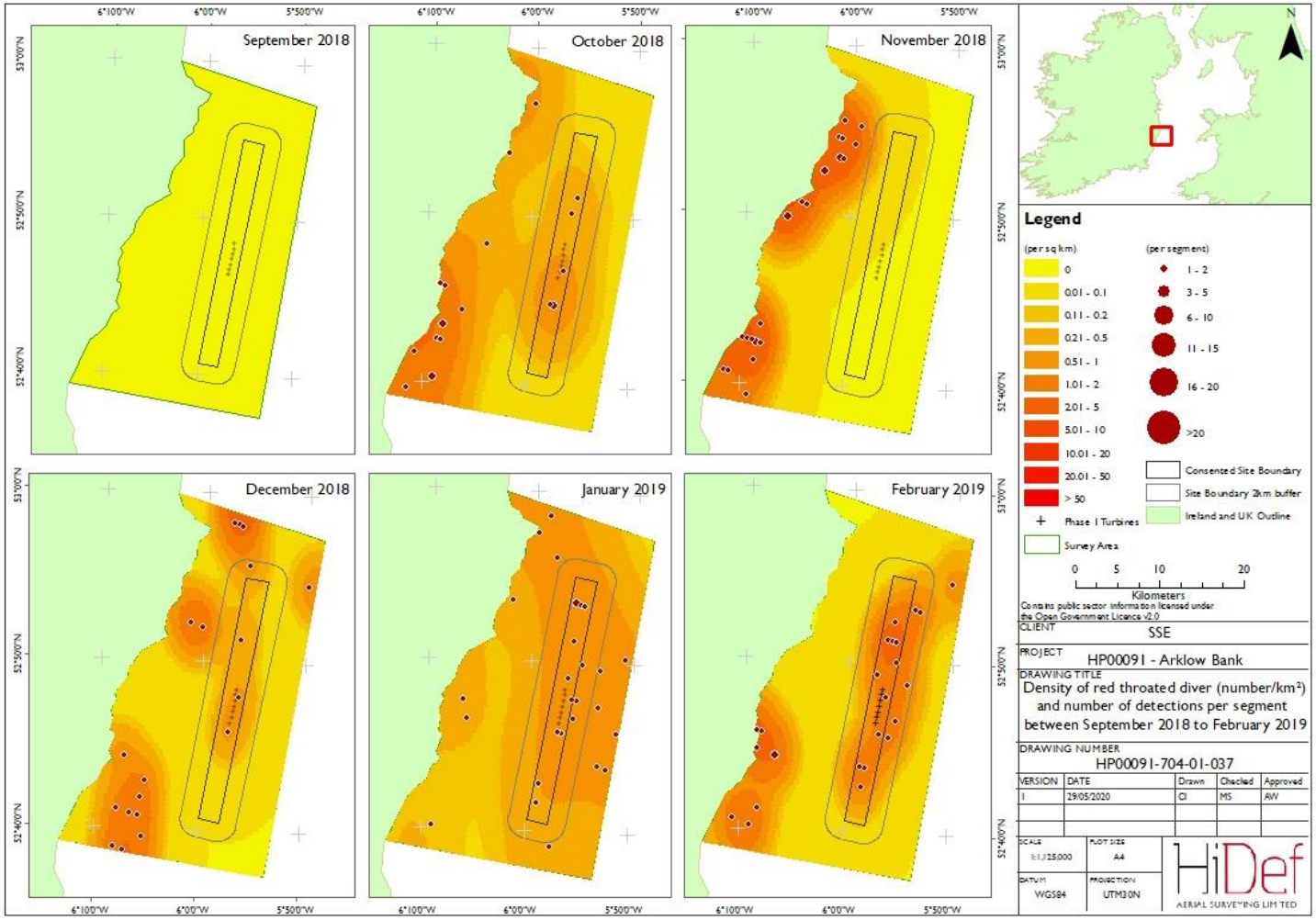


Figure 4 **Densities of red-throated diver (number/km²) and number of detections per segment between March 2019 and August 2019**

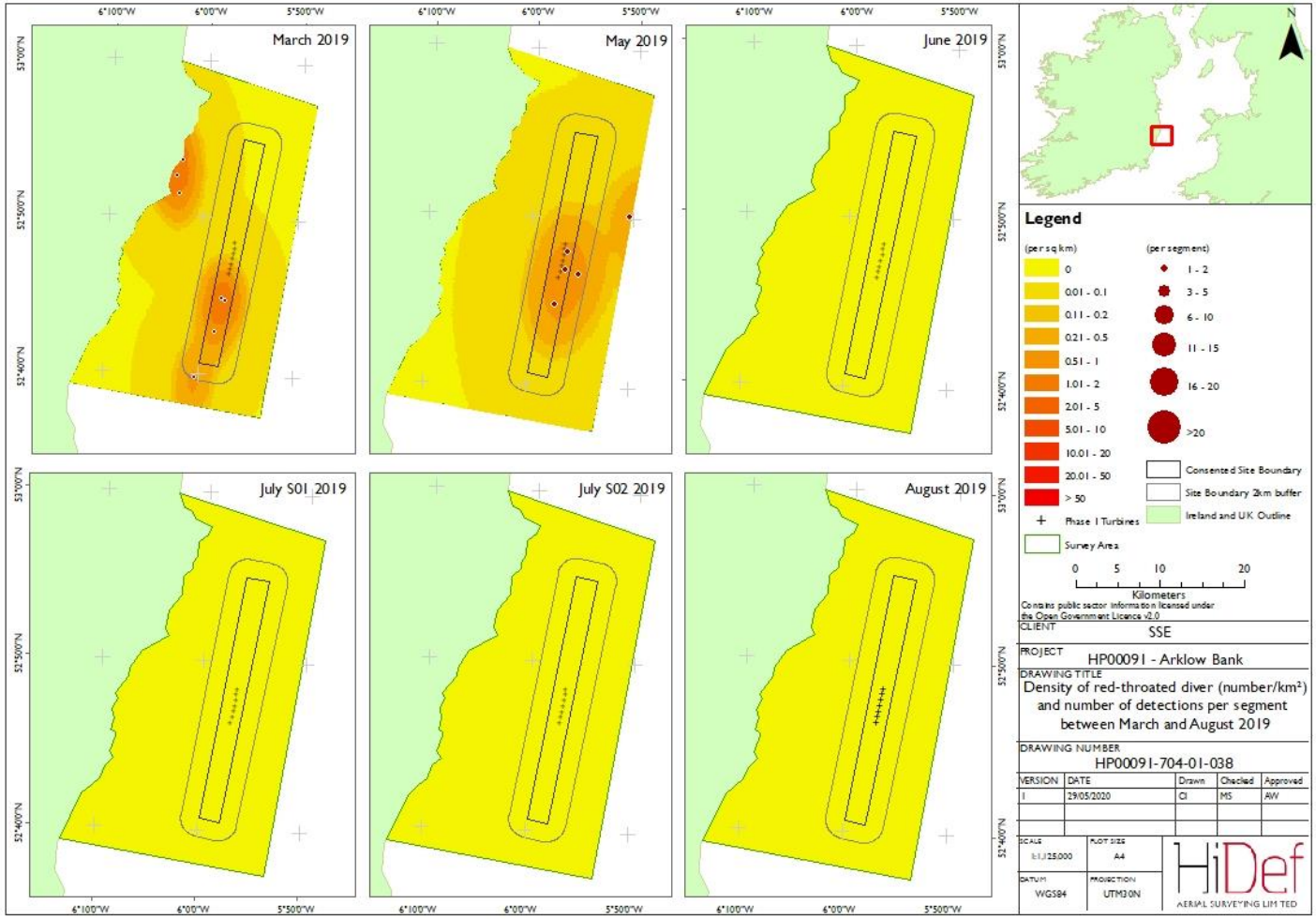


Figure 5 **Densities of red-throated diver (number/km²) and number of detections per segment between September 2019 and February 2020**

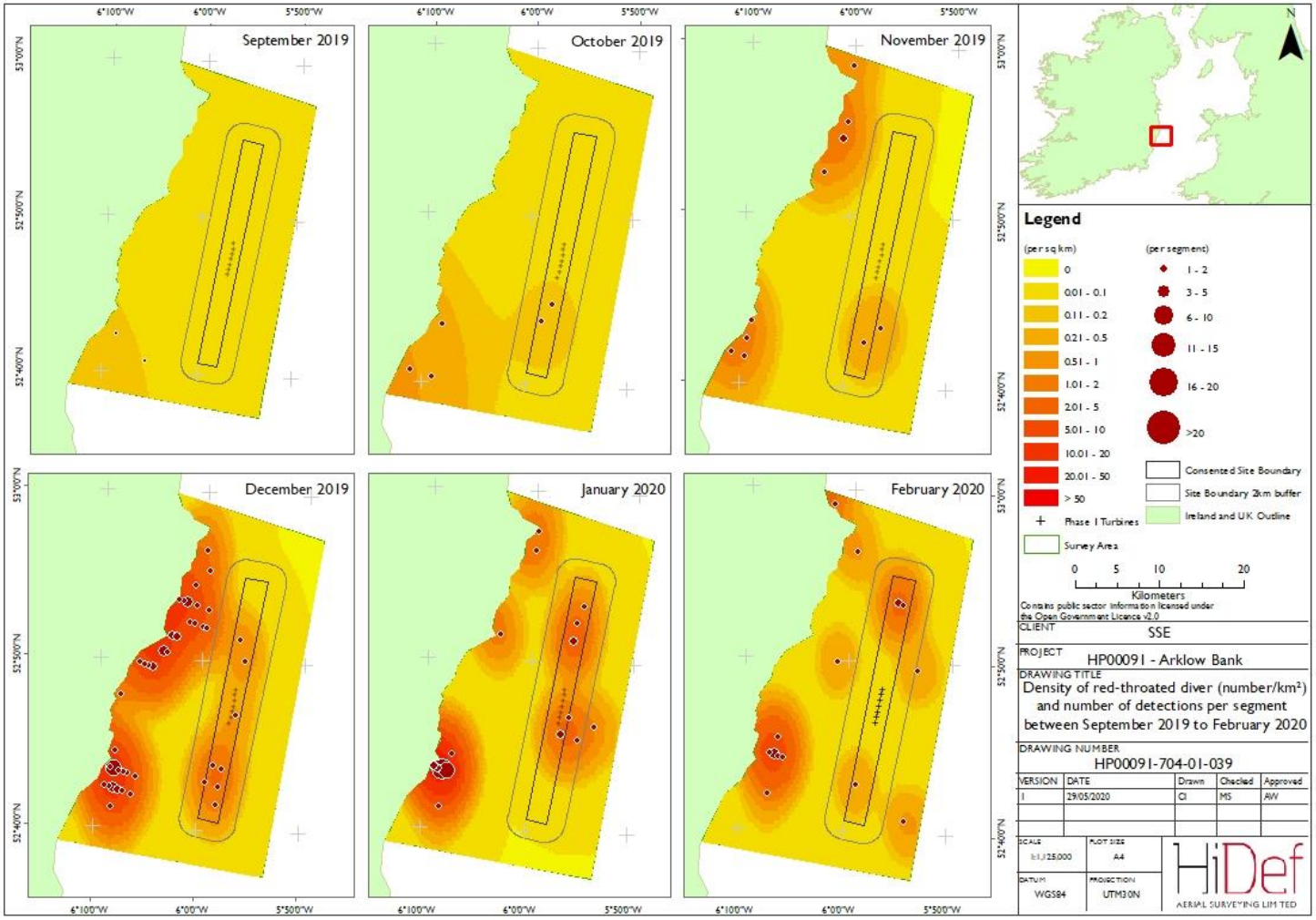
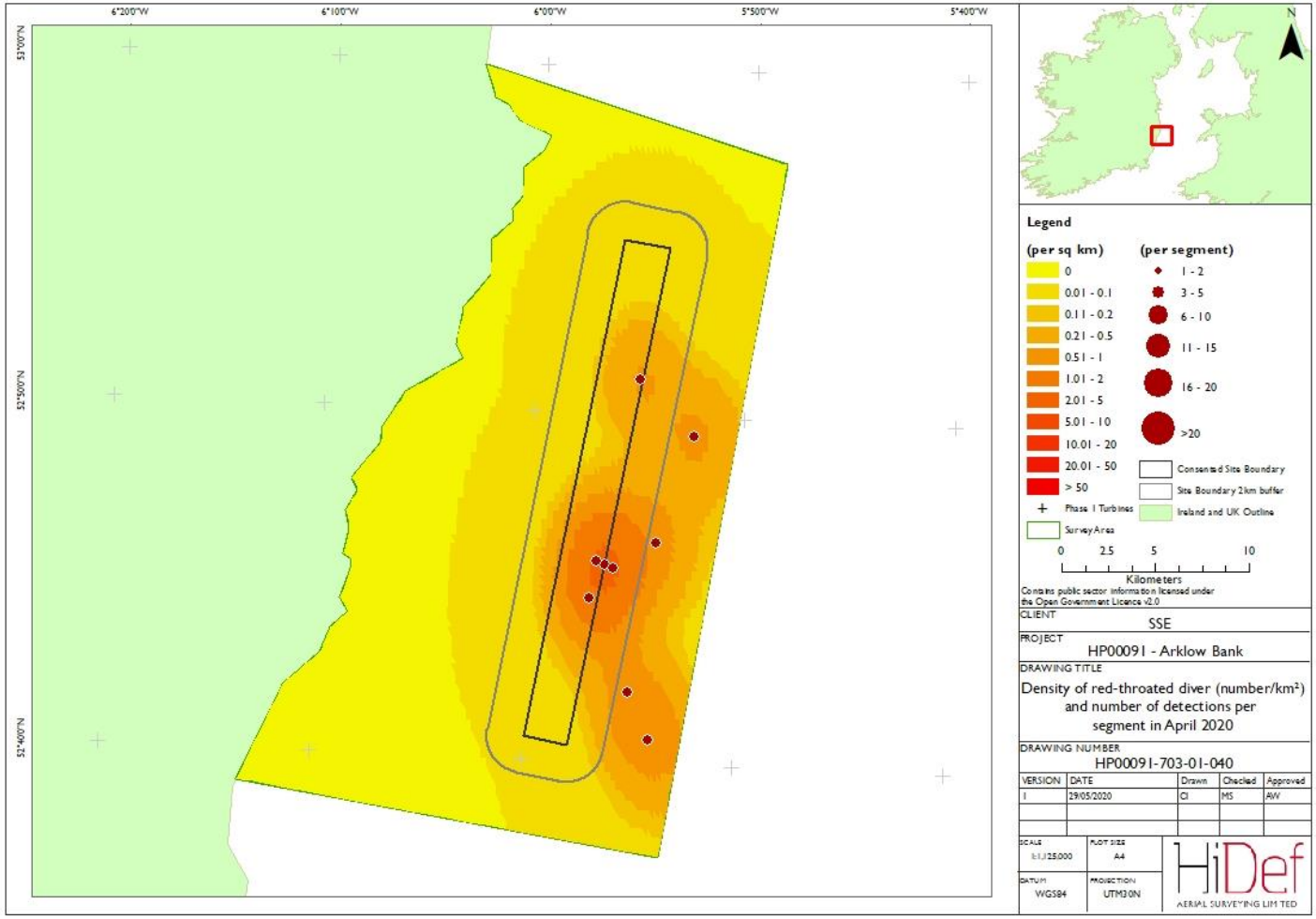


Figure 6 **Densities of red-throated diver (number/km²) and number of detections per segment in April 2020**



3.5.2 Manx shearwater

71 The densities of Manx shearwater (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in figures Figure 7 to Figure 11. Further interpretation is included within the discussion section.

72 In 2018 spring birds were widely distributed peaking in with much lower numbers through summer. In August high densities occurred around the Arklow Bank area itself and to the east of the development site. No birds were recorded October to March 2019.

73 Lower numbers occurred through 2019 with a clear pattern of records offshore and in the southern sector of the survey site. No birds were recorded from October to February 2020. In April 2020 distribution was scattered across the site with a notable peak in densities in the south-east sector.

Figure 7 **Densities of Manx shearwater (number/km²) and number of detections per segment between March 2018 and August 2018**

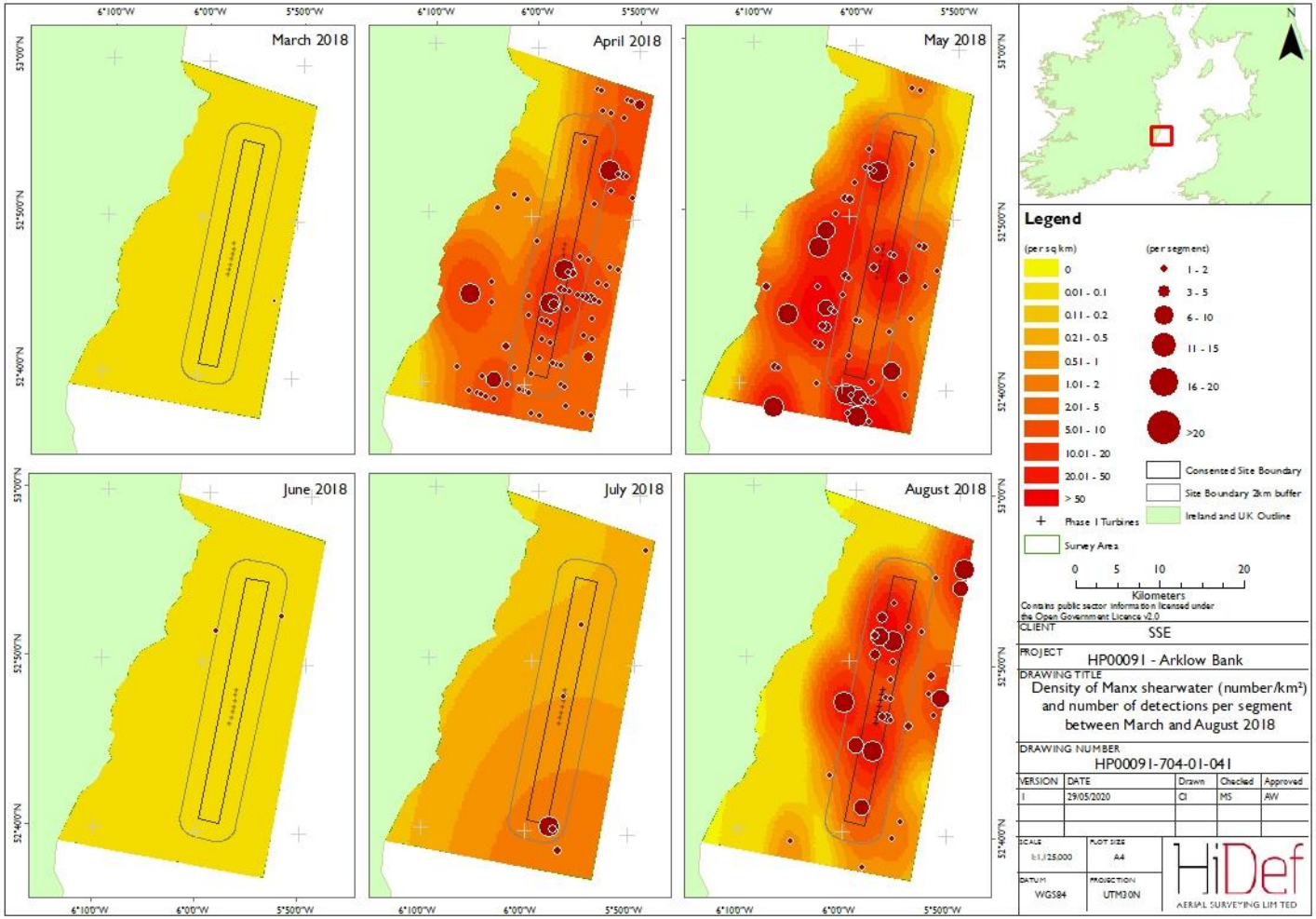


Figure 8 **Densities of Manx shearwater (number/km²) and number of detections per segment between September 2018 and February 2019**

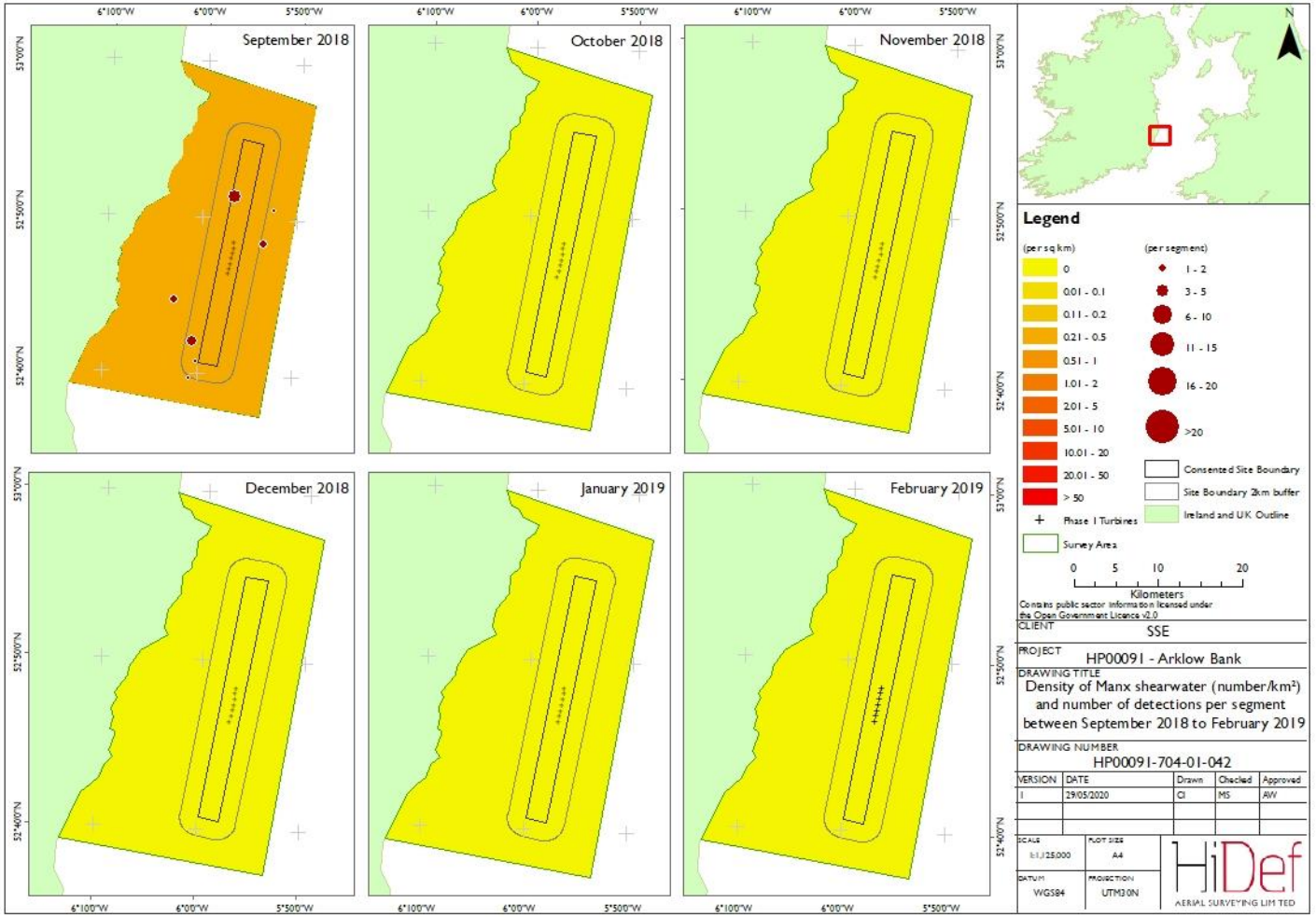


Figure 9 **Densities of Manx shearwater (number/km²) and number of detections per segment between March 2019 and August 2019**

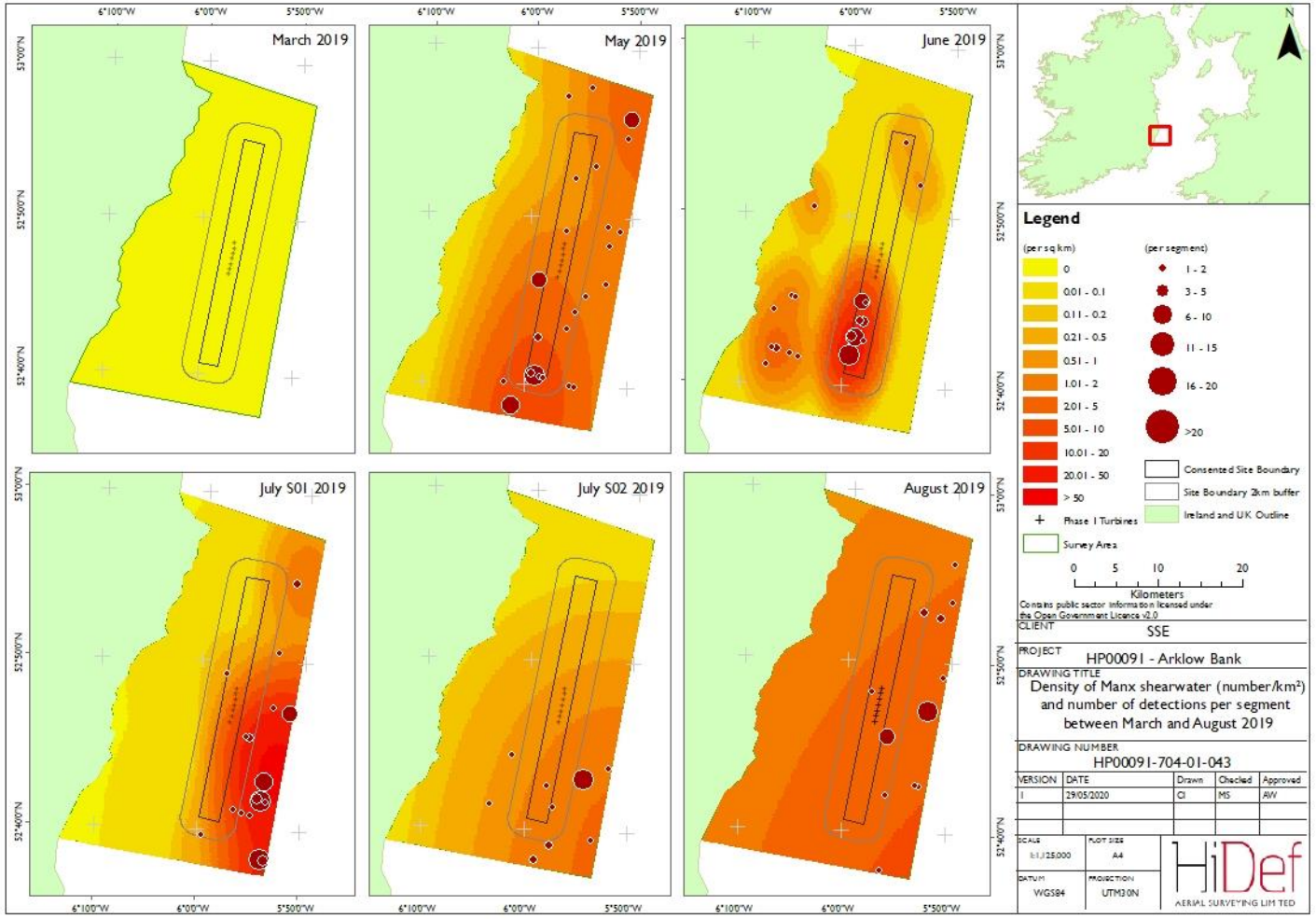


Figure 10 **Densities of Manx shearwater (number/km²) and number of detections per segment between September 2019 and February 2020**

