Royal HaskoningDHV
Enhancing Society Together

VATTENFALL

Norfolk Boreas Offshore Wind Farm

Appendix 15.1

Navigational Risk Assessment

Environmental Statement

Volume 3

Applicant: Norfolk Boreas Limited
Document Reference: 6.3.15.1
Pursuant to APFP Regulation: 5(2)(a)

Date: June 2019
Revision: Version 1
Author: Anatec Limited

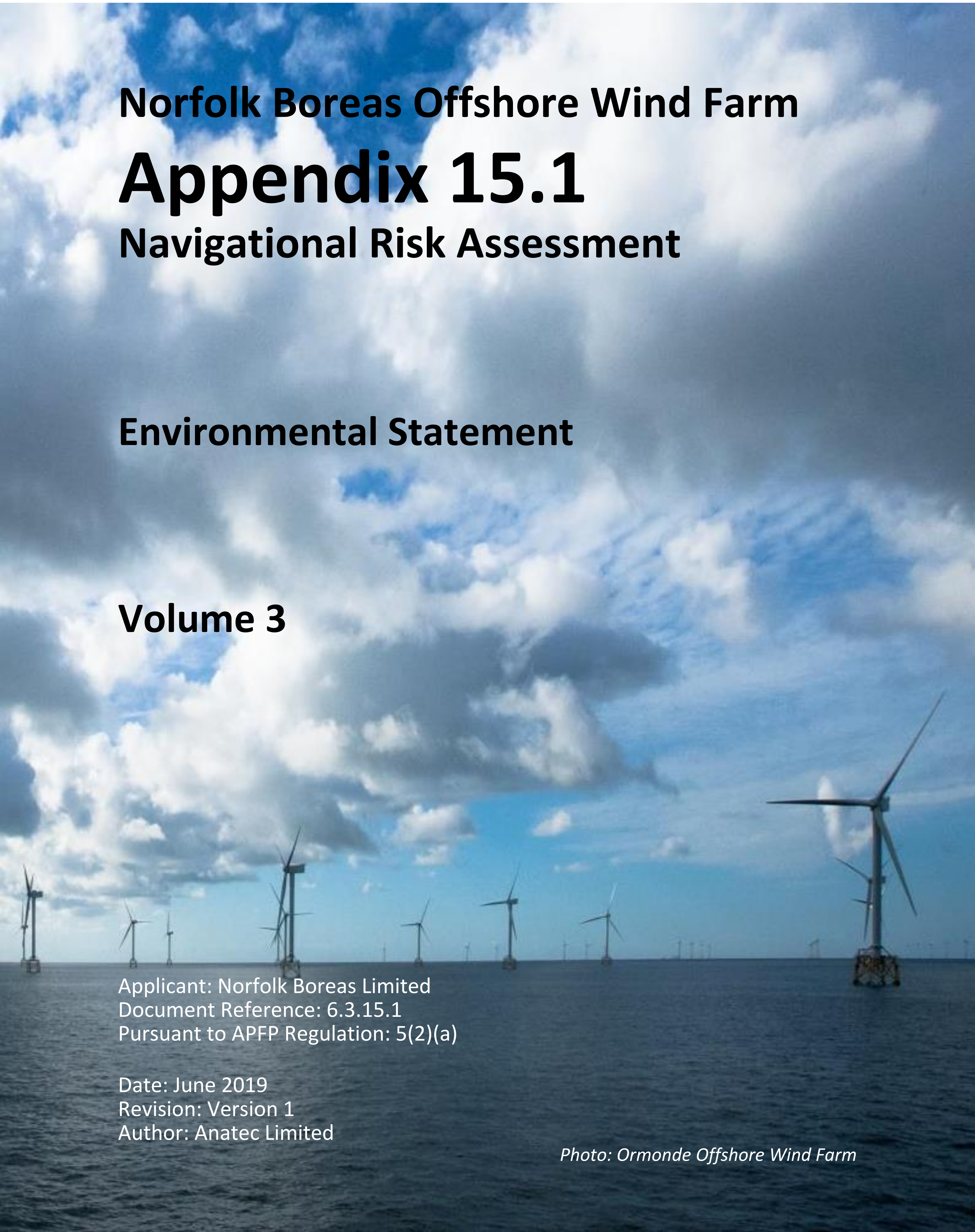


Photo: Ormonde Offshore Wind Farm

This page is intentionally blank.

Appendix 15.1

Norfolk Boreas

Navigation Risk Assessment

Prepared by	Anatec Limited
Presented to	Norfolk Boreas Limited
Date	15 April 2019
Revision Number	05
Document Reference	A4053-NBL-NRA-2

	Aberdeen Office	Cambridge Office
Address	10 Exchange Street, Aberdeen, AB11 6PH, UK	Braemoor, No. 4 The Warren, Witchford Ely, Cambs, CB6 2HN, UK
Tel	01224 253700	01353 661200
Fax	0709 2367306	0709 2367306
Email	aberdeen@anatec.com	cambs@anatec.com

Revision Number	Date	Summary of Change
00	31 July 2018	Initial Draft
01	31 August 2018	Draft for PEIR
02	17 September 2018	Anatec revisions for PEIR
03	20 February 2019	Anatec revisions for ES
04	06 March 2019	Further ES revisions
05	15 April 2019	Final ES Version

Table of Contents

Table of Figures

Table of Tables

Abbreviations Table

Abbreviation	Definition
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
ALB	All Weather Lifeboat
AtoN	Aid to Navigation
AWAC	Acoustic Waves and Currents
BEIS	Department of Business, Energy and Industrial Strategy
BMAPA	British Marine Aggregate Producers Association
BWEA	British Wind Energy Association
CA	Cruising Association
CAA	Civil Aviation Authority
CGOC	Coastguard Operations Centre
CIA	Cumulative Impact Assessment
COLREGS	International Regulations for Preventing Collisions at Sea
CoS	Chamber of Shipping
CRT	Coastguard Rescue Team
dB	Decibel
DC	Direct Current
DCO	Development Consent Order
DfT	Department for Transport
DML	Deemed Marine License
DSC	Digital Selective Calling
DWR	Deep Water Route
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
ERCoP	Emergency Response Cooperation Plan
ES	Environmental Statement
EU	European Union
FSA	Formal Safety Assessment
ft	Foot

Abbreviation	Definition
GPS	Global Positioning System
HAT	Highest Astronomical Tide
HDD	Horizontal Direction Drilling
HLB	Hover Lifeboat
HSE	Health and Safety Executive
HVDC	High Voltage Direct Current
IALA	International Association of Lighthouse Authorities
IHO	International Hydrographic Organisation
ILB	Inshore Lifeboat
IMO	International Maritime Organization
IPS	Intermediate Peripheral Structure
IRC	International Racing Certificate
ISO	International Organization for Standardization
ITAP	Institut für technische und angewandte Physik
kHz	Kilohertz
km	Kilometres
LCD	Liquid-Crystal Display
m	Metre
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MEHRA	Marine Environmental High Risk Area
Met Mast	Meteorological Mast
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
MOD	Ministry of Defence
MSC	Maritime Safety Council
MSI	Maritime Safety Information
MW	Megawatt
NAVTEX	Navigational Telex

Abbreviation	Definition
nm	Nautical Mile
NOREL	Nautical Offshore Renewable Energy Liaison
NRA	Navigation Risk Assessment
NUC	Not Under Command
OREI	Offshore Renewable Energy Installation
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Impact Assessment
PEXA	Practise and Exercise Area
PLA	Port of London Authority
PLL	Potential Loss of Life
RAF	Royal Air Force
REZ	Renewable Energy Zone
RNLI	Royal National Lifeboat Institution
RoRo	Roll on Roll Off
RYA	Royal Yachting Association
SAR	Search and Rescue
SMS	Safety Management System
SNSOWF	Southern North Sea Offshore Wind Forum
SOLAS	Safety of Life At Sea
SPS	Significant Peripheral Structure
TH	Trinity House
TSS	Traffic Separation Scheme
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency
VTS	Vessel Traffic Service

1 Introduction

1.1 Background

1. Anatec Limited (hereafter referred to as Anatec) were commissioned by Vattenfall Wind Power Limited to undertake a Navigation Risk Assessment (NRA) for the proposed Norfolk Boreas Offshore Wind Farm (hereafter referred to as Norfolk Boreas, or the 'project'). The NRA presents information on the proposed project relative to the existing and predicted future case shipping and navigation activity, and forms the key technical appendix to Chapter 15 Shipping and Navigation of the Environmental Statement (ES).

2. This version of the NRA has been drafted in support of the ES and has been informed by stakeholder feedback received under the Section 42 consultation process following publication of the Preliminary Environmental Information Report (PEIR) in November 2018.

1.2 Navigation Risk Assessment

3. An Environmental Impact Assessment (EIA) is a process through which environmental effects of a project, both positive and negative, are identified, in accordance with European Union (EU) Directives. Impacts on shipping and navigation are primarily informed by an NRA which follows the required Maritime and Coastguard Agency (MCA) methodology (MCA, 2015), and Marine Guidance Note (MGN) 543 (MCA, 2016). Further details of this guidance are provided in section 2.1.

4. In line with the MCA guidance, this NRA includes:

- Overview of base case environment;
- Marine traffic surveys;
- Implications of wind farms including position of wind turbines;
- Assessment of navigational risk pre and post development of Norfolk Boreas;
- Formal Safety Assessment (FSA);
- Implications on marine navigation and communication equipment;
- Identification of mitigation measures;
- Emergency response; and
- Through life safety management.

5. To demonstrate compliance with the MCA methodology, a completed MGN 543 checklist is provided in Appendix 15.2 MGN 543 Checklist.

6. The NRA has been reviewed by each phase of the project, namely:

- Construction;
- Operation and maintenance; and
- Decommissioning.

2 Regulations and Guidance

2.1 Primary Guidance

7. The primary guidance documents used to inform this NRA are as follows:

- MCA MGN 543 (Merchant and Fishing) Safety of Navigation Offshore Renewable Energy Installations (OREIs) – Guidance on United Kingdom (UK) Navigational Practice, Safety and Emergency Response (MCA, 2016);
- MCA Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms (2015); and
- Guidelines for FSA – Maritime Safety Council (MSC)/Circular 1023/MEPC/Circular 392 (International Maritime Organization (IMO), 2002).

8. MGN 543 highlights issues that shall be taken into consideration when assessing the effect on navigational safety from offshore renewable energy developments, proposed in UK internal waters, territorial sea or Renewable Energy Zones (REZ).

9. The MCA require that their methodology is used as a template for preparing NRAs. The methodology is centred on risk management and requires a submission that shows that sufficient controls are, or will be, in place for the assessed risk (base case and future case) to be judged as broadly acceptable or tolerable with mitigation. A checklist referencing the sections in this report which address all MCA requirements is presented in Appendix 15.2 MGN 543 Checklist.

2.2 Other Guidance

10. Other guidance documents considered as part of the NRA process on a secondary basis include the following:

- MCA MGN 372 (Merchant and Fishing) Guidance to Mariners Operating in the Vicinity of UK OREIs (MCA, 2008);
- International Association of Marine Aids to Navigation (AtoN) and Lighthouse Authorities (IALA) Recommendation O-139 on The Marking of Man-Made Offshore Structures, Edition Two (IALA, 2013);
- Royal Yachting Association (RYA) – The RYA's Position on Offshore Renewable Energy Developments Paper One – Wind Energy (RYA, 2015); and
- Department for Business, Energy and Industrial Strategy (BEIS) Standard Marking Schedule for Offshore Installations (BEIS, 2011).

3 Navigation Risk Assessment Methodology

3.1 Norfolk Boreas In-Isolation Assessment Methodology

11. The NRA is the technical document which informs the FSA process for Norfolk Boreas in Chapter 15 Shipping and Navigation of the ES. The NRA uses a baseline assessment (established using the data sources listed in section 6) to identify potential impacts relevant to shipping and navigation receptors that may arise as a result of the proposed project. Impacts are then reviewed and screened in to be carried forward to the ES based on the following additional aspects of the NRA:

- Scoping Opinion;
- Baseline data and assessment;
- Expert opinion;
- Level of stakeholder concern;
- Number of transits of specific vessel and / or vessel type;
- Effect of any vessel deviation;
- Outputs of modelling where undertaken; and
- Lessons learned from existing offshore projects including work undertaken as part of the former East Anglia Zone.

12. The impacts evaluated within the NRA include required effects as detailed within MGN 543 (listed in Appendix B – MGN Checklist) and as required by the MCA.

13. Where an impact has been identified the overall severity of consequence to the receptor and the frequency of occurrence has been determined in the ES. As this process incorporates a degree of subjectivity, the assessment within the ES uses the various sources provided within the NRA (see list above) to inform the rankings assigned to each impact.

14. The definitions used within the assessment for identification of the severity of consequence and the frequency of occurrence are presented in Table 15.4 and Table 15.5 of Chapter 15 Shipping and Navigation.

15. The severity of consequence has been assessed against the frequency of occurrence to provide the level of tolerability of the impact. The tolerability matrix is shown in Table 15.6 of Chapter 15 Shipping and Navigation. The tolerability of the impact is then defined as per Table 3.1; if the risk of the impact is considered Unacceptable then further mitigation or design change would be required to reduce the risk to Tolerable or Broadly Acceptable. The impact is then considered to be As Low As Reasonably Practicable (ALARP) within no worse than Tolerable parameters. However, unacceptable levels of tolerability will require further mitigation to reduce them to ALARP.

Table 3.1 Tolerability Rankings

	Broadly Acceptable	Risk ALARP with no additional mitigations or monitoring required above embedded mitigations. Not significant under EIA.
	Tolerable	Risk acceptable but may require additional mitigation measures and monitoring in place to control and reduce to ALARP. Not significant under EIA.
	Unacceptable	Significant risk with mitigation or design modification required to reduce to ALARP.

16. Impacts considered Broadly Acceptable or Tolerable are not significant in EIA terms, whereas Unacceptable impacts are significant.

17. Further detail of the methodology is contained within section 15.4 of Chapter 15 Shipping and Navigation. The "in-isolation" FSA assessment of potential impacts is contained within section 15.7 of the Chapter.

3.2 Cumulative Impacts Assessment Methodology

18. Cumulative impacts have been considered for shipping and navigation within this NRA; this includes impacts of other offshore developments, as well as activities associated with other marine operations. Fishing, recreation and marine aggregate dredging transits have been considered as part of the baseline assessment.

19. Cumulative impacts of the zonal development plans for the Round Three development zones within the southern North Sea were assessed under the Southern North Sea Offshore Wind Forum (SNSOWF) in 2013 (SNSOWF, 2013). It was recognised that due to the scale and location of these Round Three zones (Dogger Bank, the former Hornsea Zone and the former East Anglia Zone) co-ordination was required between zones in order for the respective developers to successfully undertake their respective Zone Appraisal and Planning process. This work has been updated (Anatec, 2018) using up to date marine traffic data, with the results used within this NRA to predict cumulative routeing patterns in the vicinity of the proposed project (see section 19.3).

20. Cumulative impacts are considered in Chapter 15 Shipping and Navigation.

3.3 Transboundary Impacts Assessment Methodology

21. Transboundary impacts of offshore wind developments with regards to vessel routeing and international ports have also been assessed. Fishing, recreation and marine aggregate dredging impacts, although they have the potential to be internationally owned or located, have been considered as part of the baseline assessment. Transboundary impacts are considered in Chapter 15 Shipping and Navigation.

3.4 Assumptions

22. The shipping and navigation baseline and impact assessment has been carried out based on the information available and responses received at the time of preparation. It is assumed that any notable changes will be re-assessed and re-modelled if and when required.

23. Data assumptions (and associated limitations) are discussed in section 15.5.3 of Chapter 15 Shipping and Navigation.

3.5 Study Areas

3.5.1 Offshore Wind Farm (OWF) Site Study Area

24. Assessment of the wind farm area has been primarily undertaken within a 10 nautical mile (nm) buffer of the Norfolk Boreas site (as shown in Figure 3.1). This is hereafter referred to as the “OWF site study area”. This area encompasses all relevant shipping routes within the vicinity of the proposed project that have been identified through marine traffic analysis (Automatic Identification System (AIS) and Radar data), including those associated with the IMO routeing measures. In some cases, data sets have been considered beyond the 10nm extent if considered appropriate; in particular, cumulative routeing has been assessed over a wider geographical area as vessel displacement can impact routeing beyond 10nm.

25. The OWF site study area is shown in Figure 3.1.

3.5.2 Offshore Cable Corridor Study Area

26. In addition to the array areas, marine traffic data (AIS data only) and navigational features (where appropriate) have also been considered within a 5nm buffer of the offshore cable corridor (hereby referred to as the “offshore cable corridor study area”). The offshore cable corridor study area was initially defined to include the most up to date iteration of the project interconnector search area available at the time. However, since the analysis was first undertaken at the PEIR stage, the project interconnector search area has been altered to include a portion of the gap between the project interconnector search area and the Norfolk Boreas site. This new section is therefore not included within the offshore cable corridor study area; however the limited spatial extent of the change means there is negligible impact on the assessment undertaken at the PEIR stage. Regardless, the OWF site study area (see section 3.5.1) does capture the affected area.

27. The offshore cable corridor study area is shown in Figure 3.1.

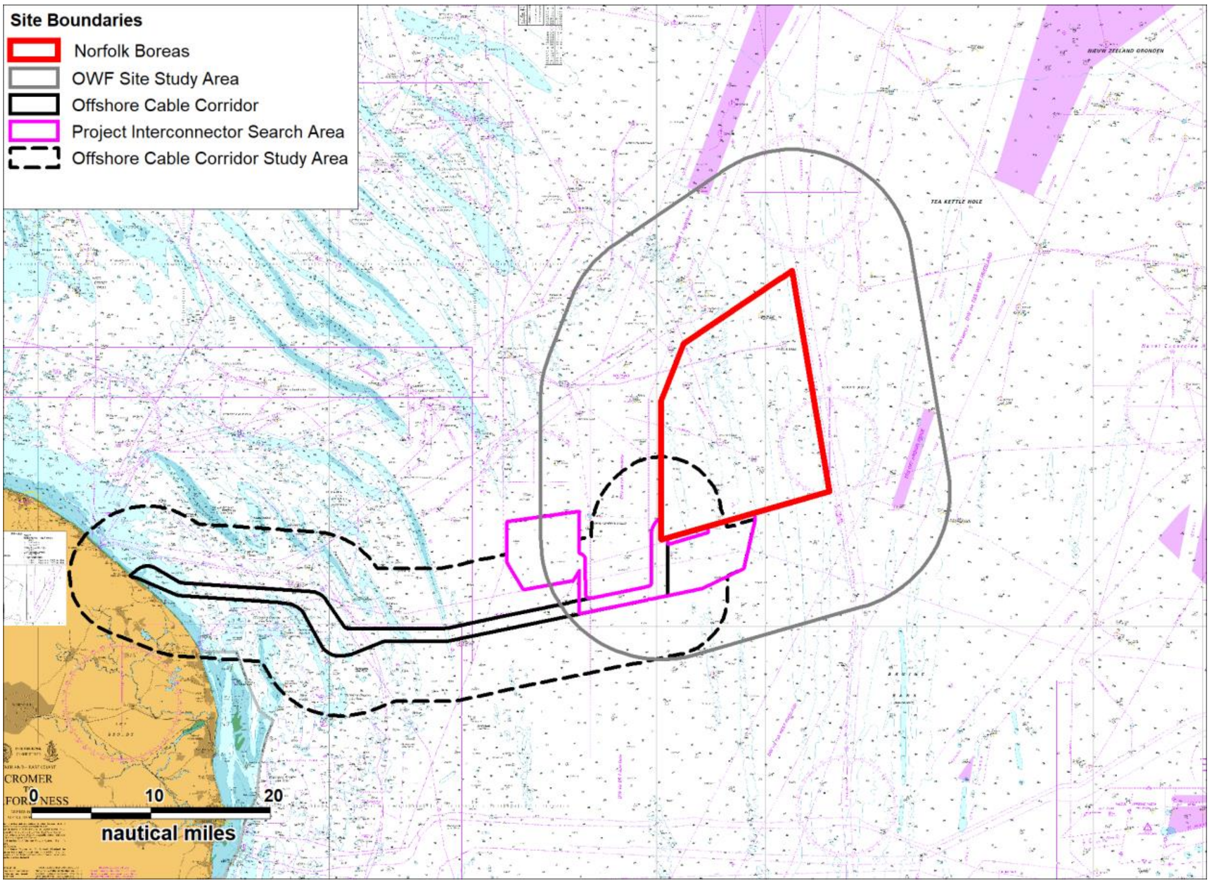


Figure 3.1 Study Area Overview

4 Project Description

4.1 Introduction

28. This section presents project details of Norfolk Boreas and the associated offshore electrical transmission works. The proposed project is located within the southern North Sea, approximately 40nm east off the UK coast, and covers an area of approximately 210nm^2. The project can accommodate up to 1,800 Megawatts (MW), which will be built in up to two phases.

4.2 Wind Farm Boundaries

29. Figure 4.1 presents the Norfolk Boreas boundary, the offshore cable corridor (within which the offshore export cables will be installed), and the project interconnector search area relative to the UK coastline. The project interconnector search area represents the area within which a project interconnector could be installed linking Norfolk Boreas to Norfolk Vanguard.

30. Following this, the key corner coordinates of the Norfolk Boreas site shown in Figure 4.1 are detailed in Table 4.1.

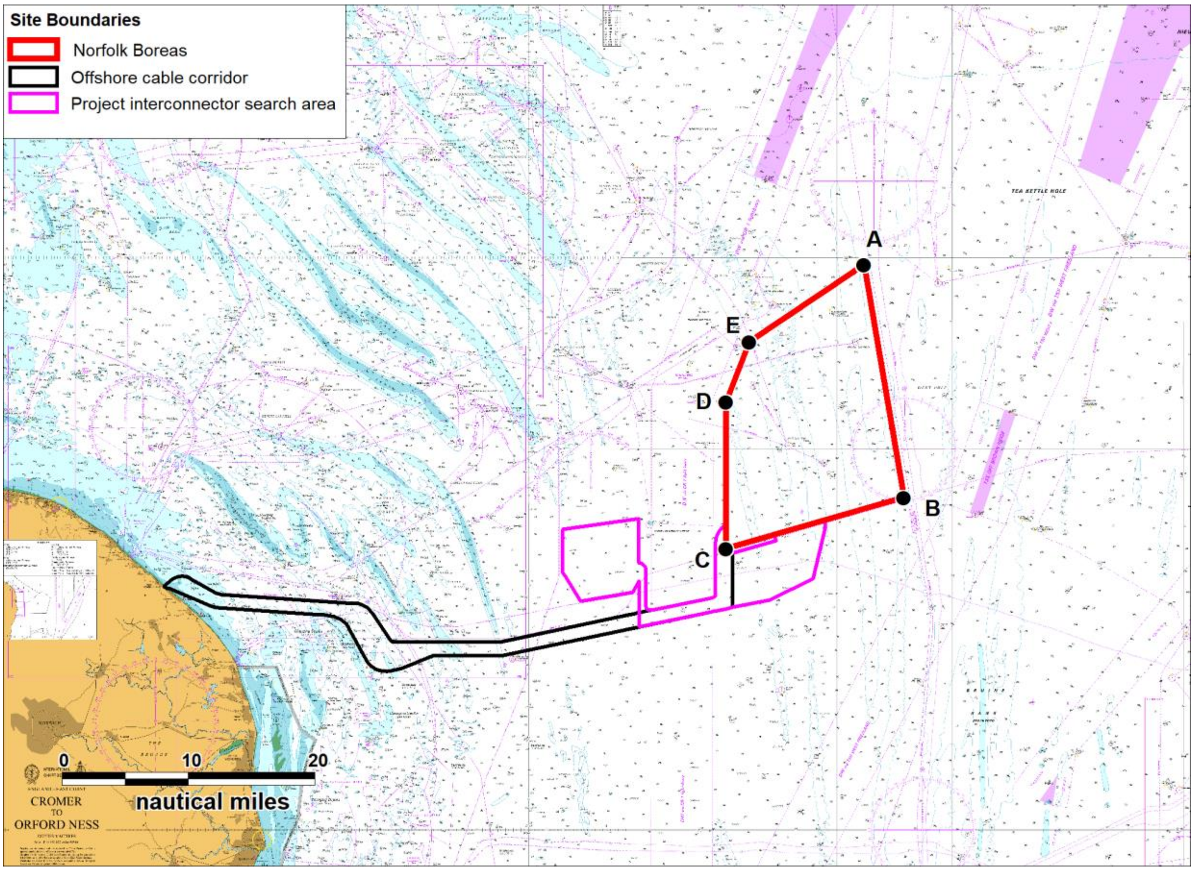


Figure 4.1 Norfolk Boreas Boundary Overview

Table 4.1 Norfolk Boreas Key Corner Coordinates (WGS84)

Corner	Latitude	Longitude
A	53° 14’ 28.798” N	003° 03’ 31.257” E
B	52° 56’ 14.962” N	003° 08’ 41.011” E
C	52° 52’ 14.268” N	002° 45’ 34.286” E
D	53° 03’ 46.106” N	002° 45’ 35.676” E
E	53° 08’ 27.770” N	002° 48’ 38.428” E

4.3 Structure Details

4.3.1 Wind Turbines

31. Wind turbine capacity (size) will range between 10MW and 20MW, and the size of wind turbines used will dictate final structure numbers. The wind turbine capacities under consideration are shown in Table 4.2, with indicative key parameters for each respective capacity included.

Table 4.2 Wind Turbine Parameters

Wind Turbine Size (MW)	Max Number of Wind Turbines	Indicative Rotor Diameter (metres (m))	Max Hub Height above Highest Astronomical Tide (HAT) (m)	Max Tip Height above HAT (m)
10	180	180	142	237
11	164	190	147	247
12	150	220	162	277
13	138	220	162	277
14	129	220	162	277
15	120	230	162	277
17	106	250	172	297
20	90	300	198.5	350

32. Regardless of the wind turbine sizes used, there will a minimum rotor blade clearance (air draft over Mean High Water Springs (MHWS)) of 22m, ensuring compliance with MGN 543 (MCA 2016) and RYA policy statements (RYA, 2015). The wind turbines will maintain at least one line of orientation, with minimum spacing of four rotor diameters length (720m for the smallest wind turbine size).

4.3.2 Foundation Types

33. The following foundation types are under consideration for the wind turbines:

- TetraBase foundations;
- Monopiles;
- Jackets on pin piles (on three or four legs);
- Jackets on suction caissons (on three or four legs); and
- Gravity base structures.

34. It is noted that more than one foundation type may be used within the Norfolk Boreas site, dependent on ground conditions, water depths, and the wind turbine models utilised.

35. With the PEIR (and associated NRA) tension leg floating foundations were modelled as the worst case foundations given the water line dimensions presented the greatest allision risk (see section 20 for further information). Following Section 42 consultation tension leg floating foundations are no longer being considered for the project (and hence are not listed above). Current foundation types being considered as part of the projects are all less than the dimensions modelled for the tension leg floating foundations and therefore it has been agreed that the worst case has been assessed and no further modelling is required at this point (see Table 5.2). It is noted that the largest foundation option now being considered is a quadropod jacket foundation.

4.3.3 Platforms

36. In addition to the wind turbines, the following platforms may also be required:

- Up to two offshore electrical platforms; and
- Up to one offshore service platform.

4.3.4 Other Ancillary Structures / Infrastructure

37. The following additional infrastructure may also be deployed within the Norfolk Boreas site:

- Up to two Meteorological Masts (Met Mast);
- Up to two Lidar buoys; and
- Up to two wave buoys.

4.4 Cables

38. Up to four offshore export cables (2 × Direct Current (DC) pairs) will be installed within the offshore cable corridor (shown in Figure 4.1), between an offshore electrical platform and the landfall. Total cable length is estimated at 500 kilometres (km) (i.e. 125km per cable), 100km of which will be within the Norfolk Boreas site (25km per cable).

39. Array cable numbers / length will depend on the final wind turbine layout; however the maximum length utilised will be 600km, all of which will be laid within the Norfolk Boreas site and the eastern part of the project interconnector search area. A project interconnector cable may also be installed within the project interconnector search area shown in Figure 4.1.

40. All cables will be buried (maximum up to 3m) with external protection used where target burial depths cannot be met.

41. A zoomed in plot of the landfall at Happisburgh is shown in Figure 4.2. It is anticipated that Horizontal Direction Drilling (HDD) will be utilised at a distance of between 700m and 1,000m from shore.

