East Anglia TWO Offshore Windfarm

Appendix 11.1

Marine Mammal Information and Survey Report

Preliminary Environmental Information
Volume 3
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Revision Summary					
Rev	**Date**	**Document Status**	**Prepared by**	**Checked by**	**Approved by**
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Annex number	Title
Annex 1	Raw Data
Annex 2	Marine mammal slighting locations

Glossary of Acronyms

CGNS	Celtic and Greater North Seas
CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
cm	Centimetre
CV	Coefficient of Variation
CI	Confidence Interval
CS	Continental Shelf
CF	correction factors
DECC	Department of Energy and Climate Change
EAOW	East Anglia Offshore Wind
EAOWFL	East Anglia Offshore Wind Farm Limited
EATL	East Anglia THREE Ltd
EIA	Environmental Impact Assessment
ES	Environmental Statement
EPS	European Protected Species
EU	European Union
EEZ	Exclusive Economic Zone
ETG	Expert Topic Group
GWFL	Galloper Wind Farm Limited
GNS	Greater North Sea
GSD	Ground Sampling Distance
HRA	Habitats Regulation Assessment
IAMMWG	Inter-Agency Marine Mammal Working Group
JCP	Joint Cetacean Protocol
JNCC	Joint Nature and Conservation Committee
kg	kilogram
km	Kilometre
km^2	Kilometre squared
m	Metre
MU	Management Unit
MATL	Marine Atlantic
nm	Nautical mile
PEIR	Preliminary Environmental Information Report
QA	Quality Assurance
SMRU	Sea Mammal Research Unit
SST	sea surface temperature
SCANS	Small Cetaceans in the European Atlantic and North Sea
SACs	Special Areas of Conservation
SCI	Site of Community Importance
SCOS	Special Committee on Seals
WF	Windfarm
WWT	Wildfowl and Wetlands Trust
ZEA	Zonal Environmental Assessment

Glossary of Terminology

Construction operation and maintenance platform	A fixed offshore structure required for construction, operation, and maintenance personnel and activities.
East Anglia TWO project	The proposed project consisting of up to 75 wind turbines, up to four offshore electrical platforms, up to one construction operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia TWO windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and the information required to support HRA.
Inter-array cables	Offshore cables which link the wind turbines to each other and the offshore electrical platforms, these cables will include fibre optic cables.
Marine Mammal Study Area	The area of which the site-specific survey for marine mammals (and seabirds) covered. This is the East Anglia TWO windfarm site plus a 4km buffer area.
Mitigation areas	Areas captured within the Development Area specifically for mitigating expected or anticipated impacts.
Offshore development area	The East Anglia TWO windfarm site and offshore cable corridor (up to Mean High Water Springs).
Offshore electrical infrastructure	The transmission assets required to export generated electricity to shore. This includes inter-array cables from the wind turbines to the offshore electrical platforms, offshore electrical platforms, platform link cables and export cables from the offshore electrical platforms to the landfall.
Offshore electrical platform	A fixed structure located within the windfarm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which would bring electricity from the offshore electrical platforms to the landfall, these cables will include fibre optic cables.
Offshore infrastructure	All of the offshore infrastructure including wind turbines, platforms, and cables.
Offshore platform	A collective term for the offshore operation and maintenance platform and the offshore electrical platforms.
Platform link cable	Electrical cable which links one or more offshore platforms, these cables will include fibre optic cables.

11.1 Marine Mammal Information and Survey Report

11.1 Marine Mammal Information

1. In UK waters, two groups of marine mammals occur: cetaceans (whales, dolphins and porpoises) and pinnipeds (seals). The data presented by Reid et al. (2003), Small Cetaceans in the European Atlantic and North Sea (SCANS)-I (Hammond et al. 2002), SCANS-II (Hammond et al. 2013), SCANS-III (Hammond et al. 2017) and the Joint Nature and Conservation Committee (JNCC) (2013) indicate the marine mammal species that occur regularly over large parts of the southern North Sea are harbour porpoise *Phocoena phocoena*, grey seal *Halichoerus grypus*, harbour seal *Phoca vitulina*, white-beaked dolphin *Lagenorhynchus albirostris* and minke whale *Balaenoptera acutorostrata.*

2. Marine mammal species, including Atlantic white-sided dolphin *Lagenorhynchus acutus*, bottlenose dolphin *Tursiops truncatus*, killer whale *Orcinus orca*, sperm whale *Physeter macrocephalus*, long-finned pilot whale *Globicephala melas*, Risso's dolphin *Grampus griseus*, striped dolphin *Stenella coeruleoalba* and other seal species are occasional or rare visitors to the southern North Sea (e.g. Reid et al. 2003; Hammond et al. 2013, 2017; Department of Energy and Climate Change (DECC) 2016; Special Committee on Seals (SCOS) 2017). Species considered as occasional or rare visitors have not been considered further in the description of the existing environment for marine mammals.

11.1.1 Data Sources

3. As outlined in the ***Chapter 11 Marine Mammals***, information to support the environmental impact assessment (EIA) will be based on 24 months (November 2015 to April 2016, September 2016 to October 2017 and May 2018 to August 2018) of survey data for the East Anglia TWO windfarm site plus 4km buffer (referred to as the marine mammal survey area), as agreed through the Evidence Plan Process (EPP) (Marine Mammal Expert Topic Group (ETG) meeting, March 2018).

4. The assessment for the Preliminary Environmental Information Report (PEIR) has been based on the data currently available for November 2015 to April 2016, September 2016 to October 2017 and May 2018 (21 months).

5. APEM Ltd collected high resolution aerial digital still imagery for marine mammals (combined with ornithology surveys) over the marine mammal survey

area, capturing imagery at 2cm Ground Sampling Distance (GSD). Coverage of the marine mammal survey area was between approximately 11% and 13% per month. All images were analysed to enumerate marine mammals to species level, where possible (see ***section 11.2*** of this appendix for further details).

6. In addition, the surveys for other offshore wind farms in the former East Anglia Zone, as outlined in ***Table A11.1.1*** provide useful context.

Table A11.1.1 Data sets used for informing Marine Mammals Existing Environment

Data Set	Spatial Coverage	Survey Timing
Zone Environmental Appraisal (ZEA) ornithology and marine mammal survey (video, completed by Hi-Def)	Former East Anglia Zone	November 2009 to March 2010
East Anglia ONE ornithology and marine mammal survey (digital aerial surveys completed by APEM and boat-based surveys completed by The Institute of Estuarine and Coastal Studies (IECS))	East Anglia ONE plus 4km buffer	November 2009 to October 2011 May 2010 to April 2011
ZEA ornithology and marine mammal survey (digital aerial, completed by APEM)	Former East Anglia Zone	April 2010 to April 2011
Aerial ornithology and marine mammal surveys (digital aerial, completed by APEM)	Former East Anglia TWO windfarm site	September 2011 to December 2012
East Anglia THREE ornithology and marine mammal survey (digital aerial, completed by APEM)	East Anglia THREE plus 4km buffer	September 2011 to August 2013
East Anglia FOUR (now Norfolk Vanguard East) ornithology and marine mammal survey (digital aerial, completed by APEM)	East Anglia FOUR plus 4km buffer	March 2012 to April 2016
Norfolk Vanguard ornithology and marine mammal survey (digital aerial, completed by APEM)	Norfolk Vanguard plus 4km buffer	September 2015 to August 2017
Norfolk Boreas ornithology and marine mammal survey (digital aerial, completed by APEM)	Norfolk Boreas plus 4km buffer	August 2016 to January 2018
East Anglia TWO aerial ornithology and marine mammal survey (digital aerial, completed by APEM)	East Anglia TWO windfarm site plus 4km buffer	2015-ongoing
East Anglia ONE North aerial ornithology and marine mammal survey (digital aerial, completed by APEM)	East Anglia ONE North windfarm site plus 4km buffer	2016-ongoing

7. Further to the survey data outlined in ***Table A11.1.1***, a range of information has also informed the EIA, including, but not limited to, the data sources listed in ***Table A11.1.2.***

Table A11.1.2 Additional Information Sources for Marine Mammals Existing Environment

Information Source	Year	Spatial Coverage	Notes
Small Cetaceans in the European Atlantic and North Sea (SCANS-III) data (Hammond et al. 2017)	Summer 2016	North Sea and European Atlantic waters	Provides information including abundance and density estimates of cetaceans in European Atlantic waters in summer 2016, including the proposed East Anglia TWO offshore development area.
SCANS-II data (Hammond et al. 2013)	July 2005	North Sea and European Atlantic shelf waters	Provides information including abundance and density estimates for the proposed East Anglia TWO offshore development area.
Management Units (MUs) for cetaceans in UK waters (Inter-Agency Marine Mammal Working Group (IAMMWG) 2015)	2015	UK waters	Provides information on MU for the proposed East Anglia TWO offshore development area.
Offshore Energy Strategic Environmental Assessment (including relevant appendices and technical reports) (Department of Energy and Climate Change (DECC) (now BEIS 2016)	2016	UK waters	Provides information for the wider southern North Sea area.
The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area (Heinänen and Skov 2015)	1994-2011	UK Exclusive Economic Zone (EEZ)	Data was used to determine harbour porpoise cSAC/SCI sites. Provides information on harbour porpoise in southern North Sea area.
Revised Phase III data analysis of Joint Cetacean Protocol (JCP) data resources (Paxton et al. 2016)	1994-2011	UK EEZ	Provides information for the Norfolk Bank development area, which includes the proposed East Anglia TWO windfarm site.

Information Source	Year	Spatial Coverage	Notes
Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011 (Gilles et al. 2012)	Summer 2011	Dogger Bank and adjacent areas	Provides information for wider area.
Seasonal habitat-based density models for a marine top predator, the harbour porpoise, in a dynamic environment (Gilles et al. 2016)	2005-2013	UK (SCANS II, Dogger Bank), Belgium, the Netherlands, Germany, and Denmark	Provides information for central and southern North Sea area.
Distribution of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008 (The Wildfowl and Wetlands Trust (WWT) 2009)	2001-2008	UK areas of the North Sea	Provides information for on species in southern North Sea area.
MARINElife surveys from ferries routes across the southern North Sea area (MARINElife 2018)	2017-May 2018	Southern North Sea	Provides information on species in southern North Sea area.
Sea Watch Foundation volunteer sightings off eastern England (Sea Watch Foundation 2018)	2017-May 2018	East coast of England	Provides information on species sighted along east coast of England.
UK seal at sea density estimates and usage maps (Russell et al. 2017)	1988-2012	North Sea	Provides information on abundance and density estimates for seal species.
Seal telemetry data (e.g. Sharples **et al**. 2008; Russell and McConnell 2014; Russell 2016)	1988-2010; 2015	North Sea	Provides information on movements and distribution of seal species.
Special Committee on Seals (SCOS) annual reporting of scientific advice on matters related to the management of seal populations (SCOS 2017).	2017	North Sea	Provides information on seal species.
Counts of grey seal in the Wadden Sea (Trilateral	Spring 2017	Wadden Sea	Counts of grey seal during moult season.

Information Source	Year	Spatial Coverage	Notes
Seal Expert Group (TSEG) 2017a)			
Counts of harbour seal counts in the Wadden Sea (TSEG) 2017b)	June 2017	Wadden Sea	Counts of harbour seal during pupping season.

11.1.2 Cetaceans

8. Cetacean populations occurring in UK waters are generally wide-ranging; their distribution and abundance vary considerably over time and space, influenced by both natural and anthropogenic factors (Reid et al. 2003). There may be areas of regular high density for some species, but how important these areas are in comparison to others in their natural range, is still generally unknown (Reid et al. 2003). Given that these species are not constrained to UK waters and are known to travel considerable distances, the assessment is made over a wider geographic context to incorporate potential population impacts throughout their range.

11.1.2.1 North Sea Area

9. Compared to the central and northern North Sea, the southern North Sea has a relatively low abundance of marine mammals, with the exception of the harbour porpoise (DECC 2016). Ten species of cetacean have been recorded within the southern North Sea, however, only harbour porpoise can be considered to be common to the area throughout the year, with white-beaked dolphin and minke whale occurring as seasonal visitors (DECC 2016).

10. During the SCANS-II surveys in July 2005 and SCANS-III surveys in summer 2016, the cetacean species recorded in the southern North Sea area were harbour porpoise, bottlenose dolphin, white-beaked dolphin and minke whale (Hammond et al. 2013, 2017). Of these, harbour porpoise were most commonly recorded.

11. The Joint Cetacean Protocol (JCP) report (Paxton et al. 2016) indicates that the only cetacean species recorded in significant number within the Norfolk Bank Development Area (an area, defined in the JCP report, off East Anglia which includes the East Anglia TWO offshore development area) is harbour porpoise, while there are low numbers of minke whale, bottlenose dolphin, common dolphin and white-beaked dolphin. There are no records of Risso's dolphin or Atlantic white-sided dolphin within the Norfolk Bank Development Area (Paxton et al. 2016).

12. MARINElife (2018), a UK-based charity, record marine mammal and seabird sightings from a variety of platforms, including ferry routes crossing the southern North Sea. There are two active and one discontinued ferry route that pass in the vicinity of the East Anglia TWO offshore development area, these are the Felixstowe to Vlaardingen route, the Hull to Zeebrugge and Rosyth to Zeebrugge route[1]. See ***Table A11.1.3*** below for a summary of all marine mammal sightings for these three routes for 2017 and to July 2018[2]. It should be noted that from the sightings reports on the MARINElife (2018) website does not provide accurate location data and therefore sightings could have been recorded at any point between the two port locations.

13. The Sea Watch Foundation collate volunteer cetacean sightings around the UK. For the east England coast in 2017 and early 2018, sightings submitted are predominantly harbour porpoise, other cetacean species that have been recorded include white-beaked dolphin off the Suffolk coast, common dolphin in the river Thames, and one minke whale off the coast at Happisburgh (Sea Watch Foundation 2018).

Table A11.1.3 Summary of all marine mammal sightings collated from the MARINELife surveys

Survey	Species	Number recorded
Felixstowe to Vlaardingen MARINELife survey		
July 2018	N/A	N/A
June 2018	Harbour porpoise	1
May 2018	Harbour seal	2
April 2018	Grey seal	1
	Harbour porpoise	9
	Harbour seal	2
March 2018	Grey seal	1
	Harbour porpoise	3
August 2017	Harbour porpoise	2
	Dolphin sp.	1
July 2017	Harbour porpoise	5
	Grey seal	1
	Dolphin sp	4

[1] The Rosyth to Zeebrugge ferry route ceased operating in April 2018.
[2] Up to March 2018 for the Rosyth to Zeebrugge ferry route.

Survey	Species	Number recorded
May 2017	Harbour porpoise	1
	Seal sp.	1
February 2017	Harbour porpoise	5
Total recorded (all species)		39
Hull to Zeebrugge MARINELife survey		
July 2018	Grey seal	5
	Harbour porpoise	5
May 2018	Grey seal	1
	Harbour seal	1
	Unidentified cetacean sp.	1
April 2018	Harbour porpoise	2
October 2017	Harbour porpoise	8
September 2017	Harbour porpoise	1
July 2017	Unidentified whale sp.	1
	Unidentifiied dolphin or porpoise	1
June 2017	Harbour porpoise	1
April 2017	Harbour porpoise	3
	Bottlenose dolphin	2
Total recorded (all species)		32
Rosyth to Zeebruge MARINELife survey		
March 2018	Bottlenose dolphin	1
	Common dolphin	1
	Harbour porpoise	4
	Grey seal	2
	Harbour seal	1
	Seal sp.	2
February 2018	Harbour porpoise	2
	Unidentifiied dolphin sp.	4

Survey	Species	Number recorded
	Seal sp.	1
November 2017	Harbour porpoise	1
October 2017	Harbour porpoise	5
	Grey seal	1
May 2017	Minke whale	4
	Harbour porpoise	60
	White-beaked dolphin	15
	Grey seal	53
	Harbour seal	1
March 2017	Grey seal	1
February 2017	Common dolphin	3
	Harbour porpoise	1
Total recorded (all species)		163

11.1.2.2 Former East Anglia Zone Windfarms

14. During the 2009-2011 surveys, as part of the former East Anglia Zone, low numbers of cetaceans were recorded, with only 108 individual cetaceans identified from 17 months of aerial data (East Anglia Offshore Wind (EAOW) 2012c). The majority of the cetaceans positively identified in aerial surveys were harbour porpoise, which accounted for 38% of sightings, with an additional 53% listed as 'small cetaceans' (which are most likely to be harbour porpoise, but as identification could not be confirmed they are classed as small cetaceans). A further 6% of aerial sightings were identified as 'patterned dolphins' (which are most likely to be white-beaked dolphin) (EAOW 2012c).

15. These data were used to create modelled cetacean abundancies across the former East Anglia Zone for all seasons. These modelled abundancies showed an increase in the numbers of cetaceans in autumn and winter periods, and in the south, west and north-east areas of the former East Anglia Zone. Within the East Anglia TWO windfarm site, the modelled abundancies of cetaceans were consistently low, except in autumn 2010 which saw a small increase in abundances (EAOW 2012b).

16. During 24 months of aerial surveys covering the East Anglia ONE site, 10km to the east of the East Anglia TWO windfarm site, 181 cetaceans in total were recorded, 130 of which (72%) were positively identified as harbour porpoise,

12.5% identified as either a porpoise or small cetacean (which were most likely to be harbour porpoise), 0.5% as patterned dolphin, and 15% were recorded as unidentified cetacean species (EAOW 2012b).

17. The boat based survey data from the East Anglia ONE site identified 83% of all cetaceans recorded as being harbour porpoise. The boat based surveys also recorded low numbers of three dolphin species: white-beaked dolphin (8%), bottlenose dolphin (6%) and Risso's dolphin (2%), as well as unidentified dolphin species (2%). On the basis of the boat-based survey results, it was considered likely that the majority of 'small cetaceans' recorded from the Zone's aerial surveys were harbour porpoise (East Anglia ONE Limited (EAOL) 2012).

18. During the 24 months (September 2011 to August 2013) of East Anglia THREE aerial surveys which is located approximately 45km north-east of the East Anglia TWO windfarm site, 341 cetaceans in total were recorded within the East Anglia THREE site and buffer area, 149 of which (44%) were positively identified as harbour porpoise, and a further 188 (55%) identified as either a porpoise or small cetacean. Four white beaked dolphin were also recorded (East Anglia THREE Ltd (EATL) 2015).

19. During the Norfolk Vanguard East site surveys (approximately 62km to the north-east of the East Anglia TWO windfarm site), including the East Anglia FOUR surveys, from March 2012 to April 2016 for the windfarm area and 4km buffer, 636 cetaceans were recorded, with 249 (39% of recorded sightings) identified as harbour porpoise and 373 (59% of recorded sightings) classed as unidentified small cetacean (which have been included as harbour porpoise for the impact assessment). Three white-beaked dolphin, two common dolphin, two patterned dolphin and seven unidentified dolphin species were also recorded (Norfolk Vanguard Limited 2018).

20. During Norfolk Vanguard West site surveys from September 2015 to August 2017 for the windfarm area and 4km buffer (approximately 57km north-east from the East Anglia Two windfarm site), 478 cetaceans were recorded, of which 144 (30% of recorded sightings) were identified as harbour porpoise and 317 (66% of recorded sightings) classed as unidentified small cetacean (which have been included as harbour porpoise for the impact assessment). Thirteen unidentified dolphin and four white-beaked dolphin were also recorded (Norfolk Vanguard Limited 2018).

11.1.2.3 East Anglia TWO surveys

21. The marine mammal surveys of the East Anglia TWO windfarm site and a 4km buffer (referred to as the marine mammal survey area) covers the period of November 2015 to April 2016, September 2016 to October 2017, and May 2018. It should be noted that there are three further months of survey data to be

included in the Environmental Statement (ES). To date, the marine mammal surveys have identified a total of 436 marine mammals within the marine mammal survey area. Of those, 15.8% (n=69) were identified as harbour porpoise, with a further 80.7% (n=352) identified as small cetaceans (either dolphin or porpoise species). It should be noted that is considered probable that the majority of these sightings will be harbour porpoise considering the know species abundancies in the vicinity of the East Anglia TWO windfarm site. A total of 0.7% of the sightings were identified as dolphin species (n=3) and 2.7% (n=12) were identified as seal species. See ***section 11.2*** for the full data analysis of the marine mammal surveys undertaken for the proposed East Anglia TWO project.

22. Species sighting records during the East Anglia TWO surveys are consistent with the conclusions of previously modelled abundances for the former East Anglia Zone. For the site-specific surveys, unidentified small cetacean and harbour porpoise were the most commonly recorded species, and the months with the highest numbers of sightings were January, February and March. Marine mammal sightings recorded during the East Anglia TWO surveys up to May 2018 are presented in

23. ***Table*** A11.1.7 The available data from the East Anglia TWO surveys, surveys within the former Zone, surveys for other offshore windfarms in the southern North Sea and other data sources, including SCANS-II (Hammond et al. 2013) and SCANS-III (Hammond et al. 2017), indicate that harbour porpoise is the most abundant cetacean species present within this region, with occasional sightings of dolphin species (most likely white-beaked dolphin), with rare sightings of low numbers of other cetaceans.

11.1.3 Harbour porpoise

11.1.3.1 Distribution

24. Harbour porpoise is the most commonly sighted cetacean in the North Sea (Reid et al. 2003; Wildfowl and Wetlands Trust (WWT) 2009; ASCOBANS 2012; Hammond et al. 2013, 2017; Sea Watch Foundation 2018) and is the cetacean most likely to be observed in the East Anglia TWO offshore development area.

25. Harbour porpoise distribution is generally restricted to the temperate and sub-arctic waters of the Northern Hemisphere, mainly on the continental shelf at depths of 20-200m and primarily within water temperatures ranging from 11 to 14°C (DECC 2016; Reid et al. 2003).

26. The JNCC Cetacean Atlas (Reid et al. 2003) recorded sightings of harbour porpoise throughout the southern North Sea, although the overall sightings were low in this region compared to the north and central North Sea (Reid et al. 2003).

27. Data on the distribution of marine mammals in UK areas of the North Sea have also been collected opportunistically during aerial surveys for birds conducted by WWT Consulting from 2001-2008 (WWT 2009). Between 2001 and 2008, a total of 4,588 sightings, comprising 5,439 individual animals, were made of harbour porpoise (WWT 2009). The results show a similar distribution in occurrence to those presented in Reid et al. (2003), with higher relative densities close to shore around the east coast and off the Lincolnshire and Yorkshire coasts, but with much higher relative densities recorded off the coast between Norfolk and Kent. Results for the WWT surveys are also similar to those recorded during SCANS-II, in which higher numbers of harbour porpoise were recorded in the southern North Sea areas than the more northerly survey areas.

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

29. Initial data from the SCANS-III survey also indicates that the occurrence of harbour porpoise is greater in the central and southern areas of the North Sea compared to the northern North Sea (***Plate A11.1.1***; Hammond et al. 2017), which is consistent with SCANS-II. Modelling of the new data from 2016 to investigate fine scale distribution and habitat use is in progress (Hammond et al. 2017).

