MORGAN AND MORECAMBE OFFSHORE WIND FARMS: TRANSMISSION ASSETS

Environmental Statement

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Appendix A: Morgan Offshore Wind Project: Generation Assets – Marine Mammal Technical Report

MORGAN OFFSHORE WIND PROJECT:

GENERATION ASSETS

Environmental Statement

Volume 4, Annex 4.1: Marine mammals technical report

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Image of an offshore wind farm

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Glossary

Term	Meaning
Benthic	Species that live on or near the sea bottom, irrespective of the depth of the sea.
Bentho-pelagic	Benthopelagic species usually float in the water column just above the sea floor and can occupy either shallow coastal waters or deep waters offshore.
Demersal	Species that live close to the sea floor.
Ground Sampling Distance	Ground sampling distance (GSD) is the distance between two consecutive pixel centres measured on the ground. The bigger the GSD, the lower the spatial resolution of the image and details are less visible.
Inverse Distance Weighted	A statistical tool that uses a method of interpolation that estimates cell values by averaging the values of sample data points in the neighbourhood of each processing cell.
Marine mammal Management Unit	Management Units (MUs) for marine mammals in UK waters, which provide an indication of the spatial scales at which impacts of plans and projects alone, cumulatively and in combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK. For cetaceans, these management units are defined by the Inter-Agency Marine Mammal Working Group. For seal species (grey and harbour seal), the Special Committee on Seals (SCOS) provided advice on seal management units (SMU).
Morgan Aerial Survey Area	Morgan Array Area plus 10 km buffer.
Neritic species	Species occurring in the coastal waters (shallow marine environment) where light can penetrate to the ocean floor and generally corresponding to the continental shelf waters.
Ontogenetic variation	Changes due to changes in gene expression through development.
Pelagic	Species which live and feed within the water column.
Sea state	Sea states are categorical values used to give an approximate but concise description of sea condition, as this will affect the probability of a sighting. Sea state conditions used in the aerial surveys were 0 = Calm (Glassy), 1 = Calm (Rippled), 2 = Smooth, 3 = Slightly Moderate and 4 = Moderate.
Teuthophagic	Species primarily preys on cephalopods.

Acronyms

Acronym	Description
AyM	Awel y Môr
CCW	Countryside Council for Wales
CGNS	Celtic and Greater North Seas
CI	Confidence Interval
CIS	Celtic and Irish Seas
CL	Confidence Limit
CMR	Capture mark recapture

Acronym	Description
cSAC	candidate Special Area of Conservation
CV	Coefficient of variation
DSM	Density surface model
EA	Environment Agency
EIRPHOT	Irish and Celtic Sea Database for grey seals
EWG	Expert Working Group
GSD	Ground Sampling Distance
GSRP	Grey Seal Reference Population
GyM	Gwynt y Môr
HSRP	Harbour Seal Reference Population
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Seas
IS	Irish Sea
ISAA	Information to Support Appropriate Assessment
ISZ	Irish Sea Zone
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
MDZ	Morlais Demonstration Zone
MNR	Marine Nature Reserve
MMEA	Manx Marine Environmental Assessment
MMO	Marine Management Organisation
MMOb	Marine Mammal Observer
MMMU	Marine Mammal Management Unit
MU	Management Unit
MWDW	Manx Whale and Dolphin Watch
MWT	Manx Wildlife Trust
NERC	Natural Environment Research Council
NRW	Natural Resources Wales
OSPAR	Oslo and Paris Conventions
PAM	Passive Acoustic Monitoring
PEIR	Preliminary Environmental Information Report
QA	Quality Assurance
SAC	Special Area of Conservation
SCANS	Small Cetaceans in European Atlantic waters and the North Sea
SDM	Species Distribution Model
SEACAMS	Sustainable Expansion of Applied Coastal and Marine Sectors Project

Acronym	Description
SCOS	Special Committee on Seals
SMRU	Sea Mammal Research Unit
SMU	Seal Management Unit
SWF	Sea Watch Foundation
TWT	The Wildlife Trusts

Units

Unit	Description
cm	Centimetre
ft	Foot
km	Kilometre
kg	Kilogram
km^2	Square kilometre
kn	Knot
m	Metre
m^2	Metre Squared
ms^{-1}	Metres per second
nm	Nautical mile
°	Degrees
°C	Degrees centigrade
%	Percentage

1 Marine mammal technical report

1.1 Introduction

1.1.1.1 This marine mammal technical report provides a detailed baseline characterisation of the marine mammal ecology for the Morgan Offshore Wind Project: Generation Assets (hereafter referred to as the Morgan Generation Assets), and the surrounding area. Data was collated through a detailed desktop study of the existing resources available for marine mammals within the region, incorporating data from third party organisations, to gain a historical perspective.

1.1.1.2 Recent site-specific survey data from aerial digital surveys were available to inform the baseline characterisation. Aerial digital surveys for the Morgan Generation Assets began in April 2021 to March 2023, and as such the full 24 months of surveys were available for baseline characterisation.

1.1.1.3 Moreover, the Sea Mammal Research Unit (SMRU) provided telemetry maps and haul-out counts for harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus* for the four Seal Management Units (SMU) that cover the Irish Sea (see section 1.2), and these have been used as an additional data source to aid baseline characterisation (Wright and Sinclair, 2022).

1.1.1.4 The aim of this technical report is to provide a robust baseline characterisation of the marine mammals likely to be present within the marine mammal study areas and against which the potential impacts of the Morgan Generation Assets can be assessed.

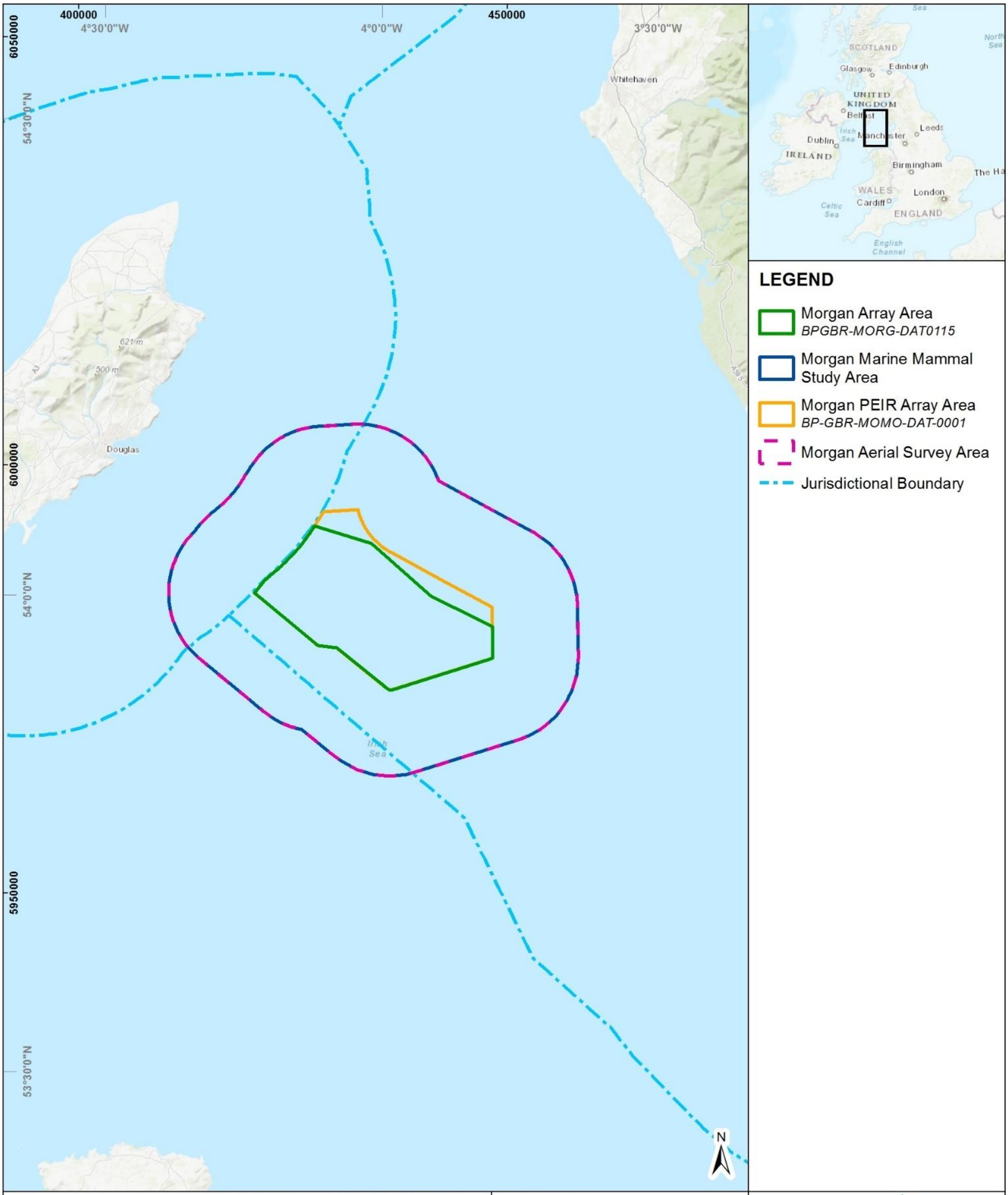
1.2 Study area

1.2.1.1 Marine mammals are spatially and temporally variable, therefore for the purposes of the marine mammal baseline characterisation, two study areas have been defined (Figure 1.1):

- **Morgan marine mammal study area**: this area is defined as the area encompassing the Morgan Array Area plus a buffer of approximately 10 to 13.3 km, which is based upon the Morgan Aerial Survey Area (see section 1.4.3). Following the Preliminary Environmental Information Report (PEIR), the size of the array project boundary has been reduced, so whilst the buffer extent remains the same as for PEIR, the area of the buffer has increased around the redefined Morgan Array Area (previously a 10 km buffer) (see Figure 1.1)
- **Regional marine mammal study area**: marine mammals are highly mobile and may range over large distances and therefore, to provide a wider context, the desktop review considered the marine mammal ecology, distribution and density/abundance within the Irish Sea and wider Celtic Sea.

1.2.1.2 For the quantitative impact assessment species specific populations were considered over a regional scale, within the context of their relevant species Management Units (MU) as defined by the Inter-Agency Marine Mammal Working Group (IAMMWG) (IAMMWG, 2021) and the Special Committee on Seals (SCOS) (SCOS, 2020) (illustrated in Figure 1.2 and Figure 1.3). Further details of the relevant species MUs are provided in the species accounts (section 1.7 and summarised in section 1.8).

1.2.1.3 For the purpose of the cumulative assessment and, as agreed with consultees during the Marine Mammals Expert Working Group (EWG) meeting number 2 (see section 1.3), screening of projects was undertaken within the relevant species MUs with the maximum extent delineated by the Celtic and Irish Seas (CIS) MU. This was to ensure a proportionate approach was taken, such that the screening focussed on the region within which receptor-impact pathways are considered likely to occur. Cumulative effects from the Morgan Generation Assets are considered unlikely to occur with projects over the extent of the Celtic and Greater North Seas (CGNS) MU (in the North Sea, for example). With respect to grey seal, however, an extended screening area was applied following specific feedback from the Marine Mammal EWG and included projects within the Oslo and Paris Conventions (OSPAR) Region III.



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Project Name:
MORGAN OFFSHORE WIND PROJECT

0 2.5 5 10 nm
0 5 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-014-00

Drawing Title:
MORGAN ARRAY AREA AND THE MORGAN MARINE MAMMAL STUDY AREA

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

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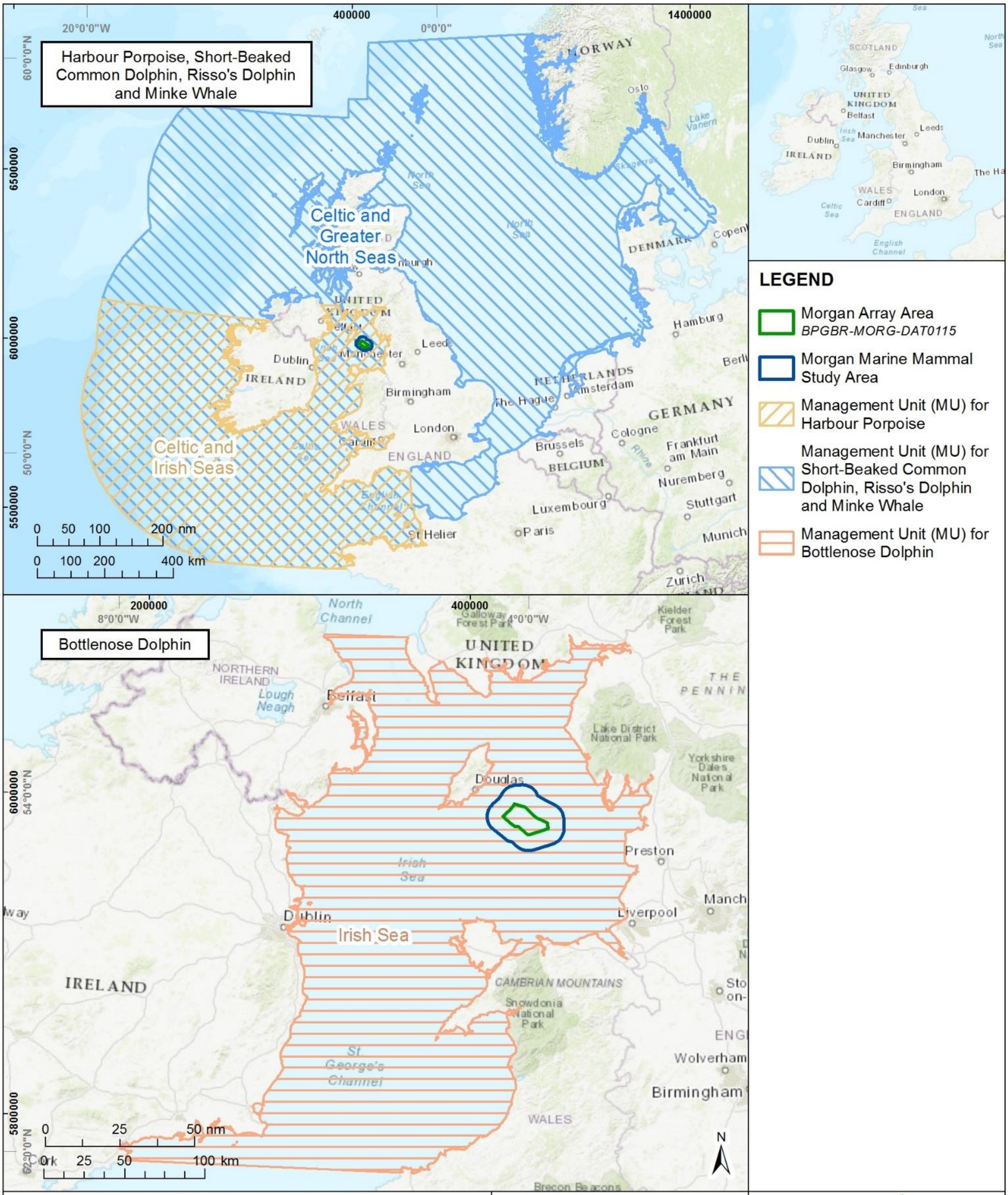
Figure 1.1: Morgan Array Area and Morgan marine mammal study area.



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Data Sources: Client, JNCC

Project Name:
MORGAN OFFSHORE WIND PROJECT

Drawing Number:
RPSE-MG-ES-MAM-015-00

Drawing Title:
MARINE MAMMAL STUDY AREAS AND RELEVANT SPECIES MANAGEMENT UNITS (MUS) FOR CETACEAN SPECIES

Geodetic Information:
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Projection: ETRS 1989 UTM Zone 30N
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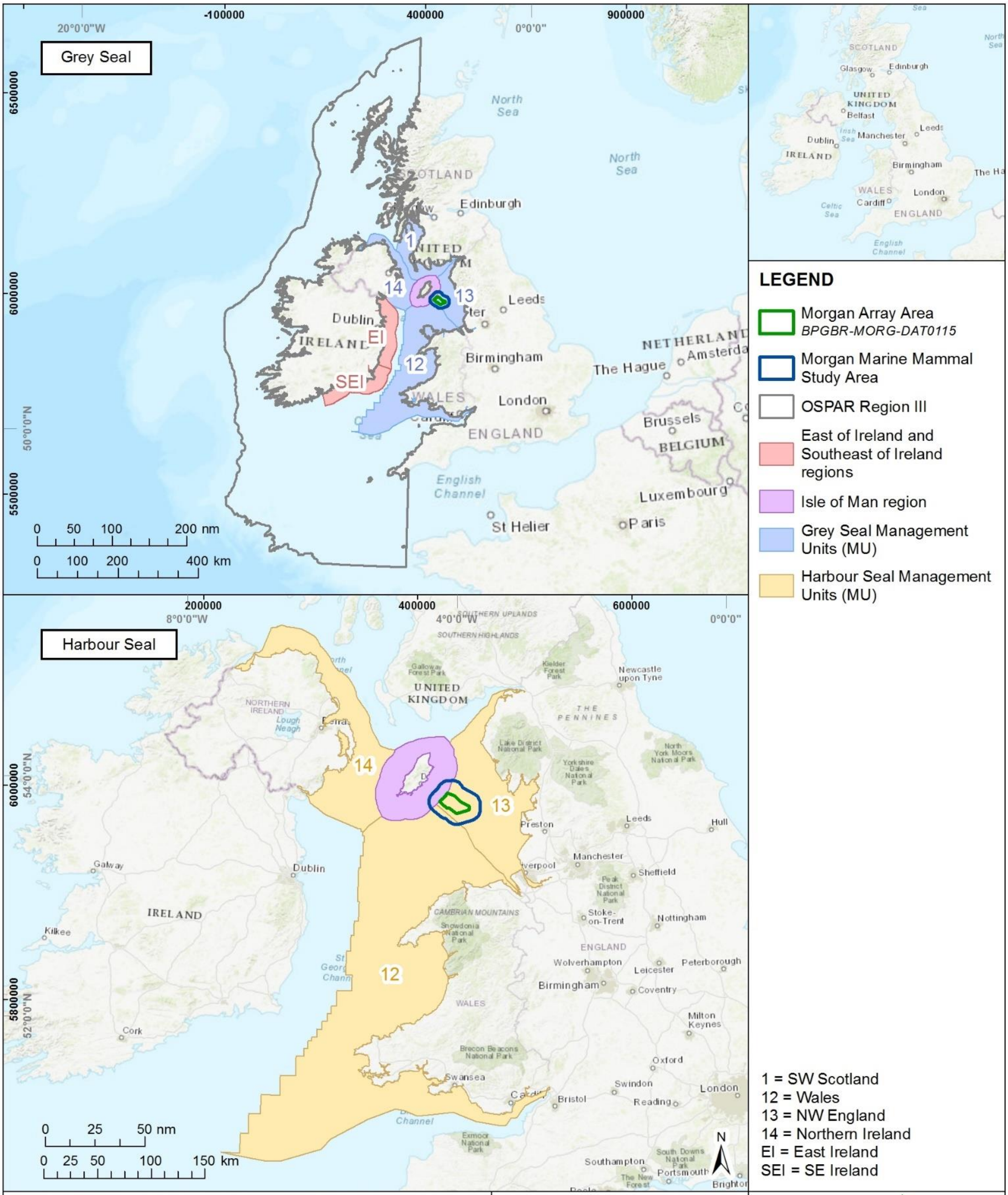
Figure 1.2: Marine mammal study areas and relevant species MUs for cetacean species.



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Data Sources: Client, JNCC, SCOS, NPWS

Project Name:
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Drawing Number:
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Drawing Title:
MARINE MAMMAL STUDY AREAS AND RELEVANT SPECIES MANAGEMENT UNITS (MUS) FOR PINNIPED SPECIES

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:16,000,000

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Figure 1.3: Marine mammal study areas and relevant species MUs for pinniped species.

1.3 Consultation

1.3.1.1 A summary of the key matters raised during consultation activities undertaken to date specific to marine mammals is presented in Table 1.1 below.

Table 1.1: Summary of key matters raised during consultation activities undertaken to date for the Morgan Generation Assets.

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
April 2021	**Introduction to the project meeting –** Natural England, Marine Management Organisation (MMO), Joint Nature Conservation Committee (JNCC), Natural Resources Wales (NRW), The Wildlife Trusts (TWT) and Environment Agency (EA)	Inception meeting. Provision of initial information on the marine mammal surveys for the Morgan Array Area.	Coverage of Morgan aerial surveys is detailed in Appendix A.
November 2021	**Evidence Plan Steering group meeting –** Natural England, MMO, JNCC and NRW	• Focus on analysis assuming baseline is appropriate • Mitigation hierarchy and stakeholder discussions held early on • Natural England agreed limited data on project areas.	Evidence-based approach has been used in the report, based on extensive baseline characterisation.
February 2022	**Marine Mammals EWG 1 –** Natural England, MMO, JNCC, NRW, TWT and EA	Use of digital aerial survey data requires an assessment of the suitability of analysing data covering 12% of the survey area, such as a power analysis to support approach.	Coverage of Morgan aerial surveys is detailed in Appendix A, standing at over 12%, exceeding several previously consented projects and 10% minimum coverage suggested by literature (BSH, 2013). Coefficient of variation (CV) also provided in this technical report to give measure of precision to support approach, but noted CVs will be higher for marine mammals, due to very low sighting numbers given their life history, so the difference between raw counts would be proportionally greater.
		EWG suggested evidence of sufficient levels of Quality Assurance (QA) should be provided to resolve any concerns regarding the detection probability or species identification confidence associated with the chosen method (e.g. sample images in range of confidence scenarios and visibility conditions).	As detailed in Appendix A, in the processing of aerial data marine mammals identified in the images were categorised to the lowest taxonomic level possible. Size of individuals can be measured to aid in species-level identification. APEM uses the precautionary principle and only identifies to species level when there is 100% confidence and includes a comprehensive internal QA process (details of which are detailed in section 1.4.4). APEM only gives definite species sightings

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
			where an animal can be identified to species level with high confidence. Where a marine mammal sighting cannot be identified with high confidence to species level, sightings are given in their own non-species specific categories (e.g. 'seal species', 'dolphin/porpoise', 'marine mammal'). Full details of the survey methodology, data processing, data analyses, and assumptions and limitations are provided in Appendix A.
		Survey feedback – EWG advised caution in applying feedback on the survey design with respect to birds to marine mammals.	The technical report has tailored any survey design to marine mammals only and is detailed in Appendix A.
		Regional marine mammal study area – NRW queried study area extent.	The Marine Mammal Management Units (MMMU) have been used to provide regional context in baseline data as highlighted in section 1.2.
		Key species – include minke whale.	Included in this technical report (section 1.7.6), Volume 2, Chapter 4: Marine mammals of the Environmental Statement, and the Information to Support Appropriate Assessment (ISAA) (Document Reference E1).
		Desktop data sources – additional sources considered for applicability.	Additional data sources or informative documents have been included where applicable (see section 1.5).
July 2022	**Morgan EIA Scoping Opinion** The Planning Inspectorate	The Inspectorate does not agree to scope out impacts to Harbour Seals. Based on the literature review and recent surveys low numbers of harbour seal are located within the generation asset area that may be impacted. The Applicant should agree the scope of an assessment for this species with the EWG.	Harbour seal has been included in the baseline environment of the technical report (section 1.7.8), though noting they were not included in Awel y Môr (AyM) Offshore Wind Farm.
		The regional study area for marine mammals is proposed to be the extent of the Irish Sea. The Inspectorate considers that the relevant Management Unit for each marine mammal receptor identified is the appropriate scale for consideration of the regional impacts for marine mammals.	The MMMUs are used to provide regional context in baseline data as highlighted in section 1.2.

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
		The Scoping Report explains that aerial digital marine mammal surveys collected 30% of the sea surface and 12% was analysed. The Environmental Statement should explain the rationale behind the 12% value and demonstrate that the survey coverage is appropriate to provide adequate baseline characterisation. The Environmental Statement should include reference to any agreements reached through the EWG, including relevant consultation bodies such as NRW and Natural England.	Coverage of Morgan aerial surveys have been detailed in Appendix A, standing at over 12% to date, exceeding several previously consented projects and 10% minimum coverage suggested by literature (BSH, 2013). CVs have also been provided in this technical report to give a measure of precision to support approach, but noted CVs will be higher for marine mammals, due to very low sighting numbers given their life history, so the difference between raw counts would be proportionally greater (section 1.7).
		A number of datasets proposed to be used to inform the regional marine mammal study area (i.e. out with the site-specific survey area) are more than 10 years old. Whilst it is acknowledged site-specific surveys have been undertaken, the Applicant should ensure that the baseline data used in the Environmental Statement assessments are sufficiently up to date to provide a robust baseline.	The comprehensive desktop undertaken has included recent data where available (Table 1.2).
	Isle of Man Department of Infrastructure	Refer to the Manx Marine Environmental Assessment (MMEA) which provides a useful overview of the Island's marine environment and should be taken into account as part of both the transboundary and possibly also the cumulative impacts assessment as part of this application.	The MMEA has been included in the baseline desktop review (section 1.6).
		The Committee notes that the Management Units for these cetaceans include Isle of Man territorial waters and, as such, consider it appropriate that this area is included within the assessment for these species.	MMMUs have been used to provide regional context in baseline data as highlighted in section 1.2.
		Key species – include minke whale.	Minke whale included in this technical report (section 1.7.6), Volume 2, Chapter 4: Marine mammals of the Environmental Statement and the ISAA (Document Reference E1).
		Recommends engagement with the Manx Whale and Dolphin Watch (MWDW) and Manx Wildlife Trust (MWT).	MWDW and MWT contacted as part of desk study and data obtained presented in this report (section

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
			1.5.21 for MWDW and 1.5.22 for MWT).
		Several Manx Marine Nature Reserves (MNR) specifically include cetaceans in their designation features, including presumed feeding grounds for Cardigan Bay bottlenose dolphin, regionally important populations of Risso's dolphin and wide-ranging populations of grey seal.	These have been included in the report in section 1.6.1.
		Inclusion of Isle of Man Wildlife Act 1990.	Legislation included in section 1.6.1. of this report.
	JNCC	Regional marine mammal study areas – JNCC query study area extent.	MMMUs have been used to provide regional context in baseline data as highlighted in section 1.2.
		Agree that harbour porpoise, minke whale, bottlenose dolphin, common dolphin, Risso’s dolphin, and grey seal are scoped into the EIA; and white-beaked dolphin and harbour seal are scoped out.	White-beaked dolphin have been scoped out, but harbour seal scoped in as result of EWG discussions (section 1.7.8).
	Natural England	MMMUs should be used as the regional study area for the purposes of calculating the reference populations, the screening extent as regards Special Areas of Conservation (SAC), and for cumulative impacts spatial screening extent.	MMMUs have been used to provide regional context in baseline data as highlighted in section 1.2.
		Suggest harbour seal cannot yet be excluded from the high-level assessment until there is suitable evidence (i.e. from the results of the complete digital aerial survey campaign) for their exclusion.	Harbour seal was scoped in as result of EWG discussions (section 1.7.8).
		Advise data derived from the site-specific aerial surveys is considered alongside existing data for the area when selecting the best/most precautionary estimate of marine mammal density to use for the quantitative assessment.	MMMUs and other existing baseline data have been used to provide regional context when selecting estimates for quantitative assessment (section 1.6).
		We advise that the regional study area for each marine mammal receptor should be based on the relevant MU for that receptor, insofar as the study area or MUs should be used to determine the appropriate reference population, SAC that should be screened.	MMMUs and other existing baseline data have been used to provide regional context when selecting estimates for quantitative assessment (section 1.6).

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
		Data source suggestions for inclusion.	Included in baseline in section 1.5.
		Note that a number of individuals could not be identified to species level. We welcome clarification on how these observations are going to be included in the assessment to ensure that species' density estimates are not underestimated.	Combining densities to give the most precautionary estimate of density for use in the impact assessment (see section 1.6). Detailed methods are given in Appendix A.
		Carter *et al.* (2020) should be used as a source of telemetry data for seals, which can inform the movements and origins of seals in the study area.	More recent Carter *et al.* (2022) maps are used in this technical report (section 1.5.20). Telemetry data obtained from SMRU are also incorporated in section 1.5.18 to inform movements of seals in the regional marine mammal study area.
	NRW	NRW (A) advise that the MMMU is the appropriate scale for consideration of offsite impacts for marine mammals as per NRW's Position Statement.	The MMMUs have been used to provide regional context in baseline data as highlighted in section 1.2.
		If Digital Aerial Survey (DAS) data is to be used in environmental assessments, an assessment of the suitability of analysing data covering 12% of the survey area, such as a power analysis, should be provided to support the approach taken.	Coverage of Morgan aerial surveys is detailed in Appendix A, standing at over 12%, exceeding several previously consented projects and 10% minimum coverage suggested by literature (BSH, 2013). CVs have also been provided in this technical report to give measure of precision to support approach, but noted CVs will be higher for marine mammals, due to very low sighting numbers given their life history, so the difference between raw counts would be proportionally greater.
July 2022	**Marine Mammals EWG 2 –** Natural England, MMO, JNCC, NRW, TWT and Cefas.	Agreement sought on approach to the baseline characterisation with regards to regional marine mammal study area. NRW in agreement that Celtic and Irish Sea (harbour porpoise) MU is an appropriate study area for dolphin and minke whale.	Species-specific MUs have been applied (see section 1.2) as reference populations. Agreement that the Celtic and Irish Sea (harbour porpoise MU) is an appropriate marine mammal study area.
		Discussion of species to scope in/out of the PEIR and ISAA. Agreement that white-beaked dolphin can be scoped out.	Harbour seal has been included in the baseline environment of the technical report (section 1.7.8). White-beaked dolphin scoped out.
November 2022	**Marine Mammals EWG 3** – MMO, Natural England, NRW, TWT, DEFA, Isle of Man Government and Cefas.	NRW have used OSPAR Region III as a reference population for grey seal and acknowledge that the use of OSPAR Region III could dilute the assessment of impact, but the size of OSPAR Region III is likely appropriate to the level of	OSPAR Region III reference population has discussed in paragraph 1.7.7.43.

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
		connectivity between grey seal colonies. NRW confirmed OSPAR Region III includes the Isle of Man population.	
		Natural England proposed a high-level qualitative assessment on haul-out sites (i.e. a qualitative assessment of movements from key haul-out sites to the project area).	Information on haul-out sites and seal movement telemetry data has been provided in relevant species accounts for grey seal (section 1.7.7) and harbour seal (section 1.7.8).
		TWT provided grey seal count data for the haul-out site on Walney Island.	Data has been included in section 1.5.23 and discussed in grey seal species account (section 1.7.7), provided by Cumbria Wildlife Trust.
		NRW advised the use of the Welsh Marine Mammal Atlas as it comprises 30 years of survey data and highlights higher densities around the Isle of Anglesey and avoids issue of 'snapshot' data.	Densities from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) have been set out in relevant species accounts (sections 1.7.2 to 1.7.6). Densities taken forward to assessment for harbour porpoise, bottlenose dolphin and common dolphin are derived from this data source.
June 2023	**Statutory consultation responses** Natural England	Natural England advises that 24 months of survey effort is the minimum expected evidence standard for marine mammal impact assessment.	24 months of surveys were conducted and associated survey data is detailed in Appendix A.
		Natural England advises that harbour seal should be included in the list of species likely to occur within the regional marine mammal study area.	Harbour seal has been included in the list of species likely to occur within the regional marine mammal study area (sections 1.6.2 and 1.7.8).
		Natural England advises the inclusion of Marine Mammal Atlas (Evans & Waggitt, 2023) in the list of desktop literature, and densities should be reviewed where relevant using this reference).	The Marine Mammal Atlas (Evans & Waggitt, 2023) has been included in the list of desktop literature (Table 1.2 and section 1.5.16). Densities have been reviewed to take into account this reference, and proposed densities to be taken forward to assessment have been set out in sections 1.7.2 to 1.7.6).
		Natural England advises Carter *et al.,* 2022 reference on grey seal foraging range should be included (i.e. 448 km).	Foraging range of 448 km, from Carter *et al,* 2022 has been included (section 1.7.7).
	NRW	NRW recommend adding clarification regarding MMMUs used for grey seal, given that the Celtic and Irish Seas MU was used as the regional marine mammal study area for cetaceans, but not grey seal.	Study areas used have been described in section 1.7.2, with further detail on the grey seal reference population given in paragraph 1.7.7.42.

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
		NRW recommend the most precautionary (or the most scientifically robust) density values should be taken forward to the assessment.	Density estimates to be taken forward to the assessment have been set out in sections 1.7.2 to 1.7.8.
	Isle of Man Government	The Isle of Man Government queried the inclusion of Isle of Man data in the haul out and telemetry report from SMRU and sought confirmation that Manx populations have been adequately and equally included. The Isle of Man Government also sought clarification that the Manx grey seal population has been appropriately considered within the baseline.	The seal telemetry and haul out report (Appendix B) has presented available data that SMRU hold for the SMUs, and confirmed they do not hold any additional data for the Isle of Man. However, data has been obtained from Manx Wildlife Trust and has been presented in section 1.5.22, and relevant grey seal (1.7.7) and harbour seal (1.7.8) species accounts. Specific grey seal sections dedicated to the Isle of Man have been given in sections 1.7.7.19 *et seq* and 1.7.7.37 and the 'Grey Seal Reference Population (GSRP)' detailed in paragraph 1.7.7.42 has included an estimate for the Isle of Man from Howe (2018b) which was confirmed in a subsequent EWG05 meeting in August 2023. Furthermore, the Carter *et al*. (2022) maps used to derive densities (paragraph 1.7.7.22 for grey seal and 1.7.8.15 for harbour seal) cover the waters around the Isle of Man and therefore the Isle of Man has been included in densities taken forward to the impact assessment (Table 1.15).
		Cardigan Bay and Manx winter population of bottlenose dolphins on the east coast are believed to be the same group, based on data, including from photographic recognition of individuals. They suggested this should be acknowledged, and a specific assessment of the Manx population	Detailed discussion of connectivity of bottlenose dolphin with Manx waters has been presented in paragraph 1.7.3.8. This section also clarifies animals are likely to move between Cardigan Bay and the Isle of Man. However, a specific assessment of the Manx population (as opposed to the Cardigan Bay population) would not support this suggestion of one single population. Isle of Man confirmed content with approach in the subsequent EWG05 meeting (August 23).
		Isle of Man Government requested clarification on the nature of the seasonal data provided by MWDW.	A personal communication was provided from the MWDW on seasonality of cetaceans around the Isle of Man and has been included in relevant paragraphs 1.7.2.46, 1.7.3.37, 1.7.5.25 and 1.7.6.22.

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
June 2023	**Marine Mammals EWG 05** – MMO, Natural England, NRW, JNCC, TWT and Cefas.	NRW recommend the use of densities from the Welsh Marine Mammal Atlas. As previously mentioned, the Atlas links 30 years of sightings and effort data with a number of other environmental parameters. NRW confirmed agreement with the remaining species densities and reference populations provided in note appended to the draft Meeting Minutes. NRW agree to using both approaches to grey seal reference populations in parallel. NRW mentioned that when screening in projects if a smaller area is proposed (other than OSPAR III) for grey seal and justified, NRW (A) would not anticipate ruling it out. While we would still advise the use of OSPAR III for screening, we are conscious that a large MU could be somewhat un-pragmatic. Alternatives such as (1) the maximum foraging range of 448 km (Carter *et al.*, 2022); (2) International Council for the Exploration of the Seas (ICES) divisions 7a,e,f,g,h; or (3) ICES divisions 7a,b,e,f,g,h,j would still be acceptable as screening distances.	Densities from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) have been given (alongside other desktop and site-specific densities) in relevant species accounts sections (1.7.2 to 1.7.6). Densities taken forward to assessment for harbour porpoise, bottlenose dolphin and short-beaked common dolphin have been derived from the Welsh Marine Mammal Atlas. The reference population taken forward to assessment, the GSRP has been discussed in paragraph 1.7.7.42. The OSPAR Region III population number has been applied to the assessment for additional context and is discussed in paragraph 1.7.7.43. The cumulative screening approach has been discussed in paragraph 1.2.1.3. For grey seal this comprises the GSRP discussed in paragraph 1.7.7.42, and for harbour seal this comprises the Harbour Seal Reference Population (HSRP) as discussed in paragraph 1.7.8.23.
		Natural England did not have objections to presenting OSPAR region III alongside MUs for comparison but advise that a more precautionary MUs should be taken forward to the assessment. Natural England agreed with the use of one single bottlenose dolphin density across the whole study area, agreeing with the use of Welsh Marine Mammal Atlas going forward unless new evidence (e.g. two years of site specific surveys or SCAN IV) reveals higher densities. Natural England referenced the Best Practice Guidelines Phase III, and agreed Welsh Marine Mammal Atlas was suitable for harbour porpoise and bottlenose dolphin.	The reference population taken forward to assessment, the GSRP has been discussed in paragraph 1.7.7.42. The OSPAR Region III population number has been applied to the assessment for additional context and is discussed in paragraph 1.7.7.43. Densities from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) have been given (alongside other desktop and site-specific densities) in relevant species accounts sections (1.7.2 to 1.7.6). Densities taken forward to assessment for harbour porpoise, bottlenose dolphin and short-beaked common dolphin have been derived from the Welsh Marine Mammal Atlas.
August 2023	Marine mammals meeting on Isle of Man data (Isle of	Isle of Man Government wanted clarification that the Manx grey seal	MWT provided a pers. comms to explain connectivity of grey seals

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
	Man Government, MWDW and MWT)	population has been appropriately considered within the baseline and offered additional pers. comms surrounding connectivity in Isle of Man waters. RPS requested confirmation that the Isle of Man population estimate is suitable.	around the Isle of Man. These have been included in relevant species accounts sections (1.7.2 to 1.7.8). MWT and MWDW confirmed content with list of data sources presented in Table 1.2. MWT confirmed the estimate of 400 is suitable, and provided additional context to this in pers. comm.
September 2023	Expert Working Group Technical Note	Detail on baseline characterisation, proposed regional marine mammal study area, and grey seal reference population for CEA was presented. Natural England agreed with the data sources presented for baseline characterisation, noting SCANS IV has been published and would be a valuable addition to baseline characterisation. Natural England maintained their advice on the densities used in the assessment i.e. to use Welsh Marine Mammal Atlas for agreed species unless new data reveals evidence of greater densities (SCANS IV and two years of site specific surveys). NRW agreed with densities and population numbers outlined, and with the proposed use of common dolphin densities from Evans and Waggitt (2023), unless new data reveals evidence of greater densities. NRW also acknowledged and agreed with the rationale provided for the choice of Nmin for the grey seal OSPAR III population. JNCC noted baseline characterisation does not rely on aerial surveys alone and were content with the regional marine mammal study area. JNCC agreed with densities discussed including update to short-beaked common dolphin density to Evans and Waggitt (2023). Cefas deferred to Natural England and to other relevant SNCBs for their comments on the specific issues covered in the Technical Note.	Density estimates and reference populations to be taken forward to the assessment have been set out in sections 1.7.2 to 1.7.8. Densities taken forward to assessment for harbour porpoise, bottlenose dolphin and short-beaked common dolphin have been derived from the Welsh Marine Mammal Atlas. SCANS IV data has been added to relevant species accounts (1.7.2 to 1.7.6). Grey seal reference populations taken forward to assessment have been discussed in paragraph 1.7.7.40 for the GSRP and paragraph 1.7.7.41 for OSPAR Region III.
October 2023	Email detailing Morgan Generation species densities	The methodology and relevant densities presented in the SCANS IV survey report were reviewed and included data as a baseline characterisation source in technical reports for both projects. An email	Density estimates and reference populations to be taken forward to the assessment have been set out in sections 1.7.2 to 1.7.8, as agreed with the EWG. The Welsh Marine Mammal Atlas densities were used

Date	Consultee and type of response	Comment	Response to comment and/or where addressed in technical report
		detailing densities that will be applied to the assessments for all cetacean species was provided to the EWG. Densities remained as agreed through the fifth expert working group meeting (June 2023) and/or the associated September technical note (i.e. no changes from the September 2023 Technical Note are proposed). Natural England, NRW, Cefas, Wildlife Trust Wales all agreed with the approach outlined.	for harbour porpoise, bottlenose dolphin and short-beaked common dolphin. SCANS III estimates were taken forward for Risso's dolphin and minke whale as they were more precautionary than SCANS IV estimates.

1.4 Methodology

1.4.1 Overview

1.4.1.1 Information on marine mammals within the regional marine mammal study area was collected through a detailed desktop review of existing studies and datasets and site-specific surveys.

1.4.2 Desktop study

1.4.2.1 Information on marine mammals within the marine regional mammal study area was collected through a detailed desktop review of existing studies and datasets. These are summarised at Table 1.2, with more detailed summaries of each data source presented below. These data sources are applied in support of detailed species accounts, set out in sections 1.7.2 to 1.7.8.

Table 1.2: Summary of key desktop sources.

Title	Source	Year	Author
Awel y Môr Offshore Wind Farm surveys	APEM Ltd.	2019 to 2021	Sinclair *et al*. (2021)
Gwynt y Môr Offshore Wind Farm baseline	Centre for Marine and Coastal Studies (CMACS)	2003 to 2005	CMACS Ltd. (2011; 2013); Goddard *et al*. (2017); Goddard *et al*. (2018); Goulding *et al*. (2019)
Rhiannon Wind Farm aerial and boat-based surveys	Celtic Array Ltd.	2010 to 2013	Celtic Array Ltd. (2014)
Morecambe Offshore Windfarm: Generation Assets Marine Mammal Information and Survey data (this includes HiDef aerial digital site surveys)	Morecambe Offshore Windfarm, Ltd.	Aerial surveys from March 2021 to February 2022	Morecambe Offshore Windfarm, Ltd (2023)

Title	Source	Year	Author
Estimates of cetacean abundance in European Atlantic waters from the Small Cetaceans in European Atlantic waters and the North Sea (SCANS) aerial and shipboard surveys	SCANS	1994; 2005; 2016; 2022	Hammond *et al*. (2002); Hammond *et al*. (2017); Hammond *et al*. (2021); Gilles *et al.* (2023)
Density surface modelling from SCANS-III surveys	SCANS	2016	Lacey *et al*. (2022)
Joint Cetacean Protocol (JCP) Phase I, III Analysis	JCP	1994 to 2010	Paxton and Thomas (2010); Paxton *et al*. (2016)
JNCC Report 544: Harbour Porpoise Density	JNCC	1994 2011	Heinänen and Skov (2015)
Atlas of the Marine Mammals of Wales (2012)	Countryside Council for Wales (CCW)	1990 to 2009	Baines and Evans (2012)
Distribution maps of cetacean and seabird populations in the northeast Atlantic (2020)	Bangor University	1980 to 2018	Waggitt *et al.* (2020)
Modelled Distribution and Abundance of Cetaceans and Seabirds in Wales and Surrounding Waters (2023) (Welsh Marine Mammal Atlas)	NRW	1990 to 2020	Evans and Waggitt (2023)
ObSERVE surveys	National Parks and Wildlife Service (NPWS)	2015 to 2017	Rogan *et al.* (2018)
Strategic Environmental Assessment 6	SMRU	2005	Hammond *et al*. (2005)
Special Committee on Seals (SCOS) Reports	SMRU	1990 to 2020	SMRU
Seal Telemetry Data	SMRU	2004 to 2018	Wright and Sinclair (2022)
Habitat-based predictions of at-sea distribution for grey and harbour seal in the British Isles	Report to Department for Business, Energy and Industrial Strategy (BEIS)	1996 to 2015	Carter *et al*. (2020; 2022)
Manx Whale and Dolphin Watch (MWDW) surveys • Opportunistic and effort-based sighting data.	MWDW	2006 to 2022	Data from MWDW Manley (2021, 2020, 2019); Clark *et al.* (2019, 2017); Felce and Adams (2016); Felce, 2015; Adams (2017)

Title	Source	Year	Author
Manx Wildlife Trust (MWT) surveys: • Seal pup surveys on Calf of Man • Opportunistic land sightings • Seal haul-out survey data • Calf of Man Seal survey reports 2017 to 2021.	MWT	• 2017 to 2021 • 2016 to 2022 • 2017 • 2017 to 2021.	MWT
Manx Marine Environmental Assessment	Isle of Man Government	2018	Howe (2018a); Howe (2018b)
Walney Nature Reserve survey data	Cumbria Wildlife Trust	1981 to 2023	Data from Cumbria Wildlife Trust
Anglesey based surveys	Various sources	2002 to 2018	Shucksmith *et al*. (2009); Jacobs (2018); Veneruso and Evans (2012); Pesante *et al*. (2008); Duckett (2018); Evans *et al*. (2015)
Updated abundance estimates for cetacean Management Units in UK waters	JNCC	2021	Inter-Agency Marine Mammal Working Group (IAMMWG) (2021)

1.4.3 Site specific surveys

1.4.3.1 A summary of the site-specific surveys undertaken to inform the marine mammal assessment is outlined in Table 1.3 below.

1.4.3.2 The Morgan Aerial Survey Area was based upon a pre-scoping original array area layout plus a buffer of 10 km. The Aerial Survey Area remains unchanged from PEIR to Environmental Statement, and forms part of the boundary of the Morgan marine mammal study area (see section 1.2). The Morgan Array Area itself has reduced in spatial extent from PEIR to Environmental Statement, but it remains within the boundaries of the Morgan Aerial Survey Area and results in an increased buffer region (10 km to 13.3 km).

Table 1.3: Summary of survey undertaken to inform marine mammals.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Aerial Digital Surveys - Morgan	Morgan Array Area plus 10 to 13.3 km buffer	Aerial digital survey	APEM Ltd.	April 2021 to March 2023	Aerial survey data analysis- Appendix A

1.4.4 APEM survey approach

1.4.4.1 The Morgan Aerial Survey Area comprises the Morgan Array Area with a 10 km to 13.3 km buffer. The total area surveyed for Morgan was 1,378 km^2. Monthly surveys were carried out between April 2021 and March 2023, and were carried out monthly to give two years of baseline data.

1.4.4.2 The Morgan aerial surveys are being undertaken by APEM and full details of the method are given in Appendix A. Utilising a bespoke camera system on twin-craft engine aircraft, they use a grid-based collection method to collect 30% of the sea surface area and analysed at least 12% of the Morgan Aerial Survey Area. Still images along 18 survey lines with approximately 2 km between-track were collected to give 1.5 cm Ground Sampling Distance (GSD) digital still images.

1.4.4.3 All surveys were undertaken in weather conditions that did not compromise the ability to provide data on the identification, distribution and abundance of marine megafauna and were also safe to fly in. Favourable conditions for surveying are defined as a cloud base of >396 m, visibility of >5 km, wind speed of <30 kn and a sea state of no more than four (moderate). Measures were taken to minimise glint and glare which may affect the discovery and identification of marine mammals. Some surveys were undertaken over more than one day or over two flights in one day due to weather constraints or to avoid non-optimal sun angles. Further detailed description of these conditions, measures and survey approaches are given in Appendix A.

1.4.4.4 In processing of aerial data, marine mammals identified in the images were categorised to the lowest taxonomic level possible. Size of individuals can be measured to aid in species-level identification. APEM uses the precautionary principle and only identifies to species level when there is 100% confidence. Comprehensive internal QA processes were undertaken, which included checking for missed targets and review of each image ‘snag’ (i.e. a marine mammal located within the image) for correct species identification by a minimum of two members of staff. APEM included their Senior Marine Mammal Consultant and Principal Marine Mammal Consultant in the QA process of all marine mammal images, who hold a minimum of five years’ experience in identifying marine mammals to species level, nationally and internationally. Full details of the survey methodology, data processing, data analyses, and assumptions and limitations are provided in Appendix A, along with further detail on the APEM marine mammal consultancy team.

1.4.4.5 Summary statistics were produced to describe the data for each of the key species or species groups within the Morgan Aerial Survey dataset. For Morgan Generation Assets the full 24 months are analysed for the Environmental Statement. Data from these surveys have been used to provide current information on species presence, distribution and abundance/densities within the survey area.

1.5 Other studies and data sources

1.5.1 Awel y Môr Offshore Wind Farm

1.5.1.1 Monthly digital still aerial surveys were conducted by APEM, to collect data on the abundance and distribution of marine mammals to characterise the baseline to inform an Environmental Impact Assessment (EIA) for the AyM Offshore Wind Farm (Sinclair *et al.*, 2021). One survey per month was carried out for two years, from March 2020 to February 2022. Surveys were only undertaken under suitable conditions (where the cloud base was over 1,700 ft, visibility was higher than 5 km, wind speed below 30 kn and sea state at a maximum of four). Where poor weather conditions prevented surveys, they were conducted at the next available time (with a minimum of seven days required between data collection months). The surveys covered the AyM Offshore Wind Farm array area (Figure 1.4), plus a 4 km buffer to the north of the site and an 8 km buffer to the south of the site (these areas were informed by post-construction species surveys from Gwynt y Môr Offshore Wind Farm (GyM)). It consisted of a gridded survey design with data collected from east to west with a 4 km spacing, leading to 10% coverage using 2 cm GSD imagery captured at 1,700 ft. High altitudes were chosen to allow for clearance of the 500 ft proposed wind turbines to facilitate consistent monitoring in the post-construction phase. The 2 cm GSD was chosen to allow for identification of the majority of marine megafauna, but to minimise disturbance. The survey also aimed to get species specific density estimates for the site, but identification rates were low and thus not suitable for providing density estimates.

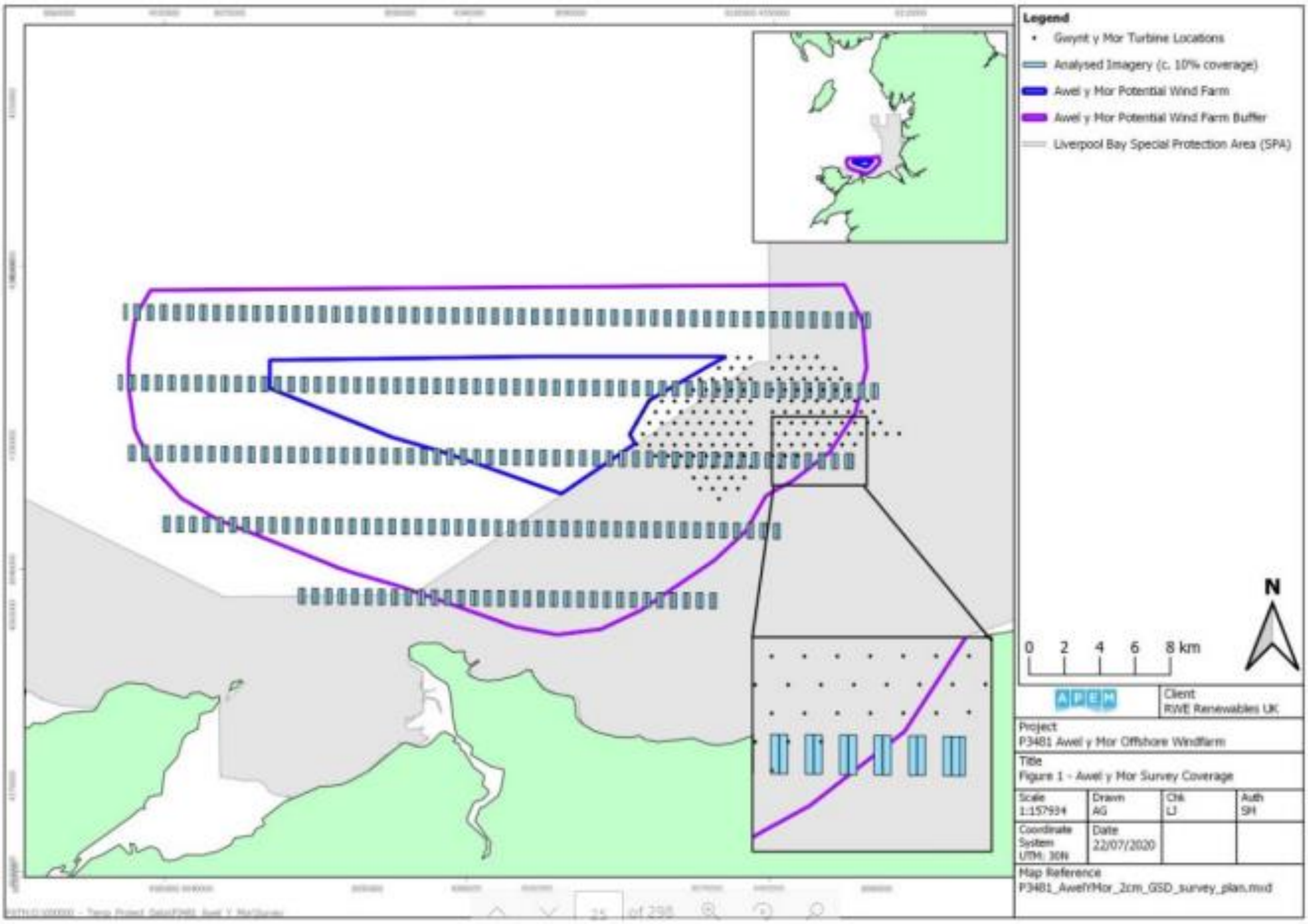


Figure 1.4: Marine mammal survey area for Awel y Môr Offshore Wind Farm. From Sinclair *et al.*, 2021.

1.5.2 Gwynt y Môr Offshore Wind Farm baseline, mitigation and post-construction surveys

1.5.2.1 Boat and land-based visual surveys were carried out for the initial GyM Offshore Wind Farm EIA in 2003 and 2004, and towed and static acoustic monitoring carried out between 2004 and 2005. Baseline monitoring was carried out using digital aerial surveys and visual marine mammal sightings data from vessels involved in Wind Farm related activity (CMACS Ltd, 2011). Four winter aerial surveys were carried out between October 2010 and March 2011, and one summer survey in July 2010. Neither survey identified animals to species level, and datasets were not sufficient to generate abundance or density estimates. However, a pod of bottlenose dolphin and two harbour porpoise *Phocoena phocoena* were observed in baseline benthic surveys. During construction GyM Offshore Wind Farm implemented marine mammal mitigation and associated monitoring between 08 May 2012 and 05 April 2013 (CMACS Ltd, 2013).

1.5.2.2 Post construction, 17 digital aerial surveys were conducted between July 2016 and March 2019. The area covered the offshore wind farm, buffer and wider area (Goddard *et al.,* 2017; Goddard *et al.,* 2018, Goulding *et al.,* 2019). A total of 110 marine mammals were recorded, including 63 grey seal and 4 harbour porpoise (other categories were non-species specific).

1.5.3 Rhiannon Wind Farm

1.5.3.1 Rhiannon Wind Farm was the first of the three Potential Development Areas to be taken forward within the Irish Sea Zone, for the EIA, which included marine mammal surveys (Celtic Array Limited, 2014). Whilst the project was halted in 2014 due to complex ground conditions, the final report on aerial and boat-based surveys undertaken to collect data to establish baseline use of the Irish Sea Zone, is available and was submitted to the TCE Marine Data Exchange.

1.5.3.2 Twelve digital video aerial surveys were flown by HiDef between 25 April 2012 and 01 March 2013 (Celtic Array Ltd, 2014). Between April 2012 and October 2012, surveys were flown using a rig comprising four standard HiDef cameras with sensors set to a resolution of 2 cm Ground Sample Distance. Each camera sampled a strip of 50 m width, separated from the next camera by 50 m, thus providing a combined sampled width of 200 m within a 350 m overall strip (see Figure 1.5). In November 2012 the surveys were flown using a rig comprising four HiDef Gen II cameras with sensors again 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 approximately 20 m. Only harbour porpoise were present in the Irish Sea Zone (ISZ) on a consistent basis (sighted in 11 out of the 12 months of survey, with a total of 227 individuals) though a pod of short-beaked common dolphin *Delphinus delphis* was recorded in July (six individuals) and grey seal were recorded in February and March (seven individuals).

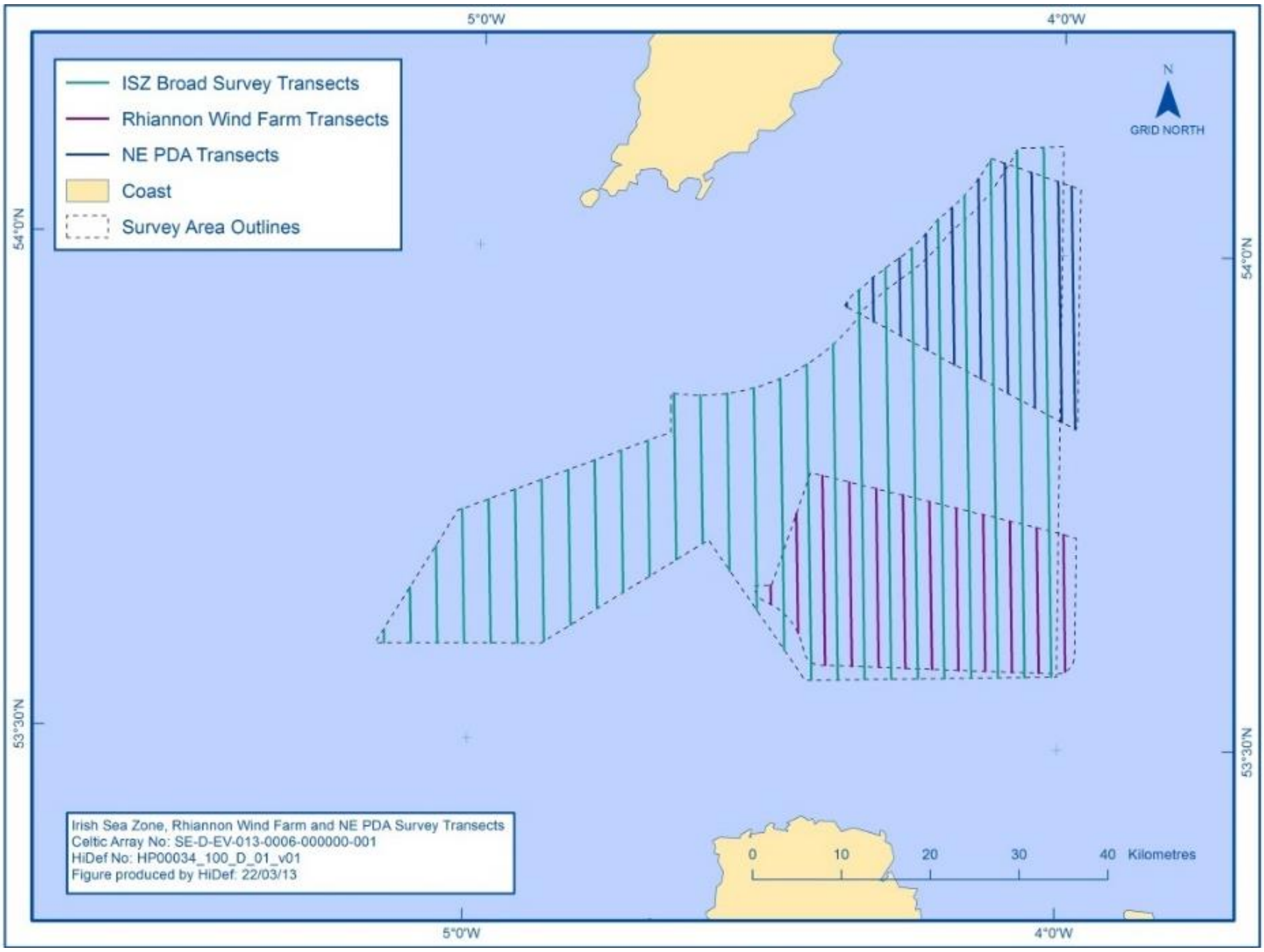
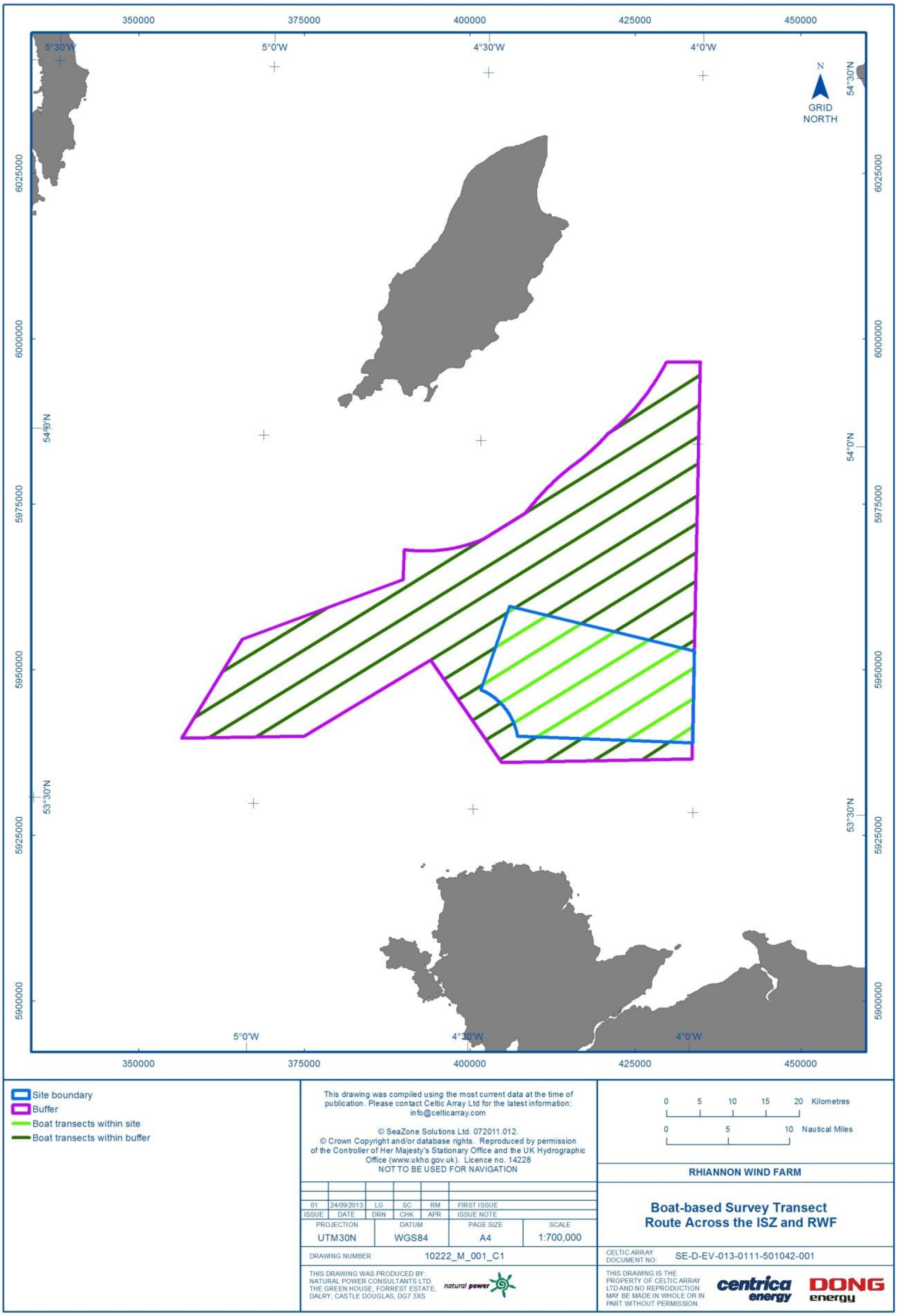


Figure 1.5: Location of aerial survey transects within the ISZ, proposed Rhiannon Wind Farm and NE Potential Development Area (Celtic Array Ltd, 2014).

1.5.3.3 Boat surveys comprised a series of 17 transects at a 3.7 km spacing, from 21 March 2010 to 13 April 2012 (Figure 1.6). Visual surveys comprised a single dedicated Marine Mammal Observer (MMOb) at a deck height of 7 m above the sea surface. Marine mammal species (identified to species level) recorded during boat-based visual surveys included harbour porpoise (516 individuals, 44 of which calves/juveniles), grey seal (66 individuals), minke whale *Balaenoptera acutorostrata* (21 individuals), bottlenose dolphin (13 individuals), Risso's dolphin *Grampus griseus* (18 individuals) and short-beaked common dolphin (8 individuals). No harbour seals were recorded. Where data allowed, distance analysis was undertaken to estimate density and abundance of individual species, and the only species for which sufficient data were available was harbour porpoise.

1.5.3.4 Acoustic surveys were also used to detect echolocation clicks, with a hydrophone towed at a depth of 7 m. The hydrophone array consisted of a 250 m tow/data cable followed by four potted hydrophone elements and a depth sensor. A total of 310 acoustic detections were identified as harbour porpoise. Harbour porpoise were the only species with sufficient detections to allow density and abundance estimation. Two sets of density estimates were presented for acoustic data, one using all detections classified as either good or moderate and a second set using only those detections classified as good.



This drawing was compiled using the most current data at the time of publication. Please contact Celtic Array Ltd for the latest information: info@celticarray.com

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01	24/09/2013	LG	SC	RM	FIRST ISSUE
ISSUE	DATE	DRN	CHK	APR	ISSUE NOTE

PROJECTION	DATUM	PAGE SIZE	SCALE
UTM30N	WGS84	A4	1:700,000

DRAWING NUMBER: 10222_M_001_C1

CELTIC ARRAY DOCUMENT NO: SE-D-EV-013-0111-501042-001

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Figure 1.6: Location of transects traversed during boat-based surveys of the ISZ (from Celtic Array Ltd., 2013).

1.5.4 Morecambe Offshore Windfarm: Generation Assets

1.5.4.1 For Morecambe Offshore Windfarm: Generation Assets, HiDef Aerial Surveying Limited (‘HiDef’) collected high resolution aerial digital still imagery for marine megafauna (combined with ornithology surveys) over the survey area which includes the windfarm site and a 4 to 10 km buffer (Morecambe Offshore Windfarm Ltd, 2023) (see Figure 1.7). The buffer extends 10 km to the north and east due to proximity to Liverpool Bay Special Protection Area for birds. The total survey area is 651 km^2.

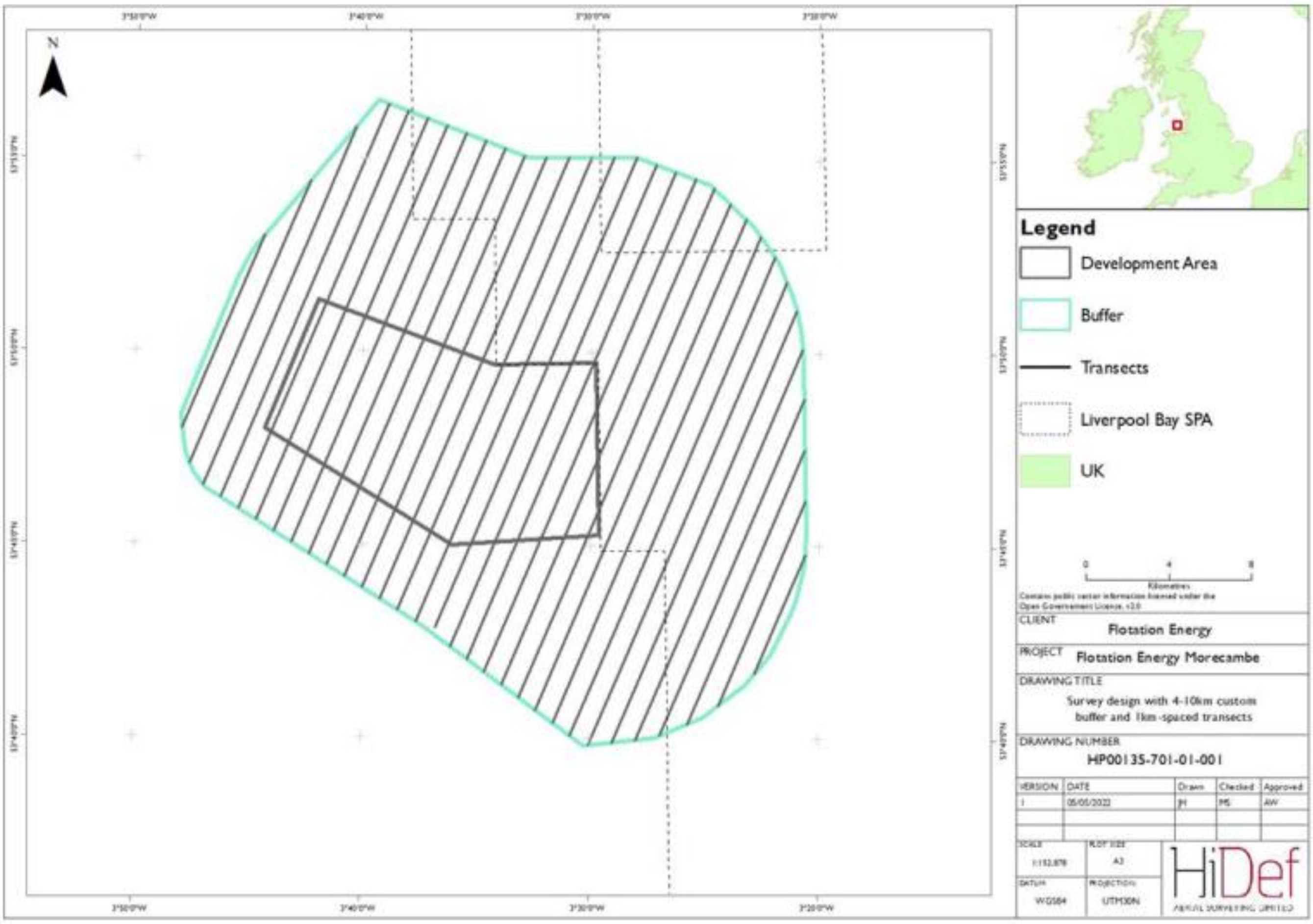


Figure 1.7: Morecambe survey design with 4 to 10 km buffer, with 1 km spaced transects flown between March 2021 and February 2022 (Morecambe Offshore Windfarm Ltd, 2023).

1.5.4.2 Monthly aerial surveys commenced in March 2021, extending over 24 months. The aerial surveys were conducted along a series of strip transects (31 strip transects at 1 km spacing) across the windfarm site and buffers every month for 24 months. Sightings indicated that harbour porpoise was the most abundant marine mammal species present within the survey area, were recorded in all 12 months across the entire survey area.

1.5.4.3 Abundance and density estimates were calculated based upon confirmed sightings for harbour porpoise only. Estimates were calculated using strip transect analysis and a statistical technique called kernel density estimation (KDE) to create density surface maps. The average density estimate for the 12 months of survey is expressed as the maximum absolute density estimate (number of animals per km^2) (corrected for availability bias) for the whole survey area (density estimate = 1.394 animals per km^2). The average abundance estimate for the 12 months of survey is expressed as the estimated number of animals within the whole survey area (corrected for availability bias) (abundance estimate = 912 (95% Confidence Interval (CI) = 512.5 – 1389)).

1.5.5 Mona Offshore Wind Project

1.5.5.1 For Mona Offshore Wind Project (Mona Offshore Wind Ltd, 2024), the Mona Aerial Survey Area was surveyed by APEM Ltd, covering a total area of 1,447 km^2. Surveys started in March 2020 and ended in February 2022, carried out monthly to give two years of baseline data. The aerial surveys used a grid-based collection method to collect 30% of the sea surface area and analysed at least 14% of the Mona Aerial Survey Area (Mona Offshore Wind Ltd, 2024).

1.5.5.2 Harbour porpoise accounted for the highest number of individuals identified to species level across the Mona Aerial Survey Area, and was recorded in all survey months except for July, November and December 2020. Grey seal accounted for the second highest number of sightings but were not recorded in every month over the survey period. For other sightings identified to species level – bottlenose dolphin, Risso’s dolphin and harbour seal, both the number and frequency of sightings were low. Bottlenose dolphin were encountered in two months of the year (June 2021 and January 2022), Risso’s dolphin were encountered in just one month of the year (November 2020) and one harbour seal was encountered in March 2020 only.

1.5.5.3 Modelling of the Mona aerial survey data allowed absolute estimates of mean abundance, densities and confidence limits to be given for grey seal and for harbour porpoise for the Mona Aerial Survey Area. Low sighting occurrences for other species meant modelling of densities was not possible (Mona Offshore Wind Ltd, 2024).

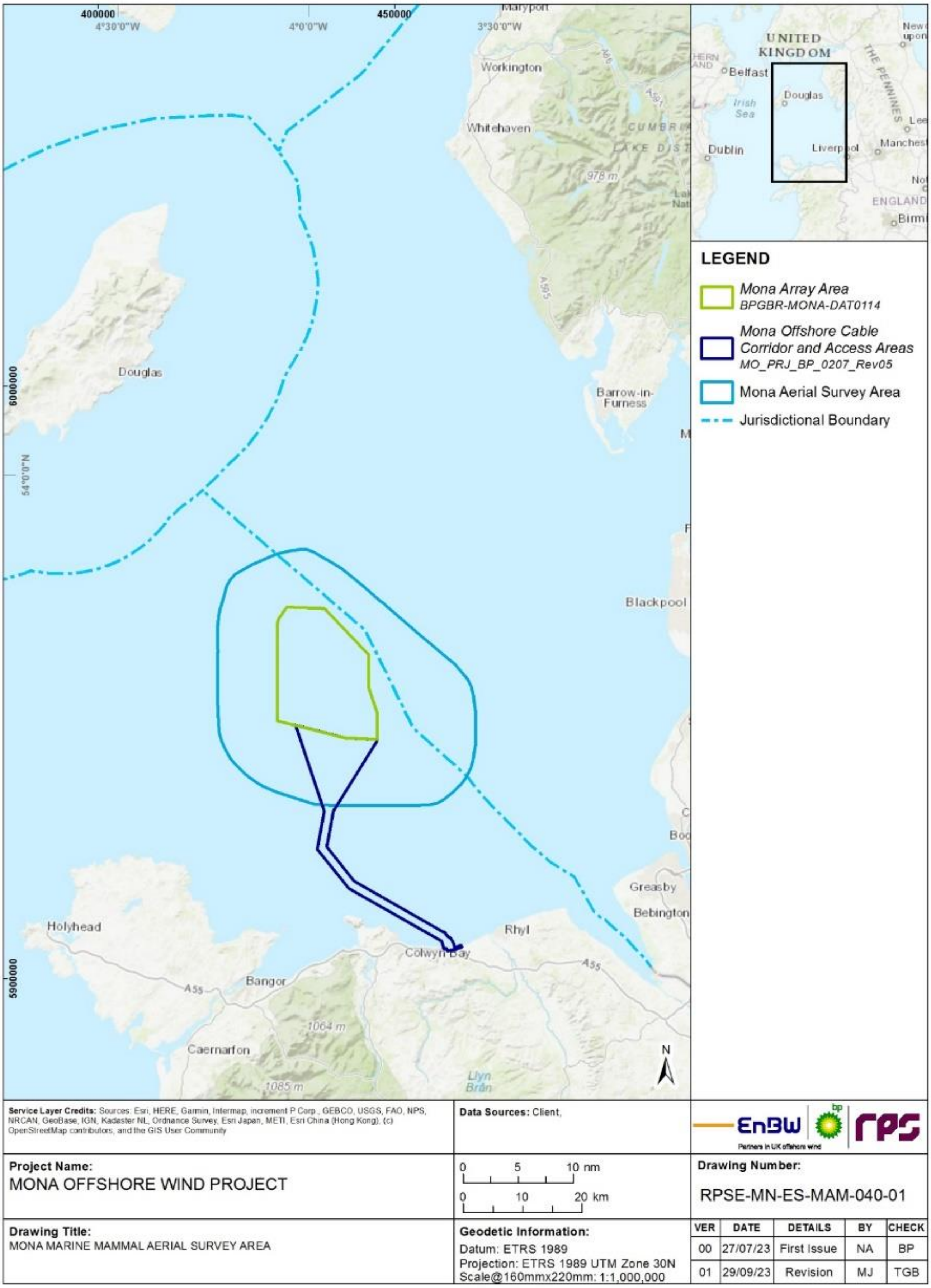


Figure 1.8 Mona marine mammal Aerial Survey Area from Mona Offshore Wind Ltd (2024).

1.5.6 Small Cetaceans in European Atlantic waters and the North Sea (SCANS) Surveys

SCANS-I, SCANS-II,SCANS-III and SCANS-IV survey extents

1.5.6.1 The main objective of Small Cetaceans in European Atlantic waters and the North Sea (SCANS) surveys was to estimate small cetacean abundance and density in the North Sea and European Atlantic continental shelf waters. The SCANS-I surveys were completed in 1994 (Hammond *et al.*, 2002), SCANS-II in July 2005 (Hammond *et al.*, 2013), SCANS-III in July 2016 (Hammond *et al.*, 2017; Hammond *et al.*, 2021) and SCANS-VI in September 2022 (Gilles *et al.,* 2023) all comprised vessel and aerial surveys. Both methodologies were designed to correct for availability and detection bias and allowed the estimation of absolute abundance for each of the blocks covered by the surveys.

1.5.6.2 SCANS-I surveys did not cover the Morgan Array Area but did cover the Celtic Sea to the south of the Morgan Generation Assets (Block A) (Hammond *et al.,* 2002) (Figure 1.9). The Morgan Array Area falls in the SCANS-II survey block O (Hammond *et al.,* 2013) (Figure 1.10) and SCANS-III survey area F (with survey block E adjacent) (Figure 1.11), and SCANS-IV block CS-E (Figure 1.12), all surveyed by aircraft.

1.5.6.3 The aerial transects in SCANS-II covered 15,802 km in good or moderate conditions in an area of 364,371 km^2 (Hammond *et al.*, 2013). For block O, the survey area was 45,417 km^2 with a total survey effort of 2,264 km.

1.5.6.4 In 2016, the SCANS-III aerial survey total search effort was 51,286.7 km and covered a surface area of 1,208,744 km^2 (Hammond *et al.*, 2021). Block F has a surface area of 12,322 km^2 with 619.8 km surveyed under primary effort whilst Block E has an area of 34,870 km^2, with 2,252.7 km surveyed under primary effort. The original SCANS-III data was published in the Hammond *et al.* (2017) report, which has been revised following the discovery of some analytical errors and the updated version Hammond *et al.* (2021) is used for the purpose of this study.

1.5.6.5 In 2022 the SCANS-IV aerial survey total search effort was 71,651.9km and covered a surface area of 1,467,358 km^2. The Morgan Generation Assets lies within block CS-E which has a surface area of 12,274 km^2, with 740.8 km surveyed under primary effort. Block CS D lies adjacent and has a surface area of 34,867 km^2, with 2,375.2 km surveyed under primary search effort. Both blocks were surveyed between 28 June and 15 August 2022.

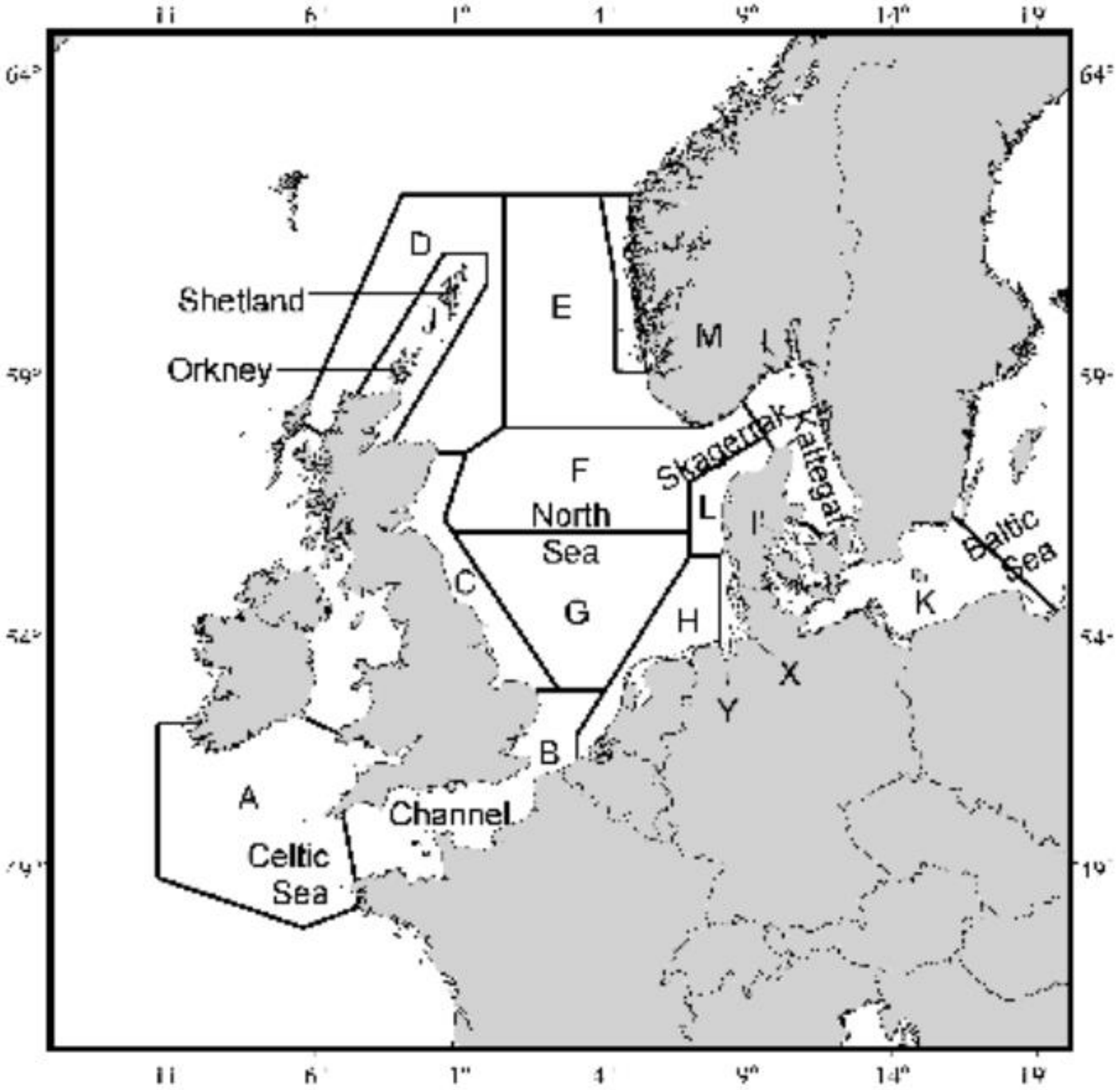


Figure 1.9: Area covered during the SCANS-I survey in 1994 (from Hammond *et al.,* 2002) (from Hammond *et al.,* 2002). The aerial transects in SCANS-II covered 15,802 km in good or moderate conditions in an area of 364,371 km^2 (Hammond *et al.,* 2013). For Block O, the survey area was 45,417 km^2 with a total survey effort of 2,264 km.

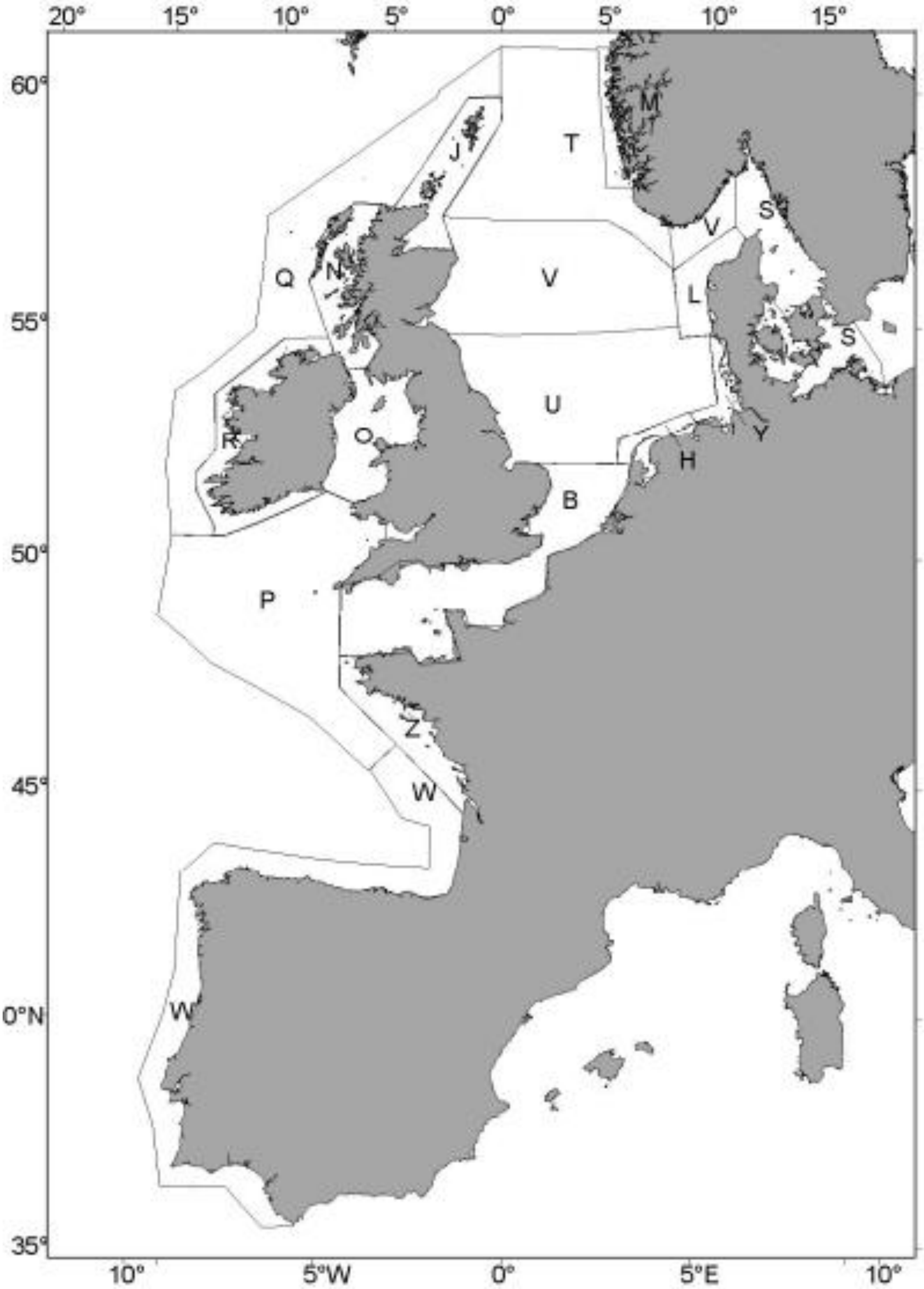


Figure 1.10: Survey blocks for SCANS-II surveys in 2005 (from Hammond *et al.,* 2013).

1.5.6.6 In 2016, the SCANS-III aerial survey total search effort was 51,286.7 km and covered a surface area of 1,208,744 km^2 (Hammond *et al.*, 2021). Block F has a surface area of 12,322 km^2 with 619.8 km surveyed under primary effort whilst adjacent Block E has an area of 34,870 km^2, with 2,252.7 km surveyed under primary effort. The original SCANS-III data was published in the Hammond *et al.* (2017) report, which has been revised following the discovery of some analytical errors; data from the updated version Hammond *et al.* (2021) is presented in this report.

1.5.6.7 SCANS-IV surveys were undertaken in July 2022, but the data is not available currently at the time of writing, for inclusion in this Environmental Statement.

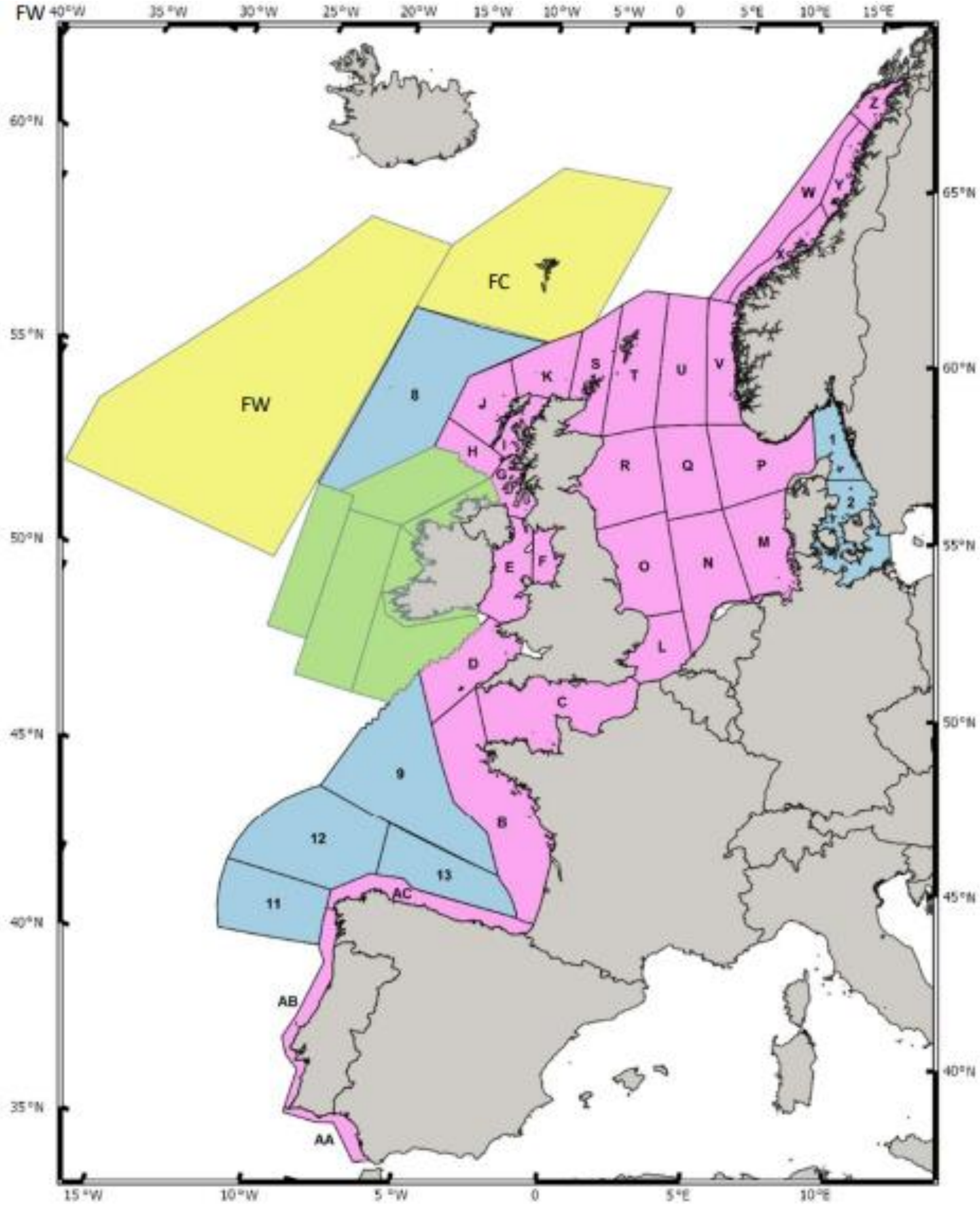


Figure 1.11: SCANS-III Blocks surveyed in 2016. Pink blocks surveyed by aerial surveys (from Hammond *et al.,* 2021).

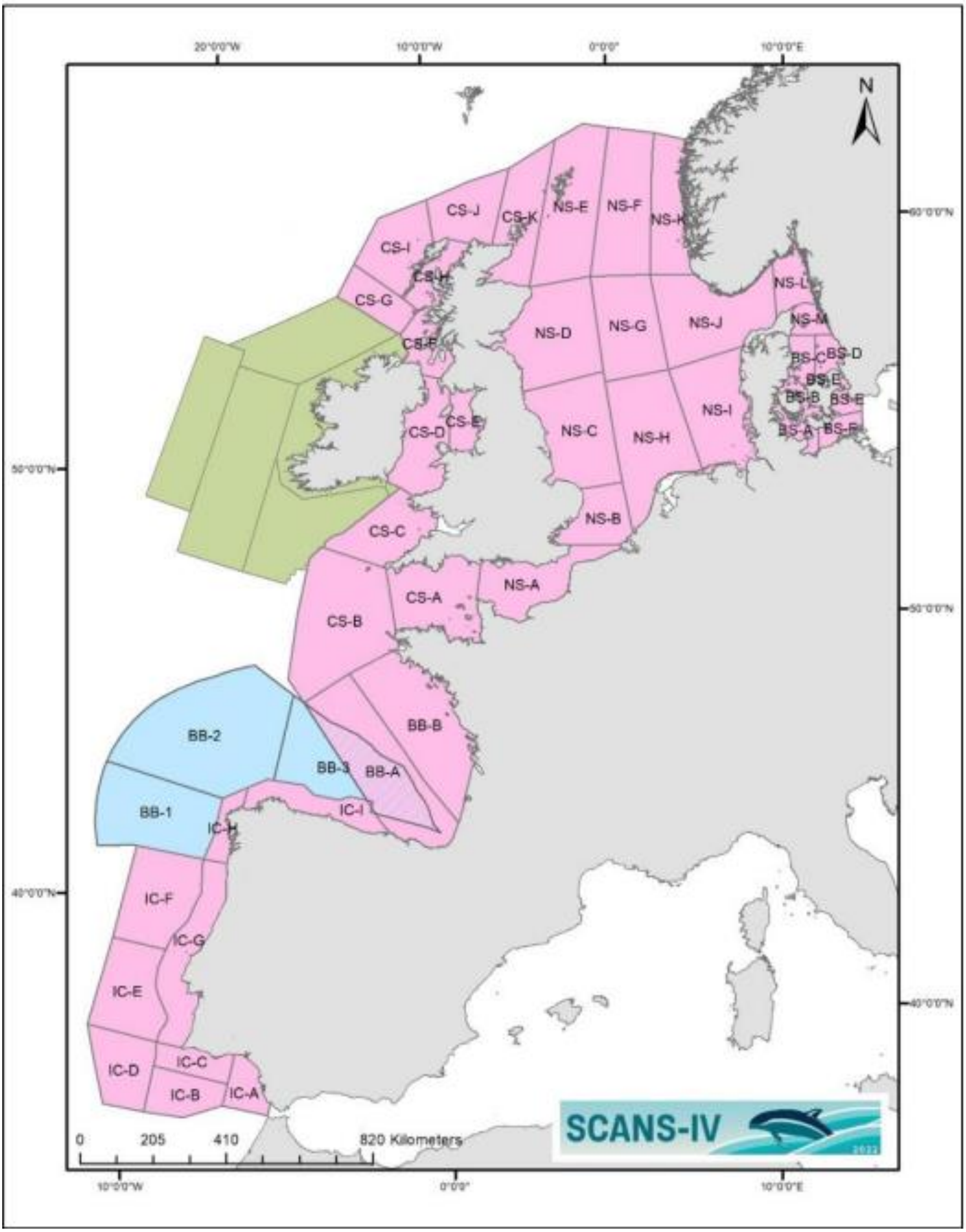


Figure 1.12: SCANS-IV blocks surveyed in 2022. Pink blocks surveyed by aerial surveys (from Gilles *et al.*, 2023).

SCANS-III density surface models (DSM)

1.5.6.8 Although a primary aim of SCANS-III was to provide robust large-scale estimates of cetacean abundance (*Hammond et al*., 2021), SCANS-III data was also used to provide information on summer distribution by modelling the data in relation to spatially linked environmental features to generate density surface maps. Lacey *et al.* (2022) presents density surface model (DSM) data for those cetacean species for which sufficient data were obtained during SCANS-III, which includes harbour porpoise, bottlenose dolphin, short-beaked common dolphin and minke whale. The cetacean data used in the analysis were the same as those used to obtain design-based estimates of abundance in Hammond *et al.* (2021).

1.5.6.9 The modelling used environmental covariates (which were selected as having the potential to explain additional variability in cetacean density) including depth, slope, aspect, distance from the coast, topography, sea level anomaly and sea surface temperature. The spatial resolution of the fitted models was approximately 10 km and the spatial resolution of the model predictions was 10 x 10 km cells.

1.5.6.10 Maps showing surfaces of predicted density and estimated CV of predicted density were produced for each species for SCANS-III, with patterns of predicted density influenced by model covariates, fitted smooth functions and spatial variation in the values of the covariates in the prediction grid. Lower CVs are generally associated with areas of higher density and thus confidence in predictions in areas of low density is poorer, with magnitude of CV influenced by model fit. To note, the density surfaces are for summer distributions only, as this is when SCANS-III was carried out. The maps allow density surfaces to be overlaid with the Morgan marine mammal study area for mean density outputs, discussed within relevant species sections (harbour porpoise section 1.7.2, bottlenose dolphin section 1.7.3, short-beaked common dolphin section 1.7.4 and minke whale section 1.7.6).

1.5.7 ObSERVE surveys

1.5.7.1 Aerial surveys were conducted between 2015 and 2017 in the offshore waters of Ireland, with the aim of investigating occurrence, distribution and abundance of key marine species (Rogan *et al.,* 2018). The surveys for cetaceans consisted of line-transects with observer effort concentrated within approximately 500 m either side of the aircraft. Nineteen species of cetaceans were sighted over two years, with 1,844 sightings.

1.5.7.2 The Morgan marine mammal study area is located closest to Stratum 5 (Figure 1.13) the only strata in the Irish Sea, which covers only the west Irish coastal waters of the Irish Sea (the ‘western Irish Sea’ stratum). Species-specific sightings, density distributions and abundance estimates were given for the entire survey area as well as by stratum and season. Per species, sightings were pooled over all strata and all seasons to fit a single detection function, rather than attempting to fit separate functions per season. This approach assumes that there are no regional, seasonal or inter-annual differences in observer ability or species behaviour in any of the strata flown.

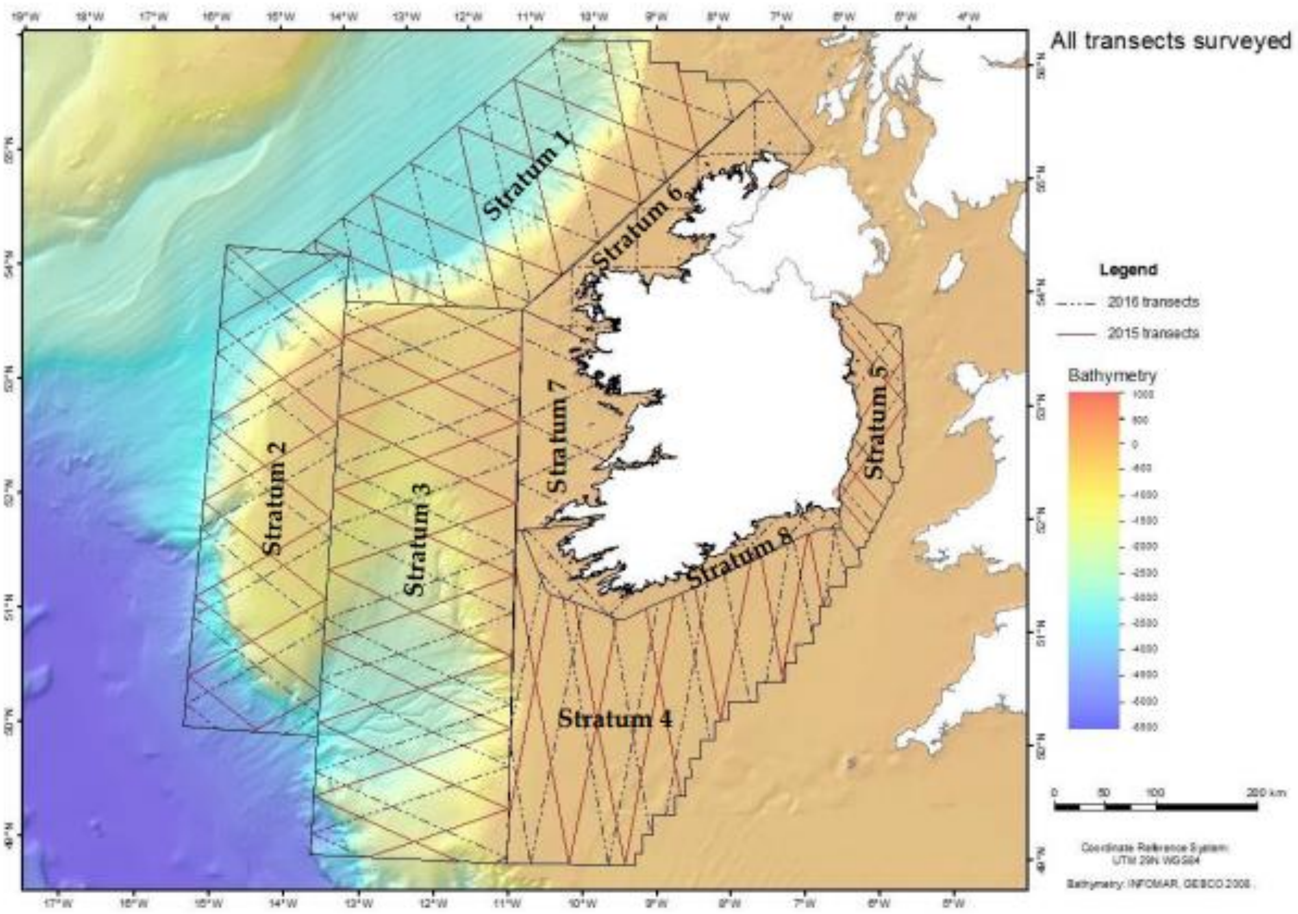


Figure 1.13: ObSERVE Aerial transect lines flown in summer and winter 2015 and 2016 (from Rogan *et al.,* 2018).

1.5.8 Inter-Agency Marine Mammal Working Group MUs

1.5.8.1 In 2015, the IAMMWG defined MUs for the seven most common cetacean species found in UK waters (IAMMWG, 2015): harbour porpoise, bottlenose dolphin, short-beaked common dolphin, white-beaked dolphin *Lagenorhynchus albirostris*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, Risso's dolphin and minke whale. Abundance estimates were calculated for each species within their respective MUs using the most recent data available at the time, notably estimates from the SCANS-II.

1.5.8.2 In an update to the 2015 IAMMWG report, the most recent abundance estimates for key marine mammal species in the UK and their MUs used the most up-to-date data available as of February 2021 (IAMMWG, 2022). The data was largely derived from SCANS-III (Hammond *et al.,* 2017) and the ObSERVE Programme (Rogan *et al*., 2018). The IAMMWG also reviewed information published since 2015 to determine if there was sufficient evidence to warrant a change to any of the MU boundaries (IAMMWG, 2023). All MUs for harbour porpoise, short-beaked common dolphin, Risso's dolphin and minke whale remain unchanged, and the Irish Sea (IS) MU for bottlenose dolphin remains unchanged.

1.5.9 Joint Cetacean Protocol (JCP) Phase III Analysis

1.5.9.1 The Joint Cetacean Protocol (JCP) Phase III analysis included 38 data sources, with data from at least 542 distinct survey platforms (ships and aircraft) conducted to estimate spatial and temporal patterns of abundance of seven species of cetacean over a 17-year period (1994 to 2010) (Paxton *et al.*, 2016). Approximately 1.09 million km^2 of effort is included, covering the region from 48° N to c. 64° N and from the continental shelf edge west of Ireland to the Kattegat in the east. Species of cetaceans included in the study were harbour porpoise, minke whale, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, white-beaked dolphin and Atlantic white-sided dolphin. Density surface models were used to predict species density over a fine scale grid of 25 km^2 resolution for one day in each season in each survey year. The data were divided into regions and seasonal estimates of abundance given for winter (January to March), spring (April to June), summer (July to September) and autumn (October to December).

1.5.9.2 The Morgan Generation Assets are situated within the 'Irish Sea' area of special commercial interest (which is different to the geographic region of the Irish Sea), covering an area of 8,227 km^2.

1.5.10 Phase One Data Analysis of Joint Cetacean Protocol Data

1.5.10.1 The JCP data resource (see paragraph 1.5.9.1) was initially utilised to fit density surface models for the Irish Sea area only (Paxton and Thomas, 2010). Using data compiled from surveys between 1980 and 2008 seasonal density surfaces estimates were successfully predicted for harbour porpoise, minke whale, bottlenose dolphin, short-beaked common dolphin and Risso's dolphin.

1.5.11 Joint Cetacean Data Programme

1.5.11.1 The Joint Cetacean Data Programme (JCDP) launched in 2022, aiming to collate existing cetacean monitoring datasets in the UK and wider northeast Atlantic waters. The data portal collates cetacean data collected at-sea via ship-based or aerial observer/digital methodologies. Datasets submitted are standardised to ensure commonality between datasets, according to the JDCP Data Standard. Publicly available data within the Irish Sea for the Environmental Statement at the time of writing only contained SCANS-II data, which is previously discussed in section 1.5.6.

1.5.12 JNCC Report 544: Harbour porpoise density

1.5.12.1 Heinänen and Skov (2015) conducted a detailed analysis of 18 years of survey data on harbour porpoise around the UK between 1994 and 2011 held in the JCP database. The goal of this analysis was to try to identify '*discrete and persistent areas of high density'* that might be considered important for harbour porpoise, with the ultimate goal of determining SACs for the species. The approach involved building predictive models using corrected sightings rates analysed with respect to topographic, hydrodynamic and anthropogenic covariates, to generate predicted distribution maps of density estimates for the waters around the UK. The analysis grouped data into three subsets: 1994 to 1999, 2000 to 2005 and 2006 to 2011 to account for patchy survey effort and analysed summer (April to September) and winter (October to March) data separately to explore whether distribution patterns were different between seasons.

1.5.12.2 Due to the uneven survey effort over the modelled period, there was a large degree of uncertainty in modelled distributions. Additionally, the analysis presented in Heinänen and Skov (2015) relied on extensive extrapolation of survey data over space and time. Any such extrapolation is sensitive to the covariates used in models and makes the assumption that these relationships hold outside of the surveyed areas.

1.5.13 JNCC Report: 543 Persistent high occurrence and abundance of harbour porpoise and bottlenose dolphin

1.5.13.1 A study by Evans *et al.* (2015) for JNCC analysed a long-term dataset of land-based observations from 1965 at 678 sites around the UK, with the aim to identify persistent high areas of abundance and occurrence for harbour porpoise and bottlenose dolphin. Over 74,000 hours of land-based watches and 50,000 sightings of bottlenose dolphin and harbour porpoise were observed from 678 sites around the UK coast. The modelled coastal distributions showed bottlenose dolphin are concentrated around west Wales and east Scotland, whilst harbour porpoise were much more evenly distributed. There was very little overlap between species.

1.5.14 Northeast Atlantic distribution maps (2020)

1.5.14.1 Waggitt *et al.* (2020) produced distribution maps of cetacean and seabird populations in the northeast Atlantic. The study collated 2.68 million km of diverse survey data between 1980 and 2018 to maximise spatial and temporal coverage. The study then used detection functions to estimate variation in the surface area covered among these surveys to standardise measurements of effort and animal densities. Finally, Species Distribution Models (SDMs) were used to predict comprehensive distribution maps of these taxa in the northeast Atlantic at 10 km resolution.

1.5.14.2 Twelve cetacean species were modelled which included harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin and minke whale. It is important to highlight that this study focused on the offshore ecotype of bottlenose dolphin to avoid confounding influences hindering the development of SDM for either ecotype, whilst the bottlenose dolphin found in the IS MU are the inshore ecotype.

1.5.15 Atlas of Marine Mammals of Wales (2012)

1.5.15.1 The Atlas of the Marine Mammals of Wales collected data from 16 projects to assess the distribution of marine mammals in the Irish Sea (St George's Channel and greater part of the Bristol Channel) (Baines and Evans, 2012). The database comprised of 216,031 km of effort from vessel and aerial surveys and 13,399 hours of land-based effort, spanning 20 years from 1990 to 2009. The project database comprised 32,986 cetacean sightings totalling 99,085 individuals of 12 species (harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, minke whale, fin whale *Balaenoptera physalus*, white-beaked dolphin, Atlantic white-sided dolphin, long-finned pilot whale *Globicephala melas*, humpback whale *Megaptera novaeangliae* and northern bottlenose whale *Hyperoodon ampullatus*). Whilst the database has good broad scale information on the distribution of marine mammals in Irish waters, it has several limitations. The data is between 11 and 30 years old and the authors state that survey coverage was inadequate in all but a few areas.

1.5.16 Welsh Marine Mammal Atlas (2023)

1.5.16.1 A new version of the Atlas of the Marine Mammals of Wales (hereafter known as the Welsh Marine Mammal Atlas) was commissioned by Natural Resources Wales (NRW) in 2020 and maps marine species distribution and abundance using habitat-based modelling (Evans and Waggitt, 2023). Modelled densities were provided at 2.5 km^2 resolution for those species sufficiently common enough to allow robust modelling, which included five cetacean species (harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin and minke whale) and 13 seabird species.

1.5.16.2 Densities were derived from vessel, aerial visual and aerial digital observation platforms between 1990 and 2020. Data were collated and analysed for an area encompassing the Irish Sea, Bristol Channel and the area of the Celtic Sea commonly referred to as the 'Celtic Deep', south as far as due west of the Isles of Scilly (approximately 50° north).

1.5.16.3 Sightings rates were also determined for the more common species (given in paragraph 1.5.16.1) as well as the less common cetaceans and birds. These included striped dolphin *Stenella coeruleoalba*, white-beaked dolphin, Atlantic white-sided dolphin, killer whale *Orcinus orca*, long-finned pilot whale, fin whale and humpback whale.

1.5.16.4 Evans and Waggitt (2023) recommended that distribution patterns are taken from the full 30-year data set, and the report subsequently provided an annual composite map for each species showing the maximum density whenever it occurred over the 30 years of data for each cell. Alongside these maximum densities, the report also provided monthly and seasonal (by quarter) density maps for each species. To adopt a precautionary approach, and further to the advice from NRW during the EWG consultation for the Morgan Generation Assets, the average density estimates for the Morgan marine mammal study area were taken from the maximum density maps. Therefore, estimates are highly precautionary as this is the highest value observed for each cell (2.5 km^2 resolution) at any one point in time.

1.5.17 Special Committee on Seals

1.5.17.1 Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) provides scientific advice to government on matters related to the management of seal populations through the advice provided by the SCOS. SMRU provides this advice to SCOS on an annual basis through meetings and an annual report. The report includes advice on matters related to the management of seal populations, including general information on British seals, information on their current status, and addresses specific questions raised by regulators and stakeholders. The most recent publicly available SCOS report is SCOS, 2021 which presents the data collected up to 2020.

1.5.18 SMRU Seal Surveys

1.5.18.1 SMRU carries out surveys of harbour seal and grey seal in Scotland and on the east coast of England to contribute to the NERCs statutory obligation under the Conservation of Seals Act 1970 through provision of scientific advice on matters related to the management of seal populations to the UK Government. SMRU surveys, as well as surveys by a number of other organisations (including NatureScot, Natural England, the Countryside Council for Wales, the National Trust and the Lincolnshire Wildlife Trust) form the routine monitoring of seal populations around the UK.

1.5.18.2 Seals are widely distributed around the UK coast and most surveys are carried out from the air by either light aircraft or helicopter. All surveys are of seals that are hauled-out on shore and it is possible to differentiate between the two species using their thermal profiles and their group structure on shore. On account of differences in the breeding behaviour of harbour and grey seal the two species are surveyed at different times in their annual cycle. While grey seal are counted on all harbour seal surveys, harbour seal are very rarely seen on any of the grey seal breeding colony surveys.

1.5.18.3 A SMRU report was commissioned to support the baseline assessment for the Morgan Generation Assets (Wright and Sinclair, 2022). The report presents information and telemetry data that SMRU holds for the four seal management units that span the Irish Sea (12 Wales, 13 NW England, 14 Northern Ireland and 1 SW Scotland) (to note they do not have any available data for the Isle of Man region). The following sections provide a brief account of the surveys carried out for seals and the data is presented in Appendix B.

Haul-out surveys and grey seal pup counts

Harbour seal

1.5.18.4 Harbour seal tend to be dispersed when breeding and, to an extent, aggregate when moulting so the main harbour seal surveys are carried out during their annual moult in August (further details of survey methods are given in Appendix B). The moult counts obtained represent the number of harbour seal that were on shore (not those in the sea at time of survey) at the time of the survey and are an estimate of the minimum size of the population. Harbour seal count data from August moult census surveys were available from 1996 to 2019.

1.5.18.5 SMRU also conducts surveys of harbour seal during the breeding season in June and July in only a small number of areas. There were no harbour seal breeding surveys conducted in the regional marine mammal study area.

Grey seal

1.5.18.6 Grey seal counts are obtained from the same August harbour seal moult surveys, but during August grey seal distribution is highly variable, and these counts are a snapshot of local summer distribution but are not a reliable census of population size. These data do, however, provide useful information on the summer and non-breeding season distribution of grey seal.

1.5.18.7 Grey seal aggregate at traditional colonies when breeding during the autumn and early winter months. Main breeding colonies are therefore surveyed annually between mid-September and late November to estimate the numbers of grey seal pups born at each colony although since 2010 most colonies switched to biennial surveys. The grey seal pup production database contains data from 1989 to 2019 and includes 74 breeding colonies (though not all colonies have been surveyed since 1989 and some smaller colonies are surveyed more sporadically than others).

1.5.18.8 There are no regularly monitored grey seal breeding colonies within the Southwest Scotland MU. In Wales, grey seal are counted using aerial, ground and vessel-based surveys due to hauling out in caves and ‘cryptic habitats’. NRW monitors grey seal partly through the maintenance of the Irish and Celtic Sea database for grey seal, named EIRPHOT. In Northwest England MU, The Cumbria Wildlife Trust and Walney Bird Observatory record grey seal haul-out counts at South Walney and have provided SMRU with counts at low tide since 2015. The area has been considered a pupping site since 2015. In Northern Ireland, The National Trust monitors the grey seal haul-outs at Strangford Lough.

1.5.19 Seal Telemetry Data

1.5.19.1 SMRU has deployed telemetry tags on grey seal and harbour seal in the UK since 1988 and 2001, respectively. The telemetry tags transmit data on seal locations with the tag duration (number of days) varying between individual deployments. Telemetry data are particularly useful as they provide information on seal movement patterns away from their haul-out sites, provide data on the foraging behaviour of seals at sea and demonstrate connectivity between areas.

1.5.19.2 There are data from two types of telemetry tag, which differ by their data transmission methods. Data transmission can be through the Argos satellite system (Argos tags) or GPS phone tags which combine GPS quality locations with transmission of data using the Global System for Mobile communication (GSM) phone network. These methods are described in more detail in Appendix B.

1.5.19.3 Telemetry data presented in this report draws on the SMRU commissioned study (Wright and Sinclair, 2022), which presents an analysis of existing satellite data to describe the movements of harbour and grey seal within the four MUs (Northwest England, Wales, Southwest Scotland and Northern Ireland) that cover the regional marine mammal study area (Appendix B). SMRU does not hold any telemetry data for the Isle of Man. A 100 km buffer region for grey seals and 50 km buffer region for harbour seal is used to determine connectivity with the Morgan Generation Assets, based upon average foraging ranges for the two species (SCOS, 2018; Russell and McConnell, 2014).

1.5.20 Seal Usage Maps

1.5.20.1 Carter *et al*. (2022) have produced the most recent revised estimated at-sea distribution usage maps for both grey and harbour seal based on habitat association modelling. The study uses an extensive high-resolution GPS tracking dataset containing 114 grey and 239 harbour seal to model habitat preference and generate at-sea distribution estimates for the entire UK and Ireland populations of both species. Previous studies predicted seal distribution, but no study has previously used habitat preference to generate distribution estimates for the whole of the UK and Ireland. Given the regional differences in population dynamics (Thompson *et al.,* 2019, Thomas *et al*., 2019), diet (Gosch *et al.,* 2019, Wilson and Hammond, 2019) and foraging trip characteristics (Huon *et al.*, 2021) updated distribution estimates were required for the entire populations for both species, based on regional habitat preference.

1.5.20.2 Past usage maps (Russell *et al*., 2017) contained telemetry data from 270 grey seal and 330 harbour seal tagged within the UK only and incorporated count data between 1996 and 2015. The subsequent Carter *et al.* (2020) maps incorporate an additional 100 GPS telemetry tags deployed on grey seal at sites where recent tracking data were lacking.

1.5.20.3 Carter *et al.* (2022) at sea usage maps represent the number of grey and harbour seal estimated to be in the water in each 5 x 5 km grid cell at any given time, based upon habitat-based models. Values in the Carter *et al.* (2022) report were presented as spatial predictions of relative density, but absolute densities can be calculated based on population scalars presented in the Supplementary material (S7.4) of Carter *et al. (*2022). There were previous concerns about accuracy of scalars used for previous at-sea usage maps (Russell *et al*., 2016; Lonergan *et al*., 2013), but updated scalars for Carter *et al*. (2022) were derived from telemetry data. The overall UK and Ireland population size was estimated using the first scalar (the total number of seals counted on most recent surveys was assumed to represent 72% of the harbour seal population, and 25.15% of the grey seal population (SCOS, 2021)) and this was converted to the at-sea population using the second scalar, which is the mean percentage of time spent at-sea during the season (82.36% for harbour seal and

86.16% for grey seal (SCOS, 2021)). Carter *et al*. (2022) acknowledges that the scalars used do not reflect regional variation in seal behaviour and scalars are given as population mean estimates, and thus there is uncertainty around these estimates.

1.5.20.4 Given the above, results of the analysis of densities presented in Carter *et al*. (2022) are to be taken as approximate estimates, rather than definitive numbers.

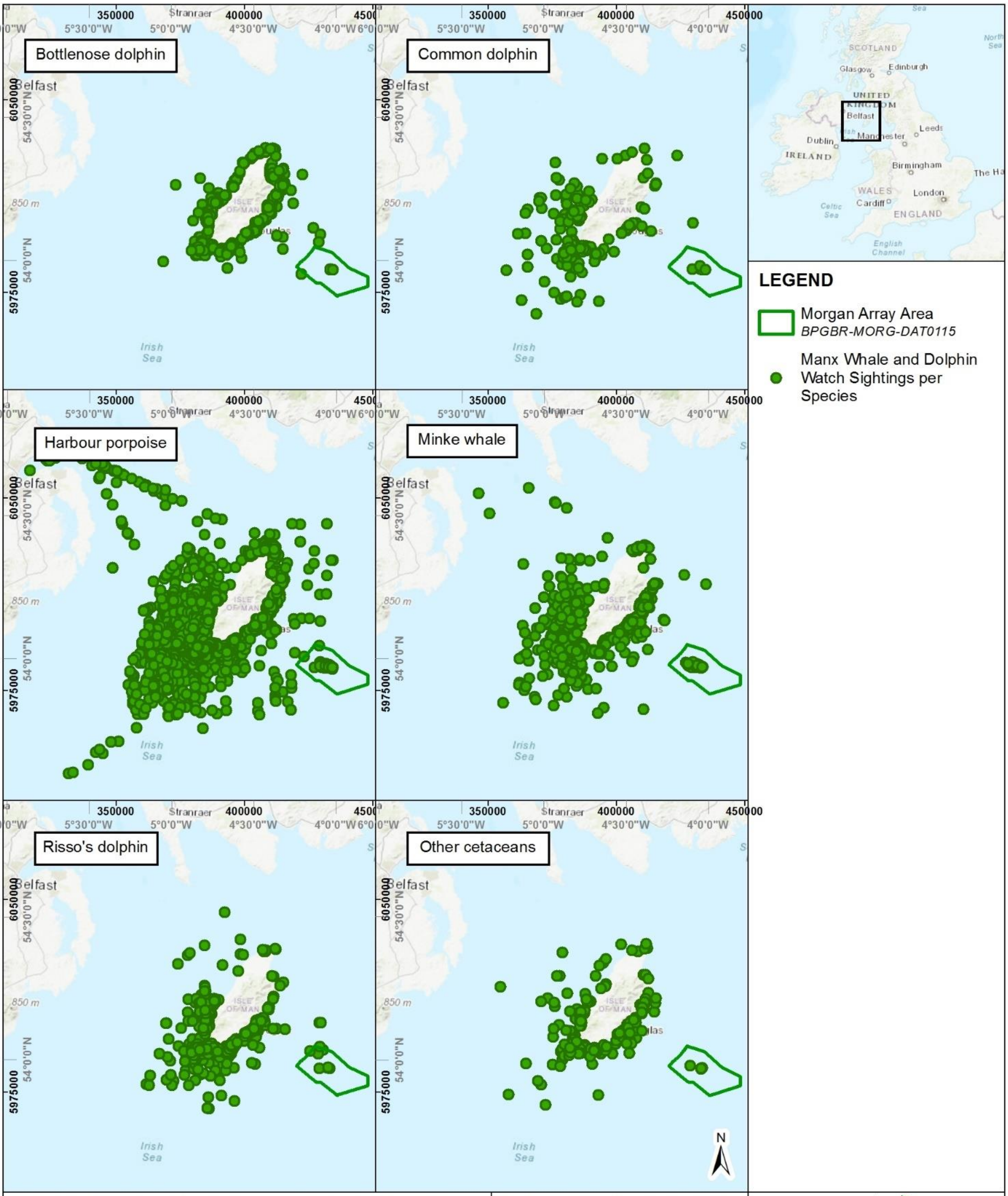
1.5.21 Manx Whale and Dolphin Watch (MWDW) surveys

1.5.21.1 The MWDW have conducted vessel-based marine mammal surveys throughout Manx territorial waters, with 88 trips carried out between 2007 and 2021 to survey cetaceans. This totalled 11,975.3 km of surveys, most of which were conducted in the summer months between May and September. Harbour porpoise, short-beaked common dolphin, bottlenose dolphin, Risso’s dolphin and minke whale were reported during these surveys. There were 961 cetacean sightings, of which 769 were of harbour porpoise (80%) (Manley, 2021; 2020; 2019; Clark *et al.,* 2019; 2018; 2017; Felce and Adams, 2016; Felce, 2015). The most recent report (Manley, 2021) presents data for 2021 surveys (including trips on vessels of opportunity) conducted between May and September, surveying 346 km. Harbour porpoise were the most observed cetacean species as in previous years, representing 36 (75 individuals) of the 47 cetacean sightings.

1.5.21.2 Effort-based land surveys have also been carried out since 2006, at seven survey sites, throughout the year when the sea state is Beaufort scale 3 or less and data is presented as cetacean-positive intervals (15-minute interval where a cetacean is sighted). Data includes species, total number of individuals in the group, group composition, behaviour, direction of movement and distance and angle of the group from the observers. Species observed included harbour porpoise, Risso’s dolphin, bottlenose dolphin, short-beaked common dolphin and minke whale and the highest sighting rates for cetaceans were July and August.

1.5.21.3 Public sighting data is also available by MWDW, with sightings reported from 2006 to 2015. This data is opportunistic from various platforms such as boat or land and lacks information on survey effort and environmental conditions. Species reported includes bottlenose dolphin, short-beaked common dolphin, Risso’s dolphin, minke whale and harbour porpoise.

1.5.21.4 Opportunistic and effort based sighting data from 2006 to 2022 was requested from MWDW for harbour porpoise, bottlenose dolphin, Risso’s, common dolphin, and minke whale and is presented in Figure 1.14. Harbour porpoise were sighted as recently as 2022 (14/01/2022), and 409 were sighted in 2021. For other species, 7,164 of bottlenose dolphin, 703 short-beaked common dolphin, 338 Risso’s dolphin and 45 minke whale were sighted in 2021 (MWDW, 2022). Other cetaceans such as fin whale and humpback whale have been recorded in MWDW datasets.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Manx Whale and Dolphin Watch

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

Drawing Number:
RPSE-MG-ES-MAM-017-00

Drawing Title:
MWDW DATA FROM 2006 TO 2022 FOR HARBOUR PORPOISE, BOTTLENOSE DOLPHIN, RISSO'S DOLPHIN, COMMON DOLPHIN, AND MINKE WHALE (MWDW, 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

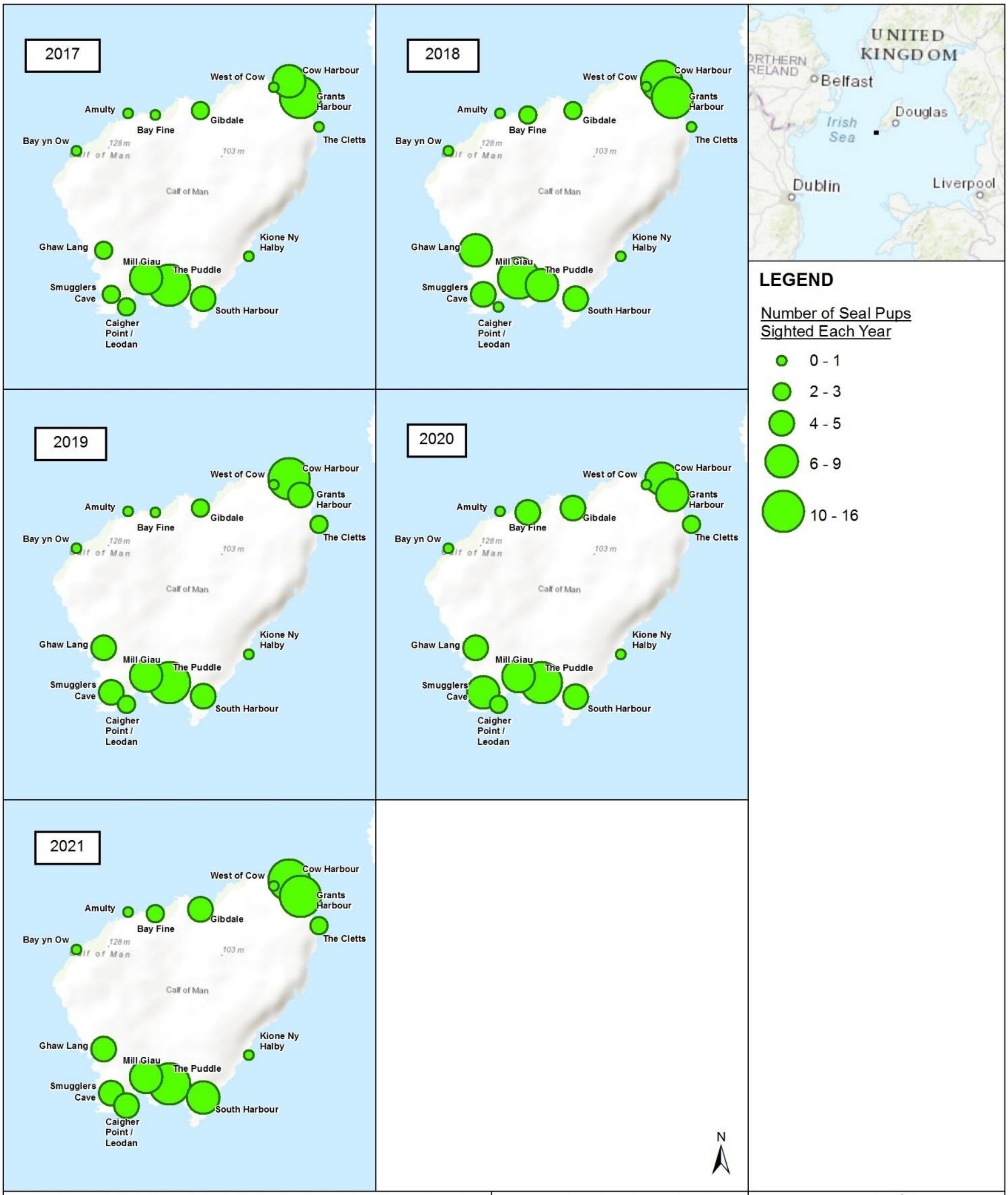
VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	BP

Figure 1.14: MWDW data from 2006 to 2022 for harbour porpoise, bottlenose dolphin, Risso's, short-beaked common dolphin and minke whale. Data requested from MWDW (2022).

1.5.22 Manx Wildlife Trust

1.5.22.1 Manx Wildlife Trust (MWT) holds data on seal species around the Isle of Man. Data was provided by MWT for seal pup surveys carried out annually on the Calf of Man (2017 to 2021) (Figure 1.15). They also provided opportunistic land sightings from 2017 to 2022 (Figure 1.16) and a dedicated seal haul out survey in 2017 (Figure 1.17) for the Isle of Man.

1.5.22.2 For the Calf of Man surveys, for the six weeks of each pupping season, two seal surveyors were based on the Calf of Man to complete observational surveys of seal pup numbers and general grey seal abundance at 12 sites around the island.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Manx Wildlife Trust

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 0.25 0.5 nm
0 0.5 1 km

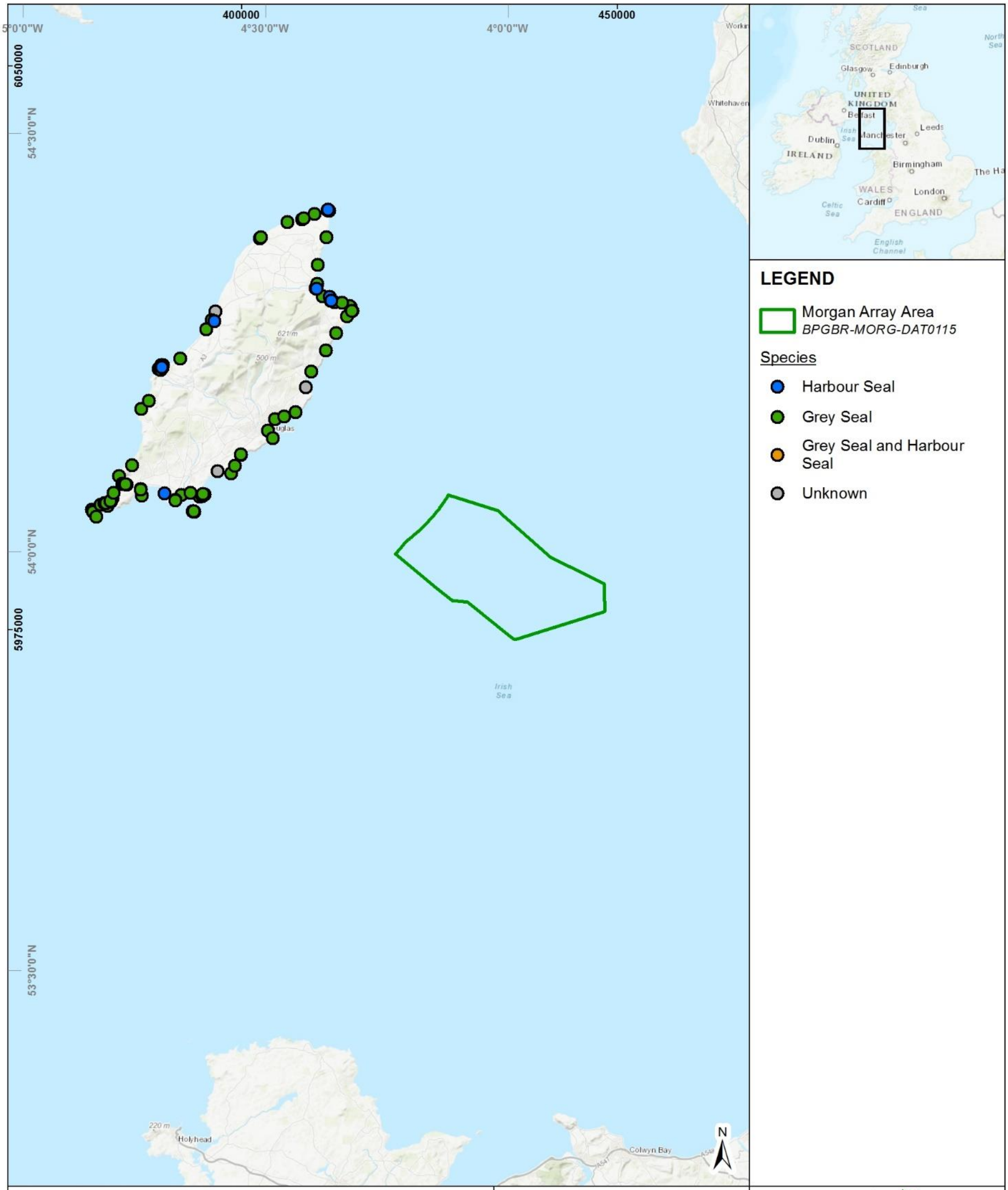
Drawing Number:
RPSE-MG-ES-MAM-018-00

Drawing Title:
SEAL PUP DATA FROM MWT, FROM 2017 TO 2020 FOR THE CALF OF MAN (MWT, 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:49,500

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	BP

Figure 1.15: Seal pup data from MWT, from 2017 to 2020 for the Calf of Man (MWT, 2022).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Manx Wildlife Trust

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 2.5 5 10 nm
0 5 10 20 km

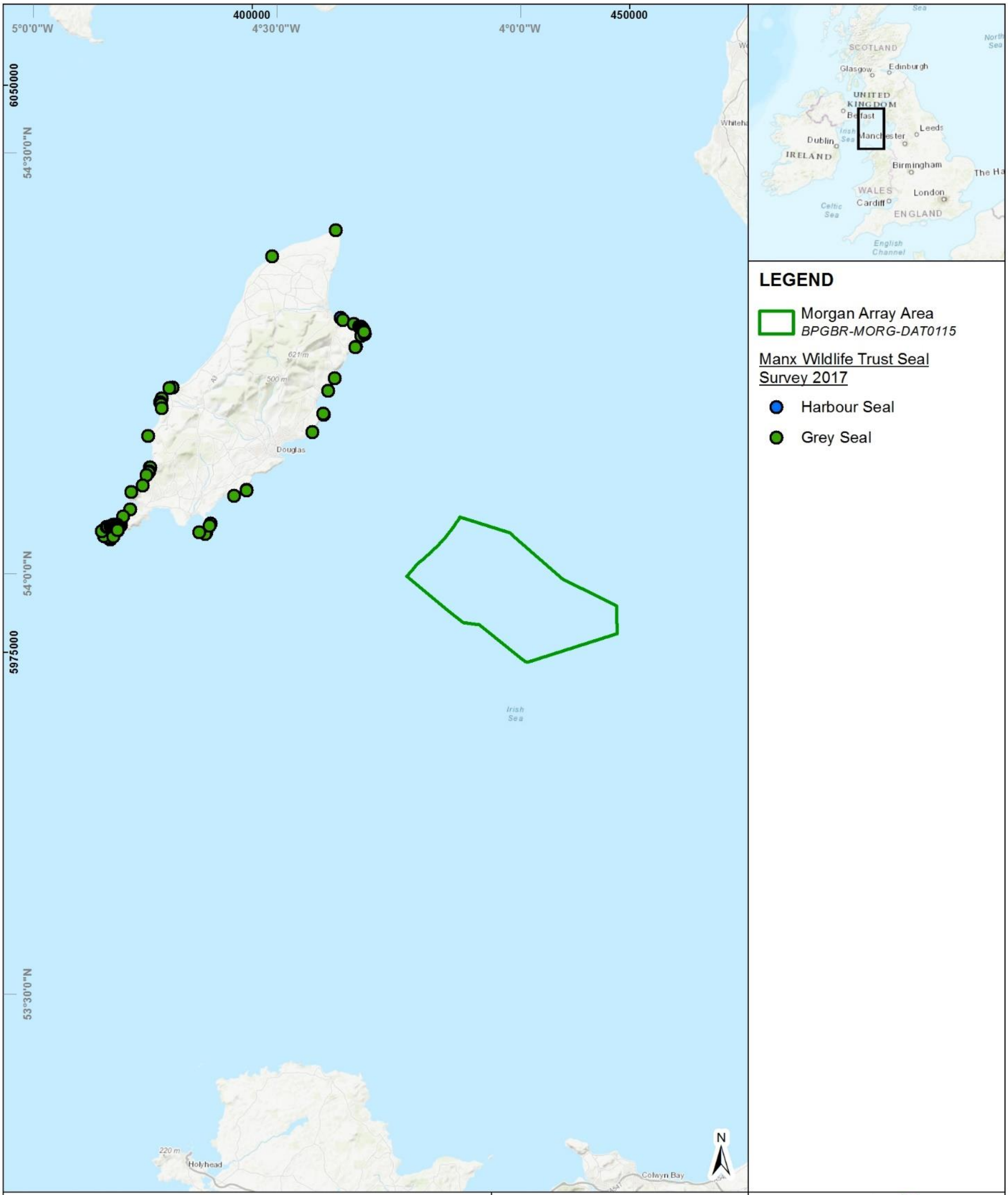
Drawing Number:
RPSE-MG-ES-MAM-019-00

Drawing Title:
SEAL (GREY AND HARBOUR) SIGHTINGS FROM 2017 TO 2022 AROUND THE ISLE OF MAN (MWT, 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:850,000

VER	DATE	DETAILS	BY	CHECK
00	13/07/23	First Issue	NA	BP

Figure 1.16: Grey seal and harbour seal sightings from 2017 to 2022 around the Isle of Man (MWT, 2022).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Manx Wildlife Trust

Partners in UK offshore wind

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 2.5 5 10 nm
0 5 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-020-00

Drawing Title:
2017 SEAL SURVEY DATA FROM MWT (2022).
HARBOUR SEAL AND GREY SEAL

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:850,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	BP

Figure 1.17: Grey seal and harbour seal survey data, 2017 (MWT, 2022).

1.5.23 Walney Nature Reserve

1.5.23.1 Cumbria Wildlife Trust provided data on grey seal counts at South Walney Nature Reserve from 1981 to 2023 (Cumbria Wildlife Trust, 2023). South Walney is the only known grey seal breeding site in the Northwest SMU (SCOS, 2021). Surveys are undertaken every two weeks from September to March, with highest numbers usually seen in late January and February. Pups are usually born on the reserve from mid-September to mid-October. An increase in seals has been observed at Walney Nature Reserve (Figure 1.18).

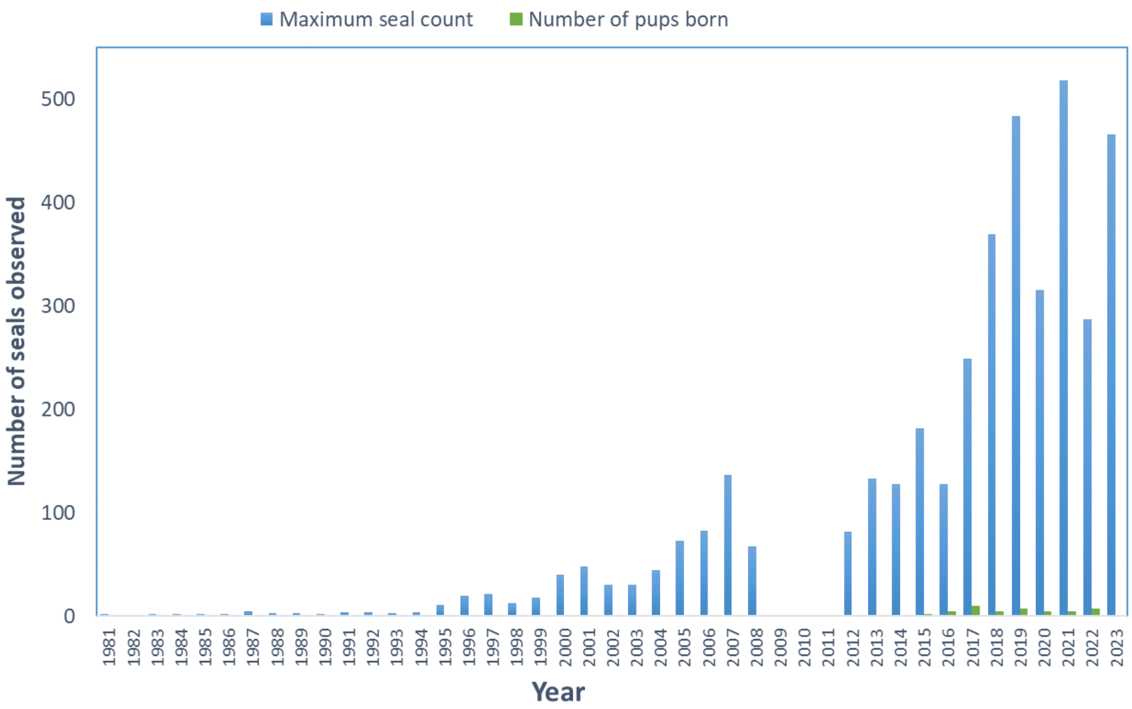


Figure 1.18: Historical maximum count data from South Walney Nature Reserve for maximum seal count observed during annual surveys between September to March (blue) and number of pups born per year (green). Data from Cumbria Wildlife Trust (2023).

