Scotland England Green Link 1 / Eastern Link 1 - Marine Scheme

Environmental Appraisal Report
Volume 2

Chapter 10 - Marine Mammals

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National Grid Electricity Transmission and Scottish Power Transmission

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Executive Summary

This chapter of the Environmental Appraisal Report (EAR) contains an appraisal of the potential interaction of the Marine Scheme and marine mammals, focusing on the marine area between Mean High Water Springs (MHWS) at the Scottish landfall area at Thorntonloch Beach in East Lothian, and MHWS at the English landfall area at Seaham, County Durham. This includes any intertidal areas between MHWS and Mean Low Water Springs (MLWS) where there are haul out locations used for breeding.

The appraisal follows the methodology as set out within Chapter 4: Approach to Environmental Appraisal, with the identification and appraisal of effects and mitigation following the Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland – Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018, and updated September 2019) and based on expert judgments.

The marine mammal baseline is presented in Section 10.5 of this EAR chapter. This identifies relevant designated sites which may be impacted by the Marine Scheme, as well as being a source of marine mammal features, i.e. cited cetaceans and seals, that may occur within a zone of Influence (ZoI) and interact with the Marine Scheme. Determination of the marine mammal baseline has been informed by the extensive body of literature identified in this chapter reporting the distribution and abundance of marine mammal receptors in the western North Sea.

The potential effects of the Marine Scheme on marine mammals have been appraised in Section 10.6. Where appropriate, proportionate measures to avoid or mitigate for any identified adverse effects are identified. This appraisal concludes that the potential effects during the installation, operation (including maintenance and repair) and decommissioning of the Marine Scheme on marine mammal receptors are **not significant**.

The potential for interaction between the Marine Scheme and other plans/projects is considered in Chapter 16: Cumulative and In-Combination Effects. No interaction is anticipated between the Marine Scheme, and the Scottish and English Onshore Schemes as there are no likely pathways identified for underwater noise, vessel movement, electric and magnetic fields (EMF) or thermal emissions.

10. Marine Mammals

10.1 Introduction

This chapter of this Environmental Appraisal Report (EAR) contains an appraisal of the potential interaction between the Marine Scheme and marine mammals.

The Marine Scheme comprises the marine component of the Scotland England Green Link 1 (SEGL1) / Eastern Link 1 (EL1), extending from the Mean High Water Springs (MHWS) at the Scottish landfall on Thorntonloch beach, to the MHWS at the English landfall near Seaham. It is located within both English and Scottish territorial waters, within the 12 nautical mile (NM) limit from the coast. The Marine Scheme comprises an installation corridor approximately 176 km length and 500 m maximum width within which cables will be installed (hereinafter referred to as the 'marine installation corridor'). The marine installation corridor extends from kilometre point (KP) 0, at its landfall in Scotland, to KP 176, at its landfall in England (see Figure 1-3). The Marine Scheme activities cover the following phases: installation, operation (including maintenance and repair), and decommissioning. Detailed descriptions of each of the Marine Scheme phases can be found in Chapter 2: Project Description.

The marine mammal baseline, as determined through desk-based research, is presented in Section 10.5 of this chapter. All cetaceans are European protected species (EPS), which it is an offence to capture, harass or disturb (NatureScot, 2021). Further detail on EPS is presented in Section 10.5. This chapter also considers those marine mammals included as Priority Marine Features[1] (PMFs) in Scotland (Section 10.5).

The potential impacts of the Marine Scheme on marine mammals have been appraised in Section 10.6. Where appropriate, proportionate measures to avoid, mitigate or compensate for any identified adverse effects are identified.

The potential for interaction between the Marine Scheme and other plans/projects, which may result in significant cumulative effects in marine mammals, is considered in Chapter 16: Cumulative and In-Combination Effects.

10.2 Legislation, Policy and Guidance

This section outlines legislation, policy, and guidance relevant to the appraisal of the potential effects on marine mammals associated with the installation, operation (including maintenance and repair) and decommissioning of the Marine Scheme. For further information regarding the legislative and policy context refer to Chapter 3: Legislative and Policy Framework.

A number of policies and regulations aim to assure that marine mammals are taken into account during planning and execution of projects within UK waters. For the Marine Scheme these include the UK Marine Policy Statement (MPS) and the UK Marine Plans, specifically the Scottish National Marine Plan (Scottish Government, 2015), and the North East Inshore and North East Offshore Marine Plan[2] have a number of relevant policies specific to marine mammals which are presented in Volume 3 Appendix 3.1: Marine Plan Compliance Checklist.

A number of policies and laws require decision makers to consider the environmental impacts of a project. Legislation and policy relevant to the appraisal of Marine Scheme's effects marine mammals is presented in Volume 3 Appendix 3.2: Topic Specific Legislation.

The key guidance documents used to inform the appraisal of the Marine Scheme impacts on marine mammals include:

[1] Priority Marine Features (PMFs) are species and habitats which have been prioritised for conservation, and are characteristic of Scottish seas. A number of legislations and designations have been put in place to protect these species, which allows the focus of conservation measures to develop the vision of marine nature conservation set out by Marine Scotland (NatureScot, Priority marine features in Scotland's seas, 2020).

[2] The Marine Scheme falls entirely within the UK territorial waters (i.e. 12 NM), therefore within the Inshore portion of the North East marine area. The marine plan for the North East area has combined both inshore and offshore portions.

- JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys[3] (JNCC, 2017);
- JNCC Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (JNCC, 2020);
- The Protection of Marine European Protected Species (EPS) From Injury and Disturbance: Draft Guidance for the Marine Area in England and Wales and the UK Offshore Marine Area[4] (2010);
- The Protection of Marine EPS from Injury and Disturbance for the Marine Area in Scottish Inshore Waters[5] (Scottish Government (SG) and Scottish Natural Heritage (NatureScot, 2021);
- The Scottish Marine Wildlife Watching Code for advice, information and recommendations for watching marine wildlife (SNH, 2017); and
- The Guide to Best Practice for Watching Marine Wildlife to reduce the disturbance of important marine species (SNH, 2017).

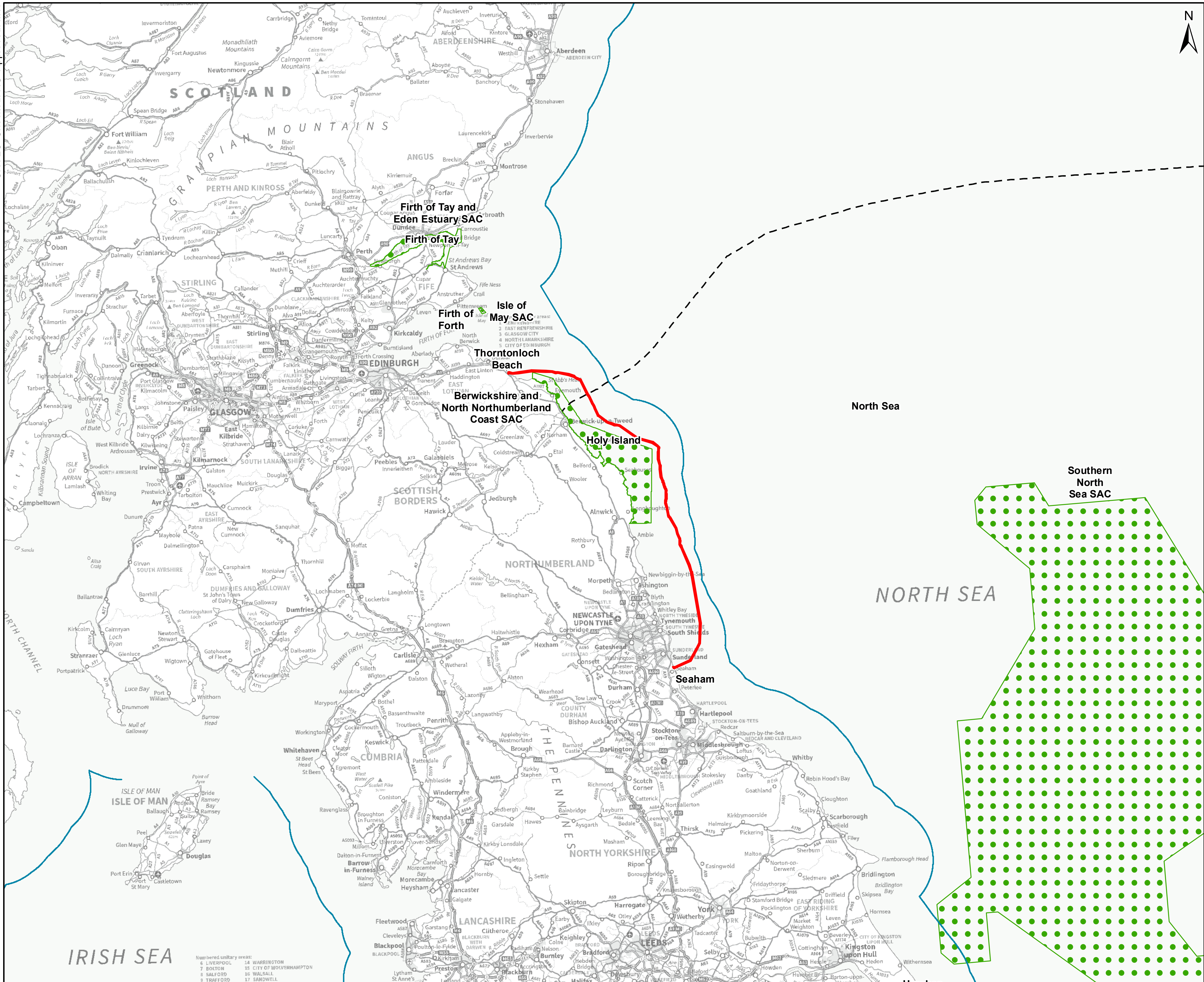
10.3 The Study Area

The study area for marine mammals has been determined at a scale that recognises the highly mobile and transient nature of marine mammal species and the potential implications of local impacts on wider species populations. For example, there are known to be wide ranging coastal movements of bottlenose dolphin, and also long-distance foraging trips, of up to 135 km, by grey seal.

Data to support the baseline characterisation is available at a range of different spatial scales, depending on the data source and the species of interest. For example, species specific data, based on Management Units (MUs) published by the Inter Agency Marine Mammal Working Group (IAMMWG), and is available for seven of the most common cetacean species included in UK waters: harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, short-beaked common dolphin, Atlantic white-sided dolphin and Risso's dolphin (IAMMWG, 2015). The MUs divide up different parts of UK waters to allow abundance estimates to be calculated for each species (IAMMWG, 2021). The International Council for Exploration of the Seas has defined Assessment Units (AU) for marine mammals, such as the North Sea AU for harbour porpoise. For less common species the AU areas are much larger.

The study area for the marine mammal appraisal is the North Sea AU, which encompasses the Greater North Sea Ecoregion (North Sea, English Channel, Skagerrak, and Kattegat) (ICES, 2018), with a focus on the marine installation corridor, as illustrated in Figure 10-1.

[3] http://jncc.defra.gov.uk/pdf/jncc_guidelines_seismicsurvey_aug2017.pdf
[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850708/Draft_Guidance_on_the_Protection_of_Marine_European_Protected_Species_from_Injurt_and_Disturbance.pdf
[5] https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2020/07/marine-european-protected-species-protection-from-injury-and-disturbance/documents/marine-european-protected-species-guidance-july-2020/marine-european-protected-species-guidance-july-2020/govscot%3Adocument/EPS%2Bguidance%2BJuly%2B2020.pdf?forceDownload=true



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Flanders Marine Institute (2018). Maritime Boundaries Geodatabase: Territorial Seas (12NM), version 2.
Available online at http://www.marineregions.org/. https://doi.org/10.14284/313
Contains information from Scottish Government (Marine Scotland) & Sea Mammal Research Unit licensed under the Open Government Licence v3.0

0 50 100 km

Coordinate System: WGS1984 Zone 30N

Scale @ A3 1:1,500,000

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PROJECT

Scotland England Green Link 1 / Eastern Link 1

KEY

- Marine Installation Corridor
- UK Territorial Sea Limit
- Scottish/English Water Border
- Special Area of Conservation (SAC)

TITLE

Figure 10-1
Study Area

REFERENCE

SEGL1_M_EAR_10-1_v2_20220221

SHEET NUMBER 1 of 1

DATE 21/02/2022

10.4 Approach to Appraisal and Data Sources

10.4.1 Appraisal Methodology

This chapter applies the environmental appraisal methodology as detailed in Chapter 4: Approach to Environmental Appraisal. The identification and appraisal of impacts and mitigation are based on expert judgment and following Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in Britain and Ireland – Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018). For the key marine mammal specific guidance documents used, see Section 10.2.

Receptor sensitivity and potential magnitude of environmental effects have been appraised using the terminology outlined in Chapter 4.

A non-statutory scoping report was submitted to the Marine Management Organisation (MMO) and Marine Scotland Licensing Operations Team (MS-LOT) for consultation in March 2021[6]. The scoping report identified aspects of the Marine Scheme that have the potential to impact marine mammals during installation, operation and decommissioning (NGET & SPT, 2021).

10.4.2 Data Sources and Consultations

10.4.2.1 Data Sources

Baseline conditions have been established by undertaking a desktop review of published information and through consultation with relevant organisations. The key data sources used to inform the baseline description and appraisal include:

- Atlas of Cetacean Distribution in north-west European Waters (Reid, Evans, & Northridge, 2003);
- UK Biodiversity Action Plan (UK BAP) (JNCC, UK Biodiversity Action Plan (UK BAP) 1994, 1994);
- UK Cetacean Status Review (Evans, Anderwald, & Baines, 2003);
- Small Cetaceans in European Atlantic waters and the North Sea (SCANS) Project. See further details in SCANS Data (I, II and III) below;
- Sea Watch Foundation (Sea Watch Foundation, 2012a);
- Sea Mammal Research Unit (SMRU) (SMRU, 2021);
- UK Cetacean Stranding Investigation Programme (CSIP) (UK Cetacean Stranding Investigation Programme, 2021);
- Inter-Agency Marine Mammal Working Group (IAMMWG, 2021);
- Updated information on the abundance distribution of marine mammal species in the Scottish Northern North Sea region and Scottish Atlantic waters (Hague, Sinclair, & and Sparling, 2020);
- Updated information on the distribution of grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* around the UK (Russell, Jones, & and Morris, 2017);
- Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles (Carter, et al., 2020);
- Distribution models for harbour porpoise within the UK Exclusive Economic Zone based on 18 years of survey data collected as part of the Joint Cetacean Protocol (Heinänen & Skov, 2015);
- WWT Data (2001 – 2008) – WWT Consulting carried out aerial surveys for water birds. Opportunistic sightings of cetaceans, seals, turtles, sharks and ocean sunfish were also recorded and reported in WWT Consulting (2009). This data provides information about the distribution and abundance of these taxa around the British Isles (WWT Consulting, 2009);

[6] The non-statutory scoping report is publicly available from: https://marine.gov.scot/sites/default/files/segl_el1_marine_scoping_report_-_base_report_rev_2.0.pdf

- Updated distribution models for 12 species of cetacean covering the north east Atlantic based on survey data collected between 1980 and 2018 (Waggitt J. , et al., 2019); and
- Special Committee on Seals (SCOS, 2020) - SCOS provides scientific advice to the government annually on matters related the management of seal populations. This includes information related to the abundance, distribution.

SCANS Data (I, II, and III)

As part of the SCANS Project, surveys have been undertaken within the study area (defined in Section 10.3). As part of the SCANS Project, surveys have been undertaken within the study area (defined in Section 10.3) to estimate the abundance of small cetaceans across the North Sea. The first survey (SCANS-I) was undertaken in 1994 and involved standard boat-based line transect surveys and aerial transect surveys based on the specific methods of Hiby and Lovell (1998) to estimate, for the first time, the abundance of various cetacean species in waters around the UK. This programme has evolved and was repeated in 2005 (Hammond, et al., 2013) (i.e. SCANS-II) and again in 2016 (Hammond P. , et al., 2017), updated in 2021 (Hammond, et al., 2021) (i.e. SCANS-III).

It should be noted that SCANS surveys were conducted in the summer and therefore data is representative of summer distributions only (Hammond, et al., 2021). However, it is understood that the densities of cetaceans around the British Isles are likely to be highest during this season, supported by modelling by Waggitt et al. (2019). Therefore, the abundances presented in Section 10.5 are considered to represent the worst-case scenario and show the highest likely abundances to be encountered within the study area (Section 10.3).

The marine installation corridor will pass through survey Blocks R and O, which are loosely correlated with the border between Scottish and English waters, partitioning just further south in line with Newcastle. Estimates of abundance for each marine mammal species have been derived for each survey block and for the total survey area.

Although the same area was not always sampled in each of the three SCANS monitoring years, some inference of temporal trends can be made from the data. This information can also be used to predict the potential evolution of baseline conditions for marine mammals within the study area. As such, the SCANS data represents a key data source for cetaceans.

10.4.2.2 Summary of Consultations

Following the submission of the non-statutory Scoping Report in April 2021, the MMO, MS-LOT and respective consultees and advisers had the opportunity to express their opinions and provide feedback on the proposal and EAR scope, which has been considered in this chapter.

Further details of the consultation process and associated responses are presented in Chapter 6: Consultation and Stakeholder Engagement.

Table 10-1 summarises consultation responses received from relevant statutory and non-statutory consultees in relation to ornithology for the Marine Scheme and outlines how and where this has been addressed in this chapter.

Table 10-1: Scoping report consultation

Consultee	Consultee response/ comment	How and where addressed
MS-LOT (Marine Scotland Science)	Advises on baseline density information sources for seals	Literature has been reviewed and data appropriately incorporated into Section 10.5.2 of this chapter.
MS-LOT (Marine Scotland Science)	Bottlenose dolphin are a feature of the Moray Firth SAC and should be scoped into the appraisal.	A baseline for bottlenose dolphin is included in Section 10.5.1.2 of this chapter and is considered throughout the Section 10.6 Appraisal of Potential Impacts.
MS-LOT (Marine Scotland Science)	Recommend considering disturbance from the physical presence of vessels, in addition to collision.	These impact pathways have been considered in Section 10.6.
MS-LOT (Marine Scotland Science)	Recommend that appropriate underwater noise modelling techniques to be used for the EA (in addition to in support of the EPS license)	Underwater sound modelling has not been undertaken. Sound sources from the project are restricted to geophysical surveys and cable installation vessel movements. The appraisal uses effective deterrent ranges from available literature (Section 10.6.2.1).
NatureScot	Note that Berwickshire and North Northumberland Coast SAC is a joint site within both Scottish and English waters.	Noted. Clarification has been added to Section 10.5.4.
NatureScot	Bottlenose dolphin is a feature of the Moray Firth SAC should also be screened in. Expect a MMMP to be submitted for the preconstruction and construction periods of this project	A baseline for bottlenose dolphin is included in Section 10.5.1.2 of this chapter and impacts are considered in Section 10.6 Appraisal of Potential Impacts.
NatureScot	EPS license for preconstruction geophysical survey recommended.	An EPS license was obtained for the pre-appraisal survey in 2021. The same process will be followed for preconstruction and post construction monitoring surveys
MMO	Cumulative noise impacts on marine mammals should be considered; effects to be modelled; mitigation and monitoring to be outlined.	Assessment of the low intensity sound produced during cable installation impact distances for underwater sound will be based on sound propagation estimates using geometric spreading calculations.
The Wildlife Trust	'*Marine Mammals – baseline environment and study area* *Please note that the Moray Firth SAC should be scoped into the assessment. Evidence suggests that the east coast of England is functionally linked to this site, and therefore impacts must be assessed and mitigated. This is in line with Natural England advice.*	The interconnectivity between the Marine Scheme activities and the population of designating species of the Moray Firth SAC is considered by Stage 1 HRA screening, within Volume 3 Appendix 8.2: Habitat Regulations Assessment Report.
The Wildlife Trust	*Please note the importance of the area for white beaked dolphins; careful assessment will be required. Linked to comments in TWT Ref 10, evidence suggests that Farnes East MCZ is an important area for white beaked dolphins, which further supports the need to avoid cabling through this site.*'	Whilst not a designated feature of Farnes East MCZ, white-beaked dolphin are specifically acknowledged as a baseline species within Section 0 of this report and are addressed in the impact appraisal in Section 10.6.

10.4.3 Data Gaps and Limitations

The availability of data for marine mammals within the North Sea region is considered sufficient to characterise the baseline and as such, provide a good understanding of the existing environment. There are, however, limitations to the marine mammal surveys, which form the basis of the baseline. This is primarily due to the highly mobile nature of marine mammal species and the potential variability in usage of the area. As a result, each survey contributing to the available library of research, realistically, only provides a snapshot.

