Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Environmental Statement Volume 4

Annex 7-1: Marine Mammals Technical Report

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Vattenfall Wind Power Ltd

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Volume 4

Annex 7-1: Marine Mammals Technical Report

June 2018

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1. Introduction

1.1.1 The proposed Thanet Extension Offshore Wind Farm (hereafter referred to as Thanet Extension) site is located approximately 8 km from the Isle of Thanet. It is situated so that it completely surrounds the existing Thanet Offshore Wind Farm (TOWF) and is in water depths between 13 and 43 m. The TOWF has been operational since 2010 and comprises 100 x Vestas V90 3.0 MW turbines and is situated approximately 11 km off the east Kent coast. The Thanet Extension will comprise of up to 34 WTG (Wind Turbine Generators) in an area of approximately 70 km^2. At this stage the exact landfall options have not been confirmed, but it is expected to be in Pegwell Bay.

1.1.2 The purpose of this document is to provide a characterisation of the baseline environment to understand the range of species, and the abundance and density of marine mammals that could potentially be impacted by the Thanet Extension. The baseline data have been compiled through a combination of a literature reviews and data obtained from site-specific surveys.

2. Legislation

2.1.1 This section outlines the legislation, policy and guidance that is relevant to the assessment of the potential impacts on marine mammals associated with the construction, operation and decommissioning of the Thanet Extension project. In addition, other national, regional and local policies are considered within this assessment where they are judged to be relevant.

2.2 Habitats Directive

2.2.1 All cetaceans in Northern European waters are listed under Annex IV of the EU Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the Habitats Directive) as European Protected Species (EPS) of Community Interest and in need of strict protection. The harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) have protection under Annex II as species of Community Interest whose conservation requires the designation of Special Areas of Conservation (SACs).

2.2.2 The Habitats Directive is transposed through the Conservation of Habitats and Species Regulations 2010 (in relation to reserved matters) and the 1994 Regulations. The Conservation (Natural Habitats, &c.) Regulations (1994, as amended in 2007) implement the Habitats Directives in territorial waters out to 12nm. The Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 (as amended) (the Offshore Marine Regulations) transpose the provisions of the Habitats Directive in offshore waters, beyond 12 nautical miles. The Habitat Regulations provide protection for designated sites, known as Natura 2000 sites which include SACs and Special Protection Areas.

2.3 The Habitats Regulations

2.3.1 The Habitats Regulations and the Offshore Marine Regulations make it an offence to injure or disturb any EPS. Any incidence of disturbance would be considered an offence if the disturbance is likely to have an ecologically significant adverse effect on a significant number of animals (note: for the purpose of simplification, in this guidance, references to 'adversely affect(ed)' should be taken to mean 'significantly affect the ability to survive, breed, or rear or nurture their young'). The second element is that the disturbance must be likely to significantly affect the local distribution or abundance of the species. A disturbance offence would be committed if either of these elements occurred.

2.4 European Protected Species

2.4.1 JNCC has published guidance which defines deliberate disturbance and the circumstances in which an EPS licence is required (JNCC 2008). This document provides guidance on how to determine what constitutes a 'deliberate disturbance', a 'significant' effect on the ability of the species to survive, breed, or rear/nurture their young, what is a 'significant' group of animals and what are considered to be 'significant' effects on the distribution and abundance of a species.

2.4.2 What constitutes a significant number of animals depends on the species, its population size, local abundance, its Favourable Conservation Status (FCS), the behaviour of the species and the circumstances in which the disturbance might take place (i.e. time of year, and the spatial and temporal range of the impact). For a significant effect on the local distribution or abundance of a species to occur, disturbance would need to produce more than a transient effect and result in a detrimental change from the natural variability in the spatial-temporal distribution and abundance of the species and its populations within their natural range. This would occur, for example, if a significant group of animals of a population were to become displaced, either from an area which they are known to persistently use or from a fraction of their natural range, for long periods of time; particularly if animals are displaced from essential habitats to less suitable ones.

2.4.3 If the risk of injury or significant disturbance cannot be reduced to negligible levels with mitigation, then an EPS licence is required. In England, offshore EPS licencing is managed by the Marine Management Organisation. Licenses are granted if 1) the reason for the license relates to one of the specified purposes listed in Regulation 44(2) of the Conservation (Natural Habitats) Regulations 1994 (as amended), which includes renewable energy purposes, 2) there is no satisfactory alternative way to reduce injury or disturbance risk and 3) the action authorised must not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range (Regulation 44(3)(b)).

2.5 Special Areas of Conservation

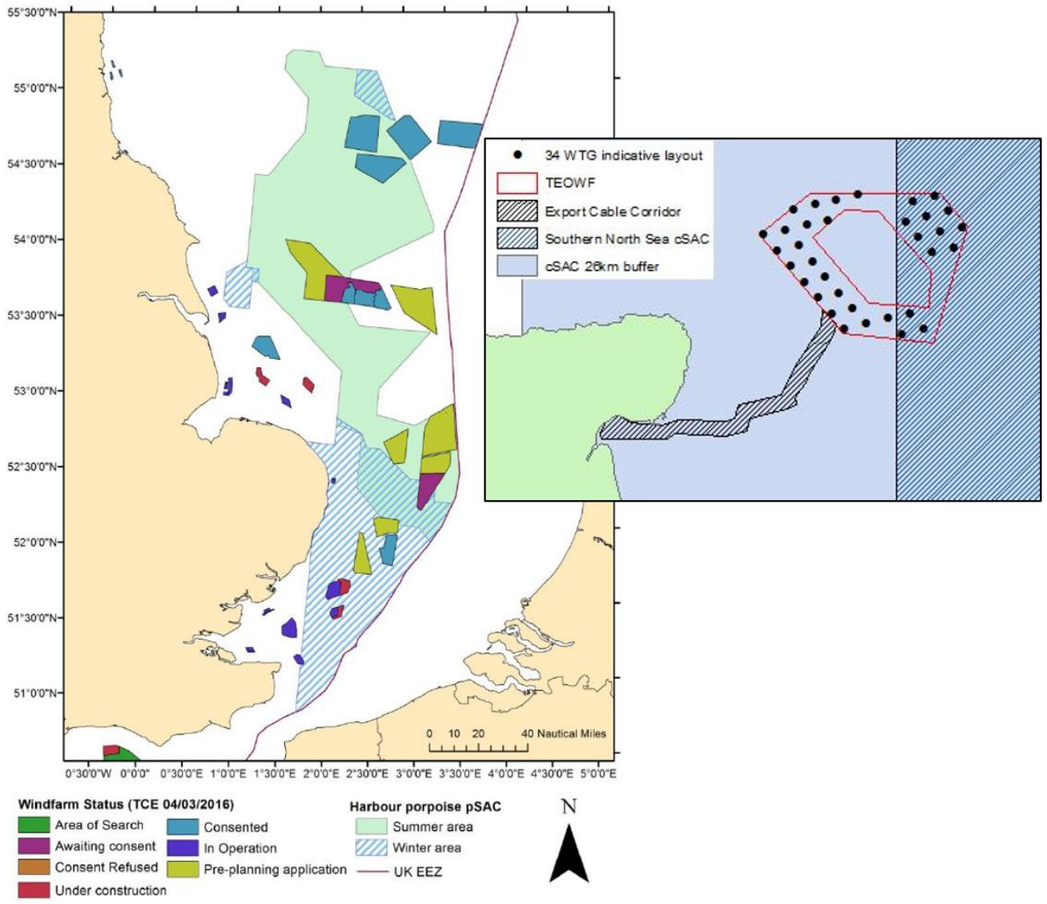
2.5.1 In order to conserve biodiversity, by maintaining or restoring Annex II species to a favourable conservation status, the Habitats Directive requires the designation of SACs for harbour porpoise, bottlenose dolphins, harbour seals and grey seals.

Harbour Porpoise

2.5.2 In 2016 five possible SACs (pSACs) for harbour porpoise were proposed in England, Northern Ireland and Wales, which following consultation were then submitted by the UK Government to the European Commission for formal designation. At this stage these sites are known as candidate SACs (cSACs). One of these five sites, the Southern North Sea (SNS) cSAC is relevant to Thanet Extension. The Southern North Sea cSAC has been divided into two areas based on the apparent seasonality of harbour porpoise density: the northern summer area where harbour porpoise densities are highest in the summer months (April to September inclusive), and the southern winter area where porpoise densities are higher in the winter months (October to March inclusive). The Thanet Extension Offshore Wind Farm overlaps with the 'winter' portion of the cSAC.

2.5.3 Full consideration of the potential impact on the draft conservation objectives of the cSAC will be presented as part of the Report to Inform Appropriate Assessment (RIAA).

Figure 2.1 Southern North Sea cSAC for harbour porpoise and location of wind farm areas (JNCC 2017a). Seasonal areas of the pSAC are shown. Inset: overlap between the Thanet Extension indicative WTG locations and the cSAC.



Harbour Seals

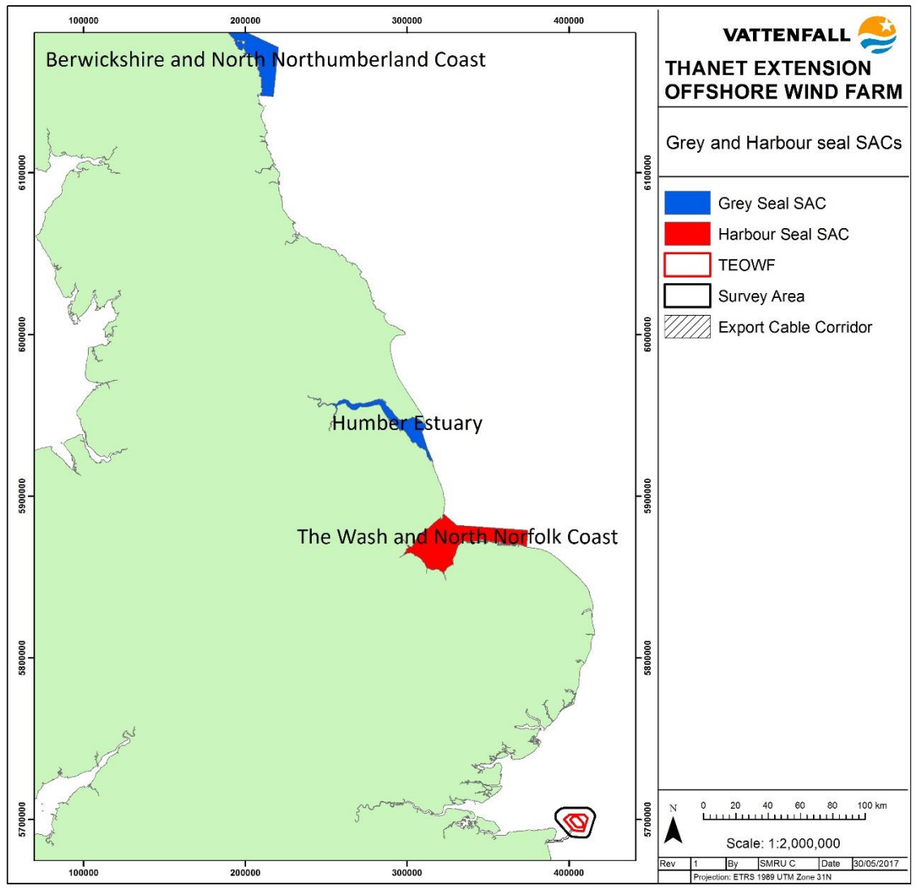
2.5.4 The closest harbour seal SAC to the Thanet Extension is The Wash and North Norfolk Coast SAC where harbour seals are listed as the primary reason for site selection. The Wash and North Norfolk Coast SAC supports the largest breeding colony of harbour seals in the UK[1]. The boundary of The Wash and North Norfolk Coast SAC is approximately 190 km from the boundary of the Thanet Extension (Figure 2.2).

Grey Seals

2.5.5 The closest grey seal SAC to the Thanet Extension is the Humber Estuary SAC where grey seals are listed as a qualifying feature but not the primary reason for site selection. The Humber Estuary SAC is approximately 265 km from the boundary of the Thanet Extension. To the north of that is the Berwickshire and North Northumberland Coast SAC where grey seals are listed as the primary reason for site selection. The boundary of the Berwickshire and North Northumberland Coast SAC is approximately 500 km from the boundary of the Thanet Extension (Figure 2.2).

[1] http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUcode=UK0017075

Figure 2.2 Grey and harbour seal SACs in relation to the Thanet Extension (TEOWF) Site.



2.6 Bonn Convention

2.6.1 The Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention) requires members to conserve migratory species and their habitats by providing strict protection for endangered migratory species (Appendix I of the Convention), and lists migratory species which would benefit from multilateral Agreements for conservation and management (Appendix II). There are 16 cetacean species listed under Appendix I of the Bonn Convention.

2.6.2 The UK ratified the Convention in 1985. The legal requirement for the strict protection of Appendix I species is provided by the Wildlife & Countryside Act (1981 as amended). The UK has entered into legally binding Agreements under the Convention, including the Agreement on the Conservation of Small Cetaceans in the Baltic, North-East Atlantic, Irish and North Seas (ASCOBANS).

2.7 ASCOBANS

2.7.1 Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) came into force inin 1994. The aim of the Agreement is for member parties to cooperate to achieve and maintain a favourable conservation status for small cetaceans. ASCOBANS is applied in all UK waters in accordance with existing statutory protection for cetacean species.

2.8 Berne Convention

2.8.1 The Convention on the Conservation of European Wildlife and Natural Habitats (the Berne Convention) aims to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention). There are 19 species of cetacean listed under Annex II of the Berne Convention (strictly protected fauna), including harbour porpoise, bottlenose dolphins, common dolphins, Risso's dolphins, white-beaked dolphins and minke whales. All other cetacean species as well as both grey and harbour seals are listed under Annex III of the Berne Convention (protected fauna). The obligations of the Convention are transposed into national law by means of the Wildlife and Countryside Act (1981 as amended).

2.9 Wildlife and Countryside Act, 1981

2.9.1 The Wildlife and Countryside Act, 1981 makes it an offence to intentionally (or recklessly) kill, injure or take any wild animal listed on Schedule 5, and prohibits interference with places used for shelter or protection, or intentionally disturbing animals occupying such places. All cetacean species are protected within the 12 mile territorial waters under Schedule 5 of the Wildlife and Countryside Act.

2.10 Conservation of Seals Act, 1970

2.10.1 Both grey and harbour seal species are protected under the Conservation of Seals Act (1970) which provides closed seasons during which it is an offence to take or kill any seal except under licence.

2.10.2 Following the Phocine Distemper Virus (PDV) outbreak in 1999, an Order was issued under the Conservation of Seals Act providing year round protection to both grey and harbour seals on the east and south-east coast of England, from Berwick to Newhaven (under the Conservation of Seals (England) Order 1999).

2.11 National Policy Statements

2.11.1 The Overarching National Policy Statement (NPS) for Energy ('EN-1'), in-conjunction with the NPS for Renewable Energy Infrastructure ('EN-3'), provide the primary policy framework within which the Project will be considered during the application process for Development Consent.

2.11.1.1 NPS EN-3 paragraphs 2.6.90-2.6.99 provide guidance on the elements to include in the assessment of the effects of impacts on marine mammals. Including: details of likely feeding areas, birthing areas, nursery areas and haul-out sites; known migration or commuting routes; duration of the potentially disturbing activity including cumulative/in-combination effects with other plans or projects; baseline noise levels; predicted noise levels in relation to mortality, permanent threshold shift (PTS) and temporary threshold shift (TTS); soft start noise levels according to proposed hammer and pile design; and operational noise. All of these elements will be considered in the baseline environment description and the impact assessment.

2.11.2 NPS EN-3 paragraphs 2.6.94 to 2.6.99 are also relevant for marine mammals as they outline the issues and mitigation that may be considered. This refers to preferred methods of construction and suitable noise mitigation, the conservation status of EPS and highlights that fixed structures are unlikely to cause a significant collision risk to marine mammals.

2.12 UK Biodiversity Action Plan (BAP) and the UK Post-2010 Biodiversity Framework (2012)

2.12.1 The UK Biodiversity Action Plan (UK BAP) was published in 1994 as a response to the 1992 Rio de Janeiro Convention on Biological Diversity. The UK BAP identifies biological resources in the UK and plans for their conservation. This was succeeded by the UK Post-2010 Biodiversity Framework in 2012 in response to the Convention on Biological Diversity's Strategic Plan for Biodiversity 2011-2020 (published in 2010) and the EU Biodiversity Strategy (published in 2011). The UK Post-2010 Biodiversity Framework describes how the UK can meet the Aichi Biodiversity Targets. The UK BAP identified priority species that are the most threatened and require conservation. These UK BAP priority species include the cetacean and seal species present in UK waters. This list of priority species is still used to inform statutory lists of priority species in the UK.

3. Data Sources

3.1.1 Characterisation of the baseline environment to understand the spatial and temporal diversity, abundance and density of marine mammals that could potentially be impacted by the Thanet Extension Project has been produced through a combination of a literature reviews and site-specific surveys. This section of the report summarises the key data sources examined to establish the baseline.

3.2 Thanet Extension Offshore Wind Farm Baseline Surveys

3.2.1 Site-specific surveys have been undertaken to characterise the marine mammal baseline environment at the Thanet Extension site. Vattenfall commissioned an initial three months of vessel surveys to collect baseline data on birds and marine mammals. These surveys were conducted between January and March 2016 (Figure 3.1). The survey consisted of nine transects, spaced approximately 3 km apart.

Table 3.1 Details of the three months of vessel surveys in the Thanet Extension survey area.

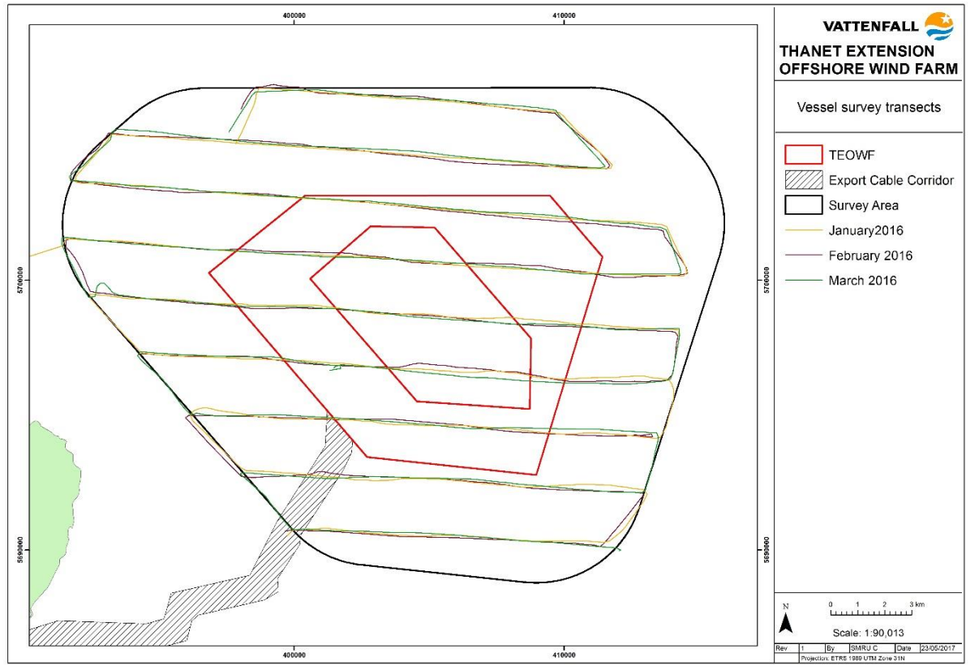
Survey Date	Sea State (WMO code)	Distance Surveyed (km)
18 – 19th January 2016	3 / 1-2	84.4
18 – 19th February 2016	3-4 / 3	128.5
20 – 21st March 2016	2-4 / 1-3	122.8

3.2.2 Following this, it was advised by SNCBs that aerial surveys were conducted instead of vessel surveys (for details of this consultation see Volume 2, Chapter 4: Offshore Ornithology). Therefore, APEM were contracted to conduct aerial surveys of Thanet Extension and a 4 km buffer around it. The data available from these 24 surveys is between March 2016 and February 2018. A further two months of data were collected in January and February 2018, however these data had not been processed in time for inclusion in this assessment chapter. The survey methodology was designed for both bird and marine mammal species using a grid-based survey design at 2 cm resolution to achieve a minimum of ten percent coverage. The data collected were high-resolution digital still images using a GPS-linked bespoke flight management system to ensure the tracks were flown with a high degree of accuracy. The aerial surveys were conducted along either 22 or 37 transects with nodes spaced 868 m or 500 m apart, respectively (depending on the camera system used). All photographs from the surveys were processed and where possible, marine mammals were identified to species level. An internal QA of the photographs was undertaken to ensure that no animals were missed and to ensure correct species identification before being sent for external QA by SMRU Consulting. A strict probability score of species identification is assigned to each photograph. An animal in a photograph is only categorised as “definite” if the reviewer is 100% certain of the species identification. However, due to the number of animals that were submerged in the photographs a probability score of definite is difficult, leading to many of the photographs being categorised as “probable” for the species ID. Further details can be found in Annex 6.1: Offshore Ornithology Baseline Technical Report.

Table 3.2 Details of the 24 months of aerial surveys in the Thanet Extension survey area.

Survey Date	Sea State (WMO code)
21st March 2016	2
5th April 2016	2
5th May 2016	2
21st June 2016	1-3
7th July 2016	2
11-12th August 2016	1-3 / 1-2
6th September 2016	2-3
6th October 2016	3
13th November 2016	3-4
3rd December 2016	3
5th January 2017	3
7th February 2017	1
March 2017	1-4
April 2017	1-2
May 2017	1
June 2017	2-3
July 2017	3-4
August 2017	2-3
September 2017	2-3
October 2017	3-4
5th November 2017	2-3
5th December 2017	3
January 2018	Not provided
February 2018	Not provided

Figure 3.1 Survey area and transect lines for the Thanet Extension Offshore Wind Farm (TEOWF) baseline characterisation vessel surveys for birds and marine mammals.

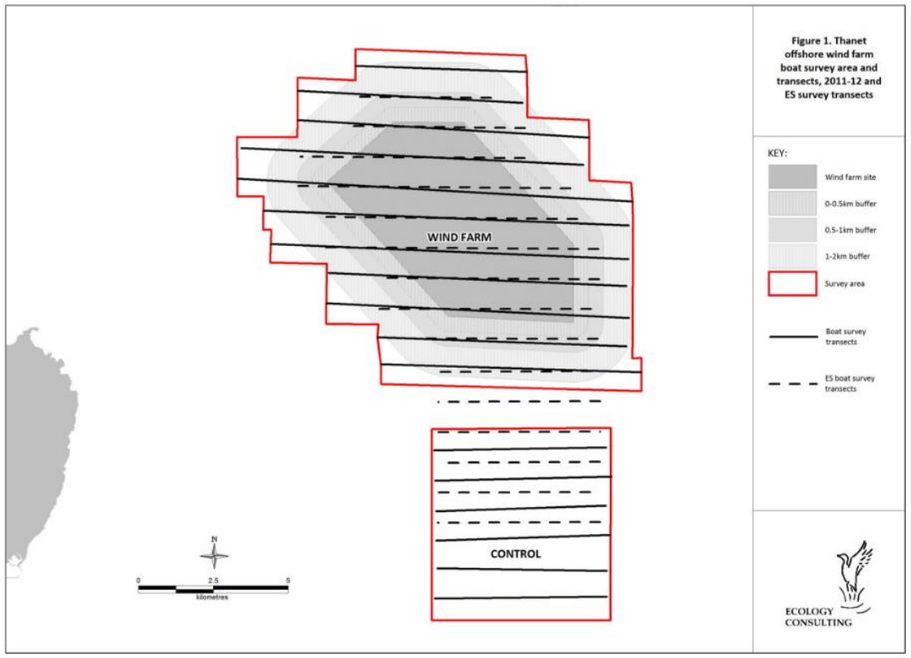


3.3 Thanet Offshore Wind Farm Ornithological Surveys

3.3.1 There have been a series of pre-, during and post-construction surveys at the Thanet Offshore Wind Farm (TOWF), which were conducted primarily to survey birds. Pre-construction surveys for birds were conducted by vessel between November 2004 and October 2005, and by aerial survey between November 2004 and March 2005 (Royal Haskoning 2005). Construction vessel based surveys for birds were conducted between February and March 2009 and again between October 2009 and March 2010 (Royal Haskoning 2010). Post-construction vessel based surveys have been conducted between October 2010 and March 2011, then between October 2011 and March 2012 and again between October 2012 and January 2013 (TOWFL 2012a, b, 2013b). The pre-construction surveys covered the wind farm site plus a 1km buffer (total 67 km^2) and a control area to the South (33 km^2) (Figure 3.2). This survey area was extended in 2009 to cover the wind farm site plus a 22 km buffer (total 111 km^2) and a control area to the South (38 km^2).

3.3.2 The surveys were conducted following the JNCC Seabirds at Sea recommendations by experienced ornithologists that had also been trained as Marine Mammal Observers. Sightings of marine mammals were recorded during the surveys but no dedicated surveys for marine mammals were conducted.

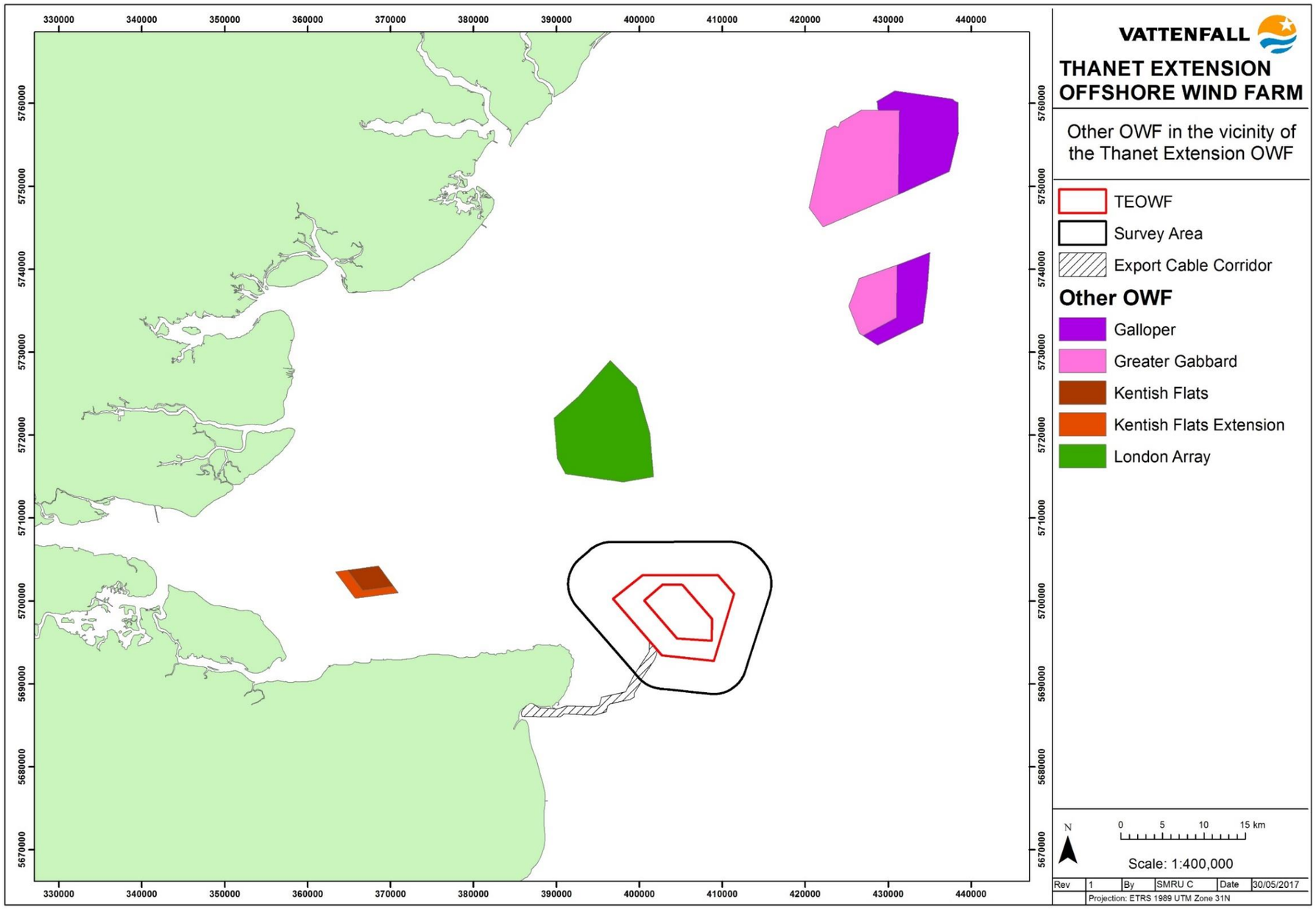
Figure 3.2 Thanet Offshore Wind Farm ornithological survey transects between 2004 and 2005 (pre-construction ES boat survey transects) and between 2009 and 2012 (construction and post-construction surveys) (TOWFL 2012b).