1.5.24 Anglesey-based surveys

1.5.24.1 Several studies have been conducted off the coast of Anglesey. A three year research study to estimate abundance and density of harbour porpoise off the north coast of Anglesey was carried out between May and September in the years 2002 to 2004 (Shucksmith *et al.,* 2009) (Figure 1.19). Abundance and densities were estimated using distance-based sampling techniques but were limited to summer only estimates for coastal waters. Porpoise densities were highest at Point Lynas and South Stack.

1.5.24.2 A project on behalf of the Welsh Government was undertaken to research marine mammals at tidal rapid sites in Wales between Autumn 2009 and 2010, and to collect data relevant to assessing risks if tidal turbines were installed at these sites (Gordon *et al.,* 2011). Study sites were off the Skerries and South Stacks in northwest Anglesey and Pembrokeshire. This was conducted using visual and acoustic surveys and visual observations from shore. A telemetry study of grey seal using high resolution fastloc

GPS and depth tags was also carried out. Tags were attached to newly weaned pups at breeding beaches close to tidal rapid sites in the autumn of 2009 and 2010. The majority of visual sighting data was harbour porpoise, with a few bottlenose dolphin and short-beaked common dolphin encounters, and grey seal sighted. Towed acoustic surveys showed that porpoise densities were high in both study areas, whilst substantial numbers of short-beaked common dolphin were also detected visually and acoustically in the study area off the Bishops and Clerks west of Pembrokeshire. The telemetry study suggested young seals are making extensive use of high tidal current areas around their breeding beaches.

1.5.24.3 Several surveys are available for informing baselines for projects Horizon Nuclear Power Wyldfa Newydd Project and Morlais Demonstration Zone (MDZ). Around the north of Anglesey, visual boat-based line-transect surveys were undertaken between 2016 and 2017 (21 surveys across 14 months) to give abundance and density estimates to inform the baseline characterisation for the Horizon Nuclear Power Wylfa Newydd Project (Jacobs, 2018). Between May and August 2016 marine mammal sightings were recorded by trained European Seabirds at Sea (ESAS) surveyors, however after this the methodology was altered to include dedicated MMOb providing continuous survey effort and recording bearings and distances to sightings.

1.5.24.4 For the baseline for MDZ, boat-based dedicated visual marine mammal surveys were carried out by Natural Power (24 surveys between November 2016 and October 2018) and additional boat and acoustic surveys targeting marine mammals were carried out by Sustainable Expansion of Applied Coastal and Marine Sectors Project (SEACAMS) (18 surveys between Jan 2015 and Dec 2016). The surveys targeted the MDZ area off the west of Holy Island (Figure 1.20). Harbour porpoise, bottlenose dolphin, Risso’s dolphin and grey seal were observed during the surveys.

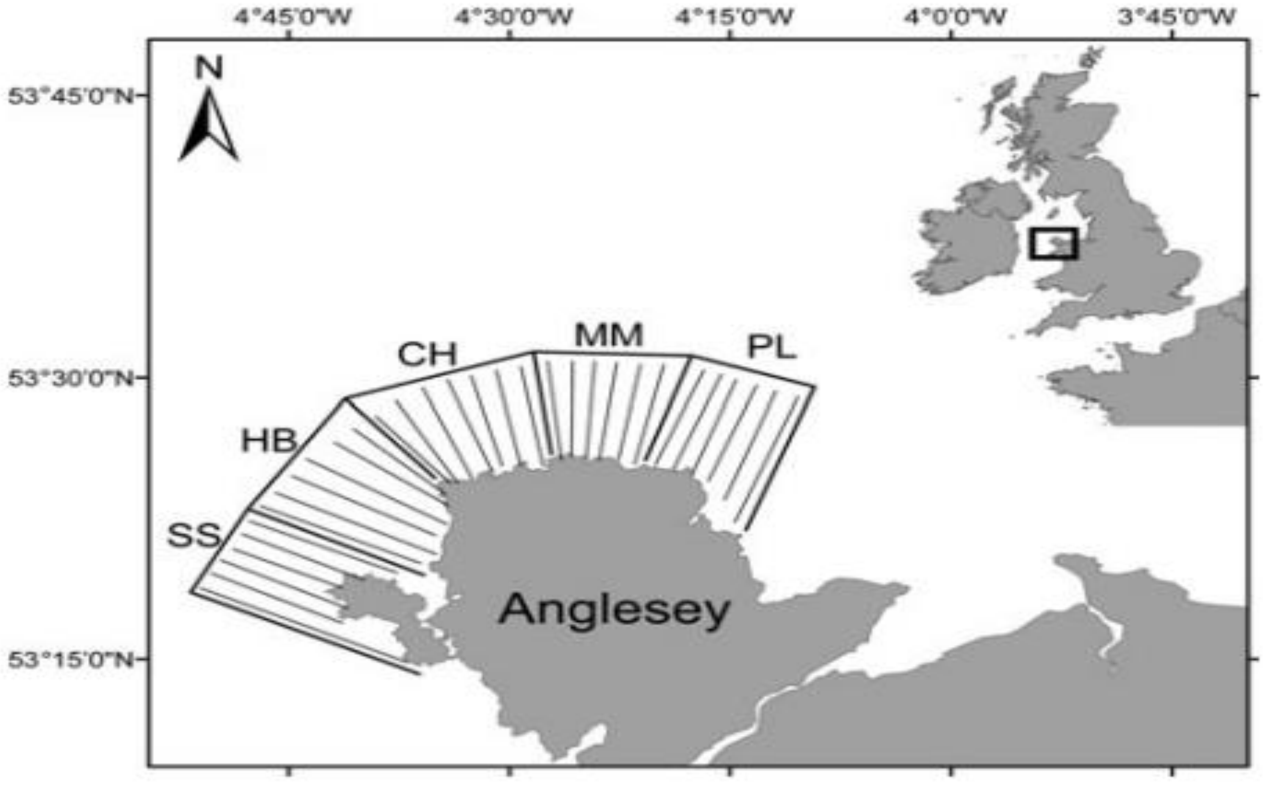


Figure 1.19: The study area of north coast of Anglesey split in to the five sectors with the transect lines (from Shucksmith *et al.,* 2009).

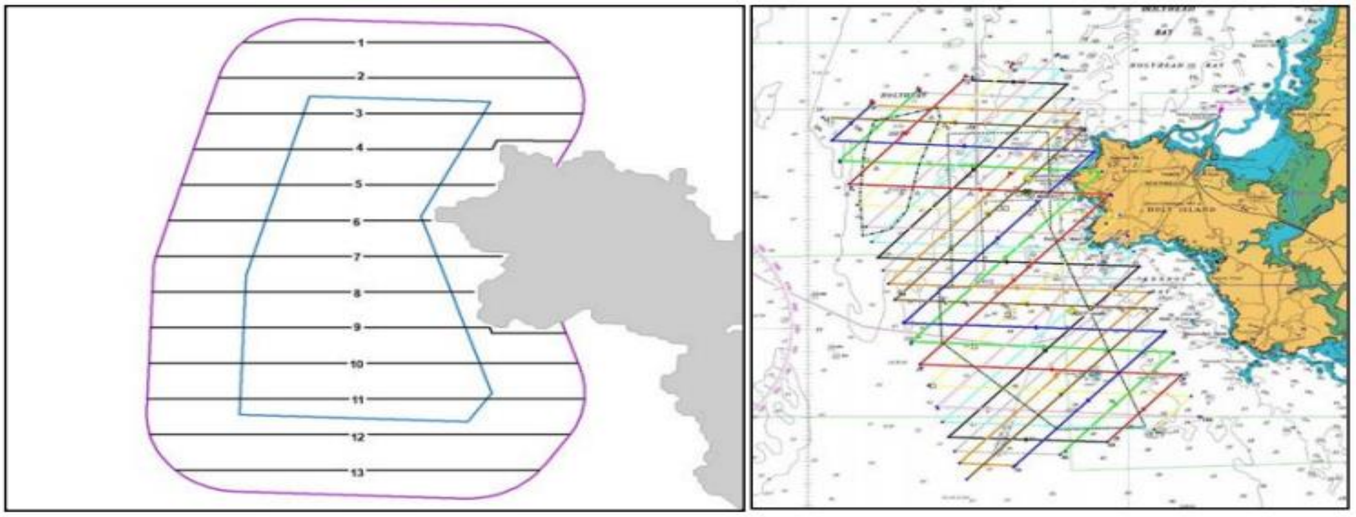


Figure 1.20: Survey transects for MDZ (from Royal Haskoning DHV, 2019).

1.5.25 Cardigan bay surveys

1.5.25.1 Cardigan Bay has been a focus of research for bottlenose dolphin and harbour porpoise due to known high densities of both species within this region. Cardigan Bay is in the southwest of the Irish Sea, to the south of the Morgan Generation Assets. Sea Watch Foundation (SWF) carried out research work on behalf of the CCW to investigate abundance and life history of bottlenose dolphin in Cardigan Bay. Seventy-six line boat-based transect surveys specifically targeting marine mammals were carried out in Cardigan Bay between April 2005 and December 2007. These were used to calculated abundance estimates for bottlenose dolphin and harbour porpoise (Pesante *et al.,* 2008), but grey seal were recorded in surveys also.

1.5.25.2 Subsequently in 2011, Veneruso and Evans (2012) carried out another research study for CCW to monitor bottlenose dolphin and harbour porpoise populations in Cardigan Bay, to provide preliminary information on the condition of both species in Cardigan Bay and Pen Llŷn a’r Sarnau SACs. Fifteen line-transect boat surveys were carried out in 2011 using a distance sampling approach covering 1993km, as well as dedicated *ad libitum* surveys between May and July 2011 covering 1,706 km in Cardigan Bay SAC.

1.5.25.3 Further field research by SWF, for NRW, was carried out between 2011 and 2013 to provide information on the condition of bottlenose dolphin and harbour porpoise in Cardigan Bay including both the Cardigan Bay and Pen Llŷn a’r Sarnau SACs and offshore areas (Feingold and Evans, 2014). Dedicated line-transect boat surveys were carried out in Cardigan Bay between July and October 2011, and between April and October in 2012 and 2013. A total of 83 line-transect surveys were conducted, amounting to over 10,000 km of effort in favourable conditions and abundance was estimated for bottlenose dolphin and harbour porpoise in Cardigan Bay SAC and all of Cardigan Bay.

1.5.25.4 A later study on connectivity within and beyond Cardigan Bay SAC by bottlenose dolphin (Duckett, 2018) used SWF data (encounters and individual photo ID records) from 2006 to 2018 to report on the status of individuals in North Wales, and to compile information to advise policymakers on the potential creation of an additional SAC in North Wales.

1.6 Baseline environment

1.6.1 Legislation and conservation designations

Legal framework

1.6.1.1 The Applicant entered into agreement for lease for the Morgan Generation Assets in early 2023 through the Offshore Wind Leasing Round 4 process.

1.6.1.2 The regional marine mammal study area includes SACs designated for marine mammals. SACs are protected areas in the UK, designated under the Conservation of Habitats and Species Regulations 2017 in England and Wales (including the adjacent territorial sea). In Scotland the European Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, known as the Habitats Directive, is translated into legal obligations by the Conservation (Natural Habitats, etc.) Regulations 1994; updated in 2019 as a result of the UK leaving the EU. In Northern Ireland, to ensure The Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 are operable after the end of the EU transition period, changes were made by The Conservation (Natural Habitats, etc.) (Amendment) (Northern Ireland) (EU Exit) Regulations 2019). The Conservation of Offshore Marine Habitats and Species Regulations 2017 remain relevant to the UK offshore area more than 12 nm from land. The Morgan Generation Assets are over 12 nm from land.

1.6.1.3 Under these regulations, the UK Government and devolved administrations are required to establish a network of important high-quality conservation sites that will make a significant contribution to conserving the habitats and species identified in Annexes I and II, respectively, of the Habitats Directive. The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds).

1.6.1.4 Qualifying features for SACs within the Irish Sea include Annex II species harbour porpoise, bottlenose dolphin, grey seal and harbour seal.

1.6.1.5 For the Isle of Man, the 1990 Wildlife Act is the primary wildlife protection legislation and sets out schedules of Manx species of animal and plant that are protected by law from injury or disturbance. It also establishes the legal protection of Areas of Special Scientific Interest, National Nature Reserves (NNRs) and MNRs. This list of species was revised in 2004, and the Act itself received some amendment under the Agriculture (Miscellaneous Provisions) Act in 2008.

1.6.1.6 Designation features for the MNRs includes harbour porpoise, Risso’s dolphin, bottlenose dolphin, grey seal and harbour seal.

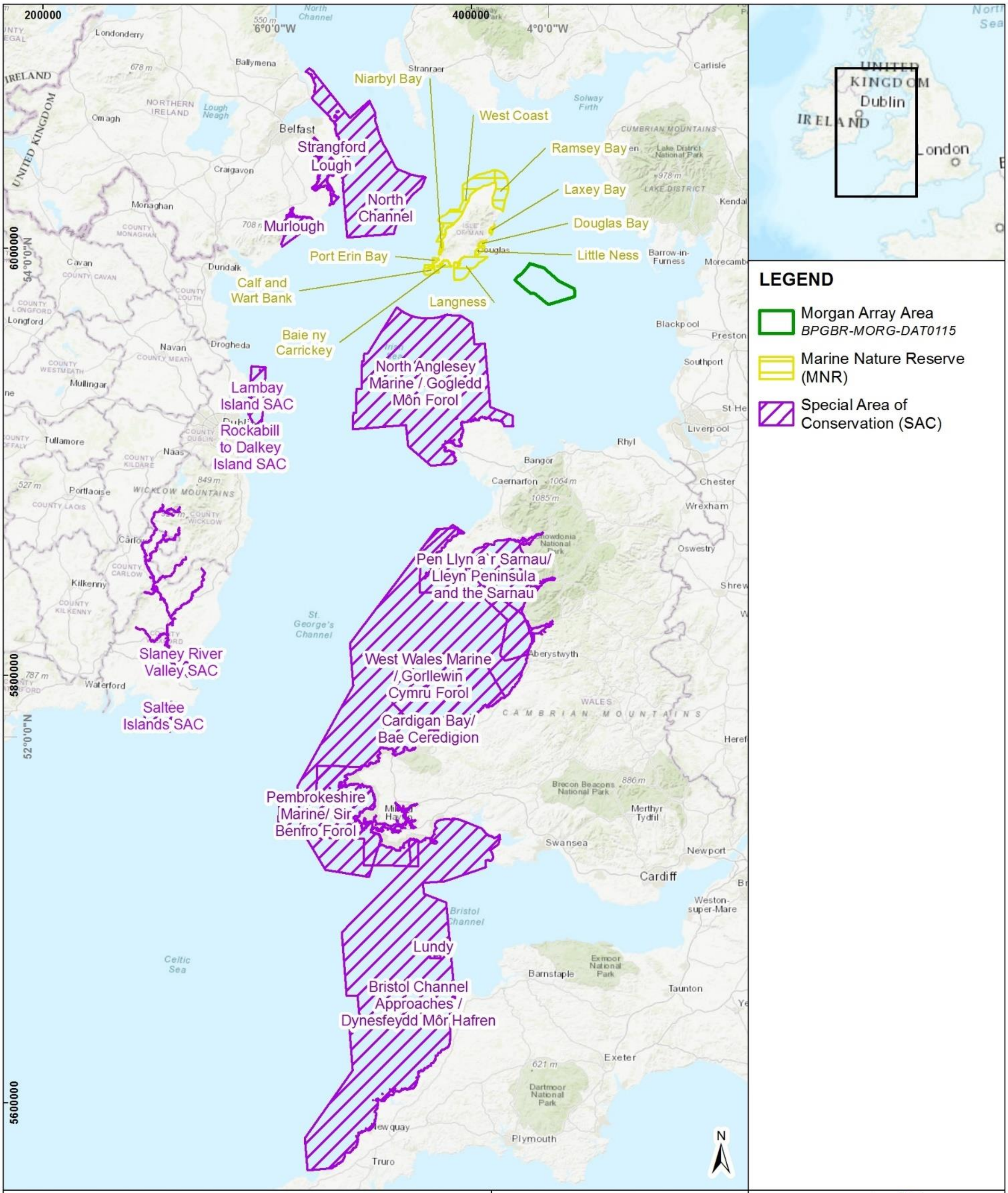
Conservation designations

1.6.1.7 A number of designated areas within the Irish Sea, extending into the Celtic Sea (i.e. the regional marine mammal study area) have marine mammals as notified interest features (Table 1.4). A HRA Stage 1 Screening Report (Document Reference E1.4) has been produced for the whole of the regional marine mammal study area to determine the sites that should be screened into the Information to Support Appropriate Assessment (ISAA) Part 2 – SAC Assessments (Document Reference E1.2). In this technical report we present an overview of European sites that fall within the regional marine mammal study area. A summary of the relevant marine mammal qualifying interest and/or protected features for each site is provided in Table 1.4 and shown alongside the Morgan Array Area in Figure 1.21.

Table 1.4: SACs and MNRs designated for the protection of marine mammals within the regional marine mammal study area.

Designated site	Distance to the Morgan Array Area (marine route) (km)	Features
Langness MNR	16.7	Harbour seal *Phoca vitulina* Grey seal *Halichoerus grypus* Harbour porpoise *Phocoena phocoena* Risso's dolphin *Grampus griseus*
Little Ness MNR	20.4	Harbour porpoise *Phocoena phocoena* Bottlenose dolphin *Tursiops truncatus* Minke whale Balaenoptera acutorostrata Risso's dolphin *Grampus griseus*
Douglas Bay MNR	22.2	Bottlenose dolphin *Tursiops truncatus* Risso's dolphin *Grampus griseus*
Laxey Bay MNR	22.4	Harbour porpoise *Phocoena phocoena* Minke whale *Balaenoptera acutorostrata* Bottlenose dolphin *Tursiops truncatus*
Ramsey Bay MNR	27.3	Harbour seal *Phoca vitulina* Grey seal *Halichoerus grypus*
North Anglesey Marine/Gogledd Môn Forol SAC	28.2	Harbour porpoise *Phocoena phocoena*
Baie Ny Carrickey MNR	30.2	Risso's dolphin *Grampus griseus* Harbour porpoise *Phocoena phocoena* Bottlenose dolphin *Tursiops truncatus*
Calf and Wart Bank MNR	35.8	Risso's dolphin *Grampus griseus* Harbour porpoise *Phocoena phocoena*
Port Erin Bay MNR	40.1	Harbour porpoise *Phocoena phocoena*
Niarbyl MNR	44.7	Harbour porpoise *Phocoena phocoena* Grey seal *Halichoerus grypus*
West Coast MNR	41.6	Harbour porpoise *Phocoena phocoena* Harbour seal *Phoca vitulina* Grey seal *Halichoerus grypus*
North Channel SAC	62.6	Harbour porpoise *Phocoena phocoena*
Strangford Lough SAC	93.8	Harbour seal *Phoca vitulina*
Murlough SAC	98.4	Harbour seal *Phoca vitulina*

Designated site	Distance to the Morgan Array Area (marine route) (km)	Features
Pen Llŷn a`r Sarnau/ Llŷn Peninsula and the Sarnau SAC	122.0	• Bottlenose dolphin *Tursiops truncatus*
		• Grey seal *Halichoerus grypus*
West Wales Marine/Gorllewin Cymru Forol SAC	123.3	• Harbour porpoise *Phocoena phocoena*
Rockabill to Dalkey Island SAC	123.4	• Harbour porpoise *Phocoena phocoena*
Lambay Island SAC	130.4	• Harbour seal *Phoca vitulina*
		• Grey seal *Halichoerus grypus*
Cardigan Bay/Bae Ceredigion SAC	190.4	• Bottlenose dolphin *Tursiops truncatus*
		• Grey seal *Halichoerus grypus*
Slaney River Valley SAC	211.53	• Harbour seal *Phoca vitulina*
Pembrokeshire Marine/Sir Benfro Forol SAC	215.24	• Grey seal *Halichoerus grypus*
Saltee Islands SAC	237.94	• Grey seal *Halichoerus grypus*
Bristol Channel Approaches/ Dynesfeydd Môr Hafren SAC	281.11	• Harbour porpoise *Phocoena phocoena*
Lundy SAC	320.28	• Grey seal *Halichoerus grypus*



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Data Sources: Client, JNCC, NPWS.

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 10 20 40 nm
0 20 40 80 km

Drawing Number:
RPSE-MG-ES-MAM-021-00

Drawing Title:
SITES DESIGNATED FOR THE PROTECTION OF MARINE MAMMALS WITHIN THE REGIONAL MARINE MAMMAL STUDY AREA

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:3,000,000

VER	DATE	DETAILS	BY	CHECK
00	13/07/23	First Issue	NA	BP

Figure 1.21: Sites designated for the protection of marine mammals within the regional marine mammal study area.

Special Areas of Conservation (SAC)

North Anglesey Marine/Gogledd Môn Forol SAC

1.6.1.8 The North Anglesey Marine SAC extends north and west from the coast of Anglesey (JNCC, 2022a). The landward boundary of the SAC follows the mean low water mark from Holy Island round to Dulas Bay and covers 3,249.49 km^2. The Annex II species, harbour porpoise, is a primary reason for selection of this site.

North Channel SAC

1.6.1.9 North Channel SAC is located along the east coast of Northern Ireland and has been identified as an important winter area for harbour porpoise, supporting an estimated 1.2% of the UK Celtic and Irish Seas Management Unit (MU) population. This SAC has an area of 1,604 km^2 and supports areas where large groups of up to 100 harbour porpoise have been sighted and is thus designated for harbour porpoise. Eighteen years of survey data collated through the JCP (JCP, 2022) were analysed to identify areas with persistently high harbour porpoise occurrence. The modelled outputs of this analysis demonstrated that the North Channel SAC persistently contains densities of porpoises which are within the top 10% of those for the Celtic and Irish Seas MU (IAMMWG, 2015) during winter, and thus defined the SAC boundaries.

Strangford Lough SAC

1.6.1.10 Strangford Lough is a large (150 km^2) marine inlet on the east coast of County Down in the northwest Irish Sea. Almost land-locked, Strangford Lough is separated from the Irish Sea by the Ards Peninsula to the east and is bounded to the south by the Lecale coast. It is connected to the open sea by the Strangford Narrows. It is designated for harbour seal, for which the area is considered to support a significant presence, with the minimum population declared at the time of designation as 210 animals (DAERA, 2022a).

Murlough SAC

1.6.1.11 Murlough SAC covers an area of 119.02 km^2 and adjoins Dundrum Bay including the shallow waters of the Bay. The beach area at Ballykinler is important as a haul-out area for harbour seal and therefore the SAC has been designated for this species (DAERA, 2022b).

Pen Llŷn a`r Sarnau/Llŷn Peninsula and the Sarnau SAC

1.6.1.12 Llŷn Peninsula and the Sarnau SAC is situated in northwest Wales. The boundary extends from Nefyn on the north coast of Llŷn and includes parts of the seashore and the waters and seabed around the Llŷn Peninsula, in north Cardigan Bay and along the Meirionnydd coast to Clarach in Ceredigion south of the Dyfi estuary. The SAC covers 1,460.12 km^2 and is designated for bottlenose dolphin and grey seal (NRW, 2018a). Bottlenose dolphin are considered of significant importance within Pen Llŷn a'r Sarnau SAC even though they do not appear to form a semi-resident group within the sea area encompassed by this site (as they do in Cardigan Bay). The Pen Llŷn and Bardsey Island grey seal population is the largest breeding colony in the north of Wales. The SAC contains a number of important pupping sites for the grey seal concentrated around the northwest of the SAC including Bardsey Island. Persistent breeding seals in the SAC are part of a wider population that extends to southwest

Wales and to the southeast and east Irish coasts, and possibly beyond the Irish Sea. In the SAC the main period of pup production in North Wales is in September to October, but with some activity from early August to the end of November.

West Wales Marine/Gorllewin Cymru Forol SAC

1.6.1.13 West Wales Marine SAC is located off the coast of Wales, from the Llŷn peninsula in the north, to Pembrokeshire in the southwest, comprising an entirely marine area of 7,376.14 km^2 (JNCC, 2022b). This SAC overlaps a number of other SACs including parts of Pembrokeshire Marine SAC and the Pen Llŷn a'r Sarnau SAC and encompasses the entire Cardigan Bay SAC. The whole West Wales Marine SAC has been identified as an area of importance for harbour porpoise in summer, and a smaller section at the south of the site (Cardigan Bay area) has been identified as important winter habitat this species. Survey data collated through the JCP (2022) were analysed to identify areas with persistently high harbour porpoise occurrence. The modelled outputs of this analysis demonstrate that the West Wales Marine SAC occurs within the top 10% of persistent high-density areas for harbour porpoise in UK waters for both winter and summer seasons.

Rockabill to Dalkey Island SAC

1.6.1.14 Rockabill to Dalkey Island SAC is situated in the west Irish Sea. Covering an area of 272.9 km^2, the site extends southward of Rockabill, in a strip approximately 7 km wide and 40 km in length, running adjacent to Howth Head, and crossing Dublin Bay to Frazer Bank in south Co. Dublin (NPWS, 2022a). The area is designated for harbour porpoise and represents a key habitat within the Irish Sea. The species occurs year-round within the site and comparatively high group sizes have been recorded. The site also supports common seal and grey seal, and bottlenose dolphin, minke whale, fin whale, killer whale, Risso's dolphin and short-beaked common dolphin have all been recorded in the area.

Lambay Island SAC

1.6.1.15 Lambay Island, in the west Irish Sea, is a large (2.5 km^2) inhabited island lying 4 km off Portrane on the north County Dublin coast (NPWS, 2022b). Lambay Island supports the principal breeding colony of grey seal on the east coast of Ireland, numbering between 196 and 252 seals, across all age cohorts. The site also contains regionally significant numbers of harbour seal, of which up to 47 individuals have been counted. Both species occur all year round, and intertidal shorelines, coves and caves of the Island are used by resting and moulting seals. The SAC is designated for both grey seal and harbour seal.

Cardigan Bay/Bae Ceredigion SAC

1.6.1.16 Cardigan Bay SAC extends from Ceibwr Bay in Pembrokeshire to Aberarth in Ceredigion and seaward almost 20 km, covering an area of 958.57 km^2 (JNCC, 2022c). The SAC is designated for bottlenose dolphin and grey seal. Cardigan Bay is one of two coastal areas in the UK where bottlenose dolphin are most frequently recorded and are seen year-round. Cardigan Bay bottlenose dolphin are highly mobile, and the resident population is estimated at between 100 to 300 individuals (NRW, 2018b). The dolphins appear to use the inshore waters of Cardigan Bay for both feeding and reproduction, and in the summer months calves and juveniles are often observed with adult individuals or groups.

1.6.1.17 Grey seal present within Cardigan Bay do not form a discrete population but are centred (in terms of abundance) on Cardigan Bay and are considered part of the SW England and Wales MU. Tracking data show that individual seals transit to France, the west coast of Scotland and Ireland (NRW, 2018a).

Slaney River Valley SAC

1.6.1.18 Slaney River Valley in the west Irish Sea comprises the freshwater stretches of the River Slaney as far as the Wicklow Mountains, covering an area of 60.18 km^2 and supports regionally significant numbers of harbour seal (NPWS, 2022c). This Annex II species occurs year-round in Wexford Harbour where several sandbanks are used for breeding, moulting and resting activity. At least 27 harbour seal regularly occur within the site.

Pembrokeshire Marine/Sir Benfro Forol SAC

1.6.1.19 Pembrokeshire Marine SAC, in the southeast Irish Sea, extends from just north of Abereiddy on the north Pembrokeshire coast to just east of Manorbier in the south. The site includes the inshore waters of the islands of Ramsey, Skomer, Grassholm, Skokholm, the Bishops and Clerks and The Smalls, covering an area of 1,380.39 km^2 and is designated for grey seal (JNCC, 2022d).

1.6.1.20 Pembrokeshire in southwest Wales is representative of grey seal colonies in the southwest part of the breeding range in the UK. It is the largest breeding colony on the west coast of England and Wales, representing over 2 % of annual UK pup production (NRW, 2018c).

Saltee Islands SAC

1.6.1.21 Saltee Islands SAC comprises the Saltees Islands and surrounding waters, with the islands located between 4 and 5 km off the south Wexford coast, covering an area of 158 km^2. Great Saltee has a breeding population of grey seal, for which it is designated, which has been estimated at 571 to 744 individuals in 2005 (NPWS, 2022d). A one-off moult count in 2007 gave a figure of 246 individual (NPWS, 2022d).

Bristol Channel Approaches

1.6.1.22 Bristol Channel Approaches SAC spans the Bristol Channel between the north Cornwall coast into Carmarthen Bay in Wales, covering an area of 5,850 km^2, and is designated for harbour porpoise (JNCC, 2022e). The site is estimated to support 4.7% of the Celtic and Irish Seas MU. Harbour porpoise is present within the site year round, but during the winter there are persistently higher densities of harbour porpoise compared to the surrounding MU. The SAC encompasses Lundy Marine Conservation Zone (MCZ).

Lundy SAC

1.6.1.23 Lundy SAC is located in the Western Channel and Celtic Sea, and covers an area of 3,070.95 km^2, with 99% of area marine. It is designated for grey seal, with a resident population of approximately 180 grey seals (Landmark Trust, 2022).

Marine Nature Reserves

Langness MNR

1.6.1.24 Langness MNR is one of the largest Manx MNR reserves at 88.67 km^2 and extends from Castletown in the south up to Santon Head in the north, encompassing the Langness peninsula and Derbyhaven Bay. The MNR was designated in 2018 for harbour seal, grey seal, harbour porpoise and Risso's dolphin (DEFA, 2018).

Little Ness MNR

1.6.1.25 Little Ness MNR is 10 km^2 and extends from Douglas Bay in the north, to Little Ness in the south and out to one nautical mile. Whilst the designation features of this MNR do not include cetaceans (IoM Government, 2022a), it is an important cetacean area and corresponds to a permanent site for MWDW land-based surveys (see Figure 1.14) and given all cetacean species are protected in Manx waters, Little Ness has been included.

Douglas Bay MNR

1.6.1.26 Douglas Bay MNR is 4.54 km^2 and extends inshore from Onchan Head to Douglas Head, excluding the inner harbour area. Despite being a busy commercial port, the area is regularly used by bottlenose dolphin and Risso's dolphin, and thus was designated in 2018 for these two species (IoM Government, 2022a).

Laxey Bay MNR

1.6.1.27 Laxey Bay MNR is 3.97 km^2 and was designated in 2018, extending inshore from Carrick Roayrt to Clay Head. It is designated for harbour porpoise, bottlenose dolphin, and minke whale (DEFA, 2018).

Ramsey Bay MNR

1.6.1.28 Ramsey Bay MNR is one of the largest MNRs in the UK, with an area of 96.98 km^2 and spans the northeast of the coast from the Point of Ayre to Maughold Head. It was designated in 2011 for harbour and grey seal species (Isle of Man Government, 2022a).

Baie Ny Carrickey MNR

1.6.1.29 Baie ny Carrickey MNR covers an area of 11.37 km^2 and spans the territorial sea between Black Head and Scarlett Stack (IoM Government, 2022b). It was designated in 2018 for harbour porpoise, Risso's dolphin and bottlenose dolphin.

Calf and Wart Bank MNR

1.6.1.30 Calf and Wart Bank MNR is located off the southwest coast of the Isle of Man, encompassing the Calf of Man with an area of 20.15 km^2. It was designated in 2018 for harbour porpoise and Risso's dolphin.

Port Erin MNR

1.6.1.31 Port Erin MNR extends to the west coast of the Isle of Man and covers an area of 4.34 km^2. It was designated in 2018 for harbour porpoise.

Niarbyl MNR

1.6.1.32 Niarbyl MNR is located on the west coast of the Isle of Man, spanning from Elby Point to the headland of Fleshwick Bay east to the coastline, with an area of 5.66 km^2. It was designated in 2018 for harbour porpoise and grey seal.

West Coast MNR

1.6.1.33 West Coast MNR is the largest MNR, spanning an area of 184.82 km^2. This designation, spanning the length of the coast from the Point of Ayre to Niarbyl, is important for harbour porpoise, grey seal and harbour seal.

1.6.2 Overview of marine mammals

Regional marine mammal study area summary

1.6.2.1 The Irish Sea is an important area for marine mammals, with 24 species of cetacean to date sighted in Irish waters (O'Brien *et al.*, 2009) and two species of pinniped. Seven species are known to occur regularly in this region (and thus form the key species taken forward to assessment); harbour porpoise, short-beaked common dolphin, bottlenose dolphin, Risso's dolphin, minke whale, grey seal and harbour seal. Other species are occasional or rare visitors to the area and include fin whale, sei whale *Balaenoptera borealis*, sperm whale *Physeter macrocephalus*, northern bottlenose whale, Sowerby's beaked whale *Mesoplodon bidens*, white-beaked dolphin, Atlantic white-sided dolphin, striped dolphin and killer whale (Table 1.5).

1.6.2.2 The occurrence of cetacean species is often unpredictable due to their highly mobile nature and the distribution of marine mammals in the Irish Sea is patchy. Harbour porpoise is sighted throughout the area, whilst Risso's dolphin and short-beaked common dolphin are sighted towards the south of the Irish sea. Bottlenose dolphin sightings are highest in the Cardigan Bay SAC compared to the rest of the Irish Sea. Harbour seal individuals are concentrated along the coast of Northern Ireland and in the Firth of Clyde, whilst grey seal extensively use areas of the south Irish Sea, the north of St George's Channel, and Liverpool Bay (Hammond *et al.*, 2005). Wales, southeast Ireland and Liverpool Bay support important haul-out sites for grey seal and individuals from these areas may form a separate population from the grey seal found to the north off west Scotland and to the south off Cornwall and France. Harbour seal haul out along the northeast coast of Ireland.

Table 1.5: Summary of Cetacean and Pinniped Species Found in the regional marine mammal study area. Sources: Reid *et al.* (2003); O'Brien *et al.* (2009); Baines and Evans (2012); Waggitt *et al.* (2020), Carter *et al.* (2022).

Species	Occurrence in the Irish Sea	Description of Species Distribution
Toothed Whales, Dolphins and Porpoises		
Harbour porpoise *Phocoena phocoena*	Abundant	Widespread in cold and temperate northwest European shelf waters, and abundant throughout the Irish Sea. Common inshore species found in high densities in the Irish Sea. Highest relative abundances in the west half of the central Irish Sea (Wall *et al*., 2013). High predicted relative densities in both winter and summer in the Irish Sea (Waggitt *et al.,* 2020).
Bottlenose dolphin *Tursiops truncatus*	Common	Near-global distribution, widely distributed in the North Atlantic and occurs year-round throughout the Irish Sea near-shore. Predominately coastal distribution (though low densities have been recorded offshore). Concentrations of resident populations in Cardigan Bay and off the coast of Co. Wexford. Seasonal differences in dispersion have been noted (e.g. dolphins in summer occurring mainly in small groups near the coast, centred upon Cardigan Bay, dispersing more widely and generally northwards, where they may form very large groups in winter).
Risso's dolphin *Grampus griseus*	Common	Worldwide distribution, and in northwest Europe appears to be continental shelf species. Clusters regularly seen in the Irish Sea, with a relatively localised distribution, forming a wide band running southwest to northeast that encompasses west Pembrokeshire, the west end of the LlŷnPeninsula and Anglesey in Wales, the southeast coast of Ireland in the west, and waters around the Isle of Man in the north.
Short-beaked common dolphin *Delphinus delphis*	Common	Most numerous offshore cetacean species in the temperate northeast Atlantic. Widespread and abundant, centred upon the Celtic Deep at the south end of the Irish Sea, where water depths range from 50 to 150 m. High-density area extends eastwards towards the coast and islands of west Pembrokeshire. Elsewhere in the Irish Sea, the species occurs at low densities mainly offshore, in a central band that extends northwards towards the Isle of Man.
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Occasional	Occur in cold and temperate waters of the North Atlantic, typically in deep waters along the continental shelf, with fewer numbers around Ireland, and is rare in the Irish Sea.
Killer whale *Orcinus orca*	Occasional	Largely distributed in the north of the North Sea off the northwest of Scotland, but occasionally seen around the Isle of Man and St George's Channel.
White-beaked dolphin *Lagenorhynchus albirostris*	Occasional	Abundant and widespread around the coast of the British Isles from the North Sea, across to the west of Scotland and down to west Ireland but also occurs occasionally off the south of Ireland and in the Irish Sea.
Beluga whale *Delphinapterus leuca*	Rare	Arctic and sub-arctic species but few sightings off northwest Scotland, around the Northern Isles and in the North Sea.
False killer whale *Pseudorca crassidens*	Rare	Warm water species preferring deep offshore waters in tropical and sub-tropical waters but few sightings in the UK.
Long-finned pilot whale *Globicephala melas*	Rare	Mainly distributed in the deeper colder waters of the North Atlantic but sometimes recorded in east of the Irish Sea, sometimes close to the coast.

Species	Occurrence in the Irish Sea	Description of Species Distribution
Pygmy sperm whale *Kogia breviceps*	Rare	Species is rare in UK waters, but some historical strandings in southwest Ireland.
Sperm whale *Physeter macrocephlus*	Rare	Occurs mainly in deep waters to the northwest of the UK and only rarely found in the Irish Sea.
Striped dolphin *Stenella coeruleoalba*	Rare	Species is rare in UK waters, preferring warmer waters south of the UK.
Beaked Whales		
Sowerby's beaked whale *Mesoplodon bidens*	Rare	Associated with deep water off the shelf edge to the north and west of Scotland.
Northern bottlenose whale *Hyperoodon ampullatus*	Rare	Occurs in North Atlantic, favouring cold deep water and very rarely seen in the Irish Sea.
Cuvier's beaked whale *Ziphius cavirostris*	Rare	Wide geographical distribution, with very few sightings in UK waters, mostly off west seaboard of Britain and Ireland.
True's beaked whale *Mesoplodon mirus*	Rare	Inhabits warm-temperate seas, mainly in the North Atlantic, with very few strandings on west coast of Ireland.
Gervais' beaked whale *Mesoplodon europaeus*	Rare	Inhabits warm temperate and tropical Atlantic waters, but only known via strandings.
Baleen Whales		
Humpback whale *Megaptera novaeangliae*	Rare	Favours deeper waters over and along edges of continental shelfs and around oceanic islands, but sightings have occurred in the north of the Irish Sea, south Irish Sea, Celtic Sea and Western Channel. Most sightings have been made between May and September, which is when small numbers have also been seen off the continental shelf west and north of Scotland.
Minke whale *Balaenoptera acutorostrata*	Common	Ranges widely and can be observed throughout the north of the North Sea but is more localised in the Irish Sea.
Northern right whale *Eubalaena glacialis*	Rare	Confined to the north of the Atlantic, largely in the west along the east coast of the US and Canada, with very few individuals observed in UK waters. Some historical whaling records in Blacksod Bay in Co. Mayo on the west coast of Ireland, and a few reports of individuals in European waters, including two sightings from northwest of Donegal in the past decade.
Fin whale *Balaenoptera physalus*	Rare	More typical of the deep waters to the north and west of Scotland rather but occasionally sighted off the south coast of Ireland and in the St George's Channel.
Sei whale *Balaenoptera borealis*	Rare	Concentrated in deep waters in the North Atlantic towards Iceland, but some sightings between south Ireland and southwest England.

Species	Occurrence in the Irish Sea	Description of Species Distribution
Blue whale *Balaenoptera musculus*	Rare	Sightings and acoustic detections in recent years have shown they occur during the summer and autumn months offshore along the continental shelf edge, to the southwest of Ireland.
Pinnipeds		
Grey seal *Halichoerus grypus*	Abundant	Restricted to North Atlantic but found all around the UK, with breeding populations around the coast of the Irish Sea. High counts along east of Northern Ireland, southwest of Isle of man, and north coast of Wales and River Dee. At-sea seal distribution maps show high density areas in the southeast of the Irish Sea, and along the east coast of Ireland and west Isle of Man (Carter *et al*., 2022).
Harbour seal *Phoca vitulina*	Abundant	Hauls out on coasts of Scotland and Northern Ireland, with high haul-out counts on the east of Northern Ireland. At-sea seal distribution maps show high density areas on the east coast of Northern Ireland (Carter *et al*., 2022).

Morgan aerial digital survey data

1.6.2.3 Data from site-specific surveys conducted within the Morgan Aerial Survey Area demonstrate that several marine mammal species occurred regularly within the Morgan marine mammal study area. Harbour porpoise, bottlenose dolphin and grey seal and were all observed within the Morgan Aerial Survey Area. Monthly raw sightings (number of animals) across the Morgan Aerial Survey Area are given in Appendix A.

1.6.2.4 Of cetaceans, harbour porpoise was the most frequently recorded species and was sighted in every month of the 24 months of Morgan Generation Assets surveys. Highest encounter rates were in August 2021 (n = 36). Grey seal were sighted in lower numbers than harbour porpoise, in 16 of the 24 months of surveys. Other sightings identified to species level were bottlenose dolphin, sighted in one month (June 2021, n = 9) of the 24 months of surveys, and short-beaked common dolphin sighted in three months (July 2022 n = 8, September 2022 n = 12 and October 2022 n = 15). Full details of the aerial survey data are given in Appendix A.

1.6.2.5 For the Morgan Generation Assets aerial surveys, there were also a number of cetacean sightings (‘dolphin species’, ‘dolphin/porpoise’) that could not be assigned to species level which had high sightings and frequency. Similarly, there were a large number of sightings classified as ‘seal species’ or ‘phocid species’ due to the issue of identifying to species level from aerial survey data. For the purposes of further analyses these were assigned to grey seal as this was the most commonly occurring seal species across the aerial survey area. There were a number of sightings that were classified as ‘marine mammal species’ which could not be identified down to species level.

1.6.2.6 Densities are discussed in each relevant section within each species account (section 1.7), and detailed descriptions given in Appendix A.

1.6.2.7 Modelling of the Morgan aerial survey data allowed absolute estimates of mean abundance, densities and confidence limits to be given for harbour porpoise and grey seal for the Morgan Aerial Survey Area. Low sighting rates for other species meant modelling of densities was not possible.

Table 1.6: Summary table of estimated absolute (corrected for availability bias) abundance and density, per species/grouping, for 'bio-seasons' within the Morgan Aerial Survey Area.

Temporal division	Mean absolute abundance	Design-based approach				Model-based approach			
		Mean density	Lower CL	Upper CL	CV	Mean density	Lower CL	Upper CL	CV
Harbour porpoise									
'Winter'	220	0.159	0.130	0.194	0.740	0.050	0.034	0.067	0.860
'Summer'	303	0.219	0.179	0.268	0.518	0.062	0.043	0.082	0.647
Overall	261	0.189	0.154	0.231	0.619	0.056	0.018	0.095	0.750
Grey seal									
'Non-pupping'	98	0.071	0.052	0.092	0.746	0.020	0.001	0.040	0.742
'Pupping'	180	0.130	0.095	0.168	0.753	0.018	0.003	0.038	1.100
Overall	137	0.099	0.072	0.128	0.852	0.019	0.0019	0.0392	0.867
'Porpoise species'									
'Winter'	252	0.182	0.147	0.221	0.812	0.054	0.038	0.071	0.806
'Summer'	362	0.262	0.212	0.318	0.452	0.070	0.050	0.090	0.622
Overall	307	0.222	0.180	0.269	0.618	0.062	0.023	0.102	0.714

1.7 Species accounts

1.7.1 Overview

1.7.1.1 The following section provides more detailed baseline information for each of the key species identified as likely to occur within the regional marine mammal study area (see Table 1.5). These are:

- Harbour porpoise
- Bottlenose dolphin
- Short-beaked common dolphin
- Risso's dolphin
- Minke whale
- Grey seal
- Harbour seal.

1.7.2 Harbour porpoise

Ecology

1.7.2.1 Porpoises comprise a group of relatively small-bodied Odontoceti (toothed) cetaceans within the family Phocoenidae. The harbour porpoise is one of the smallest cetacean species, reaching a maximum length of 1.9 m. On average females grow to a length of 1.6 m whilst males reach 1.45 m in length (Lockyer, 1995). Porpoises in the Celtic and Irish Seas MU (Figure 1.22) have been shown to be significantly larger in their maximum length, asymptotic length and average length at 50% maturity compared to porpoises in the North Sea MU, in a study by Murphy *et al.* (2020). Although the recorded longevity is 24 years, most individuals do not live past 12 years of age (Lockyer, 2003).

1.7.2.2 Often living in cool, high latitude waters, harbour porpoise have a higher metabolic rate than dolphins and therefore need to feed more frequently and consume more prey per unit body weight, in order to maintain their body temperature and other energy needs (Rojano-Doñate *et al.,* 2018). For this reason, porpoise may be highly susceptible to changes in the abundance of prey species or disturbance from foraging areas. A harbour porpoise's field metabolic rate, however, remains stable over seasonally changing water temperatures. Heat loss is deemed to be managed via cyclical fluctuations in energy intake to build up a blubber layer that offsets the extra cost of thermoregulation during winter (Rojano-Doñate *et al.,* 2018).

1.7.2.3 Harbour porpoise feeds on a wide range of fish species, but mainly small shoaling species from demersal or pelagic habitats (Santos and Pierce, 2003; Aarfjord, 1995). There are regional and seasonal differences in diet; interannual variation depending on the availability of prey species; and ontogenetic variation (adult and juveniles), with juveniles targeting smaller species such as gobies Gobiidae or smaller individuals of the same prey species targeted by adults (Santos and Pierce, 2003). Analysis of 73 stomachs of harbour porpoise from strandings in Irish waters show that they primarily forage on fish (78%) with the remainder comprising cephalopods and crustaceans (Rogan, 2009). Species such as whiting, *Trispoterus* spp, unidentified gadoids and herring are important. This diet is similar to analyses elsewhere in European waters; whiting and sandeels were found to be important in Scotland (Santos *et al.,* 2004) and in the North Sea during summer (Ransijn *et al.,* 2019) whilst during the winter season European sprat *Sprattus sprattus* and Atlantic herring also contributed to overall energy density.

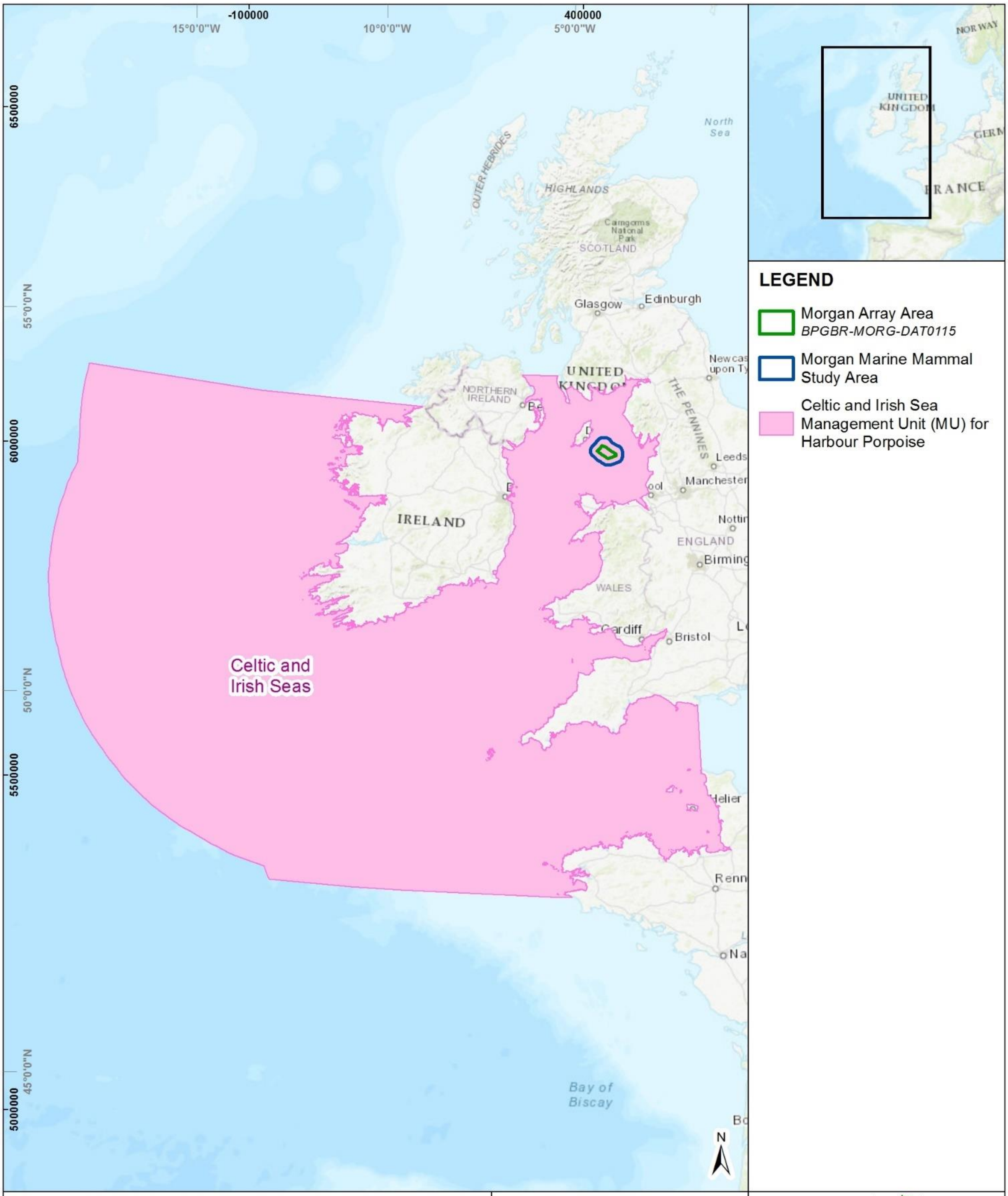
1.7.2.4 Harbour porpoise regularly forage around tidal races, overfalls, and upwelling zones during the ebb phase of the tide (Pierpoint, 2008). Waggitt *et al*. (2018) explored regional scale patterns in occupancy of tidal stream environments in Anglesey and found that encounters with animals were concentrated in small areas (<200 m^2) and increased during certain tidal states (ebb vs. flood). In sites showing relatively high maximum current speeds (2.67 to 2.87 ms^{-1}) encounters were strongly associated with the emergence of shearlines but in sites with relatively low maximum current speeds (1.70 to 2.08 ms^{-1}), encounters were more associated with areas of shallow water during peak current speeds. The overall probability of encounters was higher in low current sites. Waggitt *et al.* (201) suggested likelihood of interactions with porpoise could be reduced by restricting developments to sites with high maximum current speeds (>2.5 ms^{-1}) and placing turbines in areas of laminar currents therein.

1.7.2.5 These results are consistent with Embling *et al.* (2010), who analysed results of the dedicated surveys conducted in the south Inner Hebrides and found that maximum tidal current is the best environmental explanation of persistent harbour porpoise abundance.

1.7.2.6 Although harbour porpoise generally hunt alone or in small groups, this species is often seen in larger aggregations of 50 or more individuals, either associated with food concentrations or seasonal migrations. Within these loose aggregations, segregation may occur, with females travelling with their calves and yearlings, and immature animals of each sex being segregated into groups.

1.7.2.7 The age at sexual maturation for the harbour porpoise is approximately three to four years and reproduction is strongly seasonal with mating occurring between June and August (Lockyer, 1995). Gestation is 10 to 11 months and there is a peak in birth rate around the British Isles during the months of June to July (Boyd *et al.*, 1999).

1.7.2.8 A range of threats to harbour porpoise around the UK have been identified, with bycatch in fishing gears considered the greatest (Calderan and Leaper, 2019). Harbour porpoise is particularly vulnerable to getting caught in bottom-set gill nets as a result of their feeding behaviour. Other threats include prey depletion, pollution that may affect the health of individuals, as well as acoustic and physical disturbance (Evans and Prior, 2012). These threats are considered likely to continue or increase in future. They are also susceptible to bottlenose dolphin attack and some studies have shown distributions of the two species show relatively little overlap (Pesante *et al.,* 2008; Simon *et al.,* 2010). Where an overlap does exist, there is likely to be aggression between the two species (Norrman *et al.,* 2015). Nuuttila *et al*., (2017) showed fine-scale temporal partitioning between the species occurring at three levels: seasonal variation (porpoise detections peaking in winter, bottlenose dolphin in summer), diel variation (porpoise detections higher at night, dolphins highest shortly after sunrise) and tidal variation (peak dolphin detections occurring during ebb at the middle of the tidal cycle and before low tide, harbour porpoise detections were highest at slack water, during and after high water with a secondary peak recorded during and after low water).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 25 50 100 nm
0 50 100 200 km

Drawing Number:
RPSE-MG-ES-MAM-022-00

Drawing Title:
CELTIC AND IRISH SEAS MU FOR HARBOUR PORPOISE

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:9,600,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	BP

Figure 1.22: Celtic and Irish Seas MU for harbour porpoise with the Morgan marine mammal study area.

Distribution and occurrence

1.7.2.9 Harbour porpoise is widely distributed throughout the Irish Sea and through the regional marine mammal study area and is the most common cetacean in the region (Reid *et al*., 2003; Hammond *et al*., 2005; Baines and Evans, 2012; Wall *et al.,* 2013). Wide-scale historical data collating heterogenous datasets from 1990 to 2009 in the Atlas of the Marine Mammals of Wales (Baines and Evans, 2012) confirms regular widespread sightings of harbour porpoise across the Irish Sea (Figure 1.23). Species distribution was not even throughout the Irish Sea. Hotspots occurred off North and West Anglesey (particularly around Point Lynas and South Stack, Holyhead), the southwest coast of the Llŷn Peninsula, south Cardigan Bay, in the vicinity of Strumble Head and the west Pembrokeshire islands (Skomer and Ramsey), and in the Bristol Channel off the south coast of Wales (around the Gower Peninsula and in Swansea Bay). Whilst the data has broad scale information, limitations include the age of the data and inadequate survey coverage. Most recent SCANS-IV data showed widespread sightings across the Irish Sea in summer 2022 (Gilles *et al.,* 2021), and the observed distribution of harbour porpoise from SCANS-III and the ObSERVE survey around Ireland at the same time (Rogan *et al*. 2018), was similar to that observed in SCANS-II in 2005 (Hammond *et al.*, 2013). Sighting data from MWDW shows harbour porpoise are widespread in Manx waters around the Isle of Man, extending out towards the Morgan Array Area (Figure 1.14) and up towards the coast of Northern Ireland.

1.7.2.10 Heinänen and Skov (2015) found that in the Celtic and Irish Sea MUs water depth, surface sediments, current speed and eddy potential all play a major role as determinants of the distribution of harbour porpoise in this management unit. In the winter season, water depth and current speed are the major determinants of distribution with some influence from surface salinity. An increased probability of occurrence has been associated with increasing current speed, yet a tendency for lower probability of occurrence has been observed at very high current speeds of greater than 0.7 m/s (Heinänen and Skov, 2015). In summer, current speed and eddy potential are important, with similar increasing probabilities with increasing current speed up to 0.4 m/s and increasing eddy activity.

1.7.2.11 Based on spatio-temporal modelling using species and environmental data, Heinänen and Skov (2015) also concluded that high densities of harbour porpoise are associated with depth and season: the shallowest areas (areas shallower than 40 m) and winter months supporting high densities. During summer, harbour porpoise are associated with areas of high eddy activity and degree of coarseness of sediments also plays an important role. Peak densities were associated with sandy-gravelly sediments, with lower densities in muddy areas. Harbour porpoise are often found in areas of high shipping traffic, however, notably the number of ships also has a significant effect on their occurrence (Heinänen and Skov, 2015). This study found that densities of porpoise decreased with increasing levels of traffic. Density of ships was a static predictor variable, given as the mean number of ships per year in each cell (Heinänen and Skov, 2015). A threshold level in terms of impact seems to be a traffic density of approximately 15,000 ships/year (approximately 50 ships per day).

1.7.2.12 Data from the Morgan Generation Assets aerial survey data for the two years of survey found that harbour porpoise were recorded in all months of the year and there were higher concentrations in the north part of the Morgan Aerial Survey Area. Further detail is available in Appendix A

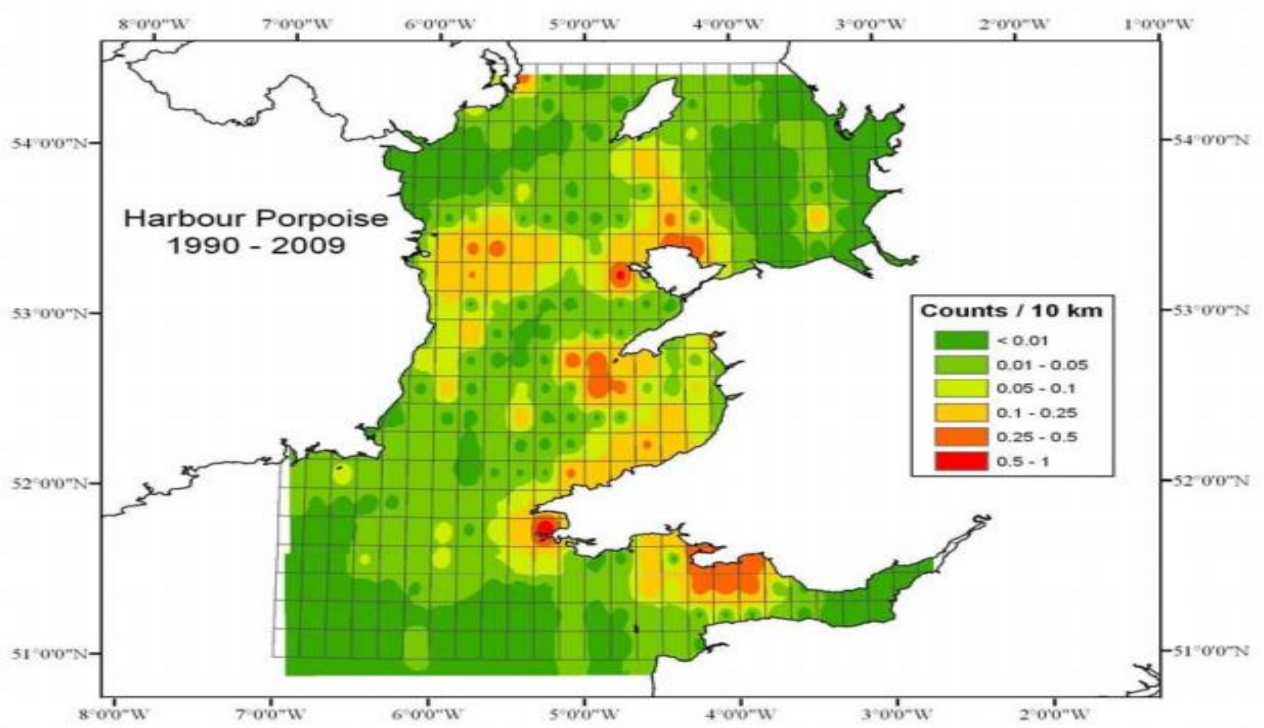


Figure 1.23: Inverse Distance Weighted interpolated map of harbour porpoise distribution from the 2012 Atlas of the Marine Mammals of Wales (from Baines and Evans, 2012).

Density/abundance

1.7.2.13 Density and abundance estimates were available across a broad area within the regional marine mammal study area and provides an overview of harbour porpoise densities over different spatial scales.

Density

1.7.2.14 Broadscale data highlights the variance in density estimates from different sources. Data from SCANS-III that covered European Atlantic waters reported densities of 0.239 animals per km^2 (CV = 0.282) in Block E and 0.086 animals per km^2 (CV = 0.383) in Block F (Hammond *et al.,* 2021). Surveys were carried out between 27 June and 31 July 2016, therefore focused on a limited summer period and thus densities may vary in other months of the year. SCANS-III DSM data (see paragraph 1.5.6.8) (Lacey *et al.*, 2022) gave a mean density of 0.411 animals per km^2 and a maximum of 0.446 animals per km^2 for the Morgan marine mammal study area (Figure 1.24), with density maps showing higher areas of density in the east Irish Sea[1].

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[1] Data from SCANS-III estimates are given as point densities and have been transformed to grid using Voronoi triangle/polygon method to create a grid surface for clearer illustration.

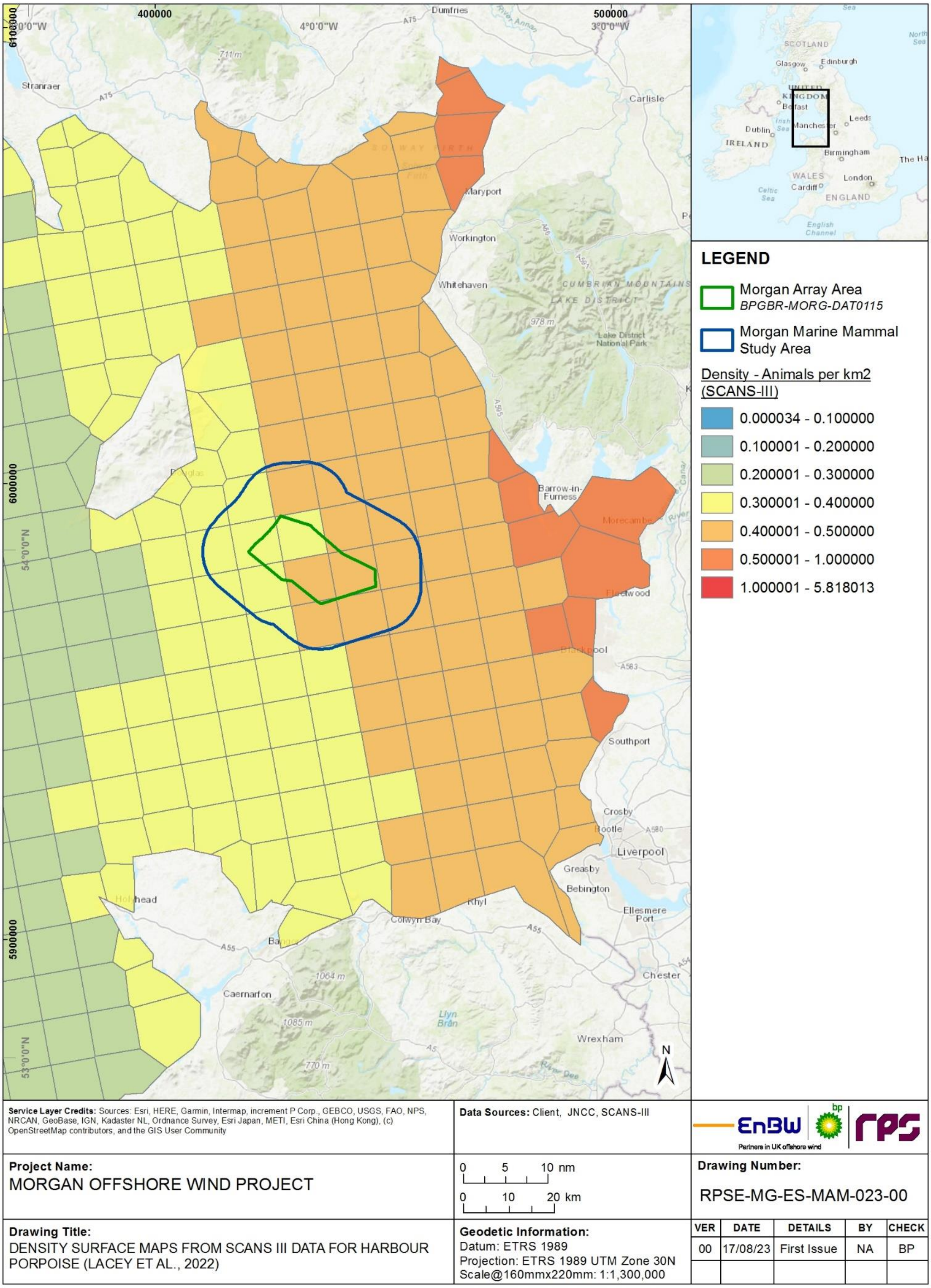

Figure 1.24: Density surface maps from SCANS-III data for harbour porpoise (Lacey *et al.*, 2022).

1.7.2.15 In the ObSERVE program, aerial surveys were conducted in the offshore waters of Ireland (west Irish Sea) between 2015 and 2017 (Rogan *et al*., 2018) with the aim to investigate the occurrence, distribution and abundance of key marine species. Stratum 5 (western Irish Sea) is relevant to the regional marine mammal study area and covers an area of 11,110 km^2. Corrected design-based estimates and model-based estimates were given for each season (Summer 2015, Winter 2015, Summer 2016, Winter 2016). Densities were high in comparison to other broadscale studies (ranging from 0.696 animals per km^2 in summer 2015 to 1.046 animals per km^2 in summer 2016 for design-based estimates). Predicted summer distributions for harbour porpoise in 2015 and 2016 was high in Stratum 5, thus highlighting the importance of the west Irish Sea compared to other Irish waters.

1.7.2.16 Density surface modelling in JCP Phase III, aimed at providing estimates of both abundance and changes in abundance for common cetacean species in UK water, gave a mean density of 0.8738 animals per km^2 across the entire JCP Phase III study region, with areas of relative higher density for harbour porpoise in the Irish and Celtic Sea (Paxton *et al.,* 2016). This mean density falls within the range predicted for the west Irish sea using the ObSERVE data (see paragraph 1.7.2.15). Harbour porpoise densities fluctuated throughout the year in the JCP Phase III data, and in the entire Irish Sea predicted mean summer densities ranged from approximately 0.8 animals per km^2 in years 1994 to 2000, to 5 animals per km^2 in 2001 to 2006 and 2007 to 2010 periods[2]. In winter, spring and autumn 2010, predicted mean densities reached approximately 2, 0.8 and 0.6 animals per km^2 respectively for the entire Irish Sea region. These high values are driven by the persistent high densities around Cardigan Bay and Anglesey (where the North Anglesey Marine SAC and the West Wales Marine SAC are designated for harbour porpoise), whereas lower densities of approximately 0.4 to 0.8 are seen around the Morgan marine mammal study area (0.4 in 1994 to 2000 and 2007 to 2010 periods and in summer 2010, 0.6 in winter 2010, and 0.8 in 2001 to 2006). The high densities observed in the Irish Sea are not located close to the Morgan marine mammal study area. The JCP Phase III data are heavily caveated: authors stated the JCP data comprises poor spatial and temporal coverage, and results should be considered indicative rather than an accurate representation of species density or abundances. The study also combines 38 data sources from 542 distinct survey platforms and therefore deriving robust density estimates from such heterogenous data is difficult and should be interpreted with caution.

1.7.2.17 This study builds upon the Phase One Data Analysis (Paxton and Thomas, 2010), which predicted density surfaces for harbour porpoise from data from 1980 to 2009. Densities for the Morgan marine mammal study area ranged from 0.25 to 0.1 animals per km^2 in 1983, 1990 and 1997, but higher densities in the regional marine mammal study area[3]. For example, 2004 showed much higher densities up to 1.25 animals per km^2 around Anglesey and the east coast of Ireland emphasising that densities can be driven by localised persistent densities.

1.7.2.18 Using JCP data, Heinänen and Skov (2015) were able to develop a spatial map showing those areas around the UK that supported persistent and ‘high’ (=>3.0 animals per km^2) of harbour porpoise, and subsequently used to inform designation of SACs for harbour porpoise. For the Irish Sea, three such areas of ‘high’ densities were

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[2] JCP Phase III densities are approximations read off density surface maps in the report (Paxton *et al.,* 2016), rather than derived from database. JDCP data was requested but not available currently.

[3] JCP Phase I densities are approximations read off the density surface prediction maps in the JCP report (Paxton and Thomas, 2010).

identified: the North Anglesey SAC (28.2 km to the south of the Morgan Array Area), the North Channel SAC (62.6 km to the northwest of the Morgan Array Area) and the West Wales Marine SAC (121.15 km south of the Morgan Array Area).

1.7.2.19 A study by Waggitt *et al*. (2020) collated diverse survey data to generate predicted distribution maps at 10 km resolution for 12 cetacean species (and 12 seabird species) using SDMs. The study confirmed harbour porpoise to be abundant year-round in the Irish Sea with higher densities towards the east of the Irish Sea (Figure 1.25). The predicted densities for harbour porpoise for the Morgan Array Area are given in Figure 1.26 (January to June) and Figure 1.27 (July to December) and shows higher density areas are present further inshore in the east of the Irish Sea, towards Liverpool Bay, from January to June but appears to show increased densities in offshore areas from June to October. Highest densities were predicted in March with 0.76 animals per km^2 in high density areas in the east Irish Sea. Estimate of densities in the Morgan marine mammal study area are lower, with an average density in August as 0.546 animals per km^2. It must be noted however, that such large-scale modelling is unlikely to identify small and isolated sub-populations of cetaceans.

1.7.2.20 Aside from boat and aerial surveys, other methods of data collection have been utilised to give density estimates. Evans *et al*. (2015) analysed long term effort-related land-based observations, to identify occurrence and abundance in coastal areas around the UK, using data from 678 sites all around the UK coastline. Effort was concentrated during summer months from May to September, therefore is not reflective of year-round distributions. Count rate was provided alongside GAM-based predictions of density for each MU, and found porpoises were widely distributed throughout the Celtic and Irish Sea MU, with hotspots in west and north Pembrokeshire coast, and northwest and north coasts of Anglesey – confirming studies by Shucksmith *et al*. (2009), Gordon *et al*. (2011) and Heinänen and Skov (2015) that suggested high densities in these areas.

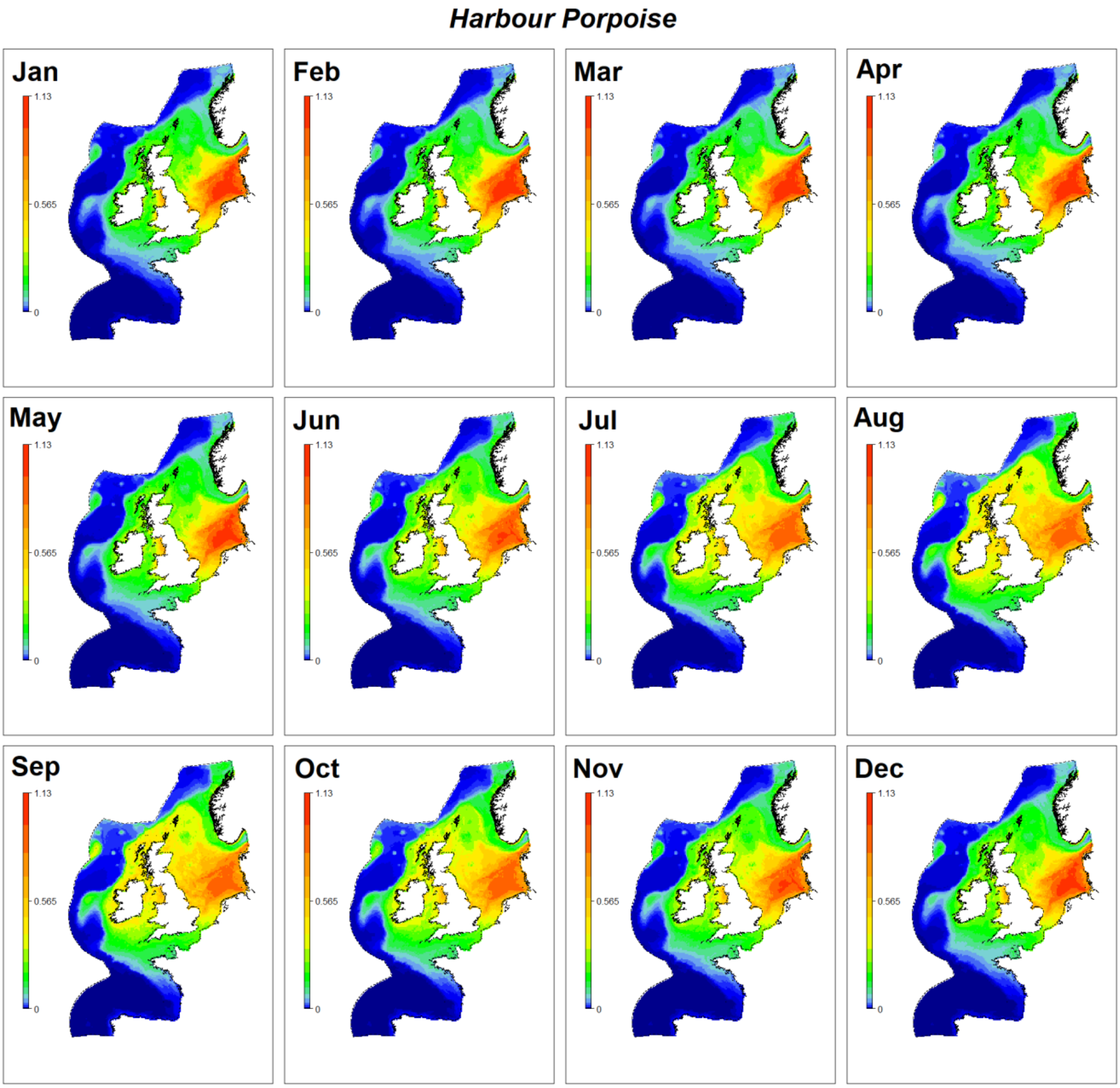


Figure 1.25: Predicted distributions for harbour porpoise per month for the entire study area, from Waggitt *et al.* (2020).

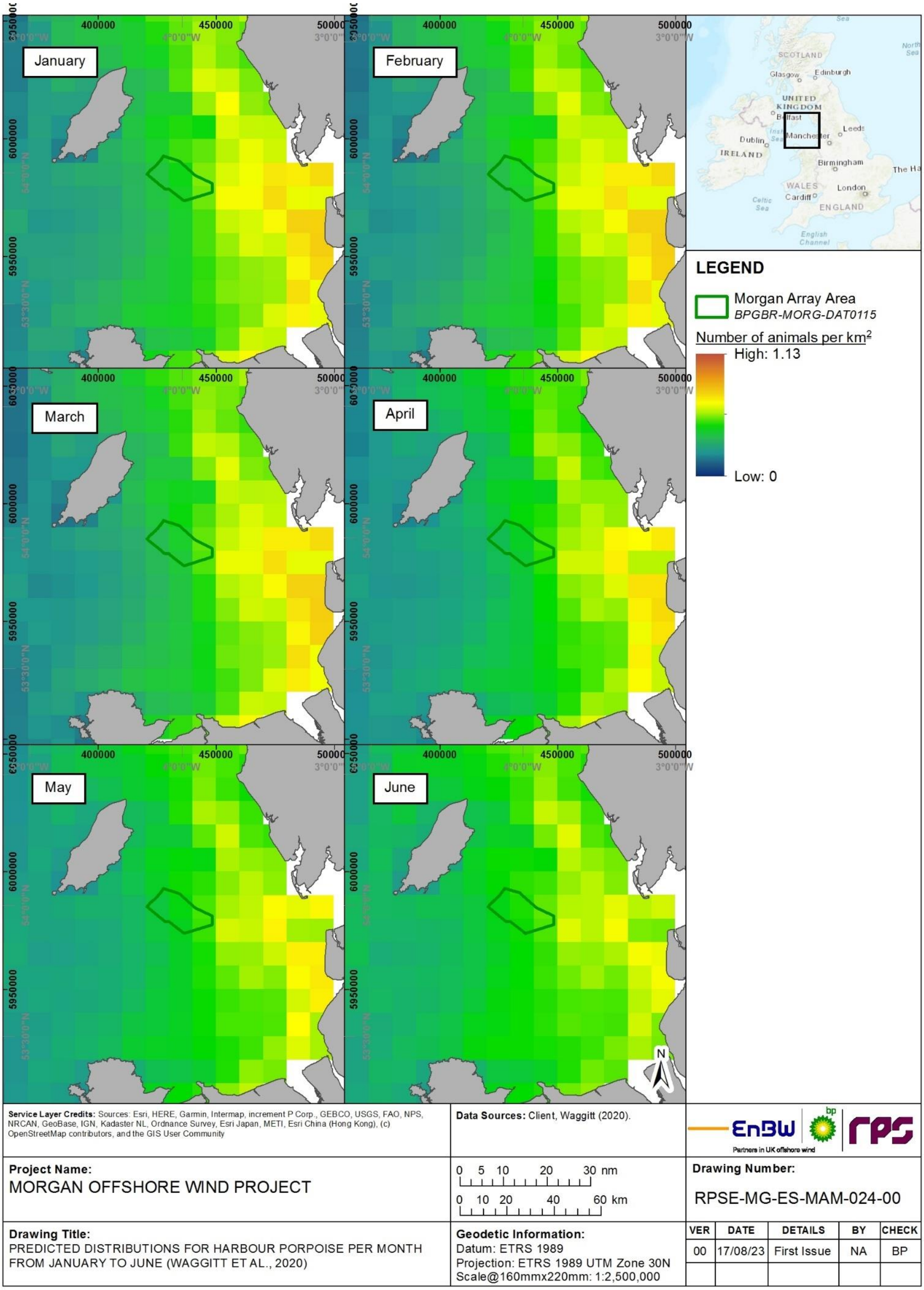
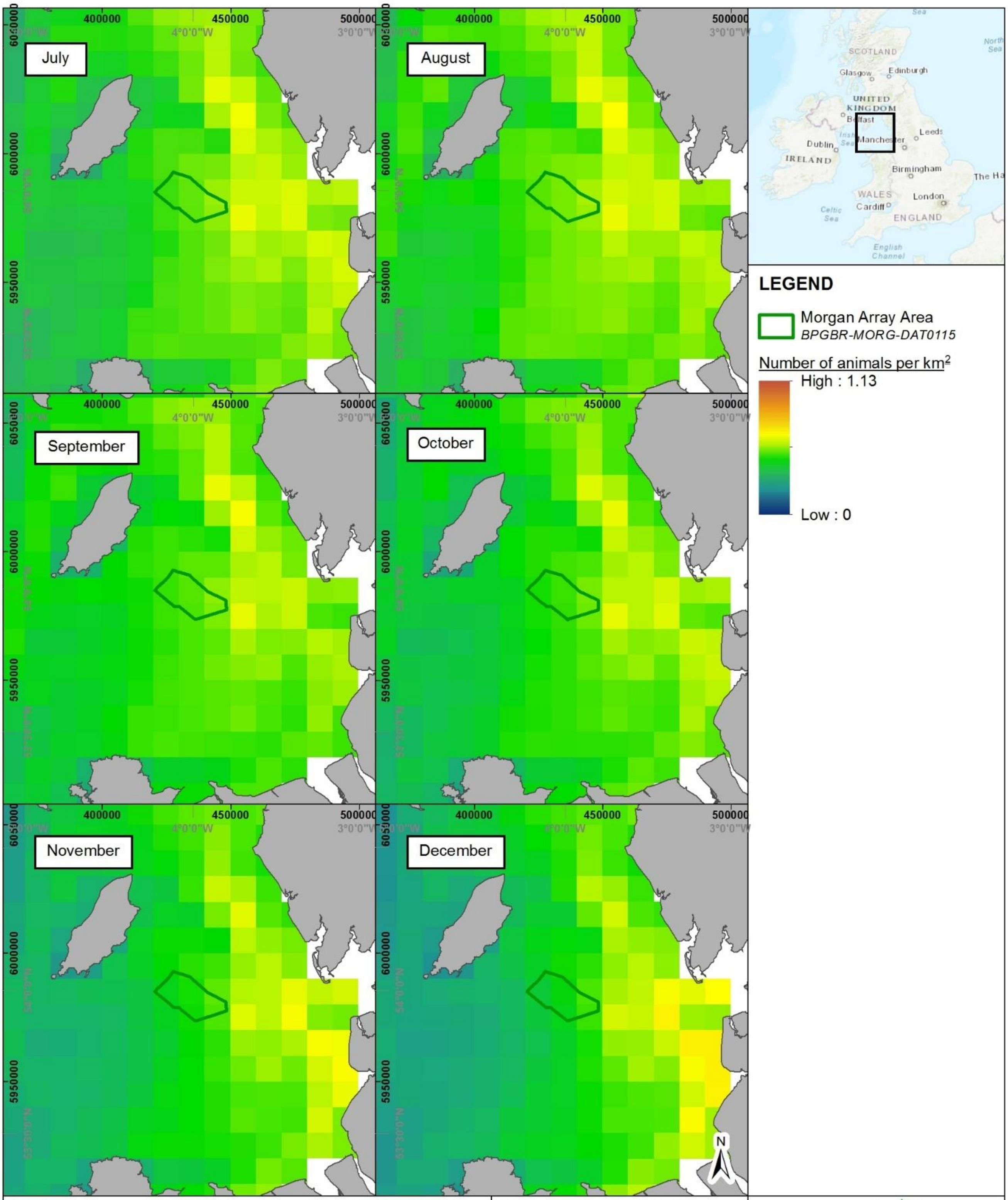


Figure 1.26: Predicted distributions for harbour porpoise per month from January to June (Waggitt *et al.*, 2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

Drawing Number:
RPSE-MG-ES-MAM-025-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR HARBOUR PORPOISE PER MONTH FROM JULY TO DECEMBER (WAGGITT ET AL., 2020)

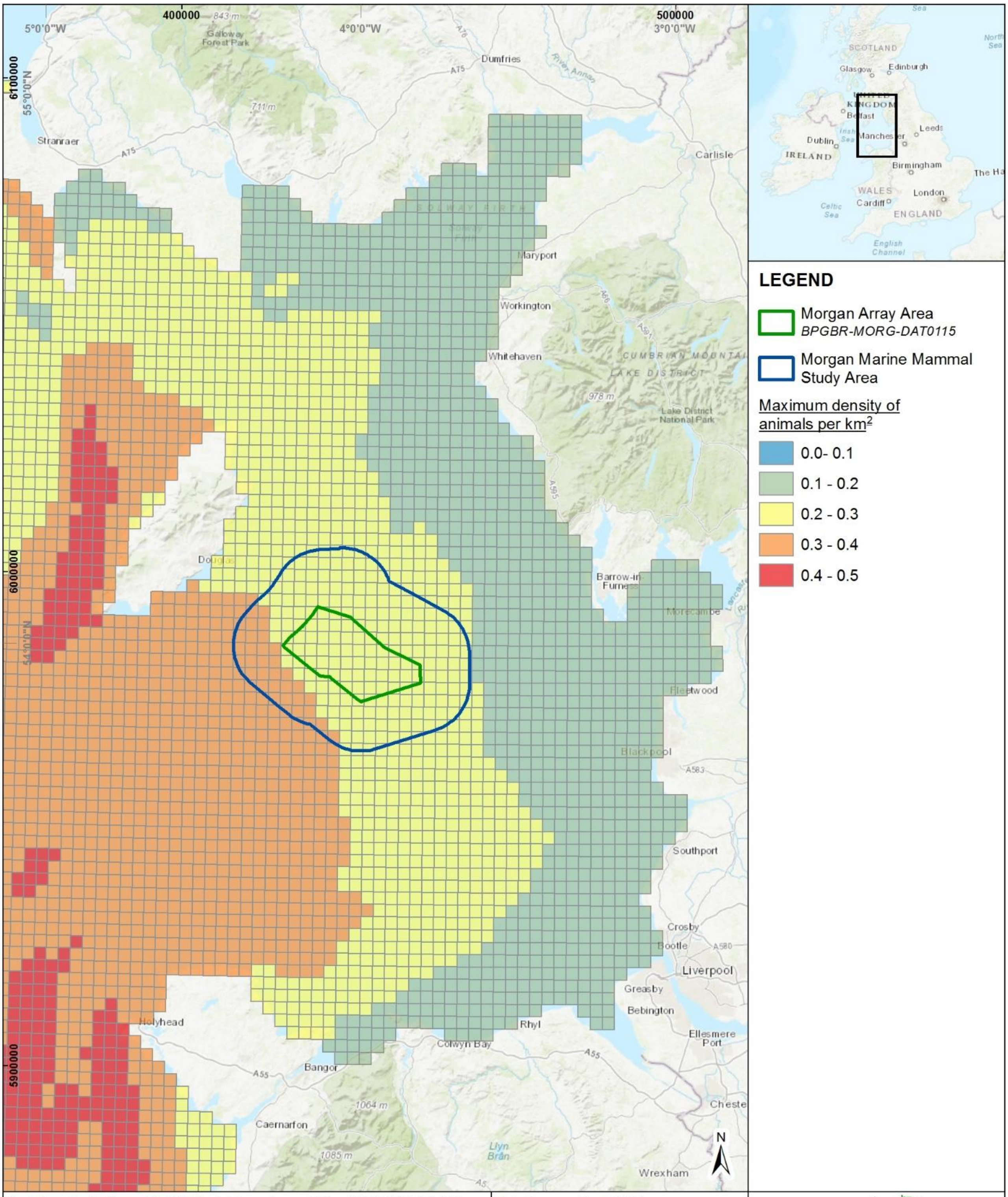
Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	BP

Figure 1.27: Predicted distributions for harbour porpoise per month from July to December (Waggitt *et al.*, 2020).

1.7.2.21 Modelled outputs at 2.5 km^2 resolution from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) indicated areas of high density between north Anglesey and the Isle of Man, as well as the outer part of Cardigan Bay, west Pembrokeshire, and along east Ireland (the coastal area particularly from County Dublin south to County Waterford). Lower densities were reported for the Celtic Deep and north coast of Cornwall. When densities are modelled by quarter (measured as the mean density per cell across months within a season), highest densities were observed in July to September.

1.7.2.22 The average density for the Morgan marine mammal study area from the annual composite maps (as recommended by NRW and authors of the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023), and agreed with Natural England, see paragraph 1.5.16.4) was 0.262 animals per km^2. As set out in paragraph 1.5.16.4 this density estimate is highly precautionary as this is the highest value observed for each cell (2.5 km^2 resolution) at any one point in time. A slightly lower average density was estimated for the Morgan Array Area only (i.e. not including the 10 to 13.3 km buffer), calculated as 0.260 animals per km^2.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, NRW

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-026-00

Drawing Title:
HARBOUR PORPOISE ANNUAL COMPOSITE MODELLED DENSITIES (MEASURED AS THE MAXIMUM DENSITY PER CELL ACROSS MONTHS) FROM THE WELSH MARINE MAMMAL ATLAS (EVANS AND WAGGITT, 2023)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,300,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	LB

Figure 1.28: Harbour Porpoise annual composite modelled densities (measured as the maximum density per cell across months) from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023).

1.7.2.23 Aside from boat and aerial surveys, other methods of data collection have been utilised to give density estimates for context in the Morgan marine mammal study area. Evans *et al*. (2015) analysed long term effort-related land-based observations, to identify occurrence and abundance in coastal areas around the UK, using data from 678 sites all around the UK coastline. Effort was concentrated during summer months from May to September, therefore is not reflective of year-round distributions. Count rate was provided alongside generalised additive model (GAM) based predictions of density for each MU. Evans *et al*. (2015) found porpoises were widely distributed throughout the Celtic and Irish Sea MU, with hotspots along the west and north Pembrokeshire coast, and the northwest and north coasts of Anglesey. This confirms studies by Shucksmith *et al*. (2009), Gordon *et al*. (2011) and Heinänen and Skov (2015) that suggested high densities in these areas.

Isle of Man

1.7.2.24 Several studies have focused on more localised areas, including the waters around the Isle of Man, thus giving more detailed densities for a smaller spatial area. Detailed in the cetacean chapter of the Manx Marine Environmental Assessment (Howe, 2018a), boat-based surveys undertaken around the Isle of Man between 2006 and 2010 recorded sightings of porpoise year-round, with an estimated average density of 0.207 animals per km^2 (CV = 0.211) (Howe, 2018a). There were slightly higher sightings per km^2 in summer (0.038 sightings per km^2) than in winter (0.038 sightings per km^2) and a level of seasonal onshore movement in Manx waters suggested by Howe (2018a), but these sighting rates do not reflect actual porpoise densities. The MWDW opportunistic and effort based sighting data from 2006 to 2022 showed that harbour porpoise were sighted as recently as 2022 (14/01/2022), and 409 were sighted in 2021 (MWDW, 2022). During MWDW vessel-based marine mammal surveys across Manx waters between 2007 and 2021, harbour porpoise were sighted 769 times (representing 80% of sightings). In 2021, harbour porpoise sightings represented 36 (75 individuals) of the 47 cetacean sightings (Manley, 2021). These studies are limited to Manx waters, but aid in providing detailed estimates for more localised areas.

Anglesey and Cardigan Bay

1.7.2.25 Other small-scale surveys report higher densities of harbour porpoise in areas such as Anglesey and Cardigan Bay. For example, Gordon *et al.* (2011) estimated there to be 0.38 animals per km^2 around The Skerries (64.64 km to the west of the Morgan Array Area) and Carmel Head (68.36 km to the west of the Morgan Array Area) whilst Shucksmith *et al*. (2009) provided a density estimate of 0.630 animals per km^2 (CV = 0.20) for the waters around Anglesey (58.51 km to the south of the Morgan Array Area). As described previously (paragraph 1.7.2.18) Heinänen and Skov (2015) reported areas of 'high' summer densities in 2000 to 2005 and 2006 to 2011 around Anglesey. Predicted summer densities for 2003 demonstrated 'high' densities between the Isle of Man and Anglesey, similar to Baines and Evans (2012), but these predicted densities were lower during summer 1997 and 2009. Persistent 'high' density areas during summer are identified to the south and east of the Morgan marine mammal study area (Figure 1.29) but not during winter (Figure 1.30) and do not overlap with the Morgan Array Area.

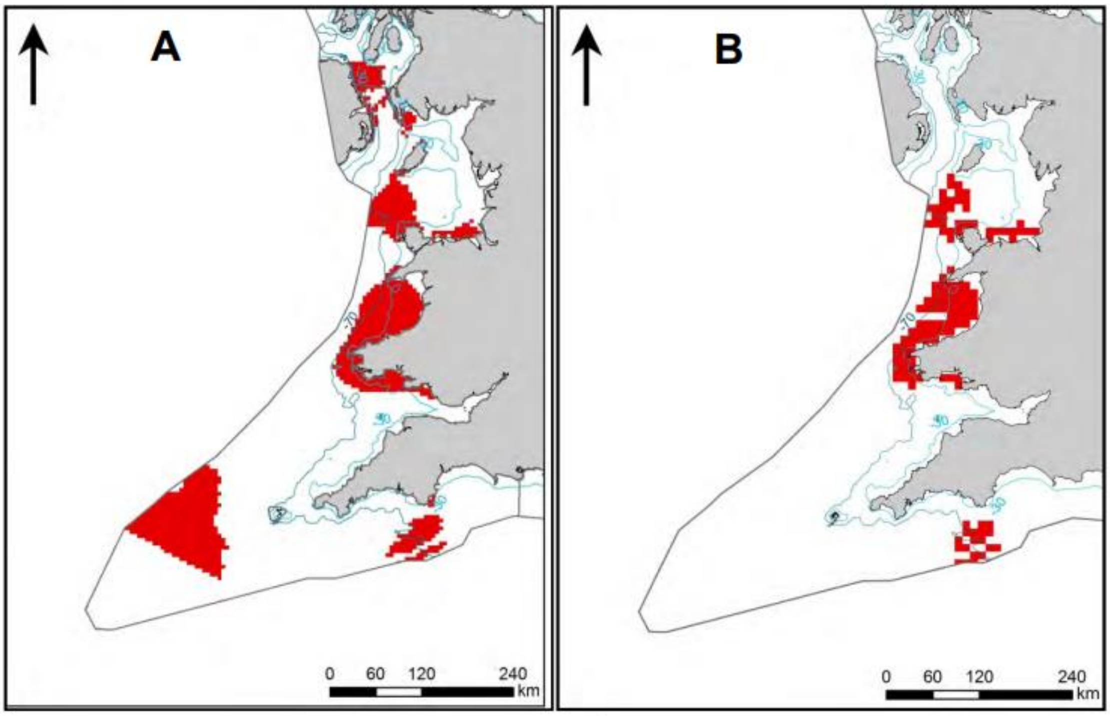


Figure 1.29: **Persistent high-density areas identified and selected in Management Unit 0 during summer, from Heinänen and Skov (2015). In map A the red colours mark areas with where persistent high densities as defined by the upper 90th percentile have been identified. In the map B the red colours mark persistent high-density areas with survey effort from three or more years.**

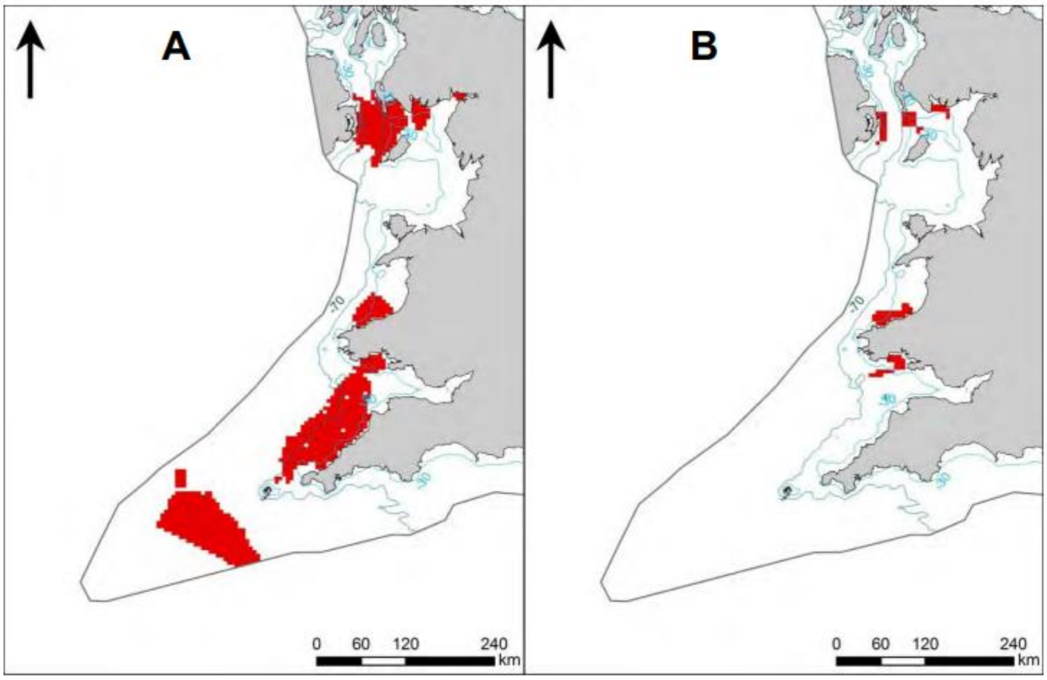


Figure 1.30: **Persistent high-density areas identified and selected in Management Unit 0 during winter, from Heinänen and Skov (2015). In map A the red colours mark areas with where persistent high densities as defined by the upper 90 percentile have been identified. In map B the red colours mark persistent high-density areas with survey effort from three or more years.**

1.7.2.26 More recently, several consenting surveys have provided further fine-scale local density data for harbour porpoise. Wylfa Newydd nuclear power station is located approximately 65 km to the southwest of the Morgan Array Area, west of Cemaes Bay on the island of Anglesey, off the northwest coast of Wales. The Wylfa Newydd nuclear power station surveys (Jacobs, 2018) gave estimates of harbour porpoise relative density of 0.323 porpoise per km^2. This assumes that the probability of detection of an animal on the track line (g(0)), or perception bias, is = 1, (i.e. assumes every animal on the track line is detected). This unlikely to be the case for marine mammals who spend much of their time below the surface. Therefore when using probability of detection as g(0) = 0.5 (50% of the number of animals on the track line are detectable) densities were 0.646 porpoise per km^2 (Jacobs, 2018).

1.7.2.27 Site-specific boat surveys were used to inform the baseline characterisation for the MDZ (Royal Haskoning DHV, 2019) which is located in West Anglesey, off the coast of Holy Island, approximately 54 km southwest of the Morgan Generation Assets. The density estimate range from the site surveys were 0.5 to 1 animal per km^2. Densities were highest in January 2017 (1 porpoise per km^2, 95% CI = 0.02 to 1.11), similar to the Wylfa Newydd surveys which also had highest rates in January. The average estimated relative density within the Morlais site was 0.213 porpoise per km^2, and 0.218 porpoise per km^2 in the 2 km buffer area. Dedicated harbour porpoise boat-based surveys have also been conducted off West Anglesey by SEACAMS (SEACAMS, 2019), which included the Morlais site. Eighteen surveys were conducted between January 2015 and December 2016. The SEACAMS gave relative densities of individuals as 0.43 animals per km^2 (CV = 0.18), but correcting for incomplete detection (g(0) = 0.61) density ranged from 0.714 (CV = 0.33) to 0.852 (CV = 0.33) individuals per km^2.

1.7.2.28 In surveys for Rhiannon Wind Farm (Celtic Array Ltd., 2014), estimated density abundance of harbour porpoise within the ISZ based on encounters recorded during visual and acoustic boat-based surveys was given at 0.02 animals per km^2 from visual sightings, 0.12 animals per km^2 for acoustic detection (good and moderate combined) and 0.09 animals per km^2 for acoustic detection (good) (see section 1.5.3 for further explanation of categories). Aerial surveys of the Irish Sea Zone produced an overall density of 0.09 per km^2 for the Zone over the entire year.

1.7.2.29 Recent site-specific survey data from April 2019 to February 2021 for the baseline characterisation for AyM Offshore Wind Farm, which is located approximately 47 km to the south of the Morgan Array Area, confirmed a total of 27 harbour porpoise in monthly digital still aerial surveys by APEM over the survey period, but data was not sufficient for estimating densities within the area.

1.7.2.30 From two years of aerial surveys at Mona Offshore Wind Project (Mona Offshore Wind Ltd, 2024), a mean absolute density of 0.079 animals per km^2 per month was estimated from design-based approach for the Mona Aerial Survey Area, with highest densities in July (0.175 animals per km^2) and lowest densities in April (0.012 animals per km^2). Model-based densities averaged as 0.014 animals per km^2 per month, with highest densities in January (0.066 animals per km^2, 95% CL = 0.040 to 0.096) and lowest densities in April (0.002 animals per km^2, 95% CL = 0.001 to 0.003). Design-based approaches gave densities of 0.097 and 0.061 animals per km^2 for winter and summer respectively. Mean absolute density from the model-based approach was 0.022 for Winter (95% CL = 0.005 to 0.041, CV = 0.5) and 0.013 for Summer (95% CL = 0.005 to 0.023, CV = 0.478).

1.7.2.31 Both design-based and model-based relative and absolute densities from the aerial digital survey data for the Morgan Aerial Survey Area are given in full in Appendix A.

A mean absolute density of 0.189 animals per km^2 per month was estimated for the Morgan Aerial Survey Area from a design-based approach, with highest densities in August (0.307 animals per km^2, 95% CL = 0.250 to 0.375) and lowest densities in November (0.053 animals per km^2, 95% CL = 0.043 to 0.065). For model-based densities a mean absolute density of 0.056 animals per km^2 per month, with highest densities in October (0.118 animals per km^2, 95% CL = 0.055 to 0.181) and lowest densities in September (0.012 animals per km^2, 95% CL = 0.000 to 0.029).

1.7.2.32 For the model-based approach, the most robust (and biologically relevant) model was developed by combining the data by 'bio-season' specific to harbour porpoise. As discussed in more detail in Appendix A, dividing the year into bio-seasons is an accepted approach which supports the designation of SACs (Heinänen & Skov, 2015). The mean absolute density (animals per km^2) for the model-based approach was 0.050 for winter (95% CL = 0.034 to 0.067, CV = 0.860) and 0.062 for summer (95% CL = 0.043 to 0.082, CV = 0.647). A similar approach was applied to design-based estimates; mean absolute density (animals per km^2) for winter was 0.159 (95% CL = 0.130 to 0.194, CV = 0.740) and 0.219 for summer (95% CL = 0.179 to 0.268, CV = 0.518).

1.7.2.33 Spatial modelling using linear models showed harbour porpoise density appears to have concentrations of occurrence in the northwest and southeast parts of the Morgan Aerial Survey Area (density maps are presented in Appendix A) particularly in the summer bio-season. Full details of the modelling approach are set out in Appendix A.

Summary of densities

1.7.2.34 Overall, harbour porpoise are abundant throughout the Irish Sea with areas of high density found in the east Irish Sea, where the Morgan marine mammal study area is located. A comparison of harbour porpoise densities from key data sources which overlap the Morgan marine mammal study area is shown in Table 1.7.

1.7.2.35 The predicted estimate of mean densities for the Morgan marine mammal study area and Morgan Array Area from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) are comparable to the SCANS-III block E estimate (Hammond *et al.,* 2021), but provide densities derived from higher resolution data than block E of the SCANS-III surveys (2.5 km^2 resolution, compared to a single estimate over 34,870 km^2). Densities from the northeast Atlantic distribution maps (Waggitt *et al.*, 2020) and SCANS-III DSM data (Lacey *et al.*, 2022) are derived from slightly lower resolution data (10 km resolution for both datasets) compared to the Welsh Marine Mammal Atlas data. In addition, the Welsh Marine Mammal Atlas data is specific to the Irish Sea, in which the Morgan Generation Assets is located, whereas data from SCANS -IV, SCANS-III, the northeast Atlantic distribution maps and SCANS-III DSM data cover far larger geographic areas. Furthermore, densities from the Welsh Marine Mammal Atlas are higher than absolute densities from Morgan aerial surveys.

1.7.2.36 The density taken forward to assessment is the density for the Morgan marine mammal study area from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) (highlighted in bold in Table 1.7) as a precautionary but proportionate density for the area. This choice of density was consulted upon, and densities agreed via the Marine Mammal EWG for the Morgan Generation Assets.

Table 1.7: Comparison of harbour porpoise densities from key data sources.

a. Note Welsh Marine Mammal Atlas data (Evans and Waggitt, 2023) are presented for both the Morgan array area only and the Morgan marine mammal study area (Morgan Array Area plus 10 km to 13.3 km buffer).

Source	Density (animals per km^2)	Estimate of variation
SCANS-IV – block CS-E (Gilles *et al.*, 2023)	0.5153	0.250 (CV)
SCANS-III - block E (Hammond *et al.*, 2021)	0.239	0.282 (CV)
SCANS-III – block F (Hammond *et al.*, 2021)	0.086	0.383 (CV)
SCANS-III DSM for the Morgan marine mammal study area (Lacey *et al.*, 2022)	0.411	0.191 (CV)
APEM aerial survey bio-season design based for the Morgan Generation Assets – absolute densities	Winter = 0.159 Summer = 0.219	Winter (95% CIs = 0.130 to 0.194) Summer (95% CIs = 0.179 to 0.268)
Northeast Atlantic distribution maps (Waggitt *et al.*, 2020) for the Morgan marine mammal study area for August (peak month)	0.546	0.530 to 0.564 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023)[a] for the Morgan Array area from annual composite maps	0.260	0.242 to 0.281 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) for the Morgan marine mammal study area from annual composite maps	**0.262**	**0.244 to 0.283 (95% CIs)**

Abundance

1.7.2.37 Abundance estimates for harbour porpoise vary considerably depending on the dataset and spatial scale. For the relevant MU for harbour porpoise (Celtic and Irish Seas MU) the abundance is estimated as 62,517 (CV = 0.13, 95% CI = 48,324 to 80,877) individuals (IAMMWG, 2021). These abundance estimates are based on the results of the SCANS-III surveys (Hammond *et al.*, 2017) and ObSERVE Programme (Rogan *et al.*, 2018). Abundance estimates from SCANS-III gave 8,320 animals for Block E (95% CI = 4,643 to 14,354) and 1,056 animals (95% CI = 342 to 2,010) for Block F. Recent SCANS-IV estimates for block CS-E gave 6,325 animals (95% CI = 3,663 to 10,162). JCP Phase III gave predicted abundances for the Irish sea by season; winter abundance for harbour porpoise was 4,600 animals; spring was 2,300 animals; summer was 3,200 animals; and autumn had 2,000 animals (Paxton *et al.*, 2016).

1.7.2.38 ObSERVE surveys were conducted in the offshore waters of Ireland between 2015 and 2017 (Rogan *et al.*, 2018), within Stratum 5 (western Irish Sea) of relevance to the regional marine mammal study area. Whilst a total of 256 porpoises were recorded across the entire survey area, corrected design-based estimates and model-based estimates were given for each season (Summer 2015, Winter 2015, Summer 2016, Winter 2016). Corrected abundance estimates ranged from 7,494.6 animals (CV = 35.7, 95% Cl = 4,789.0 to 11,728) in summer 2015 to 11,624.5 animals (CV = 28.2, 95% Cl = 87,25.8 to 15,486.0) in summer 2016. Estimates for the winter season were lower compared to summer (Figure 1.31).

1.7.2.39 In surveys for Rhiannon Wind Farm (Celtic Array Ltd., 2014), estimated density abundance of harbour porpoise within the ISZ based on encounters recorded during visual and acoustic boat-based surveys was given at 0.02 animals per km^2 from visual sightings, 0.12 animals per km^2 for acoustic detection (good and moderate combined) and 0.09 animals per km^2 for acoustic detection (good) (see section 1.5.3 for further explanation of categories). Aerial surveys of the Irish Sea Zone produced an overall density of 0.09 per km^2 for the Zone over the entire year.

1.7.2.40 Several historical studies had more localised abundance values targeting known high-use areas by cetaceans (Anglesey and Cardigan Bay), meaning higher survey coverage and effort. Dedicated visual surveys in Anglesey comprising of 31 transect line surveys between 2002 and 2004 gave abundances of 309 individuals (CV = 0.20) for the 489 km^2 study site.

1.7.2.41 SWF carried out line transect surveys in Cardigan Bay SAC during April to October in 2005, 2006 and 2007 and although an increase in abundance was seen over this period (from 107 to 214 animals) this was still slighter lower than recorded in previous years (e.g. 236 in 2003 and 215 in 2004). Later, in July 2011, line-transect surveys carried out in Cardigan Bay SAC, Pen Llŷn a’r Sarnau SAC and outer Cardigan Bay generated an abundance estimate of 990 individuals for the combined area (95% Cl = 585 to 1673) albeit with a high CV (27.1) (Veneruso and Evans, 2012). For Cardigan Bay SAC only, abundance estimates were 302 individuals (95% Cl = 129 to 711) which was deemed low compared to other studies but again a high CV (44.61) suggests this estimate may be highly variable. Further to this, line transect surveys and ab libitum boat surveys were continued in summer months from July 2011 to October 2013 by SWF within Cardigan Bay and Pen Llŷn a’r Sarnau SAC (Feingold and Evans, 2014). Abundance estimates ranged from 1074 (CV 28.73, 95% Cl 634 to 1821) in 2011 to 410 (CV 20.42, 95% Cl = 298 to 564) in 2013. Total encounter rates from *ad libitum* surveys ranged between 0.003 animals per km to 0.052 animals per km.

1.7.2.42 The Mona aerial digital surveys presented in Mona Offshore Wind Ltd (2024) gave both relative and absolute abundance estimates per month. The average means absolute abundance (i.e. corrected for availability bias) for the area was 114 animals in the Mona Aerial Survey Area per month. Mean absolute abundance across the months ranged from 17 animals (in April) to 252 animals (in January). When combined by meteorological season, winter had the highest absolute abundance estimates with 207 animals in the survey area, whilst spring had the lowest with 56 animals. When using bio-season, winter had an abundance of 140 animals in the area and 88 animals during the summer.

1.7.2.43 The Morgan aerial digital surveys gave both relative and absolute abundance estimates per month (full details in Appendix A). For the Morgan Aerial Survey Area, the average mean absolute abundance for the area was 261 animals per month. Mean absolute abundance across the months ranged from 74 animals (in November) to 423 animals (in August). When applying bio-seasons, abundance was calculated for winter as 220 animals and summer as 303 animals.

1.7.2.44 The MMOb and Passive Acoustic Monitoring (PAM) Report also provides sightings data for visual and acoustic monitoring during the Applicant's targeted integrated surveys in the Irish Sea. During these surveys there were three visual sightings of harbour porpoise from April 2022 to May 2022.

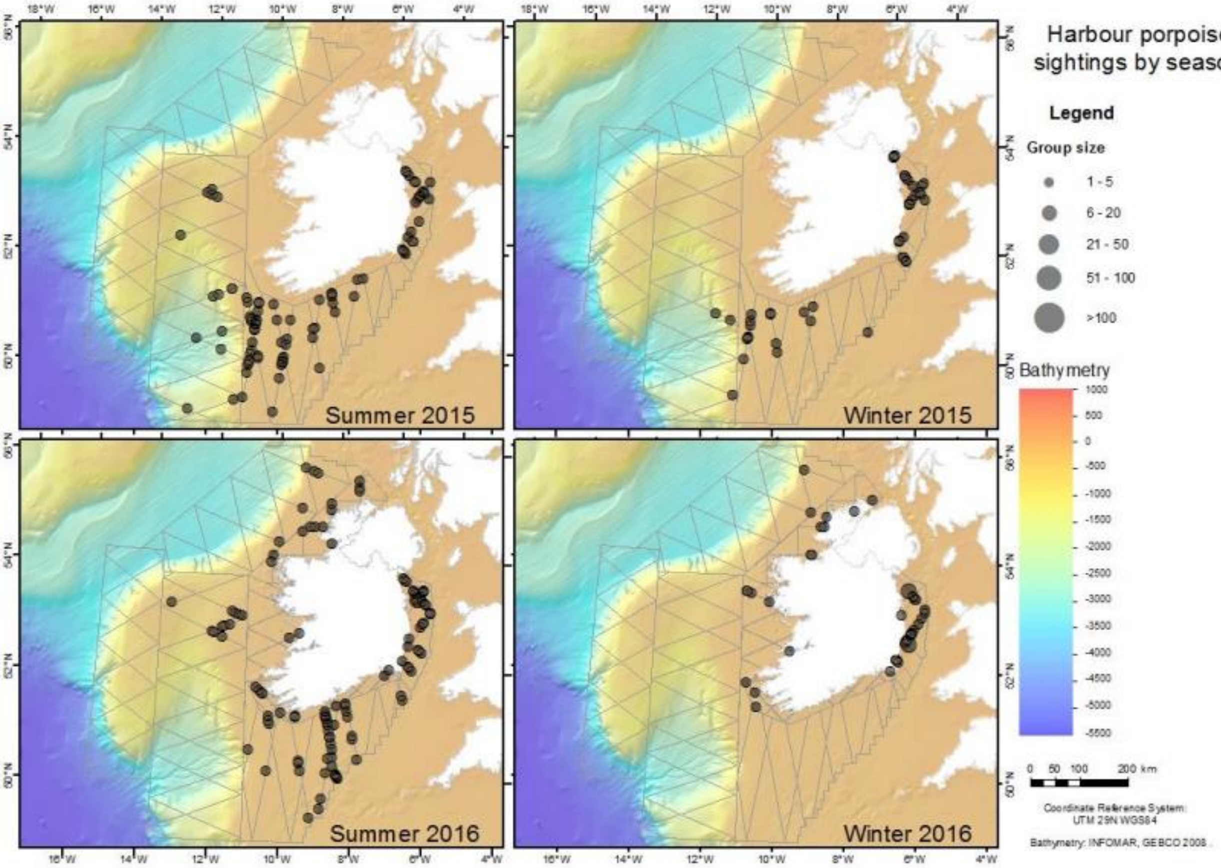


Figure 1.31: Sightings of harbour porpoise in each survey period (bottom). Grey lines indicate the survey tracklines along which sightings were made. Circles are proportional to the estimated number of porpoises seen in each sighting. From Rogan *et al.* (2018).

Seasonality

1.7.2.45 The Atlas of the Marine Mammals of Wales considers harbour porpoise to be present year-round in the Irish Sea (Baines and Evans, 2012). The northeast Atlantic distribution maps (Waggitt *et al.*, 2020) (Figure 1.26) showed moderate densities year-round towards the east of the Irish Sea, overlapping the Morgan marine mammal study area, with increased densities further inshore towards Liverpool Bay. However, during the Wylfa Newydd surveys around the north of Anglesey there were higher sighting rates in January compared to summer months (Jacobs, 2018) and was similar to seasonality found during the MDZ surveys (Royal Haskoning DHV, 2019) which also had highest densities in January 2017. These findings corroborated the JCP Phase III results, where highest densities of harbour porpoise were recorded during winter months (Paxton *et al.,* 2016). MWDW data shows there are sightings of harbour presence year-round in Manx waters but given they are combined sightings from boat-based surveys and opportunistic data, it lacks temporal or spatial context to draw conclusions on seasonality.

1.7.2.46 MWDW data shows there are sightings of harbour porpoise year-round in Manx waters. This data is a combination of boat-based surveys and opportunistic sightings. However, data has not been analysed in the context of effort and therefore it is not possible to draw direct conclusions on seasonality. However, MWDW have provided the information that "*the 16 years of sightings data showing consistency in the temporal observation of each species would seem to reflect a true seasonality of these cetaceans in Manx waters. This is further supported by noting public records of cetaceans are received year-round indicating that lower winter survey effort has not created a false seasonality*" (MWDW, personal communication, June 2023).

1.7.2.47 Model results from Heinänen and Skov (2015) indicated that water depth, surface sediments, current speed and eddy potential all play a major role as determinants of the distribution of harbour porpoise in this MU, during the summer season. Porpoise calves occur throughout the regional marine mammal study area (Baines and Evans, 2012). The calving period for harbour porpoise is primarily between May and July, when sea temperatures are increasing (Sørensen and Kinze 1994; Lockyer, 1995; Börjesson and Read 2003; Learmonth *et al.*, 2014).

1.7.2.48 In the Morgan aerial survey data, there was very little evidence of seasonality when modelled by bio-season, with similar densities in winter (mean absolute density = 0.050, CV = 0.860) and summer (0.062, CV = 0.647). The low confidence in the model and high CVs mean that interpretation of the results with respect to seasonal distinctions is difficult. The absolute density from design-based estimates also reflected similar density in winter (mean density = 0.159, CV = 0.740) compared to summer (mean density = 0.219, CV = 0.518).

1.7.3 Bottlenose dolphin

Ecology

1.7.3.1 Bottlenose dolphin are members of the family Delphinidae, which are oceanic dolphins found in temperate and tropical waters worldwide. The largest of the beaked dolphin, this species ranges in size from 1.9 to 3.8 m and can live, on average, between 20 to 30 years. On average, males reach sexual maturity at 10 to 12 years and females at five to 10 years. Mating occurs during the summer months, with gestation taking 12 months and calves suckling for 18 to 24 months. Females generally reproduce every three to six years (Mitcheson, 2008).

1.7.3.2 There is variation in the patterns of habitat use of bottlenose dolphin, even within a population, and generally the distribution of this species is influenced by factors such as tidal state, weather conditions, resource availability, life cycle stage, or season (Hastie *et al.,* 2004). A study of the stomach contents of 12 bottlenose dolphin in Irish waters gave total of 37 prey taxa, suggesting that they have a broad diet, but the main prey items were species of gadoid fish (pollack, saithe, haddock, blue whiting and whiting) (Hernandez-Milan *et al.,* 2015). This is similar to those typical prey items for bottlenose dolphin in Scottish waters which included cod, saithe, salmon and haddock (Santos *et al.,* 2001). Differences in diet were also found among these populations, where their stomach contents suggest that these animals might be foraging in different habitats. Significant differences were also found between male and female dolphin diet, with males having eaten a wider variety of prey items than females.

1.7.3.3 Bottlenose dolphin are frequently seen in groups rather than individually, although group size in coastal populations may be smaller than offshore populations; however, very little is known about offshore populations (Rogan *et al.*, 2018). Studies on bottlenose dolphin in Cardigan Bay suggest distance from coast had a significant effect on encounter rates, with the dolphins favouring habitat as close as five kilometres from the coast. They also showed a preference for shallow waters (5 to 10 m deep) and gentle slopes (Pesante *et al.*, 2008).

Distribution and occurrence

1.7.3.4 Bottlenose dolphin are found in warm and temperate waters globally and are widely distributed in the North Atlantic. In the Irish Sea, they appear to have a predominantly coastal distribution (Baines and Evans, 2012), although low densities have been recorded offshore, particularly in St George's Channel and the southwest area of the Irish Sea (Baines and Evans, 2012). Surveys have indicated bottlenose dolphin have a strong preference for coastal waters (Feingold and Evans, 2014; Pesante *et al.*, 2008). In the Atlas of the Marine Mammals of Wales (Baines and Evans, 2012) regular sightings of bottlenose dolphin were confirmed across the Irish Sea study area, with areas of high counts per kilometre seen in Cardigan Bay and Anglesey (Figure 1.31) (Baines and Evans, 2012; Evans *et al*., 2015). JCP Phase III data also demonstrated bottlenose dolphin were essentially coastal, with consistent regions of high density in Cardigan Bay, the Moray Firth and the west coast of Ireland (Paxton *et al*., 2016*).* Data from MWDW shows bottlenose dolphin are widespread in Manx waters around the Isle of Man, extending out towards the Morgan Array Area, but no sightings were located within the Morgan Array Area (Figure 1.14).

1.7.3.5 There is evidence of large home ranges for bottlenose dolphin, but in the Irish sea their distribution is largely coastal (Oudejans *et al.*, 2015; Paxton *et al.,* 2016). In Anglesey for example, the majority (83%) of sightings by SWF were located within six kilometres from the coastline (Feingold and Evans, 2014). Therefore, it can be reasonably assumed that most bottlenose dolphin will be located within that 6 km region from the coastline, and those coastal areas may be comparable to other high use areas in the regional marine mammal study area (such as in outer Cardigan Bay which has higher densities, as described in Lohrengel *et al.,* 2018). Further offshore, towards the Morgan Array Area, lower densities may be more reflective of the offshore bottlenose dolphin distributions. The Welsh Marine Mammal Atlas demonstrates high densities along the coastal region of Cardigan Bay (Evans and Waggitt, 2023; Figure 1.38).

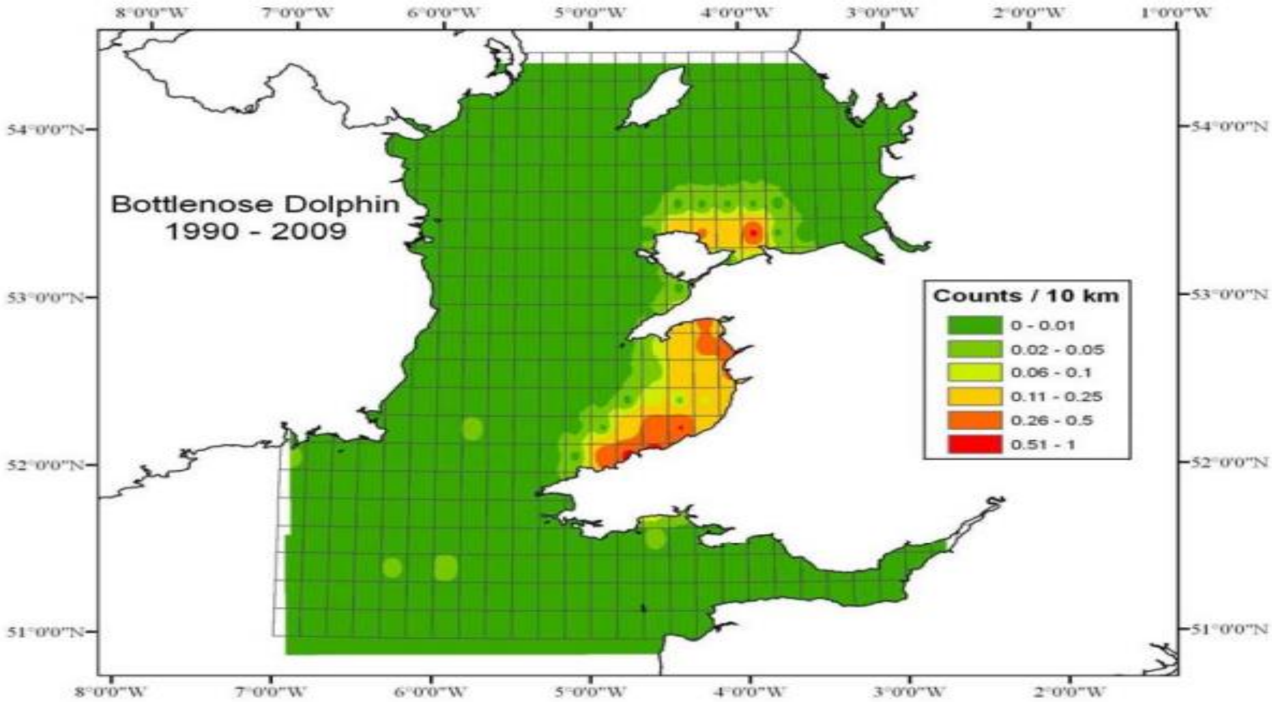


Figure 1.32: Inverse Distance Weighted interpolated map of bottlenose dolphin distribution, from Baines and Evans (2012).

1.7.3.6 In UK territorial waters there are two semi-resident groups of bottlenose dolphin, in Cardigan Bay and the Moray Firth (Wilson *et al.*, 1997). These two areas have been designated due to the Annex II species presence, with the Moray Firth in northeast Scotland supports the only known resident population of bottlenose dolphin in the North Sea (JNCC, 2022f) where dolphins are present all year round. There is also a resident population in the Shannon Estuary, Ireland (Ingram and Rogan, 2002; 2003).

Connectivity with Manx waters

1.7.3.7 Bottlenose dolphin from Cardigan Bay are likely interact with animals in waters of southwest UK and south Ireland and are likely to be moving and exchanging with more distant populations (Pesante *et al.,* 2008), with population having a wide habitat range up to the Isle of Man (Duckett, 2018). Howe (2018a) confirmed movement of individuals between Manx waters and Cardigan Bay using comparison of photo ID catalogues in the two areas.

1.7.3.8 Howe (2018a) suggested bottlenose dolphins in Manx waters are highly temporal and sighted only in winter months (between late August and March) where the waters provide vital habitat during these months. There was no observed spatial pattern in terms of the distribution of sightings in Manx waters (Howe, 2018a), and this is also reflected in MWDW sighting data (Figure 1.14) which shows sightings around the entire coastline of the Isle of Man. In contrast to the winter seasonal distribution around Manx waters, bottlenose dolphins occupy the waters around Cardigan Bay during summer months, reflecting the use of this area as a key calving area for the species. The majority of pregnant females are thought to give birth in the inshore waters around Cardigan Bay (Duckett, 2018). However, after giving birth many individuals moved out of Cardigan bay and travelled north of the Llŷn Peninsula, into the waters of the south Irish Sea with calves within two years of giving birth (Duckett, 2018).

1.7.3.9 Although there is evidence of site fidelity in coastal bottlenose dolphin populations Robinson *et al.* (2012) showed that there were long distance movements by individuals between UK and Irish Waters. Eight individuals, monitored over a 10-year period (2001 to 2010), were resighted within coastal areas in the Moray Firth, Inner Hebrides and Shannon Estuary with minimum dispersal distances of up to 1,277 km (Robinson *et al.,* 2012).

Density/abundance

1.7.3.10 Density and abundance estimates are available across a broader area within the regional marine mammal study area for bottlenose dolphin.

Density

1.7.3.11 The Morgan Array Area lies within Block F of the SCANS-III surveys in 2016 (Figure 1.11) but no bottlenose dolphin were sighted within this block. Bottlenose dolphin were recorded in the adjacent Block E, which spans the regional marine mammal study area, and the estimated density was 0.0082 animals per km^2 (CV = 0.573). As mentioned, surveys were carried out between 27 June and 31 July 2016, thus focused on a limited summer period and thus densities may vary in other months of the year. SCANS-III DSM data (see paragraph 1.5.6.8) (Lacey *et al.*, 2022) gave mean densities of 0.017 animals per km^2 and a maximum of 0.02 animals per km^2 for the Morgan marine mammal study area (Figure 1.33), with density maps showing higher areas of density in the east Irish Sea[4]. Recent SCANS-IV data reported densities of 0.0104 animals per km^2 (CV = 0.700) in block CS-E and 0.2352 animals per km^2 (CV = 0.353) in block CS-D (Gilles *et al.*, 2023).

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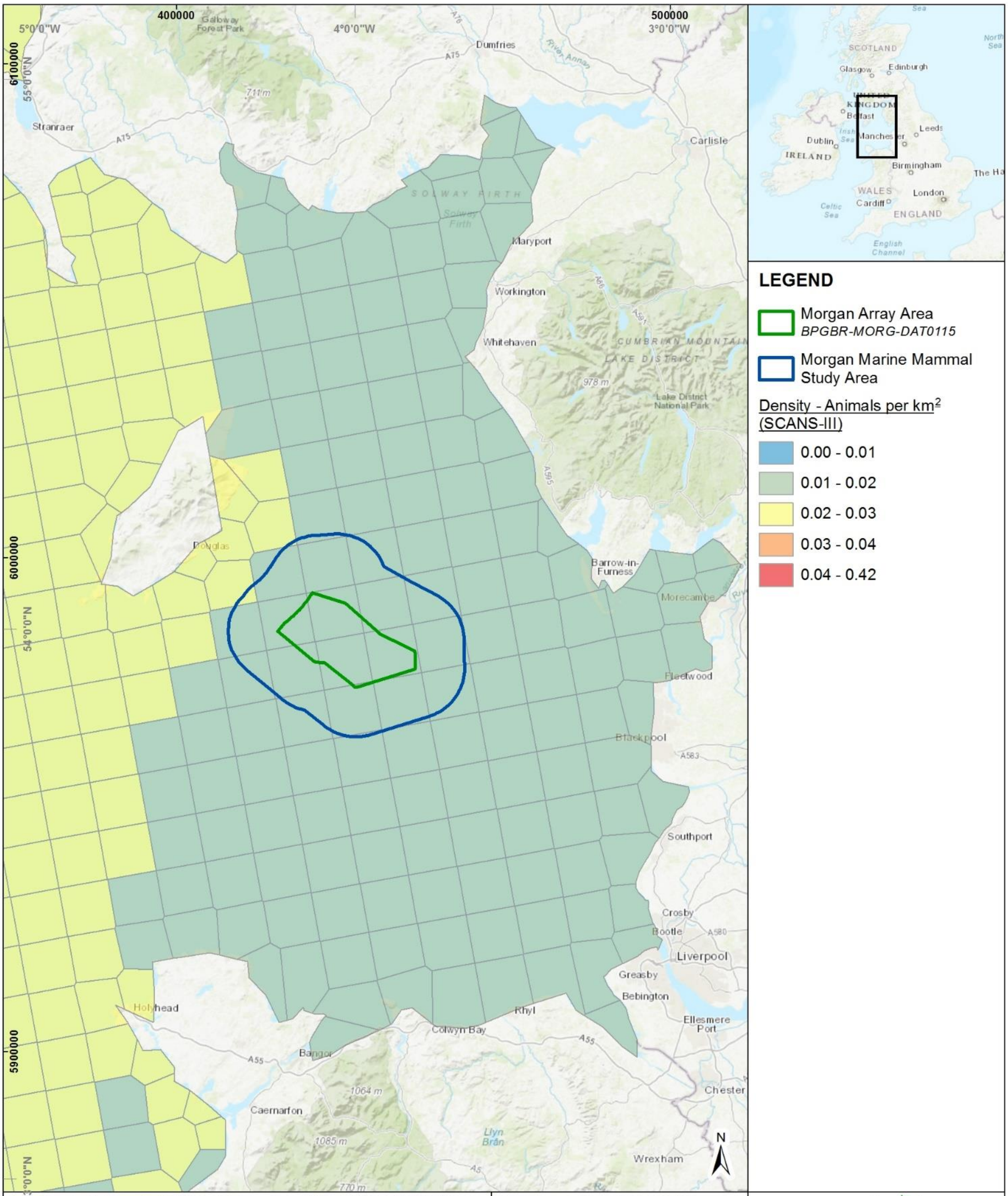
[4] Data from SCANS-III estimates are given as point densities and have been transformed to grid using Voronoi triangle/polygon method to create a grid surface for clearer illustration.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC, SCANS-III

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-027-00

Drawing Title:
DENSITY SURFACE MAPS FROM SCANS III DATA FOR BOTTLENOSE DOLPHIN (LACEY ET AL., 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,300,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	LB

Figure 1.33: Density surface maps from SCANS-III data for bottlenose dolphin (Lacey *et al.*, 2022).

1.7.3.12 During ObSERVE surveys bottlenose dolphin was more frequently seen in the winter than in the summer in both years and was the most frequently sighted cetacean species in the surveys (Rogan *et al.*, 2018) (Figure 1.34) and bottlenose dolphin calves were seen in most of the surveyed regions (71 sightings). However, Stratum 5 (western Irish Sea) had much fewer sightings than other strata and of the four survey periods, this species was only observed in Summer 2016 and winter 2016/17. Peak estimates of density for these surveys were given as 0.0106 animals per km^2 and 0.0366 animals per km^2 for summer and winter respectively.

1.7.3.13 JCP Phase III density surface modelling gave mean densities of 0.067 animals per km^2 across the entire region of interest, with some areas of high density around Cardigan Bay (Paxton *et al*., 2016)[5]. Mean predicted summer densities in the Irish Sea showed densities reaching two animals per km^2 for summer data combined for the periods 1994 to 2000, 2001 to 2006 and 2007 to 2010, all of which exist in the Cardigan Bay area. Winter densities for 2010 in the Irish Sea area peaked at one animal per km^2, again along the Cardigan Bay coast. This study builds upon the Phase One data analysis (Paxton and Thomas, 2010), which predicted density surfaces for bottlenose dolphin from data from 1980 to 2009. Densities for the Irish Sea ranged from 0.01 to 1 animal per km^2 in 1983, 1990, 1997 and 2004, with areas of higher densities in Cardigan Bay, around Anglesey and close to the coast in Liverpool Bay (5 animals per km^2), however densities in the region of the Morgan Array Area were 0.01 to 1 animal per km^2 (Paxton and Thomas, 2010).

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[5] JCP Phase III densities are approximations read off density surface maps in the report (Paxton et al., 2016), rather than derived from database. JDCP data was requested but not available currently.

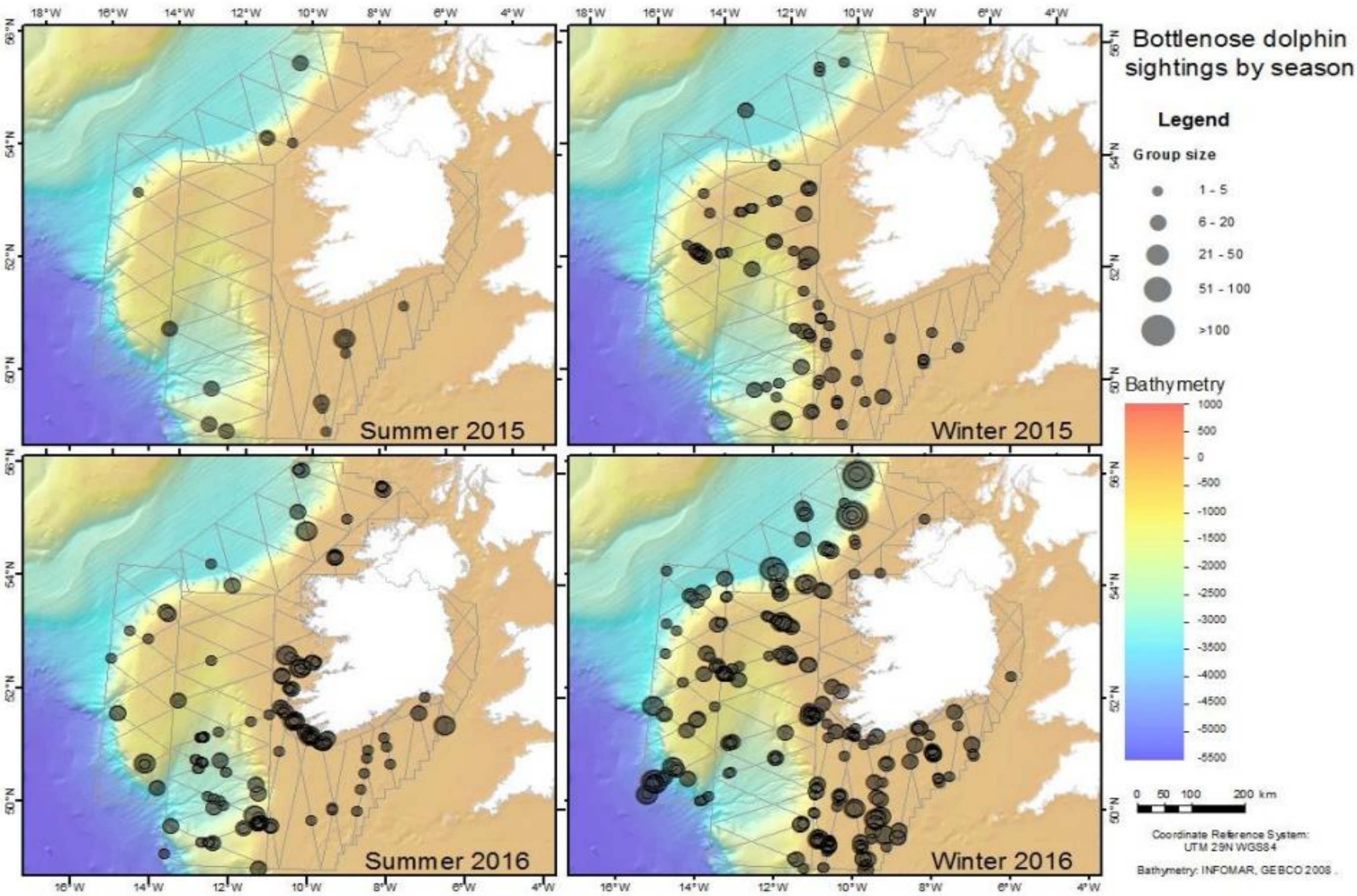


Figure 1.34: Sightings of bottlenose dolphin in each survey period (bottom). Grey lines indicate the survey tracklines along which sightings were made. Circles are proportional to the number of dolphins in each sighting. From Rogan *et al.* (2018).

1.7.3.14 Most recently, northeast Atlantic distribution maps for bottlenose dolphin at monthly scales, demonstrated bottlenose dolphin densities to be fairly consistent all year round (Figure 1.35), with some higher densities in winter (January) than in summer (July) off the west coast of Ireland and Bay of Biscay (Waggitt *et al.,* 2020). Low density areas of bottlenose were predicted in the Irish Sea year-round but this finding does not appear to reflect the known localised higher densities around Cardigan Bay (Evans and Waggitt, 2023; Lohrengel *et al.,* 2018). The northeast Atlantic distribution maps (Waggitt *et al.*, 2020) show that small and isolated sub-populations would have little influence on these broad scale models, and despite seasonal movements being detected, seasonal increases and decreases in densities without notable changes in distribution were more commonplace. Predicted distributions for bottlenose dolphin per month for the Morgan marine mammal study area show low relative densities year-round (Figure 1.36, Figure 1.37). Highest densities in the east Irish sea were predicted in August with 0.025 animals per km^2 in high density areas. However, within the Morgan marine mammal study area, bottlenose dolphin densities were highest in August and reached 0.0016 animals per km^2 for Morgan Array Area, thus very low densities.