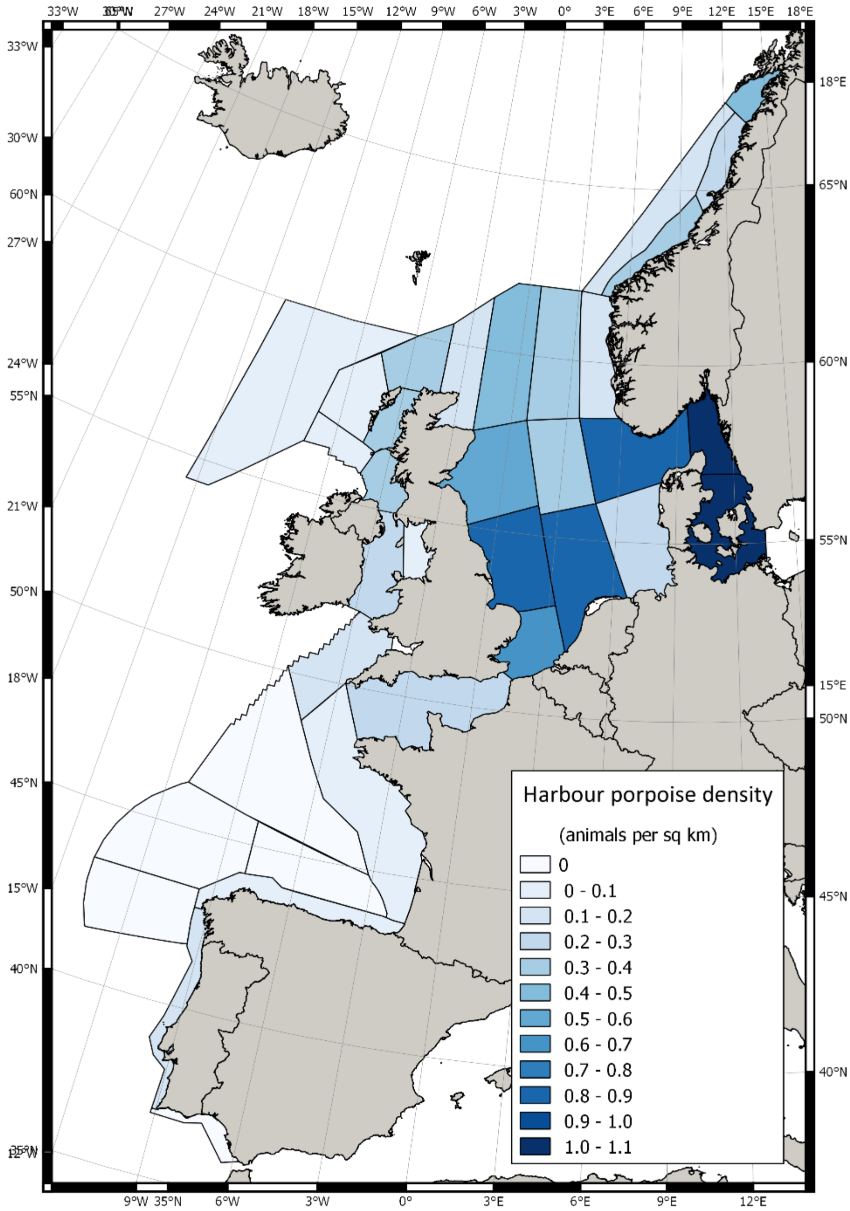

Plate A11.1.1 Estimated density of harbour porpoise in each SCANS-III survey block (Source: Hammond et al. 2017)

30. Statistical modelling of 18 years of survey data between 1994 and 2011 of the entire UK Exclusive Economic Zone (EEZ) for harbour porpoise using the JCP data together with environmental data (such as water depth, hydrodynamics, sediments and shipping) was undertaken by Heinänen and Skov (2015) to identify discrete and persistent areas of relatively high harbour porpoise density. The model results (Heinänen and Skov 2015) indicated that the sampled densities of harbour porpoise were influenced by both oceanographic and anthropogenic pressure variables. The coarseness of surface sediments played a major role in the presence and density of porpoises. Water depth and hydrodynamic variables also had an influence on harbour porpoise distribution in the North Sea, with peaks in preferences during summer at depths of 40m

and 200m. Other variables included surface salinity, stability of the water column (described by temperature differences), stratification and eddy activity. The model results also indicated a negative relationship between the number of ships and the distribution of harbour porpoises in the North Sea (Heinänen and Skov 2015).

31. Within the southern North Sea, Heinänen and Skov (2015) identified one area of high harbour porpoise density; from the western slopes of Dogger Bank south along a 30m depth contour towards an area off the Norfolk coast. This was further split into three areas due to inter-annual variations.

- North-western edge of Dogger Bank (summer);
- Inner Silver Pit; and
- Offshore area east of Norfolk and east of outer Thames estuary (winter).

32. The Heinänen and Skov (2015) analysis was used in the identification of potential Special Areas of Conservation (SAC) for harbour porpoise in UK waters (see ***section 11.1.5.2.4***).

33. Gilles et al. (2016) assessed nine years of harbour porpoise survey data (2005 to 2013) collected in the UK (SCANS II, Dogger Bank), Belgium, the Netherlands, Germany, and Denmark, to develop seasonal habitat-based density models for the central and southern North Sea. The models indicated that densities generally increased with day length, with highest densities predicted when day length exceeded 14.5 hours during the months of June through August. The highest harbour porpoise density occurred 150km offshore and at depths between 25 and 40m. Harbour porpoise densities also increased with higher probability for sea surface temperature (SST) fronts and decreased with distance to sandeel grounds.

34. The seasonal maps produced by Gilles et al. (2016) for harbour porpoise density across the central and south-eastern North Sea were consistent with previously described seasonal patterns of harbour porpoise distribution. The spring seasonal density map indicated major hotspots in the southern and south-eastern part of the North Sea, mainly inshore close to the Belgian and Dutch coasts extending toward the German coast off the East Frisian Islands. The model also predicted high densities in the area of the Sylt Outer Reef in the German North Sea as well as north off the coast of Jutland in Denmark. Another potential hotspot in spring was at Dogger Bank and the area north-west of this large sandbank (Gilles et al. 2016). In summer, there was an apparent shift, compared to spring, toward offshore and western areas, with a large hotspot present off the German and Danish west coast that extended toward the Dogger Bank. The seasonal model for autumn indicated lower densities compared to

spring and summer, the distribution was spatially heterogeneous and areas with higher densities were predicted north-west of the Dogger Bank and off the German and Danish west coasts (Gilles et al. 2016).

35. The JCP Phase-III report (Paxton et al. 2016) indicated that for an area to the east of East Anglia, including the former East Anglia Zone (totalling 14,295km^2 and referred to as the Norfolk Bank development area in the JCP report), abundances of harbour porpoise ranged from 5,300 (Confidence Interval (CI) = 2,600-15,600) in the spring and 13,700 (CI = 7,000-26,200) in the winter, with numbers in summer and autumn being in between this range. The Norfolk Bank development area covers 2.4% of the North Sea Management Unit (MU), but the abundance estimate of harbour porpoise in this area equates to 13.9% (CI = 8.9-19.2%) of the North Sea MU, indicating a high use of the area (Paxton et al. 2016). ***Plate A11.1.2*** illustrates the distribution of harbour porpoise, based on modelled densities for summer 2010 from the JCP Phase-III report.

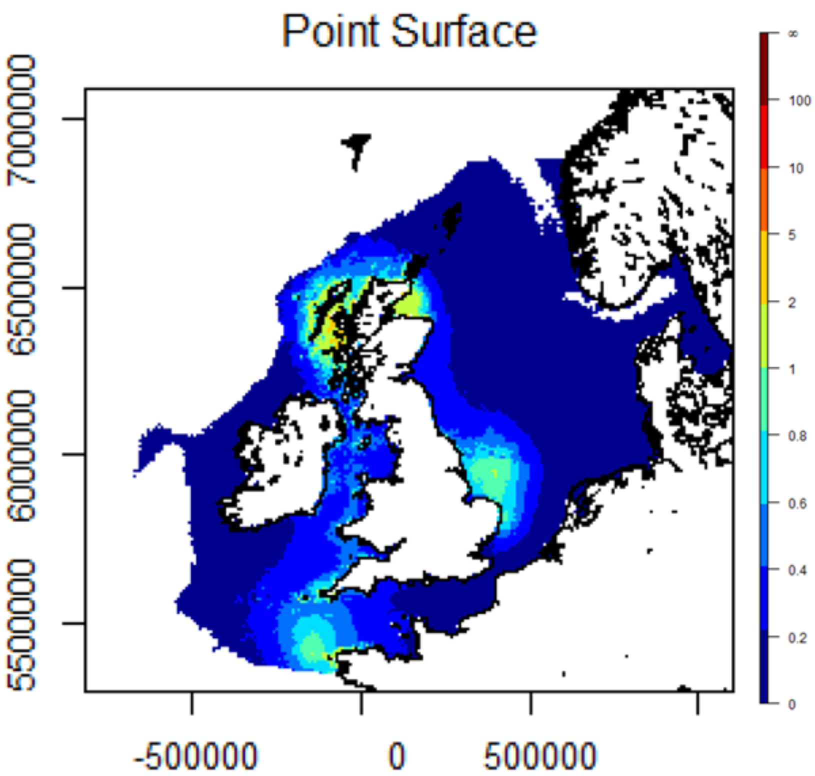

Plate A11.1.2 Distribution of harbour porpoise based on predicted JCP harbour porpoise densities (animals/km^2) for summer 2010 (Source: Paxton et al. 2016).

11.1.3.2 Diet

36. The main prey fish species of harbour porpoise typically include sandeels (*Ammodytidae spp.*), whiting *Merlangius merlangus*, herring *Clupea harengus*, mackerel *Scomber scombrus*, sprat *Sprattus sprattus*, cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, saithe *Pollachius virens*, pollack

Pollachius pollachius, Norway pout *Trisopterus esmarkii* as well as flat fish such as flounder *Platichthys flesus* and sole *Solea solea* (Rogan and Berrow 1996; Reid et al. 2003; Santos and Pierce 2003; Santos et al. 2004; Evans and Baines 2010). Other prey species such as cephalopods, other molluscs, crustaceans and polychaetes have also been recorded (Berrow and Rogan 1995; Kastelein et al. 1997; Börjesson et al. 2003; Santos and Pierce 2003; Santos et al. 2004; Pierce et al. 2007).

37. Harbour porpoise have relatively high daily energy demands and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein et al. 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it has been estimated that it can only rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein et al. 1997).

38. A recent study by Wisniewska et al. (2016) using high-resolution movement and prey echo recording tags on five wild harbour porpoise has shown that porpoises forage nearly continuously day and night, to meet their metabolic demands foraging on small prey. Although harbour porpoise diet typically comprises of large numbers of relatively small fish prey, primarily less than 25cm and frequently less than 5cm in length (e.g. Börjesson et al. 2003), as outlined above, they feed on wide variety of prey species and sizes, and would be expected to take larger prey when available. However, larger prey sizes overlap with those taken by commercial fisheries (Wisniewska et al. 2016).

11.1.3.3 Abundance and Density Estimates

11.1.3.3.1 North Sea Management Unit

39. Harbour porpoise within the eastern North Atlantic are generally considered to be part of a continuous biological population that extends from the French coastline of the Bay of Biscay to northern Norway and Iceland (Tolley and Rosel 2006; Fontaine et al. 2007, 2014; Inter-Agency Marine Mammal Working Group (IAMMWG) 2015). However, for conservation and management purposes, it is necessary to consider this population as smaller MUs.

40. The IAMMWG defined three MUs for harbour porpoise: North Sea; West Scotland and the Celtic and Irish Sea. The East Anglia TWO offshore development area is located in the North Sea MU which comprises ICES area IV, VIId and part of Division IIIa (Skagerrak and northern Kattegat (***Plate A11.1.3***).

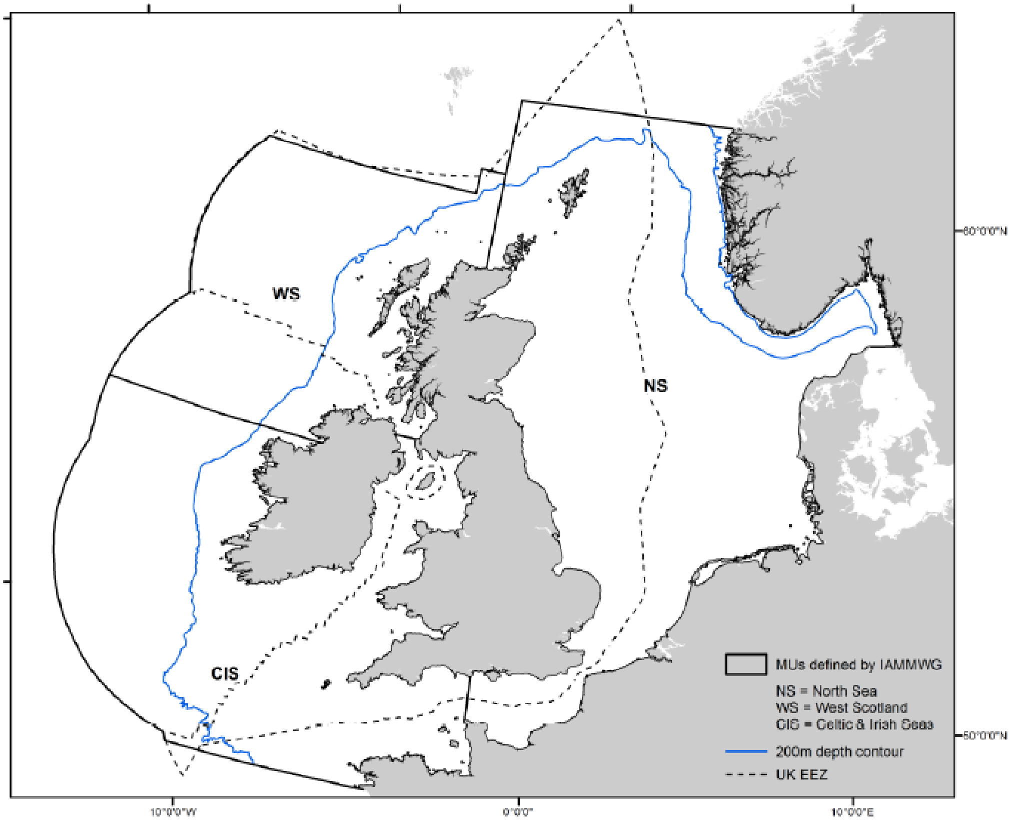

Plate A11.1.3 Harbour porpoise MUs (Source: IAMMWG 2015).

41. The SCANS-III estimate of harbour porpoise abundance in the North Sea MU is 345,373 (Coefficient of Variation (CV) = 0.18; 95% CI = 246,526-495,752) with a density estimate of 0.52/km^2 (CV = 0.18; Hammond *et al*. 2017).

11.1.3.3.2 SCANS Data

42. In July 2005, SCANS-II surveyed the entire European Union (EU) Atlantic continental shelf to generate robust estimates of abundance for harbour porpoise and other cetacean species. For the entire SCANS-II survey area, harbour porpoise abundance in the summer of 2005 was estimated to be 375,358 (CV = 0.197, 256,304-549,713; Hammond et al. 2013). The East Anglia TWO site lies within SCANS-II survey block B. It was estimated that the abundance of harbour porpoise in survey block B (***Plate A11.1.4)*** was 40,927 (CV = 0.38) with an estimated mean density of 0.331 individuals per km^2 (CV = 0.38) (Hammond et al. 2013).

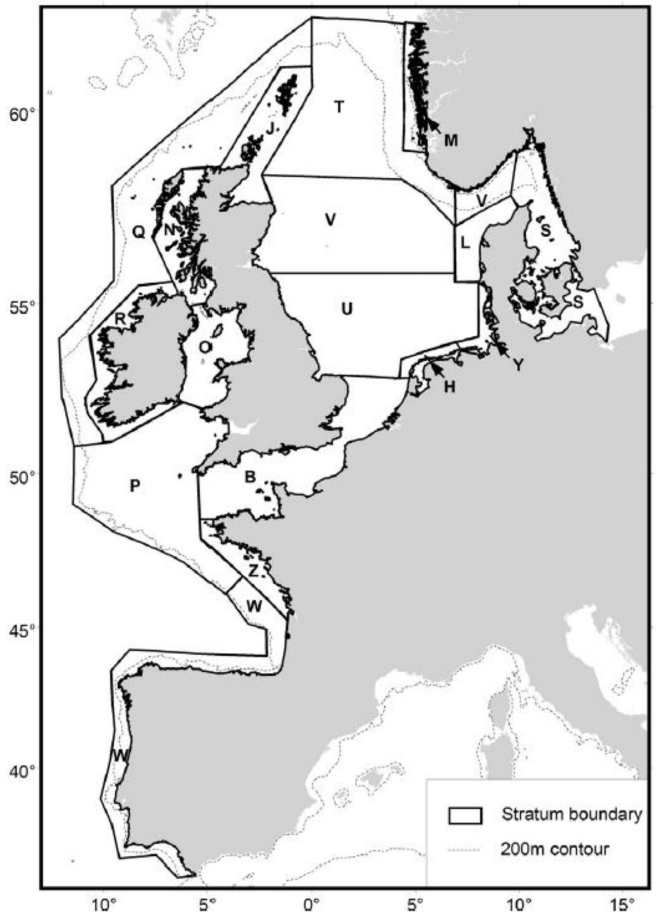

Plate A11.1.4 Survey blocks for the SCANS-II surveys (Source: Hammond et al. 2013)

43. SCANS-III in the summer of 2016 surveyed all European Atlantic waters from the Strait of Gibraltar in the south to 62°N in the north and extending west to the 200nm limits of all EU Member States (***Plate A11.1.5***; Hammond et al. 2017). The survey area was not the same as SCANS-II. For the entire SCANS-III survey area, harbour porpoise abundance in the summer of 2016 was estimated to be 466,569 with an overall estimated density of 0.381/km^2 (CV = 0.154; 95% CI = 345,306-630,417; Hammond et al. 2017).

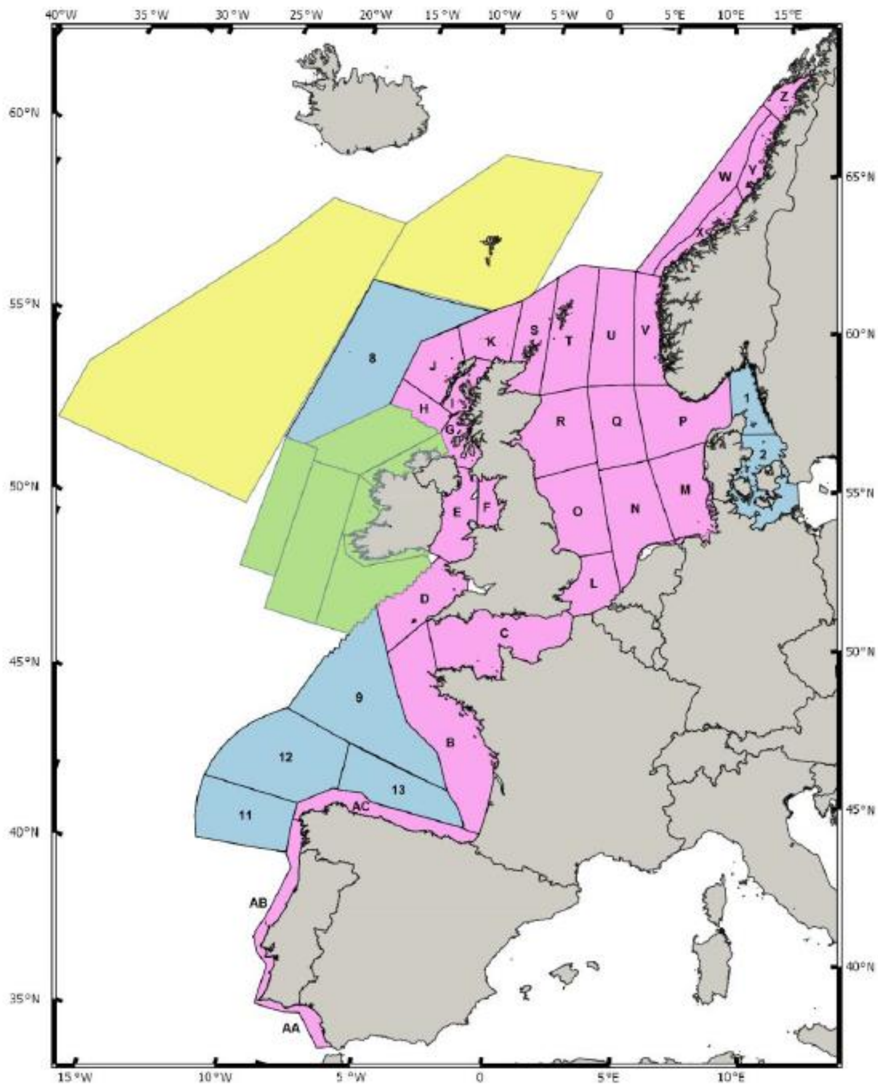

Plate A11.1.5 Survey blocks covered by SCANS-III and adjacent surveys
(Source: Hammond et al. 2017). SCANS-III = pink lettered blocks surveyed by air; blue numbered blocks were surveyed by ship. Blocks coloured green to the south, west and north of Ireland were surveyed by the Irish ObSERVE project. Blocks coloured yellow were surveyed by the Faroe Islands as part of the North Atlantic Sightings Survey in 2015.

44. The East Anglia TWO site is located in SCANS-III survey block L (***Plate A11.1.5***):

45. The estimated abundance of harbour porpoise in SCANS-III survey block L is 19,064 harbour porpoise (CV = 0.38; 95% CI = 6,933-35,703), with an estimated density of 0.607 harbour porpoise/km^2 (CV = 0.38; Hammond et al. 2017).

46. It should be noted that SCANS data is corrected for any animals that might be missed (Hammond et al. 2017) and therefore the application of any further correction factors is not required.

11.1.3.3.3 East Anglia ONE Site Specific Survey

47. For the East Anglia ONE windfarm, 24 months of aerial survey data was undertaken from November 2009 to October 2011 across the site plus 4km buffer zone. In total, 181 marine mammals were recorded, 72% of which were identified as harbour porpoise (n=130), with a further 12.5% identified as either a dolphin or porpoise and 15% as unidentified cetacean species (EAOWL 2012). If it is assumed that all marine mammal sightings are of harbour porpoise (as a worst-case scenario) it is estimated that the maximum density across the East Anglia ONE windfarm site of harbour porpoise is 1.4/km^2, with a mean density of 0.19/km^2 (EAOWFL 2012).

11.1.3.3.4 East Anglia THREE Site Specific Survey

48. The East Anglia THREE aerial surveys indicated harbour porpoise occurred across the East Anglia THREE site plus buffer during both survey years. During the East Anglia THREE aerial surveys, high resolution aerial stills captured marine mammals both above and just below the surface. The mean estimates of density were generated from the East Anglia THREE site plus buffer using counts with a correction factor (based on the JCP Phase II report (Paxton et al. 2011)) to take into account animals that were not seen (EATL 2015). The estimated mean density of harbour porpoise within the East Anglia THREE site plus buffer across the full 24 month survey period was 0.179 individuals per km^2 and for all sightings classified as 'unidentified small cetacean' that were assumed to be harbour porpoise the estimated density was 0.294 individuals per km^2 (EATL 2015).

11.1.3.3.5 Norfolk Vanguard Site Specific Survey

49. The Norfolk Vanguard site specific surveys included 32 months of data for Norfolk Vanguard East, and 24 months for Norfolk Vanguard West. The Norfolk Vanguard East survey data included a 4km buffer, with an overlap with the Norfolk Boreas Site.

50. The Norfolk Vanguard site specific surveys were undertaken using the same methodologies as that of the East Anglia TWO site specific surveys.

51. At Norfolk Vanguard East, the annual mean density estimate, when using the seasonal correction factor is 1.26/km^2. The density estimate during summer (April to September) is 0.73/km^2 and during the winter (October to March) the estimated density is 1.8/km^2 at Norfolk Vanguard East (Norfolk Vanguard Limited 2018).

52. At Norfolk Vanguard West, the annual mean density estimate, when using the seasonal correction factor is 0.79/km^2. The density estimate during summer (April to September) is 0.57/km^2 and during the winter (October to March) the

estimated density is 1.01/km^2 at Norfolk Vanguard West (Norfolk Vanguard Limited 2018).

11.1.3.3.6 East Anglia TWO Survey

53. APEM collected high resolution aerial digital still imagery for marine mammals over the East Anglia TWO windfarm marine mammal survey area. Further information is provided on the analysis and interpretation of the survey results in ***section 11.2*** of this appendix.

54. The information included in this PEIR is based on 21 months of survey for the East Anglia TWO windfarm site (November 2015 to April 2016, from September 2016 to October 2017, and May 2018).