3.4 Other Offshore Wind Farm Site Specific Survey Data

There are five offshore wind farms in the vicinity of the Thanet Extension that have conducted site specific surveys and presented marine mammal sightings; these include the Galloper WF, the Greater Gabbard OWF, the Kentish Flats OWF, the Kentish Flats Extension OWF and the London Array 1 OWF (Figure 3.3).

Figure 3.3 Locations of offshore wind farms (OWF) in the vicinity of the Thanet Extension (TEOWF) that have conducted site-specific surveys and recorded marine mammals.

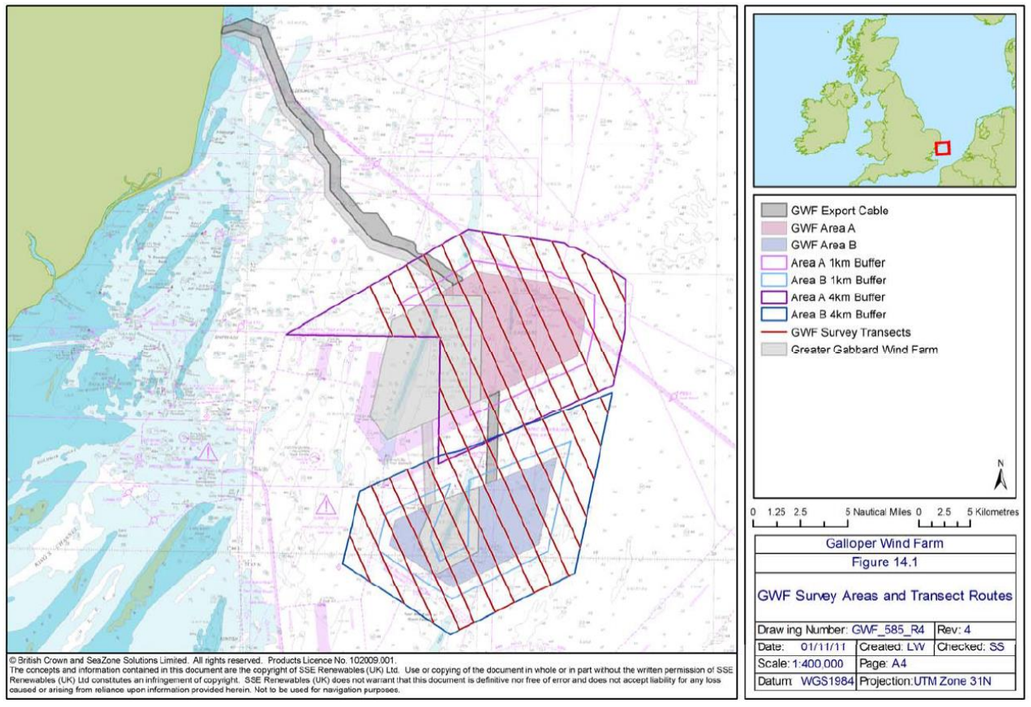


Greater Gabbard & Galloper Offshore Wind Farms

3.4.1 The Greater Gabbard Offshore Wind Farm (GGOWF) and the Galloper Wind Farm (GWF) are approximately 34 km north east of the Thanet Extension. Baseline surveys for birds were conducted for the GGOWF between April 2004 and April 2006. Pre-construction vessel transect surveys were conducted between June 2008 and May 2009, followed by during-construction surveys between June 2009 and May 2011. Post-construction surveys were conducted between June 2011 and June 2014. The GGOWF baseline survey recorded four species of marine mammal: harbour porpoise, harbour seal, grey seal and Risso's dolphins.

3.4.2 Pre-construction vessel transect surveys for the Galloper Wind Farm (GWF) were conducted monthly between June 2008 and May 2011 (Figure 3.4) (Royal Haskoning 2011). These were primarily ornithological surveys conducted using standard COWRIE methods, where marine mammals were incidentally sighted and recorded.

Figure 3.4 Galloper Offshore Wind farm survey areas and transect routes (Royal Haskoning 2011).



London Array Offshore Wind Farm

3.4.3 The London Array Offshore Wind Farm is located approximately 11 km north from the Thanet Extension. Vessel based pre-construction ornithological surveys were conducted approximately monthly at the London Array between October 2002 and June 2004. Aerial pre-construction surveys were also conducted between January 2002 and June 2004. Both of these surveys were conducted for birds and so all marine mammal sightings are incidental only as collected by the bird surveyors..

Kentish Flats and Kentish Flats Extension Offshore Wind Farms

3.4.4 The Kentish Flats and Kentish Flats Extension Offshore Wind Farms are approximately 26 km west of the Thanet Extension. Ornithological vessel surveys were conducted at Kentish Flats OWF and for the Kentish Flats Extension OWF between 2002 and 2010 during which, incidental sightings of marine mammals were recorded. A total of 93 vessel surveys were undertaken and harbour porpoise, harbour seals and unidentified seal species were incidentally sighted. In additional to these, five aerial surveys were conducted between 2001 and 2003, during which marine mammals were incidentally sighted.

3.5 WWT Thames Strategic Environmental Assessment

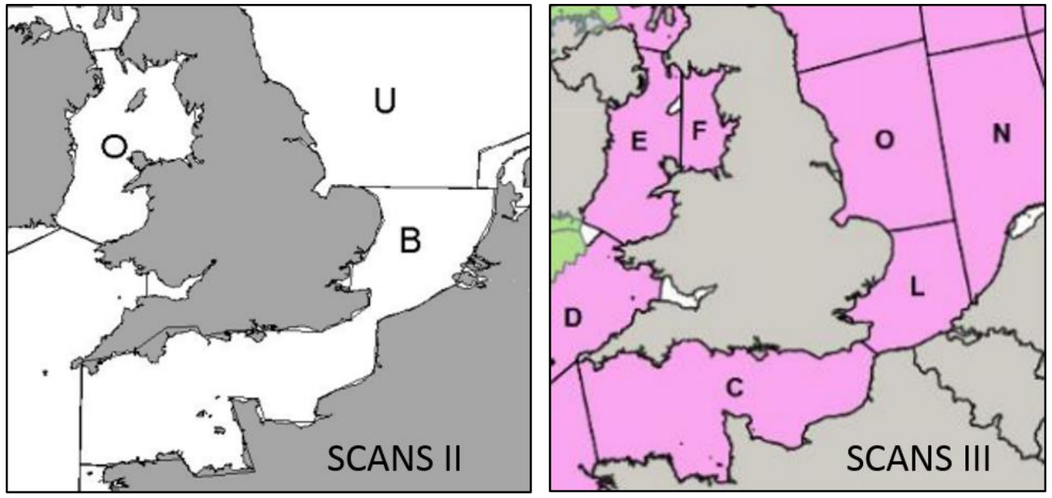
3.5.1 Larger scale aerial surveys covering the Thames Strategic Environmental Assessment Area were organised by the Wildfowl and Wetlands Trust (WWT) between 2004 and 2006, as part of the Round 2 programme. Again, these surveys were conducted primarily for birds and the method employed was direct visual observations.

3.6 SCANS Surveys

3.6.1 The SCANS (Small Cetaceans in the European Atlantic and North Sea) I surveys were completed in 1994, SCANS II in July 2005 and SCANS III in July 2016 and comprised of a combination of vessel and aerial surveys. The main objective of these surveys was to estimate small cetacean abundance and density in the North Sea and European Atlantic continental shelf waters. The aerial surveys involved a single aircraft method using circle-backs (or race-track) methods (Hammond et al. 2006). The Thanet Extension Development Area is located with the SCANS I and II survey area B. The 1994 vessel surveys within survey area B covered a total transect length of 1,470 km (Hammond et al. 2002). The 2005 aerial surveys within survey area B covered a total transect line length of 3,674 km and an area of 123,825 km^2 (Burt et al. 2006b).

3.6.2 The Thanet Extension is located in SCANS III survey block L which was surveyed by aircraft covering a total surface area of 31,404 km^2 of which 1,949.3 km was surveyed as the primary search effort (Hammond et al. 2017). It is important to note the change in the survey blocks used in SCANS III. The SCANS II survey block B was split into two main survey blocks for SCANS III, block L and block C (and also includes part of block O and N). By comparison, SCANS III survey block L is approximately a quarter of the size of SCANS II survey block B; therefore, block wide abundance and density information will not be directly comparable between the two surveys. The difference in the survey blocks can be seen in Figure 3.5.

Figure 3.5 The SCANS II and SCANS III aerial survey blocks (Hammond et al. 2013, Hammond et al. 2017). Thanet Extension is located in SCANS II block B and SCANS II block L.



3.6.3 While the SCANS surveys provide sightings, density and abundance estimates for marine mammals present in the North Sea and European Atlantic continental shelf waters, the surveys are conducted during one month, every 11 years and so do not provide fine scale temporal or spatial information on species abundance and distribution.

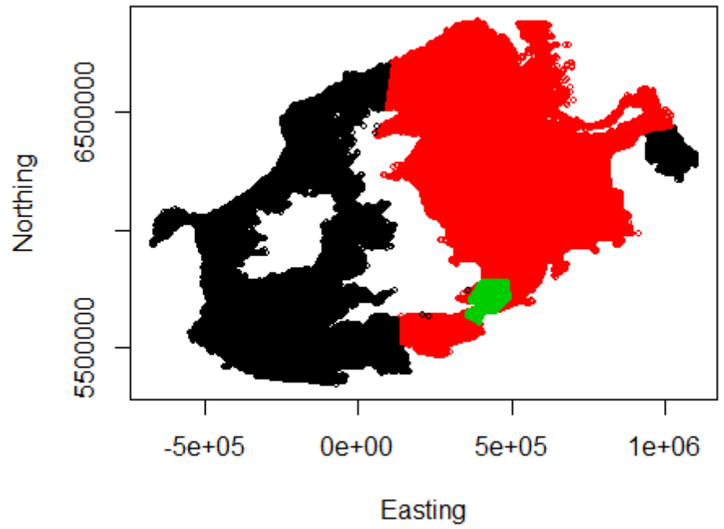
3.7 JCP Phase III Analysis

3.7.1 The Joint Cetacean Protocol (JCP) Phase III analysis included datasets from 38 data sources, totalling over 1.05 million km of survey effort between 1994 and 2010 (Paxton et al. 2016). The JCP Phase III analysis was conducted to combine these data sources to estimate spatial and temporal patterns of abundance for seven species of cetaceans: harbour porpoise, minke whale, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, white-beaked dolphin and Atlantic white-sided dolphin.

3.7.2 In 2017, JNCC released R code that can be used to extract the cetacean abundance estimates for summer 2007-2010 (average) for a user specified area. This code was originally created by Charles Paxton at CREEM, and was modified by JNCC to include abundance estimates that are scaled to the SCANS III results. The user specified area used to extract these abundance estimates is shown in

3.7.3 in green and consists of a total area of 13,229.7 km2.

Figure 3 6 The user specified area used to extract cetacean abundance and density estimates from the JCP III R code. The map shows the whole area under consideration (black), the harbour porpoise North Sea MU (red) and the specific area of interest (green).



3.8 JNCC Report 544: Harbour Porpoise Density

3.8.1 Heinänen and Skov (2015) conducted a detailed analysis of 18 years of survey data on harbour porpoise around the UK between 1994 and 2011 collected by the JCP. The goal of this analysis was to try to identify "discrete and persistent areas" that might be considered important for harbour porpoise with the ultimate goal of determining SACs for the species. Their approach involved constructing predictive models using corrected sightings rates analysed with respect to topographic, hydrodynamic and anthropogenic covariates and then generating predicted distribution maps of density estimates for the waters around the UK. The analysis grouped data into three subsets: 1994-1999, 2000-2005 and 2006-2011 to account for patchy survey effort and analysed summer (April-September) and winter (October- March) data separately to explore whether distribution patterns were different between seasons. The authors note that "*due to the uneven survey effort over the modelled period, the uncertainty in modelled distributions vary to a large extent*" and that "*model uncertainties are particularly high during winter*"

3.8.2 The areas identified as containing persistently high predicted harbour porpoise densities were formed of high confidence data, and were used as part of the assessment conducted by JNCC and NE to designate five cSACs for harbour porpoise in England, Wales and Northern Ireland.

3.9 SMRU Seal Haul-out Surveys

3.9.1 The Sea Mammal Research Unit (SMRU) carries out surveys of harbour and grey seals in Scotland and on the east coast of England to contribute to NERC's statutory obligation under the Conservation of Seals Act 1970 'to provide the (UK government) with scientific advice on matters related to the management of seal populations'. These SMRU surveys are funded by NERC, SNH and Natural England and are used form the routine, statutory monitoring of seal populations around the UK.

Harbour Seals

3.9.2 Surveys of harbour seals are carried out during the summer months. The main population surveys are carried out when harbour seals are moulting, during the first three weeks of August. To maximise the numbers of seals on shore and to reduce the effects of environmental variables on counts, surveys are restricted to within two hours either side of afternoon low tides on days with no rain. Grey seals are also counted on all harbour seal surveys, although this data does not necessarily provide a reliable index of population size. The counts obtained represent the number of seals that were on shore at the time of the survey and are an estimate of the minimum size of the population. They do not represent the total size of the local population since a number of seals would have been at sea at the time of the survey. It is noted that these data refer to the numbers of seals found within the surveyed areas only at the time of the survey; numbers and distribution may differ at other times of the year.

3.9.3 Since 2001, SMRU have carried out pup counts of the entire breeding population in The Wash. Since 2004 this has involved a single annual breeding season count, commissioned by Natural England. These counts are conducted at the end of June or beginning of July when the peak counts are expected. Periodically, additional series of surveys are needed within a breeding season to re-estimate the date of the peak number of pups ashore. In addition, the repeat surveys provide information on the ratio between peak pup counts and pup production and can provide information on the likely error on estimates of pup production. Sequences of five surveys spread across the breeding season were carried out in 2008, 2010, 2015 and 2016.

Grey Seals

3.9.4 Grey seals aggregate in the autumn to breed at traditional colonies. Their distribution during the breeding season is very different to their distribution at other times of the year. SMRU's main surveys of grey seals are designed to estimate the numbers of pups born at the main breeding colonies around Scotland. Breeding grey seals are surveyed annually between mid-September and late November using large-format vertical photography from a fixed-wing aircraft. Over 60 colonies are surveyed annually between three and seven times, at 10 to 12 day intervals, through the breeding season. Total pup production for each colony is derived from the series of counts obtained. Approximately 40 additional colonies are surveyed less regularly. The main grey seal breeding colonies in Shetland, England, Wales and Northern Ireland are counted by other, local, organisations. Scottish Natural Heritage (SNH) staff count pups in Shetland in a manner compatible with counts from aerially surveyed colonies.

3.9.5 While grey seals are counted during the August harbour seal moult surveys, SMRU does not conduct regular targeted grey seal haul-out surveys in England. A complete survey of grey seal August counts in the Northeast England MU was last conducted in 2008. In addition to this, helicopter surveys with thermal imagers from the Farne Islands to the Scottish boarder were conducted most recently in 2015.

3.10 SMRU Seal Telemetry

3.10.1 SMRU has deployed telemetry tags on grey seals and harbour seals in the UK since 1988 and 2001, respectively. These tags transmit data on seal locations with the tag duration (number of days) varying between individual deployments. There are two types of telemetry tag which differ by their data transmission methods. Data transmission can be through the ARGOS satellite system (ARGOS tags) or GPS Phone tags which combine GPS quality locations with transmission of data using the GSM mobile phone network. Both types of transmission result in location fixes, but data from GPS phone tags comprise better quality and more frequent locations by incorporating the Fastloc GPS system (Wildtrack Telemetry Systems, UK) which obtains the GPS location within a fraction of second and therefore collects data even when the animal surfaces for a short period. The GPS tags attempt to collect location data every 5 minutes. Both types of tags use precision wet/dry sensors as well as pressure and temperature sensors to obtain detailed individual dive (max depth, shape, time at depth, etc.) and haul-out records. Data are stored on board the tags and then relayed by a satellite (ARGOS tags) or by quad-band GSM mobile phone module to SMRU when the animal is within range of the GSM mobile phone network. The data are then stored in databases, cleaned according to methods described in Russell et al. (2011) and processed for analysis. Telemetry data are particularly useful as they provide information on seal movement patterns away from their haul-out sites, provide data on the foraging behaviour of seals at sea and demonstrate connectivity between areas.

3.11 Seal Usage Maps

3.11.1 The seal at-sea usage maps were created in order to predict the at-sea density of seals in order to inform impact assessments and marine spatial planning. The original SMRU seal density maps were produced as a deliverable of Scottish Government Marine Mammal Scientific Support Research Programme (MMSS/001/01) and were published in Jones et al. (2015). These have since been revised to include new seal telemetry and haul-out count data and modifications have been made to the modelling process (Russell et al. 2017). The analysis uses telemetry data from 270 grey seals and 330 harbour seals tagged in the UK only between 1991 – 2015, and haul-out count data from 1996 - 2015 to produce UK-wide maps of estimated at-sea density with associated uncertainty. The combined at-sea usage and haul-out data were scaled to the population size estimate from 2015.

3.12 ZSL Seal Counts

3.12.1 The Zoological Society of London (ZSL) has conducted surveys of both harbour and grey seals in the Greater Thames Estuary annually during the August harbour seal moult since 2013. These data combine three aerial, two boat and two land-based transects to make a comprehensive count of harbour seals in the region. The counts are conducted within two hours either side of low tide, when the greatest number of seals are likely to be hauled out.

3.13 SCOS

3.13.1 Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) provides scientific advice to government on matters related to the management of seal populations through the advice provided by the Special Committee on Seals (SCOS). SMRU provides this advice to SCOS on an annual basis through meetings and an annual report. The report includes advice on matters related to the management of seal populations, including general information on British seals, information on their current status, and addresses specific questions raised by regulators and stakeholders. The most recent publically available SCOS report is SCOS (2017) which presents the data collected up to 2016.

4. Baseline Data

4.1.1 The following sections describe the available data on marine mammals within the North Sea and in relation to the Thanet Extension, in order to determine their spatial and temporal patterns of abundance and density.

4.2 Harbour Porpoise

4.2.1 Harbour porpoise are the smallest and most abundant cetacean species in UK waters (Reid et al. 2003). They are typically sighted in small groups between one and three individuals. Animals are frequently sighted throughout coastal habitats with studies suggesting they are highly mobile and cover large distances (Nabe-Nielsen et al. 2011). Harbour porpoise in the UK are considered to have a FCS (JNCC 2013). Thanet Extension is located within the North Sea MU for harbour porpoise (IAMMWG 2015), which is estimated to have an abundance of 227,298 porpoise (95% CI: 176,360 – 292,948) based on estimates from Hammond et al. (2013). The modelling conducted on the SCANS II data have since been revised using a point independence model which is less likely to result in a negatively biased abundance estimate. The revised harbour porpoise abundance for the North Sea using the SCANS II data was 355,000 (CV 0.22) (Hammond et al. 2017) which suggests that the IAMMWG (2015) MU abundance data should therefore be considered out of date and not applicable.

4.2.2 Based on the SCANS III data (Hammond et al. 2017), the estimated abundance of harbour porpoise in the ICES North Sea Assessment Unit is 345,373 (95% CI: 246,526 – 495,752) with an estimated density of 0.52 porpoise/km^2. The trend analysis conducted as of estimates in the North Sea and the Skagerrak/Kattegat/Belt Seas show no support for changes in harbour porpoise abundance since 1994 (Hammond et al. 2017).

4.2.3 The following sections describe the available data on harbour porpoise within the North Sea Management Unit and, specifically, in relation to the Thanet Extension, in order to determine their spatial and temporal patterns of abundance and density.

Thanet Extension Offshore Wind Farm

Vessel surveys

4.2.4 During the three months of vessel line transect surveys conducted across the Thanet Extension area a total of 33 harbour porpoise were sighted with a maximum sightings rate of 0.187 porpoise/km in February 2016 (Table 4.1). The sightings were all primarily located on the eastern side of the survey area (Figure 4.2).

Table 4.1 Harbour porpoise counts during the 3 months of vessel surveys covering the Thanet Extension Offshore Wind Farm survey area.

	TOWF	Thanet Extension	Thanet Extension 4km buffer	Total Count	Distance Surveyed (km)	Sightings Rate (#/km)
Jan-16	3	2	6	**11**	84.4	0.130
Feb-16	1	1	22	**24**	128.5	0.187
Mar-16	0	0	5	**5**	122.8	0.041
Total Count	**4**	**3**	**33**			

Aerial surveys

4.2.5 During the 24 months of aerial surveys conducted across the Thanet Extension survey area, a total of 47 harbour porpoise have been identified from the still images collected by APEM (Table 4.2). A further 235 sightings of small cetaceans of insufficient quality to identify to species were also recorded during these surveys (Table 4.2). The reason behind the high number of "unidentified small cetacean" sightings (83% of the cetacean sightings) is due to the strict probability scoring of the photographs for species identification. A large number of the photographs were of submerged animals where the reviewers found it difficult to be 100% confident in their species identification and therefore were unable to categorise the species identification as "definite". Many of these "unidentified small cetacean" sightings are likely to be "probable" harbour porpoise; therefore, for the purpose of analysis the two datasets (definite harbour porpoise and unidentified small cetacean) were combined and treated as all harbour porpoise. When these two datasets are combined then there is an apparent seasonal pattern to the sightings data, where sightings are highest in late winter/ early spring. Although it is important to note that the effects of variable sighting conditions have not been considered in this analysis and care must be taken not to confound seasonal patterns with differences in detectability. While sightings were highest in February and March 2017, the survey in February 2017 was one of only two surveys to be conducted in sea state one (ripples in water). Harbour porpoise are notoriously difficult to detect during visual surveys due to their small size and inconspicuous surfacing behaviours. The detection probabilities for cryptic species, such as the harbour porpoise, are estimated to decrease with increasing sea state leading to most harbour porpoise visual studies to be restricted to sea conditions up to a maximum of sea state two (small wavelets that do not break). Although most studies of the effect of sea state on harbour porpoise detectability have been carried out in relation to boat-based visual surveys, it is also likely that sea conditions may affect harbour porpoise detectability during aerial surveys, although perhaps to a lesser extent when sighting conditions allow the detection of non-surfacing animals.

4.2.6 There is a spatial pattern in the sightings of combined harbour porpoise and dolphin/porpoise. The sightings in the summer months were loosely clustered in the north-east part of the survey area, while in the winter months there is a concentration of sightings in the south-eastern part of the survey area (Figure 4.3)

Table 4.2 Combined counts of porpoise and unidentified small cetacean sightings during the 24 months of aerial surveys covering the Thanet Extension survey area.

	Porpoise	Unidentified small cetacean	Total	Sea State
Mar-16	0	9	9	**2**
Apr-16	4	9	13	**2**
May-16	0	0	0	**2**
Jun-16	1	2	3	**1-3**
Jul-16	5	0	5	**2**
Aug-16	3	1	4	**1-3**
Sep-16	1	0	1	**2-3**
Oct-16	0	1	1	**3**
Nov-16	0	6	6	**3-4**
Dec-16	2	2	4	**3**
Jan-17	0	4	4	**3**
Feb-17	15	56	71	**1**
Mar-17	11	61	72	1-4
Apr-17	1	4	5	1-2
May-17	0	1	1	1
Jun-17	2	8	10	2-3
Jul-17	0	0	0	3-4
Aug-17	2	5	7	2-3
Sep-17	0	1	1	2-3
Oct-17	0	4	4	3-4
Nov-17	0	3	3	2-3
Dec-17	0	1	1	3
Jan-18	0	31	31	1-3
Feb-18	0	26	26	1
Total Count	**47**	**235**	**282**	

4.2.7 Porpoise abundance was estimated by dividing the raw counts by the number of images taken to provide a mean number of porpoise per image. This was then multiplied by the total number of images required for the survey area. The resulting abundance and density estimates are provided in Table 4.3.

4.2.8 A report produced by APEM (Voet et al. 2017) provides a correction factor to account for availability bias in aerial digital still surveys. This correction factor assumes that the top 2 m of water are visible in the digital still images and uses animal-borne telemetry data from Teilmann et al. (2007) and Teilmann et al. (2013) on the proportion of time that harbour porpoise spend in the top two meters of the water column. The abundance estimate is then adjusted by this correction factor to account for animals below two meters water depth that are not available for detection at the time of the survey.

4.2.9 The telemetry data presented in Teilmann *et al.* (2007) and Teilmann *et al.* (2013) demonstrated significant variation in the depth distribution of porpoise with season. Therefore a seasonal correction factor was applied where the mean total time harbour porpoises spent at zero to two meters was 47.2% in winter, 57.1% in spring, 54.7% in summer and 45.5% in autumn. The corrected abundance and density data are presented in Table 4.3. The existing data available in the literature and from site-specific surveys at nearby OWF (as outlined below) show that no species of dolphin is common in the greater Thames Estuary area; therefore it is unlikely that these unidentified small cetacean sightings are dolphin species. Therefore, the same correction factor was applied to the unidentified small cetacean sightings, densities were calculated based on a survey area of 345 km^2 and combined with the harbour porpoise data Table 4.3. These data present corrected densities of up to 4.11 combined porpoise/dolphins per km^2 in February 2017 and 3.21 combined porpoise/dolphin per km^2 in March 2017, with much lower densities throughout the rest of the year (mean of 0.61 combined porpoise/dolphins per km^2, Table 4.3 and Figure 4.1 Corrected density estimates for combined “harbour porpoise” and “dolphin/porpoise” by survey month between March 2016 and February 2018). Interestingly the estimated peak in density in March 2017 is not reflected in the March 2016 data (0.43 in March 2016 and 3.21 in March 2017). Likewise the estimated peak density in February 2017 (4.11 combined porpoise/dolphins per km^2) was not reflected in the February 2018 data where the estimated density was much lower (1.45 combined porpoise/dolphins per km^2).