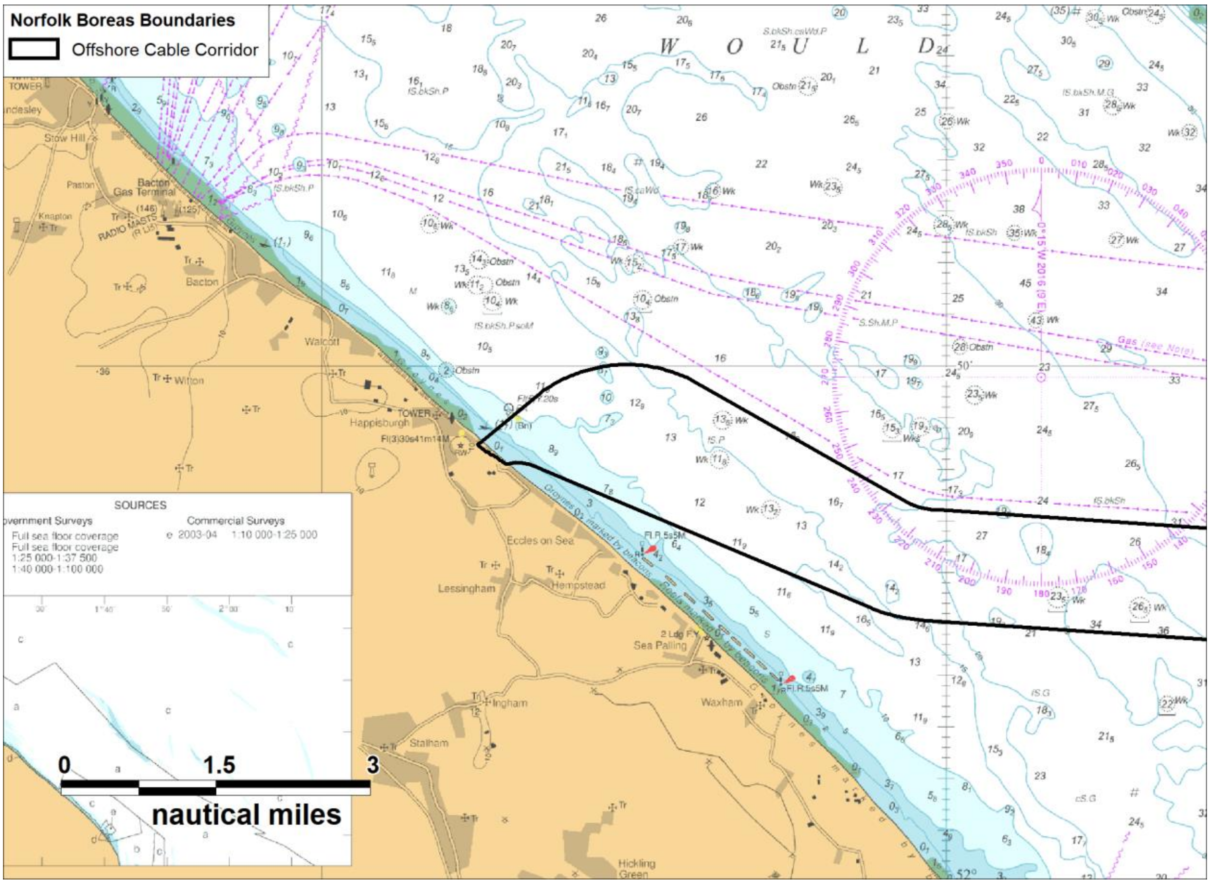


Figure 4.2 Offshore Cable Corridor Landfall

5 Consultation

5.1 Introduction

42. Norfolk Boreas Limited have undertaken extensive consultation on the project with various key marine stakeholders, both statutory and non-statutory. The key outputs of these consultations are provided in this section.

43. Consultation undertaken and considered within this NRA includes:

- Responses to the Scoping Report (Royal HaskoningDHV, 2017);
- Consultation meetings with the key statutory marine stakeholders;
- Responses under Section 42 of the Planning Act 2008 in response to the PEIR;
- Hazard consultations undertaken with regular operators and other relevant statutory / non-statutory bodies; and
- Correspondence with regular operators of the area, as identified from the marine traffic survey data (see section 12).

44. Responses from marine stakeholders in relation to the Offshore Order Limits Change Report are detailed within Chapter 15 Shipping and Navigation.

5.2 Scoping

45. The responses to the Scoping Report (Royal HaskoningDHV, 2017) deemed relevant to Shipping and Navigation, as included in the Scoping Opinion (PINS, 2017), are provided in Table 5.1.

Table 5.1 Scoping Responses

Organisation	Comment	Response / Where Addressed
Secretary of State	The EIA should consider a worst case scenario in its navigation assessment. The EIA should set out how such a worst case scenario has been determined.	The EIA undertaken in Chapter 15 Shipping and Navigation assumes the worst case scenario, as set out in section 15.7.3 of the Chapter.
	If the Davy platform is still in place upon undertaking of the EIA, it should still be considered cumulatively, even if it is planned to be decommissioned prior to construction. This includes cumulative impacts of the decommissioning process.	The scenario in which the Davy platform is not decommissioned prior to the construction of Norfolk Boreas is included within the impact assessment undertaken in Chapter 15 Shipping and Navigation.
	The EIA should provide justification for the rise in traffic of 10% assumed in the future case modelling.	For vessel to vessel collisions, cases of 10% and 20% have been

Organisation	Comment	Response / Where Addressed
		assessed within this NRA in line with the scenarios assessed for Norfolk Vanguard (Anatec, 2017) at the request of the Chamber of Shipping (CoS). The 10% value has been assumed to ensure comparison with other North Sea development assessments and is considered to be a realistic future case scenario.
	Exposed cables could create a snagging risk to vessel anchors, and this should be assessed within the EIA.	The snagging risk to anchors has been assessed within Chapter 15 Shipping and Navigation.
	The EIA should clearly identify whether or not an effect is considered to be significant, as per the EIA Regulations 2009.	The EIA undertaken in Chapter 15 Shipping and Navigation uses an FSA approach as required under the MCA methodology (MCA, 2015). Impacts are assessed as either Broadly Acceptable (not significant in EIA terms), Tolerable (not significant in EIA terms), or Unacceptable (significant in EIA terms).
Marine Management Organisation (MMO)	Non-renewable developments such as aggregate dredging and port and harbour developments should be considered within the Cumulative Impact Assessment (CIA).	Marine aggregate dredging and port / harbour developments have been considered as part of the baseline (section 8).
MCA	The EIA should include assessment of the following impacts for both commercial and recreational vessels: ▪ Collision; ▪ Navigational safety; ▪ Visual intrusion and noise; ▪ Risk management and emergency response; ▪ Marking and lighting; ▪ Information to mariners;	Impact screening is undertaken within section 27.2 of this NRA. The EIA undertaken in Chapter 15 Shipping and Navigation then assessed the screened in impacts.

Organisation	Comment	Response / Where Addressed
	▪ Effect on small craft navigational and communication equipment; ▪ Risk to drifting recreational craft in adverse weather or tidal conditions; and ▪ Squeeze of small craft into the routes of larger commercial vessels.	
	A Navigational Risk Assessment will need to be submitted in accordance with MGN 543 (and MGN 372) and the MCA Methodology for Assessing the Marine Navigation Safety & Emergency Response Risks of OREI. This NRA should be accompanied by a detailed MGN 543 Checklist.	This document represents the NRA undertaken for the Norfolk Boreas application and has been informed by the stated guidance documents (see section 2) A completed MGN 543 checklist is presented in Appendix 15.2.
	MGN 543 Annex 2 requires that hydrographic surveys should fulfil the requirements of the International Hydrographic Organisation (IHO) Order 1a standard, with the final data supplied as a digital full density data set, and survey reports to the MCA Hydrography Manager.	Norfolk Boreas Limited will ensure the hydrographic surveys are compliant with IHO Order 1a and MCA requirements.
	Particular attention should be paid to cabling routes and where appropriate burial depth for which a Burial Protection Index study should be completed and, subject to the traffic volumes, an anchor penetration study may be necessary. If cable protection is required e.g. rock bags, concrete mattresses, the MCA would be willing to accept a 5% reduction in surrounding depths referenced to Chart Datum.	Norfolk Boreas Limited will undertake an assessment of cable burial / protection post consent as per section 25 (embedded mitigation). This will include consideration of under keel clearance issues.
	The Radar effects of a wind farm on ships' Radars are an important issue and the effects, particularly with respect to adjacent wind farms on either side of a route, will need to be assessed on a site specific basis taking into consideration previous reports on the subject available on the MCA website.	Impacts on marine Radar are assessed in section 22.8.

Organisation	Comment	Response / Where Addressed
	The development area carries a significant amount of through traffic and liner routes; attention needs to be paid to routeing, particularly in heavy weather ensuring shipping can continue to make safe passage without significant large scale deviations.	Deviations are assessed within section 19 (post wind farm routeing). Adverse weather routeing is discussed in section 18.4.
	Particular consideration will need to be given to the implications of the site size and location of Search and Rescue (SAR) resources and Emergency Response Cooperation Plans (ERCoP). Attention should be paid to the level of Radar surveillance, AIS and shore-based Very High Frequency (VHF) radio coverage and give due consideration for appropriate mitigation such as Radar, AIS receivers and in-field, Marine Band VHF radio communications aerial(s) (VHF voice with Digital Selective Calling (DSC)) that can cover the entire wind farm sites and their surrounding areas.	The layout will be agreed with the MCA (with consideration as to the Design Rules in Table 25.1) and MMO post consent. The mechanism securing this will be via the Deemed Marine Licence (DML) which will form part of the Development Consent Order (DCO). This will include consideration of SAR and emergency response.
Norfolk County Council	The CIA should include consideration of operational, consented or proposed wind farms off the Norfolk Coast. All impacts should be considered for commercial vessels, fishing vessels and recreational vessels. It should be ensured that there will not be any demonstrable negative impact on Norfolk's ports as a consequence of the proposed offshore wind farms and any potential change in shipping and navigational routes.	The CIA considered all projects listed in section 1.8. Ports are considered within the NRA (Appendix 15.1), and impacts were subsequently screened out on the basis of proximity. Impacts have been assessed for commercial, fishing, and recreational vessels.
	The EIA should indicate that suitable navigation and shipping mitigation measures can be agreed with the appropriate regulatory bodies to ensure that Norfolk's Ports (King's Lynn and Wells) are not adversely affected by this proposal.	Mitigation measures considered embedded are listed in section 25. Details on ports are provided in section 8.5, and impact screening has been undertaken in section 27.2.
Trinity House	The NRA should include:	Marine traffic analysis has been

Organisation	Comment	Response / Where Addressed
(TH)	▪ Comprehensive vessel traffic analysis in accordance with MGN 543; and ▪ Cumulative and in-combination impacts on shipping routes.	undertaken, with the results provided in section 12 (for the Norfolk Boreas site) and section 13 (for the offshore cable corridor). Shipping routes have been analysed at a cumulative and in-combination level in section 19.
	Proposed layouts should comply with MGN 543. Any structures located outside of the array will require additional risk assessment.	Compliance with MGN 543 is considered embedded mitigation (section 25). The layout will be agreed with the MCA (via the MMO) post consent with consideration as to the Design Rules in Table 25.1.
	Wind farm structures should be marked in line with IALA O-139 requirements, and additional AtoNs (e.g. buoyage) may be necessary.	Lighting and marking will be in line with IALA O-139, and will be agreed with TH post consent (including buoyage).
	All lighting and marking is required to be agreed with TH. All AtoNs must meet the internationally recognised availability and reporting standards.	Lighting and marking requirements will be agreed with TH post consent. AtoNs will be designed to meet the required availability standards.
	A buffer zone between the wind farm and the Deep Water Route (DWR) to the west should be fully considered.	Buffer zones will be implemented in line with those agreed for Norfolk Vanguard and East Anglia THREE to ensure a continuous and consistent separation between structures and the DWRs.
	National transboundary issues should be assessed, through consultation with the Dutch authorities.	The Dutch authority (Rijkswaterstaat) has been consulted with in regards to cumulative impacts on vessel routeing.
	A decommissioning plan, which includes a scenario where on decommissioning and on completion of removal operations an obstruction is left on site (attributable to	A decommissioning plan will be agreed post consent. Decommissioning impacts are assessed within the impact

Organisation	Comment	Response / Where Addressed
	the wind farm) which is considered to be a danger to navigation and which it has not proved possible to remove, should be considered. Such an obstruction may require to be marked until such time as it is either removed or no longer considered a danger to navigation, the continuing cost of which would need to be met by the developer / operator.	assessment in Chapter 15 Shipping and Navigation.
	Marking of the export cables and the associated installation vessels should be considered. If it is necessary for the cables to be protected by rock armour, concrete mattresses or similar protection which lies clear of the surrounding seabed, the impact on navigation and the requirement for appropriate risk mitigation measures needs to be assessed.	An assessment of cable burial and protection will be undertaken post consent, as per the embedded mitigation listed in section 25.

5.3 Post Scoping

46. Post Scoping, consultation has been ongoing with the key marine stakeholders. Key outputs of these meetings are detailed in Table 5.2.

Table 5.2 Post Scoping Consultation

Consultee	Comment	Response / Where Addressed
MCA (May 2018)	The MCA queried whether non AIS traffic has been accounted for.	The data sources used to inform the baseline are detailed in section 6. This includes visual observation and Radar data. Additional fishing and recreational data sources have also been considered.
	MCA noted that lighting and marking (including aviation lighting) will need to be considered in line with lighting and marking approved for Norfolk Vanguard.	Lighting and marking will be undertaken post consent, as per the embedded mitigation listed in section 25. Lighting and marking will be designed to be sympathetic to that

Consultee	Comment	Response / Where Addressed
		agreed for Norfolk Vanguard.
	MCA stated if the Met Mast is still present when other structures are installed, it will need to be accounted for within layout discussions surrounding lines of orientation.	The layout will be agreed with the MCA post consent (with consideration as to the Design Rules in Table 25.1) via agreement with the MMO which will be secured in the DML, and consideration would be given to the Met Mast if present.
TH (May 2018)	TH stated any issues relating to alignment with platforms (oil or gas) will need to be assessed. Oil and gas decommissioning activities will need to be assessed cumulatively where information is publicly available.	The layout will be agreed with the MCA post consent (with consideration as to the Design Rules in Table 25.1) via agreement with the MMO which will be secured in the DML.
	Should the export cables interfere with existing buoys, TH must be consulted prior to installation to ensure both navigational and commercial concerns are addressed.	No buoys were identified within the offshore cable corridor (see section 8.3). However, TH would be consulted if any works were to interfere with existing buoyage.
Rijkswaterstaat (May 2018)	Queried if consultation responses from Rijkswaterstaat issued for other projects would be considered for Norfolk Boreas (notably for East Anglia THREE).	Section 5.7 provides details of how key outputs of the Vanguard consultation process have been incorporated into the NRA. Consultation outputs of other projects have been considered at a high level; however any points considered as requiring addressing specifically have been highlighted in the Section 42 response to the PEIR.
	Cumulative routeing within the Dutch sector and within the vicinity of Norfolk	The output of this consultation has been incorporated into

Consultee	Comment	Response / Where Addressed
	Boreas was discussed.	the cumulative routeing assessment undertaken in section 19.3.
MCA (January 2019)	Content that the worst case (200 turbines) has already been modelled and modelling would not need to be redone for the 180 turbine layout.	Noted.
	MCA noted that although not within their remit, consideration should be given to operational helicopter access if platforms are included within the array.	Operational helicopter access will be in line with CAP 437 guidance.
	Noted that they would also like export cable route data to be brought up to date and in line with the summer 2018 data.	Analysis of the summer 2018 data within the offshore cable corridor study area has been carried out in section 13 and is summarised in Chapter 15 of the ES.
TH (January 2019)	No concerns marking sample layouts shown and indicated that lighting was likely to initially be done on a project in isolation basis with lights removed (turned) off as required when other projects were built or decommissioned.	Noted.
MCA and TH (January 2019)	Content that the floating foundation had been removed and that TetraBase foundations were now a consideration. As under keel clearance would be a minimum of 10m, MCA and TH raised no concerns over this.	Noted.
	No concerns with the increased interconnector search area of the HVDC options noting that worst case has already been considered.	Noted.
	No concerns with accommodation platforms becoming accommodation and / or refuelling platforms.	Noted. It is highlighted that the accommodation / and or refuelling platform is now referred to as the offshore service platform.
	Content with the design rules being noted	Noted.

Consultee	Comment	Response / Where Addressed
	within the DCO as long as the condition still allowed for final sign off.	
	The Design Rules were discussed as an ongoing matter.	Noted. Further discussion will be undertaken with the MCA and TH.
MCA and TH (January 2019)	Design rule consultation April 2019 - meetings to finalise wording of the Design Rules.	Final wording of the Design Rules as agreed with MCA and TH is given in section 25.2.

5.4 Section 42 Responses

47. Responses received under Section 42 of the Planning Act 2008 in response to the PEIR are detailed in Table 5.3.

Table 5.3 Section 42 Responses

Consultee	Comment	Response / Where Addressed
MCA	The development area carries a significant amount of through traffic. Attention therefore needs to be paid to routeing, particularly in heavy weather to ensure safe passage without significant large scale deviations.	Deviations are assessed within section 19 (post wind farm routeing). Adverse weather routeing is discussed in section 18.4.
	Possible cumulative and in combination effects on routes should be considered taking into account Norfolk Vanguard East, Norfolk Vanguard West, East Anglia 3 and other Southern North Sea operations.	Cumulative impacts are discussed in section 14 and assessed in section 15.8 of Chapter 15 of the ES.
	Turbine layout design will require MCA approval prior to construction to minimise risk to surface vessels, including rescue boats and SAR aircraft. Structures must be aligned in straight rows and columns, including any platforms with a minimum of two lines orientation. Any additional navigation safety and / or SAR requirements as per MGN 543 Annex 5 (v2) will be agreed at the approval stage.	The layout and any additional navigational safety and / or SAR requirements will be agreed with the MCA post consent in line with the Design Rules (see Table 25.1).

Consultee	Comment	Response / Where Addressed
	An approved ERCoP is required prior to construction. The ERCoP is an active operational document and must remain current during all stages of the project. A SAR checklist will be discussed post consent.	An ERCoP would be produced post consent and agreed with the MCA as per section 25. The SAR checklist process will be discussed and agreed with the MCA post consent.
	Supports safety zones during construction, maintenance and decommissioning phases. Should be noted that operational safety zones may have maximum 50m radius from individual turbines. Justification and evidence for 50m operational safety zone would be required.	A safety zone application would be produced and agreed with the MCA post consent, noting that the application for safety zones is assumed as embedded mitigation in section 25. This may include provision for operational safety zones around manned platforms.
	Information on potential mooring arrangements for floating turbines should be included in the ES. This includes possible anchor and line spread, monitoring, recovery of turbines and third party verification. Recent MCA and HSE guidance should be referenced.	Floating tension leg platforms are no longer being considered therefore no response is required.
	MCA would like to see continuous construction which is progressive across the wind farm with no opportunity for two separate areas to be constructed with a gap in the middle.	Norfolk Boreas Limited considers that the effects of disparate construction sites are mitigated, notably through the use of aids to navigation during the entire construction phase. Embedded mitigation is listed in section 25.
MMO	A cable burial risk assessment is proposed pre-construction. The cable burial risk assessment also needs to be conducted post construction and updated regularly to provide understanding of burial and mitigate risks to other sea users. Risk assessment should include mitigation that will be required. This should be presented within the ES. Further information required on how changes in burial depths over time are addressed in the EIA, and how risks are to be	Norfolk Boreas Limited will undertake an assessment of cable burial / protection post consent, as per the embedded mitigation listed in section 25. Further details, including risk mitigation and promulgation of information are summarised in section 26.3.

Consultee	Comment	Response / Where Addressed
	communicated to fishermen and other sea users.	
	If during construction, any unused cables are to be cut and clumped at the point of intersection with the windfarm cables, requests clarification on how the impact on other sea users will be assessed and mitigated to avoid navigational risk.	Norfolk Boreas Limited would undertake an assessment of cable burial / protection post consent as per section 25 (embedded mitigation) where the approach to disused cables will also be detailed.
	Notes that Vattenfall has stated that cable protection is to be kept to a minimum which is welcomed. However, the MMO expects that contingency for unexpected exposures / unburied cables will be built into the assessments.	An assessment of cable burial and protection will be undertaken post consent, as per the embedded mitigation listed in section 25. Protection will be periodically monitored to identify any areas of exposure or ineffective protection as per section 26.3.
TH	Contents of letter noted. Look forward to working with Norfolk Boreas Limited up to and throughout the application process.	Noted.
Rijkswaterstaat	Of the 40+ potential impacts on shipping and navigation, only 12 have been assessed as 'Tolerable' of which 4 Tolerable with mitigation'. The other potential impacts are assessed as 'Broadly acceptable' or 'no impact'. This seems a mild result, certainly if cumulative effects are considered. Could you elaborate on this issue and especially on the following two issues?	The impact assessment has been undertaken using the IMO FSA, as per MCA requirements and in line with the shipping and navigation assessments that have been undertaken for similar UK developments. Under the relevant MCA guidance this approach is primarily concerned with ensuring mariner safety, considering consequence (safety) and the frequency of the effect into account to determine overall impact significance. Further details are provided in section 15.4 of the ES. The rankings for the Norfolk Boreas ES are considered justified

Consultee	Comment	Response / Where Addressed
		on the basis that impact significance has been based on the likely frequency at which any given consequence will occur (as assessed within this comprehensive NRA).
	Could you explain why a collision of a commercial vessel with third party vessels or a structure would only have MINOR consequences (slight injury, minor damage, tier 1 pollution assistance, minor business safety)? Experts in The Netherlands have pointed out more severe consequence due to the exchange of a lot of energy. Even in the case when a large ship drifts into an OWF. But of course real data on this subject sparse.	The assessment considers both frequency and consequence of each impact, with consideration of both most likely and realistic worst cases considered within the hazard log, produced as part of the NRA process (Appendix 15.1 to the ES), which ultimately feeds into the impact assessment. In this case, the minor consequence ranking was attached to the assessed frequency at which a collision with such consequences was estimated to occur (at most reasonable probable), based on the findings of the NRA (Appendix 15.1 to the ES). A collision resulting in more severe consequences (which is acknowledged as a feasible outcome) would be assessed as being of a lesser frequency than a collision with minor consequences, leading to the same overall significance (at most tolerable with mitigation).
	Deviation of routeing due to adverse weather – for commercial vessels the frequency is considered to be remote 1 in 10 to 100 years) but according to our information this should be ‘frequent’(yearly)	The remote frequency assessed refers to the frequency at which an incident of restricted adverse weather routeing would be likely to result in moderate safety consequences. It is agreed that Norfolk Boreas will impact upon adverse weather routeing on a more frequent basis (as per

Consultee	Comment	Response / Where Addressed
		Section 18.4 of the NRA (Appendix 15.1 to the ES)), however the significant majority of such cases were assessed as being likely to be of a lower consequence i.e. time increases rather than safety effects. Therefore, had a higher frequency been considered, the overall significance would not have changed (tolerable with mitigation).
	It is stated that DFDS IJmuiden – Newcastle is the busiest route required to deviate, however minor and that's a fair assessment. But it can also be said that with minor adjustments to the OWF ('topping off'), this deviation can be avoided and collision will further decrease. Is this something Vattenfall would consider?	This was raised previously during a consultation call between Rijkswaterstaat and Vattenfall on the 8th May 2018. At this application stage of the project it cannot be confirmed how much of the site will be built out, however Vattenfall will consider consultation responses on the subject during the layout approval process which will be undertaken with the MCA and Trinity House (TH). No concerns were raised during consultation with regular operators regarding the northern boundary of the Norfolk Boreas site (including from the operator of the route that intersect the Northern tip). Cumulative assessment also shows any deviation to be manageable when considered with the identified projects that could include cumulative impacts. It is noted that as per Environmental Impact Assessment regulations it is only reasonable that Vattenfall consider cumulative projects which are reasonably

Consultee	Comment	Response / Where Addressed
		foreseeable.
	The Dutch government has indeed planned a corridor in the scheduled OWF 'IJmuiden Ver' coinciding with the routing IJmuiden Newcastle.	As per EIA regulations any assessment of cumulative impacts is based on projects or other activities that are active or reasonably foreseeable. Given that a detailed design of the proposed navigation corridor is not publicly available we are not able to make an assessment.
	It is stated that there is likely to be a collective increase in emergency response requirements due to increased incident rates, more personnel and more vessels. You refer to self-help capability, which should also be considered within the project specific impacts. Could you elaborate on this issue? What does that mean? What kind of measures will be taken?	Self-help refers to any vessel, personnel, facility or resource associated with Norfolk Boreas that could be used in an emergency situation. A full list of the available resources cannot be provided at this stage of the project, however comprehensive details will be provided in the Emergency Response Cooperation Plan (ERCoP) which will be produced post consent in consultation with the MCA. Indicatively, this will include construction/maintenance vessels and crew, lifesaving equipment on board the vessels and wind farm structures, and any further relevant onshore facilities.
	Why is it relevant to note the majority of fishing vessels are Dutch beam trawlers?	The NRA and ES follow the guidance contained within MGN 543 which requires the assessment to detail break downs of vessels types within the study area. It is typical to note type and nationality of fishing vessels given that this provides additional detail on the nature of transits and movements.

5.5 Regular Operator

48. Regular operators in the area were identified from the marine traffic survey data, and contacted for comment. Further details of this process are provided in Appendix 15.4 Regular Operator Consultation.

49. The responses received are summarised in Table 5.4.

Table 5.4 Regular Operator Consultation Summary

Operator	Comment	Response / Where Addressed
DFDS	Stated that the Newcastle / Amsterdam route will be impacted, including both the main route, and two adverse weather routes.	Vessel deviations are assessed in section 19, with adverse weather considered in section 18.4. Associated impacts are assessed in Chapter 15 Shipping and Navigation.
Scotline	Stated that the wind farm will result in more vessels requiring use of the DWR, which will lead to increased encounters with the large vessels currently using the DWR.	Collision risk has been modelled in section 21, with associated impacts assessed in Chapter 15 Shipping and Navigation.
	Noted issues arising from both Norfolk Boreas and Norfolk Vanguard to Scotline continental trade traffic travelling between UK East Coast (Humber) and mainland Europe.	Vessel deviations are assessed in section 19. Associated impacts are assessed in Chapter 15 Shipping and Navigation.
	Stated adverse impact to vessel routeing when winds are blowing from between south and northwest direction. In this instance Scotline vessels will hug UK coast and then cut across in the vicinity of Norfolk Boreas and Norfolk Vanguard.	Adverse weather is considered in section 18.4. Associated impacts are assessed in Chapter 15 Shipping and Navigation.
	Noted delays to transits could result in missing tidal entries to UK ports, leading to time/money loss.	Vessel deviations are assessed in section 19. Associated impacts are assessed in Chapter 15 Shipping and Navigation.

5.6 Hazard Consultations

50. Norfolk Boreas Limited hosted Hazard Consultations at the Vattenfall Offices in London on the 23rd May 2018. Both statutory stakeholders and regular operators were invited to attend the meetings, which were held primarily for the purpose of discussing routeing and other hazards associated with Norfolk Boreas, including in a cumulative context.

51. The output of these was used to inform the Hazard Log, which is discussed further in Section 23; however for reference, the key consultation points arising from the meetings are presented in Table 5.5.

Table 5.5 Hazard Consultation Meeting Outputs

Organisation	Comment	Response / Where Addressed
BP Shipping	BP Shipping content with 1nm spacing between DWR and bordering wind farms but stated their biggest concern was a vessel breaking down.	Drifting risk has been modelled in section 21.2.2.2, with associated impacts assessed in Chapter 15 Shipping and Navigation.
CoS	CoS stated the IMO routeing measures should be included within the cumulative case.	All routeing assessment (pre wind farm, post wind farm, and cumulative) has taken account of the IMO routeing measures.
	CoS raised concerns over small vessels being displaced into the DWRs which were originally intended for larger, deep draughted vessels.	Smaller vessels may choose to transit through the wind farms. Post wind farm routeing has been assessed in section 19, with associated impacts assessed in Chapter 15 Shipping and Navigation.
RYA	RYA expressed concern over reduction of coastal water depths through external cable protection.	Any cable protection will comply with MGN 543.
Scotline	Scotline raised concern over the impact of Norfolk Boreas on Scotline routes from Inverness to the continent and from Rochester, north-	Post wind farm routeing has been assessed in section 19, with associated impacts assessed in Chapter 15 Shipping and Navigation.

