Dudgeon and Sheringham Shoal Offshore Wind Farm Extensions

Preliminary Environmental Information Report

Volume 3

Appendix 12.1 - Marine Mammal Information and Survey Data

April 2021

Title:	
Dudgeon and Sheringham Shoal Offshore Wind Farm Extensions **Preliminary Environmental Information Report** **Appendix 12.1 Marine Mammal Information and Survey Data**	
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Table of Contents

List of Tables

List of Plates

Glossary of Acronyms

ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
CBD	Convention on Biological Diversity
CCW	Countryside Council for Wales
CES	Coastal East Scotland
CITES	Convention on International Trade in Endangered Species
CI	Confidence intervals
CIS	Celtic and Irish Sea
cm	Centimeter
CRoW	The Countryside and Rights of Way Act
CV	Coefficient of variation
DECC	Department for Energy and Climate Change
DEP	Dudgeon Extension Project
DOW	Dudgeon Offshore Wind Farm
EC	European Commission
EEZ	Exclusive economic zone
EIA	Environmental Impact Assessment
EPS	European Protected Species
ETG	Expert Topic Group
EU	European Union
FCS	Favourable Conservation Status
IAMMWG	Inter-Agency Marine Mammal Working Group
IWC	International Whaling Commission

JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
KDE	kernel density estimation
kg	Kilogram
km	Kilometre
km^2	Square kilometre
m	meter
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Management Organisation
MPS	Marine Policy Statement
MSFD	Marine Strategy Framework Directive
MU	Management Unit
MW	Megawatts
NE	Natural England
nm	Nautical mile
NNR	National Nature Reserve
NS	North Sea
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
SCANS	Small Cetaceans in European Atlantic waters and the North Sea
SCOS	Special Committee on Seals
SEP	Sheringham Extension Project
SMRU	Sea Mammal Research Unit

SNS	Southern North Sea
TSEG	Trilateral Seal Expert Group
UK	United Kingdom
UXO	Unexploded Ordnance
WS	West Scotland
WWT	Wildfowl and Wetlands Trust

Glossary of Terms

The Applicant	Equinor New Energy Limited
Array cables	Cables which link the wind turbine generators to the offshore substation platforms.
Dudgeon Offshore Wind Farm Extension site	The Dudgeon Offshore Wind Farm Extension offshore wind farm boundary.
The Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension site as well as all onshore and offshore infrastructure.
Designated site	Sites designated for nature conservation under the Habitats Directive and Birds Directive. This includes candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation and Special Protection Areas, and is defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the EIA and HRA for certain topics.
Horizontal directional drilling (HDD) zones	The areas within the onshore cable route which would house HDD entry or exit points.
Interlink cables	Buried offshore cables which link offshore substation platforms.
Integrated Grid Option	Transmission infrastructure which serves both extension projects
Landfall	The point at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water
Offshore export cables	The cables which would bring electricity from the offshore substation platform(s) to the landfall.
Offshore scoping area	An area that encompasses all planned offshore infrastructure, including landfall options at both Weybourne and Bacton, and allows sufficient room for receptor identification and environmental

	surveys. This will be refined following further site selection and consultation.
Offshore substation platform	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
PEIR boundary	The area subject to survey and preliminary impact assessment to inform the PEIR, including all permanent and temporary works for DEP and SEP. The PEIR boundary will be refined down to the final DCO boundary ahead of the application for development consent.
Study area	Area where potential impacts from the project could occur, as defined for each individual EIA topic.
Sheringham Shoal Offshore Wind Farm Extension site	Sheringham Shoal Offshore Wind Farm Extension offshore wind farm boundary.
The Sheringham Offshore Wind Farm Extension Project (SEP)	The Sheringham Offshore Wind Farm Extension site as well as all onshore and offshore infrastructure.

12.1 MARINE MAMMAL INFORMATION AND SURVEY DATA

12.1.1 Introduction

1. This appendix provides additional marine mammal information and survey data to support **Chapter 12 Marine Mammal Ecology**.

12.1.2 Marine Mammal Species

2. In the United Kingdom (UK) waters, two groups of marine mammals occur: cetaceans (whales, dolphins and porpoises) and pinnipeds (seals). During the site specific surveys for both the Dudgeon and Sheringham Shoal Offshore Wind Farms, harbour porpoise (*Phocoena phocoena*) were the most commonly sighted marine mammal species for both projects, with the highest numbers being recorded in the spring and summer months (Dudgeon Offshore Wind Limited, 2009; Scira Offshore Energy Ltd, 2006).
3. This is supported by other wider scale surveys and reporting for marine mammals in the area, including by Department for Energy and Climate Change (DECC) (2016), Small Cetaceans in European Atlantic waters and the North Sea (SCANS) surveys (Hammond *et al.*, 2017) and Joint Cetacean Protocol (JCP) data resources (Paxton *et al*., 2016). While a number of cetacean species have been recorded within the southern areas of the North Sea, only harbour porpoise occur regularly throughout the year, while minke whale (*Balaenoptera acutorostrata*) could occur in the area, particularly during in the summer periods and white-beaked dolphin (*Lagenorhynchus albirostris*) are less frequent (DECC, 2016; Hammond *et al.,* 2017; Paxton *et al*., 2016). Other cetacean species, including bottlenose dolphin (*Tursiops truncatus)* and white-sided dolphin (*Lagenorhynchus acutus*) are relatively uncommon in the area (DECC, 2016), although it should be noted that the number of bottlenose dolphin sightings has recently been increasing along the east coast of England.
4. Both UK seal species, grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) are present in the area in relatively high number, due to nearby key breeding areas for both species (DECC, 2016).
5. The most recent public sightings reported to the SeaWatch Foundation in the east of England (at the time of writing; August 2019 to February 2021) were predominantly harbour porpoise (n=133), common dolphin (*Delphinus delphis*) (n=31), bottlenose dolphin (n=13), northern bottlenose whale (*Hyperoodon ampullatus*) (n=7), unknown cetacean species (n=6), humpback whale (*Megaptera novaeangliae*) (n=4), unidentified whale (n=3), unknown dolphin species (n=2), minke whale (n=2), Sowerby's beaked whale (*Mesoplodon bidens*) (n=2), harbour seal (n=1) (SeaWatch Foundation, 2021). Of these, only harbour porpoise and bottlenose dolphin (which have been specifically recorded at Sheringham) have been sighted near DEP and SEP in significant number, with low numbers of minke whale, humpback whale, northern bottlenose whale, and Sowerby's beaked whale also recorded nearby (SeaWatch Foundation, 2021).

6. Other marine mammal species, including Atlantic white-sided dolphin, bottlenose dolphin, killer whale (*Orcinus orca)*, sperm whale (*Physeter macrocephalus*), long-finned pilot whale (*Globicephala melas*), Risso's dolphin (*Grampus griseus*), striped dolphin (*Stenella coeruleoalba*) and other seal species are occasional or rare visitors to the southern North Sea (e.g. Reid *et al.*, 2003; Hammond *et al.*, 2013, 2017; DECC, 2016; SCOS, 2019).
7. Site characterisation has been undertaken using site specific data for DEP and SEP, as well as existing data from other offshore wind farms in the area and other available information for the region.
8. Based on the site-specific surveys and other data sources, the key species of interest and therefore the focus of the assessments will be on the following species:
    - Harbour porpoise – present throughout the year, although may be variations in seasonal occurrence;
    - White-beaked dolphin – seasonal occurrence in low numbers;
    - Minke whale – seasonal occurrence in low numbers;
    - Bottlenose dolphin – historically not common in the area, with limited data, however, recent reporting has indicated that the number are increasing the area, and so have been included on a precautionary basis.
    - Grey seal – present throughout the year; and
    - Harbour seal – present throughout the year.

12.1.3 Study Area

9. Management Units (MUs) provide an indication of the spatial scales at which effects of plans and projects alone, and in-combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK (Inter-Agency Marine Mammal Working Group (IAMMWG), 2015). The study area, MUs and reference populations have been determined based on the most relevant information and scale at which potential impacts from DEP and SEP alone and in-combination with other plans and projects could occur.
10. For each species of marine mammal, the following study areas have been defined based on the relevant MUs, current knowledge and understanding of the biology of each species:
    - Harbour porpoise: North Sea (NS) MU;
    - Bottlenose dolphin: Greater North Sea and Coastal East Scotland[1];
    - White-beaked dolphin: Celtic and Greater North Seas MU;
    - Minke whale: Celtic and Greater North Seas MU;
    - Grey seal: South-east England, North-east England and UK East Coast Mus, and the Wadden Sea region; and
    - Harbour seal: South-east England MU and the Wadden Sea region.

[1] Evidence of the recent change in bottlenose dolphin distribution in the North Sea suggests that individuals are travelling south from the Moray Firth population which is within the Coastal East Scotland MU; therefore, for bottlenose dolphin both MUs will be used to define the study area for bottlenose dolphin.

11. There is the potential for seals from haul-out sites to move along the coast and offshore to forage in and around the proposed Project areas. Key haul-out sites for both seal species within the vicinity of the DEP and SEP sites include:
    - Blakeney Point (located 12km from the nearest part of either DEP or SEP (closest swimmable distance[2]), including export cable corridors and landfall locations).
    - Other haul-out sites are located at Horsey (44km), Scroby Sands (58km), the Wash (57km) and Donna Nook (66km).

12.1.4 Policy, Legislation and Guidance

12.1.4.1 National and Regional Marine Policies

12. As outlined in the **Chapter 12 Marine Mammal Ecology** there are a number of pieces of legislation, policy and guidance applicable to the assessment of marine mammals. These include:
    - The Marine Strategy Framework Directive (MSFD) 2008/56/EC (EC, 2008);
    - The Marine Policy Statement (MPS) (HM Government, 2011); and
    - The East Inshore and East Offshore Marine Plans (HM Government, 2014).

12.1.4.1.1 The Marine Strategy Framework Directive

13. Annex I of the MSFD states that to ensure that good environmental status is met, the following must be considered:
    - Biological diversity should be maintained;
    - The quality and occurrence of habitats, as well as the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions;
    - All elements of the marine food web, to the extent that they are known, occur at normal abundance and diversity levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity;
    - Concentrations of contaminants are at levels not giving rise to pollution effects;
    - Properties and quantities of marine litter do not cause harm to the coastal and marine environment; and
    - Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

[2] Swimmable distance is the distance at which a marine mammal would have to travel to reach the location of interest (i.e. it takes into account areas of land).

12.1.4.1.2 The Marine Policy Statement

14. The MPS (HM Government, 2011) provides a high-level approach to marine planning and the general principles for decision making. It sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning. The high-level objective of 'Living within environmental limits' covers the points relevant to marine mammals, this requires that:

- Biodiversity is protected, conserved and where appropriate recovered and loss has been halted.
- Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems.
- Our oceans support viable populations of representative, rare, vulnerable, and valued species.

12.1.4.1.3 The East Inshore and East Offshore Marine Plans

15. Within both the East Inshore and East Offshore Marine Plans (HM Government, 2014), a set of objectives have been set out to ensure biodiversity protections and are of relevance to marine mammals as they cover policies and commitments on the wider ecosystem, as set out within the MPS and the MSFD.

- Objective 6: "To have a healthy, resilient and adaptable marine ecosystem in the East Marine Plan areas"; and
- Objective 7: "To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas".

12.1.4.2 Other National and International Legislation for Marine Mammals

16. **Table 12-1** provides an overview of national and international legislation in relation to marine mammals.

Table 12-1: Summary Table for National and International Legislations Relevant for Marine Mammals

Legislation	Level of Protection	Species Included	Details
Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)	International	Odontocetes	Formulated in 1992, this agreement has been signed by eight European countries bordering the Baltic and North Seas (including the English Channel) and includes the United Kingdom (UK). Under the Agreement, provision is made for the protection of specific areas, monitoring, research, information exchange, pollution control and increasing public awareness of small cetaceans.
The Berne Convention 1979	International	All cetaceans, grey seal and harbor seal	The Convention conveys special protection to those species that are vulnerable or endangered. Appendix II (strictly protected fauna): 19 species of cetacean. Appendix III (protected fauna): all remaining cetaceans, grey and harbour seal. Although an international convention, it is implemented within the UK through the Wildlife and Countryside Act 1981 (with any aspects not implemented via that route brought in by the Habitats Directive).
The Bonn Convention 1979	International	All cetaceans	Protects migratory wild animals across all, or part of their natural range, through international co-operation, and relates particularly to those species in danger of extinction. One of the measures identified is the adoption of legally binding agreements, including ASCOBANS.
Oslo and Paris Convention for the Protection of	International	Bowhead whale *Balaena*	OSPAR has established a list of threatened and/or declining species in the North East Atlantic. These species have been targeted as part of further work on the conservation and

Legislation	Level of Protection	Species Included	Details
the Marine Environment 1992 (OSPAR)		*mysticetus*, northern right whale *Eubalaena glacialis*, blue whale *Balaenoptera musculus*, and harbour porpoise	protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the EC Habitats and Birds directives and measures under the Berne Convention and the Bonn Convention.
International Convention for the Regulation of Whaling 1956	International	All cetacean species	This Convention established the International Whaling Commission (IWC) who regulates the direct exploitation and conservation of large whales (in particular sperm and large baleen whales) as a resource and the impact of human activities on cetaceans. The regulation considered scientific matters related to small cetaceans, in particular the enforcing a moratorium on commercial whaling which came into force in 1986.
Convention on International Trade in Endangered Species of Wild	International	All cetacean species	Prohibits the international trade in species listed in Annex 1 (including sperm whales, northern right whales, and baleen whales) and allows for the controlled trade of all other cetacean species.

Legislation	Level of Protection	Species Included	Details
Fauna and Flora (CITES) 1975			
Convention on Biological Diversity (CBD) 1993	International	All marine mammal species	Requires signatories to identify processes and activities that are likely to have impacts on the conservation of and sustainable use of biological diversity, inducing the introduction of appropriate procedures requiring an EIA and mitigation procedures.
The Conservation of Habitats and Species Regulations 2017 and The Conservation of Offshore Marine Habitats and Species Regulations 2017	National	All cetaceans, grey and harbour seal	'The Habitats Regulations 2017'. Provisions of The Habitats Regulations are described further in **Chapter 12 Marine Mammal Ecology**. It should be noted that the Habitats Regulations apply within the territorial seas and to marine areas within UK jurisdiction, beyond 12 nautical miles (nm).
The Wildlife and Countryside Act 1981 (as amended)	National	All cetaceans	Schedule five: all cetaceans are fully protected within UK territorial waters. This protects them from killing or injury, sale, destruction of a particular habitat (which they use for protection or shelter) and disturbance. Schedule six: Short-beaked common dolphin, bottlenose dolphin and harbour porpoise; prevents these species being used as a

Legislation	Level of Protection	Species Included	Details
			decoy to attract other animals. This schedule also prohibits the use of vehicles to take or drive them, prevents nets, traps or electrical devices from being set in such a way that would injure them and prevents the use of nets or sounds to trap or snare them.
The Countryside and Rights of Way Act (CroW) 2000	National	All cetaceans	Under the CroW Act 2000, it is an offence to intentionally or recklessly disturb any wild animal included under Schedule 5 of the Wildlife and Countryside Act.
Conservation of Seals Act 1970	National	Grey and harbour seal	Provides closed seasons, during which it is an offence to take or kill any seal, except under licence or in certain circumstances (grey seal: 1 September to 31 December; harbour seal: 1 June to 31 August). Following the halving of the harbour seal population as a result of the Phocine Distemper Virus in 1988, an Order was issued under the Act which provided year-round protection of both grey and harbour seal on the east coast of England. The Order was last renewed in 1999.

12.1.4.3 European Protected Species Guidance

17. All cetacean species are all listed as European Protected Species (EPS) under Annex IV of the Habitats Directive, and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. Within the UK, The Habitats Directive is enacted through The Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017. Under these Regulations, it is an offence if harbour porpoise are deliberately disturbed in such a way as to:
    - deliberately capture, injure or kill any EPS;
    - to deliberately disturb them; or
    - to damage or destroy a breeding site or resting place.

18. The Joint Nature Conservation Committee (JNCC), Natural England (NE) and the Countryside Council for Wales (CCW) (JNCC *et al.,* 2010) have produced draft guidance concerning the Regulations on the deliberate disturbance of marine EPS, which provides an interpretation of the regulations in greater detail, including for pile driving operations (JNCC, 2010a), seismic surveys (JNCC, 2017a) and the use of explosives (JNCC, 2010b).
19. The draft guidance provides the following interpretations of deliberate injury and disturbance offences under both the Habitats Regulations and Offshore Regulations (now the Habitats Regulations, 2017), as detailed in the paragraphs below:

    "*Deliberate actions are to be understood as actions by a person who knows, in light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action;*

    Certain activities that produce loud sounds in areas where EPS could be present have the potential to result in an injury offence, unless appropriate mitigation measures are implemented to prevent the exposure of animals to sound levels capable of causing injury".
20. For the purposes of marine users, the draft guidance states that a disturbance which can cause offence should be interpreted as:

    "*Disturbance which is significant in that it is likely to be detrimental to the animals of an EPS or significantly affect their local abundance or distribution*".
21. The draft guidelines further states that a disturbance offence is more likely where an activity causes persistent noise in an area for long periods of time, and highlights that sporadic "trivial disturbance" should not be considered as a disturbance offence under Article 12.

22. Any action that could increase the risk of a long-term decline of the population, increase the risk of a reduction of the range of the species, and/or increase the risk of a reduction of the size of the habitat of the species can be regarded as a disturbance under the Regulations. For a disturbance to be considered non-trivial, the disturbance to marine EPS would need to be likely to at least increase the risk of a certain negative impact on the species at Favourable Conservation Status (FCS) .

23. JNCC *et al.* (2010) state that:

> "*In any population with a positive rate of growth, or a population remaining stable at what is assumed to be the environmental carrying capacity, a certain number of animals can potentially be removed as a consequence of anthropogenic activities (e.g. through killing, injury or permanent loss of reproductive ability), in addition to natural mortality, without causing the population to decrease in numbers, or preventing recovery, if the population is depleted. Beyond a certain threshold however, there could be a detrimental effect on the population*".

24. Further discussion on the use of thresholds for significance and the permanent or temporary nature of any disturbance is considered by defining the magnitude of potential effect in the assessment (**Section 12.4.3.1** of **Chapter 12 Marine Mammal Ecology**). Consideration of any potential essential habitat or geographical structuring of EPS is provided in the existing environment section (**Section** Error! Reference source not found. of **Chapter 12 Marine Mammal Ecology**).

25. An EPS licence is required if the risk of injury or disturbance to cetacean species is assessed as likely under the Habitats Regulations 2017. If a licence is required, an application must be submitted, the assessment of which comprises three tests, namely:

- Whether the activity falls within one of the purposes specified in Regulation 55 of the Habitats Regulations. Only the purpose of "preserving public health or public safety or other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment" is of relevance to marine mammals in this context;
- That there are no satisfactory alternatives to the activity proposed (that would not incur the risk of offence); and
- That the licensing of the activity will not result in a negative impact on the species'/ population's FCS.

26. Under the definitions of 'deliberate disturbance' in the Habitats Regulations, chronic exposure and / or displacement of animals could be regarded as a disturbance offence. Therefore, if these risks cannot be avoided, then the Applicant is likely to be required to apply for an EPS licence from the Marine Management Organisation (MMO) in order to be exempt from the offence.