10.5 Baseline Conditions

This section presents the marine mammal baseline for the Marine Scheme, which covers the two groups of marine mammals occurring in UK waters, namely cetaceans (whales, dolphins, and porpoises) and pinnipeds (seals).

A total of 28 cetacean species have been observed, and two species of seal are present, in UK waters. However, most are occasional visitors and within the Greater North Sea Ecoregion, the International Council for the Exploration of the Sea (ICES) lists four cetacean species as commonly occurring or resident and a further five as regular but less common (ICES, 2019). Management Units (MU) have been defined for these species, with the exception of the killer whale and the long-finned pilot whale, by the Inter-Agency Marine Mammal Working Group (IAMMWG) to determine animal abundance estimates at appropriate spatial scales (IAMMWG, 2021). This baseline will also consider the two seal species present in the UK, the harbour seal and grey seal.

Most marine mammals are wide ranging and those recorded within the study area are likely to be individuals from larger biological populations originating at points along the English and Scottish coast. This baseline characterises marine mammal species known or likely to be present within the study area.

10.5.1 Cetaceans

Within the Greater North Sea Ecoregion[7], the four most commonly occurring or resident cetacean species (ICES, 2019) are:

- harbour porpoise *Phocoena phocoena*;
- bottlenose dolphin *Tursiops truncatus*;
- white-beaked dolphin *Lagenorhynchus albirostris*; and
- minke whale *Balaenoptera acutorostrata*.

A further five cetaceans, the short-beaked common dolphin *Delphinus delphis*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, long-finned pilot whale *Globicephala melas*, killer whale *Orcinus orca*, and Risso's dolphin *Grampus griseus* occur regularly but are less common.

A summary of the conservation protection afforded to the four most common cetacean species is presented in Table 10-2.

[7] The Greater North Sea ecoregion includes the North Sea, English Channel, Skagerrak, and Kattegat

Table 10-2: Summary of protection status for the most common cetaceans known to be present in the study area

Common name	Latin name	Wildlife and Countryside Act, 1981	EC Habitats Directive (Annex)	Bonn Convention (Appendix)	Bern Convention (Appendix)	ASCOBANS	Priority Marine Features (PMFs) (Scotland)
Harbour porpoise	*Phocoena phocoena*	✓	II, IV	II[1]	II	✓	✓[6]
Bottlenose dolphin	*Tursiops truncatus*	✓	II, IV	II[2]	II	✓	✓[6]
White-beaked dolphin	*Lagenorhynchus albirostris*	✓	IV	II[3]	II	✓	✓[6]
Minke whale	*Balaenoptera acutorostrata*	✓	IV	-	II	-	✓[6]

[1] North and Baltic Sea, western North Atlantic, Black Sea and North West African populations
[2] North and Baltic Sea populations
[3] Only North and Baltic Sea populations

Priority Marine Features:
[4] Offshore waters
[5]Territorial waters
[6]Both

10.5.1.1 Harbour porpoise

The harbour porpoise is one of the most common marine mammals in the North Sea (Hammond, et al., 2021) (Figure 10-2). The species has a widespread distribution across the North Sea and Scottish waters, as far north as the Pentland Firth (Sea Watch Foundation, 2012a) (Hague, Sinclair, & Sparling, 2020). They are present throughout the year, with numbers peaking from July – September (Hague, et al., 2020). Numbers during the winter months tend to be lower, though it is suggested this may be due to decreased detectability during the winter. They forage mainly for sandeel *Ammodytes* sp. (Maeda, et al., 2021) and grow up to 1.5 m in length (MacLoed, Begona Santos, Reid, Scott, & Pierce, 2007). For the east coast waters of the UK, the highest density of animals occurs in the southern region of the North Sea (Hague, et al., 2020), reflected in the designation of the Southern North Sea Special Area of Conservation (SAC) specifically for harbour porpoise (impact to designated sites appraised in Volume 3 Appendix 8.2: Habitat Regulations Assessment Report).

Harbour porpoise are generally observed in small groups of up to three individuals. The mean group size observed from the SCANS-III data was 1.38 individuals for Block R and 1.31 individuals for Block O, with an average of 1.35 individuals for all blocks (Hammond, et al., 2021). Occasionally, large aggregations are observed but these probably result from many small groups and individuals concentrating in the same place at the same time to exploit feeding resources, as opposed to being coordinated gatherings (Hoek, 1992).

SCANS-III data indicated that within Block R the estimated abundance was 38,646 individuals (95% CL = 20,584 – 66,524) with a density of 0.599 individuals/km^2 (Hammond, et al., 2021). In Block O, abundance and density were higher, with an estimated abundance of 53,485 individuals (95% Confidence Limits (CL) = 37,413 – 81,695) and a density of 0.888 individuals / km^2 (Hammond, et al., 2021). Figure 10-2 presents the density distribution of harbour porpoise throughout the study area as determined during the 2016 SCANS-III survey. These densities suggest that harbour porpoise are likely to be present within the marine installation corridor in Blocks R and O. There has been no obvious trend in the number of harbour porpoise in the North Sea since the mid-1990s (Hammond, et al., 2021) though there has been a shift in distribution southwards (Hammond et al., 2013) (Figure 10-3). A summary of SCANS-III data for harbour porpoise is provided in Table 10-3.

Recent model predictions by Waggitt et al. (2019) show the highest density of harbour porpoise occurring in the southern North Sea during the winter (Figure 10-2). During the summer months, density remains high in the southern North Sea but also increases towards the central and northern North Sea, which encompasses the marine installation corridor and both landfalls. Density predictions for the North Sea MU (Heinänen & Skov, 2015) shows good agreement to the SCANS-III survey data and modelling by Waggitt et al. (2019). This shows higher summer densities generally found in the southern part of the North Sea, particularly in the vicinity of Silver Pit and the north-western slopes of Dogger Bank. However, smaller areas of persistent high densities were also identified in the outer Moray Firth SAC. Winter predictions indicated high densities in the southern part of the North Sea encompassing the outer Thames Estuary and the inner Silver Pit, south east of Flamborough Head.

The most recent abundance estimates for the North Sea MU have been reported (IAMMWG, 2021) based on a reassessment of the SCANS-III survey data (Hammond, et al., 2021) where 346,601 individuals were reported (95% Confidence Interval (CI) = 289,498 – 419,967). Of these, 159,632 individuals (95% CI = 127,442 - 199,954) were reported to be present in the UK portion of the MU (i.e. abundance within the UK Exclusive Economic Zone (EEZ)) (IAMMWG, 2021).

There are no SACs designated for harbour porpoise within the accepted screening distance for maximum likely impacts of 50 km[8] of the marine installation corridor. Regional movements of harbour porpoise have also been considered in order to identify any populations beyond the screening distance that may be regular users of other areas within the 50 km buffer from the marine installation corridor. The closest SAC designated for harbour porpoise is the Southern North Sea SAC, located approximately 111 km from the marine installation corridor. For further information on designated sites, see Section 10.5.3.

The harbour porpoise was considered to be ‘threatened and declining’ in the Greater North Sea by the OSPAR commission (2008). However, in the UK the range and future prospect of the harbour porpoise is considered to be of ‘favourable’ conservation status although the overall trend in the conservation status of this species is unknown (JNCC, 2019). Globally, this species is now considered of ‘least concern’ by the International Union of Conservation of Nature (IUCN), although was previously considered vulnerable (IUCN, 2021).

[8] A distance of 50 km is the distance within which SACs for cetaceans should be scoped in for consideration. This is based on regulator advice that there is no potential for Marine Plans or projects to result in likely significant effects on sites with marine mammal qualifying features that are located further away than 50 km (MMO, 2019).

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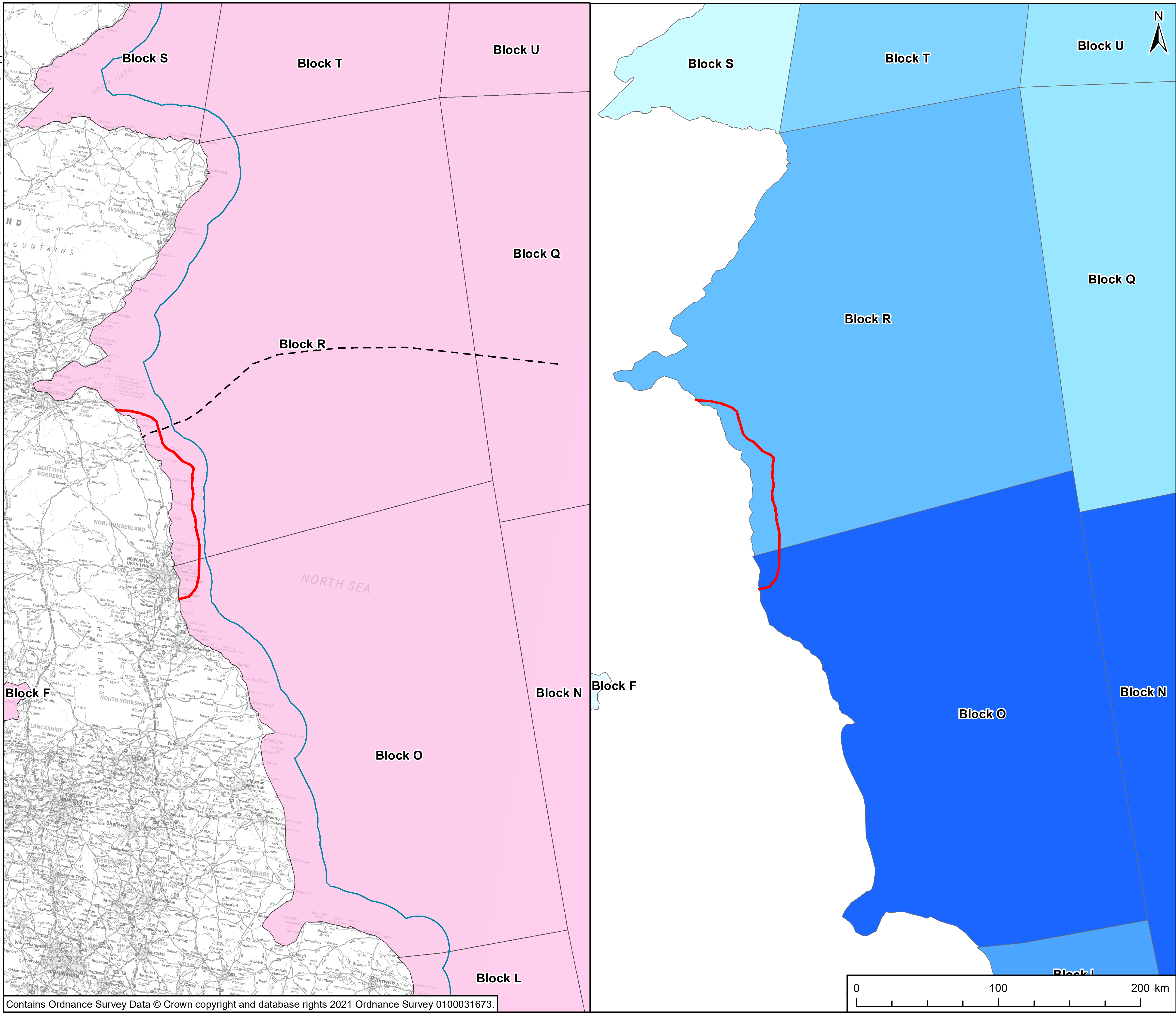

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Scale @ A3 1:2,500,000

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PROJECT

Scotland England Green Link 1 / Eastern Link 1

KEY

- Marine Installation Corridor
- UK Territorial Sea Limit
- Scottish/English Water Border

SCANS-III Survey Block

- Aerial Survey Method

Harbour Porpoise Density

(animals per sq km)

- 0
- 0 - 0.1
- 0.1- 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1.0
- 1.0 - 1.1

TITLE

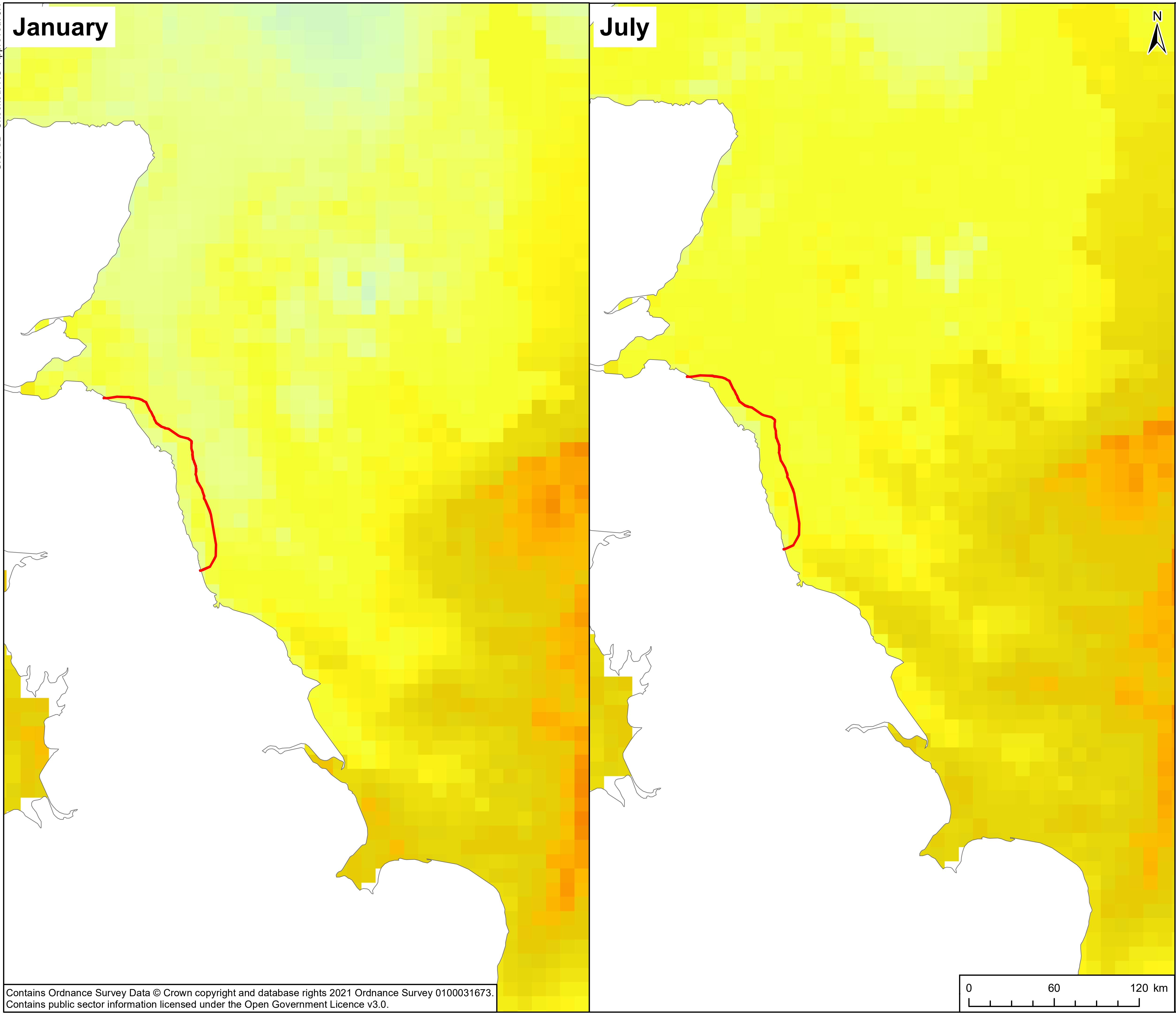
Figure 10-2
SCANS-III Survey Blocks and Harbour Porpoise Density
(source: Hammond et al., 2021)

REFERENCE

SEGL1_M_EAR_10-2_v1_20220504

SHEET NUMBER: 1 of 1

DATE: 04/05/2022



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Scale @ A3 1:2,500,000

GIS: SB Checked: RG Approved: JH

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SP TRANSMISSION

PROJECT

Scotland England Green Link 1 / Eastern Link 1

KEY

Marine Installation Corridor

Distribution of Harbour Porpoise (Waggit 2019)

(animals per square km)

High : 1.1

Low : 0

TITLE

Figure 10-3
Harbour porpoise spatial variation in predicted densities (individuals/km2) in January and July (Source: Waggit et al., 2019)

REFERENCE

SEGL1_M_EAR_10-3_v1_20220504

SHEET NUMBER	DATE
1 of 1	04/05/2022

10.5.1.2 Bottlenose dolphin

The bottlenose dolphin is a large species reaching 2.5 – 3.0 m in length and weighing up to 275 kg (Sea Watch Foundation, 2012a). There are two distinct ecotypes of bottlenose dolphin in UK waters – a wide-ranging offshore type, and an inshore (coastal) type that tends to stay within 30 km of the coast and demonstrates greater habitat fidelity (Hague, Sinclair, & Sparling, 2020). There are several groups of inshore bottlenose dolphin in UK waters, with limited interchange between them (Robinson, et al., 2012; Cheney, et al., 2013; IAMMWG, 2021). There is relatively little known about the offshore ecotype compared with the coastal ecotype (Waggitt J. , et al., 2019).

The coastal ecotype is resident year-round in Scottish waters, though numbers generally peak between July and October (Hague, Sinclair, & Sparling, 2020), for example the population found in the Moray Firth SAC. The bottlenose dolphin has highly diverse and flexible feeding techniques, often displaying cooperative feeding, where dolphin pods work together to tightly pack fish shoals from opposite sides, consuming the fish from either side (Taylor & Saayman, 1972).

During the SCANS-III survey in 2016, Block R had a total of 1,924 individuals (95% CL = 0 – 5,048) with a density of 0.030 individuals / km^2 observed (Hammond, et al., 2021) (Figure 10-4). Pods of bottlenose dolphin within Block R had a mean group size of 5.25 individuals. No bottlenose dolphin were recorded in Block O. Table 10-3 provides a summary of SCANS-III estimates for bottlenose dolphin. The findings of the SCANS-III surveys are consistent with more long-term data sets (1980 – 2018) used by Waggitt et al. (2019) to predict densities of bottlenose dolphin across the north east Atlantic (Figure 10-4). Very little variation throughout the year is also shown for bottlenose dolphin. There was no data reported for coastal bottlenose dolphins in these predictions as coastal ecotypes were excluded. The distribution of bottlenose dolphin offshore has not changed (Moffat, et al., 2020).

The range of the bottlenose dolphin population found in the Moray Firth SAC has extended southwards since the designation of the SAC, with the population now found as far south as the Firth of Forth and Berwick-upon-Tweed (Hague, Sinclair, & Sparling, 2020; Arso Civil M. , et al., 2021). These locations are an estimated 300 km away from the boundary of the SAC (Hague, Sinclair, & Sparling, 2020). The Firth of Tay and Tay Estuary, and St Andrews Bay have been identified as particularly important areas for bottlenose dolphins from the Moray Firth SAC (Hague, Sinclair, & Sparling, 2020; Arso Civil M. , et al., 2021), with around 52% of the population found here, which increases during the summer months (Arso Civil M. , et al., 2019). The five-year population average (2015-2019) of bottlenose dolphins in the Firth of Tay and Tay Estuary, and St Andrews Bay is 224 individuals (95% CI = 214 – 234) (Arso Civil M. , et al., 2021). Although the Tay Estuary and adjacent waters are further north than the marine installation corridor, the presence of Moray Firth bottlenose dolphin in these waters indicate that movement along the east coast of Scotland and England is high. There is some seasonal variation, with movement from the Tay Estuary and adjacent waters towards the Moray Firth SAC being highest in early summer. In late summer, movement in the opposite direction increases.

As bottlenose dolphin are now known to travel as far south as Berwick-upon-Tweed, it is highly likely that this species will be present in coastal waters around Thorntonloch and on the approach to the Scottish landfall, up to 30 km from the coast. However, the presence of Moray Firth bottlenose dolphin in the remaining marine installation corridor further south to Seaham is thought unlikely, given the low density in Block O (Hammond, et al., 2021).

The study area falls within two IAMMWG management units for bottlenose dolphin: the Greater North Sea MU and the Coastal East Scotland MU. The most recent abundance estimates for the Greater North Sea MU was reported in IAMMWG (2021) derived from the SCANS-III survey (Hammond P. , et al., 2017). Within this MU, the abundance of bottlenose dolphin is estimated to be 2,022 individuals (95% Confidence Interval (CI) = 548 – 7,453) with around 93% of these in the UK portion of the MU.

The Coastal East Scotland MU, which falls entirely in UK waters, has an estimated abundance of 189 individuals (95% CI = 155 – 216) (IAMMWG, 2021). This is dominated by the resident bottlenose dolphin population in the Moray Firth SAC (Thompson, et al., 2011). The latest population estimate for the SAC was taken in 2016 where 103 individuals were recorded (95% CI = 93 – 115). Although inter-annual variability has been observed, the number of bottlenose dolphins using the SAC has remained stable (Cheney, Graham, Barton, Hammond, & and Thompson, 2018).