Organisation	Comment	Response / Where Addressed
	east bound.	
	Scotline raised concern over adverse weather routeing due to the preference to transit the UK coast southbound before transiting the sea area where Norfolk Boreas, Norfolk Vanguard and East Anglia THREE are proposed.	Adverse weather routeing is discussed in section 18.4, with associated impacts assessed in Chapter 15 Shipping and Navigation.
	Scotline raised concern over vessel breakdown within the vicinity of a wind farm.	Drifting risk has been assessed quantitatively in section 21.2.2.2, with associated impacts assessed in Chapter 15 Shipping and Navigation.
	Scotline stated that if smaller vessels are displaced into the DWR, the larger vessels' lack of manoeuvrability would be a concern.	Displacement impacts are assessed in Chapter 15 Shipping and Navigation.
	Post meeting: Queried FSA terminology, particularly the definitions of the significance rankings.	The FSA process (including terminology) is described in Chapter 15 Shipping and Navigation.
	Post meeting: Raised concerns over time / financial costs arising from deviations around wind farm. Concerns also raised over displacement of traffic leading to a navigation or pollution incident.	Impacts associated with vessel deviation and displacement are assessed in Chapter 15 Shipping and Navigation.
Cruising Association (CA)	CA stated concerns over cumulative impacts.	Cumulative impacts are assessed within Chapter 15 Shipping and Navigation.
	CA stated concern over wind farm vessels causing congestion within port	Marine coordination will be in place as per the embedded mitigation listed in section

Organisation	Comment	Response / Where Addressed
	approaches.	25.
	CA noted that consistency of appearance within a wind farm is of importance to recreational users.	Lighting and marking will be agreed with the MCA and TH post consent. The layout will be agreed with the MCA post consent (with consideration as to the Design Rules in Table 25.1) via agreement with the MMO.
	CA stated that under keel clearance would be an issue in areas where depths are currently less than 10m.	Norfolk Boreas will undertake an assessment of cable burial and protection post consent as per section 25 (embedded mitigation). This will include consideration of under keel clearance issues. Norfolk Boreas will also comply with MGN 543.

5.7 Relevant Norfolk Vanguard Consultation

52. Extensive consultation has previously been undertaken for the Norfolk Vanguard OWF (both Norfolk Boreas Limited and Norfolk Vanguard Limited are subsidiaries of Vattenfall Wind Power Limited). Given the two projects present similar concerns to marine stakeholders, particularly in relation to the proximity to the DWR traffic, the consultation responses received in relation to Norfolk Vanguard[1] that are also considered relevant to Norfolk Boreas are summarised in Table 5.6.

Table 5.6 Norfolk Vanguard Consultation Summary

Organisation	Comment	Response / Where Addressed
MCA (Meeting held on the 17th March 2017 with MCA and	MCA noted that synchronisation between East Anglia THREE, Norfolk Vanguard East and Norfolk Boreas was important	Lighting and marking will be agreed with the key stakeholders (MCA, TH, Civil Aviation Authority (CAA))

[1] This does not represent a comprehensive log of the Norfolk Vanguard consultation, with only key points deemed directly relevant to Norfolk Boreas shown.

Organisation	Comment	Response / Where Addressed
TH)	especially for aviation lighting.	post consent, and this will include consideration of Norfolk Vanguard and East Anglia THREE.
TH (Meeting held on the 17th March 2017 with MCA and TH)	Preference for straight edges and no isolated turbines.	The layout will be agreed with the MCA post consent (with consideration as to the Design Rules in Table 25.1) via agreement with the MMO which will be secured in the DML.
CoS (Meeting held on the 8th May 2017)	Access points will be needed for wind farm service vessels in the area, and it will need to be known where they are likely to be crossing the DWR. It should be ensured that the impact of wind farm construction and operational traffic is considered in the NRA.	Displacement and collision impact associated with wind farm traffic are assessed in Chapter 15 Shipping and Navigation.
BP Shipping (Email correspondence – 7th April 2017)	BP Shipping would appreciate if the impact of the proposed wind farms could be reviewed with specific focus upon shipping density in the region – the loss of navigational space and the impact upon the shipping which will be navigating in and or around the DWRs.	Vessel density has been considered as part of the marine traffic assessment undertaken in section 12.2.5. Impacts associated with the DWRs are assessed in Chapter 15 Shipping and Navigation.
CA (Meeting held on the 8th May 2017)	The key concern is the cumulative impact of all the projects in the former East Anglia Zone as opposed to just that from the Norfolk Vanguard and Norfolk Boreas sites.	Chapter 15 Shipping and Navigation includes consideration of potential impacts on a cumulative basis.
Rijkswaterstaat (Written correspondence	Norfolk Vanguard is situated within a nautically important area, close to IMO DWRs. One of	The guidelines have been considered in section 17.4 of this NRA.

Organisation	Comment	Response / Where Addressed
– 19th May 2017)	the main concerns for the Dutch government is the safety of shipping in these routes. Rijkswaterstaat asked for this to be taken into consideration when designing the layout of the wind farm.	

6 Data Sources

6.1 Marine Traffic Data

6.1.1 Overview

53. The primary input to this NRA is the marine traffic survey data collected from vessel based surveys undertaken at the Norfolk Boreas site, comprising AIS recordings, Radar recordings, and visual observations (where feasible). This data has been collected as per MGN 543 (as demonstrated in the MGN 543 checklist available in Appendix 15.2), and the collection approach was agreed with the MCA and TH in 2017. An additional survey has been undertaken in summer 2018 to ensure an up to date assessment is provided within the ES (post PEIR).

54. To provide coverage of the offshore cable corridor study area, the survey data was supplemented with additional AIS data collected from shore based receivers. As the shore based data was observed to bolster coverage of the eastern extent of the OWF site study area, it has also been incorporated into the analysis of the Norfolk Boreas site.

55. Any traffic deemed as engaging in temporary operations (e.g. temporary guard duties, survey work, salvage operations) have been excluded from the marine traffic assessments.

56. Further details of the data collected, and the subsequent analysis, are presented in section 12 (for the Norfolk Boreas site) and section 13 (for the offshore cable corridor).

6.1.2 Summer Survey 2017

57. A summer survey was undertaken in July and August 2017, and therefore does not fall within the required timeframe of MGN 543 (data collected within 24 months of submission of the ES). However, as the data collected on site by the *Fugro Pioneer* was observed to provide good coverage of the OWF site study area when supplemented with additional AIS collected from the Met Mast over the same period, it has still been considered within this NRA for the purpose of ensuring vessel numbers used as input to the modelling are accurate.

6.1.3 Winter Survey 2018

58. A winter survey was undertaken in February 2018 by the *Resolute* while stationed at the Norfolk Boreas site. Given typical winter conditions, the data does not provide coverage of the entire OWF site study area (though coverage of the Norfolk Boreas site itself is good).

6.1.4 Summer Survey 2018

59. A second summer survey was undertaken in August of 2018. This data set was being processed at the time of writing of the PEIR and associated NRA however it is now available and has been used to validate the summer 2017 assessment for inclusion within the DCO application to ensure data compliance with MGN 543 (MCA, 2016). It is noted that as per the summer 2017 survey, the 2018 summer AIS data has also been supplemented with additional Met Mast AIS collected over the same time period.

60. As detailed in section 27.3, the findings of the validation exercise (comparing the two summer surveys) are not deemed as affecting the assessment undertaken at the PEIR stage (which was informed by the 2017 summer data). Therefore, no additional collision or allision modelling has been undertaken based on the summer 2018 data.

6.2 Other Data Sources

61. In addition to the marine traffic data, the following data sources have also been considered within the NRA:

- Maritime incident data from the Marine Accident Investigation Branch (MAIB) (2005 to 2014);
- Maritime incident data from the Royal National Lifeboat Institution (RNLI) (2005 to 2014);
- Marine aggregate dredging data licence areas and active areas and transit routes from The Crown Estate (2017) and the British Marine Aggregate Producers Association (BMAPA) (2016);
- The Crown Estate UK offshore wind farm boundaries (2017);
- Admiralty Sailing Direction – North Sea (West) Pilot NP 54 United Kingdom (Hydrographic Office (UKHO), 2016);
- UKHO Admiralty Charts (in particular 1503, 1504, 1631 and 1632);
- Sightings surveillance fishing vessel data (2005 to 2009);
- Satellite surveillance fishing vessel data (2009);
- RYA UK Coastal Atlas of Recreational Boating (2009) and Geographic Information System Shape Files (2016);
- Wind data collected from the Met Mast (2013 to 2016); and
- Wave data collected from within Norfolk Vanguard East (2012 / 2013).

7 Lessons Learned

62. There is considerable benefit to developers in the sharing of lessons learned within the offshore industry. The NRA, and in particular the hazard assessment, includes general consideration for lessons learned and expert opinion from previous offshore wind farm projects and other sea users.

63. Lessons learned data sources include:

- A Report compiled by the Port of London Authority based on experience of the Kentish Flats Wind Farm Development, Nautical Offshore Renewable Energy Liaison (NOREL) Work Paper, WP4 (2nd NOREL) (NOREL Group, unknown);
- East Anglia THREE ES Volume 1 Chapter 15 Shipping and Navigation (Scottish Power and Vattenfall, 2015).
- East Anglia ONE Offshore Windfarm ES Volume 2 Offshore, Chapter 15 – Shipping and Navigation (Scottish Power and Vattenfall, 2012);
- East Anglia ONE Offshore Windfarm NRA (Anatec, 2012);
- East Anglia THREE Offshore Windfarm NRA (Anatec 2015);
- Guidelines for Health and Safety in the Wind Energy Industry (Renewables UK, (2014);
- Norfolk Vanguard NRA (Anatec, 2017);
- Offshore Wind Farm Helicopter Search and Rescue (SAR) – Trials Undertaken at the North Hoyle Wind Farm Report of helicopter SAR trials undertaken with Royal Air Force Valley C Flight 22 Squadron on March 22nd 2005 (MCA, 2005);
- Results of the electromagnetic investigations 2nd edition, Southampton, MCA and QinetiQ (Department for Transport (DfT), 2004);
- Sharing the Wind – Identification of recreational boating interests in the Thames Estuary, Greater Wash and North West (Liverpool Bay) (RYA and CA, 2004); and
- Strategic Assessment of Impacts on Navigation of Shipping and Related Effects on Other Marine Activities Arising from the Development of Offshore Wind Farms in the UK REZ (The Crown Estate, 2012).

8 Existing Environment – Navigational Features

8.1 Introduction

64. This section presents the navigational baseline assumed within this NRA, which has been established based on the data sources outlined in section 6. The marine traffic baseline has been established in section 12, based on the results of the marine traffic surveys.

8.2 Routeing Measures

65. The IMO adopted routeing measures most relevant to Norfolk Boreas are presented in Figure 8.1. Routeing measures further afield are visible on the background charts, but have not been highlighted specifically, for the purposes of clarity.

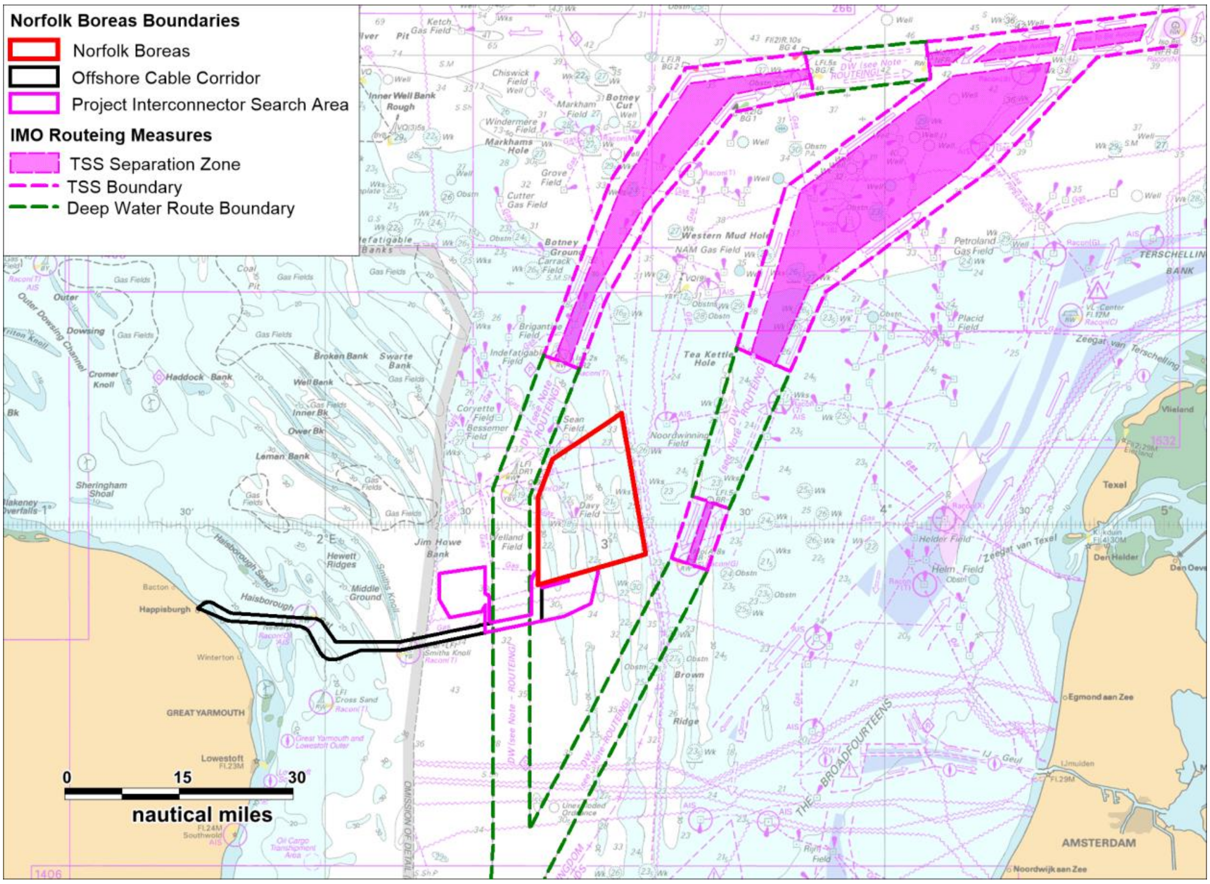


Figure 8.1 IMO Adopted Routeing Measures

66. The DR1 Lightbuoy DWR is positioned west of Norfolk Boreas, with a separation distance of approximately 1nm. This DWR connects to the Off Botney Ground Traffic Separation Scheme (TSS) around 10nm to the north. The Off Brown TSS is to the east, and is positioned (at its closest) approximately 3.4nm from the site. This TSS

links to the West Friesland DWR, which adjoins the DR1 Lightbuoy DWR approximately 30nm to the south of the site.

8.3 Aids to Navigation

67. The AtoNs within 10nm of the Norfolk Boreas site are presented in Figure 8.2. AtoNs installed on existing oil and gas platforms and the Met Mast have been included. Further details of the oil and gas platforms are provided in section 8.7.

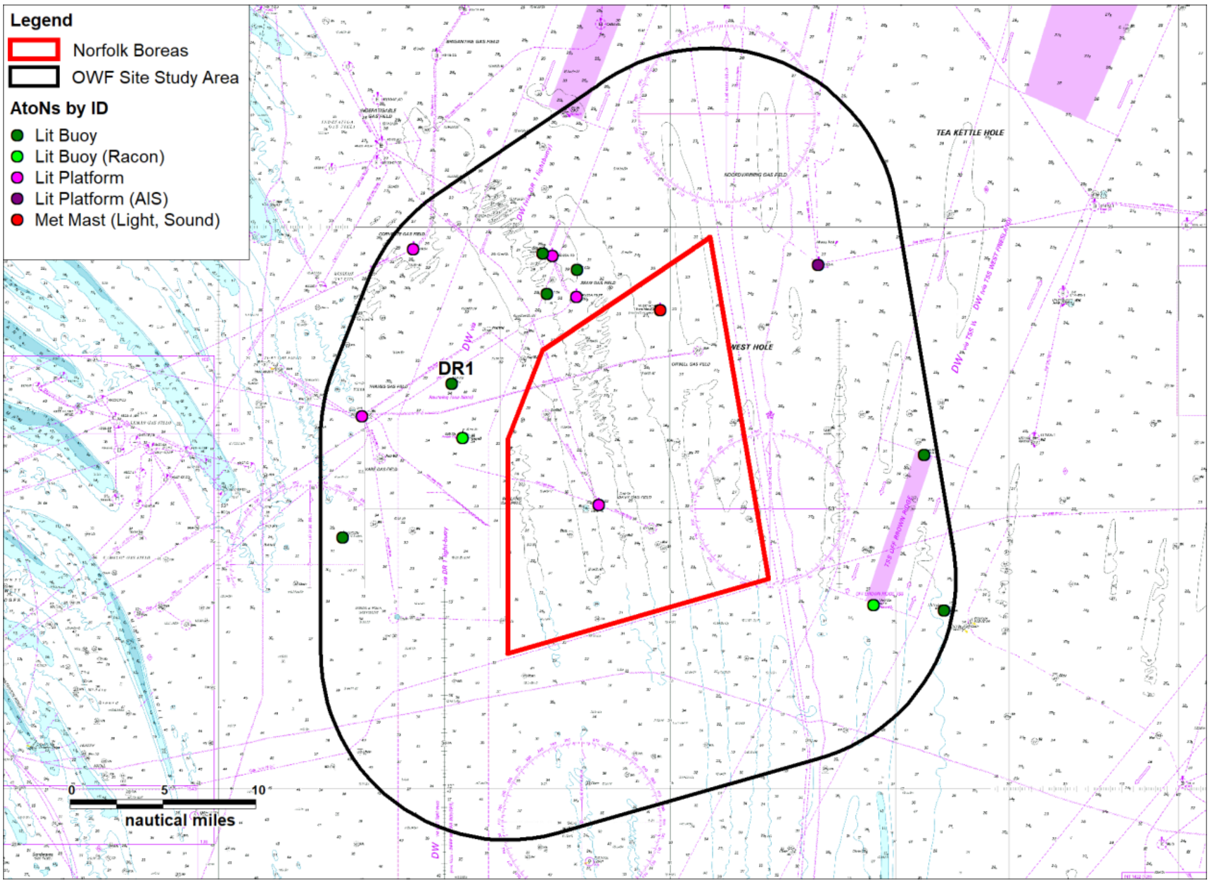


Figure 8.2 AtoNs within 10nm of Norfolk Boreas

68. Of note is the DR1 Lightbuoy marking the DR1 DWR, and the buoys and lights marking the Sean platforms north of the site. Both ends of the Off Brown Ridge TSS are marked with light buoys, with the northern buoy also fitted with Racon capability. The K13-A platform at the Noordwinning field east of the site transmits via AIS.

69. Within the Norfolk Boreas site itself, the Davy platform is lit as standard, and the Met Mast is fitted with lights and sound signals. A note on the charts states the Met Mast is also marked by buoys, however the positions of these buoys are not charted.

70. The AtoNs identified within the offshore cable corridor study area are shown in Figure 8.3. No AtoNs were identified within the offshore cable corridor itself.

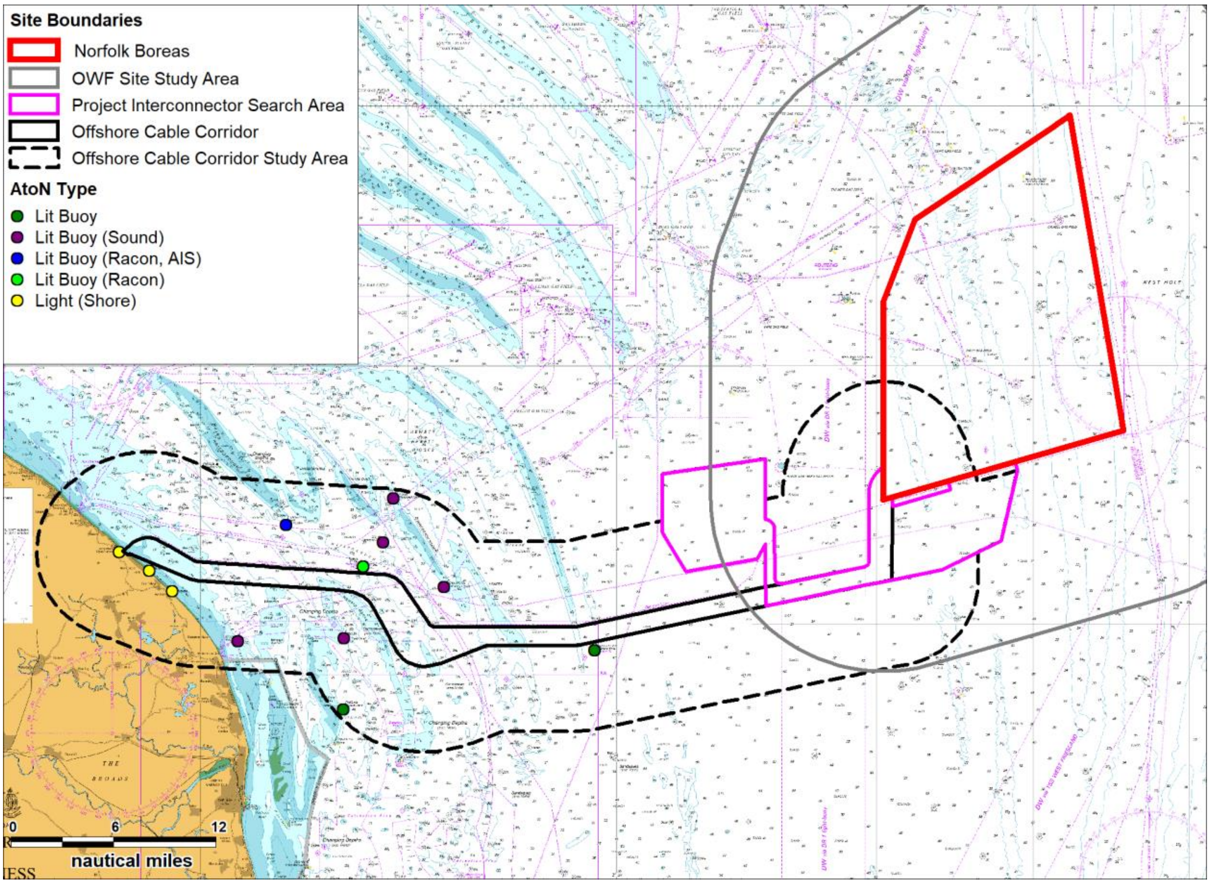


Figure 8.3 AtoNs within Offshore Cable Corridor Study Area

8.4 Anchorage Areas

71. Anchorage areas have been identified based on a review of Admiralty Charts and the Admiralty Sailing Directions (UKHO, 2016). No charted anchorages were identified, however one area recommended for anchorage within the Admiralty Sailing Directions (UKHO, 2016) was identified within the study areas, as presented in Figure 8.4.

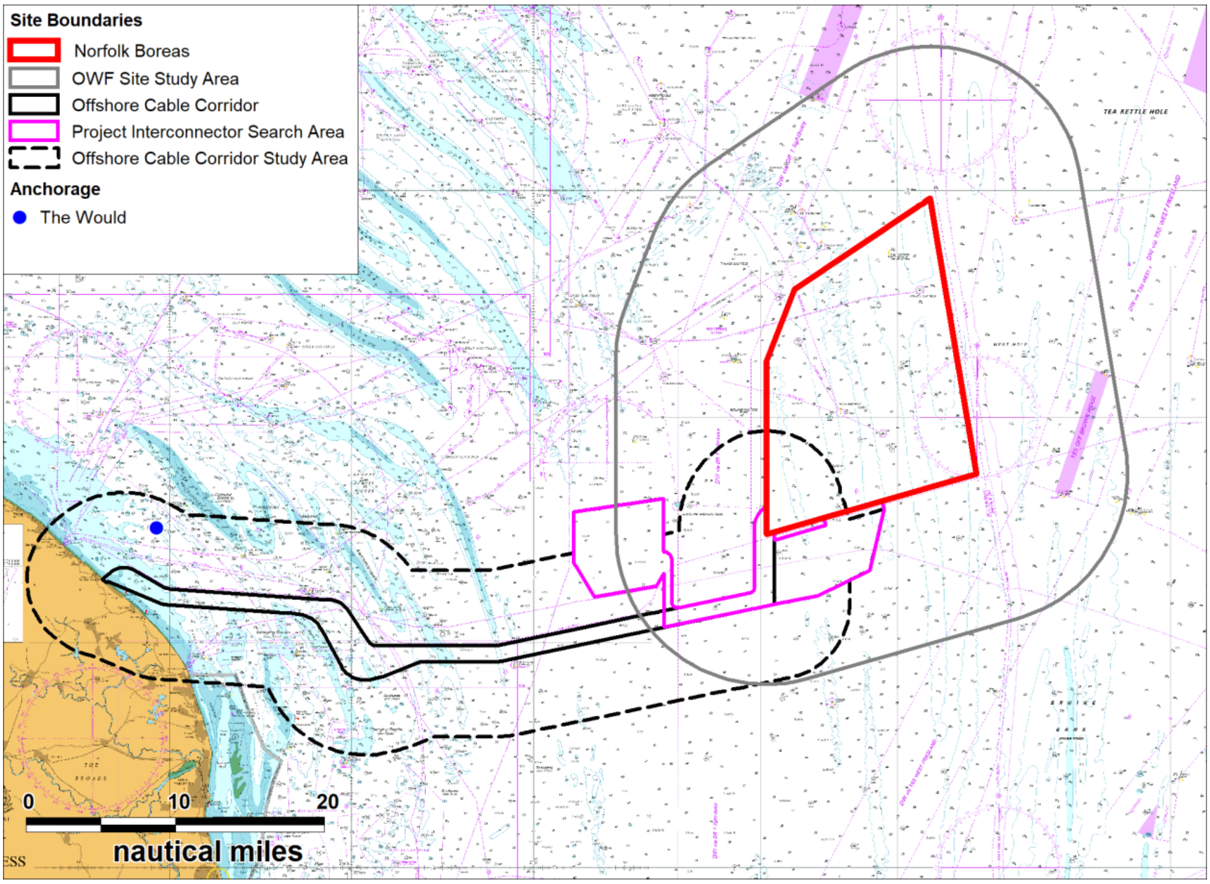


Figure 8.4 Anchorage Areas

72. The Would is noted as providing a suitable area for anchoring between Bacton and Winterton Ness, avoiding the charted wrecks, pipelines, and cables. This area is located near the export cable landfall at Happisburgh.

8.5 Ports

73. The ports within the vicinity of Norfolk Boreas are presented in Figure 8.5. There are no ports within the offshore cable corridor study area, with the nearest being Cromer and Great Yarmouth, both approximately 11nm from the corridor boundary.

74. Port arrival statistics between 2012 and 2017 (DfT, 2018) for key ports in the area are presented in Figure 8.5. Of note is an increase in callings at Great Yarmouth in 2016 over 2012 to 2015 levels. This may be related to increased wind farm activity, or North Sea decommissioning.