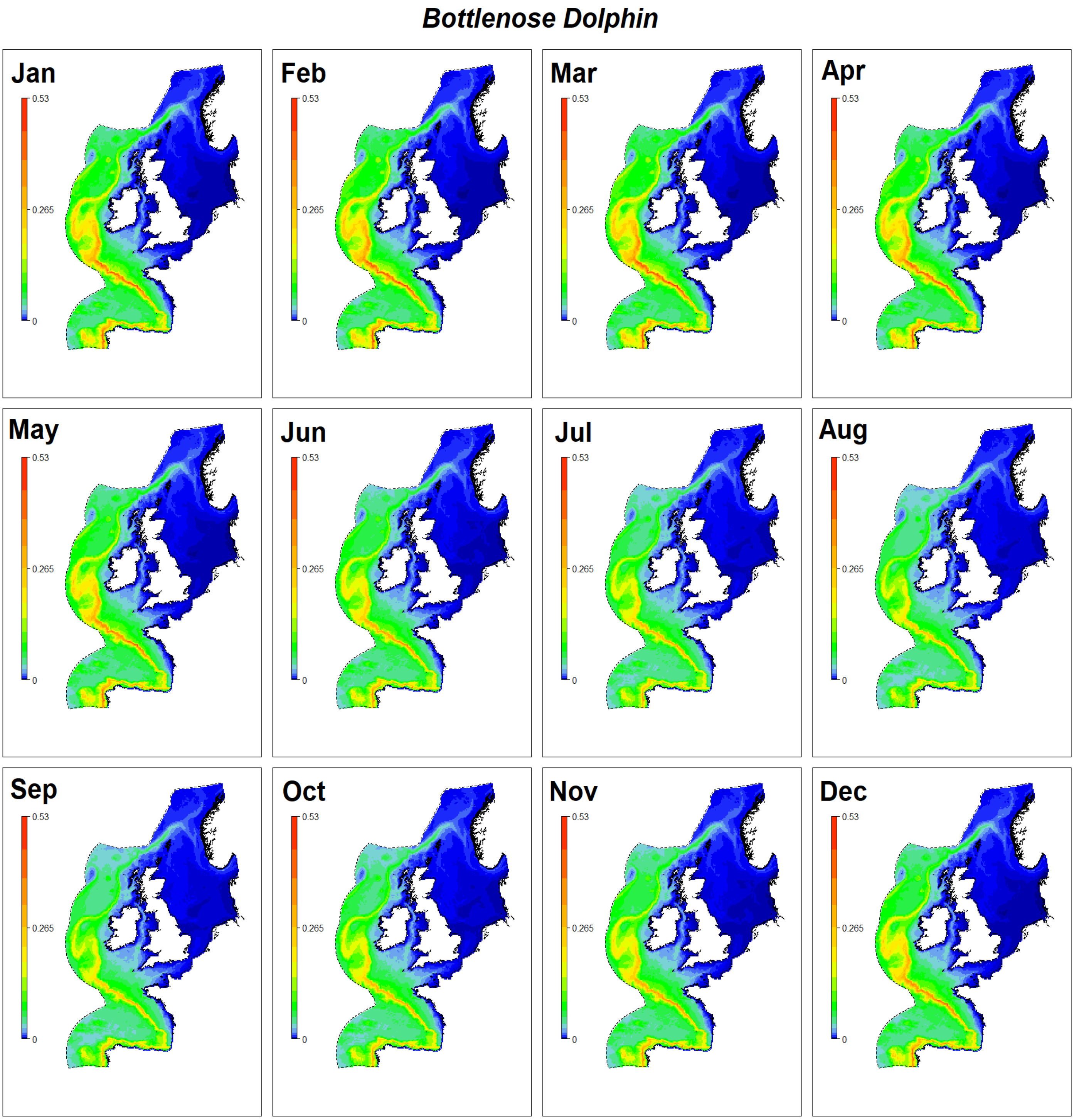
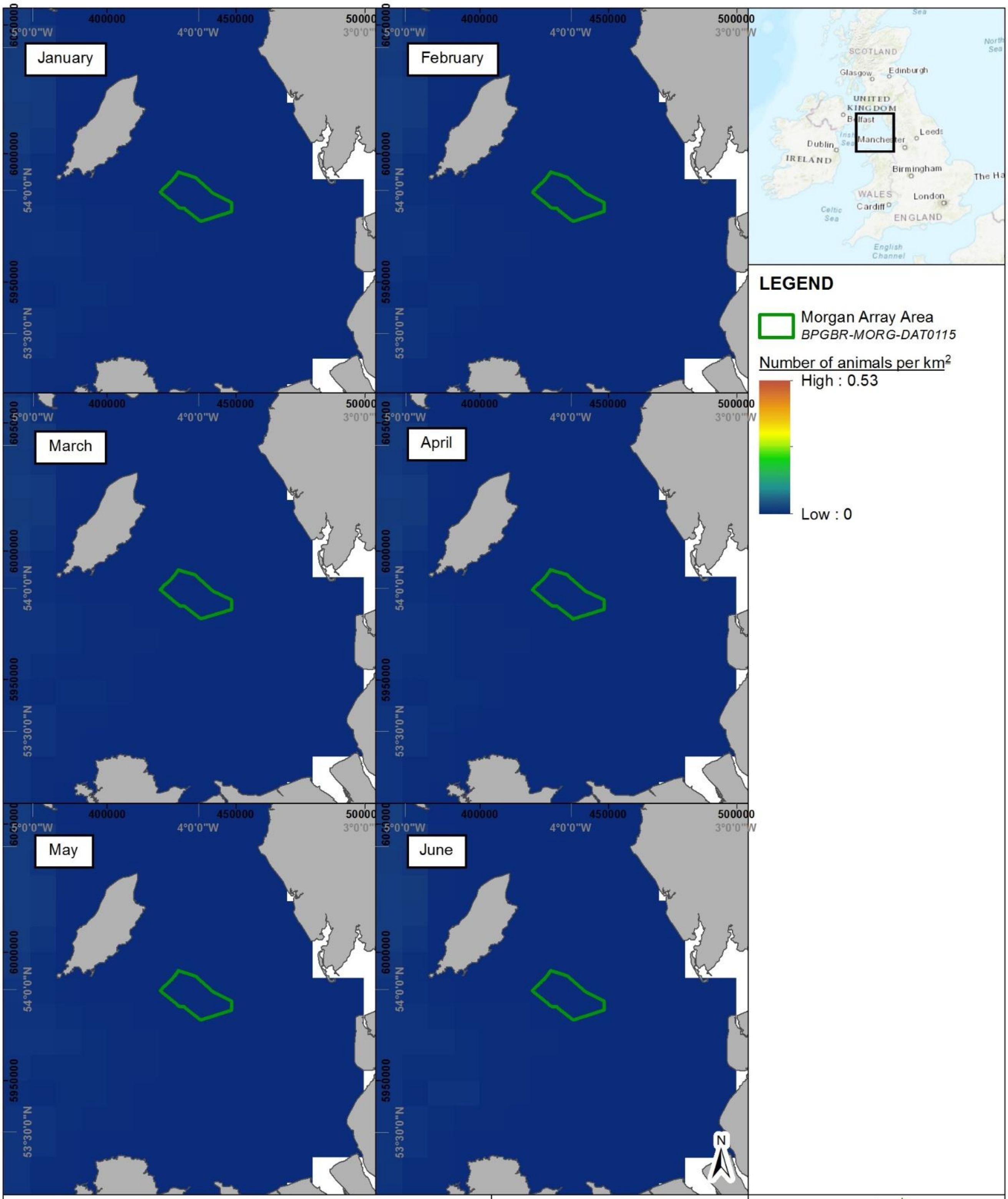


Figure 1.35: Predicted distributions for bottlenose dolphin per month for the entire study area, from Waggitt *et al.* (2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

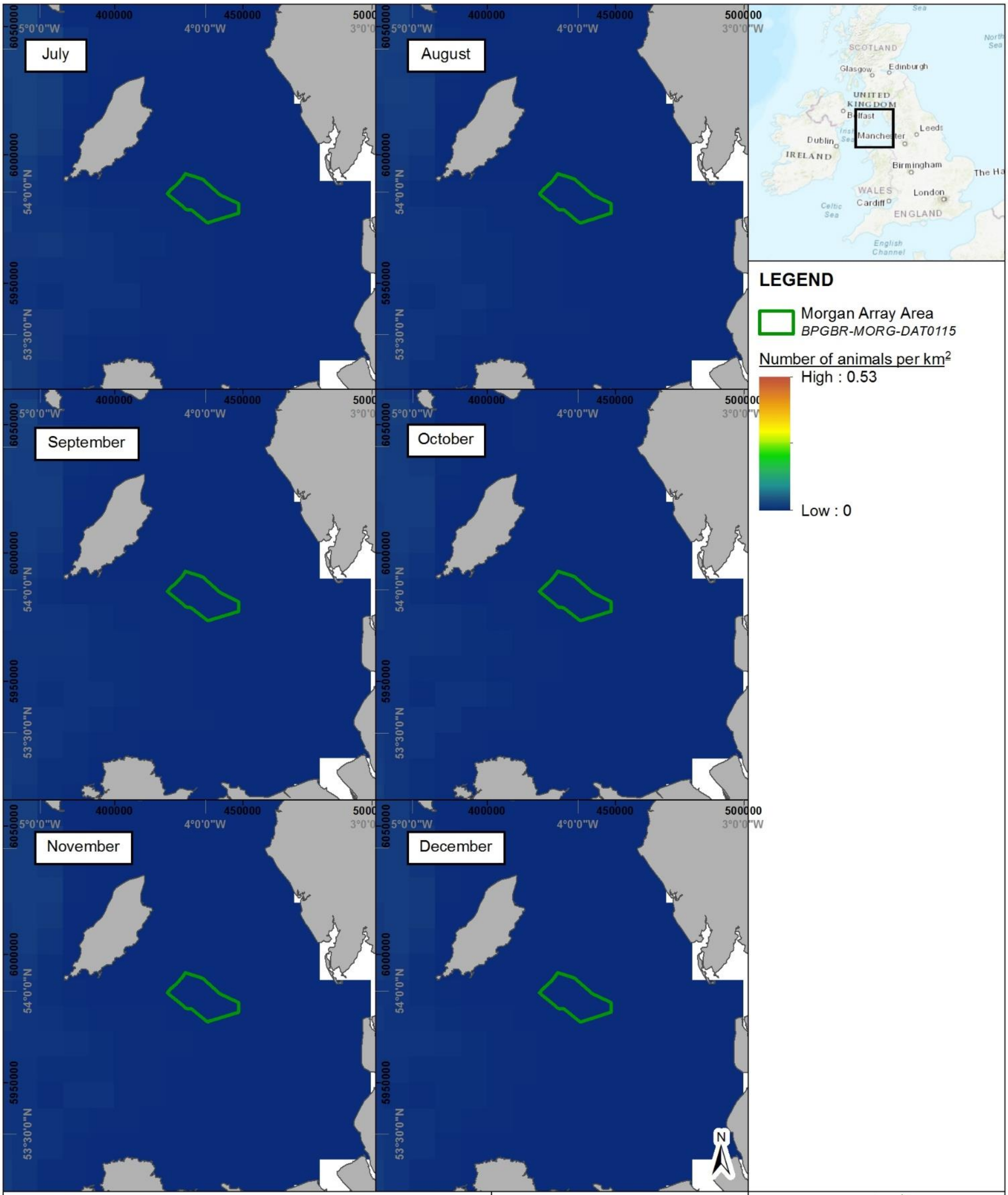
Drawing Number:
RPSE-MG-ES-MAM-028-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR BOTTLENOSE DOLPHIN PER MONTH FROM JANUARY TO JUNE (WAGGITT ET AL., 2020)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	LB

Figure 1.36: Predicted distributions for bottlenose dolphin per month from January to June for the Morgan Array Area, data from Waggitt *et al.* (2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

Drawing Number:
RPSE-MG-ES-MAM-029-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR BOTTLENOSE DOLPHIN PER MONTH FROM JULY TO DECEMBER (WAGGITT ET AL., 2020)

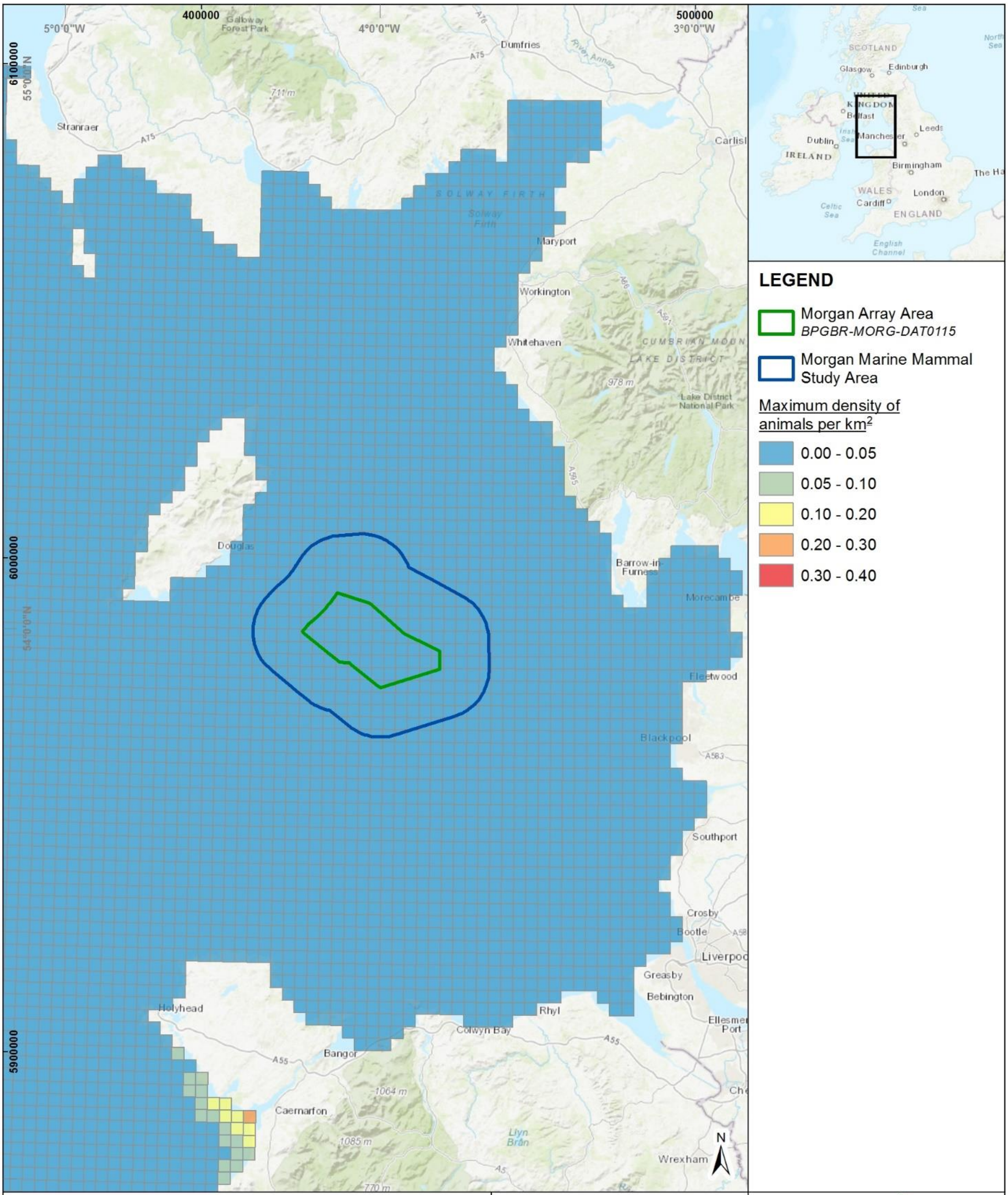
Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	NA	LB

Figure 1.37: Predicted distributions for bottlenose dolphin per month for the Morgan Array Area, data from Waggitt *et al.* (2020).

1.7.3.15 Modelled outputs from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) indicated the importance of Cardigan Bay, with higher densities along the coast reaching 0.36 animals per km^2. Lower densities were presented for other areas, where groups rarely remain for extended periods in any one locality, instead ranging around and often occurring more offshore along the north coast of the Llŷn Peninsula, around Anglesey, the coast of mainland north Wales east to Liverpool Bay, around the Isle of Man and probably elsewhere in the Irish Sea (Evans and Waggitt, 2023). The authors suggested that modelled distributions reflects a true picture of bottlenose in the Irish Sea with high densities year round in Cardigan Bay, but may under-represent their wider distribution between November and May as bottlenose dolphin do not remain for extended periods of time in these areas (around the Llŷn Peninsula, Anglesey, the coast of mainland North Wales east to Liverpool Bay and around the Isle of Man) and are often moving offshore, which may not be captured in the modelled distributions.

1.7.3.16 The average density for the Morgan marine mammal study area from the annual composite maps (as recommended by NRW and authors of the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023), and agreed with Natural England, see paragraph 1.5.16.4) was 0.00124 animals per km^2. As set out in paragraph 1.5.16.4 this density estimate is highly precautionary as this is the highest value observed for each cell (2.5 km^2 resolution) at any one point in time. The average density for the Morgan Array Area was 0.00114 animals per km^2 (Figure 1.38).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, NRW

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-030-00

Drawing Title:
BOTTLENOSE DOLPHIN ANNUAL COMPOSITE MODELLED DENSITIES (MEASURED AS THE MAXIMUM DENSITY PER CELL ACROSS MONTHS) (EVANS AND WAGGITT, 2023)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,300,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.38: Bottlenose dolphin annual composite modelled densities (measured as the maximum density per cell across months) for the Morgan marine mammal study area (Evans and Waggitt, 2023).

1.7.3.17 Several studies have targeted areas of high use, particularly in Cardigan Bay, given a resident population exists in this area, but most give abundance estimates rather than densities. Baines *et al.* (2002) carried out boat line transect surveys across Cardigan Bay SAC from April to September 2001. The study gave estimates of 0.2607 animals per km^2 (CV = 0.237) for the inshore zone of the candidate Special Area of Conservation (cSAC) (now designated Cardigan Bay SAC), with density of animals per km^2 as 0.2483 (CV = 0.335) for May to July and 0.2932 (CV = 0.329) for August to September. Density from coastal and extra transects were also used and gave estimates of 0.2128 (CV = 0.3201) and 0.1120 (CV = 0.3582) respectively. It is noted only data from inshore transects have been used to calculate abundance, as no sightings were obtained from the offshore half of the cSAC.

1.7.3.18 More recently, Lohrengel *et al.* (2018) summarised distance sampling surveys between Cardigan Bay and the wider Cardigan Bay to provide estimates of abundance for bottlenose dolphin (described in detail in paragraph 1.7.3.32). Densities for these areas have been calculated using this abundance data (Sinclair *et al.*, 2021). Within Cardigan Bay SAC, density estimates for the SAC have been given as 0.088 dolphins per km^2 (based upon abundance estimates of 85 dolphins in 2016, 95% CI = 44 to 160), and SAC area of 958.58 km^2. For the wider Cardigan Bay area (reported as 4,986.86 km^2), a density of 0.035 dolphins per km^2 has been given (based upon abundance estimates of 174 dolphins in 2016, 95 % CI = 150 to 246 in closed population capture, mark and recapture (CMR) model). This does, however, assume uniform density of animals throughout the areas and the study did not extend into North Wales, thus not covering the Morgan marine mammal study area.

1.7.3.19 Though abundance estimates vary by sampling method (e.g. line transects, distance sampling, CMRs, closed/open population modelling), there remains a large inter-annual variance in abundance. Duckett (2018) reported that females recorded from North Wales were significantly more likely to move into Cardigan Bay in the year and year +1 of breeding, suggesting it is a favoured breeding/nursing area for bottlenose dolphin. This is corroborated by a higher peak of sightings in winter in Manx waters (Howe, 2018a) suggesting this is important winter habitat for the species, where animals move further offshore. Overall, whilst there has been a suggested decline over the last 10 years in Cardigan Bay (with design models indicating some permanent emigration from this area) (Lohrengel *et al*., 2018), abundance appears to be relatively stable in the Irish Sea (IS) MU (IAMMWG, 2022; Evans and Waggitt, 2023). However much of this region has not been well surveyed for population trends and it may be difficult to determine an overall trend for the IS MU.

1.7.3.20 The regional marine mammal study area includes the waters of the Isle of Man territorial sea and, as discussed in paragraph 1.7.3.8, bottlenose dolphin have been commonly reported in Manx Waters, particularly off the southwest coast, mainly between August and March (Felce, 2014; 2015; Adams, 2017; Howe, 2018a). These studies in Manx waters have given count-rates or cetacean positive intervals but not abundances or densities.

1.7.3.21 Site specific digital aerial surveys for Morgan Generation Assets did not record enough bottlenose dolphin in the area to carry out model-based density analyses.

Summary of densities

1.7.3.22 Overall, bottlenose dolphin are abundant in the Irish sea but there are known areas of high density in Cardigan Bay, to the south of the Morgan marine mammal study area which may increase mean density estimates for the Irish Sea as a whole (Table 1.8). However, densities around the Morgan marine mammal study area remain low.

1.7.3.23 Predicted estimates of mean density for the Morgan marine mammal study area from the northeast Atlantic distribution maps (Waggitt *et al.*, 2020) are very similar to those from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023), although Waggitt *et al.* (2020) represents the offshore ecotype of bottlenose dolphin. Estimates are lower than the SCANS-III block E estimate, however the SCANS-III density is for a large-scale block that includes the Cardigan Bay population. Morgan Generation Assets lies in SCANS-III block F, within which no bottlenose dolphins were recorded. SCANS-IV block CS-E also demonstrated a higher density value, but (as highlighted in Lacey *et al.,* 2022) large scale line transect surveys (such as SCANS) are not designed to collect data at a sufficiently small spatial scale necessary to generate estimates of abundance for small coastal populations, such as the bottlenose dolphin population in the Irish Sea. The SCANS-III DSM density (Lacey *et al.,* (2022) for the Morgan Generation Assets is higher than the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) but is a dataset based on UK-wide modelling of SCANS-III unlike the Welsh Marine Mammal Atlas which specifically accounts for the inshore ecotype of bottlenose dolphin in the Irish Sea MU.

1.7.3.24 Therefore (and as requested during the EWG process) the density taken forward to assessment is derived from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) for the Morgan marine mammal study area, providing the most robust density estimate for the area.

Table 1.8: Comparison of bottlenose dolphin densities from key data sources.

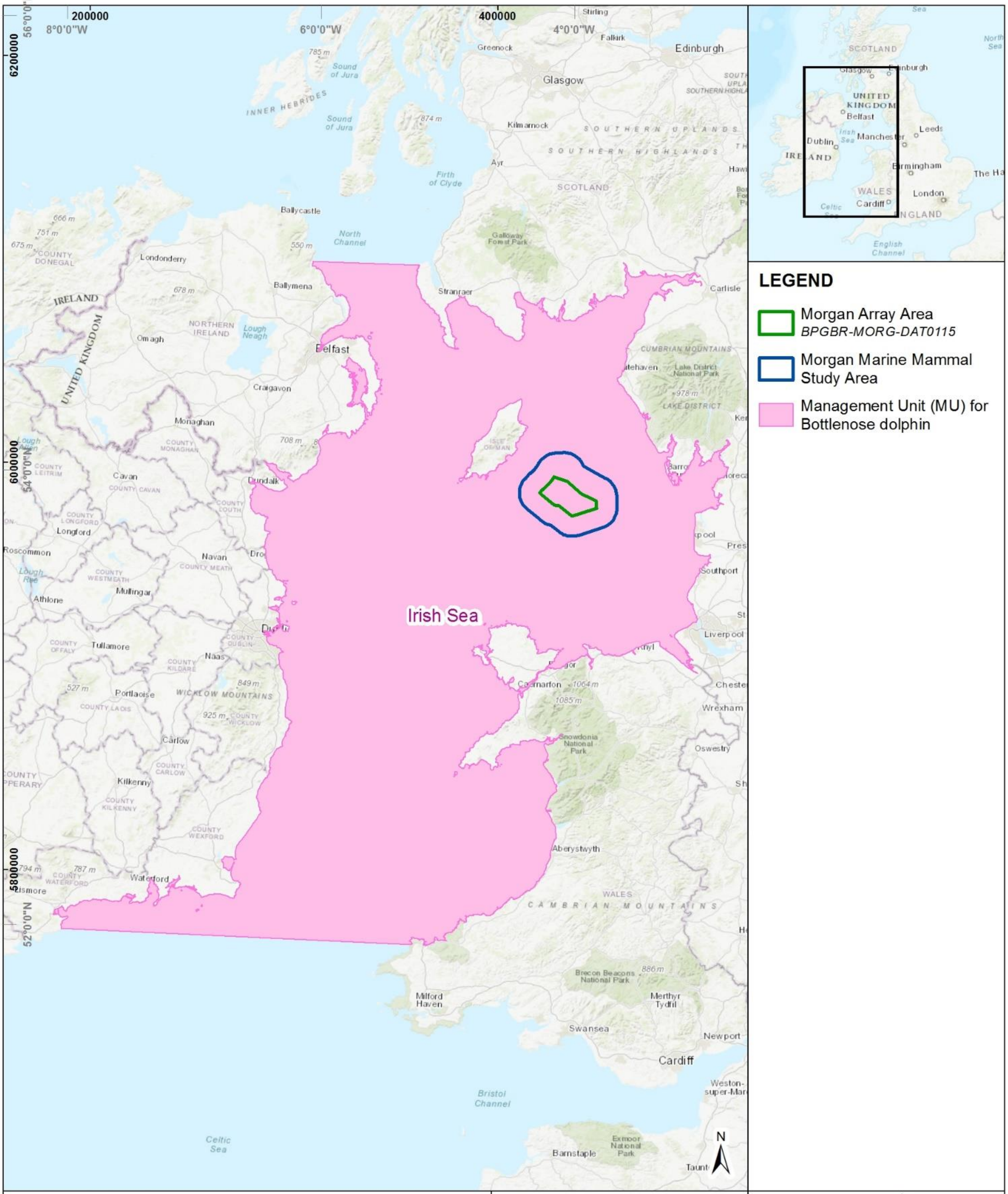
a. Note Welsh Marine Mammal Atlas data (Evans and Waggitt, 2023) are presented for both the Morgan Array Area only and the Morgan marine mammal study area (Morgan Array Area plus 10 km to 13.3 km buffer).

Source	Density (animals per km^2)	Estimate of variation
SCANS-IV – block CS-E (Gilles *et al.*, 2023)	0.0104	0.700 (CV)
SCANS-III - block E (Hammond *et al.*, 2021)	0.0082	0.573 (CV)
SCANS-III DSM for the Morgan marine mammal study area (Lacey *et al.*, 2022)	0.0174	0.017 (CV)
Northeast Atlantic distribution maps (Waggitt *et al.*, 2020) for the Morgan marine mammal study area for August (peak month)	0.0156	0.001 to 0.002 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023)[a] for the Morgan Array Area from annual composite maps	0.0011	0.0004 to 0.0025 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) for the Morgan marine mammal study area from annual composite maps	**0.0012**	**0.0005 to 0.0027 (95% CIs)**

Abundance

Broadscale abundances

1.7.3.25 On a widescale, IAMMWG (2022; 2023) estimated abundance for the Irish Sea MU (Figure 1.39) as 293 individuals of bottlenose dolphin (CV = 0.54, 95% CI = 108 to 793). SCANS-III gave abundance estimates of 288 individuals (95% CI = 0 to 664) and mean group size of 1.50 (CV = 0.192) for Block E, and no bottlenose dolphin were sighted within Block F. Abundance within the Irish Sea MU (IAMMWG, 2021), overall, appears stable, although much of the region has not been well surveyed for population trends. Recent SCANS-IV surveys gave abundance estimates of 127 animals (95% CI = 3 to 353) and mean group size of 1.50 (CV = 0.333) for block CS-E. Block CS-D had a much higher abundance (than the equivalent SCANS-III block) of 8,199 animals (95% CI = 3,595 to 15,158) but this block extends towards the Celtic Sea, and therefore may include the more abundant offshore ecotype of bottlenose dolphin found in the Offshore Channel, Celtic Sea and Southwest England (OCSW) MU.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 10 20 40 nm
0 25 50 km

Drawing Number:
RPSE-MG-ES-MAM-031-00

Drawing Title:
IRISH SEA MU FOR BOTTLENOSE DOLPHIN

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:3,150,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.39: Irish Sea MU for bottlenose dolphin with the Morgan marine mammal study area.

1.7.3.26 From the 3,065 sightings over all surveys included in the JCP Phase III dataset estimated predicted abundances in 2010 were given per season for the Irish Sea. Winter abundance for bottlenose dolphin was 10 animals, spring was 30 animals, summer was 30 animals and autumn had 10 animals (Paxton *et al.,* 2016).

1.7.3.27 During ObSERVE surveys (details given in section 1.5.7), bottlenose dolphin were not observed in Strata 5 in summer 2015 or winter 2015/16, but in summer 2016 model-based estimates abundance was 118 animals (CV = 117.94, 95% CI = 0 to 1,129). No designed-based estimates were given for summer 2016 for Strata 5. For winter 2016/2017 designed based estimate abundance for Strata 5 is 401 animals (CV = 93.55, 95% CI = 76 to 2,105) whilst model-based estimates of abundance were 223 animals (CV = 82.55, 95% confident interval = 0 to 828).

Localised abundances

1.7.3.28 Several studies have targeted areas of high use, particularly in Cardigan Bay given a resident population exists in this area. There is variability in abundance estimates over the years.

Cardigan Bay

1.7.3.29 Boat transects in Cardigan Bay SAC by Baines *et al.* (2002) gave estimates of 135 animals in Cardigan Bay SAC (CV = 0.237, 95% CI 85 to 214), with 128 animals for May to July (CV = 0.3352, 95% CI = 67 to 245) and 152 from August to September (CV = 0.329, 95% CI = 80 to 287).

1.7.3.30 Later, SWF carried out boat line transect surveys in Cardigan Bay SAC during April to October from 2005 to 2007 (Pesante *et al.,* 2008). Abundance analyses for Cardigan Bay SAC provided estimates of 154 individuals of bottlenose dolphin for 2005, 206 individuals for 2006 and 109 individuals for 2007 and demonstrated an increase in the population size compared to previous estimates for the period 2003 to 2004 (140 dolphins). The study also carried out photoidentification wherever possible, with an average of 58% of the population marked and as such the overall estimate for Cardigan Bay in any one year was therefore 133 animals in 2005, 179 in 2006, and 198 in 2007, but 328 when considering the entire 2001 to 2007 period. Two other models were also used. The closed population model using the period from 2001 to 2007 gave abundance estimates of between 121 and 210 individuals using the Cardigan Bay SAC in any one year, and 379 over the whole period, whilst the open population model (which considered the entire Cardigan Bay) estimated between 154 and 248 individuals in each year. All three approaches indicate that Cardigan Bay supports the largest coastal bottlenose dolphin population in the British Isles (Pesante *et al.,* 2008).

1.7.3.31 Later in 2011, research was carried out by SWF to provide preliminary information on the condition of bottlenose dolphin and harbour porpoise in both the Cardigan Bay and Pen Llŷn a'r Sarnau SACs (Veneruso and Evans, 2012). The abundance estimate for the whole of Cardigan Bay was 296 animals (95% CL = 170 to 518, CV = 28.82) from line transect surveys.

1.7.3.32 Further studies by Feingold and Evans (2014) in Cardigan Bay between 2011 and 2013 recorded a total of 295 bottlenose dolphin, with 128 bottlenose dolphin recorded in line-transect mode. Abundance estimates varied between years, with 309 in 2011 (95% CL = 179 to 353, CV 28.34), 330 in 2012 (95% CL = 203 to 534, CV = 24.87) and 254 individuals in 2013 (95% CL = 151 to 427, CV = 26.83).

1.7.3.33 More recently, Lohrengel *et al.* (2018) summarised distance sampling surveys between 2014 and 2016 in Cardigan Bay and gave an estimate of 64 individuals (95% CI = 19 to 220; CV = 0.65) in 2015 and 84 (95% CI = 44 to 160; CV = 0.33) in 2016 for Cardigan Bay SAC; and for the wider Cardigan Bay (including Cardigan Bay SAC and Pen Llŷn a'r Sarnau SAC), 277 (95% CI = 138 to 555; CV = 0.36) in 2015, 289 (95% CI = 184 to 453; CV = 0.23) in 2016 based on distance sampling. CMR analysis using a closed population gave estimates of up to 147 (95% CI = 127 to194; CV = 0.29) in 2016 for Cardigan Bay SAC, and a peak of 206 individuals (95% CI = 171 to 278; CV = 0.28) occurring in 2015 in the wider Cardigan Bay. The latest CMR estimate (2019) for the Cardigan Bay SAC is 138 individuals (95% CI = 68 to 303 animals) representing a slight decline, but no significant change since the start of the CMR time series in 2001 (Evans and Waggitt, 2023).

1.7.3.34 The Mona Offshore Wind Project (Mona Offshore Wind Ltd, 2024) reported aerial surveys recorded maximum raw counts of six bottlenose dolphin in the Mona Aerial Survey Area (June 2021), which gave maximum abundance estimates of 29 bottlenose dolphins for the Mona Aerial Survey Area in June 2021.

1.7.3.35 Aerial surveys recorded maximum raw counts of nine bottlenose dolphin in the Morgan Aerial Survey Area (June 2021), which gave maximum abundance estimates of 71 bottlenose dolphin for the Morgan Aerial Survey Area in June 2021.

1.7.3.36 During integrated surveys detailed in the PAM and MMO Report, there were eight visual sightings of bottlenose dolphin from April 2022 to May 2022.

Seasonality

1.7.3.37 Marked seasonal trends are evident in bottlenose dolphin distribution in Cardigan Bay, with high coastal sighting rates in the summer and autumn and low rates in late winter and early spring (Baines and Evans, 2012). Winter aerial surveys and TPOD acoustic data from coastal sites around Cardigan Bay showed a strong seasonal peak in summer, and there was a significant increase in the overall number of individuals that were encountered and identified in the summer months when compared to the winter (Duckett, 2018). There is some suggestion of dispersal into the Irish Sea during winter, with a northward shift in distribution (Pesante *et al.*, 2008). It has been proposed least a third of the Cardigan Bay population move into north Wales and Manx waters (Pesante *et al.*, 2008).

1.7.3.38 In Manx waters, bottlenose dolphin show a very clear temporal pattern, with 73% of sightings being reported between October and March (Howe, 2018a), with a winter peak unusual for cetacean species in temperate waters in Europe. This opposite temporal regime of sightings of bottlenose in Cardigan Bay compared to Manx waters may suggest that Manx waters may provide vital winter habitat, whilst Cardigan Bay is important for calving during summer months. MWDW data Figure 1.14) shows a general pattern of higher bottlenose dolphin sightings in winter months than summer months. As detailed in paragraph 1.7.2.46, MWDW confirmed that sightings data reflects a true seasonality of these cetaceans in Manx waters and that lower winter survey effort has not created a false seasonality (MWDW, personal communication, June 2023).

1.7.3.39 This seasonal pattern was also detected in the ObSERVE surveys (Rogan *et al.*, 2018) where sightings of bottlenose were higher during winter in Stratum 5 (the western Irish sea). SWF also suggested that there may also be some range shift towards the north in response to increased pressure from boat traffic in Cardigan Bay (Howe, 2018a).

1.7.3.40 Calves have been observed most months of the year, but particularly between April and October (Berrow *et al.*, 2010). Cardigan Bay has been suggested as a preferable calving area, and between 13 and 20 bottlenose calves have been recorded annually between 2005 and 2007 within the SAC (Pesante *et al.*, 2008).

1.7.4 Short-beaked common dolphin

Ecology

1.7.4.1 The short-beaked common dolphin is a member of the Delphinidae family, which are oceanic dolphin found in temperate and tropical waters worldwide. It is widely distributed throughout Europe, and around the UK, is common in the west approaches to the Channel and the south Irish Sea (particularly around the Celtic Deep) and around the Inner Hebrides north to Skye (SWF, 2012a). It is one of the smallest true dolphins, measuring between 2.1 to 2.4 m in length and weighing between 75 and 85 kg, with a long slender body with tall pointed dorsal fin. Short-beaked common dolphin can live to between 30 to 35 years. It has a distinctive pattern on its flanks, with tan or yellowish patch before the dorsal fin, and pale grey behind. It is a very agile active dolphin capable of great speeds and is often found in large active schools. Short-beaked common dolphin are found in a wide range of group sizes from small schools to large concentrations of 1,000 to 5,000 individuals but the average group size reported in Reid *et al.* (2003) was 14 individuals. In offshore waters southwest of the UK, they occasionally form mixed schools with striped dolphin. School size increases in mid-summer and mid-winter, possibly linked to the dolphins following prey moving inshore.

1.7.4.2 Short-beaked common dolphin appear to have two calving peaks (spring and autumn) with a gestation period of 10 to 11 months. Calves are 80 to 90 cm long at birth. They are weaned at 19 months, and the mother has a resting period of about four months before her next pregnancy so that calving intervals are generally two or three years or more. Males become sexually mature between five to seven years of age, and females at around six years.

1.7.4.3 They are mainly opportunistic feeders and have a varied diet which often consists of small schooling fish (e.g. cod, hake, mackerel, sardine, pilchard, horse mackerel, scad, sprat, sand eel, herring, whiting and blue whiting, as well as squid). However, the type of food taken depends on local availability, with small pelagic schooling fishes and squids likely to be the main food items in the Irish Sea (Hammond *et al.,* 2005). The species often uses co-operative feeding techniques to herd schools of fish, panicking the fish through frenzied activity and taking them in the confusion, which is known as ‘bait-balling’.

Distribution

1.7.4.4 The short-beaked common dolphin has a worldwide distribution and inhabits both oceanic and shelf-edge waters of tropical, subtropical and temperate seas of the Atlantic and Indo-Pacific. The majority of sightings having been reported in waters south of 60°N (Murphy *et al.,* 2013), but analysis of summer sightings on shelf waters around the UK and adjacent waters showed the vast majority of short-beaked common dolphin to occur in waters above 14°C in temperature (MacLeod *et al.,* 2008, Cañadas *et al.*, 2009). Strong seasonal shifts in their distribution have been observed, including winter inshore movements onto the Celtic Shelf (Northridge *et al.,* 2004). They are also the most frequently sighted and abundant cetacean recorded during Celtic Sea herring surveys off the south coast of Ireland in October (O’Donnell *et al.* 2017; 2018). The

ObSERVE aerial surveys of Irish waters showed short-beaked common dolphin to be widely distributed in shelf waters off the south and west coasts of Ireland, with higher numbers observed in winter (Rogan *et al.,* 2018). The species has been observed further north and east in shelf seas in recent years, reflecting changes in the strength of the Gulf Stream. Sighting data from MWDW shows short-beaked common dolphin are widespread in Manx waters around the Isle of Man, extending out towards the Morgan Array Area (Figure 1.14).

1.7.4.5 During the summer (May to September), the majority of sightings are more widely dispersed along and off the continental shelf slope and in deep waters to the southwest of the UK (Murphy *et al.,* 2005; Murphy *et al*., 2008), off the west coast of Ireland and to the west and northwest of Scotland. This likely coincides with the mating and calving period.

Density/abundance

Density

1.7.4.6 Density and abundance estimates were available across a broader area within the regional marine mammal study area. SCANS-III is a key baseline dataset, and the Morgan Array Area lies within Block F for the SCANS-III surveys in 2016 (Figure 1.11), but no short-beaked common dolphin were sighted within that block or the adjacent Block E. Predicted density values using SCANS-III data was presented in the Offshore Energy SEA 4: Appendix 1 Environmental Baseline (BEIS, 2022) and showed short-beaked common dolphin densities were low (0 to 0.07 animals per km^2) in the Irish sea but increased towards the Celtic Sea (Figure 1.40). The SCANS-II density for Block O was 0.018 animals per km^2 (CV = 0.78).

1.7.4.7 Prior to the SCANS surveys, wide-scale historical data collating heterogenous data from 1990 to 2009 in the Atlas of the Marine Mammals of Wales (Baines and Evans, 2012) confirms regular sightings of short-beaked common dolphin across the Irish Sea study area. The Irish Atlas of Marine Mammals also confirmed short-beaked common dolphin were recorded in all months of the year (Wall, 2013), with high densities in the south approaches to the Irish Sea in the spring and summer.

1.7.4.8 SCANS-III DSM data (see paragraph 1.5.6.8) gave a mean density of 0.00457 animals per km^2 and a maximum of 0.00647 animals per km^2 for the Morgan marine mammal study area (Figure 1.41), with density maps showing higher areas of density in the east Irish Sea[6] (Lacey *et al.*, 2022).

1.7.4.9 Recent SCANS-IV data did not report any short-beaked common dolphin in block CS-E (in which the Morgan Offshore Wind Project lies) but reported a density of 0.0272 animals per km^2 (CV = 0.814) in adjacent block CS-D (Gilles *et al.*, 2023).

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[6] Data from SCANS-III estimates are given as point densities and have been transformed to grid using Voronoi triangle/polygon method to create a grid surface for clearer illustration.

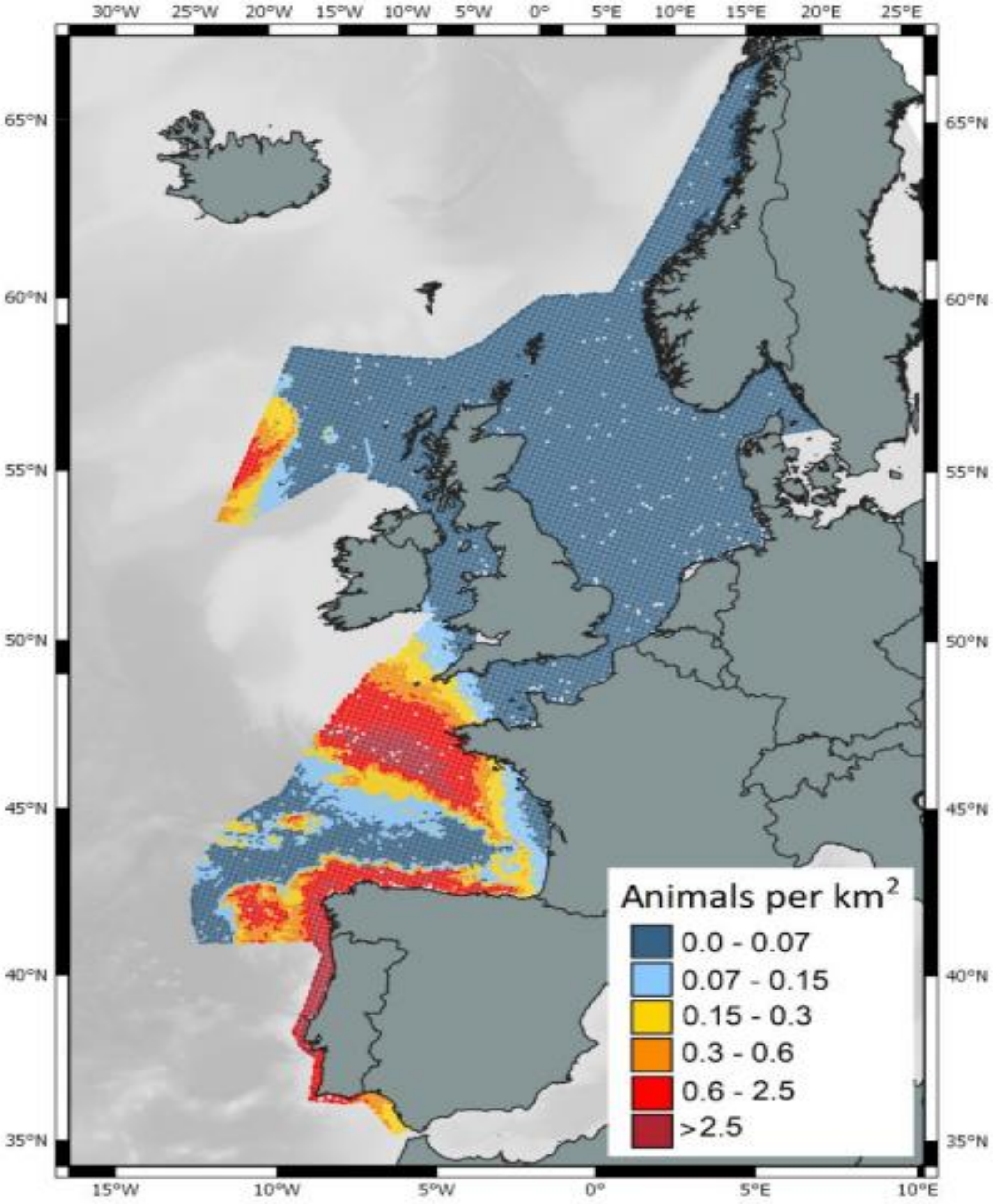
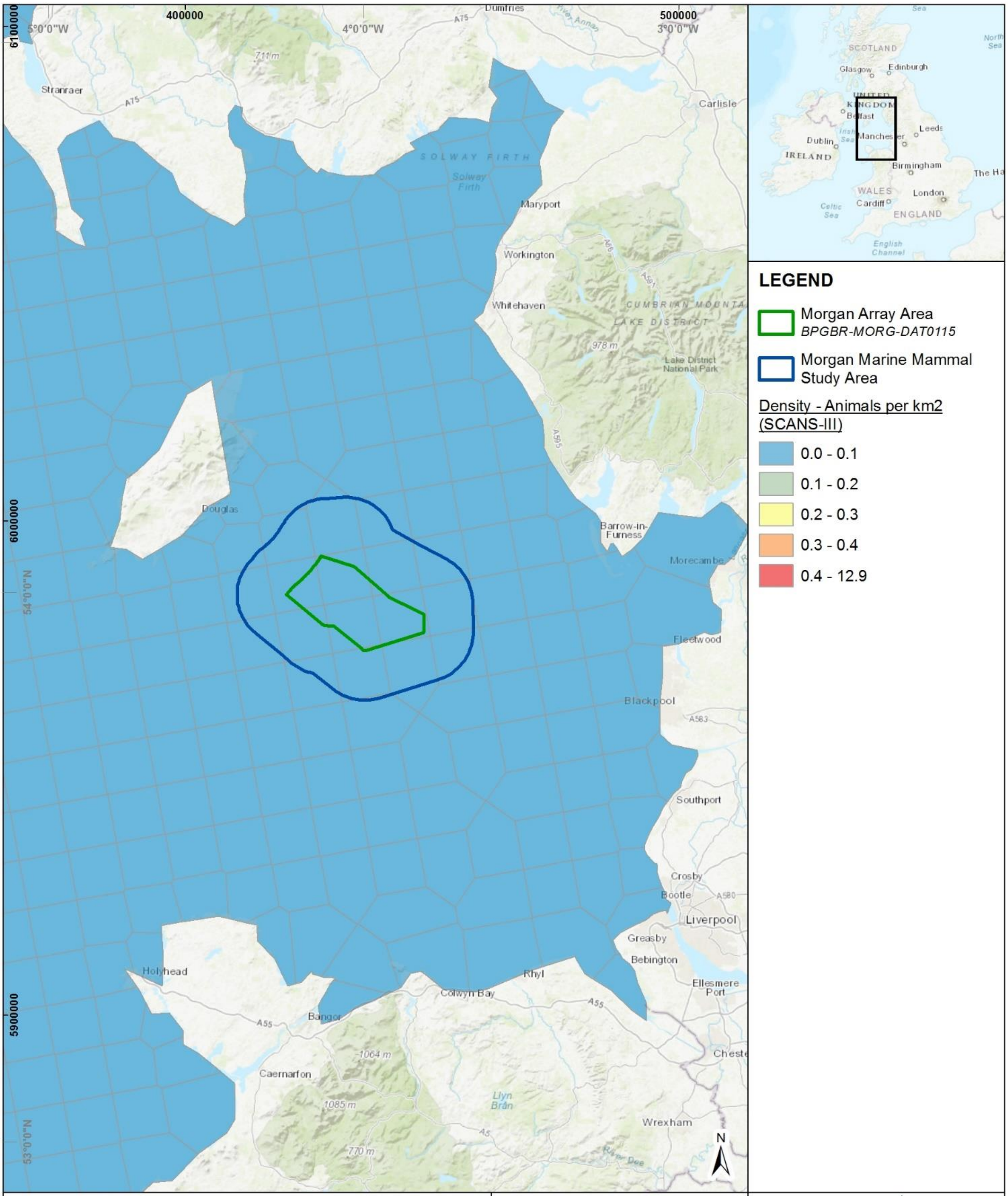


Figure 1.40: Density predictions for short-beaked common dolphin based on the observed distributions and their relationships with habitat variables (longitude and latitude, plus distance from coast, depth or aspect of seabed slope if selected), from BEIS (2022).



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Data Sources: Client, JNCC, SCANS-III

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-035-00

Drawing Title:
DENSITY SURFACE MAPS FROM SCANS III DATA FOR COMMON DOLPHIN FROM LACEY ET AL. (2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,300,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.41: Density surface maps from SCANS-III data for short-beaked common dolphin (Lacey *et al.*, 2022).

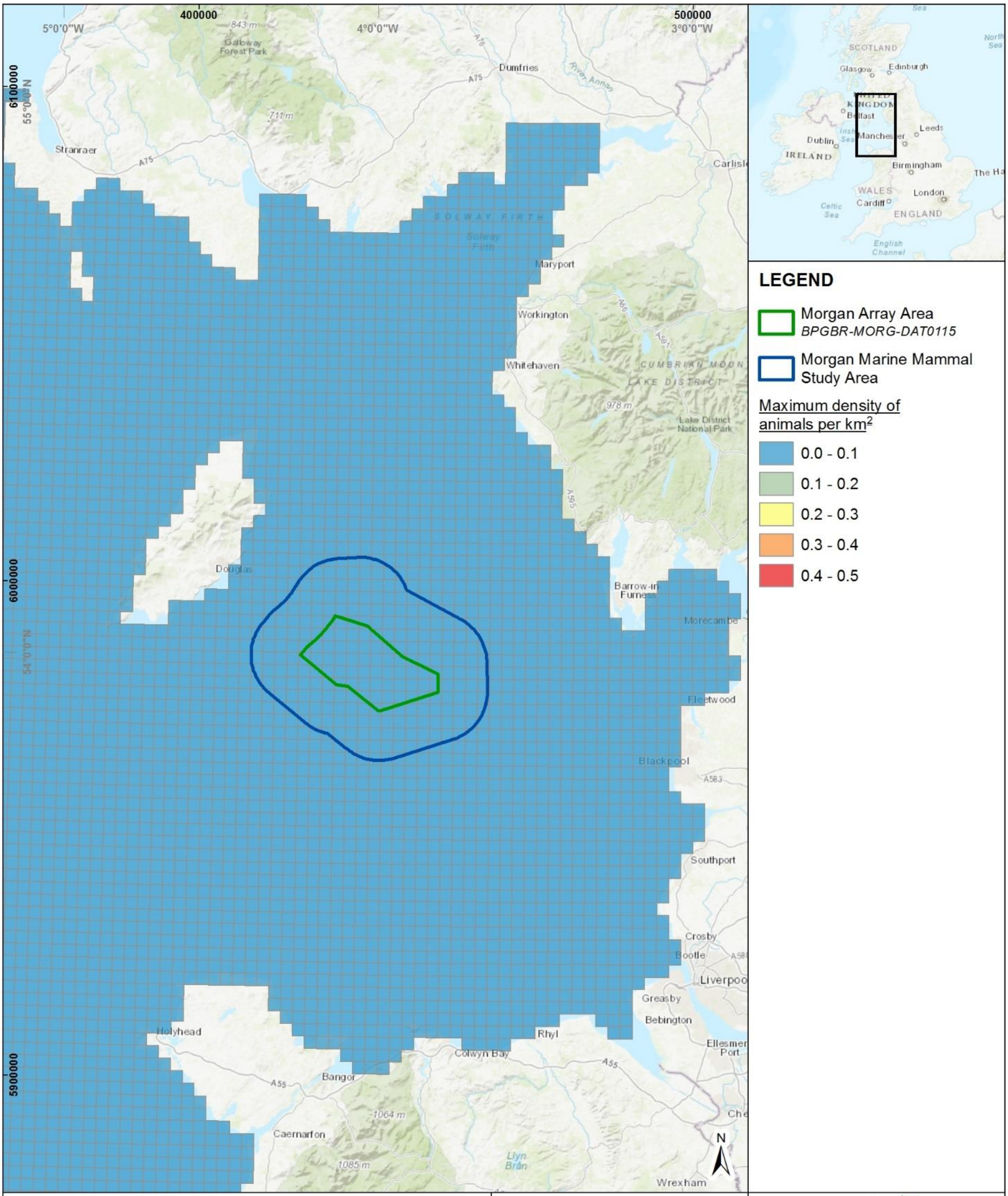
1.7.4.10 Joint Cetacean Protocol Phase III density surface modelling gave mean densities of 0.117 (SE = 0.009) animals per km^2 across the entire region of interest (UK waters and North Sea), but highest densities in the southwest of the prediction area, to the west of Ireland and the Hebrides (Paxton *et al*., 2016). In the Irish Sea, mean predicted densities were 0.5 animals per km^2 for summer 2001 to 2006 and 2017 to 2010, spring, autumn and winter 2010 (Paxton *et al.*, 2016). Areas of higher density were predicted for the Celtic Deep, to the south of the regional marine mammal study area. Much lower densities of approximately 0.05 animals per km^2 were estimated for the east Irish Sea (Paxton *et al.*, 2016). This study builds upon the Phase One Data Analysis (Paxton and Thomas, 2010), which predicted density surfaces for short-beaked common dolphin from data from 1980 to 2009. Densities for the Morgan marine mammal study area were 0.5 animals per km^2 in 1983, 1990, 1997 and 2004. Some areas of higher density were predicted off the southwest of Pembrokeshire in 1997 and 2004 (up to five animals per km^2) towards the Celtic Deep. These higher density areas off west Pembrokeshire are also confirmed in acoustic and visual surveys by Gordon *et al.* (2011) which confirmed substantial numbers of short-beaked common dolphin off the Bishops and Clerks. However, there were insufficient independent encounters to model patterns of density and distribution in this study by Gordon *et al.* (2011).

1.7.4.11 The northeast Atlantic distribution maps from Waggitt *et al.* (2020) showed low densities all year round in the Irish Sea, particularly the east Irish Sea, but densities were higher from May to October (Figure 1.43). Figure 1.44 and Figure 1.45 demonstrates the predicted monthly densities for short-beaked common dolphin for the Morgan marine mammal study area and demonstrates how areas of higher densities during summer months from July to September exist to the west of Morgan Array Area. This is similar to patterns observed in Wall (2013) and Baines and Evans (2012). Highest densities in the east Irish Sea are predicted in August with 0.339 animals per km^2 in high density areas. However, within the Morgan marine mammal study area, short-beaked common dolphin densities were highest in August and reached 0.0659 animals per km^2 for the Morgan Array Area, thus still a low density compared to other areas of the Irish Sea (Waggitt *et al.,* 2020).

1.7.4.12 Modelled outputs from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) indicated short-beaked common dolphin are most abundant in the Celtic Deep within St. George’s Channel but their distribution does extend northwards in deeper waters through the middle of the Irish Sea. Large groups have only been recorded in areas deeper than 50 m in the Irish Sea, though smaller group or individual sightings have occurred in the Bristol Channel, off the North Wales Coast and around the Isle of Man. The study does caveat that density maps for short-beaked common dolphin need careful interpretation because survey effort is patchy and greater in the south Irish Sea than elsewhere and, although modelled density maps aim to overcome this bias, there may be greater uncertainty. Numbers are greatest in summer although the species is recorded in all months of the year and may be under-recorded in winter when offshore survey effort is much lower. Animals in this area move up and down the shelf edge and are believed to be part of the same wide northeast Atlantic population (Murphy *et al.*, 2021).

1.7.4.13 The average density for the Morgan marine mammal study area from the annual composite maps (as recommended by NRW and authors of the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023), and agreed with Natural England, see paragraph 1.5.16.4) was 0.000288 animals per km^2. As set out in paragraph 1.5.16.4 this density estimate is highly precautionary as this is the highest value observed for each cell (2.5 km^2 resolution) at any one point in time. The average density for the Morgan Array Area was 0.000286 animals per km^2 (Evans and Waggitt, 2023; Figure 1.42).

1.7.4.14 No short-beaked common dolphin were recorded during the 24 months of site-specific aerial surveys in the Morgan Aerial Survey Area.



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Data Sources: Client, NRW

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-032-00

Drawing Title:
SHORT-BEAKED COMMON DOLPHIN ANNUAL COMPOSITE MODELLED DENSITIES (MEASURED AS THE MAXIMUM DENSITY PER CELL ACROSS MONTHS) (EVANS AND WAGGITT, 2023)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,300,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.42: Short-beaked common dolphin annual composite modelled densities (measured as the maximum density per cell across months) (Evans and Waggitt, 2023).

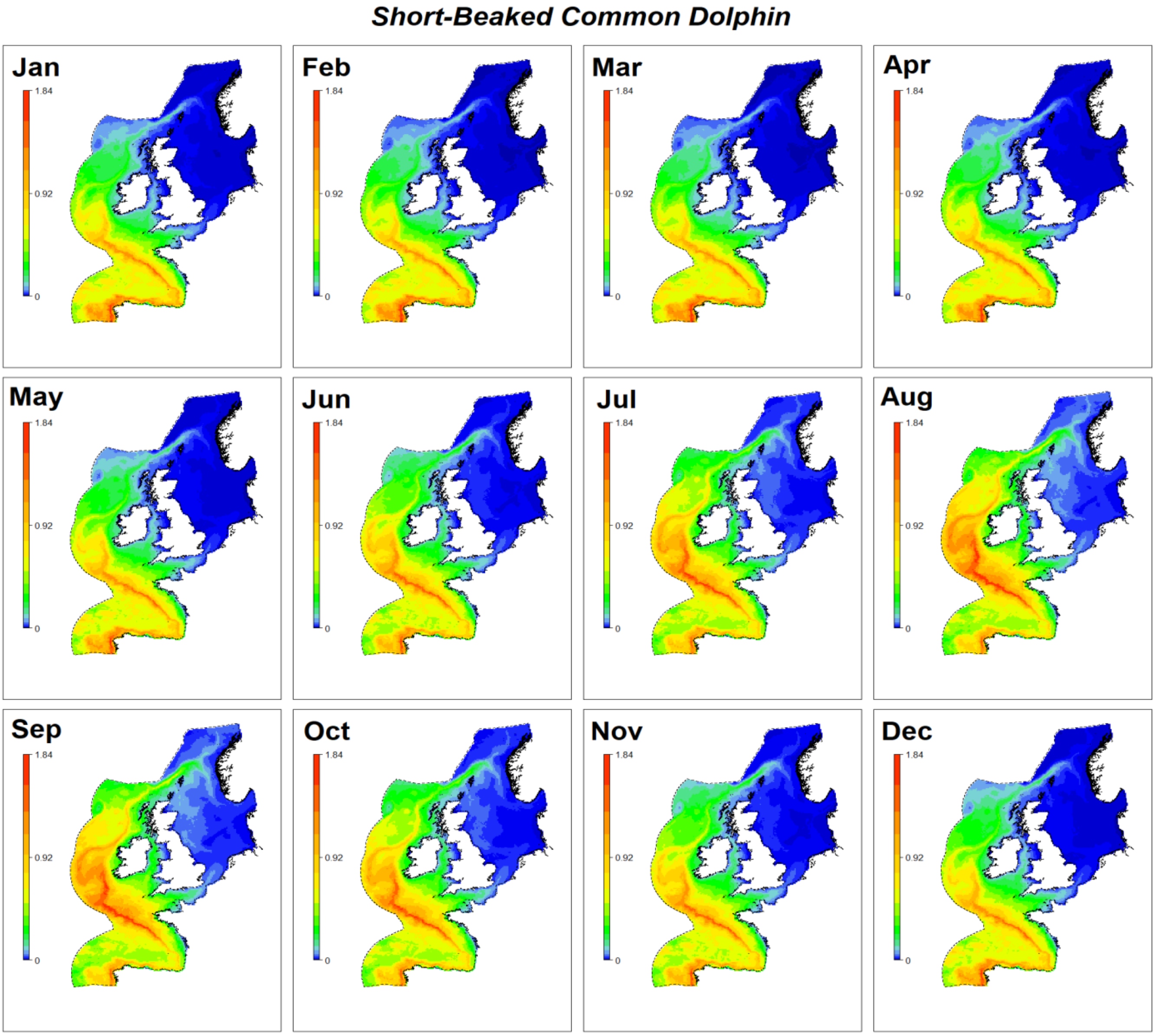
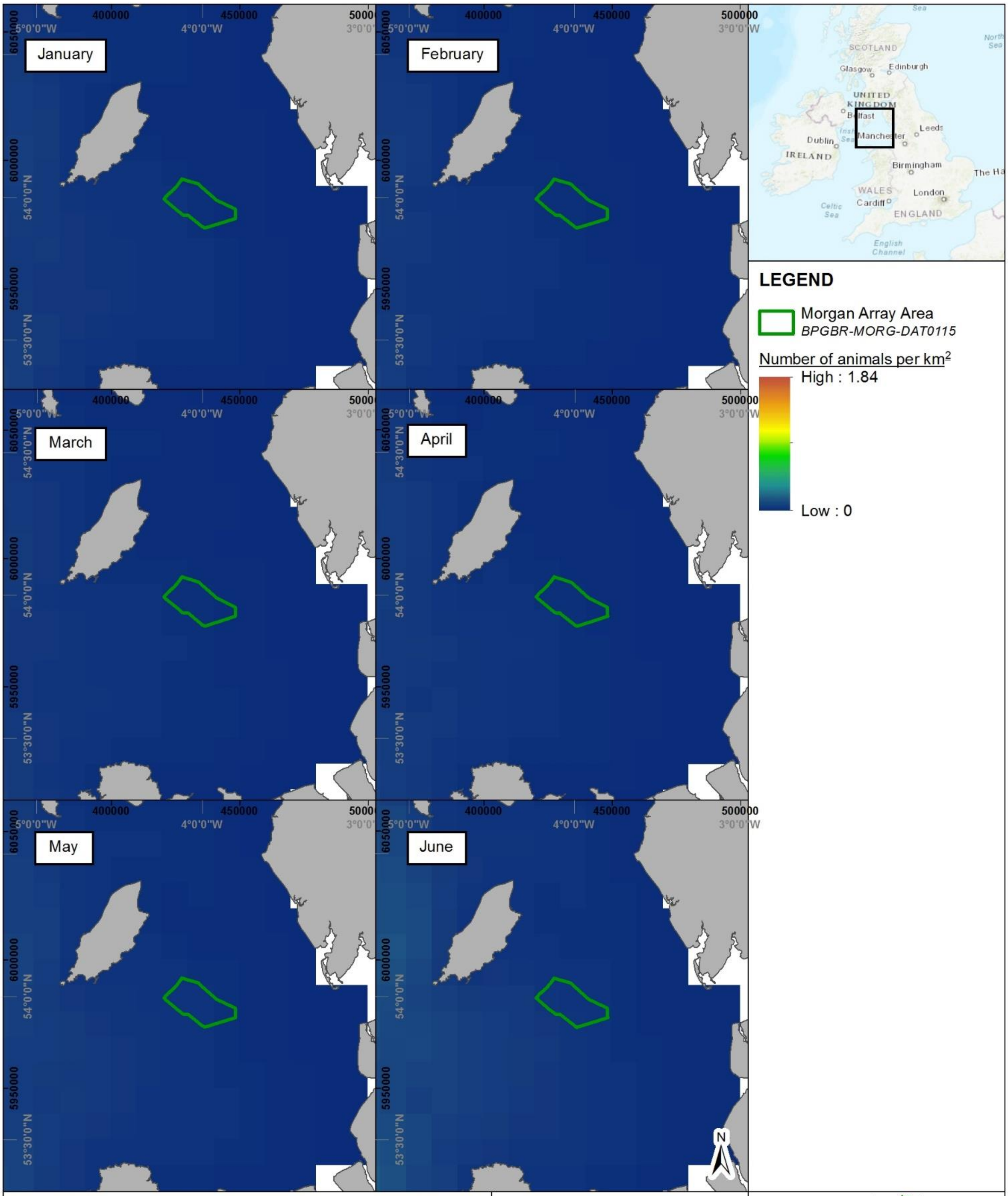


Figure 1.43: Predicted distributions for short-beaked common dolphin per month for the entire study area, from Waggitt *et al.* (2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

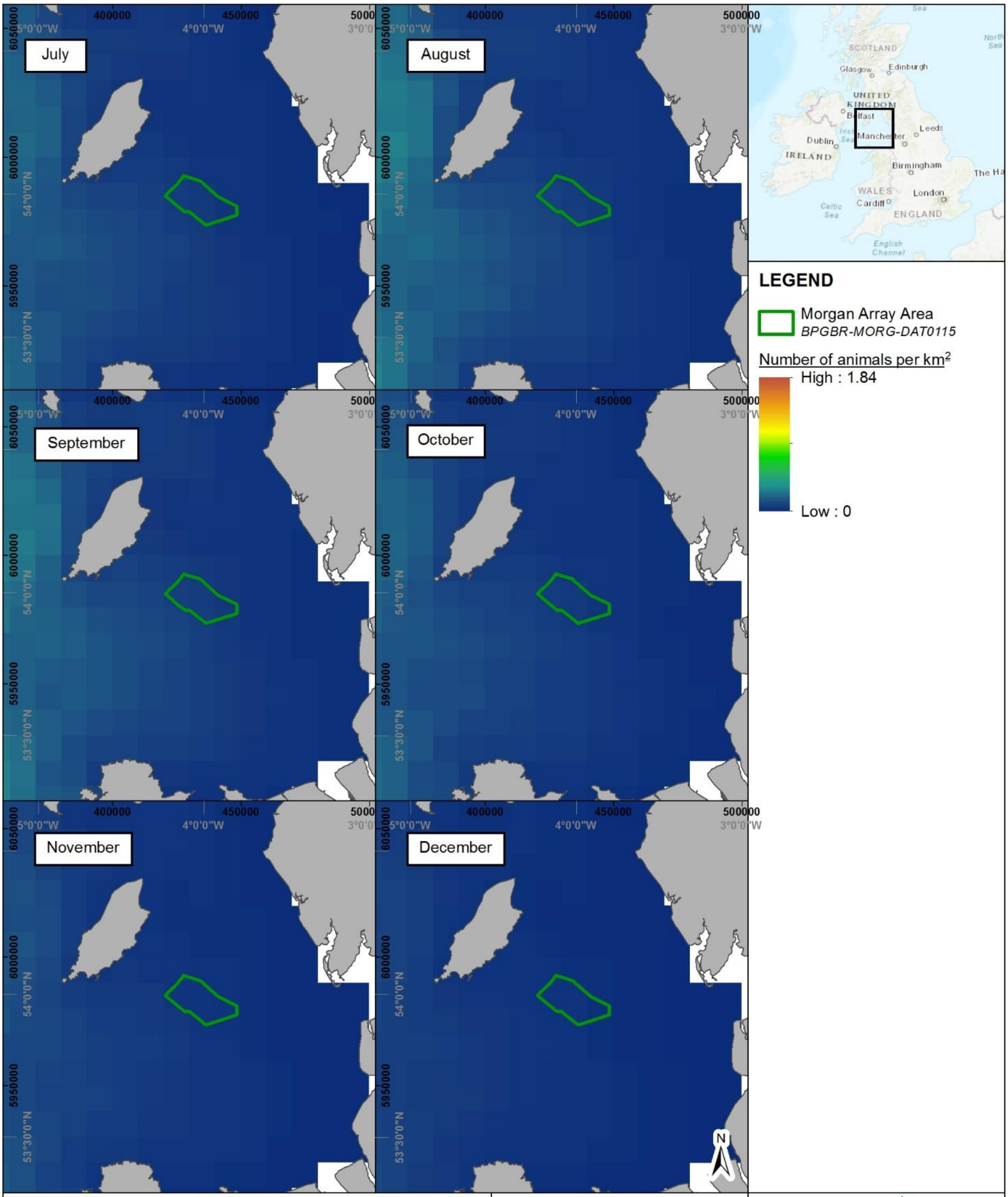
Drawing Number:
RPSE-MG-ES-MAM-033-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR SHORT-BEAKED COMMON DOLPHIN PER MONTH FROM JANUARY TO JUNE (WAGGITT ET AL., 2020)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.44: Predicted distributions for short-beaked common dolphin per month from January to June (Waggitt *et al.*, 2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

Drawing Number:
RPSE-MG-ES-MAM-034-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR SHORT-BEAKED COMMON DOLPHIN PER MONTH FROM JULY TO DECEMBER (WAGGITT ET AL., 2020)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.45: Predicted distributions for short-beaked common dolphin per month from July to December (Waggitt *et al.,* 2020).

Summary of densities

1.7.4.15 Overall, short-beaked common dolphin are common in the Irish sea but areas of high density appear to be found in the south Irish Sea, around the Celtic deep. These higher densities can therefore increase mean density for the entire Irish Sea region. However, in the east Irish Sea, where the Morgan marine mammal study area is located, observed densities are consistently lower. A summary of key densities is presented in Table 1.9.

1.7.4.16 Further to S42 feedback from consultees the density taken forward to assessment is from the most recent Welsh Marine Mammal Atlas data specific to the Irish Sea region (Evans and Waggitt, 2023) for the Morgan marine mammal study area, as this was considered to be the most representative density for the region, rather than older SCANS II data or broad scale block estimates from an adjacent SCANS-IV block (CS-D) (Gilles *et al.,* 2023).

Table 1.9: Comparison of short-beaked common dolphin densities from key data sources.

a Note Welsh Marine Mammal Atlas data (Evans and Waggitt, 2023) are presented for both the Morgan Array Area only and the Morgan marine mammal study area (Morgan Array Area plus 10 km to 13.3 km buffer).

b No short-beaked common dolphin were recorded within this SCANS block.

Source	Density (animals per km^2)	Estimate of variation
SCANS-IV – block CS-D (Gilles *et al.,* 2023)	0.0272	0.814 (CV)
SCANS-IV – block CS-E (Gilles *et al.,* 2023)	-[b]	
SCANS-III - block E (Hammond *et al.,* 2021)	- [b]	
SCANS-III - block F (Hammond *et al.,* 2021)	- [b]	
SCANS-II - block O (Hammond *et al.,* 2013)	0.018	0.78 (CV)
SCANS-III DSM for the Morgan marine mammal study area (Lacey *et al.,* 2022)	0.00457	0.190 (CV)
Northeast Atlantic distribution maps (Waggitt *et al.*, 2020) for the Morgan marine mammal study area	0.0659	0.059 to 0.073 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023)[a] for the Morgan Array Area	0.000286	0.00013 to 0.00057 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) for the Morgan marine mammal study area	**0.000288**	**0.00014 to 0.00057 (95% CIs)**

Abundance

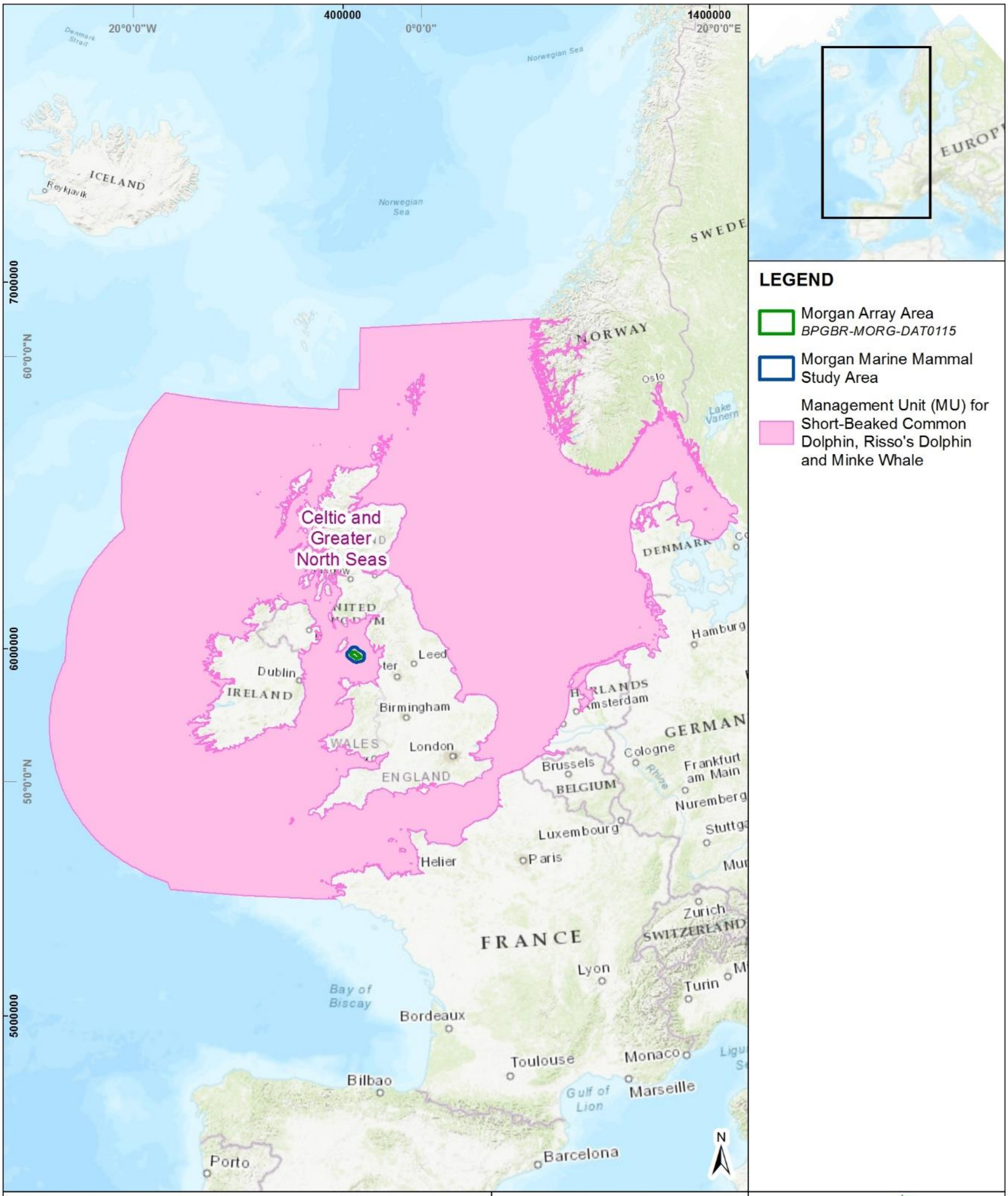
1.7.4.17 Broad scale estimates of abundance for short-beaked common dolphin exist, with IAMMWG (2022; 2023) estimating abundance for the CGNS (Figure 1.46) MU as 102,656 (CV = 0.29, 95% CI = 58,932 to 178,822) short-beaked common dolphin.

1.7.4.18 For the Irish Sea in particular, JCP Phase III analysis gave estimated predicted abundances in 2010 per season, with winter abundance for short-beaked common dolphin was 10 animals (95% CL = 0 to 50), spring was 50 animals (95% CL = 20 to 160), summer was 80 animals (95% CL = 30 to 260), and autumn had 310 animals (95% CL = 110 to 860). Summer and autumn therefore had the highest abundances.

1.7.4.19 During ObSERVE surveys (Rogan *et al.*, 2018), short-beaked common dolphin were seen in neritic waters, predominantly to the south and west of Ireland, but no sightings were recorded in the western Irish Sea stratum (Stratum 5).

1.7.4.20 In surveys for Rhiannon Wind Farm (Celtic Array Ltd., 2014), a single sighting of eight short-beaked common dolphin was recorded during the boat-based visual surveys. Insufficient sightings of short-beaked common dolphins were made during the boat-based surveys to generate a site-specific abundance estimate.

1.7.4.21 Data from the MWDW confirms short-beaked common dolphin have been regularly observed in Manx waters (Howe, 2018a) with data on sightings and observation counts, but abundance and density estimates are not given. Sighting data requested from MWDW is presented in Figure 1.14.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 50 100 200 nm
0 100 200 400 km

Drawing Number:
RPSE-MG-ES-MAM-036-00

Drawing Title:
CELTIC AND GREATER NORTH SEAS MANAGEMENT UNIT (MU) FOR SHORT-BEAKED COMMON DOLPHIN, RISSO'S DOLPHIN AND MINKE WHALE

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:17,500,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.46: Celtic and Greater North Seas MU for short-beaked common dolphin, Risso's dolphin and minke whale, with the Morgan marine mammal study area.

Seasonality

1.7.4.22 Analysis of summer sightings on shelf waters around the UK and adjacent waters showed the vast majority of short-beaked common dolphin to occur in waters above 14°C in temperature (MacLeod *et al.,* 2008; Cañadas *et al.,* 2009), and therefore there may be seasonal patterns depending on water temperature. The species moves onto continental shelf waters in the summer and then back offshore in the winter (Evans *et al.,* 2003). During the summer, coinciding with the mating/calving period (May to September), the majority of sightings are more widely dispersed along and off the continental shelf slope and in deep waters to the southwest of the UK (BEIS, 2022), off the west coast of Ireland and to the west and northwest of Scotland. There is evidence of strong seasonal shifts in short-beaked common dolphin around the UK, with winter inshore movements onto the Celtic Shelf and into the west English Channel and St. George's Channel resulting in pronounced concentrations (Northridge *et al.,* 2004). The northeast Atlantic distribution maps (Waggitt *et al.*, 2020) predicted low short-beaked common dolphin densities present all year round, but densities were higher in summer. MWDW data also shows higher sighting rates in July and August than other times of the year, but sightings were observed year-round in Manx waters. Howe (2018a) states the temporal distribution of short-beaked common dolphin in Manx waters matches that of short-beaked common dolphin throughout the UK, being seen mainly between May and September.

1.7.5 Risso's dolphin

Ecology

1.7.5.1 Risso's dolphin are oceanic dolphin widely distributed in tropical and temperate seas, and the only member of their genus. They tend to inhabit deeper water, which is home to their preferred prey of squid, octopus and cuttlefish but can occasionally be seen in coastal areas, and in the UK, they appear to prefer shallower waters of 50 to 100 m (Evans *et al.*, 2003). The majority of Risso's dolphin sightings in UK waters have been reported around the Hebrides, the Celtic Sea, west English Channel and the Irish Sea. The species is uncommon but regularly sighted in the south Irish Sea, particularly off the northwest and southwest coast of Wales and around the Isle of Man (Evans *et al.*, 2003).

1.7.5.2 They have robust, stocky bodies with a tall sickle-shaped dorsal fin, no prominent beak and a distinctive blunt melon with a v-shaped crease running from the upper lip to the blowhole. They have narrow tail stocks with median notch and concave trailing edge (Evans, 2008). Calves are born grey but turn darker grey to dark brown as they become juveniles. As they age, they become more silvery-grey, and the body is often covered in scars by other Risso's or prey species (squid). Adult Risso's dolphin measure between 2.6 to 3.7 m in length, and the average lifespan is between 20 to 30 years. Sexual maturity occurs between 8 to 10 years for females and 10 to 12 years for males, with a gestation lasting 13 to 14 months and calving interval at 2.4 years (Baird, 2009). Adults can weigh up to 500 kg.

1.7.5.3 They are typically encountered in groups of up to 20 individuals, but may form larger aggregations, including mixed schools with bottlenose dolphin (Reid *et al.,* 2003). In the North Atlantic, Risso's dolphin have occasionally been observed in association with other cetaceans, including long-finned pilot whale, white-beaked dolphin, white-sided dolphin and bottlenose dolphin (Reid *et al.,* 2003), and several suspected Risso's-bottlenose dolphin hybrid individuals have been sighted off west Scotland (Hodgins *et* *al.,* 2014). particularly adult males, show very strong associations, whereas others have pair only or no associations, particularly juveniles (Hartman *et al.,* 2008).

1.7.5.4 Risso's dolphin are known to be almost exclusively teuthophagic, meaning they feed primarily on squid (both neritic and oceanic species) and octopus within the UK, although they also eat cuttlefish and various fish species. Limited behavioural research suggests that they feed primarily at night. Stomach contents analysis of five Risso's dolphin from UK waters found that the primary prey species was the curled octopus *Eledone cirrhosa*, followed by the cuttlefish *Sepia officinalis*, the veined squid *Loligo forbesi* and the flying squid *Todarodes sagittatus* (Clarke and Pascoe, 1985; Santos *et al.*, 1994). There does appear to be regional variations in dietary preferences (Evans and Bjørge, 2013), and there have also been large seasonal variations in prey type observed (Bloch *et al.*, 2012) and resource partitioning between subgroups (Würtz *et al.*, 1992). SWF have observed them travelling in a line formation which is thought to improve effectiveness of hunting (SWF, 2012b).

Distribution

1.7.5.5 Risso's dolphin are distributed worldwide in temperate and tropical oceans and appear to have a preference for steep shelf-edge habitats (Baird, 2009). The range of Risso's dolphin seems to be limited by water temperature, with animals most common in waters between 15°C and 20°C and rarely found in waters below 10°C. The species is uncommon but regularly sighted in the south Irish Sea, particularly off the northwest and southwest coast of Wales and around the Isle of Man (Evans *et al.*, 2003). The Irish Sea group is unusual because of the shallow waters that the population inhabits, Risso's dolphin elsewhere tending to favour deep (over 1000 m) waters.

1.7.5.6 Risso's dolphin appear to have a localised distribution in the Irish Sea, in a wide band running from southwest to northeast which encompasses west Pembrokeshire, the west end of the Lleyn Peninsula and Anglesey, the southeast coast of Ireland, and around the north of the Isle of Man (Baines and Evans, 2012) (Figure 1.47). This general distribution appears to have persisted over the long-term although numbers visiting the coasts of Wales have varied greatly between years. They have mainly been observed in the region in summer (Hammond *et al*., 2005). Young animals have been reported off the north coasts of Pembrokeshire and Anglesey and in Manx waters (Baines and Evans, 2012).

1.7.5.7 Sightings data from MWDW show Risso's dolphin are widespread in Manx waters around the Isle of Man, extending out into the Morgan Array Area (Figure 1.14).

1.7.5.8 Studies conducted by SWF, Whale and Dolphin Conservation (WDC) and MWDW indicate movements of recognisable individuals of Risso's dolphin between Cornwall, Pembrokeshire, the Lleyn Peninsula, Anglesey, the Isle of Man and West Scotland (Evans *et al.*, 2015). Similarly, through photo-identification both seasonal and long-term site-fidelity has been revealed for some Risso's dolphin in the waters off Bardsey Island in Cardigan Bay (de Boer *et al.*, 2013; Eisfeld-Pierantonio and James, 2018).

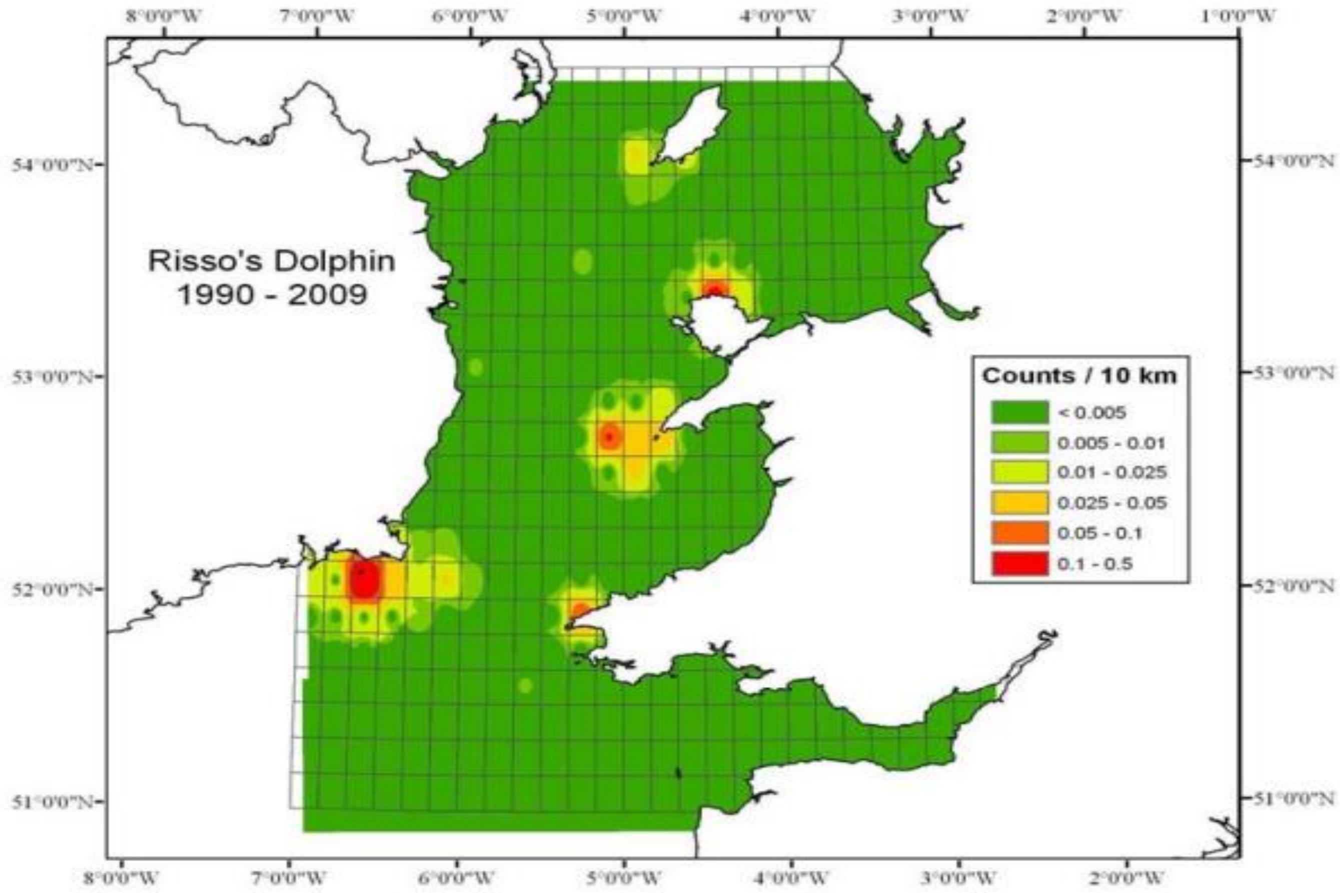


Figure 1.47: Inverse Distance Weighted interpolated map of Risso's dolphin distribution, from Baines and Evans (2012).

Density/abundance

1.7.5.9 Density and abundance estimates were available across a broader area within the regional marine mammal study area for Risso's dolphin.

Density

1.7.5.10 The Morgan Array area lies within Block F for the SCANS-III surveys in 2016 and although no Risso's dolphin were sighted within this block they were recorded in the adjacent Block E and estimated density was given at 0.0313 animals per km^2 (CV = 0.686). Recent SCANS-IV data did not report any Risso's dolphin in block CS-E, but reported a density of 0.0022 animals per km^2 (CV = 1.012) in adjacent block CS-D (Gilles *et al.*, 2023). JCP Phase III density surface modelling gave mean densities of 0.004 animals per km^2 across the entire JCP Phase III region (UK and North Sea waters), with some areas of high density around the Isle of Man and west of Anglesey. Predicted mean summer densities in the 1994 to 2010 period and 2007 to 2010 period reached 0.5 animals per km^2 to the west of the Isle of Man, but 0.09 animals per km^2 in 2001 to 2006. Predicted mean winter and autumn densities in 2010 were low across the Irish Sea (0.01 animals per km^2), whilst spring densities reached 0.03 animals per km^2. For the Morgan Array Area, densities were 0.01 animals per km^2 in summers from

2001 to 2006 combined, summers 2007 to 2010 combined and winter 2010[7] and therefore lower than the rest of the Irish Sea. In the previous JCP Phase I study (Paxton and Thomas, 2010) densities for the Morgan marine mammal study area was 0.01 animals per km^2 in 1983 and 1990, but in 1997 and 2004 densities ranged between 0.01 and 0.04 animals per km^2, with the areas of higher densities in a band through the Irish Sea passing the west of the Isle of Man[8].

1.7.5.11 During ObSERVE surveys (Rogan *et al.*, 2018), Risso's dolphin were seen in all seasons in both years in a variety of habitats (Figure 1.48), some sightings were close to shore, whilst others were over deeper waters. Density was low across years and CVs per stratum were high resulting in wide 95% confidence limits. Risso's dolphin were only observed in Stratum 5 (western Irish Sea) during Season 1 (summer 2015). For Season 1 design-based estimate of density was 0.0032 animals per km^2.

1.7.5.12 The northeast Atlantic distribution maps of Risso's dolphin at monthly scales by Waggitt *et al.* (2020) demonstrated Risso's dolphin densities to be lower in the Irish Sea from November to May, with increased densities in summer months between June to September (Figure 1.49). Figure 1.50 and Figure 1.51 demonstrates the predicted monthly densities for Risso's dolphin for the extent of Morgan marine mammal study area and demonstrates areas of low-density overlap. There are areas of higher density around the southwest of the Isle of Man from July to November, and towards Anglesey between July and October but these are further from the Morgan marine mammal study area. Highest densities in the east Irish Sea were predicted in August with 0.0095 animals per km^2 in high density areas around the Isle of Man. Estimate of densities within the Morgan marine mammal study area are lower, at 0.0013 animals per km^2 (August). This aligns with previous studies (Stevens, 2014; de Boer *et al.*, 2013; 2002) which found areas of high sightings densities and predicted habitat suitability around the coast of the Isle of Man, Anglesey, Bardsey Island and west Pembrokeshire.

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[7] JCP Phase III densities are approximations read off density surface maps in the report (Paxton *et al*., 2016), rather than derived from database. JDCP data was requested but not available currently.

[8] JCP Phase I densities are approximations read off the density surface prediction maps in the JCP report (Paxton and Thomas, 2010).

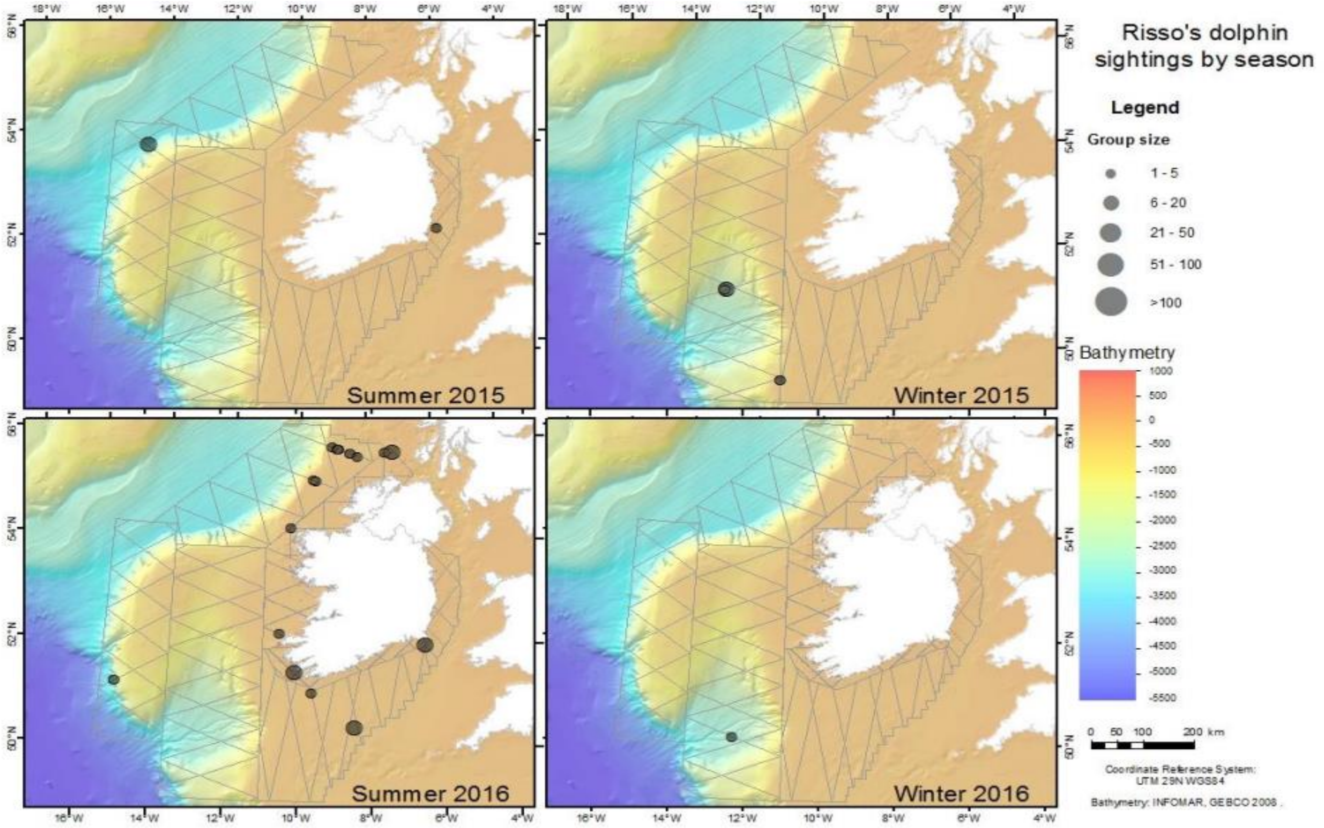


Figure 1.48: Sightings of Risso's dolphin in each survey period (bottom). Grey lines indicate the survey tracklines along which sightings were made. Circles are proportional to the number of dolphins in each sighting. From Rogan *et al.*, 2018.

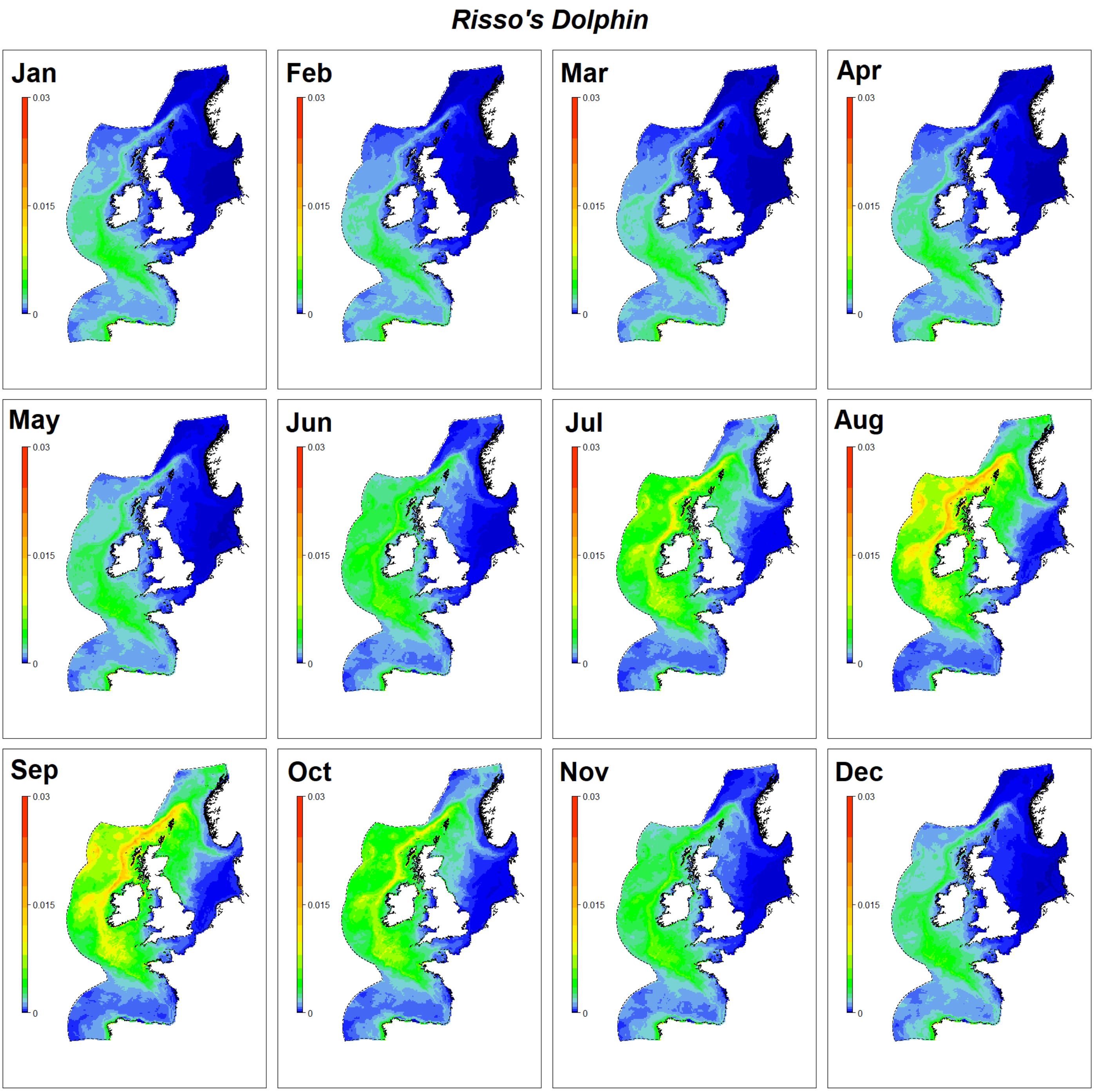
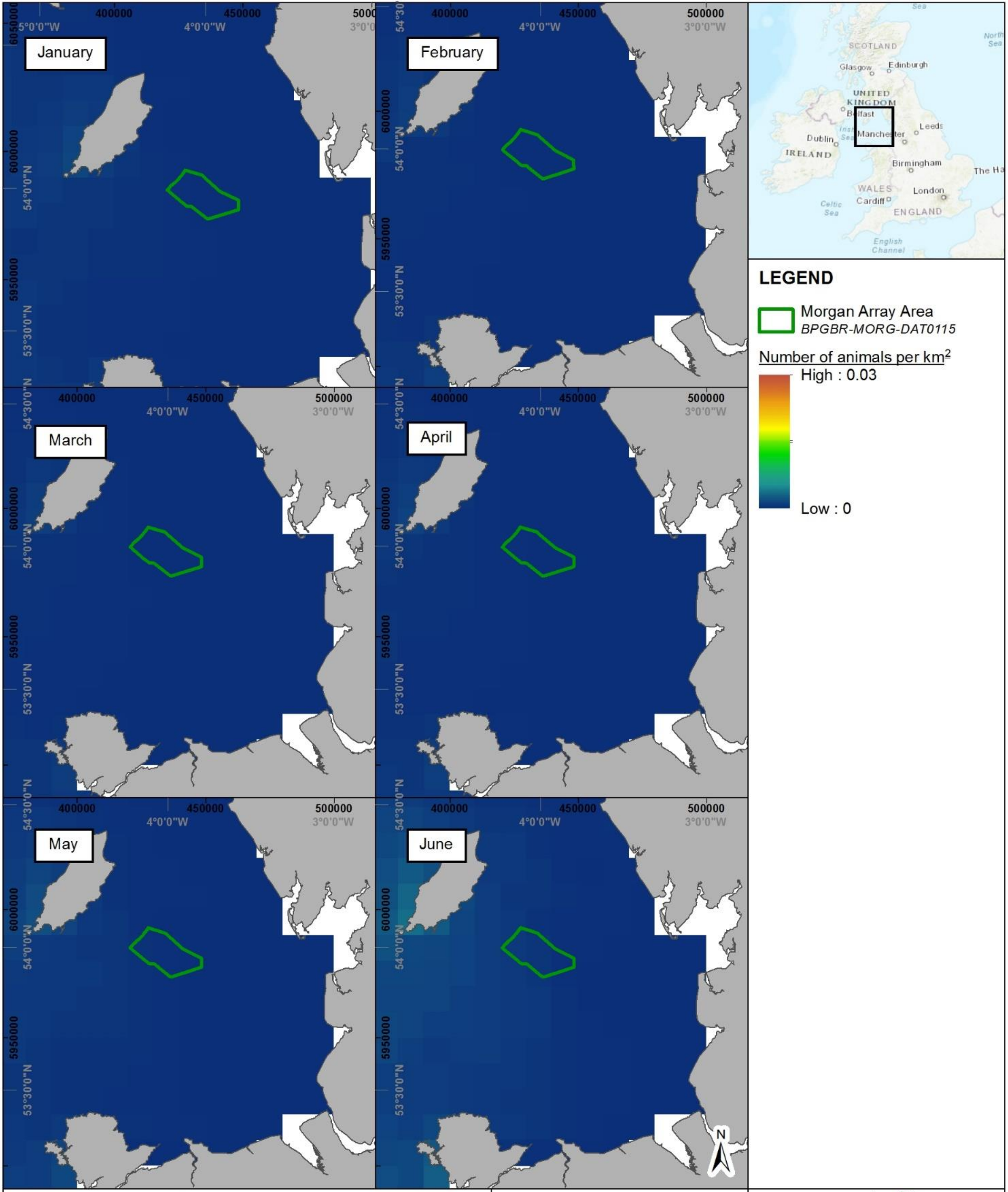


Figure 1.49: Predicted distributions for Risso’s dolphin per month for the entire study area, from Waggitt *et al.* (2020).



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Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

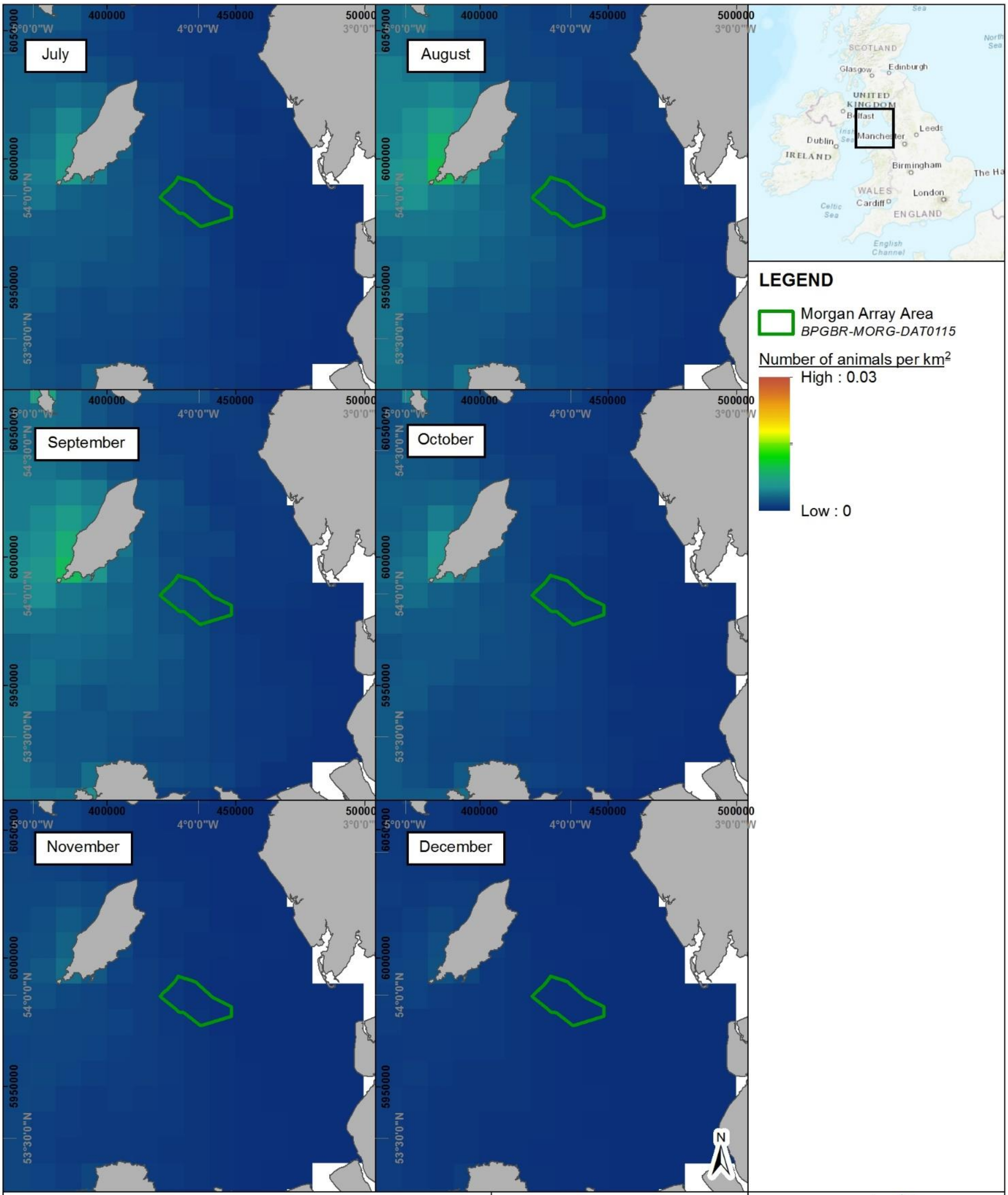
Drawing Number:
RPSE-MG-ES-MAM-037-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR RISSO'S DOLPHIN PER MONTH FROM JANUARY TO JUNE (WAGGITT ET AL., 2020)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.50: Predicted distributions for Risso's dolphin per month from January to June (Waggitt *et al.*, 2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

Drawing Number:
RPSE-MG-ES-MAM-038-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR RISSO'S DOLPHIN PER MONTH FROM JULY TO DECEMBER (WAGGITT ET AL., 2020)

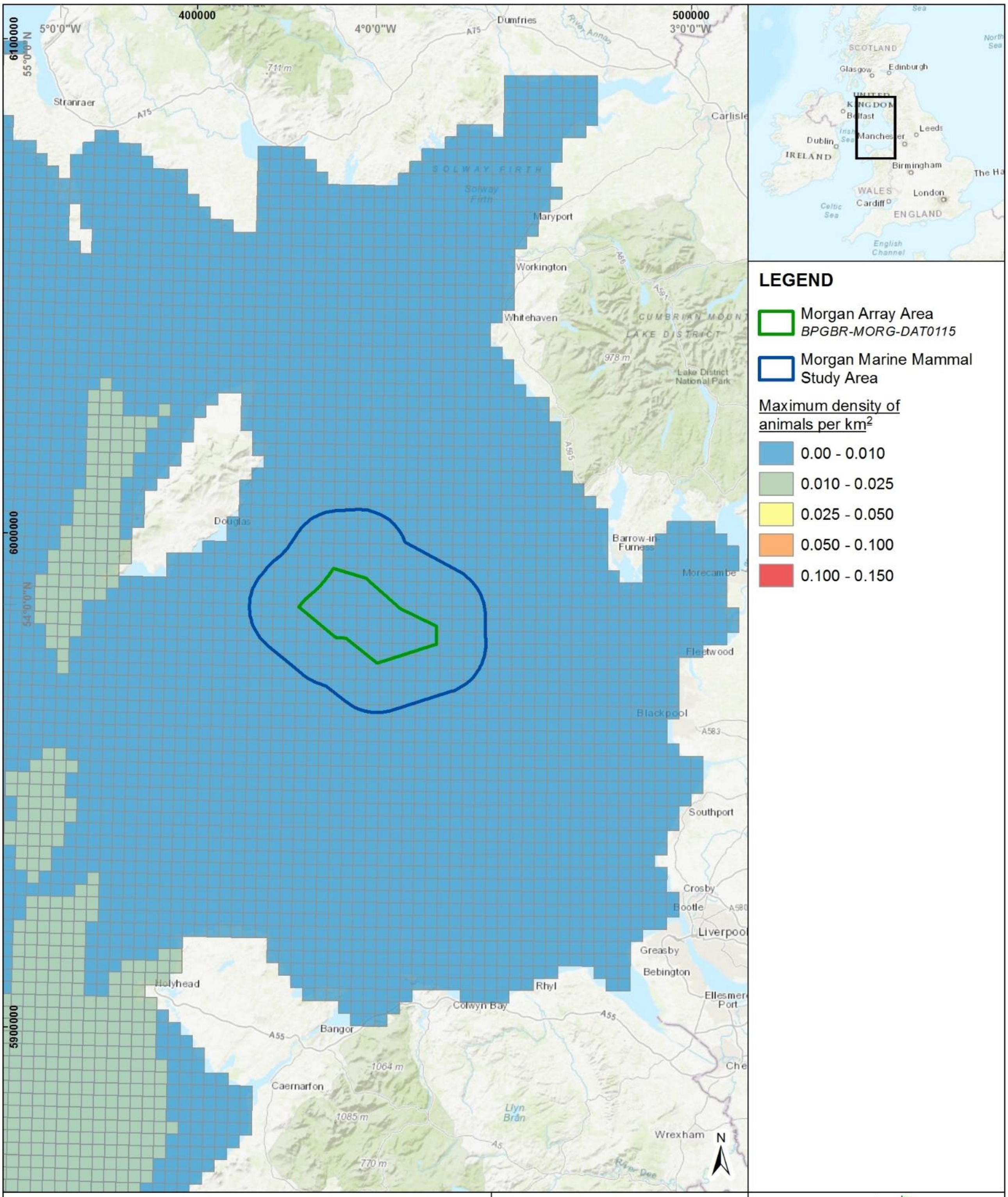
Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.51: Predicted distributions for Risso's dolphin per month from July to December (Waggitt *et al.*, 2020).

1.7.5.13 Modelled outputs from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) indicated Risso's dolphin occur at various locations across the Irish Sea with decadal maps showing the same principal areas for the species. Principal areas included the waters off the Co. Wexford coast in southeast Ireland, to the west of Pembrokeshire, off the western end of the Llŷn Peninsula around Bardsey Island and beyond, off northwest and north Anglesey, and around the Isle of Man. Modelled distributions suggested that the core population distribution occurs in the south Irish Sea. Sightings occurred mainly between June and October, and although the species has been recorded in every month of the year, there were few sightings between December and March, suggesting that the species may move offshore or even entirely out of the region (Evans and Waggitt, 2023).

1.7.5.14 The average density for the Morgan marine mammal study area from the annual composite maps (as recommended by NRW and authors of the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023), and agreed with Natural England, see paragraph 1.5.16.4) was 0.0009 animals per km^2. As set out in paragraph 1.5.16.4 this density estimate is highly precautionary as this is the highest value observed for each cell (2.5 km^2 resolution) at any one point in time. The density for the Morgan Array Area as 0.0006 animals per km^2 (Figure 1.52).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, NRW

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-039-00

Drawing Title:
RISSO'S DOLPHIN ANNUAL COMPOSITE MODELLED DENSITIES (MEASURED AS THE MAXIMUM DENSITY PER CELL ACROSS MONTHS) (EVANS AND WAGGITT, 2023)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,300,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.52: Risso's dolphin annual composite modelled densities (measured as the maximum density per cell across months) (Evans and Waggitt, 2023).

1.7.5.15 More locally, MWDW data confirms this presence of Risso's dolphin in the waters around the Isle of Man (Figure 1.14), with Risso's dolphin the most commonly sighted dolphin species in Manx territorial waters (Felce, 2014). Sightings are common in the area but are often given as counts of sightings rather than abundances or densities (Howe*,* 2018a; Stevens, 2014). The majority of sightings are around the east or the southwest of the Island (Figure 1.14).

1.7.5.16 No Risso's dolphin were recorded during the 24 months of site-specific aerial surveys in the Morgan Aerial Survey Area.

Summary of densities

1.7.5.17 Risso's dolphin are common in the regional marine mammal study area, particularly to the south of the Irish and Celtic Seas, but areas of high density appear to be also located towards the Isle of Man and northwest and southwest coast of Wales.

1.7.5.18 The density taken forward to assessment is the SCANS-III (Hammond *et al*., 2021) estimate for adjacent Block E, as agreed with the EWG. This is the most precautionary estimate compared to the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) estimate, Waggitt *et al.* (2020) and SCANS-IV block CS-D (Gilles *et al.,* 2023) density estimates. Risso's were not included in SCANS-III DSM maps (Lacey *et al*., 2022).

Table 1.10: Comparison of Risso's dolphin densities from key data sources.

a. Note Welsh Marine Mammal Atlas data (Evans and Waggitt, 2023) are presented for both the Morgan Array Area only and the Morgan marine mammal study area (Morgan Array Area plus 10 km to 13.3 km buffer).

b. No Risso's dolphin were recorded within this SCANS block.

Source	Density (animals per km^2)	Estimate of variation
SCANS-IV – block CS-D (Gilles *et al.,* 2023)	0.0022	1.012 (CV)
SCANS-IV – block CS-E (Gilles *et al.,* 2023)	-[b]	
SCANS-III – block E	**0.0313**	**0.686 (CV)**
SCANS-III – block F	-[b]	-
Northeast Atlantic distribution maps (Waggitt *et al.*, 2020) for the Morgan marine mammal study area	0.0013	0.0010 to 0.0017 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023)[a] for the Morgan Array Area	0.0006	0.0003 to 0.0012 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) for the Morgan marine mammal study area	0.0009	0.0004 to 0.0018 (95% CIs)

Abundance

1.7.5.19 IAMMWG (2022; 2023) estimated abundance for the CGNS MU (12,262 (CV = 0.46, 95% CI = 5,227 to 28,764) Risso's dolphin (Figure 1.46). The Morgan Generation Assets lie within Block F for the SCANS-III surveys in 2016 but no Risso's dolphin were sighted within the block. They were recorded in the adjacent Block E and abundance estimated at 1,090 animals (95% CI = 0 to 2,843) and mean group size of 7.50 (CV = 0.200). In recent SCANS-IV data, no Risso's dolphin were sighted within block CS-E (in which the Morgan Offshore Wind Project lies) but 75 animals (95% = 2 to 259) were estimated in the adjacent block CS-D.

1.7.5.20 JCP Phase III analysis gave sightings of 284 Risso's dolphin within the truncation distance. In the Irish Sea, estimated predicted abundances in 2010 were given per season, with winter abundance for Risso's dolphin was zero animals (95% CL: 0 to 10), spring was 70 animals (95% CL: 0 to 280), summer was 30 animals (95% CL: 30 to 160) and autumn had zero animals (95% CL: 0 to 10). ObSERVE surveys (Rogan *et al.*, 2018), gave Season 1 design-based estimate of abundance for Stratum 5 (western Irish Sea) was 35.1 animals (CV = 96.16, 95% CI = 7 to 188).

1.7.5.21 More locally, MWDW confirms this presence of Risso's dolphin in the area, with Risso's dolphin as the most commonly seen dolphin species in Manx territorial waters (Felce, 2014). Sightings are common in the area but are often given as counts of sightings rather than abundances or densities (Howe, 2018a; Stevens, 2014). MWDW sightings from 2006 to 2021 are presented in Figure 1.14.

1.7.5.22 In surveys for Rhiannon Wind Farm (Celtic Array Ltd., 2014), three observations were recorded during the boat-based visual surveys, comprising 18 animals. All sightings were between June and September with group size ranging between 2 and 10 animals. Insufficient sightings of Risso's dolphins were made during the boat-based surveys to generate a site-specific abundance estimate.

1.7.5.23 Aerial surveys for the Mona Offshore Wind Project demonstrated two Risso's dolphin were recorded in November 2020 (Mona Offshore Wind Ltd, 2024) with relative design-based abundance estimate of 14 Risso's dolphin for the Mona Aerial Survey Area.

Seasonality

1.7.5.24 Risso's dolphin are observed year-round in the UK but are mainly a summer and autumn visitor with highest sighting rates in summer months (Evans *et al.*, 2003, Reid *et al.*, 2003; Baines and Evans, 2012; Wall, 2013). They are regularly seen in Welsh waters between July to September (Baines and Evans, 2012). Risso's dolphin are known to breed in the Celtic and Irish Sea and young have been observed when groups have been sighted (Baines and Evans, 2012). The northeast Atlantic distribution maps (Waggitt *et al.,* 2020) show increased relative densities off the southwest coast of the Isle of Man from June to October.

1.7.5.25 Howe (2018a) suggested Risso's dolphin show high seasonality to Manx waters, with marked spatial and temporal distribution, being present only between March and September and with 90% of sightings on the east coast of the Island around the Calf of Man or to the south west of the Calf. Data obtained from MWDW (2022) also shows higher sightings of Risso's dolphin in summer months, with peaks in June and July.

1.7.6 Minke whale

Ecology

1.7.6.1 Minke whale is the most frequently sighted mysticete (baleen whale) species in UK waters and is particularly common around the Northern Isles and in regions of the North Sea (Weir, 2001). Minke whale typically live up to 60 years, with male minke whale reaching sexual maturity at the age of five to eight years and females at the age of six to eight years. In the northern hemisphere, mating occurs between October to March and the gestation period lasts approximately 10 months, with the peak birth period between December and January (Seawatch Foundation, 2012c). Calves usually nurse for a period of four to six months.

1.7.6.2 This species tends to be observed either solitarily or in pairs or threes. However, in higher latitudes larger groups of 10 to 15 individuals can be observed, particularly in areas of high prey density (Anderwald *et al.*, 2007). Mostly inhabiting continental shelf waters, this species occurs in depths of less than 200 m and can often be seen close to land. This species is often known to exploit prey resources through other species that herd prey, enabling a low energy foraging strategy. Some regional differences exist with respect to diet (Robinson *et al.*, 2007). Minke whale follow prey distribution and sandeel are the key food resource throughout the North Sea, with sprat, shad and herring also preferred prey items (Robinson and Tetley, 2007). Samples taken from the stomach contents of specimens within the North Sea determined that in UK waters the dominant prey items were sandeels, followed by clupeids *Clupeidae* and to a lesser extent mackerel *Scomber scombrus* (Robinson *et al.*, 2007). In the Irish Sea, two known herring stocks exist and minke whale seem to mirror these stocks in Manx Waters. The Manx herring stock are known to spawn on the east coast of the island, in September to October (Bowers, 1969), hence the presence of Minke whale on the east coast during these months whilst during the summer months, the Manx stock and Mourne stock are found together off the west coast of the island (Bowers, 1980). However, Hammond *et al.* (2005) states there is no specific information on feeding in the SEA6 area. Some genetic differentiation among individuals has been reported (Andersen *et al.,* 2003) but since this does not appear to be caused by geographic structuring within the northeast Atlantic (Anderwald *et al.,* 2011). They are usually observed singly or in pairs although may form larger feeding aggregations of 10 to 15 individuals (Reid *et al.,* 2003).

Distribution

1.7.6.3 Minke whale inhabit all major oceans of the world and are most abundant in relatively cool waters, and on the continental shelf in waters. In UK waters, minke whale are widely distributed and present year-round but by far the most sightings within continental shelf waters occur between May and September, with peak numbers from July to September, depending on the region (Evans *et al.*, 2003). During these summer months, they are widely distributed throughout the region, including coastal and offshore shelf waters, and deeper waters on and beyond the shelf slope.

1.7.6.4 In the 2012 Atlas of the Marine Mammals of Wales, highest densities of sightings occurred in the area of the Celtic Deep, although the species is found also in deeper areas (generally >50 m) northwards particularly between the coast of Co. Dublin and Anglesey, and around the Isle of Man (Baines and Evans, 2012). In the Irish Sea, minke whale mainly occur in the south and west of the area (Hammond *et al.*, 2005), and are present from late April to early August (Wall, 2013). This is confirmed by a high degree of seasonality to Manx waters, as detailed in the Manx Marine Environmental Statement, with presence between June and November (Howe, 2018a). Howe (2018a) also noted a clear spatial aspect to the distribution of minke whale sightings in Manx waters, with the majority of summer sightings on the west coast of the island, whereas in the autumn most sightings are on the east coast. As mentioned, two herring stocks in the Irish Sea (the Mourne Stock and the Manx Stock) may drive this pattern, with the Manx herring stock spawning east coast of the island in September to October (Bowers, 1969), and Mourne stock are found together off the west coast of the island (Bowers, 1980). Sighting data 2006 to 2022 obtained from MWDW (MWDW, 2022) confirms minke whale are widespread in Manx waters around the Isle of Man, with some sightings to the north and northwest of the Morgan Array Area (Figure 1.14) and up towards the coast of Northern Ireland.

Density/abundance

Density

1.7.6.5 The Morgan Array Area lies within Block F for the SCANS-III surveys in 2016, but no minke whale were recorded in this block. However, the regional marine mammal study area also spans block E, and estimated densities were 0.0173 animals per km^2 (CV = 0.618). The Offshore Energy SEA 4: Appendix 1 Environmental Baseline (BEIS, 2022) used SCANS-III data to give predicted density surfaces for Minke whale in 2016 and demonstrated high areas of minke whale density around the Isle of Man (0.027 to 0.036 animals per km^2) and moderate densities across the entire Irish Sea (0.012 to 0.02 animals per km^2). These densities are predictions based upon based on the observed distributions and their relationships with habitat variables (longitude and latitude, plus distance from coast, depth or aspect of seabed slope) (Figure 1.53).

1.7.6.6 SCANS-III DSM data (see paragraph 1.5.6.8) (Lacey *et al.*, 2022) gave mean densities of 0.024 animals per km^2 and a maximum of 0.032 animals per km^2 for the Morgan marine mammal study area (Figure 1.54), with density maps showing higher areas of density in the east Irish Sea[9].

1.7.6.7 Recent SCANS-IV data reported densities of 0.0088 animals per km^2 (CV = 1.145) in block CS-E and 0.0137 animals per km^2 (CV = 0.632) in block CS-D (Gilles *et al.*, 2023), noting surveys for these blocks were carried out over a limited summer period (between 28 June and 15 August 2022) and thus densities may vary in other months of the year.

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[9] Data from SCANS-III estimates are given as point densities and have been transformed to grid using Voronoi triangle/polygon method to create a grid surface for clearer illustration.

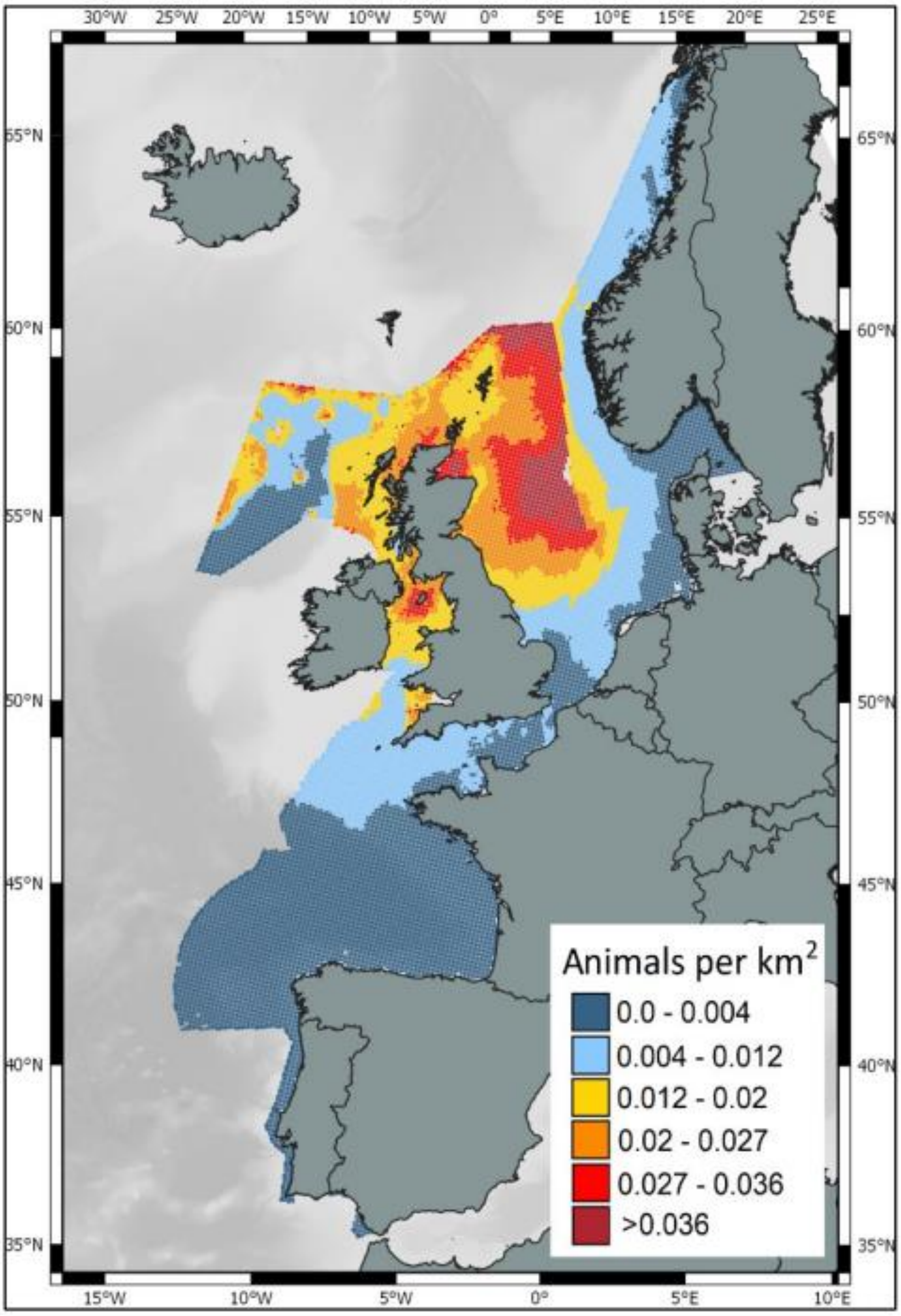
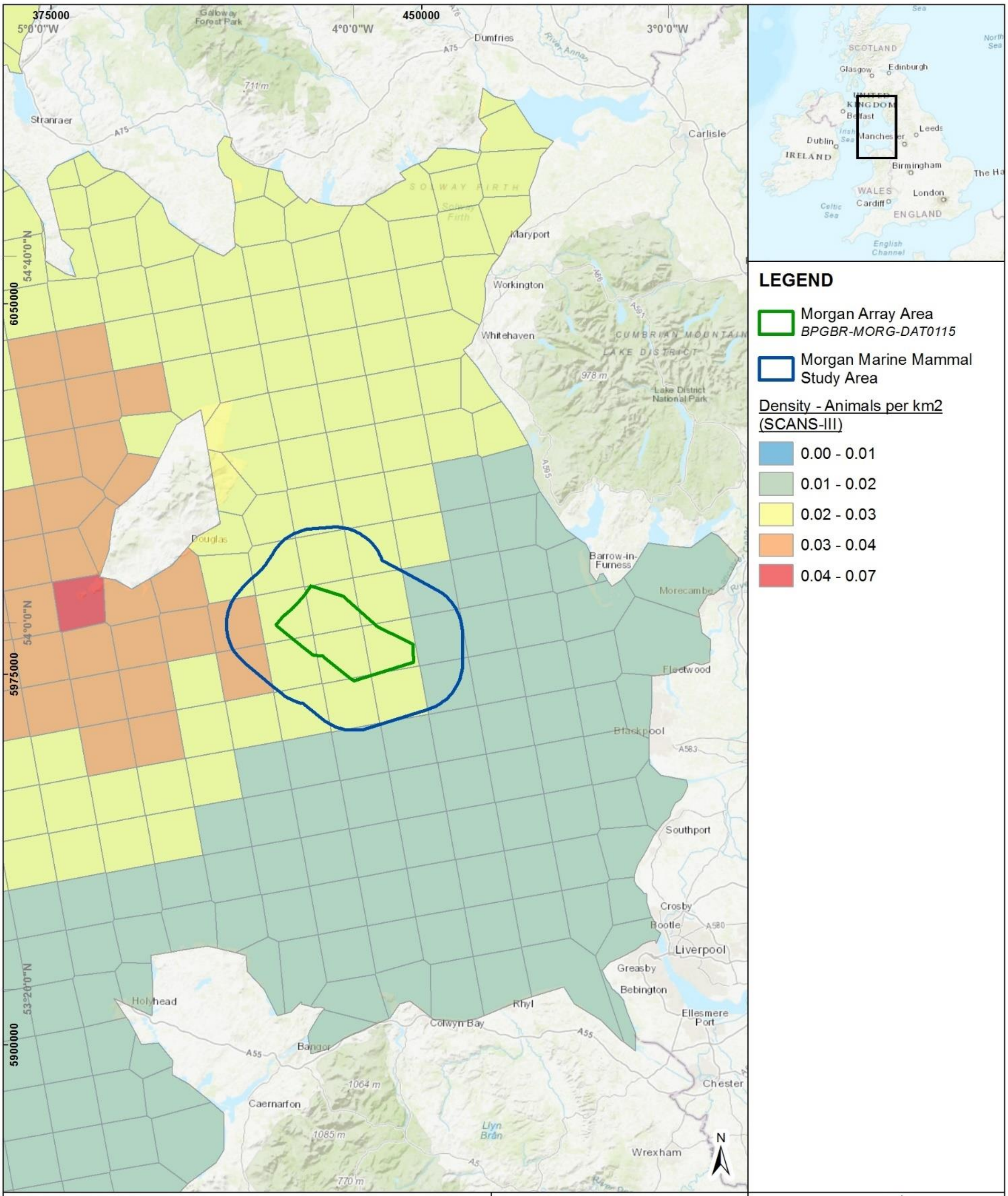


Figure 1.53: Predicted density surface for minke whale in 2016, using SCANS-III data, from Offshore Energy SEA 4: Appendix 1 Environmental Baseline (BEIS, 2022.).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC, SCANS-III

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-040-00

Drawing Title:
DENSITY SURFACE MAPS FROM SCANS III DATA FOR MINKE WHALE (LACEY ET AL., 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,300,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.54: Density surface maps from SCANS-III data for minke whale (Lacey *et al.,* 2022).

1.7.6.8 JCP III (Paxton *et al.,* 2016) density surface modelling gave mean densities of 0.022 animals per km^2 across the entire region of interest (UK wide), with some areas of persistent high relative density around the Isle of Man (in summer 2010 densities of 0.1 animals per km^2). Mean minke whale densities in the entire Irish Sea for summers from the periods 1994 to 2000, 2001 to 2006 reached 0.5 animals per km^2, whilst summers in 2007 to 2010 reached 0.2 animals per km^2. Minke whale densities for spring, autumn and winter 2010 were lower, at 0.02 animals per km^2 across the Irish Sea region. For the Morgan marine mammal study area, densities were lower than in the Irish Sea, with 0.02 animals per km^2 for spring, summer and winter 2010, and 0.04 animals per km^2 in summer periods 2001 to 2006 and 2007 to 2010.

1.7.6.9 This study builds upon the Phase One Data Analysis (Paxton and Thomas, 2010), which predicted density surfaces for minke from data from 1980 to 2009. In the Irish Sea there were some areas of higher densities in 2004 along the east coast of Ireland (0.05 animals per km^2) and around the Isle of Man (0.02 animals per km^2), but densities for the Morgan marine mammal study area were 0.005 animals per km^2 in 1983, 1990, 1997 and 2004.

1.7.6.10 More recently, minke whale was the most frequently observed mysticete species in ObSERVE surveys in Irish Waters in 2015 and 2016 and included one sighting of a mother and calf pair (Rogan *et al.*, 2018). There was high use of coastal waters in the summer months, including in the Irish Sea, but the Irish Sea appeared unsuitable for minke whale during winter. For summer 2015, the corrected design-based estimate of density was 0.045 animals per km^2. There were no minke whale observed in Stratum 5 (western Irish Sea) during winter 2015/2016 or winter 2016/2017. For summer 2016, corrected design-based density was 0.016 animals per km^2.

1.7.6.11 The northeast Atlantic distribution maps of minke whale at monthly scales by Waggitt *et al.* (2020) showed areas of low minke whale density in the Irish Sea compared to areas in northwest Scotland, with higher densities from June to October (Figure 1.55). Figure 1.56 and Figure 1.57 demonstrates the predicted monthly densities for minke whale for the region of the Morgan marine mammal study area. Densities are low in the east Irish Sea, with the highest predicted densities in August with 0.0409 animals per km^2. Densities are higher in the mid channel and west side of the Irish Sea, particularly around the Isle of Man from July to November, and towards the west of the Irish Sea. Within the Morgan marine mammal study area, highest densities were 0.0074 animals per km^2 in August for the Morgan Array Area, thus very low in comparison to other areas of the Irish Sea.

1.7.6.12 No minke whale were recorded during the 24 months of site-specific aerial surveys in the Morgan Aerial Survey Area.

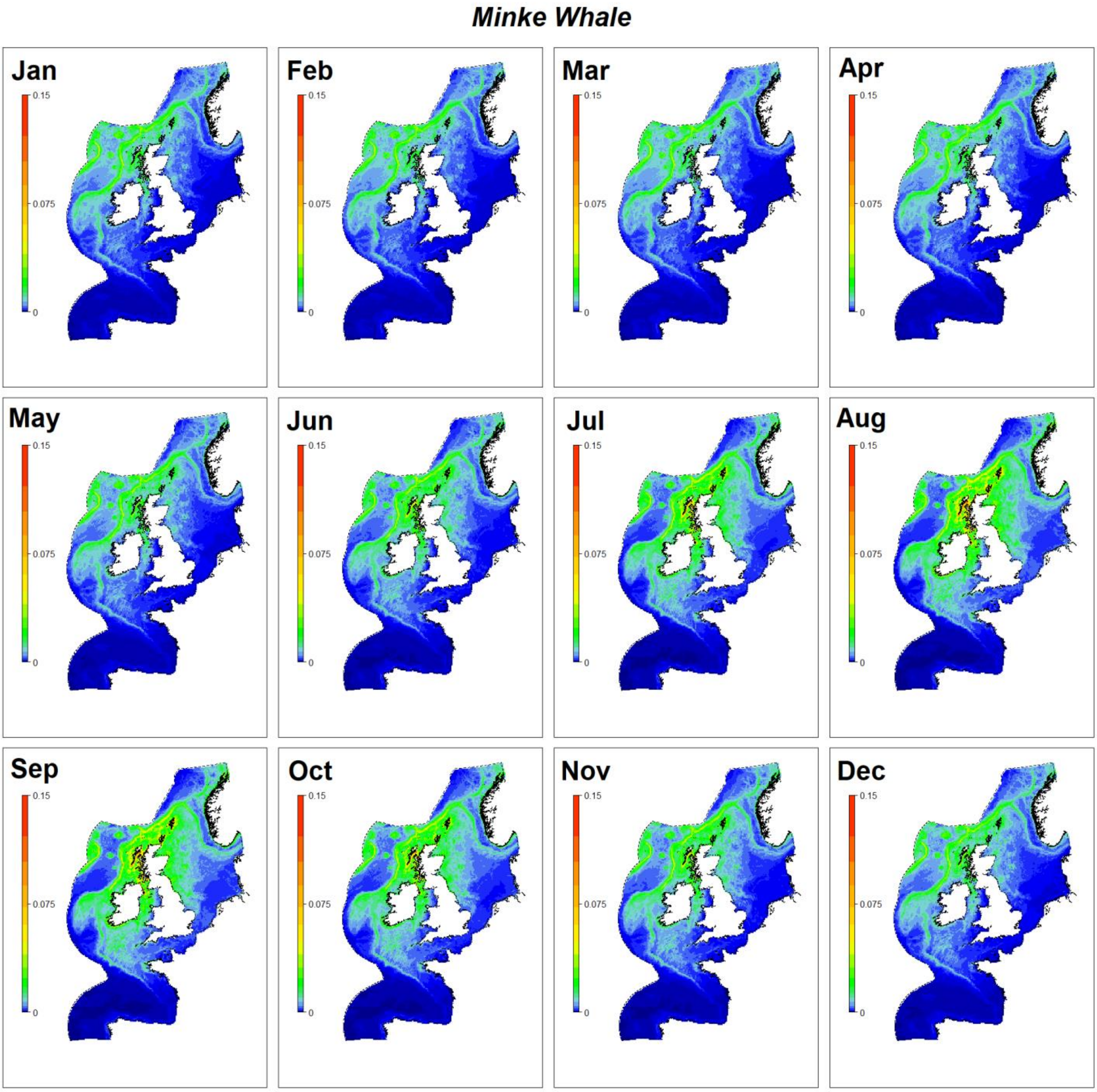
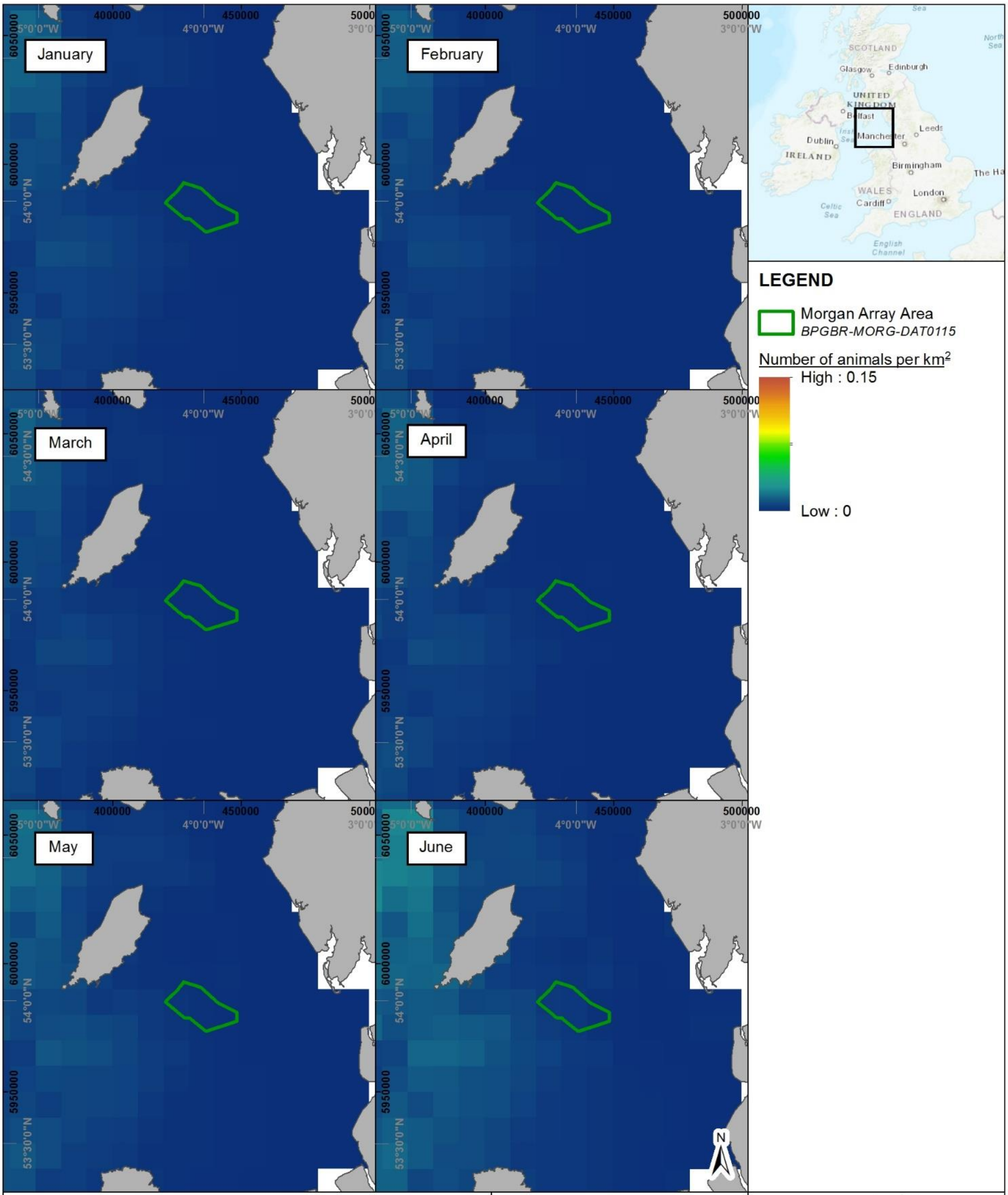


Figure 1.55: Predicted distributions for minke whale per month for the entire study area, from Waggitt *et al.,* (2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

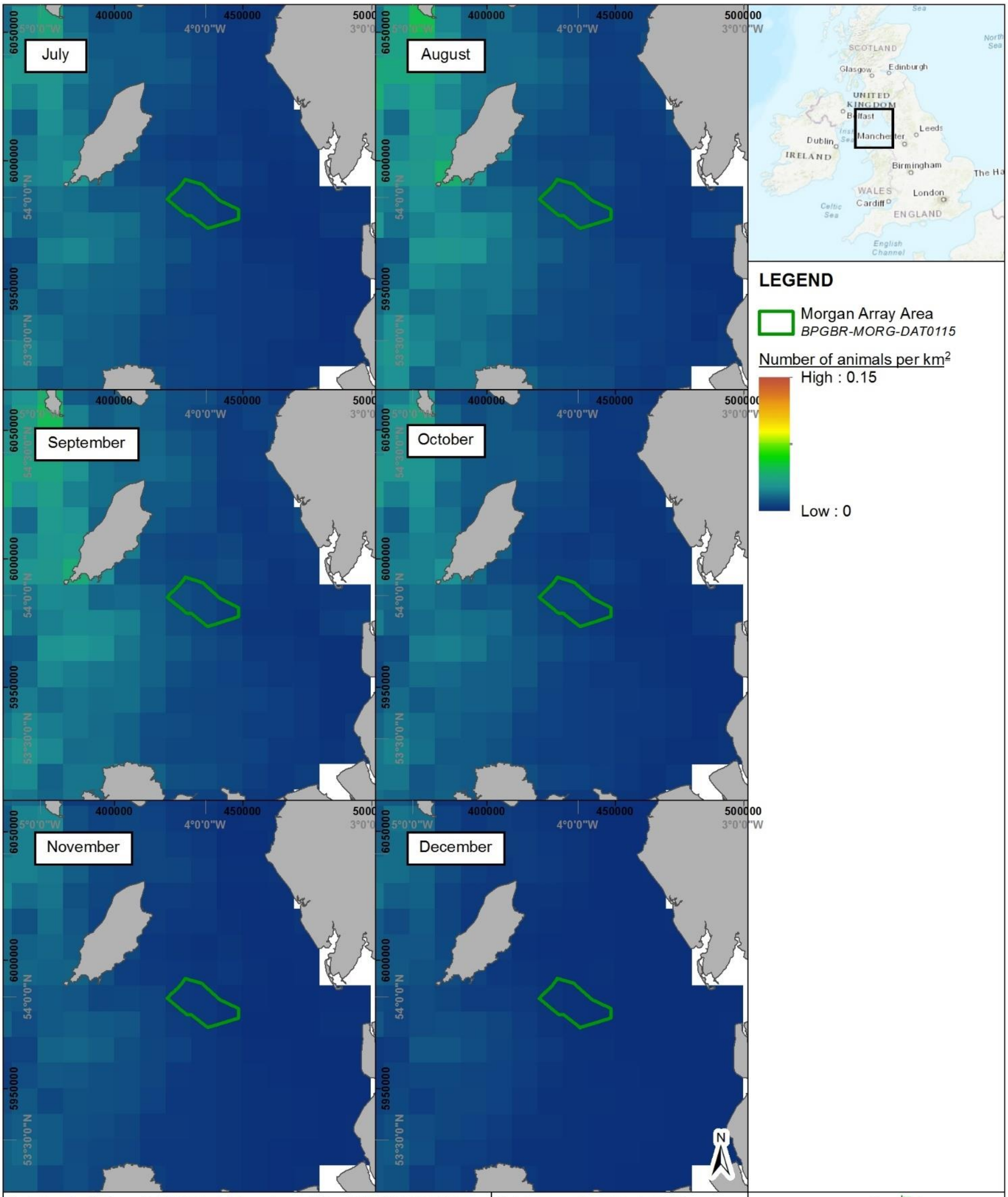
Drawing Number:
RPSE-MG-ES-MAM-041-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR MINKE WHALE PER MONTH FROM JANUARY TO JUNE (WAGGITT ET AL., 2020)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.56: Predicted distributions for minke whale per month from January to June (Waggitt *et al.*, 2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, Waggitt (2020).

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

Drawing Number:
RPSE-MG-ES-MAM-042-00

Drawing Title:
PREDICTED DISTRIBUTIONS FOR MINKE WHALE PER MONTH FROM JULY TO DECEMBER (WAGGITT ET AL., 2020)

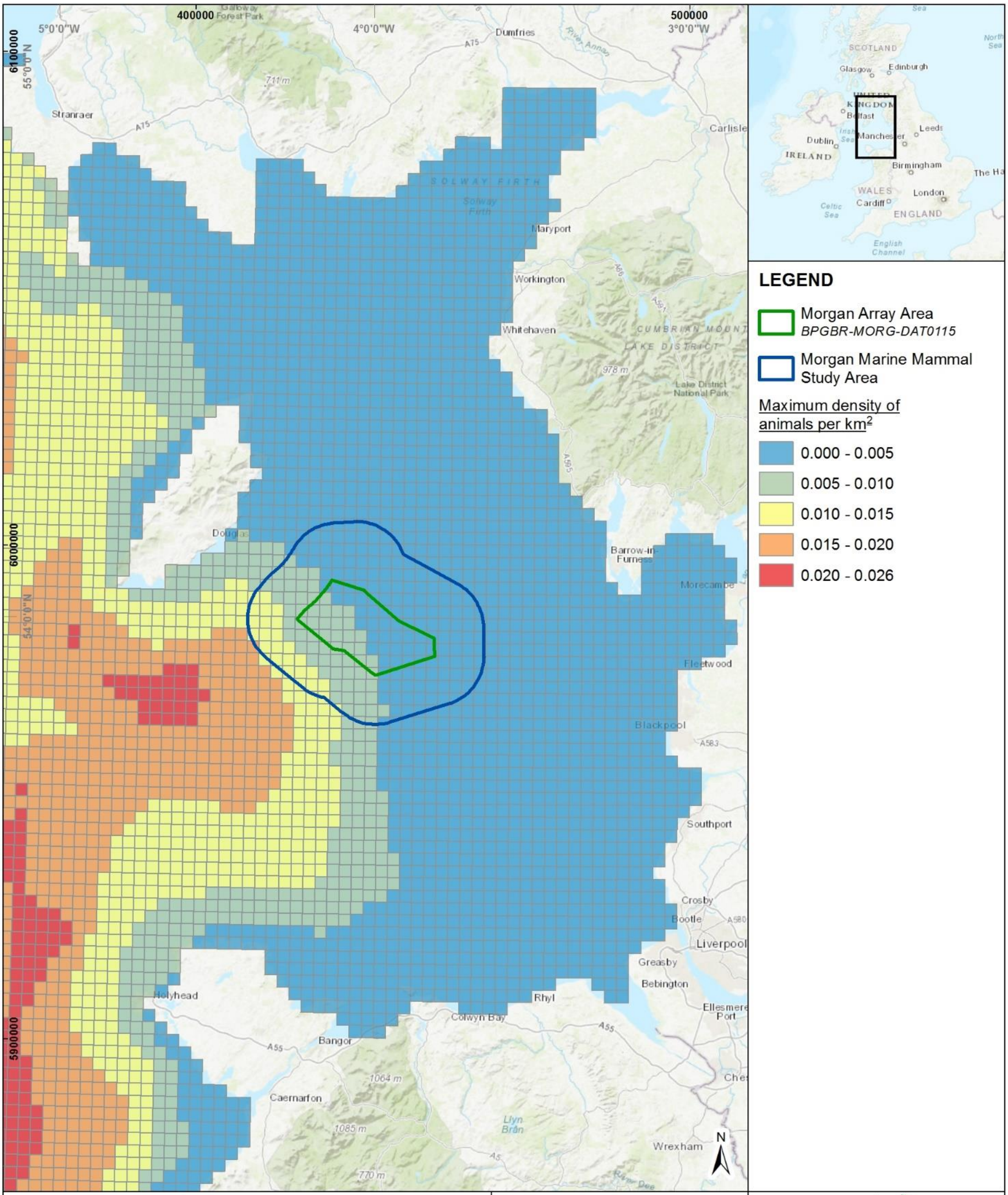
Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.57: Predicted distributions for minke whale per month for July to December (Waggitt *et al.,* 2020).