55. Density estimates were calculated from the raw data counts (see ***section 11.2*** of this appendix) for harbour porpoise species and unidentified small cetacean (all assumed to be harbour porpoise to produce a worst-case density and abundance estimate – see below for further information). Correction factors (see ***section 11.2.2.4*** of this appendix) were then applied to the data to account for the presence of individuals below 2m water depth (the depth at which it is no longer possible to detect marine mammals from aerial imagery).

56. The annual mean density estimate when using the seasonal correction factor is 0.71/km^2 for the East Anglia TWO survey area.

57. The density estimate during summer (April to September) is 0.41/km^2 and during the winter (October to March) the estimated density is 1.01/km^2 using the corrected densities.

58. The East Anglia TWO windfarm survey area estimate of 0.71/km^2, based on the mean annual density and using the seasonal correction factors, has been used to inform the assessments of impact. Using the mean annual density allows for seasonal variation in the number of harbour porpoise that could be present.

11.1.3.3.7 Reference population for assessment

59. The reference population used in the assessment for harbour porpoise is the latest SCANS-III estimate of harbour porpoise abundance in the North Sea MU of 345,373 (CV = 0.18; 95% CI = 246,526-495,752; Hammond et al. 2017).

11.1.4 Dolphin Species

11.1.4.1 Distribution

60. White-beaked dolphin are widespread across the northern European continental shelf, and in the North Sea they tend to be more numerous within 200nm of the Scottish and north-eastern English coasts (Northridge et al. 1995). White-beaked dolphin are present year-round in the North Sea, mainly in waters of 50-100m depth, with most sightings recorded between June and October

(Reid et al. 2003). This species is cited as the most abundant cetacean after harbour porpoise in the North Sea (Jansen et al. 2010), and the waters off the coast of Scotland and north-east England are one of the four global areas of peak abundance. White-beaked dolphin are widely distributed within the central North Sea, however, very few sightings are recorded along the east coast of England or south of the Humber Estuary, with a small number of sightings in shallow waters near the North Norfolk Sandbanks and Dogger Bank areas (Gilles et al. 2012; DECC 2016). The occurrence of white-beaked dolphin in the southern North Sea is relatively low (Reid et al. 2003; Hammond et al. 2013, 2017).

61. The bottlenose dolphin has a worldwide distribution across tropical and temperate seas of both hemispheres and can be found in coastal and continental shelf waters (Reid et al. 2003; DECC 2016). In most regions, including the UK Continental Shelf (CS), inshore and offshore 'sub-populations' tend to be distinct (DECC 2016; Oudejans et al. 2015). In UK waters, inshore individuals are frequently reported off north-east and south-west Scotland, in the Irish Sea, and in the western English Channel (DECC 2016; IAMMWG 2015). There are two main areas of UK territorial waters where there are semi-resident groups of bottlenose dolphins: Cardigan Bay in Wales and the Moray Firth on the north-east coast of Scotland, both of these areas have been designated SACs for bottlenose dolphins. There are also smaller populations of bottlenose dolphins off south Dorset and around Cornwall (Wood 1998). The occurrence of bottlenose dolphin in the southern North Sea is very low (Reid et al. 2003; Hammond et al. 2013, 2017).

62. The common dolphin is the most numerous offshore cetacean species in the north east Atlantic, most often sighted off the western coast of the UK, in the Celtic Sea, and western approaches to the Channel, it is only occasionally sighted in the North Sea during the summer months (Reid et al. 2003).

63. During the Rosyth to Zeebrugge ferry trips in 2017 and 2018, cetacean species recorded included white-beaked dolphin in May 2017 (n = 15); common dolphin in February 2017 (n = 3) and 2018 (n = 1), bottlenose dolphin in 2018 (n = 1), and unidentified dolphin species in 2018 (n = 4) (MARINElife 2018). On the Hull to Zeebrugge ferry route, bottlenose dolphin were recorded off the Belgium coast in April 2017 (n = 2) and unidentified dolphin species in 2017 (n = 2). In 2018, no dolphin species have been sighted along this route (MARINElife 2018). It should be noted, that these sightings could have been made at any point between the two port locations.

64. Sea Watch volunteer cetacean sightings for eastern England coast in 2017 and early 2018 include white-beaked dolphin off the Suffolk coast and common dolphin in the river Thames (Sea Watch Foundation 2018).

65. As outlined in ***section 11.1.2***, surveys undertaken in the former Zone from November 2009 until April 2011 recorded very low numbers of patterned dolphins (6% of the 108 cetacean sightings), which were most likely to be white-beaked dolphin (EAOW 2012c).

66. The boat based surveys for East Anglia ONE recorded low numbers of three dolphin species: white-beaked dolphin (8% of 181 cetacean sightings), bottlenose dolphin (6%) and Risso's dolphin (2%), as well as unidentified dolphin species (2%; (EAOWFL 2012).

67. During 24 months of aerial surveys conducted for the East Anglia THREE site plus buffer, four white-beaked dolphin were recorded (for the dolphins which could be identified to species level). These sightings lead to very low estimates of average abundance and density across the site, and given the sporadic nature of the sightings, it was not appropriate to assume an average density over the entire survey period (EATL 2015). No bottlenose dolphin were positively sighted during the aerial surveys of the East Anglia THREE site plus buffer (EATL 2015). Only one common dolphin was recorded across the 24-month site specific survey period, in December 2011 within the East Anglia THREE site plus buffer (EATL 2015).

11.1.4.2 Abundance and Density Estimates

11.1.4.2.1 Management Units

68. Scientific evidence supports the assumption that white-beaked dolphin from around the British Isles and North Sea represent one population, with movement between Scottish waters and the Danish North Sea and Skagerrak (Banhuera-Hinestroza et al. 2009; IAMMWG 2015). The single MU for white-beaked dolphin, the Celtic and Greater North Seas (CGNS) MU, comprises all UK waters and extends to the seaward boundary used by the European Commission for Habitats Directive reporting (area known as Marine Atlantic, termed MATL) (IAMMWG 2015). However, it is worth noting that this species usually occurs on the continental shelf (Reid et al. 2003; IAMMWG 2015). The abundance of white-beaked dolphin in the CGNS MU is 15,895 animals (CV=0.29; 95% CI=9,107-27,743; IAMMWG 2015) and in the UK EEZ white-beaked dolphin abundance is 11,694 (CV = 0.30; 95% CI = 6,578-20,790), which are derived from the SCANS-II abundance estimate for continental shelf waters (Hammond et al. 2013).

69. IAMMWG currently recognise seven MUs for bottlenose dolphin in UK waters. The East Anglia TWO offshore development area is located in the Greater North Sea (GNS) MU, which is represented by ICES Area IV, excluding coastal east Scotland; and ICES area IIIa. The estimated bottlenose dolphin population size of the GNS MU is zero (IAMMWG 2015).

70. The single MU for common dolphin, the CGNS MU, comprises all UK waters and extends to the seaward boundary (IAMMWG 2015). The abundance of common dolphin in the CGNS MU is 56,556 (CV = 0.28; 95% CI = 33,014-96,920) and the UK component (abundance within the UK EEZ) is 13,607 (CV = 0.23; 95% CI = 8,720-21,234). These estimates were derived from SCANS-II (Hammond et al. 2013) and Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA; Macleod et al. 2009) and are likely to be biased low due to perception bias that could not be corrected for in the aerial surveys (IAMMWG 2015).

11.1.4.2.2 SCANS Data

71. The SCANS-II survey provided a wider European population estimate of 16,536 white-beaked dolphin (95% CI = 9,245 – 29,586; Hammond *et al*. 2013). The East Anglia TWO offshore development area is located within Block B of the SCANS-II survey (***Plate A11.1.4***; Hammond et al. 2013). No white-beaked dolphin were recorded for the SCANS-II survey block B, and the population estimate for Block U was 501 (CV = 0.97).

72. For the entire SCANS-III survey area (note that it is not the same area as SCANS-II), white-beaked dolphin abundance in the summer of 2016 was estimated to be 36,287 with an overall estimated density of 0.030/km^2 (CV = 0.29; 95% CI = 18,694-61,869; Hammond et al. 2017). As previously discussed, the East Anglia TWO offshore development area is located in SCANS-III survey block L. White-beaked dolphin were not recorded in survey block L during SCANS-III survey. The estimated abundance in SCANS-III survey block O (approximately 64km north of the East Anglia TWO windfarm site) was 143 white-beaked dolphins (CV=0.97; 95% CI = 0-490), with an estimated density of 0.002 white-beaked dolphins per km^2 (CV=0.97; Hammond et al. 2017).

73. During the SCANS-II surveys, two bottlenose dolphin groups were sighted within survey block B, resulting in an estimated density of 0.0032 individuals per km^2 (CV = 0.74) and an abundance estimate of 395 bottlenose dolphin (CV = 0.74; Hammond et al. 2013). No bottlenose dolphin were sighted within block U during the SCANS-II survey. During the SCANS-III surveys no bottlenose dolphin were recorded in survey block O or survey block L (Hammond *et al*. 2017).

74. Common dolphin were not recorded in the North Sea area during the SCANS-II or SCANS-III surveys (Hammond et al. 2013, 2017).

11.1.4.2.3 East Anglia ONE Site Specific Surveys

75. For the East Anglia ONE site specific surveys across the wind farm area plus 4km buffer, only one patterned dolphin was recorded, while there were 21 sightings of white-beaked dolphin (this equates to 12.2% of the total marine

mammal sightings (n=181)) (EAOWFL 2012). The East Anglia ONE ES concluded that while there were relatively low sightings of white-beaked dolphins, it was considered likely that they would regularly occur across the site, particularly in the summer period (EAOWFL 2012).

11.1.4.2.4 East Anglia THREE Site Specific Surveys

76. For the site specific surveys undertaken across the East Anglia THREE windfarm site plus 4km buffer, four white-beaked dolphin were recorded (EATL 2015). No other dolphin species were recorded within the East Anglia THREE surveys.

11.1.4.2.5 Norfolk Vanguard Site Specific Surveys

77. The total number of dolphin species recorded during the aerial surveys for Norfolk Vanguard East, including the East Anglia FOUR surveys, from March 2012 to April 2016 (32 months) was 14 dolphins for Norfolk Vanguard East and 4km buffer. Of these, only three were identified as white-beaked dolphin, two as patterned dolphin, two as common dolphin and seven as unidentified dolphin species (Norfolk Vanguard Limited 2018). The total number of dolphin species recorded during the aerial surveys from September 2015 to August 2017 for Norfolk Vanguard West and 4km buffer was 14 dolphins, of which 4 were identified as white-beaked dolphins (Norfolk Vanguard Limited 2018).

78. It was not possible to estimate abundance or density estimates based on the very low sightings of dolphin species during the Norfolk Vanguard aerial surveys (Norfolk Vanguard Limited 2018).

11.1.4.2.6 East Anglia TWO Site Specific Surveys

79. During the aerial surveys for the East Anglia TWO site specific surveys, from November 2015 to April 2016, from September 2016 to October 2017, and May 2018, a total of three dolphins were recorded within the marine mammal survey area.

80. It was not possible to estimate abundance or density estimates based on the very low sightings of dolphin species during the East Anglia TWO site aerial surveys.

81. Taking into account the very low numbers of dolphin species recorded in the site specific surveys for East Anglia ONE, TWO and THREE, Norfolk Vanguard or within the East Anglia Zone surveys, along with the SCANS-II and SCANS-III surveys, white-beaked dolphin, bottlenose dolphin and common dolphin have not been included in the impact assessment as there is a very low risk of having a significant, if any, impact on these species.

11.1.5 Minke Whale

11.1.5.1 Distribution

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

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

84. The JCP Phase III Report (Paxton et al. 2016) shows no minke whale abundance within the southern North Sea south of Humberside.

85. During the Rosyth to Zeebrugge ferry trips in 2017 and 2018 the cetacean species recorded included minke whale in May 2017. On the Felixstowe to Vlaardingen ferry route across the southern North Sea, one minke whale was recorded in May 2016 and on the Hull to Zeebrugge ferry route an unidentified whale was recorded in July 2017 (MARINElife 2018). It should be noted, that these sightings could have been made be at any point between the two port locations.

11.1.5.2 Abundance and Density Estimates

11.1.5.2.1 Celtic and Greater North Seas Management Unit

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

87. The abundance of minke whales in the CGNS MU is 23,528 animals (CV = 0.27; 95% CI = 13,989-39,572; IAMMWG 2015). The estimate was derived from SCANS-II (Hammond et al. 2013) and CODA (Macleod et al. 2009) and is likely to be underestimated. The IAMMWG (2015) note the abundance of minke whales is highly seasonal, with abundance peaking during migration south into waters around the UK for summer.

11.1.5.2.2 SCANS Data

88. SCANS-I in July 1994, estimated 8,445 minke whale (95% CI = 5,000-13,500) (Hammond et al. 2002). The SCANS-II survey gave an overall estimate of 18,958 minke whale (CV = 0.347); with 10,786 minke whale (CV = 0.29) for the North Sea area; and 13,734 minke whale (CV = 0.41; 95%CI = 9,800 – 36,700) within an area comparable to the 1994 survey (Hammond et al. 2013). Although these estimates were not significantly different, there were noticeable changes in distribution between the two surveys (analogous to those observed in harbour porpoise) which again is most likely to be linked to changes in prey availability.

89. SCANS-II estimated the average minke whale density across survey block B to be 0.01 individuals per km^2 and the estimated abundance was 1,199 individuals (CV = 0.98) and for Block U the estimated population was 3,655 (CV = 0.69) with a density of 0.023 individuals per km^2 (CV = 0.69) Hammond et al. 2013). The high CV value indicates there is a large amount of uncertainty around this estimate, this is a function of the very low sightings rates; only two groups were sighted in block B and four in Block U. Hammond et al. (2013) confirms that these two sightings were in the vicinity of the Channel Islands, and not in close proximity to the East Anglia TWO offshore development area.

90. For the entire SCANS-III survey area (not the same area as SCANS-II), minke whale in the summer of 2016 was estimated to be 14,759 with an overall estimated density of 0.008/km^2 (CV = 0.327; 95% CI = 7,908-27,544; Hammond et al. 2017).

91. The East Anglia TWO offshore development area is located in SCANS-III survey block L. Minke whale were not recorded in survey block L during SCANS-III survey. The estimated abundance in SCANS-III survey block O (approximately 64km north of the East Anglia TWO windfarm site) was 603 minke whale (CV=0.62; 95% CI = 109-1,670), with an estimated density of 0.010 minke whale per km^2 (CV=0.62; Hammond et al. 2017). However, it should be noted that the SCANS III survey recorded no minke whale in the North Sea south of Humberside.

11.1.5.2.3 Site Specific Surveys

92. No minke whale or potential minke whale sightings have been made in the aerial surveys for the former East Anglia Zone, East Anglia TWO, East Anglia ONE, East Anglia THREE or Norfolk Vanguard.

93. As a result of the lack of sightings during the site specific surveys, the former East Anglia Zone surveys and the lack of sightings in this area of the North Sea during the SCANS-II and SCANS-III surveys, minke whale have not been included in the impact assessment as there is a very low risk of having a significant, if any, impact on this species.

11.1.5.2.4 Designated Sites of Conservation Importance

94. All cetaceans in UK waters are classed as European Protected Species (EPS) under Annex IV of the Habitats Directive (EU Directive 92/43/EEC) and therefore are internationally important. Bottlenose dolphin and harbour porpoise are additionally listed under Annex II of the Habitats Directive and are afforded protection through the designation of Natura 2000 sites.

95. Bottlenose dolphin has not been identified during the East Anglia TWO aerial surveys and no bottlenose dolphin were positively sighted during the aerial surveys of the adjacent East Anglia ONE site (EATL 2015) or during the East Anglia THREE surveys. However, 16 individuals were recorded during the boat-based surveys for East Anglia ONE (EAOL 2012). During SCANS-III surveys in summer 2016, no bottlenose dolphin were recorded within the southern North Sea (Hammond et al. 2017). During the SCANS-II surveys, only two bottlenose dolphin groups were sighted within the survey block which encompasses the East Anglia Zone; resulting in an estimated density of 0.0032 (CV = 0.74) individuals per km^2 (Hammond et al. 2013). There are currently seven MUs for bottlenose dolphin in UK waters; the East Anglia TWO windfarm site is located in the GNS MU, which has an estimated population size of zero (IAMMWG 2015). Taking into account the very low occurrence of sightings in and around the East Anglia TWO offshore development area and the assessment of the GNS MU population size by the IAMMWG, this species was screened out from further assessment in the EIA and information for the Habitats Regulation Assessment (HRA).

11.1.6 Pinnipeds

96. Two seal species live and breed in UK waters: grey seal *Halichoerus grypus* and harbour (or common) seal *Phoca vitulina* (SCOS 2017). Both species are present in the southern North Sea and have been recorded in the former East Anglia Zone, therefore both species are considered in the EIA and assessments for the HRA.

97. Other seal species that occasionally occur in UK coastal waters, include ringed seals *Phoca hispida*, harp seals *Phoca groenlandica*, bearded seals *Erignathus barbatus* and hooded seals *Cystophora crystata*, all of which are Arctic species and are only rarely encountered in UK waters (SCOS 2017).

98. The seal species included in the assessment has been agreed with the marine mammal Expert Topic Group (ETG) for East Anglia TWO at the ETG meeting on 6th March 2018.

99. It is possible, based on the foraging ranges of seal species and the distances from key haul-out sites, that seals may cross the East Anglia TWO windfarm site. However, the aerial surveys for the East Anglia Zone ZEA did not identify

any seals. Previous surveys undertaken around the area of the former East Anglia Zone by WWT recorded eight seals in June 2009 and ten seals in July and August 2009 (EAOW 2012b). Similarly, only three seals were recorded within the East Anglia ONE marine mammal survey area (EAOW 2012a), with six grey seals and three harbour seals within Galloper Wind Farm (Galloper Wind Farm Limited (GWFL) 2011) and only two within the East Anglia THREE site surveys (EATL 2015).

100. While aerial surveys are not the most appropriate method to determining at sea densities of seals, the Seals at Sea dataset (Russell *et al*. 2017) confirms that grey seal and harbour seal use of the East Anglia TWO windfarm site and export cable corridor is low.

11.1.6.1 Grey seal

11.1.6.1.1 Distribution

101. Grey seals only occur in the North Atlantic, Barents and Baltic Sea with their main concentrations on the east coast of Canada and United States of America and in north-west Europe (SCOS 2017).

102. Approximately 38% of the worlds grey seals breed in the UK and 88% of these breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. There are also breeding colonies in Shetland, on the north and east coasts of mainland Britain and in south-west England and Wales (SCOS 2017).

103. The Sea Mammal Research Unit (SMRU), in collaboration with others, deployed 269 telemetry tags on grey seals around the UK between 1988 and 2010 (Russell and McConnell 2014). The telemetry data for grey seal adults (***Plate A11.1.6a***) and pups (***Plate A11.1.6*b**) indicate that only the track of one grey seal pup tagged at the Isle of May in 2002 in the vicinity of the East Anglia TWO offshore development area (***Plate A11.1.6*b**; Russell and McConnell 2014).

104. Tags deployed on grey seals at Donna Nook and Blakeney Point in May 2015, indicated that they used multiple haul-out sites; with one grey seal hauling out in the Netherlands and one in Northern France (Russell 2016). ***Plate A11.1.7*** shows the tagged seal movements along the east coast of England and indicates that grey seal travel between haul-out sites along the east coast of England, as well as to the north of France and up to the Firth of Forth and across Fladden Ground and Dogger Bank (Russell 2016). Russell et al. (2013) found that between 21% and 58% of female grey seals used different regions for breeding and foraging.

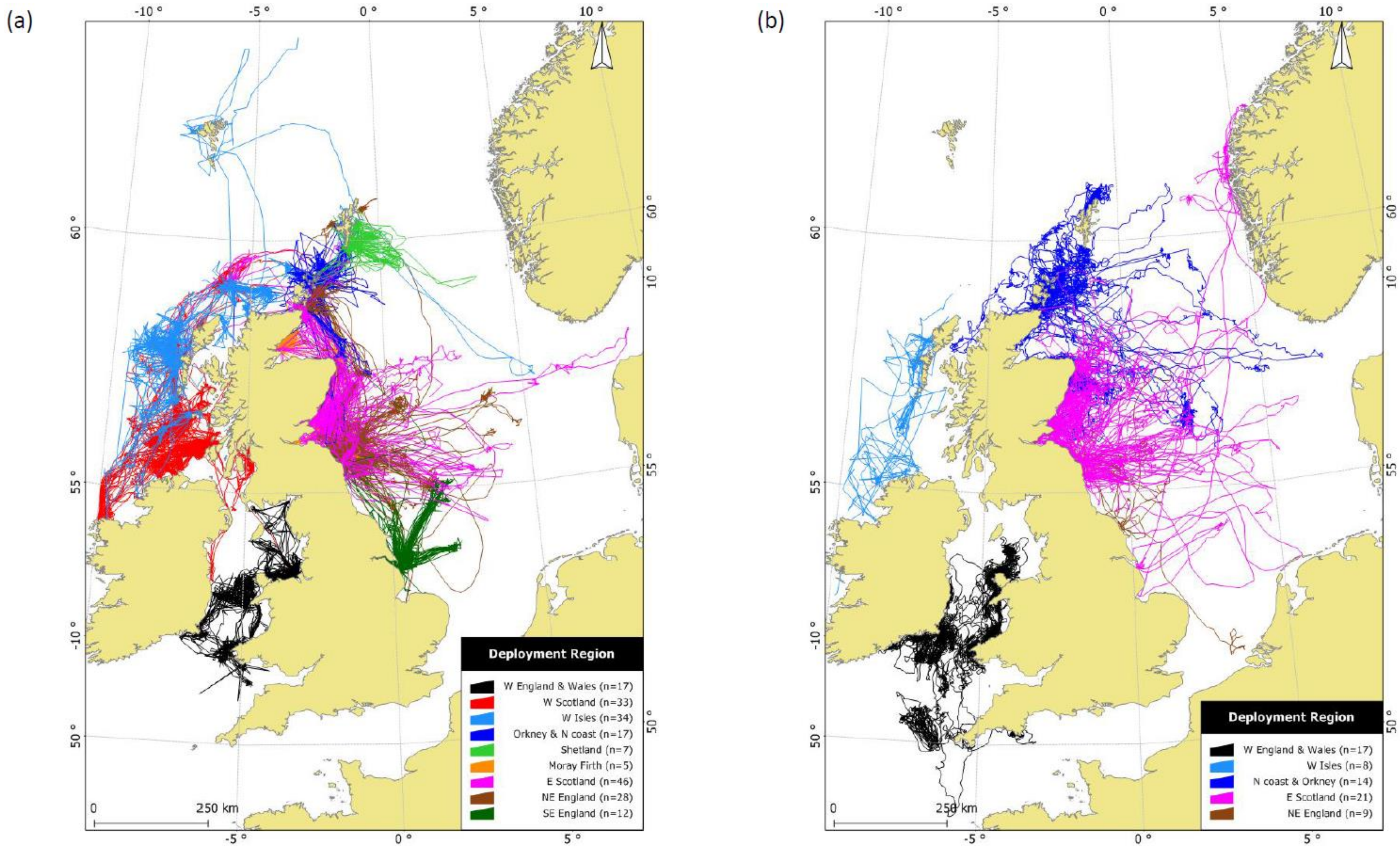

Plate A11.1.6 Telemetry tracks by deployment region for grey seals aged (a) one year or over and (b) pups (Source: Russell and McConnell 2014)

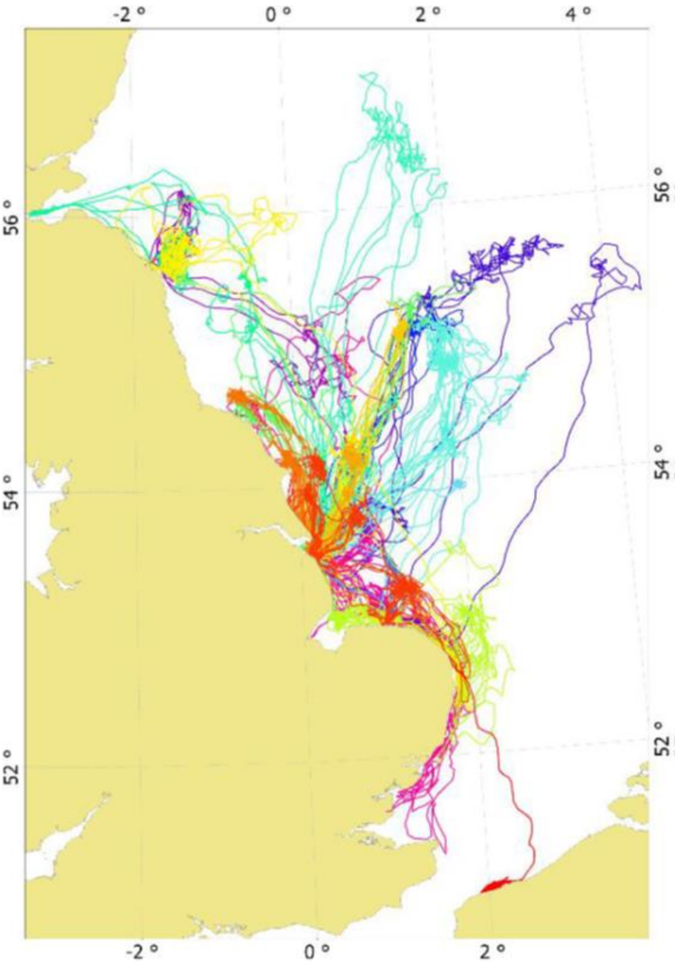

Plate A11.1.7 Tagged grey seal movements along the East coast of England (Source: Russell 2016)

105. Aerial surveys conducted for the East Anglia Zone (ZEA Report) from November 2009 to April 2011, did not record any observations of seals (EAOW 2012c).