The population of bottlenose dolphin along the east coast of Scotland and England has been increasing in size and in range, and it is expected that this is a trend which is likely to continue (Arso Civil M. , et al., 2019). The range of bottlenose dolphin is considered to be at 'favourable' conservation status in UK waters, which has remained stable for several years (JNCC, 2019) and is of 'least concern' globally (IUCN, 2019).

10.5.1.3 White-beaked dolphin

The white-beaked dolphin is an endemic species in the North Sea with a population of around 36,000 individuals (Sea Watch Foundation, 2012b; IJsselddijk, et al., 2018). This species is generally sighted in small groups of 5 – 10 individuals but much larger groups of 20 – 100 individuals have been seen during summer months (Sea Watch Foundation, 2012b). It is typically found in waters less than 200 m deep and most frequently observed in the summer (Hague, Sinclair, & and Sparling, 2020). However, it can be found year-round in Scottish waters. The white-beaked dolphin feeds on fish, mainly haddock and whiting (Canning, et al., 2008), and also cephalopods and crustaceans (Sea Watch Foundation, 2012b).

During the SCANS-III survey, the highest estimated densities included those recorded in the northern North Sea (Hammond, et al., 2021) (Figure 10-5). Block R exhibited the highest abundance and second highest density of this species with a total of 15,694 individuals (95% CL = 3,022 – 33,340), with a density of 0.243 individuals/km^2 recorded. Block R overlaps with the hotspot for white-beaked dolphin in the northern North Sea (Hague, Sinclair, & Sparling, 2020), explaining the high abundance that is found here. However, further south in Block O, including the English landfall, abundance and density were much lower, with a total of 143 individuals (95% CL = 0 – 490) and a density of 0.002 individuals/km^2 recorded (Hammond, et al., 2021).

Recent model predictions indicate that density increases southwards during the summer months, encompassing the offshore region of the marine installation corridor and the approaches to the Scottish and English landfalls. During this time, densities also increase around northern Scotland, which persist in the winter, although on a lower scale. Densities appear to remain low in coastal waters throughout the year. However, the data suggests that white-beaked dolphin are likely to travel through the marine installation corridor in English waters during the summer months, but their presence throughout the rest of the year is thought unlikely.

Evidence suggests that although the white-beaked dolphin is not a protected feature of the Farnes East Marine Conservation Zone (MCZ), it is still an important habitat for this species with high numbers recorded in the MCZ compared to surrounding locations (Brereton, Kitching, Davies, McNie, & Walker, 2016). The marine installation corridor passes through this MCZ, increasing the likelihood that white-beaked dolphin will interact with the cable route. The density of white-beaked dolphin increases in this area during the summer months, suggesting interaction with the marine installation corridor will also increase during this time (Waggitt J. , et al., 2019).

The IAMMWG management unit for white-beaked dolphin is the Celtic and Greater North Sea MU (IAMMWG, 2021). The most recent estimated abundance for the Celtic and Greater North Sea MU is estimated to be 43,951 individuals (95% Confidence Interval (CI) = 28,439 – 67,924). Of these, 34,025 individuals (95% CI = 20,026 – 57,807) were reported to be present in the UK portion of the MU. The estimate was derived from the updated SCANS-III abundance estimates for continental shelf waters, representing the core range for this species (Hammond, et al., 2021).

At present this species is considered to have a 'favourable' conservation status in UK waters (JNCC, 2019) and globally it is of 'least concern' (IUCN, 2019).

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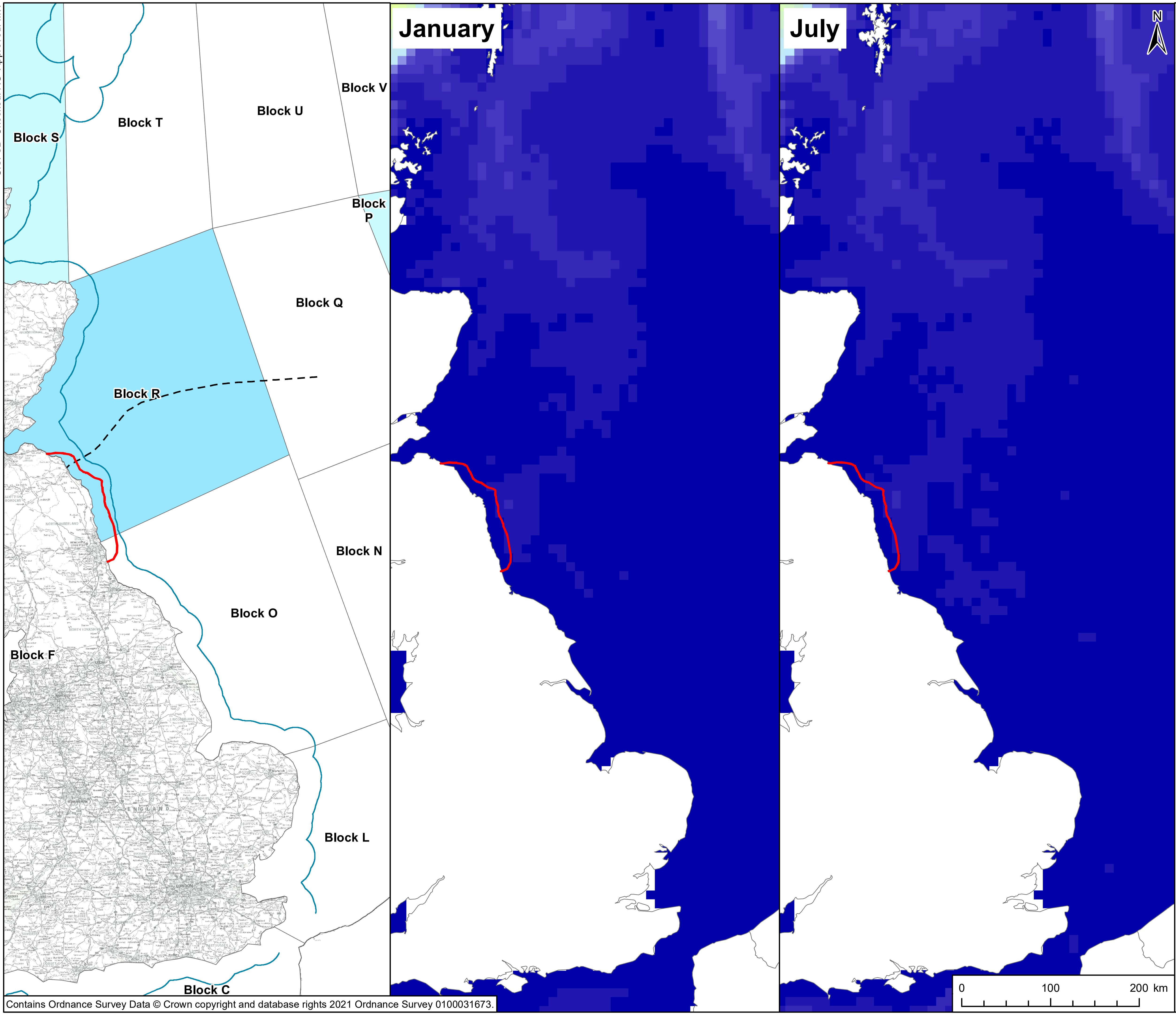

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Scale @ A3 1:4,000,000

nationalgrid
SP TRANSMISSION

PROJECT

Scotland England Green Link 1 / Eastern Link 1

KEY

- Marine Installation Corridor
- UK Territorial Sea Limit
- Scottish/English Water Border

SCANS-III Bottlenose Dolphin Density (Harper et el., 2021)

(animals per sq km)

- 0
- 0 - 0.025
- 0.025 - 0.050

Distribution of Bottlenose Dolphin (Waggit 2019)

(animals per square km)

High : 0.5

Low : 0

TITLE

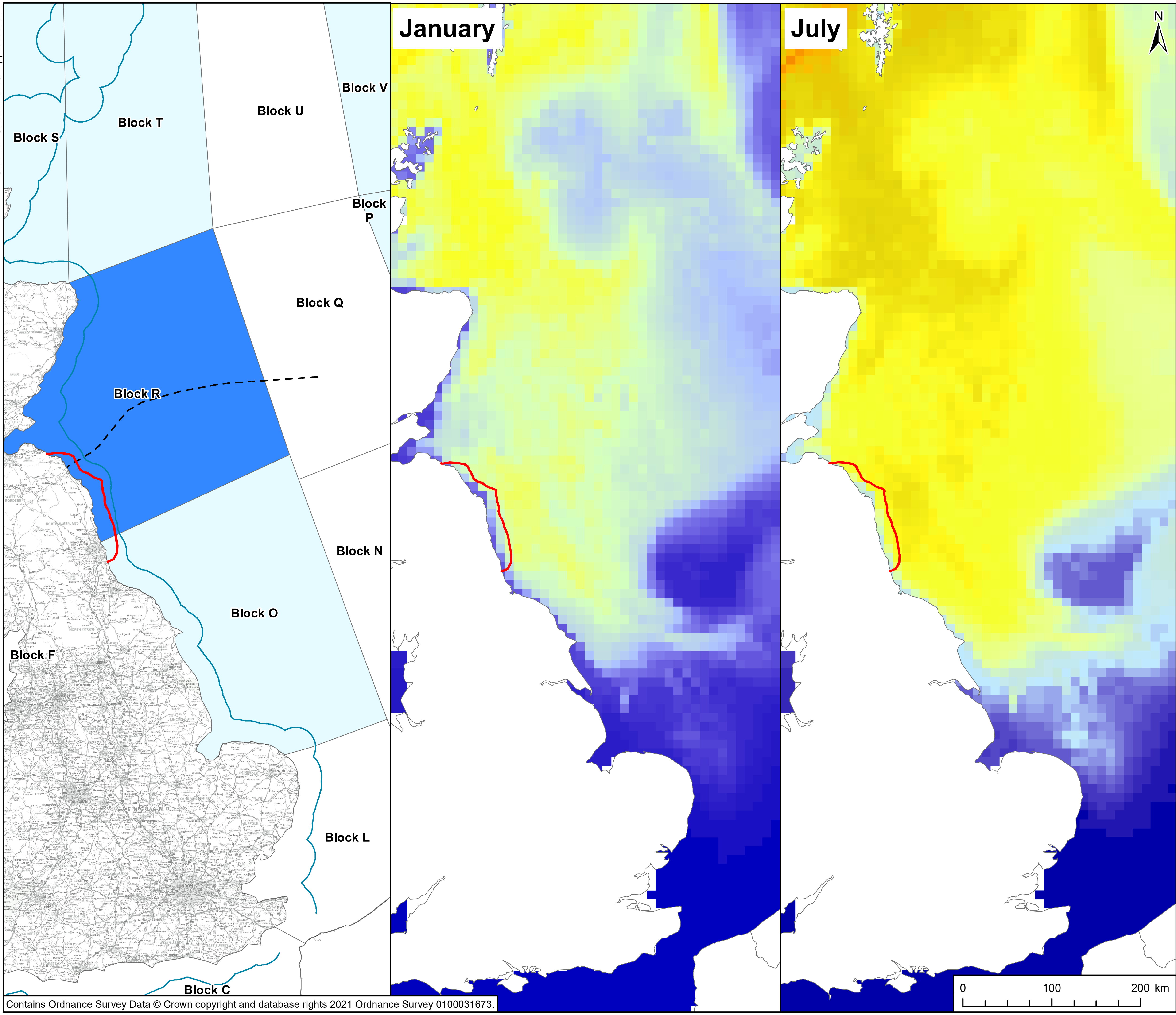
Figure 10-4
Bottlenose Dolphin Density and Distribution

REFERENCE

SEGL1_M_EAR_10-4_v1_20220504

SHEET NUMBER: 1 of 1

DATE: 04/05/2022



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SP TRANSMISSION

PROJECT

Scotland England Green Link 1 / Eastern Link 1

KEY

- Marine Installation Corridor
- UK Territorial Sea Limit
- Scottish/English Water Border

SCANS-III White-beaked Dolphin Density (Harper et el., 2021)

(animals per sq km)

- 0
- 0 - 0.05
- 0.20 - 0.25

Distribution of White-Beaked Dolphin (Waggit 2019)

(animals per square km)

- High : 0.21
- Low : 0

TITLE

Figure 10-5
White-Beaked Dolphin Density and Distribution

REFERENCE

SEGL1_M_EAR_10-5_v1_20220504

SHEET NUMBER: 1 of 1

DATE: 04/05/2022

10.5.1.4 Minke whale

The minke whale is relatively common. Minke whale are concentrated in coastal waters around Scotland with most sightings between June and August (Hammond, et al., 2021). They are considered seasonal visitors and are concentrated in offshore areas of the North Sea (Hague, Sinclair, & Sparling, 2020). It has been suggested there are three different foraging behaviours exhibited by minke whales: using fast movements in different directions, associating their foraging with seabird feeding activity (particularly in late summer (Evans, Anderwald, & Hepworth, 2008), and using lunge feeding (de Boer, 2010). The dominant prey item is sandeel, however they also feed on other fish species including herring, haddock, and mackerel (Olsen & Holst, 2001).

Block R exhibited the highest abundance of all the survey blocks (Hague, Sinclair, & Sparling, 2020) with 2,498 individuals (95% CL = 604 – 6,791) recorded and a population density of 0.039 individuals / km^2. The average group size was 1.18 individuals (Hammond P. , et al., 2017). In Block O, abundance was much lower, with 603 individuals (95% CL = 109 – 1,670) (Figure 10-6). The population density was estimated to be 0.010 individuals / km^2 and the average group size was 1.0 individual. This suggests minke whale are more likely to be present in higher numbers around the northern extent of the marine installation corridor compared to the southern. Table 10-3 provides a summary of SCANS-III data for minke whale.

However, minke whale presence appears to be seasonal. Recent model predictions indicate the highest densities of minke whale are within the north western region of the North Sea, particularly along the coast of northern England and Scotland (Waggitt J. , et al., 2019). The density of minke whale increases southwards towards English landfall during the summer months. However, densities still remain low. This suggests that low densities of minke whale may be found in the marine installation corridor throughout the year, with a slight increase during the summer.

The IAMMWG management unit for minke whale is the Celtic and Greater North Sea MU. The most recent estimated abundance for the Celtic and Greater North Sea MU was reported in IAMMWG (2021) which was derived from the SCANS-III survey (Hammond P. , et al., 2017). Within the Celtic and Greater North Sea MU, the abundance of minke whale is estimated to be 20,118 individuals (95% CI = 14,061 – 28,786). Of these, 10,288 individuals (95% CI = 6,210 – 17,042) were reported to be present in the UK portion of the MU (Hammond P. , et al., 2017).

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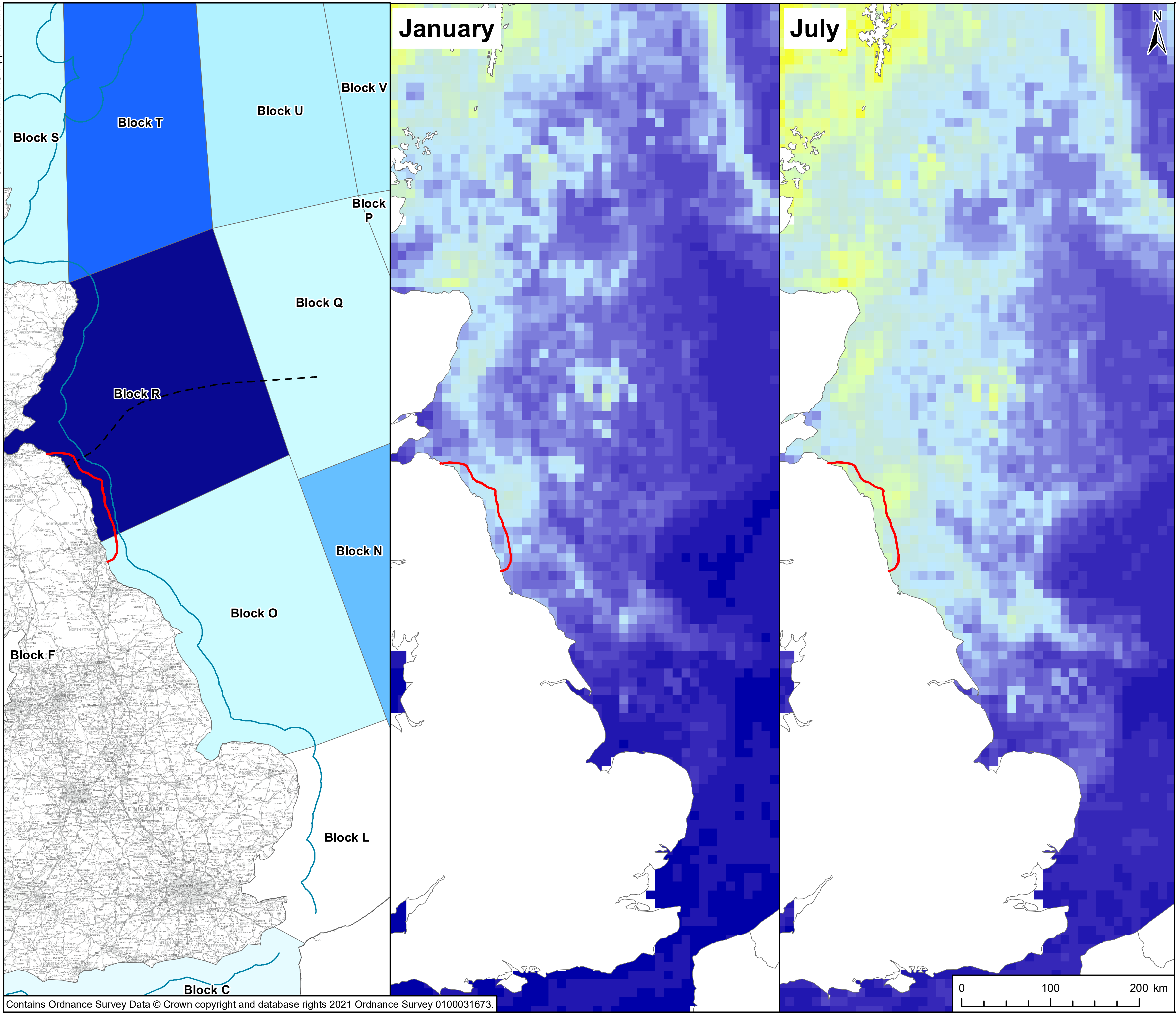

Coordinate System: WGS1984 Zone 30N

Scale @ A3 1:4,000,000

nationalgrid
SP TRANSMISSION

PROJECT

Scotland England Green Link 1 / Eastern Link 1

KEY

Marine Installation Corridor

UK Territorial Sea Limit

Scottish/English Water Border

SCANS-III Minke Whale Density (Harper et al., 2021)

(animals per sq km)

0

0 - 0.005

0.005 - 0.010

0.010 - 0.015

0.020 - 0.025

0.030 - 0.035

0.035 - 0.040

Distribution of Minke Whale (Waggit 2019)

(animals per square km)

High : 0.11

Low : 0

TITLE

Figure 10-5
Minke Whale Density and Distribution

REFERENCE

SEGL1_M_EAR_10-6_v1_20220504

SHEET NUMBER | DATE

1 of 1 | 04/05/2022

10.5.1.5 Other cetacean species

In addition to the four most common species, an additional five cetaceans may occur within the study area at times but are less common. These species are:

- Atlantic white-sided dolphin;
- Short-beaked common dolphin;
- Long-finned pilot whale;
- Killer whale; and
- Risso's dolphin.

White-sided dolphins prefer deeper, cool waters (7 – 12º C), and are often found along the edges of continental shelves at depths of 100 – 500 m. In UK waters this species is distributed in a broad zone from west of Ireland to the north and north-west of Britain. They are also found in deep waters around the north of Scotland throughout the year but are rare in the central and north-eastern North Sea, occurring in this area mainly in summer (Reid, Evans, & Northridge, 2003; Waggitt J. , et al., 2019). Modelling by Waggitt et al. (2019) shows very low densities around the UK in both summer and winter months (Hague, Sinclair, & Sparling, 2020). The most recent estimated abundance for white-sided dolphins in the Celtic and Greater North Seas MU is 18,128 individuals (95% CI=6,049-54,323), with 12,293 of these individuals (95% CI=3,891-38,841) occurring in the UK portion (IAMMWG, Inter-Agency Marine Mammal Working Group, 2021). There are only density estimates for Block R. Block R had an abundance of 644 individuals (95% CI=0-2,069) and a density of 0.01 individuals/km^2 (Hammond, et al., 2021) mean group size reported is three individuals.