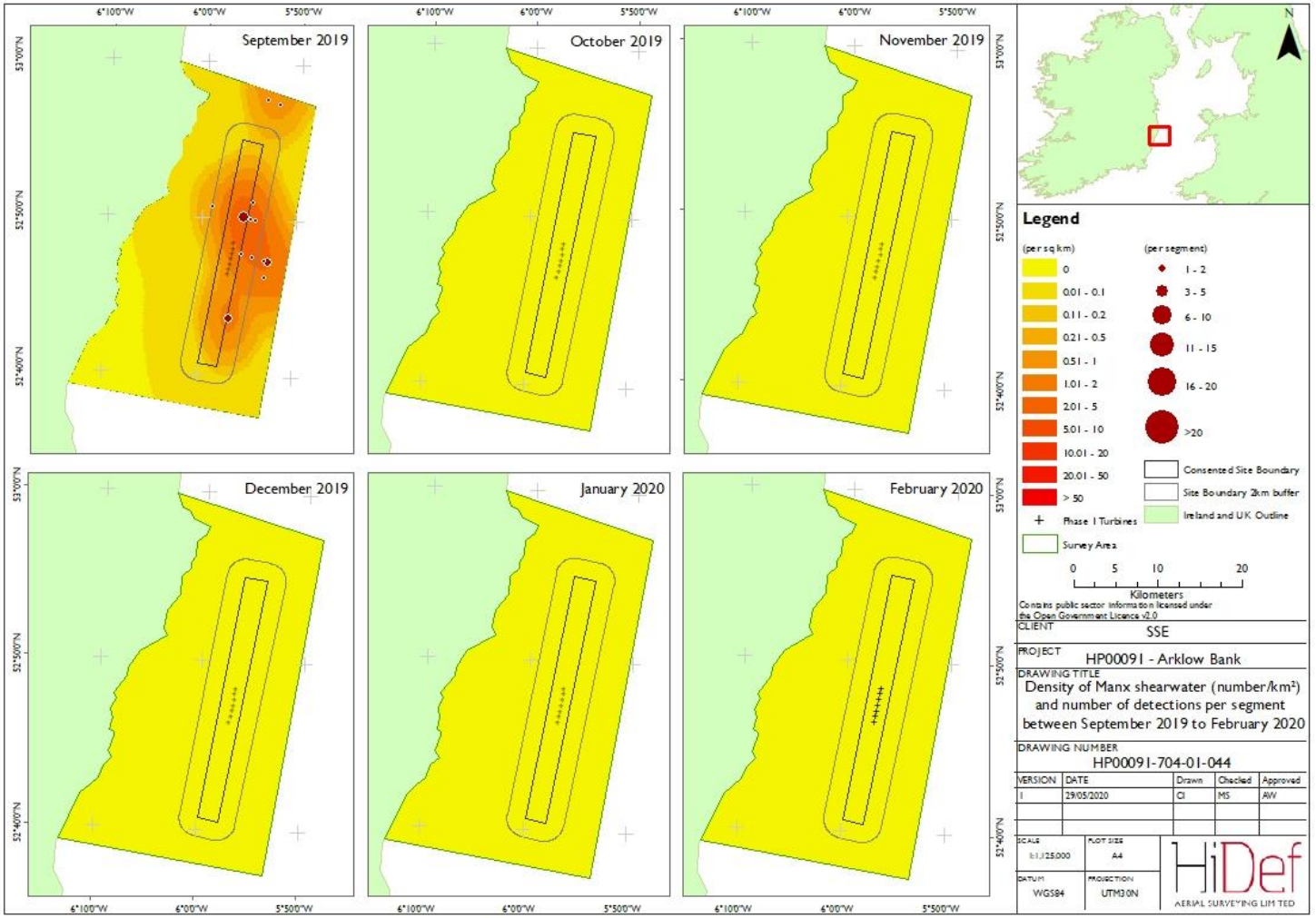
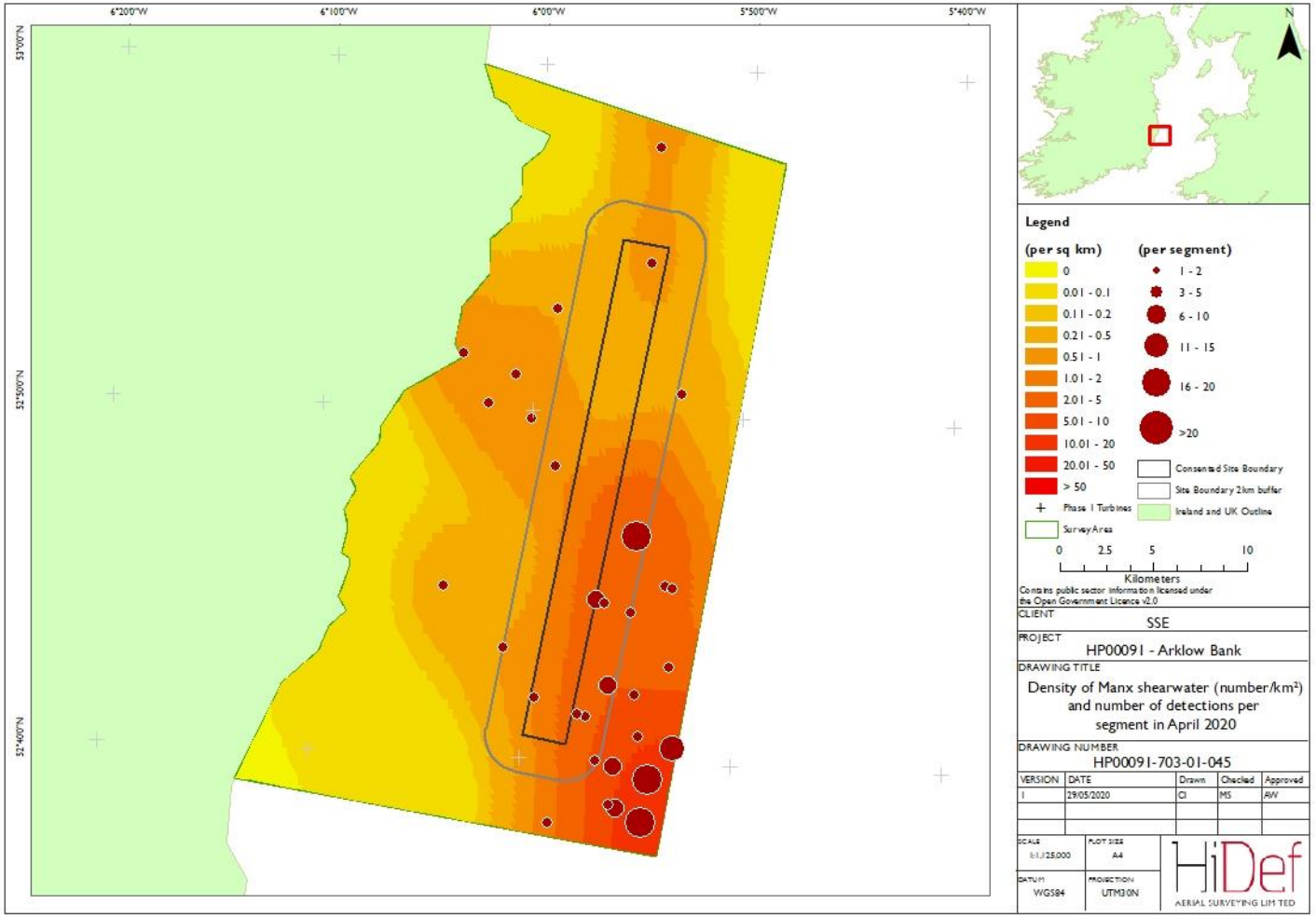


Figure 11 Densities of Manx shearwater (number/km²) and number of detections per segment in April 2020



3.5.3 Gannet

74 The densities of gannet (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in figures Figure 12 to Figure 16. More interpretation is included within the discussion section.

75 Gannets occurred in very low densities throughout the 25 surveys across the two-year period. No clear pattern of distribution was discernible, but generally birds tended to be detected around Arklow Bank or in offshore waters, compared to coastal areas.

Figure 12 **Densities of gannet (number/km²) and number of detections per segment between March 2018 and August 2018**

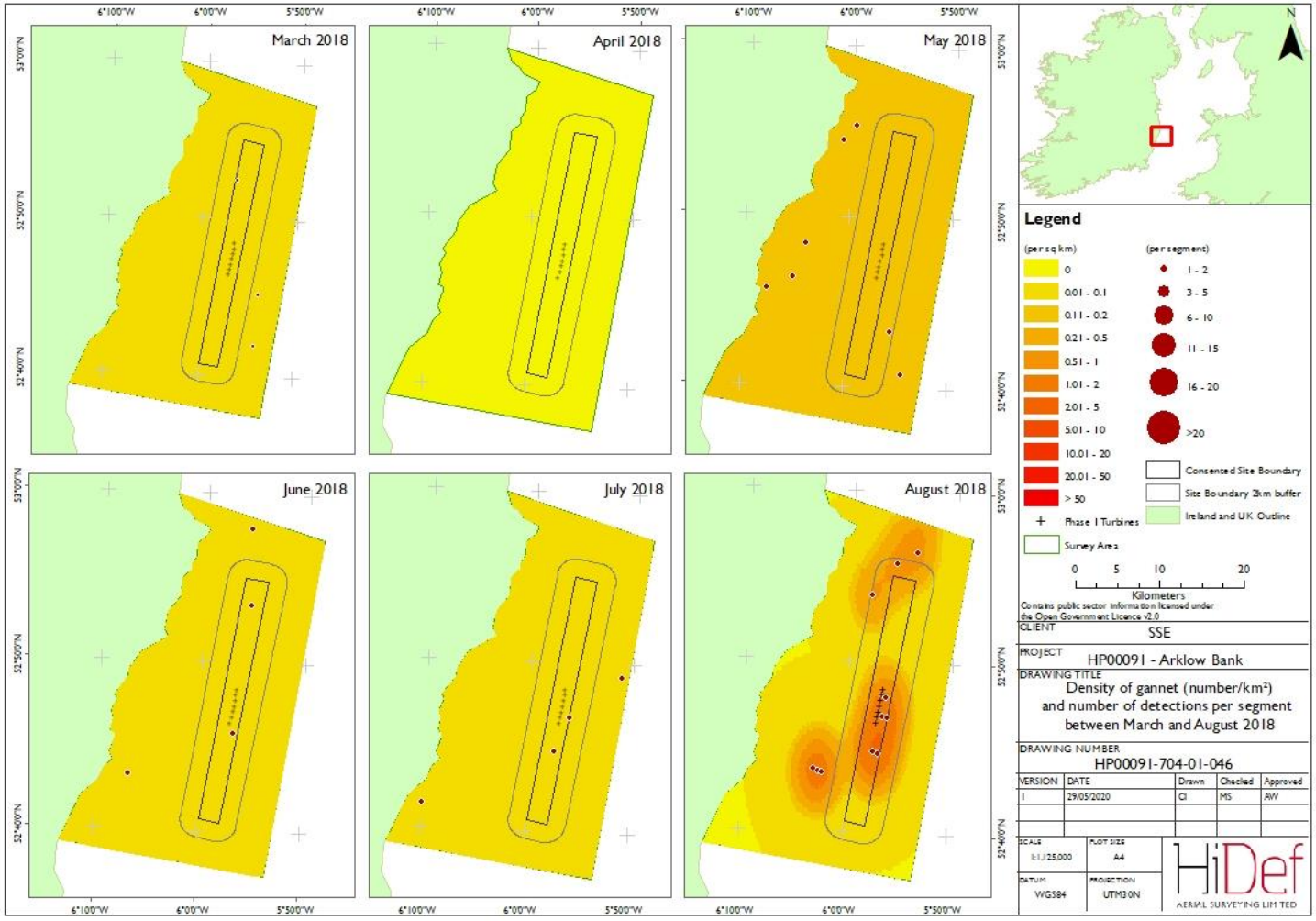


Figure 13 **Densities of gannet (number/km²) and number of detections per segment between September 2018 and February 2019**

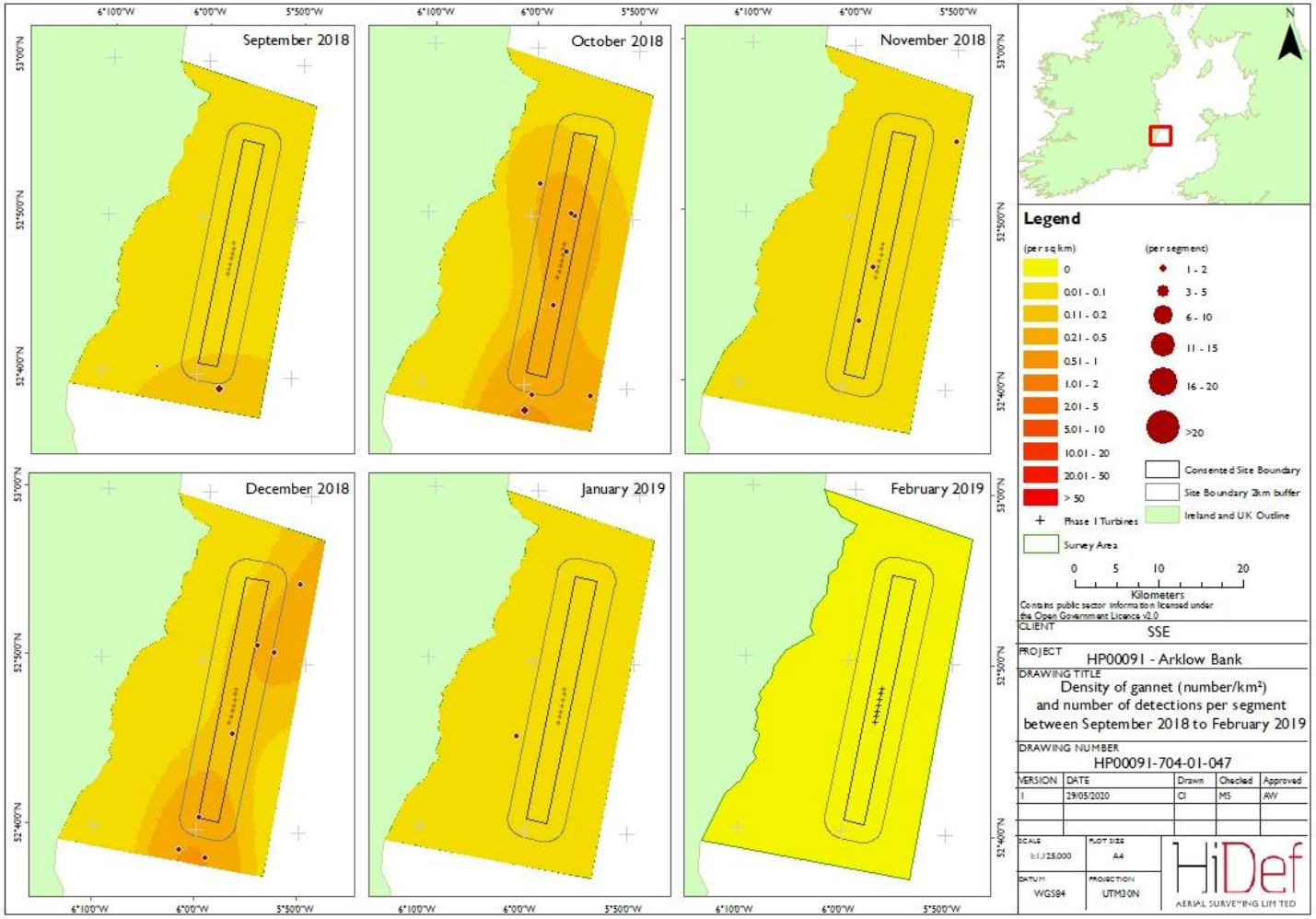


Figure 14 **Densities of gannet (number/km²) and number of detections per segment between March 2019 and August 2019**

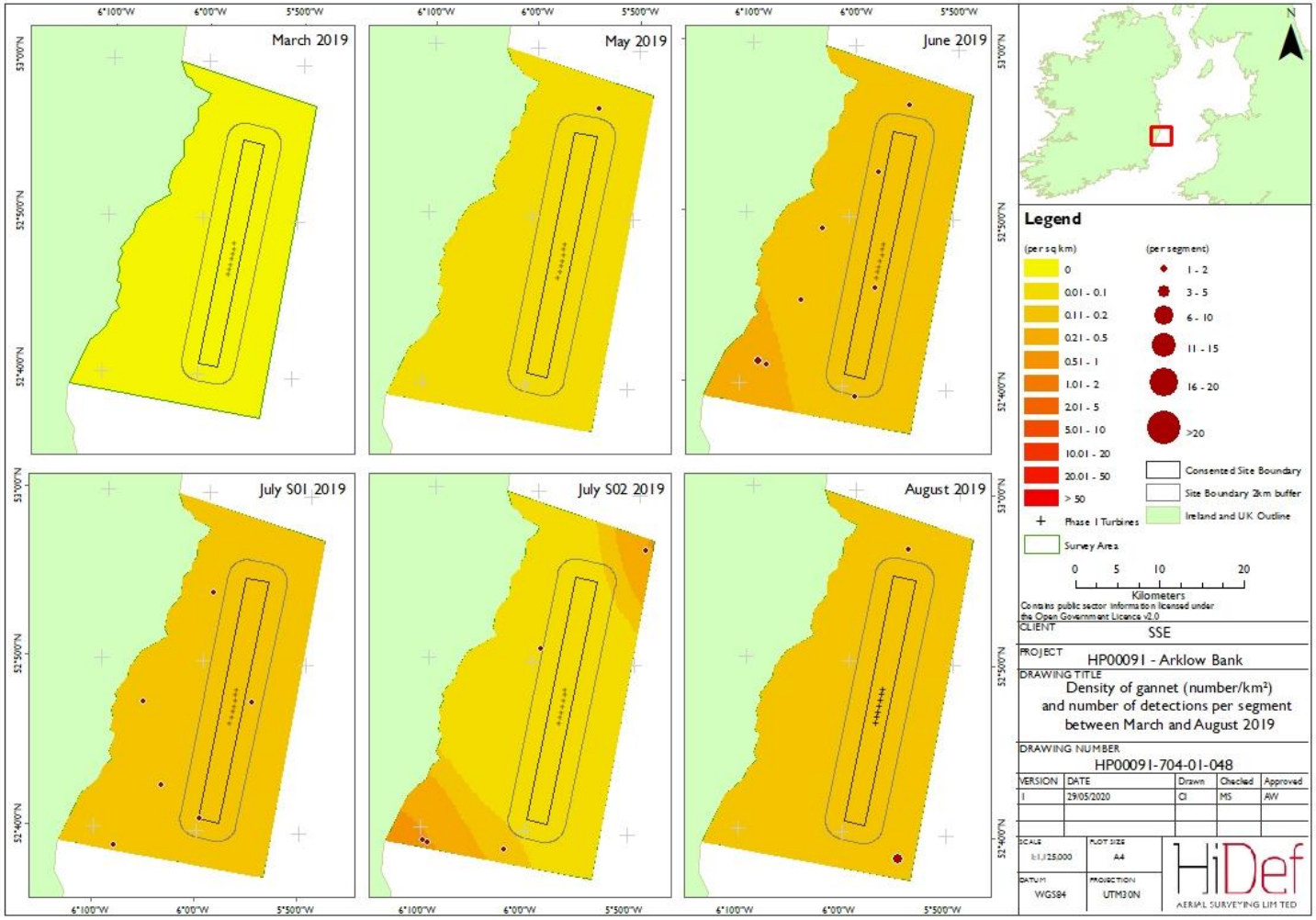


Figure 15 **Densities of gannet (number/km²) and number of detections per segment between September 2019 and February 2020**

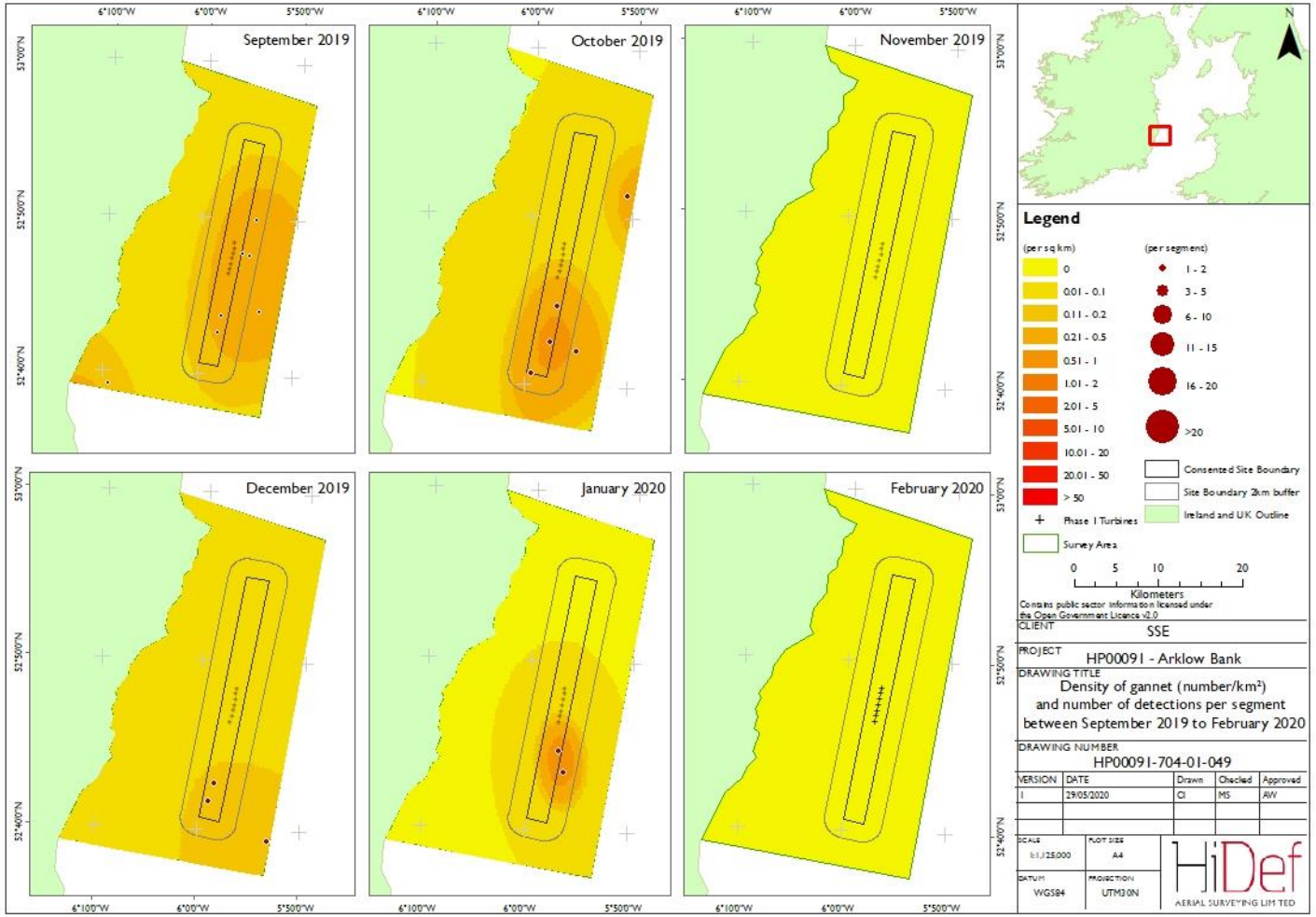
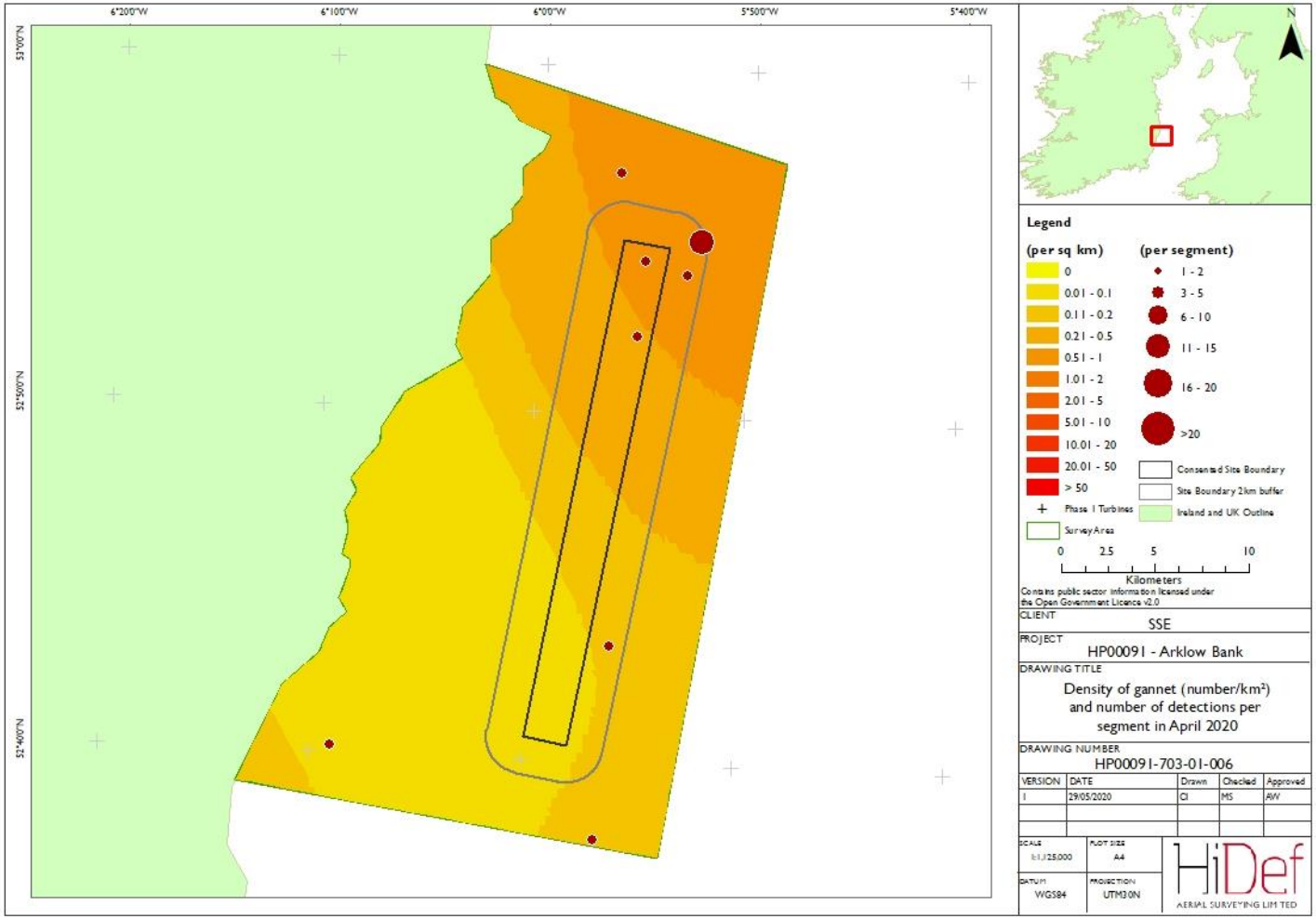


Figure 16 **Densities of gannet (number/km²) and number of detections per segment in April 2020**



3.5.4 Kittiwake

76 The densities of kittiwake (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in figures Figure 17 to Figure 21. Greater interpretation is included within the discussion section.

77 Records were well scattered over the survey site. Low densities occurred through spring 2018 peaking in May with highest numbers around or in the southern part of the development site. Further density peaks occurred around Arklow Bank itself in July and August. Birds were widely distributed in August in low numbers.

78 Autumn 2018 recorded low densities but a wide special distribution. High numbers occurred in December 2018 and February 2019, with the southern sector of the development site being the focal area. Spring and summer counts of kittiwakes were modest and widely spread.

79 From November 2019 large numbers and high densities were recorded through much of the winter, with the development site, Arklow Bank itself, attracting significant counts in its southern section. By April 2020 birds were still heavily utilising the area with most again across the development footprint.

