MachairWind Offshore Windfarm

Appendix 10.2 Marine Mammals and Leatherback Turtle Baseline

This page is intentionally blank

TABLE OF CONTENTS

List of Tables

List of Plates

List of Figures

GLOSSARY OF ACRONYMS

Term	Description
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
CES	Crown Estate Scotland
CGNS	Celtic Great North Sea
CI	Confidence Intervals
CL	Confidence Level
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
CV	Coefficient of Variation
CWSH	Coastal West Scotland and Hebrides
DAS	Digital Aerial Surveys
dB	Decibel
DPH	Detection Positive Hours
DPUE	Detection per Unit Effort
EEZ	Exclusive Ecological Zone
EIAR	Environmental Impact Assessment Report
EOWDC	European Offshore Wind Deployment Centre
ETG	Expert Topic Group
GPS	Global Positioning System
HWDT	Hebrides Whale Dolphin Trust
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
IOGP	International Association of Oil & Gas Producers
IPI	inter-pulse interval
IS	Irish Sea
ISRP	Independent Scientific Review Panel
IUCN	International Union for Conservation of Nature
IWC	Internation Whale Commission
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
kHz	Kilohertz
km	Kilometre

Term	Description
MBES	Multibeam Echo Sounder
MMO	Marine Mammal Observer
MPA	Marine Protected Area
MU	Management Unit
NAMMCO	North Atlantic Marine Mammal Commission
NC	Nature Conservation
NI	Northern Ireland
OAA	Option Agreement Area
O&M	Operations and Maintenance
OnTDA	Onshore Transmission Development Area
ORCA	Organisation Cetacea
OSPAR	Oslo–Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
OW	Oceanic Waters
PAM	Passive Acoustic Monitoring
PTS	Permanent Threshold Shift
RoI	Republic of Ireland
RMU	Regional Management Units
RMS	Root Mean Square
SAMS	Scottish Association for Marine Science
SBP	Sub bottom Profiler
SCANS	Small cetacean in the European Atlantic and the North Sea
SCOS	Special Committee on Seals
SEL / $L_{E,p}$	Sound Exposure Level
SEL_{cum} / $L_{E,p,t}$	Cumulative Sound Exposure Level
SEL_{SS} / $L_{E,p,ss}$	Single Strike Sound Exposure Level
SMFS	Scottish Marine Fisheries Service
SMRU	Sea Mammal Research Unit
SPL / L_p	Sound Pressure Level
SPL_{peak} / $L_{p\text{-pk}}$	Peak Sound Pressure Level
SWF	Sea Watch Foundation
TTS	Temporary Threshold Shift
WCC	West Coast Community
WDC	Whale and Dolphin Conservation

Term	Description
WDA	Windfarm Development Area
WTG	Wind Turbine Generator
UK	United Kingdom
UXO	Unexploded Ordnance Clearance

GLOSSARY OF TERMS

Term	Description
Collision	The act or process of two moving objects colliding.
Development Area	Application boundary for consenting purposes which, for the Project, consists of a Windfarm Development Area, Offshore Export Cable Corridor, and Onshore Transmission Development Area. Separate consent and marine licence applications will be submitted for each Development Area where applicable.
Environmental Impact Assessment (EIA)	The process of evaluating the likely significant environmental effects of a proposed development over and above the existing circumstances (or 'baseline').
EIA Scoping Windfarm Development Area (WDA) Boundary	The 510 km 2 WDA boundary presented at the Project's EIA Scoping Stage.
International Council for the Exploration of the Seas (ICES) statistical rectangles	The International Council for the Exploration of the Seas (ICES) standardise the division of sea areas to enable statistical analysis of data. Each ICES statistical rectangle is 30 min latitude by 1 degree longitude in size (approximately 30 x 30 nautical miles). A number of rectangles are amalgamated to create ICES statistical areas.
Landfall	The area from Mean Low Water Springs to a transition bay(s), where the offshore export cable(s) come ashore.
MachairWind Offshore Windfarm	An offshore windfarm capable of exporting around 2 GW of renewable energy to the National Electricity Transmission System. MachairWind Offshore Windfarm comprises three Development Areas: • The WDA – located on the west coast of Scotland to the northwest of Islay and west of Colonsay; • The Offshore Export Cable Corridor – a preliminary boundary extending from the WDA to mean high water springs at a landfall location near Girvan, South Ayrshire; and • The Onshore Transmission Development Area – a preliminary boundary which extends landward from mean low water springs and includes the land required for the landfall of the offshore export cables and their route up to but not including the proposed high voltage direct current switching station which will be developed and constructed by Transmission Owner, ScottishPower Transmission. Separate consent and licence applications will be submitted for each Development Area.
Management Units (MUs)	The MUs provide an indication of the spatial scales at which impacts of plans and projects alone, cumulatively and in-combination, need to be assessed for the marine mammal species in UK waters, with consistency across the UK.
National Electricity Transmission System	The high-voltage electricity power transmission network serving Great Britain which receives electricity from generators (such as offshore windfarms) and transmits that electricity to anywhere on the National Electricity Transmission System to satisfy demand.
Offshore export cable	Armoured cable containing electrical cores between the offshore substation platform(s) and landfall. Offshore export cables will include bundled fibre optic cables. The offshore export cables are subject to Marine Licence applications under the Marine (Scotland) Act 2010. The portion of the offshore export cable(s) located within the WDA is assessed as part of this MachairWind WDA EIA and a marine licence application to construct, alter or improve this portion has been submitted alongside the WDA application. A separate marine licence application will be submitted for the portion of the offshore export cable(s) from the WDA boundary to mean high water Mean High Water Springs.

Term	Description
Offshore Substation Platform (OSP)	An offshore platform with a fixed foundation located within the WDA which houses electrical equipment such as transformers, switchgear, protection and control systems, and enables the windfarm's renewable electricity to be collected via inter-array cables and exported to the National Electricity Transmission System via offshore export cables.
Option Agreement Area (OAA)	The seabed area awarded to ScottishPower Renewables in January 2022 through the Scotwind leasing round.
OSPAR	OSPAR started in 1972 with the Oslo Convention against dumping and was broadened to cover land-based sources of marine pollution and the offshore industry by the Paris Convention of 1974. These two conventions were unified, updated and extended by the 1992 OSPAR Convention. OSPAR is so named because of the original Oslo and Paris Conventions ("OS" for Oslo and "PAR" for Paris).
Pelagic	Of or relating to the open sea.
Permanent Threshold Shift (PTS)	A permanent total or partial loss of hearing sensitivity caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity.
ScotWind	A Crown Estate Scotland seabed leasing round which enabled developers to propose offshore wind projects and apply for seabed rights to plan and build windfarms in Scottish waters.
Scour protection	Protective measures to avoid sediment being eroded away from the base of the wind turbine generator foundations as a result of the flow of water.
The Applicant	The legal entity submitting consent applications for the MachairWind Offshore Windfarm, namely Machairwind Limited.
The Project	MachairWind Offshore Windfarm including all its Development Areas and associated infrastructure.
WDA infrastructure	The offshore generation and transmission infrastructure located within the WDA including but not limited to: WTGs, WTG fixed foundations (and associated scour protection), OSP(s), OSP fixed foundations (and associated scour protection), IACs, OSP link and offshore export cable(s) and their associated external cable protection (insofar as these are located within the WDA) and fibre optic cables.
Wind Turbine Generator (WTG)	A wind turbine generator which converts wind energy into electrical energy. Each wind turbine generator is a complex system composed of a high number of components. Typically, the main components include the rotor assembly (composed of three blades and a hub); the nacelle (containing a generator, shaft and gearbox, power electronic converter and transformer); and the tower (containing lifting equipment and the switchgear).
Windfarm Development Area (WDA)	The application boundary within the OAA where consent will be sought for the proposed WDA infrastructure. The WDA infrastructure is subject to Section 36 consent and marine licence applications (generation and transmission) which are being applied for separately from the Offshore ECC infrastructure and OnTDA infrastructure.

1. INTRODUCTION

1. This appendix, prepared by Haskoning; should be read in conjunction with **Chapter 10 Marine Mammals and Leatherback Turtle** of the Windfarm Development Area (WDA) Environmental Impact Assessment (EIA) Report (EIAR) and the Report to Inform Appropriate Assessment (RIAA). This appendix details the existing environment for marine mammals and leatherback turtle and sets out the species scoped in and out of the EIA.

2. Within the WDA, the Hebrides, and west coast of Scotland, 13 different marine mammal species have been identified (Paxton et al., 2016; Waggitt et al., 2019; Hammond et al., 2021; Gilles et al., 2023; Special Committee on Seals (SCOS), 2024, Hebridean Whale Dolphin Trust (HWDT), 2024; Hague et al., 2020) plus one turtle:

- Odontocetes (Toothed whales):
  - Harbour porpoise; (*Phocoena phocoena);*
  - Bottlenose dolphin (*Tursiops truncatus)*;
  - Short-beaked common dolphin (*Delphinus delphis);*
  - Atlantic white-sided dolphin (*Lagenorhynchus acutus)*;
  - White-beaked dolphin (*Lagenorhynchus genus);*
  - Risso's dolphin *(Grampus griseus);*
  - Killer whale (*Orcinus orca);* and
  - Long-finned pilot whale (*Globicephala melaena;*
- Mysticeti (Baleen whales):
  - Minke whale *(Balaenoptera acutorstrata);*
  - Fin whale *(Balaenoptera physalus); and*
  - Humpback whale (Megaptera novaeangliae).
- Pinnipeds:
  - Grey seal (*Halichoerus grypus)*; and
  - Harbour seal (*Phoca vitulina)*.
- Sea turtles
  - Leatherback turtle (*Dermochelys coriacea).*

3. The purpose of this appendix is to provide a robust baseline characterisation of marine mammals and leatherback turtle within the Marine Mammals and Leatherback Turtle Study Area and Wider Study Area (**Section 2**), against which the potential impacts of construction, operation and maintenance (O&M) and decommissioning of the WDA infrastructure / activities are assessed.

4. Data sources used to characterise the marine mammal and leatherback turtle baseline are provided in **Section 4** and include:

- Site-specific surveys:
  - Project's Digital Aerial Survey (DAS) data (**Section 4.1.1**); and
  - Third-Party DAS data (**Section 4.1.3**)
- Sightings data during the Project's site investigation surveys (**Section 4.2**); and
- Sightings data from HWDT Silurian expeditions (**Section 4.3**).

5. Existing desk-based data sources (such as SCANS-IV, Waggitt et al., Inter-Agency Marine Mammal Working Group (IAMMWG) data and regional monitoring programmes) have also been used to characterise the baseline environment (see **Chapter 10 Marine Mammals and Leatherback Turtle** for further details).

6. For each receptor listed above, a comprehensive desk-based review has been carried out alongside consideration of site-specific data sources. This desk-based review collates existing information on the occurrence and density of marine mammals and leatherback turtle within the study areas. It has been prepared to support the assessment of potential impacts presented in **Chapter 10 Marine Mammals and Leatherback Turtle**.

7. Density estimates (expressed as animals per km²) and reference populations are summarised to provide context for potential WDA-related impacts. Seasonal patterns and distribution trends are highlighted where data allow. While this review represents the best available evidence, limitations include reliance on modelled data and assumptions regarding MU boundaries.

8. The baseline review is structured as follows:

- Odontocetes (Toothed whales) (**Section 5**);
- Mysticetes (Baleen whales) (**Section 6**);
- Pinnipeds (**Section 7**);
- Leatherback turtle (**Section 8**); and
- Descriptions of species' sensitivities to impacts assessed in the EIAR are presented in **Section 9**.

9. For the baseline review for each species, the following is provided:

- A desk-based review collating evidence on abundance and occurrence in the study areas;
- Site specific density estimates presenting results from the Project's DAS;
- A summary of abundance and density estimates from the Project's DAS and desk-based sources which provides the density estimate taken forward for assessment in **Chapter 10 Marine Mammals and Leatherback Turtle**; and
- Information on diet and foraging behaviour.

2. MARINE MAMMALS AND LEATHERBACK TURTLE STUDY AREAS

10. The Marine Mammals and Leatherback Turtle Study Area (hereafter 'Study Area') is defined by the Option Agreement Area (OAA), plus a 10 (Kilometre) km buffer (see **Figure 3.1**). However, given that marine mammals are highly mobile predators, their status and activity within or adjacent to the Study Area is considered in the context of their MUs and the United Kingdom (UK) portion of each species' population as part of a Wider Study Area. MUs are based on evidence on population structure, movement ecology, habitat use and wider population distribution and therefore reflect the best scientific understanding of how species use UK waters throughout the year. Using MUs to define the Wider Study Area ensures the assessment is undertaken at a scale relevant to the biological population, rather than only the animals temporarily present within the Project's DAS footprint, since individuals recorded locally may represent only a small part of the wider MU population. All receptor MUs (UK portion) representing the Wider Study Area are presented in **Figure 3.1**.

11. The OAA is the lease area awarded to the Applicant by Crown Estate Scotland (CES) under the ScotWind leasing process. The OAA is 754 km^2. The WDA is a smaller, refined area within the OAA, which has been defined after detailed constraints analysis and environmental studies. It is the consenting boundary for the construction and operation of the WDA infrastructure. Initially, the WDA was reduced from OAA area of 754 km² to the EIA Scoping WDA boundary of 510 km² following site investigation and stakeholder feedback. Since EIA scoping, the WDA has reduced further to 448 km^2 (see **Chapter 4 Site Selection and Alternatives**).

12. From the Project's DAS surveys, density estimates are based on the OAA plus a 4 km buffer. For some of the Project's DAS surveys, the buffer was extended to 6 km and then 10 km however this was for ornithology purposes, with data being banked and not considered quantitatively for the marine mammal baseline.

13. Where available, density estimates from desk-based sources are provided. Where there are no density estimates within desk-based sources, such as Small cetacean in the European Atlantic and the North Sea (SCANS), these have been calculated based on at sea populations over the Study Area. For example, for cetaceans, the distribution density maps from Waggitt et al. (2019) have been applied to estimate species densities within the Study Area (over the OAA or the SCANS CS-F survey block). These maps provide modelled predictions of cetacean densities at a 10 km grid resolution across the North-East Atlantic. By overlaying the area of interest onto these grids, the relevant cells were extracted and their density values aggregated to calculate mean densities for the zone. This approach ensures that the Project uses robust, standardised data derived from extensive survey effort, allowing quantification of species presence and abundance accurately within and around the Study Area.

14. For pinnipeds, density estimates from Carter et al. (2022) and Carter et al. (2025) have been incorporated to quantify species presence within the Study Area and have been calculated for the OAA plus 4 km buffer. Both studies provide habitat-based predictions of at-sea distribution for grey and harbour seals using telemetry data and population scaling. The Carter et al. (2022) dataset was used to derive precautionary densities for harbour seals, while Carter et al. (2025) was applied for grey seals, reflecting updated tracking data and revised population estimates. These datasets present mean density values on a 5 km × 5 km grid, which were overlaid with the OAA plus 4 km buffer to extract relevant cells. The densities were then aggregated and normalised by area to calculate mean density and estimate abundance within the OAA plus 4 km buffer. This approach

ensures that the Project uses the most current and robust spatial data for impact assessment for both grey and harbour seal, as well as maintaining consistency with other receptors.

15. A table summarising all density estimates is included for each receptor in this document including which of those is used a worst-case scenario for the assessment.

16. In addition to the Project's DAS, the Project commissioned the Scottish Association for Marine Science (SAMS) to analyse data from HWDT Silurian expedition data collected between 2018 and 2024 together with earlier published data from 2003 to 2017 across the inshore Hebridean waters. The analysis also incorporates passive acoustic monitoring (PAM) data for harbour porpoise from 2011 to 2024, as well as citizen science records from the HWDT Whale Track app, including sightings from 2018 to 2024 (see **Appendix 10.3 Analysis of Hebridean Whale & Dolphin Trust Visual and Passive Acoustic Survey Data**).

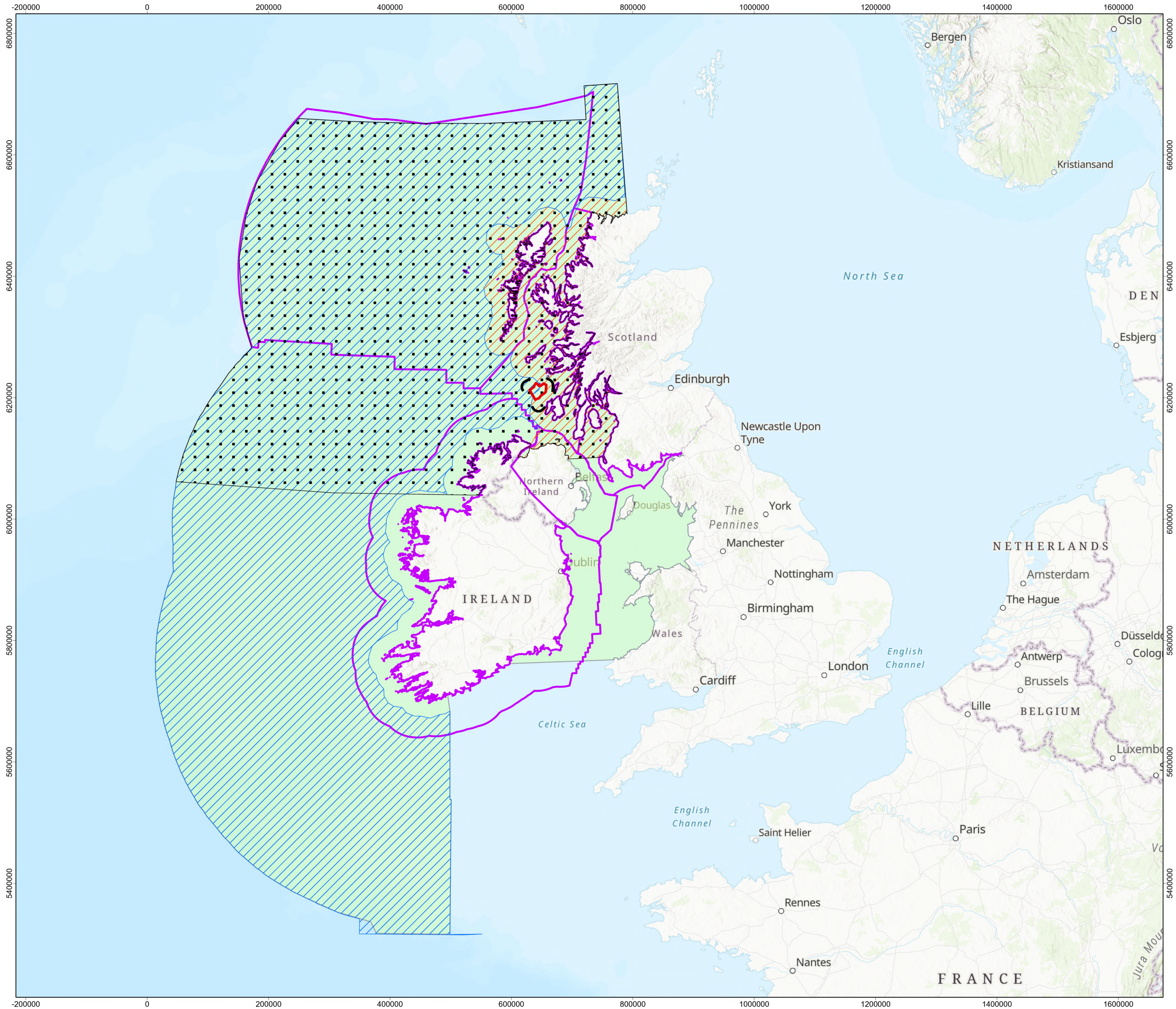
3. DESIGNATED SITES

17. **Table 3.1** describes sites designated for marine mammal features in the Study Area and these are shown on **Figure 3.2**. These designations form a key component of the marine mammal baseline review, providing essential context on species of conservation importance and informing the assessment of potential impacts within and adjacent to the WDA.

Table 3.1 Designated sites for marine mammals

Designated Site	Protected marine mammal feature(s)	Closest approximate distance from the WDA (km)
Special Areas of Conservation (SAC)		
Inner Hebrides and the Minches SAC	Harbour porpoise	<0.1
Treshnish Isles SAC	Grey seal	40
South-East Islay Skerries SAC	Harbour seal	60
Skerries and causeway SAC	Harbour porpoise	62
Eileanan agus Sgeiran Lios mór SAC	Harbour seal	83
Marine Protected Areas (MPAs) and Nature Conservations MPAs (NC MPAs)		
Sea of the Hebrides NC MPA	Minke whale Basking shark[1]	2.9

[1] Note that basking shark is considered in the **Report to Inform NCMPA Assessment** and **Chapter 9 Fish (Including Basking Shark) and Shellfish**.



Windfarm Development Area

Marine Mammal and Leatherback Turtle Study Area

Delphinids, Mysticetes, and Leatherback turtle CGNS Management unit, and North Atlantic range

Seal Wider Mangement Unit

Bottlenose Dolphin Oceanic Waters Management Unit

Bottlenose Dolphin Coastal West Scotland and Hebrides Management Unit

Harbour Porpoise Western Scotland Management Unit

N

0 50 100 200 Kilometres

2	16/04/2026	AB	GC	SB	PB
REV	REV DATE	GIS CREATOR	GIS REVIEWER	TECHNICAL CHECKER	TECHNICAL APPROVER

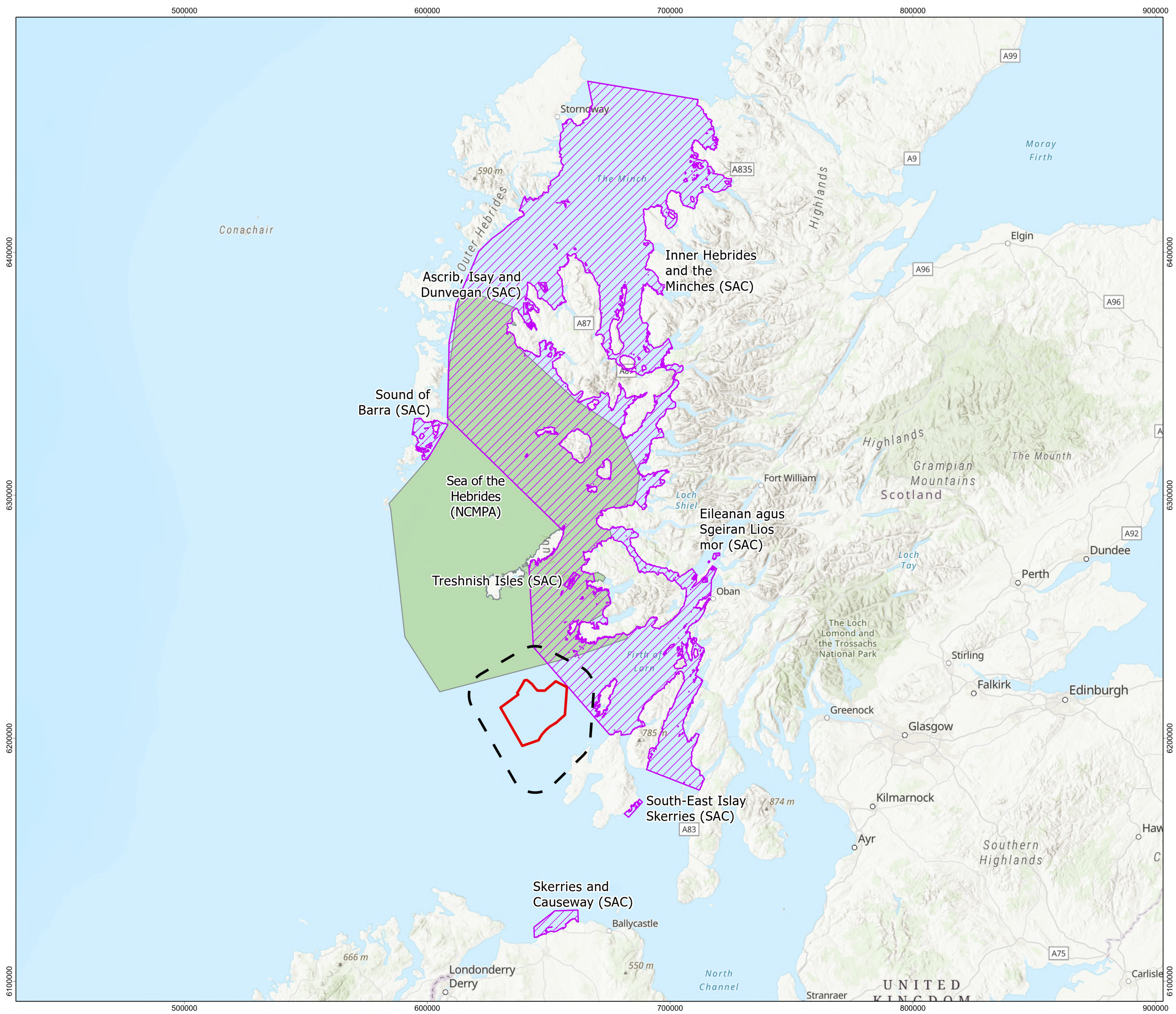
DRAWING NUMBER	MCW-DWF-ENV-MAP-RHS-000072		
DATUM	ETRS89	PROJECTION	UTM Zone 29N
SCALE	1:6,000,000	PAGE SIZE	A3
PROJECT TITLE	MachairWind		

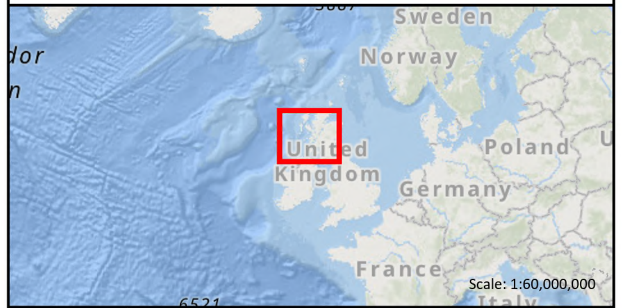
Figure 3.1 Marine Mammal and Leatherback Turtle Study Area and Wider Study Area covering species Management Units

NOT TO BE USED FOR NAVIGATION

Haskoning Enhancing Society Together
ScottishPower Renewables

Project: C:\Users\304634\OneDrive - Royal HaskoningDHV\WIP\03 GIS\A02_Figures\03_EIA\01_WDA\Chap_10_MarineMammals\Appx_10-2_LeatherbackTurtle\MCW_EIA_WDA_LeatherbackTurtle.aprx
Name: Fig_3-1_MCW-DWF-ENV-MAP-RHS-000072_LeatherbackTurtleStudyArea





REV	REV DATE	GIS CREATOR	GIS REVIEWER	TECHNICAL CHECKER	TECHNICAL APPROVER
2	16/04/2026	AB	GC	SB	PB

DRAWING NUMBER	MCW-DWF-ENV-MAP-RHS-000074		
DATUM	ETRS89	PROJECTION	UTM Zone 29N
SCALE	1:1,500,000	PAGE SIZE	A3
PROJECT TITLE	MachairWind		

Figure 3.2 Marine Mammal and Leatherback Turtle Study Area and Designated Sites

NOT TO BE USED FOR NAVIGATION

Haskoning Enhancing Society Together
ScottishPower Renewables

4. DATA SOURCES

4.1. SITE-SPECIFIC SURVEYS

4.1.1. The Project's Digital Aerial Survey Methodology

18. The Project's DAS was conducted for marine fauna and seabirds using digital aerial still imagery (see Annex 11.2a of **Appendix 11.2 Baseline** of **Chapter 11 Offshore Ornithology**).

19. The aerial surveys captured images at 1.5 cm ground sampling distance along 13 transect lines spaced approximately 3.2 km apart. The surveys incorporated a 4 km buffer around the OAA totalling a survey area of 1,241 km^2 from April 2021 to September 2023. increasing to a 6 km buffer from October 2021 to January 2022 and further increased to a 10 km buffer for the remaining surveys (from February 2022 to September 2023) (**Plate 4.2**). The buffer around the OAA was extended due to the need to collect ornithology data over these areas, and the data was banked in case it was required at a later date to assess for any potential impacts to birds. For marine mammals, the current Project DAS results for the OAA, plus a 4 km buffer, are used to calculate density estimates where relevant.

20. On four occasions, DAS occurred in a different month due to sustained periods of strong winds, low clouds and/or rain/snow in the planned month. The affected months/surveys were:

- The December 2021 survey was completed as an additional survey in December 2022. Throughout the report, this survey is referred to as the first December 2022 survey (Survey 20).
- The February 2022 survey (Survey 10) was completed on 21 March 2022. Throughout the report, this survey is referred to as the first March 2022 survey (Survey 10).
- The June 2022 survey (Survey 14) was completed on 11 July 2022. Throughout the report, this survey is referred to as the June 2022 survey.
- The October 2022 survey (Survey 18) was completed on 04 November 2022. Throughout the report, this survey is referred to as the October 2022 survey.

21. Imagery was captured in raw format and post-processed to ensure optimal quality for the subsequent stage of image analysis, to extract information on marine fauna or other notable occurrences. Data analysis follows a two-stage process in which images are reviewed (10%) then the detected objects are identified to species or species group level. The images then undergo Quality Control.

22. Density and abundance estimates are calculated using the raw counts divided by the number of images collected to give the mean number of animals per image (i). Population estimates (N) for each survey month were subsequently generated by multiplying the mean number of animals per image by the total number of images required to cover the Survey Area (A): N = i A.

23. Non-parametric bootstrap methods were used for variance estimation. A variability statistic was generated by re-sampling 999 times with replacement from the raw count data. The statistic was evaluated from each of these 999 bootstrap samples and upper and lower 95% Confidence Intervals (CI) of these 999 values were taken as the variability of the statistic over the population (Efron and Tibshirani, 1993).

24. A measure of precision was calculated using a Poisson estimator, suitable for a pseudo-Poisson over-dispersed distribution. This produced a coefficient of variation (CV) based on the relationship of the standard error to the mean.

25. The DAS method has been designed to optimise the data collection for all bird and marine mammal species using a grid-based survey design at 1.5 cm resolution to achieve a minimum of 10% coverage for analysis.

26. The number of unidentified individuals in a group is proportioned to the specific species that are contained within that group based on the relative abundance of the positively identified species in that month's survey. For example, in the case of harbour porpoise, the count consists of:

- Positively identified harbour porpoise + proportion of group level identified porpoise/dolphin species;
- Instances can occur when there are no positively identified species in months where group level identified individuals have been recorded. A hierarchical approach as follows was applied to such cases with the preferable method being the first or the second, where possible:
  - Use the proportion from the same month, same year;
  - Use the proportion from the same month, different year;
  - Use the proportion from the same season, same year;
  - Use the proportion from the same season, different year;
  - Use the proportion from the same month, wider area (i.e. using proportion from the 4 km buffer as a proxy for the site); and
  - Use the proportion from the same season, wider area (i.e. using proportion from the 4 km buffer as a proxy for the OAA).

27. **Table 4.1** clarifies which marine mammals were attributed to which species group.

Table 4.1 Marine mammal species in unidentified groups (APEM, 2024)

<table>
<tr><th>Species</th><th>Group Level 1</th><th>Group Level 2</th><th>Group Level 3</th><th>Group Level 4</th></tr>
<tr><td>Grey seal</td><td colspan="3">Seal species</td><td rowspan="7">Unidentified marine mammal species</td></tr>
<tr><td>Risso's dolphin</td><td colspan="2" rowspan="4">Dolphin species</td><td rowspan="5">Dolphin / porpoise species</td></tr>
<tr><td>Common dolphin</td></tr>
<tr><td>Bottlenose dolphin</td></tr>
<tr><td>White-beaked dolphin</td></tr>
<tr><td>Harbour porpoise</td><td colspan="2">Harbour porpoise</td></tr>
<tr><td>Common minke whale</td><td colspan="2">Minke whale</td><td>Whale species</td></tr>
</table>

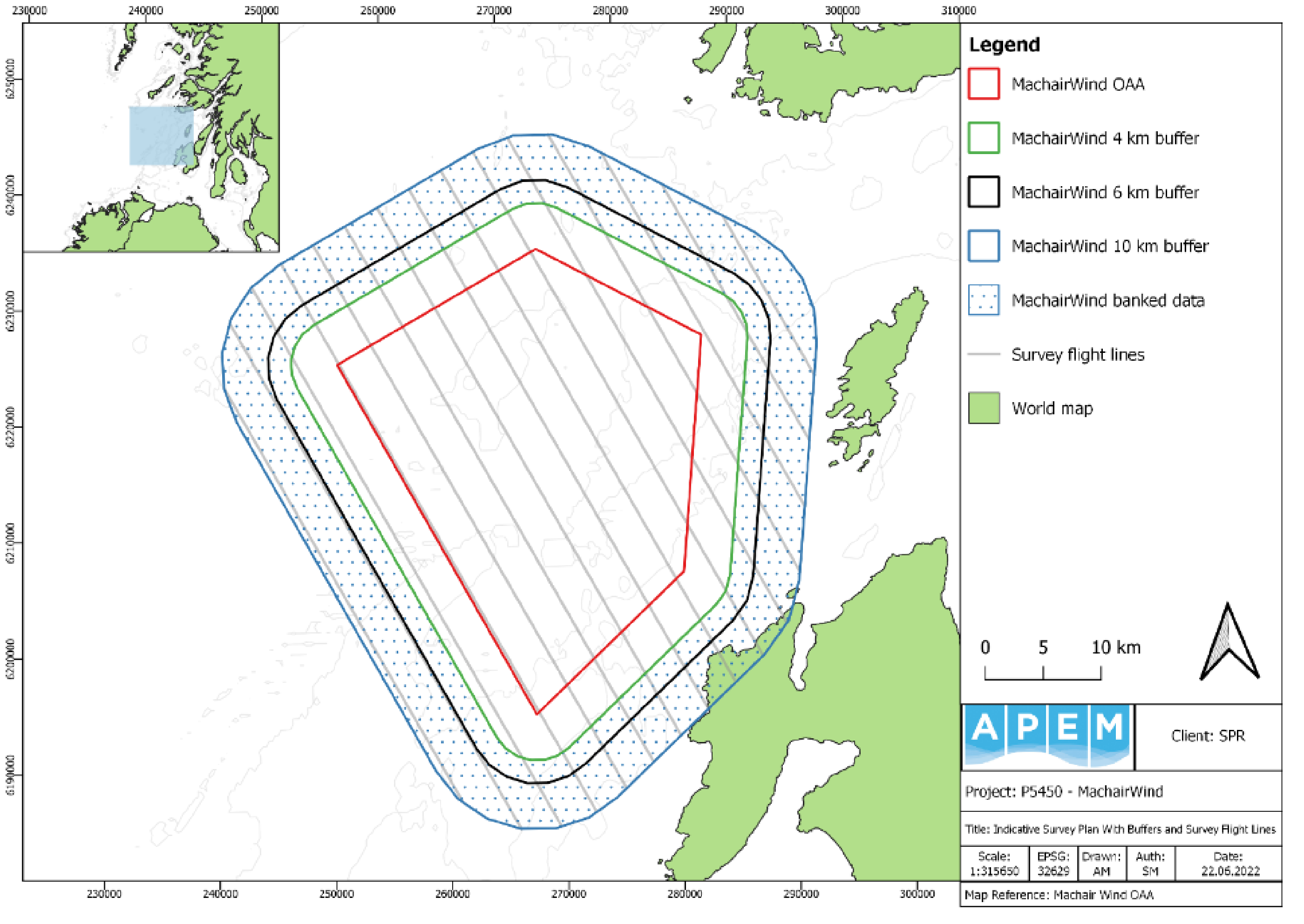


Plate 4.1 Project's DAS coverage of the MachairWind OAA site plus 4 km buffer (and buffer extension) and 3.2 km transects

4.1.2. The Project's Digital Aerial Survey Data

28. **Table 4.2** presents the marine mammal and leatherback turtle data from the Project's DAS within the OAA plus 4 km buffer from April 2021 to September 2023.

29. Project DAS data from the OAA plus 4 km buffer for each species (**Table 4.2**), has been used to calculate abundance and density estimates. Upper and lower CI and CV were also calculated for these density and abundance estimates. The density of animals at the site (and hence the population size), the standard deviation, 95% CI and CV are then estimated using a non-parametric bootstrap method with replacement (Canty and Ripley, 2010).

30. For animals that dive, making them difficult to survey given the amount of time they spend underwater, an availability bias or correction factor must be applied. Applying these availability bias or correction factors transfers a relative abundance or density estimate to an absolute estimate. This has only been applied to marine mammals.

31. To account for unidentified individuals recorded (any marine mammal individuals that could not be attributed to a species level), the abundance estimates presented for these unidentified marine mammals (for example porpoise/dolphin species and seal species) in **Sections 5.1.2; 5.2.2; 5.3.2; 5.6.2; 6.1.2** and **7.1.2** have been apportioned to include an attribution of unidentified individuals into the monthly abundance estimates and densities. This is based upon an apportionment of the group level identified individuals between those species within that group that were identified to species level within each individual monthly abundance estimate as described in **Paragraph 26.**

Table 4.2 Marine mammal data from the Project's DAS for the OAA plus a 4 km buffer

Survey date	Grey seal	Seal species	Harbour porpoise	Dolphin / porpoise	Common dolphin	Bottlenose dolphin	Risso's dolphin	Unidentified dolphin species	Minke whale	Marine mammal species	Leatherback turtle
Apr-21	5	1	6	7	20	0	0	2	0	0	0
May-21	8	3	5	4	23	0	0	0	1	1	0
Jun-21	0	5	8	5	0	0	0	5	0	0	0
Jul-21	16	6	23	5	4	0	0	0	4	1	0
Aug-21	5	0	10	4	23	0	0	0	6	0	0
Sep-21	1	1	2	3	6	0	0	0	0	0	0
Oct-21	0	2	2	0	12	3	0	2	0	2	0
Nov-21	2	0	5	2	4	0	0	0	0	0	0
Jan-22	3	1	6	6	94	0	0	7	0	0	0
Feb-22	0	0	5	8	6	0	0	0	0	2	0
Mar-22	7	4	42	0	14	0	0	0	2	1	0
Apr-22	1	1	8	2	2	0	0	0	4	1	0
May-22	6	3	12	3	8	0	0	0	2	1	0
Jun-22	5	1	6	3	27	0	0	0	2	0	0
Jul-22	18	3	20	0	20	0	0	0	4	0	0
Aug-22	4	4	0	3	11	0	0	0	1	0	0
Sep-22	5	4	1	3	6	0	0	1	0	0	1
Oct-22	1	0	4	1	8	0	0	0	0	0	0

Survey date	Grey seal	Seal species	Harbour porpoise	Dolphin / porpoise	Common dolphin	Bottlenose dolphin	Risso's dolphin	Unidentified dolphin species	Minke whale	Marine mammal species	Leatherback turtle
Nov-22	1	3	12	5	78	0	0	0	1	2	0
Dec-22 (S20)	1	2	0	1	12	0	2	0	0	1	0
Dec-22 (S21)	1	0	1	1	5	0	0	0	0	0	0
Jan-23	2	2	5	4	64	0	0	0	0	0	0
Feb-23	5	9	21	32	265	0	0	0	0	0	0
Mar-23	3	2	2	0	60	0	0	0	0	0	0
Apr-23	5	13	13	2	4	0	0	0	2	0	0
May-23	6	8	8	2	59	0	0	0	0	1	0
Jun-23	14	10	10	0	178	0	0	0	5	0	0
Jul-23	11	5	5	7	140	0	0	0	8	0	0
Aug-23	20	12	12	2	45	0	0	0	1	0	0
Sep-23	9	11	11	7	111	0	0	0	1	0	0
Total	**165**	**116**	**265**	**122**	**1,309**	**3**	**2**	**17**	**44**	**13**	**1**

4.1.3. Third-Party Digital Aerial Survey Data

32. In addition, to the Project's DAS described above, APEM were contracted by a third-party to carry out a DAS survey campaign over a portion of the OAA prior to the announcement of exclusivity agreements with Crown Estate Scotland. This campaign was undertaken from October 2020 to December 2021, and the associated data was acquired by the Applicant to provide a better understanding of marine mammal presence for the baseline, surveying the area shown on **Plate 4.2**. The survey was a grid-based design with 16 transects spaced 2 km apart, generating 12% coverage.

33. Marine mammal data from the Third-Party DAS is provided in **Table 4.3.**

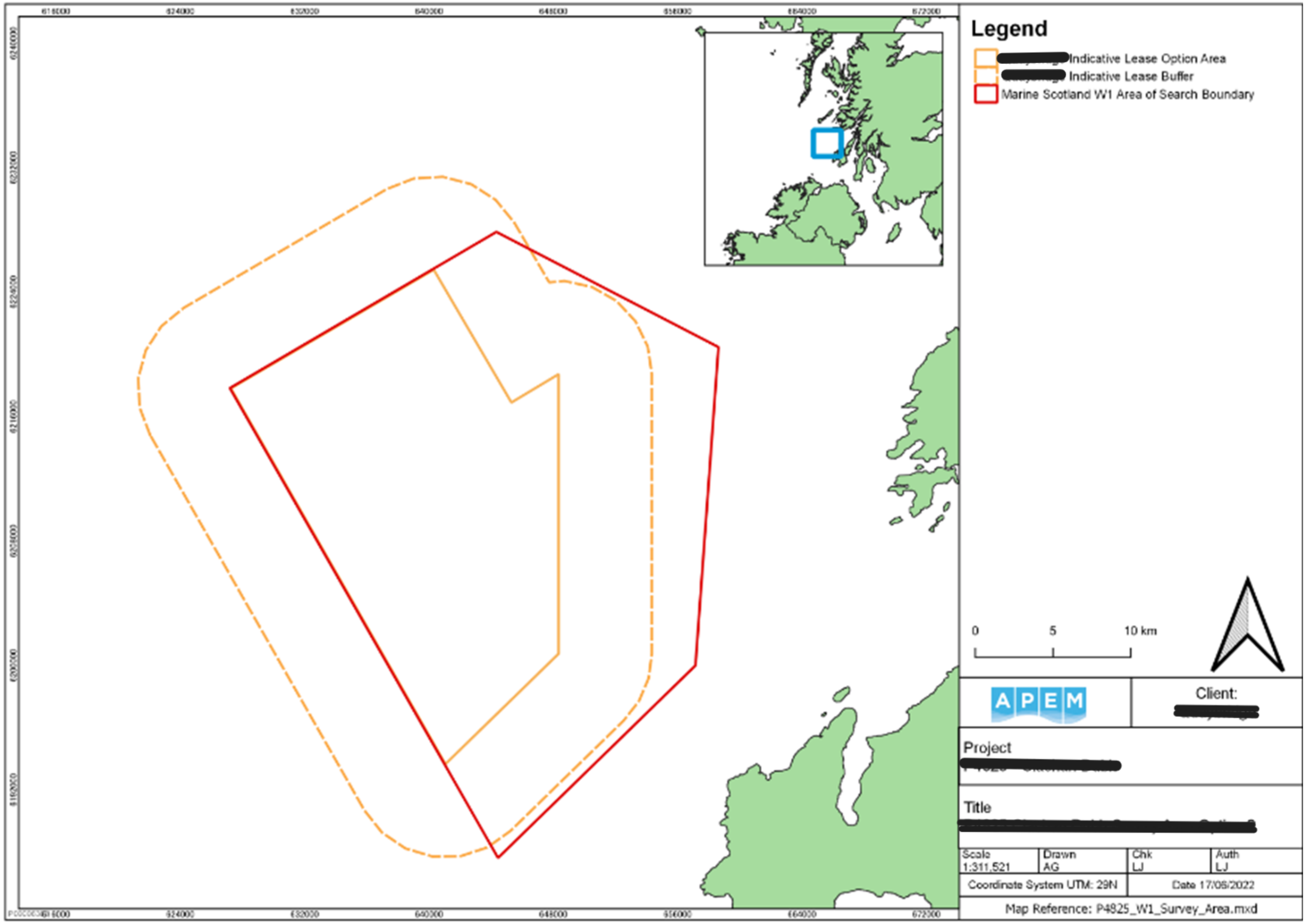


Plate 4.2 Digital aerial surveys of Machair site October 2020 to December 2020

Table 4.3 Marine mammal data from the third-party DAS

Survey month	Grey seal	Unidentified seal	Common dolphin	Bottlenose dolphin	Risso's dolphin	Unidentified dolphin	Harbour porpoise	Dolphin or porpoise species	Minke whale	Marine mammal species	Total
Oct-20	0	3	9	0	0	2	0	6	0	0	20
Nov-20	0	5	0	0	0	6	1	4	0	0	16
Dec-20	0	0	11	1	0	8	1	11	0	0	32
Jan-21	0	0	0	0	0	8	0	11	0	0	19
Feb-21	0	4	15	0	0	0	7	25	0	0	51
Mar-21	3	1	59	0	0	0	17	9	0	0	89
Apr-21	1	6	36	0	0	0	6	4	0	0	53
May-21	26	24	89	0	1	0	68	9	6	1	224
Jun-21	8	0	43	0	0	0	6	3	0	0	60
Jul-21	11	1	1	0	1	0	32	0	9	0	55
Aug-21	0	6	6	0	0	0	4	2	1	1	20
Sep-21	4	0	52	0	0	7	1	4	7	0	75
Oct-21	1	1	3	0	0	0	2	2	0	0	9
Nov-21	2	1	162	0	0	1	12	3	0	1	182
Dec-21	3	0	21	0	0	0	1	1	0	0	26
Total	**59**	**52**	**507**	**1**	**2**	**32**	**158**	**94**	**23**	**3**	**931**

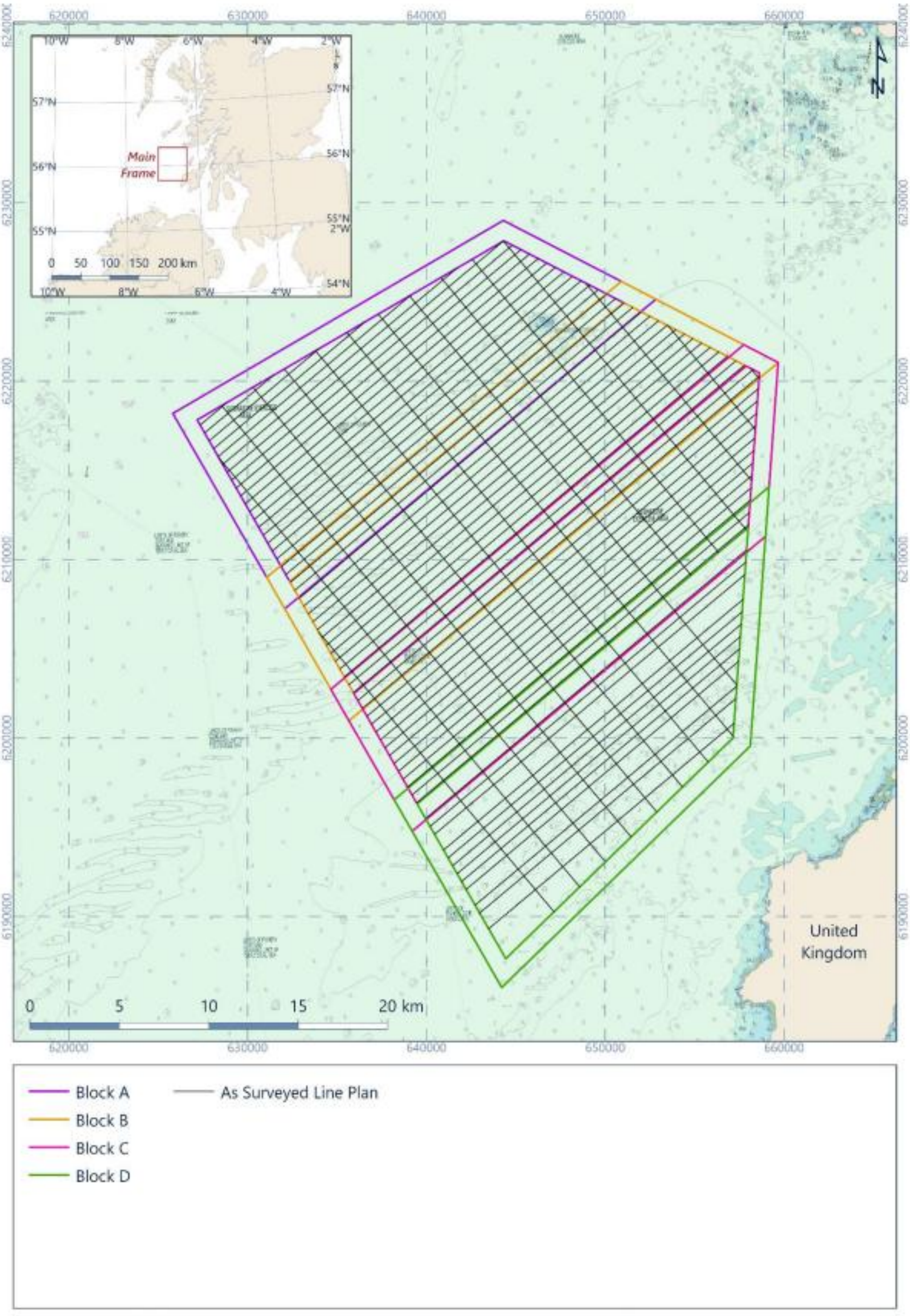
4.2. MARINE MAMMAL SIGHTINGS DURING PROJECT SITE INVESTIGATION SURVEYS

34. During the geophysical site investigation surveys undertaken from August to November 2023, Marine Mammal Observers (MMO) and PAM surveyed the OAA.

