Morven North Offshore Wind Array Project

Environmental Impact Assessment Report

Volume 3, Annex 10.1: Marine Mammals Shared Baseline Technical Report

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1 Introduction

1.1.1.1 The Morven North Offshore Wind Array Project (hereafter "Morven North") and the Morven South Offshore Wind Array Project (hereafter "Morven South") are both located within the Morven Option Lease Agreement Site (hereafter "Morven Site") in Scottish offshore waters (Figure 1.1). Morven North is located approximately 61.2km from the Aberdeenshire coast (at its closest point) and Morven South is located approximately 86.1km from the Aberdeenshire coast (at its closest point). Each project will comprise wind turbines, Offshore Substation Platforms (OSPs), associated foundations, inter-array and interconnector cables and offshore infrastructure. Consent for the offshore export cables of Morven North and Morven South will be consented separately.

1.1.1.2 As shown in Figure 1.1, Morven North is situated northwest of Morven South and directly adjacent. The external boundaries of the Morven North and Morven South correspond with the boundaries of the Morven Site.

1.1.1.3 This Morven North and Morven South Marine Mammal Shared Technical Report (hereafter referred to as the Marine Mammal Shared Technical Report) presents the baseline characterisation of marine mammals for both Morven North and Morven South.

1.1.1.4 Consent for Morven North and Morven South will be sought separately, supported by a separate Environmental Impact Assessment (EIA) and Habitats Regulations Appraisal (HRA) for each project. However, the survey campaign and/or desk-based studies that support the impact assessments for Morven North and Morven South are based on the Morven Site, which accommodates both Morven North and Morven South. Given the proximity of these two projects there is a level of comparability and consistency of information as reported in the present Marine Mammal Shared Technical Report. Where possible, information pertaining to Morven North and Morven South has also been presented separately for each project to characterise the marine mammal ecological baseline as accurately as possible.

1.1.1.5 The information from this Marine Mammal Shared Technical Report provides the technical baseline to inform the assessment of the likely significant effects of Morven North and Morven South on marine mammals. This report accompanies the EIA provided in Volume 2, Chapter 10: Marine Mammals of the respective Morven North EIA Report and Morven South EIA Report, the Morven North Report to Inform Appropriate Assessment and the Morven South Report to Inform Appropriate Assessment, to support the respective consent applications.

1.1.1.6 Data were collated through a detailed desktop study of the existing resources available for marine mammals within the Morven North and Morven South Regional Marine Mammal Study Area (hereafter "Morven Regional Marine Mammal Study Area"), incorporating data from third party organisations, to gain a historical perspective. The data from 33 months of site specific aerial surveys (January 2021 to September 2023, inclusive) was investigated to inform the baseline characterisation. Additionally, Sea Mammal Research Unit (SMRU) Consulting provided telemetry maps and haul-out counts for harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus* and these have been used to inform baseline characterisation (Stevens, 2023).

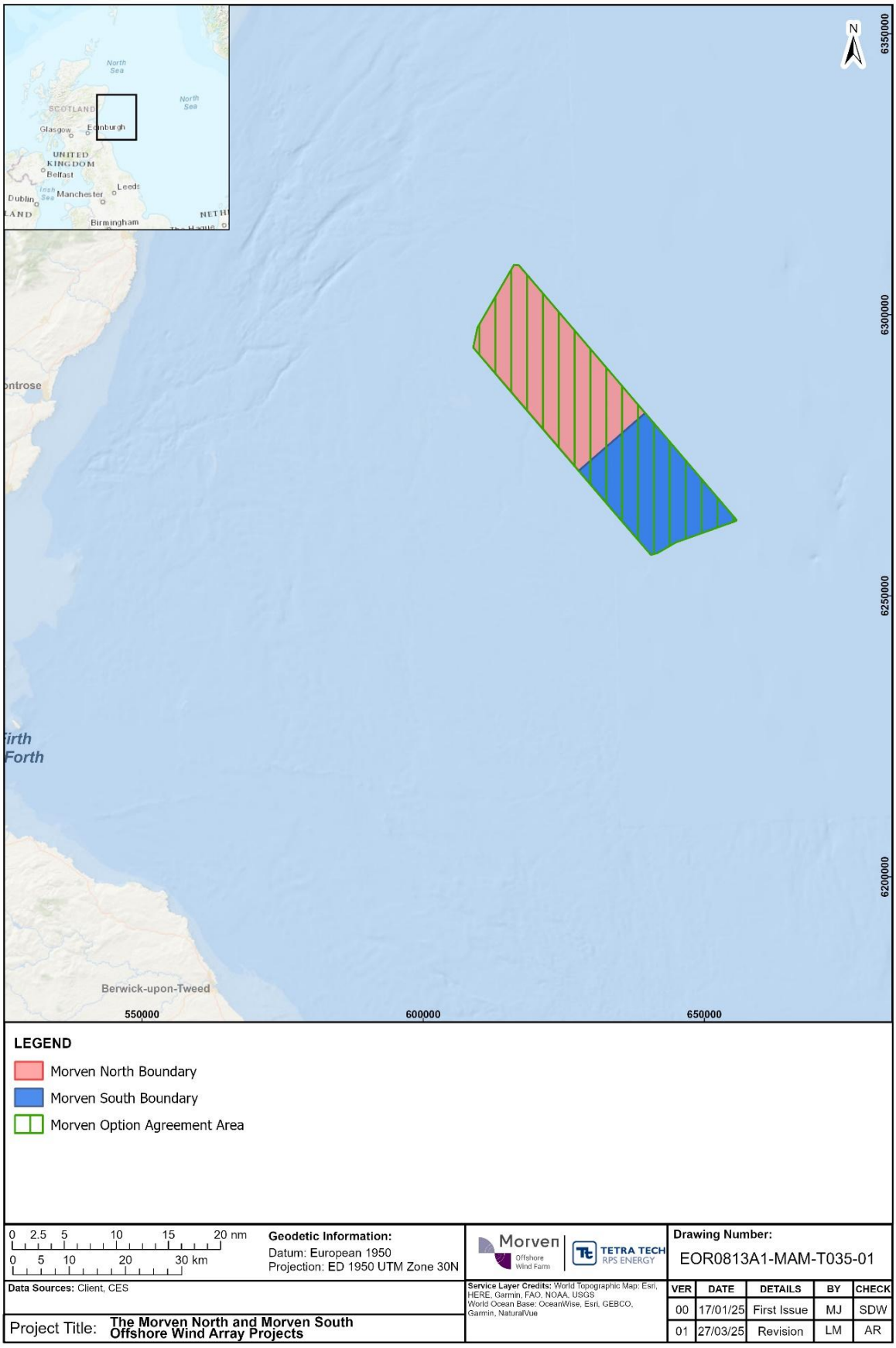

Figure 1.1: The boundaries of Morven North and Morven South within the Morven Site

1.2 Study Areas

1.2.1.1 Four study areas are defined for marine mammals:

- the Morven North Marine Mammal Study Area;
- the Morven South Marine Mammal Study Area;
- the Morven Site Marine Mammal Study Area; and
- the Morven North and South Regional Marine Mammal Study Area.

1.2.1.2 The study areas defined for marine mammals are shown in Figure 1.2 and defined as follows:

- The **Morven North Marine Mammal Study Area** includes the Morven North Boundary, plus a buffer extending 4km from the Morven North Boundary.
- The **Morven South Marine Mammal Study Area** includes the Morven South Boundary, plus a buffer extending 4km from the Morven South Boundary.
- The **Morven Site Marine Mammal Study Area** includes the Morven Site plus a buffer extending 4km from this boundary). This area was covered by site specific digital aerial surveys (DAS) carried out between January 2021 and September 2023.
- The **Morven North and Morven South Regional Marine Mammal Study Area** encompasses wider northern North Sea geographic region to account for the highly mobile nature of marine mammals, which are able to range over large distances. The Morven North and Morven South Regional Marine Mammal Study Area has informed the screening of internationally designated sites and is also the area within which projects considered for cumulative effects/in-combination assessment have been identified.

1.2.1.3 The study areas for marine mammals for the Morven Site (i.e. the Morven Site Marine Mammal Study Area and the Morven Regional Marine Mammal Study Area) were presented to and agreed during the scoping process for the Morven Site.

1.2.1.4 The underlying principles used to define the study area(s) for Morven North and Morven South have not changed, other than the limits (i.e. a 4km buffer) have been applied relative to each Project, rather than the Morven Site. The Morven North Marine Mammal Study Area and Morven South Marine Mammal Study Area were presented to the Marine Directorate Licensing Operations Team (MD-LOT) via a “Targeted Consultation Exercise” undertaken in Quarter 1, 2025.

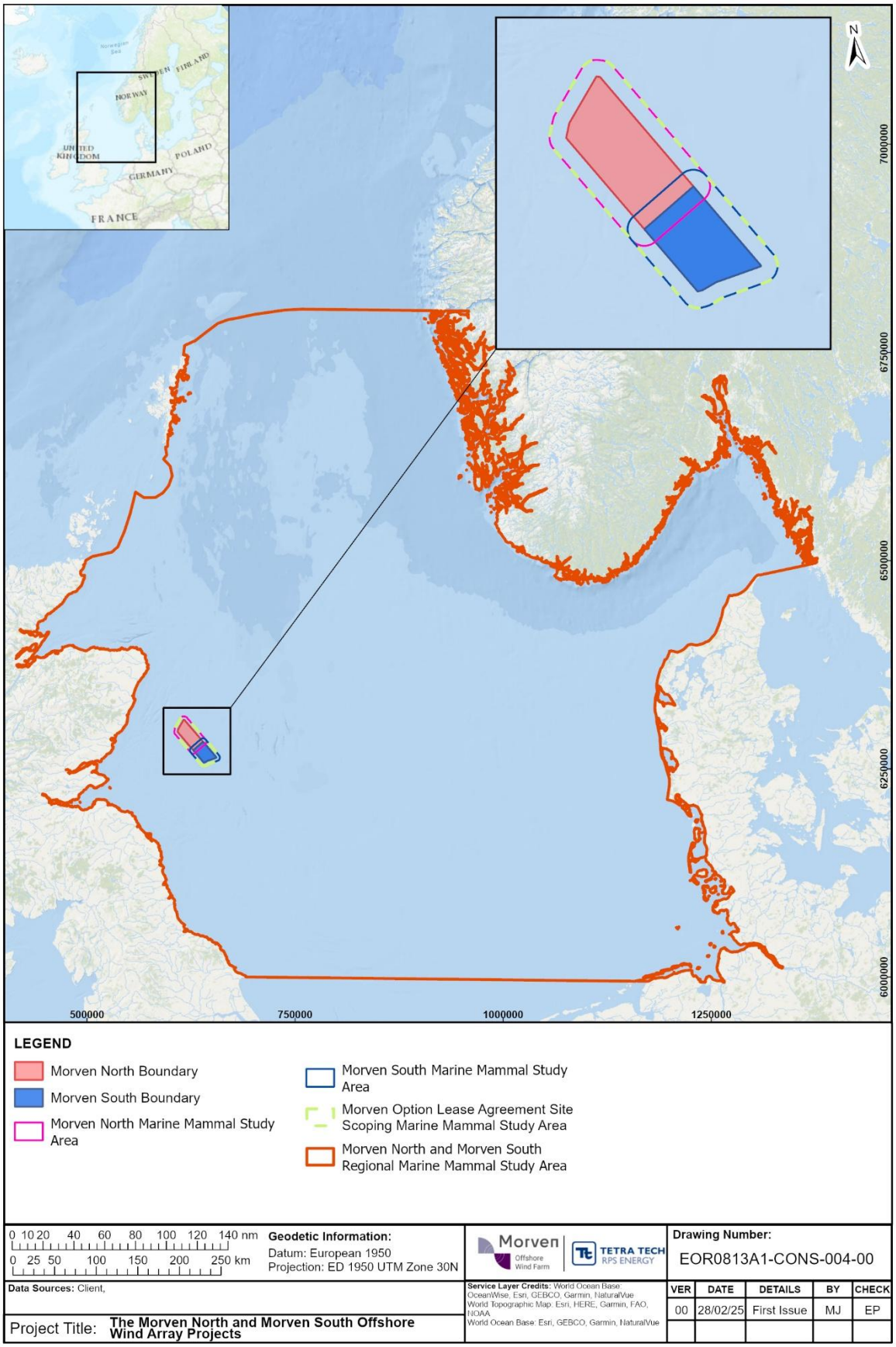

Figure 1.2: Morven North and Morven South Marine Mammal Study Areas and the Morven North and Morven South Regional Marine Mammal Study Area

2 Methodology

2.1 Desktop Study

2.1.1 Regional Data Sources

2.1.1.1 Information on marine mammals within the Morven Regional Marine Mammal Study Area was collected through a detailed desktop review of existing studies and datasets, listed in Table 2.1.

Table 2.1: Key sources of information for the marine mammal baseline characterisation

Title	Survey/Date Years	Author
Updated habitat-based at sea distribution maps for harbour and grey seals in Scotland	2022 GPS tracking dataset (nine grey seals and 26 harbour seals)	Carter *et al.* (2025)
Spatial models of cetacean density in European Atlantic waters based on SCANS-IV summer 2022 survey data.	2022	Gilles *et al.* (2025)
Estimates of cetacean abundance in European Atlantic waters from the SCANS-IV aerial and shipboard surveys	2022	Gilles *et al.* (2023)
Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management	2005 to 2019 GPS tracking dataset (114 grey seals and 239 harbour seals)	Carter *et al.* (2022)
Regional Baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters	2020 report on Management Units (MUs) for marine mammals	Hague *et al.* (2020)
Seal haul-out counts	1996 to 2021	Stevens (2023)
Bottlenose dolphin Photo-Identification (ID) surveys and Special Areas of Conservation (SAC) site condition monitoring	2009 to 2019	Arso Civil *et al.* (2019)
		Cheney *et al.* (2018)
		Quick *et al.* (2014)
		Cheney *et al.* (2013)
Distribution maps of cetacean and seabird populations in the North East Atlantic	1980 to 2018	Waggitt *et al.* (2020)
Seal telemetry data	1990 to 2018	Stevens (2023)
Estimates of cetacean abundance in European Atlantic waters from the SCANS-III aerial and shipboard surveys	2016	Hammond *et al.* (2021)
Modelled density surfaces of cetaceans in European Atlantic waters in summer 2016 from the	2016	Lacey *et al.* (2022)

Title	Survey/Date Years	Author
SCANS-III aerial and shipboard surveys		
Forth and Tay Offshore Wind Developers Group (FTOWDG) cetacean survey data analysis report	2009 to 2011	Mackenzie *et al.* (2012)
Joint Nature Conservation Committee (JNCC) Report 544: The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area	1994 to 2011	Heinänen and Skov (2015)
Analysis of The Crown Estate (TCE) aerial survey data for marine mammals for the FTOWDG	2009 to 2010	Grellier and Lacey (2011)
Cetacean Baseline Characterisation for the Firth of Tay: Bottlenose dolphins	Photo-ID: 2009 and 2010 PAM: 2006 to 2009	Quick and Cheney (2011)
Joint Cetacean Protocol Phase III	1994 to 2010	Paxton *et al.* (2016)

2.1.2 Site Specific Surveys

2.1.2.1 A summary of the site specific surveys undertaken to inform the marine mammal assessment for Morven North and Morven South is outlined in Table 2.2 and is presented in more detail in Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report.

2.1.2.2 The DAS campaign for Morven North and Morven South commenced in January 2021 and survey flights were undertaken monthly, with a total of 33 months of data collected, up to and including September 2023. As described in Section 1 the study area for the DAS campaign was delineated as the boundary of the Morven Site plus a 4km buffer and is hereafter referred to as the "Morven Site Marine Mammal Study Area".

2.1.2.3 The surveys were conducted by APEM Limited (hereafter "APEM") following a grid-based survey design across 30 transects, spaced 2km apart (Figure 2.1). Data were collected at a flight altitude of approximately 400m, and a flight speed of approximately 120kn. Digital still images were collected covering at least 32.5% of the sea surface within the Morven Site Marine Mammal Study Area, with at least 11.75% of these images analysed.

Table 2.2: Summary of surveys undertaken across the Morven Site Marine Mammal Study Area

Title	Extent of Survey	Overview of Survey	Survey Contractor	Date	Reference to Further Information
DAS	Morven Site plus 4km buffer.	Digital aerial survey.	APEM Ltd.	January 2021 to September 2023	Volume 3, Annex 10.3.

2.1.2.4 As described in paragraph 1.1.1.4, and given that the Morven North Marine Mammal Study Area is directly adjacent to the Morven South Marine Mammal Study Area, there is a level of comparability and consistency of information between the two Projects.

2.1.2.5 Although the spatial scale over which marine mammal populations occur is substantially greater than the boundaries for the two projects, the analysis of site specific surveys presented in this Marine Mammal Shared Technical Report summarises the results of design-based analysis of DAS data for the Morven Site Marine Mammal Study Area, Morven North Marine Mammal Study Area and the Morven South Marine Mammal Study Area. However, the sample size available from the 33 months of DAS observations was not sufficient to allow modelling for the separate North and South study areas, so model-based analysis has been conducted only for the combined Morven Site Marine Mammal Study Area.

2.1.2.6 Dividing the year into two “bio-seasons” was considered to be the most pragmatic way to summarise density estimates in the context of broad-scale seasonal patterns in the spatial distribution of some species. For harbour porpoise bio-seasons were based upon the “summer” (April to September) and “winter” (October to March) divisions described by Heinänen and Skov (2015). For grey seal bio-seasons were defined as ‘breeding’ (August to December) and “non-breeding” (January to July), based upon the timing of this species’ reproductive cycle in this region (SCOS, 2019, Marine Scotland, 2020).

2.1.2.7 A full breakdown of these analyses is presented in Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report.

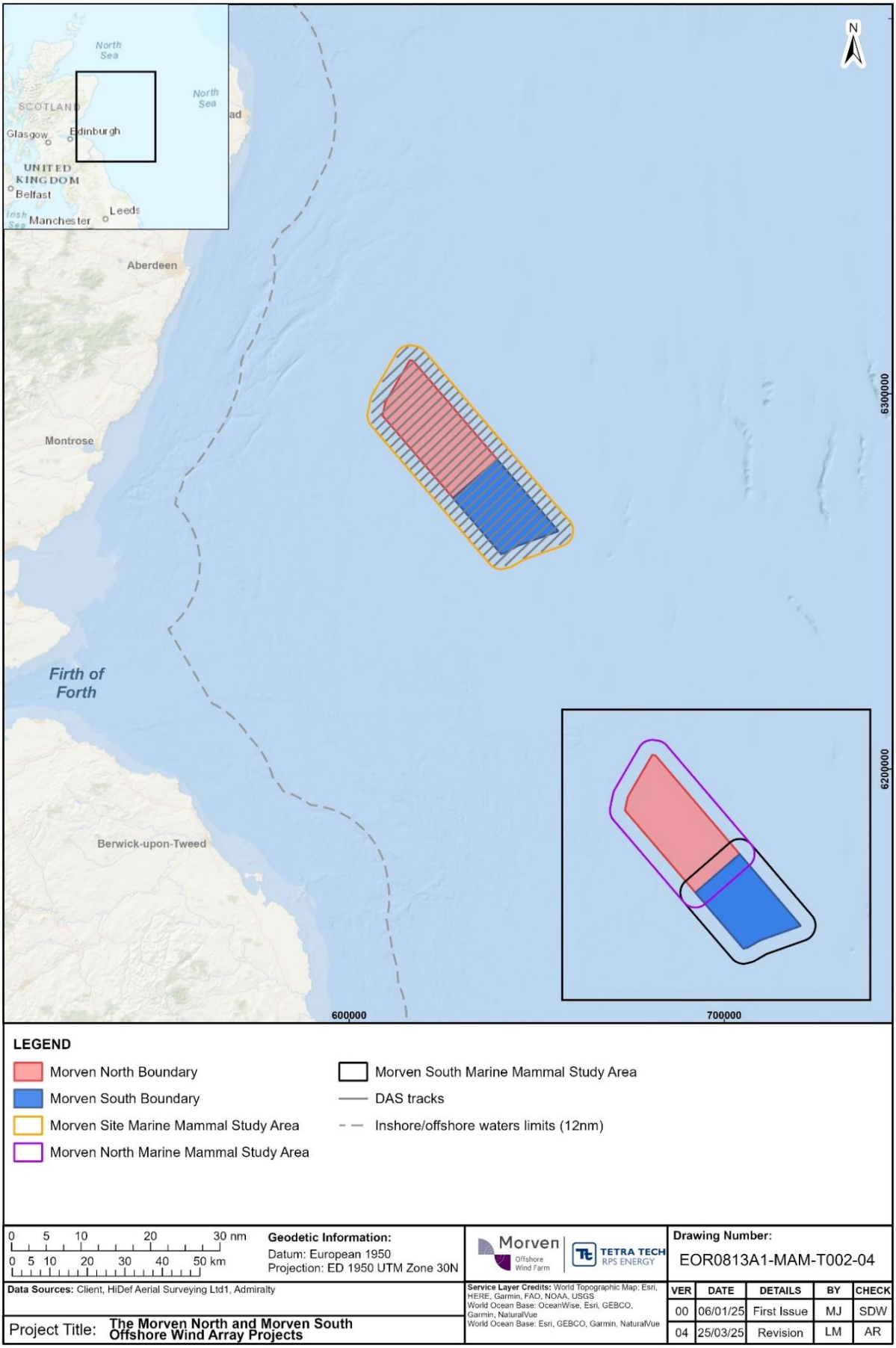

Figure 2.1: Digital Aerial Survey Transects flown over the Morven Site Marine Mammal Study Area

2.1.3 Historical Surveys

2.1.3.1 Historically, surveys have been carried out within inshore and offshore waters near to Morven North and Morven South (Table 2.3). While most of these surveys do not overlap with the Morven North and Morven South (and in some cases the data is relatively old: up to 16 years), these data provide a useful context for the wider distribution of marine mammals in the North Sea.

Table 2.3: Summary of surveys undertaken in the vicinity of the Morven North and Morven South

Survey	Extent of Survey	Overview of Survey type	Survey Contractor	Date	Reference to Further Information
The Crown Estate (TCE) Aerial Survey	Firth of Forth and Tay, Scottish Territorial Waters	DAS	WWT Consulting	May 2009 to March 2010	Grellier and Lacey (2011) MacLeod and Sparling (2011)
Neart na Gaoithe Boat-Based Surveys	Neart na Gaoithe Array area plus 8km buffer	Visual boat-based survey	Natural Research (Projects) Ltd, Cork Ecology and Bureau Waardenburg	November 2009 to October 2011	(Mainstream Renewable Power Limited, 2012)
Seagreen boat-based Surveys	Firth of Forth Round 3 Zone	Visual boat-based survey	ECON Energy	May 2010 to November 2011	Sparling (2012)
Seagreen Bird Surveys	Firth of Forth Round 3 Zone plus 2km buffer	Visual boat-based survey	ECON Energy	May 2017 to August 2017	Seagreen Wind Energy Limited (2018)
Berwick Bank Aerial Surveys	Berwick Bank Array area plus ~16km buffer	DAS	HiDef	March 2019 to April 2021	SSE Renewables (2022a)
Ossian Array Aerial Surveys	Ossian Array are plus ~8km buffer	DAS	HiDef	March 2021 to February 2023	(Ossian OWFL, 2024)
SSE Regional Survey	E1 and E2 Offshore Wind Plan Options 2020 plus ~12km buffer	DAS	HiDef	April 2022 to August 2023	(HiDef, 2023)

TCE aerial surveys

2.1.3.2 A series of visual aerial surveys of offshore wind farm sites were commissioned between 2009 and 2010 by TCE (these surveys are hereinafter referred to as "TCE aerial surveys"). Surveys were carried out during 24 days between May and August 2009 (summer) and November 2009 and March 2010 (winter) (Grellier and Lacey, 2011). The transect design of these visual aerial surveys of Scottish territorial waters was based on parallel lines of equal spacing (the precise distance is not reported) in both inshore (up to 12nm) and offshore (greater than 12nm) areas (Grellier and Lacey, 2011,

MacLeod and Sparling, 2011). Between five and 48 sections of transects were flown in any one survey day and observed track length varied from 341km to 1,116km (Figure 2.2).

Neart na Gaoithe boat-based Surveys

2.1.3.3 Visual boat-based surveys for marine mammals and seabirds were carried out between November 2009 and October 2011 by Natural Research (Projects) Ltd, Cork Ecology and Bureau Waardenburg. The surveys encompassed the Neart na Gaoithe Array area plus an 8km buffer, located approximately 15km off Fife Ness (Figure 4.2). Surveys were conducted across 32 days between November 2009 and October 2010 and 28 days between December 2010 and October 2011 (no survey was conducted in November 2010), following transect lines distributed 2km apart and running in a northwest to southeast direction. Over the 23 surveys, a total of 7,164.2km of survey effort was conducted (Mainstream Renewable Power Limited, 2012).

Seagreen boat-based surveys

2.1.3.4 The visual boat-based surveys for marine mammals and seabirds were commissioned by Seagreen Wind Energy Limited and were carried out by ECON Energy between May 2010 and November 2011. The surveys encompassed the Firth of Forth Round 3 Zone, which is approximately 2,850km2 and approximately 25km offshore of the Firth of Forth (Figure 2.2). The monthly surveys followed transect lines distributed 3.7km apart across four different routes (east, west, north and south), spaced at 300m from each other (Sparling, 2012). Over the 19 surveys, a total of 17,017km of survey effort was conducted (Sparling, 2012).

Seagreen ornithology surveys

2.1.3.5 Incidental recordings of marine mammals were recorded during visual, boat-based ornithology surveys undertaken for what was previously known as the Seagreen Alpha/Bravo Project area (and known since 2018 as "Seagreen"). Surveys were conducted in summer 2017 (May to August inclusive) with sea state ranging between one and four on the Douglas Sea scale, resulting in excellent to average conditions for sighting marine mammals. A summary of the marine mammal incidental sightings was reported in the Seagreen Marine Mammal Baseline Technical Report (Seagreen Wind Energy Limited, 2018).

Berwick Bank aerial surveys

2.1.3.6 DAS of seabirds and marine mammals were commissioned by Berwick Bank Wind Farm Limited to inform the ecological baseline for the Berwick Bank Offshore Wind Farm. Surveys encompassed the Berwick Bank Array area plus 16km buffer (Figure 2.2), covering a total area of 4,980km^2 through 37 transects spaced 2km apart. Transects were surveyed to cover a total length of approximately 2,490km each month, and data from two cameras (0.25km combined width) were subsampled to provide a minimum target of 10.0% coverage of the total survey area. Surveys commenced in March 2019 and continued monthly up to and including April 2021 with an additional survey undertaken in May 2020 and April 2021.

Ossian Array aerial surveys

2.1.3.7 DAS of seabirds and marine mammals were commissioned by SSE Renewables to inform the ecological baseline for the Ossian Offshore Wind Farm Project. Surveys encompassed the Ossian Array area plus an 8km buffer (Figure 2.2), covering a total area of 2,264km^2 through 31 transects spaced 2.5km apart. Transects were surveyed to cover a total length of approximately 905km each month, and data from four cameras (0.5km combined width) were subsampled to provide a minimum target of 10% coverage of the total survey area. Surveys commenced in March 2021 and continued monthly, for 24 months, up to and including February 2023.

SSE Regional survey

2.1.3.8 DAS of seabirds and marine mammals were commissioned by the E1 and E2 area developers including MvOWL, to inform the ecological baseline for the region. The region encompasses the E1 and E2 Offshore Wind Plan Options 2020 (Scottish Government, 2020), approximately 45km east of the Aberdeenshire coast, The survey area covered by DAS flights comprised the E1 and E2 boundaries plus a 12km buffer (Figure 2.2), covering a total area of 11,553km^2 through 30 transects spaced 5km apart. Transects were surveyed to cover a total length of approximately 2,308km each month, and data from four cameras (0.5km combined width) were subsampled to provide a minimum target of 5% coverage of the total survey area. Surveys commenced in April 2022 and continued for 18 months, up to and including August 2023. All marine mammal observations were recorded however, design-based analysis and density and abundance estimates were calculated only for harbour porpoise.

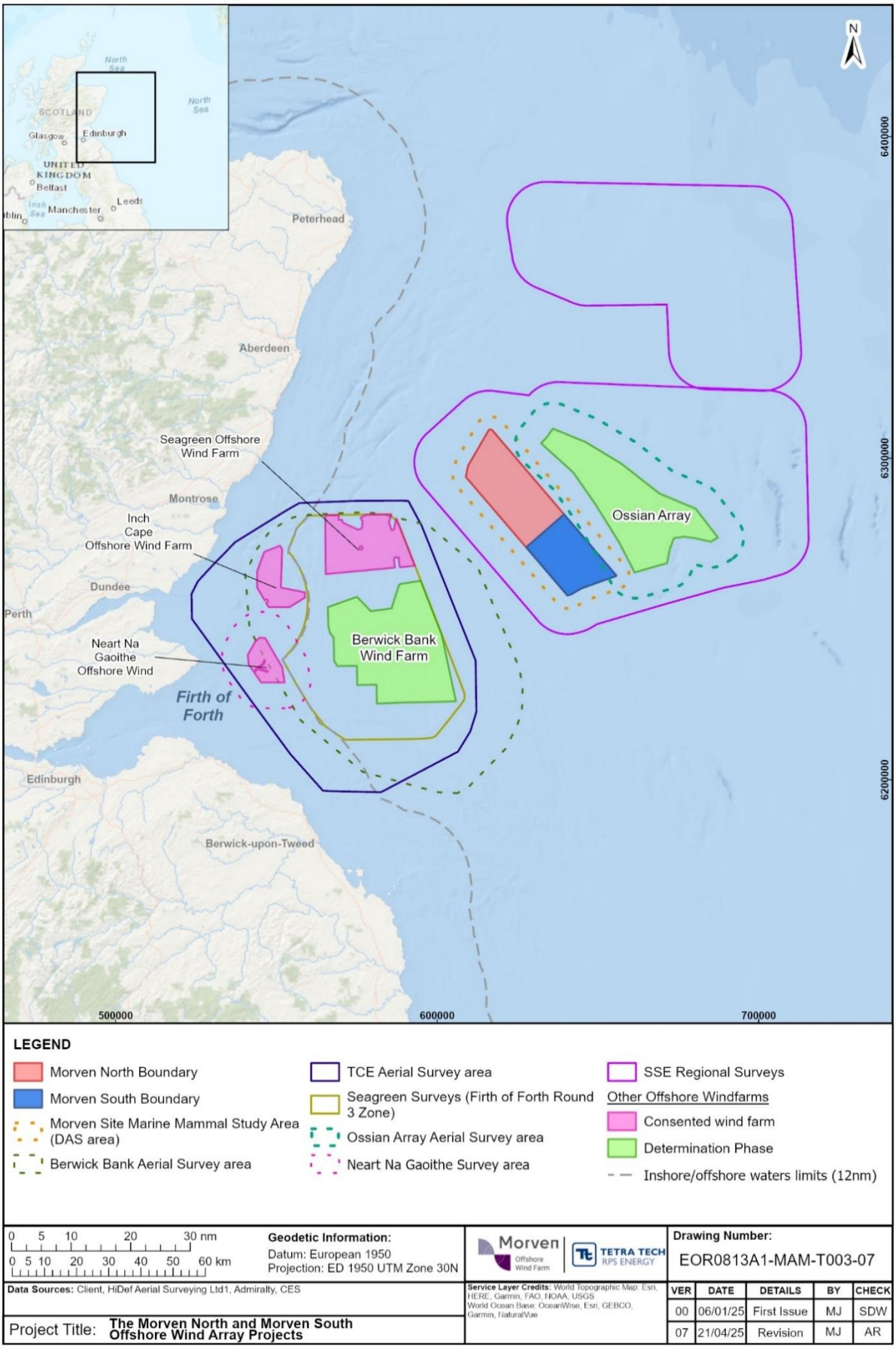

Figure 2.2: Surveys conducted in the vicinity of Morven North and Morven South

2.2 Assumptions and Limitations

2.2.1 Marine mammal observers

2.2.1.1 Boat-based surveys rely on marine mammal observers to record the number of marine mammals and accurately identify the individuals to species level. Ideally, a survey team, following a standard distance sampling approach, should consist of three people – one to monitor the track line, the second to monitor over distance and the third to write down sightings. The team is usually rotated to reduce the possibility of observer fatigue. The Seagreen boat-based survey adopted the use of only a single marine mammal observer which they noted may have resulted in under-recording (Sparling, 2012).

2.2.1.2 There is less potential for under-recording during aerial surveys, e.g. DAS, as all observations within the transect strip length are recorded and can be investigated during the analysis of data.

2.2.2 Weather conditions

2.2.2.1 Boat-based surveys are often carried out to collect bird and marine mammal data simultaneously. However, seabird surveys can be carried out in Douglas Sea states of up to four, while marine mammals are surveyed only in Douglas Sea states of up to three. If bird surveys were carried out simultaneously, as in the case of the Seagreen boat-based surveys (Sparling, 2012), there is a risk that encounter rates may be biased downwards if portions of the survey were carried out in sea states above three. Harbour porpoise in particular are difficult to record and sea states of up to two are often recommended.

2.2.2.2 Compared to boat-based surveys, sea state is less problematic for aerial surveys, e.g. DAS, as surveys can effectively be carried out in Douglas Sea states of up to four for both marine mammals and birds.

2.2.3 Delayed surveys

2.2.3.1 Logistical issues and/or downtime due to unsuitable weather conditions can prevent DAS flights from being conducted. However, no flights in the Morven Site Marine Mammal Study Area DAS campaign were delayed, and all surveys occurred during the month for which they were planned.

2.2.4 Bias in data

2.2.4.1 Marine mammals spend most of the time underwater and may therefore be unavailable for detection at the surface. Underestimating counts due to imperfect detection is known as “availability bias”, and this can be corrected for using species-specific correction factors. The correction factor used is based on an estimate of the probability that an animal is at the surface at any random point in time. The value is then used to estimate the total number of animals that may be present within the survey area, by accounting for the number of animals estimated to be below the surface and not visible for detection. In the case of DAS, animals may be available for detection if they are just below the surface, but the depth at which animals may be detected is dependent upon water clarity.

2.2.4.2 If a group of animals on the transect line is at the surface, they may not be detected due to various factors such as observation conditions or observer fatigue, known as “perception bias”. Given that some marine mammal species are known to actively avoid vessels of any kind, either by moving away or by diving, unquantifiable bias may be introduced into the data collected during boat-based surveys (Palka and Hammond, 2001). Perception bias is less of a limiting factor for aerial surveys since highdefinition video or still imagery captures all animals on the surface and their detection is less influenced by the ability of an observer to detect an animal. For both boat-based and aerial surveys it may be difficult to record wide-ranging or cryptic species when making snapshot counts.

2.2.4.3 Data from historic surveys, as well as site specific DAS, provide a count for the relative numbers of each species (or species group) within transects. This is estimated as the number of animals

identified, adjusted for survey effort, and when calculated across the relevant survey area, can provide a relative density. However, estimates of relative count or density do not allow for estimations of availability bias. Therefore, published correction factors, where considered to be appropriate, are applied to data to correct for bias in data to approximate absolute numbers. Correction factors applied to the site specific DAS data in this Shared Technical Report are described in more detail in Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report.

2.2.5 Species Identification

2.2.5.1 Regardless of the type of survey, the identification of marine mammals to species level can be challenging, especially when an individual is submerged. In aerial shots collected during aerial surveys, only part of the animal is above the surface and on some occasions, it is not possible to distinguish between species. In the processing of aerial survey data from DAS, marine mammals identified in the images are categorised to the lowest taxonomic level possible and a comprehensive internal Quality Assurance (QA) process is conducted. Where a marine mammal sighting cannot be identified to species level with high confidence, sightings are given in their own non-species-specific categories (e.g. “Dolphin/Porpoise”, “Dolphin species”, “Seal species”, “Whale species” and “Marine mammal species”).

2.2.5.2 In line with the Scoping Opinion (MD-LOT, 2023) and in order to ensure that bias is not introduced to the DAS modelling results, data from broader non-species-specific classifications will not be assigned to species categories. As such, sightings classed as “Dolphin/Porpoise”, “Dolphin species”, “Seal species”, “Whale species” and “Marine Mammal species” were not considered in species-specific density/abundance analyses, however, these data were presented as summary statistics (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report).

Survey Timings

2.2.5.3 Two of the historic survey campaigns, namely TCE aerial surveys and Seagreen boat-based surveys, took place between 2009 and 2011 (refer to Section 2.1.3 for more details). These data is now more than 10 years old, and it is possible for changes in the distribution and abundance of marine mammals in the wider Firth of Forth and Tay to have occurred. The most recent historic surveys (for Berwick Bank Offshore Wind Farm) were conducted between March 2019 and April 2021 (Table 2.3).

2.2.5.4 The site specific DAS for the Morven Site Marine Mammal Study Area have been conducted monthly between January 2021 and September 2023. Data collected represent a snapshot over a single survey day on each month. This is a standard survey method applied for marine mammal data collection to inform the baseline for offshore wind developments. The differences in sighting rates between months may be due to seasonal changes and it may be possible to investigate seasonality of sightings based on aerial survey data. The environmental conditions also have the potential to influence these results, however data collected over a short time frame (one day) does not allow this to be explored further.

2.3 Studies and Data

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

2.3.1.1 The first SCANS surveys were conducted in summer 1994 to provide estimates of abundance and density of small cetaceans in the North Sea and European Atlantic continental shelf waters. The SCANS-II surveys were completed in July 2005 and SCANS-III in July 2016. All surveys comprised a combination of vessel and aerial surveys. Both aerial and boat-based survey methodologies were designed to correct for availability and detection bias and to allow the estimation of absolute abundance. The results of the SCANS-III surveys were published in the Hammond *et al.* (2017) report, which was subsequently revised following the discovery of some analytical errors Hammond *et al.* (2021). SCANS-IV commenced at the end of June 2022, with the report published in September 2023 (Gilles *et al.*, 2023).

2.3.1.2 The Morven Site Marine Mammal Study Area is located within SCANS-IV Survey Block NS-D, which corresponds spatially with SCANS-III Survey Block R (Figure 2.3). Since the survey blocks used in the SCANS-III and SCANS-IV surveys coincide, some comparison of abundance and density estimates between these surveys is possible. For instance, a lack of sightings of some species in one survey campaign could be supplemented by sightings in another (e.g. bottlenose dolphin was not present in SCANS-IV Block NS-D but were present in SCANS-III Block R). However, it is important to note that although these survey blocks coincide, the environmental and biological drivers of marine mammal distribution may not coincide between surveys, and as such direct comparisons are not possible.

2.3.1.3 The winter SCANS surveys were undertaken in the southern North Sea from January 2024 to March 2024 (Ramirez-Martinez *et al.*, 2025), as a temporal extension to the SCANS-IV surveys, and to explore the feasibility of undertaking similar surveys during the winter. Although the spatial coverage of the surveys does not match the full extent of the SCANS-IV surveys (Gilles *et al.*, 2023), the winter SCANS surveys do include Block NS-D, which aligns with the corresponding Survey Block in SCANS-IV. It is also important to note that winter SCANS only presents density estimates for harbour porpoise and white-beaked dolphin.