Figure 17 **Densities of kittiwake (number/km²) and number of detections per segment between March 2018 and August 2018**

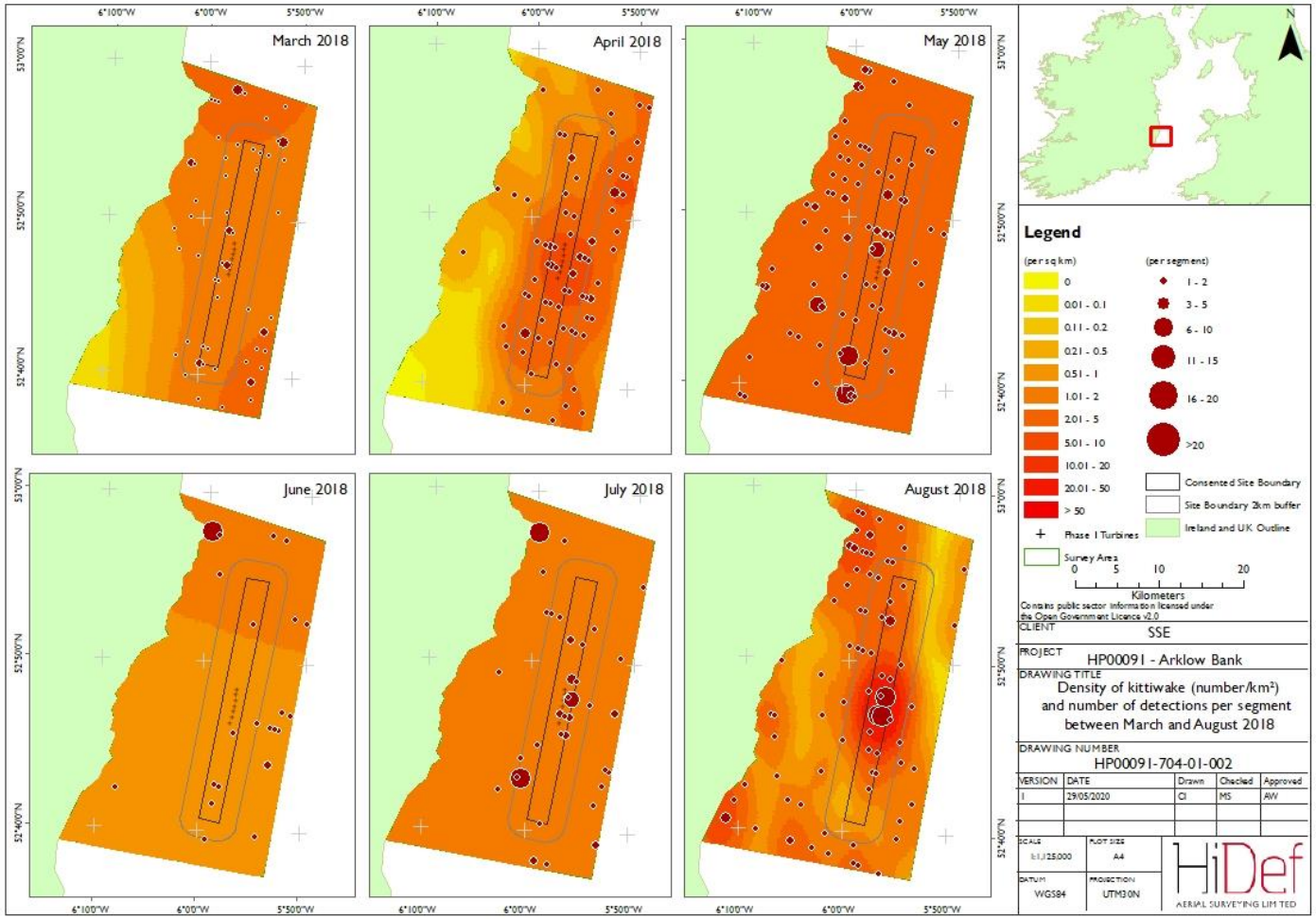


Figure 18 **Densities of kittiwake (number/km²) and number of detections per segment between September 2018 and February 2019**

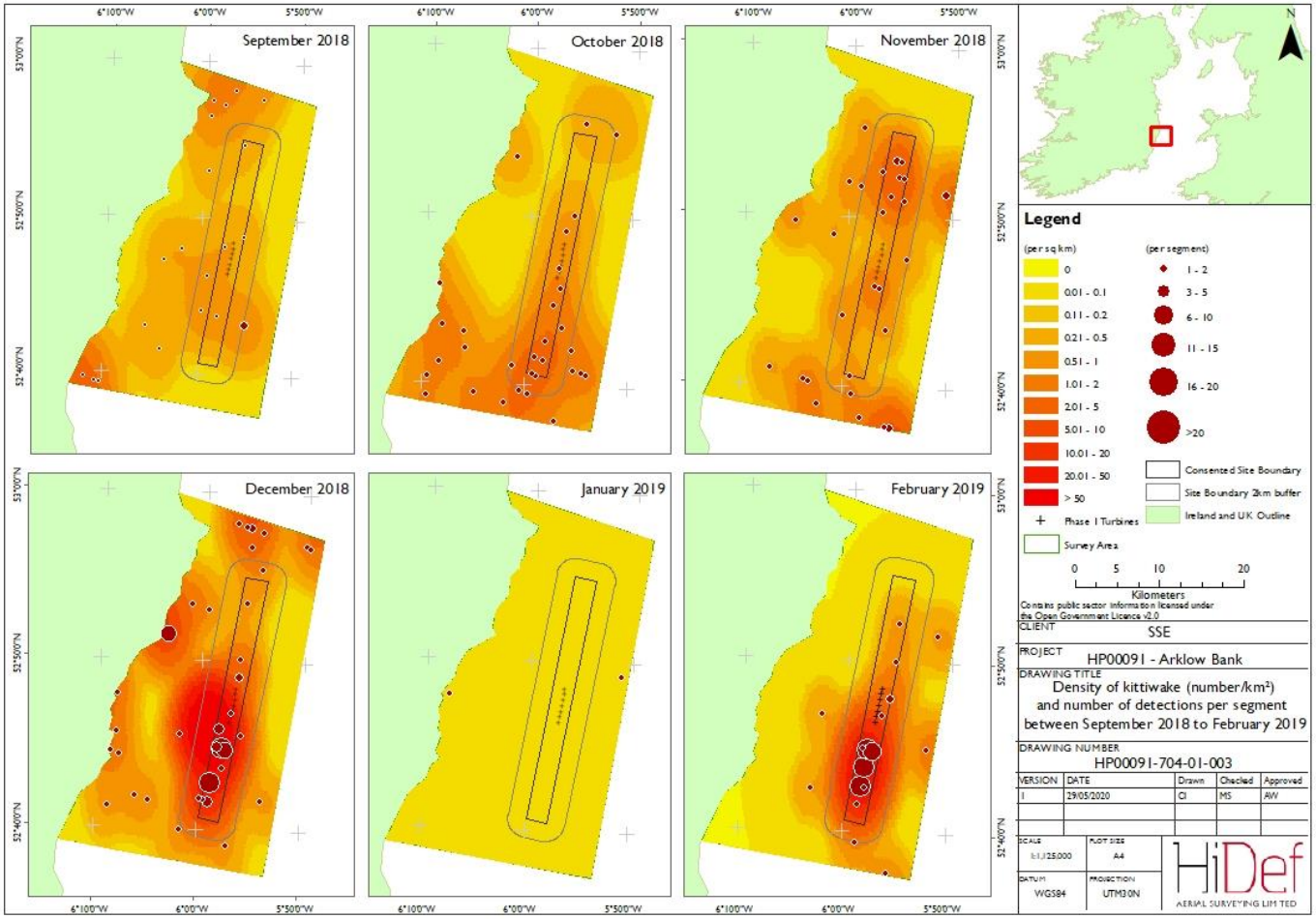


Figure 19 **Densities of kittiwake (number/km²) and number of detections per segment between March 2019 and August 2019**

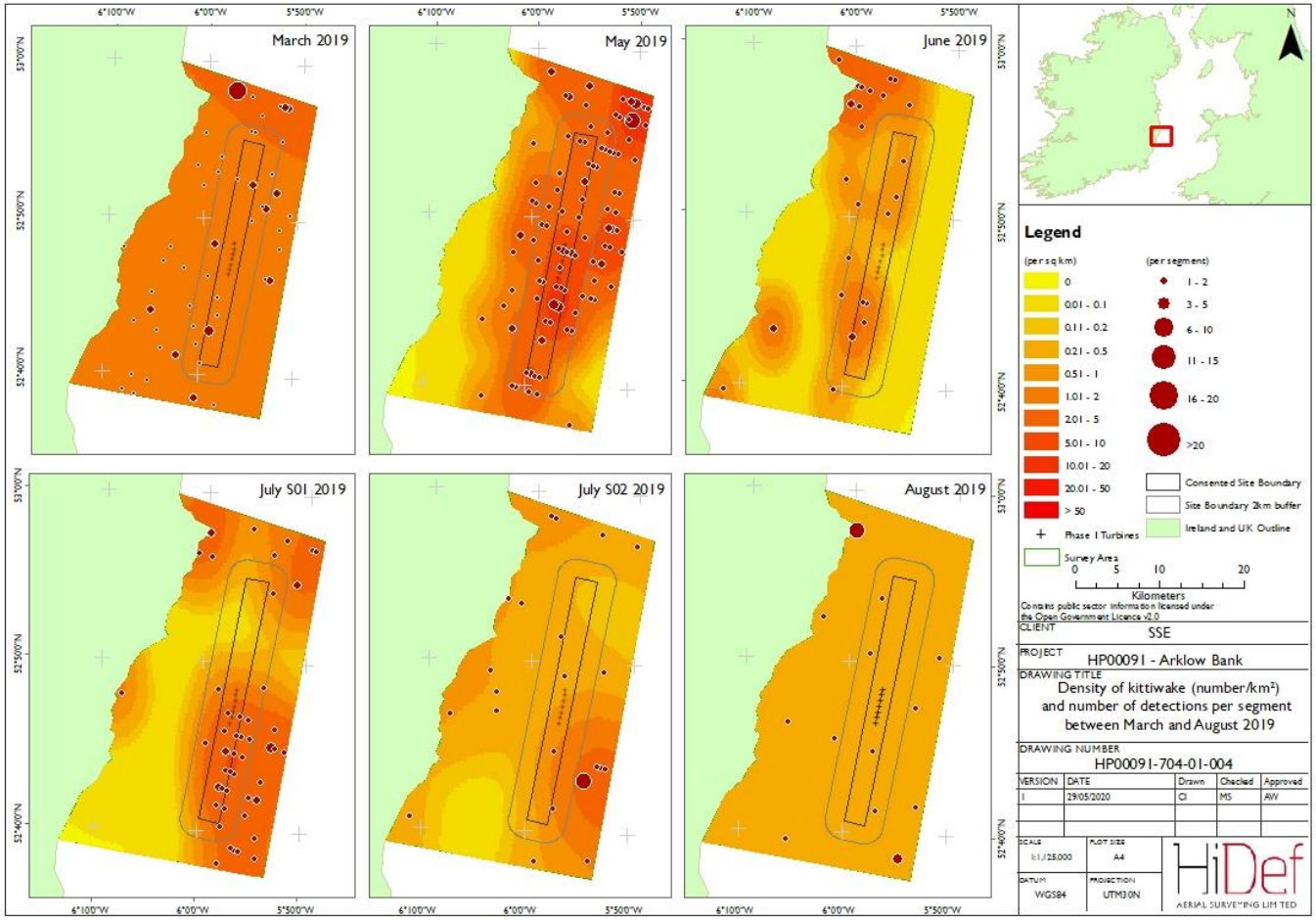


Figure 20 **Densities of kittiwake (number/km²) and number of detections per segment between September 2019 and February 2020**

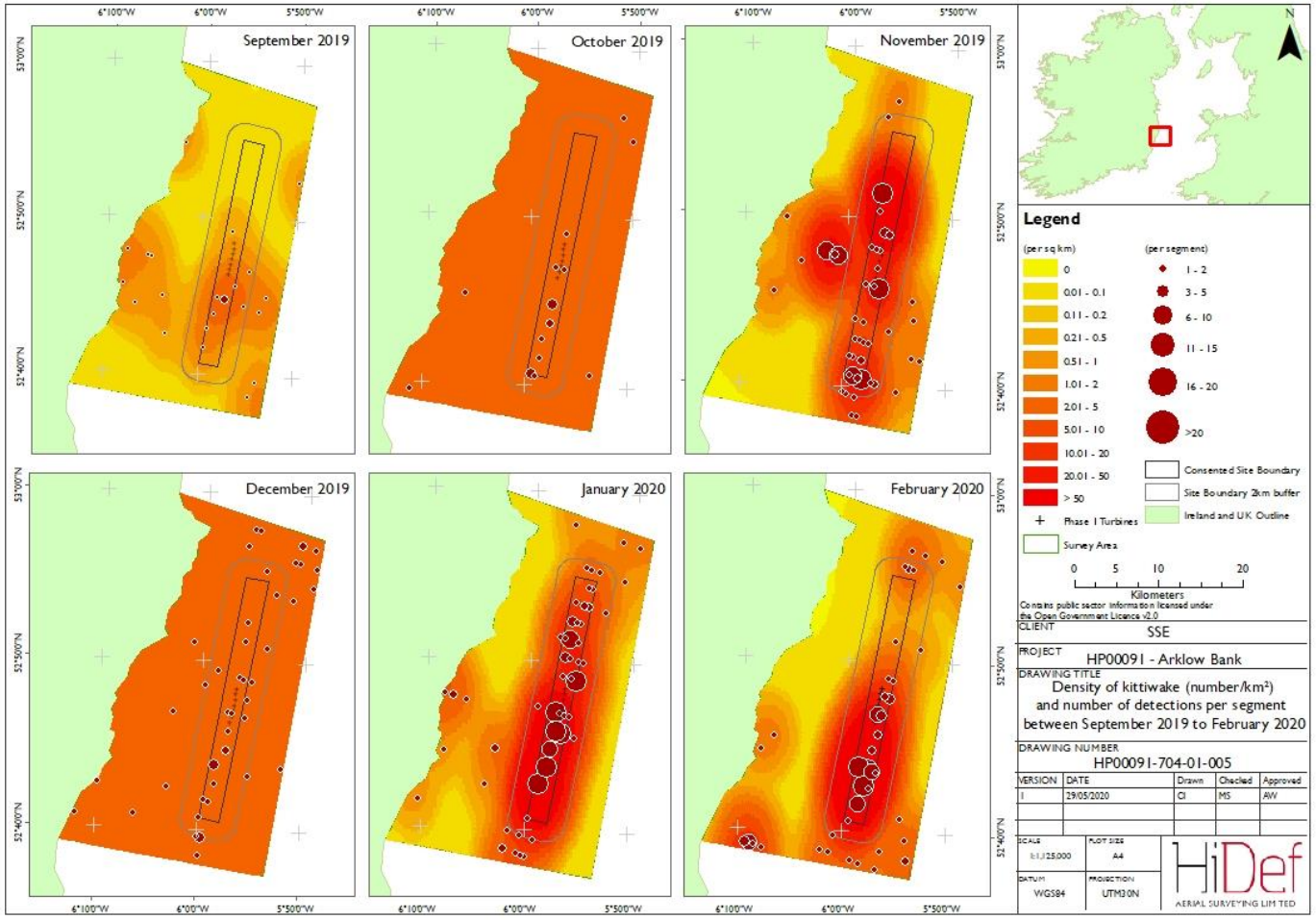
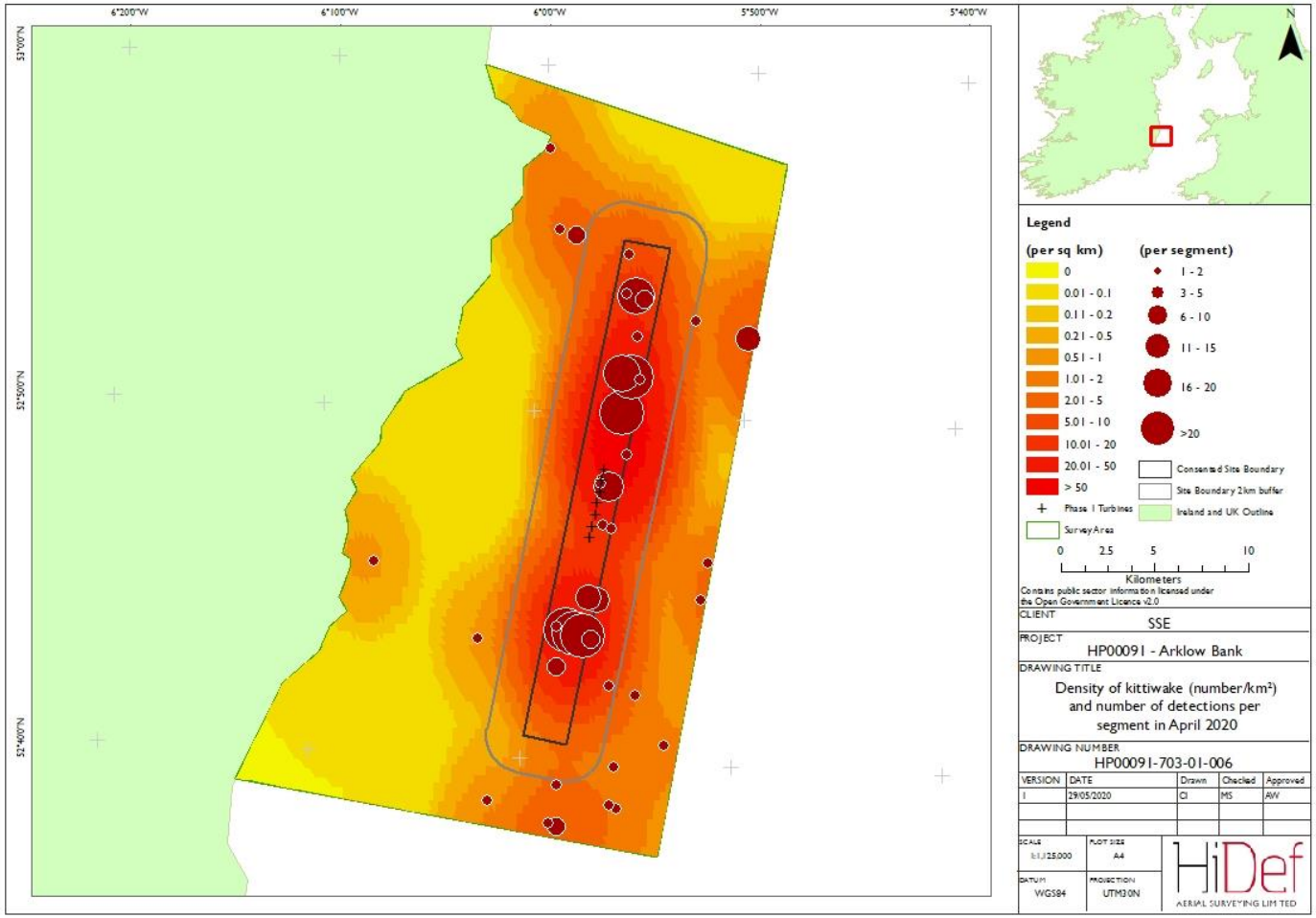


Figure 21 Densities of kittiwake (number/km²) and number of detections per segment in April 2020



3.5.5 Herring gull

80 The densities of herring gull (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in figures Figure 22 to Figure 26. Interpretation is included within the discussion.

81 Low numbers and densities occurred through the two-year survey period. Spatial distribution was wide, with a bias towards coastal waters. Birds were rarely recorded from Arklow Bank itself and the development area at all seasons.

Figure 22 **Densities of herring gull (number/km²) and number of detections per segment between March 2018 and August 2018**

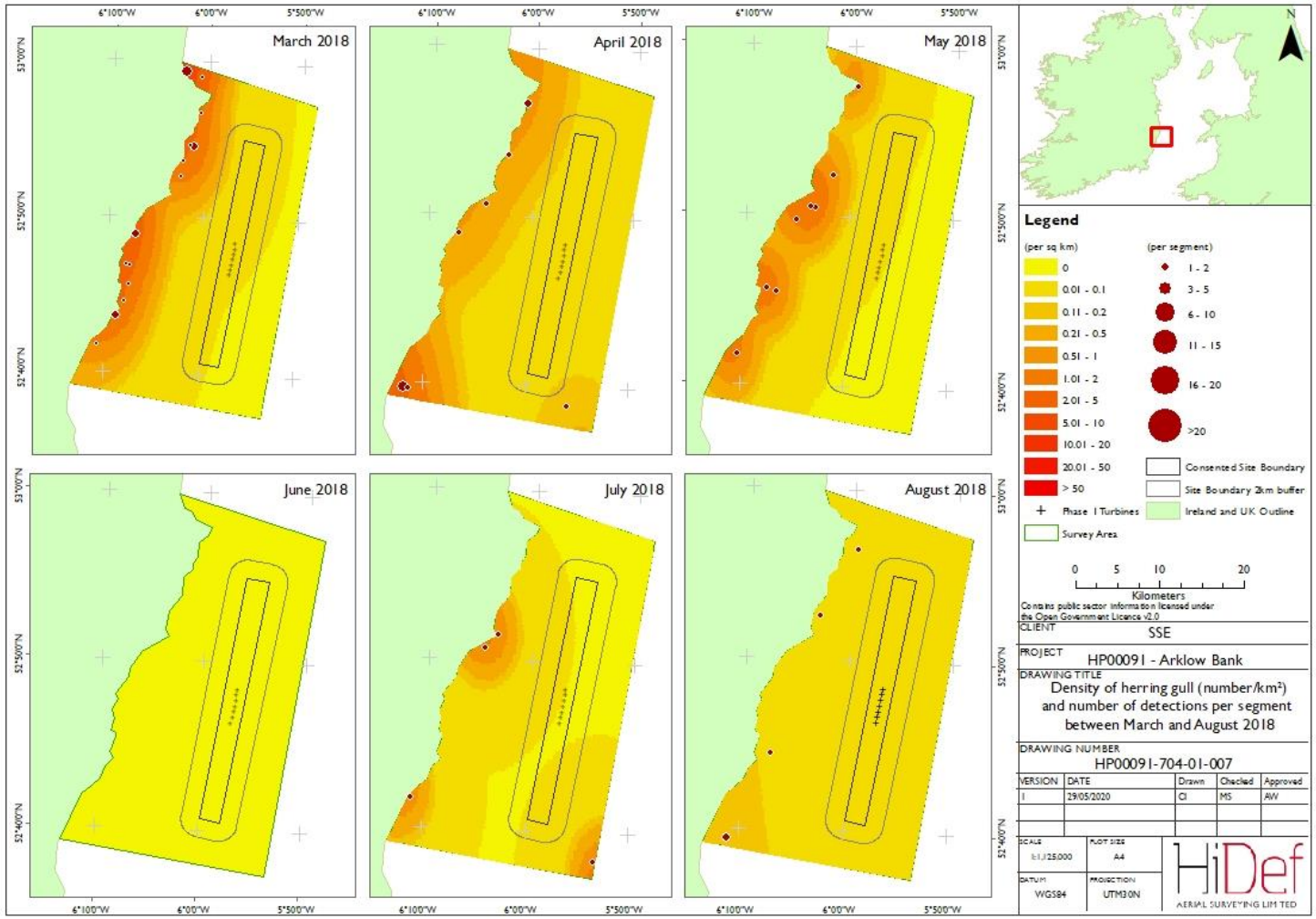


Figure 23 **Densities of herring gull (number/km²) and number of detections per segment between September 2018 and February 2019**

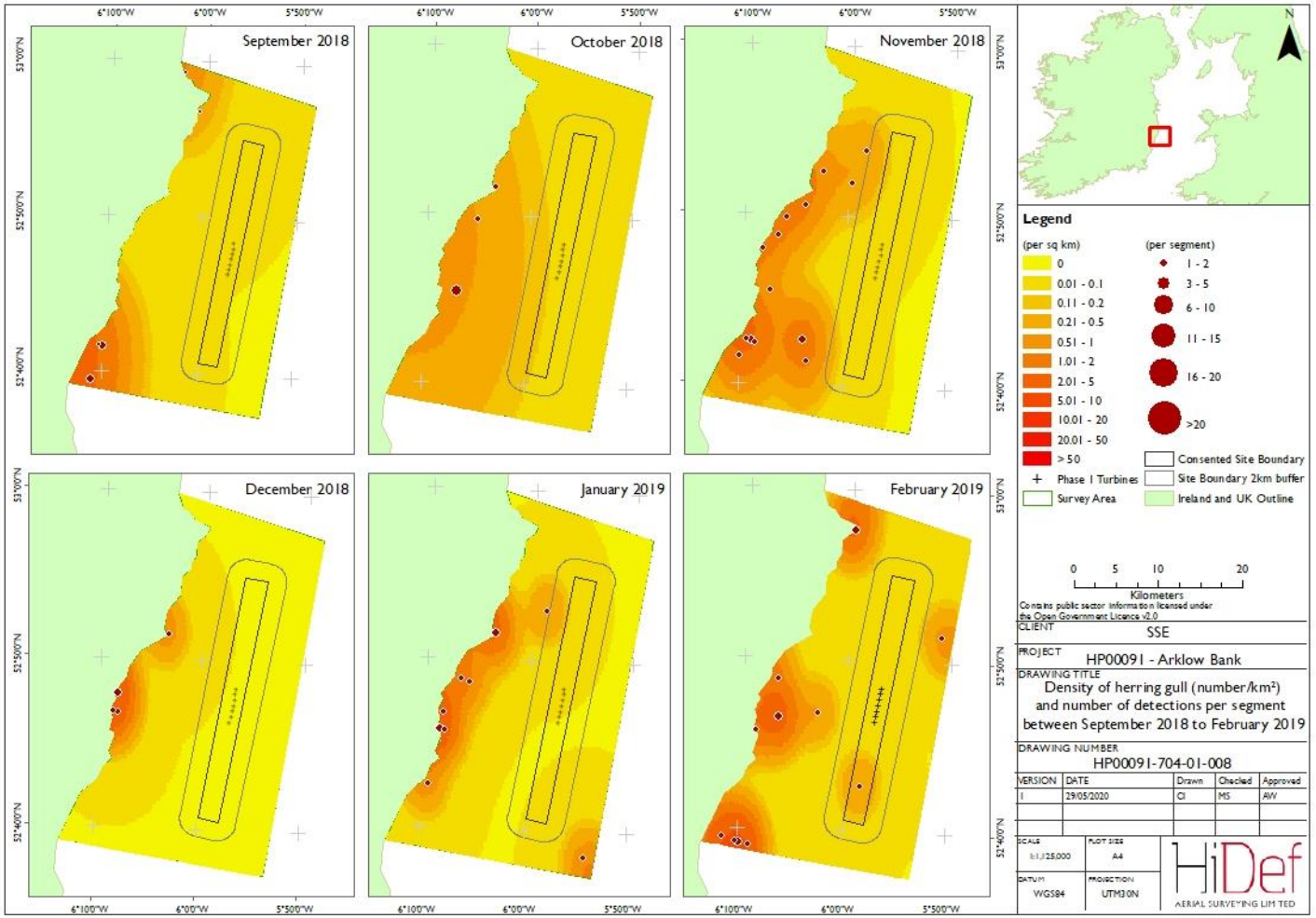


Figure 24 **Densities of herring gull (number/km²) and number of detections per segment between March 2019 and August 2019**

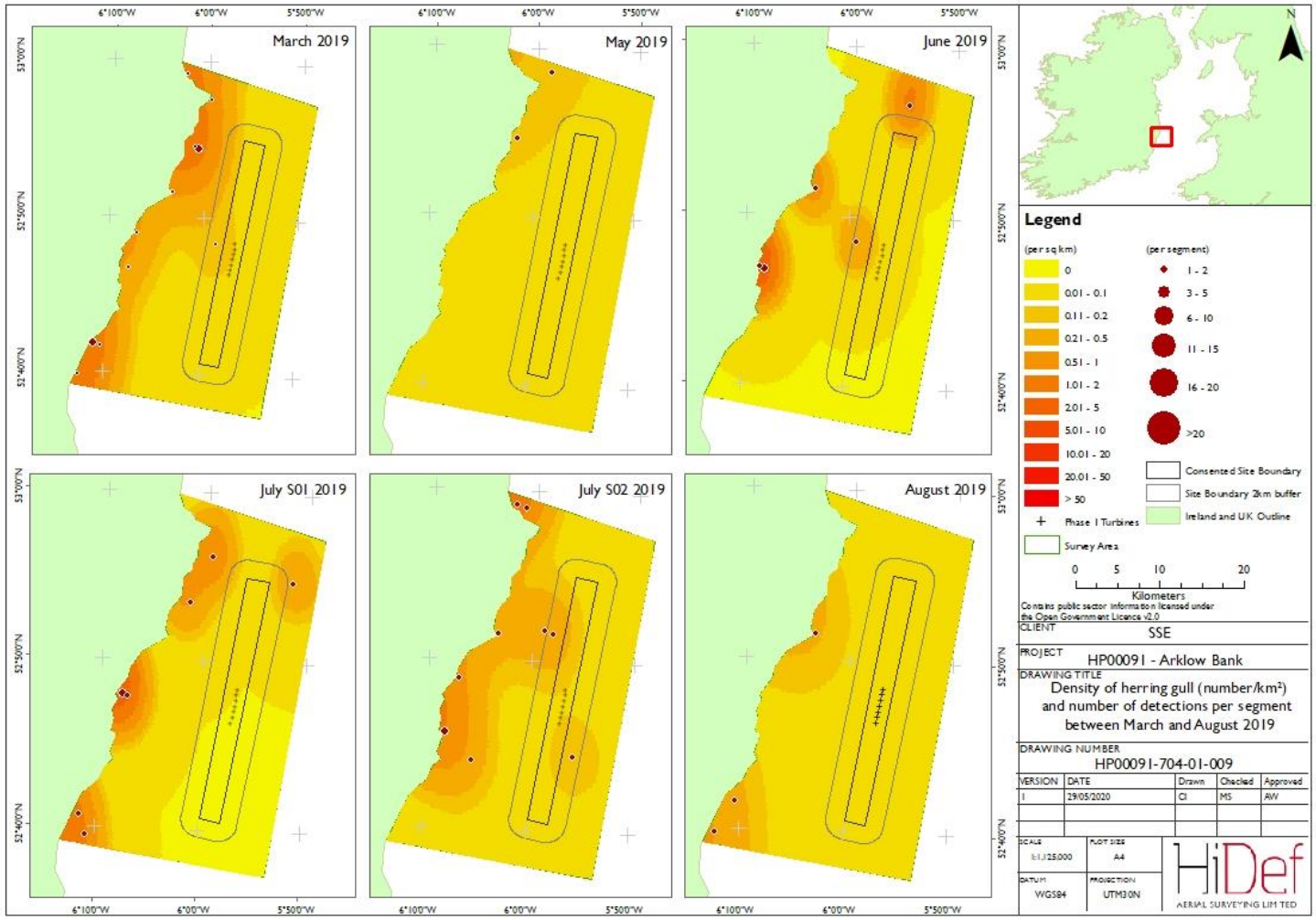


Figure 25 **Densities of herring gull (number/km²) and number of detections per segment between September 2019 and February 2020**