35. Dedicated marine mammal observations were conducted from the bridge (15 m bridge height plus observer's eye height above sea level) during daylight hours. During hours of darkness or poor visibility, PAM was undertaken as a suitable alternative to marine mammal observation. Overall, the MMOs undertook 415 hours and 18 minutes of visual monitoring, and the PAM operators undertook 164 hours and 26 minutes of acoustic monitoring.

36. In 2025, an additional geophysical survey was undertaken between April and July 2025 surveying the WDA. The total MMO effort was 906 hours and 15 minutes and a total of 273 hours and 23 minutes of PAM effort was conducted.

37. Marine mammal sightings detection for both surveys is presented in **Table 4.4**



Coordinate System: ETRS 1989 UTM Zone 29N; Caveats: Esri, 2023; SevenCs' electronic navigation charts. SevenCs explicitly state that the data are not certified by an official authority and that the data may not be used for navigation or other safety related purposes.

Plate 4.3 2023 Geophysical and Environmental Survey blocks and line plan for MachairWind OAA

Table 4.4 Summary of number of marine mammals recorded and number of acoustic detections

Survey month	Harbour porpoise	Common dolphin	Bottlenose dolphin	Long-finned pilot whale	Unidentified dolphin	Minke whale	Fin whale	Unidentified whale	Grey seal	Unidentified Seal
Aug-23	-	66	-	-	1	-	-	-	-	-
Sep-23	-	103	-	-	32	-	-	-	1	17
Oct-23	-	160	3	3	31	1	-	-	-	1
Nov-23	-	21	-	-	4	-	-	-	-	-
Apr-25	1	143	-	-	-	2	-	-	-	1
May-25	-	287	-	-	36	10	1	-	2	1
Jun-25	-	75	-	-	1	9	-	1	-	-
Jul-25	-	90	15	-	14	-	-	-	-	-
Total	**1**	**945**	**18**	**3**	**119**	**1**	**1**	**1**	**3**	**20**

4.3. SIGHTINGS DATA FROM HEBRIDEAN WHALE AND DOLPHIN TRUST SILURIAN EXPEDITIONS

38. **Appendix 10.3 Analysis of Hebridean Whale & Dolphin Trust Visual and Passive Acoustic Survey data off Western Scotland** provides an analysis of sightings data from HWDT expeditions aboard the Silurian research vessel from 2018 to 2024 and was undertaken by the SAMS and HWDT.

39. In summary, the surrounding waters of the WDA support diverse marine mammals and megafauna. HWDT surveys (2018–2024) covered part of the WDA plus a 30 km buffer, with most effort to the north and east, enabling analysis of spatial and temporal trends locally and across western Scotland. In total fourteen species were recorded, with harbour porpoise, common dolphin and minke whale together representing >90% of all sightings. Lower number of sightings were reported for bottlenose dolphin, Risso's dolphin, fin whale and humpback whale.

40. Detection per Unit Effort (DPUE) rates varied due to operational factors and ecological changes; common dolphin sightings increased notably, suggesting improved habitat suitability, whereas harbour porpoise trends were less clear and may indicate a decline.

41. For more information, see **Appendix 10.3 Analysis of Hebridean Whale & Dolphin Trust Visual and Passive Acoustic Survey data off Western Scotland**.

5. BASELINE REVIEW FOR ODONTOCETES (TOOTHED WHALES)

42. The following baseline review provides a desk-based review in addition to the data sources listed above on abundance and occurrence of each toothed whale receptor in the study areas alongside results from the Project's DAS. Data sources include:

- Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters (Hague et al., 2020);
- HWDT species information;
- Whale and dolphin Conservation (WDC) Shorewatch Report (Rodríguez-Mendoza et al., 2025)
- COMPASS project;
- SCANS-III/IV reports (Hammond et al., 2021; Giles et al., 2023);
- Joint Cetacean Protocol (JCP) data resources (Paxton et al., 2016);
- Sea Watch Foundation (SWF) public sightings;
- Organisation cetacea (ORCA) sightings on ferry routes;
- Distribution and abundance maps for cetacean species around Europe (Waggitt et al., 2019);
- MUs for cetaceans in UK waters (IAMMWG, 2023);
- Abundance and population references from North Atlantic Marine Mammal Commission. (NAMMCO);

43. The combination of DAS and desk-based data; identifies density estimates (animals/km²) used for EIA **Chapter 10 Marine Mammals and Leatherback Turtle**.

44. The baseline review for toothed whales includes harbour porpoise and delphinids.

5.1. HARBOUR PORPOISE

5.1.1. Desk-Based Review

45. Harbour porpoise is the most common cetacean in UK waters, they are resident all year and are found in the eastern North Atlantic (Villadsgaard et al., 2007). They are frequently recorded around the coasts of Ireland and Northern Ireland (NI) (Rogan and Berrow, 1996), and the west of Scotland, which has one of the highest abundances of harbour porpoises in Europe (Waggitt et al., 2019) in relatively inshore waters throughout the northern hemisphere. Harbour porpoise are widespread throughout coastal regions of the Hebrides, with highest occurrences around the small isles and the number of harbour porpoises in Hebridean waters is amongst some of the highest densities in Europe (HWDT, 2025a).

46. WDC Shorewatch Programme provides systematic, effort-based, long-term monitoring of cetaceans around the Scottish coast, enabling the identification of local and regional patterns in species occurrence, seasonal variation, and long-term trends. This report provides updated analyses of cetacean occurrence along the Scottish coast, using data collected through the Shorewatch programme and building on the previous work of Gutiérrez-Muñoz et al. (2021). It incorporates six additional years of observations (2018–2023) and includes data from newly established Shorewatch sites (Rodríguez-Mendoza et al., 2025). For harbour porpoise, the results found the West Highlands and Outer Hebrides regions had the highest overall probability of harbour porpoise occurrence with seasonal peaks in July and October to November. Harbour porpoise numbers peaked around 2016, before declining (Rodríguez-Mendoza et al., 2025), which is consistent with earlier findings (Gutiérrez-Muñoz et al., 2021).

47. The Scottish Marine Atlas states that harbour porpoise is abundant in all Scottish waters with a preference for coastal areas, shallow bays, estuaries and sea lochs (Baxter et al., 2011). During the COMPASS project, C-PODs (Chelonia Ltd, UK) were deployed at ten sites (max. 100 m depth) throughout the cross-border region of Scotland, NI and the Republic of Ireland (RoI) (**Plate 5.1**) between November 2017 and June 2020. Across the whole array and time series, porpoises were detected on 96% of days. Between locations, detection positive days ranged from 46.3% of days at Malin, to 100% of days at Stoer Head, Copelands and Skerries. The highest average rates of detection positive hours (DPH) occurred at Skerries, Copelands, Tolsta and Stoer Head, and the lowest rate of detection was at Malin. Across the whole acoustic array, increased rates of harbour porpoise DPH were recorded during winter and seasonal-diel plots of detection positive minutes also indicated higher detection rates at night compared to daytime, observed at many sites across the array (Edwards et al., 2019).

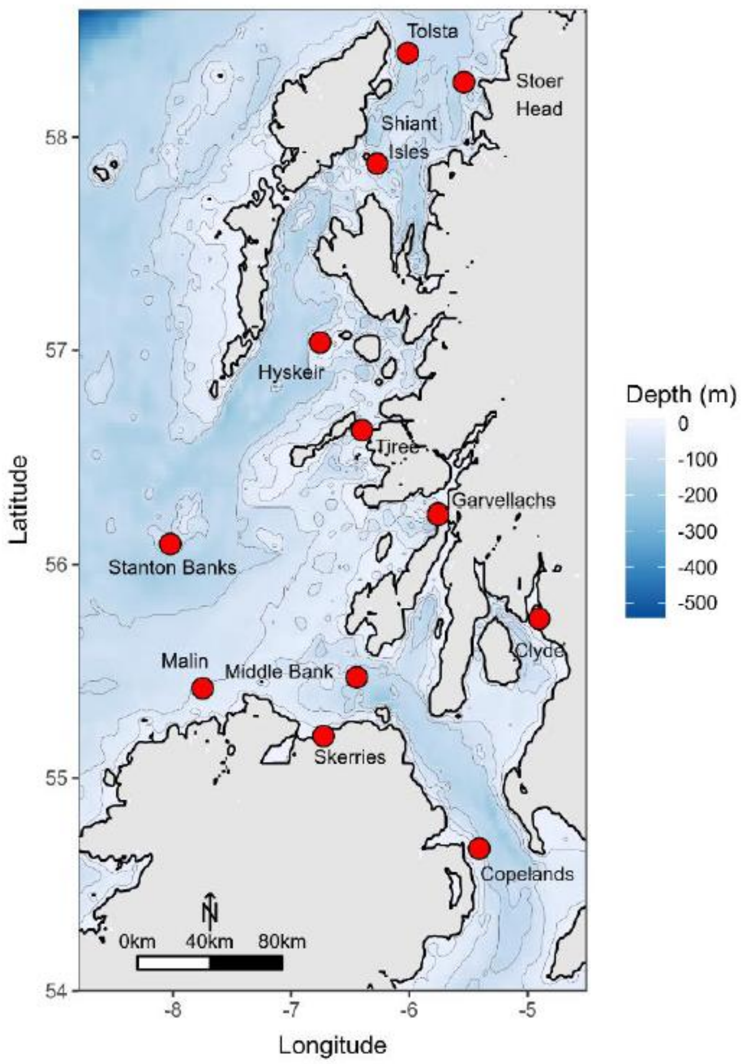


Plate 5.1 Locations of COMPASS acoustic monitoring moorings in the cross-border region of Scotland, Northern Ireland and the Republic of Ireland. Note that moorings at the Tiree and Clyde locations have not been deployed successfully and hence no data has been available for these sites so far (Edwards et al., 2020)

48. ObSERVE (Giralt Paradell et al.,2024) carried out aerial surveys in the waters in the Irish Exclusive Ecological Zone (EEZ), which is a geomorphologically heterogeneous region, consisting of three main depth regimes (Dransfeld et al., 2014). The continental shelf is less than 400 m deep, and includes areas such as the Irish Sea (IS), the Celtic Sea and the Porcupine Bank. The ObSERVE surveys cover the Wider Study Area, as the WDA is less than 50 km away from the northeast border of the survey area. Data was collected in the summers of 2021 and 2022 and the winters of 2021 to 2022 and 2022 to 2023. Harbour porpoise was the second most frequent cetacean sighted in the surveys with 128 sightings, comprising 212 individuals. The highest density of harbour porpoise documented was 0.123 animals per km in the summer season (Giralt Paradell et al.,2024).

49. Data from the SWF from public sightings, was documented during July to December 2022, March to December 2023 and January to September 2025 in the Inner Hebrides recorded at least 91 (246 individuals) sightings in 2022, at least 65 sightings (137 individuals) and at least 105 sightings (257 individuals) in 2025 (SWF, 2025). In the Outer Hebrides, in 2022 at least 88 sightings were recorded (203 individuals), at least 78 (420 individuals) in 2023 and 98 (276 individuals) in 2025. Although the SWF public sightings can be scarce, this does show that harbour porpoise have a regular occurrence in the Hebrides.

50. The Interactive web map from ORCA (2006 to 2023) also supports that there is a high presence of harbour porpoise within the Study Area in the Inner Hebrides (**Plate 5.2**).

Plate 5.2 Harbour porpoise sightings during ORCA surveys from 2006 to 2023 (ORCA, 2025)

51. The most recent assessment of harbour porpoise in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the UK population (JNCC 2019a, Hague et al., 2020).

52. The IAMMWG have defined three MUs for harbour porpoises (**Plate 5.3**). The estimate of harbour porpoise abundance in the West Scotland (WS) MU (which is where the WDA is located) is 24,305 (CV = 0.18; 95%; CI = 17,121 – 34,505) (IAMMWG, 2023). This is the reference population for harbour porpoise for use in the EIAR. Small cetaceans in the European Atlantic and the North Sea (SCANS)-IV reported an estimated abundance of 24,699 individuals (95% Confidence Level (CL) = 14,626 - 38,996), although only partial coverage of this MU was achieved in the SCANS-IV survey.

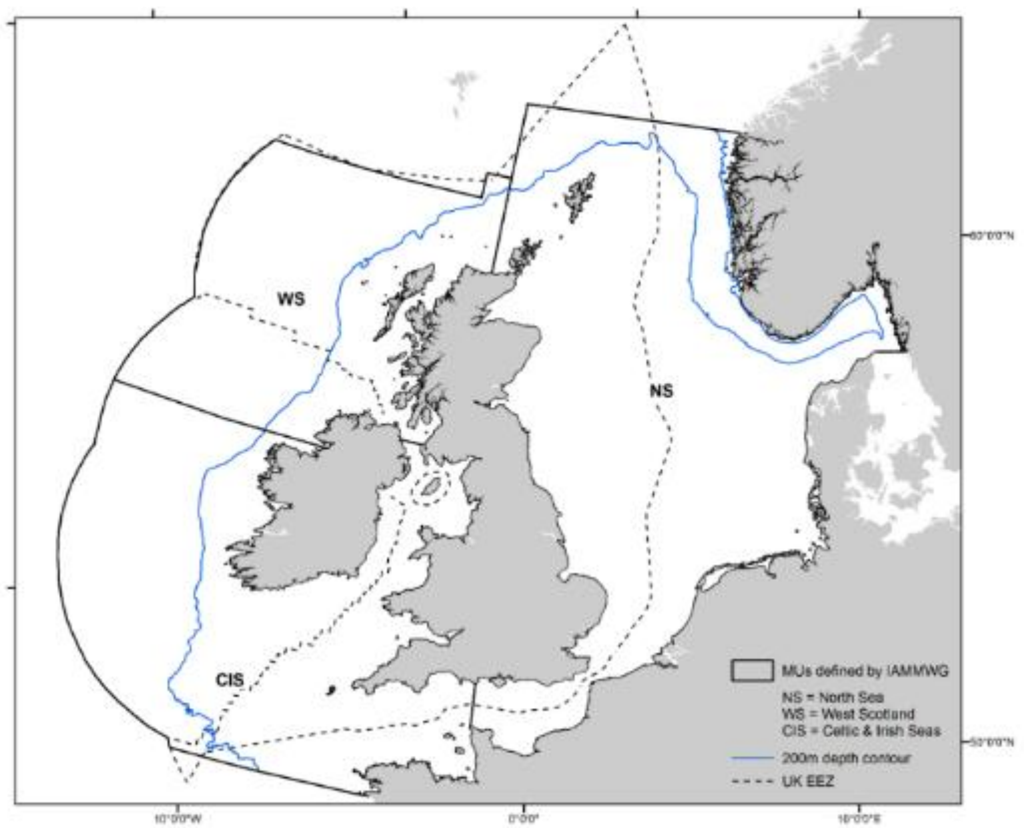


Plate 5.3 Harbour porpoise Management Units – species is largely confined to the continental shelf (i.e. waters less than 200 m depth) (IAMMWG, 2023)

53. The Joint Cetacean Protocol (JCP) Phase III Report (Paxton et al., 2016) shows there is potential for density estimates ranging from 0.4 to 2.0 harbour porpoise per km^2 within the Study Area. Based on the JCP Phase III data (**Plate 5.4**); Hague et al. (2020) estimated there to be density estimates ranging from 0.29 to 0.62 individuals per km^2 in the Islay area, and 0.35 to 0.87 individuals per km^2 in the Sound of Islay area, with the highest densities in winter.

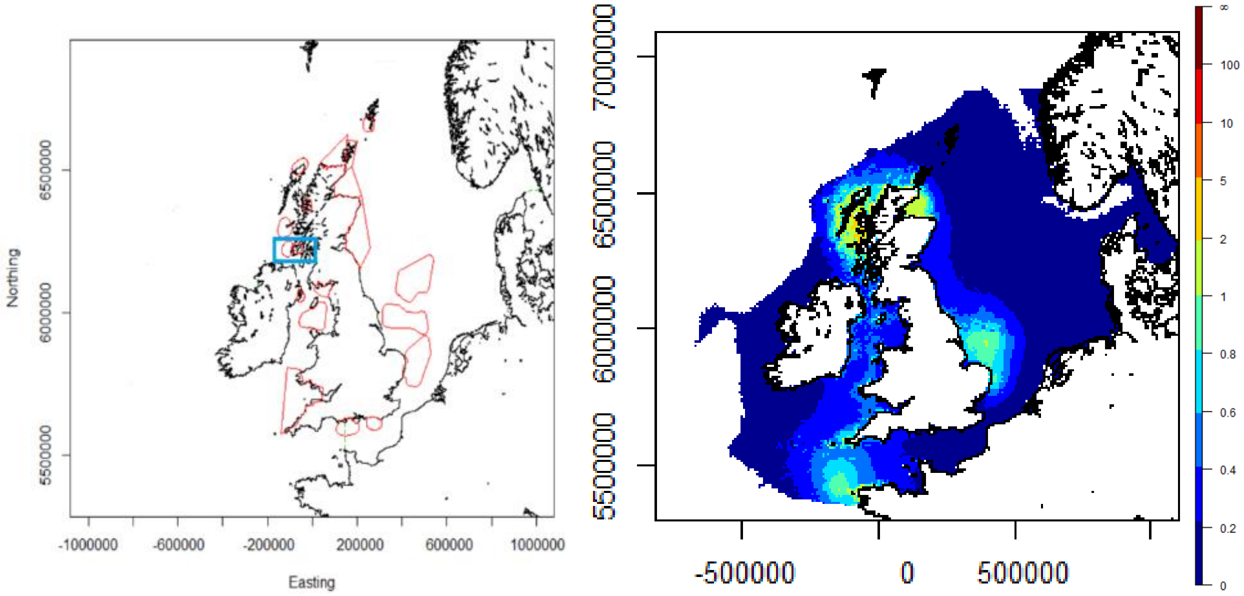


Plate 5.4 Phase III each developer area in red (relevant areas to the Project in blue box); Right = harbour porpoise density (/km^2) for summer 2010 (Paxton et al. (2016)

54. Distribution and abundance maps were developed by Waggitt et al. (2019) for cetacean species around Europe. For harbour porpoise, the distribution maps show a clear pattern of medium harbour porpoise density in the Hebrides, and the coasts of WS in the winter, with slightly higher densities in the summer, (**Plate 5.5**; Waggitt et al., 2019). "Medium density" for harbour porpoise generally refers to 0.3–0.6 individuals per km², based on regional datasets like Waggitt et al. (2019) and SCANS surveys. It is defined using predicted densities aggregated at 10 km grid resolution, classified by statistical breaks (e.g., Jenks Natural Breaks Classification) across the full range of values. These models classify densities into ranges (low, medium, high) based on quantile breaks across predicted values, with medium typically falling in the mid-range of observed densities (e.g., ~0.3–0.6 individuals/km² for small cetaceans like harbour porpoise) (Roberts et al., 2016).

55. Interrogation of these data[2], including all 10 km 'grids' that overlap with the specified area, reveals a maximum density estimate of 0.505 individuals per km^2 (average of all overlapping 10 km 'grids') for the OAA.

56. Average Waggitt et al. (2019) densities across the area of the SCANS-IV block CS-F have also been calculated to show the density of harbour porpoise across a wider area in comparison and results in a maximum density of 0.503 harbour porpoise per km^2 for the OAA.

[2] Available from: https:// doi.org/10.5061/dryad.mw6m905sz

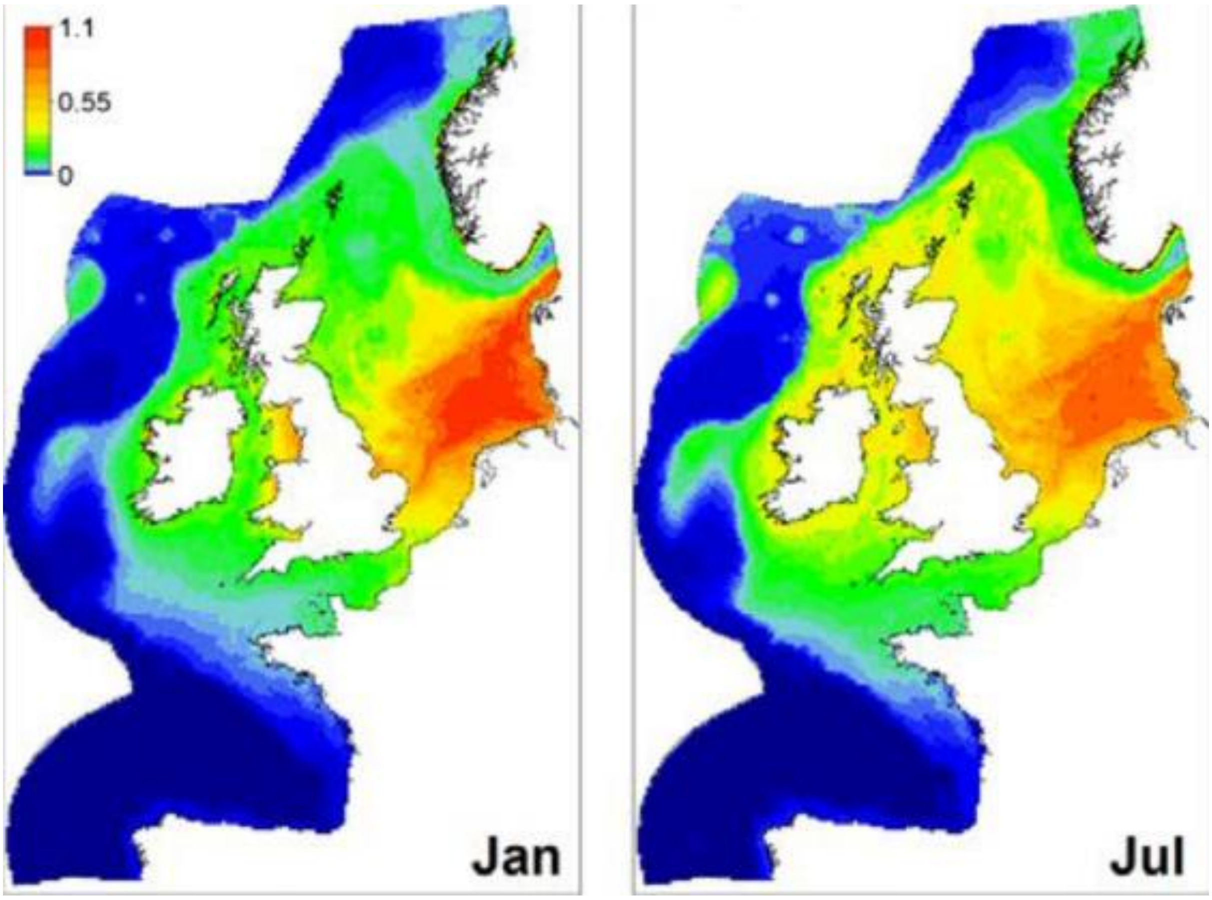


Plate 5.5 Spatial Variation in Predicted Densities (Individuals (per km²) of Harbour Porpoise in January and July in the North-East Atlantic). Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

57. The SCANS-III survey (summer 2016) produced modelled density surfaces for cetaceans across European Atlantic waters, including west of Scotland, where the Project is located. The area lies within the SCANS-III Block H / Western Scotland offshore region, which was covered by both shipboard and aerial survey effort (Lacey et al., 2022). Harbour porpoise showed low to moderate densities (0.05 to 0.25 animals per km^2) in offshore waters west of the Hebrides, with highest concentrations generally occurring further east, closer to coastal waters on the Scottish mainland (Lacey et al., 2022).

58. Harbour porpoise was identified as the most frequently sighted cetacean in Scottish waters via all three SCANS surveys (Hagee et al., 2020). The site-specific density estimates for harbour porpoise, from the SCANS-IV surveys (Gilles et al., 2023) is used to provide context for the wider area. The Project is in SCANS-IV survey block CS-F, and close to block CS-G (**Plate 5.6**):

- Survey Block CS-F
  - Abundance = 3,064 individuals (95% CI = 688-5,906);
  - Density = 0.2010/km^2 (CV=0.425).
- Survey Block CS-G
  - Abundance = 301 individuals (95% CI = 2-937);
  - Density = 0.0150/km^2 (CV=0.725).

Plate 5.6 SCANs IV survey design MachairWind WDA in survey block CS-F (Gilles et al., 2023)

5.1.2. Site-Specific Density Estimates

59. Harbour porpoise were recorded in 28 of the 30 monthly surveys. The results from the Project's DAS provide a peak total number of 265 individuals and an average density of 0.116 harbour porpoise per km^2 in the OAA, plus 4 km buffer.

60. The correction factors described in Voet et al. (2017) (which are based on those described in Teilmann et al. (2013)), were applied to the total abundance (surfacing and submerged individuals). These are provided in **Table 5.1**.

Table 5.1 Seasonal harbour porpoise correction factor

Season	Correction Factor
Spring (Mar-May)	0.571
Summer (Jun-Aug)	0.547
Autumn (Sep-Nov)	0.455
Winter (Dec-Feb)	0.472

61. The correction factors presented in **Table 5.1** have been used for the monthly density estimates derived from the DAS surveys for harbour porpoise for each season, to account for those that would be under the surface, and therefore unavailable to count. These densities have also been apportioned to take account of the individuals that could not be identified to species level.

62. The highest seasonal average density estimate was recorded in the summer season (April to September) with the highest over the three summer seasons (2021, 2022, and 2023) being 0.42 harbour porpoise per km^2 (**Table 5.2)**. NatureScot advised in written responses (received 14 November 2025) to questions posed at the second Expert Topic Group (ETG) meeting on 15 October 2025, where the density estimate proposed to be used for the assessment of harbour porpoise was 0.771/km^2 which represents the highest monthly density estimate and was in line with advice from NatureScot received in the Scoping Opinion. This was the highest monthly survey record in March 2021 (survey 11). NatureScot's response was *"We note for harbour porpoise that the density estimate proposed for the assessment is 0.771/km^2 from March 2022. However, we advise that although the highest monthly density estimates provide context and are useful to see reflected within the assessment, we advise that the average DAS density estimates should be used for the assessment, particularly if they are the highest estimate available (i.e. compared to SCANS)*". Therefore, the highest seasonal average of 0.42 harbour porpoise / km^2 has been taken forward for the assessment in **Chapter 10 Marine Mammals and Leatherback Turtle**.

Table 5.2 Seasonal average density estimate of harbour porpoise in the OAA plus 4 km buffer

Season	Density estimate (APEM) with correction factor added (individuals / km$^{2)}$
Summer (Apr-Sep) highest average	0.42
Autumn (Oct-Mar) highest average	0.27
Annual average	0.24

5.1.3. Summary of Abundance and Density Estimates for Harbour Porpoise

63. **Table 5.3** provides an initial summary of the density estimate and population estimates of harbour porpoise. Although the highest density estimates is Hauge et al. (2020), the DAS data include recent data (up to 2023), capturing current distribution patterns and seasonal variability. Hague et al. (2020) data are from older datasets (pre-2020), which may not account for recent ecological changes or shifts in porpoise distribution.

64. In addition, EIAR guidance and recent literature emphasise using site-specific, contemporary data wherever possible for impact assessment. DAS meets this criterion, whereas Hague et al. (2020) is considered secondary or supporting context (Marine Scotland, 2024).

65. Based on written feedback from NatureScot received on 14 November 2025, in response to questions posed by the Applicant at ETG 2 on 15 October 2025, the highest seasonal average density estimate from the Project DAS is used in **Chapter 10 Marine Mammals and Leatherback Turtle**.

Table 5.3 Summary of reference population and density estimates to inform the assessments on harbour porpoise

Density (individuals / km)	Density data source	Reference population	Reference population data source
0.4 to 2.0	Paxton et al. (2016)	**UK: 24,305 (West Scotland (WS) Management Unit (MU))** **Total: 28,936 (WS MU)**	IAMMWG (2023)
0.29 to 0.87	Hauge et al. (2020)		
0.505	(Maximum density) Waggitt et al. (2019)		
0.503	Waggitt et al. (2019) densities over SCANS-IV CS-F block		
0.05-0.25	SCANS-III Modelled density ranges (Lacey et al., 2016)		
0.2010	SCANS-IV CS-F block (Gilles et al. 2023)		
0.42 (highest seasonal average density)	**Project DAS (harbour porpoise)**		
Density estimates taken forward for assessment are shown in **green**			

5.1.4. Diet and Foraging Behaviour

66. The harbour porpoise has a generalist diet and eats a range of different fish, squid, octopus and shellfish (Andreason et al., 2017) but can have temporal focuses on just one or two different prey-species (Booth, 2020; Sveegard et al., 2012). Harbour porpoises in the Hebrides have been observed to prey on 20 different species (HWDT, 2025a).

67. Foraging behaviours and diets have been observed to change with age and size. – Andreason et al., (2017) found that younger and smaller species of porpoise focused a quarter of their diet on benthic species (25% goby species: *Family Gobiidae*).

68. When feeding, the harbour porpoise can go to the surface up to 4 times for intervals of 10-20 seconds then proceed to dive and hunt for 6 minutes (HWDT, 2025a).

69. Foraging can also alter due to anthropogenic pressures. Studies suggest that after exposure to high-intensity, broadband noise sources, such as pile driving, harbour porpoises stop vocalising and therefore are likely to stop foraging (Brandt et al., 2018; Dahne et al., 2013)).

5.2. BOTTLENOSE DOLPHIN

5.2.1. Desk-Based Review

70. In the Inner Hebrides, bottlenose dolphin is resident all year, usually travelling in small pods of three to ten individuals and is most often sighted in the coastal regions in the Inner Hebrides, around the small isles (Brown, 2018). There are two different ecotypes of bottlenose dolphins in Scottish waters: the coastal ecotype and the offshore ecotype. The coastal ecotype inhabits coastal areas, sea, estuaries and lochs (Hague et al., 2020).

71. The most recent assessment of bottlenose dolphins in UK waters concluded that the overall trend in Conservation Status was ‘Unknown’, highlighting that although the population size appears to be stable, there were too few data points to confidently conclude on the current and future population trends (JNCC 2019b, Hague et al., 2020).

72. In the COMPASS and MarPAMM projects within the Wider Study Area, dolphin detection rates were low, with average DPH between 0.15 and 3.92 across the sites (**Plate 5.1**). The delphinid clicks can be attributed to any dolphin species.

73. During the ObSERVE surveys (Giralt Paradell et al., 2024), bottlenose dolphin were the third most frequently sighted cetacean with 121 sightings, 472 individuals in the Wider Study Area. The highest density for bottlenose dolphin in S6A stratum is 0.090 animals per km (Giralt Paradell et al., 2024).

74. Data from the SWF from public sightings (July to December 2022, March to December 2023 and January to September 2025), in the Inner Hebrides recorded at least 38 (308) sightings in 2022, at least 27 (227) sightings in 2023 and at least 47 (465) sightings) in 2025 (SWF, 2025). In the Outer Hebrides, in 2022 at least six (48) sightings were recorded, at least six (28) in 2023 and nine (32) in 2025 (SWF, 2025), which shows they have a regular occurrence in the Hebrides.

75. The ORCA Surveys (2006-2023) interactive web map indicates that 45 sightings of bottlenose dolphin have been recorded within Study Area.

76. Nykanen et al. (2019) studied connectivity between bottlenose dolphin MU’s using genetic markers. This resulted in six clusters with one cluster mainly consisting of coastal bottlenose dolphins from Wales and west Scotland. Although estimated migration rates were low between most populations, there was mean migration rate of 18.1% between Galicia and east Scotland, and mean rate of 25.7% from east Scotland to Wales–west Scotland (see **Plate 5.7**). Although this evidence does support that there is connectivity between the two populations, evidence is based primarily based on strandings data, which may lead to under-estimated population structure (Bilgmann, et al., 2011). Although there is evidence of some connectivity, there is not enough to conclude that the two populations function as a single, well-connected population unit for assessment purposes.

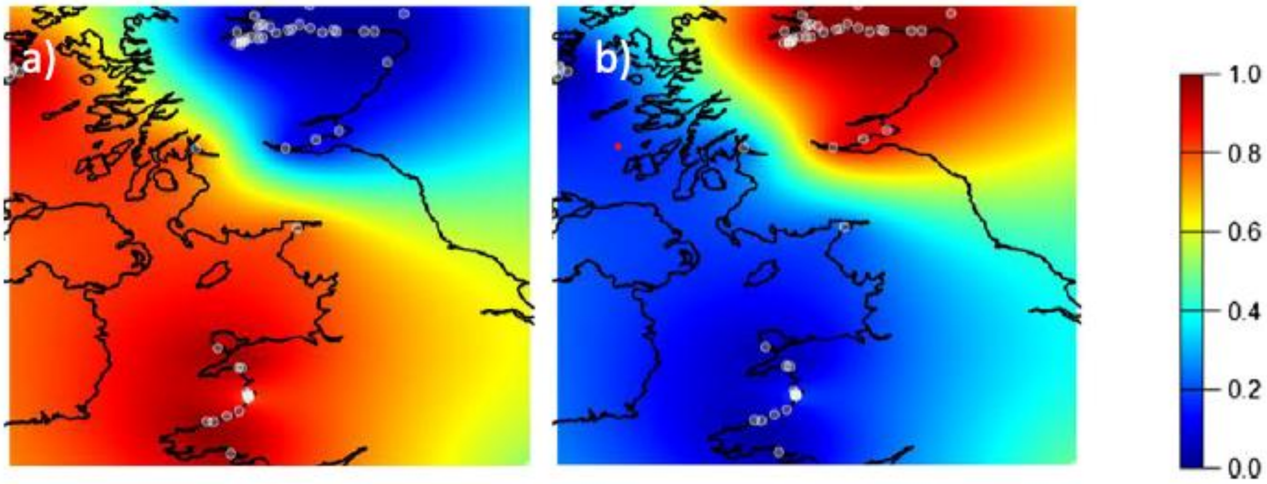


Plate 5.7 Map of individual assignment probabilities per population using only the samples from coastal Wales, west and east Scotland (N = 53): (a) west Scotland and Wales and (b) east Scotland. The colour scale bar indicates the assignment probabilities

77. The IAMMWG have defined seven MUs for bottlenose dolphin (**Plate 5.8**). The WDA is within both the Coastal West Scotland and Hebrides (CWSH) MU and the Oceanic Waters (OW) MU. The estimate of bottlenose dolphin abundance in the Hebrides (CWSH MU) is 45 (CI = 33 – 66), (Cheney et al., 2013; IAMMWG, 2023) for the abundance for OW is 1,299 (CI = 597 – 2,826) and the IS is 186 (CI = 70-492), (Cheney et al., 2013; Hammond et al., 2021; Rogan et al., 2018; IAMMWG, 2023). Any potential impacts from the WDA alone and the cumulative assessment are assessed against the CWSH and OW MUs, separately, as any individuals could be from either of the MU populations.

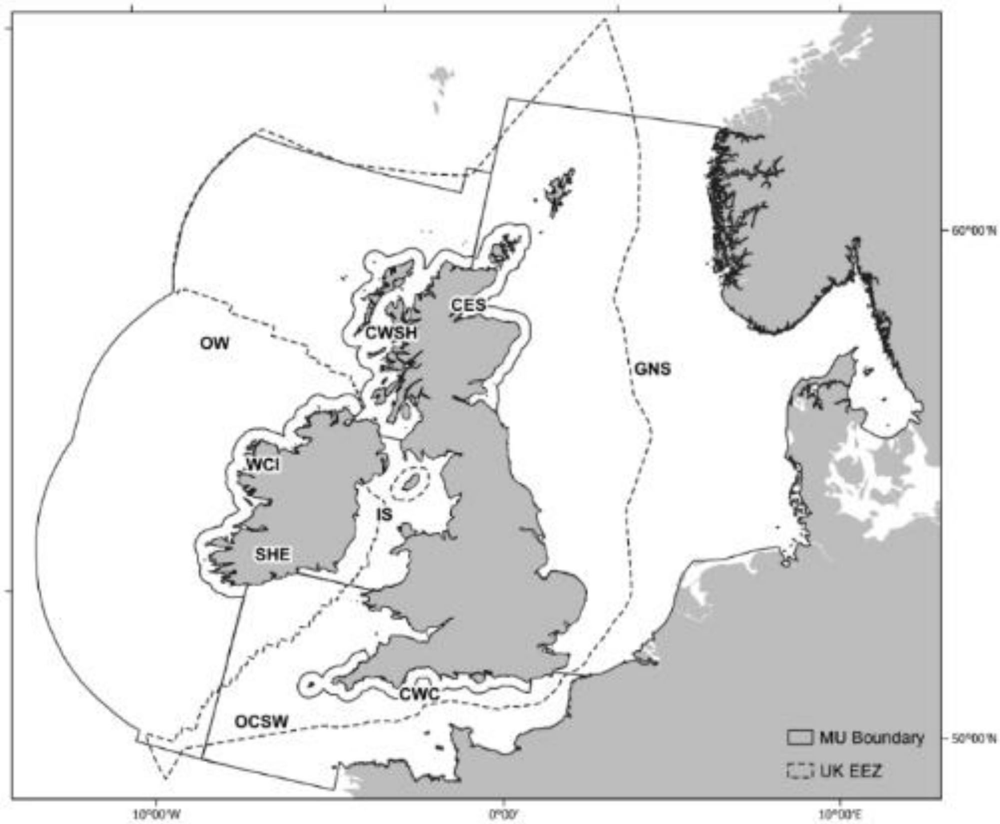


Plate 5.8 Bottlenose dolphin Management Units (IAMMWG, 2023)

78. The JCP Phase III Report (Paxton et al., 2016) estimates there is the potential for a bottlenose dolphin density estimate that ranges from 0 to 0.1 bottlenose dolphin per km^2 within the Study Area.

79. Distribution and abundance maps were developed by Waggitt et al. (2019) for cetacean species around Europe. For bottlenose dolphin, the distribution maps show a clear pattern of a low density in the Hebrides, and the coasts of WS in the winter, with higher densities in January, (**Plate 5.9**; Waggitt et al., 2019). Interrogation of this data[2], including all 10 km 'grids' that overlap with the specified area, reveals an average annual density estimate of 0.002 individuals per km^2 (average of all overlapping 10 km 'grids') for the OAA.

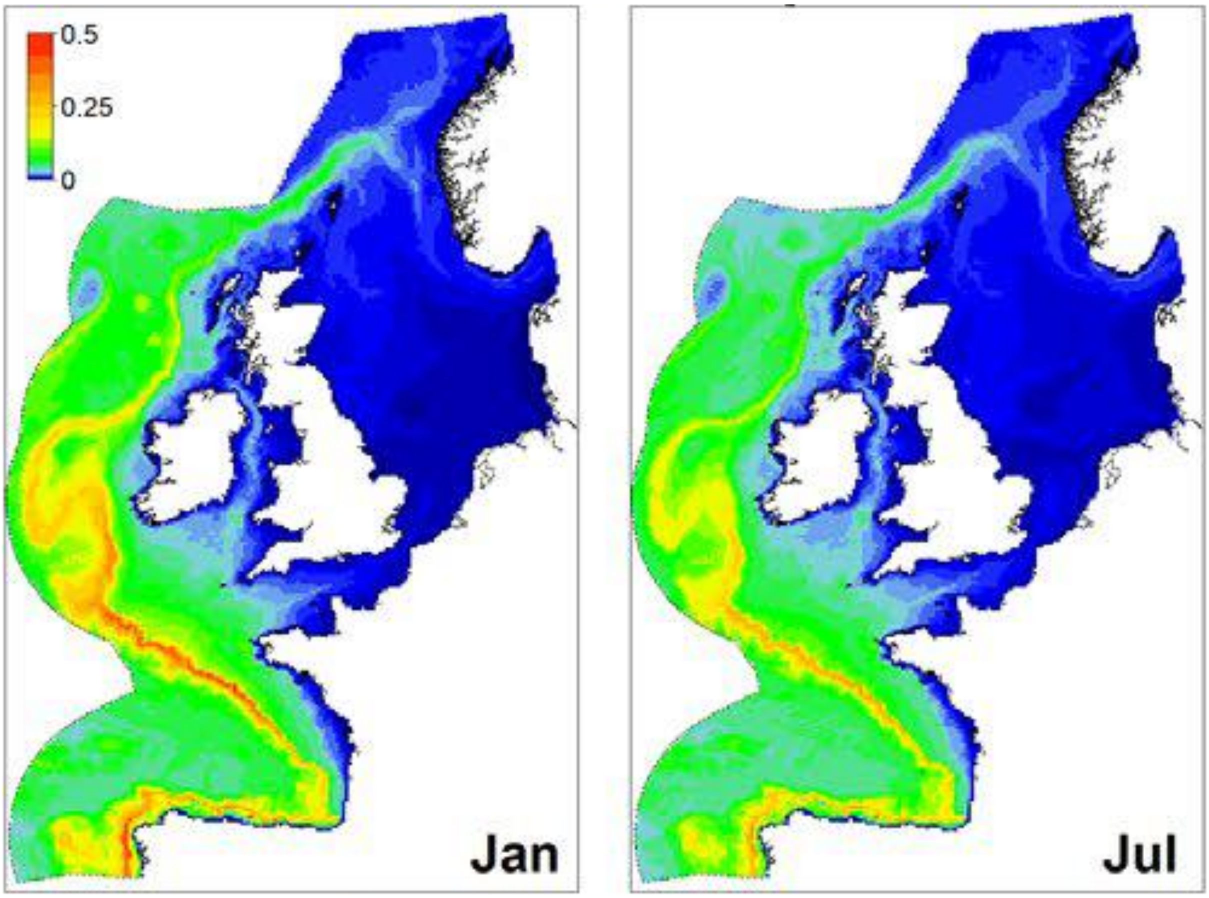


Plate 5.9 Spatial Variation in Predicted Densities (Individuals (per km²) of Bottlenose Dolphin in January and July in the North-East Atlantic). Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

80. The SCANS-III modelled density report shows that the density range for bottlenose dolphin is low (<0.01 animals per km²) for the Outer Hebrides and the West of Scotland (Lacey et al., 2022),

81. Results from the SCANS-IV survey (the most recent available and undertaken in summer 2022; Gilles et al., 2023) provides estimated density and abundances of bottlenose dolphin for the Study Area. The WDA is in SCANS-IV survey block CS-F, and close to block CS-G (**Plate 5.6**).

- Survey Block CS-F
  - Abundance = 647 individuals (95% CI = 13-2,198);
  - Density = 0.0425/km² (CV=0.4777).
- Survey Block CS-G
  - Abundance = 1,069 individuals (95% CI = 13-2,778);
  - Density = 0.0532/km² (CV=0.742).

5.2.2. Site-Specific Density Estimates for Bottlenose Dolphin

82. During the Project's DAS, there was only one recording of bottlenose dolphin, where the individual was recorded in October 2021, resulting in a density estimate of 0.02 bottlenose dolphin per km² in the OAA plus 4 km buffer. Due to the low number of bottlenose dolphin sightings, this estimate has not been corrected to account for availability bias.

5.2.3. Summary of Abundance and Density Estimates for Bottlenose Dolphin

83. **Table 5.4** provides an initial summary of the density estimate and population estimates of bottlenose dolphin to inform the EIAR. The SCANS-IV density estimates for survey block CS-F are used in **Chapter 10 Marine Mammals and Leatherback Turtle**.

Table 5.4 Summary of reference population and density estimates to inform the assessments on bottlenose dolphin

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0-0.1	Paxton et al. (2016)	**UK: 45 (CWSH MU)** **UK: 1,299 (OW MU)** **Total: 70,249 (OW MU)**	IAMMWG (2023)
0.002	Waggitt et al. (2019)		
<0.01	SCANS-III Modelled density ranges (Lacey et al., 2016)		
0.0425	**SCANS-IV CS-F block (Gilles et al. 2023)**		
0.02	Project DAS (bottlenose dolphin only)		
Density estimates taken forward for assessment are shown in **green**			

5.2.4. Diet and Foraging Behaviour

84. Bottlenose dolphins have been observed in the Hebrides to co-operatively forage in groups and work together to herd fish (HWDT, 2025b). The species can grow up to 4m long and utilise their size to strike species with their tails, stunning their prey, a process called ‘fish-whacking’.

85. Santos, et al., (2001), observed the stomach contents of 10 bottlenose dolphins in Scottish waters and found that the diets mainly consist of cod (*Gadus morhua)*, saithe (*Pollachius virens)*, and whiting (*Merlangius merlangus*). Several other species were also found in the stomach contents including: salmon (*salmo salar)* and haddock (*Melanogrammus aeglefinus)*. Additionally, bottlenose dolphins have been observed to eat crustaceans and cephalopods (HWDT, 2025b).

5.3. COMMON DOLPHIN

5.3.1. Desk-Based Review

86. Common dolphin are present in the Hebrides, with sightings from the HWDT surveys peaking between April and October, with sightings occurring sporadically in the winter months (Hague et al., 2020). Common dolphin can be found in coastal and offshore regions with a preference for areas of steep seabed (Baxter et al., 2011), and continental shelf waters (Evans et al., 2011).

87. WDC Shorewatch data indicate that the Outer Hebrides and West Highlands had the highest overall probability of common dolphin occurrence, with peaks in August, although absolute values remained low, and both regions showed significant upward trends (Rodríguez-Mendoza et al., 2025). These patterns are consistent with wider research showing high summer occurrence of common dolphins in the Little Minch and Sea of the Hebrides, with more localised winter distributions in areas such as the Sound of Sleat and the Firth of Lorn (Hartny-Mills et al., 2024; Evans & James, 2019). Common dolphins along Scotland's west coast are typically associated with deeper offshore waters (70–240 m), a preference supported by both Shorewatch data and earlier studies (Weir et al., 2009a). Regional trends also indicate increasing occurrence in the northern Minch, reflecting a northward shift in distribution within the west coast region (MacLeod et al., 2005; Evans and Waggitt, 2020; Rodríguez-Mendoza et al., 2025).

88. The abundance of common dolphin in the Inner Hebrides increased from 0.05 individuals per 100 km^2 in 2003 to 1.1 individuals per 100 km^2 in 2017 (or 0.0005 / km^2 and 0.011 / km^2 respectively) and are recorded throughout the year (HWDT, 2025c).

89. Common dolphin were the most sighted cetacean species in the Wider Study Area during the ObSERVE surveys (Giralt Paradell et al., 2024) across all survey seasons. In total, 812 sightings comprising 5,725 individuals occurred across the survey area in 2021 and 2022. Encounter rates were 47% greater in summer reflecting the large numbers of sightings, and larger groups observed. The maximum density recorded in the 2022 surveys in the S6A stratum was 1.578 animals per km (Giralt Paradell et al., 2024).

90. Data from the SWF from public sightings, (July to December 2022, March to December 2023 and January to September 2025), in the Inner Hebrides recorded at least 55 (745) sightings in 2022, at least 49 (854) sightings and at least 195 (3,133) sightings in 2025 (SWF, 2025). In the Outer Hebrides, in 2022 at least 142 (2,295) sightings were recorded, at least 35 (718) in 2023 and 164 (3,095) in 2025 (SWF, 2025). Data from SWF shows high numbers occur in the Inner Hebrides with a slight increase in common dolphin sightings in 2025, from previous years.

91. The Interactive web map from ORCA (2006-2023) illustrates that hundreds of common dolphin sightings have been recorded within the Hebrides during their surveys on ferry routes in the Study Area and Wider Study Area (**Plate 5.10**).