1.7.6.13 Modelled outputs from the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) indicated minke whale density was high across the west Irish Sea, with lower densities towards the east. Sightings broadly coincided with the two main frontal systems in the Irish Sea (the Celtic Sea Front in the south and the Irish Sea Front in the north) but it should be noted that survey effort between those two regions has been very limited, and modelled distributions indicate similar densities in the deeper waters of the Irish Sea between those two fronts.

1.7.6.14 The average density for the Morgan marine mammal study area from the annual composite maps (as recommended by NRW and authors of the Marine Mammal Atlas (Evans and Waggitt, 2023), and agreed with Natural England, see paragraph 1.5.16.4) was 0.0051 animals per km^2. As set out in paragraph 1.5.16.4 this density estimate is highly precautionary as this is the highest value observed for each cell (2.5 km^2 resolution) at any one point in time. The average density for the Morgan Array Area was 0.0047 animals per km^2 (Figure 1.58).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, NRW

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 nm
0 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-043-00

Drawing Title:
MINKE WHALE ANNUAL COMPOSITE MODELLED DENSITIES (MEASURED AS THE MAXIMUM DENSITY PER CELL ACROSS MONTHS) (EVANS AND WAGGITT, 2023)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,300,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.58: Minke whale annual composite modelled densities (measured as the maximum density per cell across months) (Evans and Waggitt, 2023).

Summary of densities

1.7.6.15 Minke whale are distributed across the Irish sea, with high densities seen in the west Irish Sea and around the Isle of Man. No minke whale were observed in SCANS-III block F but animals were observed in block E (Hammond *et al.,* 2021); this density is greater than the densities for the Morgan marine mammal study area and Morgan Array Area derived from the Waggitt *et al.,* 2020, the Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) and SCANS-IV (Gilles *et al.*, 2023) (which are all similar in value). SCANS-III DSM maps (Lacey *et al*., 2022) also provided a similar estimate to the SCANS III estimate, which is expected due to use of the same sightings data source.

1.7.6.16 Therefore, the density taken forward to assessment is the SCANS-III block E estimate (Hammond *et al.,* 2021), as agreed through the Marine Mammal EWG process for the Morgan Generation Assets.

Table 1.11: Comparison of minke whale densities from key data sources.

a. Note Welsh Marine Mammal Atlas data (Evans and Waggitt, 2023) are presented for both the Morgan array area only and the Morgan marine mammal study area (Morgan Array Area plus 10 km to 13.3 km buffer).

b. No minke whale were recorded within this SCANS block.

Source	Density (animals per km^2)	Estimate of variation
SCANS-IV – block CS-E (Gilles *et al.,* 2023)	0.0088	1.145 (CV)
SCANS-IV – block CS-D (Gilles *et al.,* 2023)	0.0137	0.632 (CV)
SCANS-III – block E (Hammond *et al.,* 2021)	**0.0173**	**0.618**
SCANS-III – block F (Hammond *et al.,* 2021)	-[b]	-
SCANS-III DSM for the Morgan marine mammal study area (Lacey *et al.,* 2022)	0.024	0.369 (CV)
Northeast Atlantic distribution maps (Waggitt *et al.*, 2020)[a] for the Morgan marine mammal study area	0.0074	0.0064 to 0.0086 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) for the Morgan Array Area	0.0047	0.0031 to 0.0074 (95% CIs)
Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) for the Morgan marine mammal study area	0.0051	0.0033 to 0.0080 (95% CIs)

Abundance

1.7.6.17 Broad scale abundance estimates are available for minke whale. All minke whale in UK waters are considered to be part of the CGNS MU (Figure 1.46). Based on the most up to date estimates, the abundance of minke whale in this MU is 20,118 animals (CV = 0.18, 95% CI = 14,061 to 28,786; IAMMWG, 2022; 2023). The Morgan Generation Assets lie within block F for the SCANS-III surveys in 2016, but no minke whale were recorded in this block. However, the regional marine mammal study area also spans block E, and a mean group size of 1.00 and abundance of 603 animals was estimated for this block (95% CI = 134 to 1,753). Recent SCANS-IV data gave abundance estimates of 108 animals (95% CI = 1 to 491) for block CS-E and 477 animals (95% CI = 85 to 1,425) for block CS-D (Gilles *et al.,* 2023).

1.7.6.18 JCP Phase III analysis gave total sightings of 1,860 minke whale for the JCP III survey region, and in the Irish Sea, estimated predicted abundances in 2010 were given per season, with winter abundance for minke whale was 10 animals, spring was 40 animals, summer was 190 animals and autumn had 20 animals.

1.7.6.19 The ObSERVE surveys recorded minke whale in all strata (Figure 1.59) but for Season 1 (summer 2015), corrected design-based estimates abundance for Stratum 5 (western Irish Sea) is 494.7 animals (CV = 68.75, 95% Cl = 221.5 to 1105.0). There were no minke whale observed in Stratum 5 (western Irish Sea) during winter 2015/2016 or winter 2016/2017). For summer 2016, the corrected design-based estimate of abundance for Stratum 5 (western Irish Sea) was 180.1 animals (CV = 106.13, 95% Cl = 58.6 to 552.9).

1.7.6.20 In surveys for Rhiannon Wind Farm (Celtic Array Ltd., 2014), 19 minke whale sightings of 21 animals were made during the boat-based visual surveys. All observations were made between May and August and all bar two were of single animals. Insufficient sightings of minke whale were made during the boat-based surveys to generate a site-specific abundance estimate.

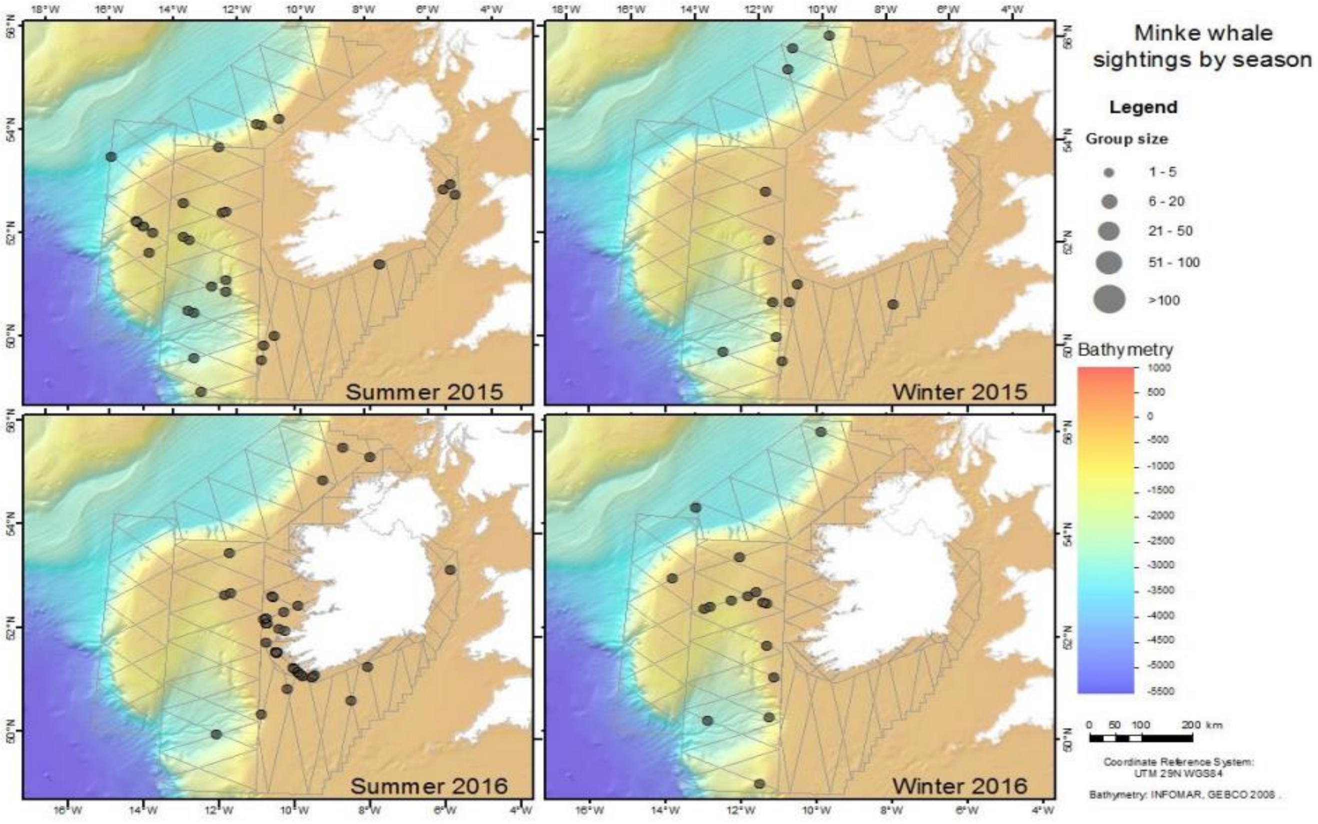


Figure 1.59: Sightings of minke whale in each survey period (bottom). Grey lines indicate the survey track lines along which sightings were made. Circles are proportional to the number of individuals in each sighting. From Rogan *et al.* (2018).

Seasonality

1.7.6.21 Minke whale show high seasonality to the area, as a summer visitor, similar to recent studies in the North Sea where minke whale were detected from May to November (Risch *et al.*, 2019). There is evidence that minke whale undertake large-scale seasonal migrations between feeding and breeding grounds (Risch *et al.,* 2014; Skaug *et al.,* 2004).

1.7.6.22 In Manx waters, they are present between June and the end of November (Howe 2018a). MWDW data shows higher numbers of minke whale sightings in months from June to November (MWDW, 2022), and as detailed in paragraph 1.7.2.46, MWDW confirmed that sightings data reflects a true on seasonality cannot be drawn due to lack of survey effort has not created a false seasonality (MWDW, personal communication, June 2023).

1.7.6.23 Howe (2018a) suggests a very clear spatial aspect to the distribution of minke whale sightings in Manx waters. In the summer (June to August), virtually all sightings are on the west coast of the island, whereas in the autumn (September to November), most sightings are on the east coast. The driving factor behind both temporal and spatial patterns appears to be the distribution of herring, a recognised food source of minke whale in Manx waters. There are two known herring stocks in the Irish Sea, known as the Mourne stock, near the east coast of Northern Ireland and the Manx stock. The Manx herring stock are known to spawn on the east coast of the island, in September to October (Bowers, 1969), hence the presence of minke whale on the east coast during these months. During the summer months, the Manx stock and Mourne stock are found together off the west coast of the island (Bowers, 1980), hence the presence of minke whale in this area between these months. Both temporally and spatially, the distribution of minke whale seems to mirror the distribution of the Irish Sea herring in Manx waters. Sightings in Irish waters also appear to reflect this seasonal pattern (Howe, 2018a).

1.7.6.24 Similarly, Baines and Evans (2012) suggest minke whale is a summer visitor to the region, with few sightings in winter, although this may partly be due to low effort at that period. There is no evidence as yet that the species breeds in Welsh waters. ObSERVE surveys in Irish waters also highlighted minke whale were more commonly sighted in summer, with sightings higher in summer 2015 and 2016, with estimated abundances of 494.7 animals and 180.1 animals for the Strata 5 (West Irish Sea) area. Wall (2013) suggested highest relative abundances of minke whale were in the west Irish Sea in spring. Both peaks in relative abundance were thought to be due to whale foraging on concentrations of pelagic schooling fish (Wall *et al.,* 2013). JCP Phase III data also showed higher estimated abundances of minke whale (190 animals) in summer in the Irish Sea than winter, spring and autumn.

1.7.6.25 The northeast Atlantic distribution maps from Waggitt *et al*. (2020) show higher densities of minke whale in July than January, and this is reflected in Figure 1.56 and Figure 1.57, with higher densities around the Morgan marine mammal study area from June to November.

1.7.6.26 The Welsh Marine Mammal Atlas (Evans and Waggitt, 2023) suggested strong seasonality in sightings with most occurring during April to September, some in and around the Celtic Deep in October to December, and very few between January and March. Survey effort was much lower in winter than in summer, so although sightings data likely reflects a general seasonal offshore movement into the Atlantic, some individuals likely remain in the region during winter, as revealed from casual sightings elsewhere in UK waters (Anderwald *et al.*, 2007).

1.7.6.27 Risch *et al.* (2019) also demonstrated strong diel periodicity, whereby during autumn and spring, minke whale pulse train detections showed calling rates were lowest during daylight and highest during the night. Diel variation in baleen whale vocalisations has also been attributed to prey distribution, with reduced vocalisation rates during active feeding and an increase in vocalisations in a social context at hours of lowest prey availability (Risch *et al*., 2019). Minke whale main prey items, such as sandeel species, show a strong diurnal pattern and are generally less available in the water column during the night (Risch *et al*., 2019).

1.7.7 Grey seal

Ecology

1.7.7.1 Grey seal is the larger of the two pinniped species which occur around the British Isles. Males weigh up to 300 kg and female up to 200 kg. Grey seal can live for over 20 to 30 years, with females tending to live longer than males (SCOS, 2015). Sexual maturity is reached at approximately 10 years in males and five years in females (SCOS, 2015), and gestation occurs over 10 to 11 months.

1.7.7.2 Grey seal gathers in colonies on land (known as haul-outs) where they breed, rest, moult and engage in social activity. Russell and Lonergan (2012) reported that haul-out events occur also at sea on exposed sandbanks, but their frequency is low, and their duration is on average shorter than those events on land. Breeding occurs between September to December and the annual moult between November to April (Harwood and Wylie, 1987). Female grey seal tend to return to the same breeding site at which they were born to give birth. Preferred breeding locations around the UK coast include rocky shores, beaches, caves, sandbanks and small, largely uninhabited islands. Pupping tends to take place between August and November (SCOS, 2018) in the UK, though there is a clockwise cline in mean birth date around the UK. The largest pupping sites are located in the Inner and Outer Hebrides, Orkney, Isle of May, Farne Islands and Donna Nook (JNCC, 2022g), with 84% of the population breeding in Scotland. There are however smaller colonies around Wales, including Lundy and islands off Pembrokeshire and the Llŷn Peninsula, and east Northern Ireland.

1.7.7.3 The SMRU Report commissioned as an additional baseline source (Wright and Sinclair, 2022) states there are seven designated seal haul-out sites located in the Southwest Scotland MU, one of which overlaps into the Northwest England MU but these haul-outs are over ~74 km swimming distance away from the Morgan Array Area (Table 1.12) and therefore there is expected to be no direct impacts to seals on land while hauled-out at these designated sites. There are no designated grey seal breeding colonies in the Morgan marine mammal study area.

Table 1.12: Designated seal haul-out sites in the Southwest Scotland MU based on August survey counts (both grey seal and harbour seal). From SMRU report (Wright and Sinclair, 2022).

[a] Distances presented in the SMRU Report have been revised to align with the latest Morgan Array Area.

Site ID	Site Name	Location	Distance from the Morgan Array Area (km) (marine route)[a]	Description
SW-001	Sanda and Sheep Island	Mull of Kintyre	168.3	Intertidal sandbanks and rocky coastline of Sanda and Sheep Island and associated rocky outcrops.
SW-002	Sound of Pladda Skerries	South Arran	182.8	Intertidal sandbanks and rocky coastline between Port a Ghillie Ghlais and Port Dearg and associated rocky outcrops.

Site ID	Site Name	Location	Distance from the Morgan Array Area (km) (marine route)[a]	Description
SW-003	Rubha nan Sgarbh	Kilbrannan Sound, East Kintyre	198.5	Intertidal sandbanks and rocky coastline between Pluck Point and Sgorshuil and associated rocky outcrops.
SW-004	Yellow Rock	Ardnacross Bay, East Kintyre	190.2	Intertidal sandbanks and rocky coastline between Macringan’s Point and the north end of Yellow Rock and associated rocky outcrops.
SW-005	Lady Isle	Firth of Clyde, West of Troon	202.6	Entire island of Lady Isle and associated rocky outcrops
SW-006	Little Scares	Luce Bay, between Mull of Galloway and Burrow Head	76.6	Entire islands of the Big Scares and the Little Scares.
SW-007	Solway Firth Outer Sandbank	Solway Firth, between Southerness Point and Dubmill Point	89.8	Intertidal mud banks southeast of Southerness Point in the Solway Estuary.

1.7.7.4 Grey seal give birth to a single, white-coated pup which are weaned over a period of 17 to 23 days (SCOS, 2018), with the pups leaving the breeding site for the sea after approximately one month. Following this, the female comes into oestrus and mating occurs, after which adult grey seal return to sea to forage and build up fat reserves. Just before weaning the pups shed their white natal coat (lanugo) and develop their first adult coat. Moult occurs in stages at the colony with juvenile seal moulting first, followed by adults.

1.7.7.5 They are generalist feeders, foraging mainly on the seabed at depths of up to 100 m, although they are probably capable of feeding at all the depths found across the UK continental shelf. They take a wide variety of prey including sandeels, gadoids (cod, whiting, haddock, ling), and flatfish (plaice, sole, flounder, dab). Gosch (2017) reported that there are significant regional and temporal differences in the diet of grey seal. Seals in shallow waters show a preference for demersal and groundfish species such as cephalopods and flatfish, whilst seal foraging in deeper waters, over sandy substrates, will target pelagic and bentho pelagic species such as blue whiting *Micromesistius poutassou* and sandeels (Gosch, 2017). Food requirements depend on the size of the seal and fat content (oiliness) of the prey, but an average consumption estimate of an adult is 4 to 7kg of fish per seal per day depending on the prey species. Studies of seal diet in the west Irish Sea found gadoids were the main prey species among the 19 species identified in stomach samples from by-caught seals (n = 17) (Kiely *et al.*, 2000), whilst seal faecal samples collected at haul-out sites between 1997 and 1998 showed 23 species of prey with gadoids and flatfish dominant in the diet. *Trisopterus* species (Bib, Norway Pout and Poor Cod), plaice and whiting appeared to be the most important species in the diet of grey seal in the west Irish Sea (Kiely *et al.*, 2000).

1.7.7.6 Grey seal tend to forage in the open sea, returning to land regularly to haul out. Foraging trips can be wide-ranging; tracking data from Carter *et al.,* 2022 showed a maximum foraging range of 448 km. However, tracking studies have shown that most foraging is likely to occur within 100 km of a haul-out site (SCOS, 2018). Foraging trips can last anywhere between 1 and 30 days. Movements of grey seal between haul-out sites in the North Sea and haul-out sites in the Outer Hebrides have been recorded as well as movements from sites in Wales and northwest France, to the Inner Hebrides (SCOS, 2020). Grey seal swim at an average of 1-2 ms^{-1} (Gallon *et al.*, 2007) and dive to depths of up to 100 m (SCOS, 2015), though they have been recorded at much greater depths. The distribution and size of the main grey seal breeding colonies in the UK are shown in Figure 1.60, from SCOS, 2020.

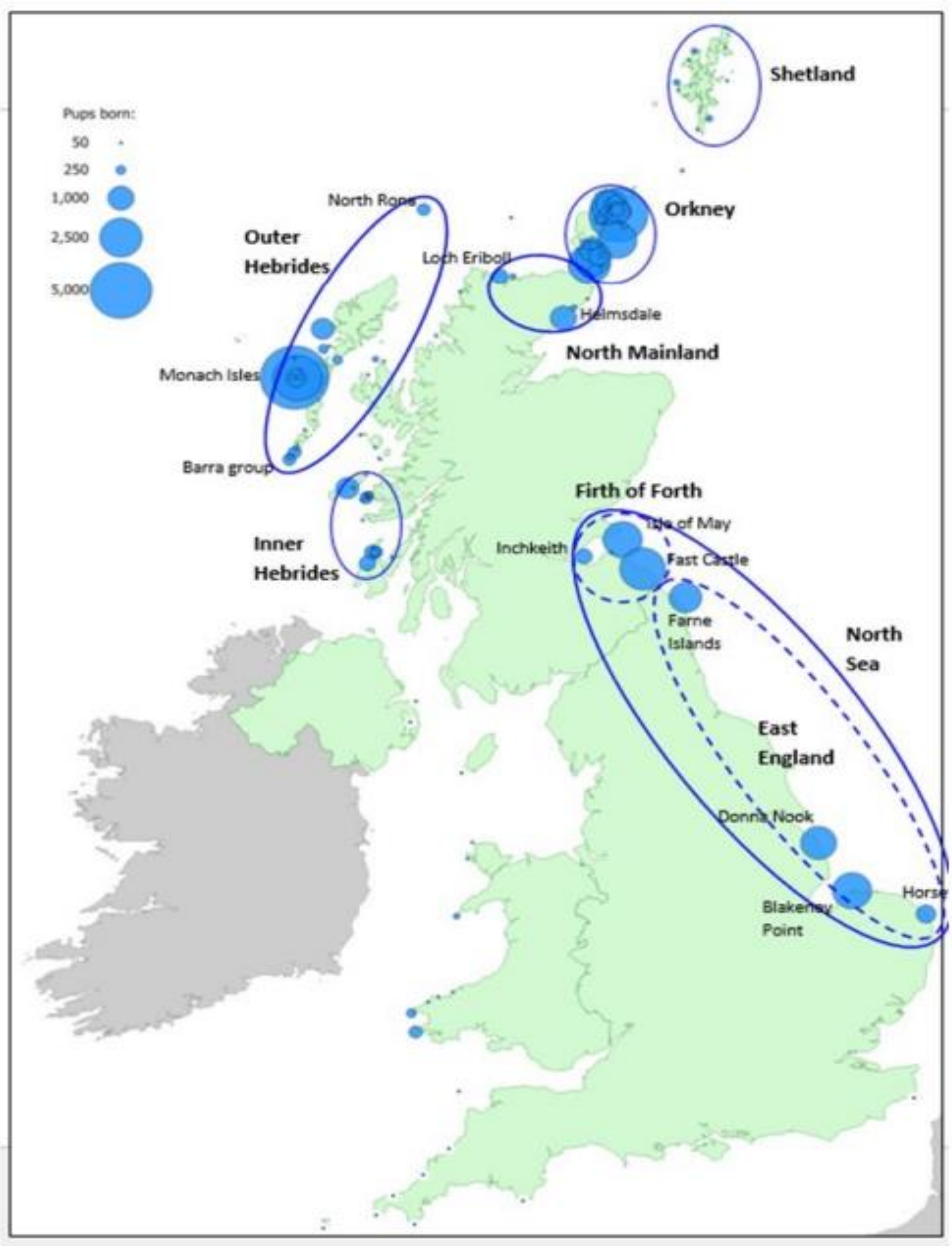


Figure 1.60: Distribution and size of the main grey seal breeding colonies in the UK. Blue ovals indicate groups of regularly monitored colonies within each region and blue circles represent number of pups born. From SCOS (2020)[10].

Distribution

1.7.7.7 Globally there are three centres of grey seal abundance: one in the east of Canada and the northeast USA, a second around the coast of the UK, especially in Scottish coastal waters, and a third, smaller group in the Baltic Sea. All populations are known to be increasing (SCOS, 2020). Approximately 35% of the world population occurs in the UK and 82% of the European population (SCOS, 2021). Grey seal numbers around

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[10] Within the east coast region, estimates of the number of pups are based upon a combination of SMRU aerial surveys (northern dashed area) and ground surveys (southern dashed area) conducted Lincolnshire Wildlife Trust, National Trust and Friends of Horsey Seals.

the UK have increased steadily over the past 60 years since survey effort began, but the rate of population growth varies among regions (Thomas *et al.,* 2019).

1.7.7.8 Population size is derived by extrapolation of pup production surveys and demographic parameters, and the total UK grey seal population of at the start of the 2020 breeding season (before pups are born) was estimated at 157,300 individuals (approximate 95% CI 144,600 to 169,400) (SCOS, 2020). The grey seal pup production and 2019 population estimates for Wales, England, Scotland and Northern Ireland are given in Table 1.13.

Table 1.13: Grey seal pup production by country (based on 2019 pup production estimates), and total population estimates at the start of the 2020 breeding season. From SCOS (2021).

Location	Pup production in 2019	2020 Population Estimate
England	11,300	30,700
Wales	2,250	5,200
Scotland	54,050	120,800
Northern Ireland	250	600
Total	**67,850**	**157,300**

1.7.7.9 Grey seal pup production in 2019 of 2,250 pups presented in SCOS (2021) resulted in a 2020 population estimate of 5,200 individuals in Wales. The largest breeding population in the Irish Sea and southwest UK is located in Pembrokeshire, accounting for 4% of the UK grey seal breeding population (Strong and Morris 2010; Stringell *et al*., 2014). The majority of this pup production is located around Yyns Dewi/Ramsey Island and the north Pembrokeshire mainland coast between St Davids Head and the Teifi Estuary (Morgan *et al.,* 2018). In north Wales, smaller breeding populations can be found on the west coast of Anglesey and the Lleyn Peninsula. Grey seal pup production in northwest England is comparatively low compared to that of Wales, whilst in Northern Ireland, the majority of grey seal pups are born in Strangford Lough where the National Trust estimated a pup production of 181 in 2019. There are no regularly monitored grey seal breeding sites within the Southwest Scotland MU.

1.7.7.10 Population studies of the Celtic and Irish Sea have revealed that grey seal are present year-round on both the Irish and Welsh coasts. Seals are known to move between the two areas, with higher numbers of seals seen to move between the southeast coast of Ireland and the southwest coast of Wales (Kiely *et al.*, 2000). Telemetry studies at five SACs across the UK demonstrated adults and pups travel between Pembrokeshire Marine SAC, Lleyn Peninsula and the Sarnau SAC and the Saltee Islands SAC (Ireland) (SCOS, 2014).

1.7.7.11 Haul-out counts are presented in the SMRU data report for each MU (Appendix B). In the Southwest Scotland MU (Figure 1.1), the main haul-outs sites where grey seal have been counted are located in the north region of the MU, with comparatively higher counts than harbour seal along the south coast of the MU. From 1997 to 2018, the August grey seal haul-out counts have increased, and haul-out locations remain consistent throughout the years.

1.7.7.12 In the Northwest England MU (Figure 1.1), there are two main grey seal haul-out sites: one in the Dee Estuary on the Welsh-English border (Hilbre Island), and South Walney. In 2019 and 2020, the August count at Walney Island was 248 and 300 adults, respectively. It has been a pupping site since 2015 and numbers are currently still low (2-10 pups produced per year), however data suggests grey seal abundance is steadily increasing (SCOS, 2020). Less extensive monitoring has occurred at the Dee Estuary haul-out site (SCOS, 2020). This is reflected in historical count data provided by Cumbria Wildlife Trust from Walney Island (Cumbria Wildlife Trust, 2023; Figure 1.18), with maximum seal count increasing particularly from 2012 onwards. In North Wales, grey seal mainly haul out around the coast of Anglesey (including the Skerries), around Llandudno (Angel Bay) and the Dee Estuary (Hilbre North and West Hoyle Sandbank). At the Dee Estuary, there were 236 unique individuals identified by left head extracts from the EIRPHOT database, and photo-ID data showed connectivity between the Dee Estuary and the Skerries, with some connectivity with Cardigan Bay and Skomer (Langley *et al*., 2018). Monitoring of grey seal by the Angel Bay Seal Volunteer Group has been conducted at Angel Bay, Llandudno (Porth Dyniewaid) since 2016 and they are now additionally monitoring at Pigeon's Cave, on Great Orme (Angel Bay Seal Volunteer Group, 2021). In Northern Ireland, grey seal mainly haul out in Carlingford Lough, Murlough SAC, Strangford Narrows, North and South Rocks (east of the Ards), the Copeland Islands and Rathlin Island (Duck and Morris, 2019).

1.7.7.13 SACs designated for grey seal in the regional marine mammal study area include Cardigan Bay SAC (qualifying feature), Pembrokeshire Marine SAC (primary feature), Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau SAC (qualifying feature), and The Maidens SAC (qualifying feature). Pembrokeshire Marine SAC is representative of grey seal colonies in the southwest part of the breeding range in the UK and is the largest breeding colony on the west coast south of the Solway Firth, representing over 2% of annual UK pup production (JNCC, 2022d). Telemetry studies from Carter *et al.* (2020) include tagging deployments from Ramsey and Skomer Islands, Bardsey Island and the Dee Estuary and shows that seals hauling out at one SAC during the foraging season may comprise breeding stock from another (Carter *et al.,* 2020).

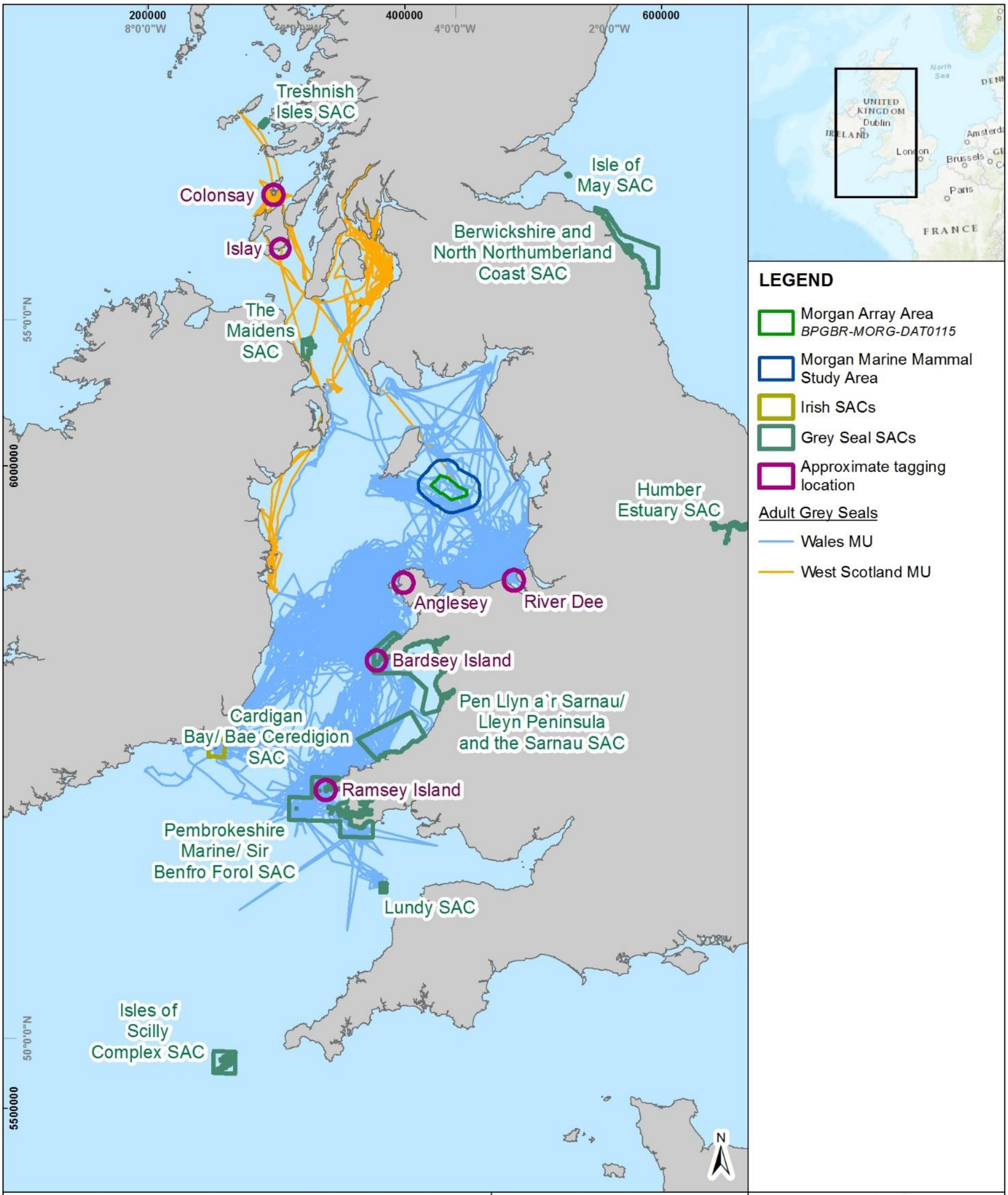
1.7.7.14 Connectivity between breeding stocks was reflected in a research study by Langley *et al.* (2020) who suggested inter-annual breeding is high in the Irish Sea. The study utilised a photo ID database known as EIRPHOT to look at spatial connectivity of haul-out sites and fidelity of adult females to breeding sites. It contains images from 280 sites around the UK, collected between 1992 and 2016, with a specific focus on the Celtic and Irish Seas from 1996 onwards and had a minimum of 2688 female grey seal in the database. Locations within EIRPHOT were largely along the Welsh coast and islands (n = 246), with other sites in Ireland (n = 23), Isle of Man (n = 3), England (n = 1), Scotland (n = 1) and France (n = 1). The Dee Estuary and Skerries were amongst sites reported on in Langley *et al*., (2020), located closest to the Morgan Generation Assets. Results showed adjacent locations (such as Lleyn Peninsula and Bardsey) were highly connected (spatial transition probability = 0.7) but that there were still connections across the entire region, up to 230 km apart (e.g. Skomer and Dee Estuary, spatial transition probability = 0.004). Skomer was the most connected, with individuals moving between Skomer and all other broad areas, whilst the Dee Estuary was one of the least connected areas. The study highlighted extensive site use beyond protected areas, and thus grey seal should be expected widely within the Irish Sea. Wright and Sinclair (2022) also concluded that there is a high level of connectivity between the Morgan Generation Assets and the Pen Llŷn a'r Sarnau/Llyen Peninsula, the Sarnau SAC and the Pembrokeshire Marine/Sir Benfro Forol SAC and the Cardigan Bay SAC and lower levels of connectivity with grey seal SACs at further distances from the Morgan Generation Assets.

1.7.7.15 Telemetry data were available for harbour and grey seal from tags deployed by SMRU (Wright and Sinclair, 2022), referencing the SMUs in Figure 1.2. In total, 43 adult grey seal recorded telemetry data within the regional marine mammal study area (Figure 1.61). Thirty-nine adult grey seal (and one juvenile) were tagged in the Wales MU between 2004 and 2018, and therefore recorded tracks throughout the regional marine mammal study area (Figure 1.61). No adult individuals of grey seal were tagged in the Northwest England, Southwest Scotland or Northern Ireland MUs. An additional four grey seal were tagged in the adjacent West Scotland MU, to the north of the Southwest Scotland MU, with tracks seen across the north part of the Irish Sea and down the east coast of Ireland and are therefore included (Figure 1.61). There was connectivity with several UK and Irish grey seal SACs. Of the adult grey seal that were recorded within the regional marine mammal study area, there was (non-exclusive) connectivity with several UK and Irish grey seal SACs: 17 with Pen Llŷn a'r Sarnau/Llyen Peninsula and the Sarnau SAC (39.5%), 14 with Pembrokeshire Marine/Sir Benfro Forol SAC (32.6%), 10 with Cardigan Bay SAC (18.6%), four with Saltee Islands SAC (Ireland) (9.3%), one with The Maidens SAC (2.3%) and one with Lundy SAC (Southwest England MU) (2.3%). Some individuals visited multiple SACs. Of these adult grey seal, 36 recorded tracks within a 100 km buffer as described by SMRU (based upon general typical ranging distances) (Wright and Sinclair, 2022) of the Morgan Generation Assets (Figure 1.62). Nineteen of those showed connectivity to the surrounding SACs (Pen Llŷn a'r Sarnau/Llyen Peninsula and the Sarnau SAC, Pembrokeshire Marine/Sir Benfro Forol SAC, Saltee Islands SAC and The Maidens SAC) suggesting a high level of connectivity between SACs and the Morgan marine mammals study area.

1.7.7.16 For pups and juvenile grey seal, movement data obtained from telemetry tags may not be representative of the typical movement patterns of adult grey seal. One juvenile grey seal and 17 grey seal pups were tagged in the Wales MU between 2009 and 2017 (no grey seal juvenile/pups were tagged in the Northwest England, Southwest Scotland or Northern Ireland MUs). Juvenile/pups showed non-exclusive connectivity to multiple SACs: 11 juveniles/pups with Pembrokeshire Marine/Sir Benfro Forol SAC (61.1%), 10 with Pen Llŷn a'r Sarnau/Llyen Peninsula and the Sarnau SAC (55.6%), four with Cardigan Bay SAC (22.2%), four with Saltee Islands SAC (Ireland) (22.2%), two with Isle of Scilly Complex SAC (11.1%) Figure 1.63). Of these 18 juvenile/pups, 13 recorded telemetry tracks within a 100 km buffer of the Morgan Generation Assets described by SMRU (Figure 1.64), 11 of which showed connectivity to surrounding SACs.

1.7.7.17 The most recent UK-wide study of at-sea distribution for grey seal by Carter *et al.*, (2022) demonstrated areas of high use around Liverpool Bay, the east coast of Ireland and to the northwest of the Isle of Man. Finer scale seasonal movements were also identified in the study, with seals transitioning between sites within the Irish Sea, but not leaving Wales. This confirms at-sea usage maps by Carter *et al. (*2020) who highlighted some higher densities observed around Liverpool Bay close to the Morgan marine mammal study area than in the west Irish Sea.

1.7.7.18 Duck and Morris (2019) conducted thermal-imaging surveys of grey seal around Ireland in August 2017 and 2018, with the Irish coast divided into five regions, east, southeast, southwest, west and north. In all surveys the greatest proportion of grey seal were counted in the west of Ireland. In the east and southeast, closest to the Morgan Generation Assets, the grey seal count was substantially higher in 2017/2018 than in 2011/2012. The 2017/2018 survey found that there is currently only very little spatial overlap between major haul-out aggregations of harbour seal and grey seal in Ireland.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, SMRU

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 25 50 nm
0 50 100 km

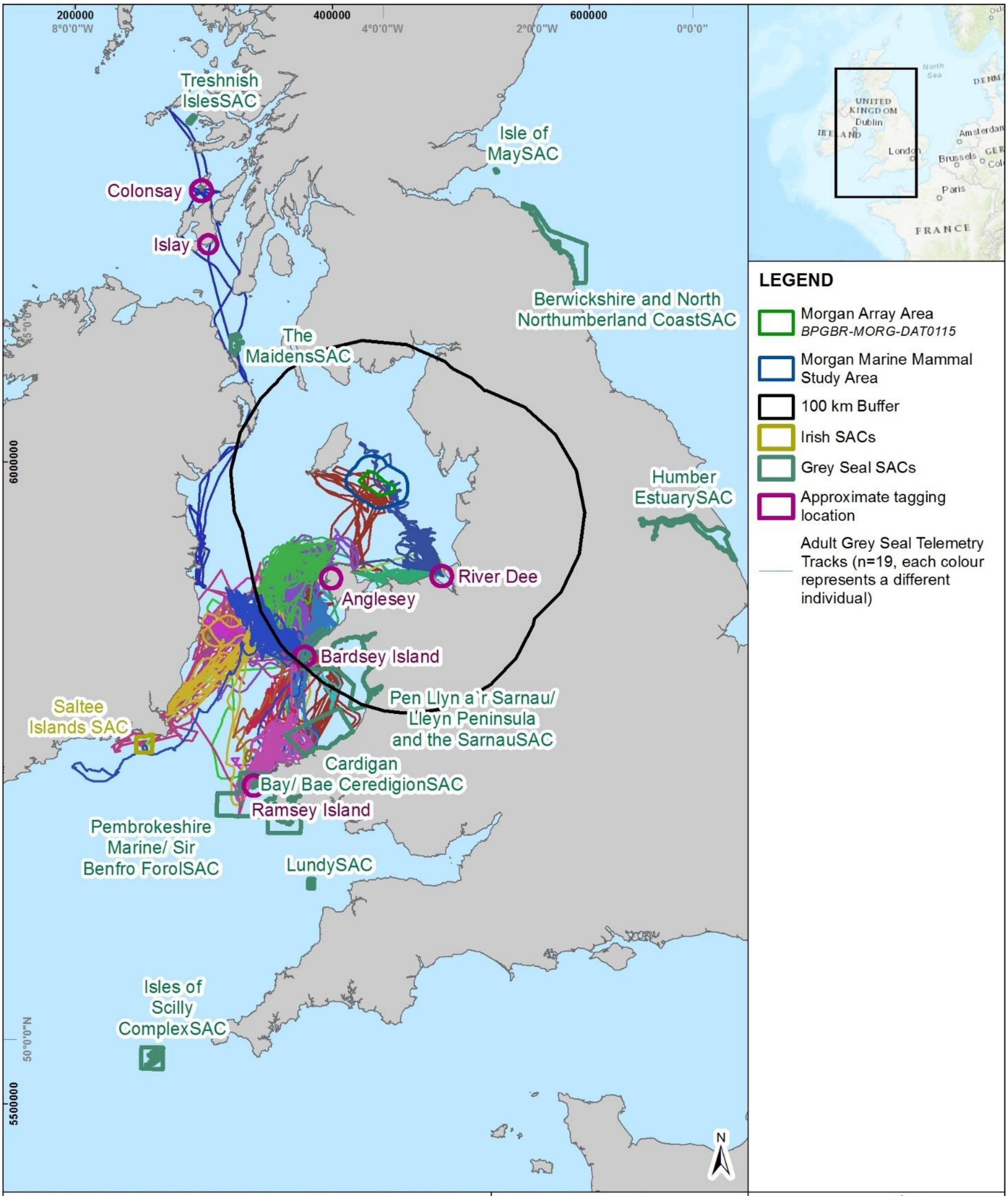
Drawing Number:
RPSE-MG-ES-MAM-044-00

Drawing Title:
TELEMETRY TRACKS FOR ALL 43 ADULT GREY SEAL (AND ONE JUVENILE) THAT ENTERED THE REGIONAL MARINE MAMMAL STUDY AREA (WRIGHT AND SINCLAIR, 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:5,000,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.61: Telemetry tracks for all 43 adult grey seal (and one juvenile) that entered the regional marine mammal study area (coloured by the MU they were tagged in). Wright and Sinclair (2022).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, SMRU

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 25 50 nm
0 50 100 km

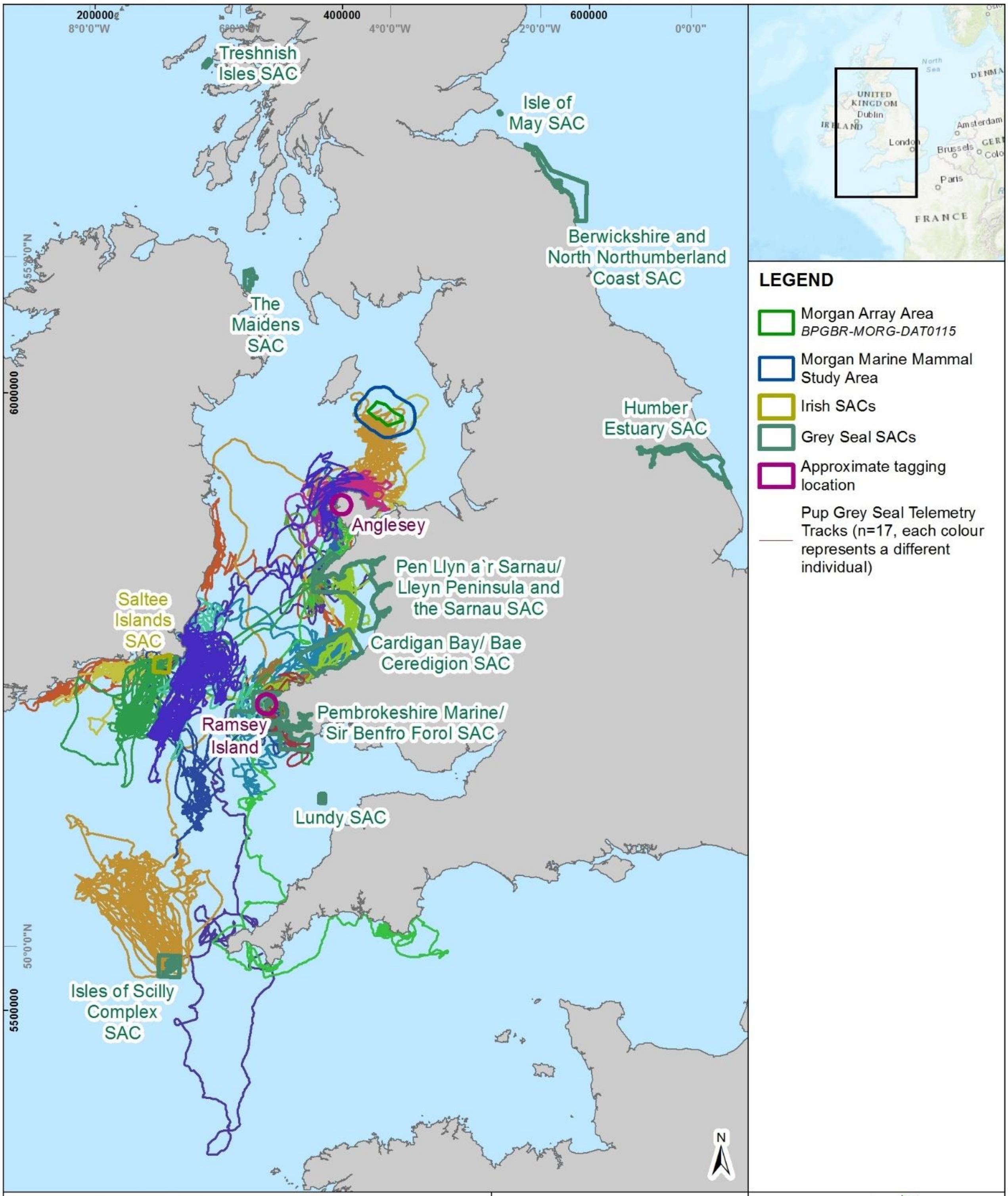
Drawing Number:
RPSE-MG-ES-MAM-045-00

Drawing Title:
ADULT GREY SEAL TELEMETRY TRACKS RECORDED WITHIN A 100 KM BUFFER, SHOWING CONNECTIVITY TO THE SURROUNDING SACS (N=19)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:5,000,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.62: Adult grey seal telemetry tracks recorded within the 100 km buffer and showed connectivity to the surrounding SACs (n=19; all tagged in the Wales MU) (Wright and Sinclair, 2022).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, SMRU

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 25 50 nm
0 50 100 km

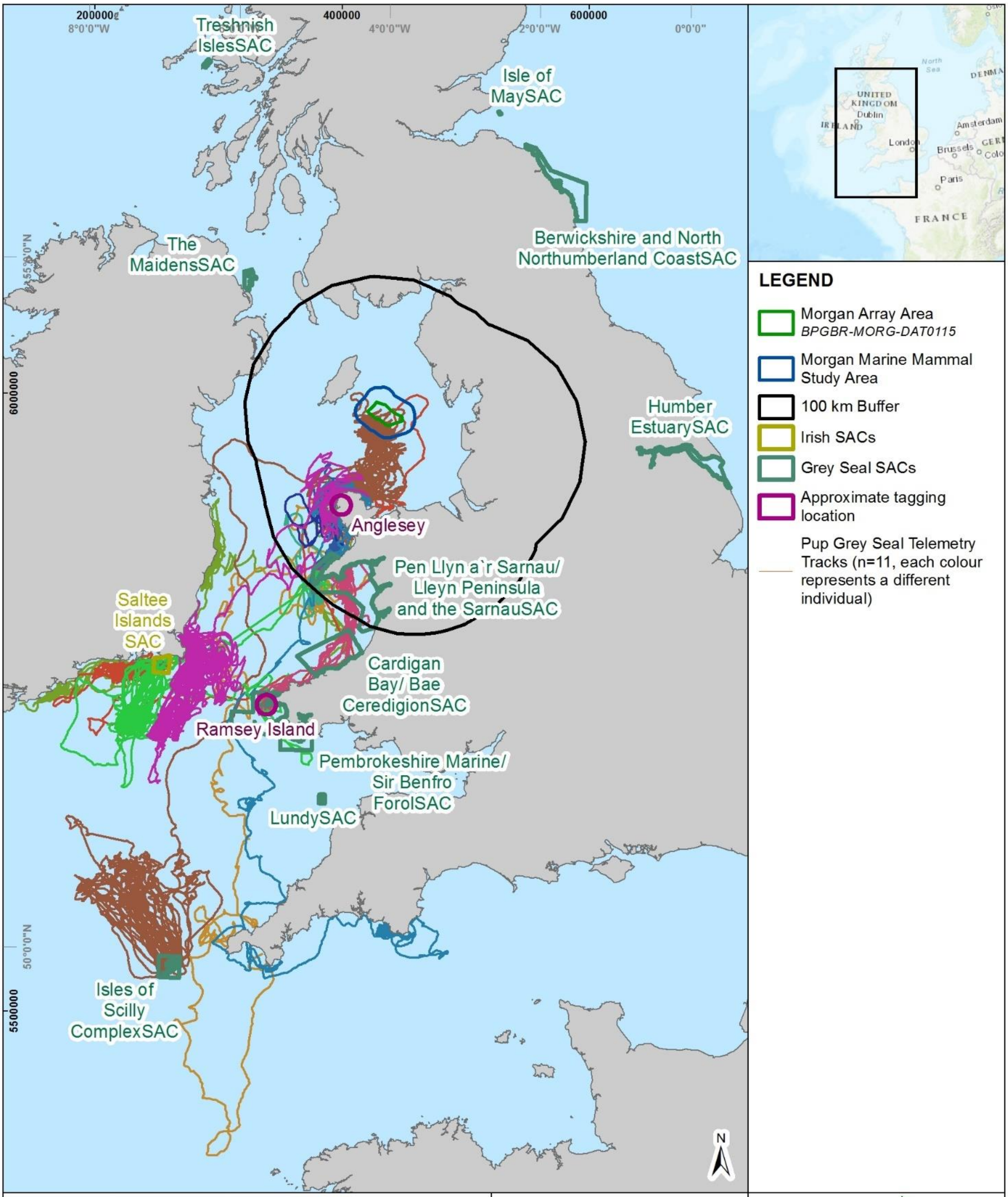
Drawing Number:
RPSE-MG-ES-MAM-046-00

Drawing Title:
TELEMETRY TRACKS FOR JUVENILE/PUP GREY SEAL THAT ENTERED THE REGIONAL MARINE MAMMAL STUDY AREA (N=18; ALL INDIVIDUALS TAGGED IN WALES MU) (WRIGHT AND SINCLAIR, 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:5,200,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.63: Telemetry tracks for all juvenile/pup grey seal that entered the regional marine mammal study area (n=18; all tagged in the Wales MU) (Wright and Sinclair, 2022).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, SMRU

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 25 50 nm
0 50 100 km

Drawing Number:
RPSE-MG-ES-MAM-047-00

Drawing Title:
JUVENILE/PUP GREY SEAL TELEMETRY TRACKS RECORDED WITHIN A 100 KM BUFFER, AND CONNECTIVITY TO THE SURROUNDING SACS (N=11; ALL INDIVIDUALS TAGGED IN WALES MU) (WRIGHT AND SINCLAIR, 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:5,200,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.64: Juvenile/pup grey seal telemetry tracks that recorded data in the 100 km buffer and showed connectivity to the surrounding SACS (n=11; all tagged in the Wales MU) (Wright and Sinclair, 2022).

Isle of Man grey seals

1.7.7.19 The Isle of Man is an important area for grey seal, using coastal areas all around the Manx coast (Howe, 2018b). Howe (2018b) suggests that a number of animals are fairly resident to the Island, but a much higher number of transient individuals visit the Island. Observational sightings from the Isle of Man from 2017 to 2022 showed grey seal around the entire coastline of the Island (Figure 1.16), whilst specific seal surveys carried out in 2017 showed counts of grey seal along the coast, particularly on the Calf of Man and around Maughold (Figure 1.17).

1.7.7.20 Key haul-out sites include the Calf of Man, The Sound, Langness and Maughold (Stokes and Young, 2021). The Calf of Man is an important pupping site for grey seal around the Isle of Man with high counts of pups in all years from 2017 to 2021 (MWT, 2022) (Figure 1.15), and fidelity to pupping locations apparent on the Calf of Man (Howe, 2018b). The 2021 Calf of Man Seal Survey (Stokes and Young, 2021) recorded 62 pups on the Calf of Man over the survey (the same as in 2020), with historical data ranging from a minimum of 26 pups counted in 2009 to a maximum of 84 pups in 2016. However, pupping also occurs elsewhere around the Manx coast, for example around the southwest coast and at Maughold (Figure 1.17). Recently, the Point of Ayre has become an important haul out site for grey seals, with over 100 animals seen regularly (highest count at 160) (MWT, pers. comms., 2023). Gob Garvain, Santon head, Maughold Head, Clay head and Contrary head and Calf of Man have also been highlighted as important sites for grey seals, though are not designated sites (MWT, pers. comms., 2023).

1.7.7.21 MWT also highlighted, through Photo ID work, mobile connectivity of seals on the Isle of Man with other areas in the regional marine mammal study area. One grey seal ('Tulip Belle') has been matched with the Cornwall Seal Group Research Trust and demonstrates movement between the Calf and Cornwall for several years, breeding on the Calf of Man (MWT, pers. comms., 2023). In August 2023 a grey seal from Cornwall was observed in Manx waters (near Fleshwick, north of Port Erin); confirmed by the flipper tag and obvious scar on its side (MWT, pers. comms., 2023).

Density/abundance

Density

1.7.7.22 A study UK-wide at-sea distribution for grey seal by Carter *et al.*, (2022) demonstrated areas of high use around Liverpool Bay, the east coast of Ireland and to the northwest of the Isle of Man (Figure 1.65). These maps improve on those in Carter *et al.* (2020) and have increased potential for ecological insights on both regional and population wide scales. Finer scale seasonal movements were also identified Carter *et al*, (2020), with seal transitioning between sites within the Irish Sea, but not leaving Wales. Distribution and predicted number of grey seal from Carter *et al.* (2022) in the vicinity of the Morgan Array Area are presented in Figure 1.66, showing areas of high density at seal usage in the inshore areas of Liverpool Bay (> 50 to 100 animals per 25 km^2) to the southeast of the developments, and moderate densities (> 5 to 10 animals per 25 km^2) further offshore towards the Morgan Array Area and to the southwest of the Isle of Man. Average grey seal density from Carter *et al.* (2022) for the Morgan marine mammal study area was estimated at 1.03 animals per 25 km^2 (= 0.0412 animals per km^2). This density was carried forward to the assessment as agreed with the Marine Mammal EWG.

1.7.7.23 SMRU seal tagging data also showed grey seal tracks have been recorded throughout the regional marine mammal study area, with a higher density of tracks in the south region of the regional marine mammal study area in the Northwest England and Wales MUs and a lower density in the northern region of the regional marine mammal study area.

1.7.7.24 The Mona Offshore Wind Project presented both design-based and model-based densities for the Mona Array Area for grey seal (Mona Offshore Wind Ltd, 2024). Design-based approach gave a mean absolute density of 0.109 animals per km^2 for the Mona Aerial Survey Area across the months, with highest densities for March (0.205 animals per km^2) and lowest in May (0.03 animals per km^2). The most biologically relevant design-based estimates by 'bio-season' (pupping versus non-pupping season) predicted a mean absolute density (i.e. adjusted for availability bias) of 0.049 in the pupping season and 0.139 in the non-pupping season. A model-based approach gave an average absolute density estimate of 0.020 animals per km^2 per month with the highest densities for March and December (0.042 animals per km^2, 95% CL = 0.028 to 0.057) and lowest for May (0.003 animals per km^2, CL = 0.002 to 0.004). The most biologically relevant model was observed in the "bio-season" model (pupping versus non-pupping season) which predicted a mean absolute density (model based) of 0.016 animals/km^2 (95% CI: 0.005 to 0.026, CV = 0.264) during the pupping season and 0.023 animals/km^2 (95% CI: 0.015 to 0.036, CV = 0.274) during the non-pupping season for the Mona Aerial Survey Area. Spatial density mapping using linear models showed relative higher densities in the northwest and southeast of the Mona Aerial Survey Area.

1.7.7.25 Both design-based and model-based densities are available from the aerial digital survey data for the Morgan Array Area plus buffer for grey seal (Appendix A). The design-based approach gave a mean absolute density of 0.099 animals per km^2 across the 24 months, with highest densities for March (0.182 animals per km^2) and lowest in November (0.036 animals per km^2). Model-based approach gave an average absolute density estimate of 0.019 animals per km^2 per month with the highest densities for December (0.0352 animals per km^2, 95% CL = 0.0041 to 0.0670) and lowest for March (0.0104 animals per km^2, 95% CL = 0.000 to 0.0221). The "bio-season" model predicted a mean absolute density of 0.0184 animals/km^2 (95 % CI: 0.0028 to 0.0377) during the pupping season, and 0.0196 animals/km^2 (95% CI: 0.0014 to 0.0400) during the non-pupping season.

1.7.7.26 Spatial density mapping using linear models showed relative higher densities in the non-pupping season for the Morgan Generation Assets, but densities were distributed throughout the area, with some higher densities towards the northeast and east of the Morgan Aerial Survey Area (density maps are presented in Appendix A).

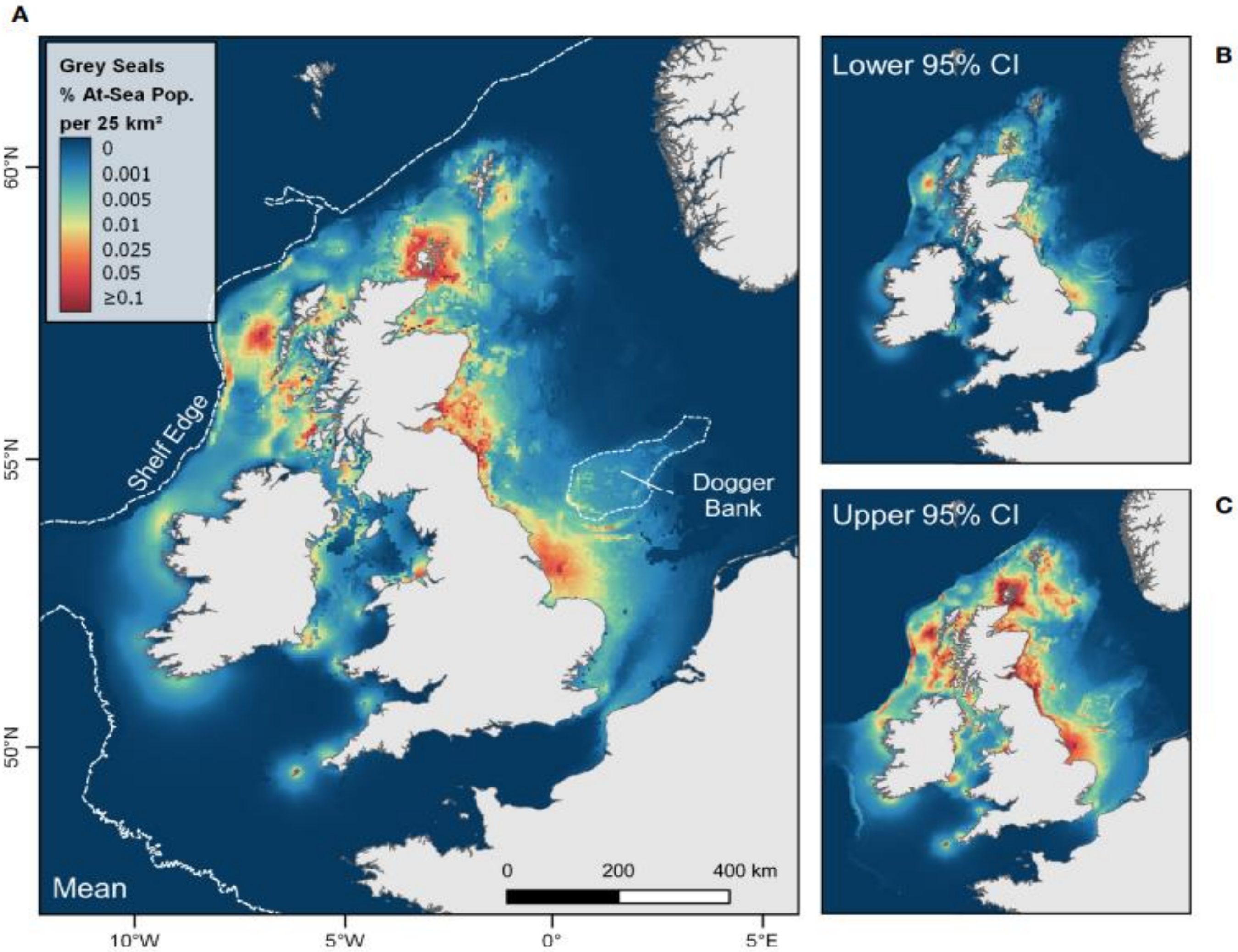
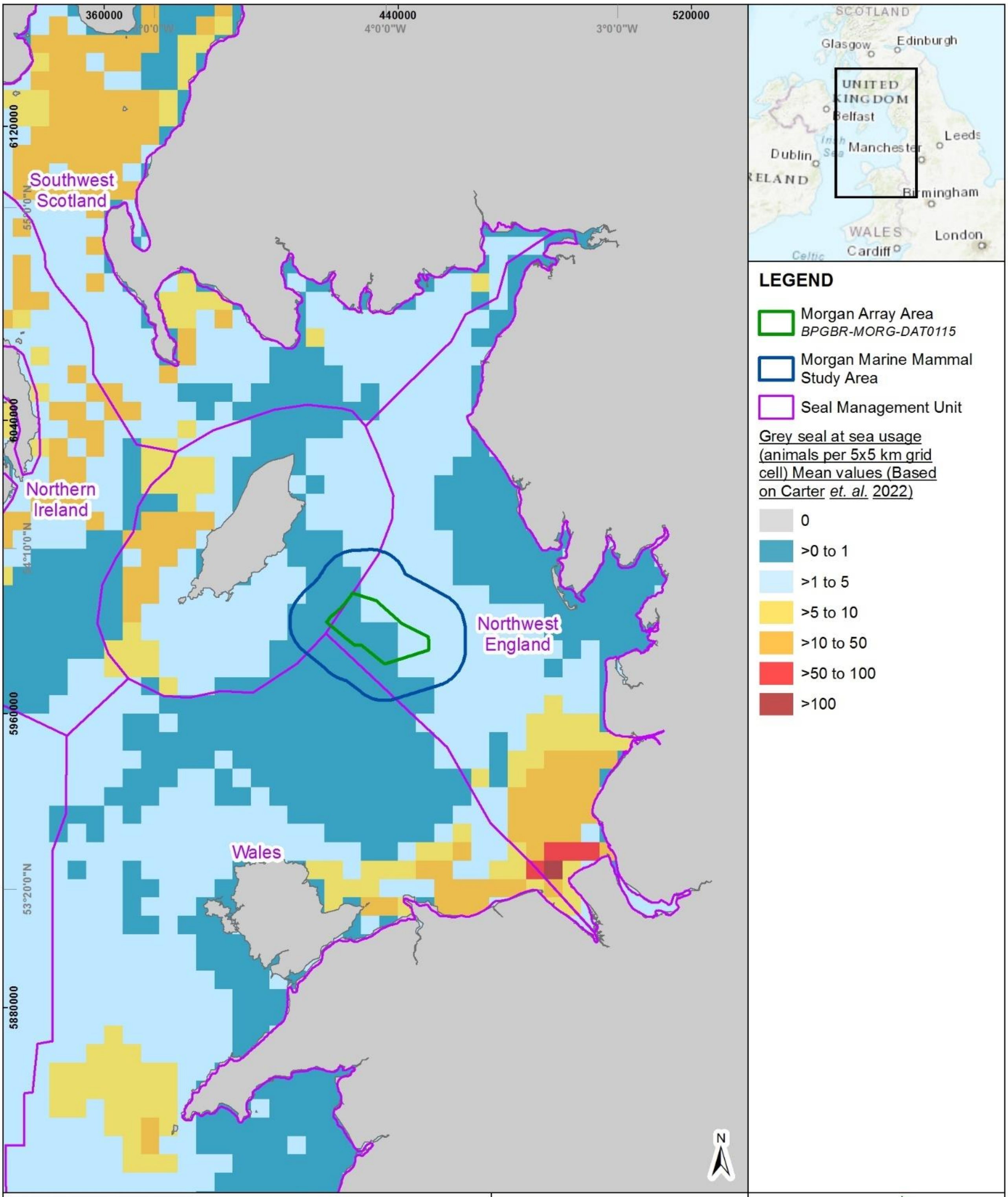


Figure 1.65: Grey seal at-sea distribution maps (Carter *et al.,* 2022).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC, St Andrews University

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 nm
0 10 20 40 km

Drawing Number:
RPSE-MG-ES-MAM-048-00

Drawing Title:
DISTRIBUTION AND PREDICTED NUMBER OF GREY SEAL IN 5 KM X 5 KM GRID CELLS (MEAN) (CARTER ET AL., 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,750,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.66: The distribution and predicted number of grey seal in 5 km x 5 km grid cells (mean) in the vicinity of the Morgan Generation Assets (Carter *et al.*, 2022).

Abundance/Counts

1.7.7.27 Grey seal population trends are assessed from the counts of pups born during the autumn breeding season, when females congregate on land to give birth (SCOS, 2020). SCOS (2020) was the most recent report to present August counts of grey seals at haul out sites in the British Isle specifically by SMUs which can be converted to population estimates using a scalar (see paragraph 1.7.7.29).

1.7.7.28 The latest 2021 SCOS report presented a total population estimate (not by SMU) for the UK (therefore not including the Republic of Ireland) of 157,300 animals (approximate 95% CI 144,600 to 169,400) at the start of the 2020 breeding season. This uses a mathematical model which converts pup production estimates in 2019 to estimates of total population size (1+ aged population at the start of the breeding season) (SCOS, 2021).

1.7.7.29 Russell *et al.* (2016) previously estimated that 23.9% of the total grey seal population are hauled-out and available to count during August surveys based upon 25 GPS tagged seals. However, this was subsequently updated in SCOS (2021). A large grey seal tagging programme increased sample size (n=60) allowing the analysis to be revisited and provides a new mean estimate of the percentage of the population hauled out of 25.15% (95% CI: 21.45 to 29.07%).

1.7.7.30 Broad scale data primarily includes the SCOS Seal Management Units which are currently used as the relevant MUs in the absence of defined SMUs from the IAMMWG (2021). Relevant SMUs from the SCOS 2020 report are Wales, Northwest England, Northern Ireland and Southwest Scotland (Figure 1.67). SCOS (2020) states there is limited data for SMUS 10 to 13 (which includes Wales, NW England) and values given are rough estimates and advises caution during interpretation. Abundances are estimated from counts per SMU, as it is estimated that grey seal spend 25.15% of their time hauled-out on average (SCOS, 2021). No updated counts are given per SMU in SCOS (2021) therefore estimates will be based upon counts presented in SCOS (2020) and Appendix B.

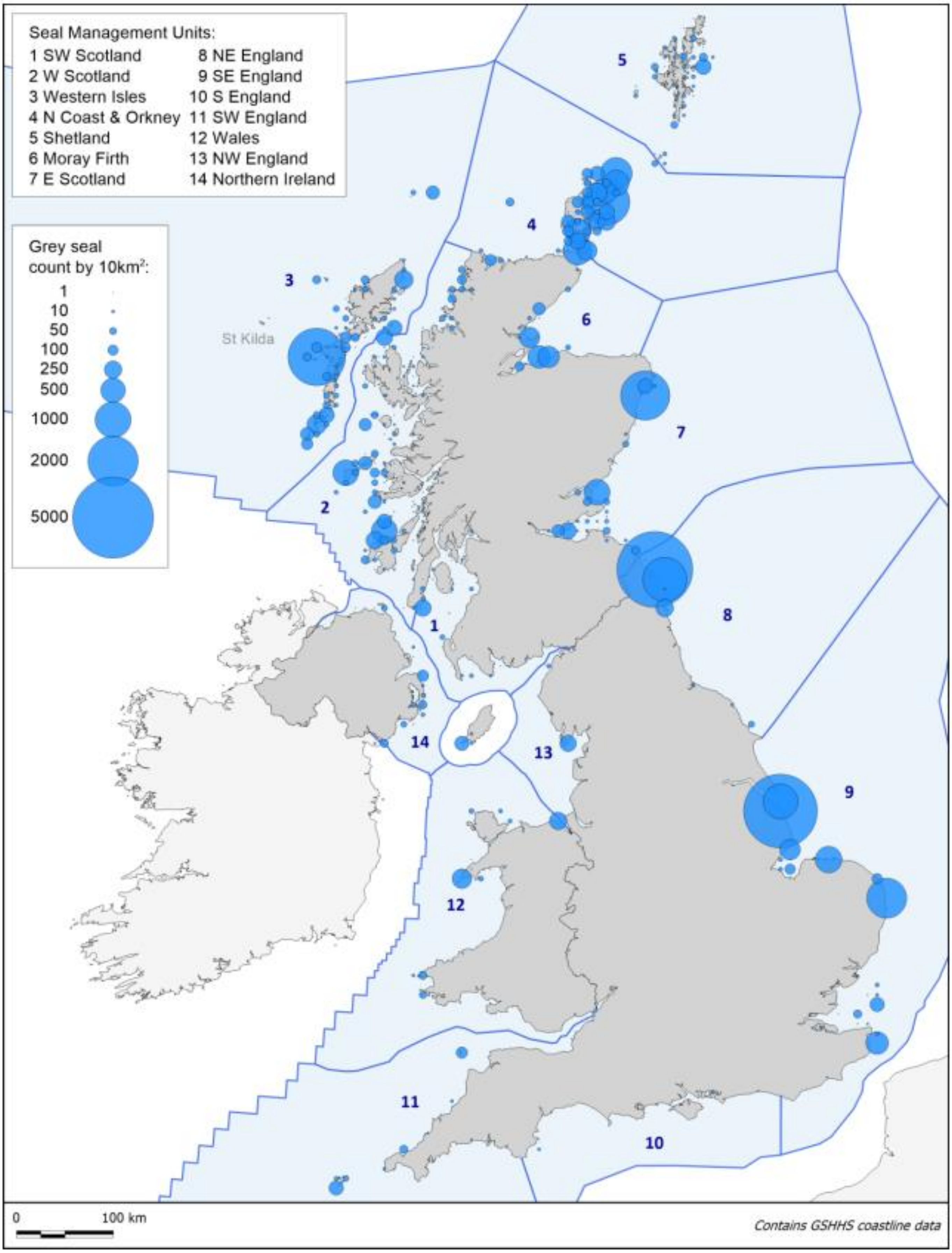


Figure 1.67: August distribution of grey seal around the British Isles by 10 km squares based on the most recent available haul-out count data collected up until 2019 (SCOS, 2020).

1.7.7.31 Estimates of grey seal counted in August 2018 in the Wales MU and Northwest England MU are 900 and 250, respectively. Extrapolating to population size based on the proportion hauled-out (based upon scalar in SCOS 2021) gives grey seal abundance estimates for the Wales and Northwest England MUs of approximately 3,766 and 1,046 grey seal, respectively. However, given the lack of dedicated SMRU surveys in these areas, this estimate should be considered with caution due to the limited data used to inform the estimate. Additional data was available from the Cumbria Wildlife Trust which started conducting low tide counts of grey seal at South Walney in 2019 (Wright and Sinclair, 2022). Thus far, a total of 248 and 300 grey seal have been counted in 2019 and 2020 respectively for the Cumbria grey seal surveys (counts are not yet available for 2021).

1.7.7.32 In the Southwest Scotland MU, grey seal August haul-out counts have been lower than harbour seal counts. Overall, counts within the MU have seen a steady increase from 75 in the 1997 to 1997 period to 517 in the 2016 to 2019 period. The August haul-out count of 517 can be scaled to account for the proportion of the population at sea at the time of the survey, resulting in a population estimate of 2,056 grey seal in the Southwest Scotland MU.

1.7.7.33 In the Northern Ireland MU, the most recent August haul-out survey conducted in 2018 showed an estimated count of 505 grey seal, resulting in a population estimate of 2,008 grey seal in the Northern Ireland MU. There is an indication of an increasing population within these areas however due to the lack of dedicated surveys, a population trend could not be estimated (SCOS, 2021).

1.7.7.34 Several studies focused on smaller areas such as the Irish Sea, or Wales. Population size and seasonal distribution of grey seal at principal haul-out sites in the central and south Irish Sea were investigated in a INTERREG Programme study conducted between 1996 and 1998 (Kiely *et al.,* 2000). This study included ground counts of annual pup production, which recorded 177 new-born pups at Irish study sites and 744 pups at sites spanning Ceredigion, north Pembrokeshire and Ramsey Island in southwest Wales. All-age population estimates for the Irish Sea were 5,198 to 6,976 grey seal and was supported by photo-identification mark-recapture data which delivered an estimate of 5,613 seal (CV = 0.2%).

1.7.7.35 For Ireland, Ó Cadhla *et al.*, (2007) provided the first grey seal population size in 2005, which gave definitive minimum population estimate of 5,509 to 7,083 grey seals of all ages for the Republic Ireland. Following SMRU methods to assess breeding population size, this was revised to 5,859 to 7,533 grey seal of all ages, and population estimate of 1,574 pups for the Republic of Ireland and approximately 100 pups for Northern Ireland in 2005 (SCOS, 2007). Ground truthing was also included in the 2005 study which suggested a slight under-recording of the true number of pups present due to reliance on aerial imagery.

1.7.7.36 For Wales waters, the West Wales Grey Seal Census (WWGSC) established a core concentration of breeding grey seal, with all-age estimates of 5000 animals for west Wales (Baines *et al.*, 1995). Major haul-out sites were also identified in North Wales (Lleyn Peninsula, Anglesey and West Hoyle Sandbank) in census studies by Westcott (2002) and Westcott and Stringell (2002; 2003; 2004). Westcott (2002) tentatively estimated the total number of grey seal at North Wales sites as 365 for 2001 to 2002, whilst Westcott and Stringell (2003) estimated the 2002 to 2003 population as 385 seal, based upon 110 pups and the same correction factor of 3.5. This correction factor is derived from a life table in Hewer (1974) to calculate seal population numbers from the number of pups born. In 2006, grey seal monitoring at the Pembrokeshire Marine

SAC incorporating Ramsey Island gave estimates of 788 grey seal (adults and juveniles) on Pembrokeshire mainland (Strong *et al.*, 2006).

1.7.7.37 The Manx Marine Environmental Assessment details an estimate of 350 to 400 individuals on the Isle of Man (Howe, 2018b). Monthly counts on the island recorded from snapshot surveys have ranged from 135 to 405 individuals (Sharpe, 2007). MWT (pers. comm, 2023) reported 365 seals in 2017 during an island-wide survey in 2017, though this was a one-off snapshot during October and November. The Calf of Man seal catalogue has around 450 individuals, but this covers the span of the programme from 2009 to 2022 (pers. comm, 2023). At the south end of the Isle of Man, there is a resident population estimated at 50 seal which is included in the total population estimate given above. Therefore, the estimate of 400 animals from Howe (2018b) aligns and accounts for monthly mean estimate reported in Sharpe (2007), with Howe (2018b) stating population numbers are stable or possibly elevated compared to Sharpe (2007).

1.7.7.38 Morris and Duck (2019) gave counts of harbour seal and grey seal in Ireland from surveys in 2003, 2011/2012 and 2017/2018. In the most recent survey (2017/2018) in the East region 418 grey seal were counted, and in the southeast 556 grey seal were counted (Figure 1.4). Using population scalars from SCOS (2020) this results in population estimates of 1,662 grey seal for the east region and 2,211 for the southeast region. The study suggests grey seal numbers are increasing at a significantly higher rate than harbour seal (currently in the order of 2.5 to 3.5 times more grey seal than harbour seal in Ireland).

1.7.7.39 Recent aerial surveys for the Mona Offshore Wind Project (Mona Offshore Wind Ltd, 2024) showed grey seal abundance varied across months and seasons, with greatest abundance observed during the winter (December to February) and spring (March to May) months. Mean absolute abundance (i.e. adjusted by availability bias) was 146 animals in the Mona Aerial Survey Area per month, with the lowest abundance of 43 animals per the aerial survey area in May and the highest in March of 296 animals in the survey area. Note these are absolute abundances, adjusted to the size of the aerial survey area and corrected for availability, rather than relative abundances. When split by bio-season, mean absolute abundance was 71 animals per survey area in the pupping season and 201 in the non-pupping season.

1.7.7.40 For the Morgan Aerial Survey Area, grey seal abundance varied across months and seasons with highest abundances in March, with 251 animals from mean absolute abundance (i.e. adjusted by availability bias). Abundance was modelled by month, within meteorological seasons, and within the ‘pupping’ (August to November) and ‘non-pupping’ (December to July) divisions determined in consultation with Manx Wildlife Trust, for clarity referred to here as ‘bio-seasons’. Mean absolute abundance was 137 animals in the Morgan Aerial Survey Area per month, with the lowest abundance of 50 animals in November and the highest in March of 251. Note these are absolute abundances, adjusted to the size of the aerial survey area and corrected for availability, rather than relative abundances. When split by bio-season, mean absolute abundance was 98 animals in the pupping season and 180 in the non-pupping season.

1.7.7.41 During integrated surveys detailed in the PAM and MMO Report, there were also 39 visual sightings of grey seal from April 2022 to June 2022.

1.7.7.42 The reference population taken forward to assessment for grey seal comprises a combined sum of population estimates from populations within the Irish Sea including: four SMUs that cover the Irish sea and show connectivity to each other in telemetry figures (12: Wales = 3,579; 13: NW England = 994; 14: Northern Ireland = 2,008 and

1: SW Scotland = 2,056); separate estimates for the East of Ireland (1,662) and Southeast of Ireland (2,211) from Morris and Duck (2019); and the Isle of Man estimate (400) from Howe (2018b). The combined populations form one Grey Seal Reference Population (GSRP) for the impact assessment, which gives a total of 12,910 grey seal. This is deemed the most relevant reference population to apply to the impact assessment.

1.7.7.43 During the EWG consultations, NRW requested consideration of OSPAR Regional III, particularly with respect to cumulative impacts of other projects. The OSPAR Region III Nmin estimate of 60,780 from the OSPAR Quality Status Report[11] for 2023 will be applied for additional context in the assessment (Banga, 2022). This has been chosen as a conservative estimate for OSPAR Region III, over the N value of 64,854 to facilitate a precautionary approach.

Seasonality

1.7.7.44 UK grey seal breed in the autumn, but there is a clockwise cline in the mean birth date around the UK (SCOS, 2018). In the southwest of the UK (including Wales) the pupping season occurs between August and November, with peak births in September and October (Morgan *et al.,* 2018; Langley *et al.,* 2020; SCOS, 2020). However, pups have also been recorded outside of this period and have been recorded throughout the year at Ramsey Island (Morgan *et al*., 2018). In Manx waters, the grey seal pupping season usually occurs between September and November with moulting December to March (Howe, 2018b).

1.7.7.45 Grey seal may redistribute outside of the breeding season so regional differences in population estimates do not necessarily reflect the of the year, grey seal in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season (between August and December) (SCOS, 2020).

1.7.7.46 Studies in North Wales demonstrated grey seal were found to be present at all surveyed sites throughout the year, albeit in varying numbers (Westcott, 2002; Westcott and Stringell, 2003; 2004). The number of grey seal assembled ashore is generally greater in the summer months than in winter for the North Wales region surveyed. It was suggested seals use the islands off the east coast of Anglesey much more intensively in the winter months than in summer, whilst the West Hoyle Sandbank and Bardsey Island rises to a peak in the summer months. In summer 2003, largest counts were recorded for West Hoyle Sandbank on the Dee Estuary (330 on 11 July 2003), which is the closest site to the Morgan Generation Assets and Ynys Enlli/Bardsey Island (228 on 30 July 2003). In winter, most of the largest winter counts were recorded for the east Anglesey islands (Wescott and Stringell, 2004). Ynys Dulas recorded 139 on February 2003, and Puffin Island 127 on December 2003, and 116 for the West Hoyle Sandbank in November 2002. The highest winter counts were lower than the highest summer counts for the region as a whole and were made in the central sector of the range (Westcott and Stringell, 2004). Recent evidence from Wales has shown that pup production at Marloes Peninsula and Skomer is increasing, and the onset of the pupping season is getting earlier (Bull *et al.,* 2017a; 2017b; Morgan *et al.,* 2014; 2018). Bull *et al.* (2021) found that climate causes shifts in grey seal pupping phenology, with warmer years associated with an older average age of mothers and a

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[11] The OSPAR Quality Status Report (QSR) 2023 reflects the work of the Contracting Parties, scientists, experts and their institutions, and the OSPAR Secretariat, to assess the status of various components of the North-East Atlantic and examine how conditions have changed since the last QSR (2010)

temperature increase of 2°C causing a pupping season to advance of approximately seven days.

1.7.7.47 On the east coast of Ireland, the largest grey seal haul-outs were recorded during the months of July and August, peaking during annual breeding (September to December) and moulting seasons (November to March) (Kiely *et al.,* 2000).

1.7.8 Harbour seal

Ecology

1.7.8.1 Harbour seal is the smaller of the two species of pinniped that breed in the UK, typically weighing between 80 to 100 kg (SCOS, 2015). Female harbour seal become sexually mature at three to five years of age and gestation lasts between 10.5 and 11 months (Thompson and Härkönen, 2008). Harbour seal are long-lived animals with individuals estimated to live to between 20 and 30 years (SCOS, 2018). Breeding and moulting seasons take place between June and August (Carter *et al.*, 2022). Pups are born in June and July having moulted their white coats prior to birth, allowing harbour seal pups to swim within a few hours of birth (Burns, 2002). During lactation, females spend much of their time in the water with their pups and, although they will forage during this period, distances travelled at this time are more restricted than during other periods (Thompson *et al*., 1994). Following the spring/summer breeding and nursing season, the annual moult of harbour seals occurs in late summer (Wilson and Jones, 2018; Thompson *et al.,* 2019).

1.7.8.2 Different sex and age classes are thought to haul out at different times during the moult (which may influence the proportion of the total population that are counted during surveys), with juvenile harbour seal moulting earliest and adult males latest (Cronin *et al.*, 2014; Daniel *et al.*, 2003; Thompson and Rothery, 1987). Timings of the moult are different between Ireland, Scotland and the Wadden Sea (Cronin *et al.*, 2014) and it has also been suggested the timing of the moult also varies throughout the UK.

1.7.8.3 Harbour seal, are central place foragers, requiring haul-out sites on land for resting, moulting and breeding, and dispersing from these sites to forage at sea. In order to reduce time and energy searching for prey, animals are likely to travel directly to areas of previously or predictably high foraging success (Bailey *et al*., 2014). Harbour seal persist in discrete metapopulations and tend to stay within 50 km of the coast, although most foraging trips are over shorter ranges (Russell and McConnell, 2014). Harbour seal have a smaller maximum foraging range of 273 km, than grey seal (448 km) (Carter *et al.,* 2022). Harbour seal, an income breeder, undertakes foraging trips during lactation, in contrast to grey seal which are capital breeders and tend to stay with the pups until they are weaned (Bonner, 1972). Since harbour seal females need to regularly return to their pups at the haul-out site they may be more limited in foraging distance. Carter *et al.* (2022) found during their study, that distance to haul-out site was the primary driver of distribution for harbour seal in all regions. Because of the constraint on their foraging range, particularly during the breeding season, harbour seal may be particularly vulnerable to changes in prey abundance or disturbance events from human activities (Bailey *et al*., 2014).

1.7.8.4 Harbour seal breeds in small groups scattered along the coastline. They breed between June and August (Carter *et al.*, 2022), and study has shown peak pupping time at two sites at Dundrum Bay, County Down in the Irish Sea to be between 04 July and 15 July (Wilson and Jones, 2018). Haul out sites are on two types of intertidal habitat; sandbanks and beaches (such as in the east coast of England and Scotland) or rocky shores (such as West Scotland). There is also evidence for a slight temporal effect on numbers of seals hauled out, with higher numbers associated with low tides occurring in the afternoon (Russell *et al*., 2015; Thompson and Harwood, 1990).

1.7.8.5 Harbour seal are opportunistic, generalist feeders and their diet varies both seasonally and from region to region (Hammond *et al*., 2001; Wilson and Hammond, 2016) as they consume prey in relation to its availability (Kavanagh *et al.*, 2010). Analyses of seal scat in Ireland has demonstrated that a wide variety of prey items are exploited by harbour seal, including species from the surface, mid-water and benthic habitats such as sandeels, whitefish, herring, sprat, common octopus and squid *Loligo* spp. (Hammond and Wilson, 2016). Gadoid fish (whiting, pollack and haddock) are key prey species of harbour seal with pouting *Trisopterus luscus* contributing to the largest proportion of diet by weight (Kavanagh *et al.,* 2010). In the Irish Sea, a study on the seasonal and regional estimates of harbour seal diet demonstrated in southeast Scotland (to the north of the marine mammal regional study area) the diet comprised primarily flatfish (mainly plaice) and also sandeel and large gadids (Wilson and Hammond, 2016).

Distribution

1.7.8.6 Harbour seal are widely distributed, inhabiting temperate and subpolar seas throughout the Northern Hemisphere. The UK and Ireland represents an important population centre for both species, with approximately 36% of the pup production for Eastern Atlantic subspecies of harbour seal (SCOS, 2020). Carter *et al.* (2022) suggested large centres of harbour seal abundance in Shetland, The Wash (in southeast England) and west Scotland, with high density at-sea areas adjacent to those hotspots. For management purposes, the UK harbour seal population is subdivided into SMUs that were defined on the basis of the spatial distribution of haul-out sites (Figure 1.68). The wide geographical spread of haul-out sites and their general inaccessibility means that aerial surveys provide the best practical method for obtaining reliable indices of abundance.

1.7.8.7 Surveys of harbour seal are carried out during the summer and early autumn months in the UK. There are two types of surveys conducted: breeding counts and moult counts. Breeding seals are surveyed in June and July annually in a small number of areas (Moray Firth and, in recent years, in Lincolnshire and Norfolk), and a very limited number of breeding season surveys have been carried out on behalf of NatureScot in areas designated as SACs for harbour seal in Scottish waters. Given that there are no harbour seal breeding surveys conducted in the regional marine mammal study area, these are not considered further.

1.7.8.8 The main population surveys for harbour seal are carried out during moulting, during the first three weeks of August when the greatest and most consistent numbers of harbour seal are believed to haul-out ashore during their annual moult. To maximise the numbers of seals on shore and to reduce the effects of environmental variables, surveys are restricted to within two hours either side of afternoon low tides on days with no rain. The frequency of surveys differ, with annual moult surveys carried out in Lincolnshire and Norfolk (England), the Moray Firth and the Firth of Tay (Scotland) whilst the remainder of the Scottish coast is surveyed approximately every four to five years, although there is considerable variation between areas (more detail in Appendix B).

1.7.8.9 The main harbour seal haul-outs are located in the north region of the regional marine mammal study area, in the Southwest Scotland MU, particularly in the north of the MU (Figure 1.68).

1.7.8.10 There is no information on the location of harbour seal hauled-out in the Wales and Northwest England MUs (Wright and Sinclair, 2022) as numbers are so few and there are no dedicated SMRU surveys routinely carried in these MUs, with “estimates compiled from counts shared by other organisations”. In Northern Ireland most harbour seal haul-outs are located in the southeast of the country, with most harbour seal being counted at Carlingford Lough, Murlough SAC and Rathlin Island (Duck and Morris, 2019). Harbour seal were counted in aerial surveys (in 2002, 2011 and 2018) in the Maidens SAC, Strangford Lough SAC and Murlough SAC.

1.7.8.11 Interregional movements within the foraging season are more limited (Russell *et al*., 2013) particularly for harbour seal (Carroll *et al*., 2020). Telemetry data presented in Wright and Sinclair (2022) showed no harbour seal were tagged in the Northwest England, Wales or Southwest Scotland MUs between 2001 and 2017, but 34 harbour seal were tagged in the Northern Ireland MU between 2006 to 2010 (Figure 1.69). All 34 harbour seal recorded telemetry tracks within the regional marine mammal study area, confirming harbour seal usage of the area. Furthermore, telemetry track data from 12 harbour seal tagged in the adjacent West Scotland MU were recorded within the regional marine mammal study area (specifically within Southwest Scotland and Northern Ireland MUs). A total of 46 harbour seal telemetry tracks were recorded in the regional marine mammal study area (Figure 1.69). Five harbour seal (all tagged in Northern Ireland MU) were recorded within 50 km of the Morgan Array Area, but no tracks were recorded within or south of the Morgan Array Area (Figure 1.70). These seals showed connectivity to the surrounding SACs, and with the south coast of the Isle of Man

1.7.8.12 Duck and Morris (2019) carried out thermal-imaging surveys of harbour seal around Ireland in August 2017 and 2018, with the Irish coast divided into five regions: east, southeast, southwest, west and north. In all surveys the greatest proportion of harbour seal were counted in the west of Ireland, and the smallest proportions were in the east and southeast (3% and 1% in 2017/2018; 3% and 2% in 2011/2012; 4% and 1% in 2003).

1.7.8.13 Past telemetry studies have also confirmed harbour seal movements between Inner Strangford Lough and the Irish Sea (Sparling *et al.,* 2018). In this study, the turbine did not prevent transit of the animals through the channel to give a barrier effect, but animal behaviour did change during operation and some degree of local avoidance was evident thus minimising collision risk.

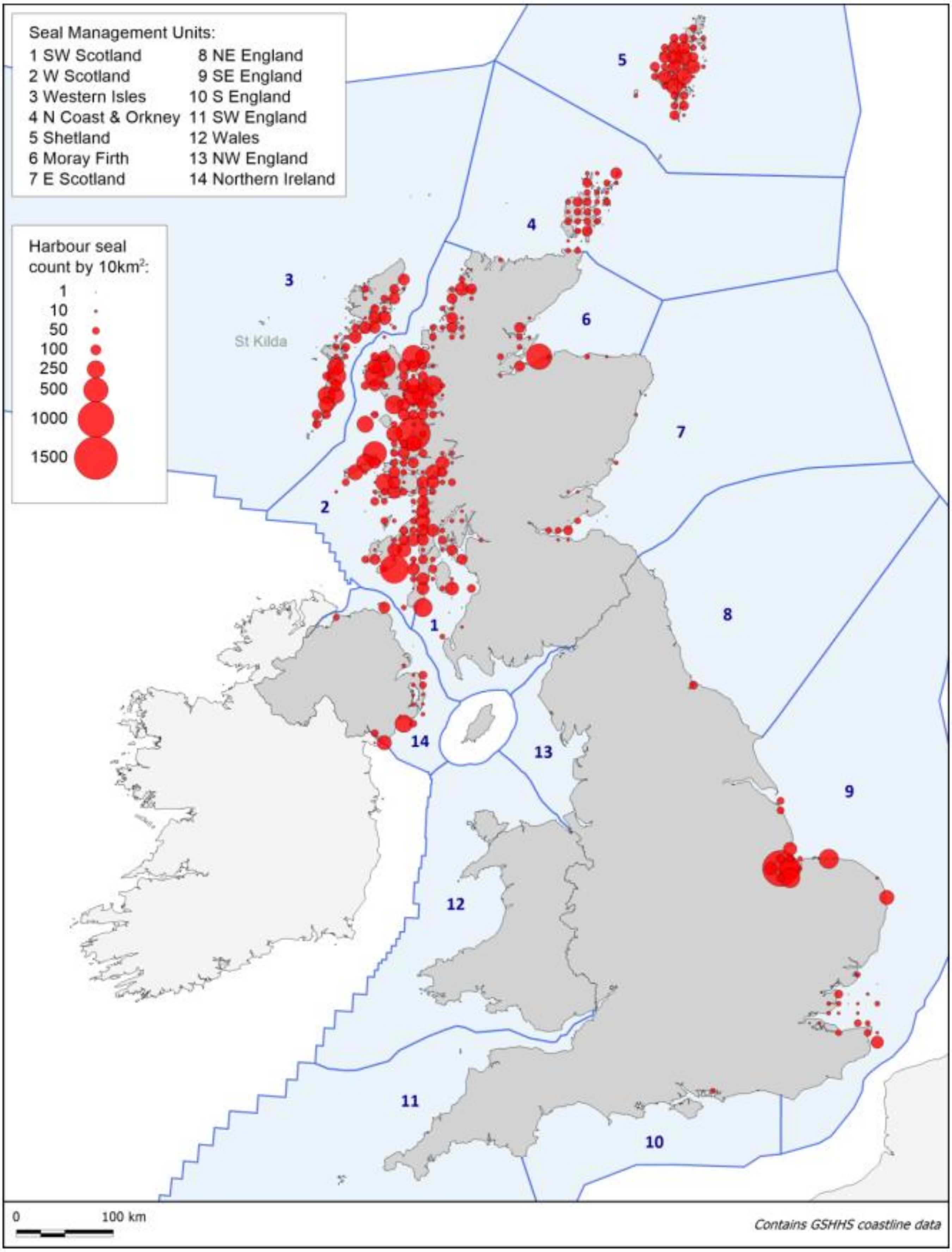
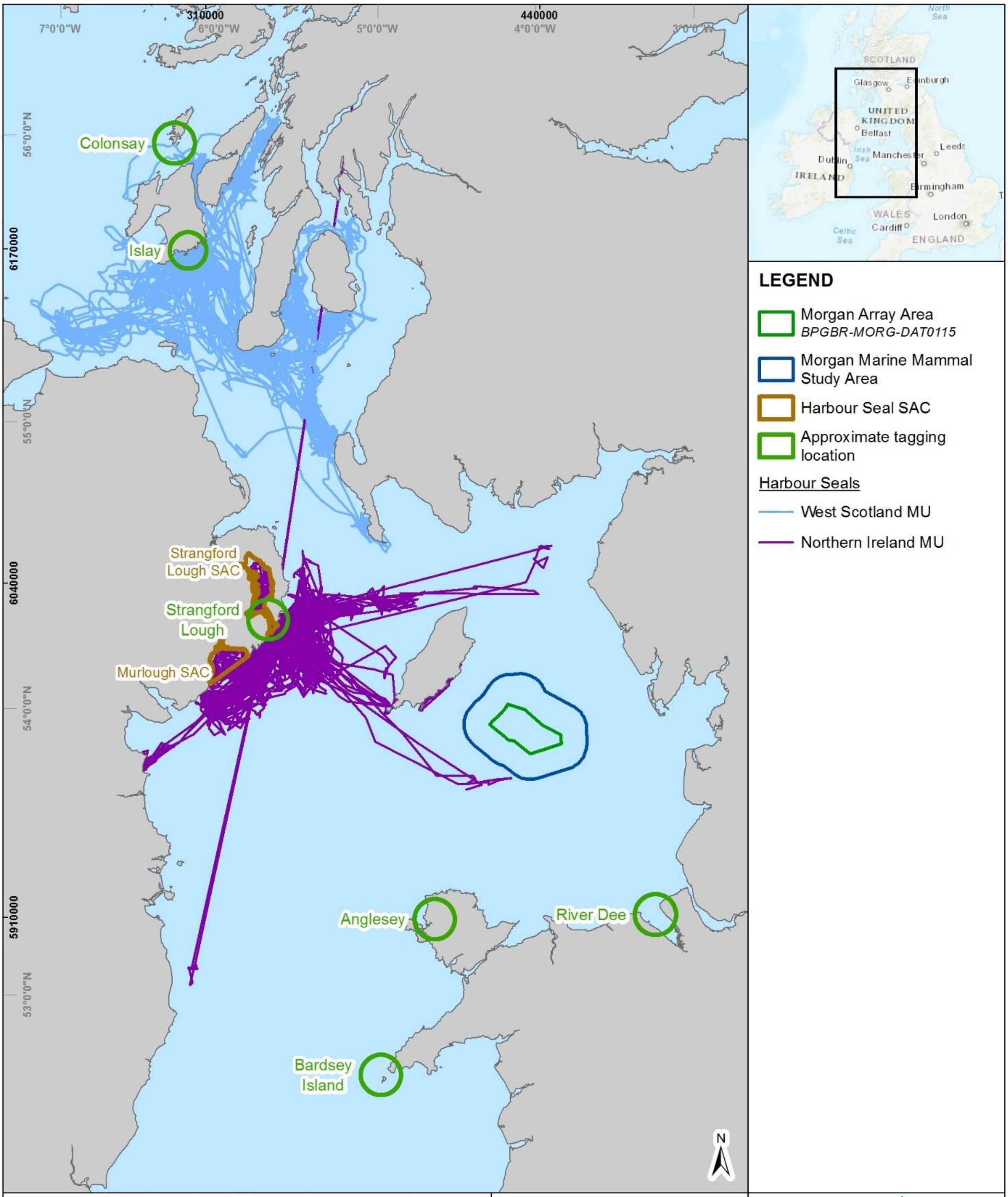


Figure 1.68: August distribution of harbour seal around the British Isles by 10 km squares based on the most recent available haul-out count data collected up until 2019. Limited data available for SMUs 10 to 13. Figure obtained from SCOS (2020).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, SMRU

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 nm
0 10 20 40 60 km

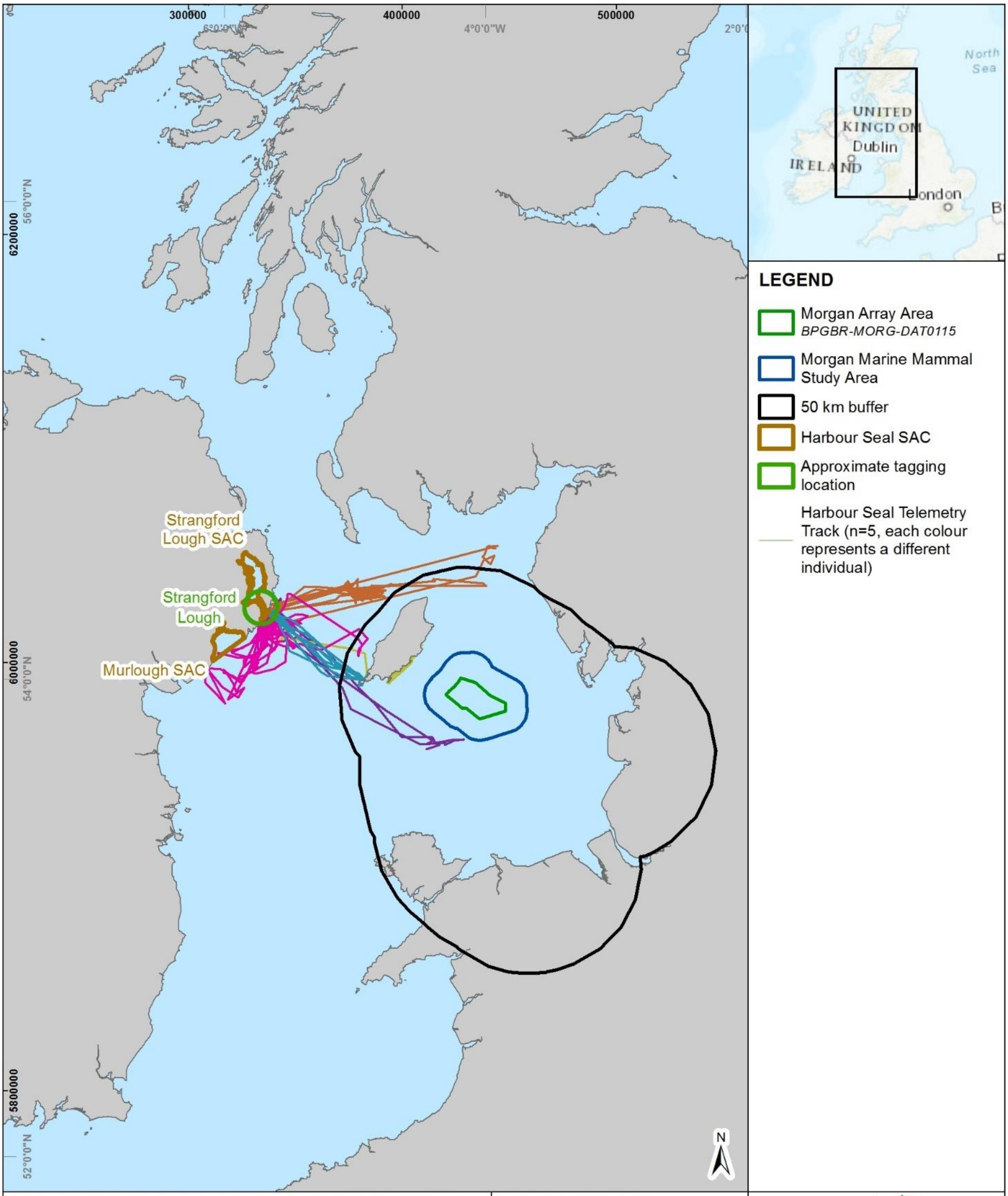
Drawing Number:
RPSE-MG-ES-MAM-049-00

Drawing Title:
TELEMETRY TRACKS FOR ALL 46 HARBOUR SEAL THAT ENTERED THE REGIONAL MARINE MAMMAL STUDY AREA (34 TAGGED IN THE NORTHERN IRELAND MU AND 12 TAGGED IN WEST SCOTLAND MU) (WRIGHT AND SINCLAIR, 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,500,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.69: Telemetry tracks for all harbour seal that entered the regional marine mammal study area (n=46; 34 tagged in the Northern Ireland MU and 12 tagged in West Scotland MU, from 2006 to 2010) (Wright and Sinclair, 2022).



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, SMRU

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 30 40 nm
0 10 20 40 60 80 km

Drawing Number:
RPSE-MG-ES-MAM-050-00

Drawing Title:
HARBOUR SEAL TELEMETRY TRACKS RECORDED WITHIN A 50 KM BUFFER, SHOWING CONNECTIVITY TO THE SURROUNDING SACS (N=5; ALL INDIVIDUALS TAGGED IN THE NORTHERN IRELAND MU)" (WRIGHT AND SINCLAIR, 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:3,000,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

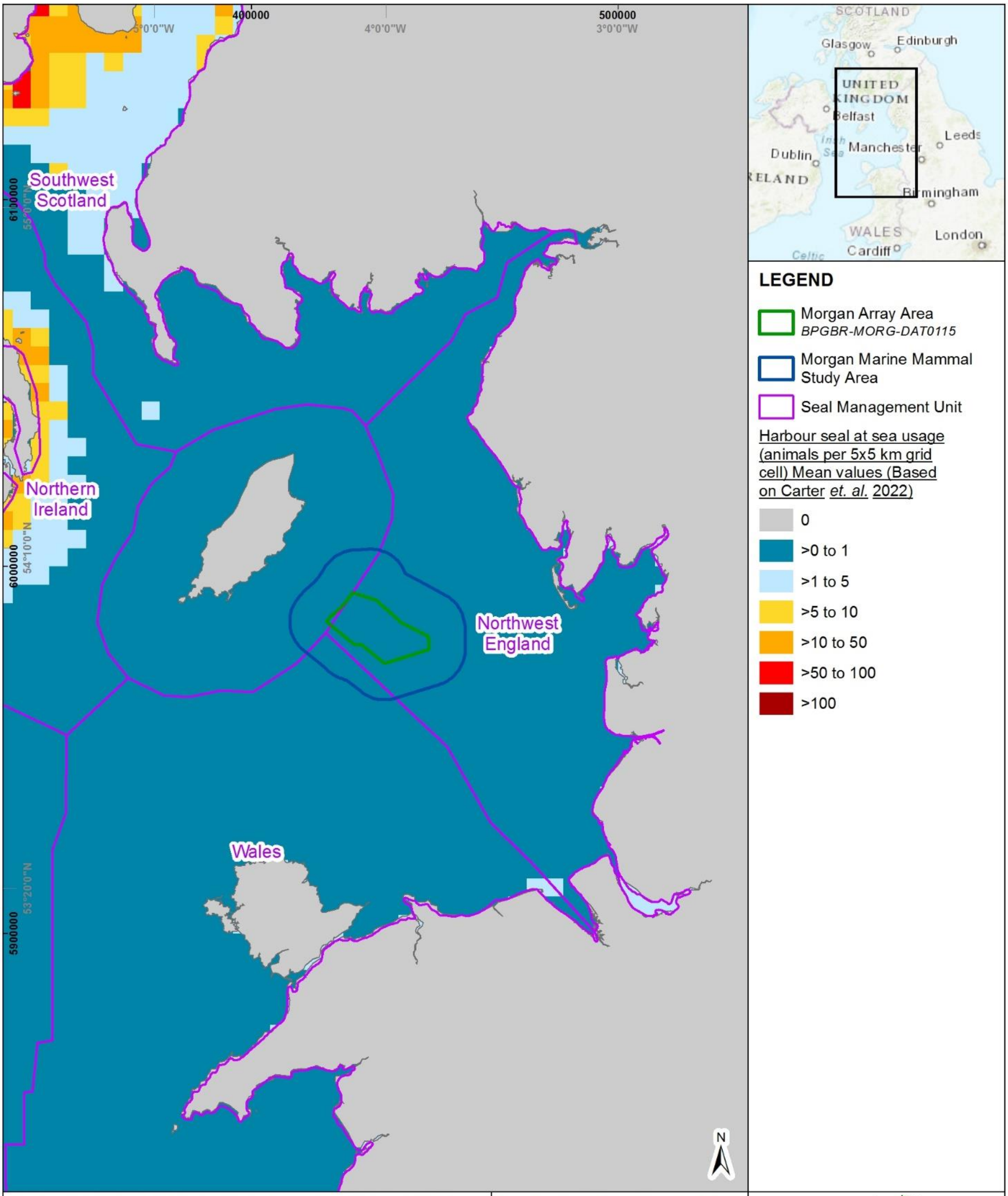
Figure 1.70: Harbour seal telemetry tracks recorded within a 50 km buffer, showing connectivity to the surrounding SACs (n=5; all individuals tagged in Northern Ireland MU, 2006 to 2010) (Wright and Sinclair, 2022).

Density/abundance

Density

1.7.8.14 The Morgan Array Area is located in Wales and Northwest England SMUs. The nearest designated haul out sites for harbour seal in the MU in the vicinity of the Morgan Array Area are Manx MNRs (Calf and Wart Bank, Langness, Ramsey and West Coast), and Murlough SAC, Strangford Lough SAC and The Maidens SAC.

1.7.8.15 Mean harbour seal at-sea usage in the vicinity of the Morgan marine mammal study area is low (Carter *et al.*, 2022), with the main area of usage in the regional marine mammal study area along the east coast of Northern Ireland. Within the Morgan marine mammal study area, the average value (of the mean at sea usage) from Carter *et al*., 2022 was estimated at 0.001177 animals per 5 x 5 km grid cell, equating to a density of 0.00005 animals per km^2 (Figure 1.71). This density was carried forward to the assessment as agreed with the Marine Mammal EWG.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, JNCC, St Andrews University

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 5 10 20 nm
0 10 20 40 km

Drawing Number:
RPSE-MG-ES-MAM-051-00

Drawing Title:
DISTRIBUTION AND PREDICTED NUMBER OF HARBOUR SEAL IN 5 KM X 5 KM GRID CELLS (MEAN) (CARTER ET AL., 2022)

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:1,750,000

VER	DATE	DETAILS	BY	CHECK
00	18/08/23	First Issue	NA	LB

Figure 1.71: The distribution and predicted number of harbour seal in 5 km x 5 km grid cells (mean at sea usage) (Carter *et al.*, 2022).

Abundance/Counts

1.7.8.16 The most recent estimate of the UK harbour seal population (2016 to 2021) is 43,750 (approximate 95% CI: 35,800 to 58,300) (SCOS, 2021). This is derived by scaling the most recent composite count of 31,500 (based on surveys between 2016 and 2021) for the estimated proportion hauled out during the surveys (0.72 (95% CI: 0.54 to 0.88; from Lonergan *et al.*, 2013). The overall UK population has increased in the last decade, but there are significant differences in the population dynamics between SMUs.

1.7.8.17 In the Republic of Ireland research programmes have established national population baselines for harbour seal in 2003 (Cronin *et al.,* 2007), and the harbour seal population assessment, carried out during the moult season determined a minimum population of 2905 harbour seal. This estimate in 2003 was combined with a comparable survey of Northern Ireland in 2002 (Duck, 2006) and gives an all-Ireland minimum population of 3,988 harbour seal.

1.7.8.18 The relevant SMUs that surround the Morgan Array Area are Wales, Southwest Scotland, Wales and Northern Ireland (Table 1.14). In the Wales and Northwest England MU, there are no dedicated harbour seal surveys routinely carried out due to the very low numbers of seals (Wright and Sinclair, 2022, Appendix B) but harbour seal haul-out counts for those MUs have remained steady over the survey periods.

1.7.8.19 SCOS (2021) provides the latest updated estimates of harbour seal populations in the British Isles per SMU, and these are reported in Table 1.14. Estimates are based on the most recent August counts of harbour seals at haul-out sites scaled by the proportion of the population estimated to be hauled out from Lonergan *et al.* (2013).

Table 1.14: Harbour seal August haul-out counts for various survey periods. Data from SCOS (2021).

SMU	Parameter	2011 to 2015	2016 to 2021
Wales	Count	10	10
	Population estimate	13	13
NW England	Count	5	5
	Population estimate	6	6
Northern Ireland	Count	948	1,012
	Population estimate	1,316	1,405
Southwest Scotland	Count	1,200	1,709
	Population estimate	1,666	2,373

1.7.8.20 In the most recent survey period (from 2016 to 2019), the harbour seal haul-out counts for the Wales and Northwest England MUs were 10 and 5, respectively. When scaled by the proportion of seals hauled-out at the time of the counts to give estimated population sizes, Wales MU has an estimated population size of 13 harbour seal and Northwest England MU has an estimated population size of six harbour seal.

1.7.8.21 For the Northern Ireland MU, the haul-out count of 1,012 seal gave a population estimate of 1,405 harbour seal. The population appears to have declined slowly after 2002 in Northern Ireland MU but appears to be stable since 2011. Sites within this MU are not surveyed annually, with the most recent full survey in 2018 showing a 6.8% increase from the previous survey period (2011 to 2015).

1.7.8.22 Similarly, not all sites within Southwest Scotland MU are surveyed annually and the most recent August haul-out count of 1,709 harbour seal for the 2016-2019 count period gave a population estimate of 2,373 harbour seal in the MU. The rate of increase over the past five years was approximately 3.9% per annum (SCOS, 2021).

1.7.8.23 Connectivity presented in Figure 1.69 and Figure 1.70 demonstrates there is little overlap in at-sea space use between the Southwest Scotland MU and the three remaining MUs that cover the Irish Sea (Wales, Northern Ireland and Northwest England MU) and therefore the three SMUs to be taken forward as the reference population (the HSRP) to the assessment are the combined total of the Wales, Northern Ireland and Northwest England MU population estimates (a total of 1,424 harbour seal).

1.7.8.24 Other localised estimates of abundance have been given for Strangford Lough, to the northwest of the regional marine mammal study area, as 200 animals (Lonergan, 2013). Morris and Duck (2019) presented counts of harbour seal and grey seal in Ireland from surveys in 2003, 2011/2012 and 2017/2018. In the most recent survey (2017/2019) in the east region 131 harbour seal were counted, and in the southeast 34 grey seal were counted (Figure 1.3). Using population scalars from Lonergan *et al.* (2013) this leads to population estimates of 182 harbour seal for the east region and 47 for the southeast region. The study suggests grey seal numbers are increasing at a significantly higher rate than harbour seal (currently in the order of 2.5 to 3.5 times more grey seal than harbour seal in Ireland).

1.7.8.25 In the Mona aerial surveys (Mona Offshore Wind, 2024), only one harbour seal was observed in aerial surveys, in March 2020. This led to an abundance estimate of eight within the whole Mona Aerial Survey Area.

1.7.8.26 In the Morgan aerial surveys, no harbour seal were observed for the entire 24 months across the Morgan Aerial Survey Area.

Seasonality

1.7.8.27 Measures of abundance and distribution are largely based on summer surveys during either the pupping or moulting seasons but may vary seasonally. For example, in a study in the Moray Firth, harbour seal in the SAC showed changes in their seasonal pattern of site-use over this period and results highlighted that seasonal patterns may vary over time (Cordes *et al*., 2011).

1.8 Summary

1.8.1.1 Data gathered through a desk-top review and Morgan aerial surveys found that that the Irish Sea supports a number of different marine mammal species with internationally important populations of certain species occurring within the vicinity of the Morgan Generation Assets. Key marine mammals identified within the regional marine mammal study area included: harbour porpoise, bottlenose dolphin, minke whale, short-beaked common dolphin, Risso’s dolphin, grey seal and harbour seal.

1.8.1.2 Where possible, mean monthly density estimates were generated for these species using site-specific data (from Morgan aerial surveys) gathered during monthly aerial digital surveys across the Morgan Array Area plus 10 to 13.3 km buffer. Where it was not possible to estimate densities due to low sightings rates, data were sought from published sources including regional studies of key species. A summary of the mean densities for each species are provided in Table 1.15. Where site specific density estimates are suitable with acceptable CVs, they are used. If density estimates and CVs are not suitable, alternative densities are given (such as SCANS-III block estimates). Some species may different densities between offshore and onshore areas (e.g. bottlenose dolphin, harbour seal and grey seal) and therefore different density estimates can be derived for inshore areas. Offshore estimates are most reflective of the Morgan Array Area (Table 1.15).

1.8.1.3 Sites designated for the conservation of internationally important populations closest to the Morgan marine mammal study area include Langness MNR, Little Ness MNR, Douglas Bay MNR, Laxey Bay MNR, Ramsey Bay MNR, North Anglesey Marine/Gogledd Môn Forol SAC, Baie Ny Carrickey MNR, Calf and Wart Bank MNR, Port Erin Bay MNR, Niarbyl MNR, West Coast MNR, North Channel SAC, Strangford Lough SAC and Murlough SAC. These sites lie 16.78 km to 98.4 km distance from the Morgan Array Area (Table 1.4).

1.8.1.4 Pen Llŷn a`r Sarnau/Llŷn Peninsula and the Sarnau SAC, West Wales Marine/Gorllewin Cymru Forol SAC, Rockabill to Dalkey Island SAC, Lambay Island SAC, Cardigan Bay/Bae Ceredigion SAC, Slaney River Valley SAC, Pembrokeshire Marine/Sir Benfro Forol SAC, Saltee Islands SAC, Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC and Lundy SAC are also designated for the conservation of internationally important populations, lying at distances from 122.0 km to 320.28 km from the Morgan Array Area (Table 1.4).

Table 1.15: Summary of marine mammal receptors to be considered in the Marine mammal chapter together with relevant densities and reference population sizes (species-specific MUs, SCANS-II, SCANS-III blocks).

[1] Density derived from Evans and Waggitt (2023) for the Morgan marine mammal study area.

[2] SCANS-III (Hammond *et al.,* 2021) for adjacent block E (none observed for block F).

[3] Carter *et al.* (2022) values – average densities calculated to per km^2 from 25 km^2 cells for the Morgan marine mammal study area.

[4] All population estimates include the Isle of Man unless population estimate given separately.

[5] Based upon counts in SCOS (2020) and Morris and Duck (2019) with updated scalar of 0.215 from SCOS (2021) for grey seal.

[6] From Howe (2018b).

[7] Population estimates per SMU from SCOS (2021).

Species	**Density (animals per km^2)**	**Management Unit (MU)**	**Reference population MU[4]**
Harbour porpoise *Phocoena phocoena*	0.262[1]	Celtic and Irish Sea	62,517
Bottlenose dolphin *Tursiops truncatus*	0.0012[1]	Irish Sea	293
Short-beaked common dolphin *Delphinus delphis*	0.00029[1]	Celtic and Greater North Seas	102,656
Risso’s dolphin *Grampus griseus*	0.0313[2]	Celtic and Greater North Seas	12,262
Minke whale *Balaenoptera acutorostrata*	0.0173[2]	Celtic and Greater North Seas	20,118
Grey seal *Halichoerus grypus*	0.0412[3]	12 Wales 13 NW England 14 Northern Ireland 1 SW Scotland Isle of Man estimate East of Ireland Southeast of Ireland (‘Grey Seal Reference Population’ (GSRP))	3,579[5] 994[5] 2,008[5] 2,056[5] 400[6] 1,662[5] 2,211[5]
		OSPAR Region III	60,780
Harbour seal *Phoca vitulina*	0.00005[3]	12 Wales 13 NW England 14 Northern Ireland Isle of Man (HSRP)	13[7] 6[7] 1,405[7] No estimate available

1.9 References

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Appendix A: Aerial Survey Data Analysis

MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Environmental Statement

Volume 4, Annex 4.1: Appendix A: Marine Mammal Aerial Survey Data Analyses

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Image of an offshore wind farm

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Glossary

Term	Meaning
Morgan Aerial Survey Area	Morgan Array Area plus 10 to 13.3 km buffer. The Morgan Aerial Survey Area was based upon a pre-scoping original array area layout plus a buffer of 10 km. The Morgan Array Area itself has reduced in spatial extent from PEIR to the Environmental Statement but remains within the boundaries of the Morgan Aerial Survey Area, resulting in an increased buffer region (10 to 13.3 km). The Morgan Aerial Survey Area remains unchanged from Preliminary Environmental Information Report (PEIR) to Environmental Statement.
Bio-season	Division of time into ‘seasons’ according to ecologically driven changes in distribution. For harbour porpoise this is winter (October to March) and summer (April to September). For grey seal this is pupping (August to November) and non-pupping (December to July).
Degrees of freedom	The number of independent pieces of information used in estimating a test statistic (e.g. a sample mean) which are free to vary, often calculated as the number of data points, or the number of categories, minus one. For instance, if the mean of a set of n values is known, n-1 values may vary, but for the given result to be correct, the n^{th} value would be determined by the other values.
Offset term	A covariate in a generalised linear model with a known or pre-specified coefficient. This can be included in a model so that the contribution of the covariate can be accounted for, without it being considered as a predictor variable in its own right (e.g. survey effort can be included so that marine mammal occurrence can be modelled as a per-unit-effort rate, with respect to the spatial and environmental covariates of interest).
Quasi-poisson	When analysing count data, a Poisson regression assumes that the variance of the data is equal to the mean. When a data set contains a lot of zero counts (is ‘zero-inflated’), its mean skews towards zero while its variance may increase, and the assumptions of the Poisson regression are no longer valid. A quasi-poisson regression facilitates analysis of zero-inflated data, by accounting for this skew.

Acronyms

Acronym	Description
CI	Confidence Interval
CL	Confidence Limit
CV	Coefficient of Variation
GSD	Ground Sampling Distance
ICES	International Council for the Exploration of the Seas
MHWS	Mean High Water Springs
PEIR	Preliminary Environmental Information Report
QA	Quality Assurance
SAC	Special Area of Conservation
SE	Standard Error
SMRU	Sea Mammal Research Unit
SPA	Special Protection Area
ZoI	Zone of Influence

Units

Unit	Description
%	Percentage
cm	Centimetre
m	Metre
km	Kilometre
km^2	Square kilometre
nm	Nautical mile
kn	Knot
ft	Feet
s	Second

A.1. Introduction

A.1.1.1.1 Morgan Offshore Wind Limited (the Applicant), a joint venture of Energie Baden-Württemberg AG (EnBW) and bp Alternative Energy Investments Limited are developing the Morgan Offshore Wind: Project Generation Assets (hereafter referred to as the Morgan Generation Assets).

A.1.1.1.2 The Morgan Array Area (i.e. the area of the Morgan Generation Assets within which the offshore wind turbines will be located) is 280 km^2 in area and is located 22.3 km (12 nm) from the Isle of Man coastline, 37.2 km (20.1 nm) from the northwest coast of England and 58.5 km (31.6 nm) from the Welsh coastline (Anglesey) (when measured from Mean High Water Springs (MHWS)).

A.1.1.1.3 To inform the baseline for marine mammals and offshore ornithology, the Applicant commissioned aerial surveys, undertaken by APEM Ltd., across a pre-scoping original array area layout plus 10 km buffer. Aerial surveys commenced in April 2021 and were undertaken monthly, with a total of 24 months of data collected up until March 2023.

A.1.1.1.4 The Morgan Aerial Survey Area remains unchanged from the Preliminary Environmental Information Report (PEIR) to the Environmental Statement. It was based upon a pre-scoping original array area layout plus a buffer of 10 km. However, the Morgan Array Area itself has reduced in spatial extent from PEIR to the Environmental Statement, but it remains within the boundaries of the Morgan Aerial Survey Area and results in an increased buffer region (10 to 13.3 km).

A.1.1.1.5 The extent of the Morgan Aerial Survey Area provides an indication of marine mammal activity over the Morgan Array Area and beyond and therefore will be useful to determine where a Zone of Influence (ZoI) for impacts associated with the Morgan Generation Assets extend further than the Morgan Array Area (although may not cover the full extent of the ZoI for all impacts (e.g. piling noise)).

A.2. Methodology

A.2.1 Study area

A.2.1.1.1 The Morgan Aerial Survey Area, comprising the Morgan Array Area plus 10 to 13.3 km buffer, is located in the Liverpool Bay area of the Irish Sea (Figure A.1). Due to the proximity of the Liverpool Bay Special Protection Area (SPA), an original buffer of 10 km was implemented, bringing the total area surveyed to 1,378 km^2. The Morgan Array Area was refined following commencement of the digital aerial surveys (see paragraph A.1.1.1.4).

A.2.1.1.2 Surveys commenced in April 2021 and were conducted monthly until March 2023, providing 24 months of observations.

A.2.2 Survey approach

A.2.2.1.1 The Morgan aerial surveys have been undertaken by APEM. APEM used a grid-based collection method in which imagery of 30% of the sea surface was collected, and data from at least 12% of the Morgan Aerial Survey Area were analysed. A summary of coverage for each monthly survey is presented in Table A.1. For context, it has been suggested baseline studies should collect a minimum of 10% coverage (BSH, 2013), noting that the BSH study was based on transect-based surveys, and it has been suggested that due to the high number of replicates achieved from grid-based surveys this method requires less coverage compared to transect-based surveys (Coppack *et al.,* 2017; Weidauer *et al.,* 2016). APEM utilised a bespoke camera system fitted into a twin-engine aircraft and custom flight planning software allowed each flight line to be accurately mapped for use before and during the flight.

A.2.2.1.2 The camera system captured abutting still imagery along 18 parallel survey lines spaced approximately 2 km apart. The aircraft collected the data at an altitude of approximately 1,300 ft (~400 m), and a speed of approximately 120 kn. The data collected were 1.5 cm Ground Sampling Distance (GSD) digital still images. Sea states are categorical values used to give an approximate but concise description of sea condition, as this will affect the probability of a sighting. Sea state conditions used in the aerial survey were 0 = Calm (Glassy), 1 = Calm (Rippled), 2 = Smooth, 3 = Slightly Moderate and 4 = Moderate.

A.2.2.1.3 All surveys were undertaken in weather conditions that did not compromise the ability to provide data on the identification, distribution and abundance of marine megafauna and were also safe to fly in. Favourable conditions for surveying are defined as a cloud base of >396 m, visibility of >5 km, wind speed of <30 kn and a sea state of no more than four (moderate).

A.2.2.1.4 Measures were taken to minimise glint and glare (strong reflected light off the sea), that makes finding and identifying marine megafauna more difficult. On days with minimal cloud, surveys were avoided for two hours around midday. This reduced the risk of collecting images that are difficult to analyse. Due to weather constraints some surveys were undertaken over more than one day; where this was the case, the survey was undertaken at the very next opportunity. In other surveys two flights were needed to cover the survey area whilst avoiding non-optimal sun angle.

A.2.3 Processing of aerial data

A.2.3.1.1 The images were analysed to enumerate marine mammals. Internal Quality Assurance (QA) was undertaken to check for missed targets and to ensure that species were correctly identified. Marine mammals identified from the images were located within the images and categorised to the lowest taxonomic level possible.

A.2.3.1.2 The analysis was undertaken by senior image analysts with at least two years of full-time experience. Image analysts receive ongoing identification training from APEM's QA Manager and have access to a regularly updated in-house image archive reference library to aid in the identification of marine mammals. As part of the image analysis process the size of individuals can also be measured, which can aid in species-level identification. Images are always reviewed by a minimum of two staff members as part of a comprehensive internal QA process. APEM have included their Senior Marine Mammal Consultant and Principal Marine Mammal Consultant in the QA process of all images, holding a minimum of five years' experience at identifying marine mammals to species level nationally and internationally.

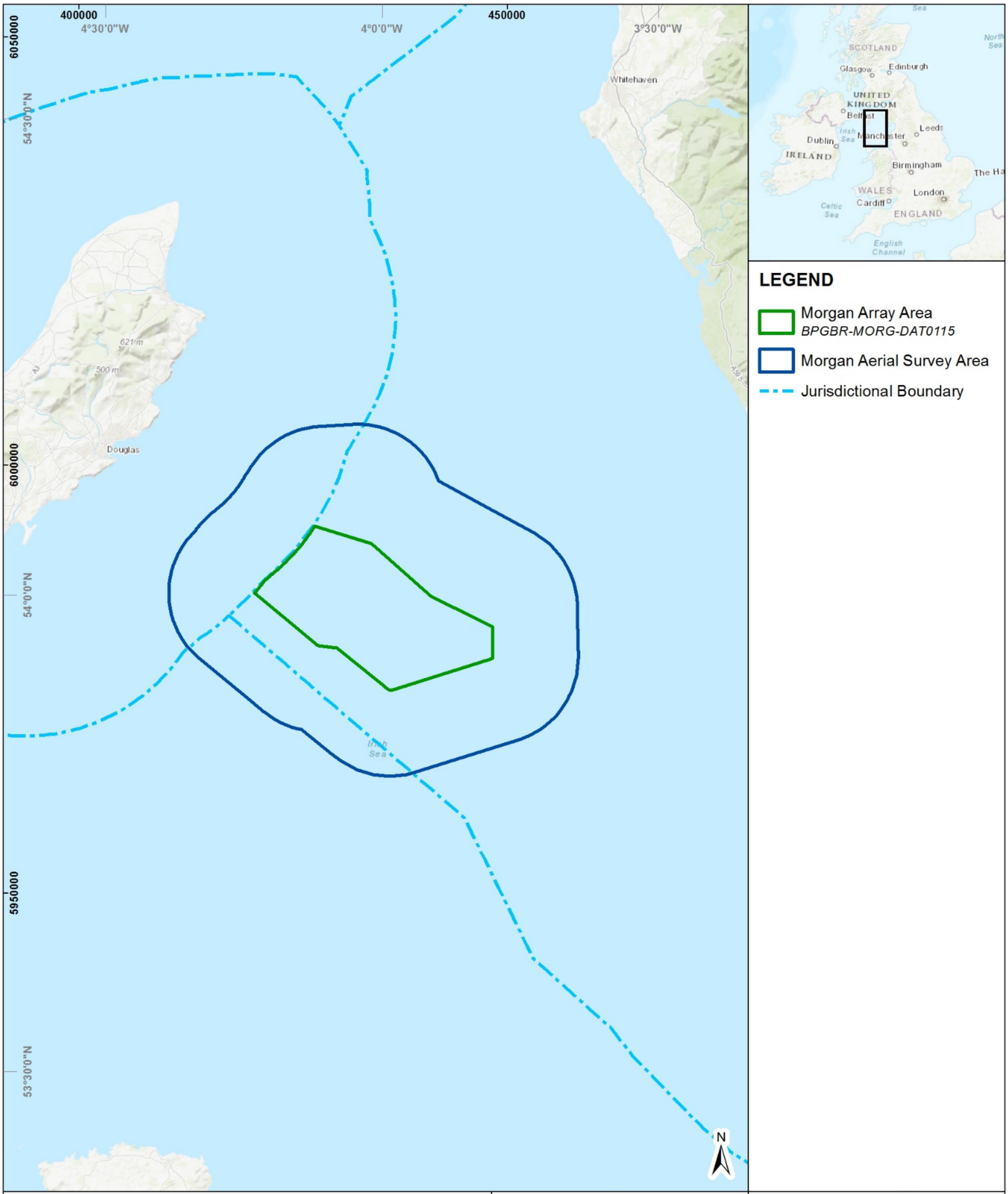
A.2.3.1.3 APEM's marine mammal consultancy team includes:

- Helen Hedworth: Principal Marine Mammal Consultant, with experience of environmental impact assessment coordination, and marine mammal and noise monitoring and mitigation for offshore and coastal development projects
- Dr Ross Culloch: Technical Specialist, Ross joined APEM at the end of February 2022 from Marine Scotland Science, bringing a wealth of expertise in the field of marine mammal ecology, conservation and management

- Ashleigh Kitchiner: a Senior Marine Mammal Consultant with a comprehensive knowledge of marine mammal ecology and six years of experience in providing services from survey design and execution to post-processing analysis.

A.2.3.1.4 APEM uses the precautionary principle and only identify species to a level they are 100% confident with. Accurate identification is based upon species level ID; and if a target cannot be identified to species level it is assigned to the next taxonomic level possible.

A.2.3.1.5 Summary statistics (monthly sightings, monthly mean density and group size) were produced to describe the data for each of the key species or species groups within the aerial survey dataset.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, MMO

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 2.5 5 10 nm
0 5 10 20 km

Drawing Number:
RPSE-MG-ES-MAM-001-00

Drawing Title:
MORGAN MARINE MAMMAL AERIAL SURVEY AREA

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.1: Morgan marine mammal Aerial Survey Area.

A.2.4 Density estimates with bootstrapping

A.2.4.1.1 Statistically robust, design-based baseline population estimates for marine mammals identified in the Morgan Aerial Survey Area were calculated. For each aerial digital survey, species-specific abundances and density estimates for the Morgan Aerial Survey Area were produced, with upper and lower confidence limits and precision estimates in the form of a Coefficient of Variation (CV). The input data comprised of geo-referenced locations of marine mammals contained within each individual digital still image, which were used to generate the raw counts for the analysis. Only individuals located within the Morgan Aerial Survey Area (the Morgan Array Area and buffer) were used to calculate the population estimates.

A.2.4.1.2 Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. The statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% confidence intervals of these 999 values taken as the variability of the statistic over the population (Tibshirani and Efron, 1993). Measures of precision were calculated using a negative binomial estimator, suitable for a pseudo-Poisson over-dispersed distribution (Elliott, 1977). This produced a poisson CV labelled 'Precision' in APEM reporting, based on the relationship of the Standard Error (SE) to the mean. A target precision of ≤ 0.16 allows the detection of a population change of a factor as small as two (Bohlin, 1990).

A.2.4.1.3 For marine mammals however, it is unlikely that low CVs would be obtainable. It is not always possible to achieve the 0.16 target precision on species with lower abundances, as the calculation uses both the sample number and encounter rate. To get a sufficient sample size for cryptic species, in particular species that spend the majority of their life underwater such as cetaceans, a high level of survey effort would be required. CVs will be higher for marine mammals, due to very low sighting numbers given their life history, so the difference between raw counts would be proportionally greater. Literature has highlighted CVs for marine mammal abundances can be large (Taylor *et al*., 2007), and detecting population trends is difficult due to small sample size and relatively large uncertainty in abundance or density estimates (Authier *et al*., 2020). Expert groups (International Council for the Exploration of the Seas (ICES), 2008; 2014; 2016) have discussed this at length, but statistical power to detect change remained low (ICES, 2016; OSPAR, 2017). Furthermore, there will be big differences between species and months due to abundance and distribution within the Morgan Aerial Survey Area. As discussed in A.2.5.1.2, for density modelling, where possible species categories were grouped to give higher sample numbers to improve power and CVs and provide more conservative estimates of density.

A.2.4.1.4 All analysis and data manipulation were conducted in the R programming language (R Development Core Team, 2022) and non-parametric 95% confidence intervals were generated using the 'boot' library of functions (Canty and Ripley, 2021).

A.2.4.1.5 Raw counts, abundance, confidence limits and precision (Poisson CV) were provided monthly (where animals were present) for each species for the Morgan Aerial Survey Area.

A.2.5 Model-based density estimates

A.2.5.1.1 For the Morgan Aerial Survey Area data were imported into R statistical software v4.2.0 (R Core Team, 2022), and the MRSea package v1.3.1 (Scott-Hayward *et al*.,

2013) was used in the analysis to best predict the density of marine mammals within the Morgan Aerial Survey Area.

A.2.5.1.2 When carrying out density estimates, based on the frequency of occurrence of known species across the Morgan Aerial Survey Area, unidentified seal species were considered most likely to be grey seal and as such were grouped together. Whilst unidentified seals were assigned to grey seal, it is noted that this does not discount the possibility that unidentified seal species may have been harbour seal.

A.2.5.1.3 Months were initially modelled separately; however this approach was not found to be robust due to data being too sparse to fit MRSea models. Next data were explored by pooling across months within the meteorological seasons (winter: December, January, February; spring: March, April, May; summer: June, July, August; and autumn: September, October, November) to overcome this issue, incorporating the biological assumption that species behave similarly within each season. Again, data pooled by meteorological season also proved too sparse for robust analysis. Finally, data were pooled into two ‘bio-seasons’ according to species, (discussed in detail in the paragraphs A.3.6.1.1, and A.3.6.1.2, in the relevant species modelling accounts) and this proved to be the most statistically robust approach. For completeness, however, the results of all three modelled approaches have been presented in this report.

A.2.5.1.4 The following covariates were used within all modelling to predict species distribution:

- Bathymetry (depth and ruggedness)
- Distance to coast
- Latitude and longitude
- Season.

A.2.5.1.5 The degree of smoothing for each species and season was determined within the MRSea software using tenfold cross validation and a range of different models were explored to determine the best model to predict species distribution. Within each of the exploratory models, separate maps with associated 95% lower and upper confidence intervals were also produced for each species and season.

A.2.5.1.6 Before any analyses could take place, the data had to be pre-processed to ensure no survey date/time data were missing from image identifiers, which would prevent accurate assignment and cross-referencing of observations. There were no occurrences of missing information and no data required removing from subsequent analysis.

A.2.5.1.7 In total, for the Morgan Aerial Survey Area, 432 survey transects were used in the analysis (18 flight lines, for 24 months) covering a total survey area of 4,289.20 km^2 and incorporating 21,865 images (mean 0.20 km^2 (SD = 0.05) coverage per image.

A.2.6 Data limitations

A.2.6.1 Snap-shot data

A.2.6.1.1 Aerial survey data represent a snapshot of marine mammal distribution and densities within a given survey month and may not fully capture the natural variability of marine mammal distribution or densities over time. Changes in sightings rates may be influenced by environmental conditions; however, due to the short time frames (single day) of data collection, this has not been possible to analyse. Therefore, whilst differences in sightings rates between months may be due to seasonal changes, environmental conditions also have the potential to influence these results.

A.2.6.2 Bias

A.2.6.2.1 Availability bias - an estimator of the probability that an animal is available at any randomly chosen time – is used as multiplier to account for the period of time that each species may be available for detection. In the case of aerial digital surveys, the time when an animal is available for detection is during the period that an animal is on the sea surface or just below the surface.

A.2.6.2.2 Availability bias is likely to be influenced by extrinsic factors that combine to produce a situation that is unique to each survey: factors such as light conditions, water clarity (turbidity), and animal behaviour can influence whether an animal will be detected, particularly those beneath the water surface. In most cases (section A.3.2.2), animals were noted and identified from digital images where the animal is under the sea surface. The depth at which reliable interpretation of images is assured will therefore rely considerably on the factors mentioned and for this reason availability bias may differ from month to month.

A.2.6.2.3 Estimates of availability bias during aerial surveys are often based on studies looking at diving behaviour of a species, which provide a correction factor for the proportion of time that animals are under the sea surface and therefore not available for detection. For the purpose of this assessment, correction factors were derived from studies in the Baltic and North Seas. The caveat here is that species correction factors are unlikely to be a true representation of availability bias from one region to another, or from one month to the next, due to the potential spatial and temporal differences in environmental conditions. However, a precautionary approach was taken by reviewing the literature to compare correction factors from different studies and different months and then applying a conservative estimate (see section A.3.5.1.7 and A.3.5.1.12).

A.2.6.2.4 Perception bias – where an animal is available for detection, but the detection is missed – is less of a limiting factor during digital aerial surveys compared to visual boat-based surveys since the high-definition video utilised during digital aerial surveys captures all animals on the sea surface, or just under the sea surface, and the detection is not influenced by the ability of an observer to detect an animal. In addition, during data processing, a 20% subsample of the data were quality assured to ensure that images were not overlooked and therefore the potential for perception bias is negligible.

A.2.6.2.5 Similarly, response bias, where an animal may respond to the presence of the platform (either moving towards or away from the platform), is considered to be less of a limiting factor for aerial surveys compared to boat-based surveys. Therefore, the potential for response bias is negligible.

A.2.6.3 Species identification

A.2.6.3.1 Animals were identified first to a species group (e.g. seals) and then to species level where possible (for example grey seal or harbour seal). For seals, the identification to species level is more difficult as it is not always possible to distinguish between species where an individual is submerged. A subsample of data was subject to an external QA process by a third-party marine mammal expert to ensure agreement in identification. Where a full species identification could not be made, rather than discarding data, where possible the animal sighting was assigned to a species based on the representation of the key species within the Morgan Aerial Survey Area.

A.3. Results

A.3.1 Summary data

A.3.1.1 Survey descriptions

A.3.1.1.1 Coverage was evenly spaced over the survey areas (as discussed in A.2.1.1.2) and is presented in Figure A.2. A summary of monthly survey coverage is presented in Table A.1.

A.3.1.1.2 This provided consistent spatial coverage of the Morgan Aerial Survey Area monthly for two years (April 2021 to March 2023), which spanned seasonal breeding seasons for marine mammals (such as harbour porpoise (bio-seasons used described in A.3.6.1.11) and grey seal (bio-seasons used described in A.3.6.1.24)).

A.3.1.1.3 A summary of the survey dates and conditions during surveys of the Morgan Array Area is given in Table A.2. Of the 24 surveys, 16 were conducted in sea states of 1 or less and visibility was at least 10 km in all surveys. No surveys were postponed into later months, although one survey (01 August 2022) was aborted due to low cloud and repeated within one week (06 August 2022), and one survey (March 2023) was conducted across two consecutive days.

Table A.1: Monthly survey effort across the Morgan Aerial Survey Area.

Survey no.	Survey month	Survey coverage (km^2)	Survey coverage (% Morgan Aerial Survey Area)
1	April 2021	178.99	12.99
2	May 2021	177.73	12.90
3	June 2021	177.95	12.91
4	July 2021	179.56	13.03
5	August 2021	175.60	12.74
6	September 2021	177.54	12.88
7	October 2021	181.28	13.16
8	November 2021	177.25	12.86
9	December 2021	174.34	12.65
10	January 2021	178.52	12.95
11	February 2022	178.68	12.97
12	February 2022	179.09	13.00
13	April 2022	177.86	12.91
14	May 2022	178.16	12.93
15	June 2022	178.53	12.96
16	August 2022	177.83	12.91
17	July 2022	178.92	12.98

Survey no.	Survey month	Survey coverage (km^2)	Survey coverage (% Morgan Aerial Survey Area)
18	September 2022	195.53	14.19
19	October 2022	177.89	12.91
20	November 2022	177.63	12.89
21	December 2022	179.91	13.06
22	January 2023	177.10	12.85
23	February 2023	178.87	12.98
24	March 2023	174.41	12.66

Table A.2: Survey dates and conditions during surveys for Morgan Aerial Survey Area.