106. During aerial surveys at the East Anglia ONE site (EAOL 2012), no observations of grey seal were made. Grey seals were also not recorded during boat based surveys at the East Anglia ONE site, suggesting that there is low usage of the East Anglia ONE site (EAOWFL 2012).

107. A total of five seals were recorded during the aerial surveys for Norfolk Vanguard East and 4km buffer, including the former East Anglia FOUR surveys, these were not identified to species. A total of four seals were recorded during the aerial surveys for Norfolk Vanguard West and 4km buffer, two of which were identified as grey seal.

108. During East Anglia THREE surveys only two seals were recorded, observations of seals were not classified to a particular species (EATL 2015). The results of the East Anglia THREE aerial surveys support the tagging data and suggest that there is low usage of the former East Anglia Zone.

109. For the East Anglia THREE EIA (EATL 2015), EATL commissioned SMRU Marine Ltd and IMARES to investigate the connectivity between tagged grey seal and the East Anglia THREE site plus a 20km buffer area (EATL 2015). The SMRU study was based on their database of telemetry data of tagged grey seal pups and adults from important breeding locations in UK, including the Farne Islands, Donna Nook, Abertay Sands and the Isle of May from 1988 to 2008. The study indicated that none of the 92 tagged grey seals aged one year or over entered the East Anglia THREE site, within a buffer of 20km or the surrounding area. However, the tracks did indicate the movement of grey seals between MUs on the east coast of England and Scotland. From the Dutch telemetry studies, a total of 77 grey seal were tagged at haul-out sites in the Netherlands between 2005 and 2013. Of these seals, six were found to travel within 20km of the East Anglia THREE site. Of these six seals, three entered the offshore cable corridor and two were within the East Anglia THREE site. Although, it is likely all grey seals from Dutch sites spent less than 2% of their 'time-at-sea' within the East Anglia THREE site. However, the study did indicate the movement of grey seal between the UK and Dutch sites.

110. The north Dutch coastline is an important foraging zone and migration route for grey seal (Brasseur *et al*. 2010). A study on the grey seal development in the Dutch part of the Wadden Sea shows that the growth of the breeding population is fuelled by the annual immigration of grey seals from the UK (Brasseur et al. 2014).

111. There is a considerable amount of movement of grey seals that occurs (as observed from telemetry data) among the different areas and regional subunits of the North Sea and no evidence to suggest that grey seals on the North Sea coasts of Denmark, Germany, the Netherlands or France are independent from those in the UK (SCOS 2017).

112. Spatial distributions indicate that grey seals have homogeneous usage near-shore, that they typically range widely and frequently travel over 100km between haul-out sites, and that they tend to spend approximately 15% of their time far-offshore, e.g. more than 50km from the coast (Russell and McConnell 2014; SCOS 2017).

113. Marine Scotland commissioned SMRU to produce maps of grey seal distribution in UK waters (Russell et al. 2017). These maps were produced by combining information about the movement patterns of electronically tagged seals with survey counts of seals at haul-out sites. The resulting maps show estimates of mean seal usage (seals per 5 km x 5 km grid cell) within UK waters. The maps indicate that grey seal usage is relatively low in and around the East Anglia TWO windfarm site and slightly higher along the cable corridor (***Volume 2 Figure 11.2***; Russell et al. 2017).

11.1.6.1.1.1 Haul-Out Sites

114. In the UK, grey seals typically breed on remote uninhabited islands or coasts and in small numbers in sea caves, where they can avoid busy beaches and storm surges, although they are also known to breed on some exposed beaches. For example, at Donna Nook in Lincolnshire, grey seals have become habituated to human disturbance and over 70,000 people visit this colony during the breeding season with no apparent impact on the breeding seals (SCOS 2016).

115. Historically, Donna Nook has been the most important breeding site for grey seals on the east coast of England, however, there has been a considerable increase in the number of pups born at Blakeney Point, with this site now the biggest grey seal breeding colony in England, overtaking Donna Nook (SCOS 2016).

116. While grey seal are not currently a qualifying feature at the North Norfolk SAC (which includes Blakeney Point) or Winterton-Horsey Dunes SAC, it is recognised that these sites are important for the population, as breeding, moulting and haul-out sites. Therefore, consideration will be given to grey seal as part of the North Norfolk SAC and Winterton-Horsey Dunes SAC in the assessments for the HRA, to determine if there is the potential for any disturbance to grey seals hauled out at these sites.

117. At Horsey on the Norfolk coastline from Winterton to Waxham, grey seal use the haul-out sites for breeding and moulting. Counts undertaken by the Friends of Horsey Seals wardens in the 2016-17 breeding season indicated that the overall numbers of births increased from 1,236 in 2015-2016 to 1,487. The first births were recorded in early November and birth rate peaked on the 2nd December 2016 (Rothney 2017). Counts undertaken in the 2017-18 breeding season (from October 2017 to January 2018) indicated that the total pups born this season were 1,825 (Friends of Horsey 2018). Counts in 2015-16, during a 15 week period from 15th October 2015 to 21st January 2016, indicated that the number of adult grey seals recorded varied with the stage in the breeding cycle. The recent counts indicate that the breeding colony of grey seals at Horsey-Winterton is continuing to increase in numbers and expand its distribution (Rothney 2016).

11.1.6.1.2 Diet and Foraging

118. Grey seals are generalist feeders, foraging mainly on the sea bed at depths of up to 100m although they are probably capable of feeding at all the depths found across the UK continental shelf (SCOS 2017).

119. In the North Sea, principal prey items are sandeel, whitefish (such as cod, haddock, whiting and ling *Molva molva*) and flatfish (plaice *Pleuronectes*

platessa, sole, flounder, and dab *Limanda limanda*) (Hammond and Grellier 2006). Amongst these, sandeels are typically the predominant prey species. Diet varies seasonally and from region to region (SCOS 2016).

120. Food requirements depend on the size of the seal and fat content (oiliness) of the prey, but an average consumption estimate of an adult is 4 to 7kg per seal per day depending on the prey species (SCOS 2017).

121. Grey seal typically forage in the open sea and return regularly to haul out on land where they rest, moult and breed. They may range widely to forage and frequently travel. Foraging trips can last anywhere between one and 30 days (SCOS 2017).

122. Tracking of individual seals has shown that most foraging probably occurs within 100km of a haul-out site, with ranges of approximately 145km (Thompson et al. 1996), although they can feed up to several hundred kilometres offshore, with ranges of 1,088 to 6,400km recorded (Dietz et al. 2003). Individual grey seals based at a specific haul-out site often make repeated trips to the same region offshore, but will occasionally move to a new haul-out site and begin foraging in a new region (SCOS 2017). Movements have been recorded between haul-out sites on the east coast of England and the Outer Hebrides (SCOS 2017). Studies of regular foraging and dispersal between winter breeding sites, and summer foraging and haul out sites indicates ranges of 1,000km (e.g. McConnell et al. 1992).

123. Telemetry studies of grey seal in the UK have identified a highly heterogeneous spatial distribution with a small number of offshore ‘hot spots’ continually utilised (Matthiopolous et al. 2004; Russell et al. 2017).

124. Data analyses of tagged seals indicate that foraging distribution is related to their breeding distribution (Russell and McConnell 2014). Female grey seal do not forage while suckling their pups. Therefore, the movement of female grey seals differs between the foraging and breeding seasons. Russell et al. (2013) found that between 21 and 58% of females used different regions for foraging and breeding.

125. The resulting tracks from the tags also show grey seals range far from land and pups may have more long ranging movements than adults (***Plate A11.1.6***; Russell and McConnell 2014).

11.1.6.1.3 Abundance and Density Estimates

126. Grey seal abundance and density estimates are reported in ***Chapter 11 Marine Mammals***.

11.1.6.1.3.1 Reference Population for Assessment

127. Grey seal reference populations used for the assessment are reported in ***Chapter 11 Marine Mammals***.

11.1.6.2 Harbour Seal

11.1.6.2.1 Distribution

128. Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one subspecies *Phoca vitulina vitulina* (SCOS 2017).

129. On the east coast of Britain harbour seal distribution is generally restricted, with concentrations in the major estuaries of the Thames, The Wash and the Moray Firth (SCOS 2017).

130. SMRU, in collaboration with others, has deployed around 344 telemetry tags on harbour seals around the UK between 2001 and 2012 (Russell and McConnell 2014). The tracks indicate that very few tagged harbour seals have been recorded in the immediate vicinity of the East Anglia TWO offshore development area, with tracks moving along the coast between The Wash and the Thames Estuary (***Plate A11.1.8***).

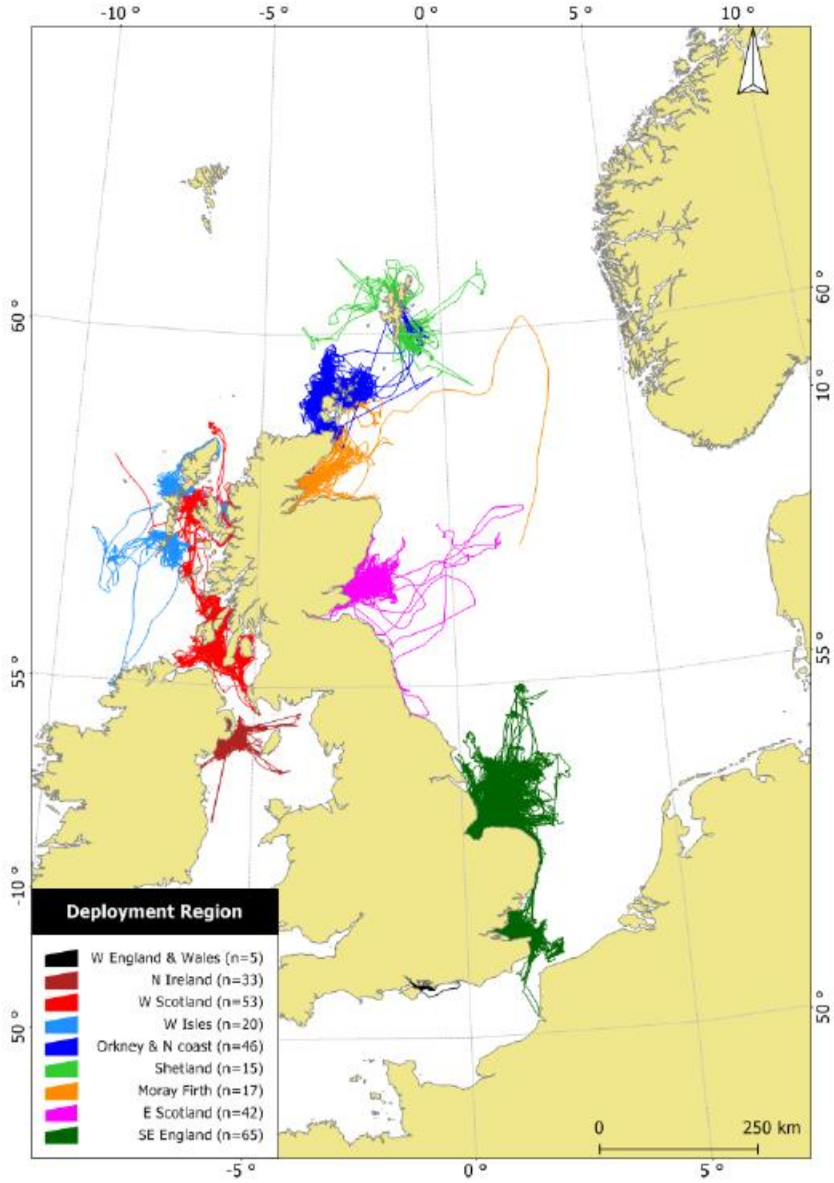

Plate A11.1.8 Telemetry tracks by deployment region for harbour seals aged one year or over (Source: Russell and McConnell 2014)

131. Aerial surveys conducted for the former East Anglia Zone, did not record any observations of seals (EAOW 2012c) neither did aerial surveys at the East Anglia ONE site. However, during boat based surveys, three harbour seal were recorded at the East Anglia ONE site, suggesting that there is low usage of the East Anglia ONE site (EAOL 2012). As outlined for grey seal, only two unidentified seals were recorded during East Anglia THREE surveys (EATL 2015). The results of the surveys support the tagging data and suggest that there is low usage of the former East Anglia Zone.

132. For the East Anglia THREE EIA (EATL 2015), EATL commissioned SMRU Marine Ltd and IMARES to investigate the connectivity between tagged harbour

seal and the East Anglia THREE site and a 20km buffer area around the site (EATL 2015). The SMRU study was based on their database of telemetry data of harbour seal juveniles and adults from tagging locations including the Wash and the Thames Estuary from 2003 to 2012, including data from the Zoological Society of London seal tagging study. The SMRU study indicated that none of the 43 tagged harbour seals aged one or above entered the East Anglia THREE site plus a 20km buffer area or surrounding area. For the Dutch telemetry studies, a total of 273 harbour seal were tagged at sites in the Netherlands between 1997 and 2013. Of these seals, 10 were found to travel within 20km of the EA3 site. Of these 10 seals, six entered the offshore cable corridor and two were within the East Anglia THREE site. Although, it is likely all but one harbour seal spent less than 2% of their 'time-at-sea' within the area, with an exception being a harbour seal tagged in 2007 which spent at least 2% and up to 17% of its 'time-at-sea' within the East Anglia THREE offshore cable corridor. The Dutch tagging data illustrate the long ranging movements of harbour seal and levels of connectivity between Dutch haul out sites and those on the east coast of England (EATL 2015).

133. The SMRU maps of harbour seal distribution in UK waters (Russell et al. 2017), based on the movement patterns of electronically tagged seals with survey counts of seals at haul-out sites, indicate that harbour seal usage is relatively low in and around the East Anglia TWO windfarm site, and is higher along the coast and cable corridor (Russell et al. 2017).

134. Spatial distributions indicate harbour seals persist in discrete regional populations, display heterogeneous usage and generally stay within 50km of the coast (Russell and McConnell 2014).

11.1.6.2.1.1 Haul-Out Sites

135. See PEIR Chapter 11 Marine Mammals.

11.1.6.2.2 Diet and Foraging

136. The range of foraging trips varies depending on the surrounding marine habitat (e.g. 25km on the west of Scotland (Cunningham *et al*. 2009); 30km-45km in the Moray Firth (Tollit et al. 1998; Thompson and Miller 1990). However, data from The Wash (from 2003- 2005) suggest that harbour seal in this area travel further, and repeatedly forage between 75km and 120km offshore (with one seal travelling 220km; Sharples et al. 2008). Telemetry studies indicate that the tracks of tagged harbour seals have a more coastal distribution than grey seals and do not travel as far from haul-outs (***Plate A11.1.8***; Russell and McConnell 2014).

137. It is estimated harbour seals eat 3-5 kg per adult seal per day depending on the prey species (SCOS 2017).

11.1.6.2.3 Abundance and Density Estimates

138. Harbour seal abundance and density estimates are reported in PEIR ***Chapter 11 Marine Mammals***.

11.1.6.2.3.1 Reference Population for Assessment

139. Reference populations used for the assessment are reported in PEIR ***Chapter 11 Marine Mammals***.

11.2 Marine Mammal Survey Data

11.2.1 Introduction

140. This appendix summarises the marine mammal data collected during the marine mammal site specific surveys within the East Anglia TWO windfarm site and a 4km buffer (hereafter referred to as the '*marine mammal survey area*') (***Plate A11.2.1***). The purpose of these surveys is to assess the temporal and spatial variation in marine mammal abundance and distribution in and around the East Anglia TWO windfarm site.

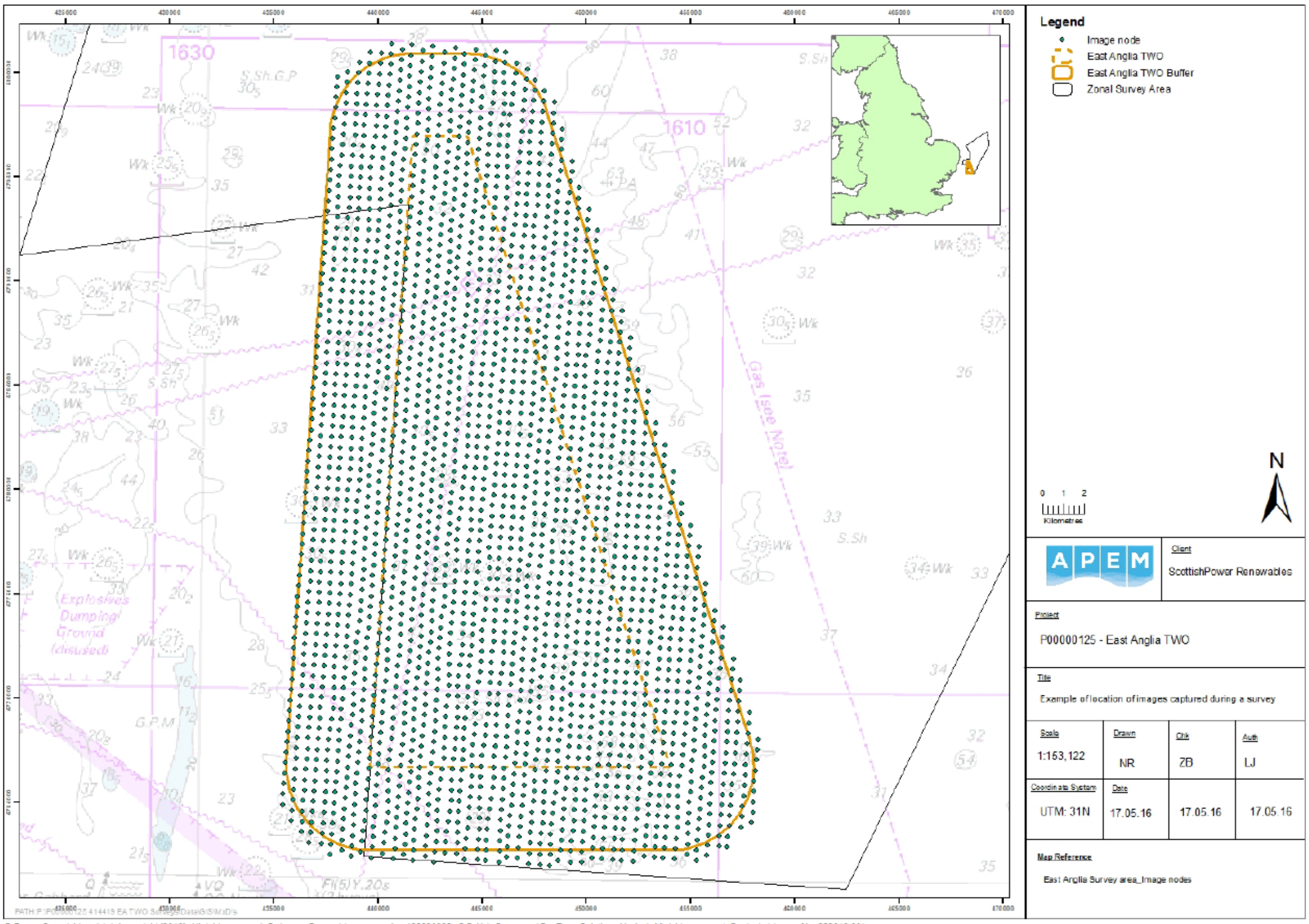

Plate A11.2.1 Location of the East Anglia TWO windfarm site + 4km buffer (the marine mammal survey area) with basic survey design and estimated image collection points (image nodes).

141. The following monthly aerial surveys have been undertaken for the marine mammal survey area and used to characterise the area for marine mammals:

- Aerial survey from November 2015 to April 2016, from September 2016 to October 2017, and from May 2018 to August 2018.

142. The information included in this appendix used to support the PEIR is based on:

- Aerial survey data of the marine mammal survey area from November 2015 to April 2016, from September 2016 to October 2017, and May 2018.

143. The full data from all surveys will be included within the ES.

144. The aerial surveys were designed specifically to collect adequate and robust data on both marine mammals and birds across the marine mammal survey area. Aerial surveys have been used in the SCANS surveys, including the SCANS-III surveys to estimate cetacean abundance (Hammond et al. 2017).

145. The technology underlining aerial digital methods for surveying marine mammals has evolved considerably in recent years and several independent studies have justified the growing confidence in the emerging use of digital survey methods (Voet et al. 2017; Lowry 1999; Koski et al. 2013; Stewart et al. 2013). The improvement of digital sensors and enhancement of imagery resolution now allows for the monitoring of large areas at a small ground sampling distance (Voet et al. 2017). Additionally, perception or detection bias can be minimised and the production of permanent records allows species identification, group size and behaviour to be re-analysed. During aerial surveys, marine mammals can be seen not only when breaking the surface, but when below the surface as well. Under normal conditions, harbour porpoises are available for detection during aerial surveys when in the top two metres of the water column (Teilmann et al. 2007; 2013). Therefore, correction factors have been applied to take into account the animals that are submerged, so that robust density estimates can be calculated (see ***section 11.2.2.4*** of this appendix).

146. The digital aerial survey approach has many advantages over alternative methods. It is performed from an altitude at which disturbance to target species is minimal, and is not subject to the bias of repulsion (i.e. inducing flee responses in marine mammals, such as harbour porpoise, that can influence the numbers recorded and affect their apparent distribution) or attraction (i.e. some marine mammal species, such as bottlenose dolphin may be attracted to boats and ride the bow wave formed by the vessel). The aerial survey approach also provides very accurate positioning data, and can be interpreted to provide information on swimming direction and the distance between animals in a pod. Furthermore, owing to the speed of the aircraft, it is possible to cover large areas in a single day of survey, meaning within-survey temporal variance is minimised. Images collected can be scrutinised post hoc, are subject to Quality Assurance (QA), and provide a permanent record for future interpretation.

147. A major advantage of collecting many digital still images is the resulting statistical power. Each image is a representative sample of marine mammal distribution and abundance, and can be considered independent from every

other image due to the 500m separation between image centres. In this way, a systematic grid of many independent estimates of the abundance is formed, resulting in increased precision of abundance estimates.

148. It is also necessary to understand certain restrictions and limitations associated with aerial survey for marine mammals. For example, it is often difficult to identify individuals to species level from the imagery and higher-level groupings are frequently used for classification, which influences the information available for individual species that can be taken forward for further assessment (see ***section 11.2.2.3***). Although submerged individuals near the surface can be observed, water clarity could introduce bias in the results with more individuals likely to be recorded during calm weather with greater water clarity than following a storm when water is potentially more turbid. Marine mammals spend a large proportion of time underwater and individuals present which are too deep to be captured by the imagery will not be recorded, requiring the application of a correction factor (see ***section 11.2.2.4***).