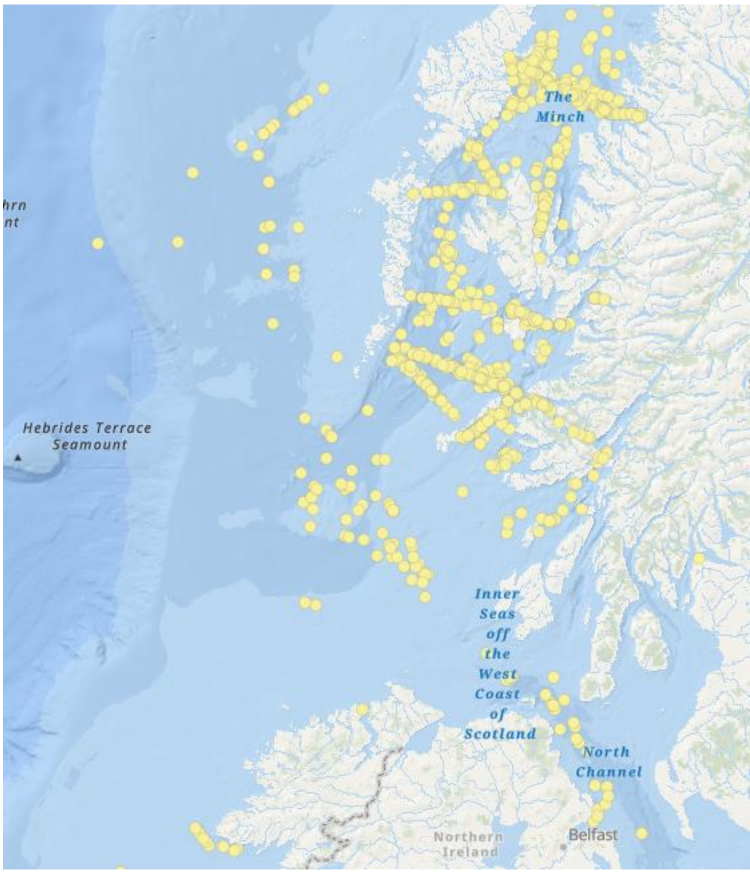


Plate 5.10 Common dolphin sightings during ORCA surveys from 2006 to 2023 (ORCA, 2025)

92. The most recent assessment of common dolphin in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019c, Hague et al., 2020).

93. The IAMMWG have defined one MU for common dolphin; the Celtic Great North Sea (CGNS) MU (**Plate 5.11**). The estimate of common dolphin abundance in the CGNS MU is 57,417 (CV: 0.32, CI = 30,850 – 106,863) (IAMMWG, 2023). This is the reference population for common dolphin that is used in the EIAR.

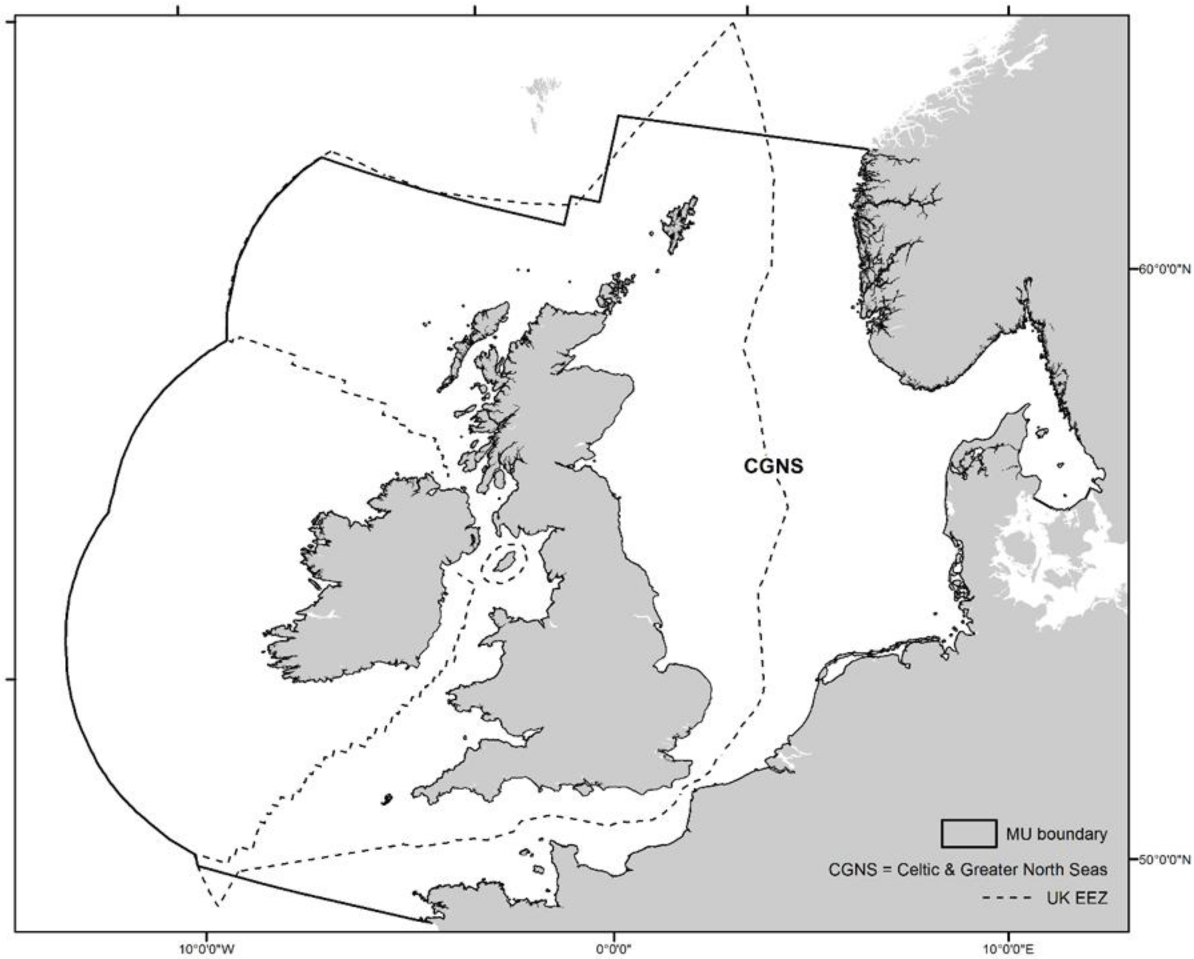


Plate 5.11 Management Unit for common dolphin, white-beaked dolphin, Atlantic white-sided dolphin, Risso's dolphin and minke whale (IAMMWG, 2023)

94. The JCP Phase III Report (Paxton et al., 2016) estimates that there is between 0 and 0.5 common dolphin per km^2 within the Study Area. Scottish Marine Fisheries Service (SMFS) (2020) estimated there to be density estimates ranging up to 0.09 individuals per km^2 in the Islay area, and up to 0.03 individuals per km^2 in the Sound of Islay area, with the highest densities in the autumn.

95. The distribution maps for common dolphin (developed by Waggitt et al., 2019) show a clear pattern of higher density to the western coastal areas of the UK, extending south to the Bay of Biscay (**Plate 5.12**). The distribution maps indicate a 'corridor' of increased common dolphin density in the Wider Study Area travelling from the west of Scotland, southwards around the west coast of NI and the RoI.

96. Interrogation of this data[2], including all 10 km 'grids' that overlap with the specified area, reveals a maximum annual density estimate of 0.021 individuals per km^2 (average of all overlapping 10 km 'grids') for the OAA.

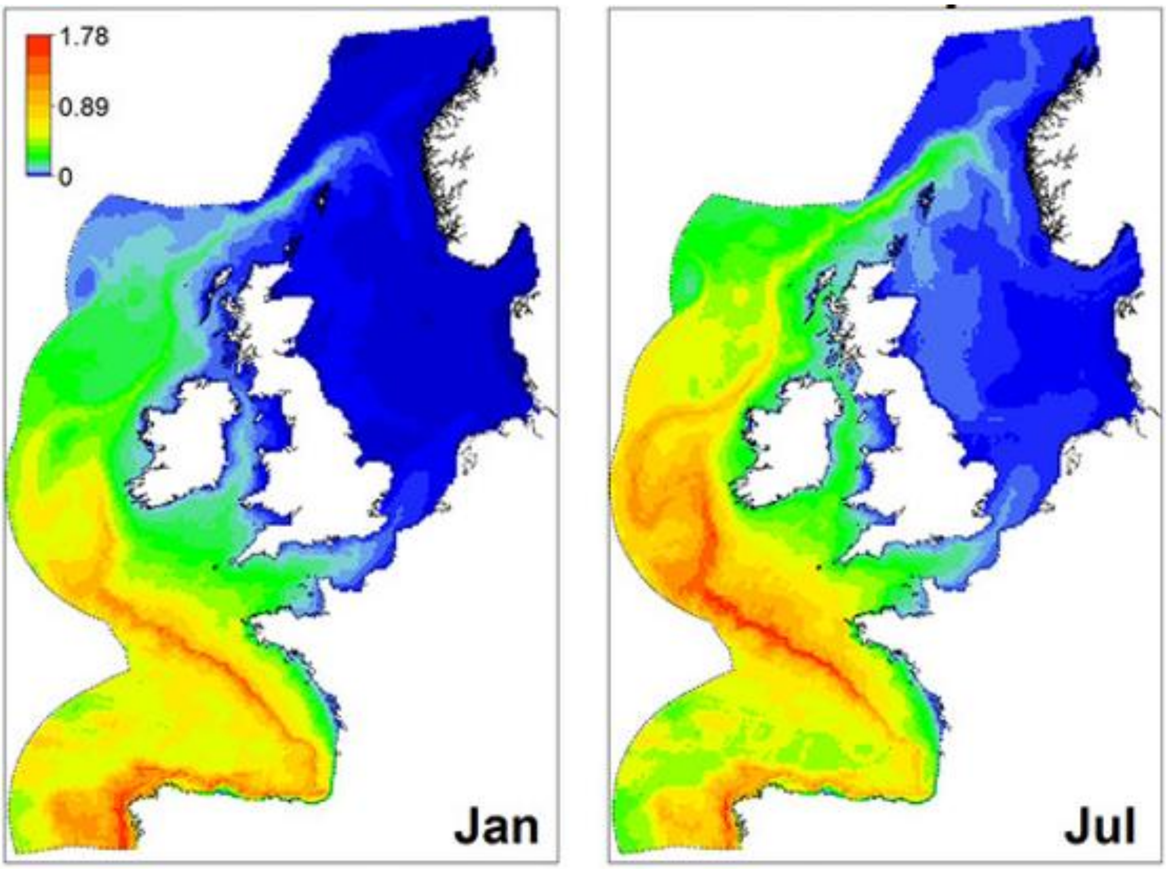


Plate 5.12 Spatial Variation in Predicted Densities (Individuals (per km²) of Common Dolphin in January and July in the North-East Atlantic). Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

97. Modelled densities for common dolphin from the SCANS-III survey were moderate (0.10-0.40 animals per km²) in the area west of the Hebrides, reflecting their widespread offshore distribution in the North-East Atlantic during the summer months (June to August) (Lacey et al., 2022).

98. Results from the SCANS-IV survey (Gilles et al., 2023) provides estimated density and abundances for the relevant survey blocks (**Plate 5.12**), for common dolphin, of:

- Survey Block CS-F
  - Abundance = 829 individuals (95% CI = 14-3,244); and
  - Density = 0.0544/km² (CV=1.028).
- Survey Block CS-G
  - Abundance = 1,515 individuals (95% CI = 280-3,281); and
  - Density = 0.0754/km² (CV=0.496).

5.3.2. Site-Specific Density Estimates for Common Dolphin

99. In total, common dolphin were recorded in 29 of the 30 site-specific DAS. A peak estimate of 1,301 individuals was recorded, resulting in an average density estimate of 0.445 individuals per km². A correction factor of 0.675 was applied to account for any diving animals (De Boer et al., 2008), which results in an average annual density estimate of 0.7901 common dolphin per km² in the OAA plus 4 km buffer.

100. **Table 5.5** presents the estimated seasonal densities of common dolphin calculated and apportioned by APEM, as well as densities estimated using the correction factor (De Boer et al., 2008). The highest estimated density occurs in the summer season, 0.8025 common dolphin per km^2 in the OAA plus 4 km buffer.

Table 5.5 Seasonal common dolphin densities with correction factor in the OAA

Season	Density estimate (APEM) (individuals / km^2)	Density estimated with correction factor added
Summer (Apr-Sep)	0.54	0.80
Winter (Oct-Mar)	0.58	0.78

5.3.3. Summary of Abundance and Density Estimates for Common Dolphin

101. **Table 5.6** provides an initial summary of the density estimate and population estimates of common dolphin. The density estimates from the Project DAS (summer average) is used in **Chapter 10 Marine Mammals and Leatherback Turtle**, as it is most precautionary.

Table 5.6 Summary of reference population and density estimates to inform the assessments on common dolphin

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0.011	HWDT (2025c)	**UK: 57,417 (CGNS MU)** **Total: 102,656 (CGNS MU)**	IAMMWG (2023)
0-0.5	Paxton et al. (2016)		
0.03 - 0.09	SMFS (2020)		
0.021	Waggitt et al. (2019)		
0.10-0.40	SCANS-III Modelled density ranges (Lacey et al., 2022)		
0.0754	SCANS-IV CS-F block (Gilles et al. 2023)		
0.80 summer (seasonal average)	**Project DAS (common dolphin only)**		
Density estimates taken forward for assessment are shown in **green**			

5.3.4. Diet and Foraging Behaviour

102. Common dolphin are epipelagic predators and predate in the upper zones of water column (Pusineri, et al., 2007) with a variety of foraging techniques. It is stated that the most documented foraging technique internationally is the circling of shoaling fish at the water surface (Weir, et al., 2009b).

103. Diets of common dolphins in the Northeast Atlantic consist majorly of fish and some cephalopods (Pusineri, et al., 2007). However, common dolphins have been observed to be opportunistic predators and will predate most shoaling epipelagic fish (HWDT, 2025c; Weir et al, 2009b).

5.4. ATLANTIC WHITE-SIDED DOLPHIN

5.4.1. Desk-Based Review

104. The Atlantic white-sided dolphin is usually located in continental shelf regions west of the Outer Hebrides, preferring temperate and sub-polar seas with a preference for deeper waters (Hague et al., 2020). Although they tend to move closer to the coast during summer months, they are rarely recorded within the Continental Shelf in the Hebrides (HWDT, 2025d).

105. The most recent assessment of Atlantic white-sided dolphins in UK waters concluded that the overall trend in Conservation Status was 'Unknown', highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019i, Hague et al., 2020).

106. Macleod et al. (2003) surveyed three areas of northwestern Scottish waters (including the Outer Hebrides, west of the Shetland Islands and the central Faroe-Shetland Channel) and recorded Atlantic white-sided dolphin to be the most abundant species throughout that area. They were sighted predominantly in the deeper waters beyond the continental shelf edge. Relative abundance in the Outer Hebrides was 1.85 sightings / 100 km.

107. In the ObSERVE surveys (Giralt Paradell et al., 2024), in the Wider Study Area; Atlantic white-sided dolphins were seen on 11 occasions in Summer 2021, with 24 individuals observed in group sizes of one to three individuals mostly occurring along continental slopes. No density estimate was calculated for the S6A stratum.

108. Data from the SWF from public sightings, (July to December 2022, March to December 2023 and January to September 2025), in the Inner Hebrides recorded no dolphins in 2022, at least four (122) sightings in 2023 and at least three (19) sightings in 2025 (SWF, 2025). In the Outer Hebrides, again in 2022 there were no sightings recorded, at least six (31) in 2023 and one (five) in 2025 (SWF, 2025).

109. The Interactive web map from, ORCA (2006-2023) has no records of Atlantic white-sided dolphin within the Study Area.

110. The IAMMWG have defined one MU for white-sided dolphin; the CGNS MU (**Plate 5.10**). The estimate of white-sided dolphin abundance in the CGNS MU is 12,293 (CV: 0.64, CI = 3,891 – 38,841) (IAMMWG, 2023). This is the reference population for Atlantic white-sided dolphin for use in the EIAR.

111. The JCP Phase III Report (Paxton et al., 2016) estimates there is up to 0.01 Atlantic white-sided dolphin per km^2 in the Study Area.

112. The distribution maps for Atlantic white-sided dolphin (**Plate 5.12**), developed by Waggitt et al*.,* 2019) show a clear pattern of higher density in the offshore regions with almost no distribution in the coastal regions in January, however there is a slight increase in the Inner Hebrides in the July map.

113. Interrogation of this data, including all 10 km 'grids' that overlap with the specified area, reveals an average annual density estimate of 0.021 individuals per km^2 (average of all overlapping 10 km 'grids') for the OAA plus 4 km buffer.

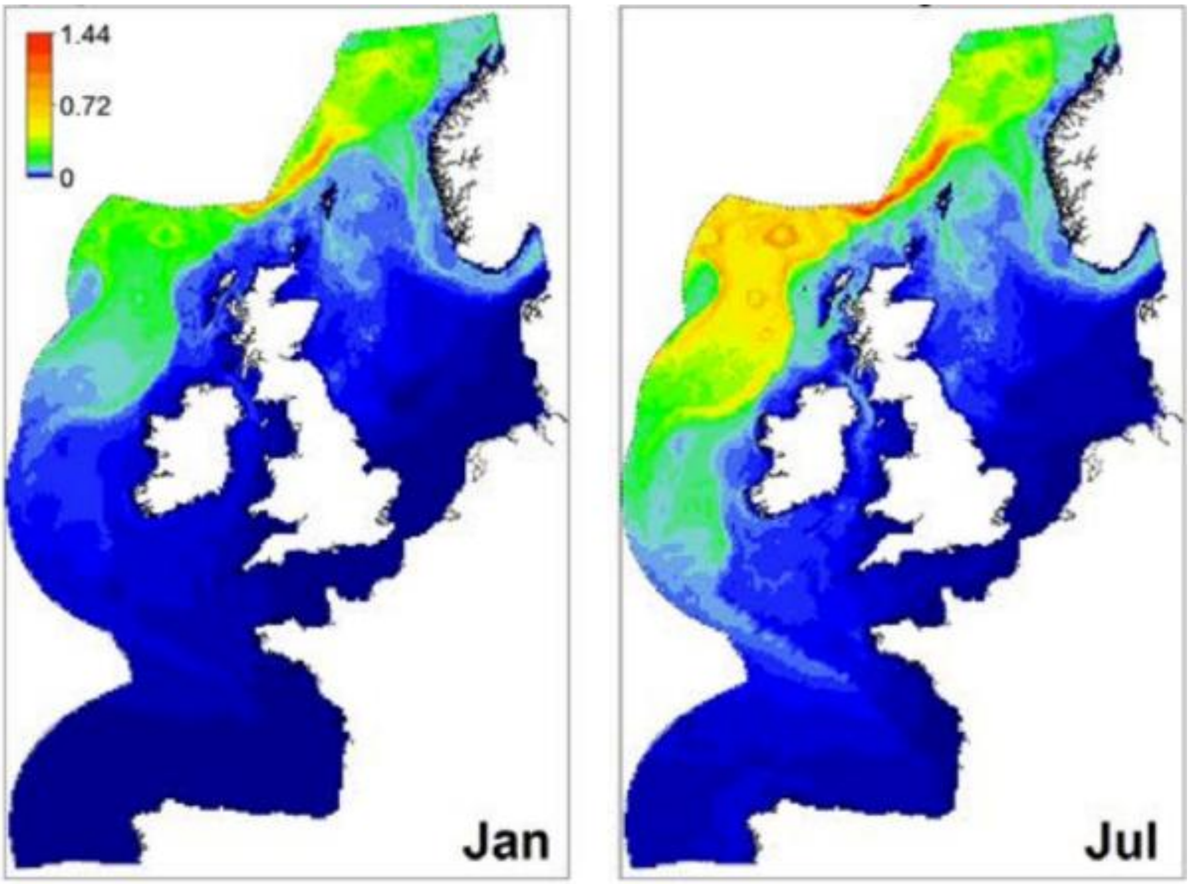


Plate 5.13 Spatial Variation in Predicted Densities (Individuals (per km^2) of Atlantic white-sided Dolphin in January and July in the NE Atlantic). Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

114. For the SCANS-IV survey, there are no abundance, or density estimates for Atlantic white-sided dolphin in survey block CS-F, however there is a density estimate for block CS-G and CS-H (**Plate 5.13**) (Gilles et al., 2023) which estimates:

- For survey block CS-G
  - Abundance = 451 individuals (95% CI = 7-1,464); and
  - Density = 0.0224/km^2 (CV=0.971).
- For survey block CS-H
  - Abundance = 390 individuals (95% CI = 8-1,130); and
  - Density = 0.0279/km^2 (CV=0.775).

5.4.2. Site-Specific Density Estimates for Atlantic White-Sided Dolphin

115. While Atlantic white-sided dolphin has not been recorded in the Project's DAS, the desk-based review shows that there is potential for their presence in the area, and therefore they have been included in the assessment.

5.4.3. Summary of Abundance and Density Estimates for Atlantic White-Sided Dolphin

116. **Table 5.7** provides an initial summary of the density estimate and population estimates of Atlantic white-sided dolphin. The SCANS-IV density estimates for survey block CS-H are used in **Chapter 10 Marine Mammals and Leatherback Turtle** as it is the most precautionary density estimate.

Table 5.7 Summary of reference population and density estimates to inform the assessments on Atlantic white-sided dolphin

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0.01	Paxton et al. (2016)	**UK: 12,293 (CGNS MU)** **Total: 18,128 (CGNS MU)**	IAMMWG (2023)
0.021	Waggitt et al. (2019)		
0.0224 (SCANS-IV Survey block CS-G)	**Giles et al. (2023)**		
0.0279 **(SCANS Survey block CS-H)**			
Density estimates taken forward for assessment are shown in **green**			

5.4.4. Diet and Foraging Behaviour

117. Atlantic white-sided dolphin prioritises higher quality prey at lower trophic levels and consume smaller mesopelagic and pelagic prey (Spitz et al., 2010). They forage independently but have been observed to co-operatively herd schools of fish and force them to the surface (HWDT, 2025d).

118. Stable isotope analysis of skin samples from stranded species on the Scottish coastline, found that white-sided dolphins prioritise foraging on small to medium size (~30cm or less) Gadiformes, such as cod, pouting and blue whiting that are found in Irish waters (Plint, et al., 2023). However, Hernandez-Milian et al., (2015), concluded that high quantities of their diet consisted of mackerel and mesopelagic fish (Myctophidae and silver pout), therefore the diet of the white-sided dolphin can be quite specialised, focusing on higher quality prey types.

5.5. WHITE-BEAKED DOLPHIN

5.5.1. Desk-Based Review

119. White-beaked dolphins are regularly recorded in the Hebrides, mainly in the open waters around the Outer Hebrides (HWDT, 2025e). White-beaked dolphins are abundant all year round, with sightings higher in the summer months (Hague et al., 2020). In the Hebrides, white-beaked dolphin distribution is mainly around the northwestern coast, within water depths of 50 to 100 m (Evans et al., 2011). Data from SWF and SCANS suggest a distributional shift northward from more southerly areas of the Hebrides and West Scotland shelf toward northern and northwestern waters, closer to the Outer Hebrides and deeper shelf edge zones (Evans et al., 2011, Hague et al., 2020).

120. The HWDT have recorded a decline in white-beaked dolphin numbers, whereas common dolphin has increased. This could potentially mean that two species are in competition for prey or habitat. Data from the HWDT surveys between 2003 and 2019 have recorded an annual presence of white-beaked dolphin, with occurrence more in the Outer Hebrides in open water.

121. White-beaked dolphin sightings were infrequent in the WDC Shorewatch data, but regional analysis showed a distinct peak in the Outer Hebrides during 2017 to 2018, with seasonal highs in June and a smaller winter peak (Rodríguez-Mendoza et al., 2025). These patterns are consistent with broader

observations of the species' preference for deeper offshore waters, particularly in areas such as the north Minch and west of Harris (Weir et al., 2009a; Hartny-Mills et al., 2024).

122. In the ObSERVE surveys (Giralt Paradell et al., 2024); in the Wider Study Area; there were only three encounters of white-beaked dolphin comprising 21 individuals.

123. Data from the SWF from public sightings, (July to December 2022, March to December 2023 and January to September 2025) shows that in the Inner Hebrides there were two (3) sightings recorded in 2022 and no sightings in 2023, or in 2025 (SWF, 2025). In the Outer Hebrides, no sightings were recorded in 2022, at least six (31) were recorded in 2023 and at least one (five) in 2025 (SWF, 2025).

124. The Interactive web map from ORCA (2006-2023) has approximately 48 records of white-beaked dolphin sightings within the Study Area.

125. The most recent assessment of white-beaked dolphins in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019d; Hauge et al 2020).

126. The IAMMWG have defined one MU for white-beaked dolphin; the CGNS MU (**Plate 5.14**). The estimate of white-beaked dolphin abundance in the CGNS MU is 34,025 (CV: 0.28, CI = 20,026 – 57,807) (IAMMWG, 2023). This is the reference population for white-beaked dolphin for use in the EIAR.

127. The JCP Phase III Report (Paxton et al., 2016) estimates there to be a density estimate of up to 0.1 white-beaked dolphin per km^2 in the Study Area.

128. For white-beaked dolphin, the distribution maps (developed by Waggitt *et al.,* 2019) show a clear pattern of higher density in the Wider Study Area, with decreasing densities southwards of Scotland along the west coast of England. There is also a clear seasonal difference in the densities of white-beaked dolphin, with higher densities in July, particularly in the north of their range (**Plate 5.14**; Waggitt et al., 2019). Interrogation of this data[2], including all 10 km 'grids' that overlap with the specified area, reveals a maximum density estimate of 0.124 individuals per km^2 (average of all overlapping 10 km 'grids') for the OAA.

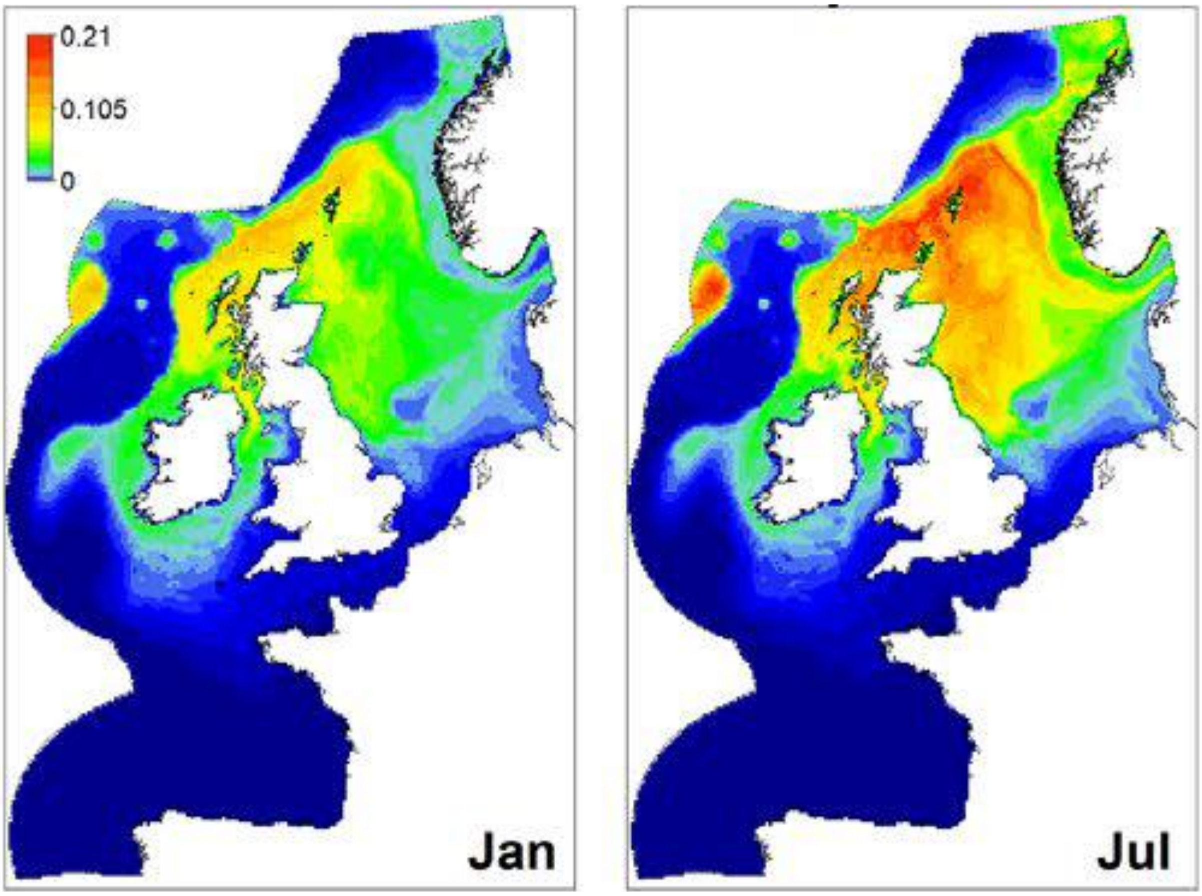


Plate 5.14 Spatial Variation in Predicted Densities (Individuals (per km²) of White-beaked Dolphin in January and July in the NE Atlantic). Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

129. Modelled densities from the SCANS-III survey were low in western Scottish offshore waters (<0.05 animals per km²), with higher densities predicted further north (Outer Hebrides) (Lacey et al., 2022).

130. For the SCANS-IV survey, there are no abundance, or density estimates for white-beaked dolphin in survey block CS-F, however there is a density estimate for block CS-G (**Plate 5.14**) (Gilles et al., 2023) which estimates:

- Abundance = 5,113 individuals (95% CI = 67-15,405); and
- Density = 0.2543/km² (CV=0.815).

5.5.2. Site-Specific Density Estimates for White-Beaked Dolphin

131. No white-beaked dolphin was recorded in the Project's DAS.

5.5.3. Summary of Abundance and Density Estimates for White-Beaked dolphin

132. While white-beaked dolphin has not been recorded in the Project's DAS, the desk-based review shows that there is potential for white-beaked dolphin presence in the area, and therefore they are scoped in to the assessment.

133. **Table 5.8** provides an initial summary of the density estimate and population estimates of white-beaked dolphin. The SCANS-IV density estimates for survey block CS-G are used in **Chapter 10 Marine Mammals and Leatherback Turtle**.

Table 5.8 Summary of reference population and density estimates to inform the assessments on white-beaked dolphin

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0 - 0.1	Paxton et al. (2016)	**UK: 34,025 (CGNS MU)** **Total: 43,951 (CGNS MU)**	IAMMWG (2023)
0.124	Waggitt et al. (2019)		
<0.05	SCANS-III Modelled density ranges (Lacey et al., 2022)		
0.2543	**SCANS-IV CS-G block (Gilles et al. 2023)**		
Density estimates taken forward for assessment are shown in **green**			

5.5.4. Diet and Foraging Behaviour

134. White-beaked dolphins have opportunistic diets, that can feed on both demersal and epipelagic species (Weir, et al., 2009b), however three main prey species have been observed to be abundant in stomach contents: haddock, cod, and whiting (Canning, et al., 2008; Jansen, et al., 2010).

135. HWDT (2025e), have observed white-beaked dolphins using similar foraging techniques to other dolphins, such as circling shoals and ‘fish-whacking’ with their tails. They have also been observed to forage at the same time in the same area as minke whales and humpback whales.

136. When foraging, white-beaked dolphins use ultrasonic buzzing clicks to locate prey. During foraging the white-beaked dolphins produce slow buzz clicks (Yang, et al., 2021). Anthropogenic noise has the potential to disrupt foraging within the construction area as it will disrupt the echolocation capacity of the species.

5.6. RISSO’S DOLPHIN

5.6.1. Desk-Based Review

137. Risso’s dolphin are widely distributed around the Hebrides, inhabiting deep waters but occasionally can be sighted near the coast. Risso’s dolphin are present all year round, mainly in the Outer Hebrides but there have been frequent sightings in the Kintyre peninsula, around Coll, Tiree, Mull and Skye (Brown, 2018) and have been recorded to a higher occurrence in the Hebrides in the summer months (Hague et al., 2020). Risso’s dolphin can be distributed in open water, coastal regions, straights and sounds and lochs with a preference for continental shelfs and areas with sloping seabeds (Baxter et al., 2011).

138. Reid et al (2003), recorded Risso’s dolphins as a predominantly continental shelf species, with most sightings in Scottish waters located in west Scotland suggesting there is some evidence of seasonality to their distribution, with high sightings in the Minches (Study Area) between May and September and then an increase at the continental shelf edge in winter. However, inference was limited by uneven effort throughout the year (Hague et al., 2020).

139. WDC Shorewatch data indicate that Risso’s dolphin occurrence is highest in the West Highlands and the Outer Hebrides, with predicted abundance greatest in the Outer Hebrides, although a slight decline was observed in 2017 (Rodríguez-Mendoza et al., 2025). The key site recorded was Tiumpan Head. This reflects the species’ preference for deeper offshore waters, with individuals regularly recorded around the Isle of Lewis in summer. Peak occurrences in August and September align with

wider research identifying the Minches and Sea of the Hebrides as important breeding and calving areas (Evans and James, 2019; IUCN-MMPATF, 2024). The North-east Lewis NCMPA was designated in 2020 in recognition of its importance for Risso's dolphins, particularly for mothers with calves and juvenile groups (Weir et al., 2019).

140. Risso's dolphins were encountered 30 times comprising 91 individuals in the Wider Study Area during the ObSERVE aerial surveys in 2021 and 2022. The maximum density was recorded in SA6 stratum in the winter season resulting in 0.089 animals per km (Giralt Paradell et al., 2024).

141. Data from the SWF from public sightings, (July to December 2022, March to December 2023 and January to September 2025) in the Inner Hebrides recorded at least four (22) sightings in 2022, no sightings in 2023 and at least one (2) sighting in 2025 (SWF, 2025). In the Outer Hebrides, at least 11 (48) sightings were recorded in 2022, at least seven (40) in 2023 and at least 11 (38) in 2025 (SWF, 2025).

142. The Interactive web map from ORCA (2006-2023) has approximately 34 records of sightings of Risso's dolphin within the Study Area.

143. Sightings from HWDT suggest Risso's dolphins are present year-round around the west of Scotland, usually inhabiting deeper waters, such as those around Tiumpan Head on the Isle of Lewis. Sightings around the Hebrides are off northeast Lewis in the Outer Hebrides, and around Coll, Tiree, Mull and Skye. This data contributed to the proposed designation of the North-east Lewis NCMPA and suggests that the deeper water close to land is an important calving and feeding area for Risso's dolphins. (Hague et al., 2020). Sightings data from HWDT between 2003 and 2019 showed sightings recorded along the boundary of the OAA, where there were >0.007 Risso's dolphin sightings per unit effort (km) (**Plate 5.15**).

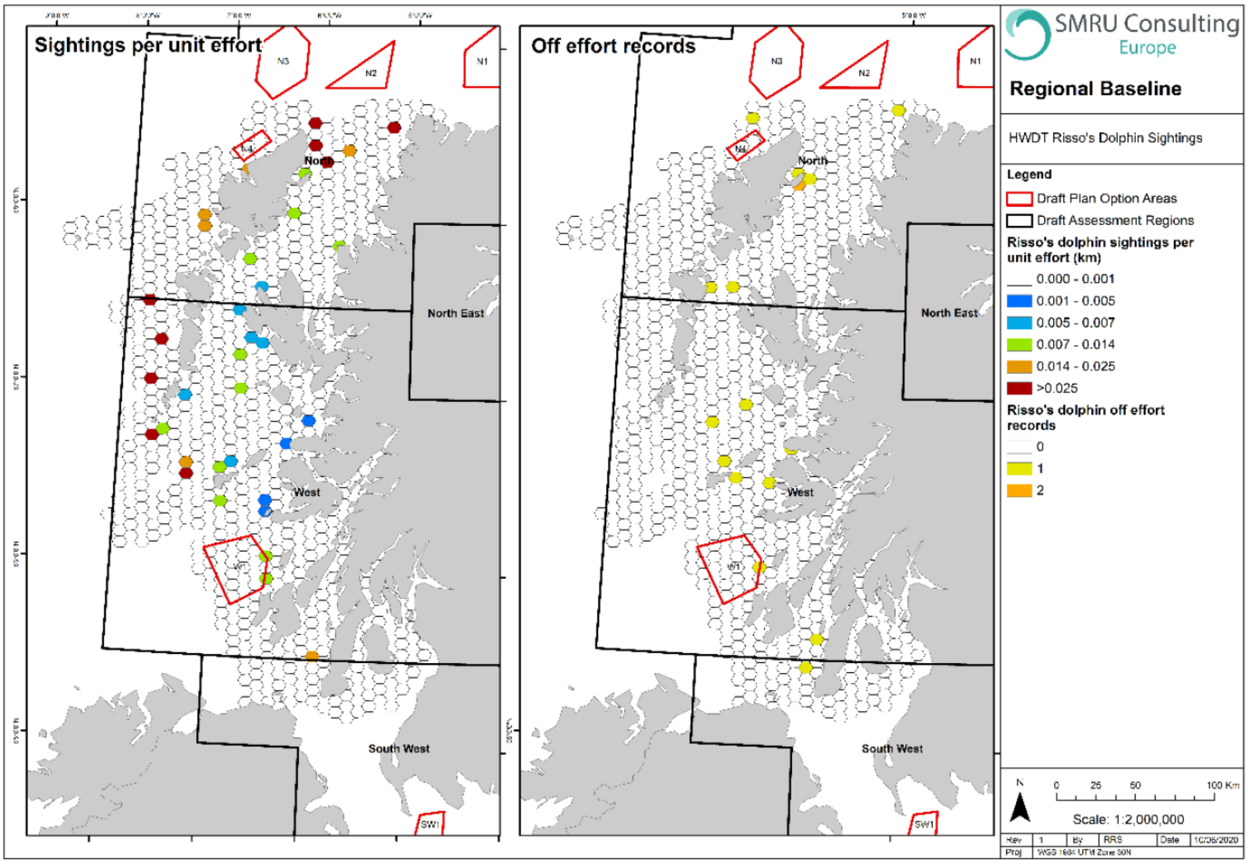


Plate 5.15 Sightings per unit effort, and off effort sightings, of Risso's dolphins during vessel based surveys 2003-2019 (Hebridean Whale and Dolphin Trust 2020). Note, white cell denotes >1 km effort but no sightings.

144. The most recent assessment of Risso's dolphins in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019e, Hague et al., 2020).

145. The IAMMWG have defined one MU for Risso's dolphin; the CGNS MU (**Plate 5.10**). The estimate of Risso's dolphin abundance in the CGNS MU is 8,687 (CV: 0.63, CI = 2,810– 26,852) (IAMMWG 2023). This is the reference population that is used in the EIAR.

146. The JCP Phase III Report (Paxton et al., 2016) estimates there is up to 0.01 Risso's dolphin per km^2 within the Study Area.

147. The distribution maps for Risso's dolphin (developed by Waggitt *et al.,* 2019) show a clear pattern of higher density to the western areas of the UK, where density increases in the summer months in the Study Area (**Plate 5.16**). The distribution maps indicate a 'corridor' of increased Risso's dolphin density in the Wider Study Area travelling northwards around the west coast of the NI and the RoI to the western and northern areas of Scotland.

148. Interrogation of this data[2], including all 10 km 'grids' that overlap with the specified area, reveals a maximum density estimate of 0.003 individuals per km^2 (average of all overlapping 10 km 'grids') for the OAA.

149. Average Waggitt et al. (2019) densities across the area of the SCANS-IV block CS-F have also been calculated to show the density of Risso's dolphin across a wider area in comparison and results in an annual density of 0.002 Risso's dolphin per km^2 for the Project.

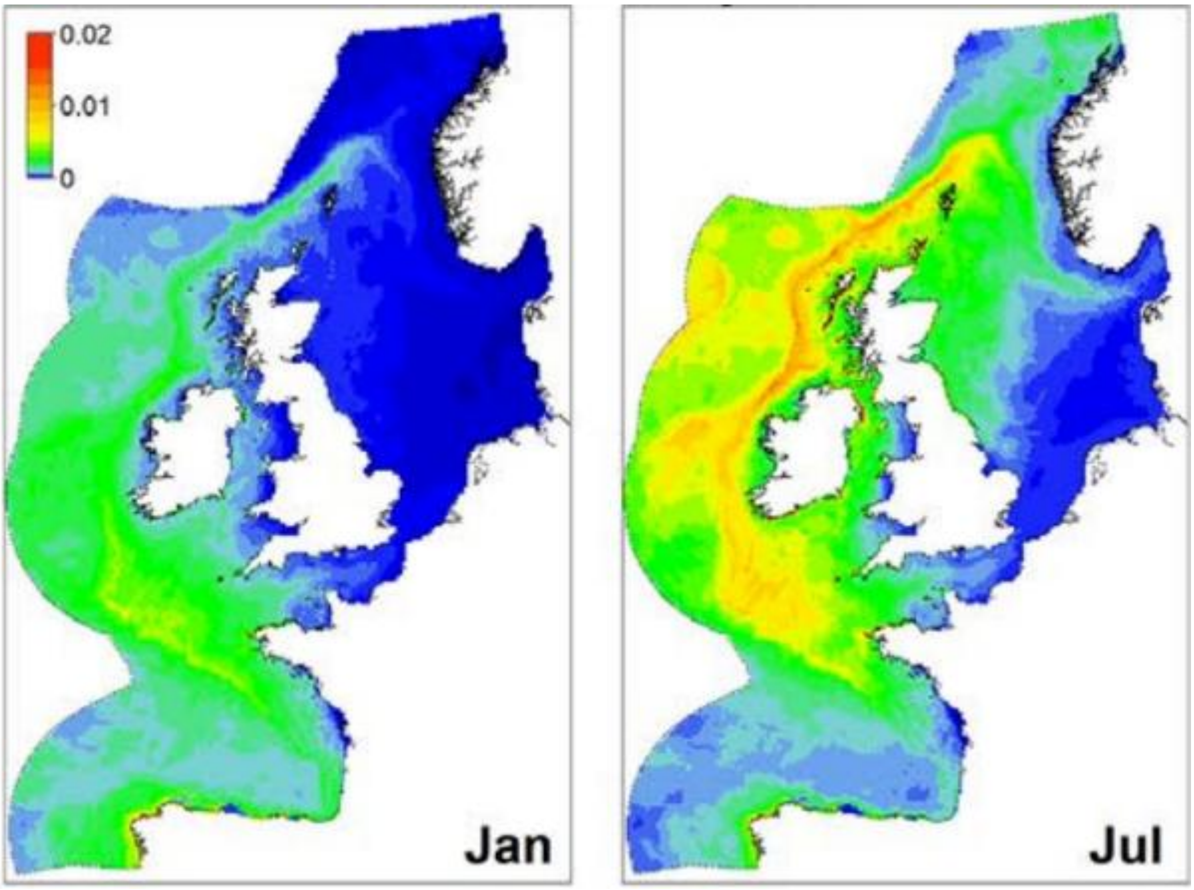


Plate 5.16 Spatial Variation in Predicted Densities (Individuals (per km^2) of Risso's Dolphin in January and July in the North-East Atlantic). Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019.

150. For the SCANS-IV survey, there are no abundance, or density estimates for Risso's dolphin in survey block CS-G, however there is a density estimate for block CS-F (Gilles et al., 2023) which estimates:

- Abundance = 41 individuals (95% CI = 1-153); and
- Density = 0.0027/km^2 (CV=1.006).

5.6.2. Site-Specific Density Estimates for Risso's dolphin

151. Two Risso's dolphin were recorded in the Project's December 2022 DAS, resulting in an average density estimate of 0.01 individuals per km^2 in the OAA plus 4 km buffer. Due to the low number of individuals sighted, these density and abundance estimates have not been corrected for availability bias.

5.6.3. Summary of Abundance and Density Estimates for Risso's dolphin

152. **Table 5.9** provides an initial summary of the density estimate and population estimates for Risso's dolphin. The Project's DAS density estimates for Risso's dolphin is used in **Chapter 10 Marine Mammals and Leatherback Turtle**.

Table 5.9 Summary of reference population and density estimates to inform the assessments on Risso's dolphin

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0 - 0.01	Paxton et al. (2016)	**UK: 8,687 (CGNS MU)** **Total: 12,262 (CGNS MU)**	IAMMWG (2023)
0.003	Waggitt et al. (2019)		
0.002	Waggitt et al. (2019) densities over SCANS-IV CS-F block (annual density)		
0.0027	SCANS-IV CS-F block (Gilles et al. 2023)		
0.01	**Project DAS (Risso's dolphin only)**		
Density estimates taken forward for assessment are shown in **green**			

5.6.4. Diet and Foraging Behaviour

153. The Risso's dolphin, is a deep-sea cetacean with a diet predominantly consisting of squid, with some octopus and cuttlefish. Risso's dolphin generally feed at night-time when their preferred prey migrates towards the surface (HWDT, 2025). The stomach contents of six stranded Risso's dolphins in the Mediterranean Sea were analysed. A total of 578 cephalopod beaks (166 uppers and 392 lowers) were found, identified as 386 individuals from 19 different species of *Coleoidea cephalopods*, one *Sepiolida*, eight *Octopoda*, and ten species belonging to the Order *Oegopsida* (Luna et al., 2022)

5.7. KILLER WHALE

5.7.1. Desk-Based Review

154. Killer whale have a cosmopolitan range, where they can be distributed in all oceans across the globe, making them one of the most widespread cetaceans. There is a small group of killer whales that is found in the Hebrides, known as the West Coast Community (WCC) (Sanders, 2023). The most distinctive animal in the group is John Coe, easily recognisable due to a chunk missing from his dorsal fin, and he has been regularly sighted since 1992 throughout the Hebrides and the Study Area. Killer whales from Shetland, Orkney, Iceland and Norway have also been recorded in the Hebrides (HWDT, 2025f).

155. Killer whale sighted around the Northern Isles and further offshore are likely part of a wider North Atlantic community of killer whales, with evidence of movement from the Northern Isles to Iceland to summer-spawning herring grounds (Foote et al. 2010). During the winter months, killer whales are often recorded offshore in Scottish waters (Luque et al. 2006).

156. In the Northeastern Atlantic, two types of killer whale have been described. Type 1 are smaller, over six metres in length, and mostly found in Iceland and Norway. Some Type 1s have been recorded in the Shetland and Orkney isles, referred to as the Northern Isles Community, using the area to forage for other marine mammals. Sightings are becoming more frequent, and therefore considered as

residents (Sanders, 2023). These killer whales have been recorded in the Outer Hebrides by HWDT in 2018. The Type 2s are larger reaching nine metres, and solely hunt pinnipeds, more commonly harbour seal, along with other cetaceans such as harbour porpoise, and minke whale. The WCC is considered to be Type 2. The WCC are considered to be transient, travelling at great distances in search for food (Sanders, 2023).

157. In the Wider Study Area during the ObSERVE surveys (Giralt Paradell et al., 2024), two killer whales were sighted on one occasion near the Porcupine Basin in summer 2021, which is southwest of Ireland.

158. Data from the SWF from public sightings (July to December 2022, March to December 2023 and January to September 2025) shows that in the Inner Hebrides in 2023, there were at least two sightings (2) and in 2025, seven sightings (16) (SWF, 2025). In the Outer Hebrides, in 2023 there were at least 11 sightings (28) recorded and at least two sightings (12) in 2025 (SWF, 2025).

159. The Interactive web map from ORCA (2006-2023) has recorded approximately six sightings of killer whale, with 16 individuals within the Study Area. Most of the sightings consisted of two individuals.

160. Reid et al. (2003) documented killer whales to be widely distributed in Scottish waters around the west coast in the Study Area, which is likely to be the west coast community. The Scottish Marine Atlas describes killer whale habitat as open coast, straits and sounds, sea lochs and offshore, with sightings all around the coast but mainly concentrated around Mull, the north-east coast and the Northern Isles (Baxter et al., 2011, Hague et al., 2020).

161. The most recent assessment of killer whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC, 2019f, Hague et al., 2020).

162. There is no estimated abundance for killer whales from IAMMWG, however the North Atlantic Marine Mammal Commission (NAMMCO), estimate the abundance for killer whales in the Northeast Atlantic to be 15,014 (NAMMCO, 2025a), or an MU of <10 for the individuals regularly sighted off Scotland (Beck et al., 2014), where the group has been recorded to be eight individuals (HWDT, 2025f). Any assessments would be undertaken against the WCC population estimate of eight, as well as the wider Northeast Atlantic population estimate of 15,014.

163. The distribution maps for killer whale (developed by Waggitt et al*.,* 2019) indicate a slightly higher density within the Study Area in July compared to January (**Plate 5.17**). Interrogation of this data[2], including all 10 km ‘grids’ that overlap with the specified area, reveals a maximum density estimate of 0.0008 individuals per km^2 (average of all overlapping 10 km ‘grids’) for the OAA.