4.2.10 This correction factor is based on the assumption that the digital still images provide full visibility of the top two meters of the water column and so it is assumed that any porpoise present between zero to two meters depth will be available for detection (and equally as important, that porpoises below two meters are undetected). This assumption has not been tested and therefore it is important to note that the effect of variable sighting conditions affecting the depth of the water visible during surveys has not been accounted for in these estimates. It would be expected that the visible depth is likely to vary between surveys. Such variation could have the effect of either underestimating (if the portion visible was less than two meters) or overestimating (if the portion visible is more than two meters) harbour porpoise abundance.

4.2.11 Although APEM did not collect site and survey specific turbidity data, they have stated that "*our aerial digital surveys over the Thanet Extension Survey Area did not suffer from heavy loads of turbidity*" and that they "*have confidence in being able to detect down to two metres below the sea surface*" (pers. com. Sean Sweeney, APEM Ltd.).

4.2.12 While site and survey specific measures of visibility in the water column are not available, alternative sources of data on turbidity and sediment concentration data can allow us to make an estimate as to whether or not this assumption may be valid at this site. A common method used to estimate visibility in the water column is to use a Secchi disk which is a black and white disk that is lowered into the water; the depth at which the disc ceases to be visible from the surface is called the "Secchi depth". For example, Capuzzo et al. (2015) have presented the results of secchi depth measurements taken in the southern and central north sea during the 20th century. Their results showed that for the East Anglia Plume area (within which the Thanet Extension is located), the mean secchi depth measurements post 1950 were 5.52 m in the summer (n=45, SD=1.06) and 1.1 m in the spring/autumn (n=43, SD=0.82). While the exact depths are not listed for all 88 measurements, the mean of 5.52 and 1.1 is 3.31 m. If these measurements are representative of the visibility at the Thanet Extension site, then the correction factor assuming a 2 m visible depth may be underestimating the visible depth in the summer (and therefore overestimating the number of porpoise) and overestimating the visible depth in the spring/autumn (and therefore underestimating the number of porpoise). If the average of 3.31 m is true then the 2 m correction factor will underestimate the visible depth and therefore overestimate the number of porpoise predicted to be present, which makes the resulting estimate precautionary.

4.2.13 In another study, Aarup (2002) presents secchi depth measurements from across the North Sea and the Balitc Sea. The raw data were available from this study and there were a total of 76 secchi depth readings from within a 10 km buffer around the Thanet Extension study area. These data are from 1994 and 1997 and for the months May – November. The secchi depth readings varied considerably from 0 to 7 m, with an average across all 76 measurements of 2.3 m. While these data are not recent, they are within the Thanet Extension area and show that, while there is a high level of variability in the data, the average of 2.3 m visible depth would support the assumption that on average a 2 m depth visibility is possible at this site and that the correction factor applied to the data is suitable.

4.2.14 As detailed in Volume 2 Chapter 2: Marine Geology, Oceanography and Physical Processes, monthly averaged satellite imagery of surface suspended particulate matter within the Thanet Extension array area is generally >10 mg/l, with higher concentrations in the winter months (30 – 80 mg/l) occasionally reaching up to 100 mg/l. By applying a general rule of thumb of <100 mg/l SPM = Kd 0.97 (pers. com. Mike Best, Environment Agency) and S=1.4/Kd where S= secchi depth and Kd= light attenuation (Kirk 1994) then the levels of suspended particulate matter within the Thanet Extension array area of <100 mg/l would result in an estimated secchi depth visibility of 1.44 m. However, it should be noted that this is a very rough and ready rule of thumb, that surface reflection can result in significant errors when measuring secchi depths and that this rule of thumb estimate is less reliable for more turbid transitional water bodies.

4.2.15 If we assume that the average visible depth during the surveys was 1.5 m and that animals distribute themselves uniformly between 0 and 2 m depth, then the correction factor can be adjusted by multiplying it by 0.75. This results in an average corrected density of 0.69 combined porpoise and dolphin/porpoise/km^2 across the 22 survey months.

4.2.16 Given that no survey and site specific data are available, the assumption of visibility to 2 m depth has been taken forward based on APEMs confidence in their ability to see animals to this depth at this site. Given the effects of variable detectability (both from variable sea state and from visibility into the water column), there remains some uncertainty in the extent of these remaining potential biases, and therefore in the extent that these estimates can be considered robust absolute density estimates. However, this approach represents a step forward in correcting survey biases in marine mammal aerial survey data and correlates closely with estimated densities from other methods. The mean density estimated from the Thanet Extension aerial surveys (0.610 combined porpoise/dolphins per km^2) is fractionally higher than the SCANS III Block L estimate of 0.607 porpoise/km^2, however, the SCANS III density estimates have 95% confidence intervals while the APEM data do not. Therefore the resulting mean site specific survey estimates (plus minimum and maximum density) will be used in the marine mammal impact assessment alongside mean density estimates from the SCANS III survey (plus 95% Confidence Intervals). This has been agreed with the Offshore Ecology Technical Expert Panel.

Table 4.3 Abundance and density estimates for the sightings of "harbour porpoise" combined with the additional "dolphin/porpoise" sightings before and after correcting for availability bias with the correction factor (Voet et al. 2017).

	Abundance	Density (#/km²)	Correction Factor	Corrected Abundance	Corrected Density (#/km²)	Sea State
	Combined Porpoise and Dolphin/Porpoise					
Mar-16	85	0.25	0.571	149	0.43	2
Apr-16	123	0.36	0.571	215	0.62	2
May-16	0	0.00	0.571	0	0.00	2
Jun-16	25	0.07	0.547	46	0.13	1-3
Jul-16	43	0.12	0.547	79	0.23	2
Aug-16	33	0.10	0.547	60	0.17	1-3
Sep-16	9	0.03	0.455	20	0.06	2-3
Oct-16	8	0.02	0.455	18	0.05	3
Nov-16	53	0.15	0.455	116	0.34	3-4
Dec-16	36	0.10	0.472	76	0.22	3
Jan-17	34	0.10	0.472	72	0.21	3
Feb-17	671	1.94	0.472	1422	4.11	1
Mar-17	633	1.83	0.571	1109	3.21	1-4
Apr-17	47	0.14	0.571	82	0.24	1-2
May-17	9	0.03	0.571	16	0.05	1
Jun-17	94	0.27	0.547	172	0.50	2-3
Jul-17	0	0.00	0.547	0	0.00	3-4
Aug-17	66	0.19	0.547	121	0.35	2-3
Sep-17	9	0.03	0.455	20	0.06	2-3
Oct-17	38	0.11	0.455	84	0.24	3-4
Nov-17	28	0.08	0.455	62	0.18	2-3
Dec-17	9	0.03	0.472	19	0.06	3
Jan-18	285	0.82	0.472	604	1.75	1-3
Feb-18	236	0.68	0.472	500	1.45	1
			Min	**0**	**0.00**	
			Mean	**211**	**0.61**	
			Max	**1,422**	**4.11**	

Figure 4.1 Corrected density estimates for combined "harbour porpoise" and "dolphin/porpoise" by survey month between March 2016 and February 2018.

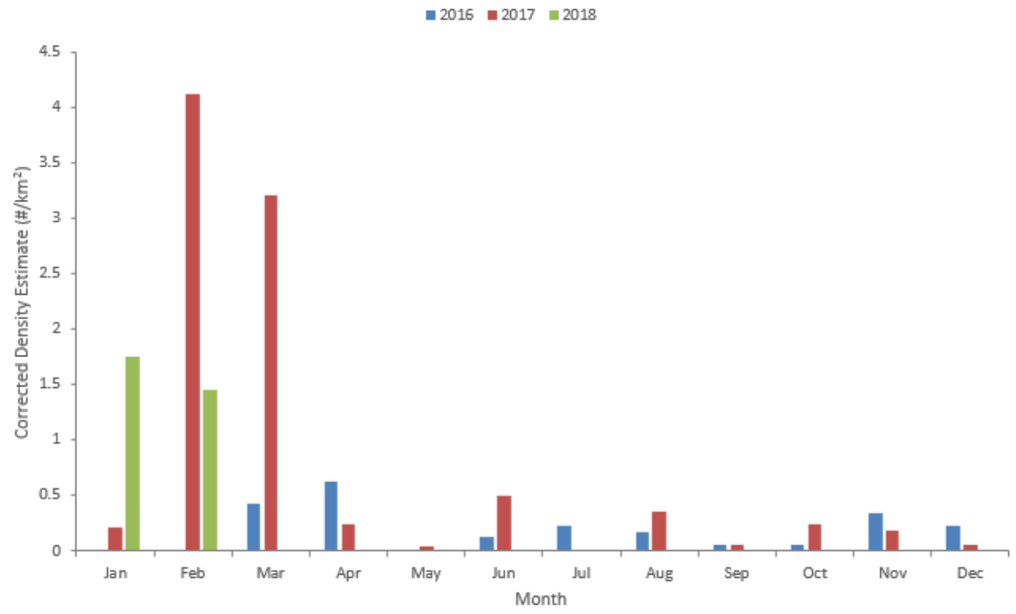


Figure 4.2 Sightings of marine mammals during the 3 months of Thanet Extension vessel surveys.

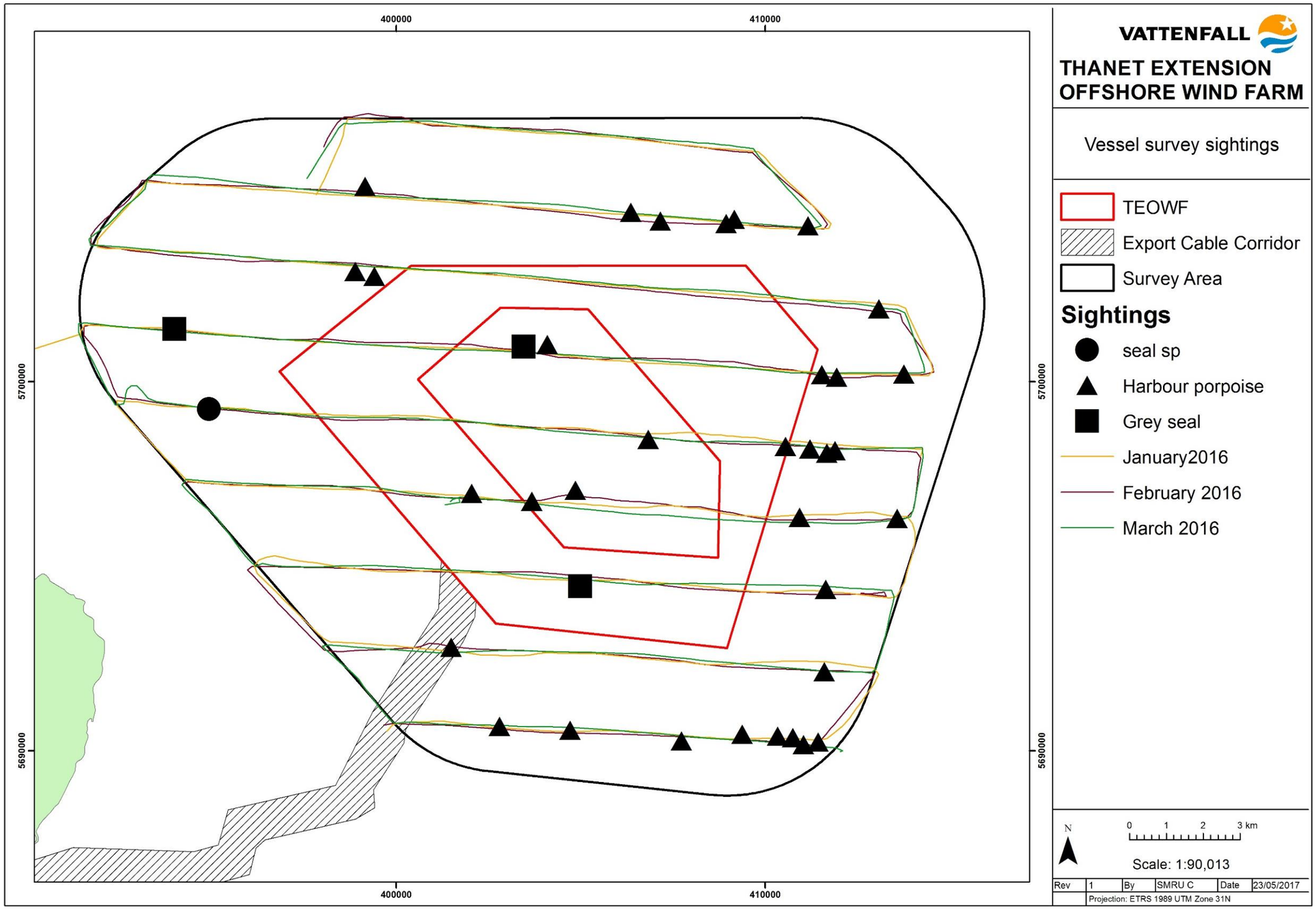
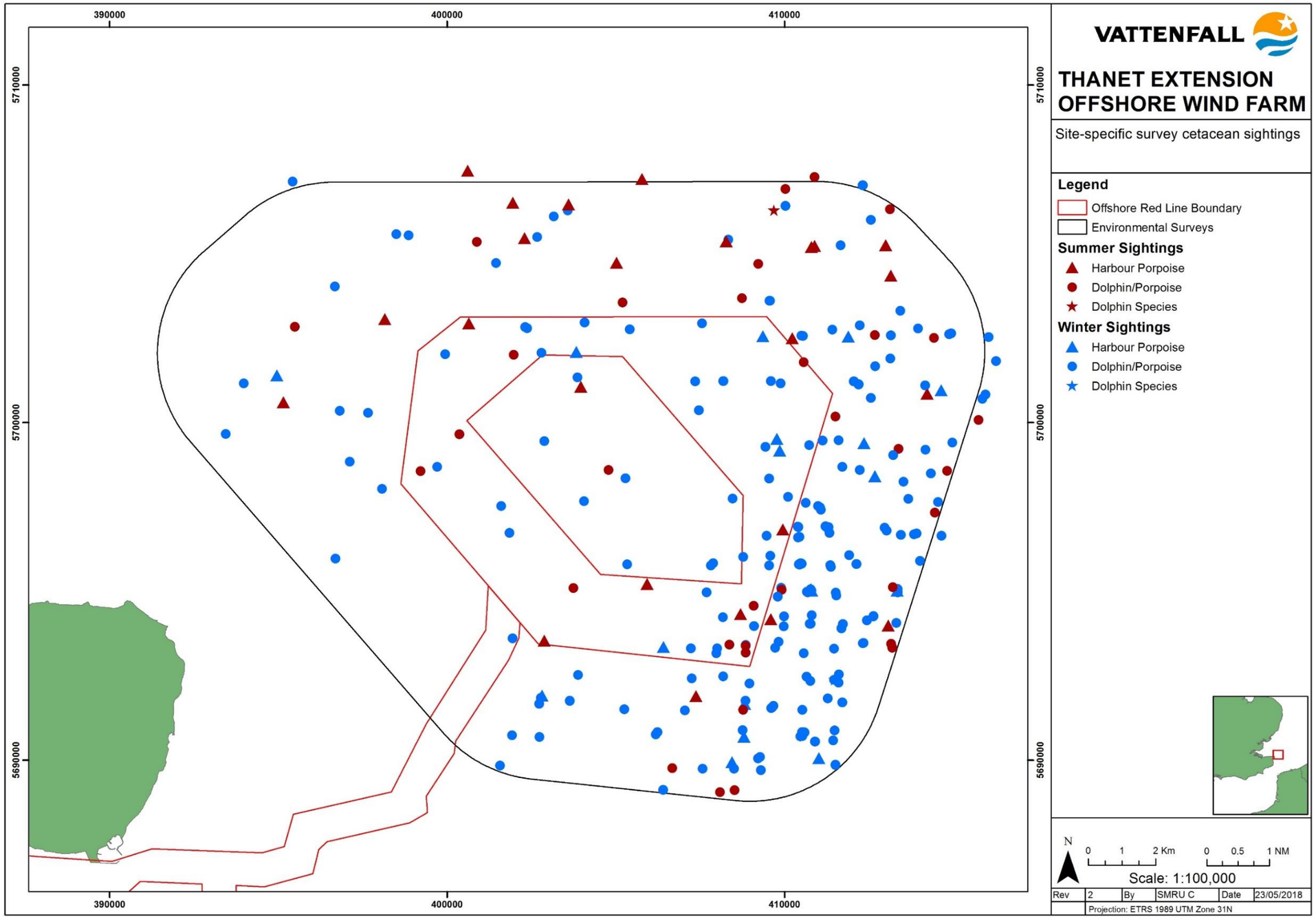


Figure 4.3 Sightings of harbour porpoise and dolphin/porpoise during the 24 months of APEM Thanet Extension aerial surveys. Summer = Apr-Sep, Winter = Oct-Mar.



Thanet Offshore Wind Farm Ornithological Surveys

4.2.17 Harbour porpoise were the main cetacean species sighted during the pre-, during and post-construction TOWF ornithological vessel based surveys. The survey data collected were analysed to determine if there was evidence of a change in harbour porpoise numbers during the construction phase. The results of this analysis identified a statistically significant decline in porpoise incidental sightings within the TOWF site during the construction phase compared to the pre-construction baseline, with no statistical evidence of a decline outside of the TOWF site or beyond the end of the construction period (TOWFL 2013a). The fact that porpoises were sighted during construction surveys indicates that they were not completely excluded during construction. These data may also indicate that the construction of TOWF only resulted in small scale and temporary disturbance of harbour porpoises. However, it should be noted that these are only incidental sightings and not dedicated marine mammal surveys. Therefore, any comparison relies on a constant detection probability over time for marine mammals – an assumption that remains untested for these surveys.

4.2.18 The post-construction monitoring data show that harbour porpoise were incidentally sighted in all surveyed months (October to March) across all post-construction survey years, with increasing numbers of incidental sightings between January and March compared to October-December (Figure 4.4). The locations of the incidental sightings made during the post-construction surveys between 2010 and 2013 show a change in sightings locations from being primarily located in the south east corner of the TOWF site and buffer in 2010-2011 to the sightings being located in the north and eastern areas of the TOWF site and buffer in 2012-2013 (Figure 4.5). The temporal pattern is similar to that seen in the aerial surveys, with higher number of sightings in the winter months. However, as highlighted above, since no dedicated marine mammal surveys were conducted there may be biases in these data that have not been quantified or corrected for.

Figure 4.4 Harbour porpoise incidental sightings during the Thanet Offshore Wind Farm vessel-based post-construction ornithological surveys between 2010 and 2013.

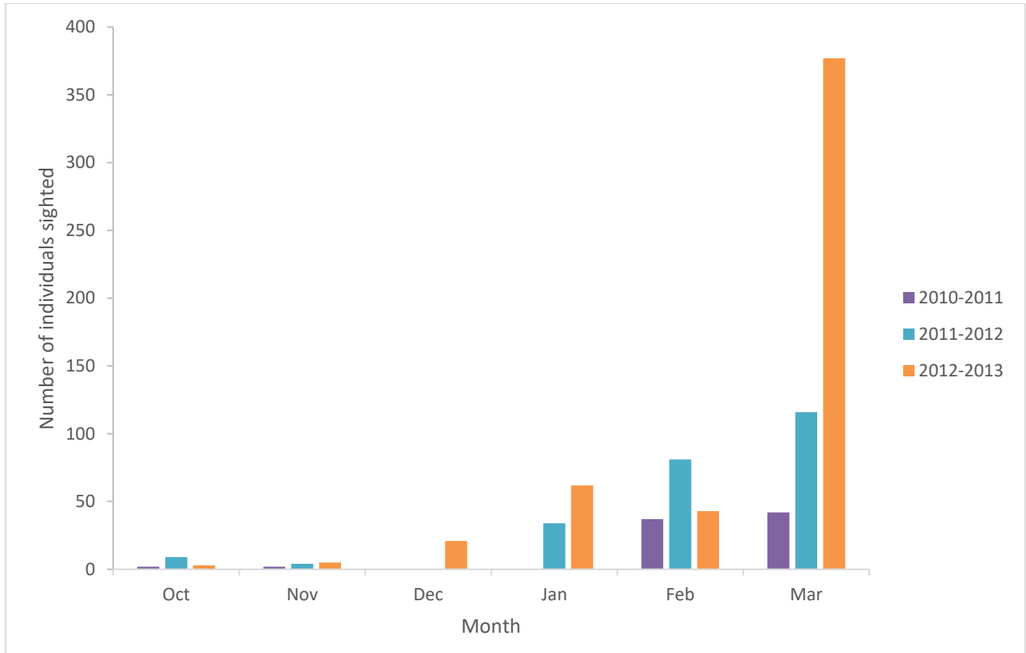
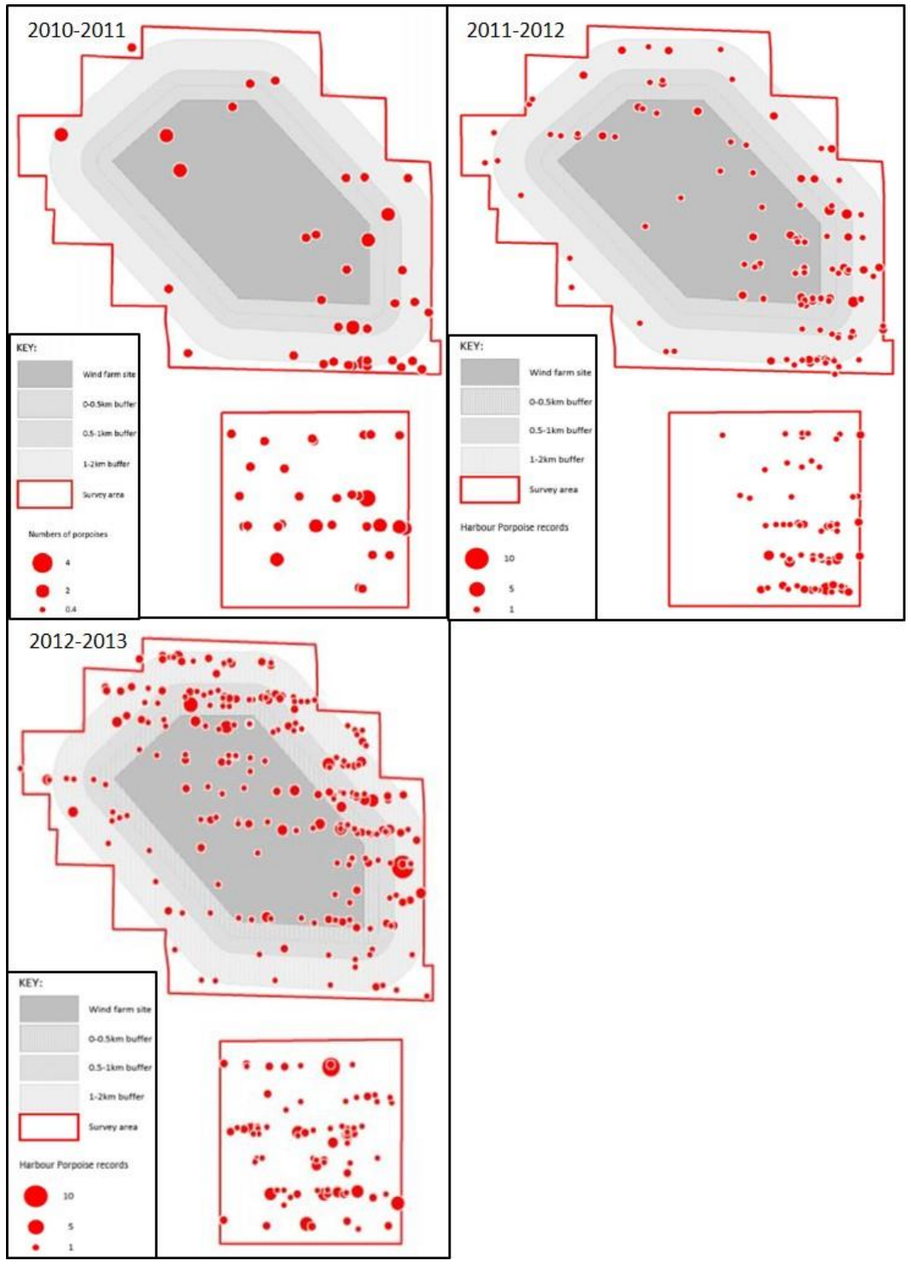


Figure 4.5 Harbour porpoise incidental sightings during the Thanet Offshore Wind Farm post-construction vessel-based ornithological surveys between 2010 and 2011 (TOWFL 2012a), 2011 and 2012 (TOWFL 2012b) and 2012 and 2013 (TOWFL 2013a).



SCANS Surveys

4.2.19 The data collected during the 1994 SCANS I vessel surveys in survey area B produced no sightings of harbour porpoise (Hammond et al. 2002).

4.2.20 The data collected during the 2005 SCANS II aerial surveys produced an abundance estimate of 40,927 porpoise in survey area B (95% CI: 19,192 - 84,607) with a corresponding density of 0.331 porpoise/km^2 (95% CI: 0.155 – 0.683) (Burt et al. 2006b). The SCANS II data were modelled to produce density surface maps for harbour porpoise. From these data, there are 17 grid cells within the Thanet Extension survey area (Figure 4.7). These density estimates range between 0.212 and 0.273 porpoise/km^2 with a mean of 0.243 porpoise/km^2. There is an obvious spatial pattern in the estimated densities within and surrounding the Thanet Extension site and survey area, with higher densities to the north and east of the site and survey area. These data also illustrate that compared to other locations in the North Sea (Figure 4.7 inset) the density of harbour porpoises in the Thanet Extension area are low.

4.2.21 The aerial survey data collected in survey block L for SCANS III produced an estimated harbour porpoise abundance of 19,064 (95% CI: 6,933 – 65,703) and a density of 0.607 porpoise/km^2. These SCANS III density values are taken forward for Thanet Extension impact assessment as they are: a) the most recent of the SCANS survey density estimates and are therefore most likely to represent the current porpoise densities in the area; and b) the density is estimated for a smaller survey block than in previous SCANS surveys which makes it more applicable to the Thanet Extension area than previous survey blocks which estimated the density over a much wider area. However it should be noted that the SCANS III data are for a single summer time point estimate and may not be representative of harbour porpoise abundance and density at other times of the year. Therefore, the SCANS III data will be presented in the impact assessment alongside the results of the APEM Thanet Extension site specific survey to provide a range of estimates.

Joint Cetacean Protocol (JCP) Phase III Analysis

4.2.22 The R code provided by JNCC was used to determine the number of harbour porpoise within the area defined in

4.2.23 . This resulted in a harbour porpoise abundance estimate for the area averaged for summer 2007-2010 of 15,355 (95% CI 8,679 – 22,699) which equates to a density estimate of 1.16 porpoise/km^2 (95% CI 0.66 – 1.72). This is higher than the SCANS III summer 2016 density estimate for block L, however, it is within the range of density estimates obtained from the Thanet Extension surveys where densities ranged between 0.00 and 4.11 porpoise/km^2.

