LLŶR FLOATING OFFSHORE WIND PROJECT

Llŷr 1 Floating Offshore Wind Farm

Environmental Statement

Volume 6: Appendix 21A – Marine Mammal and Megafauna Baseline

August 2024

Prepared by: Llŷr Floating Wind Ltd

Document Status

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Acronyms and abbreviations

Acronym, Abbreviation or Unit	Definition	Acronym, Abbreviation or Unit	Definition
%	Percentage	MERP	Marine Ecosystems Research Programme
adbe	Absolute design-based estimate	MPA	Marine Protected Area
ambe	Absolute model-based estimate	MU	Management Unit
ASL	Above Sea Level	n	Number
CI	Confidence Interval	NRW	Natural Resources Wales
CL	Confidence Limit	NRW (A)	Natural Resources Wales Advisory
cm	Centimetre	OSPAR	Oslo Paris Commission
CMR	Capture-Mark-Recapture	QA	Quality Assurance
CV	Coefficient of Variation	rdbe	Relative design-based estimate
DAS	Digital Video Aerial Survey	RMU	Regional Management Unit
EIA	Environmental Impact Assessment	S01	Survey 01
ES	Environmental Statement	S02	Survey 02
HiDef	HiDef Aerial Surveying Ltd	SAC	Special Area of Conservation
HRA	Habitat Regulations Assessment	SCANS	Small Cetaceans in the European Atlantic waters and North Sea
IAMMWG	Inter-Agency Marine Mammal Working Group	SCOS	Special Committee On Seals
IUCN	International Union for Conservation of Nature	SD	Standard Deviation
JCP	Joint Cetacean Protocol	SMRU	Sea Mammal Research Unit
JNCC	Joint Nature Conservation Committee	SMU	Seal Management Unit
km	Kilometre	SST	Sea surface temperature
km^2	Square kilometre	SWF	Sea Watch Foundation
Llŷr	Llŷr Floating Offshore Wind Project	UK	United Kingdom
m	Metre	WWT	Wildfowl and Wetland Trust
MCZ	Marine Conservation Zone		

Glossary of project terms

Term	Definition
The Applicant	The developer of the Project, Llŷr Floating Wind Limited.
Array	All wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure within the Array Area, as defined, when considered collectively, excluding the offshore export cable(s).

Term	Definition
Array Area	The area within which the wind turbine generators, inter array cables, mooring lines, floating sub-structures and supporting subsea infrastructure will be located
Floventis Energy	A joint venture company between Cierco Ltd and SBM Offshore Ltd of which Llŷr Floating Wind Ltd is a wholly owned subsidiary.
Landfall	The location where the offshore export cable(s) from the Array Area, as defined, are brought onshore and connected to the onshore export cables (as defined) via the transition joint bays (TJB).
Llŷr 1	The proposed Project, for which the Applicant is applying for Section 36 and Marine Licence consents. Including all offshore and onshore infrastructure and activities, and all project phases.
Marine Licence	A licence required under the Marine and Coastal Access Act 2009 for marine works which is administered by Natural Resources Wales (NRW) Marine Licensing Team (MLT) on behalf of the Welsh Ministers.
Offshore Development Area	The footprint of the offshore infrastructure and associated temporary works, comprised of the Array Area and the Offshore Export Cable Corridor, as defined, that forms the offshore boundary for the S36 Consent and Marine Licence application
Offshore Export Cable	The cable(s) that transmit electricity produced by the WTGs to landfall.
Offshore Export Cable Corridor (OfECC)	The area within which the offshore export cable circuit(s) will be located, from the Array Area to the Landfall.
Onshore Development Area	The footprint of the onshore infrastructure and associated temporary works, comprised of the Onshore Export Cable Corridor and the Onshore Substation, as defined, and including new access routes and visibility splays, that forms the onshore boundary for the planning application.
Onshore Export Cable(s)	The cable(s) that transmit electricity from the landfall to the onshore substation
Onshore Export Cable Corridor (OnECC)	The area within which the onshore export cable circuit(s) will be located.
proposed Project	All aspects of the Llŷr 1 development (i.e. the onshore and offshore components).
Onshore Substation	Located within the Onshore Development Area, converts high voltage generated electricity into low voltage electricity that can be used for the grid and domestic consumption.
Section 36 consent	Consent to construct and operate an offshore generating station, under Section 36 (S.36) of the Electricity Act 1989. This includes deemed planning permission for onshore works.
Density estimate (n/km^2 or $animals/km^2$)	The average number of animals per square km surveyed over a defined area.
Population estimate	The mean number of animals estimated within the defined area.

Term	Definition
(number)	
95% Confidence/Credible Interval (CI)	A measure of uncertainty in the mean value. If the analysis was repeated, 95% of the time the mean population estimate would fall within this range. The smaller the CI range the more confident we can be that the mean estimate is an accurate reflection of the true population size.
Confidence Limit (CL)	The upper and lower values that define the range of the 95% confidence interval.
Standard Deviation (SD)	The amount of variation or dispersion of a set of values. A low SD indicates that the bootstrap values tend to be close to the mean of the set.
Coefficient of Variation (CV) (%)	A standard measure that describes the dispersion of data points around the mean. The lower the CV the more precise the estimate. It is calculated as the SD / mean.
Relative abundance	This is the estimated population size based on animals recorded on or above the sea surface and does not account for any that may be diving and thus submerged at the time of survey.
Absolute abundance	The estimated population size including an estimate for the number of animals that are believed to be submerged at the time of survey.

Contents

List of Figures

List of Tables

21-A MARINE MAMMAL AND MEGAFAUNA BASELINE

21.1 Introduction

1. Llŷr Floating Offshore Wind Project (hereafter 'Llŷr' or 'the proposed Project') is a proposed offshore floating wind demonstration project, located approximately 35 km off the south coast of Pembrokeshire, Wales and approximately 72 km from the north coast of Devon, England. The proposed Project is being developed by Llŷr Floating Wind Ltd, a joint venture between Cierco and SBM Offshore.

2. This **Appendix 21A**, prepared by HiDef Aerial Surveying Ltd. ('HiDef'), follows on from the survey summary provided during pre-application discussion (20 January 2023; **Volume 3**, **Chapter 21: Marine Mammals, Tables 21-4** and **Table 21-5**). It provides a characterisation of the baseline environment surrounding the proposed Project, including information on the density and abundance of key marine mammal and megafauna species that could be at potential risk of impact from the proposed Project's development, operation and decommission. It supports the Environmental Statement (ES) **Chapter 21: Marine Mammals** and **Appendix 8E: HRA RIAA** (Habitats Regulations Assessment; Report to Inform Appropriate Assessment). Baseline data were obtained through two years of site-specific digital video aerial surveys (DAS) flown by HiDef (March 2020 to March 2022), as well as literature reviews of survey programmes conducted in the vicinity of the proposed Project (see more details in **Section 21.2**).

3. **Chapter 21: Marine Mammals** includes a summary of the statutory advice and pre-application liaison carried out with Natural Resources Wales Advisory (NRW (A)) and the Joint Nature Conservation Committee (JNCC) as well as the wider stakeholder liaison (including with the Royal Society for the Protection of Birds and the Wildlife Trusts) for this receptor group (**Chapter 21, Tables 21-4** and **Table 21-5**).

21.1.1. Species

4. Various marine mammal and megafauna species have been recorded in the Celtic Sea, including pinnipeds (e.g., grey seal *Halichoerus grypus*); cetaceans, with the presence of odontocetes (e.g., harbour porpoise *Phocoena phocoena*) and mysticetes (e.g., minke whale *Balaenoptera acutorostrata*); marine turtles (e.g., leatherback turtle *Dermochelys coriacea*); and various shark species (Baines and Evans, 2012; Wall *et al.,* 2013; Evans and Waggitt, 2023)

5. This report outlines six key marine mammal and megafauna species identified through Scoping. These species are considered key due to their conservation status, but also, due to their recorded frequency of occurrence during site-specific surveys and other offshore developments in the vicinity of the proposed Project (e.g., Project Erebus), together with reported occurrence in surveys of the wider region such as the Small Cetaceans in European Atlantic waters and the North Sea surveys (SCANS-III and IV; Hammond *et al.,* 2021; Gilles *et al.,* 2023) and ObSERVE (Rogan *et al.,* 2018).

6. The key species of interest identified for the area within and surrounding the proposed Project include:

- Grey seal;
- Harbour porpoise;
- Short-beaked common dolphin *delphinus delphis*, hereafter 'common dolphin';
- Bottlenose dolphin *tursiops truncatus*;
- Minke whale; and

- Leatherback turtle.

7. Basking shark *Cetorhinus maximus*, blue shark (*Prionace glauca*), ocean sunfish *Mola mola* and lion's mane jellyfish *Cyanea capillata* were also recorded in the Llŷr marine megafauna survey area during the survey period, albeit in very low numbers (six, three, one and four individuals, respectively; **Appendix 21A: Annex A** and **Appendix 21A: Annex B**). Basking sharks are being assessed in **Volume 3, Chapter 20: Fish and Shellfish Ecology** and are therefore, not covered in this **Appendix 21A**. The other three species (blue shark, ocean sunfish and lion's mane jellyfish) were observed in too low numbers to be included in this assessment and were therefore, not included in the list of key species.

21.1.2. Study Area

8. The Study Areas relevant to the assessment of marine mammals and megafauna have been defined on a species-by-species basis, considering the ecology, behaviour scale of movement and population structure for each species. The Study Area has been defined at two spatial scales:

- The species-specific **Management Units (MUs)** or **Regional Management Unit (RMU)** take into account the wider distribution, density and abundance of animals and are used as the reference population for the assessment of potential impact at the population scale (**Figure 21A-1** and **Figure 21A-2**. **Table 21A-1** summarises the relevant species-specific MUs within which the proposed Project is located and their associated marine mammal and megafauna populations; and
- The **Llŷr marine megafauna survey area** for all species is used to indicate site-specific local abundance and densities (**Figure 21A-3**).

Table 21A-1. Key marine mammal and megafauna species Management Units (MUs) and respective abundance estimates obtained from IAMMWG (2022) for cetaceans, SCOS (2022) and Carter et al. (2022) for grey seals and IUCN (2019) for leatherback turtles

Species	MU	Abundance in MU (individual)	95% Confidence Interval (CI) (individual)	Coefficient of variation (CV)
Minke whale	Celtic and Greater North Seas	20,118	14,061 – 28,786	0.18
Common dolphin	Celtic and Greater North Seas	102,656	58,932 – 178,822	0.29
Bottlenose dolphin	Offshore Channel and SW England	10,947	6,727 – 17,814	0.25
Harbour porpoise	Celtic and Irish Sea	62,517	48,324 – 80,877	0.13
Grey seal	OSPAR Region III – England	27,000*†	-	-
	OSPAR Region III – Wales	5,400*†	-	-
	OSPAR Region III – Northern Ireland	500*†	-	-
	OSPAR Region III	65,442**†	-	-

Species	MU	Abundance in MU (individual)	95% Confidence Interval (CI) (individual)	Coefficient of variation (CV)
Leatherback turtle	Northwest Atlantic RMU	23,010†	-	-

**Population estimates for the start of the 2022 breeding season, rounded to the nearest 100*

***Population estimate was extracted from the at-sea density estimates obtained from Carter et al. (2022), corrected for haul-out seals and based on SCOS (2022) overall UK population (n=162,000)*

†Confidence intervals and coefficient of variation are not provided in the original references

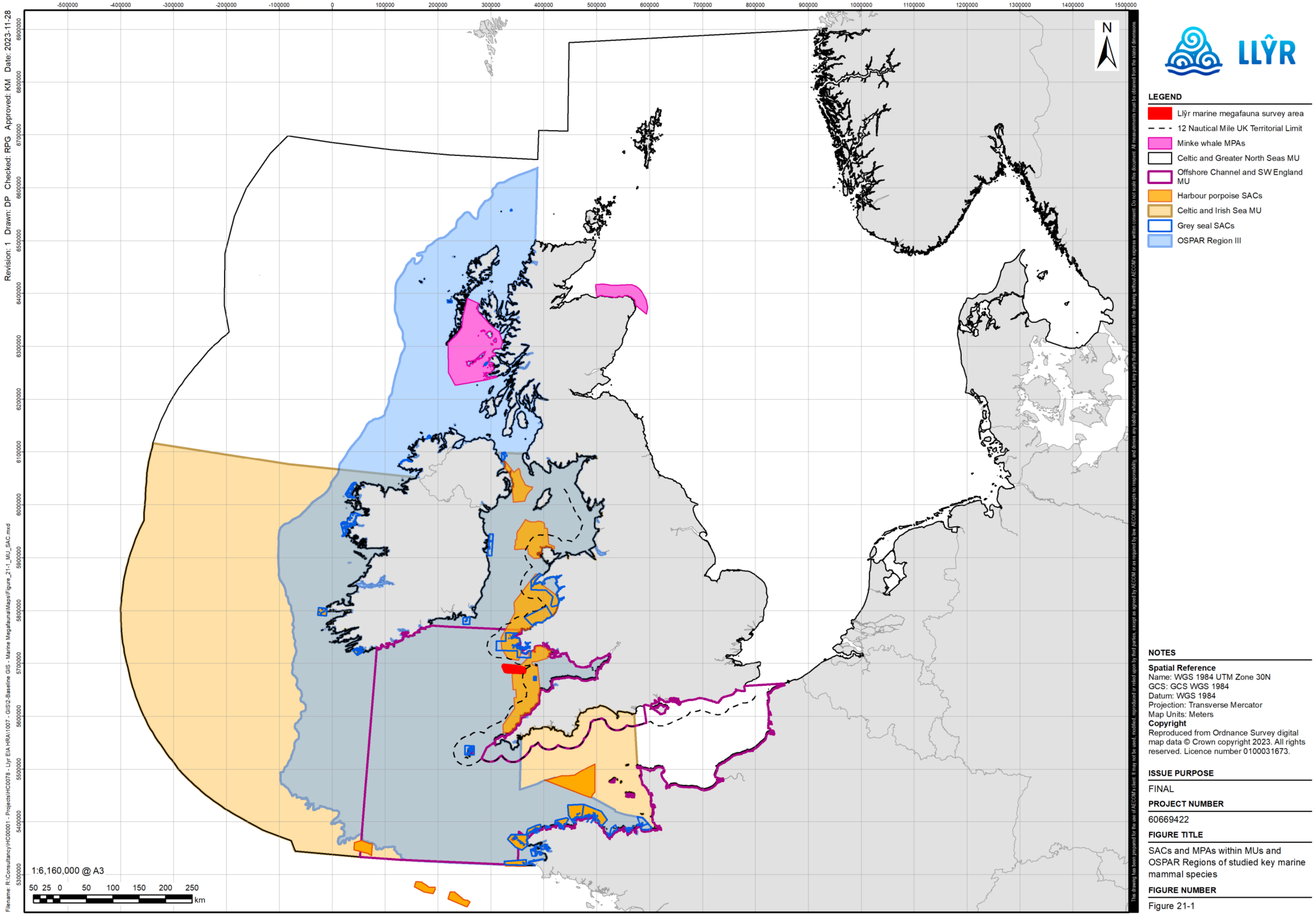

Figure 21A-1. Special Areas of Conservation (SACs) and Marine Protected Areas (MPAs) located within relevant Management Units (MUs) and OSPAR region associated with key marine mammal species

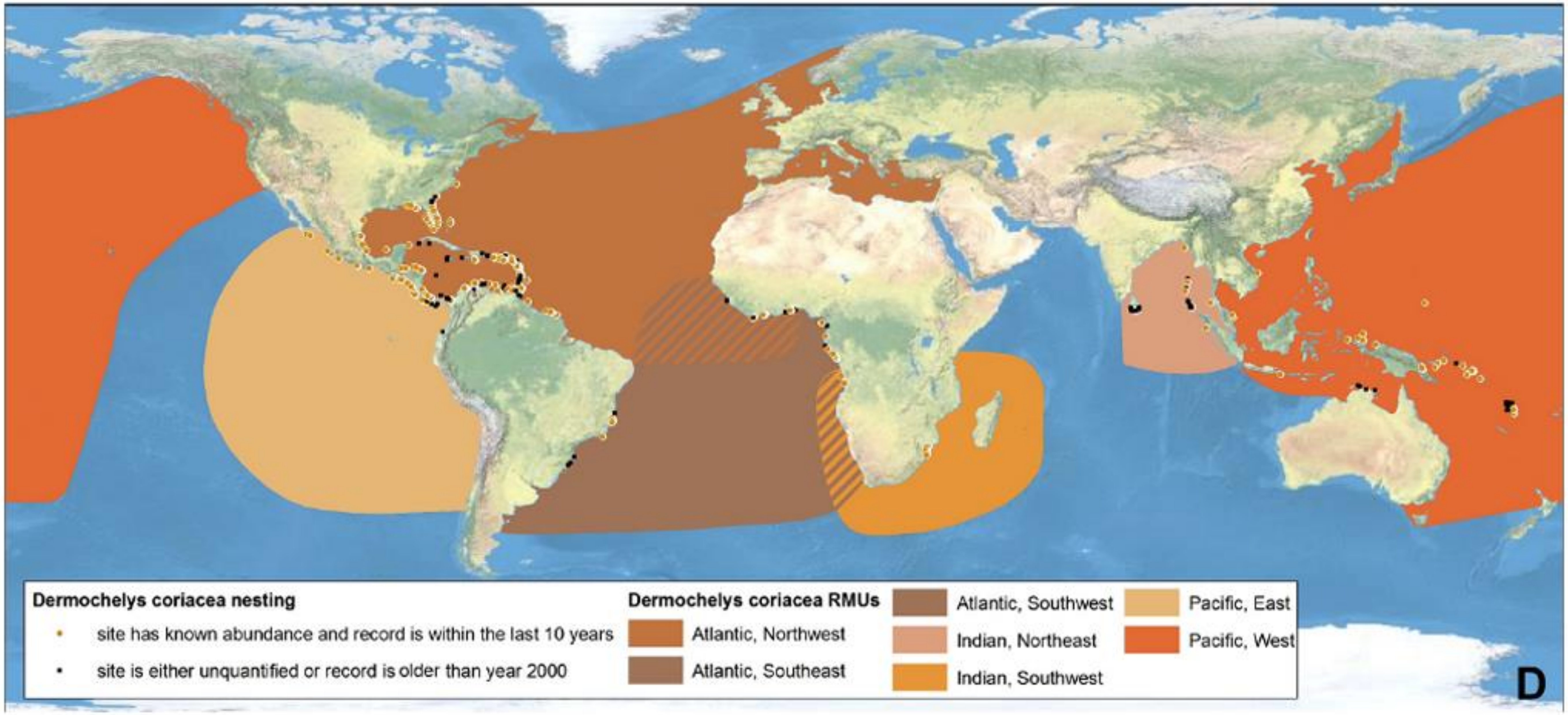

Figure 21A-2. Regional Management Units (RMUs) for the leatherback turtle (Wallace et al., 2010)

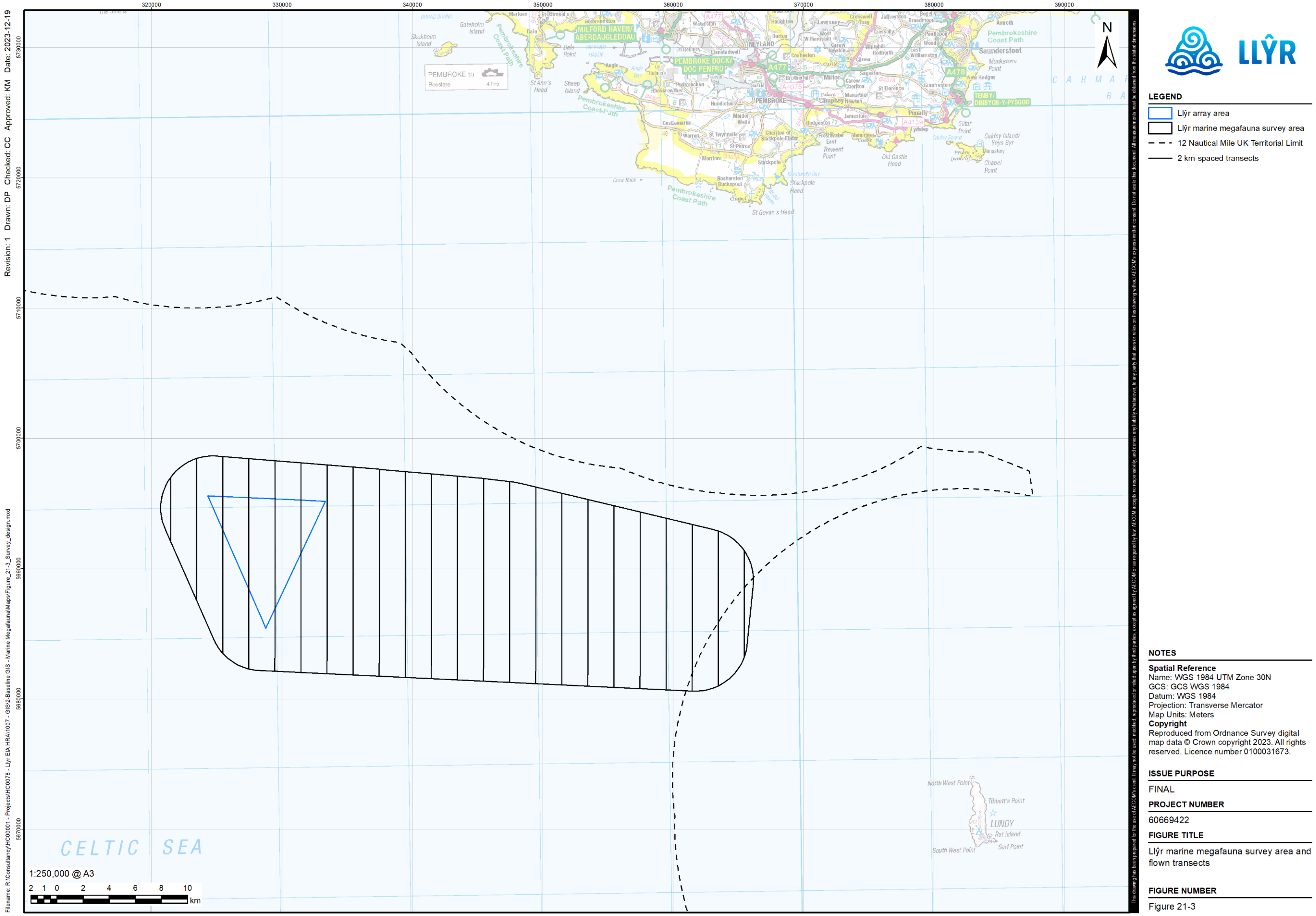

Figure 21A-3. HiDef digital aerial survey design of the Llŷr marine megafauna survey area with 2 km-spaced transects

21.2 Data Sources

9. **Table 21A-2** and the following sections provide information on the data sources used to characterise the baseline environment for the key marine mammal and megafauna species in relation to the proposed Project. This section provides details on the survey and analysis methodologies used in studies conducted in the vicinity of the proposed Project, as well as their limitations. Results from individual studies for each key species will be discussed within each relevant species-specific section (**21.3.1** to **21.3.6**).

Table 21A-2. Data sources used in this report to inform baseline characterisation of key marine mammal and megafauna species

Data source	Date	Type of data	Coverage
Site-specific survey	Mar 2020 – Mar 2022	Digital video aerial surveys (DAS)	Llŷr marine megafauna survey area
Project Erebus site-specific surveys (Darias-O'Hara *et al.*, 2021)	Oct 2019 – Sep 2021	Digital video aerial surveys (DAS)	Project Erebus and 4 km buffer
Welsh Marine Atlas (Baines and Evans, 2012)	1990 – 2009	Visual aerial, vessel and land-based visual surveys	Welsh waters
Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023)	1990 – 2020	Vessel, visual and digital aerial surveys	Welsh waters
Small Cetaceans in European Atlantic waters and the North Sea (SCANS-III) (Hammond *et al.*, 2021)	Jun - Aug 2016	Visual aerial and vessel surveys	European Atlantic waters
Small Cetaceans in European Atlantic waters and the North Sea (SCANS-IV) (Gilles *et al.,* 2023)	Jun – Oct 2022	Visual aerial and vessel surveys	European Atlantic waters
ObSERVE (Rogan *et al.*, 2018)	Summer / Winter 2015 and 2016	Visual aerial surveys	Offshore waters within and beyond Irish continental shelf
Sea Watch Foundation bottlenose dolphin surveys (Lohrengel *et al.*, 2018)	2014 – 2016	Vessel and photo-ID surveys	Cardigan Bay SAC and wider Cardigan Bay
Joint Cetacean Protocol (JCP) Phase III (Paxton *et al.*, 2016)	1994 – 2010	Visual and digital aerial, vessel and land-based surveys	Northern European shelf
Harbour porpoise densities (Heinänen and Skov, 2015)	1994 – 2011	Vessel and visual aerial surveys	UK waters
Marine Ecosystems Research Programme (MERP) maps (Waggitt *et al.*, 2019)	1980 – 2018	Visual and digital aerial and vessel visual surveys	European Atlantic waters

Data source	Date	Type of data	Coverage
Scientific advice on matters related to management of seal populations: 2022 (SCOS, 2022)	2022	Collation of data on counts and population estimates	UK coastline
Natural Resources Wales grey seal pup counts (Bull *et al*., 2017a; 2017b; Morgan *et al*., 2018)	1983 – 2015	Pup counts	Skomer Marine Conservation Zone (MCZ) and Pembrokeshire Marine SAC
Natural Resources Wales grey seal breeding census (Büche, 2021)	1983 -2021	Breeding census	Skomer MCZ
EIRPHOT database (Langlay *et al*., 2018; 2020)	1992 – 2016	Adult grey seal photo ID	Welsh and Irish coastlines
Seal at-sea distribution (Vincent *et al*., 2017)	1999 – 2014	Telemetry data	East Atlantic and North Sea
Foraging habitat selection of grey and harbour seals (Huon *et al*., 2021)	2008 – 2014	Telemetry data	East Atlantic
Grey seal at-sea density (Russel *et al.* 2017	1988 - 2016	Telemetry data	UK, Irish and French waters
Grey seal at-sea density (Carter *et al*., 2020; 2022)	1991 – 2019	Habitat-based predictions using telemetry and count data	UK and Irish waters
Wildfowl and Wetland Trust aerial surveys (WWT Consulting, 2009)	2001 – 2008	Visual aerial surveys	UK waters
Long-term insights into marine turtle sightings, strandings and captures around the UK and Ireland (TURTLE database) (Botterell *et al*., 2020)	1910 – 2021	Live and dead turtle sightings, strandings and captures	UK and Irish waters
British and Irish Marine Turtle Stranding and Sightings Annual Report 2022 (Penrose and Westfield, 2023)	2011 – 2022	Live and dead turtle sightings, strandings and captures	UK and Irish waters
Interregional co-operation programme INTERREG Irish Sea leatherback turtle Project (Houghton *et al*., 2006a; 2006b)	2003 – 2005	Visual aerial surveys	Irish Sea
Leatherback turtle satellite-tagged in European waters (Doyle *et al*., 2008)	2005 – 2006	Telemetry data	Atlantic Ocean

21.2.1. *Site-Specific Surveys*

Survey Design and Programme

10. In February 2020, Llŷr Floating Wind Limited commissioned HiDef to undertake a programme of high-resolution DAS focusing on marine mammals and other marine megafauna interests as well as seabird.

11. HiDef designed the survey methodology to provide information suitable for the proposed Project for which baseline characterisation and associated assessment of abundance and distribution of marine mammals and seabirds is required to inform the Environmental Impact Assessment (EIA) and HRA.

Survey Flights

12. A series of 23 strip transects placed at 2 km intervals were flown monthly between March 2020 and March 2022. Survey coverage for the Llŷr marine ornithology survey area (640.92 km^2) and Array Area (44.90 km^2) are presented in **Table 21A-3**. The survey design aimed to achieve 12.5% coverage of the overall surveyed area (**Figure 21A-3**). The recommended minimum coverage for DAS characterisation surveys of birds and marine mammals for the purposes of EIA / HRA is 10%. This minimum threshold is currently industry standard (e.g., during the Hornsea Three inspection, the Inspector favoured 10% coverage as being sufficient) and is the minimum target set out in Natural Resources Wales (NRW) survey guidance (2022) (as per Webb and Nehls, 2019). Aiming for a percentage coverage slightly higher than this minimum ensured that this target was achieved in all surveys (**Table 21A-3**), accounting for any minor variations in survey effort due to weather conditions, etc. Further justifications are provided in **Appendix 22A: Annex B - Technical Notes on Survey Design and Data Analysis.**

13. Four surveys were flown outside of their intended month, due to no available weather windows. Rescheduled surveys were conducted in as close a time frame as possible, except for March 2021 when this could not be achieved. Therefore, two surveys were flown in June 2020 (survey one (S01) on 08 June 2020, and survey two (S02) on 24 June 2020); in January 2021 (S01 on 10 January 2021 and S02 on 25 January 2021); in May 2021 (S01 on 14 May 2021 and S02 on 27 May 2021) and an additional survey was flown in March 2022 (**Table 21A-3** and **Table 21A-4**). For data analysis purposes, each rescheduled survey was used to represent a missed month as described in **Table 21A-4** and agreed with NRW (A) at the meeting held on 08 February 2023 (discussing the survey summary paper issued 20 January 2023; **Chapter 21, Tables 21-4** and **Table 21-5**).

14. In June S01 2020, two transects were cut shorter in the west of the Llŷr marine megafauna survey area due to a camera fault, resulting in slightly reduced coverage. In January 2022, two transects were missed in the east of the Array Area due to a camera fault, resulting in slightly reduced coverage (**Table 21A-3**, **Table 21A-4** and **Figure 21A-4**).

Table 21A-3. Survey effort across the 24 surveys over Llŷr marine megafauna survey area between March 2020 and March 2022

Survey	Date	Number of transects analysed	Total length of analysed transects (km)	Area covered (km^2)	Area covered (%)
1	25 March 2020	23	322.87	80.72	12.60
2	14 April 2020	23	321.84	80.46	12.56
3	08 June 2020*	23	310.78	77.70	12.13
4	24 June 2020	23	321.45	80.36	12.54
5	21 July 2020	23	322.20	80.55	12.57
6	31 August 2020	23	321.22	80.30	12.53
7	12 September 2020	23	319.99	80.00	12.49
8	22 October 2020	23	321.69	80.42	12.55
9	26 November 2020	23	320.60	80.15	12.51
10	10 January 2021	23	322.02	80.50	12.57
11	25 January 2021	23	321.09	80.27	12.53
12	22 February 2021	23	319.11	79.78	12.45
13	14 May 2021	23	320.22	80.06	12.50
14	27 May 2021	23	321.45	80.36	12.54
15	15 June 2021	23	322.12	80.53	12.57
16	14 July 2021	23	322.55	80.64	12.59
17	16 August 2021	23	322.55	80.64	12.59
18	01 September 2021	23	319.09	79.77	12.45
19	22 October 2021	23	321.40	80.35	12.54
20	20 November 2021	23	318.79	79.70	12.44
21	16 December 2021	23	319.80	79.95	12.48
22	05 January 2022*	21	290.55	72.64	11.34
23	26 February 2022	23	317.53	79.39	12.39
24	20 March 2022	23	321.74	80.43	12.55

**Reduced coverage due to technical issues*

Table 21A-4. Treatment of rescheduled surveys

Survey name	Used to represent
June S01 2020	May 2020
June S02 2020	June 2020
January S01 2021	December 2020
January S02 2021	January 2021
May S01 2021	April 2021
May S02 2021	May 2021
March 2022	March 2021

17. Transects extended roughly north to south, perpendicular to the depth contours along the coast. Such a design ensured that each transect sampled a similar range of habitats (primarily relating to water depth) and would reduce the variation in bird and mammal abundance estimates between transects.

18. Surveys were flown using an aircraft equipped with four HiDef Gen II digital video cameras with sensors set to a resolution of 2 cm ground sample distance. Each camera sampled a strip of 125 m width, separated from the next camera by ~25 m, thus providing a combined sampled width of 500 m within a 575 m overall strip. Data captured from two cameras out of the four cameras were reviewed and used in data analysis.

19. The surveys were flown along the transect pattern shown in **Figure 21A-3** at a height of approximately 550 m (1,800’) above sea level (ASL). Hammond *et al*. (2013) highlight that an aerial survey flown at an altitude of 183 m is not likely to result in a responsive reaction from any marine mammal.

20. Position data for the aircraft were captured from a Garmin GPSMap 296 receiver with differential GPS facilitated 1 m accuracy for the positions and recording updates in location at one second intervals for later matching to animal observations.

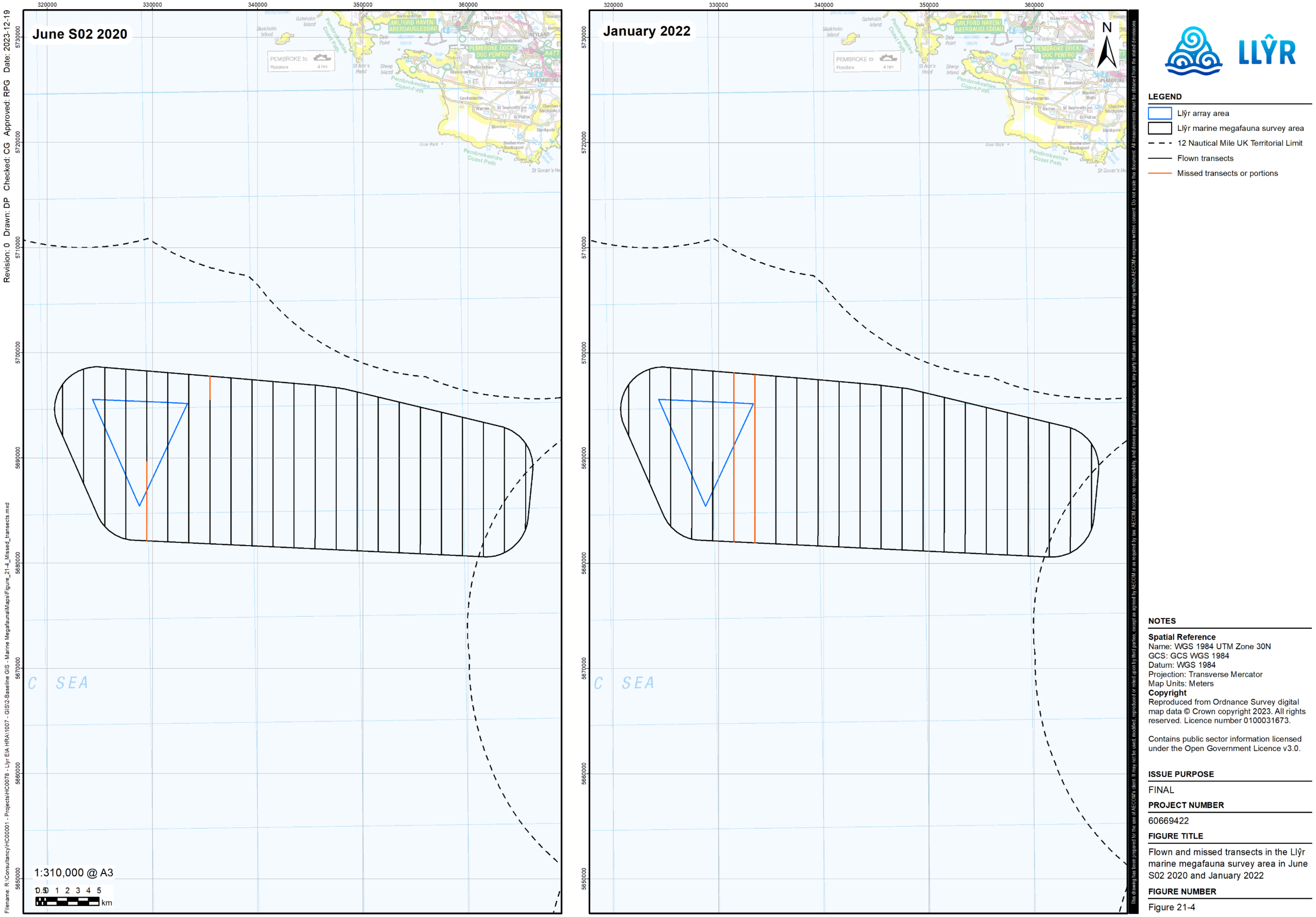

Figure 21A-4. Flown and missed transects over the Llŷr marine megafauna survey area in June S02 2020 and January 2022

Data Review and Object Identification

21. Data were viewed by trained reviewers who marked any objects in the footage as requiring further analysis, as well as determining which were birds, marine megafauna or anthropogenic objects such as ships or buoys.

22. As part of HiDef's quality assurance (QA) process, an additional 'blind' review of 20% of the raw data was performed 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 data re-reviewed. If required, additional training was given to improve performance.

23. Objects were only recorded where they reached a reference line (known as 'the red line') which defined the true transect width of 125 m for each camera. By excluding objects that did not cross the red line, biases to abundance estimates caused by flux (movement of objects in the video footage relative to the aircraft, such as where the survey craft is buffeted by airflow) were eliminated.

Object Identification

24. Images marked as requiring further analysis were reviewed by the ID Team; ornithologists[1] and marine mammal specialists[2] for identification to the lowest taxonomic level possible and for assessment of the approximate age and the sex of each animal, as well as any behaviour traits visible from the imagery.

25. At least 20% of all objects were selected at random and subjected to a separate 'blind' QA process. If less than 90% agreement was attained for any individual camera, then corrective action was initiated: if appropriate, the failed identifier's data were discarded, and the data re-identified. Any disputed identifications were passed to a third-party expert ornithologist / marine mammal specialist for a final decision. The level of agreement within the QA process is calculated as the final number of agreements as a percentage of all identifications subjected for QA for the entire survey.

26. 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'[3].

27. It is important to note that confidence ratings are not standardised. The likelihood of achieving a definite or probable identification is not consistent for all component members of a species group. Confidence scores should not be used to filter or weight the probability of a species group being one species or another in any analysis, as this will lead to biased results, particularly if the identification rate is low.

28. Any animals that could not be identified to species level were assigned to a category 'No ID' and only identified to group level. If, on occasion, the unidentified bird is suspected of belonging to two possible genera, then a broader group category may be used. For example, a marine mammal would usually be assigned to the group category 'Dolphin species' if

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1 HiDef currently employs three current and former members of the British Birds Rarities Committee (BBRC) as expert ornithologists.

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

3 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.

identified as a common dolphin, or to 'Small cetacean species' if identified as a harbour porpoise. However, if the marine mammal has the potential to be either, then it would be assigned to a wider group category 'Cetacean species' and the species level recorded as 'No ID'.

29. In the case of marine mammals, additional information was recorded on basic behaviour (i.e., whether the marine mammal was surfacing or submerged). Detail was recorded where possible on approximate age (adult / calf) and any other details of interest.

Data Analysis

Apportioning of Unidentified Animals

30. Apportioning of 'unidentified' marine mammals and megafauna to species level was undertaken on all data for the purposes of calculating density and population estimates. The number of unidentified animals in each species group were assigned to species where appropriate, based on their respective abundance ratio. For example, if identified common dolphins and harbour porpoise occurred in a 4:1 ratio, then 80% of unidentified cetaceans would be assigned to common dolphins and 20% assigned to harbour porpoise. Apportioning of unidentified animals was undertaken prior design-based and model-based estimates calculation. All estimates presented in this **Appendix 21A** are those which account for (include) the unidentified animals.

Design-Based Estimates

31. Site-specific abundance and density estimates were derived through design-based and model-based approaches.

32. For design-based analyses, survey data were trimmed to the Llŷr marine megafauna survey area. Each transect was treated as an independent analysis unit, and the assumption was made that transects can be treated as statistically independent random samples (Buckland *et al.,* 2021). The length of each transect and its breadth (i.e., the width of the field of view of the camera) multiplied together gave the transect area and dividing the number of observations on that transect by the transect area gave a point estimate of the density of that species for the transect. The density of animals at the survey area (and hence the population size), the Standard Deviation (SD), the 95% Confidence Intervals (CIs) and Coefficient of Variation (CV) were then estimated using a non-parametric bootstrap method with replacement (Buckland *et al*., 2001).

33. The upper and lower 95% Confidence Limits (CLs) were performed by way of a blocked bootstrapping technique, where the data are split into blocks of time and random samples are taken from each block, to ensure equal transect effort was sampled across each iteration. This was achieved 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 1,000 bootstrap iterations were performed from which the mean and SD of the sampled means were calculated, as well as the relative standard error as defined by the SD divided by the mean (or the CV). Data were processed in the R programming language (version 4.2.1) (R Core team, 2022).

34. The density estimate is expressed as the average number of animals per square km surveyed over the Llŷr marine megafauna survey area, and the population estimate was then calculated as the average density multiplied by the area of interest. The SD is a measure of the variance of the population estimate, standardised by the number of samples (transects). The upper and lower CLs define the range that the population estimate falls within with 95% certainty. The CV is a measure of the precision of the population and density estimates.

1. Monthly density and abundance estimates for each species are presented for Llŷr marine megafauna survey area. In addition, means are calculated for each year and for the entire two-year survey programme. Although installation noise potentially arising from a floating wind farm is less than for a scheme with piled fixed foundations, consideration was given to calculating a density for each species for those months in which installation of cable anchors, and thus pin-piling, is most likely. As such, estimates were also calculated for two seasons: May – October (summer) and November - April (winter). These seasonal definitions follow NRW and JNCC advice (17 February and 04 August 2023; **Chapter 21, Table 21-5**) and are based on the predictive outputs from the GLM-GEE models used to develop the recent update to the Welsh Marine Atlas (Evans and Waggitt, 2023) which links 30 years of sightings and effort data with several other parameters to derive relevant densities.
2. Design-based estimates were then corrected for availability bias for harbour porpoise and common dolphin (see below).
3. In this **Appendix 21A**, design-based estimates are only presented for grey seal, bottlenose dolphin and minke whale, the three species for which model-based estimates were not calculated. Design-based estimates for harbour porpoise and common dolphin are presented in **Appendix 21A: Annex B** for context only.

Model-Based Estimates

4. Model-based estimates were undertaken for key species where possible, to overcome the problems of missing transects and smaller sample sizes within the Array Area. Model-based abundance estimations were performed using spatial analysis in the ‘inlabru’ statistical package in R (Bachl *et al.,* 2019; R Core Team, 2022).
5. The inlabru package makes Bayesian inference easier to carry out on a range of spatial data sets, including locations of individuals or groups, counts in plots, points, and distance sampling data – where the information used for inference are the recorded distances to objects of interest (usually animals) obtained by surveying lines or points (Buckland *et al*.,2001; Bachl *et al.,* 2019). Inlabru can be used to obtain abundance estimates and the mean, median, SD, and quantiles of these estimates. It uses a prediction method based on fast Monte Carlo sampling, a class of techniques for repeated random sampling to obtain numerical results. This method allows posterior prediction of general expressions of the latent variables (i.e., variables that cannot be measured directly). This produces a posterior distribution, which is defined as the revised or updated probability of an event occurring after considering new information (Bachl *et al.,* 2018; Hayes, 2021). This is compared to MRSea’s model outputs, which are used in the bootstrapping (random sampling) function from which the mean, median, SD, and quantiles are calculated.
6. Inlabru was chosen for model fitting, and employing this approach proved to be computationally efficient, demonstrating approximately three times faster processing speed compared to MRSea (Keogan *et al.,* 2022). Moreover, based on practical experience, it is more adept at handling smaller sample sizes compared to its counterpart. This was agreed with NRW (A) and JNCC at a stakeholder meeting (07 March 2023), on the basis that justification of the inlabru method was provided, with the relevant note issued on 16 March 2023 (**Appendix 22A: Annex B** for detail; **Chapter 21, Table 21-5**).
7. Model-based analyses were performed on common dolphin and harbour porpoise data only, as these were the only species with sufficient observations in the DAS. Models were fitted using Gaussian random fields and the stochastic partial differential equation approach to implement log Gaussian Cox processes. This specific approach to analysis in inlabru is especially useful when there is observed or unobserved environmental variation, as it is

described through a random structure based on an underlying random field (i.e., a collection of random variables, such as a two-dimensional space of coordinates). Models were fitted to data across the Llŷr marine megafauna survey area, with predictions made for this full area. Annual and two-year mean densities were calculated, alongside mean seasonal estimates for summer and winter.

8. Environmental covariates including bathymetry, slope, sea surface temperature, and seabed sediment were tested in the models to identify whether they influenced the density and abundance estimates and were removed from the models if there was no significant effect, i.e., no significant difference between results from the models with and without the covariates. For this proposed Project, none of the tested environmental covariates were found to have a significant effect on the estimates, they were therefore, all removed from the final models.

9. Mean density surface maps were created and are presented for harbour porpoise and common dolphin (**Section 21.3.2** and **21.3.3**). Alongside those, maps displaying mean upper and lower credible limits and the CV for the two species are presented in **Appendix 21A: Annex A.**

Availability Bias

10. Both design-based and model-based estimates for common dolphin and harbour porpoise were corrected for animals diving at the time of the survey using previously published species-specific dive duration data to give estimates of absolute abundance (Teilmann *et al.,* 2013; Paxton *et al.,* 2016). Due to the lack of available dive duration data, corrections were not applied to other species presented in this report.

11. The proportion of harbour porpoise surfacing (defined as where the dorsal fin is clear of the water surface in the middle frame of the sequence in which the animal is present) was calculated for the full survey period, to mimic the surfacing behaviour category in Teilmann *et al.* (2013) which corresponds to periods when the transmitter on the dorsal fin of tagged animals is completely clear of the water. The proportion of surfacing animals was calculated for all surveys combined due to relatively small sample sizes during individual surveys. The calculated relative density of harbour porpoise was multiplied by the proportion of surfacing encounters to estimate the density of surfacing harbour porpoise. This was divided by the appropriate correction factor from Teilmann *et al.* (2013) to produce estimates of absolute density and abundance (**Table 21A-5**).

Table 21A-5. Correction factors used to account for availability bias for harbour porpoise at different times of the year and at different times of the day (Teilmann et al., 2013)

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

Month	Surface behaviour	
	09:00 – 15:00	15:00 – 21:00
October	0.0413	0.0399
November	0.0406	0.0392
December	0.0429	0.0415

12. In the absence of telemetry data for common dolphin, the probability of an animal being available at the surface was derived using the equation provided by Laake *et al.* (1997), after Paxton *et al.* (2016):

$$P(Avail) = \frac{E[s]}{E[s] + E[d]} + E_d \times \frac{(1 - e^{-t/E[d]})}{E[s] + E[d]}$$

13. Where estimated (E) parameters are s = surface time, d = dive time and t = window of time during which an animal is within the visual range of the observer, estimated as the amount of time it takes for the HiDef camera to pass over each frame of footage.

14. This approach was applied using estimated common dolphin mean surface and dive times as provided by Evans, P. in Paxton *et al.* (2016). Relative density and abundance were divided by P(Avail) to give absolute density and abundance.

15. Ideally, absolute density and abundance estimates derived through site-specific surveys would be taken forward for use in quantitative impact assessment for every considered marine mammal and megafauna species as these data span all seasons over multiple years. However, there are limitations when considering sample size of some species, the lack of available dive duration data for many species (therefore, the inability to calculate absolute abundance estimates) and the lack of survey coverage over potential impact ranges.

Raw Counts

16. Over the two-year survey period, four marine mammal species as well as two shark species, lion's mane jellyfish and ocean sunfish were recorded in the Llŷr marine megafauna survey area. The total number of marine mammals and megafauna recorded during the two-years of DAS are presented in **Table 21A-6** and individually in each species sub-section (**21.3.1** to **21.3.6**).

Table 21A-6. Sightings of marine mammal and megafauna in the Llŷr marine megafauna survey area over the two-year survey period (March 2020 to March 2022)

Species	Latin name	Llŷr marine megafauna survey aera
Minke whale	*Balaenoptera acutorostrata*	4
Common dolphin	*Delphinus delphis*	2,230
Harbour porpoise	*Phocoena phocoena*	58
Grey seal	*Halichoerus grypus*	11
Basking shark	*Cetorhinus maximus*	6
Blue shark	*Prionace glauca*	3
Lion's mane jellyfish	*Cyanea capillata*	1
Ocean sunfish	*Mola mola*	4
Total		**2,317**

21.2.2. *Project Erebus Surveys*

17. In October 2019, Blue Gem Wind commissioned HiDef to undertake a programme of high-resolution digital video aerial surveys for marine mammals and megafauna, ornithological and human activity over the proposed Erebus Project. A total of 24 monthly surveys were flown between October 2019 and September 2021 (**Table 21A-7**). HiDef designed a survey that placed 1 km-spaced transects across the Erebus Survey Area. The total survey area equated to 200.11 km^2 (**Figure 21A-5**) (Darias-O'Hara *et al.*, 2021). The southeast part of the Erebus survey area overlaps with the northwest part of the Llŷr marine megafauna survey area (**Figure 21A-5**).

18. The same survey methodology was used for both the proposed Project and the Erebus Project (Darias-O'Hara *et al.*, 2021). Additionally, a similar analysis process was applied, with site-specific abundance and density estimates derived through design-based approaches using a non-parametric block bootstrap method with replacement (Buckland *et al.,* 2001), with a total of 5,000 bootstrap iterations performed. Abundance and density estimates for harbour porpoise and common dolphins were corrected by HiDef and SMRU Consulting for availability bias, using previously published species-specific dive duration data from Teilmann *et al.* (2013) and Bilgmann *et al*. (2018), respectively. Further detail on the methodology can be found in Darias-O'Hara *et al.* (2021).

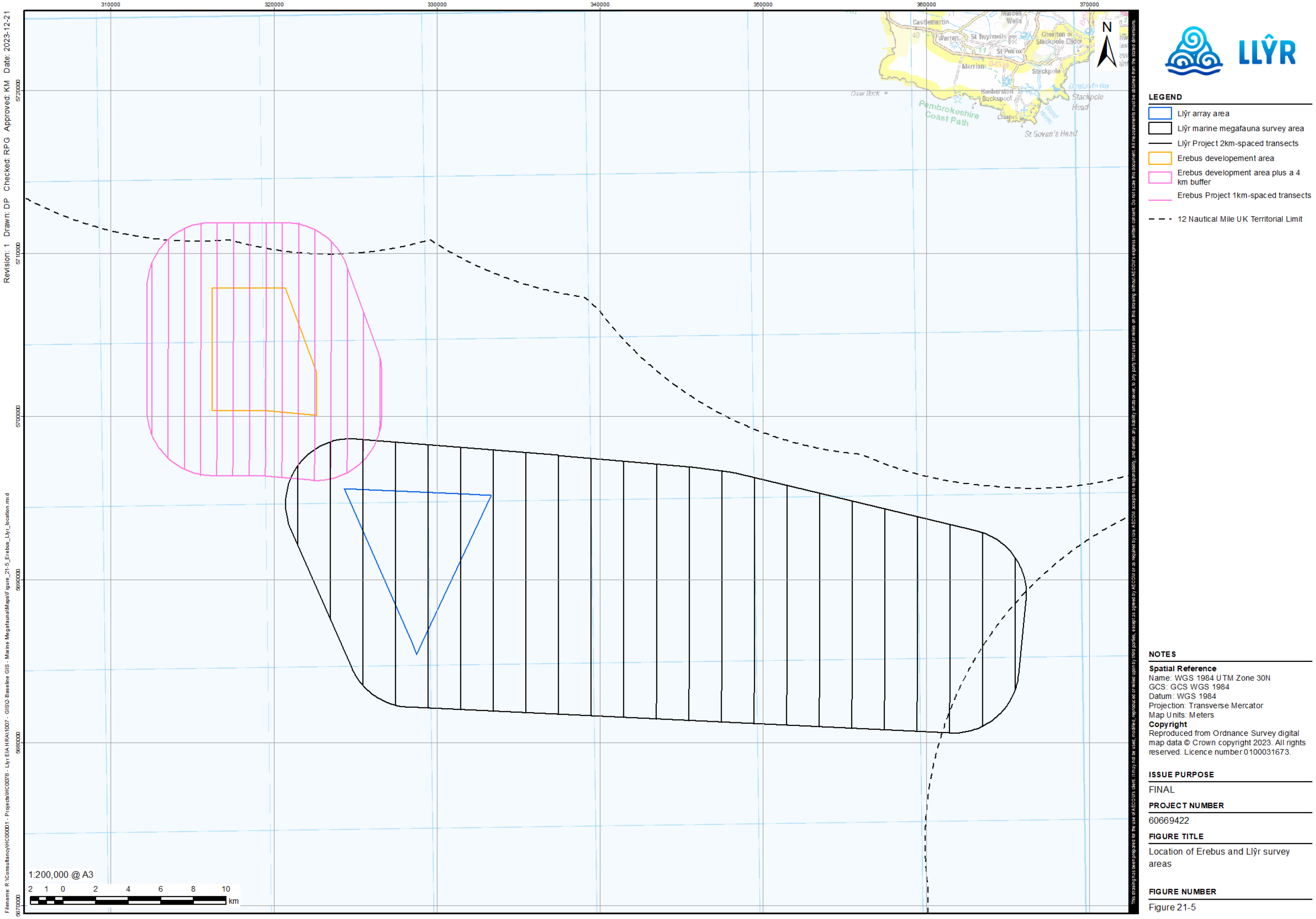


Figure 21A-5. Location of the Erebus survey area and Llŷr marine megafauna survey area

Table 21A-7. Survey effort across the 24 surveys of the Erebus Survey area from October 2019 to September 2021 (HiDef Aerial Surveying Ltd., 2021)

Survey	Date	Number of transects analysed	Total length of analysed transects (km)	Area covered (km^2)	Area covered (%)
1	22 October 2019	15	203.37	50.84	25.41
2	08 November 2019	15	203.46	50.87	25.42
3	04 December 2019	15	203.27	50.82	25.40
4	18 January 2020	15	202.87	50.72	25.35
5	04 February 2020	15	197.05	49.26	24.62
6	03 March 2020	15	203.27	50.82	25.40
7	04 April 2020	15	203.23	50.81	25.39
8	08 June 2020	15	203.29	50.82	25.40
9	24 June 2020	15	203.62	50.90	25.44
10	23 July 2020	15	203.02	50.76	25.37
11	31 August 2020	15	203.82	50.96	25.47
12	12 September 2020	15	203.33	50.83	25.40
13	15 October 2020	15	203.55	50.89	25.43
14	22 November 2020	15	204.17	51.04	25.51
15	31 December 2020	15	203.23	50.81	25.39
16	16 January 2021	15	203.83	50.96	25.46
17	22 February 2021	15	203.59	50.90	25.43
18	05 March 2021	15	203.39	50.85	25.41
19	10 April 2021	15	203.58	50.89	25.43
20	14 May 2021	15	203.87	50.97	25.47
21	15 June 2021	15	203.49	50.87	25.42
22	14 July 2021	15	203.48	50.87	25.42
23	16 August 2021	15	203.60	50.90	25.44
24	01 September 2021	15	203.69	50.92	25.45

21.2.3. Welsh Marine Atlas and Cetaceans and Seabirds of Wales

19. The Welsh Marine Atlas is a database containing marine mammal data collected from 16 survey projects along the Welsh coast and covering the Irish Sea, St. George's Channel, and the majority of the Bristol Channel between 1990 and 2009 (**Figure 21A-6**) (Baines and Evans, 2012). The database includes 13,399 hours of land-based effort and 216,031 km of effort from both vessel and aircraft surveys between 1990 and 2009. A total of 32,986 sightings of cetaceans were reported, amounting to 99,085 individuals across 12 species. Additional data for grey seals were gathered from the Countryside Council of Wales, amounting to 2,586 at-

sea sightings (comprising 3,424 individuals). Effort and associated sightings were mapped on a 10 x 10 km grid separated per survey method (vessel, aerial and land-base) for regular species. Visibility bias was corrected on a species-by-species basis. If little or no data were available for a species within the Study Area, two methods of interpolation were used for predictive modelling, including, an inverse distance weighted interpolation (deterministic method) and kriging, a geostatistical method (Baines and Evans, 2012).

20. The data gathered by Baines and Evans (2012) do not provide information on densities or uncertainties within the Llŷr marine megafauna survey area but instead support a general overview of species distribution in the Irish and Celtic Seas.

21. The Welsh Marine Atlas was updated by Evans and Waggitt (2023; 'Cetaceans and Seabirds of Wales') to include a total of 20 datasets from 1990 to 2020, gathered from vessel, visual aerial and digital aerial surveys, which covered a total of 447,526 km of survey effort for cetacean species. This version of the atlas covers a slightly larger area than the previous version (Baines and Evans, 2012), with some extension to the north of the Irish Sea and south and west of the Celtic Sea and English channel (**Figure 21A-7**). A total of 54,661 cumulative individuals across 12 species were reported. Building on methodology used by Paxton *et al.* (2016) and accounting for environmental variables in the modelling, sighting rate and modelled surface density maps were provided at a 2.5 km resolution for harbour porpoise, bottlenose dolphins, common dolphins and minke whales.

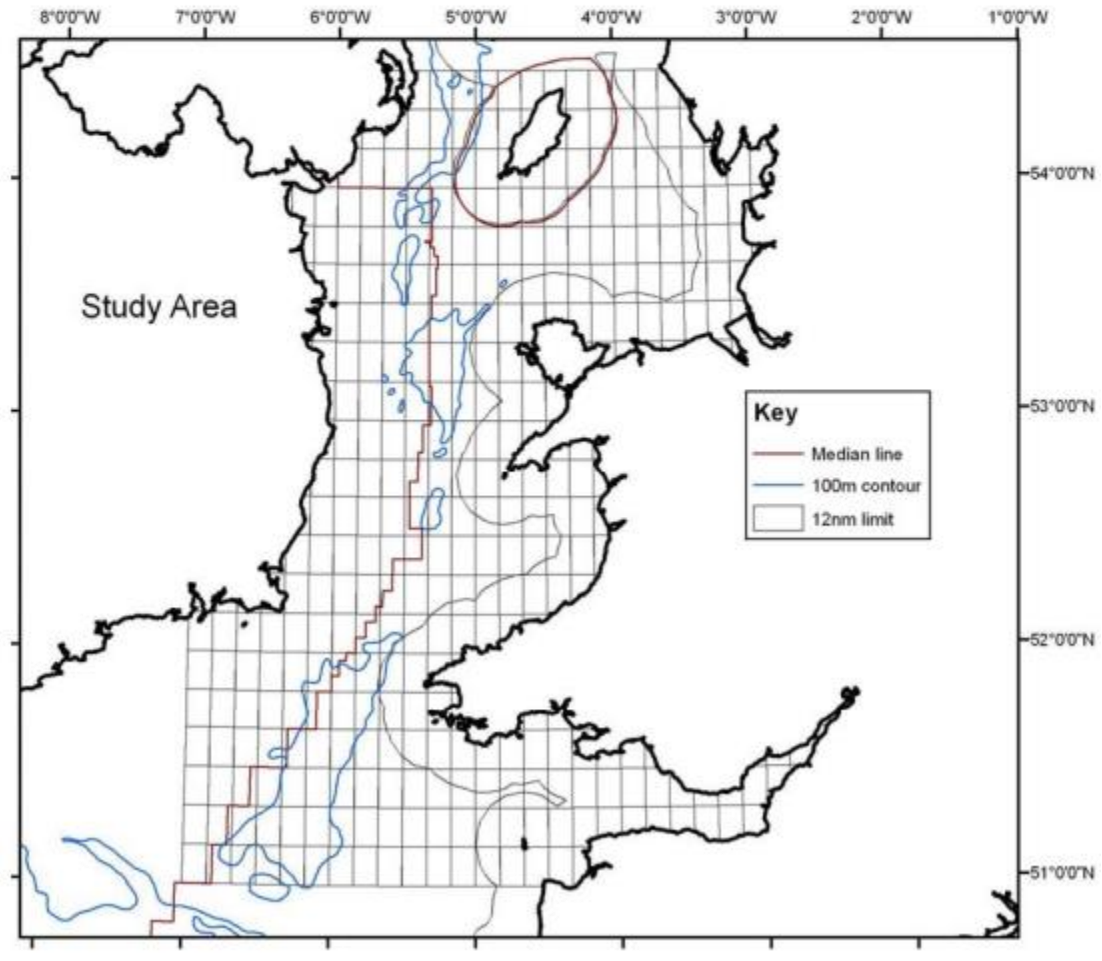


Figure 21A-6. Area covered by the Welsh Marine Atlas database (Baines and Evans, 2012)

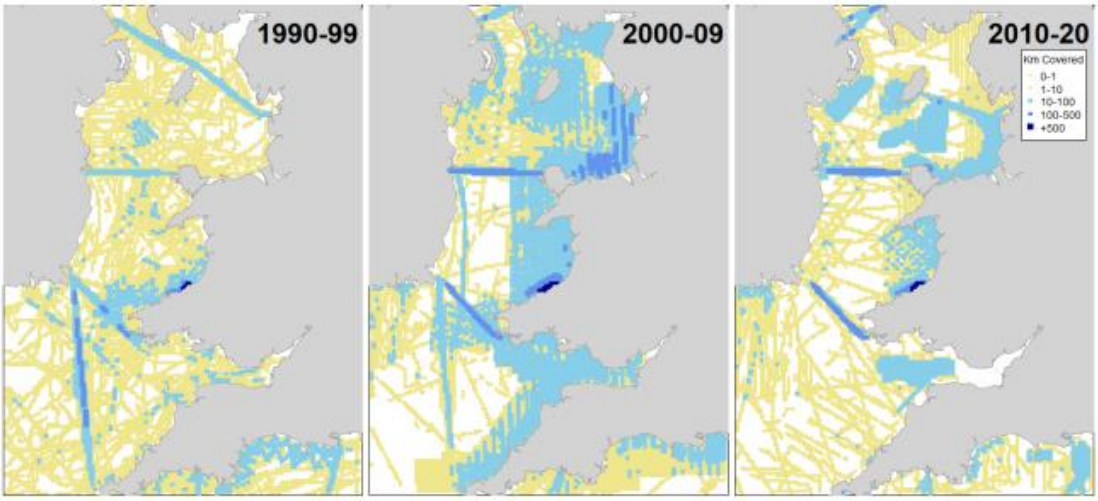


Figure 21A-7. Survey effort (km²) for cetaceans from 20 datasets (vessel, visual aerial and digital aerial data) between 1990 and 2020 (Evans and Waggitt, 2023)

21.2.4. Small Cetaceans in European Atlantic Waters and the North Sea Surveys (SCANS)

22. Small Cetaceans in the European Atlantic waters and North Sea (SCANS) surveys have been conducted since 1994, at approximately decadal intervals, until recently (SCANS in 1995 [Hammond *et al.,* 2002]; SCANS-II in 2005 [Hammond *et al.,* 2013]; SCANS-III in 2016 [Hammond *et al.,* 2021]; and SCANS-IV in 2022 [Gilles *et al.,* 2023]). SCANS large-scale visual aerial and boat-based surveys were implemented to produce absolute abundance estimates of cetaceans in European Atlantic waters. SCANS-III surveys were flown between June and August 2016, while SCANS-IV surveys were conducted between July and October 2022; and represent the most up to date regional density estimates.