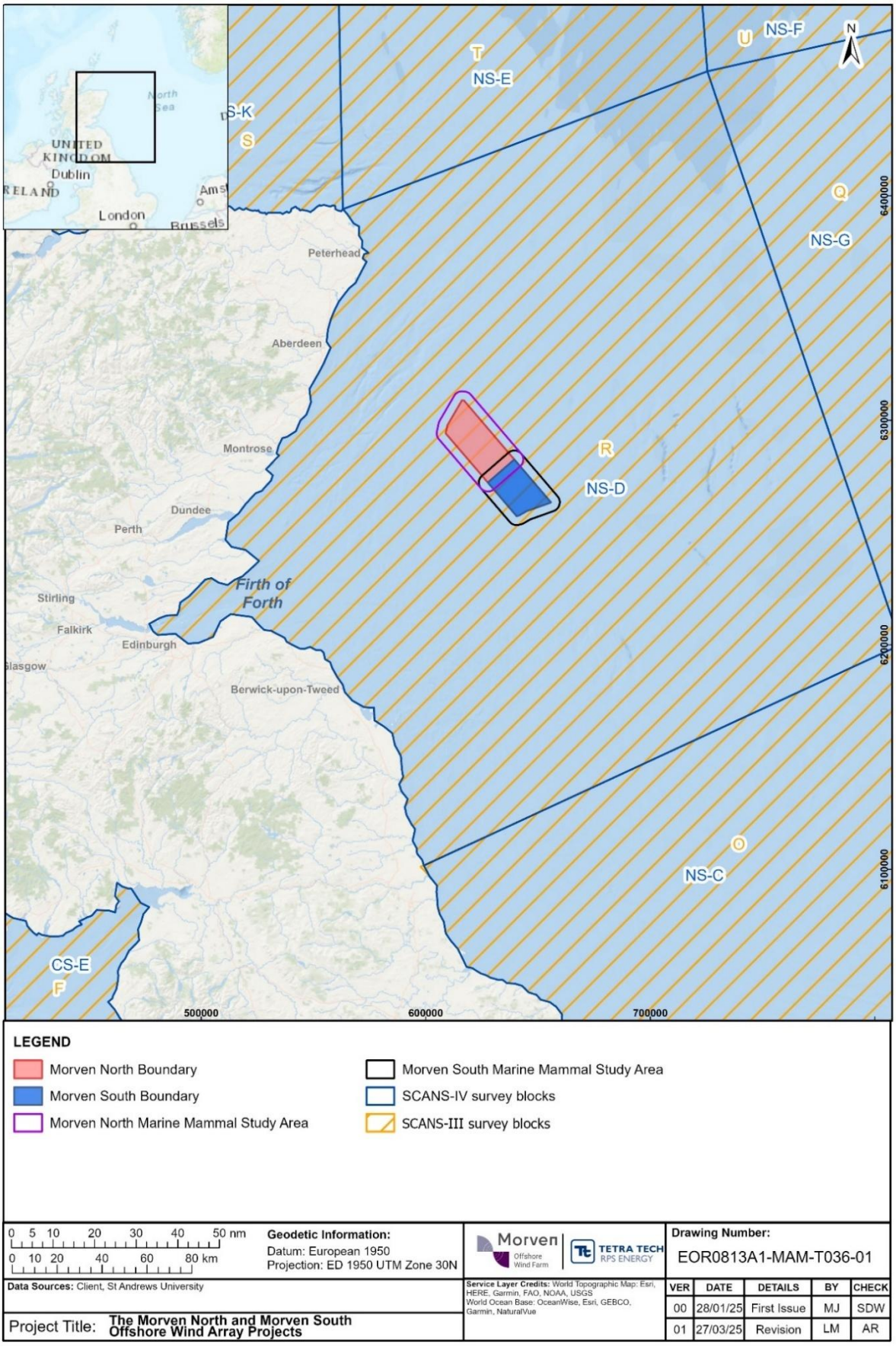

Figure 2.3: SCANS-III and SCANS-IV Survey Blocks in relation to Morven North and Morven South Marine Mammal Study Areas

2.3.2 SCANS Density Surfaces (Gilles *et al.*, 2025)

2.3.2.1 SCANS-IV data were used by Gilles *et al.* (2025) to provide information on summer distribution of recorded species by modelling the data in relation to spatially linked environmental features to generate density surface maps.

2.3.2.2 Gilles *et al.* (2025) presents density surface modelling for harbour porpoise, bottlenose dolphin, short-beaked common dolphin *Delphinus delphis* and minke whale. Density surface 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 (i.e. the difference between recorded sea level and mean sea level) and sea surface temperature. Consecutive records made along the aerial survey transects were combined into 10km segments of search effort to allow density estimates to be predicted to a spatial grid of 10km x 10km resolution.

2.3.2.3 Analyses was undertaken to produce predictions of surface density and associated coefficients of variation (CV) for each species for SCANS-IV, 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 (Gilles *et al.*, 2025). To note, the density surfaces were for summer distributions only, as this is when SCANS-IV was carried out. The figures allow density surfaces to be overlaid with the Morven Site Marine Mammal Study Area for mean density outputs and are discussed in Section 5 for relevant species.

2.3.3 Distribution Maps of Cetacean Populations (Waggitt *et al.*, 2020)

2.3.3.1 Waggitt *et al.* (2020) produced distribution maps of cetacean and seabird populations in the North East 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 North East Atlantic at 10km resolution.

2.3.4 Joint Cetacean Protocol (JCP) Phase III Analysis

2.3.4.1 The JCP Phase III analysis combined datasets from 38 sources, collected from boat-based and aerial platforms between 1994 and 2010. The total survey effort of over 1.05 million km was undertaken to estimate spatial and temporal patterns of abundance for seven species of cetaceans (Paxton *et al.*, 2016). Developer areas were chosen based on best available information at this time of the areas of interest for renewable energy developments and referred to as “areas of commercial interest” (Paxton *et al.*, 2016).

2.3.4.2 The following species were included in the analysis: harbour porpoise, minke whale, bottlenose dolphin, short-beaked common dolphin, Risso’s dolphin *Grampus griseus*, white-beaked dolphin and Atlantic white-sided dolphin *Lagenorhynchus acutus*. Density surface models were used to predict species density over a fine scale grid of 25km2 resolution for one day in each season in each survey year. The data were divided into regions for which seasonal abundance in winter (January to March), spring (April to June), summer (July to September) and autumn (October to December) was estimated. The Morven Site Marine Mammal Study Area is situated just at the edge of the “Firth of Forth area of commercial interest” (Figure 2.4) and the corresponding data is now between 14 and 30 years old, however, this study provides useful context of historical patterns of marine mammal occurrence and distribution within the Morven North and Morven South Regional Marine Mammal Study Area.

2.3.4.3 It should be noted that, as stated by Paxton *et al.* (2016), the abundance estimates produced by the JCP Phase III modelling will be less reliable than those obtained from a well-designed dedicated abundance survey given the assumptions made when standardising the data and the spatial and

temporal patchiness of the data available. For these reasons, the information provided by the JCP Phase III analysis has been included for context only, and the findings are not considered further.

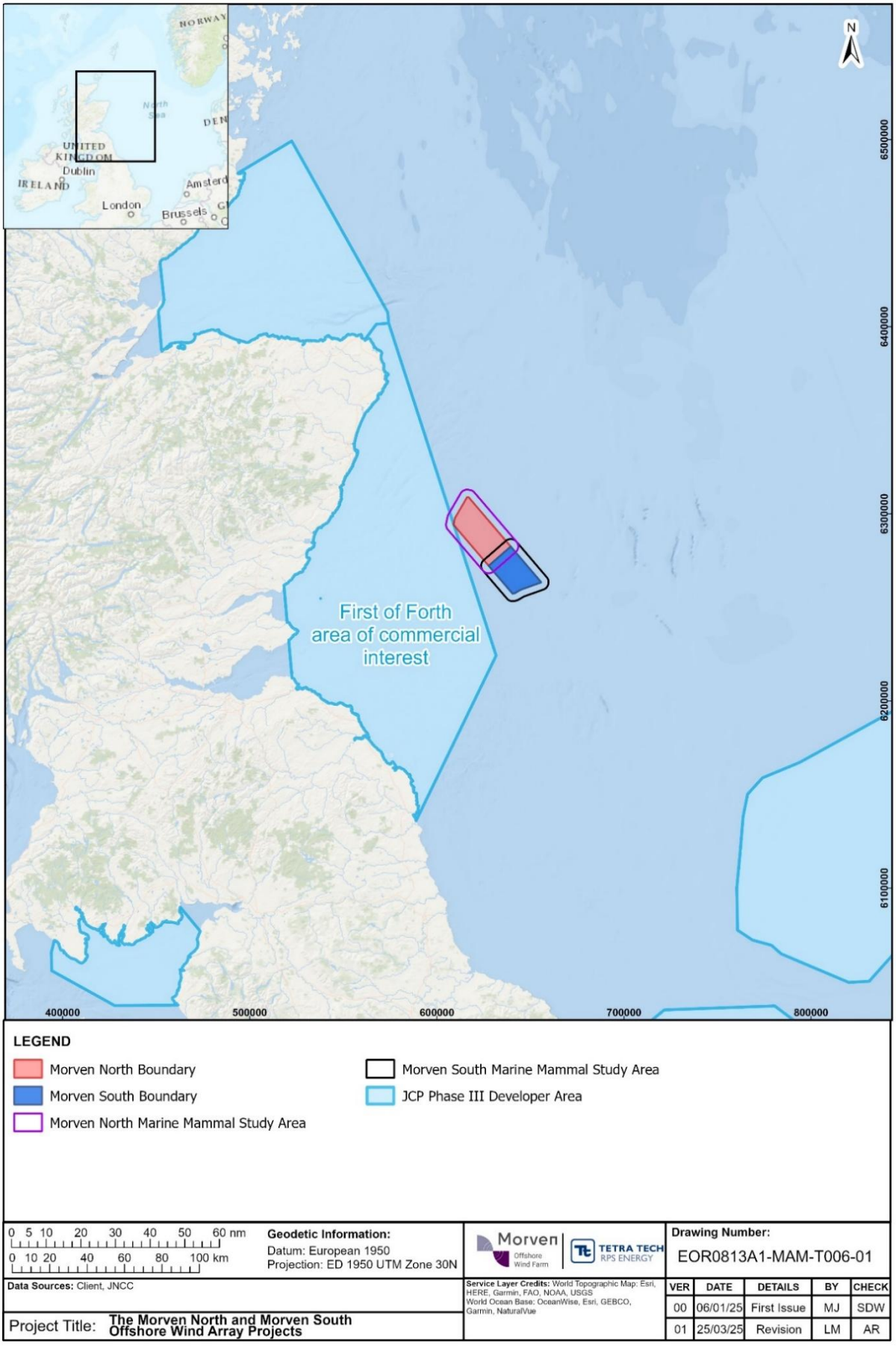

Figure 2.4: JCP Phase III Developers Areas

2.3.5 JNCC Report 544: Harbour Porpoise Density

2.3.5.1 Heinänen and Skov (2015) conducted a detailed analysis of the majority of the standardised JCP data resources to identify "discrete and persistent areas of high density" that might be considered important for harbour porpoise, with the goal of determining SACs for the species. Outputs of the analysis included distribution maps of density estimates for the waters around the UK, and the results are summarised in paragraphs 4.2.2.2, 4.2.2.3 and 4.2.3.2. The analysis grouped data into three subsets: 1994 to 1999, 2000 to 2005 and 2006 to 2011 to account for patchy survey effort. To explore whether distribution patterns differed between seasons, the study analysed summer (April to September) and winter (October to March) data separately. 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 assumes that these relationships hold true outside of the surveyed areas. Given the uneven survey effort over the modelled period, there was a large degree of uncertainty in modelled distributions.

2.3.6 Special Committee on Seals (SCOS)

2.3.6.1 Natural Environment Research Council (NERC) provides scientific advice to government on matters related to the management of seal populations. NERC has appointed SCOS to formulate this advice which is provided by SMRU through a series of scientific briefing papers, meetings, and an annual report. The annual report includes advice on matters related to the management of seal populations, including general information on British seals and information on their current status. The most recent publicly available SCOS report is (SCOS, 2022) which presents data collected and population estimates up to and including 2022.

2.3.7 SMRU Seal Surveys

2.3.7.1 SMRU carries out surveys of harbour and grey seals in Scotland and on the east coast of England to contribute to the NERC's 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 form the routine monitoring of seal populations around the UK. Most surveys are carried out in August from the air by either light aircraft or helicopter and record seals that are hauled-out on shore. Although both species are surveyed during the month of August, on account of differences in the breeding behaviour of harbour and grey seals, these surveys correspond to different points in the two species' annual cycles.

2.3.7.2 A SMRU report was commissioned to support the baseline assessment for Morven North and Morven South and associated Morven Site Marine Mammal Study Area. The report provided a detailed account of grey and harbour seal haul-outs and telemetry tracks within the vicinity of Morven North and Morven South as well as East Scotland and Northeast England seal Management Units (MUs) (Stevens, 2023) (Figure 2.5).

2.3.8 Grey Seals

2.3.8.1 In the UK, grey seals are surveyed during their breeding season (August to December), wherein pup counts are conducted at known breeding colonies. 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 other colonies are surveyed by ground count by other organisations (including NatureScot, Natural England, Natural Resources Wales, National Trust, and Lincolnshire Wildlife Trust) (Stevens, 2023). The grey seal pup production database contains data from 1996 to 2021 and includes 74 breeding colonies, 70 of which are in Scotland and one of which is in Northeast England (though not all colonies have been surveyed consistently since 1989 and some smaller colonies are surveyed more sporadically than others). The most recent complete grey seal pup production survey (covering Orkney, Inner and Outer Hebrides and the North Sea colonies) was conducted in 2019. It should be noted that grey seal distribution during the breeding season is very different to their distribution at other times of the year.

2.3.8.2 Grey seals are also counted during SMRU's harbour seal August moult surveys, however, counts of grey seals during the summer months can be highly variable and, although these counts are not used as a population index, they provide useful information on the summer and non-breeding season distribution of grey seals. The most recent data available for the East Scotland and Northeast England seal MUs are from 2021.

2.3.9 Harbour Seals

2.3.9.1 Surveys of harbour seals are carried out during the summer and early autumn months. There are two types of surveys conducted: breeding season counts and August moult counts. Given that there are no harbour seal breeding surveys conducted in the East Scotland or Northeast England seal MUs, these are not considered further in this report (Stevens, 2023). The main population surveys are carried out when harbour seals are moulting, during the first three weeks of August. The frequency of surveys differs by area (Stevens, 2023). In general, moult surveys are conducted annually in Lincolnshire and Norfolk (England), and in 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. The most recent data available for the East Scotland and Northeast England seal MUs are from 2021 (Stevens, 2023).

2.3.10 Designated Seal Haul-out Sites

2.3.10.1 Seal haul-out sites are locations on land where seals come ashore to rest, moult or breed. In Scotland, seal haul-out sites are designated under section 117 of the Marine (Scotland) Act 2010, The Protection of Seals (Designation of Haul-out Sites) (Scotland) Order 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, 2014).

2.3.10.2 The Morven Regional Marine Mammal Study Area contains three designated haul-out sites for both grey seal and harbour seal, and three seasonal grey seal haul-out sites (Table 2.4; Figure 2.5), all located within the East Scotland seal MU. Haul-out sites are designated only in Scotland and, as such, none are located in the Northeast England seal MU. The closest designated haul-out site to the Morven Site Marine Mammal Study Area Ythan River Mouth (a seasonal non-breeding haul-out), is located 65.8km to the northwest, and the closest breeding colony haul-out site is Fast Castle, 101.3km to the southwest (Figure 2.5).

Table 2.4: Designated seal haul-out sites within the Morven Regional Marine Mammal Study Area

Seal Haul-out	Distance from Morven North Marine Mammal Study Area (km)	Distance from Morven South Marine Mammal Study Area (km)	Distance from Morven Site Marine Mammal Study Area (km)	Designation
Ythan River Mouth (EC-003)	65.8	99.9	65.8	Harbour seal and grey seal haul-out (non-breeding)
Fast Castle (BC-043)	101.3	101.0	101.0	Seasonal grey seal haul-out (breeding)
Craigleith (BC-045)	117.0	120.1	117.0	Seasonal grey seal haul-out (breeding)
Kinghorn rocks (EC-001)	137.3	143.5	137.3	Harbour seal and grey seal haul-out (non-breeding)
Inchkeith (BC-044)	140.0	145.1	140.0	Seasonal grey seal haul-out (breeding)
Inchmickery and Cow & Calves (EC-002)	148.2	154.0	148.2	Harbour seal and grey seal haul-out (non-breeding)

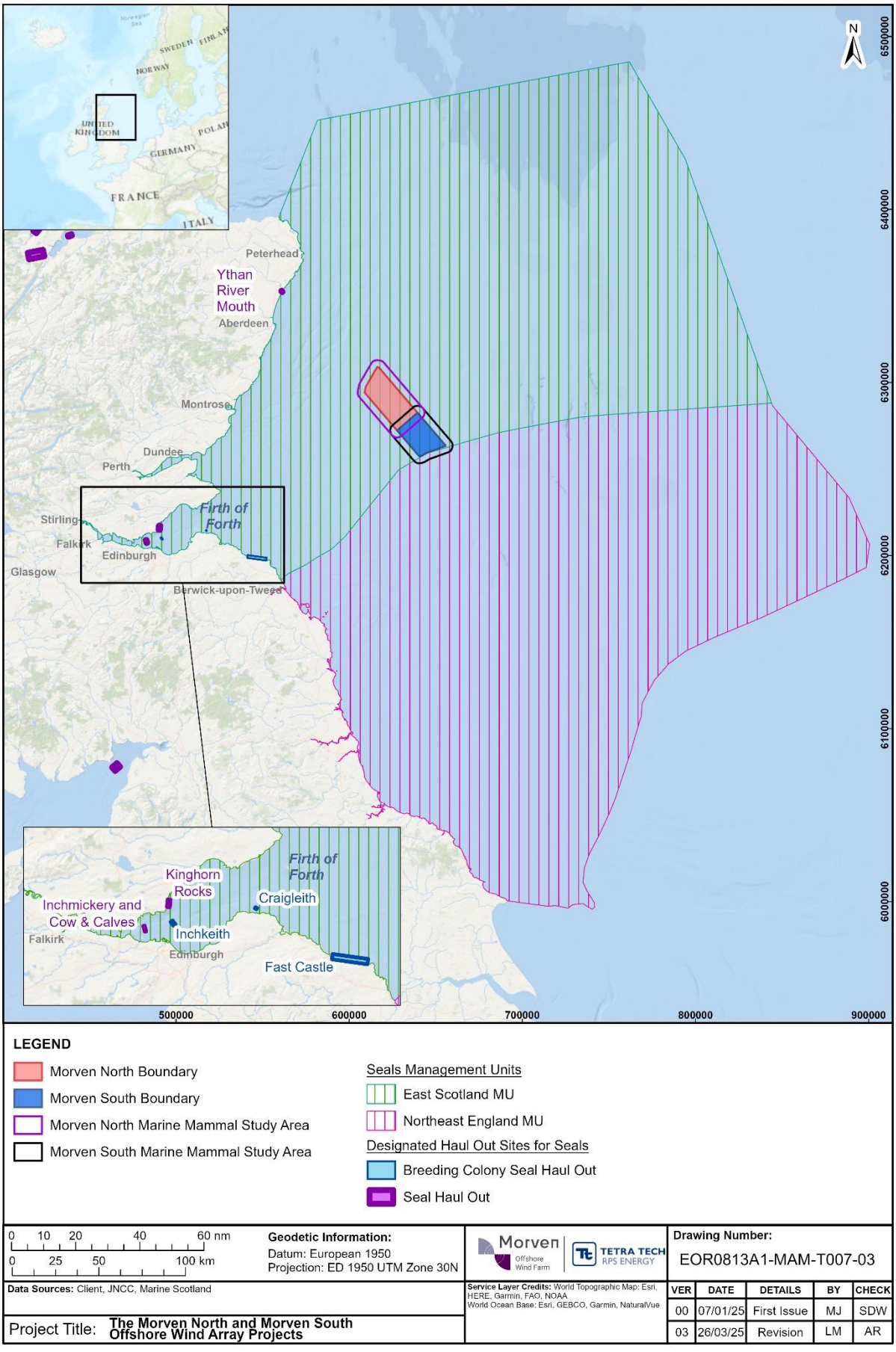

Figure 2.5: Seal MUs and Designated Sites

2.3.11 Seal Telemetry Data

2.3.11.1 SMRU has deployed telemetry tags on grey seals and harbour seals in the UK since 1988 and 2001, respectively. 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. Data obtained during telemetry studies provide information on seal movement patterns away from their haul-out sites, as well as data on the foraging behaviour of seals at sea and demonstrate connectivity between areas.

2.3.11.2 Telemetry data presented in this report for grey seal and harbour seal (Sections 4.7 and 0, respectively) draws on the SMRU commissioned study (Stevens, 2023), which presents an analysis of existing satellite data to describe the movements of harbour and grey seal within or in the vicinity of the Morven Site Marine Mammal Study Area.

2.3.12 Seal Usage Maps

2.3.12.1 Carter *et al.* (2022) presents the most up-to-date seal usage maps for UK waters. The study utilised a high-resolution GPS tracking dataset (114 grey seals and 239 harbour seals) and wide spatial coverage to model habitat preference and generate at sea distribution estimates for the entire UK and Ireland populations of both species of seals. Additionally, the study provides SAC specific estimates of at sea distribution, demonstrating that hotspots of at sea density cannot always be apportioned to the nearest SAC. The at sea usage maps represent the number of grey and harbour seals estimated to be in the water in each 5km x 5km grid cell at any one time. Values in the Carter *et al.* (2022) report are presented as spatial predictions of relative density.

2.3.12.2 Carter *et al.* (2025) continues the work presented in Carter *et al.* (2022) by the inclusion of additional seals tagged in Shetland (grey seal n = 9, harbour seal n = 26). The modelling approach and interpretation/presentation of data (5km by 5km grid cell) are comparable to that in Carter *et al.* (2022), however the modelling only includes data from seals tagged in Scotland, so the results of these studies are not directly comparable. Moreover, by excluding animals known to use habitat in the vicinity of the Morven Site Marine Mammal Study Area (i.e. those tagged in the Northeast England and Southeast England seal MUs: see Figure 4.20 to Figure 4.23) subsequent density estimates are likely to be less robust and less conservative. Similarly, modelled density surfaces for harbour seal from Carter *et al.* (2025) do not overlap with the Morven Site Marine Mammal Study Area. For this reason, density estimates in Section 4.7.3 for grey seal present the results from both studies for context, while density estimates in Section 4.8.3 for harbour seal present only results from Carter *et al.* (2022).The East Coast Marine Mammal Acoustic Study (ECOMMAS)

2.3.12.3 The ECOMMAS Project (Brookes, 2017) uses acoustic recorders, known as C-PODs, at locations in the Moray Firth, Firth of Tay, Firth of Forth and Aberdeenshire coast, to estimate the distribution of small cetaceans around the east coast of Scotland from detection of echolocation clicks. Since the start of the ECOMMAS Project in 2013, C-POD recorders have been deployed across the summer every year. Since 2015, two deployments per year have been undertaken, meaning that data can be collected from April to November. The information collected from these recorders contributes to the UK's reporting under the Marine Strategy Framework Directive.

2.3.12.4 At ten locations, groups of three recorders are deployed at approximately 5km intervals perpendicular to the coast, to provide data at increasing distance offshore. At each of these locations a broadband acoustic recorder is also deployed to record ambient underwater sound levels, as well as other animal vocalisations.

2.3.13 Distribution Maps of Cetacean and Seabird Populations in the North East Atlantic

2.3.13.1 (Waggitt *et al.*, 2020) collated and standardised data from 2.68 million km of cetacean and seabird surveys carried out in the North East Atlantic between 1980 and 2018. The study consisted of three

stages – collating survey data, linking differences among surveys with various parameters (platform type, transect design, observation method and weather) to calculate the variations in the surface area covered, and generating Surface Density Model (SDM)s. As a result, distribution maps were provided for 12 cetacean and 12 bird species at 10km resolution and monthly frequency in the northeast Atlantic.

3 Baseline Environment

3.1 Legislation and Conservation Designations

3.1.1 Legal Framework

3.1.1.1 The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) make it an offence to disturb a cetacean intentionally or recklessly in Scottish inshore waters (within 12nm of the coast). Improved protection for seals is provided in the Marine (Scotland) Act 2010. In the UK, all species of marine mammals up to 12nm are protected under the Wildlife and Countryside Act (1981). In Scotland basking shark *Cetorhinus maximus* is given full protection under Schedule 5 of the Wildlife and Countryside Act 1981. However, the basking shark is not included as a part of the scope of this document as it has been included in the Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report.

3.1.1.2 Several marine mammal species present in the UK waters are listed in Annex II of the Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora) as species whose conservation requires the designation of SACs. In Scotland, the Habitats Directive, is translated into legal obligations by the Conservation (Natural Habitats, etc.) Regulations 1994 (as amended), the Conservation of Habitats and Species Regulations 2017, the Conservation of Offshore Marine Habitats and Species Regulations 2017, the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 and the Wildlife and Countryside Act 1981.

3.1.1.3 The obligations implemented under the Habitats Directive continue to apply in Scotland through the Conservation of Habitats and Species Amendment (EU Exit) Regulations 2019 to European sites (which include SACs) in the UK that already existed on 31 December 2020 and now comprise part of the UK National Site Network.

3.1.1.4 Annex II marine mammal species for which SACs are designated within Scottish waters include harbour porpoise, grey seal, harbour seal and bottlenose dolphin. Under Annex IV of the Habitats Directive, all cetacean species are afforded strict protection wherever they occur within a Member State's territory, both inside and outside designated protected areas. These are termed European Protected Species (EPS).

3.1.1.5 The Marine (Scotland) Act 2010 and The UK Marine and Coastal Access Act 2009 include provisions to designate Nature Conservation Marine Protected Areas (ncMPAs) (within territorial and offshore waters, respectively). These are areas of the sea with special controls to protect species and habitats, and to support the wider marine ecosystem. A total of 36 MPAs have been designated in Scotland's seas, of which three list marine mammal species as features.

3.1.2 Conservation Designations

3.1.2.1 There are several nationally and internationally designated areas within the Morven Regional Marine Mammal Study Area that have marine mammals as notified interest features (Table 3.1). A total of six SACs and one ncMPA lie within the Morven Regional Marine Mammal Study Area (Figure 3.1)

3.1.2.2 The entire Morven Regional Marine Mammal Study Area has been screened under the HRA process to identify the UK National Site Network sites that should be considered further in the Morven North and Morven South EIAs and Morven North and Morven South Reports to Inform Appropriate Assessments (RIAAs) (see Habitats Regulations Appraisal Chapter 2.1: Report to Inform Appropriate Assessment Part 2: SAC Assessments).

3.1.2.3 An overview of UK National Site Network sites that were designated within the UK portion of the Morven Regional Marine Mammal Study Area and are likely to have connectivity with Morven North and Morven South is presented within this report. A summary of the relevant marine mammal

qualifying interest and/or protected features for each site is provided in Table 3.1, and presented in Figure 3.1.

Table 3.1: Sites designated for the protection of marine mammals within the Morven Regional Marine Mammal Study Area.

Site Name	Distance from Morven North Marine Mammal Study Area (km)	Distance from Morven South Marine Mammal Study Area (km)	Distance from Morven Site Marine Mammal Study Area (km)	Marine Mammal Qualifying Feature/s
Berwickshire and North Northumberland Coast SAC	97.9	93.3	93.3	Grey seal
Isle of May SAC	100.7	104.7	100.7	Grey seal
Firth of Tay and Eden Estuary SAC	91.9	105.3	91.9	Harbour seal
Southern North Sea SAC	155.8	131.2	131.2	Harbour porpoise
Southern Trench ncMPA	52.8	86.7	52.8	Minke whale
Moray Firth SAC	187.3	214.8	187.3	Bottlenose dolphin
Dornoch Firth and Morrich More SAC	214.7	249.5	214.7	Harbour seal

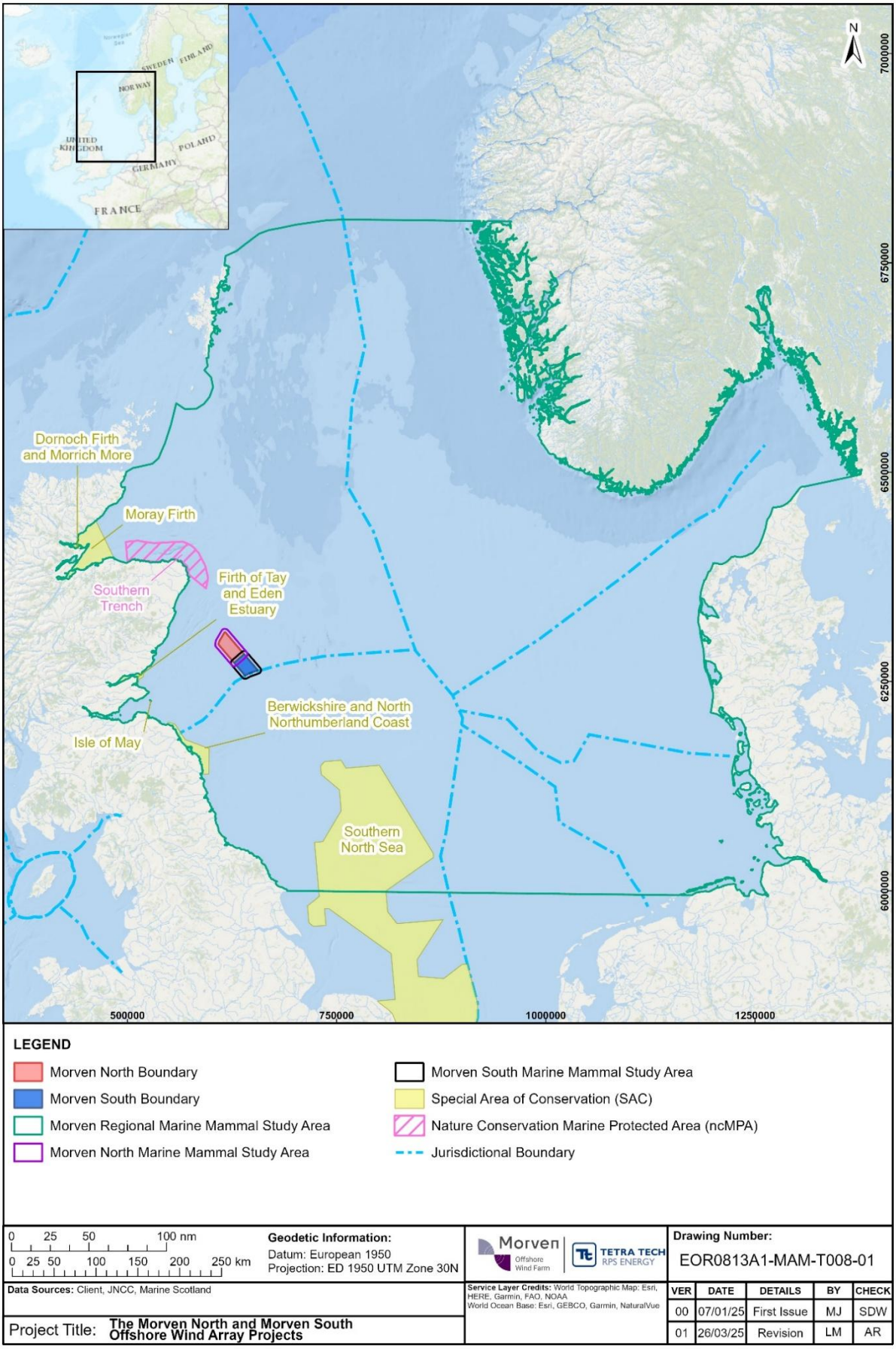

Figure 3.1: Designated sites in the Morven Regional Marine Mammal Study Area

Berwickshire and North Northumberland Coast SAC

3.1.2.4 The Berwickshire and North Northumberland Coast SAC (Figure 3.1) extends over an area of 652km^2 and lies 93.3km from the Morven Site Marine Mammal Study Area(JNCC, 2024). The SAC features an extensive and diverse stretch of coastline in southeast Scotland and northeast England and hosts a range of Annex I habitats, including mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, reefs as well as submerged and partially submerged sea caves (JNCC, 2024)

3.1.2.5 This SAC is located within the East Scotland and Northeast England seal MUs and contains two large, discrete Annex II grey seal breeding populations at the Farne Islands and Fast Castle. The Farne Islands have been an important breeding site since the Middle Ages (SCOS, 2022), while Fast Castle is a recently established breeding site first colonised in the 1990s. The grey seal pup production at the Farne Islands and Fast Castle has shown a recent, rapid increase (Stevens, 2023). From 2014 to 2019, the mean estimated increase in grey seal pup production at Farne Islands was 53% (SCOS, 2022).

Isle of May SAC

3.1.2.6 The Isle of May SAC extends over an area of 3.5km^2 (JNCC, 2023a). The SAC is located 100.7km from the Morven Site Marine Mammal Study Area (Figure 3.1) and supports a breeding colony of grey seals (JNCC, 2023a). It is located within the East Scotland seal MU.

3.1.2.7 Grey seal pup production at the Isle of May SAC increased at a rate of 9.9% per year since surveys began (1979), before reaching an peak of approximately 2,000 pups in the late 1990s (SCOS, 2022). Although prior to the 1990s the Isle of May SAC was the dominant location for grey seal pup production within the East Scotland MU, pup production is now considered to be stable or potentially declining (Stevens, 2023).

Firth of Tay and Eden Estuary SAC

3.1.2.8 The Firth of Tay and Eden Estuary SAC lies 91.9km west of the Morven Site Marine Mammal Study Area (Figure 3.1), covers an area of approximately 155km^2 and comprises of two high quality estuarine areas, which are integral components of a large, geomorphologically complex area (JNCC, 2023b). The SAC supports a breeding colony of harbour seal. Adult harbour seals use sandbanks within this SAC as a haul-out habitat to rest, pup and moult (JNCC, 2023b).

3.1.2.9 Between 1990 and 2002, the majority of the East Scotland seal MU harbour seal population was located in the Firth of Tay and Eden Estuary SAC. During this period, harbour seal counts in this SAC remained stable, representing approximately 85% of the East Scotland seal MU count (Stevens, 2023). The population within the SAC then declined rapidly from 2002 to 2021 to a count of 41 individuals, representing an approximate 95% decline in the population. As such, the SAC now accounts for approximately 16% of the haul-out counts in the East Scotland seal MU. There is, however, recent evidence that this decline may be slowing (Stevens, 2023).

Southern North Sea SAC

3.1.2.10 The Southern North Sea SAC lies along the east coast of England (Figure 3.1), predominantly in the offshore waters (88% of the site) of the central and southern North Sea. The SAC covers an area of 36,951km^2 and is located 131.2km to the southeast of the Morven Site Marine Mammal Study Area. It was designated for harbour porpoise (JNCC, 2023c) and supports an estimated 17.5% of the UK North Sea MU population. The northern section of the SAC (approximately two-thirds of its total area) supports higher densities of harbour porpoise during the summer season (April to September) (Heinänen and Skov, 2015), while the southern section is recognised as an important area during the winter season (October to March) (JNCC, 2023c).

Southern Trench ncMPA

3.1.2.11 The Southern Trench ncMPA lies off the Aberdeenshire coast, 52.8km north of the Morven Site Marine Mammal Study Area and covers an area of approximately 2,398km^2 (Figure 3.1). The ncMPA features a 250m deep trench running parallel with the coast for 58km which functions as a nursery ground for juvenile fish. The dynamic mixing zone of warm and cold waters (front) attracts shoals of herring, mackerel and cod to the area. The soft sands covering much of the seabed also provide habitat for sandeels, and the presence of these prey species in turn supports top predators like minke whale (NatureScot, 2020).

Moray Firth SAC

3.1.2.12 The Moray Firth in northeast Scotland supports the only known resident population of bottlenose dolphin in the North Sea. The Moray Firth SAC is located 187.3km to the northwest of the Morven Site Marine Mammal Study Area (Figure 3.1) and covers an area of 1,512km^2 (JNCC, 2025). Bottlenose dolphins associated with the Moray Firth SAC are part of a Scottish east coast population of 224 animals that range south past Aberdeen to the Firths of Tay and Forth (Arso Civil *et al.*, 2019, Quick *et al.*, 2014). Data from site condition monitoring for the SAC suggest that the proportion of the east coast of Scotland bottlenose dolphin population that use the SAC has declined, although the overall population along the east coast is increasing (Arso Civil *et al.*, 2019, Cheney *et al.*, 2018, Arso Civil *et al.*, 2021). The resident population of bottlenose dolphin from the Moray Firth SAC is now known to venture down the coast of East Scotland and England as far south as Scarborough, where there have been regular sightings in recent years (Hackett, 2022).

Dornoch Firth and Morrich More SAC

3.1.2.13 The Dornoch Firth is the most northerly large estuary in Britain, located 214.7km from the Morven Site Marine Mammal Study Area (Figure 3.1). The SAC overlaps with the Moray Firth SAC and supports a significant proportion of the inner Moray Firth population of harbour seal, which is a primary reason for designation of this site. This is the most northerly harbour seal population to utilise sandbanks as a haul-out and breeding site, and represents approximately 2% of the UK population (JNCC, 2023d).

3.2 Overview of Marine Mammals

3.2.1 Morven Regional Marine Mammal Study Area

3.2.1.1 There are 12 species of cetaceans and two species of pinnipeds (Table 3.2) that are regularly encountered within the Morven Regional Marine Mammal Study Area (Hammond *et al.*, 2021, Hammond *et al.*, 2013, Weir, 2001).

3.2.1.2 The northern North Sea (delineated approximately between 57°N and 60°N (Weir, 2001)) supports several species of cetaceans, with both abundance and diversity decreasing in a southwards cline. Marine mammal distribution is strongly influenced by the distribution of prey, and the greater abundance of pelagic prey species adjacent to the deep Atlantic and along the continental shelf edge (northwards of 60°N), may attract a higher abundance and diversity of cetaceans, compared to the southern part of the northern North Sea (towards approximately 57°N (Weir, 2001)), where the Morven Site Marine Mammal Study Area Boundary is located. Within the waters off the east of Scotland, cetacean species more commonly recorded include harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale, while other cetacean species have been recorded as occasional or rare visitors to this region (Table 3.2).

3.2.1.3 The east coast of Scotland and northeast coast of England support multiple haul-out sites for grey seal and harbour seal (SCOS, 2022, Weir, 2001). Although higher densities of these species may be expected in the vicinity of haul-outs at certain times of the year, the relationship between at sea distribution and use of land-based sites is not clearcut and requires further research (Carter *et al.*, 2022). One of the reasons for this uncertainty is that grey seals exhibit partial migration and may

move between regions for breeding and foraging, so individuals that breed in an SAC, for example, may not necessarily forage nearby (Carter *et al.*, 2022).

Table 3.2: Summary of marine mammal species previously recorded in the Morven Regional Marine Mammal Study Area based on published data sources. Sources: (Gilles *et al.*, 2023, Hammond *et al.*, 2021, Hammond *et al.*, 2013, Weir, 2001, NMPi, 2025) and Citizen Projects (pers. comm.)

Species	Occurrence in North Sea	Description
Toothed whales (including dolphins and porpoises)		
Harbour porpoise *(Phocoena phocoena)*	Abundant	Abundant and widespread throughout the northern North Sea and is the most frequently reported cetacean in the North Sea.
Bottlenose dolphin (*Tursiops truncatus*)	Common	Occurs within the northern North Sea. However, bottlenose dolphins are more likely to be observed in coastal waters less than 30m deep and within 2km from the coast (Paxton *et al.*, 2016).
White-beaked dolphin (*Lagenorhynchus albirostris)*	Abundant	Abundant and widespread throughout the northern North Sea and is the second most frequently reported cetacean in the North Sea.
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Occasional	Occurs typically in deep waters along continental shelf although regularly enters the North Sea over summer months.
Short-beaked common dolphin (*Delphinus delphis*)	Occasional	Occasionally sighted along the east coast of the UK and is mostly associated with warmer waters to the south and west of the UK.
Killer whale (*Orcinus orca*)	Occasional	Largely distributed in the northern North Sea but most sightings are from around the Shetland Isles or the Norwegian coast.
Risso's dolphin (*Grampus griseus*)	Occasional	Widely distributed around the Northern Isles; sightings along the east coast of the UK are rare.
Long-finned pilot whale (*Globicephala melas*)	Rare	Rarely recorded off the continental shelf edge and is mainly distributed in the colder waters of the North Atlantic.
Baleen whales		
Minke whale (*Balaenoptera acutorostrata*)	Common	Ranges widely and can be observed throughout the northern North Sea.
Humpback whale (*Megaptera novaeangliae*)	Occasional	Mostly recorded around the Northern and Western Scottish Isles with occasional sightings in the Firth of Forth, with the frequency of sightings increasing in recent years.
Fin whale (*Balaenoptera physalus*)	Rare	More typical of the deep waters to the north and west of Scotland rather than the North Sea, small numbers reported in the northern North Sea.

Species	Occurrence in North Sea	Description
Beaked whales		
Sowerby's beaked whale (*Mesoplodon bidens*)	Rare	Associated with deep water off the shelf edge to the north and west of Scotland and is rarely recorded in the northern North Sea.
Pinnipeds		
Grey seal (*Halichoerus grypus*)	Common	Most at sea occurrence is within 100km of a haul-out site, possible up to several hundred kilometres offshore. Majority of UK population breeds in Scotland with large and rapidly growing colonies on the east coast of Scotland and England.
Harbour seal (*Phoca vitulina*)	Occasional	Distribution on the east coast is restricted with concentrations in the Firths of Forth and Tay, and the Moray Firth. Scotland supports approximately 85% of the UK harbour seal population.

3.2.2 Site Specific DAS

3.2.2.1 Given that the extent of the Morven Site Marine Mammal Study Area was covered by the DAS campaign, data from DAS is considered the most accurate to inform marine mammal presence and distribution in the vicinity of Morven North and Morven South.

3.2.2.2 It is important to note that, given the overlap between the Morven North Marine Mammal Study Area and the Morven South Marine Mammal Study Area, simply summing the respective abundance estimates to calculate an overall abundance for the Morven Site Marine Mammal Study Area would result in double-counting where the two study areas overlap. Abundance estimates for the Morven Site Marine Mammal Study Area were therefore calculated separately.

Morven Site Marine Mammal Study Area

3.2.2.3 Data from DAS conducted within the Morven Site Marine Mammal Study Area demonstrated that several marine mammal species occurred regularly within the Morven Site Marine Mammal Study Area. Harbour porpoise was the most commonly identified species across the 33 months of DAS data (n = 594), followed by white-beaked dolphin (n = 85). Low numbers of short-beaked common dolphin (n = 8), grey seal (n = 11), minke whale (n = 6) and humpback whale (n = 1) were also observed.

3.2.2.4 No other species were recorded, including bottlenose dolphin and harbour seal. For cetaceans, unidentified individuals observed (n=94) were assigned to broader categories (e.g. “dolphin/porpoise” or “dolphin sp”). Sightings classified as “phocid” or “seal species” (n = 33) occurred in 15 months, due to the difficulty of identifying phocids to species level from aerial survey data A total of 848 individuals were identified, and monthly raw sightings (i.e. numbers of individuals) recorded across the Morven Site Marine Mammal Study Area are summarised in Table 3.3.