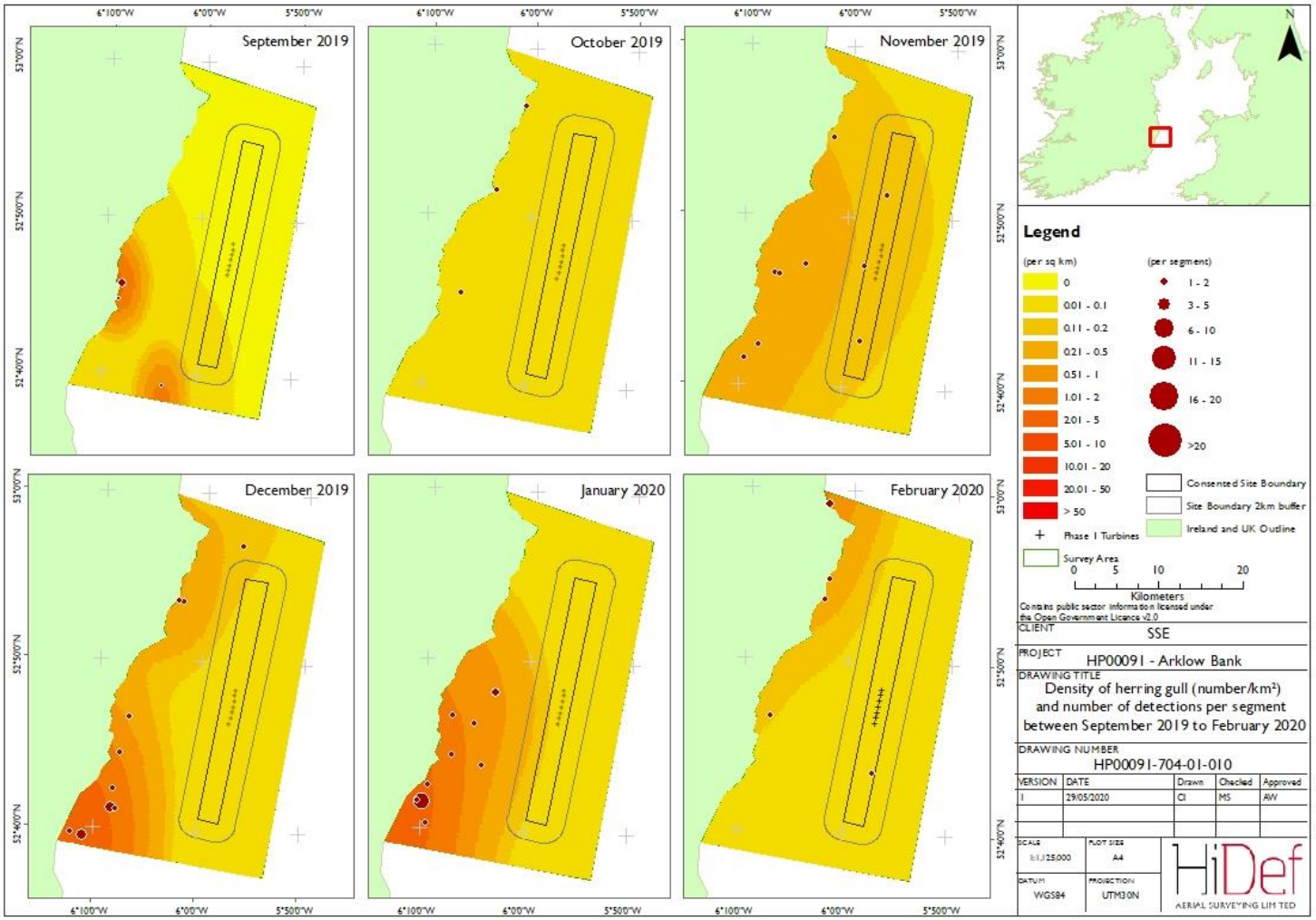
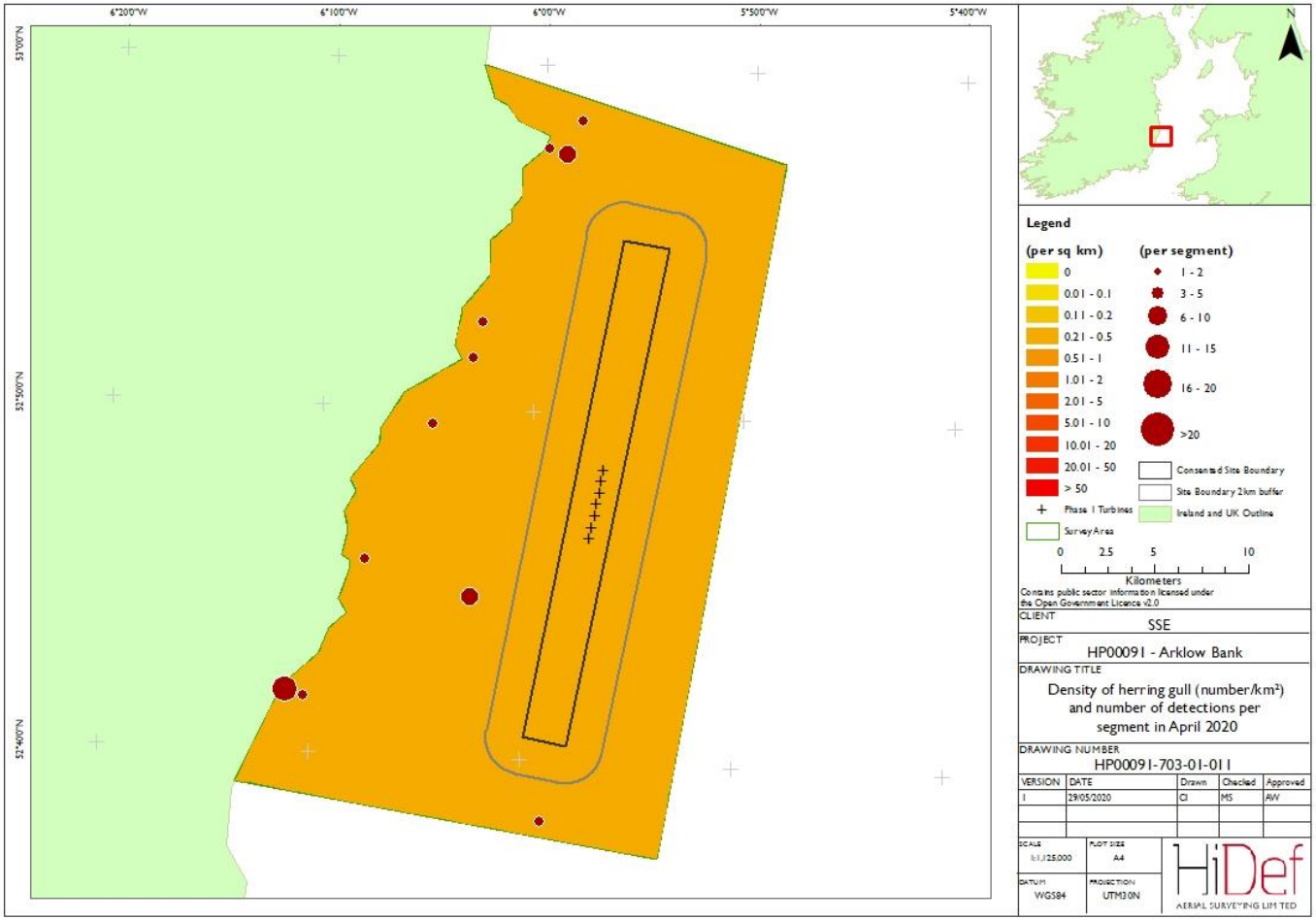


Figure 26 **Densities of herring gull (number/km²) and number of detections per segment in April 2020**



3.5.6 Sandwich tern

82 The densities of Sandwich tern (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in figures Figure 27 to Figure 31. Interpretation is included within the discussion.

83 A summer visitor with overall low numbers. May 2018 records were located in a narrow coastal strip and no others were recorded till August.

84 Through 2019 Sandwich tern densities were very low again with a coastal focus to the south-west of the survey site.

Figure 27 **Densities of Sandwich tern (number/km²) and number of detections per segment between March 2018 and August 2018**

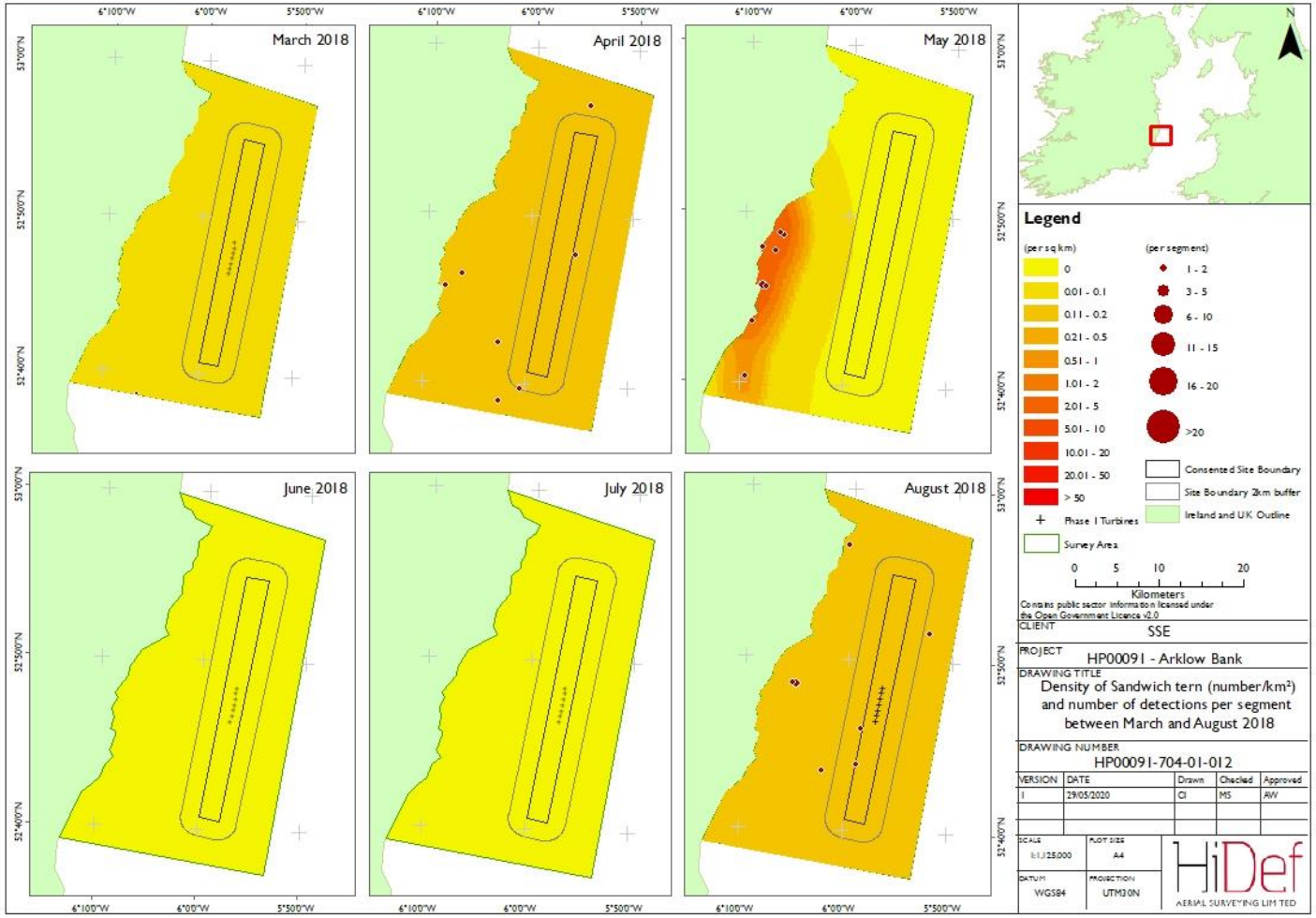


Figure 28 **Densities of Sandwich tern (number/km²) and number of detections per segment between September 2018 and February 2019**

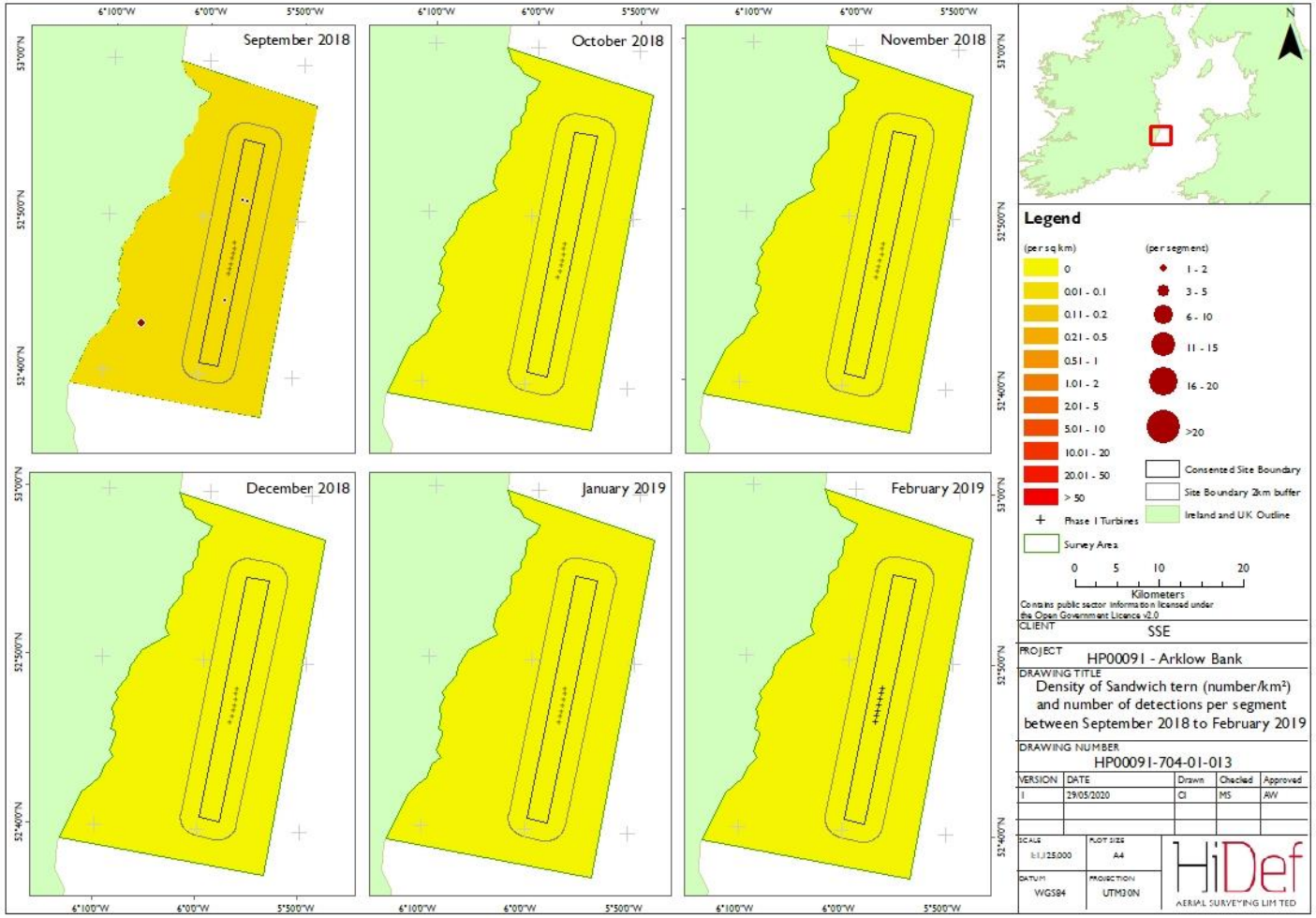


Figure 29 **Densities of Sandwich tern (number/km²) and number of detections per segment between March 2019 and August 2019**

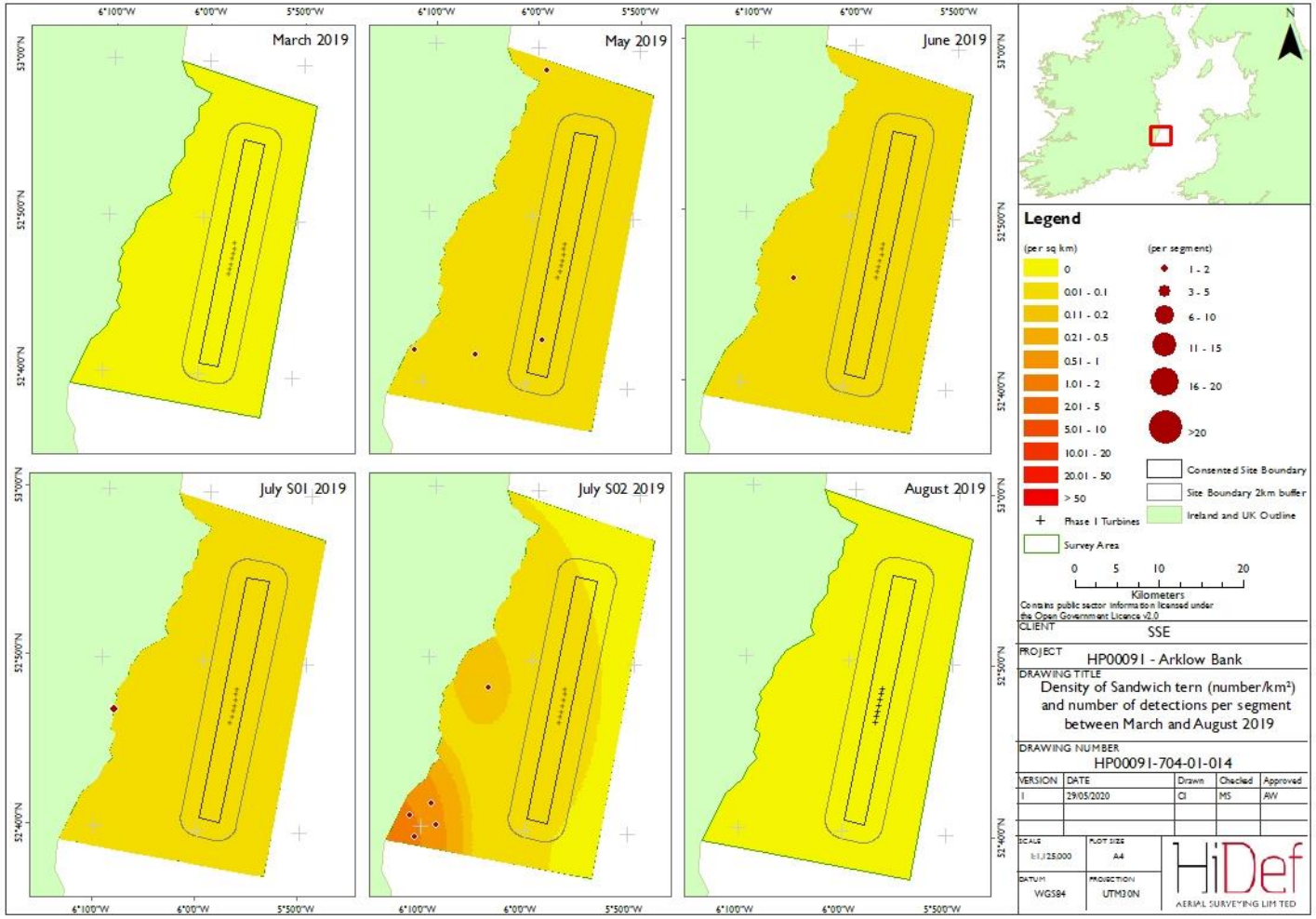


Figure 30 **Densities of Sandwich tern (number/km²) and number of detections per segment between September 2019 and February 2020**

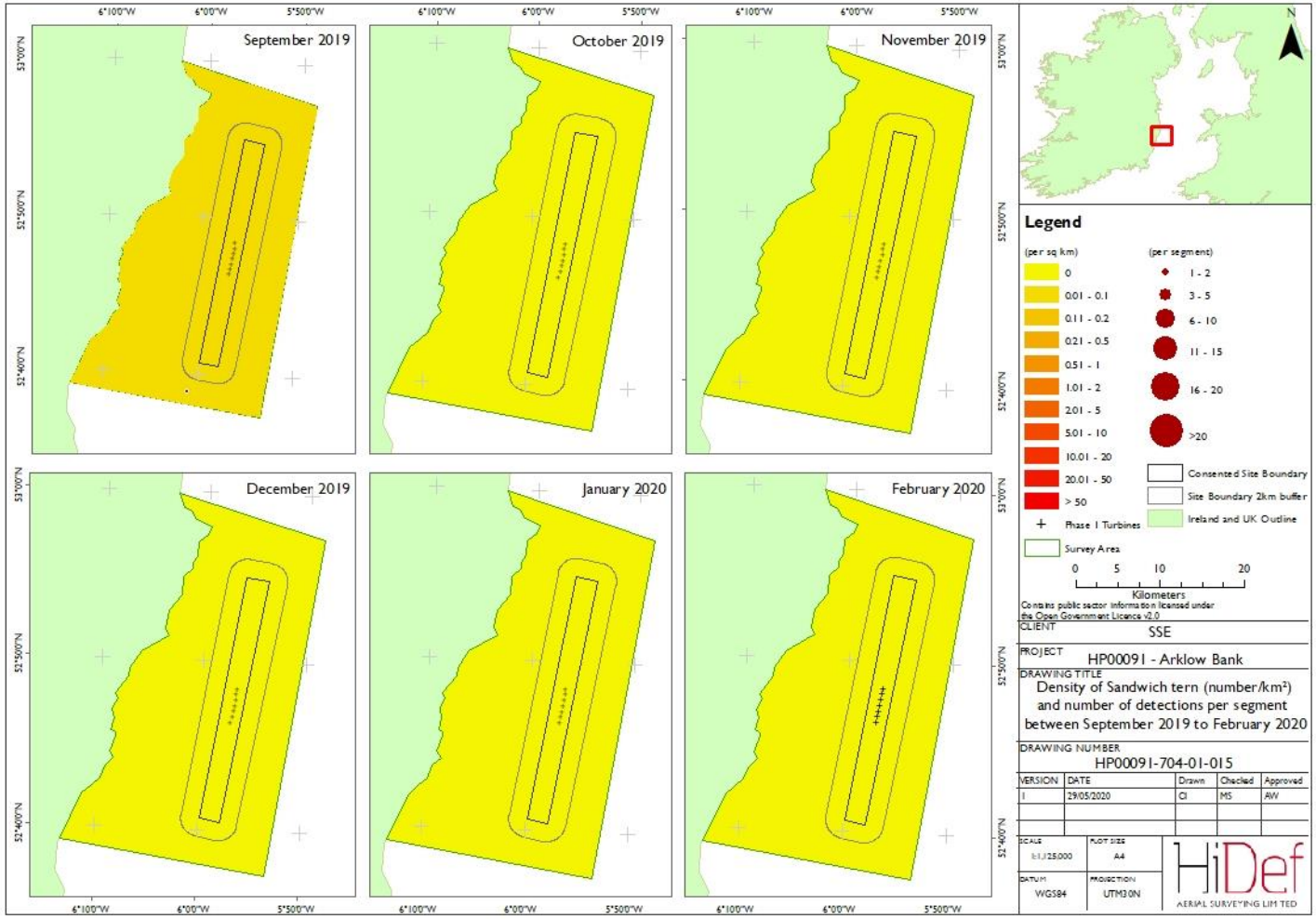
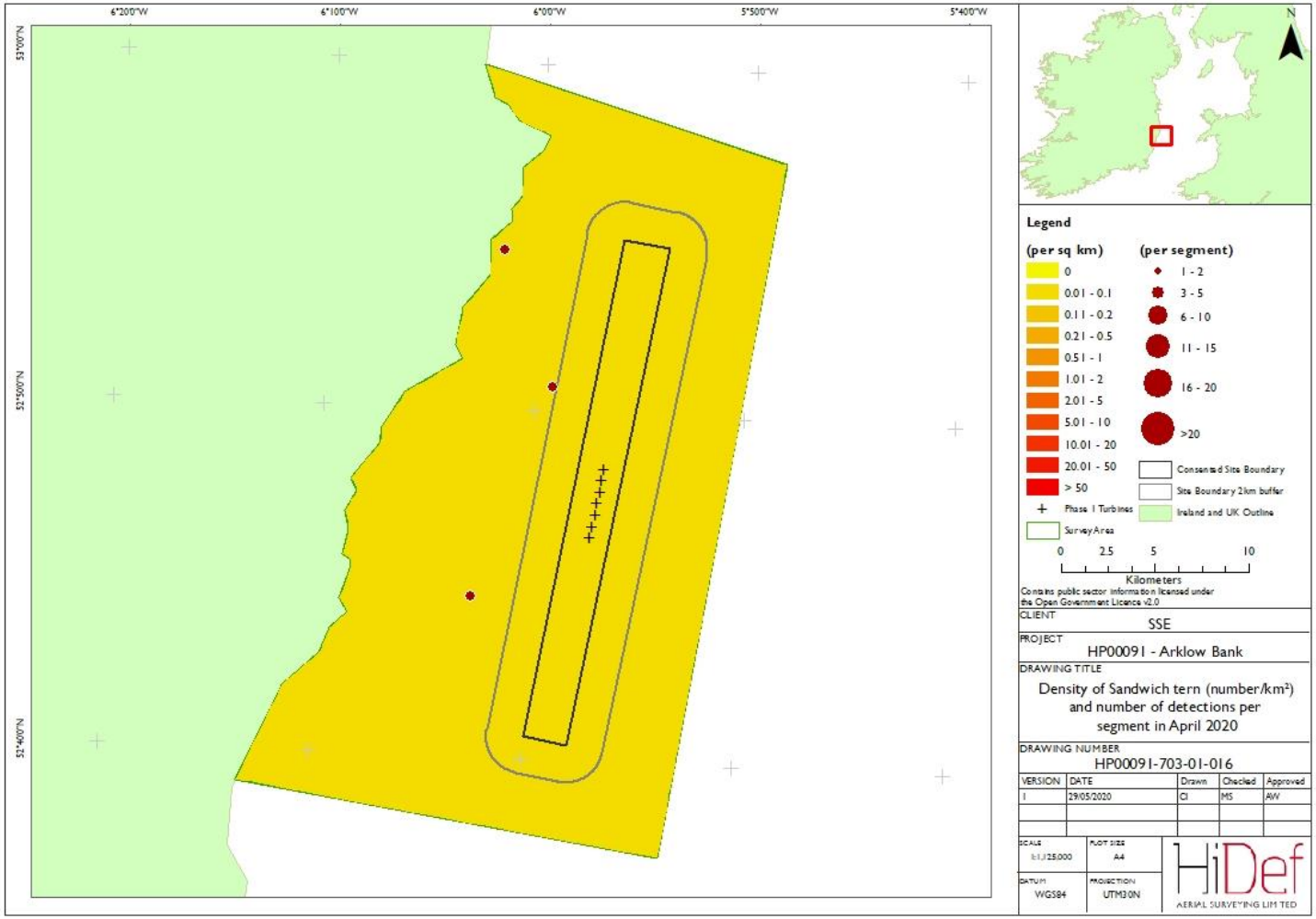


Figure 31 Densities of Sandwich tern (number/km²) and number of detections per segment in April 2020



3.5.7 Common tern

85 The densities of common tern (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in figures Figure 32 to Figure 35. Interpretation is included within the discussion.

86 Generally low densities and numbers through the whole two-year period bar a high month of activity in August 2018 with modest densities in and around Arklow Bank, with some birds remaining through September in this area.