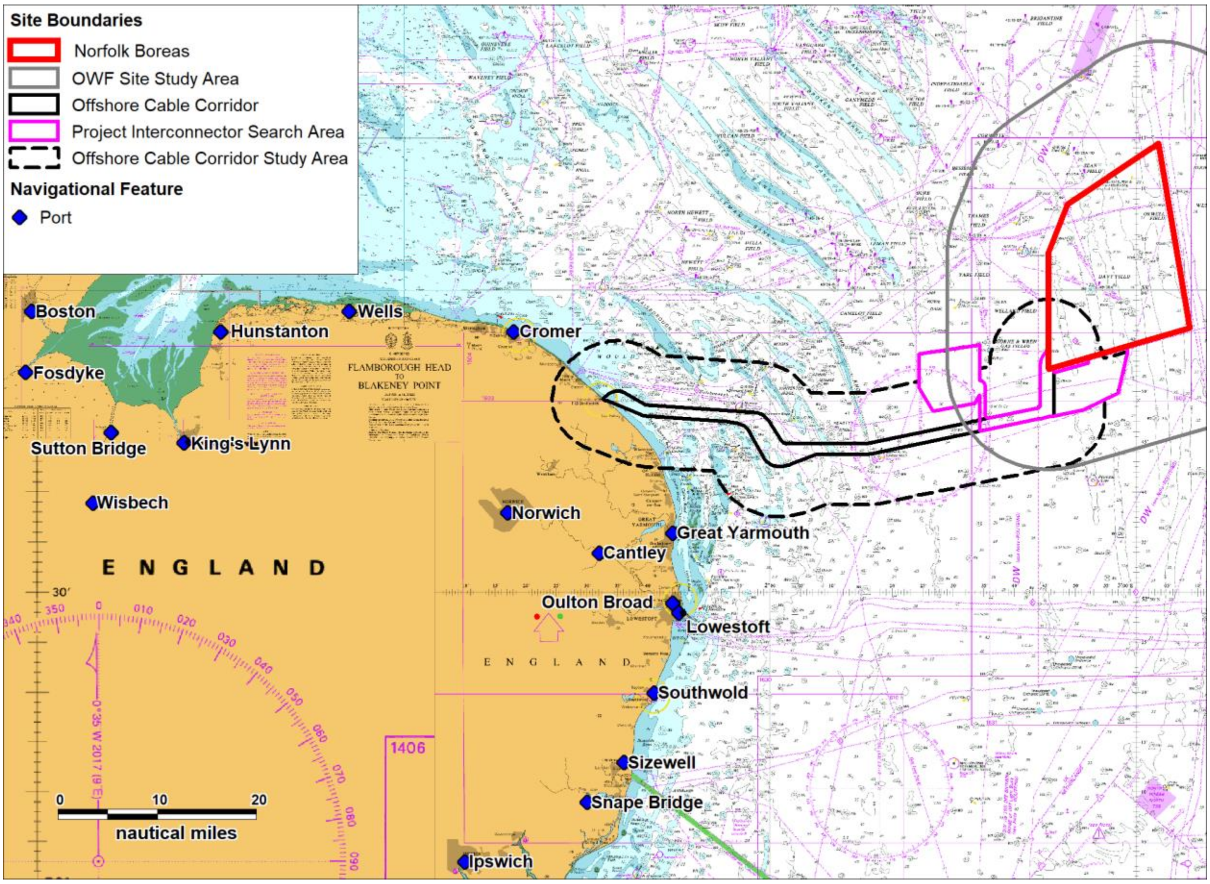


Figure 8.5 Ports relative to Norfolk Boreas

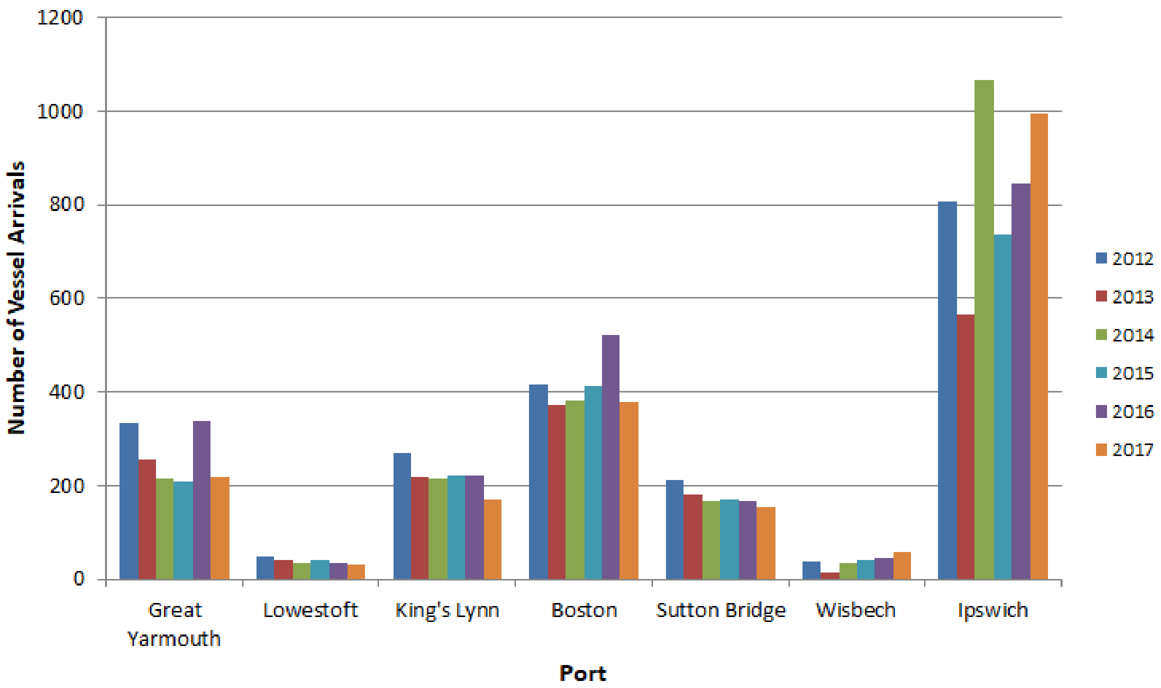


Figure 8.6 Port Arrivals 2012-2017 – includes Tanker, Roll On Roll Off (RoRo), Container, and General Cargo vessels only (DfT, 2018)

75. No pilot boarding arrangements or Vessel Traffic Services (VTS) relevant to Norfolk Boreas were identified, noting that no major ports are located within the offshore cable corridor study area.

8.6 Ministry of Defence Practice and Exercise Areas

76. There are no Ministry of Defence (MOD) Practice and Exercise Areas (PEXA) within either study area. The nearest is UKHO-PEXA-D323C, located 20nm north of Norfolk Boreas. This PEXA is used by the Royal Air Force (RAF) for air combat training, high energy manoeuvres, and supersonic flight between altitudes of 5,000 and 66,000 feet (ft).

8.7 Oil and Gas Infrastructure

77. The oil and gas platforms identified within the OWF site study area are shown in Figure 8.7. Any subsea pipeline identified as intersecting either study area has been included in the figure.

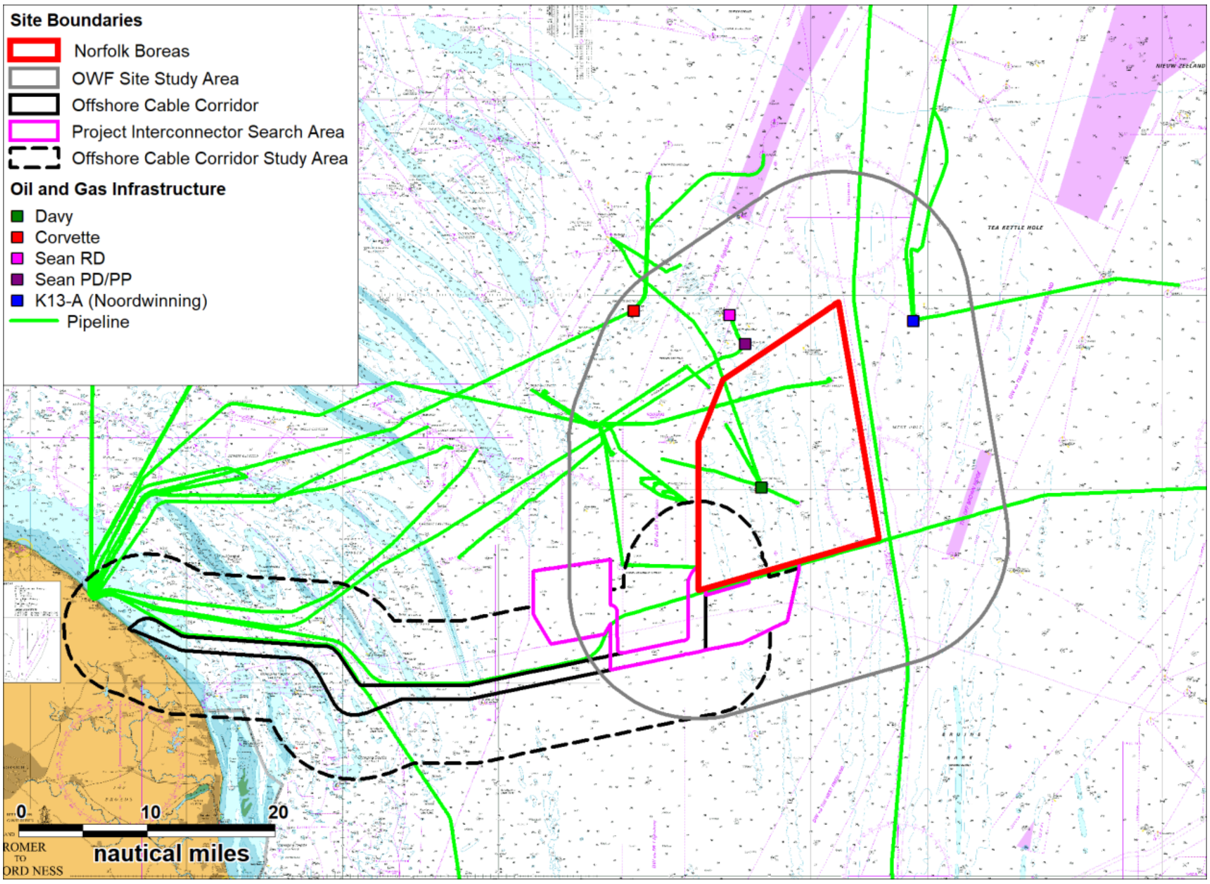


Figure 8.7 Oil and Gas Infrastructure

78. It is anticipated that the Davy platform (within the Norfolk Boreas site) will be decommissioned and removed prior to commencement of construction of Norfolk Boreas. Details of the other platforms within the OWF site study area are shown in Table 8.1.

Table 8.1 Oil and Gas Platforms within OWF Site Study Area

Platform	Distance from Norfolk Boreas Site (nm)	Status
Davy	0	Active
Sean PP	1.4	Active
Sean PD	1.4	Active
Sean RD	3.9	Active
K13-A (Noordwinning)	5.4	Inactive
Corvette	8.7	Active

79. The K13-A platform, while no longer active in terms of production, still acts as a transit station for the WestGateTransport pipeline.

8.8 Marine Aggregate Dredging Areas

80. The marine aggregate dredging areas identified are presented in Figure 8.8. Also included are indicative BMAPA dredger transit routes observed to intersect either study area.

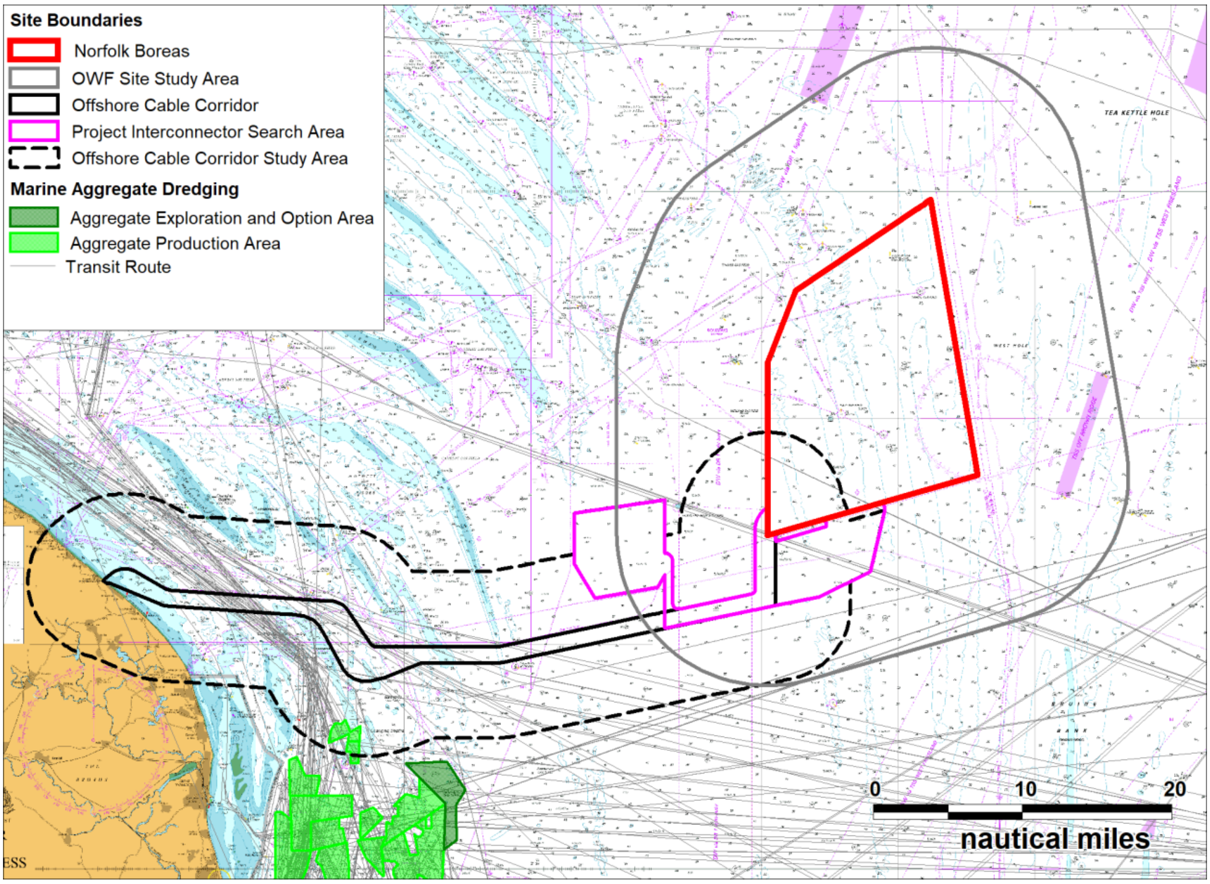


Figure 8.8 Marine Aggregate Dredging

81. There is only one marine aggregate dredging area within the study areas, the North Cross Sands aggregate production area, operated by Tarmac Marine Ltd. The majority of dredging transit routes are coastal, however continental routes were also observed, including one intersecting the Norfolk Boreas site.

8.9 Other Offshore Wind Farm Projects

82. Other nearby UK wind farm projects are presented relative to Norfolk Boreas in Figure 8.9. It should be noted that only operational wind farms or those under construction are considered within the baseline; however all relevant projects are considered cumulatively regardless of phase. Further details are provided in section 24.

83. Relevant non UK wind farms are shown in Figure 15.2 of Chapter 15 Shipping and Navigation.

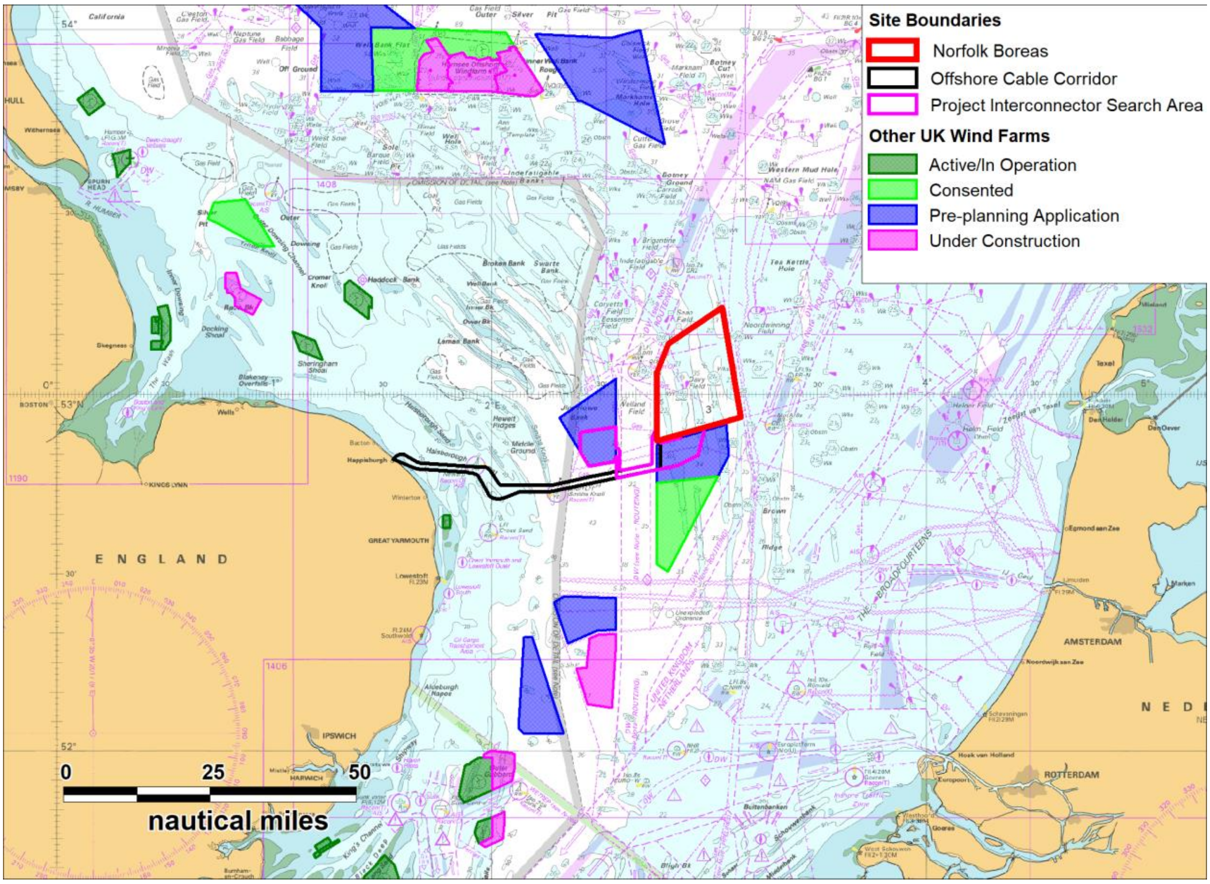


Figure 8.9 Other UK Wind Farm Projects

8.10 Submarine Cables

84. The subsea cables identified as crossing the study areas are shown in Figure 8.10.

85. Overall, five subsea cables were identified within the study areas. Four of these cables intersect the offshore cable corridor, and three make landfall within the offshore cable corridor study area, all at Winterton-on-Sea, approximately 8nm south east of the landfall site. One of these cables was also observed to intersect the Norfolk Boreas site.

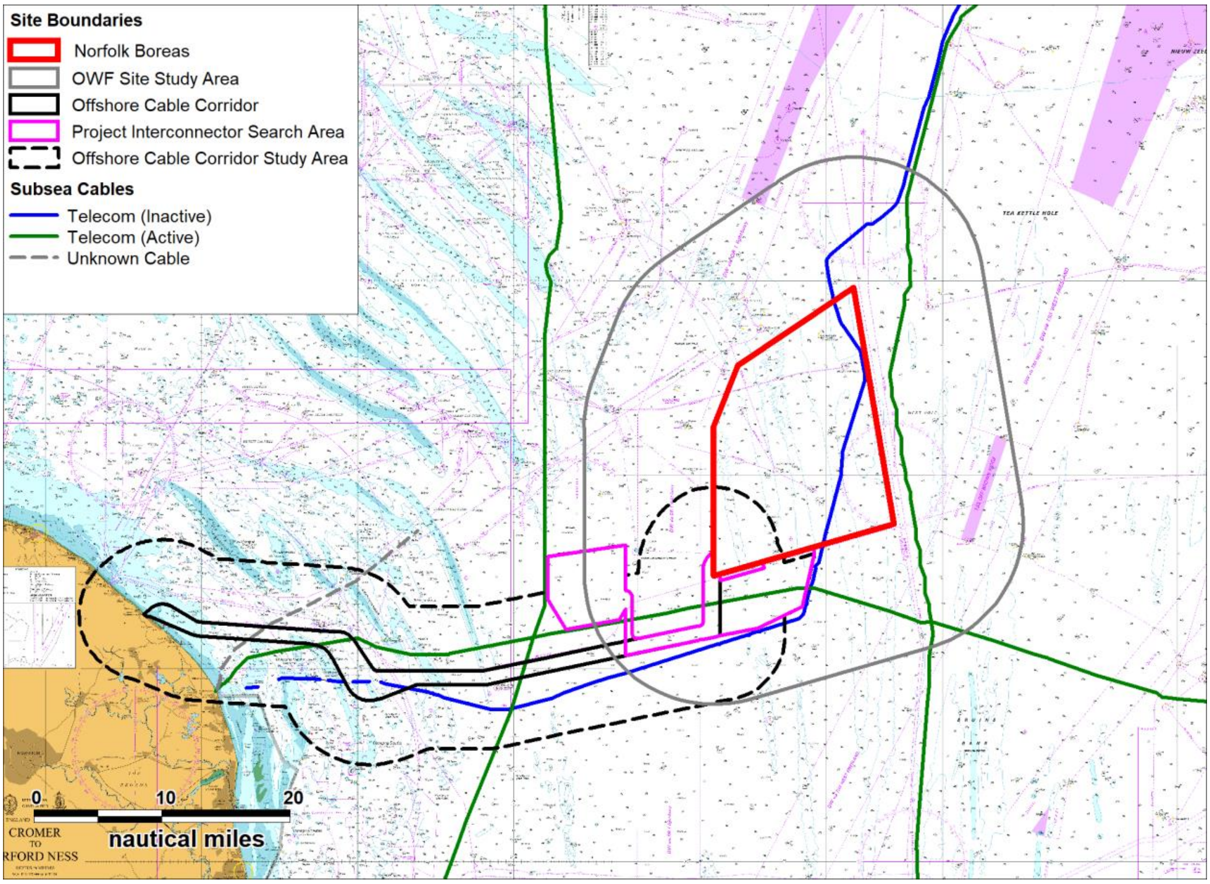


Figure 8.10 Submarine Cables

8.11 Marine Environmental High Risk Areas

86. There were no Marine Environmental High Risk Areas (MEHRAs) identified on the coast of the offshore cable corridor study area, with the nearest being in excess of 40nm to the south.

8.12 Wrecks

87. The locations of the wrecks identified within the study areas are presented in Figure 8.11.

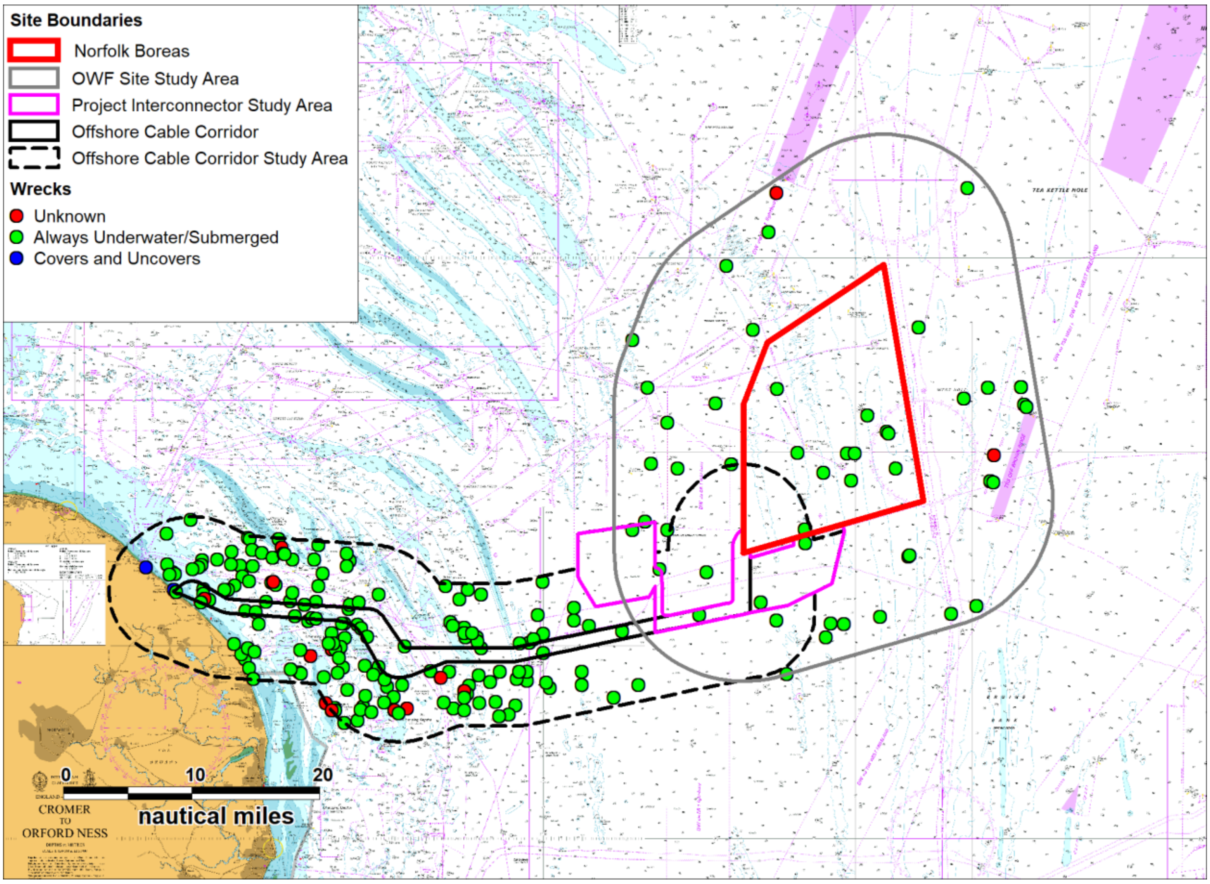


Figure 8.11 Wrecks relative to Norfolk Boreas

88. There are a total of 57 wrecks within the OWF site study area, 11 of which are within the Norfolk Boreas site itself. A total of 177 wrecks lie within the offshore cable corridor study area, 19 of which are within the offshore cable corridor itself.

9 MetOcean Data

89. The data used to establish MetOcean conditions within the vicinity of the Norfolk Boreas site is detailed below. Further details of MetOcean conditions are available in Chapter 8 Marine Geology, Oceanography and Physical processes.

9.1 Wind Data

90. Wind direction probabilities in the area have been estimated based on data collected from the local Met Mast between 2013 and 2016. Longer term in-house data has been used for the purposes of validating the Met Mast data findings; however it is noted that the additional data was collected from two points outwith the Norfolk Boreas site.

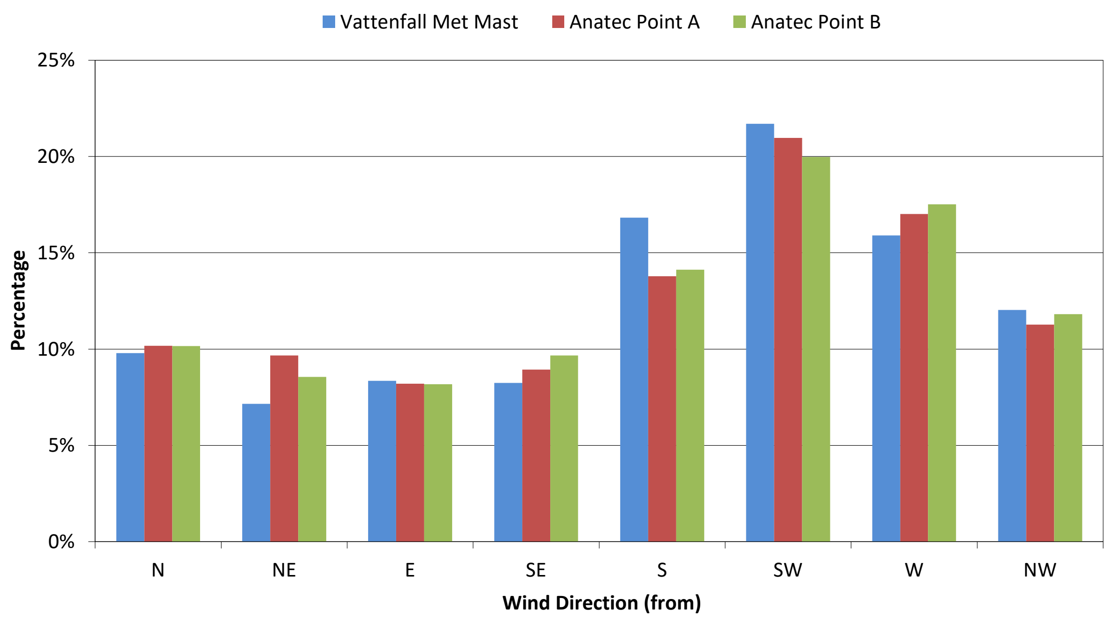


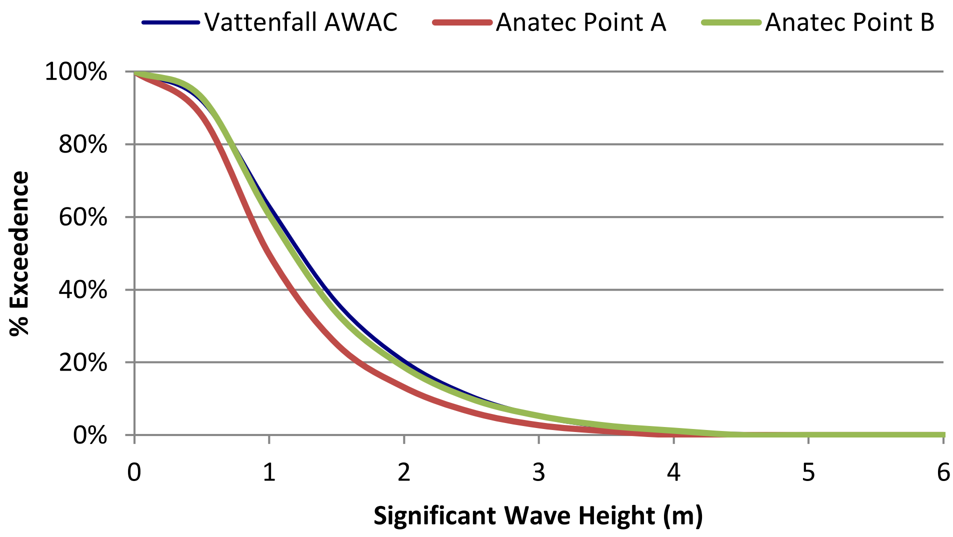
Figure 9.1 Wind Direction Probability

91. There was good correlation between the Met Mast data and Anatec's in-house data, with both indicating the prevalent direction was from the south west. Based on the findings of the validation, the Met Mast data has been used as input to the collision and allision modelling undertaken as part of this NRA.