Table 3.3: Monthly raw sightings (uncorrected for effort) data across the Morven Site Marine Mammal Study Area

Survey Month	Harbour Porpoise	White-beaked Dolphin	Common Dolphin	Grey Seal	Minke Whale	Humpback Whale	Dolphin/Porpoise	Dolphin Species	Seal Species	Whale Species	Marine Mammal Species	Total
January 2021	-	-	-	-	-	-	-	-	1	-	-	**1**
February 2021	-	-	-	-	-	-	2	-	2	-	-	**4**
March 2021	-	-	-	-	-	-	2	-	1	-	-	**3**
April 2021	3	-	-	-	-	-	2	-	7	-	-	**12**
May 2021	116	-	-	-	1	-	32	9	2	-	-	**160**
June 2021	3	10	-	1	1	-	2	1	-	-	1	**19**
July 2021	47	4	-	-	2	-	2	-	1	1	3	**60**
August 2021	7	2	-	-	-	-	-	-	-	-	1	**10**
September 2021	9	8	-	-	-	-	-	-	-	-	2	**19**
October 2021	5	-	-	-	-	-	4	-	-	-	-	**9**
November 2021	2	-	-	-	-	-	-	-	1	-	-	**3**
December 2021	7	-	-	1	-	-	-	-	-	-	2	**10**
January 2022	-	5	-	-	-	-	-	-	-	-	-	**5**
February 2022	7	8	-	1	-	-	6	-	3	-	1	**26**
March 2022	6	-	-	-	-	-	-	-	5	-	2	**13**
April 2022	1	-	-	-	-	-	1	-	1	-	-	**3**
May 2022	158	-	-	-	1	1	9	-	4	-	2	**175**
June 2022	3	-	8	-	-	-	1	-	-	-	-	**12**
July 2022	10	6	-	-	-	-	-	-	-	-	-	**16**
August 2022	3	6	-	-	-	-	-	-	-	-	-	**9**
September 2022	23	8	-	1	1	-	1	1	-	-	-	**35**
October 2022	22	-	-	-	-	-	9	-	-	-	-	**31**

Survey Month	Harbour Porpoise	White-beaked Dolphin	Common Dolphin	Grey Seal	Minke Whale	Humpback Whale	Dolphin/Porpoise	Dolphin Species	Seal Species	Whale Species	Marine Mammal Species	Total
November 2022	9	-	-	-	-	-	-	-	-	-	-	**9**
December 2022	2	-	-	-	-	-	1	-	-	-	-	**3**
January 2023	1	-	-	-	-	-	-	-	-	-	-	**1**
February 2023	2	-	-	-	-	-	-	-	-	-	-	**2**
March 2023	3	-	-	2	-	-	-	-	-	-	-	**5**
April 2023	21	5	-	1	-	-	3	-	2	-	-	**32**
May 2023	17	-	-	1	-	-	3	-	1	-	-	**22**
June 2023	57	9	-	-	-	-	-	-	1	-	1	**68**
July 2023	35	8	-	1	-	-	-	-	1	-	-	**45**
August 2023	8	5	-	1	-	-	1	-	-	-	-	**15**
September 2023	7	1	-	1	-	-	-	2	-	-	-	**11**
Total	**594**	**85**	**8**	**11**	**6**	**1**	**81**	**13**	**33**	**1**	**15**	**848**

Morven North Marine Mammal Study Area

3.2.2.5 Data from DAS conducted within the Morven North Marine Mammal Study Area demonstrated that several marine mammal species occurred regularly within the Morven North Marine Mammal Study Area. Harbour porpoise was the most commonly identified species across the 33 months of DAS data (n = 466), followed by white-beaked dolphin (n = 73). Low numbers of short-beaked common dolphin (n = 8), grey seal (n = 8), minke whale (n = 6) and humpback whale (n = 1) were also observed.

3.2.2.6 No other species were recorded, including bottlenose dolphin and harbour seal. For cetaceans, unidentified individuals observed (n = 83) were assigned to broader categories (e.g. “dolphin/porpoise” or “dolphin sp”). Sightings classified as “phocid” or “seal species” (n = 21) occurred in 13 months, due to the difficulty of identifying phocids to species level from aerial survey data. A total of 680 individuals across all species/species categories were identified, and monthly raw sightings (i.e. numbers of individuals) recorded across the Morven North Marine Mammal Study Area are summarised in Table 3.4.

Table 3.4: Monthly raw sightings (uncorrected for effort) data across the Morven North Marine Mammal Study Area

Survey Month	Harbour Porpoise	White-beaked Dolphin	Common Dolphin	Grey Seal	Minke Whale	Humpback Whale	Dolphin/ Porpoise	Dolphin Species	Seal Species	Marine Mammal Species	Total
January 2021	-	-	-	-	-	-	-	-	1	-	**1**
February 2021	-	-	-	-	-	-	2	-	2	-	**4**
March 2021	-	-	-	-	-	-	2	-	1	-	**3**
April 2021	1	-	-	-	-	-	1	-	3	-	**5**
May 2021	110	-	-	-	1	-	30	9	1	-	**151**
June 2021	3	10	-	-	1	-	2	1	-	-	**17**
July 2021	31	4	-	-	2	-	-	-	-	3	**40**
August 2021	5	-	-	-	-	-	-	-	-	1	**6**
September 2021	9	8	-	-	-	-	-	-	-	2	**19**
October 2021	2	-	-	-	-	-	4	-	-	-	**6**
November 2021	2	-	-	-	-	-	-	-	1	-	**3**
December 2021	7	-	-	1	-	-	-	-	-	2	**10**
January 2022	-	5	-	-	-	-	-	-	-	-	**5**
February 2022	5	8	-	1	-	-	4	-	2	1	**21**
March 2022	3	-	-	-	-	-	-	-	2	2	**7**
April 2022	1	-	-	-	-	-	1	-	-	-	**2**
May 2022	156	-	-	-	1	1	7	-	4	2	**171**
June 2022	2	-	8	-	-	-	1	-	-	-	**11**
July 2022	6	6	-	-	-	-	-	-	-	-	**12**
August 2022	1	4	-	-	-	-	-	-	-	-	**5**
September 2022	12	-	-	-	1	-	1	1	-	-	**15**
October 2022	14	-	-	-	-	-	9	-	-	-	**23**
November 2022	-	-	-	-	-	-	-	-	-	-	**-**

Survey Month	Harbour Porpoise	White-beaked Dolphin	Common Dolphin	Grey Seal	Minke Whale	Humpback Whale	Dolphin/ Porpoise	Dolphin Species	Seal Species	Marine Mammal Species	Total
December 2022	2	-	-	-	-	-	1	-	-	-	**3**
January 2023	1	-	-	-	-	-	-	-	-	-	**1**
February 2023	1	-	-	-	-	-	-	-	-	-	**1**
March 2023	3	-	-	1	-	-	-	-	-	-	**4**
April 2023	13	5	-	1	-	-	1	-	1	-	**21**
May 2023	9	-	-	1	-	-	3	-	1	-	**14**
June 2023	34	9	-	-	-	-	-	-	1	1	**45**
July 2023	24	8	-	1	-	-	-	-	1	-	**34**
August 2023	7	5	-	1	-	-	1	-	-	-	**14**
September 2023	2	1	-	1	-	-	-	2	-	-	**6**
Total	**466**	**73**	**8**	**8**	**6**	**1**	**70**	**13**	**21**	**14**	**680**

Morven South Marine Mammal Study Area

3.2.2.7 Data from DAS conducted within the Morven South Marine Mammal Study Area demonstrated that several marine mammal species occurred regularly within the Morven North Marine Mammal Study Area. Harbour porpoise was the most commonly identified species across the 33 months of DAS data (n = 171), followed by white-beaked dolphin (n = 40). Low numbers of short-beaked common dolphin (n = 8) and grey seal (n = 4) were also observed.

3.2.2.8 No other species were recorded within the Morven South Marine Mammal Study Area, including minke whale, humpback whale, bottlenose dolphin and harbour seal. For cetaceans, unidentified individuals observed (n = 18) were assigned to broader categories (e.g. “dolphin/porpoise” or “dolphin sp”). Sightings classified as “phocid” or “seal species” (n = 18) occurred in nine months, due to the difficulty of identifying phocids to species level from aerial survey data. A total of 265 individuals across all species/species categories were identified, and monthly raw sightings (i.e. numbers of individuals) recorded across the Morven South Marine Mammal Study Area are summarised in Table 3.5.

Table 3.5: Monthly raw sightings (uncorrected for effort) data across the Morven South Marine Mammal Study Area

Survey Month	Harbour Porpoise	White-beaked Dolphin	Common Dolphin	Grey Seal	Dolphin/ Porpoise	Dolphin Species	Seal Species	Whale Species	Marine Mammal Species	Total
January 2021	-	-	-	-	-	-	-	-	-	**-**
February 2021	-	-	-	-	2	-	-	-	-	**2**
March 2021	-	-	-	-	-	-	-	-	-	**-**
April 2021	3	-	-	-	1	-	7	-	-	**11**
May 2021	5	-	-	-	4	-	1	-	-	**10**
June 2021	-	7	-	1	-	-	-	-	1	**9**
July 2021	25	4	-	-	2	-	1	1	1	**34**
August 2021	2	2	-	-	-	-	-	-	-	**4**
September 2021	-	8	-	-	-	-	-	-	2	**10**
October 2021	4	-	-	-	-	-	-	-	-	**4**
November 2021	-	-	-	-	-	-	-	-	-	**-**
December 2021	-	-	-	-	-	-	-	-	1	**1**
January 2022	-	-	-	-	-	-	-	-	-	**-**
February 2022	2	-	-	1	2	-	1	-	-	**6**
March 2022	4	-	-	-	-	-	3	-	-	**7**
April 2022	1	-	-	-	-	-	1	-	-	**2**
May 2022	4	-	-	-	2	-	1	-	-	**7**
June 2022	1	-	8	-	-	-	-	-	-	**9**
July 2022	5	-	-	-	-	-	-	-	-	**5**
August 2022	2	2	-	-	-	-	-	-	-	**4**
September 2022	12	8	-	1	-	1	-	-	-	**22**
October 2022	10	-	-	-	-	-	-	-	-	**10**
November 2022	9	-	-	-	-	-	-	-	-	**9**

Survey Month	Harbour Porpoise	White-beaked Dolphin	Common Dolphin	Grey Seal	Dolphin/ Porpoise	Dolphin Species	Seal Species	Whale Species	Marine Mammal Species	Total
December 2022	-	-	-	-	-	-	-	-	-	**-**
January 2023	-	-	-	-	-	-	-	-	-	**-**
February 2023	1	-	-	-	-	-	-	-	-	**1**
March 2023	2	-	-	1	-	-	-	-	-	**3**
April 2023	12	5	-	-	3	-	2	-	-	**22**
May 2023	10	-	-	-	1	-	1	-	-	**12**
June 2023	34	4	-	-	-	-	-	-	-	**38**
July 2023	13	-	-	-	-	-	-	-	-	**13**
August 2023	4	-	-	-	-	-	-	-	-	**4**
September 2023	6	-	-	-	-	-	-	-	-	**6**
Total	**171**	**40**	**8**	**4**	**17**	**1**	**18**	**1**	**5**	**265**

4 Species Accounts

4.1.1.1 The following section provides more detailed baseline information for each of the key species identified within the Morven Site Marine Mammal Study Area. These key species were selected as being the most likely to be present in and around the Morven Site Marine Mammal Study Area and are based upon patterns of distribution and abundance estimated from existing regional data (e.g. historical and ongoing surveys, incidental sightings) and site specific DAS data. The key species are:

- harbour porpoise;
- white-beaked dolphin;
- bottlenose dolphin;
- minke whale;
- humpback whale (included for qualitative assessment);
- grey seal; and
- harbour seal.

4.2 Harbour Porpoise

4.2.1 Ecology

4.2.1.1 The harbour porpoise is a small odontocete (toothed whale) which inhabits coastal temperate and boreal waters of the northern hemisphere. It reaches a maximum body length of 1.9m (Bjørge and Tolley, 2009), with females and males reaching an average length of 1.6m and 1.45m, respectively (Lockyer, 1995). The maximum recorded longevity is approximately 24 years, although most individuals do not live beyond 12 years (Lockyer, 2013). Sexual maturity in harbour porpoise is reached at three to four years and reproduction is strongly seasonal, with mating occurring between June and August (Lockyer, 1995). Gestation lasts 10 to 11 months and peak birth rate around the UK occurs during the months of June and July (Boyd *et al.*, 1999).

4.2.1.2 Harbour porpoise are predominantly piscivorous, feeding mainly on small demersal or pelagic shoaling fish species (Santos and Pierce, 2003). Regional, seasonal and inter-annual variation in diet is driven by the availability of prey species as well as individual age, with younger animals targeting smaller individuals or smaller species (Santos and Pierce, 2003). Energy maps of harbour porpoise prey species suggest that the energetic value of prey in the North Sea is greatest in the summer, with diet largely comprising sandeels Ammodytidae and whiting (*Merlangius merlangus*). During the winter European sprat (*Sprattus sprattus*) and Atlantic herring (*Clupea harengus*) also contribute to overall energy density (Santos and Pierce, 2003, Ransijn *et al.*, 2019, Santos, 1998).

4.2.1.3 The geographic range of harbour porpoise coincides with cool, high latitude waters (see Section 4.2.2), and with a greater body surface-area-to-volume ratio than other, larger cetacean species, the potential for heat energy to be lost to the surrounding water is increased (Kastelein *et al.*, 2018, Kastelein *et al.*, 2019a, Lambert, 2020). To maintain body temperature and other energy needs, harbour porpoise feed frequently and with an extensible stomach are able to ingest up to 90% of daily energetic requirements in one hour, and can feed again shortly afterwards (Booth *et al.*, 2019, Kastelein *et al.*, 2019b). Metabolic rate remains largely stable across seasonal changes in water temperature, with thermal regulation attained via cyclical fluctuations in energy intake to manage a blubber layer that offsets the energetic cost of thermoregulation during winter (Rojano-Doñate *et al.*, 2018). For this reason, porpoise may be susceptible to changes in the abundance of prey species or disturbance from foraging areas. Recent studies in Iceland suggest that, despite ecosystem changes, harbour porpoise show no long-term changes in trophic ecology, suggesting that this species may be able to adapt to changes in the distribution of prey, or shift to other prey at similar trophic levels (Samarra *et al.*, 2022).

4.2.1.4 Bycatch in fisheries is the predominant threat to harbour porpoise in the North Sea (Lusseau *et al.*, 2023), and are particularly vulnerable to being caught in bottom-set gill nets, due to their feeding behaviour. Other threats include prey depletion, pollution affecting the health of individuals, and acoustic and physical disturbance (Evans and Prior, 2012).

4.2.1.5 Although harbour porpoise individuals generally hunt alone or in small groups, this species can be seen in larger aggregations of 50 or more individuals, either during seasonal migrations or associated with increased concentrations of prey. Within these aggregations, segregation may occur, with females travelling with their calves and yearlings, and immature animals of each sex segregating into groups.

4.2.2 Distribution and Occurrence

4.2.2.1 The harbour porpoise is widespread throughout the cold and temperate Atlantic seas of Europe, including the North Sea, the Irish Sea, and the Baltic Sea (JNCC, 2023e). In the North Sea MU (IAMMWG, 2023) water depths and hydrodynamic variables appear to be the most important factors predicting the presence of harbour porpoise (Heinänen and Skov, 2015). During summer (defined by Heinänen and Skov (2015) as April to September, inclusive), animals were expected to favour areas of stratification. Lower occurrence of harbour porpoise was also associated with lower salinity waters, indicating an avoidance of estuarine waters (Heinänen and Skov, 2015).

4.2.2.2 The Heinänen and Skov (2015) analysis concluded that in the summer months, harbour porpoise presence in the North Sea MU was best predicted by season, water depth and salinity of surface waters. In the winter months (defined by Heinänen and Skov (2015) as October to March, inclusive) the presence of harbour porpoise was best predicted by the season, water depth and seabed surface sediments. During those winter months a peak in presence was observed at water depths of 30m to 40m.

4.2.2.3 In the Moray Firth the proportion of time during which acoustic detection of harbour porpoise occurred in muddy habitats increased by 18% during hours of darkness (Williamson *et al.*, 2016). Detections of harbour porpoise also differed according to depth in different sediment types between hours of darkness and daylight. In muddy areas with a water depth of between 50m to 60m, detections at night were almost double those during daylight hours. Therefore, it can be concluded that harbour porpoise use different types of habitats during hours of daylight and darkness and their distribution may change accordingly.

4.2.2.4 Amongst historical surveys undertaken to inform the regional baseline, and those for other offshore wind developments, harbour porpoise was the most commonly identified cetacean. These include TCE aerial surveys (Grellier and Lacey, 2011), Berwick Bank aerial surveys (SSE Renewables, 2022b) Ossian Array aerial surveys (Ossian OWFL, 2024), SSE Regional Survey aerial surveys (HiDef, 2023) and boat-based surveys for Seagreen (Sparling, 2012, Seagreen Wind Energy Limited, 2018) and Neart na Gaoithe (Mainstream Renewable Power, 2019).

4.2.2.5 Harbour porpoise accounted for the highest number of sightings across all species in the DAS of the Morven Site Marine Mammal Study Area, with a total of 593 animals recorded across 29 months (comprising 33 months of survey, four of which contained no harbour porpoise sightings). No clear temporal or spatial patterns were observed in the distribution of harbour porpoise sightings, although notable concentrations of animals did occur in the north of the Morven Site Marine Mammal Study Area (i.e. within the Morven North Marine Mammal Study Area) during May 2021 and May 2022 (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report).

4.2.3 Density/abundance

Published Literature

4.2.3.1 Density and abundance estimates of harbour porpoise are available from various studies carried out across a broader area within the Morven Regional Marine Mammal Study Area. IAMMWG (2023) estimated abundance for the whole North Sea MU (Figure 4.1) as 346,601 animals (95% confidence interval (CI) = 289,498 to 419,967, CV = 0.09). Within the UK portion of the North Sea MU, the estimated abundance is 159,632 animals (95% CI = 127,442 to 199,954, CV = 0.12).

4.2.3.2 Heinänen and Skov (2015) report on harbour porpoise distribution modelling intended to determine whether there are clearly identifiable and persistent areas of "relatively high" density for the designation of SACs. This analysis concluded that predicted density estimates within the outer Firth of Forth and Firth of Tay region were relatively low compared to other parts of the North Sea with higher densities expected in the outer Moray Firth.

4.2.3.3 To provide additional context, JCP Phase III analyses estimated seasonal abundance for harbour porpoise in 2010 for the Firth of Forth area of commercial interest region (Paxton *et al.*, 2016) (Figure 2.4). Highest abundance of harbour porpoise was predicted for winter (January to March), with 7,000 animals estimated (95% CI = 5,200 to 11,800), corresponding to a density estimate of 0.492 animals/km^2 (95% CI = 0.365 to 0.829). In the context of the Management Unit population, the predicted abundance in the Firth of Forth was reported as 1.4% of the estimated population for the North Sea MU (95% CI = 0.6% to 2.3%), based on the mean of estimates for summers 2007 to 2010. The conclusions of this study corroborated the results presented by Heinänen and Skov (2015).

4.2.3.4 The SCANS-III surveys (Hammond *et al.*, 2021) estimated a mean harbour porpoise density across block R as 0.599 animals/km^2 (95% CI = 0.319 to 1.032, CV = 0.287), corresponding to an abundance estimate of approximately 38,646 animals (95% CI = 20,584 to 66,524; CV = 0.29). Mean density and abundance estimates from the SCANS-IV surveys were comparable with those from SCANS-III. The estimated density across Block NS-D (which coincides with SCANS-III Block R) of 0.599 animals/km^2 (95% CI = 0.280 to 1.185, CV = 0.367) corresponds to an abundance of 38,577 individuals (95% CI = 18,017 to 76,361), and indicates no notable changes in harbour porpoise abundance between the two survey periods (Gilles *et al.*, 2023).

4.2.3.5 Results of 'winterSCANS' surveys (conducted between January 2024 and March 2024) estimated a mean density of 0.257 animals/km^2, equivalent to an abundance of 16,558 animals across the Survey Block (95% CI = 9,239 to 27,021, CV = 0.265). This lower density during the winter months further corroborates predictions presented by Heinänen and Skov (2015), whereby winter densities in this region are expected to be lower.

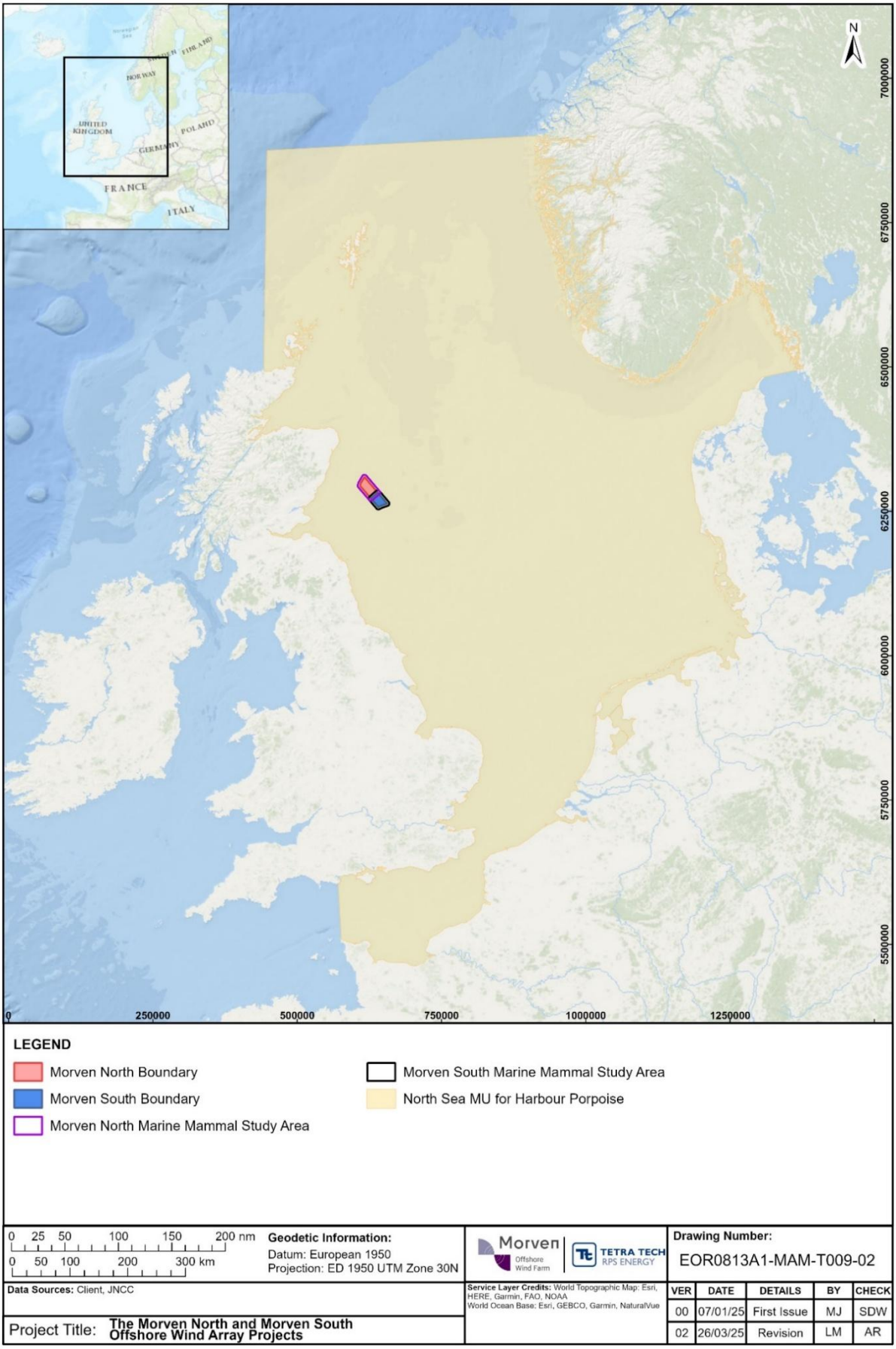

Figure 4.1: North Sea Management Unit for harbour porpoise (IAMWWG, 2023)

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4.2.3.6 Finer scale surface density estimates within the 10x10km grids for the SCANS-III data (Section 2.3.2) were averaged for the Morven Site Marine Mammal Study Area to give a mean density of 0.684 animals/km^2 and a maximum of 0.936 animals/km^2 (Lacey *et al.*, 2022). Corresponding modelled estimates based upon the SCANS-IV surveys (Gilles *et al.*, 2025) estimated a mean density of 0.363 animals/km^2, and a maximum of 0.673 animals/km^2 which are both notably lower than the corresponding estimate from Lacey *et al.* (2022). Areas of higher density occurred to the southeast of the Morven Site Marine Mammal Study Area (Figure 4.2).

4.2.3.7 Monthly predicted distribution maps of harbour porpoise from Waggitt *et al.* (2020) overlaid on the Morven Site Marine Mammal Study Area suggest that harbour porpoise densities are higher throughout autumn and summer months (Figure 4.3, Figure 4.4 and Figure 4.5). Highest densities were predicted in August with a mean of 0.531 animals/km^2, and an overall mean of 0.367 animals/km^2. The density of harbour porpoise increases to the southeast of the Morven Site Boundary.

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4.2.3.8 The patterns seen in the Morven North Marine Mammal Study Area reflected those described above (paragraph 4.2.3.4 et seq) for the Morven Site Marine Mammal Study Area. SCANS-III density surface estimates (Section 2.3.2) within the Morven North Marine Mammal Study Area produced a mean of 0.652 animals/km^2 and a maximum of 0.890 animals/km^2 (Lacey *et al.*, 2022). Corresponding modelled estimates based upon the SCANS-IV surveys (Gilles *et al.*, 2025) estimated a mean density of 0.298 animals/km^2, and a maximum of 0.578 animals/km^2 which are both substantially lower than the corresponding estimate from Lacey *et al.* (2022). Areas of higher density occurred to the southeast of the Morven North Marine Mammal Study Area (Figure 4.2)

4.2.3.9 Monthly predicted distribution maps of harbour porpoise from Waggitt *et al.* (2020) overlaid on the Morven North Marine Mammal Study Area suggest that harbour porpoise densities are higher throughout summer and autumn months (Figure 4.3, Figure 4.4 and Figure 4.5). Highest densities were predicted in August with a mean of 0.522 animals/km^2, and an overall mean of 0.369 animals/km^2.

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4.2.3.10 The patterns seen in the Morven South Marine Mammal Study Area reflected those described above (paragraph 4.2.3.4 et seq) for the Morven Site Marine Mammal Study Area. SCANS-III density surface estimates (Section 2.3.2) within the Morven South Marine Mammal Study Area produced a mean of 0.724 animals/km^2 and a maximum of 0.994 animals/km^2 (Lacey *et al.*, 2022). Corresponding modelled estimates based upon the SCANS-IV surveys (Gilles *et al.*, 2025) estimated a mean density of 0.2983 animals/km^2, and a maximum of 0.0.578 animals/km^2 which are both substantially lower than the corresponding estimate from Lacey *et al.* (2022). Areas of higher density occurred to the southeast of the Morven South Marine Mammal Study Area (Figure 4.2).

4.2.3.11 Monthly predicted distribution maps of harbour porpoise from Waggitt *et al.* (2020) overlaid on the Morven South Marine Mammal Study Area suggest that harbour porpoise densities are higher throughout summer and autumn months (Figure 4.3, Figure 4.4 and Figure 4.5). Highest densities were predicted in August with a mean of 0.547 animals/km^2, and an overall mean of 0.369 animals/km^2.

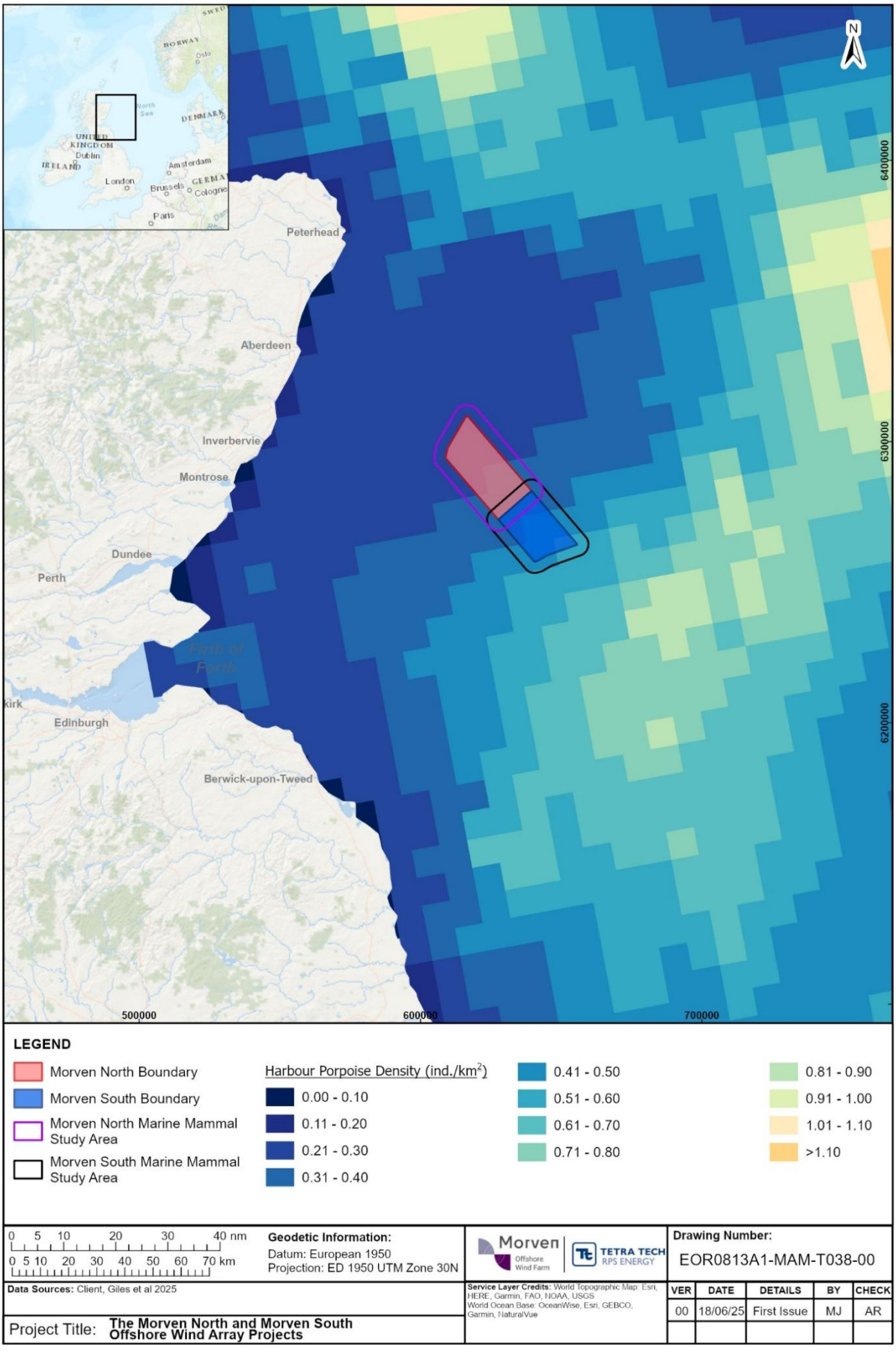

Figure 4.2: Harbour Porpoise Density Surface Derived from SCANS-IV Data from Gilles *et al.* (2025)

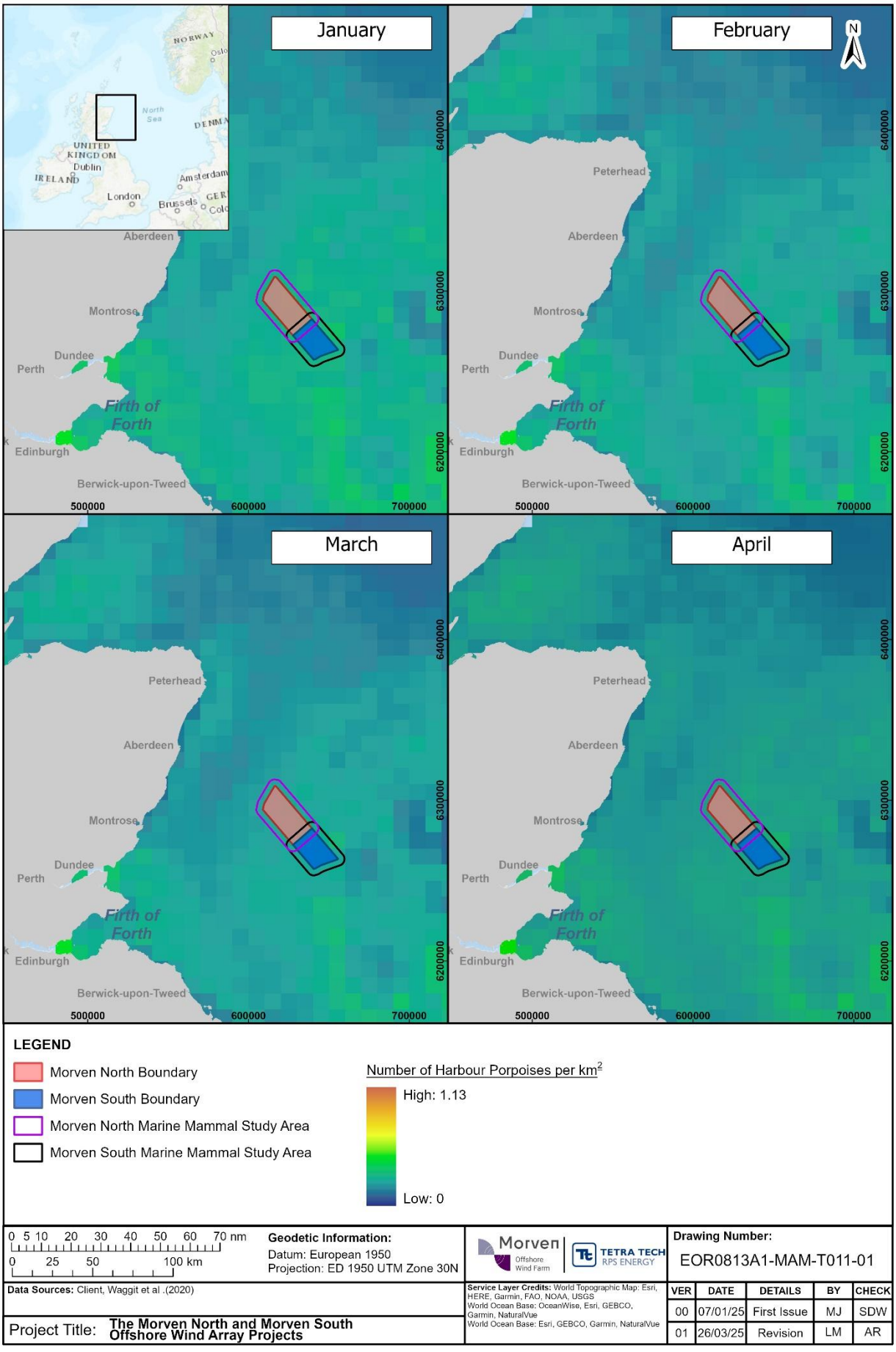

Figure 4.3: Harbour porpoise density from January to April based on Waggitt *et al.* (2020)

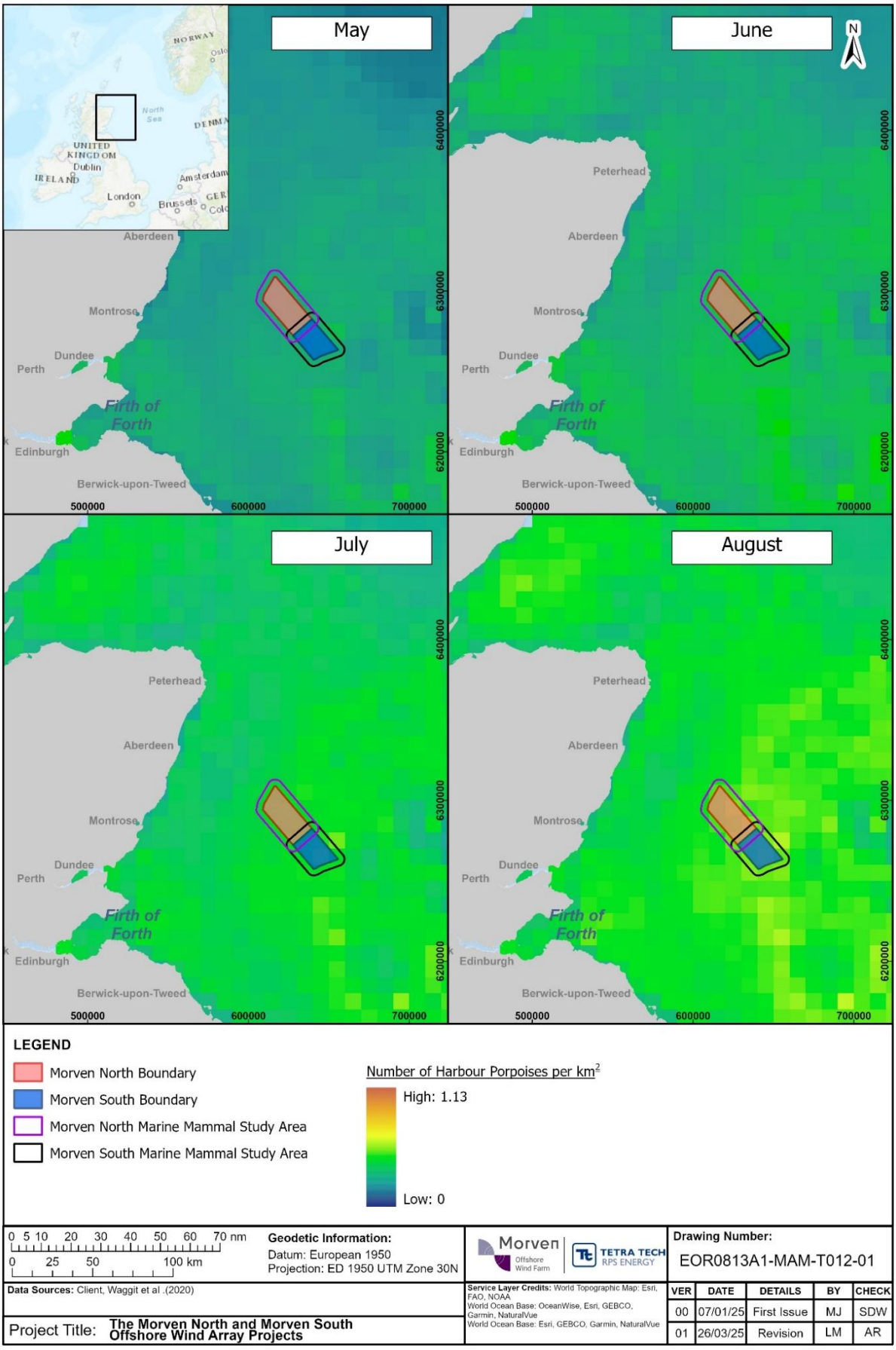

Figure 4.4: Harbour porpoise density from May to August based on Waggitt *et al.* (2020)

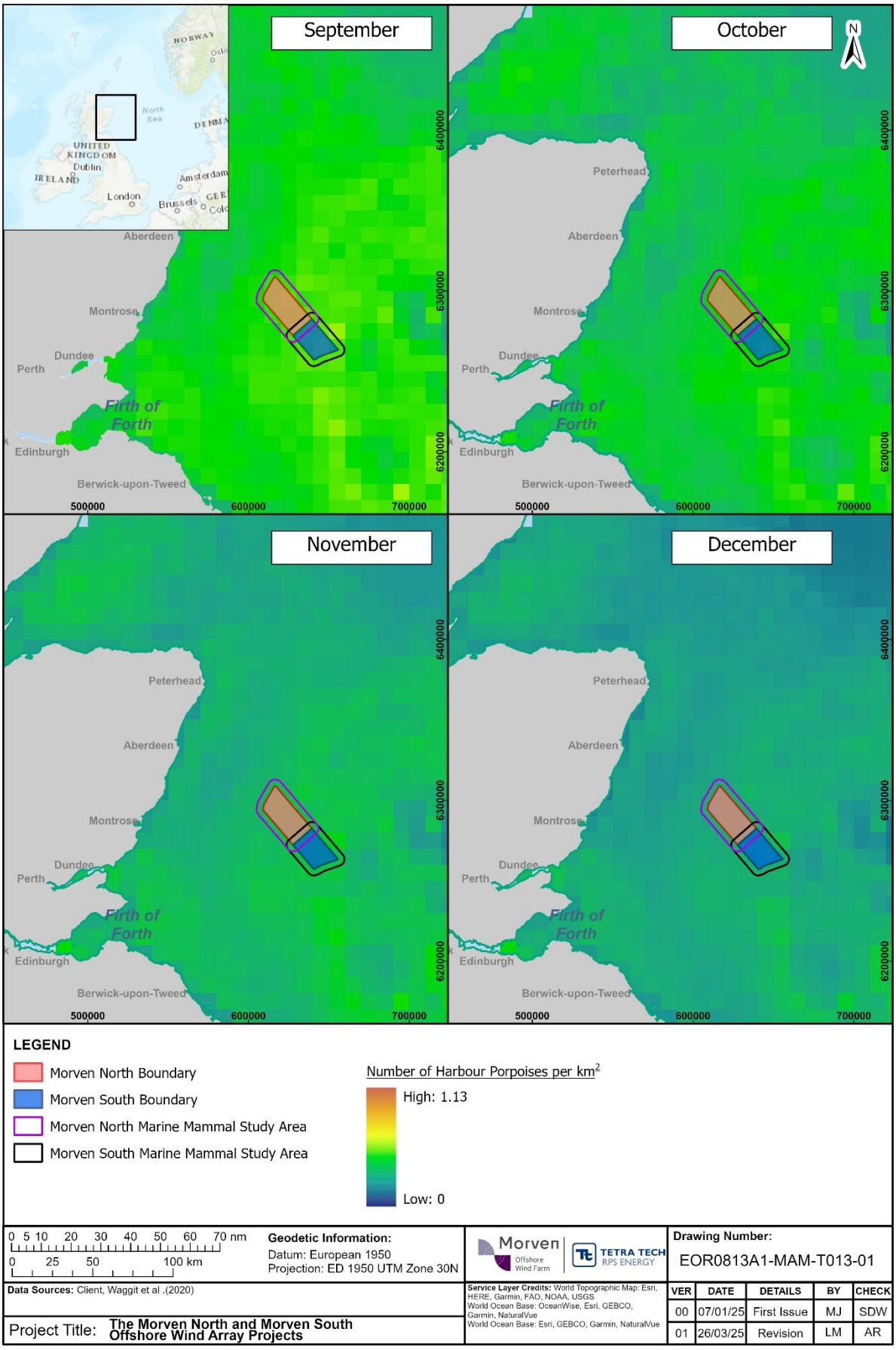

Figure 4.5: Harbour porpoise density from September to December based on Waggitt *et al.* (2020)

Commercial Surveys

Historical surveys for other OWFs

4.2.3.12 A number of historical surveys were undertaken more than ten years ago (TCE Aerial Survey, Neart na Gaoithe Boat-based Surveys and Seagreen boat-based surveys) with these surveys area all to southwest (further inshore) of the Morven Site (Figure 2.2). Densities were available for the TCE aerial surveys (Figure 2.2) providing an overall mean of 0.080 animals/km^2, with 0.099 animals/km^2 and 0.048 animals/km^2 in summer and winter, respectively (Grellier and Lacey, 2011). No detection function was able to be calculated for these surveys, and as such estimates of absolute density were not available. These estimates correspond to an abundance across the FTOWDG survey area (Figure 2.2) between summer 2009 and winter 2010 of 583 individuals (95% CI = 582 to 1,235) (Mackenzie *et al.*, 2012). Peak densities derived from the site specific surveys for Neart na Gaoithe (Gordon, 2012) were higher than those estimated for TCE surveys with a mean of 0.38 animals/km^2 (Mainstream Renewable Power, 2019). Seagreen boat-based surveys recorded encounter rates, but did not calculate density estimates.