Figure 32 **Densities of common tern (number/km²) and number of detections per segment between March 2018 and August 2018**

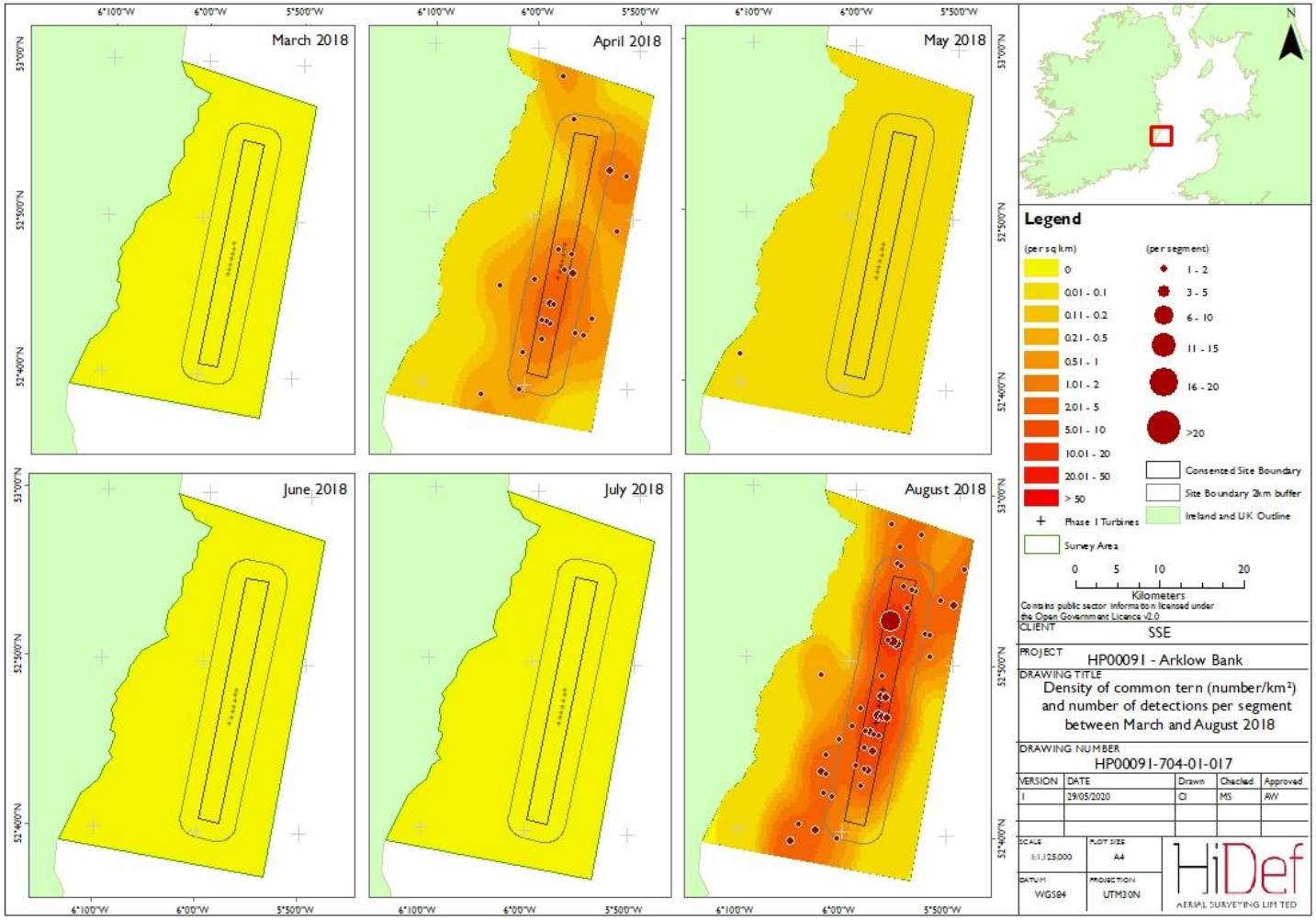


Figure 33 **Densities of common tern (number/km²) and number of detections per segment between September 2018 and February 2019**

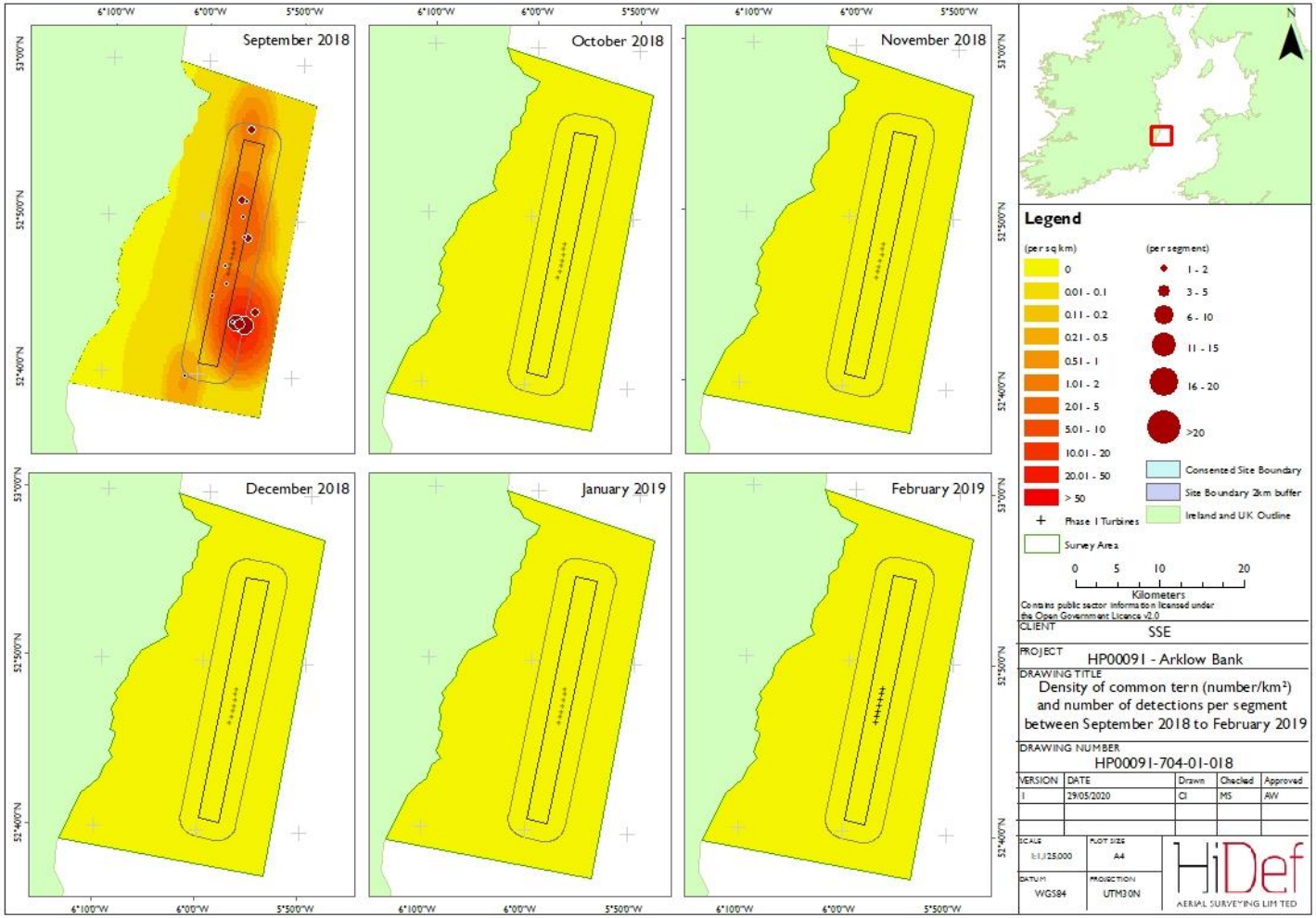


Figure 34 **Densities of common tern (number/km²) and number of detections per segment between March 2019 and August 2019**

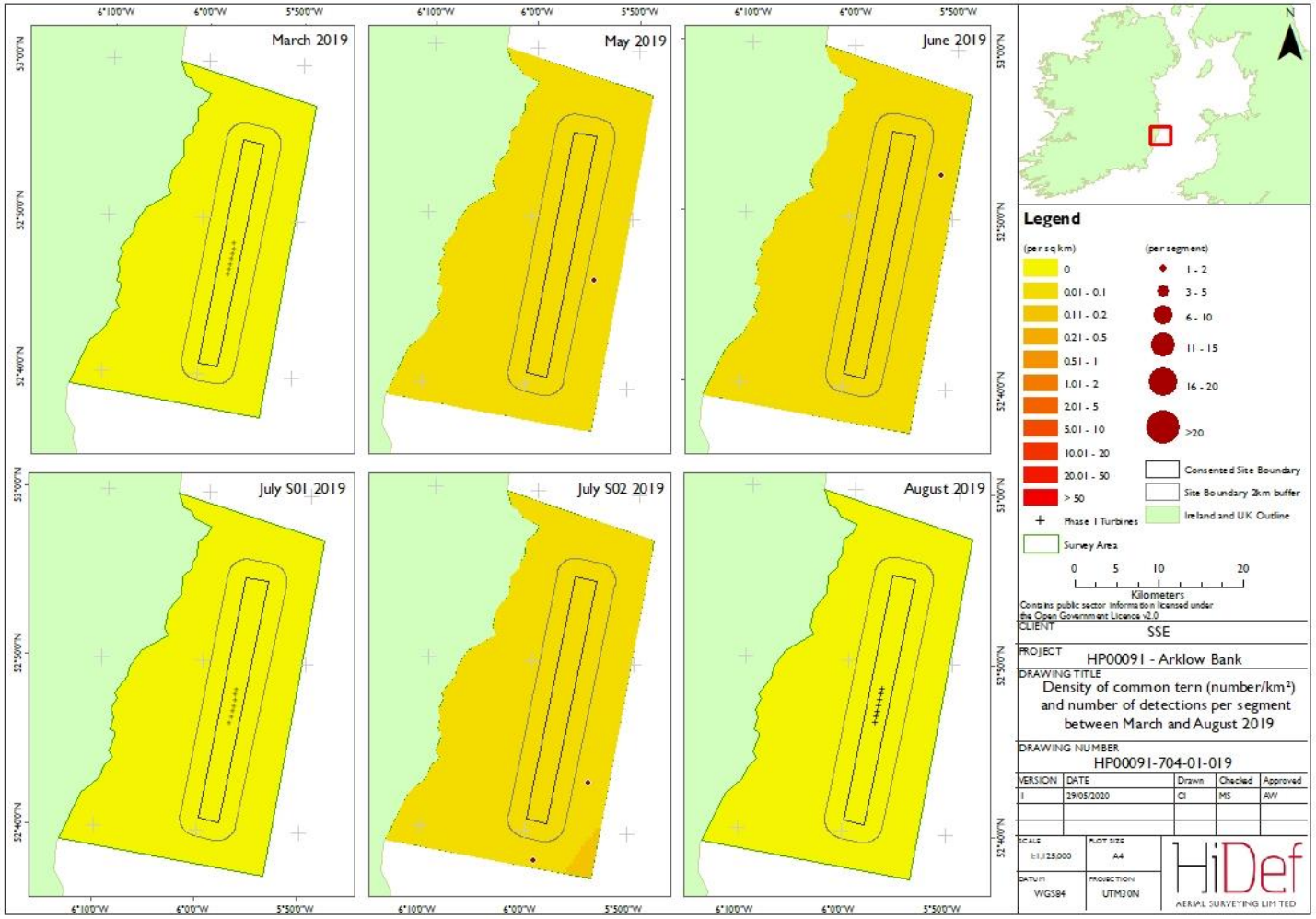
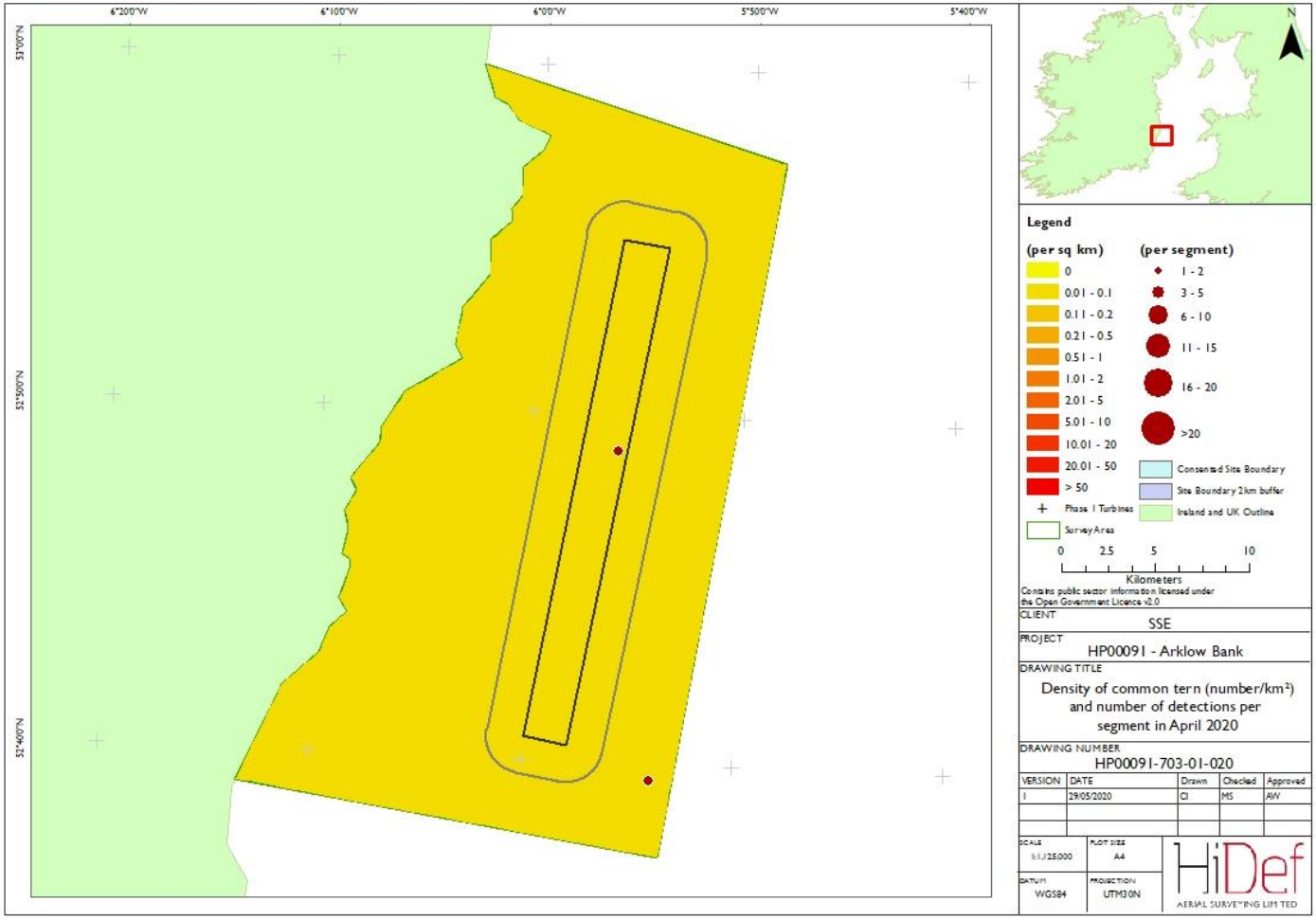


Figure 35 Densities of common tern (number/km²) and number of detections per segment in April 2020



3.5.8 Arctic tern

87 The densities of Arctic tern (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in figures Figure 36 to Figure 40. Further interpretation is included within the discussion.

88 As a summer visitor, birds returned in spring and used the Arklow Bank area in modest densities in April and May 2018. Numbers peaked in August 2018 with densities again concentrated around the central development site.

89 Arctic terns were rare over the entire survey site in 2019 with a small density hotspot occurring in April 2020 on the central Arklow Bank development site.

Figure 36 **Densities of Arctic tern (number/km²) and number of detections per segment between March 2018 and August 2018**

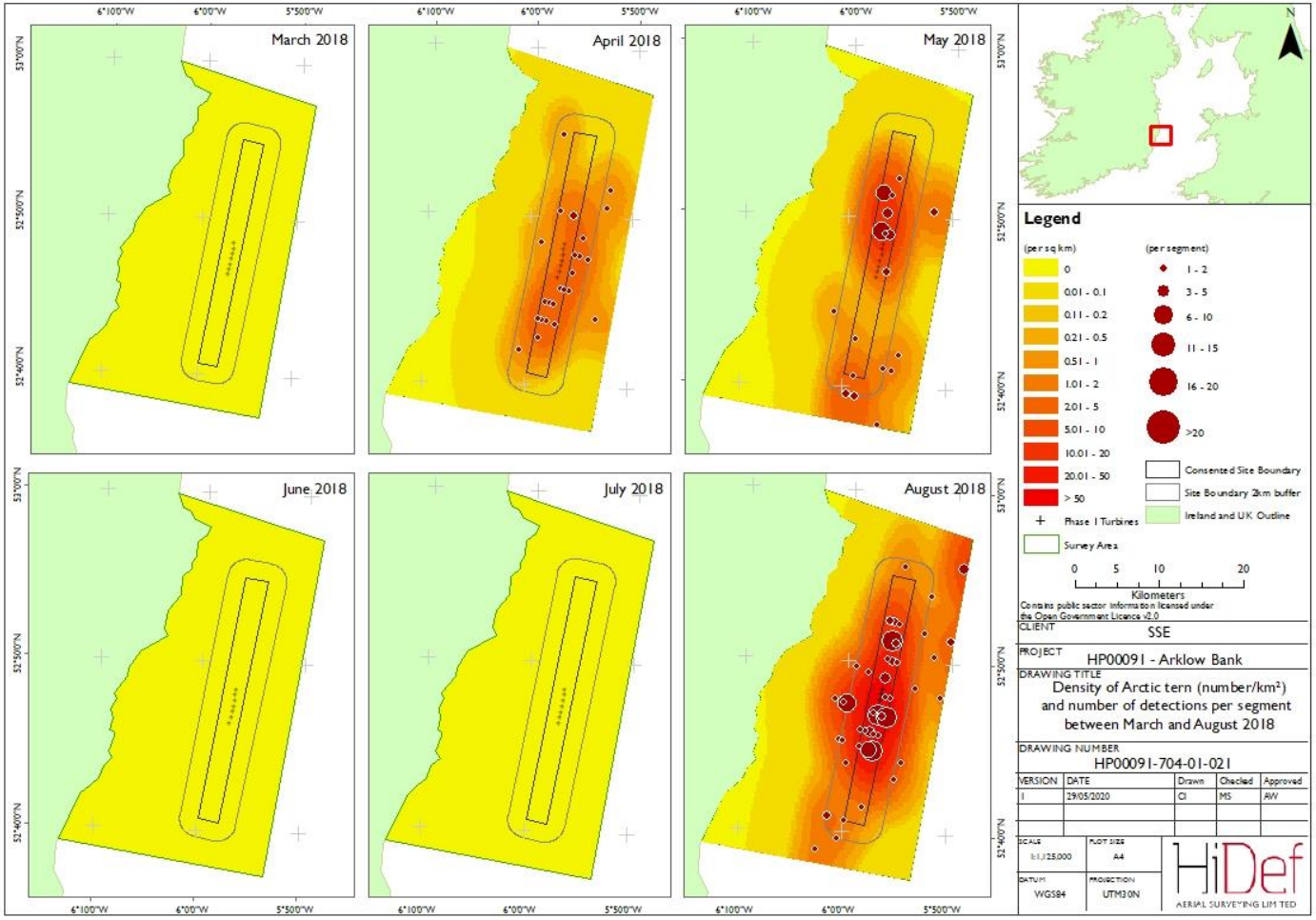


Figure 37 **Densities of Arctic tern (number/km²) and number of detections per segment between September 2018 and February 2019**

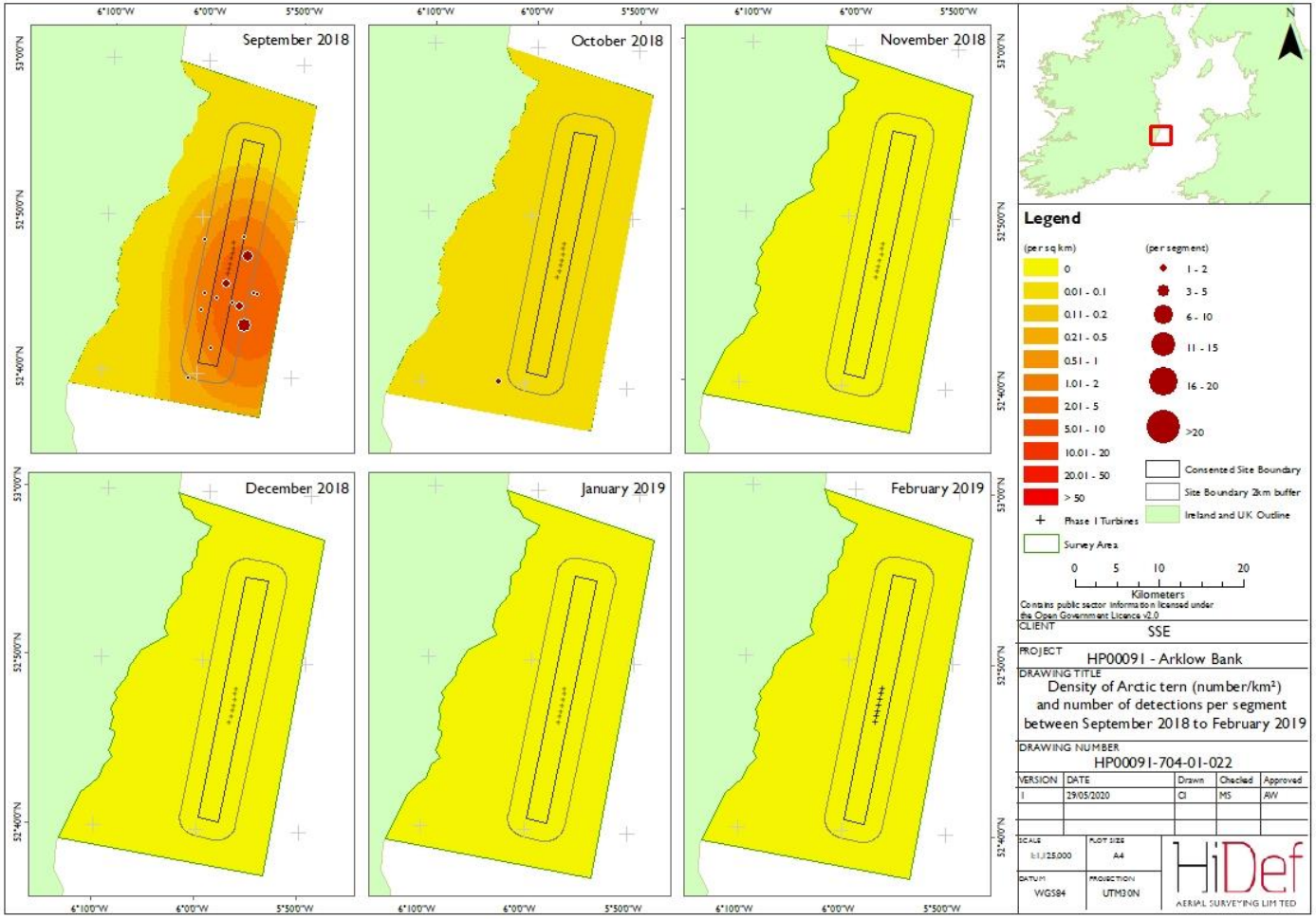


Figure 38 **Densities of Arctic tern (number/km²) and number of detections per segment between March 2019 and August 2019**

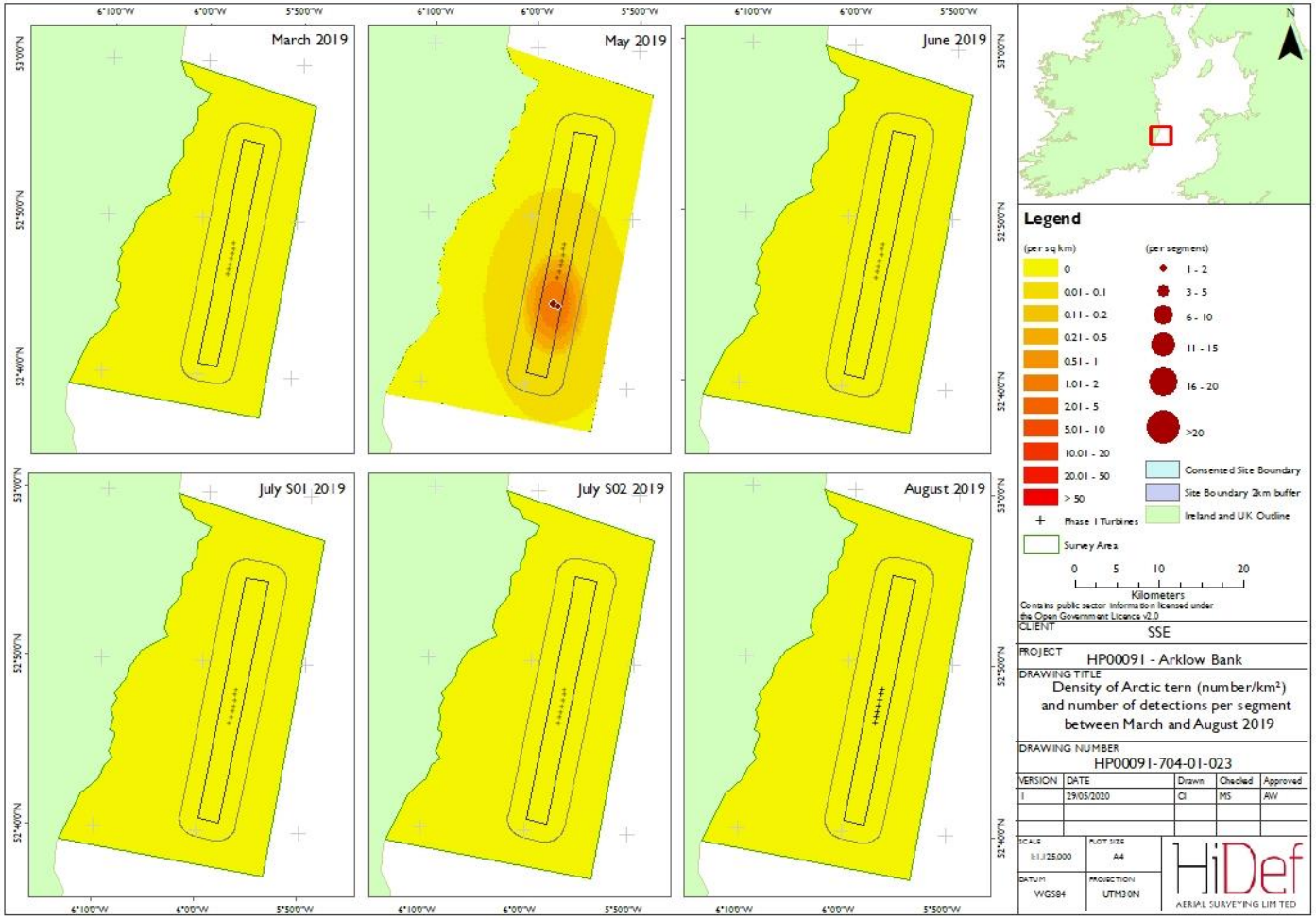


Figure 39 **Densities of Arctic tern (number/km²) and number of detections per segment between September 2019 and February 2020**