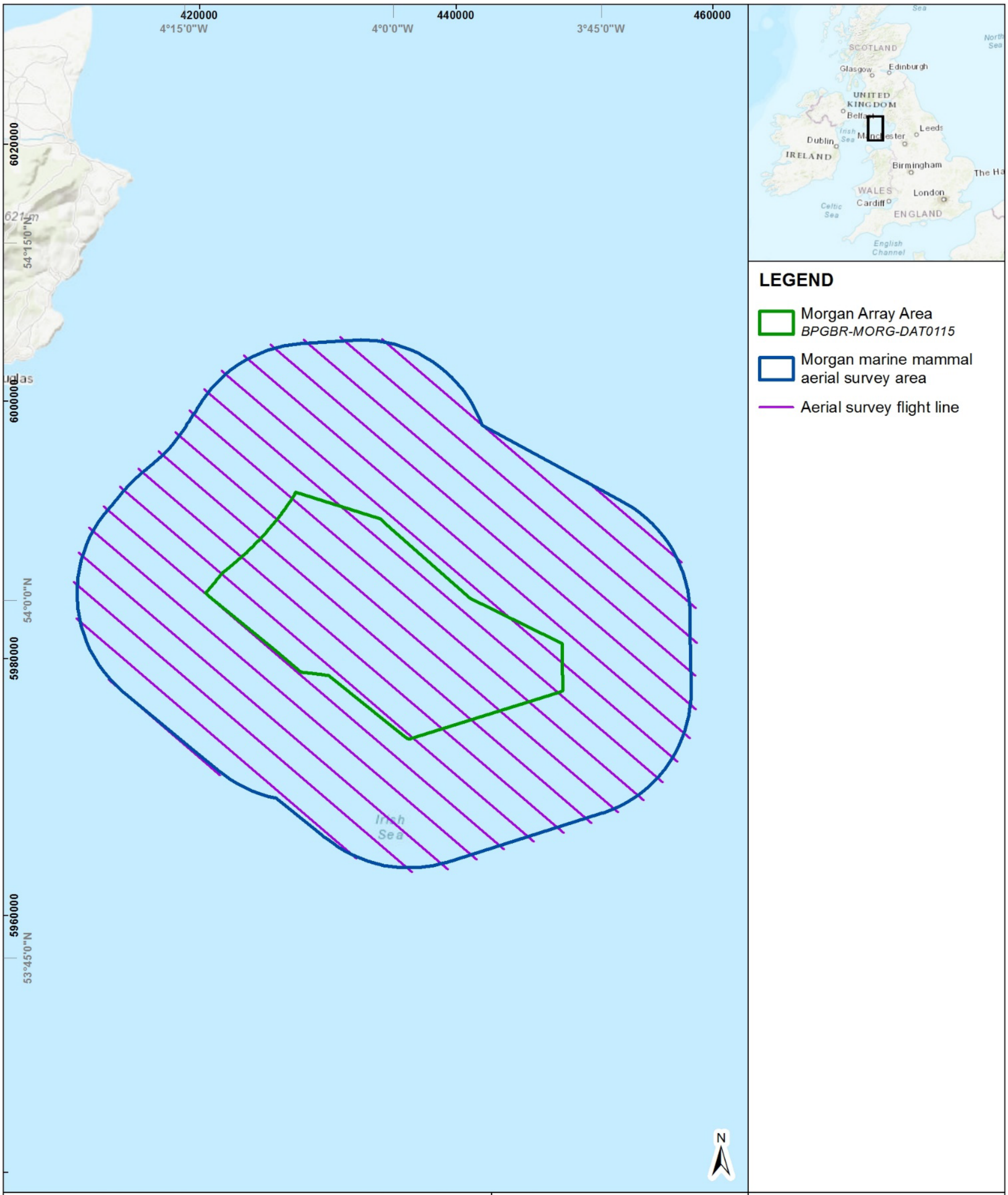
1 Sea state categories: 0 = Calm (Glassy), 1 = Calm (Rippled), 2 = Smooth, 3 = Slightly Moderate, 4 = Moderate

2 Turbidity categories: 0 = Clear, 1 = Slightly Turbid, 2 = Moderately Turbid, 3 = Highly Turbid

3 Cloud cover coverage categories: 0 = Clear, 1 – 10 = Few, 11 – 50 = Scattered, 51 – 95 = Broken, 96 – 100 = Overcast

Survey no.	Month	Date	Visibility (km)	Sea state[1]	Glint/Glare (%)	Turbidity[2]	Cloud cover (%)[3]	Air Temp (°C)	Wind speed (knots)	Wind direction
1	April 2021	17/04/2021	10+	1	0	0	0 - 95	6	5	N
2	May 2021	05/05/2021	10+	0	0	1	30 - 60	4	10 - 16	N
3	June 2021	03/06/2021	10+	1	0	1	50 - 60	10 - 11	9 - 22	S - WSW
4	July 2021	05/07/2021	10+	2	5	1	20 - 40	12	18	SW
5	August 2021	24/08/2021	10+	2	0 - 25	2	25	15	10	SE
6	September 2021	08/09/2021	10+	1 - 2	0 - 30	0 - 1	50 - 80	23 - 25	20 - 25	SE
7	October 2021	10/10/2021	10+	1	0 - 15	0 - 1	25 - 96	12	15	NW
8	November 2021	04/11/2021	15+	3	0 - 15	2	75 - 80	6	14 - 17	N
9	December 2021	02/12/2021	10+	1 - 2	0 - 10	2	10 - 40	4 - 5	15	NW
10	January 2021	11/01/2021	15+	3	0 - 10	3	30 - 99	6 - 7	8 - 16	SW - W
11	February 2022	27/02/2022	10+	2	0 - 30	1	0	4 - 5	17 - 32	SSE
12	March 2022	12/03/2022	10+	1 - 2	0	1 - 2	20	5 - 7	7 - 18	S
13	April 2022	01/04/2022	30+	1 - 2	0	0 - 1	0	1	14 - 21	NE
14	May 2022	07/05/2022	10+	1	20 - 40	2	25 - 50	9	3 - 8	N
15	June 2022	02/06/2022	10+	1	0 - 30	0	40 - 90	11 - 12	4 - 7	SSE
16	July 2022	02/07/2022	10+	2	0 - 40	1	75	10	16	W
17	August 2022	06/08/2022	20+	3	3 - 12	2 - 3	30 - 35	11 - 12	9 - 12	WSW - WNW
18	September 2022	04/09/2022	10+	1	5	1	10 - 20	14 - 17	8 - 15	SSE - S
19	October 2022	02/10/2022	10+	1 - 2	5 - 10	1 - 2	10 - 50	11	14 - 15	W

Survey no.	Month	Date	Visibility (km)	Sea state[1]	Glint/Glare (%)	Turbidity[2]	Cloud cover (%)[3]	Air Temp (°C)	Wind speed (knots)	Wind direction
20	November 2022	12/11/2022	10+	1 - 3	5 - 15	2	30 - 50	10 - 11	7 - 15	E - SE
21	December 2022	17/12/2022	20+	2	0 - 5	1	20	1	15	W
22	January 2023	20/01/2023	25	1	0	1	20 - 70	0	4 - 6	NW
23	February 2023	05/02/2023	15	2	0 - 10	2	85 - 95	4 - 6	11 - 23	S
24	March 2023	04/03/2023	10+	1	0	1	90	1 - 2	4 - 12	N - NE
		05/03/2023	10+	1	0	1	80	4	15	NNW



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client,

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 2.5 5 nm
0 5 10 km

Drawing Number:
RPSE-MG-ES-MAM-052-00

Drawing Title:
MORGAN MARINE MAMMAL AERIAL SURVEY FLIGHT LINES

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:500,000

VER	DATE	DETAILS	BY	CHECK
00	25/08/23	First Issue	NA	AR

Figure A.2: Aerial survey flight lines for the Morgan Aerial Survey Area.

A.3.1.2 Counts by species

A.3.1.2.1 Marine mammal counts are presented in Figure A.3 and Table A.3. Harbour porpoise accounted for the highest number of sightings identified to species level (based on raw count data) across the Morgan Aerial Survey Area and was recorded in all survey months to date (Table A.3). Highest encounters were in August 2021 with a total of 36 harbour porpoise.

A.3.1.2.2 Grey seal accounted for the second highest number of individuals identified to species level (n = 34) but was not recorded in eight out of 24 surveys. The only other marine mammals identified to species level were nine bottlenose dolphins, observed only once, in June 2021 as a group of eight and one separate individual, and short-beaked common dolphin, observed in July 2022, September 2022 and October 2022 (Table A.3). Risso's dolphin and harbour seal have not been included in Table A.3 as no individuals were encountered during the 24 months of surveying.

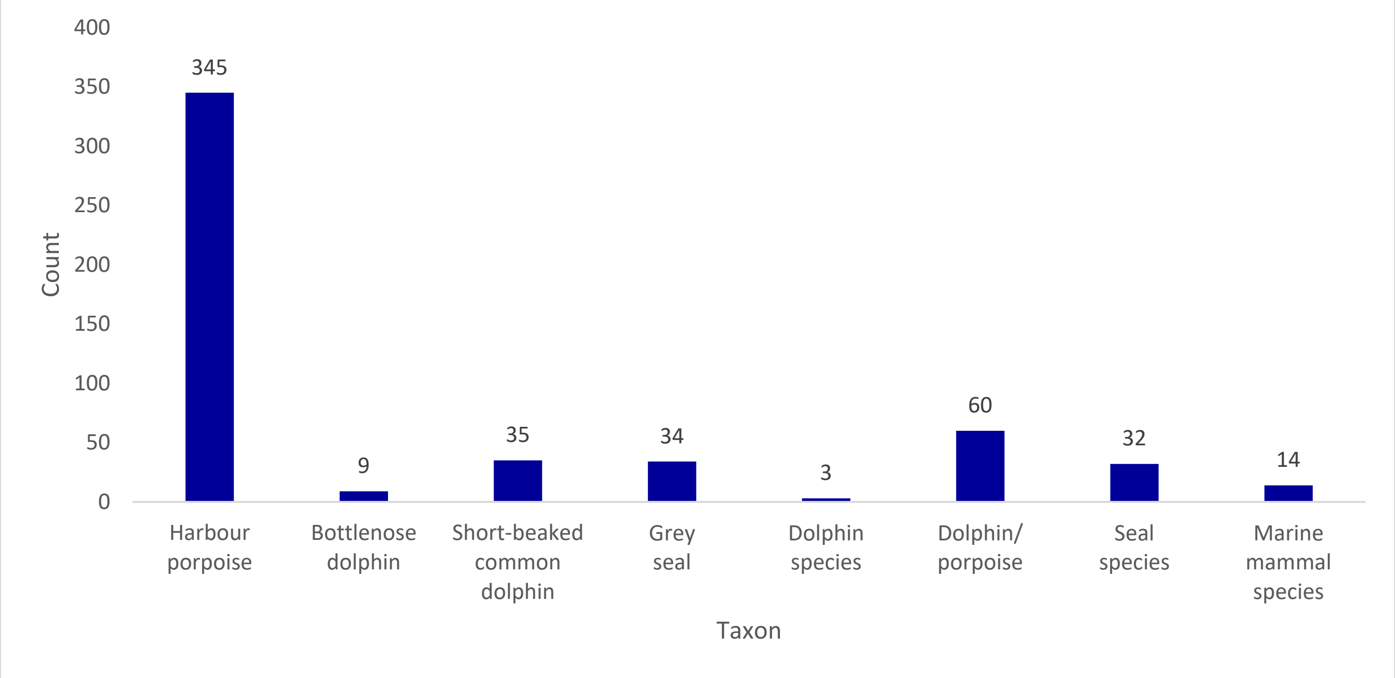


Figure A.3: Marine mammal sightings classified by label, in the Morgan Aerial Survey Area. Species names are 'definite' confidence sightings.

A.3.1.2.3 There were also 63 cetacean sightings ('dolphin species', 'dolphin/porpoise') that could not be assigned to species level. Frequency of sightings was low for 'dolphin species', occurring only in September 2021 and May 2022, whereas 'dolphin/porpoise' were encountered during seven surveys in the first year of surveying, and five surveys in the second year. Similarly, there were 32 animals classified as 'seal species' due to the difficulty of identifying to species level from aerial survey data.

A.3.1.2.4 Sightings data were such that further analyses could only be reliably undertaken for grey seal and harbour porpoise since counts of other species were too low to generate density estimates. Therefore, a conservative approach was undertaken for the analyses to include data where species sightings were given at a higher taxonomic level (i.e. could not be identified to species level). This ensured that data would not be 'thrown out' where it could be assigned and would also increase the sample size in the analyses. Thus, those animals identified as ‘seal species’ were assigned to grey seal as this was the most commonly occurring seal species across the Morgan Aerial Survey Area. Similarly, whilst harbour porpoise was analysed initially just using sightings identified to the harbour porpoise species level, this species was also grouped together with animals identified as ‘dolphin/porpoise’ in a category called ‘porpoise species’.

A.3.1.2.5 There were 14 animals that were classified as ‘marine mammal species’ which could not be identified down to species level. Given the uncertainty in identifying the species of these animals, and the low rate of incidence, all ‘marine mammal species’ were excluded from subsequent analysis.

Table A.3: Monthly raw sightings data (number of animals) across the Morgan Aerial Survey Area.

Survey no.	Month survey	Date	Species level identification				Non-species level identification				Total
			Harbour porpoise	Bottlenose dolphin	Short-beaked common dolphin	Grey seal	Dolphin species	Dolphin/ Porpoise	Seal species	Marine mammal species	
1	April 2021	17/04/2021	20			2		10	1	1	**34**
2	May 2021	05/05/2021	8			1		4		1	**14**
3	June 2021	03/06/2021	26	9		1		7	2		**42**
4	July 2021	05/07/2021	11			1		6	2		**20**
5	August 2021	24/08/2021	36			2					**38**
6	September 2021	08/09/2021	11			1	1	7	2		**22**
7	October 2021	10/10/2021	13					1	2		**16**
8	November 2021	04/11/2021	6								**6**
9	December 2021	02/12/2021	3			1					**4**
10	January 2021	11/01/2021	14			1		6		2	**23**
11	February 2022	27/02/2022	16			1					**17**
12	March 2022	12/03/2022	14			2			2	2	**20**
13	April 2022	01/04/2022	11			6		2	1	1	**21**
14	May 2022	07/05/2022	21				2		3		**26**
15	June 2022	02/06/2022	10							1	**11**
16	July 2022	02/07/2022	13		8			3		1	**25**
17	August 2022	06/08/2022	10								**10**
18	September 2022	04/09/2022	24		12	1			2	1	**40**
19	October 2022	02/10/2022	9		15				5		**29**

Survey no.	Month survey	Date	Species level identification				Non-species level identification				Total
			Harbour porpoise	Bottlenose dolphin	Short-beaked common dolphin	Grey seal	Dolphin species	Dolphin/ Porpoise	Seal species	Marine mammal species	
20	November 2022	12/11/2022	2			1			1		**4**
21	December 2022	17/12/2022	6						2	2	**10**
22	January 2023	20/01/2023	29			6		1	3	1	**40**
23	February 2023	05/02/2023	5			4		2	1		**12**
24	March 2023	04/03/2023	27			3		11	3	1	**25**
		05/03/2023									
Total			**345**	**9**	**35**	**34**	**3**	**60**	**32**	**14**	**509**

A.3.2 Group size

A.3.2.1.1 Group size was calculated using source image files. Any image that had more than one animal in it was deemed a group, as they occur within a close enough vicinity to each other. Average group size was given per month, alongside minimum and maximum group sizes and 95% confidence intervals (CI) for species and for those non-species-specific groupings (Table A.4; Table A.5). Note that 95% CIs could not be calculated in cases where only one group, or no groups, of a species were observed.

A.3.2.1.2 The overall mean group size for harbour porpoise was 2.18 animals, with a maximum of five animals and a minimum group size of two animals. For bottlenose dolphin, since only one group was observed the mean, minimum and maximum group size was eight animals.

A.3.2.1.3 Whilst grey seal were observed in 16 out of 24 survey months, all animals were observed as single individuals, and were therefore not considered to be a group. No harbour seal or Risso's dolphin were observed across the 24-month survey period.

Table A.4: Monthly mean, minimum and maximum group sizes for species sightings, with 95% CIs, across the Morgan Aerial Survey Area.

	Harbour porpoise			Bottlenose dolphin			Short-beaked common dolphin			Grey seal		
Month	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
January	2.75	2	5	-	-	-	-	-	-	-	-	-
February	2.00	2	2	-	-	-	-	-	-	-	-	-
March	2.00	2	2	-	-	-	-	-	-	-	-	-
April	2.00	2	2	-	-	-	-	-	-	-	-	-
May	2.00	2	2	-	-	-	-	-	-	-	-	-
June	2.00	2	2	8.00	8	8	2.00	2	2	-	-	-
July	2.75	2	4	-	-	-	-	-	-	-	-	-
August	2.09	2	3	-	-	-	-	-	-	-	-	-
September	2.29	2	3	-	-	-	12.00	12	12	-	-	-
October	2.14	2	3	-	-	-	7.50	4	11	-	-	-
November	2.00	2	2	-	-	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**2.18**	**2.00**	**2.73**	**8.00**	**8**	**8**	**7.17**	**6.00**	**8.33**	**n/a**	**n/a**	**n/a**
95% CI (±)	**0.17**	**0.00**	**0.60**	**n/a**	**n/a**	**n/a**	**5.67**	**5.99**	**6.23**	**n/a**	**n/a**	**n/a**

Table A.5: Monthly mean, minimum and maximum group sizes for non-species-specific grouping sightings across the Morgan Aerial Survey Area.

	Dolphin species			Dolphin/Porpoise			Seal species			Marine mammal species		
Month	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
January	-	-	-	2.00	2	2	-	-	-	-	-	-
February	-	-	-	-	-	-	-	-	-	-	-	-
March	-	-	-	2.00	2	2	-	-	-	-	-	-
April	-	-	-	2.00	2	2	-	-	-	-	-	-
May	2.00	2	2	-	-	-	-	-	-	-	-	-
June	-	-	-	2.50	2	3	-	-	-	-	-	-
July	-	-	-	2.00	2	2	-	-	-	-	-	-
August	-	-	-	-	-	-	-	-	-	-	-	-
September	-	-	-	2.00	2	2	-	-	-	-	-	-
October	-	-	-	-	-	-	3.00	3	3	-	-	-
November	-	-	-	-	-	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-	-	-	-	-	-
Mean	**2.00**	**2**	**2**	**2.08**	**2.00**	**2.17**	**3.00**	**3**	**3**	**n/a**	**n/a**	**n/a**
95%CI	**n/a**	**n/a**	**n/a**	**0.08**	**0.00**	**0.17**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**

A.3.2.2 Surfacing and submerged behaviour

A.3.2.2.1 Only the June 2021 survey recorded no surfacing animals, whereas all other months recorded at least one animal at the surface (Figure A.4). In November 2021, December 2021 and February 2023, the number of sightings based on surfacing animals was equal to those for submerged animals. All other months had more submerged animals than surfacing animals. It is considered possible that as water clarity decreases (e.g. during winter months), the depth at which an animal is able to be detected would decrease and therefore the proportion of animals recorded when submerged would also decrease during those months. This appears broadly true here, as the proportion of animals detected while submerged does tend to decrease from September 2021 and September 2022. However, in January 2022 and December 2022 submerged animals comprised 87% and 88% of detections, respectively, so there is no clear evidence of distinct seasonal patterns in detection.

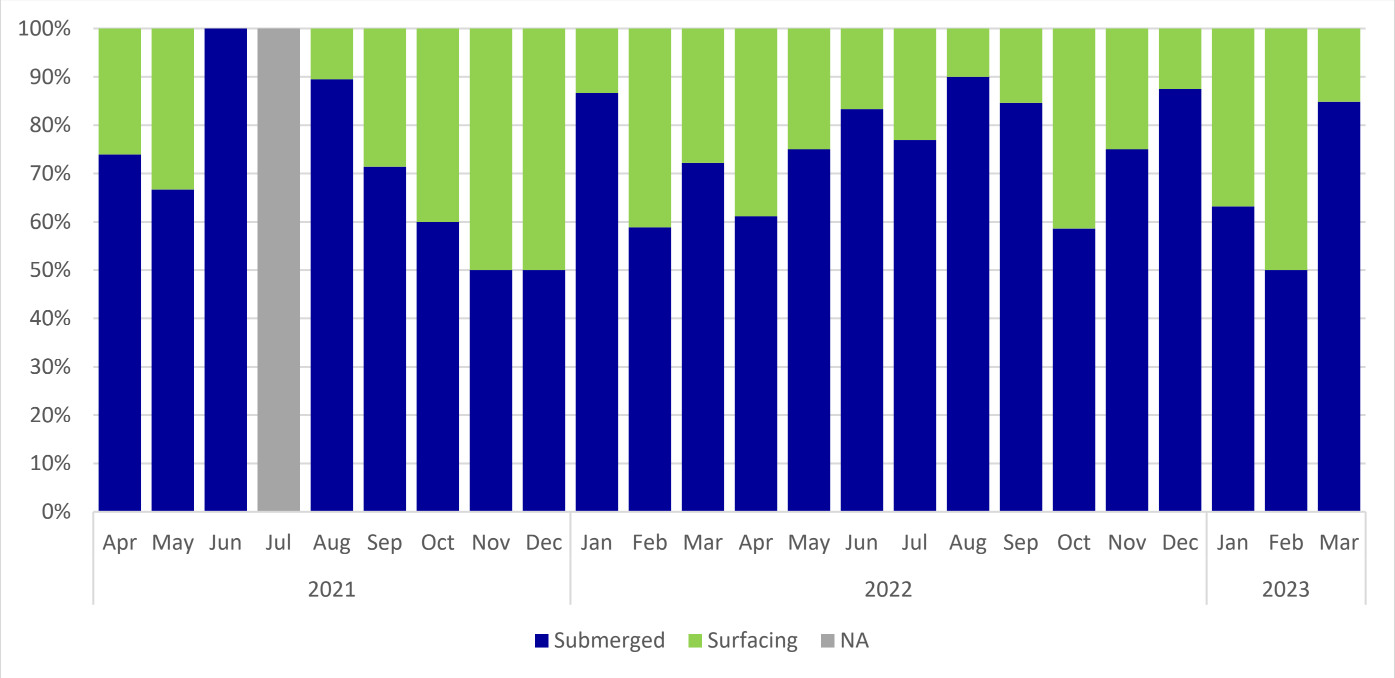


Figure A.4: Summary data showing surfacing categories by month combined across species observed in the Morgan Aerial Survey Area.

A.3.2.2.2 There were also inter-species differences noted in the surfacing categories for species identified to species level (Figure A.5). Bottlenose dolphin was only observed as submerged (but note that this is based on only two instances when this species was identified), with grey seal observed at the surface in 56% of observations. Harbour porpoise and Short-beaked common dolphin were sighted below the surface in 81% and 77% of sightings, respectively.

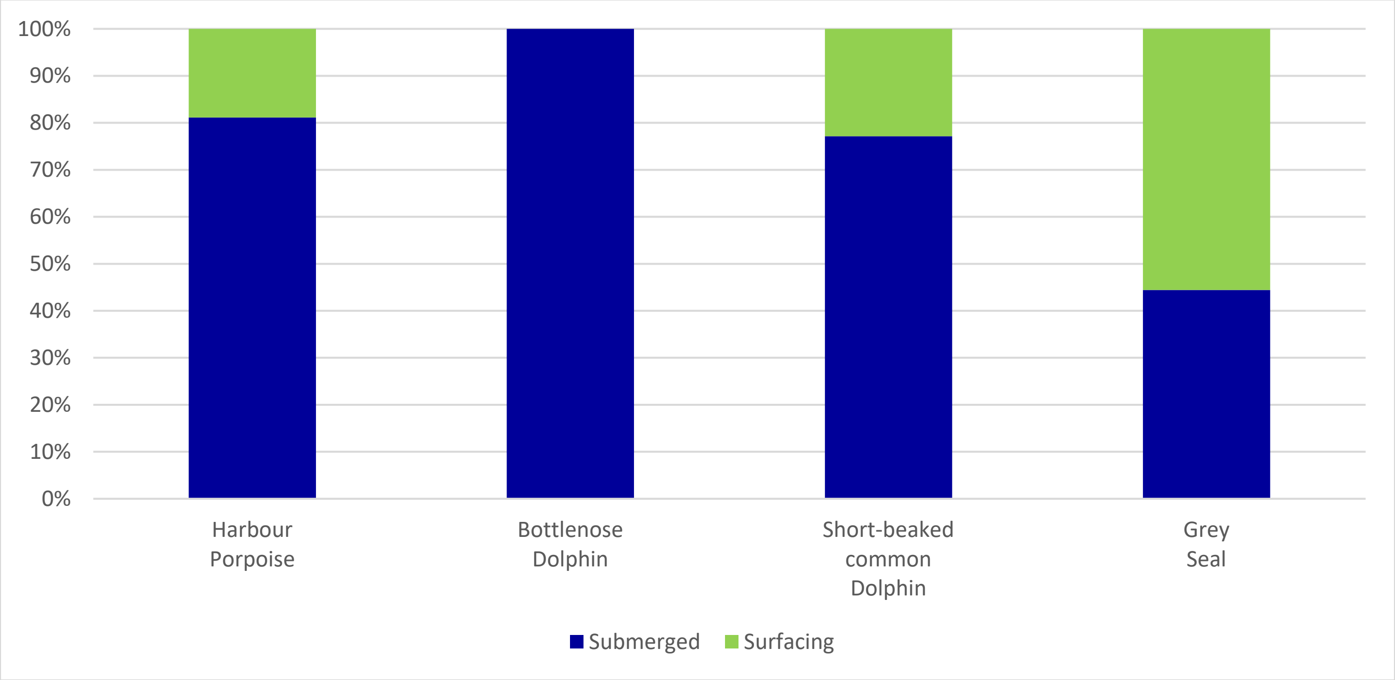


Figure A.5: **Summary data showing surfacing categories by species combined across months for Morgan Generation Assets surveys.**

A.3.3 Confidence assessment

A.3.3.1.1 Confidence in identification varied by species/species group for the Morgan aerial surveys. Where possible, high-confidence sightings were identified to species level, but where not possible they were assigned to other descriptive categories (Table A.3). Figure A.6 to Figure A.17 present the distribution of sightings of marine mammals in the Morgan Aerial Survey Area. A total of 34 animals were identified as grey seal, whilst a further 32 animals were identified as seal species (i.e. they could not be assigned to either grey seal or harbour seal and were instead labelled 'seal species').

A.3.3.1.2 For cetaceans, a total of nine bottlenose dolphin and 345 harbour porpoise were identified to species level, whilst a further three were labelled as 'dolphin species' and 60 identified as 'dolphin/porpoise' (i.e. could not be assigned to a species). Fourteen sightings could not be assigned to cetacean or seal and were assigned the label 'marine mammal species'.

A.3.4 Distribution of sightings

A.3.4.1.1 Sightings of marine mammals were spatially distributed throughout the Morgan Aerial Survey Area. Figure A.6 to Figure A.17 show the distribution of the sightings per survey month.

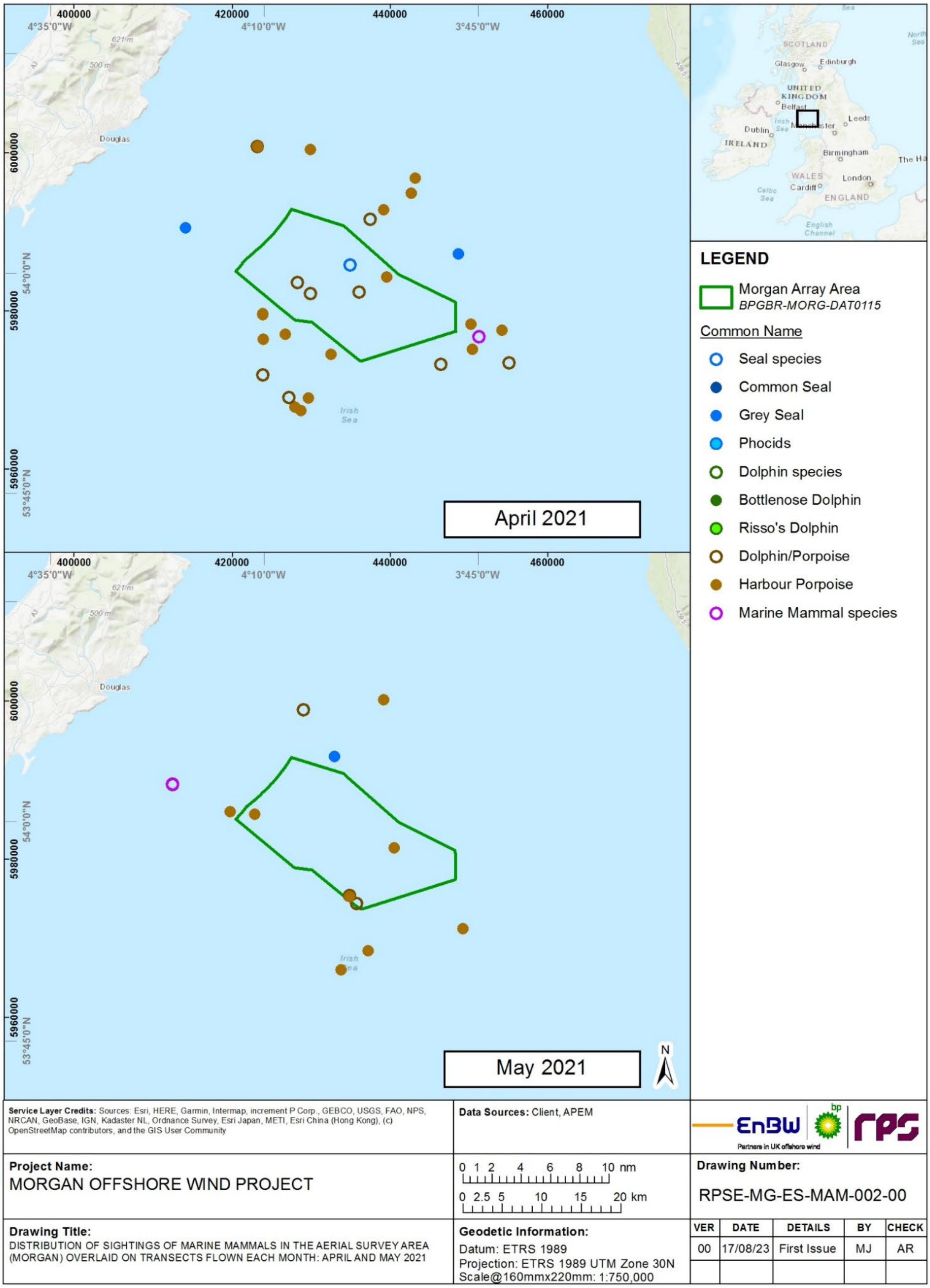
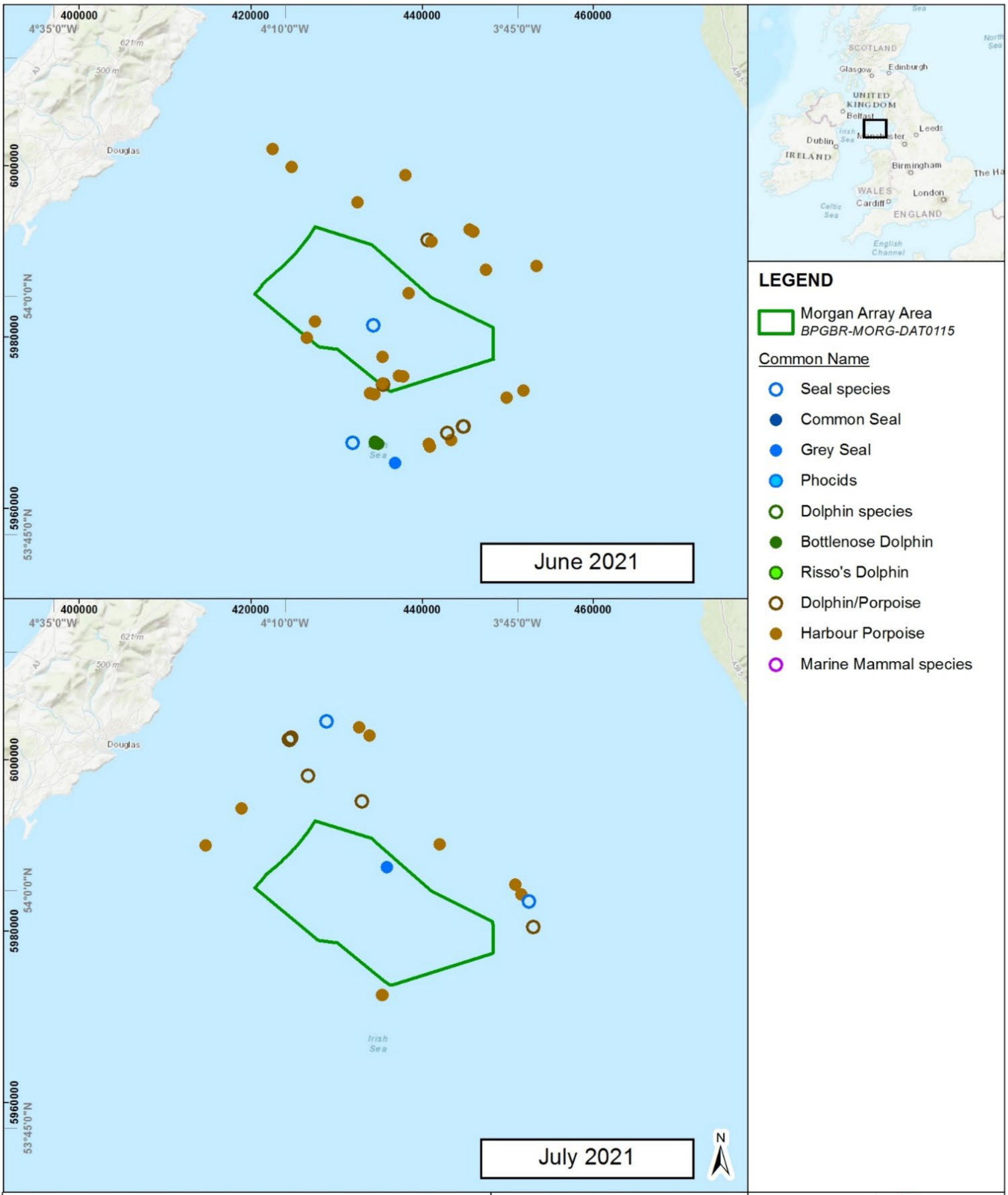


Figure A.6: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: April 2021 and July 2021.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

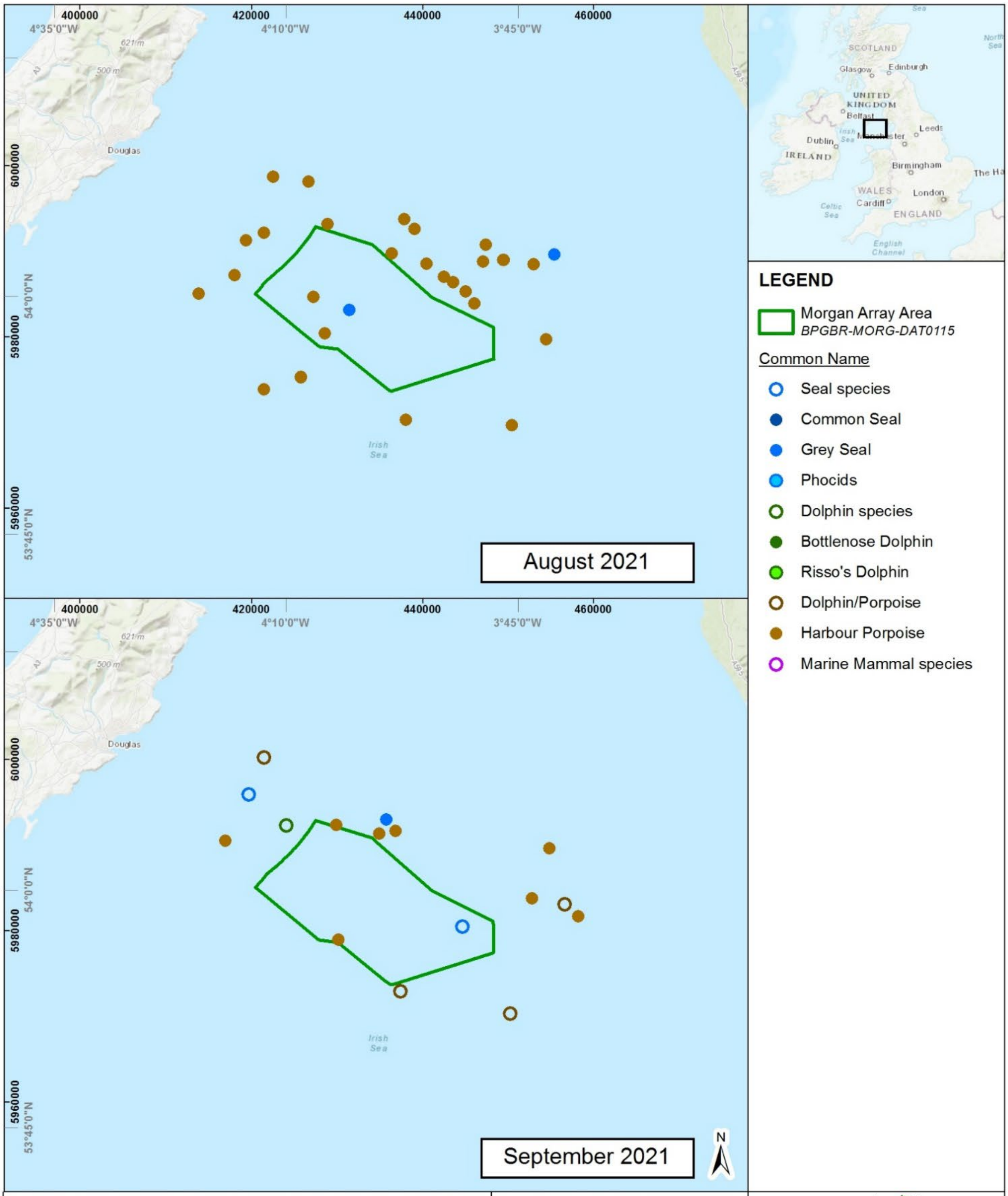
Drawing Number:
RPSE-MG-ES-MAM-003-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: JUNE AND JULY 2021

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.7: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: June 2021 and July 2021.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

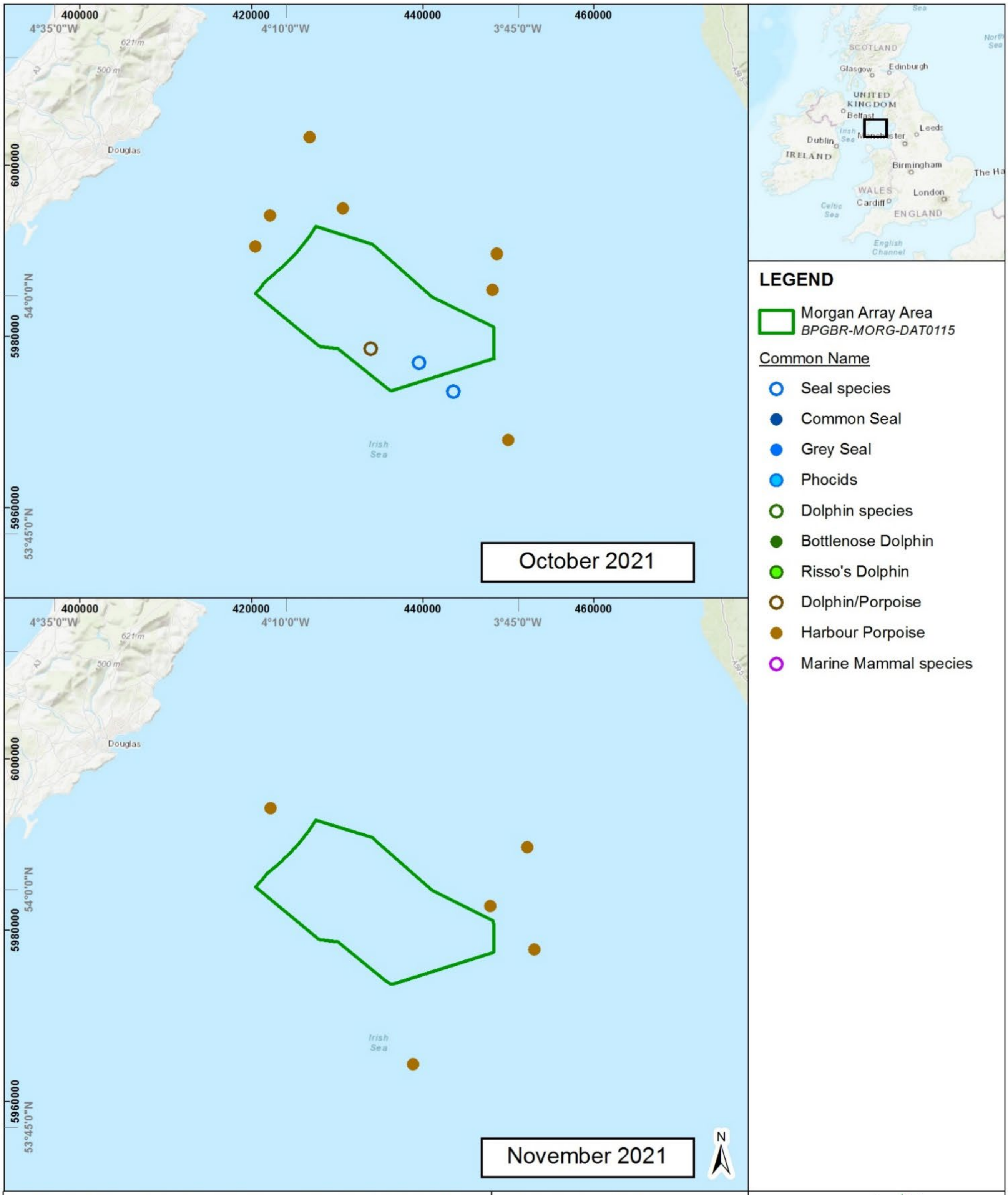
Drawing Number:
RPSE-MG-ES-MAM-004-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: AUGUST AND SEPTEMBER 2021

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.8: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: August 2021 and September 2021.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

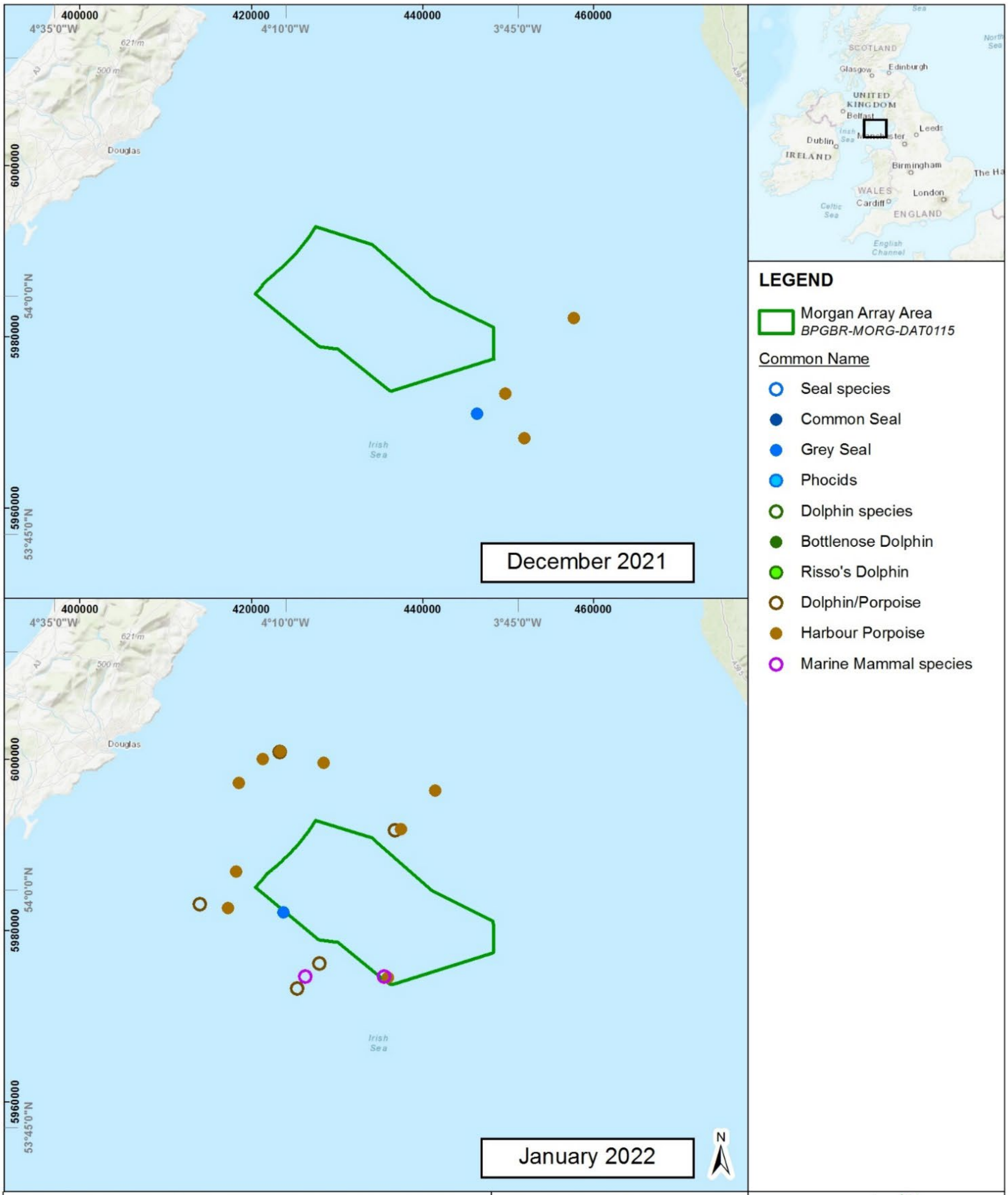
Drawing Number:
RPSE-MG-ES-MAM-005-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: OCTOBER AND NOVEMBER 2021

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.9: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: October 2021 and November 2021.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

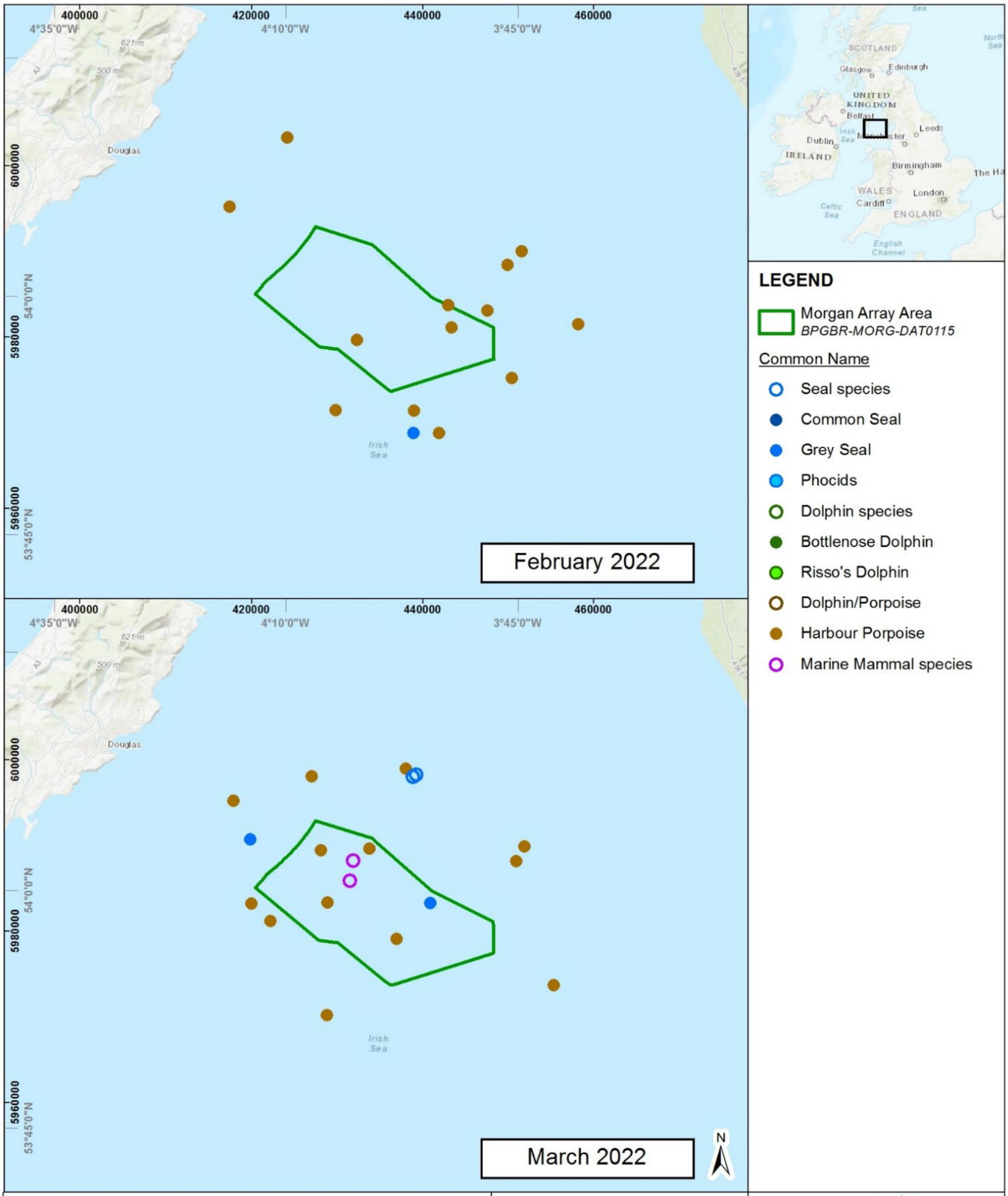
Drawing Number:
RPSE-MG-ES-MAM-006-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: DECEMBER 2021 AND JANUARY 2022

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.10: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: December 2021 and January 2022.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

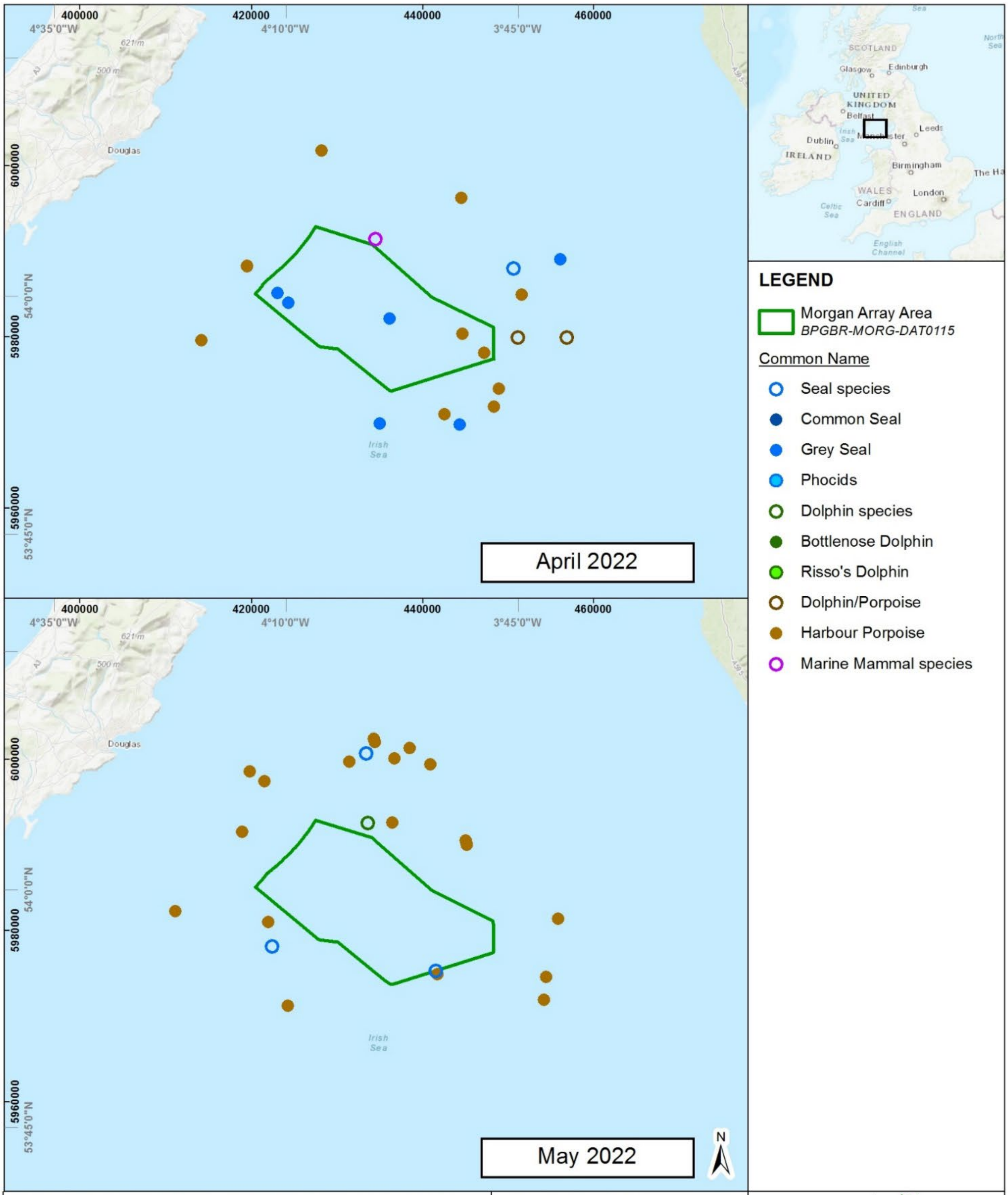
Drawing Number:
RPSE-MG-ES-MAM-007-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: FEBRUARY AND MARCH 2022

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.11: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: February 2022 and March 2022.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

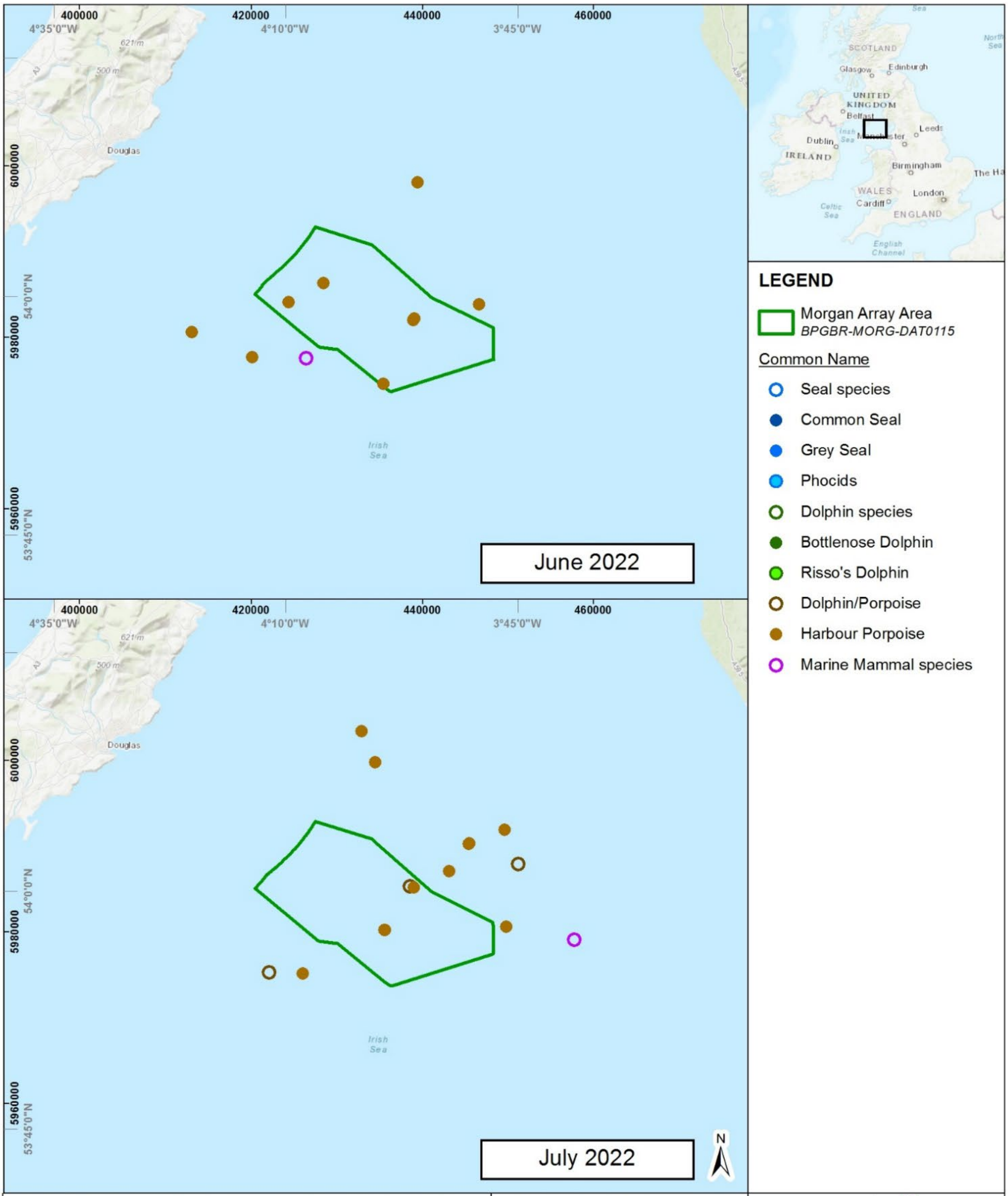
Drawing Number:
RPSE-MG-ES-MAM-008-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: APRIL AND MAY 2022

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.12: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: April 2022 and May 2022.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Partners in UK offshore wind

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

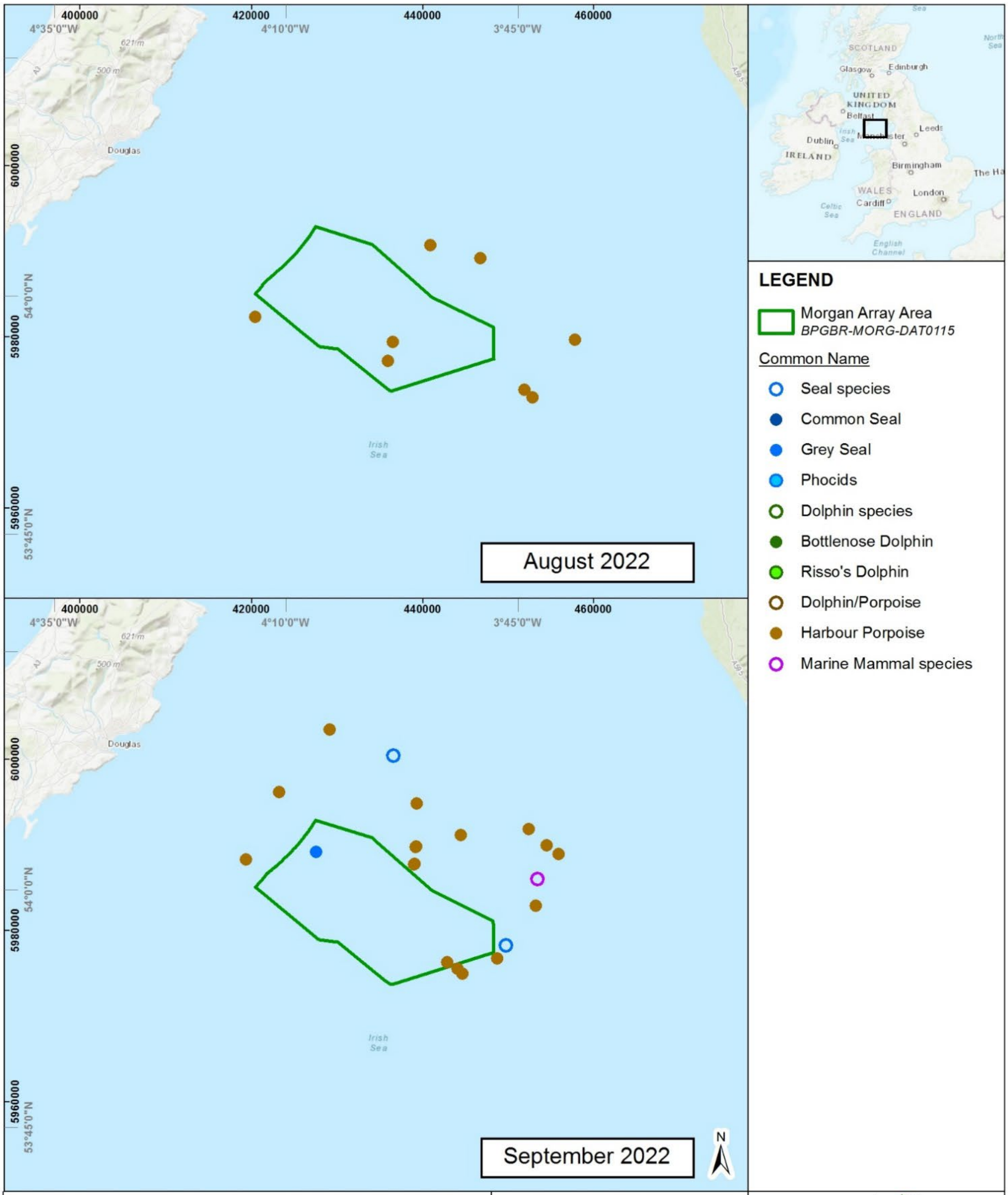
Drawing Number:
RPSE-MG-ES-MAM-009-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: JUNE AND JULY 2022

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.13: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: June 2022 and July 2022.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Partners in UK offshore wind

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

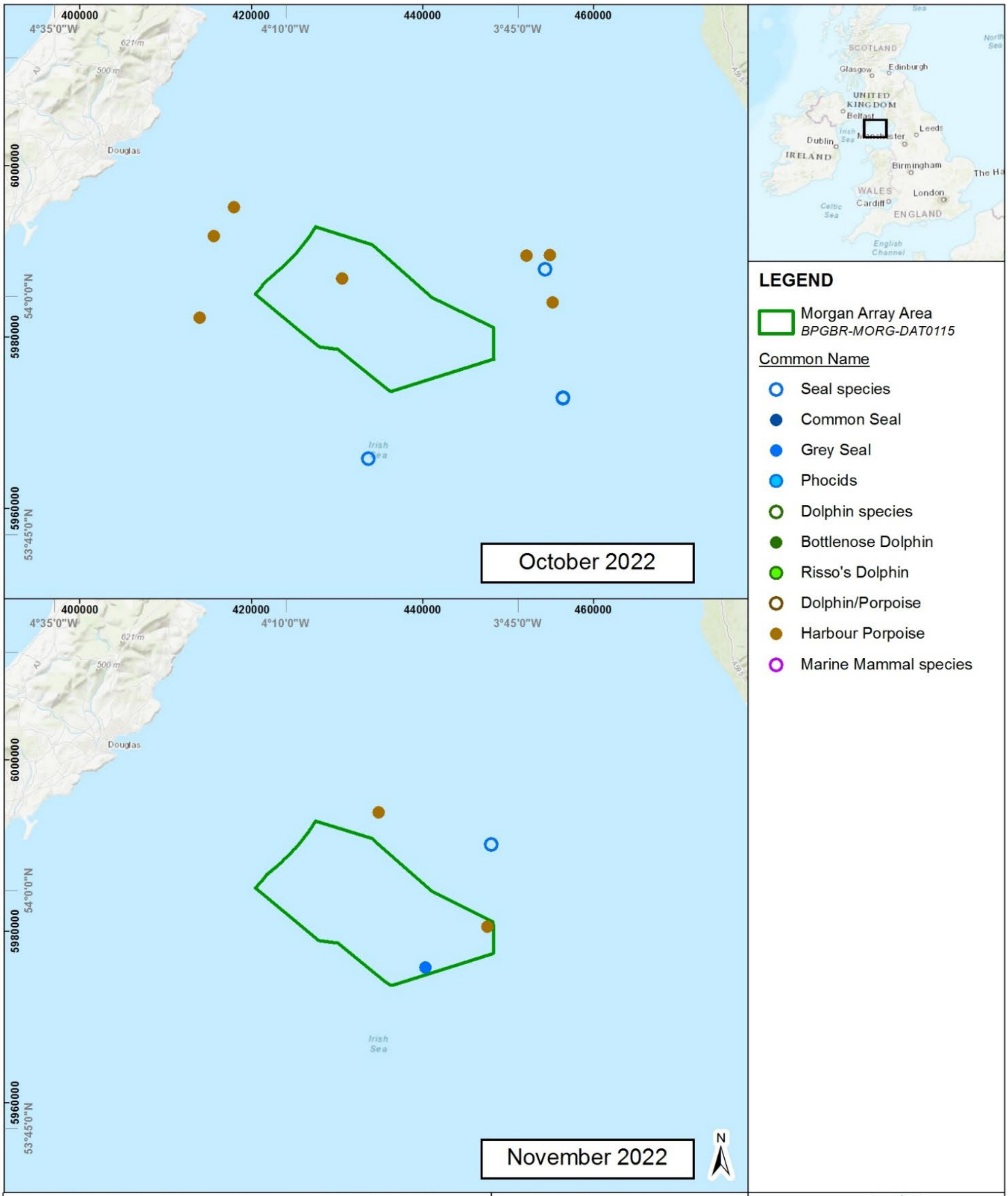
Drawing Number:
RPSE-MG-ES-MAM-010-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: AUGUST AND SEPTEMBER 2022

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.14: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: August 2022 and September 2022.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

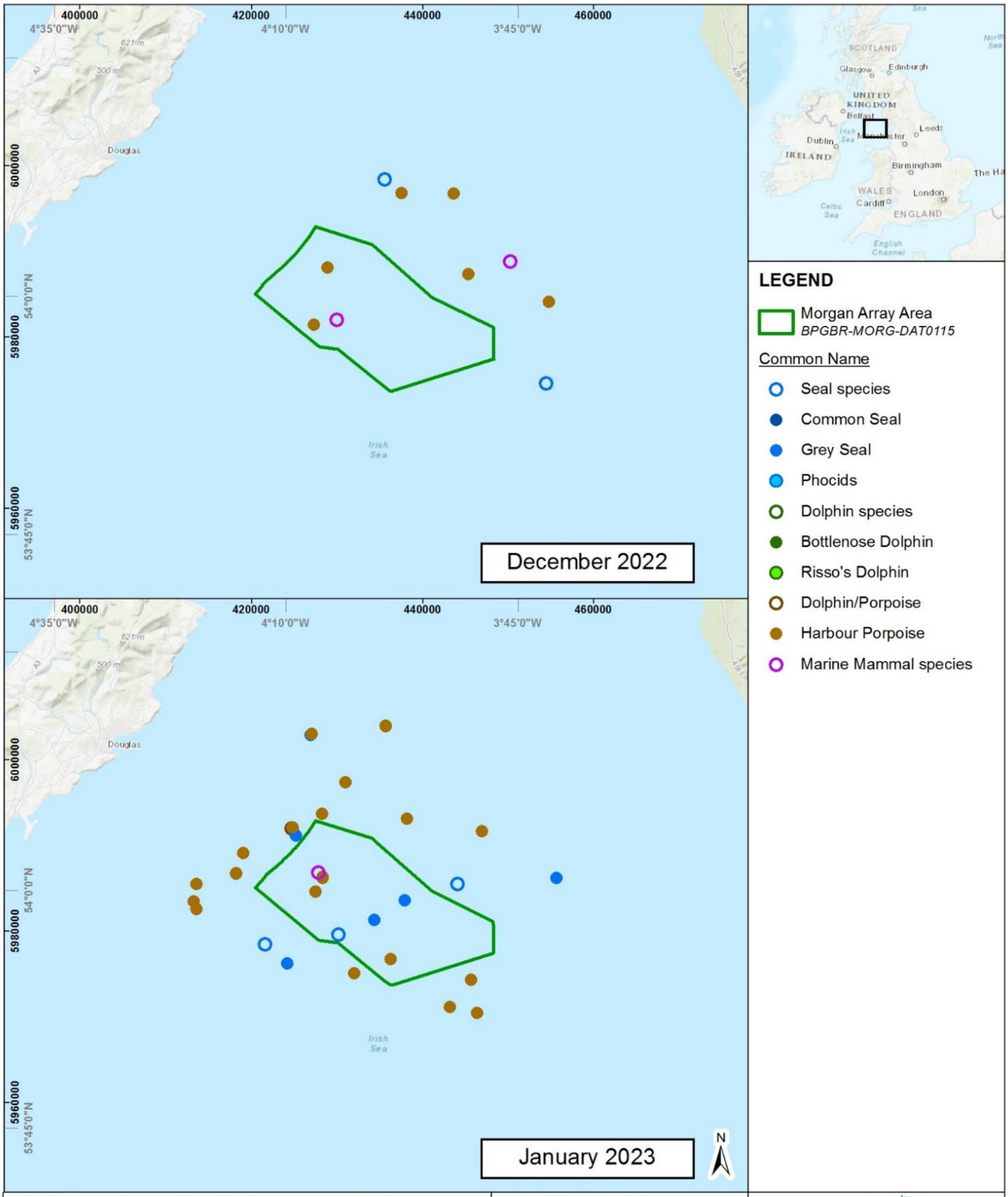
Drawing Number:
RPSE-MG-ES-MAM-011-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: OCTOBER AND NOVEMBER 2022

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.15: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: October 2022 and November 2022.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

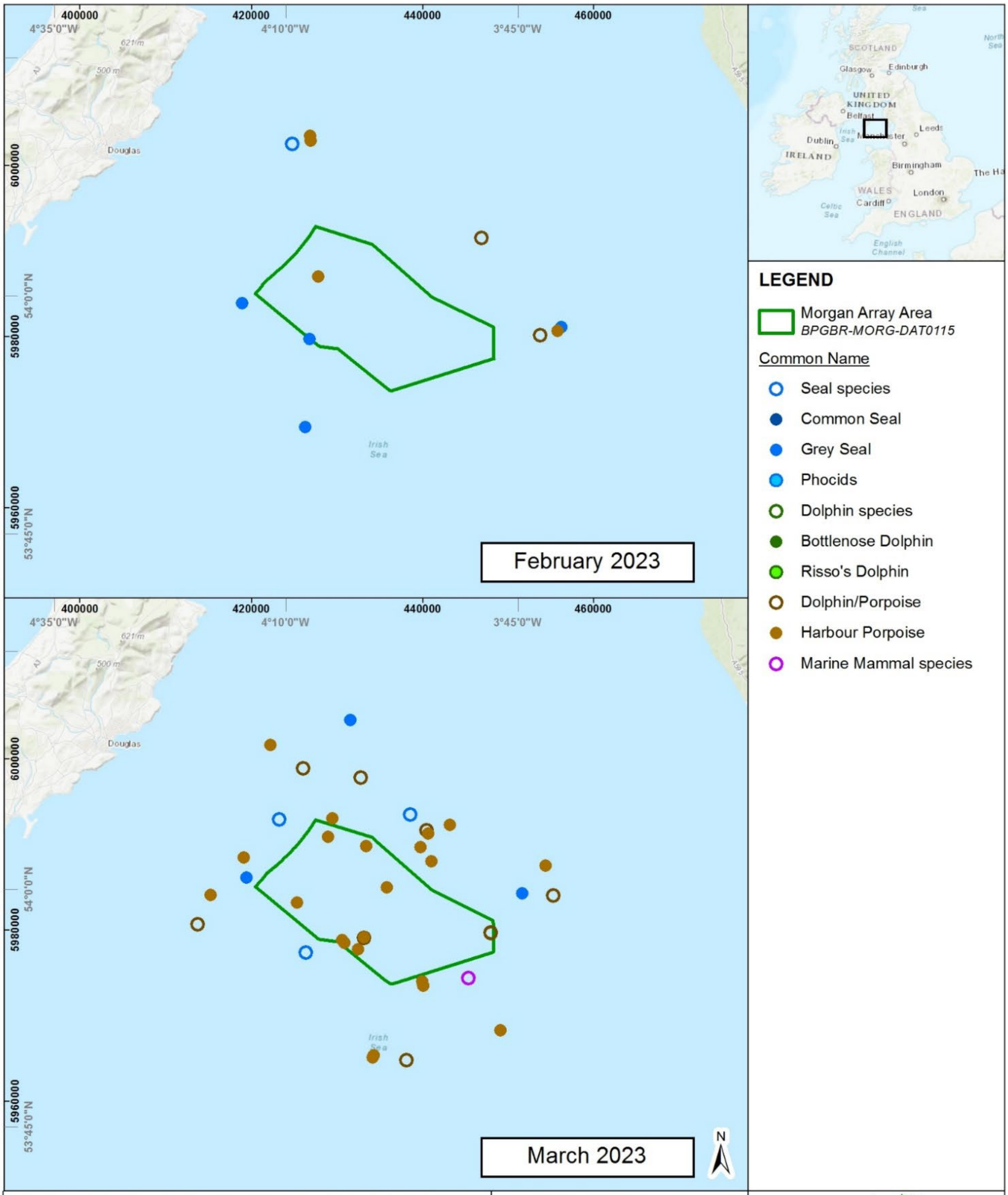
Drawing Number:
RPSE-MG-ES-MAM-012-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: DECEMBER 2022 AND JANUARY 2023

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.16: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: December 2022 and January 2023.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client, APEM

Project Name:
MORGAN OFFSHORE WIND PROJECT

0 1 2 4 6 8 10 nm
0 2.5 5 10 15 20 km

Drawing Number:
RPSE-MG-ES-MAM-013-00

Drawing Title:
DISTRIBUTION OF SIGHTINGS OF MARINE MAMMALS IN THE AERIAL SURVEY AREA (MORGAN) OVERLAID ON TRANSECTS FLOWN EACH MONTH: FEBRUARY AND MARCH 2023

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:750,000

VER	DATE	DETAILS	BY	CHECK
00	17/08/23	First Issue	MJ	AR

Figure A.17: Distribution of sightings of marine mammals in the Morgan Aerial Survey Area: February 2023 and March 2023.

A.3.5 Density estimates with bootstrapping

A.3.5.1 Design-based approach

A.3.5.1.1 Previously published density estimates for marine mammals are discussed and presented in Volume 4, Annex 4.1: Marine mammal technical report of the Environmental Statement; this report focuses on densities derived from the recent aerial surveys only.

A.3.5.1.2 Monthly mean densities of marine mammals were calculated from the aerial survey count data. First, raw counts were adjusted to take account of the area covered in each aerial survey flight (Table A.1) to give estimates of abundance across the whole Morgan Aerial Survey Area. These relative abundances were then corrected for availability bias (see section A.2.6.2.1 to A.2.6.2.3) to give estimates of absolute abundance, and densities were then calculated by dividing abundance estimates by the size of the Morgan Aerial Survey Area (1,378 km^2). Average densities were then calculated for each month, season, bio-season and across the whole survey period.

A.3.5.1.3 Uncertainty in the data was estimated with upper and lower 95% confidence limits (CL) and CV. CLs were calculated from the survey densities via non-parametric bootstrapping (1,000 replicates), and CVs were calculated as the standard deviation divided by the mean of the data (e.g. standard deviation of January densities, divided by the mean of January densities).

A.3.5.1.4 Design-based summaries for bottlenose dolphin and short-beaked common dolphin were not possible due to the low number of observations. There were no observations of either Risso’s dolphin or harbour seal.

Harbour porpoise

A.3.5.1.5 For harbour porpoise relative abundance and density were calculated by month, within meteorological seasons, and within the October to March and April to September divisions described by Heinänen and Skov (2015). The division of the year into two equal halves is based upon bimodal patterns of spatial distribution (‘Winter’ and ‘Summer’, respectively) and is intended to address the difficulties in implementing criteria for designating a Special Area of Conservation (SAC) (Heinänen & Skov, 2015). This approach has been applied here to assist in estimating harbour porpoise density at a broader temporal scale that is relevant to this species, to complement the estimates calculated across human-defined months and meteorological seasons. For clarity, the seasonal divisions defined by Heinänen and Skov (2015) are referred to here as ‘bio-seasons’.

A.3.5.1.6 Estimated absolute densities for harbour porpoise over the Morgan Aerial Survey Area are given for all surveys (Figure A.18 and Table A.6) and summarised across months (Figure A.19), with simulation of mean for monthly absolute density estimates presented in Figure A.20.

A.3.5.1.7 Relative density estimates of harbour porpoise can be corrected for availability bias (paragraph A.2.6.2.1) using a published correction factors based on the proportion of time individuals are likely to be at or near the surface and available for detection. For example, availability bias was estimated based on a tagging study in the Baltic/North Sea which looked at the proportion of time that harbour porpoise spent surfacing or in the top 0 to 2 m (Teilman *et al*., 2013). Notably, in this study Teilman *et al*. (2013) found no significant difference in diving behaviour between geographic areas or in relation to the size of the animals, although there was a significant seasonal difference in diving behaviour. The correction factor which gave the lowest estimate of availability (i.e. most conservative) was 42.5%, based on winter months, when surfacing time was found to be lower than in other seasons (Teilman *et al*., 2013).

A.3.5.1.8 Similarly, fine scale movements of harbour porpoise in the Danish North Sea were investigated by van Beest *et al*. (2018). GPS and dive recorder (V-tags) were used to record the diving behaviour of tagged individuals and the study estimated a mean dive duration of 53 s (min = 10.1 s, max = 250.0 s) and a mean surfacing time of 39 s (min = 2 s, max = 309 s). Using the mean values, the availability bias was calculated as 42.4% (mean surfacing time as a proportion of the mean surfacing time plus mean dive time) which corroborates the value estimated by Teilman *et al.* (2013).

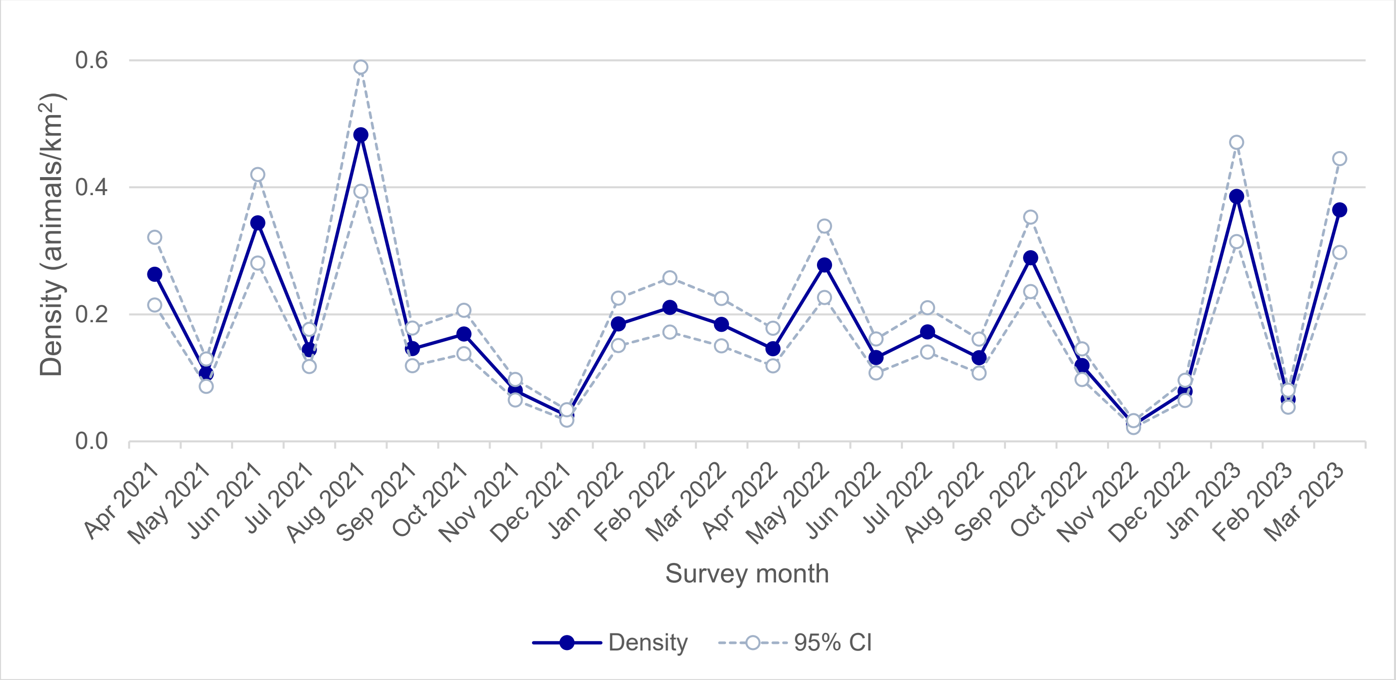


Figure A.18: Estimated absolute density for each survey of harbour porpoise (corrected for availability bias) over the Morgan Aerial Survey Area, with 95% CI.

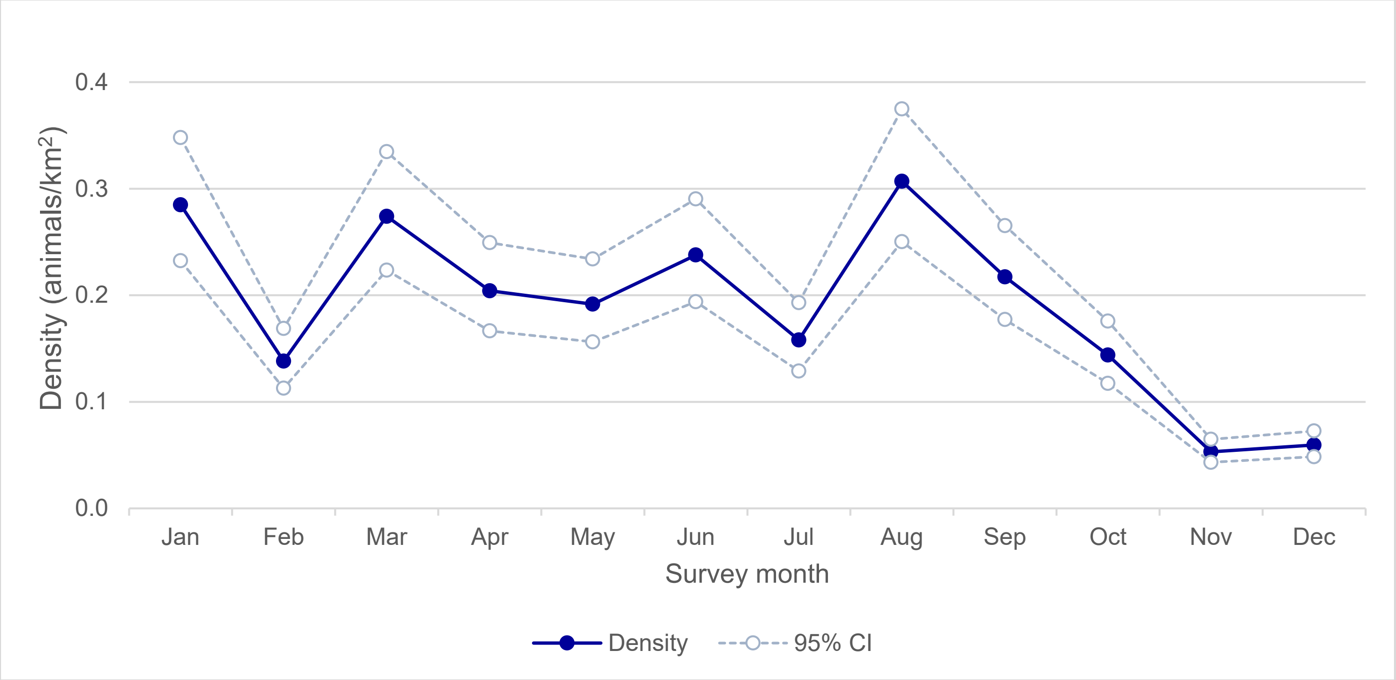


Figure A.19: Estimated monthly mean absolute density of harbour porpoise (corrected for availability bias) over the Morgan Aerial Survey Area, with 95% CI.

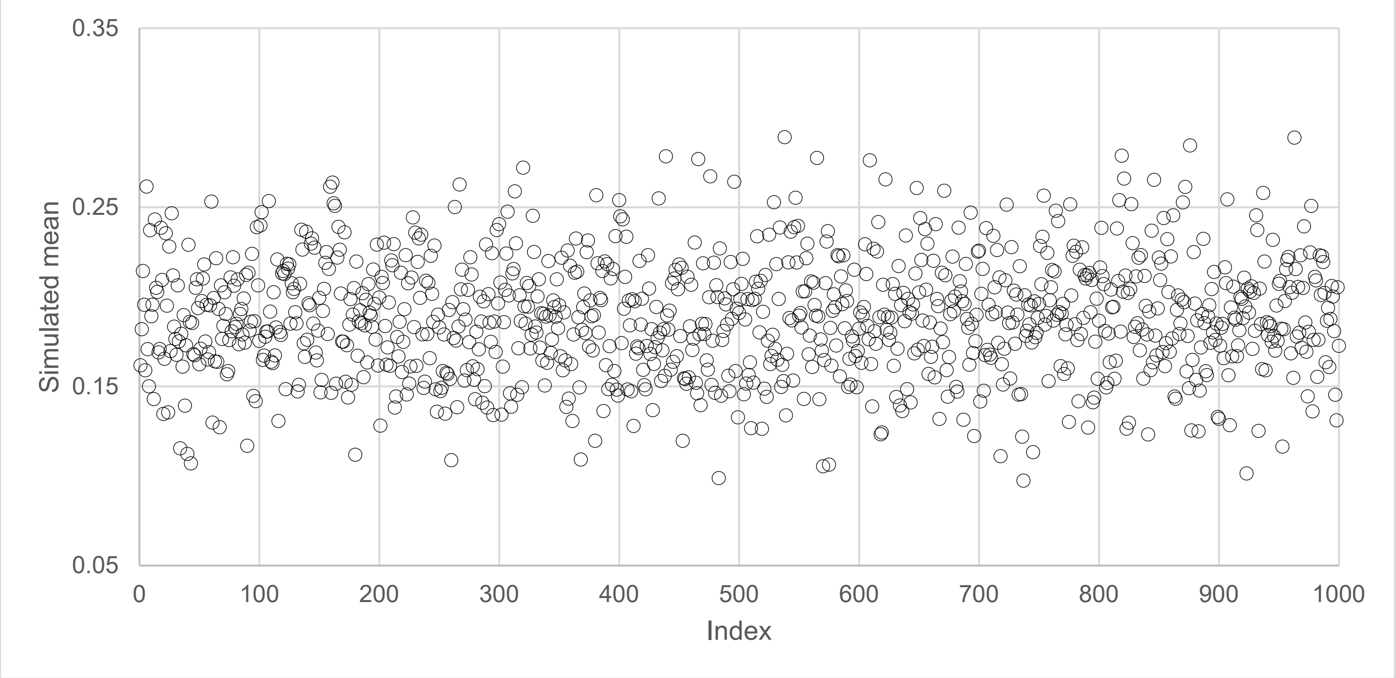


Figure A.20: Simulation of mean for monthly absolute density estimates of harbour porpoise (corrected for availability bias) from design-based approach.

Table A.6: Design-based monthly, seasonal (meteorological and bio), and overall absolute density estimates (corrected for availability bias) of harbour porpoise, including lower and upper 95% CLs, and CV.

Temporal division	Mean absolute abundance	Mean absolute density (animals/km^2)	Lower CL	Upper CL	CV
Monthly					
January	393	0.285	0.232	0.348	0.498
February	191	0.138	0.113	0.169	0.741
March	378	0.274	0.224	0.335	0.465
April	282	0.204	0.167	0.249	0.406
May	265	0.192	0.156	0.234	0.633
June	328	0.238	0.194	0.290	0.630
July	218	0.158	0.129	0.193	0.125
August	423	0.307	0.250	0.375	0.808
September	300	0.217	0.177	0.265	0.465
October	199	0.144	0.117	0.176	0.244
November	74	0.053	0.043	0.065	0.708
December	82	0.059	0.049	0.073	0.452
Meteorological season					
Winter	222	0.161	0.131	0.196	0.804
Spring	308	0.223	0.182	0.273	0.428
Summer	323	0.234	0.191	0.286	0.623
Autumn	191	0.138	0.113	0.169	0.647
Bio-season					
‘Winter’	220	0.159	0.130	0.194	0.740
‘Summer’	303	0.219	0.179	0.268	0.518
Year					
Annual	261	0.189	0.154	0.231	0.619

Grey seal

A.3.5.1.9 As for harbour porpoise, spatial distribution of grey seal has been estimated across monthly, seasonal and ‘bio-season’ scales. For grey seal, the ‘bio-season’ has been determined based upon potential changes in distribution between the pupping season (defined in consultation with Manx Wildlife Trust, as August to November for this region) and the non-pupping season (December to July). This is due to the expectation that most females would be hauled out during the pupping season, rather than being at sea.

A.3.5.1.10 Estimated absolute densities for grey seal over the Morgan Aerial Survey Area are given for all surveys (Figure A.21 and Table A.7) and summarised across months

(Figure A.22), with simulation of mean for monthly absolute density estimates presented in Figure A.20.

A.3.5.1.11 A tracking study of three male grey seal in the Farne Islands (northeast England) found that the average proportion of time animals were submerged as they travelled was 84.3%, and this was slightly lower during short duration trips (83.4%) (Thompson *et al*., 1991). Therefore, it follows that the average proportion of time a travelling grey seal would be available for detection ranges between 15.7% and 16.6%.

A.3.5.1.12 Similarly, telemetry data from tags deployed by the Sea Mammal Research Unit (SMRU) on grey seal in the North Sea recorded 1,551 grey seal dives. These data were analysed for the Hornsea Three Offshore Wind Farm (to estimate detection probability) and showed that 60% of surfacing periods were between 15 and 45 s, with an average of 40 s (Ørsted, 2018). Dive durations varied between 20 and 496 s with an average of 216 s (Ørsted, 2018). The average values reported from the telemetry data were used to estimate the proportion of time that grey seal were surfacing compared to diving to give an indication of the availability bias for the site-specific aerial surveys. The estimated availability was calculated as 15.6% and was therefore similar to the figures cited by Thompson *et al*. (1991).

A.3.5.1.13 As with harbour porpoise, it was assumed that all animals on (or near) the surface were available for detection during the aerial surveys (i.e. no perception bias) (A.2.6.2.4). The correction factor for availability bias, based on the telemetry studies described above, was 15.6% as the most conservative estimate.

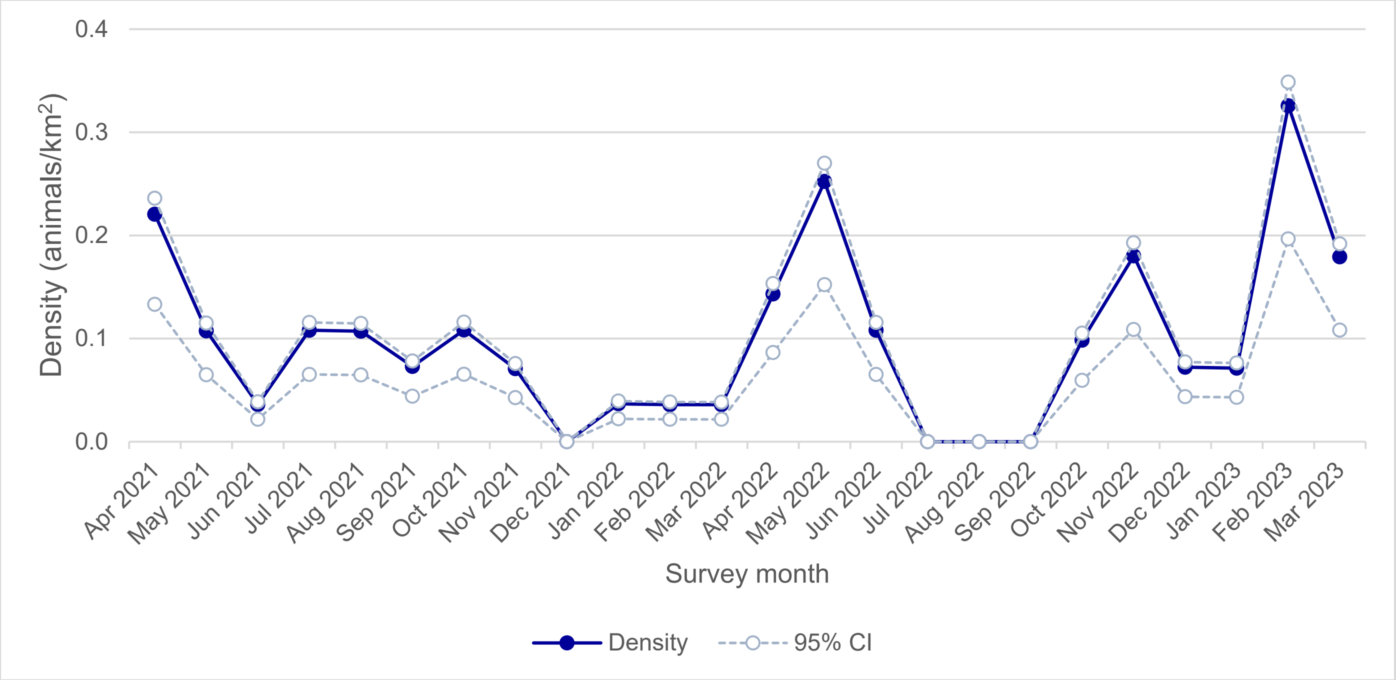


Figure A.21: Estimated absolute density for each survey of grey seal (corrected for availability bias) over the Morgan Aerial Survey Area, with 95% CI.

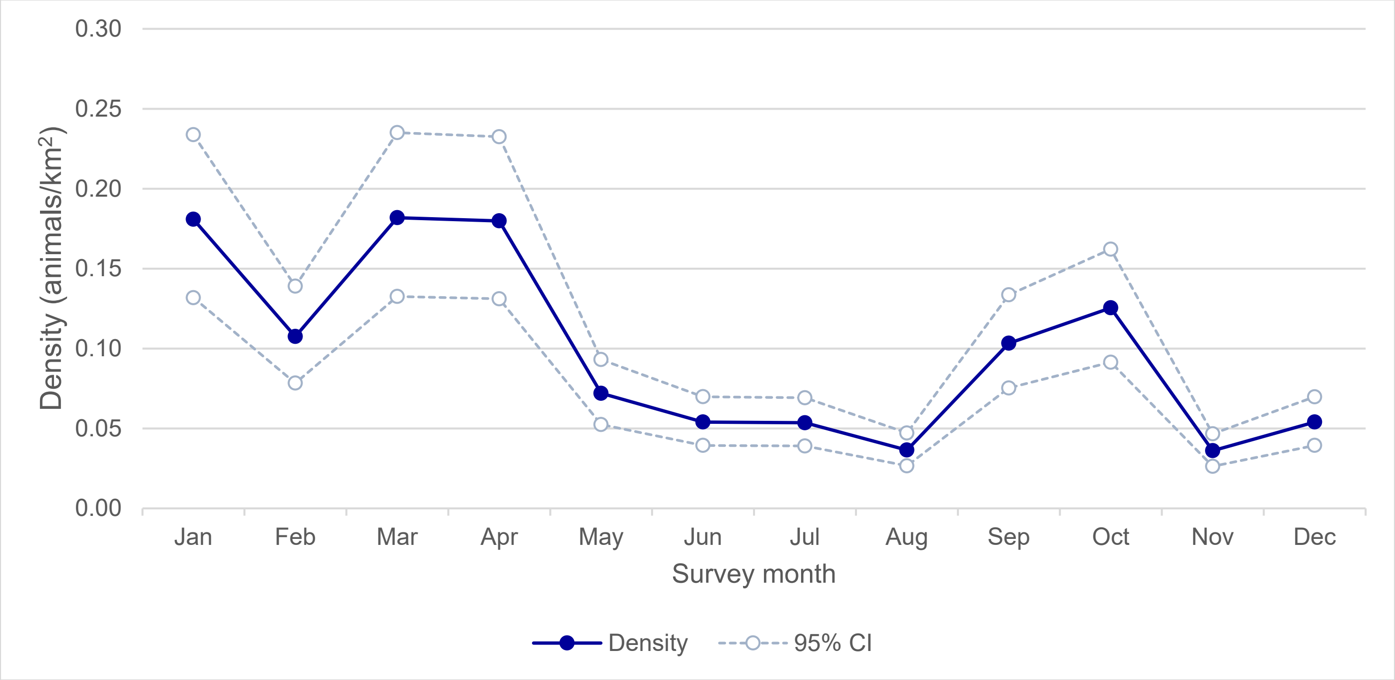


Figure A.22: Estimated monthly mean absolute density of grey seal (corrected for availability bias) over the Morgan Aerial Survey Area, with 95% CI.

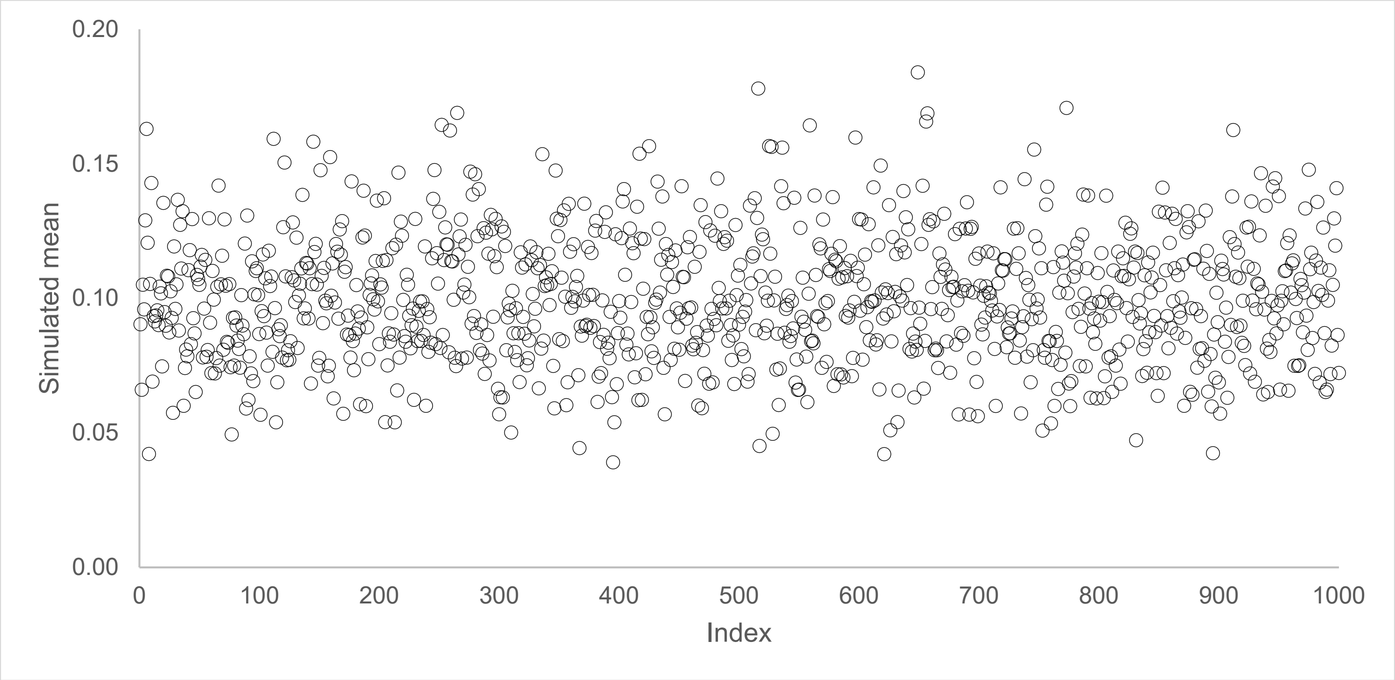


Figure A.23: Simulation of mean for monthly absolute density estimates of grey seal (corrected for availability bias) from design-based approach.

Table A.7: Design-based monthly, seasonal (meteorological and bio), and overall absolute density estimates of grey seal (corrected for availability bias), including lower and upper 95% CLs, and CV.

Temporal division	Mean absolute abundance	Mean absolute density (animals/km^2)	Lower CL	Upper CL	CV
Monthly					
January	250	0.181	0.132	0.234	1.133
February	149	0.108	0.078	0.139	0.942
March	251	0.182	0.133	0.235	0.301
April	248	0.180	0.131	0.232	0.569
May	100	0.072	0.052	0.093	0.706
June	75	0.054	0.039	0.070	1.414
July	74	0.054	0.039	0.069	1.414
August	51	0.037	0.027	0.047	1.414
September	143	0.103	0.075	0.134	0.068
October	173	0.125	0.091	0.162	0.617
November	50	0.036	0.026	0.047	1.414
December	75	0.054	0.039	0.070	0.452
Meteorological season					
Winter	158	0.114	0.083	0.148	1.030
Spring	250	0.181	0.132	0.234	0.441
Summer	67	0.048	0.035	0.062	1.127
Autumn	122	0.088	0.064	0.114	0.666
Bio-season					
‘Pupping’	98	0.071	0.052	0.092	0.746
‘Non-pupping’	180	0.130	0.095	0.168	0.753
Year					
Overall estimate	137	0.099	0.072	0.128	0.852

Porpoise species

A.3.5.1.14 For ‘porpoise species’ (i.e. harbour porpoise plus ‘dolphin/porpoise species’ relative abundance and density were calculated by month, within meteorological seasons, and within the ‘winter’ (October to March) and ‘summer’ (April to September) ‘bio-seasons’ (see paragraph A.3.5.1.5).

A.3.5.1.15 The correction factor applied to ‘porpoise species’ was as that described for harbour porpoise where it was assumed that 42.4% of animals were available for detection as per Teilmann *et al.* (2013) (see paragraph A.3.5.1.7 *et seq.*). Estimated absolute densities for ‘porpoise species’ over the Morgan Aerial Survey Area are given for all surveys (Figure A.18 and Table A.8) and summarised across months (Figure A.19), with simulation of mean for monthly absolute density estimates presented in Figure A.20.

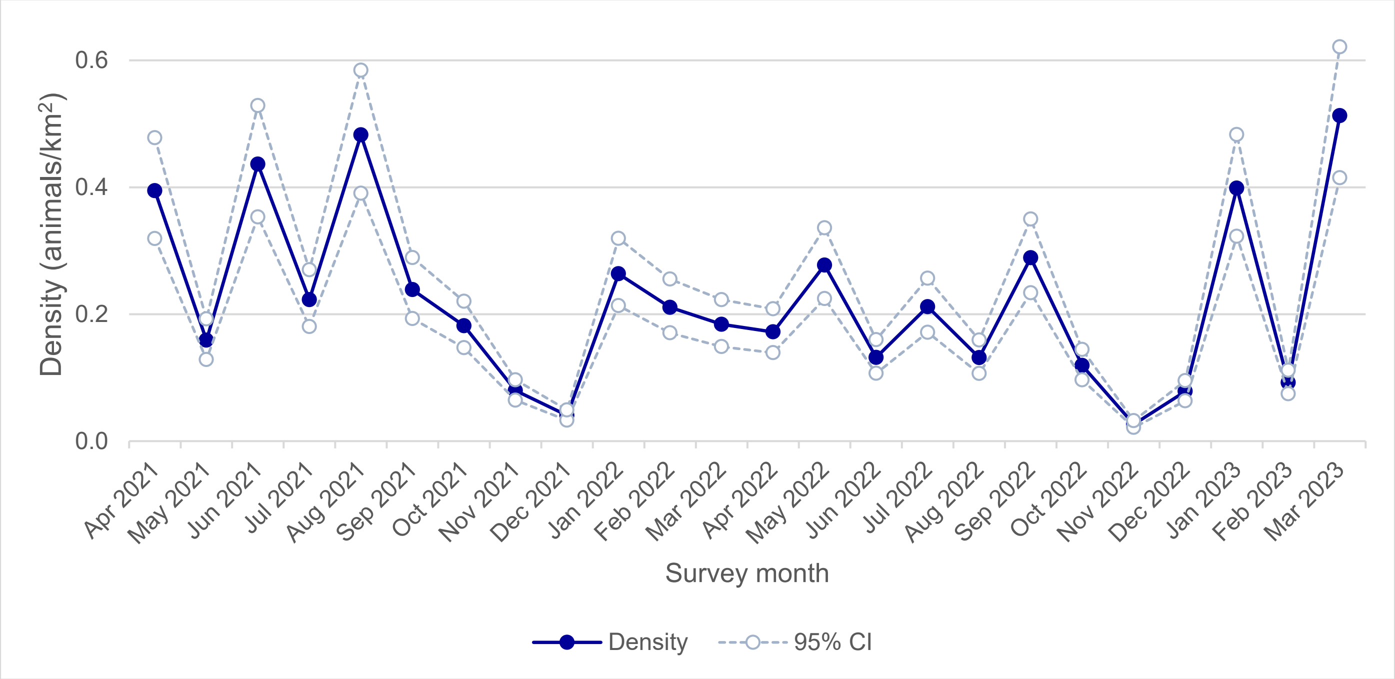


Figure A.24: **Estimated absolute density of 'porpoise species' (corrected for availability bias) over the Morgan Aerial Survey Area, for all monthly surveys, with 95% CI.**

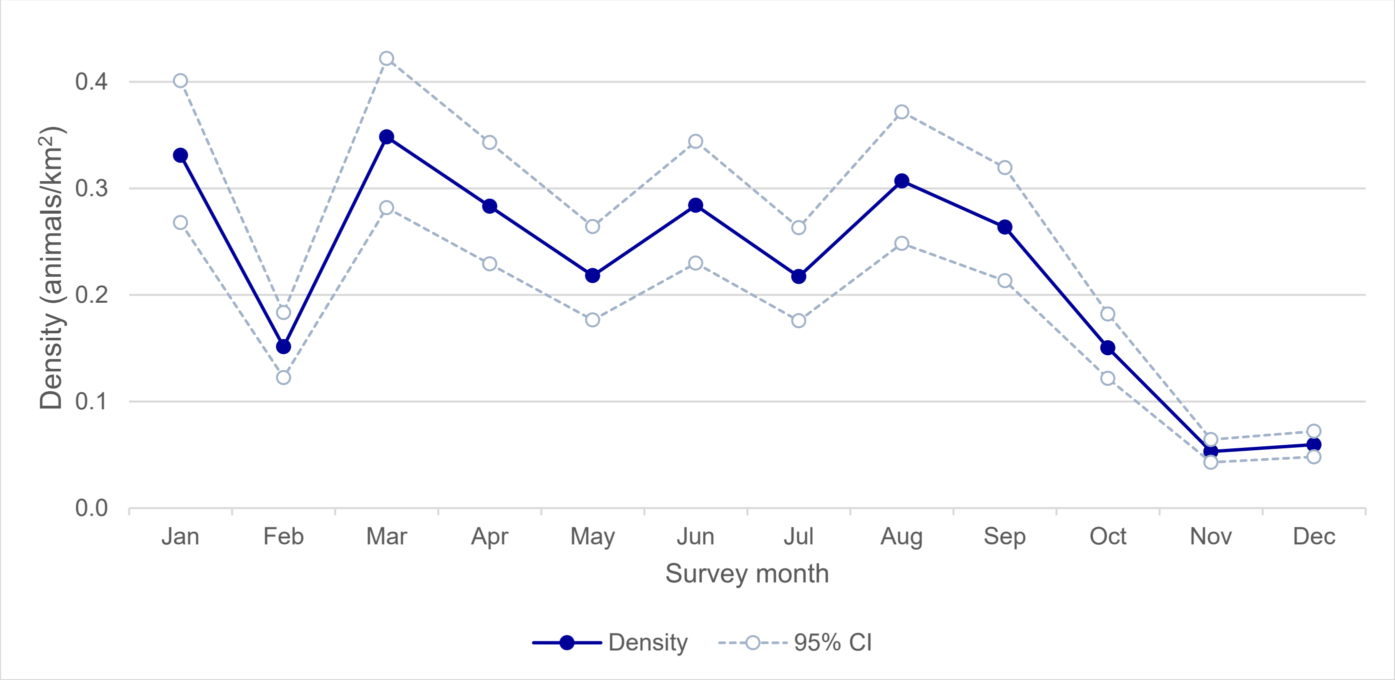


Figure A.25: **Estimated monthly mean absolute density of 'porpoise species' (corrected for availability bias) over the Morgan Aerial Survey Area, with 95% CI.**

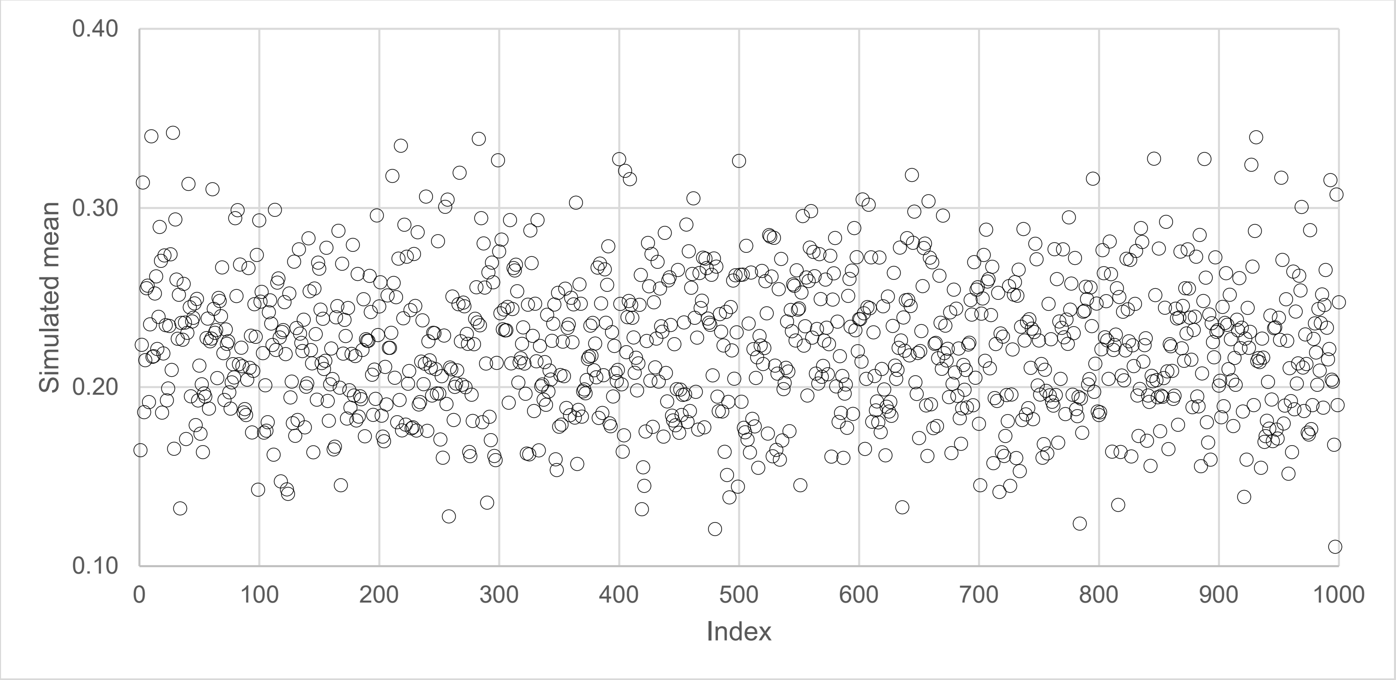


Figure A.26: Simulation of mean for monthly absolute density estimates of 'porpoise species' (corrected for availability bias) from design-based approach.

Table A.8: Design-based monthly, seasonal (meteorological and bio), and overall absolute density estimates of 'porpoise species' (corrected for availability bias), including lower and upper 95% CLs, and CV.

Temporal division	Mean absolute abundance	Mean absolute density (animals/km^2)	Lower CL	Upper CL	CV
Monthly					
January	457	0.331	0.268	0.401	0.288
February	209	0.151	0.122	0.183	0.554
March	480	0.348	0.282	0.422	0.667
April	391	0.283	0.229	0.343	0.555
May	301	0.218	0.176	0.264	0.384
June	392	0.284	0.230	0.344	0.758
July	300	0.217	0.176	0.263	0.036
August	423	0.307	0.248	0.372	0.808
September	364	0.264	0.213	0.319	0.135
October	208	0.150	0.122	0.182	0.295
November	74	0.053	0.043	0.064	0.708
December	82	0.059	0.048	0.072	0.452
Meteorological season					
Winter	249	0.181	0.146	0.219	0.756
Spring	391	0.283	0.229	0.343	0.506
Summer	372	0.269	0.218	0.326	0.567
Autumn	215	0.156	0.126	0.189	0.636
Bio-season					
'Winter'	252	0.182	0.147	0.221	0.812
'Summer'	362	0.262	0.212	0.318	0.452
Year					
Overall estimate	307	0.222	0.180	0.269	0.618

A.3.6 Model-based density estimates

A.3.6.1.1 When carrying out model based density estimates, as described in paragraph A.3.1.2.1, based on the frequency of occurrence of known species across the Morgan Aerial Survey Area, unidentified seal species were considered most likely to be grey seal and as such were grouped together to produce a more conservative estimate of grey seal density. Whilst unidentified seals were assigned to grey seal, it is noted that this does not discount the possibility that unidentified seal species may have been harbour seal. For this species, the SMRU published at-sea densities of harbour seal were, instead, available to provide densities for the baseline characterisation within Volume 4, Annex 4.1: Marine mammal technical report of the Environmental Statement (e.g. Carter *et al*., 2022).

A.3.6.1.2 Harbour porpoise was initially modelled as a variable in its own right, but to increase sample size and improve model robustness, this was also pooled with animals identified as 'Dolphin/Porpoise'; labelled together as 'porpoise species'. As with grey seal, this grouping does not discount the possibility that some individuals may have been dolphin species, but by pooling the data a more conservative density for harbour porpoise could be estimated. For other species of dolphin published densities in this region (e.g. Waggitt *et al*., 2020) have been sourced to provide a robust baseline characterisation within Volume 4, Annex 4.1: Marine mammal technical report of the Environmental Statement.

A.3.6.1.3 Similarly, there were 14 unidentified marine mammal species, but the uncertainty around these meant that they could not be confidently included in a suitable grouping and were excluded from the modelling.

A.3.6.1.4 Mean relative abundance (i.e. raw count adjusted for survey coverage) and density estimates (abundance divided by survey area) were calculated across the Morgan Aerial Survey Area. Uncertainty in the data is given as 95% CLs, and CV. These measures were given for monthly and seasonal (meteorological and bio-season) divisions, and aggregated across all surveys, for the Morgan Aerial Survey Area.

Harbour porpoise

A.3.6.1.5 For harbour porpoise relative abundance/density was modelled by month, within meteorological seasons, and within the 'winter' (October to March) and 'summer' (April to September) divisions described by Heinänen and Skov (2015), for clarity referred to here as 'bio-seasons'.

A.3.6.1.6 Harbour porpoise abundance varied through time, with higher densities across the Morgan Aerial Survey Area observed during the spring (March to May) and summer (June to August) months.

A.3.6.1.7 Monthly and seasonal (meteorological) mean abundances were large enough for modelling using the MRSea package (n >30 required for each temporal division analysed), which provided greater temporal resolution to predictions. However, results from the MRSea analyses provided insufficient predictive power at all temporal divisions, and density estimates were considerably lower than those derived from the design-based approach, so these could not be used to robustly predict estimates of spatial density.

A.3.6.1.8 Due to the lower-than-expected predictive power of the MRSea model ($r^2 = 0.005$), relative density was calculated from generalised linear models (GLM), following a quasi-poisson error structure to facilitate analysis of the preponderance of zero counts which led to overdispersion of the data.

A.3.6.1.9 Global models were built, incorporating nesting for each temporal division (month, meteorological season, bio-season), and included harbour porpoise abundance as a response, with survey effort and all environmental covariates discussed in paragraph A.2.5.1.4 included as predictors. A final model was generated via backwards stepwise reduction, based upon removal of non-significant ($\alpha = 0.05$) covariates, until survey effort, temporal parameters, distance to coast and latitude/longitude remained as significant predictors. A summary of the parameters included in the final model, and their estimated effect sizes, is presented in Table A.9. Note that survey effort is not included here since it was included in the GLM as an offset term (i.e. survey effort data was accounted for in the model but was not input as a variable in its own right).

Table A.9: Summary of model parameters and explained deviance for harbour porpoise GLM (quasi-poisson structure, 'log' link). Nesting within temporal parameters is indicated by ':'.

Model parameter	Degrees of freedom (df)	Deviance explained (%)
Bioseason	1	0.127
Bioseason:Season	4	0.618
Bioseason:Season:Month	6	2.325
Distance to coast	1	0.016
Longitude	1	0.079
Latitude	1	0.666
Overall model	**14**	**3.832**

A.3.6.1.10 Mean relative abundance (i.e. raw count) and density estimates (animals/km^2, calculated across whole survey area), 95% confidence intervals, and CVs were calculated. These measures are given in Table A.10, for monthly and seasonal (meteorological and bio-season) divisions, and aggregated across all surveys, for the Morgan Aerial Survey Area (1,378 km^2).

A.3.6.1.11 Bio-season was determined to be the most appropriate division as harbour porpoise have been seen to change their distribution patterns between these two 'seasons' (Heinänen and Skov, 2015), and these patterns form part of the evidence base upon which SACs are designated.

A.3.6.1.12 Harbour porpoise densities were estimated from the 'bio-season' model, which predicted a mean relative density of 0.021 animals/km^2 (95% CLs: 0.014, 0.028) during the winter bio-season, and 0.027 animals/km^2 (95% CLs: 0.018, 0.035) during the summer bio-season (Table A.10).

Table A.10: GLM-based monthly, seasonal, and total relative density estimates of harbour porpoise, including Lower and Upper 95% CLs, and CV.

Temporal division	Mean relative density (animals/km^2)	Lower CL	Upper CL	CV
Month				
Jan	0.021	0.005	0.037	0.509
Feb	0.017	0.004	0.032	0.521
Mar	0.024	0.007	0.042	0.537
Apr	0.025	0.007	0.043	0.313
May	0.039	0.017	0.061	0.676
Jun	0.032	0.012	0.052	0.440
Jul	0.022	0.005	0.038	0.443
Aug	0.005	0.000	0.013	0.669
Sep	0.005	0.000	0.012	0.420
Oct	0.050	0.023	0.077	0.328
Nov	0.016	0.003	0.029	0.589
Dec	0.030	0.010	0.049	0.499
Meteorological season				
Winter	0.023	0.006	0.039	0.567
Spring	0.030	0.010	0.049	0.638
Summer	0.020	0.006	0.034	0.750
Autumn	0.024	0.009	0.040	0.939
Bio-season				
‘Winter’	0.021	0.014	0.028	0.647
‘Summer’	0.027	0.018	0.035	0.860
Year				
Overall estimate	0.024	0.008	0.041	0.750

A.3.6.1.13 Relative abundance and density values were adjusted to account for availability bias, using the most conservative correction factor of 0.425 (see paragraph A.3.5.1.7), to provide estimates of absolute abundance and density, and 95% confidence limits Table A.11).

Table A.11: GLM-based monthly, seasonal, and total absolute density estimates of harbour porpoise, including Lower and Upper 95% CLs, and CV.

Temporal division	Mean absolute density (animals/km^2)	Lower CL	Upper CL	CV
Month				
Jan	0.049	0.012	0.087	0.256
Feb	0.041	0.008	0.075	0.254
Mar	0.057	0.017	0.098	0.250
Apr	0.059	0.017	0.102	0.250
May	0.092	0.040	0.144	0.251
Jun	0.075	0.027	0.122	0.249
Jul	0.051	0.013	0.090	0.248
Aug	0.013	0.000	0.031	0.247
Sep	0.012	0.000	0.029	0.252
Oct	0.118	0.055	0.181	0.251
Nov	0.037	0.008	0.069	0.250
Dec	0.070	0.024	0.116	0.248
Meteorological season				
Winter	0.053	0.015	0.092	0.567
Spring	0.070	0.025	0.115	0.638
Summer	0.046	0.013	0.081	0.750
Autumn	0.056	0.021	0.093	0.939
Bio-season				
'Winter'	0.050	0.034	0.067	0.860
'Summer'	0.062	0.043	0.082	0.647
Year				
Overall estimate	0.056	0.018	0.095	0.750

A.3.6.1.14 Harbour porpoise density appears broadly uniformly low across the Morgan Aerial Survey Area, with greater concentration of occurrence in the north part of the aerial survey area in both bio-seasons, with higher density occurring in the summer bio-season (April to September: Figure A.27).

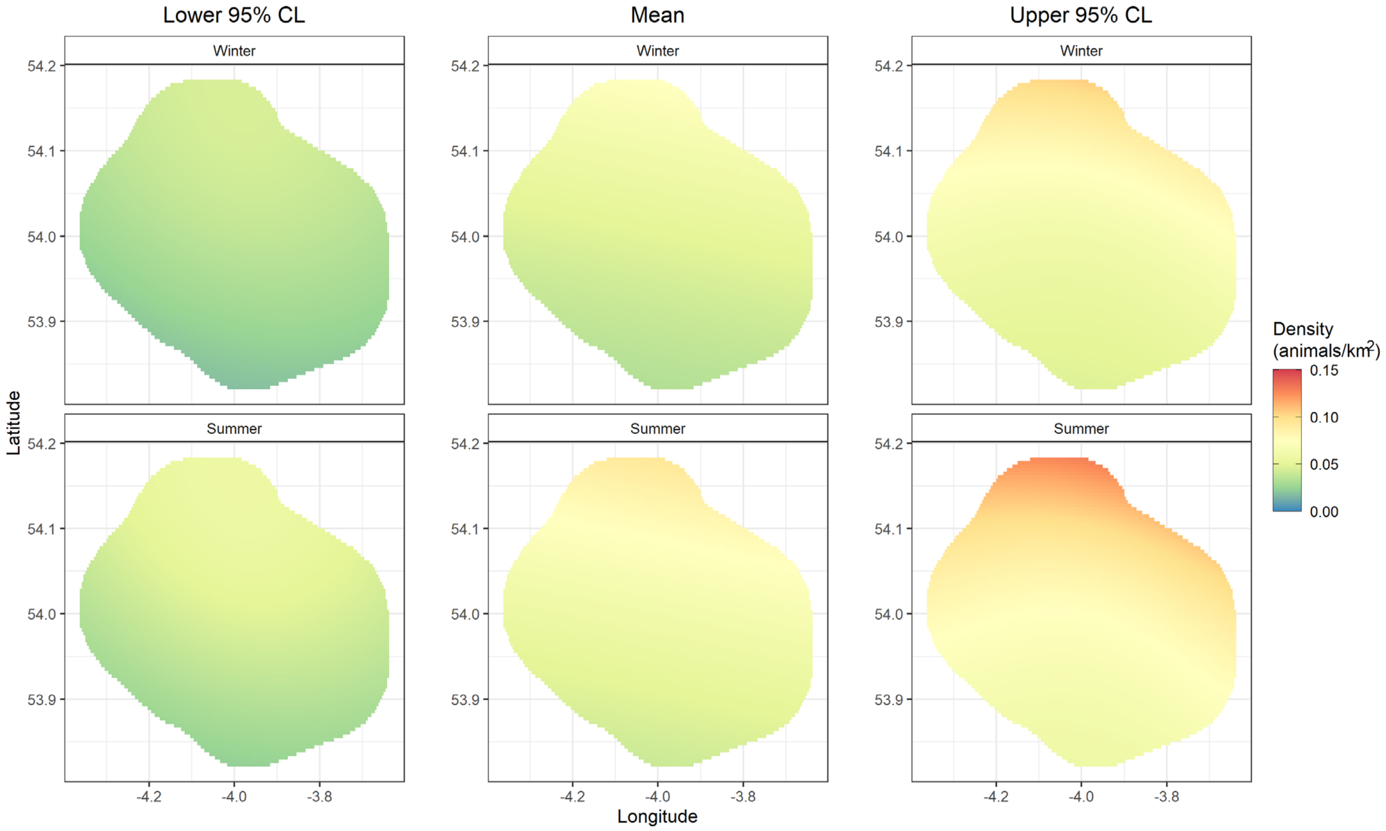


Figure A.27: GLM-estimated absolute density of harbour porpoise for the Morgan Aerial Survey Area, with lower and upper 95% CLs, for 'Winter' and 'Summer' bio-seasons.

A.3.6.1.15 GLM-based estimates were consistently and considerably lower than design-based estimates across all temporal divisions. The greatest difference between design-based and GLM-based estimates was in the monthly estimate for August, when the GLM-based estimate of 0.013 animals/km^2 compared to a design-based estimate of 0.307 animals/km^2.

A.3.6.1.16 The monthly density estimate for December was the only instance in which estimated density was greater in the GLM-based approach: 0.070 animals/km^2 compared to a design-based estimate of 0.059 animals/km^2.

A.3.6.1.17 High coefficients of variation indicate a great deal of variability between estimates. These are likely due to the difficulty of the linear model to incorporate environmental covariates, leaving much of the variance unexplained, and contributing to the low predictive power of these models.

A.3.6.1.18 Density estimates obtained from the model-based approach should still be interpreted with caution. These linear models are not sufficiently robust to make predictions of density, and as such should not be relied upon for estimates of spatial distribution within the Morgan Aerial Survey Area. Estimates of occurrence and density should therefore be based upon the values obtained via the design-based approach.

Grey Seal

A.3.6.1.19 Grey seal density (i.e. pooled counts of grey seal, ‘seal species’ and ‘phocid’) was modelled by month, within meteorological seasons, and within the ‘Pupping’ (August to November) and ‘Non-pupping’ (December to July) divisions determined in consultation with Manx Wildlife Trust, for clarity referred to here as ‘bio-seasons’.

A.3.6.1.20 Sample sizes divided by month and season (meteorological and bio-season) were too small for robust modelling using the MRSea package (n > 30 required), so grey seal relative density was instead estimated from GLMs, following the method described in paragraph A.3.6.1.8. Bio-season was determined to be an appropriate division, as grey seal spatial distribution changes between the pupping and non-pupping seasons. A summary of the parameters included in the final model, and their estimated effect sizes, is presented in Table A.12. Note that survey effort is not included here since it was included as an offset term.

Table A.12: Summary of model parameters and explained deviance for grey seal GLM (quasi-poisson structure, ‘log’ link). Nesting within temporal parameters is indicated by ‘:’.

Model parameter	df	Deviance explained (%)
Bioseason	1	0.234
Bioseason:Season	3	0.953
Bioseason:Season:Month	7	1.371
Distance to coast	1	0.147
Longitude	1	0.024
Latitude	1	0.143
Overall model	**14**	**2.872**

A.3.6.1.21 Mean relative abundance and density estimates, 95% confidence intervals, and CV were calculated (see paragraph A.3.6.1.4) for monthly and seasonal (meteorological and bio-season) divisions, and aggregated across all surveys, for the whole Morgan Aerial Survey Area (1,378 km^2). These estimates are presented in Table A.13.

A.3.6.1.22 Grey seal density varied across months and seasons, with greatest density estimates modelled for the months of January (relative density = 0.0054 animals/km^2, 95% CLs: 0.0008, 0.0103), October (0.0055 animals/km^2, 95% CLs: 0.0014, 0.0100) and December (0.0055 animals/km^2, 95% CLs: 0.0006, 0.0104).

Table A.13: GLM-based monthly, seasonal, and total relative density estimates of grey seal, including Lower and Upper 95% CLs, and CV.

Temporal division	Mean absolute density (animals/km^2)	Lower CL	Upper CL	CV
Month				
Jan	0.0054	0.0008	0.0103	0.4432
Feb	0.0022	0.0000	0.0050	0.5462
Mar	0.0016	0.0000	0.0034	1.0353
Apr	0.0016	0.0000	0.0035	1.0353
May	0.0011	0.0000	0.0026	1.0353
Jun	0.0032	0.0000	0.0069	0.1896
Jul	0.0038	0.0003	0.0078	0.4739
Aug	0.0011	0.0000	0.0026	1.0353
Sep	0.0016	0.0000	0.0041	0.3800
Oct	0.0055	0.0014	0.0100	0.8378
Nov	0.0033	0.0003	0.0068	0.7059
Dec	0.0055	0.0006	0.0104	0.2864
Meteorological season				
Winter	0.0044	0.0005	0.0086	0.5435
Spring	0.0014	0.0000	0.0032	1.0663
Summer	0.0027	0.0001	0.0057	0.6394
Autumn	0.0035	0.0006	0.0070	0.9753
Bio-season				
‘Non-pupping’	0.0031	0.0002	0.0062	0.7419
‘Pupping’	0.0029	0.0004	0.0059	1.0976
Year				
Overall estimate	0.0030	0.0003	0.0061	0.8669

A.3.6.1.23 Relative abundance and density values were adjusted to account for availability bias of grey seal, using the most conservative correction factor of 0.156 (Thompson *et al.*, 1991; Ørsted, 2018; see paragraph A.3.5.1.11 *et seq.*), to provide estimates of absolute abundance and density, and 95% confidence intervals (Table A.14).

A.3.6.1.24 Grey seal densities were estimated from the ‘bio-season’ model, which predicted a mean absolute density of 0.0184 animals/km^2 (95% CLs: 0.0028, 0.0377) during the pupping season, and 0.0196 animals/km^2 (95% CLs: 0.0014, 0.0400) during the non-pupping season.

Table A.14: GLM-based monthly, seasonal, and total absolute density estimates of grey seal (corrected for availability bias), including Lower and Upper 95% CLs, and CV.

Temporal division	Mean absolute density (animals/km^2)	Lower CL	Upper CL	CV
Month				
Jan	0.0349	0.0054	0.0661	0.4432
Feb	0.0140	0.0000	0.0323	0.5462
Mar	0.0104	0.0000	0.0221	1.0353
Apr	0.0105	0.0000	0.0223	1.0353
May	0.0069	0.0000	0.0164	1.0353
Jun	0.0207	0.0000	0.0441	0.1896
Jul	0.0244	0.0019	0.0497	0.4739
Aug	0.0070	0.0000	0.0165	1.0353
Sep	0.0105	0.0000	0.0265	0.3800
Oct	0.0351	0.0092	0.0643	0.8378
Nov	0.0210	0.0019	0.0433	0.7059
Dec	0.0352	0.0041	0.0670	0.2864
Meteorological season				
Winter	0.0280	0.0031	0.0551	0.5435
Spring	0.0093	0.0000	0.0203	1.0663
Summer	0.0174	0.0006	0.0368	0.6394
Autumn	0.0222	0.0037	0.0447	0.9753
Bio-season				
‘Non-pupping’	0.0196	0.0014	0.0400	0.7419
‘Pupping’	0.0184	0.0028	0.0377	1.0976
Year				
Overall estimate	0.0192	0.0019	0.0392	0.8669

A.3.6.1.25 Bio-season is biologically relevant to the pupping and non-pupping seasons, and this produced the best-fit GLM. Density distributions within the Morgan Aerial Survey Area were generated according to bio-season and are presented in Figure A.28.

A.3.6.1.26 Grey seal density appears uniformly low, with highest spatial occurrence along the east and northeast boundary of the Morgan Aerial Survey Area, particularly in the non-pupping season (December to July). This is most apparent when considering the upper 95% CL of the mean densities (Figure A.28).

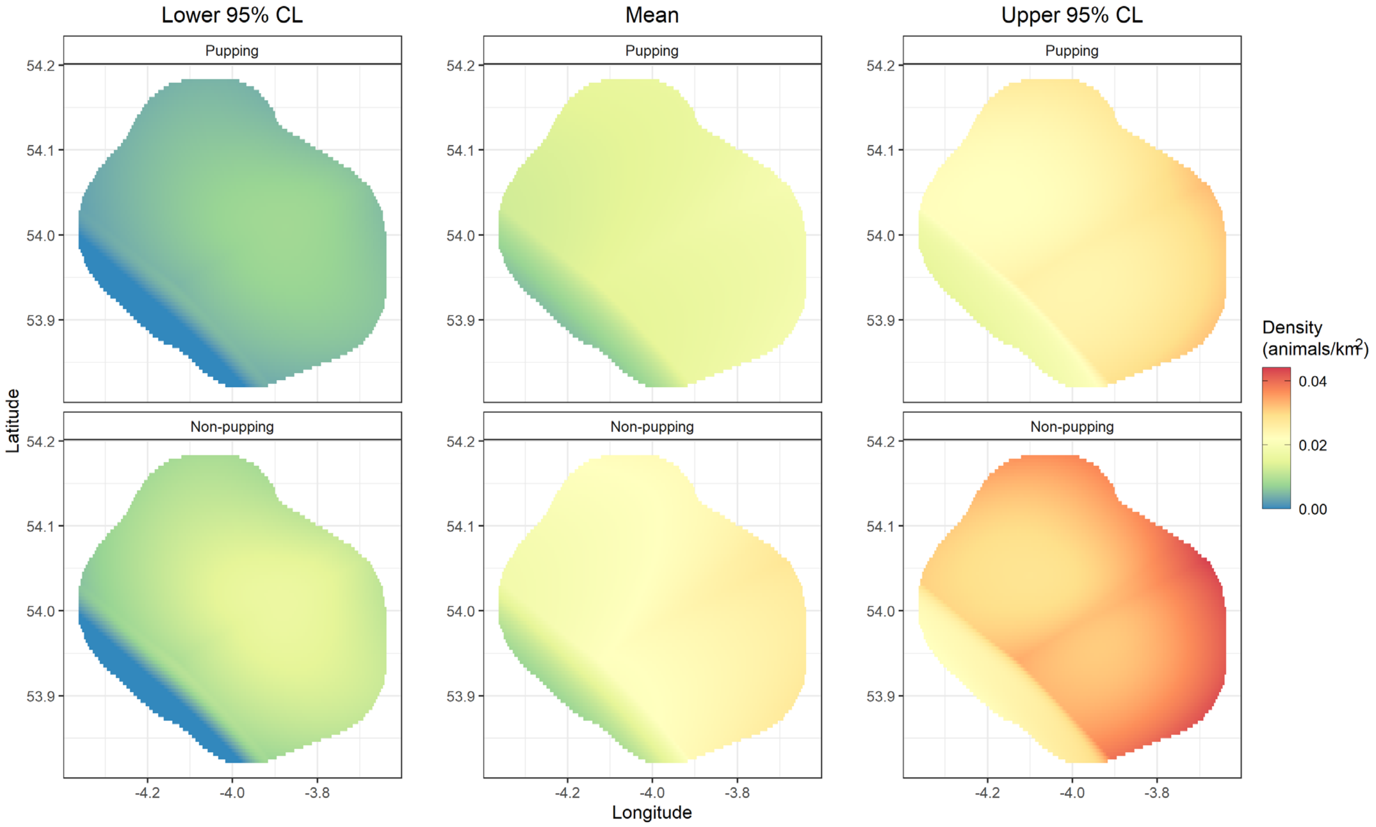


Figure A.28: GLM-estimated grey seal density (centre panels) for the Morgan Aerial Survey Area, with lower and upper 95% confidence intervals, split by 'bio-season'.

A.3.6.1.27 High coefficients of variation indicate a great deal of variability between estimates, and these are likely due to the difficulty of the models to incorporate environmental covariates, leaving much of the variance unexplained, and contributing to the low predictive power of these models.

A.3.6.1.28 In all cases mean relative and absolute densities, derived from the GLMs, are lower than equivalent densities obtained in the design-based approach, and high coefficients of variation indicate a great deal of variability between estimates. These are likely due to the difficulty of the models to incorporate environmental covariates, leaving much of the variance unexplained, and contributing to the low predictive power of these models. The linear models are not sufficiently robust to make predictions of grey seal density, and as such should not be relied upon to estimate distribution within the Morgan Aerial Survey Area. For this reason estimates of grey seal occurrence and density should be based upon estimates of abundance obtained from the design-based approach.

Porpoise species

A.3.6.1.29 'Porpoise species' (harbour porpoise plus 'dolphin/porpoise species'; see paragraph A.3.6.1.2) abundance occurred in similar patterns across the Morgan Aerial Survey Area as seen in harbour porpoise.

A.3.6.1.30 Sample sizes divided by month and meteorological season were sufficient for modelling using the MRSea package. However, results from this analysis, including when divided into bio-season, provided insufficient predictive power (r^2 = 0.012), and could not be used to predict robust estimates of spatial density. Due to the lower-than-expected predictive power of the MRSea model, relative density was calculated from GLMs, as described in paragraph A.3.6.1.8. A summary of the parameters included in the final model, and their estimated contribution to the effect (i.e. marine mammal occurrence), is presented in Table A.15. Note that survey effort is not included here since it was included as an offset term.

Table A.15: Summary of model parameters and explained deviance for 'porpoise species' GLM (quasi-poisson structure, 'log' link). Nesting within temporal parameters is indicated by ':'.

Model parameter	df	Deviance explained (%)
Bioseason	1	0.180
Bioseason:Season	4	0.680
Bioseason:Season:Month	6	2.292
Distance to coast	1	0.021
Longitude	1	0.062
Latitude	1	0.491
Overall model	**14**	**3.727**

A.3.6.1.31 Mean relative abundance and density estimates, 95% confidence intervals, and coefficients of variation were calculated for monthly and seasonal (meteorological and bio-season) divisions, and aggregated across all surveys, for the Morgan Aerial Survey Area (1,378 km^2). These estimates are presented in Table A.16.

Table A.16: GLM-based monthly, seasonal, and total relative density estimates of 'porpoise species', including Lower and Upper 95% CLs, and CV.

Temporal division	Mean relative density (animals/km^2)	Lower CL	Upper CL	CV
Month				
January	0.027	0.009	0.045	0.534
February	0.019	0.004	0.034	0.393
March	0.028	0.010	0.046	0.578
April	0.030	0.011	0.050	0.240
May	0.039	0.018	0.061	0.659
June	0.036	0.014	0.057	0.303
July	0.022	0.006	0.039	0.436
August	0.005	0.000	0.013	0.653
September	0.005	0.000	0.012	0.398
October	0.053	0.027	0.080	0.267
November	0.017	0.003	0.031	0.480
December	0.035	0.015	0.056	0.565
Meteorological season				
Winter	0.027	0.009	0.045	0.600
Spring	0.032	0.013	0.052	0.578
Summer	0.021	0.007	0.036	0.712
Autumn	0.025	0.010	0.041	0.907
Bio-season				
'Winter'	0.023	0.016	0.030	0.806
'Summer'	0.030	0.021	0.038	0.622
Year				
Overall estimate	0.026	0.010	0.043	0.714

A.3.6.1.32 Since 'porpoise species' are predominantly harbour porpoise, the estimated patterns of density are similar to those presented for harbour porpoise. Estimated density varied across months and seasons, with greatest density estimates modelled for the months of October (0.053 animals/km^2, 95% CLs: 0.027, 0.080).

A.3.6.1.33 As for harbour porpoise when identified to species level, 'porpoise species' densities were estimated from the 'bio-season' model, which predicted a mean relative density of 0.023 animals/km^2 (95% CLs: 0.016, 0.030) during the winter bio-season, and 0.030 animals/km^2 (95% CLs: 0.021, 0.038) during the summer bio-season.

A.3.6.1.34 Relative abundance and density values were adjusted to account for availability bias, using the most conservative correction factor appropriate to porpoise species of 0.425 (see paragraph A.3.5.1.7 *et seq.*), to provide estimates of absolute abundance and density, and 95% confidence intervals (Table A.17).

Table A.17: GLM-based monthly, seasonal, and total absolute density estimates of ‘porpoise species’, including Lower and Upper 95% CLs, and CV.