27. If required, the EPS licence application will be submitted post-consent. At that point in time, the project design envelope will have been further refined through detailed design and procurement activities and further detail will be available on the techniques selected for the construction of the windfarm, as well as the mitigation measures that will be in place following the development of Marine Mammal Mitigation Plan (MMMP) for piling and Unexploded Ordnance (UXO) clearance.

12.1.5 Site specific surveys

28. In order to provide site specific and up to date information on which to base the impact assessment, a site-specific aerial survey was conducted for both marine mammals and seabirds. HiDef Aerial Surveying Limited ('HiDef') collected high resolution aerial digital still imagery for marine megafauna (combined with ornithology surveys) over both DEP and SEP, including a 4km buffer (the survey area; **Plate 12-0-1**Error! Reference source not found.). In October 2018, the survey area was revised to include an extension to the site (**Plate 12-0-1**).

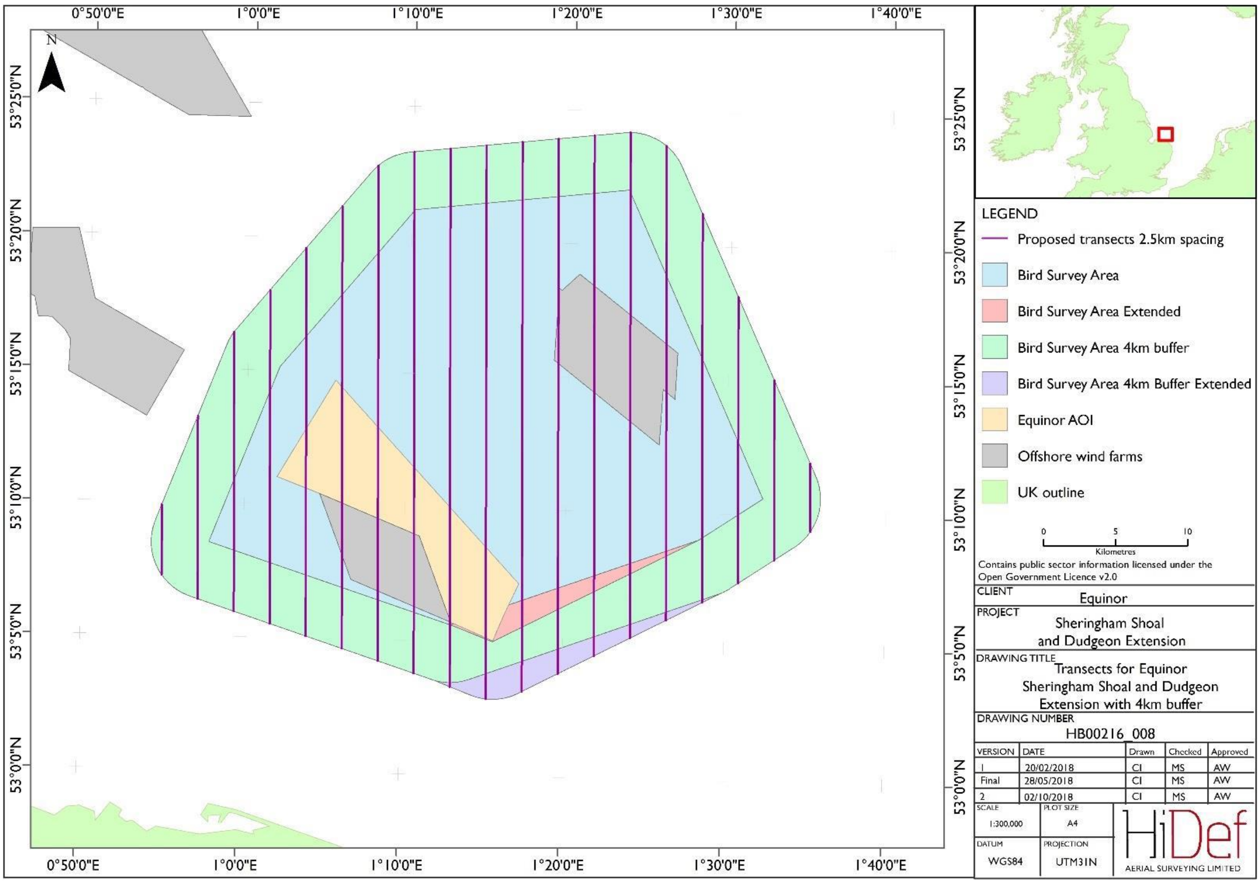


Plate 12-0-1: Survey area for DEP and SEP with 4km buffer (including extension) and 2.5km transects

29. The aerial survey was conducted along a series of strip transects (at 2.5km spacing), flown on a monthly basis from May 2018 to April 2020. A site coverage of 10% was achieved through this strip-transect design. Additional surveys were undertaken from April to August 2019 in order to collect additional data through the sandwich tern breeding season.

30. Data analysis follows a two-stage process in which video footage is reviewed (with a 20% random sample used for audit) then the detected objects are identified to species or species group level (again with 20% selected at random for audit). The audit of both stages requires 90% agreement to be achieved.

31. Density and abundance estimates are calculated using strip transect analysis and a statistical technique called kernel density estimation (KDE) was used to create density surface maps.

32. The aerial survey method has been designed to optimise the data collection for all bird and marine mammal species using a grid-based survey design at 2cm resolution to achieve a minimum of 10% coverage using a twin-engine aircraft.

33. **Table 12-2** shows the numbers of marine mammals recorded during the aerial surveys from May 2018 to April 2020. The results indicate that harbour porpoise and unidentified seals are present in the highest numbers, with just one individual identified as a minke whale.

Table 12-2: HiDef surveys species counts for DEP and SEP and 4km buffer (May 2018 to April 2020 [survey number in brackets where relevant]).

Survey Date	Grey seal	Harbour seal	Minke whale	Harbour porpoise	Seal species	Seal / small cetacean species
May -18	2	0	0	16	3	4
Jun-18	0	0	0	12	6	4
Jul-18	0	0	1	16	3	4
Aug -18	1	5	0	29	7	2
Sep -18	2	0	0	14	0	1
Oct-18	2	6	0	18	2	0
Nov -18	1	0	0	8	2	1

Survey Date	Grey seal	Harbour seal	Minke whale	Harbour porpoise	Seal species	Seal / small cetacean species
Dec -18	0	0	0	2	2	2
Jan-19	2	2	0	2	5	0
Feb -19	1	0	0	18	4	5
Mar -19	0	0	0	8	7	1
Apr-19 (1)	0	0	0	4	3	0
Apr-19 (2)	1	2	0	34	9	0
May -19 (1)	0	0	0	31	3	0
May -19 (2)	0	0	0	26	9	0
Jun-19 (1)	1	2	0	25	9	1
Jun-19 (2)	5	0	0	20	14	1
Jul-19 (1)	1	3	0	34	21	2
Jul-19 (2)	3	0	0	33	41	0

Survey Date	Grey seal	Harbour seal	Minke whale	Harbour porpoise	Seal species	Seal / small cetacean species
Aug -19 (1)	0	0	0	21	12	0
Aug -19 (2)	1	0	0	20	4	0
Sep -19	0	0	0	6	4	1
Oct-19	1	1	0	10	5	0
Nov -19	1	0	0	7	3	1
Dec -19	3	0	0	1	1	0
Jan-20	0	0	0	2	1	5
Feb -20	1	0	0	2	4	1
Mar -20	2	0	0	3	6	0
Apr-20	0	0	0	20	8	0
TOTAL	**31**	**21**	**1**	**442**	**198**	**36**

34. From the sightings numbers (as shown above) of each marine mammal species, or marine mammal species group, abundance and density estimates were calculated. Upper and lower confidence intervals (CI) as well as coefficient of variation (CV) were also calculated for these density and abundance estimates. The density of animals at the site (and hence the population size), the standard deviation, 95% CI and CV are then estimated using a non-parametric bootstrap method with replacement (Buckland *et al*., 2001).

35. For species, such as marine mammals, that dive and therefore spend a considerable amount of time underwater, an availability bias, or correction factor, must be applied in order to account for those individuals that it is not possible to survey as they are underwater. Without these availability bias, or correction factors, being corrected for, any abundance or density estimate would be relative only, rather than being an absolute estimate.
36. The correction factors applied for harbour porpoise are dependent on the month, and time of day for which data was collected (see **Table12-3**). For other species, and species groups, the relevant correction factors are described in more detail in the relevant section below.
37. Density maps have also been generated from the site-specific survey data at the Projects. To build a density map, the study area is covered with a fine mesh of study points and the density is calculated at each point in the mesh in turn.

Table12-3: Correction factors used to account for the availability bias for harbour porpoise for different months, and times of day (taken from Teilmann et al., 2013)

Month	Behavior			
	Surface		0 – 2m	
	09:00-15:00	15:00 – 21:00	09:00 – 15:00	15:00 – 21:00
January	0.0490	0.0476	0.4381	0.418614
February	0.0398	0.0384	0.3748	0.355348
March	0.0543	0.0529	0.4637	0.444271
April	0.0646	0.0632	0.5708	0.551331
May	0.0563	0.0549	0.5262	0.506735
June	0.0518	0.0503	0.5093	0.489809
July	0.0493	0.0479	0.5116	0.492099
August	0.0530	0.0516	0.4508	0.431293
September	0.0420	0.0406	0.4468	0.427348
October	0.0413	0.0399	0.4422	0.42276
November	0.0406	0.0392	0.4439	0.424431
December	0.0429	0.0415	0.4790	0.459555

12.1.6 Existing Environment

12.1.6.1 Harbour Porpoise

12.1.6.1.1 Distribution

38. Within the southern North Sea area, harbour porpoise are the most common marine mammal species. During the Dudgeon Offshore Windfarm (DOW) baseline boat-based surveys (from December 2007 to April 2009; Dudgeon Offshore Wind Limited, 2009) a total of 33 harbour porpoise were recorded, mostly in pairs (although some groups of four to six individuals were also recorded). It was noted in the DOW Surveys that the survey methodology was likely to result in underestimation of harbour porpoise numbers present near the site.

39. Through the Sheringham Shoal Offshore Wind Farm baseline surveys (also boat-based; Scira Offshore Energy Ltd, 2006), undertaken from March 2004 to February 2006, harbour porpoise were recorded relatively frequently, and was the most commonly sighted marine mammal species within the survey, with counts of up to 13 individuals in a survey day (July 2004).

40. Heinänen and Skov (2015) identified one area of high harbour porpoise density in the summer period; from the western slopes of Dogger Bank south along a 30m depth contour towards an area off the Norfolk coast. High densities in winter were also identified in the southern North Sea, within an area between Flamborough Head and the outer Thames Estuary. High densities of harbour porpoise were predicted near both DEP and SEP, while high densities in summer were predicted to be further offshore.

41. The JCP Phase III Report (Paxton *et al*., 2016) identifies a similar distribution of high harbour porpoise density, with a relatively high density in the southern North Sea, with an estimated density of 0.6-1.0 individuals per km^2 in the vicinity of DEP and SEP (0.2-0.6 per km^2 – 1.0-2.0 per km^2 97.5% CI; Paxton *et al.,* 2016).

42. Seasonal maps produced by Gilles *et al.* (2016) for harbour porpoise density across the central and south-eastern North Sea, indicated that in spring there were higher density areas in the southern and south-eastern part of the North Sea (with an estimated density of 0-0.8 individuals per km^2 in the vicinity of DEP and SEP). In summer, there was an apparent shift, compared to spring, toward offshore and western areas (with an estimated density of 0.81-2.5 individuals per km^2 in the vicinity of DEP and SEP). In autumn, there were lower densities compared to spring and summer, and the distribution was spatially heterogeneous (with an estimated density of 0.41-1.50 individuals per km^2 in the vicinity of DEP and SEP; Gilles *et al.,* (2016).

43. Distribution and abundance maps were developed by Waggitt *et al.* (2020) for cetacean species around Europe. For harbour porpoise, the distribution maps show a clear pattern of high harbour porpoise density in the southern North Sea, and the coasts of south-east England, for both January and July (**Plate 12-0-2**; Waggitt *et al*., 2020). Interrogation of this data[3], including all 10km 'grids' that overlap with the specified area, reveals an average annual density estimate of:

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

- 0.565 individuals per km^2 (average of all overlapping 10km ‘grids’) for the SEP Site;
- 0.546 individuals per km^2 (average of all overlapping 10km ‘grids’) for the DEP Site; and
- 0.558 individuals per km^2 (average of all overlapping 10km ‘grids’) for SEP, DEP, and all export cables.

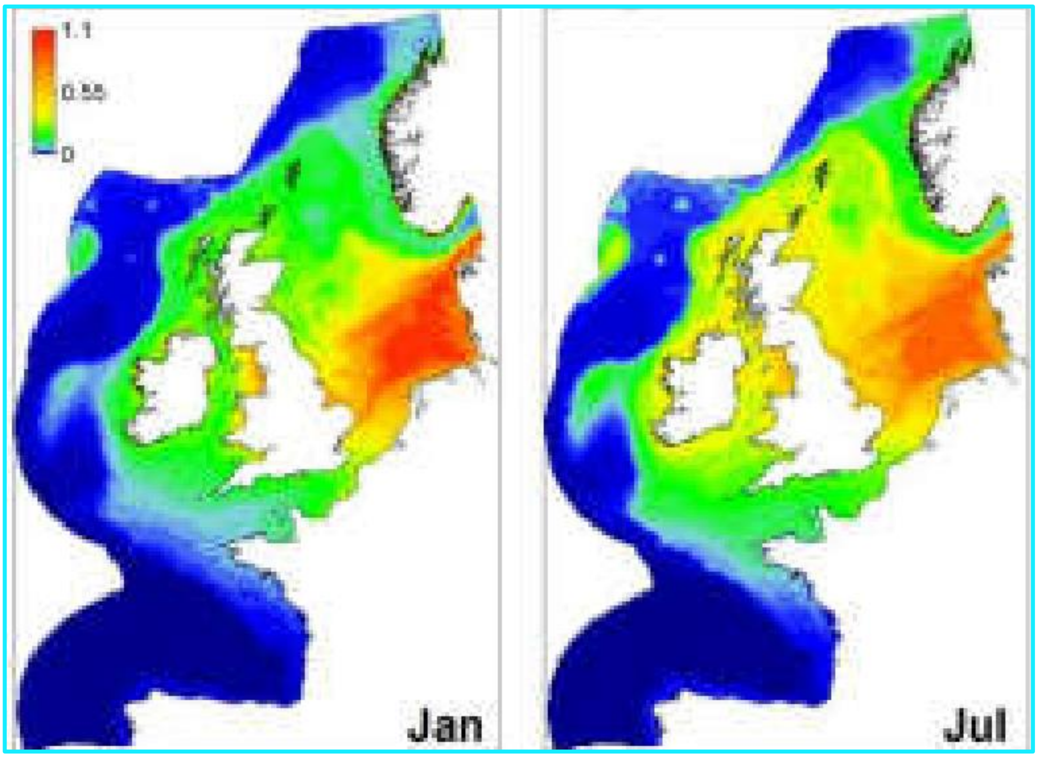


Plate 12-0-2: Spatial variation in predicted densities (individuals per km of harbour porpoise in January and July in the North-East Atlantic). Values are provided at 10 km resolution. Source: Waggitt et al., 2020.

12.1.6.1.2 Site-Specific Surveys

44. Data from the DEP and SEP site specific surveys were used to generate abundance and density estimates for the sites with a 4km buffer.

45. As noted above, harbour porpoise was the most commonly sighted marine mammal species during the surveys, with a total of 442 individuals recorded through the 29 survey dates.

Density Estimates for Harbour Porpoise

46. Density estimates have been calculated from the raw data counts for (i) harbour porpoise; (ii) cetacean species, and (iii) seal / small cetacean. These have also been corrected for availability bias. Individuals from the two species groupings listed above are assumed to all be harbour porpoise as a worst-case, and are considered together within the density and abundance estimates as set out below. These abundance and densities are for the entire survey area, plus 4km buffer (i.e. they relevant for both DEP and SEP).
47. Correction factors were then be applied to the density estimates to account for the presence of individuals below 2m water depth (the depth at which it is no longer possible to detect marine mammals from aerial imagery).
48. The correction factors used for harbour porpoise are detailed in **Section 12.1.5** above. These are based on Teilmann *et al.* (2013), with different correction factors applied for different months, times of day, and for whether individuals would be at the surface or within the top 2m of the water column. More general correction factors have been applied to the species groups that have the potential to be harbour porpoise, and are set out below.
49. Voet *et al.* (2017) have determined seasonal correction factors for harbour porpoise that can be used to determine abundance and density estimates obtained from aerial digital surveys (**Table 12-4**). These seasonal correction factors are based on published dive profile data from harbour porpoise tagged in the North Sea. The Teilmann *et al.* (2013) tagging study indicated significant differences in the percentage of time that each harbour porpoise spent between 0 and 2m water depth with the time of year. Spring and summer had a higher average time spent between 0 and 2m compared autumn and winter. Therefore, to take this into account, Teilmann *et al.* (2013) suggest that aerial survey data should be corrected for time submerged as well as for seasonal effects.
50. The seasonal correction factors in **Table 12-4** has been used to generate harbour porpoise site specific density estimates for the DEP and SEP sites and 4km buffer.

Table 12-4 Harbour porpoise seasonal correction factors

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

51. Site specific density estimates for harbour porpoise have then been calculated, based on the density estimate (with availability bias) for harbour porpoise and for the density estimates with correction factors as set out in **Table 12-4** for the other species groups that could be harbour porpoise (i.e. cetaceans, and seals / small cetaceans). Different densities have been calculated for the winter (October to March) and summer (April to September) to account for the difference in abundance.

52. The maximum density of each month was taken for each of the species groups, and corrected for availability. The average of the winter months, summer months, and annual density has then been calculated based on the maximum calculated for each month. **Table 12-5** shows the density estimates for harbour porpoise only, and **Table 12-6** shows the densities when the two other species groups are included (i.e. all individuals that have the potential to be harbour porpoise).

Table 12-5: Maximum harbour porpoise density estimate calculated for each month, corrected for availability bias, with summer, winter and annual density estimate for whole survey area, DEP plus 4km buffer, and SEP plus 4km buffer (note that the whole survey area covers a larger area than for DEP and SEP (plus 4km buffers) combined)

Month	Maximum density estimate (corrected) for whole survey area	Maximum density estimate (corrected) for DEP + 4km buffer*	Maximum density estimate (corrected) for SEP + 4km buffer
January	0.11	0.13	0.000
February	0.98	1.63	1.140
March	0.31	0.72	0.179
April	0.69	2.41	0.552
May	1.19	2.88	0.173
June	1.07	1.50	1.063
July	1.52	3.55	1.117
August	1.00	2.08	0.489
September	0.73	1.85	0.231
October	0.94	1.73	0.863
November	0.34	0.48	0.718
December	0.13	0.15	0.000

Month	Maximum density estimate (corrected) for whole survey area	Maximum density estimate (corrected) for DEP + 4km buffer*	Maximum density estimate (corrected) for SEP + 4km buffer
Average winter	**0.47**	**0.81**	**0.48**
Average summer	**1.03**	**2.38**	**0.60**
Average annual	**0.75**	**1.59**	**0.54**

** does not include the species grouping 'cetacean' as no density estimate available.*

Table 12-6: Maximum harbour porpoise density estimate (including cetaceans and seal / small cetacean species groups) calculated for each month, corrected for availability bias, with summer, winter and annual density estimate for whole survey area, DEP Site plus 4km buffer, and SEP Site plus 4km buffer (note that the whole survey area covers a larger area than for DEP Site and SEP Site (plus 4km buffers) combined)

Month	Maximum density estimate (corrected) for whole survey area	Maximum density estimate (corrected) for DEP Site+ 4km buffer*	Maximum density estimate (corrected) for SEP Site + 4km buffer*
January	0.19	0.30	0.064
February	1.30	1.71	1.140
March	0.45	0.72	0.179
April	1.15	2.41	0.552
May	1.65	2.98	0.225
June	1.51	1.54	1.063
July	2.05	3.59	1.172
August	1.37	2.15	0.489
September	1.02	1.90	0.297
October	1.27	1.73	0.863
November	0.47	0.48	0.784

Month	Maximum density estimate (corrected) for whole survey area	Maximum density estimate (corrected) for DEP Site+ 4km buffer*	Maximum density estimate (corrected) for SEP Site + 4km buffer*
December	0.21	0.15	0.064
Average winter	**0.65**	**0.85**	**0.52**
Average summer	**1.46**	**2.43**	**0.63**
Average annual	**1.05**	**1.64**	**0.57**

** does not include the species grouping 'cetacean' as no density estimate available.*

Abundance Estimates for Harbour Porpoise

53. The abundance estimates of harbour porpoise at DEP and SEP have been derived and estimates have been corrected in the same way as the density estimates above. All species groupings that have the potential to be harbour porpoise are included (i.e. harbour porpoise have been corrected, the species groups cetaceans and seals / small cetaceans have been corrected as shown in **Table 12-6** above).