164. Average Waggitt et al. (2019) densities across the area of the SCANS-IV block CS-F have also been calculated to show the density of killer whale across a wider area in comparison to the Study Area and results in an annual density of 0.001 killer whale per km^2 for the Project.

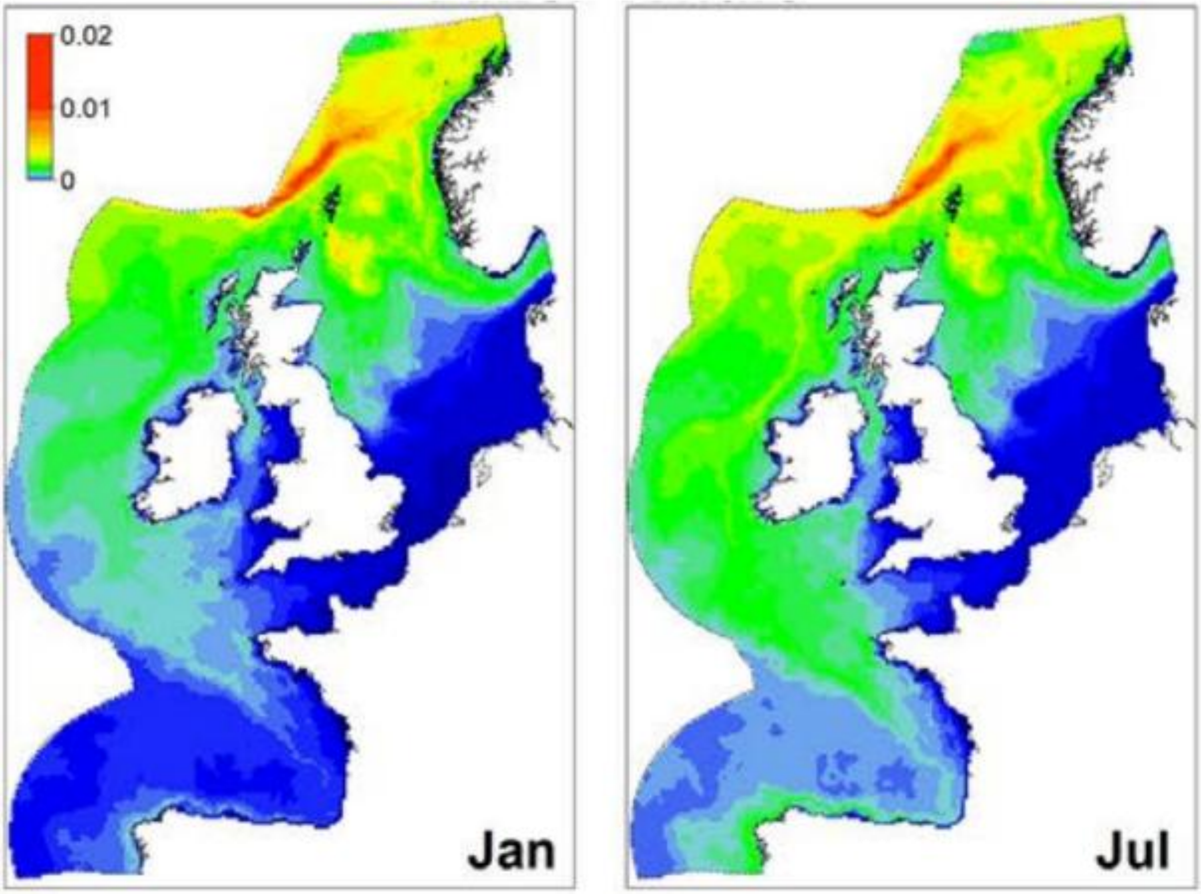


Plate 5.17 Spatial Variation in Predicted Densities (Individuals (per km²) of killer whale in January and July in the North-East Atlantic). Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

165. For the SCANS-IV survey, there are no abundance, or density estimates for killer whale in either survey block CS-F or CS-G (Gilles et al., 2023).

5.7.2. Site-Specific Density Estimates for Killer Whale

166. No killer whales were recorded in the Project's DAS.

5.7.3. Summary of Abundance and Density Estimates for Killer Whale

167. While killer whale has not been recorded in the Project's DAS, the baseline study shows that there is potential for killer whale presence in the Study Area due to the known presence of a killer whale pod (the west coast community) in the Hebrides. Therefore, killer whale has been scoped in for assessment.

168. **Table 5.10** provides an initial summary of the density estimate and population estimates of killer whale that will inform the assessments within the EIAR. The Waggitt et al (2019) densities over the SCANS-IV CS-F survey block have been used in **Chapter 10 Marine Mammals and Leatherback Turtle**.

Table 5.10 Summary of reference population and density estimates to inform the assessments on killer whale

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0.0008	Waggitt et al. (2019)	**15,014 (Northeast Atlantic)** **8 (West Coast community)**	NAMMCO (2023) HWDT (2025f)
0.001	**Waggitt et al. (2019) densities over SCANS-IV CS-F block (annual density)**		
Density estimates taken forward for assessment are shown in **green**			

5.7.4. Diet and Foraging Behaviour

169. Type 1s Killer whales will mostly feed on Atlantic herring (*Clupea harengus*) and have been recorded to follow the fish migrations of herring. To a lesser extent prey can consist of Atlantic mackerel (*Scomber scombrus)* (Sanders, 2023). However, what is unique about this type is that the groups that come to the Shetland and Orkney Isles will swich their prey type from fish to small mammals such as harbour seal and harbour porpoise as well as eider ducks (HWDT, 2025).

170. The WCC (Type 2s) feed on marine mammals, from minke whale to harbour porpoise and pinnipeds, hunting co-operatively and in silence (HWDT, 2025) to remain undetected from their prey. This silent hunting behaviour is in contrast to the Type 1s who actively use echolocation to hunt.).

5.8. LONG-FINNED PILOT WHALE

5.8.1. Desk-Based Review

171. Long-finned pilot whale usually prefers deep water but have been found in coastal regions, most likely due to prey distribution. Therefore, the species is widely distributed in the Hebrides and is also the most common cetacean to strand in the Hebrides (HWDT, 2025g).

172. Sighting surveys in 1987 and 1989 generated an abundance estimate of more than 750,000 long-finned pilot whales in the central and north-eastern North Atlantic (Buckland et al.,1993). A recent analysis of pilot whale abundance estimates for the central and north-eastern North Atlantic in the 28-year period from 1987 to 2015, found no detectable trend (Pike et al., 2018).

173. The most recent assessment of pilot whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC, 2019g, Hague et al., 2020).

174. Long-finned pilot whales were sighted on 40 occasions, comprising of 212 individuals, with the greatest number of sightings recorded in the summer 2021 and mainly in deeper waters in the Wider Study Area during the ObSERVE surveys. No density estimate was recorded in stratum S6A (Giralt Paradell et al., 2024).

175. Data from the SWF from public sightings, (July to December 2022, March to December 2023 and January to September 2025) in the Inner Hebrides and Outer Hebrides have no recordings of long-finned pilot whales from 2022, 2023 and 2025 (SWF, 2025).

176. The Interactive web map from ORCA (2006-2023) has ten sightings of long-finned pilot whales recorded within the Study Area.

177. Sightings data from four surveys conducted from ships and airplanes during 2005-2007 in European waters SCANS-II (Hammond et al., 2006), Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA), and Trans North Atlantic Sightings Survey, were used to estimate cetacean abundance using double-platform line transect methods. The model-based estimate of abundance in the eastern North Atlantic from the four surveys combined was 152,071 (CV 0.32) long-finned pilot whales (Rogan et al., 2017). Pilot whale sightings were distributed widely along the continental shelf edge and in ocean waters in the Wider Study Area, strongly associated with the 2,000 m depth contour (Hague et al., 2020). Reid et al. (2003) and Evans et al. (2011) recorded similar patterns of distribution stating long-finned pilot whale prefer deeper waters, (2,000 to 3,000 m) with less occurrences in coastal regions around the west and north coast of Scotland in the Study Area.

178. The distribution maps for pilot whale show a clear pattern of slightly higher density to the coastal areas of the Hebrides in January compared to July (**Plate 5.18**). Over the entire North-East Atlantic, Waggitt et al. (2019) suggested long-finned pilot whale move into deeper waters during the summer months, but also persist in the region year-round, showing a similar distribution all year (Hague et al., 2020).

179. Interrogation of this data[2], including all 10 km 'grids' that overlap with the specified area, reveals a maximum density estimate of 0.0009 individuals per km^2 (average of all overlapping 10 km 'grids') for the OAA.

180. Average Waggitt et al. (2019) densities across the area of the SCANS-IV block CS-F have also been calculated to show the density of pilot whale across a wider area in comparison, which results in an annual density of 0.0001 pilot whale per km^2 for the Project.

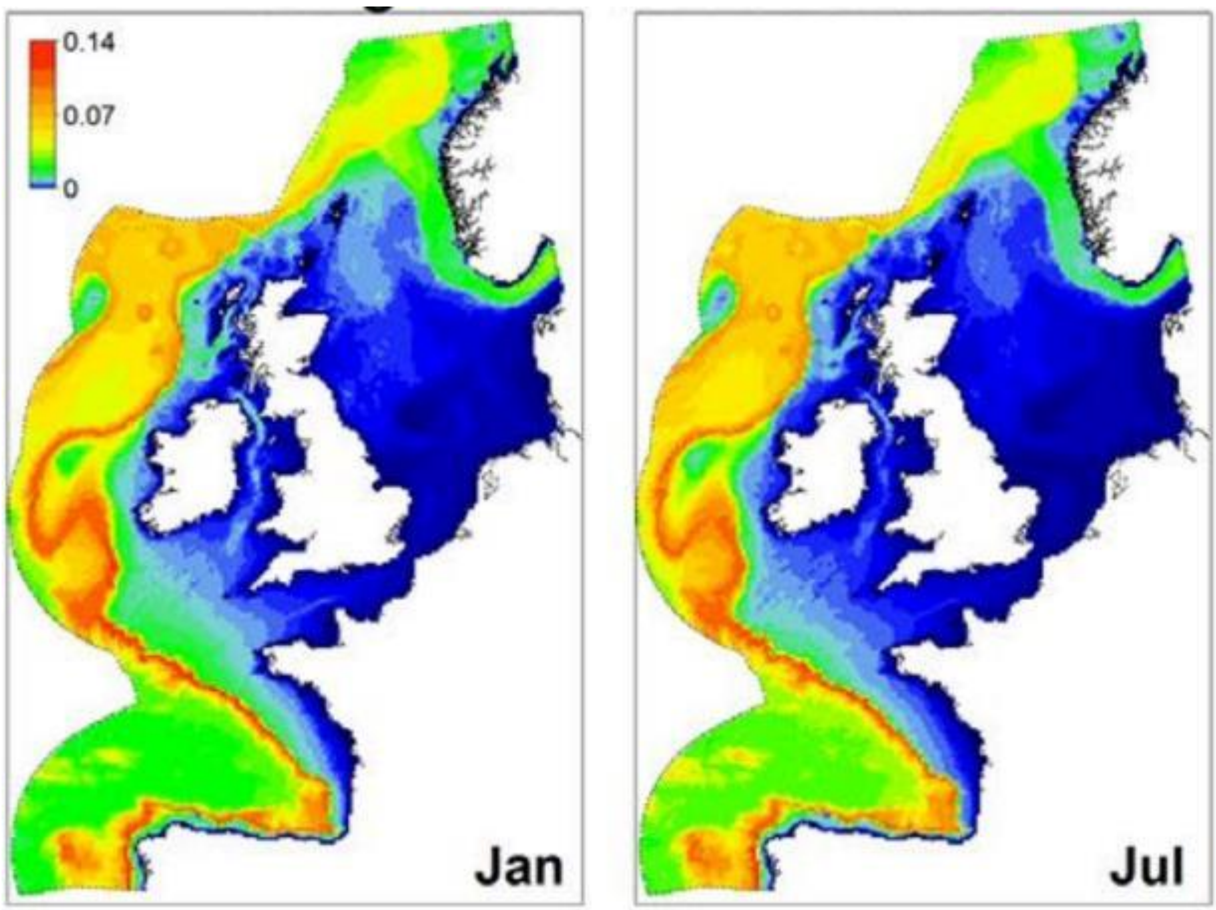


Plate 5.18 Spatial Variation in Predicted Densities Individuals per km² of pilot whale in January and July in the North-East Atlantic. Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

181. The SCANS-III density modelling report shows low densities for long-finned pilot whale in waters west of the Outer Hebrides, with the highest densities occurring further offshore in deeper Atlantic waters (Lacey et al., 2022).

182. For the SCANS-IV survey, there are no abundance, or density estimates for long-finned pilot whales in survey block CS-F, however there is a density estimate for block CS-G in the Wider Study Area (Gilles et al., 2023) which estimates:

- Abundance = 655 individuals (95% CI = 101-4,245); and
- Density = 0.0326/km² (CV=1.010).

5.8.2. Site-Specific Density Estimates for Long-Finned Pilot Whale

183. No long-finned pilot whales were recorded in the Project's DAS, however, three pilot whales were recorded by MMOs during the geophysical site investigation surveys in the OAA in 2023. Therefore, long-finned pilot whale has been scoped into the assessment.

5.8.3. Summary of Abundance and Density Estimates for Long-Finned Pilot Whale

184. **Table 5.11** summaries long-finned pilot whale densities. The SCANS-IV density estimates for survey block CS-G is used in **Chapter 10 Marine Mammals and Leatherback Turtle**.

Table 5.11 Summary of reference population and density estimates to inform the assessments on long-finned pilot whale

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0.0009	Waggitt et al. (2019)	**152,071 (Northeast Atlantic)**	(Rogan et al., 2017)
0.001	Waggitt et al. (2019) densities over SCANS-IV CS-F block (annual density)		
0.01-0.05	SCANS-III Modelled density ranges (Lacey et al., 2022)		
0.0326	**SCANS-IV CS-G (Gilles et al., 2023)**		
Density estimates taken forward for assessment are shown in **green**			

5.8.4. Diet and Foraging Behaviour

185. Long-finned pilot whale forage in deeper waters, off continental slopes, feeding on squid and fish (mainly mackerel and cod in UK waters), but may also feed on other species of fish, small octopus and shrimp (HWDT, 2025).

186. Santos et al. (2013) analysed the stomach contents of stranded pilot whales from Portugal, Galicia, and Scotland between 1990 and 2011 to assess dietary composition. The study found cephalopods to be the primary prey, predominantly from the families Octopodidae and Ommastrephidae. Regional variation was evident, with octopi species (*Eledone cirrhosa*) more common in Iberian samples, while ommastrephid squid dominated in Scotland. Multivariate analysis indicated both geographical and seasonal differences in diet. Overall, the findings confirm cephalopods as the main prey of pilot whales, with octopus replacing ommastrephid squid as the principal prey in the northeast Atlantic.

6. BASELINE REVIEW FOR MYSTICETES (BALEEN WHALES)

187. The baseline review for mysticetes (baleen whales) for this Project includes minke whale, fin whale and humpback whale. The baseline review provides a desk-based review on abundance and occurrence of each receptor in the study areas and results from the Project DAS and the data sources listed in **Section 5**.

188. The Combination of DAS and desk-based data; identifies density estimates (animals/km²) used for EIA **Chapter 10 Marine Mammals and Leatherback Turtle**.

6.1. MINKE WHALE

6.1.1. Desk-Based Review

189. Minke whale is a seasonal visitor to the region and can be sighted in the Study Area; in coastal waters around the Inner Hebrides between January and October with a peak between June and August, though minke whales are present in coastal UK waters year-round (Evans et al., 2011). During the autumn, minke distribution appears to shift offshore, potentially associated with breeding (Evans et al., 2011, Hagueet al., 2020).

190. The most recent assessment of minke whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019h, Hague et al., 2020).

191. WDC Shorewatch data confirm that minke whales are most frequently observed at sites in the Outer Hebrides and Inner Hebrides, with peak occurrence in summer months (June to August) (Rodríguez-Mendoza et al., 2025). These findings are consistent with wider research identifying the Minches and Sea of the Hebrides as important seasonal habitats for the species, particularly for feeding and breeding during the summer months (Evans and James, 2019; Hartny-Mills et al., 2024). The recurring peak in sightings between June and August across Shorewatch sites reflects established patterns in prey availability and migratory behaviour (Rodríguez-Mendoza et al., 2025).

192. The COMPASS project was the first attempt to describe the spatial distribution of minke whale vocalisations on the west coast of Scotland. Pulse trains produced by minke whale were analysed for data from five moorings in Scottish waters; deployed at Tolsta, Stoer Head, Shiant Isles, Hyskeir and Stanton Bank. Data used for the minke whale analysis were made on a total of 798 days (Tolsta: 139 days, Stoer Head: 154 days, Shiant Isles: 156 days, Hyskeir: 206 days, and Stanton Bank: 330 days). Most detection positive days were recorded at Stanton Bank (143 days). At Hyskeir in the Wider Study Area, five detection positive days were recorded. At both Tolsta and the Shiant Isles four detection positive days were recorded. No detections were made at Stoer Head. All recordings of minke whale were recorded in April and May. At Stanton Bank in the Wider Study Area, a clear diel pattern in acoustic detections with most vocalisations occurring during night and dusk/dawn hours (Gibson et al., 2020). This vocal activity can be related to social activity, or a display of fitness by vocal means at night, or foraging (Risch et al., 2013). With sandeels (*Ammodytes tobianus)* returning to their sediments at night (van der Kooij et al. 2008), minke whales may be forced to pause their feeding activity due to a lack of prey and visibility. In total minke whales were the most frequently observed and abundant baleen whale species, numbering approximately 12,000 in the summer and 5,000 in the winter. In addition, there were significant sightings of Minke whale calves (Gibson et al., 2020).

193. In the Wider Study Area during the ObSERVE surveys (Giralt Paradell et al., 2024), a total of 39 minke whales in 39 sightings were sighted in spring, summer and autumn (April to November). Most of the sightings were in continental shelf waters less than 200 m deep. No density estimates for minke whale was recorded in stratum SA6 (Giralt Paradell et al., 2024).

194. Data from the SWF from public sightings, (July to December 2022, March to December 2023 and January to September 2025) in the Inner Hebrides recorded at least 68 sightings (84) in 2022, at least 43 sightings (58) in 2023 and at least 154 sightings (287) in 2025 (SWF, 2025). In the Outer Hebrides, in 2022 at least 82 sightings (144) were recorded, at least 36 sightings (55) in 2023 and 162 sighting (257) in 2025 up until September (SWF, 2025).

195. The Interactive web map from ORCA (2006-2023) has recorded numerous sightings of minke whale within the Study Area and the Wider Study Area (**Plate 6.1**).

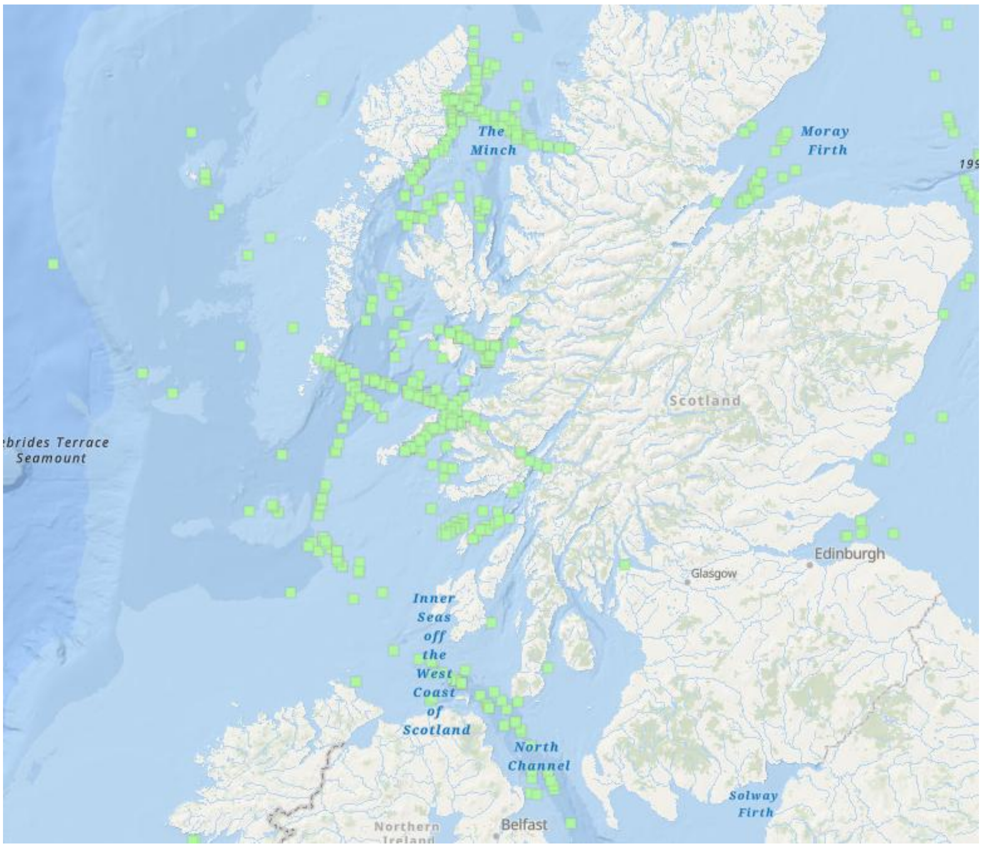


Plate 6.1 Minke whale sightings during surveys from 2006 to 2023 (ORCA, 2025)

196. The Atlantic Frontier surveys (Weir et al., 2001) in the Wider Study Area recorded minke whale as the most common mysticetes recorded in Scottish waters, with the majority (118 of 130) of sightings occurring in depths less than 200 m (Hague et al., 2020).

197. The IAMMWG have defined one MU for minke whale; the CGNS MU (**Plate 5.9**). The estimate of minke whale abundance in the CGNS MU is 10,288 (CV: 0.26, CI = 6,210– 17,042) (IAMMWG, 2023). This is the reference population for minke whale for use in the EIAR.

198. The JCP Phase III Report (Paxton et al., 2016) estimates there is between 0.02 to 0.1 minke whale per km^2 within the Study Area. SMFS (2020) estimated there to be density estimates of up to 0.05

individuals per km^2 in the Islay area, and up to 0.02 individuals per km^2 in the Sound of Islay area, with the highest densities in summer.

199. For minke whale, the distribution maps (developed by Waggitt et al., 2019) show a clear pattern of higher density in the west coasts of Scotland, in both the Study Area and Wider Study Area, the northeast coast of Ireland with decreasing densities southwards of Scotland along the west coast of England. There is a seasonal difference in the densities of minke whale, with higher densities in July, which is particularly evident in both the Study Area and Wider Study Area (**Plate 6.2**).

200. Interrogation of this data[2], including all 10 km 'grids' that overlap with the specified area, reveals a maximum density estimate of 0.015 individuals per km^2 (average of all overlapping 10 km 'grids') for the OAA and a maximum summer density of 0.01 individuals per km^2.

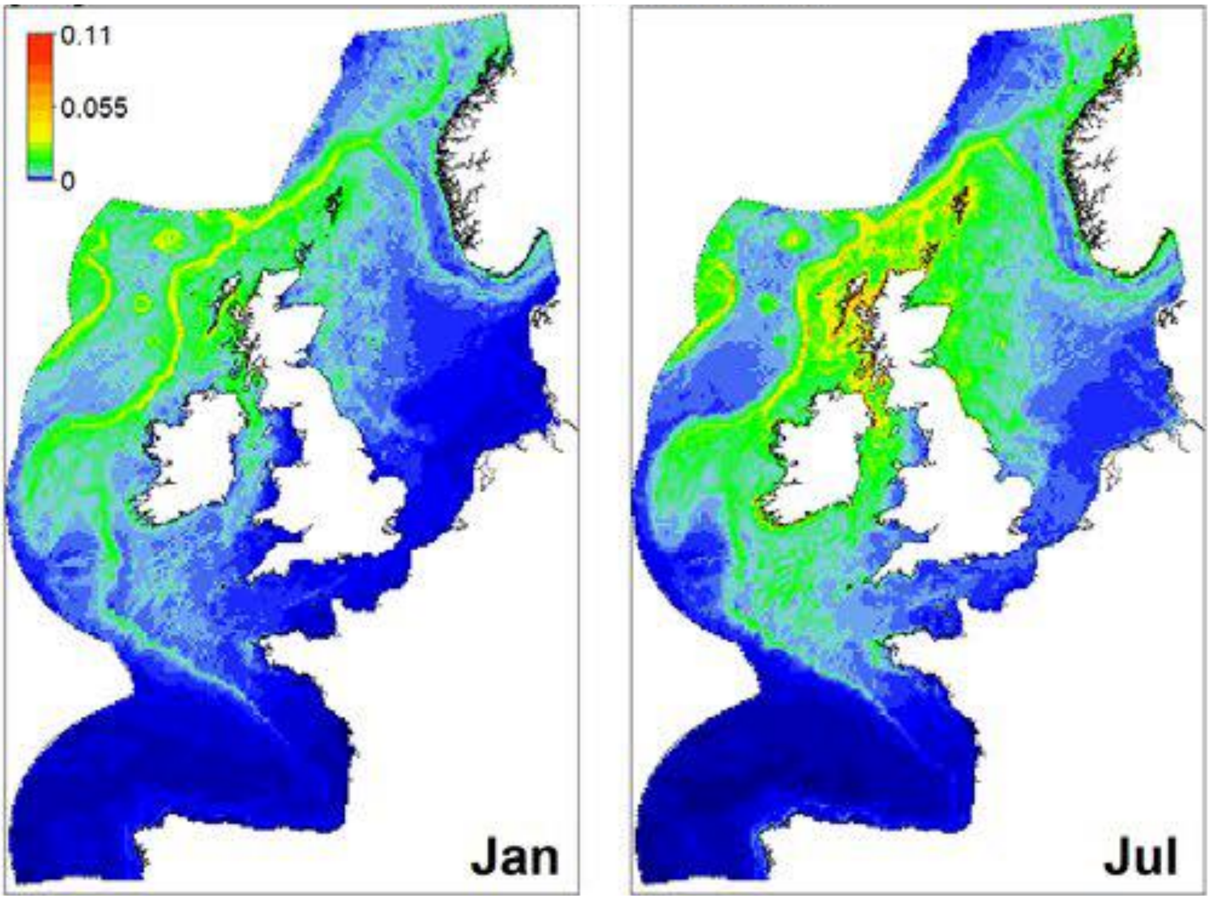


Plate 6.2 Spatial Variation in Predicted Densities, Individuals per km² of Minke Whale in January and July in the North-East Atlantic. Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

201. Paxton et al. (2014) collated survey data across Scotland's waters, from 1994-2012, to identify persistently high areas of marine mammal density. For minke whale in the Study Area, analysis of this data showed a density ranging from 0.2 to 2.0 individuals per km^2, for all seasons. This data was used to designate the Sea of the Hebrides NCMPA for minke whale. Further information on the Sea of the Hebrides NCMPA is provided in the **Report to Inform Marine Protected Area Assessment**.

202. Minke whale density range from the SCANS-III survey (summer 2016) was low to moderate (0.005 to 0.03 animals per km^2) west of the Hebrides with greater concentrations occurring further north and closer to the continental shelf edge (Lacey et al., 2022).

203. For the SCANS-IV survey, there are no abundance, or density estimates for minke whales in survey block CS-G, however there is a density estimate for block CS-F (**Plate 6.2**) (Gilles et al., 2023) which estimates:

- Abundance = 209 individuals (95% CI = 2-954); and
- Density = 0.0137/km^2 (CV=1.091).

6.1.2. Site-Specific Density Estimates for Minke Whale

204. Minke whale were recorded in 15 of the Project's DAS surveys during the months from March to November, with a total of 57 whales and a maximum density estimate of 0.05 minke whale per km^2. The average density across the 30 monthly surveys equates to 0.009 minke whale per km^2. Adding a correction factor of 0.12 to account for availability bias due to submerged individuals (Hedie-Jorgensen et al., 2010), the average annual density is 0.075 minke whale per km^2 in the OAA plus 4 km buffer. Based on written feedback from NatureScot received on 14 November 2025 in response to questions posed by the Applicant at ETG 2 on 15 October 2025 for harbour porpoise (**Section 5.1.2**), highest seasonal averages have been used to define worst-case density estimates. The highest densities were recorded in the summer months. Adding a correction factor of 0.12; the highest summer seasonal average equates to 0.21 minke whale per km^2.

6.1.3. Summary of Abundance and Density Estimates for Minke Whale

205. Due to the relatively high number of minke whale present in the OAA plus a 4 km buffer as recorded in the Project's DAS, this species has been scoped in for further assessment.

206. **Table 6.1** provides an initial summary of the density estimate and population estimates of minke whale. The highest density recorded is from Paxton et al. (2014), however, the Project's DAS density estimate for minke whale provides a precautionary yet realistic basis for the impact assessment. It reflects actual conditions within the WDA, aligns with regulatory guidance, and avoids the overestimation inherent in applying Paxton et al. (2014) broad-scale densities, which are not representative of the site.

207. In addition, EIAR guidance and recent literature emphasise using site-specific, contemporary data wherever possible for impact assessment. DAS meets this criterion, whereas Paxton et al. (2014) is considered secondary or supporting context (Marine Scotland, 2024).

208. Review of the DAS survey data showed that the highest monthly density estimate for minke whale was 0.05 individuals per km^2. When applying the correction factor of 0.12, this results in an adjusted density estimate of 0.416 minke whales per km^2. However, this value was considered overly precautionary and not ecologically realistic when compared with other density sources, such as SCANS.

209. Following the NatureScot recommended approach to be applied for harbour porpoise (**Section 5.1.2**), the highest summer seasonal average density using the DAS survey data has been used. The highest summer seasonal average density for the OAA plus the 4 km buffer is 0.21 minke whale per km^2; which is considered highly conservative when compared against the desk-based sources presented in **Table 6.1**.

Table 6.1 Summary of reference population and density estimates to inform the assessments on minke whale

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0.02-0.05	Paxton et al. (2016)	**UK: 10,288 (CGNS MU)** **Total: 20,118 (CGNS MU)**	IAMMWG (2023)
0.015	Waggitt et al. (2019)		
0.0137	SCANS-IV CS-F block (Gilles et al. 2023)		
0.027	SCANS-III G block (Hammond et al. 2021)		
0.005–0.03	SCANS-III Modelled density ranges (Lacey et al., 2022)		
0.2 – 2.0	Paxton et al. (2014)		
0.21	**Project DAS (highest summer average)**		
Density estimates taken forward for assessment are shown in **green**			

6.1.4. Diet and Foraging Behaviour

210. Minke whales feed on a variety of fish species, including herring, cod and haddock. Minke whale feed by engulfing large volumes of prey and water, which they then ‘sieve’ out of through their baleen plates and swallow their prey whole.

211. A study into the diet of minke whale in Scotland sampled a total of 110 minke whale for stomach contents from 1992 to 2002. Within this area, minke whale were found to prey upon a number of different species at the population level, however, their diet mainly comprised of sandeels (*Ammodytidae)* with around two thirds of the diet by weight comprised of herring and sprat (*Sprattus sprattus)* (Pierce et al., 2004). Results on minke whale diet were consistent with results from the North Sea, with 84% of individuals were found to prey upon only one species. Sandeels (56% of total prey by biomass) and mackerel (30% of total prey by biomass) were found to be the most dominant prey species for minke whale in the northern North Sea (Windsland et al. 2007).

6.2. FIN WHALE

6.2.1. Desk-Based Review

212. Fin whale are widely distributed throughout all major oceans. They are large pelagic dwellers but seem to favour shelf waters between temperate and polar regions (HWDT, 2025h) and have been recorded in coastal waters. Fin whale occurrence is rare in Scottish waters due to their preference for deeper waters over the continental shelf edge (Hague et al., 2020). Fin whales show seasonal migrations, spending the summer in polar regions and then moving south to winter in lower latitudes, and are likely to forage during migration (Lydersen et al., 2020). A portion of the population (particularly males) remains through the winter even in cold temperate regions such as Iceland, Ireland, and the British Isles (Lydersen et al., 2020). The Scottish Marine Atlas (Baxter et al., 2011) describes fin whale habitat as deep water (400-2,000 m) beyond the edge of the continental shelf, with a preference for banks, mounds and areas of upwelling and frontal zones.

213. Fin whales are not usually seen in groups near islands or coasts (in the Study Area) and are difficult to study, for instance due to their pelagic occurrence and large spatial movements, as well as harsh conditions for data collection at high latitudes. Clear migratory routes and wintering (breeding) grounds have not yet been identified. A recent tagging study in Svalbard found a portion of tagged individuals staying in the local area throughout autumn and early winter, while the rest moved in a south-westerly direction, with some travelling as far as the coast of northern Africa (Lydersen et al., 2020). The analysis showing the continental slope and nearby deep waters to be an important area for this species, possibly for feeding and/or migration.

214. Pike et al. (2019) observed an increase in fin whale numbers around the Faroe Islands and south of Iceland in recent years (*417 in 2007 to 11,000 in 2015*), compared to earlier surveys conducted by NAMMCO. It is speculated that this could be due to a northern incursion of fin whales into the area from the Spanish stock area, where both earlier and recent surveys found fin whales to be abundant (Buckland et al., 2001, Hammond et al., 2013, Hammond et al., 2021, Gilles et al., 2023).

215. In the Wider Study Area, while overall abundance over the entire NAMMCO survey area is not directly comparable due to varying coverage between surveys, the numbers reported by Pike et al. (2019) are the highest of any survey in the Central North Atlantic in recent years. This suggests either an increase in abundance in northern areas, a distributional shift, or a combination of both. A distributional shift is plausible, as Víkingsson et al. (2015) demonstrated that fin whales increased both in abundance and altered their distribution patterns within the NAMMCO survey area between 1987 and 2007. This change was associated with an increase in sea surface temperature and changes in ocean currents and circulation, likely affecting prey availability, particularly in the western part of the NAMMCO area.

216. It appears that this pattern may be continuing, allowing this species to expand its range and numbers in the Central North Atlantic. Surveys in the southeastern part of the North Atlantic (i.e. SCANS and CODA), including the most recent one conducted in 2022, have not shown any corresponding decrease in fin whale numbers further south (Sanpera and Jover 1989, Buckland et al., 2001, Hammond et al., 2021, Gilles et al., 2023). This suggests an overall increase in fin whale abundance in the wider North Atlantic area. Recent estimates of fin whale abundance in the Norwegian survey area to the east and north of Iceland and the Faroes suggest numbers in the low thousands (Øien, 2009), (Leonard and Øien, 2019a;b;c;d).

217. During the ObSERVE surveys (Giralt Paradell et al., 2024) in the Wider Study Area, there were 15 sightings comprising 15 individuals. Fin whales were exclusively seen in deeper waters, greater than 500 m, beyond the continental slope, particularly in the Porcupine Basin.

218. Data from the SWF from public sightings, (July to December 2022, March to December 2023 and January to September 2025) in the Inner Hebrides recorded at least three sightings (4) in 2023. In the Outer Hebrides, in 2022 at least 13 sightings (17) were recorded, at least six sightings (six) in 2023 and 12 sightings (14) in 2025 up until September (SWF, 2025).

219. The Interactive web map from ORCA (2006-2023) recorded 15 sightings of fin whale within the Wider Study Area.

220. The most recent assessment of fin whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019i).

221. There were no fin whales recorded in the SCANS-IV or SCAN-III survey within the survey block CS-F or any of the adjacent blocks.

222. Fin whale density range from the SCANS-III survey (summer 2016) was low to moderate (<0.005 to 0.02 animals per km^2), in offshore waters west of Scotland and the Outer Hebrides (Lacey et al., 2022).

223. The species distribution maps presented by Waggitt et al. (2019) documented very low densities of fin whale in the Study Area, with a slight increase in density in the Wider Study Area far offshore of north-western Scotland during the summer months (**Plate 6.3**).

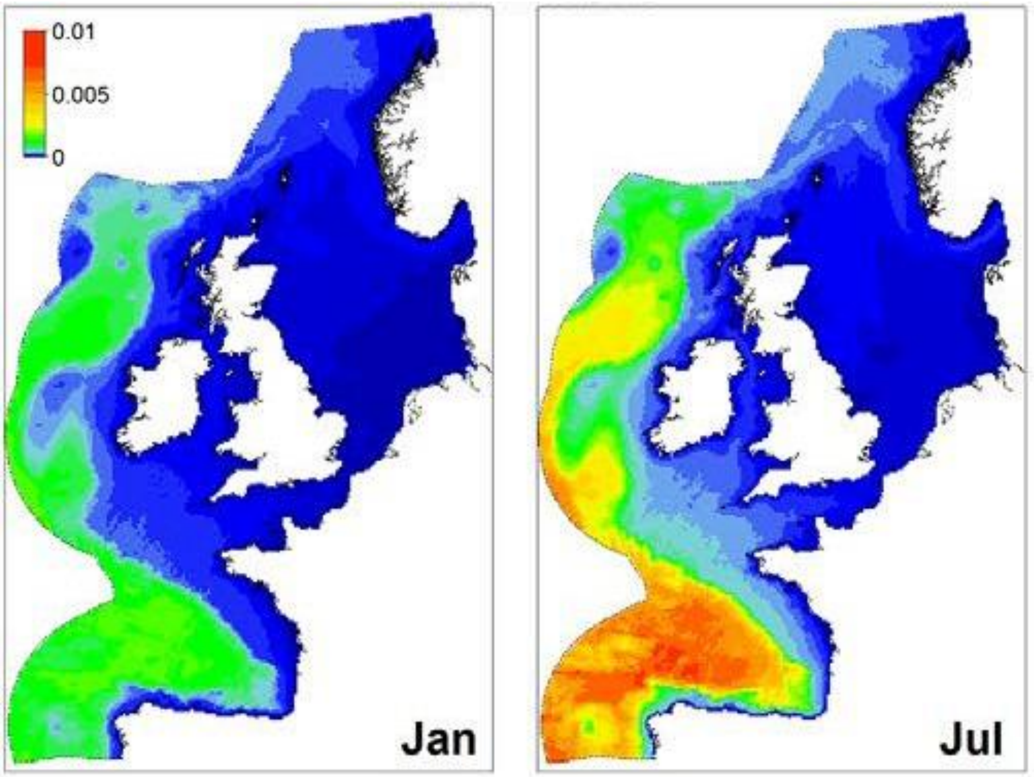


Plate 6.3 Spatial Variation in Predicted Densities (Individuals (per km^2) of Fin whale in January and July in the NE Atlantic). Values are Provided at 10 km Resolution. Source: Waggitt et al., 2019

224. The total fin whale population in the North Atlantic is estimated at 35,000 to 50,000; numbers were significantly reduced by whaling activities during the 20th Century. The most appropriate value for UK waters is 3,330 individuals with a lower value of 1,927 and an upper value of 5,753, which is the first reliable abundance estimate following a dedicated survey covering UK waters for this species (JNCC, 2019i). The JNCC estimated abundance of 3,330 is used in the assessment **Chapter 10 Marine Mammals and Leatherback Turtle**.

6.2.2. Site-Specific Density Estimates for Fin Whale

225. No fin whales were recorded in the Project's DAS. However, in the Project's geophysical survey in 2025, in May, a single fin whale was recorded in the WDA.

6.2.3. Summary of Abundance and Density Estimates for Fin Whale

226. As a single fin whale has been recorded within the WDA, this species has been scoped into the assessment. As there were no density estimates recorded from the DAS, or from any of the SCANS surveys, density estimates have been derived from Waggitt et al (2019). Interrogation of this data[2],

including all 10 km ‘grids’ that overlap with the SCANS-IV CS-F survey block is used in **Chapter 10 Marine Mammals and Leatherback Turtle** (**Table 6.2**).

Table 6.2 Summary of reference population and density estimates to inform the assessments on fin whale

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0.0001	Waggitt et al. (2019)	**3,330 (Northeast Atlantic)**	(JNCC, 2019)
0.002	**Waggitt et al. (2019) densities over SCANS-IV CS-F block (annual density)**		
<0.005 -0.02	SCANS-III Modelled density ranges (Lacey et al., 2022)		
Density estimates taken forward for assessment are shown in **green**			

6.2.4. Diet and Foraging Behaviour

227. The fin whale is a pelagic feeder. Its diet consists mainly of planktonic crustaceans (particularly *euphausiids*) as well as small fish such as herring, mackerel and cod, squid, as well as krill, with a variation in diet probably between areas and seasons (HWDT, 2025h).

228. Fin whales are choosing to return to the waters around the Hebrides each year to feed, however it is unknown what prey species are enticing them inshore. Research efforts, including community-led projects involving whale-watchers and scientists, have focused on analysing whale faeces to better understand their diet. These studies have revealed evidence that the whales are feeding on krill. However, the exact proportions of krill versus fishlike herring in their diet are still being investigated through stable isotope analysis of samples collected in the region (Paterson, 2025).

6.3. HUMPBACK WHALE

6.3.1. Desk-Based Review

229. Humpback whale numbers were severely depleted by commercial whaling in the 20th Century but now populations are beginning to recover globally and are widely distributed throughout the world’s oceans. Humpback whales were considered rare in Scottish waters and have occasionally been recorded in the Study Area, however sightings are becoming more frequent all around the UK coast.

230. Humpback whale undertake seasonal migrations between tropical breeding grounds (winter) and high latitude feeding grounds (summer) (Whitehead and Rendell, 2014). In recent years there has been an increase in sightings in the Northeast Atlantic although there is a lack of dedicated data in this area and it is not known what the whales are using the area for.

231. Humpback whale sightings were relatively infrequent in the WDC Shorewatch data, though regional patterns indicate emerging presence in the Outer Hebrides and potentially the West Highlands, with a seasonal peak in December (Rodríguez-Mendoza et al., 2025). Their winter occurrence may reflect changing prey availability or a return to historically used habitats, as indicated by early 20th-century whaling records (Ryan et al., 2022). Recent increases in humpback whale visits to Scottish waters exceed what would be expected from population recovery alone, suggesting a distributional shift, and this trend coincides with rising entanglement incidents in static fishing gear (Leaper et al., 2022), highlighting the need for continued monitoring.

232. Acoustic recordings from the COMPASS project were collected in the Wider Study Area at Tolsta and Stanton Bank between November 2017 and February 2019, spanning 648 days. Humpback whales were detected in the Wider Study Area on 43 days at Stanton Bank and 16 days at Tolsta. The timing and duration suggested this area is a migratory stopover for humpback whales on northbound migration, as humpback whales were detected continuously for 10-12 days at both sites at the end of March which could indicate that they are remaining in the area for longer periods rather than quickly passing through (Gibson et al., 2020).

233. Data from the SWF from public sightings, (July to December 2022, March to December 2023 and January to September 2025) recorded at least one sighting in 2022 and 2025 up until early September and two sightings in 2023 in the Inner Hebrides. In the Outer Hebrides, in 2022 at least four sightings (5) were recorded, at least eight sightings (22) in 2023 and 22 sightings (24) in 2025 up until September (SWF, 2025).

234. The Interactive web map from, ORCA (2006-2023) has recorded 20 sightings of humpback whale within the Study Area and the Wider Study Area.

235. There were no sightings of humpback whales in any if the SCANS surveys, and humpback whale were also not included in the data collation or modelling of abundance or species distribution presented by either Paxton et al. (2016); Waggitt et al. (2019), or Waggitt et al. (2020).

236. The most recent assessment of humpback whales in UK waters concluded that the overall trend in Conservation Status was Unknown, highlighting that there was insufficient data to establish a trend for the population size nor potential future prospects for the population (JNCC 2019j, Hague et al., 2020).

237. The humpback whale population was estimated in 2001 for the British Isles, Norwegian Sea and Barents Sea, with an estimate of 1,450 (CV 0.29); (Øien et al., 2009). The population estimate for Norway, Greenland, Faroes and Jan Mayen was estimated in 2015, with an abundance of 10,031 (CV 0.36) (Pike et al., 2018). For both populations together, the estimate would be around 15,000 humpback whale (CV 0.25) (NAMMCO, 2023c).

6.3.2. Site-Specific Density Estimates for Humpback Whale

238. No humpback whale were recorded in the Project's DAS.

6.3.3. Summary of Abundance and Density Estimates for Humpback Whale

239. The initial desk-based review of humpback whales indicated there would be a relatively low presence within the OAA. However, more sightings of humpback whale have been recorded along the west coast of Scotland. The Scottish Humpback ID Project confirms that 100 individual humpback whales have now been catalogued in Scotland, with around ten new individuals added each year in recent seasons (Scottish Humpback ID Project, 2024). Many matches link Hebridean sightings to Icelandic feeding grounds (HWDT, 2022). Although sightings are steadily increasing in the Hebrides, the number of humpback whales is still considered low in absolute terms (Ryan, et al., 2016; HWDT, 2024; Scottish Humpback ID Project, 2024).

240. Therefore, humpback whale has been scoped in for further assessment. Due to a lack of information on an appropriate population estimate for Scottish (or UK) waters on which to base an assessment, only qualitative assessments are undertaken for this species. A density estimate from HWDT data for Scottish inshore waters was derived by using sightings data from Silurian surveys. Based on Silurian data, there would be 0.015 individuals per 1,000 km^2. This would correspond to an average of 1.4 humpback whales present at any one time in Scottish inshore waters (Territorial Sea

measuring 90,404 km^2 in area). However, this data was used to estimate entanglements of humpback whales, not abundance.

241. As there is no density estimates for humpback whale, this species will be assessed qualitatively in **Chapter 10 Marine Mammals and Leatherback Turtle** as recommended by NatureScot in the Scoping Opinion.

6.3.4. Diet and Foraging Behaviour

242. There is limited data on the diet of humpback whale along the west coast of Scotland. It was thought that humpback whales do not feed during migration, however humpback whales were recorded feeding during their southward migration along the coast of southeastern New South Wales, Australia, feeding on schools of small pelagic fish as well as the coastal krill species (*Nyctiphanes australis)* (Stamation et al., 2007).

243. In the North Atlantic, humpback whale primarily feed on krill (euphausiids) and small schooling fish such as mackerel, capelin, Atlantic herring and sandeels (Heide-Jørgensen and Laidre, 2007, Heide-Jørgensen et al., 2007, Magnusdóttir et al. 2014). They have been known to aggregate in areas with strong currents and upwelling where prey has naturally occurred or have been observed to create a bubble-net feeding (whale exhales to create a ring of bubbles underwater) to capture small prey species such as herring and krill. Both methods require a social formation. In addition, humpback whale are capable of foraging alone, using ‘lunge feeding’ (Simon et al. 2012).

7. BASELINE REVIEW FOR PINNIPEDS

244. The baseline review for pinnipeds, grey and harbour seal, provides a desk-based review on abundance and occurrence of each receptor in the study areas and results from the Project DAS. Data sources include:

- SCOS annual reporting of scientific advice on matters related to the management of seal populations (e.g. SCOS, 2024).
- Seals at-sea relative density maps (Carter et al., 2022, Carter et al., 2025).
- Seal telemetry data (Sharples et al., 2008; Russel and McConnell, 2014).
- NatureScot Research Report 1256- Aerial surveys of seals in Scotland (Morris et al., 2021).
- Marine Protected seal haul-out resources (Marien Scotland 2010).

245. The Combination of DAS and desk-based data; identifies density estimates (animals/km²) used for EIA **Chapter 10 Marine Mammals and Leatherback Turtle**.

7.1. GREY SEAL

7.1.1. Desk-Based Review

246. Grey seals only occur in the North Atlantic, Barents and Baltic Sea, with their main concentrations on the east coast of Canada and the United States, and in north-west Europe (SCOS, 2024).

247. Approximately 36% of the world's grey seals breed in the UK, and 81% of these breed at colonies in Scotland with the main concentrations in the Wider Study Area. Grey seals are wide ranging and can breed and forage in different areas (Russell and McConnell., 2014). Maximum foraging ranges for grey seal has been recorded to be up to 448 km (Carter et al., 2022) and studies from Russell (2016) have shown that grey seals will utilise and travel between different haul-out sites.

248. Global Positioning System (GPS) tracking data from tagged grey seal indicate there is the potential for presence throughout both study areas. Carter et al (2025) provides a map of grey seal trips to and from haul outs in Scotland (the tagging data was cleaned to remove data during the grey seal breeding season) including data from seals tagged across the UK, Ireland, and France. The underlying data (see Carter et al., 2022) was updated with additional tracking data and is now based on 169 grey seals, compared to an initial 114 grey seals in Carter et al. (2022). The tracking data indicates that the tagged grey seals that hauled out along the coastal area of west Scotland are using the Study Area where the WDA is located (**Plate 7.1**).