23. 'Circle-back' visual aerial surveys were flown at approximately 180 m ASL with two observers recording cetaceans and one observer recording sighting conditions using information on sea conditions, water turbidity and glare. Double platform boat-based surveys were conducted using the trial-observer configuration (Hammond *et al*., 2021; Gilles *et al.,* 2023). The survey methodologies enabled corrections for visibility bias to be incorporated into the absolute abundance estimates. The proposed Project is located in the SCANS-III survey Block D and SCANS-IV survey Block CS-C, covering an area of 48,590 km^2 and 36,031 km^2 in which 1,744 km and 2,471 km of survey effort were conducted, respectively (**Figure 21A-8**).

24. Seasonal abundance cannot be drawn from the surveys and results should only be considered relevant to mid-summer months (generally June – August), which may not be representative of the rest of the year.

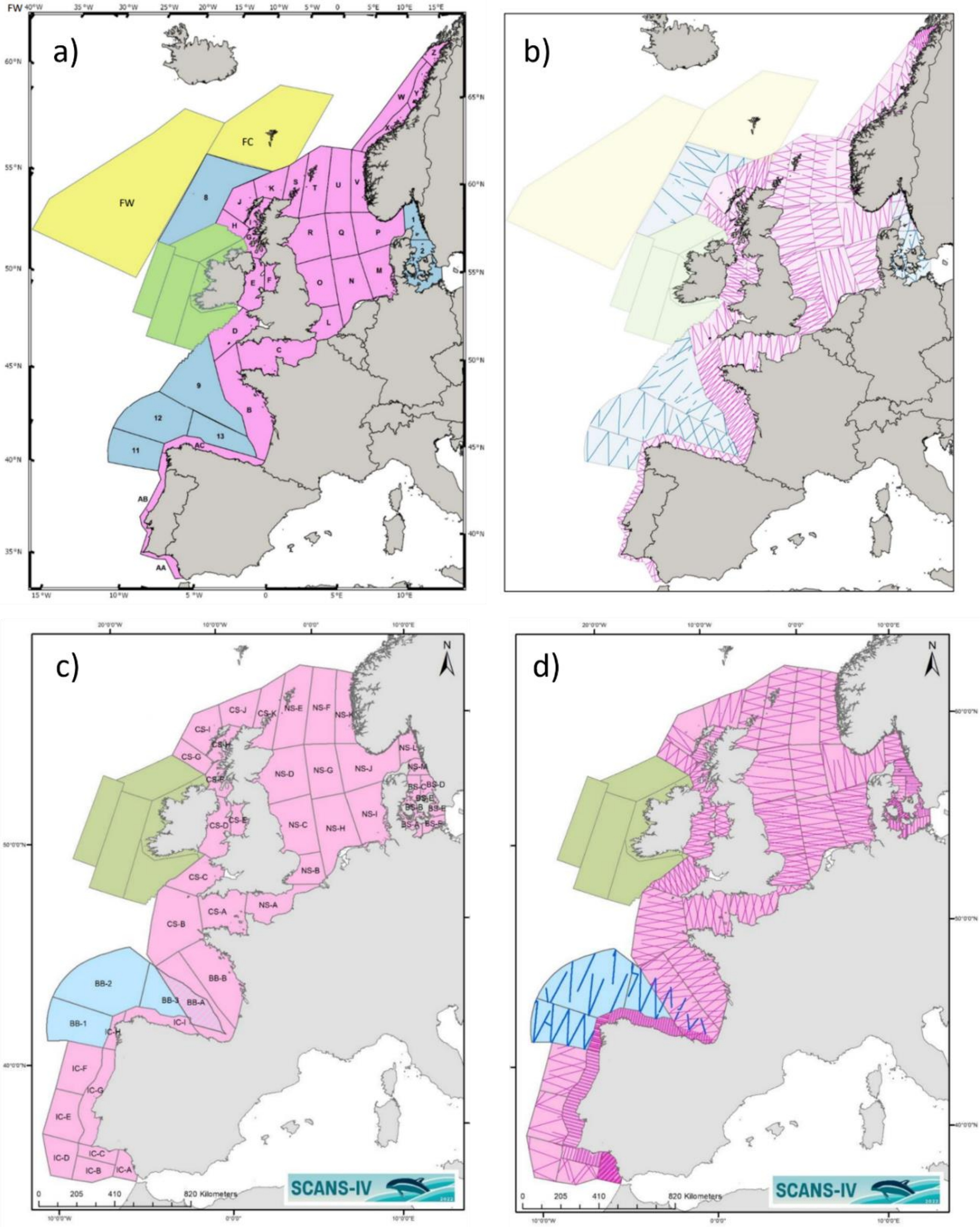


Figure 21A-8. Area covered by the SCANS-III (a) and SCANS-IV (c) and corresponding search effort completed in all weather conditions (b; d), (pink zones were surveyed by planes, blue zones were surveyed by vessels, green zones were surveyed by the ObSERVE project (Rogan et al., 2018), yellow zones were surveyed by the Faroe Islands) (Hammond et al., 2021; Gilles et al., 2023). The proposed Project is located in Block D (SCANS-III) and Block CS-C (SCANS-IV)

21.2.5. ObSERVE Surveys

25. The ObSERVE programme consists of large-scale aerial surveys conducted within Irish shelf and offshore waters during the summer and winter 2015 and 2016 to collect data on the distributions and abundances of key marine birds and megafauna (**Figure 21A-9**) (Rogan *et al.,* 2018). More recent ObSERVE surveys have been conducted, but outputs will not be available for use during this impact assessment.

26. The ObSERVE Study Area was divided into five strata in 2015 and eight strata in 2016. The survey design consisted of two sets of zig-zag transects flown per stratum designed to provide equal coverage probability. Using a line-transect methodology, the two observers searched on each side of the plane out to a distance of 500 m. In 2015, a total distance of 16,802 km was flown within a 297,480 km^2 area, while a total distance of 20,295 km was surveyed in 2016 over a survey area of 339,377 km^2 (Rogan *et al.,* 2018).

27. When surveying the Study Area, environmental conditions were also recorded by the observers, such as sea state and glare. Throughout the two years of survey, a total of 1,844 cetacean sightings were recorded, amounting to 8,633 individuals across 19 species. Other species, including leatherback turtles (three individuals), ocean sunfish (347 individuals), jellyfish (five individuals) and shark species (13 basking sharks and 58 blue sharks) were recorded. When more than 60 sightings for a cetacean species / species group were recorded, design-based and model-based methods were used to estimate absolute abundance (Rogan *et al.,* 2018).

28. For harbour porpoise, dolphins and minke whales, the circle-back methodology used in the SCANS-III surveys was used (Rogan *et al*., 2018; Hammond *et al*., 2021).

29. Although none of the strata covered by the ObSERVE surveys overlap with the proposed Project, estimates from Stratum 4 and Stratum 5 are discussed in this report due to their proximity to the proposed Project (**Figure 21A-9**). Marine mammals and megafauna species are highly mobile, therefore, there is potential for connectivity between animals observed in Irish waters and those that may be observed in the vicinity of the proposed Project.

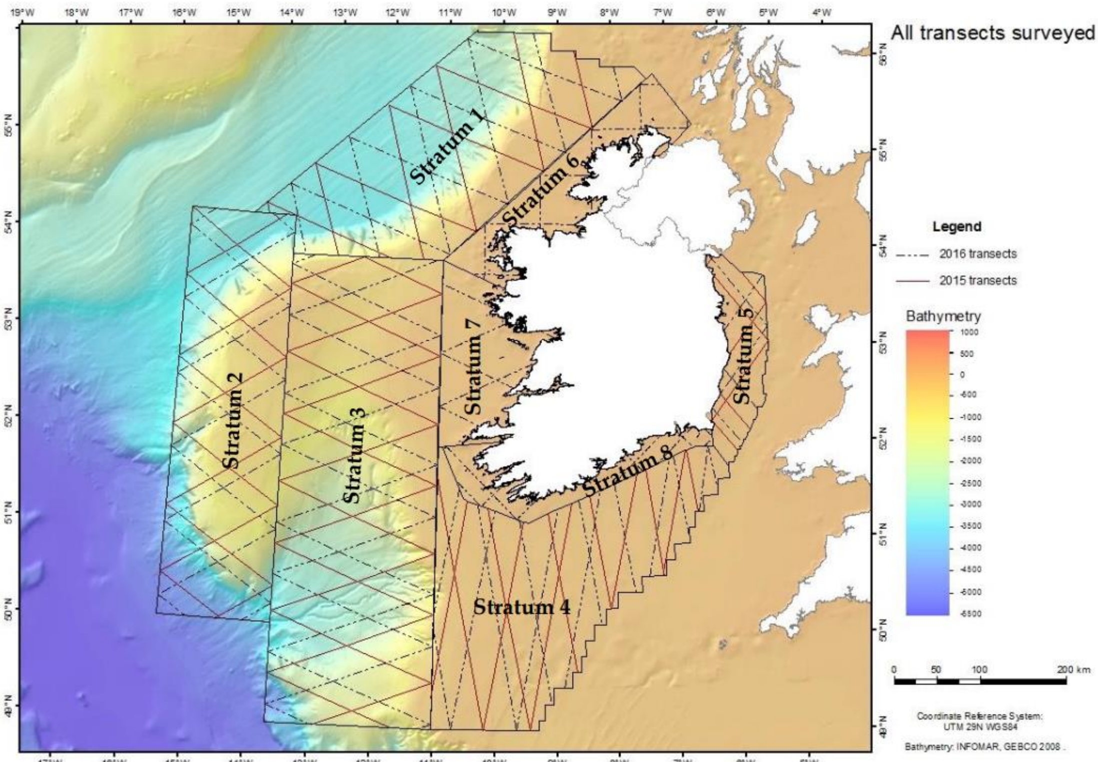


Figure 21A-9. Area covered by the ObSERVE surveys in 2015 and 2016 (Rogan et al., 2018)

21.2.6. Sea Watch Foundation Bottlenose Dolphin Surveys

30. The semi-resident population of bottlenose dolphin present in Cardigan Bay represents one of the two largest groups in UK waters and is a qualifying feature of the Cardigan Bay / Bae Ceredigion SAC and the Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau SAC, located approximately 100 km and 150 km north of the proposed Project, respectively.

31. Between 2014 and 2016, Sea Watch Foundation (SWF) conducted boat-based surveys to monitor the bottlenose dolphin population of Cardigan Bay (Lohrengel *et al.*, 2018). Using line transect and dedicated non-line transects, the Cardigan Bay SAC and wider Cardigan Bay area were surveyed, with population estimates available only for 2015 and 2016 due to incomplete coverage in 2014 (**Figure 21A-10**). These surveys build on earlier surveys carried out by SWF since 2001 in the Cardigan Bay SAC and since 2005 in northern Cardigan Bay. Abundance estimates were obtained through distance sampling, based on the boat-based line transects surveys and photo identification from Capture-Mark-Recapture (CMR) analyses.

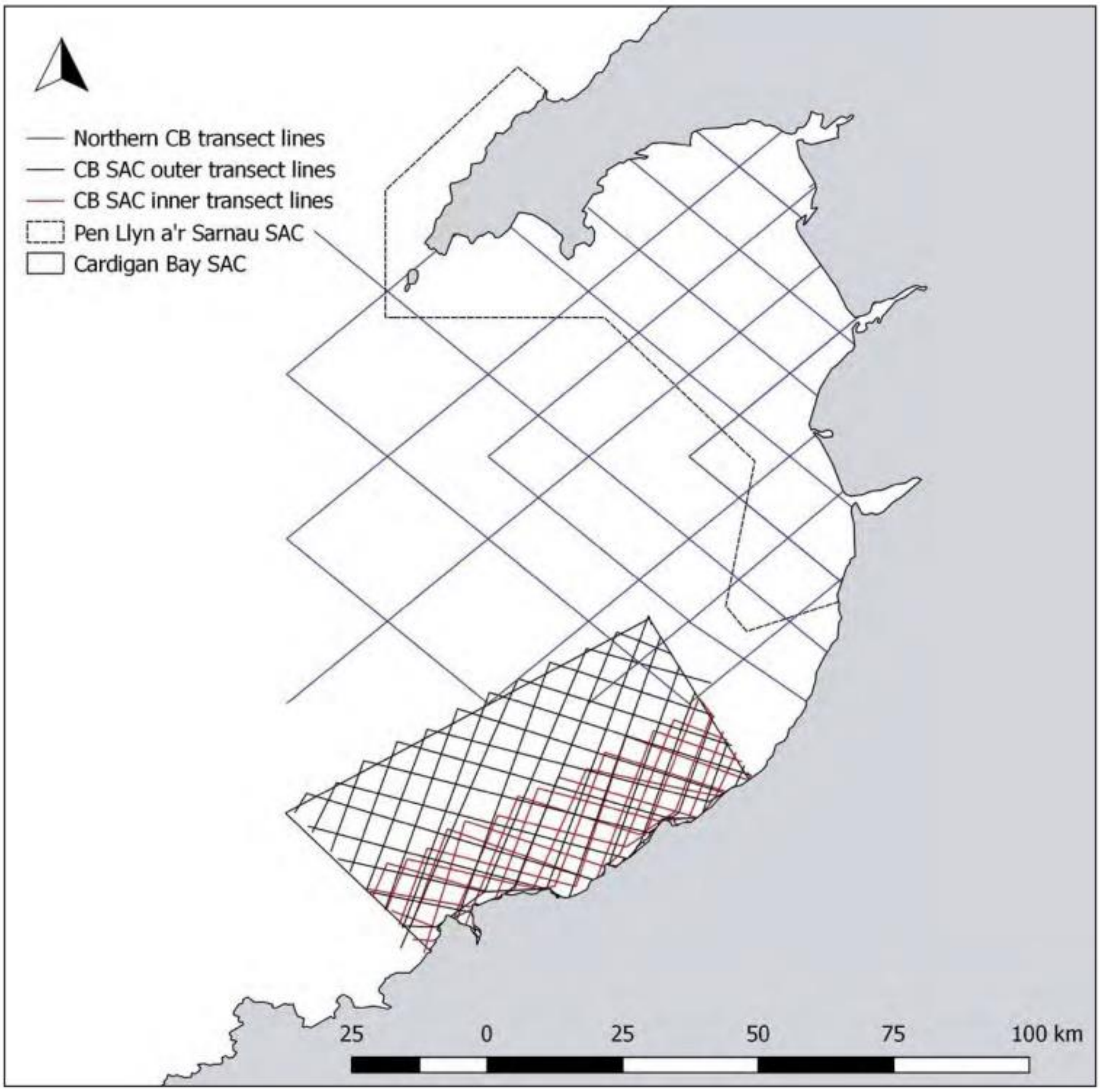


Figure 21A-10. Survey area covered by the Sea Watch Foundation bottlenose dolphin surveys in 2015 and 2016 (Lohrengel et al., 2018)

21.2.7. *Joint Cetacean Protocol (JCP)*

32. The Joint Cetacean Protocol (JCP) was initiated by the JNCC to collate survey data and generate estimates of abundance, distribution and population trends for cetaceans in the North Sea and adjacent waters. Multiple phases of analysis were performed on the data (Phase I, Paxton and Thomas, 2010; Phase II, Paxton *et al.,* 2011; Phase III, Paxton *et al.,* 2016). Data presented in the JCP Phase III analysis report were collected by 38 sources over 17 years (1994-2010) and 1.09 million km^2 of survey effort (Paxton *et al.,* 2016).

33. The aim of the report was to provide spatial and temporal patterns of abundance of key cetacean species, including harbour porpoise, minke whales, bottlenose dolphins, and

common dolphins. Abundance estimates for specific areas of interest for offshore development are presented in the report, including the Atlantic Array Area (Bristol Channel and adjacent Irish Sea) equating to an area of 19,649 km^2 and overlapping with the proposed Project (**Figure 21A-11**). When possible, availability bias was taken into account to produce absolute estimates. The abundance estimated provided in Paxton *et al.* (2016) (12 to 28 years) are old compared to those generated from the 2020-2022 digital video aerial survey data at the proposed Project; however, it can provide wider scale context on distribution.

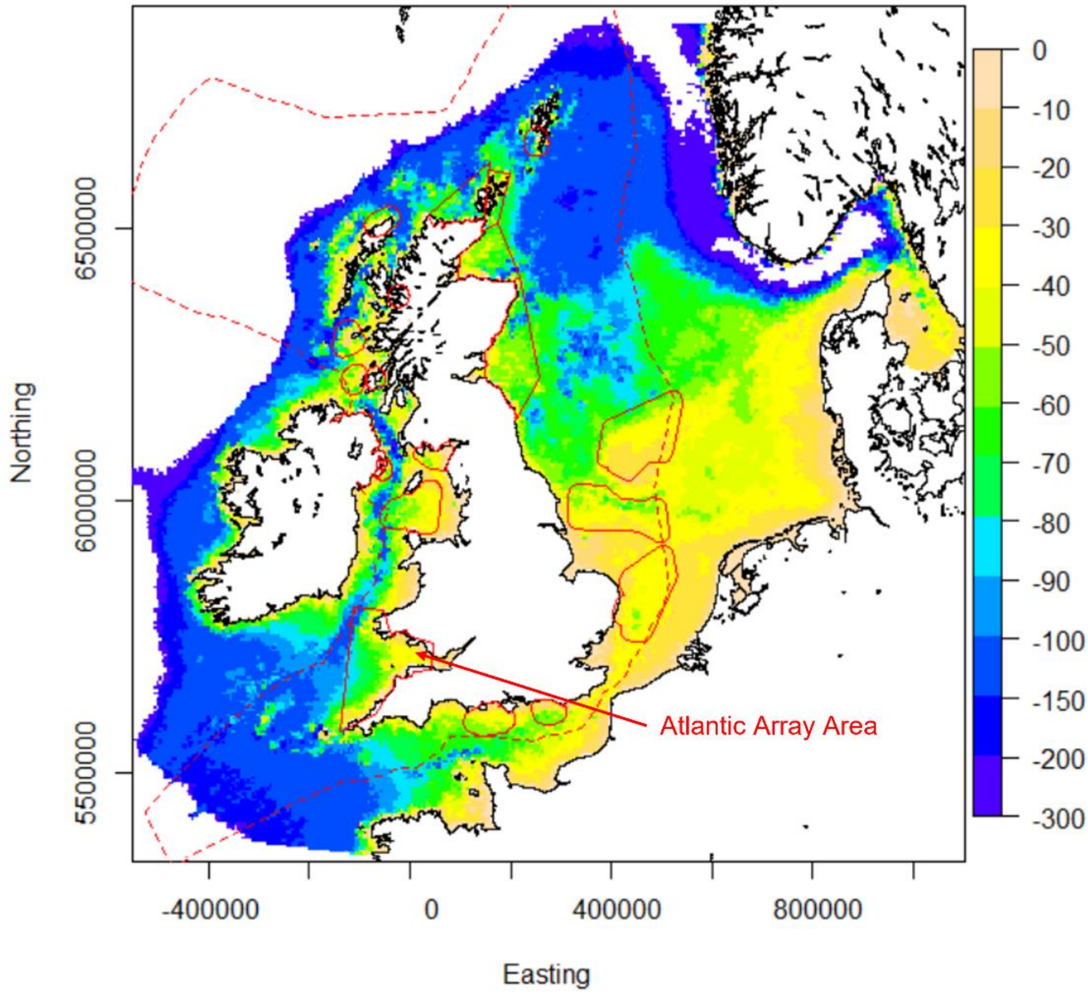


Figure 21A-11. Area covered by the JCP Phase III report (red full line), (red dashed lines represent the British Exclusive Economic Zone and the colour gradient represents the depth in m) (Paxton et al., 2016)

21.2.8. UK Harbour Porpoise Density for the Purpose of Identifying SACs

34. Heinänen and Skov (2015) also used the JCP data on harbour porpoise in the UK between 1994 and 2011. Distribution models were used to provide a list of the 'discrete and persistent' areas of relatively high density of harbour porpoise and compared between years (1994-1999, 2000-2005 and 2006-2011) and seasons (summer: April to September, winter: October to March). Environmental data for processes which are likely to aggregate harbour porpoise prey (such as currents and water movement / fronts) were used within models as well as anthropogenic pressures such as mean shipping intensity to further refine predictions of relatively high density and determine the possible influence of these processes on observed density and distribution. However, as noted by Heinänen and Skov (2015), uneven survey effort over the studied years increased the uncertainty of the modelled distributions. This report was used to inform the identification of discreet and persistent area of relatively high harbour porpoise

density; therefore, this is included for information only and it is not recommended for use as absolute density estimates.

21.2.9. MERP Surveys and Distribution Maps of Cetacean and Seabird Populations in the Northeast Atlantic

35. The MERP project started in 2014 and ran for five years. One of the main objectives of the project was to improve the understanding of key ecosystem services which are the source of marine food webs, bottom-up or top-down processes (National Oceanography Centre, 2022). As part of this project, Waggitt *et al.* (2019) collated a total of 2.68 million km of survey data from Northeast Atlantic surveys conducted between 1980 and 2018 to produce species distribution maps of cetaceans and seabirds at basin and monthly scales. Data were only used if collected via visual aerial and vessel-based surveys with dedicated surveyors and reported effort and transect design. Data were standardised based on the platform-type, transect design, observation method and weather by calculating variations in surface area covered. Mean monthly and 10 km resolution densities for each species were predicted for the near three-decade period. No density estimates were available for extraction, therefore, maps from the study are presented for illustration purposes only and can be used to support seasonal trends observed in other survey programmes and studies.

21.2.10. Grey Seal Surveys

36. In the North Atlantic, grey seals primarily breed from August to December and moult between December and April (Vincent *et al.*, 2017; SCOS, 2022). During the moulting period, both pups and adults spend more time hauled-out rather than at-sea. Grey seals have been recorded travelling long distances from their haul-out sites using different haul-out sites throughout the year (Vincent *et al.*, 2017). The UK is home to about 35% of the grey seal world population, and Wales is home to about 3.3% of the UK grey seal population, with greater densities found in Pembrokeshire (SCOS, 2021; 2022). For the purposes of estimating population size, grey seal surveys usually take place during the breeding and pupping period to coincide with the period where there is a maximum number of individuals on land. These surveys are further complimented by telemetry surveys to understand distribution of seals at-sea.

Haul-Out and Telemetry Surveys

37. Aerial surveys are often accompanied with ground-based surveys to overcome detection rate issues. In Wales, grey seals often give birth and take care of the pups in caves, limiting the detection rate from aerial surveys at the time of population census (Stringell *et al.*, 2014). Grey seal haul-out surveys have been conducted by NRW in Wales, focussing on seal pups on the Skomer Island and Marloes peninsula between 1983 and 2021 (Bull *et al.,* 2017a; 2017b; Morgan *et al.,* 2018; Büche, 2021). Additionally, photographic ID is often conducted on scarred seals to understand potential population and individual movements. Around Wales and Ireland such data have been saved into the EIRPHOT database since 1992 (Langlay *et al.,* 2018; 2020).

38. Telemetry studies can provide information on foraging behaviour and areas, as well as interactions between or within haul-out or pupping sites, etc. (Matthiopoulos *et al*., 2004; Breed *et al*., 2009). Grey seal telemetry studies have been undertaken in the UK since 1988 (e.g., Russel *et al.,* 2017; Carter *et al.*, 2020; 2022). Typically, two types of telemetry tags can be used with different transmission systems:

- Phone tags: transmission through mobile phone network; and
- Argos tags: transmission through Argos satellite.

39. Because grey seals often travel long distances to forage, other studies conducted off the northern coasts of France have tagged seals that were observed in the Celtic and Irish Seas (Vincent *et al.,* 2017; Huon *et al.,* 2021).

Seal Distribution

40. As a result of the various haul-out and telemetry surveys conducted for SCOS (2021; 2022), distribution maps were derived and can be used to inform impact assessments. At-sea density with associated uncertainty maps were published in Russell *et al.* (2017) and used telemetry data from 270 grey seals tagged in the UK between 1991 – 2016, and haul-out count data from 1996 – 2015 (**Figure 21A-12**). However, multiple haul-out sites were not visited by tagged seals, resulting in numerous 'null usage' cells in the data.

41. A more recent study has been conducted by Carter *et al.* (2020; 2022) which built on the data presented in Russel *et al.* (2017). In this study, a habitat modelling approach was employed using GPS telemetry data from 114 grey seals tagged between 2017 and 2019 together with the most recently available haul-out count data in order to provide estimated at-sea densities from all known haul-out sites in the UK and Ireland (**Figure 21A-13**). The predicted distribution maps produced represent relative seal density at-sea around the UK and Ireland in each grid cell (5 km^2).

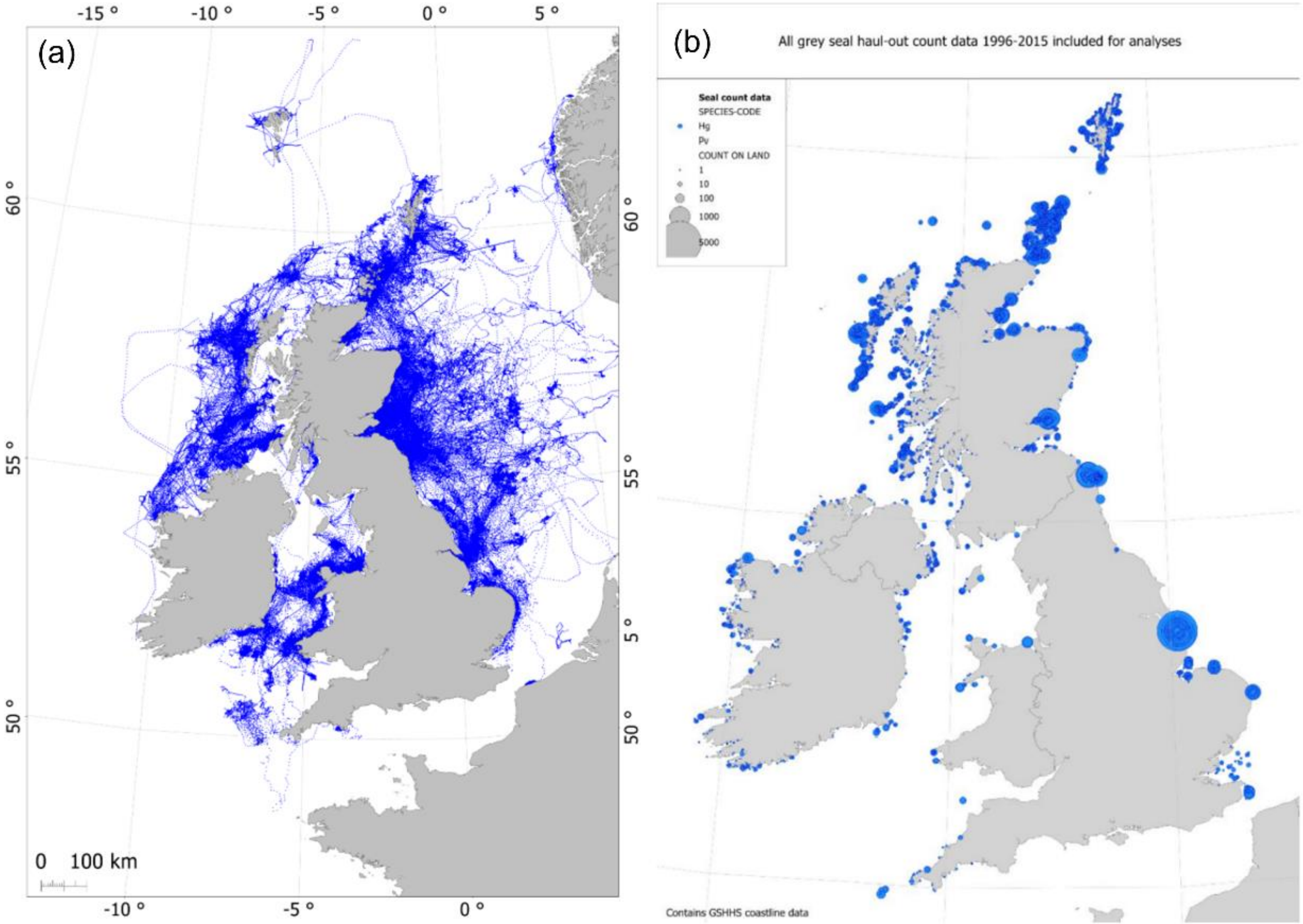


Figure 21A-12. GPS tracking data for grey seals (a; 270 animals, 1991 to 2016) and haul-out count data for grey seals (b; 1996 to 2015) (Russel et al., 2017)

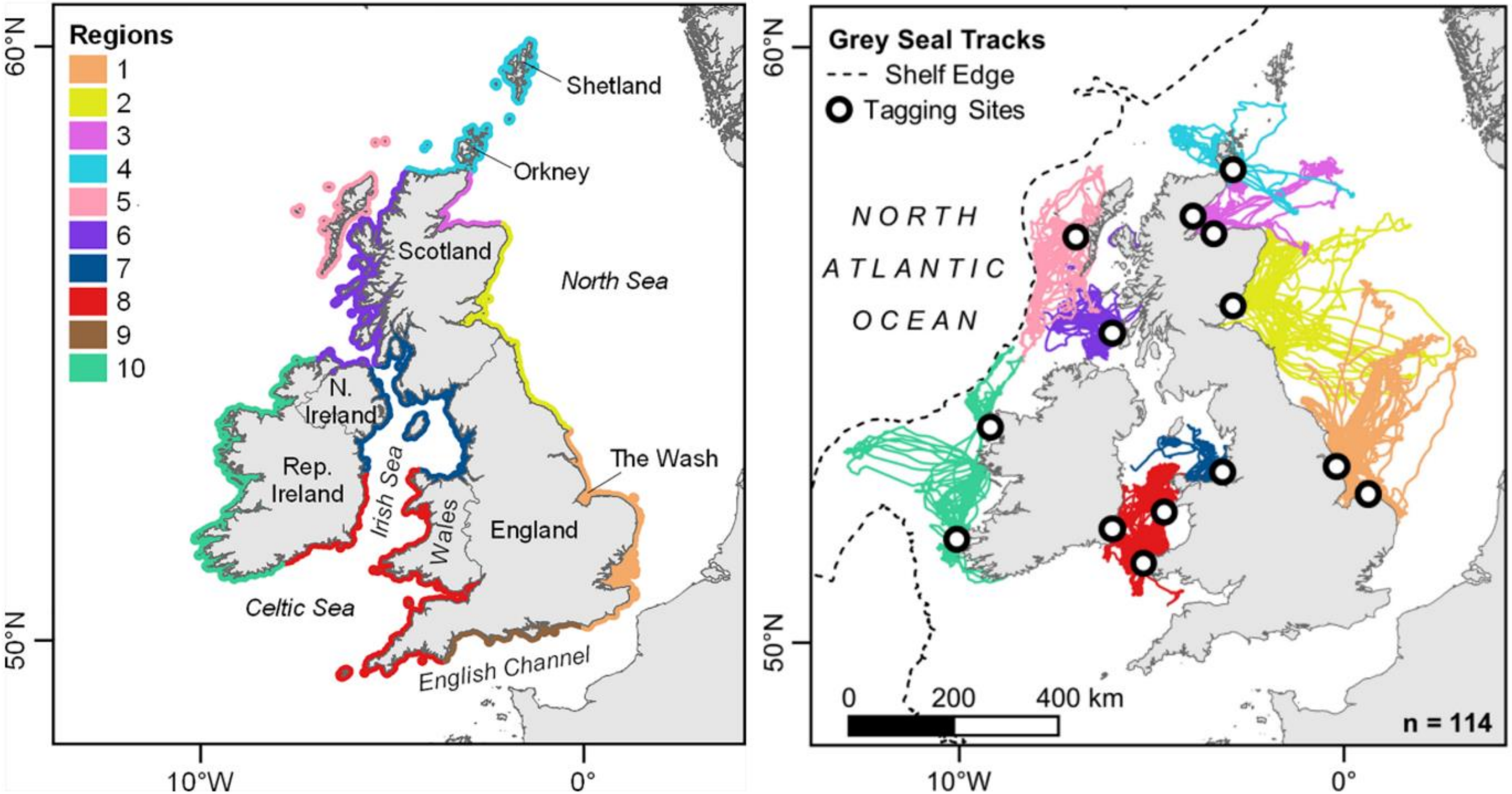


Figure 21A-13. Study Area with regional designation used for the habitat preference models and tracking data for grey seals (114 individuals). Tracks are coloured per region (Carter et al., 2022)

21.2.11. Wildfowl and Wetland Trust Surveys

42. The Wildlife and Wetland Trust (WWT) flew visual aerial surveys between 2001 and 2008 to primarily collect data on the distribution and abundance of waterbirds and opportunistically collect data on cetaceans, seals, turtles, sharks and ocean sunfish. Following a distance-sampling methodology, north-south transects were flown 2 km apart across defined regions around the UK (**Figure 21A-14**) (WWT Consulting, 2009). Observers also recorded sea state, cloud cover, haze, glare and visibility at intervals during each transect and at every change of condition. Transects with poor visibility were abandoned and data collected during poor conditions were reviewed and discarded if deemed to be too affected. Estimates of relative densities for each species and species group were calculated per 2 km x 2 km grid cells (WWT Consulting, 2009).

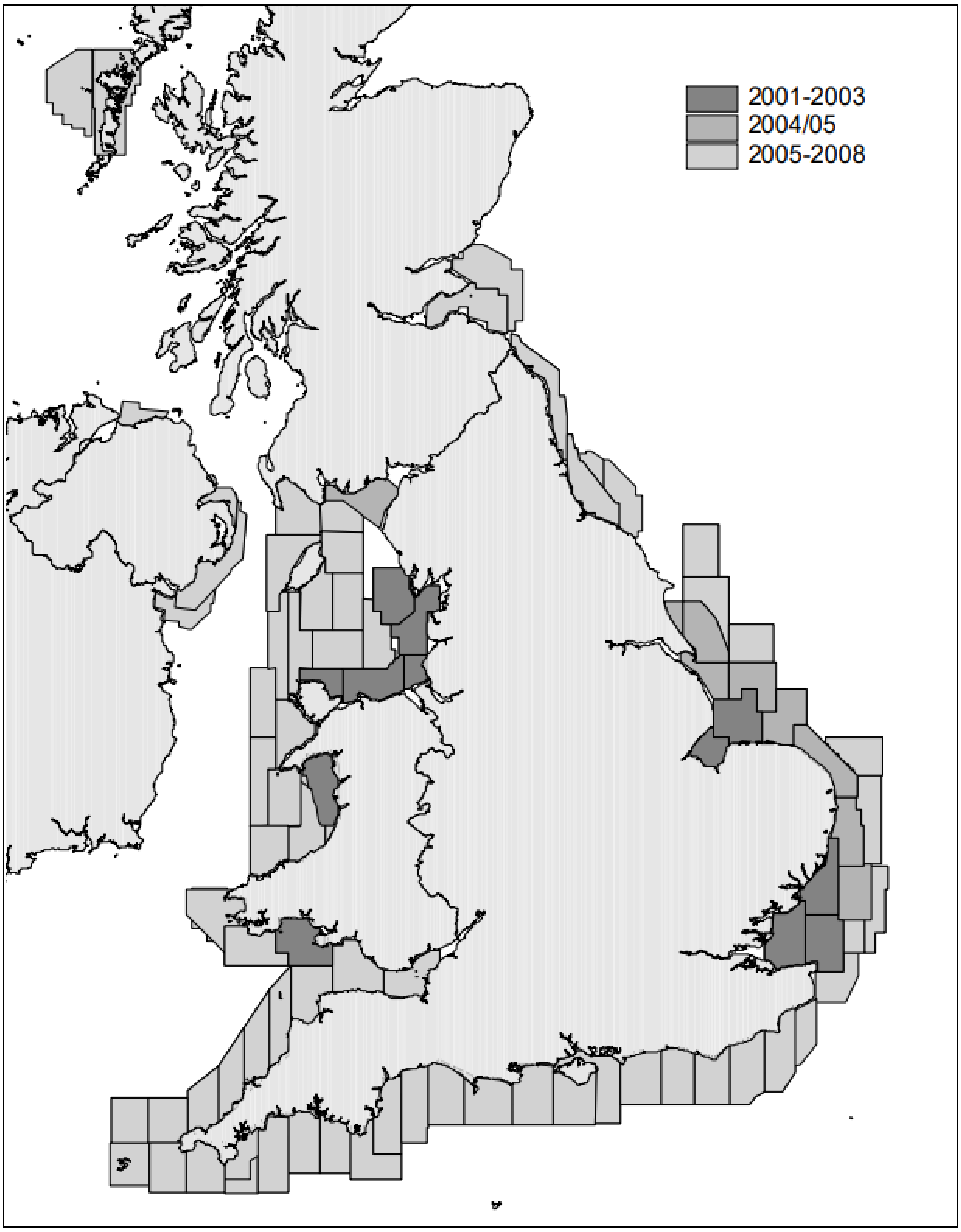


Figure 21A-14. Aerial survey blocks flown between 2001 and 2008 by WWT Consulting (2009)

21.2.12. *Marine Environmental Monitoring: TURTLE Database*

43. Turtle sightings, strandings and captures are recorded around the UK and Ireland and registered by Marine Environmental Monitoring in the TURTLE database, as part of the UK Cetacean Strandings Investigation Programme. Turtles have recorded to be indirectly captured as bycatch in fishing nets, ropes and lines, drift nets and ghost gear. Records date back to 1910 (Botterell *et al*., 2020) and reports of submitted data have been produced annually since 2001, the most recent presenting 2022 data (Penrose and Westfield, 2023). Botterell *et al*. (2020) analysed data from the TURTLE database between 1910 and 2018 to determine spatio-temporal trends of live and dead turtle sightings, strandings and incidental capture around the UK and Ireland. During that period, 1,997 marine turtles were identified with 1,683 being leatherback turtles.

21.2.13. INTERREG Irish Sea Leatherback Turtle Project

44. As part of the European INTERREG Irish Sea leatherback turtle Project, established in 2003, multiple studies were conducted and focused on the understanding of leatherback turtle distribution around the UK and Ireland and the potential link to the distribution of their main prey, jellyfish (Houghton *et al.*, 2006a). During this project, visual aerial surveys of the Irish Sea were conducted to detect prey abundance and turtle distribution between 2003 and 2005 (Houghton *et al*., 2006b), while two leatherback turtles were tracked with satellite tags in 2005 and 2006 off the southwest coast of Ireland (Doyle *et al*., 2008).

21.3 Species Accounts

45. The following key species accounts present density and population estimates for grey seal, harbour porpoise, common dolphin, bottlenose dolphin, minke whale and leatherback turtle from site-specific surveys, and other survey programmes conducted within the Celtic and Irish Seas.

46. Design-based abundance estimates from DAS conducted between March 2020 to March 2022 for all other encountered species are presented in **Appendix 21A: Annex B.**

21.3.1. Grey Seal

47. Grey seals are distributed throughout the northern hemisphere. They are generalist feeders and can forage at-sea for up to 30 days, over hundreds of kilometres, making the species one of the most wide-ranging species in the UK (JNCC, 2019a; SCOS, 2021; 2022). They generally haul-out between December and April to moult, and August to December for the breeding season. In the UK, grey seals are designated features of 13 SACs, five of which are located in the Celtic Sea, with two in the vicinity of the proposed Project (Pembrokeshire Marine / Sir Benfro Forol SAC (~23 km north) and Lundy SAC (~55 km east)). MUs are currently only defined and agreed UK wide for cetaceans (IAMMWG, 2022), as such no MU is assigned to seal species, therefore, as agreed with NRW, the OSPAR Region III is used instead (NRW Screening and Scoping Opinion, 05 July 2022) (**Figure 21A-1**).

Site-Specific Surveys

48. Throughout the two-year survey period across the Llŷr marine megafauna survey area, 11 grey seals were recorded (**Table 21A-8**). Amongst all observations recorded during the survey period, six were unidentified to species level. This resulted in a peak relative design-based density of 0.04 animals/km^2 (95% CI 0.00 – 0.08) in the Llŷr marine megafauna survey area, equating to an abundance of 24 animals (95% CI 0 – 54) (**Table 21A-8**). No conclusion can be made regarding the spatial distribution over the site due to the low number of sightings (**Figure 21A-15**). Average density was higher in summer than winter, which aligns with expectations given winter pupping and moulting ties adults closer to haul-outs.

Table 21A-8. Relative design-based density and abundance estimates of grey seals recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022 (Summer= May – October, Winter= November – April; n= number)

Survey	Date	Raw count (n)	Relative density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)
1	25 Mar 2020	1	0.02	16	0	40	68.18
2	14 Apr 2020	1	0.02	16	0	39	67.18
3	08 Jun 2020	0	0.00	0	0	0	0
4	24 Jun 2020	2	0.02	16	0	40	67.46
5	21 Jul 2020	3	0.04	24	0	54	54.02
6	31 Aug 2020	1	0.03	17	0	40	66.11
7	12 Sep 2020	0	0.00	0	0	0	0
8	22 Oct 2020	0	0.00	0	0	0	0
9	26 Nov 2020	0	0.00	0	0	0	0
10	10 Jan 2021	0	0.00	0	0	0	0
11	25 Jan 2021	0	0.00	0	0	0	0
12	22 Feb 2021	0	0.00	0	0	0	0
13	14 May 2021	1	0.01	8	0	24	93.77
14	27 May 2021	1	0.02	16	0	40	70.8
15	15 Jun 2021	0	0.00	0	0	0	0
16	14 Jul 2021	0	0.00	0	0	0	0
17	16 Aug 2021	0	0.00	0	0	0	0
18	01 Sep 2021	0	0.00	0	0	0	0
19	22 Oct 2021	0	0.00	0	0	0	0
20	20 Nov 2021	0	0.00	0	0	0	0
21	16 Dec 2021	0	0.00	0	0	0	0
22	05 Jan 2022	0	0.00	0	0	0	0
23	26 Feb 2022	1	0.02	16	0	40	66.06
24	20 Mar 2022	0	0.00	0	0	0	0
Average Year 1 (1 – 12)		**-**	**0.011**	**7**	**3**	**12**	**99.46**
Average Year 2 (13 – 24)		**-**	**0.004**	**3**	**0**	**6**	**153.46**
Total average		**-**	**0.008**	**5**	**3**	**8**	**118.09**
Summer average		**-**	**0.012**	**8**	**4**	**12**	**96.16**
Winter average		**-**	**0.003**	**3**	**0**	**5**	**168.40**

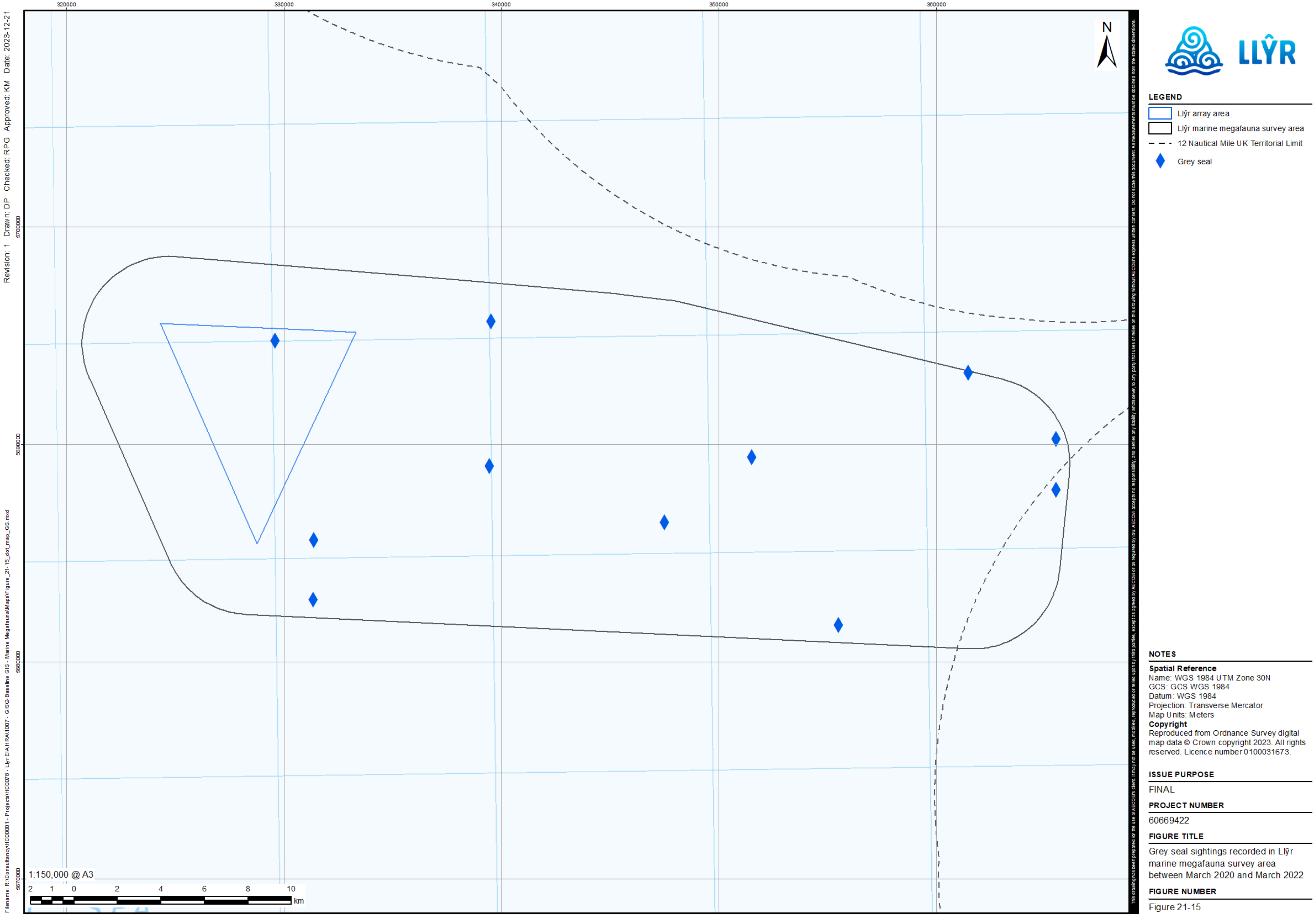


Figure 21A-15. Grey seal sightings recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022

Project Erebus Surveys

49. Throughout the two-year survey period across the Erebus survey area, only four grey seals were recorded during winter months, in November 2019, February and March 2021. When grey seals were recorded, estimated relative densities ranged from 0.02 seals/km^2 to 0.04 seals/km^2, respectively. Over the 24-month survey period a relative density of 0.003 seals/km^2 was estimated (**Table 21A-9**). No conclusion can be made regarding the spatial distribution over the site due to the low number of sightings (**Figure 21-16**) (Darias-O'Hara *et al.*, 2021).

Table 21A-9. Raw count, relative density and abundance estimates of grey seal recorded in the Erebus survey area (development area plus a 4 km buffer) between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Survey	Date	Raw count (n)	Relative density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)
2	08 Nov 19	1	0.02	4	0	12	0.94
17	22 Feb 21	1	0.02	4	0	12	0.95
18	05 Mar 21	2	0.04	8	0	24	0.93
All other surveys		0	0.00	0	0	0	0.00
Average Year 1 (1 – 12)		-	**0.002**	**1**	-	-	-
Average Year 2 (13 – 24)		-	**0.005**	**0**	-	-	-
Total average		-	**0.003**	**1**	-	-	-

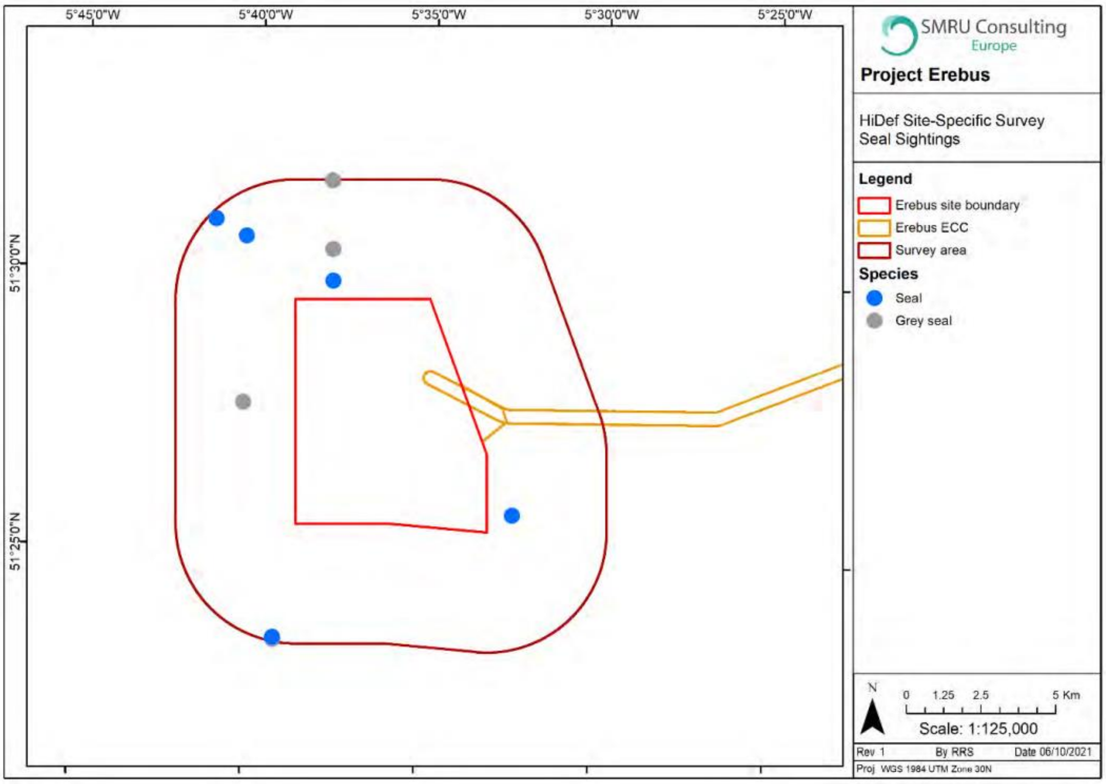


Figure 21-16. Grey seal sightings recorded in the Erebus survey area between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Welsh Marine Atlas

50. Between 1990 and 2009, a total of 2,580 grey seal sightings, amounting to 33,428 individuals were recorded in the Welsh Marine Atlas database (**Figure 21A-17**) (Baines and Evans, 2012). Grey seals were the only seal species present in the database.

51. Grey seal sightings were more numerous during the spring and summer months, although it should be noted that survey effort was not equivalent in each month and that surveyors were not targeting seals as much as cetaceans, therefore, numerous individuals may not have been recorded (**Figure 21A-18** and **Figure 21A-19**) (Baines and Evans, 2012).

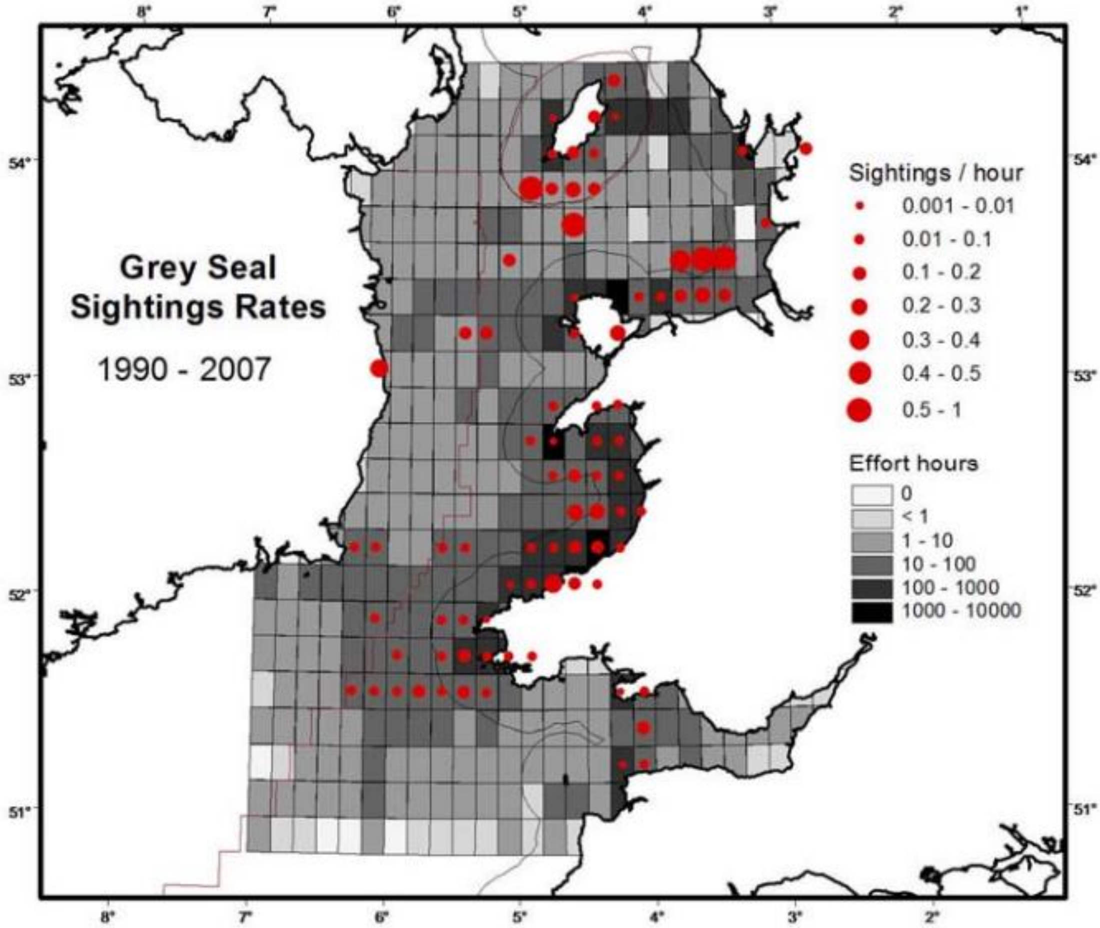


Figure 21A-17. Sighting rates of grey seals from vessel and land-based surveys organised between 1990 and 2007 (Baines and Evans, 2012)

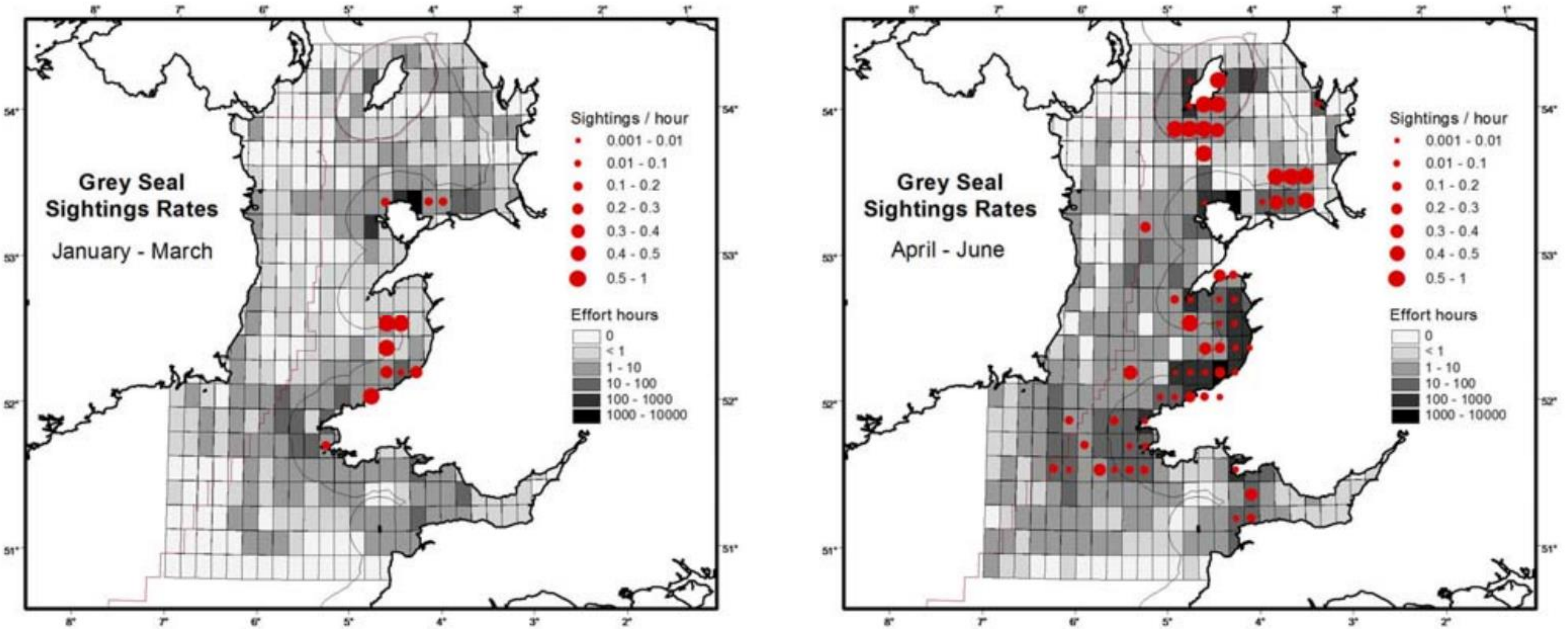


Figure 21A-18. Long-term quarterly mean sightings rates of grey seals from vessel and land-based surveys organised between January and June, between 1990 and 2007 (Baines and Evans, 2012)

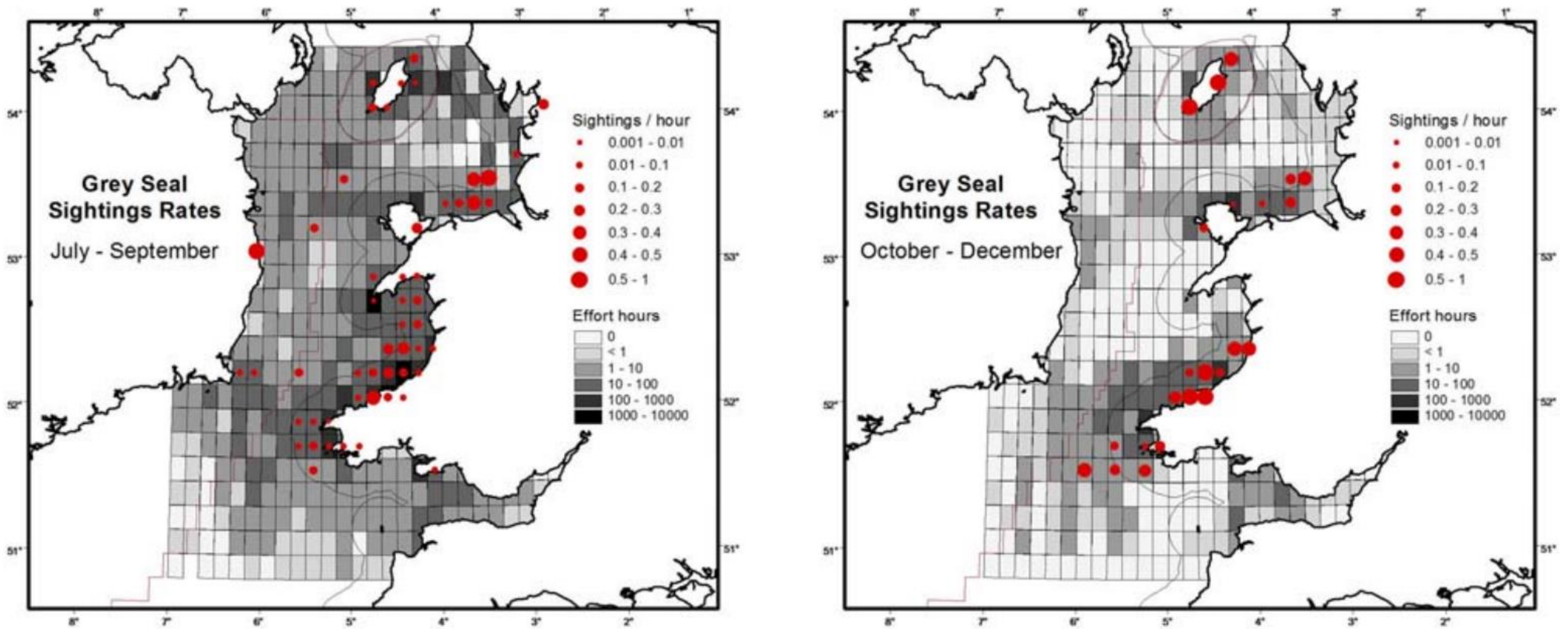


Figure 21A-19. Long-term quarterly mean sightings rates of grey seals from vessel and land-based surveys organised between July and December, between 1990 and 2007 (Baines and Evans, 2012)

SCOS Seal Haul-Out Surveys

52. In 2019, grey seal pup production of 67,850 and 2,250 animals was estimated for the UK and Wales, respectively, equating to an estimated population of 162,000 and 5,400 grey seals in 2022, respectively (SCOS, 2022) (**Figure 21A-20**). Most of the UK grey seal SACs are designated in Scotland, however, there is also an SAC off the east coast of England and the southwest of Wales. Pembrokeshire Marine / Sir Benfro Forol SAC is designated for the protection of grey seals at Skomer, Marloes Peninsula and Ramsey Island, where the pup production is continuing to increase (SCOS, 2021; 2022). Additionally, grey seal is a qualifying feature of the Pen Llŷn a`r Sarnau / Lleyn Peninsula and the Sarnau SAC, where large haul-out sites can be found.