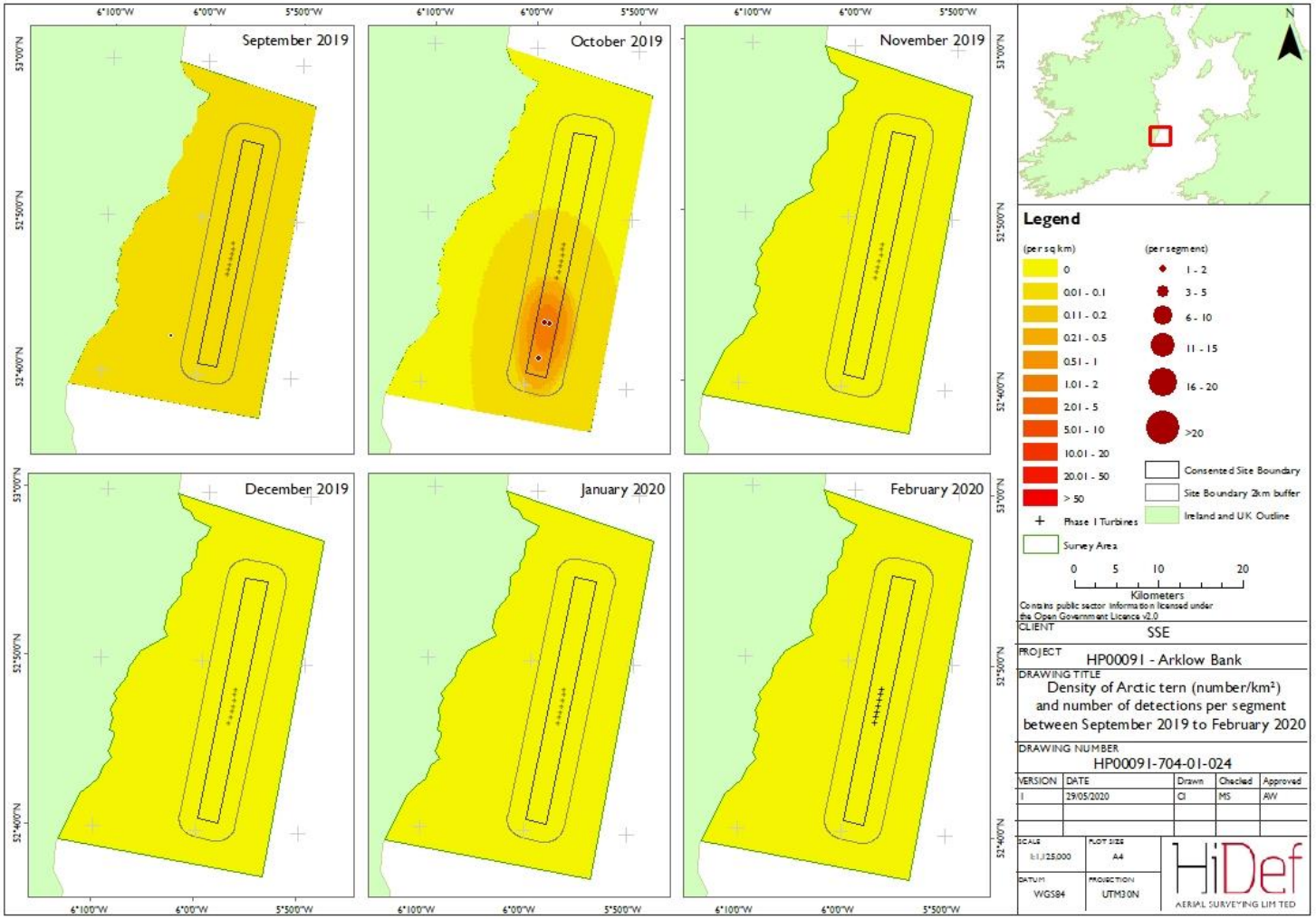
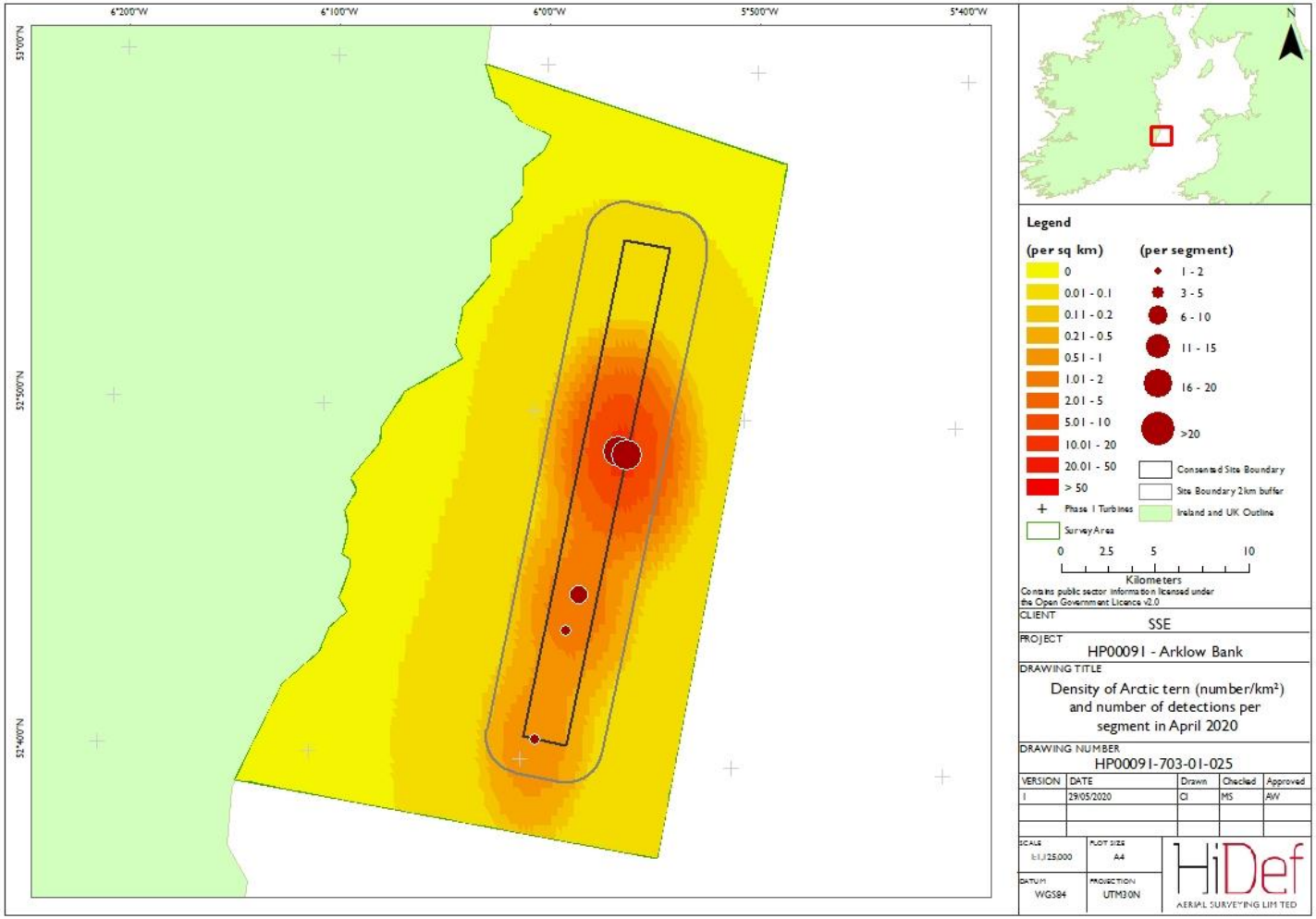


Figure 40 Densities of Arctic tern (number/km²) and number of detections per segment in April 2020



3.5.9 Guillemot

90 The densities of guillemot (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in figures Figure 41 to Figure 45. Further interpretation is included within the discussion.

91 Recorded in very high densities with wide spatial coverage over the entire survey site in many months, notably early and late summer 2018 through to November.

92 This strong pattern was replicated in 2019 but with the addition of high densities around Arklow Bank through the winter month, especially in the southern part.

Figure 41 **Densities of guillemot (number/km²) and number of detections per segment between March 2018 and August 2018**

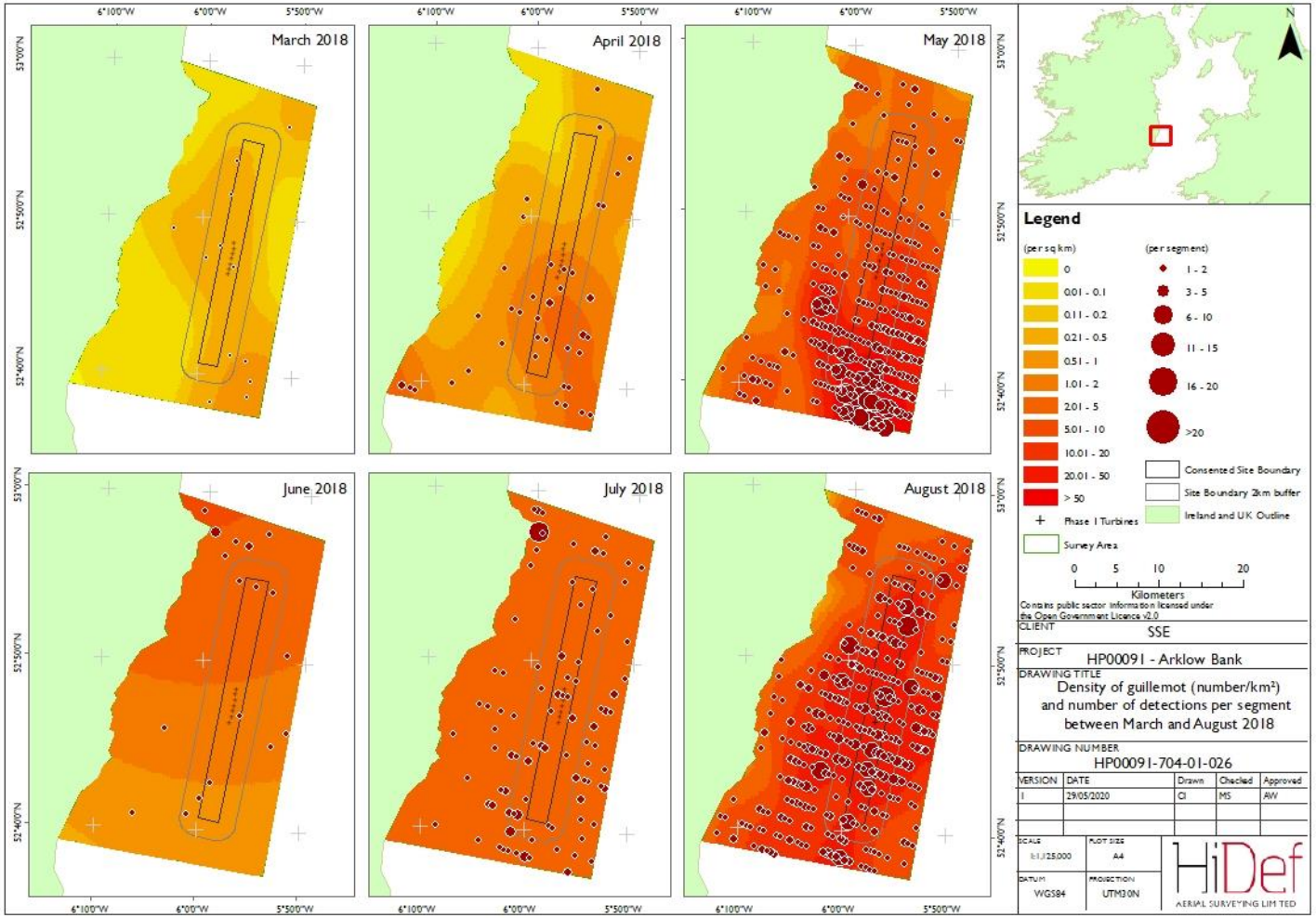


Figure 42 **Densities of guillemot (number/km²) and number of detections per segment between September 2018 and February 2019**

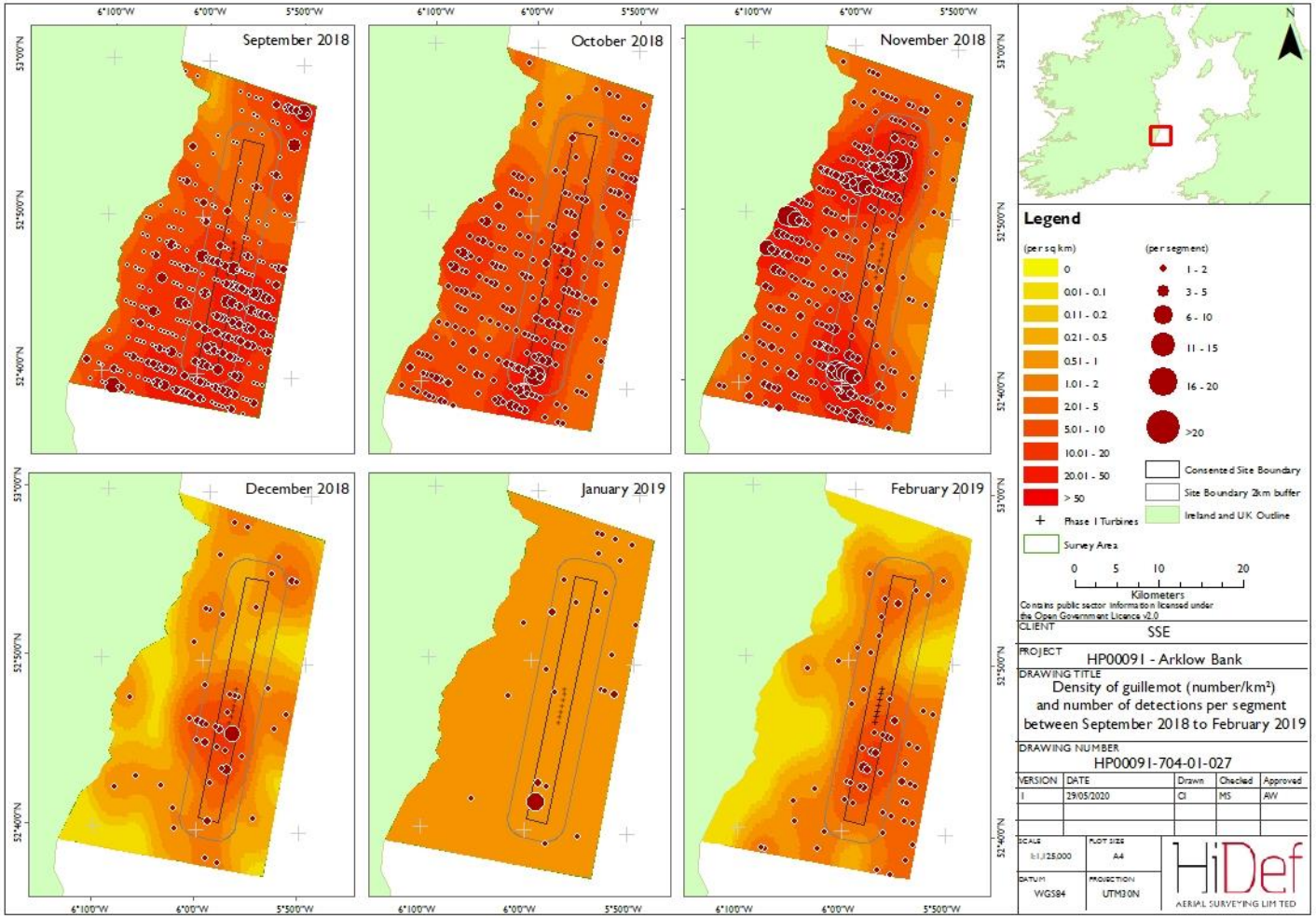


Figure 43 **Densities of guillemot (number/km²) and number of detections per segment between March 2019 and August 2019**

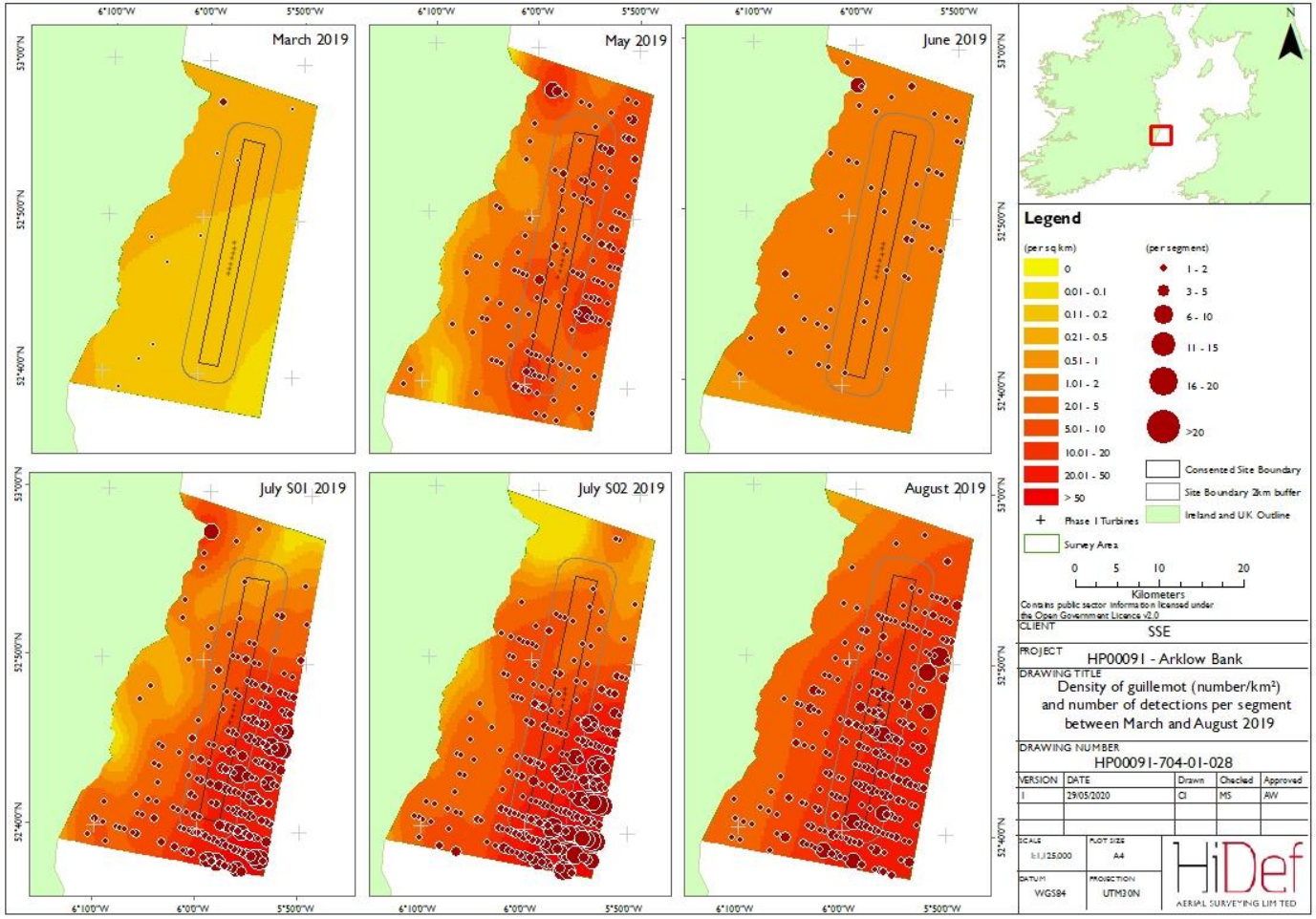


Figure 44 **Densities of guillemot (number/km²) and number of detections per segment between September 2019 and February 2020**

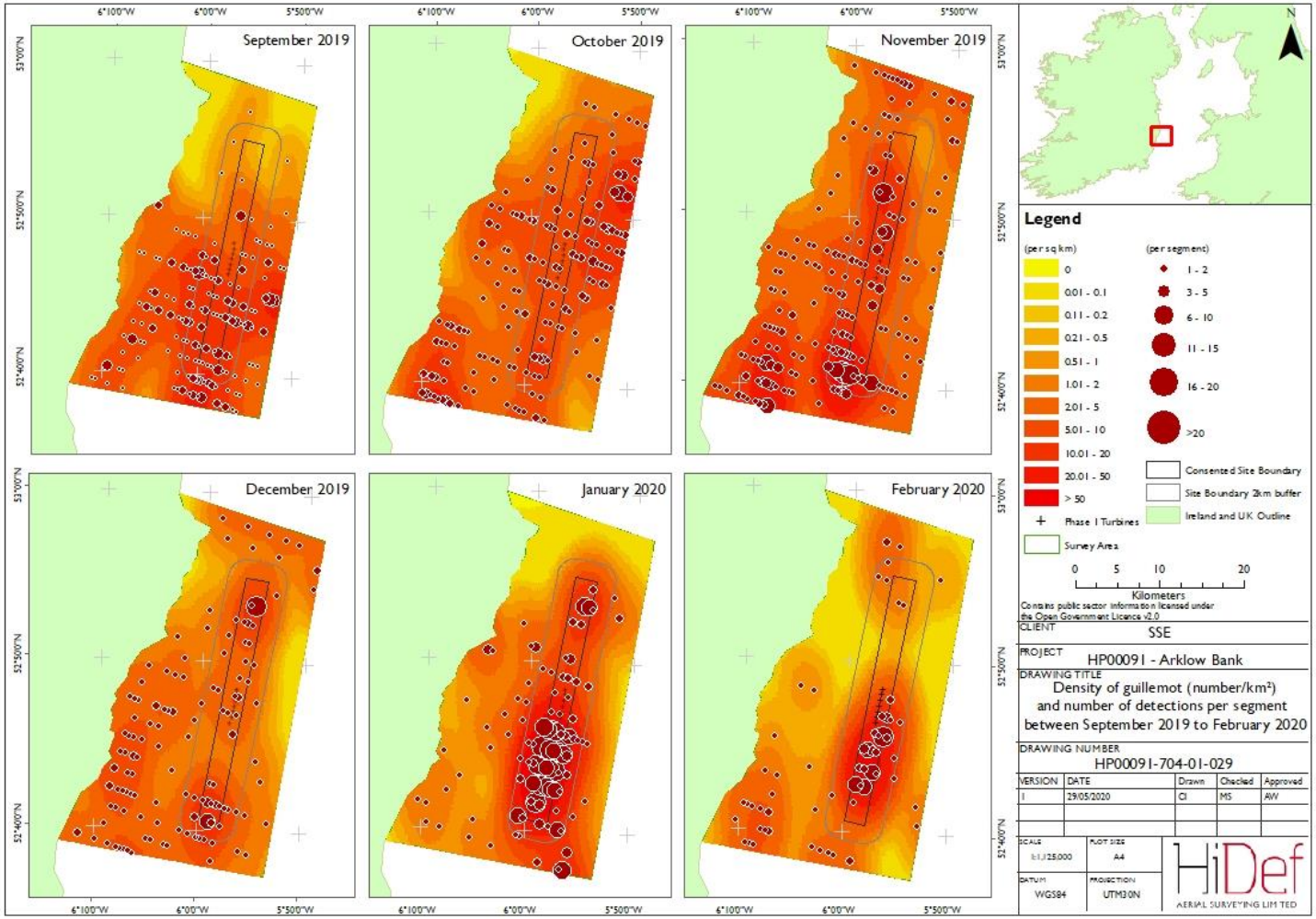
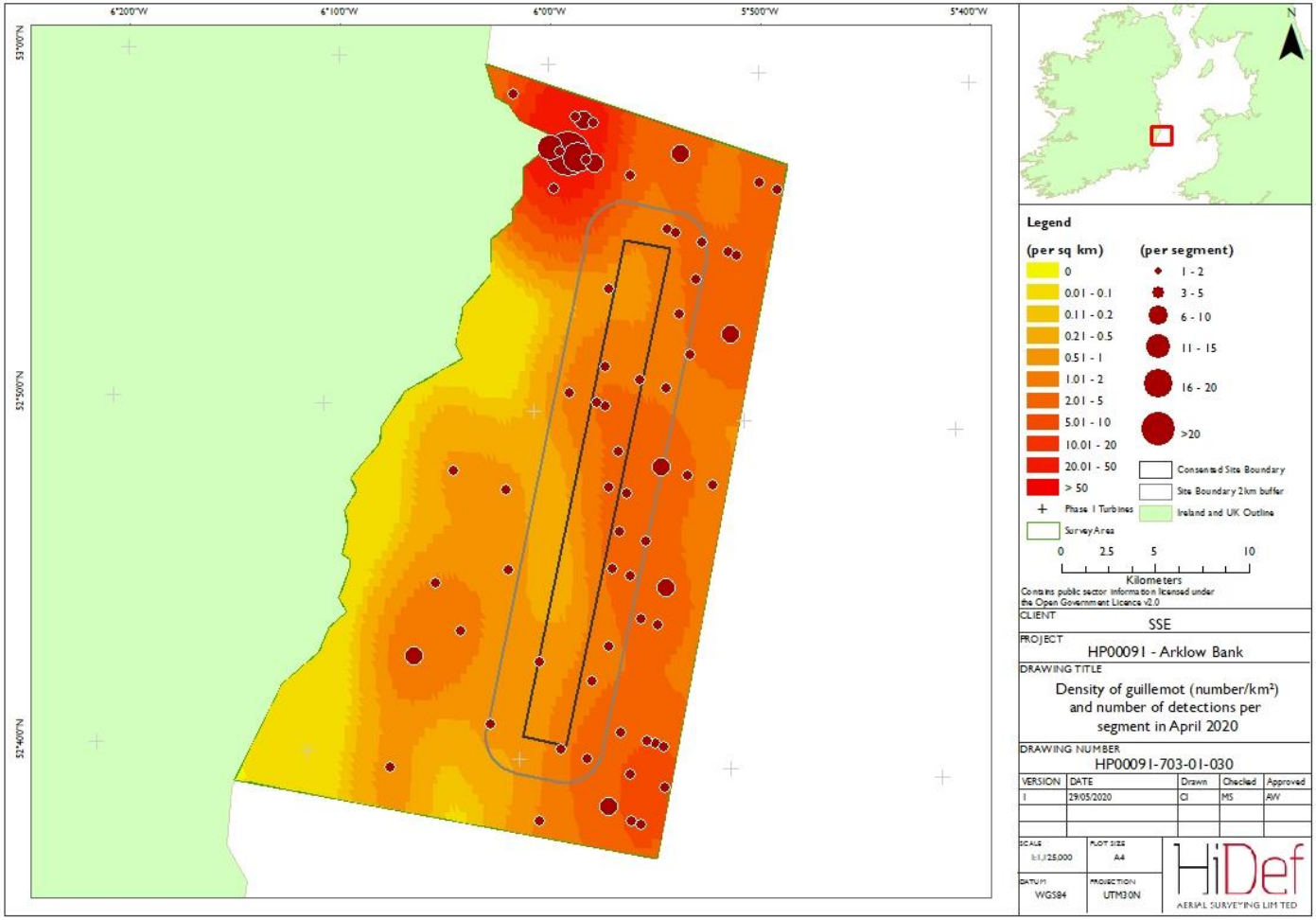


Figure 45 **Densities of guillemot (number/km²) and number of detections per segment in April 2020**



3.5.10 Razorbill

93 The densities of razorbills (birds/km²) and number of detections per segment for the twenty-five (25) month period are displayed in Figure 46 to Figure 50. Interpretation is included within the discussion.

94 Razorbills were scarce across site for most of 2018 until late summer where high densities arrived through August and September 2020. Lower numbers utilised the south of the development site from December to February 2019.

95 Through the first half of 2019 there were scattered records across the survey site. Numbers notably increased from November 2019 through to February 2020 with densities greatest around the core development site.