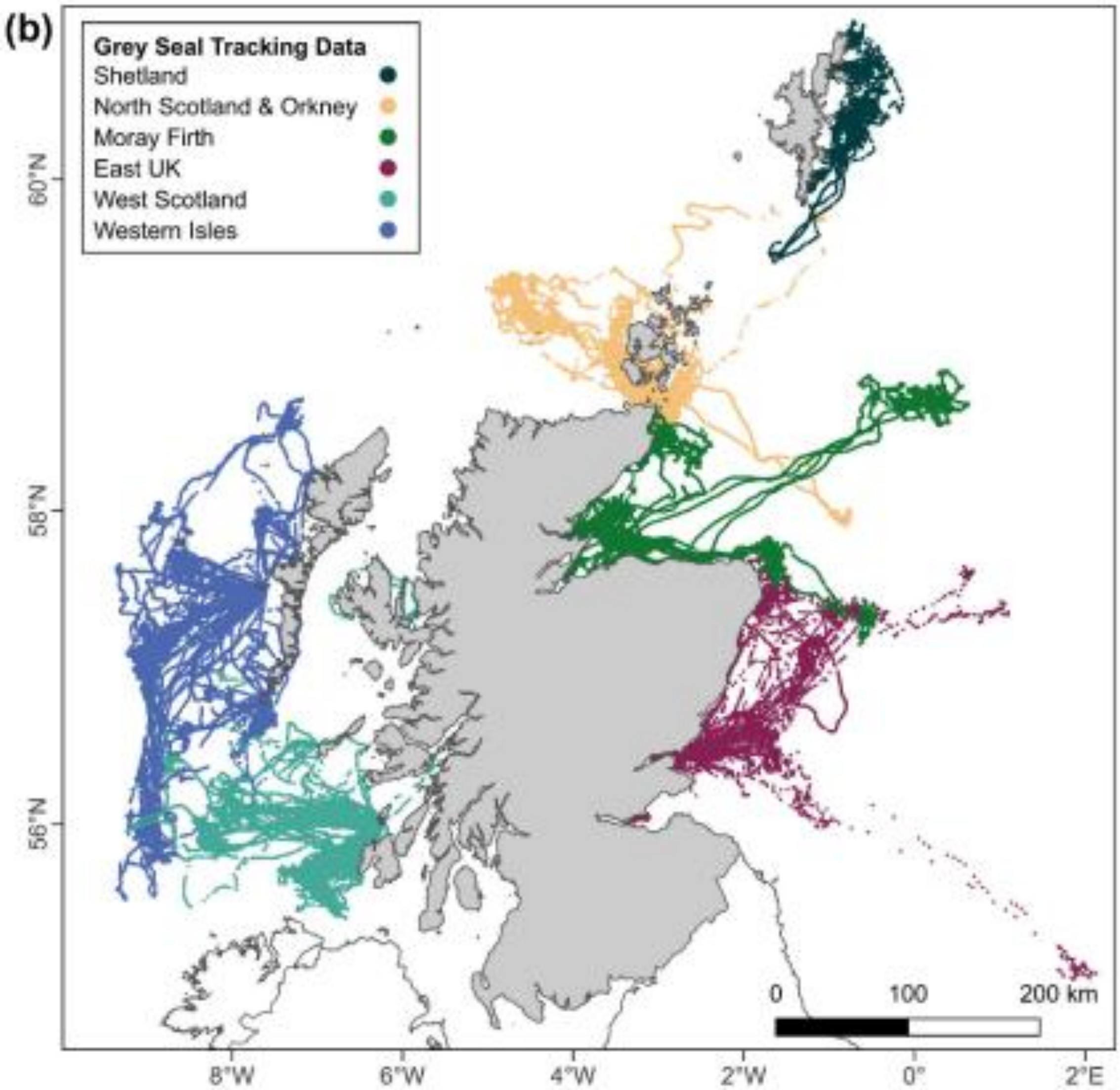


Plate 7.1 Tracking Data for Grey Seals (n=169) Hauling out in Scotland (Carter et al., 2025)

249. Carter et al. (2022) provides a map of grey seal trips to and from haul outs in the Inner Hebrides having connection with the Outer Hebrides, and the RoI, with limited connection with south-west Scotland, England, or Northern Ireland waters (**Plate 7.2**).

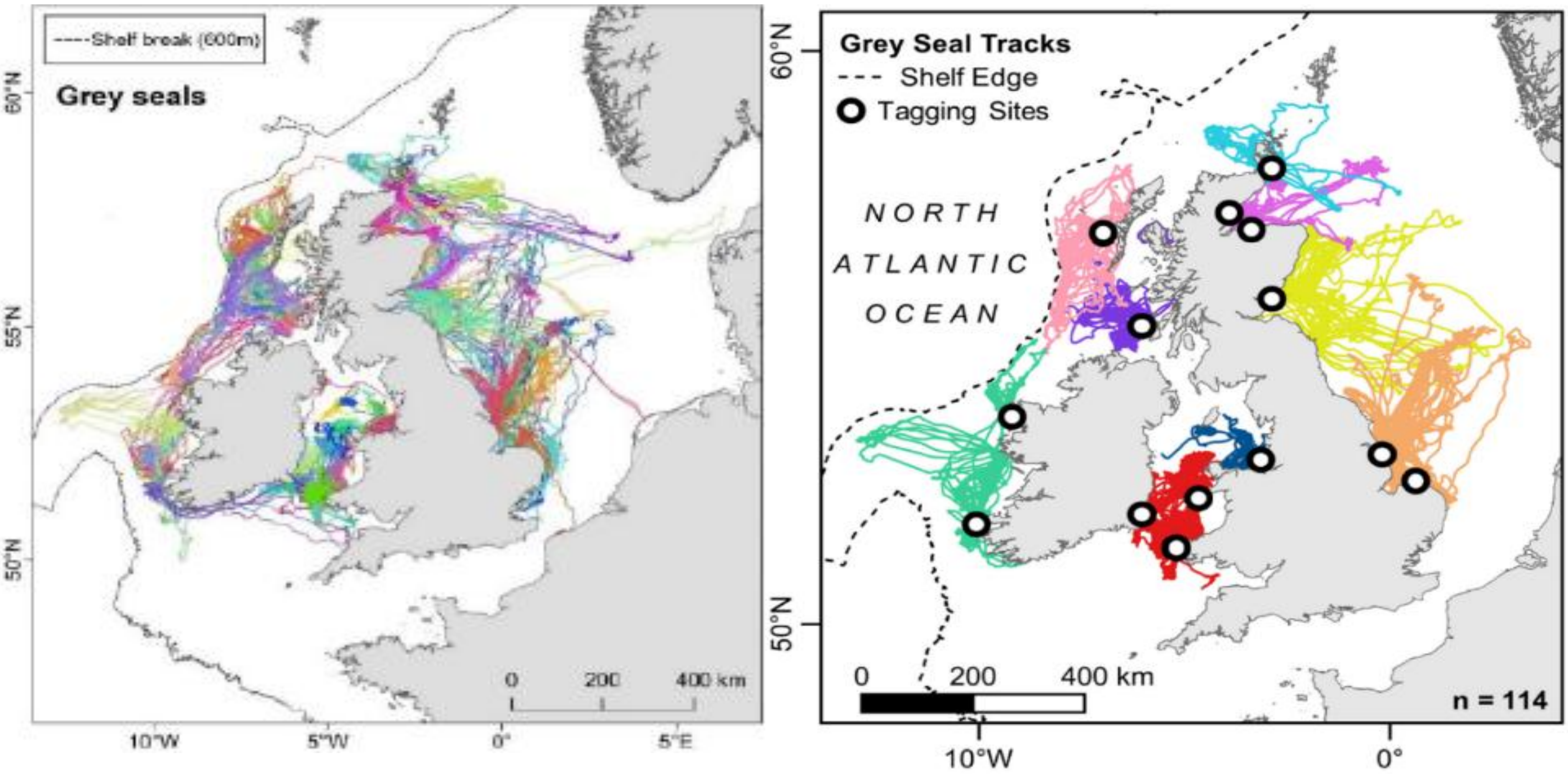


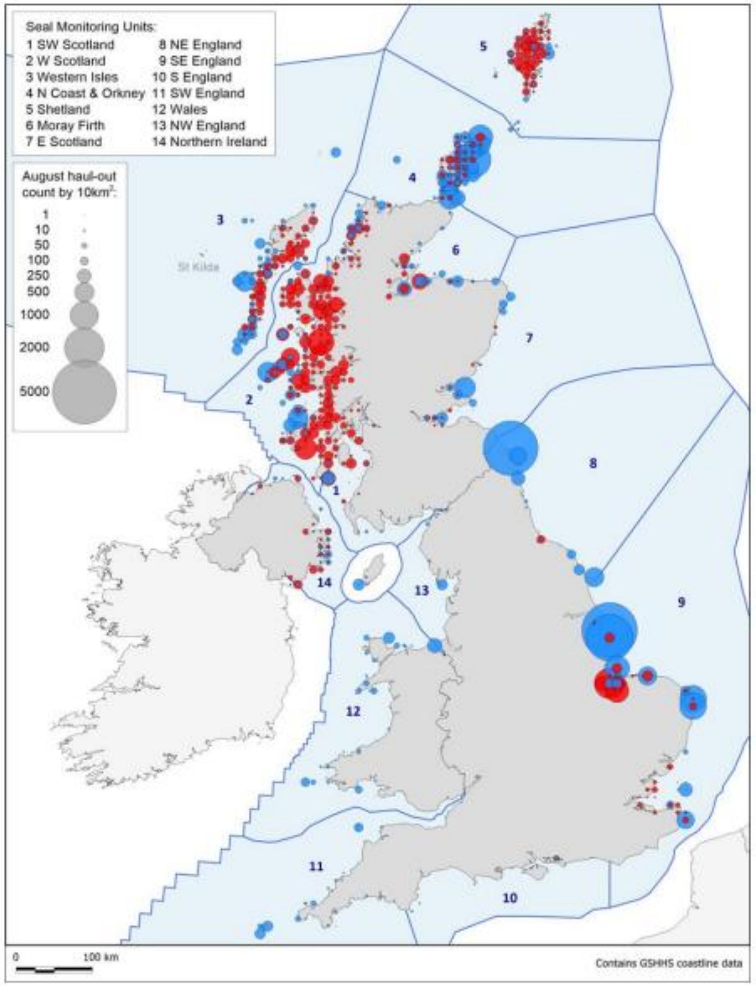
Plate 7.2 GPS tracking data for grey seal, n=114, Carter et al., 2020; Right = GPS tracking data for grey seal, cleaned to remove erroneous location estimates, and trips between regions during the breeding season, n=114, Carter et al., 2022

250. In the UK, there are 14 seal MUs (**Plate 7.3**), as well as five regions in the RoI. The Study Area is within the West Scotland MU, which is the primary MU used to inform the assessment. It is proposed to also include the Western Isles, south-west Scotland, Northern Ireland, and RoI as a wider population reference to account for grey seal moving in the wider area.

251. **Table 7.1** provides the latest grey seal counts within the relevant areas, as well as the corrected population numbers. To generate an abundance estimate for seals, it is necessary to take account of those individuals that were not available to count during the August counts, therefore, a correction factor is applied to the counts to generate a population estimate. The correction factor for grey seal is 0.2515 (Russell et al*.,* 2021).

252. Impacts on grey seal in the EIAR are assessed based on:

- West Scotland MU population; and
- The wider population which includes the West Scotland, Southwest Scotland, Western Isles and NI MUs, with the RoI.



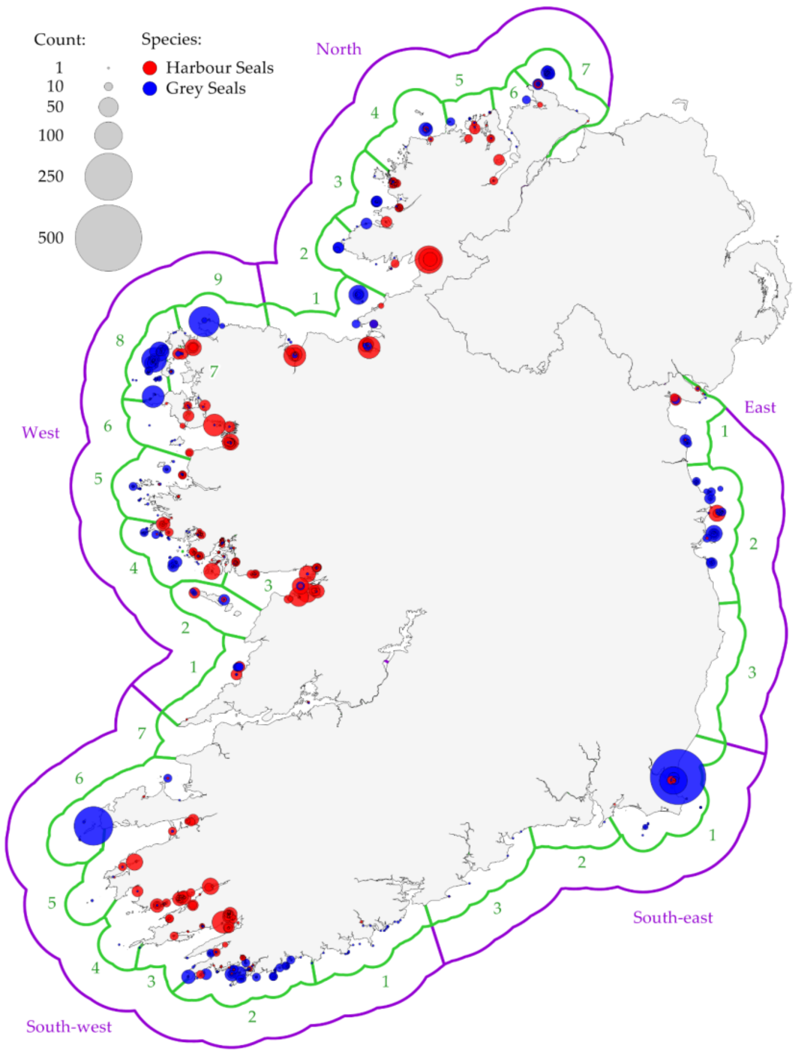


Plate 7.3 Seal Management Units for the UK coast, SCOS, 2024; Right = Republic of Ireland regions, Morris and Duck 2019

Table 7.1 Grey seal population count estimates

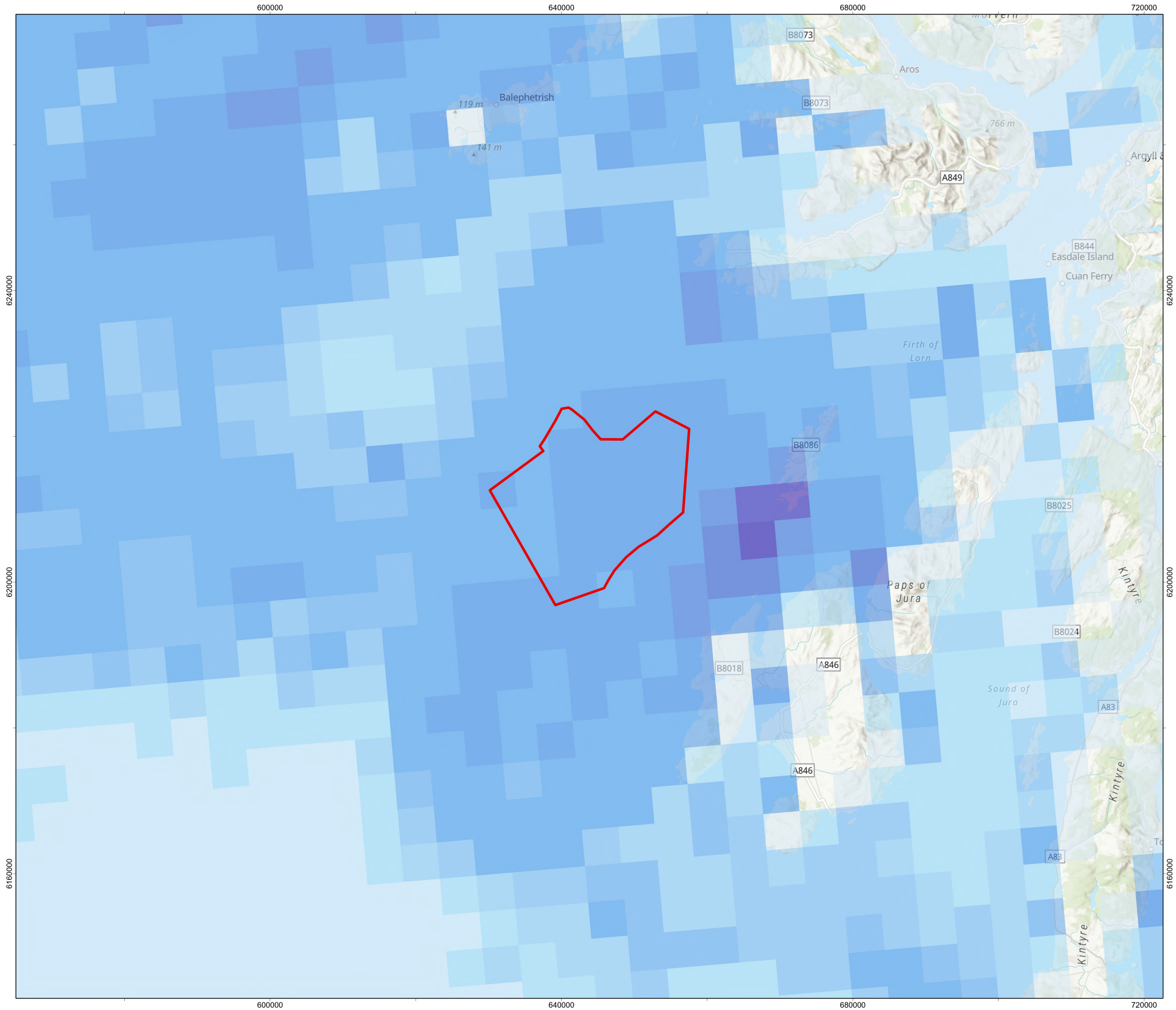
MU / Region	Grey seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Grey seal total population
West Scotland	4,388	SCOS, 2024	0.2515	17,447
Southwest Scotland	517	SCOS, 2024	0.2515	2,056
Western Isles	3,473			13,809
NI	549			2,183
RoI total	3,698	Morris and Duck, 2019		14,704
Total wider reference population	12,625	-	-	50,199
Key	Reference populations taken forward for assessment are shown in green			

253. For density estimates of grey seal, Carter et al. (2025) provides habitat-based predictions of at sea distribution for seals in the Study Area. The habitat preference distribution maps provide absolute density estimates per species, on a 5 km by 5 km grid of relative at sea density for seals hauling-out in the British Isles. It is important to note that Carter et al. (2022) provides relative density (i.e. percentage of the total at sea population in each grid at any one time).

254. The grey seal relative density map (**Plate 7.4**) shows the mean predicted relative density for both the Study Area and the Wider Study Area is relatively high for the UK and the RoI, with areas of increased densities close to the Isle of Jura, Colonsay and Islay, where there are a number of grey seal haul-out sites.

255. The grey seal absolute density estimates for the OAA plus 4 km buffer have been calculated from the seal at-sea usage maps (Carter et al., 2025) based on the 5 km by 5 km grids that overlap with the OAA plus 4 km buffer and are corrected against the total UK and the RoI population estimates. The total grey seal population in the British Isles is 173,360 (**Table 7.1**; SCOS, 2024). This total population estimate is corrected to determine the total number of individuals that may be at-sea at any time, using a correction factor of 0.8616 for grey seal (Russell et al., 2015). There are therefore approximately 159,367 grey seals at sea at any one time, based on the corrected values and most recent haul-out counts for the UK. This is the at-sea population estimate used with the Carter et al. (2022) data to calculate density estimates.

256. Based on the Carter et al. (2025) data, the absolute density across the OAA plus 4 km buffer is 0.88 grey seal per km^2 (**Figure 7.1**).



Windfarm Development Area

Grey Seal Relative Density (Mean) (% per 25km²)

- 0 - 0.002
- 0.0021 - 0.004
- 0.0041 - 0.006
- 0.0061 - 0.008
- 0.0081 - 0.01
- 0.011 - 0.02
- 0.021 - 0.04
- 0.041 - 0.06
- 0.061 - 0.08
- 0.11 - 0.2
- 0.21 - 0.75

N

0 5 10 20 Kilometres

1	13/11/2025	FC	GC	SB	PM
REV	REV DATE	GIS CREATOR	GIS REVIEWER	TECHNICAL CHECKER	TECHNICAL APPROVER

DRAWING NUMBER	MCW-DWF-ENV-MAP-RHS-000131		
DATUM	ETRS89	PROJECTION	UTM Zone 29N
SCALE	1:500,000	PAGE SIZE	A3
PROJECT TITLE	MachairWind		

Figure 7.1: Grey Seal Density over Windfarm Development Area using Carter Density (2025)

NOT TO BE USED FOR NAVIGATION

Haskoning Enhancing Society Together

ScottishPower Renewables

Project: C:\Users\304634\OneDrive - Royal HaskoningDHV\WIP\03 GIS\A02_Figures\03_EIA\01_WDA\Chap_10_MarineMammals\Appx_10-2_LeatherbackTurtle\MCW_EIA_WDA_LeatherbackTurtle.aprx
Name: Fig_7-1_MCW-DWF-ENV-MAP-RHS-000131_GreySealDensity_CarterDensity2025

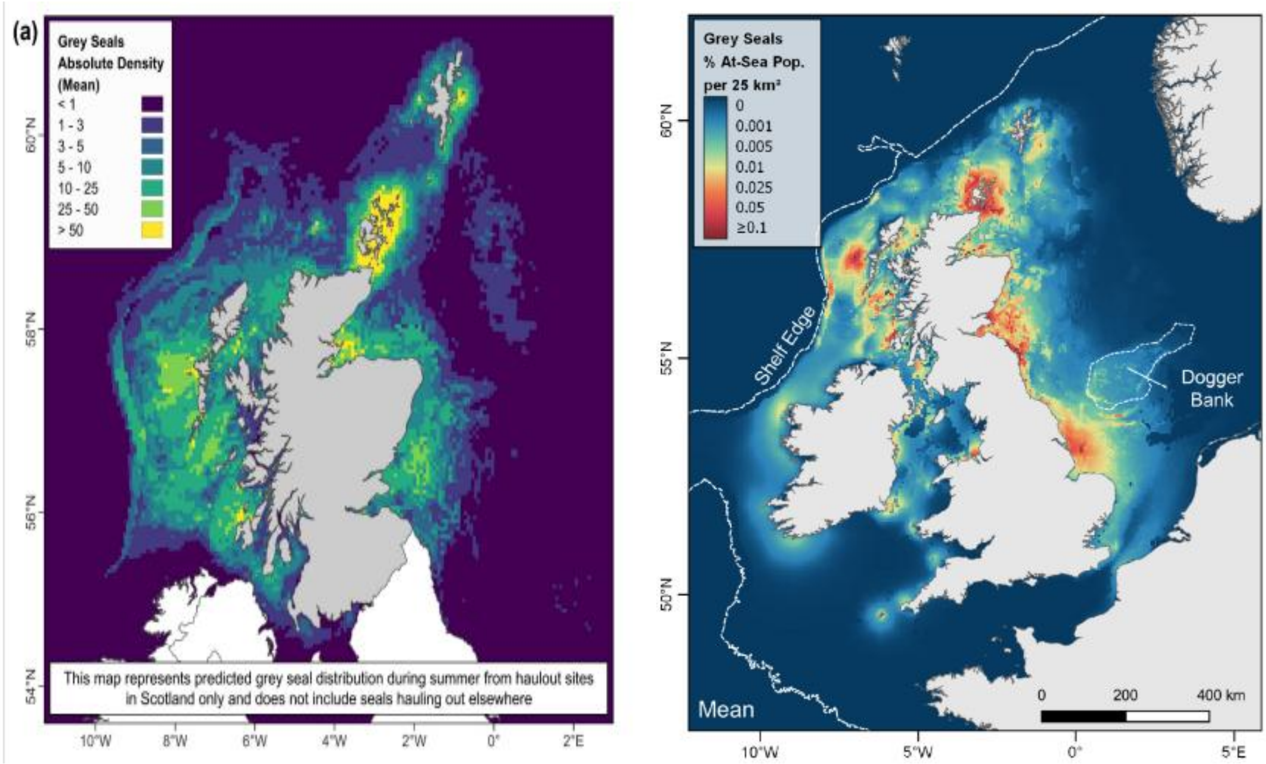


Plate 7.4 At-sea distribution of grey seals; maps show mean percentage of at-sea population estimated to be present in each 5 km x 5 km grid cell at any one time, (Carter et al., 2025 on left and Carter et al 2022 on right to represent the NI and ROI populations

7.1.2. Site-Specific Density Estimates for Grey Seal

257. During the Project's DAS, grey seal were recorded in 27 of the 30 surveys, with a total of 165 individuals recorded resulting in an average density estimate of 0.036 grey seal per km^2. Adding a correction factor to account for diving species, the average density estimates equate to 0.132 grey seal per km^2 in the OAA plus 4 km buffer.

7.1.3. Summary of Abundance and Density Estimates for Grey seal

258. **Table 7.2** provides an initial summary of the density estimate and population estimates of grey seal for the OAA plus a 4 km buffer from the Project's DAS and from Carter et al., 2022; 2025. Density estimates from Carter et al (2025) for the OAA plus 4 km buffer is the most precautionary and is used in **Chapter 10 Marine Mammals and Leatherback Turtle**.

Table 7.2 Summary of grey seal reference population and density estimates to inform the assessments

Density (individuals / km^2)	Density data source	Reference population	Reference population data source
0.88	**Carter et al. (2025)**	**WS MU: 17,447** **Wider population: 50,199**	SCOS (2024)
0.81	Carter et al. (2022)		
0.132	Project DAS (grey seal and apportioned seal species data)		
Density estimates taken forward for assessment are shown in **green**			

7.1.4. Grey Seal Protected Haul-Out Sites

Protected seal haul-out sites are coastal locations that seals use to breed, moult and rest. Almost 200 seal haul-out sites have been designated through The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014 which was amended with additional sites in 2017. These haul-out sites are protected under Section 117 of the Marine (Scotland) Act 2010. The Act is designed to assist in protecting the seals when they are at their most vulnerable, and as such provide additional protection from intentional or reckless harassment.

259. There are a number of haul-out sites for grey seal in the Study Area, close to the WDA and in the Wider Study Area (**Plate 7.5**). The nearest major grey seal protected seal haul-out sites are on the Islands of Colonsay, Islay, Jura, the west coast of Mull, Tiree and Coll. **Table 7.3** below provides the latest data from 2019 from surveys of principal breeding sites, including those in the Inner Hebrides, where available. Due to the number and location of the known seal haul out sites, disturbance at protected seal haul-out sites is assessed in the EIAR.

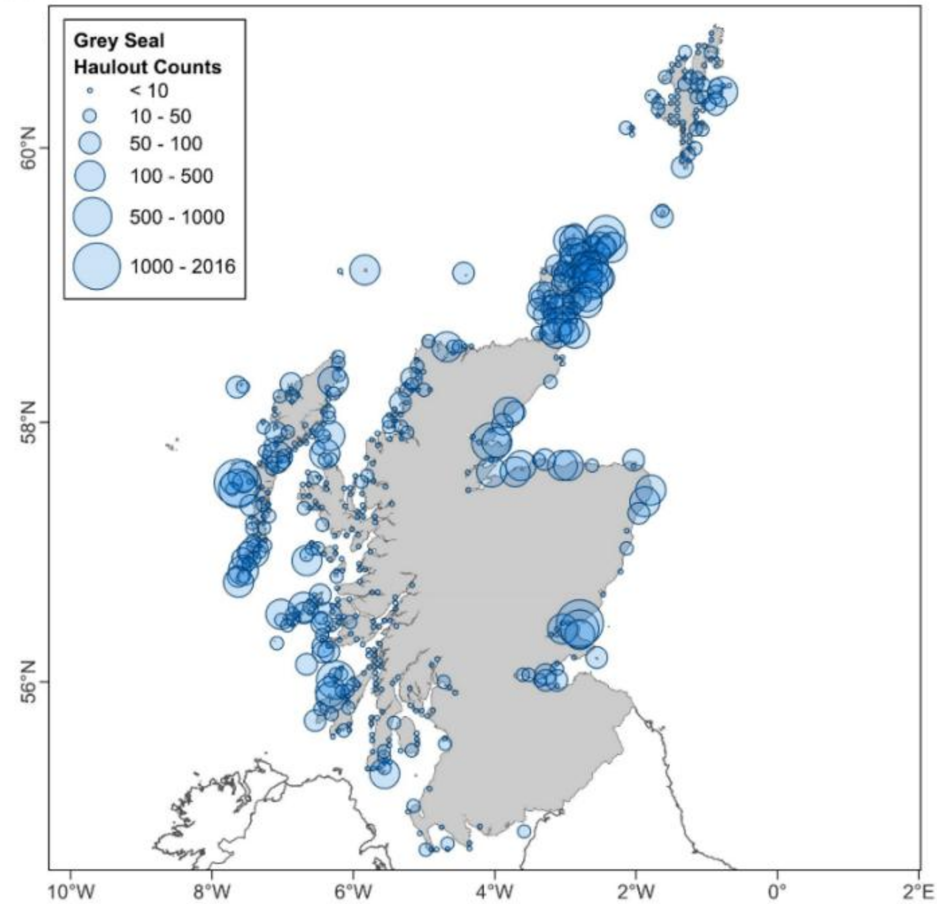


Plate 7.5 Grey seal haul-outs sites, and latest counts, in Scotland During August Surveys Between 2011-2023 (Carter et al., 2025)

Table 7.3 Grey seal haul-out sites

Site	Approximate distance to the WDA (km)	Grey seal count	Source
Oronsay	12.5	50+ pup production in 2012	SCOS (2019)
South Oronsay	13	-	-
Nave Island	15.5	-	-
Soa, Mull	18	20+ pup production (2012)	SCOS (2019)
Outer Loch Tarbert	31.5	-	-
Treshnish Isles	40	160	-
Gunna	48	500+ pup production	SCOS (2019)
Friesland bay	50.5	-	
Arinthluic	52	2% of grey seal management area's population	SCOS (2019)
Hough Skerries	53	19% of grey seal management area's population	SCOS (2019)
Craighase small Isle and lowland mans	58	Pupping site	SCOS (2019)
Cains of Coll	58	Pupping site 2% of grey seal management area's population	SCOS (2019)
Sanda and Sheep Island	99	resting, moulting, and breeding. Likely pupping	Marine Scotland (2010)
Rubhan nan sgarbh	130	<5% South-West Scotland MU population	Marine Scotland (2010)
Sand of Pladda Skernes	133	Not directly listed; likely low to moderate	SCOS, (2024)
Lady Isle	191	No information, potentially a resting/moulting site	-
Litle Scares	211	No information, potentially a resting/moulting site	-
Solway Firth Outer Sandbach	279	No information, potentially a resting/moulting site	-

7.1.5. Diet and Foraging Behaviour

260. Grey seal will typically forage in the open sea and return regularly to land to haul-out, although they may frequently travel up to 100 km between haul-out sites. Foraging trips generally occur within 100 km of their haul-out sites, 50 km during the breeding/pupping season although grey seal can travel up to several hundred kilometres offshore to forage (SCOS, 2024).

261. Individual grey seal based at a specific haul-out site often make repeated trips to the same region offshore but will occasionally move to a new haul-out site and begin foraging in a new region (SCOS, 2019). Telemetry studies of grey seal in the UK have identified a highly heterogeneous spatial distribution with a small number of offshore ‘hot spots’ continually utilised (Matthiopoulos et al., 2004; Russell et al., 2017).

262. Grey seals are generalist feeders, feeding on a wide variety of prey species (SCOS, 2024; Hammond and Grellier 2006). Diet varies seasonally and from region to region (SCOS, 2024).

263. In the Hebrides, principal prey items are sandeel, whitefish (such as cod, haddock, whiting and ling (*Molva molva*) and flatfish (plaice (*Pleuronectes platessa)*, sole, flounder, and dab (*Limanda limanda)* (Hammond and Grellier, 2006) and cephalopods. Amongst these, sandeels are typically the predominant prey species.

264. Food requirements depend on the size of the seal and fat content (oiliness) of the prey, but an average consumption estimate of an adult is 4 to 7 kg per seal per day depending on the prey species (SCOS, 2023).

7.2. HARBOUR SEAL

7.2.1. Desk-Based Review

265. Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one subspecies *Phoca vitulina* (SCOS, 2023). Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and the Northern Isles.

266. Carter et al. (2025) provides a map of harbour seal trips to and from haul outs in both the Study Area and the Wider Study Area (**Plate 7.6**) (the tagging data was cleaned to remove data during the grey seal breeding season) including data from seals tagged across the UK, Ireland, and France. The underlying data (see Carter et al., 2022) was updated with additional tracking data and is now based on 222 harbour seals, Carter et al. (2025). The tracking data indicates that the tagged harbour seals hauled out along the coastal area of west Scotland are active throughout the Study Area.

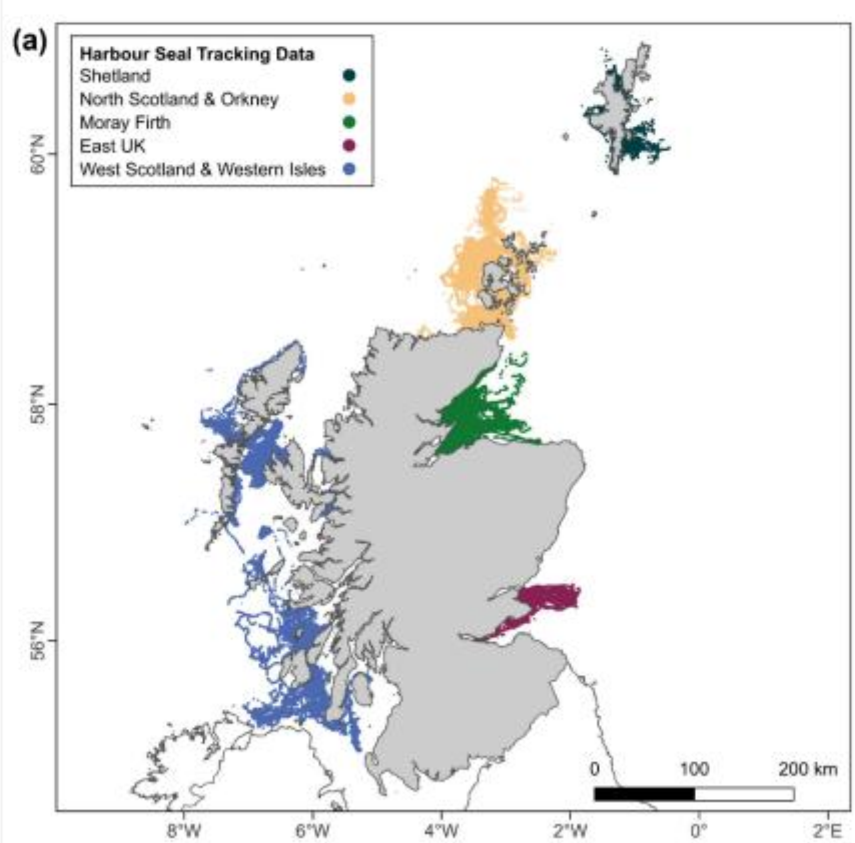


Plate 7.6 Tracking Data for Harbour Seals (n=222) Hauling out in Scotland (Carter et al., 2025)

267. Harbour seal have foraging ranges of up to 273 km (Carter et al., 2022), and the GPS tracking data from tagged harbour seal indicate there is potential for presence in the Study Area (**Plate 7.7**). Harbour seal within the Study Area have connectivity with the Inner Hebrides, Outer Hebrides, south-west Scotland, Northern Ireland, and north of the RoI. There is no connectivity with English waters (**Plate 7.7**). As for grey seal, the West Scotland MU is the primary MU used to inform the assessment. It is proposed to also include the Western Isles, Southwest Scotland, and NI MUs, as well as the RoI, as a wider population, to account for harbour seal moving in the Wider Study Area (**Plate 7.8, Plate 7.3**).

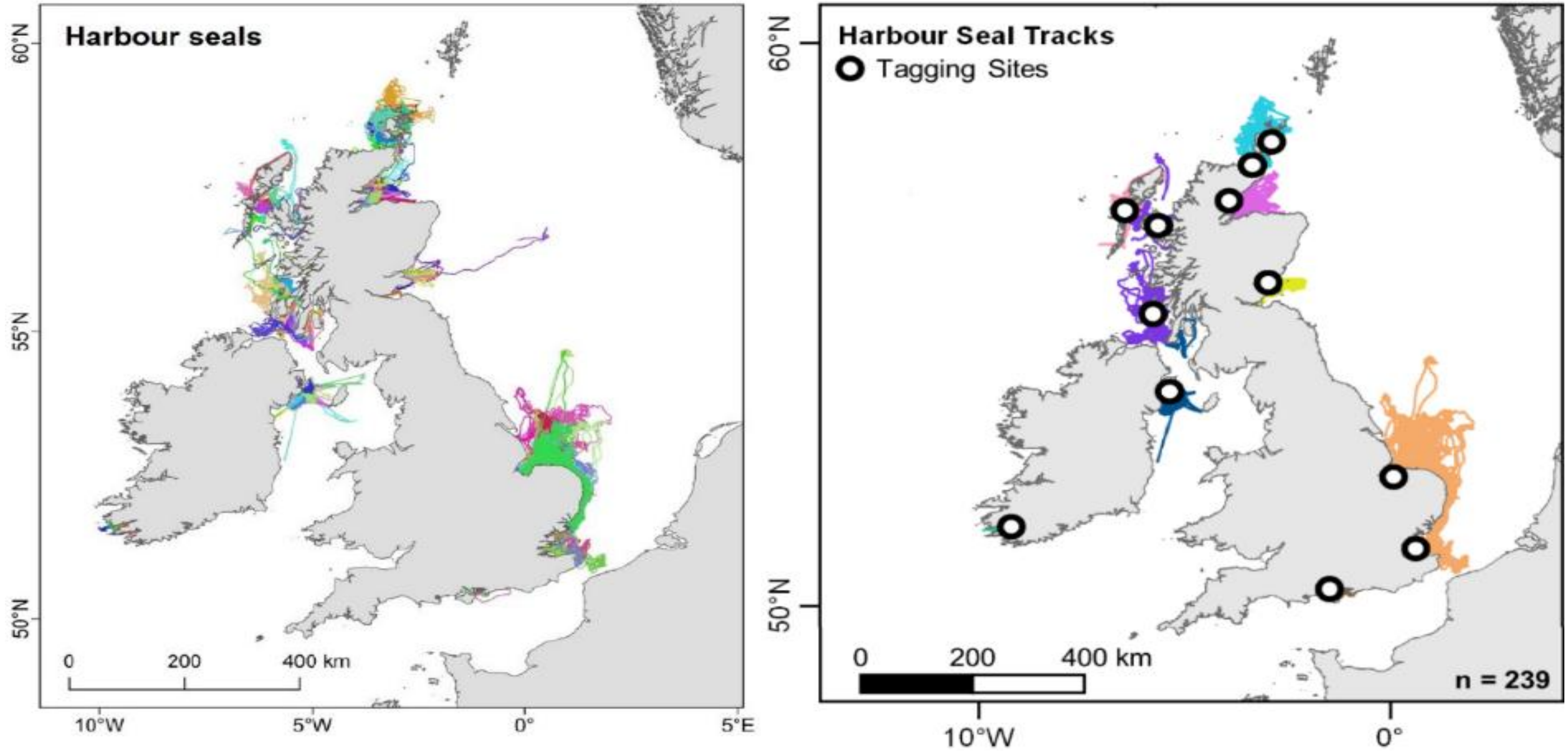


Plate 7.7 GPS tracking data for harbour seal, n=239, Carter et al., 2020; Right = Carter et al., 2022

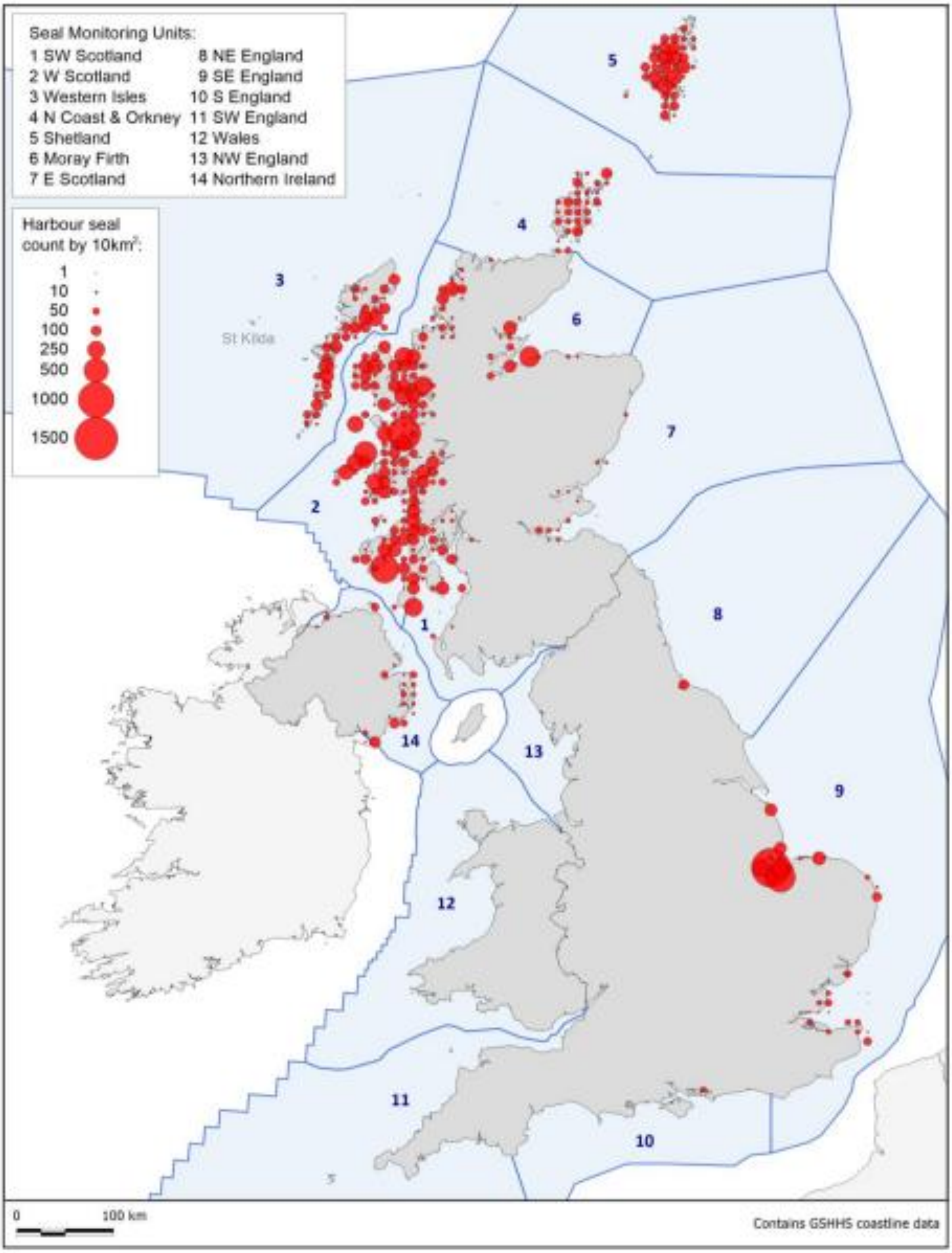


Plate 7.8 Seal management units for the UK, SCOS, 2024

268. **Table 7.4** provides the latest harbour seal counts within both the Study Area and the Wider Study Area, as well as the corrected population numbers. To generate an abundance, estimate for seals, it is necessary to take account of those individuals that were not available to count during the August counts, therefore, a correction factor is applied to the counts to generate a population estimate. The correction factor for harbour seal is 0.72 (Lonergan et al., 2013).

Table 7.4 Harbour seal population count estimates

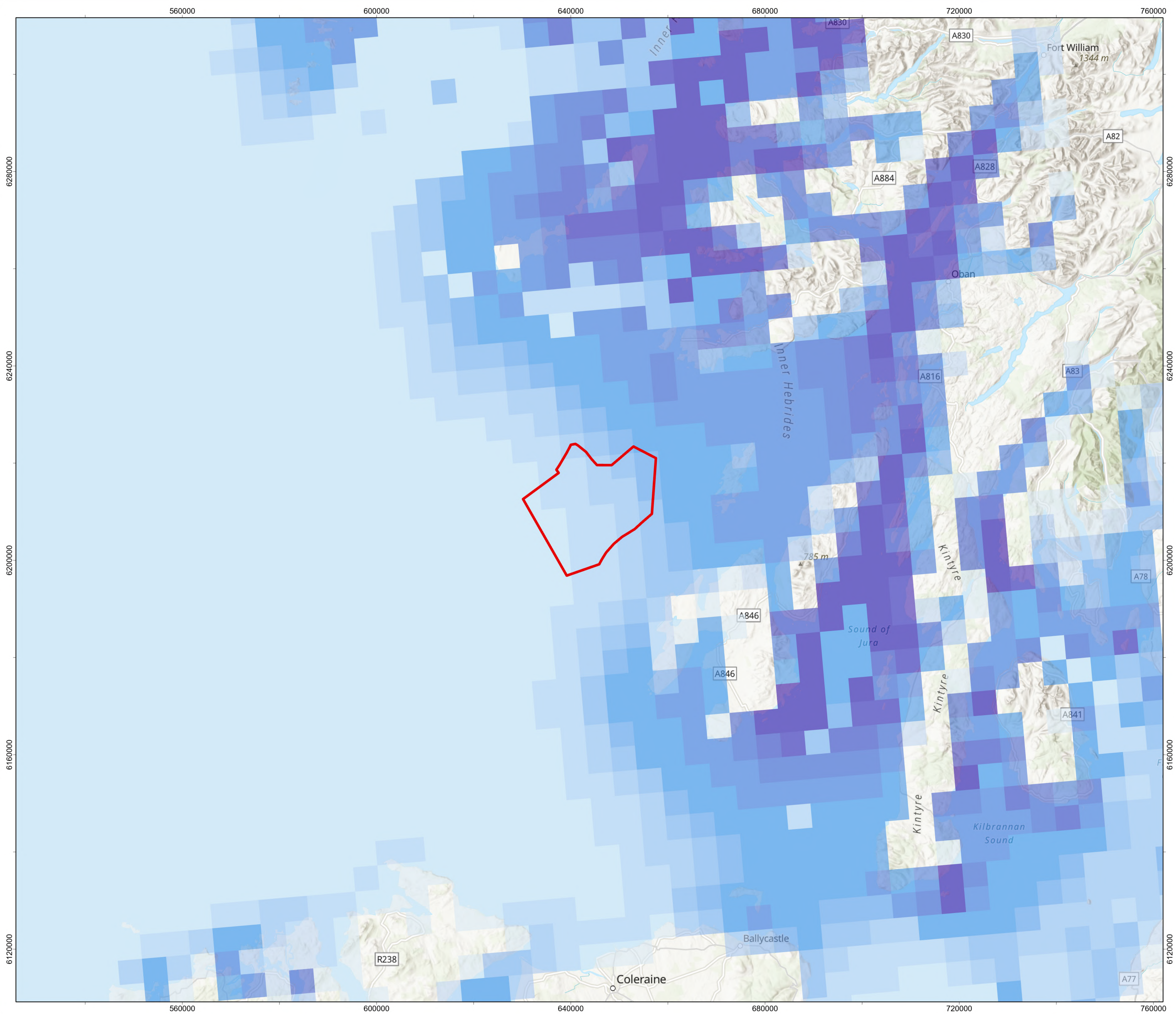
MU / region	Harbour seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Harbour seal total population
West Scotland	14,189	SCOS, 2024	0.72	**19,707**
Western Isles	3,080	SCOS, 2024	0.72	4,278
Southwest Scotland	1,709			2,374
NI	818			1,136
RoI total	4,007	Morris and Duck, 2019		5,565
Total wider reference population	23,803	-	0.72	**33,060**
Key	Reference populations taken forward for assessment are shown in **green**			

269. For density estimates of harbour seal, Carter et al. (2025) provides habitat-based predictions of at sea distribution for seals around the Study Area. The Carter et al. (2025) predicted distribution maps provide estimates per species, on a 5 km by 5 km grid of absolute density for seals hauling-out in Scotland.