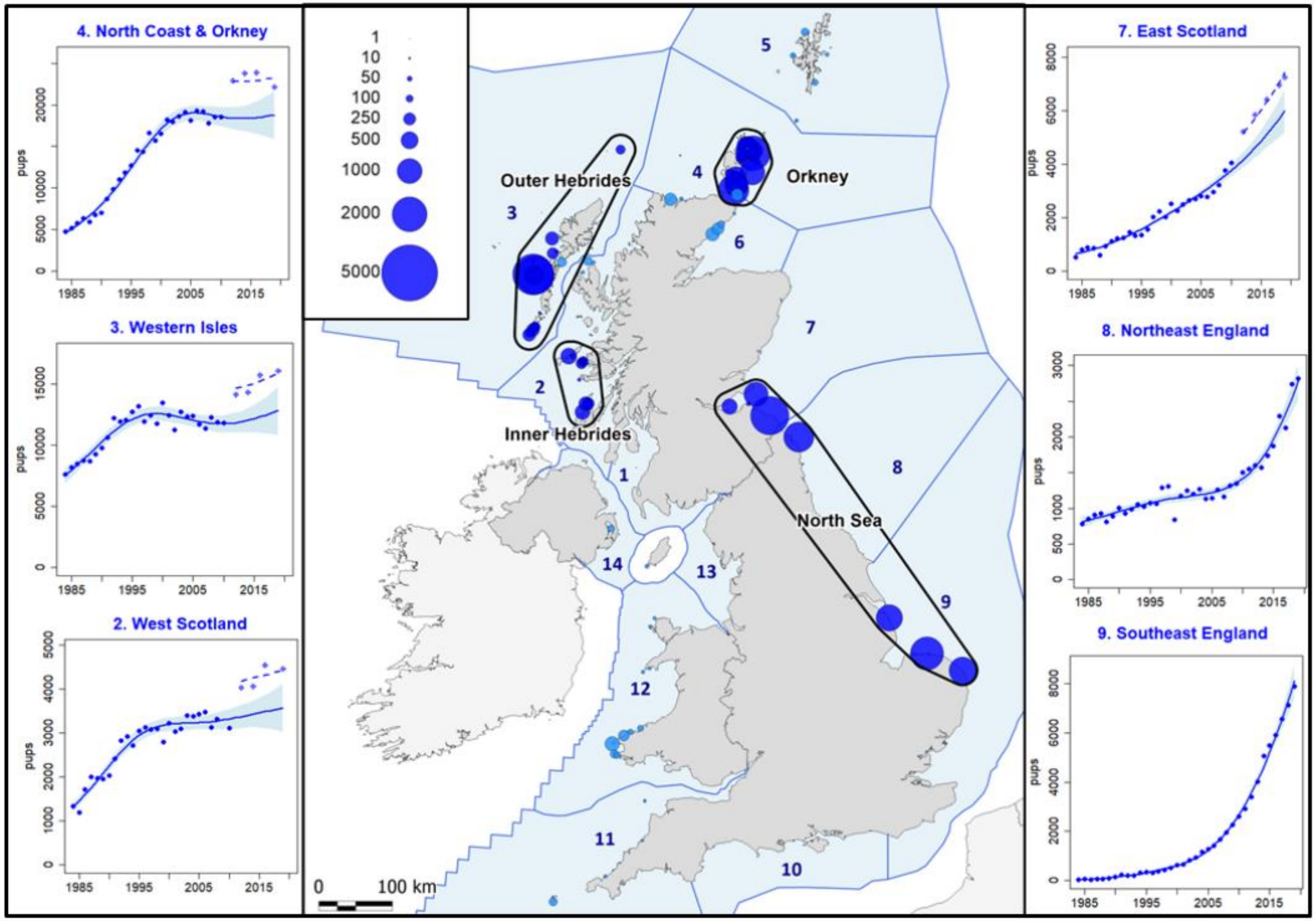


Figure 21A-20. Distribution and estimated grey seal pup production in the UK. Dark blue circles highlight the regularly monitored colonies, while light blue circles highlight sites sporadically monitored. 'For regularly monitored colonies, on a Seal Monitoring Unit (SMU)-scale, the pup production estimates by year, and predicted trend and associated 95% confidence intervals, are shown. For aerially surveyed SMUs (2-7), the dashed line shows the same trend as the solid line but at the level of pup production predicted from digital surveys' (SCOS, 2022)

Grey Seal Breeding Census' and Temporal Trends and Phenology in Pup Counts

53. Wales hosts almost 4% of the UK population of breeding grey seals, the majority of which are found in Pembrokeshire (Morgan *et al*., 2018; SCOS, 2022). On Ramsay Island (located within Pembrokeshire Marine SAC), pup records have continuously increased since recording began in 1992, with 380 pups recorded between August 2015 and December 2016 (Morgan *et al*., 2018).

54. Productivity is also increasing on Skomer Island, where, in 2021, 265 pups were born; the highest number ever recorded (Büche, 2021). Within the Skomer MCZ (**Figure 21A-21**) which includes Skomer Island and the mainland, a total of 446 pups were born between August and November 2021, also a record number (**Figure 21A-22**; Büche, 2021).

55. The record number of grey seal pups follows an average yearly increase on Skomer of 10.2% between 2011 – 2015 (Bull, 2017a). Prior to this, the pup counts increased on average 8.9% annually between 1983 – 1993 and remained stable for nearly 20 years with no net gain until 2011 (Bull, 2017a). The mainland (Marloes Peninsula) also experienced an increase in grey seal pup counts averaging 6.2% each year between 1993 – 2013 (Bull, 2017b). The number of pups within the entire Skomer MCZ increased substantially between 2009 and 2015, doubling from around 200 pups in that period (**Figure 21A-22**; Bull *et al*., 2021).

56. Although the population trend is relatively consistent within the MCZ, the times when seals utilise the sites at Skomer varies (**Figure 21A-23**). There is also considerable variation in pupping season timing and length, this is particularly the case for the end of the pupping season (Bull *et al*., 2021). Increases in winter sea surface temperature (SST) were associated with an earlier pupping season. SST was not found to influence individual pupping dates; however, the age of the mother was significant, with older individuals pupping earlier in the season. Additionally, in years with greater SST, the average age of mothers was older. Bull *et al*. (2021) suggests that climate impacts grey seal phenology by altering the age structure at breeding sites.

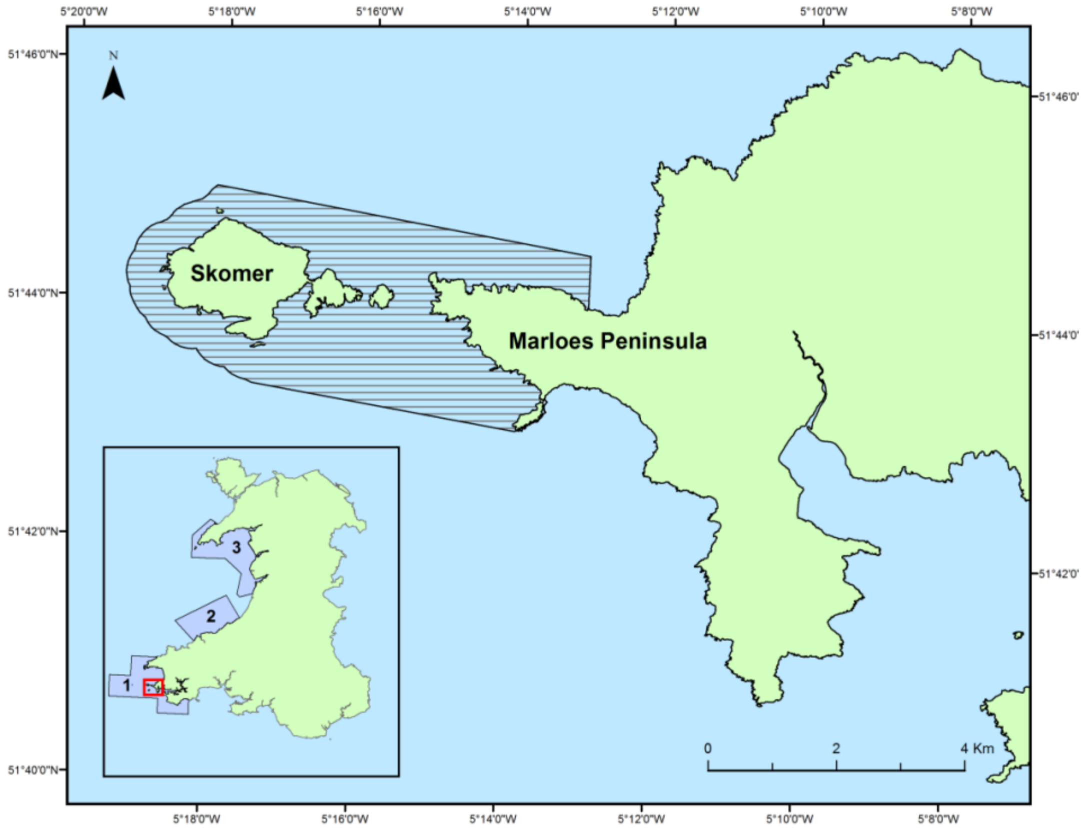


Figure 21A-21. Skomer Marine Conservation Zone 1. Pembrokshire Marine SAC, 2. Cardigan Bay SAC, 3. Lleyn Peninsula and the Sarns SAC (Bull et al., 2017a)

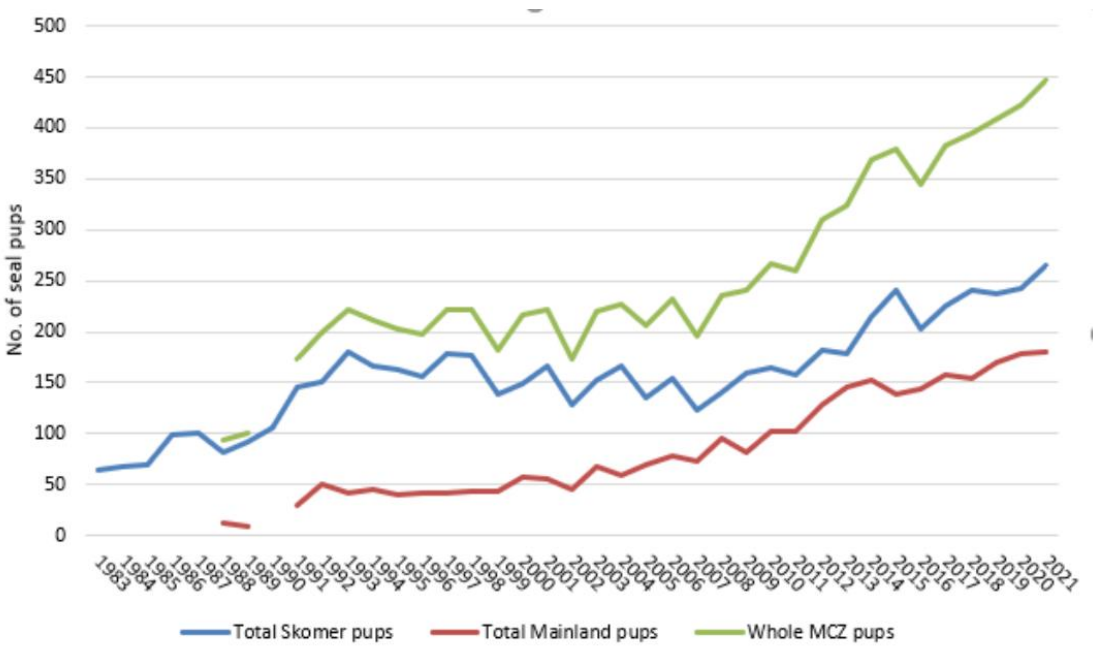
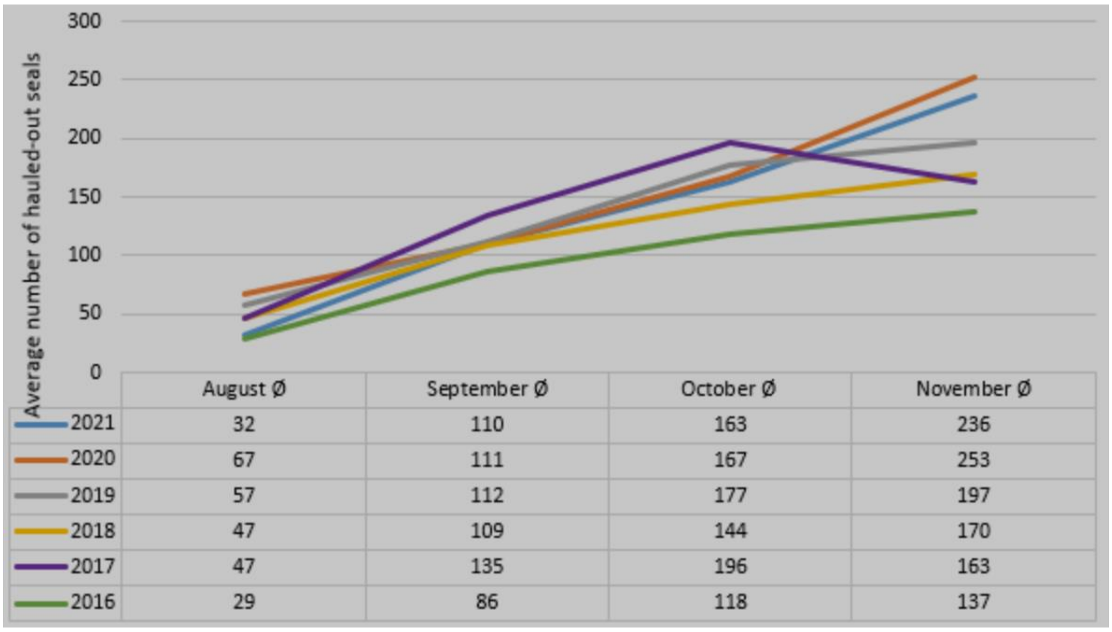


Figure 21A-22. Number of seal pups born in Skomer MCZ 1983-2021 (Büche, 2021)



	August Ø	September Ø	October Ø	November Ø
2021	32	110	163	236
2020	67	111	167	253
2019	57	112	177	197
2018	47	109	144	170
2017	47	135	196	163
2016	29	86	118	137

Figure 21A-23. Average number of seals using Skomer per month between 2016 and 2021 (Büche, 2021)

EIRPHOT Database

57. The EIRPHOT database (1992 – 2016) (Langlay *et al*., 2020) is a photographic identification (photo-ID) database. From this, it is estimated a minimum of 2,688 female grey seals use haul-out sites on the Welsh coast (**Figure 21A-24**), the majority of which were only seen once (77%), with less than 1% being recorded seven times or more (Langlay *et al*., 2018; 2020). Of those individuals that were recorded more than once (recaptured), a large proportion were at the same site they were originally seen in. The database also highlights that there is considerable movement between the sites surveyed around the Welsh coastline.

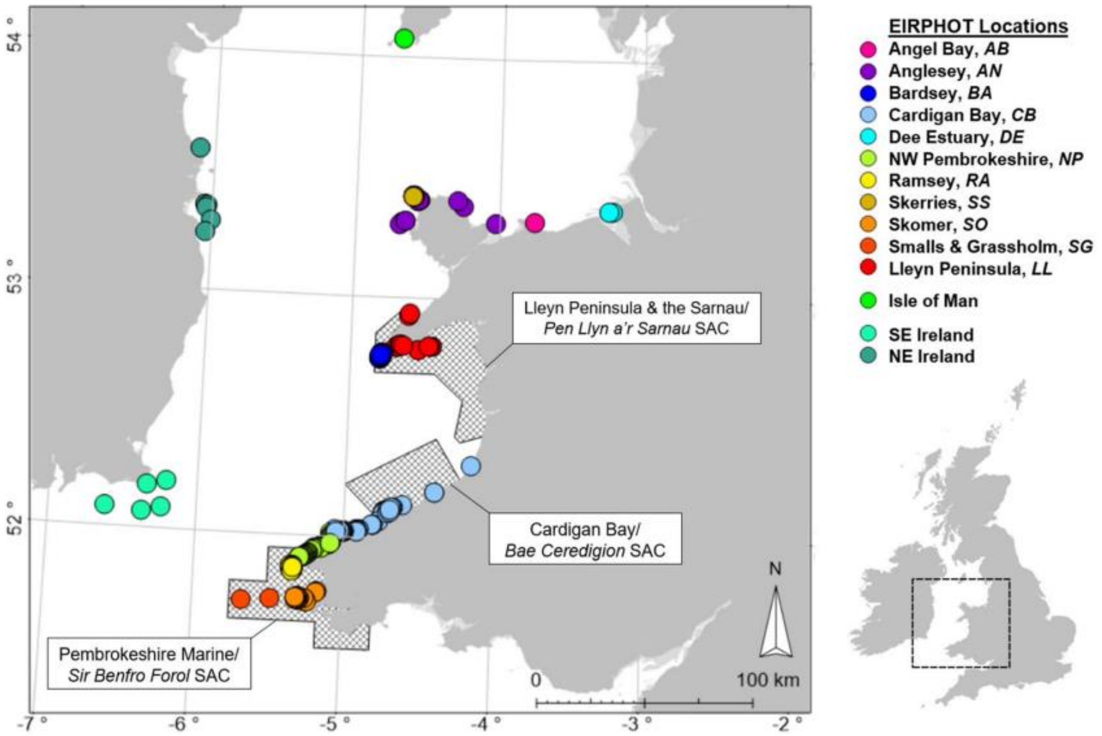


Figure 21A-24. Grey seal haul-out sites covered by the EIRPHOT database (Langlay et al., 2020)

Telemetry Surveys / Habitat Preference

58. Vincent *et al.* (2017) presented seal distributions and movements from French haul-out sites of 45 grey seals tagged between 1999 and 2014. The tagging data showed large movements and connectivity between haul-out sites, including with those in southern England, Ireland and Wales. Of the 34 seals that were tagged at the Molene Archipelago haul-out site, 65% were recorded travelling in the English Channel and / or the Celtic Sea, with six seals recorded hauling out during the breeding season in southwest UK and Ireland (**Figure 21A-25**) (Vincent *et al.*, 2017).

59. Huon *et al.* (2021) used telemetry data to understand the relationship between foraging behaviour and physical habitat features around the North Sea and east Atlantic. Using a conversion factor, the authors estimated that 996 grey seals would be hauled-out in the Irish Sea area in August 2012. For the study, a total of 46 grey seals were tagged between 2008 and 2014. It was observed that in the Irish Sea, seals tend to use a foraging habitat within 50 km from shore, therefore, selecting a foraging area close to the haul-out site, in shallow and tidal waters (**Figure 21A-26**).

60. Percentage at-sea population maps were produced for grey seal around the UK and Ireland using data between 1991 and 2016 (Russel *et al.,* 2017; **Figure 21A-12**). Although the usage around the Welsh coast is generally lower compared to parts of Scotland and the east coast of England, grey seals use areas off Pembrokeshire, near the proposed Project.

61. Most recently, Carter *et al.* (2020; 2022) evaluated the habitat-based distribution of grey seals around the UK and Ireland using telemetry data. Data from 114 grey seals tagged from 26 sites between 2005 and 2019 were used and new at-sea estimates were provided (**Figure 21A-13** and **Figure 21A-27**). Mean predicted at-sea relative density for the Llŷr marine megafauna survey area were derived from Carter *et al.* (2022) and calculated at 0.012 animals/km^2 (**Figure 21A-28**).

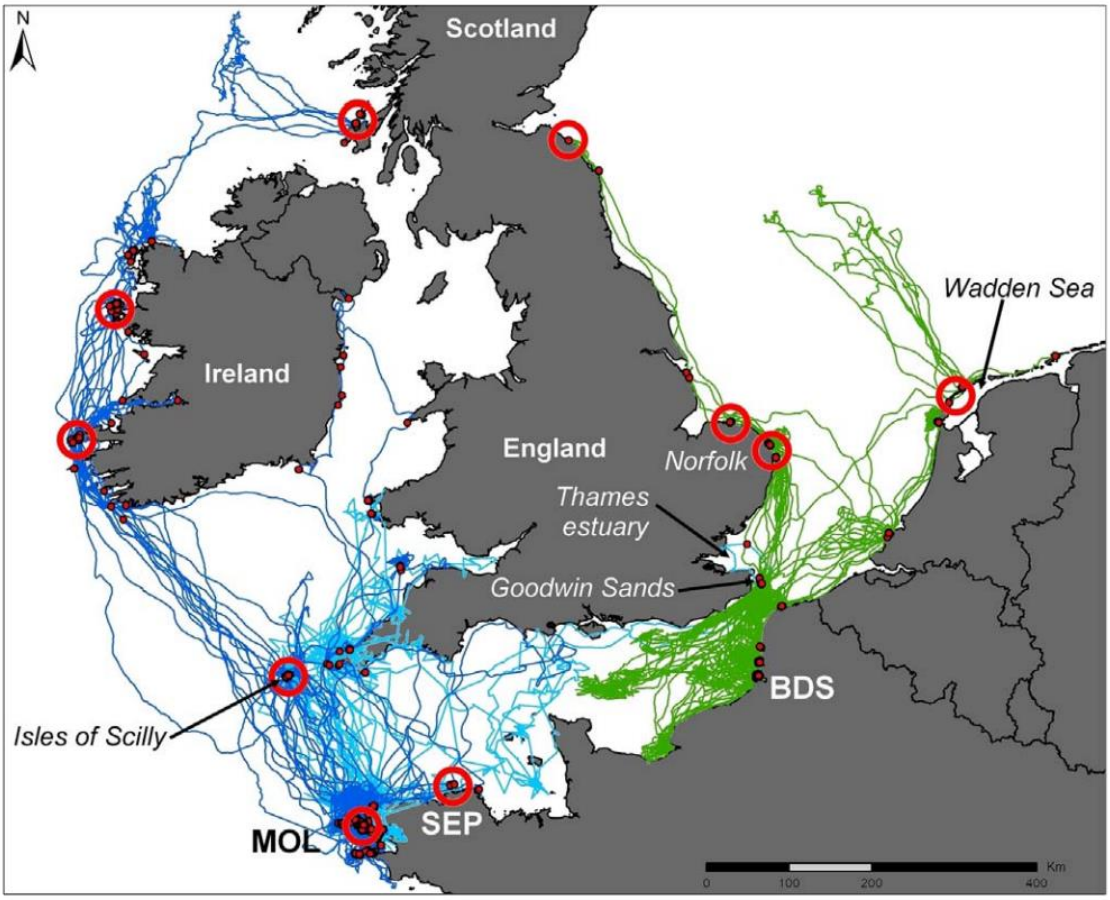


Figure 21A-25. Telemetry tracks of grey seals tagged in France. Red circles represent breeding locations, while red dots indicate the location of haul-out sites. Tracks from BDS (Baie de Somme) in green (11 seals in 2012) and tracks from MOL (Molene archipelago) in light blue (15 seals between 1999 and 2009) and dark blue (19 seals between 2010 and 2013), (Vincent et al., 2017)

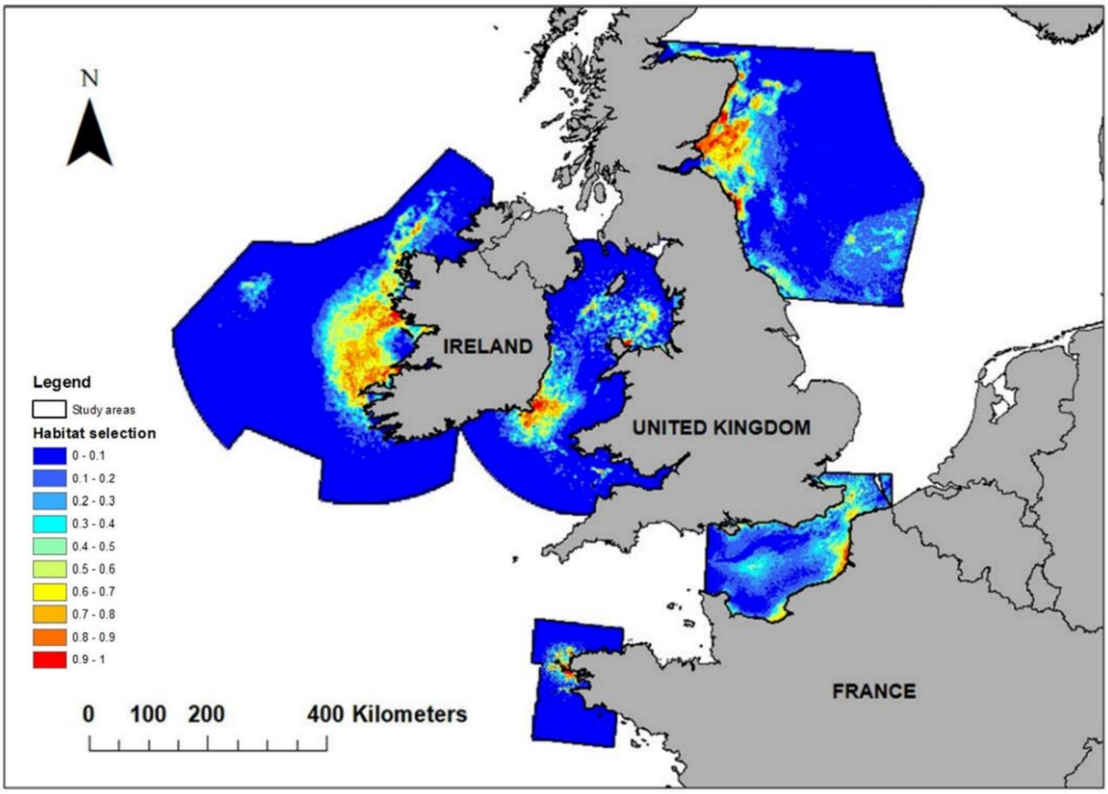


Figure 21A-26. Habitat selection for grey seal across the Study Area (Huon et al., 2021)

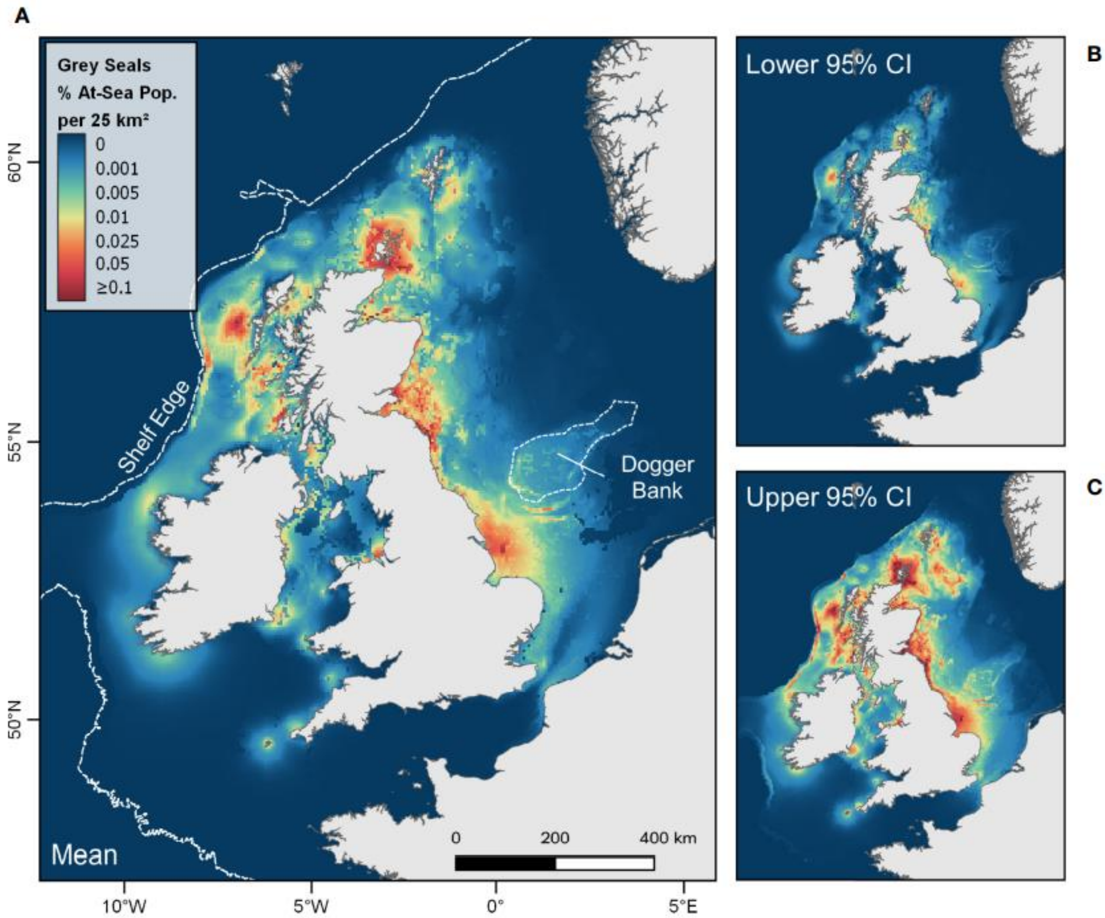


Figure 21A-27. Predicted grey seal percentage at-sea distribution (relative density) per 5 x 5 km grid cell (a, lower 95% CL; b, mean; c, upper 95% CL) (Carter et al., 2022)

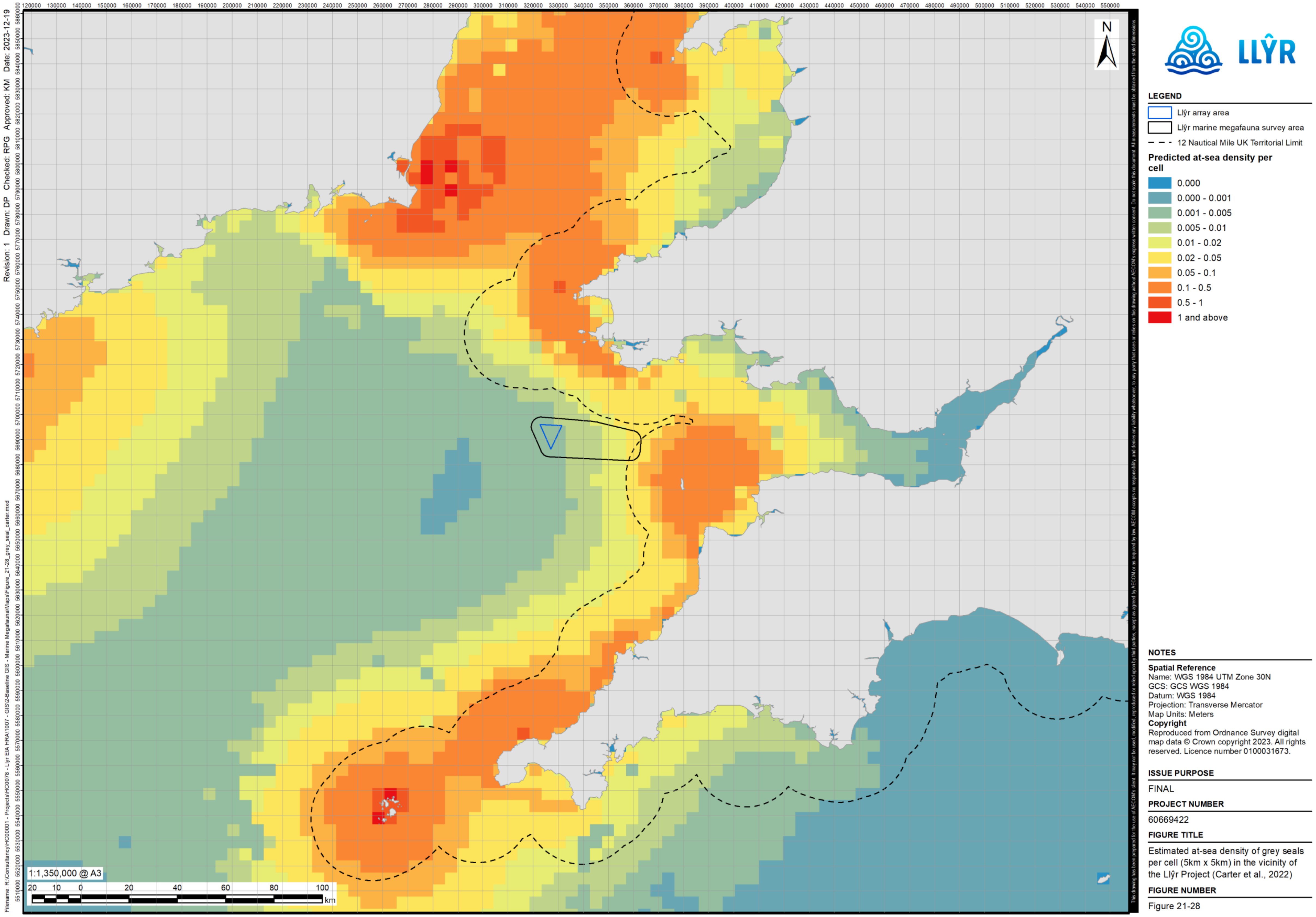


Figure 21A-28. Mean predicted percentage at-sea population of grey seal (relative density) per 5 km x 5 km grid cell derived from Carter et al. (2022)

Grey Seal Summary

62. The number of seal pups born at sites on the southwest coast of Wales, near the proposed Project are increasing annually. Several sources have assessed the occurrence of grey seal in regions relevant to the proposed Project, and provided estimates of density and abundance which could be taken forward for use in quantitative impact assessment. The available information has provided a range of estimates from 0.000 animals/km^2 to 0.015 animals/km^2 (**Table 21A-10**). Data analysis methodology varied between surveys, therefore, comparison between estimates derived through different studies should be undertaken with caution. Estimates of density and abundance from the DAS site-specific survey data may not be representative due to difficulties differentiating between harbour and grey seals, with six seals unidentified to species level compared to 11 identified grey seals recorded in the Llŷr marine megafauna survey area. It should also be noted that none of the site-specific estimates were corrected for animals diving/hauled-out at the time of the survey.

63. The most recent data are site-specific survey data collected by HiDef between 2020 and 2022 which indicated that grey seals may be present in the proposed Project in relatively low densities. The estimates gave an average relative design-based density for the full survey period of 0.008 animals/km^2 in the Llŷr marine megafauna survey area, with peak estimates recorded during the summer period (0.04 animals/km^2 [July 2020]).

64. Due to the very low number of grey seal observations recorded during the site-specific DAS, it was concluded that at-sea grey seal density data in Carter *et al.* (2022) will be used to inform quantitative impact assessment.

Table 21A-10. Summary of grey seal density estimates collected around the Array Area presented in this report (highlighted cells correspond to the densities recommended to be used for quantitative impact assessment)

Study or survey programme	Area		Time scale	Average density (n/km^2)
	Name	Size (km^2)		
Proposed Project, HiDef site-specific surveys	Llŷr marine megafauna survey area	640.92	Year 1 Mar 2020 – Feb 2021	0.011 (rdbe)
			Year 2 May 2021 – Mar 2022	0.004 (rdbe)
			All surveys Mar 2020 – Mar 2022	0.008 (rdbe)
Erebus Project, HiDef site-specific surveys (Darias-O'Hara *et al.,* 2021)	Erebus survey area (development area plus a 4 km buffer)	200.11	All surveys Oct 2019 – Sep 2021	0.003 (relative)
Grey seal at-sea density estimates in UK waters (Carter *et al*., 2022)	Llŷr marine megafauna survey area	640.92	2005 - 2019	0.012 (at-sea)

**rdbe: relative design-based estimates*

21.3.2. Harbour Porpoise

65. Harbour porpoise is a globally distributed species, typically found on the continental shelf. Harbour porpoise are the most common cetaceans in UK waters (JNCC, 2019b). Porpoise numbers and spatial distribution have remained stable in the northeast Atlantic at least since the 1990s, although some distribution shifts have been observed in the North Sea and English Channel (Hammond *et al*., 2002; 2013; 2021; Gilles *et al.,* 2023). Distribution is likely related to prey availability which in UK waters can include small schooling fish but may vary to utilise seasonally abundant prey (Rogan and Berrow, 1996; Pierpoint, 2008). Harbour porpoise have been recorded throughout the Irish Sea and Bristol Channel (Evans and Waggitt, 2023), but they are thought to prefer coastal areas of high tidal energy such as north Anglesey, Bardsey and Ramsey Sounds (Evans and Waggitt, 2023).

66. In the UK, harbour porpoise are designated features of seven SACs, one located in the southern North Sea, five located in the Irish and Celtic Seas, and one in west Scotland. The closest SAC to the proposed Project is the Bristol Channel Approaches / Dynesfeydd Môr Hafren SAC. There are three MUs identified for harbour porpoise (IAMMWG, 2022), with the Celtic and Irish Seas MU overlapping with the proposed Project (**Figure 21A-1**).

Site-Specific Surveys

67. Throughout the two-year survey period, harbour porpoise were the second most abundant marine mammal species observed, with a total of 58 harbour porpoise recorded (38 in Year 1, and 20 in Year 2) across the Llŷr marine megafauna survey area (**Table 21A-11** and **Table 21A-12**). Overall, although harbour porpoise was observed throughout the Llŷr marine megafauna survey area, there was not an obvious distribution pattern (**Figure 21A-29**).

68. Model-based estimates calculated an average absolute density for the whole survey period of 0.137 animals/km^2 (95% CI 0.015 – 0.542) in the Llŷr marine megafauna survey area, equating to a mean abundance of 145 animals (95% CI 103 – 226) (**Table 21A-11**). Mean density and abundance was estimated to be higher in the winter than the summer (0.181 animals/km^2 [95% CI 0.10 – 0.270] and 0.157 animals/km^2 [95% CI 0.095 – 0.249], respectively) over the Llŷr marine megafauna survey area. Density surfaces of model-based absolute estimates indicate very low densities across the Llŷr marine megafauna survey area (**Figure 21A-30**).

69. For comparison, design-based methods across the entire survey programme, resulted in an average absolute density of 0.20 animals/km^2 (95% CI 0.14 – 0.26), equating to a mean abundance of 129 animals (95% CI 92 – 167) (**Table 21A-12**). Similar estimates were derived from both model and design-based approaches to estimate density and abundance (**Figure 21A-31**).

Table 21A-11. Absolute model-based density and abundance estimates of harbour porpoises recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022 (Summer= May – October, Winter= November – April; Year 1= March 2020 – February 2021; Year 2= May S01 2021 – March 2022)

Survey period	Density estimate (n/km²)	Lower 95% CL (n/km²)	Upper 95% CL (n/km²)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	SD (n)	CV (%)
Summer average	0.157	0.095	0.249	105	71	160	21	20.20
Winter average	0.181	0.107	0.270	116	69	173	34	28.88
Total average	0.137	0.015	0.542	145	103	226	29	19.87
Average Year 1	0.311	0.230	0.420	199	147	269	32	16.08
Average Year 2	0.047	0.002	0.245	53	29	90	20	37.81

Table 21A-12. Absolute design-based density and abundance estimates of harbour porpoises recorded in the Llŷr marine megafauna survey area (Summer= May – October, Winter= November – April)

Survey	Date	Raw count (n)	Absolute density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)
Llŷr marine megafauna survey area							
1	25 Mar 2020	3	0.27	174	42	336	44.63
2	14 Apr 2020	1	0.06	38	0	108	94.8
3	08 Jun 2020	12	1.27	813	416	1321	28.99
4	24 Jun 2020	7	0.55	353	114	639	39.7
5	21 Jul 2020	2	0.15	97	0	239	65.65
6	31 Aug 2020	0	0.00	0	0	0	0
7	12 Sep 2020	0	0.00	0	0	0	0
8	22 Oct 2020	4	0.34	220	0	490	56
9	26 Nov 2020	2	0.63	405	112	803	46.27
10	10 Jan 2021	0	0.00	0	0	0	0
11	25 Jan 2021	3	0.22	141	0	375	74.1
12	22 Feb 2021	4	0.38	240	60	467	43.33
13	14 May 2021	2	0.13	83	0	204	67.46
14	27 May 2021	3	0.19	122	0	324	72.59
15	15 Jun 2021	0	0.00	0	0	0	0
16	14 Jul 2021	0	0.00	0	0	0	0
17	16 Aug 2021	0	0.00	0	0	0	0
18	01 Sep 2021	1	0.08	53	0	167	101.78
19	22 Oct 2021	0	0.00	0	0	0	0
20	20 Nov 2021	1	0.09	58	0	173	97.53
21	16 Dec 2021	1	0.09	56	0	211	95.42
22	05 Jan 2022	0	0.00	0	0	0	0
23	26 Feb 2022	3	0.28	180	0	529	95.93
24	20 Mar 2022	9	0.11	74	8	163	54.08
Average Year 1 (1 – 12)		-	**0.323**	**207**	**142**	**272**	**55.73**
Average Year 2 (13 – 24)		-	**0.081**	**52**	**15**	**89**	**125.22**
Total average		-	**0.202**	**129**	**92**	**167**	**72.35**
Summer average		-	**0.203**	**130**	**80**	**180**	**68.36**
Winter average		-	**0.201**	**129**	**73**	**185**	**76.18**

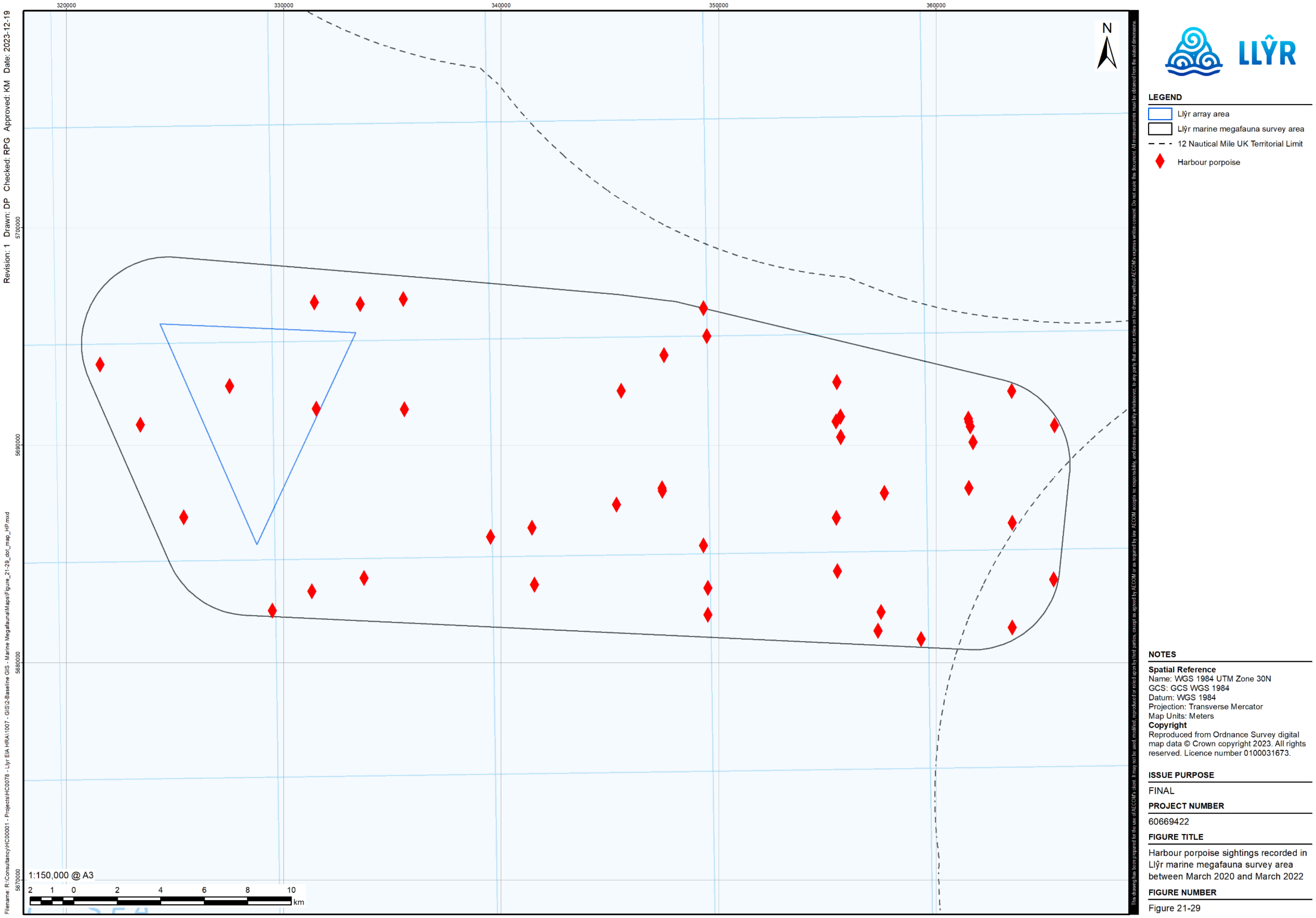


Figure 21A-29. Harbour porpoise sightings recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022

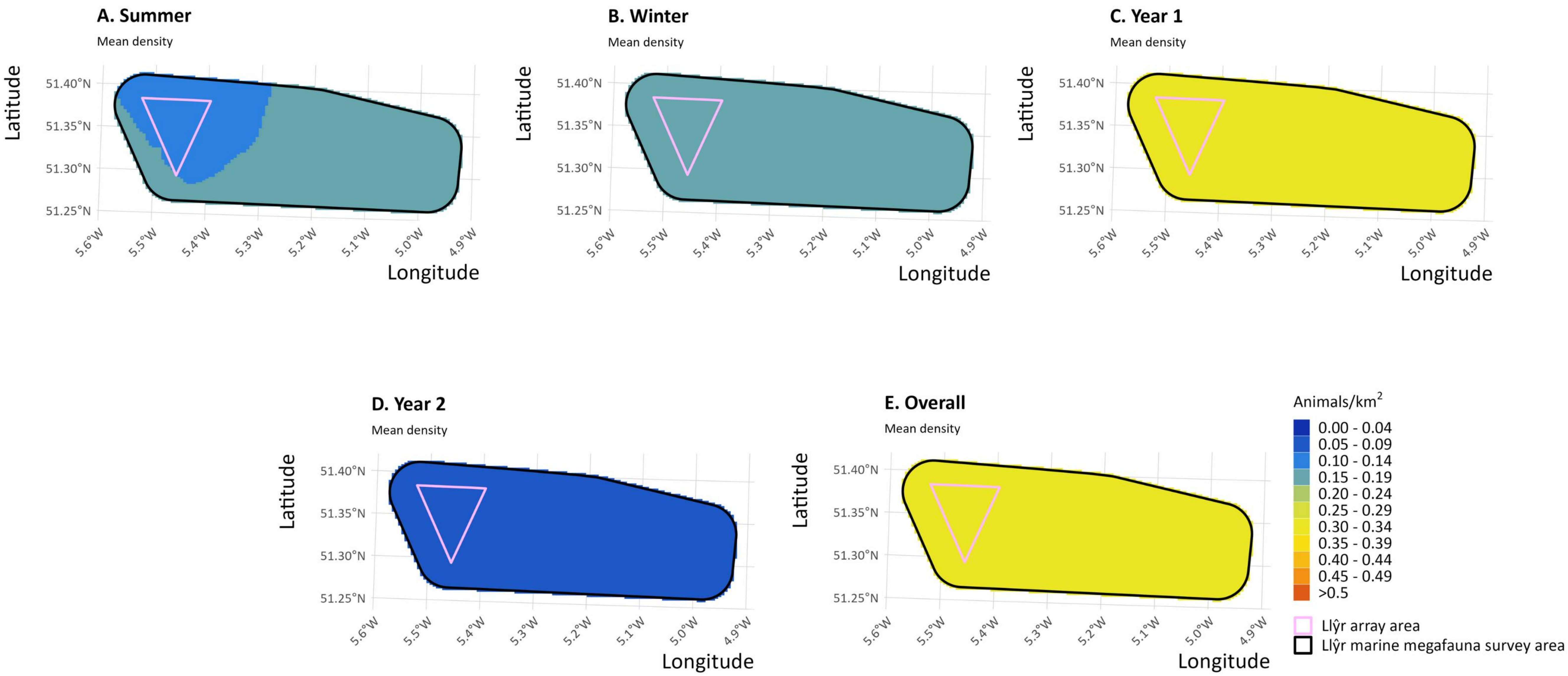


Figure 21A-30. Mean model-based density surface for harbour porpoise in the Llŷr marine megafauna survey area during the summer (A), winter (B), Year 1 (C), Year 2 (D) and full survey period (E)

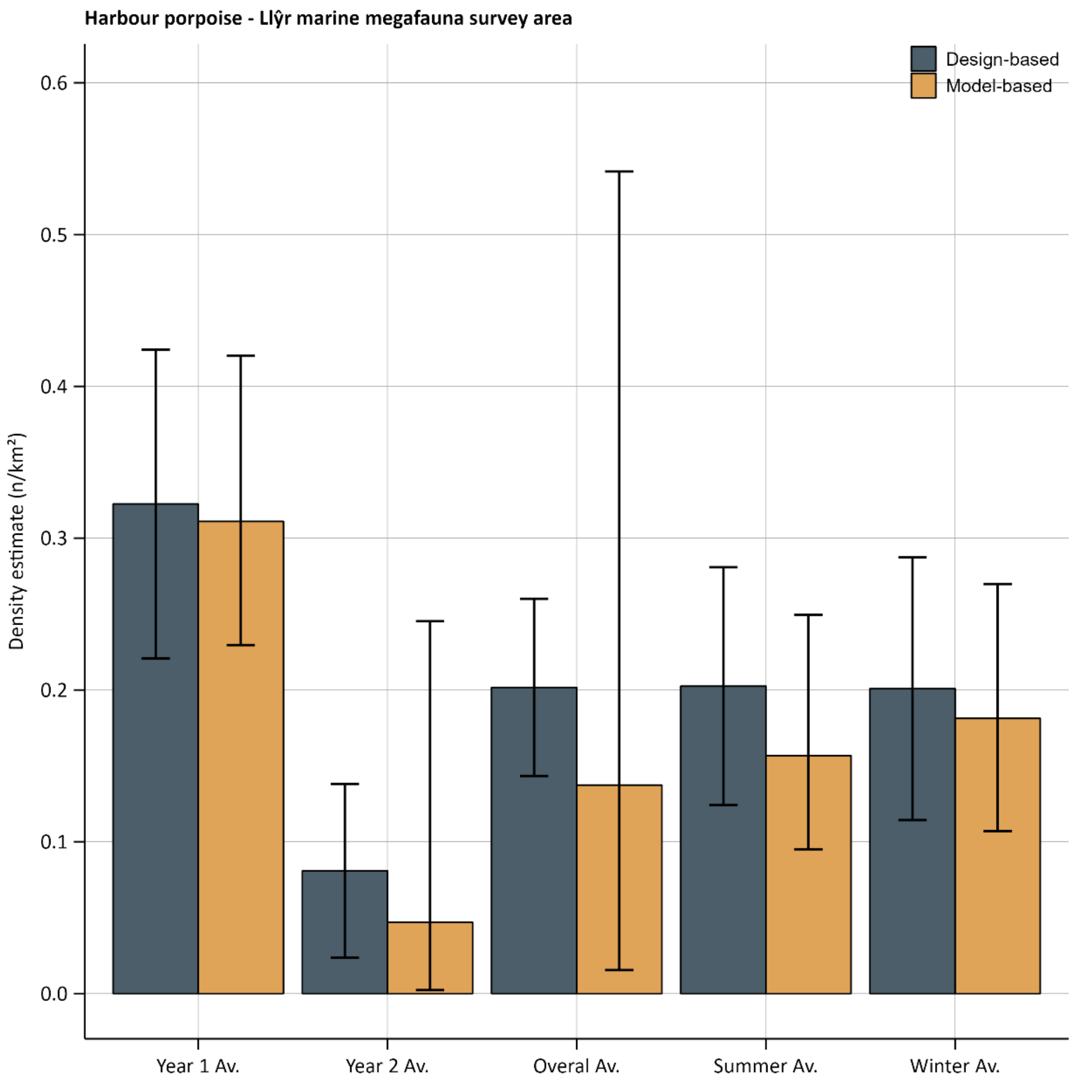


Figure 21A-31. Comparison of design- and model-based density estimates of harbour porpoise per survey period in the Llŷr marine megafauna survey area

Project Erebus Surveys

70. Throughout the two-year survey period across the Erebus survey area, a total of 83 harbour porpoise were recorded sporadically (22 in Year 1, 61 in Year 2) (**Table 21A-13**) (Darias-O'Hara *et al.*, 2021).

71. When observed, relative harbour porpoise estimates ranged from 0.02 porpoise/km^2 (December 2019 and June S01 2020) to 0.16 porpoise/km^2 (January 2020 and March 2020) in Year 1 and 0.02 porpoise/km^2 (December 2020) to 0.47 porpoise/km^2 (March 2021) in Year 2, equating to 4 porpoise (95% CI 0 – 12) and 32 porpoise (95% CI 8 – 65) and (95% CI 8 – 59), respectively in Year 1 and 4 porpoise (95% CI 0 – 12) and 94 porpoise (95% CI 27 – 198), respectively in Year 2. The average relative density over the 24-month period was estimated at 0.07 porpoise/km^2 (**Table 21A-13**) (Darias-O'Hara *et al.*, 2021).

72. Absolute density estimates were also provided, corrected using diving rates recorded by Teilmann *et al.* (2013) in the North Sea. This resulted in an absolute density estimate over the 24-month period of 0.40 porpoise/km^2.

73. No clear seasonal pattern can be depicted from the low number of sightings, however, the month of March recorded the most sightings in each year of survey. Overall, harbour porpoise

were observed across the whole survey area, without particular distribution pattern (**Table 21A-13** and **Figure 21A-32**) (Darias-O'Hara *et al.*, 2021).