54. These abundance estimates are shown in **Table 12-7**. As shown in **Plate 12-3**, and mentioned above, there is a clear seasonal pattern in the abundance of harbour porpoise within the entire survey area, with higher numbers present in the summer months, including the species that may be harbour porpoise. After being corrected for availability bias, the highest abundance estimate for harbour porpoise was in July 2019, with 2,556 individuals, while the lowest abundance estimate was 75 in March 2020.

Table 12-7: Estimated abundance of harbour porpoise within whole survey area, corrected for availability bias

Month	Maximum abundance estimate (corrected) for harbour porpoise	Maximum abundance estimate (corrected) for harbour porpoise (including cetaceans and seal / small cetaceans)
22-May-18	790	1,160
18-Jun-18	655	948
02-Jul-18	846	1,213
06-Aug-18	1,264	1,743
12-Sep-18	927	1,252
09-Oct-18	1,205	1,601

Month	Maximum abundance estimate (corrected) for harbour porpoise	Maximum abundance estimate (corrected) for harbour porpoise (including cetaceans and seal / small cetaceans)
14-Nov-18	479	655
04-Dec-18	136	204
19-Jan-19	119	163
14-Feb-19	1,257	1,660
05-Mar-19	415	574
04-Apr-19	176	248
26-Apr-19	1,368	1,927
10-May-19	1,521	2,064
24-May-19	1,131	1,534
15-Jun-19	1,347	1,824
20-Jun-19	971	1,393
03-Jul-19	1,912	2,556
17-Jul-19	1,804	2,387
08-Aug-19	577	780
22-Aug-19	1,054	1,403
18-Sep-19	357	476
03-Oct-19	673	893
13-Nov-19	349	811
03-Dec-19	65	86
10-Jan-20	119	479
08-Feb-20	140	693

Month	Maximum abundance estimate (corrected) for harbour porpoise	Maximum abundance estimate (corrected) for harbour porpoise (including cetaceans and seal / small cetaceans)
06-Mar-20	56	75
03-Apr-20	861	1,211

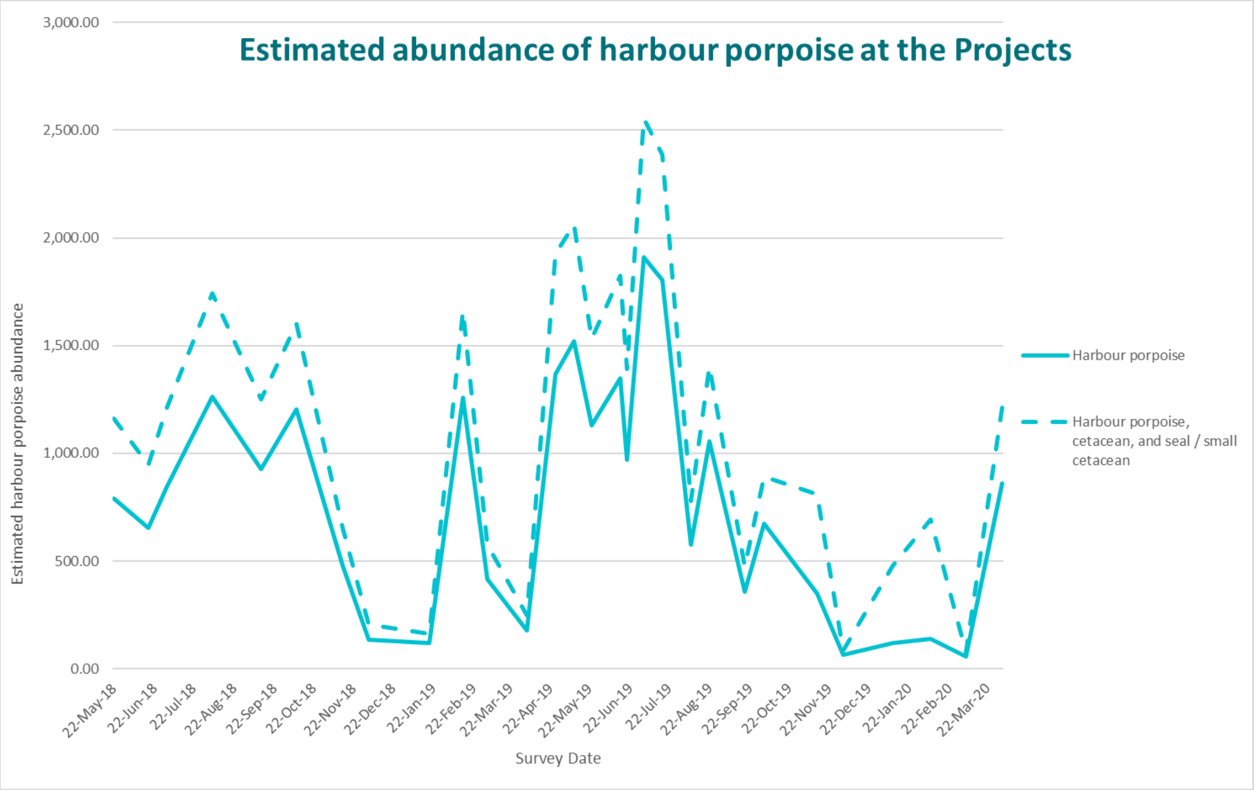


Plate 12-3: Estimated abundance of harbour porpoise within whole survey area, corrected for availability bias

Harbour Porpoise Distribution Patterns within DEP and SEP

55. The distribution of harbour porpoise within DEP and SEP varied, with individuals present across the survey area (both DEP and SEP, with a 4km buffer), including within the existing Dudgeon and Sheringham Shoal offshore wind farms. There is no evident pattern of harbour porpoise distribution within the survey area, with no indication of a particular area of importance. See **Annex 1** – Site Specific Harbour Porpoise Density Mapsfor harbour porpoise monthly density maps.

12.1.6.1.3 Abundance and Density Estimates for Harbour Porpoise

56. A series of large scale surveys for cetaceans in European Atlantic waters was initiated in summer 1994, in the North Sea and adjacent waters (SCANS, 1995; Hammond *et al.,* 2002) and continued in summer 2005 in all shelf waters (SCANS-II 2008; Hammond *et al.,* 2013). Despite no overall change in population size between the SCANS-I and SCANS-II surveys, large scale changes in the distribution of harbour porpoise were observed between 1994 and 2005, with the main concentration shifting from north eastern UK and Denmark to the southern North Sea. Such large-scale changes in the distribution of harbour porpoise are likely the result of changes to the availability of principal prey within the North Sea (SCANS-II, 2008).

57. Results from the SCANS-III survey (the most recent available; undertaken in summer 2016; Hammond *et al.,* 2017) also indicate that the occurrence of harbour porpoise is greater in the central and southern areas of the North Sea compared to the northern North Sea.

58. Within the impact assessments for harbour porpoise, and in addition to the site specific density estimates for harbour porpoise, density estimates from the SCANS-III surveys (Hammond *et al.*, 2017) will also be used to provide context for the wider area. The DEP and SEP sites are both in SCANS-III survey blocks O:

- Abundance = 53,485 harbour porpoise (CV = 0.21; 95% CI = 37,413-81,695)
- Density = 0.888 harbour porpoise/km^2 (CV=0.21)

59. Harbour porpoise within the eastern North Atlantic are generally considered to be part of a continuous biological population that extends from the French coastline of the Bay of Biscay to northern Norway and Iceland (Tolley and Rosel, 2006; Fontaine *et al.*, 2007, 2014; IAMMWG, 2015). However, for conservation and management purposes, it is necessary to consider this population within smaller MUs. MUs provide an indication of the spatial scales at which effects of plans and projects alone, and in-combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK (IAMMWG, 2015).

60. IAMMWG defined three MUs for harbour porpoise: North Sea (NS); West Scotland (WS); and the Celtic and Irish Sea (CIS). DEP and SEP are located in the NS MU.

61. The SCANS-III estimate of harbour porpoise abundance in the North Sea MU is 345,373 (CV = 0.18; 95%; CI = 246,526-495,752) with a density estimate of 0.52/km^2 (CV = 0.18; Hammond *et al.,* 2017). This is the reference population for harbour porpoise, of which any potential impacts will be assessed against, as agreed as part of the marine mammal Expert Topic Group (ETG) (see **Section 12.2** of **Chapter 12 Marine Mammal Ecology**) at the meeting on 3rd December 2019.

12.1.6.1.4 Diet

62. The distribution and occurrence of harbour porpoise, as well as other marine mammal species is most likely to be related the availability and distribution of their prey species. For example, sandeels (Ammodytidae species), which are known prey for harbour porpoise, exhibit a strong association with key surface sediments (Gilles *et al.,* 2016; Clarke *et al.,* 1998).

63. Harbour porpoise are generalist feeders, and their diet reflects available prey in an area. Therefore, their diet varies geographically, seasonally and annually, reflecting changes in available food resources and differences in diet between sexes or age classes may also exist. The diet of the harbour porpoise consists of a wide variety of fish, including pelagic schooling fish, as well as demersal and benthic species, especially Gadoids, Clupeids and sandeels (Berrow and Rogan 1995; Kastelein *et al.,* 1997; Börjesson *et al.,* 2003; Santos and Pierce 2003; Santos *et al.,* 2004).
64. Harbour porpoise tend to concentrate their movements in small focal regions (Johnston *et al.,* 2005), which often approximate to particular topographic and oceanographic features and are associated with prey aggregations (Raum-Suryan and Harvey 1998; Johnston *et al.,* 2005; Keiper *et al.,* 2005; Tynan *et al.,* 2005). Consequently, habitat use is highly correlated with prey density rather than any particular habitat type.
65. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet its daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al*., 1997).

12.1.6.2 Bottlenose Dolphin

12.1.6.2.1 Distribution

66. Throughout its range, the bottlenose dolphin occurs in a diverse range of habitats, from shallow estuaries and bays, coastal waters, continental shelf edge and deep open offshore ocean waters. However, it is primarily an inshore species, with most sightings within 10km of land, but they can also occur offshore, often in association with other cetaceans[4].
67. In coastal waters, bottlenose dolphin are often associated with river estuaries, headlands or sandbanks, where there is uneven bottom relief and/or strong tidal currents (e.g. Lewis and Evans, 1993; Wilson *et al.,* 1997; Liret *et al.,* 1998; Liret, 2001; Ingram and Rogan 2002; Reid *et al.,* 2003).
68. A resident population of bottlenose dolphin is present in the Moray Firth, with an estimated 209 individuals (95% CI 198 – 230; Arso Civil *et al*., 2019) which are known to travel south along the Aberdeenshire coast. Historically, very few sightings of bottlenose dolphin were recorded further south on the east coast of the UK, however, in recent years an increase in bottlenose dolphins in the north-east of England have been reported (Aynsley, 2017), with one individual from the Moray Firth population being recorded as far south as The Netherlands.
69. Bottlenose dolphin sightings were made year-round along the north-east England coast (between 2013 and 2016; Aynsley, 2017), suggesting that there is no seasonal pattern to the increase in recent sightings numbers. A total of 48 of the individuals sighted within this period on the north-east coast were attributed to being part of the Moray Firth population using photo-identification. A total of 11 calves were also sighted, indicating that bottlenose dolphin in this area of coastline are reproductively active.

[4] https://sac.jncc.gov.uk/species/S1349/

70. The results of the JCP Phase III Report (Paxton *et al.*, 2016) identified that for bottlenose dolphin, densities are low across much of UK waters, with higher densities off the west coast of Wales, and within the Moray Firth. The density of bottlenose dolphin within the southern North Sea (and near to both DEP and SEP) is low, with less than 0.1 individuals per km^2 (97.5% CI 0-0.1 – 0-0.1 per km^2) (Paxton *et al.*, 2016).

71. The SCANS -III survey shows a similar distribution pattern, with no bottlenose dolphin identified within the southern North Sea survey block L or the more northerly block O, and higher densities with block R, for the east coast of Scotland (Hammond *et al.*, 2017).

72. For bottlenose dolphin, the distribution maps (developed by Waggitt *et al.,* 2020) show a clear pattern of higher density to the western coastal areas of the UK, extending south to the Bay of Biscay (**Plate 12-4***Plate 12-6*; Waggitt *et al*., 2020). Densities of bottlenose dolphin in the North Sea are very low in comparison. The distribution maps also indicate a 'corridor' of increased bottlenose dolphin density travelling from west of Scotland, southwards around the west coast of the Northern Ireland and the Republic of Ireland, and through the centre of the Bay of Biscay. Interrogation of this data[5], including all 10km 'grids' that overlap with the specified area, reveals an average annual density estimate of:

- 0.0001 individuals per km^2 (average of all overlapping 10km 'grids') for the SEP Site;
- 0.00015 individuals per km^2 (average of all overlapping 10km 'grids') for the DEP Site; and
- 0.00013 individuals per km^2 (average of all overlapping 10km 'grids') for SEP, DEP, and all export cables.

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

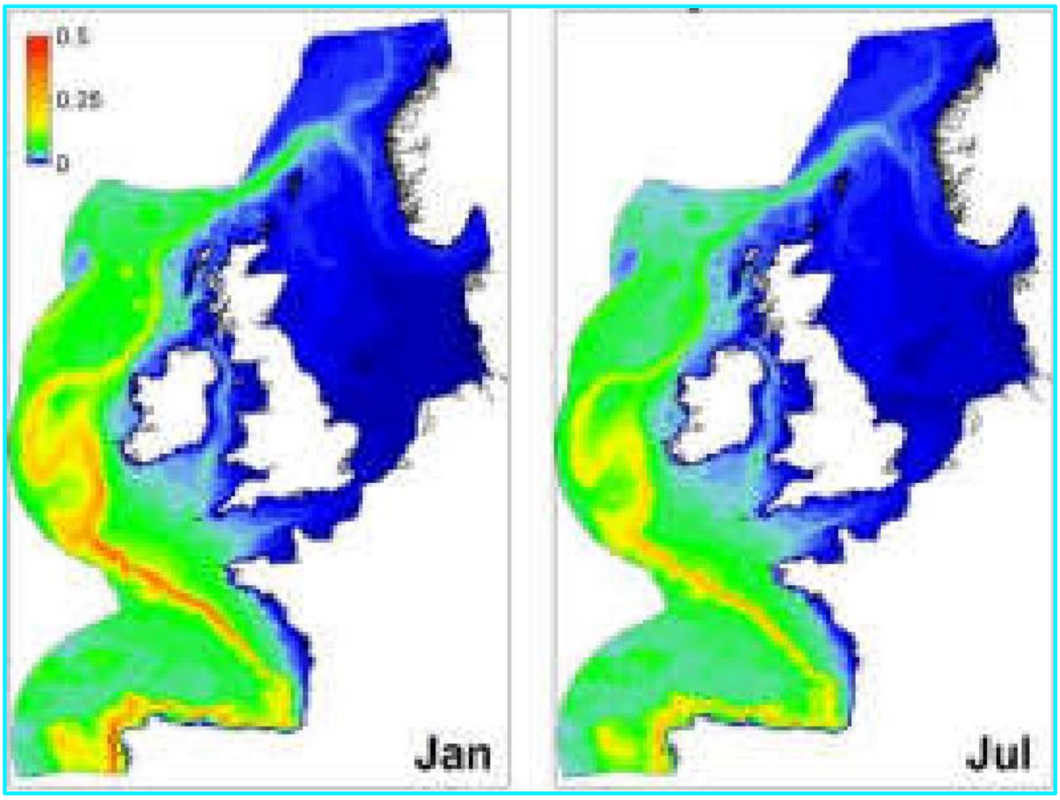


Plate 12-4: Spatial variation in predicted densities (individuals per km of bottlenose dolphin in January and July in the North-East Atlantic). Values are provided at 10 km resolution. Source: Waggitt et al., 2020.

12.1.6.2.2 Site Specific Surveys

73. During the site specific aerial surveys of both DEP and SEP, undertaken from May 2018 to April 2020, no bottlenose dolphin were recorded. However, a number of sightings were recorded as seal / small cetacean species, or cetacean species, some of which could have been bottlenose dolphin.

12.1.6.2.3 Abundance and Density Estimates for Bottlenose Dolphin

74. As sightings of bottlenose dolphin have been increasingly reported along the north-east coast of England, they have also been included in the assessment. For the entire SCANS-III survey area, bottlenose dolphin abundance in the summer of 2016 was estimated to be 19,201, with an overall estimated density of 0.0016/km^2 (CV = 0.24; 95% CI = 11,404-29,670; Hammond *et al.*, 2017).

75. There is currently no density estimate for bottlenose dolphin in and around DEP or SEP, therefore, the number of bottlenose dolphins that could be impacted has been based on the SCANS-III density estimates for the adjacent survey block R, which covers the Moray Firth area, of which includes the same bottlenose dolphin population as had recently been recorded off the east coast of England.

76. Therefore, within the impact assessments for bottlenose dolphin, density estimates from the SCANS-III surveys will be used for block R (Hammond *et al*., 2017):

- Abundance = 1,924 bottlenose dolphin (CV=0.86; 95% CI=0-5,048)
- Density = 0.03 bottlenose dolphin/km^2 (CV=0.86; 95%)

77. As for the density estimate, there is currently no reference population estimate for bottlenose dolphin for the Greater North Sea MU, of which sits DEP and SEP, the reference population for SCANS-III survey block R of 1,924 individuals (Hammond *et al*., 2017). In addition, the assessments are out into context of the Coastal East Scotland (CES) MU; with a population estimate for the bottlenose dolphin of 195 (95% CI = 162 - 253; IAMMWG, 2015).

12.1.6.2.4 Diet

78. Bottlenose dolphin are opportunistic feeders and take a wide variety of fish and invertebrate species. Benthic and pelagic fish (both solitary and schooling species), including haddock *Melanogrammus aeglefinus*, saithe *Pollachius virens*, pollock *Pollachius pollachius*, cod *adus morhua*, whiting *Merlangius merlangus*, hake *Merluccius merluccius*, blue whiting *Micromesistius poutassou*, bass *Dicentrarchus labrax*, mullet *Mugilidae*, mackerel *Scombridae*, salmon *Salmo salar*, sea trout *Salmo trutta trutta*, flounder *Platichthys flesus*, sprat *Sprattus sprattus* and sandeels, as well as octopus and other cephalopods have all been recorded in the diet of bottlenose dolphin (Santos *et al.,* 2001; Santos *et al.,* 2004; Reid *et al.,* 2003).