4.2.3.13 For those surveys undertaken less than ten years ago (Seagreen bird surveys, Berwick Bank Aerial Surveys, Ossian Array Aerial Surveys and SSE Regional Surveys), absolute mean monthly density estimates were available. Absolute densities correct for bias in the data and therefore can be compared across surveys, providing more robust data to inform the ecological baseline for mariner mammals. For example, aerial surveys undertaken 2019 to 2021 to inform the baseline for the Berwick Bank Offshore Wind Farm (Figure 2.2) calculated a mean absolute density estimate of 0.299 animals/km^2 (95% CI = 0.155 to 0.652) with a peak during spring of 0.826 animals/km^2 (95% CI = 0.440 to 1.616) (SSE Renewables, 2022c). Aerial surveys for the Ossian Array (March 2021 to February 2022, inclusive) estimated similar overall absolute densities for harbour porpoise of 0.357 animals/km^2 (Ossian OWFL, 2024). When considered over a finer temporal scale, greater density of 0.651 animals/km^2 was estimated during the "summer" bio-season (as defined by Heinänen and Skov (2015)), with a much lower density of 0.062 animals/km^2 during the "winter" bio-season. The broader scale SSE Regional Surveys, which incorporates both the Morven Site Marine Mammal Study Area and the Ossian Array boundary (Figure 2.2), estimated an absolute density of 0.334 animals/km^2 across the 18-month survey period, which breaks down to 0.057 animals/km^2 during the "winter" bio-season, and 0.511 animals/km^2 during the "summer" bio-season (HiDef, 2023). These historical surveys are comparable to those estimated during the SCANS-III and SCANS-IV surveys suggesting a stable harbour porpoise population within the Firth of Forth region.

Site specific surveys

4.2.3.14 Monthly densities of harbour porpoise are presented below for the design-based analyses of site specific DAS data (January 2021 and September 2023, inclusive; see Section 3.2.2) for the Morven Site Marine Mammal Study Area and also separately for the Morven North Marine Mammal Study Area and Morven South Marine Mammal Study Area. As it was not possible to split the data into North and South for the model-based approach (due to poor model-fit) the results are presented only for the Morven Site Marine Mammal Study Area (see Section 3.2.2).

4.2.3.15 In all cases, relative estimates were corrected for availability bias (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report) using the most conservative conversion factor of 42.5%, based on methods described by Teilmann *et al.* (2013).

Morven Site Marine Mammal Study Area

4.2.3.16 Estimates of absolute density from the design-based analysis of DAS data for the Morven Site Marine Mammal Study Area were 0.059 animals/km^2 for the winter bio-season (95% CI = 0.028 to 0.101, CV = 1.308), and 0.396 animals/km^2 for summer (95% CI = 0.175 to 0.689, CV = 1.469). The mean absolute density estimate (bootstrapped with replacement) across all transects and all monthly surveys for the 33 months of DAS data was estimated as 0.243 animals/km^2 (95% CI = 0.111 to 0.423).

4.2.3.17 Overall mean absolute density from the model-based approach, calculated across all 33 months of DAS data, was 0.148 animals/km^2 (95% CI = 0.073 to 0.317, CV = 1.721). Model-fit was too poor for consideration when divided by “summer” and ”inter” bio-seasons, and as such the results from this analysis are not presented here.

4.2.3.18 The largest group size of harbour porpoise recorded during DAS of the Morven Site Marine Mammal Study Area consisted of 12 individuals, with the highest raw survey count being 158 individuals during May 2022.

4.2.3.19 The outputs of the model-based analysis indicate that harbour porpoise density may be greater at the north of the Morven Site Marine Mammal Study Area (Figure 4.6), although this pattern is not clearly defined across the 33-months of DAS data. Outputs of the model-based analysis did not reflect temporal or spatial distribution when considered at the bio-season and meteorological season scale as the fit of these models was poor. Similarly, density estimates derived from the model-based analysis did not align well with those obtained via design-based methods.

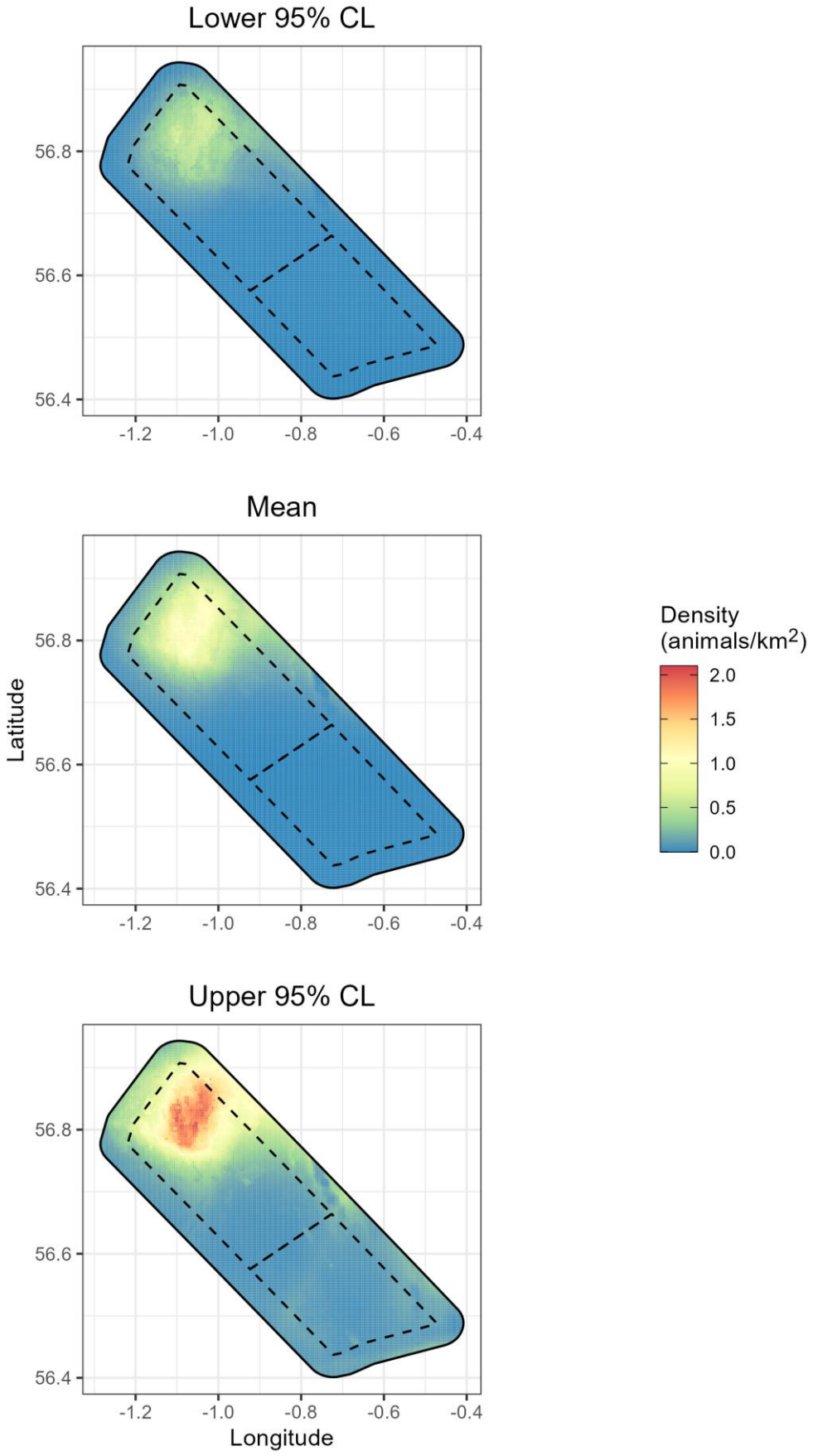

Figure 4.6: Predicted mean absolute density of harbour porpoise across the Morven Site Marine Mammal Study Area. Dashed line indicates Morven Site

Morven North Marine Mammal Study Area

4.2.3.20 Focussing only on the Morven North Marine Mammal Study Area estimates of absolute density from the design-based analysis of DAS data were 0.057 animals/km^2 for the winter bio-season (95% CI = 0.020 to 0.103, CV = 1.308), and 0.500 animals/km^2 for summer (95% CI = 0.175 to 0.904, CV = 1.773). The mean absolute density estimate (bootstrapped with replacement) across all transects and all monthly surveys for the 33 months of DAS data was estimated as 0.299 animals/km^2 (95% CI = 0.105 to 0.540, CV = 2.299). Note, however that the CV are relatively high for these estimates suggesting that there is a high variability in the data.

4.2.3.21 The largest group size of harbour porpoise recorded during DAS of the Morven North Marine Mammal Study Area consisted of 12 individuals, with the highest raw survey count being 156 individuals during May 2022.

4.2.3.22 As described in paragraph 2.1.2.5, the model-based analyses did not allow for a separate density estimate for harbour porpoise in the Morven North Marine Mammal Study Area.

Morven South Marine Mammal Study Area

4.2.3.23 Estimates of absolute density from the design-based analysis of DAS data for the Morven South Marine Mammal Study Area were 0.059 animals/km^2 for the winter bio-season (95% CI = 0.035 to 0.088, CV = 1.561), and 0.219 animals/km^2 for summer (95% CI = 0.130 to 0.325, CV = 1.138). The mean absolute density estimate (bootstrapped with replacement) across all transects and all monthly surveys for the 33 months of DAS data was estimated as 0.147 animals/km^2 (95% CI = 0.087 to 0.217, CV = 1.421). As above, high CVs suggest a high level of variability in the density estimates.

4.2.3.24 The largest group of harbour porpoise recorded during DAS of the Morven South Marine Mammal Study Area consisted of 12 individuals, with the highest raw survey count being 34 individuals during June 2023.

4.2.3.25 As described in paragraph 2.1.2.5, the model-based analyses did not allow for a separate density estimate for harbour porpoise in the Morven South Marine Mammal Study Area.

4.2.4 Seasonality

4.2.4.1 Across datasets, harbour porpoise counts were generally higher during late spring and summer months. The monthly encounter rate for harbour porpoise from the Morven Site Marine Mammal Study Area DAS data varied across months with the encounter rate for May 2021, and May 2022 being particular peaks (n = 116 and 158, respectively), although May 2023 was comparatively low (n = 17) (Table 3.3).

4.2.4.2 Similarly, analysis of Berwick Bank aerial survey data suggested highest encounter rates during spring each year (April and May) and lowest during winter and autumn (from November 2019 to March 2020 and from October 2020 to February 2021) (SSE Renewables, 2022a).

4.2.4.3 During the TCE aerial surveys (Figure 2.2) harbour porpoises were recorded nearly three times as often in summer (2.01 sightings/100km) compared to winter (0.70 sightings/100km) (Grellier and Lacey, 2011). The same pattern of higher encounter rates during summer months was also recorded during the Seagreen boat-based surveys (Sparling, 2012). The Seagreen boat-based surveys in summer 2017 recorded the highest counts of harbour porpoise between May and July (Seagreen Wind Energy Limited, 2018).

4.2.5 Summary

4.2.5.1 Harbour porpoise is abundant throughout the North Sea with areas of higher density located in the southern North Sea. A comparison of density estimates from key data sources for harbour porpoise is presented in Table 4.1.

4.2.5.2 Heinänen and Skov (2015) reported that pooling data according to temporal patterns of harbour porpoise distribution is the most appropriate method for studying harbour porpoise abundance/densities. As such, estimates of harbour porpoise density from DAS presented in Table 4.1 are based on the division of the year into two bio-seasons. The most precautionary estimate was obtained during "summer" (April to September).

4.2.5.3 Predicted estimates of mean density for the Morven Site Marine Mammal Study Area from Waggitt *et al.* (2020), SCANS-III Block R and SCANS-IV Block NS-D estimates are all in the same order of magnitude and therefore comparable (Table 4.1). While surface density estimates from Gilles *et al.* (2025) and Waggitt *et al.* (2020) are at a finer spatial resolution compared to the SCANS block data, SCANS-IV block data (from 2022) are more conservative, and represent the most up-to-date density estimates for harbour porpoise and therefore are favoured over other density estimates which are derived from data more than eight years old. In addition, SCANS-IV data reflect densities across the wider region and therefore can be applied where the Zone of Influence (ZoI) extends beyond the Morven Site Marine Mammal Study Area.

4.2.5.4 In summary, it is considered that the SCANS-IV density is the most appropriate to inform impact assessments and a harbour porpoise density of 0.599 animals/km^2 will be taken forward to the assessment.

Table 4.1: Comparison of density estimates for harbour porpoise in the vicinity of the Morven Site Marine Mammal Study Area. Text in bold is the value carried forward for the assessment

Source	Survey Area	Density (animals/km^2)	CV
SCANS-III design-based estimates (Hammond *et al.*, 2021)	Block R	0.599	0.287
SCANS-III density surface models (Lacey *et al.*, 2022)	Morven Site Marine Mammal Study Area	0.684	0.160
	Morven North Marine Mammal Study Area	0.652	0.157
	Morven South Marine Mammal Study Area	0.724	0.162
SCANS-IV design-based estimates (Gilles *et al.*, 2023)	**Block NS-D**	**0.599**	**0.367**
SCANS-IV density surface models (Gilles *et al.*, 2025)	Morven Site Marine Mammal Study Area	0.363	0.368
	Morven North Marine Mammal Study Area	0.298	0.694
	Morven South Marine Mammal Study Area	0.433	0.335
winterSCANS design-based estimates (Ramirez-Martinez *et al.*, 2025)	**Block NS-D**	**0.257**	**0.265**
Distribution maps of cetacean and seabird populations in the North East Atlantic (Waggitt *et al.*, 2020)	Morven Site Marine Mammal Study Area	0.531	-
	Morven North Marine Mammal Study Area	0.522	-
	Morven South Marine Mammal Study Area	0.547	-
Site specific DAS design-based	Morven Site Marine Mammal Study Area (summer bio-season)	0.396	1.469
	Morven North Marine Mammal Study Area (summer bio-season)	0.500	1.773
	Morven South Marine Mammal Study Area (summer bio-season)	0.219	1.138
Site specific DAS model-based	Morven Site Marine Mammal Study Area (33-month DAS data)	0.148	1.721

4.3 Bottlenose Dolphin

4.3.1 Ecology

4.3.1.1 Bottlenose dolphin are odontocetes of the family Delphinidae, found in temperate and tropical waters worldwide. It is the largest of the beaked dolphins, ranging in length from 1.9m to 3.8m. Bottlenose dolphin live, on average, between 20 to 30 years, with males reaching 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)

4.3.1.2 Bottlenose dolphin are more frequently seen in groups rather than individually, and group size in offshore populations may be larger than coastal populations, although relatively little is known about offshore populations (Rogan *et al.*, 2018). For example, mean group size across the SCANS-III survey areas was estimated as 5.25 individuals (Hammond *et al.*, 2021), while group sizes in the outer Moray Firth varied between two and 70 animals (Robinson *et al.*, 2017).

4.3.1.3 The distribution of bottlenose dolphin is influenced by tidal state, weather conditions, resource availability, life cycle stage and seasonal factors and within-population variation in patterns of habitat use have been observed (Hastie *et al.*, 2004). Typical prey items in Scottish waters include cod (*Gadus morhua*), saithe (Pollachius virens), salmon (*Salmo salar),* haddock (*Melanogrammus aeglefinus)* and whiting (Santos *et al.*, 2001).

4.3.2 Distribution and Occurrence

4.3.2.1 Bottlenose dolphin is present within the northern North Sea and comprises discrete offshore and inshore population ecotypes (Cheney *et al.*, 2013). Morven North is located in the offshore region and will therefore predominantly overlap with the offshore population represented by the Greater North Sea (GNS) MU. However, only the coastal population, distributed within the 2m to 20m depth contour and approximately 2km from the shore, is well studied (Geelhoed *et al.*, 2022). The inshore population within the East Coastal East Scotland (CES) MU has strong links with the Moray Firth SAC.

4.3.2.2 Based on data collected in the 1980s and 1990s, the Moray Firth SAC is thought to encompass the core area of occurrence for the resident coastal bottlenose dolphin population. Occupancy rates and habitat modelling from the ECOMMAS have highlighted that the waters between Stonehaven and Aberdeen are also a potential area of high occupancy (Palmer *et al.*, 2019).

4.3.2.3 The ECOMMAS C-POD study found that broadband acoustic occupancy rates throughout the survey were generally higher for C-PODs closer to the shoreline (Palmer *et al.*, 2019), supporting the findings of previous investigations (Thompson *et al.*, 2015). This suggests that bottlenose dolphins are more likely to be observed in coastal waters, within 5km of shore and therefore are unlikely to be present in the offshore areas that may be exposed to significant construction noise from offshore wind farms. These results were corroborated by (Quick *et al.*, 2014) which reported that dolphins were mostly encountered in waters less than 30m deep, generally in waters between 2m and 20m and within 2km from the coast. (Paxton *et al.*, 2016) also describes bottlenose dolphin distribution as coastal.

4.3.2.4 A high proportion of bottlenose dolphins from the Coastal East Scotland MU (Figure 4.7) population use both the Tayside and Fife area as well as the Moray Firth SAC, over a range of temporal scales (Quick *et al.*, 2014), and more than half of this population consistently uses the St Andrews Bay and the Tay estuary (Arso Civil *et al.*, 2019). Boat-based survey data collected between the Moray Firth and Fife Ness in the summers of 2017 to 2019 also show that the Tay estuary and adjacent waters continue to be used by approximately 53% of the population every summer (Arso Civil *et al.*, 2021).

4.3.2.5 Although historic accounts suggest that bottlenose dolphin are not new to the area between the Firth of Forth and Withernsea (Bloom, 1991), the data detailed in the Sea Watch Foundation's National

Whale and Dolphin Watch reports have revealed an influx of animals in the last decade (Hackett, 2022, Sea Watch Foundation, 2023). A photo-identification study and analysis of sightings data support these findings and show that annual sightings of bottlenose dolphins along Northeast England have steadily increased since 2019 (Hackett, 2022).

4.3.2.6 Between March and October 2018, 16 post-construction surveys were undertaken for the Blyth Offshore Demonstrator project, located 5km off the Northumberland coast (EDF Renewables, 2019), during which bottlenose dolphin were recorded during two surveys. No bottlenose dolphin were recorded during associated pre-construction site investigation surveys carried out between March and October 2016 (EDF Renewables, 2019).

4.3.2.7 As well as commercial and formal scientific projects, citizen science projects are also an important source of information on the distribution of bottlenose dolphin along the east coast of the UK. Ongoing citizen science projects suggest that some members of this population are relocating from Scottish waters into waters off the coast of eastern England (as far south as Scarborough, Figure 4.7) (Hackett, 2022). North East Cetacean Project (NECP) encourages the public to share cetacean sightings from the Humber to the Scottish Border (NECP, 2021). Another project which combines research and citizen science photo-identification data, specifically of bottlenose dolphins, is called Citizen Fins (Citizen Fins, 2023). This collaboration allows for photo-identification work to match photos taken by citizens in England with the East Coast Scotland Bottlenose Dolphin Photo-ID Catalogue. Many individuals from the East Coast Scotland population were positively identified from the Northumberland coast at numerous locations, including Cresswell, Beacon Point, King Edward's Bay (Tynemouth), Whitburn Beach and Roker Beach (Citizen Fins, 2023). As such, the results of photo-identification analysis suggest that animals found off the northeast coast of England are not a separate, isolated population from those in the Moray Firth SAC.

4.3.3 Density/abundance

Published Literature

4.3.3.1 The population estimate of bottlenose dolphin for the Coastal East Scotland MU (Figure 4.7) is 195 individuals (95% CI = 162 to 253) based on photo-ID counts between 2006 and 2007 (Cheney *et al.*, 2013). Following this estimate, the bottlenose dolphin population on the east coast of Scotland appears to be increasing and varied from 129 (95% CI = 104 to 155) in 2001 to 189 (95% CI = 155 to 216) in 2015 (Cheney *et al.*, 2018). The most up-to-date bottlenose dolphin population estimate for Coastal East Scotland MU is 226 individuals (Cheney *et al.*, 2024), corresponding to an estimated density of 0.010 animals/km^2. Overall, the number of individuals resident in the Moray Firth SAC appears to have reduced in proportion due to an overall increase in population size and expansion of range (Cheney *et al.*, 2018).

4.3.3.2 The SCANS-III estimated abundance for Survey Block R which covers the offshore area (Figure 2.4) was 1,924 bottlenose dolphins (95% CI = 0 to 5,408) (Hammond *et al.*, 2021). This is a much higher estimate than the abundance estimate for the Coastal East Scotland population derived from the dedicated photo-identification surveys described in paragraph 4.3.2.5 (Cheney *et al.*, 2018). However, studies for the Coastal East Scotland population are focussed on inshore waters, and SCANS-III results were obtained through large scale surveys, including offshore waters. Studies suggest that inshore and offshore populations are often ecologically and genetically discrete (Cheney *et al.*, 2013).

4.3.3.3 The population estimate for bottlenose dolphin for the Greater North Sea MU was 2,022 animals with 1,885 animals in the UK portion of this MU. Densities for bottlenose dolphin within SCANS-III Survey Block R, covering the offshore area, have been reported as 0.030 animals/km^2 (Hammond *et al.*, 2021). Updated modelled density surfaces using the SCANS-III data (Lacey *et al.*, 2022) gave a mean density of 0.004 animals/km^2 and a maximum of 0.015 animals/km^2 for the Morven Site Marine Mammal Study Area (Figure 4.8), with density maps showing higher areas of density in the inshore waters close to the Firths of Forth and Tay estuaries. There were no bottlenose dolphin sightings in SCANS-IV Survey Block NS-D (Gilles *et al.*, 2023), however density surface modelling extrapolated from other sightings linked to environmental variables from the SCANS-IV data provided a mean

density estimate of 0.001 animals/km^2 for the Morven Site Marine Mammal Study Area (95% CI = 0.000 to 0.011, CV = 4.486).

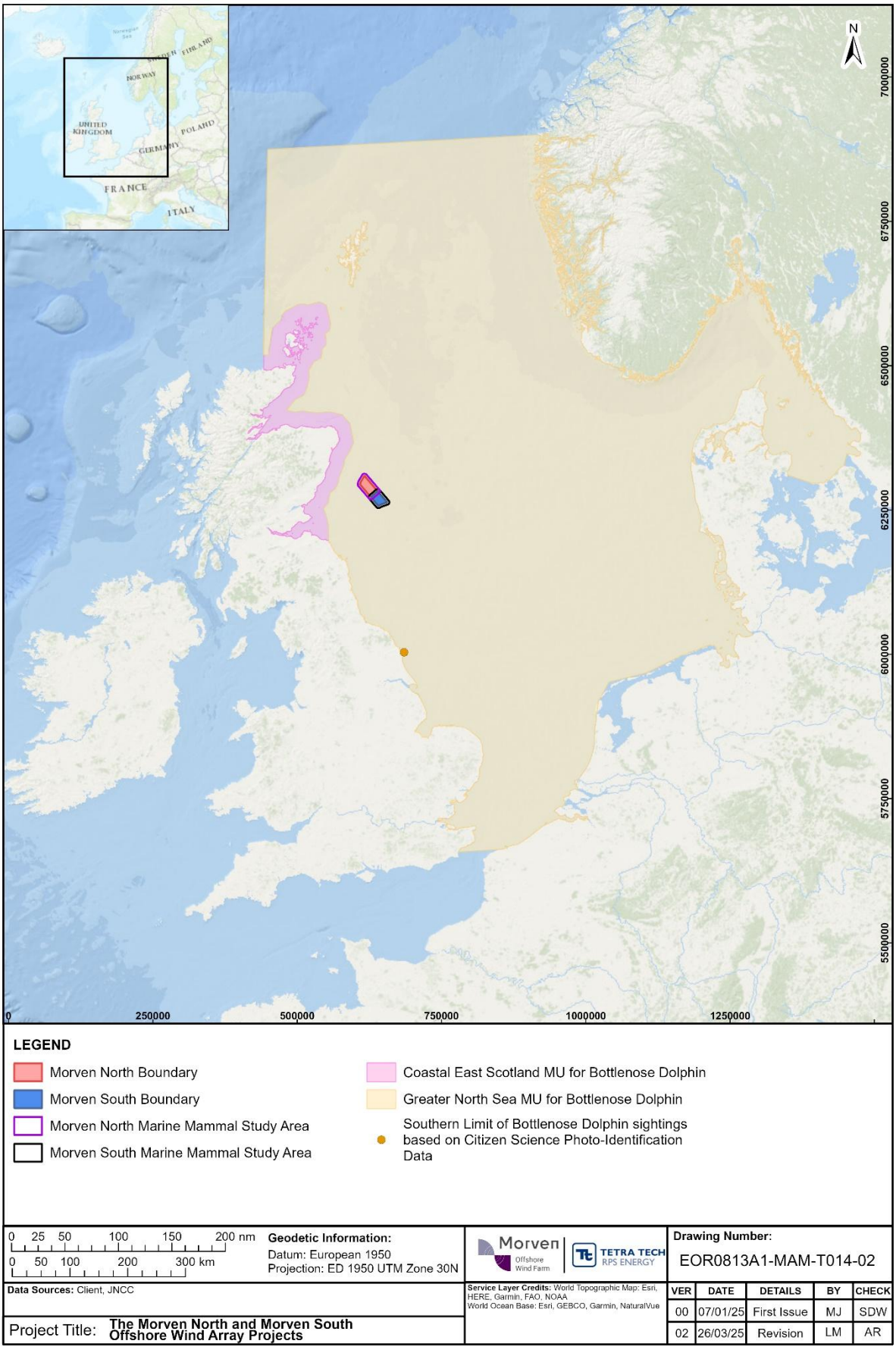

Figure 4.7: Bottlenose dolphin MU in the vicinity of the Morven Site Marine Mammal Study Area (IAMMWG, 2023) and southern limit of bottlenose dolphin sightings (Hackett, 2022)

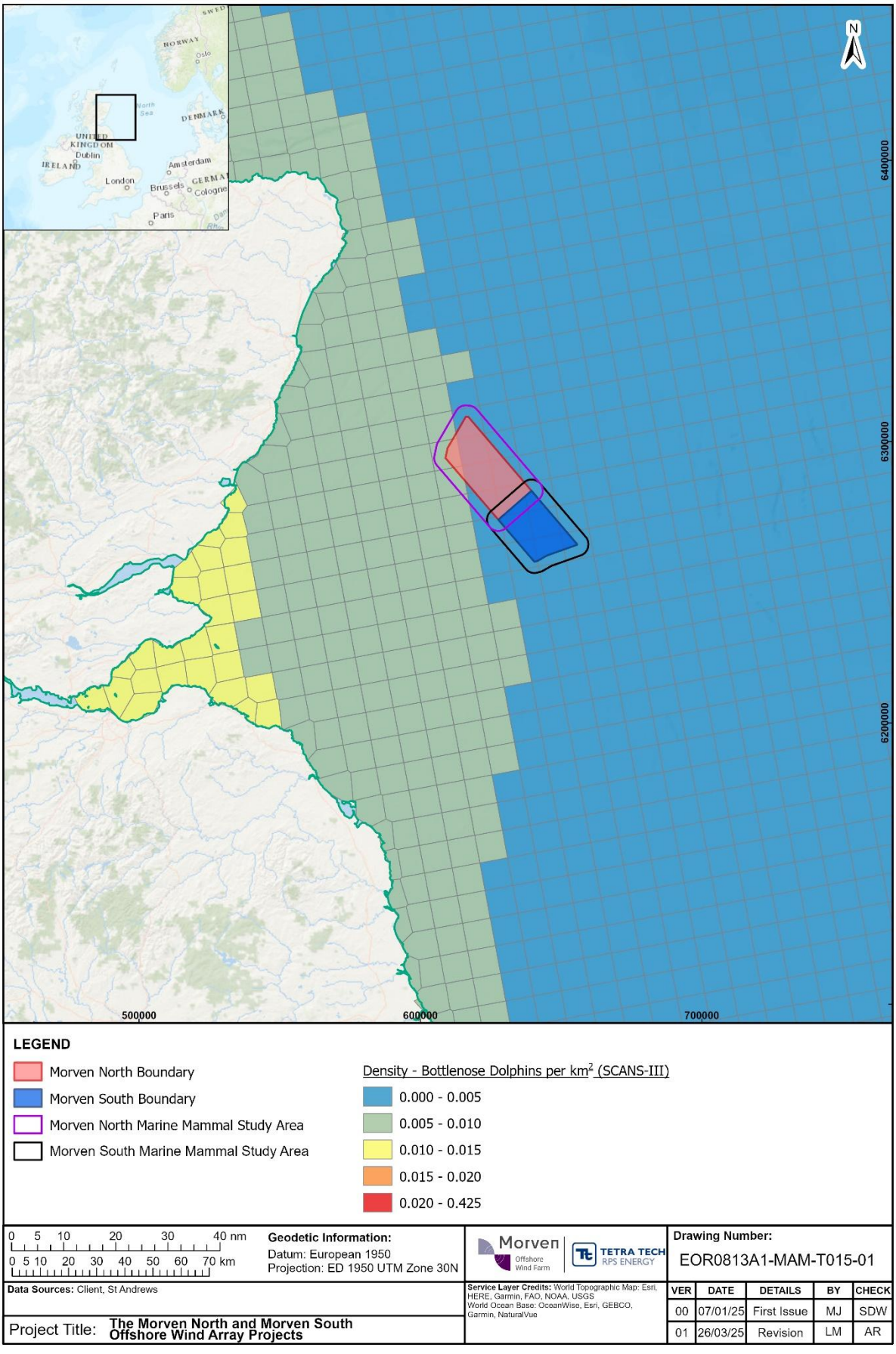

Figure 4.8: Density surface maps from SCANS-III data for bottlenose dolphin based on Lacey et al. (2022)

4.3.3.4 To capture the patchiness in coastal distribution of bottlenose dolphins and estimate density, an analysis of ECOMMAS data was undertaken for the Berwick Bank Offshore Wind Farm in the Firth of Forth (SSE Renewables, 2022a). The analysis considered the most up-to-date coastal population size based on and Hackett (2022), distributional range between the Moray Firth and Firth of Forth as presented in, coastal distribution within 5km from the shore (Palmer *et al.*, 2019, Arso Civil, 2014, Oudejans *et al.*, 2015) and depth preference of 2m to 20m (Quick *et al.*, 2014). Assuming even distribution of 50% population of bottlenose dolphin between Peterhead and the Farne Islands, excluding the outer Firth of Tay, a density of 0.197 animals/km^2 was calculated. To reflect the relative importance of the outer Firth of Tay in terms of bottlenose dolphin distribution, the habitat preference map for bottlenose dolphins in the Firth of Tay and adjacent areas as modelled by Arso Civil *et al.* (2019) was used. Four distinct segments were identified on the habitat preference maps: Fife Ness to St Andrews, Outer Firth of Tay, Arbroath, and Montrose; a number of bottlenose dolphins was estimated for each of the segments. The density within the Firth of Tay and 2m to 20m depth contour was estimated as 0.294 animals/km^2. It should be noted that this analysis did not consider individuals from the Coastal East Scotland bottlenose dolphin population that range further south and along the Northumberland coast.

4.3.3.5 Predicted distribution maps of bottlenose dolphin at monthly scales by Waggitt *et al.* (2020) demonstrated bottlenose dolphin densities to be consistently low throughout the year (Figure 4.8, Figure 4.9 and Figure 4.10). Highest densities within the Morven Site Marine Mammal Study Area were predicted in August with a maximum of 0.00271 animals/km^2. However, as a limitation, authors of this study highlight that small and isolated sub-populations would have little influence on these broad-scale models and that there may have been substantial changes in populations across the study period. As such, density estimates provided by Waggitt *et al.* (2020) may not be a true reflection of densities for the Coastal East Scotland bottlenose dolphin population due to its small size and recent southward expansion.

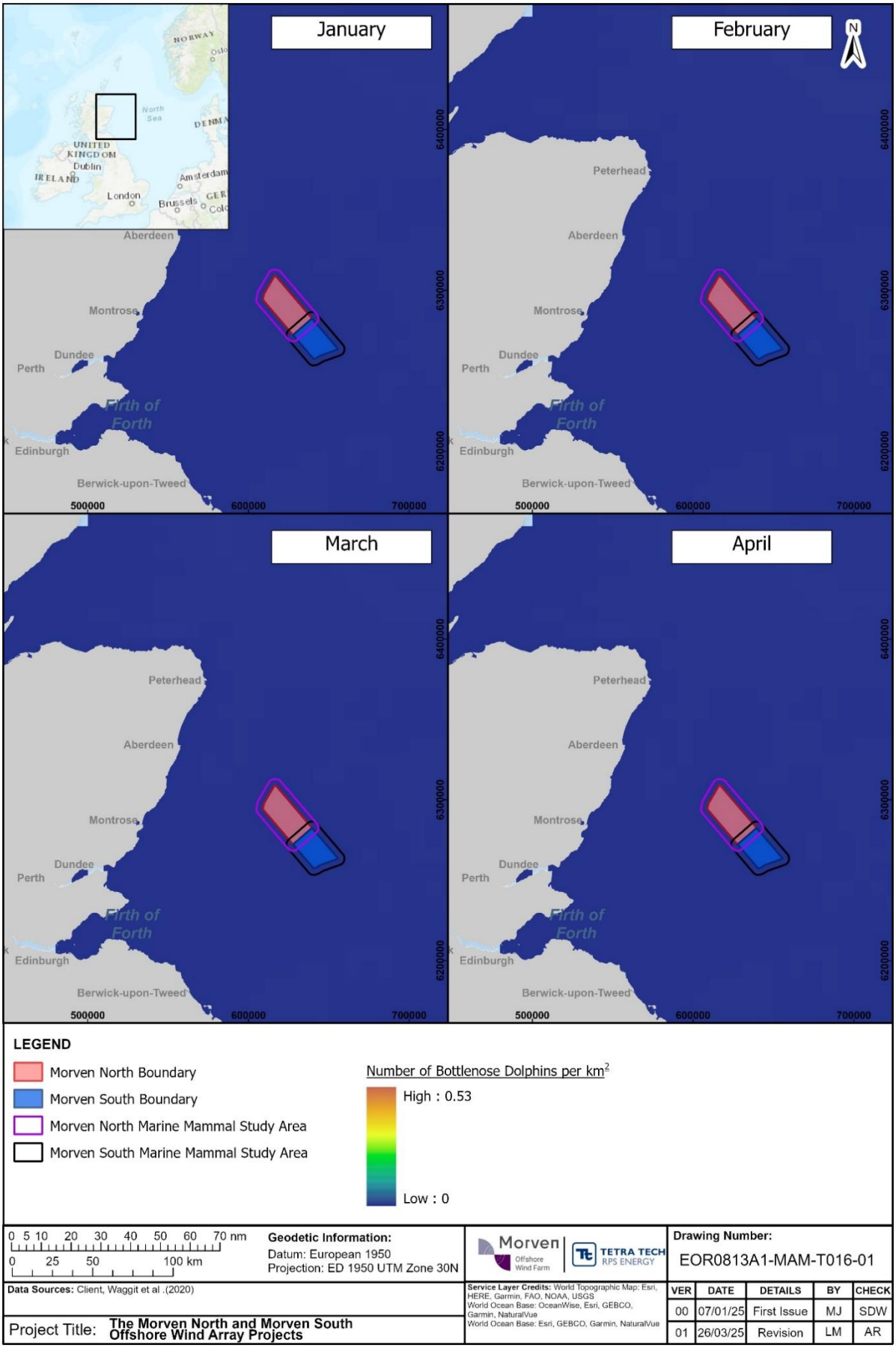

Figure 4.9: Bottlenose dolphin density from January to April based on Waggitt *et al.* (2020)

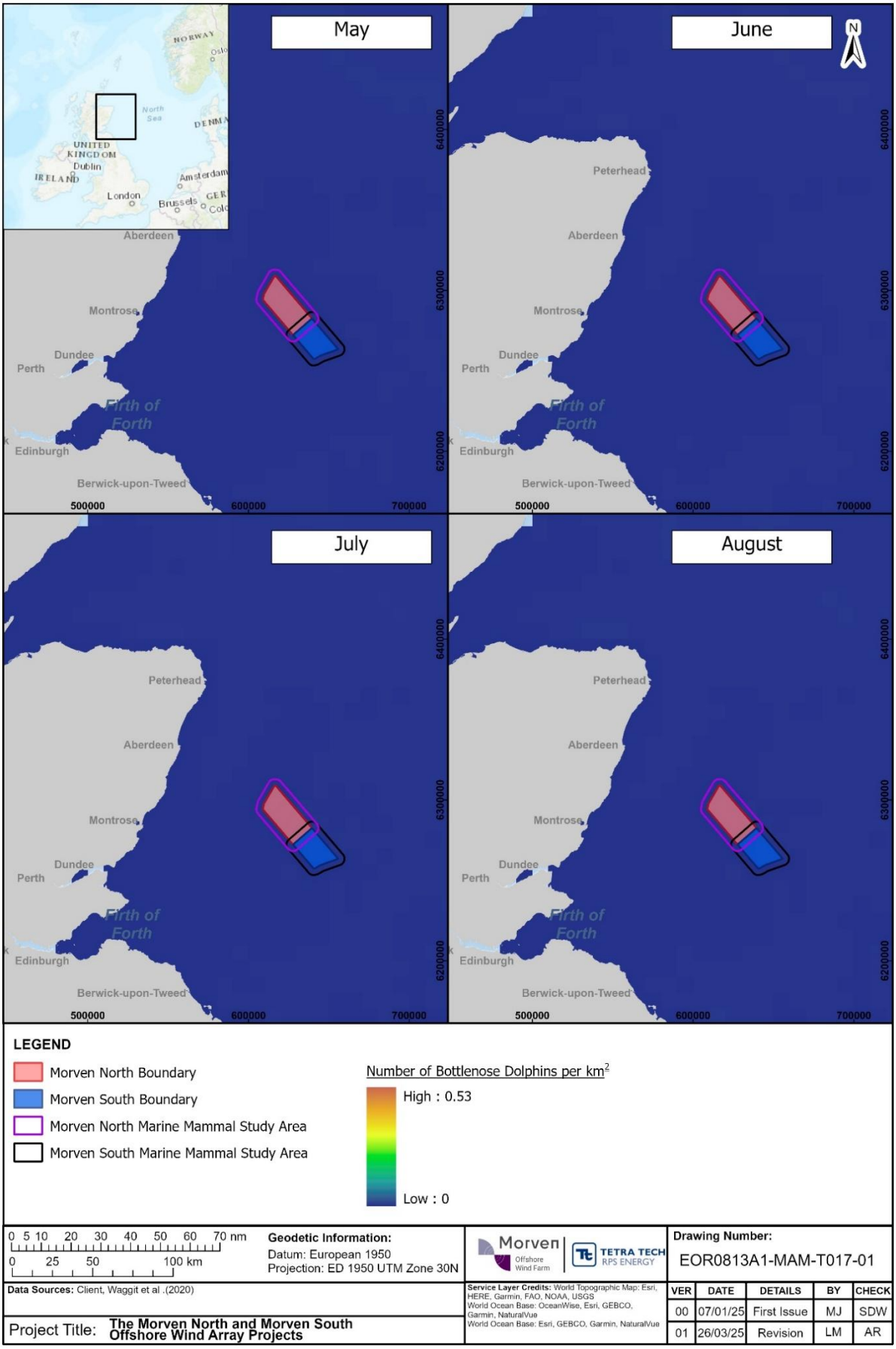

Figure 4.10: Bottlenose dolphin density from May to August based on Waggitt *et al.* (2020)

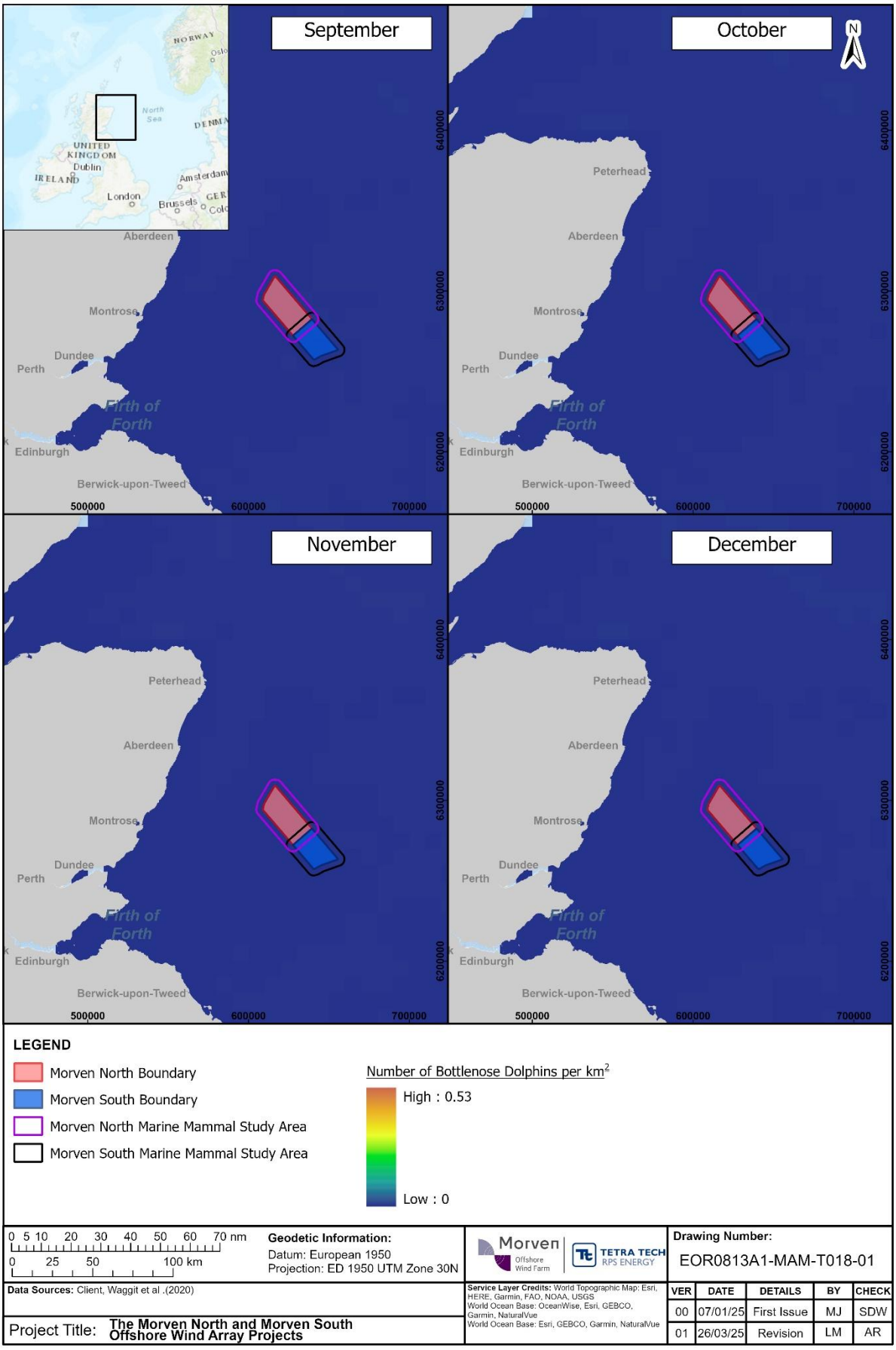

Figure 4.11: Bottlenose dolphin density from September to December based on Waggitt *et al.* (2020)

Commercial Surveys

Historical surveys for other OWFs

4.3.3.6 Surveys conducted more than ten years old suggest very low numbers of bottlenose dolphin within the outer Firth of Forth. For example, there were no records of bottlenose dolphins in the offshore waters during three years (2009 to 2012) of boat-based surveys within the Neart na Gaoithe Offshore Wind Farm area (Mainstream Renewable Power, 2019). Similarly, low numbers of bottlenose dolphins were recorded during the historic surveys in the wider Firth of Forth and Tay areas and therefore there are no density estimates that were informed by these surveys.