Figure 46 Densities of razorbill (number/km²) and number of detections per segment between March 2018 and August 2018

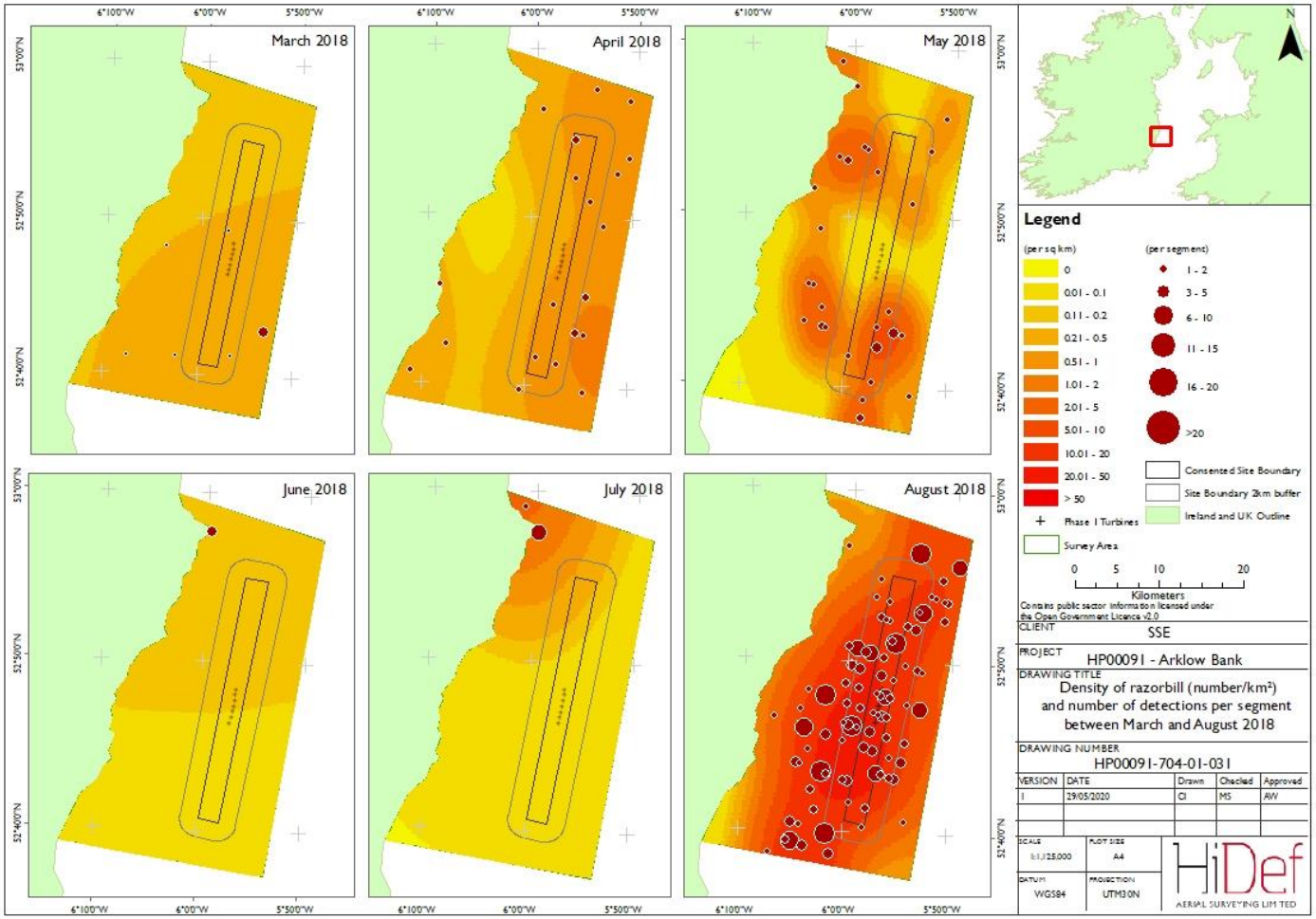


Figure 47 **Densities of razorbill (number/km²) and number of detections per segment between September 2018 and February 2019**

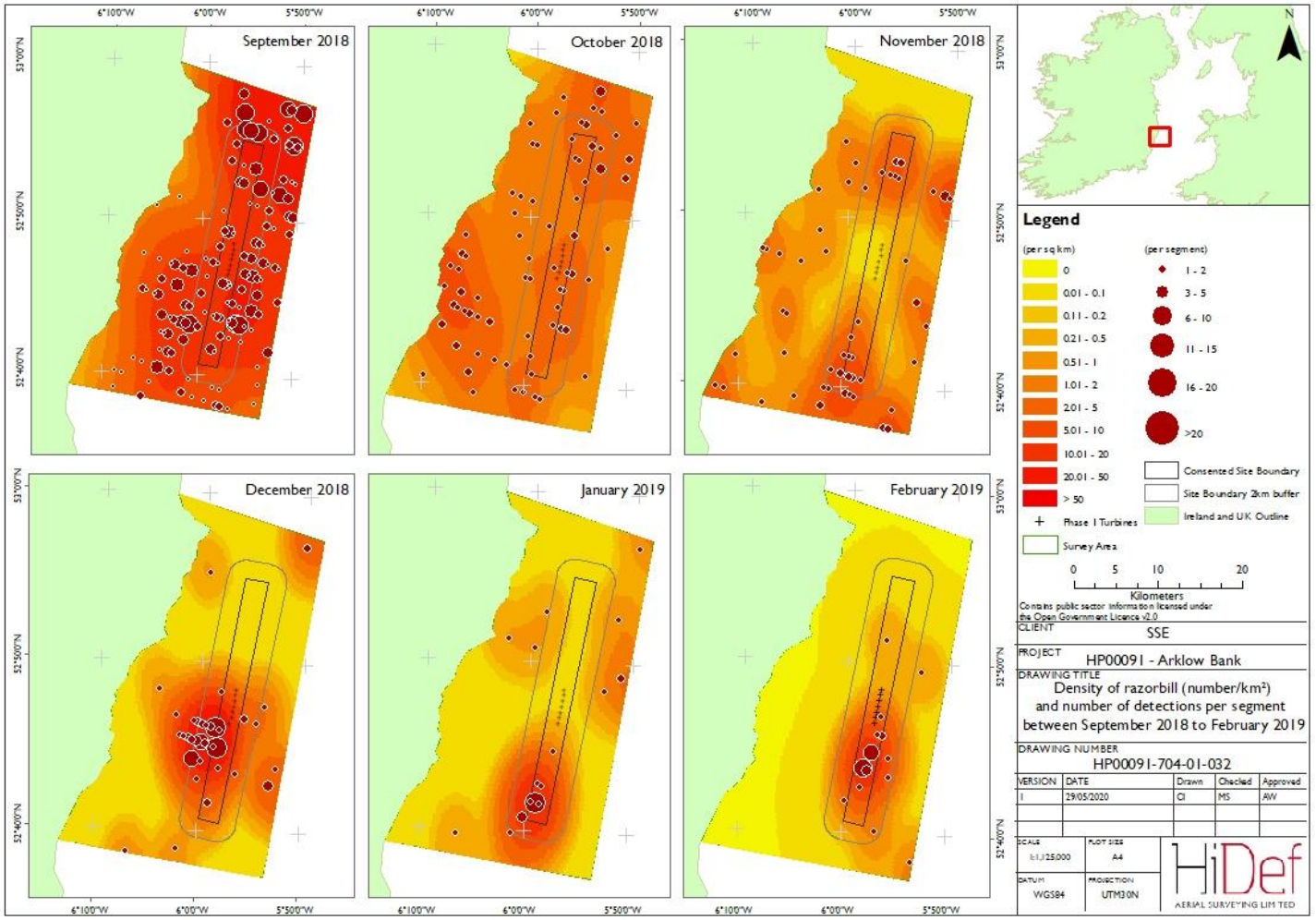


Figure 48 **Densities of razorbill (number/km²) and number of detections per segment between March 2019 and August 2019**

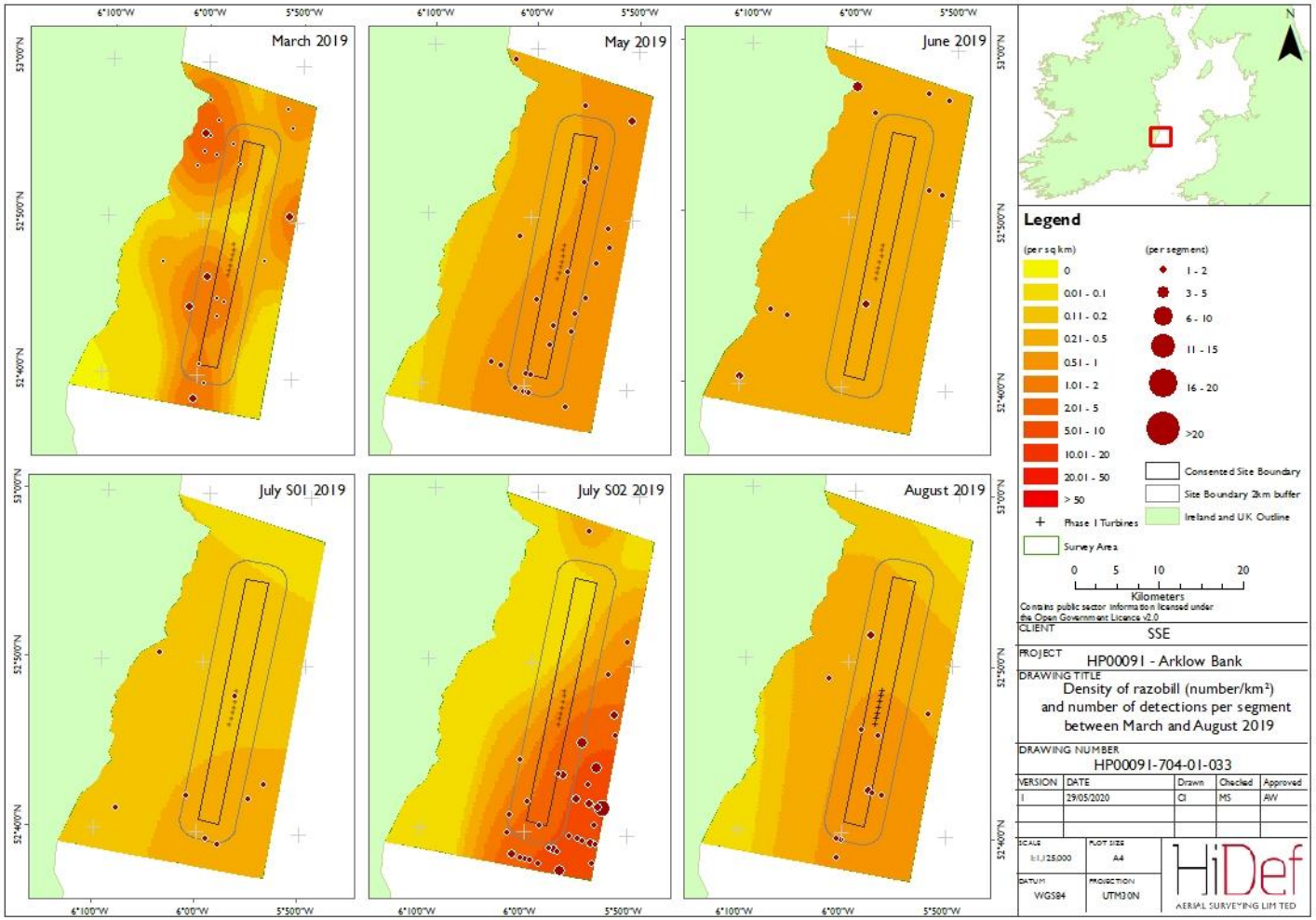


Figure 49 **Densities of razorbill (number/km²) and number of detections per segment between September 2019 and February 2020**

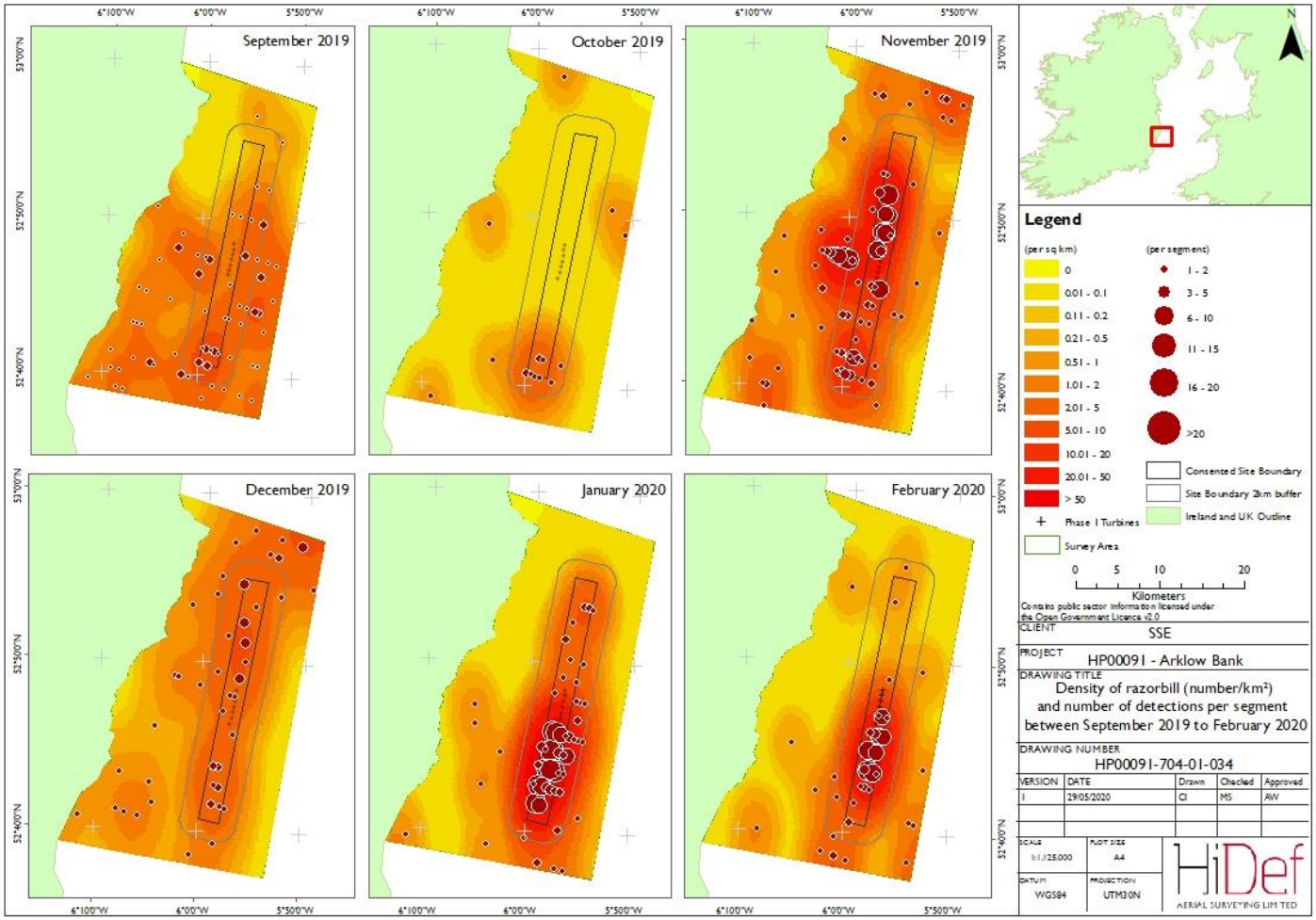
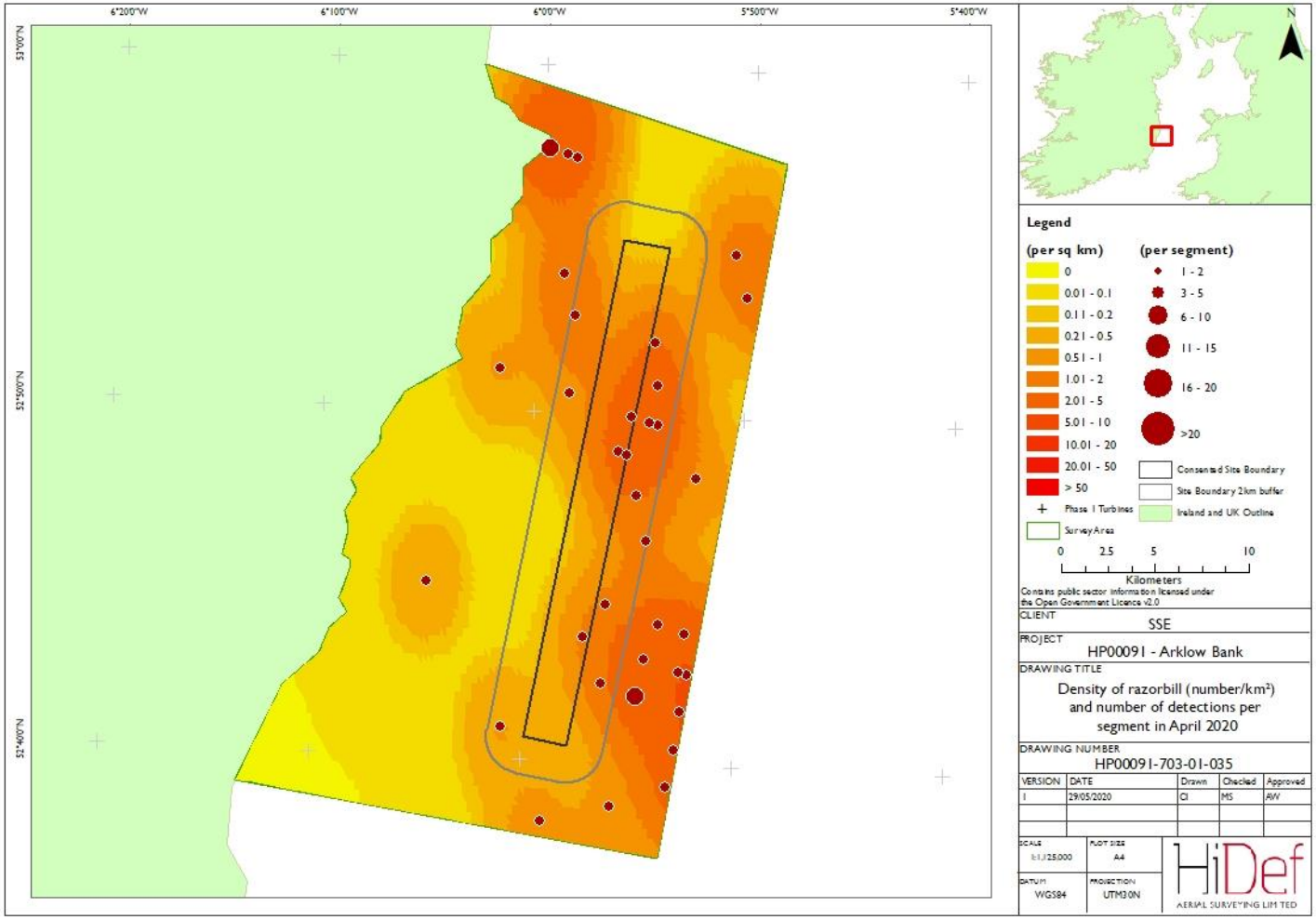


Figure 50 Densities of razorbill (number/km²) and number of detections per segment in April 2020



3.5.11 Harbour Porpoise

96 The densities of harbour porpoise (animals/km²) and number of detections per segment for the twenty-five (25) month period are displayed in Figure 51 to Figure 55. Interpretation is included within the discussion.

97 Harbour porpoise were regular in low densities across the survey site for most of 2018 until late summer where numbers dropped before increasing later in the autumn.

98 No animals were noted in June of either survey year.

99 Overall, the pattern was for animals to be dispersed widely with no clear pattern of usage around the site.

Figure 51 Densities of harbour porpoise (number/km²) and number of detections per segment between March and August 2018

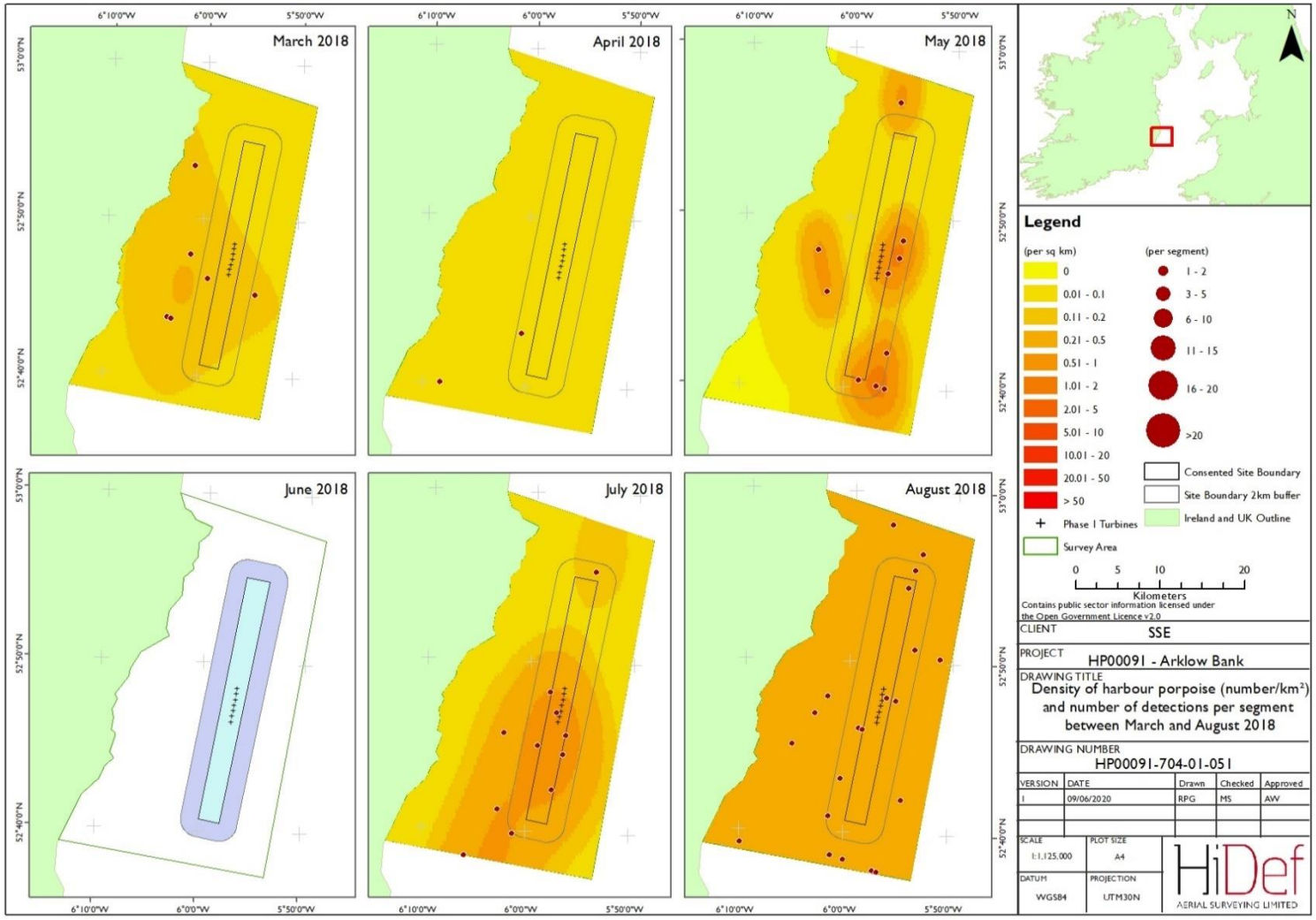


Figure 52 **Densities of harbour porpoise (number/km²) and number of detections per segment between September 2018 and February 2019**

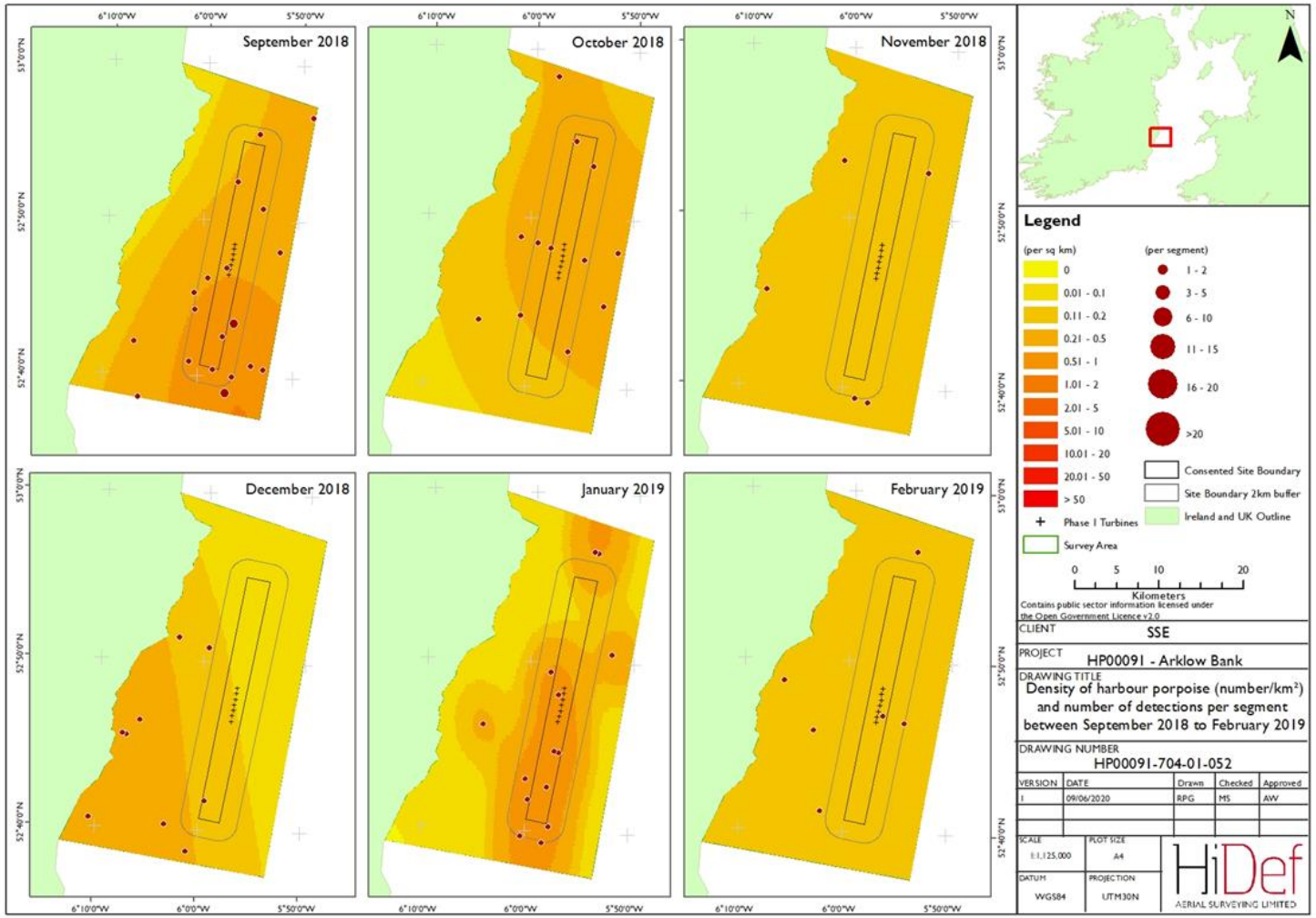


Figure 53 **Densities of harbour porpoise (number/km²) and number of detections per segment between March and August 2019**

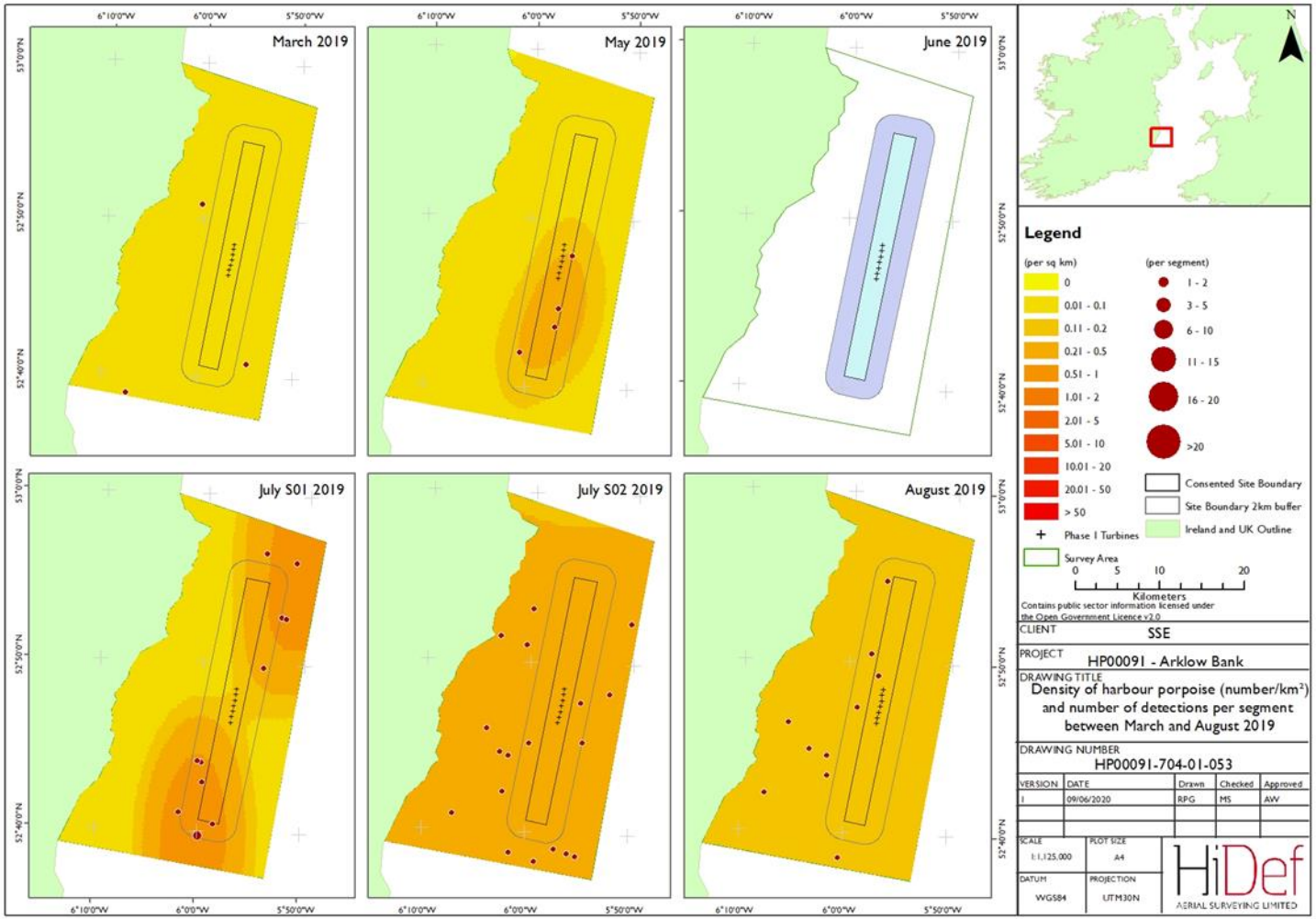


Figure 54 **Densities of harbour porpoise (number/km²) and number of detections per segment between September 2019 and February 2020**