270. The harbour seal absolute density map (**Plate 7.9**; Carter et al., 2025) and relative density map (**Plate 7.10**; Carter et al., 2022) shows the mean predicted densities for the OAA plus 4 km buffer are relatively high, with areas of increased densities south of the Isles of Islay and Jura, and Loch Linnhe where there are a number of harbour seal haul-out sites.

271. Harbour seal absolute density estimates for the OAA plus 4 km buffer have been calculated from the seal at sea usage maps (Carter et al*.,* 2025) based on the 5 km by 5 km grids that overlap with the OAA plus 4 km buffer, corrected against the total UK and the RoI population estimates. The total harbour seal population in the British Isles is 46,090 (**Table 7.4**; SCOS, 2024). This total population estimate has been corrected to determine the total number of harbour seal that may be at-sea at any time, using a correction factor of 0.8236 for harbour seal (Russell et al., 2015). There are therefore approximately 37,960 harbour seals, based on the corrected values and most recent haul-out counts for the UK. This is the at-sea population estimate used with the Carter et al. (2025) data to calculate density estimates.

272. Based on the Carter et al. (2022) data, the density for the OAA plus 4 km is 0.08 harbour seal per km^2 (**Figure 7.2**).



Windfarm Development Area

Mean Harbour Seal At-Sea Usage (% per 25km²)

- 0 - 0.002
- 0.0021 - 0.004
- 0.0041 - 0.006
- 0.0061 - 0.008
- 0.0081 - 0.01
- 0.011 - 0.02
- 0.021 - 0.04
- 0.041 - 0.06
- 0.061 - 0.08
- 0.081 - 0.1
- 0.11 - 0.45

N

0 5 10 20 30 Kilometres

1	13/11/2025	FC	GC	SB	PM
REV	REV DATE	GIS CREATOR	GIS REVIEWER	TECHNICAL CHECKER	TECHNICAL APPROVER

DRAWING NUMBER	MCW-DWF-ENV-MAP-RHS-000132		
DATUM	ETRS89	PROJECTION	UTM Zone 29N
SCALE	1:750,000	PAGE SIZE	A3
PROJECT TITLE	MachairWind		

Figure 7.2: Harbour Seal Density over Windfarm Development Area using Carter Density (2022)

NOT TO BE USED FOR NAVIGATION

Haskoning Enhancing Society Together
ScottishPower Renewables

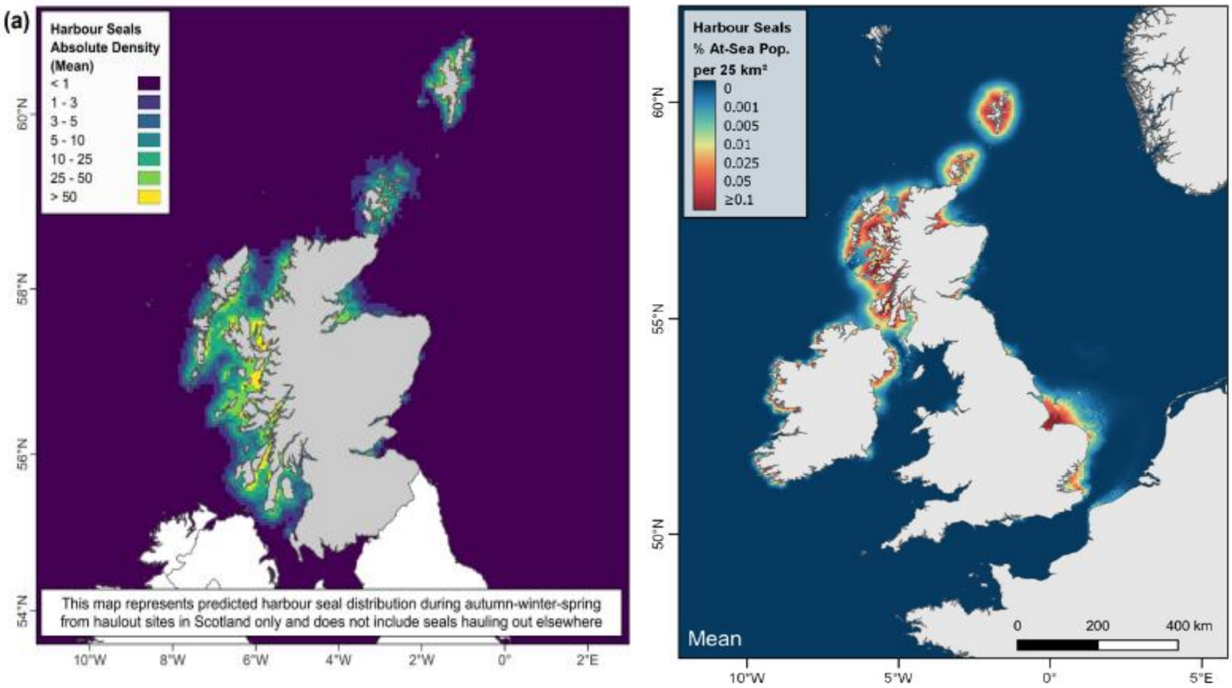


Plate 7.9 At-sea distribution of harbour seals; maps show mean percentage of at-sea population estimated to be present in each 5 km x 5 km grid cell at any one time, (Carter et al., 2025 on left and Carter et al 2022 on right to represent the NI and RoI populations)

7.2.2. Site-Specific Density Estimates for Harbour Seal

273. No harbour seals were recorded in the Project's DAS.

7.2.3. Summary of Abundance and Density Estimates for Harbour seal

274. **Table 7.5** provides an initial summary of the density estimate and population estimates of harbour seal for the OAA plus 4 km buffer. Using Carter et al. (2022, 2025). Density estimates from Carter et al. (2022) for the OAA plus 4 km buffer is used in **Chapter 10 Marine Mammals and Leatherback Turtle** as it is more precautionary.

Table 7.5 Summary of reference population and density estimates to inform the assessments

Density (individuals/km^2)	Density data source	Reference population	Reference population data source
0.05	Carter et al. (2025)	**WS MU: 19,707** **Wider population: 33,017**	SCOS (2024)
0.08	**Carter et al. (2022)**		
Density estimates taken forward for assessment are shown in **green**			

7.2.4. Harbour Seal Protected Haul-Out Sites

275. There are a number of haul-out sites for harbour seal in both the Study Area and the Wider Study Area (**Plate 7.10**). The nearest major harbour seal haul-out sites are to the south of Islay and Jura,

to the east of Mull and on Colonsay. **Table 7.6** below provides the latest data from 2019 from surveys of principal breeding sites, including those in the Inner Hebrides, where available. Due to the number and location of the known seal haul-out sites, disturbance to seal haul-out sites is assessed in the EIAR.

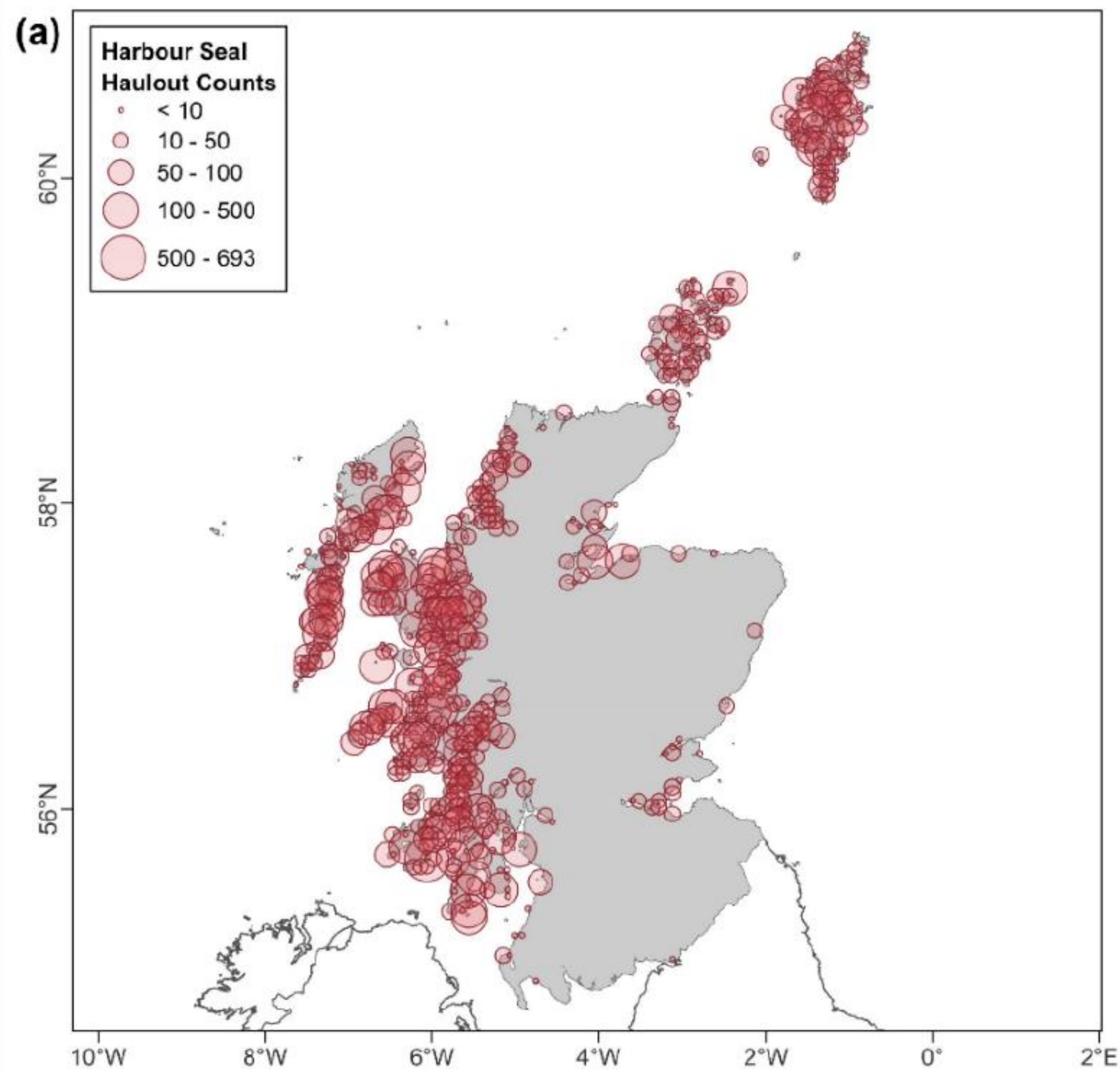


Plate 7.10 Harbour seal haul-outs sites, and latest counts, in Scotland, (Cater et al., 2025)

Table 7.6 Harbour seal haul-out counts

Site	Approximate Distance from WDA (km)	Harbour seal count	Source
Oronsay Strand	12.5	50+ pup production (2012)	SCOS (2019)
Soa, Mull	18	20+	-
Outer Loch Tarbery	31.5	-	-

Site	Approximate Distance from WDA (km)	Harbour seal count	Source
Gunna	48	500+ pups	SCOS (2019)
Soa (Coll)	48	20+	SCOS (2019)
Craighouse Small Isles and Lowlandman's Bay	52	-	-
South-West Islay Skerries	52	706	SCOS (2019)
Cains of Coll	58	-	-
South Jura	59	-	-
Eileanan agus Sgeiran Lios mor	83	238	SCOS (2019)
Sanda and Sheep Island	99	No information, potentially a resting/moulting site	-
Yellow rock	126	No information, potentially a resting/moulting site	-
Sand of Pladda Skernes	133	No information, potentially a resting/moulting site	-
Litle Scares	211	No information, potentially a resting/moulting site	-

7.2.5. Diet and Foraging Behaviour

276. Harbour seal take a wide variety of prey including sandeels, gadoids, herring and sprat, flatfish, and cephalopods. Diet varies seasonally and regionally; prey diversity and diet quality also showed some regional and seasonal variation (SCOS, 2024). It is estimated harbour seals eat 3 to 5 kg per adult seal per day depending on the prey species (SCOS, 2023).

8. BASELINE REVIEW FOR LEATHERBACK TURTLES

8.1. LEATHERBACK TURTLE

277. The baseline review for leatherback turtle provides information on abundance and occurrence in the Study Area; the Wider Study Area and results from the Project DAS.

278. Data sources include:

- ObSERVE surveys;
- Regional management units (RMUs) (Wallace et al. 2010); and
- UK studies (e.g. Botterell et al., 2020; Houghton et al., 2006; Witt et al., 2007).

8.1.1. Desk-Based Review

279. Leatherback turtle is listed as 'Vulnerable' by the International Union for Conservation of Nature (IUCN), (2022) and is the only species of marine reptile to be considered a regular member of the UK marine fauna. Leatherbacks are seasonal visitors to UK waters as they are able to metabolically raise their body temperature above their surrounding environment (Bostrom et al., 2010), which allows them to survive in cooler waters such as the UK. Leatherback turtles migrate to UK waters to feed on jellyfish.

280. Leatherback turtles undertake extensive trans-oceanic migrations to waters surrounding the UK, within the Atlantic Northwest regional MU (Wallace et al., 2010). Most sightings in UK waters occur during June to October, with a peak in August; strandings peak slightly later in September and October (Botterell et al., 2020). Leatherback turtles have a wide-ranging migration in response to food distribution including jellyfish and other gelatinous zooplankton and their presence in UK waters is often due to displacement from their normal range by adverse currents (BEIS, 2022; Robinson et al., 2022; Jones et al., 2012). Leatherback turtles are rare in the Hebrides but have been detected in the summer and autumn months, most likely during their migrations between their breeding and feeding grounds (**Plate 8.1**).

281. Botterell et al. (2020) undertook a review of marine turtle sightings in the UK and Ireland from 1910 to 2018. Among their findings, reports of leatherback turtles increased over the decades to a peak in the 1990s, but since then records appear to have gradually declined. While there were 553 instances in the 1990s, there were 464 in the 2000s and 256 since 2010. The timing of records suggests that leatherback turtles enter British and Irish waters from the south and west. However, these waters are likely to represent the most northern limit of leatherback turtle migration, evidenced by a notable decrease in annual records and a limited number of sightings across the UK (Botterell et al., 2020).

282. Leatherback turtles are a single species globally, with seven RMUs worldwide, each representing a different subpopulation (**Plate 8.1**) (Wallace et al., 2010). It is the Atlantic, Northwest MU that mostly likely represents leatherback turtles in UK waters.

283. In the Wider Study Area; during the ObSERVE surveys (Giralt Paradell et al., 2024), only two leatherback turtles were sighted, and both sightings occurred to the west of Ireland.

284. During 2003-2005 (June-October) (Houghton et al., 2006) carried out aerial surveys throughout the Wider Study Area in the Irish and Celtic Seas to determine the abundance of leatherback turtles and their jellyfish prey. During the surveys, four live and one dead leatherback turtle were observed with two of the live animals found within 1 km of barrel jellyfish (*Rhizostoma)* octopui aggregations. These sightings equate to 0.25 leatherbacks per 1,000 km of track flown (or 0.06 leatherbacks per 100 km^2) within the Irish and Celtic Seas (Doyle et al., 2008).

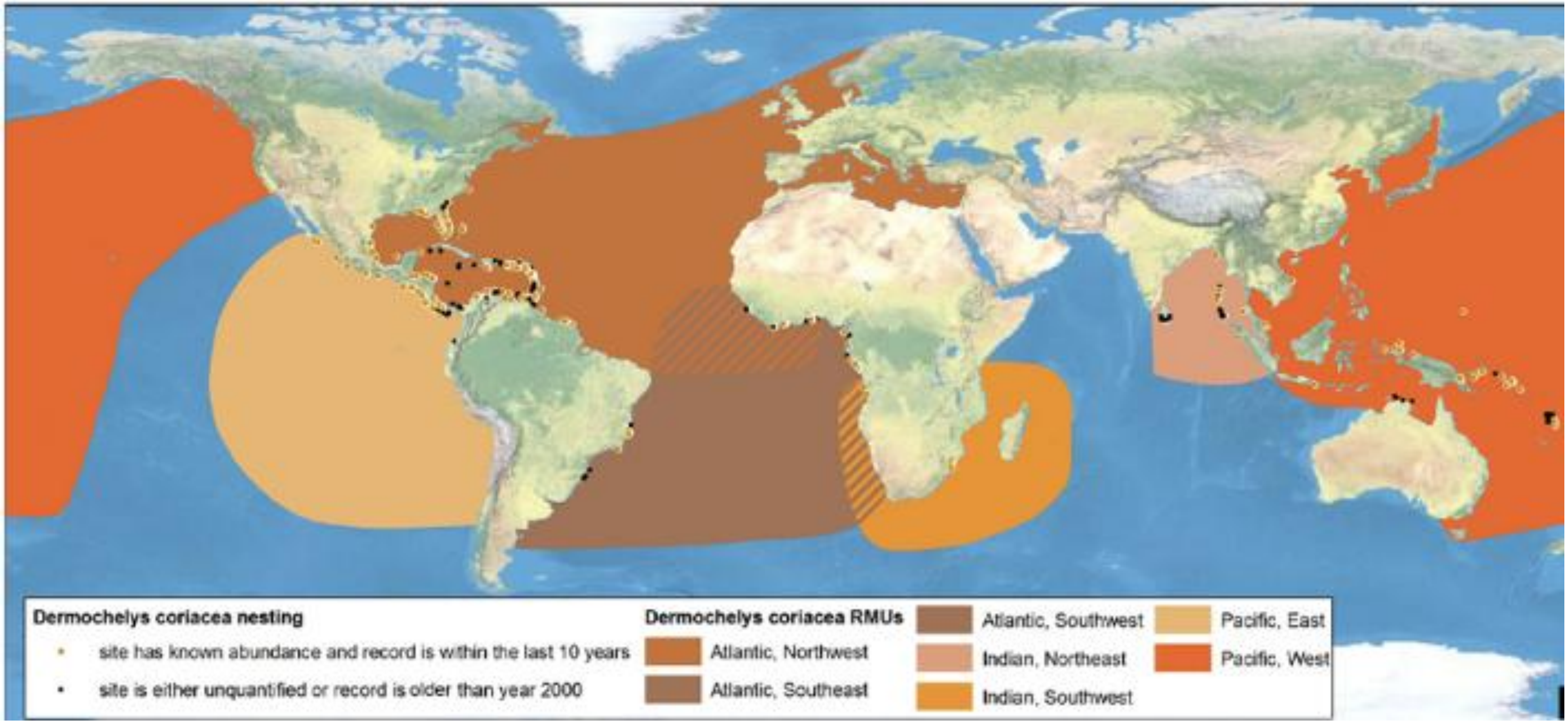


Plate 8.1 Regional management unit for leatherback turtle, Site-Specific Density Estimates for leatherback turtle (Wallace et al., 2010)

8.1.2. Site-Specific Density Estimates for Leatherback turtle

285. A single leatherback turtle was detected during the Project DAS in September 2022, which equates to a density estimate of 0.01 turtles per km^2 in the OAA plus 4 km buffer. The current population sizes are not well known in most areas; however, in the North Atlantic the population is estimated to be between 34,000 and 94,000 adults (U.S. Fish and Wildlife Service, 2020).

8.1.3. Summary of Abundance and Density Estimates for Leatherback turtle

286. The only density for leatherback turtle in the Study Area is what has been derived from the Project's DAS. There are no density estimates in desk-based sources in the Hebrides.

287. Therefore, due to a lack of information on an appropriate population estimate for Scottish (or UK) waters on which to base an assessment, only qualitative assessments are undertaken for this species in **Chapter 10 Marine Mammals and Leatherback Turtle**.

8.1.4. Diet and Foraging Behaviour

288. Leatherback turtle exhibits the widest spatial distribution of any reptile, moving through equatorial, tropical and temperate waters (Witt et al., 2007). Leatherback turtles grow on a diet of clear, watery, jellylike animals. They eat so many jellyfish that it makes up for the lack of nutritional quality that it serves (Turtle org, 2025). Leatherbacks also feed on other soft-bodied organisms, such as other cnidarians and cephalopods.

9. MARINE MAMMAL AND LEATHERBACK TURTLE SENSITIVITY

289. Marine mammals are highly sensitive receptors with respect to underwater noise generated during offshore windfarm development. These species depend on acoustic cues for essential behaviours such as navigation, communication, foraging, and predator avoidance, making them particularly vulnerable to disturbance from anthropogenic sound sources. Construction activities; especially impact pile driving produces high-intensity impulsive noise that poses the greatest risk to marine mammals, requiring regulatory monitoring and mitigation measures to avoid auditory injury or behavioural disruption (Offshore Wind Facts, 2024). Leatherback turtles are considered sensitive to underwater noise, especially low-frequency and impulsive sounds. Their hearing range overlaps strongly industrial noise such as piling, and studies show detectable behavioural responses (Dow Piniak et al., 2012)

290. Operational noise, although continuous and lower in intensity, can also contribute to cumulative impacts; recent research indicates that larger turbine models (10–20 MW) may generate underwater noise capable of causing temporary threshold shifts (TTS) in low-frequency cetaceans at distances of several hundred metres (Thomsen et al., 2024). Sea turtles, including leatherbacks, also face multiple anthropogenic pressures such as vessel strikes and habitat degradation, and additional disturbance from underwater noise may exacerbate these existing threats by contributing to habitat displacement or altered migratory behaviour (NRDC, 2025). Within **Chapter 10 Marine Mammals and Leatherback Turtle**, these sensitivities are considered to ensure that potential impacts from offshore wind-related noise are fully understood and that robust mitigation strategies are implemented to safeguard protected marine species.

291. For each impact assessed in **Chapter 10 Marine Mammals and Leatherback Turtle**, the sensitivity assigned to each receptor–impact pathway was agreed with NatureScot during the second ETG meeting held on 14 October 2025 (see Table 10.2 of **Chapter 10 Marine Mammals and Leatherback Turtle**). The agreed sensitivities are summarised and described in this Appendix.

9.1. SENSITIVITY FOR IMPACT 1: UNDERWATER NOISE DURING GEOPHYSICAL SURVEYS

292. Potential impacts from geophysical surveys in the WDA is assessed in Section 10.11.1.2 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.1.1. Harbour Porpoise

293. The highest permanent threshold shift (PTS) range from geophysical surveys is for harbour porpoise (see Section 10.11.1.2 in **Chapter 10 Marine Mammals and Leatherback Turtle**), making them the most sensitive to sound sources from geophysical equipment. However, for PTS to occur, the animal would have to be in close proximity for a prolonged amount of time, which is highly unlikely. There is no recorded impact ranges for Temporary Threshold Shift (TTS), therefore PTS is assessed as a worst-case in Section 10.11.1.2 in **Chapter 10 Marine Mammals and Leatherback Turtle**.

294. Stone (2024) suggested that cetaceans, including harbour porpoise react aversively to noise from pingers and chirpers, however, distances were only reported for chirpers. Harbour porpoise was recorded to show an average minimum avoidance range of 2 km from active chirp sub-bottom profilers (SBPs) (Majewska et al., 2025). Veneruso (2024) found a significant reduction in porpoise detections coinciding with the SBP survey (Majewska et al., 2025).

295. Harbour porpoise is deemed to have limited resilience to PTS, low recoverability and high international value; therefore, the sensitivity to PTS is **high**. As harbour porpoise is deemed to have some resilience to behavioural disturbance, the sensitivity is assigned as **medium**.

9.1.2. Delphinids

296. Delphinids are the least sensitive cetacean to auditory injury from underwater noise (see Section 10.11.1.2 in **Chapter 10 Marine Mammals and Leatherback Turtle**). However, an event involving the long-term displacement and mass stranding of approximately 100 melon-headed whales (*Peponocephala electra*) occurred 2008 in the Loza Lagoon system in northwest Madagascar, which is an extremely atypical area for this species. The Independent Scientific Review Panel (ISRP) concluded that this mass stranding event was due to a 12 kilohertz (kHz) Multibeam Echo Sounder (MBES) that was operating prior to the mass stranding event (Southall et al., 2013). A study by Cholewiak et al. (2017) investigated the impact of MBES on toothed whales and reported that there was a decrease in beaked whale (*Ziphiidae*) vocalisations (high frequency cetacean like delphinids), when the source was actively transmitting. This suggested that animals either moved away from the area or reduced foraging activity (although findings were not statistically significant).

297. Captive bottlenose dolphins exhibited changes in behaviour when exposed to one second tonal signals at frequencies similar to sounds emitted by an MBES and found that the behavioural changes typically involved attempts to avoid the sound exposure (Schlundt et al., 2000; Finneran et al., 2002; Finneran and Schlundt, 2004). In addition, observed reactions have included silencing and dispersal by sperm whales (Watkins et al., 1985), increased vocalisations and no dispersal by pilot whales (Rendell and Gordon, 1999).

298. Results from 201 seismic surveys in the UK and adjacent waters demonstrated that delphinids (bottlenose dolphin and white-beaked dolphin) can be disturbed by seismic exploration and showed strongest lateral spatial avoidance, moving out of the area, whilst killer whales showed more localised spatial avoidance, orienting away from the vessel and increasing distance from source but not leaving the area completely (Stone and Tasker, 2023).

299. The sensitivity of delphinids to PTS is **high**, due to low recoverability and high value. For disturbance, the sensitivity is assigned as **medium**, as delphinids have the ability to adapt and recover from disturbance.

9.1.3. Mysticetes

300. Mysticetes produce low frequency calls and songs designed for long distance communications to attract a mate, to send information on prey distribution, and warning threats etc. Humpback whale vocalisations vary with season and have been most generally categorised as song or non-song. Non-song calls seem to be produced by males, females, adults, and calves throughout the year during their annual migrations (Kowarski, et al., 2021), to facilitate communication, maintain contact with mothers and calves, and potentially signal breeding or aggressive interactions (McNamara and Dunlop, 2025). However, it is suggested that no communication amongst mysticetes will be masked from the equipment used in the geophysical surveys, with this more likely to occur from the vessel noise (Erbe et al., 2019).

301. During exposure to a 21 to 25 kHz whale finding sonar with a source level of 215 decibels (dB) re 1 μPa m, grey whales (*Eschrichtius robustus*) (low frequency cetacean) reacted by orienting slightly away from the source and being deflected from their course by 200 m (Frankel, 2020). When a 38 kHz echosounder and a 150 kHz acoustic Doppler current profiler were transmitting during studies in the eastern tropical Pacific, baleen whales showed no significant responses.

302. Studies of grey, bowhead (*Balaena mysticetus*), and humpback whales have shown that seismic pulses with received levels of 160 to 170 dB re 1 µPa root mean square (RMS) seem to cause obvious avoidance behaviour in a substantial fraction of the animals exposed (Richardson et al., 1995).

303. The sensitivity of mysticetes to PTS is assigned as **high** due to low recoverability. For disturbance the sensitivity is assigned as **medium**, as mysticetes have the ability to adapt and recover.

9.1.4. Pinnipeds

304. Pinnipeds use sound both in air and water for social and reproductive interactions (Southall et al. 2007), but not for finding prey. Therefore, Thompson et al. (2012) suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans. Pinnipeds can also hold their heads out of the water during exposure to loud noise and potentially avoid PTS during a passing geophysical survey. As such, sensitivity to PTS in harbour and grey seal is expected to be lower than cetacean species such as harbour porpoise, with the individual showing some tolerance to avoid, adapt to or accommodate or recover from the impact (for example, Russell, 2016b).

305. Hastie et al., (2014) conducted a series of behavioural response tests on two captive grey seals to determine their reactions to underwater noise from a multibeam imaging echosounder, operating at a frequency range of 375 kHz which included significant signal components down to 6 kHz. Results indicated that the two seals reacted to the signal by significantly increasing their dive durations. Because of the likely brevity of exposure to the MBES sounds, pinniped reactions are expected to be limited to startle or otherwise brief responses of no lasting consequence to the animals (Hastie et al., 2014)).

306. The sensitivity of grey and harbour seal to PTS is **high**, due to low recoverability. For disturbance the sensitivity is assigned as **medium**, as pinnipeds have the ability to adapt and recover.

9.1.5. Leatherback turtle

307. Survey equipment utilised in geophysical surveys (See Section 10.11.1.2 in **Chapter 10 Marine Mammals and Leatherback Turtle**) such as SBP often operate within the hearing sensitivity of leatherback turtle, 50 Hz to 1.6 kHz, and therefore has the potential to cause auditory injury. Section 10.11.1.1.1 in **Chapter 10 Marine Mammals and Leatherback Turtle** shows that turtles have very similar thresholds for PTS/TTS to delphinids.

308. As a precautionary approach and due to the high international value of the receptor, the sensitivity of leatherback turtle to PTS is **high** and, for disturbance, as leatherback turtles have the ability to adapt and recover, the sensitivity is assigned as **medium**.

9.2. SENSITIVITY FOR IMPACT 2: UNDERWATER NOISE DURING UNEXPLODED ORDNANCE CLEARANCE

309. The sensitivity for all receptors for auditory injury and disturbance from unexploded ordnance (UXO) clearance is presented in **Appendix 10.6 UXO Clearance Assessment.**

310. Potential impacts from UXO clearance in the WDA are assessed in **Appendix 10.6 UXO Clearance Assessment**.

9.3. SENSITIVITY FOR IMPACT 3: AUDITORY INJURY FROM UNDERWATER NOISE DURING PILING

311. Potential auditory injury from piling in the WDA is assessed in Section 10.11.1.4 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.3.1. Harbour porpoise

312. Harbour porpoise is highly sensitive to impulsive underwater noise generated during piling activities. Within close range of unmitigated piling operations, harbour porpoise may experience physiological effects such as injury, permanent or temporary hearing loss, i.e. PTS or TTS respectively; (Kastelein et al., 2015).

313. Kastelein et al. (2021) looked at TTS induced and hearing recovery in a female harbour porpoise after exposure to one, two, and four hours of continuous one-sixth-octave noise band cantered at 500 Hz, which is within the frequency range of many high-amplitude anthropogenic sounds such as piling. The impulsive sound source was recorded to have an intensity of SPL / L_p of 163 dB re 1 µPa and sound exposure Level (SEL / $L_{E,p}$) 199 to 206 dB re 1 µPa. Hearing thresholds for 0.5, 0.71, and 1 kHz tonal signals were determined before and after exposure, and after four-hour exposure to the sound, TTS was found in the harbour porpoise hearing threshold at 500 Hz.

314. The Final Report on TTS in Seals and Porpoises (Sea Mammal Research Company (SEAMARCO), 2025), part of a broader study on pile driving impacts, found that harbour porpoise was more sensitive to TTS, as they exhibit TTS above approximately 2.5 dB, at SEL / $L_{E,p}$ of 152 and 162 dB re 1 µPa^{2}s. In addition, harbour porpoise exhibited behavioural changes prior to any measurable TTS, as the porpoise was deterred (in all exposures) by pile driving playback sounds with a peak sound pressure level SPL_{peak} / $L_{p\text{-}k,p}$ of 139 dB re 1 µPa. This suggests that porpoises are highly sensitive to underwater sound, reacting to noise exposure at levels below those required to cause auditory injury.

315. Harbour porpoise is deemed to have limited resilience to auditory injury (PTS), low recoverability and high international value. For that reason, the sensitivity for auditory injury (PTS) is assigned as **high** and TTS is assigned as **medium** as it is recoverable.

9.3.2. Delphinids

316. Delphinids, including bottlenose and common dolphins, are acoustically active species that rely on sound for communication, navigation, and foraging. Construction activities such as piling, can mask these signals and disrupt social behaviours. Studies have shown dolphins exhibit avoidance behaviour and reduced presence near piling sites, with changes in vocalisation patterns also reported (Dähne et al., 2013; Pirotta et al., 2015). While they are capable of evading noise sources, repeated exposure may lead to long-term habitat displacement.

317. Mulsow et al. (2023) looked at auditory injury (TTS) in captive bottlenose dolphins, from an impulsive source emitting 10 ms impulses centred at 8 kHz, mostly with a sound pressure level (SPL / L_p) of 175 to 180 dB re 1 µPa whilst the inter-pulse interval (IPI) and number of pulses varied. Mulsow et

al. (2023) found that TTS in bottlenose dolphin increased with increasing cumulative sound exposure level (SELcum / $L_{E,p,t}$), with the lowest TTS onset of 184 dB re 1 μPa, although exposures with 20 s IPI and SELcum / $L_{E,p,t}$ of 182 to 183 dB re 1 μPa produced respective TTS of 35 and 16 dB in two dolphin. Recovery rates were similar to those from other studies with non-impulsive sources and depended on the magnitude of the initial TTS.

318. Therefore, due to the low recoverability and high international value, the sensitivity for auditory injury (PTS) is assigned as **high** and TTS is assigned as **medium** as it is recoverable.

9.3.3. Mysticetes

319. Mysticetes are sensitive to low-frequency sounds which is the peak frequency in piling operations. Construction activities, such as piling, create sounds that can interfere with communication and feeding, and may cause large-scale avoidance behaviour. Auditory evoked potential studies confirm their sensitivity to frequencies up to 64 kHz (Houser et al., 2001; Tubelli et al., 2012), and behavioural responses to piling have included altered migration routes and reduced presence in feeding areas (Southall et al., 2007).

320. Due to the low recoverability and high international value, the sensitivity for auditory injury (PTS) is assigned as **high**, and TTS is assigned as **medium** as it is recoverable.

9.3.4. Pinnipeds

321. Grey and harbour seal are exposed to underwater noise both in water and in air at haul-out sites. Piling noise, particularly in the low-frequency range, can cause permanent and temporary hearing shifts and behavioural changes such as altered haul-out patterns and reduced foraging efficiency. Audiogram studies show best sensitivity around 4 kHz (Kastelein et al., 2009; Reichmuth et al., 2013), and field observations have documented seal avoidance of active piling zones (Thompson et al., 2013).

322. To examine TTS from mid-frequency noise, a harbour seal was exposed to a 4.1 kHz underwater tone that was incrementally increased in SPL / L_p and duration during the experiment. As expected, TTS occurred at 4.1 kHz whilst the harbour seal hearing threshold recovered within 48 hours, there was a PTS of at least 8 dB at 5.8 kHz (Reichmeth et al., 2019).

323. Due to the low recoverability and high international value, the sensitivity for auditory injury (PTS) is assigned as **high**, and TTS is assigned as **medium** as it is recoverable for pinnipeds.

9.3.5. Leatherback turtle

324. Leatherback turtles, while less acoustically sensitive than marine mammals, can detect low-frequency sounds below 1,000 Hz, which overlap with piling noise. Direct TTS studies are rare in turtles. Moein et al. (1994) repeatedly exposed loggerhead turtles to airguns presented at three source sound levels (175, 177, and 179 dB re 1 μPa) in an 18 x 61 m enclosure in a 3.6 m deep river. Physiological measurements (blood chemistry) showed increases in stress levels (as measured by increases in glucose and white blood cell count), and pre- and post-exposure hearing measurements showed a change in hearing physiology (phase shifts or non-repeatability of response recordings) and temporary decrease in hearing sensitivity in some turtles.

325. Few behavioural response studies have been done, however startle reactions, altered swimming patterns, and avoidance of noisy areas have been observed during marine construction activities (Samuel et al., 2005).

326. DeRuiter and Doukara (2012) studied the response of sea turtles to seismic airguns, which is a high intensity impulsive sound source, with continuous pulses, similar to pile driving, and found that the noise interrupted basking behaviour of sea turtles causing them to dive, with some showing a startle response and dove immediately after the airgun array shots. However, Weir (2007) did not detect any response from sea turtles to seismic airguns, with 80% of sea turtles remaining at the surface. However, turtles were observed to dive when in close proximity to the seismic vessel or the towed equipment (~10 m). This research shows that sea turtle response to impulsive noise sources could vary by region, and by species.

327. These findings support the fact the turtles are sensitive to underwater noise, and this may affect navigation and energy expenditure, particularly in nearshore foraging habitats.

328. Due to the low recoverability and high international value, the sensitivity of the receptor is therefore assigned as **high** for PTS, whilst for TTS is assigned as **medium** as it is recoverable.

9.4. SENSITIVITY FOR IMPACT 4: DISTURBANCE AND BEHAVIOURAL IMPACTS FROM UNDERWATER NOSIE DURING PILING

329. Potential disturbance from piling in the WDA is assessed in Section 10.11.1.5 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.4.1. Harbour porpoise

330. Recent research has highlighted significant behavioural impacts of underwater noise from piling activities. For harbour porpoises, studies have shown that behavioural reactions, such as fleeing or altered movement patterns, can occur at received sound levels between 95 to 115 dB re 1 μPa, when weighted for their auditory sensitivity (Tougaard, 2025). These reactions, although individually minor, can accumulate over time, potentially affecting feeding, resting, and reproductive behaviours, and ultimately impacting population dynamics.

331. Studies on harbour porpoise response to piling during offshore windfarm construction (Gescha 1 and 2; Rose et al., 2019) indicate that, despite significant reductions in noise levels through advanced noise abatement (up to 15 dB lower than unmitigated piling and below the 160 dB German Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie) limit at 750 m), disturbance persisted over similar ranges and durations as earlier campaigns without noise abatement. Displacement typically extended 11 to 19 km from piling and lasted 28 to 48 hours, with some avoidance observed up to 24-hours prior to piling, likely due to vessel activity. In addition, findings from Beatrice Offshore Windfarm (Graham et al., 2019) show a decreasing response over time, suggesting habituation, with initial 50% response distances of 7.4 km reducing to 1.3 km by the end of the campaign. Overall, disturbance is influenced by multiple factors, including vessel activity and proximity, rather than noise level alone.

332. Despite the high international value; the sensitivity for disturbance from underwater noise from piling for harbour porpoise is assigned as **medium** due to having some resilience to behavioural disturbance.

9.4.2. Delphinids

333. Research on bottlenose dolphin responses to piling indicates generally weak behavioural effects rather than exclusion. Graham et al. (2017) reported slight reductions in time spent near harbour construction sites during impact and vibration piling, with fine-scale responses occurring at received SEL / $L_{E,p}$ values of 104 to 136 dB re 1 μPa²s. At Beatrice Offshore Windfarm (2017), dolphin

detections decreased by 50% within 53 km of piling, while Moray East Offshore Windfarm (2019) showed no significant change (Fernandez-Betelu et al., 2021).

334. Delphinids are highly acoustically sensitive, and recent studies highlight that short impulsive sounds, such as pile-driving, elevate behavioural hearing thresholds by 11 to 25 dB, increasing disruption (Accomando et al., 2025). Dolphins have also been observed to modify whistle characteristics under elevated noise conditions, suggesting impaired communication (Marley et al., 2017).

335. Despite the high international value; the sensitivity for disturbance from underwater noise from piling for delphinids is assigned as **medium** due to having some resilience to behavioural disturbance and high recoverability.

9.4.3. Mysticetes

336. There is limited information on the behavioural response of mysticetes to piling, however Southall et al. (2007) includes a summary of the observed behavioural responses from other noise sources such as seismic air guns which is very similar to piling in frequency and amplitude.

337. Mysticetes are highly sensitive to low-frequency impulsive sounds such as seismic airguns and pile driving, which share similar acoustic properties. Documented studies indicate that behavioural responses, including startle reactions, changes in vocal behaviour, temporary cessation of reproductive activity, and avoidance, typically occur at received levels of 150 to 160 dB re 1 µPa (RMS) (Malme et al., 1983; Malme et al., 1984; Richardson et al., 1986; Ljungblad et al., 1988; McCauley et al., 2000). In some cases, avoidance has been observed at levels as low as 130 to 145 dB re 1 µPa, particularly when whales are within a few kilometres of the source (Dunlop et al., 2017; Darias-O'Hara et al., 2025). Responses can range from short-term avoidance to long-term displacement, highlighting the potential for significant disruption during activities like piling (Southall et al., 2007).

338. Species-specific research indicates that humpback whales reduce vocalisation and exhibit avoidance near seismic sources (Cerchio et al., 2014; Dunlop et al., 2018), while fin whales have been documented to move away, alter vocal characteristics, and even cease singing for extended periods during surveys (Castellote et al., 2012; IWC, 2007). Bowhead whales show strong avoidance during migration, sometimes up to 20 km from the source, though responses are less pronounced during foraging (Koski and Johnson, 1987; Richardson et al., 1999; Miller et al., 2005). Given the similarity between seismic airgun noise and pile driving, these findings provide valuable insight into the likely behavioural impacts on minke, fin, and humpback whales during piling operations (Macdonald et al., 1995).

339. In summary, documented studies have shown that mysticetes show a behavioural response to impulsive noise and can show signs of avoidance or displacement up to 20 km from seismic airguns. Because the acoustic properties of both seismic airguns and impact pile driving are similar with both being a loud broadband impulsive sound and similar in frequency, the research described above can provide an insight into minke whale, fin whale and humpback whale behavioural impacts to piling.

340. The sensitivity for disturbance from underwater noise from piling for mysticetes is assigned as **medium** due to having some resilience to behavioural disturbance, high recoverability and high international value.

9.4.4. Pinnipeds

341. Research has confirmed that pinnipeds, including harbour and grey seals, exhibit measurable behavioural responses to underwater noise from piling activities. These responses include temporary

displacement from haul-out sites, reduced foraging efficiency, and altered dive behaviour, particularly in proximity to high-intensity impulsive sounds. A 2025 study by Kastelein et al. demonstrated that behavioural responses in seals, such as avoidance, altered swimming patterns, and jumping out of the water, began at single strike sound exposure levels (SEL_{ss} / $L_{E,p,ss}$) of around 131 dB re 1 µPa²s. In addition to this, field observations have shown that seal abundance can significantly decline within 25 km of active piling activities. Data from tagged harbour seals in the Wash and North Norfolk Coast SAC indicated that seals were not excluded from the vicinity of the Lincs Offshore Windfarm during the construction phase however there was clear evidence of avoidance during pile driving events (Russell et al., 2016). Seal activity was significantly reduced at ranges of up to 25 km from piling sites. However, within two hours of cessation of piling, seal distribution returned to pre-piling levels (Russell et al., 2016a, Whyte et al., 2020), reinforcing the idea that even distant noise sources can influence pinniped behaviour (Russell et al., 2016).

342. The sensitivity for disturbance from underwater noise from piling for pinnipeds is assigned as **medium** due to having some resilience to behavioural disturbance, high recoverability and high international value.

9.4.5. Leatherback Turtle

343. Leatherback turtles, although less studied compared to marine mammals, are known to be sensitive to low-frequency sounds. A synthesis of bioacoustics disruption studies from 1992 to 2024 found that sea turtles may exhibit changes in diving behaviour and orientation in response to anthropogenic noise, suggesting potential interference with migratory and foraging patterns (Harding and Cousins, 2022).

344. Protected Species Observers (US equivalent to MMO) have recorded sea turtles to actively avoid areas where pile driving occurs, particularly during offshore windfarm construction and port development projects, leaving ensonified zones (predicted impact ranges) around a pile driving site (Special Initiative on Offshore Wind, 2025).

345. McCauley et al. (2000) exposed one green and one loggerhead sea turtle in an open-water cage to an approaching-departing single airgun (20 in^3 chamber); the turtles increased their swimming activity when received levels reached 166 dB re 1 µ Pa RMS SPL / L_p and demonstrated more erratic behaviour at received levels greater than 175 dB re 1 µ Pa RMS.

346. Therefore, the sensitivity of leatherback turtles is assigned as **medium** due to having some resilience to behavioural disturbance, high recoverability and high international value.

9.5. SENSITIVITY FOR IMPACT 5: AUDITORY INJURY AND BEHAVIOURAL IMPACTS FROM UNDERWATER NOISE FROM NON-PILING ACTIVITIES

347. Potential impacts from non-piling activities in the WDA is assessed in Section 10.11.1.6 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.5.1. Harbour porpoise

348. Harbour porpoise shows sensitivity to underwater noise generated by dredging and other non-piling activities such as trenching and rock placement. Noise disturbance from dredging and rock placement has been shown to cause significant behavioural changes in harbour porpoise. For example, during offshore windfarm construction involving dredging and rock dumping, harbour porpoise exhibited strong avoidance behaviour and reduced echolocation activity, indicating displacement from key habitats (Benhemma-Le Gall et al., 2021).

349. Due to the low recoverability and high international value, the sensitivity of harbour porpoise to PTS is **high**, whilst the sensitivity for TTS and disturbance is assigned as **medium** due to the receptor group having some resilience to behavioural disturbance, and as TTS is recoverable.

9.5.2. Delphinids

350. Delphinids are vulnerable to both direct and indirect impacts of dredging and rock replacement. Noise emissions from dredgers produce low frequency broadband sounds with peak energies below 1 kHz, which can cause behavioural changes and acoustic masking (Todd et al., 2015).

351. The underwater noise modelling (see **Appendix 10.1 Underwater Noise Modelling Report**) predicted PTS ranges to be less than 50 m for delphinids, which indicates that PTS is not expected to occur, as the hearing threshold would not be exceeded.

352. Despite the high international value, the sensitivity of delphinids is assigned as **medium** for TTS and disturbance as the receptor group has some resilience to behavioural disturbance and TTS is recoverable.

9.5.3. Mysticetes

353. Mysticetes are primarily affected by underwater noise and changes in prey dynamics resulting from dredging and rock replacement. Noise sources from other constructions activities tend to be in the lower frequency range, meaning mysticetes are the group most susceptible to any dredge noise effects (Clark et al., 2009; NAPIER, 2017) due to having a hearing range of 7 Hz to 22 kHz (Southall et al., 2007). Other construction activities are expected to be non-injurious with the strongest responses resulting in short-term masking of some whales' communication calls and possibly temporary avoidance of the immediate area by mysticetes during their migration (e.g. Todd et al., 2015).

354. Due to the low recoverability and high international value, for mysticetes; the sensitivity is assigned as **high** for PTS. The sensitivity of mysticetes is assigned as **medium** for TTS and disturbance as mysticetes have some resilience to behavioural disturbance and TTS is recoverable.

9.5.4. Pinnipeds

355. Pinnipeds may experience short-term behavioural changes due to underwater noise from dredging and rock replacement, such as avoidance or displacement. However, New Zealand fur seals have shown no responses to ongoing dredging at a port development (Todd et al., 2015).

356. The underwater noise modelling (see **Appendix 10.1 Underwater Noise Modelling Report**) predicted PTS ranges to be less than 50 m, which means that PTS from non-piling activities, which indicates that PTS is not expected to occur, as the hearing threshold would not be exceeded.

357. Due to the high international value, the sensitivity of pinnipeds is assigned as **medium** for TTS and disturbance as the receptor group has some resilience to behavioural disturbance and TTS is recoverable.

9.5.5. Leatherback Turtle

358. Leatherback turtles are at risk of injury or mortality from dredging equipment, particularly trailing suction hopper dredges. Turbidity and underwater noise from dredging may cause turtles to avoid key habitats, disrupting feeding and migration (Reine, 2022).

359. The underwater noise modelling (see **Appendix 10.1 Underwater Noise Modelling Report**) predicted PTS ranges to be less than 50 m for delphinids, which indicates that PTS is not expected

to occur, as the hearing threshold would not be exceeded. Due to the similarities in turtles' and delphinids' PTS/TTS thresholds, this has been applied to the leatherback turtle.

360. Due to the high international value, the sensitivity of leatherback turtle is assigned as **medium** for TTS and disturbance as having some resilience to behavioural disturbance and TTS is recoverable.

9.6. SENSITIVITY FOR IMPACT 6: AUDITORY INJURY AND BEHAVIOURAL IMPACTS FROM VESSEL NOISE

361. Potential impacts from the presence of vessels in the WDA is assessed in Section 10.11.1.7 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.6.1. Harbour porpoise

362. A recent study combined aerial surveys conducted between 2015 and 2022 with AIS vessel traffic data and environmental covariates to evaluate the influence of maritime activity on harbour porpoise distribution in the North Sea (Pigeault et al., 2024). Key findings indicate that:

- Harbour porpoises avoid high vessel traffic areas, maintaining up to 9 km distance;
- Key predictors: number of vessels and average proximity; and
- Persistent vessel activity creates long-term zones of reduced presence.

363. Numerous offshore windfarm studies have recorded deterrence ranges of harbour porpoise due to the presence of vessels.

- Brandt et al. (2018) found a decline in harbour porpoise within 2 km of German offshore windfarms before piling due to vessel activity.
- Studies in the Moray Firth indicate that harbour porpoise had a mean distance of 2 km from construction vessels, with no responses recorded beyond 4 km (Benhemma-Le Gall et al., 2021).
- Benhemma-Le Gall et al. (2023) found that vessel type matters. Beatrice Offshore Windfarm (anchored vessel) saw a 32.8% decrease and Moray East (jack-up vessel) saw a 13.2% decrease in detections before piling mitigation.