4.3.3.7 For more recent surveys (conducted less than ten years old) bottlenose dolphins were again recorded in low numbers. During the Berwick Bank aerial surveys only one and six individuals were encountered in October 2019 and April 2021 respectively (SSE Renewables, 2022a). There were also no records of bottlenose dolphins during the Seagreen boat-based surveys, which took place approx. 25km offshore (Sparling, 2012), and no observations were made during the Ossian Array aerial surveys (Ossian OWFL, 2024) or the SSE Regional Surveys (HiDef, 2023).

Site specific surveys

4.3.3.8 No bottlenose dolphin individuals were recorded during DAS of the Morven Site Marine Mammal Study Area, and as such design- or model-based density and abundance estimates for this species are not available for any of the Morven Marine Mammal Study Areas.

4.3.4 Seasonality

4.3.4.1 In the Moray Firth, three times as many individuals occurred in inshore waters in the summer compared to the winter months (Thompson *et al.*, 2011). and within the Firth of Forth bottlenose dolphins were more expected to be approximately 85% to 100% more abundant during spring and summer compared to the winter months (Paxton *et al.*, 2016). Similarly, a photo-identification study and analysis of sightings data conducted by (Hackett, 2022) showed that although sightings of bottlenose dolphins between Firth of Forth and Withernsea are recorded year-round, the rates at which bottlenose dolphins are being seen are three to seven times higher during summer than other seasons. It has been suggested that this seasonal inshore occurrence of bottlenose dolphin may be linked to periods when animals move into warmer shallow waters to calve and nurse their young during the summer months. Breeding in bottlenose dolphins is usually seasonal and varies with location but in the Moray Firth the peak calving period is in the late summer (Culloch and Robinson, 2008). Other driving factors may also include seasonal distribution of prey species. Seasonal trends in offshore populations are unknown.

4.3.5 Summary

4.3.5.1 Overall, bottlenose dolphins are present across the northern North Sea, however, only the coastal population, distributed within the 2m to 20m depth contour and approximately 2km from the shore, is well documented in literature. Comparison of key data sources for bottlenose dolphin is shown in Table 4.2.

4.3.5.2 As presented in paragraph 4.3.3.8, design or model-based density and abundance estimates for bottlenose dolphin based on DAS are not available.

4.3.5.3 Predicted estimates of mean density for the Morven Site Marine Mammal Study Area from Waggitt *et al.* (2020) are comparable to the Lacey *et al.* (2022) estimate and are provided at the same resolution (10km x 10km). SCANS-III densities published by (Hammond *et al.*, 2021) are an order of magnitude higher, however these are based on one estimate for a large block (Figure 2.3) that covers both inshore and offshore waters. As presented in paragraph 4.3.2.3, the distribution of bottlenose dolphins within the Coastal East Scotland MU is restricted to coastal areas within 2km to 5km of the shore and therefore the density within these areas is expected to be higher than offshore. As such,

it is considered that densities presented in (Hammond *et al.*, 2021) may not be representative of offshore waters, where the Morven Site Marine Mammal Study Area is located.

4.3.5.4 Lacey *et al.* (2022) used SCANS-III data alongside environmental covariates such as depth and slope (see Section 2.3.1) in the density surface modelling. As described in paragraph 4.3.2.3, depth is an important predictor for bottlenose dolphin distribution. Therefore, studies that consider environmental conditions allow discrimination among different habitats (e.g. shallow vs deep) and are preferrable when predicting bottlenose dolphin density. While environmental covariates are also considered by Waggitt *et al.* (2020) and Gilles *et al.* (2025), the density estimates reported for bottlenose dolphin by Lacey *et al.* (2022) are more conservative and are considered more appropriate to use to reflect densities of bottlenose dolphins in offshore waters where the Morven Site Marine Mammal Study Area is located. A density of 0.005 animals/km^2, as reported by Lacey *et al.* (2022) will therefore be taken forward to the assessment for offshore waters, and a density estimate of 0.010 animals/km^2 will be taken forward for inshore/coastal waters.

4.3.5.5 Where impacts could extend into inshore areas (e.g. vessel movements to/from the Morven North and Morven South that may pass through the Coastal East Scotland MU) the density applied to this area in particular will be 0.010 animals/km^2 (Arso Civil *et al.*, 2021, IAMMWG, 2023).

Table 4.2: Comparison of offshore density estimates for bottlenose dolphin in the vicinity of the Morven Site Marine Mammal Study Area and for the Coastal East Scotland MU inshore population. Text in bold are the values taken through for the assessment

Source	Survey Area	Density1 (animals/km^2)	CV
Offshore Bottlenose Dolphin Population			
SCANS-III design-based estimates (Hammond *et al.*, 2021)	Block R	0.030	0.861
SCANS-III density surface models (Lacey *et al.*, 2022)	**Morven Site Marine Mammal Study Area**	**0.004**	**0.662**
	Morven North Marine Mammal Study Area	**0.005**	**0.656**
	Morven South Marine Mammal Study Area	**0.004**	**0.670**
SCANS-IV design-based estimates (Gilles *et al.*, 2023)	Block NS-D	N/A	-
SCANS-IV density surface models (Gilles *et al.*, 2025)	Morven Site Marine Mammal Study Area	0.001	4.951
	Morven North Marine Mammal Study Area	0.001	4.486
	Morven South Marine Mammal Study Area	0.001	5.378
Distribution maps of cetacean and seabird populations in the North East Atlantic (Waggitt *et al.*, 2020)	Morven Site Marine Mammal Study Area	0.002	-
	Morven North Marine Mammal Study Area	0.002	-
	Morven South Marine Mammal Study Area	0.002	-
Site specific DAS: design-based	Morven Site Marine Mammal Study Area	N/A	-
Site specific DAS: model-based	Morven Site Marine Mammal Study Area	N/A	-

[1] Density estimates of "N/A" indicate that bottlenose dolphin were not identified for the duration of the respective survey campaign.

Source	Survey Area	Density1 (animals/km^2)	CV
Inshore Bottlenose Dolphin Population			
Review of Management Unit boundaries for cetaceans in UK waters (2023) (IAMMWG, 2023)	Coastal East Scotland MU	0.010	0.02

4.4 White-beaked Dolphin

4.4.1 Ecology

4.4.1.1 The white-beaked dolphin is another member of family Delphinidae (oceanic dolphins). It is a robust species that grows up to 3.5m for males and 3.05m for females. Adults become sexually mature at a length of approximately 2.6m and at approximately 12 to 13 years of age (Reeves *et al.*, 1999). The mating season for white-beaked dolphin is between July and August with the gestation period lasting approximately 11 months (Culik, 2010). Little is known about the reproductive behaviour of this species and while it was thought that births occur offshore in the northern North Sea (Evans, 1991), there is also evidence to suggest that females move into inshore waters to give birth (Canning *et al.*, 2008, Weir *et al.*, 2007).

4.4.1.2 The white-beaked dolphin is classified as Least Concern on the International Union for Conservation of Nature (IUCN) Red List (Sharpe and Berggren, 2023). However, there are concerns about the potential impact of climate change driving a reduction in its range (MacLeod *et al.*, 2005). In general, white-beaked dolphin are found in waters cooler than approximately 18˚C and are most common in waters below 13˚C (Tetley and Dolman, 2013). It has been suggested that due to the increase in sea surface temperature between 1948 and 2003, the suitable habitat of white-beaked dolphin in Scottish waters decreased, which has resulted in reduced species presence (MacLeod *et al.*, 2005, van Weelden *et al.*, 2021).

4.4.1.3 The white-beaked dolphin is understood to have a broad diet (Samarra *et al.*, 2022), with the main prey species in Scottish waters being whiting, alongside other clupeids (e.g. herring), gadoids (e.g. haddock and cod) and shad (Alosa spp.) (Canning *et al.*, 2008). Although the distribution and abundance of prey species affects the distribution and abundance of white-beaked dolphin, this species tends to be influenced by temperature with larger numbers and group sizes associated with cooler temperatures (Evans, 1991, Canning *et al.*, 2008, Weir *et al.*, 2007). Recent studies in Iceland demonstrate that, despite regional ecosystem changes, white-beaked dolphin showed no long-term changes in trophic ecology, suggesting that this species may adapt to changes in prey distribution or shift to similar prey (Samarra *et al.*, 2022).

4.4.2 Distribution and Occurrence

4.4.2.1 The white-beaked dolphin inhabits the temperate and subarctic North Atlantic (Schick *et al.*, 2020) and is the second most numerous cetacean in the North Sea, recorded more frequently in the western sector of the central and northern North Sea, generally in small groups of three to four animals (Reid *et al.*, 2003).

4.4.2.2 In the northeast Atlantic white-beaked dolphins are generally restricted to shelf waters and prefer waters less than 120m deep (Tetley and Dolman, 2013). However, some individuals have been encountered in deeper waters around Scotland, between approximately 106.5m to 134.5m (Weir *et al.*, 2009). This indicates the preference of white-beaked dolphins to inhabit open waters located outside of the immediate coastal zone. Moreover, other habitat variables, such as slope and seabed aspect, were thought to be important factors in driving occurrence (Tetley and Dolman, 2013). White-beaked dolphins are capable of long-range regional movements, although individuals can also show repeated inter-annual site fidelity.

4.4.2.3 During TCE aerial surveys, white-beaked dolphin were encountered in both inshore and offshore waters, with most encounters recorded offshore (Figure 2.2) in groups of one to six individuals (Grellier and Lacey, 2011). During the Seagreen Offshore Wind Farm boat-based surveys, white-beaked dolphin mostly occurred in groups: with a mean group size of three and a maximum of 15 individuals (Sparling, 2012), with greater density in the northeast of the Seagreen survey area (Figure 2.2). During the Berwick Bank aerial surveys, white-beaked dolphin sightings were most often in the southeast of the Berwick Bank survey area (Figure 2.2). No clear patterns in distribution of white-beaked dolphin can be concluded based on DAS sightings (see Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report).

4.4.3 Density/abundance

Published Literature

The relevant MU for white-beaked dolphin is the Celtic and Greater North Seas (CGNS) MU (Figure 4.12) which has an estimated population size of 43,951 animals in the whole MU (95% CI = 28,439 to 67,924; CV = 0.22) (IAMMWG, 2023). The abundance estimate in the UK portion of the CGNS MU is 34,025 animals (95% CI = 20,026 to 57,807, CV = 0.28). The SCANS-III estimated abundance for Survey Block R (Figure 2.3) was 15,694 (95% CI = 3,022 to 33,340; CV = 0.48) (Hammond *et al.*, 2021). SCANS-IV reported white-beaked dolphin abundance within Survey Block NS-D (Figure 2.4) of 5,149 individuals representing approximately one-third of the SCANS-III estimates for Survey Block R, indicating a reduction in white-beaked dolphin abundance (Gilles *et al.*, 2023).

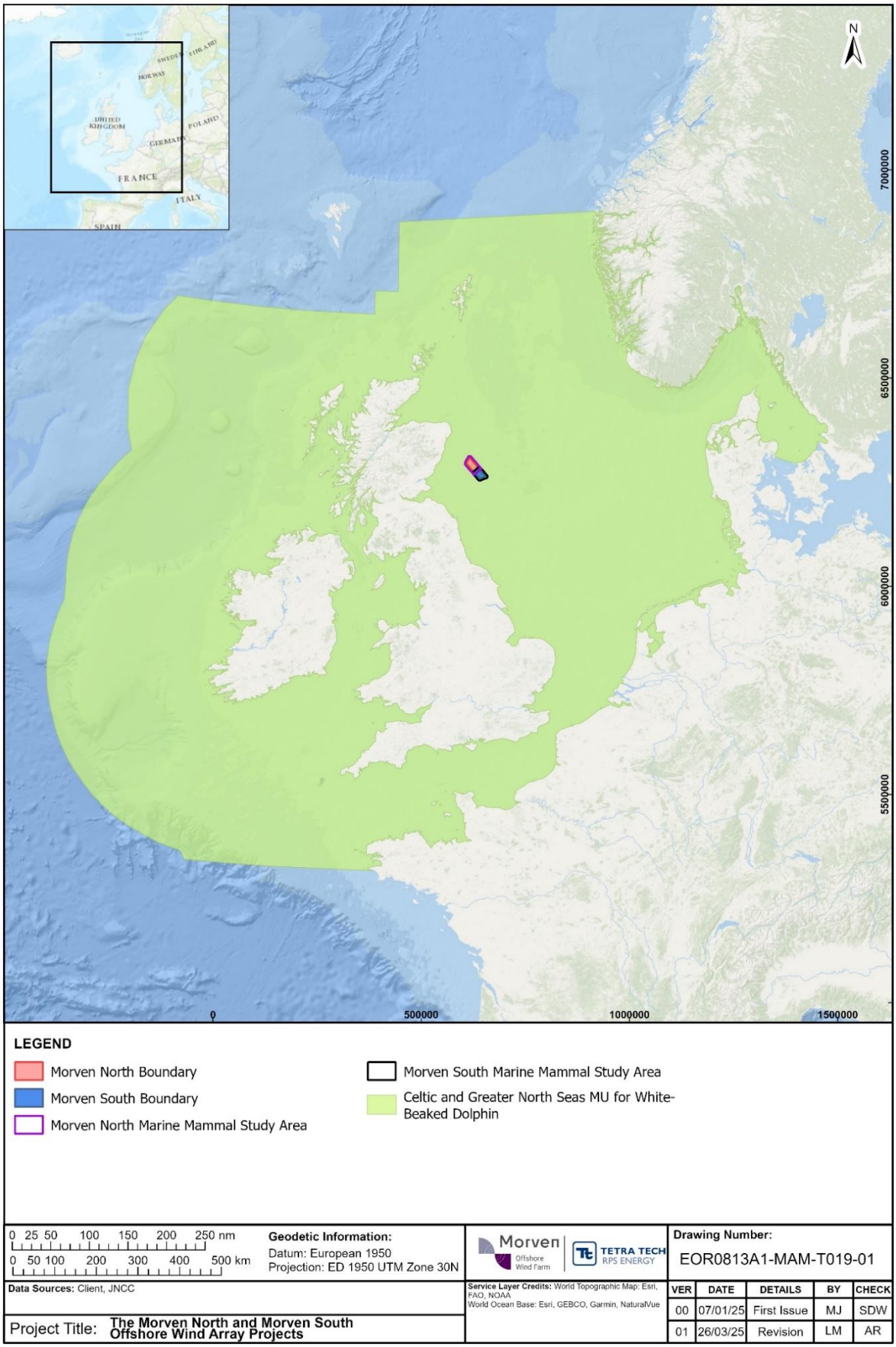

Figure 4.12: Celtic and Greater North Seas Management Unit for white-beaked dolphin and minke whale (IAMWWG, 2023).

4.4.3.1 SCANS-III surveys reported white-beaked dolphin densities of 0.243 animals/km^2 across Survey Block R (Hammond *et al.*, 2021). Modelled density surfaces using these SCANS-III data (Lacey *et al.*, 2022) estimated a mean density of 0.120 animals/km^2 and a maximum of 0.181 animals/km^2 for the Morven Site Marine Mammal Study Area, with density maps showing higher areas of density in the offshore waters north of the Morven Site Marine Mammal Study Area. The more recent SCANS-IV surveys reported a density estimate across Survey Block NS-D of 0.080 animals/km^2 (Gilles *et al.*, 2023) which is approximately one-third that of the previous SCANS survey campaign (Hammond *et al.*, 2021).

4.4.3.2 The JCP Phase III analysis provided estimated seasonal abundances for white-beaked dolphin in 2010 for the Firth of Forth area of commercial interest (Figure 2.5). Highest abundance was estimated in the spring months with 1,760 animals (95% CI = 620 to 4,530) (Paxton *et al.*, 2016). This equated to density estimates between 0.029 animals/km^2 in winter and 0.124 animals/km^2 in summer and therefore were lower than the estimate for SCANS-III Survey Block R of 0.243 animals/km^2 (Hammond *et al.*, 2021), but higher than the modelled density surface estimate of 0.004 animals/km^2 derived from the same SCANS-III data (Lacey *et al.*, 2022). Corresponding modelled estimates based upon the SCANS-IV surveys (Gilles *et al.*, 2025) estimated a mean density of 0.044 animals/km^2, and a maximum of 0.212 animals/km^2 which are both lower than the corresponding estimate from Lacey *et al.* (2022). Areas of higher density occurred to the northeast of the Morven Site Marine Mammal Study Area (Figure 4.2).

4.4.3.3 Density estimates for white-beaked dolphin, modelled and mapped at a monthly scale (Figure 4.13, Figure 4.14 and Figure 4.15), suggest densities to be relatively low throughout the year (Waggitt *et al.*, 2020). The highest densities within the Morven Site Marine Mammal Study Area were predicted for August, with a maximum of 0.123 animals/km^2 (Figure 4.15). This estimate aligns with predicted densities for the Morven North Marine Mammal Study Area and the Morven South Marine Mammal Study Area.

4.4.3.4 Results of winter SCANS surveys (conducted between January 2024 and March 2024) estimated a mean density of 0.005 animals/km^2, equivalent to an abundance of 314 animals across the NS-D Survey Block (95% CI = 0 to 1,012, CV = 0.930) (Ramirez-Martinez *et al.*, 2025).

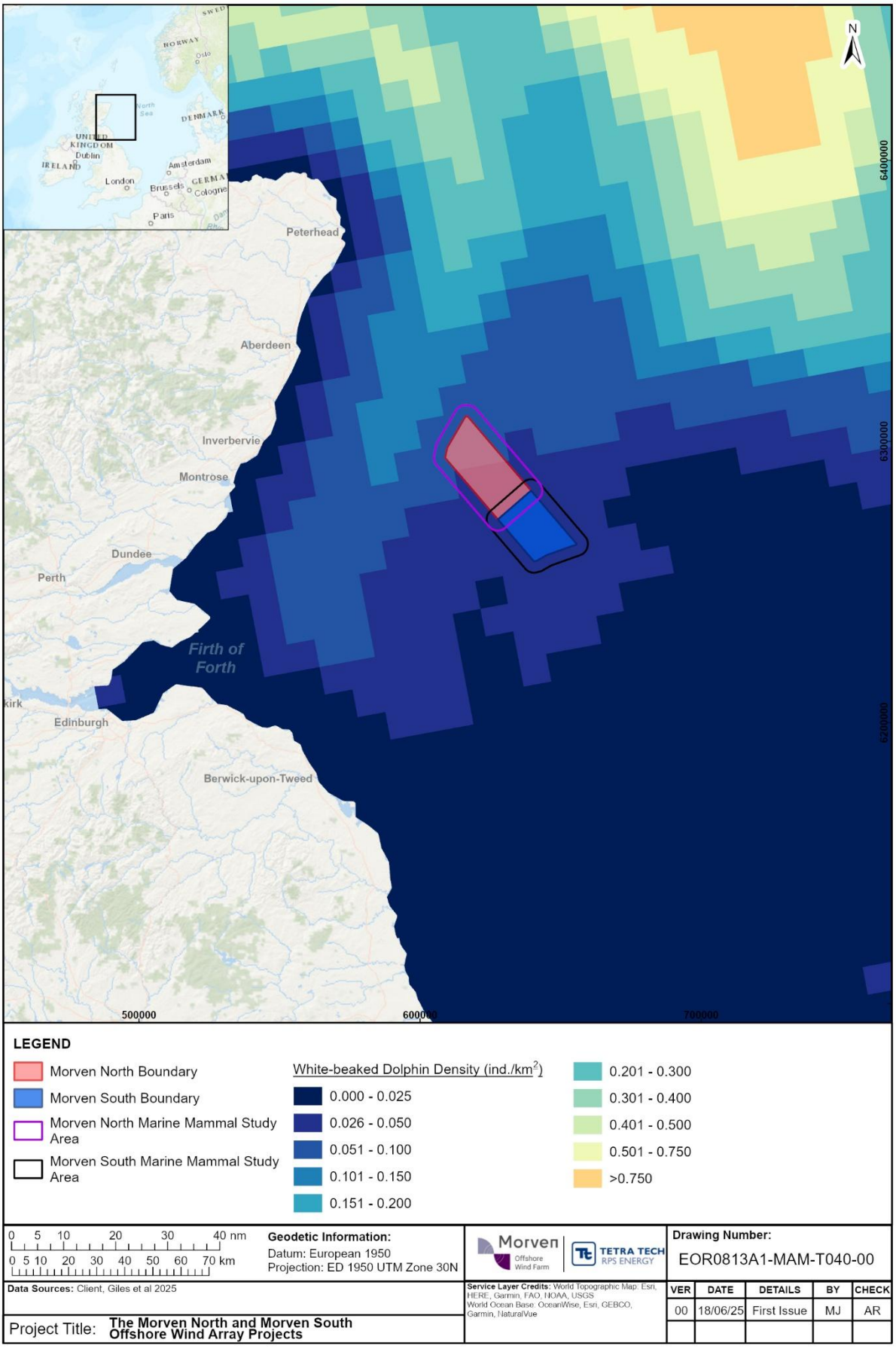

Figure 4.13: Density surface maps from SCANS-IV data for white-beaked dolphin based on Gilles *et al.* (2025)

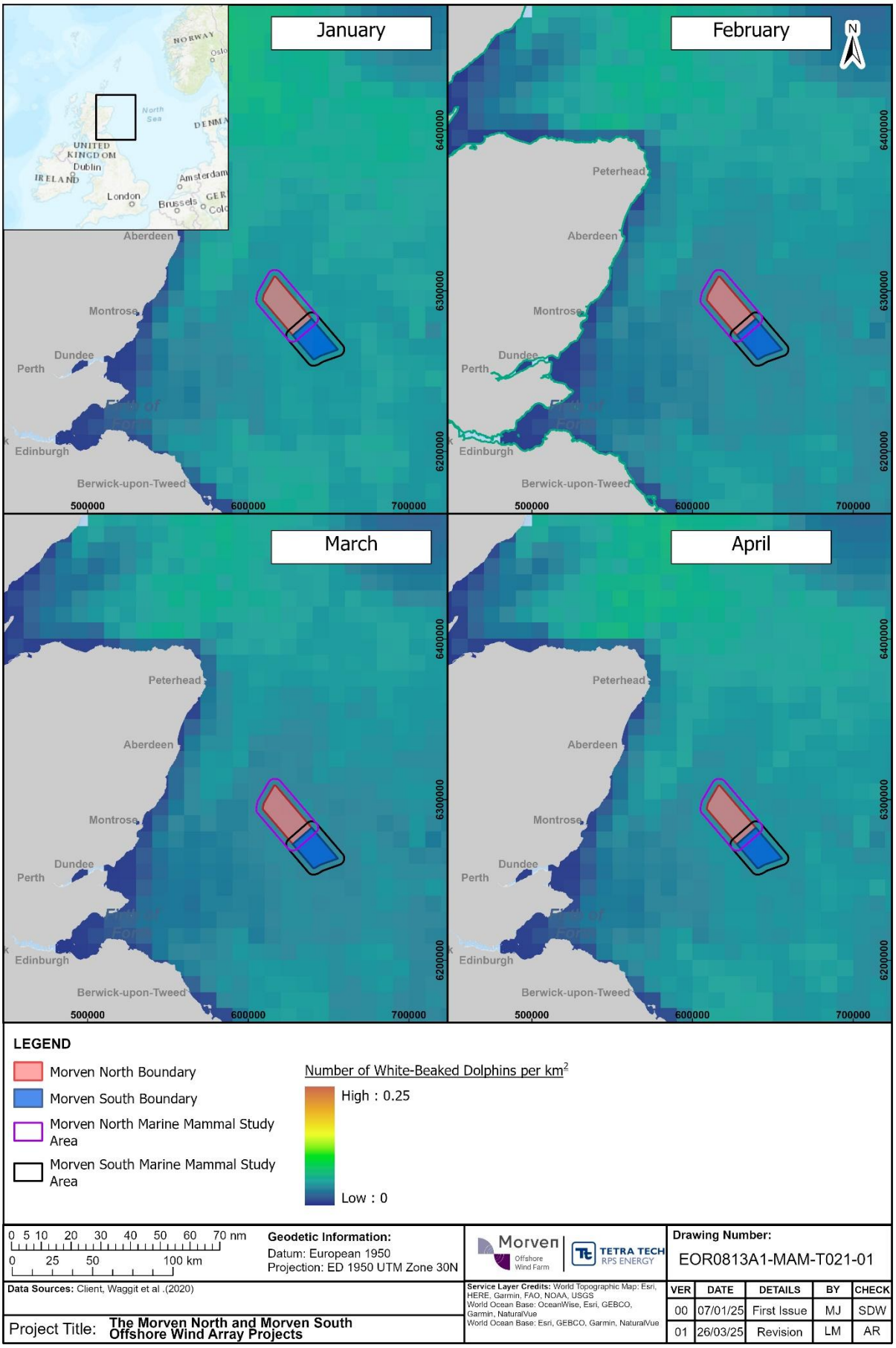

Figure 4.14: White-beaked dolphin density from January to April based on Waggitt *et al.* (2020)

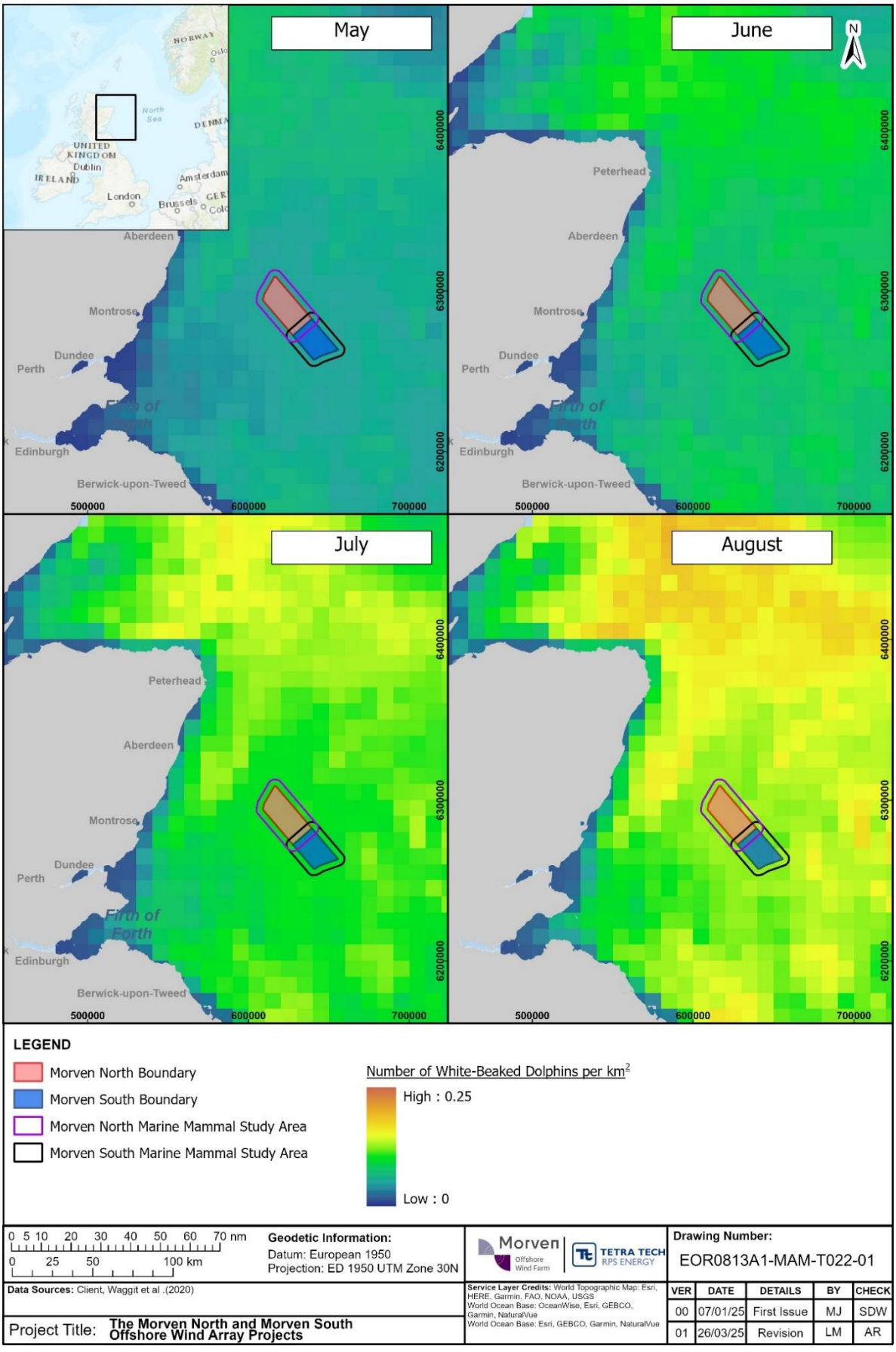

Figure 4.15: White-beaked dolphin density from May to August based on Waggitt *et al.* (2020)

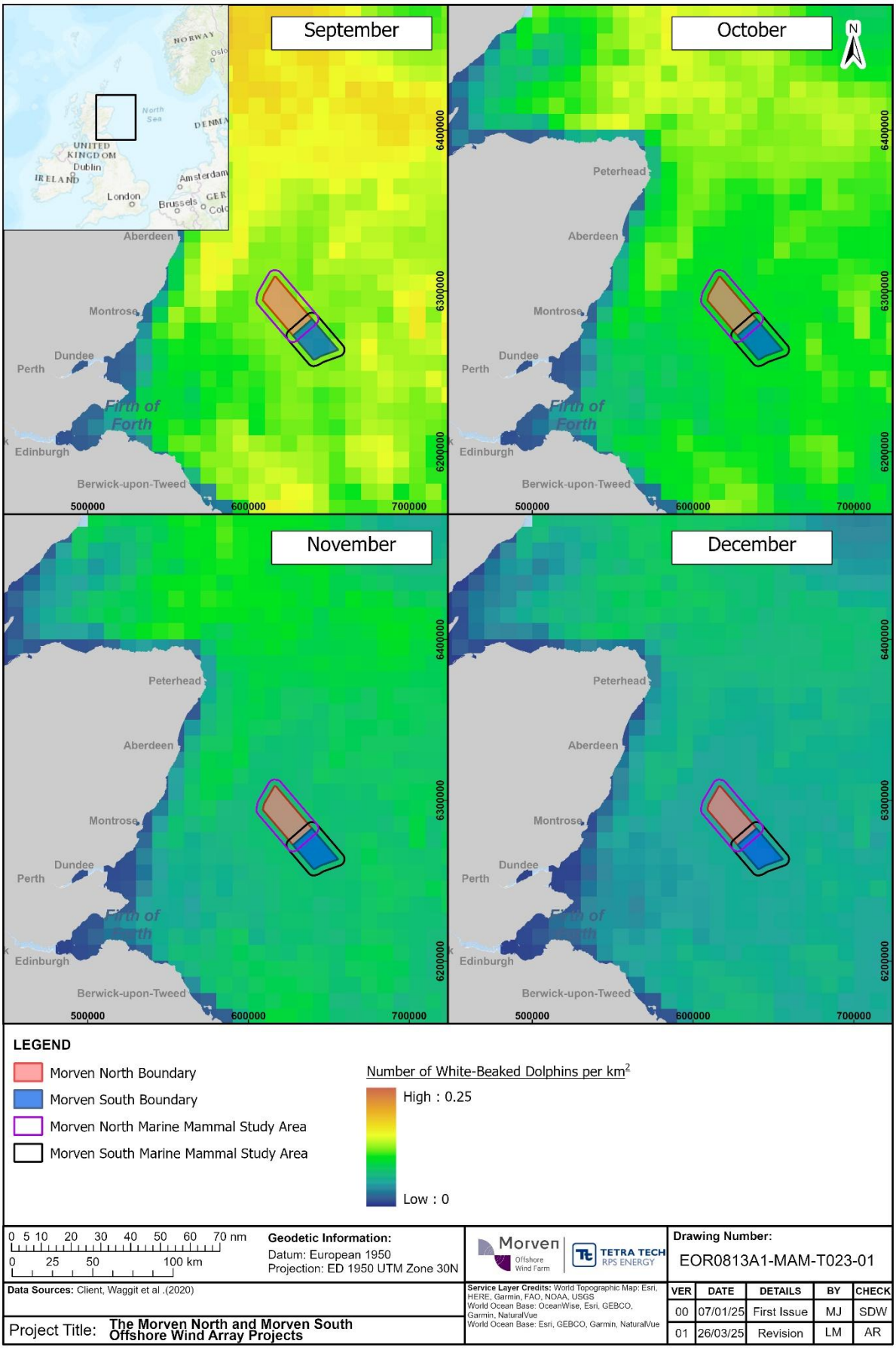

Figure 4.16: White-beaked dolphin density from September to December based on Waggitt *et al.* (2020)

Commercial Surveys

Historical surveys for other OWFs

4.4.3.5 For surveys older than ten years, after correcting for availability, estimated absolute abundance for the TCE aerial surveys and Seagreen boat-based survey areas across the survey period was 293 (95% CI = 267 to 1,055) individuals (Mackenzie *et al.*, 2012). An availability bias correction for white-beaked dolphin was unavailable, therefore, this study applied a value for bottlenose dolphin (0.11). Absolute density estimates for the TCE aerial and Seagreen boat-based surveys had high uncertainty and ranged from 0 to 1 animal/km^2 in a single grid cell over the survey period.

4.4.3.6 For surveys conducted less than ten years ago (and therefore more relevant to the current ecological baseline) density estimates suggested low numbers within the outer Firth of Forth. For example, the monthly absolute density of white-beaked dolphin estimated from Berwick Bank aerial surveys was 0.050 animals/km^2 (95% CI = 0.017 to 0.094; CV = 1.40) (SSE Renewables, 2022a). Similarly, surveys for the Ossian Array (March 2021 to February 2022, inclusive) estimated overall absolute densities for white-beaked dolphin of 0.031 animals/km^2 (Ossian OWFL, 2024). When considered over a finer temporal scale, a slightly greater density of 0.057 animals/km^2 was estimated during the summer, with lower densities of 0.024 animals/km^2 during the winter and spring, and 0.016 animals/km^2 during the autumn. The broader scale SSE Regional Surveys presented no estimates of absolute density for white-beaked dolphin (HiDef, 2023).

Site specific surveys

4.4.3.7 Monthly densities of white-beaked dolphin are presented below for the design-based analyses of site specific DAS data (January 2021 and September 2023, inclusive; see Section 3.2.2) for the Morven Site Marine Mammal Study Area and also separately for the Morven North Marine Mammal Study Area and Morven South Marine Mammal Study Area. As it was not possible to split the data into North and South for the model-based approach (due to poor model-fit) the results are presented only for the Morven Site Marine Mammal Study Area (see Section 3.2.2).

4.4.3.8 In all cases, relative estimates were corrected for availability bias (see Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report) using the most conservative conversion factor of 18%, based on methods described by (Rasmussen *et al.*, 2013).

Morven Site Marine Mammal Study Area

4.4.3.9 Relative density estimates of white-beaked dolphin from DAS of Morven Site Marine Mammal Study Area were corrected for availability bias using the correction factor of 0.180 presented by Rasmussen *et al.* (2013) (see Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report). White-beaked dolphin was observed during DAS in numbers that allowed modelling to be undertaken, and although these allowed estimates of distribution to be visualised, modelling results were not sufficiently robust to facilitate credible predictions.

4.4.3.10 The difficulty of the model to generate prediction data can be seen particularly clearly in the Upper 95% CL density estimates presented in Figure 4.17, which indicates a great deal of variability, and areas of delineation which do not reflect actual patterns of distribution (namely in the area of DAS coverage corresponding to the Morven South Marine Mammal Study Area, where predicted density was too high to be displayed within the selected colour range, and is represented by areas of grey). No clear spatial preference was identified in observations of white-beaked dolphin, with animals occurring throughout the Morven Site Marine Mammal Study Area, and a slight concentration occurring towards the central western boundary.