9.2 Wave

92. Significant wave height data was available from an Acoustic Waves and Currents (AWAC) sensor located within the Norfolk Vanguard East site over a 12 month period from December 2012 to December 2013. To ensure the data is indicative of conditions within the Norfolk Boreas site, Anatec's long term in-house data has been used to validate the findings. The significant wave height exceedance curve produced by the AWAC data is presented in Figure 9.3, which includes the equivalent data

from the same two Anatec in-house MetOcean data sources introduced in section 9.2.



93. It is observed that overall there is again good correlation between the data collected by Vattenfall and Anatec's in house data, with the proportion of the significant wave height exceeding 5m (defined as a severe sea state) only 0.09%.

9.3 Visibility

94. Historically, visibility has been shown to have a major influence on the risk of vessel collision and allision. The annual average probability of bad visibility (defined as less than 1km) for the UK North Sea is approximately 0.03, i.e. an average of 3.0% of the year[2]. The North Sea (West) Pilot NP 54 (UKHO 2016) gives approximate values for visibility in the area, as shown in Table 9.1.

Table 9.1 Average Incidence of Fog (UKHO 2016)

Month	Incidence of Fog
February	3 to 4%
May	3 to 4%
August	1 to 2%
November	0 to 1%

[2] Estimated based on All Year Weather Data - Central North Sea (Forties), 1st January 1975 to 31st December 1994, Norwegian Meteorological Institute, Weather Data Recorded at the Frigg Field from January 1981 to December 1997, and Met Office Data for Sea Area 52.7-54.3° N, 001-003° E, October 1854 to October 1992.

95. As part of the Norfolk Vanguard NRA (Anatec, 2018) for the purposes of validation, an assessment of visibility data recorded from a Met Mast installed at Ijmuiden was also undertaken. The data indicated that incidence of poor visibility (< 1km) was approximately 2%.

96. For the purposes of the modelling (see section 21) and based upon the available information, the probability of poor visibility has been assumed to be in line with the UK North Sea average, namely 3%.

9.4 Tide

97. Tidal current data has been taken from UKHO Admiralty Chart 1408. The positions of the diamonds considered are presented in Figure 9.2. Following this, the table showing the corresponding tidal stream details (taken directly from the chart) is presented in Figure 9.3.

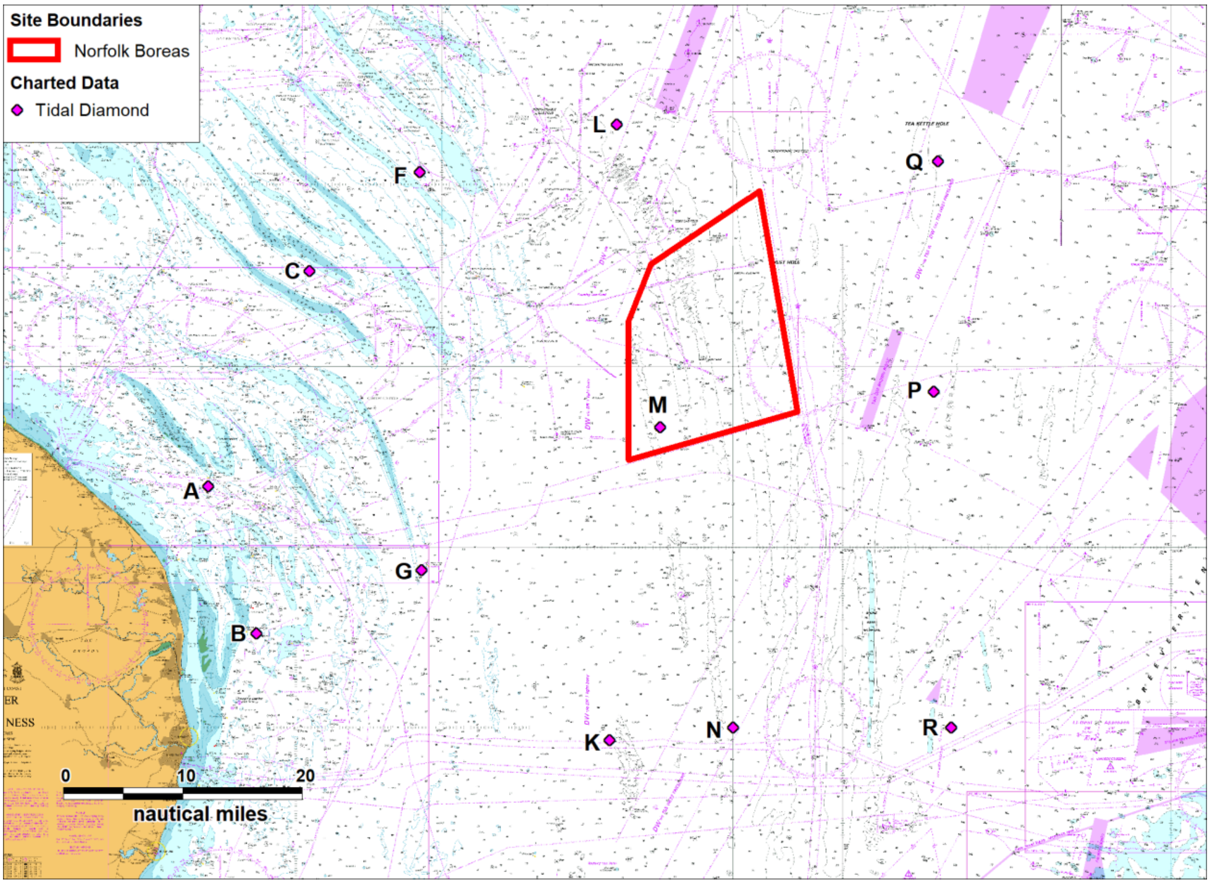


Figure 9.2 UKHO Admiralty Chart 1408 Tidal Diamond Locations

Tidal Streams referred to HW at DOVER

	A 52°50'0N 1 47·9E		B 52°38'0N 1 54·4E		C 53°08'0N 2 01·9E		D 51°59'0N 2 05·9E		E 52°15'5N 2 11·6E		F 53°16'5N 2 16·9E		G 52°43'0N 2 16·9E		H 51°51'0N 2 29·4E		J 52°01'0N 2 40·0E		K 52°29'0N 2 43·0E		
−6	141	0·6 0·4	004	0·2 0·0	134	0·7 0·3	073	0·6 0·4	005	0·5 0·3	049	0·4 0·2	014	1·0 0·5	337	0·3 0·2	328	0·6 0·4	053	0·6 0·5	−6
−5	141	1·9 1·1	178	1·8 1·2	138	1·7 1·1	198	0·8 0·3	196	0·9 0·5	131	1·1 0·5	139	0·5 0·3	224	0·6 0·4	324	0·7 0·3	180	0·3 0·3	−5
−4	141	2·6 1·5	179	2·9 1·9	141	2·2 1·4	202	1·8 0·8	195	1·9 1·1	139	2·1 1·0	169	1·7 0·8	209	1·5 1·0	208	1·5 0·7	190	1·0 0·5	−4
−3	141	2·5 1·5	179	3·5 2·2	141	1·9 1·4	203	2·1 1·3	197	2·4 1·3	146	2·1 1·1	175	2·2 1·1	209	1·9 1·3	207	1·8 1·2	192	1·4 0·9	−3
−2	141	1·9 1·1	179	2·9 2·1	143	1·2 0·9	205	2·2 1·4	201	2·3 1·3	152	1·7 0·9	180	2·0 1·0	206	1·6 1·0	208	1·8 1·2	195	1·5 1·1	−2
−1	141	0·9 0·5	179	1·8 1·4	154	0·3 0·2	204	1·8 1·1	202	1·8 1·0	167	0·9 0·5	185	1·7 0·8	199	1·0 0·7	204	1·5 0·9	195	1·3 0·9	−1
0	321	0·2 0·1	180	0·4 0·2	300	0·6 0·2	196	0·8 0·5	208	0·7 0·4	267	0·5 0·2	190	1·0 0·5	176	0·4 0·3	187	0·7 0·5	191	0·9 0·6	0
+1	321	1·4 0·8	357	1·2 0·9	318	1·2 0·8	063	0·6 0·3	018	0·7 0·4	312	0·9 0·5	306	0·3 0·1	051	0·5 0·3	078	0·7 0·4	077	0·3 0·2	+1
+2	321	2·3 1·3	359	2·7 1·8	321	1·7 1·2	032	1·6 0·8	024	1·9 1·0	320	1·5 0·7	348	1·2 0·6	036	1·3 0·9	039	1·4 0·8	027	0·9 0·5	+2
+3	321	2·7 1·5	359	3·3 2·3	321	1·9 1·3	027	2·1 1·2	022	2·4 1·3	325	2·0 1·0	354	1·9 1·0	022	1·6 1·1	031	1·8 1·1	018	1·4 0·9	+3
+4	321	2·4 1·3	359	3·1 2·1	321	1·6 1·1	026	2·1 1·2	019	2·4 1·3	329	2·0 1·0	356	2·1 1·1	027	1·6 1·1	026	1·8 1·1	014	1·7 1·0	+4
+5	321	1·4 0·7	359	2·2 1·6	324	0·8 0·6	026	1·6 0·9	016	1·9 1·1	331	1·3 0·6	359	1·9 0·9	021	1·0 0·7	018	1·5 0·8	009	1·4 0·9	+5
+6		0·0 0·0	000	1·0 0·7	122	0·2 0·1	024	0·8 0·6	009	1·0 0·5	002	0·6 0·3	009	1·2 0·6	357	0·4 0·3	004	0·8 0·5	005	0·9 0·6	+6

	L 53°20'0N 2 44·0E		M 52°55'0N 2 50·0E		N 52°30'0N 2 59·9E		P 52°58'0N 3 27·5E		Q 53°17'0N 3 28·0E		R 52°30'0N 3 30·0E		S 51°52'5N 3 38·8E		T 52°56'0N 4 20·0E		U 53°14'0N 4 25·0E		V 53°27'0N 4 47·0E		
−6	078	0·7 0·5	062	0·6 0·4	353	0·6 0·3	039	0·8 0·4	057	0·8 0·6	018	0·6 0·4	312	0·5 0·4	020	1·0 0·8	038	1·1 0·9	054	1·3 1·0	−6
−5	120	0·9 0·4	131	0·7 0·3	152	0·4 0·2	118	0·5 0·3	094	0·7 0·5	150	0·1 0·1	237	0·9 0·6	059	0·5 0·4	051	0·8 0·6	060	1·1 0·8	−5
−4	147	1·0 0·6	166	1·1 0·6	165	1·0 0·5	159	0·6 0·3	138	0·7 0·4	190	0·9 0·6	223	1·4 0·9	158	0·4 0·2	097	0·4 0·3	069	0·8 0·5	−4
−3	161	1·1 0·8	177	1·4 0·9	186	1·4 0·7	172	1·2 0·8	169	0·9 0·6	203	1·4 1·0	222	1·5 1·1	191	0·9 0·8	180	0·4 0·5	100	0·3 0·2	−3
−2	173	1·0 0·8	187	1·4 1·0	205	1·5 0·7	195	1·2 0·8	189	0·9 0·8	204	1·6 1·1	222	1·5 1·1	197	1·2 1·0	204	0·8 0·8	203	0·5 0·5	−2
−1	194	0·8 0·6	198	1·1 0·8	201	1·1 0·5	206	1·0 0·8	205	0·8 0·7	201	1·1 0·8	218	1·2 0·8	199	1·2 1·0	211	1·0 0·9	229	0·8 0·8	−1
0	233	0·5 0·4	214	0·8 0·5	217	0·6 0·3	211	0·8 0·6	222	0·7 0·6	198	0·6 0·3	196	0·6 0·4	200	1·0 0·8	215	1·0 0·9	233	1·0 0·9	0
+1	282	0·6 0·4	284	0·4 0·2	291	0·1 0·0	256	0·6 0·4	249	0·6 0·4	224	0·2 0·1	087	0·9 0·6	203	0·8 0·5	221	0·9 0·7	238	1·1 0·9	+1
+2	323	0·8 0·5	347	0·9 0·5	006	0·7 0·4	326	0·3 0·1	296	0·5 0·3	006	1·0 0·7	051	1·6 1·0	207	0·3 0·1	230	0·6 0·4	242	1·0 0·6	+2
+3	347	1·1 0·7	005	1·3 0·9	016	1·3 0·6	358	1·1 0·6	357	0·8 0·5	013	1·3 0·9	043	1·7 1·2	000	0·8 0·7	350	0·3 0·4	242	0·7 0·3	+3
+4	001	1·0 0·8	010	1·5 1·0	017	1·5 0·7	005	1·3 0·8	016	1·0 0·8	013	1·5 1·0	039	1·4 1·0	017	1·4 1·1	025	1·0 0·8	022	0·5 0·5	+4
+5	017	0·7 0·7	014	1·2 0·9	010	1·3 0·6	012	1·3 0·8	026	1·0 0·8	014	1·3 0·8	029	1·0 0·7	016	1·4 1·1	030	1·3 1·1	047	1·1 0·9	+5
+6	059	0·6 0·5	036	0·7 0·6	356	0·9 0·4	017	1·0 0·6	045	0·8 0·7	014	0·8 0·6	345	0·5 0·4	018	1·1 0·9	035	1·2 1·0	051	1·3 1·0	+6

Figure 9.3 UKHO Admiralty Chart 1408 Tidal Stream Data

98. Based on the available data and the distance offshore of the Norfolk Boreas site, no impacts are expected at high water that would not also be expected at low water, and vice versa. The structures within the Norfolk Boreas site are expected to have no impact on the existing tidal streams.

10 Emergency Response

10.1 Introduction

99. This section summarises the existing SAR resources relevant to Norfolk Boreas and the surrounding waters. Given the distance offshore, Norfolk Boreas Limited will be required to consider self-help facilities for its own personnel and vessels. As per requirements under the International Convention for the Safety of Life at Sea (SOLAS) (IMO, 1974), any on-site vessels will also render assistance to a third party vessel in distress if they are able.

10.2 SAR Helicopters

100. In March 2013, the Bristow Group were awarded the contract by the MCA (as an executive agency of DfT) to provide helicopter SAR operations in the UK over a ten year period. Bristow have now been operating the service since April 2015, and operate ten base locations strategically placed around the UK from which helicopters are mobilised, as shown in Figure 10.1.

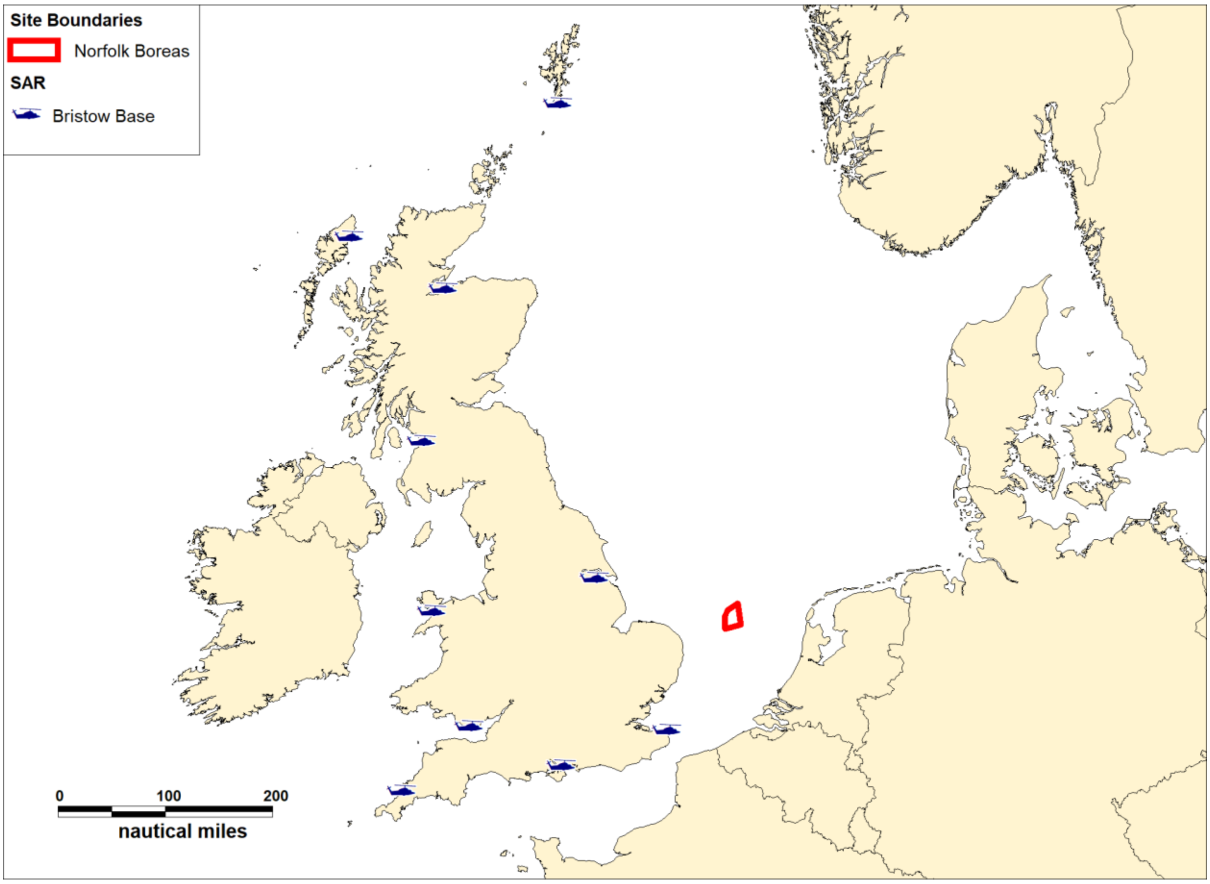


Figure 10.1 Bristow SAR Bases in UK

101. The nearest bases to Norfolk Boreas are those at Manston (~110nm) and Humberside (~120nm). Manston is equipped with two Agusta Westland AW189 helicopters, and Humberside with two Sikorsky S92 helicopters. Both helicopter types have air speeds of 145 knots, and endurance times of over four hours. The base from which helicopters would be mobilised in the event of an incident requiring helicopter assistance at Norfolk Boreas would be dependent upon the resources available at the time, however it would likely be from either the Manston or Humberside base.

10.3 RNLI

102. At the time of writing, the RNLI operate 238 lifeboat stations located around the UK and Ireland, with an active fleet of more than 350 lifeboats. This includes both All Weather Lifeboats (ALB) which can be operated in all weather conditions, and Inshore Lifeboats (ILB), suitable for coastal operations. The RNLI now also utilise Hover Lifeboats (HLB), which are capable of navigating areas which ALBs and ILBs cannot (e.g. mudflats); however no HLBs are available at the stations considered for Norfolk Boreas.

103. The positions of RNLI stations within 100nm of the Norfolk Boreas site are presented in Figure 10.2. ALBs generally operate within a 100nm limit (due to endurance and transit time). Details of these stations are then provided in Table 10.1.

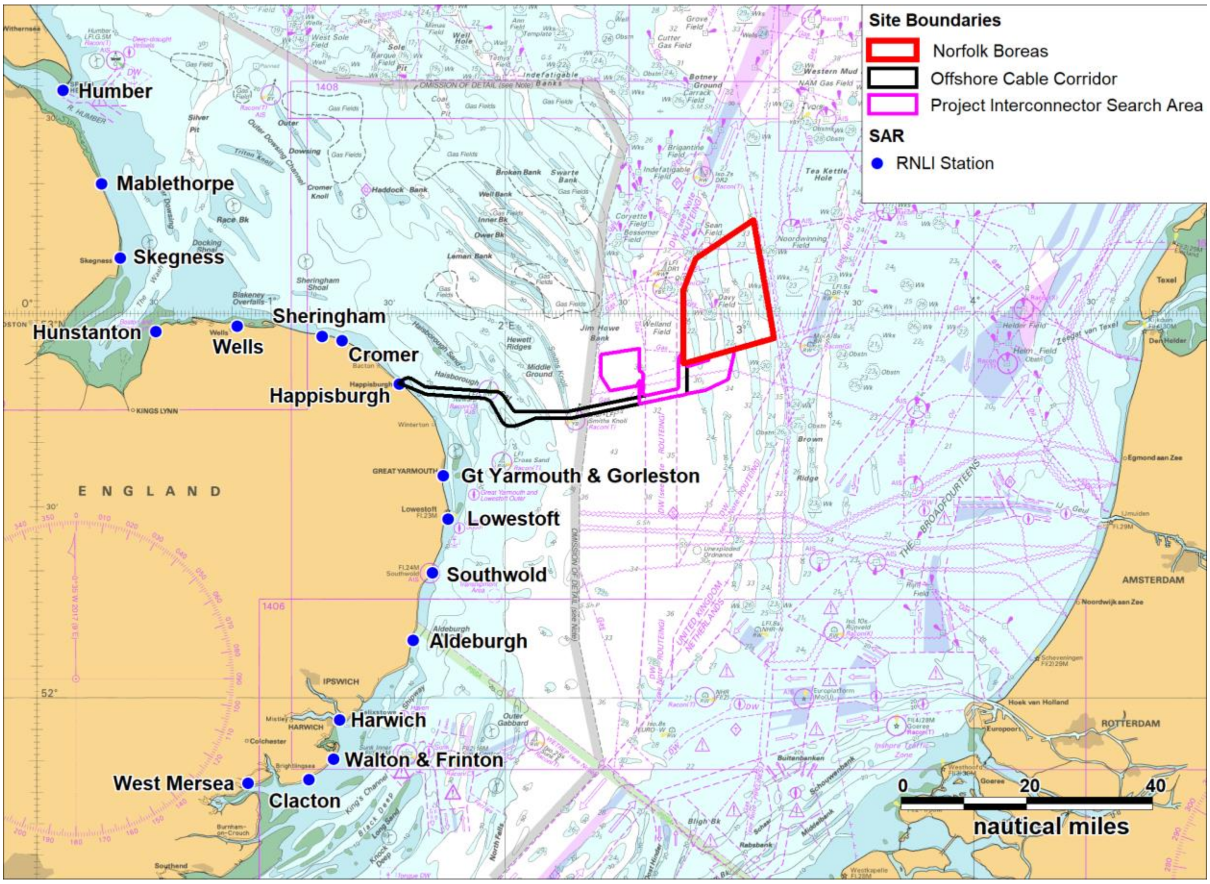


Figure 10.2 RNLI Stations within 100nm of Norfolk Boreas

Table 10.1 RNLI Stations within 100nm of Norfolk Boreas - Details

Station	Lifeboats	ALB Class	ILB Class	Approx. Distance to Site (nm)
Aldeburgh	ALB and ILB	Mersey	D Class	60
Clacton	ILB (×2)	–	B and D Class	88
Cromer	ALB and ILB	Tamar	D Class	52
Great Yarmouth & Gorleston	ALB and ILB	Trent	B Class	41
Happisburgh	ILB (×2)	–	B and D Class	44
Harwich	ALB and ILB	Severn	B Class	77
Humber	ALB	Severn	–	100
Hunstanton	ILB and HLB	–	B Class	82
Lowestoft	ALB	Shannon	–	44
Mablethorpe	ILB (x2)	–	D Class	92

Station	Lifeboats	ALB Class	ILB Class	Approx. Distance to Site (nm)
Sheringham	ILB	–	B Class	56
Skegness	ALB and ILB	Shannon	D Class	89
Southwold	ILB	–	B Class	51
Walton & Frinton	ALB	Tamar	–	83
Wells	ALB and ILB	Mersey	D Class	69
West Mersea	ILB	–	B Class	95

10.4 HM Coastguard Stations

104. HM Coastguard, a division of the MCA, is responsible for requesting and tasking SAR resources made available to other authorities and for co-ordinating the subsequent SAR operations (unless they fall within military jurisdiction).

105. The HM Coastguard co-ordinates SAR through a network of 11 Coastguard Operations Centres (CGOC), including a National Maritime Operations Centre based in Hampshire. A corps of over 3,500 volunteer Coastguard Rescue Officers around the UK form over 352 local Coastguard Rescue Teams (CRT) involved in coastal rescue, searches and surveillance.

106. All of the MCA's operations, including SAR, are divided into three geographical regions. The East of England Region covers the east and south coasts of England from the Scottish border down to the Dorset and Devon border, and therefore covers the area around Norfolk Boreas.

107. Each region is divided into six districts with its own CGOC, which coordinates the SAR response for maritime and coastal emergencies within its district boundaries (East of England includes an additional station, London Coastguard, for co-coordinating SAR on the River Thames). The nearest rescue co-ordination centre to Norfolk Boreas is the Humber CGOC based in Bridlington, East Yorkshire, located approximately 125nm from the site.

10.5 Third Party Assistance

108. Companies operating offshore typically have resources of vessels, helicopters and other equipment available for normal operations that can assist with emergencies offshore. Additionally all vessels under IMO obligations set out in SOLAS (IMO, 1974) as amended are required to render assistance to any person or vessel in distress if safely able to do so.

11 Maritime Incidents

11.1 Introduction

109. This section reviews maritime incidents that have occurred in the vicinity of Norfolk Boreas throughout the ten year period between 2005 and 2014.

110. The analysis is intended to provide a general indication as to whether the area of the proposed project is currently low or high risk in terms of maritime incidents. If it was found to be a particularly high risk area for incidents, this may indicate that the project could exacerbate the existing maritime safety risks in the area.

111. Data from the following sources have been analysed:

- MAIB; and
- RNLI Response.

112. It should be considered that the same incident can be recorded within both sources.

11.2 MAIB Incident Data

11.2.1 Overview

113. All UK commercial vessels are required to report accidents to the MAIB. Non-UK vessels do not have to report unless they are in a UK port or within 12nm territorial waters and carrying passengers to a UK port. There are also no requirements for non-commercial recreational craft to report accidents to the MAIB.

114. The MAIB aim for 97% accuracy when reporting the locations of incidents.

11.2.2 Norfolk Boreas Site

115. No incidents were recorded by the MAIB within the OWF site study area during the period studied. This is likely due to the distance of the site from the shore. As referenced in the introductory text, this should not be taken to mean no incidents occurred, merely that none were reported to the MAIB within the timeframe studied.

11.2.3 Offshore Cable Corridor

116. The incidents recorded by the MAIB within the offshore cable corridor study area between 2005 and 2014 are presented in Figure 11.1, colour coded by incident type. Following this, the incidents are presented colour coded by vessel type in Figure 11.2.