79. Diet analysis suggests that bottlenose dolphin are selective opportunists and although they may have preference for a type of prey, their diet seems to be determined largely by prey availability. Research in Australia has shown that when presented with a choice, they will preferentially feed on certain types of prey, particularly those with a high fat content (Corkeron *et al.,* 1990).

80. Analysis of the stomach contents of ten bottlenose dolphin in Scottish waters, from 1990 to 1999, reveals that the main prey are cod (29.6% by weight), saithe (23.6% by weight), and whiting (23.4% by weight), although other species including salmon (5.8% by weight), haddock (5.4% by weight) and cephalopods (2.5% by weight) were also identified in lower number (Santos *et al*., 2001).

12.1.6.3 White-beaked Dolphin

12.1.6.3.1 Distribution

81. White-beaked dolphin are widely distributed within the central North Sea, however, very few sightings are recorded along the east coast of England or south of the Humber Estuary, with a small number of sightings in offshore waters within the shallow waters near the North Norfolk Sandbanks and Dogger Bank areas (Gilles *et al.*, 2012; DECC, 2016). The occurrence of white-beaked dolphin in the southern North Sea is relatively low (Reid *et al.*, 2003; Hammond *et al.*, 2013; 2017).

82. A review of the strandings data of white-beaked dolphin in the North Sea were collated and assessed by ASCOBANS (IJsseldijk *et al*., 2018) in order to determine temporal and spatial trends in the distributions of white-beaked dolphin in the south-western North Sea. Strandings data used within the review were from Belgium, Germany, the Netherlands and the UK, from 1991 to 2017. This review indicates that there has been a reduction in the abundance of white-beaked dolphin in the south-east coasts of the UK, with an increase in the north-east area (IJsseldijk *et al*., 2018).

83. Data on the distribution of marine mammals in UK areas of the North Sea have been collected opportunistically during aerial surveys for birds conducted by Wildfowl and Wetlands Trust (WWT) Consulting from 2001-2008 (WWT, 2009). A number of unknown dolphin species were also recorded, with local clusters present north-east off Flamborough Head. White-beaked dolphin were also recorded in small numbers in the north-east, again off Flamborough Head (WWT, 2009).

84. Marine mammal sightings made at oil and gas installations in the central North Sea through the Danish offshore marine mammal sightings reporting programme from 2013 to 2016 (sightings are incidental reportings from staff at oil and gas platforms, which are located approximately 200km from the west coast of Denmark) indicate that white-beaked dolphin are one of the less common species sighted in the far offshore areas (Delefosse *et al*., 2018).

85. The results of the JCP Phase III Report (Paxton *et al.*, 2016) identified that for white-beaked dolphin, densities are low across much of UK waters, with higher densities shown to be in the Hebrides and the northern North Sea. The density of white-beaked dolphin within the southern North Sea (and near to both DEP and SEP) is low, with less than 0.1 individuals per km^2 (97.5% CI 0-0.1 – 0-0.2 per km^2) (Paxton *et al.*, 2016).

86. The SCANS-III survey shows a similar distribution pattern, with no white-beaked dolphin identified within the southern North Sea survey block L, and low but increasing densities with the more northerly North Sea survey blocks (blocks O and R) (Hammond *et al.*, 2017).

87. For white-beaked dolphin, the distribution maps (developed by Waggitt *et al.,* 2020) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, with decreasing densities southwards of Scotland along the east coast of England. There is also a clear seasonal difference in the densities of white-beaked dolphin, with higher densities in July, particularly to the north of their range (**Plate 12-5**; Waggitt *et al*., 2020). DEP and SEP are located to the very southern end of the area with relatively higher densities, and there appears to be no significant different in their seasonal distributions within this area. Interrogation of this data[6], including all 10km 'grids' that overlap with the specified area, reveals an average annual density estimate of:

- 0.0055 individuals per km^2 (average of all overlapping 10km 'grids') for the SEP Site;

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

- 0.0075 individuals per km² (average of all overlapping 10km 'grids') for the DEP Site; and
- 0.0058 individuals per km² (average of all overlapping 10km 'grids') for SEP, DEP, and all export cables.

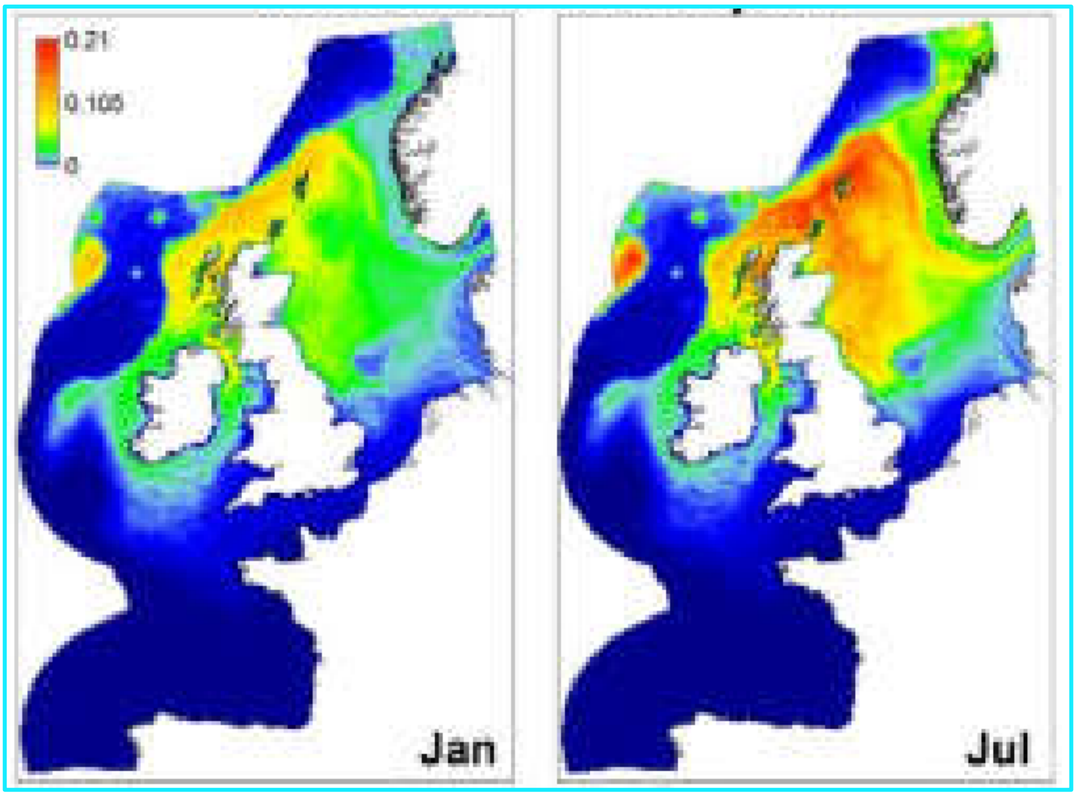


Plate 12-5: Spatial variation in predicted densities (individuals per km of white-beaked dolphin in January and July in the North-East Atlantic). Values are provided at 10 km resolution. Source: Waggitt et al., 2020.

12.1.6.3.2 Site Specific Surveys

88. During the site specific aerial surveys of both DEP and SEP, undertaken from May 2018 to April 2020, no white-beaked dolphin were recorded. However, a number of sightings were recorded as seal / small cetacean species, or cetacean species, some of which could have been white-beaked dolphin.

12.1.6.3.3 Abundance and Density Estimates for White Beaked Dolphin

89. For the entire SCANS-III survey area, white-beaked dolphin abundance in the summer of 2016 was estimated to be 36,287 with an overall estimated density of 0.030/km² (CV = 0.29; 95% CI = 18,694-61,869; Hammond *et al.*, 2017). DEP and SEP are located in SCANS-III survey block O (Hammond *et al*., 2017):
    - Abundance = 143 white-beaked dolphin (CV=0.97; 95% CI= 0-490)
    - Density = 0.002 white-beaked dolphin/km² (CV=0.97)

90. Within the impact assessments for white-beaked dolphin, the worse-case density estimates for the Project areas will be used. For white-beaked dolphin the highest density estimate was from the distribution maps developed by Waggitt *et al.* (2020), with a project wide (for both DEP and SEP) density estimate of 0.006 individuals per km^2.

91. Scientific evidence supports the assumption that white-beaked dolphin from around the British Isles and North Sea represent one population, with movement between Scottish waters and the Danish North Sea and Skagerrak (Banguera-Hinestroza *et al.*, 2010; IAMMWG, 2015).

92. The single MU for white-beaked dolphin, the Celtic and Greater North Seas MU, comprises all UK waters and extends to the seaward boundary used by the European Commission for Habitats Directive reporting (area known as Marine Atlantic, termed MATL) (IAMMWG, 2015). However, it is worth noting that this species usually occurs on the continental shelf (Reid *et al.*, 2003; IAMMWG, 2015). The UK EEZ white-beaked dolphin abundance is 11,694 (CV = 0.30; 95% CI = 6,578-20,790), which are derived from the SCANS-II abundance estimate for continental shelf waters (Hammond *et al.*, 2013).

93. The reference population for white-beaked dolphin in the Celtic and Greater North Sea MU is 15,895 animals (CV=0.29; 95% CI=9,107-27,743; IAMMWG, 2015). This is the reference population for white-beaked dolphin, of which any potential impacts will be assessed against, as agreed as part of the marine mammal ETG (see **Section 12.2** of **Chapter 12 Marine Mammals**) at the meeting on 3rd December 2019.

12.1.6.3.4 Diet

94. Analysis of the stomach contents of white-beaked dolphin have shown that the species feed on a wide range of fish and squid species, including cod, whiting, and hake (Kinze *et al.,* 1997; Reeves *et al.,* 1999). White-beaked dolphin have also been observed to associate with herring *Clupea harengus* (Harmer, 1927; Fraser, 1946; Evans, 1980) and mackeral (Evans *et al.*, 1987) shoals, and anecdotal evidence from fisherman in Scotland suggests that individuals seen inshore may coincide with mackerel appearing in the same areas (Canning *et al*., 2008).

95. Dietary analysis for 22 white-beaked dolphin stranded around the UK coast between 1992 and 2003 (Canning *et al*., 2008) found that while a wide variety of prey species were identified, the majority of prey were from a much smaller number of species. Haddock and whiting were the most predominantly found, representing 43% and 24% respectively of the total reconstructed weight, cod represented a further 11% of the total reconstructed weight.

12.1.6.4 Minke Whale

12.1.6.4.1 Distribution

96. Minke whales are widely distributed along the Atlantic seaboard of Britain and Ireland and throughout the North Sea. The JNCC Cetacean Atlas (Reid *et al.*, 2003), indicates that minke whale occur regularly in the North Sea to the north of Humberside, but are comparatively scarce in the southern North Sea. Animals are present throughout the year, but most sightings are between May and September (Reid *et al.*, 2003). DECC (2016) support this, stating that sightings rarely extend past Dogger Bank, but that occasional sightings of minke whale are made as far south as Flamborough Head and the north Humberside coastlines between July and October (DECC, 2016).

97. Higher densities of minke whale have been recorded along the margins of Dogger Bank and adjacent areas in spring and summer (de Boer, 2010; Gilles *et al.*, 2012; Hammond *et al.*, 2013). Few sightings of minke whale have been made further south of these areas and it is thought that they probably enter the North Sea from the north (DECC, 2016). Minke whales appear to move into the North Sea at the beginning of May and are present throughout the summer until October (Northridge *et al.*, 1995).

98. The JCP Phase III Report (Paxton *et al.*, 2016) identified a total of 1,860 minke whale sightings within the UK offshore area. The density of minke whale was predicted to be highest along the northern coast of the UK, from Yorkshire north to the Kintyre Peninsula. The resultant density maps produced in the JCP Phase III Report (Paxton *et al.*, 2016) show a minke whale density of less than 0.04 per km^2 for the southern North Sea (97.5% CI 0-0.02 – 0.08 per km^2) below the Humber Estuary and Flamborough Head.

99. For minke whale, the distribution maps (developed by Waggitt *et al.,* 2020) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, Ireland and within the CIS, with decreasing densities southwards of Scotland along the east coast of England. There is a clear seasonal difference in the densities of minke whale, with higher densities in July, which is particularly evident in the north of their range (**Plate 12-6**; Waggitt *et al*., 2020). In addition, the distribution maps indicate a ‘corridor’ of increased minke whale density travelling from north of Orkney, around the north and west coasts of the UK to Northern Ireland. DEP and SEP are located to the very southern end of the area with relatively higher densities, and there appears to be no significant different in their seasonal distributions within this area. Interrogation of this data[7], including all 10km ‘grids’ that overlap with the specified area, reveals an average annual density estimate of:

- 0.002 individuals per km^2 (average of all overlapping 10km ‘grids’) for the SEP Site;
- 0.0025 individuals per km^2 (average of all overlapping 10km ‘grids’) for the DEP Site; and
- 0.0022 individuals per km^2 (average of all overlapping 10km ‘grids’) for SEP, DEP, and all export cables.

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

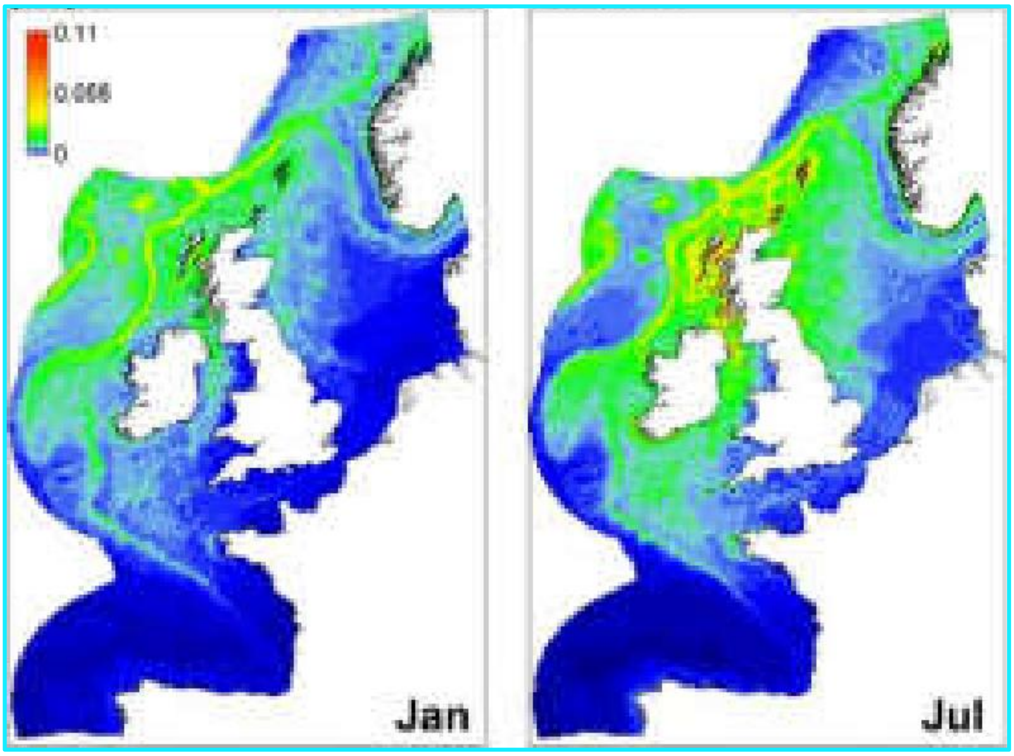


Plate 12-6: Spatial variation in predicted densities (individuals per km of minke whale in January and July in the North-East Atlantic). Values are provided at 10 km resolution. Source: Waggitt et al., 2020.

12.1.6.4.2 Site Specific Surveys

100. During the DEP and SEP site specific aerial surveys (29 surveys undertaken between May 2018 and April 2020), a single minke whale was positively identified in July 2018 just north of DEP, resulting in a relative density estimate of 0.01 individuals per km^2. This is the same density estimate as for the SCANS-III survey (see below).

12.1.6.4.3 Abundance and Density Estimates for Minke Whale

101. For the entire SCANS-III survey area, minke whale abundance in the summer of 2016 was estimated to be 14,759 with an overall estimated density of 0.0008/km^2 (CV = 0.327; 95% CI = 7,908-27,544; Hammond *et al.*, 2017).

102. Within the impact assessments for minke whale, density estimates from the SCANS-III surveys will be used. DEP and SEP are located in SCANS-III survey block O (Hammond *et al*., 2017):

- Abundance = 603 minke whale (CV=0.62; 95% CI=109-1,670)
- Density = 0.01 minke whale/km^2 (CV=0.62; 95%)

103. Genetic evidence suggests that the minke whales of the North Atlantic are likely to be a single genetic population (Anderwald *et al.*, 2012). Therefore, IAMMWG (2015) considers a single MU is appropriate for minke whales in European waters.

104. The single MU for minke is the Celtic and Greater North Seas MU, covering the same geographical area as described for white-beaked dolphin in **Section 12.1.6.2.4** (IAMMWG, 2015). The reference population for minke whales in the Celtic and Greater North Seas MU is 23,528 animals (CV = 0.27; 95% CI = 13,989-39,572; IAMMWG, 2015). This estimate was derived from SCANS-II (Hammond *et al.*, 2013) and CODA (Macleod *et al.*, 2009) and is likely to be underestimated. The IAMMWG (2015) note the abundance of minke whales is highly seasonal, with abundance peaking during migration south into waters around the UK for summer.

12.1.6.4.4 Diet

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

106. A study into the diet of minke whale in the north-eastern Atlantic sampled a total of 210 minke whale forestomach contents from 2000 to 2004, with a total of 37 minke whale samples analysed within the northern North Sea. Within this area, minke whale were found to prey upon a number of different species at the population level, however, 84% of individuals were found to prey upon only one species. Sandeels (56% of total prey by biomass) and mackerel (30% of total prey by biomass) were found to be the most dominant prey species for minke whale in the northern North Sea (Windsland *et al.,* 2007).

12.1.6.5 Grey Seal

12.1.6.5.1 Distribution

107. Grey seals only occur in the North Atlantic, Barents and Baltic Sea with their main concentrations on the east coast of Canada and United States of America and in north-west Europe (SCOS, 2019).

108. Approximately 34% of the worlds grey seals breed in the UK, and 88% of these breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. There are also breeding colonies in Shetland, on the north and east coasts of mainland Britain and in south-west England and Wales (SCOS, 2019).

109. Grey seals are wide ranging and can breed and forage in different areas (Russell *et al.,* 2013). For example, tags deployed on grey seals at Donna Nook and Blakeney Point in May 2015, indicated that they used multiple haul-outs sites; with one hauling out in the Netherlands and one in Northern France (Russell, 2016). **Plate 12-7** shows the tagged seal movements along the east coast of England, and indicates that grey seal travel between haul-out sites along the east coast of England, as well as to the north of France, Firth of Forth and Dogger Bank, and travel through both DEP and SEP (Russell, 2016).