4.4.3.11 As such, although white-beaked dolphin density within the Morven Site Marine Mammal Study Area can be estimated via both model-based and design-based methods, design-based estimates are favoured since these are a more direct representation of observed patterns, albeit with its own inherent biases, as described in Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report.

4.4.3.12 Given seasonality of white-beaked dolphin sightings and higher number of records during summer, design-based density estimates were calculated across four seasons, with a peak absolute density estimate of 0.177 animals/km^2 during summer (95% CI = 0.100 to 0.261, CV = 0.586).

Morven North Marine Mammal Study Area

4.4.3.13 White-beaked dolphin was not observed within the Morven North Marine Mammal Study Area in sufficient numbers to allow modelling to be undertaken, and therefore density estimates from DAS data were only undertaken via design-based methods.

4.4.3.14 Given seasonality of white-beaked dolphin sightings and higher number of records during summer, design-based density estimates for the Morven North Marine Mammal Study Area were calculated across four seasons, with a peak absolute density estimate of 0.256 animals/km^2 during summer (95% CI = 0.136 to 0.382, CV = 0.705).

Morven South Marine Mammal Study Area

4.4.3.15 White-beaked dolphin was not observed within the Morven South Marine Mammal Study Area in sufficient numbers to allow modelling to be undertaken, and therefore density estimates from DAS data were only undertaken via design-based methods.

4.4.3.16 Given seasonality of white-beaked dolphin sightings and higher number of records during summer, design-based density estimates for the Morven South Marine Mammal Study Area were calculated across four seasons. Observations were greater in summer (n = 19), with a mean absolute density estimate of 0.139 animals/km^2 during summer (95% CI = 0.048 to 0.229, CV = 1.176). However, white-beaked dolphin density were slightly greater in autumn (although fewer observations: n = 16) with a mean absolute density of 0.152 animals/km^2 (95% CI = 0.053 to 0.0.251, CV = 1.708).

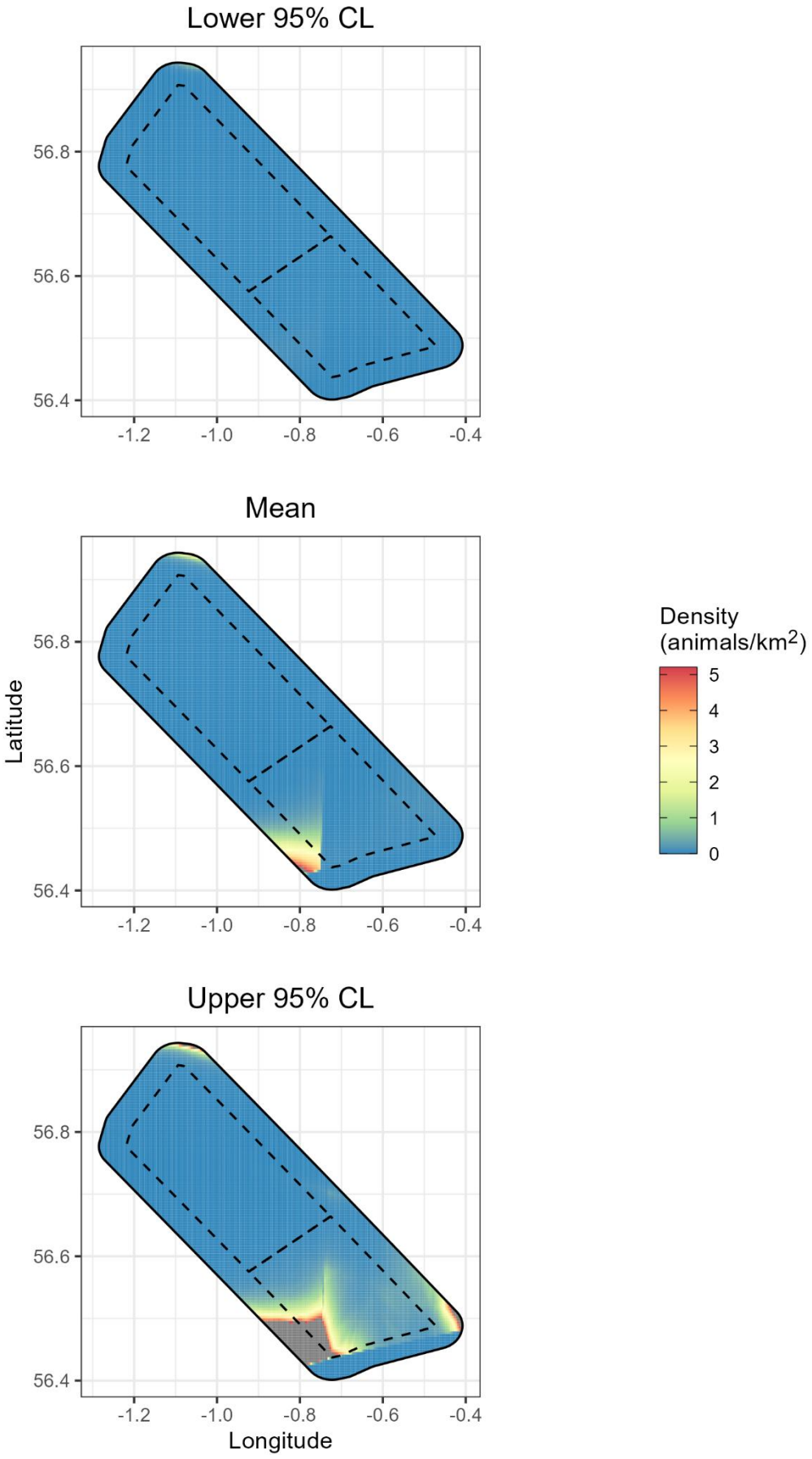

Figure 4.17: Predicted mean absolute density of white-beaked dolphin across the Morven Site Marine Mammal Study

Area, summarised across the full 33-month DAS campaign

4.4.4 Seasonality

4.4.4.1 White-beaked dolphin was observed more frequently in summer than in winter during multiple survey campaigns (Grellier and Lacey, 2011, Sparling, 2012, Seagreen Wind Energy Limited, 2018). White-beaked dolphin sightings were recorded during the Berwick Bank aerial surveys during summer months only, between June and September each year, with peak sightings in September 2020 (SSE Renewables, 2022a).

4.4.4.2 During DAS for the Morven Site Marine Mammal Study Area, white-beaked dolphins were recorded between June and September (inclusive), with additional incidental sightings occurring in the months of January, February and April.

4.4.5 Summary

4.4.5.1 Overall, white-beaked dolphin is abundant in the central and northern North Sea, and a comparison of key data sources for white-beaked dolphin density is shown in Table 4.3.

4.4.5.2 The white-beaked dolphin is endemic to the colder waters of the North Atlantic and prefer water temperatures ranging from 8°C to 13°C (MacLeod *et al.*, 2008). A number of studies have suggested that the abundance of white-beaked dolphins in the UK waters is declining as a result of increases in local water temperature (MacLeod *et al.*, 2005, van Weelden *et al.*, 2021, MacLeod *et al.*, 2008, MacLeod *et al.*, 2007, Lambert *et al.*, 2014). Findings from SCANS-IV surveys conducted in 2022 suggest a decline in the number of white-beaked dolphins on the east coast of Scotland with an estimated density of 0.080 animals/km^2 for Block NS-D (Gilles *et al.*, 2023) compared to the density of 0.243 animals/km^2 for block R during SCANS-III surveys carried out in 2016 (Hammond *et al.*, 2021).

4.4.5.3 Predicted estimates of mean density for the Morven Site Marine Mammal Study Area were also available from older data sources. Those from Waggitt *et al.* (2020) are comparable to those presented by Lacey *et al.* (2022) and are provided at the same resolution (10km x 10km). Densities from the SCANS-III surveys (Hammond *et al.*, 2021) are the highest, however, unlike Lacey *et al.*, (2022) these data do not take into account variability in cetacean density associated with environmental covariates (such as depth, slope, distance from the coast). Sea surface temperature and depth are important predictors for white-beaked dolphin distribution.

Morven Site Marine Mammal Study Area

4.4.5.4 Given the number of white-beaked dolphin sightings over the 33 months of DAS data, it was possible to provide site specific density estimates for the Morven Site Marine Mammal Study Area. However, due to the poor fit of the model-based analysis (see paragraph 4.4.3.5), the design-based analysis was favoured, despite its inability to incorporate environmental variability. The most precautionary figure of 0.177 animals/km^2 from design-based analysis was based on observations made during the months of June to August (i.e. the summer meteorological season, when occurrence is higher), although the overall average across all surveys was estimated as is 0.081 animals/km^2 (Table 4.3). High CVs in the analyses suggest there is some uncertainty with the DAS estimates and is likely a reflection of the small area covered by site specific surveys compared to the broader coverage of the SCANS surveys.

4.4.5.5 As described for harbour porpoise, the SCANS-IV data represent the most up-to-date and robust data on cetaceans within the Morven Regional Marine Mammal Study Area and are also appropriate where the ZoI could extend beyond the Morven Site Marine Mammal Study Area. As such the SCANS-IV data is the most appropriate to use for white-beaked dolphin, and a density of 0.080 animals/km^2 will be taken forward to the assessment.

Morven North Marine Mammal Study Area

4.4.5.6 Given the number of white-beaked dolphin sightings over the 33 months of DAS data, it was possible to provide site specific density estimates for the Morven North Marine Mammal Study Area. However, due to the low number of observations model-based analysis was not possible.

4.4.5.7 The most precautionary figure of 0.256 animals/km^2 from design-based analysis was based on observations made during the months of June to August (i.e. the summer meteorological season, when occurrence is higher), with the overall average across all surveys was estimated as is 0.110 animals/km^2 (Table 4.3). High CVs in the analyses suggest there is some uncertainty with the DAS estimates and is likely a reflection of the small area covered by site specific surveys compared to the broader coverage of the SCANS surveys.

4.4.5.8 As described for harbour porpoise, the SCANS-IV data represent the most up-to-date and robust data on cetaceans within the Morven Regional Marine Mammal Study Area and are also appropriate where the ZoI could extend beyond the Morven North Marine Mammal Study Area. As such the SCANS-IV data is the most appropriate to use for white-beaked dolphin, and a density of 0.080 animals/km^2 will be taken forward to the assessment.

Morven South Marine Mammal Study Area

4.4.5.9 Given the number of white-beaked dolphin sightings over the 33 months of DAS data, it was possible to provide site specific density estimates for the Morven South Marine Mammal Study Area. However, due to the low number of observations model-based analysis was not possible.

4.4.5.10 The most precautionary figure of 0.152 animals/km^2 from design-based analysis was based on observations made during the month of September (i.e. the only month during the autumn when observations were made). The mean absolute density calculated from greatest levels of occurrence (the summer meteorological season) was 0.139 animals/km^2, while the overall average across all surveys was estimated as is 0.080 animals/km^2 (Table 4.3). High CVs in the analyses suggest there is some uncertainty with the DAS estimates and is likely a reflection of the small area covered by site specific surveys compared to the broader coverage of the SCANS surveys.

4.4.5.11 As described for harbour porpoise, the SCANS-IV data represent the most up-to-date and robust data on cetaceans within the Morven Regional Marine Mammal Study Area and are also appropriate where the ZoI could extend beyond the Morven South Marine Mammal Study Area. As such the SCANS-IV data is the most appropriate to use for white-beaked dolphin, and a density of 0.080 animals/km^2 (which also corresponds with the overall mean absolute abundance from design-based analysis of DAS data) will be taken forward to the assessment.

Table 4.3: Comparison of density estimates for white-beaked dolphin in the vicinity of the Morven Site Marine Mammal Study Area. Text in bold are the values taken forward for assessment

Source	Survey Area	Density (animals/km^2)	CV
SCANS-III design-based estimates (Hammond *et al.*, 2021)	Block R	0.243	0.484
SCANS-III density surface models (Lacey *et al.*, 2022)	Morven Site Marine Mammal Study Area	0.091	0.782
	Morven North Marine Mammal Study Area	0.099	0.706
	Morven South Marine Mammal Study Area	0.078	0.880
SCANS-IV design-based estimates (Gilles *et al.*, 2023)	**Block NS-D**	**0.080**	**0.481**
SCANS-IV density surface models (Gilles *et al.*, 2025)	Morven Site Marine Mammal Study Area	0.044	1.509
	Morven North Marine Mammal Study Area	0.053	1.426

Source	Survey Area	Density (animals/km^2)	CV
	Morven South Marine Mammal Study Area	0.031	1.638
Distribution maps of cetacean and seabird populations in the North East Atlantic (Waggitt *et al.*, 2020)	Morven Site Marine Mammal Study Area	0.123	-
	Morven North Marine Mammal Study Area	0.123	-
	Morven South Marine Mammal Study Area	0.123	-
Site specific DAS: design-based	Morven Site Marine Mammal Study Area (summer meteorological season)	0.175	0.586
	Morven North Marine Mammal Study Area (summer meteorological season)	0.256	0.705
	Morven South Marine Mammal Study Area (autumn meteorological season)	0.152	1.708
Site specific DAS: model-based	Morven Site Marine Mammal Study Area (overall estimate)	0.088	4.972

4.5 Minke Whale

4.5.1 Ecology

4.5.1.1 Minke whale is the smallest baleen whale found in UK waters, measuring 7m to 10m when fully grown, with females usually slightly longer than males. Individuals typically live up to 60 years and reach sexual maturity at the age of five to eight years (males) and six to eight years (females). In the northern hemisphere, mating occurs between October and March and the gestation period lasts approximately 10 months, with the peak birth period between December and January (Sea Watch Foundation, 2012). Calves usually nurse for a period of four to six months.

4.5.1.2 Minke whale are largely observed as single animals or in pairs or threes. At higher latitudes, including northern Scotland, larger groups of 10 to 15 individuals can be observed, particularly in areas of high prey density (Anderwald and Evans, 2007). Minke whale recorded during DAS of the Morven Site Marine Mammal Study Area occurred only as single animals, with a total of six animals observed across the whole DAS campaign (see Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report).

4.5.1.3 Minke whale distribution mirrors that of its prey species, with regional differences in diet composition (Eerkes-Medrano *et al.*, 2021). Sandeel are a key resource throughout the North Sea, with sprat, shad, herring and mackerel (*Scomber scombrus*) also a substantial component of the diet (Robinson *et al.*, 2021, Robinson and Tetley, 2007, Tetley *et al.*, 2008). In the Moray Firth juveniles tend to exploit low-energy feeding methods, targeting low-density patches of prey, while adult minke whales use a range of active entrapment specialisations, exhibiting flexibility in targeted prey and variation between individuals and seasons (Robinson *et al.*, 2021).

4.5.2 Distribution and Occurrence

4.5.2.1 Minke whale is the most frequently sighted mysticete species in UK waters and is particularly common around the Northern Isles and in regions of the North Sea (Weir, 2001, Robinson and Tetley, 2007). This species mostly inhabits continental shelf waters, occurs in depths of less than 200m and can often be seen close to land. Higher densities are observed between May and September, with peak numbers from July to September, depending on the region (Evans *et al.*, 2003). There are no clear latitudinal trends in migration and distribution (Sea Watch Foundation, 2023), although sightings in the north and east of Scotland have increased since the 1990s, most likely due to an increase in prey availability (Evans *et al.*, 2003).

4.5.2.2 Based on data from boat-based studies in the Moray Firth between 2001 and 2006, spatial and temporal distribution of minke whale can be highly variable, which is common in studies of baleen whales on their feeding grounds (Robinson *et al.*, 2009). Over 70% of minke whale recorded in the Moray Firth study area occurred in steeply sloped areas at depths of between 20m and 50m (Robinson *et al.*, 2009). Benthic slope, water depth, proximity to shore and sediment-type are important environmental features for minke whale (Robinson *et al.*, 2021).

4.5.2.3 The Moray Firth in particular attracts above-average densities of minke whale relative to the adjacent and wider North Sea waters (Paxton *et al.*, 2014), likely due to rich feeding grounds during summer and autumn months, with the Southern Trench ncMPA designated for minke whale along the southern coast of the outer Moray Firth. The boundaries of the Southern Trench ncMPA enclose deep shelf waters (~200m in depth) and core frontal systems, which concentrate nutrients and plankton, attracting fish species. In 2006, disproportionate numbers of both adult and juvenile minkes were sighted inshore within the Moray Firth study area, coinciding with the introduction of the European Union wide ban on the North Sea sandeel fishery. It has therefore been suggested that minke whale were profiting from high densities of sandeel prey (Robinson *et al.*, 2021).

4.5.2.4 The distribution of minke whale is highly correlated with sediment and substrate type (Robinson *et al.*, 2009). Geodiversity features of the Southern Trench ncMPA, such as burrowed mud, provides optimal nursery areas and the arrival of whales each year appears to be synchronised with the emergence of sandeels into the water column to feed, with over 66% of encounters showing a clear spatial trend for sandy-gravel sediments (i.e. optimal sandeel habitat) (Robinson *et al.*, 2009).

4.5.2.5 During the historic TCE aerial surveys minke whales were encountered throughout the survey area (Figure 2.2), with slightly more sightings in the northern part of the survey area (Grellier and Lacey, 2011). Minke whales were mostly recorded as single animals, although three animals were sighted together in May 2010 and two in June 2011. During the Berwick Bank aerial surveys, minke whales were recorded throughout the surveyed area (Figure 2.2) (SSE Renewables, 2022a).

4.5.2.6 Given that minke whale were recorded in only five months during DAS of the Morven Site Marine Mammal Study Area, no clear pattern in their distribution across the Morven Site Marine Mammal Study Area could be concluded (see Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report).

4.5.3 Density/abundance

Published Literature

4.5.3.1 All minke whale in UK waters are considered as part of the CGNS MU (Figure 4.18). Based on the most up-to-date estimates, the abundance of minke whale in the whole MU is 20,118 animals (95% CI = 14,061 to 28,786; CV = 0.18) IAMMWG (2023). The estimated abundance of minke whale within the UK portion of the CGNS MU is 10,288 animals (95% CI = 6,210 to 17,042, CV = 0.26). The SCANS-III estimated abundance for Survey Block R (Figure 2.3) was 2,498 (95% CI = 604 to 6,791; CV = 0.61), corresponding to a mean density of 0.0387 animals/km^2 across Survey Block R.

4.5.3.2 The recent SCANS-IV survey campaign reported minke whale abundance within Survey Block NS-D (coinciding directly with SCANS-III Survey Block R) of 2,702 individuals (Gilles *et al.*, 2023). This corresponds to a density of 0.0420 animals/km^2 indicating an increase in minke whale abundance when compared to SCANS-III observations (Hammond *et al.*, 2021).

4.5.3.3 Modelled density surfaces using the SCANS-III data (Lacey *et al.*, 2022) estimated a mean density of 0.026 animals/km^2 and a maximum of 0.043 animals/km^2 for the Morven Site Marine Mammal Study Area. Corresponding modelled estimates based upon the SCANS-IV surveys (Gilles *et al.*, 2025) estimated a mean density of 0.030 animals/km^2, and a maximum of 0.091 animals/km^2 which are both higher than the corresponding estimate from Lacey *et al.* (2022).Density maps showing higher areas of density in the offshore waters northeast of the Morven Site Marine Mammal Study Area (Figure 4.18).

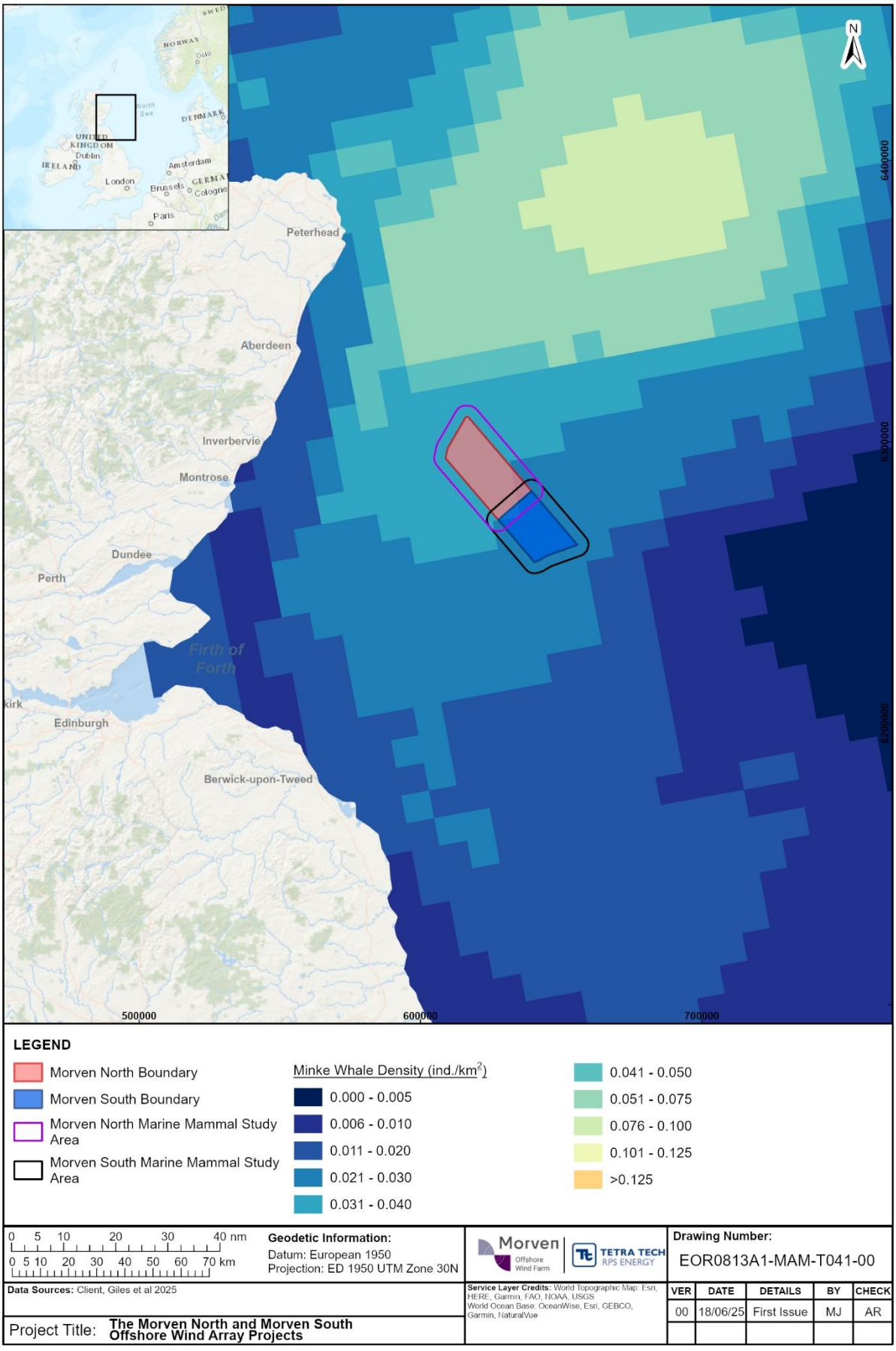

Figure 4.18: Density surface maps from SCANS-IV data for minke whale based on Gilles *et al.* (2025)

4.5.3.4 The JCP Phase III analyses presented seasonal abundances for minke whale in 2010 for the Firth of Forth area of commercial interest (Figure 2.4). Highest abundance was expected in the summer months, estimated at 360 animals (95% CI = 140 to 990), equating 1.4% (95% CI = 0.6 to 2.3) of the CGNS MU population estimate (Paxton *et al.*, 2016), and corresponding to a density estimates of 0.025 animals/km^2 (95% CI = 0.010 to 0.070). Estimates in all other seasons were low (20 animals during autumn and winter, 60 animals during spring).

Commercial Surveys

4.5.3.5 Historical surveys for other OWFs for surveys conducted more than ten years ago (and therefore of less suitability in describing the current ecological baseline) sightings data from the TCE aerial surveys and Seagreen boat-based surveys, indicated an absolute abundance of 594 individuals for the survey area (Mackenzie *et al.*, 2012), with a high level of uncertainty due to the low number of sightings (95% CI = 483 to 2,695).

4.5.3.6 For surveys conducted less than ten years ago sighting numbers (and therefore density estimates) were variable. The greatest number of minke whale counted from the Seagreen bird surveys was 13 animals in July 2017. (Seagreen Wind Energy Limited, 2018). More recently, surveys for the Ossian Array (March 2021 to February 2022, inclusive) recorded 12 individuals across the whole 24-month survey campaign (Ossian OWFL, 2024). The low number of observations of minke whale were too infrequent for estimates of absolute density to be confidently calculated. Similarly, the broader scale SSE Regional Surveys, which incorporates the Morven Site Marine Mammal Study Area and the survey area for the Ossian Array (Figure 2.2), did not present a density estimate for minke whale (HiDef, 2023).Mean monthly density of minke whale based on the Berwick Bank aerial survey data was estimated as 0.016 animals/km^2 (95% CI = 0.009 to 0.023) (SSE Renewables, 2022a).

Site specific surveys

4.5.3.7 Monthly densities of minke whale are presented below for the design-based analyses of site specific DAS data (January 2021 and September 2023, inclusive; see Section 3.2.2) for the Morven Site Marine Mammal Study Area and also separately for the Morven North Marine Mammal Study Area. No observations of minke whale were made within the Morven South Marine Mammal Study Area.

4.5.3.8 In all cases, relative estimates were corrected for availability bias (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report) using the most conservative conversion factor of 44%, based on methods described by (McGarry *et al.*, 2017).

Morven Site Marine Mammal Study Area

4.5.3.9 Minke whale was recorded in five months during DAS of the Morven Site Marine Mammal Study Area and due to low numbers of sightings (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report), model-based density and abundance estimates for this species are not available. Design-based analyses suggested an overall density of 0.002 animals/km^2 (95% CI = 0.001 to 0.004; CV = 2.554) within the Morven Site Marine Mammal Study Area, with a maximum seasonal density of 0.004 animals/km^2 (95% CI = 0.001 to 0.007; CV = 2.120) during summer. All observations of minke whale were made in the north and northwest of the Morven Site Marine Mammal Study Area, corresponding with the Morven North Marine Mammal Study Area (see paragraph 1.2.1.1).

Morven North Marine Mammal Study Area

4.5.3.10 Minke whale was recorded in five months during DAS of the Morven North Marine Mammal Study Area and due to low numbers of sightings (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report), model-based density and abundance estimates for this species are not available. Design-based analyses suggested an overall density of 0.004 animals/km^2 (95% CI = 0.001 to 0.006; CV = 2.554) within the Morven North Marine Mammal Study Area, and a maximum seasonal density of 0.007 animals/km^2 (95% CI = 0.002 to 0.012; CV = 2.119) during summer.

Morven South Marine Mammal Study Area

4.5.3.11 No observations of minke whale were made within the Morven South Marine Mammal Study Area.

4.5.4 Seasonality

4.5.4.1 During boat-based surveys in the Moray Firth, carried out between May and October, 2001 to 2006, minke whale were encountered each month with an annual peak in occurrence from July to August (Robinson *et al.*, 2009). The distribution of whales showed a progressive (albeit variable between years) inshore movement of animals across the summer and autumn months, reversing towards the end of the study period, and possibly associated with seasonal differences in the composition and abundance of prey communities (Robinson *et al.*, 2021).

4.5.4.2 The presence of minke whale was recorded across 10 sites between the southern edge of St. Abbs and northern Moray Firth from 2016 to 2018 (Risch *et al.*, 2019). Across all sites and all years, minke whale were first detected in late May and detections generally reduced at the end of October. During autumn and spring, minke whale vocalisations showed strong diel periodicity, 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).

4.5.4.3 The results of the analysis of sightings data from Seagreen boat-based surveys are in line with previous studies of Aberdeenshire coastal waters that reported minke whales to be highly seasonal (Sparling, 2012). Encounter rates were highest in the spring and summer and relatively low in autumn and winter. A similar pattern was reflected in the Neart na Gaoithe boat-based surveys and Berwick Bank aerial surveys, with sightings recorded only between May and November (Mainstream Renewable Power, 2019) and between April and September (SSE Renewables, 2022a), respectively. Within the Morven Site Marine Mammal Study Area, minke whale were only recorded during the months of May, June and July in year one (2021), and during May and September of year two (2022).

4.5.5 Summary

4.5.5.1 Overall, minke whales are widely distributed in the northern North Sea. Comparison of key data sources for minke whale is shown in Table 4.4.

4.5.5.2 Sightings of minke whale during site specific DAS of the Morven Site Marine Mammal Study Area were too infrequent to estimate temporal patterns of density, and design-based analysis indicated density estimates that were an order of magnitude lower than those from SCANS surveys (Gilles *et al.*, 2023, Hammond *et al.*, 2021) and associated density surface modelling (Lacey *et al.*, 2022). Given the infrequency and low number of sightings, model-based analysis of minke whale density was not possible. As a result, it was not possible to incorporate modelled density estimates derived from site specific DAS.

4.5.5.3 Density surface modelling of SCANS-III and SCANS-IV data alongside environmental covariates identified that depth and slope are important predictors for minke whale distribution (Gilles *et al.*, 2025, Lacey *et al.*, 2022). As such, studies that incorporate environmental conditions to distinguish among different habitats (e.g. shallow vs deep) are favoured when predicting minke whale density. Similarly, Waggitt *et al.* (2020) incorporated environmental covariates into the modelling and a density estimate of 0.010 animals/km^2 was representative of the Morven Site Marine Mammal Study Area. However, both Lacey *et al.*, (2022) and Waggitt *et al.*, (2020) used data that was eight or more years old. Therefore, the data carried forward to the assessment was SCANS-IV (data from 2022) with a density of 0.042 animals/km^2 as this was considered to be the most robust and recent estimate, and was a more conservative estimate than the corresponding density surface models (Gilles *et al.*, 2025).

Table 4.4: Comparison of density estimates for minke whale in the vicinity of the Morven Site Marine Mammal Study Area. Text in bold are the values taken forward for assessment

Source	Survey Area	Density (animals/km^2)	CV
SCANS-III design-based estimates (Hammond *et al.*, 2021)	Block R	0.040	0.614
SCANS-III density surface models (Lacey *et al.*, 2022)	Morven Site Marine Mammal Study Area	0.026	0.276
	Morven North Marine Mammal Study Area	0.026	0.275
	Morven South Marine Mammal Study Area	0.026	0.277
SCANS-IV design-based estimates (Gilles *et al.*, 2023)	**Block NS-D**	**0.042**	**0.594**
SCANS-IV density surface models (Gilles *et al.*, 2025)	Morven Site Marine Mammal Study Area	0.030	0.824
	Morven North Marine Mammal Study Area	0.033	0.815
	Morven South Marine Mammal Study Area	0.027	0.839
Distribution maps of cetacean and seabird populations in the North East Atlantic (Waggitt *et al.*, 2020)	Morven Site Marine Mammal Study Area	0.010	-
	Morven North Marine Mammal Study Area	0.010	-
	Morven South Marine Mammal Study Area	0.010	-
Site specific DAS: design-based	Morven Site Marine Mammal Study Area (summer meteorological season)	0.002	2.554
	Morven North Marine Mammal Study Area (summer meteorological season)	0.004	2.554
	Morven South Marine Mammal Study Area	n/a	n/a
Site specific DAS: model-based	Morven Site Marine Mammal Study Area	n/a	n/a

4.6 Humpback Whale

4.6.1 Ecology

4.6.1.1 The humpback whale is a medium-sized baleen whale (mysticete) of up to 17m length and weighing approximately 40 tonnes at maturity (Hebridean Whale and Dolphin Trust, 2023). Humpback whales are easy to distinguish from other baleen whales due to their distinctive appearance with exceptionally long flippers, which are one-quarter to one-third of their total body length (Hebridean Whale and Dolphin Trust, 2023, Johnson and Wolman, 1984).

4.6.1.2 Humpback whale behaviour varies between seasons (Hebridean Whale and Dolphin Trust, 2023). During breeding periods in the tropics, humpbacks fast, relying on their large fat reserves built up during the previous non-breeding season (Rizzo and Schulte, 2009). Humpback whales usually occur as solitary individuals or in small groups of up to seven animals, and long-term associations are rare. They can dive for up to 40 minutes and raise their tail fluke when making a deep dive (Hebridean Whale and Dolphin Trust, 2023). There are no studies on prey resources in Scottish waters, although individuals in the Celtic Sea have been reported to prefer sprat and herring (Ryan *et al.*, 2014).

4.6.1.3 Following a severe decline due to commercial whaling, humpback whale populations in the North Atlantic region have been steadily recovering during the late 20th century (Johnson and Wolman, 1984, O'Neil *et al.*, 2019). In the western North Atlantic, entanglement in static fishing gear such as crab and lobster pots is the largest source of anthropogenic mortality and injury for this species (Ryan *et al.*, 2016, Leaper *et al.*, 2022).

4.6.2 Distribution and Occurrence

4.6.2.1 Humpback whales are known for making annual migrations over long distances, (Rizzo and Schulte, 2009). During summer individuals feed at high latitudes to restore blubber stores that may have become depleted while fasting during the previous breeding season. In winter, they move to lower latitudes, where they mate and calve, fasting for long periods (Rizzo and Schulte, 2009). Feeding animals show preference for areas of upwelling, high chlorophyll a concentration and frontal areas with changes in temperature, depth and currents, where prey occurs in higher concentrations (Meynecke *et al.*, 2021). Preferred calving grounds were identified as shallow, warm and with slow water movement to aid the survival of calves (Meynecke *et al.*, 2021). Although they favour inshore waters and continental shelf areas, humpback whales travel through open waters during their migration (Hebridean Whale and Dolphin Trust, 2023).

4.6.2.2 Climate change is likely to play a key role in the distribution of humpback whales. Between 1984 and 2010 humpback whales feeding in the Gulf of St. Lawrence (Canada) shifted their date of arrival earlier at a rate of more than one day per year, and that the departure date also shifted earlier (Ramp *et al.*, 2015). The trend in arrival was strongly related to earlier ice break-up and rising Sea surface temperature , likely triggering earlier primary productivity suggesting that further changes to humpback whale distribution or annual life cycle may occur with ongoing climatic changes (Ramp *et al.*, 2015).

4.6.2.3 Historically, most commercial catches were to the north of Shetland, although several were also taken at the continental shelf edge, to the west of the Outer Hebrides and comprised approximately 0.7% of all baleen whale landings (Ryan *et al.*, 2022). In 2016 a humpback whale photographed off Shetland was identified as an individual previous recorded off Guadeloupe in 2015, and represented the first confirmed connection between animals in the UK and any breeding ground (Jones *et al.*, 2017). The calculated great-circle distance between these sighting locations is approximately 6,900km. Humpback whales in Scottish waters have also been matched with both recovering (western North Atlantic) and non-recovering (Cape Verde) breeding populations (Ryan *et al.*, 2022), and in 2022, the 100th individual was added to the Scottish Humpback ID Catalogue (Hebridean Whale and Dolphin Trust, 2022a).

4.6.2.4 The first confirmed record of a humpback whale in the Firth of Forth occurred in 2003, with further records in 2006, 2012 and 2017. Sightings by citizen science projects in recent years suggest an increase in occurrence in inshore waters (Hague, 2023).

4.6.2.5 Some individuals in the Firth of Forth were matched with records off the Scottish west coast (Isle of Coll, Hebrides) (Hebridean Whale and Dolphin Trust, 2022b), and from Svalbard, Norway (O'Neil *et al.*, 2019). The latter study also provided the first confirmed record of an individual returning to the Firth of Forth in consecutive years and it has been suggested that the Firth of Forth may provide a migratory stopover, or a feeding or recovery opportunity as part of a longer migration (O'Neil *et al.*, 2019).

4.6.3 Density/abundance

Published Literature

4.6.3.1 No contemporary density or abundance estimate exists for humpback whales in Scottish waters and no individuals have been detected during any SCANS surveys between 1994 and 2022 (Gilles *et al.*, 2023, Hammond *et al.*, 2021, Hammond *et al.*, 2013, Hammond *et al.*, 2002). Although records of humpback whale remain relatively low, records in Scotland and the wider eastern North Atlantic region have increased since the mid-1980s (O'Neil *et al.*, 2019, Evans and Waggitt, 2023). There is little information on the historical abundance or density of humpback whales in Scottish waters prior to commercial whaling, although archived logbooks suggest that they have historically been present in low densities (Weir, 2001, O'Neil *et al.*, 2019).

Commercial Surveys

Historical surveys for other OWFs

4.6.3.2 Humpback whales were not recorded in any of the historical surveys described in Section 2.1 that took place within the wider Firth of Forth and Tay (Table 2.3 and Figure 2.2).

Site specific surveys

4.6.3.3 One individual was identified in May 2022 during DAS of the Morven Site Marine Mammal Study Area (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report). The location of this observation corresponds with the Morven North Marine Mammal Study Area. Given that only a single observation was made across the 33-months of DAS data, there was insufficient data to generate density, or abundance estimates for humpback whale.

Seasonality

4.6.3.4 Over recent years, most of the sightings in the Firth of Forth were reported in winter, between December and March, with some sightings in August and October (O'Neil *et al.*, 2019, Hague, 2023).

4.7 Grey Seal

4.7.1 Ecology

4.7.1.1 The grey seal is the larger of two pinniped species which occur around the British Isles, with males weighing up to 300kg and females up to 200 kg. The average lifespan is between 20 to 30 years, although females tend to live longer than males. Females reach sexual maturity at between three and five years old and males at around six years, although they are not thought to be socially mature until eight years old (Hall and Thompson, 2009).

4.7.1.2 Grey seals breed, rest, moult and engage in social activity when they gather in colonies on land (known as haul-outs). Haul-out events occur also at sea on exposed sandbanks, but their frequency is low, and their duration is on average shorter than events on land (Russell and Lonergan, 2012).

4.7.1.3 Female grey seals tend to exhibit natal fidelity in their pupping locations, which in the UK include remote, uninhabited islands or coasts and occasionally in caves, allowing females with young pups to move inland away from busy beaches and storm surges (SCOS, 2022). Grey seal may also breed on exposed, cliff-backed beaches but these locations limit the opportunity to avoid storm surges and may result in higher levels of pup mortality (SCOS, 2022). In the UK, grey seals begin breeding in the autumn months, with a clockwise cline in the mean birth date around the UK (SCOS, 2022). The majority of pups in southwest Britain are born between August and October; in north and west Scotland peak pupping occurs mainly between September and late November; in East Scotland between October and December and in eastern England pupping occurs mainly between early November to mid-December.

4.7.1.4 Grey seal give birth to a single, white-coated pup which is weaned over a period of 17 to 23 days (SCOS, 2022). Pups shed their white natal coat and develop their first adult coat at the time of weaning, after which pups remain at the breeding colony for up to three weeks. Following departure of pups, females come into oestrus and mating occurs before females return to sea to forage and build up fat reserves.

4.7.1.5 Grey seal along the Scottish coast exhibits a preference for offshore foraging, returning to land regularly to haul-out. (Damseaux *et al.*, 2021). Foraging trips can be wide-ranging, although tracking studies suggest that most foraging is likely to occur within 100km of a haul-out site (SCOS, 2022), and during the breeding season foraging may be restricted to approximately 20km from the breeding site.

4.7.1.6 Marine geomorphological features such as slopes, foot slopes and hollows attract grey seal as these features may support aggregations of prey, improving prey capture success (Wyles *et al.*, 2022). Grey seal has a selective diet, which may comprise up to 50% plaice and sole (*Solea solea*), 46% sandeels and some gadoids, with some seasonal and regional variation (Damseaux *et al.*, 2021, Hammond *et al.*, 2005). Seals in shallow waters may also show a preference for demersal and groundfish species such as cephalopods and flatfish, while seals foraging in deeper waters, over sandy substrates, will target pelagic and benthopelagic species such as blue whiting (*Micromesistius poutassou*) and sandeels (Gosch, 2017).

4.7.2 Distribution and Occurrence

4.7.2.1 Globally, grey seal occurs in three regional concentrations: eastern Canada and the northeast USA, around the coast of the UK (especially in Scottish coastal waters), and the Baltic Sea. All populations are known to be increasing, however, numbers are still relatively low in the Baltic where the population has been reduced by pollution and historical human exploitation (SCOS, 2022, Galatius *et al.*, 2020).

4.7.2.2 As discussed in Section 2.3.10, seal haul-out sites are locations on land where seals come ashore to rest, moult or breed. In the East Scotland seal MU, grey seal haul-out sites (both designated and not designated) are concentrated around sites in the Firth of Forth and the Tay and Eden estuaries as well as further north around Peterhead and Fraserburgh (Figure 4.19). Within the Northeast England seal MU, the largest concentrations of haul-outs can be found along the north Northumberland coast and within the Tees Estuary (Figure 4.19). As discussed in Section 2.3.10, those in England are not designated haul-outs.

Morven Site Marine Mammal Study Area

4.7.2.3 The nearest designated haul-out sites for grey seals from the Morven Site Marine Mammal Study Area are Kinghorn Rocks, Inchmickery and Cow and Calves, Fast Castle, Inchkeith and Craigleith (Figure 3.1). The closest site, Fast Castle, is a breeding haul-out located approximately 66km from the Morven Site Marine Mammal Study Area, while the nearest non-breeding haul-out is Kinghorn Rocks, approximately 137km from the Morven Site Marine Mammal Study Area.