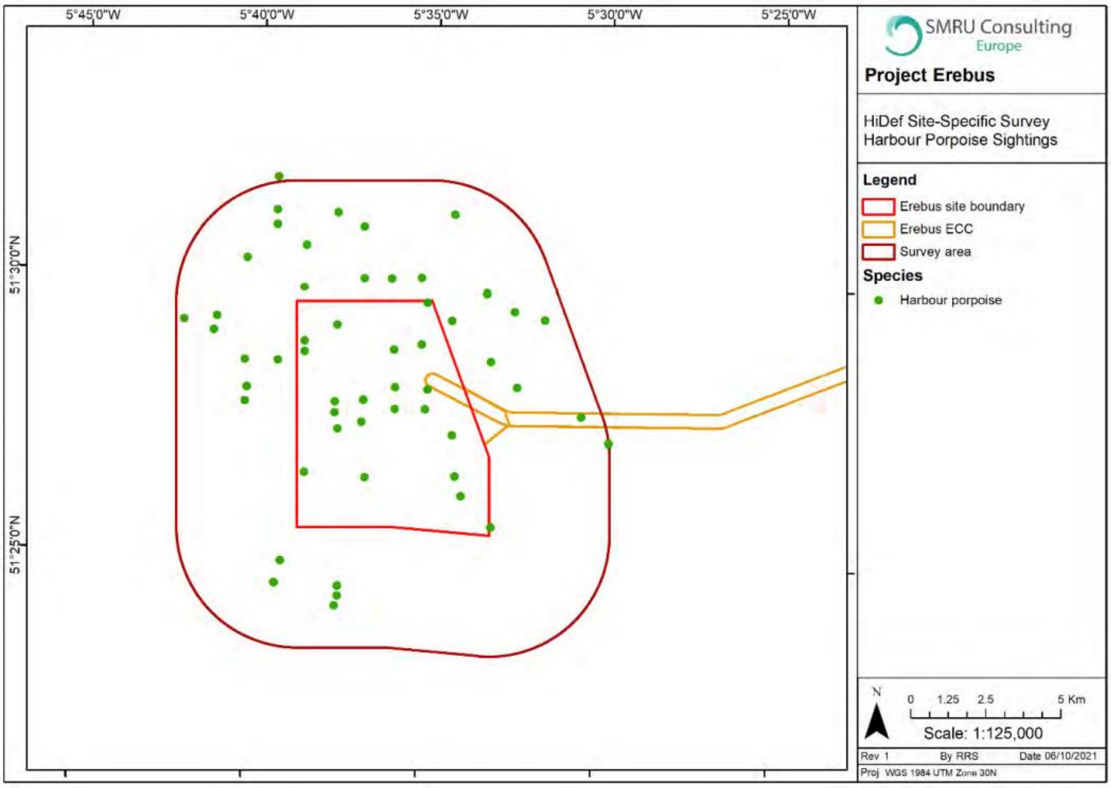


Figure 21A-32. Harbour porpoise sightings recorded in the Erebus survey area between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Table 21A-13. Raw count, relative density and abundance estimates of harbour porpoise recorded in the Erebus survey area (development area plus a 4 km buffer) between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Survey	Date	Raw count (n)	Relative estimates					Absolute estimates			
			Density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)	Density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)
1	22 Oct 19	0	0.00	0	0	0	0.00	0.00	0	0	0
2	08 Nov 19	0	0.00	0	0	0	0.00	0.00	0	0	0
3	04 Dec 19	1	0.02	4	0	12	0.95	0.13	26	0	77
4	18 Jan 20	8	0.16	32	8	65	0.48	0.90	181	45	379
5	04 Feb 20	0	0.00	0	0	0	0.00	0.00	0	0	0
6	03 Mar 20	8	0.16	32	8	59	0.41	0.82	163	41	301
7	04 Apr 20	0	0.00	0	0	0	0.00	0.00	0	0	0
8	08 Jun 20	1	0.02	4	0	12	0.98	0.11	21	0	64
9	24 Jun 20	0	0.00	0	0	0	0.00	0.00	0	0	0
10	23 Jul 20	0	0.00	0	0	0	0.00	0.00	0	0	0
11	31 Aug 20	4	0.08	16	0	39	0.66	0.42	84	0	204
12	12 Sep 20	0	0.00	0	0	0	0.00	0.00	0	0	0
13	15 Oct 20	8	0.15	31	0	87	0.82	1.07	221	0	590
14	22 Nov 20	0	0.00	0	0	0	0.00	0.00	0	0	0
15	31 Dec 20	2	0.02	4	0	12	0.95	0.13	26	0	77
16	16 Jan 21	0	0.00	0	0	0	0.00	0.00	0	0	0
17	22 Feb 21	23	0.45	91	50	135	0.24	3.13	633	341	940
18	05 Mar 21	24	0.47	94	27	198	0.50	2.4	485	138	1,020
19	10 Apr 21	2	0.04	8	0	24	0.97	0.17	34	0	103
20	14 May 21	0	0.00	0	0	0	0.00	0.00	0	0	0
21	15 Jun 21	2	0.04	8	0	24	0.93	0.21	43	0	128
22	14 Jul 21	0	0.00	0	0	0	0.00	0.00	0	0	0
23	16 Aug 21	0	0.00	0	0	0	0.00	0.00	0	0	0
24	01 Sep 21	0	0.00	0	0	0	0.00	0.00	0	0	0

Survey	Date	Raw count (n)	Relative estimates					Absolute estimates			
			Density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)	Density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)
Average Year 1 (1 – 12)		-	**0.04**	**7**	-	-	-	**0.20**	**40**	-	**-**
Average Year 2 (13 – 24)		-	**0.10**	**20**	-	-	-	**0.59**	**120**	-	**-**
Total average		-	**0.07**	**14**	-	-	-	**0.40**	**80**	-	**-**

Welsh Marine Atlas and Cetaceans and Seabirds of Wales

74. Between 1990 and 2009, a total of 13,056 harbour porpoise sightings, amounting to 35,700 individuals, were recorded in the Welsh Marine Atlas database (**Figure 21A-33**) (Baines and Evans, 2012). Harbour porpoise was the most abundant species recorded in the Welsh Marine Atlas database and third most in the Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023; **Figure 21A-34**).

75. The majority of sightings were recorded along the Welsh and Irish coasts, with many sightings recorded in Swansea Bay, just north of the proposed Project and Irish Sea (**Figure 21A-33** and **Figure 21A-34**). Modelled densities peaked in the summer months, between July and September, and were at their lowest between January and March (**Figure 21A-35**), although it should be noted that survey effort was not equivalent in each month and reduced for aerial surveys compared to boat-based surveys (Baines and Evans, 2012; Evans and Waggitt, 2023).

76. Within the Llŷr marine megafauna survey area, a mean maximum relative density of 0.087 individuals/km^2 was estimated (Evans and Waggitt, 2023).

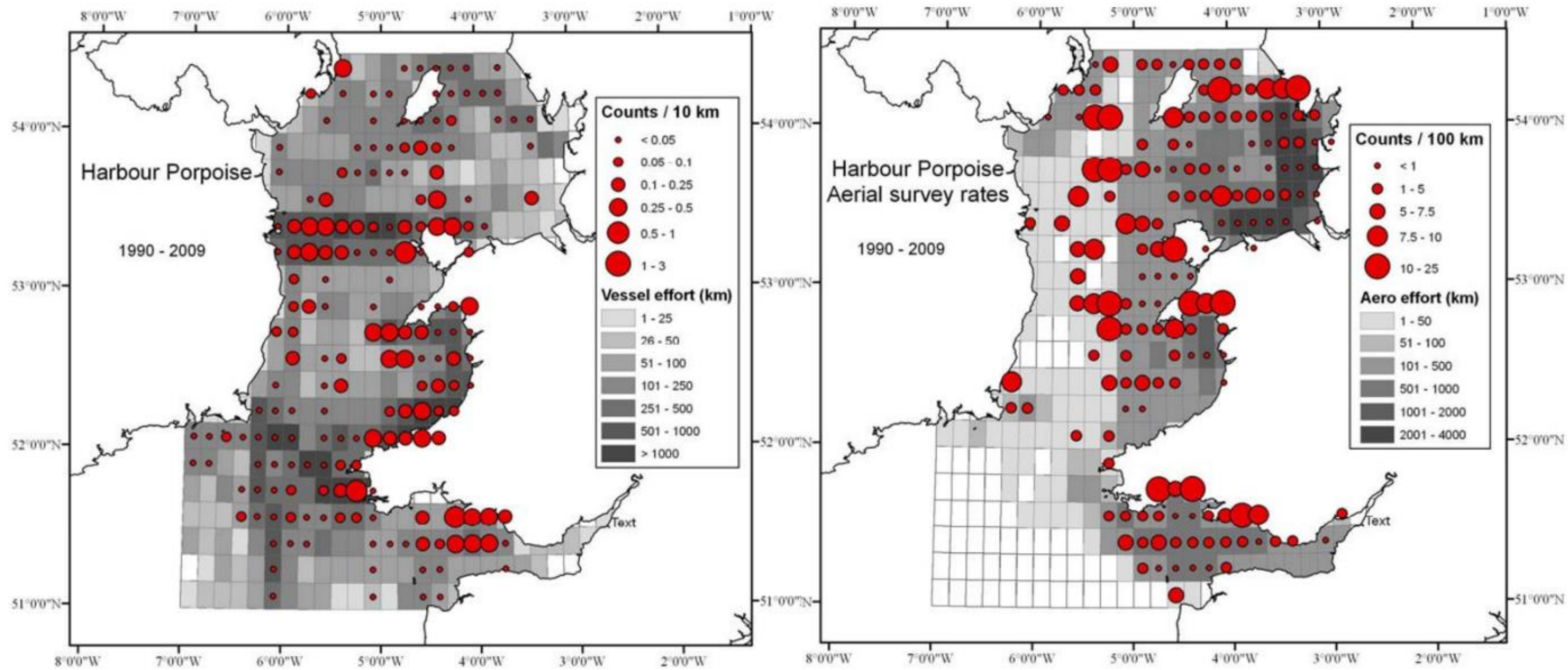
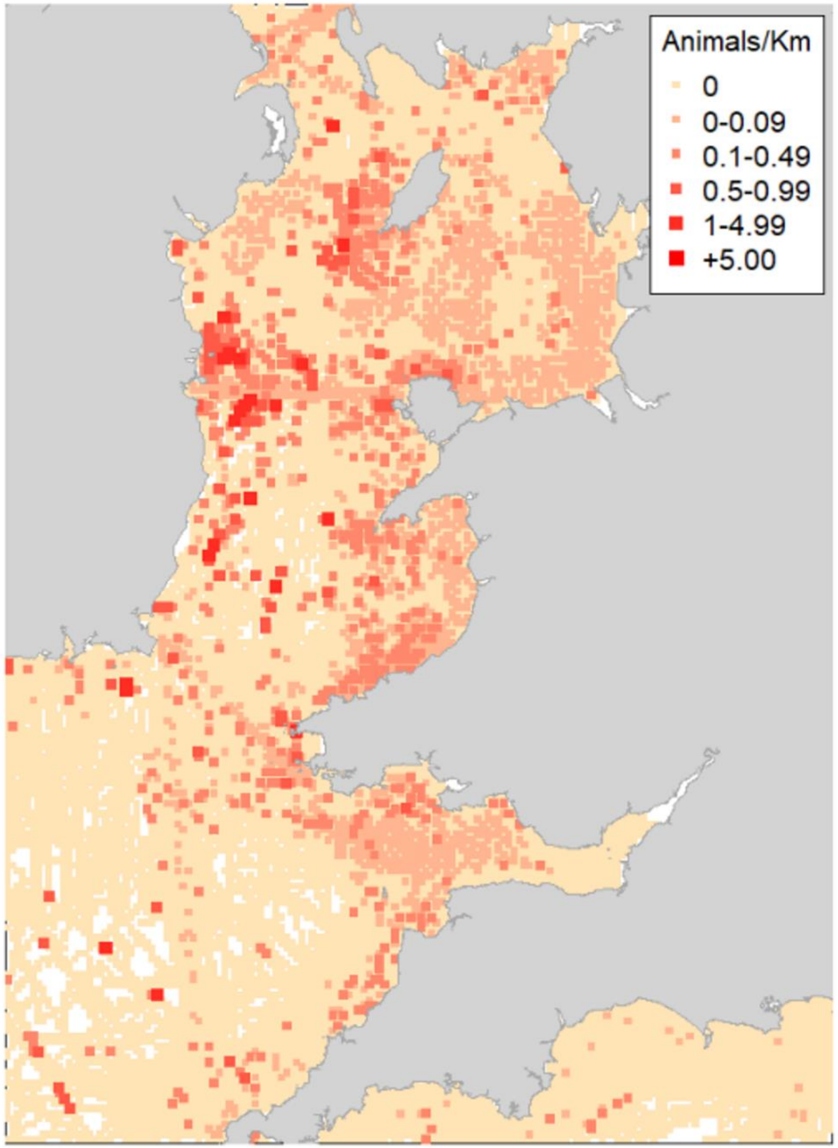


Figure 21A-33. Long-term mean sighting rates of harbour porpoise with vessel counts per 10 km and aerial counts per 100 km collected between 1990 and 2009 (Baines and Evans, 2012)



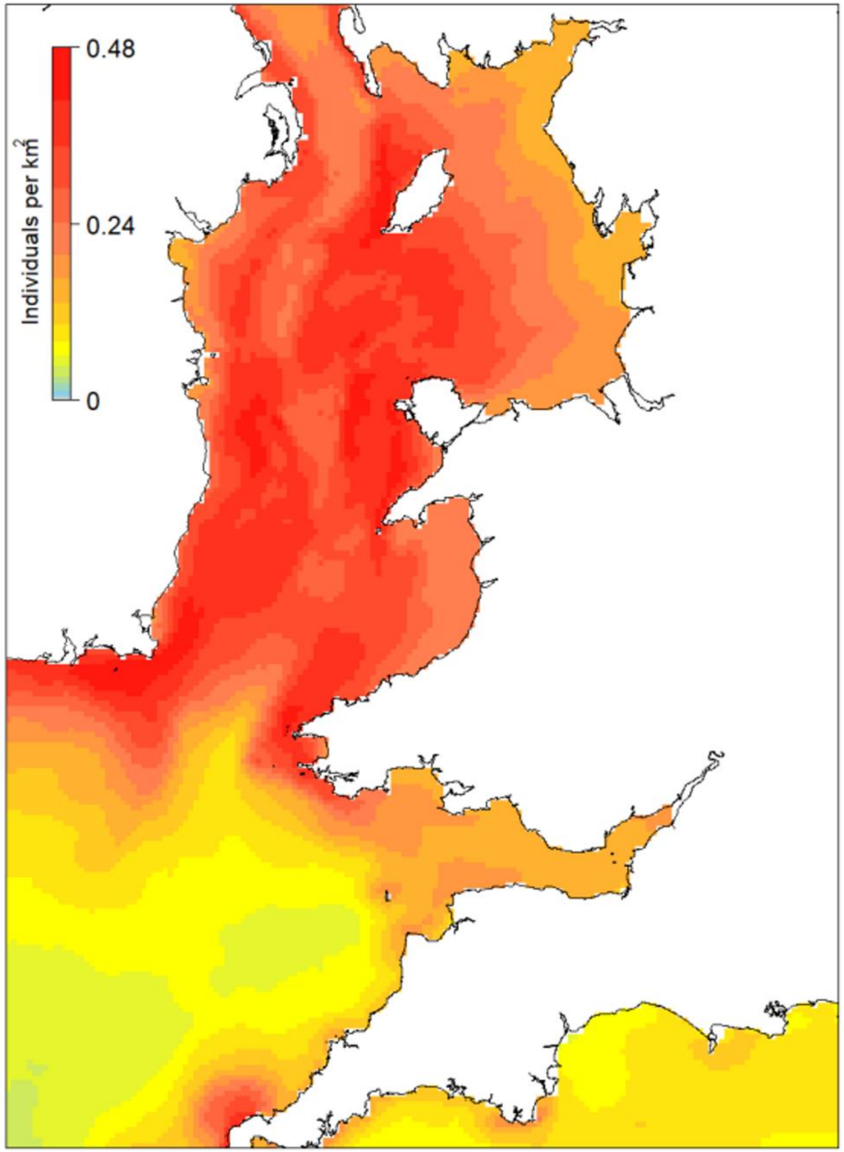


Figure 21A-34. Harbour porpoise sighting rate (n/km; left) and modelled densities (n/km^2; right) between 1990 and 2020 (Evans and Waggitt, 2023)

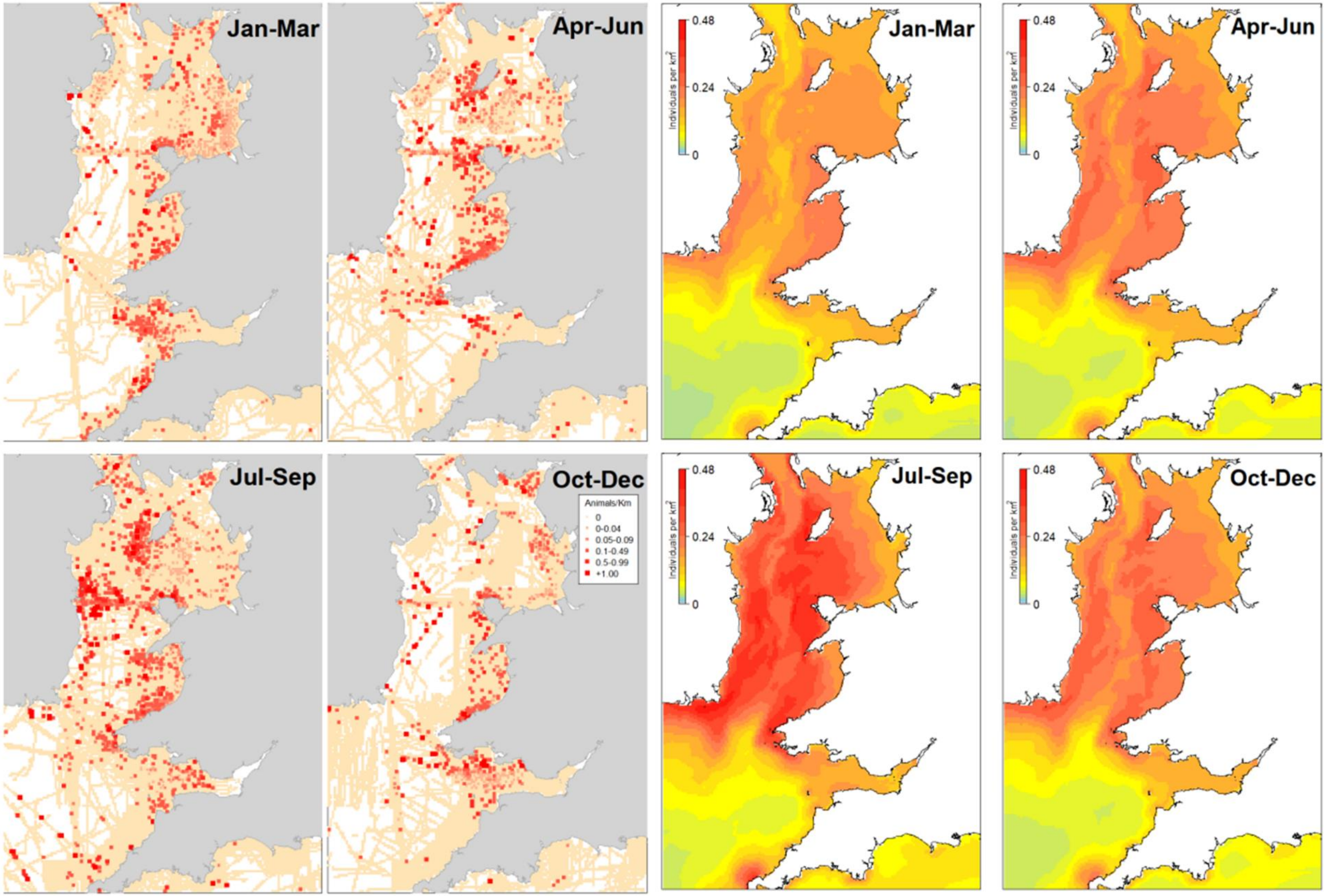


Figure 21A-35. Harbour porpoise sightings rates (n/km; left) and mean modelled densities (n/km^2; right) by quarter over the 1990-2020 period (Evans and Waggitt, 2023)

SCANS-III and IV Surveys

77. During the July 2016 aerial survey (SCANS-III), a total of 1,602 harbour porpoise were sighted in primary[4] search effort, mainly recorded in the North Sea. In Block D, the estimated absolute density was 0.118 porpoise/km^2 (0.489 CV) with a corresponding abundance of 5,734 porpoise (95% CI 1,697 – 12,452) (**Figure 21A-36**) (Hammond *et al.*, 2021).

78. During the June - August 2022 aerial surveys (SCANS-IV), a total of 2,045 harbour porpoise were sighted in primary search effort, mainly observed in the North Sea, Belt Sea and Irish Sea. In Block CS-C, the estimated absolute density was 0.016 porpoise/km^2 (0.506 CV) with a corresponding abundance of 564 porpoise (95% CI 104 – 1,183) (**Figure 21A-36**) (Gilles *et al.*, 2023).

79. Density surface models using SCANS-III data (Lacey *et al.,* 2022) also suggest harbour porpoise density is highest in the North Sea and between Denmark and Sweden (**Figure 21A-37**). Around the Llŷr marine megafauna survey area, surface densities were estimated to range between 0.00 and 0.25 porpoise/km^2 (Lacey *et al.*, 2022).

[4] Primary search effort relates to the observations made from the primary survey platform. Tracker observations used for mark and recapture data for the estimation of the detection probability (Hammond *et al.,* 2021).

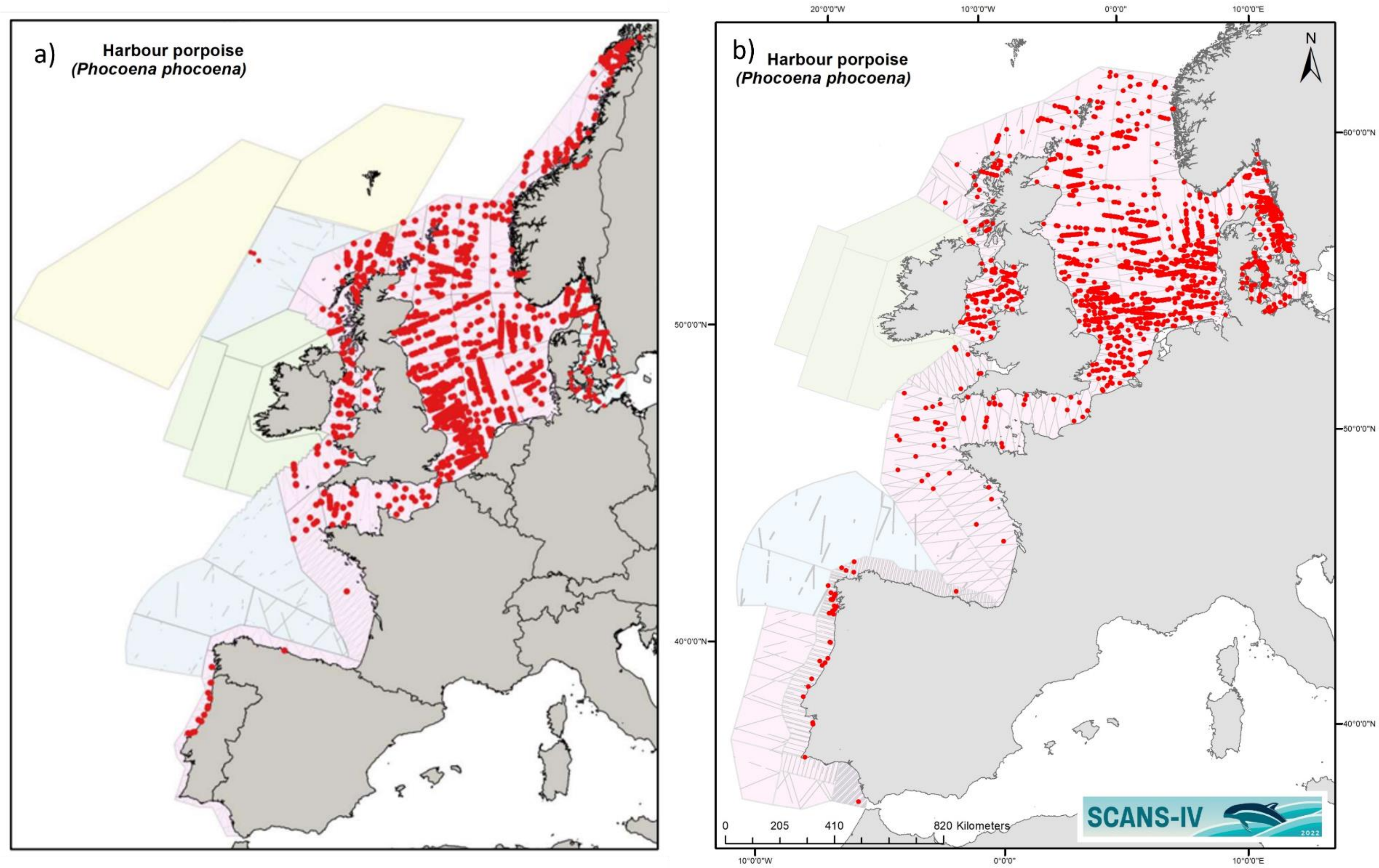


Figure 21A-36. Harbour porpoise sightings collected during the SCANS-III (a) and IV (b) surveys flown in July 2016 (Hammond et al., 2021) and between June and August 2022 (Gilles et al., 2023). Refer to Figure 21A-8 for Block identification

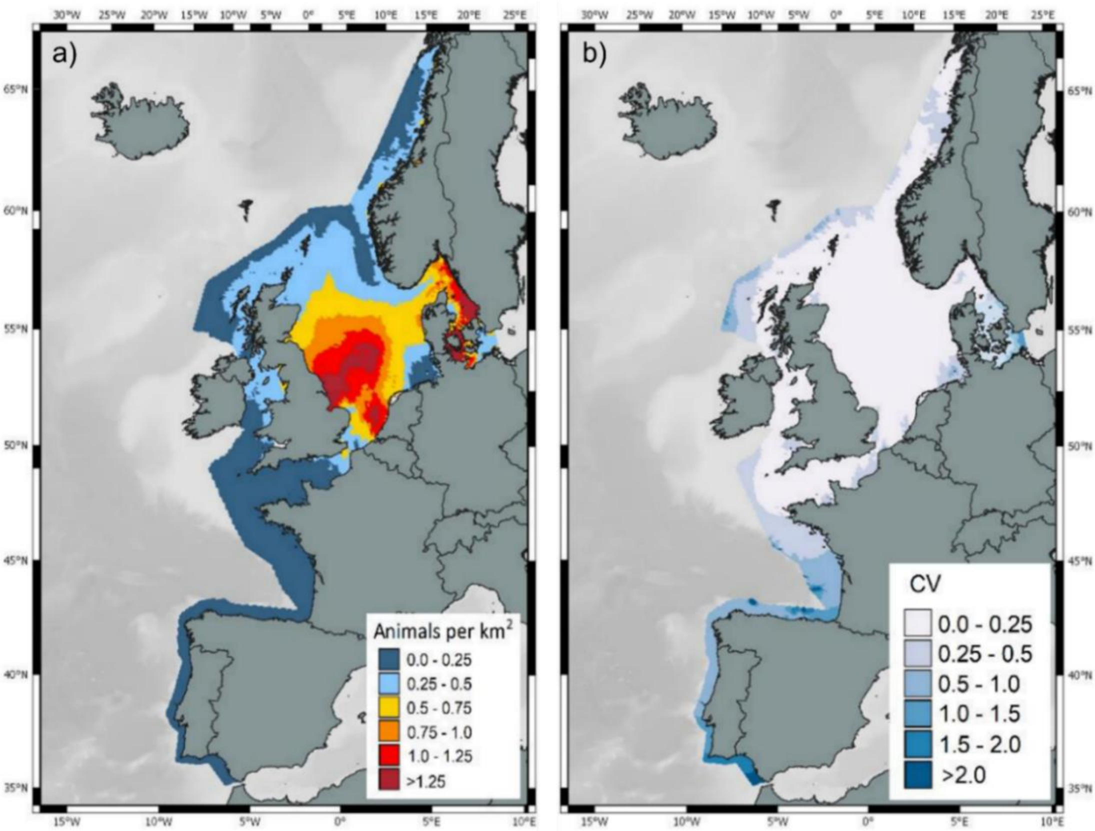


Figure 21A-37. Estimated surface density (a) and associated CV (b) for harbour porpoise in SCANS-III (2016) (Lacey et al., 2022)

ObSERVE Surveys

80. Harbour porpoise was the second most frequently sighted cetacean in the ObSERVE surveys, with sightings occurring primarily in coastal waters, especially in the Irish Sea, as well as in the Celtic Deep (**Figure 21A-38**) (Rogan *et al.*, 2018). Throughout the survey area and survey period, porpoise abundance was consistently greater during summer months in both Strata 4 and 5 (**Figure 21A-39**). However, mean group sizes were larger during the winter (approximately two individuals) than during the summer (approximately one individual) (**Table 21A-14**).

81. A total of 94 groups were observed in Stratum 4 (mean size of one individual) throughout the first three seasons, while 105 individual groups of mean size ranging from one to two individuals were recorded in Stratum 5 throughout the survey period. No harbour porpoises were recorded in winter 2016 in Stratum 4 (Celtic Seas) (Rogan *et al.*, 2018).

82. Absolute density estimates for harbour porpoise were calculated using design- and model-based methods. Absolute design-based densities in Stratum 4 ranged from 0.060 porpoise/km^2 (winter 2015) to 0.227 porpoise/km^2 (summer 2015 and 2016), equating to 3,752 porpoise (95% CI 2,345 – 6,002), 14,190 porpoise (95% CI 10,792 – 18,658) and 14,196 porpoise (95% CI 9,363 – 21,524), respectively (**Table 21A-14**). Absolute design-based estimates for Stratum 5 ranged from 0.696 porpoise/km^2 (summer 2015) to 1.046 porpoise/km^2 (summer 2016), equating to 7,734 porpoise (95% CI 5,248 – 11,398) and 11,625 porpoise (95% CI 8,726 – 15,486), respectively (**Table 21A-14**). Absolute model-based density estimates were only available for summer 2015 and 2016 and resulted in lower densities than design-based estimates (**Table 21A-14**).

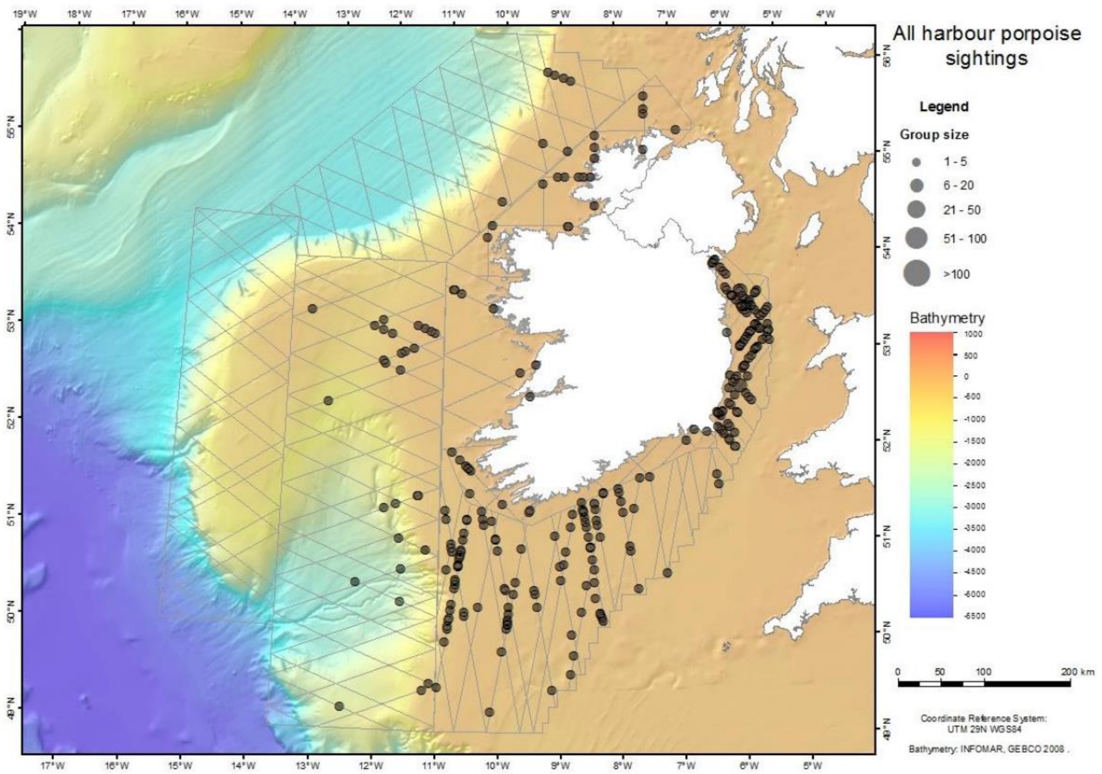


Figure 21A-38. Harbour porpoise sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

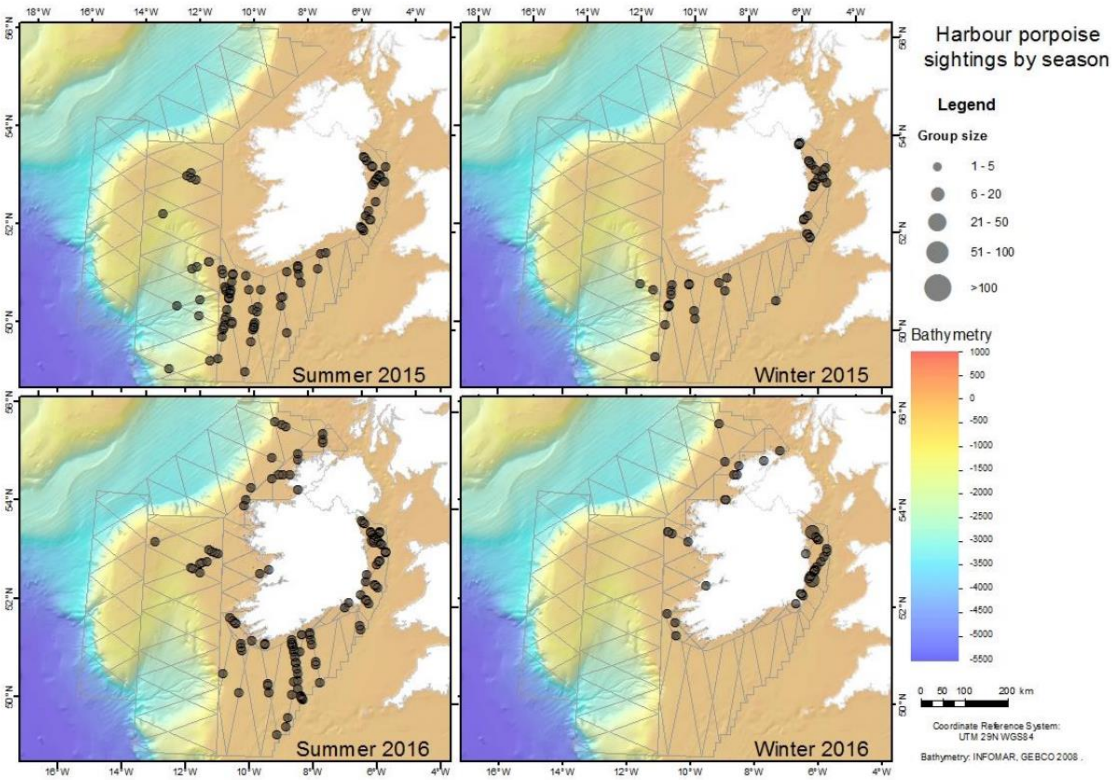


Figure 21A-39. Seasonal harbour porpoise sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

Table 21A-14. Harbour porpoise absolute design-based and model-based density and abundance estimates for Strata 4 and 5 of the ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018) (n/a[1] = no sightings data; n/a[2] = too few sightings to generate model-based estimates)

Stratum	Season	Absolute design-based estimates				Absolute model-based estimates			
		Density (n/km²)	Abundance (n)	Lower 95% CL	Upper 95% CL	Density (n/km²)	Abundance (n)	Lower 95% CL	Upper 95% CL
Stratum 4	Summer 2015	0.227	14,190	10,792	18,658	0.205	12,810	8,114	20,223
	Winter 2015	0.060	3,752	2,345	6,002	n/a[2]			
	Summer 2016	0.227	14,196	9,363	21,524	0.222	13,921	10,046	19,292
	Winter 2016	n/a[1]				n/a[1]			
Stratum 5	Summer 2015	0.696	7,734	5,245	11,398	0.675	7,495	4,789	11,729
	Winter 2015	0.867	9,636	5,634	16,483	n/a[2]			
	Summer 2016	1.046	11,625	8,726	15,486	0.942	10,466	7,928	13,816
	Winter 2016	0.924	10,264	7,555	13,943	n/a[2]			

JCP Phase III

83. Across the 17 years of data collected in the JCP Phase III report, 20,032 harbour porpoise sightings were recorded, ranging from 104 sightings in 1998 to 3,700 sightings in 2009. The latest year of data, 2010, recorded a total of 1,381 sightings. Maps of predicted density for summer 2010 suggest relatively low densities for the species around the UK, with much greater densities predicted in the north of Scotland, southeast and southwest of England (**Figure 21A-40** and **Figure 21A-41**). In the Atlantic Array, an area covering 1.8% of the Celtic and Greater North Sea MU, estimated abundance for 2010 was slightly greater in winter and summer than in spring and autumn (absolute density of 0.433 animals/km^2 and 0.438 animals/km^2, respectively). The average absolute density across all seasons was estimated as 0.384 animals/km^2 (**Table 21A-15**, **Figure 21A-40** and **Figure 21A-41**) (Paxton *et al.*, 2016).

Table 21A-15. Harbour porpoise absolute density and abundance estimates for 2010 in the Atlantic Array (19,649 km^2) based on the JCP Phase III data (Paxton et al., 2016)

Season	Absolute density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)
Winter	0.433	8,500	5,100	12,800
Spring	0.361	7,100	4,300	12,700
Summer	0.438	8,600	5,600	13,300
Autumn	0.305	6,000	4,100	9,900
Average	**0.384**	**7,233**	**-**	**-**

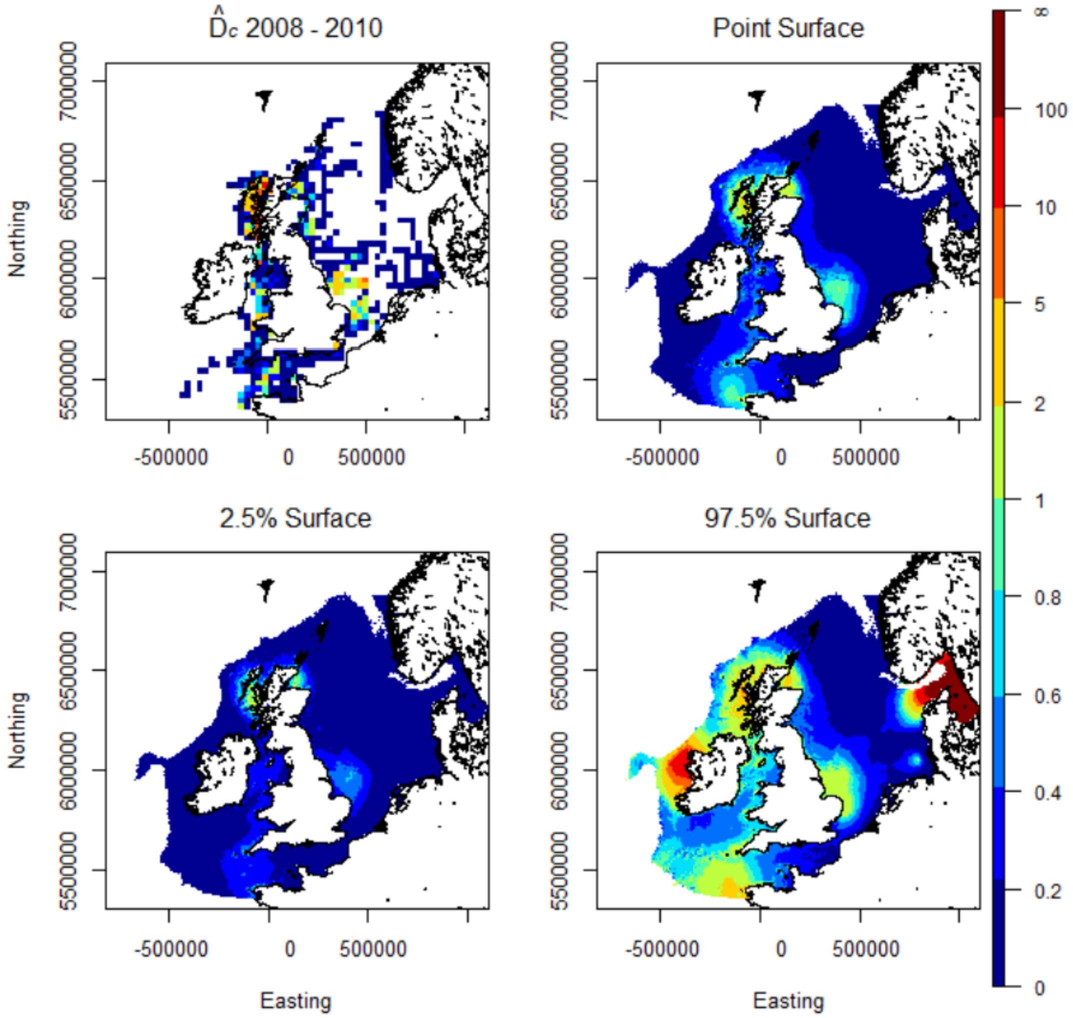


Figure 21A-40. Predicted densities ($\hat{D}_c$) of harbour porpoise for the summer 2010 (Paxton et al., 2016). Top left map represents the input densities of summers from all years. Top right map represents the predicted densities for the summer 2010. Bottom maps represent the 95% CL density estimates

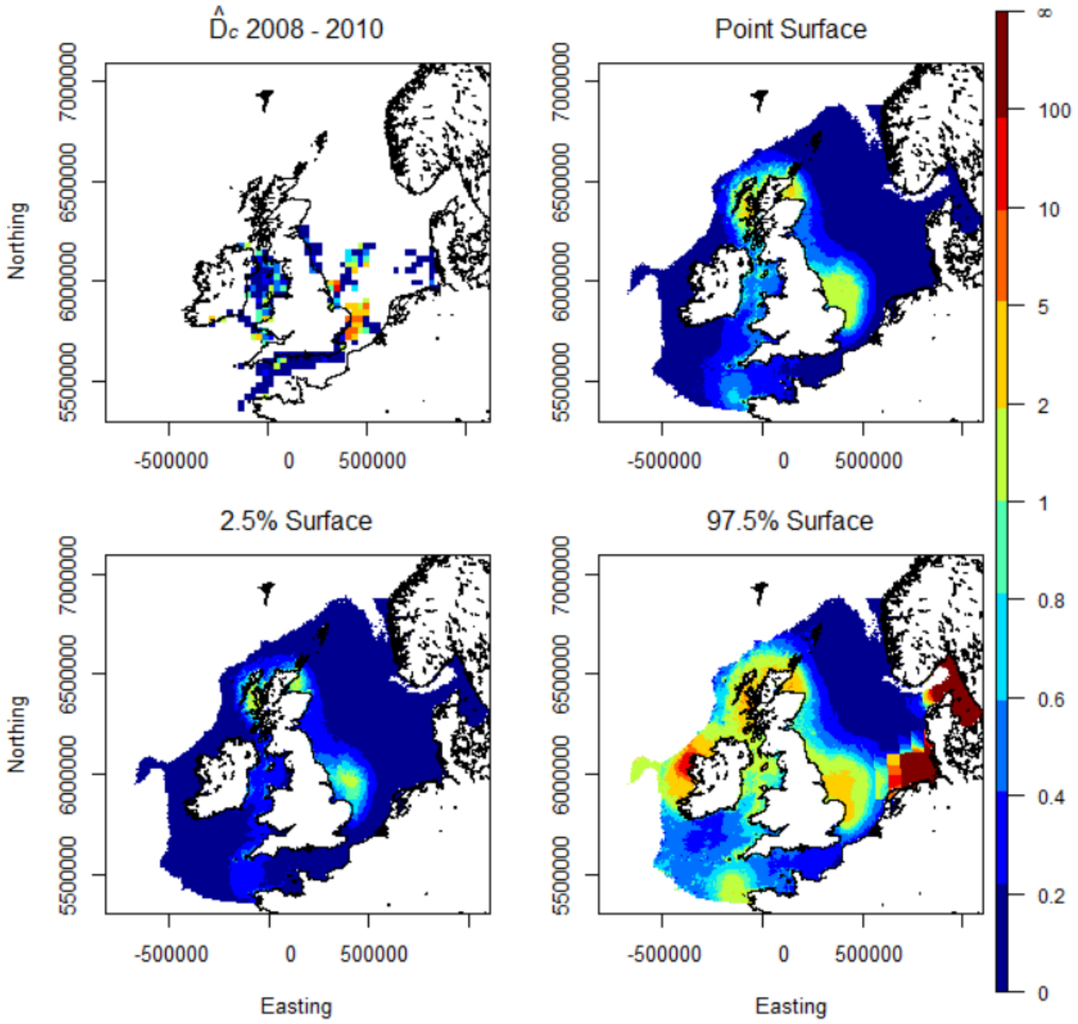


Figure 21A-41. Predicted densities ($\hat{D}_c$) of harbour porpoise for the winter 2010 (Paxton et al., 2016). Top left map represents the input densities of winters from all years. Top right map represents the predicted densities for the winter 2010. Bottom maps represent the 95% CL density estimates

UK Harbour Porpoise Density for the Purpose of Identifying SACs

84. Using survey data on harbour porpoise from the JCP database (1994 – 2011), Heinänen and Skov (2015) provided comparative maps of the 'discrete and persistent' areas of relatively high density of harbour porpoise between periods (1994-1999, 2000-2005 and 2006-2011) and seasons (summer: April to September, winter: October to March) (**Figure 21A-42**). Relatively higher densities around the Array Area were predicted during the winter compared to the summer period ((**Figure 21A-43**), during which higher density areas of harbour porpoise were predicted off northwest Wales rather than in the south, even though a strong variation between years was predicted (Heinänen and Skov, 2015).

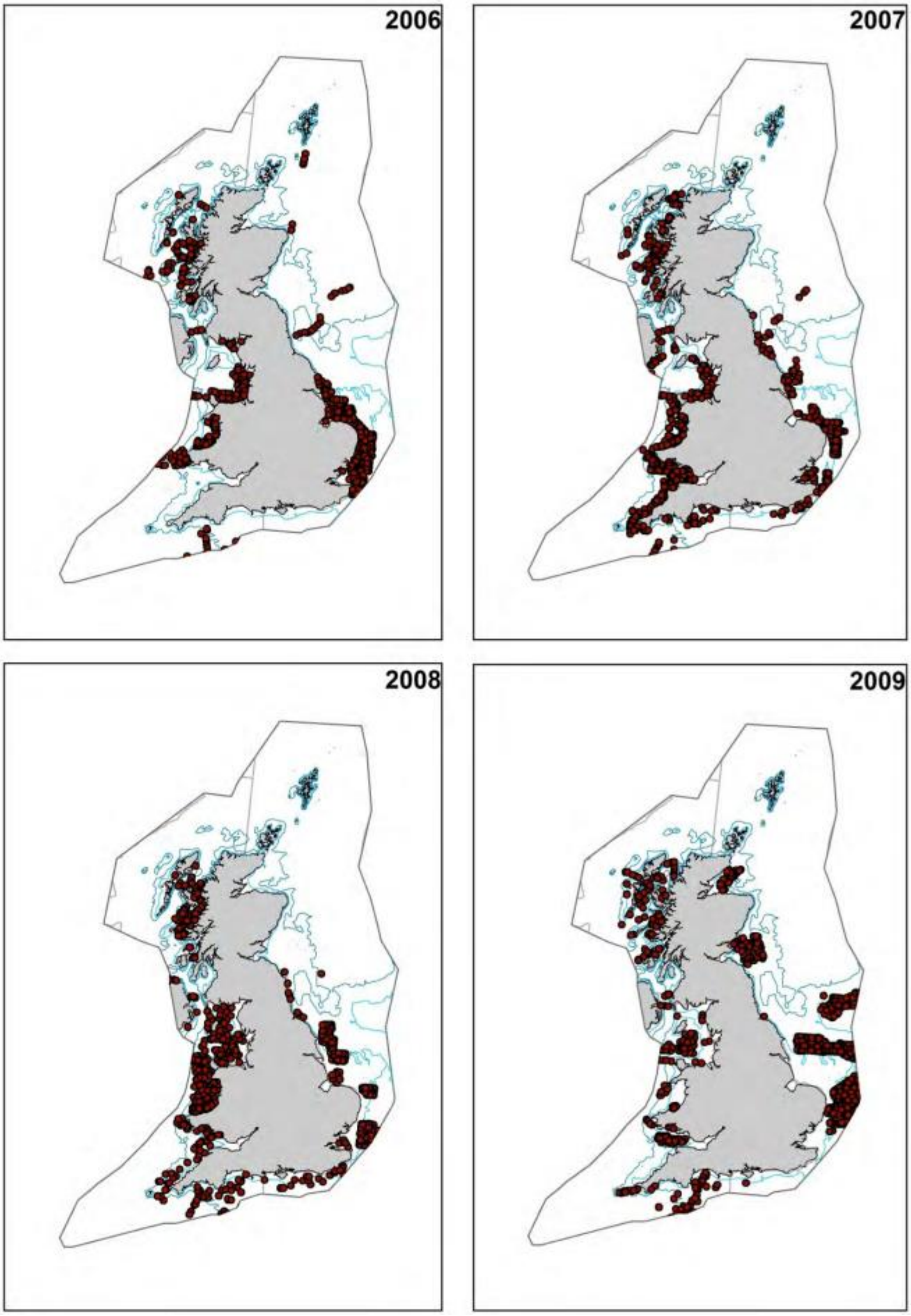


Figure 21A-42. Harbour porpoise observations collected from the JCP database and used for the Heinänen and Skov study (2015)

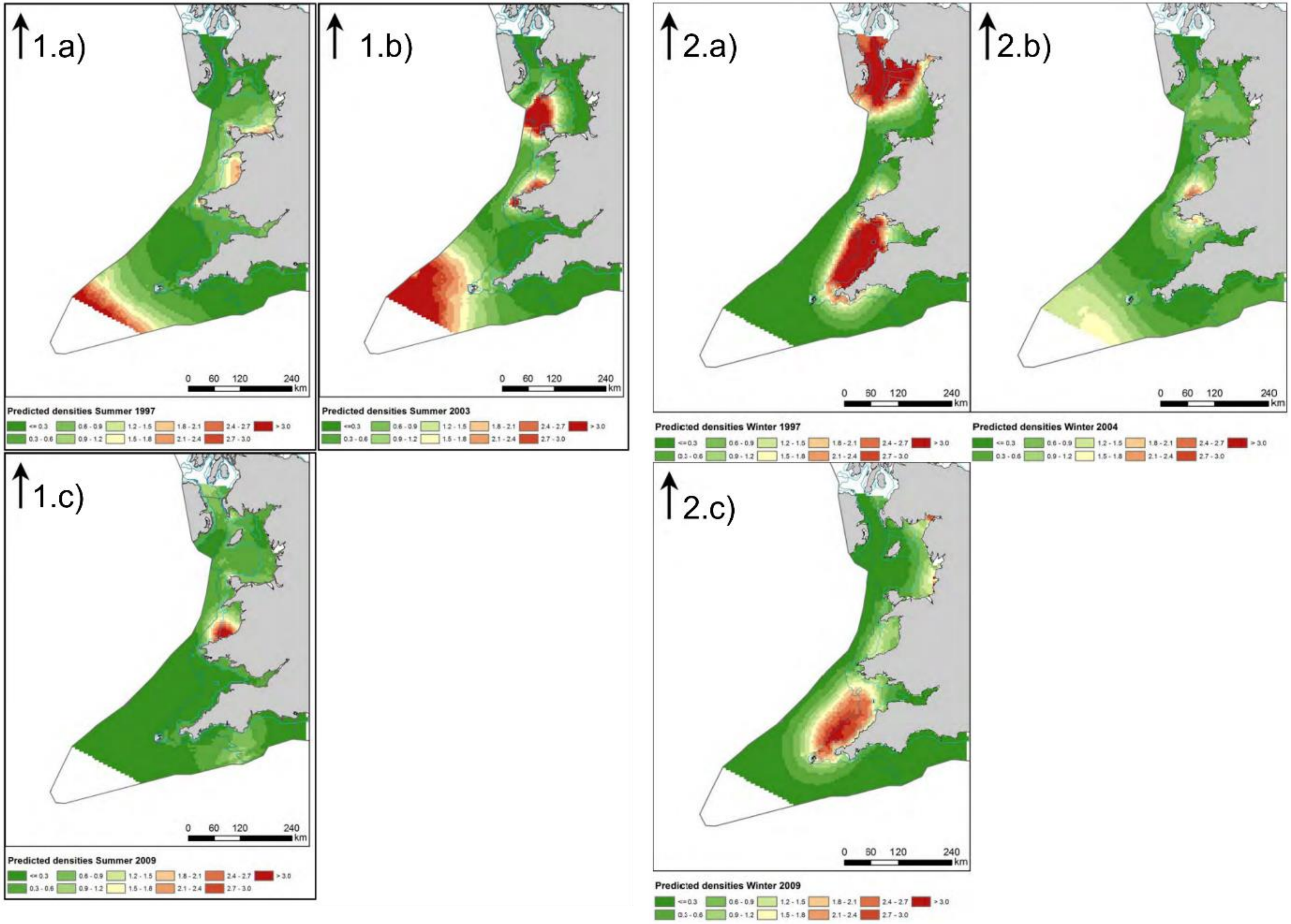


Figure 21A-43. Predicted density (porpoise/km^2) during the summer (1) and winter (2) in 1997 (a), 2004 (b) and 2009 (c) (Heinänen and Skov, 2015)

MERP Surveys and Distribution Maps of Cetacean and Seabird Populations in the Northeast Atlantic

85. A total of 41,685 harbour porpoise sightings amounting to 63,958 individuals were recorded between 1980 and 2018 via aerial and boat-based surveys (Waggitt *et al.*, 2019). The predicted monthly distribution maps show an increased presence of harbour porpoise in UK waters and in the Celtic Sea around the Array Area in the summer (July to September) (**Figure 21A-44** and **Figure 21A-45**).

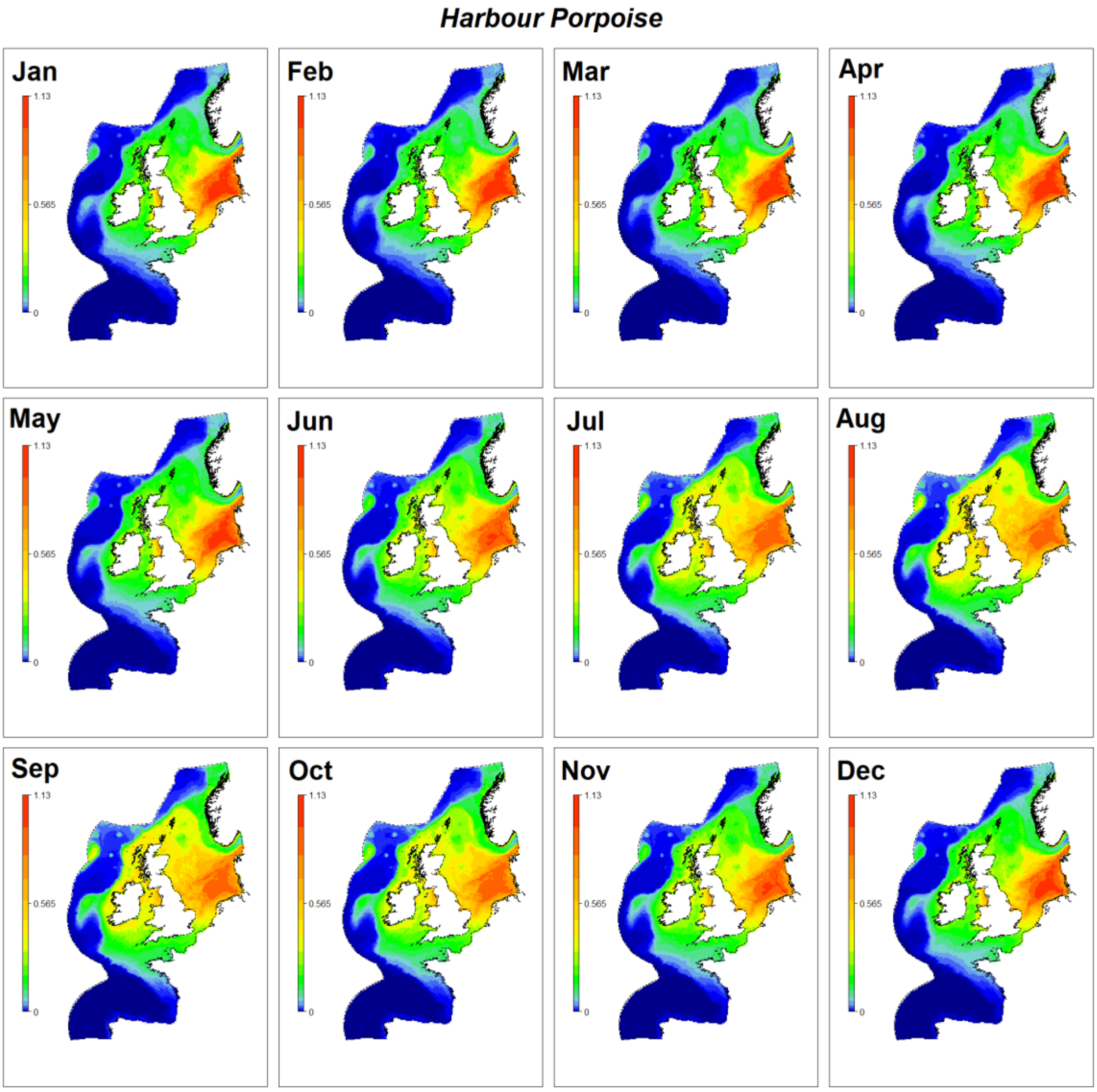


Figure 21A-44. Monthly predicted densities (animals/km^2) of harbour porpoise in the Northeast Atlantic (values provided at 10 km resolution) (Waggitt et al., 2019)

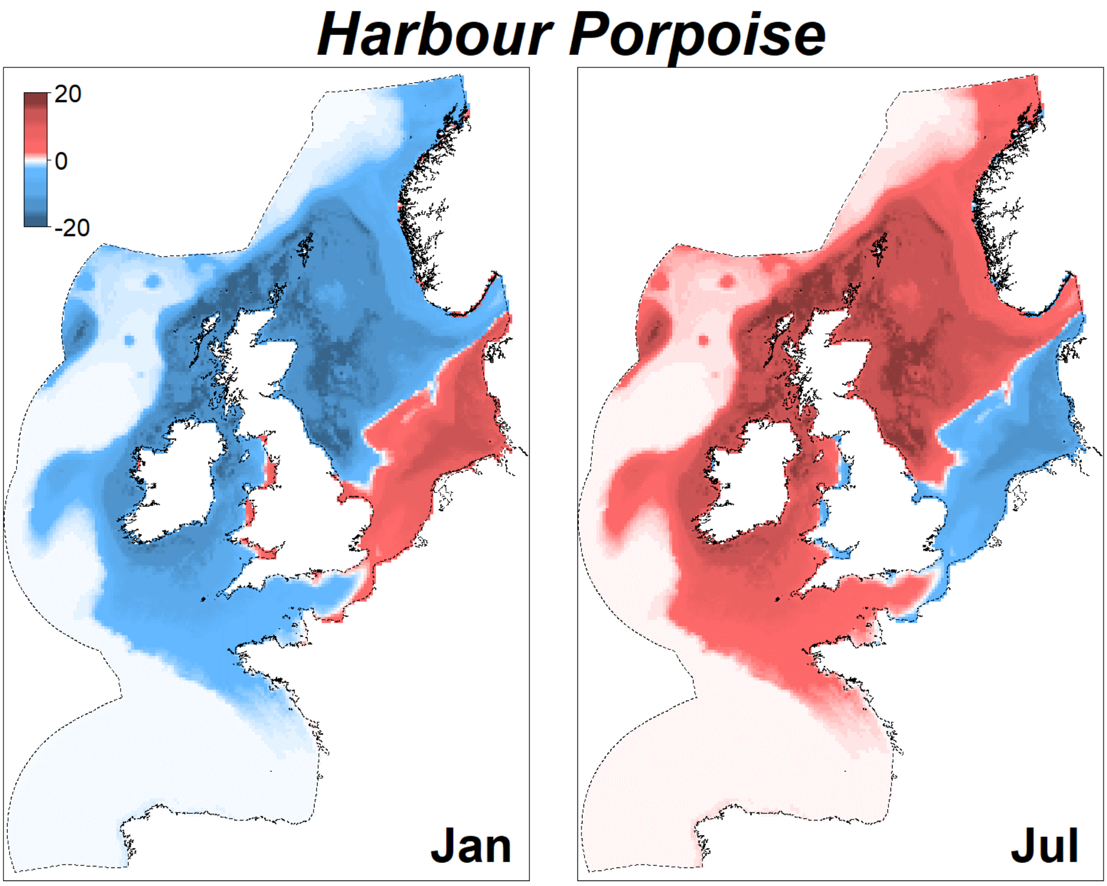


Figure 21A-45. Difference in predicted densities (animals/km^2) of harbour porpoise between January and July in the Northeast Atlantic ('Values are relative to the other month and have been standardised by converting them into percentages of the maximum predicted density. Red and blue colours indicate increases and decreases from the other month, respectively') (Waggitt et al., 2019)

Harbour Porpoise Summary

86. Several sources provide multiple estimates of harbour porpoise density and abundance which could be taken forward for use in quantitative impact assessment for the proposed Project. They provided a range of estimates from 0.030 animals/km^2 to 1.064 animals/km^2 (**Table 21A-16**). Data analysis methodology varied between surveys, so comparison between estimates derived through different studies should be undertaken with caution. It should be noted that estimates from the Cetaceans and Seabirds of Wales, JCP, SCANS and ObSERVE (Paxton *et al*., 2016; Rogan *et al.,* 2018; Hammond *et al.,* 2021; Evans and Waggitt, 2023), provided absolute estimates with correction for availability bias.