Temporal division	Mean absolute density (animals/km^2)	Lower CL	Upper CL	CV
Month				
January	0.063	0.022	0.105	0.534
February	0.045	0.010	0.080	0.393
March	0.065	0.023	0.107	0.578
April	0.071	0.025	0.117	0.240
May	0.092	0.041	0.143	0.659
June	0.084	0.034	0.133	0.303
July	0.053	0.015	0.091	0.436
August	0.013	0.000	0.030	0.653
September	0.012	0.000	0.029	0.398
October	0.126	0.063	0.189	0.267
November	0.040	0.008	0.072	0.480
December	0.083	0.034	0.132	0.565
Meteorological season				
Winter	0.064	0.022	0.105	0.600
Spring	0.076	0.030	0.122	0.578
Summer	0.050	0.016	0.085	0.712
Autumn	0.059	0.024	0.097	0.907
Bio-season				
‘Winter’	0.054	0.038	0.071	0.806
‘Summer’	0.070	0.050	0.090	0.622
Year				
Overall estimate	0.062	0.023	0.102	0.714

A.3.6.1.35 Density distributions within the Morgan Aerial Survey Area were generated according to bio-season and are presented in Figure A.29. ‘Porpoise species’ density appears to be concentrated at the north region of the Morgan Aerial Survey Area, with greater density during the winter bio-season (October to March).

A.3.6.1.36 In all cases mean relative and absolute densities, derived from the linear models, are lower than equivalent densities obtained in the design-based approach. High coefficients of variation indicate a great deal of variability between estimates. These are likely due to the difficulty of the linear model to incorporate environmental covariates, leaving much of the variance unexplained, and contributing to the low predictive power of these models.

A.3.6.1.37 Mean relative and absolute densities, derived from the generalised linear models, are consistently lower than estimates obtained via the design-based approach. These linear models are not sufficiently robust to make predictions of density, and as such should not be relied upon to estimate distribution within the Morgan Aerial Survey Area. For this reason, estimates of occurrence and density should be based upon the estimates of abundance obtained from the design-based approach.

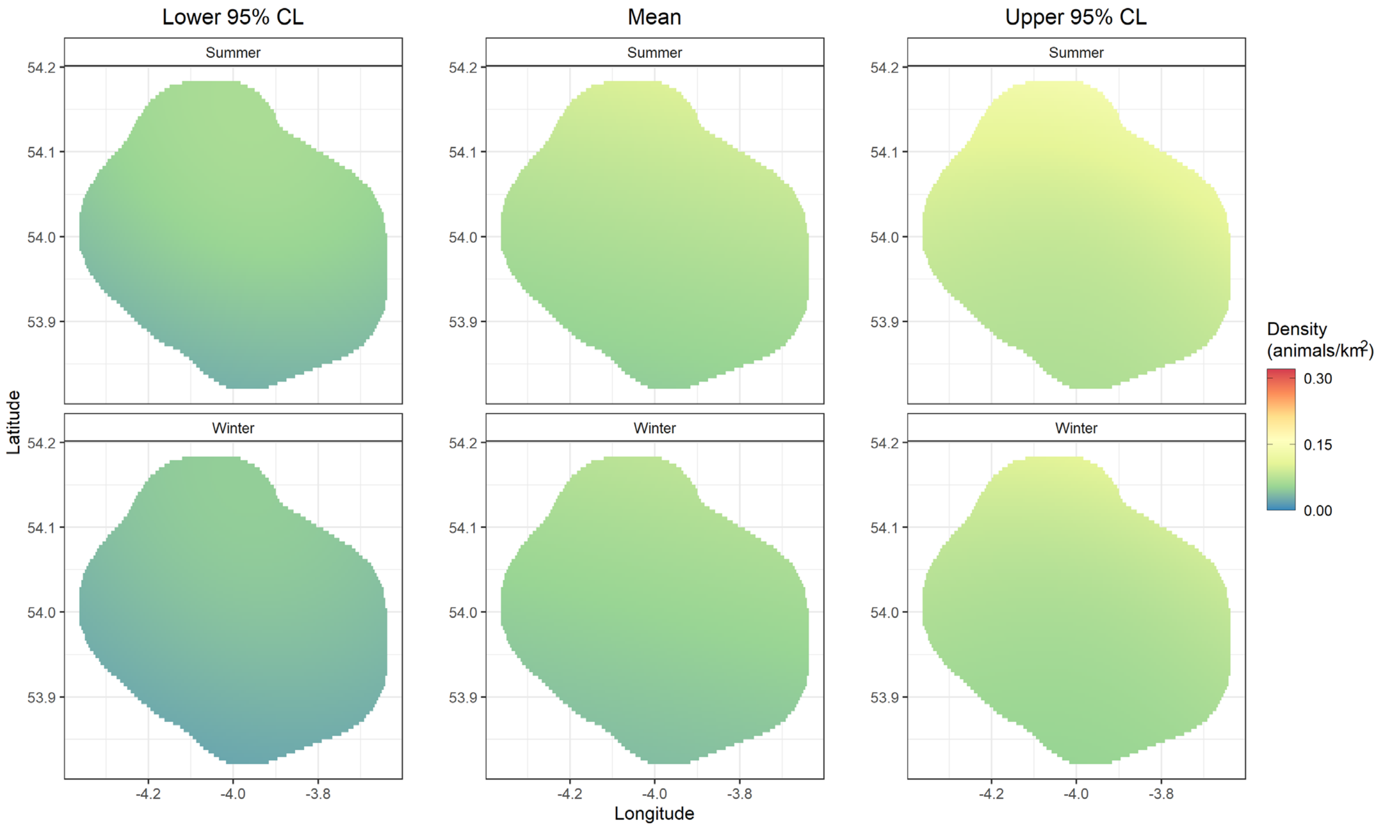


Figure A.29: GLM-estimated ‘porpoise species’ absolute density for the Morgan Aerial Survey Area, with lower and upper 95% CLs, split by ‘bio-season’.

A.3.6.1.38 GLM-based estimates were consistently and considerably lower than design-based estimates across all temporal divisions. The monthly density estimate for December was the only instance in which estimated density was greater in the GLM-based approach (0.083 animals/km^2) than the design-based estimate (0.059 animals/km^2), representing a difference of 40.86%.

Summary

A.3.6.1.39 This report provides a summary of marine mammal activity recorded during the digital aerial surveys across the Morgan Array Area and buffer (the Morgan Aerial Survey Area).

A.3.6.1.40 A target coverage of 12% of the aerial survey area was processed by APEM Ltd. The mean area actually processed in practice for the Morgan Aerial Survey Area was 12.97% (±0.06% SE).

A.3.6.1.41 The division of the year into two bio-seasons for harbour porpoise (and 'porpoise species'), based upon bimodal patterns of spatial distribution ('Winter' and 'Summer') is an approach intended to address the difficulties in implementing criteria for designating SACs (Heinänen & Skov, 2015). This approach has also been applied to biologically relevant seasons for grey seal ('Pupping' and 'Non-pupping') and is the approach to be taken forward to the Environmental Impact Assessment.

A.3.6.1.42 Densities were modelled using both a design-based approach, with bootstrapping to obtain confidence limits, and a model-based approach, incorporating environmental covariates as predictors of density distribution. Where possible, relative density estimates were corrected for availability bias to give absolute densities. Telemetry studies of the diving behaviour of different species were useful in indicating the average proportion of time that individuals of a species may be on, or near, the surface and available for detection. Note that the limitations of using availability bias estimates from published studies are recognised (e.g. potentially subject to geographic, seasonal, diurnal, and individual animal variation) and therefore absolute densities are considered to be approximations only.

A.3.6.1.43 Harbour porpoise accounted for the highest number of sightings identified to species level (n = 345, based on raw count data) across the Morgan Aerial Survey Area, and was recorded in all survey months. Grey seal (which included sightings of 'seal species') accounted for the second highest number of sightings (n = 34) and was recorded in all but nine months. There were 32 sightings classified as 'seal species' and 14 'marine mammal species' due to the issue of identifying to species level from aerial survey data, as well as a number of cetacean sightings ('dolphin species', 'dolphin/porpoise') that could not be assigned to species level (n = 63). For the purposes of analyses 'seal species' were grouped together with grey seal, whilst an additional analyses was also undertaken for 'porpoise species' which included 'dolphins/porpoise' plus harbour porpoise.

A.3.6.1.44 Bottlenose dolphin was encountered in one survey month (two sightings in June 2021: one group of eight animals, plus one solo individual). Risso's dolphin, minke whale and harbour seal were not encountered during the whole 24 months of the Morgan Aerial survey.

A.3.6.1.45 A summary of the density estimates using both design-based and model-based approaches is provided below (Table A.18).

Table A.18: Summary table of estimated absolute abundance and density, per species/grouping within the Morgan Aerial Survey Area. Density is expressed as animals/km^2.

Temporal division	Mean absolute abundance	Design-based approach				Model-based approach			
		Mean density	Lower CL	Upper CL	CV	Mean density	Lower CL	Upper CL	CV
Harbour porpoise									
'Winter'	220	0.159	0.130	0.194	0.740	0.050	0.034	0.067	0.860
'Summer'	303	0.219	0.179	0.268	0.518	0.062	0.043	0.082	0.647
Overall	261	0.189	0.154	0.231	0.619	0.056	0.018	0.095	0.750
Grey seal									
'Non-pupping'	98	0.071	0.052	0.092	0.746	0.020	0.001	0.040	0.742
'Pupping'	180	0.130	0.095	0.168	0.753	0.018	0.003	0.038	1.100
Overall	137	0.099	0.072	0.128	0.852	0.019	0.0019	0.0392	0.867
'Porpoise species'									
'Winter'	252	0.182	0.147	0.221	0.812	0.054	0.038	0.071	0.806
'Summer'	362	0.262	0.212	0.318	0.452	0.070	0.050	0.090	0.622
Overall	307	0.222	0.180	0.269	0.618	0.062	0.023	0.102	0.714

A.3.6.1.46 There was no clear spatial pattern in distribution for any of the species in the Morgan Aerial Survey Area, although some higher concentrations of harbour porpoise, and 'porpoise species', were visible in estimated density plots in the north of the survey area. Grey seal was found at higher densities along the northeast boundary of the Morgan Aerial Survey Area.

A.3.6.1.47 The model-based approach using the MRSea package for R was unable to robustly predict the distribution of marine mammal density from these data for the Morgan Aerial Survey Area, due to low number of sightings. As an alternative, GLMs were employed to make simple estimates based only on seasonal and spatial covariates, since these models were unable to incorporate environmental information (bathymetry, distance to coast).

A.3.6.1.48 The GLMs are based entirely upon observations of marine mammal species within the Morgan Aerial Survey Area. Although these are a useful tool in estimating distribution based upon confirmed occurrence, these models do not provide sufficient statistical power for predictions of spatial distribution, abundance or density to be made for any of the species considered.

A.3.6.1.49 As a result of the simplified model-based approach, and the "snap-shot" nature of the aerial surveys, any assessment based on interpretation of the suggested seasonality and spatial distribution of marine mammals should be undertaken with caution, and preference given to estimates obtained via the design-based approach.

A.3.6.1.50 Design-based analyses found that the highest mean absolute densities for the biologically relevant bio-seasons occurred in the summer bio-season for harbour porpoise with 0.219 animals/km^2 (CLs: 0.179, 0.268). Similarly, for combined 'porpoise species' the summer bio-season produced higher densities compare to winter with 0.262 animals/km^2 (CLs: 0.212, 0.318).

A.3.6.1.51 Mean monthly absolute density of grey seal (including 'seal species'), estimated using the design-based approach, was highest during the non-pupping bio-season with 0.130 animals/km^2 (CLs: 0.095, 0.168).

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Appendix B: SMRU Seal Haul out and telemetry data in relation to the Morgan Offshore Wind Project: Generation Assets.

SMRU Consulting

understand ◆ assess ◆ mitigate

Seal haul-out and telemetry data in relation to the Morgan Offshore Wind Project: Generation Assets

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Report Code:	SMRUC-RPS-2022-004
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1 Introduction

SMRU Consulting was contracted by RPS to provide seal haul-out count and telemetry data in relation to the Morgan Offshore Wind Project: Generation Assets (hereafter referred to as the Morgan Generation Assets). At the time of enquiry (June 2022), the area of interest for the data request was the regional marine mammal study area, bounded by the limits of the Irish Sea[1]. This overlaps with the Northwest England, Wales, Southwest Scotland and Northern Ireland seal MUs and the combined area of these MUs are hereafter referred to as the seal telemetry and haul-out study area. The following data was requested:

- Harbour seal *Phoca vitulina* haul-out count data from August moult census surveys between 1996 and 2018 to examine site specific abundance and interannual patterns in counts over time. This will cover all haul-outs within the seal telemetry and haul-out study area
- Associated grey seal *Halichoerus grypus* haul-out counts from these same August surveys (although please note that during the summer months grey seal distribution is highly variable and these counts, while giving a single snapshot of local summer distribution, are not a reliable census of population size)
- Provision of regional and national context for these counts
- Grey seal pup production estimates from all regularly surveyed breeding sites within the seal telemetry and haul-out study area
- Provision of seal satellite tracking data from tagged harbour and grey seal - either animals tagged at the Special Areas of Conservation (SACs) and visiting the seal telemetry and haul-out study area or visiting the seal telemetry and haul-out study area and also hauling-out at the SACs
- Provision of satellite tracking data from all harbour or grey seal which cross the seal telemetry and haul-out study area regardless of where tagged, if not already included in the datasets specified above
- A basic quantification of the degree of connectivity between the seal telemetry and haul-out study area and protected haul out sites.

Note: SMRU do not carry out haul-out counts in the Northwest England MU or the Wales MU. Estimates of seals hauled-out in these MUs are '*compiled from counts shared by other organisations or found in reports & on websites*' (SCOS, 2021).

1.1 Seal telemetry and haul-out study area

The seal telemetry and haul-out study area comprises the total area of four MUs, namely the Northwest England, Wales, Southwest Scotland and Northern Ireland seal MUs (Figure 1). The Morgan Generation Assets is entirely located within the Northwest England MU. The Morgan marine mammal study area comprises the Morgan Array Area plus a 10 km buffer.

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[1] In the Marine Mammals Technical Report, the regional marine mammal study area has been subsequently widened to cover the Irish Sea and wider Celtic Sea after this report was requested.

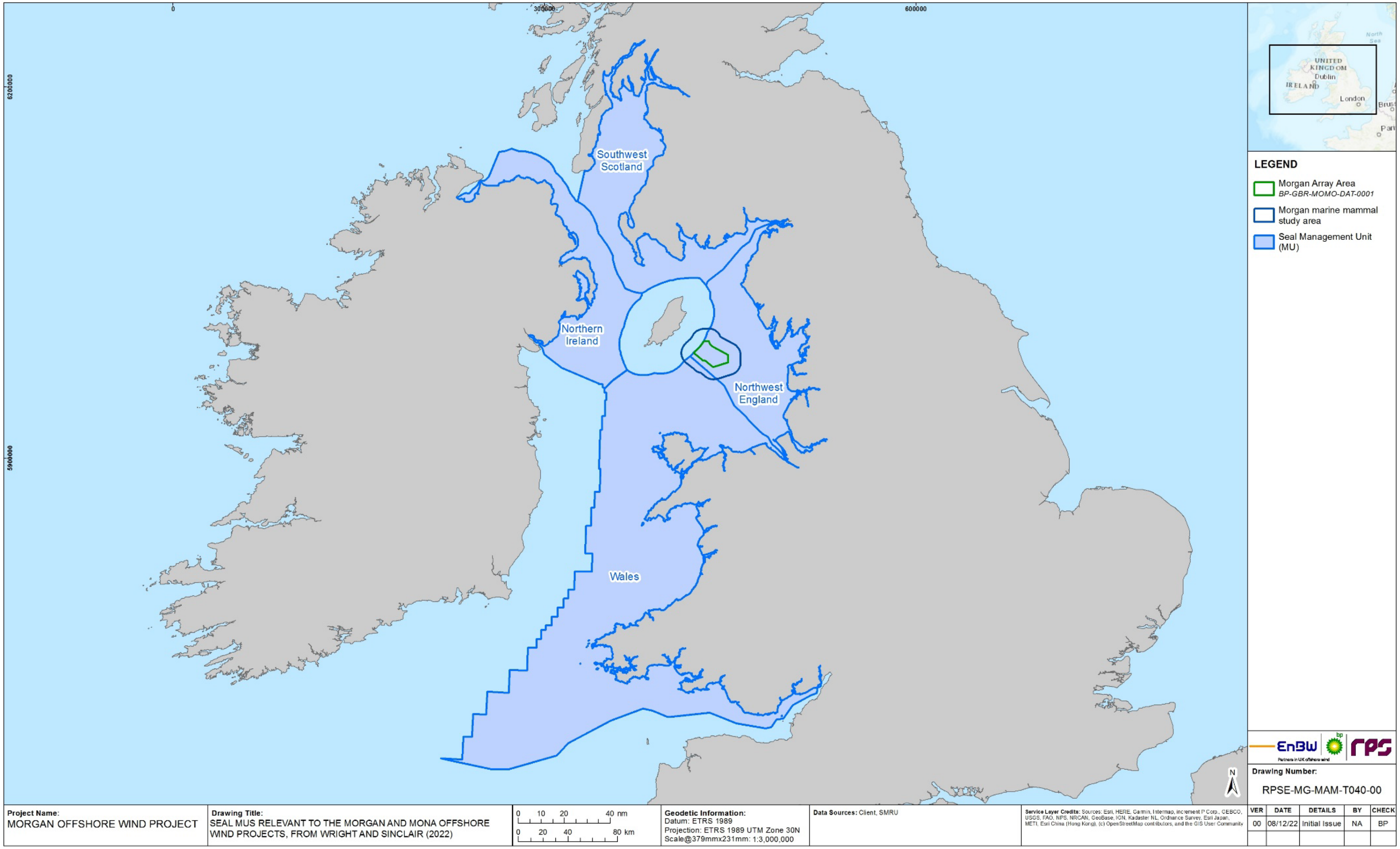

Figure 1: Morgan marine mammal study area and relevant MUs.

2 Methods

2.1 Haul-out Surveys

2.1.1 Sea Mammal Research Unit (SMRU) Surveys

The Sea Mammal Research Unit (SMRU) carries out surveys of harbour (or common) and grey seal in Scotland and on the east coast of England to contribute to the Natural Environment Research Council's (NERC's) statutory obligation under the Conservation of Seals Act 1970 '*to provide the (UK government) with scientific advice on matters related to the management of seal populations*'. These SMRU surveys, as well as surveys by other organisations (including NatureScot, Natural England, the Natural Resources Wales, the National Trust and the Lincolnshire Wildlife Trust) form the routine monitoring of seal populations around the UK. The annually submitted 'Advice', which includes information on recent changes in grey and harbour seal numbers, can be found in the Special Committee on Seals (SCOS) reports on SMRU's website[2].

Seals are widely distributed around the UK coast and most surveys are carried out from the air by either light aircraft or helicopter. SMRU does not survey the entire UK coast; surveys are concentrated in Scotland and on the east coast of England (Lincolnshire and Norfolk) where seals are relatively abundant and easy to survey. All surveys are of seals that are hauled-out on shore.

On account of differences in the breeding behaviour of harbour and grey seal, the two species are surveyed at different times in their annual cycle. Harbour seal tend to be dispersed when breeding and aggregate, to an extent, when moulting, so the main harbour seal surveys are carried out during their annual moult in August. In contrast, grey seal aggregate at traditional colonies when breeding and, therefore, grey seal surveys are designed to estimate the numbers of pups born at these colonies, during the autumn breeding season (between August and December). Harbour seal are also surveyed in a few areas during their breeding season in June and July. While grey seal are counted on all harbour seal surveys, harbour seal are very rarely seen on any of the grey seal breeding colony surveys.

2.1.1.1 Harbour Seal

Surveys of harbour seal are carried out during the summer and early autumn months. There are two types of surveys conducted: breeding counts and moult counts.

Breeding seals are surveyed in June and July. Breeding season surveys are carried out (almost) annually in the Moray Firth and, in recent years, in Lincolnshire and Norfolk. A very limited number of breeding season surveys have been carried out on behalf of NatureScot in areas designated as SACs for harbour seal in Scottish waters. Given that there are no harbour seal breeding surveys conducted in the seal telemetry and haul-out study area, these are not considered further in this report.

The main population surveys are carried out when harbour seal are moulting, during the first three weeks of August. The greatest and most consistent numbers of harbour seal are hauled-out ashore during their annual moult. To maximise the numbers of seals on shore and to reduce the effects of environmental variables, surveys are restricted to within two hours either side of low tides and are not conducted in the rain.

The frequency of surveys differs by area. In general, moult surveys that are conducted annually are carried out in Lincolnshire and Norfolk (England), the Moray Firth and the Firth of Tay (Scotland). The remainder of the Scottish coast is surveyed approximately every four to five years, although there is considerable variation between areas.

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[2] http://www.smru.st-andrews.ac.uk/research-policy/scos/

Harbour seal inhabiting rocky shores using a helicopter equipped with a thermal imaging camera that can detect seals hauled out ashore at a distance of up to 3 km It is possible to differentiate between the two species using their thermal profiles, the group structure on shore, a ‘real’ image from a camcorder, directly using binoculars or retrospectively from high resolution digital photographs. In some instances, however, species identity is still uncertain, and the seals are classified as ‘species unknown’.

The moult counts represent the number of harbour seal that were on shore at the time of the survey and are an estimate of the minimum size of the population. They do not represent the total size of the local population since a number of seals would have been at sea at the time of the survey. Note that these data refer to the numbers of seals found within the surveyed areas only at the time of the survey; numbers and distribution are likely to differ at other times of the year (such as the breeding period).

Numbers of grey seal are also counted during the harbour seal August moult surveys. Counts of greys seal during the summer months are highly variable and are not used as a population index in this species, however they provide useful information on the summer and non-breeding season distribution of grey seal. It is possible to differentiate between the two species using thermal profiles and their group structure on shore. Species identity is confirmed using a ‘real’ image from a camcorder and directly using binoculars. The most recent data for the seal telemetry and haul-out study area are from the period 2016 to 2019.

It is estimated that 72% of the total harbour seal population are hauled-out and available to count during August surveys (Lonergan *et al.*, 2013). The harbour seal counts can be scaled by the proportion of seals hauled-out at the time of the counts, providing an estimated population size for an MU.

2.1.1.2 Grey seal

Grey seal aggregate in the autumn (August to December) to breed at traditional colonies, and therefore their distribution during the breeding season is very different to their distribution at other times of the year (such as the annual moult – December to April, or other times of the year where they spend less time hauled-out and travel further between haul-outs sites).

It is estimated that 23.9% of the total grey seal population are hauled-out and available to count during August surveys (Russell *et al.*, 2016) and therefore the total number of grey seal in the population for any given count period can be estimated by using the proportion of seals hauled-out.

2.1.1.2.1 Scotland

Grey seal are surveyed during their breeding season (August to December). Most breeding colonies are surveyed by SMRU by fixed wing aerial vertical photography (Hebrides, Orkney, North Scotland the Northeast Scotland, and most of the Firth of Forth) while others are surveyed by ground count by other organisations (Shetland and Incholm in the Firth of Forth). The grey seal pup production database contains data from 1989 to 2019 and includes 74 breeding colonies (though not all colonies have been surveyed consistently since 1989 and some smaller colonies are surveyed more sporadically than others). Most breeding colonies used to be surveyed annually, however from 2010 most colonies switched to biennial surveys instead due to reductions in funding combined with increased aerial survey cost (SCOS, 2015) (Note: surveys in southeast England remain annual).

There are no known breeding colonies within the Southwest Scotland MU.

2.1.1.2.2 Wales

In Wales, grey seal are difficult to count at haul-out sites from aerial surveys as, during the pupping season, many haul-out in caves and in ‘*cryptic habitats where topographic features completely or partially obscure the habitat from aerial view*’; therefore ground and vessel-based surveys are more likely to result in accurate estimates, but are challenging due to cost, personnel and resource limitations (Stringell *et al.*, 2014).

Grey seal haul-out around the Welsh coastline which Natural Resources Wales (NRW) monitors partly through the maintenance of the EIRPHOT database of photo-ID data from 246 haul-out sites around the Welsh coast and islands.

2.1.1.2.3 Northwest England

In the Northwest England MU, there are no dedicated SMRU seal haul-out surveys conducted due to the low numbers of seals (SCOS, 2021). The Cumbria Wildlife Trust and Walney Bird Observatory have recorded seal counts at the South Walney haul-out during the breeding and moulting seasons, and the area has been considered a pupping site since 2015. Since 2019, Cumbria Wildlife Trust have provided SMRU with breeding counts of grey seal during low tide.

2.1.1.2.4 Northern Ireland

The National Trust monitors the grey seal haul-outs in Northern Ireland, specifically the Strangford Lough haul-out where the majority of pups are born. August haul-out surveys conducted by SMRU are not completed annually in Northern Ireland. In 2002, 2011 and 2018 August surveys conducted by SMRU were commissioned by the Department of Agriculture, Environment and Rural Affairs, Northern Ireland) (Duck and Morris, 2019).

2.1.2 Summary of methods

1. Population surveys of harbour seal are carried out during their annual moult in August
2. Harbour seal August moult surveys provide an estimate of the minimum size of the population, not the total population size
3. In general, harbour seal population (August moult) surveys are carried out once every four to five years in most of Scotland but annually in Lincolnshire, Norfolk, the Moray Firth and the Firth of Tay. Surveys are conducted less frequently in Wales and Northern Ireland
4. The main grey seal surveys are conducted in the autumn to estimate the number of pups born at the main breeding colonies around the UK. These pup counts are used by SMRU to estimate the total grey seal population size
5. Grey seal are also counted during harbour seal August moult surveys. Their numbers are highly variable in the summer months and provide information on the summer distribution and abundance of grey seal. These data also feed into the population model alongside pup data in order to estimate grey seal total population size
6. Population estimates of seals can be obtained by scaling the August haul-out count data by the proportion of the total population hauled-out and available for the count (harbour seal: 72%, grey seal: 23.9%)
7. Results of all surveys are presented annually to the UK Government as part of NERC's statutory obligation under the Conservation of Seals Act 1970. These results are available in the SCOS documents on SMRU's website[3]
8. In Wales, grey seal are counted using aerial, ground and vessel-based surveys due to hauling out in caves and 'cryptic habitats'. NRW monitors and commissions monitoring of grey seal partly through the maintenance of the EIRPHOT database of photo-ID data (Russell and Morris, 2021)

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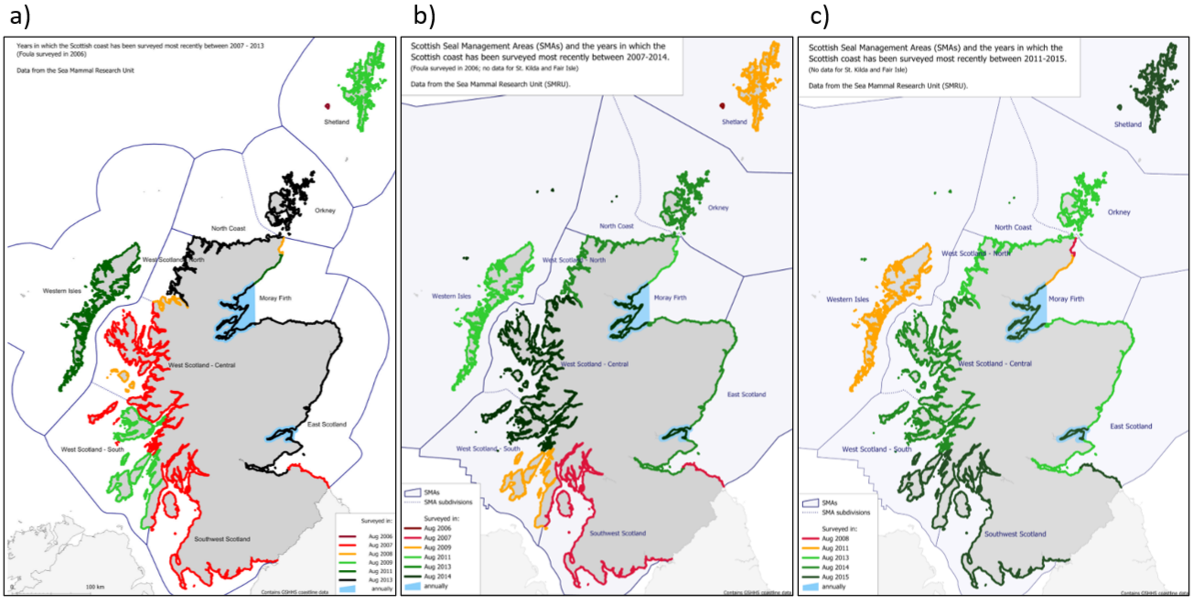
[3] http://www.smru.st-andrews.ac.uk/research-policy/scos/

9. In Northwest England, The Cumbria Wildlife Trust and Walney Bird Observatory record grey seal haul-out counts at South Walney and have provided SMRU with counts at low tide since 2019. The area has been considered a pupping site since 2015

10. In Northern Ireland, The National Trust monitors the grey seal haul-outs at Strangford Lough. SMRU August haul-out surveys are not conducted annually.

The haul out count data from the annual SMRU surveys are not appropriate for assessing fine scale distribution of haul out sites – the data we have are a snapshot of a single day in August in each of the surveyed years and it is only appropriate to interpret these on a regional scale. The numbers present at any one location can be highly variable between months and years and as such the data should not be used to inform decisions relating to micro-siting infrastructure.

Note: Only a part of the Scottish coast can be surveyed in one year, resulting in big differences in the area covered annually. Ideally, the entire Scottish coast is completed every five years. Figures are provided in SCOS reports (and are duplicated here for information - Figure 2, Figure 3 and Figure 4) to highlight which part of the Scottish coastline has been surveyed each year. In SCOS reporting, tables of the most recent haul-out counts are provided by ‘survey period’ (1996 to 1997, 2000 to 2006, 2007 to 2009, 2011 to 2015 and 2016 to 2019) as these represent periods within which the entire Scottish coastline was surveyed.

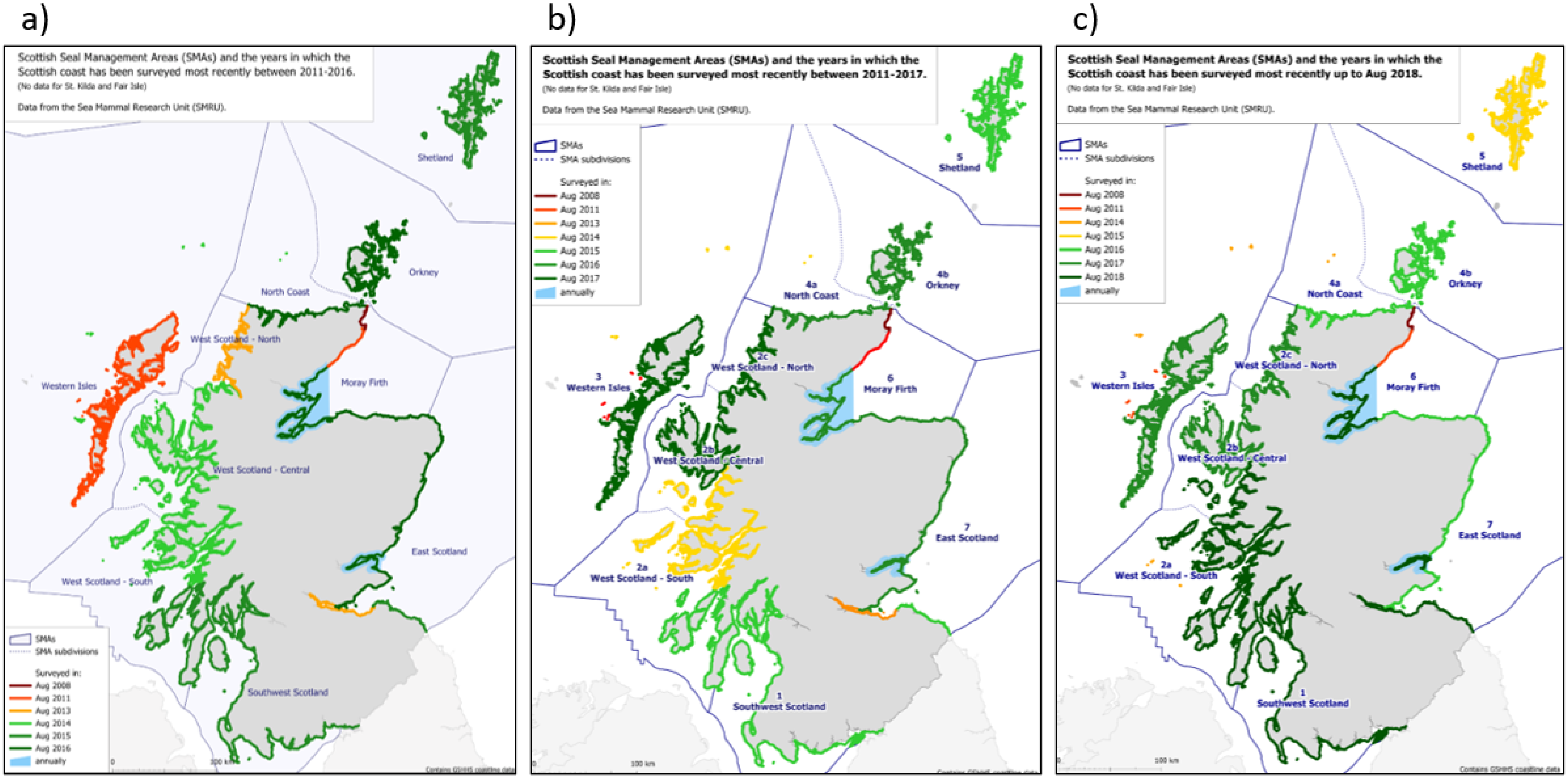


a) Most areas were surveyed between 2007 and 2013. Foula, off Shetland, was last surveyed in 2006. The enclosed areas of the Firth of Tay and the Moray Firth (between Findhorn and Helmsdale) are surveyed every year, usually by fixed-wing aircraft.

b) Most areas were surveyed between 2007 and 2014. Foula, off Shetland, was last surveyed in 2006. The enclosed areas of the Firth of Tay and the Moray Firth (between Findhorn and Helmsdale) are surveyed every year, usually by fixed-wing aircraft.

c) Most areas were surveyed between 2011 and 2015. The enclosed areas of the Firth of Tay and the Moray Firth (between Findhorn and Helmsdale) are surveyed every year, usually by fixed-wing aircraft.

Figure 2: Years in which different parts of Scotland were surveyed by helicopter using a thermal imaging camera. a) 2006 to 2013 (SCOS, 2015), b) 2007 to 2014 (SCOS, 2016), c) 2011 to 2015 (SCOS, 2017).



a) Most areas were surveyed between 2011 and 2015. The enclosed areas of the Firth of Tay and the Moray Firth (between Findhorn and Helmsdale) are surveyed every year, usually by fixed-wing aircraft.

b) Most areas were surveyed between 2013 and 2017. The blue shaded areas of the Firth of Tay and the Moray Firth (between Findhorn and Helmsdale) are surveyed every year, usually by fixed-wing aircraft.

c) Most areas were surveyed between 2015 and 2018. The blue shaded areas of the Firth of Tay and the Moray Firth (between Findhorn and Helmsdale) are surveyed every year, usually by fixed-wing aircraft.

Figure 3: Years in which different parts of Scotland were surveyed by helicopter using a thermal imaging camera. a) 2011 to 2016 (SCOS, 2018), b) 2011 to 2017 (SCOS, 2019), c) 2011 to 2018 (SCOS, 2020).

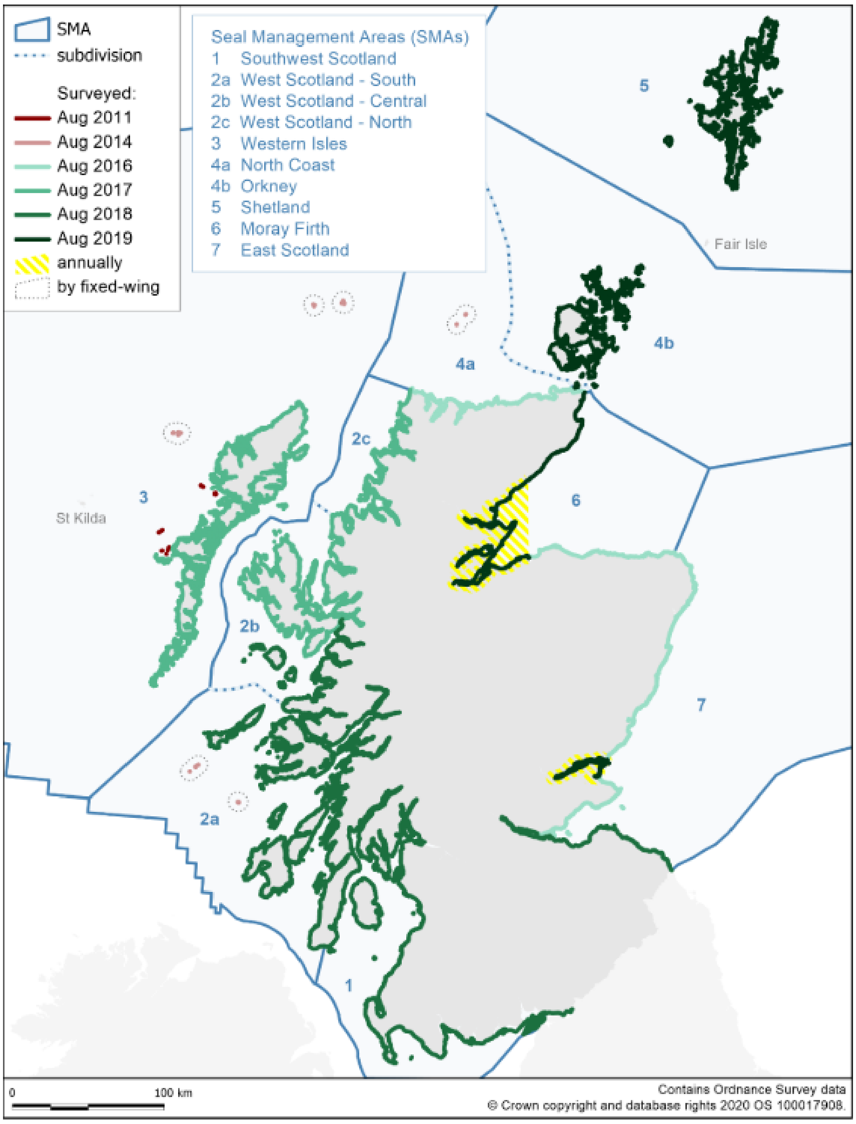


Figure 4: The most recent aerial surveys carried out during the harbour seal moult in August (SCOS, 2021).

Most areas were last surveyed between 2016 and 2019. The yellow shaded areas of the Firth of Tay and the Moray Firth (between Helmsdale and Findhorn) are surveyed every year, usually by fixed-wing aircraft. Offshore islands were last surveyed in 2014 by fixed-wing aircraft. However, only very small numbers of harbour seal are found on islands last surveyed pre-2016. St Kilda and Fair Isle have not been covered properly by aerial surveys.

2.2 Telemetry data

Relevant data were available for harbour and grey seal from telemetry tags deployed by SMRU. Tags are glued to the fur on the back of the seal's neck and fall off with the fur during the annual moult, if not before. These tags transmit data on seal locations with the tag duration (number of days) varying between individual deployments. It is worth noting that the timing of the tag deployment can be important, especially for grey seal, since movement patterns can differ between the breeding and non-breeding seasons (Russell *et al.*, 2013).

There are data from two types of telemetry tag presented in this report which differ by their data transmission methods. Data transmission can be through the Argos satellite system (Argos tags) or Global Positioning System (GPS) phone tags which combine GPS quality locations with transmission of data using the Global System for Mobile communication (GSM) phone network. Both types of transmission result in location estimates, but the spatial and temporal resolution of the locational data varies with deployment. Argos location tags can have an error of >2.5 km (Vincent *et al.*, 2002) while GPS location tags have a better location accuracy, with a typical error of <50 m (Patterson *et al.*, 2010). Data from GPS phone tags also provide more frequent locations by the incorporating the Fastloc GPS system (Wildtrack Telemetry Systems, UK) which obtains locational data within a fraction of a second and therefore can collect data even when the animal surfaces for a short period. The GPS tags attempt to collect location data every 5 to 20 minutes (depending on the parametrisation at set-up). Data are stored on board the tags and then relayed to SMRU by a satellite (Argos tags) or by quad-band GSM mobile phone module when the animal is within range of the GSM mobile phone network. The data are then stored in databases, cleaned according to methods described in Russell *et al.* (2011).

3 Legislation

In the UK, seals are protected under the Conservation of Seals Act 1970 in England and Wales, The Wildlife (Northern Ireland) Order 1985 in Northern Ireland and the Marine (Scotland) Act 2010.

The Conservation of Seals Act 1970 prohibits the taking of seals and killing of seals using any poisonous substance or use of any firearm other than a rifle with specified ammunition. It is an offence to take or kill a seal unless a specific License has been granted. Licences can be granted by Natural England (England) and NRW (Wales) under powers conferred by the Secretary for State. The Fisheries Act 2020 amended the Conversation of Seals Act 1970 and the Wildlife (Northern Ireland) Order 1985, to prohibit the international or reckless killing, injuring or taking of seals. In addition, the legislative changes removed the provision to grant licenses for the purposes of protection, promotion or development of commercial fisheries or aquaculture. Under Article 10 of the Wildlife (Northern Ireland) Order 1985, it is an offense to disturb seals intentionally or recklessly at any haul-out site in Northern Ireland.

In Scotland, seals are protected under the Marine (Scotland) Act 2010 (which supersedes the Conservation of Seals Act). Part 6 of this Act prohibits the taking of seals except under licence. Licences can be granted for scientific and welfare reasons[4]. NERC, through the SCOS and the SMRU, provides advice on all licence applications and haul out designations. Part 6 of this Act also prohibits harassment and injury to seals. The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014 laid in the Scottish Parliament on 26 June 2014 which, from 30 September 2014, makes it an offence to harass seals at these sites. Harassment involves any activity that pesters, torments, troubles or attacks a seal on a designated haul-out site. In particular, it would include any action that causes a significant proportion of seals on a haul-out site to leave that site either more than once or repeatedly or, in the worst cases, to abandon it permanently (Marine Scotland, 2014a, b).

In Ireland, seals are protected under the Irish Wildlife Act 1976. The National Parks & Wildlife service (NPWS) is the regulatory body responsible for designating and advising on protected habitats and species in Ireland.

3.1 SACs

The European Union's Council Directive 92/43/EEC (commonly known as the 'Habitats Directive') requires the creation of a Europe-wide network of SACs for designated species. This network of SACs is designed to ensure that the species listed in Annex II of the Habitats Directive, which includes both grey and harbour seal, are maintained in a favourable conservation status in their natural range (Article 3(1)). Information on the SACs which have been designated for harbour seal can be found on

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[4] Note: the Animals and Wildlife (Penalties, Protections and Powers) (Scotland) Act 2020 amended the Marine (Scotland) Act 2010. The change removed the granting licenses to kill or take seals for the protection of the health and welfare of farmed fish, and to prevent serious damage to fisheries or fish farms.

the JNCC website[5]. Information on the SACs which have been designated for grey seal can be found on the JNCC website[6].

The Habitats Directive requires the creation of a Europe-wide network of SACs. The network of SACs is designed to ensure that the species listed in Annex II of the Directive are restored at a favourable conservation status in their natural range (Article 3(1)). The EU Habitats Directive (1992) lists both grey and harbour seal in Annex II and Annex V and requires that SACs be established for their protection (Table 1).

Table 1: SACs designated for their seal populations within the seal telemetry and haul-out study area.

There are no designated SACs for the harbour seal in Wales.
There are no designated SACs for seals in the Northwest England MU

[1] It should be noted that these SACs are not located within the specified seal telemetry and haul-out study area, however some are referred to later in the report.

MU	SAC	Marine mammal species
Wales MU	Pembrokeshire Marine/Sir Benfro Forol	Grey seal (designated)
	Cardigan Bay	Grey seal (qualifying feature)
	Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau	Grey seal (qualifying feature)
Northern Ireland MU	The Maidens	Grey seal (qualifying feature)
	Murlough	Grey seal (qualifying feature)
	Strangford Lough	Harbour seal (qualifying feature)
Ireland[1]	Saltee Islands	Grey seal (designated)
	Roaringwater Bay and Islands	Grey seal (designated)
	Blasket Islands	Grey seal (designated)
	Slaney River Valley	Harbour seal (designated)
	Lambay Island	Harbour and grey seal (qualifying)

3.2 Designated haul-out sites

In the Southwest Scotland MU, there are seven designated seal haul-out sites, one of which overlaps into the Northwest England MU (Table 2 and Figure 6). However, these haul-outs are over ~74 km swimming distance away from the Morgan Generation Assets (Table 2) and therefore there is expected to be no direct impacts to seals while hauled-out at these designated sites. There are no designated grey seal breeding colonies in the vicinity of the Morgan Generation Assets or surrounding MUs.

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[5] https://sac.jncc.gov.uk/species/S1365/

[6] https://sac.jncc.gov.uk/species/S1364/

Table 2: Designated seal haul-out sites in the Southwest Scotland MU based on August survey counts (both species).

<table>
<tr><th>Site ID</th><th>Site Name</th><th>Location</th><th>Distance from Morgan Generation Assets by sea</th></tr>
<tr><td>**SW-006**</td><td>**Little Scares**</td><td>**Luce Bay, between Mull if Galloway and Burrow Head**</td><td>**~74 km**</td></tr>
<tr><td colspan="4">Entire islands of the Big Scares and the Little Scares.</td></tr>
<tr><td>**SW-007**</td><td>**Solway Firth Outer Sandbank**</td><td>**Solway Firth, between Southerness Point and Dubmill Point**</td><td>**~87 km**</td></tr>
<tr><td colspan="4">Intertidal mud banks southeast of Southerness Point in the Solway Estuary.</td></tr>
<tr><td>**SW-001**</td><td>**Sanda & Sheep Island**</td><td>**Mull of Kintyre**</td><td>**~175 km**</td></tr>
<tr><td colspan="4">Intertidal sandbanks and rocky coastline of Sanda and Sheep Island and associated rocky outcrops.</td></tr>
<tr><td>**SW-004**</td><td>**Yellow Rock**</td><td>**Ardnacross Bay, East Kintyre**</td><td>**~185 km**</td></tr>
<tr><td colspan="4">Intertidal sandbanks and rocky coastline between Macringan’s Point and the north end of Yellow Rock and associated rocky outcrops.</td></tr>
<tr><td>**SW-002**</td><td>**Sound of Pladda Skerries**</td><td>**South Arran**</td><td>**~190 km**</td></tr>
<tr><td colspan="4">Intertidal sandbanks and rocky coastline between Port a Ghillie Ghlais and Port Dearg and associated rocky outcrops.</td></tr>
<tr><td>**SW-003**</td><td>**Rubha nan Sgarbh**</td><td>**Kilbrannan Sound, East Kintyre**</td><td>**~197 km**</td></tr>
<tr><td colspan="4">Intertidal sandbanks and rocky coastline between Pluck Point and Sgorshuil and associated rocky outcrops.</td></tr>
<tr><td>**SW-005**</td><td>**Lady Isle**</td><td>**Firth of Clyde, West of Troon**</td><td>**~200 km**</td></tr>
<tr><td colspan="4">Entire island of Lady Isle and associated rocky outcrops.</td></tr>
</table>

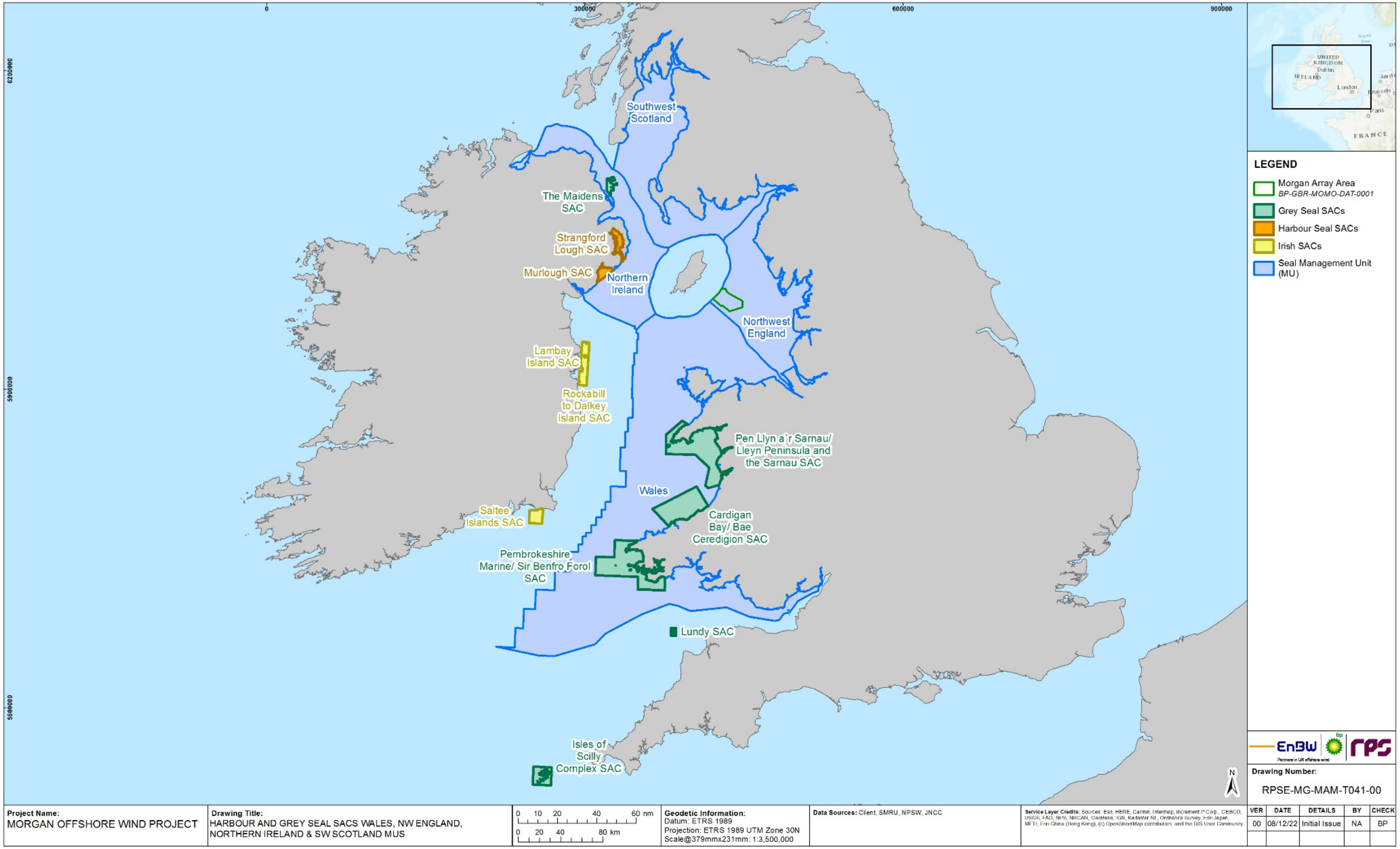
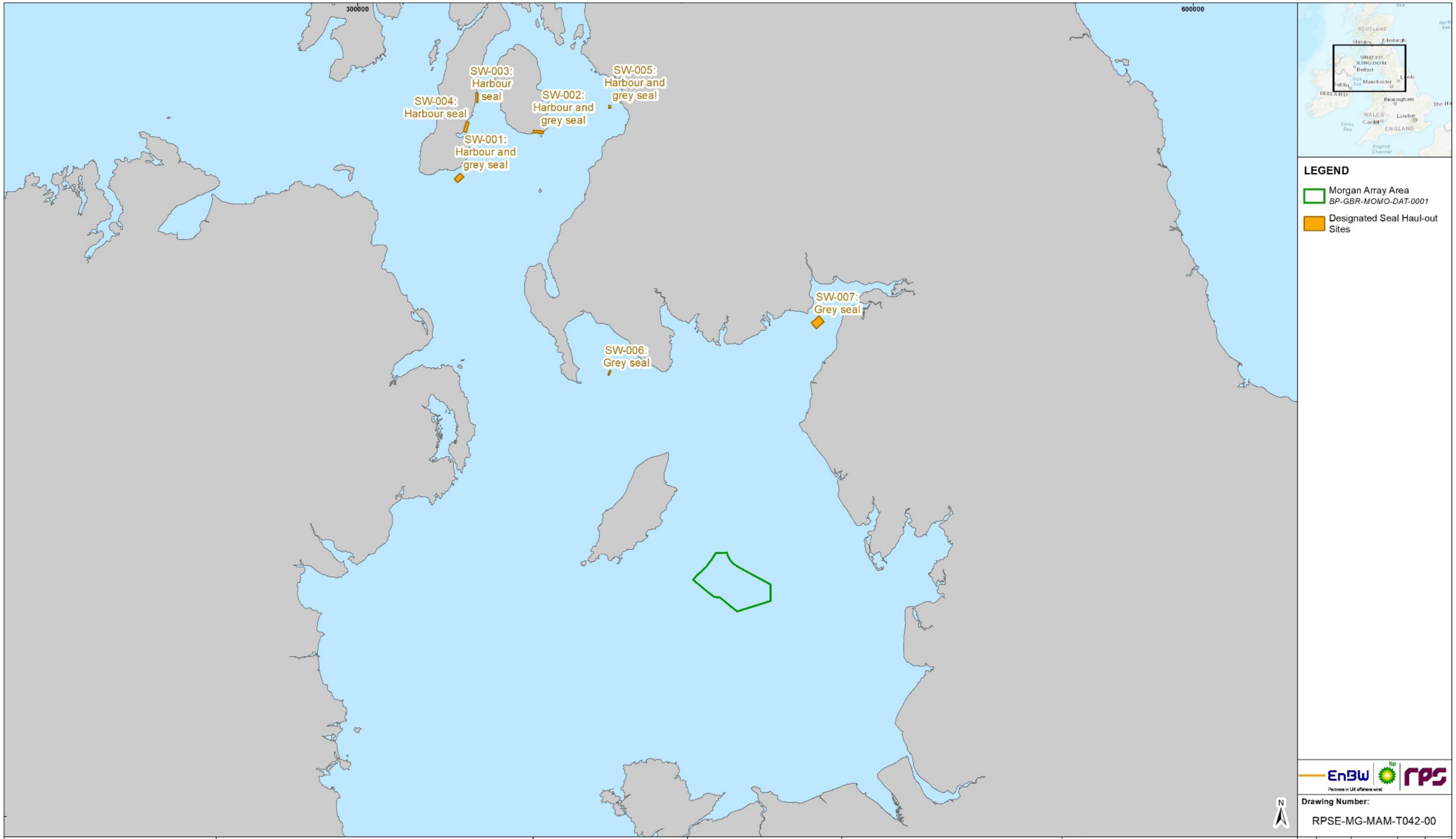


Figure 5: Harbour and grey seal SACs – labels are provided for those SACs mentioned in the report text.



Drawing Number:
RPSE-MG-MAM-T042-00

Project Name:
MORGAN OFFSHORE WIND PROJECT

Drawing Title:
DESIGNATED HAUL-OUT SITES IN THE MARINE MAMMAL STUDY AREA

0 10 20 nm
0 20 40 km

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@379mmx231mm: 1:1,386,667

Data Sources: Client, SMRU, NPSW, JNCC

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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Figure 6: Designated seal haul-out sites in the vicinity of the Morgan Generation Assets

4 August haul-out counts

4.1 Harbour seal

4.1.1 National counts

The most recent August haul-out count for the whole of Scotland is for the count period 2016 to 2019, where a total of 26,846 harbour seal were counted. For England and Wales, a further 3,886 harbour seal were counted and in Northern Ireland 1,012 were counted. This results in a total count of 31,744 harbour seal in the UK (and 35,751 including the Republic of Ireland) (Figure 7) (SCOS, 2021) and an estimated population of ~44,100 harbour seal[7] in the UK (~49,700 including the Republic of Ireland).

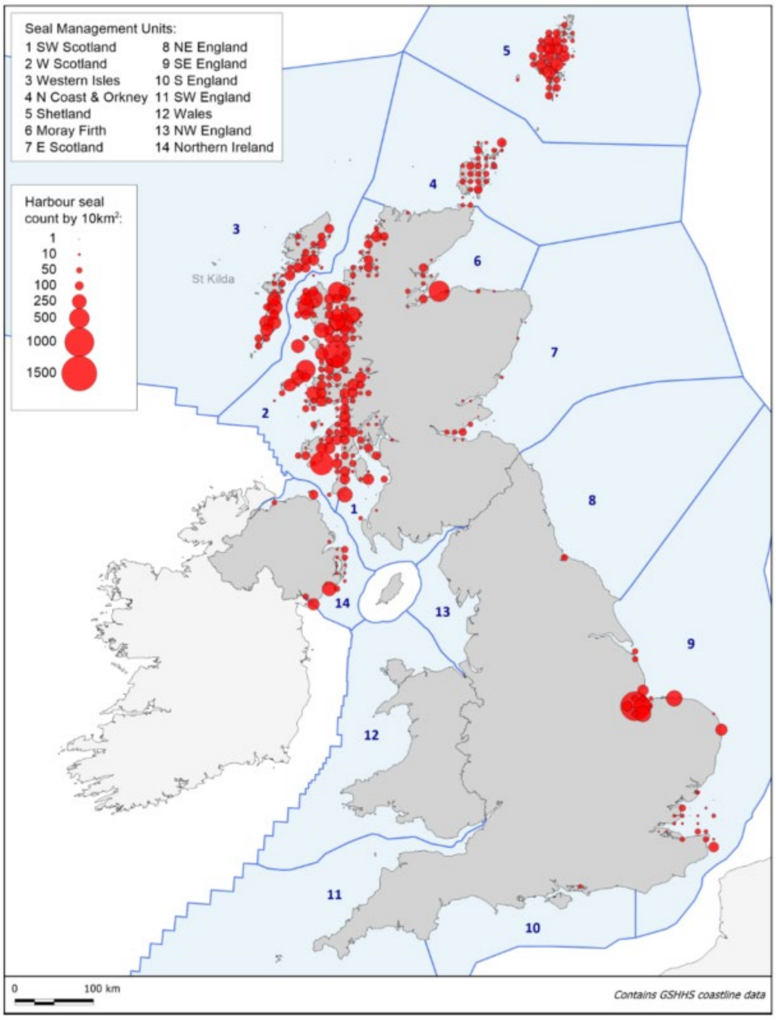

Figure 7 **August distribution of harbour seal around the British Isles by 10 km squares based on the most recent available haul-out count data collected up until 2019. Limited data available for seal management units 10 to 13; no data available for St Kilda. Figure obtained from SCOS (2021).**

4.1.2 MU counts

In the Wales and Northwest England MUs, there are no dedicated harbour seal surveys routinely carried out due to the very low numbers of seal (SCOS, 2021). Harbour seal haul-out counts for the

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[7] Calculated as: (31,744/72)*100

Wales and Northwest England MU have remained steady over the survey periods (Table 3). It has been suggested that the slight increase in the most recent survey periods could be due to improved species identification and increased reporting of seal counts (SCOS, 2021). In the most recent survey period 2016 to 2019, the harbour seal haul-out counts for the Wales and Northwest England MUs were ten and five, respectively. This results in an estimated population size of 14 harbour seal for the Wales MU and seven for the Northwest England MU.

The Northern Ireland MU is not surveyed annually, with only three full surveys of the harbour seal population having been conducted since 2002 (2002, 2011 and 2018). A full survey of the MU was most recently conducted in 2018 which showed a haul-out count of 1,012, a 6.8% increase from the previous survey period of 2011-2015 (Table 3) (SCOS, 2021). The population size of the MU can be estimated by scaling the 2018 haul-out count (1,012) by the proportion of seals hauled-out at the time of the count, resulting in an estimate of 1,406 harbour seal in the Northern Ireland MU.

Sites within the Southwest Scotland MU are not surveyed annually, with surveys conducted in 1996, 2005, 2007, 2009, 2015 and 2018 (Table 3). Harbour seal haul-out counts from the 2005 August survey, showed a decline from the 1996 count. Since 2007 the harbour seal counts have recovered with a 12% per annum (SCOS, 2021) increase between 2015 and 2018, suggesting a rapidly increasing population (Figure 8). The most recent August haul-out count of 1,709 harbour seal for the 2016-2019 count period results in a population estimate of 2,374 harbour seal in the Southwest Scotland MU.

Table 3: Harbour seal August haul-out counts for various survey periods. Data from SCOS (2021).

1 No SMRU surveys, but some data available. Estimates compiled from counts shared by other organisations (Langstone Harbour Board & Chichester Harbour Conservancy, Natural England, Natural Resources Wales, RSPB, Hilbre Bird Observatory) or found in reports & on websites (Boyle, 2012; Büche & Stubbings, 2019; Hilbrebirdobs blogspot; Leeney et al., 2010; Sayer, 2010, 2011, 2012a, 2012b; Sayer et al., 2012; Westcott, 2002, 2009; Westcott & Stringell, 2004; Woodfin Jones, 2019). Apparent increases may partly be due to increased reporting and improved species identification.

2 Surveys carried out by SMRU and funded by Northern Ireland Environment Agency (NIEA) in 2002, 2011 & 2018 (Morris & Duck, 2019a) and Marine Current Turbines Ltd in 2006-2008 & 2010 (SMRU Ltd, 2010).

HARBOUR SEAL		**1996 to 1997**	**2000 to 2006**	**2007 to 2009**	**2011 to 2015**	**2016 to 2019**
Wales[1]	Count	2	5	5	10	10
	Population estimate	3	7	7	14	14
NW England[1]	Count	2	5	5	5	5
	Population estimate	3	7	7	7	7
Northern Ireland[2]	Count	-	1,176	1,101	948	1,012
	Population estimate	-	1,633	1,529	1,317	1,406
Southwest Scotland	Count	929	623	923	1,200	1,709
	Population estimate	1,290	865	1,282	1,667	2,374

Figure 8: **August haul-out counts of harbour seal within each of the MUs within the seal telemetry and haul-out study area. Data from SCOS (2021).**

4.1.3 Distribution of haul-outs

Figure 9 and Figure 10 show the distribution of harbour seal August haul-out counts across the seal telemetry and haul-out study area. The main harbour seal haul-outs where seals have been counted are located in the north region of the seal telemetry and haul-out study area, in the Southwest Scotland MU. The majority of the haul-out counts are in the north of the MU with a maximum of nine harbour seal counts along the south coast of the MU in 2007. From 1997 to 2018, the counts have remained relatively consistent and stable, with the exception of 2009, where only one site, Sanda Island, on the west of the MU has recorded counts.

There is no information on the location of harbour seal hauled-out in the Wales and Northwest England MUs.

Most harbour seal haul-out locations in Northern Ireland are located in the southeast of the country, with most harbour seal being counted at Carlingford Lough, Murlough SAC and Rathlin Island (Figure 11) (Duck and Morris, 2019).

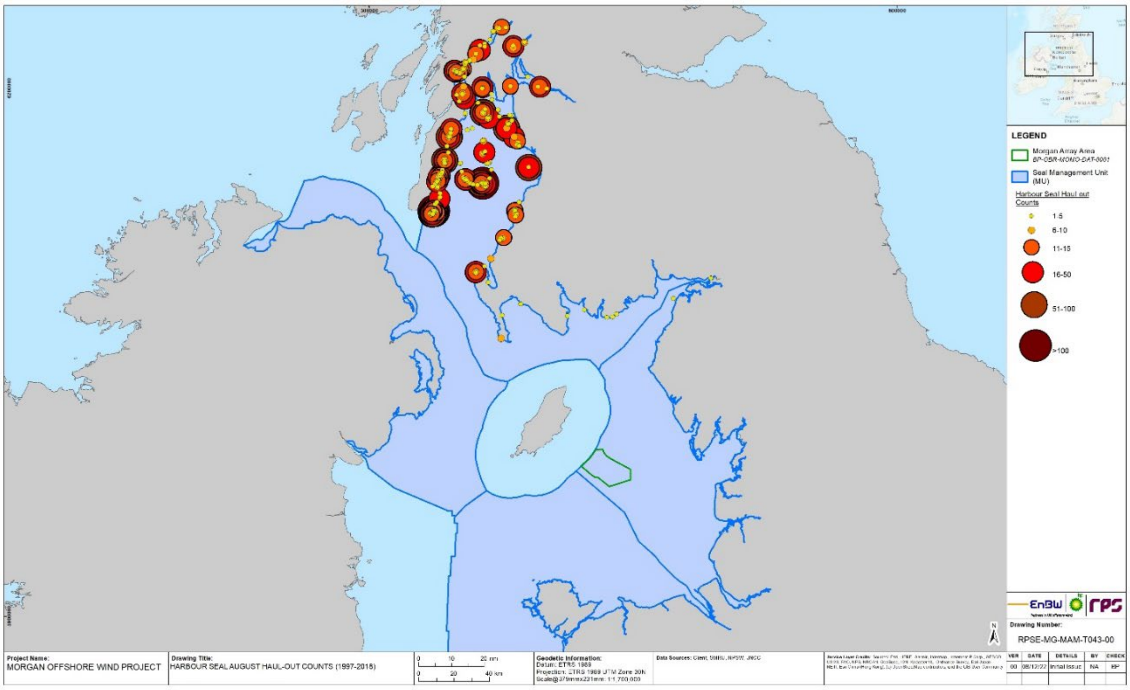

Figure 9: **All August harbour seal haul-out counts in the Southwest Scotland MU between 1997 and 2018 combined. Data provided by SMRU.**

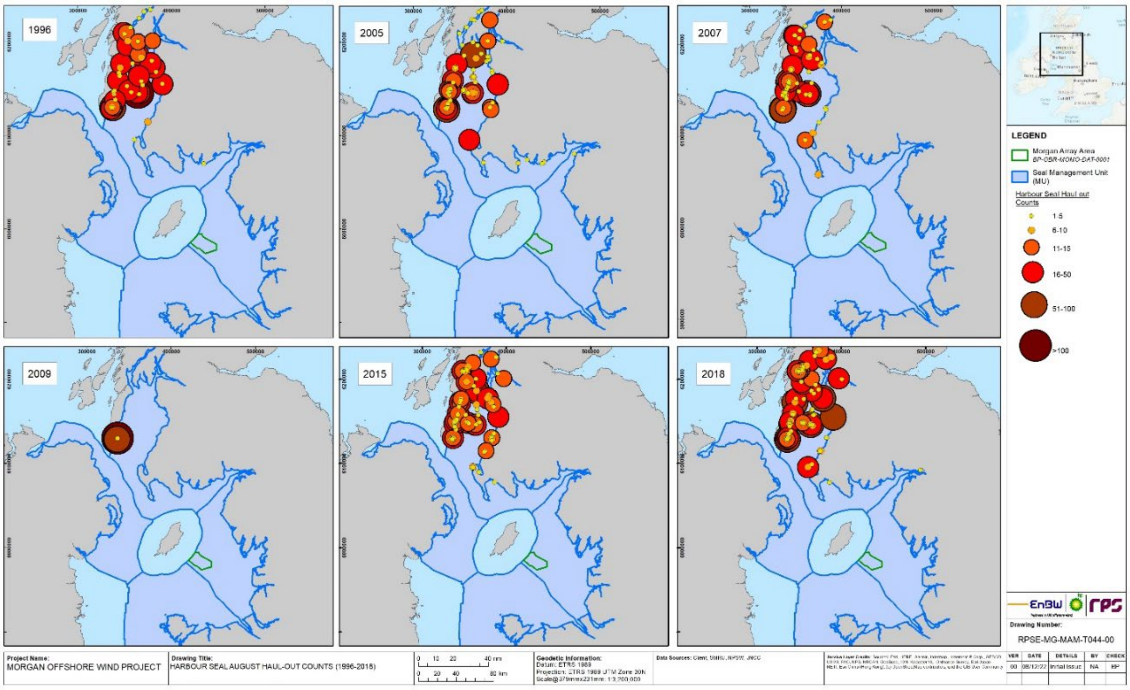

Figure 10: **Annual August harbour seal haul-out counts in the Southwest Scotland MU between 1997 and 2018. Data provided by SMRU.**

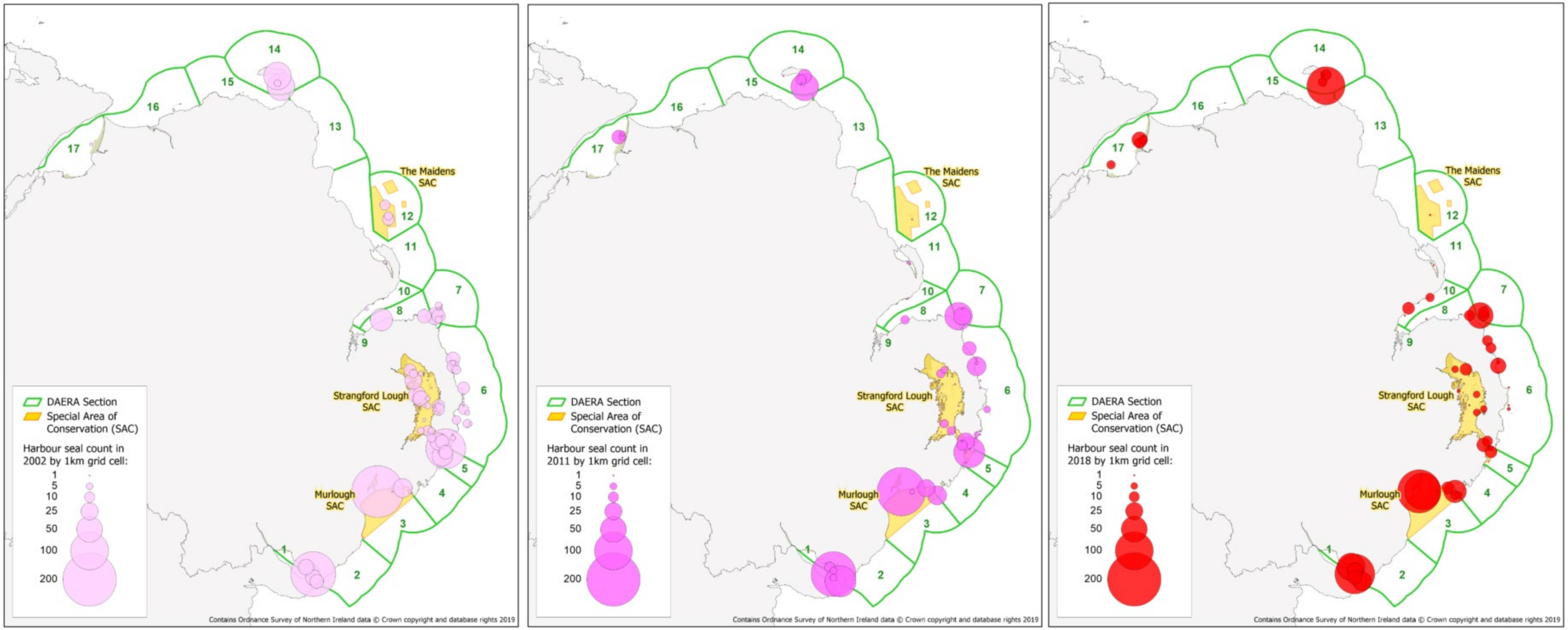

Figure 11: The distribution of harbour seal, by 1 km squares, in Northern Ireland in August 2002 (left), 2011 (middle) and 2018 (right). Aerial survey by the Sea Mammal Research Unit. Figure obtained from Duck and Morris (2019).

4.2 Grey seal

4.2.1 National Counts

The most recent August haul-out count for the whole of Scotland is for the count period 2016 to 2019, where a total of 25,412 grey seal were counted. In addition, in England and Wales a further 16,848 grey seal were counted and a further 505 were counted in Northern Ireland. This resulted in a total count of 42,260 grey seal in Britain (46,463 including the Republic of Ireland) across this four-year survey period (Figure 12) (SCOS, 2021). The population estimate for Britain is ~176,820 grey seal[8] 7(~179,000 in the UK and ~194,500 including Ireland).

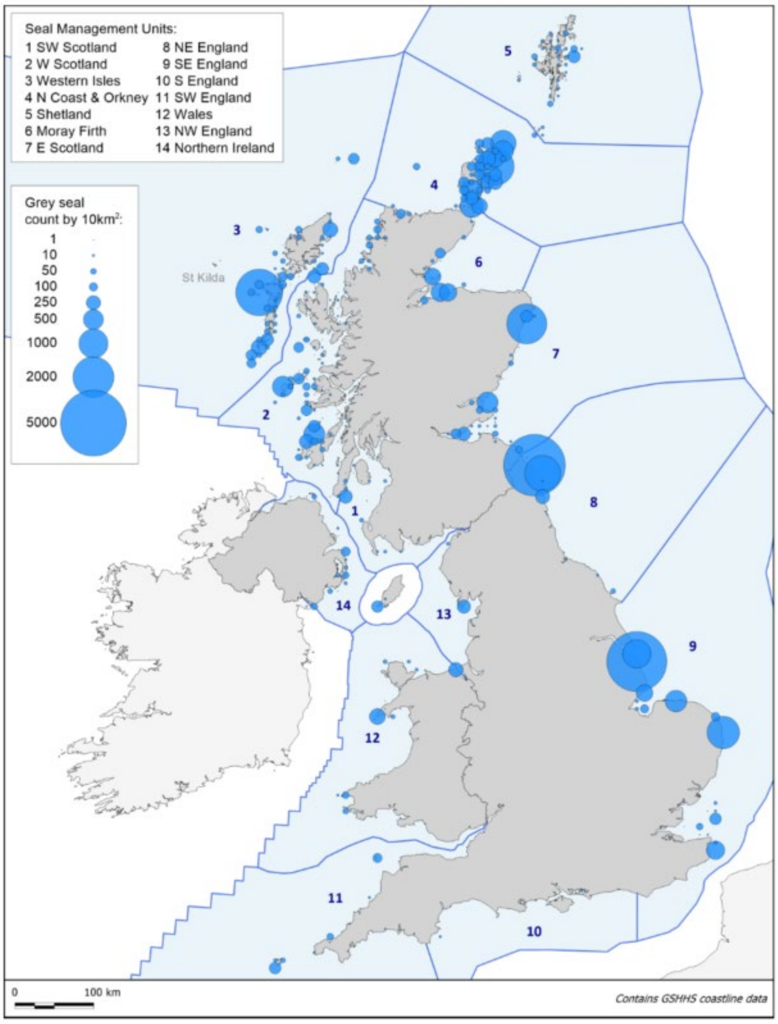

Figure 12: **August distribution of grey seal around the British Isles by 10 km squares based on the most recent available haul-out count data collected up until 2019. Limited data available for SMUs 10 to 13; no data available for St Kilda. Figure obtained from SCOS (2021).**

4.2.2 MU Counts

Estimates of grey seal counted in August 2018 in the Wales MU and Northwest England MU are 900 and 250, respectively (Table 4). There is indication of an increase in haul-out counts (Table 4 and Figure 13), however, it is suggested this could be due to an increase in species reporting (SCOS, 2021).

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[8] Calculated as: (42,260/23.9)*100

Accounting for the grey seal at-sea at the time of the count, the grey seal estimates for the Wales and Northwest England MUs are approximately 3,766 and 1,046 grey seal, respectively. However, given the lack of dedicated surveys in these areas, this estimate should be considered with caution due to the limited data used to inform the estimate. In addition to the data presented in Table 4, the Cumbria Wildlife Trust started conducting low tide counts of grey seal in 2019. Thus far, a total of 248 and 300 grey seal have been counted in 2019 and 2020 respectively (counts are not yet available for 2021).

In the Southwest Scotland MU, grey seal August haul-out counts have been lower than harbour seal counts (Table 4) (SCOS, 2021). Overall, counts within the MU have seen a steady increase from 75 in the 1997 to 1997 period to 517 in the 2016 to 2019 period (Figure 13). The August haul-out count of 517 results in a population estimate of 2,163 grey seal in the Southwest Scotland MU.

In the Northern Ireland MU, the most recent August haul-out survey conducted in 2018 showed an estimated count of 505 grey seal (Table 4) (SCOS, 2021). This haul-out count can be scaled to account for the proportion of the population at sea at the time of the survey, resulting in a population estimate of 2,113 grey seal in the Northern Ireland MU. There is an indication of an increasing population within these areas (Table 3 Figure 13), however due to the lack of dedicated surveys, a population trend could not be estimated (SCOS, 2021).

Table 4: Grey seal August haul-out counts for various survey periods. Data from SCOS (2021).

1 No SMRU surveys, but some data available. Estimates compiled from counts shared by other organisations (Langstone Harbour Board & Chichester Harbour Conservancy, Natural England, Natural Resources Wales, RSPB, Hilbre Bird Observatory) or found in reports & on websites (Boyle, 2012; Büche & Stubbings, 2019; Hilbrebirdobs blogspot; Leeney et al., 2010; Sayer, 2010, 2011, 2012a, 2012b; Sayer et al., 2012; Westcott, 2002, 2009; Westcott & Stringell, 2004; Woodfin Jones, 2019). Apparent increases may partly be due to increased reporting.

2 Surveys carried out by SMRU and funded by Northern Ireland Environment Agency (NIEA) in 2002, 2011 & 2018 (Morris & Duck, 2019a) and Marine Current Turbines Ltd in 2006-2008 & 2010 (SMRU Ltd, 2010).

GREY SEAL		**1996 to 1997**	**2000 to 2006**	**2007 to 2009**	**2011 to 2015**	**2016- to 019**
Wales[1]	Count	-	750	750	850	900
	Population estimate	-	3,138	3,138	3,556	3,766
Northwest England[1]	Count	-	30	30	50	250
	Population estimate	-	126	126	209	1,046
Northern Ireland[2]	Count	-	272	243	468	505
	Population estimate	-	1,138	1,017	1,958	2,113
Southwest Scotland	Count	75	206	233	374	517
	Population estimate	314	862	975	1,565	2,163

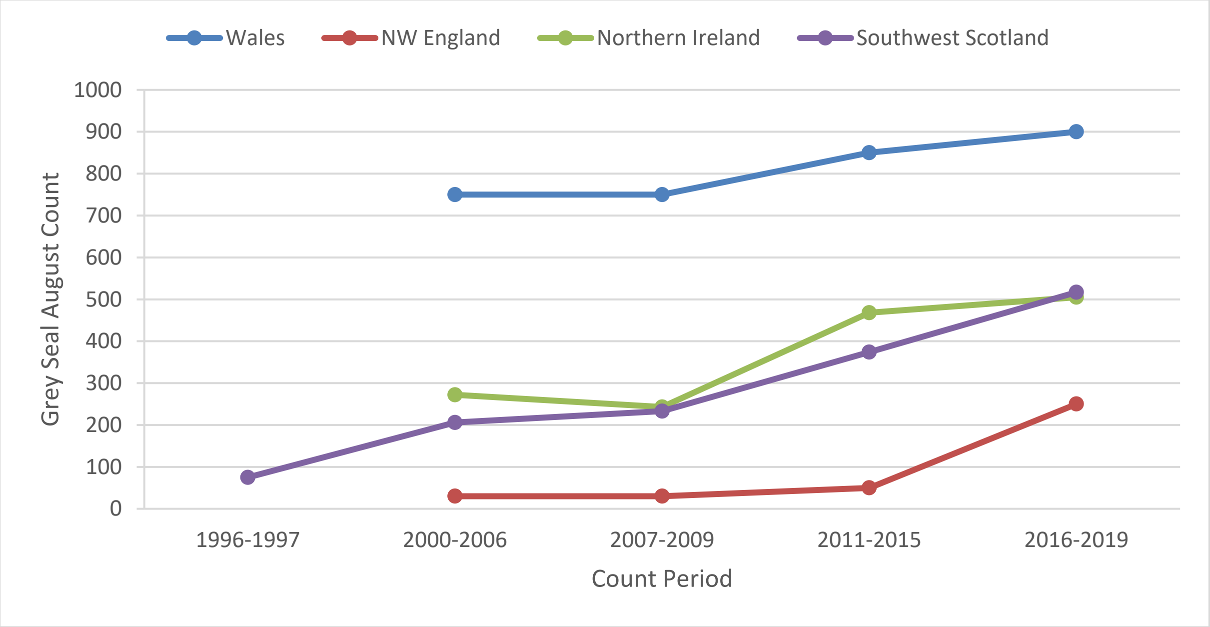

Figure 13: August haul-out counts of grey seal within each of the MUs within the seal telemetry and haul-out study area. Data from SCOS (2021).

4.2.3 Distribution of haul-outs

Figure 14 and Figure 15 (SW Scotland MU), Figure 19 (Wales MU) and Figure 20 (Northern Ireland MU) show the distribution of grey seal August haul-out counts across the seal telemetry and haul-out study area.

In the Southwest Scotland MU (Figure 14 and Figure 15), the main haul-out sites where grey seal have been counted are located in the north region of the MU, with comparatively higher counts than harbour seal along the south coast of the MU. From 1997 to 2018, the August grey seal haul-out counts have increased, and the haul-out locations have remained consistent throughout the years. Like the harbour seal counts, the haul-out counts for grey seal in 2009 are only recorded for Sanda Island on the west of the MU.

In the Northwest England MU, there are two main grey seal haul-out sites: one in the Dee Estuary on the Welsh-English border (Hilbre Island), and South Walney (Figure 12).

In North Wales, grey seal mainly haul-out around the coast of Anglesey (including the Skerries), around Llandudno (Angel Bay) and the Dee Estuary (Hilbre North and West Hoyle Sandbank) (Figure 16). At the Dee Estuary, there were 236 unique individuals identified by left head extracts from the EIRPHOT database, and photo-ID data showed connectivity between the Dee Estuary and the Skerries, with some connectivity with Cardigan Bay and Skomer (Langley *et al.*, 2018). Monitoring of grey seal by the Angel Bay Seal Volunteer Group, supported by the North Wales Wildlife Trust, has been conducted at Angel Bay, Llandudno (Porth Dyniewaid) since 2016 and are now additionally monitoring at Pigeon's Cave, on Great Orme (Angel Bay Seal Volunteer Group, 2021)[9]. These locations are visited all year round by seals, with the sites used for pupping, mating and moulting from mid-August to April. During the 2020 to 2021 season, the maximum seal haul-out count in one instance was 247 seals at Angel Bay in November 2020 (Figure 17). Though far fewer surveys have been conducted at Pigeon's Cave, the sightings confirm grey seal presence in 2020 to 2021 (Figure 19). The haul-out count data highlights

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[9] As referenced in: Awel y Môr Offshore Wind Farm Category 6: Environmental Statement Volume 4, Annex 7.1: Marine Mammal Baseline Characterisation Application Reference: 6.4.7.1

that both Angel Bay and Pigeon's Cave are known grey seal pupping areas, and for Angel Bay, the counts have shown an overall increasing trend since records began in 2016 (Figure 18).

In Northern Ireland, grey seal mainly haul out in Carlingford Lough, Murlough SAC, Strangford Narrows, North and South Rocks (east of the Ards), the Copeland Islands and Rathlin Island (Figure 20) (Duck and Morris, 2019).

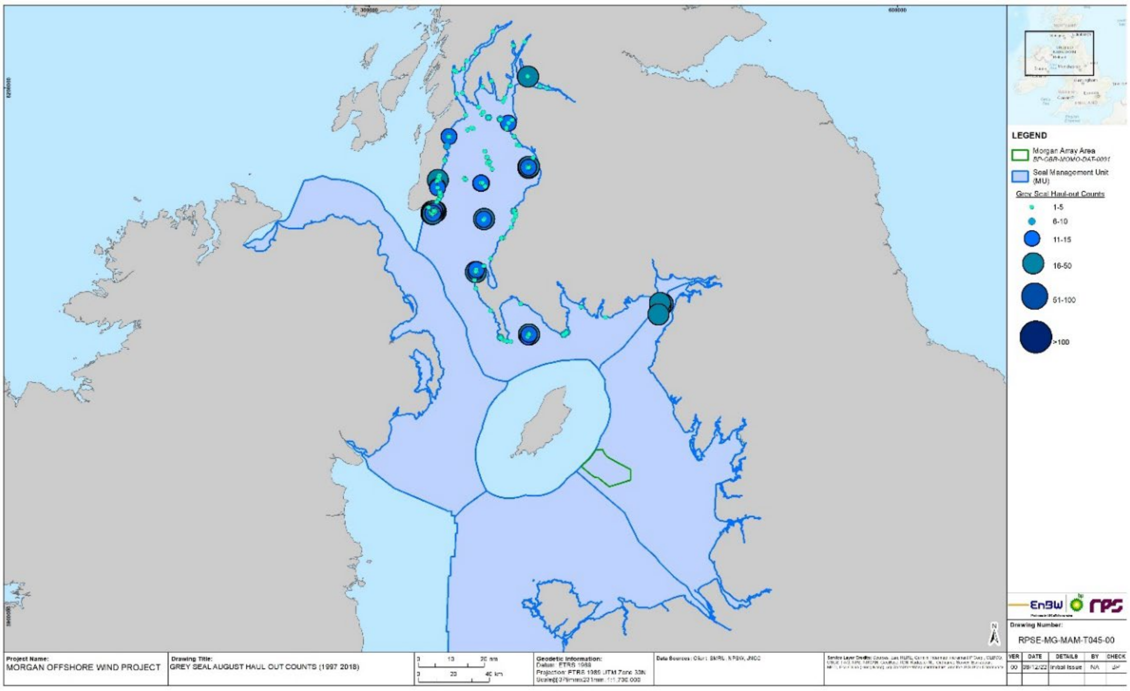

Figure 14: All August grey seal haul-out counts in the Southwest Scotland MU between 1997 and 2018 combined.

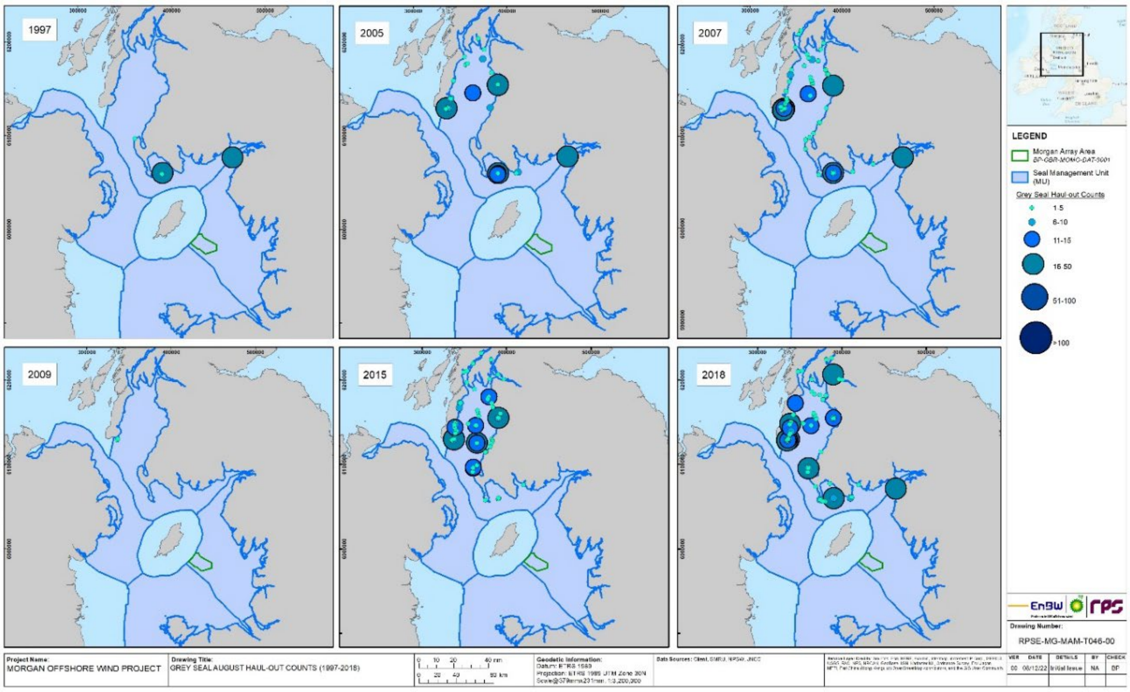

Figure 15: Annual August grey seal haul-out counts in the Southwest Scotland MU between 1997 and 2018.

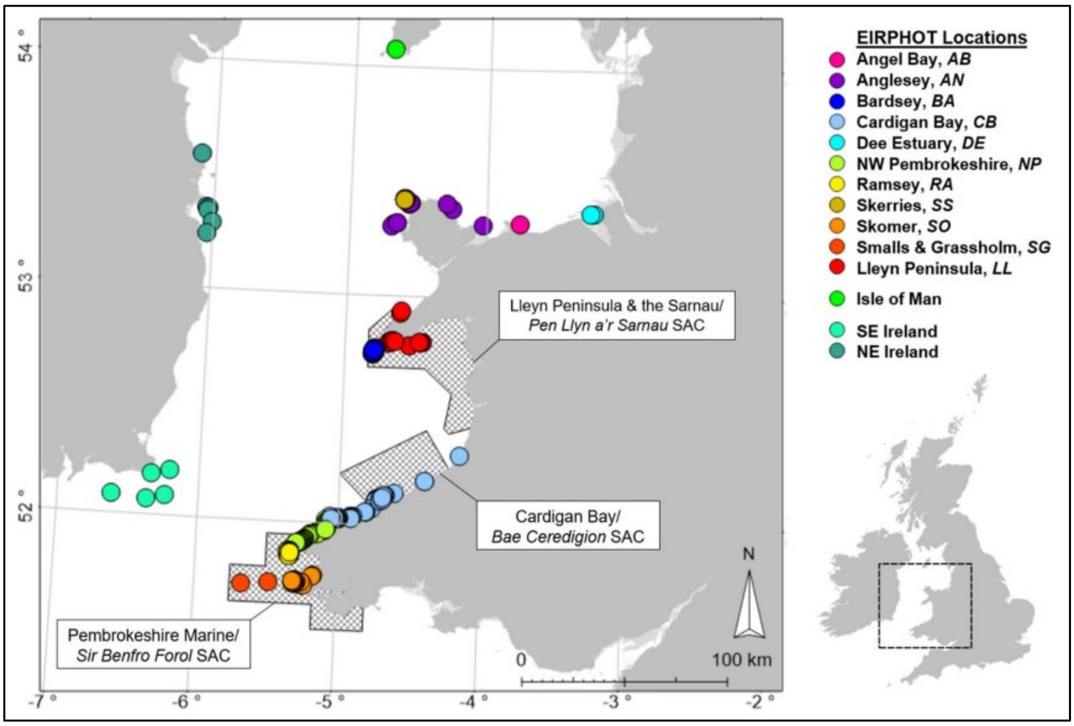

Figure 16: Celtic and Irish Sea grey seal haul-out sites covered by the EIRPHOT database (Langley *et al.*, 2020).

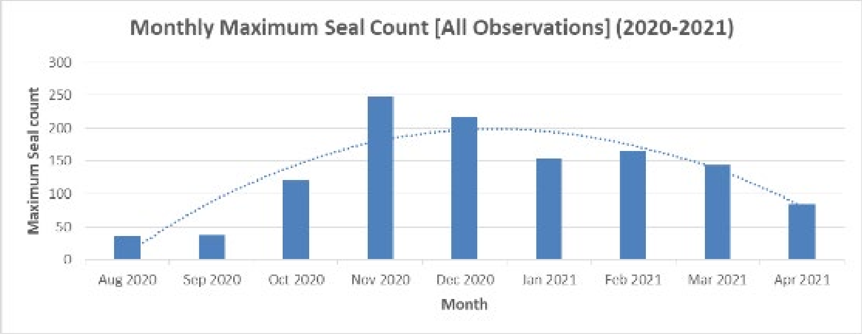

Figure 17: Monthly maximum seal count at Angel Bay from 2020-2021. Figure from the Angel Bay Seal Volunteer Group (2021).

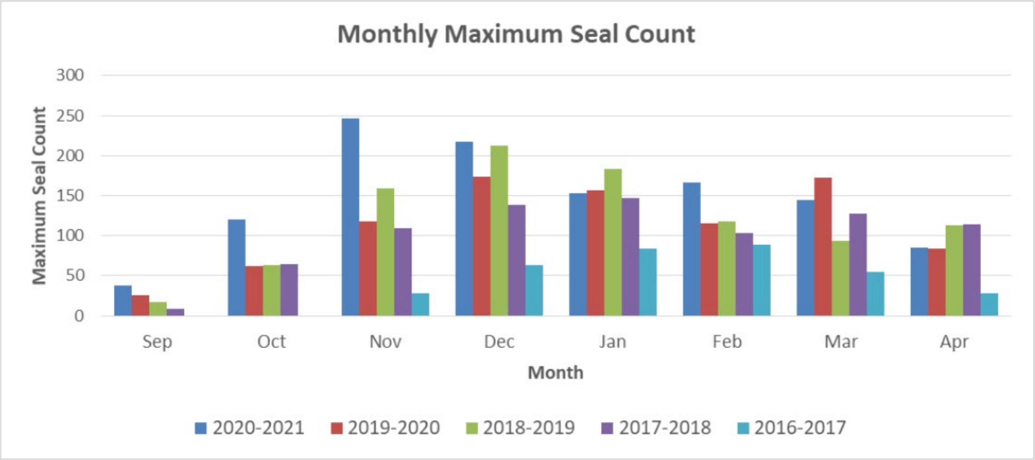

Figure 18: Monthly maximum seal count at Angel Bay from 2016-2021. Figure from the Angel Bay Seal Volunteer Group (2021).

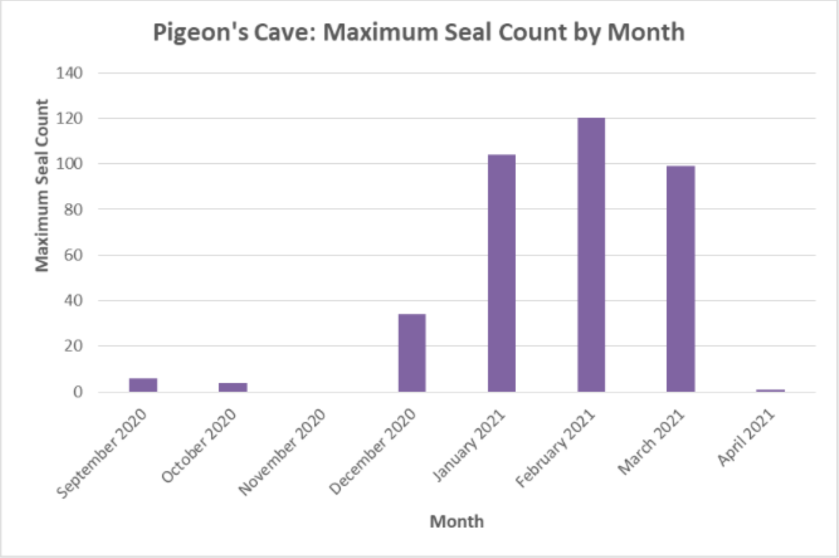

Figure 19: Monthly maximum seal count at Pigeon's Cave from 2020-2021. Figure from the Angel Bay Seal Volunteer Group (2021).

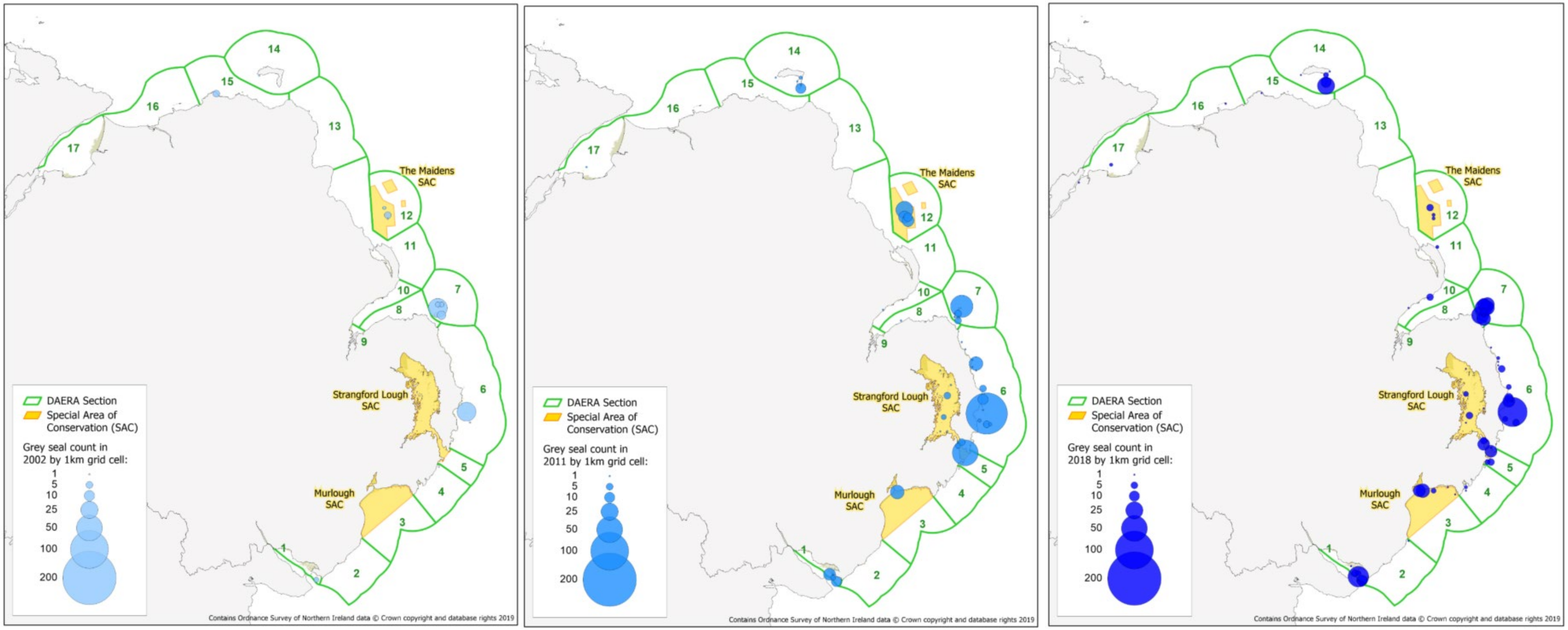

Figure 20: The distribution of grey seal, by 1 km squares, in Northern Ireland in August 2002 (left), 2011 (middle) and 2018 (right). Aerial survey by the Sea Mammal Research Unit. Figure obtained from (Duck and Morris 2019).

5 Grey Seal Pup Counts

Grey seal typically express a preference for remote breeding sites and cryptic habitats (Stringell *et al.*, 2014, SCOS, 2020, 2021) which can make pup abundance difficult to quantify. In 2018, total UK pup production was estimated at 68,050 (95% CI: 60,500 to 75,100) based on ground count data and estimates from less frequently aerial surveyed colonies (Figure 21).

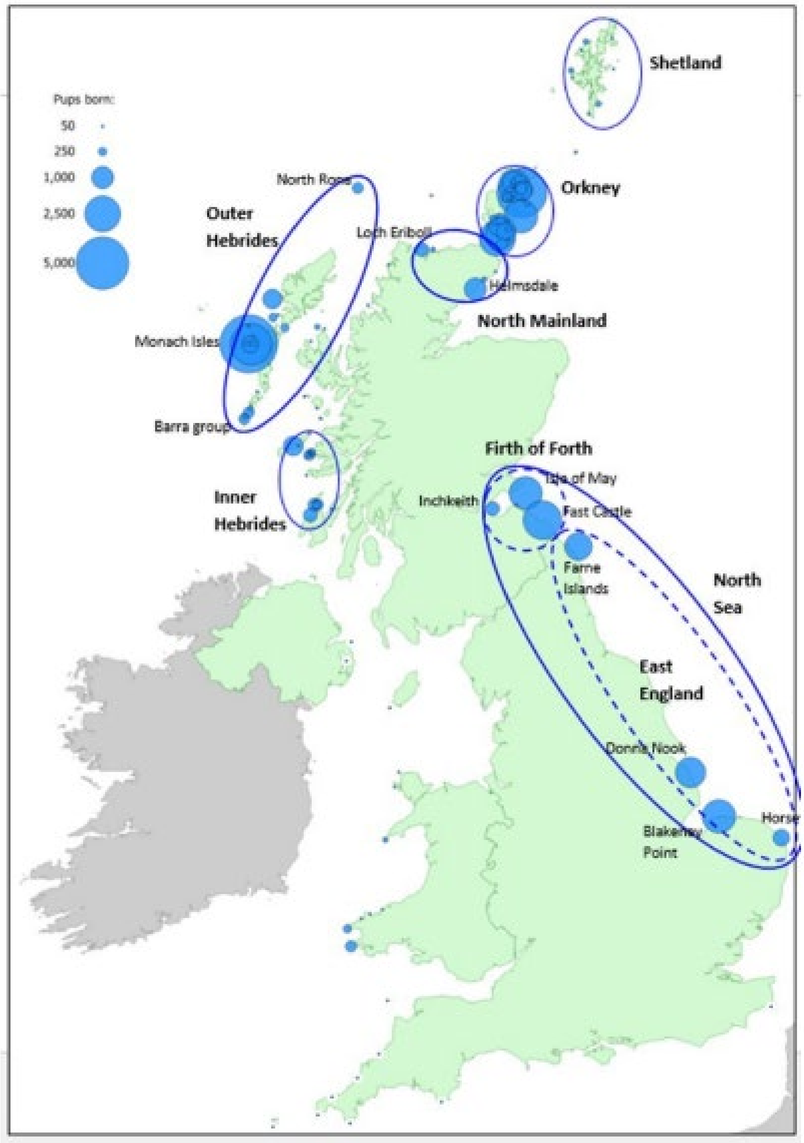

Figure 21: **Distribution and size of the main grey seal breeding colonies in the UK. Blue ovals indicate groups of regularly monitored colonies within each region and blue circles represent number of pups born (SCOS, 2020). Note: the North Sea colonies are sub-divided into the Firth of Forth colonies, and the East England colonies (dashed blue ovals).**

Grey seal pup production in 2016 in Wales was estimated as 2,250 pups, resulting in a population estimate for Wales of 5,000 grey seal at the start of the 2019 breeding season; though it is important to note that the pup production estimate for the Wales MU includes data from sites that have not been surveyed since the early 1990's and as such, there is considerable uncertainty in this estimate (SCOS, 2021).

The largest breeding population in the Irish Sea and southwest UK is located in Pembrokeshire (Figure 21), accounting for 4% of the UK grey seal breeding population (Strong and Morris, 2010; Stringell *et al.*, 2014). The majority of this pup production is located around Ynys Dewi/Ramsey Island and the north Pembrokeshire mainland coast between St Davids Head and the Teifi Estuary (Morgan *et al.*, 2018). In North Wales, smaller breeding populations can be found on the west coast of Anglesey and the Lleyn Peninsula and islands (Figure 22).

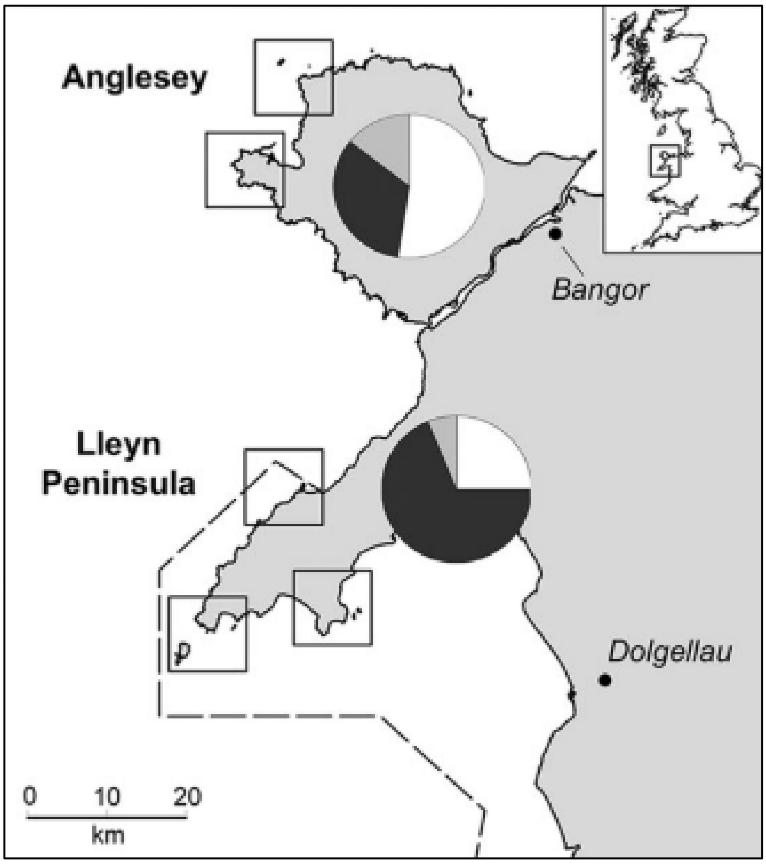

Figure 22: Grey seal pupping sites in North Wales (open boxes). Pie charts indicate the proportion of cave (black), other cryptic (grey) and non-cryptic/open onshore pupping habitats for Anglesey (n=21 sites) and the Lleyn Peninsula (n= 16 sites) (Stringell *et al.*, 2014).

In the southwest of the UK (including Wales) the pupping season occurs between August and November, with peak births in September and October (Morgan *et al.*, 2018; Langley *et al.*, 2020; SCOS, 2020). However, pups have also been recorded outside of this period and have been recorded throughout the year at Ramsey Island (Morgan *et al.*, 2018).

Grey seal pup production in Northwest England is comparatively low to that of Wales. Since 2015, South Walney has been a pupping site, however, numbers counted by the Cumbria Wildlife Trust and Walney Bird Observatory are low at only 2 to 10 grey seal pups per year (SCOS, 2021).

In Northern Ireland, the majority of grey seal pups are born in Strangford Lough where the National Trust estimated a pup production of 181 in 2019, an increase from 10 in 1992 (Culloch *et al.*, 2018). However, monitoring across Northern Ireland is more sporadic and an overall pup production of 250 grey seal pups was estimated (SCOS, 2021).

There are no regularly monitored grey seal breeding sites in with Southwest Scotland MU.

6 Telemetry Data

6.1 Harbour seal

Harbour seal typically forage within 40 to 50 km from their haul-out sites (compared to >100 km for grey seal) (SCOS, 2020). Between 2001 and 2017, no harbour seal were tagged in the Northwest England, Wales or Southwest Scotland MUs. In the Northern Ireland MU, 34 adult harbour seal were tagged from 2006 to 2010, and (given that the tagging location was within the seal telemetry and haul-out study area) all 34 harbour seal recorded telemetry tracks within the seal telemetry and haul-out study area (Table 5 and Figure 23). Note: these were all adult seals.

Whilst the focus of this report was on the seal telemetry and haul-out study area (the Northwest England, Wales, Southwest Scotland and Northern Ireland MUs), telemetry track data from 12 harbour seal (10 adults, 2 juvenile) tagged in the West Scotland MU were recorded within the seal telemetry and haul-out study area, specifically in the Southwest Scotland and Northern Ireland MUs, north of the Morgan Generation Assets (Figure 23). This resulted in a total of 46 tagged animals recorded within the seal telemetry and haul-out study area.

Of the 46 tagged harbour seal that entered the seal telemetry and haul-out study area, five had telemetry track data recorded within the 50km buffer[10] of the Morgan Generation Assets (Figure 24). The telemetry tracks were recorded between 2006 and 2008 and were concentrated within the northwest region of the seal telemetry and haul-out study area. No tracks were recorded within, east or south east of the Morgan marine mammal study area (Figure 23 and Figure 24). All 34 harbour seal tagged in the Northern Ireland MU (Figure 23), including the five which entered the 50 km buffer of the Morgan Generation Assets (Figure 24), showed connectivity to the Strangford Lough SAC (tagging location).

Table 5: Summary information for the 34 harbour seal tagged in the Northern Ireland MU.

Date	Total	Location	Sex	Tag Type	Funders
April 2006	7	Strangford Lough	1x F 6x M	GPS GSM	NERC
May 2006	5	Strangford Lough	4x F 1x M	GPS GSM	NERC
March 2008	9	Strangford Lough	3x F 6x M	GPS GSM	BEIS
April 2008	1	Strangford Lough	F	GPS GSM	BEIS
April 2010	12	Strangford Lough	4x F 8x M	GPS GSM	BEIS and MCT

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[10] 50km buffer selected since harbour seal typically forage within 40 to 50km from their haul-out sites.

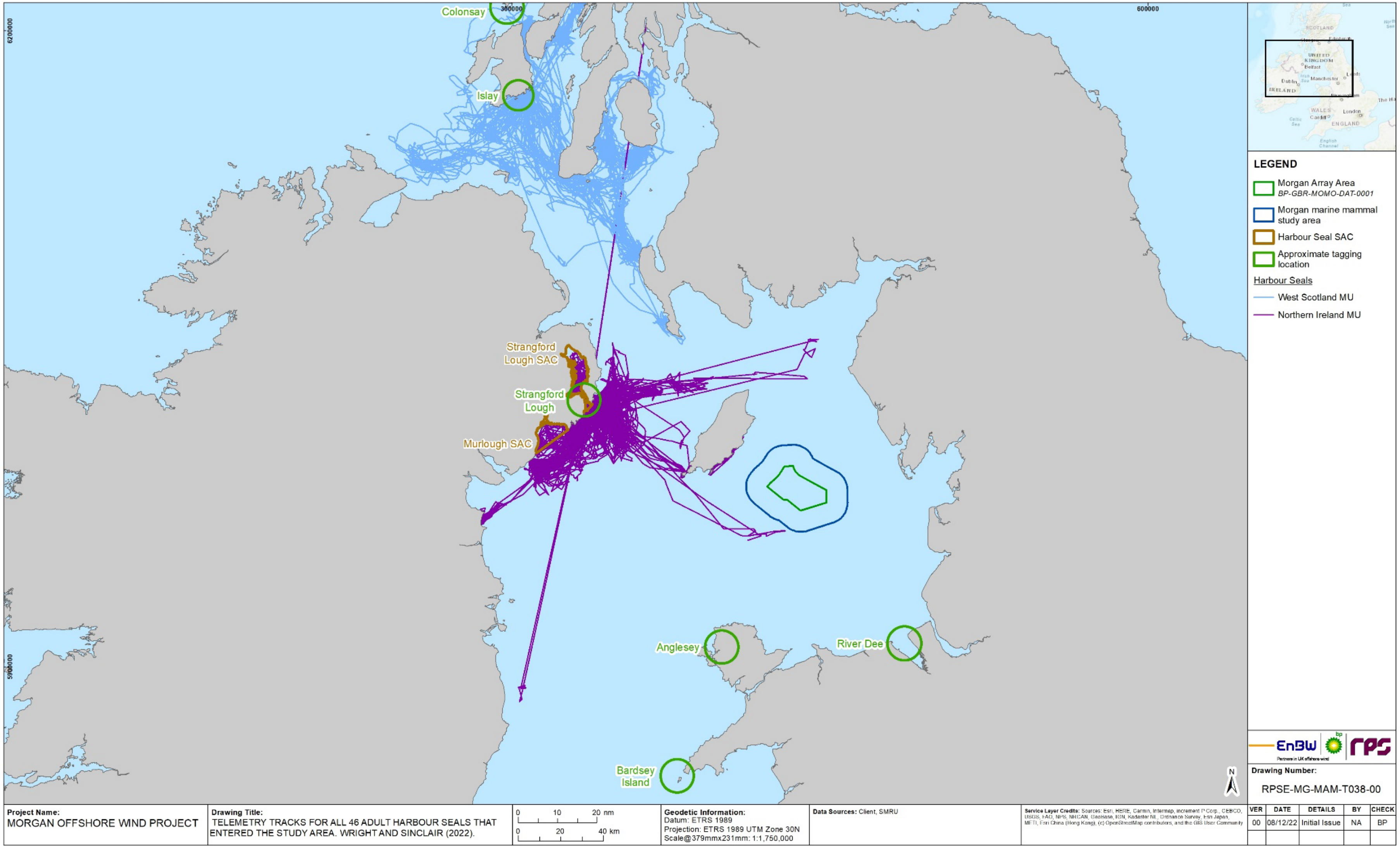

Figure 23: Telemetry tracks for all 46 harbour seals that entered the seal telemetry and haul-out study area (34 tagged in the Northern Ireland MU and 12 tagged in West Scotland MU). Data provided by SMRU Consulting (2022).

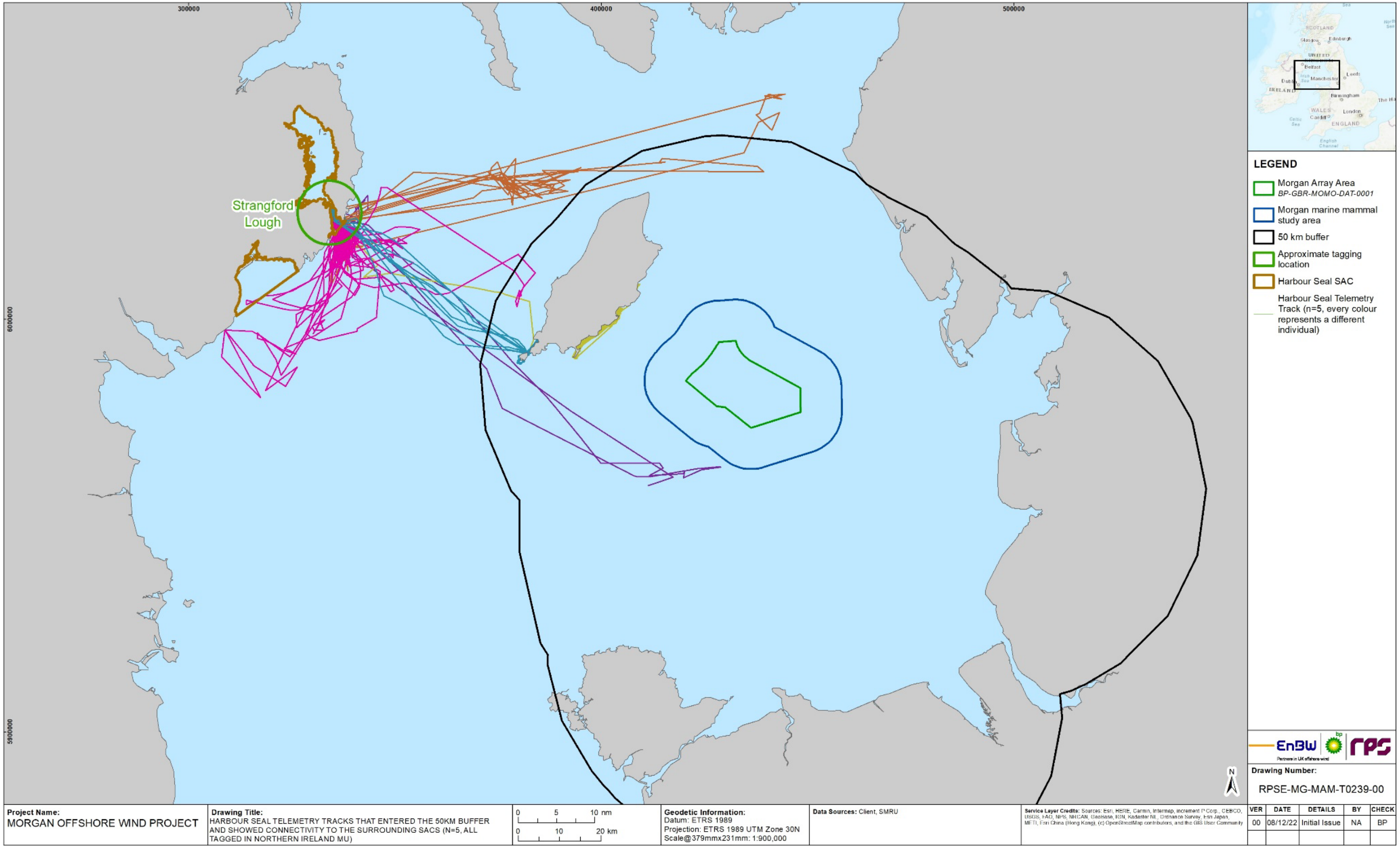

Figure 24: Harbour seal telemetry tracks that entered the 50km buffer and showed connectivity to the surrounding SACs (n=5, all tagged in Northern Ireland MU. Each colour represents an individual animal. Tagging period 2006-2010, tracks recorded 2006-2008). Data provided by SMRU Consulting (2022).

6.2 Grey seals

6.2.1 Adults

Telemetry data have shown that grey seals travel further to forage and between haul-out sites than harbour seals. Grey seals typically forage within 100km of a haul-out site and foraging trips can last for 30 days, however individual tracks have shown that some grey seals can make trips several hundred kilometres offshore (SCOS, 2020).

In total, 39 adult grey seals and one juvenile grey seal have been tagged in the Wales MU between 2004 and 2018, and therefore recorded tracks in the seal telemetry and haul-out study area (Table 6). No adult grey seals have been tagged in the Northwest England, Southwest Scotland or Northern Ireland MUs.

All tagged adult grey seals recorded within the seal telemetry and haul-out study area were investigated to determine their origin (tagging location). In total, 44 adult/juvenile grey seals recorded telemetry data within the seal telemetry and haul-out study area, 40 of which were tagged in the Wales MU and four were tagged in the West Scotland MU (Figure 25). Grey seal tracks have been recorded throughout the seal telemetry and haul-out study area, with a higher density of tracks in the south region of the seal telemetry and haul-out study area in the Northwest England and Wales MUs and a lower density in the north region of the seal telemetry and haul-out study area.

Of the 43 adult grey seals that were recorded within the seal telemetry and haul-out study area, there was connectivity with several UK and Irish grey seal SACs[11].

- 17 with Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau SAC (38.6%)
- 14 with Pembrokeshire Marine/Sir Benfro Forol SAC (31.8%)
- 10 with Cardigan Bay SAC (22.7%)
- 4 with Saltee Islands SAC (Ireland) (9.1%)
- 1 with The Maidens SAC (2.3%)
- 1 with Lundy SAC (SouthWest England MU) (2.3%).

Of the 44 adult grey seal that recorded telemetry track data within the seal telemetry and haul-out study area, 36 recorded tracks within a 100 km buffer of the Morgan Generation Assets, 19 of which showed connectivity to the surrounding SACs (Figure 26). The connectivity between the surrounding SACs and the 36 individuals within the 100 km buffer is similar to that of the seal telemetry and haul-out study area:

- 17 with Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau SAC (47.2%)
- 8 with Pembrokeshire Marine/Sir Benfro Forol SAC (22.2%)
- 8 with Cardigan Bay SAC (22.2%)
- 3 with Saltee Islands SAC (8.3%)
- 1 with The Maidens SAC (2.8%).

Therefore, it can be concluded that there is a high level of connectivity between the seal telemetry and haul-out study area and the Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau SAC and the Pembrokeshire Marine/Sir Benfro Forol SAC and the Cardigan Bay SAC, and comparatively lower levels of connectivity with grey seal SACs at further distances from the Morgan Generation Assets.

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[11] Note: some seals showed connectivity with more than one SAC and therefore, the numbers reflect every SAC that was entered.

6.2.2 Pups

The movement data obtained from telemetry tags on pups may not be representative of the typical movement patterns of adult grey seals, since recently weaned pups are known to disperse widely to haul-out locations far from their birth colony location (Brasseur *et al.*, 2015; Carter *et al.*, 2017; Peschko *et al.*, 2020). Therefore, their telemetry data has been shown separately here.
In total, 17 grey seal pups have been tagged in the Wales MU between 2009 and 2017 (Table 6 and Figure 27). No grey seal pups have been tagged in the Northwest England, Southwest Scotland or Northern Ireland MUs.

As for the adult seals, any tagged grey seal pups within the seal telemetry and haul-out study area were investigated to determine their origin. The grey seal juvenile/pup telemetry tracks were concentrated in the Wales and Northwest England MUs of the seal telemetry and haul-out study area, with one pup entering the Northern Ireland MU and none recorded entering the Southwest Scotland MU.

These 17 pup grey seal showed connectivity with several UK and Irish grey seal SACs[12]:

- 11 with Pembrokeshire Marine/Sir Benfro Forol SAC (64.7%)
- 10 with Pen Llŷn a'r Sarnau/ Lleyn Peninsula and the Sarnau SAC (58.8%)
- 4 with Cardigan Bay SAC (23.5%)
- 4 with Saltee Islands SAC (Ireland) (23.5%)
- 2 with Isle of Scilly Complex SAC (11.8%).

Of the 17 grey seal pups recorded within the seal telemetry and haul-out study area, 13 recorded telemetry tracks within a 100km buffer of the Morgan Generation Assets, 11 of which showed connectivity to surrounding SACs (Figure 28). The connectivity between the surrounding SACs and the 13 individual pups within the 10km buffer is similar to that of seal telemetry and haul-out study area:

- 10 with Pen Llŷn a'r Sarnau/ Lleyn Peninsula and the Sarnau SAC (76.9%)
- 6 with Pembrokeshire Marine/Sir Benfro Forol SAC (46.2%)
- 3 with Cardigan Bay SAC (23.1%)
- 3 with Saltee Islands SAC (Ireland) (23.1%)
- 2 with Isle of Scilly Complex SAC (15.4%).

---

[12] Note: some seals showed connectivity with more than one SAC

Table 6: Summary information for the 57 grey seal tagged in the Wales MU.

MU	Year	#	Tagging Location	Sex	Tag Type
Adults (n=39) & Juveniles (n=1)					
Wales	June 2004	18 adult	4 x Bardsey 7 x Ramsey 7 x River Dee	9 x F, 9 x M	ARGOS SRDL
	June 2017	3 adult	River Dee	1 x F, 2x M	ARGOS GSM/SRDL
	July 2017	8 adult 1 juv	River Dee	6 x F, 3 x M	GPS GSM
	May 2018	10 adult	Bardsey	6 x F, 4 x M	9 x GSP GSM 1 x ARGOS SRDL
Pups (n=17)					
Wales	Oct 2009	5 pup	3 x Anglesey 2 x Bardsey	3 x F, 2 x M	GPS GSM
	Oct 2010	9 pup	2 x Anglesey 7 x Ramsey	5 x F, 4 x M	GPS GSM
	Nov 2010	3 pup	Anglesey	2 x F, 1 x M	GPS GSM

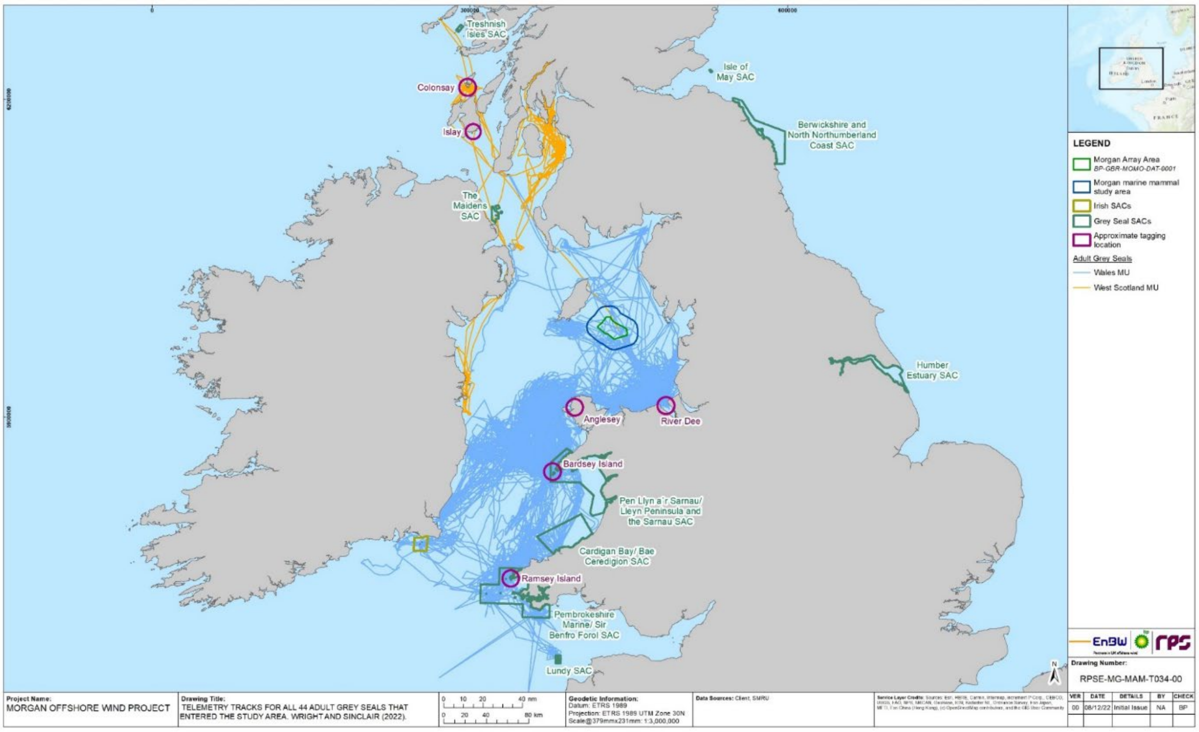


Figure 25: Telemetry tracks for all 43 adult grey seal (and one juvenile) that entered the seal telemetry and haul-out study area (coloured by the MU they were tagged in. Note, West Scotland MU is not within the seal telemetry and haul-out study area. West Scotland MU tracks recorded in 2003, Wales MU tracks recorded 2004 and 2017-2018). Data provided by SMRU Consulting (2022).

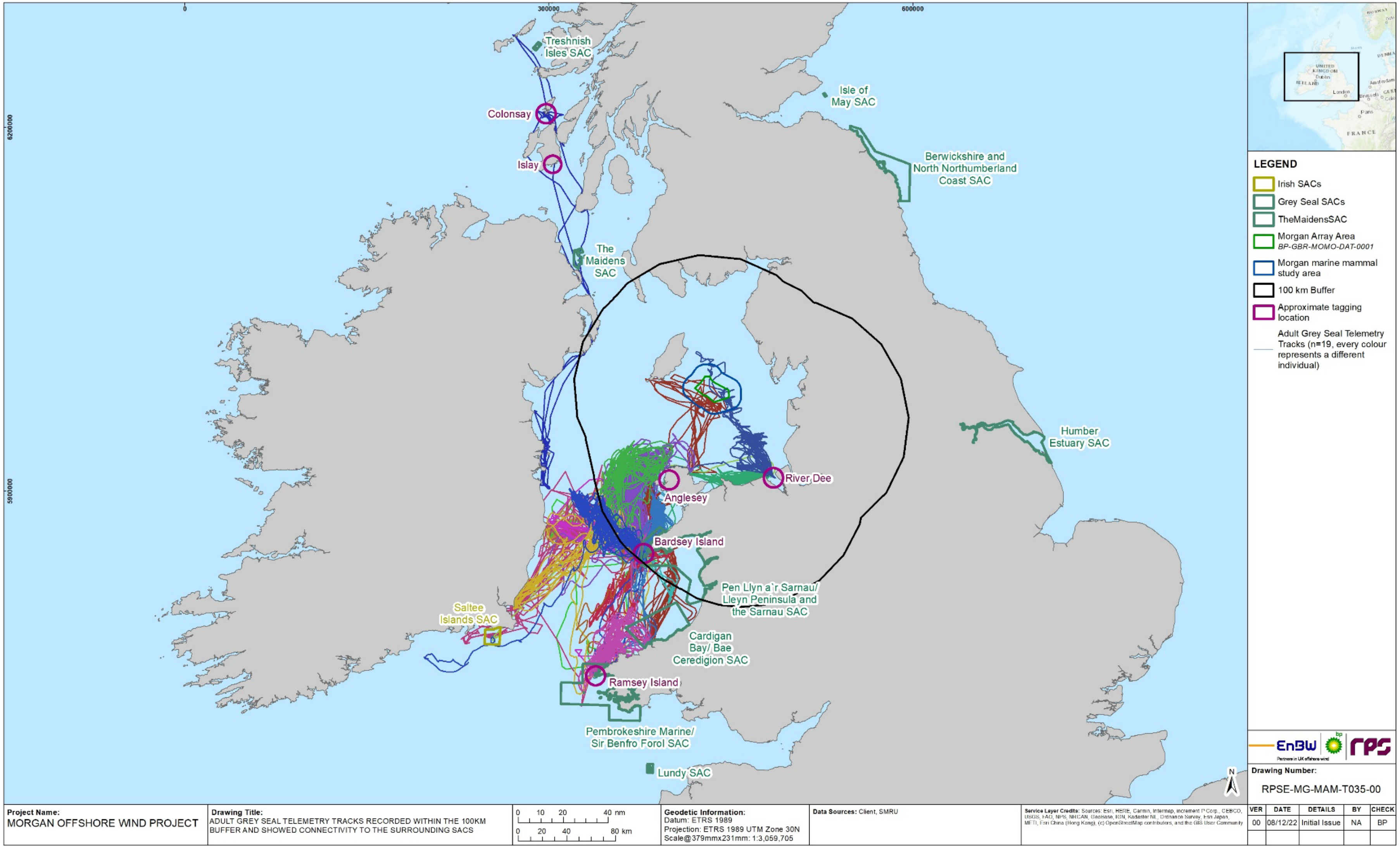
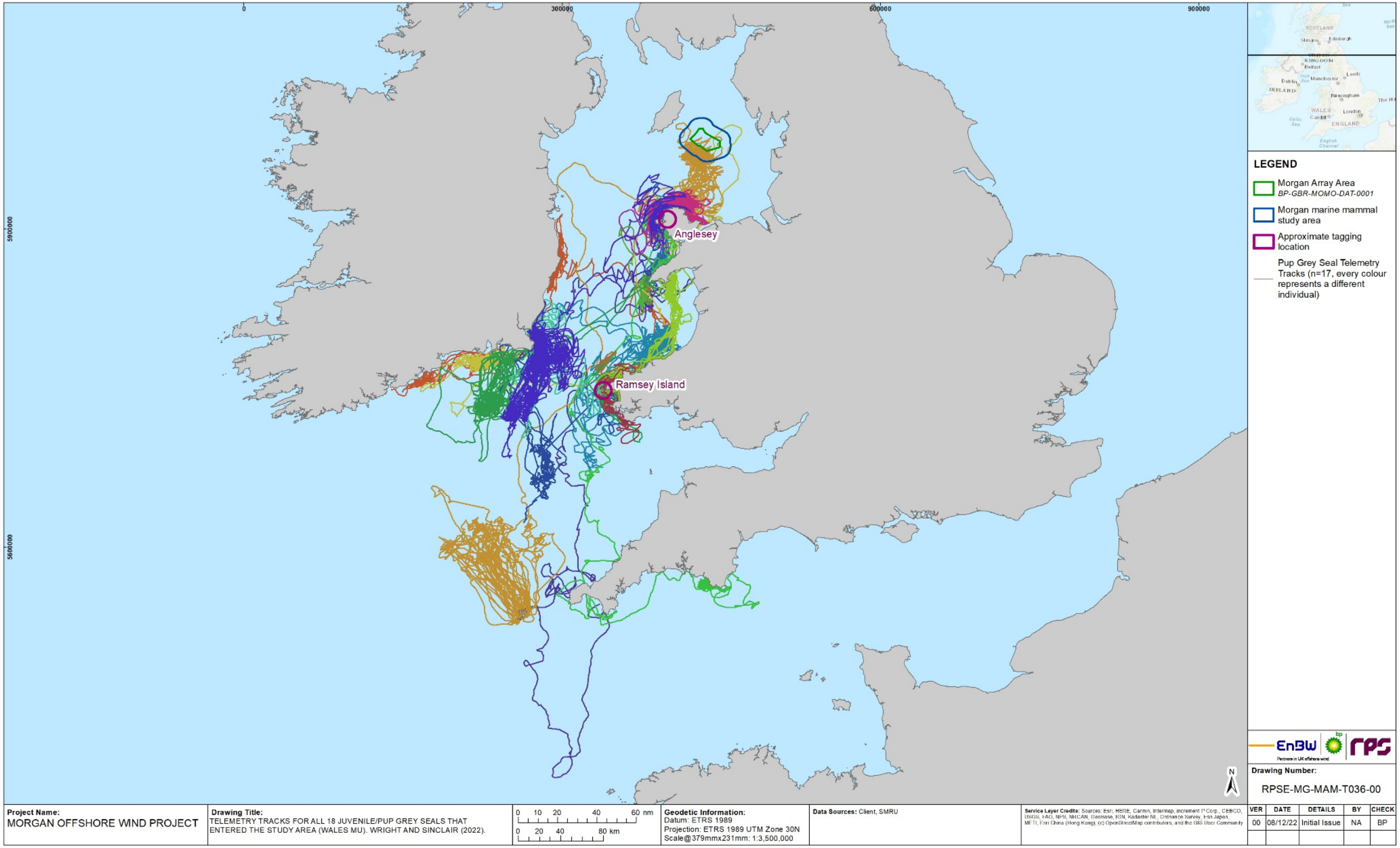


Figure 26: Adult grey seal telemetry tracks recorded within the 100km buffer and showed connectivity to the surrounding SACs (n=19, each colour represents an individual animal. Tracks recorded as per Figure 25). Data provided by SMRU Consulting (2022).



Project Name: MORGAN OFFSHORE WIND PROJECT

Drawing Title: TELEMETRY TRACKS FOR ALL 18 JUVENILE/PUP GREY SEALS THAT ENTERED THE STUDY AREA (WALES MU). WRIGHT AND SINCLAIR (2022).

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@379mmx231mm: 1:3,500,000

Data Sources: Client, SMRU

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Drawing Number: RPSE-MG-MAM-T036-00

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00	08/12/22	Initial Issue	NA	BP

Figure 27: Telemetry tracks for all 17 pup grey seal that entered the seal telemetry and haul-out study area (all individuals were tagged in the Wales MU, each colour represents an individual animal. Tracks recorded 2009-2010). Data provided by SMRU Consulting (2022).

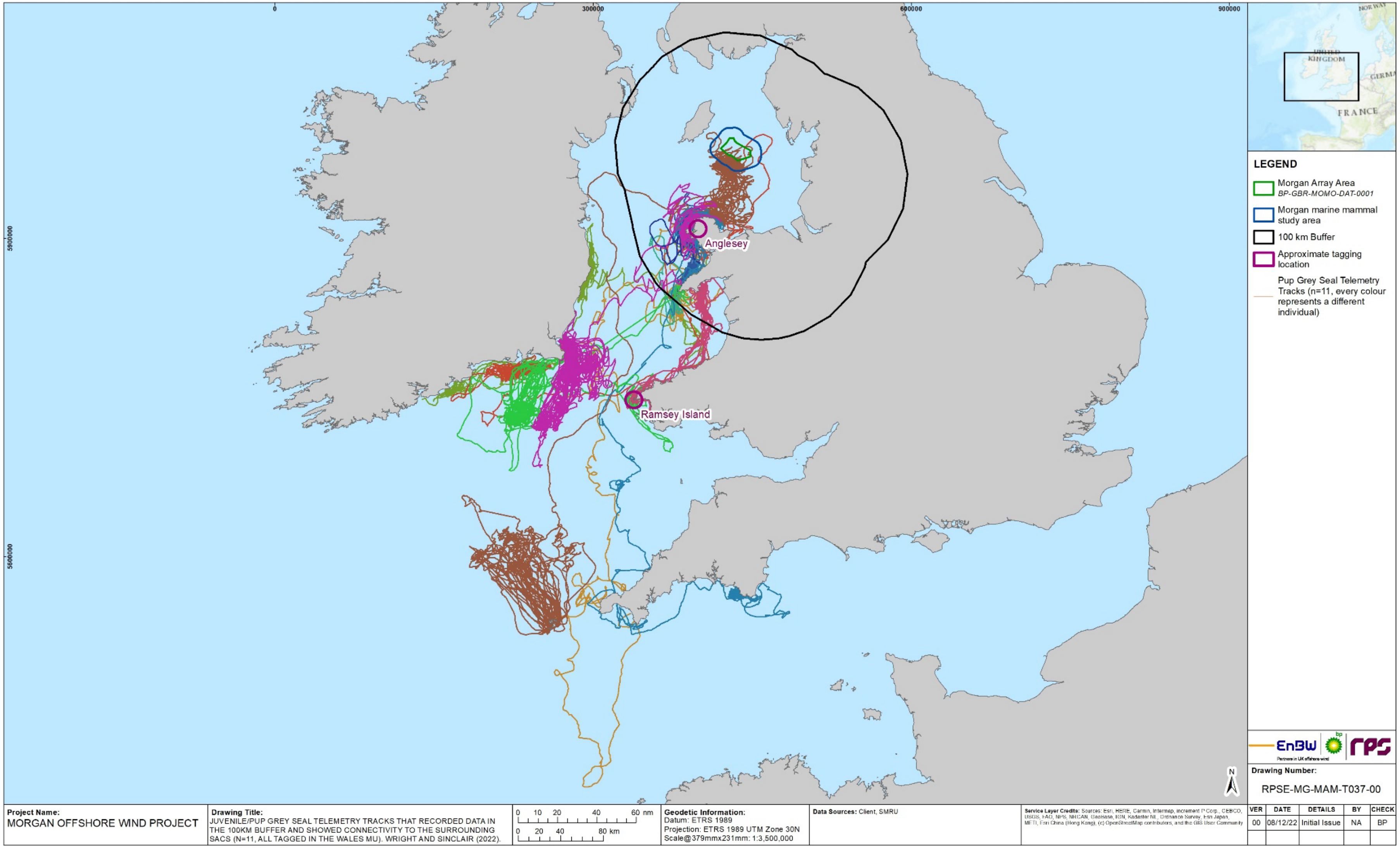

Figure 28: Pup grey seal telemetry tracks that recorded data in the 100km buffer and showed connectivity to the surrounding SACS (n=11, all tagged in the Wales MU, each colour represents an individual animal. Tracks recorded 2009-2010). Data provided by SMRU Consulting (2022).

7 Summary

A summary of haul-out count data, grey seal pup count data and telemetry data (as presented in sections 1 to 6) is set out below.

7.1 Haul-out counts

- There are no dedicated SMRU surveys routinely carried in the Northwest England and Wales MUs, with "estimates compiled from counts shared by other organisations"
- No sites within the Southwest Scotland and Northern Ireland MUs are surveyed annually
- Harbour seal:
  - Wales MU: The 2016 to 2019 August haul-out count of 10 can be scaled to account for the proportion of the population at sea at the time of the survey to result in a population estimate of ~14 harbour seal
  - Northwest England MU: The 2016 to 2019 August haul-out count of five can be scaled to account for the proportion of the population at sea at the time of the survey to result in a population estimate of ~7 harbour seal
  - Northern Ireland MU: The August haul-out count of 1,012 in 2018 can be scaled to account for the proportion of the population at sea at the time of the survey to result in a population estimate of ~1,406 harbour seal
  - Southwest Scotland MU: The 2016 to 2019 August haul-out count of 1,709 can be scaled to account for the proportion of the population at sea at the time of the survey to result in a population estimate of ~2,374 harbour seal
- Grey seal:
  - Wales MU: The August haul-out count of 900 in 2018 can be scaled to account for the proportion of the population at sea at the time of the survey to result in a population estimate of ~3,766 grey seal
  - Northwest England MU: The August haul-out count of 250 in 2018 can be scaled to account for the proportion of the population at sea at the time of the survey to result in a population estimate of ~1,046 grey seal. A total of 248 and 300 grey seal were counted in 2019 and 2020, respectively by the Cumbria Wildlife Trust
  - Northern Ireland MU: The August haul-out count of 505 in 2018 can be scaled to account for the proportion of the population at sea at the time of the survey to result in a population estimate of ~2,113 grey seal
  - Southwest Scotland MU: The August haul-out count of 517 in 2018 can be scaled to account for the proportion of the population at sea at the time of the survey to result in a population estimate of ~2,163 grey seal.

7.2 Grey seal pup counts

- Wales MU: An estimated 2,000 pups were counted in 2018. The main breeding sites in Wales are in North Wales, Skomer and North Pembrokeshire. The largest breeding population in the Irish sea and southwest UK is in Pembrokeshire (Figure 21), accounting for 4% of the UK breeding population
- Northwest England MU: Pup production at South Walney is low at only 2 to 10 grey seal pups per year

- Northern Ireland MU: Overall, a pup production of 250 was estimated, specifically Strangford Lough has shown an increase in pup production from 10 in the early 1990s to 181 in 2019.

7.3 Telemetry

- Harbour seal:
  - Telemetry tracks were concentrated within the northwest region of the seal telemetry and haul-out study area and no tracks were recorded within the Morgan marine mammal study area
  - All harbour seal within the 50 km buffer of the Morgan Generation Assets showed connectivity to the Strangford Lough SAC
- Grey seal:
  - Telemetry tracks were recorded throughout the seal telemetry and haul-out study area, with a higher density of telemetry tracks in the south region and a lower density in the north region of the seal telemetry and haul-out study area
  - There were higher levels of connectivity between the seal telemetry and haul-out study area and the Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau SAC and the Pembrokeshire Marine/Sir Benfro Forol SAC and the Cardigan Bay SAC
  - There were lower levels of expected connectivity between the seal telemetry and haul-out study area and grey seal SACs at further distances (e.g. Isle of Scilly Complex SAC, Lundy SAC, The Maidens SAC, and the Saltee Islands (SAC).