11.2.2 Methodology

11.2.2.1 Data Collection

149. APEM collected high resolution aerial digital still imagery over the marine mammal survey area. The monthly surveys collected imagery data at 2cm Ground Sampling Distance (GSD) with the image nodes (estimated image collection points) being spaced in a grid pattern of 868m (or 500m depending on the camera system). Coverage of the marine mammal survey area was between approximately 10% and 12.74% per month. ***Plate A11.2.1*** shows the survey area for the East Anglia TWO windfarm site and 4km buffer (the marine mammal survey area).

150. The aerial surveys were completed using a Vulcanair P68 C Observer twin-engine survey aircraft using a bespoke GPS-linked flight management system to ensure the survey tracks were completed with high accuracy. Further details on APEMs aerial survey methodologies are provided in ***Appendix 12.1.***

151. All images were analysed to enumerate marine mammals to species level, where possible. Internal QA was carried out by APEM on each survey. Images were assessed in batches with a different staff member responsible for each batch. Each image containing marine mammals was reviewed and checked by APEM’s dedicated QA Manager, ensuring that 100% of marine mammals recorded were subject to internal QA to ensure the species identification is correct. Images containing no marine mammals were removed and kept separately for further internal QA. Of these ‘blank’ images, 10% were randomly selected for internal QA by a different staff member to that which initially analysed the imagery. If there was less than 90% agreement, the entire batch would be re-analysed as part of the QA procedures. Following internal QA,

external QA was carried out by the Sea Mammal Research Unit (SMRU), who provided an independent third-party assessment of the marine mammals recorded in each survey.

11.2.2.2 Data Analysis

152. Raw data were supplied to MacArthur Green as plane GPS track logs, containing details for each image location and observation logs, containing details of all objects (seabird, marine mammal, vessel, etc.) recorded. The datasets were merged using the image ID to obtain a single dataset. All non-marine mammal records were removed prior to analysis of marine mammal density and abundance estimates. Analysis was conducted for each monthly survey separately. Marine mammal locations were assigned to the following sub-zones; windfarm site, windfarm site plus 2km buffer and windfarm plus 4km buffer (note that each buffer width also included the windfarm data).

153. Density and abundance can be estimated in two ways using these data, referred to as design based and model based methods. Design based methods apply a straightforward extrapolation, with density estimated for the surveyed area (i.e. the sum of all the image footprints) and multiplied up to the total area to obtain abundance. This makes the assumption that the surveyed sample is representative of the un-surveyed region, thus the design of survey is important (hence 'design based'). A design based estimate has no spatial variation in the estimated density or abundance.

154. Model based methods use explanatory data (e.g. spatial coordinates, sea depth, etc.) fitted to observations to estimate the expected number of observation in un-surveyed regions. Model based estimates can therefore generate variable density surfaces reflecting the relationships between data and covariates. However, to obtain reliable model based estimates it is necessary to have a reasonably large number of observations to permit robust parameter estimation. Thus, this can only be conducted for more numerous species.

155. For the current preliminary assessment, only design based methods have been used. Model based methods will also be undertaken for species-survey combinations which meet the minimum sample size requirements (as an approx. guide a minimum of 50 observations per survey is typically required). These will be included, where possible, in the final ES submission.

156. Design based confidence intervals for each species were obtained using a bootstrap resampling method. For each survey, images were drawn randomly (with replacement) from the dataset until the same number of images as the original sample was obtained (e.g. if the survey comprised 350 images, each resampled datase*t al*so contained 350 images, drawn from the original dataset). This process was repeated 1,000 times and the density and abundance

calculated for each resampled dataset. The upper and lower 95% confidence limits were calculated across the 1,000 samples to estimate sampling variation.

11.2.2.3 Species Identification

157. In some instances, an image had sufficient clarity to identify an individual to species level, whereas for other individuals the clarity may not have been sufficient to identify to species levels and it was necessary instead to categorise the individual at a lower identification level e.g. unidentified patterned dolphin species (see ***Table A11.1.4 for*** the different levels of identification of individuals).

158. Sightings were assigned to a specific species where possible, where this was not possible, sightings were allocated to one of the following categories:

- Unidentified cetacean species;
- Phocid species (seals);
- Unidentified dolphin or porpoise (small cetacean);
- Unidentified dolphin; and
- Unidentified patterned dolphin.

Table A11.1.4 Marine mammal identification levels according to species and species groups used within baseline report

<table>
<tr><th>Identification level 1</th><th>Identification level 2</th><th>Identification level 3</th><th>Identification level 4</th><th>Identification level 5</th></tr>
<tr><td rowspan="7">Unidentified cetacean species</td><td rowspan="7">Unidentified dolphin / porpoise</td><td colspan="3">Harbour porpoise</td></tr>
<tr><td rowspan="6">Unidentified dolphin species</td><td colspan="2">Risso’s dolphin</td></tr>
<tr><td colspan="2">Bottlenose dolphin</td></tr>
<tr><td rowspan="4">Unidentified patterned dolphin species</td><td>White-beaked dolphin</td></tr>
<tr><td>Atlantic white-sided dolphin</td></tr>
<tr><td>Common dolphin</td></tr>
<tr><td>Striped dolphin</td></tr>
<tr><td rowspan="2">Phocid species</td><td colspan="4">Grey seal</td></tr>
<tr><td colspan="4">Harbour seal</td></tr>
</table>

159. The surveys within the marine mammal survey area indicates that harbour porpoise is the most abundant marine mammal species. It is therefore assumed that a large number of unidentified small cetaceans are likely to be harbour porpoise. As a worst-case scenario (i.e. maximum possible density estimate)

for harbour porpoise, the density has been obtained by adding the number of harbour porpoise recorded to the number of unidentified small cetaceans. For this reason, two estimates for harbour porpoise were obtained:

- Identified harbour porpoise; and
- Identified harbour porpoise plus unidentified small cetacean (dolphin or porpoise).

160. The maximum estimate based on identified harbour porpoise plus unidentified small cetacean is used in the impact assessment as the worst-case scenario.

11.2.2.4 Correction Factors

161. It is only possible for aerial imagery to capture marine mammals at the sea surface and just below, therefore correction factors (CF) must be applied to the raw data counts for each species to account for individuals that could be below the sea surface.

11.2.2.4.1 Harbour porpoise

162. The colour and size of harbour porpoise (small in comparison to other marine mammal species) make them relatively easy to identify from aerial imaging. They can be seen on the waters surface and within the top 2m of the water column (Teilmann et al. 2007, 2013; Williamson et al. 2016). Correction factors are used to account for the probability of harbour porpoise being below the water surface or detection zone (i.e. below 2m for harbour porpoise) and being undetectable by aerial surveys.

163. Voet *et al*. (2017) determined correction factors for harbour porpoise in the North Sea based on published marine mammal dive profile data. Teilmann *et al*. (2013) tagged 35 harbour porpoise in the waters around Denmark using satellite transmitters. The satellite transmitters recorded data for a period of on average 135 days, the minimum and maximum days of contact were 25 days and 349 days, respectively (Teilmann et al. 2013).

164. The percentage of time that each harbour porpoise spent between 0 and 2m water depth (including the time that the dorsal fin was above the water surface) was analysed, with no significant differences being found between male and female porpoise, the size of the individual (used as a proxy for age) or in the location that the individual was tagged.

165. There were, however, significant differences in the time of year, with the spring and summer having a higher average time spent between 0 and 2m compared autumn and winter. These seasonal average surface times are based on documented dive profile data of a large number of animals covering a wide range of ages and both sexes. Therefore, to take this into account, Teilmann

et al. (2013) suggest that aerial survey data should be corrected for time submerged as well as for seasonal effects.

166. Taking into account the seasonal average surface times presented in Teilmann et al. (2013), Voet et al. (2017) established seasonal correction factors for harbour porpoise to use to determine abundance and density estimates obtained from aerial digital surveys.

Table A11.1.5 Harbour porpoise seasonal correction factors

Season	Correction Factor
Spring (March – May)	0.571
Summer (June – August)	0.547
Autumn (September – November)	0.455
Winter (December - February)	0.472

167. The seasonal correction factors in ***Table A11.1.5*** were applied to the monthly data to take into account for the probability of harbour porpoise being below the water surface or detection zone (i.e. below 2m for harbour porpoise) and being undetectable by aerial surveys.

168. Turbidity can affect the ability to detect marine mammals in the 2m detection zone below the surface. Water clarity (Secchi depth) in the North Sea varies with water depth and distance from the coast (Dupont and Aksnes 2013). Long-term overall measurements of Secchi depth for the southern and central North Sea in the area of the proposed East Anglia TWO offshore development area indicate means of between 5.52m-1 (SD = 1.06) and 3.27m-1 (SD=2.22) in summer, 2.70m-1 (SD = 2.41) in spring / autumn and 1.66m-1 (SD = 0.93) in winter (Capuzzo et al. 2015).

169. Therefore, there is no indication of any limitations in observing marine mammals up to 2m below the surface. The correction factors take into account the number of animals that could be below 2m from the surface and not detected during the aerial surveys.

170. Correction factors are based on individual species and typically cannot be applied to species groups (such as unidentified small cetaceans). However, as it is assumed that all individuals in the 'harbour porpoise and unidentified small cetacean' group are harbour porpoise, the correction factor for harbour porpoise was applied to this group.

171. Previously the acceptance of digital survey methods has been queried owing to uncertainty over their ability to provide reliable estimates of spatial and temporal variation in absolute abundance or density as corrected from relative measures. However, correcting the density estimates for availability bias increases the confidence levels in these estimates. Therefore, it is believed that the harbour porpoise aerial digital counts corrected using the seasonal correction factors deliver realistic density estimates.

172. The density estimates from the site specific aerial surveys using the correction factors are comparable to those from the SCANS-III survey, although as expected are slightly higher for the site specific survey areas compared to the larger SCANS-III survey blocks. For example, the SCANS-III density estimate for survey block L (0.607 harbour porpoise per km^2) is relatively similar to the East Anglia TWO windfarm site density estimate average annual of 0.710 harbour porpoise per km^2.

11.2.2.5 Survey Effort

173. Monthly coverage was between 10 and 12.74% of the marine mammal survey area, covering five transects per month (***Table A11.1.6***). Note that the remaining monthly survey data will be added into this summary for the ES.

Table A11.1.6 Monthly survey coverage and effort for the East Anglia TWO windfarm site

Month of Survey	Number of Transects	Coverage	Number of Images	Weather Conditions
November 2015	-	10.53%	831	• Visibility of 5-10km. • Winds variable from 30-40 knots from north-westerly direction, sea states of 3-4.
December 2015	-	10.5%	829	• Visibility of 8-10km. • Winds of 40 knots from south-westerly direction, sea states of 3-4.
January 2016	-	12.74%	2,548	• Visibility of more than 10km. • Winds variable from 25-45 knots from south-westerly to westerly direction, sea states of 3.
February 2016	-	10.54%	832	• Visibility of more than 10km. • Winds variable from 15-20 knots from north-easterly direction, sea states of 2-4.
March 2016	-	10.54%	832	• Visibility of more than 10km.

Month of Survey	Number of Transects	Coverage	Number of Images	Weather Conditions
				• Winds of 15 knots from south-westerly direction, sea states of 3.
April 2016	-	10.54%	832	• Visibility of more than 10km. • Winds variable from 10-15 knots from south-westerly to westerly direction, sea states of 2.
September 2016	5	10.44%	800	• Clear skies with cloud cover of 10% and visibility of 10km. • No precipitation. • Winds variable from 20-60 knots from southerly direction, sea states of 2-3 and water turbidity of 2.
October 2016	5	10.53%	807	• Cloud cover overcast of 80% and visibility of more than 10km. • No precipitation. • Winds variable from 20 knots from south-easterly direction, sea states of 3 and water turbidity of 2.
November 2016	5	10%	953	• Cloud cover of 80% and visibility of more than 10km. • No precipitation. • Winds variable from 20-25 knots from south-westerly direction, sea states of 4 and water turbidity of 3.
December 2016	5	10%	949	• Cloud cover broken with 40-60% and visibility of more than 10km. • No precipitation. • Winds variable from 30-40 knots from westerly direction, sea states of 3 and water turbidity of 2.
January 2017	5	10%	953	• Cloud cover of 0% and visibility of more than 10km. • No precipitation. • Winds variable from 15-20 knots from easterly direction,

Month of Survey	Number of Transects	Coverage	Number of Images	Weather Conditions
				sea states of 3 and water turbidity of 3.
February 2017	5	10%	953	• Cloud cover of 50-60% and visibility of more than 10km. • No precipitation. • Winds variable from 20-25 knots from north-westerly direction, sea states of 2-3 and water turbidity of 2.
March 2017	5	10%	953	• Cloud cover of 80% and visibility of more than 10km. • No precipitation. • Winds of 30 knots from south-westerly direction, sea states of 3 and water turbidity of 2.
April 2017	5	10%	953	• Cloud cover of 75-95% and visibility of more than 10km. • No precipitation. • Winds variable from 20 knots from south-westerly direction, sea states of 1 and water turbidity of 0.
May 2017	5	10%	953	• Cloud cover of 75-95% and visibility of more than 10km. • No precipitation. • Winds variable from 25-30 knots from south-westerly direction, sea states of 2-3 and water turbidity of 2.
June 2017	5	10%	953	• Cloud cover of 90% and visibility of more than 10km. • No precipitation. • Winds of 9 knots from southerly direction, sea states of 1 and water turbidity of 0.
July 2017	5	10%	953	• Cloud cover of 95-100% and visibility of more than 10km. • No precipitation. • Winds of 20 knots from north-westerly direction, sea states of 3 and water turbidity of 2.

Month of Survey	Number of Transects	Coverage	Number of Images	Weather Conditions
August 2017	5	10%	953	• Cloud cover of 30-40% and visibility of more than 10km. • No precipitation. • Winds of 18 knots from north-easterly direction, sea states of 4 and water turbidity of 2.
September 2017	5	10%	953	• Cloud cover of 25-50% and visibility of more than 10km. • No precipitation. • Winds of 10 knots from a westerly direction, sea states of 3-4 and water turbidity of 2.
October 2017	5	10%	953	• Cloud cover of 75-95% and visibility of more than 10km. • No precipitation. • Winds variable from 30-35 knots from south-easterly direction, sea states of 4 and water turbidity of 2.
May 2018	5	10%	958	• Clear skies and visibility of more than 10km. • No precipitation. • Winds of 10 knots from south-westerly direction, sea states of 0 and water turbidity of 0.

11.2.3 Results

174. **Annex** 1: Raw Data shows the full raw data count for surveys completed for the East Anglia TWO marine mammal survey area, with harbour porpoise counts and harbour porpoise and unidentified small cetacean counts. The data is split between the East Anglia TWO windfarm site only, the East Anglia TWO windfarm site and 2km buffer and the East Anglia TWO windfarm site and 4km buffer area.

11.2.3.1 Raw Data Counts

175.

176. ***Table*** A11.1.7 summarises the raw data count for the marine mammal survey area.

Table A11.1.7 East Anglia TWO windfarm site raw data count for surveys within the marine mammal survey area

Date	Harbour porpoise	Dolphin species / harbour porpoise	Dolphin species	Seal species
November 2015	0	10	0	0
December 2015	1	4	0	0
January 2016	10	44	1	1
February 2016	11	28	0	0
March 2016	6	24	0	0
April 2016	5	21	0	1
September 2016	0	3	2	0
October 2016	0	0	0	0
November 2016	0	2	0	0
December 2016	0	5	0	0
January 2017	4	78	0	2
February 2017	5	21	0	0
March 2017	3	43	0	1
April 2017	6	14	0	2
May 2017	0	0	0	0
June 2017	3	16	0	1
July 2017	0	3	0	0
August 2017	2	5	0	1
September 2017	1	4	0	0
October 2017	0	1	0	0
May 2018	12	26	0	3
Totals	69	352	3	12

11.2.3.2 Corrected Data

177. To correct the final counts to account for the availability bias for individuals at the water's surface, the count is divided by the correction factor (mean time spent at surface). The updated seasonal correction factors for harbour porpoise in ***Table A11.1.5*** have been used. See ***Table A11.1.8*** for the corrected data for the East Anglia TWO windfarm site marine mammal survey area.

Table A11.1.8 Correction Factors applied to the East Anglia TWO windfarm site marine mammal survey area

Date	Harbour porpoise		Dolphin species / harbour porpoise		Dolphin species		Seal species	
	Raw data count	With seasonal CF (see table 2.2)	Raw data count	With seasonal CF (see table 2.2)	Raw data count	With dolphin species CF (0.11)	Raw data count	With seal species CF (0.18)
November 2015	0	0	10	22.0	0	0	0	0
December 2015	1	2.1	4	8.5	0	0	0	0
January 2016	10	21.2	44	93.2	1	9.1	1	5.6
February 2016	11	23.3	28	59.3	0	0	0	0
March 2016	6	10.5	24	42.0	0	0	0	0
April 2016	5	8.8	21	36.8	0	0	1	5.6
September 2016	0	0	3	6.6	2	18.2	0	0
October 2016	0	0	0	0	0	0	0	0
November 2016	0	0	2	4.4	0	0	0	0
December 2016	0	0	5	10.6	0	0	0	0
January 2017	4	8.5	78	165.3	0	0	2	11.1
February 2017	5	10.6	21	44.5	0	0	0	0
March 2017	3	5.3	43	75.3	0	0	1	5.6
April 2017	6	10.5	14	24.5	0	0	2	11.1

Date	Harbour porpoise		Dolphin species / harbour porpoise		Dolphin species		Seal species	
	Raw data count	With seasonal CF (see table 2.2)	Raw data count	With seasonal CF (see table 2.2)	Raw data count	With dolphin species CF (0.11)	Raw data count	With seal species CF (0.18)
May 2017	0	0	0	0	0	0	0	0
June 2017	3	5.5	16	29.3	0	0	1	5.6
July 2017	0	0	3	5.5	0	0	0	0
August 2017	2	3.7	5	9.1	0	0	1	5.6
September 2017	1	2.2	4	8.8	0	0	0	0
October 2017	0	0	1	2.2	0	0	0	0
May 2018	12	21.0	26	45.5	0	0	3	16.7
Totals	69	133.1	352	693.4	3	27.3	12	66.9

11.2.3.3 Abundance Estimates

178. The abundance of harbour porpoise and unidentified small cetaceans were estimated from the raw data counts. Correction factors were then applied to the data to account for the presence of individuals below 2m water depth (the depth at which it is no longer possible to detect marine mammals from aerial imagery). ***Plate A11.2.2*** and Plate*Error! Reference source not found.* ***A11.2.3*** show the abundance estimates for harbour porpoise and harbour porpoise and unidentified dolphin / porpoise across the East Anglia TWO marine mammal survey area.

179. ***Section 11.2.2.2*** outlines the approach used for the abundance estimates.

180. The highest number of harbour porpoise for the marine mammal survey area was recorded in May 2018, with an estimated abundance of 113 individuals, resulting in an abundance estimate of 248 with the seasonal correction factor (***Plate A11.2.2***). When unidentified small cetaceans are included, the highest abundance estimate was in January 2017 with an abundance of 751 individuals, resulting in an abundance of 1,650 with the seasonal correction factor (Plate A11.2.3).

181. There is a seasonal pattern of abundances for the harbour porpoise only data, with the highest abundances being during the winter months (November to April) with the exception of May 2018, where the highest abundancies of harbour porpoise were recorded (***Plate A11.2.2***). For the abundancies including unidentified small cetaceans (dolphins or porpoises), there is again a seasonal pattern, with higher abundancies in the winter period (November to May (***Plate A11.2.3***).

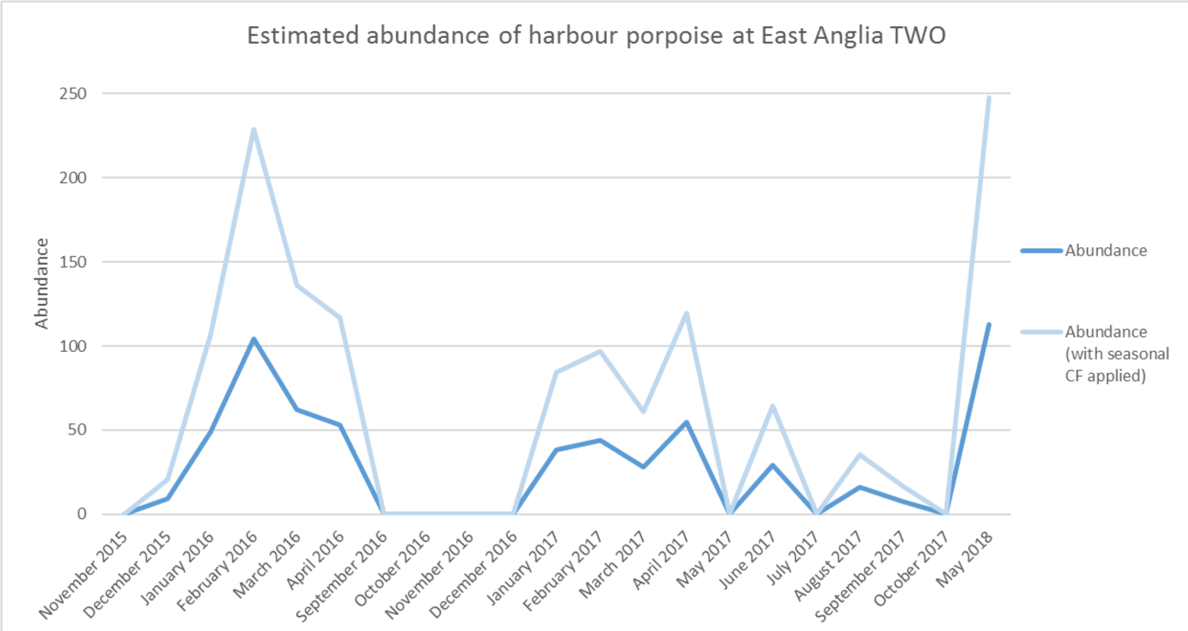

Plate A11.2.2 The estimated abundance of harbour porpoise across the East Anglia TWO windfarm site marine mammal survey area with seasonal correction factor applied.

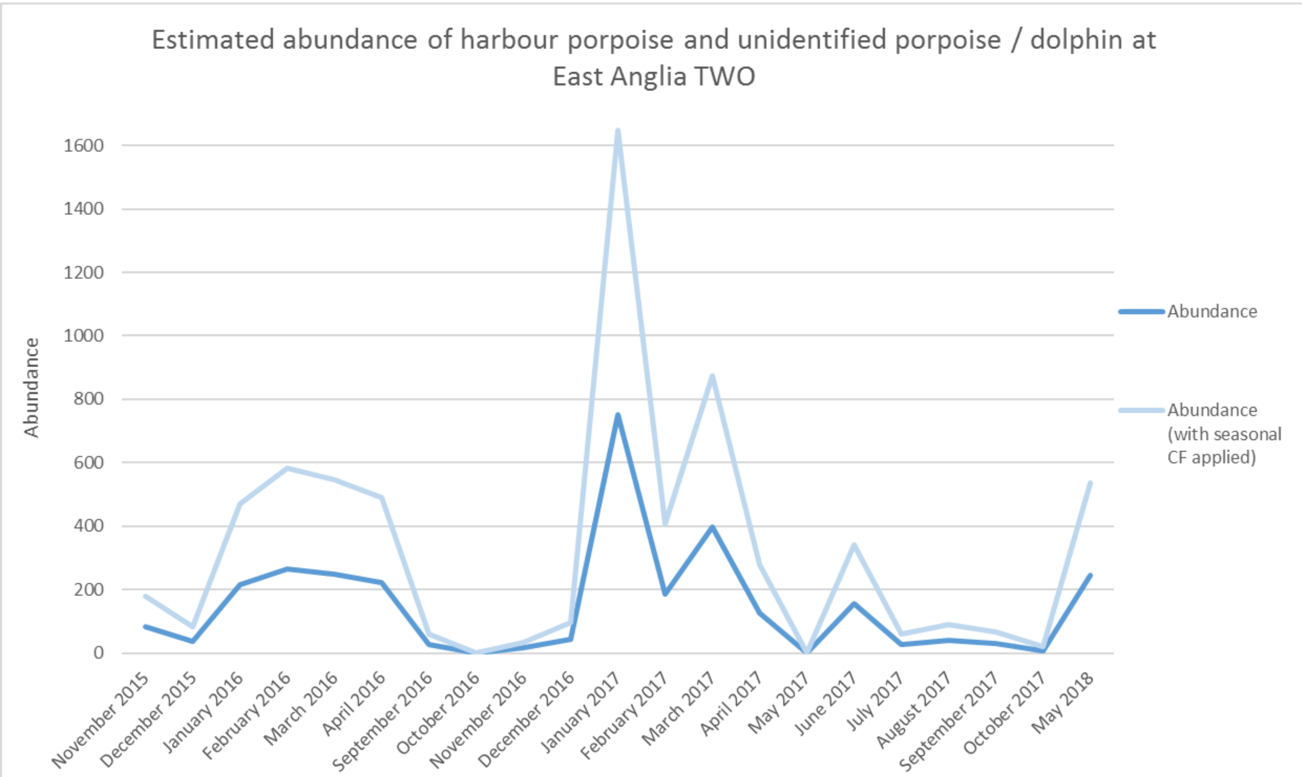

Plate A11.2.3 The estimated abundance of harbour porpoise and unidentified small cetaceans across East Anglia TWO windfarm site marine mammal survey area with seasonal correction factor applied.