87. The most recent data are the site-specific digital video aerial survey data collected by HiDef between 2020 and 2022 which indicate some seasonal variation in abundance, with higher densities estimated in the winter compared to summer; this corroborates the findings of Heinänen and Skov (2015). The average model-based absolute density for the whole survey period was estimated at 0.137 animals/km^2 in the Llŷr marine megafauna survey area. Estimated densities from the site-specific surveys data are consistent with those presented in SCANS-III (Hammond *et al*., 2021), but greater than those of SCANS-IV and smaller than all other estimates recorded around the proposed Project (**Table 21A-16**). However, the data sources presented are varied spatially, temporally, and methodologically; therefore, more weight has been given to SCANS and site-specific survey information as the most appropriate for assessment.

88. Given that available estimates for harbour porpoise in the site-specific surveys are comparable to the regional SCANS-III estimates, and greater than the SCANS-IV estimates, the site-specific surveys should be used for quantitative impact assessment as a precautionary approach. This model-based estimate of 0.137 animals/km^2 for the Llŷr marine megafauna survey area represents an absolute density and is spatially relevant to the area of the proposed Project.

Table 21A-16. Summary of harbour porpoise density estimates collected around the Array Area presented in this report (highlighted cells correspond to the densities recommended to be used for quantitative impact assessment)

Study or survey programme	Area		Time scale	Average density (n/km^2)
	Name	Size (km^2)		
Proposed Project, HiDef site-specific surveys	Llŷr marine megafauna survey area	640.92	Year 1 Mar 2020 – Feb 2021	0.323 (adbe*) 0.311 (ambe**)
			Year 2 May 2021 – Mar 2022	0.081 (adbe) 0.047 (ambe)
			All surveys Mar 2020 – Mar 2022	0.202 (adbe) **0.137 (ambe)**
Erebus Project, HiDef site-specific surveys (Darias-O'Hara *et al.*, 2021)	Erebus survey area (development area plus a 4 km buffer)	200.11	Year 1 Oct 2019 – Sep 2020	0.037 (relative) 0.200 (absolute)
			Year 2 Oct 2020 – Sep 2021	0.100 (relative) 0.590 (absolute)
			All surveys Oct 2019 – Sep 2021	0.070 (relative) 0.400 (absolute)
Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023)	Llŷr marine megafauna survey area	640.92	1990 - 2020	0.087 (relative)
SCANS-III surveys (Hammond *et al.*, 2021)	Block D – Celtic and Irish Seas	48,590	Jun – Jul 2016	0.118 (absolute)
SCANS-IV surveys (Gilles *et al.*, 2023)	Block CS-C	36,031	Jun – Aug 2022	0.016 (absolute)
ObSERVE surveys (Rogan *et al.*, 2018)	Stratum 4 – Celtic Sea	n/a	Summer 2015	0.227 (adbe) 0.205 (ambe)
			Winter 2015	0.060 (adbe)
			Summer 2016	0.227 (adbe) 0.222 (ambe)
	Stratum 5 – Irish Sea	n/a	Summer 2015	0.696 (adbe) 0.675 (ambe)
			Winter 2015	0.867 (adbe)
			Summer 2016	1.064 (adbe) 0.942 (ambe)
			Winter 2016	0.924 (adbe)

Study or survey programme	Area		Time scale	Average density (n/km²)
	Name	Size (km²)		
JCP Phase III (Paxton *et al.,* 2016)	Atlantic Array	19,649	Winter 2010	0.433 (absolute)
			Spring 2010	0.361 (absolute)
			Summer 2010	0.438 (absolute)
			Autumn 2010	0.305 (absolute)
			Average 2010	0.384 (absolute)

**adbe: absolute design-based estimates, **ambe: absolute model-based estimates*

21.3.3. Common Dolphin

89. Common dolphins are a globally distributed species, typically found in deeper offshore waters but can be found in shallower coastal and shelf waters (Murphy *et al*., 2013). Common dolphins generally occur in greatest densities in the south and west of the UK (JNCC, 2019c). Their presence is generally thought to follow prey distribution, which itself is heavily influenced by oceanographic features (Evans and Bjørge, 2013). Common dolphins are highly social and tend to occur in groups, sometimes numbering in the hundreds, travelling at speed.

90. In Europe and in the UK, common dolphins are listed and protected under at least 11 different policies but are not an Annex II species under the Habitats Directive[5] and, therefore, do not require designated protected areas. Currently, the Celtic and Greater North Seas MU (IAMMWG, 2022) is the only MU assigned to the species (**Figure 21A-1**).

Site-Specific Surveys

91. Throughout the two-year survey period, common dolphin was the most abundant marine mammal species, with a total of 2,230 dolphins recorded (1,496 in Year 1 and 734 in Year 2) across the whole Llŷr marine megafauna survey area (**Figure 21A-46**,**Table 21A-18**). Overall, more common dolphins were observed during the summer, with fluctuating numbers in the other three seasons (**Table 21A-18**).

92. Model-based estimates calculated average relative and absolute densities (uncorrected and corrected for availability bias, respectively) for the whole survey period of 1.06 animals/ km² (95% CI 0.64 – 1.70) and 15.97 animals/km² (95% CI 9.65 – 25.62) in the Llŷr marine megafauna survey area, respectively. This equated to mean abundance estimates of 793 animals (95% CI 723 – 862) and 11,966 animals (95% CI 10,911 – 13,008), respectively (**Table 21A-17**). Mean densities and abundance were estimated to be higher in the summer than the winter for both relative and absolute estimates over the Llŷr marine megafauna survey area. Density surfaces of model-based absolute estimates indicate relatively sparse densities across the Llŷr marine megafauna survey area, with higher densities generally found outside the Array Area

[5] The legislation transposing the EU Habitats Directive has been amended so that the strict protections afforded to sites, habitats and species continues following EU Exit. The suite of legislative instruments is collectively termed the 'Habitat Regulations'. The Habitat Regulations were amended in 2019 as a result of the UK leaving the EU within the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.

(**Figure 21A-47**). Similar estimates were derived from both model-based and design-based approaches to estimate absolute density and abundance (**Figure 21A-48**).

93. For comparison, design-based methods across the entire survey programme, resulted in an average absolute density of 17.41 animals/km^2 (95% CI 12.01 – 22.81) in the Llŷr marine megafauna survey area, equating to a mean abundance of 11,119 animals (95% CI 7,669 – 14,569) (**Table 21A-18**).

Table 21A-17. Relative and absolute model-based density and abundance estimates of common dolphins recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022 (Summer= May – October, Winter= November – April; Year 1= March 2020 – February 2021; Year 2= May S01 2021 – March 2022)

Survey period	Density estimate (n/km²)	Lower 95% CL (n/km²)	Upper 95% CL (n/km²)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	SD (n)	CV (%)
Relative estimates								
Summer average	1.496	0.970	2.278	1154	1068	1239	225	23.45
Winter average	0.508	0.261	0.935	413	359	469	118	36.17
Total average	1.058	0.640	1.698	793	723	862	184	27.07
Average Year 1	1.388	0.778	2.428	982	940	999	288	32.42
Average Year 2	0.660	0.308	1.347	538	477	610	185	43.83
Absolute estimates								
Summer average	22.564	14.639	34.373	17402	16117	18692	4081	23.45
Winter average	7.659	3.933	14.105	6224	5411	7075	2251	36.17
Total average	15.966	9.652	25.617	11966	10911	13008	2770	23.15
Average Year 1	20.942	11.735	36.629	14813	14185	15078	4352	29.38
Average Year 2	9.966	4.646	20.320	8123	7189	9208	2797	34.43

Table 21A-18. Raw count, absolute design-based density and abundance estimates of common dolphins recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022 (Summer= May – October, Winter= November – April)

Survey	Date	Raw count (n)	Absolute density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)
1	25 Mar 2020	6	0.74	471	0	1197	70.18
2	14 Apr 2020	5	0.93	595	0	1777	95.26
3	08 Jun 2020	122	24.70	15776	9111	23240	23.64
4	24 Jun 2020	608	115.48	73757	26370	151987	46.38
5	21 Jul 2020	76	14.50	9260	2773	18252	43.6
6	31 Aug 2020	162	30.47	19458	10990	28754	23.24
7	12 Sep 2020	34	6.47	4134	1455	8071	40.03
8	22 Oct 2020	88	16.29	10406	1539	25413	66.41
9	26 Nov 2020	131	24.70	15778	8856	23666	24.46
10	10 Jan 2021	15	2.89	1848	0	4135	55.96
11	25 Jan 2021	189	34.25	21874	2283	59073	76.06
12	22 Feb 2021	60	11.27	7200	1303	14970	48.99
13	14 May 2021	16	3.02	1930	0	5815	98.25
14	27 May 2021	191	35.33	22567	7648	42176	40.73
15	15 Jun 2021	279	52.67	33642	17646	54984	27.44
16	14 Jul 2021	101	18.68	11930	4033	21280	36.09
17	16 Aug 2021	3	0.55	355	0	935	72.11
18	01 Sep 2021	0	0.00	0	0	0	0
19	22 Oct 2021	2	0.39	253	0	735	96.42
20	20 Nov 2021	28	5.49	3509	725	6751	44.13
21	16 Dec 2021	24	4.65	2971	0	7141	60.99
22	05 Jan 2022	60	13.95	8910	3344	15107	34.6
23	26 Feb 2022	0	0.00	0	0	0	0
24	20 Mar 2022	30	0.37	237	32	592	62.93
Average Year 1 (1 – 12)		**-**	**23.56**	**15046**	**8560**	**21533**	**76.20**
Average Year 2 (13 – 24)		**-**	**11.26**	**7192**	**4841**	**9543**	**57.77**
Total average		**-**	**17.41**	**11119**	**7669**	**14569**	**77.55**
Summer average		**-**	**25.23**	**16117**	**9971**	**22263**	**67.40**
Winter average		**-**	**9.58**	**6121**	**2987**	**9256**	**90.51**

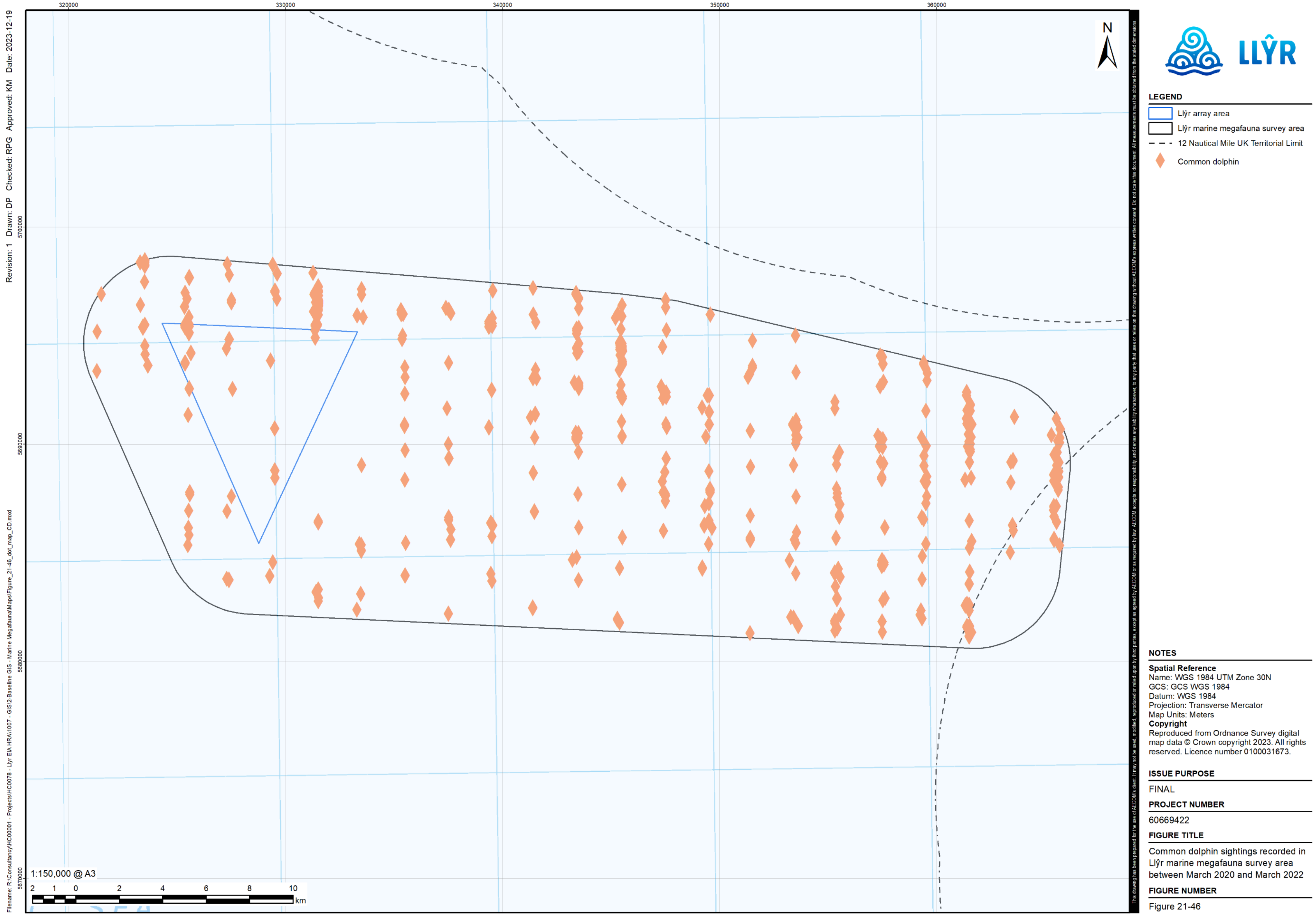


Figure 21A-46. Common dolphin sightings recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022

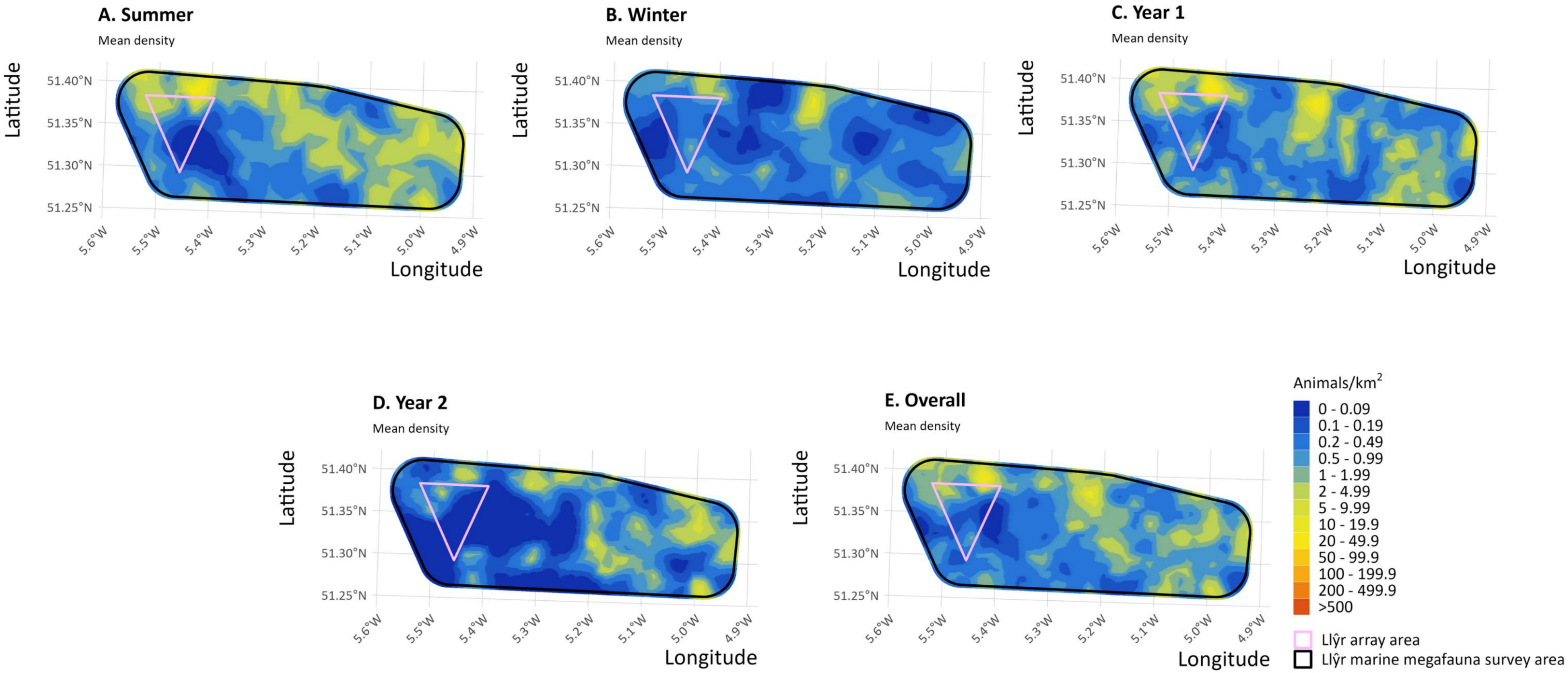


Figure 21A-47. Mean model-based density surface for common dolphins in the Llŷr marine megafauna survey area during the summer (A), winter (B), Year 1 (C), Year 2 (D) and full survey period I

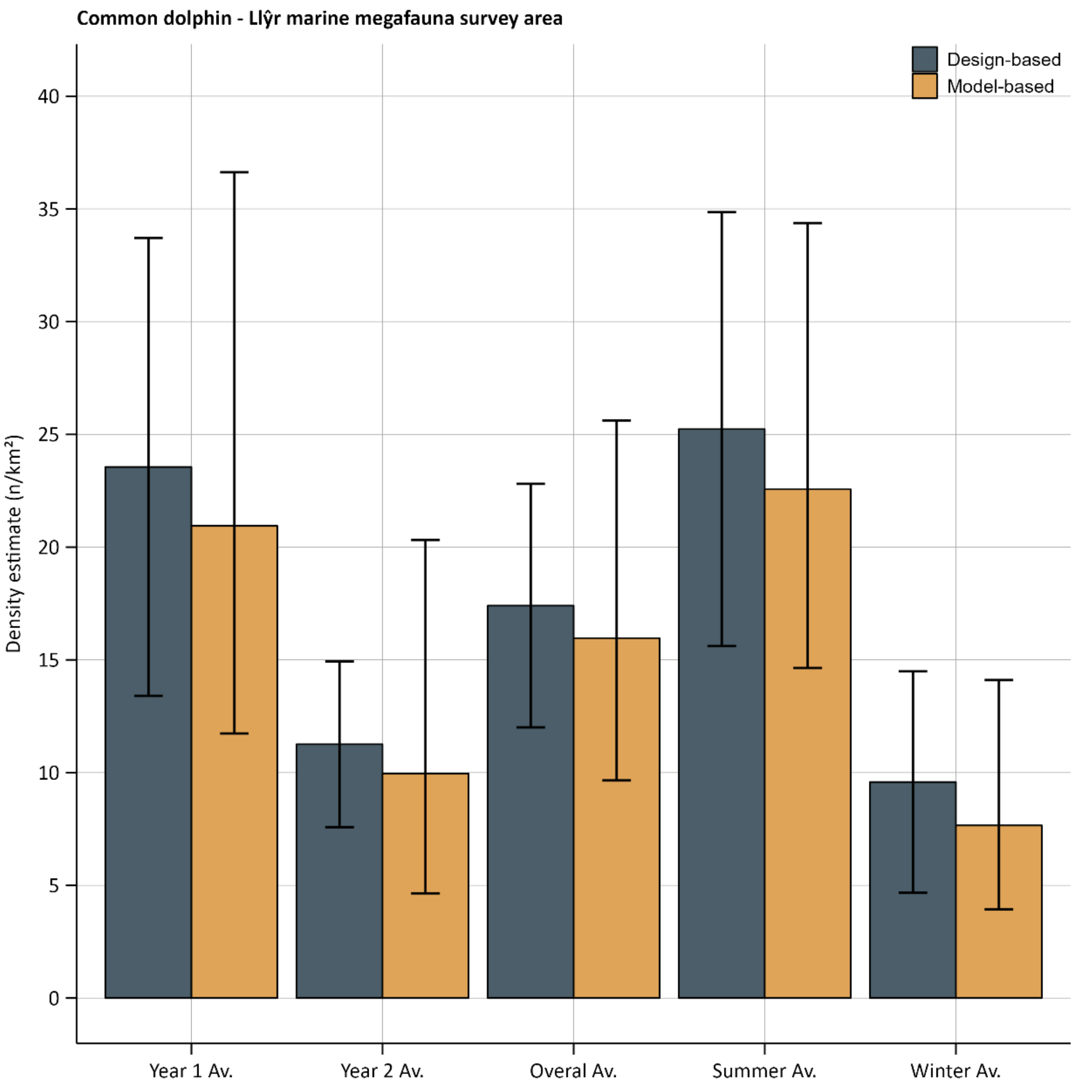


Figure 21A-48. Comparison of design- and model-based density estimates of common dolphins per survey period in the Llŷr marine megafauna survey area

Project Erebus Surveys

94. Throughout the two-year survey period across the Erebus survey area, a total of 1,929 common dolphins were recorded (1,320 in Year 1, 609 in Year 2). Absence of common dolphins was only recorded in the October 2019 survey (**Table 21A-19**) (Darias-O'Hara *et al.*, 2021).

95. These observations resulted in relative estimates ranging from 0.00 animals/km^2 (October 2019) to 5.43 animals/km^2 (January 2020) in Year 1 and 0.02 animals/km^2 (August 2021) to 2.98 animals/km^2 (March 2021) in Year 2, equating to 0 dolphins (95% CI 0 – 0) and 1,086 dolphins (95% CI 682 – 1,489) in Year 1 and 4 dolphins (95% CI 0 – 12) and 597 dolphins (95% CI 278 – 1,025) in Year 2, respectively. The average relative density over the 24-month period was estimated at 1.52 animals/km^2 (**Table 21A-19**) (Darias-O'Hara *et al.*, 2021).

96. Absolute density estimates were also provided, using diving rates recorded in south Australia by Bilgmann *et al.* (2018). A 94% availability rate of groups was used and resulted in an absolute density estimate over the 24-month period only slightly greater than the relative estimate, at 1.61 animals/km^2 (**Table 21A-19**).

97. There did not appear to be a strong seasonal pattern, although slightly more common dolphins were observed during the summer in both years of survey. Overall, common dolphins

were observed across the whole survey area, without an obvious distribution pattern (**Figure 21A-49**) (Darias-O'Hara *et al.*, 2021).

Table 21A-19. Raw count, relative and absolute density and relative abundance estimates of common dolphins recorded in the Erebus survey area (development area plus a 4 km buffer) between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Survey	Date	Raw count (n)	Relative density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)	Absolute density (n/km^2)
1	22 Oct 2019	0	0.00	0	0	0	0.00	0.00
2	08 Nov 2019	40	0.72	145	39	269	0.41	0.77
3	04 Dec 2019	11	0.22	44	0	104	0.62	0.23
4	18 Jan 2020	275	5.43	1,086	682	1,489	0.19	5.78
5	04 Feb 2020	36	0.73	147	45	272	0.40	0.78
6	03 Mar 2020	24	0.47	95	28	165	0.38	0.50
7	04 Apr 2020	15	0.16	32	0	94	0.95	0.17
8	08 Jun 2020	226	4.38	876	341	1,592	0.37	4.66
9	24 Jun 2020	142	2.78	556	140	1,140	0.47	2.96
10	23 Jul 2020	251	4.83	967	515	1,466	0.25	5.14
11	31 Aug 2020	68	1.30	261	110	427	0.31	1.38
12	12 Sep 2020	232	4.48	896	0	2,651	0.92	4.77
13	15 Oct 2020	116	2.27	454	203	809	0.35	2.41
14	22 Nov 2020	3	0.06	12	0	35	0.93	0.06
15	31 Dec 2020	9	0.10	20	0	49	0.66	0.11
16	16 Jan 2021	13	0.25	51	8	112	0.53	0.27
17	22 Feb 2021	66	1.30	261	130	404	0.27	1.38
18	05 Mar 2021	152	2.98	597	278	1,025	0.32	3.17
19	10 Apr 2021	12	0.24	48	0	109	0.58	0.26
20	14 May 2021	8	0.16	32	0	86	0.75	0.17
21	15 Jun 2021	96	1.90	380	196	574	0.26	2.02
22	14 Jul 2021	78	0.55	111	0	283	0.68	0.59
23	16 Aug 2021	1	0.02	4	0	12	0.95	0.02
24	01 Sep 2021	55	1.08	217	0	490	0.59	1.15
Average Year 1 (1 – 12)		-	**2.13**	**425**	-	-	-	**2.26**
Average Year 2 (13 – 24)		-	**0.91**	**182**	-	-	-	**0.97**
Total average		-	**1.52**	**304**	-	-	-	**1.61**

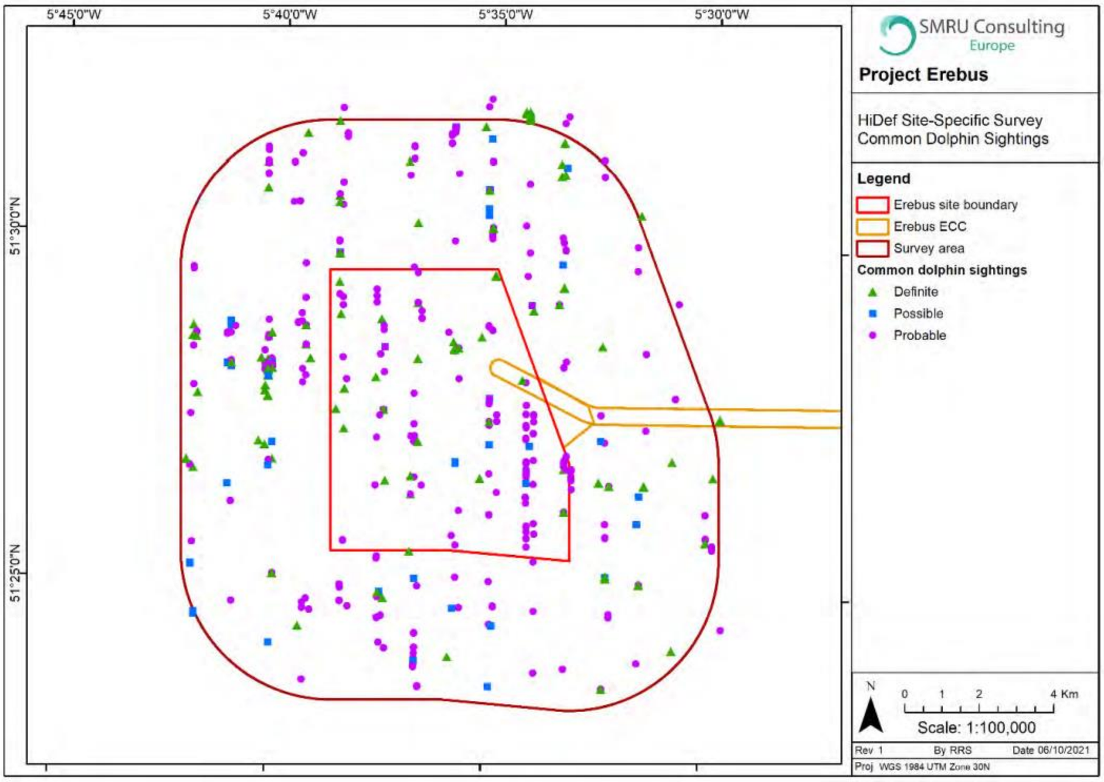


Figure 21A-49. Common dolphin sightings recorded in the Erebus survey area between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Welsh Marine Atlas and Cetaceans and Seabirds of Wales

98. Between 1990 and 2009, a total of 1,502 common dolphin sightings, amounting to 19,861 individuals were recorded in the Welsh Marine Atlas database (**Figure 21A-50**) (Baines and Evans, 2012). In the Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023), a total of 23,170 cumulative individuals were contained in the database (**Figure 21A-51**). Common dolphins were the second most and most abundant species recorded in the survey area in each report, respectively.

99. A greater number of sightings was recorded in the southwest part of the survey area and in close vicinity to the proposed Project, in the Celtic Deep region (**Figure 21A-50** and **Figure 21A-51**). Modelled densities peaked in the summer months, between July and September, and were at their lowest between January and March (**Figure 21A-52**), although it should be noted that survey effort was not equivalent in each month and was reduced for aerial surveys compared to boat-based surveys (Baines and Evans, 2012; Evans and Waggitt, 2023).

100. Within the Llŷr marine megafauna survey area, a mean maximum relative density of 0.233 individuals/km^2, was estimated (Evans and Waggitt, 2023).

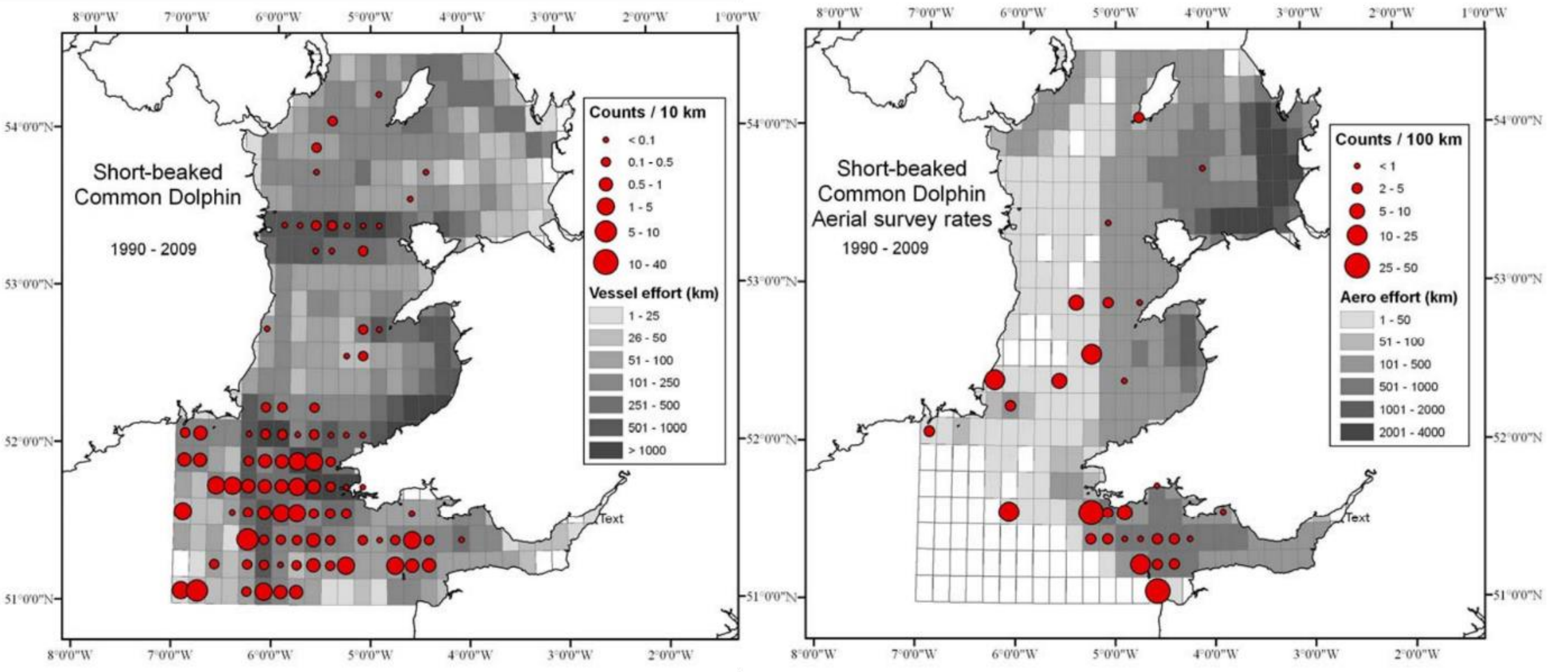


Figure 21A-50. Long-term mean sighting rates of common dolphins with vessel counts per 10 km and aerial counts per 100 km collected between 1990 and 2009 (Baines and Evans, 2012)

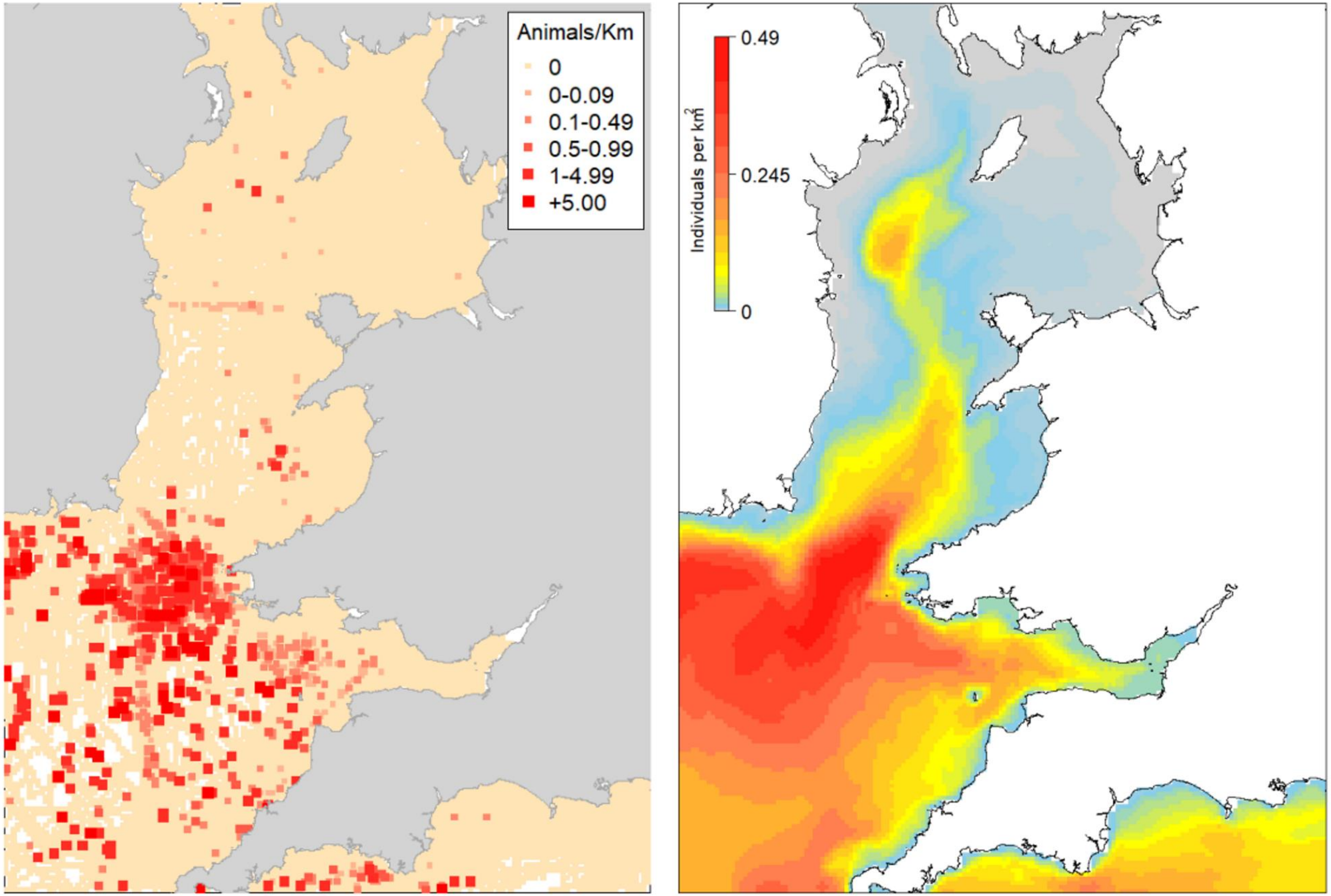


Figure 21A-51. Common dolphin sighting rate (n/km; left) and modelled densities (n/km^2; right) between 1990 and 2020 (Evans and Waggitt, 2023)

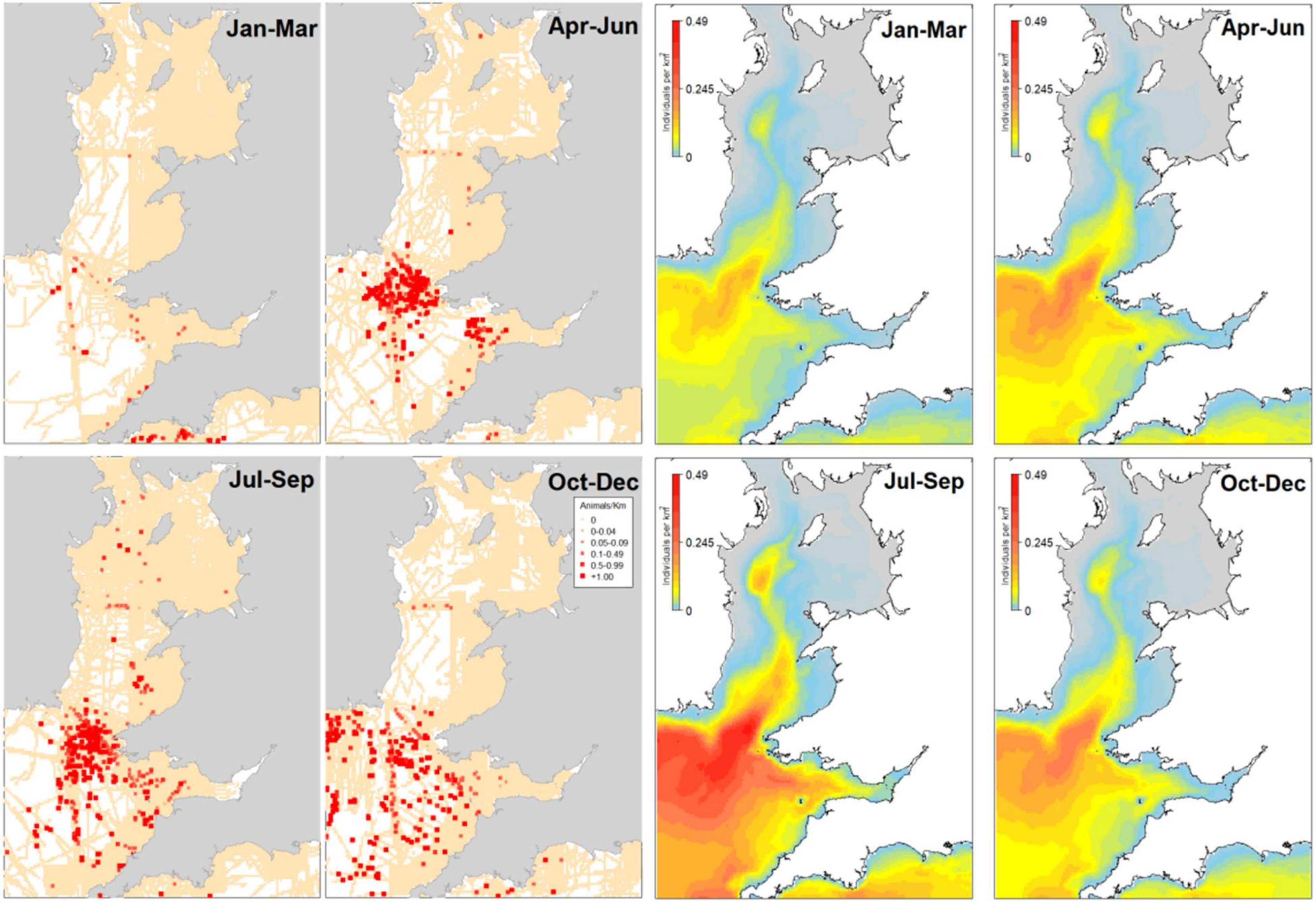


Figure 21A-52. Common dolphin sightings rates (n/km; left) and mean modelled densities (n/km^2; right) by quarter over the 1990-2020 period (Evans and Waggitt, 2023)

SCANS-III and IV Surveys

101. During the July 2016 aerial survey (SCANS-III), a total of 502 common dolphins were sighted on primary[6] search effort, mainly observed in the Bay of Biscay. In Block D, the estimated absolute density was 0.374 animals/km^2 (0.413 CV) with a corresponding abundance of 18,187 dolphins (95% CI 4,394 – 33,077) (**Figure 21A-53**).

102. Between the June and August 2022 aerial surveys (SCANS-IV), a total of 992 common dolphins were sighted in primary search effort, mainly observed in the Celtic Sea and Iberian Peninsula. In Block CS-C, the estimated absolute density was 0.8410 animals/km^2 (0.264 CV) with a corresponding abundance of 30,301 dolphins (95% CI 17,888 – 51,902) (**Figure 21A-53**) (Gilles *et al.,* 2023).

103. Density surface models using SCANS-III data (Lacey *et al.,* 2022) also suggest common dolphin density is highest in the Atlantic, across the Bay of Biscay and the coast of Portugal (**Figure 21A-54**). Around the Llŷr marine megafauna survey area, surface densities were estimated to range between 0.07 and 0.15 animals/km^2 (Lacey *et al.*, 2022).

[6] Primary search effort relates to the observations made from the primary survey platform. Tracker observations used for mark and recapture data for the estimation of the detection probability (Hammond *et al.,* 2021).

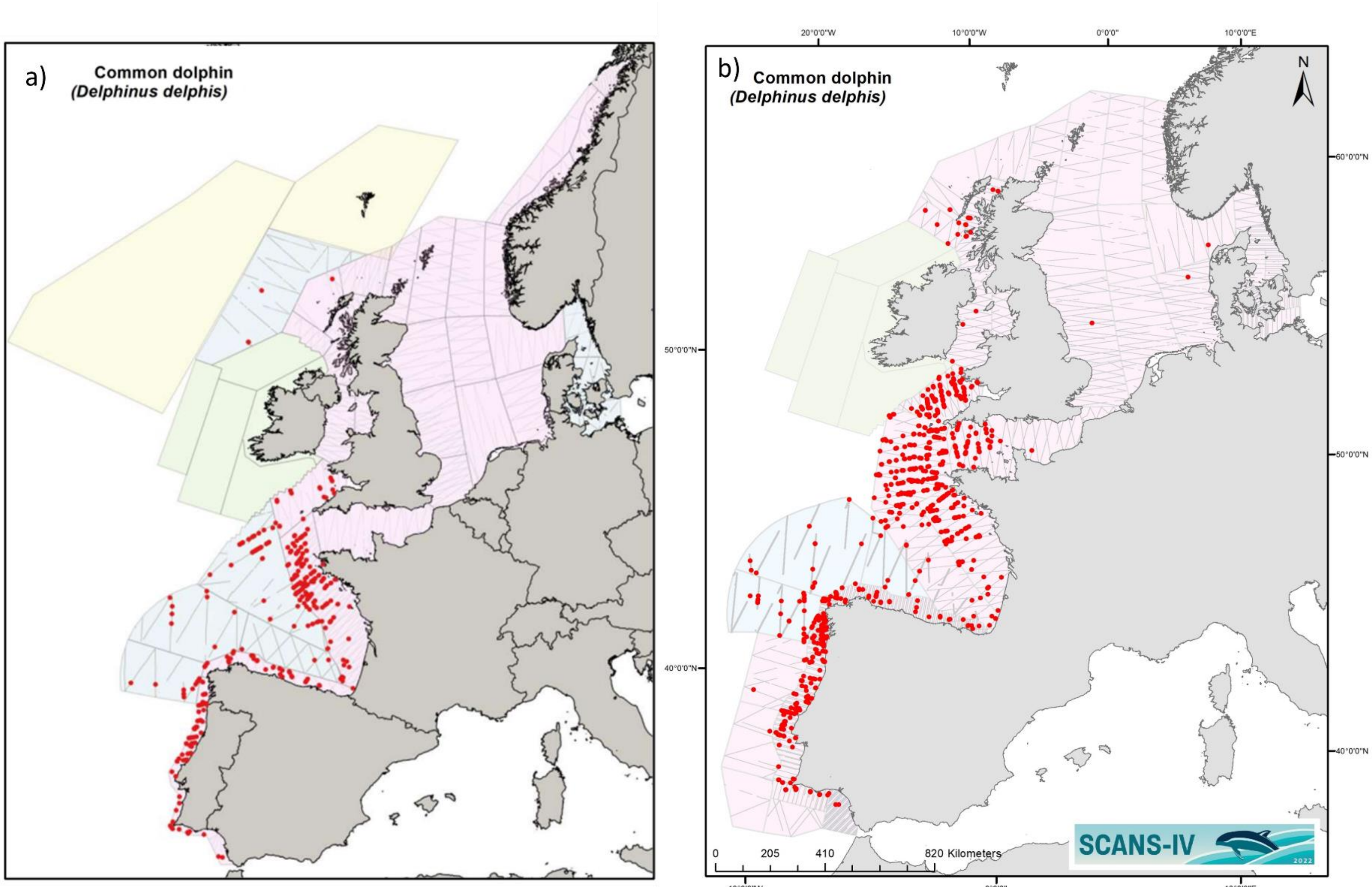


Figure 21A-53. Common dolphin sightings collected during the SCANS-III (a) and IV (b) surveys flown in July 2016 (Hammond et al., 2021) and between June and August 2022 (Gilles et al., 2023). Refer to Figure 21A-8 for Block identification

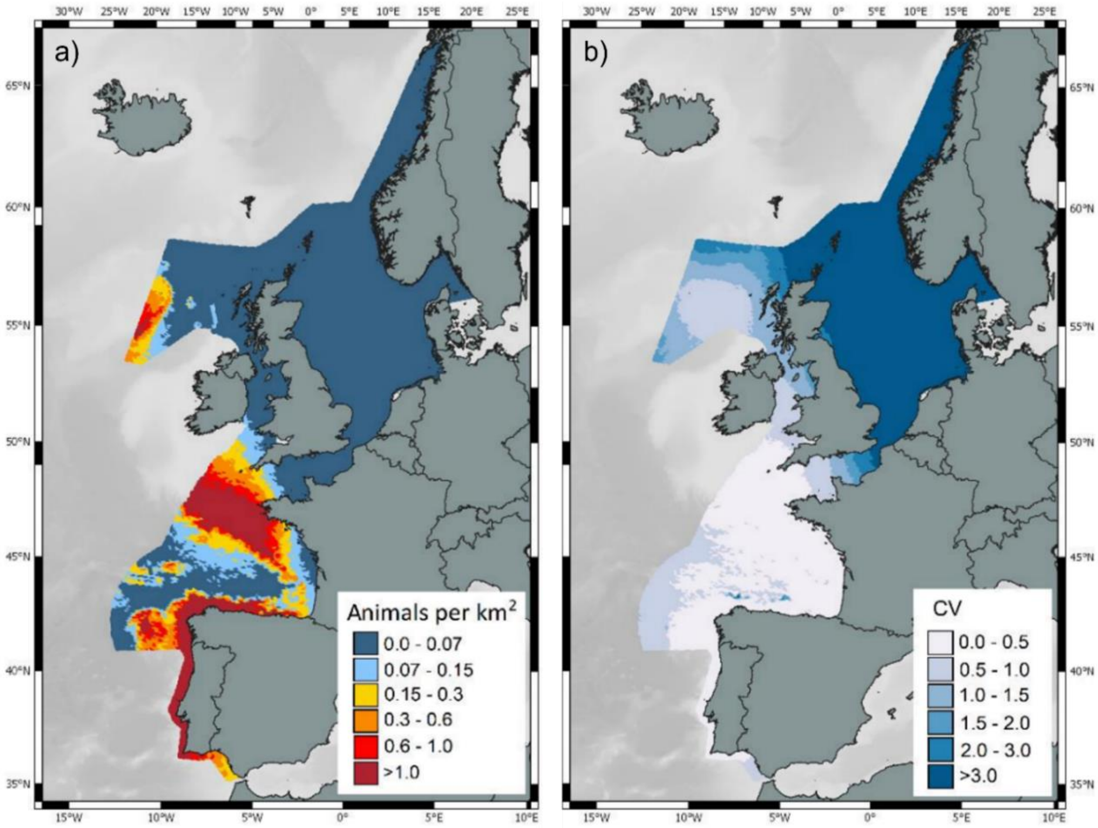


Figure 21A-54. Estimated surface density (a) and associated CV (b) for common dolphins in SCANS-III (2016) (Lacey et al., 2022)

ObSERVE Surveys

104. Across the ObSERVE survey area, common dolphins showed inter-annual and seasonal differences, with a greater number of observations recorded during the winter 2015 surveys compared to the summer 2015 surveys. However, the opposite scenario was true in 2016 (**Figure 21A-56**) (Rogan *et al.*, 2018). The species was mainly observed in offshore waters, in the south and west of Ireland (**Figure 21A-55**).

105. Three groups (mean group size five individuals) were observed in Stratum 4 during summer 2015, while 37 groups (mean group nine individuals) were recorded during winter 2015. No common dolphins were recorded in 2016 in Stratum 4 (Celtic Sea), nor in both years in Stratum 5 (Rogan *et al.*, 2018).

106. Absolute design-based densities in Stratum 4 were estimated at 0.044 animals/km^2 (summer 2015) and 0.637 animals/km^2 (winter 2015), equating to 2,760 dolphins (95% CI 1,164 – 6,542) and 39,899 dolphins (95% CI 19,670 – 80,930), respectively (**Table 21A-31**).

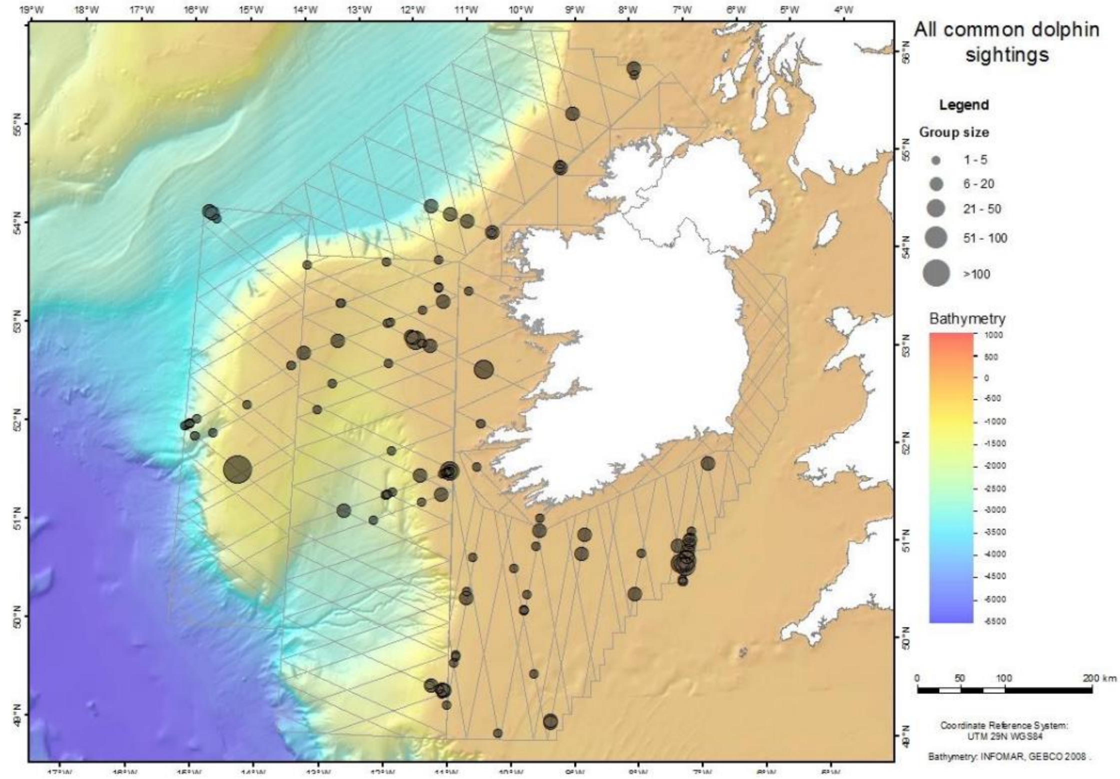


Figure 21A-55. Common dolphin sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

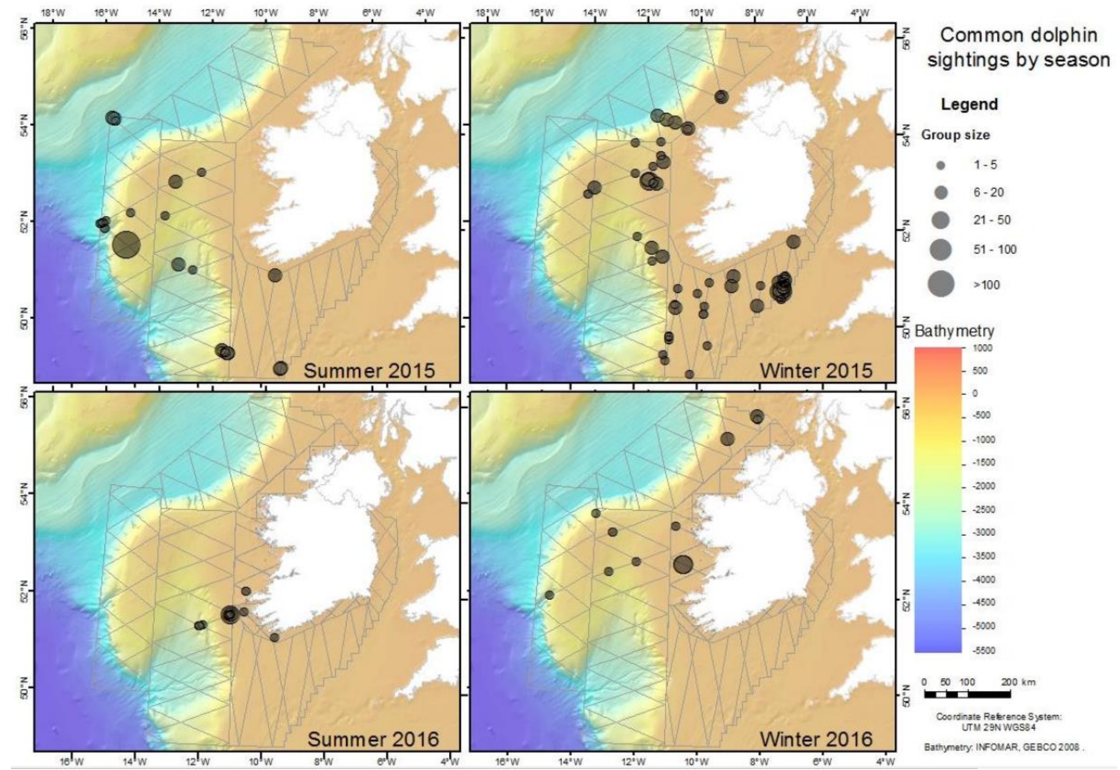


Figure 21A-56. Seasonal common dolphin sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

Table 21A-20. Common dolphin absolute design-based density and abundance estimates for Strata 4 of the ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018) (NB: no observations were recorded in Stratum 5) (n/a = no sightings data)

Stratum	Season	Absolute design-based estimates			
		Density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)
Stratum 4	Summer 2015	0.044	2,760	1,164	6,542
	Winter 2015	0.637	39,899	19,670	80,930
	Summer 2016	n/a			
	Winter 2016	n/a			

JCP Phase III

107. Across the 17 years of data collected in the JCP Phase III report, 2,411 common dolphin sightings were recorded, ranging from 32 sightings in 1999 to 468 sightings in 2005. The latest year of data, 2010, recorded a total of 232 sightings. Maps of predicted density for summer 2010 suggest very low densities for the species around the UK, with much greater densities predicted in the west Irish coast and Celtic Seas (**Figure 21A-57** and **Figure 21A-58**). In the Atlantic Array, an area covering 1.8% of the Celtic and Greater North Sea MU, estimated abundance for 2010 was highest in the autumn (absolute density of 1.686 animals/km^2) with the lowest density estimates between the winter and spring seasons (winter absolute density of 0.124 animals/km^2). The average absolute density across all seasons was calculated at 0.634 animals/km^2 (**Table 21A-21**, **Figure 21A-57** and **Figure 21A-58**) (Paxton *et al.*, 2016).