JNCC Report 544: Harbour Porpoise Density

4.2.24 The Heinänen and Skov (2015) analysis concluded that in the summer months, harbour porpoise presence in the North Sea MU was best predicted by season, water depth, surface salinity and eddy potential, while the density was best predicted by season, the water depth and the vertical temperature gradient. For the summer months the modelling showed a peak in densities at the inner shelf waters (30-50 m depth) and that animals seemed to avoid well mixed areas and waters with high current speeds as well as avoiding areas with muddy or hard bottom substrates.

4.2.25 In the winter months the presence of harbour porpoise was best predicted by the season, water depth, eddy potential and the surface sediments. For the winter months the modelling showed a peak in presence was observed at water depths of 30-40 m and that animals seemed to avoid waters with high current speeds as well as avoiding areas with muddy bottom substrates.

4.2.26 Overall, this analysis predicted higher harbour porpoise densities in the winter than the summer, in the southern part of the North Sea MU (Figure 4.8), with predicted density estimates for the Thanet Extension area of up to >3 porpoise/km^2 in the winter of 1997 and up to 3 porpoise/km^2 in the winter of 2009; though it is important to note that the authors stated that "and that "*model uncertainties are particularly high during winter*". It is also worth highlighting here that the analysis presented in Heinänen and Skov (2015) relies on extensive extrapolation of survey data over space and time. Any such extrapolation is sensitive to the covariates used in models, as opposed to predictions within the support of the data. Subjective decisions in the retention of covariates in Heinänen and Skov (2015) calls into question the validity of such extrapolation. The survey effort on which the analysis is based was particularly patchy in time in the southern North Sea which may limit the degree of confidence for any predictions. Despite the noted uncertainties in the data, the areas that were subsequently identified as cSACs for harbour porpoise were formed of high confidence data. It is also important to note that harbour porpoise density varies significantly in space and time as evidenced by the site specific densities obtained from the Thanet Extension surveys where densities ranged between 0.00 and 4.11 porpoise/km^2.

4.2.27 The Thanet Extension is located within the persistent high-density area identified and selected in the southern North Sea Management Unit during the winter (Figure 4.6); which has since been put forward as a cSAC as a result of these data.

Figure 4.6 Predicted persistent high-density areas identified and selected in the North Sea Management Unit during summer (S) and winter (W). Map A identifies areas with persistent high densities as defined by the upper 90th percentile. Map B identifies persistent high-density areas with survey effort from 3+ years.

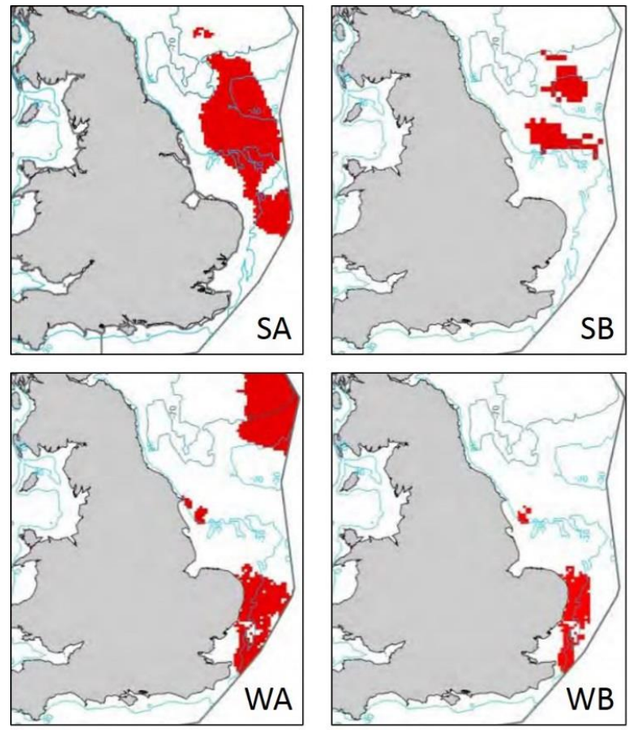


Figure 4.7 Density estimates for harbour porpoise, modelled using the SCANS II data, in relation to the Thanet Extension Offshore Wind Farm.

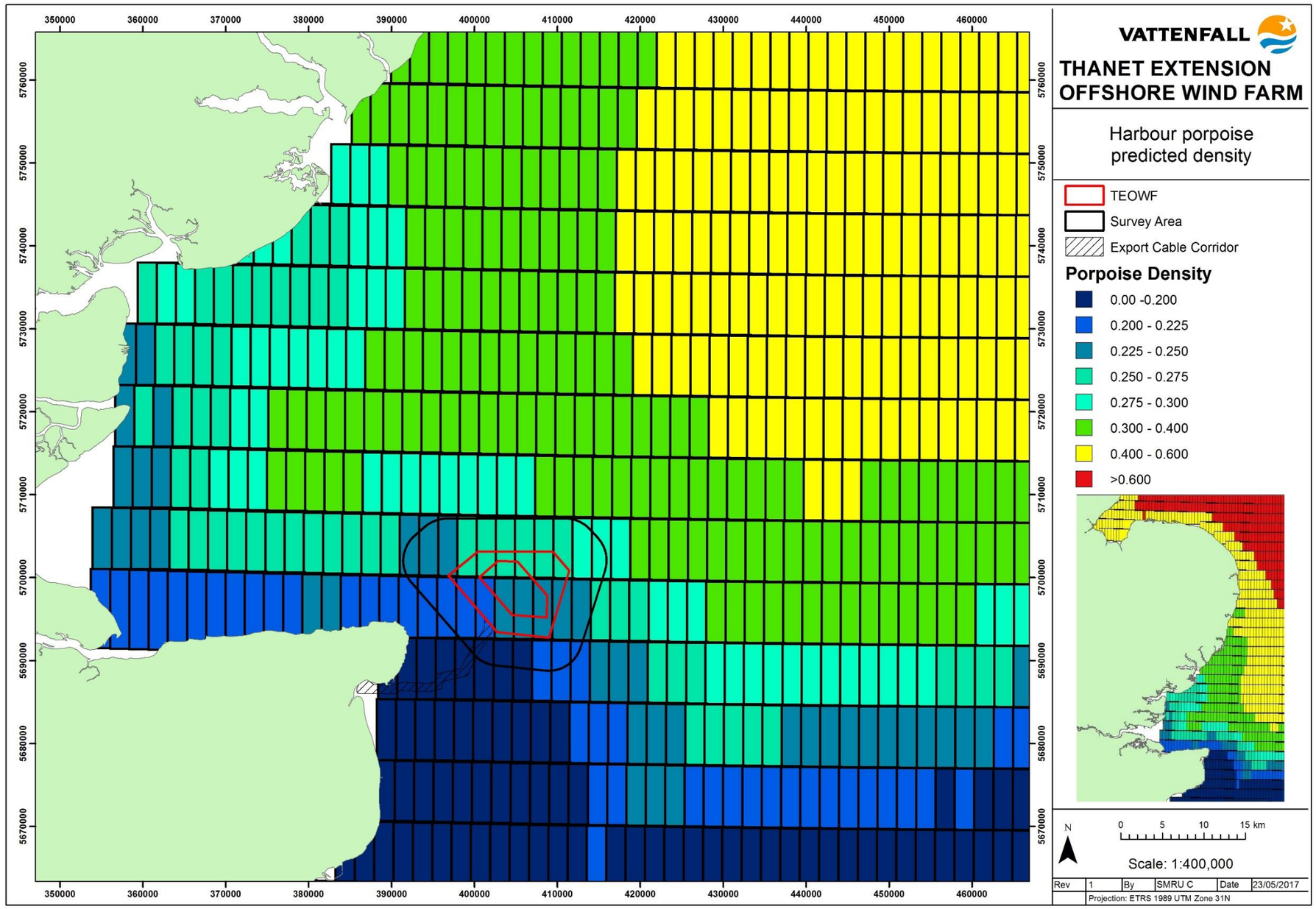
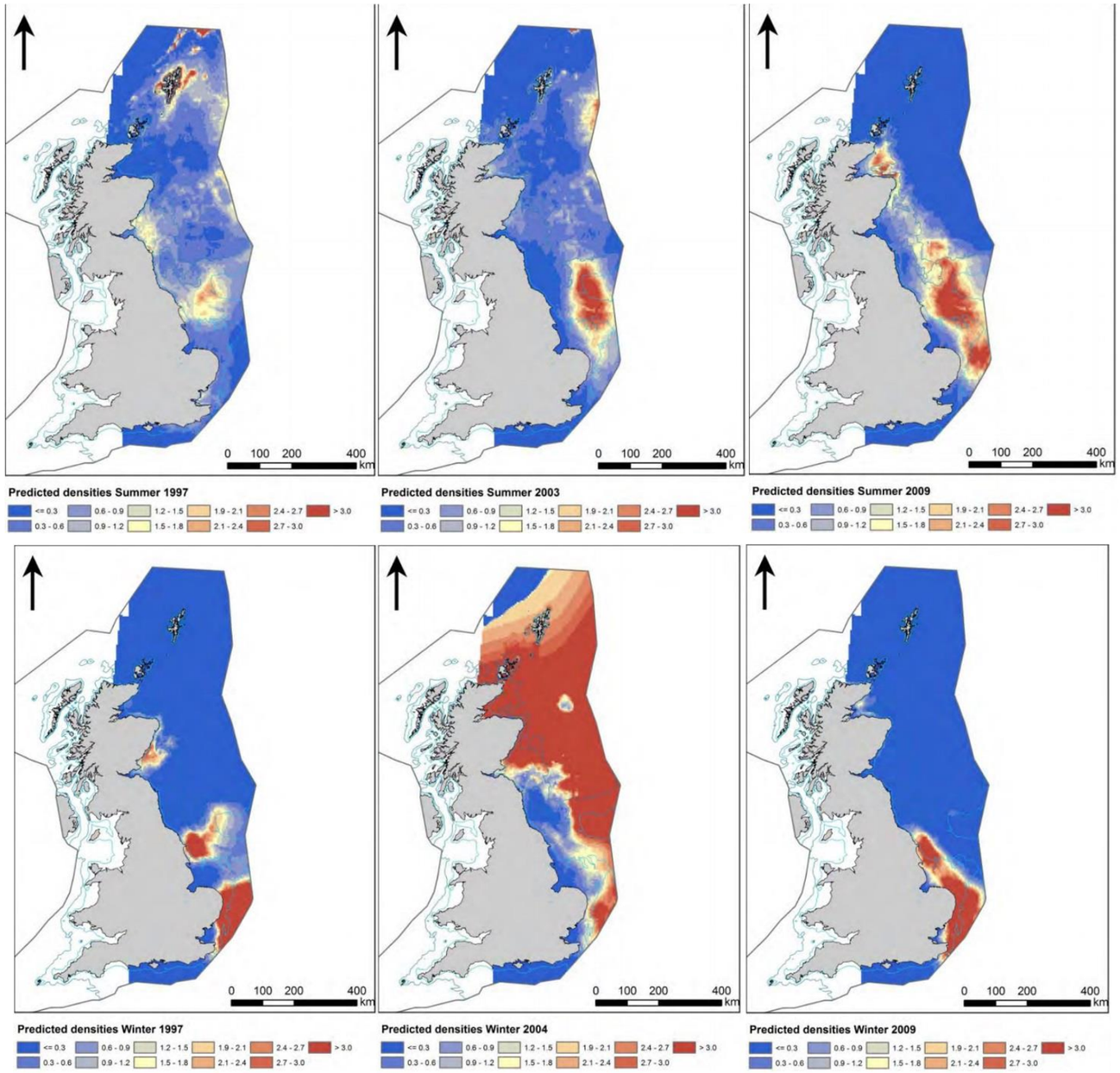


Figure 4.8 Predicted densities (number/km^2) during summer (top) and winter (bottom) in the North Sea Management Unit for three different years in each model period (Heinänen and Skov 2015).



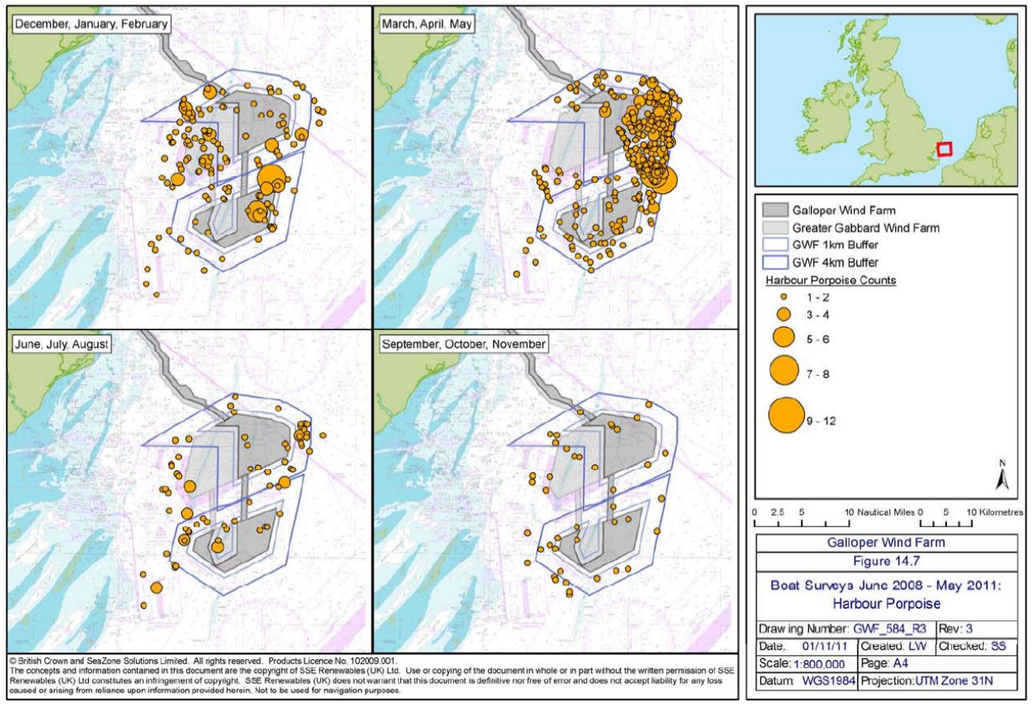
Greater Gabbard & Galloper Offshore Wind Farms

4.2.28 Harbour porpoise were the main species of marine mammal recorded during the GGOWF baseline and GWF pre-construction ornithological surveys with a total of 570 incidental sightings recorded over the surveys. These data highlight that harbour porpoise are present year round in the area, with the highest incidental sightings rate recorded between April and May in 2010 and in the north east parts of the survey area (Figure 4.9).

Table 4.4 Harbour porpoise incidental sightings recorded during the Galloper Wind Farm pre-construction vessel transect surveys (Royal Haskoning 2011). '–'denotes no survey was conducted in that month.

	2008	2009	2010	2011	Total Count
Jan	-	0	6	1	**7**
Feb	-	56	11	24	**91**
Mar	-	21	5	0	**26**
Apr	-	26	156	7	**189**
May	-	-	140	2	**142**
Jun	1	13	8	-	**22**
Jul	1	-	27	-	**28**
Aug	11	5	0	-	**16**
Sep	5	7	3	-	**15**
Oct	3	3	0	-	**6**
Nov	2	-	3	-	**5**
Dec	13	-	10	-	**23**

Figure 4.9 Harbour porpoise incidental sightings during the Galloper vessel based ornithological surveys between June 2008 and May 2011 (Royal Haskoning 2011).



London Array Offshore Wind Farm

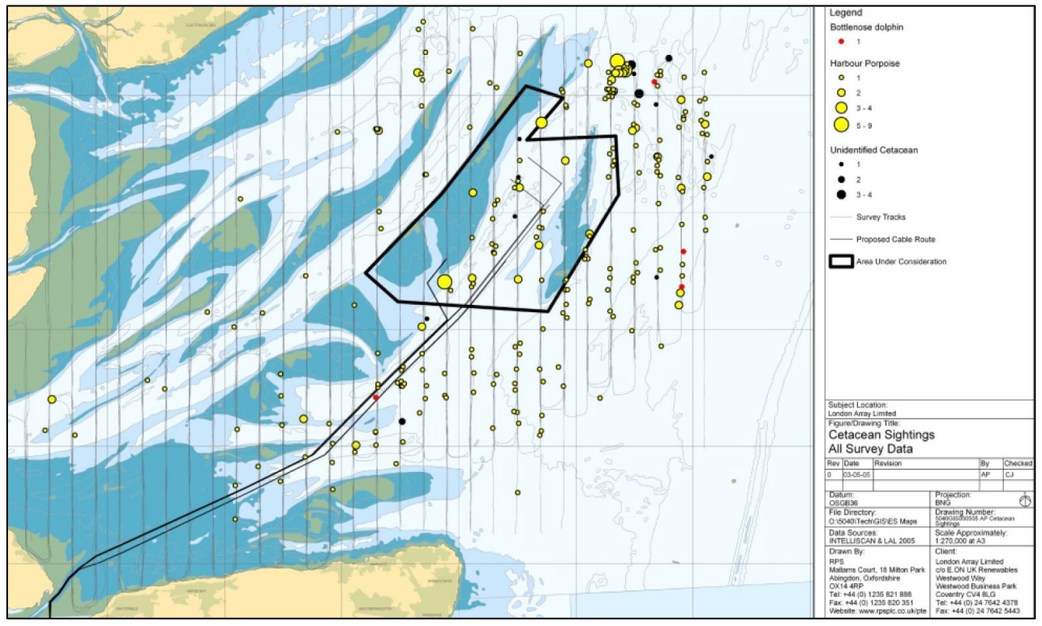
4.2.29 Harbour porpoise were incidentally sighted on six of the pre-construction aerial surveys conducted at the London Array Offshore Wind Farm (RPS 2005). Over these six surveys a total of 6,273 km. During these six surveys, a total of 298 porpoise were incidentally sighted, with most sightings recorded in the month of February in both 2003 and 2004 (Table 4.5).

Table 4.5 Incidental porpoise sightings during the London Array OWF pre-construction aerial surveys for birds between Jan 2002 and Jun 2004.

	Distance (km)	# Sightings
Aug-02	912	4
Jan-03	1219	44
Feb-03	1240	105
Nov-03	764	14
Dec-03	729	6
Feb-04	1409	125
TOTAL	**6273**	**298**

4.2.30 Harbour porpoise were also sighted during the pre-construction vessel survey days conducted at the London Array Offshore Wind Farm (RPS 2005). Over these 39 survey days a total of 3,028.82 km was surveyed which totalled 216.67 hours. During these 39 surveys a total of 80 porpoise were incidentally sighted (Table 4.6 and Figure 4.10). Almost all of the incidental porpoise sightings occurred on 18th February 2004 where 52 porpoise were recorded.

Figure 4.10 Cetacean incidental sightings recorded during the London Array OWF surveys (RPS 2005).



Kentish Flats and Kentish Flats Extension offshore Wind Farms

4.2.31 Harbour porpoise were the only species of cetacean incidentally sighted during the 93 ornithological vessel surveys conducted at the Kentish Flats site between 2002 and 2010. In the 93 surveys, a total of 14 harbour porpoise were incidentally recorded. Only two harbour porpoise were recorded during the five aerial surveys for the Kentish Flats EIA between 2001 and 2003. Both of these surveys report low sightings rates of porpoise, however, since the surveys were conducted for birds and marine mammals were recorded only incidentally, the sightings rates are expected to be underestimates.

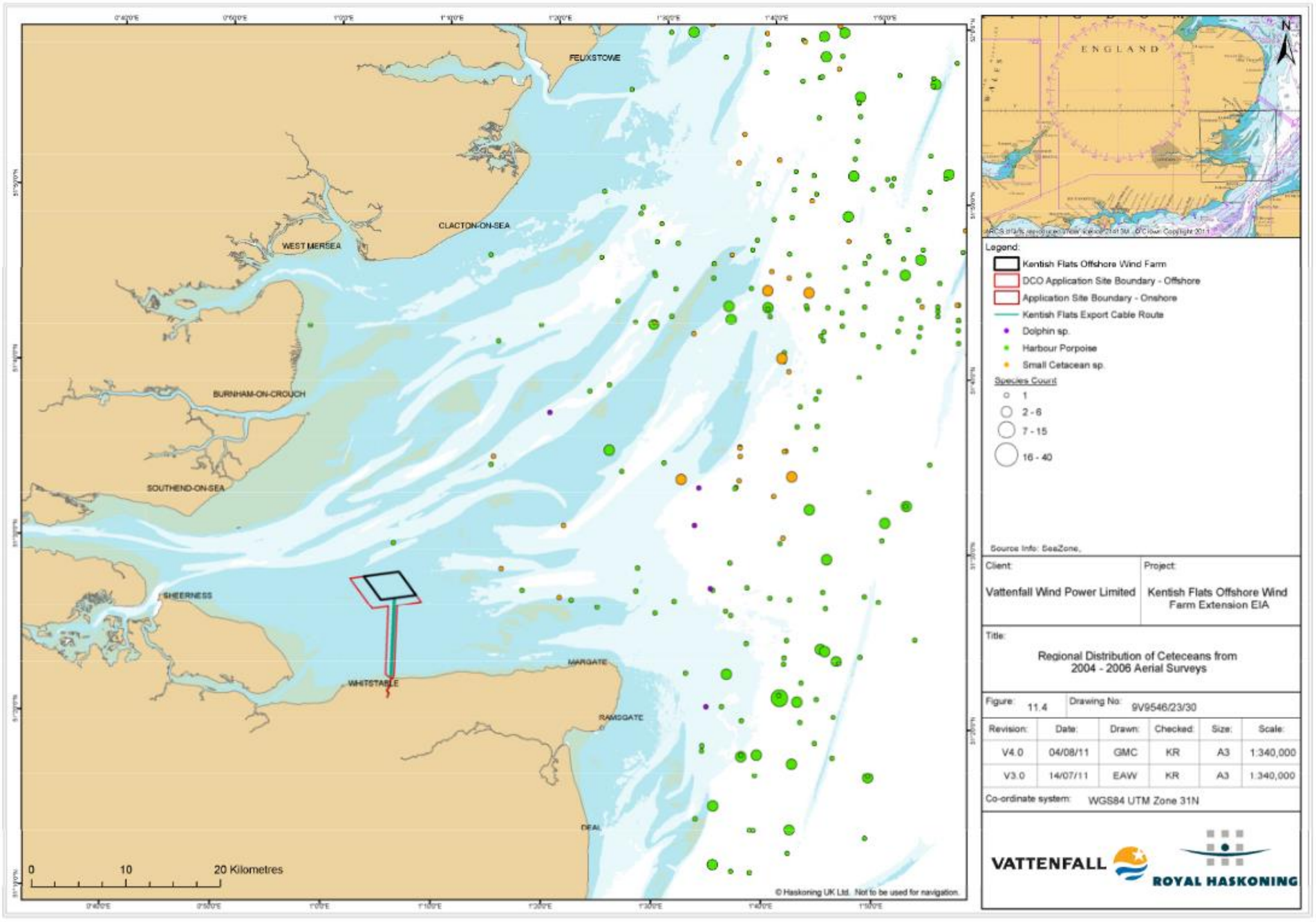
WWT Thames Strategic Environmental Assessment

4.2.32 The Thames Strategic Environmental Assessment aerial surveys recorded sightings of harbour porpoise during the surveys conducted between October 2004 and August 2006. These raw survey data were not available to include in this PEI, however, they have previously been presented in the Kentish Flats Extension ES (VWPL 2011) (Figure 4.11). These sightings show that porpoise were sighted more frequently in the offshore waters of outer Thames Estuary than the more coastal waters or the inner Thames estuary. There were sightings from this survey that overlap with the Thanet Extension survey area and surrounding waters.

Table 4.6 Incidental porpoise sightings during the London Array OWF pre-construction vessel surveys for birds between Oct 2002 and Jun 2004.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	# Sightings	-	-	-	-	-	-	-	-	-	0	3	1
	Distance (km)	-	-	-	-	-	-	-	-	-	252.07	210.35	98.5
	Hours	-	-	-	-	-	-	-	-	-	16.2	11.15	6.3
2003	# Sightings	-	4	-	0	0	0	1	2	1	4	1	2
	Distance (km)	-	206.40	-	190.8	-	192.4	178.3	-	123.9	183.1	176.9	174.6
	Hours	-	14.87	-	13.05	-	12.68	15.11	-	10.35	11.48	13.31	13.23
2004	# Sightings	3	56	2	7	0	6	-	-	-	-	-	-
	Distance (km)	174.30	186.80	140.70	177.20	179.10	183.40	-	-	-	-	-	-
	Hours	13.62	13.85	11.56	12.12	13.57	14.22	-	-	-	-	-	-
TOTAL	**# Sightings**	**3**	**60**	**2**	**7**	**0**	**6**	**1**	**2**	**1**	**4**	**4**	**3**
	Distance (km)	**174.3**	**393.2**	**140.7**	**368.0**	**179.1**	**375.8**	**178.3**	**0.0**	**123.9**	**435.17**	**387.25**	**273.1**
	Hours	**13.62**	**28.72**	**11.56**	**25.17**	**13.57**	**26.90**	**15.11**	**0.00**	**10.35**	**27.68**	**24.46**	**19.53**
	#/km	**0.017**	**0.1526**	**0.014**	**0.019**	**0**	**0.016**	**0.006**		**0.008**	**0.0092**	**0.0103**	**0.011**
	#/hour	**0.22**	**2.0891**	**0.173**	**0.2781**	**0**	**0.223**	**0.066**		**0.097**	**0.1445**	**0.1635**	**0.154**

Figure 4.11 Distribution of cetacean sightings during the 2004-2006 aerial surveys of the Thames Strategic Environmental Assessment Area (VWPL 2011).



Conclusion

4.2.33 All data sources examined have confirmed that harbour porpoise are present in the southern North Sea, within the Greater Thames Estuary area and the Thanet Extension area. There is strong evidence of harbour porpoise density and sightings rates being seasonal in this area although different sources suggest different patterns. The Heinänen and Skov (2015) modelling of the JCP data showed that predicted porpoise densities in the southern North Sea were higher in the winter (October - March) than the summer (April - September). However, the site specific data from the Thanet site and data collected at nearby OWFs, shows that higher numbers of porpoises are generally only seen over the late winter/ early spring period (February - May), with low numbers the rest of the year. From these data it is possible to conclude that harbour porpoise densities in the Thanet Extension area may be higher in the late winter and early spring months in comparison to the rest of the year.

4.2.34 Currently, the only sources of data on the density of harbour porpoise in the Thanet Extension area are from SCANS III (Hammond et al. 2017), the JNCC report on areas of persistent porpoise densities, modelled using the JCP data (Heinänen and Skov 2015) and the density estimates obtained from the APEM aerial surveys of the Thanet Extension survey area (Voet et al. 2017).

4.2.35 The Heinänen and Skov (2015) analysis produced predicted density estimates for the Thanet Extension area of over three porpoise/km^2 in the winter of 1997 and up to three porpoise/km^2 in the winter of 2009. Though it is important to recognise the limitations of the data used and the method of analysis conducted which limits degree of confidence for these density predictions.