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Appendix B: Morecambe Offshore Wind farm: Generation Assets - Marine Mammal Information and Survey data

Morecambe Offshore Windfarm: Generation Assets

Environmental Statement

Volume 5

Appendix 11.2 Marine Mammal Information and Survey Data

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Rev 01

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Glossary of Acronyms

ADD	Acoustic deterrent device
AfL	Agreement for Lease Area
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
ASSI	Area of Special Scientific Interest
BEIS[1]	Department for Business, Energy and Industrial Strategy[1]
BSH	German Federal Maritime and Hydrographic Agency
CBD	Convention on Biological Diversity
CCW	Countryside Council for Wales
CEA	Cumulative Effects Assessment
CGNS	Celtic and Greater North Seas
CI	Confidence Interval
CIS	Celtic and Irish Seas
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CL	Confidence Limit
CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
CPOD	Cetacean Porpoise Detectors
CRoW	Countryside and Rights of Way Act
CV	Coefficient of Variation
CWT	Cumbria Wildlife Trust
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
DEFA	Department of Environment, Food and Agriculture (IoM)
DESNZ	Department for Energy Security and Net Zero
DRC	Dose-Response Curve
EDR	Effective Deterrent Ranges
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
EPS	European Protected Species
ES	Environmental Statement
ETG	Expert Topic Group

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[1] As of February 2023, BEIS is known as the Department for Energy Security and Net Zero (DESNZ)

EU	European Union
FCS	Favourable Conservation Status
GES	Good Environmental Status
GSD	Ground Sample Distance
HRA	Habitat Regulations Assessment
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
IoM	Isle of Man
iPCoD	Interim Population Consequences of Disturbance
IS	Irish Sea
IWC	International Whaling Commission
JCDP	The Joint Cetacean Data Programme
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
KDE	Kernel Density Estimation
MAC	Maritime Area Consents
META	Marine Energy Test Area
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MNR	Marine Noise Registry
MNRs	Marine Nature Reserves
MOD	Military of Defence
MPS	Marine Policy Statement
MSFD	Marine Strategy Framework Directive
MSR	Marine Strategy Regulations
MU	Management Units
MWDW	Manx Whale and Dolphin Watch
NCMPA	Nature Conservation Marine Protected Areas
NE	Natural England
NI	Northern Ireland
NMFS	National Marine and Fisheries Service
NNR	National Nature Reserve
NOAA	National Oceanic and Atmospheric Administration
NPWS	National Parks and Wildlife Service NPWS
NS	North Sea
NW	North-West

OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
PDE	Project Design Envelope
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PTS	Permanent Threshold Shift
RA	Risk Assessment
RIAA	Report to Inform Appropriate Assessment
RoI	Republic of Ireland
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SD	Standard deviation
SEL	Sound Exposure Level
SEL_{cum}	Sound Exposure Level from cumulative exposure
SEL_{SS}	Sound Exposure Level from single strike
SMRU	Sea Mammal Research Unit
SPA	Special Protection Area
SPL_{peak}	peak Sound Pressure Level
TTS	Temporary Threshold Shift
TWT	The Wildlife Trust
UK	United Kingdom
UXO	Unexploded Ordnance
WS	West Scotland

Glossary of Unit Terms

µPa	Micro Pascal
dB	Decibel
kHz	Kilohertz
km	Kilometre
m	Metre
nm	Nautical mile
s	Second

Glossary of Terminology

Absolute abundance	The most accurate estimate of population size. In the case of diving birds and mammals, this includes an estimate for the number that are believed to be submerged at the time of survey.
Applicant	Morecambe Offshore Windfarm Ltd
CAVOK	"Ceiling and Visibility OK" – term used for aviation surface weather observation reports.
Coefficient of Variation *CV (%)*	The coefficient of variation is a standard measure that describes the dispersion of data points around the mean. The lower the CV the more precise the estimate. It is calculated as the SD/mean.
Confidence limit *(CL)*	The upper and lower values that define the range of the 95% confidence interval.
Density estimate *(animals/km^2)*	The average number of animals per square km surveyed.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) for certain topics. The EPP provides a mechanism to agree the information required to be submitted to the Planning Inspectorate as part of the Development Consent Order (DCO) application. This function of the EPP helps Applicants to provide sufficient information in their application, so that the Examining Authority can recommend to the Secretary of State whether or not to accept the application for examination and whether an Appropriate Assessment is required.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Generation Assets (the Project)	Generation assets associated with the Morecambe Offshore Windfarm. This is infrastructure in connection with electricity production, namely the fixed foundation wind turbine generators (WTGs), inter-array cables, offshore substation platform(s) (OSP(s)) and possible platform link cables to connect OSP(s)
Inter-array cables	Cables which link the WTGs to each other and the OSP(s).
Landfall	Where the offshore export cables would come ashore.
Offshore export cables	The cables which would bring electricity from the offshore substation platform to the landfall.
Offshore substation platform(s) (OSP(s))	A fixed structure located within the windfarm site, containing electrical equipment to aggregate the power from the WTGs and convert it into a more suitable form for export to shore.
Platform link cable	An electrical cable which links one or more OSP(s).
Population estimate *(number)*	The mean number of animals estimated within the survey area.

Relative abundance	In the case of diving birds and mammals, this is the estimated population size based on animals recorded on or above the sea surface and does not account for any that may be diving and thus submerged at the time of survey.
Safety zones	An area around a structure or vessel which should be avoided, as set out in Section 95 of the Energy Act 2004 and the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations due to the flow of water.
Standard deviation *(SD)* of population estimate	The amount of variation or dispersion of a set of values.
Study area	This is an area which is defined for EIA topic, which includes the offshore development area, as well as potential spatial and temporal considerations of the impacts on relevant receptors. The study area for each EIA topic is intended to cover the area within which an effect can be reasonably expected.
Technical stakeholders	Technical stakeholders are organisations with detailed knowledge or experience of the area within which the Project is located and/or receptors which are considered in the EIA and HRA. Examples of technical stakeholders include the Marine Management Organisation (MMO), local authorities, Natural England (NE) and the Royal Society for the Protection of Birds (RSPB).
Transmission Assets	The transmission assets refers to Morgan and Morecambe Offshore Wind Farms export cables.
Windfarm site	The area within which the WTGs, inter-array cables, OSP(s) and platform link cables will be present.
Wind turbine generators (WTGs)	A fixed structure located within the windfarm site that converts the kinetic energy of wind into electrical energy.
95% confidence interval *(CI)*	A measure of uncertainty in the mean value. If the analysis was repeated, 95% of the time the mean population estimate would fall within this range. The smaller the CI range the more confident we can be that the mean estimate is an accurate reflection of the true population size.

MORECAMBE

11.2

The future of renewable energy

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1 Introduction

1. This Appendix provides additional detail on the marine mammal baseline to support **Chapter 11 Marine Mammals** (Document Reference 5.1.11) of the Environmental Statement (ES) for the Morecambe Offshore Windfarm Generation Assets (the Project).

2. The document sets out additional information in relation to the marine mammal species scoped into the ES, including identifying the study areas applied for each species and relevant policy, legislation and guidance. Additional baseline information and data from the two-year site-specific aerial surveys conducted for the Project were also summarised, along with relevant density and abundance estimates.

1.1 Marine mammal species

3. The following marine mammal species have been scoped into the assessment:

   - Harbour porpoise (*Phocoena phocoena*)
   - Bottlenose dolphin (*Tursiops truncatus*)
   - Common dolphin (*Delphinus delphis*)
   - Risso's dolphin (*Grampus griseus*)
   - White-beaked dolphin (*Lagenorhynchus albirostris*)
   - Minke whale (*Balaenoptera acutorostrata*)
   - Grey seal (*Halichoerus grypus*)
   - Harbour seal (*Phoca vitulina*)

4. These species were determined from the site-specific aerial surveys (**Section 3**) and other data sources and were discussed and agreed with the marine mammal Expert Topic Group (ETG).

1.1.1 Study area

5. The study area for the marine mammal assessment has been defined on the basis that marine mammals are highly mobile and transitory in nature. It was, therefore, necessary to examine species occurrence, not only within the windfarm site, but also over the wider area.

1.1.1.1 Cetaceans

6. Management Units (MUs) provide an indication of the spatial scales at which the effects of plans and projects alone, and in-combination, need to be assessed for the key cetacean species in United Kingdom (UK) waters, with

consistency across the UK (Inter-Agency Marine Mammal Working Group (IAMMWG), 2023). The study area, MUs and reference populations have been determined, based on the most relevant information and scale at which potential effects from the Project-alone, and together with other plans and projects, could occur.

7. The MUs are defined geographical areas in which individuals of a particular species are found and management of human activity is applied (IAMMWG 2023). For this reason, delineation of cetacean MUs have been, as far as is practical, aligned with the International Council for the Exploration of the Sea (ICES) Subarea and/or Divisions that are used for implementation of fisheries management measures, as recommended by the ICES Working Group of Marine Mammal Ecology.

8. For each marine mammal species, the study areas have been defined based on the relevant MUs as outlined in **Table 1.1,** which provide relevant spatial scale for assessment of environmental impacts (IAMMWG, 2023)**.**

Table 1.1 Marine mammal species relevant management unit

Species	Management unit	Source	Study area Plate reference
Harbour porpoise	Celtic and Irish Sea (CIS) MU	IAMMWG, 2023	**Plate 1.1**
Bottlenose dolphin	Irish Sea (IS) MU	IAMMWG, 2023	**Plate 1.2**
Common dolphin	Celtic and Greater North Seas (CGNS) MU	IAMMWG, 2023	**Plate 1.3**
Risso's dolphin	CGNS MU	IAMMWG, 2023	**Plate 1.3**
White-beaked dolphin	CGNS MU	IAMMWG, 2023	**Plate 1.3**
Minke whale	CGNS MU	IAMMWG, 2023	**Plate 1.3**

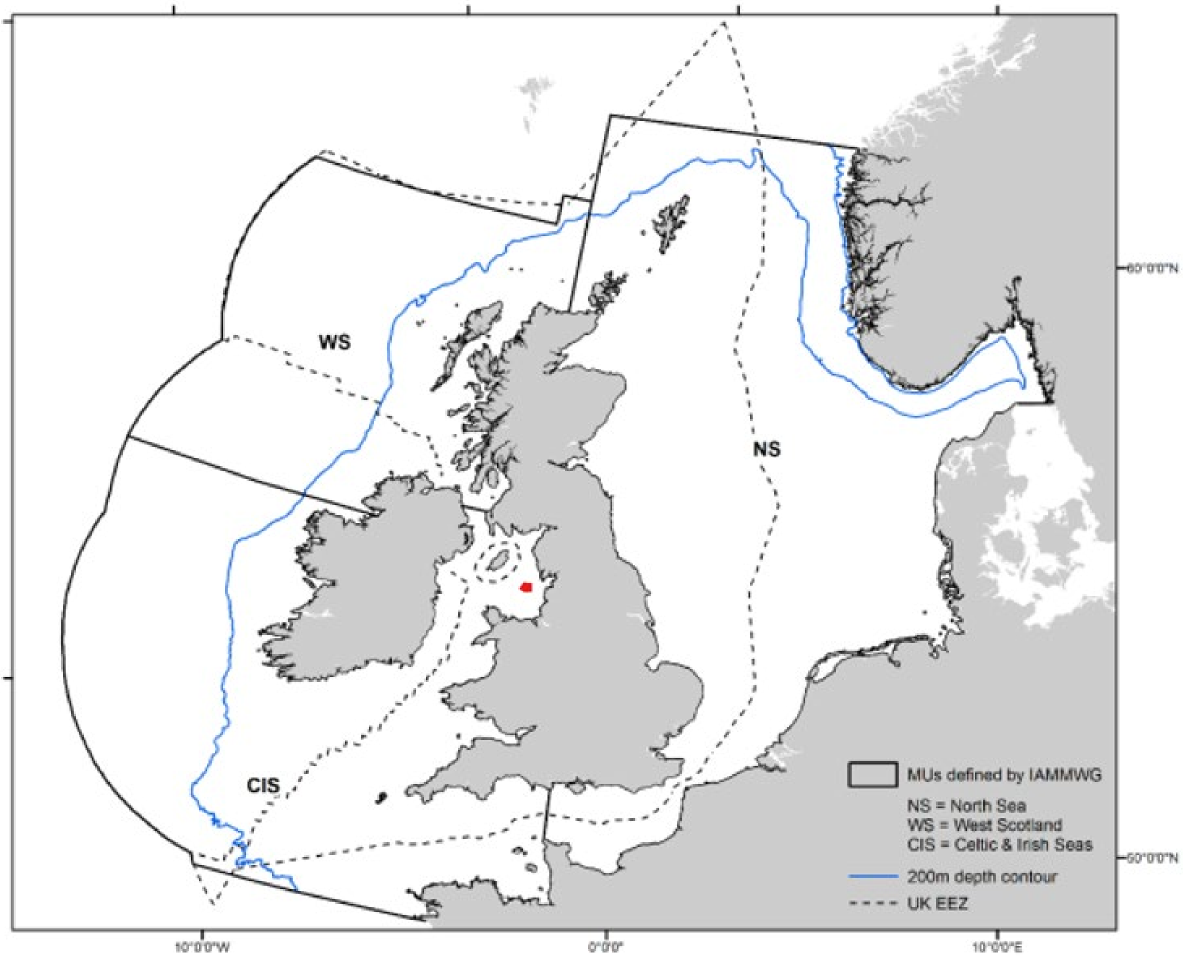

Plate 1.1 Harbour porpoise MUs; Project location is approximate (in red) (IAMMWG, 2023)

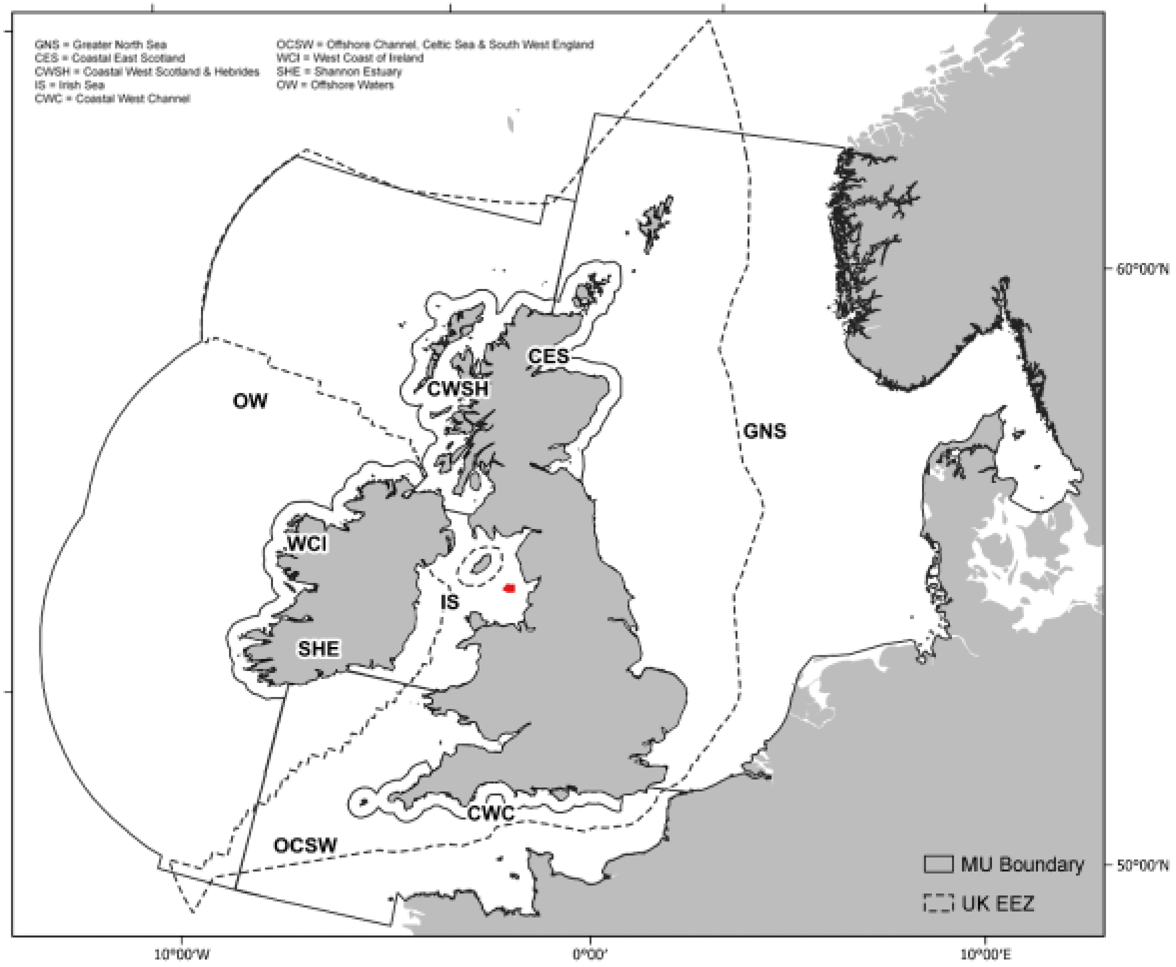

Plate 1.2 Bottlenose dolphin MUs; Project location is approximate (in red) (IAMMWG, 2023)

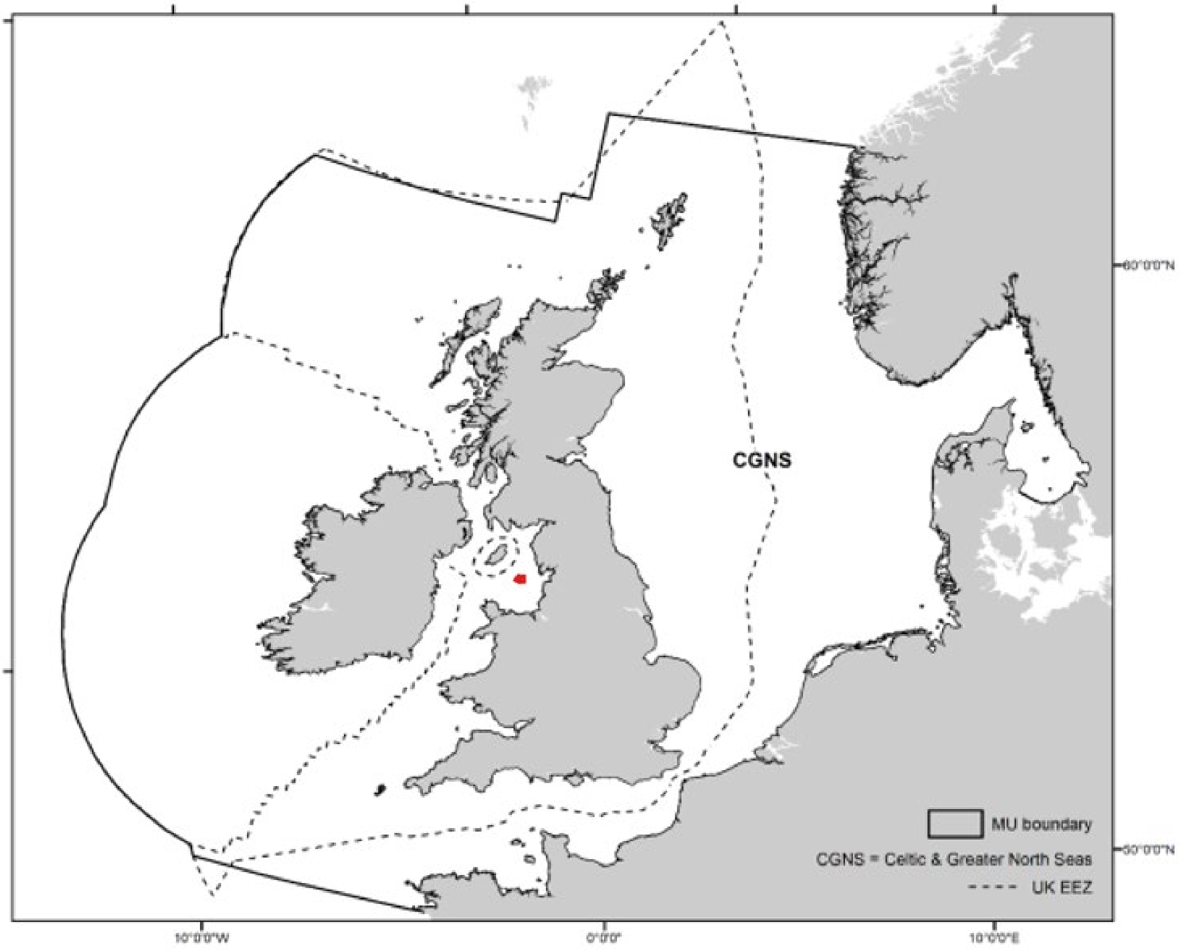

Plate 1.3 MU for common dolphin, Risso's dolphin, white-beaked dolphin and minke whale; Project location is approximate (in red) (IAMMWG, 2023)

1.1.1.2 Pinnipeds

9. Based on the movements of grey seal, and potential connectivity with the Project, the relevant MUs (**Plate 1.4** Special Committee on Seals (SCOS), 2020; **Plate 1.6** National Parks and Wildlife Service (NPWS), 2019) were:

- North-West (NW) England MU (within which the Project is located)
- Wales MU
- Northern Ireland (NI) MU
- Isle of Man (IoM) MU
- Republic of Ireland (RoI) east and southeast MUs

10. **Paragraph 201** provides a brief discussion regarding the use of the Oslo and Paris Convention for the Protection of the Marine Environment (OSPAR) Region III over the use of the seal MUs. For harbour seal, the relevant MUs (**Plate 1.5**; SCOS, 2022) were:

- North-West (NW) England MU
- Northern Ireland (NI) MU

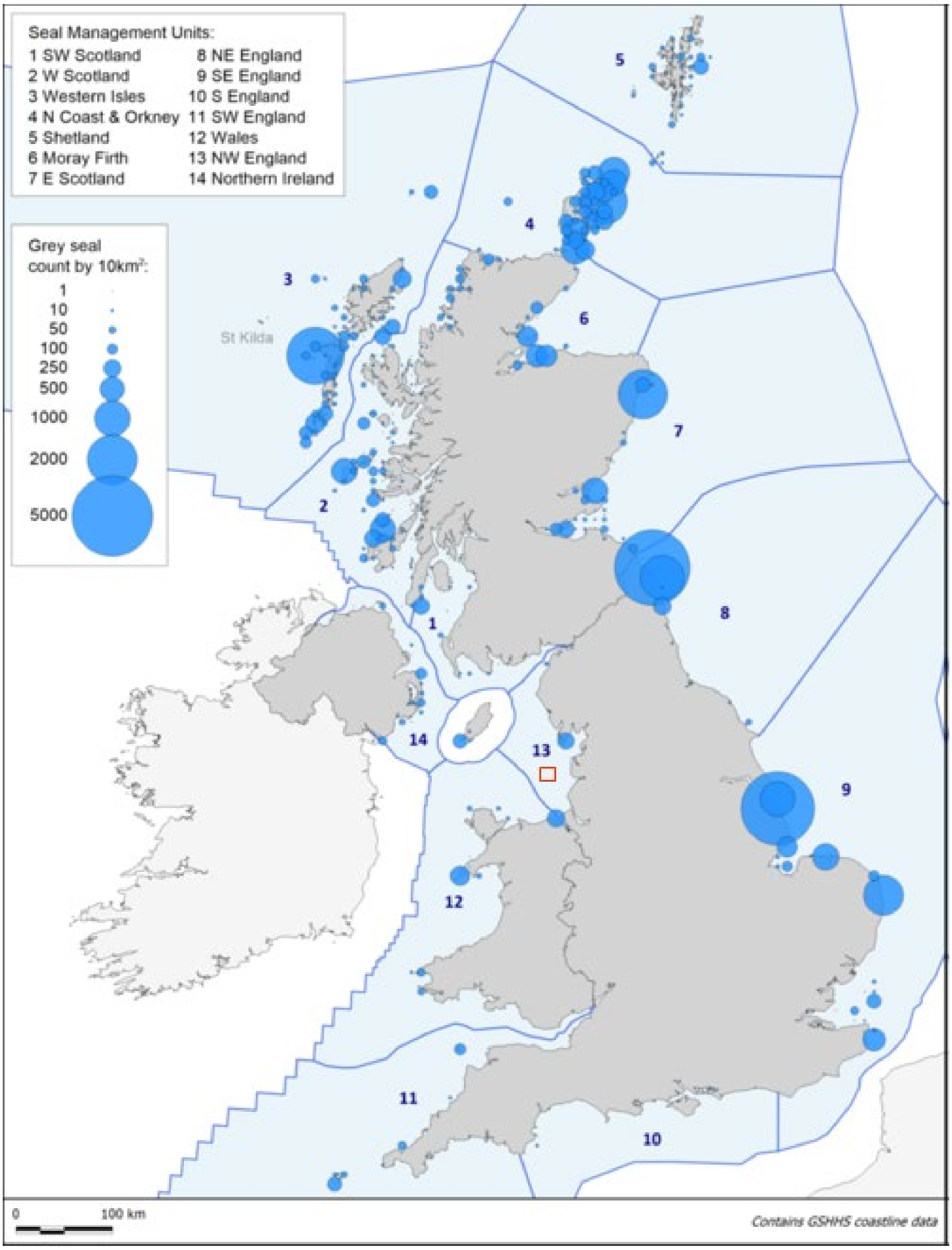

Plate 1.4 Grey seal MUs in the United Kingdom; Project location is approximate (in red) (SCOS, 2022)

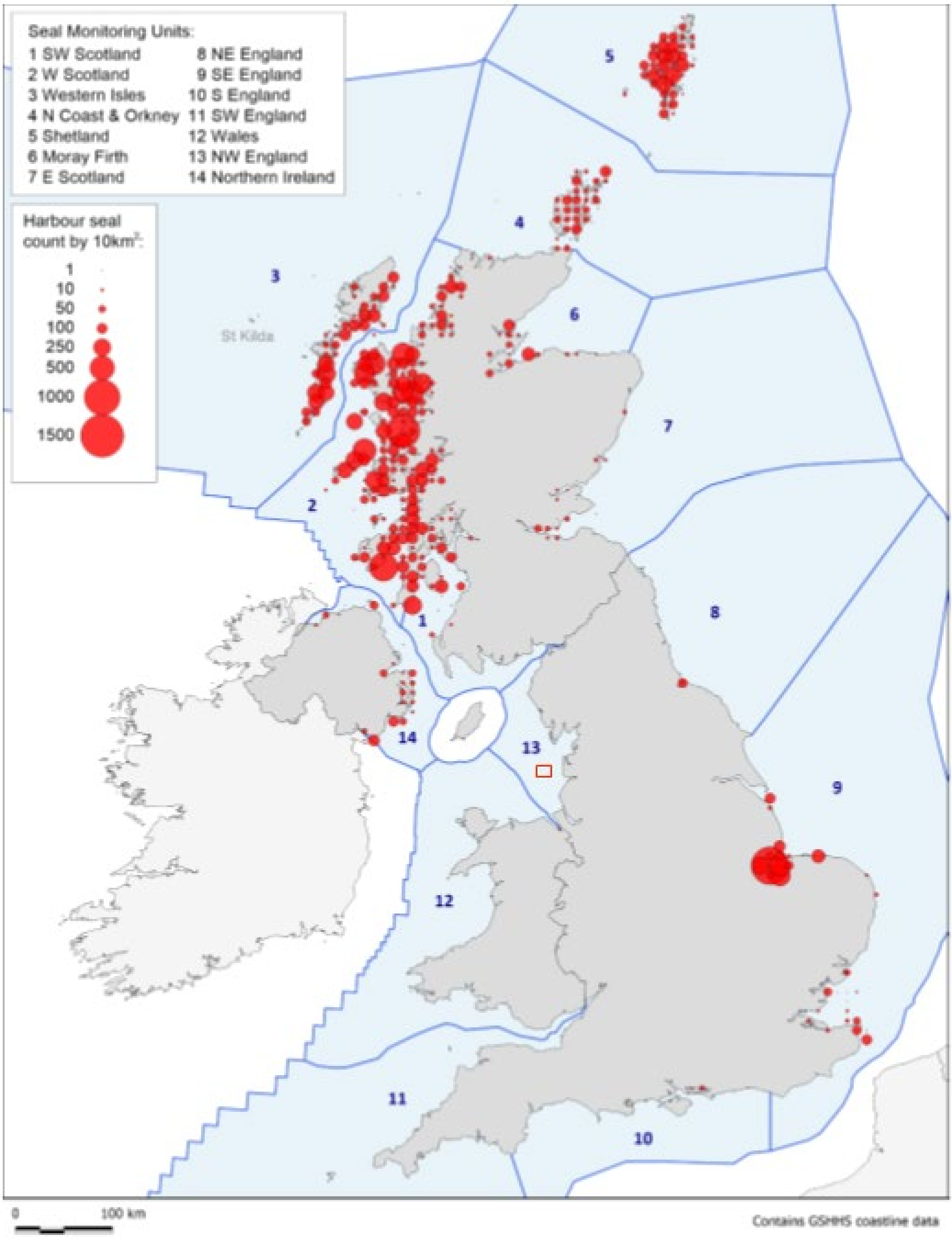

Plate 1.5 Harbour seal MUs in the United Kingdom; Project location is approximate (in red) (SCOS, 2022)

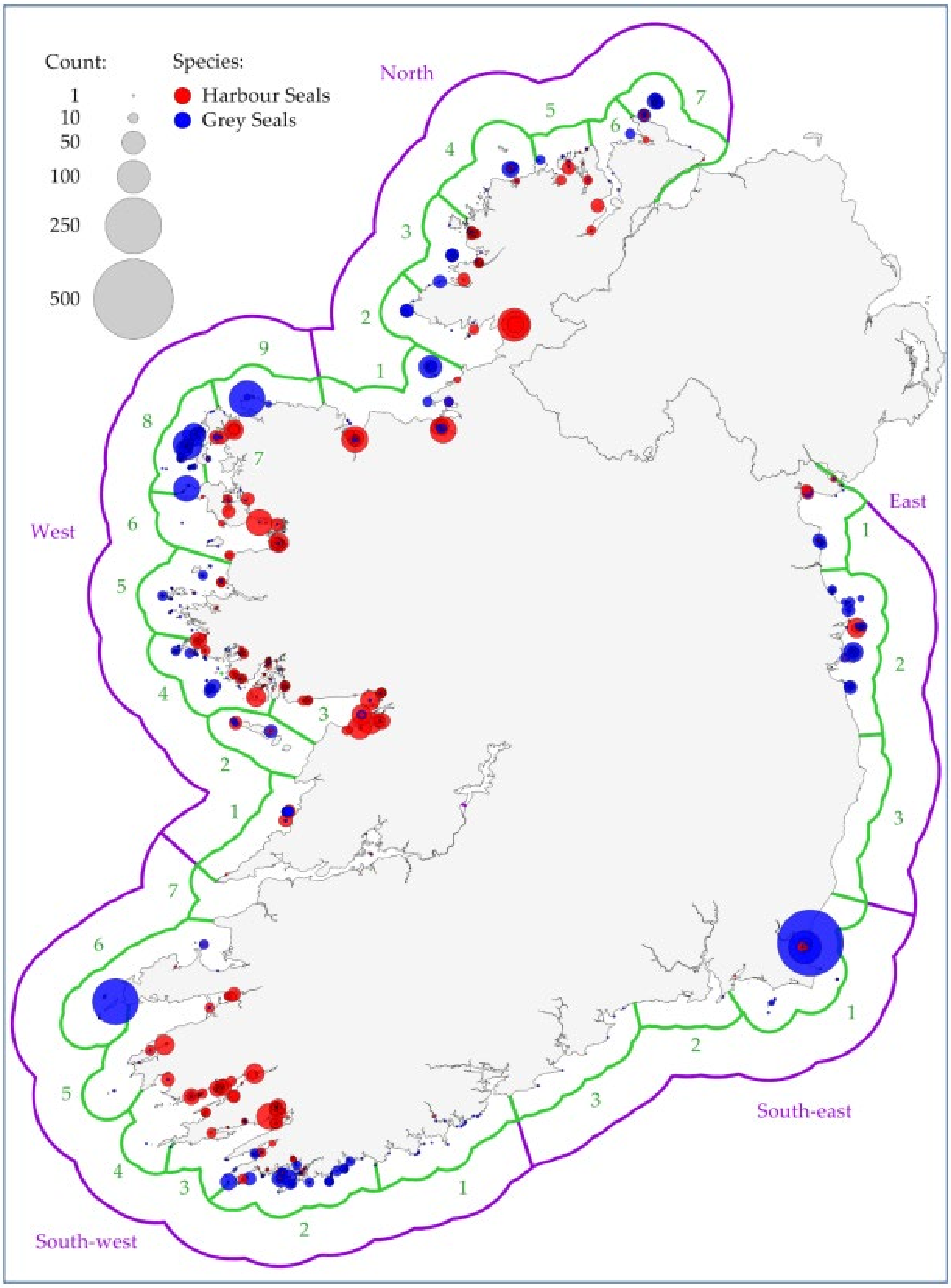

Plate 1.6 Seal MUs in the Republic of Ireland (Morris and Duck, 2019)

2 Policy, legislation, and guidance

2.1 Introduction

11. As outlined in **Chapter 11 Marine Mammals**, and detailed further below, there were a number of pieces of legislation, policy and guidance applicable to the assessment of marine mammals. This information is set out below, under the following:

- National marine policies
- Other national and international legislation for marine mammals
- European Protected Species (EPS) guidance
- Marine Wildlife Licence Requirements
- Legislation under Manx law

2.2 National marine policies and legislation/directives

12. Key national legislation and policy applicable to the marine mammal assessment included:

- The Marine Policy Statement (MPS) (UK Government, 2011)
- The Marine Strategy Framework Directive (MSFD) 2008/56/EC (EC, 2008), transposed into UK law by the Marine Strategy Regulations (MSR) 2010 SI 2010/1627 (United Kingdom (UK) Government, 2010)

2.2.1 The Marine Policy Statement

13. The MPS (UK Government, 2011) provided a high-level approach to marine planning and the general principles for decision making. It set out the framework for environmental, social and economic considerations that need to be taken into account in marine planning. The high-level objective of ‘Living within environmental limits’ covers the points relevant to marine mammals, which required that:

- Biodiversity is protected, conserved and, where appropriate, recovered and loss has been halted
- Healthy marine and coastal habitats occur across their natural range and are also able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems
- Our oceans support viable populations of representative, rare, vulnerable and valued species

2.2.2 The Marine Strategy Framework Directive

14. Annex I of the MSFD (EC, 2008) stated that to ensure that good environmental status is met, the following must be considered:

    - Biological diversity should be maintained
    - The quality and occurrence of habitats, as well as the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions
    - All elements of the marine food web, to the extent that they are known, occur at normal abundance and diversity levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity
    - Concentrations of contaminants are at levels not giving rise to pollution effects
    - Properties and quantities of marine litter do not cause harm to the coastal and marine environment
    - Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

2.2.3 The Marine Strategy Regulations

15. The MSR 2010 (as amended) established a framework of measures to achieve or maintain good environmental status (GES) in the marine environment by the year 2020[2]. Qualitative descriptors for determining GES relevant to marine mammals include:

    - Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions
    - All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity
    - Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems
    - Concentrations of contaminants are at levels not giving rise to pollution effects
    - Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

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[2] An update is expected in 2024 following review (including if BES has been achieved)

2.3 Other national and international legislation for marine mammals

16. **Table 2.1** provides an overview of national and international legislation in relation to marine mammals.

17. It should be noted that the Isle of Man, a self-governing British Crown dependency in the Irish Sea, is a signatory to most legislation concerning the UK including: Convention of Biological Diversity, Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), Bonn and Bern Convention, OSPAR and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Table 2.1 Summary table for national and international legislations relevant for marine mammals

Legislation	Level of protection	Species included	Details
Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)	International	Odontocetes	Formulated in 1992, this agreement has been signed by eight European countries bordering the Baltic and North Seas (including the English Channel) including the UK. Under the Agreement, provision was made for the protection of specific areas, monitoring, research, information exchange, pollution control and increasing public awareness of small cetaceans.
The Bern Convention 1979	International	All cetaceans, grey seal and harbour seal	The Convention conveyed special protection to those species that were vulnerable or endangered. Appendix II (strictly protected fauna): 19 species of cetacean. Appendix III (protected fauna): all remaining cetaceans, grey and harbour seal. Although an international convention, it was implemented within the UK through the Wildlife and Countryside Act 1981 (with any aspects not implemented via that route brought in by the Habitats Directive).
The Bonn Convention 1979	International	All cetaceans All marine turtle species	Protected migratory wild animals across all, or part of their natural range, through international co-operation, and related particularly to those species in danger of extinction. One of the measures identified was the adoption of legally binding agreements, including ASCOBANS.

Legislation	Level of protection	Species included	Details
EC Directive 92/43/EEC, adopted in 1992, known as the Habitats Directive	European	All cetaceans, grey and harbour seal All marine turtle species	Implemented the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention) and The Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention). The Directive aimed to conserve natural habitats of wild fauna and flora and was intended to protect biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species, including protection for specific habitats listed in Annex I and species listed in Annex II of the Directive. Annex IV also lists species in need of strict protection. The Conservation of Habitats and Species (Amendment) (European Union (EU) Exit) Regulations 2019 (2019 No. 579) set out the changes that applied since the UK left the European Union.
Oslo and Paris Convention for the Protection of the Marine Environment in the North-East Atlantic 1992 (OSPAR)	International	Bowhead whale *Balaena mysticetus*, northern right whale *Eubalaena glacialis*, blue whale *Balaenoptera musculus*, and harbour porpoise	OSPAR has established a list of threatened and/or declining species in the North East Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the EC Habitats and Birds directives and measures under the Bern Convention and the Bonn Convention.

Legislation	Level of protection	Species included	Details
International Convention for the Regulation of Whaling 1956	International	All cetacean species	This Convention established the International Whaling Commission (IWC) who regulate the direct exploitation and conservation of large whales (in particular sperm and large baleen whales) as a resource and the impact of human activities on cetaceans. The regulation considered scientific matters related to small cetaceans, in particular the enforcing of a moratorium on commercial whaling which came into force in 1986.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1975	International	All cetacean species All marine turtle species	Prohibited the international trade in species listed in Annex 1 (including sperm whales, northern right whales, and baleen whales) and allowed for the controlled trade of all other cetacean species.
Convention on Biological Diversity (CBD) 1993	International	All marine mammal species	Required signatories to identify processes and activities that were likely to have impacts on the conservation of and sustainable use of biological diversity, inducing the introduction of appropriate procedures requiring an EIA and mitigation procedures.
The Conservation of Habitats and Species Regulations 2017 and The Conservation of Offshore Marine Habitats and Species Regulations 2017	National	All cetaceans, grey and harbour seal All marine turtle species	‘The Habitats Regulations’. Provisions of The Habitats Regulations have been described further in **Chapter 11 Marine Mammals** It should be noted that the Habitats Regulations apply within the territorial seas and to marine areas within UK jurisdiction, beyond 12 nautical miles (nm).

Legislation	Level of protection	Species included	Details
The Wildlife and Countryside Act 1981 (as amended)	National	All cetaceans All marine turtle species	Schedule five: All cetaceans are fully protected within UK territorial waters. This protects them from killing or injury, sale, destruction of a particular habitat (which they use for protection or shelter) and disturbance. Schedule six: Short-beaked common dolphin, bottlenose dolphin and harbour porpoise; prevents these species from being used as a decoy to attract other animals. This schedule also prohibits the use of vehicles to take or drive them, prevented nets, traps or electrical devices from being set in such a way that would injure them and prevents the use of nets or sounds to trap or snare them.
The Countryside and Rights of Way Act (CRoW) 2000	National	All cetaceans	Under the CRoW Act 2000, it is an offence to intentionally or recklessly disturb any wild animal included under Schedule 5 of the Wildlife and Countryside Act.
Conservation of Seals Act 1970 (as amended)	National	Grey and harbour seal	As of 1st March 2021, a person would commit an offence if they intentionally or recklessly kill, injure or take a seal. The legislative changes in England and Wales, amended the Conservation of Seals Act 1970, prohibiting the intentional or reckless killing, injuring or taking of seals and removed the provision to grant licences for the purposes of protection, promotion or development of commercial fisheries or aquaculture activities. These changes were enacted to ensure compliance with the US Marine Mammal Protection Act Import Provision Rule.

Legislation	Level of protection	Species included	Details
Isle of Man Wildlife Act 1990	National	All cetaceans, seals and marine turtles	The 1990 Act is the primary wildlife protection legislation. It sets out schedules of Manx species of animal and plant that are protected by law from injury or disturbance. It also establishes the legal protection of Areas of Special Scientific Interest (ASSIs), Marine Nature Reserves (MNRs) as well as National Nature Reserves (NNRs).

2.4 European Protected Species guidance

18. All cetacean species listed as European Protected Species (EPS) under Annex IV of the Habitats Directive are protected from the deliberate killing (or injury), capture and disturbance throughout their range. Within the UK, The Habitats Directive was enacted through The Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017. Under these Regulations, it is an offence if wild animals listed in Annex IV(a) (including cetaceans) are deliberately disturbed in such a way as to:

- Deliberately capture, injure or kill any EPS
- Deliberately disturb them
- Deliberately damage or destroy a breeding site or resting place

19. The Joint Nature Conservation Committee (JNCC), Natural England (NE) and the Countryside Council for Wales (CCW) (JNCC *et al*., 2010) have produced draft guidance concerning the Habitat Regulations on the deliberate disturbance of marine EPS. This guidance provided an interpretation of the regulations in greater detail, including for pile driving operations (JNCC, 2010a), seismic surveys (JNCC, 2017) and the use of explosives (JNCC, 2010b[3]).

20. The draft guidance provided the following interpretations of deliberate injury and disturbance offences under the Habitats Regulations, as detailed in the paragraphs below:

> *"Deliberate actions are to be understood as actions by a person who knows, in light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action;*
>
> *Certain activities that produce loud sounds in areas where EPS could be present have the potential to result in an injury offence, unless appropriate mitigation measures are implemented to prevent the exposure of animals to sound levels capable of causing injury".*

---

[3] DRAFT guidelines for minimising the risk of injury to marine mammals from UXO clearance in the marine environment (JNCC, 2023) were issued for consultation in 2023. It is anticipated that the publication of the guidelines will occur after submission of this DCO Application and requirements will be updated accordingly.

21. For the purposes of marine users, the draft guidance stated that a disturbance which can cause offence should be interpreted as:

> *"Disturbance which is significant in that it is likely to be detrimental to the animals of an EPS or significantly affect their local abundance or distribution".*

22. The draft guidelines further stated that a disturbance offence would be more likely where an activity caused persistent noise in an area for long periods of time and highlighted that sporadic "trivial disturbance" should not be considered as a disturbance offence under Article 12.

23. Any action that could increase the risk of a long-term decline of the population, increase the risk of a reduction of the range of the species, and/or increase the risk of a reduction of the size of the habitat of the species could be regarded as a disturbance under the Regulations. For a disturbance to be considered non-trivial, the disturbance to marine EPS would need to be likely to at least increase the risk of a certain negative impact on the species at Favourable Conservation Status (FCS).

24. JNCC *et al*. (2010) stated that:

> *"In any population with a positive rate of growth, or a population remaining stable at what is assumed to be the environmental carrying capacity, a certain number of animals can potentially be removed as a consequence of anthropogenic activities (e.g., through killing, injury or permanent loss of reproductive ability), in addition to natural mortality, without causing the population to decrease in numbers, or preventing recovery, if the population is depleted. Beyond a certain threshold however, there could be a detrimental effect on the population".*

25. As per **Paragraph 17**, the same legislative protection for marine mammals outlined in this section and **Section 2.5** extends across the Irish Sea, and therefore to the IoM.

26. Further discussion on the use of thresholds for significance and the permanent or temporary nature of any disturbance has been considered by defining the magnitude of potential impact in the assessment (Section 11.4 of **Chapter 11 Marine Mammals**

2.5 European Protected Species requirements

27. Under the Habitats Regulations 2017, an EPS licence would be required if the risk of injury or disturbance to cetacean species, from any potential effect (i.e., underwater noise, collision risk) has been assessed as likely, following the application of mitigation. In English waters, this is referred to as marine wildlife licence. If such a licence is required, an application must be submitted, the assessment of which comprises three tests, namely:

- Whether the activity falls within one of the purposes specified in Regulation 55 of the Habitats Regulations. Only the purpose of “preserving public health or public safety or other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment” is of relevance to marine mammals in this context
- That there are no satisfactory alternatives to the activity proposed (that would not incur the risk of offence)
- That the licensing of the activity will not result in a negative impact on the species’/population’s FCS

28. A marine wildlife licence would consider all cetacean species at potential risk of injury or disturbance. It is likely that the Project would require a licence for disturbance to cetacean species as a result of the piling activities, dependent on the final design for infrastructure foundations.

29. There is currently no legislation that requires seals to be included under a marine wildlife licence; disturbance was not deemed to be an offence under the Conservation of Seals Act 1970, and in the case of injury to seals, the Marine Management Organisation (MMO) is currently only able to grant licences under very specific circumstances as listed under Section 10(1) of the Conservation of Seals Act 1970, which would not apply in the case that a marine wildlife licence was required for the construction of the Project.

30. Under the definitions of ‘deliberate disturbance’ in the Habitats Regulations, chronic exposure and/or displacement of animals could be regarded as a disturbance offence. Therefore, if these risks cannot be avoided, then the Applicant is likely to be required to apply for a marine wildlife licence from the MMO in order to be exempt from the offence.

31. If required, the marine wildlife licence application would be submitted post-consent. At that point, the Project Design Envelope (PDE) would have been further refined through detailed design and procurement activities and further detail would be available on the foundation type and techniques selected for the construction of the windfarm, as well as the mitigation measures proposed following the development of the Marine Mammal Mitigation Protocol (MMMP) for piling and Unexploded Ordnance (UXO) clearance.

2.6 Legislation under Manx law

32. Statutory marine and coastal conservation in the IoM is the responsibility of the Department of Environment, Food and Agriculture (DEFA) of the IoM Government. The main legislation available for protected species and habitats is the Wildlife Act (1990) and the Fisheries Act (2012).

33. There are several Marine Nature Reserves (MNRs) in Manx waters (IoM) and this is the main conservation designation available for subtidal sites which

have been designated under the Wildlife Act 1990. Historically many MNRs were closed or restricted areas, established for fisheries management and research. However, in 2008 the IoM MNRs project was founded, using existing data and new survey work to identify the most important marine habitats and species for protection.

34. Ramsey Bay was the first designated MNRs in 2011, which was followed by a further nine MNRs. These were re-designated on the 1st September 2018, and all are located within the 0-3nm boundary of Manx waters (**Plate 2.1**). In total, IoM MNRs cover 430km^2, 52% of the 0-3nm area or 11% of the territorial sea.

Plate 2.1 Isle of Man Marine Nature Reserves 2018

35. Of these ten MNRs, only one, Little Ness, does not include marine mammals as a designated feature. See **Table 2.2** for all MNRs and the marine mammal species that were featured in the designation list. Additional information on transboundary effects with the IoM has been discussed in Section 11.8.1 of **Chapter 11 Marine Mammals**.

Table 2.2 Isle of Man Marine Nature Reserves and their marine mammal designation features

Marine Nature Reserve	Harbour porpoise	Risso's dolphin	Bottlenose dolphin	Grey seal	Harbour seal	Minke whale
Baie ny Carrickey	✓	✓	✓	-	-	-
Calf and Wart Bank	✓	✓	-	-	-	-
Douglas	-	✓	✓	-	-	-
Langness	✓	✓	-	✓	✓	-
Laxey	✓	-	✓	-	-	✓
Little Ness	-	-	-	-	-	-
Niarbyl	✓	-	-	✓	-	-
Port Erin	✓	-	-	-	-	-
Ramsey	-	-	-	✓	✓	-
West Coast	✓	-	-	✓	✓	-

3 Site-specific surveys

3.1 Survey overview

36. In order to provide site specific and up to date information on which to base the impact assessment, site-specific aerial surveys were conducted for marine mammals and seabirds. HiDef Aerial Surveying Limited ('HiDef') collected high resolution aerial digital still imagery for marine megafauna (combined with ornithology surveys) over the survey area which included the windfarm Agreement for Lease Area (AfL)[4] and a custom 4km to 10km buffer. The buffer extended to 10km to the north and east due to proximity to Liverpool Bay Special Protection Area (SPA) for birds. The total survey area was 651km^2 (**Plate 3.1**).

37. Following Preliminary Environmental Information Report (PEIR), the windfarm site development area was reduced to 87km^2 with this revised windfarm site now forming the Application boundary. With the reduction in windfarm site, the survey custom buffer now extends 9km from the windfarm site to the west, 4km to the south and 10km to the north and east.

38. The monthly aerial surveys commenced in March 2021, extending over 24 months. The aerial surveys were conducted along a series of strip transects

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[4] The AfL area reflects the boundary assessed in the PEIR and encompasses the windfarm site assessed within the ES, noting the boundary was refined following the PEIR.

(31 strip transects at 1km spacing) across the survey area every month for 24 months. The strip transects extended roughly north-east to south-west, perpendicular to the depth contours along the coast (**Plate 3.1**). Such a design ensured that each transect sampled a similar range of habitats (primarily relating to water depth) and reduced the variation in marine mammal abundance estimates between transects. The surveys were flown along the transect pattern at a height of approximately 550m above sea level.

39. **Appendix 12.2 Aerial Survey Two Year Report March 2021 to February 2023** (Document Reference 5.2.12.2) provides full details of the survey methods as well as the full dataset for the two years of monthly surveys flown between March 2021 and February 2023, providing data from 24 surveys.

40. The surveys were undertaken using an aircraft equipped with four HiDef Gen II cameras with sensors set to a resolution of 2cm Ground Sample Distance (GSD). Each camera sampled a strip of 125m width, separated from the next camera by ~25m, to provide a combined sampled width of 500m within a 575m overall strip. Two of the four cameras were analysed, achieving approximately 25% coverage of the survey area in each flight (see **Appendix 12.2**). The remaining footage has been retained for analysis at a later stage if required.

41. Data analysis followed a two-stage process in which video footage was reviewed (with a 20% random sample used for audit) then the detected objects were identified to species or species group level (again with 20% selected at random for audit). The audit of both stages required 90% agreement to be achieved (see **Appendix 12.2**) for further details).

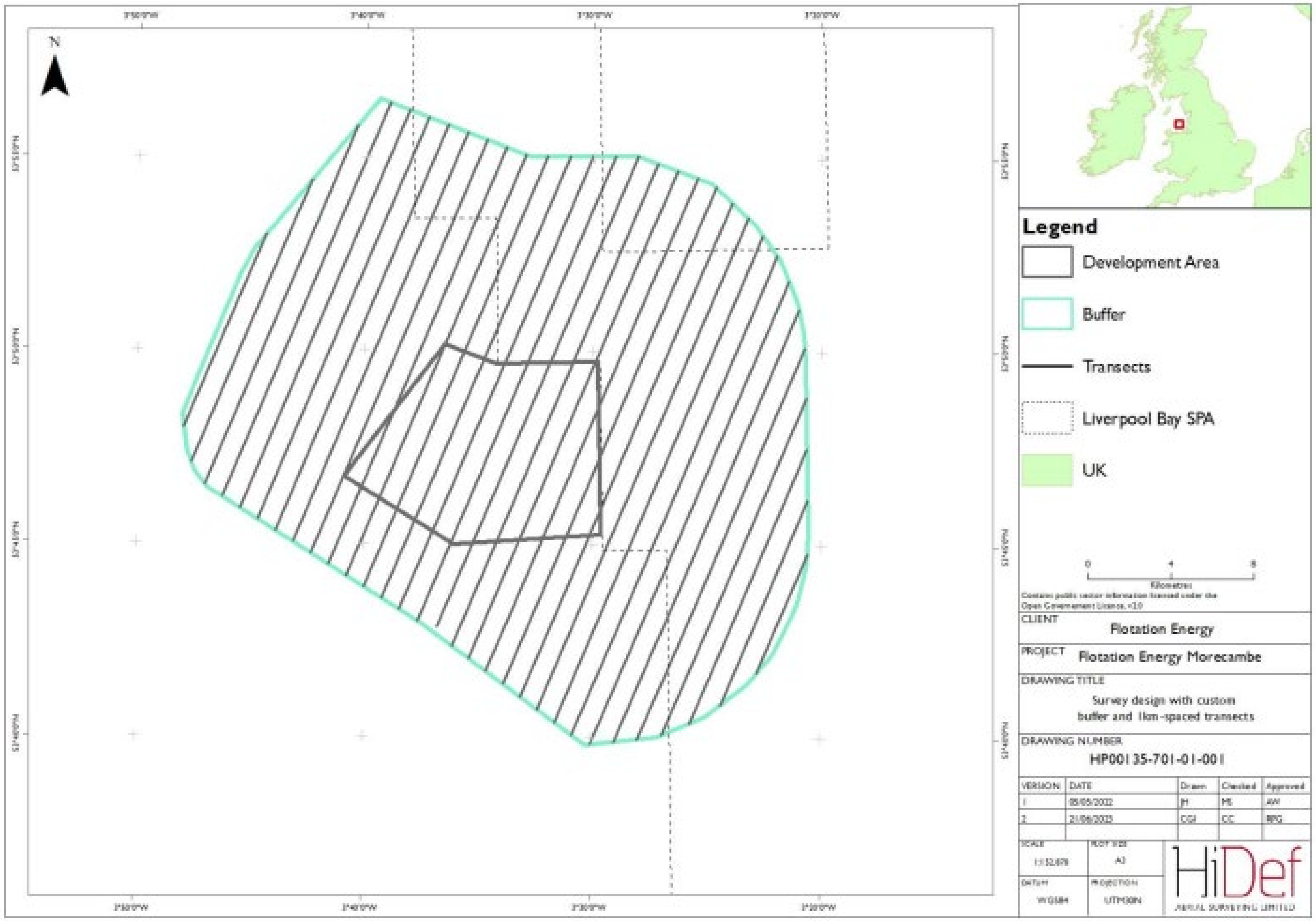

Plate 3.1 Morecambe survey design with 4-10km hybrid buffer with 1km-spaced transects flown between March 2021 and February 2023

42. The environmental conditions per survey month are summarised in **Table 3.1**, more detail can be found in HiDef's Two Year Report (**Appendix 12.2)**. The windspeeds in **Table 3.1** were measured at flight height (550m above sea level) and were typically greater than they were at ground/sea level. The windspeed's greatest effect on the data was via the sea-state, which over the entire 24 months of surveys was 2.6 (smooth - slight) on average.

*Table 3.1 Environmental conditions at flight height reported by Hi-Def in 24 monthly survey reports (CAVOK = Ceiling and Visibility OK) *Average calculated from the cameras reviewed*

Survey date	**Wind speed (knots)**	**Sea state (average*)**	**Glare (average[5]*)**	**Cloud base over site (feet)**	**Turbidity (average*)**
March 2021	16	2.03	1.00	2500	0.00
April 2021	3	3.75	1.00	3000	1.00
May 2021	10	1.00	1.00	1800+	0.99
June 2021	20-30	1.01	1.26	CAVOK	0.01
July 2021	5-12	1.00	1.00	2500+	0.00
Aug 2021	5-15	2.82	1.32	CAVOK	0.36
Sept 2021	10-20	2.32	1.85	2500+	1.00
Oct 2021	10-20	2.98	1.00	2500+	1.00
Nov 2021	20-30	4.64	1.00	2500+	1.25
Dec 2021	30	3.14	1.01	2000	1.94
Jan 2022	5-20	2.04	1.55	1800+	0.98
Feb 2022	15-25	3.25	1.00	1800+	1.00
March 2022	5-35	4.42	1.00	1800+	1.18
April 2022	14	2.51	1.04	CAVOK	1.00
May 2022	4-17	2.00	1.00	1800+	1.00
June 2022	5-25	2.01	1.00	1800+	1.00
July 2022	15	3.92	1.59	2000	1.00
Aug 2022	5	0.82	1.00	1800+	1.01
Sept 2022	15-20	1.96	1.00	CAVOK	1.22
Oct 2022	15-25	2.57	1.00	20,000	1.00
Nov 2022	10-18	1.99	1.00	2000+	1.00
Dec 2022	15-24	4.16	1.00	2000+	1.03
Feb (1) 2023	10-20	3.25	1.00	10,000	1.00
Feb (2) 2023	10-15	2.60	1.12	CAVOK	1.81

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[5] Sun-glare scoring system 0= not recorded to 4= strong (see Aerial Survey Report, **Appendix 12.2** for details)

43. Key weather effects are noted below, more detail on how the data was treated can be found in HiDef's Two Year Report (**Appendix 12.2)**

- September 2021: high glare was recorded across much of the survey area, hence only data collected in areas with a glare rating of below 3 (out of 4) was used to model population estimates
- October 2021: adverse weather conditions affected several transects to the east of the survey area, hence density and population estimates were calculated for a reduced area
- January 2023: was missed due to lack of available weather windows so two surveys were flown in February 2023 to compensate.

44. **Table 3.2** presents the numbers of marine mammals recorded during the aerial surveys from March 2021 to February 2023. The results indicated harbour porpoise were the most abundant marine mammal species present within the survey area.

45. Apportioning of 'unidentified' seals and cetacean to species level was also undertaken per survey for the purposes of calculating population estimates. The number of unidentified seals or cetacean in each species group were assigned to species where appropriate, based on their respective abundance ratios.

46. There was one unidentified dolphin species in the second year of survey data (February (1) 2023) and four unidentified cetacean species across the survey period. These animals have been apportioned in line with the abundance ratio of other cetaceans identified during the survey.

47. There were three unidentified seal/small cetaceans across the survey period. These could be harbour porpoise or grey seal, however as it was not possible to determine the species, these animals have been apportioned in line with the ratio of other seal and cetacean species during the survey.

48. There were also 59 unidentified seal species. These were most likely to be grey seal based on the ratio of recorded grey and harbour seal during the surveys. Within the survey period, only one harbour seal was identified (in July 2021). These animals have been apportioned in line with the ratio of other seal species identified (largely grey seal except for the one sighting of harbour seal) during the survey.

Table 3.2 Marine mammal species recorded during site-specific HiDef surveys of the windfarm site and buffer (March 2021 to February 2023)

Survey date	Harbour porpoise	Grey seal	Harbour seal	Seal species	Common dolphin	Bottlenose dolphin	Dolphin species	Cetacean species	Seal/ small cetacean species
March 2021	85	0	0	5	0	0	0	0	1
April 2021	13	2	0	3	0	0	0	0	0
May 2021	48	5	0	0	0	0	0	0	0
June 2021	45	4	0	5	0	0	0	0	0
July 2021	39	2	1	2	0	0	0	0	0
Aug 2021	29	2	0	2	0	0	0	1	0
Sept 2021	13	0	0	3	0	0	0	0	0
Oct 2021	25	1	0	0	0	0	0	0	0
Nov 2021	26	2	0	0	0	0	0	0	0
Dec 2021	9	2	0	0	0	0	0	0	0
Jan 2022	19	0	0	2	0	0	0	0	0
Feb 2022	21	1	0	0	0	0	0	0	0
Sub-Total	**372**	**21**	**1**	**22**	**0**	**0**	**0**	**1**	**1**
March 2022	25	4	0	2	0	0	0	0	0
April 2022	18	2	0	1	0	0	0	0	0
May 2022	179	1	0	1	0	0	0	1	0
June 2022	52	1	0	6	0	0	0	0	0
July 2022	6	0	0	1	0	0	0	1	0
Aug 2022	49	4	0	6	32	0	0	0	1
Sept 2022	27	2	0	3	0	0	0	0	0

Survey date	Harbour porpoise	Grey seal	Harbour seal	Seal species	Common dolphin	Bottlenose dolphin	Dolphin species	Cetacean species	Seal/ small cetacean species
Oct 2022	39	0	0	2	0	0	0	0	0
Nov 2022	80	3	0	5	0	0	0	1	1
Dec 2022	28	2	0	2	0	0	0	0	0
Feb (1) 2023	29	1	0	4	0	2	1	0	0
Feb (2) 2023	21	1	0	4	0	0	0	0	0
Sub-Total	**553**	**21**	**0**	**37**	**32**	**2**	**1**	**3**	**2**
Total	**925**	**42**	**1**	**59**	**32**	**2**	**1**	**4**	**3**

49. From the sightings recorded (**Table 3.2**), abundance and density estimates for the survey area were calculated. These were based on confirmed sightings only.

50. Density and abundance estimates have been calculated using strip transect analysis and a statistical technique called kernel density estimation (KDE) to create density surface maps (these are presented in **Plate 3.2** and **Plate 3.3** with further information in **Appendix 12.2**.

51. The density estimate was expressed as the average number of animals per square km in the whole survey area. The population estimate was expressed as the estimated number of animals within the whole survey area. The upper and lower confidence intervals (CIs) define the range that the population estimate fell within with 95% certainty. The coefficient of variance (CV) or the relative standard error is a measure of the precision of the population and density estimates.

52. For species such as marine mammals that dive and therefore spend time underwater, an availability bias or correction factor must be applied in order to account for those individuals that it was not possible to detect as they may have been underwater at the time of image capture. Without these availability biases or correction factors being applied, any abundance or density estimate would be relative only, rather than being an absolute estimate.

53. The depth above which harbour porpoise were available for detection has been estimated to be 2m by Teilmann *et al*. (2013) when correcting for availability bias during visual aerial surveys of harbour porpoise. The correction factors applied for harbour porpoise were dependent on the month and time of day (**Table 3.3**). Further information on the application of the correction factors is provided in **Appendix 12.2**.

Table 3.3 Correction factors used to account for the availability bias for harbour porpoise for different months and times of day (taken from Teilmann et al., 2013)

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

54. **Appendix 12.2** provides a summary of the surfacing behaviour for marine mammals in the survey area between March 2021 and February 2023.

3.2 Density estimates for harbour porpoise

55. To estimate the density of surfacing harbour porpoise, HiDef calculated the proportion of animals as snapshot surfacing. Snapshot surfacing indicated where the dorsal fin was clear of the water surface in the middle frame of the sequence in which the animal was present. This was identified using data from all survey months combined because sample sizes were too small to be accurate when calculating the surfacing proportions in individual months. HiDef then multiplied the calculated density of all harbour porpoise by the proportion of snapshot surfacing encounters in the surveys. The density of surfacing harbour porpoises was then divided by the proportion of surfacing behaviour from Teilmann *et al*. (2013) in **Table 3.3**, to derive the estimates of absolute density and abundance.

56. The monthly absolute density estimates for harbour porpoise for the whole Project survey area, including buffer, are presented in **Table 3.4**. These estimates have been corrected for availability bias based on confirmed harbour porpoise sightings only. The average summer density estimate has been determined based on average of monthly estimates for April to

September. The average winter density estimate has been determined based on average of monthly estimates for October to March. It must be noted that there were two sets of survey results for February 2023, as the survey in January 2023 could not be conducted due to adverse weather. The average annual density estimate has been determined based on the 24 survey months for the first year of site-specific surveys. It is important to note that the density for the summer average has been skewed by a single month of particularly high numbers (May 2022; n= 179; 6.25 animals/km^2). The resulting mean summer density (1.621 animals/km^2) was significantly higher than that of Evans and Waggitt (2023) (0.2 animals/km^2) for the average summer density and the most recent Small Cetaceans in European Atlantic waters and North Sea (NS) (SCANS) IV density of 0.5153 animals/km^2 for the survey block CS-E (Gilles *et al.*, 2023).

Table 3.4 Apportioned harbour porpoise absolute density estimates for each month, corrected for availability bias, with summer, winter and annual density estimates for the whole Project survey area including buffer

Month	Maximum absolute density estimate (corrected) for whole survey area (animals/km^2)
March 2021	3.09
April 2021	0.39
May 2021	1.63
June 2021	1.71
July 2021	1.54
August 2021	1.08
September 2021	1.02
October 2021	1.38
November 2021	1.25
December 2021	0.37
January 2022	0.78
February 2022	1.04
March 2022	0.88
April 2022	0.54
May 2022	6.25
June 2022	1.96
July 2022	0.26
August 2022	1.79
September 2022	1.28
October 2022	1.84

Month	Maximum absolute density estimate (corrected) for whole survey area (animals/km^2)
November 2022	3.98
December 2022	1.26
February 2023	1.43
February 2023	1.04
Average for summer period (April-Sept)	**1.621**
Average for winter period (Oct-Mar)	**1.528**
Annual average	**1.574**

3.3 Abundance estimates for harbour porpoise

57. The abundance estimates for harbour porpoise (**Table 3.5**) have been derived in the same way as the density estimates (see **Appendix 12.2**). These are presented in **Plate 3.2** - **Plate 3.5**.

Table 3.5 Apportioned absolute abundance estimates of harbour porpoise within whole Project survey area including buffer, corrected for availability bias

Month	Abundance estimate (corrected) for number of harbour porpoise in survey area	Lower and upper 95% confidence limits for abundance estimates
March 2021	2,026	1,220 - 3,018
April 2021	255	137 - 388
May 2021	1,081	732 – 1,458
June 2021	1,108	747 – 1,499
July 2021	1,010	643 – 1,427
August 2021	718	371 – 1,101
September 2021	648	148 – 1,359
October 2021	898	499 – 1,374
November 2021	820	375 – 1,351
December 2021	266	118 - 466
January 2022	498	278 - 744
February 2022	677	350 -1,043
March 2022	590	304 - 928
April 2022	358	177 – 555
May 2022	4,060	2,196 – 6,481
June 2022	1,285	747 – 1,934
July 2022	180	51 – 309

Month	Abundance estimate (corrected) for number of harbour porpoise in survey area	Lower and upper 95% confidence limits for abundance estimates
August 2022	1,178	766 – 1,639
September 2022	823	415 – 1,306
October 2022	1,197	852 -1,550
November 2022	2,569	1905 – 3,334
December 2022	835	525 – 1,182
February 2023	924	414 – 1,561
February 2023	685	390 - 1,019
Average	**1,028.7**	**598.3 – 1542.8**

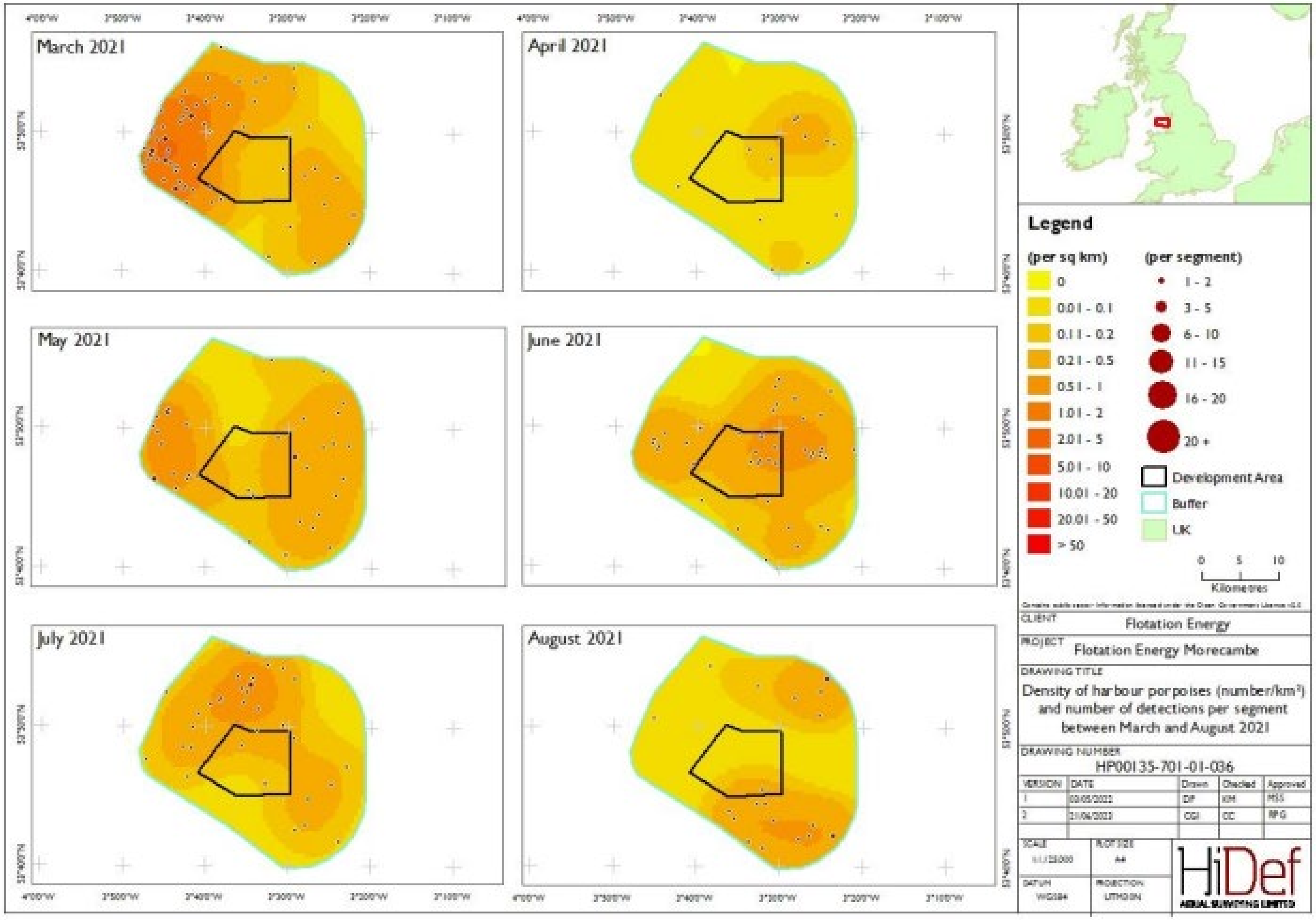

Plate 3.2 Density of harbour porpoise (number/km²) and number of detections per segment in the survey area between March and August 2021

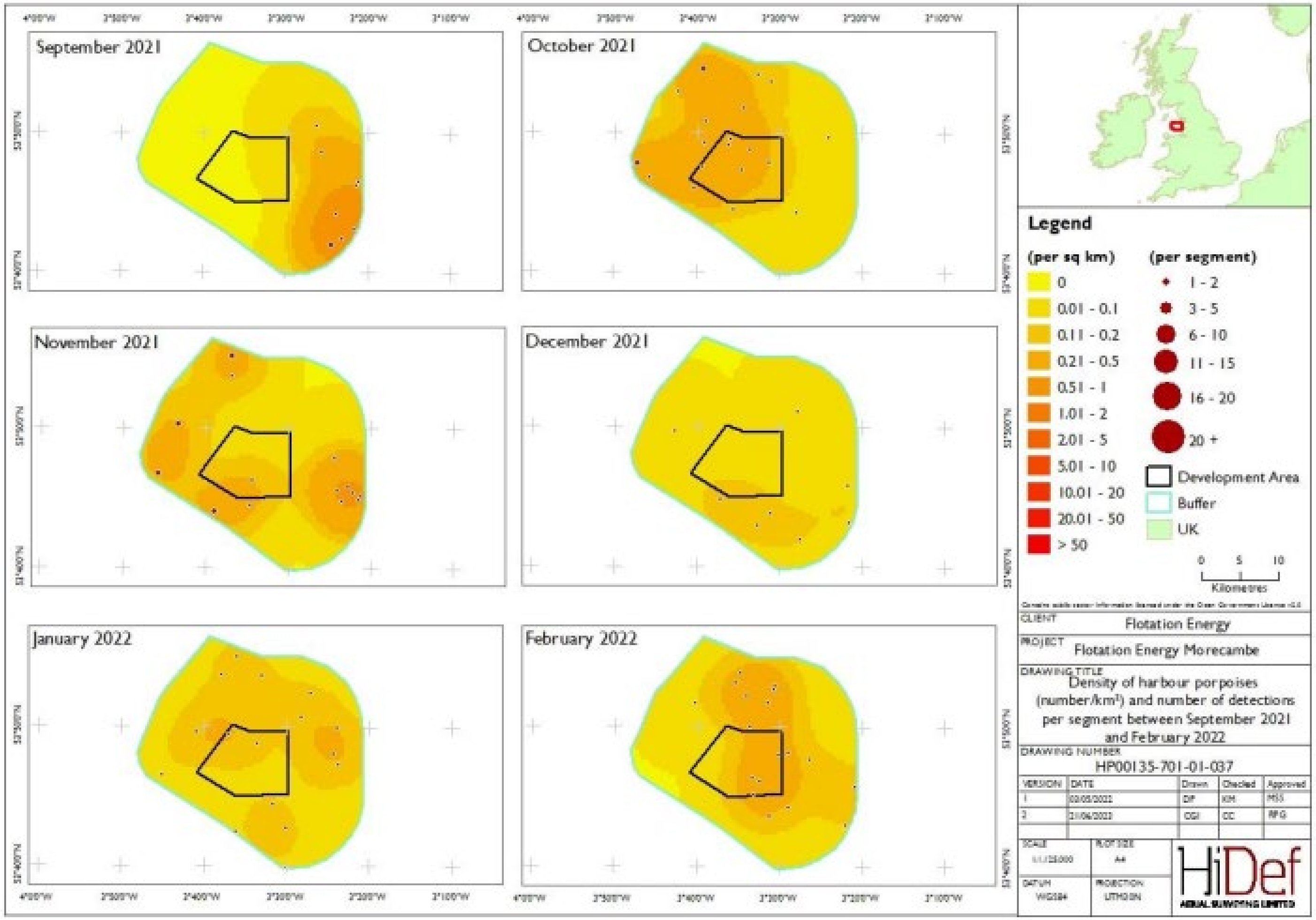

Plate 3.3 Density of harbour porpoise (number/km²) and number of detections per segment in the survey area between September 2021 and February 2022

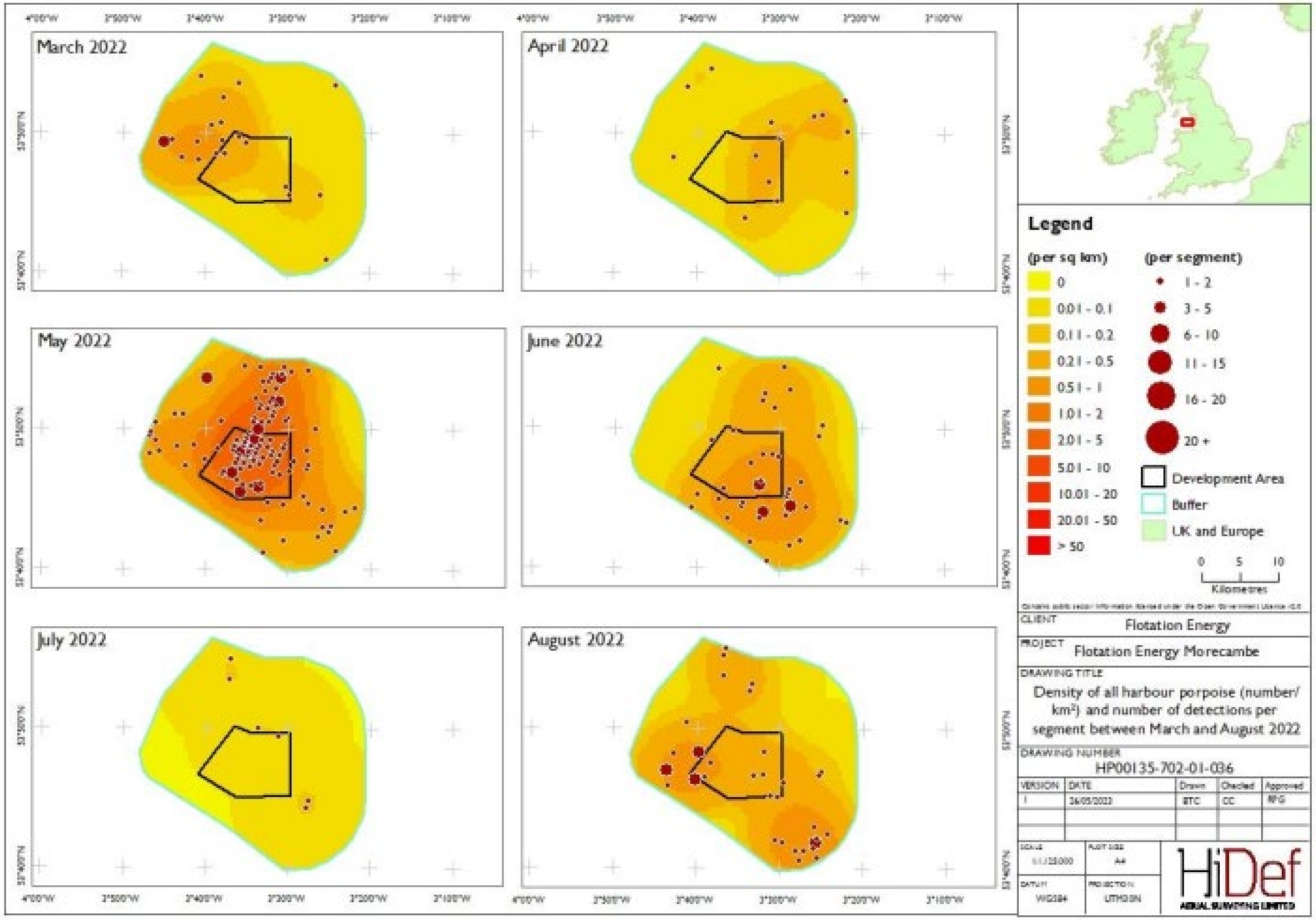

Plate 3.4 Density of harbour porpoise (number/km²) and number of detections per segment in the Morecambe survey area between March and August 2022

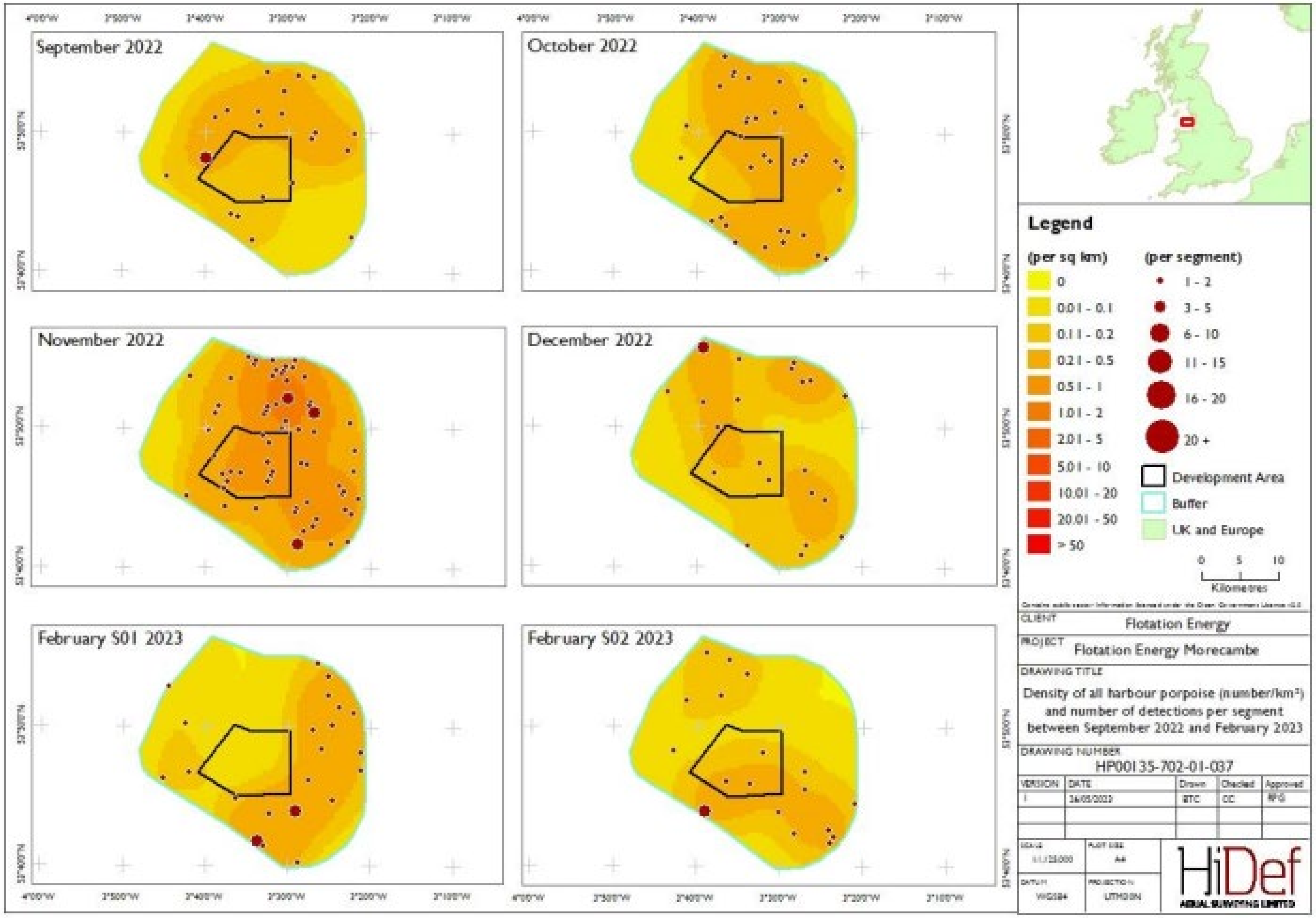

Plate 3.5 Density of harbour porpoise (number/km²) and number of detections per segment in the Morecambe survey area between September 2022 and February 2023

3.4 Density estimates for grey seal

58. The monthly absolute density estimates for grey seal for the whole Project survey area, including buffer, are presented in **Table 3.6**. Unlike for harbour porpoise, an availability bias or correction factor for seals is unavailable.

59. The average winter density estimate has been determined based on the average of monthly estimates for October to March; but due to lack of sightings it was only based on nine densities, whereas the slightly higher average summer density was based on ten density values. Neither of the site-specific (survey) densities were higher than the Project-specific density (revised area and 4km buffer) derived from the data provided by Carter *et al*. (2022) (0.100 animals/km^2); discussed further below in **Section 5.7**.

Table 3.6 Apportioned grey seal absolute density estimates for each month, corrected for availability bias, with summer, winter and annual density estimates for the whole Project survey area including buffer

Month	Maximum absolute density estimate (apportioned) for whole survey area
March 2021	*no sighting*
April 2021	0.03
May 2021	0.03
June 2021	0.06
July 2021	0.02
August 2021	0.02
September 2021	*no sighting*
October 2021	0.01
November 2021	0.01
December 2021	0.01
January 2022	*no sighting*
February 2022	0.01
March 2022	0.04
April 2022	0.02
May 2022	0.01
June 2022	0.04
July 2022	*no sighting*
August 2022	0.06
September 2022	0.03
October 2022	*no sighting*
November 2022	0.05

Month	Maximum absolute density estimate (apportioned) for whole survey area
December 2022	0.03
February 2023	0.03
February 2023	0.03
Average for summer period (April-Sept)	**0.032**
Average for winter period (Oct-Mar)	**0.024**
Annual average	**0.0284**

3.5 Abundance estimates for grey seal

60. The abundance estimates for grey seal (**Table 3.7**) have been derived in the same way as the density estimates (see **Appendix 12.2**). Maps with numbers of less abundant marine mammal (including seal) detections per segment can be found in the **Appendix 12.1 Offshore Ornithology Technical Report** (Document Reference 5.2.12.1).

Table 3.7 Apportioned absolute abundance estimates of harbour porpoise within whole Project survey area including buffer, corrected for availability bias

Month	Abundance estimates for number of grey seal in survey area	Lower and upper 95% confidence limits for abundance estimates
March 2021	*no sighting*	*no sighting*
April 2021	21	4 - 40
May 2021	21	0 - 56
June 2021	37	16 - 64
July 2021	14	3 - 28
August 2021	16	0 - 36
September 2021	*no sighting*	*no sighting*
October 2021	5	0 - 14
November 2021	9	0 - 20
December 2021	9	0 - 20
January 2022	*no sighting*	*no sighting*
February 2022	4	0 - 12
March 2022	24	8 - 43
April 2022	12	0 - 28
May 2022	8	0 - 20
June 2022	28	8 - 55
July 2022	*no sighting*	*no sighting*

Month	Abundance estimates for number of grey seal in survey area	Lower and upper 95% confidence limits for abundance estimates
August 2022	41	20 - 66
September 2022	21	4 - 39
October 2022	*no sighting*	*no sighting*
November 2022	33	16 - 52
December 2022	17	4 - 32
February 2023	20	4 - 36
February 2023	21	5 - 37
Average	**19**	**4.8 – 36.7**

3.6 Geotechnical Marine Mammal Survey Report

61. Between 17th July and 20th October 2023, Gardline conducted a series of deep geotechnical surveys within the proposed Project windfarm site. The surveys were conducted from a motor vessel, and visual monitoring for marine mammals was undertaken by non-dedicated mitigation personnel, in accordance with best practice outlined in the JNCC 'Guidelines for minimising the risk of injury to marine mammals from the geophysical surveys' (JNCC, 2017).

62. Over 1,021 hours were surveyed across the 74 days of the geotechnical survey. During this period common dolphins were seen regularly (17 occasions) throughout August and September 2023 but not October 2023. On one occasion on 9th September 2023 a super pod of 300 animals was observed slow swimming, feeding and breaching, of which 100 were identified as juveniles.

63. On only five separate occasions, bottlenose dolphin were observed spread out over the survey period (July, August, September 2023), of which one was a mother and a calf.

64. Fifteen harbour porpoise were sighted on nine occasions from July to August, in small groups of two or three individuals.

65. Grey seal were also sighted, with 33 individual grey seals sighted on separate occasions throughout all survey months.

66. Furthermore, there were four entries of unidentified dolphin species sightings, and seven entries for unidentified seal species.

4 SCANS surveys

67. A series of large-scale surveys for SCANS was initiated in summer 1994 in the North Sea and adjacent waters (SCANS 1995; Hammond *et al*., 2002).

68. SCANS-II was undertaken in summer 2005 in all shelf waters (SCANS-II 2008; *et al*., 2013) and 2007 in offshore waters (Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA), 2009).

69. SCANS-III was conducted in summer 2016 with the aim to survey all European Atlantic waters, however the final surveyed area excluded offshore waters of Portugal and also excluded waters to the south and west of Ireland which were surveyed by the Irish ObSERVE project (Hammond *et al*., 2017, 2021). The Project lies within the boundaries of block F.

70. In October 2023, the SCANS-IV report was released with data collected during the summer 2022 (Gilles *et al*., 2023), with the aim to inform the then upcoming Marine Strategic Framework Directive (MSFD) in European Atlantic Waters in 2024. This survey included the offshore waters of Portugal which had not been previously surveyed as part of SCANS, but excluded waters south and west of Ireland, which were surveyed by the ObSERVE2, and coastal Norwegian waters north of Vestfjorden. Some of the block boundaries have changed since SCANS-III, but the changes have not affected the block in which the Project lies (block CS-E)

71. With reference to **Plate 4.1** for SCANS-III and **Plate 4.2** for SCANS- IV, pink lettered blocks were surveyed by air and blue numbered blocks were surveyed by ship. Blocks coloured green to the south, west and north of Ireland were surveyed by the Irish ObSERVE2 project. SCANS-III blocks FC and FW coloured yellow were surveyed by the Faroe Islands as part of the North Atlantic Sightings Survey in 2015. The cross-hatched area represents where SCANS-IV blocks BB-3 and BB-A overlapped.

72. Amongst many other sources of information, **Section 5** provides a summary of species abundance and density estimates from SCANS-III and IV wherever possible to inform about changes in species distribution in the relevant survey blocks F and CS-E.

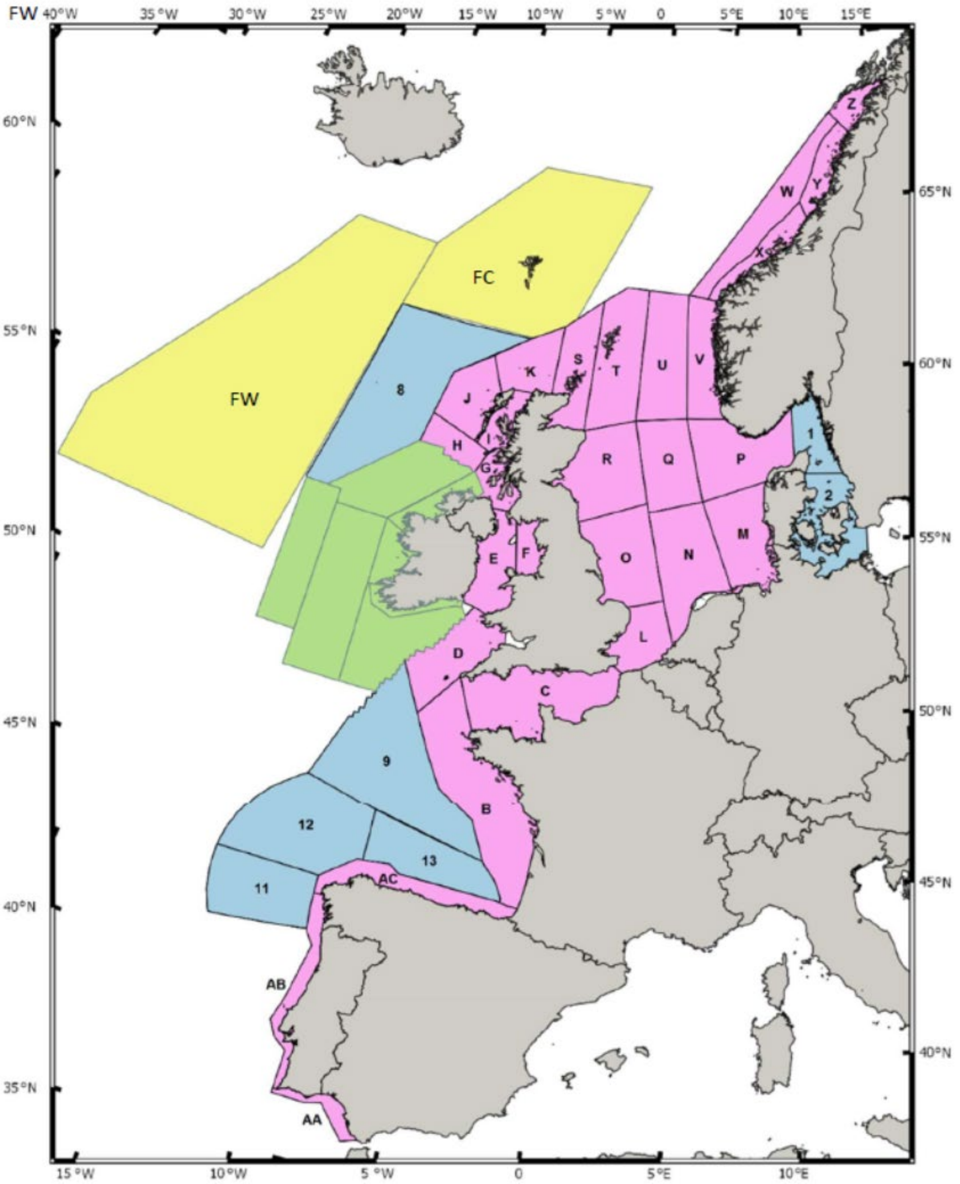

Plate 4.1 Area covered by SCANS-III and adjacent surveys (Hammond et al., 2021). Block colours: blue= ship survey, pink= aerial survey, green=ObSERVE project, yellow=North Atlantic Sightings Survey in 2015)

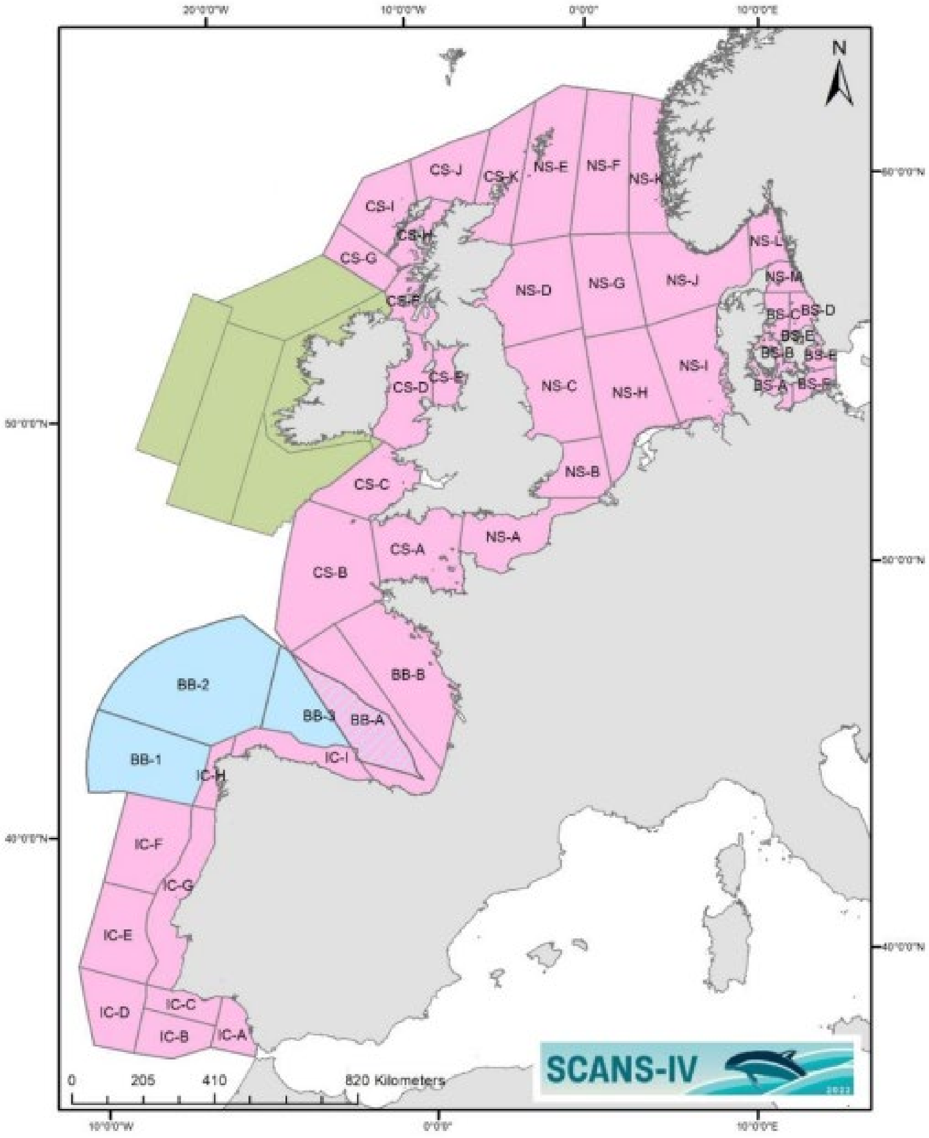

Plate 4.2 Area covered by SCANS-IV and adjacent surveys (Gilles et al., 2023) Block colours: blue= ship survey, pink= aerial survey, green=ObSERVE project)

5 Existing environment

73. The study area for marine mammals has been defined on the basis that marine mammals are highly mobile and transitory in nature. It was, therefore, necessary to examine species occurrence not only within the windfarm site, but also over the wider area. Baseline data from developments and research projects in the wider Northwest have been evaluated to determine species in the wider area of the Project.

74. A series of baseline characterisation aerial surveys were undertaken at Awel y Môr Offshore Windfarm (28.9km from the Project) completing one survey per month for two years, between March 2019 and February 2021. Over the two years of surveys only harbour porpoise were identified to species level, with the remaining sightings being classified as unidentified dolphin, unidentified seal or dolphin/porpoise. There was no seasonal or spatial pattern to the harbour porpoise sightings and a density of 0.13 porpoise/km^2 was recorded.

75. Gwynt y Môr Offshore Windfarm conducted pre- and post-construction marine mammal surveys between 2003 and 2019 by undertaking aerial, boat and land-based surveys. Species recorded included harbour porpoise, bottlenose dolphin, short-beaked common dolphin, grey seal and harbour seal (CMACS Ltd. 2005, 2011, 2013).

76. Morgan Offshore Wind Project Generation Assets began their aerial surveys in April 2021 and finished in March 2023. As presented in their PEIR (Morgan Offshore Wind Ltd, 2023), the only species observed within the first 12 surveys were bottlenose dolphin, grey seal, and harbour porpoise, of which the latter was the most commonly sighted.

77. The aerial surveys for Mona Offshore Wind Project commenced in March 2020 and finished in February 2022. Species recorded, as presented in their PEIR, included harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, grey seal and one harbour seal (Mona Offshore Wind Ltd, 2023).

78. The Manx Whale and Dolphin Watch (MWDW) have conducted land-based surveys since 2006 and vessel-based surveys throughout the Manx territorial waters since 2007. Data were available through reports provided on the MWDW website for 2007 - 2016, with additional data obtained for 2018 (Felce, 2014, 2015; Adams, 2017; Clark *et al.*, 2019). The surveys, as well as Howe (2018), have reported five main species of marine mammals in Manx territorial waters: harbour porpoise, common dolphin, bottlenose dolphin, Risso's dolphin and minke whale.

79. The Joint Cetacean Data Programme (JCDP) (2022) database was reviewed to ensure all publicly available data sources for the Irish sea had been considered to inform the baseline and existing environment. The main source listed was the SCANS III report (Hammond *et al*., 2021) which has been reviewed alongside the updated SCANS-IV data (Gilles *et al*., 2023).

80. The revised Atlas of the Marine Mammals of Wales (Evans and Waggitt, 2023) became available in June 2023 and provided density maps and species summaries for the five most commonly occurring species in the Irish Sea, including harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin and minke whale.

81. It should be noted that, although extremely rare, a humpback whale (*Balaenoptera novaeangliae*) was spotted in July 2023, just 0.5 miles off the west coast of the IoM. This has been the first sighting since 2017, with previous sightings recorded in 2010 and 2013 (Wotton, 2023). No sightings of humpback whales in Liverpool Bay have been recorded by Organisation Cetacea (in the last 30 years), the Sea Watch Foundation (July – August 2023), nor the Hebridean Whale and Dolphin Trust (between 2017 and 2023).

5.1 Harbour porpoise

5.1.1 Distribution

5.1.1.1 Abundance

82. Harbour porpoise within the eastern North Atlantic have been generally considered to be part of a continuous biological population that extends from the French coastline of the Bay of Biscay to northern Norway and Iceland (Tolley and Rosel, 2006; Fontaine *et al*., 2007, 2014; IAMMWG, 2015). However, for conservation and management purposes, it is necessary to consider this population within smaller MUs. MUs provide an indication of the spatial scales at which effects of plans and projects alone, and in-combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK (IAMMWG, 2015; 2023).

83. IAMMWG defined three MUs for harbour porpoise: North Sea (NS); West Scotland (WS); and the Celtic and Irish Sea (CIS). As outlined in **Section 1.1.1** of this Appendix, the Project is located within the CIS MU (**Plate 1.1**) with an estimated population of 62,517 CV = 0.13) individuals.

84. As outlined in **Section 3**, harbour porpoise was the most commonly sighted marine mammal species during the site-specific surveys, with a total of 925 individuals recorded for the 24-month survey period. Harbour porpoise were recorded in all 24 months and across the entire survey area.

85. Heinänen and Skov (2015) provided the results of detailed analyses of 18 years of survey data in the Joint Cetacean Protocol (JCP) undertaken to inform the identification of discrete and persistent areas of relatively high harbour porpoise density in the UK marine area.

86. Habitat preference modelling for the Celtic and Irish Seas has been conducted by Heinänen and Skov (2015), as well as Lepple (2023 unpublished), in which it was found that high densities of harbour porpoise were typically associated with shallow water depths (ranging between 20-90m). A range of studies (Evans *et al*. 2003, Reid *et al*. 2003, Shucksmith *et al.* 2009, Embling *et al*. 2009, Isojunno *et al*. 2012, Williamson *et al*. 2017) from other sea regions verified the preference for shallow water, possibly linked to distribution and proximity of abundant prey of high nutritional quality (Macleod *et al*. 2003, Johnston *et al.* 2005, Spitz *et al.* 2012).

87. Furthermore, preference for seabed heterogeneity such as headlands with tidal currents and eddies were indicated for harbour porpoise (Shucksmith *et al*. 2009, Heinänen and Skov, 2015, Waggitt *et al.* 2018) as a more complex seabed provided niches for a wide range of species. In contrast, muddier areas were predicted to have lower harbour porpoise densities.

88. The Project windfarm site consists of predominantly muddy sand and sand, whilst at areas along the coast finer sediment is found (as per assessment in **Chapter 9 Benthic Ecology** (Document Reference 5.1.9). The site-specific surveys highlighted consistent numbers of harbour porpoise, which could be related to the presence of favoured prey species (prey has been discussed below in **Section 5.1.2**).

5.1.1.2 Density

89. The predicted densities of harbour porpoise during the summer and winter seasons in the Celtic and Irish Seas showed considerable variation between periods in offshore waters and more persistent patterns in coastal areas. High densities of porpoises were estimated off the northwest and west coasts of Wales during summer, predictions which affirmed the observed densities. Predictions also indicated that the western Bristol Channel supported high densities, as did the area north of the IoM. **Plate 5.1** indicates the predicted high-density areas of harbour porpoise during summer in the Celtic and Irish Seas. **Plate 5.2** indicates the predicted high-density areas of harbour porpoise during winter in the Celtic and Irish Seas.

90. The modelling by Heinänen and Skov (2015) did not predict areas of high harbour porpoise density in or around the Project area during summer or winter (**Plate 5.1** and **Plate 5.2**).

91. The persistent high-density areas of harbour porpoise in the Celtic and Irish Seas identified by Heinänen and Skov (2015) were:

- Three coastal areas off west Wales (Pembrokeshire and Cardigan Bay), and northwest Wales (Anglesey, Llŷn Peninsula), and part of the Bristol Channel (Camarthen Bay)
- Smaller areas north of the IoM (winter) and on the Northern Irish coast near Strangford Lough
- Western Channel off Start Point, Cornwall (summer).

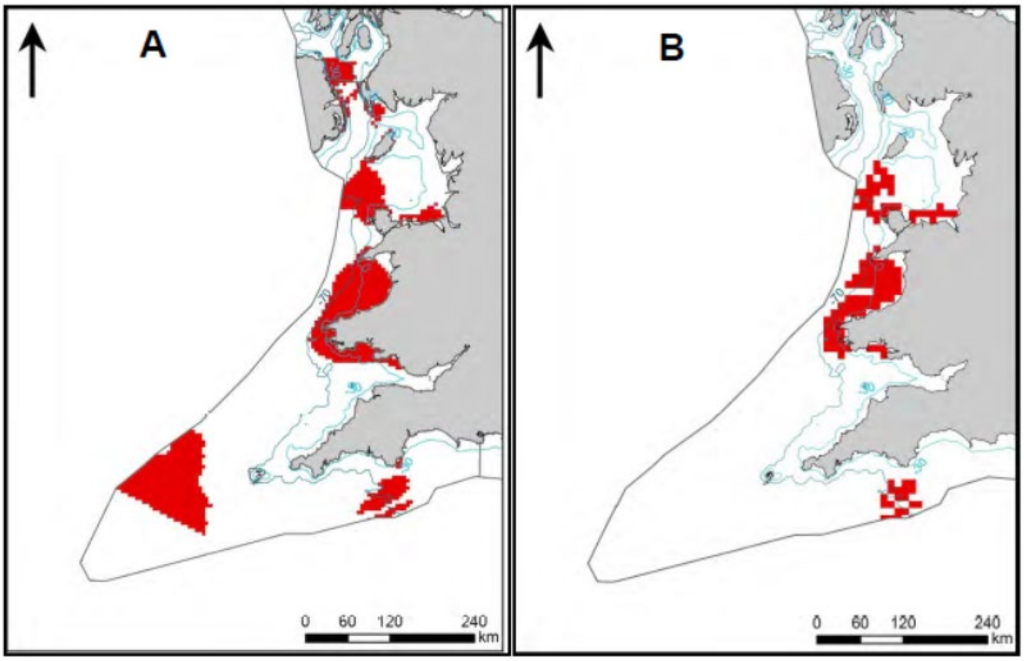

Plate 5.1 Persistent high-density areas identified during summer. In map A the red colours mark areas where persistent high densities as defined by the upper 90th percentile have been identified. In map B the red colours mark persistent high-density areas with survey effort from three or more years [Source: Heinänen and Skov (2015)]

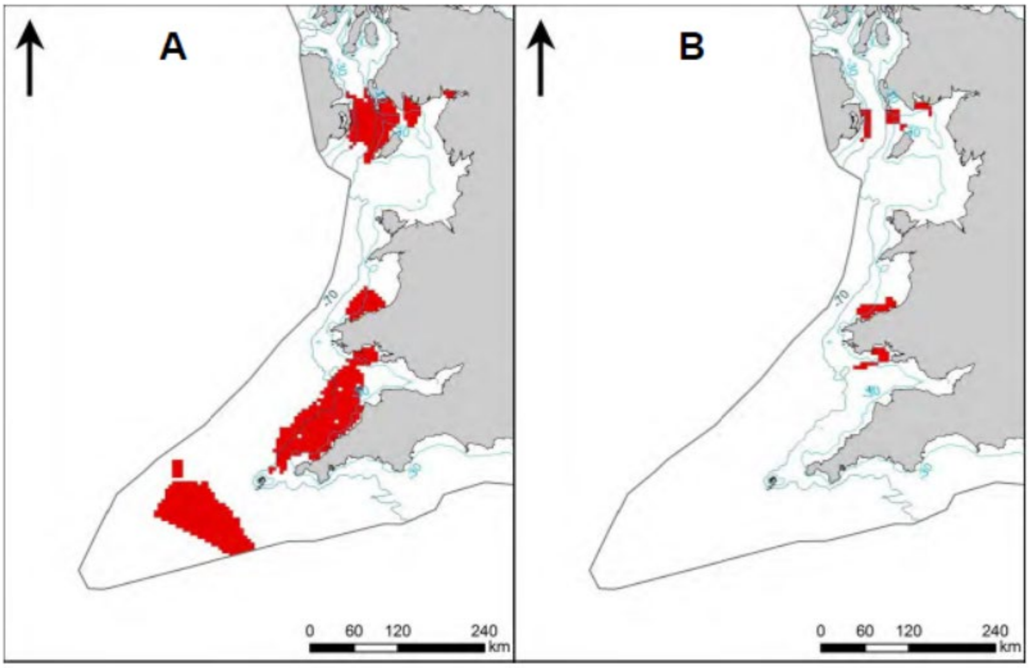

Plate 5.2 Persistent high-density areas identified during winter. In map A the red colours mark areas where persistent high densities as defined by the upper 90 percentile have been identified. In map B the red colours mark persistent high-density areas with survey effort from three or more years [Source: Heinänen and Skov (2015)]

92. The JCP Phase III Report (Paxton *et al*., 2016) identified an estimated density of 0.2 – 0.4 individuals per km^2 in the vicinity of the Project (0.4 – 0.8 per km^2 97.5% CI; Paxton *et al*., 2016).

93. Harbour porpoise have been the most frequently sighted cetacean throughout IoM territorial waters and have been sighted year-round, with an increase in sightings between April and September. Sightings between 2007 and 2014 comprised 81.3% of boat sightings, 75.1% of land-based survey sightings and 51% of opportunistic sightings (Felce, 2014). Similar results were found during surveys in 2018 where harbour porpoise comprised 73.7% of boat sightings, 71.0% of land-based survey sightings and 46.9% of opportunistic sightings (Clark *et al*., 2019). Using the boat-based survey data (2007–2014), it was estimated that the density of harbour porpoise throughout Manx waters was 0.207/km² (0.137-0.312/km², CV = 21.09%) (Howe, 2018a).

94. Distribution and abundance maps were developed by Waggitt *et al*. (2019) for cetacean species around Europe. These maps were generated based on a collation of survey effort across the northeast Atlantic between 1980 and 2018, with a total of 1,790,375km of survey effort for cetaceans. All survey data was standardized to generate distribution maps at 10km resolution, with maps generated for each species included for each month of the year.

95. The density maps in **Plate 5.3** (Waggitt *et al*., 2019) show a high distribution within the Eastern Irish Sea, and the coasts of northwest England and Wales

for both January and July, however the summer, winter and annual density for the original Project area were similar, rounded to 0.58 animals/km^2.

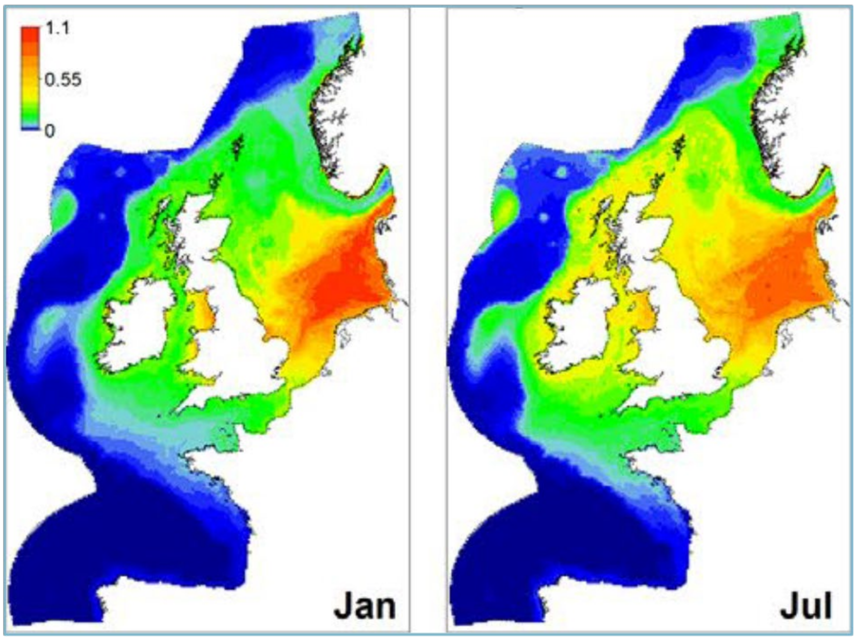

Plate 5.3 Spatial variation in predicted densities (individuals per km of harbour porpoise in January and July in the North-East Atlantic). Values have been provided at 10km resolution (Waggitt et al., 2019)

96. In contrast, the distribution of estimated density over the SCANS-III (Hammond *et al*., 2021) and IV (Gilles *et al*., 2023) survey area indicated that the occurrence of harbour porpoise was greater in western areas of the Irish Sea when compared to eastern areas of the Irish Sea (**Plate 5.4** and **Plate 5.5**).

97. Since SCANS-III, the density of harbour porpoises significantly increased from 0.086 animals/km^2 (block F) to 0.5153 animals/km^2 (CV = 0.250, 95% Confidence Limit (CL) = 3,663 – 10,162) and an estimated abundance of 6,325 individuals (in SCANS-IV; block CS-E).

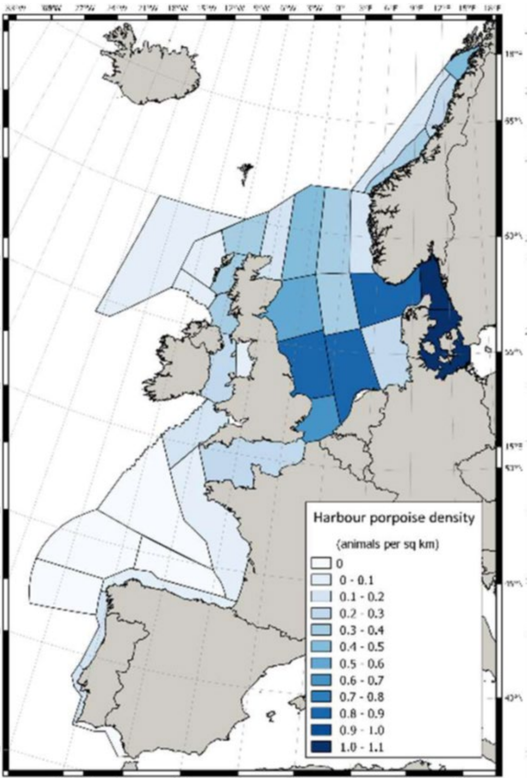

Plate 5.4 Estimated density in each survey block for harbour porpoise from SCANS-III (Hammond et al., 2021)

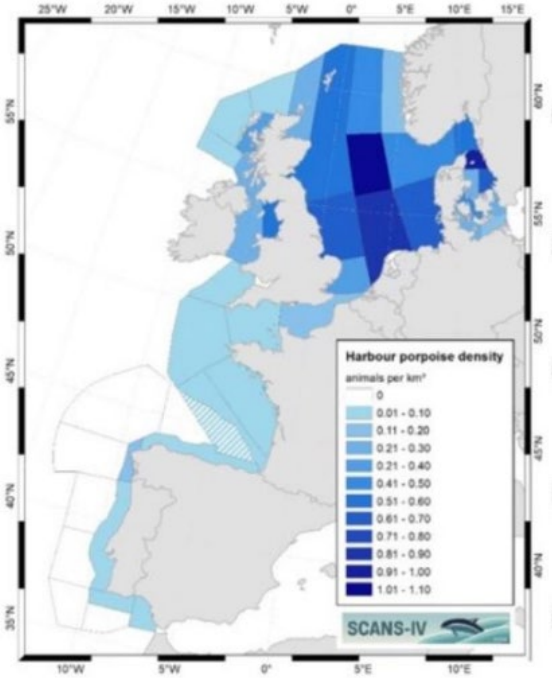

Plate 5.5 Estimated density in each survey block for harbour porpoise from SCANS-IV (Gilles et al., 2023)

98. The most recently available distribution and density maps were developed by Evans and Waggitt (2023). The data underlying these maps were a collation from different sources from three decades (1990 - 2020). The data was modelled to a very fine scale resolution of 2.5km by 2.5km grid cells, making it spatio-temporally more relevant than that of Waggitt *et al*., 2019 (described above) for the Irish Sea. Harbour porpoise densities were high year-round particularly in the relevant study area between north Anglesey and the IoM, as well as the outer part of Cardigan Bay and eastern Ireland. Distribution patterns varied both between seasons and months (**Plate 5.6**), particularly from May to September, with the highest densities overlapping with the breeding season for harbour porpoises, whose births usually peak around June (Lockyer, 1995 and 2003). The average density across the windfarm site and 4km buffer was 0.2 animals/km^2.

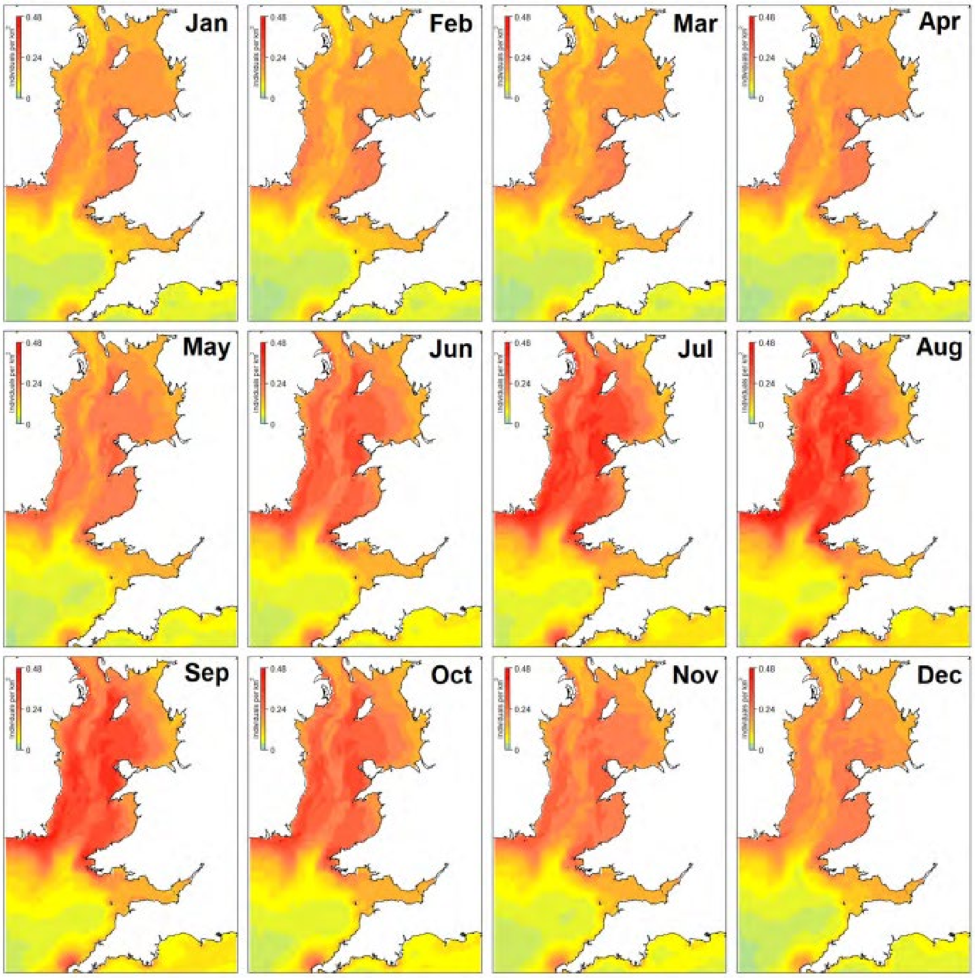

Plate 5.6 Harbour porpoise modelled densities by month (measured as the mean density per cell. Values have been provided at 2.5km resolution (Evans and Waggit, 2023)

5.1.2 Diet

99. The distribution and occurrence of harbour porpoise, as well as other marine mammal species, is considered most likely to be related the availability and distribution of their prey species. They have tended to concentrate their movements in small focal regions (Johnston *et al.,* 2005), which often approximated to particular topographic (Isojunno *et al.* 2012; Brookes *et al.* 2013, Stalder *et al.* 2020) and oceanographic features (Weir and O'Brien 2000, Johnston *et al.,* 2005, Embling *et al.* 2009, Marubini *et al.* 2009, Waggitt *et al.* 2018, Bouveroux *et al*. 2020) that have been associated with prey aggregations (Sveegaard *et al.,* 2012). Consequently, habitat use has been highly correlated with prey density rather than any particular habitat type (e.g. Sveegaard *et al.,* 2012).

100. Harbour porpoise are generalist feeders, and their diet reflects available prey in an area. Therefore, their diet varies geographically, seasonally, and annually, reflecting changes in available food resources and differences in diet between sexes or age classes may also exist. The diet of the harbour porpoise has been found to include a wide variety of fish, including pelagic schooling fish, as well as demersal and benthic species, especially Gadoids, Clupeids and sandeels (Börjesson *et al.,* 2003; Santos and Pierce 2003; Santos *et al.,* 2004; Sveegaard *et al.,* 2012).

101. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet their daily energy requirements. It has been noted that they must be near abundant food sources and are driven by the need to feed constantly (Read and Hohn 1995, Johnston *et al.* 2005, Wisniewska *et al.* 2016). However, it has been estimated that, depending on the conditions, harbour porpoise could rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.,* 1997).

5.2 Bottlenose dolphin

5.2.1 Distribution

5.2.1.1 Abundance

102. Throughout its range, the bottlenose dolphin occurs in a diverse range of habitats, from shallow estuaries and bays, coastal waters, continental shelf edge and deep open offshore ocean waters. However, it is primarily an inshore species, with most sightings within 10km of land, but they can also occur offshore, often in association with other cetaceans[6].

103. In coastal waters, bottlenose dolphin have often been associated with river estuaries (Ingram and Roger, 2002), steep benthic slopes (Wilson *et al.*, 1997, Ingram and Rogan, 2002), headlands or sandbanks, where there is uneven bottom relief and/or strong tidal currents (e.g. Lewis and Evans 1993; Wilson *et al.,*1997; Liret *et al.,* 1998; Liret, 2001; Ingram and Rogan 2002; Reid *et al.,* 2003, Moreno and Mathews, 2018).

104. In the Irish and Celtic Seas, bottlenose dolphins have a predominantly coastal distribution, with higher concentrations off west Wales (particularly Cardigan Bay) and off the coast of Co. Wexford in southeast Ireland. They have also been regularly sighted in summer off the Galloway coast of southwest Scotland and around the IoM (Hammond *et al*., 2005, Baines and Evans, 2012; Department of Energy and Climate Change (DECC), 2016).

105. It has been determined that there are two 'eco-types' of bottlenose dolphin present in Europe, the coastal type and the pelagic type, and that these types were genetically and ecologically different from each other (Louis *et al.,* 2014; Oudejans *et al.* 2015; Department for Business, Energy and Industrial Strategy (BEIS), 2022b).

106. Results of genetic analysis revealed that there were five clusters of genetically distinct coastal bottlenose dolphin populations in the UK and the north of continental Europe (Nykänen *et al.,* 2019). For these five groups, there was the potential for individuals from the east and west Scotland, Wales and Galicia to be present in the Project area, but there was no evidence of connectivity with any other coastal population of bottlenose dolphin in the UK, Ireland, and northern continental Europe. Of these five populations, the migration rates from one population to another were found to be less than 1% in all possible movements, apart from between Wales/West Scotland and East

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[6] https://sac.jncc.gov.uk/species/S1349

Scotland (with a migration rate of 25.7%) and between Galicia and East Scotland (with a migration rate of 25.7%; Nykänen *et al*., 2019).

107. The two-year site-specific surveys and the three-months geophysical have indicated that very few bottlenose dolphins seem to utilise the area.

108. As outlined in **Section 1.1.1** of this Appendix, the Project is located within the IS MU (**Plate 1.2**), with an estimated reference population of 293 (CV = 0.54) individuals (IAMMWG, 2023).

5.2.1.2 Density

109. The results of the JCP Phase III Report (Paxton *et al*., 2016) identified that for bottlenose dolphins, densities were low across much of UK waters, with higher densities off the west coast of Wales, and within the Moray Firth. The density of bottlenose dolphin within the Irish Sea was low, with less than 0.1 individuals per km^2 (97.5% CL = 0 – 0.1 per km^2) (Paxton *et al*., 2016).

110. Distribution of estimated density over the SCANS-III and IV survey area indicated that the occurrence of bottlenose dolphin was greater in western areas of the Irish Sea when compared to eastern areas of the Irish Sea (**Plate 5.7** and **Plate 5.8**).

111. During SCANS-III surveys no bottlenose dolphins were recorded in survey block F (Hammond *et al*., 2021), and only very few in block CS-E during SCANS-IV in which the Project is located (Gilles *et al*., 2023). The density in the latter survey was estimated at 0.0104 animals/km^2 (CV = 0.700; 95% CL = 3 – 353) with an abundance of 127 individuals.

112. Being the worst-case, the SCANS-IV block CS-E was taken forward for the impact assessment.

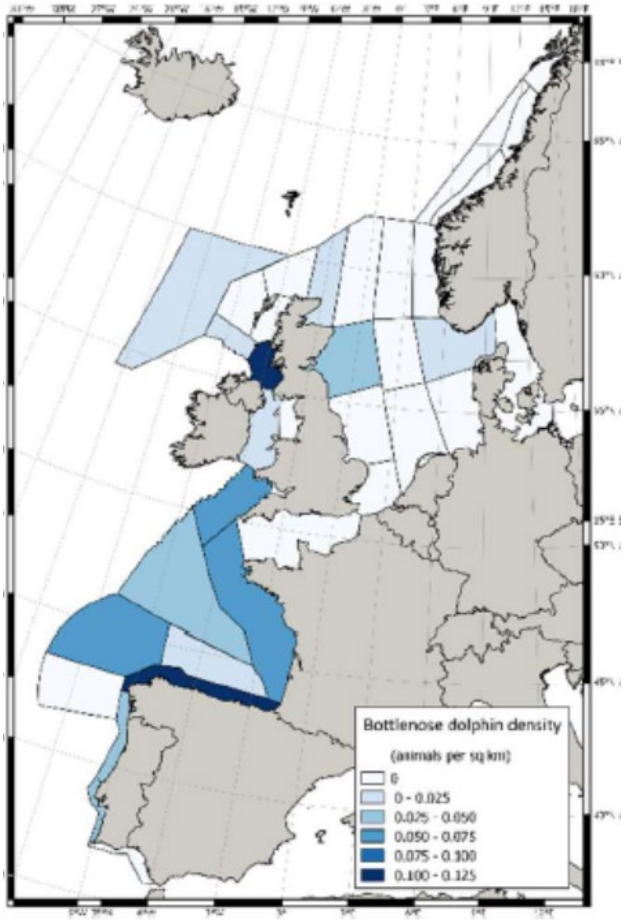

Plate 5.7 Estimated density in each survey block for bottlenose dolphin from SCANS-III (Hammond et al., 2021)

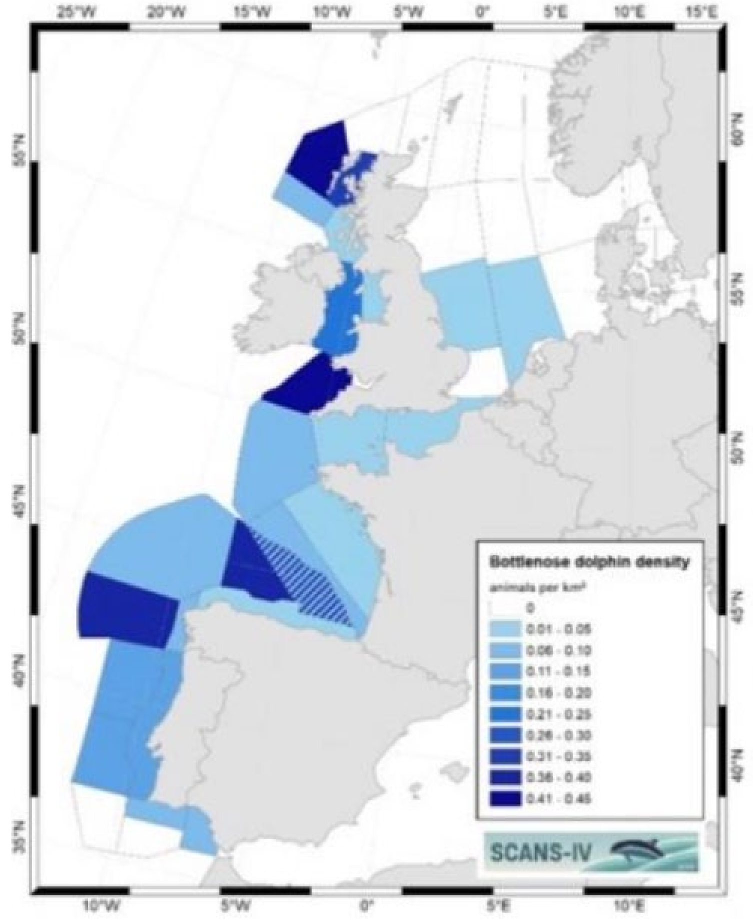

Plate 5.8 Estimated density in each survey block for bottlenose dolphin from SCANS-IV (Gilles et al., (2023)

113. Bottlenose dolphins have been reported throughout MWDW surveys and across the IoM territorial waters, they have been sighted most frequently in the winter months between November and February (60%) and most of the individuals photographed for the ID catalogue have also been photographed in Cardigan Bay. Sightings of bottlenose dolphins comprised of 0.2% of boat-based sightings, 2.2% of land-based sightings and 8.5% of opportunistic sightings between 2007 and 2014 (Felce, 2014).

114. No bottlenose dolphin were recorded in most recent 2018 boat-based and land-based surveys, but 29 opportunistic sightings of the species were reported to MWDW, comprising 5.8% of opportunistic sightings (Clark *et al*., 2019).

115. For bottlenose dolphin, the distribution maps (developed by Waggitt *et al*., 2019) showed a clear pattern of higher density to the western coastal areas of the UK, extending southwards to the Bay of Biscay (**Plate 5.9**; Waggitt *et al*., 2019). The distribution maps indicated a 'corridor' of increased bottlenose dolphin density travelling from west of Scotland, southwards around the west coast of Northern Ireland and the Republic of Ireland, and through the centre

of the Bay of Biscay. Bottlenose dolphin densities in and around the Project windfarm site were low (windfarm site with 4km buffer is 0.0006 animals/km^2).

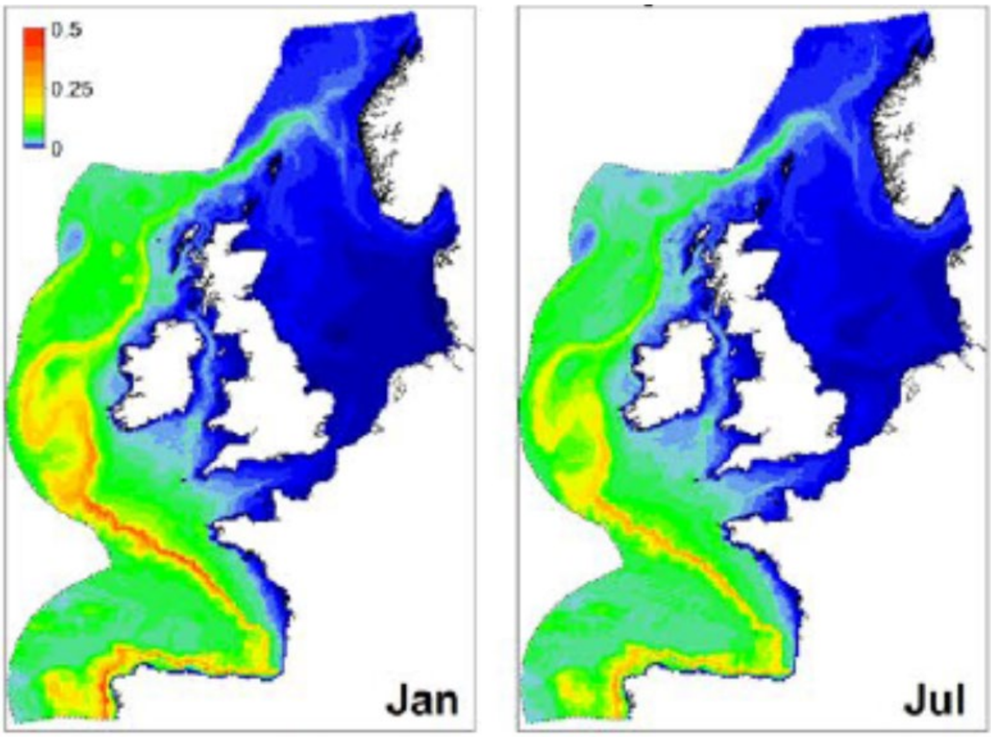

Plate 5.9 Spatial variation in predicted densities (individuals per km of the offshore ecotype bottlenose dolphin in January and July in the North-East Atlantic). Values have been provided at 10km resolution (Waggitt et al., 2019)

116. Whilst Waggitt *et al*. (2019) incorporated the offshore ecotype in their models, the fine-scale distribution maps by Evans and Waggitt (2023) identified clear coastal hotspots from the inshore ecotype. The year-round importance of Cardigan Bay and the Llŷn Peninsula is reflected in **Plate 5.10**. As already indicated from the HiDef monthly surveys, bottlenose dolphins were nearly absent, and the density derived from Evans and Waggitt (2023) confirmed low densities in the windfarm site with 4km buffer:

- Annual: 0.0011 animals/km^2
- Summer: 0.0013 animals/km^2
- Winter: 0.0009 animals/km^2

117. A proportion of the bottlenose dolphins with their summer residency in Cardigan Bay, extended their ranges between October and April to the North Wales coast and as far as the IoM (B. Manley (from MWDT) 2023, personal communication, 27 July 2023; Lohrengel *et al.* 2018).

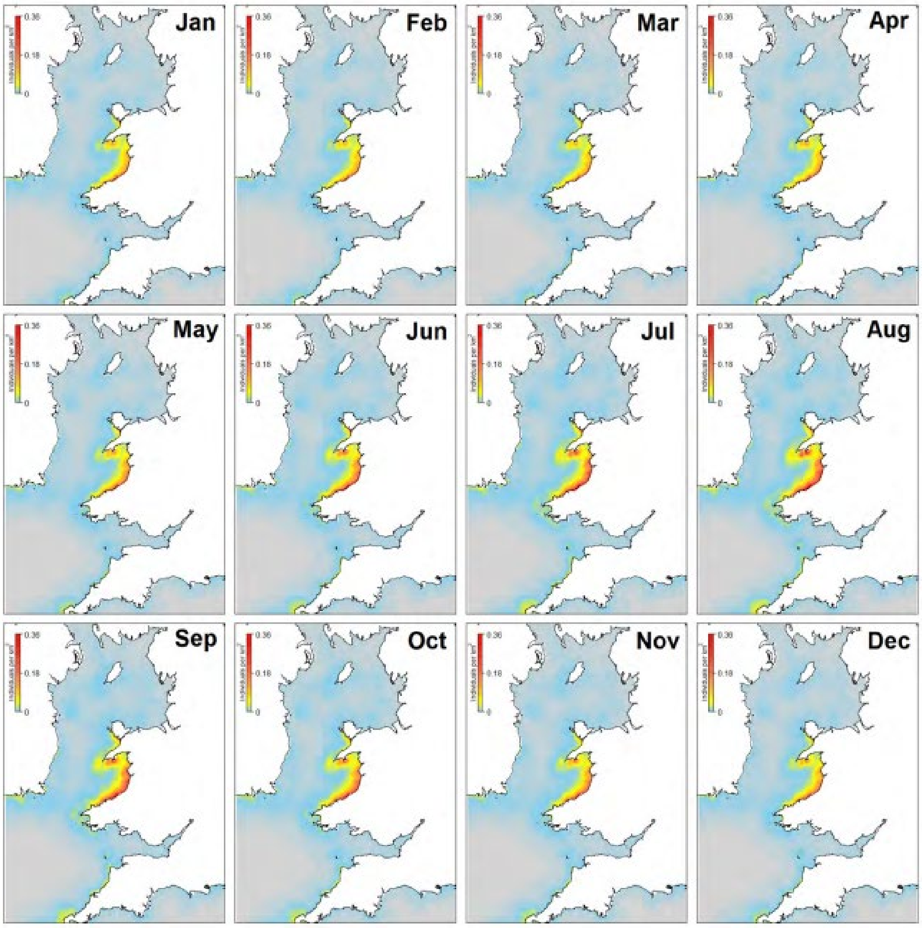

Plate 5.10 Bottlenose dolphin (inshore ecotype) modelled densities by month. Values have been provided at 2.5km resolution (Evans and Waggitt, 2023)

5.2.2 Diet

118. Bottlenose dolphin are opportunistic feeders and take a wide variety of fish and invertebrate species, benthic and pelagic fish (both solitary and schooling species), including:

- Haddock *Melanogrammus aeglefinus*
- Saithe *Pollachius virens*
- Pollock *Pollachius pollachius*
- Cod *Gadus morhua*
- Whiting *Merlangius merlangus*
- Hake *Merluccius merluccius*
- Blue whiting *Micromesistius poutassou*
- Bass *Dicentrarchus labrax*
- Mullet *Mugilidae*
- Mackerel *Scombridae*

- Salmon *Salmo salar*
- Sea trout *Salmo trutta trutta*
- Flounder *Platichthys flesus*
- Sprat *Sprattus sprattus*
- Sandeels (Ammodytidae)

119. Octopus and other cephalopods have also all been recorded in the diet of bottlenose dolphin (Santos *et al*., 2001; Santos *et al*., 2004; Reid *et al*., 2003).

120. Diet analysis has suggested that bottlenose dolphin are selective opportunists and although they may have preference for a type of prey, their diet seemed to be determined largely by prey availability. Research in Australia has shown that when presented with a choice, they would preferentially feed on certain types of prey, particularly those with a high fat content (Corkeron *et al*., 1990).

121. Analysis of the stomach contents of ten bottlenose dolphin in Scottish waters from 1990 to 1999 revealed that the main prey were cod (29.6% by weight), saithe (23.6% by weight), and whiting (23.4% by weight), although other species including salmon (5.8% by weight), haddock (5.4% by weight) and cephalopods (2.5% by weight) were also identified in lower number (Santos *et al*., 2001).

122. In Irish waters, haddock, saithe and pollock were the dominant prey species ingested, followed by whiting, blue whiting, Atlantic mackerel and horse mackerel; cephalopods were also important prey (Hernandez-Milian *et al*., 2015).

5.3 Common dolphin

5.3.1 Distribution

5.3.1.1 Abundance

123. As reviewed in BEIS (2022b), during summer common dolphin were widely distributed throughout the northeast Atlantic, from coastal waters to the mid-Atlantic ridge, from the Azores and the Strait of Gibraltar to Norway, with the majority of sightings having been reported in waters south of 60ºN (Murphy *et al*., 2013). Analysis of summer sightings on shelf waters around the UK and adjacent waters showed the vast majority of common dolphins to occur in waters above 14ºC in temperature (MacLeod *et al*., 2008; Cañadas *et al*., 2009). Strong seasonal shifts in their distribution have been noted, with winter inshore movements onto the Celtic Shelf and into the western English Channel and St. George's Channel resulting in pronounced concentrations (Northridge *et al*., 2004).

124. The JNCC Cetacean Atlas (Reid *et al*., 2003) reported common dolphin as favouring deep-water habitats. Common dolphin have been recorded in UK waters year-round, and the UK Cetacean Status Review of 2019 reported this species as ‘common’ in the Southern Irish Sea between May and October (Penrose, 2020).

125. Information on dispersal patterns and site fidelity was scarce, thus the reference population for common dolphin has been based on that of the CGNS MU, as outlined in **Section 1.1.1** (**Plate 1.3**) and was estimated to be 102,656 (CV = 0.29) animals (IAMMWG, 2023).

126. The ObSERVE aerial surveys of Irish waters found common dolphin to be widely distributed in shelf waters off the south and west coasts of Ireland, with higher numbers observed in winter (BEIS, 2022b; Rogan *et al*., 2018). They have also been the most frequently sighted and abundant cetacean recorded during Celtic Sea herring surveys off the south coast of Ireland in October (BEIS, 2022b; O’Donnell *et al*., 2017, 2018).

5.3.1.2 Density

127. Common dolphins have occasionally been sighted in IoM territorial waters, with most sightings being highly seasonal and reported in June, July and August (84%) (Howe, 2018). Sighting in IoM waters comprised 1.4% of boat-based sightings, 3.3% of sightings from land-based surveys and 3.3% of opportunistic sightings between 2007 and 2014 (Felce, 2014). No common dolphins were observed in the 2018 season during boat-based and land-based surveys, but 13 opportunistic sightings were reported, comprising 2.6% of opportunistic sightings (Clark *et al*., 2019).

128. The JCP Phase III Report (Paxton *et al*., 2016) also identified higher density estimates to the West of Ireland and in the Hebrides.

129. Distribution maps developed by Waggitt *et al*. (2019) indicated the highest density in the southwest of the Irish Sea and the Celtic Deep, and lower densities in the Irish Sea and West Scotland. There were also seasonal differences, with higher densities in July compared to January, particularly evident in the Celtic Deep (**Plate 5.11**). The densities were modelled over the Project site with 4km buffer:

- Annual average: 0.019 animals/km^2
- Summer 0.024 animals/km^2
- Winter 0.015 animals/km^2

130. **Plate 5.12** highlights common dolphin abundance in the Celtic Deep within the St George’s Channel in the most recently modelled density maps by Evans and Waggitt (2023). Seasonal differenced were highlighted in the densities

derived by Evans & Waggitt (2023), modelled over the Project site with 4km buffer:

- Annual average: 0.00014 animals/km^2
- Summer 0.0002 animals/km^2
- Winter 0.00008 animals/km^2

131. The species has been noted to prefer shelf-edge habitats where water temperatures exceed 15°C. Although common dolphins were observed in one month during the HiDef surveys sightings were rare in the Project area.