Table 21A-21. Common dolphins absolute density and abundance estimates for 2010 in the Atlantic Array (19,649 km^2) based on the JCP Phase III data (Paxton et al., 2016)

Season	Absolute density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)
Winter	0.124	2,430	1,260	5,840
Spring	0.319	6,260	2,720	16,260
Summer	0.407	7,990	4,160	25,100
Autumn	1.686	33,120	16,540	79,450
Average	**0.634**	**12,450**	**-**	**-**

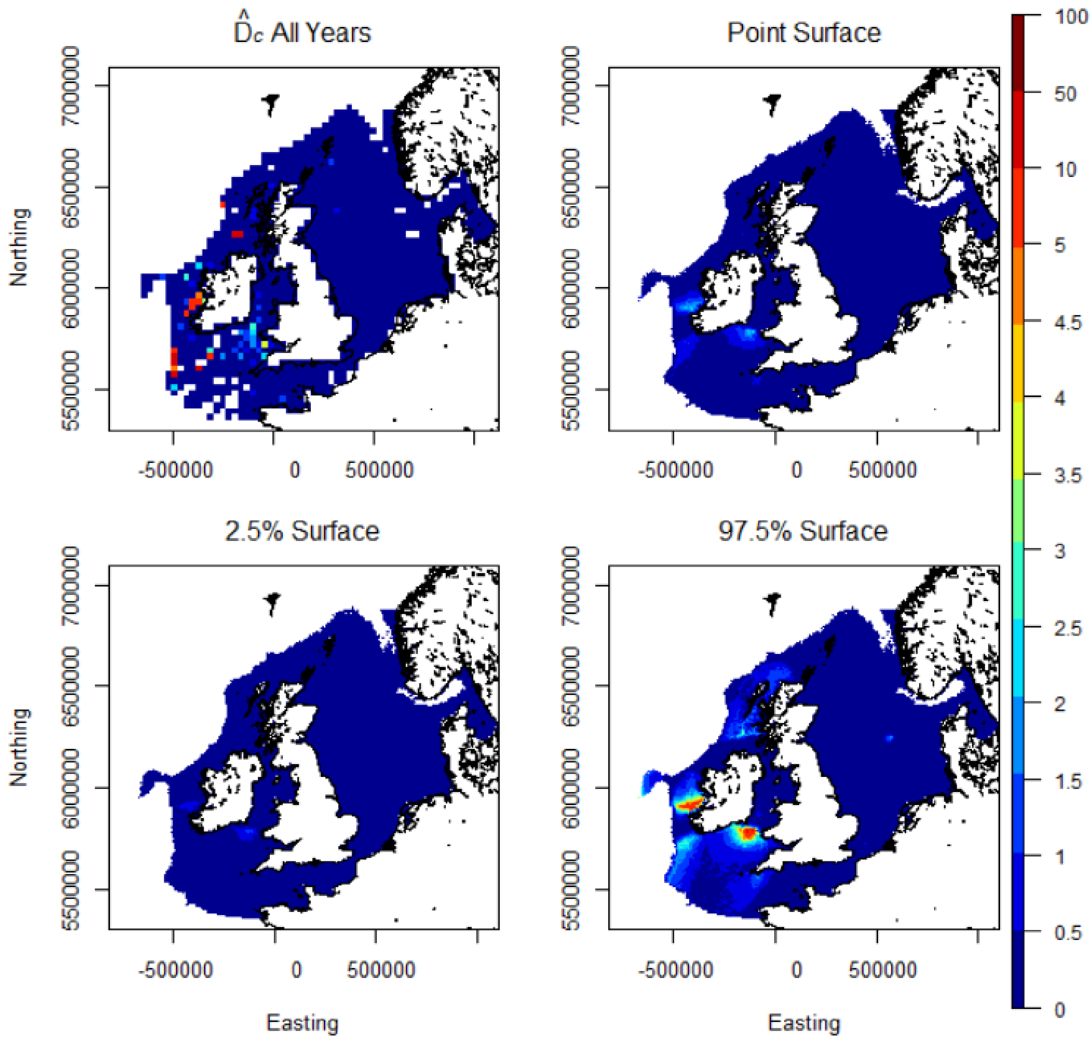


Figure 21A-57. Predicted densities ($\hat{D}_c$) of common dolphins for the summer 2010 (Paxton et al., 2016). Top left map represents the input densities of summers from all years. Top right map represents the predicted densities for the summer 2010. Bottom maps represent the 95% CL density estimates

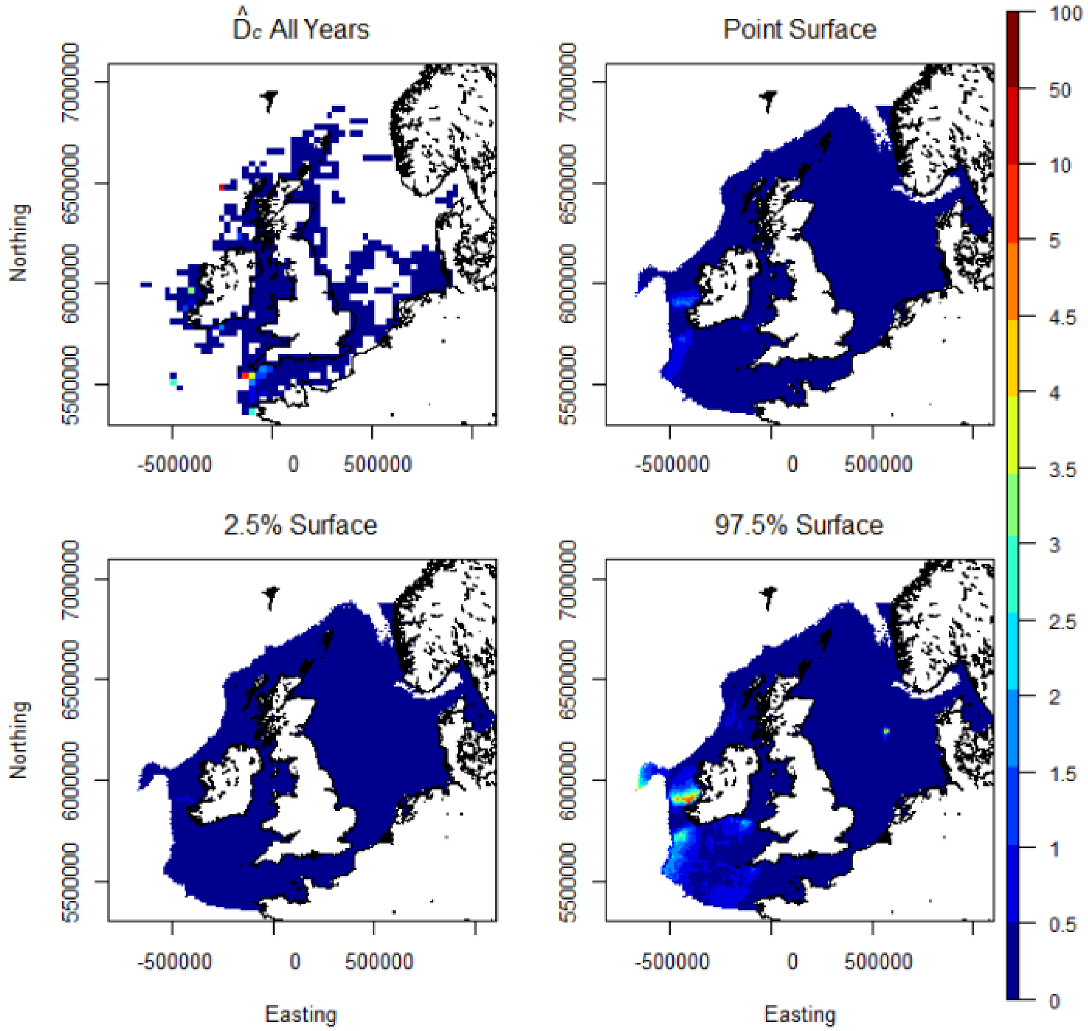


Figure 21A-58. Predicted densities ($\hat{D}_c$) of common dolphins for the winter 2010 (Paxton et al., 2016). Top left map represents the input densities of winters from all years. Top right map represents the predicted densities for the winter 2010. Bottom maps represent the 95% CL density estimates

MERP Surveys and Distribution Maps of Cetacean and Seabird Populations in the Northeast Atlantic

108. A total of 11,253 common dolphin sightings amounting to 156,290 individuals were recorded between 1980 and 2018 (Waggitt *et al.*, 2019). The predicted monthly density maps show an increased presence of common dolphins around the Array Area in August, but an overall increase of presence in the Atlantic between June and October (**Figure 21A-59**). When comparing distribution between January (winter) and June (summer) there is a clear shift with the seasons, with greater abundance off the west coast of Ireland during the summer and off the French and Spanish coasts in winter (**Figure 21A-60**).

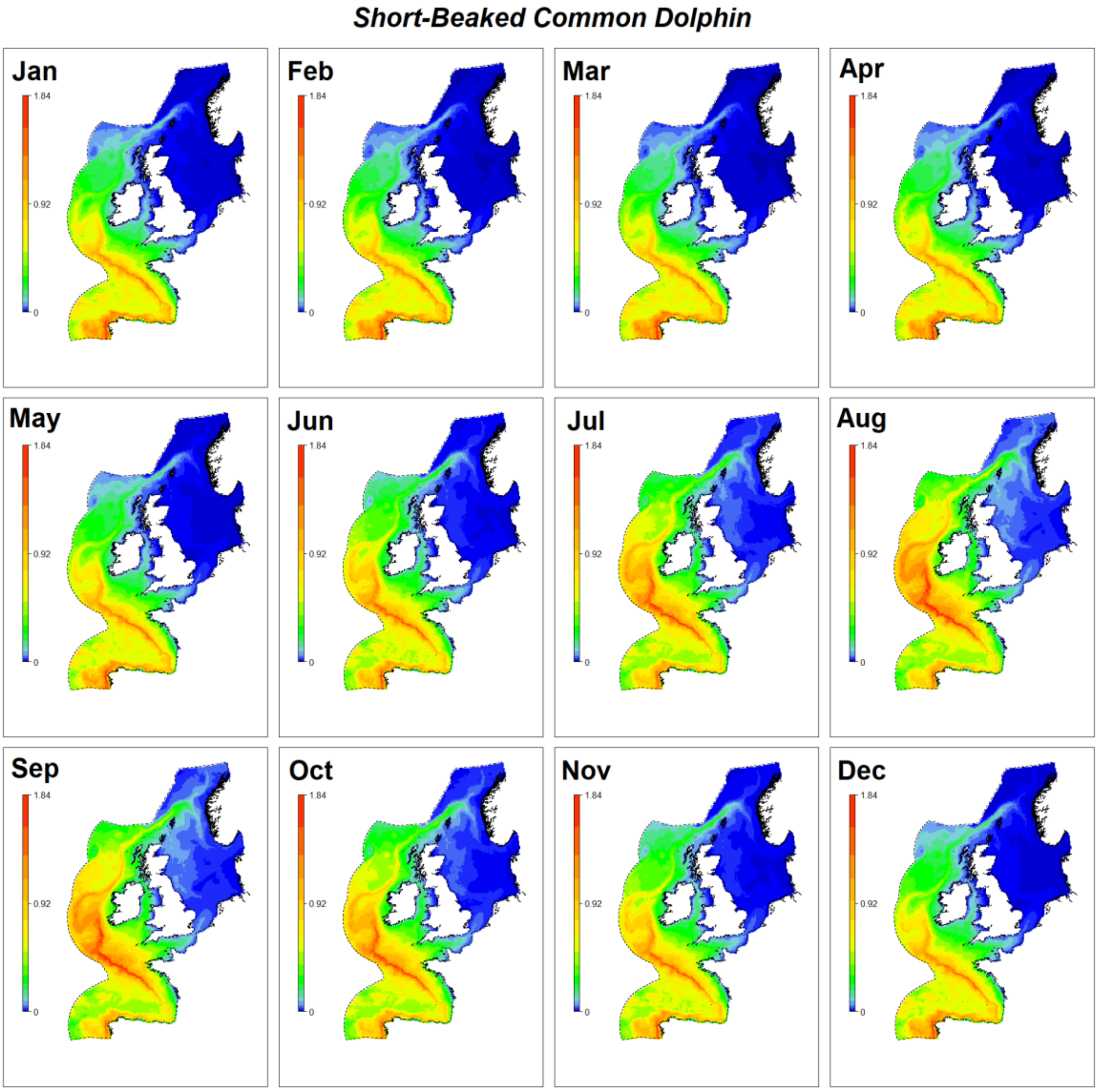


Figure 21A-59. Monthly predicted densities (animals/km^2) of common dolphins in the Northeast Atlantic (values provided at 10 km resolution) (Waggitt et al., 2019)

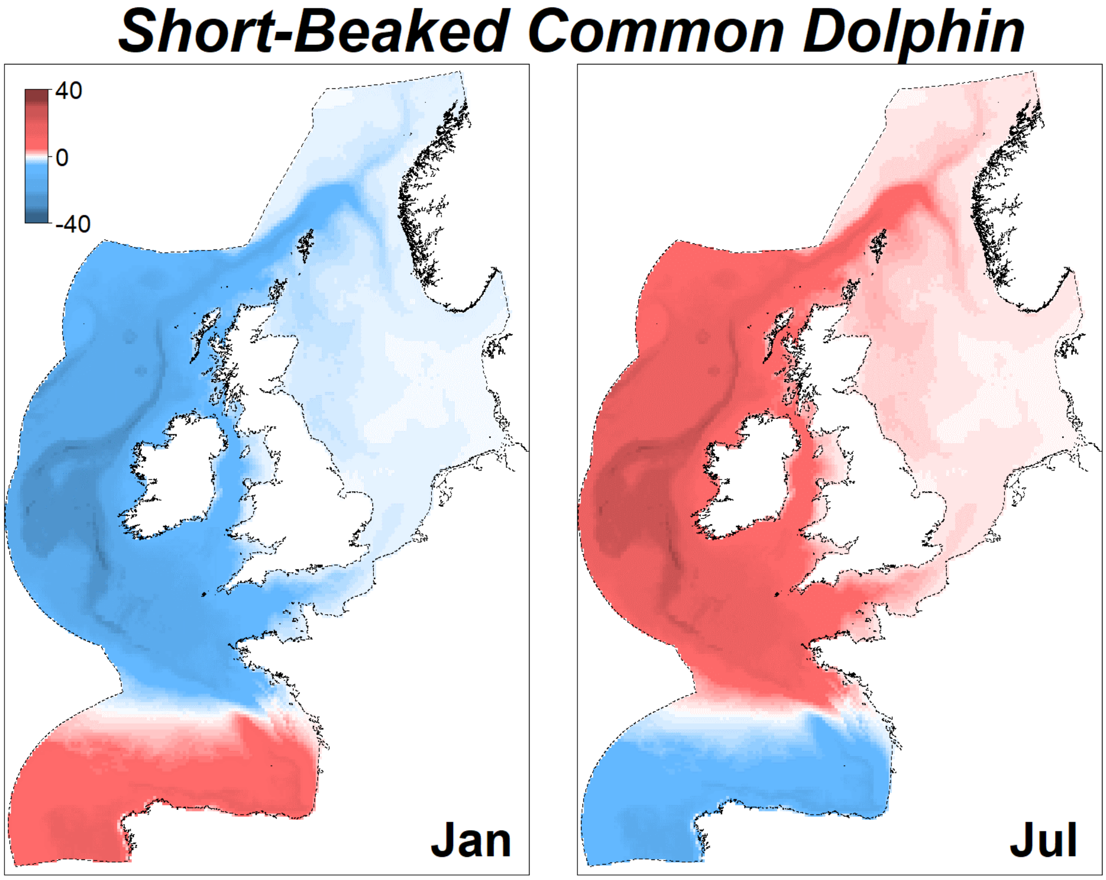


Figure 21A-60. Difference in predicted densities (animals/km^2) of common dolphins between January and July in the Northeast Atlantic ('Values are relative to the other month and have been standardised by converting them into percentages of the maximum predicted density. Red and blue colours indicate increases and decreases from the other month, respectively') (Waggitt et al., 2019)

Common Dolphin Summary

109. Several sources of common dolphin density estimates are relevant to the proposed Project, and which could be taken forward for use in quantitative impact assessment. They provided a range of estimates from 0.044 animals/km^2 to 23.56 animals/km^2 (**Table 21A-22**). Data analysis methodology varied between surveys, so comparison between estimates derived through different studies should be done with caution. Most estimates discussed in this report for this species accounted for animals diving at the time of the survey, providing absolute estimates of density and abundance.

110. The most recent data are site-specific digital video aerial survey data collected by HiDef between 2020 and 2022 which indicate some seasonal variation in abundance, with higher densities estimated in the summer compared to winter. The average model-based absolute densities for the whole survey period were estimated at 15.97 animals/km^2 in the Llŷr marine megafauna survey area. Estimated absolute densities from the site-specific surveys data are far greater than those presented in all other surveys conducted around the proposed Project area (**Table 21A-22**). Uncorrected model-based estimates are comparable to Erebus and SCANS-IV surveys indicating that the correction for availability bias applied has a major influence on the absolute estimate.

111. Common dolphins are found both within coastal and in deeper offshore waters (Evans and Waggitt, 2023). Within the Irish Sea, the highest abundance is recorded in the Celtic Deep, towards the south of the Irish Sea and northwest of the proposed Project (Evans and Waggitt, 2023). Observed densities vary seasonally and spatially within the region.

112. Common dolphins were the most abundant marine mammal encountered in the DAS, with a major peak in June 2020. Monthly sightings ranged from five to 608 animals in Year 1, and zero to 279 animals in Year 2. The respective absolute design-based density estimates for these two years ranged from 0.74 animals/km^2 to 115.48 animals/km^2 in Year 1 and 0.00 animals/km^2 to 52.67 animals/km^2 in Year 2. The peak occurrence of animals in both years occurring in June / July, and this observed peak occurrence is consistent with the pattern of occurrence presented in Evans and Waggitt (2023).

113. The average absolute design-based and model-based densities from the site-specific DAS (corrected for availability bias) across the two-year survey period for common dolphin were estimated at 17.41 animals/km^2 and 15.97 animals/km^2. This order of magnitude is higher than density estimates from other sources, such as SCANS-III (0.374 animals/km^2; Hammond *et al.,* 2021) or the Cetaceans and Seabirds of Wales (0.233 animals/km^2; Evans and Waggitt, 2023). There is a lack of information relating to availability bias for common dolphins and no agreed approach on how to correct relative estimates. HiDef adopted the approach used in Paxton *et al.* (2016). The uncorrected DAS average model-based density estimate across the survey period was 1.06 animals/km^2. We can compare this to the site-based density estimate for Erebus which was 1.52 animals/km^2, which highlights similar densities between sites.

114. The DAS densities reflect sightings data within the Llŷr marine megafauna survey area, during the time of the survey. The variability and seasonal patterns of animals present is informative in terms of site characterisation. However, it is not appropriate to assume that the resultant density estimates will be consistent beyond the Llŷr marine megafauna survey area (unless there are other data to support this as the chosen density estimate). The large number of common dolphin DAS observations is likely to reflect a group of animals passing through at the time of the survey. It, therefore, would not be appropriate to extend the DAS derived density estimates beyond the Llŷr marine megafauna survey area.

115. A regional scale density estimate is therefore, recommended to be used, using the highest estimates from SCANS-IV block CS-C of 0.841 animals/km^2. Gilles *et al.* (2023) concluded that common dolphin occurrence has increased in the Celtic Sea and is overall more northerly that in comparison to SCANS-III.

Table 21A-22. Summary of common dolphin density estimates collected around the Array Area presented in this report (highlighted cells correspond to the densities recommended to be used for quantitative impact assessment)

Study or survey programme	Area		Time scale	Average density (n/km^2)
	Name	Size (km^2)		
Proposed Project, HiDef site-specific surveys	Llŷr marine megafauna survey area	640.92	Year 1 Mar 2020 – Feb 2021	23.56 (adbe) 1.39 (rmbe*) 20.94 (ambe)
			Year 2 May 2021 – Mar 2022	11.26 (adbe) 0.66 (rmbe) 9.96 (ambe)
			All surveys Mar 2020 – Mar 2022	17.41 (adbe) 1.06(rmbe) 15.97 (ambe)
Erebus Project, HiDef site-specific surveys		200.11	Year 1 Oct 2019 – Sep 2020	2.13 (relative)

Study or survey programme	Area		Time scale	Average density (n/km^2)
	Name	Size (km^2)		
(Darias-O'Hara *et al.*, 2021)	Erebus survey area (development area plus a 4 km buffer)			2.26 (absolute)
			Year 2 Oct 2020 – Sep 2021	0.91(relative) 0.97 (absolute)
			All surveys Oct 2019 – Sep 2021	1.52 (relative) 1.61 (absolute)
Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023)	Llŷr marine megafauna survey area	640.92	1990 - 2020	0.233 (relative)
SCANS-III surveys (Hammond *et al.*, 2021)	Block D – Celtic and Irish Seas	48,590	Jun – Jul 2016	0.374 (absolute)
SCANS-IV surveys (Gilles *et al.*, 2023)	Block CS-C	36,031	Jun – Aug 2023	0.841 (absolute)
ObSERVE surveys (Rogan *et al.*, 2018)	Stratum 4 – Celtic Sea	n/a	Summer 2015	0.044 (adbe)
			Winter 2015	0.637 (adbe)
JCP Phase III (Paxton *et al.*, 2016)	Atlantic Array	19,649	Winter 2010	0.124 (absolute)
			Spring 2010	0.319 (absolute)
			Summer 2010	0.407 (absolute)
			Autumn 2010	1.686 (absolute)
			Average 2010	0.634 (absolute)

**rdbe: relative design-based estimate*

21.3.4. *Bottlenose Dolphin*

116. Bottlenose dolphin is a globally distributed species and can be found in both offshore waters and coastal and shelf waters. In the UK, two inshore semi-resident populations can be found off the east and northeast coast of Scotland (including the Moray Firth SAC) and off the coast of Wales (including Cardigan Bay SAC). Two smaller populations can be observed off the southwest coast of England and off the west coast of Scotland (JNCC, 2019d). Bottlenose dolphin distribution in Cardigan Bay can be highly variable with seasonal, diurnal and tidal cycle fluctuations (Nuuttila *et al*., 2017). It is thought that these fluctuations likely follow prey availability as well as conditions needed during calving (Nuuttila *et al*., 2017).

117. In the UK, bottlenose dolphins are a designated feature of two SACs in Wales, Cardigan Bay / Bae Ceredigion SAC and Pen Llŷn a`r Sarnau / Lleyn Peninsula and the Sarnau SAC. Currently, UK wide, nine MUs are assigned to the species (IAMMWG, 2022), with the Offshore Channel, Celtic Sea and SouthWest England MU relevant to the proposed Project (**Figure 21A-1**).

Site-Specific Surveys

118. Bottlenose dolphins were not identified during the two-year survey period in the Llŷr marine megafauna survey area (**Table 21A-23** and **Figure 21A-61**). However, across the Llŷr marine megafauna survey area, a total of 21 unidentified cetaceans and 12 unidentified dolphins were recorded (19 and seven in Year 1, and two and five in Year 2, respectively) (**Table 21A-23** and **Figure 21A-61**). Most of the observations were recorded outside the Array Area.

Table 21A-23. Raw count of unidentified cetaceans and dolphin species recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022

Survey	Date	Cetacean species	Dolphin species
1	25 Mar 2020	1	0
2	14 Apr 2020	0	0
3	08 Jun 2020	5	3
4	24 Jun 2020	1	2
5	21 Jul 2020	0	0
6	31 Aug 2020	7	0
7	12 Sep 2020	0	0
8	22 Oct 2020	0	1
9	26 Nov 2020	5	1
10	10 Jan 2021	0	0
11	25 Jan 2021	0	0
12	22 Feb 2021	0	0
13	14 May 2021	0	0
14	27 May 2021	0	0
15	15 Jun 2021	1	0
16	14 Jul 2021	0	0
17	16 Aug 2021	0	0
18	01 Sep 2021	0	0
19	22 Oct 2021	0	0
20	20 Nov 2021	0	0
21	16 Dec 2021	0	0
22	05 Jan 2022	1	5
23	26 Feb 2022	0	0
24	20 Mar 2022	0	0
Total		**21**	**12**

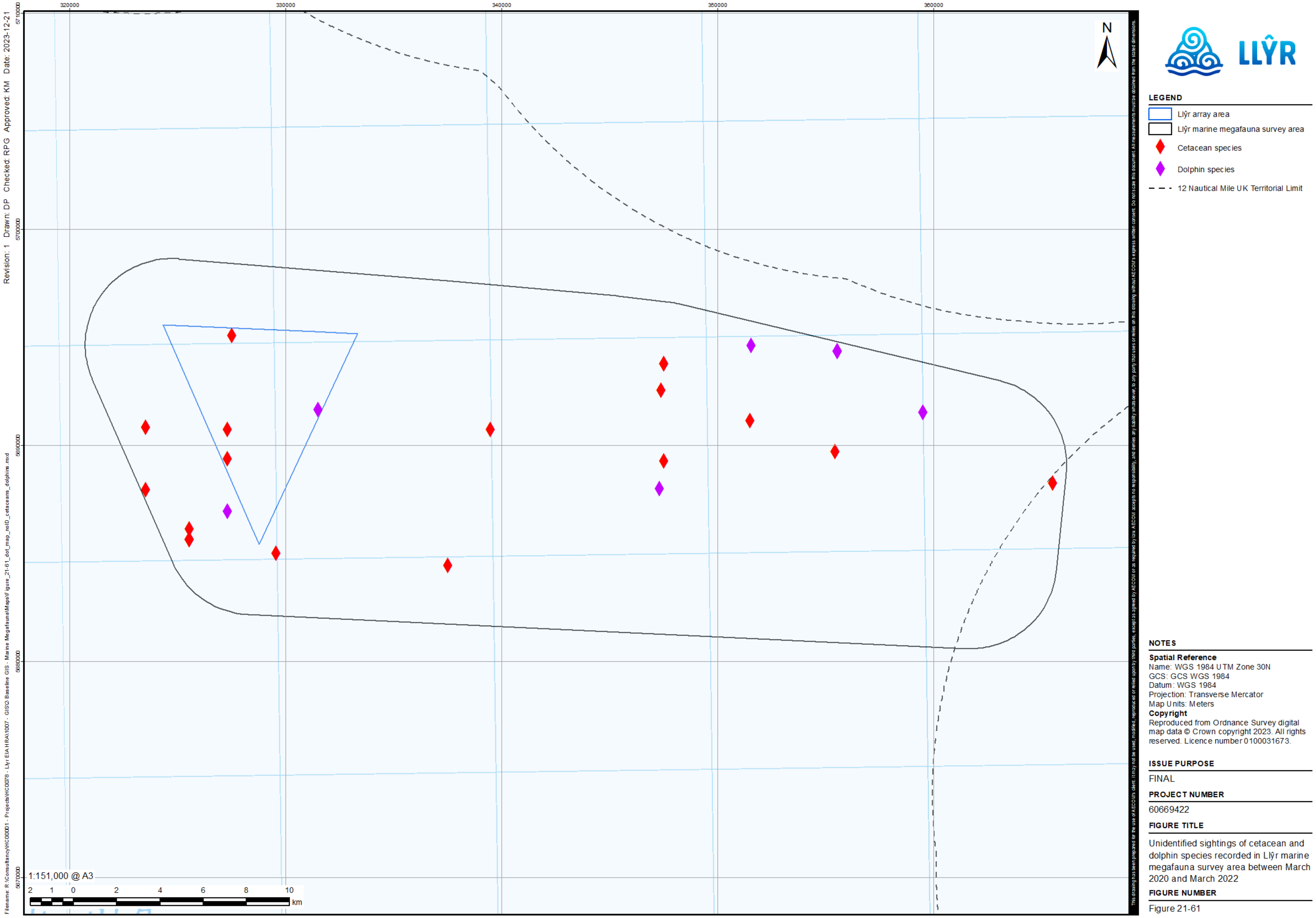


Figure 21A-61. Unidentified cetacean and dolphin species sightings recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022

Project Erebus Surveys

119. Throughout the two-year survey period across the Erebus survey area, only six bottlenose dolphins were recorded in March and two in June S02 2020, resulting in relative densities of 0.04 animals/km^2 and site abundances of 8 dolphins (95% CI 0 – 20) and 9 dolphins (95% CI 0 – 24), respectively. Over the 24-month survey period a relative density of 0.003 animals/km^2 was estimated (**Table 21A-24**). However, no conclusion can be made regarding any spatial distribution over the site due to the low number of sightings (**Figure 21-62**) (Darias-O'Hara *et al.*, 2021).

Table 21A-24. Raw count, relative density and abundance estimates of bottlenose dolphin recorded in the Erebus survey area (development area plus a 4 km buffer) between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Survey	Date	Raw count (n)	Relative density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV
6	03 Mar 2020	6	0.04	8	0	20	0.68
9	24 Jun 2020	2	0.04	9	0	24	0.93
All other surveys		0	0.00	0	0	0	0.00
Average Year 1 (1 – 12)		-	**0.007**	**1**	-	-	-
Average Year 2 (13 – 24)		-	**0.000**	**0**	-	-	-
Total average		-	**0.003**	**1**	-	-	-

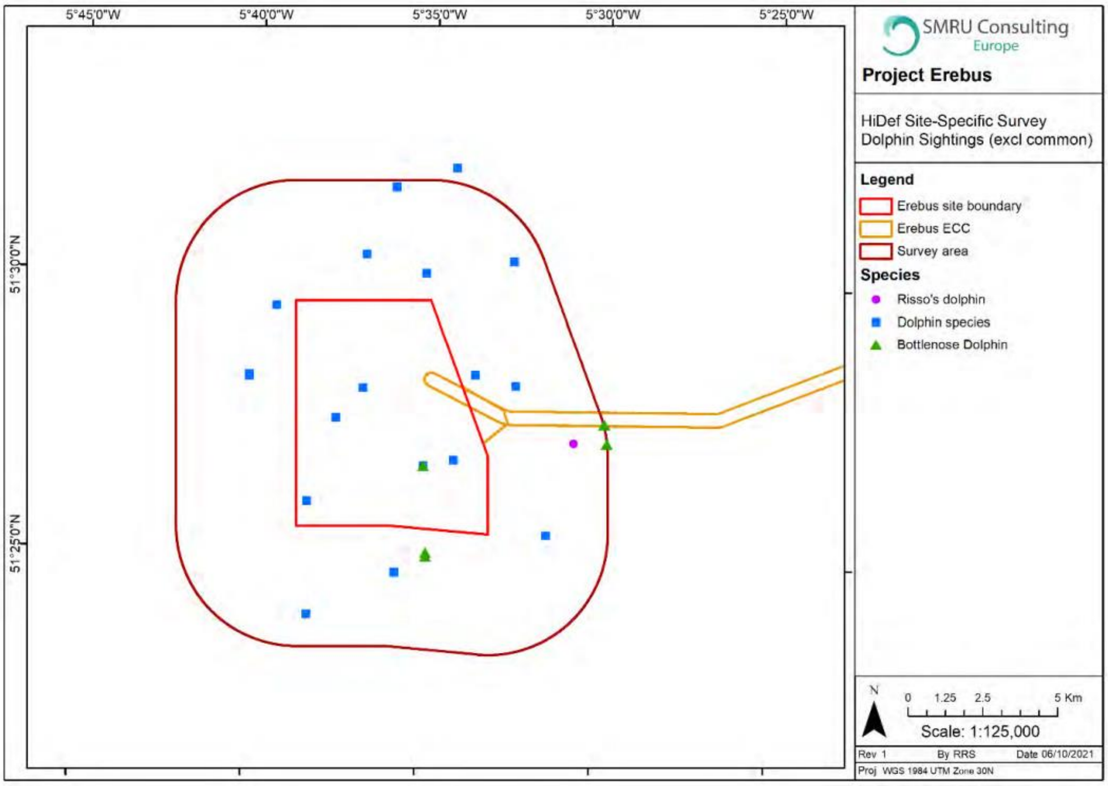


Figure 21-62. Bottlenose dolphin sightings recorded in the Erebus survey area between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Welsh Marine Atlas and Cetaceans and Seabirds of Wales

120. Between 1990 and 2009, a total of 10,236 bottlenose dolphin sightings, amounting to 33,683 individuals were recorded in the Welsh Marine Atlas database (**Figure 21A-63**) (Baines and Evans, 2012). In the Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023), a total of

17,753 cumulative individuals were contained in the database, resulting in the species being the second most abundant in the survey area (**Figure 21A-64**).

121. Bottlenose dolphins were predominantly recorded in the coastline of Cardigan Bay and in North Wales, with a small number of individuals recorded between the southwest coast of Wales and southeast coast of Ireland; northwest of the proposed Project (**Figure 21A-63** and **Figure 21A-64**). A seasonal trend can be observed in Cardigan Bay, with modelled densities peaking between the summer and early autumn periods (April to September), and were at the lowest in late winter and early spring (**Figure 21A-65**), although it should be noted that survey effort was not equivalent in each month and reduced for aerial surveys compared to boat-based surveys (Baines and Evans, 2012; Evans and Waggitt, 2023).

122. Within the Llŷr marine megafauna survey area, a mean maximum relative density of 0.001 individuals/km^2 was estimated (Evans and Waggitt, 2023).

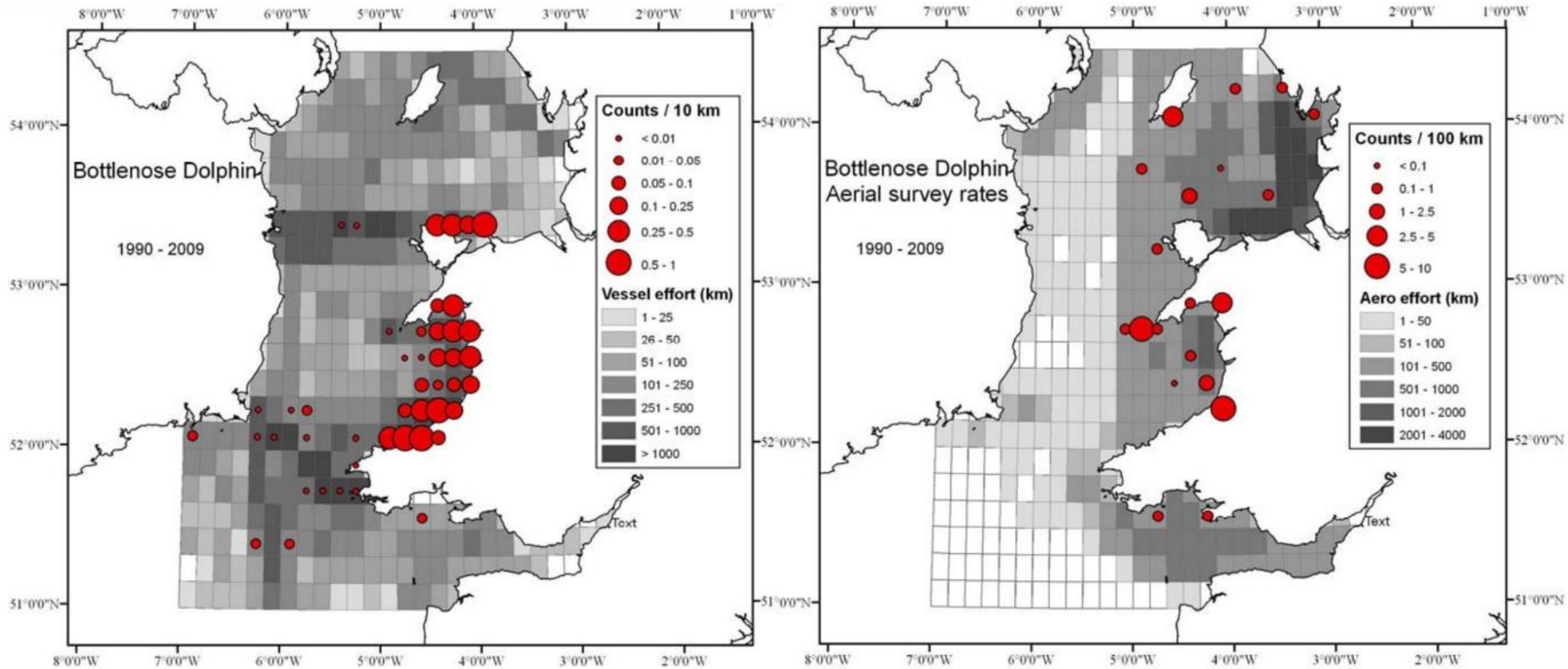


Figure 21A-63. Long-term mean sighting rates of bottlenose dolphins with vessel counts per 10 km and aerial counts per 100 km collected between 1990 and 2009 (Baines and Evans, 2012)

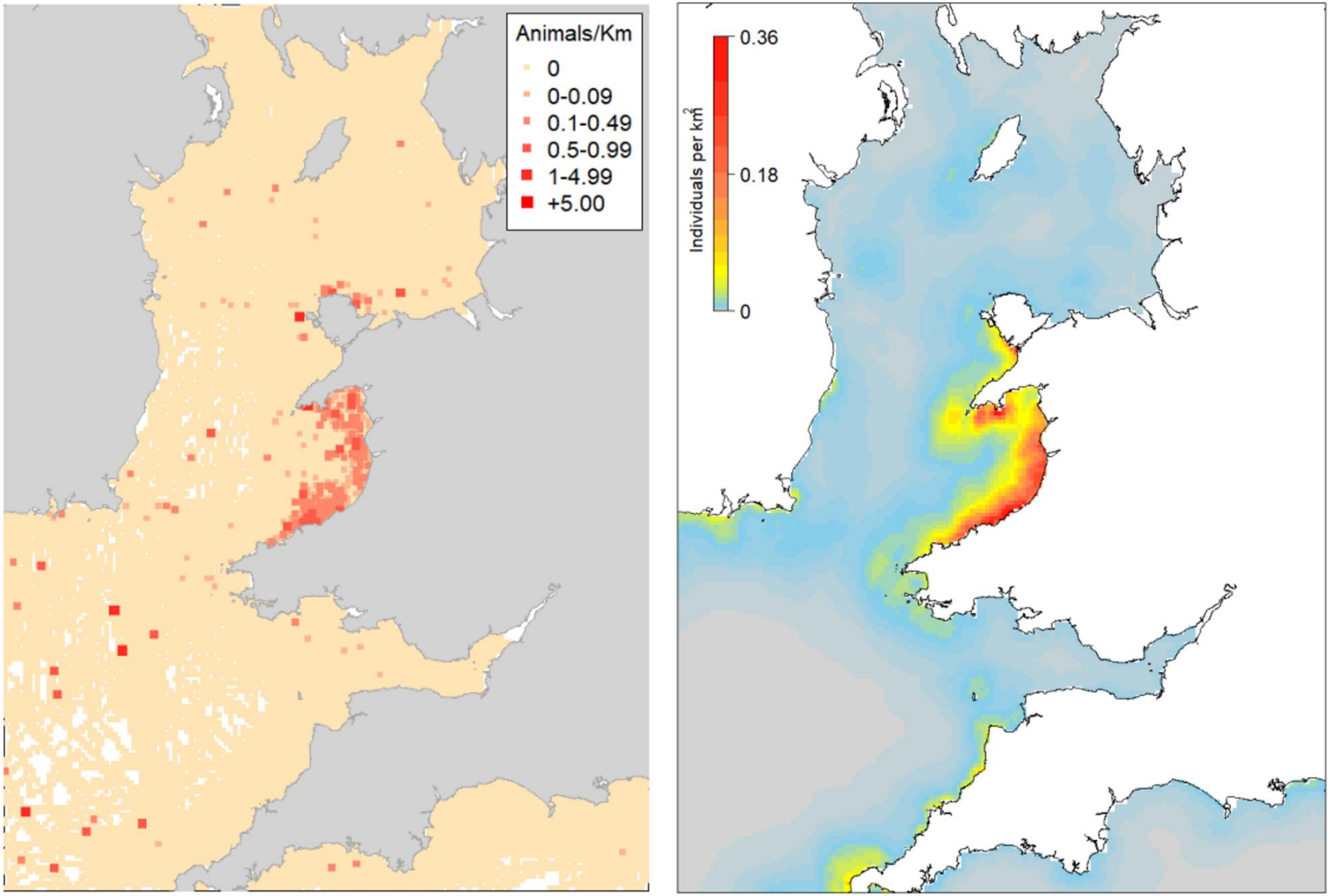


Figure 21A-64. Bottlenose dolphin sighting rate (n/km; left) and modelled densities (n/km^2; right) between 1990 and 2020 (Evans and Waggitt, 2023)

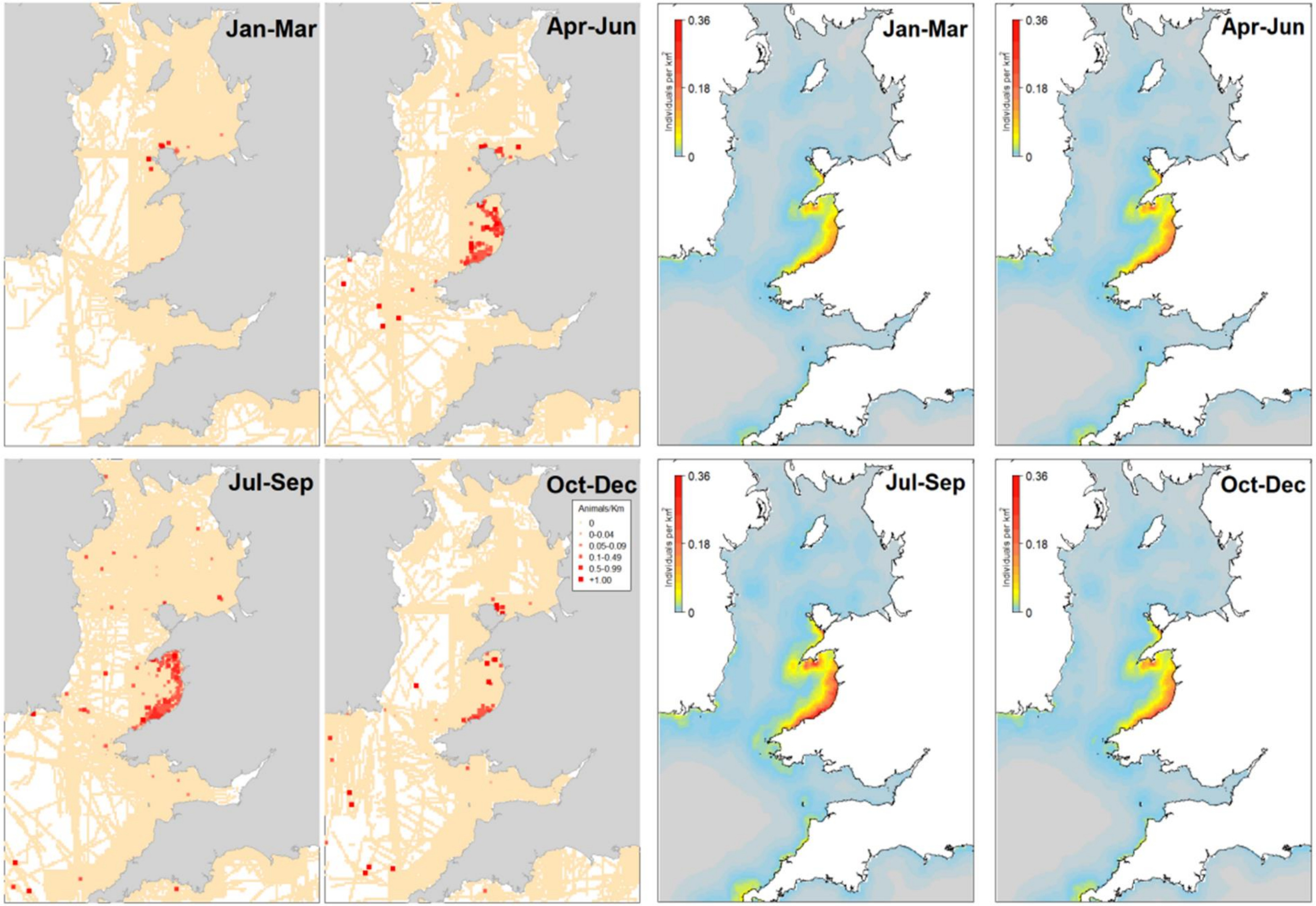


Figure 21A-65. Bottlenose dolphin sightings rates (n/km; left) and mean modelled densities (n/km^2; right) by quarter over the 1990-2020 period (Evans and Waggitt, 2023)

SCANS-III and IV Surveys

123. During the July 2016 aerial survey (SCANS-III), a total of 59 bottlenose dolphins were sighted on primary[7] search effort, mainly recorded in the Celtic Sea and Bay of Biscay. In Block D, the estimated absolute density was 0.061 animals/km^2 (0.447 CV) with a corresponding abundance of 2,938 animals (95% CI 914 – 5,867) (**Figure 21A-66**) (Hammond *et al.*, 2021).

124. Between the June and August 2022 aerial surveys (SCANS-IV), a total of 339 bottlenose dolphins were sighted in primary search effort, mainly observed in the Celtic and Irish Seas. In Block CS-C, the estimated absolute density was 0.4195 animals/km^2 (0.406 CV) with a corresponding abundance of 15,117 animals (95% CI 4,966 – 29,157) (**Figure 21A-66**) (Gilles *et al.*, 2023).

125. Density surface models using SCANS-III data (Lacey *et al.,* 2022) suggest bottlenose dolphin density is highest in the Bay of Biscay (**Figure 21A-67**). Around the Llŷr marine megafauna survey area, surface densities were estimated to range between 0.00 and 0.05 animals/km^2 (Lacey *et al.*, 2022).

[7] Primary search effort relates to the observations made from the primary survey platform. Tracker observations used for mark and recapture data for the estimation of the detection probability (Hammond *et al.,* 2021).

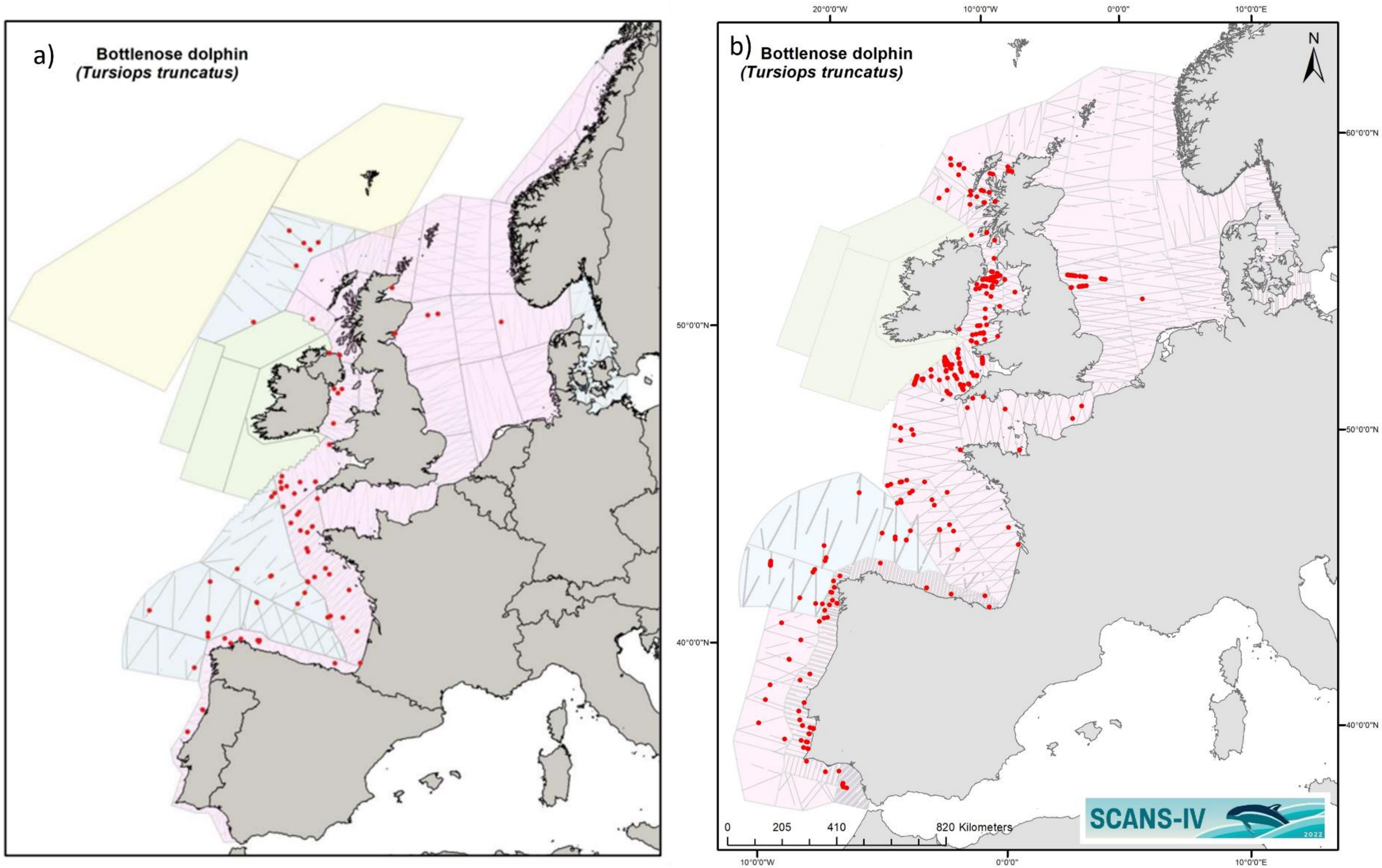


Figure 21A-66. Bottlenose dolphin sightings collected during the SCANS-III (a) and IV (b) surveys flown in July 2016 (Hammond et al., 2021) and between June and August 2022 (Gilles et al., 2023). Refer to Figure 21A-8 for Block identification

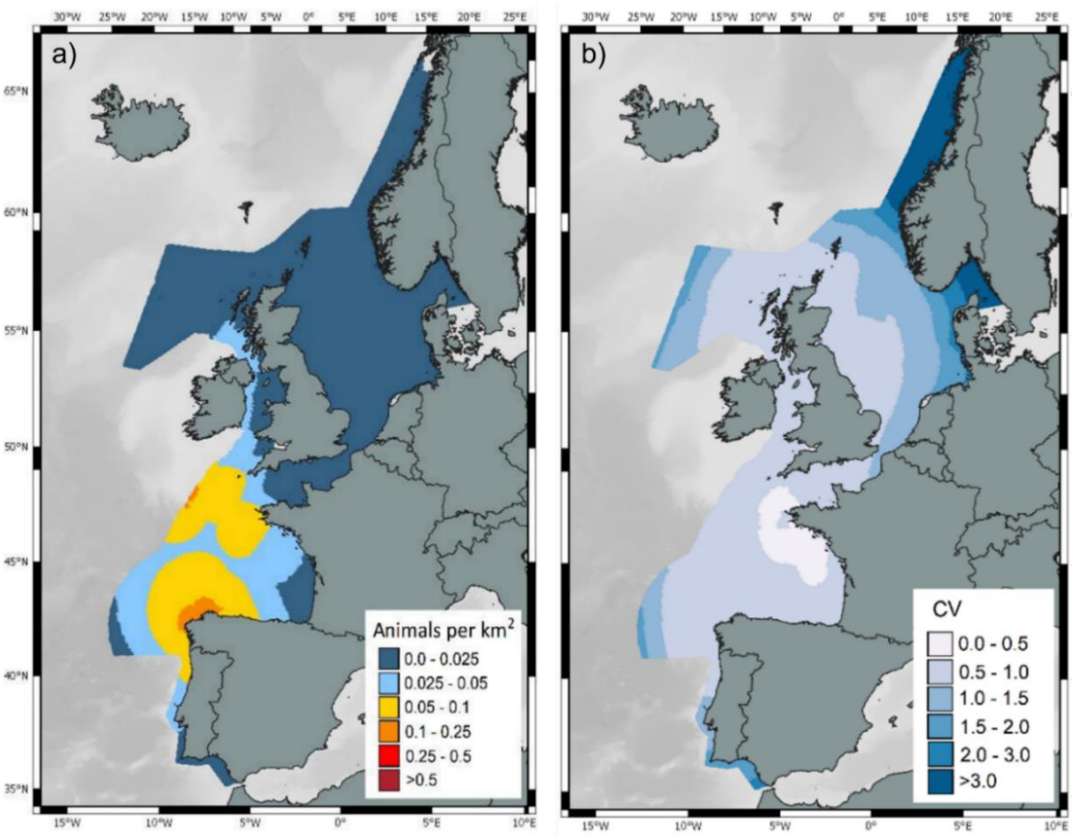


Figure 21A-67. Estimated surface density (a) and associated CV (b) for bottlenose dolphins in SCANS-III (2016) (Lacey et al., 2022)

ObSERVE Surveys

126. Bottlenose dolphin was one of the most frequently sighted cetacean in the ObSERVE surveys, except in the northern Irish Sea, where far fewer individuals were recorded (**Figure 21A-68**) (Rogan *et al.*, 2018). A clear seasonal pattern was recorded, with greater densities estimated in winter months for both years of survey (**Figure 21A-69**).

127. A total of 141 groups of mean size ranging from approximately three to eight individuals were observed in the Stratum 4 throughout the four seasons, while five individuals were recorded in the Stratum 5 during the winter 2016. No bottlenose dolphins were recorded in 2015, nor in summer 2016 in Stratum 5 (Rogan *et al.*, 2018).

128. Absolute density estimates for bottlenose dolphins were calculated with design- and model-based methods. Design-based absolute densities in Stratum 4 ranged between 0.062 animals/km^2 (summer 2015) and 0.929 animals/km^2 (winter 2016), equating to 3,885 dolphins (95% CI 1,210 – 12,473) and 58,647 dolphins (95% CI 37,881 – 90,798), respectively (**Table 21A-25**). Absolute design-based estimates for Stratum 5 in winter 2016 were considerably lower with 0.036 animals/km^2, equating to 401 dolphins (95% CI 76 – 2,105). Absolute model-based density estimates were only available for winter 2015 and the year 2016 and resulted in higher densities than design-based estimates (**Table 21A-25**).

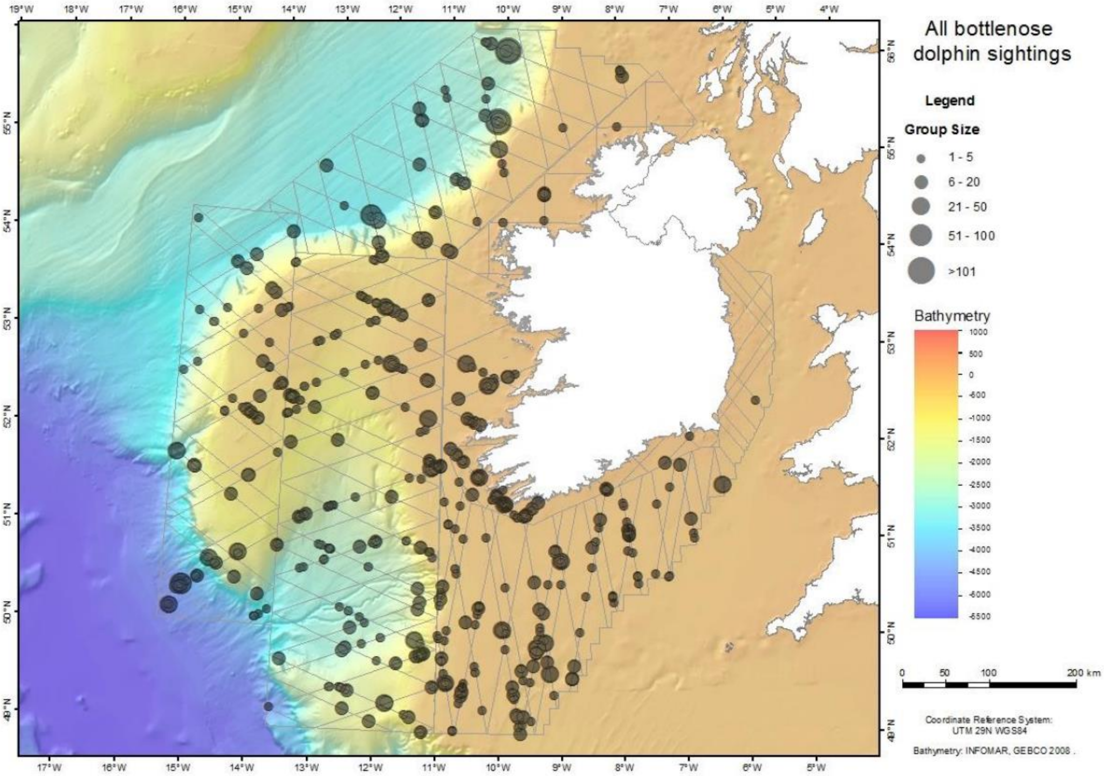


Figure 21A-68. Bottlenose dolphin sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

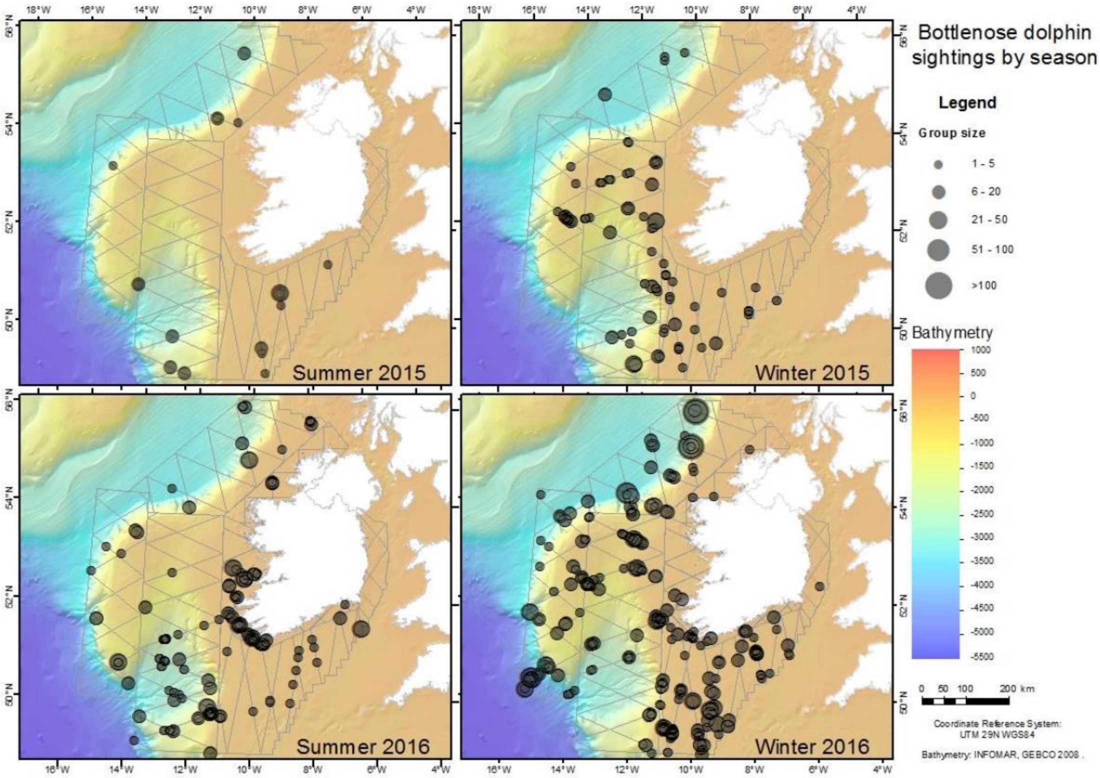


Figure 21A-69. Seasonal bottlenose dolphin sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

Table 21A-25. Bottlenose dolphin absolute design-based and model-based density and abundance estimates for Strata 4 and 5 of the ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018) (n/a[1] = no sightings data; n/a[2] = too few sightings to generate model-based estimates)

Stratum	Season	Absolute design-based estimates				Absolute model-based estimates			
		Density (n/km^2)	Abundance (n)	Lower 95% CL	Upper 95% CL	Density (n/km^2)	Abundance (n)	Lower 95% CL	Upper 95% CL
Stratum 4	Summer 2015	0.062	3,885	1,210	12,473	n/a[2]			
	Winter 2015	0.098	6,217	3,565	10,842	0.0946	5,924	3,926	10,646
	Summer 2016	0.088	5,549	2,241	13,739	0.1548	9,692	6,999	14,511
	Winter 2016	0.929	58,647	37,881	90,798	0.9143	57,246	47,481	70,548
Stratum 5	Summer 2015	n/a[1]				n/a[2]			
	Winter 2015	n/a[1]				n/a[2]			
	Summer 2016	n/a[1]				0.0106	118	0	1,129
	Winter 2016	0.036	401	76	2,105	0.0201	223	0	828

Sea Watch Foundation Bottlenose Dolphin Surveys

129. As explained in **Section 21.2.6**, Lohrengel *et al.* (2018) estimated bottlenose dolphin abundance in the Cardigan Bay SAC and wider Cardigan Bay area using CMR photo-ID data on a closed population and on distance sampling from line transect surveys (**Table 21A-26**). Data from 2001 and 2005 for the Cardigan Bay SAC and wider Cardigan Bay area respectively were collected in the original report, however, only data between 2011 and 2016 were presented in this report to describe the most up to date population estimates (Lohrengel *et al.*, 2018).

130. In 2016, abundances from a closed population CMR model were estimated at 147 dolphins (95% CI 127 – 194) and 174 dolphins (95% CI 150 – 246) in the Cardigan Bay SAC and wider Cardigan Bay area. In comparison, abundances from distance sampling were estimated at 84 dolphins (95% CI 44 – 160) and 289 dolphins (95% CI 184 – 453) for the same year and areas, respectively (**Table 21A-26**). Therefore, the distance sampling methodology estimated larger abundance for the Wider Cardigan Bay area than the closed population methodology, while the reverse was true for the Cardigan Bay SAC.

131. Of the bottlenose dolphins photographed throughout the study period, several were also recorded and photographed in north Wales and Liverpool Bay, as well as close to Fishguard, in the southern west tip of Wales, closer to the proposed Project (Lohrengel *et al.*, 2018).

Table 21A-26. Abundance estimates of bottlenose dolphins in the Cardigan Bay SAC and wider Cardigan Bay recorded in 2015 and 2016 based on the closed population CMR model and distance sampling line transect surveys conducted by the SWF bottlenose dolphin (Lohrengel et al., 2018)

Year	Cardigan Bay SAC					Wider Cardigan Bay				
	Capture events-animals captured*, Observations**	Abundance estimate	Lower 95% CL	Upper 95% CL	CV	Capture events-animals captured*, Observations**	Abundance estimate	Lower 95% CL	Upper 95% CL	CV
Closed population CMR model										
2011	197-83*	168	147	210	0.24	265-114*	225	201	271	0.21
2012	186-88*	211	175	281	0.32	293-122*	222	204	260	0.17
2013	140-61*	141	116	194	0.35	262-107*	191	176	224	0.16
2015	116-62*	146	119	210	0.40	162-90*	206	171	278	0.28
2016	141-72*	147	127	194	0.29	162-83*	174	150	246	0.30
Distance sampling										
2011	22**	133	75	235	0.30	27**	309	179	353	0.28
2012	19**	70	37	131	0.33	32**	330	203	534	0.25
2013	22**	90	45	179	0.37	33**	254	151	427	0.27
2015	12**	64	19	220	0.65	19**	277	138	555	0.36
2016	18**	84	44	160	0.33	36**	289	184	453	0.23

JCP Phase III

132. Across the 17 years of data collated in the JCP Phase III report, 3,065 bottlenose dolphin sightings were recorded, ranging from 12 sightings in 1995 to 431 sightings in 2008. The latest year of data, 2010, recorded a total of 54 sightings. Maps of predicted density for summer 2010 suggest very low densities for the species around the UK, with slightly higher densities predicted in west Wales and Irish waters (**Figure 21A-70** and **Figure 21A-71**). In the Atlantic Array, an area covering 1.8% of the Celtic and Greater North Sea MU, estimated abundance for 2010 was generally highest in the spring and summer seasons (summer absolute density of 0.006 animals/km^2) with the lowest density estimates in autumn (absolute density of 0.002 animals/km^2). The average absolute density across all seasons was calculated at 0.004 animals/km^2 (**Table 21A-27**, **Figure 21A-70** and **Figure 21A-71**) (Paxton *et al.*, 2016).