4.2.36 The porpoise density estimates presented in Voet *et al*. (2017) using the APEM aerial survey data for the Thanet Extension survey area, corrected for 'availability' provide a mean density of 0.610 porpoise/km^2 and a maximum density of 4.1 per km^2 for combined harbour porpoise and unidentified small cetacean sightings. However, as previously stated, sightings rates and therefore abundance and density estimates are subject to unquantified biases due to different sea states and sightings conditions between surveys. Therefore, there are limitations to the extent to which the corrected densities can be taken as an accurate reflection of absolute abundance. However the similarity between the APEM derived estimate and the SCANS III estimate (0.607 porpoise/km^2) provides some confidence that the digital aerial survey derived estimate is representative of porpoise presence at the site. Although it is important to bear in mind the differences in spatial and temporal coverage between these two data sources.

4.2.37 The SCANS III surveys estimated a block-wide density of 0.607 porpoise/km^2 (Hammond *et al*. 2017). The results of the quantitative impact assessment are presented below for both the SCANS III density estimate and the APEM density estimate.

4.3 Harbour Seal

4.3.1 Harbour seals are the smaller of the two species of seal resident in UK waters. They forage at sea and haul-out on land to rest, moult and breed. Harbour seals normally feed within 40-50 km around their haul-out sites and take a wide variety of prey including sandeels, gadoids, herring and sprat, flatfish, octopus and squid (SCOS 2017).

4.3.2 Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. They give birth to their pups in June and July and moult in August. At these, as well as other times of the year, harbour seals haul-out on land regularly in a pattern that is often related to the tidal cycle.

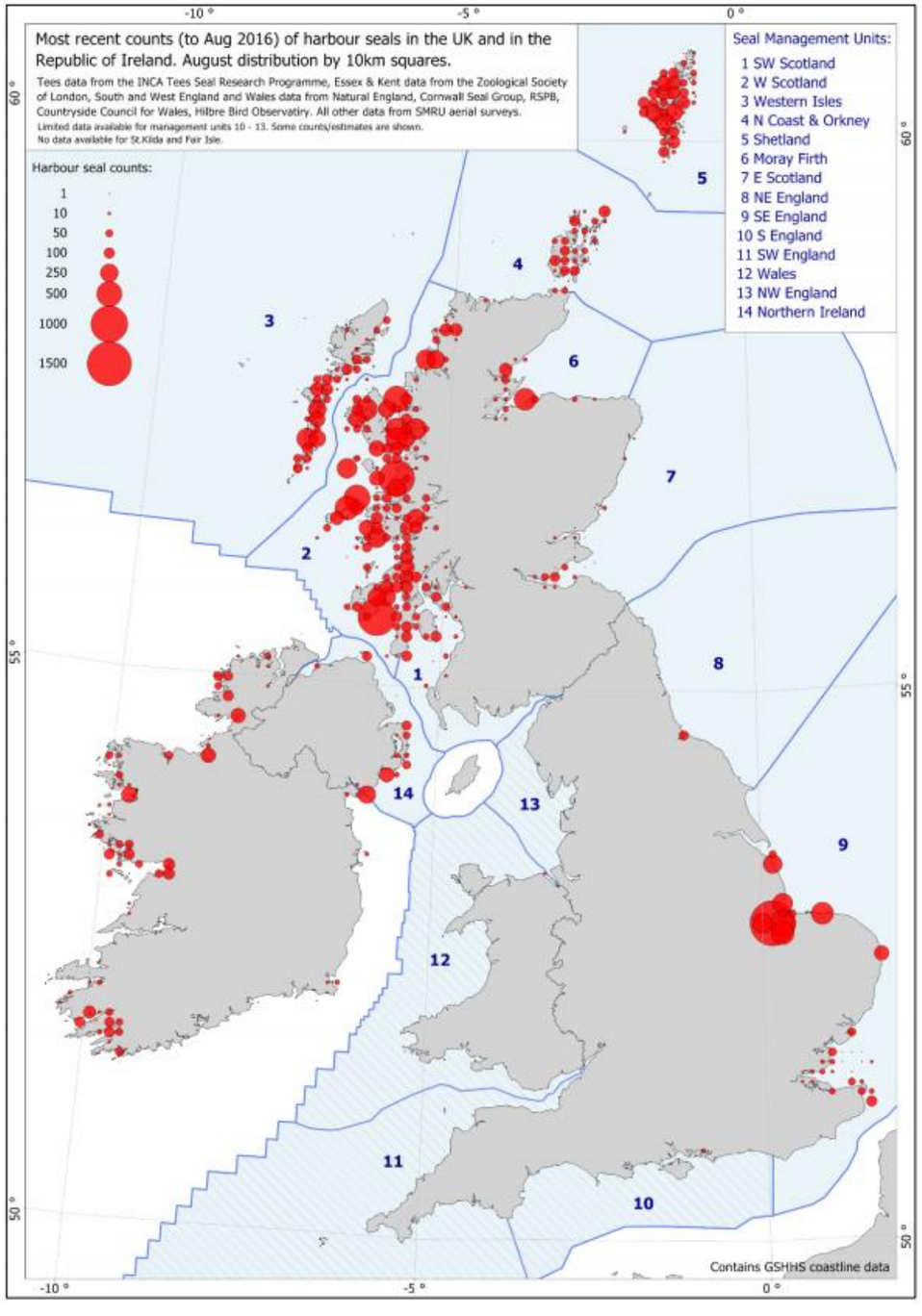
4.3.3 Approximately 30% of European harbour seals are found in the UK; this proportion has declined from approximately 40% in 2002 due to the declines in harbour seal numbers in parts of Scotland and large increases in the Wadden Sea. Harbour seals are widespread around the west coast of Scotland and throughout the Hebrides and Northern Isles. On the east coast, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth.

4.3.4 In the UK, harbour seals are considered to have an Unfavourable Inadequate Conservation Status (JNCC 2013) which means that "*a change in management or policy is required to return the habitat type or species to favourable status but there is no danger of extinction in the foreseeable future*" (ETC/BD 2014).

4.3.5 The most recent UK wide harbour seal count presented in SCOS (2017) combines data collected between 2011 - 2016. This produced a total UK count of 31,300 seals, which, scaled to account for the proportion of animals at sea at the time of the count, gives an estimated UK population size of 43,500 (95% CI: 35,600 – 58,000) (SCOS 2017). Thanet Extension is located within the South-east England seal MU. The most recent count presented in SCOS (2017) for the South-east England MU was 5,061 in 2016, which scales to a population estimate of 7,029 harbour seals in the MU (95% CI 5,751 – 9,972), which accounts for 16% of the total UK population. The counts within the South-east England MU are concentrated mainly in The Wash SAC.

4.3.6 The following sections describe the available data on harbour seals in the Southeast England seal Management Unit and, specifically, in relation to the Thanet Extension, in order to determine their spatial and temporal patterns of abundance and density.

Figure 4.12 August distribution of harbour seals around the British Isles (SCOS 2017).



Thanet Extension Offshore Wind Farm Baseline Surveys

4.3.7 During the 3 months of vessel line transect surveys of the Thanet Extension survey area between January and March 2016 there was only one sighting of an unknown seal species, which could have been either a harbour or a grey seal.

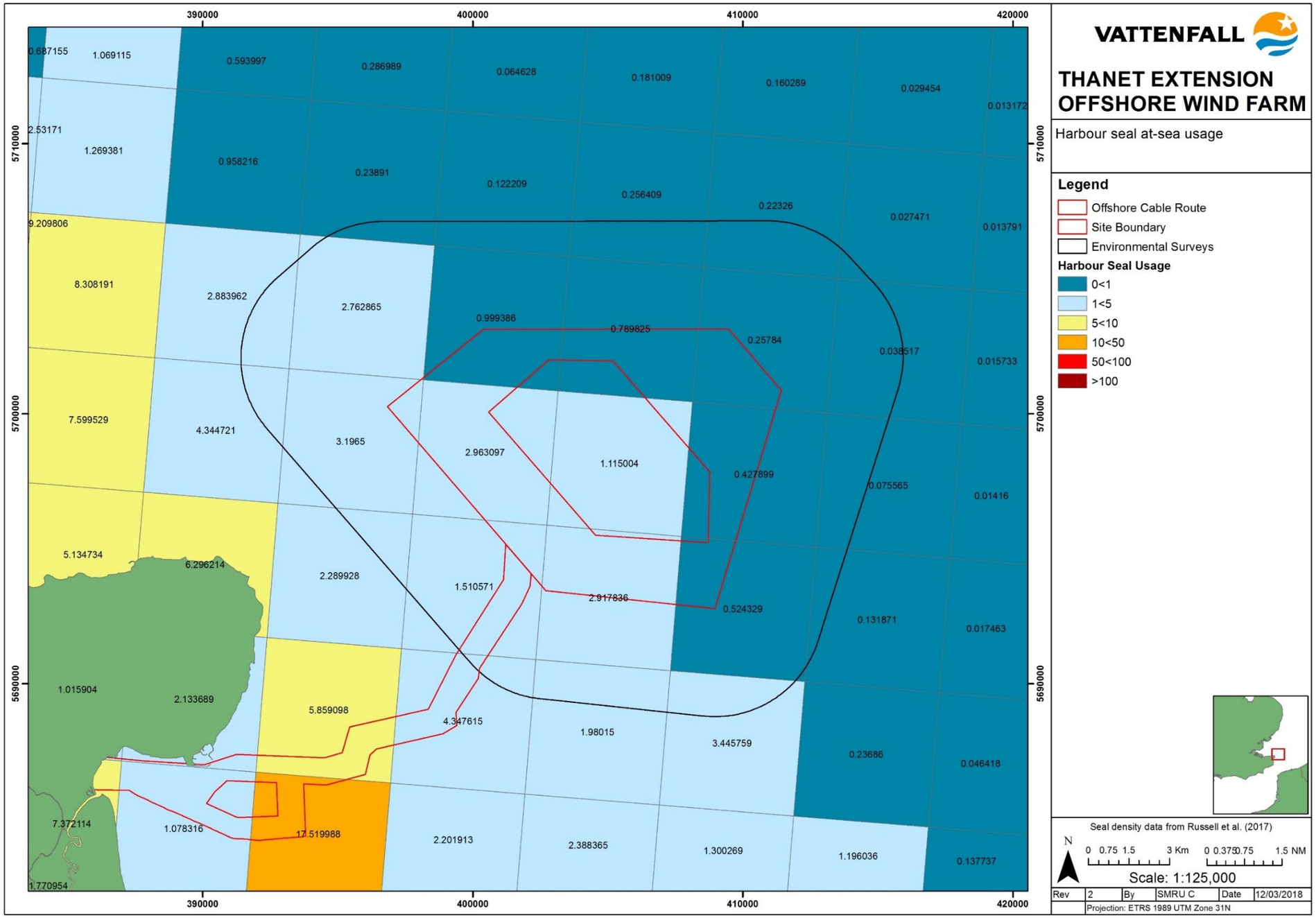
4.3.8 During the 24 months of aerial surveys conducted across the Thanet Extension survey area, a total of nine seals have been identified from the still images collected by APEM. These seals could not be identified to species level.

At-Sea Usage Maps

4.3.9 The seal usage maps (Russell et al. 2017) predict harbour seal at-sea densities of up to 3.20 seals/cell within grid cells that overlap the Thanet Extension site (CI: 1.30 – 5.09), up to 4.35 seals/cell within grid cells that overlap the survey area (CI: 0.20 – 8.49) and up to 17.52 seals/cell within grid cells that overlap the export cable corridor route (CI: 4.26 – 30.78) (Figure 4.13).

4.3.10 Assuming seals are evenly distributed within each 5x5 km grid cell, the density estimate can be scaled to provide a density per one km^2. This gives at-sea harbour seal densities of up to 0.13 seals/km^2 within grid cells that overlap the Thanet Extension site, up to 0.17 seals/km^2 within grid cells that overlap the survey area and up to 0.70 seals/km^2 within grid cells that overlap the export cable corridor route.

Figure 4.13 Estimated harbour seal at-sea usage (Russell et al. 2017). Values given are mean density estimates per 5x5 km grid cell.



Telemetry Data

4.3.11 Between 2003 and 2012 SMRU have tagged a total of 66 aged 1+ harbour seals in the South East England Management Area. Of these, 47 were tagged in The Wash and 19 were tagged in the Thames (Figure 4.15 inset and Appendix Table 9.1). A total of 11 of these tagged harbour seals had telemetry tracks that crossed into the Thanet Extension or export cable corridor, all of which were tagged in the Thames (Figure 4.15 and Appendix Table 9.1); none of the 47 seals tagged in The Wash had telemetry tracks that crossed into the Thanet Extension or export cable corridor. Two of the 11 harbour seals that had telemetry tracks that overlapped with the Thanet Extension or export cable corridor also showed telemetry tracks within The Wash SAC. Therefore, while none of the seals tagged at The Wash crossed into the Thanet Extension area, the data collected from the Thames seals show that there is a degree of connectivity between The Wash SAC, the Thames tagging sites and the Thanet Extension and export cable corridor.

Moult and Breeding Counts

The Wash

4.3.12 Breeding surveys of harbour seals at The Wash have shown a large increase in pup production from 548 pups counted in 2001 to 1,586 pup counted in 2016, with a maximum count in 2014 of 1,802 pups (nual breeding and moult counts

4.3.13 Table 4.7). This provides a 7.5% annual increase in the pup counts at The Wash between 2001 and 2016 (Thompson et al. 2017) (Figure 4.14). Interestingly, there has also been a significant increase in aged 1+ seals hauled out during the breeding surveys in terms of total count and relative to the moult count. For example, in 2001 the 1+ age count in the breeding season was 1,802 which was equivalent to 56% of the moult population count. By comparison, in 2015 the 1+ age counts in the breeding season was 4,539 which was equivalent to 127% of the moult population count.

4.3.14 The annual moult counts have shown a decrease in counts between 2001 and 2006 following the 2001 phocine distemper virus (PDV) epidemic. Since 2006, this moult count has increased from 1,695 animals to 3,086 animals in 2014, with a peak count in 2012 of 3,372 animals (nual breeding and moult counts

4.3.15 Table 4.7). This is an average annual increase of 9% between 2006 and 2014.

4.3.16 These count data show that the population of harbour seals at the closest SMRU monitored breeding site to the Thanet Extension is a healthy, increasing population, which is reflected in both the annual breeding and moult counts

Table 4.7 Harbour seal counts at The Wash between 2001 and 2016 (SCOS 2015, Thompson et al. 2017).

	2001	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Peak Pup Count	548	613	651	1054	984	994	1130	1432	1106	1469	1308	1802	1351	1586
Breeding 1+ Count	1802	1766	1699	2381	2253	2009	2523	3702	3283	3561	3345	4020	4539	3905
Moult Count	3194	2147	1946	1695	2162	2011	2829	2586	2894	3372	3174	3086	3336	3762

Figure 4.14 Harbour seal counts at The Wash between 2001 and 2016 (SCOS 2015, Thompson et al. 2017). Dotted lines show simple exponential trend-lines fitted to the data. Breeding 1+ means the number of 1+ animals counted during breeding surveys.

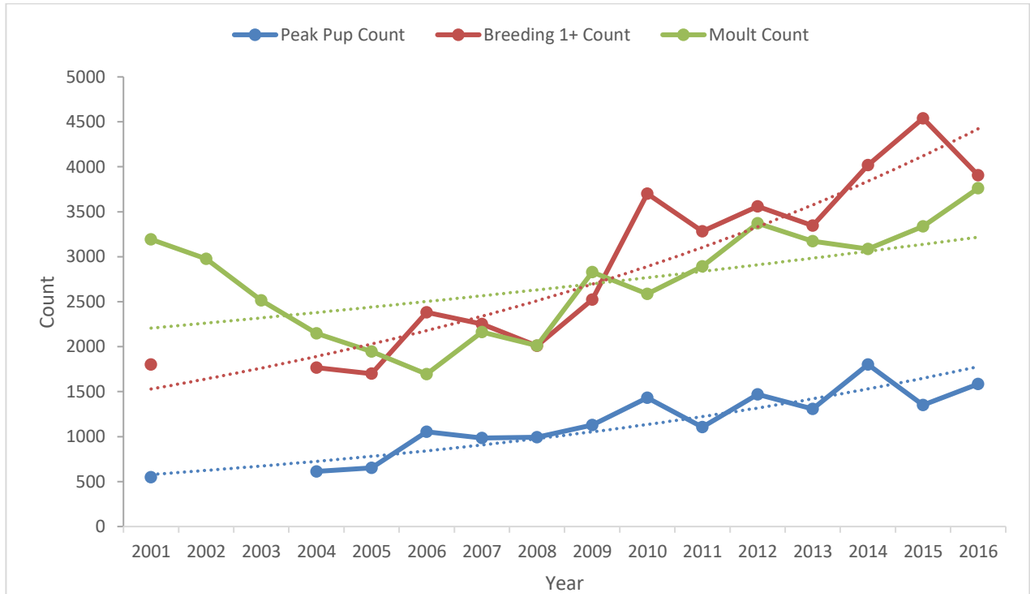
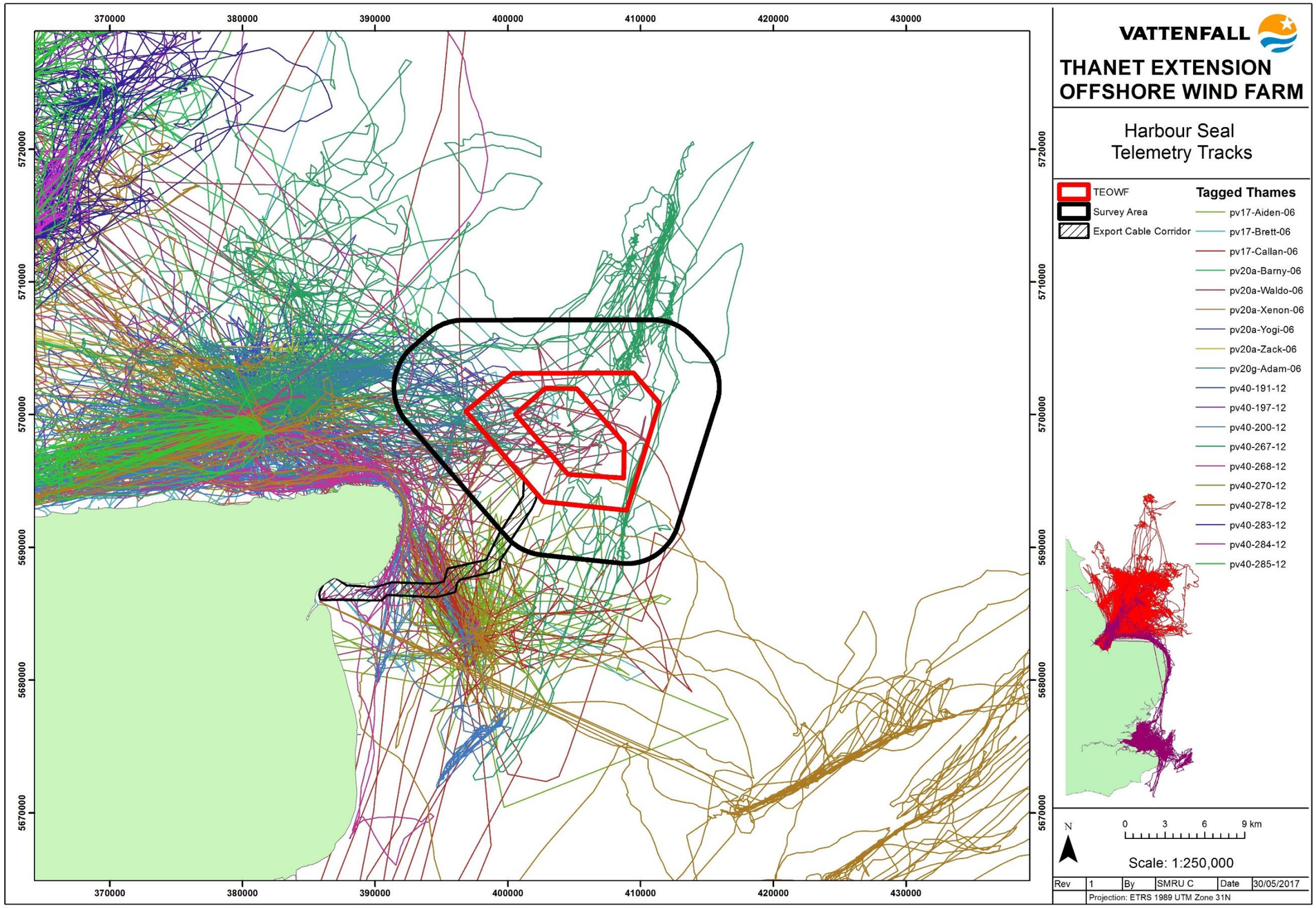


Figure 4.15 Telemetry tracks of harbour seals tagged at the Thames that overlap with the Thanet Extension (TEOWF) area. Inset map: red lines = tagged at The Wash (n=47), purple lines = tagged at the Thames (n=19).



4.3.17 Greater Thames Estuary Moult counts of harbour seals have been conducted in the Greater Thames Estuary between 2003 and 2015; in 2003, 2008 and 2010 these were conducted by SMRU and in 2013, 2014, 2015 and 2016 these were conducted by ZSL. Far fewer haul-outs were surveyed by SMRU (10-18 per year) compared to ZSL (43-53 per year) (Table 4.8). From the August moult count data, a population estimate is calculated by scaling the counts under the assumption that 72% of harbour seals are likely to be hauled out during the moult period (Lonergan et al. 2013). The harbour seal population estimate for the Greater Thames Estuary based on ZSL count data between 2013 and 2016 ranges between 626 and 964 harbour seals, with an average of 734 harbour seals (Table 4.8) (Barker and Obregon 2015).

4.3.18 Harbour seals are not evenly distributed within the Greater Thames Estuary, however, the same haul-out sites appear to be used across years. Haul-outs are located throughout the Greater Thames Estuary but with the largest haul-out being located on coastal sandbanks, which includes the areas adjacent to the Thanet Extension and the Export Cable route and landfall (Figure 4.17). Combining the counts across the Pegwell Bay area in 2016 gives a total count of 63 harbour seals (Table 4.9, Figure 4.18).

4.3.19 There is also a cluster of haul-out sites immediately south of the proposed export cable corridor route referred to generally as “Goodwin” which consists of haul-outs at: Goodwin Sands, Goodwin Knoll, South Goodwin Sand, South Kellet Gut, Gull Stream and North Trinity Bay (Table 4.9, Figure 4.18). The distance between these haul-out sites and the export cable corridor route ranges between 1.5 km (Gull Stream) and 13 km (Goodwin Knoll).

4.3.20 The Goodwin haul-out area is divided into two main clusters of haul-outs. The northern cluster contains the haul-outs named Goodwin 1, Goodwin 2, Goodwin Knoll, Goodwin Sands (Goodwin Knoll) and Gull Stream. The closest of these haul-outs to the offshore export cable corridor route is 1.5 km, the furthest is 4.3 km and main group of haul-outs (including the haul-out with the largest count) is ~2.2 km from the export cable corridor route.

4.3.21 The southern cluster contains the haul-outs called Goodwin 3, Goodwin 4, Goodwin Sands, Goodwin Sands (S Kellett Gut) and South Goodwin Sand. The closest of these haul-outs to the offshore export cable corridor route is 8.7 km and the furthest is 11.7 km.

4.3.22 In 2016 a total of 150 harbour seals were counted at the six haul-out sites in the Goodwin area (minimum distance 2.3 km from the export cable corridor route).

4.3.23 The counts of harbour seals at both Pegwell Bay and the Goodwin area have increased from 79 in 2003 to 296 in 2016. The harbour seals counted in Pegwell Bay and the Goodwin area during the 2016 moult survey represents 31% of the total population estimate for the Greater Thames Estuary.

Table 4.8 Harbour seal counts and resulting population estimates for the Greater Thames Estuary from the SMRU and ZSL surveys.

Year	Source	# Haul-outs	Total Count	Population Estimate
2003	SMRU	10	180	250
2008	SMRU	18	319	443
2010	SMRU	18	379	526
2013	ZSL	50	482	669
2014	ZSL	43	489	679
2015	ZSL	53	481	626
2016	ZSL	52	694	964

Table 4.9 Harbour seal haul-out counts closest to the export cable route (as depicted in Figure 4.18).

Year	Source	Location	# Haul-outs	Total Count
2003	SMRU	Goodwin	4	79
2008	SMRU	Goodwin	1	97
2010	SMRU	Goodwin	2	59
2013	ZSL	Outer Stour	1	40
		Inner Stour	1	1
		North Trinity Bay	1	2
		Goodwin Sands	2	40
		Goodwin Knoll	2	48
2014	ZSL	Pegwell Bay	1	16
		Goodwin Sands (S Kellett Gut)	2	59
		Goodwin Knoll	4	51
		Gull Stream	1	1
2015	ZSL	Pegwell Bay (inc. Inner & Outer Stour)	3	52
		South Goodwin Sand	3	62
		Goodwin Knoll	3	54
2016	ZSL	Pegwell Bay	1	63
		Goodwins	6	150

Figure 4.16 Harbour seal moult counts and population estimates for the Greater Thames Estuary and the Pegwell Bay and Goodwin areas.

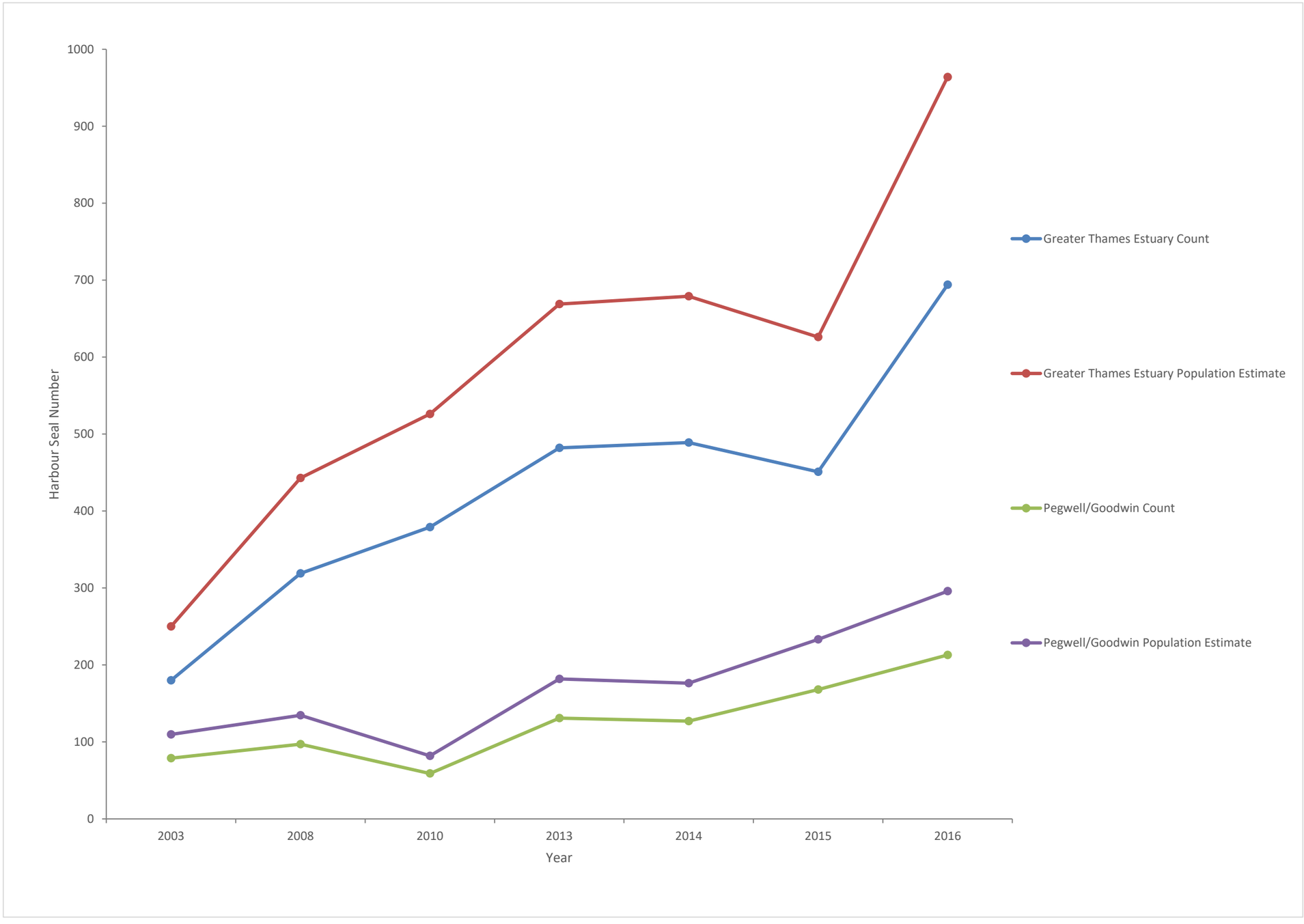


Figure 4.17 All harbour seal August moult haul-out counts in the Greater Thames Estuary collected by SMRU and ZSL between 2003 and 2016.