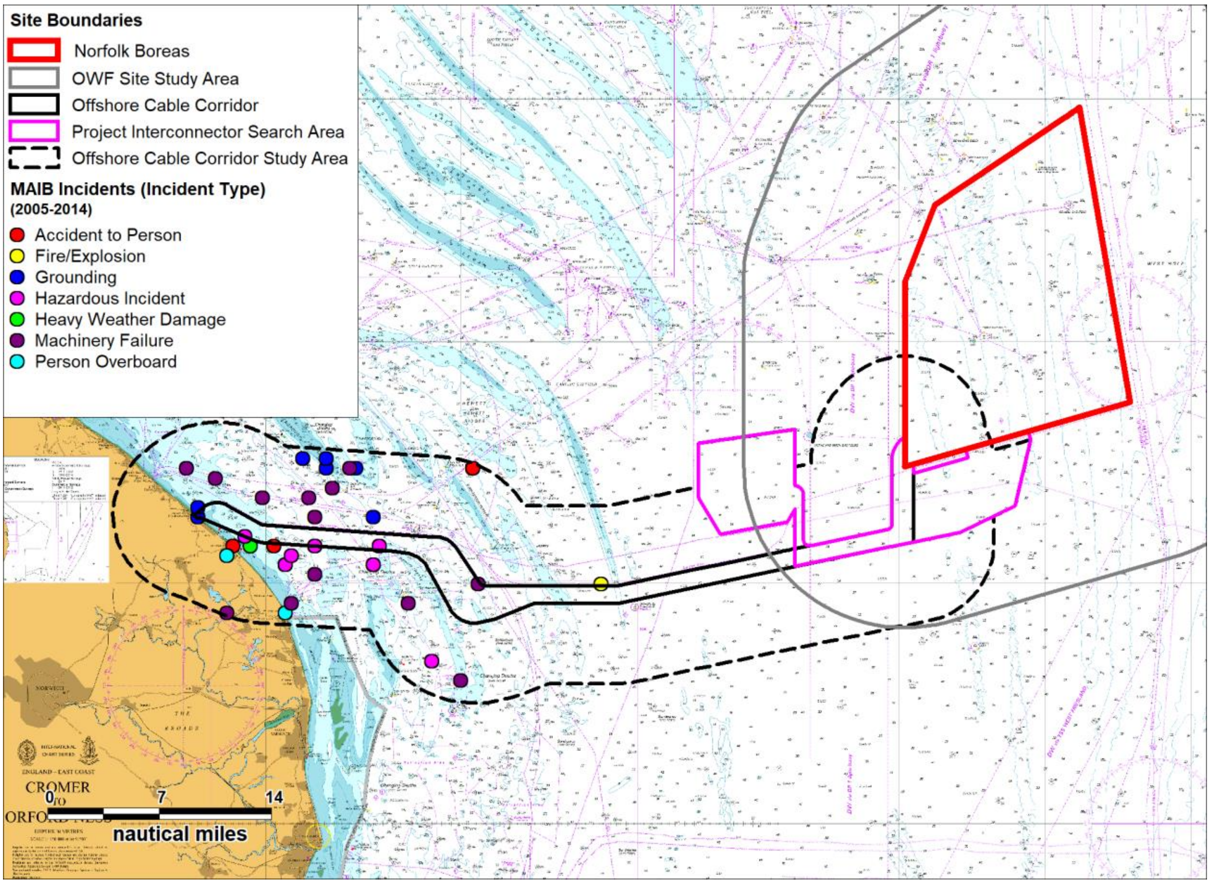


Figure 11.1 MAIB Incident Data (2005 to 2014) – Offshore Cable Corridor (Incident Type)

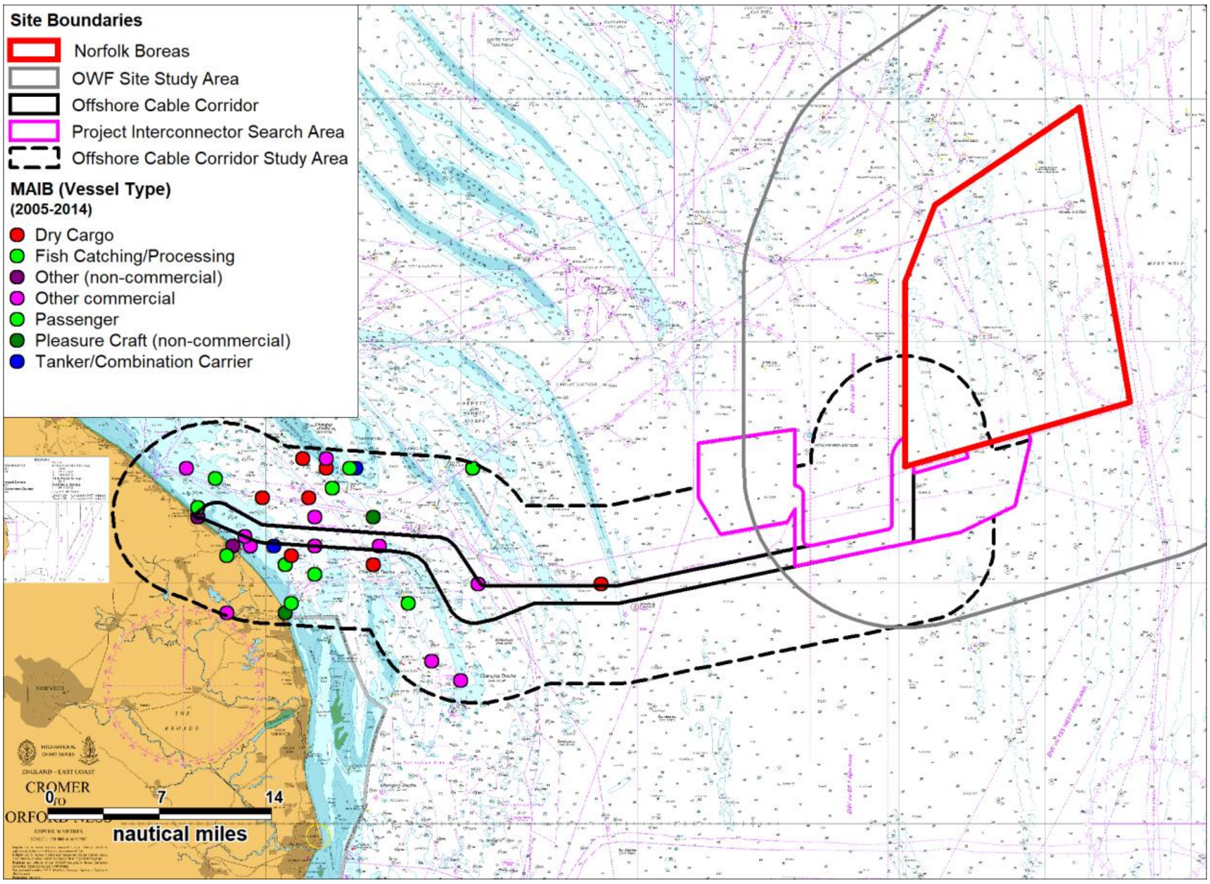


Figure 11.2 MAIB Incident Data (2005 to 2014) – Offshore Cable Corridor (Vessel Type)

117. The MAIB recorded a total of 38 incidents within the offshore cable corridor study area, six of which occurred within the offshore cable corridor itself. The most common incident type was "machinery failure" (41%), followed by "grounding" (22%) and "hazardous incident" (19%). The most common type of vessel involved in the recorded incidents was "other commercial" (34%), followed by "fish catching / processing" (27%).

118. Of particular relevance to the offshore cable corridor are three grounding incidents recorded as occurring near the Happisburgh landfall area. The three vessels associated with these incidents comprised a beam trawler, survey vessel, and small vessel with an outboard motor. No damage was recorded in the beam trawler incident, but the remaining two groundings resulted in "material damage" to the vessels involved.

11.3 RNLI Incident Data

11.3.1 Overview

119. This data provides details of incidents to which the RNLI have responded to (i.e. mobilised at least one lifeboat) during the ten year period between 2005 and 2014.

11.3.2 Norfolk Boreas Site

120. The incidents recorded by the RNLI within the OWF site study area between 2005 and 2014 are presented in Figure 11.3, colour coded by incident type.

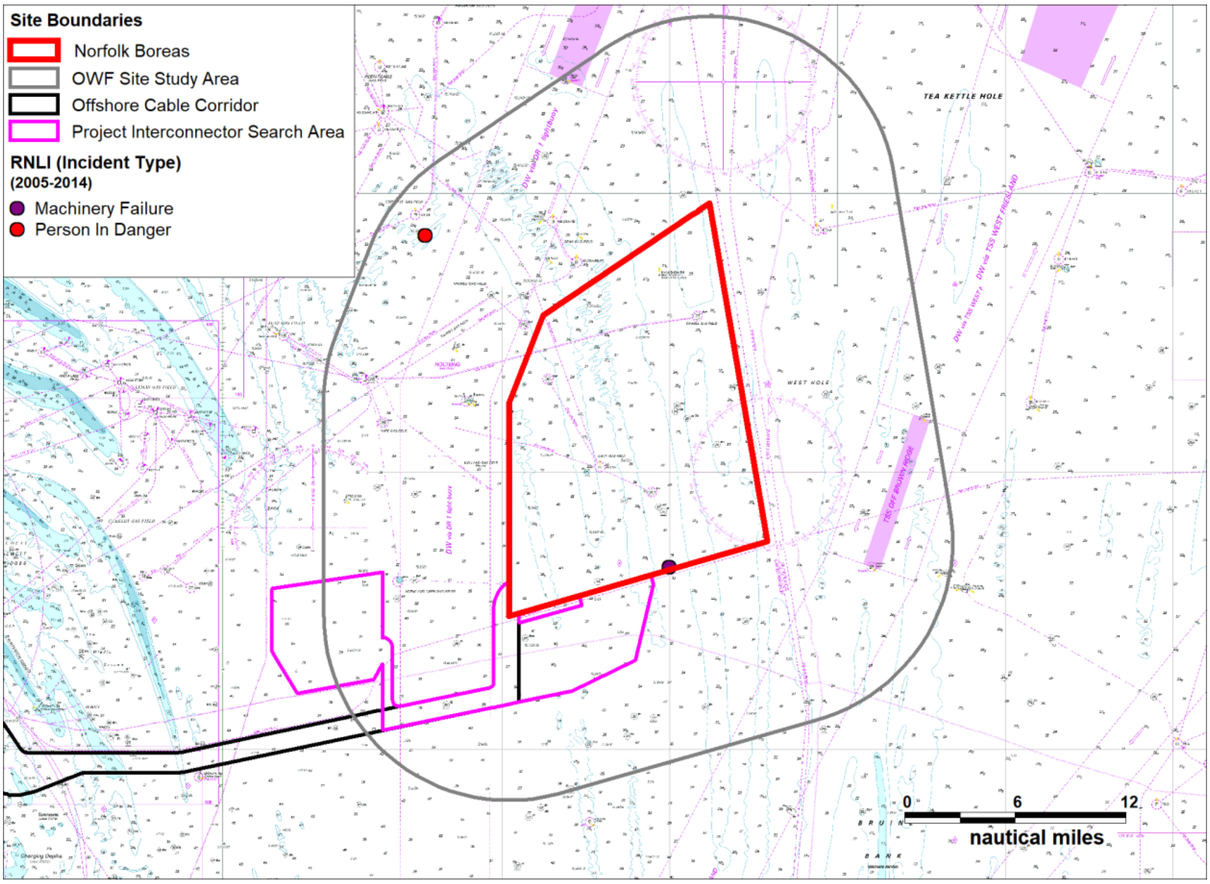


Figure 11.3 RNLI Incident Data (2005 to 2014) – Norfolk Boreas Site (Incident Type)

121. The RNLI responded to two incidents within the OWF site study area between 2005 and 2014. The first was an instance of "machinery failure" in 2010, when two crew members were rescued from a yacht with a fouled propeller. The second occurred in 2012, and involved the rescue of an injured crew member from an oil and gas support vessel. A Trent class ALB was mobilised from Great Yarmouth & Gorleston to respond to the former incident, while a Tamar class ALB from Cromer responded to the latter.

122. As shown in Figure 11.3, the "machinery failure" incident occurred within the Norfolk Boreas site, based on the information provided by the RNLI.

11.3.3 Offshore Cable Corridor

123. The incidents recorded by the RNLI within the offshore cable corridor study area between 2005 and 2014 are presented in Figure 11.3, colour coded by incident type. Following this, the recorded incidents are shown in Figure 11.5 colour coded by casualty type.

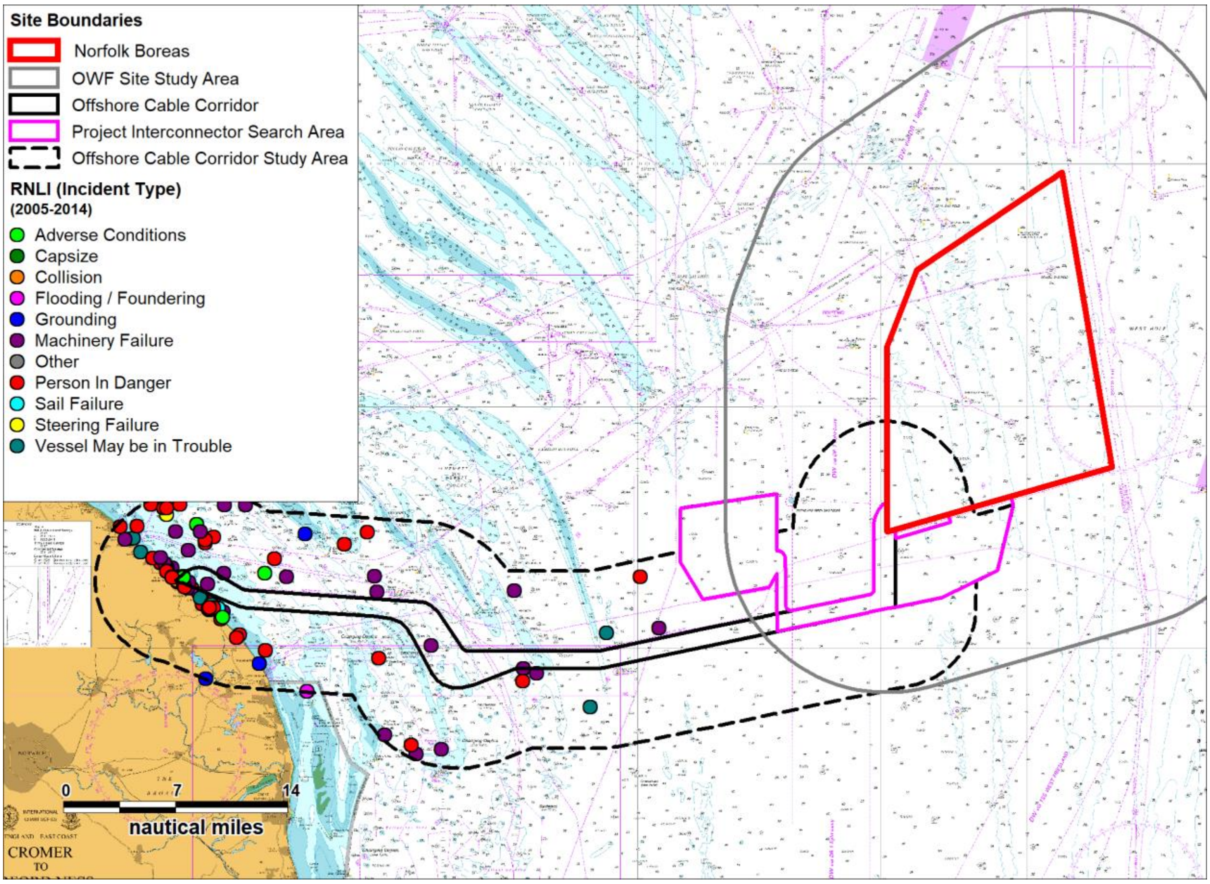


Figure 11.4 RNLI Incident Data (2005 to 2014) – Offshore Cable Corridor (Incident Type)

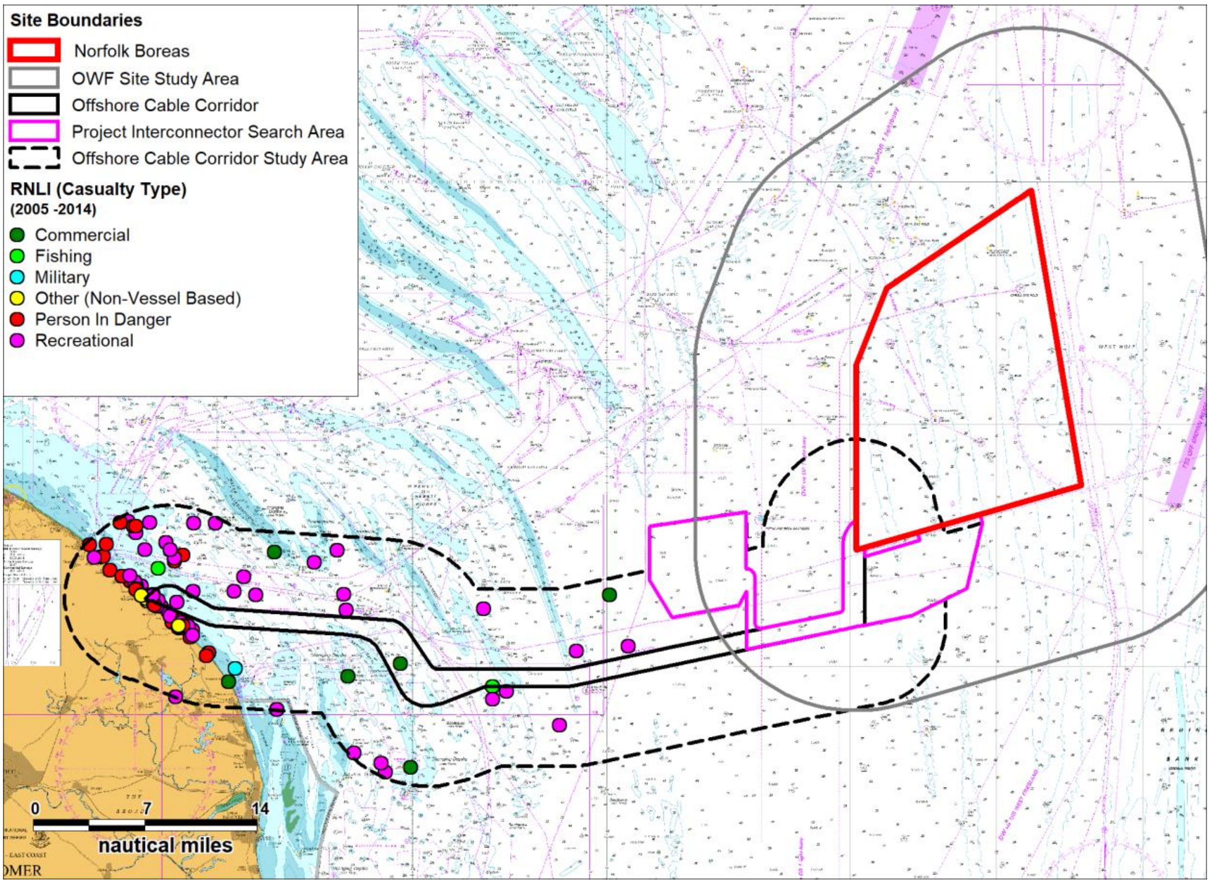


Figure 11.5 RNLI Incident Data (2005 to 2014) – Offshore Cable Corridor (Casualty Type)

124. The RNLI responded to a total of 78 incidents within the offshore cable corridor study area between 2005 and 2014, with eight of these occurring within the offshore cable corridor itself. The most common incident types responded to were "person in danger" (40%) and "machinery failure" (33%). In terms of casualties, the majority of incidents involved a recreational vessel (59%), with danger to individual crew members also common (24%).

12 Marine Traffic Analysis – Offshore Wind Farm

12.1 Overview

125. This section provides assessment of 42 days of marine traffic survey data collected from on-site survey vessels at Norfolk Boreas during 2017 and 2018. The 42 days of data was recorded over two 14 day summer periods and one 14 day winter period to account for seasonal variations (as required under MGN 543) as follows:

- Winter survey (8th and 9th February, and 15th to 27th February 2018); and
- Summer survey – 2017 (4th to 17th August 2017).
- Summer Survey – 2018 (2nd to 16th August 2018).

126. It is noted that the two 2018 surveys spanned 15 days each, however the first and last days were partial, giving 14 day effective periods.

As presented in detail in section 6.1, the PEIR (submitted in 2018) and initial NRA were informed by the summer 2017 and winter 2018 surveys. However, given that the summer 2017 survey falls outside of the required timeframe for data detailed in MGN 543 (data collected within 24 months of submission of the ES), the additional summer 2018 survey was undertaken in August 2018. This data has been used to validate the findings of the PEIR and associated draft of the NRA (see section 12.3), and to refresh the marine traffic assessment in Chapter 15: Shipping and Navigation. The full assessment of all three surveys is included within this NRA for reference.

127. As per section 27.3, no findings associated with the summer 2018 survey validation exercise are deemed as affecting the outcome of the assessment within the PEIR, and thus the impact assessment in Chapter 15: Shipping and Navigation remains unchanged from the PEIR stage.

12.2 Summer 2017 and Winter 2018 Analysis

12.2.1 Vessel Counts

128. For the 14 days analysed in summer 2017, there were an average of 63 unique vessels per day passing within the OWF site study area, recorded on AIS and Radar. An average of 14 unique vessels per day intersected the Norfolk Boreas site itself.

129. Figure 12.1 presents the daily number of unique vessels passing through the OWF site study area and intersecting the Norfolk Boreas site during summer 2017. The busiest day recorded throughout the survey period was the 15th August 2017 when 110 unique vessels were recorded within the OWF site study area. On this day a high percentage of unspecified Radar vessel tracks were recorded, and it is considered likely that these vessels were engaged in fishing based upon their behaviour. The quietest day recorded was the 12th August 2017, when 41 unique vessels were recorded within the OWF site study area.

130. Approximately 23% of traffic recorded within the OWF site study area during summer also intersected the Norfolk Boreas site. The majority of this activity was from fishing vessels (further details are provided in section 15.2).

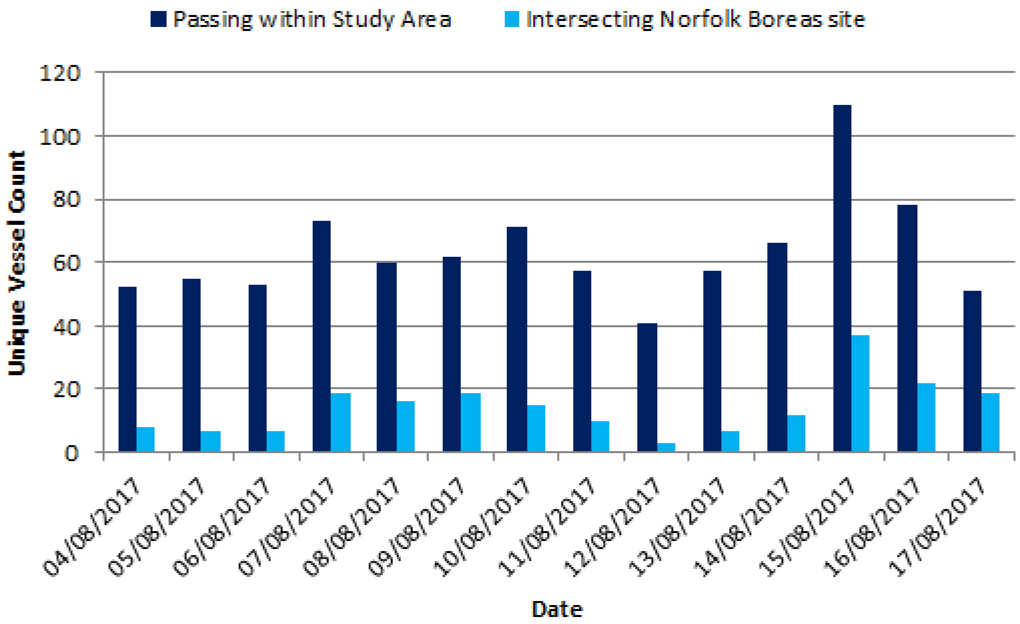


Figure 12.1 Unique Vessels per Day within OWF Site Study Area during 14 Days Summer 2017 (AIS and Radar)

131. For the 15 days analysed in winter 2018, there were an average of 36 unique vessels per day passing within the OWF site study area, recorded on AIS. An average of five unique vessels per day intersected the Norfolk Boreas site itself.

132. Figure 12.2 presents the daily number of unique vessels passing through the OWF site study area and intersecting the Norfolk Boreas site during the winter survey period in 2018. The busiest day was the 17th February 2018. The quietest days were the 8th February and 25th February 2018.

133. During the winter survey period, approximately 15% of traffic recorded within the OWF site study area also intersected the Norfolk Boreas site itself.

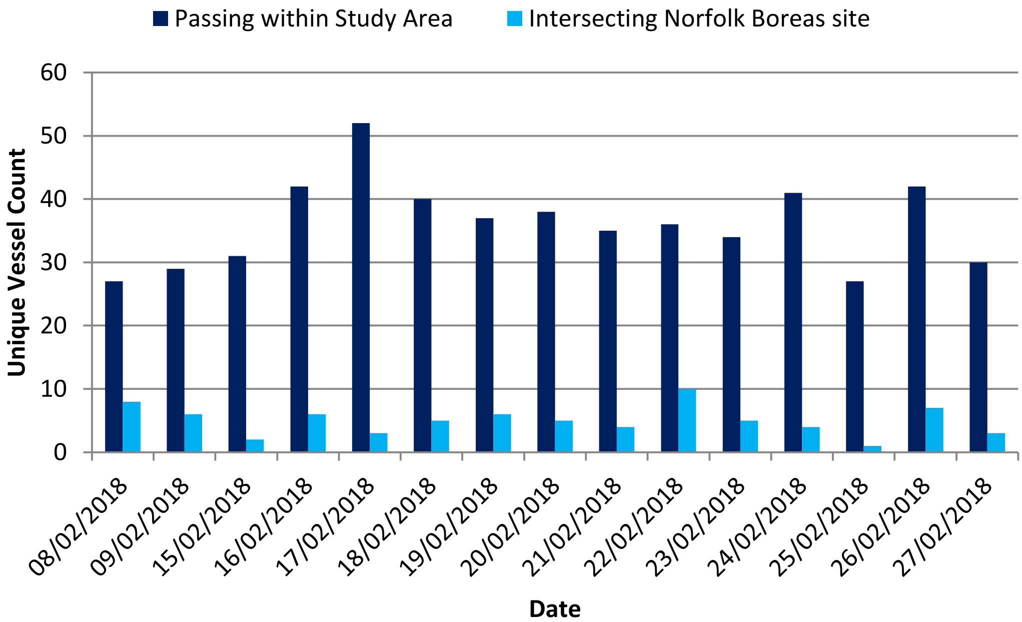


Figure 12.2 Unique Vessels per Day within OWF Site Study Area during 15 Days Winter 2018 (AIS and Radar)

12.2.2 Vessel Types

134. Figure 12.3 and Figure 12.4 present overviews of the AIS and Radar tracks (excluding temporary tracks) recorded within the OWF site study area during the summer 2017 and winter 2018 survey periods, colour-coded by vessel type.