The short-beaked common dolphin is often found in continental shelf waters, particularly in the Celtic Sea and Western Approaches to the Channel, and off southern and western Ireland (Waggitt J. , et al., 2019), in average group sizes of 14 individuals (Reid, Evans, & Northridge, 2003). It has been observed occasionally in the North Sea, mainly in summer (June to September) (Reid, Evans, & Northridge, 2003), with distribution more concentrated offshore and to the west of Scotland (Hague, Sinclair, & Sparling, 2020). There are estimated to be a total of 56,556 individuals (95% CI=33,014-96,920) within the Celtic and Greater North Seas MU (IAMMWG, Inter-Agency Marine Mammal Working Group, 2021). Of these, 13,607 individuals (95% CI=8,720-21,234) are predicted to occur within the UK proportion of the MU. There are no abundance or density estimates available for Blocks R or O for this species.

The long-finned pilot whale is a deep-water species (>200 m) and tends to be found to the west of the UK, but only in low density (Hague, Sinclair, & Sparling, 2020; Waggitt J. , et al., 2019). This species is rarely sighted in the shallower waters around northern Scotland, the northern North Sea and the Channel. As a consequence, there are no long-finned pilot whale abundance or density estimates available for the relevant SCANS blocks, or for the MU.

In UK waters, killer whales are most common off northern and western Scotland and to a lesser extent west and south of Ireland. They are usually seen as solo individuals or in groups of 8 individuals maximum (Evans, Anderwald, & Baines, 2003). They are rarely observed in the central North Sea (Reid, Evans, & Northridge, 2003). Modelling by Waggitt et al. (2019) shows that there are low densities of killer whales in the northern North Sea and eastern Scottish waters, and around much of the UK throughout the year, with very little seasonal variation (Hague, Sinclair, & Sparling, 2020; Waggitt J. , et al., 2019). Abundance or density estimates for killer whales were not reported in SCANS data (Hague, Sinclair, & Sparling, 2020).

Risso's dolphin is a continental shelf species. Most sightings in UK waters are in western Scotland, with the waters surrounding the Outer Hebrides forming a hotspot (Waggitt J. , et al., 2019). The coastal ecotype is present throughout the year in Scottish waters, with densities increasing during the summer months (Hague, Sinclair, & Sparling, 2020). Most sightings in UK waters are in western Scotland, with the waters surrounding the Outer Hebrides forming a hotspot (Waggitt J. , et al., 2019). There are other clusters of sightings in the southern Irish Sea and off south-west Ireland. There are few records of this species within the central and southern North Sea (Reid, Evans, & Northridge, 2003). There have been some sightings reported in winter of the north-east coast of Scotland. There are no abundance or density estimates from SCANS data for this species. There are estimated to be a total of 12,262 individuals (95% CI=5,227 - 28,764) within the Celtic and Greater North Seas MU (IAMMWG, Inter-Agency Marine Mammal Working Group, 2021). Of these, 8,687 individuals (95% CI=2,810 – 26,852) are predicted to occur within the UK proportion of the MU.

10.5.1.6 Summary of Cetacean Abundance and Density Estimates

Abundance and density estimates for the four key cetacean species potentially present within the marine installation corridor are provided in Table 10-3 below. This data is based on the most recent SCANS-III surveys for survey Blocks O and R (Hammond, et al., 2021).

Block O has a particularly high abundance and density of harbour porpoise and Block R immediately to the north has a high abundance and density of all four species (in relative terms).

Table 10-3: Summary of abundance and density estimates for the four key cetacean species by SCANS-III survey block

SCANS-III Survey Block	Species	Density (individuals/km^2)	Total population size per block
R (North east coast of England and east coast of Scotland)	Harbour porpoise	0.599	38,646
	Bottlenose dolphin	0.030	1,924
	White-beaked dolphin	0.243	15,694
	Minke whale	0.039	2,498
O (East coast of England)	Harbour porpoise	0.888	53,485
	Bottlenose dolphin	0	0
	White-beaked dolphin	0.002	143
	Minke whale	0.010	603
Source: Hammond et al. 2021			

10.5.2 Pinnipeds

Two seal species live and breed in UK waters: grey seal *Halichoerus grypus* and harbour (or common) seal *Phoca vitulina.* The grey seal and harbour seal are classed as top marine predators (McConnell, Fedak, Lovell, & Hammond, 2001; Sharples, Moss, Patterson, & Hammond, 2012). The diet of a harbour seal consists of several fish species including cod, whiting and sandeel (Hall, Watkins, & Hammond, 1998). The grey seal is the larger of the two species, feeding on fish species including cod, whiting and plaice (SCOS, 2020).

10.5.2.1 Harbour seal

Approximately 30% of European harbour seals are found in the UK. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles (Figure 10-7). On the east coast, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth, although small populations are found elsewhere such as Teesside and Holy Island (SCOS, 2020). The estimated total population of harbour seals for the UK from most recent counts during the moulting season (2016 – 2019) is 44,000 individuals (95% CL = 36,000-58,700). The marine installation corridor falls predominately within the North East England Seal MU but also overlaps with the East Scotland seal MU. Recent mean August harbour seal counts (2016 – 2019) identified 79 and 343 individuals within these two MUs, respectively.

As an Annex II species of the EU Habitats Directive (Hague, Sinclair, & and Sparling, 2020), the harbour seal is a designating feature of a total of 16 SACs in the UK (SCOS, 2020). Two of these occur in the North Sea: the Firth of Tay and Eden Estuary SAC in eastern Scotland and the Wash and North Norfolk Coast SAC in East Anglia, Lincolnshire. Both SACs support nationally important breeding colonies of harbour seal (~7% of the total UK population)**.** The Firth of Tay and Eden Estuary SAC is 50 km from the marine installation corridor, whilst the Wash and North Norfolk Coast SAC is located over 100 km away.

Mean harbour seal at-sea usage (i.e. the mean count of seals in the water at any point) is concentrated in SACs along the eastern English coast, including the Firth of Tay and Eden Estuary and the Wash and North Norfolk Coast (Carter, et al., 2020). Within the marine installation corridor, from KP 0 to KP 176.25 the mean at-sea usage for harbour seals is estimated to be between 0 and 50 individuals per 5 km x 5 km block (i.e. between 0 and 2 individuals per km^2), with most of this area representing a very small percentage of the at-sea population of harbour seals in the British Isles (per 25 km^2) (Hague, Sinclair, & and Sparling, 2020; Carter, et al., 2020). Telemetry data shows that very few individual seals from the Wash and North Norfolk Cast SAC are likely range beyond the English landfall site.

Harbour seals persist in discrete regional populations, usually staying within 50 km of haul-out sites (Russell & McConnell, 2014) (Russell, Jones, & and Morris, 2017). This species uses haul-out sites to moult and give birth, only leaving to forage (SCOS, 2020). Foraging trips can last up to 12 hours (Thompson, Mackay, Tollit, Enderby, & Hammond, 1998). However, the hauling-out of harbour seals is seasonal, peaking in August – September during the moulting season, with a decrease in June – July during the pupping season (Wilson, 2001). Females spend more time hauled-out during both the pupping and moulting seasons compared to males (Cunningham, et al., 2009). Prey availability also seems to influence time spent hauled out, with populations in areas of high prey availability spending more time foraging and feeding (Härkönen, 1987).

The closest harbour seal haul-out sites to the Marine Scheme are Kinghorn Rocks (approximately 53 km away in the outer Firth of Forth), and Inchmickery and Cow & Calves (approximately 62 km away in the Firth of Forth) (Table 10-4). For an activity at sea to impact a seal haul-out site, it would need to occur very close to that haul-out site, often given as a precautionary 20 km. All haul-out sites designated for harbour seals on the east coast are located more than 20 km away from the marine installation corridor (Table 10-4). They are therefore, not considered to be a key element of the harbour seal baseline as potential reckless harassment, as per the Conservation of Seals under the Marine (Scotland) Act 2010 (Scottish Government, 2014), is not a consideration for the Marine Scheme.

However, the waters around the haul-out sites may have a higher concentration of seals outside of the moulting and breeding season as harbour seals are thought to remain relatively close to a home range. Telemetry data indicates harbour seals tend to travel between 10 and 60 km during foraging trips (Thompson, Mackay, Tollit, Enderby, & Hammond, 1998) and so there is potential for harbour seals associated with Kinghorn Rocks haul-out site to forage in the marine installation corridor around the Scottish landfall. Inchmickery and Cow & Calves is located more than 60 km away and so is beyond the average foraging distance from the Marine Scheme.

Table 10-4: Relevant designated harbour seal haul-out sites

Site name (country)	Designation features	Approx. distance to marine installation corridor (km)
Kinghorn Rocks (Firth of Forth, Scotland)	This site is in place to protect any species of seal throughout the year	53
Inchmickery and Cow & Calves (Firth of Forth, Scotland)	This site is in place to protect any species of seal throughout the year	62

Around half (52%) of the seal population along the east coast of England was affected by the phocine distemper virus (PDV) epizootic in 1988 (SCOS, 2020). This mostly affected the harbour seal population in The Wash, which was further reduced by an additional 22% in 2002 by a second epizootic. The overall conservation status for harbour seal is now considered to be ‘unfavourable – inadequate’. However, this is a positive change from ‘unfavourable – bad’ since the previous reporting round in 2013 and is due to an overall increase in the abundance of harbour seal in the UK (JNCC, 2019). The overall UK population increased from 25,600 individuals in the 2007-2009 period to 31,700 individuals in the 2016-2019 period (SCOS, 2020). Overall, the East Scotland Seal MU is currently said to be stabilising following a period of decline (Hague, Sinclair, & Sparling, 2020; SCOS, 2020). However, declines are still being observed in the Tay and Eden SAC. The East Scotland Seal MU has the lowest count of harbour seals compared to all other Scottish Seal MUs. The global conservation status of harbour seal is of ‘least concern’ (IUCN, 2021).

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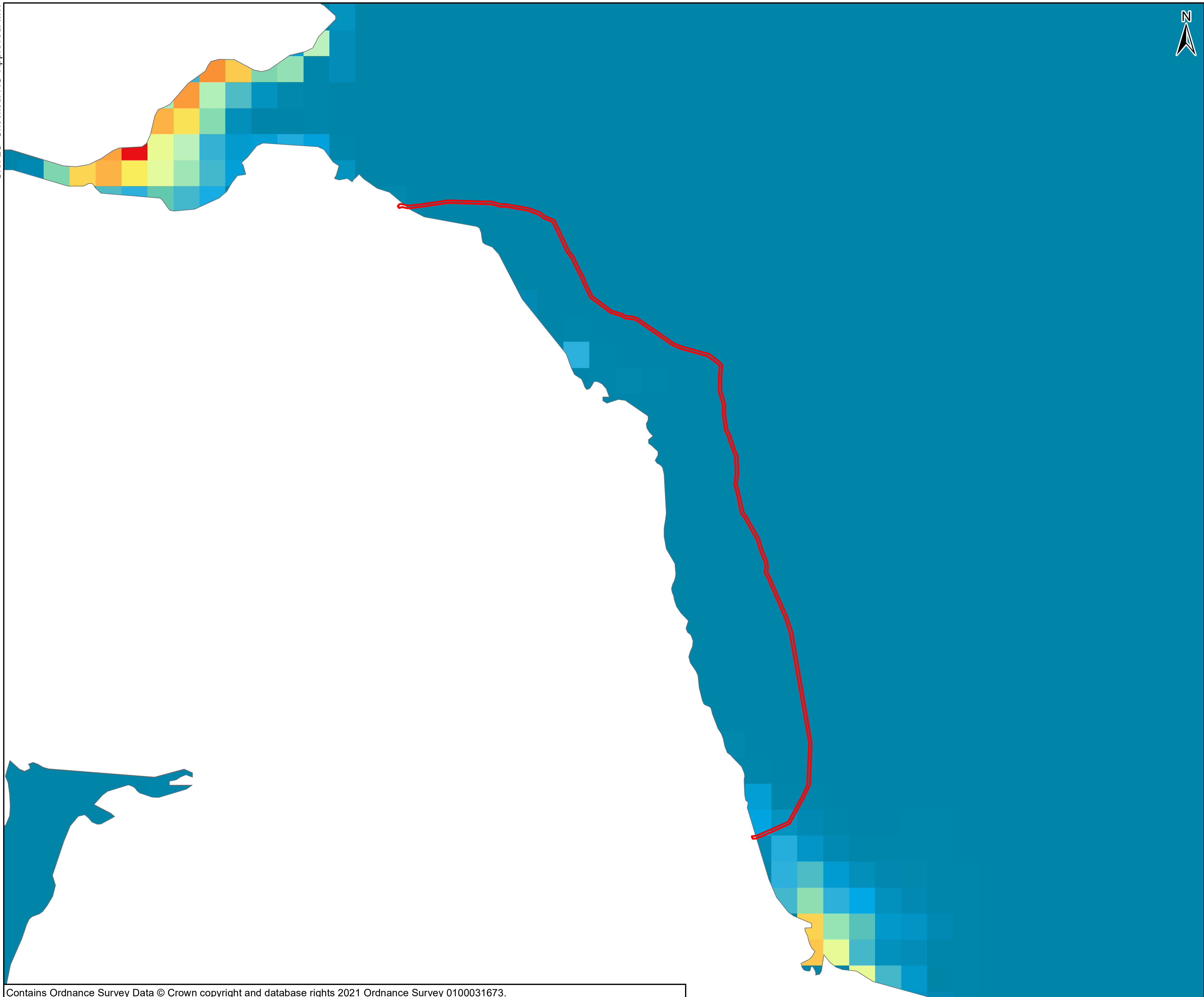

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Coordinate System: WGS1984 Zone 30N

Scale @ A3 1:700,000

nationalgrid

SP TRANSMISSION

PROJECT

Scotland England Green Link 1 / Eastern Link 1

KEY

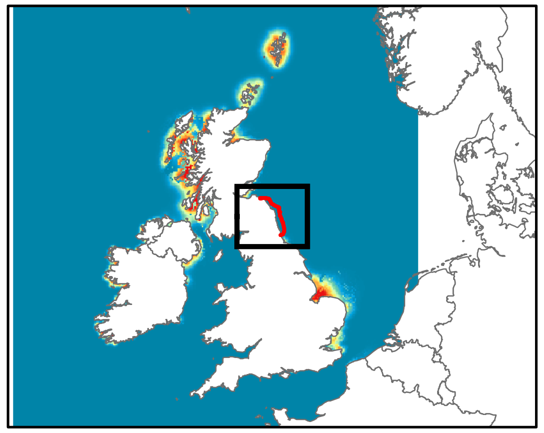
Marine Installation Corridor

Harbour Seals

Percentage of at-sea population

High : 0.1

Low : 0



TITLE

Figure 10-7
Mean percentage of at-sea population (estimated to be present in each 5 km x 5 km grid cell at any one time) of harbour seals from haulouts in the British Isles (Source: Carter et al., 2020).

REFERENCE

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10.5.2.2 Grey seal

Approximately 36% of the world's grey seal population breeds in the UK with 86% of these breeding in Scotland. The main concentrations are in the Inner and Outer Hebrides and in Orkney (Duck, 2010). The east coast of Scotland and England is also home to a number of breeding populations (SCOS, 2020). The most recent data estimate that approximately 149,700 individuals (95% CI 120,000-174,900) were present in the UK in 2019. Regional pup production estimates for North Sea colonies within proximity to the study area are shown in Table 10-5.

Table 10-5: Grey seal pup production estimates from 2018 for colonies located within proximity to the study area

Location	Haul-out locations	2019 Pup Production Estimate	Distance of colony to nearest point of marine installation corridor (km)
Firth of Forth	Fast Castle Isle of May Inchkeith	6,894	Fast Castle – 1.5 Isle of May - 25 Inchkeith - 52
Farne Islands	1 haul-out	2,737	8
Source: SCOS (2020)			

As an Annex II species of the EU Habitats Directive, the grey seal is a designating feature for a total of 13 SACs in the UK (SCOS, 2020). A screening distance (and Study Area) of 135 km has been selected for grey seal designated sites, based on known foraging distances (MMO, 2019).

Only two SACs with grey seal as a designating feature occur within this screening distance. The Isle of May SAC in eastern Scotland is 26.1 km away from the marine installation corridor and the seaward boundary of the Berwickshire and North Northumberland Coast SAC is 0.1 km away. The distance from the marine installation corridor to the nearest intertidal region of the Berwickshire and North Northumberland Coast SAC is approximately 3 km. Both sites support important breeding colonies (see Section 10.5.4). Along the marine installation corridor, the density of grey seal varies greatly from 0.0017% to 0.086% of the total UK population per 5 km x 5 km block) (Figure 10-8). This equates to a density of between 10 and 516 individuals / km^2 within a 5 km distance from the marine installation corridor. The higher density figure is at the edge of this range and the marine installation corridor is beyond the highest density of grey seals, which occur around the waters of the Farne Islands, at least 8 km away, beyond the likely ZOI of the Marine Scheme.

Haul-out sites are important to grey seals for breeding, resting and moulting (SCOS, 2020). The peak periods when grey seal will be hauled out will be during the annual breeding season (between August and December) and the moult season (between December and April). The nearest haul-out site is Fast Castle, located approximately 1.5 km away, which also partially overlaps with the Berwickshire and North Northumberland SAC. The Farne Islands and Craigleith are also nearby (Table 10-6).

For seals resting at haul-out sites to be affected by Marine Scheme activities, the activities would need to be occurring very close to the haul-out site. A precautionary screening distance of 20 km is adopted for the consideration of haul-out sites within the baseline for consideration of the potential for reckless harassment, as per the Conservation of Seals under the Marine (Scotland) Act 2010 (Scottish Government, 2014) (Section 10.2). The only haul-out sites falling within this distance to marine installation corridor are at Fast Castle and the Farne Islands (Figure 10-8).

The mean at-sea usage of grey seals is concentrated around these haul-out sites Carter et al. (2020) (Figure 10-8). Whilst modelling has shown that grey seals typically spend 43% of their foraging time within 10 km of a haul-out site (McConnell, Fedak, Lovell, & Hammond, 2001) they also forage over significant distances, up to 135 km, and can spend up to thirty days at sea without return to their haul-out site (SCOS, 2020). Grey seals forage along the eastern coast of Scotland and England, encompassing the majority of the marine installation corridor, though activity at offshore locations, close to most of the marine installation corridor is much lower in comparison (Carter, et al., 2020).

A particular hotspot is located around the coast of Thorntonloch, where the Fast Castle haul-out site is located, approximately 1.5 km from the marine installation corridor (Table 10-6). However, given their extensive potential foraging range of up to 135 km, a number of other grey seal haul-out sites, have been identified (Table 10-6).