Morven North Marine Mammal Study Area

4.7.2.4 The nearest designated haul-out sites for grey seals from the Morven North Marine Mammal Study Area are Kinghorn Rocks, Inchmickery and Cow and Calves, Fast Castle, Inchkeith and Craigleith (Figure 3.1). The closest site, Fast Castle, is a breeding haul-out located approximately 101km from the Morven North Marine Mammal Study Area, while the nearest non-breeding haul-out is Kinghorn Rocks, approximately 137km from the Morven North Marine Mammal Study Area.

Morven South Marine Mammal Study Area

4.7.2.5 The nearest designated haul-out sites for grey seals from the Morven South Marine Mammal Study Area are Kinghorn Rocks, Inchmickery and Cow and Calves, Fast Castle, Inchkeith and Craigleith (Figure 3.1). The closest site, Fast Castle, is a breeding haul-out located approximately 100km from the Morven South Marine Mammal Study Area, while the nearest non-breeding haul-out is Kinghorn Rocks, approximately 144km from the Morven South Marine Mammal Study Area.

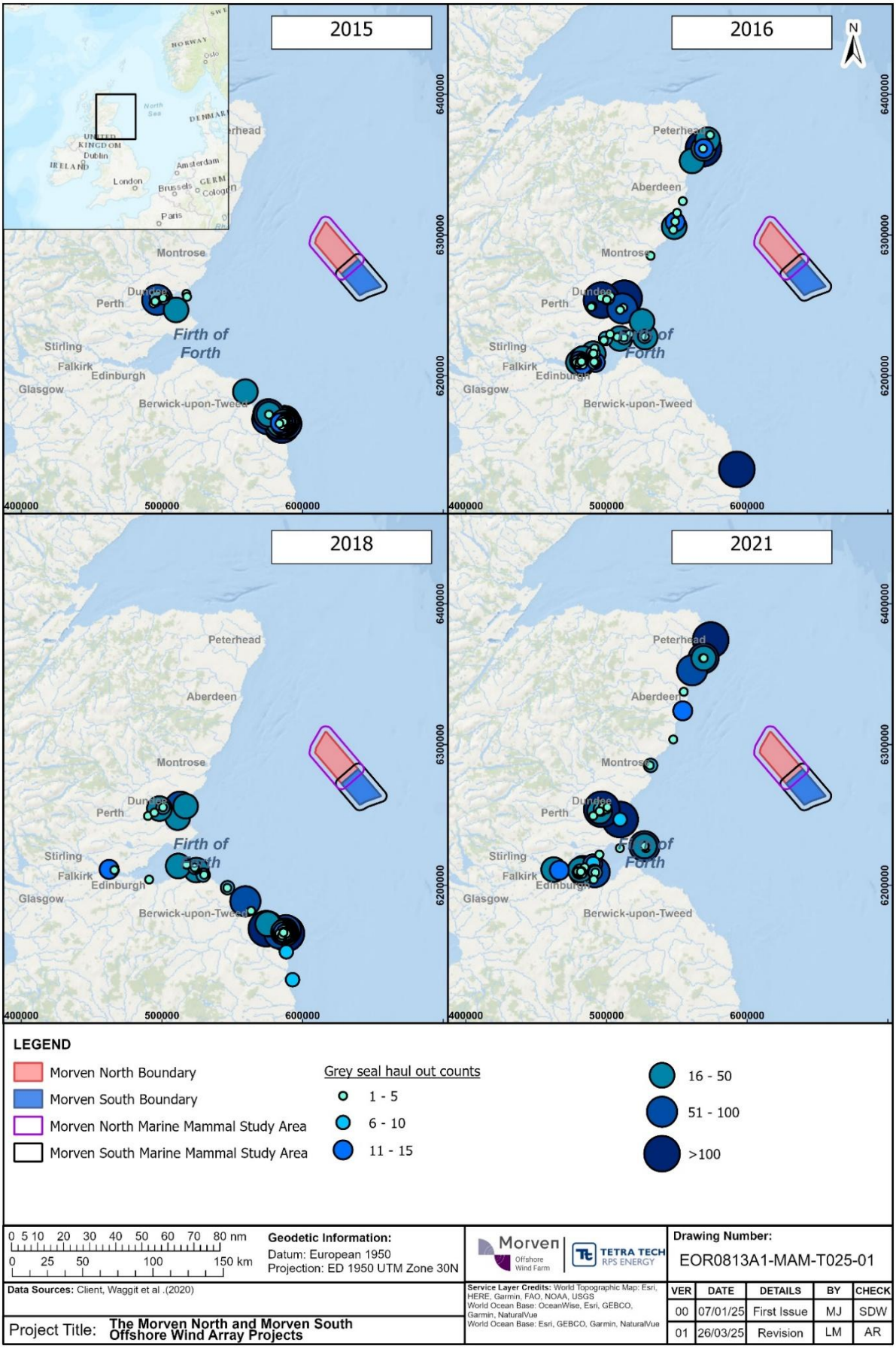

Figure 4.19: Most recent August grey seal haul-out counts (2015, 2016, 2018 and 2021)

4.7.2.6 A total of 105 grey seals of all ages were tagged in the seal MUs of interest (Figure 3.1) between 1990 and 2014, 74 in the East Scotland seal MU and 31 in the Northeast England seal MU (Stevens, 2023). The majority of tagged seals were adults and movements of all seals are illustrated in Figure 4.20. Adult grey seals that were tagged outside the East Scotland seal MU and the Northeast England seal MU also entered these seal MUs (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report). In total, of the 101 adult grey seals tracked within the seal MUs of interest, 18 were recorded within Morven Site Marine Mammal Study Area (Stevens, 2023). Fifteen of these individuals (five female and ten male) that showed use of the Morven Site Marine Mammal Study Area also showed connectivity with at least one grey seal SAC (Figure 4.21). Connectivity with only the Isle of May SAC was observed in two adult grey seals, with only the Berwickshire and North Northumberland Coast SAC in nine adult grey seals, and with both SACs in four adult grey seals (Stevens, 2023).

4.7.2.7 The telemetry tracks illustrated in Figure 4.21 suggest some connectivity between the Isle of May SAC and the Morven Site Marine Mammal Study Area. While the tracks moving between these areas represent only two of the 101 adults tracked across the relevant MUs (i.e. 2% of individuals) there is also movement of grey seal juveniles between the Isle of May SAC and the Morven Site Marine Mammal Study Area (see Figure 4.22 and paragraph 4.7.2.11). Similarly, connectivity was demonstrated between the Berwickshire and North Northumberland Coast SAC and the Morven Site Marine Mammal Study Area with nine individuals (~10% of the tracked animals) moving regularly between these areas.

4.7.2.8 Connectivity was also noted between the Humber Estuary SAC (one male of unknown age), the Faray and Holm of Faray SAC (one adult male) and the Monach Islands SAC (one adult male). Given that these last three SACs are located at further distances from the Morven Site Marine Mammal Study Area, connectivity is expected to be substantially lower.

4.7.2.9 It should be noted, however, that SACs with grey seal as a feature are designated due to the use of these locations as breeding colonies. During the breeding season grey seal generally do not travel further than 20km from the breeding colony (Carter *et al.*, 2022), and as such connectivity between SACs and other locations (including Morven Site Marine Mammal Study Area) is likely to be reduced.

4.7.2.10 Adult grey seals tracks illustrated that individuals move throughout the Morven Site Marine Mammal Study Area with no discernible fidelity to a particular location (Figure 4.19 and Figure 4.20), possibly because the water depths and benthic habitats (and therefore prey resources) present are similar across the site. While the DAS recorded a number of sightings of grey seal during site specific surveys, no clear fine scale patterns in the distribution of animals were apparent across the Morven Site Marine Mammal Study Area (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report).

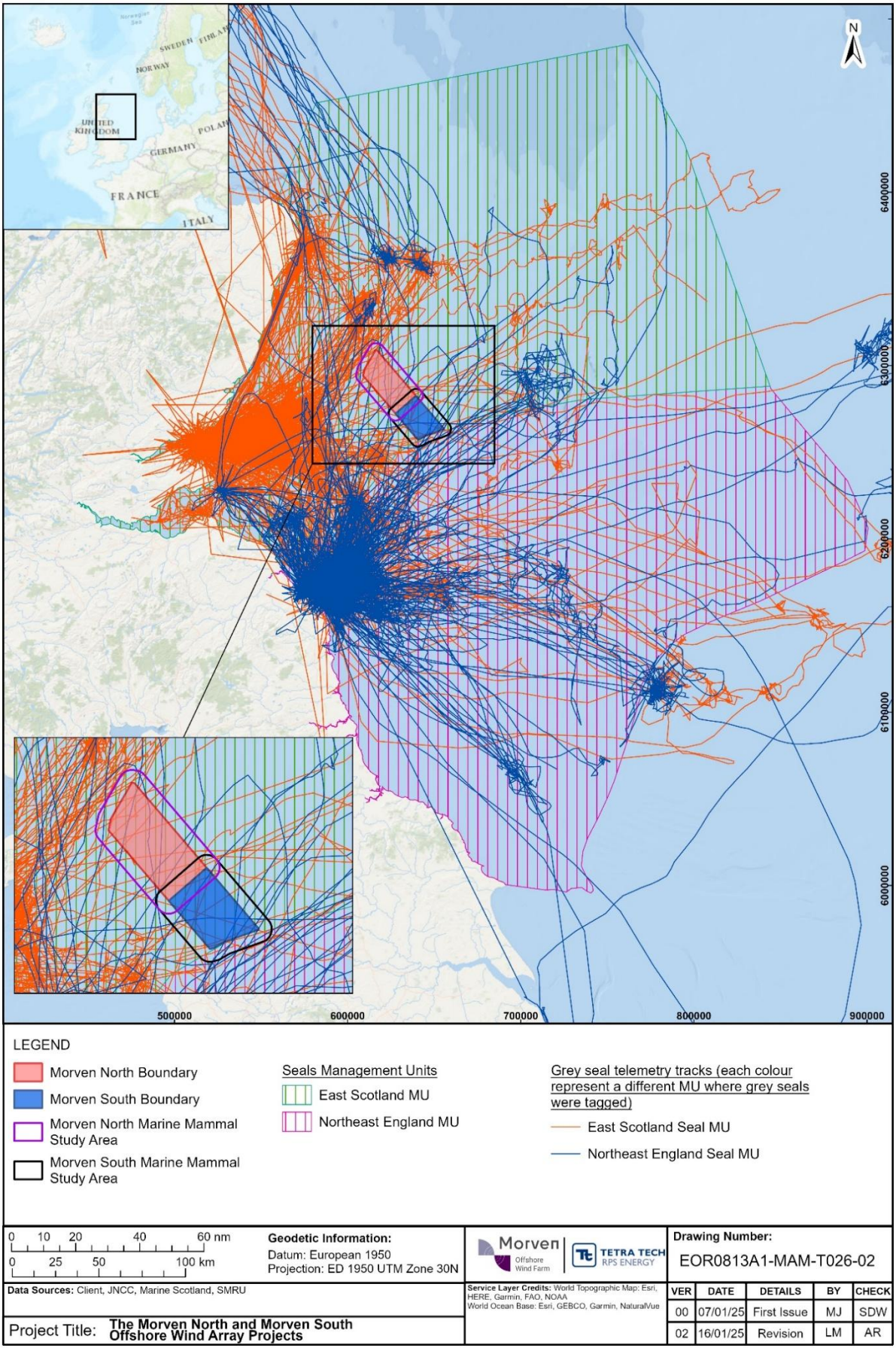

Figure 4.20: Telemetry tracks of adult grey seals tagged in the seal MUs of interest

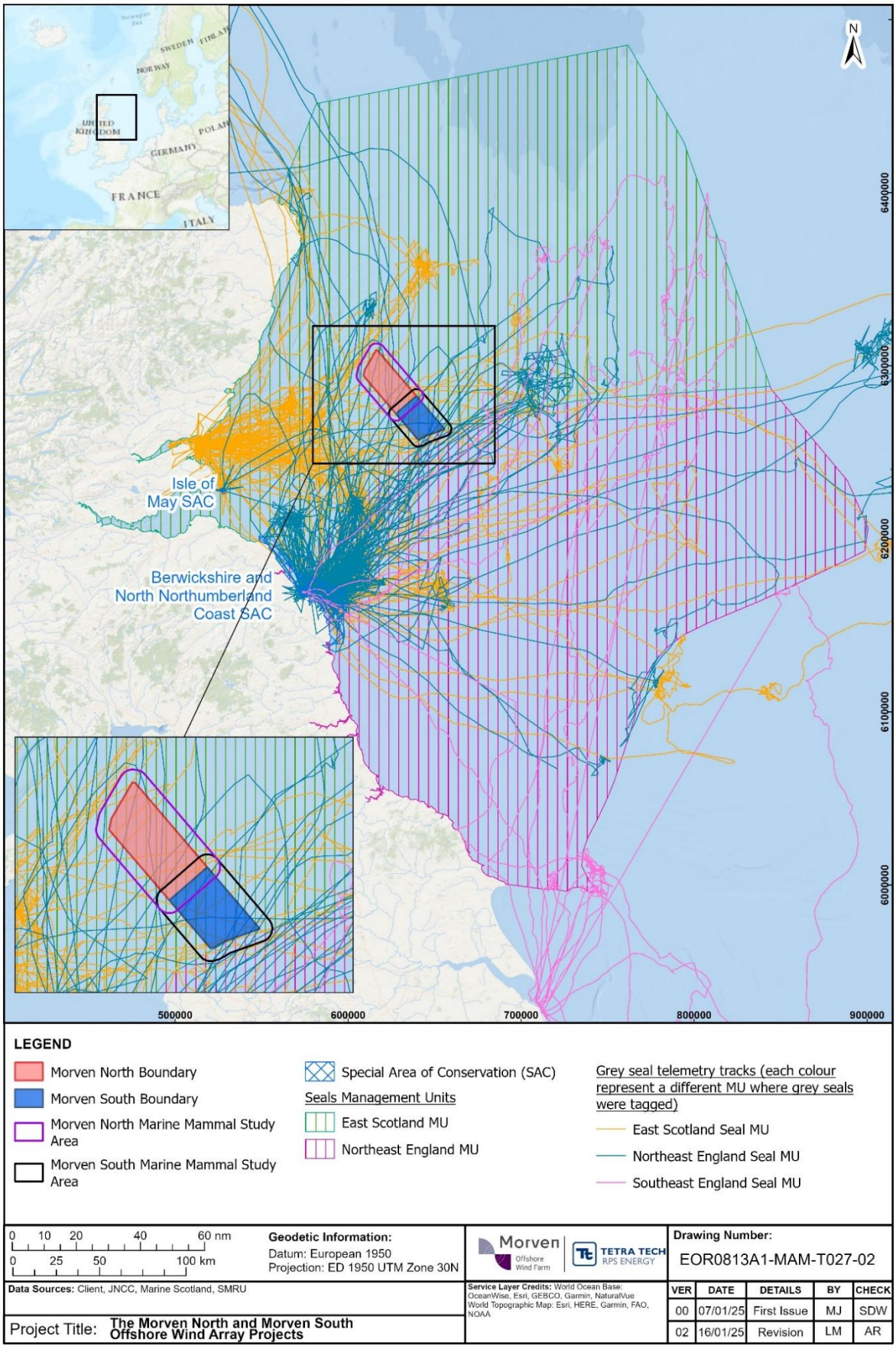

Figure 4.21: Telemetry tracks of adult grey seals with connectivity to the Morven Site Marine Mammal Study Area and SACs

4.7.2.11 Movement data were also obtained from telemetry tags on 45 pup and juveniles, with 37 individuals tagged in the seal MUs of interest (Figure 4.21). It is important to note that pup and juvenile movements 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 (Stevens, 2023). Of these 45 grey seal pups, 13 (29%) were tracked within Morven Site Marine Mammal Study Area, 11 (24%) of which were also tracked inside a grey seal SAC (Figure 4.22), indicating some connectivity between the Morven Site Marine Mammal Study Area and grey seal SACs. Connectivity with only the Isle of May SAC was observed in two grey seal pups, with only the Berwickshire and North Northumberland Coast SAC in five grey seal pups, and with both SACs in four grey seal pups. No connectivity was observed between these grey seal pups and any SAC outside the East Scotland and Northeast England seal MUs.

4.7.2.12 During the Seagreen boat-based surveys grey seals were recorded in the highest numbers over sandy shallow banks such as Scalp Bank, Marr Bank, Wee Bankie and Berwick Bank, which are thought to be important areas for sandeels, a key prey item of grey seal (Sparling, 2012). During the Berwick Bank aerial surveys grey seals were recorded throughout the surveyed area (Figure 2.2) with the mean encounter rate of 0.011 animals/km (95% CI = 0.014 to 0.007; unidentified seal sightings were precautionarily assigned to grey seal due to their prevalence in the region).

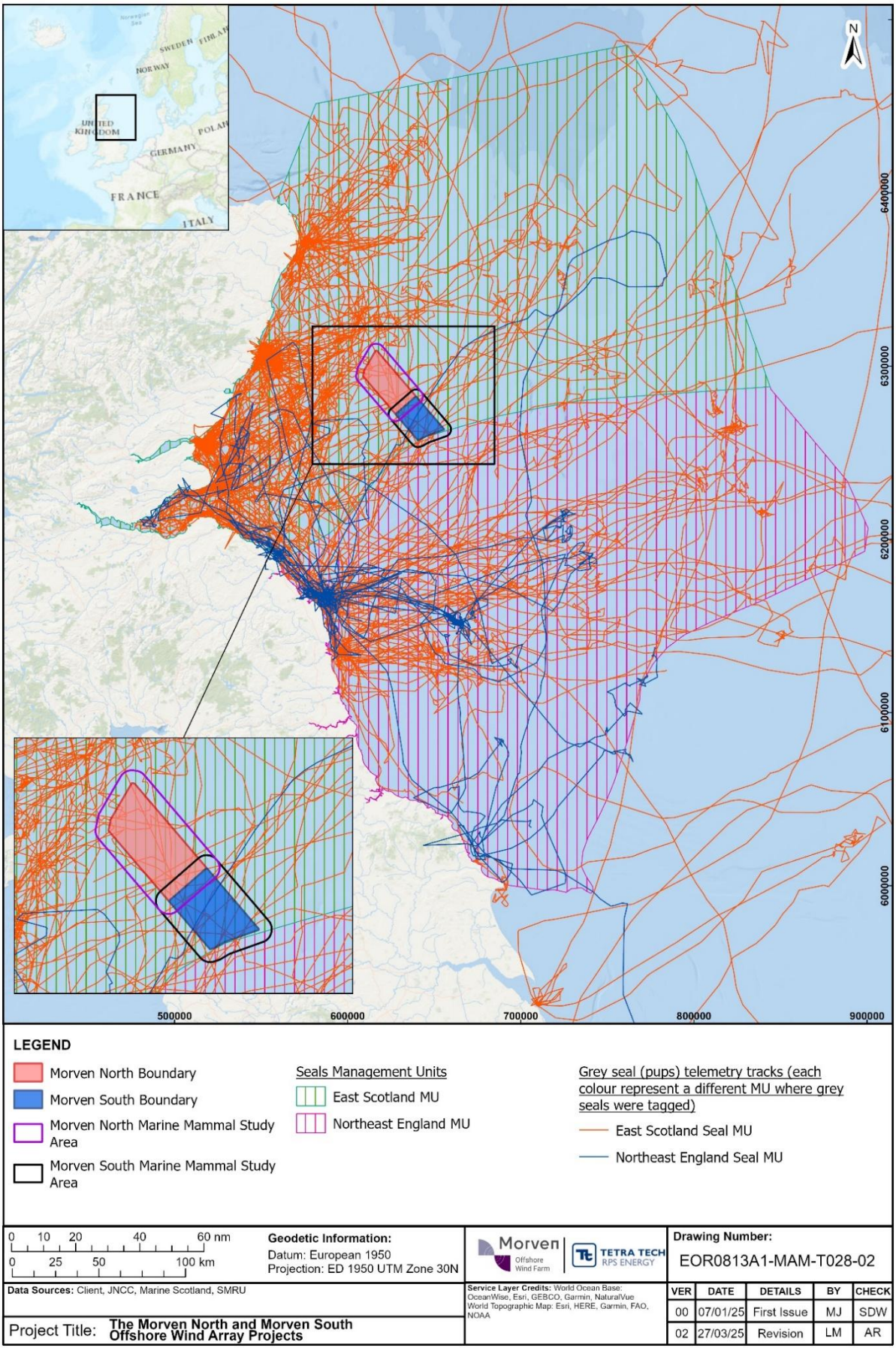

Figure 4.22: Telemetry tracks of grey seal pups tagged in the seal MUs of interest

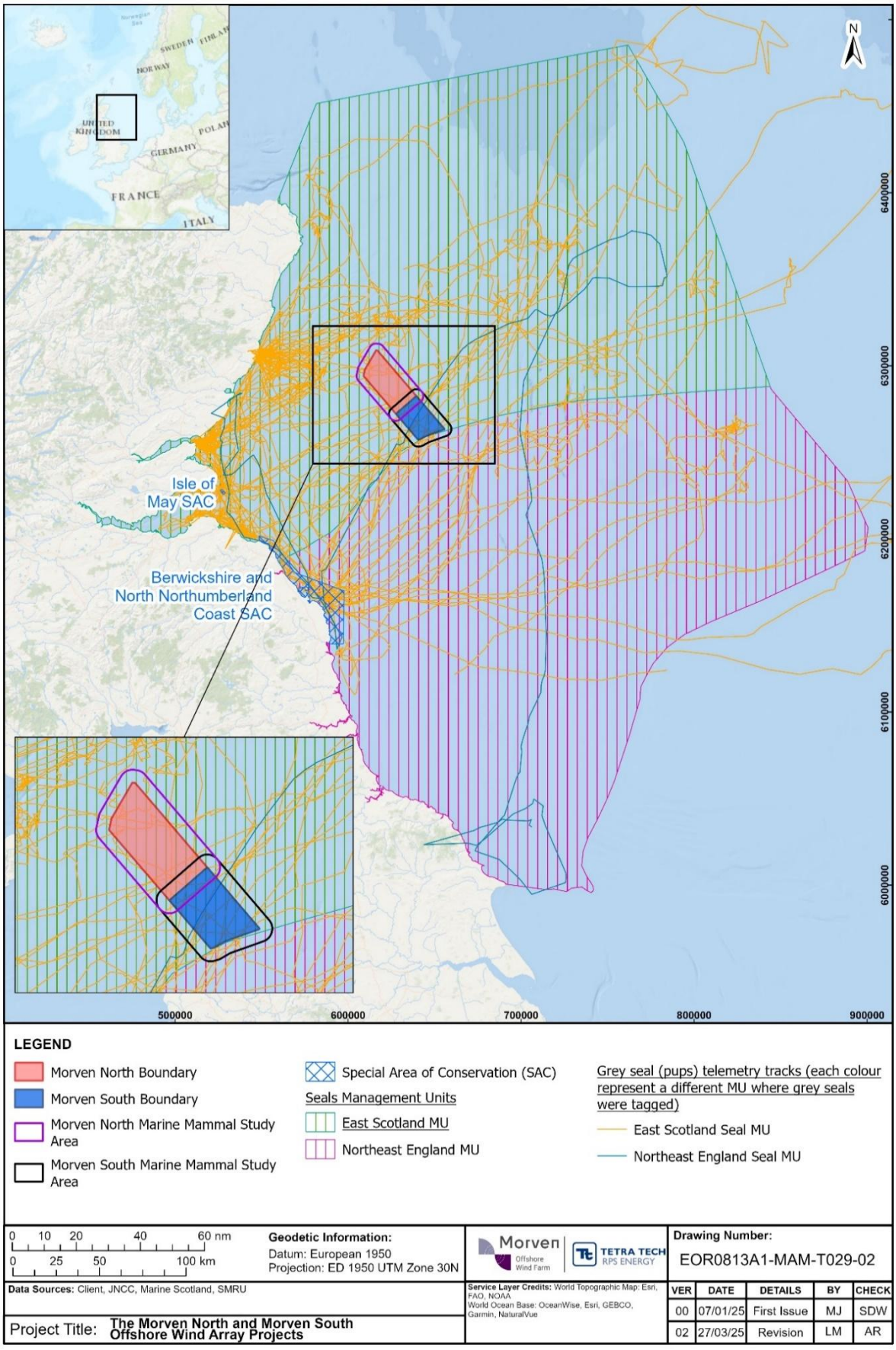

Figure 4.23: Telemetry tracks of grey seal pups with connectivity to the Morven Site Marine Mammal Study Area and SACs

4.7.3 Density/abundance

Published Literature

4.7.3.1 Grey seals encountered during SMRU harbour seal August moult surveys are recorded to provide information on grey seal summer distribution. However, grey seal numbers at haul-out sites during the summer can vary from day to day and are therefore not an accurate reflection of abundance in each region. The UK wide grey seal population is estimated using a population model that combines regional pup production estimates and August haul-out counts scaled to population estimates (Stevens, 2023).

4.7.3.2 In 2019, total UK pup production was estimated at 67,850 (95% CI = approximately 60,500 to 75,100) based primarily on estimates from less-frequently surveyed colonies as well as ground count data (Stevens, 2023). Pup production in Scotland in 2019 was estimated at 54,050 individuals, equating to approximately 79.7% of all pups born in the UK. The overall trend in pup production in the East Scotland seal MU has been increasing in recent years, however, the distribution of pup production appears to be changing (Stevens, 2023). Prior to the 1990s, the Isle of May SAC was the dominant location for pup production but since 2012, pup production estimates at the Isle of May have been overtaken by the Fast Castle colony (Stevens, 2023). Pup production estimates at the Isle of May are now considered to be stable or potentially declining (Stevens, 2023). In the Northeast England seal MU, pup production is centred entirely at the Farne Islands, where productivity has exhibited a rapid increasing trend (Stevens, 2023).

4.7.3.3 Grey seal August counts are estimated to be stable in the East Scotland seal MU and increasing in the Northeast England seal MU (Figure 4.23) (Stevens, 2023). The most recent August grey seal counts took place in 2021 in both East Scotland and Northeast England MU and resulted in a scaled August population estimates of 10,783 and 25,913 grey seals, respectively (SCOS, 2022).

4.7.3.4 The UK total grey seal population size at the start of the 2022 breeding season was estimated to be 162,000 grey seals of which 129,100 (approximately 80%) were in Scotland (Stevens, 2023).

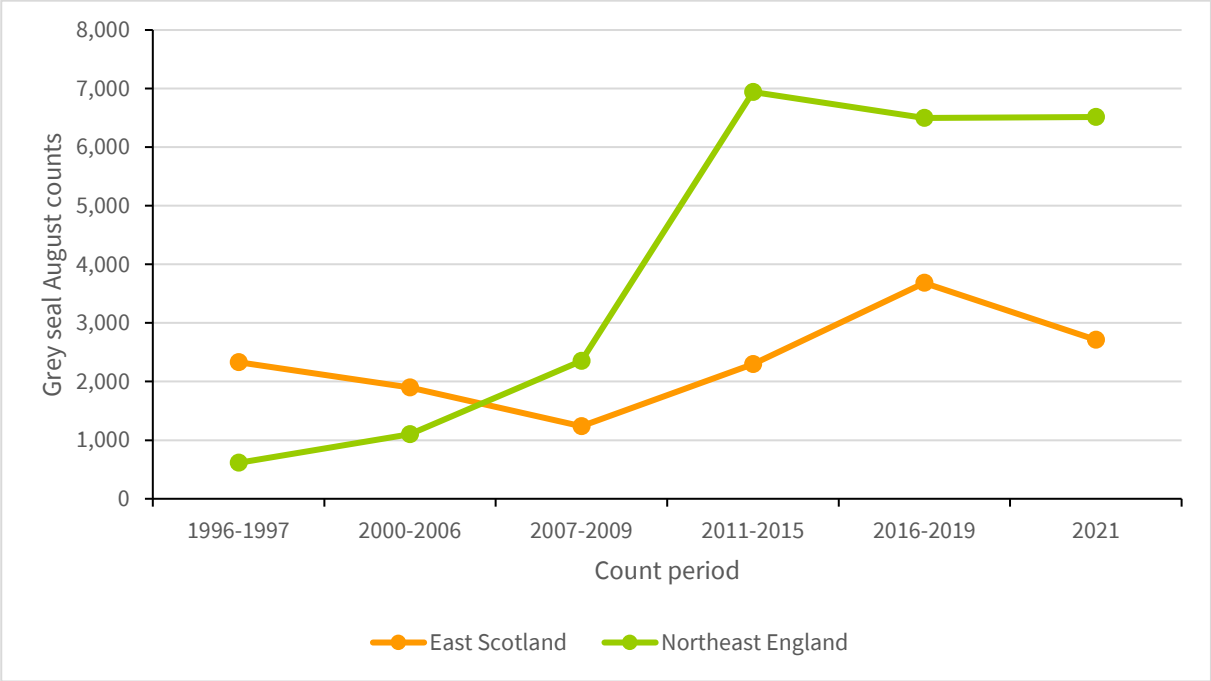

Figure 4.24: August haul-out counts (unscaled) of grey seals within seal MUs of interest (reproduced from Stevens (2023), data from SCOS (2022))

4.7.3.5 Mean grey seal at sea usage within the Morven Site Marine Mammal Study Area is relatively low, as the projects are located 60km offshore and hotspots are located closer to shore and in the vicinity of the Berwickshire and Northumberland Coast SAC, Firth of Forth, Tay and Eden Estuary and north of Aberdeen (Figure 4.24).

Morven Site Marine Mammal Study Area

4.7.3.6 The mean density of at sea usage within the Morven Site Marine Mammal Study Area was estimated at 7.230 animals per 5km x 5km grid cell (Figure 4.25), equating to a density of 0.289 animals/km^2 (Carter *et al.*, 2022). Similar modelling in Carter *et al.* (2025) estimates at sea usage density of 2.666 animals per 5km by 5km grid cell (Figure 4.26), equating to a density of 0.107 animals/km^2. However, although these results include additional animals tagged in Shetland, the updated modelling excludes all animals tagged outside Scotland, and as such these density estimates are not directly comparable with those in Carter *et al.* (2022). Similarly, by excluding animals known to use habitat in the vicinity of the Morven Site Marine Mammal Study Area (i.e. those tagged in the Northeast England and Southeast England seal MUs: see Figure 4.20 to Figure 4.23) subsequent density estimates are likely to be less conservative. Subsequently, abundance and density estimates from Carter *et al.* (2025) have not been take forward to the assessment.

Morven North Marine Mammal Study Area

4.7.3.7 The mean density of at sea usage within the Morven Site Marine Mammal Study Area was estimated at 7.897 animals per 5km x 5km grid cell (Figure 4.25), equating to a density of 0.316 animals/km^2 (Carter *et al.*, 2022). Similar modelling in Carter *et al.* (2025) estimates at sea usage density of 3.256 animals per 5km by 5km grid cell (Figure 4.26), equating to a density of 0.130 animals/km^2. Given that this is less robust and less conservative than that presented in Carter *et al.* (2022) (see paragraph 4.7.3.6) this estimate will not be taken forward to assessment.

Morven South Marine Mammal Study Area

4.7.3.8 The mean density of at sea usage within the Morven Site Marine Mammal Study Area was estimated at 6.307 animals per 5km x 5km grid cell (Figure 4.25), equating to a density of 0.252 animals/km^2 (Carter *et al.*, 2022). Similar modelling in Carter *et al.* (2025) estimates at sea usage density of 1.880 animals per 5km by 5km grid cell (Figure 4.26), equating to a density of 0.075 animals/km^2. Given that this is less robust and less conservative than that presented in Carter *et al.* (2022) (see paragraph 4.7.3.6) this estimate will not be taken forward to assessment.

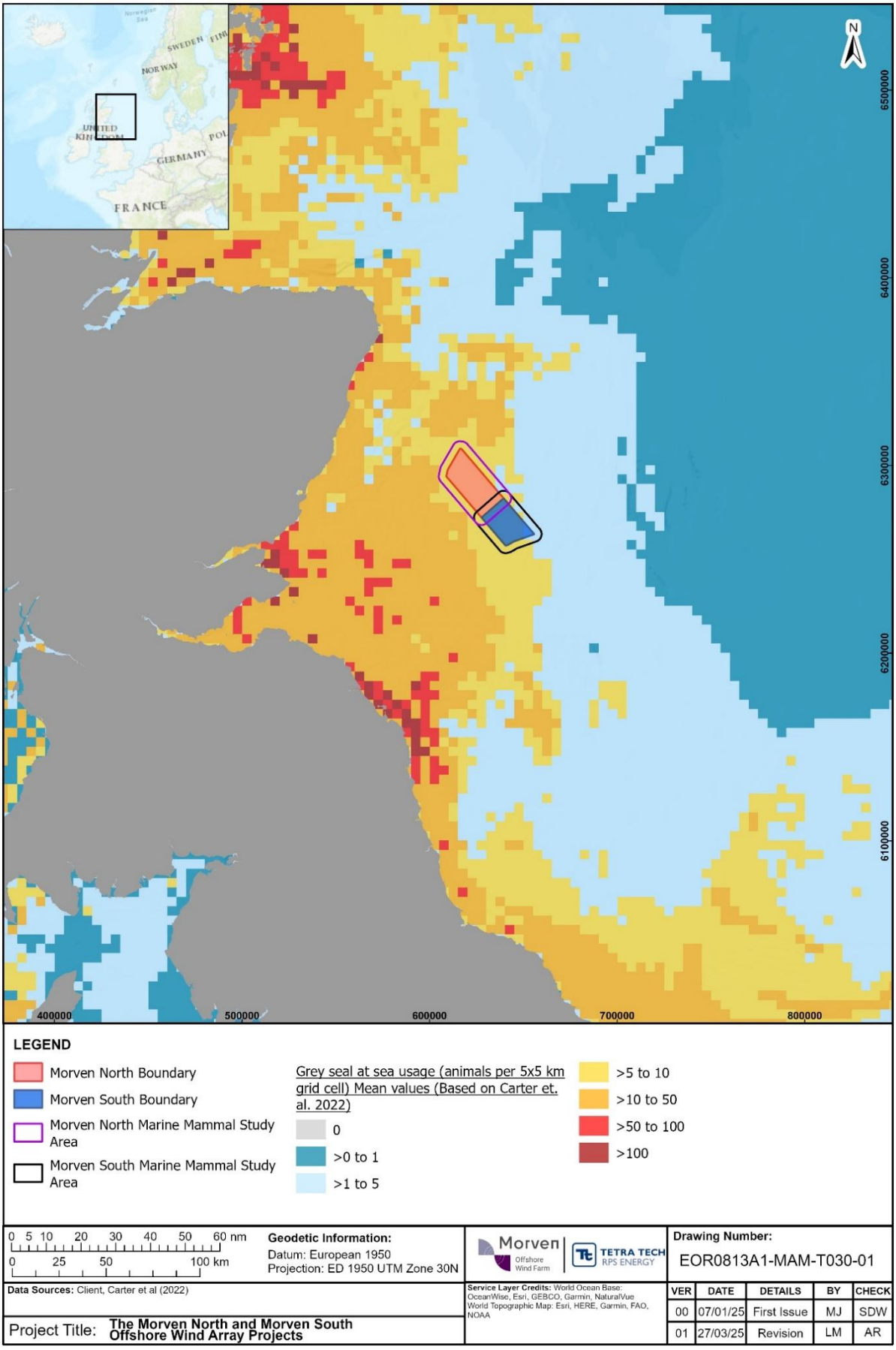

Figure 4.25: Mean grey seal at sea usage based on Carter *et al.* (2022)

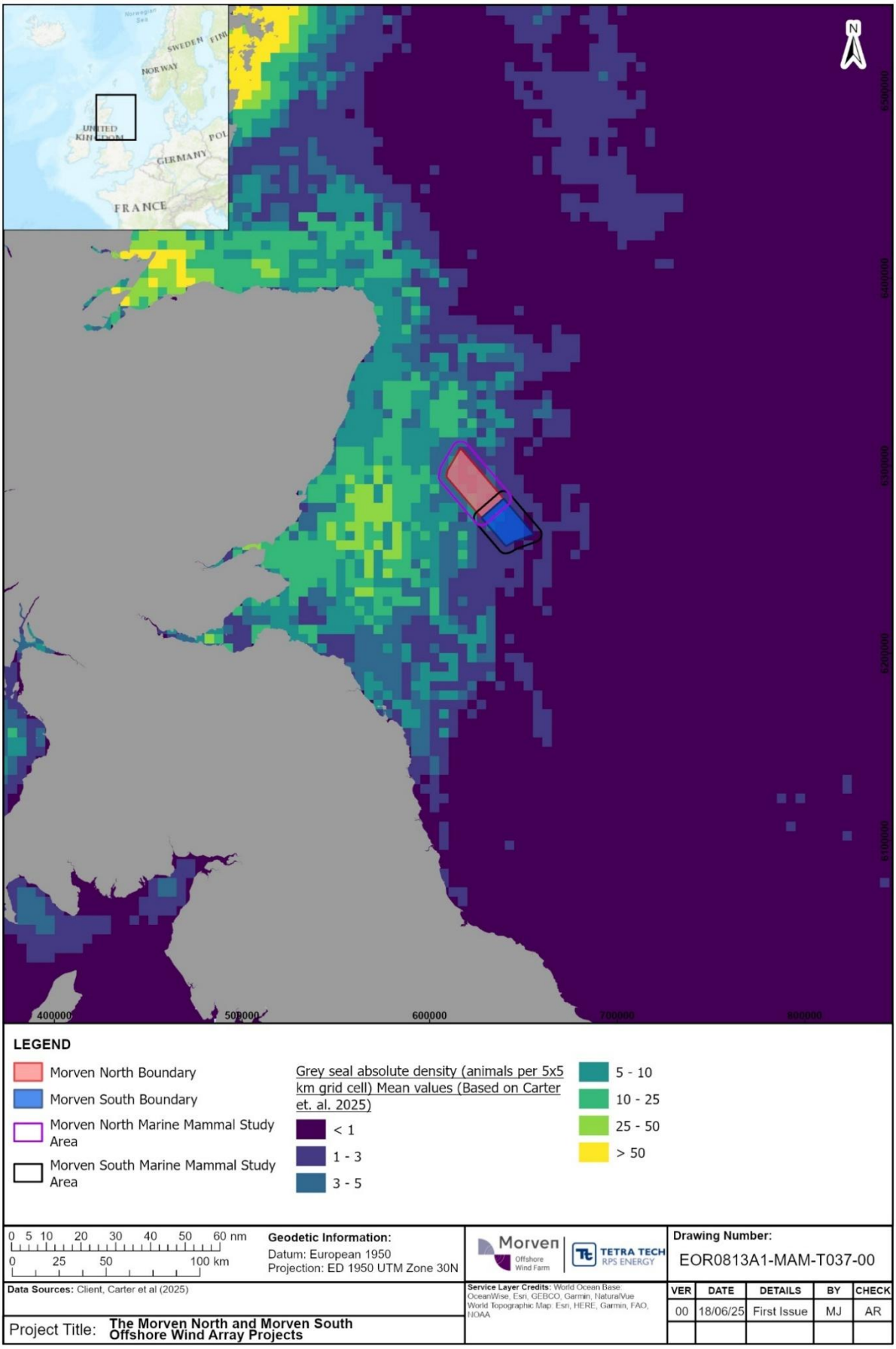

Figure 4.26: Mean grey seal at sea usage based on Carter *et al.* (2025)

Commercial Surveys

Historical surveys for other OWFs

4.7.3.9 Amongst historical surveys undertaken more than ten years ago, estimates of abundance and density vary. A minimum mean relative density during the TCE aerial surveys (Figure 2.2) of 0.106 animals/km^2 was estimated, with 0.137 animals/km^2 and 0.051 animals/km^2 in summer and winter, respectively (Grellier and Lacey, 2011). Seagreen boat-based surveys estimated an encounter rate of 0.053 animals/km, however no density estimate was presented (Sparling, 2012) and boat-based surveys for Neart na Gaoithe recorded only a count of 100 individuals across two years of survey, with no encounter rate or density estimate calculated (Mainstream Renewable Power, 2019).

4.7.3.10 More recently, seasonal density estimates estimated from Berwick Bank aerial surveys highlighted that mean monthly densities of grey seal were highest during spring months. The absolute density was estimated as 0.276 animals/km^2 with a peak mean density during spring months of 0.321 animals/km^2 (SSE Renewables, 2022a). However, Berwick Bank aerial surveys took place closer to the shore (Figure 2.2), where grey seal usage is higher compared to the Morven Site Marine Mammal Study (Figure 4.25 and Figure 4.26). These densities are therefore substantially higher than seasonal design-based estimates from the DAS campaign for Morven North and Morven South. No other commercial surveys produced density estimates for grey seal.

4.7.3.11 Surveys for the Ossian Array (March 2021 to February 2022, inclusive) estimated overall absolute densities for grey seal of 0.009 animals/km^2 (Ossian OWFL, 2024). When considered over a finer temporal scale, greater density of 0.034 animals/km^2 was estimated during the "non-breeding" bio-season (January to July) described in paragraph 2.1.2.6, with a lower density of 0.003 animals/km^2 during the "breeding" bio-season (August to December). The broader scale SSE Regional Surveys, which incorporates the Morven Site Marine Mammal Study Area and the survey area for the Ossian Array (Figure 2.2), did not present a density estimate for grey seal (HiDef, 2023).