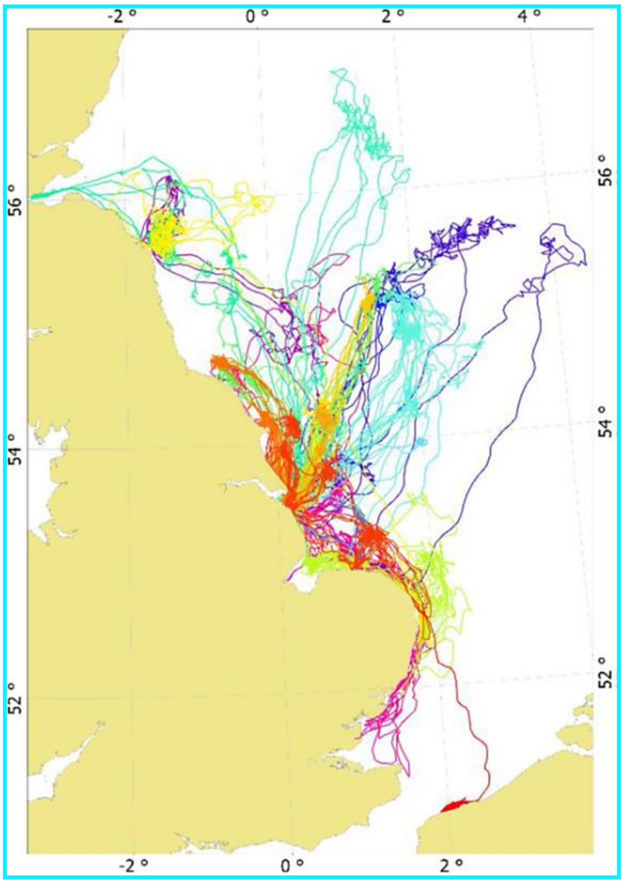


Plate 12-7: Tagged grey seal movements along the East coast of England (Russell, 2016).

110. The north Dutch coastline is also an important foraging zone and migration route for grey seal (Brasseur *et al.,* 2010). A study on the grey seal population in the Dutch part of the Wadden Sea shows that the growth of the breeding population is fuelled by the annual immigration of grey seals from the UK, indicating connectivity with the Wadden Sea area (Brasseur *et al.,* 2018).

111. This is shown through further telemetry tagging studies of grey seals, undertaken from key haul-out sites along the north coast of France (for tagged individuals from 2012; Vincent *et al*., 2017). The results of this tagging study show connectivity of grey seals from the east coast of England, to the north coasts of France, Belgium, and the Netherlands, including the Wadden Sea (**Plate 12-8**).

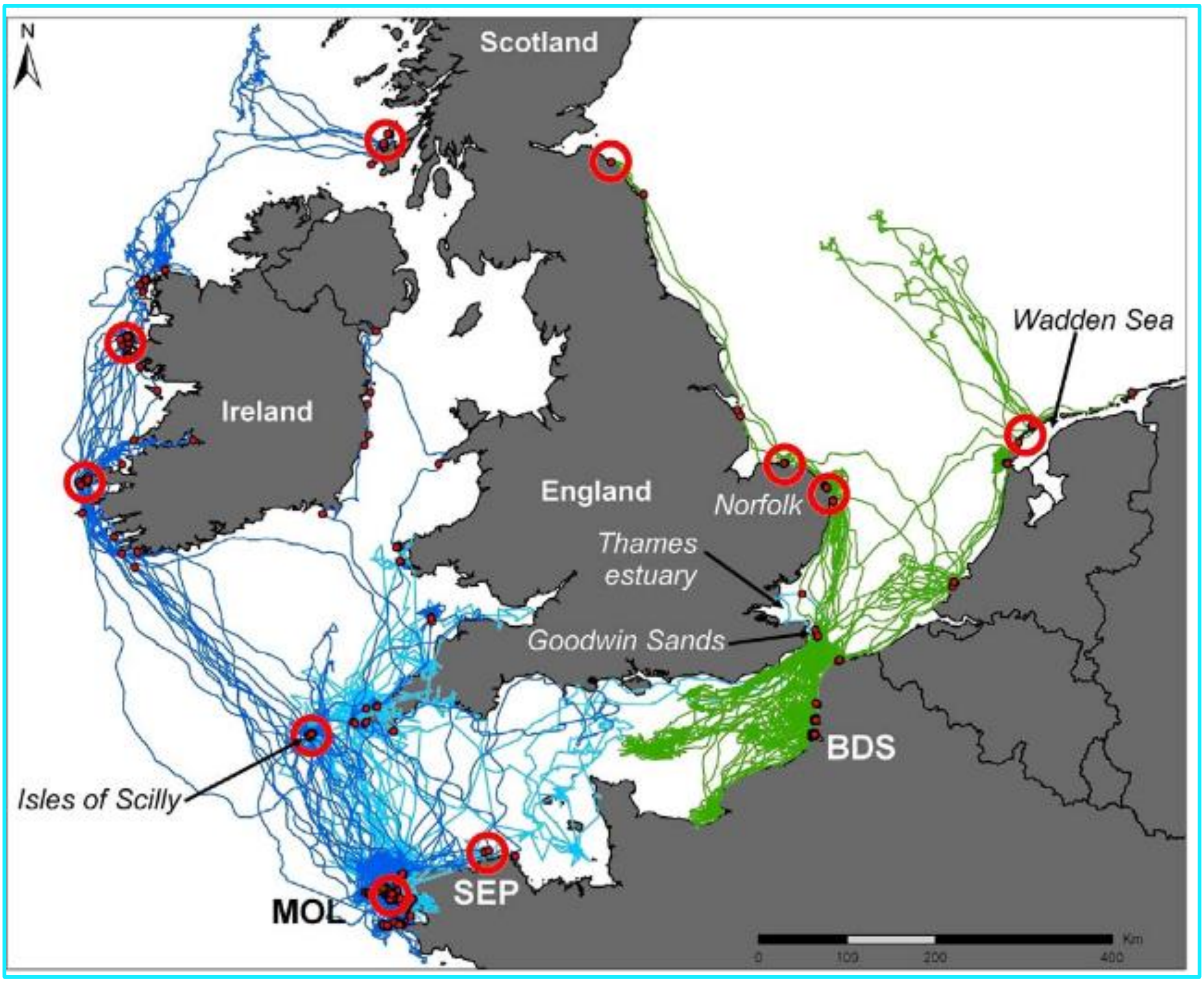


Plate 12-8: Grey seal telemetry tags (shown in green are the results from the tagging of 11 individuals in 2012, from the baie de Somme (BDS) haul-out site on the north coast of France. Red dots indicate haul-out sites, and red circles indicate breeding locations. Source: Vincent et al. (2017).

112. There is a considerable amount of movement of grey seals that occurs (as observed from telemetry data) among the different areas and regional subunits of the North Sea, and no evidence to suggest that grey seals on the North Sea coasts of Denmark, Germany, the Netherlands or France are independent from those in the UK (SCOS 2019).

12.1.6.5.2 Haul-Out Sites

113. Compared with other times of the year, grey seals in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season (SCOS, 2019).

114. In eastern England, pupping occurs mainly between early November and mid December (SCOS, 2019). Pups are typically weaned 17 to 23 days after birth, when they moult their white natal coat, and then remain on the breeding colony for up to two or three weeks before going to sea. Mating occurs at the end of lactation and then adult females depart to sea and provide no further parental care (SCOS, 2019).

115. DEP and SEP is located approximately 13.6km offshore (at the closest point). Principal grey seal haul-out sites are included in **Table 12-8**, which shows the approximate distance to the closest point of DEP and SEP, and the most recent grey seal count for each location.

Table 12-8: The most recent grey seal count at each of the nearby haul-out sites, and the distance to DEP and SEP

Haul-out site	Distance to DEP and SEP	Grey seal count
Blakeney PointNational Nature Reserve (NNR)	12km from landfall 12km from export cable corridor 38km from DEP 22km from SEP	360 (2018 grey seal count; SCOS, 2019)
Horsey Corner	44km from landfall 44km from the export cable corridor 50km from DEP 50km from SEP	1,698 adults recorded at any one time; 2,069 pups born over the 2018-2019 season (Friends of Horsey Seals, 2019)
The Wash	58km from landfall 58km from export cable corridor 75km from DEP 57km from SEP	253 (2018 grey seal count; SCOS, 2019)
Scroby Sands	59km from landfall 58km from the export cable corridor 64km from DEP 64km from SEP	497 (2018 grey seal count; SCOS, 2019)
Donna Nook	59km from landfall 58km from the export cable corridor 64km from DEP 64km from SEP	6,288 (2018 grey seal count; SCOS, 2019)

12.1.6.5.3 Site-Specific Surveys

116. As noted above, a relatively low number of grey seal were recorded during the site-specific aerial surveys, with a total of 31 individuals recorded through the 29 survey dates, however, in addition a total of 198 unidentified seal species were recorded, as well as 36 seal / small cetacean species, a proportion of which are expected to be grey seal.

117. With the exception of a large spike in unidentified seal sightings in July 2019 (with a total of 62 over two survey days), numbers of grey seal, or individuals that could be grey seal (i.e. seal species and seal / small cetacean species) were relatively similar year-round, with small spikes in sightings number, but no clear change seasonally.

Density Estimates for Grey Seal

118. Due to the low number of grey seal sightings, absolute density and abundance estimates were not possible to derive. However, relative density and abundance estimates were calculated (see **Section 12.1.5** for more information on how these have been calculated). These have been provided in order to provide site-specific information on the number of grey seal expected to be present at DEP and SEP, however, impact assessments will be based on absolute densities as derived from desk-based sources (see **Section 12.1.6.5.4** below).

119. Relative density estimates have been calculated from the raw data counts for (i) grey seal; (ii) seal species, and (iii) seal / small cetacean species. These have also been corrected for availability bias. Individuals from the two species groupings listed above are assumed to all be grey seal as a worst-case, and are considered together within the density and abundance estimates as set out below. These abundance and densities are for the entire survey area, plus 4km buffer (i.e. they relevant for both DEP and SEP).

120. Correction factors were then be applied to the relative density estimates to account for the presence of individuals below 2m water depth (the depth at which it is no longer possible to detect marine mammals from aerial imagery).

121. For grey and harbour seal, the Sea Mammal Research Unit (SMRU) used tagging studies of 44 grey seals (1997) and 17 harbour seals (2003-2004) in the Pentland Firth and Orkney (SMRU, 2011). For grey seal, data collected from 22,012 dives found an average of 27.09% time spent at the waters surface. This did not account for the time that the seals would be just below the water's surface and so would still be detectable in aerial surveys. Therefore, the correction factor for grey seal is 0.27.

122. This seasonal correction factors (of 0.27) has been used to generate grey seal relative density and abundance estimates for the DEP and SEP sites and 4km buffer.

123. Relative density estimates for grey seal have then been calculated, based on the density estimate (with correction factor applied) for grey seal and for the other species groups that could be grey seal (i.e. seal species, and seals / small cetacean species).

124. The maximum density of each month was taken for each of the species groups, and corrected for availability. The average of the annual density has then been calculated based on the maximum calculated for each month. **Table 12-9** shows the density estimates for grey seal only, and **Table12-10** shows the densities when the two other species groups are included (i.e. all individuals that have the potential to be grey seal).

Table 12-9: Maximum grey seal relative density estimates calculated for each month, corrected for availability bias, with annual density estimate for whole survey area, DEP plus 4km buffer, and SEP plus 4km buffer (note that the whole survey area covers a larger area than for DEP and SEP (plus 4km buffers) combined)

Month	Maximum density estimate (corrected) for whole survey area	Maximum density estimate (corrected) for DEP + 4km buffer	Maximum density estimate (corrected) for SEP + 4km buffer
January	0.074	0.380	0.170
February	0.037	0.074	-
March	0.074	-	0.223
April	0.037	0.124	-
May	0.074	0.307	-
June	0.148	0.745	0.531
July	0.074	0.314	0.861
August	0.037	-	0.319
September	0.074	-	0.222
October	0.074	0.161	-
November	0.037	0.074	0.074
December	0.074	0.153	0.111
Average annual	**0.068**	**0.259**	**0.314**

Table12-10: Maximum grey seal relative density estimates (including seal species and seal / small cetacean species groups) calculated for each month, corrected for availability bias, with annual density estimate for whole survey area, DEP plus 4km buffer, and SEP plus 4km buffer (note that the whole survey area covers a larger area than for DEP and SEP (plus 4km buffers) combined)

Month	Maximum density estimate (corrected) for whole survey area	Maximum density estimate (corrected) for DEP + 4km buffer	Maximum density estimate (corrected) for SEP + 4km buffer
January	0.481	0.972	0.392
February	0.333	0.370	0.222
March	0.333	0.074	0.631
April	0.333	0.420	0.222
May	0.444	0.825	0.222
June	0.778	1.337	0.865
July	1.444	1.425	1.713
August	0.481	0.444	0.541
September	0.222	0.222	0.333
October	0.407	0.235	0.222
November	0.185	0.074	0.407
December	0.222	0.227	0.444
Average annual	**0.472**	**0.552**	**0.518**

Abundance Estimates for Grey Seal

125. In addition to the density estimates as described above, abundance estimates of grey seal at DEP and SEP have been derived. These abundance estimates have been corrected in the same way as the density estimates above, and all species groupings that have the potential to be grey seal are included (i.e. grey seal have been corrected as stated above).

126. These abundance estimates are shown in **Table 12-11** and **Plate 12-9**. As shown in **Plate 12-9**, and outlined above, there is no clear seasonal pattern in the abundance of grey seal within the entire survey area, with the exception of a peak in grey seal sightings in July 2019, with an estimate of 1,700 individuals, predominantly formed of sightings within the grouping ‘seal species’.

Table 12-11: Estimated abundance of grey seal within the survey area, corrected for availability bias

Month	Maximum abundance estimate (corrected) for grey seal	Maximum abundance estimate (corrected) for grey seal (including seal species and seal / small cetacean species)
22-May-18	78	411
18-Jun-18	0	374
02-Jul-18	0	189
06-Aug-18	37	596
12-Sep-18	78	193
09-Oct-18	74	489
14-Nov-18	41	189
04-Dec-18	0	115
19-Jan-19	74	411
14-Feb-19	37	407
05-Mar-19	0	300
04-Apr-19	37	148
26-Apr-19	0	370
10-May-19	0	111
24-May-19	0	296
15-Jun-19	37	519
20-Jun-19	185	893
03-Jul-19	41	933

Month	Maximum abundance estimate (corrected) for grey seal	Maximum abundance estimate (corrected) for grey seal (including seal species and seal / small cetacean species)
17-Jul-19	111	1,700
08-Aug-19	37	374
22-Aug-19	0	152
18-Sep-19	0	200
03-Oct-19	41	300
13-Nov-19	37	226
03-Dec-19	111	259
10-Jan-20	0	226
08-Feb-20	0	230
06-Mar-20	41	300
03-Apr-20	78	374

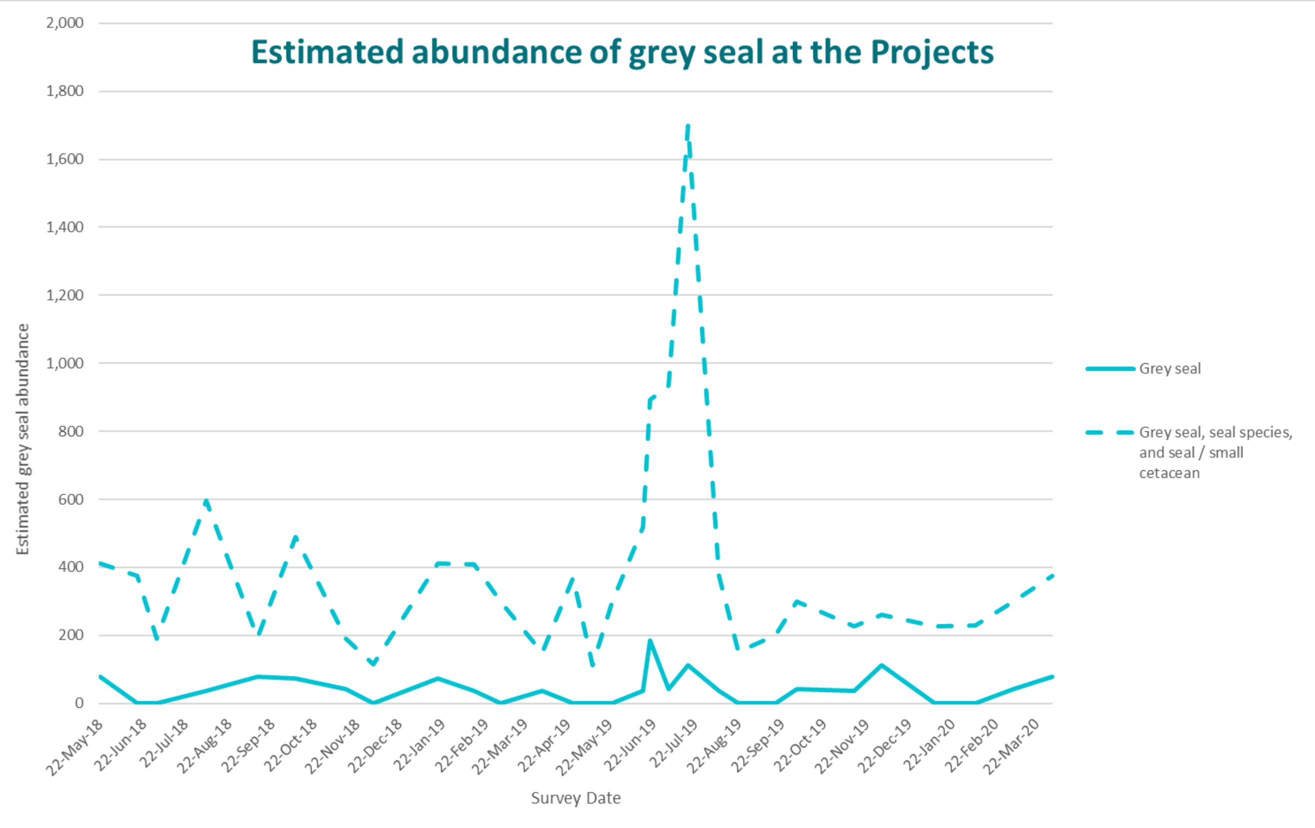


Plate 12-9: Estimated abundance of grey seal within the survey area, corrected for availability bias

12.1.6.5.4 Abundance and Density Estimates for Grey Seal

Seal Density Maps

127. The latest seal at sea maps (Russell *et al.,* 2017), were produced by SMRU by combining information about the movement patterns of electronically tagged seals with survey counts of seals at haul-out sites. The resulting maps show estimates of mean seal usage (seals per 5km x 5km grid cell) around the UK coastline.

128. The grey seal density estimates for DEP and SEP have been calculated from the 5km x 5km cells (Russell *et al.,* 2017) based on the 5km x 5km grids that overlap with each project area. The upper at-sea density estimates for these areas have been used in the assessment, as the worst-case;

- 0.47 individuals per km^2 for the SEP Site;
- 0.09 individuals per km^2 for the DEP Site; and
- 0.35 individuals per km^2 for SEP, DEP, and all export cables.

Grey Seal Population Counts

129. Grey seal population trends are assessed from the counts of pups born during the autumn breeding season, when females congregate on land to give birth (SCOS, 2019). The pup production estimates are converted to estimates of total population size (1+ aged population) using a mathematical model and projected forward (SCOS, 2019).