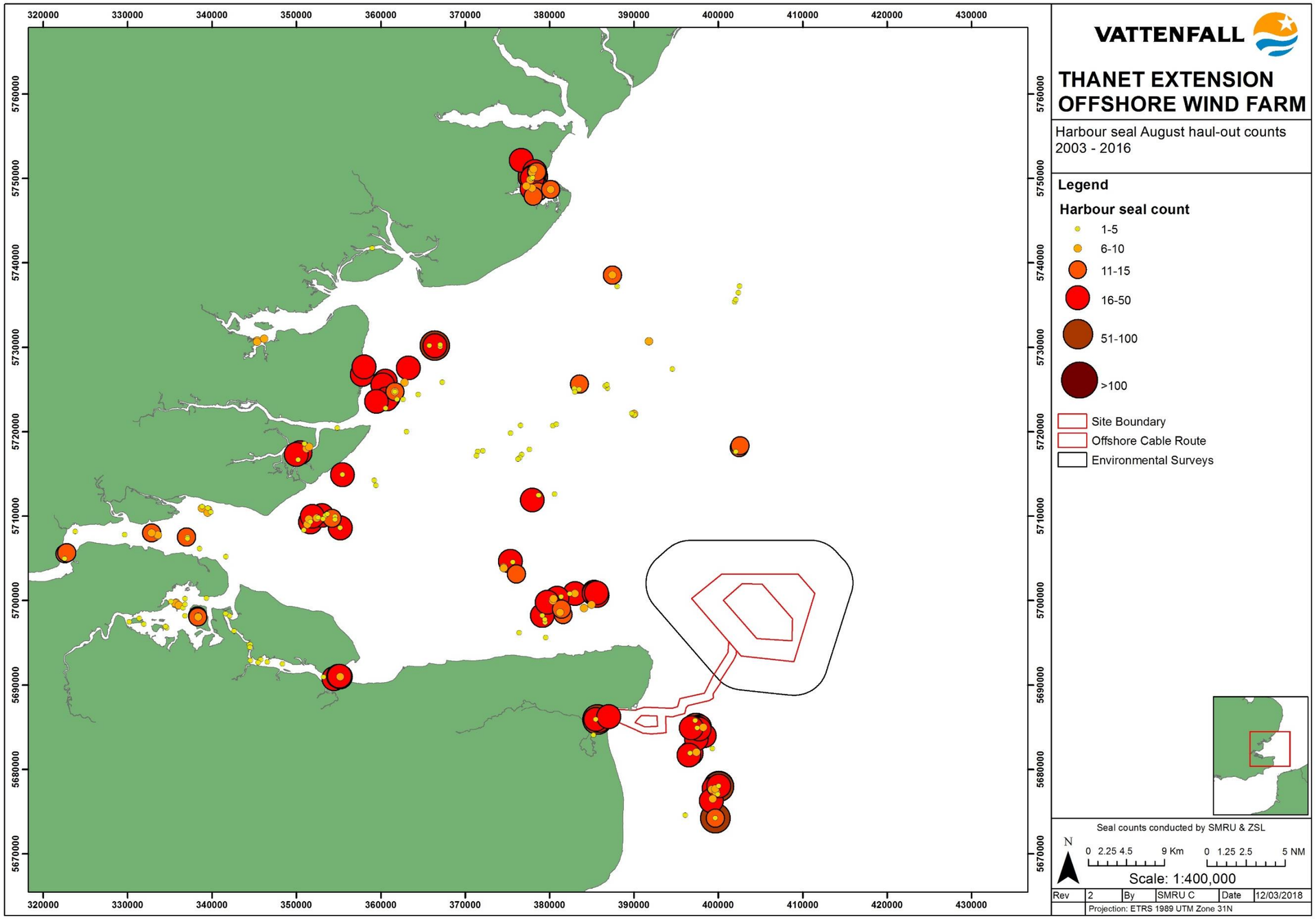
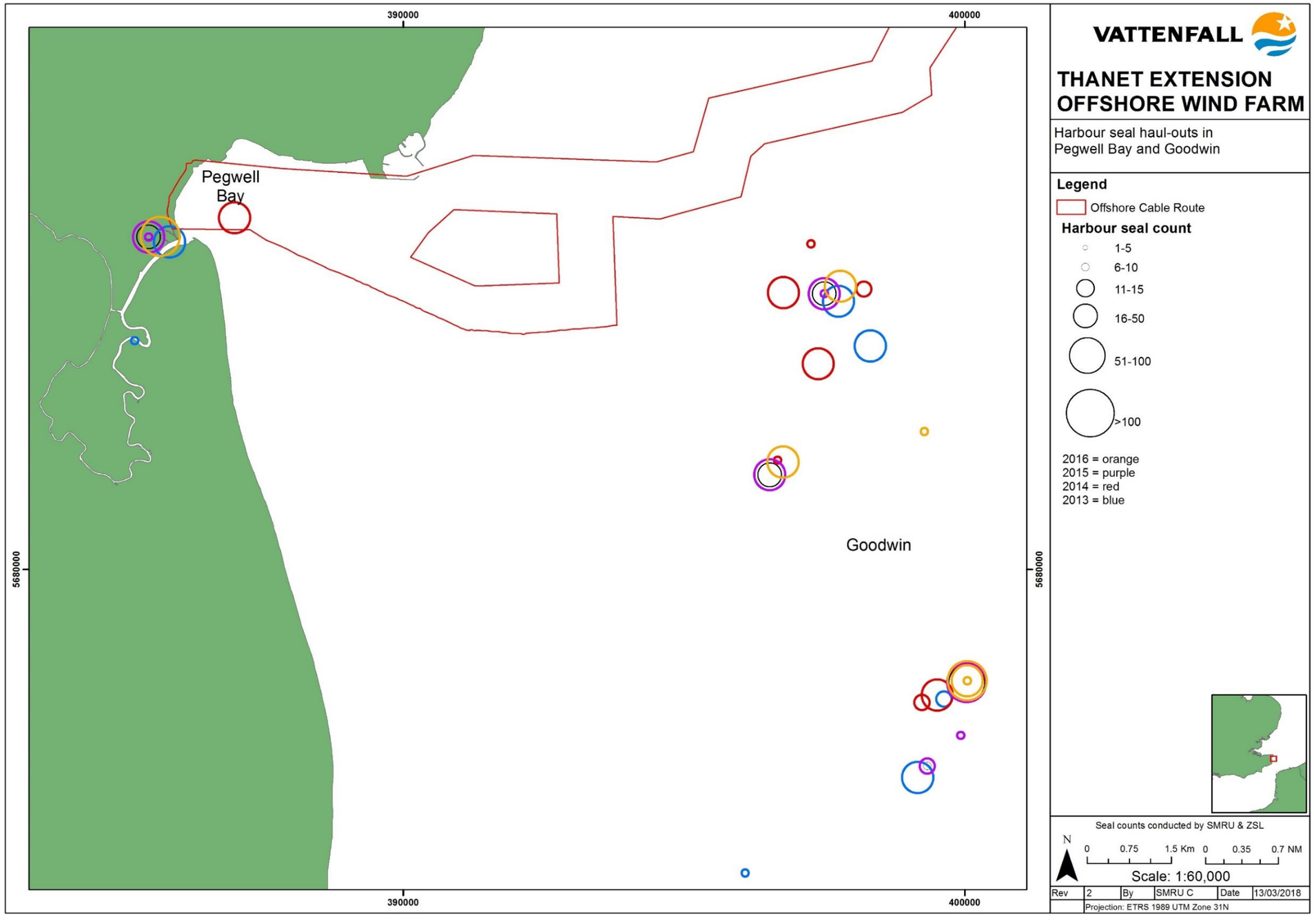


Figure 4.18 Harbour seal haul-outs in Pegwell Bay and Goodwin in 2013, 2014, 2015 and 2016.



Seal Counts – Wadden Sea

4.3.24 The latest moult count for harbour seals in the Wadden Sea is 15,900 in Germany, 7,700 in the Netherlands and 2,800 in Denmark which results in a total Wadden Sea count of 26,400 harbour seals. When the count is scaled to account for the number of animals at sea at the time of the survey, this results in a total Wadden Sea population of 36,667 seals (95% CI 30,000 – 48,889).

Conclusion

4.3.25 The SMRU breeding and moult harbour seal haul-out count data show that the population of harbour seals at The Wash (the closest monitored breeding site to Thanet Extension) is a healthy, increasing population. In addition to this, the ZSL moult counts in the Greater Thames Estuary show a stable population size. The harbour seal telemetry data show that there is some degree of connectivity between The Wash SAC, the Thames haul-out sites and Thanet Extension and export cable corridor route.

4.3.26 Of key importance for the Thanet Extension impact assessment is that there is a small harbour seal haul-out site in Pegwell Bay (63 animals counted in August 2016) which is where the Thanet Extension export cable landfall location is proposed. In addition to this, there are haul-out sites on Gull Stream, Goodwin Sands, South Goodwin Sand, Goodwin Knoll and South Kellett Gut, all of which are in close proximity to the Thanet Extension site and export cable corridor route (distance to export cable corridor route 1.5 - 11.7 km).

4.3.27 The only density estimates available for harbour seals in the Thanet Extension area are obtained from the Russell et al. (2017) seal usage maps. These give at-sea harbour seal densities of up to 0.70 seals/km^2 within the Thanet Extension survey area and export cable corridor route.

4.4 Grey Seal

4.4.1 Grey seals (*Halichoerus grypus*) are the larger of the two species of seal resident in UK waters. They haul-out on land to rest, moult and breed and forage at sea where they range widely, frequently travelling for up to 30 days with over 100 km between haul-out sites (SCOS 2016). Approximately 38% of the world's grey seal population breeds in the UK with 88% of these breeding in Scotland with other breeding colonies in Shetland, on the north and east coasts of mainland Britain and in SW England and Wales. Grey seal population data are assessed using pup counts during the autumn breeding season when females haul-out to give birth. The number of pups throughout Britain has grown steadily since the 1960s but there is clear evidence that the population growth is levelling off in all areas except the central and southern North Sea where growth rates remain high.

4.4.2 In the UK, grey seals typically breed on remote uninhabited islands or coasts and in small numbers in caves. Preferred breeding locations allow females with young pups to move inland away from busy beaches and storm surges. Seals breeding on exposed, cliff-backed beaches and in caves may have limited opportunity to avoid storm surges and may experience higher levels of pup mortality as a result. UK grey seals breed in the autumn, but there is a clockwise cline in the mean birth date around the UK. The majority of pups in SW Britain are born between August and September, in north and west Scotland pupping occurs mainly between September and late November and eastern England pupping occurs mainly between early November to mid-December.

4.4.3 The grey seal is considered to have a FCS in the UK (JNCC 2013). The most recent UK wide grey seal pup production count was in 2014, which produced a total UK pup production estimate of 60,500 (95% CI: 53,900 – 66,900), which, modelled to estimate the non-pup portion of the population, gives an estimate of 141,000 aged 1+ grey seals in the UK (95% CI: 117,500 – 168,500) (SCOS 2017).

4.4.4 The most recent August haul-out count of grey seals for the Southeast England MU is 6,085 and for the Northeast England MU is 6,948 (SCOS 2017). Combined this gives a count of 13,033 which, scaled to account for the proportion at-sea at the time of the survey gives an estimated population size of 37,237 grey seals for the Southeast and Northeast England MUs combined.

4.4.5 The following sections describe the available data on grey seals in relation to the Thanet Extension, in order to determine their spatial and temporal patterns of abundance and density.

Thanet Extension Offshore Wind Farm Baseline Surveys

4.4.6 During the three months of vessel transect surveys of the Thanet Extension survey area a total of three grey seals were sighted in addition to the one unknown seal species sighting.

Pup Production

4.4.7 Thanet Extension is not located in any of the five key breeding regions for grey seals in the UK. The nearest key breeding region for grey seals to Thanet Extension is the Donna Nook and East Anglia area of the North Sea region which encompasses the breeding colonies at Donna Nook, Blakeney Point and Horsey. In the Donna Nook and East Anglia area (Blakeney and Horsey) a total of 5,919 pups were counted in 2016 (data provided by SMRU). The 2016 pup count for the Donna Nook and East Anglia area increased from 2,566 in 2010 which is an average annual increase of 15% between 2010 - 2016.

4.4.8 The 2016 data show a large increase in pup production at Blakeney Point from 1,560 in 2013 to 2,404 in 2016 (a 54% increase), which made Blakeney Point the largest grey seal breeding colony in England. There was also a large increase in pup production at Horsey between 2014 – 2016, where the pup production count increased from 803 - 1,526 (a 90% increase). Therefore these breeding colonies and associated populations can be considered to be healthy and increasing.

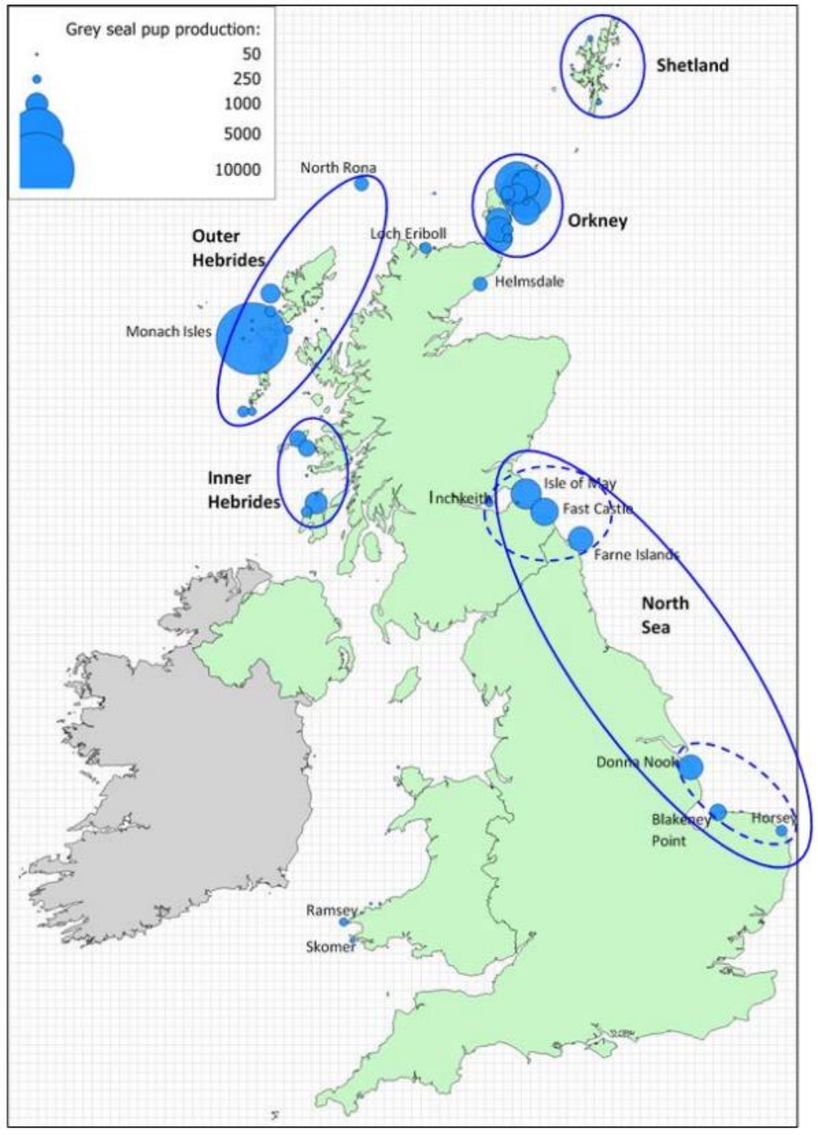
4.4.9 The grey seal pup production estimate for England (Donna Nook, East Anglia and the Farne Islands) in 2014 was 6,627 (SCOS 2017) which, using the same scaler to estimate the non-pup portion of the population, results in an English population size of 15,445 aged 1+ grey seals in 2016.

4.4.10 These data show that there are three grey seal breeding colonies in the south east coast of England: Donna Nook, Blakeney Point and Horsey. Donna Nook has shown a relatively stable pup production count over the last five years with an average per annum increase of 7.1%. Both the Blakeney Point and Horsey breeding colonies have shown large increases in pup production over the last five years with average per annum increases of 27.7% and 26.4% respectively. Therefore these breeding colonies can be considered to be healthy and increasing.

Table 4.10 Pup counts at the three grey seal breeding colonies in south east England between 2011 and 2015.

	Pup Count					Annual Change				
	2011	2012	2013	2014	2015	2011-2012	2012-2013	2013-2014	2014-2015	Average
Donna Nook	1438	1525	1676	1799	1892	6%	10%	7%	5%	7.1%
Blakeney Point	932	1222	1560	2425	2343	31%	28%	55%	-3%	27.7%
Horsey	500	612	728	803	1236	22%	19%	10%	54%	26.4%

Figure 4.19 Distribution and size of grey seal breeding colonies in 2014. Blue ovals indicate groups of colonies within each region (SCOS 2017).



At-Sea Usage Maps

4.4.11 The seal usage maps (Russell et al. 2017) predict grey seal at-sea densities of up to 0.92 seals/cell within grid cells that overlap the Thanet Extension site (CI: 0.55-1.29), up to 1.43 seals/cell within grid cells that overlap the survey area (CI: 0.83-2.03) and up to 0.84 seals/cell within grid cells that overlap the export cable corridor route (CI: 0.651-1.17) (Figure 4.23).

4.4.12 Assuming seals are evenly distributed within each 5x5 km grid cell, the density estimate can be scaled to provide a density per one km^2. This gives at-sea grey seal densities of up to 0.04 seals/km^2 within grid cells that overlap the Thanet Extension site, up to 0.06 seals/km^2 within grid cells that overlap the survey area and up to 0.03 seals/km^2 within grid cells that overlap the export cable corridor route.

Telemetry Data

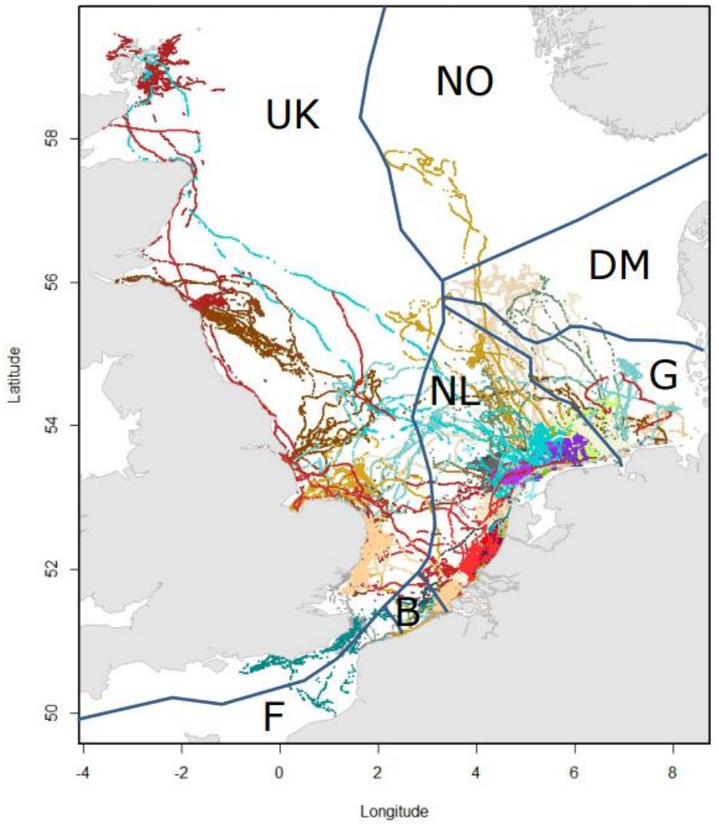
4.4.13 Between 1988 and 2015 SMRU have tagged a total of 32 aged 1+ grey seals in the South East England Management Area. Of these, 10 were tagged at Blakeney and 22 were tagged at Donna Nook. Only one of these tagged grey seals had telemetry tracks that crossed into the Thanet Extension Export Cable Area (Figure 4.24). This one seal (ID hg48-009-15) was tagged at Blakeney and also showed telemetry tracks within the Berwickshire and North Northumberland Coast SAC which indicates that there is at least a small degree of connectivity between the SAC and the Thanet Extension.

Wadden Sea Data

4.4.14 Telemetry data from grey seals tagged in the Netherlands have shown connectivity between the Wadden Sea Natura 2000 site in the Netherlands and haul-out sites and the coastal waters of the UK, including the Greater Thames Estuary area and areas around the Thanet Extension (Brasseur et al. 2015, IMARES 2015) (Figure 4.20). There is an increasing population of grey seals in the Wadden Sea, and the latest aerial breeding surveys recorded a peak pup count of 1,113 in December 2015 (Brasseur et al. 2016). The increase in pup counts between 2014 (peak count 829) and 2015 was higher than expected which indicates either a) this population is increasing and/or b) the Wadden Sea is experiencing an influx of breeding female grey seals from the UK.

4.4.15 In the Wadden Sea, the most recent pup count is available for the winter of 2016-2017 where the highest count was in mid-December of 1,279 pups (Duck and Morris 2015, TSEG 2017). The maximum number of grey seals in the Wadden Sea is obtained from moult counts in the spring. The 2017 spring moult count resulted in a total count of 5,445 grey seals (TSEG 2017). Unfortunately, there is no data on the proportion of time grey seals spend at sea during their moult period, and so these raw count data cannot be scaled to obtain a population estimate for the Wadden Sea.

Figure 4.20 Locations of grey seals tracked from sites in the Netherlands up to 2014 - colours indicate individual seals (n = 75) (Brasseur et al. 2015).



4.4.16 Telemetry data from grey seals tagged in France also show than grey seals that haul-out in Molene archipelago (MOL), Sept Iles archipelago (SEP) and baie de Somme have telemetry tracks that overlap with the Goodwin Sands area (Figure 4-21) (Vincent et al. 2017). There is also an increasing grey seal population along the French coast, with grey seal haul-out counts showing annual increases of +6% pa at MOL and +8% pa at SEP.

Figure 4-21 Grey seal temelemetry tracks from MOL (Molene archipelago, light blue n=15 tagged between 1999-2003, dark blue n=19 tagged between 2010-2013) and BDS (baie de Somme, green n=11 tagged in 2012) (Vincent et al. 2017).

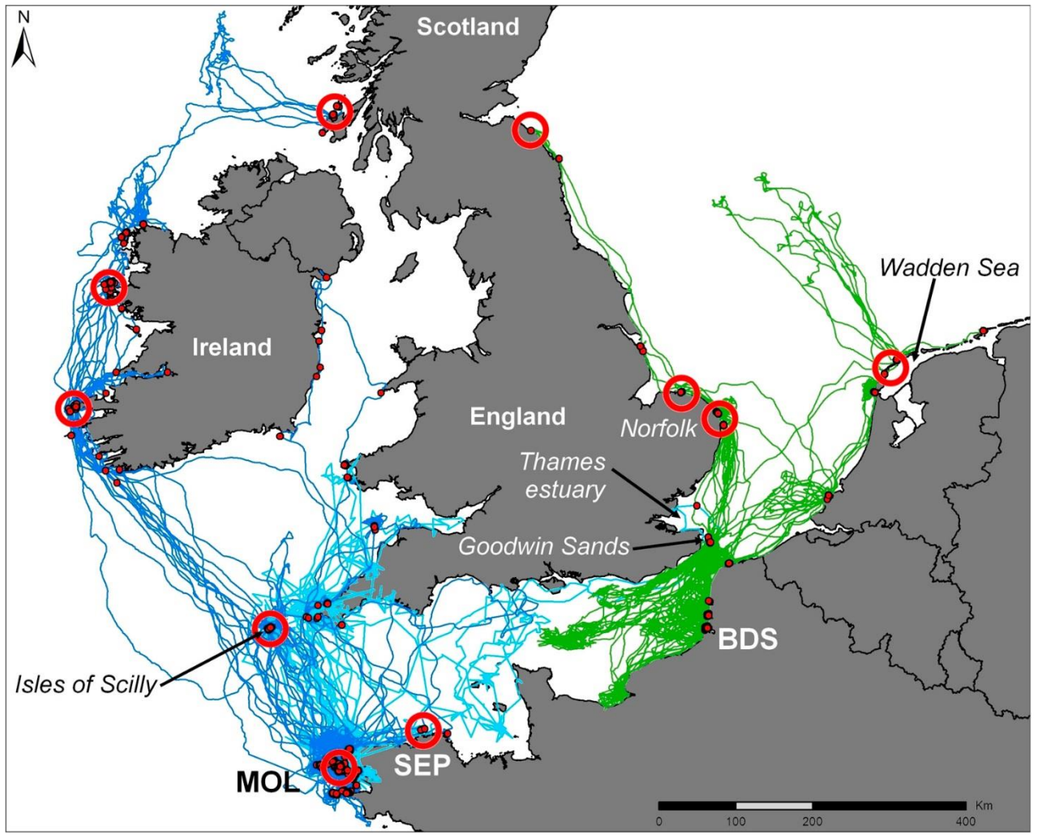


Figure 4-22 Grey seal maximum yearly counts at the main French study sites (BDA = baie d'Authie, BDS =, MOL = Molene archipelago, SEP = Sept iles archipelago and WAL = Walde) (Vincent et al. 2017).