Site specific surveys

4.7.3.12 Monthly densities of grey seal are presented below for the design-based analyses of site specific DAS data (January 2021 and September 2023, inclusive; see Section 3.2.2) for the Morven Site Marine Mammal Study Area and also separately for the Morven North Marine Mammal Study Area and Morven South Marine Mammal Study Area.

4.7.3.13 Grey seal individuals were not observed during DAS in sufficient numbers for robust model-based density estimates to be produced (i.e. surface densities estimates incorporating environmental covariates). As such their density could only be estimated via design-based methods.

4.7.3.14 In all cases, relative estimates were corrected for availability bias (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report) using the most conservative conversion factor of 15.6%, based on methods described by (Orsted, 2018) and Thompson *et al.* (1991).

Morven Site Marine Mammal Study Area

4.7.3.15 No temporal patterns in occurrence were observed, with sightings of a single animal in the months of June 2021, Dec 2021, Feb 2022, Sept 2022, April 2023 and May 2023, and two animals observed in March 2023 (Table 3.3). No spatial patterns were identified for observations of grey seal, with animals occurring throughout the Morven Site Marine Mammal Study Area, albeit at very low frequency. As such, the most precautionary grey seal densities calculated across the Morven Site Marine Mammal Study Area were estimated for spring with 0.016 animals/km^2 (95% CI = 0.007 to 0.025; CV = 1.633).

Morven North Marine Mammal Study Area

4.7.3.16 No temporal patterns in occurrence were observed, with sightings of a single animal in the months of December 2021, February 2022, September 2022, March 2023 to May 2023, and July 2023 to September 2023 (Table 3.4). No spatial patterns were identified for observations of grey seal, with animals occurring throughout the Morven North Marine Mammal Study Area, albeit at very low

frequency. As such, the most precautionary grey seal densities calculated across the Morven North Marine Mammal Study Area were estimated for spring with 0.019 animals/km^2 (95% CI = 0.009 to 0.028; CV = 1.500)

Morven South Marine Mammal Study Area

4.7.3.17 No temporal patterns in occurrence were observed, with sightings of a single animal in the months of June 2021, February 2022, September 2022 and March 2023 (Table 3.5). No spatial patterns were identified for observations of grey seal, with animals occurring throughout the Morven South Marine Mammal Study Area, albeit at very low frequency. As such, the most precautionary grey seal densities calculated across the Morven South Marine Mammal Study Area were estimated for autumn with 0.011 animals/km^2 (95% CI = 0.003 to 0.019; CV = 2.646).

4.7.4 Seasonality

4.7.4.1 Grey seal sighting rates during Seagreen boat-based surveys were lowest over the autumn and winter (Seagreen Wind Energy Limited, 2018). During the Berwick Bank aerial survey grey seals were recorded every month, except one (SSE Renewables, 2022a). Based on DAS sightings, grey seals were most abundant in spring (March to May) (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report).

4.7.4.2 Comparatively higher at sea encounter rates during summer may be related to the capital breeding strategy of grey seals, possibly indicative of a period of intense foraging where adult seals accrue energy reserves prior to the breeding season. During autumn and early winter (August to December) grey seals aggregate to breed at traditional colonies and therefore the number of seals might be expected to be low as a large proportion of the population will be hauled-out to breed.

4.7.5 Summary

4.7.5.1 The east coast of Scotland and northern England provide important breeding and haul-out habitats for grey seal (SCOS, 2022). Comparison of key data sources for grey seal is shown in Table 4.5.

Morven Site Marine Mammal Study Area

4.7.5.2 To provide the most precautionary figure, the design-based absolute density estimates from the DAS presented in Table 4.5 are based on the spring meteorological season (March to May). However, the predicted estimate of mean density for the Morven Site Marine Mammal Study Area from (Carter *et al.*, 2022) of 0.289 animals/km^2 is substantially higher than the absolute density of 0.016 animals/km^2 based on DAS data (Table 4.5). Given uncertainties associated with identification of seals to species level based on DAS data, the density of 0.289 animals/km^2 (Carter *et al.*, 2022) will be taken forward to the assessment.

Morven North Marine Mammal Study Area

4.7.5.3 To provide the most precautionary figure, the design-based absolute density estimates from the DAS presented in Table 4.5 are based on the spring meteorological season (March to May). However, the predicted estimate of mean density for the Morven North Marine Mammal Study Area from (Carter *et al.*, 2022) of 0.316 animals/km^2 is substantially higher than the absolute density of 0.019 animals/km^2 based on DAS data (Table 4.5). Given uncertainties associated with identification of seals to species level based on DAS data, the density of 0.316 animals/km^2 (Carter *et al.*, 2022) will be taken forward to the assessment.

Morven South Marine Mammal Study Area

4.7.5.4 To provide the most precautionary figure, the design-based absolute density estimates from the DAS presented in Table 4.5 are based on the autumn meteorological season (September to November). However, the predicted estimate of mean density for the Morven South Marine Mammal Study Area from (Carter *et al.*, 2022) of 0.252 animals/km^2 is substantially higher than the absolute density of 0.011 animals/km^2 based on DAS data (Table 4.5). Given uncertainties associated with identification

of seals to species level based on DAS data, the density of 0.252 animals/km^2 (Carter *et al.*, 2022) will be taken forward to the assessment.

Table 4.5: Comparison of density estimates for grey seal within the Morven Site Marine Mammal Study Area. Text in bold are the values taken forward for assessment

Source	Survey Area	Density (animals/km^2)	CV
Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management (Carter *et al.*, 2022)	**Morven Site Marine Mammal Study Area (mean estimated density)**	**0.289**	-
	Morven North Marine Mammal Study Area (mean estimated density)	**0.316**	-
	Morven South Marine Mammal Study Area (mean estimated density)	**0.252**	-
Updated Habitat-Based At Sea Distribution Maps for Harbour and Grey Seals in Scotland (Carter *et al.*, 2025)	Morven Site Marine Mammal Study Area (mean estimated density)	0.107	-
	Morven North Marine Mammal Study Area (mean estimated density)	0.130	-
	Morven South Marine Mammal Study Area (mean estimated density)	0.075	-
Site specific DAS: design-based	Morven Site Marine Mammal Study Area (spring meteorological season)	0.016	1.633
	Morven North Marine Mammal Study Area (spring meteorological season)	0.019	1.500
	Morven South Marine Mammal Study Area (autumn meteorological season)	0.011	2.646
Site specific DAS: model-based	Morven Site Marine Mammal Study Area	n/a	n/a

4.8 Harbour Seal

4.8.1 Ecology

4.8.1.1 Harbour seal typically weighs between 80kg to 100kg and is the smaller of the two species of pinniped that breed in the UK (SCOS, 2022). Males reach sexual maturity at four to six years, and females at three to five years (Lowry, 2016), with a life expectancy of between 20 and 30 years (SCOS, 2022).

4.8.1.2 Harbour seal is a central place foragers and comes ashore in sheltered waters, often on sandbanks, in estuaries and rocky areas (SCOS, 2022). Haul-out sites are required for resting, moulting, and breeding, and individuals disperse from these sites to forage at sea. 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) and tend to stay within 50km of the coast, although most foraging trips are over shorter ranges (Carter *et al.*, 2022, Russell and McConnell, 2014).

4.8.1.3 Harbour seal is a generalist feeders and diet varies both seasonally and regionally (Hammond *et al.*, 2005). Stable isotopes analysis of mercury and selenium in the blood of North Sea harbour seals revealed that typical diet is comprised of approximately 30% juvenile cod, 29% plaice (Pleuronectes platessa) and sole, and 23% monkfish (*Lophius piscatorius*), European hake (*Merluccius merluccius*) and haddock (Damseaux *et al.*, 2021).

4.8.1.4 Harbour seal females give birth in small groups scattered along the coastline, with pups born in June and July having moulted their white coats prior to birth. During lactation, females spend much of their time in the water with their pups and, although they will forage during this period, individuals travel shorter distances than during other periods (Thompson *et al.*, 1994). In recent years, a small number of surveys have been carried out in Scottish waters during the breeding season, in areas designated as SACs for harbour seals (Stevens, 2023), although none were conducted in the East Scotland or Northeast England seal MUs.

4.8.1.5 The annual moult of harbour seals in Scotland occurs in August, during which the greatest and most consistent abundance of hauled-out harbour seals occurs (SCOS, 2022). As such, the main harbour seal population surveys are carried out during this time.

4.8.2 Distribution and Occurrence

4.8.2.1 Harbour seal is found around the coasts of the North Atlantic and North Pacific from the subtropics to the Arctic (SCOS, 2022). The largest population in Europe is in the Wadden Sea, with approximately 32% found in the UK (SCOS, 2022). Harbour seal is widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast of the UK, however, the distribution of this species is more restricted with concentrations in the major estuaries of the Thames, The Wash, the Firths of Forth and Tay, and the Moray Firth.

4.8.2.2 Major declines have been documented in several harbour seal populations along the east coast of England and around Scotland (SCOS, 2022), although the pattern of declines is not universal. For instance, the decline following the 1998 phocine distemper virus outbreak in England affected mostly the Wash population but had limited impact elsewhere (SCOS, 2022). A sudden decline in the East Scotland seal MU population trend was observed in 2002 although the nature of this change remains unknown (Stevens, 2023). As previously described in Section 3.1.2, between 1990 and 2002, much of the East Scotland seal MU population was located in for the Firth of Tay and Eden Estuary SAC. During this period counts in the SAC remained stable, representing approximately 85% of the East Scotland seal MU count (Stevens, 2023). The SAC population then declined by 95% between 2002 and 2021, to 41 individuals, such that these animals account for approximately 16% of the haul-out counts in the East Scotland seal MU. Such rapid population decline appears to be restricted to the SAC, since the population estimate for the East Scotland seal MU has remained relatively stable since 2007, and there is now evidence that this decline may be slowing (Stevens, 2023) (Figure 4.25).

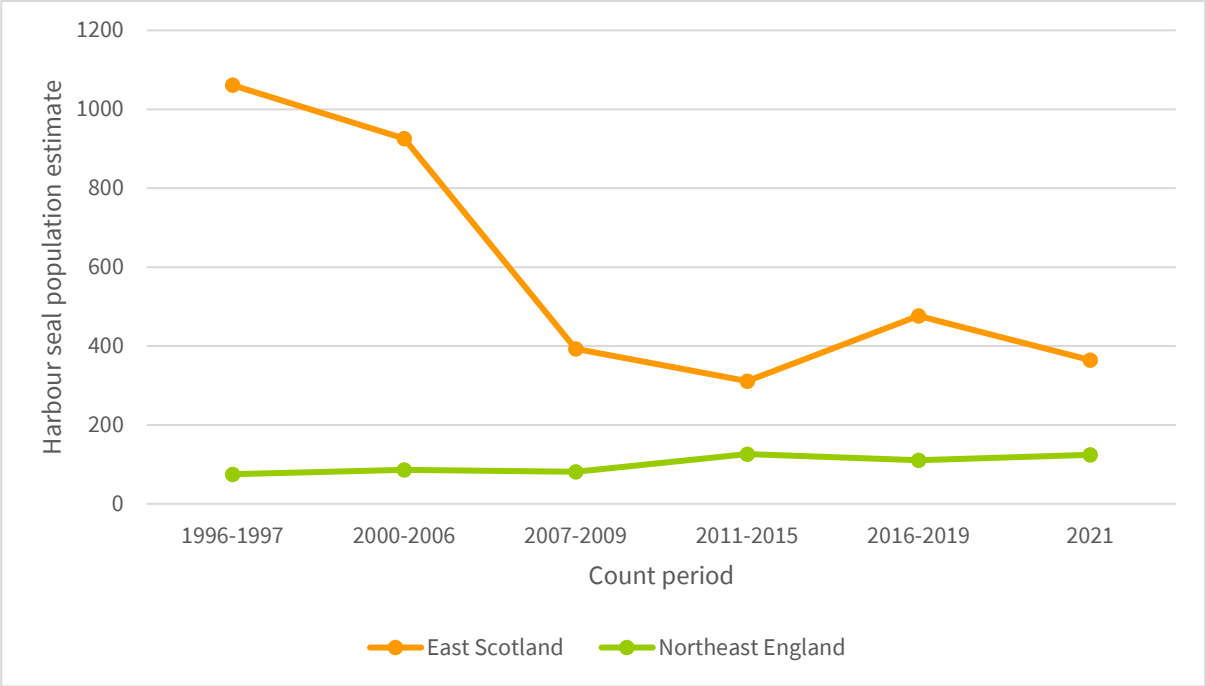

Figure 4.27: Harbour seal population estimates (scaled) within seal MUs of interest (reproduced from Stevens (2023), data from SCOS (2023))

4.8.2.3 There has also been a redistribution of harbour seals within the East Scotland seal MU and additional groups of harbour seals are located in the Firth of Forth, Montrose Basin and around the Aberdeenshire coast (Figure 4.27). Within the Northeast England seal MU, harbour seal haul-outs were primarily recorded at Lindisfarne in north Northumberland and within the Tees Estuary (near Middlesbrough) (Figure 4.27).

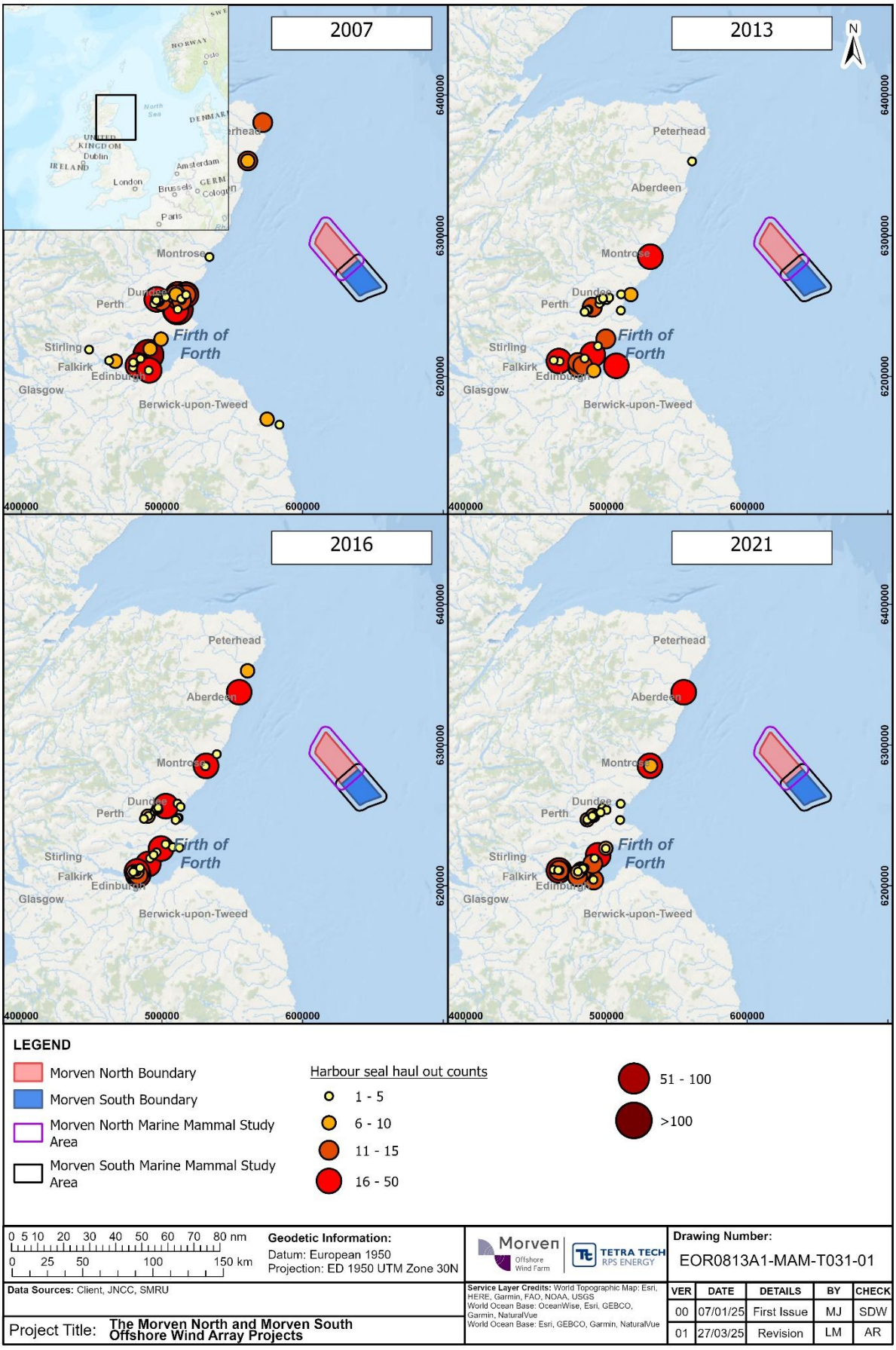

Figure 4.28: August harbour seal haul-out counts (2007, 2013, 2016 and 2021) based on Stevens (2023)

4.8.2.4 Telemetry data confirmed that harbour seal habitat usage within the Morven Site Marine Mammal Study Area is very limited. A total of 46 harbour seals were tagged in the East Scotland seal MU between 2001 and 2018 and no seals were tagged in the Northeast England seal MU (Stevens, 2023). A further four harbour seals that were tagged elsewhere entered the seal MUs of interest (Figure 4.28, see Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report (Stevens, 2023)).

4.8.2.5 In total, 50 harbour seals were tracked within the East Scotland an Northeast England seal MUs, and of these animals, four (8%) were recorded within the Morven Site Marine Mammal Study Area (Figure 4.29) (Stevens, 2023). All four of these were tagged within the Firth of Tay and Eden Estuary SAC, and although this site lies approximately 100km from the Morven Site Marine Mammal Study Area (i.e. beyond the typical 50km foraging range for harbour seal), the data suggests some degree of connectivity between these two areas Morven Site Marine Mammal Study Area (Figure 4.29).None of these individuals showed connectivity with harbour seal SACs outside of the East Scotland seal MU (Stevens, 2023).

4.8.2.6 Harbour seal tracks were recorded in the central and southern part of the Morven Site Marine Mammal Study Area (Figure 4.29). No clear patterns in distribution of harbour seal across the Morven Site Marine Mammal Study Area can be concluded based on DAS sightings as no individuals were recorded across the campaign (see Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report).

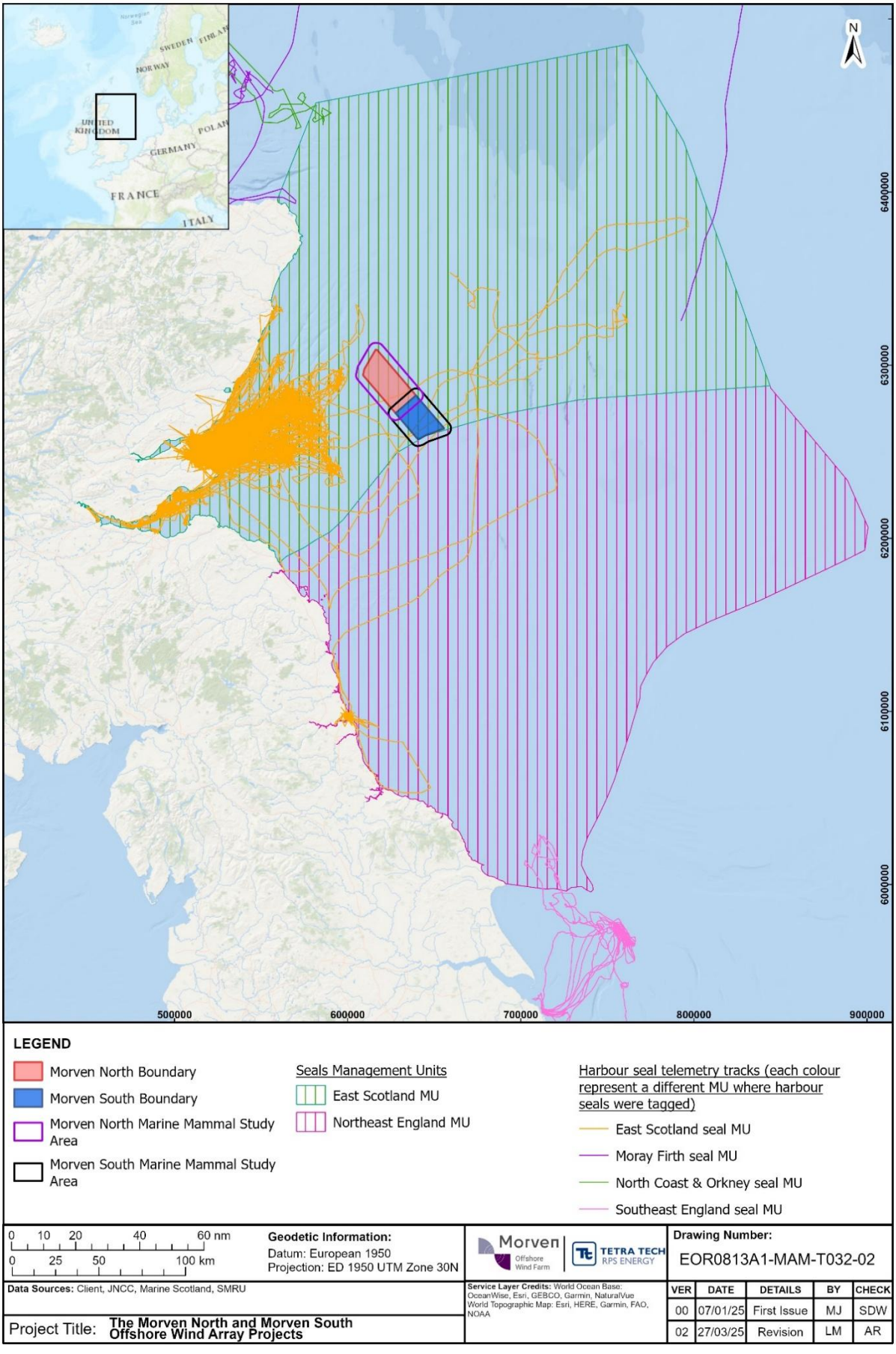

Figure 4.29: Telemetry tracks of harbour seals that entered the seal MUs of interest

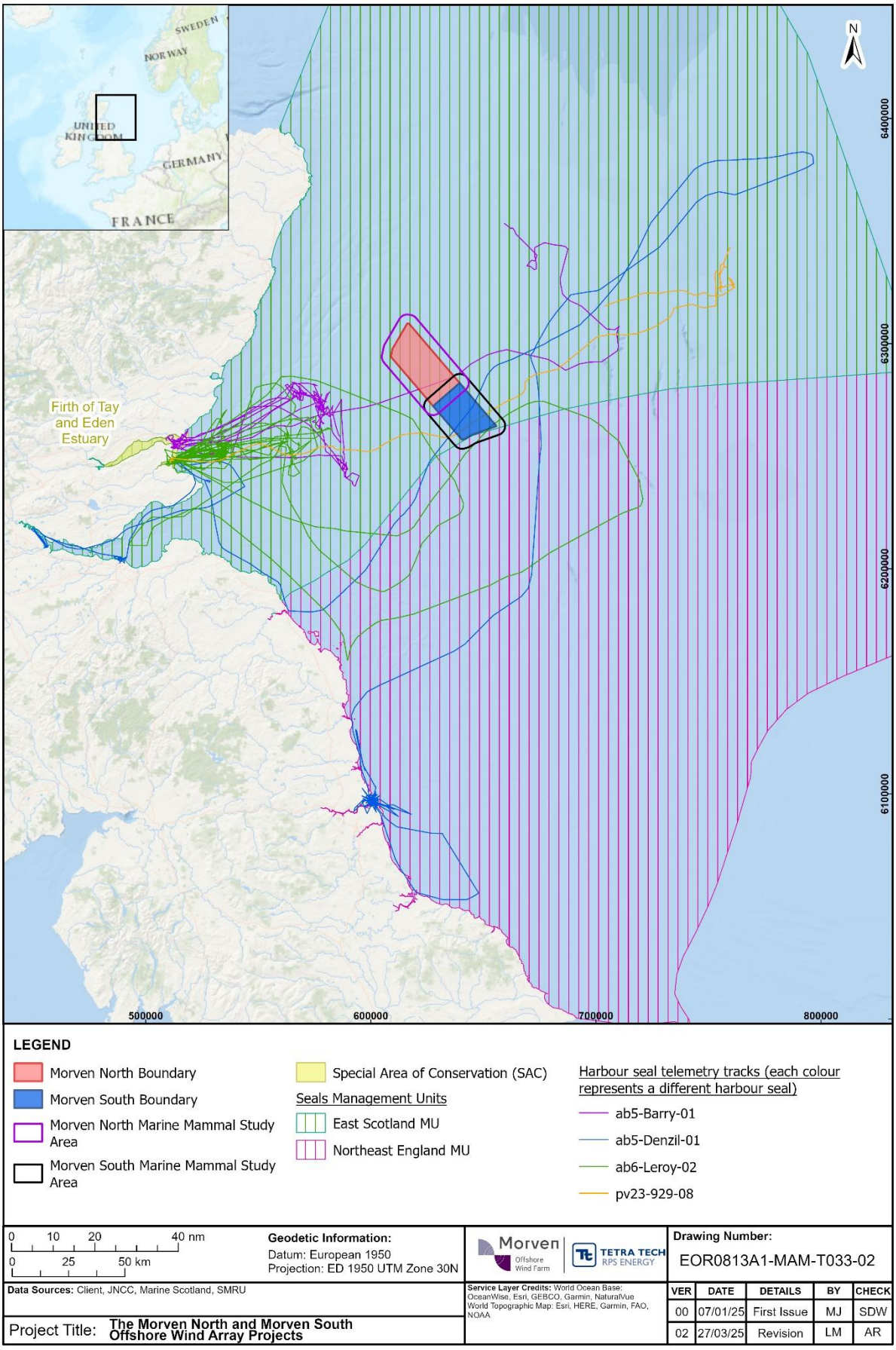

Figure 4.30: Telemetry tracks of harbour seals with connectivity to the Morven Site Marine Mammal Study Area

4.8.3 Density/abundance

Published Literature

4.8.3.1 The main population surveys are carried out when harbour seals are moulting, during the first three weeks of August. The most recent August haul-out count for the whole of Scotland is for the count period 2016 to 2019 and 2021, where a total of 26,378 harbour seals were counted (Stevens, 2023). For England and Wales, in 2021 a further 3,659 harbour seals were counted and in Northern Ireland 818 were counted. This results in a total count of 30,855 harbour seals in the UK during the period 2016 to 2021 equating to an estimated population of approximately 42,854 harbour seals in the UK (excluding the Republic of Ireland) (Stevens, 2023).

4.8.3.2 In the East Scotland seal MU, the population has been in decline since the 1996 to 1997 survey period where the highest counts of 764 individuals were recorded. In the 2016 to 2019 Survey Block, the haul -out counts within the East Scotland seal MU had increased for the first time since the decline, with 343 individuals (compared to 224 in the 2011 to 2015 Survey Block) but have since declined again in the most recent 2021 surveys to 262 individuals (Stevens, 2023), of which 37 (14%) were recorded in the Firth of Tay and Eden Estuary SAC. The current scaled population estimate (based on the 2021 count) for the East Scotland seal MU is 364 harbour seals (Stevens, 2023) (Figure 4.27). In the Northeast England seal MU, harbour seal haul-out counts are low, with the most recent haul-out count of 89 harbour seals for the 2021 count period resulting in a population estimate of 124 harbour seals (Stevens, 2023). There were sudden declines in the population noted in 1988 and 2002 and phocine distemper virus is considered to be the cause of these declines (Stevens, 2023).

Morven Site Marine Mammal Study Area

4.8.3.3 Mean harbour seal at sea usage within the Morven Site Marine Mammal Study Area is very low, with mean density of 8.20×10^{-5} animals per 5km x 5km grid cell, equating to a density of 3.28×10^{-6} animals/km^2 (Carter *et al.*, 2022) (Figure 4.30).

Morven North Marine Mammal Study Area

4.8.3.4 Mean harbour seal at sea usage within the Morven North Marine Mammal Study Area is very low, with mean density of 1.22×10^{-5} animals per 5km x 5km grid cell, equating to a density of 4.88×10^{-6} animals/km^2 (Carter *et al.*, 2022) (Figure 4.30).

Morven South Marine Mammal Study Area

4.8.3.5 Mean harbour seal at sea usage within the Morven South Marine Mammal Study Area is very low, with mean density of 3.00×10^{-6} animals per 5km x 5km grid cell, equating to a density of 1.20×10^{-7} animals/km^2 (Carter *et al.*, 2022) (Figure 4.30).

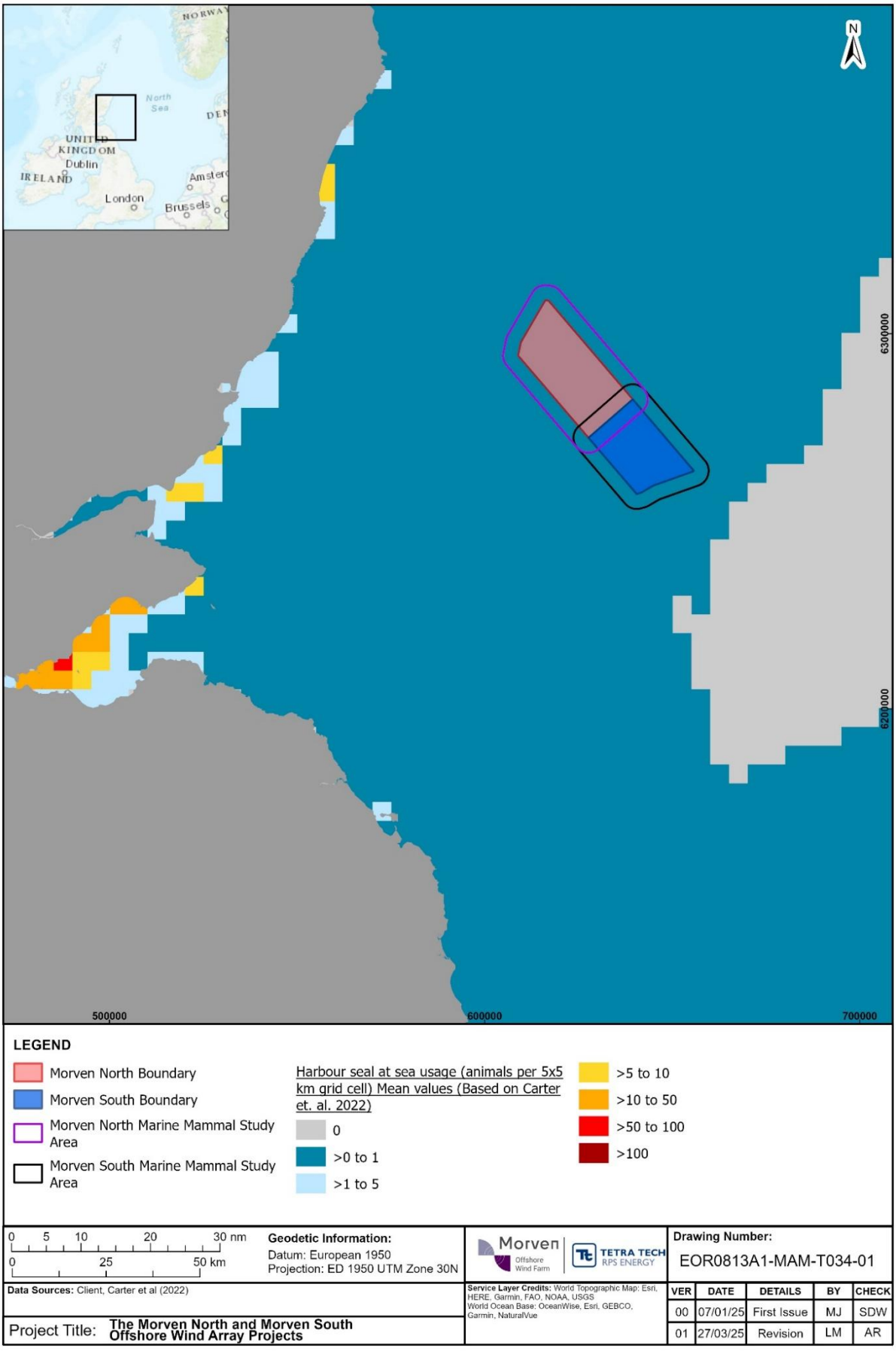

Figure 4.31: Mean harbour seal at sea usage based on Carter *et al.* (2022)

Commercial Surveys

Historical surveys for other OWFs

4.8.3.6 Seagreen boat-based surveys show that harbour seals were seen in low numbers during most months in 2010, with the only exceptions being October and November when no harbour seals were recorded (Sparling, 2012). However, it should be noted that the Seagreen boat-based surveys were conducted in the areas closer to the shorelines and Firths of Forth and Tay (Figure 2.2), where harbour seal habitat usage is higher (Figure 4.28). No harbour seals were recorded during the Seagreen boat-based surveys in 2017 (Seagreen Wind Energy Limited, 2018). Only three sightings of harbour seal were made over the 25 months of Berwick Bank aerial survey (SSE Renewables, 2022a), two observations were made during the Ossian Array aerial surveys (Ossian OWFL, 2024), and no observations were made during the SSE Regional Surveys (HiDef, 2023).

Site specific surveys

4.8.3.7 No harbour seals were recorded during DAS (see Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report) and as such, design- or model-based density and abundance estimates for this species are not available.

4.8.4 Seasonality

4.8.4.1 No clear patterns in seasonality of harbour seal can be concluded based on DAS and historic survey sightings (Figure 2.2) due to low numbers of animals identified to species level (see Volume 3, Annex 10.3: Marine Mammal Shared Digital Aerial Survey Report).

4.8.5 Summary

4.8.5.1 Harbour seals typically forage within 50km of a haul-out site and therefore their presence in offshore waters is limited (Table 4.6). Due to low numbers of harbour seal sightings during the DAS campaign for Morven North and Morven South, neither design- or model-based density and abundance estimates for this species are available. Estimated mean density of harbour seal across the Morven Site Marine Mammal Study Area is 3.28×10^{-6} animals/km^2 (Carter *et al.*, 2022).

4.8.5.2 Following feedback received in the Scoping Opinion from MD-LOT and NatureScot (MD-LOT, 2023), harbour seal was scoped into the assessment and a thorough review of its distribution and ecology within the Morven Regional Marine Mammal Study Area was carried out in Section 3.2.2. However, considering relatively short foraging ranges, low numbers of harbour seals detected during DAS, low at sea habitat usage (Figure 4.30) and a limited connectivity with the Morven Site Marine Mammal Study Area based on telemetry data (Figure 4.29), the potential for effects on harbour seal populations on the east coast of Scotland is very low.

Table 4.6: Comparison of density estimates for harbour seal within the Morven Site Marine Mammal Study Area. Text in bold are the values taken forward for assessment

Source	Survey Area	Density (animals/km^2)	CV
Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management (Carter *et al.*, 2022)	**Morven Site Marine Mammal Study Area (mean estimated density)**	**3.28 x 10^{-6}**	-
	Morven North Marine Mammal Study Area (mean estimated density)	**4.88 x 10^{-6}**	-
	Morven South Marine Mammal Study Area (mean estimated density)	**1.20 x 10^{-7}**	-
Site specific DAS: design-based	Morven Site Marine Mammal Study Area	n/a	n/a
Site specific DAS: model-based	Morven Site Marine Mammal Study Area	n/a	n/a

5 Summary

5.1 Overall Baseline Characterisation

5.1.1.1 Data gathered through a desktop review (publicly available sources as well as commercial survey results) and DAS found that the northern North Sea supports a number of different marine mammal species with internationally important populations of certain species occurring within the vicinity of the Morven Site Marine Mammal Study Area. Key marine mammals identified within the Morven Regional Marine Mammal Study Area include harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale and grey seal. Harbour seal were less abundant in the region, and humpback whale were identified through citizen science projects as occasional visitors, recorded in the vicinity of the Firth of Forth mostly over winter months.

5.1.1.2 Where possible, species-specific density estimates were generated using DAS data gathered during the 33 months of surveys across the Morven Site plus 4km buffer (i.e. the Morven Site Marine Mammal Study Area). 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 densities for each species that will be taken forward to the assessment in the EIAs are provided in Table 5.2. It should be noted that due to paucity of data on abundance and density of humpback whale in the North Sea, the assessment of impacts on this species in the EIAs will be qualitative. Species-specific MUs have also been presented as these are the relevant reference populations against which the population-level effects will be assessed within the EIA (Table 5.2).

5.1.1.3 Sites designated for the conservation of internationally important Annex II marine mammal populations within the Morven Regional Marine Mammal Study Area include the Firth of Tay and Eden Estuary SAC and Dornoch Firth and Morrich More SAC designated for harbour seal, the Berwickshire and North Northumberland Coast SAC and Isle of May SAC designated for grey seal, the Moray Firth SAC designated for bottlenose dolphin, the Southern North Sea SAC designated for harbour porpoise and the Southern Trench ncMPA designated for minke whale.

5.2 Important Ecological Features

5.2.1.1 Important Ecological Features (IEFs), in the context of marine mammals, are important species which could potentially be impacted by Morven North and/or Morven South. The Chartered Institute of Ecology and Environmental Management (CIEEM, 2022) guidance was used to define and assign importance to these IEFs. Marine mammal IEFs have been identified based on biodiversity importance, recognised through international or national legislation, conservation status/plans and on assessment of value according to the functional role of the species within the context of the regional marine mammal study area. Relevant legislation/conservation plans for marine mammals would include, for example: Annex II species under the Habitats Directive; Annex IV(a) of the Habitats Directive as EPS; species listed as threatened and/or declining by Oslo and Paris Conventions (OSPAR); IUCN Red List species; UK Biodiversity Action Plan (BAP) priority species either alone or under a grouped action plan; and PMFs in Scotland.

5.2.1.2 Table 5.1 summarises all of the IEFs within the Morven Regional Marine Mammal Study Area. All marine mammals with the potential to be affected by Morven North and/or Morven South are protected under some form of international legislation and/or are important from a conservation perspective in an international/national context and therefore the value of all marine mammal IEFs was determined to be international.

Table 5.1: Important Ecological Features within the Morven Regional Marine Mammal Study Area

IEF	Value	Justification
Odontocetes		
Harbour porpoise	International	Annex II species that is a designated feature of Southern North Sea SAC; EPS; Scottish PMF; OSPAR protected species; IUCN Red List Least Concern; and UK BAP priority species.
Bottlenose dolphin	International	Annex II species that is a designated feature of Moray Firth SAC; EPS; Scottish PMF; IUCN Red List Least Concern; and UK BAP priority species.
White-beaked dolphin	International	EPS; Scottish PMF; IUCN Red List Least Concern; and UK BAP priority species.
Mysticetes		
Minke whale	International	Protected Feature of Outhern Trench ncMPA; EPS; Scottish PMF; IUCN Red List Least Concern; and UK BAP priority species.
Humpback whale	International	EPS; IUCN Red List Least Concern; and UK BAP priority species
Pinnipeds		
Grey seal	International	Annex II species that is a designated feature of Berwickshire and Northumberland Coast SAC; IUCN Red List Least Concern; Scottish PMF

5.2.1.3 Site specific DAS data and data gathered through an extensive literature review were used to determine the most representative and robust density values to take through to the EIA. These values are presented in the following table (Table 5.2). A justification for each representative density is provided in the individual species accounts (Section 5).

Table 5.2: Summary of marine mammal IEFs to be considered in the marine mammal EIAs, together with relevant densities and reference populations

Species	Density (animals/km^2)				Management Unit	Population in Whole MU	Population in UK Portion of MU
	Morven Site Marine Mammal Study Area	Morven North Marine Mammal Study Area	Morven South Marine Mammal Study Area	Source			
Harbour porpoise	0.599	0.599	0.599	Gilles *et al.* (2023)	North Sea	346,601 (IAMMWG, 2023)	159,632 (IAMMWG, 2023)
Bottlenose dolphin	0.005	0.005	0.005	Lacey *et al.* (2022)	Greater North Sea	2,022 (IAMMWG, 2023)	1,885 (IAMMWG, 2023)
White-beaked dolphin	0.080	0.080	0.080	Gilles *et al.* (2023)	Celtic and Greater North Seas	43,951 (IAMMWG, 2023)	34,025 (IAMMWG, 2023)
Minke whale	0.042	0.042	0.042	Gilles *et al.* (2023)	Celtic and Greater North Seas	20,188 (IAMMWG, 2023)	10,288 (IAMMWG, 2023)
Humpback whale	Quantitative estimates not available for this species						
Grey seal	0.289	0.316	0.252	Carter *et al.* (2022)	East Scotland seal MU + Northeast England seal MU	10,783 + 25,913 = 36,696 (Stevens, 2023)	n/a (seal MUs contained entirely in UK waters)
Harbour seal	3.28×10^{-6}	4.88×10^{-6}	1.20×10^{-7}	Carter *et al.* (2022)	East Scotland seal MU + Northeast England seal MU	364 + 124 = 488 (Stevens, 2023)	n/a (seal MUs contained entirely in UK waters)

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