130. The most recent surveys of the principal grey seal breeding sites Scotland, Wales, Northern Ireland and south-west England, resulted in an estimate of 65,400 pups (95% CI = 58,200-72,200; SCOS 2018). When the pup production estimates are converted to estimates of total population size, there was an estimated 152,800 grey seals in 2018 (approximate 95% CI = 135,300-173,800; SCOS, 2019).

131. The estimated adult UK grey seal population size in regularly monitored colonies in 2018 was 137,200 (95% CI = 121,500-156,100), based on 2016 pup production and projecting the model forward. This is an increase of approximately 1.8% per year between 2012 and 2017 (SCOS, 2019).

132. In the southern North Sea, the rates of increase in pup production from 2010 to 2014 by an average 22% per year) suggests that there must be some immigration from colonies further north (SCOS 2016). The colonies in the southern North Sea are still increasing in population size, but the rate has been much lower in the last three years, giving an early indication that they may be reaching carrying capacity (SCOS, 2019).

133. The most recent counts of grey seal in the August surveys 2015-2018, estimated that the minimum count of grey seals in the UK was 42,997 (SCOS, 2019).

134. Coordinated aerial, boat and land surveys of the Dutch, German and Danish Wadden Sea grey seal areas including Helgoland (Germany) are aimed at estimating changes in numbers of grey seal in the Wadden Sea area. Annual surveys are conducted in the Wadden Sea, during the moult and breeding season by the Trilateral Seal Expert Group (TSEG). The most recent TSEG counts for adult grey seals were conducted by aerial surveys during the moulting period in the spring 2020. Studies show that in moult period, the animals present are not necessarily animals breeding in the Wadden Sea and considerable exchange occurs with the much larger UK population (Brasseur *et al.,* 2015; 2017). In total, the number of grey seal recorded in the Wadden Sea area has been steadily increasing, with a mean annual 9% increase over the past five years, with the most recent count of grey seal in 2020 being of 7,649, with 1,726 pups counted in the previous pupping season (winter 2019) (Brasseur *et al.,* 2020).

135. In accordance with the agreed approach for other offshore wind farms, and as agreed during the 2nd ETG meeting on the 18th June 2020, the reference population extent for grey seal will incorporate the south-east England MU, north-east England MU (IAMMWG, 2013; SCOS, 2019) and the Waddenzee population (Brauseur *et al.*, 2020).

136. The reference population for grey seal is therefore currently based on the following most recent estimates for the:

- South-east England MU = 8,199 grey seal (SCOS, 2019);
- North-east England MU = 6,502 grey seal (SCOS, 2019); and
- Waddenzee population = 9,375 grey seal (adults and pups; Brauseur *et al.*, 2020).

137. The total reference population for the assessment is therefore 24,076 grey seal.

138. Assessments will be done in the context of the nearest MU as well as the wider reference population. As a worst-case it is assumed that all seals are from the nearest MU, the south-east England MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals.

139. It is acknowledged that the UK grey seal counts are based on surveys conducted in August and the Wadden Sea region is based on counts in winter / spring (and is not a population estimate). When the pup production estimates from autumn counts are converted to estimates of total population size, there was an estimated 152,800 grey seals in 2018 (approximate 95% CI = 135,300-173,800; SCOS, 2019). The most recent counts of grey seal in the August surveys 2015-2018, estimated that the minimum count of grey seals in the UK was 42,997 (SCOS, 2019). Therefore, using the August grey seal counts for the reference population is a precautionary approach and is likely to be an underestimate of the number of grey seals in the UK MUs.

140. It is also acknowledged that the counts for the Wadden Sea region are not corrected for seals in the water and are therefore an indication of the minimum estimates of the number of seals in the area and not actual population counts.

12.1.6.5.5 Diet and Foraging

141. Grey seals will typically forage in the open sea and return regularly to land to haul-out, although they may frequently travel up to 100km between haul-out sites. Foraging trips generally occur within 100km of their haul-out sites, although grey seal can travel up to several hundred kilometres offshore to forage (SCOS, 2019). Grey seal generally travel between known foraging areas and back to the same haul-out site, but will occasionally move to a new site. For example, movements have been recorded between haul-out sites on the east coast of England and the Outer Hebrides (SCOS, 2019).

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

143. Grey seals are generalist feeders, feeding on a wide variety of prey species (SCOS, 2019; Hammond and Grellier, 2006). Diet varies seasonally and from region to region (SCOS, 2019).

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

145. Food requirements depend on the size of the seal and fat content (oiliness) of the prey, but an average consumption estimate of an adult is 4 to 7kg per seal per day depending on the prey species (SCOS, 2019).

12.1.6.6 Harbour Seal

12.1.6.6.1 Distribution

146. Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one subspecies *Phoca vitulina vitulina* (SCOS, 2019).

147. On the east coast of Britain harbour seal distribution is generally restricted, with concentrations in the major estuaries of the Thames, The Wash and the Moray Firth (SCOS, 2019).

148. SMRU, in collaboration with others, has deployed around 344 telemetry tags on harbour seals around the UK between 2001 and 2012. The spatial distributions indicate harbour seals persist in discrete regional populations, display heterogeneous usage, and generally stay within 50km of the coast (Russell and McConnell, 2014). Tagged harbour seals were observed to have a more coastal distribution than grey seals and do not travel as far from haul-outs (**Plate 0-10**; Russell and McConnell, 2014).

149. Harbour seals generally make smaller foraging trips than grey seal, typically travelling 40-50km from their haul-out sites to foraging areas (SCOS, 2019). Tracking studies have shown that harbour seals travel 50-100km offshore and can travel 200km between haul-out sites (Lowry *et al.,* 2001; Sharples *et al.,* 2012). The range of these trips varies depending on the location and surrounding marine habitat. Tagging studies undertaken on harbour seal at The Wash (2003-2005) have shown that this population travels larger distances for their foraging trips than for other harbour seal populations and repeatedly forage between 75km and 120km offshore (average was 80km), with one seal travelling 220km (Sharples *et al.,* 2012). The typical and average foraging range for harbour seal is 50-80km (SCOS, 2017).

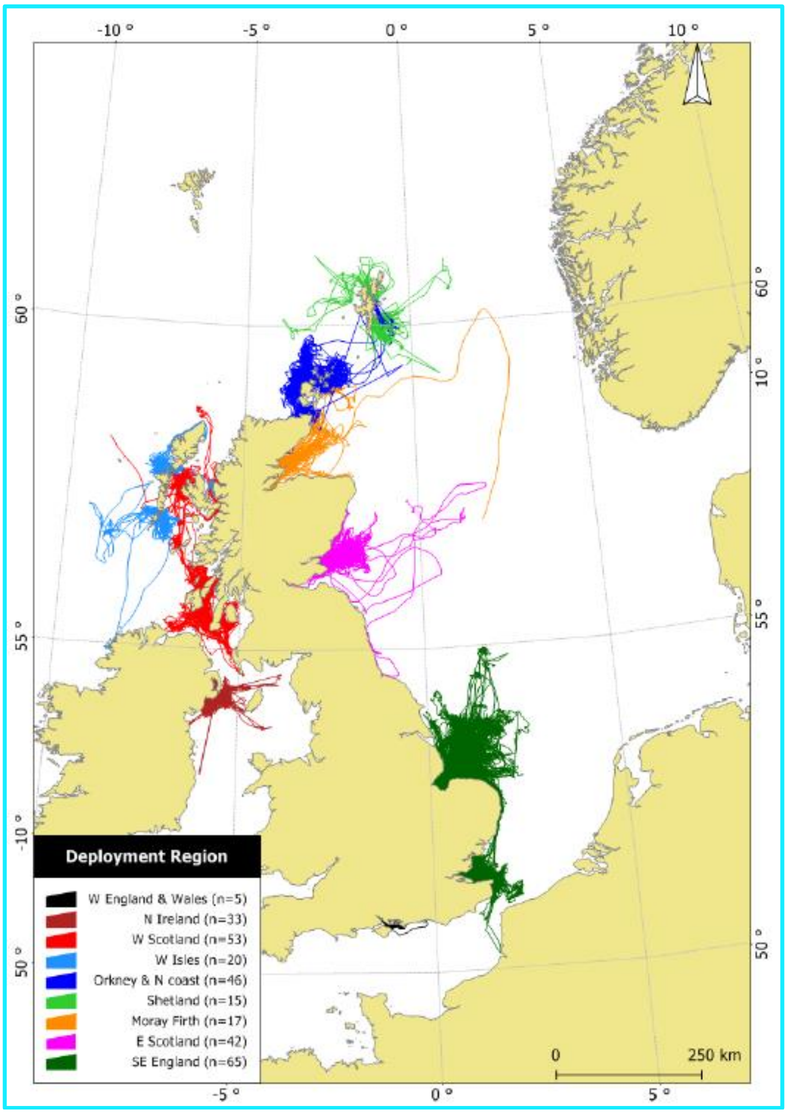


Plate 0-10: Telemetry tracks by deployment region for harbour seals aged one year or over (Russell and McConnell, 2014).

12.1.6.6.2 Haul-Out Sites

150. Harbour seal come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. Harbour seal regularly haul-out on land in a pattern that is often related to the tidal cycle (SCOS, 2019). Harbour seal give birth to their pups in June and July and pups can swim almost immediately after birth (SCOS, 2019). Harbour seals moult in August and spend a higher proportion of their time on land during the moult than at other times (SCOS, 2019).

151. DEP and SEP is located approximately 13.6km offshore (at the closest point). Principal harbour seal haul-out sites are included in **Table 12-12** below, which shows the approximate distance to the closest point of DEP and SEP, and the most recent harbour seal count for each location. These harbour seal haul-out sites are also shown on **Plate 0-10**.

Table 12-12: The most recent harbour seal count at each of the nearby haul-out sites, and the distance to DEP and SEP

Haul-out site	Distance to DEP and SEP	Harbour seal count
Blakeney Point NNR	12km from landfall 12km from export cable corridor 38km from DEP 22km from SEP	218 (2018 harbour seal count; SCOS, 2019)
The Wash	58km from landfall 58km from export cable corridor 75km from DEP 57km from SEP	3,632 (2018 harbour seal count; SCOS, 2019)
Scroby Sands	59km from landfall 58km from the export cable corridor 64km from DEP 64km from SEP	210 (2018 harbour seal count; SCOS, 2019)
Donna Nook	87km from landfall 86km from export cable corridor 68km from DEP 66km from SEP	146 (2018 harbour seal count; SCOS, 2019)

12.1.6.6.3 Site-Specific Surveys

152. As noted above, a relatively low number of harbour seal were recorded during the site-specific aerial surveys, with a total of 21 individuals recorded through the 29 survey dates, however, in addition a total of 198 unidentified seal species were recorded, as well as 36 seal / small cetacean species, a proportion of which are expected to be harbour seal.

153. With the exception of a large spike in unidentified seal sightings in June and July 2019 (with a total of 85 over four survey days), and elevated numbers of harbour seal in August and October 2018, the number of individuals that could be harbour seal (i.e. seal species and seal / small cetacean species) were relatively similar year-round, with small spikes in sightings number, with an indication of an increase in the summer periods.

Density Estimates for Harbour Seal

154. Due to the low number of harbour seal sightings, absolute density and abundance estimates were not possible to derive. However, relative density and abundance estimates were calculated (see **Section 12.1.5** for more information on how these have been calculated). These have been provided in order to provide site-specific information on the number of harbour seal expected to be present at DEP and SEP, however, impact assessments will be based on absolute densities as derived from desk-based sources (see **Section 12.1.6.6.4** below).

155. Relative density estimates have been calculated from the raw data counts for (i) harbour seal; (ii) seal species, and (iii) seal / small cetacean species. These have also been corrected for availability bias. Individuals from the two species groupings listed above are assumed to all be harbour seal as a worst-case, and are considered together within the density and abundance estimates as set out below. These abundance and densities are for the entire survey area, plus 4km buffer (i.e. they relevant for both DEP and SEP).

156. Correction factors were then be applied to the relative density estimates to account for the presence of individuals below 2m water depth (the depth at which it is no longer possible to detect marine mammals from aerial imagery).

157. As described above, SMRU used tagging studies of 44 grey seals (1997) and 17 harbour seals (2003-2004) in the Pentland Firth and Orkney (SMRU, 2012). For harbour seal, data collected from 44,156 dives found an average of 18.32% if time spent at the water's surface. This did not account for the time that the seals would be just below the water's surface and so would still be detectable in aerial surveys. Therefore, the correction factor for harbour seal is 0.18.

158. This seasonal correction factors (of 0.18) has been used to generate harbour seal relative density and abundance estimates for the DEP and SEP sites and 4km buffer.

159. Relative density estimates for harbour seal have then been calculated, based on the density estimate (with correction factor applied) for harbour seal and for the other species groups that could be harbour seal (i.e. seal species, and seals / small cetacean species).

160. The maximum density of each month was taken for each of the species groups, and corrected for availability. The average of the annual density has then been calculated based on the maximum calculated for each month. **Table 12-13** shows the density estimates for harbour seal only, and **Table 12-14** shows the densities when the two other species groups are included (i.e. all individuals that have the potential to be harbour seal). Note that relative densities could not be derived for all months, due to the low number of harbour seal sightings.

Table 12-13: Maximum harbour seal relative density estimates calculated for each month, corrected for availability bias, with annual density estimate for whole survey area, DEP plus 4km buffer, and SEP plus 4km buffer (note that the whole survey area covers a larger area than for DEP and SEP (plus 4km buffers) combined)

Month	Maximum density estimate (corrected) for whole survey area	Maximum density estimate (corrected) for DEP + 4km buffer	Maximum density estimate (corrected) for SEP + 4km buffer
January	0.11	-	0.239
February	-	-	-
March	-	-	-
April	0.11	0.186	-
May	-	-	-
June	0.11	-	-
July	0.11	0.887	0.813
August	0.22	0.898	-
September	-	-	-
October	0.28	-	0.500
November	-	-	-
December	-	-	-
Average annual	**0.016**	**0.657**	**0.517**

Table 12-14: Maximum harbour seal relative density estimates (including seal species and seal / small cetacean species groups) calculated for each month, corrected for availability bias, with annual density estimate for whole survey area, DEP plus 4km buffer, and SEP plus 4km buffer (note that the whole survey area covers a larger area than for DEP and SEP (plus 4km buffers) combined)

Month	Maximum density estimate (corrected) for whole survey area	Maximum density estimate (corrected) for DEP + 4km buffer	Maximum density estimate (corrected) for SEP + 4km buffer
January	0.519	0.889	0.572
February	0.296	0.444	0.333
March	0.259	0.111	0.611
April	0.407	0.631	0.333
May	0.370	0.778	0.333
June	0.741	0.889	0.500
July	1.481	2.554	2.091
August	0.667	1.564	0.333
September	0.148	0.333	0.167
October	0.611	0.111	0.833
November	0.148		0.500
December	0.148	0.111	0.500
Average annual	**0.483**	**0.765**	**0.592**

Abundance Estimates for Harbour Seal

161. In addition to the density estimates as described above, abundance estimates of harbour seal at DEP and SEP have been derived. These abundance estimates have been corrected in the same way as the density estimates above, and all species groupings that have the potential to be harbour seal are included (i.e. harbour seal have been corrected as stated above).

162. These abundance estimates are shown in **Table 12-15** and **Plate 12-11** below. As shown in **Plate 12-11**, and mentioned above, there is an indication of increased sightings in the summer periods, with a peak in sightings in July 2019, with an estimate of 2,342 individuals, predominantly formed of sightings within the grouping 'seal species'. Elevated abundance estimates are also seen for August and October 2018, with estimated relative abundances of 1,104 and 951 respectively, and in June and July 2019, with estimates of 1,044 and 1,484 respectively.

Table 12-15: Estimated abundance of harbour seal at DEP and SEP, corrected for availability bias, at DEP and SEP

Month	Maximum abundance estimate (corrected) for harbour seal	Maximum abundance estimate (corrected) for harbour seal (including seal species and seal / small cetacean species)
22-May-18	0	496
18-Jun-18	0	555
02-Jul-18	0	282
06-Aug-18	278	1,104
12-Sep-18	0	170
09-Oct-18	339	951
14-Nov-18	0	219
04-Dec-18	0	170
19-Jan-19	117	613
14-Feb-19	0	551
05-Mar-19	0	443
04-Apr-19	117	280
26-Apr-19	0	546
10-May-19	0	164
24-May-19	0	437
15-Jun-19	111	822
20-Jun-19	0	1,044

Month	Maximum abundance estimate (corrected) for harbour seal	Maximum abundance estimate (corrected) for harbour seal (including seal species and seal / small cetacean species)
03-Jul-19	167	1,484
17-Jul-19	0	2,342
08-Aug-19	0	498
22-Aug-19	0	224
18-Sep-19	0	296
03-Oct-19	56	438
13-Nov-19	0	279
03-Dec-19	0	218
10-Jan-20	0	338
08-Feb-20	0	339
06-Mar-20	0	382
03-Apr-20	0	437

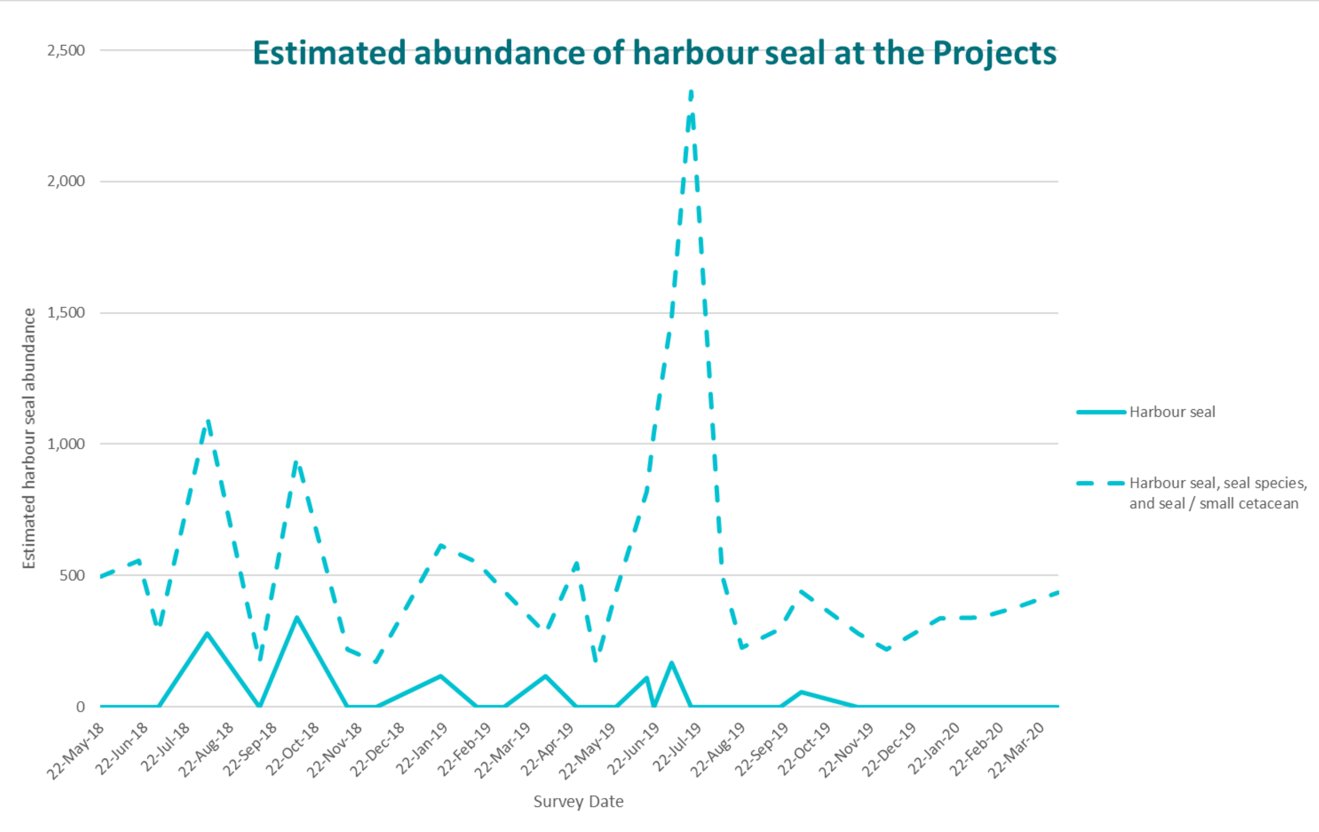


Plate 12-11: Estimated abundance of harbour seal at DEP and SEP, corrected for availability bias

12.1.6.6.4 Abundance and Density Estimates for Harbour Seal

Seal Density Maps

163. The harbour seal density estimates for DEP and SEP have been calculated from the latest seal at sea maps produced by SMRU (Russell *et al.,* 2017), based on the 5km x 5km grids that overlap with each project area. The upper at-sea density estimates for these areas have been used in the assessment, as the worst-case;

- 0.21 individuals per km^2 for the SEP Site;
- 0.24 individuals per km^2 for the DEP Site; and
- 0.19 individuals per km^2 for SEP, DEP, and all export cables.