11.2.3.4 Density Estimates

182. ***Table A11.1.9*** presents the estimated densities for harbour porpoise only at the East Anglia TWO windfarm site. The density estimates are calculated using the maximum density for each month over the survey period, which is averaged to produce an overall density estimate over a year. This then takes into account seasonal variability to produce a worst-case likely density, of which impacts can be measured against.

183. When unidentified small cetaceans are included with the harbour porpoise data (***Table A11.1.10***) the highest density estimate was in January, with an uncorrected density estimate of 1.22/km^2 (97.5% CI = 0.94-1.56/km^2); the corrected density estimates when using the seasonal correction factor is 2.58/km^2 for the East Anglia TWO windfarm site. However, the other monthly density estimates for harbour porpoise, including unidentified small cetaceans, are considerably lower than the January estimate (***Table A11.1.10***).

184. The annual mean density estimate when using the seasonal correction factor is 0.71/km^2 for the East Anglia TWO windfarm site.

185. The density estimate during summer (April to September) is 0.41/km^2 and during the winter (October to March) the estimated density is 1.01/km^2 using the corrected densities.

Table A11.1.9 The highest density estimates for the East Anglia TWO windfarm site for harbour porpoise only

By month	Density estimate (individuals / km^2) based on raw data (97.5% CI)	Density estimate (individuals / km^2) with seasonal CF
January	0.114 (0-0.265)	0.241 (0-0.562)
February	0.221 (0.111-0.354)	0.469 (0.234-0.75)
March	0.121 (0-0.283)	0.212 (0-0.495)
April	0.178 (0.036-0.3573)	0.313 (0.063-0.625)
May	0.192 (0.072-0.336)	0.337 (0.126-0.589)
June	0.077 (0-0.192)	0.140 (0-0.351)
July	0 (0-0)	0 (0-0)
August	0.042 (0-0.104)	0.076 (0-0.190)
September	0.0121 (0-0.036)	0.027 (0-0.080)
October	0 (0-0)	0 (0-0)
November	0 (0-0)	0 (0-0)
December	0.036 (0-0.109)	0.077 (0-0.232)
Yearly Average	**0.083 (0.018-0.170)**	**0.158 (0.035-0.323)**

Table A11.1.10 The highest density estimates for the East Anglia TWO windfarm site for harbour porpoise and unidentified small cetaceans

By month	Density estimate (individuals / km^2) based on raw data (97.5% CI)	Density estimate (individuals / km^2) with seasonal CF
January	1.217 (0.936-1.560)	2.578 (1.983-3.305)
February	0.506 (0.181-0.904)	1.073 (0.383-1.916)
March	0.975 (0.578-1.445)	1.707 (1.012-2.53)
April	0.371 (0.083-0.743)	0.651 (0.145-1.301)
May	0.481 (0.216-0.793)	0.842 (0.379-1.389)
June	0.253 (0.095-0.442)	0.462 (0.173-0.808)
July	0.045 (0-0.104)	0.082 (0-0.190)
August	0.095 (0-0.252)	0.173 (0-0.461)
September	0.108 (0-0.252)	0.237 (0-0.554)
October	0.014 (0-0.043)	0.031 (0-0.094)
November	0.224 (0.064-0.415)	0.492 (0.140-0.913)
December	0.093 (0.023-0.208)	0.196 (0.049-0.442)
Yearly Average	**0.365 (0.181-0.597)**	**0.710 (0.355-1.159)**

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11.4 Annex 1: Raw Data

Table A11.1.11 Raw count for the marine mammal surveys undertaken for the East Anglia TWO marine mammal survey area

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise								
Harbour porpoise	WF only	November	2015	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	December	2015	1	0.036	0.000	0.109	9.314
Harbour porpoise	WF only	January	2016	4	0.079	0.020	0.158	20.126
Harbour porpoise	WF only	February	2016	6	0.217	0.072	0.398	55.414
Harbour porpoise	WF only	March	2016	3	0.121	0.000	0.283	30.946
Harbour porpoise	WF only	April	2016	3	0.124	0.000	0.289	31.620
Harbour porpoise	WF only	September	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	October	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	November	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	December	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	January	2017	3	0.114	0.000	0.265	29.029
Harbour porpoise	WF only	February	2017	1	0.035	0.000	0.104	8.856
Harbour porpoise	WF only	March	2017	3	0.108	0.000	0.253	27.655

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise	WF only	April	2017	5	0.178	0.036	0.357	45.570
Harbour porpoise	WF only	May	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	June	2017	2	0.077	0.000	0.192	19.599
Harbour porpoise	WF only	July	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	August	2017	1	0.032	0.000	0.095	8.044
Harbour porpoise	WF only	September	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	October	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF only	May	2018	5	0.184	0.037	0.368	46.981
Harbour porpoise	WF + 2km buffer	November	2015	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 2km buffer	December	2015	1	0.022	0.000	0.066	9.340
Harbour porpoise	WF + 2km buffer	January	2016	5	0.058	0.012	0.117	24.714
Harbour porpoise	WF + 2km buffer	February	2016	10	0.221	0.111	0.354	93.670
Harbour porpoise	WF + 2km buffer	March	2016	4	0.098	0.025	0.197	41.660

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise	WF + 2km buffer	April	2016	3	0.075	0.000	0.175	31.705
Harbour porpoise	WF + 2km buffer	September	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 2km buffer	October	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 2km buffer	November	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 2km buffer	December	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 2km buffer	January	2017	3	0.074	0.000	0.174	31.530
Harbour porpoise	WF + 2km buffer	February	2017	5	0.114	0.023	0.229	48.410
Harbour porpoise	WF + 2km buffer	March	2017	3	0.072	0.000	0.167	30.327
Harbour porpoise	WF + 2km buffer	April	2017	6	0.140	0.047	0.257	59.380
Harbour porpoise	WF + 2km buffer	May	2017	0	0.000	0.000	0.000	0.000

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise	WF + 2km buffer	June	2017	3	0.076	0.000	0.177	32.165
Harbour porpoise	WF + 2km buffer	July	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 2km buffer	August	2017	2	0.042	0.000	0.104	17.597
Harbour porpoise	WF + 2km buffer	September	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 2km buffer	October	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 2km buffer	May	2018	8	0.192	0.072	0.336	81.401
Harbour porpoise	WF + 4km buffer	November	2015	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 4km buffer	December	2015	1	0.015	0.000	0.045	9.342
Harbour porpoise	WF + 4km buffer	January	2016	10	0.079	0.039	0.127	48.835
Harbour porpoise	WF + 4km buffer	February	2016	11	0.169	0.077	0.261	104.171

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise	WF + 4km buffer	March	2016	6	0.101	0.034	0.184	62.058
Harbour porpoise	WF + 4km buffer	April	2016	5	0.086	0.017	0.172	53.076
Harbour porpoise	WF + 4km buffer	September	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 4km buffer	October	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 4km buffer	November	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 4km buffer	December	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 4km buffer	January	2017	4	0.062	0.016	0.125	38.498
Harbour porpoise	WF + 4km buffer	February	2017	5	0.072	0.014	0.143	44.130
Harbour porpoise	WF + 4km buffer	March	2017	3	0.045	0.000	0.105	27.756
Harbour porpoise	WF + 4km buffer	April	2017	6	0.088	0.029	0.162	54.514

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise	WF + 4km buffer	May	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 4km buffer	June	2017	3	0.047	0.000	0.111	29.226
Harbour porpoise	WF + 4km buffer	July	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 4km buffer	August	2017	2	0.026	0.000	0.065	16.111
Harbour porpoise	WF + 4km buffer	September	2017	1	0.012	0.000	0.036	7.495
Harbour porpoise	WF + 4km buffer	October	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise	WF + 4km buffer	May	2018	12	0.183	0.091	0.290	112.684
Harbour porpoise and unidentified porpoise or dolphin								
Harbour porpoise and unidentified small cetaceans	WF only	November	2015	7	0.224	0.064	0.415	57.132
Harbour porpoise and unidentified small cetaceans	WF only	December	2015	1	0.036	0.000	0.109	9.314
Harbour porpoise and unidentified small cetaceans	WF only	January	2016	20	0.394	0.197	0.630	100.630

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise and unidentified small cetaceans	WF only	February	2016	14	0.506	0.181	0.904	129.298
Harbour porpoise and unidentified small cetaceans	WF only	March	2016	15	0.606	0.242	1.050	154.730
Harbour porpoise and unidentified small cetaceans	WF only	April	2016	9	0.371	0.083	0.743	94.861
Harbour porpoise and unidentified small cetaceans	WF only	September	2016	3	0.108	0.000	0.252	27.568
Harbour porpoise and unidentified small cetaceans	WF only	October	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified small cetaceans	WF only	November	2016	1	0.031	0.000	0.093	7.942
Harbour porpoise and unidentified small cetaceans	WF only	December	2016	2	0.070	0.000	0.175	17.902
Harbour porpoise and unidentified small cetaceans	WF only	January	2017	21	0.796	0.379	1.288	203.203
Harbour porpoise and unidentified small cetaceans	WF only	February	2017	6	0.208	0.035	0.451	53.137
Harbour porpoise and unidentified small cetaceans	WF only	March	2017	27	0.975	0.578	1.445	248.897

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise and unidentified small cetaceans	WF only	April	2017	6	0.214	0.036	0.464	54.684
Harbour porpoise and unidentified small cetaceans	WF only	May	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified small cetaceans	WF only	June	2017	6	0.230	0.038	0.500	58.797
Harbour porpoise and unidentified small cetaceans	WF only	July	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified porpoise or dolphin	WF only	August	2017	3	0.095	0.000	0.252	24.133
Harbour porpoise and unidentified small cetaceans	WF only	September	2017	1	0.029	0.000	0.087	7.403
Harbour porpoise and unidentified small cetaceans	WF only	October	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified small cetaceans	WF only	May	2018	11	0.405	0.110	0.773	103.359
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	November	2015	9	0.174	0.077	0.290	73.591
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	December	2015	2	0.044	0.000	0.132	18.681

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	January	2016	33	0.385	0.222	0.572	163.112
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	February	2016	22	0.487	0.243	0.796	206.074
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	March	2016	18	0.443	0.197	0.738	187.468
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	April	2016	13	0.324	0.100	0.599	137.386
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	September	2016	3	0.071	0.000	0.166	30.102
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	October	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	November	2016	1	0.021	0.000	0.062	8.732
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	December	2016	4	0.093	0.023	0.208	39.236
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	January	2017	39	0.968	0.620	1.365	409.895
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	February	2017	16	0.366	0.137	0.617	154.913

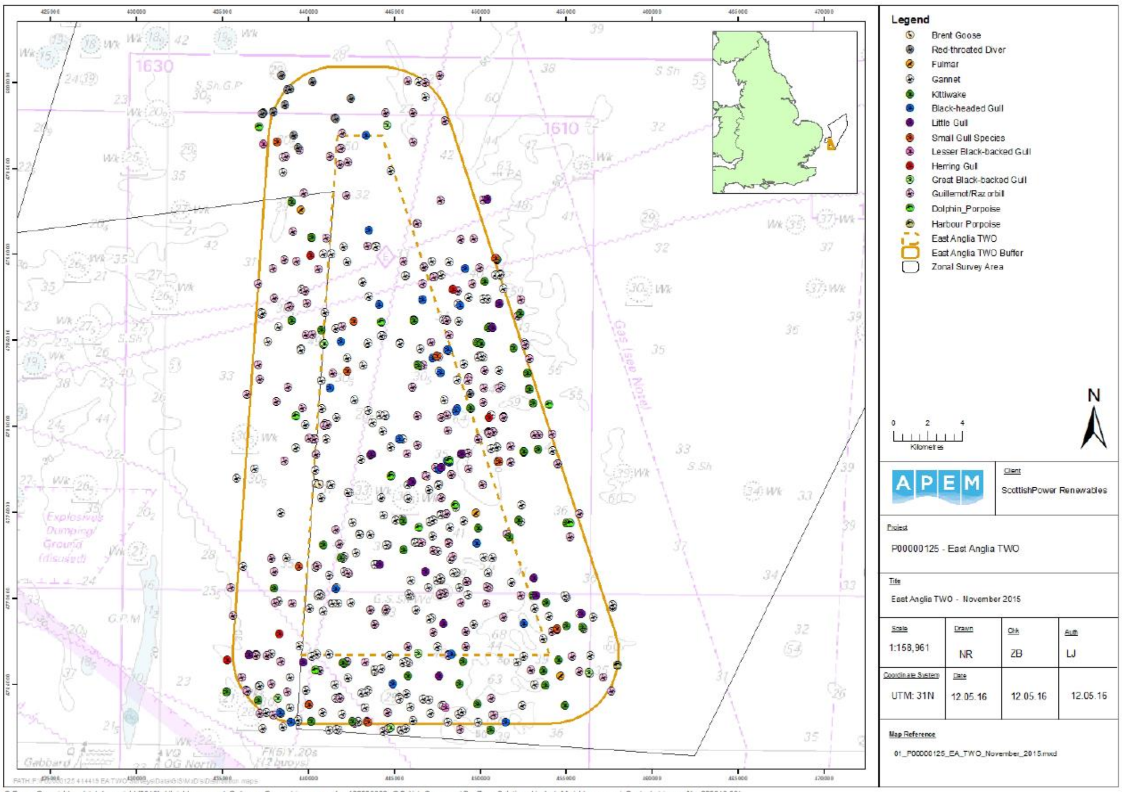
Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	March	2017	30	0.716	0.406	1.050	303.266
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	April	2017	10	0.234	0.070	0.444	98.967
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	May	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	June	2017	7	0.177	0.025	0.380	75.051
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	July	2017	1	0.024	0.000	0.071	10.075
Harbour porpoise and unidentified porpoise or dolphin	WF + 2km buffer	August	2017	4	0.083	0.000	0.208	35.194
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	September	2017	1	0.019	0.000	0.058	8.160
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	October	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified small cetaceans	WF + 2km buffer	May	2018	20	0.481	0.216	0.793	203.502
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	November	2015	10	0.133	0.053	0.226	81.994

Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	December	2015	4	0.061	0.000	0.151	37.368
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	January	2016	44	0.348	0.221	0.491	214.876
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	February	2016	28	0.430	0.215	0.645	265.163
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	March	2016	24	0.402	0.201	0.637	248.231
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	April	2016	21	0.361	0.155	0.568	222.918
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	September	2016	3	0.045	0.000	0.104	27.577
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	October	2016	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	November	2016	2	0.026	0.000	0.065	16.064
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	December	2016	5	0.072	0.014	0.144	44.397
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	January	2017	78	1.217	0.936	1.560	750.705

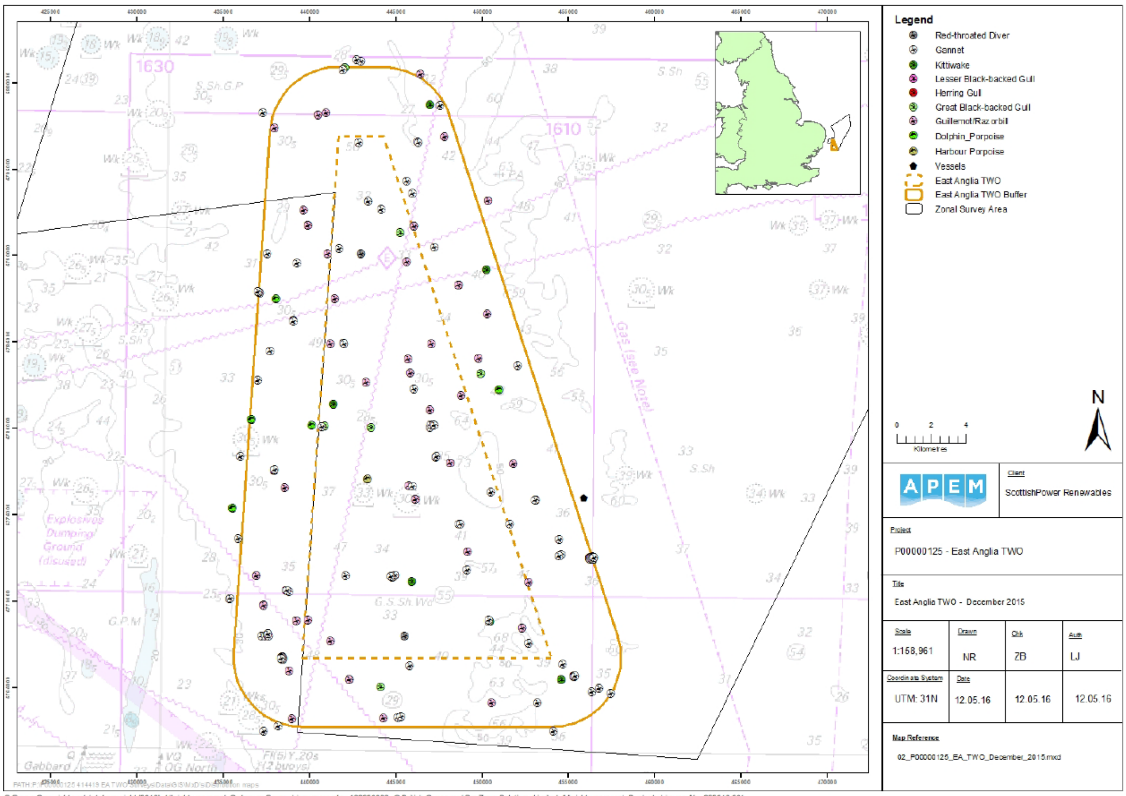
Species	Area	Month	Year	Count	Density	Lower 97.5%	Upper 97.5%	Abundance
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	February	2017	21	0.300	0.129	0.487	185.344
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	March	2017	43	0.645	0.420	0.900	397.836
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	April	2017	14	0.206	0.074	0.368	127.199
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	May	2017	0	0.000	0.000	0.000	0.000
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	June	2017	16	0.253	0.095	0.442	155.872
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	July	2017	3	0.045	0.000	0.104	27.541
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	August	2017	5	0.065	0.000	0.157	40.277
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	September	2017	4	0.049	0.000	0.121	29.978
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	October	2017	1	0.014	0.000	0.043	8.758
Harbour porpoise and unidentified small cetaceans	WF + 4km buffer	May	2018	26	0.396	0.198	0.624	244.148