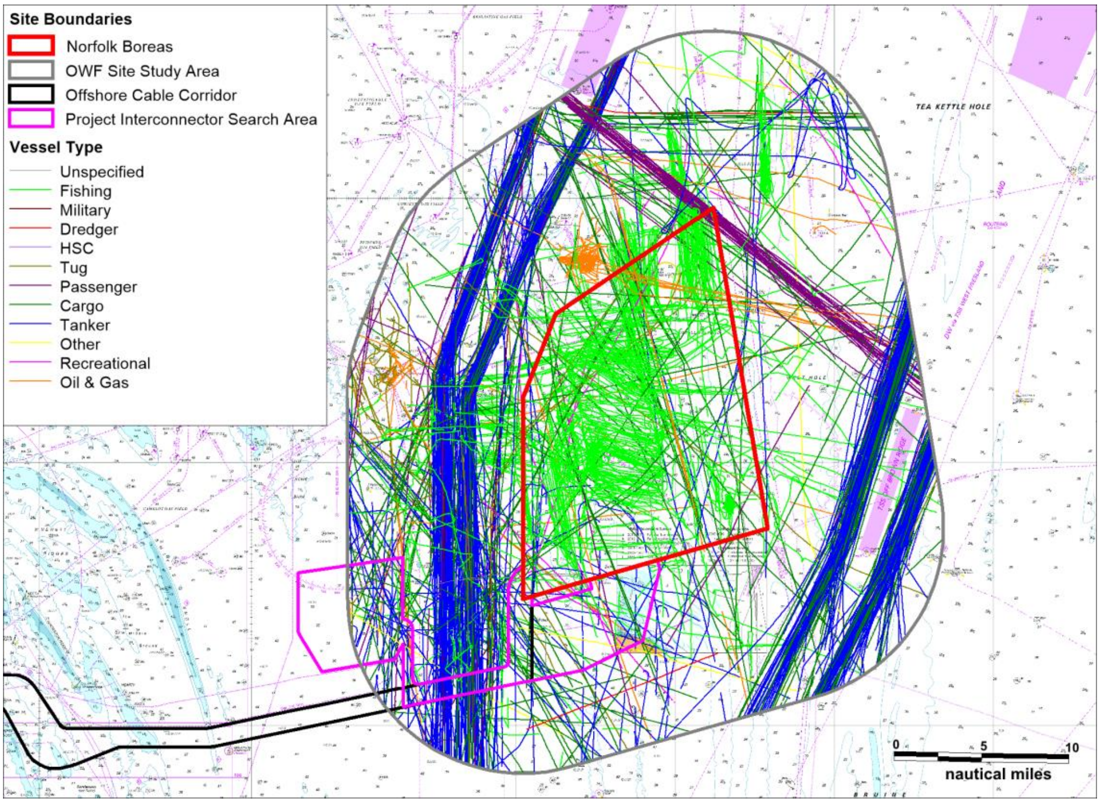


Figure 12.3 AIS and Radar Data within OWF Site Study Area (14 Days Summer 2017)

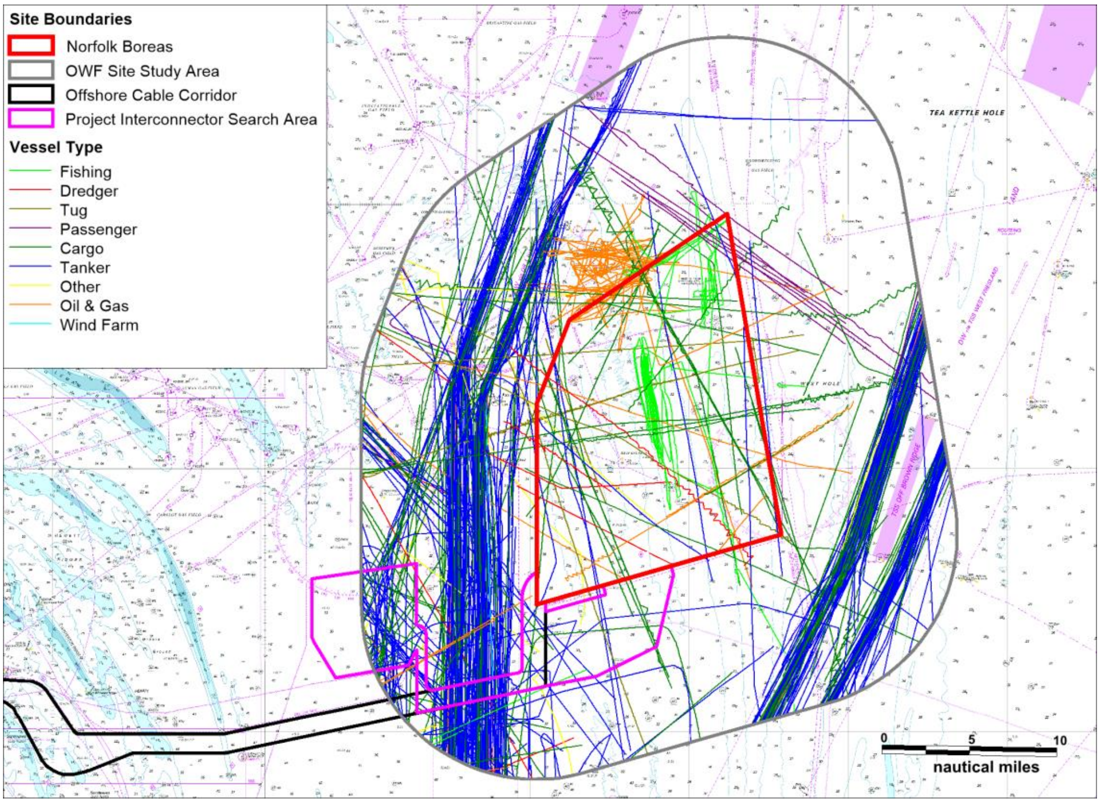


Figure 12.4 AIS and Radar data within OWF Site Study Area (15 Days Winter 2018)

135. Figure 12.5 presents analysis of the vessel types recorded within the OWF site study area and intersecting the Norfolk Boreas site during both survey periods. The category of "other" vessels includes those that are not large enough in quantity to merit their own separate category (e.g. survey or research vessels).

136. During the summer period, the majority of tracks were tankers (43%) and cargo vessels (27%). The majority of vessels recorded within the Norfolk Boreas site itself were fishing vessels (49%) and cargo vessels (21%). During the winter period the majority of tracks were tankers (54%) and cargo vessels (31%). The majority of vessels recorded within the Norfolk Boreas site itself were cargo vessels (35%) and oil and gas vessels (23%). Smaller vessels such as fishing vessels and recreational craft are less likely to transit as far offshore as Norfolk Boreas during the winter due to an increased likelihood of unfavourable weather conditions.

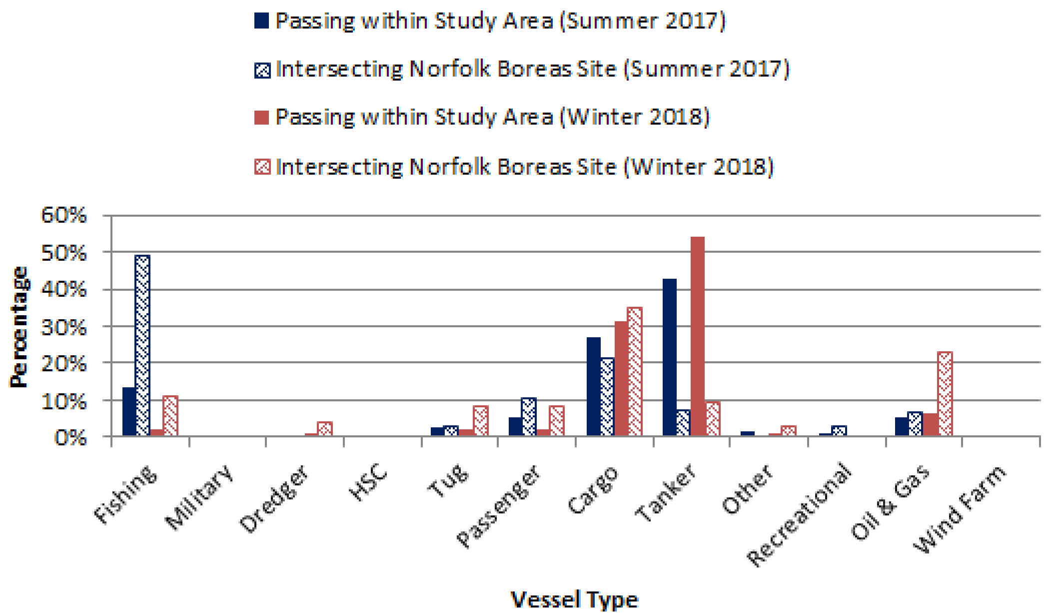


Figure 12.5 Distribution of Vessel Types within the OWF Site Study Area during 14 Days Summer 2017 and 15 Days Winter 2018

12.2.3 Vessel Sizes

12.2.3.1 Vessel Length

137. Figure 12.6 illustrates the distribution of vessel lengths observed during both the summer 2017 and winter 2018 survey periods. It should be noted that 6% of the total number of unique vessels recorded within the OWF site study area during the summer period did not broadcast a length on AIS or were recorded via Radar (and hence no length was recorded). All vessel lengths were identified during the winter survey period.

138. The average lengths of vessels within the OWF site study area throughout the summer and winter survey periods were 149m and 165m, respectively. As

mentioned previously, fewer fishing vessels and recreational vessels were recorded during winter resulting in a higher average length when compared to the summer period.

139. It should be considered that smaller vessels are less likely to broadcast information via AIS (including length), and that such vessels are therefore likely to be underrepresented within the length analysis.

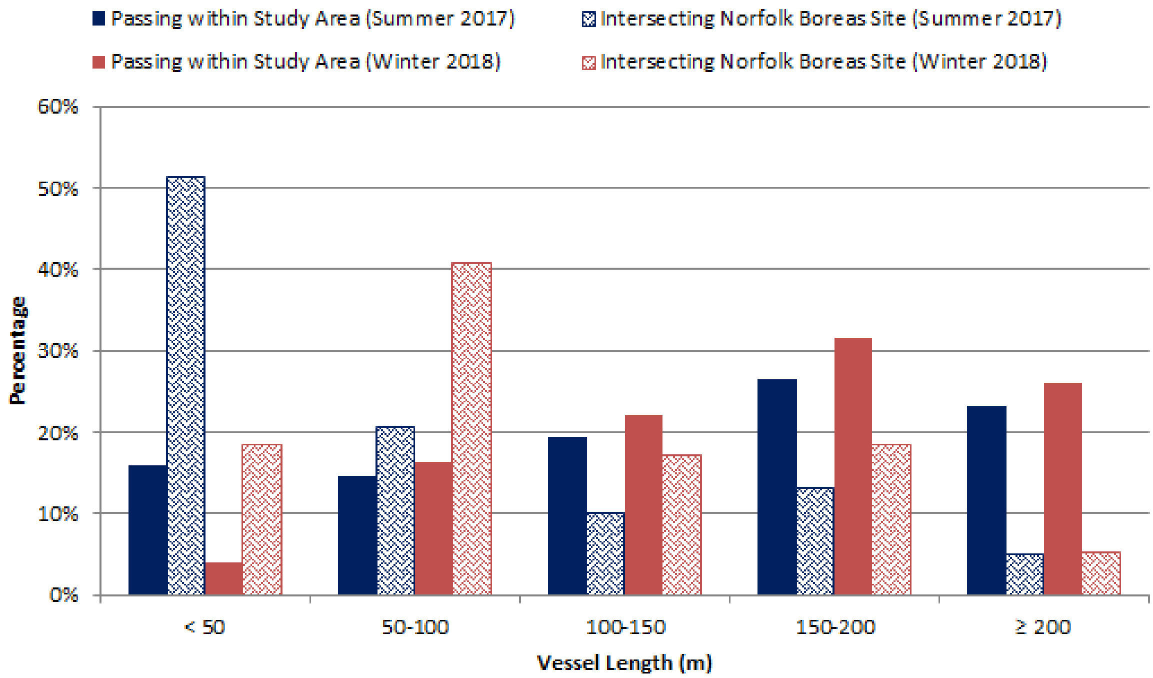


Figure 12.6 Vessel Length Distribution within the OWF Site Study Area during 14 Days Summer 2017 and 15 Days Winter 2018

140. Figure 12.7 and Figure 12.8 present an overview of the vessel tracks (excluding temporary traffic) colour-coded by vessel length, recorded within the OWF site study area during the summer 2017 and winter 2018 survey periods, respectively.

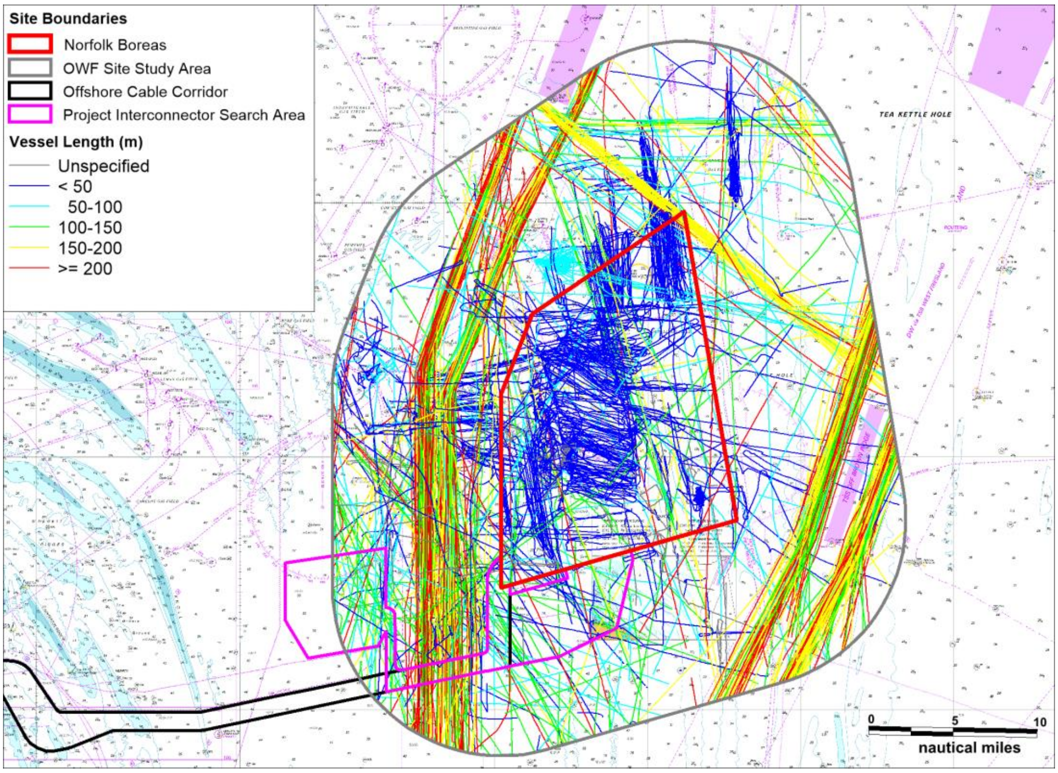


Figure 12.7 AIS and Radar Data within OWF Site Study Area by Vessel Length (14 Days Summer 2017)

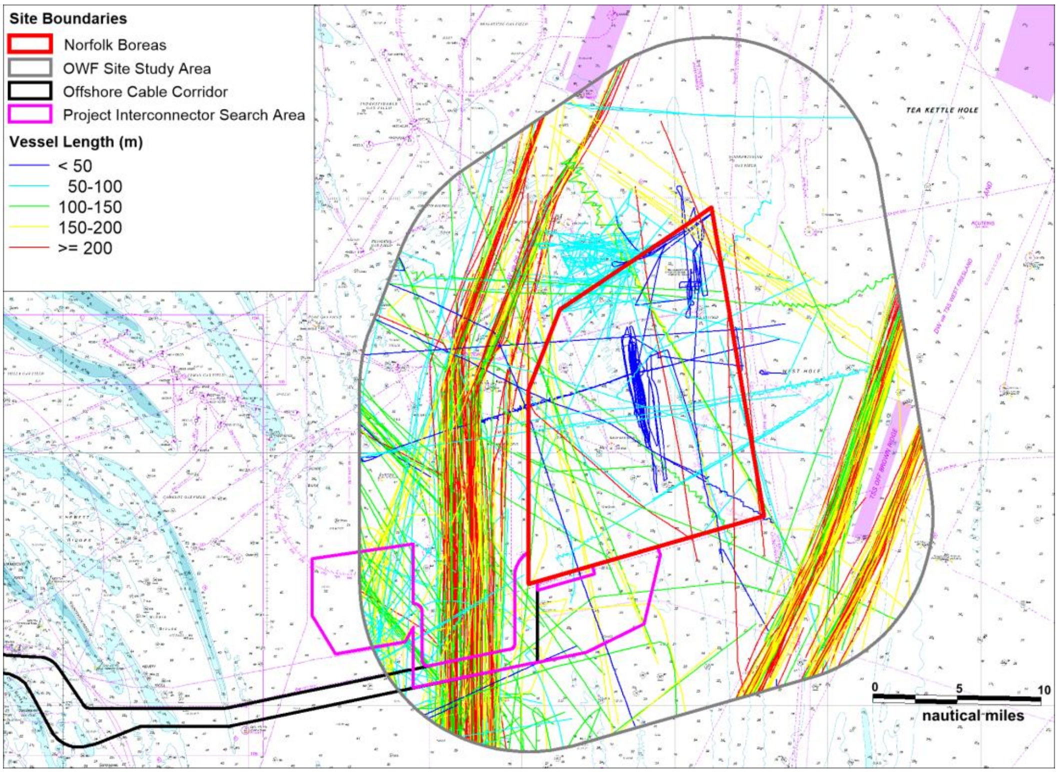


Figure 12.8 AIS and Radar Data within OWF Site Study Area by Vessel Length (15 Days Winter 2018)

141. It can be seen that during both the summer and winter survey periods, vessels of 100m length or over typically utilised the routeing measures within the OWF site study area compared to smaller vessels which typically tended to avoid the routeing measures and were either transiting through the site without using them or engaged in an activity such as fishing or oil and gas work.

12.2.3.2 Vessel Draught

142. Figure 12.9 illustrates the distribution of vessel draughts recorded throughout each survey period. It should be noted that 14% of the total number of unique vessels recorded within the OWF site study area during the summer period and 11% during the winter period did not broadcast a draught on AIS or were recorded via Radar (and hence no draught recorded). These vessels have been excluded from the analysis shown in Figure 12.9.

143. The average draughts of vessels within the OWF site study area throughout the summer 2017 and winter 2018 survey periods were 7m and 8m, respectively. As with length, smaller vessels have historically been observed to be less likely to transmit draught information via AIS, and it is therefore likely that such vessels are underrepresented within the draught analysis.

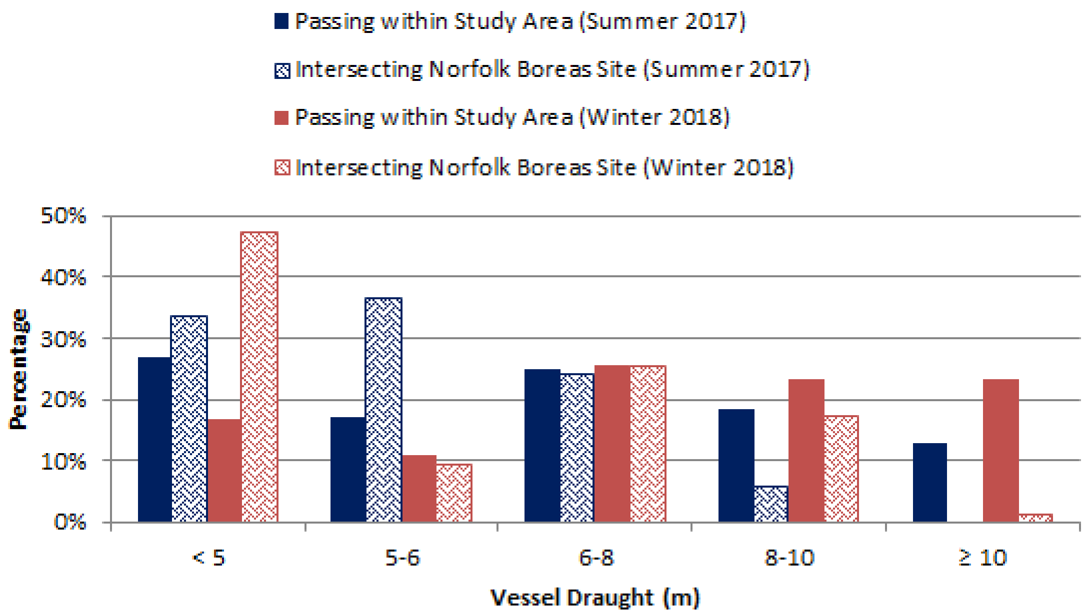


Figure 12.9 Vessel Draught Distribution within the OWF Site Study Area during 14 Days Summer 2017 and 15 Days Winter 2018

144. Figure 12.10 and Figure 12.11 present an overview of the vessel tracks (excluding temporary traffic) colour-coded by vessel draught, recorded within OWF site study area throughout the summer 2017 and winter 2018 survey periods, respectively.

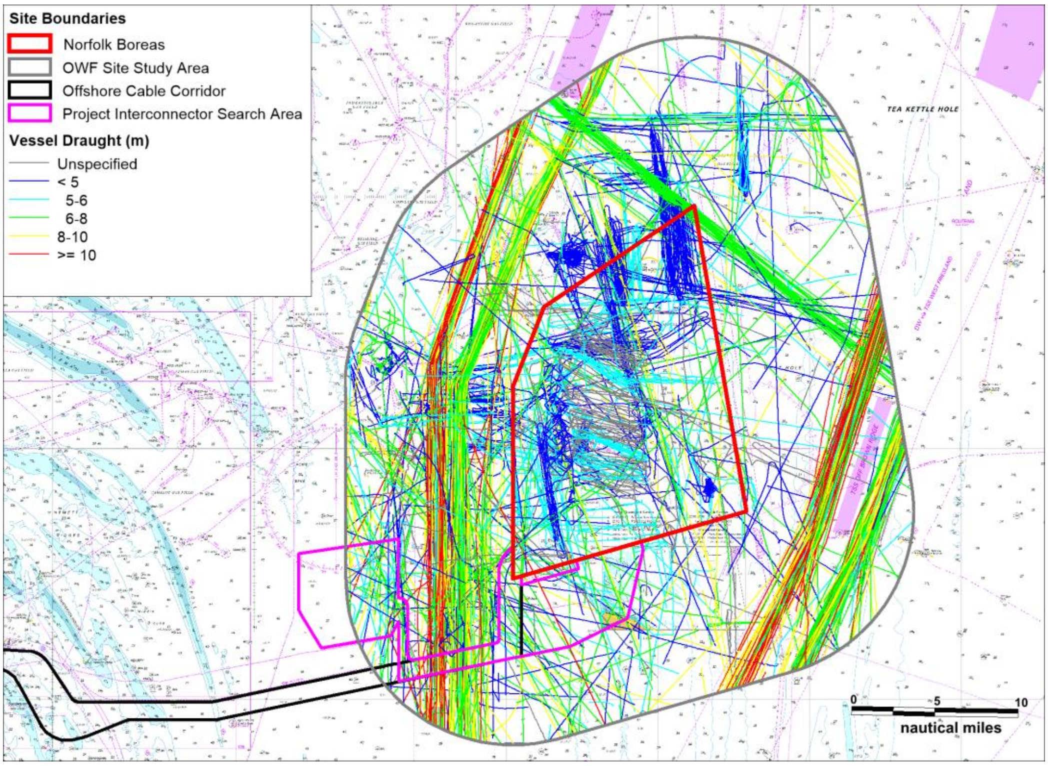


Figure 12.10 AIS and Radar Data within OWF Site Study Area by Vessel Draught (14 Days Summer 2017)

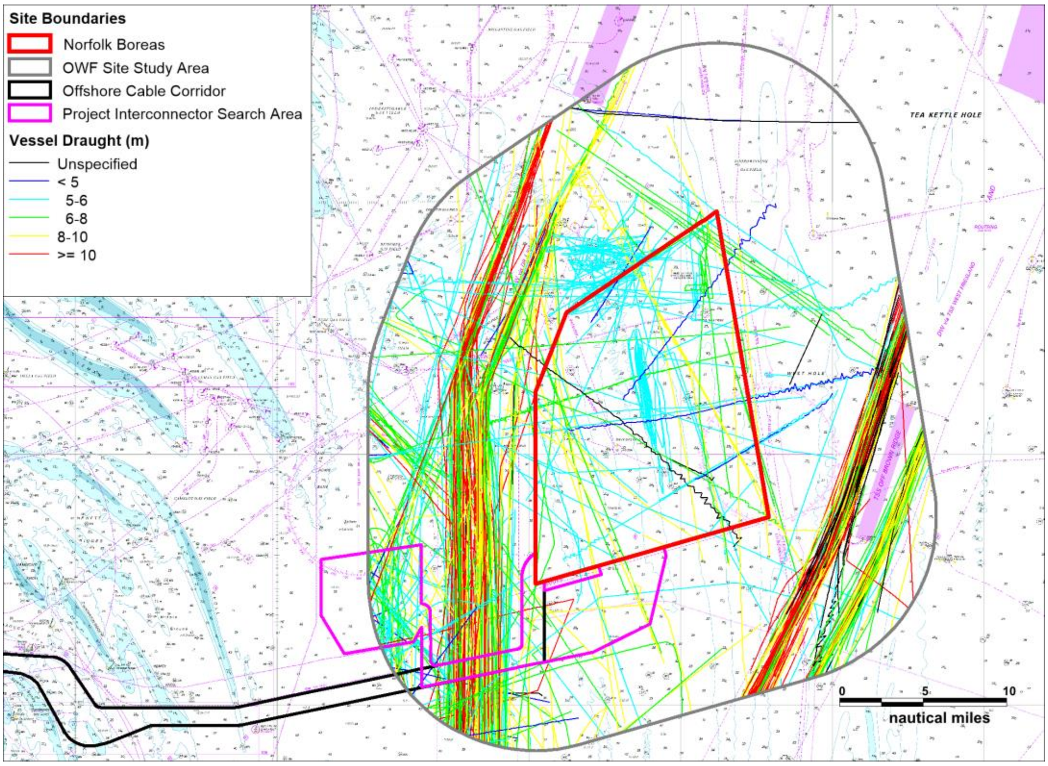


Figure 12.11 AIS and Radar Data within OWF Site Study Area by Vessel Draught (15 Days Winter 2018)

145. It can be seen that during both the summer and winter survey periods, vessels broadcasting a draught of 8m or over typically utilised the routeing measures within the OWF site study area compared to lower draught vessels which typically tended to avoid the routeing measures and were either transiting through the site without using them or engaged in an activity such as fishing or oil and gas work. This mirrors the traffic patterns observed in the vessel length analysis in section 12.2.3.1.

12.2.4 Vessel Speeds

146. Figure 12.12 illustrates the distribution of average vessel speeds recorded throughout both survey periods. It should be noted that 4% of the total number of vessel tracks recorded within the OWF site study area during the summer period did not broadcast a valid speed on AIS or Radar. These tracks have therefore been excluded from the following speed analysis.

147. The average speeds recorded within the OWF site study area throughout the summer 2017 and winter 2018 survey periods were 9.2 knots and 11.4 knots, respectively.

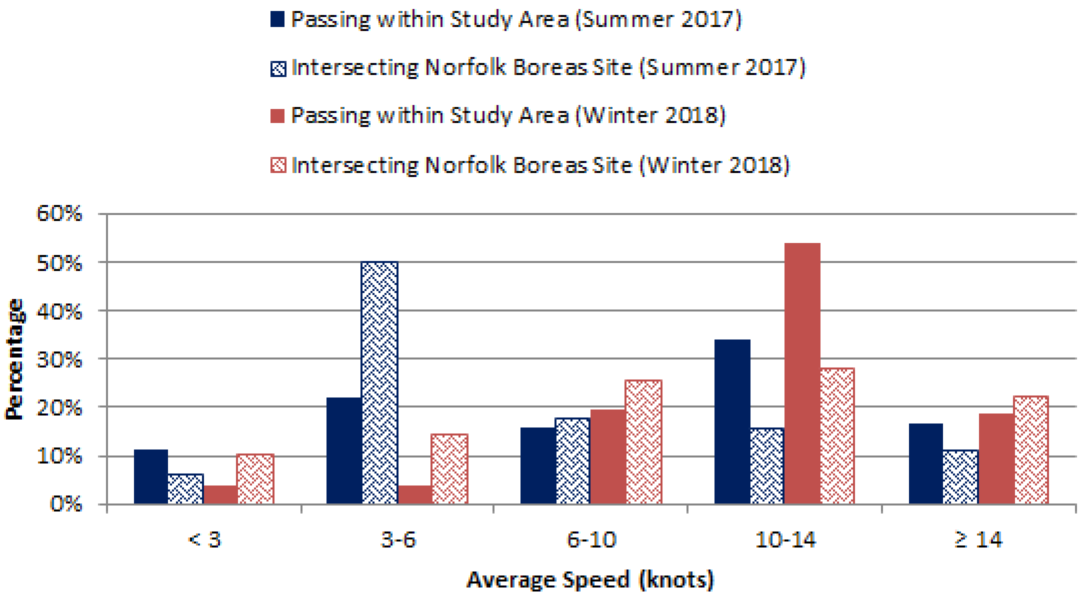


Figure 12.12 Average Vessel Speed Distribution within the OWF Site Study Area during 14 Days Summer 2017 and 15 Days Winter 2018

148. Figure 12.13 and Figure 12.14 present an overview of the vessel tracks (excluding temporary tracks) recorded within the OWF site study area throughout the summer 2017 and winter 2018 survey periods, colour-coded by average speed.