364. A further study of Berry Head, Southwest England, found a significant negative correlation between vessel frequency and porpoise sightings and foraging activity, suggesting avoidance behaviour (Roberts et al., 2019). Additional research in UK waters has shown that porpoises alter surfacing rates and movement patterns in response to different vessel types, indicating sensitivity to disturbance (Grundy, 2021).

365. An individual's decision to leave and/or return to an exposed area likely depends on its fitness, energetic status and perception of predation risk (Frid and Dill, 2002; Beale and Monaghan, 2004, Benhemma-Le Gall et al., 2023).

366. Due to the low recoverability and high international value, the sensitivity of harbour porpoise is **high** for PTS, whilst for TTS and disturbance is assigned as **medium** as harbour porpoise has some resilience to behavioural disturbance and TTS is recoverable.

9.6.2. Delphinids

367. Delphinids rely on acoustic communication and echolocation, making them vulnerable to vessel noise. Research shows that vessel noise can reduce the use of contact calls and low-frequency vocalisations, potentially altering communication patterns (Vergara et al., 2025). In UK waters, frequent vessel traffic may impair hearing sensitivity in bottlenose dolphins, affecting echolocation and foraging success. Noise also disrupts communication essential for group cohesion and prey

information sharing (Marley et al., 2017), and prolonged exposure increases the likelihood of temporary or permanent auditory damage.

368. Behavioural responses include changes in vocalisation, such as longer and louder whistles in response to increasing noise (Foote et al., 2004; Sørensen et al., 2023). Other observed impacts include altered dive patterns, increased travel speeds, reduced resting, and avoidance of noisy areas (Richardson, 2012). Vessel noise has also been linked to reduced whistle rates, elevated stress hormones, and disruption of cooperative foraging (Erbe et al., 2019). Chronic exposure may reduce foraging efficiency and increase energy expenditure, with potential consequences for health and reproductive success (Tougaard, 2025; Wisniewska et al., 2018).

369. The underwater noise modelling (see **Appendix 10.1 Underwater Noise Modelling Report**) predicted PTS ranges to be less than 50 m, which indicates that PTS is not expected to occur, as the hearing threshold would not be exceeded.

370. Despite the high international value, the sensitivity of delphinids is assigned as **medium** for TTS and disturbance as the receptor group has some resilience to behavioural disturbance and TTS is recoverable.

9.6.3. Mysticetes

371. Vessel activity in UK waters has been shown to significantly affect mysticetes, primarily through habitat displacement and behavioural disturbance. Studies off the northwest coast of Ireland, including Anderwald et al. (2013) and Culloch et al. (2016), reported reduced sightings of minke whales during periods of increased vessel traffic, particularly from utility and fishing vessels. These changes were attributed to underwater noise disrupting essential behaviours and the acoustic environment. Evidence from Natural England’s Marine Recreation Briefing further supports that vessel proximity and speed can trigger avoidance responses and interrupt feeding and social activities, as observed in Cardigan Bay and Pembrokeshire (Natural England, 2017).

372. Although direct measurements of hearing thresholds are limited, anatomical and modelling studies indicate that baleen whales are particularly susceptible to vessel noise due to the overlap in frequency and intensity (International Association of Oil & Gas Producers (IOGP), 2024). Chronic exposure to low-frequency ship noise can lead to acoustic masking, reduced vocalisation rates, and displacement from feeding or breeding areas (Erbe et al., 2019). While permanent auditory injury is unlikely under typical vessel conditions, prolonged noise exposure has been linked to elevated stress hormones (Rolland et al., 2012) and reduced reproductive success. Behavioural impacts include altered migration routes, reduced feeding activity, and changes in vocal behaviour. For example, humpback whales have been observed to shorten songs, shift frequency ranges, or cease vocalising in response to vessel noise, while North Atlantic right whales (*Eubalaena glacialis*) reduce feeding and relocate from noisy areas. Similarly, grey whales have altered migration routes to avoid high-noise zones, increasing travel distances and energy expenditure (Erbe et al., 2019).

373. The underwater noise modelling (see **Appendix 10.1 Underwater Noise Modelling Report**) predicted PTS ranges to be less than 50 m, which indicates that PTS is not expected to occur, as the hearing threshold would not be exceeded.

374. The sensitivity of mysticetes is assigned as **medium** for TTS and disturbance as the receptor group has some resilience to behavioural disturbance and TTS is recoverable.

9.6.4. Pinnipeds

375. Pinnipeds are vulnerable to underwater noise from vessels, which can lead to both auditory and behavioural impacts. Intense or prolonged exposure may cause TTS, with recovery dependent on exposure duration and intensity (Reichmuth et al., 2009). For example, a harbour seal exposed to 60 seconds of sound pressure at 181 dB re 1 µPa experienced a 48 dB TTS without behavioural response; hearing at the exposure frequency recovered within two days, but elevated thresholds at a higher frequency persisted for over a year, indicating potential permanent damage. Modelling studies in the Moray Firth estimated SEL_{cum} / $L_{E,p,t}$ between 170 and 189 dB re 1 µPa²s, exceeding thresholds for TTS onset (Southall et al., 2019; Jones et al., 2017). Vessel noise in the WDA is likely to have much lower SEL_{cum} / $L_{E,p,t}$ based on results in the underwater noise modelling for vessel noise from offshore windfarm construction activities recorded at an upper sound level of 168 dB re 1 µPa.

376. Behavioural responses to vessel noise include increased vigilance, altered dive patterns, and changes in foraging behaviour, which can raise energy expenditure and reduce access to critical habitats. Research in the English Channel and Celtic Sea found that even moderate sound levels (averaging 122 dB for adults and 111 dB for pups) significantly altered diving behaviour, with adults increasing ascent rates and pups reducing descent rates (Trigg, 2019). Tagging studies in harbour seals revealed individual variability, with some seals avoiding noisy areas while others showed signs of habituation (Ruser et al., 2023). Vessel noise can also mask or interfere with pinniped communication; grey seal vocalisations have been shown to overlap with vessel noise, potentially disrupting social interactions (Bagocius, 2014).

377. The underwater noise modelling (see **Appendix 10.1 Underwater Noise Modelling Report**) predicted PTS ranges to be less than 50 m, which indicates that PTS is not expected to occur, as the hearing threshold would not be exceeded.

378. The sensitivity of pinnipeds is assigned as **medium** for TTS and disturbance as the receptor group has some resilience to behavioural disturbance and TTS is recoverable.

9.6.5. Leatherback turtle

379. Leatherback turtles are sensitive to low-frequency vessel noise, which may interfere with navigation and predator detection. Behavioural responses include avoidance, erratic swimming, and reduced feeding. Vessel noise can also interrupt basking or resting behaviour for leatherback turtles, especially in nearshore areas.

380. Samuel et al (2005) exposed sea turtles to vessel noise and found that the turtles displayed agitated behaviour, abrupt body movements, startle responses, and even prolonged inactivity at the bottom of the tank in response to low-frequency signals. Such responses are similar to the ones observed during exposure of sea turtles to simulated boat sounds in an outdoor pool (O’Hara, 1990).

381. Chronic exposure may impair reproductive success and increase the chance of vessel strikes due to reduced awareness of approaching boats (Nelms et al., 2016; Convention on the Conservation of Migratory Species of Wild Animals (CMS), 2024).

382. The underwater noise modelling (see **Appendix 10.1 Underwater Noise Modelling Report**) predicted PTS ranges to be less than 50 m for delphinids, which has been applied to leatherback turtle, which indicates that PTS is not expected to occur, as the hearing threshold would not be exceeded.

383. The sensitivity of leatherback turtle is assigned as **medium** for TTS and disturbance as they exhibit some resilience to behavioural disturbance and TTS is recoverable.

9.7. SENSITIVITY FOR IMPACT 7: BARRIER EFFECTS DUE TO UNDERWATER NOISE

384. Potential impacts from barrier effects due to underwater noise in the WDA is assessed in Section 10.11.1.8 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.7.1. Harbour Porpoise

385. The sensitivity for barrier effects is the same as the sensitivity for disturbance, see **Sections 9.1.1**; **9.3.1**; **9.4.1**; **9.5.1** and **9.6.1**.

386. Due to the WDA being surrounded by islands and located close to SACs and MPAs, the area is considered ecologically sensitive. Nevertheless, taking into account the high international value of the receptor, its high energetic demands, and its capacity to adapt and recover, the sensitivity of harbour porpoise is assigned as **medium**.

9.7.2. Delphinid species

387. The sensitivity for barrier effects is the same as the sensitivity for disturbance, see **Sections 9.1.2**; **9.3.2**; **9.4.2**; **349** and **366**.

388. Although barrier effects can cause restrictions in foraging for delphinids, they have the potential to adapt through altering course, moving to another foraging area, and altering their vocalisation. Despite the high value of the receptor group, the sensitivity is assigned as **medium**.

9.7.3. Mysticetes

389. The sensitivity for barrier effects is the same as the sensitivity for disturbance, see **Sections 9.1.3**; **9.3.3**; **9.4.3**; **352** and **370**.

390. Barrier effects from underwater noise have the potential to restrict mysticetes accessing foraging areas and migration routes which can have implications for individuals, and at a population level. Despite the location of the WDA being in close proximity to the Sea of Hebrides NCMPA, a site designated for minke whale, and the high value of the receptor group, the sensitivity is assigned as **medium** for all mysticetes, due to their ability to adapt and recover.

9.7.4. Pinnipeds

391. The sensitivity for barrier effects is the same as the sensitivity for disturbance, see **Sections 9.1.4**; **9.3.4**; **9.4.4**; **354** and **9.6.4**.

392. Despite the high value of the species, the location of the WDA, positioned near coastal islands, SACs and protected seal haul-out sites, the sensitivity is assigned as **medium** for both grey and harbour seal, due to their ability to adapt and recover.

9.7.5. Leatherback turtle

393. The sensitivity for barrier effects is the same as the sensitivity for disturbance, see **Sections 9.1.5**; **9.3.5**; **9.4.5**; **9.5.5** and **9.6.5**.

394. Despite the high value of the receptor and the location of the WDA, in a coastal region, positioned among ecologically important islands, the sensitivity is assigned as a precautionary **medium**, due to their ability to adapt and recover.

9.8. SENSITIVITY FOR IMPACT 8: VESSEL INTERACTION (COLLISION RISK)

395. Potential collision risk from vessel activities in the WDA is assessed in Section 10.11.1.9 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.8.1. Harbour porpoise

396. Harbour porpoise are small and highly mobile, and, given their responses to vessel noise (e.g. Thomsen et al. 2006), are expected to largely avoid vessel collisions. Heinänen and Skov (2015) modelling indicates a negative relationship between the number of vessels and the distribution of harbour porpoise in the Irish and Celtic Seas during summer, suggesting that the species could exhibit avoidance behaviour which reduces the risk of collision with vessels. However, studies in the Sound of Islay and Kyle Rhea found porpoises present in high-energy tidal sites where vessel activity overlaps with porpoise foraging zones, can increase the likelihood of collision (Wilson et al., 2014). Avoidance behaviour was observed during tidal turbine operation, but not all individuals may evade fast-moving vessels, especially in narrow channels (Palmer et al., 2021a).

397. Despite the high value of the receptor, the sensitivity of harbour porpoise is assigned as **low** because harbour porpoises naturally avoid vessels, reducing the likelihood of vessel strikes.

9.8.2. Delphinids

398. Delphinids in UK waters face elevated collision risk in busy shipping corridors such as the English Channel and Celtic Sea. A multi-species risk assessment found that bottlenose dolphins are particularly vulnerable in areas of high vessel density, with co-occurrence hotspots identified in UK MPAs (Robbins, 2020a). Dolphins may not always detect or avoid fast-moving vessels, especially at night or in poor visibility (Robbins, 2020b; Palmer et al., 2021b), increasing the risk of blunt trauma or propeller injury.

399. However, delphinids are generally considered less sensitive to vessel strikes than larger baleen whales due to their smaller size, agility, and ability to exhibit avoidance behaviour. Studies indicate that delphinids often habituate to vessel presence and show lower incidence of collision-related trauma compared to mysticetes (Laist et al., 2001; Schoeman et al., 2020).

400. Despite the high value of the receptor, the sensitivity of delphinids is assigned as **low**, because delphinids are relatively small, highly agile animals capable of rapid manoeuvring and responsive movement around vessels.

9.8.3. Mysticetes

401. Vessel collisions mostly involve mysticetes (Vighi, 2025), due to their large size and as they are slow-moving and often feed near the surface, making them susceptible to vessel strikes (Laist et al., 2001). Fin whale and humpback whale are among the species most reported in vessel collisions (Vighi, 2025).

402. Observations during gas pipeline construction off northwest Ireland showed reduced whale presence during periods of high vessel traffic, suggesting displacement due to noise and potential collision risk (Culloch et al., 2016).

403. There are several other factors that may increase the vulnerability of an individual to vessel strikes, such as age (juveniles are most at risk due to their lack of experience around large ships, more time spent at the surface and reduced spatial awareness) and ambient noise (high levels of background noise may mask the sound of approaching vessels) (Laist et al., 2001; Erbe et al., 2019; Vighi, 2025).

404. Despite the high value of the receptor, the sensitivity of mysticetes is therefore assigned as **medium** because their large size and surface-oriented behaviours make them vulnerable to vessel strikes.

9.8.4. Pinnipeds

405. Pinnipeds are at risk of vessel collisions, especially in coastal areas where recreational and commercial traffic is high. A study analysed 27 confirmed cases of harbour seal deaths caused by propeller strikes in the Salish Sea region between 2002 and 2019. The study found that weaned pups accounted for 64% of cases, suggesting that their inexperience make them more vulnerable to vessel strikes (Olson et al., 2021). Postmortems found deep lacerations, amputations, and blunt force trauma consistent with propeller injuries, concluding that these injuries were fatal (Olson et al., 2021).

406. The study aimed to identify patterns in age, seasonality, and vessel activity to better understand the risks and inform mitigation strategies.

407. Harbour seal have been shown to avoid areas with underwater noise, such as vessel noise, but their dive behaviour and surfacing patterns still place them at risk of collision with vessels operating at speed (Hastie et al., 2018). Juvenile seals and individuals in transit between haul-out sites may be particularly vulnerable.

408. Pinnipeds are generally considered less sensitive to vessel strike compared to cetaceans due to their behaviour and ecology. They spend significant time underwater and can dive quickly when disturbed, reducing surface exposure where collisions occur. Protected haul-out sites are typically away from major shipping lanes, further lowering risk. Collision sensitivity assessments often rate seals as low, with negligible or minor impacts predicted in environmental studies. Their robust body structure and blubber may offer some resilience to non-lethal injuries, although severe trauma can occur at high speeds (> 5 m/s) (Hastie et al., 2018; Wilson et al., 2017; Onoufriou et al., 2019).

409. Despite the high value of the receptor, the sensitivity of pinnipeds is assigned as **low**, because they are relatively small, agile coastal species that remain alert to nearby disturbance.

9.8.5. Leatherback turtle

410. Sea turtles are particularly vulnerable to vessel collisions, when they surface for air and/or are resting at the surface between dives. All sea turtle species are at risk, however, sea turtles migrating or foraging in coastal or pelagic habitats are more vulnerable to collisions with shipping vessels.

411. Leatherback turtles migrate to UK waters in summer to feed on jellyfish, often surfacing slowly and resting near the surface. This behaviour increases their risk of vessel collision, particularly from fast-moving recreational boats and fishing vessels. Haelters and Kerckhof (1999) and Casale et al. (2003), report, from 1988 to 2003, three strandings of leatherback turtles, two of which presented lesions associated with vessel strikes, which is extremely low.

412. Despite the high value of the receptor, the sensitivity of leatherback turtle is assigned as **low**, because although their surface-resting and slow surfacing behaviours can increase collision risk, documented vessel-strike occurrences in UK waters remain extremely rare.

9.9. SENSITIVITY FOR IMPACT 9: DISTURBANCE AT PROTECTED SEAL HAUL-OUT SITES

413. Potential disturbance to protected seal haul-out sites due to noisy activities in the WDA is assessed in Section 10.11.1.10 in **Chapter 10 Marine Mammals and Leatherback Turtle** for pinnipeds.

414. Pinnipeds vary in their response to disturbance depending on the type of disturbance, whether it is noise from piling, non-piling construction activities and/or vessels or from the presence of vessels and the proximity to haul-out sites. A 2016 study at Sheringham Shoal Offshore Windfarm found no significant overall displacement of seals during construction. However, during pile driving activities, there was a significant reduction in seals at haul-out sites up to 25 km away, with numbers returning to typical levels two hours after piling ceased (Russell et al. 2016).

415. Disturbance to seals from vessel noise and presence has been demonstrated up to 500 m from haul-out sites in the UK (Cates and Acevedo-Gutierrez, 2017). Beyond 600 m, there was no discernible effect on the behaviour of harbour seal.

416. Many protected seal haul-out sites are designated for breeding/pupping. Grey seals pup in autumn (September to November) and harbour seals pup in the summer months (June to August). Any disturbance to pregnant females can have serious consequences for the unborn pup, e.g. if the pregnant female is wasting energy from fleeing, then she may not have the strength to maintain a healthy pregnancy. Another concern is for mother and pup interactions, if the mother is disturbed, it could result in the abandonment of the pup, resulting in malnourishment and death for the pup.

417. Despite the high value of pinnipeds, and due to the high adaptability and recoverability of pinnipeds, the sensitivity to disturbance at haul-out sites is assigned as **medium**.

9.10. SENSITIVITY FOR IMPACT 10: CHANGES TO PREY AVAILABILITY

418. Potential changes to prey due to activities in the WDA is assessed in Section 10.11.1.11 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.10.1. Harbour porpoise

419. Harbour porpoises have a flexible diet that varies geographically and seasonally, foraging on a range of different fish (sprat (*Sprattus sprattus*); herring (*Clupea harengus*), sandeels (*Ammodytidae*); squid, octopus and shellfish (Andreason et al., 2017), reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. Due to high metabolic demands, they must feed frequently, though depending on the environmental conditions, they can rely on blubber reserves for up to 3–5 days during short-term disturbances, depending on body condition (Kastelein et al., 2018; Leopold et al., 2023). Harbour porpoise are therefore considered to have low to medium sensitivity to changes to prey resources.

420. Due to the high international value and recoverability; the sensitivity is assigned as **medium**, where a reduction in prey could influence foraging efficiency or energy intake, but harbour porpoise retains the ability to adapt their behaviour, modify search effort, or switch to alternative prey resources.

9.10.2. Delphinids

421. Delphinids, including species like bottlenose dolphin, short-beaked common dolphin and white-beaked dolphin show broad dietary preferences and wide foraging ranges. All dolphin species are considered to have large foraging ranges, and a broad range of prey species, and are therefore considered to have low sensitivity to changes in prey resources. Recent studies highlight their ability

to shift prey and habitat use in response to environmental changes (Plint et al., 2023; Spitz et al., 2024).

422. Due to the high recoverability; the sensitivity is assigned as **low**, as delphinids have a high degree of foraging flexibility, broad diets, and the ability to relocate and exploit alternative feeding areas.

9.10.3. Mysticetes

423. Mysticetes in Scottish waters have similar prey preferences, foraging on a variety of prey, including (Ammodytidae, Mackerel (*Scomber scombrus*); herring; sprat), and krill and other euphausiids, but exhibit regional and seasonal preferences. For instance, in the Hebrides, minke whale primarily feed on sandeel and sprat with seasonal shifts in preference. Reduced prey availability can lead to a decline in foraging success and nutritional stress (Anderwald et al., 2012), causing a delay in migration, or extended residency in foraging areas with reduced reproductive success, particularly in species with high energetic demands like humpback and fin whales (Stewart et al., 2025).

424. In addition, mysticetes play a vital role in nutrient cycling and a reduction on their foraging success can affect the productivity of the ecosystem (Savoca et al., 2021).

425. The sensitivity is assigned as **medium**. Whilst a reduction in prey could influence foraging efficiency or energy intake, mysticetes retain the ability to adapt their behaviour, relocate, or switch to alternative prey resources.

9.10.4. Pinnipeds

426. Grey seal and harbour seal are opportunistic feeders, consuming a wide range of prey including fish and cephalopods. Their diet varies by region and season, with grey seal often targeting larger prey and harbour seals preferring smaller, more coastal species (Russell et al., 2023). Both species have relatively large foraging ranges and can shift foraging areas in response to prey availability (Jones et al., 2022).

427. Grey seal are opportunistic predators with the ability to switch prey based on availability. Their diet includes sandeels, cod, hake, and flatfish, many of which are commercially important. A modelling study showed that grey seals switch prey when preferred species become scarce (Smout et al., 2014). Grey seal have been recorded to switch from fish to harbour porpoise and harbour seal, and evidence suggests that grey seal predation on harbour seals has increased in recent years and may contribute to regional declines in harbour seal populations (Langley and Brownlow, 2025).

428. Harbour seal also consume a wide range of prey, including herring, redfish, squid, and flounder, but tend to target smaller prey compared to grey seal. Their diet shows regional and seasonal variation, and they may be more vulnerable to changes in prey availability due to less dietary flexibility (Lyssikatos and Wenzel, 2024).

429. The sensitivity for pinnipeds is assigned as **low**, as pinnipeds are opportunistic feeders, and have the ability to relocate and exploit alternative feeding areas.

9.10.5. Leatherback turtle

430. Leatherback turtles are highly migratory and feed primarily on gelatinous zooplankton, especially jellyfish. They are the most frequently recorded marine turtle species in UK waters, with regular sightings along the west coast of Scotland during summer months when jellyfish blooms are abundant (NatureScot, 2025). Observations from the Clyde Sea area confirm that adult leatherbacks forage in Scottish coastal waters, including Loch Fyne and Loch Long, where they have been seen actively feeding on jellyfish (O'Reilly et al., 2024). Their ability to travel vast distances and exploit

dynamic prey suggests adaptability to short-term changes in prey availability. However, broader threats such as fisheries bycatch and habitat degradation remain significant concerns for global populations (Griffiths and Wallace, 2024).

431. The sensitivity is assigned as **low**, as leatherback turtle have wide foraging areas, and can relocate to alternative feeding grounds as well as switch to alternative prey resources.

9.11. SENSITIVITY FOR IMPACT 11: UNDERWATER NOISE FROM OPERATIONAL WIND TURBINE GENERATOR

432. Potential impacts from operating Wind Turbine Generator (WTG) noise in the WDA is assessed in Section 10.11.1.12 in **Chapter 10 Marine Mammals and Leatherback Turtle** for all receptors.

9.11.1. Harbour porpoise

433. Monitoring was carried out at the Horns Rev and Nysted windfarms in Denmark during the operation between 1999 and 2006 (Diederichs et al. 2008). Numbers of harbour porpoise within Horns Rev were slightly reduced compared to the wider area during the first two years of operation, however, it was not possible to conclude that the windfarm was solely responsible for this change in abundance without analysing other dynamic environmental variables (Tougaard et al. 2009). Diederichs et al. (2008) recorded no noticeable effect on the abundances of harbour porpoise at varying wind velocities at both of the offshore windfarms studied, following two years of operation. Recent monitoring in the Belgian part of the North Sea investigated harbour porpoise responses to operational offshore windfarms using PAM. The study found that operating WTGs did not deter them from using the area, instead evidence indicated potential biological benefits due to the artificial reef structures around the WTG providing additional foraging opportunities (Leemans and Fijn, 2024).

434. The sensitivity for harbour porpoise is assigned as **medium** for auditory injury and **low** for disturbance, because of their ability to adapt and recover.

9.11.2. Delphinids

435. PAM at the Blyth Offshore Demonstrator project in Northumberland, which used gravity-base foundations, revealed no significant changes in dolphin occurrence before, during or after WTG installation. Even after three years of monitoring, between 2016 and 2019, dolphin presence remained stable, suggesting minimal behaviour disruption (Potlock et al., 2023). Further studies at the European Offshore Wind Deployment Centre (EOWDC) in northeast Scotland use photo identification and long-term tracking to assess bottlenose dolphin movements. Results showed continued use of the area during the operational phase, with no evidence of habitat abandonment or population-level impacts (Arso Civil et al., 2021). In addition, a modelling study in the Moray Firth on bottlenose dolphins further found no evidence of biologically significant effects on health or population dynamics (New et al., 2013), suggesting that operational WTG are unlikely to result in any long-term disturbance to delphinid species.

436. The sensitivity for delphinids is assigned as **medium** for auditory injury and l**ow** for disturbance, because of their ability to adapt and recover.

9.11.3. Mysticetes

437. PAM has been increasingly used to assess whale presence and behaviour near operational windfarms in the Moray Firth region. For the Salamander EIA, Sea Mammal Research Unit (SMRU) (Clarkson et al. (2024)) conducted a detailed assessment of minke whale presence within the Southern Trench MPA. The study was a predictive, desk based assessment that combined existing regional PAM data, wider evidence from Scottish waters, and habitat modelling to understand minke

whale presence and behaviour within the Southern Trench MPA and to forecast how the species might respond to future construction and operation of the project. Using these datasets and modelled noise scenarios, the study predicted that although minke whales may show short term behavioural reactions to vessel activity or turbine noise, these effects would be temporary and not sustained, and therefore unlikely to lead to long term displacement or habitat abandonment

438. An additional study in the Moray Firth examined humpback whale occurrence during the operational phase of the Beatrice Offshore Wind Farm. Using PAM combined with visual sightings, the researchers detected humpback whale vocalisations on multiple occasions across a two-year period, highlighting the continued use of the area despite WTG operation. The study found no long-term evidence of displacement or avoidant behaviour, only some short-term changes in vocalisation during periods of increased vessel traffic for maintenance visits (Fernandez-Betelu et al., 2024).

439. The sensitivity for mysticetes is assigned as **medium** for auditory injury and l**ow** for disturbance, because of their ability to adapt and recover.

9.11.4. Pinnipeds

440. Grey and harbour seal have been the subject of extensive research to understand their responses to operational offshore windfarms, with findings suggesting limited long-term disturbance. A study by Ørsted in The Wash and North Norfolk Coast SAC, deployed GPS tags on harbour seals to track their movement patterns around operational windfarms. The results highlighted that seals continued to use the area for foraging and general movements, with no evidence of displacement or habitat abandonment (Ørsted, 2024). Similarly, Whyte (2022) used biologging data to assess behavioural responses during operational phases and found no alterations in long-term movement and diving behaviour.

441. Further evidence suggests that both grey and harbour seal forage near WTG structures, with some individuals navigating windfarm arrays in grid-like patterns, suggesting potential attraction to artificial reef effects or prey aggregation (McConnell et al., 2012; Russell and McConnell, 2014). This has also been seen in a review of seal distribution in the North Sea, which also found that pinnipeds may use WTG bases as foraging hotspots (Russel et al., 2014).

442. The sensitivity for pinnipeds is assigned as **medium** for auditory injury and l**ow** for disturbance, because of their ability to adapt and recover.

9.11.5. Leatherback turtle

443. While direct field studies on their behavioural responses to operational offshore windfarms in the UK are limited, several assessments provide insight into potential impacts. The Oslo–Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Commission's 2022 status assessment confirmed that leatherbacks are regularly recorded in UK and Irish waters between June and October, with peak sightings in August, and noted no evidence of displacement due to operational windfarms. While operational noise from WTGs is significantly lower than construction-phase activities like pile driving, it may still contribute to acoustic masking, potentially interfering with turtles' ability to detect prey such as jellyfish or navigate using environmental cues.

444. The International Council for the Exploration of the Sea (ICES) Journal of Marine Science introduced the "flyway construct" as a framework for assessing offshore wind impacts on migratory species, such as leatherback turtles (Secor et al., 2025). This approach emphasises the importance of migration corridors and suggests that the placement of WTG and other associated infrastructure can alter migratory routes. Although no behavioural displacement of leatherback turtles has been documented in UK waters to date, the potential for cumulative inter-related effects, such as changes

in movement patterns, foraging efficiency, or navigation due to chronic exposure to underwater noise and electromagnetic fields, remains a concern.

445. The sensitivity for leatherback turtle is assigned as **medium** for auditory injury and l**ow** for disturbance, because of their ability to adapt and recover.

REFERENCES

Accomando, A., Stephens, J., O'Kelley, A., Nease, K., Mulsow, J., Branstetter, B., Robeck, T., & Finneran, J. (2025). Effect of sound duration and masking noise on behavioral hearing thresholds in killer whales and bottlenose dolphins. *Aquatic Noise Trust Conference Abstracts*, May 2025. https://aquaticnoise.org/wp-content/uploads/2025/05/AN2025-Abstracts-27-May-MASTER.pd [Accessed 05 May 2026]

Andreasen, H., Ross, S.D., Siebert, U., Andersen, N.G., Ronnenberg, K. and Gilles, A., (2017). Diet composition and food consumption rate of harbor porpoises (Phocoena phocoena) in the western Baltic Sea. Marine Mammal Science, *33*(4), pp.1053-1079.

Anderwald, P., Evans, P. G. H., Dyer, R., Dale, A., Wright, P. J., & Hoelzel, A. R. (2012). *Spatial scale and environmental determinants in minke whale habitat use and foraging.* Marine Ecology Progress Series, 450, 259–274. https://doi.org/10.3354/meps09573 [Accessed 05 May 2026]

Anderwald, P., Evans, P. G. H., Dyer, R., Dale, A., Wright, P. J., & Hoelzel, A. R. (2013). *Spatial scale and environmental determinants in minke whale habitat use and foraging*. Marine Ecology Progress Series, 450, 259–274. https://doi.org/10.3354/meps09573 [Accessed 05 May 2026]

APEM (2024). MachairWind Digital Aerial Surveys Technical Report, Draft Final Report April 2021 to September 2023.

Arso Civil, M., Quick, N., Mews, S., Hague, E., Cheney, B.J., Thompson, P.M., & Hammond, P.S. (2021). Improving understanding of bottlenose dolphin movements along the east coast of Scotland. Final report to the European Offshore Wind Deployment Centre (EOWDC). SMRU Consulting Report SMRUC-VAT-2020-10.

ASCOBANS (2015). Recommendations of ASCOBANS on the Requirements of Legislation to Address Monitoring and Mitigation of Small Cetacean Bycatch. October 2015.ASCOBANS, 2015.

Baxter, J. M., Boyd, I., Cox, M., Donald, A.E., Malcolm, S. J., Miles, H., Miller, B., and Moffat, C.F. (2011). Scotland's Marine Atlas: Information for the national marine plan, Marine Scotland, Edinburgh

Beck, S., Foote, A.D., Kötter, S., Harries, O., Mandleberg, L., Stevick, P.T, Whooley, P. and Durban, J. (2014). Using opportunistic photo-identifications to detect a population decline of killer whales (Orcinus orca) in British and Irish waters. Journal of the Marine Biological Association of the United Kingdom, 94(6): 1327-1333. doi:1 0.1017/S0025315413001124.

BEIS (2022). UK Offshore Energy Strategic Environmental Assessment 4 (OESEA4). Appendix A1a.6 Marine Reptiles.

Benhemma-Le Gall, A., Graham, I. M., Merchant, N. D., & Thompson, P. M. (2021). Broad-scale responses of harbour porpoises to pile-driving and vessel activities during offshore windfarm construction. *Frontiers in Marine Science*, 8, 664724. https://doi.org/10.3389/fmars.2021.664724 [Accessed 05 May 2026]

Benhemma-Le Gall, A., Thompson, P., Merchant, N., & Graham, I. (2023). Vessel noise prior to pile driving at offshore windfarm sites deters harbour porpoises from potential injury zones. Environmental Impact Assessment Review, 103, 107271. https://doi.org/10.1016/j.eiar.2023.107271 [Accessed 05 May 2026]

Bilgmann, K., Möller, L. M., Harcourt, R. G., Kemper, C. M., & Beheregaray, L. B. (2011). The use of carcasses for the analysis of cetacean population genetic structure: A comparative study in two dolphin species. PLoS ONE, 6, e20103. https://doi.org/10.1371/journal.pone.0020103

Bostrom, B.L., Jones, T.T., Hastings, M., Jones, D.R. (2010). Behaviour and Physiology: The Thermal Strategy of Leatherback Turtles.

Botterell, Z.L., Penrose, R., Witt, M.J. and Godley, B.J. (2020). Long-term insights into marine turtle sightings, strandings and captures around the UK and Ireland (1910–2018). Journal of the Marine Biological Association of the United Kingdom, 100(6), pp.869-877.

Brandt, M.J., Dragon, A.C., Diederichs, A., Bellmann, M.A., Wahl, V., Piper, W., Nabe-Nielsen, J. and Nehls, G., (2018). Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany. Marine Ecology Progress Series, *596*, pp.213-232.

Brown, W. (2018). Fine scale distribution use of harbour porpoises (Phocoena phocoena) in the Firth of Clyde. University of St Andrews.

Buckland, S., Bloch, D., Cattanach, K.L., Gunnlaugsson, T., Hoydall, K., Lens, S. and Sigurjónsson, J., (1993). Distribution and abundance of long-finned pilot whales in the North Atlantic, estimated from NASS-87 and NASS-89 data. Centro Oceanográfico de Vigo.

Canning, S. J., Santos, M. B., Reid, R. J., Evans, P. G. H., Sabin, R. C., Bailey, N., & Pierce, G. J. (2008). Seasonal distribution of white-beaked dolphins (Lagenorhynchus albirostris) in UK waters with new information on diet and habitat use. *Journal of the Marine Biological Association of the United Kingdom*, *88*(6), 1159–1166. doi:10.1017/S002531540800007

Canty, A. and Ripley, B. (2010). Boot: bootstrap R (S-Plus) functions. R package version 1.2-42

Carter, M. I. D, Bivins, M., Duck, C. D., Hastie, G. D., Morris, C. D., Moss, S. E. W., Thompson, D., Thompson, P. M., Vincent, C., Russell, D. J. F. (2025). Updated habitat-based distribution maps for harbour and grey seals in Scotland. Report to Scottish Government by Sea Mammal Research Unit, University of St Andrews.

Carter, M.I.D., Boehme, L., Cronin, M.A., Duck, C.D., Grecian, W.J., Hastie, G.D., Jessopp, M., Matthiopoulos, J., McConnell, B.J., Miller, D.L., Morris, C.D., Moss, S.E.W., Thompson, D., Thompson, P.M. and Russell, D.J.F. (2022). Sympatric Seals, Satellite Tracking and Protected Areas: Habitat-Based Distribution Estimates for Conservation and Management. Front. Mar. Sci. 9:875869. doi: 10.3389/fmars.2022.875869.

Carter, M.I.D., Boehme, L., Duck, C.D., Grecian, W.J., Hastie, G.D., McConnell, B.J., Miller, D.L., Morris, C.D., Moss, S.E.W., Thompson, D., Thompson, P.M. and Russell, D.J.F. (2020). Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. Sea Mammal Research Unit, University of St Andrews, Report to BEIS, OESEA-16-76/OESEA-17-78.

Casale, P., Nicolosi, P., Freggi, D., Turchetto, M. & Argano, R. (2003). Leatherback turtles (Dermochelys coriacea) in Italy and in the Mediterranean Basin. Herpetological Journal, 13(3), pp. 135–139. Available at: https://www.thebhs.org/publications/the-herpetological-journal/volume-13-number-3-july 2003/1722-05-leatherback-turtles-dermochelys-coriacea-in-italy-and-in-the-mediterranean-basin/fil [Accessed 05 May 2026]

Castellote, M., Clark, C. W., & Lammers, M. O. (2012). Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. *Biological Conservation*, 147(1), 115–122. https://doi.org/10.1016/j.biocon.2011.12.021

Cates, K., & Acevedo-Gutiérrez, A. (2017). Interactions between harbor seals and humans in a heavily used marine environment. *Anthrozoös*, 30(2), 239–255. https://doi.org/10.1080/08927936.2017.1310984 [Accessed 05 May 2026]

Cerchio, S., Strindberg, S., Collins, T., Bennett, C., & Rosenbaum, H. (2014). Seismic surveys negatively affect humpback whale singing activity off Northern Angola. *PLoS ONE*, 9(3), e86464. https://doi.org/10.1371/journal.pone.0086464

Cheney, B., Thompson, P.M., Ingram, S.N., Hammond, P.S., Stevick, P.T., Durban, J.W., Culloch, R.M., Elwen, S.H., Mandleberg, L., Janik, V.M., Quick, N.J., ISLAS-Villanueva, V., Robinson, K.P., Costa, M., Eisfeld, S.M., Walters, A., Phillips, C., Weir, C.R., Evans, P.G.H., Anderwald, P., Reid, R.J., Reid, J.B. and Wilson, B. (2013), Abundance of bottlenose dolphins around Scotland. Mammal Review, 43: 71-88. https://doi.org/10.1111/j.1365-2907.2011.00208.x [Accessed 05 May 2026].

Cholewiak, D., DeAngelis, A.I., Palka, D., Corkeron, P.J. and Van Parijs, S.M., (2017). Beaked whales demonstrate a marked acoustic response to the use of shipboard echosounders. Royal Society open science, 4(12), p.170940.

Clark, C. W., Ellison, W. T., & Southall, B. L. (2009). Acoustic masking in marine ecosystems: Intuitions, analysis, and implication. *Marine Ecology Progress Series*, 395, 201–222. https://doi.org/10.3354/meps08402

Clarkson, J., Majewska, K., & Sinclair, R.R. (2024). Salamander Offshore Wind Farm: Assessment of Potential Impacts on the Southern Trench MPA for Minke Whale. Report No. SMRUC-MSP-2023-015. Provided to ERM. [Unpublished]. Retrieved from Salamander Floating Wind.

Convention on the Conservation of Migratory Species of Wild Animals (CMS) (2024). State of the World's Migratory Species Report. CMS Secretariat, Bonn. Available at: https://marine-mammals.info/cms-2024-report/ [marine-mammals.info] [Accessed 05 May 2026]

Culloch, R. M., Anderwald, P., Brandecker, A., Haberlin, D., McGovern, B., Pinfield, R., Visser, F., Jessopp, M., & Cronin, M. (2016). Effect of construction-related activities and vessel traffic on marine mammals. Marine Ecology Progress Series, 549, 231–242. https://doi.org/10.3354/meps11686

Dähne, M., Gilles, A., Lucke, K., Peschko, V., Adler, S., Krügel, K., Sundermeyer, J. and Siebert, U., (2013). Effects of pile-driving on harbour porpoises (Phocoena phocoena) at the first offshore wind farm in Germany. Environmental Research Letters, 8(2), p.025002.

Darias-O'Hara, A.K., Booth, C.G., Erbe, C., Isojunno, S., Janik, V.M., Lucke, K., Southall, B., Tougaard, J., von Benda-Beckmann, A.M., & Verfuss, U.K. (2025). Behavioural response thresholds for the assessment of noise impact on Antarctic marine mammal species. Marine Policy, 179, Article 106738. https://doi.org/10.1016/j.marpol.2025.106738 [Available via University of St Andrews Repository].

De Boer, M.N., Leaper, R., Keith, S. and Simmonds, M.P., (2008). Winter abundance estimates for the common dolphin (Delphinus delphis) in the western approaches of the English Channel and the effect of responsive movement. Journal of Marine Animals and Their Ecology, 1(1), pp.14-20.

DeRuiter, S.L. and Doukara, K.L., (2012). Loggerhead turtles dive in response to airgun sound exposure. Endangered Species Research, 16, pp.55-63.

Diederichs, A., Nehls, G., Dähne, M., Adler, S., Koschinski, S., & Verfuß, U. (2008). Methodologies for measuring and assessing potential changes in marine mammal behaviour, abundance or distribution arising from the construction, operation and decommissioning of offshore windfarms. BioConsult SH report to COWRIE Ltd.

Dow Piniak, W. E., Eckert, S. A., Harms, C. A., & Stringer, E. M. (2012). *Underwater hearing sensitivity of the leatherback sea turtle (Dermochelys coriacea): Assessing the potential effect of anthropogenic noise.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Herndon, VA. OCS Study BOEM 2012-01156. 35 pp.

Doyle, T.K., Houghton, J.D.R., O'Suilleabhain, P.F., Hobson, V.J., Marnell, F., Davenport, J., Hays, G.C. (2008). Leatherback Turtles Satellite Tagged in European Waters. Endangered Species Res; 4: 23-31.

Dransfeld, L., Maxwell, H. W., Moriarty, M., Nolan, C., Kelly, E., Pedreschi, D., Slattery, N., Connolly, P. (2014). North Western Waters Atlas (Third Edition). Marine Institute.

Dunlop, R.A., Noad, M.J., McCauley, R.D., Scott-Hayward, L., Kniest, E., Slade, R., Paton, D., & Cato, D.H. (2017). *Determining the behavioural dose–response relationship of marine mammals to air gun noise and source proximity*. Journal of Experimental Biology, 220(16), 2878–2886. https://journals.biologists.com/jeb/article/220/16/2878/33557/Determining-the-behavioural-dose-response) [Accessed 05 May 2026]

Edren, S. M. C., Andersen, S. M., Teilmann, J., Carstensen, J., & Dietz, R. (2010). Effects of offshore wind farms on harbour and grey seal haul-out behaviour in the Danish Baltic Sea. *Marine Ecology Progress Series*, 419, 265–275. https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1748-7692.2009.00364.x [Accessed 05 May 2026]

Edwards, E., S. Beck, C. Gibson, K. Brookes, B. Wilson, and D. Risch. (2019). Monitoring small cetaceans using passive acoustics to inform cross-border conservation efforts. World Marine Mammal Conference, Barcelona.

Efron, B. and Tibshirani, R.J. (1993). An introduction to the bootstrap. Chapman & Hall, London.

Erbe, C., Marley, S. A., Schoeman, R. P., Smith, J. N., Trigg, L. E., & Embling, C. B. (2019). The Effects of Ship Noise on Marine Mammals—A Review. *Frontiers in Marine Science*, 6, 606. https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2019.00606/full [Accessed 05 May 2026]

Evans, P. G. H., & James, K. (2019). Status of cetaceans in the vicinity of the Isle of Skye.

Evans, P. G. H., M. E. Baines, and J. Coppock. (2011). Abundance and behaviour of cetaceans and basking sharks in the Pentland Firth and Orkney waters.

Evans, P. G. H., & Waggitt, J. J. (2020). Impacts of climate change on marine mammals, relevant to the coastal and marine environment around the UK. Marine Climate Change Impacts Partnership (MCCIP) Annual Report Card 2019 Scientific Review, 1-33.

Fernandez-Betelu, O., Graham, I. M., Brookes, K. L., Cheney, B. J., Barton, T. R., & Thompson, P. M. (2021). Far-field effects of impulsive noise on coastal bottlenose dolphins. *Frontiers in Marine Science*, 8, 664230. https://doi.org/10.3389/fmars.2021.664230 [Accessed 05 May 2026]

Fernandez-Betelu, O., Iorio-Merlo, V., Houliston, H., Graham, I. M., Cheney, B. J., Mouy, X., Davis, G., Awbery, T., Risch, D., & Thompson, P. M. (2024). *Moray Firth Marine Mammal Monitoring Programme Work Package 3 – Minke Whale Monitoring Report*. University of Aberdeen. https://www.abdn.ac.uk/media/site/sbs/documents/Minke_Whale_Monitoring_Report_-Moray_Firth_MMMP_WP3-_2024.pdf [abdn.ac.uk] [Accessed 05 May 2026]

Finneran, J. J., & Schlundt, C. E. (2004). Effects of intense pure tones on the behaviour of trained odontocetes. *SPAWAR Systems Center Technical Report 1913*. Available at: https://apps.dtic.mil/sti/tr/pdf/ADA424426.pdf [Accessed 05 May 2026]

Finneran, J. J., Schlundt, C. E., Carder, D. A., & Ridgway, S. H. (2002). Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. *Journal of the Acoustical Society of America*, 108(1), 417–431. https://doi.org/10.1121/1.429475 [Accessed 05 May 2026]

Foote, A., Osborne, R. & Hoelzel, A. Whale-call response to masking boat noise. *Nature* **428**, 910 (2004). https://doi.org/10.1038/428910a

Foote, A. D.,T. Simila, G. A. Vikingsson, and P. T. Stevick. (2010). Movement, site fidelity and connectivity in a top marine predator, the killer whale. Evolutionary Ecology 24:803-814.

Gibson, C., Beck, S., von Sachsen-Coburg und Gotha, S., Risch, D. and Edwards, E., Report for Collaborative Oceanography and Monitoring for Protected Areas and Species (IVA5015).

Gilles, A, Authier, M, Ramirez-Martinez, NC, Araújo, H, Blanchard, A, Carlström, J, Eira, C, Dorémus, G, FernándezMaldonado, C, Geelhoed, SCV, Kyhn, L, Laran, S, Nachtsheim, D, Panigada, S, Pigeault, R, Sequeira, M, Sveegaard, S, Taylor, NL, Owen, K, Saavedra, C, Vázquez-Bonales, JA, Unger, B, Hammond, PS (2023). Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys. Final report published 29 September 2023. 64 pages.

Giralt Paradell, O., Cañadas, A., Bennison, A., Todd, N., Jessopp, M., Rogan, E. (2024). Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2021-2023. Department of the Environment, Climate & Communications and Department of Housing, Local Government & Heritage, Ireland. 260pp

Graham, I.M., Merchant, N.D., Farcas, A., Barton, T.R., Cheney, B., Bono, S. and Thompson, P.M. (2019). Harbour porpoise responses to pile-driving diminish over time. R. Soc. Open sci. 6: 190335. http://dx.doi.org/10.1098/rsos.190335.

Griffiths, A. M., & Wallace, B. P. (2024). Global threats to leatherback turtles: fisheries bycatch and habitat degradation. Marine Conservation Letters, 19(1), 33–45.

Grundy, E. C. (2021). *Harbour porpoise (Phocoena phocoena) behavioural responses to recreational craft*. MSc Thesis, Bangor University. Sea Watch Foundation. Available at: https://www.seawatchfoundation.org.uk/wp-content/uploads/2022/02/Elliot-Grundy-MSc-thesis_2021.pdf [seawatchfo...ion.org.uk] [Accessed 05 May 2026]

Gutiérrez-Muñoz, P., Walters, A.E., Dolman, S.J. and Pierce, G.J. (2021). Patterns and trends in cetacean occurrence revealed by shorewatch, a land-based citizen science program in Scotland (United Kingdom). *Frontiers in Marine Science*, *8*, p.642386.

Haelters, J. & Kerckhof, F. (1999). Een waarneming van de lederschildpad *Dermochelys coriacea* (L.) en de eerste waarneming van *Stomatolepas dermochelys* Monroe & Limpus 1979 aan de Belgische kust. *De Strandvlo*, 19(1): 30–39

Hague, E.L., Sinclair, R.R., and Sparling, C.E. (2020). Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters. Scottish Marine and Freshwater Science Vol 11, No 12.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Boerjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M., Scheidat, M. and Teilmann, J. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Wageningen Marine Research.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Boerjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2021). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. June 2021.

Hammond, P. S., Macleod, K., Berggren, P., Borchers, D. L., Burt, L., Cañadas, A., Desportes, G., Donovan, G. P., Gilles, A., Gillespie, D., Gordon, J., Hedley, S. L., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M. F., Lovell, P., Scheidat, M., Sequeira, M., Siebert, U., ... & Vikingsson, G. (2006). Small Cetaceans in the European Atlantic and North Sea (SCANS-II): Final Report. Sea Mammal Research Unit, University of St Andrews. LIFE Project Number LIFE04NAT/GB/000245. https://www.ascobans.org/sites/default/files/document/AC15_21_SCANS%20II_FinalReport-Dec07_1.pdf.

Harding, S. & Cousins, N. (2022). Review of the impacts of anthropogenic underwater noise on marine biodiversity and mitigation approaches. Technical Series Report for the Secretariat of the Convention on Biological Diversity (CBD). Available via Bluedot Marine Toolbox.

Hartny-Mills, L., Hampson, J. and Lomax, A. (2024). Hebridean Cetacean Research Programme, 2021-2024. NatureScot Research Report 1364.