Table 10-6: Relevant designated grey seal haul-out sites

Site name (country)	Designation features	Approx. distance to marine installation corridor (km)
Fast Castle (Nr Eyemouth, Scotland)	**Type of haul-out**: Breeding colony This site is in place to protect any species of seal throughout the year	1.5
Farne Islands (England)	**Type of haul-out**: Breeding colony	8
Craigleith (Firth of Forth, Scotland)	**Type of haul-out**: Breeding colony This site is in place to protect any species of seal throughout the year	25
Inchkeith (Firth of Forth, Scotland)	**Type of haul-out**: Breeding colony This site is in place to protect any species of seal throughout the year	52
Kinghorn Rocks (Firth of Forth, Scotland)	This site is in place to protect any species of seal throughout the year.	53
Inchmickery and Cow & Calves (Firth of Forth, Scotland)	This site is in place to protect any species of seal throughout the year.	62

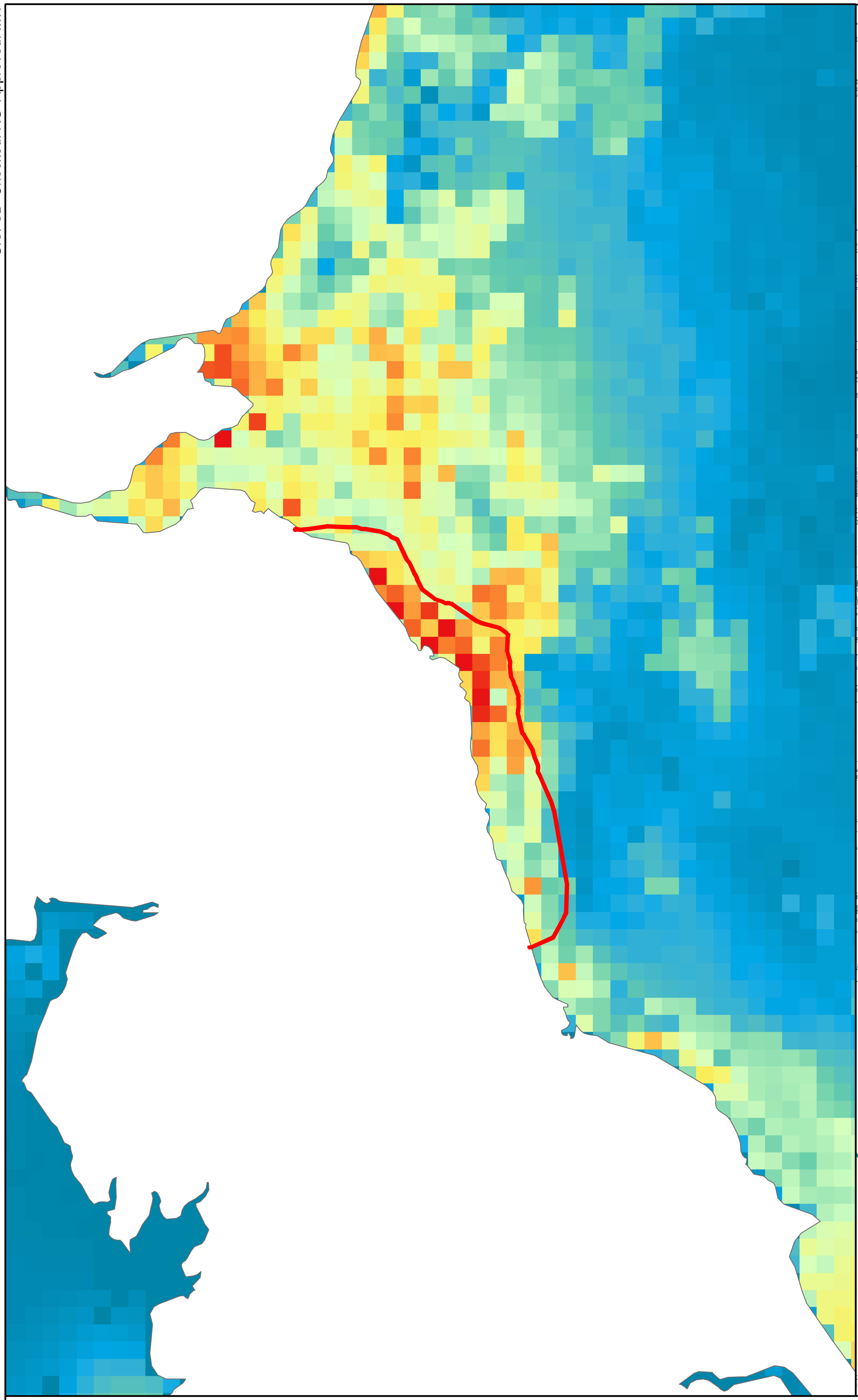
Given the known foraging distance of over 100 km in the central North Sea, and modelling data by Carter et al. (2020), it is highly likely that grey seals will frequently forage in and pass through the marine installation corridor, especially given the proximity of SACs and the Fast Castle haul-out site. Grey seals have been recorded to repeat the same foraging trip from haul-out sites (SCOS, 2020) and return to the same haul-out site 88% of the time (McConnell, Fedak, Lovell, & Hammond, 2001). This suggests that possible interactions with the marine installation corridor are even more likely.

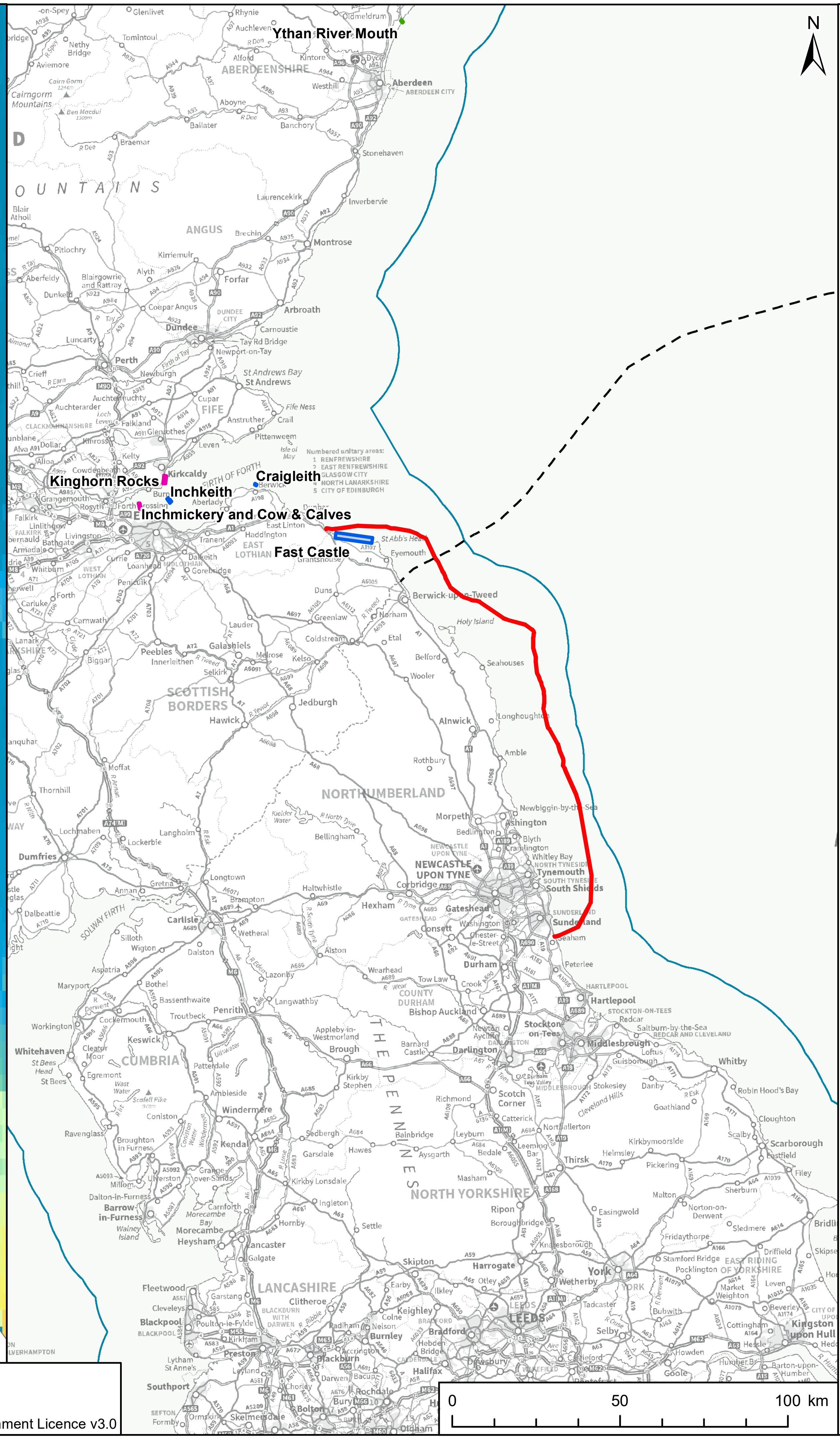
For further information on indirect impacts on the SACs due to the mobile nature of qualifying features, see Volume 3 Appendix 8.2: Habitat Regulations Assessment Report.

The UK grey seal population is considered to be stable and increasing, particularly within the eastern England colonies (SCOS, 2020). Pup production at the Isle of May SAC has reached an asymptote, which has been the case since late 1990s. In the Berwickshire and North Northumberland Coast SAC, pup production is increasing.

Overall, this species is at ‘favourable’ conservation status in the UK (JNCC, 2019). Globally, populations are also considered to be increasing and therefore the conservation status of this species is of ‘least concern’ (IUCN, 2019).

GIS: SB Checked: RG Approved: MW





nationalgrid
SP TRANSMISSION

PROJECT

Scotland England Green Link 1 / Eastern Link 1

KEY

- Marine Installation Corridor
- UK Territorial Sea Limit
- Scottish/English Water Border

Grey Seals

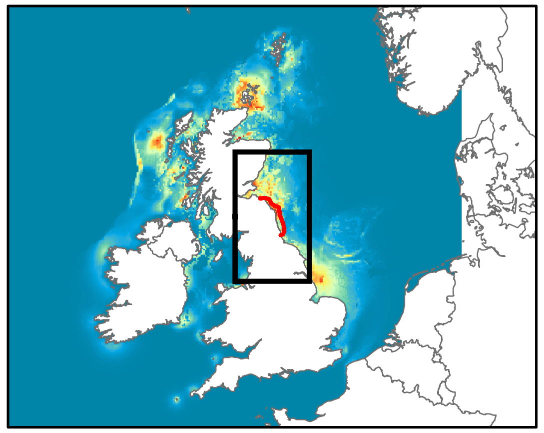
Percentage of at sea population (Source: Carter et al., 2020).

High : 0.1

Low : 0

Designated Haul-out Site for Seals

- Grey Seal - Breeding Colony Seal Haul Out
- Grey Seal - Seal Haul Out
- Harbour/Common Seal - Seal Haul Out
- Harbour/Common and Grey Seal - Seal Haul Out



TITLE

Figure 10-8
Mean percentage of at-sea population (estimated to be present in each 5 km x 5 km grid cell at any one time) of grey seals from haulouts in the British Isles (Source: Carter et al., 2020) and Relevant Designated Haul-out Sites for Seals in Scotland

REFERENCE

SEGL1_M_EAR_10-8_v1_20220504

SHEET NUMBER: 1 of 1

DATE: 04/05/2022

Coordinate System: WGS1984 Zone 30N

Scale @ A3 1:1,500,000

10.5.3 Summary of Receptors

The marine mammal receptors taken forward for consideration in the appraisal have been determined based upon the potential activity / receptor interactions (i.e. impact pathways) identified during the scoping phase, as shown in Table 10-7. Those species considered to have greatest sensitivity to a particular effect have been appraised at the species level, whereas those species with lower sensitivity have been appraised either at a high taxonomic level or by functional group as appropriate.

Table 10-7: Marine mammal receptors considered in this appraisal and their assigned value

Receptor group	Species	Rationale	Value
Cetaceans	All porpoise, dolphin and whale species present in UK waters	• Cetaceans are of international conservation importance e.g. all species are EPS and protected under WCA, 1981; • A total of 13 species of cetacean also considered PMF in Scotland	High
Pinnipeds	Harbour and grey seal	• Seals of national conservation importance • Both seal species considered PMF in Scotland	Medium

10.5.4 Relevant Designated Sites

The screening process for sites designated for marine mammals used a staged approach. Key sites have been initially identified using the relevant management units (MUs) defined by IAMMWG (2021) for each species. MUs indicate the spatial scales suited to each species in which impacts should be initially considered. Where an MU overlaps with a marine plan area within which a project such as the Marine Scheme is occurring, all sites within the MU relevant to marine mammals should be scoped in, regardless of distance (MMO, 2019).

For cetaceans, the designated sites within the relevant MUs are then restricted to those that occur within a distance of 50 km from the marine installation corridor. This reflects the distance which is recommended by the JNCC as the possible greatest distance at which disturbance from underwater sound in harbour porpoise could occur[9] (see MMO (2019)). However, given the mobile nature of cetaceans, consideration has also been given to seasonal movements of some cetacean populations between designated sites. In particular, the Moray Firth SAC, designated for the protection of bottlenose dolphin, has been screened into the appraisal, even though it is outside the 50 km screening distance generally applied in this appraisal. It is recognised that recent data show that the Moray Firth bottlenose dolphin population undertakes seasonal southward migrations to the Firth of Forth and Berwick-upon-Tweed, demonstrating that Marine Scheme related activities outside the SAC have the potential to affect the bottlenose dolphin population (Hague, Sinclair, & Sparling, 2020; Arso Civil M. , et al., 2021). For more information, see Volume 3 Appendix 8.2: Habitat Regulations Assessment Report.

For pinnipeds, screening distances have been selected based on known foraging ranges (see MMO (2019)). For harbour seals, a screening distance of 50 km is considered appropriate as this species forages close to their haul-out sites (Thompson, Mackay, Tollit, Enderby, & Hammond, 1998). Grey seals are known to forage over much larger distances up to 135 km from their haul-out sites (SCOS, 2020). Therefore, a screening distance of 135 km is considered appropriate for this species (MMO, 2019).

Table 10-8 below presents the relevant designated sites for marine mammals and their proximity to the marine installation corridor. Marine mammal species named as designated biodiversity features are highlighted in **green**.

[9] Harbour porpoise is the cetacean species with the highest sensitivity to underwater sound and this distance has been used as a reasonable worst-case scenario that applies to all cetacean species.

Table 10-8: Relevant Designated Sites for Marine Mammals

Site name (Country)	Designation	Proposed or Designated Biodiversity Features	Approximate distance from the marine installation corridor
Berwickshire and North Northumberland Coast (Scotland and England)	SAC	Annex II species that are a primary reason for site selection: • **grey seal**	337.75 m
Isle of May (Scotland)	SAC	Annex II species that are a primary reason for site selection: • **grey seal**	26.36 km
Firth of Tay and Eden Estuary (Scotland)	SAC	Annex II species that are a primary reason for site selection: • **harbour seal**	50.34 km
Southern North Sea	SAC	Annex II species that are a primary reason for site selection: • **harbour porpoise**	110.71 km
Moray Firth (Scotland)	SAC	Designated for the protection of • **bottlenose dolphin**	202.57 km

10.6 Appraisal of Potential Impacts

This section discusses the potential impacts of the Marine Scheme on marine mammals during installation, operation and decommissioning phases of the Marine Scheme as presented in Chapter 2: Project Description. The appraisal has been undertaken in accordance with CIEEM and the methodology presented in Chapter 4: Approach to Environmental Appraisal.

The potential impact pathways shown in Table 10-9 below have been scoped into the EAR during the scoping phase.

Table 10-9: Potential impacts of the Marine Scheme on Marine Mammals

Project phase	Potential impact
Route preparation and cable installation	Effect of underwater sound
	Alteration of water quality due to unplanned, releases, accidental leaks and spills from vessels and plant
	Vessel collision with marine mammals
Cable operation (including maintenance and repair)	Effects of Electric and magnetic (electromagnetic) field (EMF) emissions from buried cables
	Potential impacts the same as for route preparation and cable installation above
Decommissioning	Potential impacts the same as for route preparation and cable installation above

10.6.1 Embedded Mitigation

The following mitigation has been built into the Marine Scheme, to avoid and/or minimise impacts to marine mammals and is presented in Table 10-10.

Table 10-10: Marine mammal embedded mitigation

Measure	Description
Pre-installation	
Geophysical Surveys – underwater sound	Given the potential for injury from the use of the Sub-Bottom Profiler (SBP), mitigation measures recommended in the JNCC guidelines for minimising the risk of injury in marine mammals will be adopted, available from: https://data.jncc.gov.uk/data/e2a46de5-43d4-43f0-b296-c62134397ce4/jncc-guidelines-seismicsurvey-aug2017-web.pdf. The measures below will be included in a Marine Mammal Protection Plan (MMPP), as part of the CEMP developed for the Marine Scheme: The JNCC guidance minimises the potential for injury to cetaceans from the SBP activities using marine mammal observation. Thus, before a geophysical activity begins, there will be a period of observation by a qualified Marine Mammal Observer (or passive acoustic monitoring in the case of operations during the hours of darkness). Thus, the likelihood that any animals are within 500 m of the source, the standard observation zone, at the point at which the SBP is activated is very low. Following the observation period, SBP survey activities only commence after a period when no animals have been seen.

10.6.2 Installation Phase

10.6.2.1 Effects of underwater sound

Marine Scheme Sound Sources

A number of activities undertaken during the installation phase of the Marine Scheme will generate underwater sound which has the potential to have an impact on marine mammals. These activities are:

- Pre-installation geophysical survey, specifically underwater sound generated by MBES, SSS and USBL sources;
- Cable lay installation (likely to include a number of methods, depending on seabed conditions including ploughing, jetting and trenching);
- Rock placement on the seabed;
- Drilling at the HDD breakout locations; and
- Vessel movements including cable lay vessels with dynamic positioning (DP).

Sound can be either impulsive in nature, such as that generated by high-resolution seabed imaging sources such as multibeam echo-sounding (MBES), or by seismic, impact piling or explosions; or non-impulsive, or continuous such as dredging and drilling type activities, and sound from vessel movements, as a consequence of the use of dynamic positioning (DP). The impact of man-made sound on marine mammals depends on a range of factors including the frequency and intensity of the sound source, the duration of the sound and normal background levels as well as the sensitivity and behaviour of the receiving fauna and possible habituation to background sound sources.

For underwater sound impact assessments, the metrics are sound pressure level (SPL) and sound exposure levels (SEL). The SPL is a measure of the amplitude or intensity of a sound and, for impulsive sound sources, is typically measured as a peak or rms (root-mean-square) value. In contrast, the SEL is a time-integrated measurement of the sound energy, which takes account of the level of sound as well as the duration over which the sound is present in the acoustic environment.

The sound characteristics of the Marine Scheme activities have been determined on the basis of a significant body of knowledge of many common sound generating activities, for which there is an extensive range of values in the literature (Table 10-11). Where a range of sound source levels was found in the literature a reasonable but realistic worst-case level has been assumed.

Table 10-11: Characteristics of Underwater Sound Sources Generated by the Marine Scheme Installation Phase

Survey or cable installation activity	Operating Frequency (kHz)	Sound Pressure Level# (dB re 1µP a@1m)	Sound Source Data Reference	Scoped-in to appraisal
Swathe or multi-beam echo sounder (MBES)	170 - 450	221 235 (peak)	Genesis Oil and Gas Consultants, 2011	×
Side scan sonar (SSS) (e.g. EdgeTech 4200 Series)	300 - 600	210 - 226	Genesis (2011) and equipment specification sheet	×
Sub-bottom profiling (SBP) (e.g. Innomar SES-2000, Edgetech Chirp & Applied Acoustics 201 boomer)	0.5 – 12	238	Equipment specification sheets	✓
USBL (e.g., Kongsberg HiPAP 502)	21 - 31	207	Equipment specification sheet	✓
Cable installation (e.g., jetting, trenching)	1 - 15	178	(Nedwell, Langworthy, & Howell, 2003); Nedwell et al., (2008); Hale (2018)	×
Rock placement	n/a	< Vessel sound level	Nedwell et al. (2012)	×
HDD (e.g., break-out)	n/a	129.5	Nedwell et al. (2012)	×
Cable lay vessel (~ 140 m in length operating with DP)	0.005 - 3.2	180 - 197	Ross (1993) AT&T (2008)	×
Project support vessels including medium (50-100 m) and small (<50) boats	Low to high frequency	160 – 180	Genesis (2011) Richardson *et al.*(1995) OSPAR commission (2009)	×

Sound Pressure Level metrics in rms unless indicated.

A number of the above sound sources can either be scoped out of the appraisal or have such low sound source intensity that they are effectively masked by, and so can be appraised with, sound from other elements of the installation operation, as explained below:

- **MBES** – in shallow water (less than 200 m) MBES operates at high frequencies that fall outside the hearing range of marine mammals and the sounds produced will also attenuate quickly with distance. Thus, any significant effect from shallow water MBES is considered unlikely and this is reflected in the absence of any recommended mitigation measures for this activity (JNCC, 2010; 2017);
- **SSS** – operates at high frequency, producing sound that is outside the range of hearing of marine mammals;
- **Rock placement –** in four studies of rock placement, it was possible to faintly hear rocks falling through a fall tube to the seabed but the underwater sound from the operations was dominated by the sound of the dynamic thrusters of the rock placement vessel (Nedwell, Brooker, & Barham, 2012). Thus, the sound impact of rock placement operations is masked by vessel sound and is scoped out of the appraisal;
- **HDD** – sound measurements made during a generic HDD operation, in shallow riverine waters, recorded in the absence of vessel noise, a maximum unweighted Sound Pressure Level (SPL), of 129.5 dB re. 1µPa (Nedwell, Brooker, & Barham, 2012). The Marine Scheme HDD breakout points

will also be in sediment habitats where some sound will be absorbed. Thus, underwater sound generated by HDD will be masked by vessel sound and is scoped out of the appraisal;

- **Ploughing, jetting and trenching cable installation** - the primary source dominating underwater sound from measurements made during cable installation operations is vessel propulsion noise, particularly from the DP systems used by these vessels. Underwater sound from cable installation operations at the seabed are scoped out; and
- **Vessel movements** – there will be a limited number of vessels associated with the installation works. In comparison to background vessel activity in the North Sea (Chapter 13: Shipping and Navigation) the underwater sound from vessels involved in installation is not considered to be at a level that would have a significant impact on the ambient underwater soundscape. Individual vessel sound may be detectable by marine mammals but there is no evidence of injury caused by a constantly moving vessel. Thus, all vessel movements and associated installation activities on those vessels are scoped out of the appraisal.