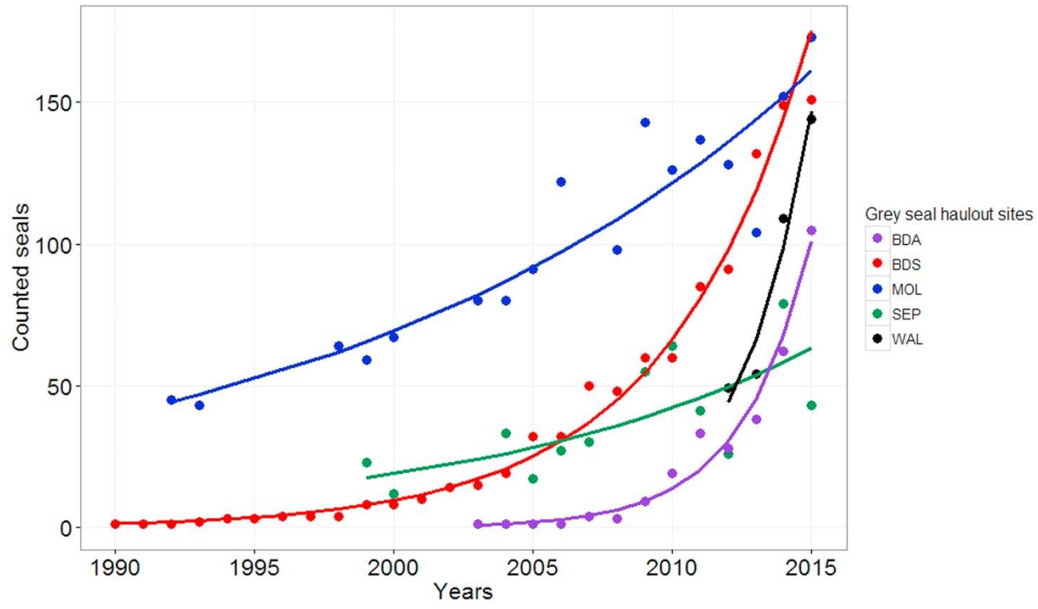


Figure 4.23 Estimated grey seal at-sea usage (Russell et al. 2017). Values given are mean density estimates per 5x5 km grid cell.

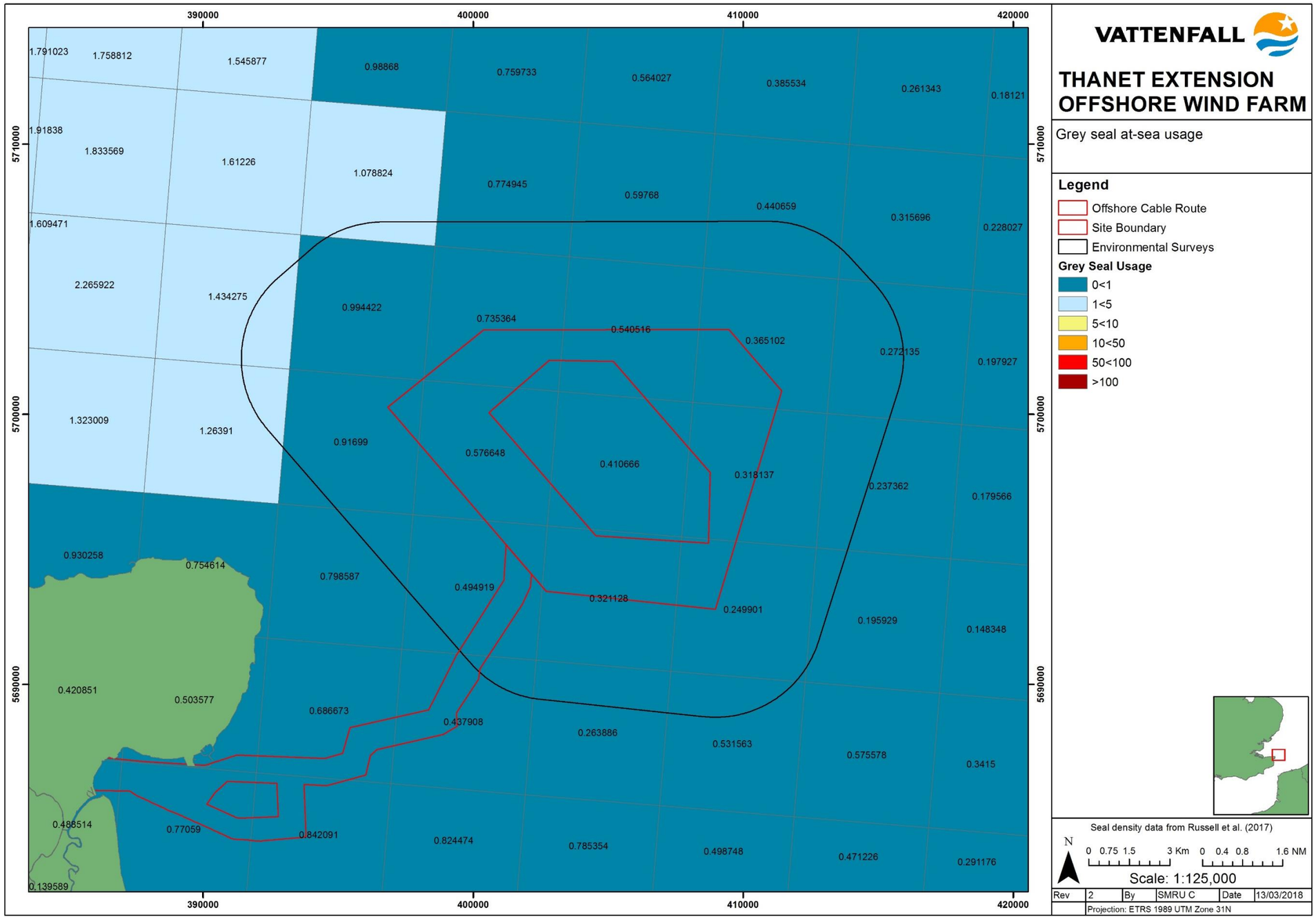
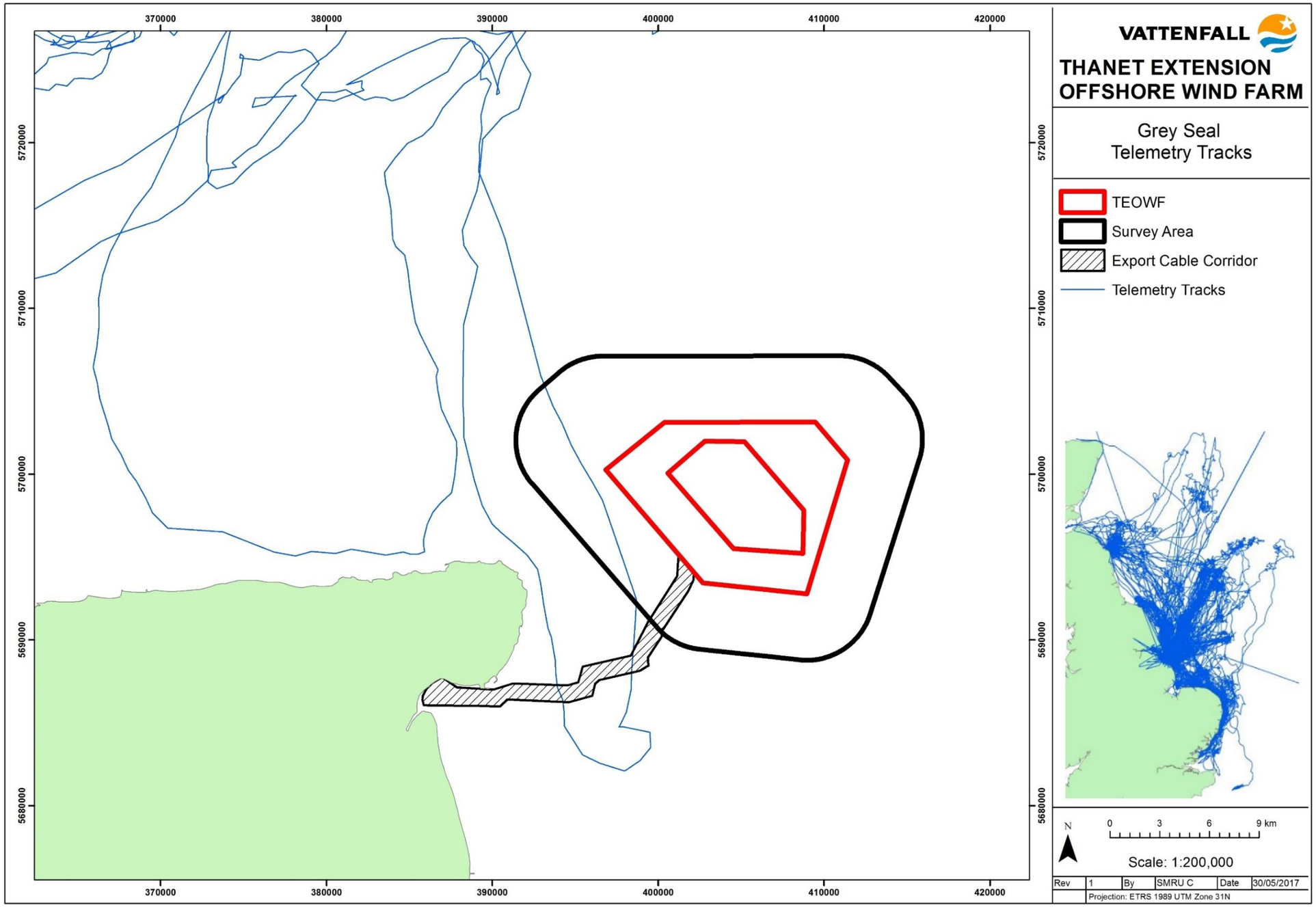


Figure 4.24 Telemetry tracks of the 32 grey seals tagged in the South East England Management Area between 1988 and 2015 (inset) and the overlap with the Thanet Extension (TEOWF) site.



Wash Count Data

4.4.17 Grey seal counts during the SMRU August harbour seal moult survey show that there are considerably fewer grey seals at The Wash and Scroby Sands in comparison to Donna Nook, which suggests that The Wash and Scroby Sands are not important haul-out sites for grey seals during August (Table 4.11). This is relevant to the Thanet Extension as these two haul-out sites are further south than Donna Nook and therefore closer to the Thanet Extension site. However, it should be noted that the timing of the surveys are conducted to coincide with the harbour seal moult, and is not a key haul-out period for grey seals. Counts of greys seals during these surveys can be highly variable and although these counts are not used as a population index, they provide useful information on the distribution of grey seals in August.

Table 4.11 Grey seal counts in south east England during the August harbour seal moult surveys between 2001 and 2015.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
The Wash	111	75	58	30	49	52	42	68	118	240	142	258	219	223	369
Donna Nook	214	291	232	609	927	1789	1834	2068	1329	2188	1930	4978	3474	4437	3766
Blakeney Point	30	11	18	10	86	142	-	375	22	49	300	65	63	445	528
Scroby Sands	70	-	36	93	106	187	-	137	157	292	323	-	219	509	520

Greater Thames Estuary Count Data

4.4.18 Grey seals are not evenly distributed within the Greater Thames Estuary, however, the same haul-out sites appear to be used across years. Haul-outs are located throughout the Greater Thames Estuary but with the largest haul-out being located on coastal sandbanks, which includes the areas adjacent to the Thanet Extension and the Export Cable route and landfall (Figure 4.25). There is a cluster of haul-out sites immediately south of the proposed export cable corridor referred to generally as “Goodwin” which consists of haul-outs at: Goodwin Sands, Goodwin Knoll, South Goodwin Sand and South Kellet Gut (Table 4.13). The distance between these haul-out sites and the export cable corridor ranges between 2 km (Goodwin Knoll) and 13 km (Goodwin). In 2016 a total of 344 grey seals were counted in the Goodwin area.

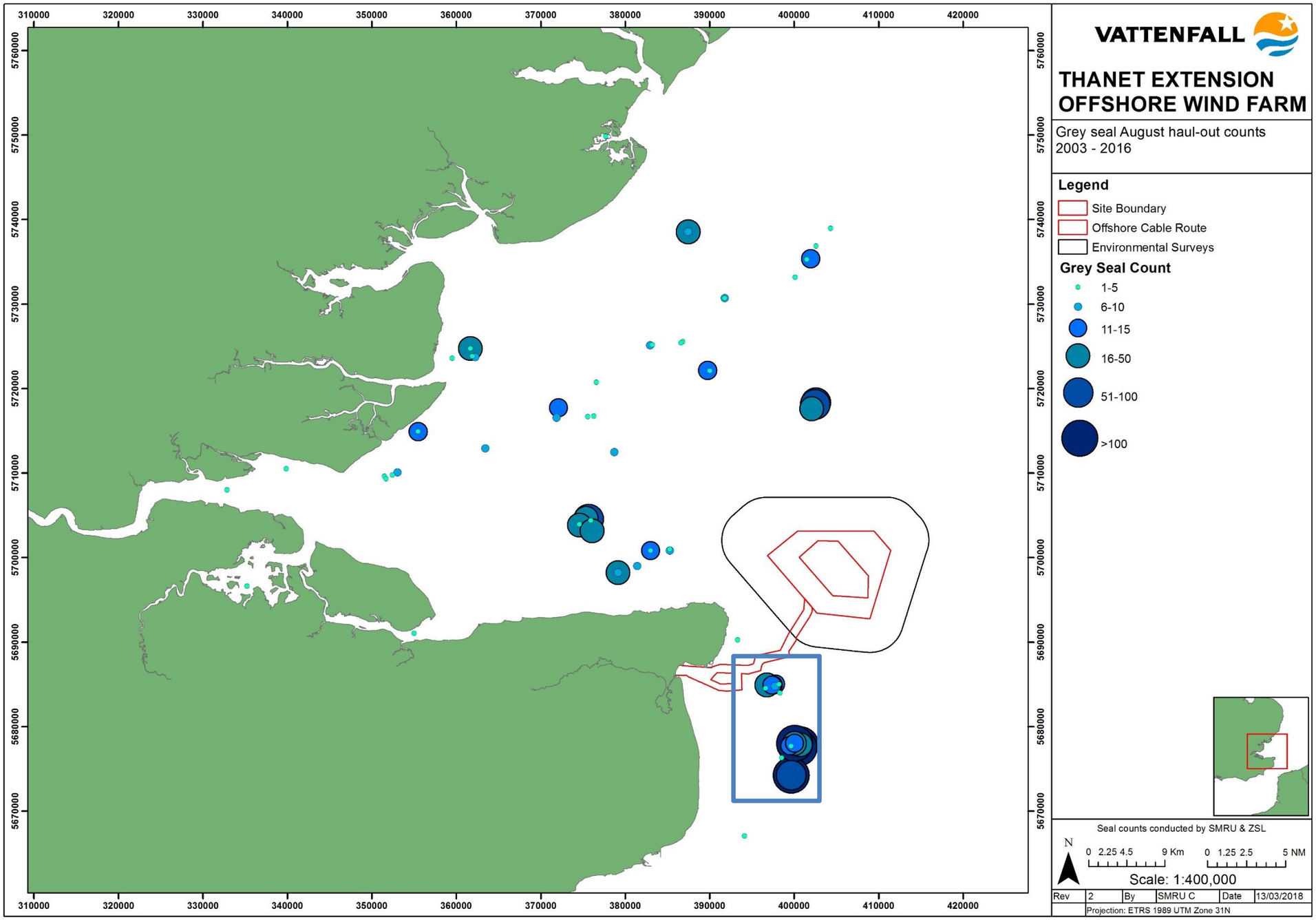
Table 4.12 Grey seal counts for the Greater Thames Estuary from the SMRU & ZSL surveys.

Year	Source	# Haul-outs	Total Count
2003	SMRU	2	96
2008	SMRU	7	160
2010	SMRU	8	376
2013	ZSL	16	203
2014	ZSL	15	449
2015	ZSL	15	454
2016	ZSL	15	481

Table 4.13 Grey seal haul-out counts closest to the export cable route (as depicted in Figure 4.25).

Year	Source	Haul-out Location	# Haul-outs	Total Count
2003	SMRU	Goodwin	1	92
2008	SMRU	Goodwin	1	125
2010	SMRU	Goodwin	2	311
2013	ZSL	Goodwin Sands	2	134
		Goodwin Knoll	3	9
2014	ZSL	Goodwin Sands (S Kellett Gut)	3	308
		Goodwin Knoll	2	19
2015	ZSL	South Goodwin Sand	2	327
		Goodwin Knoll	1	13
2016	ZSL	Goodwins	5	344

Figure 4.25 All grey seal counts in the Greater Thames Estuary recorded during the August harbour seal moult surveys conducted by SMRU and ZSL. Blue box = haul-outs listed in Table 4.15.



Conclusion

4.4.19 Thanet Extension is not located in any of the five key breeding regions for grey seals in the UK. The nearest key breeding region for grey seals to Thanet Extension is the Donna Nook and East Anglia area of the North Sea region. Donna Nook has shown a relatively stable pup production count over the last five years while both the Blakeney Point and Horsey breeding colonies have shown large increases in pup production over the last five years; therefore these breeding colonies can be considered to be healthy and increasing. From the telemetry data there is evidence of connectivity between the Berwickshire and North Northumberland Coast SAC and Thanet Extension as well as connectivity between the Wadden Sea Natura 2000 site in the Netherlands and the coastal waters in the Greater Thames Estuary area, including areas around Thanet Extension. Of importance for the Thanet Extension impact assessment is that there are grey seal haul-outs in the Goodwin area (Goodwin Sands, and Goodwin Knoll) where in 2016 344 grey seals were counted. The distance between these haul-out sites and the export cable corridor route ranges between two km (Goodwin Knoll) and 13 km (Goodwin).

4.4.20 The only density estimates available for grey seals in the Thanet Extension area are obtained from the Russell et al. (2017) seal usage maps. These give at-sea grey seal densities of up to 0.06 seals/km^2 within the Thanet Extension survey area and export cable corridor route.

4.5 Dolphin Species

4.5.1 During the 24 months of aerial surveys conducted across the Thanet Extension survey area, a total of four dolphins have been identified from the still images collected by APEM Ltd. These dolphins could not be identified to species level. Three individuals were sighted in March 2017 and one individual was sighted in June 2017. As noted in section 4.2, in addition to these, a further 235 sightings of unknown dolphin/porpoise individuals were also recorded during these surveys, with the highest number of sightings in February and March 2017. Given the existing data available in the literature and from site-specific surveys at nearby OWF (as outlined in the sections below) show that no species of dolphin is common in the greater Thames Estuary area, we would not expect these dolphin/porpoise sightings to be dolphin species. In addition, the seasonal pattern of these data shows higher sightings in the winter months, which coincides with the seasonal patterns of density observed in the harbour porpoise data. This leads to the conclusion that these dolphin/porpoise sightings are more likely to be harbour porpoise.

4.5.2 These unknown dolphin/porpoise animals were categorised as such as the images obtained were of insufficient quality to determine if the animal was either a species of dolphin or a harbour porpoise. Since no species identification is possible for any of the dolphin species or dolphin/porpoise animals recorded during the APEM aerial surveys at the Thanet Extension site, they are unable to provide any real insight into the baseline dolphin presence in the area.

4.6 Bottlenose Dolphin

4.6.1 In UK waters bottlenose dolphin (*Tursiops truncatus*) sightings are largely concentrated around the north-east coast of Scotland and Cardigan Bay in Wales where two resident populations occur. Bottlenose dolphins in the UK are considered to have a Favourable Conservation Status (JNCC 2013). The Thanet Extension is located within the Greater North Sea MU for bottlenose dolphins (excluding coastal east Scotland), however the abundance estimate for this MU is 0 and bottlenose dolphin abundance is described as "*very few animals are seen in this area*" (IAMMWG 2015). The south east coast of England (including the Thanet Extension area) is not considered to be within an ecological unit for bottlenose dolphins as recommended by ASCOBANS nor is it included in any of the ICES MUs for bottlenose dolphins.

4.6.2 The data collected during the 1994 SCANS I vessel surveys in survey area B produced no sightings of bottlenose dolphins (Hammond et al. 2002). The data collected during the 2005 SCANS II aerial surveys produced an abundance estimate of 395 bottlenose dolphins in survey area B (95% CI: 105 – 1,487) with a density of 0.0032 dolphins/km^2 (95% CI: 0.008 – 0.012) (Burt et al. 2006a). The SCANS III surveys did not record any bottlenose dolphins in survey block L (Hammond et al. 2017).

4.6.3 A total of four bottlenose dolphins were incidentally sighted on one of the pre-construction aerial surveys conducted at the London Array Offshore Wind Farm (RPS 2005). This survey was conducted in February 2004 where 1,409 km was surveyed over 7.72 hours. Only one (possible) bottlenose dolphin was sighted during the 19 pre-construction vessel survey days conducted at the London Array Offshore Wind Farm (RPS 2005).

4.6.4 No confirmed bottlenose dolphins were sighted during the 24 months of Thanet Extension APEM Ltd aerial surveys between 2016 and 2017, nor were they sighted during the TOWF ornithological vessel based surveys between 2004 and 2013, the Kentish Flats ornithological vessel surveys between 2002 and 2010 or the GGOWF and GOWF surveys between 2004 and 2011.

4.7 Common Dolphin

4.7.1 Common dolphins (*Delphinus delphis*) are mainly found on the west coast of the UK, in the Celtic Sea and the western approaches to the Channel, with relatively few sightings recorded in the North Sea (Reid et al. 2003). They are a gregarious species and have been recorded in very large groups of hundreds of individuals. Common dolphins in the UK are considered to have an Unknown Conservation Status (JNCC 2013) and all common dolphins in UK waters are considered to be part of the Celtic and Greater North Seas MU (IAMMWG 2015). There is an abundance estimate for this MU of 56,556 (95% CI: 33,014 - 96,920), of which 13,607 (95% CI: 8,720 - 21,234) are estimated within the UK EEZ; however, these abundance estimates are based on data from SCANS II (Hammond et al. 2013) and CODA (Macleod et al. 2009) which are likely to be underestimates as they were not corrected for perception bias.

4.7.2 The data collected during the 1994 SCANS I vessel surveys in survey area B produced no sightings of common dolphins (Hammond et al. 2002). The data collected during the 2005 SCANS II aerial surveys produced an abundance estimate of 14,349 common dolphins in survey area B (95% CI: 18 – 11,388,000) with a density of 0.1159 dolphins/km^2 (95% CI: 0.0001 – 91.97) (Burt et al. 2006a). The SCANS III surveys did not record any common dolphins in survey block L (Hammond et al. 2017).

4.7.3 No confirmed common dolphins were sighted during the 24 months of Thanet Extension APEM Ltd aerial surveys between 2016 and 2017, nor were they sighted during the TOWF ornithological vessel based surveys between 2004 and 2013, the London Array pre-construction aerial or vessel surveys between 2002 and 2004, the Kentish Flats ornithological vessel surveys between 2002 and 2010 or the GGOWF and GOWF surveys between 2004 and 2011.

4.8 White-Beaked Dolphin

4.8.1 White-beaked dolphins (*Lagenorhyncus albirostris*) are found in the temperate and sub-arctic waters of the North Atlantic and norther North Sea (Reid et al. 2003). In UK waters they are most commonly sighted in the central and Northern North Sea and western Scotland. White-beaked dolphins occur year round in near shore UK waters, primarily less than 100 m deep and in small groups (Reid et al. 2003). White-beaked dolphins in the UK are considered to have a Favourable Conservation Status (JNCC 2013) and all white-beaked dolphins in UK waters are considered to be part of the Celtic and Greater North Seas MU (IAMMWG 2015). There is an abundance estimate for this MU of 15,895 (95% CI: 9,107 – 27,743), of which 11,694 (95% CI: 6,578 – 20,790) are estimated within the UK EEZ, based on SCANS II abundance estimates for continental shelf waters (Hammond et al. 2013).

4.8.2 The data collected during the 1994 SCANS I and the 2005 SCANS II vessel surveys in survey area B produced no sightings of white-beaked dolphins (Hammond et al. 2002, Burt et al. 2006a). The SCANS III surveys did not record any white-beaked dolphins in survey block L (Hammond et al. 2017).

4.8.3 Four white-beaked dolphins were incidentally sighted in the GOWF study area in June 2009. In addition to this, there were also nine unidentified dolphin individuals sighted between April and June 2010 which were considered to be likely white-beaked dolphins (Royal Haskoning 2011).

4.8.4 No confirmed white-beaked dolphins were sighted during the 24 months of Thanet Extension APEM Ltd aerial surveys between 2016 and 2017, nor were they sighted during the TOWF ornithological vessel based surveys between 2004 and 2013, the London Array pre-construction aerial or vessel surveys between 2002 and 2004 or the Kentish Flats ornithological vessel surveys between 2002 and 2010.

4.9 Risso's Dolphin

4.9.1 In the UK, Risso's dolphins (*Grampus griseus*) are primarily observed around the West coast of Scotland, in the Hebrides. They form medium sized groups in UK waters, typically between 6 to 12 individuals and are often associated with other species including pilot whales, white-beaked, white-sided and bottlenose dolphins (Reid et al. 2003). They tend to be located in continental slope waters, mostly in depths of up to 100 m in the UK. Risso's dolphins in the UK are considered to have an Unknown Conservation Status (JNCC 2013). All Risso's dolphins in UK waters are considered to be part of the Celtic and Greater North Seas MU, however there is no abundance estimate available for this species (IAMMWG 2015). The SCANS III surveys did not record any Risso's dolphins in survey block L (Hammond et al. 2017).

4.9.2 Four Risso's dolphins were sighted in the GGOWF study area in January 2006 (Royal Haskoning 2011). No confirmed Risso's dolphins were sighted during the 24 months of Thanet Extension APEM Ltd aerial surveys between 2016 and 2017, nor were they sighted during the TOWF ornithological vessel based surveys between 2004 and 2013, the London Array pre-construction aerial or vessel surveys between 2002 and 2004 or the Kentish Flats ornithological vessel surveys between 2002 and 2010.

Conclusion

4.9.3 There is little evidence that any species of dolphin are common in the Thanet Extension area. There have only been sightings of four bottlenose dolphins during the London Array aerial surveys between 2002 and 2004, four white-beaked dolphins and a further nine potential white-beaked dolphins in the GOWF study area between 2009 and 2010 and four Risso's dolphins sighted in the GGOWF study area in 2006. Other than these, there have only been sightings of "dolphin/porpoise" during the APEM aerial surveys at the Thanet Extension site, where the images collected were of insufficient quality to determine whether the animals photographed were a dolphin species or a harbour porpoise. Given the seasonal pattern of these sightings and the frequency of porpoise sightings, it is probable that the majority of these sightings are of porpoise. It is therefore recommended that dolphin species are scoped out of impact assessment for the Thanet Extension.

4.10 Minke Whale

4.10.1 Minke whales (*Balaenoptera acutorostrata*) are widely distributed around the UK, with higher densities recorded on the West coast of Scotland and the western North Sea (Reid et al. 2003). They occur mainly on the continental shelf in water depths less than 200 m and are sighted more frequently in the summer months between May and September. Minke whales in the UK are considered to have a Favourable Conservation Status (JNCC 2013) and all minke whales in UK waters are considered to be part of the Celtic and Greater North Seas MU (IAMMWG 2015). There is an abundance estimate for this MU of 23,528 animals (95% CI: 13,989 - 39,572), of which 12,295 (95% CI: 7,176 - 21,066) are estimated within the UK EEZ; however, these abundance estimates are based on data from SCANS II (Hammond et al. 2013) and CODA (Macleod et al. 2009) which are likely to be underestimates due to the SCANS II aerial survey estimate not being corrected for perception bias and the CODA estimate not being corrected for either perception or availability bias.