Harbour Seal Population Counts

164. Harbour seal are counted while they are on land during their August moult, giving a minimum estimate of population size (SCOS, 2019). Combining the most recent counts (2015-2018) gives a total of 32,971 counted in the UK. Scaling this by the estimated proportion hauled out (0.72 (95% CI = 0.54-0.88)) produces an estimated total population for the UK in 2016 of 45,800 harbour seal (approximate 95% CI = 37,500-61,100; SCOS, 2019).

165. Recent trends in harbour seal populations (over the last ten years) indicate that the harbour seal populations in east coast of England are growing significantly. Between 2006 and 2012, the counts of harbour seal in The Wash doubled, and in East Anglia grew by 50%. Since 2012, the numbers of harbour seal in the region have been stable (SCOS, 2019).

166. The most recent TSEG counts for adult harbour seal seals were conducted by aerial surveys during the pupping period in June 2020, and during the moult in August 2020. In total, the number of harbour seal pups recorded in the Wadden Sea in 2020 was the highest since 2000, with a total of 9,954 pups, representing a 3% increase from the 2019 pup count. A total of 28,352 adult harbour seals were recorded during the moult, a small increase of 2% from 2019 count (Galatius *et al.,* 2020).

167. In accordance with the agreed approach for other offshore wind farms, and as agreed during the 2nd ETG meeting on the 18th June 2020, the reference population extent for harbour seal will incorporate the south-east England MU (IAMMWG, 2013; SCOS, 2019) and the Waddenzee population (Galatius *et al.,* 2020).

168. The reference population for harbour seal is therefore currently based on the following most recent estimates for the:

- South-east England MU = 4,961 harbour seal (SCOS, 2019); and
- Waddenzee population = 41,700 harbour seal (adults and pups; Galatius *et al.,* 2020).

169. The total reference population for the assessment is currently 46,661 harbour seal.

170. Assessments will be done in the context of the nearest MU as well as the wider reference population. As a worst-case it is assumed that all seals are from the nearest MU, the south-east England MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals.

12.1.6.6.5 Diet and Foraging

171. Harbour seal take a wide variety of prey including sandeels, gadoids, herring and sprat, flatfish and cephalopods. Diet varies seasonally and regionally, prey diversity and diet quality also showed some regional and seasonal variation (SCOS, 2019). It is estimated harbour seals eat 3-5 kg per adult seal per day depending on the prey species (SCOS, 2019).

172. The range of foraging trips varies depending on the surrounding marine habitat (e.g. 25km on the west of Scotland (Cunningham *et al.,* 2009); 30km-45km in the Moray Firth (Tollit *et al.,* 1998; Thompson and Miller 1990). However, data from The Wash (from 2003- 2005) suggest that harbour seal in this area travel further, and repeatedly forage between 75km and 120km offshore (with one seal travelling 220km; Sharples *et al.,* 2008). Telemetry studies indicate that the tracks of tagged harbour seals have a more coastal distribution than grey seals and do not travel as far from haul-outs.

12.1.7 References

Anderwald, P., Brandecker, A., Coleman, M., Collins, C., Denniston, H., Haberlin, M. D., Donovan, M., et al. 2012. 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. and 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, pp.178-196.

Aynsley, C.L. (2017) Bottlenose dolphins (*Tursiops truncatus*) in north-east England: A preliminary investigation into a population beyond the southern extreme of its range. MSc Thesis, Newcastle University.

Banguera-Hinestroza, E., Bjørge, A., Reid, R.J., Jepson, P. and Hoelzel, A.R., 2010. The influence of glacial epochs and habitat dependence on the diversity and phylogeography of a coastal dolphin species: Lagenorhynchus albirostris. Conservation Genetics, 11(5), pp.1823-1836.

Berrow, S.D. and Rogan, E. (1995). Stomach contents of harbour porpoises and dolphins in Irish waters. European Research on Cetaceans, 9, pp.179-181.

Börjesson, P., Berggren, P. and Ganning, B. (2003). Diet of harbour porpoises in the Kattegat and Skagerrak seas: accounting for individual variation and sample size. Marine Mammal Science, 19(1), pp.38-058.

Brasseur S. M. J. M. (2017) Seals in motion. PhD Thesis Wageningen, Wageningen University. http://edepot.wur.nl/418009

Brasseur, S., van Polanen Petel, T., Aarts, G., Meesters, E., Dijkman, E., and Reijnders, P., (2010). Grey seals (Halichoerus grypus) in the Dutch North Sea: population ecology and effects of wind farms. In: we@sea (Ed.), IMARES Report number C137/10. Available at: <http://www.we-at-sea.org/leden/docs/reports/RL2-2 2005-006 Effect of wind farms on grey seals in the Dutch North Sea.pdf>

Brasseur S., Cremer J., Czeck R., Galatius A., Jeß A., Körber P., Pund R., Siebert U.,Teilmann J. & Klöpper S. (2018) TSEG grey seal surveys in the Wadden Sea and Helgoland in 2017-2018. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Brasseur S., Carius F., Diederichs B., Galatius A., Jeß A., Körber P., Schop J., Siebert U., Teilmann J., Bie Thøstesen C. and Klöpper S. (2020). EG-Seals grey seal surveys in the Wadden Sea and Helgoland in 2019-2020. Common Wadden Sea Secretariat, Wilhelmshaven, Germany. https://www.waddensea-worldheritage.org/sites/default/files/2020_Greysealreport%202019-2020_0.pdf

Buckland, S. T., Anderson, D. R., Burnham, K. P. Laake, J. L. Borchers, D. L. & Thomas, L. (2001). Introduction to Distance Sampling. OUP, Oxford.

Canning, S.J., Santos, M.B., Reid, R.J., Evans, P.G., Sabin, R.C., Bailey, N. and Pierce, G.J., 2008. Seasonal distribution of white-beaked dolphins (Lagenorhynchus albirostris) in UK waters with new information on diet and habitat use. Marine

Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom, 88(6), p.1159.
Clarke, M.R., Santos, M.B. and Pierce, G.J. (1998). The importance of cephalopods in the diets of marine mammals and other top predators. ICES CM, 1000, p.8.
Corkeron, P.J., Bryden, M.M. and Hedstrom, K.E. (1990). Feeding by bottlenose dolphins in association with trawling operations in Moreton Bay, Australia. In The bottlenose dolphin (pp. 329-336). Academic Press.
Cunningham, L., Baxter, J.M., Boyd., I.L., Duck, C.D., Lonergan, M., Moss, S.E. and McConnell, B. (2009) 'Harbour seal movements and haul-out patterns: implications for monitoring and management'. Aquatic Conservation: Marine and Freshwater Ecosystems, 19 398-407.
DECC (now Department for Business, Energy and Industrial Strategy (BEIS)) (2016), UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3)
De Boer, M.N., 2010. Spring distribution and density of minke whale Balaenoptera acutorostrata along an offshore bank in the central North Sea. Marine Ecology Progress Series, 408, pp.265-274.
Delefosse, M., Rahbek, M.L., Roesen, L. and Clausen, K.T., (2018). Marine mammal sightings around oil and gas installations in the central North Sea. Journal of the Marine Biological Association of the United Kingdom, 98(5), pp.993-1001.
Dudgeon Offshore Wind Limited (DOWL) (2009) Dudgeon Offshore Wind Farm Environmental Statement.
EC (2008). 56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). OJEC L, 164, p.40.
Evans P.G.H. (1980) Cetaceans in British waters. Mammal Review 10, 1–52.
Evans P.G.H., Anderwald P. and Baines M.E. (1987) UK Cetacean Status Review. Report to English Nature and Countryside Council for Wales pp. 160. Oxford: Sea Watch Foundation.
Fontaine, M.C., Tolley, K.A., Siebert, U., Gobert, S., Lepoint, G., Bouquegneau, J.M. and Das, K., 2007. Long-term feeding ecology and habitat use in harbour porpoises Phocoena phocoena from Scandinavian waters inferred from trace elements and stable isotopes. BMC Ecology, 7, p.1.
Fontaine, M.L.C., Roland, K., Calves, I., Austerlitz, F., Palstra, F.P., Tolley, K.A., Ryan, S., Ferreira, M., Jauniaux, T., Llavona, A. and Ürk, B.Ö., 2014. Postglacial climate changes and rise of three ecotypes of harbour porpoises, Phocoena phocoena, in western Palearctic waters. Molecular Ecology, 23, pp.3306-3321.
Fraser F.C. (1946) Report on Cetacea stranded on the British coasts from 1933 to 1937. No. 12. London: British Museum (Natural History).
Friends of Horsey (2019). Seal Pup Count 2018-2019. Available from: http://friendsofhorseyseals.co.uk/wp-content/uploads/2019/01/Seal_Count_Report_2018-19.pdf
Galatius A., Brackmann J., Brasseur S., Diederichs B., Jeß A., Klöpper S., Körber P., Schop J., Siebert U., Teilmann J., Thøstesen B. and Schmidt B. (2020). Trilateral

surveys of Harbour Seals in the Wadden Sea and Helgoland in 2020. Common Wadden Sea Secretariat, Wilhelmshaven, Germany.

Gilles, A., Peschko, V., Scheidat, M. and Siebert, U. (2012). Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011. Document submitted by Germany to 19th ASCOBANS Advisory Committee Meeting in Galway, Ireland, 20-22 March 2012. AC19/Doc.5-08(P). 16pp.

Gilles, A., Viquerat, S., Becker, E. A., Forney, K. A., Geelhoed, S. C. V., Haelters, J., Nabe-Nielsen, J., Scheidat, M., Siebert, U., Sveegaard, S., van Beest, F. M., van Bemmelen, R.and Aarts, G. (2016). Seasonal habitat-based density models for a marine top predator, the harbour porpoise, in a dynamic environment. Ecosphere 7(6):e01367. 10.1002/ecs2.1367.

Hammond, P.S. and Grellier, K. (2006). Grey seal diet composition and prey consumption in the North Sea. Final report to Department for Environment Food and Rural Affairs on project MF0319.

Hammond PS, Gordon GCD, Grellier K, Hall AJ, Northridge SP, Thompson D, Harwood J (2002). Background information on marine mammals relevant to Strategic Environmental Assessments 2 and 3. Sea Mammal Research Unit, Gatty Marine Laboratory University of St Andrews, St Andrews.

Hammond P.S., Macleod K., Berggren P., Borchers D.L., Burt L., Cañadas A., Desportes G., Donovan G.P., Gilles A., Gillespie D., Gordon J., Hiby L., Kuklik I., Leaper R., Lehnert K, Leopold M., Lovell P., Øien N., Paxton C.G.M., Ridoux V., Rogano E., Samarraa F., Scheidatg M., Sequeirap M., Siebertg U., Skovq H., Swifta R., Tasker M.L., Teilmann J., Canneyt O.V. and Vázquez J.A. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation 164, 107-122.

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

Harmer S.F. (1927) Report of Cetacea stranded on the British Isles from 1913 to 1926. No. 10. London: British Museum (Natural History).

Heinänen, S. and 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.

HM Government (2011). Marine Policy Statement. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69322/pb3654-marine-policy-statement-110316.pdf.

HM Government (2014). The East Inshore and East Offshore Marine Plans.

IAMMWG (2013). Management Units for marine mammals in UK waters (June 2013).

IAMMWG (2015). Management Units for cetaceans in UK waters (January 2015). JNCC Report No. 547, JNCC Peterborough.

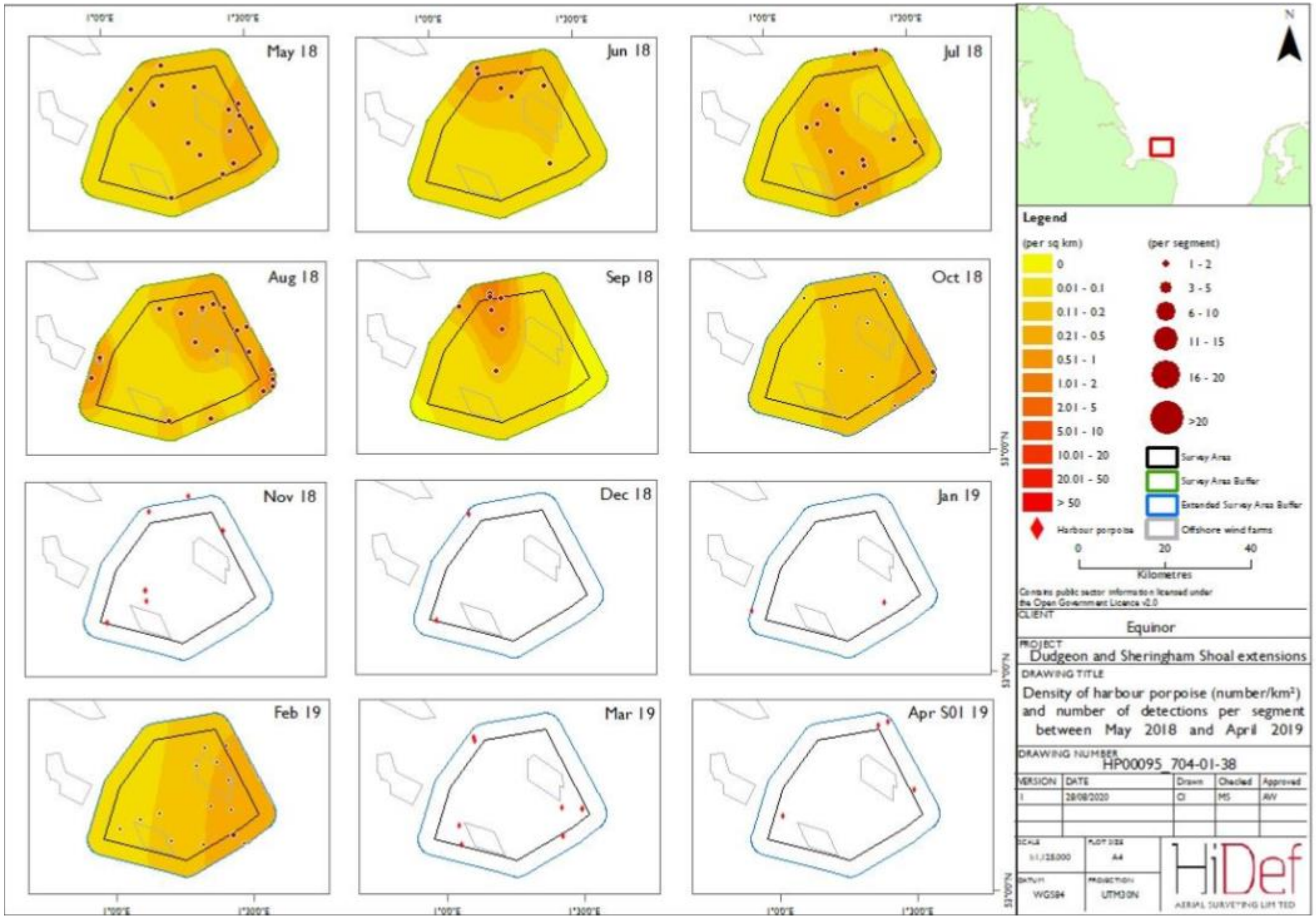
IJsseldijk, L.L., Brownlow, A., Davison, N.J., Deaville, R., Haelters, J., Keijl, G., Siebert, U. and ten Doeschate, M.T.I. (2018). Spatiotemporal trends in white-beaked dolphin strandings along the North Sea coast from 1991–2017. Lutra 61 (1): 153-163: https://www.uu.nl/sites/default/files/ijsseldijk_et_al._2018._spatiotemporal_analysis_of_white-beaked_dolphin_strandings._lutra_61_002.pdf
Ingram, S.N. and Rogan, E. (2002). Identifying critical areas and habitat preferences of bottlenose dolphins Tursiops truncatus. Marine Ecology Progress Series. 244, pp.247-255.
JNCC (2010a). JNCC guidelines for minimising the risk of injury to marine mammals from using explosives. August 2010.
JNCC (2010b). Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise. August 2010.
JNCC (2017a) SAC Selection Assessment: Southern North Sea. January, 2017. Joint Nature Conservation Committee, UK. Available from: http://jncc.defra.gov.uk/page-7243.
JNCC (2019). Article 17 Habitats Directive Report 2019: Species Conservation Status Assessments 2019. Available at: https://jncc.gov.uk/our-work/article-17-habitats-directive-report-2019-species/#regularly-occurring-species-vertebrate-species-mammals-marine
JNCC, Natural England and CCW (2010). Draft EPS Guidance - The protection of marine European Protected Species from injury and disturbance. Guidance for the marine area in England and Wales and the UK offshore marine area. Joint Nature Conservation Committee, Natural England and Countryside Council for Wales. October 2010.
Johnston, D.W., Westgate, A.J. and Read, A.J. (2005). Effects of fine-scale oceanographic features on the distribution and movements of harbour porpoises Phocoena phocoena in the Bay of Fundy. Marine Ecology Progress Series, 295, pp.279-293.
Kastelein, R.A., Hardemann, J. and Boer, H. (1997). Food consumption and body weight of harbour porpoises (*Phocoena phocoena*). In The biology of the harbour porpoise Read, A.J., Wiepkema, P.R., Nachtigall, P.E (1997). Eds. Woerden, The Netherlands: De Spil Publishers. pp. 217–234.
Keiper, C.A., Ainley, D.G., Allen, S.G. and Harvey, J.T. (2005). Marine mammal occurrence and ocean climate off central California, 1986 to 1994 and 1997 to 1999. Marine Ecology Progress Series, 289, pp.285-306.
Kinze C.C., Addink M., Smeenk C., Hartmann M.G., Richards H.W., Sonntag R.P. and Benke H. (1997) The white-beaked dolphin (Lagenorhynchus albirostris) and the white-sided dolphin (Lagenorhynchus acutus) in the North and Baltic Seas: review of available information. Report of the International Whaling Commision 47, 675–681.
Lewis, E.J. and Evans, P.G.H. (1993). Comparative ecology of bottlenose dolphins (Tursiops truncatus) in Cardigan Bay and the Moray Firth, pp.57-62. In: European