The only activities associated with the Marine Scheme that are within hearing range of marine mammals, and have the potential to have an effect, are the operation of the USBL and the SBP.

Hearing in marine mammals

Sound from anthropogenic activities can negatively impact marine mammals as it influences their ability to echolocate, communicate and it can cause physical harm (through disorientation leading to beaching, and in extreme cases, trauma to the auditory apparatus) (Southall, et al., 2007). Sound can cause certain cetacean species to change their behaviour and can result in increased alertness, modification of vocalisations, interruption or cessation of feeding or social interactions, alteration of movement or diving behaviour, and temporary or permanent habitat abandonment. In severe cases, animal responses may include panic, flight, stampede, or stranding, which could sometimes result in indirect injury or death.

Cetaceans produce and receive sound over a wide range of frequencies for communication, orientation, predator avoidance and foraging (Tyack, 2008). For the determination of the impact of underwater sound on cetaceans they have been classified into three functional hearing groups (low, medium and high), based on their peak hearing range (Southall, et al., 2007) (Table 10-12). Different species will be sensitive to different project activities. For example, baleen whales such as the minke whale, which is known to frequent UK waters, will be the most sensitive to the low frequency sounds generated by the large cable installation vessel. However, the high frequency sensitive harbour porpoise, and mid-frequency dolphins are the species most likely to be present in the Marine Scheme area (see Section 10.5).

Seals (and other pinnipeds) also produce a diversity of sounds, though generally over a lower and more restricted bandwidth (generally from 100 Hz to several tens of kHz). Their sounds are used primarily in social and reproductive interaction, both in water and air (Southall, et al., 2007).

Table 10-12: Functional marine mammal hearing groups, auditory bandwidth and potential species within the study area

Functional Hearing Group	Auditory band width	Species	Species potentially present in study area
Low frequency cetaceans (LF)	7 Hz to 35 kHz	Baleen whales	Minke whale
High frequency cetaceans (HF)	150 Hz to 160 kHz	Dolphins, toothed and beaked whales	Bottlenose dolphin Common dolphin
Very high frequency cetaceans (VHF)	275 Hz to 160 kHz	True porpoise and some small whales	Harbour porpoise
Pinnipeds in water (PW)	75 Hz to 100 kHz	Seals	Grey seal Harbour seal
Source: Southall et al. (2007); NMFS (2018); Southall et al. (2019). Functional hearing groups based on Southall et al., 2019			

There are four species of cetacean occurring in the SCANS III study areas around the Marine Scheme at an abundance high enough for animal density estimates to have been determined (Hammond, et al., 2021) (see Section 10.5). These are the harbour porpoise (high frequency functional hearing group), the white beaked dolphin (mid frequency), the bottlenose dolphin (mid frequency) and the minke whale (low frequency). There is, therefore, potential for animals in each of three functional hearing groups to be present in the vicinity of the Marine Scheme during installation.

The impact of underwater sound in marine mammals is generally split into the following categories:

- **Auditory injury** - a consequence of damage to the inner ear of marine mammals, the organ system most directly sensitive to sound exposure, can result in hearing loss, also known as hearing threshold shift which can be permanent (PTS) or temporary (TTS);
- **Behavioural responses** – are highly variable and context-specific ranging from increased alertness, altering vocal behaviour, interruption to feeding or social interaction, alteration of movement or diving behaviour, temporary or permanent habitat abandonment. In some circumstances, sound from explosions or military sonar, have been associated with animal responses such as panic, flight, stampede, or stranding, sometimes resulting in indirect injury or death could occur. Minor or temporary behavioural responses are often simply evidence that an animal has heard a sound; and
- **Masking** – anthropogenic underwater sound may partially or entirely reduce the audibility of signals of interest such as those used for communication and prey detection.

Underwater Sound Impact Threshold Criteria

The most up to date sound exposure criteria for auditory injury in marine mammals have been published by the US National Marine Fisheries Service (NMFS), often referred to as the NOAA criteria (NMFS, 2018), and updated in a recent peer-reviewed academic paper (Southall, et al., 2019). The thresholds for PTS and TTS are based on dual criteria of unweighted, instantaneous peak sound pressure levels (SPL_{peak}) and M-weighted cumulative Sound Exposure Levels (SEL_{cum}) (Table 10-13).

Table 10-13: Quantitative thresholds for auditory effects (PTS/TTS) in marine mammals

Marine Mammal Hearing Group	Impulsive Sound Sources			
	TTS	TTS	PTS	PTS
	SEL_{cum}	SPL_{peak}	SEL_{cum}	SPL_{peak}
LF cetaceans	168	213	183	219
HF cetaceans	170	224	185	230
VHF cetaceans	140	196	155	202
PW	170	212	185	218

SPL thresholds are unweighted and SEL are weighted for marine mammal hearing range. SEL thresholds are in dB re 1 μPa²s and peak SPL thresholds are in dB re 1 μPa.

Sound propagation calculations

Sound attenuates as it propagates through water and the local oceanographic conditions will affect both the path of the sound into the water column and how much sound is transmitted. A standard geometric spreading calculation was used to determine the propagation of underwater sound from the USBL and SBP activities. The spreading model assumes that sound is spread geometrically away from the source with an additional frequency-dependent absorption loss; it therefore provides conservative estimates. It also does not take into consideration the conditions within the area, such as detailed bathymetry, water column structure or sediment type and thickness. The standard formula used for estimating the transmission loss from underwater sound sources is:

$$TL = A \log (r) + B\, r + C$$

Where:

TL is the transmission loss at a distance r from the source.

A is the wave mode coefficient. For spherical waves A = 20, and cylindrical waves A = 10.

B is an attenuation factor that is dependent on water depth and sea bottom conditions.

C is a fixed attenuation due to acoustic screening. In open water this will be 0.

Note that use of cylindrical spreading (A=10) is generally suited to shallow-to-mid water depths, and spherical spreading (A=20) is generally applicable to deep water depths. Although the definition of deep vs. shallow is somewhat dependent on wavelength, Richardson (1995) suggests that depths <200 m are commonly regarded as “shallow” and >2000 m are commonly regarded as “deep” regardless of source wavelength.

Cylindrical spreading (A=10) is more conservative (i.e. further sound propagation distances for a given source level) but is likely to be overly conservative for this assessment. Richardson (1995) suggests using A=15 for underwater transmission in shallow water conditions where the depth is greater than 5 times the wavelength. For low frequency, longer wavelength sound this is going to tend toward A=20. For high frequency, shorter wavelength sound this is going to tend toward A=10.

For the purposes of this appraisal and to provide a conservative but reasonably realistic estimate of sound propagation, an empirical wave mode coefficient A = 15 has been used to determine the distance at which SPL thresholds for PTS and TTS, are met.

The dual-metric modelling approach has been used to identify impacts based on the peak sound pressure level (SPL_{peak}) and the cumulative sound exposure level (SEL_{cum}) provided in Table 10-14. The SPL_{peak} criteria is defined as those peak SPLs above which tissue injury is predicted to occur, irrespective of exposure duration. The SEL_{cum} represents the total energy produced by a noise-generating activity standardised to a one second interval. This enables a comparison of the total energy attributed to different pulsed sound sources with different time intervals. The SEL_{cum} impact zones have been determined using the M-weightings that account for the specific hearing range of each of the functional hearing groups of marine mammals.

Table 10-14: Maximum estimated distance from USBL and SBP at which the sound level will exceed the SPL_{peak} and SEL_{cum} PTS injury threshold

Acoustic source	Sound Source Level (SPLpeak)	LF Cetaceans		HF Cetaceans		VHF Cetaceans		Phocids in Water	
		SPLpeak	SELcum	SPL	SELcum	SPL	SELcum	SPL	SELcum
USBL	207 dB	<10	<10	<10	<10	<10	<10	<10	<10
SBP	238 dB	18	116	<10	<10	251	138	22	62

Note: SPL_{peak} units are dB re 1 μPa and cumulative SEL dB re 1 μPa2s

Auditory injury impacts

The predictive injury impact zone from USBL sound, based on both the SPL_{peak} and SEL_{cum} thresholds indicates that injury is only likely to occur for any animal that is in very close proximity to the sound source. In effect, for injury to occur a marine mammal would need to be within a few metres of, and directly beneath, the acoustic equipment (Table 10-14). Considering the highly mobile nature of marine mammals, the low density of all species identified in the vicinity of the marine installation corridor, and the constant movement of the survey and installation vessels, the presence of animals this close to the acoustic equipment is highly unlikely. Also, for some of the works the USBL equipment may be deployed from a towed device only a few metres above the seabed. Therefore, injury from the operation of the USBL during geophysical and installation activities is considered highly unlikely.

The injury impact distances for SBP, as expected considering the significantly higher sound intensity, are larger, particularly for low frequency and very high frequency cetaceans. The impact distances in relation to high frequency cetaceans indicate injury is not expected for the key dolphin species that could be present, largely the bottlenose and white beaked dolphin.

The injury distance estimated for seals is up to 62 m though this does not account for the directionality of the equipment, which reduces the impact range. The very low density of seals along the entire marine installation corridor, and the unlikely presence of animals directly beneath the sound source, indicates auditory injury in seals is also not anticipated.

The greatest distance relates to harbour porpoise, the most abundant marine mammal species in the North Sea. Available survey data indicates the density of harbour porpoise around the marine installation corridor is relatively low. The most important region of the North Sea for this species is the southern North Sea, as defined by the area protected by the Southern North Sea SAC, significantly beyond the marine installation corridor. Nevertheless, harbour porpoise are widespread across the North Sea and sound propagation calculations indicate injury is possible in harbour porpoise, albeit in low numbers. Auditory injury is also possible in minke whale, though to a lesser extent based on smaller estimated zones of influence and the really low density of this species, even in the Southern Trench MPA, a recognised hot spot for this species.

Given the potential for injury from the use of the SBP, mitigation measures recommended in the JNCC guidelines for minimising the risk of injury in marine mammals (JNCC, 2017) will be adopted. The measures below will be included in a Marine Mammal Protection Plan (MMPP), as part of the CEMP developed for the Marine Scheme.

The JNCC guidance minimises the potential for injury to cetaceans from the SBP activities through the use of marine mammal observation. Thus, before a geophysical activity begins, there will be a period of observation by a qualified Marine Mammal Observer (or passive acoustic monitoring in the case of operations during the hours of darkness). Thus, the likelihood that any animals are within 500 m of the source, the standard observation zone, at the point at which the SBP is activated is very low. Following the observation period, SBP survey activities only commence after a period when no animals have been seen.

Behavioural disturbance in marine mammals

Behavioural disturbance may occur, particularly in relation to the operation of the SBL, which is the sound source with the highest intensity. There are no widely agreed quantitative thresholds for behavioural disturbance, reflecting both a lack of empirical evidence and a high level of variability in behavioural responses, which are often unrelated to the sound level received (e.g., see (Gomez, et al., 2016)). Nevertheless, a threshold of 160 dB SPL_{rms} is still adopted by NOAA in relation to behavioural disturbance from impulsive sounds[10]. To account for the directionality of the acoustic sound source[11] a conservative reduction in source level of 20 dB SPL_{rms} has been assumed for behavioural disturbance, which take place at some distance from the source. The disturbance ranges, estimated using non-weighted geometric spreading formula as described above, is 63 m for USBL and 4,642 m for SBP.

The higher zone of influence for SBP is comparable with observations of behavioural disturbance in harbour porpoise in relation to geophysical surveys (Thompson, et al., 2013) and the 'effective deterrent range' (EDR) of 5 km recommended by the JNCC (2020) for the assessment of the significance of geophysical sound (SBP specifically) disturbance against the conservation objectives of harbour porpoise SACs. The EDR applies specifically to harbour porpoise only, as this species is known to be highly sensitive to underwater sound and for which there is a greater body of evidence regarding behavioural disturbance.

Disturbance in harbour porpoise, in response to a range of underwater sound sources, is well documented. For example, several field studies around wind farm installation activities and geophysical and seismic surveys, have shown that harbour porpoise demonstrate strong behavioural reactions to underwater sound. The density of animals and vocalisations are reduced temporarily for several

[10] See: https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/esa-section-7-consultation-tools-marine-mammals-west

[11] Sound pressure is released in all directions, but not in a symmetrical and uniform way. Sound levels are highest directly below the source by design, to provide optimal energy. In addition, high frequencies are more directional than low frequencies. In the horizontal plane sound levels can be between 12 and 48 dB lower, depending on the nature of the sound source (reference).

kilometres around the noise source with gradually less of an effect the further away the observations are made e.g. (Lucke, Lepper, Blanchet, & Siebert, 2009), (Stone & Tasker, 2006) and (Dahne, 2013).

The estimated number of individuals which may experience disturbance during SBP operations, based on the worst-case scenario of a 5 km impact zone, has been calculated in Table 10-15 based on the estimated population data in Table 10-3. In these calculations, the impact range of 5 km results in a potential disturbance area of 79 km^2. The calculations assume the same disturbance zone for all species, recognising this is an overestimate of effect, likely in all other marine mammal species, but particularly in relation to the high frequency dolphin species and seals.

For cetaceans the proportion of animals potentially disturbed by the SBP is less than 1% of the total population present in the SCANS III survey blocks to which the density estimates apply (Section 10.5.1). The percentage of cetaceans as a proportion of the total marine mammal management unit population will be even lower, a maximum of 0.01% (Table 10-15). For seals, the total number of animals disturbed is also a very small proportion of both the UK populations and the Scottish Seal Management Unit though it has not been possible to determine the exact percentage (Section 10.5.2).

Table 10-15: Summary of estimates of daily number of individual cetaceans within an assumed 5 km zone of influence of the geophysical survey

Species	Abundance (individuals/km^2)	No. of Individuals (per day)	Proportion of MU population (%)	Location
Harbour porpoise	0.6 – 0.9	11 - 16	< 0.01	Depending on marine installation corridor location – highest density off English east coast in the central North Sea
Bottlenose dolphin	0.03	0 - 1	< 0.01	Minimal variation in density along the whole marine installation corridor
White-beaked dolphin	0.002 – 0.2	5 - 1	<0.01	Density decreases north to south along cable route
Minke whale	0.01 – 0.04	1	<0.01	Density estimate applies along the whole marine installation corridor

However, to determine the resulting effect of the SBP related sound disturbance consideration of the duration of the disturbance and the importance of the affected area to the species concerned is particularly relevant. The SBP will not be operating continuously, it will be activately used as and when required for investigations of particular areas of the seabed where additional information is required to inform installation. Therefore, SBP sound disturbance will be intermittent, short-term and temporary, particularly considering the SBP will not be continuously moving along the marine installation corridor. Thus, any one area is subject to ensonification for a very short period of time.

The most common species in the study area, by far, is the harbour porpoise, with estimated density ranging from 0.6 individuals/km^2 in the waters of Scotland and north eastern England, to 0.9 individuals / km^2 in the southern sections of the Marine Scheme.

An understanding of the importance of the areas where disturbance could occur will play a key role in the overall impact of SBP underwater sound. The harbour porpoise is thought to have a very high metabolic rate compared to terrestrial animals of a similar size (Rojano-Doñate, et al., 2018) requiring individuals to forage almost constantly (Wisniewska, et al., 2016). The temporary exclusion of harbour porpoise from, for example, key foraging grounds, could affect individual harbour porpoise's ability to eat enough to meet its energy requirements, which could have consequences for survival and reproduction (Kastelein, Hardeman, & Boer, 1997).

There are four Marine Protected Areas designated for minke whale, but the nearest is the Southern Trench MPA, over 160 km away. The minke whale is present in very low abundance across the marine installation corridor, estimated to be between 0.01 and 0.04 individuals per km^2. The white beaked dolphin and the bottlenose dolphin, both mid-frequency hearing specialists, may also be present, most likely in the northern region of the Marine Scheme, but also in very low numbers. The bottlenose and white beaked dolphin, both high-frequency hearing specialists, may be present, most likely in the northern region of the Marine Scheme, but also at very low density. For bottlenose dolphin the nearest protected site is the Moray Firth SAC, significantly beyond any influence from the Marine Scheme. However, it is known that the range of the bottlenose dolphin population protected by this site has extended southwards since it was designated (Section 10.5.1). The Firth of Tay and Tay Estuary, and St Andrews Bay have been identified as particularly important areas for bottlenose dolphins from the Moray Firth SAC. However, these areas are over 50 km from the northern extent of the Marine Scheme and so there is no indication of any exclusion of bottlenose dolphin from particularly important habitats during geophysical survey works. Disturbance to these species is expected to be minimal as presence will be very low.

Grey seals are also likely to be present, particularly around the waters of the Farne Islands. Off the coast of Northumberland, where at sea-densities within 5 km of the marine installation corridor are up to around 516 individuals per km^2. There are two areas of high at-sea density of grey seal, the Fast Castle haul out location close to the Scottish landfall and the Farne Islands, where there are several haul-out and breeding locations. The closest haul-out location is within 1.5 km of the marine installation corridor. For any geophysical survey works during the breeding or moulting season many seals will be spending time on land, unaffected by underwater sound. Nevertheless, there will be animals foraging at these times and outside the key seasons so there is likely to be some disturbance of grey seal from geophysical activity. Any disturbance would be short-term, temporary and will be limited to very few individuals, particularly considering the vessel is continuously moving and interactions will also be of short duration. Any disturbance to seals foraging offshore is not considered likely to have an adverse impact on food availability as alternative areas for foraging are widely available.

To conclude, with the inclusion of the embedded mitigation measures there is no potential for injury to marine mammals as a result of underwater generated by the sound from Marine Scheme activities. There will be some behavioural disturbance however, particularly from the operation of the SBP, but with the inclusion of the embedded mitigation measures this will be reduced and the duration is considered to be short-term, intermittent and temporary, and the extent of the effect limited in terms of the number of individuals and the level of behavioural response. When operating, the SBP sound source will be moving most of the time, which acts as a form of soft-start, allowing animals to easily avoid oncoming sound generating vessels. Such disturbance is not predicted to interfere with any important habitat or foraging areas, behaviours or life stages and so the magnitude of the impact is predicted to be negligible**.** Combined with the medium to high value and sensitivity of this receptor, the effect is appraised as **minor** and therefore, **not significant**.

10.6.2.2 Alteration of water quality due to unplanned, releases, accidental leaks and spills from vessels and plant

There is potential for accidental spillage and release of pollutants, such as oil, fuels, lubricants or chemicals from vessels and operations involved in the installation of the HVDC cable. Any such releases, if substantial, have the potential to significantly alter water quality which could, in turn, affect any marine mammals present in the vicinity of activities. Depending on concentration pollutants such as organic compounds, oil, and heavy metals can directly and indirectly impact marine mammals, resulting in immunosuppression, genotoxicity, and endocrine disruption (Desforges, et al., 2016; Nelms, et al., 2021).

Oil and Gas UK (OGUK), the leading representative body for the UK offshore oil and gas industry, regularly reviews accidental releases into waters on the UK Continental Shelf (UKCS). Their most recent report concluded that 480 accidental oil and chemical releases occurred on the UKCS in 2018. Of the total accidental releases that have occurred across several years, the vast majority were associated with wells and hydraulic systems rather than vessels involved in cable installation (OGUK, 2019). This is supported by the most recent analysis of marine pollution from the Advisory Committee on Protection of the Sea (ACOPS, 2017) which indicated of 644 incidents of accidental discharge, only seven were attributed to offshore support vessels.

Best practice measures shall be adopted during all vessel operations to avoid and minimise any potential for impacts to water quality, including adherence to relevant guidance (e.g. Pollution Prevention Guidance). A Construction Environmental Management Plan (CEMP), Emergency Spill Response Plan and Waste Management Plan will be implemented during the installation phase of the Marine Scheme to minimise releases (Chapter 2: Project Description). Appropriate Health, Safety, and Environment (HSE) procedures (identified in the CEMP) will also be implemented, with strict weather and personnel limits to reduce any risk of accidental spillage. Furthermore, preparedness and swift response is essential for effective spill management and as such, response plans will be in place should an incident occur.

The likelihood of an accidental spillage occurring, considering also the control measures outlined above, is appraised as unlikely. Should an accident occur, any release of pollutants is expected to be small, such as release of oils or fuels from vessel engines or deck works and the impact is expected to be highly local, with any releases rapidly dispersed and diluted by wave and tidal movements. The magnitude of impact to marine mammals, a receptor group of high sensitivity and importance, is expected to be minor. Therefore, the risk of accidental spillage and associated effects on marine mammals is appraised as **minor** and therefore **not significant**.