11.5 Annex 2: Marine Mammal Sightings Locations

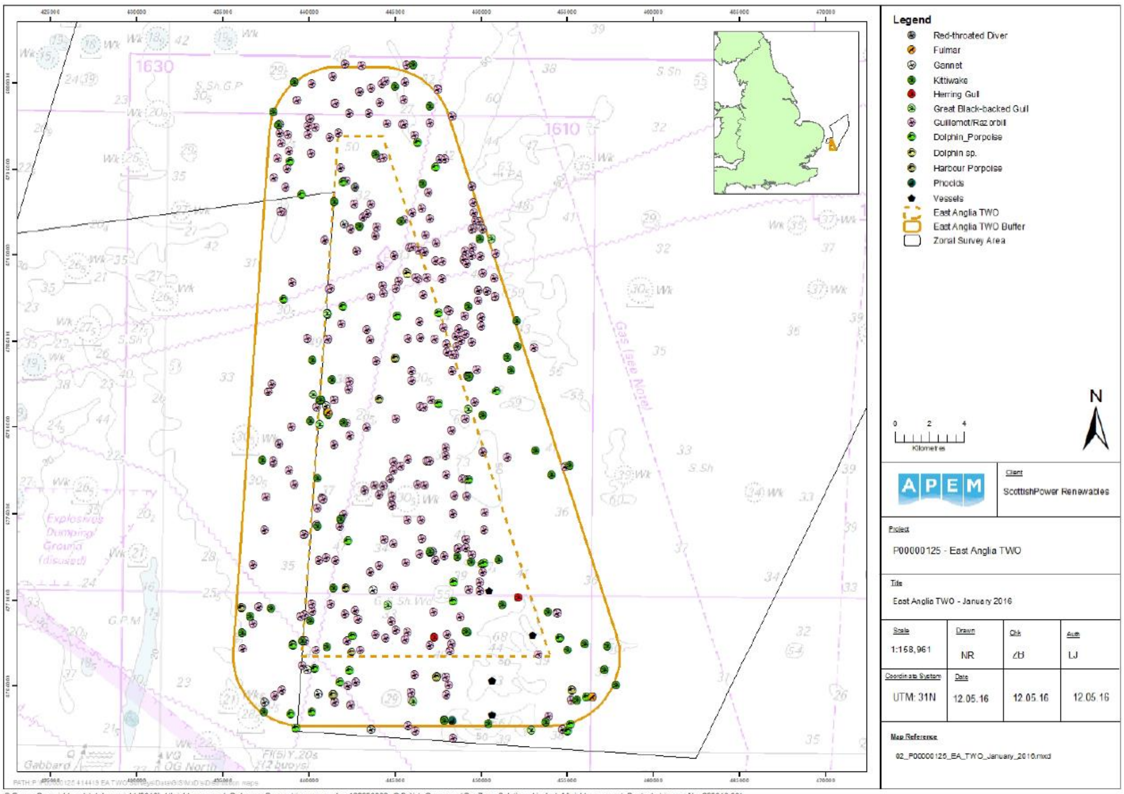
11.5.1 November 2015



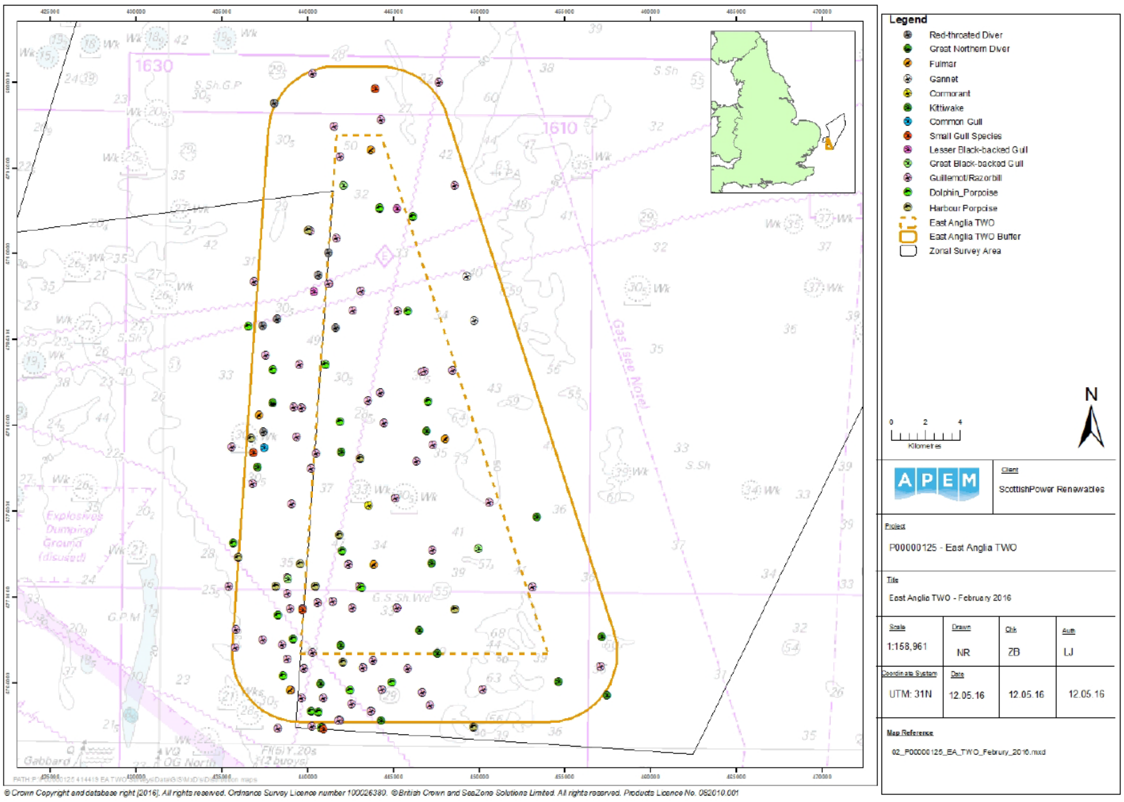
11.5.2 December 2015



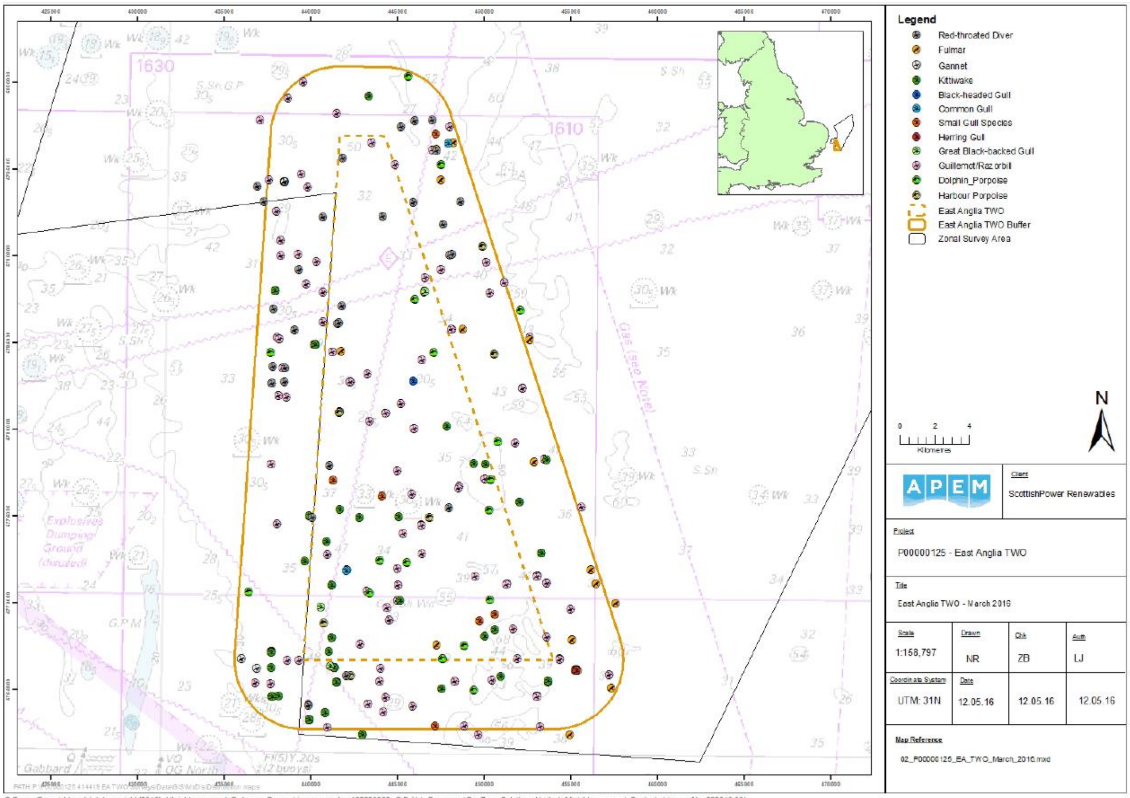
11.5.3 January 2016



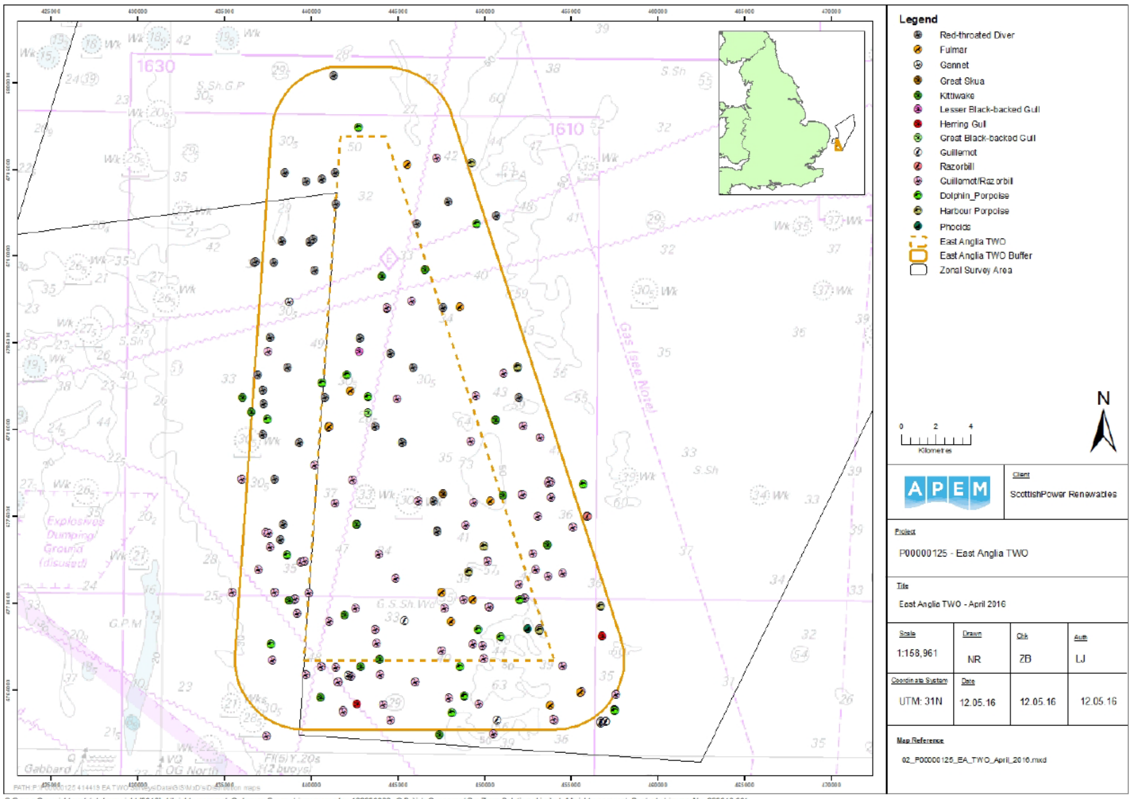
11.5.4 February 2016



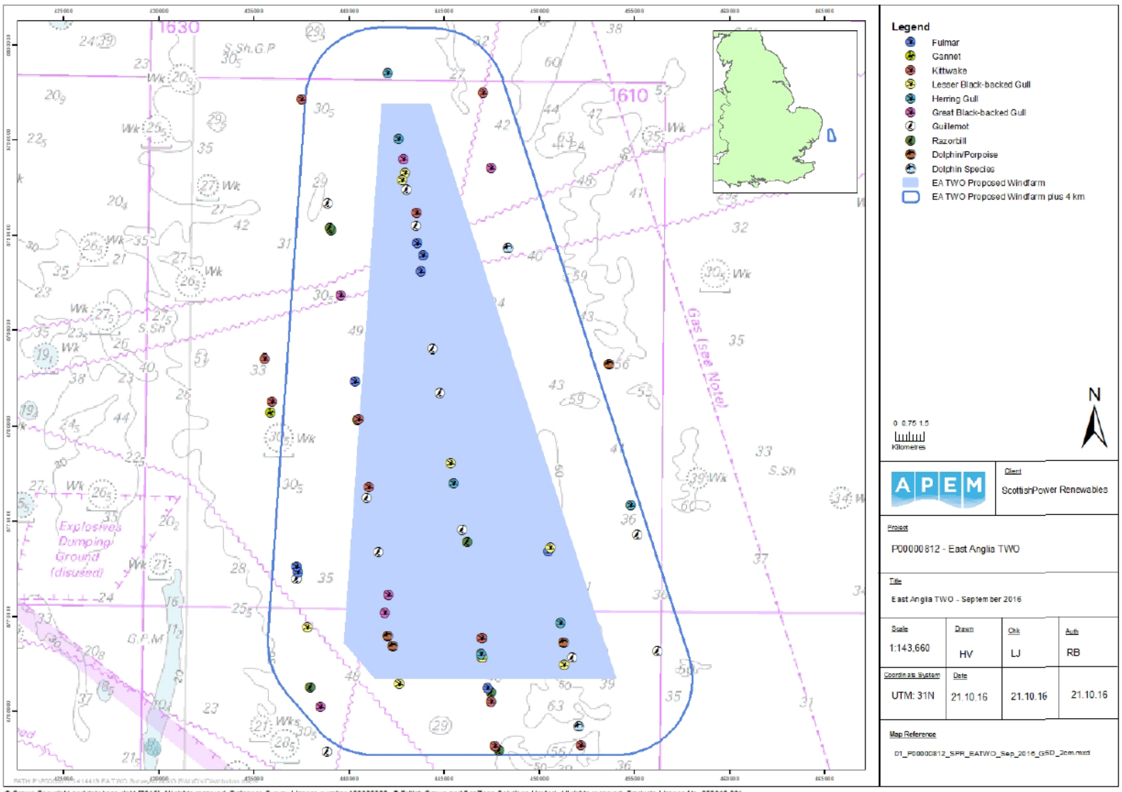
11.5.5 March 2016



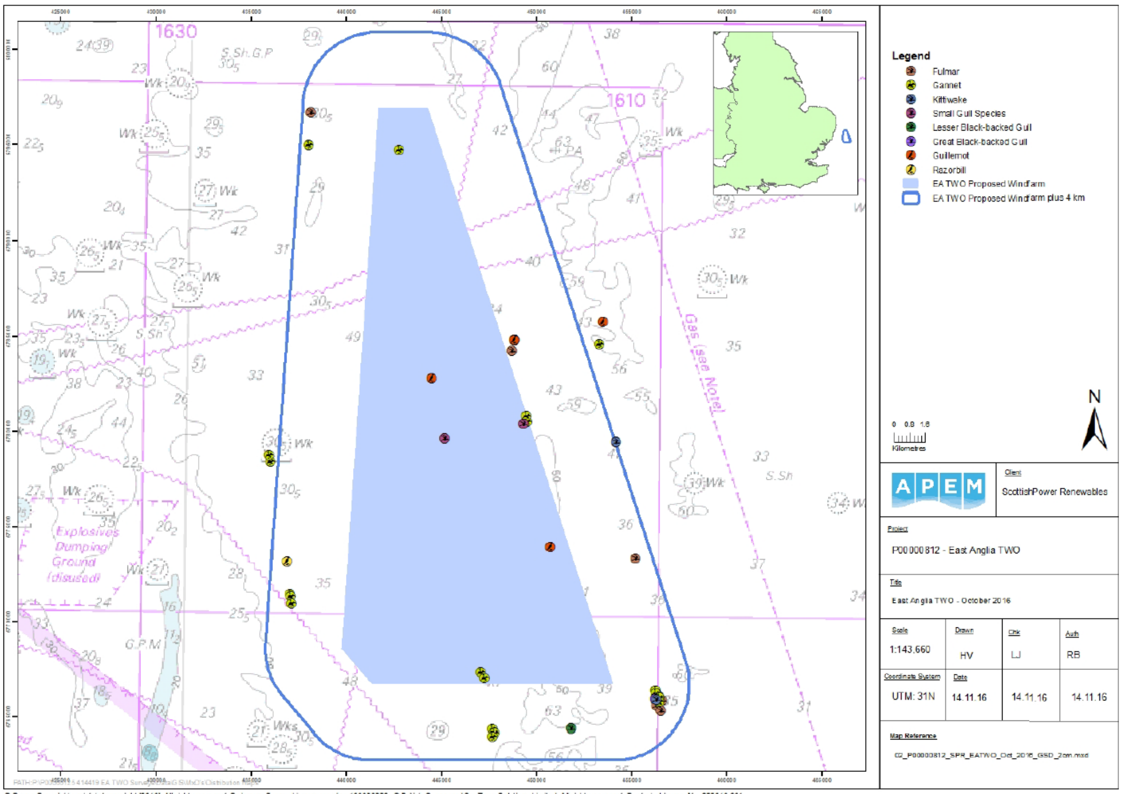
11.5.6 April 2016



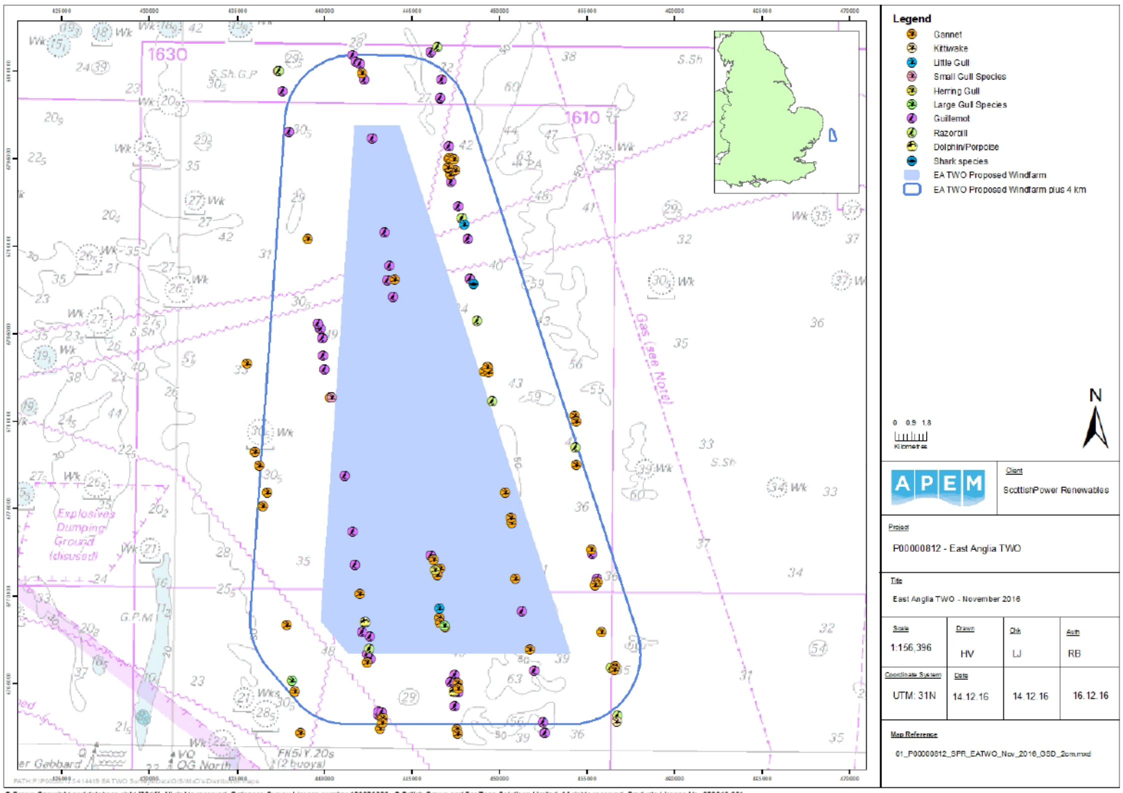
11.5.7 September 2016



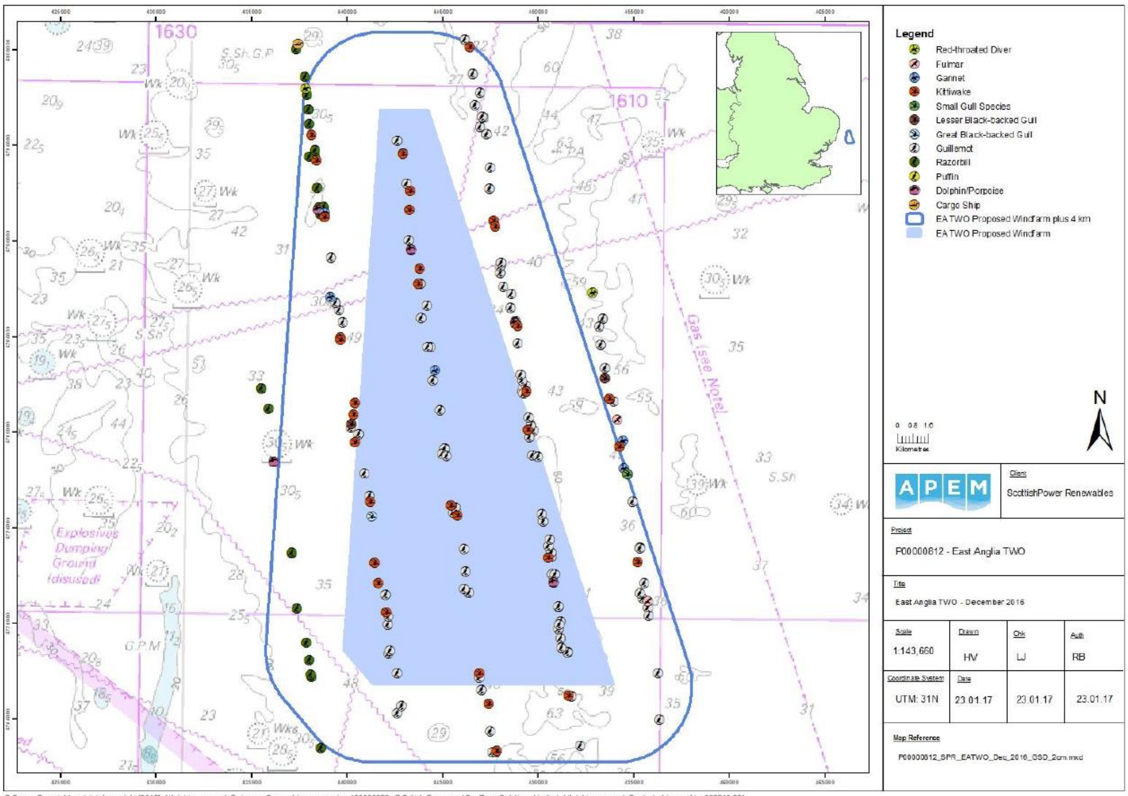
11.5.8 October 2016



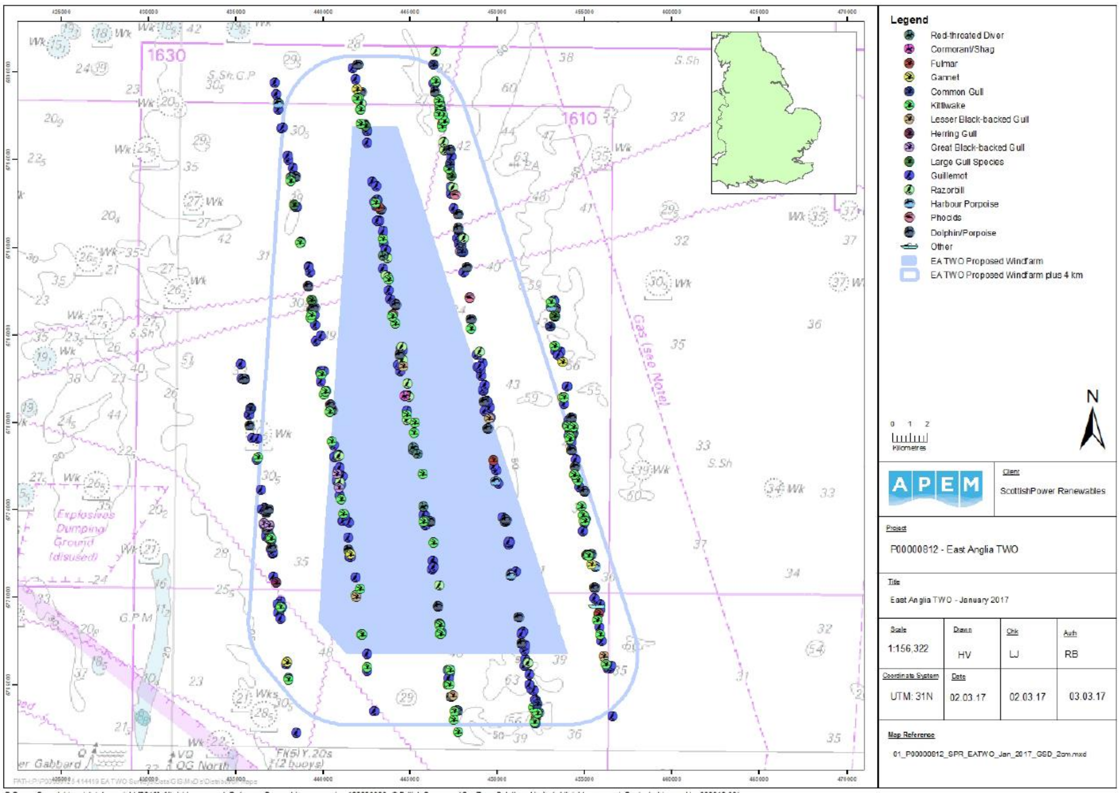
11.5.9 November 2016



11.5.10 December 2016



11.5.11 January 2017



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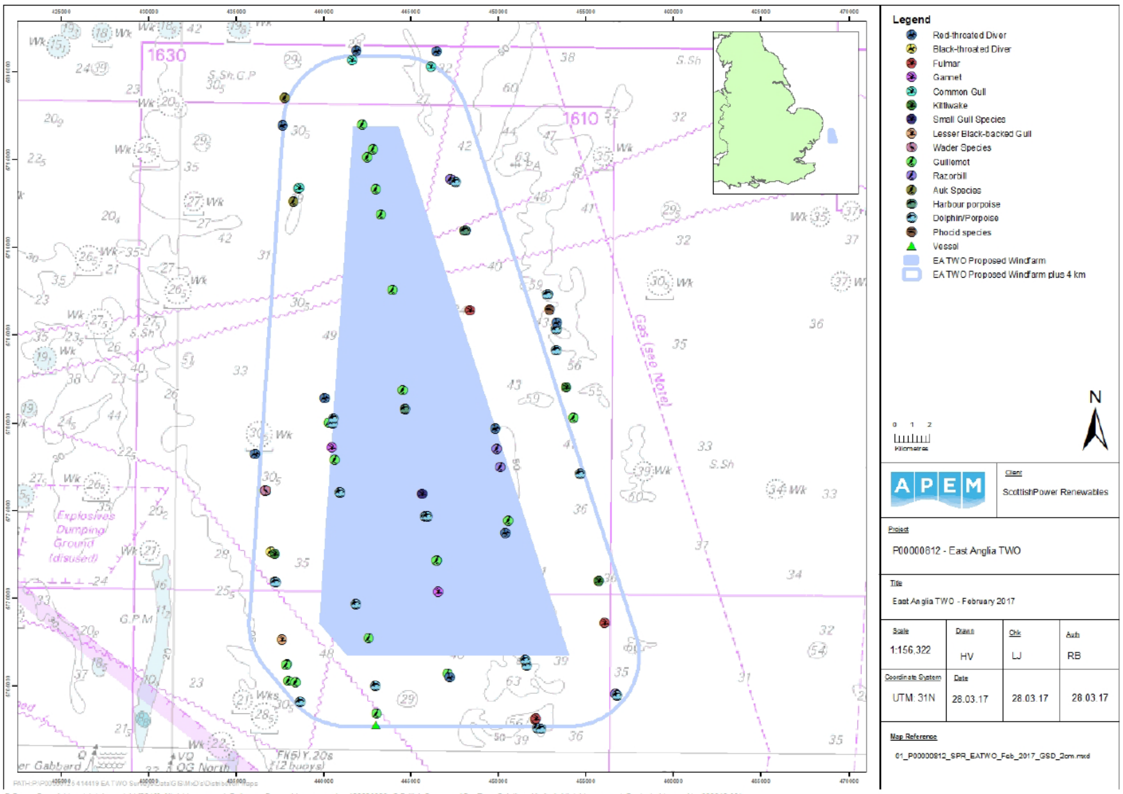