Research on Cetaceans - 7. Proc. 7th Ann. Conf. ECS, Inverness, ed P.G.H. Evans. European Cetacean Society, Cambridge, England. 306pp.
Liret, C. (2001). Domaine vital, utilisation de l'espace et des ressources :les grands dauphins, Tursiops truncatus, de l'île de Sein. Thèse de doctorat de l'Université de Bretagne Occidentale, Brest. 155 p.
Liret, C., Creton, P., Evans, P. G. H., Heimlich-Boran, J. R. and Ridoux, V. (1998). English and French coastal Tursiops from Cornwall to the Bay of Biscay, 1996. Photo-identification Catalogue. Project sponsored by Ministere de l'Environnement, France and Sea Watch Foundation, UK.
Lowry, L.F., Frost, K.J., Hoep, J.M. and Delong, R.A. (2001). Movements of satellite-tagged subadult and adult harbor seals in Prince William Sound, Alaska. Marine Mammal Science 17(4): 835−861.
Macleod, K., Burt, M.L., Cañadas, A., Rogan, E., Santos, B., Uriarte, A., Van Canneyt, O., Vázquez, J.A. and Hammond, P.S., 2012. Design-based estimates of cetacean abundance in offshore European Atlantic waters. Appendix I of the Final Report of project CODA, SMRU, University of St Andrews, Scotland NOAA.
Matthiopoulos, J., McConnell, B.J., Duck, C. and Fedak, M.A. (2004). Using satellite telemetry and aerial counts to estimate space use by grey seals around the British Isles. Journal of Applied Ecology. 41(3):476-491.
Northridge, S.P., Tasker, M.L., Webb, A. and Williams, J.M., 1995. Distribution and relative abundance of harbour porpoises (Phocoena phocoena L.), white-beaked dolphins (Lagenorhynchus albirostris Gray), and minke whales (Balaenoptera acutorostrata Lacepède) around the British Isles. ICES Journal of Marine Science, 52(1), pp.55-66.
Paxton, C.G.M., Scott-Hayward, L., Mackenzie, M., Rexstad, E. and Thomas, L. (2016). Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resources with Advisory Note, JNCC Report 517, ISSN 0963-8091: http://jncc.defra.gov.uk/page-7201.
Raum-Suryan, K.L. and Harvey, J.T. (1998). Distribution and abundance of and habitat use by harbor porpoise, Phocoena phocoena, off the northern San Juan Islands, Washington. Fishery Bulletin, 96(4), pp.808-822.
Reid, J.B, Evans, P.G.H. and Northridge, S.P. (2003). Atlas of cetacean Distribution in North west European waters. JNCC, Peterborough.
Reeves R., Smeenk C., Kinze C.C., Brownell R.L. Jr and Lien J. (1999) White-beaked dolphn Lagenorhynchus albirostris, Gray 1846. In Handbook of marine mammals vol. 6, pp. 1–30. Academic Press.
Russell, D.J.F (2016). Movements of grey seal that haul out on the UK coast of the southern North Sea. Report for the Department of Energy and Climate Change (OESEA-14-47).
Russell, D.J.F. and McConnell, B.J. (2014). Seal at-sea distribution, movements and behavior. Report to DECC. URN: 14D/085. March 2014 (final revision).

Russell, D.J., McConnell, B., Thompson, D., Duck, C., Morris, C., Harwood, J. and Matthiopoulos, J. (2013). Uncovering the links between foraging and breeding regions in a highly mobile mammal. Journal of Applied Ecology, 50(2), pp.499-509.
Russell, D.J.F, Jones, E.L. and Morris, C.D. (2017). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science Vol 8 No 25, 25pp. DOI: 10.7489/2027-1.
Santos, M.B., Pierce, G.J., Reid, R.J., Patterson, I.A.P., Ross, H.M. and Mente, E., 2001. Stomach contents of bottlenose dolphins (Tursiops truncatus) in Scottish waters. Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom, 81(5), p.873.
Santos, M.B. and Pierce, G.J. (2003). The diet of harbour porpoise (Phoceona phoceona) in the North east Atlantic. Oceanography and Marine Biology: an Annual Review 2003, 41, 355–390.
Santos, M.B., Pierce, G.J., Learmonth, J.A., Reid, R.J., Ross, H.M., Patterson, I.A.P., Reid, D.G. and Beare, D. (2004). Variability in the diet of harbor porpoises (Phocoena phocoena) in Scottish waters 1992–2003. Marine Mammal Science, 20(1), pp.1-27.
SCANS-II (2008). Small cetaceans in the European Atlantic and North Sea. Final Report submitted to the European Commission under project LIFE04NAT/GB/000245, SMRU, St Andrews.
Scira Offshore Energy Ltd. (2006) Sheringham Shoal Offshore Wind Farm Environmental Statement.
Scira Offshore Energy (2010). Sheringham Shoal Offshore Windfarm Project Seabed Intervention UXO Clearance. Available from: https://www.marinedataexchange.co.uk/ItemDetails.aspx?id=11205
SCOS (2012). Scientific Advice on Matters Related to the Management of Seal Populations: 2012.
SCOS (2017). Scientific Advice on Matters Related to the Management of Seal Populations: 2017. Available at: http://www.smru.st-andrews.ac.uk/research-policy/scos/
SCOS (2019). Scientific Advice on Matters Related to the Management of Seal Populations: 2019. Available at: http://www.smru.st-andrews.ac.uk/research-policy/scos/
Sea Watch Foundation (2021). Reports of cetacean sightings eastern England: http://www.seawatchfoundation.org.uk/recentsightings/
Sharples R.J., Matthiopoulos, J. and Hammond, P.S. (2008). Distribution and movements of harbour seals around the coast of Britain: Outer Hebrides, Shetland, Orkney, the Moray Firth, St Andrews Bay, The Wash and the Thames, Report to DTI July 2008.
Sharples, R.J., Moss, S.E., Patterson, T.A. and Hammond, P.S. (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 Ltd (Sea Mammal Research Unit Ltd) (2010). Approaches to Marine Mammal Monitoring at Marine Renewable Energy Developments. Final Report on behalf of The Crown Estate.
Teilmann, J., Christiansen, C.T., Kjellerup, S., Dietz, R. and Nachman, G. (2013). Geographic, seasonal and diurnal surface behaviour of harbour porpoise. Marine Mammal Science 29(2): E60-E76.
Thompson, P.M. and Miller, D., (1990) 'Summer foraging activity and movements of radio-tagged common seals (Phoca vitulina. L.) in the Moray Firth, Scotland'. Journal of applied Ecology, pp.492-501.
Tolley, K.A. and Rosel, P.E., 2006. Population structure and historical demography of eastern North Atlantic harbour porpoises inferred through mtDNA sequences. Marine Ecology Progress Series, 327, pp.297-308.
Tollit, D.J., Black, A.D., Thompson, P.M., Mackay, A., Corpe, H.M., Wilson, B., Parijs, S.M., Grellier, K. and Parlane, S. (1998) 'Variations in harbour seal Phoca vitulina diet and dive-depths in relation to foraging habitat'. Journal of Zoology, 244(2), pp.209-222.
Tynan, C.T., Ainley, D.G., Barth, J.A., Cowles, T.J., Pierce, S.D. and Spear, L.B. (2005). Cetacean distributions relative to ocean processes in the northern California Current System. Deep Sea Research Part Ii: Topical studies in Oceanography, 52(1), pp.145-167.
Vincent, C., Huon, M., Caurant, F., Dabin, W., Deniau, A., Dixneuf, S., Dupuis, L., Elder, J.F., Fremau, M.H., Hassani, S. and Hemon, A., 2017. Grey and harbour seals in France: Distribution at sea, connectivity and trends in abundance at haulout sites. Deep Sea Research Part II: Topical Studies in Oceanography, 141, pp.294-305.
Voet H., Rehfisch M., McGovern S. and Sweeney S. (2017). Marine Mammal Correction Factor for Availability Bias in Aerial Digital Still surveys. Case Study: Harbour porpoise (Phocoena phocoena) in the Southern North Sea. APEM Ltd.
Waggitt, J.J., Evans, P.G., Andrade, J., Banks, A.N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C.J., Durinck, J. and Felce, T. (2020). Distribution maps of cetacean and seabird populations in the North-East Atlantic. Journal of Applied Ecology, 57(2), pp.253-269.
Windsland, K., Lindstrom U., Nilssen, K.T. and Haug, T. (2007). Relative abundance and size composition of prey in the common minke whale diet in selected areas of the north-eastern Atlantic during 2000-04. J. Cetacean Res. Manage, 9(3), pp.167-178.
Wilson, B., Thompson, P.M., Hammond, P.S. (1997). Habitat use by bottlenose dolphins: seasonal distribution and stratified movement patterns in the Moray Firth Scotland. The Journal of Applied Ecology 34, pp.1365–1374.
WWT (2009). Distributions of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008. The Wildfowl and Wetlands Trust.

Annex 1 – Site Specific Harbour Porpoise Density Maps


May 18
Jun 18
Jul 18
Aug 18
Sep 18
Oct 18
Nov 18
Dec 18
Jan 19
Feb 19
Mar 19
Apr S01 19
Legend
(per sq km)
0
0.01 - 0.1
0.11 - 0.2
0.21 - 0.5
0.51 - 1
1.01 - 2
2.01 - 5
5.01 - 10
10.01 - 20
20.01 - 50
> 50
(per segment)
1 - 2
3 - 5
6 - 10
11 - 15
16 - 20
>20
Survey Area
Survey Area Buffer
Extended Survey Area Buffer
Offshore wind farms
Harbour porpoise
Kilometres
Contains public sector information licensed under the Open Government Licence v2.0
CLIENT
Equinor
PROJECT
Dudgeon and Sheringham Shoal extensions
DRAWING TITLE
Density of harbour porpoise (number/km²) and number of detections per segment between May 2018 and April 2019
DRAWING NUMBER
HP00095_704-01-38
VERSION
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Drawn
Checked
Approved
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28/08/2020
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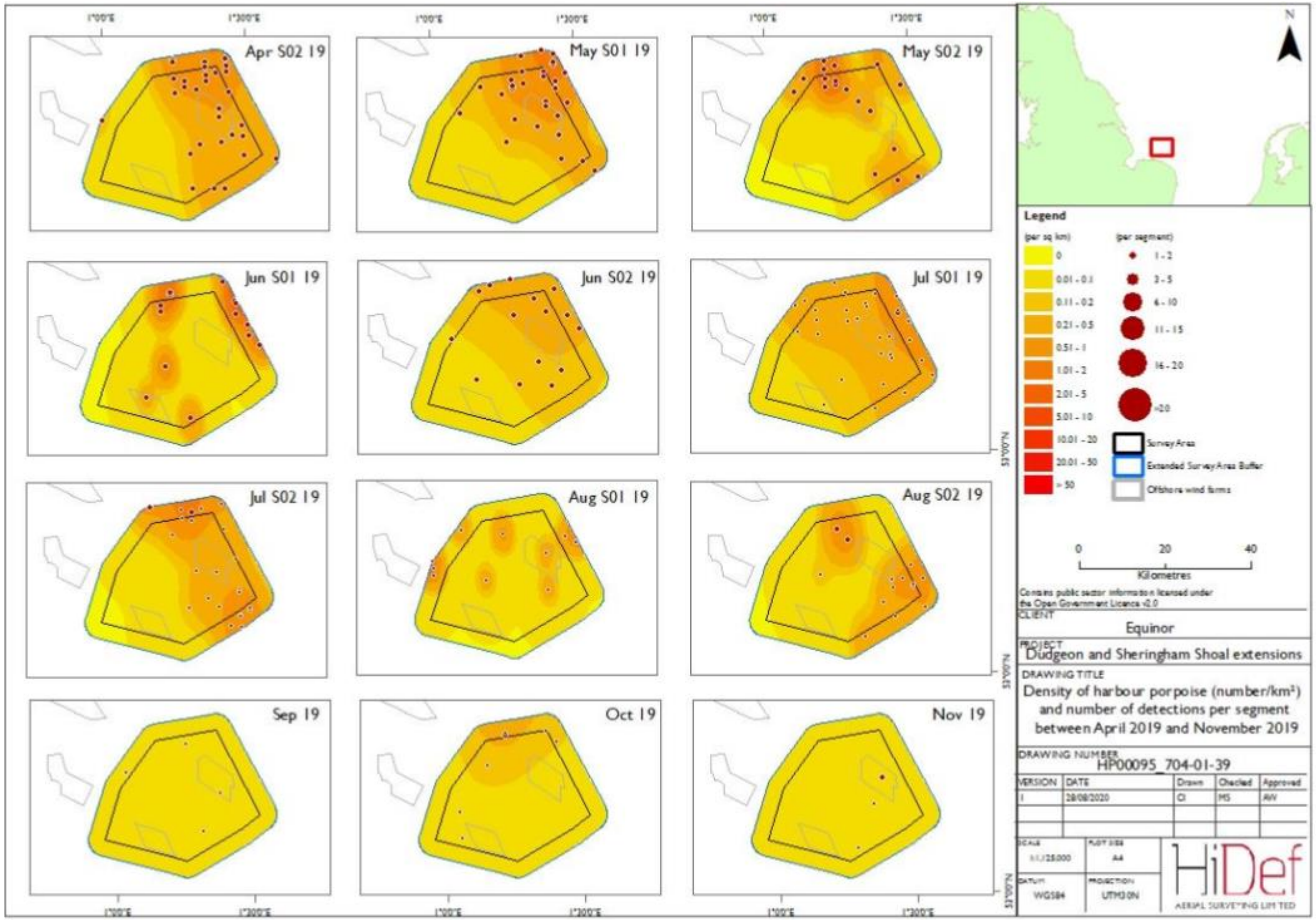
HiDef
AERIAL SURVEYING LIMITED


Apr S02 19
May S01 19
May S02 19
Jun S01 19
Jun S02 19
Jul S01 19
Jul S02 19
Aug S01 19
Aug S02 19
Sep 19
Oct 19
Nov 19
N
Legend
(per sq km)
0
0.01 - 0.1
0.11 - 0.2
0.21 - 0.5
0.51 - 1
1.01 - 2
2.01 - 5
5.01 - 10
10.01 - 20
20.01 - 50
> 50
(per segment)
1 - 2
3 - 5
6 - 10
11 - 15
16 - 20
>20
Survey Area
Extended Survey Area Buffer
Offshore wind farms
0
20
40
Kilometres
Contains public sector information licensed under the Open Government Licence v2.0
CLIENT
Equinor
PROJECT
Dudgeon and Sheringham Shoal extensions
DRAWING TITLE
Density of harbour porpoise (number/km²) and number of detections per segment between April 2019 and November 2019
DRAWING NUMBER
HP00095_704-01-39
VERSION
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Drawn
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Approved
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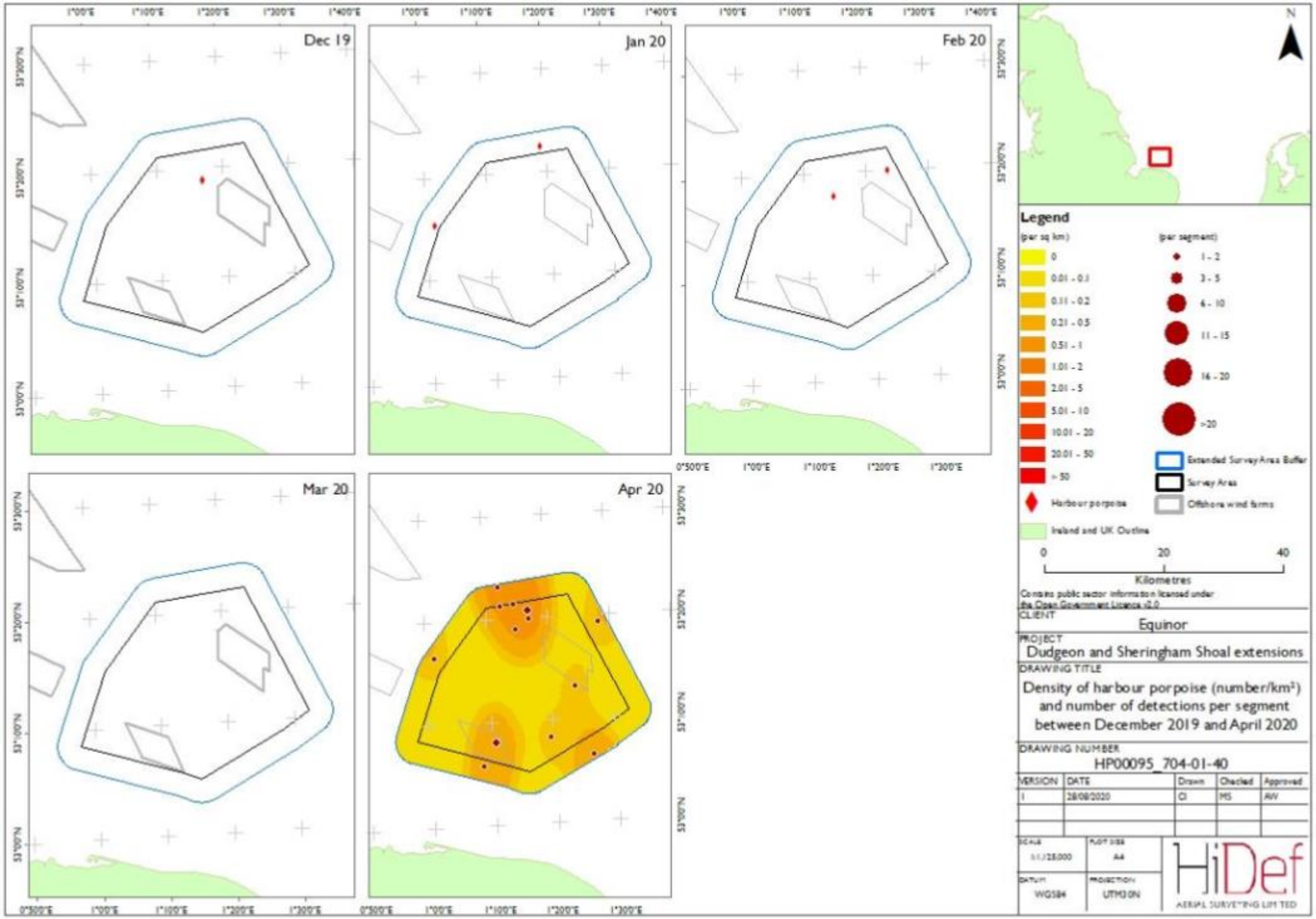
HiDef
AERIAL SURVEYING LIMITED


Dec 19
Jan 20
Feb 20
Mar 20
Apr 20
N
Legend
(per sq km)
0
0.01 - 0.1
0.11 - 0.2
0.21 - 0.5
0.51 - 1
1.01 - 2
2.01 - 5
5.01 - 10
10.01 - 20
20.01 - 50
> 50
Harbour porpoise
Ireland and UK Outline
(per segment)
1 - 2
3 - 5
6 - 10
11 - 15
16 - 20
>20
Extended Survey Area Buffer
Survey Area
Offshore wind farms
0
20
40
Kilometres
Contains public sector information licensed under the Open Government Licence v2.0
CLIENT
Equinor
PROJECT
Dudgeon and Sheringham Shoal extensions
DRAWING TITLE
Density of harbour porpoise (number/km²) and number of detections per segment between December 2019 and April 2020
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HP00095_704-01-40
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DATE
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28/08/2020
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AERIAL SURVEYING LIMITED