10.6.2.3 Vessel and marine mammal collision risk

There are resident populations of several marine mammal species in the waters surrounding the Marine Scheme (see Section 10.5 for the detailed baseline). Collisions between vessels and marine mammals can have severe consequences, including injury and possible death.

The installation phase of the Marine Scheme will involve the deployment of a number of vessels including a geophysical survey vessel for a pre-installation survey, cable laying barge and vessel, guard vessels, rock placement vessel, and additional specialised support vessels such as a jack up barge and dive support vessels for the works at the HDD breakout point in the nearshore.

Larger marine mammals, such as whales, are typically considered most at risk of vessel collision, but a recent review has found that as many other species, including smaller mammals like dolphins, porpoises, and seals may also be at risk (Schoeman, Patterson-Abrolat, & Plon, 2020). Many marine mammal species have been reported as involved in vessel strikes in the Atlantic (Winkler, Panigada, Murphy, & Ritter, 2020). These collisions were observed to result in serious injury, and even death, as animals came in contact with propeller blades or the bow, hull, skeg, and rudder (Schoeman, Patterson-Abrolat, & Plon, 2020). The severity of injury can be difficult to ascertain, however, it is likely dependent upon location of impact and depth of any gashes. Large marine mammals with thick layers of blubber appear less likely to sustain serious injury, although more study is needed regarding the relationship between species and injury severity (Schoeman, Patterson-Abrolat, & Plon, 2020).

In the region encompassing the Marine Scheme, the most likely cetacean species to occur are the harbour porpoise, white beaked and bottlenose dolphin and minke whales (Hammond P. , et al., 2021), harbour seals, and grey seals (Morris, Duck, & Thompson, 2021). The harbour porpoise is, by far, the most likely species to be observed during project activities, with an estimated density along the marine installation corridor of between 0.6 and 0.9 individuals per km^2.

Studies of harbour porpoise behaviour have indicated that they may exhibit avoidance behaviour to vessel presence (Palka & Hammond, 2001; Wisniewska, et al., 2018; Roberts, Collier, Law, & Gaion, 2019), and therefore may be capable of avoiding operations vessels. A review of harbour porpoise stranding post-mortem results found that physical trauma, such as that caused in a collision, was a factor in only a low percentage of dead harbour porpoise also indicating low collision risk in this species (Evans , Baines, & Anderwald, 2011).

In contrast, a higher proportion (15%) of stranded minke whales were found to have physical trauma indicative of collisions, due to their larger stature. A review of data collected between 2000 and 2017 found that seven percent of necropsied minke whales experienced physical trauma from ship strikes (JNCC, 2019). Minke whales were also found to be one of eight whale species most commonly involved in collisions (Dolman, Williams-Grey, Asmutis-Silva, & Isaac, 2018). Avoidance behaviour of minke whales to vessels has similarly been observed, but individual behaviours have also varied, suggesting more complex mechanisms behind avoidance of ship strikes in minke whales. A study of minke whale presence during pipeline installation indicated displacement during activities, likely attributed to their lower-frequency hearing and noise produced by vessels (Anderwald, et al., 2013). This suggests the risk of a collision between minke whale and vessels involved in very slow-moving cable installation may be lower than for some other vessel movements. The nearest area of importance for minke whale is the Southern Trench MPA, some 160 km from the Marine Scheme.

Pinnipeds are similarly at risk of injury and death from vessel collisions, although this risk is considered to be generally lower than that for cetaceans (Jones, et al., 2017). A study of pinniped presence during pipeline installation suggested avoidance of construction sites altogether, but this is thought to be a result of the noise emitted during operations, as pinnipeds also hear at lower frequencies (Anderwald, et al., 2013).

Vessel speed and draft depth are thought to be two of the biggest factors concerning collision risk and severity, as higher speeds produce a greater impact force and larger drafts have been associated with increased mortality (Rockwood, Calambokidis, & Jahncke, 2017; Schoeman, Patterson-Abrolat, & Plon, 2020; Winkler, Panigada, Murphy, & Ritter, 2020). Although species-specific relationships of collision risk require further research, several behavioural factors have still been identified that may play an important role, including amount of time spent at the surface and avoidance behaviours (Schoeman, Patterson-Abrolat, & Plon, 2020). The species most at risk is the minke whale.

Cable lay and geophysical survey vessels typically operate at speeds of 4-6 knots and transit at slightly greater speeds of 10-14 knots. At these speeds, it is unlikely that vessels pose a significant risk to marine mammals, particularly to the harbour porpoise, as studies have indicated that serious injuries to marine mammals occur at speeds >14 knots (Laist *et al*., 2001; (Winkler, Panigada, Murphy, & Ritter, 2020). There will be smaller vessels present during operations, but these will be accompanying, and thus travelling at similar speeds to the larger vessels and so unlikely to represent a significant collision risk. There will be a small number of support vessels involved in installation but are unlikely to significantly increase the risk of collision. Some studies have correlated avoidance behaviour with sustained or increased vessel traffic (Culloch, et al., 2016; Erbe, et al., 2019), and marine mammals are likely habituated to some vessel presence in the North Sea.

Although the occurrence of any collisions could cause injury or death, which would be considered a moderate or major impact, the likelihood of vessel collision with marine mammals in the marine installation corridor is appraised to be unlikely when considering the habituation of local marine mammals, avoidance behaviour or displacement and the slow vessel operation speeds. Therefore, impact risk and associated effects are appraised to be **minor** and therefore, **not significant.**

10.6.3 Operation Phase (including Maintenance and Repair)

10.6.3.1 Effects of electric and magnetic Field (EMF) emissions

EMF emitted by subsea HVDC cables (see Chapter 2: Project Description for detailed description of cable design) has the potential to affect marine mammals that are sensitive to or can detect EMF (Gill, Gloyne-Phillips, Neal, & Kimber, 2005).

The appraisal of EMF is based on the installation of two HVDC cables laid in parallel in separate trenches spaced 30 m apart, known as a ‘30 m separated bipole’, as part of the Marine Scheme. In this configuration, the distance between the cables generates a stronger magnetic field than that generated by two cables bundled together in a single trench (bundled bipole) (Öhman, Sigray, & and Westerberg, 2007). However, the cables will be buried and incorporate shielding as part of their design. Marine Scheme specific modelling has shown that magnetic fields above natural geomagnetic levels are only expected to occur in close proximity (~20 m both horizontally and vertically (above the cables)) to the cable location. Beyond this the cable installation will not raise background EMF beyond the natural range (see Chapter 2: Project Description and Volume 3 Appendix 2.1: Eastern Link EMF and Compass Deviation Assessment).

Cetaceans are thought to show sensitivity to variations in the Earth's magnetic field (Klinowska, 1990). It has been suggested that they are capable of some level of discrimination (CMACS, 2003) including the hypothesis they use geomagnetic cues during their migrations (Nyqvist, et al., 2020). There is also some evidence that spatial and temporal variation or anomalies in geomagnetic field correlate with cetacean strandings (Klimley, Putman, Keller, & Noakes, 2021; Levitt, Lai, & Manvill II, 2021). However, stranding events are also correlated with solar storms, parasitic disease, and low frequency active sonar on ships (Klimley, Putman, Keller, & Noakes, 2021; Levitt, Lai, & Manvill II, 2021). Therefore it is difficult to say with any certainty the cause of such stranding events.

There is evidence that some cetacean species, such as the Guiana dolphin, *Soltalia guianesis*, have a passive electro-receptive ability, likely used to detect weak bioelectric fields discharged by benthic prey (Czech-Damal, et al., 2011). Publications on electro-sensitivity in cetaceans are extremely sparse; and it is only supposed that other species of cetacean, such as those found in the North Sea, may also possess this ability. However, it is also recognised that EMF sensitivity in dolphins is much lower than that of elasmobranchs, and it is not thought to be a key driver in their behaviour (Czech-Damal, et al., 2011).

While underwater electrical cables are known to cause deviation from the natural geomagnetic field (Taormina, et al., 2018), mobile individual marine mammals are only exposed to it for a relatively short duration (Nyqvist, et al., 2020). Moreover, many studies have focused on behavioural impacts of EMF, but none have shown demonstratable significant impacts of EMF on cetaceans (Gill & Desender, Risk to Animals from Electrom Magnetic Fields Emitted by Electric Cables and Marine Renewable Energy Devices, 2020).

Due to the limited distance of detectable EMF from the cables, any perception by cetaceans is only likely to occur during benthic foraging, when animals may be close to the buried cable. For example, the harbour porpoise eats a wide variety of fish and cephalopods (Jefferson, Leatherwood, & M.A., 1993). Many prey items, such as sandeel, are probably taken on, or very close to, the seabed (Culik, 2010), with potential sandeel spawning and nursery grounds covering much of the marine installation corridor (Ellis et al. (2010). However, the influence of EMF over foraging areas is relatively small, particularly in comparison with the total extent of the seabed available for foraging by cetaceans in the North Sea. Thus, the pelagic and migratory nature of cetaceans would mean any contact with the marine installation corridor would be infrequent and last for only a very short period of time.

Magnetic sensitivity in marine mammals has primarily been investigated in cetaceans (Normandeau, Eponent, Tricas, & Gill, 2011) and there is no evidence to suggest that pinnipeds are directly influenced by, are sensitive to, or use magnetic fields. It is an area in which data gaps exist due to the difficulties of evaluating impacts (Taormina, et al., 2018), but it is also not highlighted as a research priority in the literature. One study suggests up to 45 Hz – 50 Hz EMF applied directly to two seals in a small pool resulted in perceived reduced efficiency during training, due to increased excitement (Yakovlev, Zaytsev, Ishkulov, & Grigoriev, 2019). The conditions of this study are not applicable to wild seals in the context of subsea cables but in general the literature indicates seals have low sensitivity to EMF. In particular, recent meta studies have discounted pinnipeds as a receptor at risk of impact from EMF generated from subsea cables (Copping, et al., 2016; Copping, et al., 2020).

For cetaceans, no link has been identified between EMF from cables and cetaceans and this receptor group is expected to have a low sensitivity to EMF emissions from the presence of subsea cables (Copping, et al., 2020). Similarly, there is no evidence to suggest particular sensitivity in pinnipeds either. Based on these findings, the very limited extent of elevated EMF associated with the Marine Scheme cable and the highly mobile nature of all marine mammals, the magnitude of the impact from EMF is considered to be negligible.

In conclusion, accounting for a negligible magnitude of effect, even for species of high importance, the effect of EMF from the Marine Scheme on marine mammals is considered to be **negligible** and therefore **not significant**.

10.6.3.2 Maintenance and cable repair effects

Maintenance activities and cable repair, where required, will be carried out using the same or similar methods as cable installation, and therefore the potential pathways for impact to marine mammals would be the same as those identified for the cable installation phase of the Marine Scheme.

Repair works are likely to be highly localised to the area of concern and therefore the spatial extent of any impacts would be small in extent. Furthermore, any maintenance or repairs works would be anticipated to take no more than several weeks to complete meaning the duration of impact would also be short.

Maintenance and unforeseen cable repair (although unlikely) are routine, and the procedures and processes are well defined and common in the industry. The effect of underwater sound on marine mammals is appraised as **minor** and therefore **not significant**.

10.6.4 Decommissioning Phase

10.6.4.1 Effects of underwater sound during decommissioning

At the end of the operational life of the cable the options for decommissioning will be evaluated and taking into consideration with other Marine Scheme constraints (e.g. safety and liability), with the least environmentally damaging option chosen if possible.

The principal options for decommissioning described in Chapter 2: Project Description are:

- Leave the cable *in-situ*, buried;
- Leave *in-situ* and provide additional protection where exposed;
- Remove sections of the cable that present a risk; or
- Remove the entire cable.

During decommissioning project activities are likely include a pre-removal geophysical survey and the removal of the cable from the seabed using techniques that are similar to installation. The sound sources and the potential impacts to marine mammals will be the same as the activities appraised for the offshore elements of the installation phase. Thus, the effect of underwater sound from decommissioning activities is considered to be **minor** and therefore **not significant.**

10.7 Mitigation and Monitoring

It is not considered that any additional mitigation and monitoring measures will be required during installation, operation (including maintenance and repair) and decommissioning phases.

10.8 Residual Impacts

No significant residual effects are predicted for marine mammals.

10.9 Cumulative and In-Combination effects

The full cumulative and in-combination effects appraisal is presented in Chapter 16: Cumulative and In-Combination Effects.

No interaction with the English and Scottish Onshore Schemes is anticipated because there are no likely pathways identified for underwater noise, vessel movement, EMF or thermal emissions.

In-combination effects are where receptors could be affected by more than one environmental impact. Where a receptor has been identified as only experiencing one effect or where only one topic has identified effects on that receptor, there is no potential for in-combination effects. The receptor groups within this chapter do not interact between chapters, therefore receptors have been wholly appraised within this respective topic chapter.

10.10 Summary of Appraisal

This chapter has considered the potential effects of the Marine Scheme on marine mammal receptors. A summary of the effects is presented in Table 10-16.

Table 10-16: Summary of environmental appraisal

Phase	Potential Impact	Receptor	Sensitivity	Magnitude / Likelihood	Significance	Project Specific Mitigation	Significance of Residual Effect
Route preparation and cable installation	Underwater sound disturbance during geophysical activities (USBL and SBP)	Cetaceans and Pinnipeds	Medium to High	Negligible	**Minor**	None required	**Minor** which is **not significant**
	Underwater sound disturbance during cable lay – seals at Scottish HDD location	Pinnipeds	High	Negligible	**Minor**	None required	**Minor** which is **not significant**
	Collision risk	Cetaceans and Pinnipeds	High	Unlikely	**Minor**	None required	**Minor** which is **not significant**
	Accidental spills	Cetaceans and Pinnipeds	High	Unlikely	**Minor**	None required	**Minor** which is **not significant**
Cable operation (including maintenance and repair)	Underwater sound disturbance	Cetaceans and Pinnipeds	Medium to High	Negligible	**Minor**	None required	**Minor** which is **not significant**
	Disturbance from EMF	Cetaceans and Pinnipeds	Low	Negligible	**Negligible**	None required	**Negligible** which is **not significant**
Decommissioning	Potential effects of decommissioning are the same as route preparation and cable installation						

10.11 References

ACOPS. (2017). *Annual survey of reported discharges and releases attributed to vessels and offshore oil and gas installations operating in the United Kingdom's exclusive economic zone. Maritime and Coastguard Agency.*

Anderwald, P., Brandecker, A., Coleman, M., Collins, C., Denniston, H., Haberlin, M. D., . . . Walshe, L. (2013). Displacement responses of a mysticete, an odontocete, and a phocid seal to construction-related vessel traffic. *Endangered Species Research, 21*, 231-240.

Arso Civil, M., Quick, N. J., Cheney, B., Pirotta, E., Thompson, P. M., & Hammond, P. S. (2019). Changing distribution of the east coast of Scotland bottlenose dolphin population and the challenges of area-based management. *Aquatic Conservation: Marine and Freshwater Ecosystems, 29*(S1), 178-196.

Arso Civil, M., Quick, N., Mews, S., Hague, E., Cheney, B., Thompson, P., & Hammond, P. (2021). *Improving understanding of bottlenose dolphin movements along the east coast of Scotland. Final report. Report number SMRUC-VAT-2020-10 provided to European Offshore Wind Deployment Centre (EOWDC), March 2021 (unpublished).* Retrieved from https://group.vattenfall.com/uk/contentassets/c65a13553f864f599431d69c8c6a57b4/bottlenose-dolphin-monitoring---final-report-2021.pdf

AT&T. (2008). *AT&T Asia America Gateway Project Draft EIR. Section 4.10 - Noise.* Retrieved 02 19, 2022, from https://ceqanet.opr.ca.gov/2007111029/2

Bailey, H., Senior, B., Simmons, D., Rusin, J., Picken, G., & Thompson, P. (2010). Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. *Marine Pollution Bulletin, 60*(6), 888-897.

Brereton, T., Kitching, M., Davies, R., McNie, F., & Walker, R. (2016). *Photo-identification Analysis of White-beaked Dolphins off South West and North East England 2007 - 2014. A report commissioned by Natural England.* Natural England.

Canning, S., Begona Santos, M., Reid, R., Evans, P., Sabin, R., Bailey, N., & Pierce, G. (2008). Seasonal distribution of white-beaked dolphins (Lagenorhyncus albirostrius) 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.

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

Cheney, B., Graham, I., Barton, T., Hammond, P., & and Thompson, P. (2018). Site Condition Monitoring of bottlenose dolphins within the Moray Firth Special Area of Conservation: 2014-2016. *Scottish Natural Heritage Research Report* (No. 1021.).

Cheney, B., Thompson, P., Ingram, S., Hammond, P., Stevick, P., Durban, J., . . . Wilson, B. (2013). Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins Tursiops truncatus in Scottish waters. *Mammal Review, 43*(1), 71-88.

CIEEM. (2018). *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine.* Version 1.1 – Updated September 2019. Chartered Institute of Ecology and Environmental Management, Winchester. .

CMACS. (2003). *A baseline assessment of electromagnetic fields generated by offshore windfarm cables.* COWRIE Report EMF.

Copping, A., Sather, N., Hanna, L., Whiting, J., Zydlewski, G., Staines, G., . . . al., e. (2016). *Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World.* Lisbon, Portugal: Ocean Energy Systems (OES) .

Copping, E. A., Hemery, L. G., Overhus, D. M., Garavelli, L., Freeman, M. C., Whiting, J. M., . . . Tugade, L. (2020). Potential Environmental Effects of Marine Renewable Energy Development—The State of the Science. *Journal of Marine Science and Engineering , 8*(11), 879.

Crocker, S., & Frantantonio, F. (2016). *Characteristics of high-frequency sounds emitted during high-resolution geophysical surveys. OCS Study, BOEM 2016-44, NUWC-NPT Technical Report 12. 203 pp.*

Crocker, S., Frantantonio, F., Hart, P., Foster, D., O'Brien, T., & Labak, S. (2019). Measurement of Sounds Emitted by Certain High-Resolution Geophysical Survey Systems. *IEEE Journal of Oceanic Engineering, 44*, 796-813. doi:10.1109/JOE.2018.2829958

Culik, B. (2010). *Odontocetes. The toothed whales: "Phocoena phocoena".* Bonn, Germany: UNEP/CMS. Retrieved January 14, 2022, from http://www.cms.int/reports/small_cetaceans/index.htm.

Culloch, R. M., Anderwald, P., Brandecker, A., Haberlin, D., McGvern, B., Pinfield, R., . . . Cronin, M. (2016). Effect of construction-related activities and vessel traffic on marine mammals. *Marine Ecology Progress Series, 549*, 231-242.

Cunningham, L., Baxter, J., Boyd, I., Duck, C., Lonergan, M., Moss, S., & McConnell, B. (2009). Harbour seal movements and haul-out patterns: implications for monitoring and management. *Aquatic Conservation: Marine and Freshwater Ecosystems, 19*, 398-407.

Czech-Damal, N. U., Liebschner, A., Miersch, L., Klauer, G., Hanke, F. D., Marshall, C., . . . Hanke, W. (2011). Electroreception in the Guiana dolphin (Sotalia guianensis). *Proceedings of the Royal Society B, 279*(1729).

Dahne, G. (2013). Effects of pile driving on harbour porpoise Phocoena phocoena at the first offshore windfarm in Germany. *IOP Science/Environment Research Letters, 8*(025002).

de Boer, M. (2010). Spring distribution and density of minke whale Balaenoptera acutorostrata along an offshore bank in the central North Sea. *MARINE ECOLOGY PROGRESS SERIES, 408*, 265-274.

Defra. (2011). *Biodiversity 2020: A strategy for England's wildlife and ecosystem services.* [Online]. Available at:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69446/pb13583-biodiversity-strategy-2020-111111.pdf .

Desforges, J.-P. W., Sonne, C., Levin, M., Siebert, U., De Guise, S., & Dietz, R. (2016). Immunotoxic effects of environmental pollutants in marine mammals. *Environment International, 86*, 126-139.

Dolman, S., Williams-Grey, V., Asmutis-Silva, R., & Isaac, S. (2018). *Vessel collisions and cetaceans.* Whale and Dolphin Conservation Society.

Duck, C. (2010). Charting Progress 2 Healthy and Biological Diverse Seas Feeder Report: Section 3.5: Seals. Published by Department for Environment Food and Rural Affairs on behalf of UKMMAS. *P506-539. In: UKMMAS. Frost, M and Hawkridge, J. (Eds.).*

Erbe, C., Marley, S. A., Shoerman, R. P., Smith, J. N., Trigg, L. E., & Embling, C. B. (2019). The effects of ship noise on marine mammals - a reivew. *Frontiers in Marine Science, 6*(606). doi:10.3389/fmars.2019.00606

Evans , P. G., Baines, M. E., & Anderwald, P. (2011). *Risk assessment of potential conflicts between shipping and cetaceans in the ASCOBANS region.* ASCOBANS Advisory Committee.