4.10.2 The data collected during the 1994 SCANS I vessel surveys in survey area B produced no sightings of minke whales (Hammond et al. 2002). The data collected during the 2005 SCANS II aerial surveys produced an abundance estimate of 1,202 minke whales in survey area B (95% CI: 243 – 5,952) with a density of 0.0097 whales/km^2 (95% CI: 0.002 – 0.0481) (Burt et al. 2006a). It should, however be noted that the only sightings of minke whales during the SCANS II block B surveys were located off Devon, with none sighted off the south east coast of England.

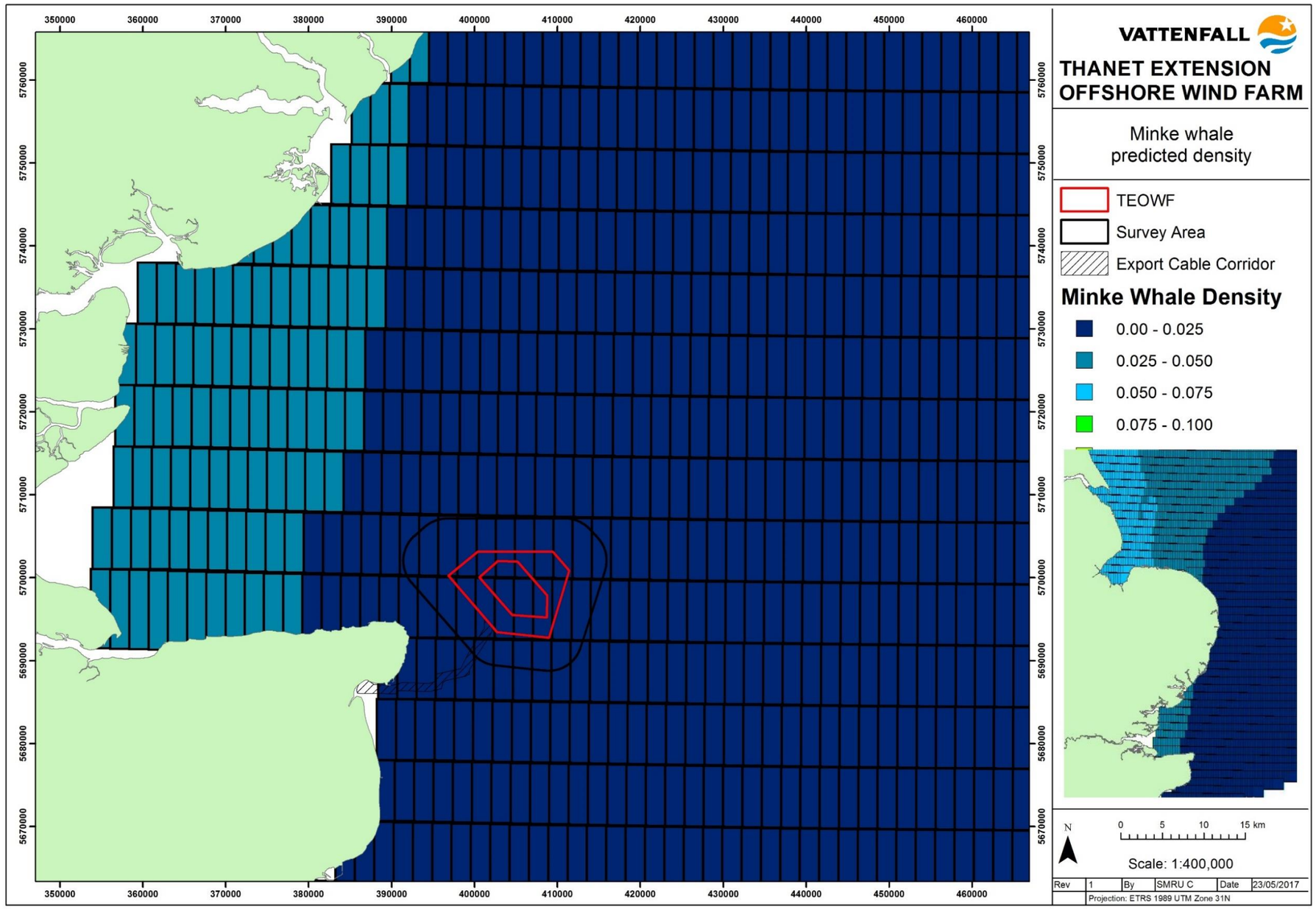
4.10.3 The SCANS II data were modelled to produce density surface maps for minke whales. From these data, there are 17 density estimates within the Thanet Extension survey area (Figure 4.26). These density estimates range between 0.0143 to 0.0216 minke whales/km^2 with a mean of 0.0174 minke whales/km^2.

4.10.4 The SCANS III surveys did not record any minke whales in survey block L (Hammond et al. 2017). No minke whales were sighted during the 24 months of Thanet Extension APEM Ltd aerial surveys between 2016 and 2017, nor were they sighted during the TOWF ornithological vessel based surveys between 2004 and 2013, the London Array pre-construction aerial or vessel surveys between 2002 and 2004, the Kentish Flats ornithological vessel surveys between 2002 and 2010 or the GGOWF and GOWF surveys between 2004 and 2011.

Conclusion

4.10.5 There is no evidence from the data sources examined that minke whales are common in the Thanet Extension area. They were not sighted in any of the site-specific surveys at the Thanet Extension, TOWF or any of the other nearby OWF in the area. The only density estimate available is from the SCANS II density surface map which estimates a maximum density of 0.0216 minke whales/km^2 within the Thanet Extension survey area. It is therefore recommended that minke whales are scoped out of impact assessment for the Thanet Extension.

Figure 4.26 Density estimates for mike whales, modelled using the SCANS II data, in relation to the Thanet Extension Offshore Wind Farm.



4.11 Conclusions

4.11.1 Based on the data presented in this baseline characterisation report, dolphin species and minke whales can be scoped out of the impact assessment for the Thanet Extension due to a lack of evidence for these species being present in the Thanet Extension area in any significant numbers at any time of the year.

4.11.2 Harbour porpoise remain scoped into the Thanet Extension impact assessment as the available literature and site specific surveys have shown that they are present in the Thanet Extension area year round. Since part of the Thanet Extension overlaps with the Southern North Sea cSAC and is completely within the 26 km HRA buffer under consideration around the cSAC, full consideration of the potential impact on the conservation objectives of the SAC following current SNCB guidance will be presented as part of the HRA.

4.11.3 Both species of seal remain scoped into the Thanet Extension impact assessment as the available literature and site specific surveys have shown that they are present in the Thanet Extension area. Both species of seal show connectivity with SAC sites and there are several haul-out sites for both species in the immediate vicinity of the Thanet Extension site and export cable route, including a harbour seal haul-out at Pegwell Bay where the export cable landfall is situated.

Table 4.14 MU and density estimates taken forward for impact assessment for each species of marine mammal. Values in brackets show 95% confidence intervals.

Species	MU	Abundance	Density (#/km^2)	Density Source
Harbour porpoise	North Sea	345,373 (246,526 – 495,752)	SCANS III: 0.607 APEM: 0.610	SCANS III (Hammond et al. 2017)
Harbour seal	Southeast England	7,029	5x5 km grid cell specific densities	At-Sea Usage Maps (Russell et al. 2017)
	Wadden Sea	36,667	na	na
Grey seal	Southeast and Northeast England	37,237	5x5 km grid cell specific densities	At-Sea Usage Maps (Russell et al. 2017)
	Wadden Sea	5,445*	na	na

** This is the raw grey seal count during the spring moult in 2017. There is no data on the proportion of grey seals at sea during this moult period and so the raw counts cannot be scaled to obtain a population estimate. Using the raw counts alone makes the assessment of impact highly precautionary.*

5. References

Aarup, T. 2002. Transparency of the North Sea and Baltic Sea-a Secchi depth data mining study. Oceanologia **44**.

Barker, J., and C. Obregon. 2015. Greater Thames Estuary Harbour Seal Population Survey. Europe Conservation Programme. Zoological Society of London.

Brasseur, S., R. Czeck, A. Galatius, L. Jensen, A. Jeff, P. Korber, U. Siebert, J. Teilmann, and S. Klopper. 2016. Grey Seal surveys in the Wadden Sea and Helgoland in 2015-2016. Trilateral Seal Expert Group.

Brasseur, S., A. de Groot, G. Aarts, E. Dijkman, and R. Kirkwood. 2015. Pupping habitat of grey seals in the Dutch Wadden Sea. IMARES Wageningen UR.

Burt, M., D. Borchers, and F. I. Samarra. 2006a. SCANS II Appendix D3.3 Aerial survey abundance estimates for minke whale and dolphins.

Burt, M., D. L. Borchers, and F. Samarra. 2006b. SCANS II Appendix D3.2 Aerial survey abundance estimates for harbour porpoise.

Capuzzo, E., D. Stephens, T. Silva, J. Barry, and R. M. Forster. 2015. Decrease in water clarity of the southern and central North Sea during the 20th century. Global Change Biology **21**:2206-2214.

Duck, C., and C. Morris. 2015. Grey seal pup production in Britain in 2014. A progress report. Sea Mammal Research Unit.

ETC/BD. 2014. Article 17 Reporting – Assessments of conservation status at the EU biogeographical level - Public consultation. ETC/BD Technical paper 3/2014, Paris.

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

Hammond, P., K. Mc Leod, and M. Scheidat. 2006. Small Cetaceans in the European Atlantic and North Sea (SCANS-II). Final Report. Saint Andrews.

Hammond, P. S., P. Berggren, H. Benke, D. L. Borchers, A. Collet, M. P. Heide-Jørgensen, S. Heimlich, A. R. Hiby, M. F. Leopold, and N. Øien. 2002. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology **39**:361-376.

Hammond, P. S., K. MacLeod, P. Berggren, D. L. Borchers, L. Burt, A. Cañadas, G. Desportes, G. P. Donovan, A. Gilles, D. Gillespie, J. Gordon, L. Hiby, I. Kuklik, R. Leaper, K. Lehnert, M. Leopold, P. Lovell, N. Øien, C. G. M. Paxton, V. Ridoux, E. Rogan, F. Samarra, M. Scheidat, M. Sequeira, U. Siebert, H. Skov, R. Swift, M. L. Tasker, J. Teilmann, O. Van Canneyt, and J. A. Vázquez. 2013. Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation **164**:107-122.

Heinänen, S., and H. Skov. 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.

IAMMWG. 2015. Management Units for cetaceans in UK waters. JNCC Report 547, ISSN 0963-8091.

IMARES. 2015. East Anglia THREE Appendix 12.4 Netherlands seal telemetry data.

JNCC. 2008. The deliberate disturbance of marine European Protected Species. Guidance for English and Welsh territorial waters and the UK offshore marine area.*in* JNCC, editor.

JNCC. 2013. The UK Approach to Assessing Conservation Status for the 2013 EU Habitats Directive Article 17 Reporting. Peterborough.

Jones, E. L., B. J. McConnell, S. Smout, P. S. Hammond, C. D. Duck, C. D. Morris, D. Thompson, D. J. Russell, C. Vincent, and M. Cronin. 2015. Patterns of space use in sympatric marine colonial predators reveal scales of spatial partitioning. Marine Ecology Progress Series **534**:235-249.

Kirk, J. T. 1994. Light and photosynthesis in aquatic ecosystems. Cambridge university press.

Lonergan, M., C. Duck, S. Moss, C. Morris, and D. Thompson. 2013. Rescaling of aerial survey data with information from small numbers of telemetry tags to estimate the size of a declining harbour seal population. Aquatic Conservation-Marine and Freshwater Ecosystems **23**:135-144.

Macleod, K., M. Burt, A. Cañadas, E. Rogan, B. Santos, A. Uriarte, O. Van Canneyt, J. Vázquez, and P. Hammond. 2009. Design-based estimates of cetacean abundance in offshore European Atlantic waters. Appendix I in the Final Report of the Cetacean Offshore Distribution and Abundance in the European Atlantic.

Nabe-Nielsen, J., J. Tougaard, J. Teilmann, and S. Sveegaard. 2011. Effects of wind farms on harbour porpoise behaviour and population dynamics.

Paxton, C., L. Scott-Hayward, M. Mackenzie, E. Rexstad, and L. Thomas. 2016. Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resources.

Reid, J. B., P. G. Evans, and S. P. Northridge. 2003. Atlas of cetacean distribution in north-west European waters. Joint Nature Conservation Committee.

Royal Haskoning. 2005. Thanet Offshore Wind Farm Environmental Statement: Section 8: Ornithology.

Royal Haskoning. 2010. Thanet Offshore Wind Farm Annual Ornithological Monitoring Report (During Construction): 2009 – 2010., Report to Thanet Offshore Wind Ltd, July 2010.

Royal Haskoning. 2011. Galloper Wind Farm Project Environmental Statement - Chapter 14: Marine Mammals.

RPS. 2005. London Array Offshore Wind Farm Environmental Statement. Volume 1: Offshore Works. London Array Ltd.

Russell, D., E. Jones, and C. Morris. 2017. Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals.

Russell, D., J. Matthiopoulos, and B. McConnell. 2011. SMRU seal telemetry quality control process. SCOS Briefing paper (11/17).

SCOS. 2015. Scientific Advice on Matters Related to the Management of Seal Populations: 2015.

SCOS. 2016. Scientific Advice on Matters Related to the Management of Seal Populations: 2016.

SCOS. 2017. Scientific Advice on Matters Related to the Management of Seal Populations: 2017.

Teilmann, J., C. T. Christiansen, S. Kjellerup, R. Dietz, and G. Nachman. 2013. Geographic, seasonal, and diurnal surface behavior of harbor porpoises. Marine Mammal Science **29**:E60-E76.

Teilmann, J., F. Larsen, and G. Desportes. 2007. Time allocation and diving behaviour of harbour porpoises (Phocoena phocoena) in Danish and adjacent waters. Journal of Cetacean Research and Management **9**:201-210.

Thompson, D., J. Onoufriou, and W. Patterson. 2017. Report on the distribution and abundance of harbour seals (*Phoca vitulina*) during the 2015 and 2016 breeding seasons in The Wash. SMRU Consulting Report Number: SMRUC-DOW-2016-016, December 2016 (Unpublished).

TOWFL. 2012a. Thanet Offshore Wind Farm. Ornithological Monitoring 2010-2011. Drafted by Ecology Consulting.

TOWFL. 2012b. Thanet Offshore Wind Farm. Ornithological Monitoring 2011-2012. Drafted by Ecology Consulting.

TOWFL. 2013a. Thanet Offshore Wind Farm Ornithological Monitoring 2012-2013. Drafted by Ecology Consulting.

TOWFL. 2013b. Thanet Offshore Wind Farm Post-Construction Survey: Ornithological Monitoring – Interim Report 2012-13.

TSEG. 2017. TSEG Grey Seal surveys in the Wadden Sea and Helgoland in 2016-2017.

Vincent, C., M. Huon, F. Caurant, W. Dabin, A. Deniau, S. Dixneuf, L. Dupuis, J.-F. Elder, M.-H. Fremau, and S. Hassani. 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.

Voet, H., M. M. Rehfisch, S. McGovern, and S. Sweeny. 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.

VWPL. 2011. Kentish Flats Offshore Wind Farm Extension Environmental Statement Section 11: Marine Mammals.

6. Glossary

Term	Definition
Incidental sighting	A sighting recorded by a surveyor that is not a dedicated marine mammal surveyor. Incidental sightings rates are expected to be lower than sightings rates obtained from dedicated marine mammal surveyors.
Perception bias	When an animal is within visible range but is not seen by the surveyor (e.g. because the surveyor is not looking in the right direction or waves obscure the surfacing). If perception bias is not accounted for then density will be underestimated.
Availability bias	When an animal is present within the survey area but is underwater and so is missed by the surveyor. If availability bias is not accounted for then density will be underestimated.
Sightings rate	This is a measure of the number of sightings per unit effort (distance, area or time) that is not corrected for perception or availability bias.

7. Acronyms

Acronym	Definition
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BAP	Biodiversity Action Plan
cSAC	candidate Special Area of Conservation
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPS	European Protected Species
ES	Environmental Statement
GGOWF	Greater Gabbard Offshore Wind Farm
GWF	Galloper Wind Farm
HRA	Habitats Regulations Assessment
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
MU	Management Unit
NERC	Natural Environment Research Council
NPS	National Policy Statement
OWF	Offshore Wind Farm
SAC	Special Area of Conservation
SCANS	Small Cetacean Abundance in the North Sea
SCOS	Special Committee on Seals
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
Thanet Extension	Thanet Extension Offshore Wind Farm
TOWF	Thanet Offshore Wind Farm
WWT	Wildfowl and Wetlands Trust
ZSL	Zoological Society of London
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea

9. Appendix 1: Tagged Seals

Table 9.1 Details of the 66 harbour seals tagged by SMRU in the South East England Management Area between 2003 and 2012. Those highlighted in light blue are the seals that had telemetry tracks that crossed into the Thanet Extension Offshore Wind Farm and Export Cable Area.

Seal Reference	Tagging Location	Tag Type	Age	Sex	Tagging Date	End Date	Tag Duration
pv3-Harry-03	Wash	ARGOS	1+	M	24/10/2003	27/03/2004	155
pv3-Isaac-03	Wash	ARGOS	1+	M	24/10/2003	08/01/2004	76
pv3-isabel-03	Wash	ARGOS	1+	F	24/10/2003	13/03/2004	141
pv3-jade-03	Wash	ARGOS	1+	F	24/10/2003	29/03/2004	157
pv3-lilly-03	Wash	ARGOS	1+	F	25/10/2003	12/05/2004	200
pv4-Jed-04	Wash	ARGOS	1+	M	18/02/2004	31/07/2004	164
pv4-Kay-04	Wash	ARGOS	1+	F	18/02/2004	12/06/2004	115
pv4-mary-04	Wash	ARGOS	1+	F	18/02/2004	03/07/2004	136
pv4-nina-04	Wash	ARGOS	1+	F	18/02/2004	23/07/2004	156
pv4-ode-04	Wash	ARGOS	1+	F	18/02/2004	12/06/2004	115
pv9-apple-04	Wash	ARGOS	1+	F	10/10/2004	03/01/2005	85
pv9-bell-04	Wash	ARGOS	1+	F	10/10/2004	04/03/2005	145
pv9-clare-04	Wash	ARGOS	1+	F	10/10/2004	07/02/2005	120
pv9-Dom-04	Wash	ARGOS	1+	M	10/10/2004	30/03/2005	171
pv9-Edd-04	Wash	ARGOS	1+	M	10/10/2004	31/01/2005	113
pv9-Fluff-04	Wash	ARGOS	1+	M	10/10/2004	02/03/2005	143
pv15-Moss-05	Wash	ARGOS	1+	M	21/03/2005	24/06/2005	95
pv15-Nevil-05	Wash	ARGOS	1+	M	21/03/2005	21/07/2005	122
pv15-Owen-05	Wash	ARGOS	1+	M	21/03/2005	24/07/2005	125
pv15-Poppy-05	Wash	ARGOS	1+	F	21/03/2005	06/06/2005	77
pv15-Q-05	Wash	ARGOS	1+	M	21/03/2005	23/07/2005	124
pv15-Romeo-05	Wash	ARGOS	1+	M	21/03/2005	28/06/2005	99
pv15-Sonja-05	Wash	ARGOS	1+	F	22/03/2005	17/08/2005	148
pv15-Tracy-05	Wash	ARGOS	1+	F	22/03/2005	29/05/2005	68
pv17-Aiden-06	Thames, Margate Sands	ARGOS	1+	M	19/02/2006	30/07/2006	161
pv17-Brett-06	Thames, Margate Sands	ARGOS	1+	M	19/02/2006	17/06/2006	118
pv17-Callan-06	Thames, Margate Sands	ARGOS	1+	M	21/02/2006	09/07/2006	138
pv20a-Barny-06	Thames, Margate Sands	ARGOS	1+	M	12/10/2006	24/02/2007	135
pv20a-Waldo-06	Thames, Margate Sands	ARGOS	1+	M	12/10/2006	09/03/2007	148
pv20a-Xenon-06	Thames, Margate Sands	ARGOS	1+	M	12/10/2006	21/02/2007	132
pv20a-Yogi-06	Thames, Margate Sands	ARGOS	1+	M	12/10/2006	09/02/2007	120
pv20a-Zack-06	Thames, Margate Sands	ARGOS	1+	M	12/10/2006	25/12/2006	74
pv20g-Adam-06	Thames, Margate Sands	phone	1+	M	13/10/2006	28/12/2006	76
pv40-191-12	Thames, Hadley Sands	phone	1+	F	16/01/2012	14/04/2012	89
pv40-197-12	Thames, Hadley Sands	phone	1+	M	16/01/2012	13/04/2012	88
pv40-283-12	Thames, Hadley Sands	phone	1+	M	16/01/2012	02/05/2012	107
pv40-284-12	Thames, Hadley Sands	phone	1+	F	16/01/2012	22/03/2012	66
pv40-285-12	Thames, Hadley Sands	phone	1+	M	16/01/2012	15/05/2012	120
pv40-200-12	Thames, Margate Sands	phone	1+	F	18/01/2012	24/05/2012	127
pv40-267-12	Thames, Margate Sands	phone	1+	M	18/01/2012	20/03/2012	62
pv40-268-12	Thames, Margate Sands	phone	1+	F	18/01/2012	02/06/2012	136
pv40-270-12	Thames, Margate Sands	phone	1+	M	18/01/2012	22/04/2012	95
pv40-278-12	Thames, Margate Sands	phone	1+	F	18/01/2012	14/04/2012	87
pv42-156-12	Wash	phone	1+	M	2012-01-24	2012-01-26	2
pv42-162-12	Wash	phone	1+	f	2012-01-23	2012-07-01	160
pv42-165-12	Wash	phone	1+	f	2012-01-21	2012-05-15	115
pv42-194-12	Wash	phone	1+	M	2012-01-23	2012-05-17	115
pv42-198-12	Wash	phone	1+	M	2012-01-24	2012-06-03	131
pv42-220-12	Wash	phone	1+	M	2012-01-24	2012-06-16	144
pv42-221-12	Wash	phone	1+	M	2012-01-24	2012-03-14	50
pv42-266-12	Wash	phone	1+	F	2012-01-24	2012-04-18	85
pv42-277-12	Wash	phone	1+	f	2012-01-23	2012-06-29	158
pv42-287-12	Wash	phone	1+	M	2012-01-24	2012-02-11	18
pv42-288-12	Wash	phone	1+	f	2012-01-21	2012-07-10	171
pv42-289-12	Wash	phone	1+	M	2012-01-25	2012-04-13	79
pv42-290-12	Wash	phone	1+	F	2012-01-25	2012-03-23	58
pv42-291-12	Wash	phone	1+	F	2012-01-23	2012-05-11	109
pv42-292-12	Wash	phone	1+	M	2012-01-24	2012-05-08	105
pv42-293-12	Wash	phone	1+	F	2012-01-25	2012-04-04	70
pv42-294-12	Wash	phone	1+	M	2012-01-25	2012-05-08	104
pv42-295-12	Wash	phone	1+	F	2012-01-25	2012-04-03	69
pv42-316-12	Wash	phone	1+	m	2012-01-22	2012-05-07	106
pv42-317-12	Wash	phone	1+	F	2012-01-23	2012-05-15	113
pv42-318-12	Wash	phone	1+	F	2012-01-23	2012-06-11	140
pv42-319-12	Wash	phone	1+	m	2012-01-22	2012-05-15	114
pv42-320-12	Wash	phone	1+	f	2012-01-21	2012-05-07	107

Table 9.2 Details of the 32 grey seals tagged by SMRU in the South East England Management Area between 1988 and 2015. Those highlighted in light blue are the seals that had telemetry tracks that crossed into the Thanet Extension Offshore Wind Farm and Export Cable Area.

Seal ID	Tagging Location	Tag Type	Age	Sex	Start Date	End Date	Duration
dn2-5813-88	Donna Nook	ARGOS	1+	M	04/08/1988	18/09/1988	45
dn3-5813-89	Donna Nook	ARGOS	1+	F	01/07/1989	13/10/1989	104
hg11-Ailsa-05	Donna Nook	ARGOS	1+	F	15/07/2005	17/01/2006	186
hg11-Bella-05	Donna Nook	ARGOS	1+	F	15/07/2005	28/12/2005	166
hg11-Donna-05	Donna Nook	ARGOS	1+	F	16/07/2005	10/01/2006	178
hg11-Festa-05	Donna Nook	ARGOS	1+	M	16/07/2005	27/07/2005	11
hg11-Garth-05	Donna Nook	ARGOS	1+	M	16/07/2005	06/12/2005	143
hg11-Hank-05	Donna Nook	ARGOS	1+	M	16/07/2005	21/12/2005	158
hg11-Jessy-05	Donna Nook	ARGOS	1+	F	16/07/2005	29/03/2006	256
hg11-Chuck-05	Donna Nook	ARGOS	1+	M	17/07/2005	18/01/2006	185
hg11-Irene-05	Donna Nook	ARGOS	1+	F	17/07/2005	10/12/2005	146
hg11-Earl-05	Donna Nook	ARGOS	1+	M	23/07/2005	20/12/2005	150
hg48-010-15	Donna Nook	phone	1+	M	2015-05-02	2015-09-29	150
hg48-011-15	Donna Nook	phone	1+	f	2015-05-02	2015-05-07	5
hg48-342-15	Donna Nook	phone	1+	f	2015-05-02	2015-11-30	212
hg48-345-15	Donna Nook	phone	1+	f	2015-05-02	2015-05-25	23
hg48-358-15	Donna Nook	phone	1+	M	2015-05-02	2015-11-21	203
hg48-359-15	Donna Nook	phone	1+	f	2015-05-02	2015-10-19	170
hg48-360-15	Donna Nook	phone	1+	f	2015-05-02	2015-12-26	238
hg48-363-15	Donna Nook	phone	1+	f	2015-05-02	2015-10-31	182
hg48-364-15	Donna Nook	phone	1+	f	2015-05-02	2015-09-02	123
hg48-924-15	Donna Nook	phone	1+	f	2015-05-02	2015-12-11	223
hg48-291-15	Blakeney	phone	1+	M	2015-05-05	2015-11-15	194
hg48-315-15	Blakeney	phone	1+	M	2015-05-05	2015-08-27	114
hg48-356-15	Blakeney	phone	1+	M	2015-05-05	2015-11-16	195
hg48-357-15	Blakeney	phone	1+	M	2015-05-05	2015-11-24	203
hg48-925-15	Blakeney	phone	1+	F	2015-05-05	2015-11-24	203
hg48-009-15	Blakeney	phone	1+	F	2015-05-07	2015-12-15	222
hg48-361-15	Blakeney	phone	1+	F	2015-05-07	2015-12-04	211
hg48-362-15	Blakeney	phone	1+	F	2015-05-07	2015-11-10	187
hg48-923-15	Blakeney	phone	1+	F	2015-05-07	2015-12-27	234
hg48-926-15	Blakeney	phone	1+	M	2015-05-07	2015-08-18	103