Hastie, G.D., Donovan, C., Götz, T. & Janik, V.M. (2014). Behavioural responses by grey seals (Halichoerus grypus) to high-frequency sonar. Marine Pollution Bulletin, 79(1–2), pp. 205–210. https://doi.org/10.1016/j.marpolbul.2013.12.013 [Accessed 05 May 2026]

Hastie, G. D., Russell, D. J. F., Lepper, P., Elliott, J., Wilson, B., Benjamins, S., & Thompson, D. (2018). Harbour seals avoid tidal turbine noise: Implications for collision risk. *Journal of Applied Ecology*, 55(2), 684–693. https://doi.org/10.1111/1365-2664.12981 [Accessed 05 May 2026]

Heide-Jørgensen, M.P. and Laidre, K.L. (2007). Autumn space-use patterns of humpback whales (*Megaptera novaeangliae*) in West Greenland. *Journal of Cetacean Research and Management, 9,* 121-126. Available at https://archive.iwc.int/pages/search.php?search=%21collection15&k= [Accessed 05 May 2026]

Heide-Jørgensen, M.P., Simon, M.J. and Laidre, K.L. (2007). Estimates of large whale abundance in Greenland waters from a ship-based survey in 2005. *Journal of Cetacean Research and Manage*ment, *9*, 95-104. Available at https://archive.iwc.int/pages/search.php?search=%21collection15&k= [Accessed 05 May 2026]

Heide-Jørgensen, M.P., Witting, L., Laidre, K.L., Hansen, R.G. and Rasmussen, M. (2010). Fully corrected estimates of common minke whale abundance in West Greenland in 2007. J. Cetacean Res. Manage., 11(2), pp.75-82.

Heinänen, S., & Skov, H. (2015). The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area. JNCC Report No. 544. https://hub.jncc.gov.uk/assets/f7450390-9a89-4986-8389-9bff5ea1978a[2] (https://hub.jncc.gov.uk/assets/f7450390-9a89-4986-8389-9bff5ea1978a) [Accessed 05 May 2026]

Hernandez-Milian, G., Santos, M.B., Reid, D.G. and Rogan, E., (2016). Insights into the diet of Atlantic white-sided dolphins (Lagenorhynchus acutus) in the Northeast Atlantic.

Houghton, J.D., Doyle, T.K., Wilson, M.W., Davenport, J. and Hays, G.C., (2006). Jellyfish aggregations and leatherback turtle foraging patterns in a temperate coastal environment. Ecology, 87(8), pp.1967-1972.

Houser, D. S., Helweg, D. A., & Moore, P. W. (2001). *A bandpass filter-bank model of auditory sensitivity in the humpback whale*. Aquatic Mammals, 27(2), 82–91.

HWDT (2020). Leatherback turtle sighting, Available at: . https://www.hwdt.org/news/2020/leatherback-turtle [Accessed 05 May 2026]

HWDT. (2022). 100th humpback whale recorded in Scottish Waters. Available at: 100th Humpback Recorded in Scottish Waters — Hebridean Whale & Dolphin Trust [Accessed 05 May 2026]

HWDT (2023). Sei whale available at: Sei Whale — Hebridean Whale & Dolphin Trust (hwdt.org).

Hebridean Whale and Dolphin Trust (HWDT). (2024). *Annual Report 2024: Whale Track and Research Findings*. Tobermory, Scotland: HWDT. [Available from HWDT website: https://hwdt.org] [Accessed 05 May 2026]

HWDT (2025a). Harbour porpoise available at: Harbour Porpoise — Hebridean Whale & Dolphin Trust (hwdt.org).

HWDT (2025b). Bottlenose dolphin. Available at: Bottlenose Dolphin - Hebridean Whale & Dolphin Trust (hwdt.org)

HWDT (2025c). Common dolphin available at: Short-beaked common dolphin — Hebridean Whale & Dolphin Trust (hwdt.org).

HWDT (2025d). Atlantic white-sided dolphin available at: Atlantic White-Sided Dolphin — Hebridean Whale & Dolphin Trust (hwdt.org).

HWDT (2025e). White-beaked dolphin available at: White-beaked Dolphin — Hebridean Whale & Dolphin Trust (hwdt.org).

HWDT (2025f). Killer whale available at: Killer Whale — Hebridean Whale & Dolphin Trust (hwdt.org).

HWDT (2025g). Pilot whale available at: Long-finned Pilot Whale — Hebridean Whale & Dolphin Trust (hwdt.org).

HWDT (20253h). Fin whale available at: Fin Whale — Hebridean Whale & Dolphin Trust (hwdt.org).

IAMMWG (2023). Updated abundance estimates for cetacean Management Units in UK waters JNCC Report No. 680, JNCC Peterborough, ISSN 0963-8091.

IJsseldijk, L., Brownlow, A., J Davison, N., Deaville, R., Haelters, J., Keijl, G., Siebert, U. and TI ten Doeschate, M., 2018. Spatiotemporal trends in white-beaked dolphin strandings along the North Sea coast from 1991–2017. *Lutra*, *61*(1), pp.153-163.

International Association of Oil & Gas Producers (IOGP). (2024). *Sound and Marine Life Joint Industry Programme: Understanding the effects of anthropogenic sound on marine mammals.* IOGP Report Series, London, UK. Available at: https://www.soundandmarinelife.org [soundandma...nelife.org] [Accessed 05 May 2026]

IUCN (2023). Leatherback turtle. Available at: https://nc.iucnredlist.org/redlist/species-of-the-day/dermochelys-coriacea/pdfs/original/dermochelys-coriacea.pdf. [Accessed 21 September 2024]

IUCN-MMPATF. (2024). Moray Firth to Humber Estuary IMMA Factsheet. IUCN Joint SSC/WCPA Marine Mammal Protected Areas Task Force. Available at: https://www.marinemammalhabitat.org/factsheets/moray-firth-to-humber-estuary-imma/ [Accessed 05 May 2026]

IWC. (2007). *Report of the Ship Strikes Working Group: Collisions between vessels and cetaceans.* Presented at the IWC Scientific Committee, IWC59, Anchorage, USA. Available at: https://archive.iwc.int/pages/download.php?direct=1&noattach=true&ref=22355&ext=pdf [Accessed 05 May 2026]

Jansen, O. E., Leopold, M. F., Meesters, E. H. W. G., & Smeenk, C. (2010). Are white-beaked dolphins Lagenorhynchus albirostris food specialists? Their diet in the southern North Sea. *Journal of the Marine Biological Association of the United Kingdom*, *90*(8), 1501–1508. doi:10.1017/S0025315410001190

JNCC. (2019a). European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1351 Harbour porpoise (*Phocoena phocoena*) UK.

JNCC, (2019b). European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1349 Bottlenose dolphin (*Tursiops truncatus*) UK.

JNCC. (2019c). European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1350 Common dolphin (*Delphinus delphis*) UK.

JNCC. (2019d). European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2031 Atlantic white- sided dolphin (*Lagenorhynchus acutus*) UK.

JNCC, (2019e). European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2030 Risso's dolphin (*Grampus griseus*) UK.

JNCC, (2019f). European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 conservation status assessment for the species: S2027 Killer whale (*Orcinus orca*) UK.

JNCC. (2019g). European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2029- Long-finned pilot whale (*Globicephala melas*) UK.

JNCC. (2019h). European Community Directive on the Conservation of Natural Habitatsand of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S2618-Minke (*Balaenoptera acutorostrata*) UK.

JNCC. (2019i). European Community Directive on the Conservation of Natural Habitatsand of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species:S2621- Fin whale (*Balaenoptera physalus*) UK.

JNCC. (2019j). European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018 Conservation status assessment for the species: S1345- Humpback whale (*Megaptera novaeangliae*) UK.

Jones, T.T., Bostrom, B.L., Hastings, M.D., Van Houtan, K.S., Pauly, D. and Jones, D.R. (2012). Resource requirements of the Pacific leatherback turtle population.

Jones, E.L., Matthiopoulos, J., McConnell, B., Duck, C., Morris, C., Butler, A., & Thompson, D. (2022). Foraging movements and spatial flexibility of UK pinnipeds in response to prey distribution. Aquatic Conservation: Marine and Freshwater Ecosystems, 32(1), pp. 112–124

Jones, E. L., Hastie, G. D., Smout, S., Onoufriou, J., & Thompson, D. (2020). Seals and shipping: quantifying population risk and individual exposure to vessel noise. University of St Andrews. https://research-portal.st-andrews.ac.uk/en/publications/seals-and-shipping-quantifying-population-risk-and-individual-exp [Accessed 05 May 2026]

Jones, E. L., Hastie, G. D., Smout, S., Onoufriou, J., Merchant, N. D., Brookes, K. L., et al. (2017). Seals and shipping: quantifying population risk and individual exposure to vessel noise. J. Appl. Ecol. 54, 1930–1940. doi: 10.1111/1365-2664. 12911

Kastelein, R. A., de Jong, C., Helder-Hoek, L., Defillet, L., Terhune, J. M., Kuiphof, F., & Van Acoleyen, L. (2025). Effect of impact pile-driving playback sound on harbor seal (*Phoca vitulina*) behavior: Dose-response relationship and frequency weighting. *Aquatic Mammals*, 51(4), 319–335. https://doi.org/10.1578/AM.51.4.2025.319 [Accessed 05 May 2026]

Kastelein, R.A., Hoek, L., Covi, J. & Gransier, R. (2015). Effect of exposure duration to pile driving sounds on temporary hearing threshold shift in harbor porpoises (Phocoena phocoena). SEAMARCO Report 2015-09.

Netherlands Ministry of Infrastructure and Environment, Rijkswaterstaat. Available at: https://tethys.pnnl.gov/sites/default/files/publications/Kastelein-et-al-2015.pdf [Accessed 05 May 2026]

Kastelein, R. A., et al. (2018). *Metabolic rates and energy requirements of harbour porpoises*. Journal of Experimental Biology.

Kastelein, R. A., van der Heul, S., Verboom, W. C., Jennings, N., van der Veen, J., & de Haan, D. (2009). *Behavioral responses of marine mammals to sound*. In Advances in Experimental Medicine and Biology (Vol. 730, pp. 43–52).

Kastelein, R.A., Helder-Hoek, L., Cornelisse, S.A., Defillet, L.N., Huijser, L.A. and Gransier, R. (2021). Temporary Hearing Threshold Shift in a Harbor Porpoise (Phocoena phocoena) Due to Exposure to a Continuous One-Sixth-Octave Noise Band Centered at 0.5 kHz. *Aquatic Mammals*, *47*(2).

Kowarski, K., Cerchio, S., Whitehead, H., & Moors-Murphy, H. (2021). Where, when, and why do western North Atlantic humpback whales begin to sing? *Bioacoustics*, *31*(4), 450–469. https://doi.org/10.1080/09524622.2021.1972838 [Accessed 05 May 2026]

Koski, W.R. and Johnson, S.R. (1987) *Behaviour of bowhead whales near seismic exploration vessels in the Alaskan Beaufort Sea, 1986*. Report prepared for U.S. Minerals Management Service by LGL Ecological Research Associates, Inc., Bryan, TX

Lacey, C., Gilles, A., Herr, H., MacLeod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Sveegaard, S., Vingada, J., Viquerat, S., Øien, N., & Hammond, P.S. (2022). Modelled density surfaces of cetaceans in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. University of St Andrews. Available at: https://scans3.wp.st-andrews.ac.uk/resources/ [Accessed 05 May 2026]

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S. and Podesta, M. (2001). Collisions between ships and whale'. Marine Mammal Science 17 (1) 30-75.

Langley, I., & Brownlow, A. (2025). *Intraguild predation in sympatric seals and the effect on a declining population*. Journal of Animal Ecology. https://doi.org/10.1111/1365-2656.70152

Leaper, R., MacLennan, E., Brownlow, A., Calderan, S.V., Dyke, K., Evans, P.G., Hartny-Mills, L., Jarvis, D., McWhinnie, L., Philp, A. and Read, F.L., (2022). Estimates of humpback and minke whale entanglements in the Scottish static pot (creel) fishery. *Endangered Species Research*, *49*, pp.217-232.

Leatherback Sea Turtles available on: Turtles.org website – https://www.seeturtles.org/leatherback-turtle?gclid=EAIaIQobChMI-9XP4Z2fgwMVJ4JaBR2xAQH7EAAYASAAEgKXMfD_BwE. [Accessed 05 May 2026]

Leemans, J.J., & Fijn, R.C. (2023). Observations of harbour porpoises in offshore wind farms: Final report. Report 23-495. Waardenburg Ecology, Culemborg, Netherlands

Leonard, D. and Øien, N. (2019a). Estimates of abundance of large whales from Norwegian ship surveys and a NASS extension survey conducted in 2015. SC/26/AE/12 for the NAMMCO Scientific Committee.

Leonard, D. and Øien, N. (2019b). Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2002-2007 SC/26/AE/09 for the NAMMCO Scientific Committee.

Leonard, D. and Øien, N. (2019c). Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2008-2013. SC/26/AE/10 for the NAMMCO Scientific Committee.

Leonard, D. and Øien, N. (2019d). Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2014-2018. SC/26/AE/11 for the NAMMCO Scientific Committee.

Leopold, M. F., et al. (2023). *Seasonal and ontogenetic variation in harbour porpoise diet*. Marine Ecology Progress Series.

Luna, A., Sánchez, P., Chicote, C. and Gazo, M., (2022). Cephalopods in the diet of Risso's dolphin (Grampus griseus) from the Mediterranean Sea: A review. *Marine Mammal Science*, *38*(2), pp.725-741.

Luque, P. L., C. G. Davis, D. G. Reid, J. Wang, and G. J. Pierce. (2006). Opportunistic sightings of killer whales from Scottish pelagic trawlers fishing for mackerel and herring off North Scotland (UK) between 2000 and 2006. Aquatic Living Resources 19:403-410.

Lydersen, C., Vacquié-Garcia, J., Heide-Jørgensen, M.P., Øien, N., Guinet, C., Kovacs, K.M. (2020). Autumn movements of fin whales (Balaenoptera physalus) from Svalbard, Norway, revealed by satellite tracking. Scientific Reports (10:16966). https://doi.org/10.1038/s41598-020-73996-z [Accessed 05 May 2026]

Lyssikatos, M. C., & Wenzel, F. W. (2024). *What bycatch tells us about the diet of harbor and gray seals and overlap with commercial fishermen*. Frontiers in Conservation Science, 5, Article 1377673. https://doi.org/10.3389/fcosc.2024.1377673 [frontiersin.org] [Accessed 05 May 2026]

Macdonald, M.A., Hildebrand, J.A. and Webb, S.C. (1995). Blue and fin whales observed on a seafloor array in the Northeast Pacific. J Acoust Soc Am. 98:712-721.

MacLeod, C. D., Bannon, S. M., Pierce, G. J., Schweder, C., Learmonth, J. A., Herman, J. S., and Reid, R. J. (2005). Climate change and the cetacean community of north-west Scotland. Biological Conservation, 124(4), 477-483.

Magnúsdóttir, E., Rasmussen, M., Lammers, M. and Svavarsson, J. (2014). Humpback whale songs during winter in subarctic waters. *Polar Biology, 37*, 427-433. https://doi.org/10.1007/s00300-014-1448-3 [Accessed 05 May 2026]

Majewska, K., Brown, A.M., Charish, R., Quinn, M. and & Matei, M. (2025). Evidence review of harbour porpoise disturbance ranges in the context of the assessment and management of impulsive noise in Special Areas of Conservation: unexploded ordnance clearance, explosives for decommissioning, seismic (airgun) survey, sub-bottom profilers, ultra-short baseline acoustic positioning, acoustic deterrent devices, multi-beam echosounders, and military sonar. JNCC Report 798. JNCC, Peterborough, ISSN 0963-8091. https://hub.jncc.gov.uk/assets/e5cab7fb-d4df-4517-a352-5a0029fb3ee9 [Accessed 05 May 2026]

Malme, C. I., & Miles, P. R. (1983). Acoustic testing procedures for determining the potential impact of underwater industrial noise on migrating gray whales. The Journal of the Acoustical Society of America, 74(S1), S54-S54.

Malme, C. I., Miles, P. R., Clark, C. W., Tyack, P., & Bird, J. E. (1984). Investigations of the potential effects of underwater noise from petroleum-industry activities on migrating gray-whale behavior. Phase 2: January 1984 migration (No. PB-86-218377/XAB; BBN-5586). Bolt, Beranek and Newman, Inc., Cambridge, MA (USA).

Marine Scotland. (2024). Marine Mammals: Methodology for combining data. Avalibale on line at: Marine mammals: methodology for combining data - gov.scot [Accessed 05 May 2026]

Marley, S.A., Salgado Kent, C.P., & Erbe, C. (2017). *Effects of vessel traffic and underwater noise on the movement of bottlenose dolphins*. Scientific Reports, 7, 13252. https://www.nature.com/articles/s41598-017-13252-z [Accessed 05 May 2026]

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K. (2000) *Marine seismic surveys: Analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid*. Centre for Marine Science and Technology Report R99-15, Curtin University of Technology, Western Australia. Available at: https://cmst.curtin.edu.au/wp-content/uploads/sites/4/2016/05/McCauley-et-al-Seismic-effects-2000.pdf [Accessed 05 May 2026]

McCauley, R.D., Fewtrell, J,, Duncan, A.J., Jenner, C., Jenner, M.N., Penrose, J.D., et al. (2000). Marine seismic surveys – a study of environmental implications. APPEA Journal. 40(8):692–708.

McConnell, B. J., Lonergan, M., & Duck, C. (2012). The implications of grey seal movements for the design of Marine Protected Areas. *Journal of Applied Ecology, 49*(2), 193–203. https://doi.org/10.1111/j.1365-2664.2011.02056.x [Accessed 05 May 2026]

McNamara, R.M. and Dunlop, R.A. (2025). Changes in call rate and call level of migrating humpback whales (Megaptera novaeangliae) in response to seismic air guns. *Marine Environmental Research*, p.107415.

Miller, G. W., Richardson, W. J., Greene, C. R., Jr., Richardson, W. J., Ljungblad, D. K., & Blees, M. K. (2005).

Moein, S., Musick, J., Keinath, J., Barnard, D., Lenhardt, M., George, R. (1994). Evaluation of seismic sources for repelling sea turtles from hopper dredges. Final report submitted to the US Army Corps of Engineers, Waterways Experiment Station. Gloucester Point (VA): Virginia Institute of Marine Science (VIMS), College of William and Mary. 42p.

Morris, C.D., and Duck, C.D. (2019). Aerial thermal-imaging survey of seals in Ireland, 2017 to 2018. Irish Wildlife Manuals, No. 111 National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

NAMMCO (2023a). Killer whale available at: Killer whale - NAMMCO. [Accessed 05 May 2026]

NAMMCO. (2020b). Fin Whale available at: https://nammco.no/fin-whale/#1478699758629-7da126c3-48a6 [Accessed 05 May 2026]

NAMMCO (2023c). Humpback whale available at: Humpback Whale - NAMMCO. [Accessed 05 May 2026]

Nykänen, M., Louis, M., Dillane, E., Alfonsi, E., Berrow, S., O'Brien, J., Brownlow, A., Covelo, P., Dabin, W., Deaville, R. and de Stephanis, R., 2019. Fine‐scale population structure and connectivity of bottlenose dolphins, Tursiops truncatus, in European waters and implications for conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *29*, pp.197-211.

NAPIER. (2017). Assessment of effects on marine mammals from proposed capital dredging and spoil disposal for the port.

Natural England. (2017). Guidance to inform marine mammal site characterisation requirements at wave and tidal stream energy sites in Wales. *Natural England Evidence Report NECR213*. Available at: https://publications.naturalengland.org.uk/category/4101 [Accessed 05 May 2026]

Natural Power Consultants Ltd. (2024). European Protected Species Risk Assessment: UXO Clearance – Inch Cape Offshore Wind Farm. Inch Cape Offshore Limited. Available at: https://marine.gov.scot/sites/default/files/inch_cape_boulder_relocation_and_puxo_target_investigation_-_eps_ra_rev_f_redacted.pdf [Accessed 05 May 2026]

NatureScot. (2025). Leatherback turtle sightings and jellyfish bloom dynamics in Scottish coastal waters. NatureScot Marine Species Monitoring Programme.

Nelms, S. E., Duncan, E. M., Broderick, A. C., Galloway, T. S., Godfrey, M. H., Hamann, M., Lindeque, P. K., & Godley, B. J. (2016). Plastic and marine turtles: a review and call for research. *ICES Journal of Marine Science*, 73(2), 165–181. https://doi.org/10.1093/icesjms/fsv165 [Accessed 05 May 2026]

New, L.F., Harwood, J., Thomas, L., Donovan, C., Clark, J.S., Hastie, G., Thompson, P.M., Cheney, B., Scott-Hayward, L., & Lusseau, D. (2013). Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance. Functional Ecology, 27(2), 314–322. https://doi.org/10.1111/1365-2435.12052 [Accessed 05 May 2026]

NOAA Fisheries. (2024). Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce. https://www.fisheries.noaa.gov [Accessed 05 May 2026]

O'Hara, J. (1990). ''Avoidance responses of loggerhead turtles, Caretta caretta, to low frequency sounds,'' Copeia 2, 546–567.

Øien, N. (2009). Distribution and abundance of large whales in Norwegian and adjacent waters based on ship surveys 1995-2001. NAMMCO Sci. Publ. 7: 31-34.

Olson, J. K., Lambourn, D. M., Huggins, J. L., Raverty, S., Scott, A. A., & Gaydos, J. K. (2021). Trends in propeller strike-induced mortality in harbor seals (*Phoca vitulina*) in the Salish Sea. *Journal of Wildlife Diseases*, 57(4), 837–846. https://www.mendeley.com/catalogue/7f0a863a-d444-3c0e-a518-29a9feeca9cc/ [Accessed 05 May 2026]

Onoufriou, J., Brownlow, A., Moss, S., Hastie, G., & Thompson, D. (2019). Empirical determination of severe trauma in seals from collisions with tidal turbine blades. *Journal of Applied Ecology*, 56(7), 1712–1724. https://doi.org/10.1111/1365-2664.13388 [Accessed 05 May 2026]

O'Reilly, L., MacLeod, K., & Griffiths, H. (2024). Leatherback turtle foraging behaviour in Loch Fyne and Loch Long. Clyde Sea Marine Biodiversity Report.

Ørsted. (2024). Harbour Seal Telemetry Monitoring Report – The Wash. Internal environmental monitoring report prepared for UK offshore wind operations.

OSPAR Commission (2022). *Status Assessment 2022 – Leatherback Turtle (Dermochelys coriacea).* OSPAR Biodiversity Committee Assessment. Available at: https://oap.ospar.org/en/ospar-assessments/committee-assessments/biodiversity-committee/status-assesments/leatherback-turtle [Accessed 05 May 2026]

Palmer, C., Booth, C., Sparling, C., and Thompson, D. (2021b) 'Marine mammal avoidance behaviour and collision risk in tidal energy environments', *Renewable Energy*, 170, pp. 1226–1238. doi:10.1016/j.renene.2021.02.056.

Palmer, R., Brookes, K. L., & Scott, B. E. (2021a). Collision risk of tidal turbines for marine animals: Behavioural insights from encounter modelling. *Journal of Applied Ecology*, 58(3), 596–607. https://doi.org/10.1111/1365-2664.13809Paterson, W. (2019). The energetic consequences of disturbance in harbour seals during the moult. *Marine Mammal Science*, 35(2), 456–472. https://doi.org/10.1111/mms.12541

Paterson, E. (2025). News - Community scooping whale poop to study the diet of whales in Scotland — The Scottish Association for Marine Science (SAMS). [Accessed 05 May 2026]

Paxton, C.G.M., Scott-Hayward, L., Mackenzie, M., Rexstad, E. and Thomas, L. (2016). Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resources with Advisory Note, JNCC Report 517, ISSN 0963-8091: http://jncc.defra.gov.uk/page-7201. [Accessed 21/09/2024]

Paxton, C.G.M., Scott-Hayward, L.A.S. and Rexstad, E. (2014). Statistical approaches to aid the identification of Marine Protected Areas for minke whale, Risso's dolphin, white-beaked dolphin and basking shark. Scottish Natural Heritage Commissioned Report No. 594.

Pierce, G.J., Santos, M.B., Reid, R.J., Patterson, I.A.P. and Ross, H.M., (2004). Diet of minke whales Balaenoptera acutorostrata in Scottish (UK) waters with notes on strandings of this species in Scotland 1992–2002. *Journal of the Marine Biological Association of the United Kingdom*, *84*(6), pp.1241-1244.

Pike, D.G., Gunnlaugsson, T., Mikkelsen, B. and Víkingsson, G.A. (2018). Estimates of the abundance of humpback whales (Megaptera novaeangliae) from the NASS Icelandic and Faroese ship surveys conducted in 2015. International Whaling Commission Scientific Committee doc. SC/67b/ASI09.

Pigeault, R., Ruser, A., Ramírez-Martínez, N. C., Geelhoed, S. C. V., Haelters, J., Nachtsheim, D. A., Schaffeld, T., Sveegaard, S., Siebert, U., & Gilles, A. (2024). Maritime traffic alters distribution of the harbour porpoise in the North Sea. *Marine Pollution Bulletin*, 208, 116925. https://doi.org/10.1016/j.marpolbul.2024.116925 [Accessed 05 May 2026]

Pike, D.G., Gunnlaugsson, T., Mikkelsen, B., Halldórsson, S.D. and Víkingsson, G.A. (2019). Estimates of the abundance of cetaceans in the central North Atlantic based on the NASS Icelandic and Faroese shipboard surveys conducted in 2015. NAMMCO Scientific Publications, 11.

Pirotta, E., Brookes, K. L., Graham, I. M., & Thompson, P. M. (2015). *Variation in harbour porpoise activity in response to seismic survey noise*. Biology Letters, 11(5), 20150351.

Plint, T., ten Doeschate, M.T., Brownlow, A.C., Davison, N.J., Hantke, G., Kitchener, A.C., Longstaffe, F.J., McGill, R.A., Simon-Nutbrown, C. and Magill, C.R., 2023. Stable isotope ecology and interspecific dietary overlap among dolphins in the Northeast Atlantic. Frontiers in Marine Science, 10, p.1111295.

Potlock, K.M., Temple, A.J., & Berggren, P. (2023). Offshore construction using gravity-base foundations indicates no long-term impacts on dolphins and harbour porpoise. Marine Biology, 170, Article 92. https://doi.org/10.1007/s00227-023-04240-1

Pusineri, C., Magnin, V., Meynier, L., Spitz, J., Hassani, S. and Ridoux, V. (2007) Food and feeding ecology of the common dolphin (*Delphinus delphis*) in the oceanic northeast Atlantic and comparison with its diet in neritic waters. Marine Mammal Science 23, 30–47.

Reichmuth, C., Holt, M. M., Mulsow, J., Sills, J. M., & Southall, B. L. (2013). *Comparative assessment of marine mammal auditory sensitivity*. Journal of Comparative Physiology A, 199(7), 535–546.

Reichmuth, C., Kastak, D. and Southall, B.L. (2009) 'Effects of noise and tonal stimuli on hearing in pinnipeds', *Technical Report*, U.S. Office of Naval Research. Available at: https://apps.dtic.mil/sti/pdfs/ADA505449.pdf [Accessed 05 May 2026]

Reine, K. J. (2022). *A literature review of beach nourishment impacts on marine turtles*. ERDC/EL TR-22-4. U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS. https://dx.doi.org/10.21079/11681/43829 [Accessed 05 May 2026]

Rendell, L., & Gordon, J. (1999). Vocal response of long-finned pilot whales (*Globicephala melas*) to military sonar in the Ligurian Sea. *Marine Mammal Science*, 15(1), 198–204. https://doi.org/10.1111/j.1748-7692.1999.tb00790.x [Accessed 05 May 2026]

Richardson, W. J., Greene, C. R., Malme, C. I., & Thomson, D. H. (1995). *Marine Mammals and Noise*. Academic Press.

Richardson, W.J., Greene, C.R., Malme, C.I. and Thomson, D.H. (1999) *Marine mammals and noise*. Academic Press, San Diego, CA. ISBN: 9780125884419

Risch, D. et al., (2013). Minke whale acoustic behavior and multi-year seasonal and diel vocalization patterns in Massachusetts Bay, USA. *Marine Ecology Progress Series,* Volume 489, pp. 279-295.

Robbins, J. (2020a) 'Multi-species risk assessment of marine mammals in relation to vessel density and co-occurrence hotspots in UK Marine Protected Areas', *Frontiers in Marine Science*, 7, Article 542648. doi:10.3389/fmars.2020.542648.

Robbins, J. (2020b) *Ship strike risk for small cetaceans in high-density traffic areas*. Journal of Cetacean Research and Management, 21, pp. 45–56.

Roberts, J. J., Best, B. D., Mannocci, L., Fujioka, E., Halpin, P. N., Palka, D. L., Garrison, L. P., Mullin, K. D., Cole, T. V., Khan, C. B., McLellan, W. A., Pabst, D. A., & Lockhart, G. G. (2016). Habitat-based marine mammal density models for the U.S. Atlantic and Gulf of Mexico. *Scientific Reports*, 6, 22615. https://doi.org/10.1038/srep22615 [Accessed 05 May 2026]

Roberts, L., Collier, S., Law, S. & Gaion, A. (2019). The impact of marine vessels on the presence and behaviour of harbour porpoise (Phocoena phocoena) in the waters off Berry Head, Brixham (South West England). Ocean & Coastal Management, 179, 104860. https://doi.org/10.1016/j.ocecoaman.2019.104860

Robinson, N.J., Sanfèlix, M.M., Blanco, G.S., Clyde-Brockway, C., Hill, J.E., Paladino, F.V., Tomás, J. and Tomillo, P.S. (2022). Effect of water temperature on the duration of the internesting interval across sea turtle species. Journal of Thermal Biology, p.103342.

Rodríguez-Mendoza, R., Gutiérrez-Muñoz, P., Walters, A. E. M., Moscrop, A., & Pierce, G. J. (2025). Analysis of WDC Shorewatch Programme coastal cetacean sightings data, for the period 2005-2023. Report to WDC, Whale and Dolphin Conservation.

Rogan, E., & Berrow, S. D. (1996). A review of harbour porpoises (*Phocoena phocoena*) in Irish waters. *Reports of the International Whaling Commission*, **46**, 595–605.

Rogan, E., Cañadas, A., Macleod, K., Santos, M.B., Mikkelsen, B., Uriarte, A., Van Canneyt, O., Vázquez, J.A. and Hammond, P.S., (2017). Distribution, abundance and habitat use of deep diving cetaceans in the North-East Atlantic. Deep Sea Research Part II: Topical Studies in Oceanography, 141, pp.8-19.

Rose, A., Brandt, M., Vilela, R., Diederichs, A., Schubert, A., Kosarev, V., Nehls, G., Volkenandt, M., Wahl, V., Michalik, A., Wendeln, H., Freund, A., Ketzer, C., Limmer, B., Laczny, M., & Piper, W. (2019). *Effects of noise-mitigated offshore pile driving on harbour porpoise abundance in the German Bight 2014–2016 (Gescha 2).* IBL Umweltplanung GmbH.

Ruser, A., Dähne, M., van Neer, A., Lucke, K., & Siebert, U. (2023). Vessel noise exposures of harbour seals from the Wadden Sea. *Scientific Reports, 13*, Article 6846. https://doi.org/10.1038/s41598-023-33283-z [Accessed 05 May 2026]

Russell, D.J.F., Brasseur, S.M.J.M., Thompson, D., Hastie, G.D., Janik, V.M., McClintock, B.T., Matthiopoulos, J., Moss, S.E., & McConnell, B. (2016b). Marine mammals trace anthropogenic structures at sea. Current Biology, 26(3), 298–300. https://doi.org/10.1016/j.cub.2015.12.067 [Accessed 05 May 2026]

Russell, D.J.F., Carter, M.I.D., Kershaw, J., Sievers, C., Hammond, P.S., Thompson, D and Sparling, C.E (2021). Investigation of contrasting seal population trends in the southeast England Seal Management Unit: data inventory. Sea Mammal Research Unit, University of St Andrews, Commissioned Report to Natural England.

Russell, D., Hastie, G., Thompson, D., et al. (2016a). Avoidance of wind farms by harbour seals is limited to pile driving activities. *Journal of Applied Ecology*, 53(6), 1642–1652. https://doi.org/10.1111/1365-2664.12678 [Accessed 05 May 2026]

Russell, D. J. F., McClintock, B. T., Matthiopoulos, J., Thompson, P. M., Thompson, D., Hammond, P. S., et al. (2015). Intrinsic and extrinsic drivers of activity budgets in sympatric grey and harbour seals. Oikos 124, 1462–1472.

Russell, D.J.F., McClintock, B.T., Matthiopoulos, J., Thompson, D., McConnell, B., Morris, C., Duck, C. & Hammond, P.S. (2023). Dietary variation and prey selection in sympatric grey and harbour seals. Marine Ecology Progress Series, 715, pp. 45–58.

Russell, D.J.F. and McConnell, B.J. (2014). Seal at-sea distribution, movements and behavior. Report to DECC. URN: 14D/085. March 2014 (final revision).

Russell, D.J.F (2016). Movements of grey seal that haul out on the UK coast of the southern North Sea. Report for the Department of Energy and Climate Change (OESEA-14-47).

Ryan, C., Berrow, S. D., McGonigle, C., O'Connor, I., & Lordan, C. (2016). Cetacean occurrence in the Hebrides: a review of 20 years of sightings data. *Journal of the Marine Biological Association of the United Kingdom*, 96(6), 1219–1230.

Ryan, C., Calderan, S., Alison, C., Leaper, R., & Risch, D. (2022). Historical occurrence of whales in Scottish waters inferred from whaling records. Aquatic Conservation: Marine and Freshwater Ecosystems, 32, 1657–1692.

Samuel, Y., Morreale, S. J., Clark, C. W., Rice, A. N., & Musick, J. A. (2005). *Underwater, low-frequency noise in a coastal sea turtle habitat*. Journal of the Acoustical Society of America, 117(3), 1465–1472.

Sanders, (2023). The last sunset in the west West. Britain's vanishing west coast orcas.

Sanpera, C., & Jover, L. (1989). Density estimate of fin whales in the North Atlantic from NASS-87 Spanish cruise data. Report of the International Whaling Commission, 39, 427-429.

Santos, M.B., Monteiro, S.S., Vingada, J.V., Ferreira, M., Lopez, A., Martinez Cedeira, J.A., Reid, R.J., Brownlow, A. and Pierce, G.J., (2014). Patterns and trends in the diet of long-finned pilot whales (Globicephala melas) in the northeast Atlantic. *Marine Mammal Science*, *30*(1), pp.1-19.

Santos MB, Pierce GJ, Reid RJ, Patterson IAP, Ross HM, Mente E., (2001). Stomach contents of bottlenose dolphins (Tursiops truncatus) in Scottish waters. *Journal of the Marine Biological Association of the United Kingdom*. 81(5):873-878. doi:10.1017/S0025315401004714.

Savoca, M. S., Czapanskiy, M. F., Kahane-Rapport, S. R., Gough, W. T., Fahlbusch, J. A., Bierlich, K. C., Segre, P. S., Di Clemente, J., Penry, G. S., Wiley, D. N., Calambokidis, J., Nowacek, D. P., Johnston, D. W., Pyenson, N. D., Friedlaender, A. S., Hazen, E. L., & Goldbogen, J. A. (2021). *Baleen whale prey consumption based on high-resolution foraging measurements*. Nature, 599, 85–90. https://par.nsf.gov/servlets/purl/10315593 [Accessed 05 May 2026]

Schoeman, R.P., Patterson-Abrolat, C., Plön, S. (2020). 'A Global Review of Vessel Collisions With Marine Animals'. *Frontiers in Marine Science*, 7,292, doi: 10.3389/fmars.2020.00292.

SCOS (2019). Scientific Advice on Matters Related to the Management of Seal Populations: 2019. Available at: http://www.smru.st-andrews.ac.uk/research-policy/scos/. [Accessed 21/09/2024].

SCOS (2023). Scientific Advice on Matters Related to the Management of Seal Populations: 2023. Available at: https://www.smru.st-andrews.ac.uk/files/2024/02/scos-2023-interim-advice-final.pdf

SCOS (2024). Scientific Advice on Matters Related to the Management of Seal Populations: 2024. Available at: https://www.smru.st-andrews.ac.uk/files/2024/02/scos-2024-report.pdf [Accessed 05 May 2026]

Scottish Humpback ID Project. (2024). *Scottish Humpback Whale Catalogue Update*. Hebridean Whale and Dolphin Trust. [Available from HWDT website: https://hwdt.org] [Accessed 05 May 2026]

Sea Turtle Org. (2025). Sea Turtles 911. *Noise Pollution by Man-Made Sound Impact Sea Turtle Behavior*. https://seaturtles911.org/research/noise.htm [Accessed 05 May 2026]

SEAMARCO (2025). Similar Hearing Thresholds at 8 kHz, but Dissimilar Susceptibility of Hearing to Damage by 8 kHz Sounds in a Harbor Porpoise, a Harbor Seal, and a California Sea Lion. Aquatic Mammals, 51(5), pp.1-7.

Secor, D.H., O'Brien, M.H.P. & Bailey, H. (2025). The flyway construct and assessment of offshore wind farm impacts on migratory marine fauna. ICES Journal of Marine Science, 82(3), fsae138. https://academic.oup.com/icesjms/article/82/3/fsae138/7815947 [Accessed 05 May 2026]

Simon, M., Johnson, M. and Madsen, P.T. (2012). Keeping momentum with a mouthful of water: behavior and kinematics of humpback whale lunge feeding. *Journal Of Experimental Biology, 215*, 3786-3798. https://doi.org/10.1242/jeb.071092 [Accessed 05 May 2026]

SMFS. (2020). *Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters: Appendix 5 – Supplementary Material – Density Estimates*. Scottish Marine and Freshwater Science, Vol 11 No 12. Marine Scotland. Retrieved from https://data.marine.gov.scot/sites/default/files//Scottish%20Marine%20and%20Freshwater%20Science%20%28SMFS%29%20Vol%2011%20No%2012_%20Appendix%205%20Supplementary%20Material.pdf [Accessed 05 May 2026]

Sørensen, P.M., Haddock, A., Guarino, E., Jaakkola, K., McMullen, C., Jensen, F.H., Tyack, P.L. and King, S.L. (2023). Anthropogenic noise impairs cooperation in bottlenose dolphins. *Current Biology*, *33*(4), pp.749-754.

Southall, B. L., et al. (2013). *Mass stranding of melon-headed whales in Madagascar: A review of potential causes*. Independent Scientific Review Panel Report.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L. (2019). Marine mammal noise exposure criteria: updated scientific recommendations for residual hearing effects. Aquatic Mammals, 45(2), pp.125-232.

Spitz, J., Mourocq, E., Schoen, V. and Ridoux, V. (2010). Proximate composition and energy content of forage species from the Bay of Biscay: high-or low-quality food?. *ICES Journal of Marine Science*, *67*(5), pp.909-915.

Special Initiative on Offshore Wind (2024). *Offshore Wind Facts: Marine Mammals and Sea Turtles.* Available at: https://tethys.pnnl.gov/publications/offshore-wind-facts-marine-mammals-sea-turtles [Accessed 05 May 2026]

Stamation, K.A., Croft, D.B., Shaughnessy, P.D. and Waples, K.A. (2007). Observations of humpback whales (Megaptera novaeangliae) feeding during their southward migration along the coast of southeastern New South Wales, Australia: identification of a possible supplemental feeding ground. *Aquatic Mammals*, *33*(2), p.165.

Stewart, J. D., Tinker, M. T., Brownell, R. L., & Read, A. J. (2025). *The future of baleen whales: Recoveries, environmental constraints, and climate change*. Science Advances, 11(26), eadv8031. https://doi.org/10.1126/sciadv.adv8031 [Accessed 05 May 2026]

Stone, C. J., & Tasker, M. L. (2023). Cetacean responses to seismic surveys in UK waters. Journal of Marine Science and Engineering, 11(2), 215.

Stone, C.J. (2024). Marine mammal observations during geophysical surveys from 1995– 2020

Sveegaard, S., Andreasen, H., Mouritsen, K.N., Jeppesen, J.P., Teilmann, J. and Kinze, C.C. (2012). Correlation between the seasonal distribution of harbour porpoises and their prey in the Sound, Baltic Sea. *Marine Biology*, *159*, pp.1029-1037.

Teilmann, J., Christiansen, C.T., Kjellerup, S., Dietz, R. and Nachman, G. (2013). Geographic, seasonal and diurnal surface behaviour of harbour porpoise. Marine Mammal Science 29(2): E60-E76.

Thompson, D., Hastie, G., Nedwell, J., McCauley, R., and Gordon, J. (2012) 'Assessing the potential for impacts of underwater noise on marine mammals: Pinniped hearing compared to cetaceans', *The Effects of Noise on Aquatic Life*, Advances in Experimental Medicine and Biology, 730, pp. 73–76. Springer. doi:10.1007/978-1-4419-7311-5_16.

Thomsen, F., Lüdemann, K., Kafemann, R., & Piper, W. (2006). Effects of offshore wind farm noise on marine mammals and fish. *COWRIE Report*. https://www.researchgate.net/publication/228653581_Effects_of_Offshore_Wind_Farm_Noise_on_Marine_Mammals_and_Fish [Accessed 05 May 2026]

Todd, V.L., Todd, I.B., Gardiner, J.C., Morrin, E.C., MacPherson, N.A., DiMarzio, N.A. and Thomsen, F., (2015). A review of impacts of marine dredging activities on marine mammals. *ICES Journal of Marine Science*, *72*(2), pp.328-340.

Tougaard, J. (2025). Behavioral reactions of harbor porpoises to impact pile driving noise are predicted by the auditory frequency weighted sound pressure level. The Journal of the Acoustical Society of America, 157(2), 1368–1377. https://doi.org/10.1121/10.0035916

Tougaard, J., Henriksen, O. D., & Miller, L. A. (2009). Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbour porpoises and seals. Journal of the Acoustical Society of America, 125(6), 3766–3773. https://doi.org/10.1121/1.3117444

Trigg, L. (2022) 'Behavioural responses of grey seals (*Halichoerus grypus*) to shipping noise in the English Channel and Celtic Sea', *Marine Mammal Science*, 38(4), pp. 1123–1138. doi:10.1111/mms.12894.

Tubelli, A. A., Zosuls, K. M., Ketten, D. R., & Mountain, D. C. (2012). *A model and experimental measurements of hearing in a minke whale (Balaenoptera acutorostrata)*. Journal of the Acoustical Society of America, 131(5), 3959–3970.

U.S. Fish and Wildlife Service (2020). Leatherback Sea Turtle (Dermochelys coriacea) species page.

van der Kooij, J., Scott, B. E. & Mackinson, S. (2008). The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. *Journal of Sea Research,* 60(3), pp. 201-209.

Veneruso, G. (2024). Chapter 4: An investigation of spatio-temporal patters in harbour porpoise distribution to inform potential impacts of a tidal energy development. PhD Thesis, Bangor University, UK. Bangor University.

Vergara, V., Mikus, M-A., Chion, C., Lagrois, D., Marcoux, M. & Michaud, R. (2025). Effects of vessel noise on beluga (Delphinapterus leucas) call type use: ultrasonic communication as an adaptation to noisy environments? Biology Open, 14(3), bio061783. https://doi.org/10.1242/bio.061783

Vighi, M. (2025). *Vessel strikes as a pressure to marine biodiversity*. Publications Office of the European Union, Luxembourg. doi:10.2760/0669755. Available at: https://data.europa.eu/doi/10.2760/0669755

Villadsgaard, A., Wahlberg, M., & Tougaard, J. (2007). Echolocation signals of wild harbour porpoises (*Phocoena phocoena*). *Journal of Experimental Biology*, **210**(1), 56–64. https://doi.org/10.1242/jeb.02618.

Voet H., Rehfisch M., McGovern S. and Sweeney S. (2017). Marine Mammal Correction Factor for Availability Bias in Aerial Digital Still surveys. Case Study: Harbour porpoise (Phocoena phocoena) in the Southern North Sea. APEM Ltd.

Waggitt, J.J., Evans, P.G., Andrade, J., Banks, A.N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C.J., Durinck, J. and Felce, T. (2019). Distribution maps of cetacean and seabird populations in the North-East Atlantic. Journal of Applied Ecology, 57(2), pp.253-269.

Wallace, B.P., DiMatteo, A.D., Hurley, B.J., Finkbeiner, E.M., Bolten, A.B., Chaloupka, M.Y., Hutchinson, B.J., Abreu-Grobois, F.A., Amorocho, D., Bjorndal, K.A. and Bourjea, J. (2010). Regional management units for marine turtles: a novel framework for prioritizing conservation and research across multiple scales. Plos one, 5(12), p.e15465.

Watkins, W. A., Schevill, W. E., & Tyack, P. (1985). Acoustic behaviour of sperm whales. In *Animal Sonar Systems* (pp. 283–290). NATO Advanced Study Institutes Series. Springer. https://doi.org/10.1007/978-1-4684-7254-7_11

Weir, C., Pollock, C., Cronin, C., and Taylor, S. (2001). Cetaceans of the Atlantic Frontier, north and west of Scotland. Continental Shelf Research 21:1047-1071.

Weir, C.R. (2007) Observations of marine turtles in relation to seismic airgun sound off Angola. Mar Turtle Newsl 116: 17−20

Weir, C. R. (2008). Short-term reactions of cetaceans to seismic surveys. Journal of the Marine Biological Association of the United Kingdom, 88(6), 1133–1137.

Weir, C.R., Macleod, C.D. and Calderan, S.V. (2009b) 'Fine-scale habitat selection by white-beaked and common dolphins in the Minch (Scotland, UK): evidence for interspecific competition or coexistence?', *Journal* *of the Marine Biological Association of the United Kingdom*, 89(5), pp. 951–960. doi:10.1017/S0025315408003287.

Weir, C.R., Stockin, K.A., & Pierce, G.J. (2009a). Distribution and habitat preferences of the common dolphin (Delphinus delphis) in the Minch, Scotland. Journal of the Marine Biological Association of the United Kingdom, 89(5), 857–865. https://doi.org/10.1017/S0025315409003121

Weir, C.R., Hodgins, N.K., Dolman, S.J., and Walters, A.E.M. (2019). Risso's dolphins (Grampus griseus) in a proposed Marine Protected Area off east Lewis (Scotland, UK), 2010–2017. Journal of the Marine Biological Association of the United Kingdom, 99(3), 703–714. https://doi.org/10.1017/S0025315418000516

Whitehead, H., & Rendell, L. (2014). The Cultural Lives of Whales and Dolphi*ns*. University of Chicago Press.

Whyte, K. F., Russell, D. J. F., Sparling, C. E., Binnerts, B., & Hastie, G. D. (2020). Estimating the effects of pile driving sounds on seals: Pitfalls and possibilities. The Journal of the Acoustical Society of America, 147(6), 3948–3958. https://doi.org/10.1121/10.0001408 Accessed 05 May 2026]

Whyte, L. (2022). Behavioural responses of harbour seals to offshore wind farm activity: A biologging approach. PhD Thesis, University of St Andrews. https://research-repository.st-andrews.ac.uk/handle/10023/26358 [Accessed 05 May 2026]

Wilson, B., Benjamins, S., Elliott, J., Gordon, J., Macaulay, J., Calderan, S., & van Geel, N. (2014). Estimates of Collision Risk of Harbour Porpoises and Marine Renewable Energy Devices at Sites of High Tidal-Stream Energy. Scottish Government Report.

Wilson, S.C., Trukhanova, I., Dmitrieva, L., Dolgova, E., Crawford, I., Baimukanov, M., Baimukanov, T., Ismagambetov, B., Pazylbekov, M., Jüssi, M., & Goodman, S.J. (2017). Assessment of impacts and potential mitigation for icebreaking vessels transiting pupping areas of an ice-breeding seal. *Biological Conservation*, 214, 213–222. https://doi.org/10.1016/j.biocon.2017.05.028 [Accessed 05 May 2026]

Windsland, K., Lindstrøm, U., Nilssen, K.T., & Haug, T. (2007). *Relative abundance and size composition of prey in the common minke whale diet in selected areas of the northeastern Atlantic during 2000–04*. Journal of Cetacean Research and Management, 9(3), Article 665. [Accessed 05 May 2026]

Wisniewska, D.M., Johnson, M., Teilmann, J., Siebert, U., Galatius, A., Dietz, R., & Madsen, P.T. (2018). High rates of vessel noise disrupt foraging in wild harbour porpoises (Phocoena phocoena). Proceedings of the Royal Society B: Biological Sciences, 285(1883), 20172314. https://doi.org/10.1098/rspb.2017.2314 [Accessed 05 May 2026]

Witt, M.J., Broderick, A.C., Johns, D.J., Martin, C., Penrose, R., Hoogmoed, M.S. and Godley, B.J., (2007). Prey landscapes help identify potential foraging habitats for leatherback turtles in the NE Atlantic. *Marine Ecology Progress Series*, *337*, pp.231-243.

Yang, L., Sharpe, M., Temple, A, J., & Berggren, P., (2021). Characterization and comparison of echolocation clicks of white-beaked dolphins (*Lagenorhynchus albirostris*) off the Northumberland coast, UK. *J. Acoust. Soc. Am.* 1 March 2021; 149 (3): 1498–1506.