Evans, P., Anderwald, P., & Baines, M. (2003). *UK Cetacean Status Review. Sea Watch Foundation. .* Report to English Nature & Countryside Council for Wales, Oxford.

Evans, P., Anderwald, P., & Hepworth, K. (2008). *Cetaceans in the vicinity of Aberdeen and adjacent seas.* Oxford: SeaWatch Foundation.

Genesis. (2011). *Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. Document J71656-Final Report-G2*. Retrieved 02 19, 2022, from https://www.semanticscholar.org/paper/Review-and-Assessment-of-Underwater-Sound-Produced-IRECTIVE/52b808718275e5203637ed083942fff8502adba9

Gill, A., & Desender, M. (2020). Risk to Animals from Electrom Magnetic Fields Emitted by Electric Cables and Marine Renewable Energy Devices. In A. E. Copping (Ed.), *OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World* (pp. 86-103). Ocean Energy Systems (OES).

Gill, A., Gloyne-Phillips, I., Neal, K., & Kimber, J. (2005). *The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms - a review.* Collaborative Offshore Wind Research into the Environment (COWRIE).

Gomez, C., Lawson, J., Wright, A., Buren, A., Tollit, D., & Lesage, V. (2016). A systematic review on the behavioural responses of wild marine mammals to noise: The disparity between science and policy. *Canadian Journal of Zoology, 94*, 801-819. doi:10.1139/cjz-2016-0098

Hague, E., Sinclair, R., & Sparling, C. (2020). Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters. *Scottish Marine and Freshwater Series, 11*(12), 309.

Hale, R. (2018). *Sounds from Submarine Cable and Pipeline Operations, EGS Survey Group representing the International Cable Protection Committee. Powerpoint Presentation.* Retrieved February 19, 2022, from http://www.un.org/depts/los/consultative_process/icp19_presentations/2.Richard%20Hale.pdf

Hall, A., Watkins, J., & Hammond, P. (1998). Seasonal variation in the diet of harbour seals in the south-western North Sea. *Marine Ecology Progress Series, 170*, 269-281.

Hammond, Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., . . . Øien, N. (2021). *Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys.* 40 pp.

Hammond, P., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., . . . and Øien, N. (2017). *Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys.* 40 pp.

Hammond, P., Macleod, K., Berggren, P., Borchers, D., Burt, L., Cañadas, A., . . . Ridoux, V. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. *Biological Conservation* , 164: 107-122.

Härkönen, T. (1987). Seasonal and regional variations in the feeding habits of the harbour seal, Phoca vitulina, in the Skagerrak and the Kattegat. *Journal of Zoology, 213*(3), 535-543.

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*(JNCC, Peterborough.).

Hiby, L., & Lovell, P. (1998). *Using Aircraft in Tandem Formation to Estimate Abundance of Harbour Porpoise.* Biometrics, 54, 1280 – 1289.

HM Govenment. (2021). *North East Inshore and North East Offshore Marine Plan.* https://www.gov.uk/government/publications/the-north-east-marine-plans-documents. Retrieved from https://www.gov.uk/government/publications/the-north-east-marine-plans-documents

HM Government. (2011). *UK Marine Policy Statement.* Available at: 10164_Marine Statement_Cov.indd (publishing.service.gov.uk): HM Government, Northern Ireland Executive, Scottish Government, Welsh Assembly Government.

Hoek, W. (1992). An unusual aggregation of harbor porpoises (Phocoena phocoena). *Marine Mammal Science*(8, 152 – 155.).

IAMMWG. (2015). *Management Units for cetaceans in UK waters.* Inter-Agency Marine Mammal Working Group. JNCC Report No. 547, Peterborough. .

IAMMWG. (2021). Updated abundance estimates for cetacean Management Units in UK waters. *JNCC Report, No. 680*(Peterborough, ISSN 0963-8091.).

IAMMWG, Inter-Agency Marine Mammal Working Group. (2021). *Updated abundance estimates for cetacean Management Units in UK waters.* Peterborough: JNCC.

ICES. (2019). Working Group on Marine Mammal Ecology (WGMME). . *ICES Scientific Reports.*(1(22), 142 pp.).

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

IUCN. (2019). *The IUCN Red List of Threatened Species. Version 2019-2.* Retrieved from http://www.iucnredlist.orghttp://www.iucnredlist.org

IUCN. (2021). *The IUCN Red List of Threatened Species. Version 2021-2*. Retrieved from http://www.iucnredlist.org

Jefferson, T., Leatherwood, S., & M.A., &. W. (1993). *FAO Species identification guide. Marine mammals.* Rome: UNEP/FAO. Retrieved January 14, 2022, from https://www.fao.org/3/t0725e/t0725e00.htm

JNCC. (1994). *UK Biodiversity Action Plan (UK BAP) 1994.* Retrieved February 03, 2022, from https://hub.jncc.gov.uk/assets/cb0ef1c9-2325-4d17-9f87-a5c84fe400bd

JNCC. (2017). *Guidelines for minimising the risk of injury to marine mammals from geophysical surveys*. Retrieved 02 19, 2022, from https://data.jncc.gov.uk/data/e2a46de5-43d4-43f0-b296-c62134397ce4/jncc-guidelines-seismicsurvey-aug2017-web.pdf

JNCC. (2019). *Article 17 Habitats Directive Report 2019: Species Conservation Status Assessments 2019*. Retrieved from https://jncc.gov.uk/our-work/article-17-habitats-directive-report-2019-species/

JNCC. (2019). *United Kingdom Conservation status assessment for the species: minke whale (Balaenoptera acutorostrata).* European Community Directive.

JNCC. (2020). *Guidance for assessing the significance of noise distribution against Conservation Objectives of harbour porpoise SACs (England, Wales and Northern Ireland). JNCC Report No. 654.* Peterborough. ISSN 0963-8091: JNCC.

JNCC and Defra (on behalf of 4CBG). (2018). *UK Post-2012 Biodiversity Framework: Revised Implementation Plan (2018-2020).* [Online]. Available at: https://data.jncc.gov.uk/data/587024ff-864f-4d1d-a669-f38cb448abdc/UKBioFwk-RevisedImpPlan-Jun2018.pdf .

Jones, E. L., Hastie, G. D., Smout, S., Onoufriou, J., Merchant, N. D., Brookes, K. L., & Thompson, D. (2017). Seals and shipping: quantiyfying population risk and individual exposure to vessel noise. *Journal of Applied Ecology, 54*(6), 1930-1940.

Kastelein, R., Hardeman, J., & Boer, H. (1997). Food consumption and body weight of harbour porpoises (Phocoena phocoena). In A. Read, P. Wiepkema, & P. Nachtigall (Eds.), *The Biology of the Harbour Porpoise* (pp. 217-233). Woerden, The Netherlands: De Spil Publishers.

Klimley, A. P., Putman, N. F., Keller, B. A., & Noakes, D. (2021). A call to assess the impacts of electromagnetic fields from subsea cables on the movement ecology of marine migrants. *Conservation Science and Practice, 3*, 436.

Klinowska, M. (1990). Geomagnetic Orientation in Cetaceans: Behavioural Evidence. In T. J.A., & K. R.A. (Eds.), *Sensory Abilities of Cetaceans. NATO ASI Series (Series A: Life Sciences)* (Vol. 196). Boston, MA: Springer.

Levitt, B. B., Lai, H. C., & Manvill II, A. M. (2021). Effects of non-ionizing electromagnetic fields on lora and fauna, Part 2 impacts: how species interact with natural and man-made EMF. *Rev Environ Health*.

Lucke, K., Lepper, P., Blanchet, M.-A., & Siebert, U. (2009). Temporary shift in massed hearing thresholds in a harbour porpoise Phocoena phocoena after exposure to seismic airgun stimuli. *Journal of Acoustical Society of America, 126*, 4060-4070.

MacLoed, C., Begona Santos, M., Reid, R., Scott, B., & Pierce, G. (2007). Linking sandeel consumption and the likelihood of starvation in harbour porpoises in the Scottish North Sea: could climate change mean more starving porpoises? *Biology Letters, 3*(2), 185-188.

McConnell, B., Fedak, M., Lovell, P., & Hammond, P. (2001). Movements and foraging areas of grey seals in the North Sea. *Journal of Applied Ecology, 36*(4), 573-590.

MMO. (2019). *Habitat Regulations Assessment for the North East, North West, South East and South West Marine Plans – Appropriate Assessment Information Report, including Screening Report.* A report produced for the Marine Management Organisation, pp 232. MMO Project No: 1188.

Moffat, C., Baxter, J., Berx, B., Bosley, K., Boulcott, P., Cox, M., . . . Webster, L. (2020). *Cetaceans - Scotland's Marine Assessment 2020.* Retrieved December 02, 2021, from https://marine.gov.scot/sma/sites/default/files/sma2020_-_cetaceans_-_healthy_and_biologically_diverse.pdf

Morris, C. D., Duck, C. D., & Thompson, D. (2021). *Aerial surveys of seals in Scotland during harbour seal moult, 2016-2019.* Nature Scot.

National Marine Fisheries Service (NMFS). (2018). *Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S Dept. of Commer, NOAA. .* NOAA Technical Memorandum NMFS-OPR59, 167 pp.

NatureScot. (2020). *Priority marine features in Scotland's seas*. Retrieved March 07, 2022, from https://www.nature.scot/professional-advice/protected-areas-and-species/priority-marine-features-scotlands-seas

NatureScot. (2021). *European protected species*. Retrieved March 08, 2022, from https://www.nature.scot/professional-advice/protected-areas-and-species/protected-species/legal-framework/habitats-directive-and-habitats-regulations/european-protected

Nedwell, J., Brooker, A., & Barham, R. (2012). *Assessment of underwater noise during the installation of export power cables at the Beatrice Offshore Windfarm. Subacoustech. Envrionmental Report No. E318R0106.* Retrieved 02 19, 2022, from http://marine.gov.scot/datafiles/lot/bowl/ES/ES%20Volume%204%20-%20Annexs/7B%20OfTW%20Underwater%20Noise/Annex%207B%20OfTW%20Underwater%20Noise.pdf

Nedwell, J., Langworthy, J., & Howell, D. (2003). *Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore windfarms, and comparison with background noise.* The Crown Estates. Retrieved from www.subacoustech/information/downloads/reports/544R0424.pdf

Nelms, S. E., Alfaro-Shigueto, J., Arnould, J. P., Avila, I. C., Nash, S. B., Campbell, E., . . . Godley, B. J. (2021). Marine mammal conservation: over the horizon. *Endangered Species Research, 44*, 291-325.

NGET & SPT. (2021). *Scotland to England Green Link (SEGL) ~ Eastern Link 1 Marine Scheme - Scoping Report.* https://marine.gov.scot/sites/default/files/segl_el1_marine_scoping_report_-_base_report_rev_2.0.pdf.

Normandeau, Eponent, Tricas, T., & Gill, A. (2011). *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species.* Camarillo, CA: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region.

Northridge, S., Cargill, A., Coram, A., Mandleber, L., Calderan, S., & Reid, B. (2020). *Entanglement of minke whales in Scottish waters; an investigation into occurrence, causes and mitigation. Sea Mammal Research Unit.* Final Report to Scottish Government CR/2007/49.

Nyqvist, D., Durif, C., Johnsen, M. G., De Jong, K., Forland, T. N., & Sivle, L. D. (2020). Electric and magnetic senses in marine animals, and potential behavioral effects of electromagnetic surveys. *Marine Environmental Research, 155*.

OGUK. (2019). *Environmental Report.*

Öhman, M. C., Sigray, P., & and Westerberg, H. (2007). Offshore windmills and the effects of electromagnetic fields on fish. *MBIO: A journal of the Human Environment, 36*(8), 630-634.

Olsen, E., & Holst, J. (2001). A note on common minke whale (Balaenoptera acutorostrata) diets in the Norwegian Sea and the North Sea. *Journal of Cetacean Research and Management, 3*(2), 179-183.

OSPAR Commission. (2008). *Case Reports for the OSPAR List of Threatened and/or Declining Species and Habitats.* Retrieved from https://www.ospar.org/site/assets/files/44267/harbour_porpoise.pdf

OSPAR Commission. (2009). *Assessment of the environmental impacts of cables. Biodiversity Series.* Retrieved 02 19, 2022, from https://qsr2010.ospar.org/media/assessments/p00437_Cables.pdf

Palka, D. L., & Hammond, P. S. (2001). Account for responsive movement in line transect estimates of abundance. *Canadian Journal of Fisheries and Aquantic Sciences, 58*(4).

Reid, J., Evans, P., & Northridge, S. (2003). *Atlas of Cetacean Distribution in north-west European Waters.* Joint Nature Conservation Committee, Peterborough.

Reid, J., Evans, P., & Northridge, S. (2003). *Atlas of Cetacean Distribution in north-west European Waters.* Peterborough: Joint Nature Conservation Committee.

Richardson, W., Greene, C., Malme, C., & Thomson, D. (1995). *Marine mammals and noise.* San Diego: Academic Press.

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 and Coastal Management, 179*. doi:10.1016/j.ocecoaman.2019.104860

Robinson, K., O'Brien, J., Berrow, S., Cheney, B., Costa, M., Eisfield, S., . . . Whooley, P. (2012). Discrete or not so discrete: Long distance movements by coastal bottlenose dolphins in UK and Irish waters. *Journal of Cetacean Research and Management, 12*(3), 365-371.

Rockwood, R. C., Calambokidis, J., & Jahncke, J. (2017). High mortality of blue, humpback and fin whales from modeling of vessel collisions on the U.S. West Coast suggests population impacts and insufficient protection. *Plos One*. doi:10.1371/journal.pone.0183052

Rojano-Doñate, L., McDonald, B., Wisniewska, D., Johnson, M., Teilmann, J., Wahlberg, M., . . . Madsen, P. (2018). High field metabolic rates of wild harbour porpoises. *Journal of Experimental Biology, 221*. doi:10.1242/jeb.185827

Ross, D. (1993). On ocean underwater ambient noise. *Acoustics Bulletin, 18*, 5-8.

Russell, D., & McConnell, B. (2014). Seal at-sea distribution, movements and behaviour. Report to UK Department of Energy and Climate Change (DECC). . (URN: 14D/085.).

Russell, D., Jones, E., & and Morris, C. (2017). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. . *Scottish Marine and Freshwater Science.* (8(25), 30 pp.).

Schoeman, R. P., Patterson-Abrolat, C., & Plon, S. (2020). A global review of vessel collision with marine mammals. *Frontiers in Marine Science, 7*. doi:10.3389/fmars.2020.00292

SCOS, S. C. (2020). *Scientific Advice on Matters Related to the Management of Sea Populations.*

Scottish Government. (2014). *Marine Scotland - Guidance on the Offence of Harrassment at Seal Haul-out Sites.* Marine Scotland.

Scottish Government. (2015). *Scotland's National Marine Plan*. Retrieved from https://www.gov.scot/publications/scotlands-national-marine-plan-9781784128555/

Sea Watch Foundation. (2012a). *Cetaceans of Eastern England.* Retrieved from https://seawatchfoundation.org.uk/wp-content/uploads/2012/07/EasternEngland.pdf

Sea Watch Foundation. (2012b). *The White Beaked Dolphin in UK Waters.* Retrieved from https://seawatchfoundation.org.uk/wp-content/uploads/2012/07/White-beaked_Dolphin.pdf

Sharples, R., Moss, S., Patterson, T., & Hammond, P. (2012). Spatial Variation in Foraging Behaviour of a Marine Top Predator (Phoca vitulina) Determined by a Large-Scale Satellite Tagging Program. *PLoS ONE, 7*(5), e37216.

SMRU. (2021). Retrieved from http://www.smru.st-andrews.ac.uk/

SNH. (2017). *Guide to Best Practice for Watching Marine Wildlife .* https://www.nature.scot/sites/default/files/2017-06/Publication%202017%20-%20A%20Guide%20to%20Best%20Practice%20for%20Watching%20Marine%20Wildlife%20SMWWC%20-%20Part%202%20-%20April%202017%20%28A2263517%29.pdf.

SNH. (2017). *Scottish Marine Wildlife Watching Code .* https://www.nature.scot/sites/default/files/2017-06/Publication%202017%20-%20The%20Scottish%20Marine%20Wildlife%20Watching%20Code%20SMWWC%20-%20Part%201%20-%20April%202017%20%28A2263518%29.pdf.

Soloway, A., & Dahl, P. (2014). Peak sound pressure and sound exposure level from underwater explosions in shallow water. *Journal of the Acoustic Society of America, 136*(EL218).

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, R., Greene Jr, C., . . . Tyack, P. (2007). Marine mammal noise exposure criteria: initial scientific recommendations. *Aquatic Mammals, 33*(4), 411-522.

Southall, B., Nowacek, D., Bowles, A., Senigaglia, V., Bejder, L., & Tyack, P. (2021). Marine Mammals Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behaviour Responses to Human Noise. *Aquatic Mammals, 47*(5), 421-464.

Southall, L., Finneran, J., Reichmuth, C., Nachtigall, E., Kettem, R., Bowles, E., . . . Tyack, L. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals, 45*(2), 125-232.

Stone, C., & Tasker, M. (2006). The effect of seismic airguns on cetaceans in UK waters. *Journal of Cetacean Research and Management, 8*, 255-263.

Taormina, B., Bald, J., Want, A., Thouzeau, G., Lejart, M., Desroy, N., & Carlier, A. (2018). A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions. *Renewable and Sustainable Energy Reviews, 96*, 380-391.

Taylor, C., & Saayman, G. (1972). The social organization and behaviour of dolphins (Tursiops aduncus) and baboons (Papio ursinus): some comparisons and assessments. *Annals of the Cape provincial Museum , 9*(Part 2), 11-49.

Thompson, P., Brookes, K., Graham, I., Barton, T., Needham, K., Bradbury, G., & Merchant, N. (2013). Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. *Proceedings of the Royal Society of B*.

Thompson, P., Cheney, B., Ingram, S., Stevick, P., Wilson, B., & and Hammond, P. (. (2011). Distribution, abundance and population structure of bottlenose dolphins in Scottish Waters. . *Scottish Government and Scottish Natural Heritage Funded Report* (No. 354).

Thompson, P., Mackay, A., Tollit, D., Enderby, S., & Hammond, P. (1998). The influence of body size and sex on the characteristics of harbour seal foraging trips. *Canadian Journal of Zoology, 76*(6), 1044-1053.

Tyack, P. (2008). Implications for marine mammals of large-scale changes in the marine acoustic environment. *Journal of Mammalogy, 89*(3), 549-558.

UK Cetacean Stranding Investigation Programme. (2021). Retrieved from http://ukstrandings.org/csip-publications/

UK Government. (2014). *Nature Conservation (Scotland) Act 2014*. Retrieved December 09, 2021, from https://www.legislation.gov.uk/asp/2004/6/contents

UK Government. (2019). *The Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations 2019*. Retrieved December 09, 2021, from https://www.legislation.gov.uk/sdsi/2019/9780111041062

UK Government. (2019). *The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019*. Retrieved December 09, 2021, from https://www.legislation.gov.uk/ukdsi/2019/9780111176573

Waggitt, J., Evans, P., Hiddink, J. G., Andrade, J., Banks, A., Boisseau, O., . . . Wanless, S. (2019). Distribution maps of cetacean and seabird populations in the North-East. *Journal of Applied Ecology, 57*(2), 105 pp.

Wilson, S. (2001). *Population growth, reproductive rate and neo-natal morbidity in a re-establishing harbour seal-colony. .* Valencia, Spain.: Seal Workshop, 13th European Cetacean Society Annual Conference, 5 April 1999.

Winkler, C., Panigada, S., Murphy, S., & Ritter, F. (2020). *Global numbers of ship strikes: an assessment of collisions between vessels and cetaceans using available data in the IWC ship strike database.* Galway, Ireland: Galway-Mayo Institute of Technology .

Wisniewska, D. M., Johnsons, 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). *The Proceedings of the Royal Society B Biological Sciences, 285*.

Wisniewska, D., Johnson, M., Teilmann, J., Rojano-Doñate, L., Shearer, J., & Sveegaard, S. (2016). Ultra-high foraging rates of harbour porpoises make them vulnarable to anthropogenic disturbance. *Current Biology, 26*, 1441-1446. doi:10.1016/j.cub.2016.03.069

WWT Consulting. (2009). Distributions of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008. *Report to the Department of Energy and Climate Change.*, p. 32 pp.

Yakovlev, A. P., Zaytsev, A., Ishkulov, D. G., & Grigoriev, V. F. (2019). The influence of low-frequency electromagnetic field on the operability of gray seals. *Vestnik of MTSU, 2*(22), 266-275.