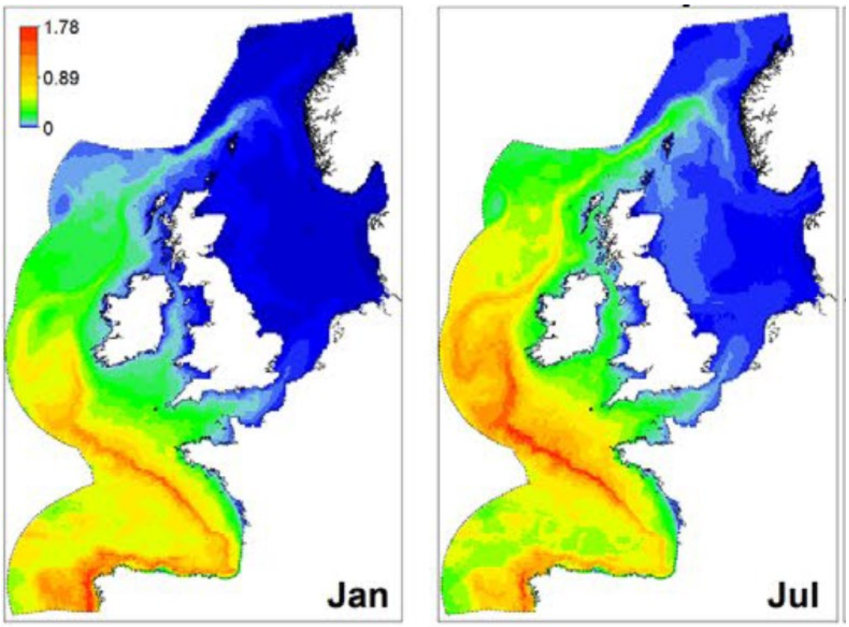

Plate 5.11 Spatial variation in predicted densities (individuals per km of common dolphin in January and July in the North-East Atlantic). Values are provided at 10km resolution (Waggitt et al., 2020)

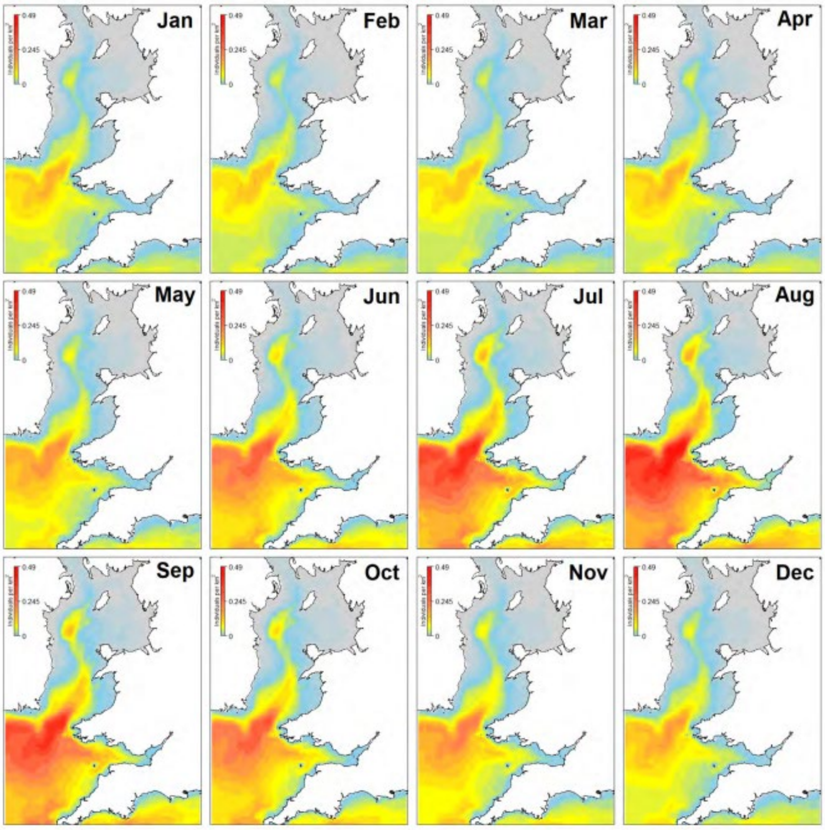

Plate 5.12 Common Dolphin modelled densities by month. Values have been provided at 2.5km resolution (Evans and Waggitt, 2023)

132. No common dolphin were observed in the Irish Sea area during the SCANS-III surveys in July, thus there were no estimated densities for either block F or E (**Plate 5.13**).

133. Similarly, during SCANS-IV (Gilles *et al*., 2023), there were no common dolphin sightings in block CS-E (**Plate 5.14**), but a few in the adjacent block CS-D resulting in a density of 0.0272 animals/km^2 (CV = 0.814; 95% CL = 32 - 2,990) with an abundance estimate of 949 individuals.

134. In order to find a density to best represent the wider area for common dolphin, data from Evans and Waggitt (2023) and Waggitt *et al*. (2019) were applied to the area of SCANS-IV block CS-E.

135. The Waggitt *et al*. (2019) densities averaged across the SCANS-IV block CS-E where the Project is located were:

- Annual: 0.022 animals/km^2
- Summer: 0.028 animals/km^2
- Winter: 0.017 animals/km^2

136. The Evans and Waggitt (2023) densities averaged across the SCANS-IV block CS-E where the Project is located were:

- Annual: 0.00008 animals/km^2
- Summer: 0.00011 animals/km^2
- Winter: 0.00005 animals/km^2

137. Being the worst-case, the mean summer density, derived from Waggitt *et al*. (2019) data over the SCANS CS-E block was taken forward for the impact assessment:

- Mean summer density: 0.028 common dolphin/km^2

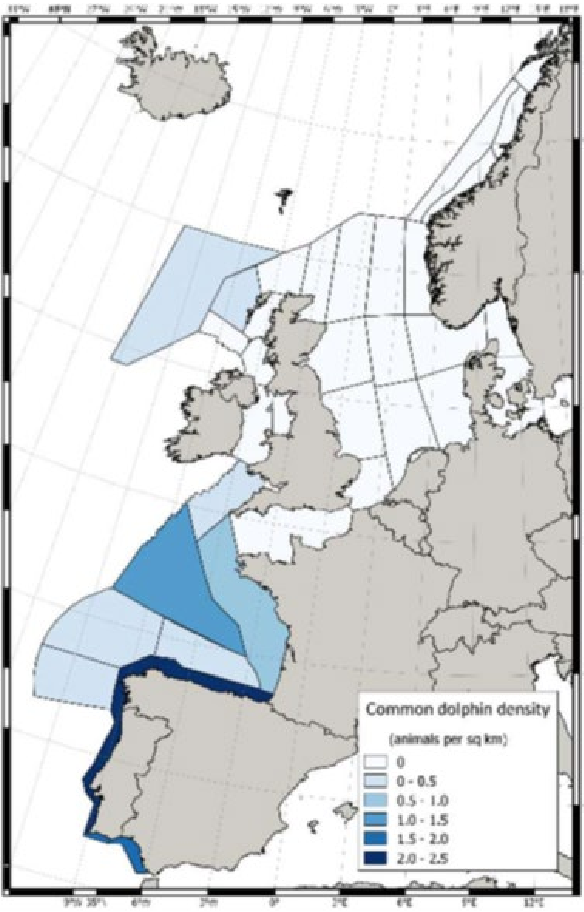

Plate 5.13 Estimated density in each survey block for common dolphin from SCANS-III (Hammond et al., 2021)

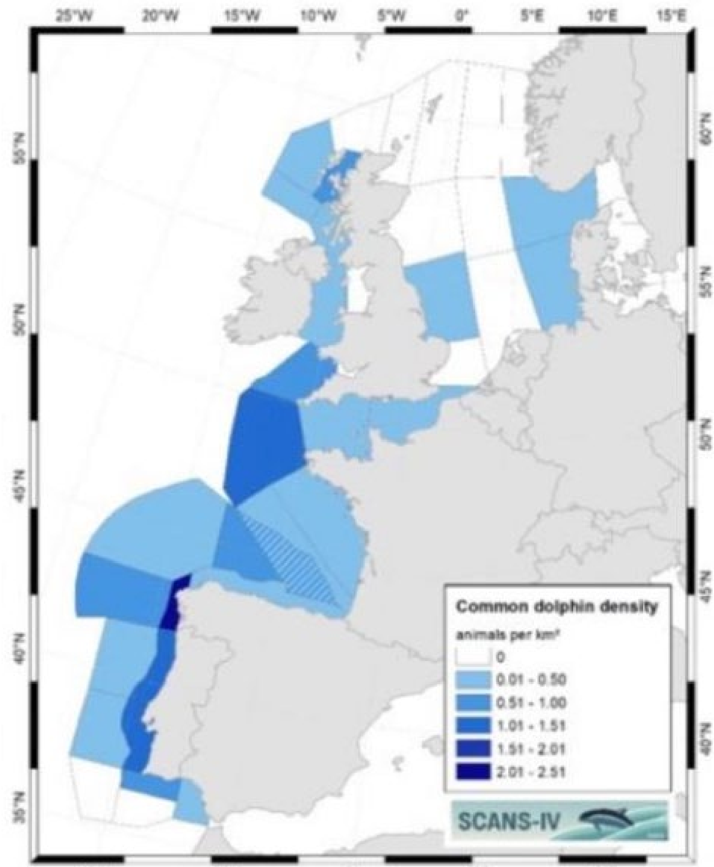

Plate 5.14 Estimated density in each survey block for common dolphin from SCANS-IV (Gilles et al., 2023)

5.3.2 Diet

138. Common dolphin are cooperative feeders, working within a pod to capture prey. They have been noted to have a varied diet of fish including haddock *Melanogrammus aeglefinus*, mackerel *Scomber scombrus*, Atlantic horse mackerel *Trachurus trachurus*, blue whiting *Micromesistius poutassou*, anchovy *Engraulida* spp., and sardine *Sardina pilchardus* (Couperus 1997; Silva 1999; Santos *et al.,* 2013; Marçalo *et al.*, 2018) which have also been targeted by commercial fishers. Other prey items recorded in common dolphins have included cephalopods and crustacea (Brophy *et al.* 2009).

139. Analysis of 63 common dolphin stomach contents from the Bay of Biscay found that their diet was dominated by fish, with mackerel being the preferred fish and cephalopods recorded as a prey of secondary importance (Pusineri *et al.* 2007). Stomach contents of 71 stranded common dolphins along the French coast between 199-2002 contained sardine, anchovy, sprat and horse mackerel (Meynier *et al.*, 2008). This study also highlighted the temporal variations in diet composition, which were attributed to prey availability in the region. It further identified that prey composition and size varied in relation to sex and maturity status of the individual animal. Statistically, common dolphins

were more likely to select high energy prey over low energy prey, which was disregarded, even when highly abundant in the area (Spitz *et al*., 2010).

5.4 Risso's dolphin

5.4.1 Distribution

5.4.1.1 Abundance

140. Risso's dolphin have been found to be distributed sporadically in UK waters, with individuals commonly recorded around the Hebrides, and seasonally in the Celtic and Irish Seas. The majority of Risso's dolphin sightings in UK waters have been reported around the Hebrides (BEIS, 2022b; Paxton *et al*., 2014).

141. The JNCC Cetacean Atlas (Reid *et al*., 2003) indicated this species in northwest Europe was primarily a continental shelf species, and most sightings were in western Scotland around the Outer Hebrides. Clusters of sightings were also recorded in the southern Irish Sea and off southwest Ireland, central and southern North Sea and the Channel.

142. The JCP Phase III Report (Paxton *et al*., 2016) identified local relative abundance off the west coast of Ireland, the northern Irish Sea and the Hebrides.

143. Risso's dolphin have been the most commonly seen dolphin species in IoM territorial waters, with almost all sightings reported between March and September, located primarily on the east and southern coasts of Manx waters (Howe, 2018). Sightings comprised of 6.5% of sightings from boat-based surveys, 13.2% from land-based surveys and 18.5% of opportunistic sightings between 2007-2014 (Felce, 2014) and 7.9% of sightings from boat-based surveys, 18.7% from land-based surveys and 30.4% of opportunistic sightings in 2019 (Clark *et al*., 2019).

5.4.1.2 Density

144. Distribution maps by Waggitt *et al*. (2019) indicated higher densities off the west coast of Ireland and the Hebrides. There were also seasonal differences, with higher densities in July than in January, particularly to the north of their range which extended to the North Sea and Irish Sea (**Plate 5.15**; Waggitt *et al*., 2019). The densities were modelled over the Project site with 4km buffer as follows:

- Annual average: 0.00024 animals/km^2
- Summer 0.0003 animals/km^2
- Winter 0.0002 animals/km^2

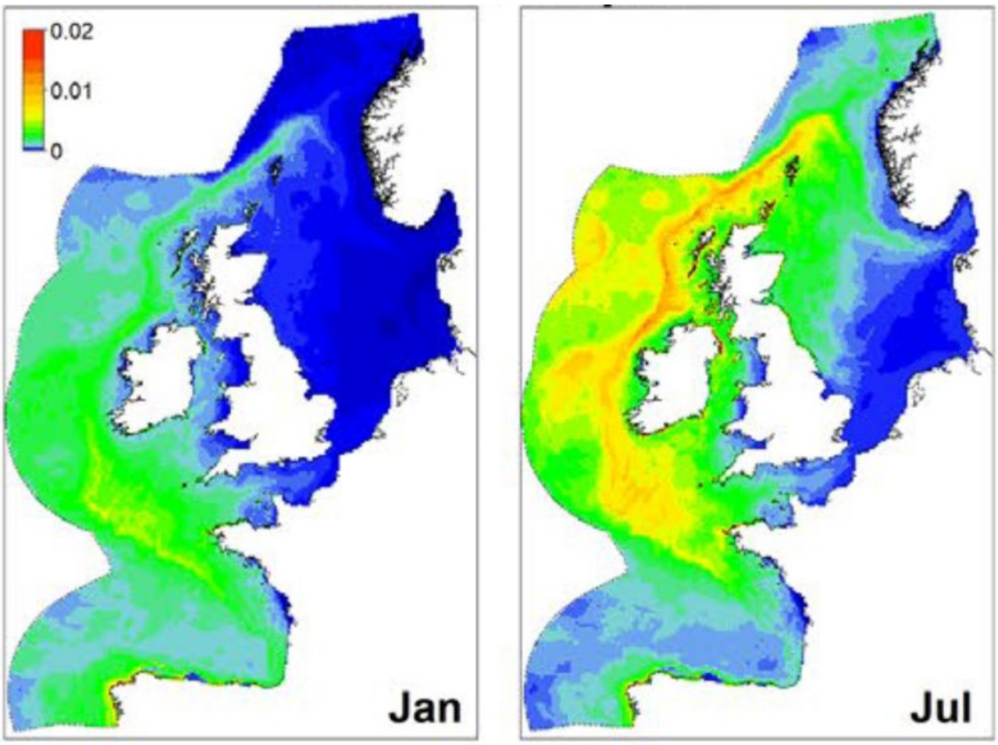

Plate 5.15 Spatial variation in predicted densities (individuals per km of Risso's dolphin in January and July in the North-East Atlantic). Values have been provided at 10 km resolution (Waggitt et al., 2019)

145. As per modelled density maps by Evans and Waggitt (2023), Risso's dolphin sightings occurred mainly between June and October, suggesting that the species moved offshore or out of the region. Densities derived by Evans & Waggitt (2023) were modelled over the Project site with 4km buffer as follows:

- Annual average: 0.00003 animals/km^2
- Summer 0.00005 animals/km^2
- Winter 0.00002 animals/km^2

146. In the same report, the authors stated findings of photo-identified individuals from North Anglesey with matches in southwest Cornwall, south-east Ireland, Pembrokeshire, Bardsey Island and the west Llŷn Peninsula, the IoM, and the Hebrides (citing Stevens (2014) and Mandlik (2021) in Evans and Waggitt, 2023).

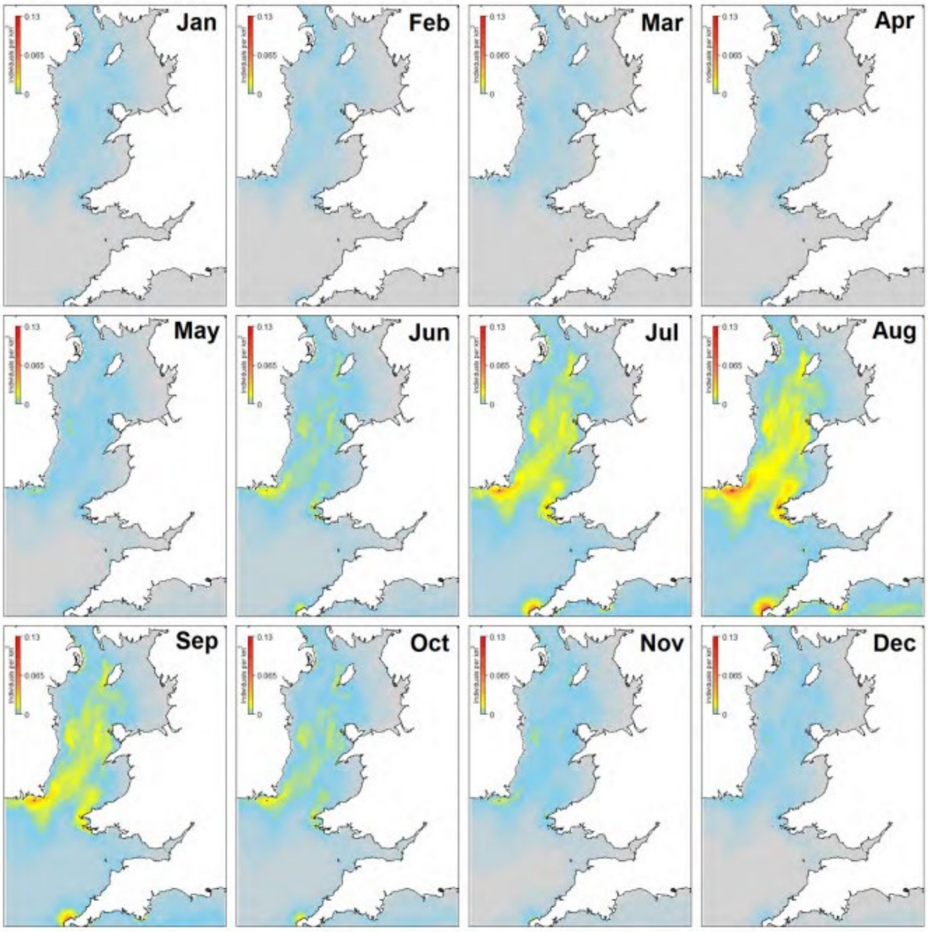

Plate 5.16 Risso's Dolphin modelled densities by month. Values have been provided at 2.5km resolution (Evans and Waggitt, 2023)

147. The SCANS-III survey recorded no Risso's dolphin within survey block F, in which the Project is located (Hammond *et al*., 2021), but in the adjacent block E had an abundance estimate of 1,090 Risso's dolphins (95% CL = 0 – 2,843) with a density estimate of 0.0313/km^2 (CV = 0.686; Hammond *et al*., 2021).

148. During SCANS-IV survey, Risso's dolphin were not seen in block CS-E, but were recorded in the adjacent block CS-D, near the southern tip of the Isle of Man. The density of this block was 0.0022 animals/km^2 (CV = 1.012; 95% CL = 2 – 259) and the abundance estimate was 75 individuals.

149. In order to find a density that represented the wider area for Risso's dolphin, the best data from Evans and Waggitt (2023) and Waggitt *et al*. (2019) were applied to the SCANS-IV block CS-E, where the Project is located.

150. The Waggitt *et al*. (2019) data applied to the SCANS block CS-E derived the following average seasonal densities:

- Annual: 0.0004 animals/km^2
- Summer: 0.0006 animals/km^2
- Winter: 0.0003 animals/km^2

151. The Evans and Waggitt (2023) densities averaged across the SCANS-IV block CS-E were:

- Annual: 0.0002 animals/km^2
- Summer: 0.0003 animals/km^2
- Winter: 0.0001 animals/km^2

152. Being the worst-case of all densities presented, the mean summer density, derived from Waggitt *et al*. (2019) data over the SCANS CS-E block was taken forward for the impact assessment:

- 0.0006 Risso's dolphin/km^2

153. The reference population was based on the population estimate of the CGNS MU of 12,262 (CV=0.46) (CI = 5,227 – 28,764) (IAMMWG, 2023).

5.4.2 Diet

154. Risso's dolphin primarily feed on cephalopods, with some fish and krill. Limited behavioural research was available, but it has been claimed that this species primarily feeds at night. The stomach contents of 11 dolphins stranded between 1992 and 2004 across Scotland were analysed (MacLeod *et al*., 2014) from which seven cephalopod taxa and three fish taxa were identified, however cephalopods made up 98% of the total prey (by weight and number). Analysis of the stomach contents of six stranded Risso's dolphins in the Mediterranean Sea found a total of 578 cephalopod beaks, identified as 386 individuals from 19 different species of Coleoidea cephalopods, one Sepiolida, eight Octopoda, and ten species belonging to the Order Oegopsida (Luna *et al*., 2022).

5.5 White-beaked dolphin

5.5.1 Distribution

5.5.1.1 Abundance

155. White-beaked dolphin have been found in temperate and sub-Arctic seas of the North Atlantic, usually over the continental shelf in waters of 50-100m depth (Reid *et al*., 2003). In UK waters, sightings occurred throughout the year, but were slightly more frequent from July to October (Reid *et al*., 2003).

156. Their distribution has been generally restricted to the northern half of UK waters, with greatest abundance in the central and northern North Sea, Orkney and Shetland and northwest Scotland (BEIS, 2022b).

157. There was only one MU for white-beaked dolphins, the CGNS MU, which was estimated to hold a population of 43,951 individuals (CV = 0.22) (IAMMWG, 2023).

5.5.1.2 Density

158. For white-beaked dolphin, the distribution maps by Waggitt *et al*. (2019) indicated higher densities in the northern North Sea and around the coasts of Scotland, with decreasing densities southwards of Scotland along the east coast of England. There was also a clear seasonal difference in the densities of white-beaked dolphin, with higher densities in July, particularly to the north of their range (**Plate 5.17**; Waggitt *et al*., 2019). Examination of this data, and all 10km grids that overlapped with the windfarm site, indicated an average density estimate for the windfarm site and 4km buffer of:

- Annual: 0.0053 animals/km^2
- Summer: 0.0052 animals/km^2
- Winter: 0.0054 animals/km^2

159. Evans and Waggitt (2023) were unable to provide density maps for this species as they only occurred rarely in the Irish Sea and the Bristol Channel.

160. The SCANS-III and IV surveys recorded no white-beaked dolphin within the survey blocks in which the Project is located, nor in any adjacent survey blocks (Gilles *et al*., 2023; Hammond *et al*., 2021).

161. In order to find a density to best represent the wider area for white-beaked dolphin, data Waggitt *et al*. (2019) were applied to the area of SCANS-IV block CS-E (where the Project is located) to give the following results:

- Annual: 0.00680 animals/km^2
- Summer: 0.00682 animals/km^2
- Winter: 0.00679 animals/km^2

162. Being the worst-case, the mean summer density, derived from Waggitt *et al*. (2019) data over the SCANS CS-E block was taken forward for the impact assessment as follows:

- Mean summer density: 0.007 white-beaked dolphin /km^2.

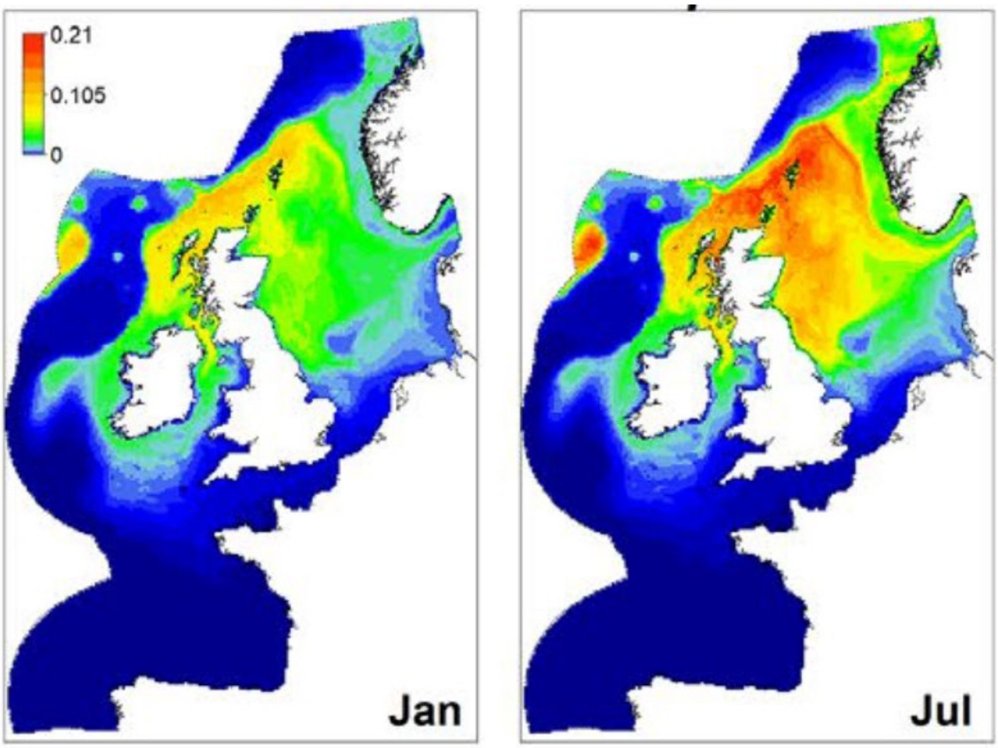

Plate 5.17 Spatial variation in predicted densities (individuals per km of white-beaked dolphin in January and July in the North-East Atlantic). Values have been provided at 10km resolution (Waggitt et al., 2019)

5.5.2 Diet

163. Dietary analysis for white-beaked dolphin stranded between 1992 and 2003 around the UK (Canning *et al.* 2008) and between 1968 and 2005 along the Dutch coast (Jansen *et al.* 2010) found that while a wide variety of prey species were identified, the majority of prey were Gadidae (cod and whiting), haddock and gobies. Canning *et al.* (2008) further identified that herring *Clupea harengus* and mackerel *Scomber scombrus* were also found in the stomachs and this was in line with older research that observed white-beaked dolphins associated with herring and mackerel shoals (Harmer, 1927; Fraser, 1946; Evans, 1980). Anecdotal evidence from fishers in Scotland suggested that individuals seen inshore may have coincided with mackerel appearing in the same areas (Canning *et al.* 2008).

5.6 Minke whale

5.6.1 Distribution

5.6.1.1 Abundance

164. Within UK waters, minke whale have most frequently been sighted in the western central-northern North Sea and west of Scotland around the Hebrides (BEIS, 2022b). They were primarily a seasonal visitor to UK waters, with

increased sightings from May to October, although some animals may remain in coastal waters year-round (BEIS, 2022b; Reid *et al*., 2003).

165. Minke whale have been sighted regularly in IoM territorial waters in the summer, they were highly seasonal and have been sighted mainly in the summer months, with 97.2% being reported between May and November. Sightings comprised 8.5% of boat-based sightings, 9.7% of sightings from land-based surveys and 14.2% of opportunistic sightings between 2007 and 2014 (Felce, 2014). In 2018 they comprised18.4% of boat-based sightings, 10.3% of sightings from land-based surveys and 12.5% of opportunistic sightings (Clark *et al*., 2019). Both the seasonality and the distribution of minke whale in IoM territorial waters were considered to reflect the seasonality and distribution of their main prey (Atlantic herring) (Howe, 2018).

166. Some genetic differentiation among individuals has been reported (e.g., Andersen *et al*., 2003), but this did not appear to be caused by geographic structuring within the north-east Atlantic (Anderwald *et al*., 2011). Minke whale of the North Atlantic were likely to be a single genetic population (Anderwald *et al*., 2012). Therefore, IAMMWG (2023) considered a single MU as appropriate for minke whale in UK waters which held an estimated population of 20,118 individuals (CV = 0.18).

5.6.1.2 Density

167. For minke whale, the distribution maps by Waggitt *et al*. (2019) indicated higher densities in the northern North Sea, around Scotland and Ireland, including the Celtic Sea area, with decreasing densities southwards of Scotland along the east coast of England (**Plate 5.18**). There were relatively low densities in and around the Project windfarm site (0.0019 animals/km^2), compared to other areas in UK waters. There was a clear seasonal difference in the densities of minke whale, with higher densities in July, which was particularly evident in the north of their range (**Plate 5.18,** Waggitt *et al*., 2019).

168. In addition, the distribution maps indicated a ‘corridor’ of increased minke whale density from north of Orkney, around the north and west coasts of the UK to Northern Ireland (**Plate 5.18**). Whilst the density of minke whales in the Project area in January was close to zero, it slightly increased in July, but the overall densities were relatively low. Densities across the windfarm site and 4km buffer were:

- Annual: 0.0019 animals/km^2
- Summer: 0.0026 animals/km^2
- Winter: 0.0013 animals/km^2

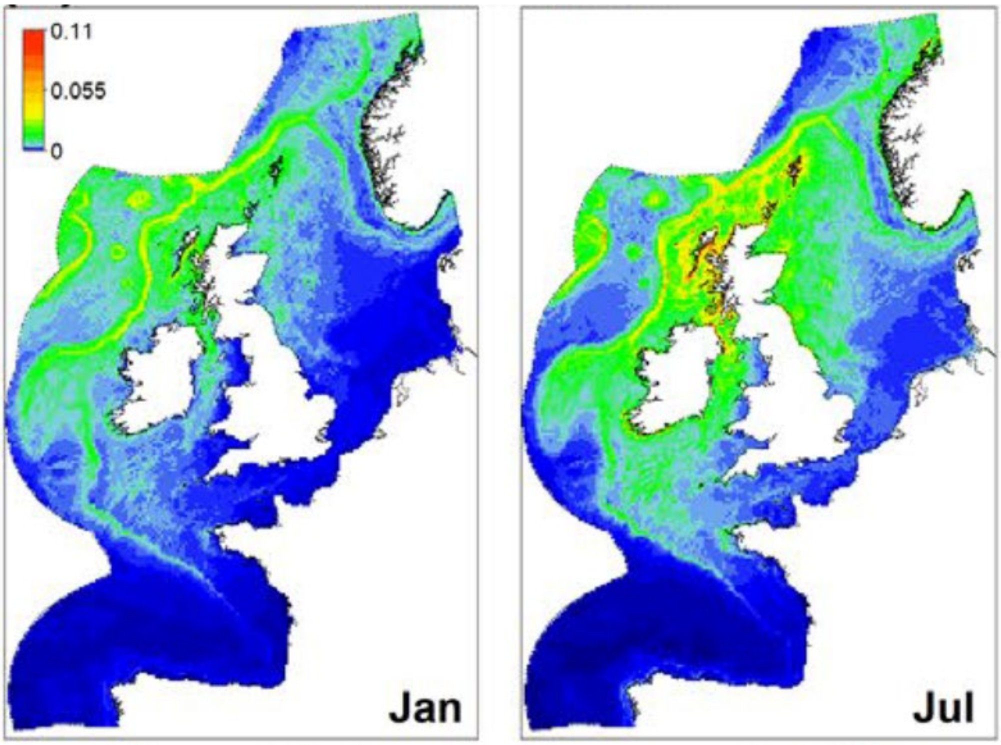

Plate 5.18 Spatial variation in predicted densities (individuals per km of minke whale in January and July in the North-East Atlantic). Values have been provided at 10km resolution (Waggitt et al., 2020)

169. Modelled distribution maps from Evans and Waggitt (2023) indicated a clear seasonal utilisation of the Celtic Deep Channel westwards from Pembrokeshire across the Celtic Deep to Co. Wexford, and from Co. Dublin north-eastwards to around the IoM between July and September (**Plate 5.19**). The densities across the site with a 4km buffer were:

- Annual: 0.0003 animals/km^2
- Summer: 0.0005 animals/km^2
- Winter: 0.0001 animals/km^2

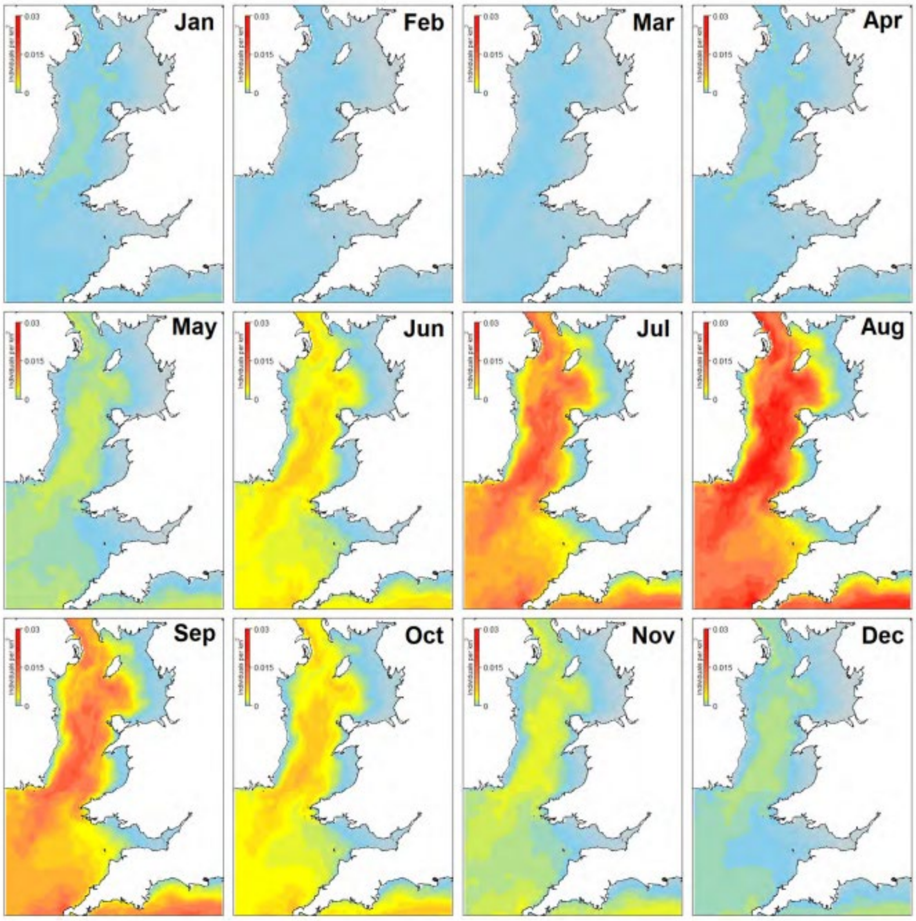

Plate 5.19 Minke whale modelled densities by month. Values provided at 2.5km resolution (Evans and Waggitt, 2023)

170. During the SCANS-III surveys, no minke whale were recorded within block F in which the Project is located. SCANS-III survey block E (located to the west of block F) had an abundance estimate of 603 minke whales (95% CL = 134 –1,753), with a density estimate of 0.0173 animals/km^2 (CV = 0.618; Hammond *et al*., 2021).

171. Only few minke whales were sighted during SCANS-IV, resulting in a low density:

- 0.0088 animals/km^2 (CV = 1.145)

172. The population abundance was estimated at 108 minke whales (95% CL = 1 - 491) in block CS-E (Gilles *et al*., 2023) (see **Plate 5.20**).

173. In order to find a density to best represent the wider area for minke whale, data from Evans and Waggitt (2023) and Waggitt *et al*. (2019) were applied were applied to the SCANS-IV block CS-E, where the Project is located.

174. The Waggitt *et al*. (2019) data applied to the SCANS block CS-E derived the following average seasonal densities:

- Annual: 0.003 animals/km^2

- Summer: 0.004 animals/km^2
- Winter: 0.002 animals/km^2

175. The Evans and Waggitt (2023) densities averaged across the SCANS-IV block CS-E where the Project is located were:

- Annual: 0.0006 animals/km^2
- Summer: 0.001 animals/km^2
- Winter: 0.0002 animals/km^2

176. Being the worst-case, the following density for SCANS-IV block CS-E was taken forward for the impact assessment:

- 0.0088 minke whale/km^2.

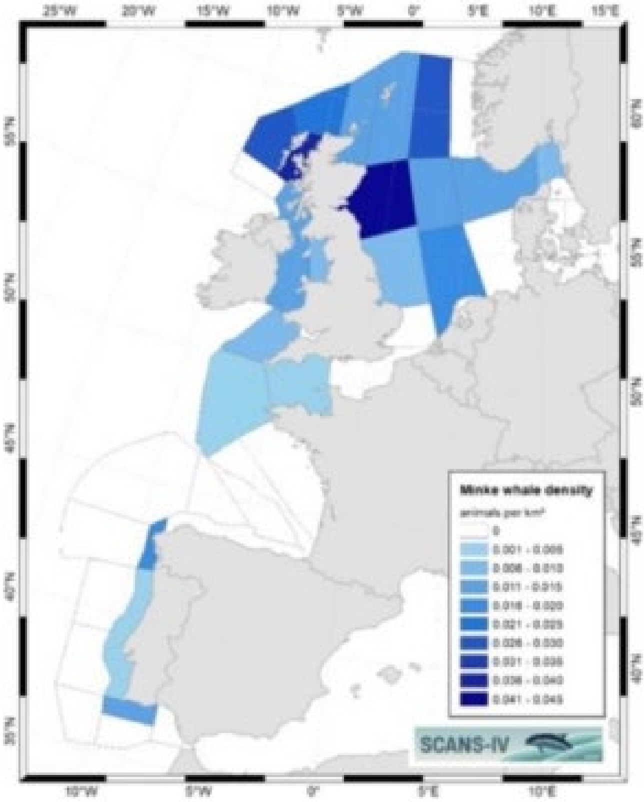

Plate 5.20 Estimated density in each survey block for minke whale from SCANS-IV (Gilles et al., 2023)

5.6.2 Diet

177. Minke whale feed on a variety of fish species, including herring, cod and haddock. They feed by engulfing large volumes of prey and water, the water is then ‘sieved’ out through their baleen plates and the remaining prey are swallowed whole.

178. A study into the diet of minke whale in the north-eastern Atlantic sampled a total of 210 minke whales forestomach contents from 2000 to 2004, with a

total of 37 forestomach samples analysed within the northern North Sea. Within this area, minke whale were found to prey upon a number of different species at the population level, however, 84% of individuals were found to prey upon only one species. Sandeels (56% of total prey by biomass) and mackerel (30% of total prey by biomass) were found to be the most dominant prey species for minke whale in the northern North Sea (Windsland *et al*., 2007).

5.7 Grey seal

5.7.1 Distribution

179. Grey seal have only been recorded in the North Atlantic, Barents and Baltic Sea with their main concentrations on the east coast of Canada and United States of America and in northwest Europe (SCOS, 2022).

180. Approximately 35% of the world's grey seals breed in the UK. 80% of these breed at colonies in Scotland, with the main concentrations in the Outer Hebrides and in Orkney. There were also breeding colonies in Shetland, on the north and east coasts of mainland Britain and in southwest England and Wales (SCOS, 2022). The IoM has provided a regionally important haul out and resting location for transient as well as resident grey seal (Howe, 2018a).

181. Grey seal have been recorded as wide ranging and able to breed and forage in different areas (Russell *et al*., 2013). They generally travelled between known foraging areas and back to the same haul-out site but also moved to new sites (Russel, 2016).

182. Carter *et al*. (2020, 2022) provided grey seal movement maps for foraging trips only (the tagging data was cleaned to remove data during the grey seal breeding season). This is shown in **Plate 5.21**, with grey seal foraging movements being primarily located along Ramsey and Skomer Islands, Bardsey Island, and the Dee Estuary with some movement offshore.

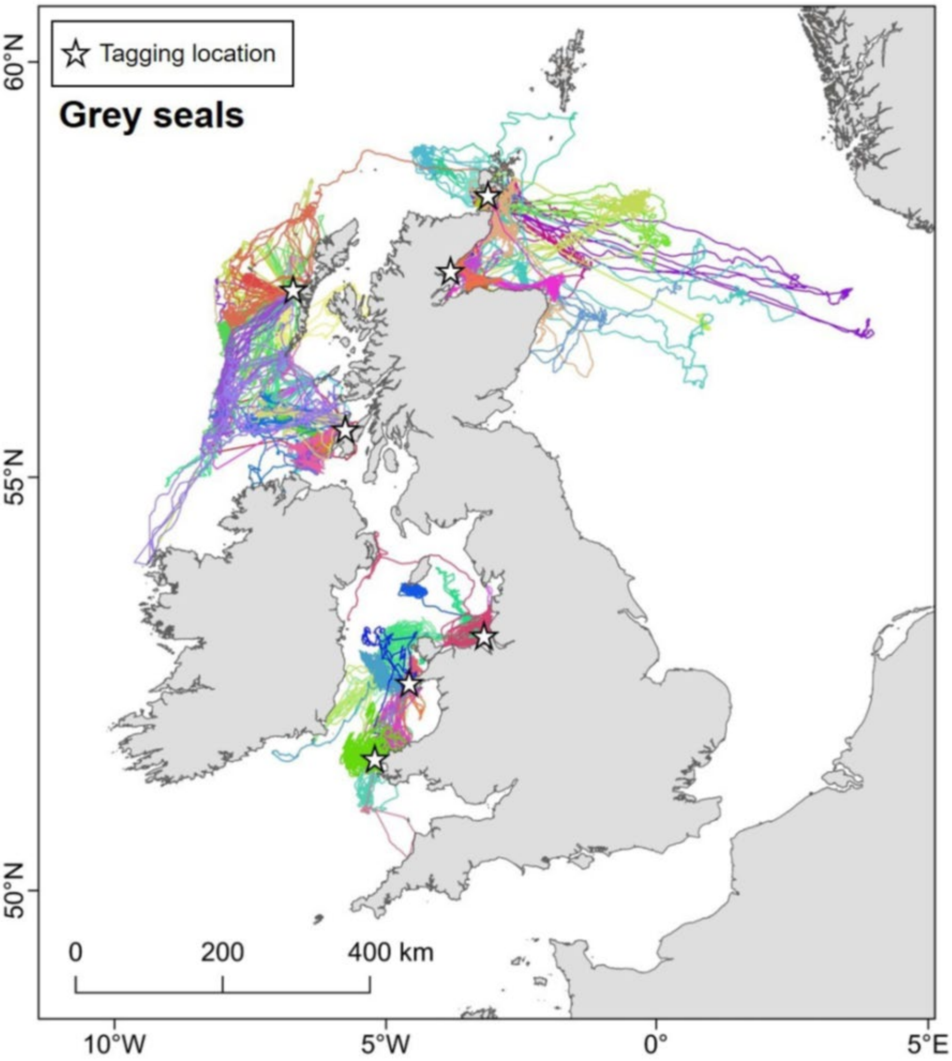

Plate 5.21 Grey seal tagging data, colour-coded by habitat preference region (Carter et al., 2020)

183. Grey seal typically forage in the open sea and they may range widely to forage and frequently travelled over 100km between haul-out sites (SCOS, 2022). Foraging trips can last anywhere between one and 30 days. Tracking of individual grey seals has shown that most foraging probably occurs within 100km of a haul-out site, although they have also been recorded feeding up to several hundred kilometres offshore (SCOS, 2022). The grey seal maximum foraging range has been estimated to be 448km based on tracking data (Carter *et al*., 2022).

5.7.2 Haul-out sites

184. Compared with other times of the year, grey seal in the UK spent longer hauled out during their annual moult (between December and April) and during their breeding season (between August and December) (SCOS, 2020).

185. In the north and west Scotland, pupping occurred mainly between September and late November, whereas in eastern England it occurs between early November to mid-December (SCOS, 2022). Pups were typically weaned 17 to 23 days after birth, when they moulted their white natal coat, and then remained in the breeding colony for up to two or three weeks before going to sea. Mating occurred at the end of lactation and then adult females departed to sea and provided no further parental care (SCOS, 2022).

186. Two main haul-out sites of grey seals have been identified in northwest England; one in the Dee Estuary on the Welsh-English border (Hilbre Island) and one at South Walney. At South Walney, Cumbria Wildlife Trust (CWT) and Walney Bird Observatory have historically conducted counts of the seals primarily during the breeding and moulting seasons. These data indicated that grey seal abundance was steadily increasing (SCOS, 2020; CTW, 2023).

187. Starting in 2019, CWT have conducted low tide counts in August to provide Sea Mammal Research Unit (SMRU) with numbers comparable to those used in the independent estimate of grey seal abundance. From the unpublished data supplied by CWT (2023), numbers steadily increased with some fluctuations in the surveys from 2019 to 2023, with counts of 482 (2019), 315 (2020), 518 (2021), 287 (2022) and 466 (2023). Pups were recorded for the first time in 2015 but since then numbers of new pups have remained low, ranging between 2 in 2015 and 10 in 2017. Since then, an average of 6 pups have been born each year (CWT, 2023).

188. The Calf of Man, a small island southwest of the Isle of Man was considered to be the most important haul-out and pupping site in the territory, although there were other locations where pupping has been observed along its coast (Howe, 2018a). Since 2009, when annual dedicated pup surveys commenced, the number of pups increased from 27 to 84 in 2016; in 2021 the survey counted 62 pups of which four were confirmed dead (Stokes *et al*. 2021).

5.7.3 Abundance and density estimates for grey seal

5.7.3.1 Seal density maps

189. The following sections provide the grey seal at-sea density estimates from a grey seal mapping dataset (Carter *et al*., 2022). **Figure 5.1** shows the relative abundance of grey seals in the wider Project area as a percentage of the total UK population.

190. The relative seals at-sea abundance maps have been used to calculate grey seal density estimates for the windfarm site. The Carter *et al*. (2022) density maps were an update to the Russell *et al*. (2017) mapping and included updated tagging studies. These density maps only included tagging studies from the UK.

191. The resultant density of seals at-sea maps (Carter *et al*., 2022) differed from the Russell *et al*. (2017) maps, in that they showed the relative density of seals in each 5km-by-5km grid cell. Each grid cell showed the percentage of the overall seal population within the British Isles, which could then be related to the current best population estimate for each species. This ensured that the relative densities could be updated based on overall population level changes.

192. To calculate a density estimate for assessments from the Carter *et al*. (2022) data, the latest at-sea population of each species was used. A correction factor was also applied to the overall population level to take account of those individuals that were estimated to be on land (**Plate 5.22** shows mean percentage of at-sea population estimated to be present in each 5 km x 5 km grid square at any one time).

193. The total grey seal population in the British Isles, at-sea, was approximately 162,000 individuals. This at-sea estimate has been based on the most recent available (SCOS, 2022) grey seal August counts of 44,833 for the UK and RoI[7], which has been corrected for both those individuals that were not available to count (0.2515; SCOS-BP 21/02 in SCOS, 2021), and for those individuals that would be at-sea at any one time (0.8616; Russel *et al*., 2015). This was the population estimate used with the Carter *et al*. (2022) data to calculate density estimates for the windfarm site (see **Section 5.7.3.2**) The grey seal density estimates for the windfarm site have been calculated from the latest seal at-sea maps produced by SMRU (Carter *et al*., 2022), based on the 5km x 5km grids that overlap with the Project area.

194. The mean at-sea density estimate derived from Carter *et al*. (2022) data over the area of the windfarm site and 4km buffer was taken forward in the impact assessment:

- Mean at-sea density estimate of 0.100 grey seal/km^2

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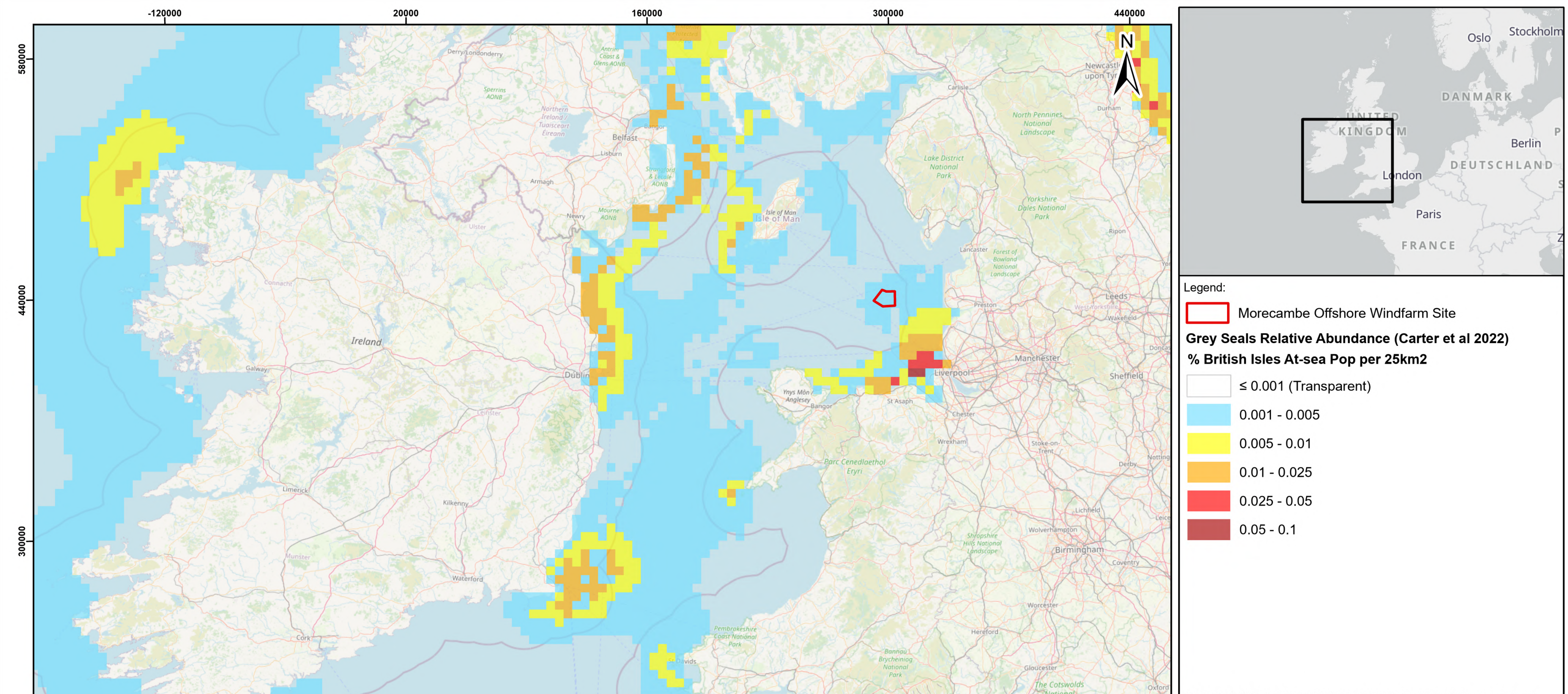
[7] Based on the latest grey seal counts provided by the 2021 grey seal counts (http://www.smru.st-andrews.ac.uk/scos/scos-data/august-seal-counts/august-seal-counts-england/) and the 2019 counts (SCOS, 2020).



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Report: Morecambe Offshore Windfarm: Generation Assets Environmental Statement

Title: Grey seal at-sea distribution. Maps show mean percentage of at-sea population estimated to be present in each 5km x 5km grid square at any one time (Carter et al., 2022)

Figure: 5.1

Drawing No: PC1165-RHD-ES-OF-DG-Z-0101

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	16/11/2023	SB	GC	A3	1:2,250,000
P02	03/04/2024	JH	SB	A3	1:2,250,000

Co-ordinate system: WGS 1984 UTM Zone 30N

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5.7.3.2 Grey seal population counts

195. Grey seal population trends have been assessed from the counts of pups born during the autumn breeding season, when females congregate on land to give birth (SCOS, 2022). The pup production estimates have been converted to estimates of total population size (1+ aged population) using a mathematical model and projected forward (SCOS, 2022).

196. The most recent surveys of the principal grey seal breeding sites in Scotland, Wales, Northern Ireland and England resulted in an estimate of 67,850 pups (in 2019; 95% CL = 60,500 – 75,200; SCOS, 2022).

197. The estimated adult UK grey seal population size in regularly monitored colonies in 2022 was 162,000 (approximate 95% CL = 146,700-178,500; SCOS, 2022). This estimate was based on 2019 pup production and represented the total population alive on the first day of the 2022 breeding season.

198. The most recent counts of grey seal in the August surveys in 2016-2021, estimated that the minimum count of grey seals in the UK was 41,135 (SCOS, 2022).

199. In order to take account of the grey seals that were not available for counting during these surveys, a population scalar was added to provide a more accurate population estimate. Approximately 0.2515 grey seals were available to count within the August surveys (i.e., were hauled out), and therefore this has been used as a correction factor (SCOS-BP 21/02 in SCOS, 2021) to derive a more accurate population estimate of grey seal within each MU (rather than the number counted). The adjusted reference population estimates for relevant MUs for grey seal were therefore derived as shown in **Table 5.1.**

Table 5.1 Grey seal counts and population estimates

Population area	Grey seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Grey seal total population
NW England MU	300	SCOS (2022)	0.2515	1,193
Wales	900	SCOS (2022)	0.2515	3,579
SW Scotland	517	SCOS (2022)	0.2515	2,056
NI MU	549	SCOS (2022)	0.2515	2,182
IoM	400	Howe (2018a)	-	400
E RoI MU	418	Morris and Duck (2019)	0.2515	1,662
SE RoI MU	556	Morris and Duck (2019)	0.2515	2,211
Total wider reference population	**3,640**			**13,283**

200. The total wider reference population taken forward to the assessment was 13,283 grey seals. Assessments have been undertaken in the context of the combined NW England MU and IoM population estimates (1,593 grey seal), as well as the wider reference population (13,283 grey seal). As a worst-case, it was assumed that all seals were from the nearest MUs (i.e. the combined NW England MU and IoM populations), although a more realistic assessment has also been presented based on the wider reference population, which took into account the movement of seals.

5.7.3.3 Limitations of approach

201. The inclusion of the aforementioned MUs was deemed sufficient for the impact assessment as they reflected known grey seal movements and distributions, and this was agreed to by Natural England during Scoping and via the Marine Mammal Ecology ETG process.

202. On the contrary, NRW's position on this matter was that all grey seals in the much larger OSPAR Region III: Celtic Seas area (**Plate 5.22**) should be used as the appropriate interim MU (NRW, 2021). The OSPAR III region held a population of 60,780 grey seals, whereas the wider reference population from the MUs included within the assessment totalled 13,283.

203. Should the OSPAR III region population be used in the impact assessment, the increase in population numbers would cause a dilution of animals affected in the assessment and was likely to underestimate effects. As such the most

precautionary approach (to use the reference population set out in **Section 5.7.3.2** above) has been taken.

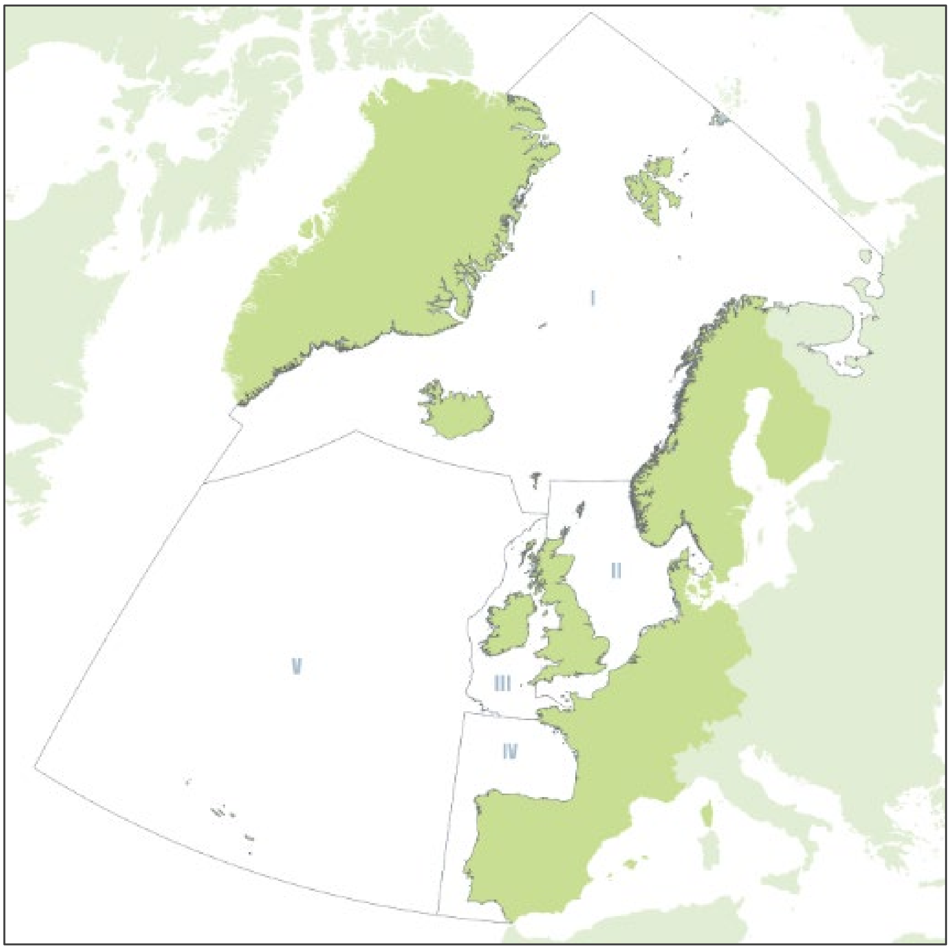


Plate 5.22 The north-east Atlantic divided into OSPAR region I: Arctic Waters, II: Greater North Sea, III: Celtic Seas, IV: Bay of Biscay and Iberian Coast, V: Wider Atlantic (Source: www.ospar.org)

5.7.4 Diet and foraging

204. Grey seals will typically forage in the open sea and return regularly to land to haul-out, although they may frequently travel up to 100km between haul-out sites. Foraging trips generally occurred within 100km of their haul-out sites, although grey seal can travel up to several hundred kilometres offshore to forage (SCOS, 2020). Grey seal generally travel between known foraging areas and back to the same haul-out site but will occasionally move to a new site. For example, movements have been recorded between haul-out sites on the east coast of England and the Outer Hebrides (SCOS, 2020).

205. Individual grey seals based at a specific haul-out site often make repeated trips to the same region offshore but will occasionally move to a new haul-out site and begin foraging in a new region (SCOS, 2020). Telemetry studies of grey seal in the UK have identified a highly heterogeneous spatial distribution

with a small number of offshore ‘hot spots’ continually utilised (Matthiopoulos *et al*., 2004; Russell *et al*., 2017).

206. Grey seals are generalist feeders, feeding on a wide variety of prey species (SCOS, 2020; Hammond and Grellier, 2006). Diet varies seasonally and from region to region (SCOS, 2020).

207. Principal prey items were sandeel, whitefish (such as cod, haddock, whiting and ling *Molva molva*) and flatfish (plaice *Pleuronectes platessa*, sole *Solea solea*, flounder, and dab *Limanda limanda*) (Hammond and Grellier, 2006). Amongst these, sandeels were typically the predominant prey species.

208. Food requirements depend on the size of the seal and fat content (oiliness) of the prey, but an average consumption estimate of an adult was 4 to 7kg per seal per day depending on the prey species (SCOS, 2020).

5.8 Harbour seal

5.8.1 Distribution

209. Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one sub-species *Phoca vitulina vitulina* (SCOS, 2020).

210. On the west coast of Britain harbour seal distribution has been generally restricted, with a total of five harbour seal counts in the NW England MU from 2016-2019 (SCOS, 2020). There was a total of 818 harbour seal recorded in counts in August 2021 in the NI MU (SCOS, 2022).

211. SMRU, in collaboration with others, deployed 344 telemetry tags on harbour seals around the UK between 2001 and 2012. The spatial distributions indicated harbour seals persisted in discrete regional populations, displayed heterogeneous usage, and generally stayed within 50km of the coast (Russell and McConnell, 2014). Tagged harbour seals were observed to have a more coastal distribution than grey seals and did not travel as far from haul-outs (Russell and McConnell, 2014).

212. Harbour seal tags, deployed between 2006 and 2017, were cleaned and analysed, and maps of tracks for all individuals included in a habitat preference analysis (n= 239) are shown in **Plate 5.23** (Carter *et al*., 2020).

213. Harbour seals generally made smaller foraging trips than grey seals, typically travelling 40-50km from their haul-out sites to foraging areas (SCOS, 2020). Tracking studies have shown that harbour seals travelled 50-100km offshore and could travel 200km between haul-out sites (Lowry *et al*., 2001; Sharples *et al.,* 2012). The range of these trips varied depending on the location and surrounding marine habitat. The typical and average foraging range for harbour seal was 50-80km (SCOS, 2021). Tracking data analysed in Carter

et al. (2022) produced a radius based on the maximum geodesic distance of 273km for harbour seals representing the species' maximum foraging range.

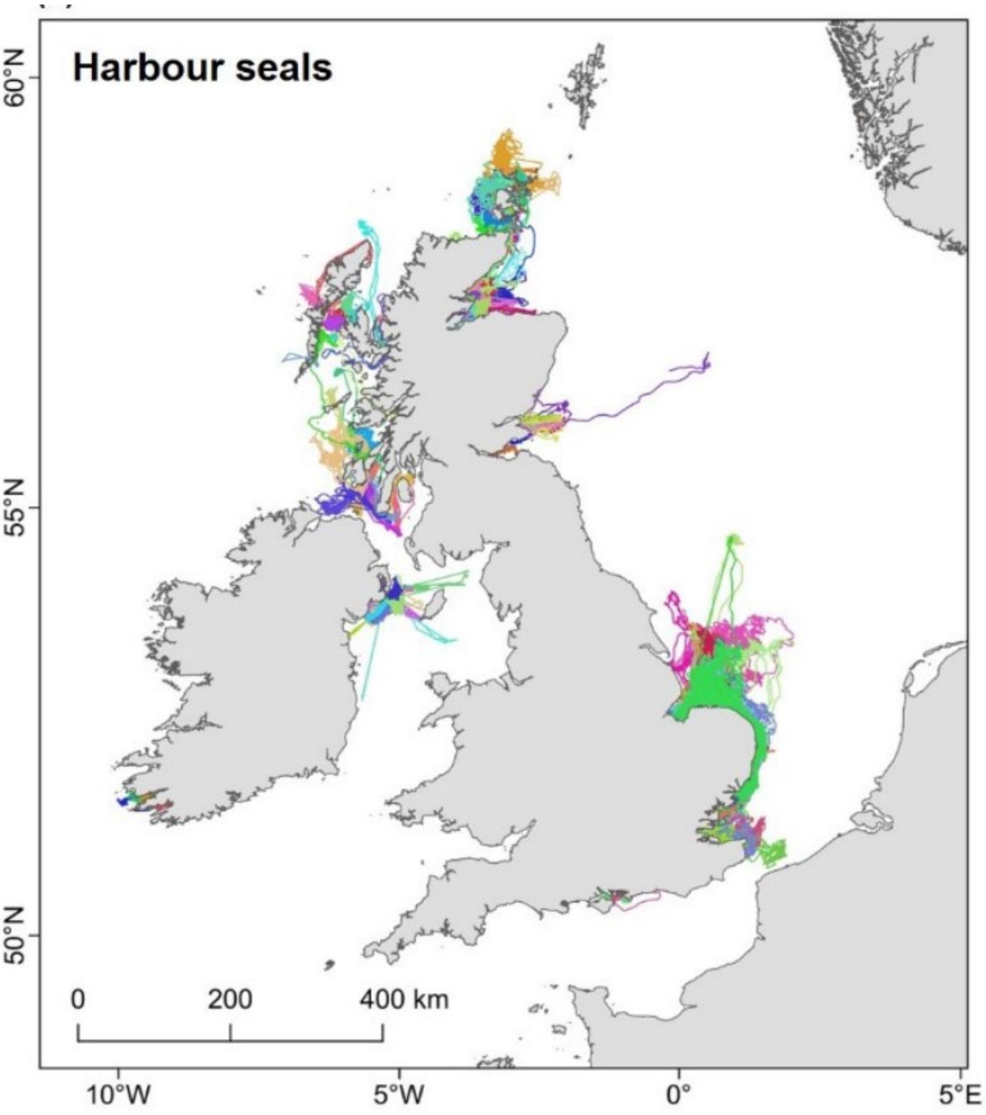


Plate 5.23 GPS tracking data for harbour seals available for habitat preference models. (Carter et al., 2020)

5.8.2 Haul-out sites

214. Harbour seal come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They regularly haul-out on land in a pattern that is often related to the tidal cycle (SCOS, 2020). Harbour seals give birth to their pups in June and July and pups can swim almost immediately after birth (SCOS, 2022). Harbour seals moult in August and spend a higher proportion of their time on land during the moult than at other times (SCOS, 2022).

215. Visits from harbour seal on the IoM are rare, but a small number haul out along the coast around The Sound and Maughold Head. Unlike for grey seal,

harbour seal are not a designated feature of any UK marine protected areas (Howe, 2018a).

5.8.3 Abundance and density estimates for harbour seal

5.8.3.1 Seal density maps

216. Impact assessments were based on densities derived from desk-based sources. Carter *et al*. (2022) provided habitat-based predictions of at-sea distribution for harbour seal around the British Isles. The habitat preference approach predicted estimates per species, on a 5km x 5km grid, of relative at-sea density for seals hauling-out in the British Isles.

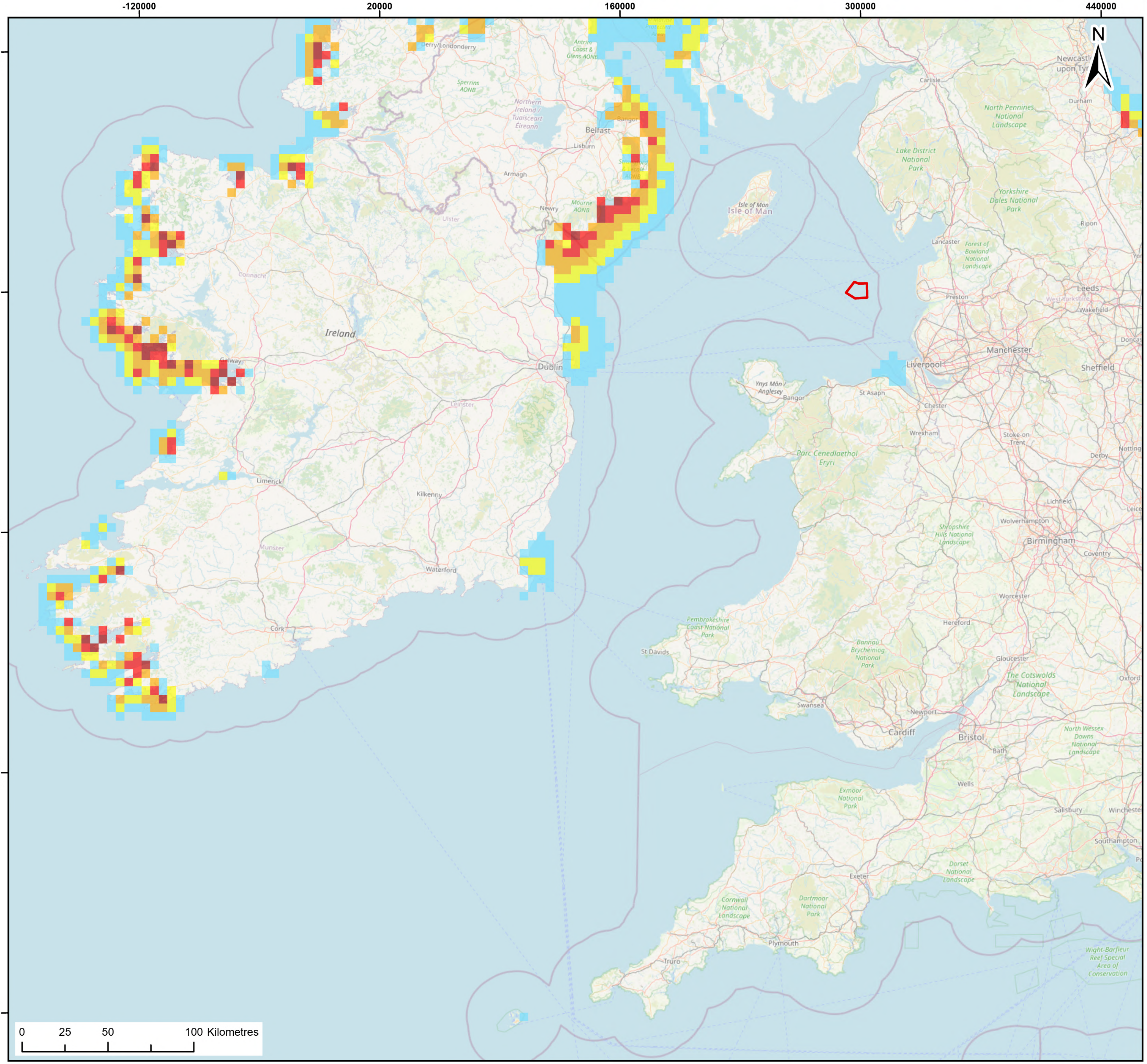
217. To calculate a density estimate to be used in the impact assessments from the Carter *et al*. (2022) data, the current at-sea population of each species was used. A correction factor was also applied to the overall population level to take account of those individuals that were estimated to be on land**. Figure 5.2** shows the mean percentage of at-sea population estimated to be present in each 5km x 5km grid square at any one time (Carter *et al*., 2022)).

218. The total at-sea harbour seal population in the British Isles was approximately 48,419 individuals. The estimate is based on the correction factors for the number of harbour seals available to count during the haul-out counts (0.72; Lonergan *et al*., 2013). The harbour seal density estimates for the windfarm site were calculated from the latest seal at-sea maps produced by SMRU (Carter *et al*., 2022), based on the 5km x 5km grids that overlap with the Project area and the estimated portion of this population expected to be at-sea (using the correction factor 0.8236; Russell *et al.,* 2015), using the most recent haul-out counts for the UK and RoI (total of 39,878 individuals; SCOS, 2022).

219. The mean at-sea density estimate derived from Carter *et al*. (2022) data over the area of the windfarm site and 4km buffer was taken forward in the impact assessment:

- Mean at-sea density of 0.00011 harbour seal/km^2.

220. Unlike the many sightings of grey seals during the 24-months of site-specific surveys, there was only one harbour seal sighted within the survey area (in July 2021) over the two year survey period and therefore no relevant densities were derived from this single sighting.



Legend:

▭ Morecambe Offshore Windfarm Site

Harbour Seals Relative Abundance (Carter et al 2022)

% British Isles At-sea Pop per 25km2

□ ≤ 0.001 (Transparent)

🟦 0.001 - 0.005

🟨 0.005 - 0.01

🟧 0.01 - 0.025

🟥 0.025 - 0.05

🟥 0.05 - 0.1

Report: Morecambe Offshore Windfarm: Generation Assets Environmental Statement

Title: Harbour seal at sea distribution. Maps show mean percentage of at-sea population estimated to be present in each 5km x 5km grid square at any one time (Carter et al., 2022)

Figure: 5.2

Drawing No: PC1165-RHD-ES-OF-DG-Z-0100

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	16/11/2023	SB	GC	A3	1:2,250,000
P02	02/04/2024	JH	GC	A3	1:2,250,000

Co-ordinate system: WGS 1984 UTM Zone 30N

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5.8.3.2 Harbour seal population counts

221. Harbour seal were counted while they were on land during their August moult, giving a minimum estimate of population size (SCOS, 2022). Combining the most recent counts (2022) gave a total of 30,855 counted in the UK. Scaling this by the estimated proportion hauled out (0.72 (95% CL = 0.54-0.88)) produced an estimated total population for the UK in 2019 of 42,854 harbour seal (approximate 95% CL = 35,062 – 57,139; SCOS, 2022).

222. The SCOS (2022) data showed abundance of harbour seals within the NW England MU remained below six from 1996-2019 (two seals from 1996-1997; and five seals from 2000-2006). Since 2000, the numbers of harbour seal in the MU have been stable at five to seven harbour seals (SCOS, 2022), but they have not been surveyed in recent years, thus it was unclear how many harbour seals were present.

223. Tagging maps showed that harbour seals that were present were most likely from neighbouring MUs and that the population was not independent from others, based on the available data (Carter *et al*., 2020, 2022). Further, no significant harbour seal breeding or haul out sites were identified in the NW England MU (SCOS, 2022).

224. Despite the low harbour seal population number within the NW England MU, it was considered as the reference population within the impact assessment, reflecting a precautionary approach to the assessment. Considering the Carter *et al*. (2020, 2022) tracking data that showed harbour seal movements most likely occur with neighbouring MU, the NW England MU and the NI MU, were considered most suitable to represent the wider reference population, and provide a more realistic wider reference population within the impact assessment.

225. The wider reference population estimates for harbour seal, based on the most recent estimates, are shown in **Table 5.2.**

Table 5.2 Harbour seal counts and population estimates

Population area	Harbour seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Harbour seal total population
NW England MU	5	SCOS, 2022	0.72	7
Northern Ireland	818	SCOS, 2022	0.72	1,136
Total wider reference population	823		0.72	**1,143**

5.8.4 Diet and foraging

226. Harbour seal take a wide variety of prey including sandeels, gadoids, herring, sprat, flatfish and cephalopods. Diet varies seasonally and regionally, prey diversity and diet quality also showed some regional and seasonal variation (SCOS, 2020). It has been estimated that harbour seals eat 3-5kg per adult seal per day depending on the prey species (SCOS, 2020) and the likely daily ration suggested approximately 3kg of fatty fish or up to 5kg of whitefish per day (BEIS, 2022b)

227. The range of foraging trips varies depending on the surrounding marine habitat. Telemetry studies have indicated that the tracks of tagged harbour seals had a more coastal distribution than grey seals and did not travel as far from haul-outs.

6 Review of potential disturbance from underwater noise during piling

228. There were no agreed thresholds or criteria for the behavioural response and disturbance of marine mammals at the time of writing, therefore it was not possible to conduct underwater noise modelling to predict impact ranges.

229. Therefore, a review of most recent available information on the potential disturbance of marine mammals during piling has been conducted to get a better understanding of the potential effects and inform the assessment set out in **Chapter 11 Marine Mammals**.

230. The JNCC *et al*. (2010) guidance proposed that "any action that is likely to increase the risk of long-term decline of the population(s) of (a) species could be regarded as disturbance under the Regulations."

231. The JNCC *et al*. (2010) guidance indicated that a score of 5 or more on the Southall *et al*. (2007) behavioural response severity scale could be significant (see **Table 6.1**). The more severe the response on the scale, the less time animals will likely tolerate the disturbance before there could be significant negative effects on life functions, which would constitute a disturbance.

Table 6.1 Southall et al. (2007) Severity Scale for Ranking Observed Behavioural Responses of Free-Ranging Marine Mammals

Response score	Corresponding behaviours in free-ranging subjects
0	No observable response.
1	Brief orientation response (investigation/visual orientation).
2	Moderate or multiple orientation behaviours Brief or minor cessation/modification of vocal behaviour Brief or minor change in respiration rates
3	Prolonged orientation behaviour Individual alert behaviour Minor changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source Moderate change in respiration rate Minor cessation or modification of vocal behaviour
4	Moderate changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source Brief, minor shift in group distribution Moderate cessation or modification of vocal behaviour

Response score	Corresponding behaviours in free-ranging subjects
5	Extensive or prolonged changes in locomotion speed, direction, and/or dive profile but no avoidance of sound source Moderate shift in group distribution Change in inter-animal distance and/or group size (aggregation or separation) Prolonged cessation or modification of vocal behaviour
6	Minor or moderate individual and/or group avoidance of sound source Brief or minor separation of females and dependent offspring Aggressive behaviour related to sound exposure (e.g., tail/flipper slapping, fluke display, jawclapping/gnashing teeth, abrupt directed movement, bubble clouds) Extended cessation or modification of vocal behaviour Visible startle response Brief cessation of reproductive behaviour
7	Extensive or prolonged aggressive behaviour Moderate separation of females and dependent offspring Clear anti-predator response Severe and/or sustained avoidance of sound source Moderate cessation of reproductive behaviour
8	Obvious aversion and/or progressive sensitisation Prolonged or significant separation of females and dependent offspring with disruption ofacoustic reunion mechanisms Long-term avoidance of area Prolonged cessation of reproductive behaviour
9	Outright panic, flight, stampede, attack of conspecifics, or stranding events Avoidance behaviour related to predator detection

232. It should be noted that a behavioural response does not mean that the individuals will avoid the area. In addition, the maximum predicted ranges for behavioural response have been based on the maximum hammer energy at the worst-case location for noise propagation. In reality, the duration of any piling at maximum energy would be less (if this energy is reached at all) and noise propagation would vary considerably with location (i.e., be less than the worst case).

6.1.1 Behavioural response of harbour porpoise to piling

233. The study of harbour porpoise at Horns Rev II (Brandt *et al.*, 2011), found that at closer distances (2.5 to 4.8km) there was 100% avoidance. However,

avoidance decreased significantly moving away from the pile driving activity, such that at distances of 10.1 to 17.8km, avoidance occurred in 32 to 49% of the population, and at 21.2km, harbour porpoise abundance reduced by just 2%. This suggests that an assumption of behavioural displacement of all individuals would be unrealistic and that in reality not all individuals would move out of the area. To take this into account within the marine mammal assessments, the proportion of harbour porpoise that may show a behavioural response has been calculated by assuming 75% or 50% could respond. This approach was consistent with the response at distances of 10.1 to 17.8km indicated by the Brandt *et al*. (2011) study (**Plate 6.1**), at which approximately 50% of individuals present could respond at the maximum predicted level as suggested by the dose-response curve (DRC) in Thompson *et al*. (2013).

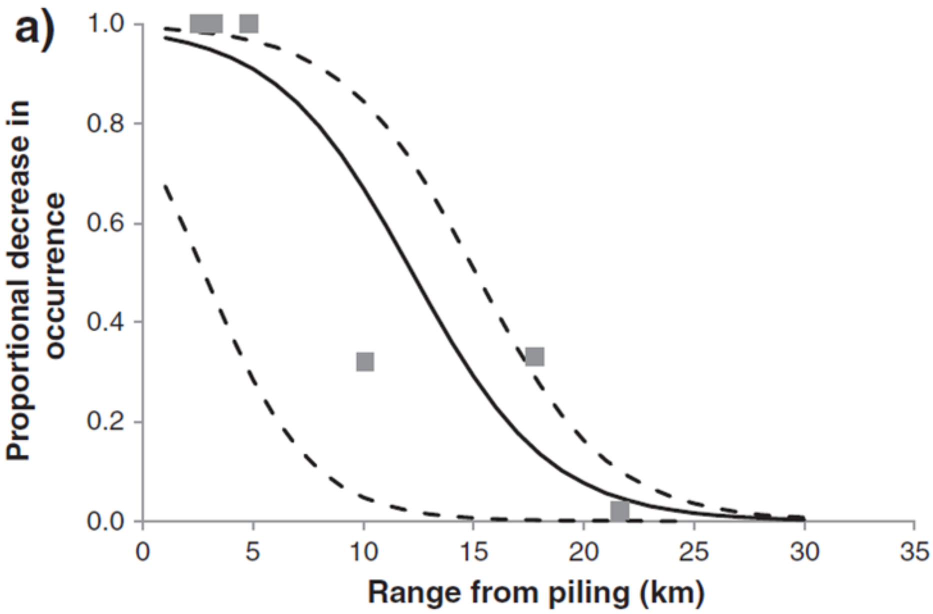


Plate 6.1 Predicted harbour porpoise dose response curve based on the monitoring of piling activity at Horns Rev II (based on data from Brandt et al., 2011, as presented in Thompson et al. (2013))

234. During the construction of two Scottish wind farms (Beatrice Offshore Wind Farm and Moray East Offshore Wind Farm), a set of cetacean porpoise detectors (CPODs) were deployed to monitor harbour porpoise presence during construction (Benhemma-Le Gall *et al*., 2021). In addition, the broadband noise levels were recorded and monitored, together with vessel Automatic Identification System (AIS) data. The purpose of this study was to assess the response of harbour porpoise to both the changes in the baseline noise level due to impact piling at the two wind farms, and due to an increase in vessel activity. Piling at Beatrice was for 2.2m jacket pin piles. The study demonstrated that there was an 8-17% decline in porpoise presence during

impact piling and other construction activities, compared to baseline levels (Benhemma-Le Gall *et al*., 2021).

235. An increase in broadband noise levels due to piling led to a significant reduction in porpoise presence. When piling was not occurring, porpoise detections decreased by 17% as the noise levels increased (from 102dB re 1 µPa (sound pressure level; SPL) to 159dB re 1 µPa (SPL)) (**Plate 6.2**; Benhemma-Le Gall *et al*., 2021). During piling, porpoise detections decreased by 9% as noise levels increased (from 102dB to 159dB). A similar reduction in buzz vocalisations was also evident; the presence of buzz vocalisations can be attributed to foraging behaviours. When piling was not taking place, buzz vocalisations decreased by 41.5% as the noise levels increased (from 104dB re 1 µPa (SPL) to 155dB re 1 µPa (SPL)). During piling, porpoise detections decreased by 61.8% as noise levels increased (from 104dB to 155dB re 1 µPa (SPL)) (Benhemma-Le Gall *et al*., 2021).

236. Harbour porpoise buzz vocalisations increased by 4.2% during Moray East piling compared to the baseline levels. At this point, Beatrice foundations were constructed, and the introduction of hard substrates were likely to have improved the fine-scale habitat for key harbour porpoise prey species, with the potential for increasing prey resources (Benhemma-Le Gall *et al*., 2021).

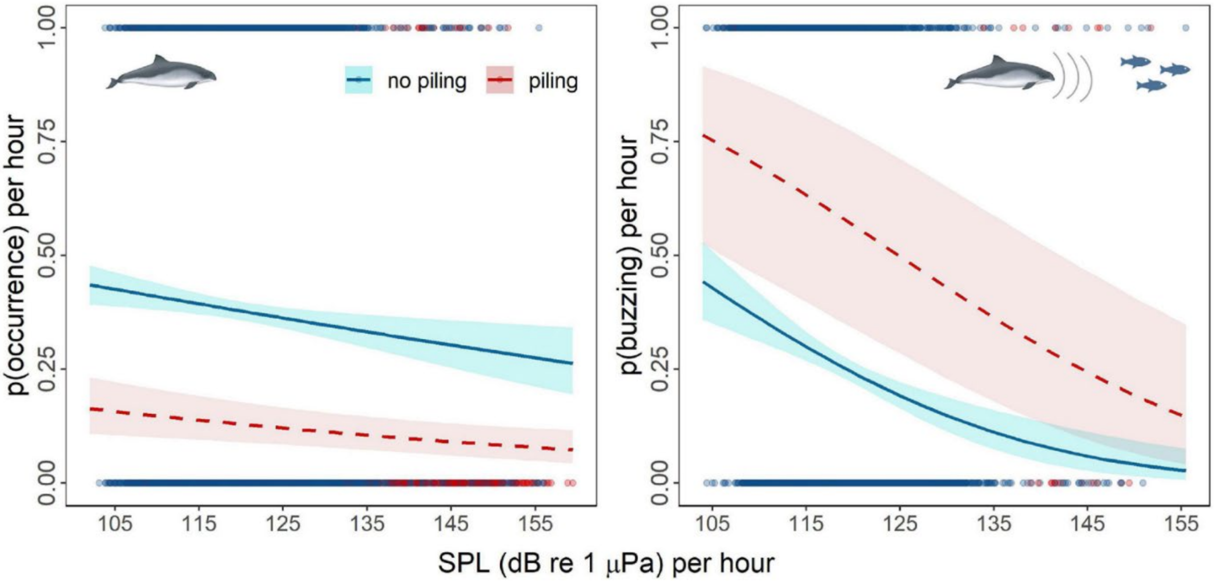


Plate 6.2 [Left] The probability of harbour porpoise presence in relation to the SPL (Red = during piling, Blue = outside of piling time, and [Right] the probability of buzzing activity per hour in relation to the SPL (Red = during piling, Blue = outside of pilin

237. A more recent study demonstrated that harbour porpoise started to leave the area in the two days leading up to a piling event, when pre-piling installation activities and vessel presence increased (Benhemma-Le Gall *et al*., 2023). The study found a 33% decline in acoustic click detections during the 48hrs prior to piling, which provided evidence that porpoises were displaced for a longer time period than just the piling event itself.

6.1.2 Behavioural response of dolphins to piling

238. There is limited information on the behavioural response of any dolphin species to piling.

239. Within the Southall et al. (2007) paper, a review of the data available for mid-frequency cetaceans (which included species other than dolphins, such as sperm whale *Physeter macrocephalus* and beluga *Delphinapterus leucas*) indicated that a significant response was observed at a SPL of 120dB to 130dB re 1µPa (root mean square (rms)), although the majority of individuals did not display a significant behavioural response until exposed to a level of 170dB to 180dB re 1µPa (rms). Other mid-frequency species were observed to have no behavioural response even when exposed to a level of 170dB to 180dB re 1µPa (rms). It should be noted that few of the reviewed studies were based on dolphin species.

240. Graham et al. (2017a) studied the responses of bottlenose dolphins due to both impact and vibration pile driving noise during harbour construction works in northeast Scotland. The study used passive acoustic monitoring (PAM) devices to record cetacean activity, and noise recorders to measure and predict received noise levels. Local abundance and patterns of occurrence of bottlenose dolphins were also compared with a five-year baseline. The median peak-to-peak source level estimated for impact piling was 240dB re 1µPa (single-pulse SEL (sound exposure level) 198dB re 1µPa^{2}s), and the rms source level for vibration piling was 192dB re 1µPa (Graham *et al.*, 2017a).

241. The results of the study found that bottlenose dolphin were not excluded from sites in the vicinity of impact piling or vibration piling; nevertheless, some small effects were detected, where bottlenose dolphins spent a reduced period of time in the vicinity of construction works during both impact and vibration piling (Graham *et al.*, 2017a). Dolphins generally showed a weak behavioural response to impact piling, reducing the amount of time they spend around the construction activity during piling (Graham *et al.*, 2017a). Observed fine-scale behavioural responses by dolphins during this study to piling occurred at predicted received single-pulse SEL values of between 104 and 136.2dB re 1µPa^{2}s for impact piling (Graham *et al.*, 2017a).

242. During the Beatrice wind farm piling campaign in 2017, dolphin detections decreased by 50% in the Impact Areas (minimum of 53km from the piling site) and decreased by 14% in the Reference Area (minimum of 80km from the piling site), compared to baseline years (Fernandez-Betelu *et al*., 2021). When impact piling was conducted at Moray East Offshore Wind Farm in 2019, no significant difference in dolphin detections between the study areas (Impact Area at a minimum of 45km from the piling site; Reference Area at a minimum of 78km from the piling site) was found in comparison to baseline years (Fernandez-Betelu *et al*., 2021).

243. The southern coast of the Moray Firth would have been the closest area to the offshore activities within this bottlenose dolphin population's range, with piling at Beatrice taking place 50–70km from the studied population, and Moray East 40–70km from the population. The analyses showed that dolphins continued using the southern coast of the Moray Firth during the seismic survey and impact pile-driving and therefore the species was not significantly affected at this distance of 40-70km (Fernandez-Betelu *et al*., 2021). While displacement distances were available for other marine mammal species (such as harbour porpoise), there were no such studies conducted for bottlenose dolphins. However, as dolphins were generally less sensitive than harbour porpoises to underwater noise, shorter ranges of displacement would be expected (Fernandez-Betelu *et al*., 2021).

244. While displacement distances were available for other marine mammal species (such as harbour porpoise), there were no such studies conducted for bottlenose dolphins. However, as dolphins were generally less sensitive than harbour porpoises to underwater noise, shorter ranges of displacement would be expected (Fernandez-Betelu *et al*., 2021).

245. It is possible that pile-driving noise can be perceived by dolphins for a minimum of 10km, and up to 40km away and interfere with dolphin communication, echolocation, and breeding. Depending on the communication, clicks can be masked up to 6km, whereas whistles have the potential to be masked up to 40km away.

246. While there was limited evidence as to the potential disturbance ranges of dolphin species due to impact piling, the above presented information indicates that the presence of dolphins may reduce due to piling works, however, there was no indication of a significant disturbance response, with individuals remaining in the vicinity of piling works. It was expected that dolphin species were less sensitive to disturbance from underwater noise than other species (such as harbour porpoise), however, due to the limited availability of evidence for dolphin species, as a precautionary approach, they were assumed to have the same sensitivity as harbour porpoise (medium).

6.1.3 Behavioural response of minke whale to piling

247. There is limited information on the behavioural response of minke whale to piling. Southall *et al.* (2007) recommended that the most appropriate way to assess the disturbance effect of a noise source on marine mammals was the use of empirical studies. The same paper presented a severity scale to apply to observed behavioural responses, and subsequent JNCC guidance indicated that a score of five or more on this behavioural response severity scale could be significant (see **Table 6.1**). A score of five relates to extensive changes in swim speed and direction, or dive pattern, but no avoidance of the

noise source, or a moderate shift in distributions, a change in group size, aggregations and separation distances, and a prolonged cessation in vocal behaviours. The higher the behavioural response score, the more likely the associated noise source would result in a significant disturbance effect.

248. Southall *et al.* (2007) included a summary of the observed behavioural responses from noise sources. However, the majority of the studies included were based on the responses to seismic surveys. These studies contained some relevant information for whale species behavioural responses.

249. Whale species were typically observed to respond significantly at a received level of 150dB to 160dB re 1µPa (rms) (Malme *et al.,* 1983, 1984; Richardson *et al.,* 1986; Ljungblad *et al.,* 1988; Todd *et al.,* 1996; McCauley *et al.,* 1998), with behavioural changes including:

- Visible startle responses
- Extended cessation or modification of vocal behaviour
- Brief cessation of reproductive behaviour
- Brief and minor separation of females and dependent offspring

250. During migration periods, avoidance behaviours of bowhead whales, *Balaena mysticetus,* were observed at distances of more than 20km from seismic sources (Koski & Johnson, 1987; Richardson *et al.,* 1999). However, during foraging periods, bowhead whales did not respond at greater than 6km from the source (Richardson *et al.,* 1986; Miller *et al.,* 2005). Richardson *et al.* (1986) concluded that due to a single airgun, avoidance and behavioural response was observed once noise levels reached more than 160dB re 1µPa.

251. For a migrating bowhead whale study, most individuals avoided a seismic survey source at distances of up to 20km (the seismic surveys used airgun arrays of up to 16 guns, and total volume of 560 to 1,500 cu. in.), with significantly reduced bowhead whale presence between 20 and 30km from the source, with estimated received noise levels of 120 to 130dB re 1µPa ($_{rms}$) at that distance (Richardson *et al.,* 1999).

252. However, during foraging periods, bowhead whales did not respond at greater than 6km from the source (Richardson et al., 1986; Miller et al., 2005). Observations of behavioural changes in baleen whale species have shown avoidance reactions of up to 10km for a seismic survey, with a noise source level of 143dB re 1µPa (peak to peak) (Macdonald *et al.,* 1995).

253. Dose-response functions for avoidance responses of grey whales *Eschrichtius robustus* to both continuous and impulsive noises were developed for vessel noise and seismic air guns by Malme (1984). For continuous noise sources, avoidance of minke whale started at a received level of 110-119dB re 1µPa ($L_{peak,\ rms}$), with more than 80% of individuals

responding at 130dB re 1 µPa ($L_{peak,\ rms}$), and 50% at 120dB re 1 µPa ($L_{peak,\ rms}$).

254. Higher noise levels were required for an avoidance response due to the impulsive noise source (seismic airguns), with 10% of migrating grey whales responding at 164dB re 1 µPa ($L_{peak,\ rms}$), 50% at 170dB re 1µPa ($L_{peak,\ rms}$), and 90% at 180dB re 1µPa ($L_{peak,\ rms}$) (Malme, 1984 *cited in* Tyack and Thomas, 2019). A secondary study (Malme *et al*., 1987) using 100 cu. in. air guns (with a source level of 226dB re 1µPa) for foraging grey whales found a response level (where individuals would cease foraging activities) of 50% at 173dB re 1µPa ($L_{peak,\ rms}$), and 10% at 163dB re 1µPa ($L_{peak,\ rms}$).

255. There was limited information on the potential disturbance ranges of minke whale to piling, however, there were some studies that provide observed disturbance of baleen whale species to seismic surveys. Baleen whale species have been observed to respond at up to 20km during migration, with disturbance observed up to 30km from a seismic source. One study found that baleen whales were more sensitive to disturbance from continuous sources than from impulsive sources. Typically, baleen whales have been reported to avoid and respond at impulsive noise levels of 150-160 re 1µPa (rms) (Malme *et al*., 1983, 1984; Richardson *et al*., 1986; Ljungblad *et al*., 1988; Todd *et al*., 1996; McCauley *et al*., 1998), with 50% of individuals responding at 170dB to 173dB re 1µPa ($L_{peak,\ rms}$) (Malme, 1984; Malme *et al*., 1987).

256. The studies summarised above suggest that baleen whale species (including minke whale) may be similarly sensitive to disturbance from underwater noise as harbour porpoise, and therefore a sensitivity of medium was appropriate.

6.1.4 Behavioural response of seals to piling

257. There was limited data on seal species presented within the Southall *et al*., 2007 paper. Although these species are not found in UK waters, one included study was for ringed seals *Pusa hispida*, bearded seals *Erignathus barbatus,* and spotted seals *Phoca largha* (Harris *et al.,* 2001), which found the onset of a significant response at a received noise level of 160 to 170dB re 1µPa (rms), although a larger proportion of individuals showed no response at noise levels of up to 180dB re 1µPa (rms). Only at much higher sound pressure levels (190 to 200dB re 1µPa (rms)) did significant numbers of seals exhibit a significant disturbance response.

258. Tagged harbour seals in the Wash indicated that seals were not excluded from the vicinity of the Lincs Offshore Wind Farm during the overall construction phase but that there was clear evidence of avoidance during pile driving, with significantly reduced levels of seal activity at ranges of up to 25km from piling sites (Russell *et al.,* 2016). However, within two hours of cessation of piling, seal distribution returned to pre-piling levels (Russell *et al.,* 2016).

6.1.5 Dose response curves

259. As per current best practice guidance (Southall *et al*., 2021), a behavioural disturbance dose-response analysis has been carried out for those species for which appropriate dose-response evidence existed within the scientific literature. In case of absence of such evidence, a fixed behavioural threshold approach (that was used in most assessments) has been applied.

260. The dose-response relationship used for harbour porpoise was developed by Graham *et al*. (2017b) using data collected on harbour porpoises during Phase 1 of piling at the Beatrice Offshore Wind Farm. This dose response relationship is displayed in **Plate 6.3**. Following the development of this dose-response relationship, further study revealed that the responses of harbour porpoises to piling noise diminished over the construction period (Graham *et al*., 2019). Therefore, the use of the dose-response relationship related to an initial piling event for all piling events in the ES marine mammal assessment can be considered conservative.

261. In the absence of species-specific dose-response data for dolphins or whales, harbour porpoise was the only species of cetacean that this analysis was applied to. Due to differences in audiograms and behaviour, it would not be appropriate to extrapolate the findings of Graham *et al*. (2017b) to other cetacean species.

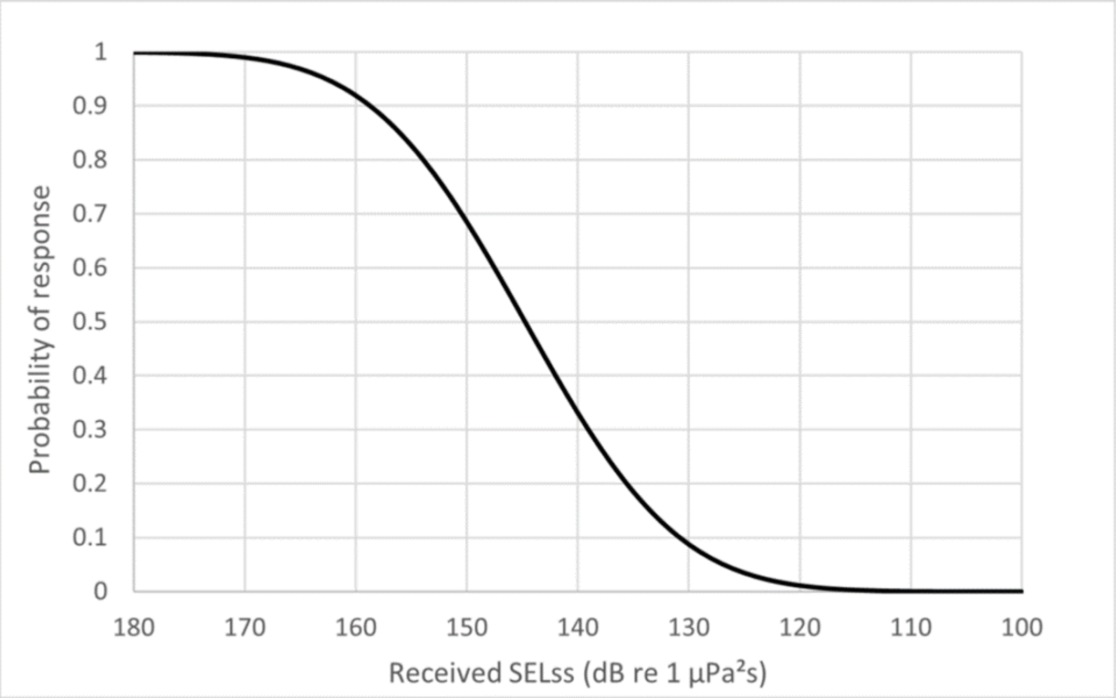


Plate 6.3 Dose-response relationship developed by Graham et al. (2017b) used for harbour porpoise in the assessment

262. For both harbour seal and grey seal, a dose-response relationship that was derived from harbour seal telemetry data collected during several months of piling at the Lincs Offshore Wind Farm has been used (Whyte *et al*., 2020). As seen in **Plate 6.4**, the greatest Sound Exposure Level from single strike (SELss) considered in the Whyte *et al*. (2020) study was 180 dB re 1µPa2s. The ES marine mammal assessment has therefore conservatively assumed that at SELss > 180dB re 1µPa^{2}s all seals would be disturbed. The dose-response curve for harbour seal has been used for grey seal, as both species have similar hearing audiograms.

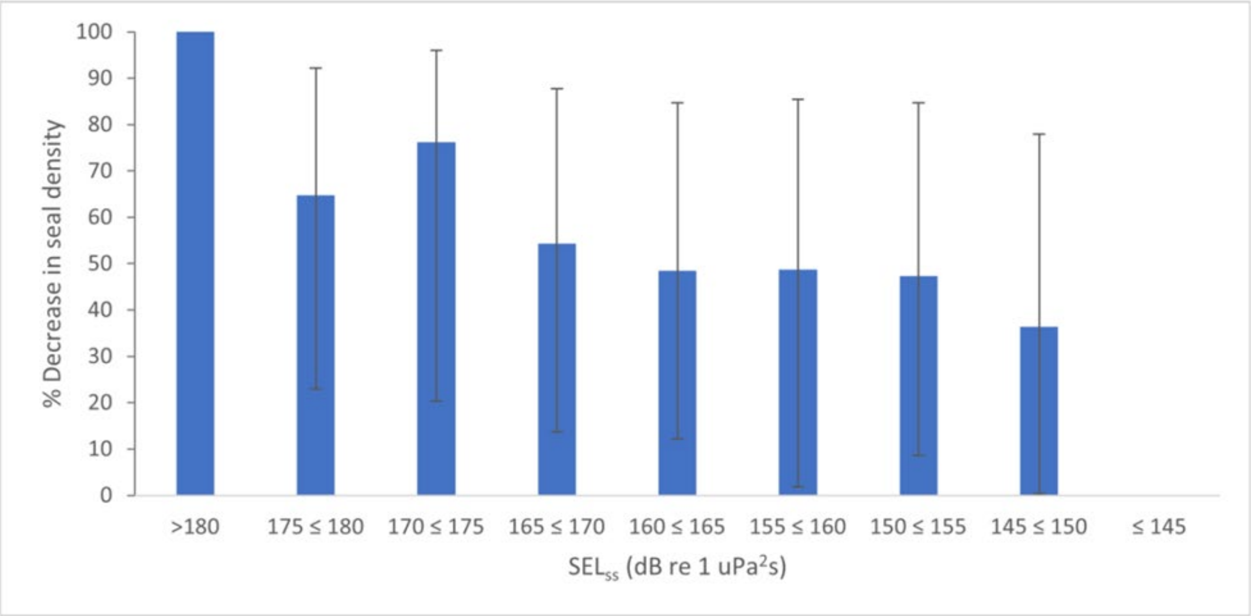
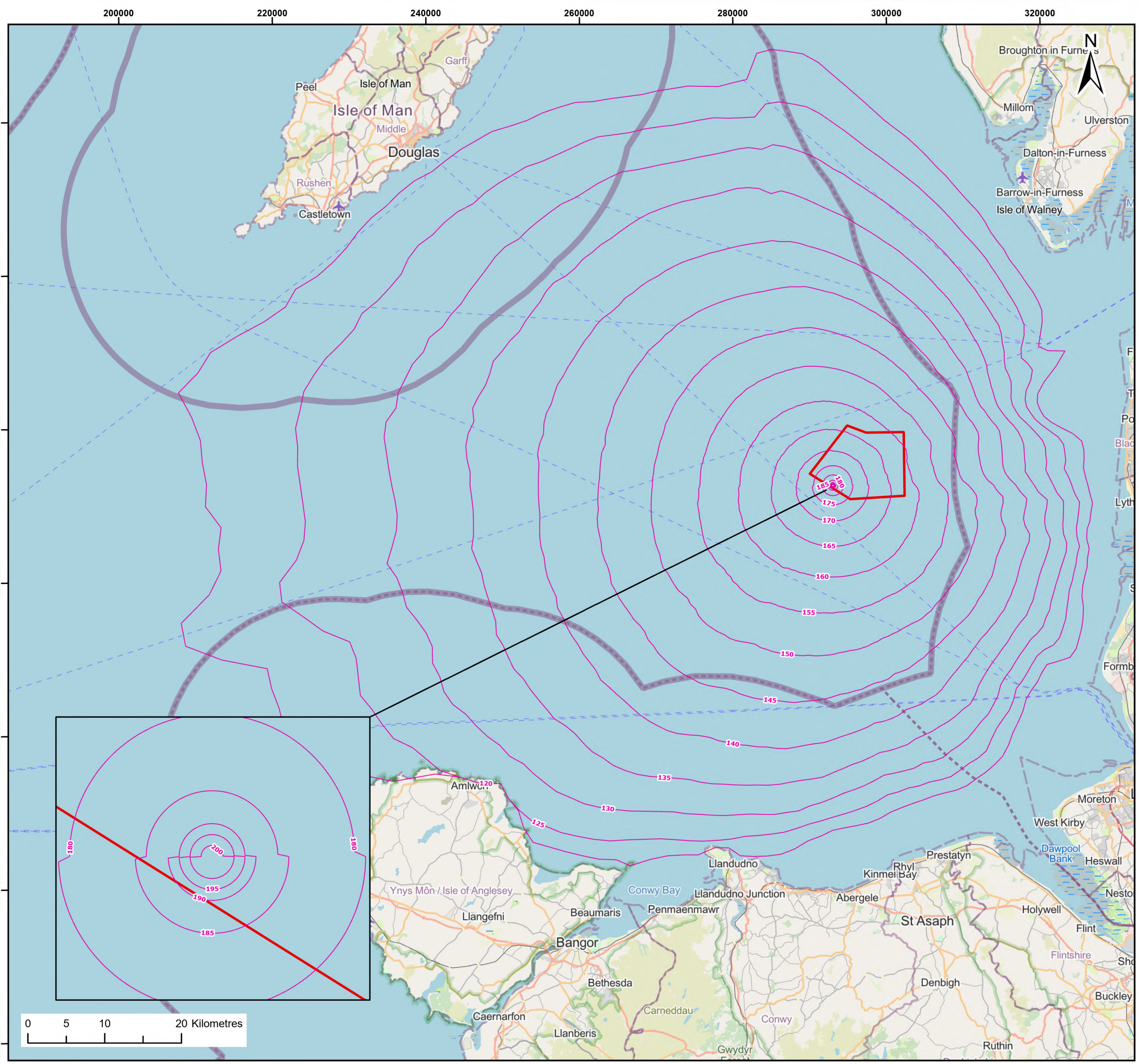


Plate 6.4 Dose-response behavioural disturbance data for harbour seal derived from the data collected and analysed by Whyte et al. (2020). This data has been used for harbour and grey seals in the assessment.

263. To estimate the number of animals disturbed by piling, SELss contours at 5dB increments (generated by the noise modelling – see **Figure 6.1** and **Figure 6.2**) were overlain on the relevant species density surfaces, to quantify the number of animals receiving each SELss, and, subsequently, the number of animals likely to be disturbed, based on the corresponding dose-response curve.



Legend:

🟥 Morecambe Offshore Windfarm Site

— 5dB contours for South West (worst-case) location using Unweighted SELss for monopiles

Report:
Morecambe Offshore Windfarm: Generation Assets
Environmental Statement

Title:
5dB contours for the South West (worst-case)
location using Unweighted SELss for monopiles

Figure: 6.1
Drawing No: PC1165-RHD-ES-OF-DR-Z-0099

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	16/11/2023	JH	SB	A3	1:500,000
P02	03/04/2024	JH	SB	A3	1:500,000

Co-ordinate system: WGS 1984 UTM Zone 30N

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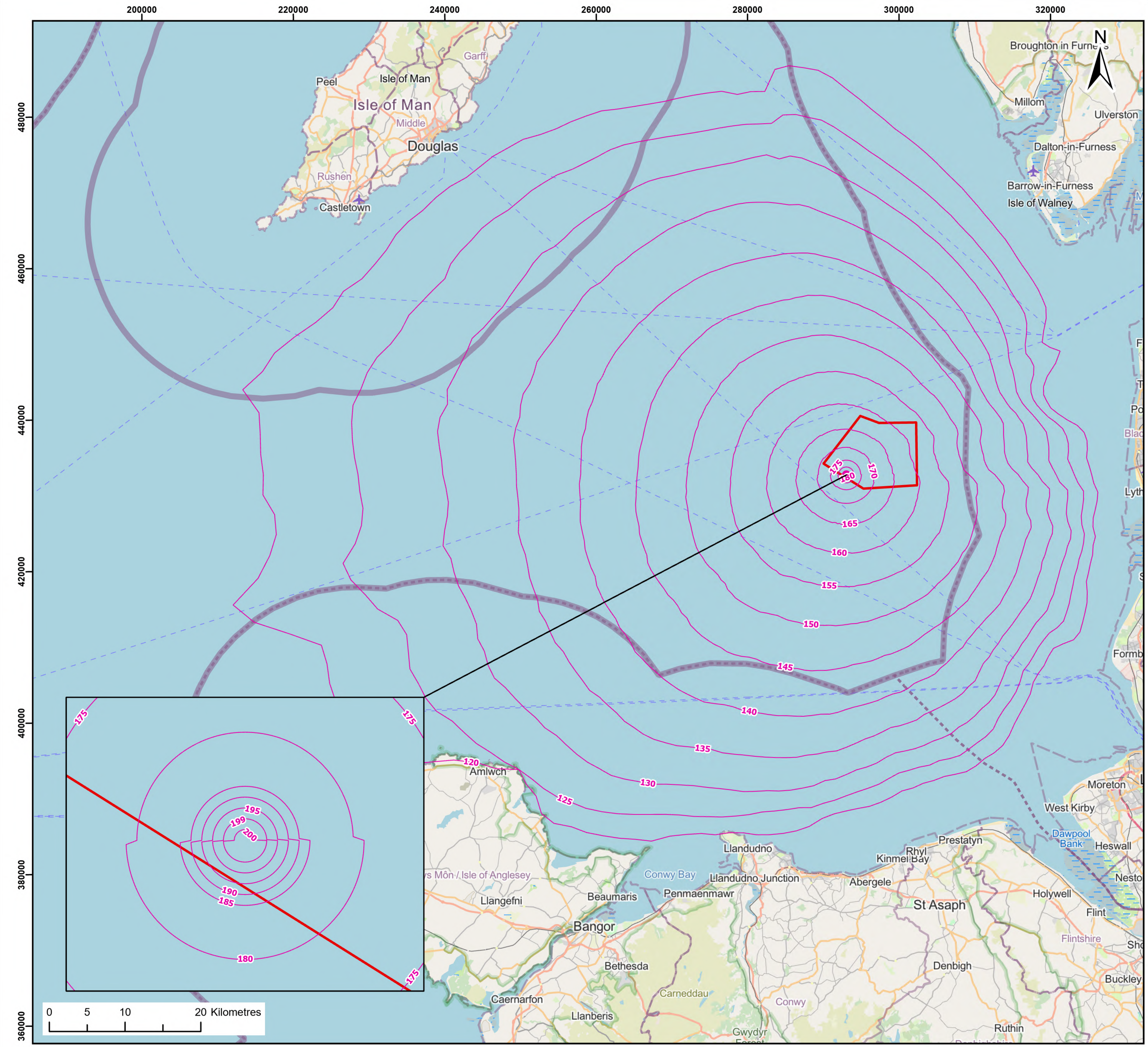

Legend:

🟥 Morecambe Offshore Windfarm Site

― 5dB contours for the South West (worst-case) location using Unweighted SELss for pinpiles

Report:
Morecambe Offshore Windfarm: Generation Assets Environmental Statement

Title:
5dB contours for the South West (worst-case) location using Unweighted SELss for pinpiles

Figure: 6.2
Drawing No: PC1165-RHD-ES-OF-DR-Z-0106

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	16/11/2023	JH	SB	A3	1:500,000
P02	03/04/2024	JH	SB	A3	1:500,000

Co-ordinate system: WGS 1984 UTM Zone 30N

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6.1.5.1 Assumptions and limitations

264. There was a lack of empirical data on bottlenose dolphin, minke whale or grey seal responses to pile driving to derive species-specific dose-response curves for these species. For grey seal, the harbour seal dose response curve has been used as a reasonable proxy since both species were of the same hearing group. For the remaining species, all dolphins and minke whale, the harbour porpoise dose-response curve was used although there were uncertainties regarding the use of this proxy since the species have all been classified as being in different hearing groups, and thus in reality their response to the same sound source was unlikely to be the same.

265. The use of the dose-response relationship for harbour seal from Whyte *et al*. (2020) in conjunction with the modelling results presented here was conservative. The exact drivers behind the dose response relationship were unknown and were likely to be influenced by a combination of distance from the sound source and the received level. Yet the dose-response curve presented in Whyte *et al*. (2020) was based upon received level only. Responses of animals were not only elicited by the received level but also by other factors, such as signal shape. The shape of a signal with the same SEL from the same sound source differs depending on distance. Piling noise has been noted to lose its impulsive character with distance (Southall *et al*. 2007, Hastie *et al*. 2019, Southall *et al.* 2019b; **Plate 6.5**), and therefore animals were expected to react less strongly to piling noise with the same received levels when exposed at larger distances. Such an effect has been quantified for blue whales with regard to military sonar, where a received level of 170dB SEL from cumulative exposure (SEL_{cum}) at 1km resulted in a probability response of >0.5 at severity score 4-6[8] whereas the same received level of 170dB SEL_{cum} at 5km resulted in a probability of response of <0.1 at severity score 4-6 (Southall *et al.* 2019a). This is important to note, since the original dataset in Whyte *et al.* (2020) showed that “predicted seal density significantly decreased within 25 km or above SEL_{ss} 145dB re 1µPa²s”.

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[8] Severity score 4-6 denotes “moderate severity”

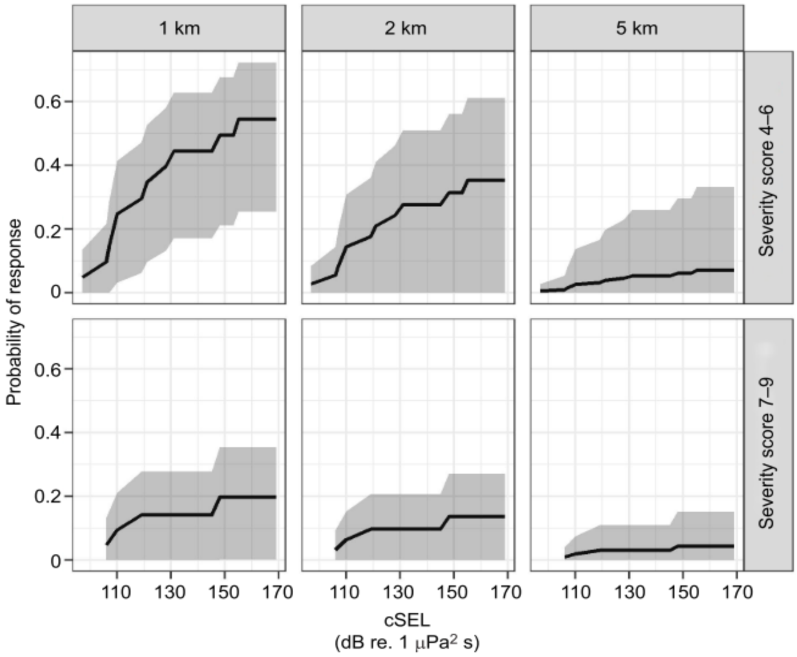

Plate 6.5 Behavioural response probability for blue whales exposed to military sonar as a function of received level and distance from the sound source. Severity score 4-6 denotes 'moderate severity 'and 7-9 denotes 'high severity'. Image taken from Southall et al. (2019)

266. In addition to these issues, it should be recognised that estimates of received noise levels were likely to be extremely conservative given they have been based on the maximum hammer energy. In practice, pile driving at other UK offshore wind farms has often been completed using much lower than the predicted hammer energies as shown for other OWFs (DOWE, 2016).

6.1.6 Beatrice offshore wind farm

267. During the piling campaign at Beatrice Offshore Wind Farm in 2017, an array of underwater noise recorders was deployed to determine noise levels associated with the piling campaign, alongside a separate array of acoustic recorders to monitor the presence of harbour porpoise during piling (Graham *et al*., 2019). Piling at Beatrice comprised four pin piles at each turbine or sub-station structure, with a 2.2m pile diameter and a maximum hammer energy of 2,400kJ. The sound levels recorded were then used to determine the sound level at each of the acoustic recorders.

268. This study assumed that a change in the number of harbour porpoise present at each location was based on the number of positive identifications of porpoise vocalisations (Graham *et al*., 2019). These two data sets (the harbour porpoise presence and the perceived sound level at each location) were then analysed to determine any disturbance impacts as a result of the piling activities and at what sound level impacts were observed. Harbour porpoise presence was measured over a period of 48 hours prior to piling being undertaken and continued following the cessation of piling to ensure that

any change in porpoise detections could be observed (a total period of 96 hours was recorded for each included piling event, with a total of 17 piling events included within this analysis) (Graham *et al*., 2019).

269. The results of the study at Beatrice Offshore Wind Farm (Graham *et al*., 2019) found that at the start of the piling campaign, there was a 50% chance of a harbour porpoise responding to piling activity, within a distance of 7.4km, during the 24 hours following piling. By the middle of the piling campaign, this 50% response distance had reduced to 4.0km, and by the end of the piling had reduced further to 1.3km. The response to audiogram weighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 54.1dB re 1µPa2s at the first location during the first 24 hours following piling, increasing to 60.0dB re 1µPa2s during the middle of the campaign, and to 70.9 dB re 1µPa2s by the end of the piling activities. Similarly, the response to unweighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 144.3dB re 1µPa2s at the first location during the first 24 hours following piling, increasing to 150.0dB re 1 1µPa2s during the middle of the campaign, and to 160.4dB re 1µPa2s by the end of the piling activities (Graham *et al*., 2019).

270. Additional comparisons were made through this study (Graham *et al*., 2019) to assess the difference in harbour porpoise presence where Acoustic Deterrent Devices (ADD) were used and where they were not, as well as relating to the number of vessels present within 1km of the piling site. A significant difference was observed in the presence of harbour porpoise where ADDs were used compared to where they were not, but only in the short-term (less than 12 hours following piling), and there was no significant difference when considering a longer time period from piling. 50% response distances for pile locations with ADD use were recorded as up to 5.3km (during 12 hours after piling), and up to 0.7km with no ADD in use in the 12 hours following piling. It should be noted however that only two locations used in the analysis deployed ADD, and therefore the sample number in this analysis was small (Graham *et al*., 2019).

271. Overall, this study showed that the response of harbour porpoise to piling activities reduced over time, suggesting a habituation effect occurred. In addition, there has been some indication that the use of ADDs would reduce the presence of harbour porpoise in the short term. Also, the higher levels of vessel activity increased the potential for a response by harbour porpoise. Harbour porpoise response to piling activity was best explained by the distance from the piling location, or from the received noise levels (taking into account weighting for their hearing) (Graham *et al*., 2019).

6.1.7 Gescha 2

272. The Gescha 2 study (Effects of noise-mitigated offshore pile driving on harbour porpoise abundance in the German Bight 2014-2016; Rose *et al*., 2019) analysed the impact from the construction of eleven offshore wind farms in Germany on harbour porpoise in the German North Sea and adjacent Dutch waters from 2014 to 2016. The study also included analysis of previously completed surveys within the Gescha 1 study, which studied the impact from the construction of eight German offshore wind farms from 2009 to 2013. The study involved the deployment of CPODs and digital aerial surveys to monitor harbour porpoise presence and abundance during the construction of these projects, alongside the measurement of noise levels associated with piling at both 750m and 1,500m from source. The piling activities monitored in this study were mostly undertaken with noise abatement systems deployed to reduce disturbance impacts on harbour porpoise.

273. The Gescha 2 study (Rose *et al*., 2019) found that noise levels recorded during piling were predominantly below the limit of 160dB at 750m (the German Federal Maritime and Hydrographic Agency (BSH) mandatory noise limit for German waters) and were 9dB lower than the noise levels recorded during the Gescha 1 study, due to advancement in noise abatement methods. The study also found that noise levels were 15dB less using noise abatement than for noise levels from unmitigated piling. It was expected that the improved efficiency of noise abatement for piling, and therefore the overall reduced noise levels, would lead to a reduction in disturbance impacts on harbour porpoise, however, this was not the case.

274. The range of disturbance impact of harbour porpoise to piling within the Gescha 2 study (Rose *et al*., 2019) was 17km (Standard Deviation (SD) 15-19km), and the duration of disturbance (i.e., the time it took for harbour porpoise to return to baseline levels) was between 28 and 48 hours, as shown by CPOD data. The impact range was found to be between 11.4 and 19.5km based on aerial data (at least 12 hours after piling) (Rose *et al*., 2019). These results were similar to those reported in the Gescha 1 study (with a disturbance range of 15km (Standard deviation (SD) 14-16km) and duration of disturbance of 25 to 30 hours), which showed higher piling noise levels (Rose *et al*., 2019). This suggested that the noise level of the piling was not the only determining factor when discussing the potential for disturbance.

275. Analysis of the CPOD data collected in the Gescha 2 study (Rose *et al*., 2019) indicated that there was no correlation between noise levels received and the range at which harbour porpoise become disturbed, for noise that was below 165dB at 750m from source. This could have been due to individuals maintaining a certain distance from noisy activities, irrespective of the actual noise levels, provided that noise level was above a certain threshold for that

individual (Rose *et al*., 2019). It should be noted however that this study recorded noise levels up to 20kHz only, and therefore there may have been higher frequency noise associated with piling that these results did not take into account.

276. A reduction in harbour porpoise presence was seen for all offshore wind farms (for both the Gescha 1 and 2 studies) up to 24 hours prior to any noisy activity occurring, which could have been due to the increased vessel activity at the pile location prior to piling taking place (Rose *et al*., 2019). However, the displacement during pile driving was noted to be larger than for the period prior to piling. In Gescha 2, a decrease in detection rates was found in the three hours prior to piling activity at a distance up to 15km from the piling location, with no difference in detection rates observed at a distance of 25km (Rose *et al*., 2019).

7 Population modelling

277. In **Chapter 11 Marine Mammals**, the assessment results for disturbance (Section 11.6.3.2), revealed that elevations in subsea noise due to piling could potentially lead to the behavioural disturbance of a large number of individuals of the key species identified within the marine mammal study area.

278. Population modelling has therefore been conducted for harbour porpoise, bottlenose dolphin, minke whale, harbour and grey seal. The interim Population Consequences of Disturbance (iPCoD) framework (Harwood *et al*. 2014, King *et al*. 2015) was used to predict the potential medium- and long-term population consequences of the predicted amount of disturbance resulting from the piling at the Project.

279. iPCoD used a stage-structured model of population dynamics with nine age classes and one stage class (adults 10 years and older). The model was used to run a number of simulations of future population trajectories with and without the predicted level of impact to facilitate an understanding of the potential future population-level consequences of predicted behavioural responses and auditory injury.

7.1 Methodology

7.1.1 Piling parameters

280. The amount of piling required for the Project would be dependent on the foundations selected and the final piling schedule. The worst-case scenario (monopiles with the highest strike rate) was taken forward for modelling in iPCoD.

281. Whilst for the underwater noise modelling (**Appendix 11.1 Underwater Noise Assessment** (Document Reference 5.2.11.1) the worst-case with regard to modelled impact ranges was presented where piling for the Project could occur sequentially (up to three monopiles or four pin-piles in a 24h period); for population modelling the worst-case assumed that only one pile would be installed in each 24h period, thereby maximising the number of days in which disturbance could occur over the construction phase.

282. At this stage, uncertainty exists around the exact piling schedule that would be used for construction of the Project, however the periods during which piling is likely to occur are known. Therefore, the required number of piling days for each project construction scenario have been distributed randomly within the known piling periods.

283. The piling parameters used in the iPCoD modelling for the Project-alone scenario is detailed in **Table 7.1**.

Table 7.1 Piling scenario used for iPCoD modelling for the Project

Parameter	Value
Number of WTGs	35
Number of OSP(s)	2
Number of piles	Monopiles: 35 (WTG) and 2 (OSP) Pin-pile: 140 (WTG) and 8 (OSP)
Number of piling days	37 (assumed 1 pile per day)
Piling window	Q2 and Q3 2027 (WTG/OSP monopiles)
Piling schedule	Q2 and Q3 2027: 37 monopile days (distributed randomly)

284. The piling parameters used in the iPCoD modelling for the projects in the cumulative assessment scenario are detailed in **Table 7.2**. Further information on the projects included has been provided in **Appendix 11.4 Marine Mammal CEA Screening** (Document Reference 5.2.11.4).

Table 7.2 Piling parameters for other projects screened into the cumulative iPCoD modelling

Project	Number of piling days	Piling schedule
Awel y Môr	201	Q1 Year 2 - Q4 Year 4 2027-2029
Erebus	18	Q4 2024 – Q4 2026
Morgan	70	2026/27
Mona	70	2026/27
Transmission Assets	6	2026/27
White Cross	5	Q2 2025 - Q3 2027

7.1.2 Model inputs

285. The iPCoD model v5.2[9] was set up using the program R v4.3.2 (R Core Team, 2023) with RStudio as the user interface. To enable the iPCoD model to be run, the following data were provided:

- Demographic parameters for each key species
- User specified input parameters
    - Vulnerable subpopulations
    - Residual days of disturbance

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[9] https://www.smruconsulting.com/population-consequences-of-disturbance-pcod

- Number of animals predicted to experience Permenant Thershold Shift (PTS) and/or disturbance during piling
- Estimated piling schedule during the proposed construction programme

7.1.3 Demographic parameters

286. Demographic parameters for the key species assessed in the population model are presented in **Table 7.3**. In the case of harbour seal, evidence for demographic parameters for the English populations was lacking (Sinclair et al., 2020). The SCOS (2022) data showed abundance of harbour seals within the NW England MU remained below six from 1996-2019 (two seals from 1996-1997; and five seals from 2000-2006).

287. Since 2000, the numbers of harbour seal in the NW England MU have been stable at five to seven harbour seals (SCOS, 2022). However, they have not been surveyed in recent years, therefore it was unclear how many harbour seals were present. The NW England MU appeared to be stable, and the MU with demographic information available (and greatest chance for connectivity), namely the NI MU, was also considered to be stable. For this reason, the demographic parameters for the NI MU have been used in the modelling for harbour seal.

Table 7.3 Demographic parameters recommended for each species for the relevant Management Unit (MU)/SMAs (Sinclair et al., 2020)

Species	MU	Age calf/pup becomes independent	Age of first birth	Calf/Pup Survival	Juvenile Survival	Adult Survival	Fertility	Growth Rate
		age1	age2					
Harbour Porpoise	North Sea	1	5	0.8455	0.85	0.925	0.34	1.00
Grey Seal	All UK	1	6	0.222	0.94	0.94	0.84	1.01
Harbour Seal	Northern Ireland	1	4	0.4	0.78	0.92	0.85	1.00
Bottlenose dolphin	All MUs (except East Coast Scotland)	2	9	0.8	0.94	0.94	0.25	1.00
Minke whale	European waters	1	9	0.7	0.77	0.96	0.91	1.00

7.1.4 Reference populations

288. The populations of marine mammal species vulnerable to piling-induced PTS/disturbance were specified in the model as the reference populations against which the effects (i.e. number of animals suffering PTS/disturbed) were assessed in **Chapter 11 Marine Mammals**, Section 11.6.3.2. **Table 7.4** provides the reference populations used in the iPCoD modelling.

Table 7.4 Reference populations used in the iPCoD modelling

Species	Area	Population
Harbour porpoise	Celtic and Irish Sea MU	62,517
Grey Seal	Wider reference population: NW England MU; SW Scotland; IoM count; Wales MU; NI MU; E RoI; SE RoI	13,283
Harbour Seal	Wider reference population: NW England MU and NI MU	1,143
Bottlenose dolphin	Irish Sea MU	293
Minke whale	Celtic and Greater North Sea MU	20,118

7.1.5 Residual days disturbance

289. Empirical evidence from constructed wind farms (e.g. Graham *et al*., 2019; Brandt *et al*., 2011) suggested that the detection of animals returned to baseline levels in the hours following a disturbance from piling and therefore, for the most part, it could be assumed that the disturbance occurred only on the day (24 hours) that piling took place (at least in the case of harbour porpoise which was the focus of these studies). However, the number of residual days of disturbance has, conservatively, been selected as one, meaning that the model assumed that disturbance occurred on the day of piling and persisted for a period of 24 hours after piling ceased.

7.1.6 Vulnerable sub-populations

290. For the purposes of the modelling, it was assumed that the entire population of interest was potentially vulnerable to pile driving disturbance and PTS.

7.1.7 Number of animals with PTS or disturbed

291. The number of animals predicted to experience PTS and/or disturbance during piling was based on the density values identified for harbour porpoise, harbour and grey seal as part of the baseline assessment in **Chapter 11 Marine Mammals**. In the case of disturbance, the estimated number of harbour porpoise and seals affected was based on effective deterrent ranges (EDRs) which are fixed ranges that are based on empirical evidence as opposed to disturbance ranges estimated from noise modelling (JNCC, 2020). The estimated number of bottlenose dolphin and minke whale affected was based on known disturbance ranges (as detailed in **Sections 6.1.2** and **6.1.3**).

292. Whilst **Chapter 11 Marine Mammals**, provided alternative estimates of the number of animals disturbed, based on a dose-response analysis (which could be considered more realistic), the estimates resulting from EDRs were greater, and were therefore used in the iPCoD model as a conservative worst-case.

293. **Table 7.5** presents the number of individuals that could potentially be disturbed due to piling at the Project-alone.

Table 7.5 Estimated number of animals to have PTS or to be disturbed during each piling event

	Number of animals affected during each piling event	
Species	**PTS**	**Disturbance**
Harbour porpoise	243	3,443 (based on 26km EDR)
Bottlenose dolphin	0.001	56.3 (based on DRC)
Minke whale	2.9	24.9 (based on 30km range)
Grey seal	0.2	196.4 (based on 25km EDR)
Harbour Seal	0.0002	0.2 (based on 25km EDR)

294. For cumulative effects assessments (CEA), the number of animals predicted to experience PTS and/or disturbance during piling was based on the density values that were published in the respective PEIR or ES chapters for the projects screened into the CEA.

295. **Table 7.6** presents the number of individuals that could potentially be affected by PTS or be disturbed from piling at the OWF projects screened into the CEA. Note: the Morgan and Morecambe Offshore Windfarms: Transmission Assets are hereafter referred to as ‘Transmission Assets’.

Table 7.6 Estimated number of marine mammals to have PTS or be disturbed from piling at the CEA screened in projects

Number of animals affected by PTS during each piling event					
Projects	**Harbour porpoise**	**Bottlenose dolphin**	**Minke whale**	**Grey seal**	**Harbour Seal**
Awel y Môr OWF	2,112	<1	3	<1	Not assessed
Erebus OWF	<1	<1	<1	<1	Not assessed
Morgan Offshore Wind Project Generation Assets	0	0	<1	0	<1
Mona Offshore Wind Project	0	0	<1	0	<1
Transmission Assets	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
White Cross OWF	0.92	0.0006	3.5	0.00005	Not assessed
Number of animals disturbed during each piling event					
Awel y Môr OWF	83	23	35	81	Not assessed
Erebus OWF	1,967	310	55	18	Not assessed
Morgan Offshore Wind Project Generation Assets	979	11	69	45	Not assessed
Mona Offshore Wind Project	429	13	69	45	Not assessed
Transmission Assets	1,793	4	69	28	Not assessed
White Cross OWF	649	0.0005	60.5	9.5	Not assessed

7.1.8 Piling schedule

296. As described in **Section 7.1.1**, the piling schedule was developed from the Project Design Envelope (PDE) which provided an estimate of the number of days piling for the WTG and OSP foundations within a defined piling phase, which is scheduled to take place within an overall offshore construction window.

7.2 Assumptions and limitations

297. The iPCoD framework (Harwood *et al*. 2014, King *et al*. 2015), provided by SMRU Consulting, has been used to predict the potential population consequences of the predicted amount of disturbance resulting from Project piling[10].

298. Insufficient empirical evidence exists regarding how alterations in behaviour and hearing sensitivity might impact the survival and reproductive capabilities of individual marine mammals. Therefore, in the absence of empirical data, the iPCoD framework used the results of an expert elicitation process, described in Donovan *et al*. (2016), to predict the effects of disturbance and PTS on survival and reproductive rates. The process generated a set of statistical distributions for these effects and then simulations were conducted using values randomly selected from these distributions that represented the opinions of a 'virtual' expert. This process was repeated many 100s of times to capture the uncertainty among experts. While the iPCoD model was subject to many assumptions and uncertainties relating to the link between impacts and vital rates, the model presented the best available scientific expert opinion at the time of assessment.

299. In the latest update of the iPCoD model there was no elicitation for minke whale (PTS or disturbance) or bottlenose dolphins (disturbance) and the results presented in **Chapter 11 Marine Mammals**, were highly conservative and represented an overestimate of any potential population level effects. There were several precautions built into the iPCoD model that meant that the results were highly precautionary and would over-estimate the true population level effects. These included, but were not limited to, the following three factors:

- The fact that the model assumed a minke whale would not forage for 24 hours after being disturbed
- The lack of density dependence in the model (meaning the population would not respond to any reduction in population size)

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[10] iPCoD version 5.2

- The level of environmental and demographic stochasticity in the model

300. The following sections explore the background to each of these factors to illustrate the level of conservatism in this modelling and provide critical context for the evaluation of these results.

7.2.1 Duration of disturbance

301. The iPCoD model for minke whale and bottlenose dolphin disturbance was last updated following the expert elicitation in 2013 (Harwood *et al.,* 2014). When this expert elicitation was conducted, the experts provided responses on the assumption that a disturbed individual would not forage for 24 hours. However, the most recent expert elicitation in 2018 highlighted that this was an unrealistic assumption for harbour porpoises (generally considered to be more responsive than minke whales and bottlenose dolphin) and was amended to assume that disturbance resulted in six hours of non-foraging time (Booth *et al*., 2019).

302. As minke whales and bottlenose dolphins were not included in the updated expert elicitation for disturbance, the iPCoD model still assumed 24 hours of non-foraging time for minke whales and bottlenose dolphin. Given the most recent understanding of marine mammal reactions to pile driving, this scenario appears unrealistic. A recent study estimated energetic costs associated with disturbance from sonar, where it was assumed that 1 hour of feeding cessation was classified as a mild response, 2 hours of feeding cessation was classified as a strong response and 8 hours of feeding cessation was classified as an extreme response (Czapanskiy *et al.,* 2021).

303. The presumption of a 24-hour feeding cessation for minke whale and bottlenose dolphin surpasses what has been typically deemed an extreme response. Hence, it has been regarded as unrealistic and likely to inflate the actual disturbance levels anticipated from the Project.

304. Despite these limitations and uncertainties, this assessment has been carried out according to best practice, using the best available scientific information, and the latest expert elicitation results from Sinclair *et al*. (2020). The information provided was therefore considered to be sufficient to carry out an adequate assessment for harbour porpoise, bottlenose dolphin, minke whale, grey seal, and harbour seal.

7.2.2 Lack of density dependence

305. Density dependence has been described as ‘the process whereby demographic rates change in response to changes in population density, resulting in an increase in the population growth rate when density decreases, and a decrease in that growth rate when density increases (Harwood *et al.*

2014). The iPCoD scenario run for bottlenose dolphin assumed no density dependence since there was insufficient data to parameterise this relationship. Essentially, this meant that there would be no ability for the modelled impacted population to increase in size and return to carrying capacity following disturbance.

306. At a recent expert elicitation on bottlenose dolphins, conducted for the purpose of modelling population impacts of the Deepwater Horizon oil spill (Schwacke *et al*. 2021), experts agreed that there would likely be a concave density dependence on fertility, which meant that, in reality, it would be expected that the impacted population would recover to carrying capacity (which was assumed to be equal to the size of unimpacted population – i.e. it was assumed the un-impacted population was at carrying capacity) rather than continuing at a stable trajectory that was smaller than that of the unimpacted population.

7.2.3 Environmental and demographic stochasticity

307. The iPCoD model attempts to model some of the sources of uncertainty inherent in the calculation of the potential effects of disturbance on marine mammal population. This includes demographic stochasticity and environmental variation. Environmental variation has been defined as *'the variation in demographic rates among years as a result of changes in environmental conditions'* (Harwood *et al*., 2014). Demographic stochasticity has been defined as *'variation among individuals in their realised vital rates as a result of random processes'* (Harwood *et al.,* 2014).

308. The iPCoD protocol describes this in further detail: 'Demographic stochasticity is caused by the fact that, even if survival and fertility rates were constant, the number of animals in a population that die and give birth will vary from year to year because of chance events. Demographic stochasticity has its greatest effect on the dynamics of relatively small populations, which has been incorporated into models for all situations where the estimated population within an MU was less than 3000 individuals. One consequence of demographic stochasticity was that two otherwise identical populations that experienced exactly the same sequence of environmental conditions would follow slightly different trajectories over time. As a result, it was possible for a "lucky" population that experienced disturbance effects to increase, whereas an identical undisturbed but "unlucky" population may decrease' (Harwood *et al.* 2014).

309. This was clearly evidenced in the outputs of iPCoD where the un-impacted (baseline) population size varied greatly between iterations, not as a result of disturbance but simply as a result of environmental and demographic stochasticity. In the example provided in **Plate 7.1**, after 25 years of

simulation, the un-impacted population size varied between 176 (lower 2.5%) and 418 (upper 97.5%). Thus, the change in population size resulting from the impact of disturbance was significantly smaller than that driven by the environmental and demographic stochasticity in the model.

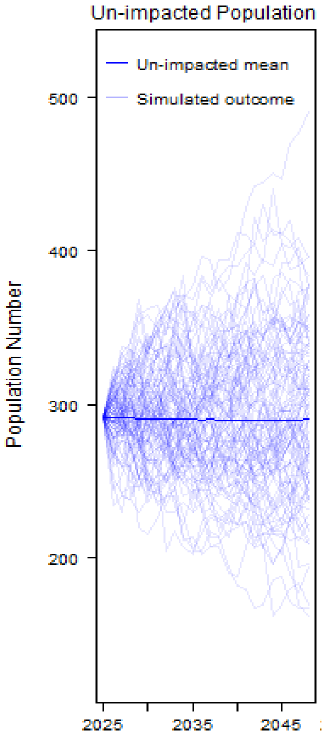

Plate 7.1 Simulated un-impacted (baseline) population size over the 25 years modelled

7.2.4 Summary

310. All of the precautions built into the iPCoD model mean that the results were considered to be highly precautionary. Despite the discussed limitations and uncertainties, this assessment has been carried out according to best practice, using the best available scientific information, and the latest expert elicitation results from Booth and Heinis (2018). The information provided was therefore considered to be sufficient to carry out an adequate assessment for bottlenose dolphin, harbour porpoise, harbour seal and grey seal. Results have also been presented for minke whale, noting the caveat above regarding no update to the expert elicitation for minke whale.

8 Review of potential disturbance from vessel activity

311. Noise levels reported by Malme *et al*. (1989) and Richardson *et al*. (1995) for transiting large surface vessels indicate that physiological damage to auditory sensitive marine mammals would be unlikely. The potential risk of PTS in marine mammals as a result of vessel noise is highly unlikely, as the sound levels would be well below the threshold for PTS (Southall *et al*., 2019b). In general, vessels generate noise in the low frequency range between 10-100 Hz (Erbe *et al*., 2019).

312. Vessel noise has been shown to affect the behaviour of marine mammals, where changes in vocalisation and behavioural state have been observed, in addition to displacement of animals from areas where ships were present.

313. The disturbance impact of displacement has been seen across a variety of marine mammal species. In a large-scale study of harbour porpoise density in UK waters, including the North Sea MU and the Irish Sea MU, increased vessel activity was associated with lower porpoise densities. However, in NW Scottish waters, shipping had little effect on the density of individuals (Heinänen and Skov, 2015). A similar trend was seen with a study of Indo-Pacific bottlenose dolphins, when analysing habitat occupancy along the coast of Western Australia, dolphin density was negatively affected by vessels at one site but had no significant impact at the other (Marley *et al*. 2017a). Displacement was also seen with harbour porpoise detections around a pile driving site, where detections declined several hours prior to the start of pile driving. The decline was assumed to be due to the increase in other construction related activities and vessel presence in advance of the actual pile driving (Brandt *et al*., 2018; Benhemma-Le Gall *et al*., 2020).

314. However, for harbour seals a recent UK telemetry study showed there was no evidence of reduced seal presence as a result of vessel traffic. This was despite distributional overlaps (overlaps were most frequently found within 50km of the coast) between seal and vessel presence and high cumulative sound levels (Jones *et al*., 2017). Another study of grey seal pup tracks in the Celtic Sea and adult grey seals in the English Channel found that no animals were exposed to cumulative shipping noise that exceeded thresholds for TTS (using the Southall *et al.,* 2019b thresholds) (Trigg *et al*., 2020). A study of grey seal pupping beaches around Ramsey Island in Pembrokeshire found that disturbance occurred when vessels were closer than 150m to seal locations (Strong and Morris, 2010). Reduced presence of common dolphins was seen with the construction of a pipeline in NW Ireland due to vessel presence, however patterns suggested disturbance impacts were only short term (Culloch *et al.,* 2016).

315. As well as the potential to have displacement effects, vessel activity has also been shown to elicit other potential behavioural changes. One study between 2012 - 2016 tagged seven harbour porpoises in a region of high shipping density in the inner Danish waters and Belt seas. The tagging of individuals provided data on responses to stressors in the marine environment. High noise levels coincided with erratic behaviour including ‘vigorous fluking’, bottom diving, interrupted foraging, and the cessation of vocalisations. Four out of six of the animals that were exposed to noise levels above 96dB re 1μPa (16kHz third octave levels) produced significantly fewer buzzes at high volumes of vessel noise. In one case, the proximity of a single vessel resulted in a 15 minute cessation in foraging (Wisniewska *et al*., 2018). Studies for bottlenose dolphin have indicated vessel presence has the potential to increase swimming speeds and reduce the time spent for foraging, resting and socialising (Marley *et al*., 2017b; Piwetz 2019). Behavioural changes associated with disturbance have also been seen in common dolphins, due to the presence of vessels. Foraging and resting activity was significantly disrupted by vessel activity and returns to foraging activity took significantly longer than returns to other states (Stockin *et al*., 2008, Meissner *et al*., 2015). Behavioural changes have also been seen in minke whale with vessel interactions including a decrease in foraging activity, increase in swim speeds and energy expenditure (Christiansen *et al*., 2014).

316. Evidence suggests marine mammal species respond to vessel presence in a variety of ways, but all have the potential to be disturbed either through displacement, behavioural changes or both. Responses depended on a range of environmental factors but also the type and size of vessels. Some of the studies mentioned above based findings on fast moving vessels and vessels seeking close proximity to species, such as fast ferries and whale watching vessels (Wisniewska *et al*., 2018; Christiansen *et al*., 2014). Therefore, less of a disturbance effect is likely for the proposed construction vessels which would be slow moving or stationary.

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