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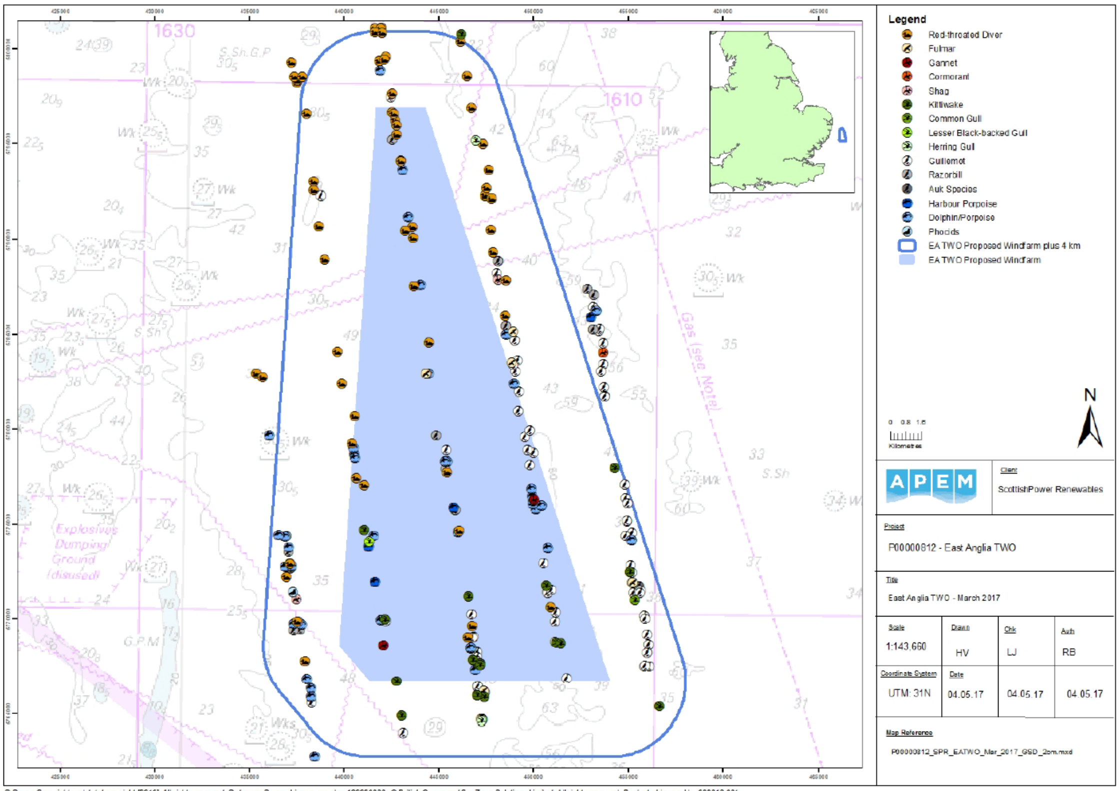

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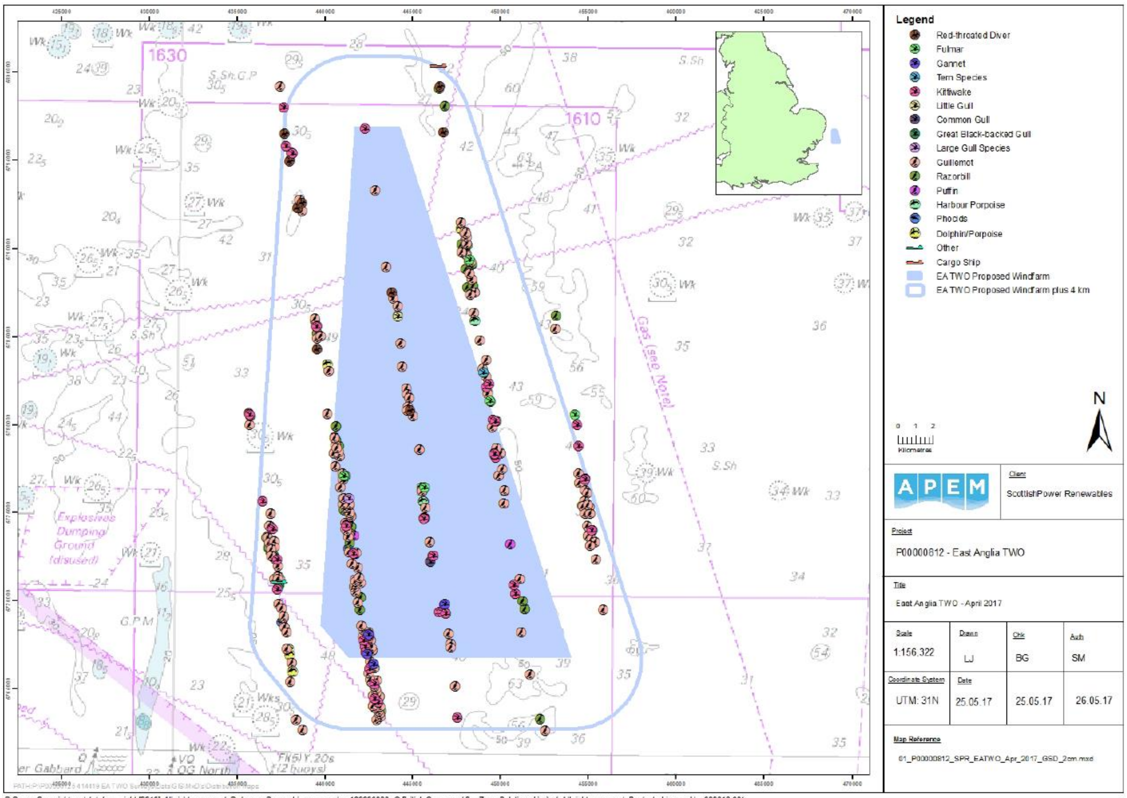
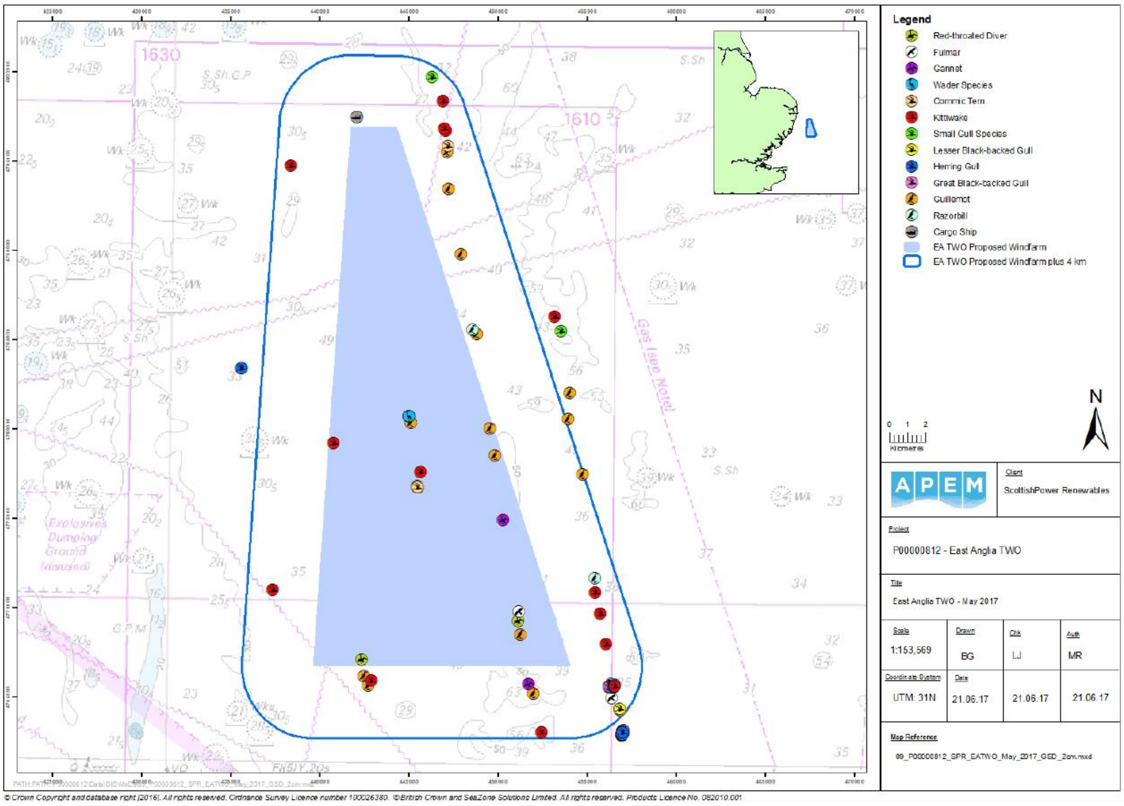
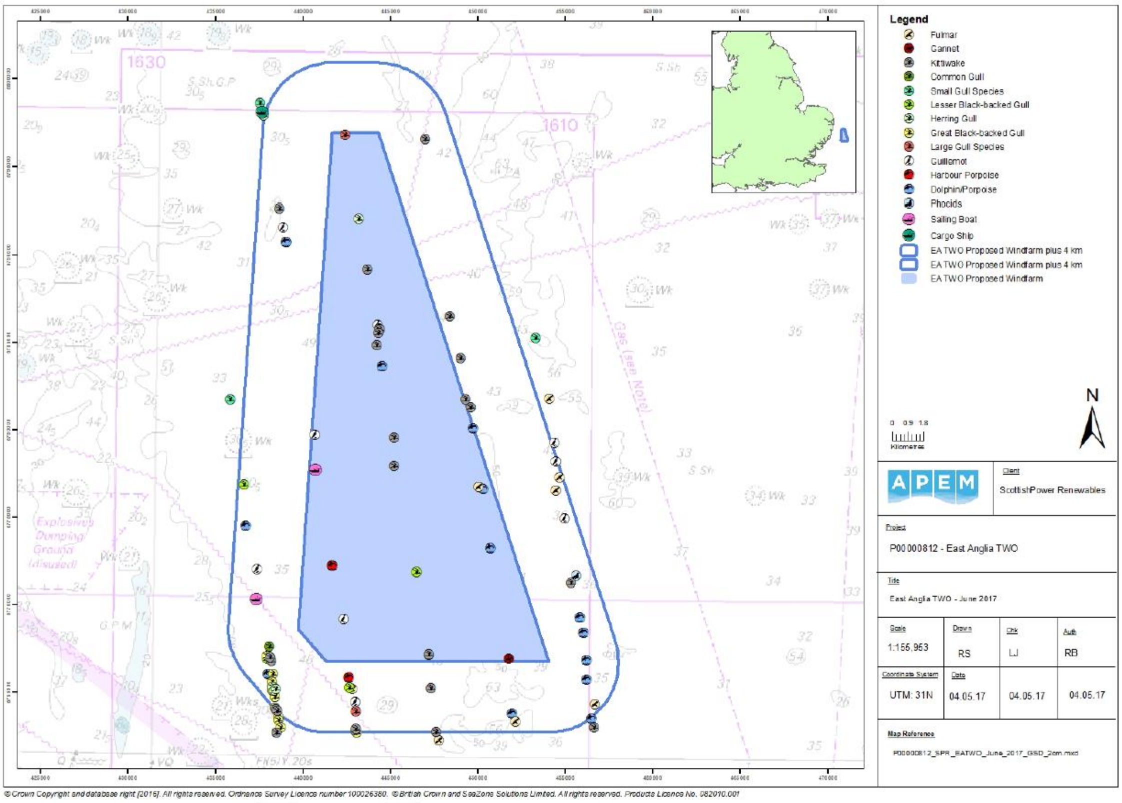


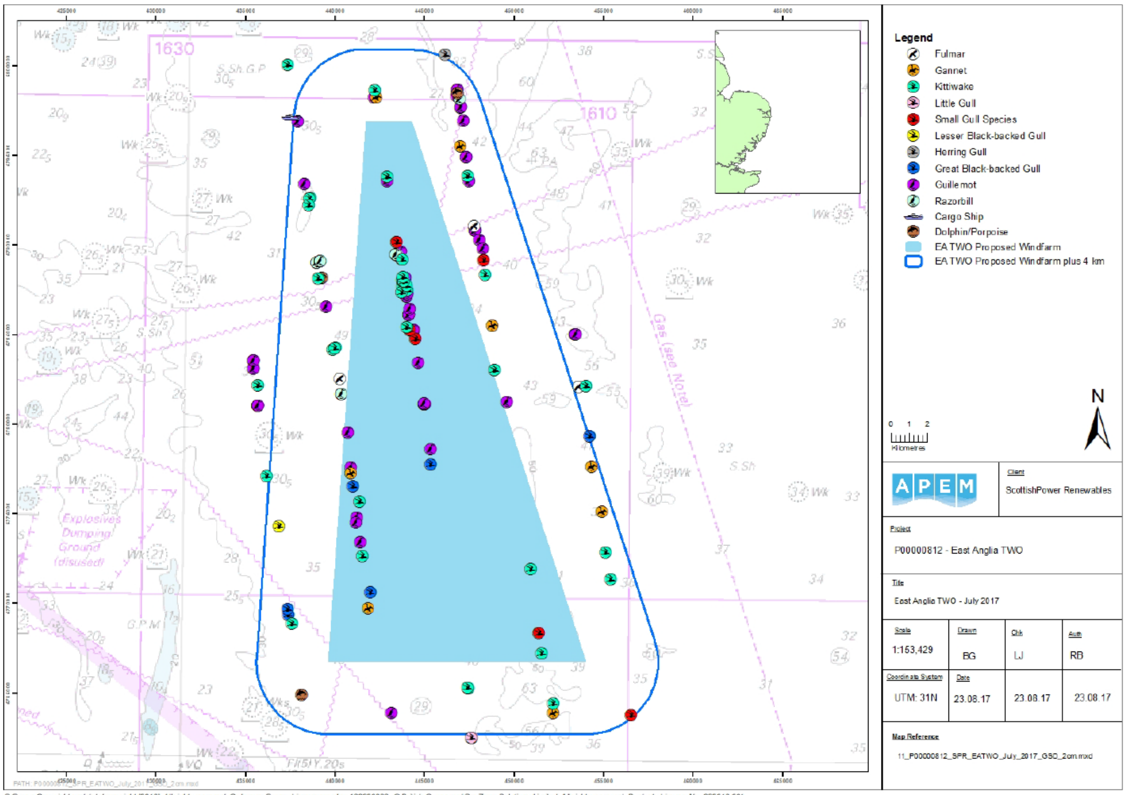
11.5.15 May 2017



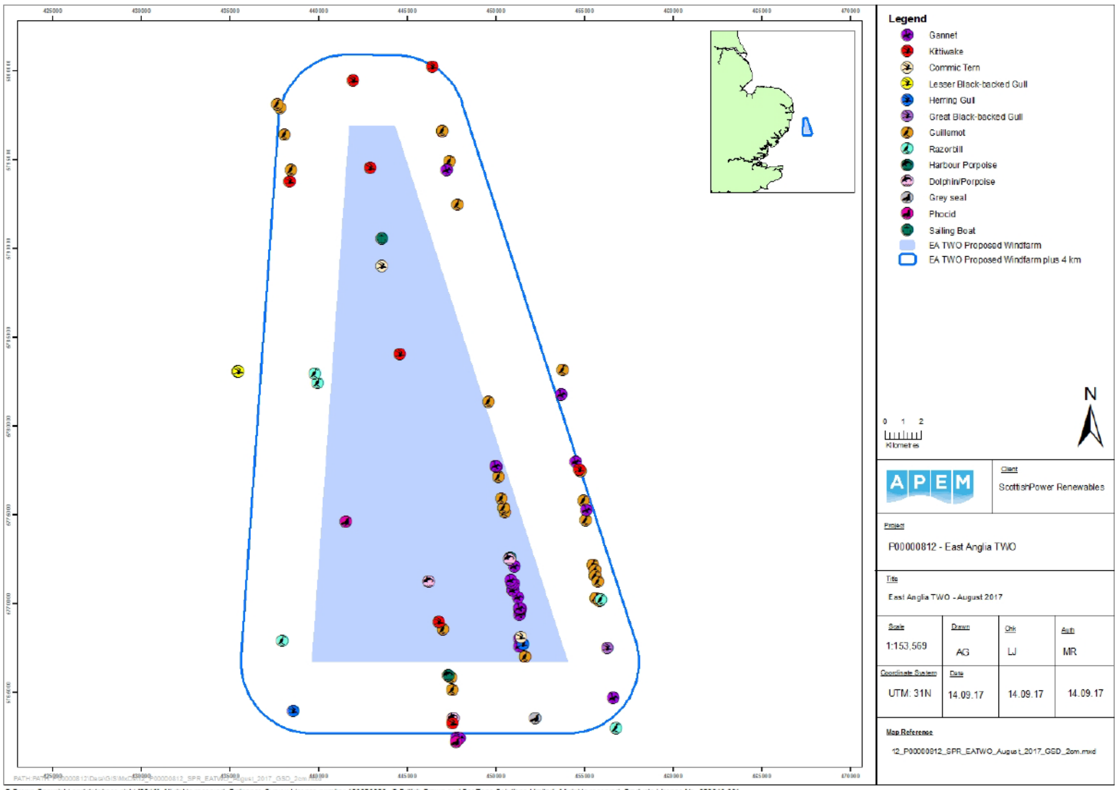
11.5.16 June 2017



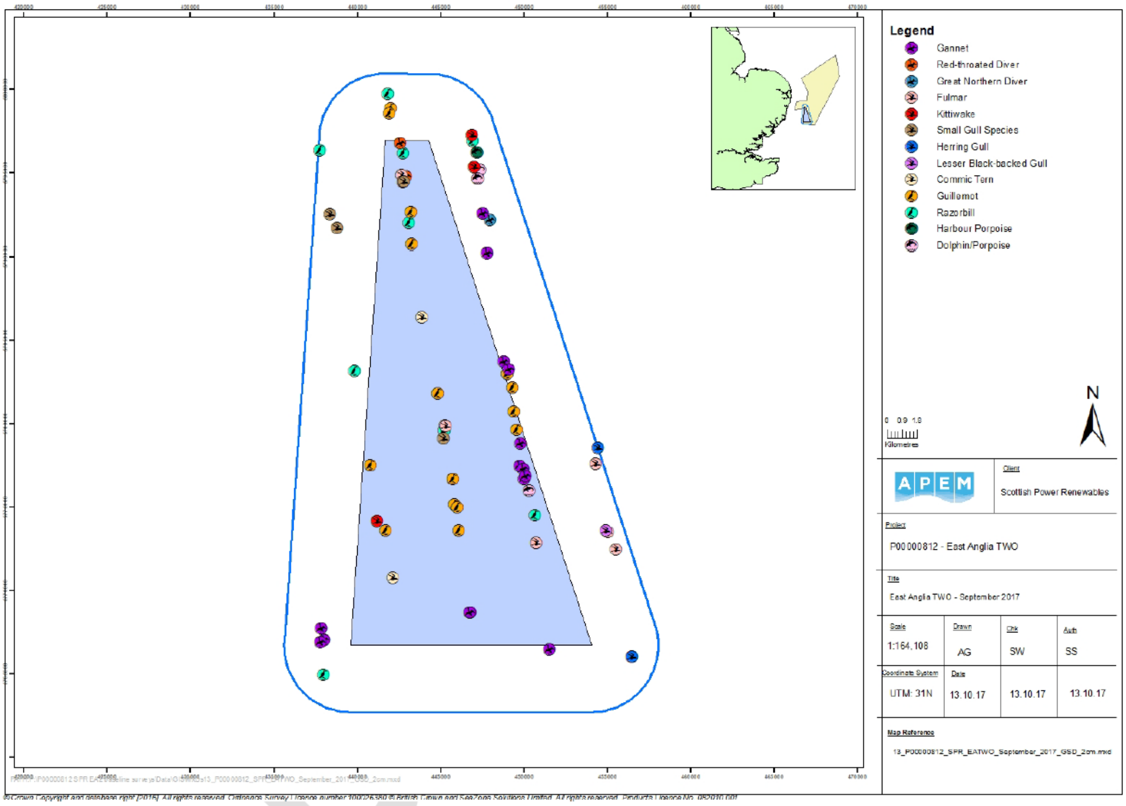
11.5.17 July 2017



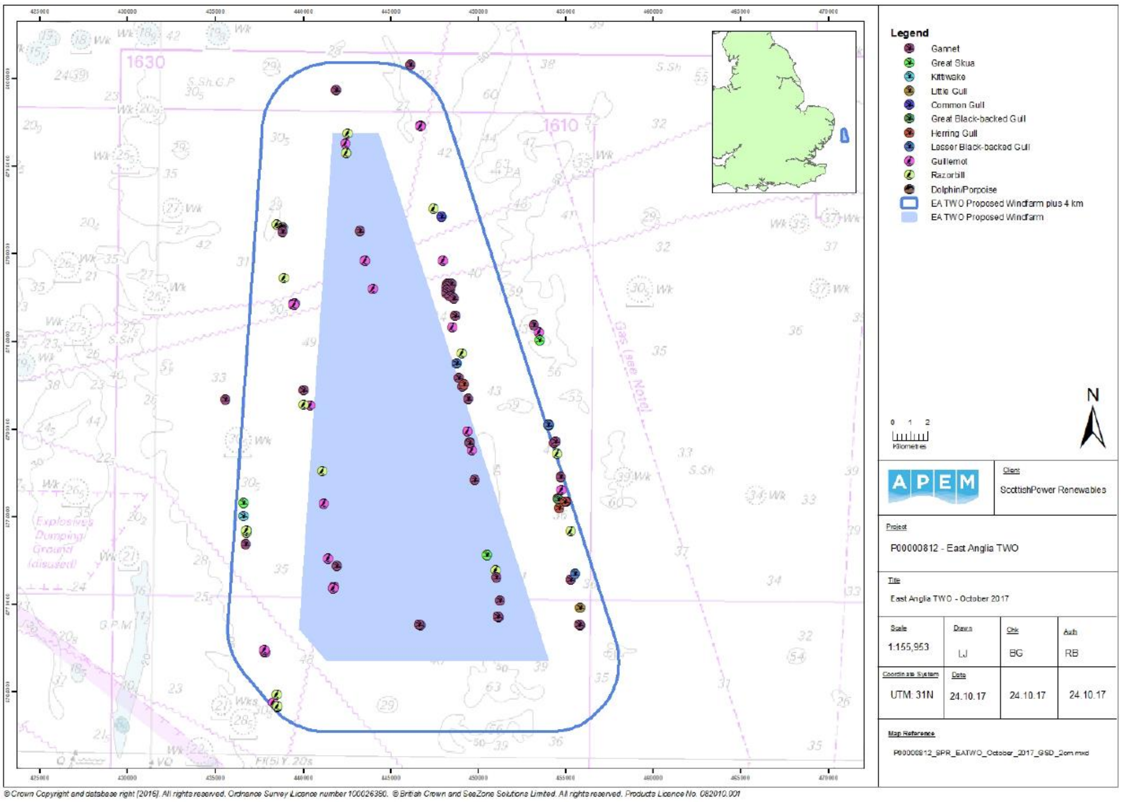
11.5.18 August 2017



11.5.19 September 2017



11.5.20 October 2017



11.5.21 May 2018