Table 21A-27. Bottlenose dolphins absolute density and abundance estimates for 2010 in the Atlantic Array (19,649 km^2) based on the JCP Phase III data (Paxton et al., 2016)

Season	Absolute density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)
Winter	0.004	70	20	330
Spring	0.005	100	30	390
Summer	0.006	120	40	490
Autumn	0.002	40	20	170
Average	**0.004**	**83**	**-**	**-**

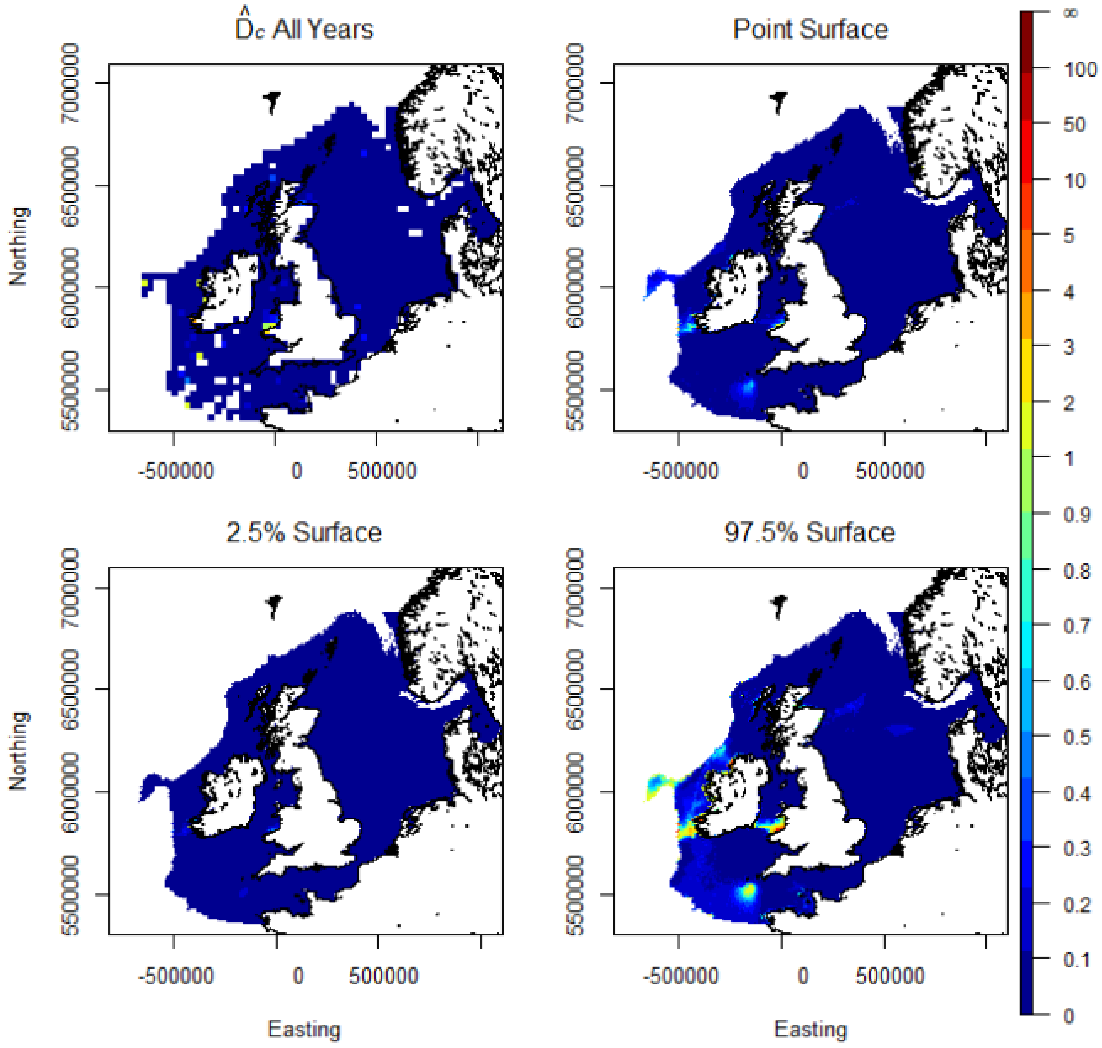


Figure 21A-70. Predicted densities ($\hat{D}_c$) of bottlenose dolphins for the summer 2010 (Paxton et al., 2016). Top left map represents the input densities of summers from all years. Top right map represents the predicted densities for the summer 2010. Bottom maps represent the 95% CL density estimates

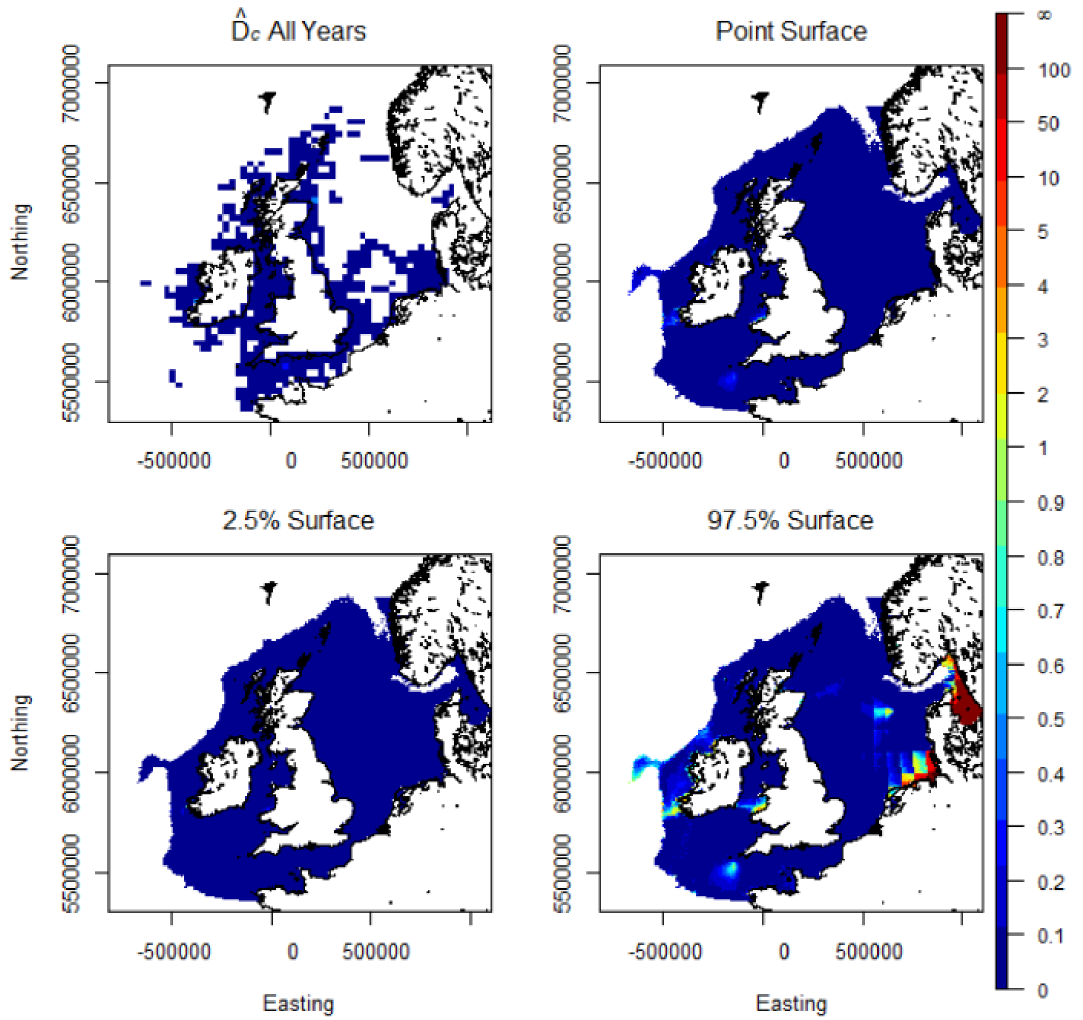


Figure 21A-71. Predicted densities ($\hat{D}_c$) of bottlenose dolphins for the winter 2010 (Paxton et al., 2016). Top left map represents the input densities of winters from all years. Top right map represents the predicted densities for the winter 2010. Bottom maps represent the 95% CL density estimates

MERP Surveys and Distribution Maps of Cetacean and Seabird Populations in the Northeast Atlantic

133. A total of 6,674 bottlenose dolphin sightings amounting to 35,109 individuals were recorded between 1980 and 2018 (Waggitt *et al.*, 2019). The predicted monthly density maps show a slight increased presence of bottlenose dolphin around the Array Area in August (in the Celtic and Irish Seas), and an overall increased presence in the Atlantic in winter and spring months (**Figure 21A-72** and **Figure 21A-73**).

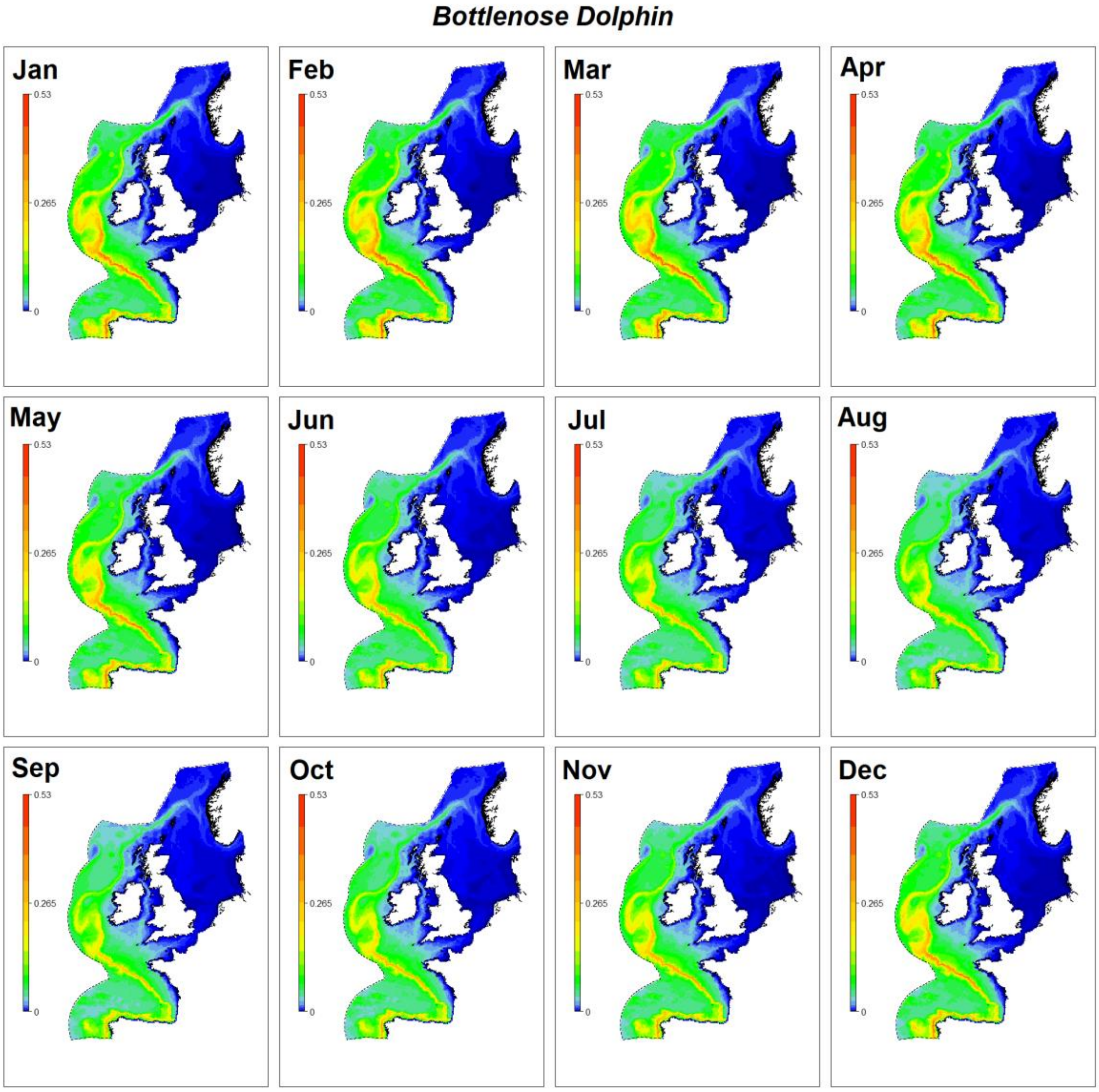


Figure 21A-72. Monthly predicted densities (animals/km^2) of bottlenose dolphins in the Northeast Atlantic (values provided at 10 km resolution) (Waggitt et al., 2019)

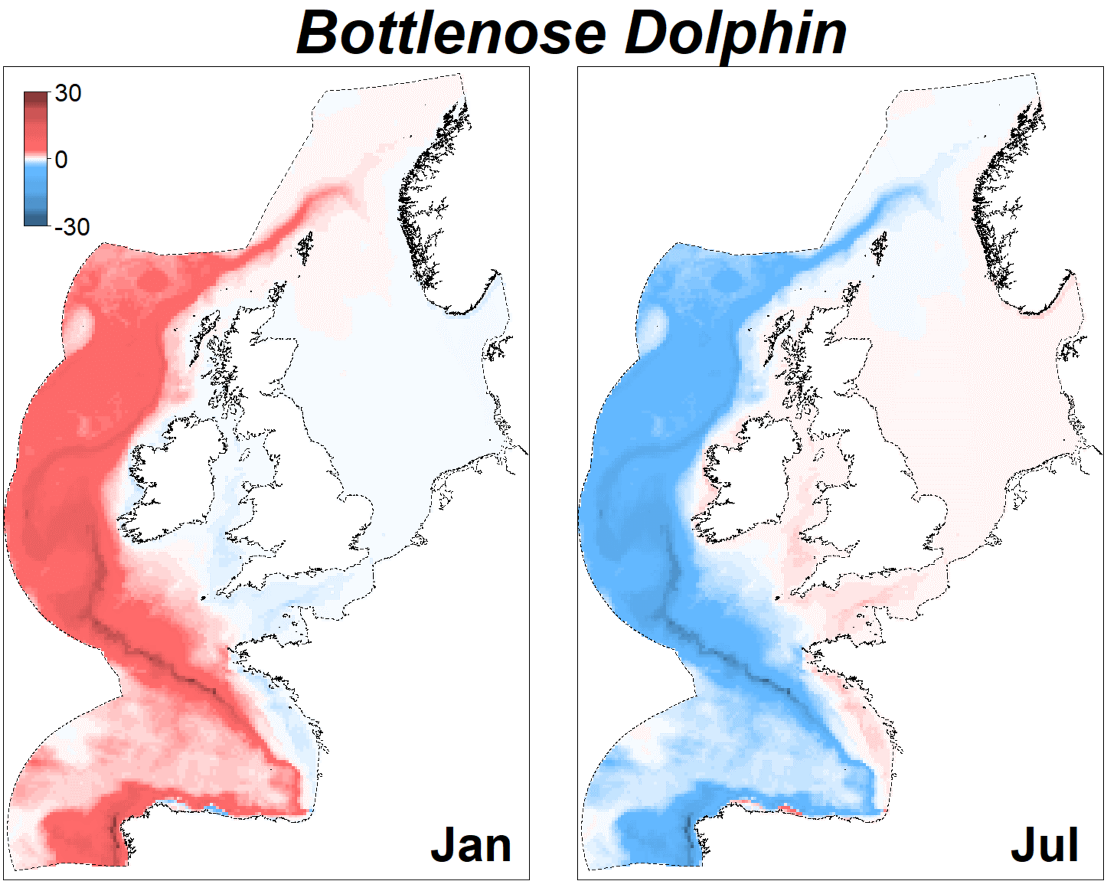


Figure 21A-73. Difference in predicted densities (animals/km^2) of bottlenose dolphins between January and July in the Northeast Atlantic ('Values are relative to the other month and have been standardised by converting them into percentages of the maximum predicted density. Red and blue colours indicate increases and decreases from the other month, respectively') (Waggitt et al., 2019)

Bottlenose Dolphin Summary

134. Several sources provide a range of bottlenose dolphin density estimates from 0.000 animals/km^2 to 0.929 animals/km^2 (**Table 21A-28**) that are relevant to the proposed Project. Data analysis methodology varied between surveys so comparison between estimates derived through different studies should be undertaken with caution. It should be noted that estimates from the JCP, SCANS and ObSERVE (Paxton *et al*., 2016; Rogan *et al.,* 2018; Hammond *et al.,* 2021), provided absolute estimates with correction for availability bias at the time of the surveys.

135. The most recent data recording bottlenose dolphins are site-specific survey data collected by HiDef at the Erebus Project site between 2019 and 2021 which indicate bottlenose dolphins may be present in the vicinity of the proposed Project in relatively low densities. The estimates gave an average relative density for the full survey period of 0.003 animals/km^2, with peak estimates recorded during the summer period (0.04 animals/km^2 [June 2020]). Estimated densities from the site-specific survey data are overall much lower than those presented in SCANS-III and ObSERVE (Rogan *et al*., 2018; Hammond *et al*., 2021) when comparing summer months estimates. SCANS-IV estimates were found to be greater than those of SCANS-III, albeit still lower than those of the ObSERVE surveys (Gilles *et al.,* 2023).

136. Although there were no sightings of bottlenose dolphins during the site-specific project DAS surveys, the Erebus site surveys did report low densities within the area. SCANS-IV observed that the distribution in 2022 was different to SCANS-III with more sightings in the northern Celtic Sea. It is precautionary to use the SCANS-IV density estimate of 0.4195 animals/km^2

which represents absolute abundance and is spatially relevant to the area of the proposed Project.

Table 21A-28. Summary of bottlenose dolphin density estimates collected around the Llŷr array rea presented in this report (highlighted cell corresponds to the density recommended to be used for quantitative impact assessment)

Study or survey programme	Area		Time scale	Average density (n/km²)
	Name	Size (km²)		
Erebus Project, HiDef site-specific surveys (Darias-O'Hara *et al.,* 2021)	Erebus survey area (development area plus a 4 km buffer)	200.11	Year 1 Oct 2019 – Sep 2020	0.007 (relative)
			Year 2 Oct 2020 – Sep 2021	0.000 (relative)
			All surveys Oct 2019 – Sep 2021	0.003 (relative)
Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023)	Llŷr marine megafauna survey area	640.92	1990 - 2020	0.001 (relative)
SCANS-III surveys (Hammond *et al.,* 2021)	Block D – Celtic and Irish Seas	48,590	Jun – Jul 2016	0.061 (absolute)
SCANS-IV surveys (Gilles *et al.,* 2023)	Block CS-C	36,031	Jun – Aug 2023	0.4195 (absolute)
ObSERVE surveys (Rogan *et al.,* 2018)	Stratum 4 – Celtic Sea	n/a	Summer 2015	0.062 (adbe)
			Winter 2015	0.098 (adbe) 0.095(ambe)
			Summer 2016	0.088 (adbe) 0.155 (ambe)
			Winter 2016	0.929 (adbe) 0.914 (ambe)
	Stratum 5 – Irish Sea	n/a	Summer 2016	0.011 (ambe)
			Winter 2016	0.036 (adbe) 0.020 (ambe)
JCP Phase III (Paxton *et al.,* 2016)	Atlantic Array	19,649	Winter 2010	0.004 (absolute)
			Spring 2010	0.005 (absolute)
			Summer 2010	0.006 (absolute)
			Autumn 2010	0.002 (absolute)
			Average 2010	0.004 (absolute)

21.3.5. Minke Whale

137. Minke whale is a globally distributed species and can be found in both offshore and shelf waters. Their distribution has previously been linked to prey availability (Macleod *et al*., 2004) which includes small shoaling fish and euphausiids (van Waerebeek *et al.,* 1999; Anderwald *et al.,* 2012). Despite being the smallest baleen whale in the northeast Atlantic, they are the most common and can generally be found seasonally around the UK. The highest densities are often observed in Scottish waters, and lower densities are recorded in the southern North Sea and English Channel (JNCC, 2019e). There is some evidence that may indicate a slight southward shift in minke whale distribution in the North Sea (Hammond *et al*., 2013; Hammond *et al*., 2021).

138. In Europe and in the UK, minke whales are European Protected Species as Annex IV species under the Habitats Directive[8]. They are listed and protected on at least eight different pieces of legislation. In December 2020, as part of the Marine Scotland Act legislation, the species was designated a protected feature of two Nature Conservation MPAs: Southern Trench and Sea of the Hebrides, located around the northeast and west coasts of Scotland, respectively. Currently, the Celtic and Greater North Seas MU (IAMMWG, 2022) is the only MU assigned to the species (**Figure 21A-1**).

Site-specific Surveys

139. Throughout the two-year survey period across the Llŷr marine megafauna survey area, four minke whales were recorded (**Table 21A-29**). All observations were made in June. This resulted in a peak relative design-based density of 0.04 animals/km^2 (95% CI 0.00 – 0.10) in June S02 2020 in the Llŷr marine megafauna survey area. This equated to an abundance of 26 animals (95% CI 0 – 64) (**Table 21A-29**). No conclusion can be made regarding the spatial distribution over the site due to the low number of sightings (**Figure 21A-74**).

Table 21A-29. Raw count, relative design-based density and abundance estimates of minke whales recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022 (Summer = April – September, Winter = October – March)

Survey	Date	Raw count (n)	Relative density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)
1	25 Mar 2020	0	0.00	0	0	0	0
2	14 Apr 2020	0	0.00	0	0	0	0
3	08 Jun 2020	0	0.00	0	0	0	0
4	24 Jun 2020	3	0.04	26	0	64	64.51
5	21 Jul 2020	0	0.00	0	0	0	0
6	31 Aug 2020	0	0.00	0	0	0	0
7	12 Sep 2020	0	0.00	0	0	0	0
8	22 Oct 2020	0	0.00	0	0	0	0
9	26 Nov 2020	0	0.00	0	0	0	0
10	10 Jan 2021	0	0.00	0	0	0	0
11	25 Jan 2021	0	0.00	0	0	0	0
12	22 Feb 2021	0	0.00	0	0	0	0

[8] The legislation transposing the EU Habitats Directive has been amended so that the strict protections afforded to sites, habitats and species continues following EU Exit. The suite of legislative instruments is collectively termed the 'Habitat Regulations'. The Habitat Regulations were amended in 2019 as a result of the UK leaving the EU within the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.

Survey	Date	Raw count (n)	Relative density (n/km²)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)	CV (%)
13	14 May 2021	0	0.00	0	0	0	0
14	27 May 2021	0	0.00	0	0	0	0
15	15 Jun 2021	1	0.02	16	0	39	70.13
16	14 Jul 2021	0	0.00	0	0	0	0
17	16 Aug 2021	0	0.00	0	0	0	0
18	01 Sep 2021	0	0.00	0	0	0	0
19	22 Oct 2021	0	0.00	0	0	0	0
20	20 Nov 2021	0	0.00	0	0	0	0
21	16 Dec 2021	0	0.00	0	0	0	0
22	05 Jan 2022	0	0.00	0	0	0	0
23	26 Feb 2022	0	0.00	0	0	0	0
24	20 Mar 2022	0	0.00	0	0	0	0
Average Year 1 (1 – 12)		**-**	**0.003**	**2**	**0**	**5**	**226.50**
Average Year 2 (13 – 24)		**-**	**0.002**	**1**	**0**	**3**	**238.16**
Total average		**-**	**0.003**	**2**	**0**	**3**	**236.18**
Summer average		**-**	**0.005**	**4**	**0**	**7**	**167.01**
Winter average		**-**	**0.000**	**0**	**0**	**0**	**0**

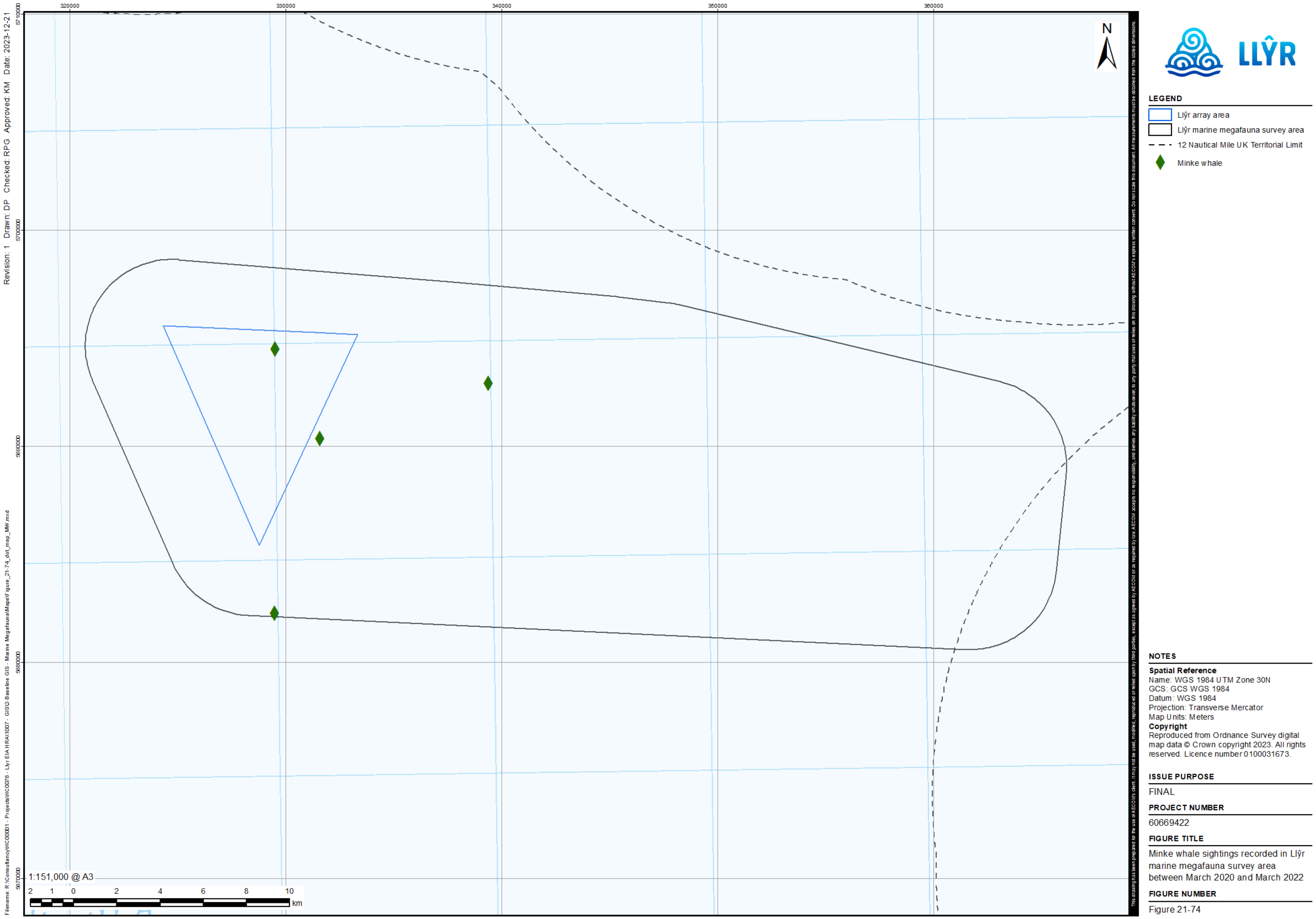


Figure 21A-74. Minke whale sightings recorded in the Llŷr marine megafauna survey area between March 2020 and March 2022

Project Erebus Surveys

140. Throughout the two-year survey period across the Erebus survey area, only three minke whales were recorded in a single survey (June S02 2020), resulting in a relative density of 0.04 animals/km^2 and an abundance of 8 animals (95% CI 0 – 19) in that month and a relative density of 0.002 animals/km^2 over the 24-month period (**Table 21A-30**). No conclusion can be made regarding the spatial distribution over the site due to the low number of sightings (**Figure 21A-75**) (Darias-O'Hara *et al.*, 2021).

Table 21A-30. Raw count, relative density and abundance estimates of minke whales recorded in the Erebus survey area (development area plus a 4 km buffer) between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Survey	Date	Raw count (n)	Relative density (n/km^2)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL n)	CV
9	24 Jun 2020	3	0.04	8	0	20	0.63
All other surveys		0	0.00	0	0	0	0.00
Average Year 1 (1 – 12)		-	**0.003**	**1**	-	-	-
Average Year 2 (13 – 24)		-	**0.000**	**0**	-	-	-
Total average		-	**0.002**	**0**	-	-	-

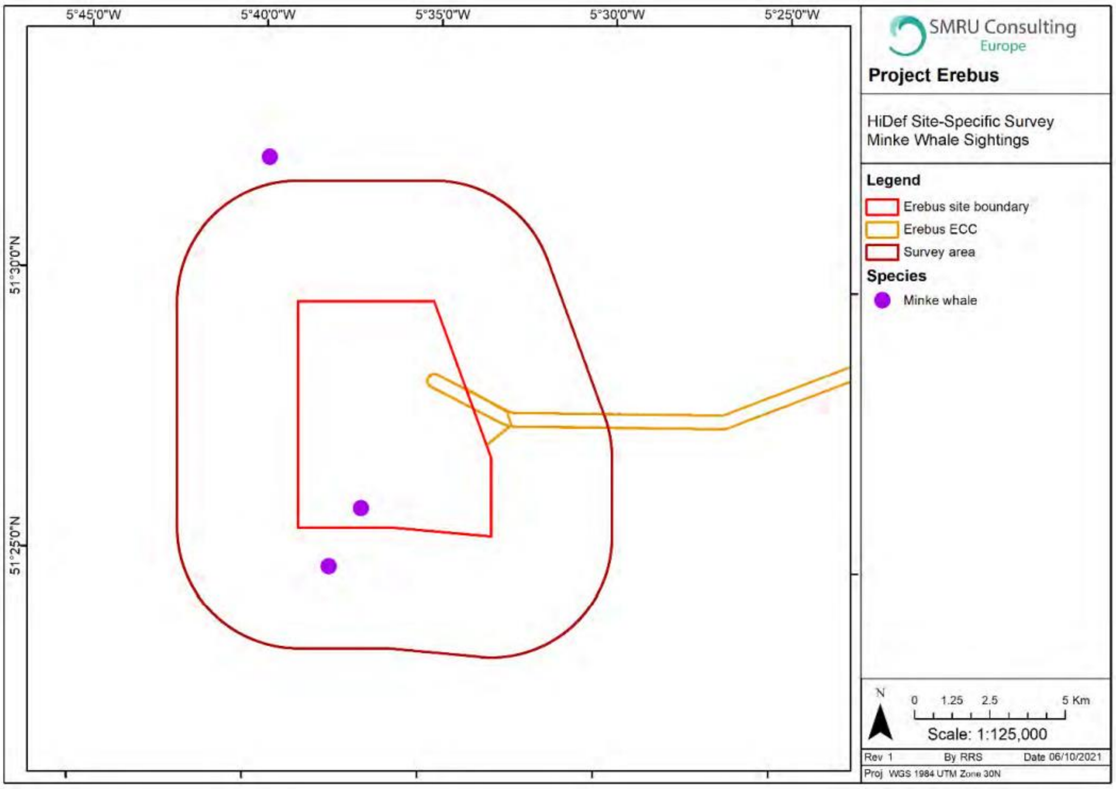


Figure 21A-75. Minke whale sightings recorded in the Erebus survey area between October 2019 and September 2021 (Darias-O'Hara et al., 2021)

Welsh Marine Atlas and Cetaceans and Seabirds of Wales

141. Between 1990 and 2009, a total of 211 minke whale sightings, amounting to 274 individuals were recorded in the Welsh Marine Atlas database (**Figure 21A-76**) (Baines and Evans, 2012). In the Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023), a total of 302 cumulative individuals were contained in the database (**Figure 21A-77**).

142. A greater number of sightings was recorded in the southwest part of the area and west of the proposed Project, close to the Irish coastline and more offshore in the Celtic Deep waters (**Figure 21A-76** and **Figure 21A-77**). A seasonal trend was observed, where modelled densities peaked between July and September, and were at their lowest between January and March (**Figure 21A-78**), although it should be noted that survey effort was not equivalent in each month and reduced for aerial surveys compared to boat-based surveys (Baines and Evans, 2012; Evans and Waggitt, 2023).

143. Within the Llŷr marine megafauna survey area, a mean maximum relative density of 0.007 individuals/km^2 was estimated (Evans and Waggitt, 2023).

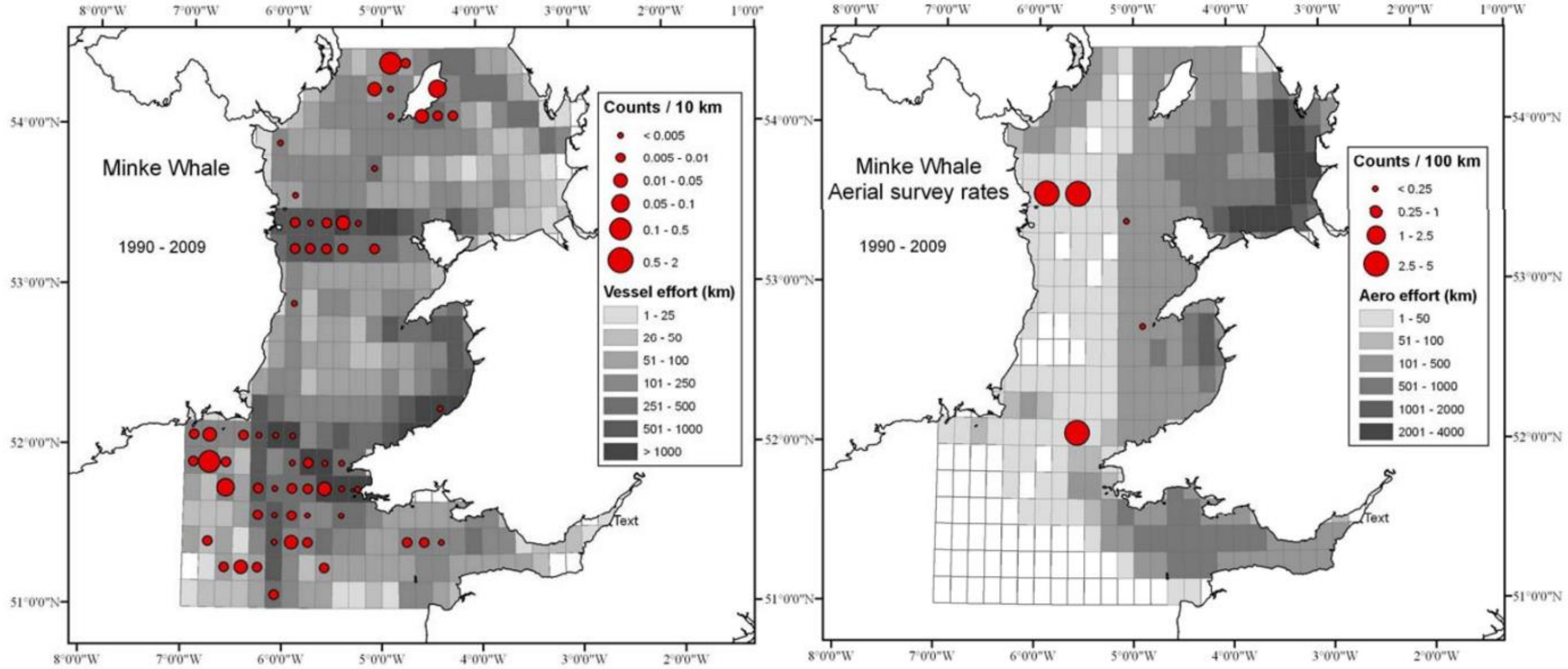
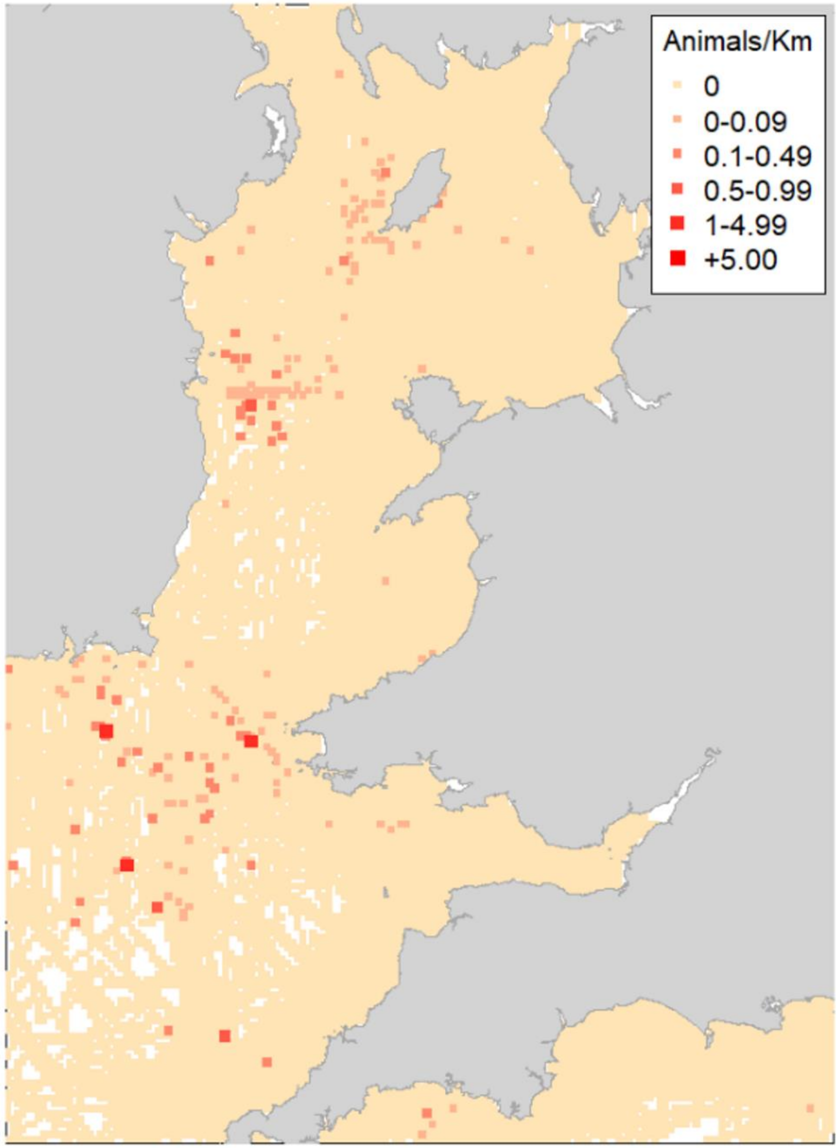


Figure 21A-76. Long-term mean sighting rates of minke whales with vessel counts per 10 km (left) and aerial counts per 100 km (right) collected between 1990 and 2009 (Baines and Evans, 2012)



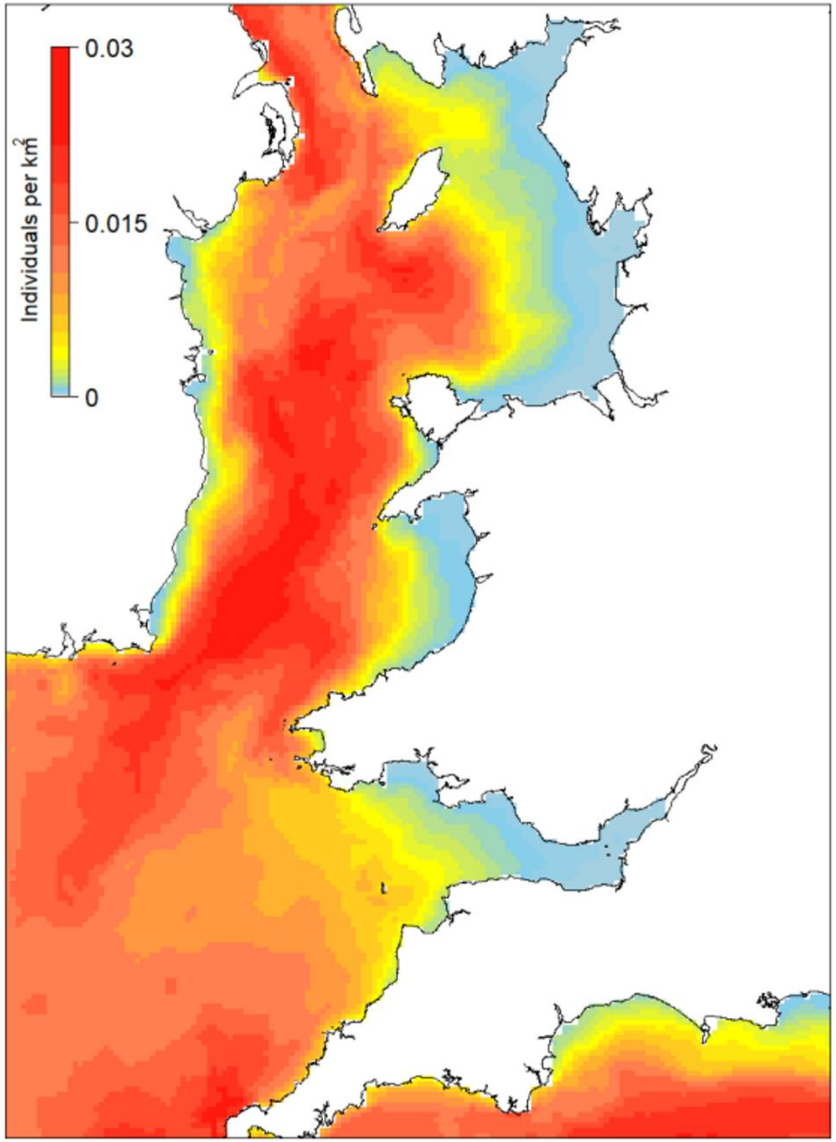


Figure 21A-77. Minke whale sighting rate (n/km; left) and modelled densities (n/km^2; right) between 1990 and 2020 (Evans and Waggitt, 2023)

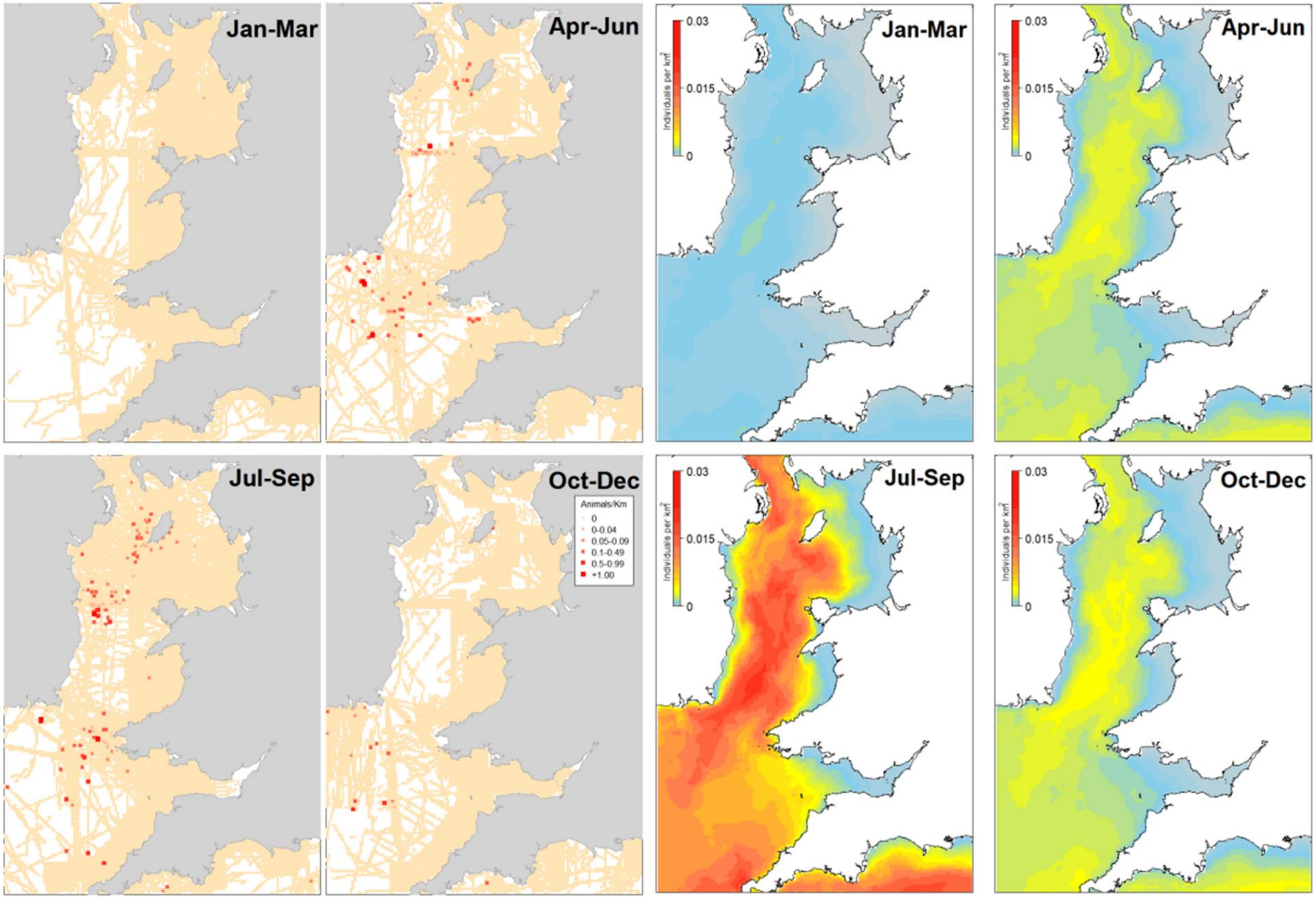


Figure 21A-78. Minke whale sightings rates (n/km; left) and mean modelled densities (n/km²; right) by quarter over the 1990-2020 period (Evans and Waggitt, 2023)

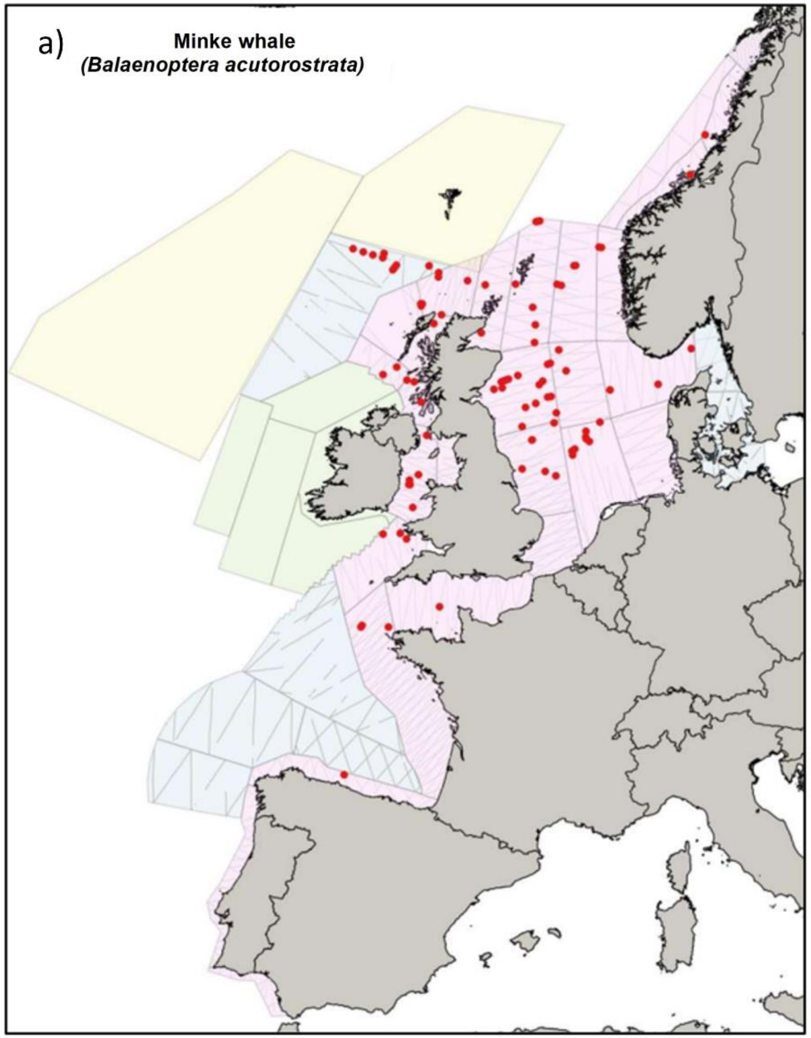
SCANS-III and IV Surveys

144. During the July 2016 aerial survey (SCANS-III), a total of 73 minke whales were sighted on primary[9] search effort, mainly observed in the North Sea. In Block D, the absolute density was 0.011 animals/km^2 (0.755 CV) with a corresponding abundance of 543 animals (95% CI 0 – 1,559) (**Figure 21A-79**) (Hammond *et al.*, 2021).

145. Between the June and August 2022 aerial surveys (SCANS-IV), a total of 78 minke whales were sighted in primary search effort, mainly observed in the North Sea. In Block CS-C, the absolute density was 0.0079 animals/km^2 (0.822 CV) with a corresponding abundance of 284 animals (95% CI 3 – 921) (**Figure 21A-79**) (Gilles *et al.*, 2023).

146. Density surface models using SCANS-III data (Lacey *et al.,* 2022) also show minke whale density is highest in the North Sea, as well as around the Isle of Man and around the southwest coast of England in the Bristol Channel, south of the proposed Project (**Figure 21A-80**). Around the Llŷr marine megafauna survey area, densities were estimated to range between 0.01 and 0.02 animals/km^2 (Lacey *et al.*, 2022).

[9] Primary search effort relates to the observations made from the primary survey platform. Tracker observations used for mark and recapture data for the estimation of the detection probability (Hammond *et al.,* 2021).



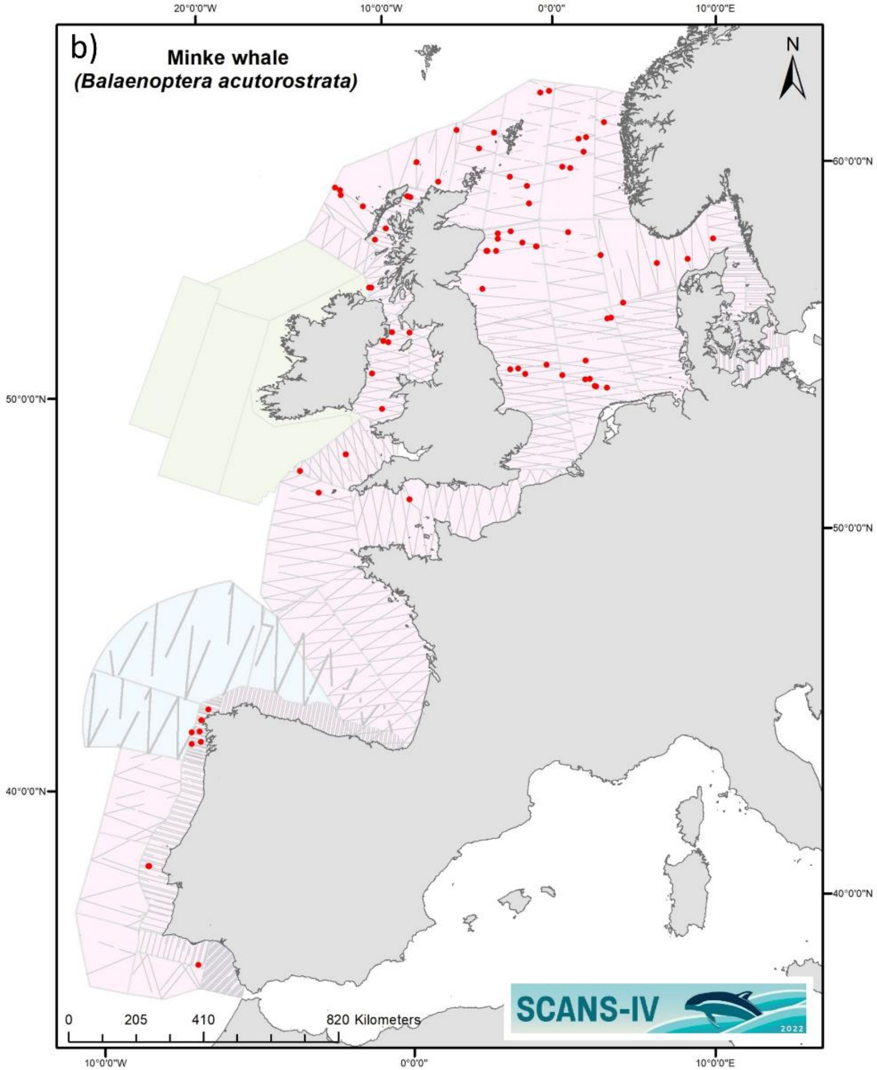


Figure 21A-79. Minke whale sightings collected during the SCANS-III (a) and IV (b) surveys flown in July 2016 (Hammond et al., 2021) and between June and August 2022 (Gilles et al., 2023). Refer to Figure 21A-8 for Block identification

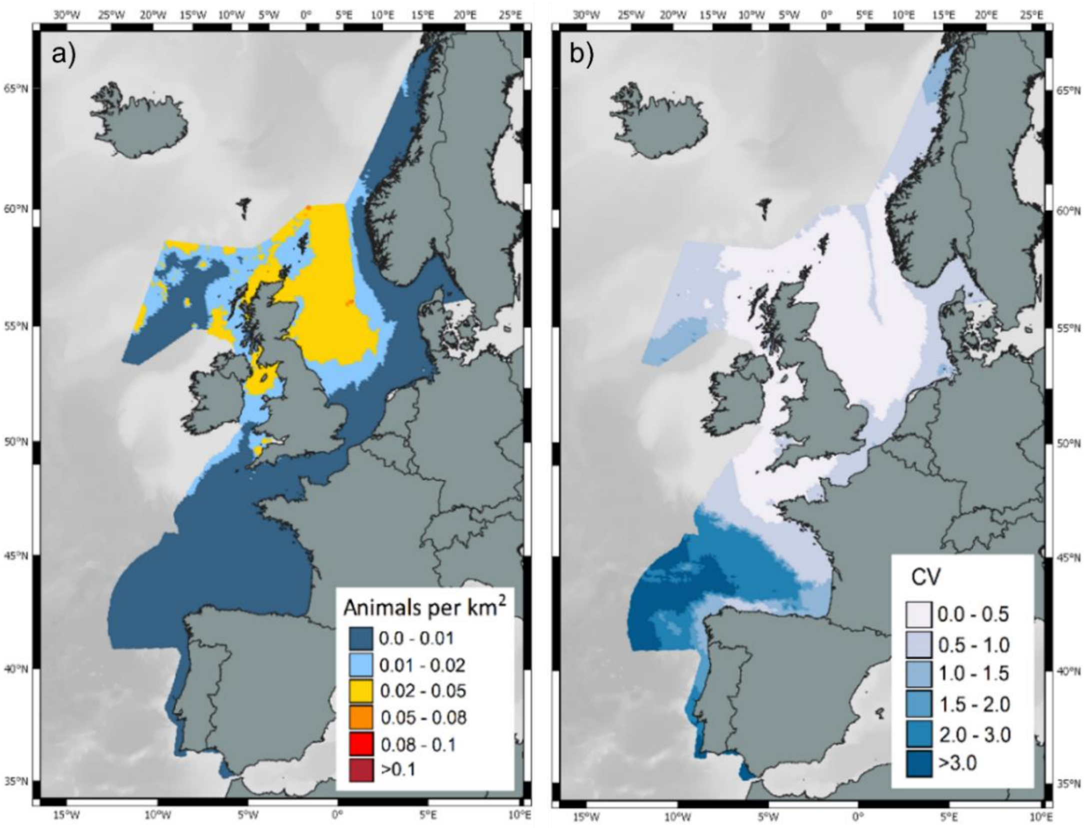


Figure 21A-80. Estimated surface density (a) and associated CV (b) for minke whales using SCANS-III data (2016) (Lacey et al., 2022)

ObSERVE Surveys

147. Between 2015 and 2016, minke whale was the most abundant baleen whale species recorded during the ObSERVE surveys, with the whales mainly observed as single individuals (Rogan *et al.*, 2018). Across the survey area, minke whales were recorded in greater numbers close to the coast in the summer seasons and were distributed more offshore during winter months, suggesting a potential seasonal movement between inshore and offshore waters (**Figure 21A-81** and **Figure 21A-82**). This is especially true for the Stratum 4, one of the closest Strata to the Array Area.

148. Across all seasons, 12 whales were recorded in Stratum 4, while only four whales were recorded in the Stratum 5 (Rogan *et al.*, 2018). Absolute design-based densities in Stratum 4 therefore, ranged between 0.00 animals/km^2 in winter 2016 and 0.013 animals/km^2 in summer 2015, equating to 0 animals (95% CI 0 – 0) and 836 animals (95% CI 382 – 1,828), respectively. In Stratum 5, no minke whales were recorded during the winter seasons and sightings were highest in summer 2015, with an absolute design-based density of 0.045 animals/km^2 and an abundance of 495 animals (95% CI 222 – 1,105) (**Table 21A-31**).