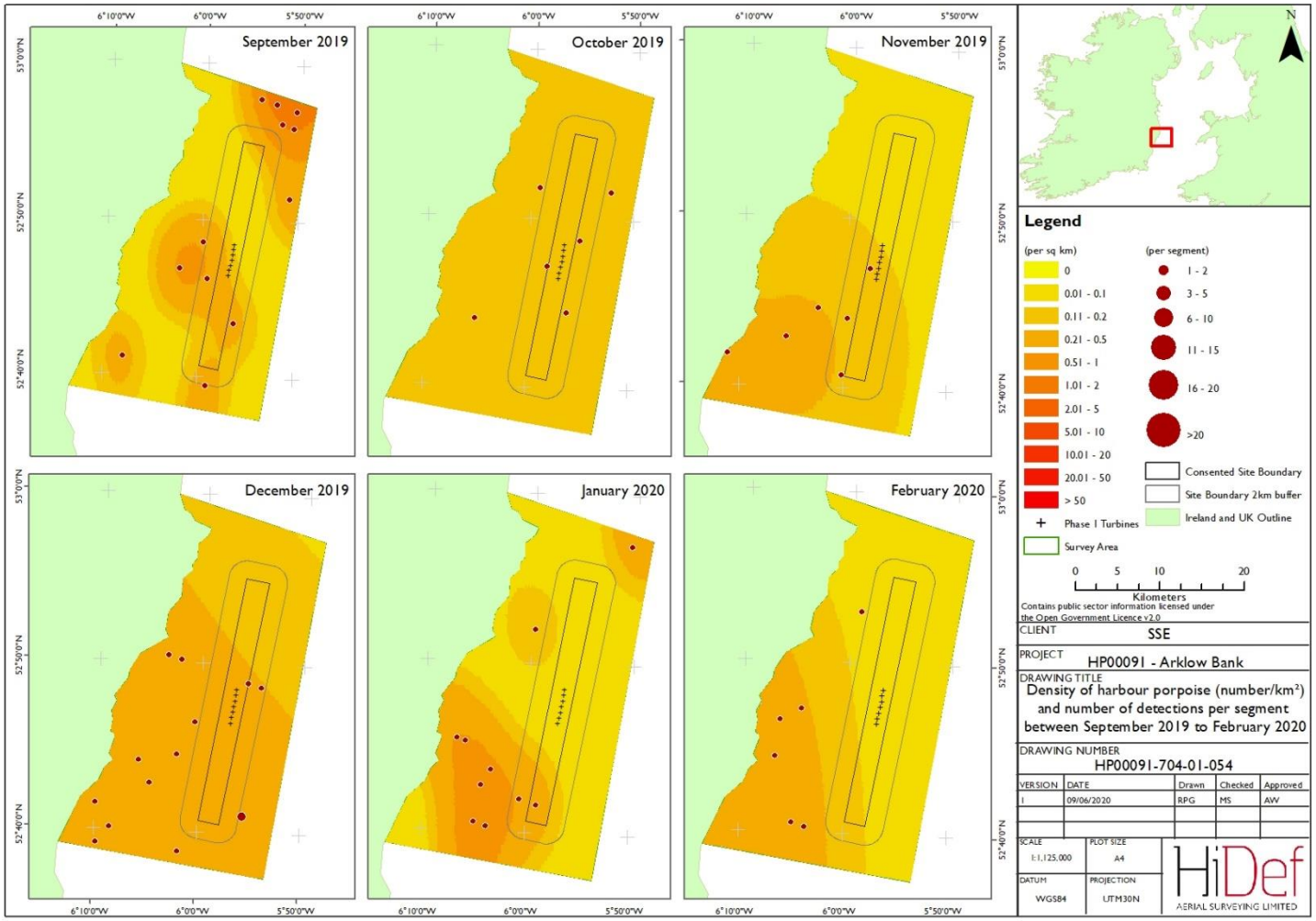
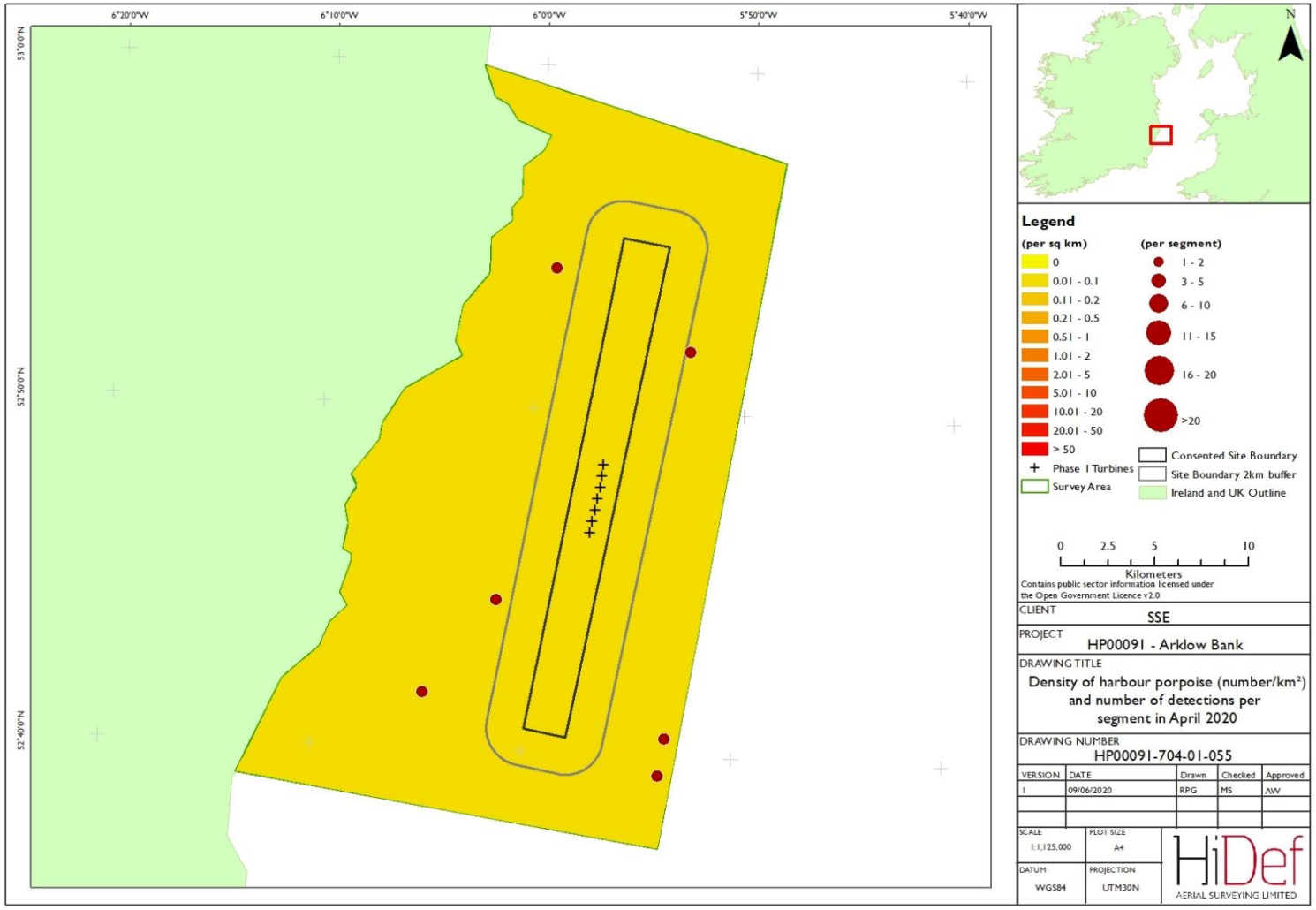


Figure 55 **Densities of harbour porpoise (number/km²) and number of detections per segment in April 2020**



3.6 Availability bias

100 The estimated relative density and numbers of certain diving bird species within Table 4 to Table 53 were multiplied by a scaling factor as outlined in section 2.5.4 in order to take account of availability bias in the detection of these species and give estimates of absolute abundance. These are shown in Table 54 to Table 56.

101 The adjusted density and abundances provide the best estimate of abundance to take account of the numbers of diving seabird species that may be submerged at the time of survey. These have only been calculated for three species: guillemots, razorbills and puffins. They have not been calculated for any other seabird species which either do not dive or would be submerged for too short a time to warrant calculation of availability bias.

102 We have used these percentage figures to scale up the relative abundance estimate of the following species sitting on the sea by factors of:

- Guillemot: 1.2375
- Razorbill: 1.174
- Puffin: 1.1416

103 Availability bias was carried out for harbour porpoise (Table 57) but not for other non-avian animals due to the low numbers present, and due to a lack of any information about their diving patterns.

Table 54 **Adjusted density and population estimates for guillemot in the Arklow Bank survey area between March 2018 and February 2020, plus April 2020, taking into account the number of birds that are estimated as being unavailable for detection**

Guillemot	Non-adjusted abundance estimates				Adjusted abundance estimates for availability bias			
	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)
27-Mar-18	0.18	121	59	185	0.22	150	74	229
23-Apr-18	0.78	532	341	737	0.92	637	347	954
10-May-18	17.29	11848	6412	18553	21.04	14418	7320	23064
21-Jun-18	2.34	1603	117	4408	2.85	1953	130	5452
03-Jul-18	3.47	2376	1365	3907	6.86	4702	2566	7777
25-Aug-18	15.48	10608	8612	12560	19.18	13140	10723	15618
07-Sep-18	12.56	8608	6556	10672	15.59	10686	8101	13154
01-Oct-18	7.59	5198	3917	6665	9.37	6421	4790	8322
22-Nov-18	13.61	9328	6266	12784	16.52	11318	7121	16230
18-Dec-18	1.24	851	414	1486	1.52	1051	501	1793
28-Jan-19	0.76	524	239	920	0.93	639	269	1159
11-Feb-19	1.46	1003	666	1388	1.76	1204	734	1733
17-Mar-19	0.20	140	60	240	0.25	174	74	295
04-May-19	3.98	2726	1987	3591	4.92	3371	2438	4471
13-Jun-19	1.27	870	547	1279	1.56	1067	662	1574
02-Jul-19	11.71	8026	5382	10715	14.53	9956	6663	13344

Guillemot	Non-adjusted abundance estimates				Adjusted abundance estimates for availability bias			
	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)
27-Jul-19	18.19	12466	7330	18176	22.63	15505	8825	22492
13-Aug-19	11.92	8166	5739	11002	14.75	10112	7164	13565
05-Sep-19	5.74	3936	2406	5727	7.04	4830	2949	6985
06-Oct-19	5.44	3727	2660	4846	6.69	4586	3268	5959
10-Nov-19	8.12	5566	3362	8706	9.97	6830	4031	10849
09-Dec-19	3.16	2165	1500	2905	3.85	2644	1777	3658
10-Jan-20	12.06	8263	3970	13089	14.36	9846	3769	16818
12-Feb-20	4.01	2747	1075	5210	4.91	3371	1270	6440
25-Apr-20	2.33	1596	729	3088	2.86	1964	875	3880

Table 55 **Adjusted density and population estimates for razorbill in the Arklow Bank survey area between March 2018 and February 2020, plus April 2020, taking into account the number of birds that are estimated as being unavailable for detection**

Razorbill	Non-adjusted abundance estimates				Adjusted abundance estimates for availability bias			
	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)
27-Mar-18	0.22	150	39	331	0.25	175	23	415
23-Apr-18	0.45	311	182	453	0.49	341	132	589
10-May-18	0.93	637	313	1025	1.05	724	282	1304
21-Jun-18	0.12	80	0	240	0.14	94	0	282
03-Jul-18	0.21	142	0	415	0.37	261	0	779
25-Aug-18	9.82	6730	4763	8928	11.55	7919	5618	10444
07-Sep-18	12.79	8766	6152	11839	14.93	10237	7024	14056
01-Oct-18	2.12	1454	1068	1884	2.48	1698	1207	2215
22-Nov-18	1.34	918	514	1369	1.58	1081	587	1641
18-Dec-18	2.68	1838	326	3782	3.16	2166	365	4474
28-Jan-19	1.07	735	120	1756	1.22	835	117	2075
11-Feb-19	0.76	518	100	1109	0.89	606	94	1338
17-Mar-19	0.54	370	239	519	0.62	429	232	650
04-May-19	0.50	340	203	498	0.57	397	228	604
13-Jun-19	0.33	229	87	405	0.39	270	94	494
02-Jul-19	0.16	111	40	194	0.18	127	23	256

Razorbill	Non-adjusted abundance estimates				Adjusted abundance estimates for availability bias			
	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)
27-Jul-19	1.41	968	501	1492	1.64	1128	596	1742
13-Aug-19	0.32	219	70	393	0.38	259	89	461
05-Sep-19	1.66	1136	709	1596	1.96	1341	829	1880
06-Oct-19	0.28	192	40	390	0.30	200	36	421
10-Nov-19	6.62	4539	2207	7352	7.77	5324	2480	8965
09-Dec-19	1.48	1016	680	1358	1.70	1161	747	1612
10-Jan-20	8.31	5697	2131	10115	9.69	6641	2273	11806
12-Feb-20	3.19	2189	699	4112	3.75	2573	728	4863
25-Apr-20	0.77	531	338	746	0.90	621	396	877

Table 56 **Adjusted density and population estimates for puffin in the Arklow Bank survey area between March 2018 and February 2020, plus April 2020, taking into account the number of birds that are estimated as being unavailable for detection**

Puffin	Non-adjusted abundance estimates				Adjusted abundance estimates for availability bias			
	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)
27-Mar-18	0.00	0	0	0	0.00	0	0	0
23-Apr-18	0.00	0	0	0	0.00	0	0	0
10-May-18	0.00	0	0	0	0.00	0	0	0
21-Jun-18	0.00	0	0	0	0.00	0	0	0
03-Jul-18	0.03	21	0	60	0.06	45	0	128
25-Aug-18	0.06	41	0	89	0.07	47	0	102
07-Sep-18	0.00	0	0	0	0.00	0	0	0
01-Oct-18	0.00	0	0	0	0.00	0	0	0
22-Nov-18	0.01	11	0	30	0.01	11	0	34
18-Dec-18	0.00	0	0	0	0.00	0	0	0
28-Jan-19	0.00	0	0	0	0.00	0	0	0
11-Feb-19	0.01	11	0	30	0.01	11	0	34
17-Mar-19	0.10	71	10	145	0.11	80	11	167
04-May-19	0.01	10	0	30	0.01	11	0	34
13-Jun-19	0.04	31	0	79	0.04	33	0	98
02-Jul-19	0.04	31	0	60	0.05	35	0	68

Puffin	Non-adjusted abundance estimates				Adjusted abundance estimates for availability bias			
	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)
27-Jul-19	0.20	141	20	335	0.23	160	23	378
13-Aug-19	0.04	30	0	90	0.05	34	0	103
05-Sep-19	0.01	10	0	30	0.01	11	0	34
06-Oct-19	0.04	31	0	91	0.05	35	0	103
10-Nov-19	0.02	11	0	30	0.02	13	0	34
09-Dec-19	0.00	0	0	0	0.00	0	0	0
10-Jan-20	0.00	0	0	0	0.00	0	0	0
12-Feb-20	0.00	0	0	0	0.00	0	0	0
25-Apr-20	0.01	11	0	30	0.01	13	0	34

Table 57 **Adjusted density and population estimates for harbour porpoise in the Arklow Bank survey area between March 2018 and February 2020, plus April 2020, taking into account the number of animals that are estimated as being unavailable for detection**

Harbour porpoise	Non-adjusted abundance estimates				Adjusted abundance estimates for availability bias			
	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)
27-Mar-18	0.09	60	10	119	0.40	269	45	533
23-Apr-18	0.03	21	0	50	0.11	79	0	188
10-May-18	0.15	101	39	174	0.65	436	168	751
21-Jun-18	0.00	0	0	0	0.00	0	0	0
03-Jul-18	0.21	141	69	219	1.04	695	340	1079
25-Aug-18	0.40	271	149	408	1.83	1243	683	1871
07-Sep-18	0.35	240	139	354	2.03	1389	804	2048
01-Oct-18	0.18	121	49	214	1.06	712	288	1259
22-Nov-18	0.10	71	10	146	0.60	425	60	874
18-Dec-18	0.16	110	39	191	0.91	623	221	1082
28-Jan-19	0.23	160	77	257	1.14	793	382	1275
11-Feb-19	0.10	71	10	148	0.61	433	61	904
17-Mar-19	0.04	31	0	68	0.18	139	0	304
04-May-19	0.06	41	10	77	0.26	177	43	332
13-Jun-19	0.00	0	0	0	0.00	0	0	0
02-Jul-19	0.23	160	60	269	1.13	789	296	1326

Harbour porpoise	Non-adjusted abundance estimates				Adjusted abundance estimates for availability bias			
	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)	Density estimate (n/km^2)	Population estimate (number)	Lower 95% confidence limit of population (number)	Upper 95% confidence limit of population (number)
27-Jul-19	0.29	202	110	307	1.43	996	542	1513
13-Aug-19	0.15	100	57	150	0.69	458	261	688
05-Sep-19	0.19	129	49	222	1.10	746	284	1284
06-Oct-19	0.12	81	30	145	0.71	477	177	853
10-Nov-19	0.10	70	20	138	0.60	419	120	826
09-Dec-19	0.25	170	60	300	1.42	963	340	1699
10-Jan-20	0.16	111	39	201	0.79	550	193	997
12-Feb-20	0.12	80	20	150	0.73	488	122	916
25-Apr-20	0.09	61	20	110	0.34	229	75	414

4 Discussion

104 Arklow Bank has been highlighted as an important area for seabirds, with certain species being flagged as high risk of collision and displacement (Burke, 2018). Herring and other large gulls, common tern, gannet, kittiwake and Sandwich tern are all ranked amongst the highest for sensitivity to collision impact, whilst red-throated diver, razorbill and guillemot were amongst those ranked highest for sensitivity to disturbance and displacement. This should be considered when interpreting survey results.

105 Red-throated divers were recorded across the non-breeding season in steady numbers, however a significant spike in abundance occurred in the second year. In winter 2018/19, estimated density of red-throated divers across the survey area peaked in November at 0.48 birds/km2, equating to 332 birds (±95% CI 177 – 503). In comparison, estimated density in winter 2019/20 peaked in December at 1.39 birds /km2, equating to an estimated abundance of 952 birds (±95% CI 514 – 1429). Birds were grouped in multiple high-density pockets, both along the Wicklow coast and offshore across the Arklow Bank consented site, especially in late winter and spring (Figure 36 to Figure 40). The majority of birds were recorded sitting, with as few as 5% of birds recorded flying during peak abundance. Birds were detected in the vicinity of the Phase 1 turbines, with birds recorded within the turbine area across multiple months (Figure 37 and Figure 38).

106 Manx shearwaters were recorded between March and September, when birds return to Irish and British colonies to breed. Density estimates of birds across the entire survey area during the 25-month period ranged between 0.01 birds/km2 and 13.76 birds/km2, with estimated abundance between 11 birds (±95% CI 0 – 30; March 2018) and 9426 birds (±95% CI 4446 – 15053). The latter was recorded during a large influx in May 2018. Distribution varied, with the majority of birds found in high densities offshore across the consented site boundary and the south-east corner of the survey area (Figure 41 to Figure 45). Birds showed little avoidance of the turbines, with areas of relative high density close to the turbines in April, May and August 2018 (Figure 38). Most birds are likely to be migrating or foraging birds, with the closest colonies in the Saltee Islands in Wexford or the Pembrokeshire Islands in Britain. Behaviour varied. As many as 66% were recorded sitting during peak abundance, and birds were recorded flying in all directions, suggesting flocks may have been utilising the area to feed and rest.

107 Kittiwakes were the second most abundant species recorded during the 25-month survey period. During the breeding season (late May to early July), kittiwake numbers were relatively high within the survey area, with estimated abundances fluctuating between 331 birds (±95% CI 184 – 508; June 2019) and 2519 birds (±95% CI 1378 – 3924; May 2018), and estimated density ranging between 0.48 and 3.68 birds/km^2 respectively. Wicklow Head SPA alone holds a breeding population of approximately 956 birds (NPWS, 2018). Kittiwake numbers were significantly higher in December 2018 and in the winter of 2019/20. This is likely due to an influx of wintering birds that spend their time out at sea. Kittiwake numbers peaked in January and February 2020 with an estimated abundance of 11,394 (±95% CI 4252 – 20253) and 13,946 (±95% CI 4497 – 25442) birds, equating to an estimated density of 16.63 and 20.35 birds/km^2 respectively.

108 The distribution of kittiwakes varied throughout the survey period, with birds found across the entirety of the survey area. However, certain hotspots are visible. Relatively high densities of kittiwakes formed in the north-west corner of the survey area in the breeding season, close to the Wicklow Head SPA. During these months, many birds were recorded flying north and north-west, suggesting probable connectivity between Arklow Bank and breeding sites such as Wicklow Head SPA, and those further north.

109 Arguably the highest densities were found further offshore. In particular, kittiwakes showed a noticeable attraction to Arklow Bank. High densities were found within the proposed development area site boundary,

such as in August 2018, December 2018 and February 2019 (Figure 17 and Figure 18); often close to or within the Phase 1 turbines. This was particularly evident when birds were in their highest numbers, such as in November 2019 and January, February and April 2020 (Figure 20 and Figure 21). Behaviour of the birds was mixed. For example, in January 2020 79% of kittiwakes (890 birds) were recorded sitting. However, in February 2020, 72% (1009 birds) were recorded flying, suggesting kittiwakes were likely to be both sitting and flying within or in close proximity to the turbines. Kittiwakes normally show patchy distributions offshore. Whilst this attraction to Arklow Bank may be of significance, it is equally important to remember that no analysis has been undertaken to compare to pre-construction levels. Arklow Bank is known for its abundant seabird populations (Coveney & Phalan, 2001, Ecology Ireland 2013), and kittiwakes from colonies such as in the western Irish Sea, have been shown to forage close to home (Wakefield et al., 2017), so distributions may simply be echoing pre-construction patterns.

110 Herring gulls were recorded in all twenty-five (25) surveys, in relatively low numbers. Little difference was apparent between the two years. Across the 25-month period, density estimates for the whole survey area ranged between 0.04 birds/km^2 (May 2019) and 0.41 birds/km^2 (March 2018), with abundance estimates ranging between 30 birds (±95% CI 0 – 79) and 283 birds (±95% CI 129 – 466) respectively. Herring gulls are known to breed along the Wicklow coast (Cummins et al., 2019). The majority of birds recorded were distributed close to shore, along the Wicklow coast, with many birds recorded flying to and from the shore. Visible density hotspots can be seen around Wicklow Head SPA in the north-west corner of the survey area, the central section of coast and the south-west corner of the survey area (Figure 22 to Figure 26). In addition, approximately 60% of aged herring gulls were recorded as being either immature or juvenile, with the highest numbers of immatures recorded prior to the breeding season, between January and April. Birds were rarely recorded within the Arklow Bank site itself. A few individuals were observed within the 2km buffer in March, June and July (S02) 2019, and birds only encroached into the consented site boundary in February 2019, November 2019 and February 2020.

111 Other large gulls (great black-backed gull *Larus marinus* and lesser black-backed gull *Larus fuscus*) were recorded in very low numbers.

112 Sandwich terns were recorded between April and September, when birds return to Irish and UK coasts to breed. Birds were recorded in low numbers, with a total of 40 observations in 2018/19 and only 16 observations in 2019/20. Estimated density of Sandwich terns across the survey area was lowest in March 2018 and September 2019 at 0.01 birds/km^2, and highest in May 2018 at 0.2 birds/km^2. This equated to estimated abundances that ranged between 10 birds (±95% CI 0 – 30) and 139 birds (±95% CI 39 – 260) across the survey period. Birds were distributed widely, both close to shore and further out to sea (Figure 27 to Figure 31). In May 2018, Sandwich terns were recorded at relatively high densities near the central region of the coast and, in July (S02) 2019, they were clustered in the south-west corner of the survey area. Birds were found within the Arklow Bank consented site boundary in a number of surveys, including April, August and September 2018 and May 2019. Those recorded in the survey area are likely to be foraging or passage birds due to the seasonal timing, with the nearest breeding colony Lady's Island Lake SPA (Cummins et al., 2019).

113 Both common and Arctic terns were recorded across the breeding season, between April and October. The first year had higher numbers for both species in the survey area, even when accounting for unidentified tern species. In 2018, common tern estimated density for the total survey area peaked at 1.9 birds/km^2, equating to an estimated 1303 birds (±95% CI 794 – 1920; August 2018). In contrast, their maximum estimated density in 2019 reached only 0.04 birds/km^2, equating to an estimated 30 birds (±95% CI 0 – 78). The lowest estimated density of common terns was 0.01 birds/km^2, equating to an estimated 10 birds (±95% CI 0 – 30) in both May 2018, May 2019 and June 2019. Common terns were distributed offshore, across the Arklow Bank consented site and further to the east. When in high numbers, common terns showed a

clear attraction to the Arklow Bank site, with high densities of birds recorded within or close to the Phase 1 turbines in April 2018, August 2018 and September 2018 (Figure 32 and Figure 33) during migration. Additional areas of high density were visible just outside of the consented site running north-east and south-west.

114 Arctic terns showed similar trends but were recorded at much higher abundances. In 2018, Arctic tern estimated density for the total area peaked at 5.5 birds/km^2, equating to an estimated 3769 birds (±95% CI 1219 - 6861; August 2018). In contrast, they reached a maximum density of only 0.06 birds/km^2 in 2019, equating to an estimated 41 birds (±95% CI 0 – 109; October 2019). The lowest estimated density of Arctic terns was 0.01 birds/km^2, equating to an estimated abundance of 11 birds (±95% CI 0 – 30) in October 2018 and September 2019. Again, the majority of observations and highest densities spread across the Arklow Bank consented site and buffer, as well as the adjacent areas north and south.

115 Guillemots were the most abundant species recorded over the survey period, present in every month. Figures were relatively comparable between both survey years. When accounting for the number of guillemots diving, density estimates for the species across the entire survey area each survey ranged between 0.22 birds/km^2 and 22.63 birds/km^2, with estimated abundances between 150 birds (±95% CI 74 – 229; March 2018) and 15,505 birds (±95% CI 8825 – 22,492; July S02 2019) at their peak. Highest numbers of birds were recorded across the breeding season and into autumn. Guillemots were distributed across the entirety of the survey area, with highest densities recorded further offshore, across the consented site and around it (Figure 41 to Figure 45). In all years, high-density 'hotspots' of guillemots were recorded around Wicklow Head early in the breeding season. Additional high-density pockets were visible in the south-east corner of the survey area (Figure 43) and the southern half of the Arklow Bank consented site (Figure 44).

116 Razorbills were also present in all months, recorded in their highest numbers in late summer 2018 and winter 2019/20. When adjusting figures to account for diving birds, estimated razorbill density recorded each month across the entire survey area ranged between 0.14 birds/km^2 and 14.93 birds/km^2, with estimated abundances between 94 birds (±95% CI 0 – 282; June 2018) and 10,237 birds (±95% CI 7024 – 14,056; September 2018). Razorbills were distributed across the entirety of the survey area, often showing similar distribution patterns to guillemots. High-density 'hotspots' were visible along the coast, around Wicklow Head, across the Arklow Bank consented site (often in the southern half) and in the south-east corner of the survey area, although this varied across months (

117 Figure **46** to

118 Figure **50**).

119 Both guillemots and razorbills are known to breed at Wicklow Head SPA (NPWS, 2018), and were recorded flying west and north-west, likely indicating connectivity between the survey area and this site.

120 Gannets were recorded in relatively low numbers across the survey area, with similar abundances in both years. Estimated density ranged between 0.1 birds/km^2 and 0.19 birds/km^2 across the first 24 surveys. This equated to estimated abundances ranging between 10 birds (±95% CI 0 – 30) and 131 birds (±95% CI 48 – 231). In comparison, April 2020 appears to be a good month for gannets, with the highest estimated density recorded at 0.25 birds/km^2, equating to an estimated 171 birds (±95% CI 39 – 356). The majority of birds were recorded flying, and high-density pockets were recorded within the consented site across multiple months (Figure 12 to Figure 16).

121 Despite being part of the qualifying species breeding at Wicklow Head SPA, fulmar *Fulmarus glacialis* were recorded in very low numbers with no notable spatial patterns apparent.

122 Harbour porpoises were recorded consistently across the survey period, except for June 2018 and June 2019. When accounting for diving animals, harbour porpoise density estimates for the survey area ranged between 0.11 animals/km^2 and 2.03 animals/km^2. This equated to absolute abundances ranging between 79 animals (±95% CI 0 – 188; April 2018) and 1389 animals (±95% CI 804 – 2048; September 2018). The highest abundances were recorded in the summer months, with additional spikes in December and January in both years. Harbour porpoises were recorded throughout the survey area, using the consented site frequently.

123 Other notable marine species were observed utilising the site. Three bottlenose dolphin *Tursiops truncatus* were recorded at the south-west tip of the consented site boundary in November 2019. Basking shark and common dolphin *Delphinus delphis* were also recorded at the same location in October and November 2019 respectively. Both harbour porpoise and bottlenose dolphin are Annex II species protected under the EU Habitats Directive. Separate studies suggest large numbers of bottlenose dolphin do not frequently use the area, with the nearest populations likely to be in Cardigan Bay and Anglesey across the Irish Sea (Baines and Evans, 2012), however harbour porpoise are reportedly not uncommon in the region (Reid et al., 2003).

124 Additionally, harbour seals *Phoca vitulina* and grey seals *Halichoerus grypus* were observed in the survey area. Both species were recorded close to the coast and offshore, with grey seal observed within the consented site boundary in April 2018. Grey seals are known to breed at Wicklow Head between September and December, thus are likely to use the area to feed. Tagged grey seals have been shown to forage long distances (Baines and Evans, 2012), suggesting individuals may also be coming from Irish populations such as the Saltee Islands, Lambay Island or as far as the Welsh coast to forage within the study area.

5 Conclusion

125 The surveys were successful in characterising the bird and mammal species present across the survey area, recording a total of 31, 291 birds across 37 species and 305 marine mammals across 5 species. In addition, two other non-avian animal species were recorded: basking shark and barrel jellyfish. An average identification rate to species level of 92.85% was achieved across the survey programme.

126 Results of this analysis should be viewed in conjunction with the two-year observation report (HP00091-703-01) and flight height data to obtain a complete view of how species utilise the site.

127 Overall, red-throated divers and gannets were found in relatively low numbers across the survey area and consented site. Manx shearwaters and kittiwakes were recorded at high densities across the survey area and consented site. Herring gulls and Sandwich terns were recorded in low numbers, often close to the coast. Common and Arctic terns were recorded in high densities in the breeding season, particularly across the consented site. Guillemots and razorbills were found in high densities across the entire survey area. Harbour porpoise were found in steady numbers, both across the survey area as a whole and within the consented site boundary.

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