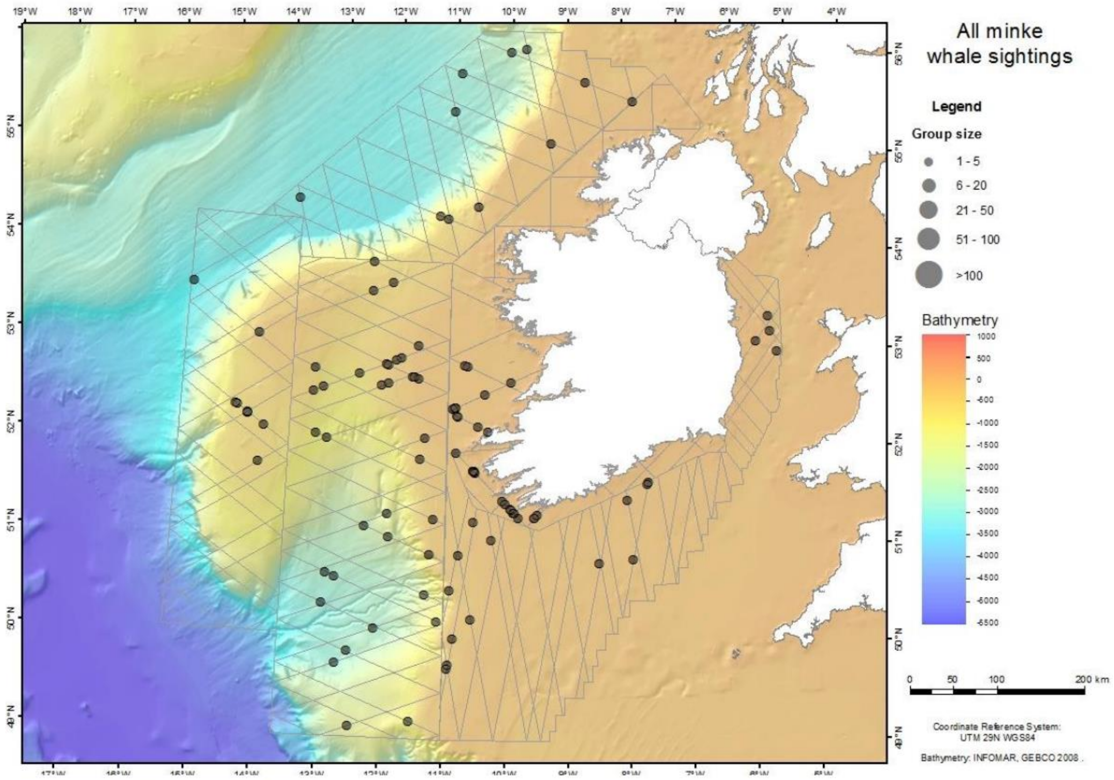


Figure 21A-81. Minke whale sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

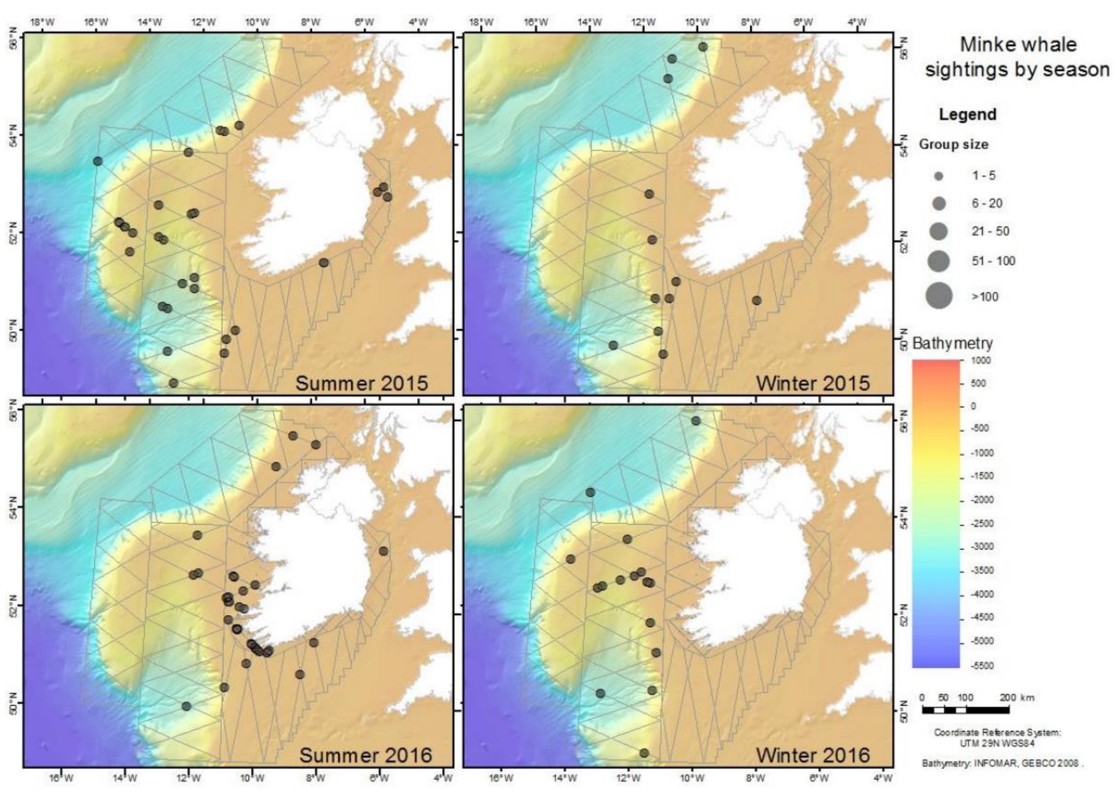


Figure 21A-82. Seasonal minke whale sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

Table 21A-31. Minke whale absolute design-based density and abundance estimates for the Strata 4 and 5 of the ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018) (n/a = no sightings data)

Stratum	Season	Absolute design-based estimates			
		Density (n/km²)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)
Stratum 4	Summer 2015	0.013	836	382	1,828
	Winter 2015	0.012	751	349	1,614
	Summer 2016	0.012	761	359	1610
	Winter 2016	n/a			
Stratum 5	Summer 2015	0.045	495	222	1,105
	Winter 2015	n/a			
	Summer 2016	0.016	180	59	553
	Winter 2016	n/a			

JCP Phase III

149. Across the 17 years of data collated in the JCP Phase III report, 1,860 minke whale sightings were recorded, ranging from 42 sightings in 1999 to 284 sightings in 1994. The latest year of data, 2010, recorded a total of 171 sightings (Paxton *et al.,* 2016). Maps of predicted density for summer 2010 suggest very low densities for the species around the UK, with slightly higher densities predicted around the Outer Hebrides, northwest Scotland (**Figure 21A-83** and **Figure 21A-84**). In the Atlantic Array, an area covering 1.8% of the Celtic and Greater North Sea MU, estimated abundance for 2010 was higher during the spring and summer seasons (summer absolute density of 0.014 animals/km^2) than during the winter and autumn seasons (winter absolute density of 0.002 animals/km^2). The average absolute density across all seasons was calculated at 0.006 animals/km^2 (**Table 21A-32**, **Figure 21A-83** and **Figure 21A-84**) (Paxton *et al.*, 2016).

Table 21A-32. Minke whale absolute density and abundance estimates for 2010 in the Atlantic Array (19,649 km²) based on the JCP Phase III data (Paxton et al., 2016)

Season	Absolute density (n/km²)	Abundance (n)	Lower 95% CL (n)	Upper 95% CL (n)
Winter	0.002	40	10	210
Spring	0.006	110	10	830
Summer	0.014	280	120	950
Autumn	0.003	50	10	200
Average	**0.006**	**120**	**-**	**-**

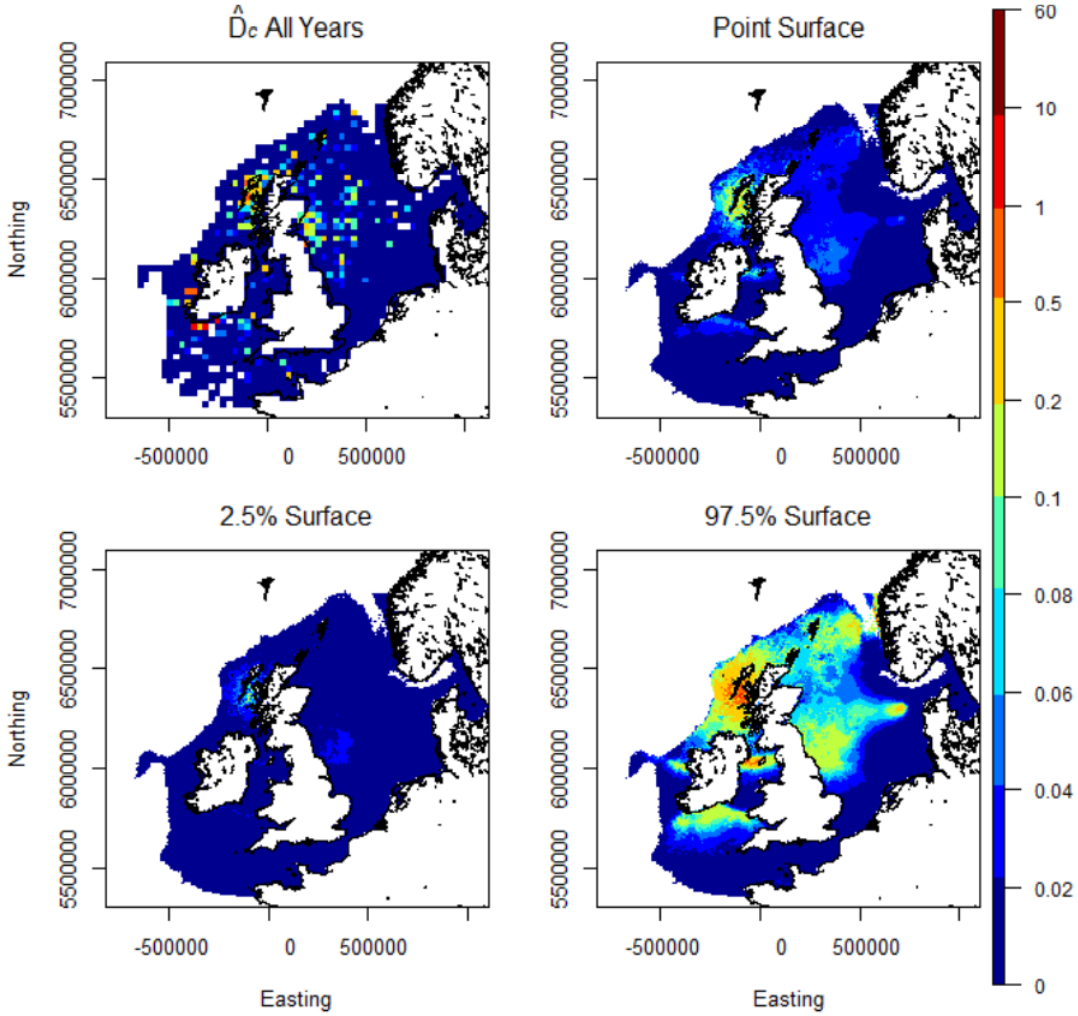


Figure 21A-83. Predicted densities ($\hat{D}_c$) of minke whales for the summer 2010 (Paxton et al., 2016). Top left map represents the input densities of summers from all years. Top right map represents the predicted densities for the summer 2010. Bottom maps represent the 95% CL density estimates

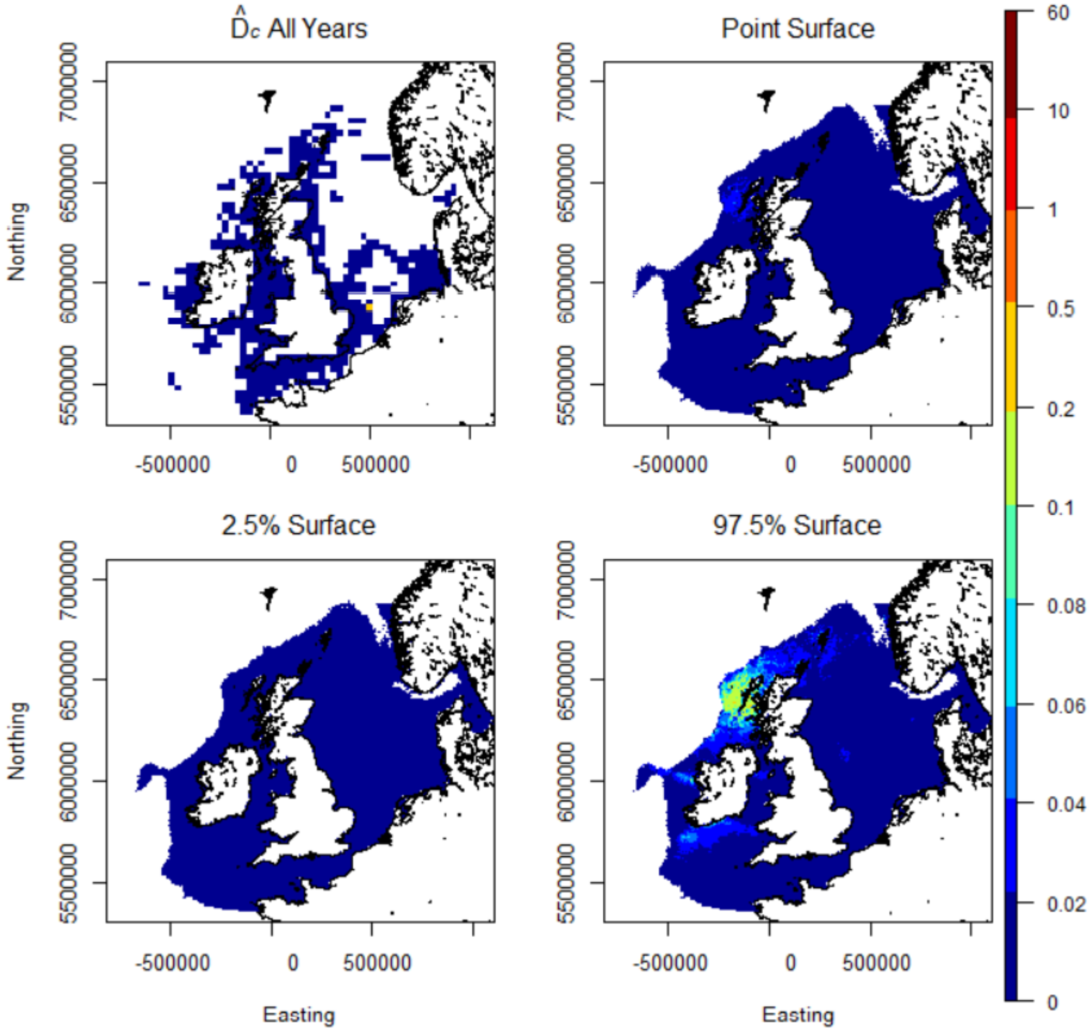


Figure 21A-84. Predicted densities ($\hat{D}_c$) of minke whales for the winter 2010 (Paxton et al., 2016). Top left map represents the input densities of winters from all years. Top right map represents the predicted densities for the winter 2010. Bottom maps represent the 95% CL density estimates

MERP Surveys and Distribution Maps of Cetacean and Seabird Populations in the Northeast Atlantic

150. A total of 3,639 minke whale sightings amounting to 4,595 individuals were recorded between 1980 and 2018 via aerial and boat-based surveys (Waggitt *et al.*, 2019). The predicted monthly density maps show an increased presence of minke whale around the Array Area during the summer months, with a reduced presence to complete absence during winter months (**Figure 21A-85** and **Figure 21A-86**) (Waggitt *et al.*, 2019).

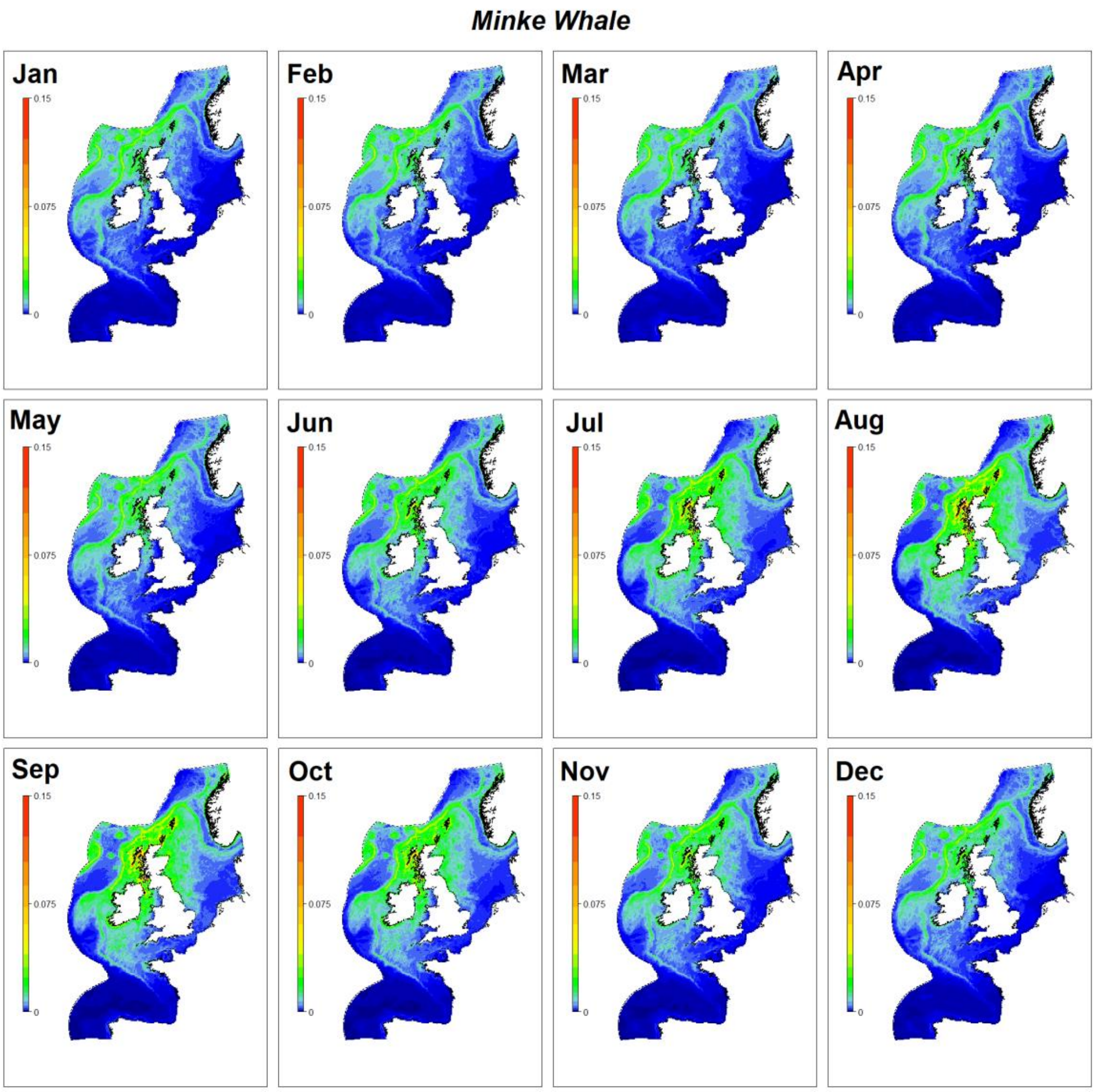


Figure 21A-85. Monthly predicted densities (animals/km²) of minke whales in the Northeast Atlantic (values provided at 10 km resolution) (Waggitt et al., 2019)

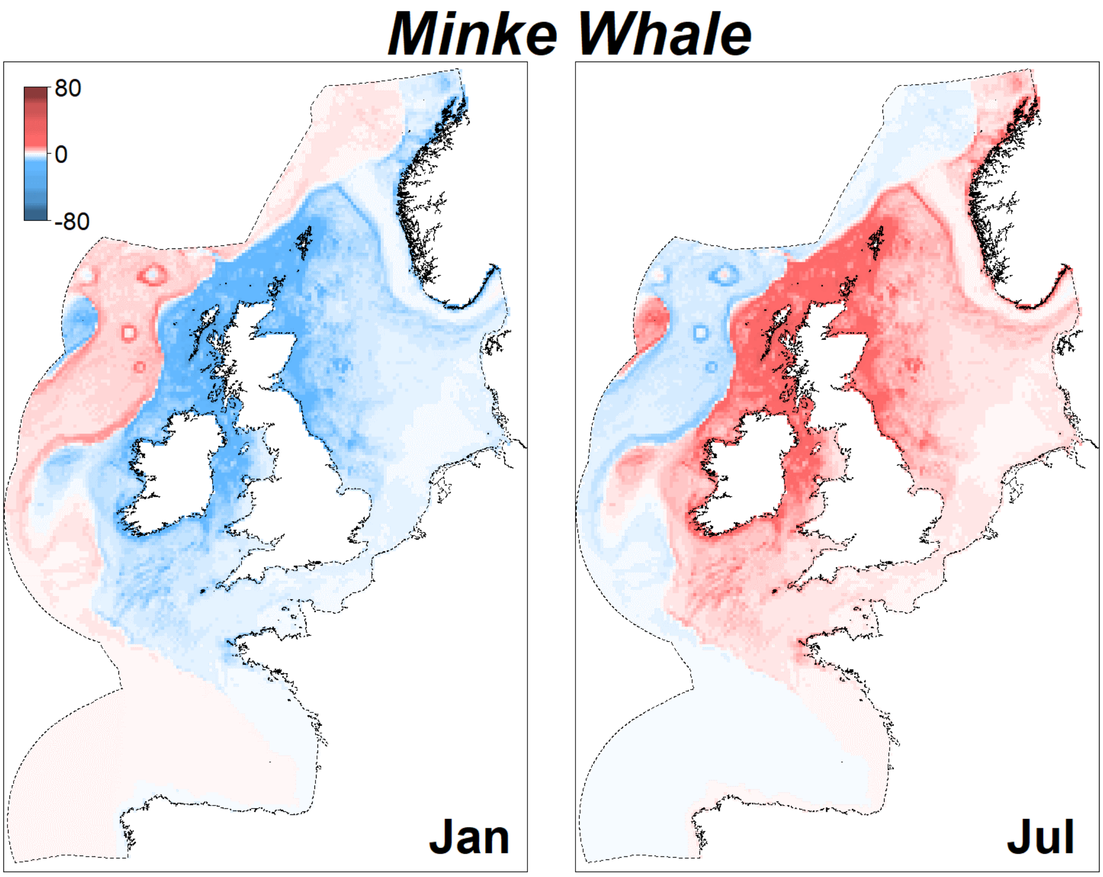


Figure 21A-86. Difference in predicted densities (animals/km²) of minke whales between January and July in the Northeast Atlantic ('Values are relative to the other month, and have been standardised by converting them into percentages of the maximum predicted density. Red and blue colours indicate increases and decreases from the other month, respectively') (Waggitt et al., 2019)

Minke Whale Summary

151. Several sources provided multiple density and population which could be taken forward for use in quantitative impact assessment. They provided a range of estimates from 0.000 animals/km² to 0.045 animals/km² (**Table 21A-33**). Data analysis methodology varied between surveys, so comparison between estimates derived through different studies should be done with caution. It should be noted that estimates from site-specific surveys provided relative design-based estimates with no correction for animals diving at the time of the survey, while estimates derived from the JCP, SCANS and ObSERVE (Paxton *et al*., 2016; Rogan *et al*., 2018; Hammond *et al*., 2021; Gilles *et al.,* 2023), provide absolute estimates of abundance.

152. The most recent site-specific surveys by HiDef between 2020 and 2022 indicate minke whales are present in the vicinity of the proposed Project in relatively low densities. The estimates gave an average relative design-based density for the full survey period of 0.003 animals/km² in the Llŷr marine megafauna survey area, with peak estimates recorded during the summer period (0.04 animals/km² [June S02 2020]). Estimated densities from the site-specific surveys data are lower overall than those presented in SCANS and ObSERVE (Rogan *et al.*, 2018; Hammond *et al*., 2021; Gilles *et al.,* 2023) when comparing summer months estimates.

153. Given that available estimates for minke whales are lower in site-specific surveys (relative) compared to SCANS-III and IV and ObSERVE (absolute); and given that the most recent estimate from SCANS-IV survey (block CS-C overlapping with the proposed Project) is lower than SCANS-III (0.008 animals/km² compared to 0.011 animals/km²), the SCANS-III estimate

will be used for quantitative impact assessment. This estimate of 0.011 animals/km^2 represents absolute abundance and is spatially relevant to the area of the proposed Project.

Table 21A-33. Summary of minke whale density estimates collected around the Array Area presented in this report (highlighted cell corresponds to the density recommended to be used for quantitative impact assessment)

Study or survey programme	Area		Time scale	Average density (n/km^2)
	Name	Size (km^2)		
Proposed Project, HiDef site-specific surveys	Llŷr marine megafauna survey area	640.92	Year 1 Mar 2020 – Feb 2021	0.003 (rdbe)
			Year 2 May 2021 – Mar 2022	0.002 (rdbe)
			All surveys Mar 2020 – Mar 2022	0.003 (rdbe)
Erebus Project, HiDef site-specific surveys (Darias-O'Hara *et al.,* 2021)	Erebus survey area (development area plus a 4 km buffer)	200.11	Year 1 Oct 2019 – Sep 2020	0.003 (relative)
			Year 2 Oct 2020 – Sep 2021	0.000 (relative)
			All surveys Oct 2019 – Sep 2021	0.002 (relative)
Cetaceans and Seabirds of Wales (Evans and Waggitt, 2023)	Llŷr marine megafauna survey area	640.92	1990 – 2020	0.007 (relative)
SCANS-III surveys (Hammond *et al.,* 2021)	Block D – Celtic and Irish Seas	48,590	Jun – Jul 2016	0.011 (absolute)
SCANS-IV surveys (Gilles *et al.,* 2023)	Block CS-C	36,031	June – Aug 2022	0.008 (absolute)
ObSERVE surveys (Rogan *et al.,* 2018)	Stratum 4 – Celtic Sea	n/a	Summer 2015	0.013 (adbe)
			Winter 2015	0.012 (adbe)
			Summer 2016	0.012 (adbe)
			Winter 2016	0.000 (adbe)
	Stratum 5 – Irish Sea	n/a	Summer 2015	0.045 (adbe)
			Winter 2015	0.000 (adbe)
			Summer 2016	0.016 (adbe)
			Winter 2016	0.000 (adbe)
JCP Phase III (Paxton *et al.,* 2016)	Atlantic Array	19,649	Winter 2010	0.002 (absolute)
			Spring 210	0.006 (absolute)
			Summer 2010	0.014 (absolute)

Study or survey programme	Area		Time scale	Average density (n/km²)
	Name	Size (km²)		
			Autumn 2010	0.003 (absolute)
			Average 2010	0.006 (absolute)

21.3.6. *Leatherback Turtle*

154. The only turtle species recorded relatively regularly in UK and Irish waters is the leatherback turtle, typically observed along western coasts. Currently, seven RMUs are defined for leatherback turtles globally, with the proposed Project located within the northwest Atlantic RMU, which extends from North and central America to northern Europe and northern Africa (IUCN, 2019; **Figure 21A-2**). Nesting in sub-tropical and tropical waters, the species migrates to temperate waters such as those around the UK during summer, to feed on gelatinous prey such as jellyfish (Witt *et al.*, 2007). Within the northwest Atlantic RMU, the species is currently listed as 'endangered' on the IUCN Red List (IUCN, 2019).

Site-Specific and Project Erebus Surveys

155. No leatherback turtles were sighted during the two-year survey periods in the Llŷr marine megafauna survey area and the Project Erebus survey area (Darias-O'Hara *et al.*, 2021).

ObSERVE Surveys

156. During the ObSERVE surveys, only three leatherback turtles were recorded, all during the summer season and located in the south of Stratum 4 (**Figure 21A-87** and **Figure 21A-88**) (Rogan *et al.*, 2018). The number of records was too small to provide abundance and density estimates for the species.

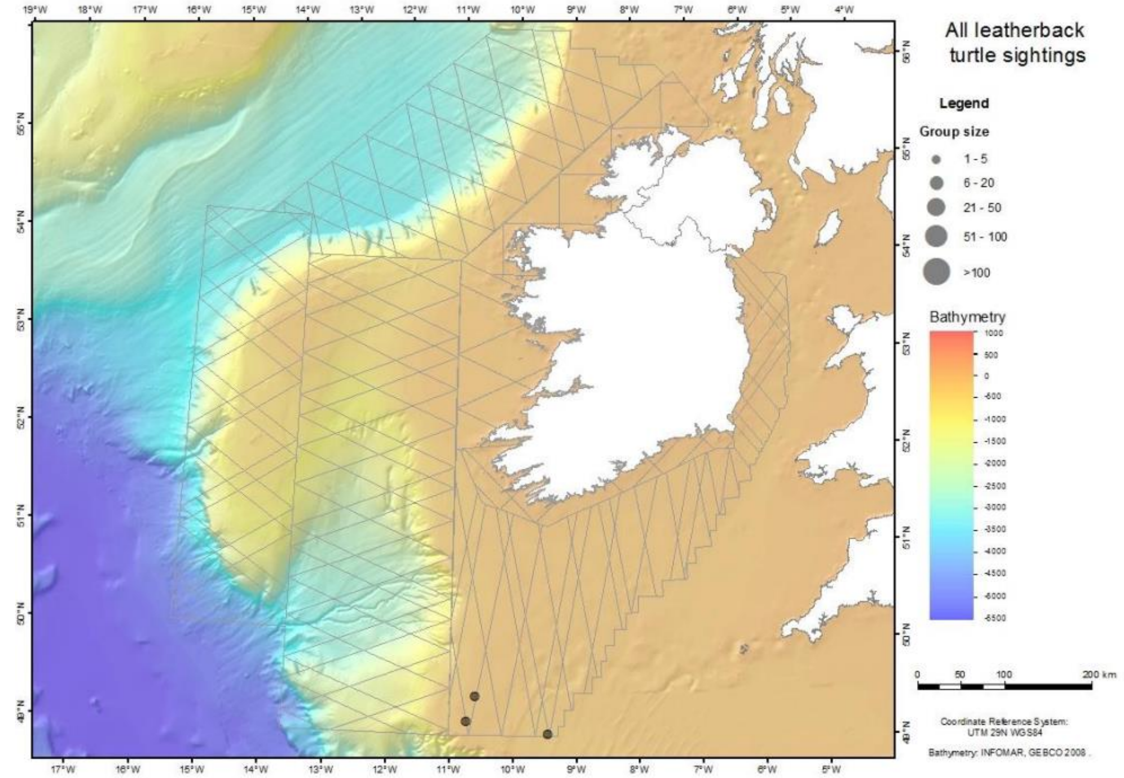


Figure 21A-87. Leatherback turtle sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

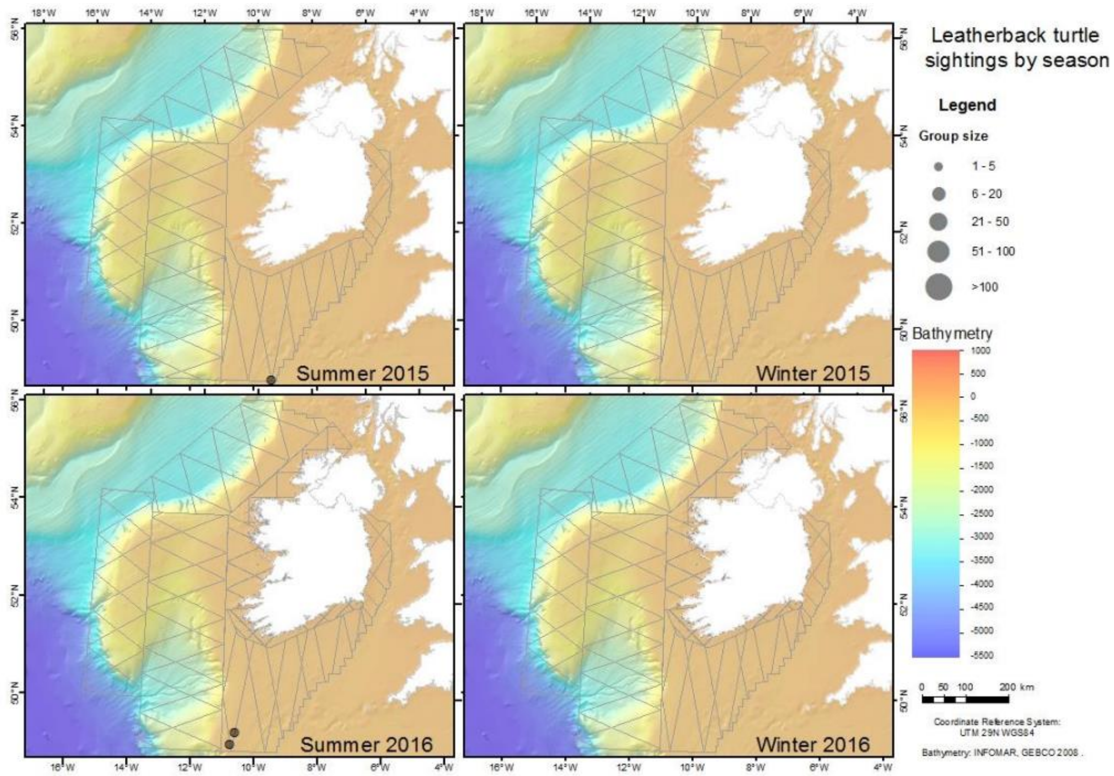


Figure 21A-88. Seasonal leatherback turtle sightings from ObSERVE surveys flown between 2015 and 2016 (Rogan et al., 2018). Refer to Figure 21A-9 for Stratum identification

Wildfowl and Wetland Trust Aerial Surveys

157. During the WWT surveys conducted between 2001 and 2008, one and two unidentified turtles were recorded in November 2007 and July 2008, respectively, all in the Carmarthen Bay, north of the proposed Project. Relative densities of turtle species were provided; however, they cannot be used to assess the density of leatherback turtles around the proposed Project as the turtle observations were not identified to species level (WWT Consulting, 2009).

Marine Environmental Monitoring TURTLE Database

158. A total of 1,683 leatherback turtles were recorded in the UK and Ireland between 1910 and 2018, including 1,319 live sightings (79.7%), 229 strandings and 135 captures (Botterell *et al.*, 2020). Throughout this period, leatherback turtle records evolved from absent in the 1920s and 1930s to low in the 1960s before peaking in the 1990s and decreasing again since (**Figure 21A-89**). Absence and very low numbers before the 1960s could be explained by a lack of monitoring and awareness. Leatherback turtle sightings were generally made between June and October, with live sightings recorded between May and November (**Figure 21A-90**). Most of the sightings of leatherback turtles occurred within the Irish and Celtic Seas and along the English Channel, with the number of sightings decreasing with increasing latitude (**Figure 21A-91**).

159. The latest British and Irish Marine Turtle Strandings and Sightings Annual Report 2022 (Penrose and Westfield, 2023) recorded 16 turtles throughout the UK and Ireland in 2022, nine of which were identified as leatherback turtles. Of the nine leatherback turtles recorded, seven were live sightings (two in England, four in Scotland and one in Wales) and two were dead strandings (one in England and one in Ireland) (**Figure 21A-92**). Monthly distributions between 2012 and 2022exhibit similar trends to those described by Botterell *et al.* (2020), with an increased presence of leatherback turtles in the UK and Ireland during summer months (**Figure 21A-93**) (Penrose and Westfield, 2023).

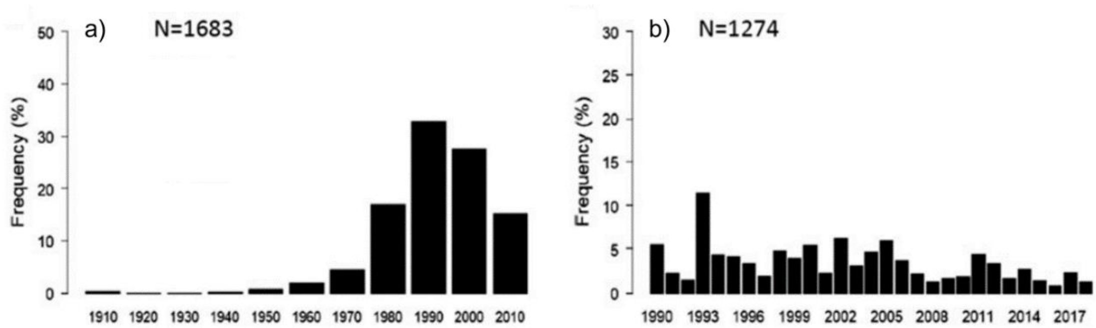


Figure 21A-89. Temporal distribution of leatherback turtles, including sightings, strandings and captures recorded in the UK and Ireland between 1910 and 2010 (a) and between 1990 and 2018 (b) (Botterell et al., 2020)

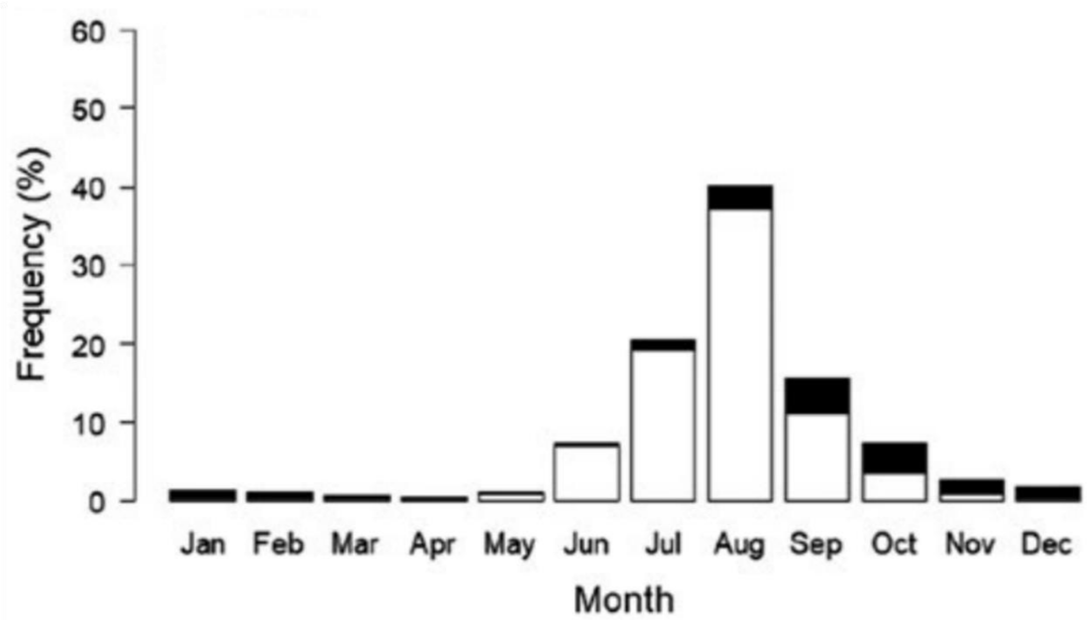


Figure 21A-90. Monthly cumulative frequency of sightings, strandings and captures of leatherback turtles in the UK and Ireland between 1910 and 2018 (n= 1,646 turtles, open bars= live turtles, filled bars= dead turtles) (Botterell et al., 2020)

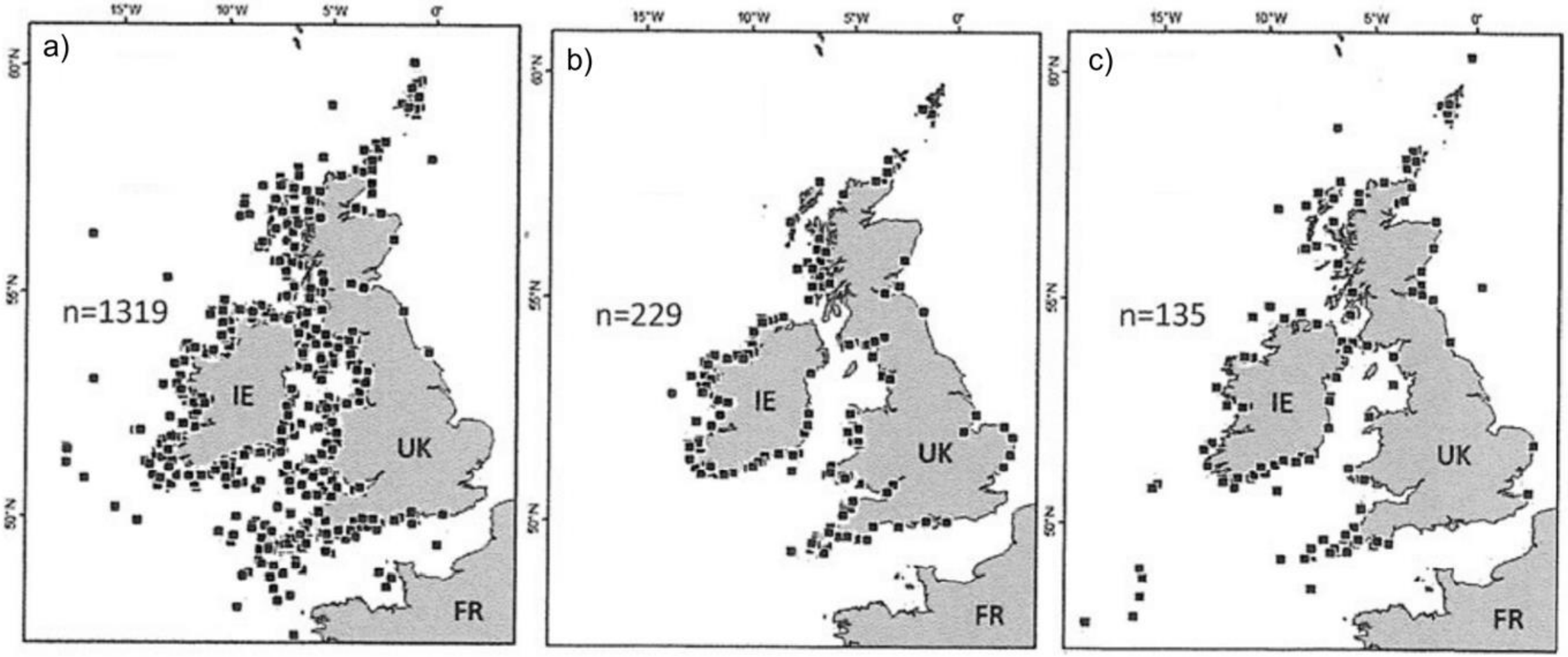


Figure 21A-91. Distribution of recorded leatherback turtle sightings (a, n= 1,319), strandings (b, n= 229) and captures (c, n= 135) in the UK and Ireland between 1910 and 2018 (Botterell et al., 2020)

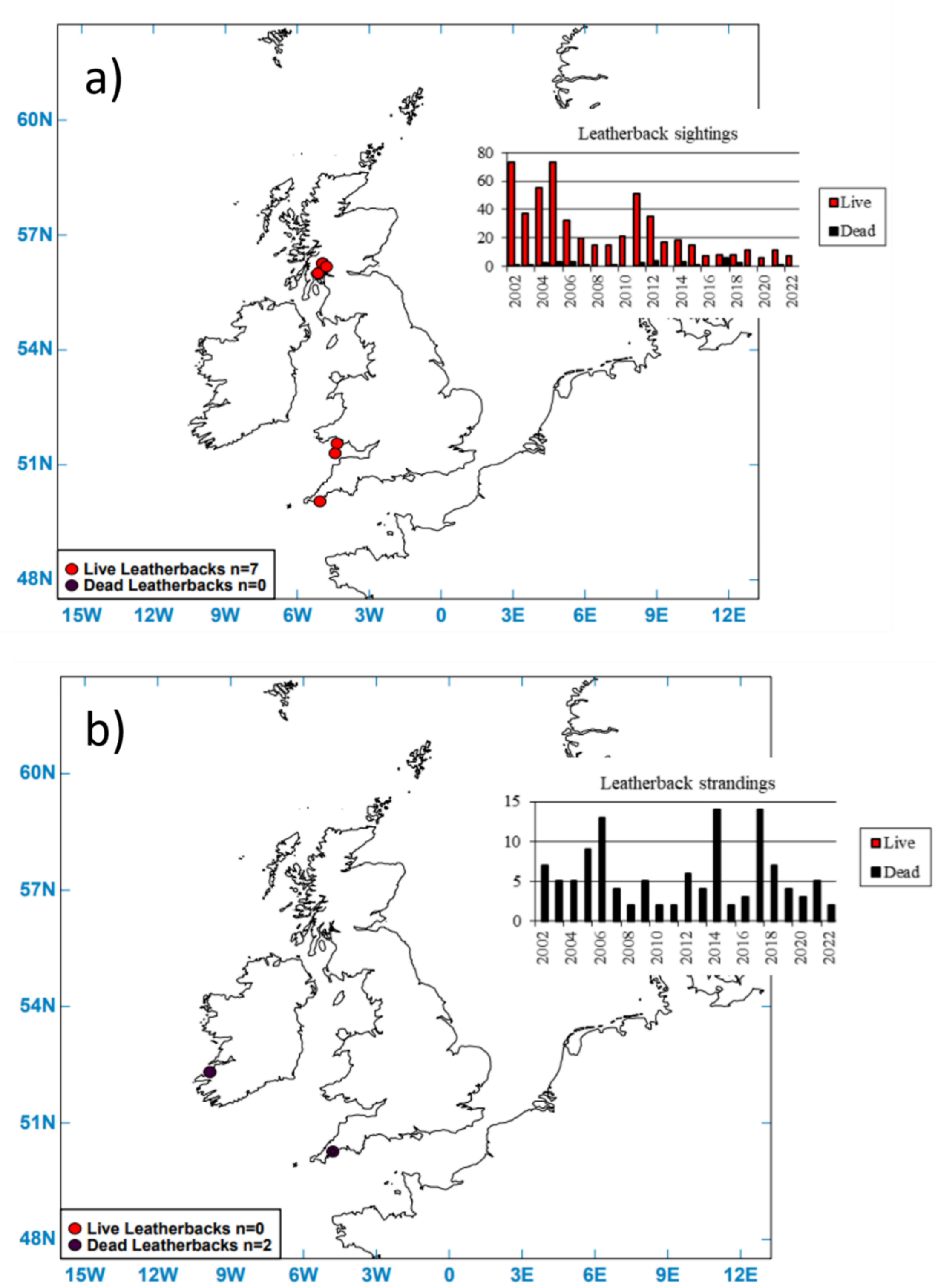


Figure 21A-92. Live and dead sightings (a) and stranding (b) records of leatherback turtles around the UK and Ireland in 2022 (Penrose and Westfield, 2023)

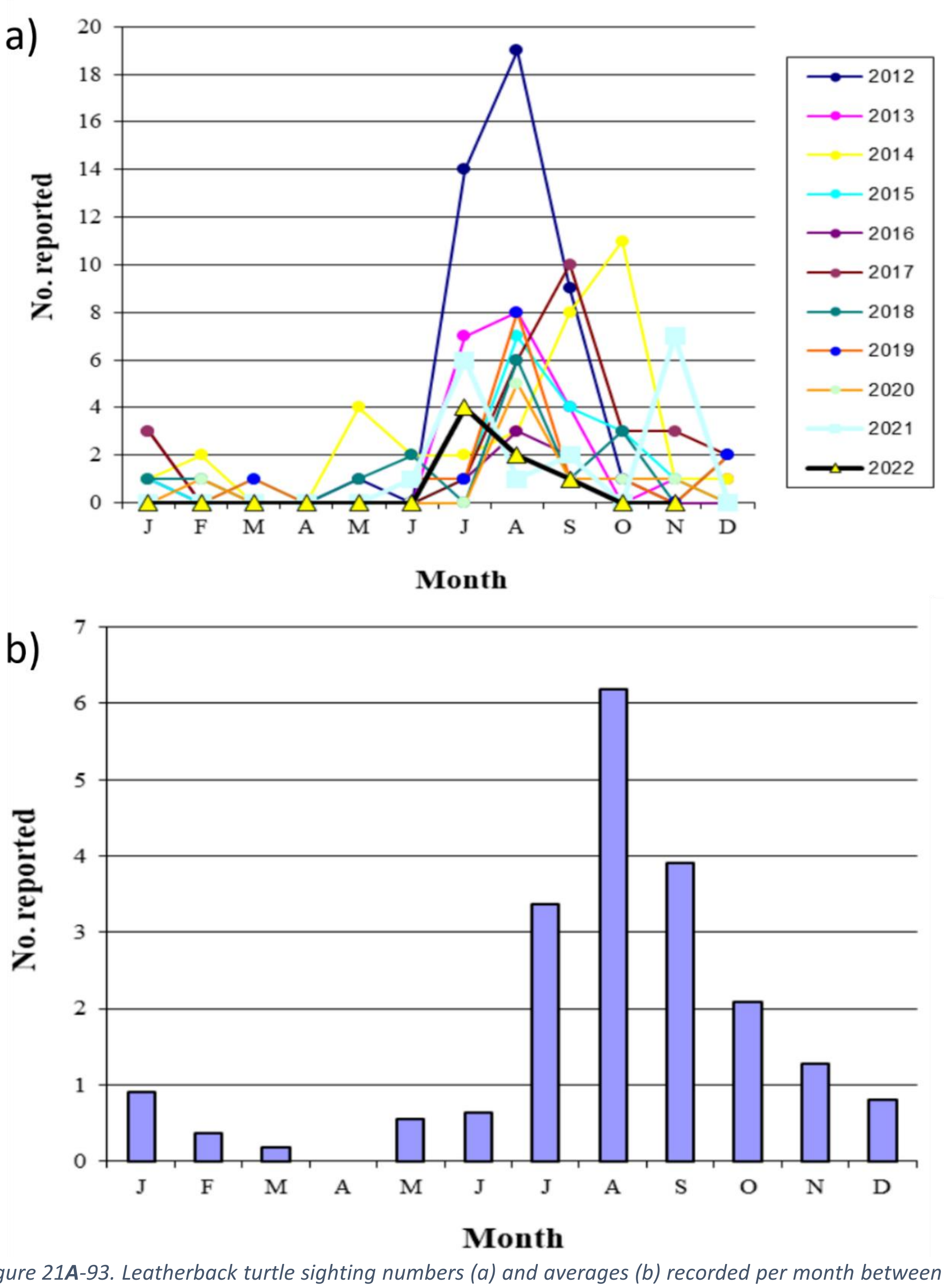


*Figure 21**A**-93. Leatherback turtle sighting numbers (a) and averages (b) recorded per month between 2012 and 2022 (Penrose and Westfield, 2023)*

INTERREG Irish Sea Leatherback Turtle Project

160. Between 1950 and 2005, a total of 143 leatherback turtles were recorded, primarily in the Irish and Celtic Seas in the southwest coast of Wales and northwest coast of England, with sightings occurring mainly between July and September (**Figure 21A-94** and **Figure 21A-95**) (Houghton *et al*., 2006a). When comparing the hotspot locations of leatherback turtles with their main prey, it was found that 22.5% of those were overlapping, but no significant relationship was concluded (Houghton *et al.*, 2006a; 2006b). A tagging study was also conducted on two individuals in August 2005 and June 2006 off the west coast of Dingle, Ireland (Doyle *et al.*, 2008). The first individual was recorded travelling south, towards

Mauritania and Cape Verde before heading back north, towards Newfoundland, Canada (**Figure 21A-96**). The second individual travelled constantly towards the south and was recorded swimming up to French Guiana (**Figure 21A-96**) (Doyle *et al.*, 2008). This study informs on the potential migration path and connectivity that could be observed between areas near the proposed Project (although not close vicinity), the Atlantic and the turtle Regional Management Unit.

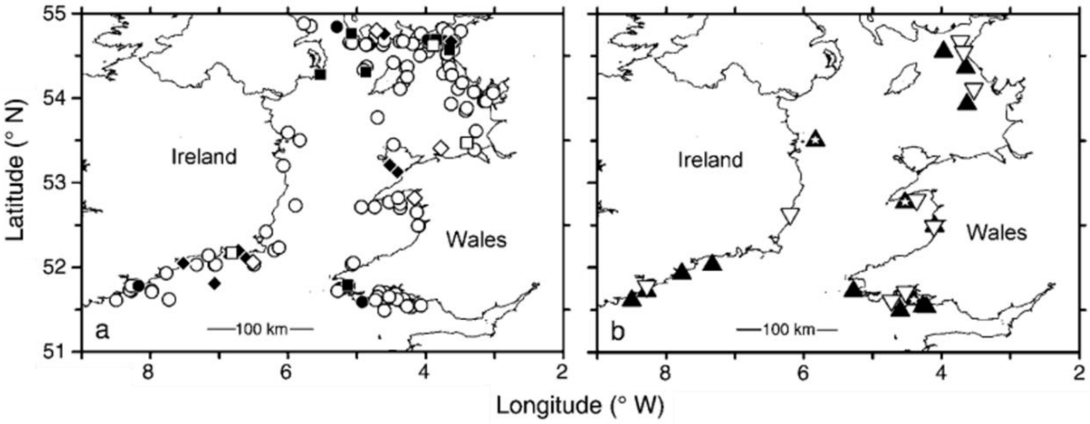


Figure 21A-94. Sightings of live leatherback turtles recorded between 1950 and 2005 (n= 143 turtles) (a) and when associated with jellyfish (b), (open circle= 2005-2005, solid circle= 1990s; open square= 1980s; solid square= 1970s; open diamond= 1960;, solid diamond= 1950s; open triangle= foraging confirmed; solid triangle= spotted with jellyfish; star= turtles marked in 2003 and 2004 during aerial surveys) (Houghton et al., 2006b)

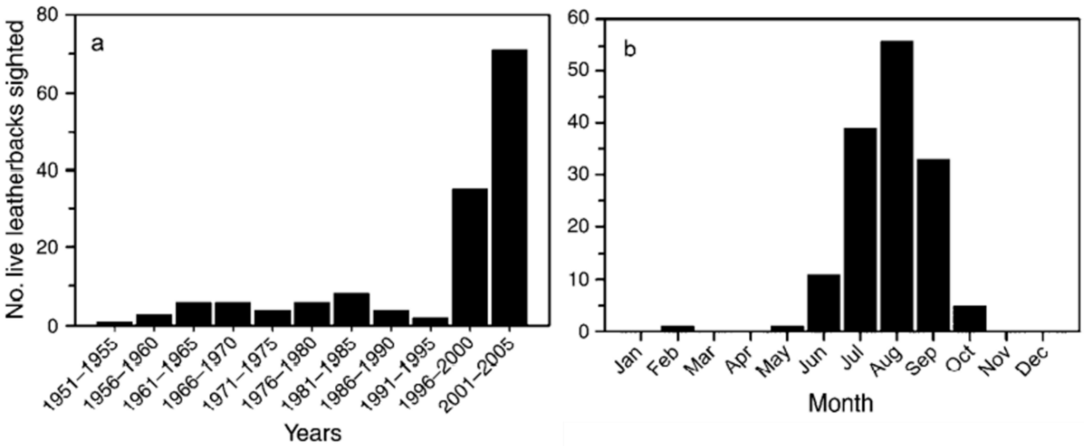


Figure 21A-95. Sightings of live leatherback turtles recorded between 1950 and 2005 (TURTLE database, n= 143 turtles) (a) and their seasonality (b) (Houghton et al., 2006b)

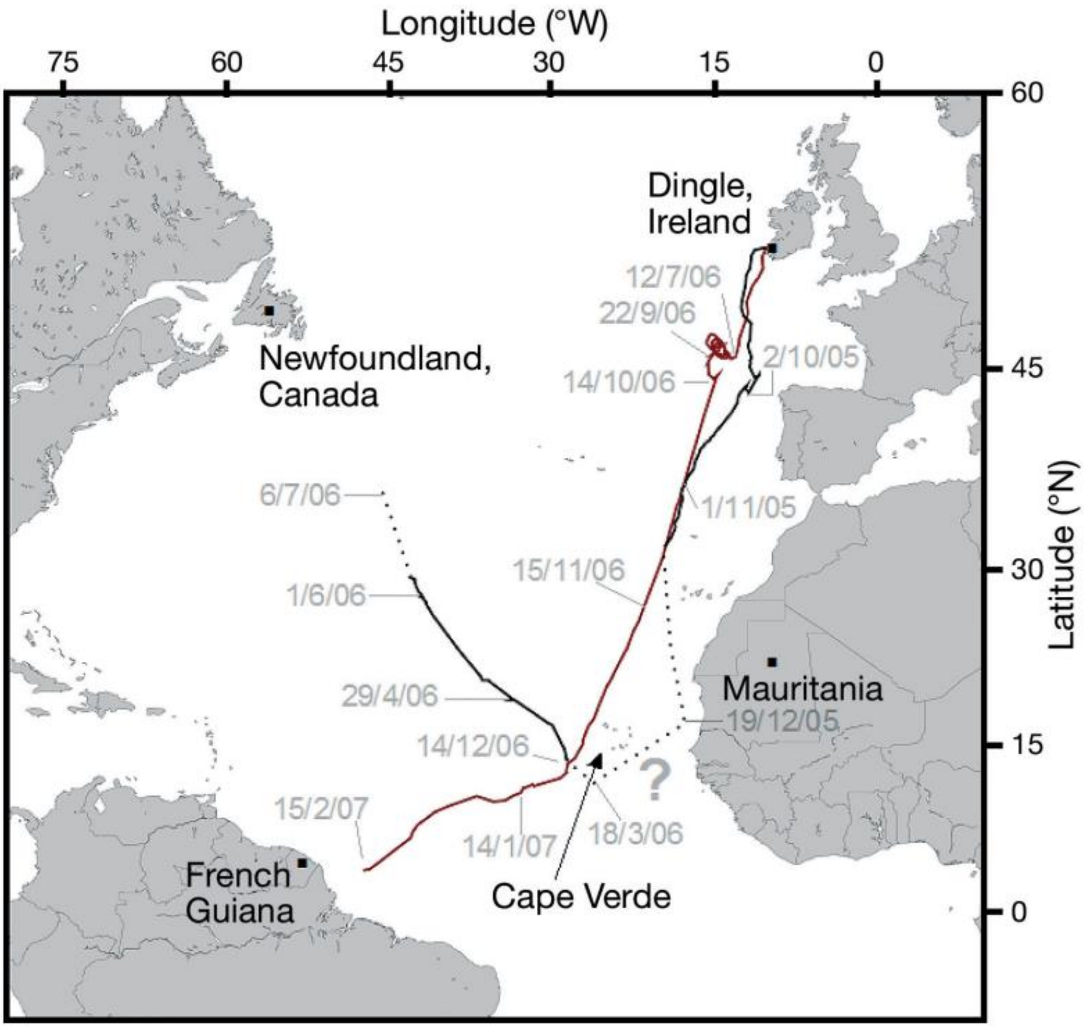


Figure 21A-96. Tracks of the two leatherback turtles tagged during the INTERREG project in August 2005 (black tracks) and June 2006 (red tracks) (Doyle et al., 2008)

Leatherback Turtle Summary

161. Although no leatherback turtles were sighted in the Llŷr marine megafauna survey area, several sources have assessed the occurrence of the species in the vicinity of the proposed Project, however, none provided density or abundance estimates. The species has only been observed occasionally throughout the decades, with sightings generally made between June and October, during the summer months. The species may be present around Wales intermittently, but densities around the proposed Project are expected to be extremely low. Therefore, leatherback turtles will not be taken forward for further assessment.

21.4 Baseline Characterisation Summary and Conclusions

162. This report has summarised the available data on marine mammals and megafauna likely to be in the region relevant to the proposed Project. The information is taken from a range of studies at various scales and methodologies which are not necessarily directly comparable. However, these sources enable conclusions to be made onsite characterisation and the identification the key species of interest that should be taken forward for impact assessment.

163. The Study Area was defined at two spatial scales (**Section 21.1.2**), the species specific MUs account for the scale of movement and population structure for each species, and the marine mammal Study Area is the finer scale site-specific local pattern of use.

164. Site surveys were conducted over two years and indicate that the Llŷr marine megafauna survey area itself:

- Is not a key area for grey seals, although they may be present in low numbers;
- Harbour porpoise is likely to be in the area, but at levels that vary seasonally, with relatively higher densities in the winter compared to summer;
- Common dolphin is also likely to be present in the area, but in widely variable numbers. Common dolphins tend to travel in groups, sometimes large groups (hundreds of individuals) and this was observed with major peaks in june / july in both years;
- Survey data suggest that the llŷr marine megafauna survey area is not well used by bottlenose dolphin. If present, it is likely that it will be in relatively low densities;
- Likewise, minke whale can be present in the llŷr marine megafauna survey area, but at relatively low densities; and
- Leatherback turtles were not observed in the Study Area, and their presence within the llŷr marine megafauna survey area is considered to be extremely low.

165. Consideration of available data at the wider scale, suggest the following key species should be considered within the quantitative impact assessment:

- Grey seals;
- Harbour porpoise;
- Common dolphin;
- Bottlenose dolphin; and
- Minke whales.

166. Leatherback turtles may also occasionally occur in the Celtic Sea but in very low densities and therefore, will not be assessed further.

167. Based on the information presented in this report, the density estimates recommended to be taken forward for impact assessment are summarised in **Table 21A-34** and were discussed at pre-application stage with NRW (A) and JNCC (**Chapter 21, Tables 21-4** and **Table 21-5**). For all species, the choice of density estimate is based on the best available information and a decision on which estimate may best represent the general regional occurrence and take account of the site survey observations.

Table 21A-34. Summary of the density estimates recommended to bring forward for impact assessment

Species	Reference population (n)	Density (n/km^2) relevant to the proposed Project	Density source
Grey seal	OSPAR III Region (65,442; SCOS, 2022; Carter *et al.*, 2022)	Cell specific densities	At-sea densities (Carter *et al.*, 2022)
Harbour porpoise	Celtic and Irish Sea (62,517; IAMMWG, 2022)	0.137 (95% CI 0.02 – 0.54; Llŷr marine megafauna survey area)	Site-specific digital video aerial survey (absolute model-based overall average)
Common dolphin	Celtic and Greater North Seas (102,656; IAMMWG, 2022)	0.841 (0.264 CV)	SCANS-IV survey block CS-C (absolute design-based estimates; Gilles *et al.*, 2023))
Bottlenose dolphin	Offshore Channel and SW England (10,947; IAMMWG, 2022)	0.4195 (0.406 CV)	SCANS-IV survey block CS-C (absolute design-based estimates; Gilles *et al.*, 2023)))
Minke whale	Celtic and Greater North Seas (20,118; IAMMWG, 2022)	0.011 (0.755 CV)	SCANS-III survey block D (absolute design-based estimates; Hammond *et al.*, 2021)
Leatherback turtle	No quantitative assessment		

21.5 References

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APPENDIX 21A: ANNEX A – ADDITIONAL MODEL-BASED MAPS

1. Annex provided as a separate document.

APPENDIX 21A: ANNEX B – DESIGN-BASED ESTIMATES

1. Annex provided as a separate document.