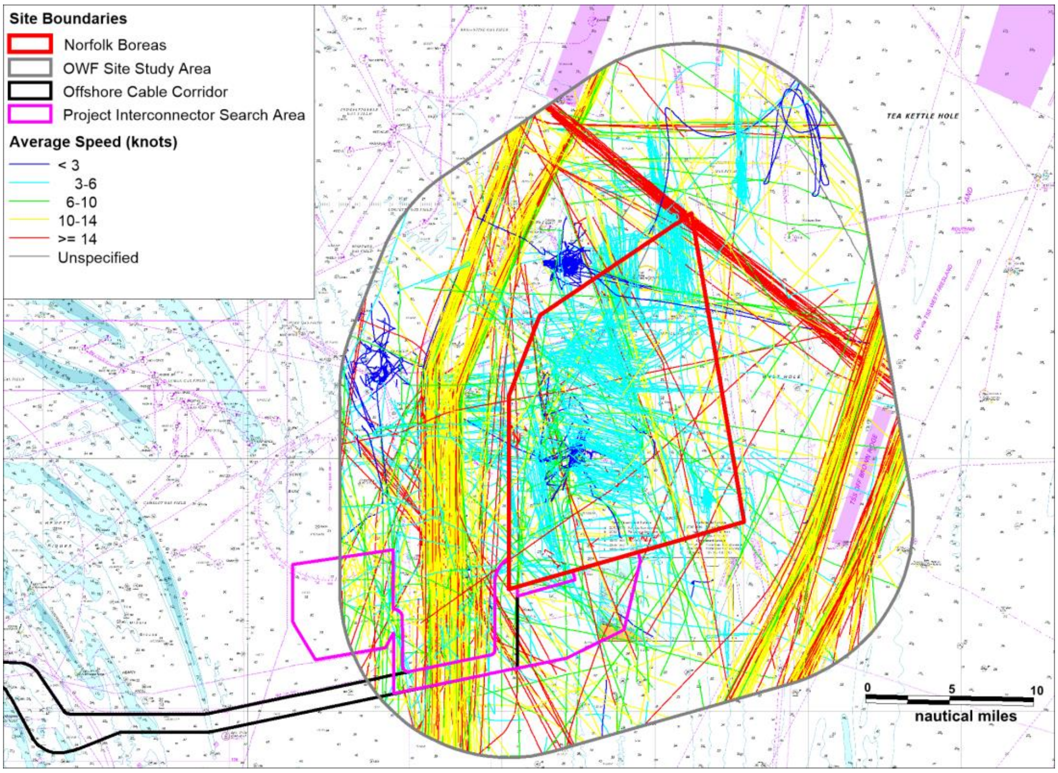


Figure 12.13 AIS and Radar Data within OWF Site Study Area by Average Speed (14 Days Summer 2017)

Figure 12.14 AIS and Radar Data within OWF Site Study Area by Average Speed (15 Days Winter 2018)

149. It can be seen that during both the summer and winter survey periods, vessels transiting at average speeds of 10 knots or over typically utilised the routeing measures within the OWF site study area compared to lower speed vessels which typically tended to avoid the routeing measures and were either transiting through the site without using them or engaged in an activity such as fishing or oil and gas work. However in both periods routeing traffic transiting at higher speeds was also observed outside of the routeing measures, in particularly passing through the north eastern corner of the Norfolk Boreas site.

12.2.5 Vessel Density

150. Figure 12.15 and Figure 12.16 present the vessel density (excluding temporary tracks) recorded in the summer 2017 and winter 2018 survey periods, respectively. This is based on the number of track intersects per cell of a 0.5×0.5nm grid covering the OWF site study area.

151. Comparing the summer and winter survey periods, there was a higher traffic density recorded during summer than winter, particularly within the Norfolk Boreas site. This is due to increased fishing vessel activity within the Norfolk Boreas site during the summer when compared to the winter period (see section 12.2.2). High density areas were also recorded within the routeing measures during both survey periods.

152. It is noted that the Newcastle to Ijmuiden route operated by DFDS is not highlighted within the winter density grid. This is due to a wider distribution of the tracks recorded on this route during the winter 2018 survey period however it is noted that the route is still present (as seen in Figure 12.3).

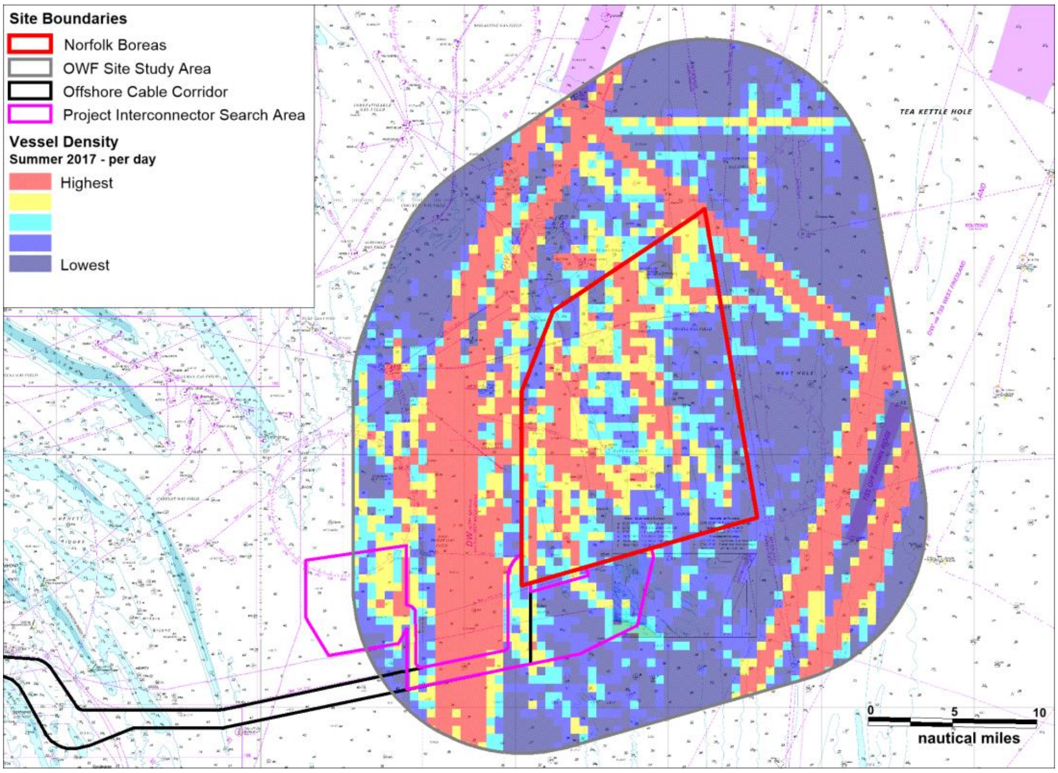


Figure 12.15 Vessel Density within the OWF Site Study Area Excluding Temporary Tracks (14 Days Summer 2017)

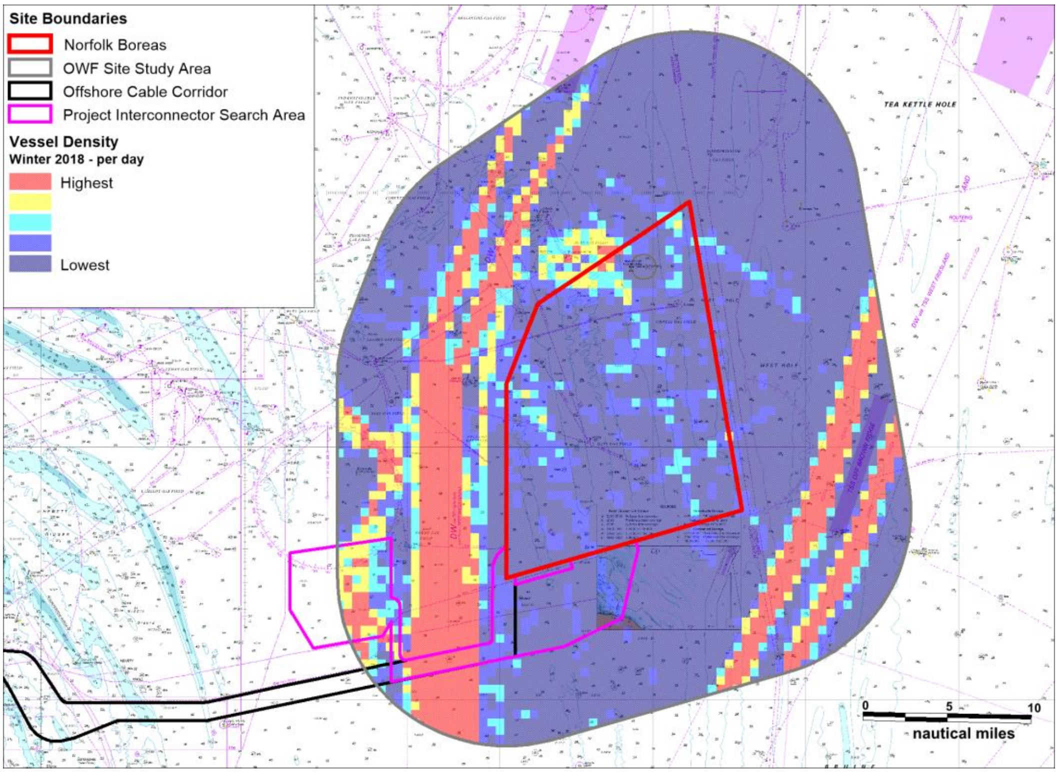


Figure 12.16 Vessel Density within the OWF Site Study Area Excluding Temporary Tacks (15 Days Winter 2018)

12.3 Additional Summer 2018 Analysis

153. This section presents the findings of the assessment of the summer 2018 marine traffic survey data. The findings have been compared against the summer 2017 data where relevant. Discussion of any observed changes in relation to the impact assessment is presented in section 27.3.

12.3.1 Vessel Count

154. For the 14 days analysed in summer 2018, there were an average of 79 unique vessels per day passing within the OWF site study area, recorded on AIS and Radar. An average of 17 unique vessels per day intersected the Norfolk Boreas site itself.

155. Figure 12.17 presents the daily number of unique vessels passing through the OWF site study area and intersecting the Norfolk Boreas site during summer 2018. The busiest day recorded throughout the survey period was the 16th August 2018 when 97 unique vessels were recorded within the OWF site study area. The quietest day recorded was the 4th August 2018, when 69 unique vessels were recorded within the OWF site study area.

156. Approximately 20% of traffic recorded within the OWF site study area during summer also intersected the Norfolk Boreas site. The majority of this activity was from fishing vessels and oil & gas vessels.

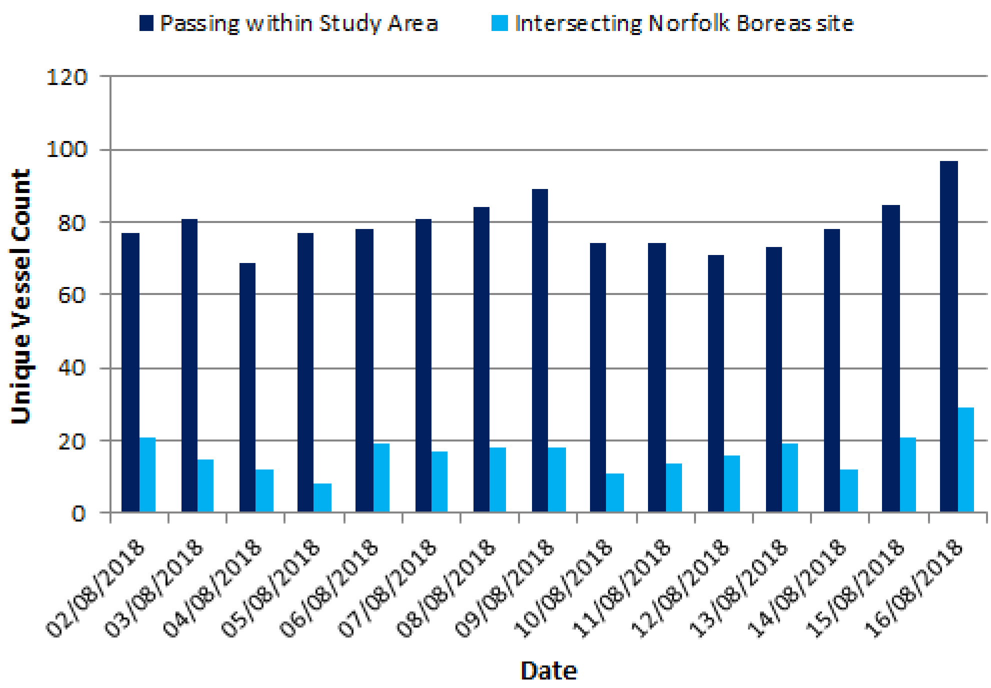


Figure 12.17 Unique Vessels per Day within OWF Site Study Area during 14 Days Summer 2018 (AIS and Radar)

12.3.2 Vessel Types

157. Figure 12.18 presents an overview of the AIS and Radar tracks (excluding temporary tracks) recorded within the OWF site study area during the summer 2018 survey period, colour-coded by vessel type.

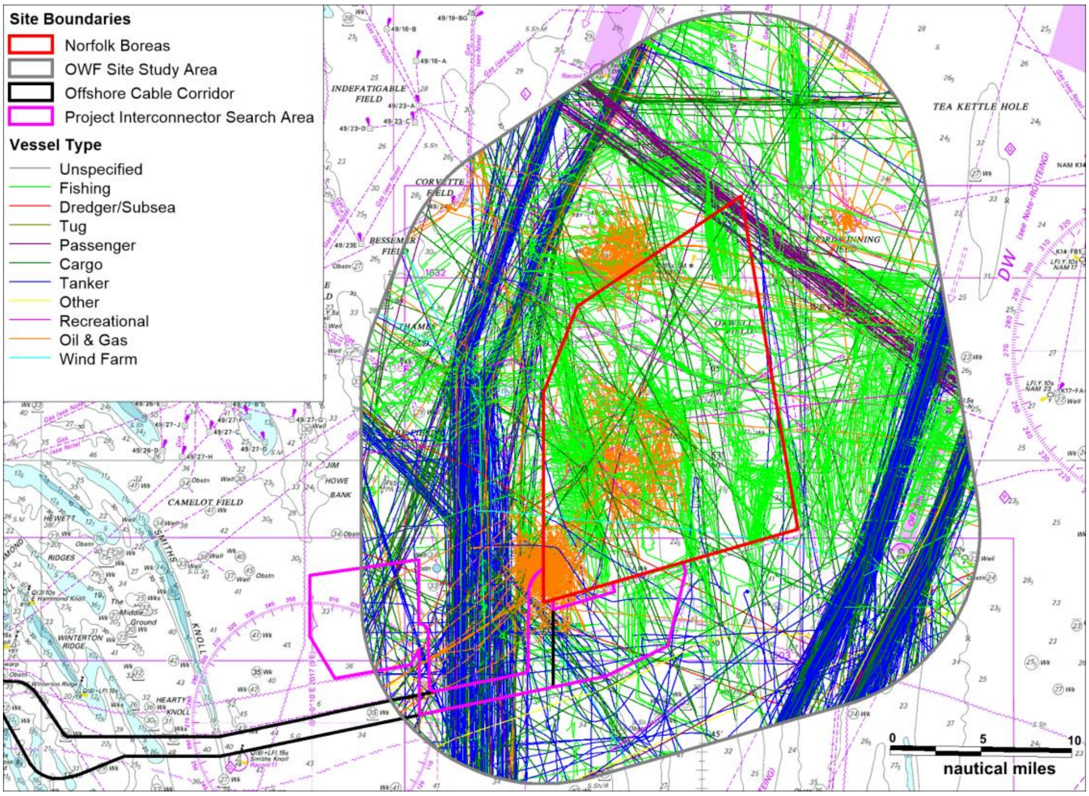


Figure 12.18 AIS and Radar Data within OWF Site Study Area (14 Days Summer 2018)

158. Figure 12.19 presents analysis of the vessel types recorded within the OWF site study area and intersecting the Norfolk Boreas site the survey period. The category of "other" vessels includes those that are not large enough in quantity to merit their own separate category (e.g. survey vessels).

159. During the summer period, the majority of tracks were tankers (41%) and cargo vessels (25%). The majority of vessels recorded within the Norfolk Boreas site itself were fishing vessels (36%) and oil & gas vessels (36%).

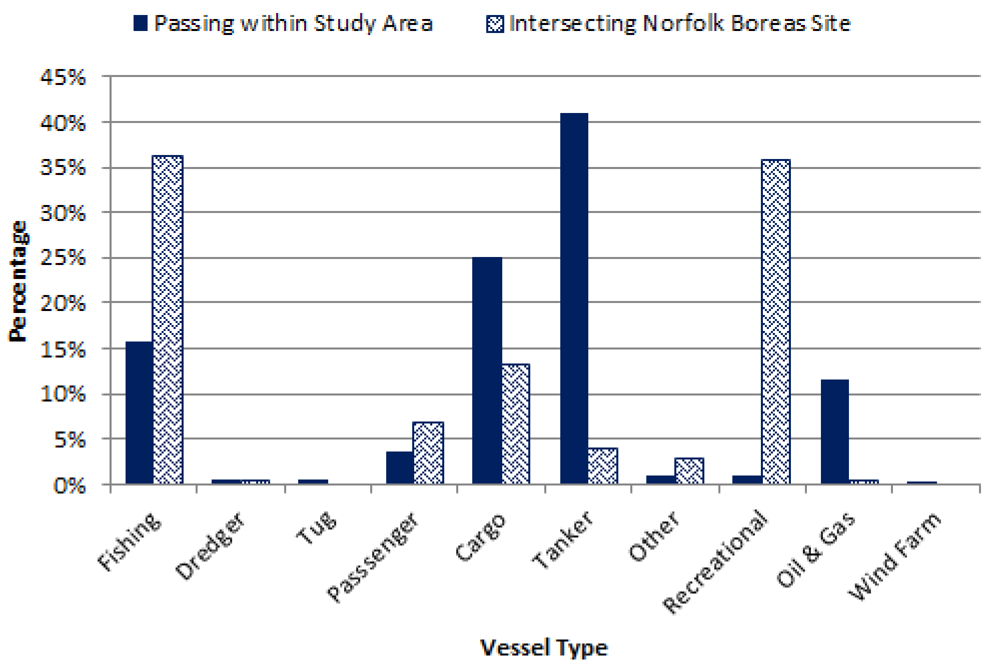


Figure 12.19 Distribution of Vessel Types within the OWF Site Study Area during 14 Days Summer 2018

160. Overall, there was good correlation between the summer 2017 and summer 2018 data sets in terms of vessel type and the distribution of vessels throughout the OWF site study area. In both 2017 and 2018, cargo vessels and tankers were the most commonly recorded vessel tracks within the OWF site study area, as would be expected given the routeing measures.

161. As mentioned in Section 12.3.1, the key differences in terms of vessel type distributions were increases in 2018 of fishing vessels and and oil and gas traffic. This is discussed in relation to the impact assessment in Section 27.3.

12.3.3 Vessel Sizes

12.3.3.1 Vessel Length

162. Figure 12.20 illustrates the distribution of vessel lengths observed during the summer 2018 survey period. It should be noted that 0.3% of the total number of unique vessels recorded within the OWF site study area during the summer period did not broadcast a length on AIS or were recorded via Radar (and hence no length was recorded).

163. The average length of vessels recorded within the OWF site study area throughout the summer was 141m with lengths ranging from 10m to over 200m.

164. It should be considered that smaller vessels are less likely to broadcast information via AIS (including length), and that such vessels are therefore likely to be underrepresented within the length analysis.

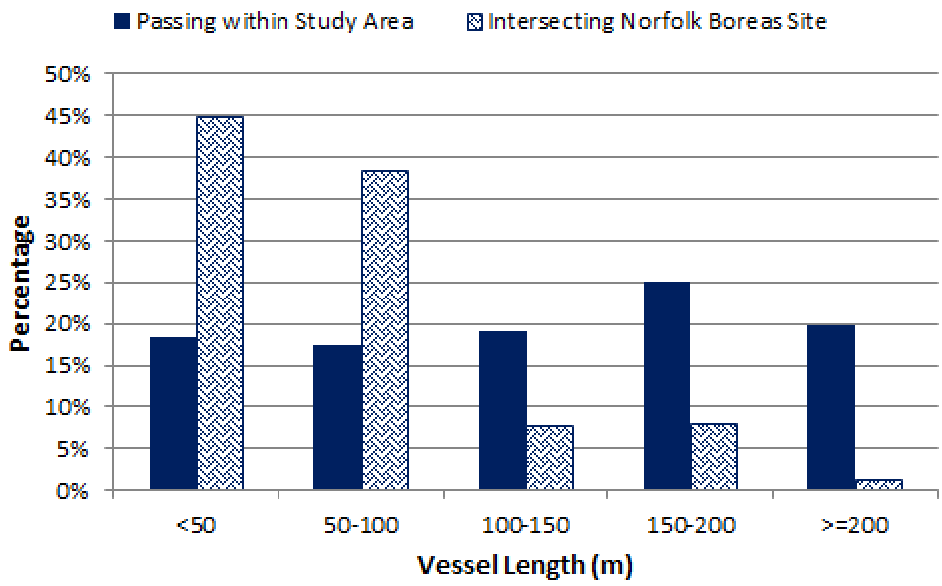


Figure 12.20 Vessel Length Distribution within the OWF Site Study Area during 14 Days Summer 2018

165. Figure 12.21 presents an overview of the vessel tracks (excluding temporary traffic) colour-coded by vessel length, recorded within the OWF site study area during the summer 2018 survey period.

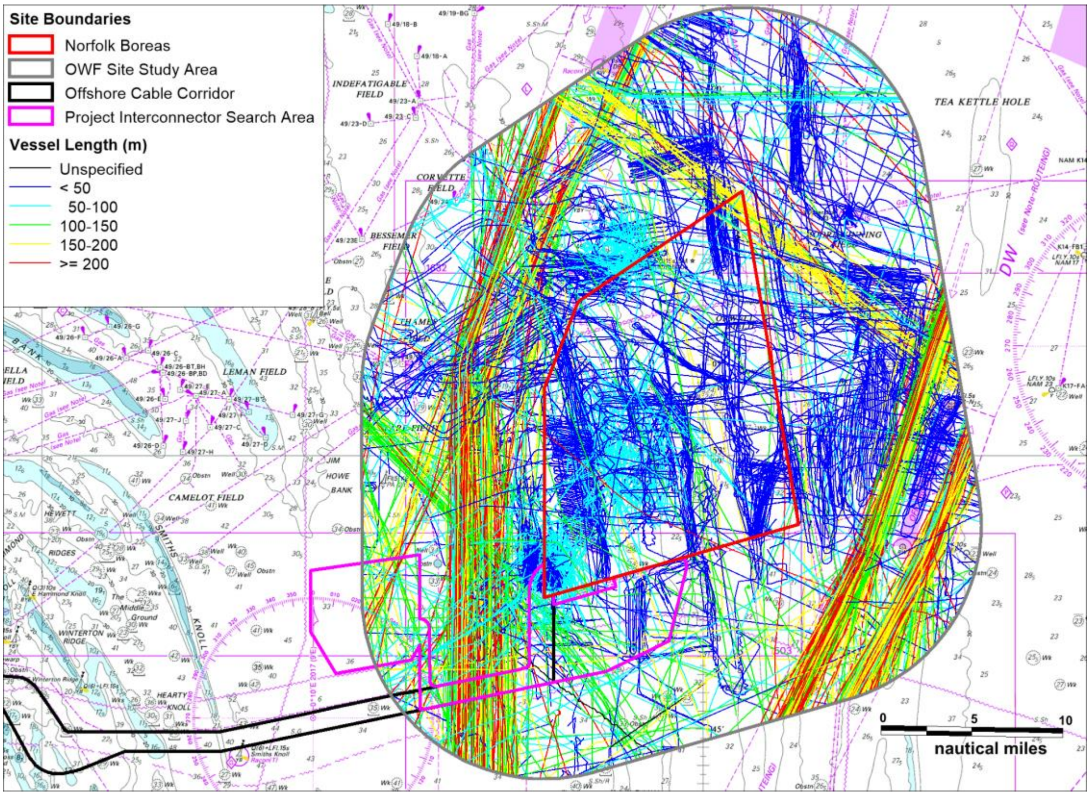


Figure 12.21 AIS and Radar Data within OWF Site Study Area by Vessel Length (14 Days Summer 2018)

166. It can be seen that during the summer survey period, vessels of 100m length or over typically utilised the routeing measures within the OWF site study area compared to smaller vessels which typically tended to avoid the routeing measures and were either transiting through the site without using them or engaged in an activity such as fishing or oil and gas work.

167. The summer 2017 (see section 12.2) and summer 2018 survey periods recorded similar average vessel lengths (149m and 141m respectively) with the most frequently recorded vessel range between 150-200m in both surveys. The distribution of the larger vessels within the routeing measures and smaller vessels actively engaged was also reflected during both summer periods.

12.3.3.2 Vessel Draught

168. Figure 12.22 illustrates the distribution of vessel draughts recorded throughout each survey period. It should be noted that 1% of the total number of unique vessels recorded within the OWF site study area during the summer period did not broadcast a draught on AIS or were recorded via Radar (and hence no draught recorded).

169. The average draughts of vessels within the OWF site study area throughout the summer 2018 survey period was 7m. As with length, smaller vessels have historically

been observed to be less likely to transmit draught information via AIS, and it is therefore likely that such vessels are underrepresented within the draught analysis.

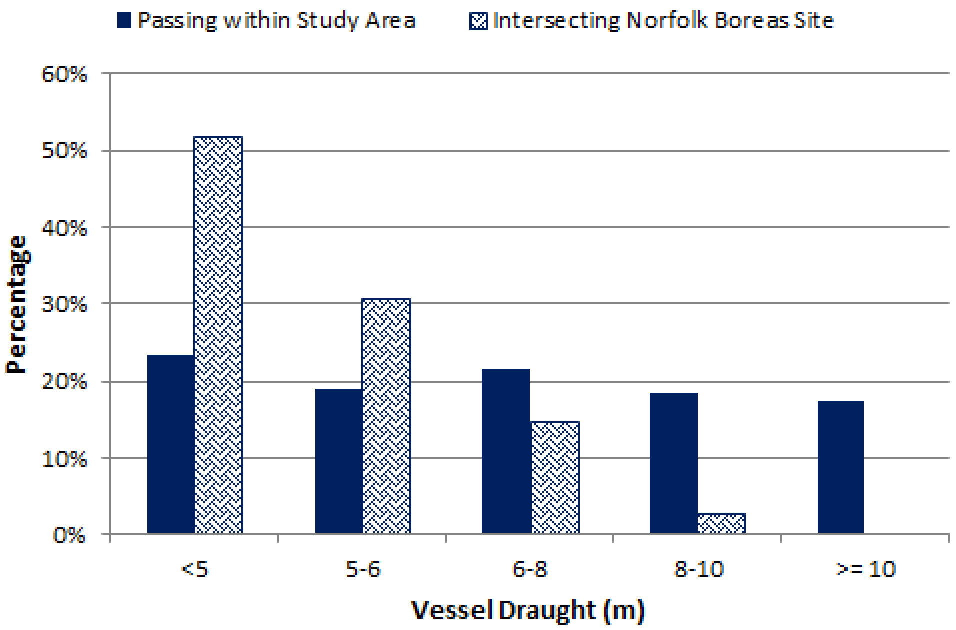


Figure 12.22 Vessel Draught Distribution within the OWF Site Study Area during 14 Days Summer 2018

170. Figure 12.23 presents an overview of the vessel tracks (excluding temporary traffic) colour-coded by vessel draught, recorded within OWF site study area throughout the summer 2018 survey period.

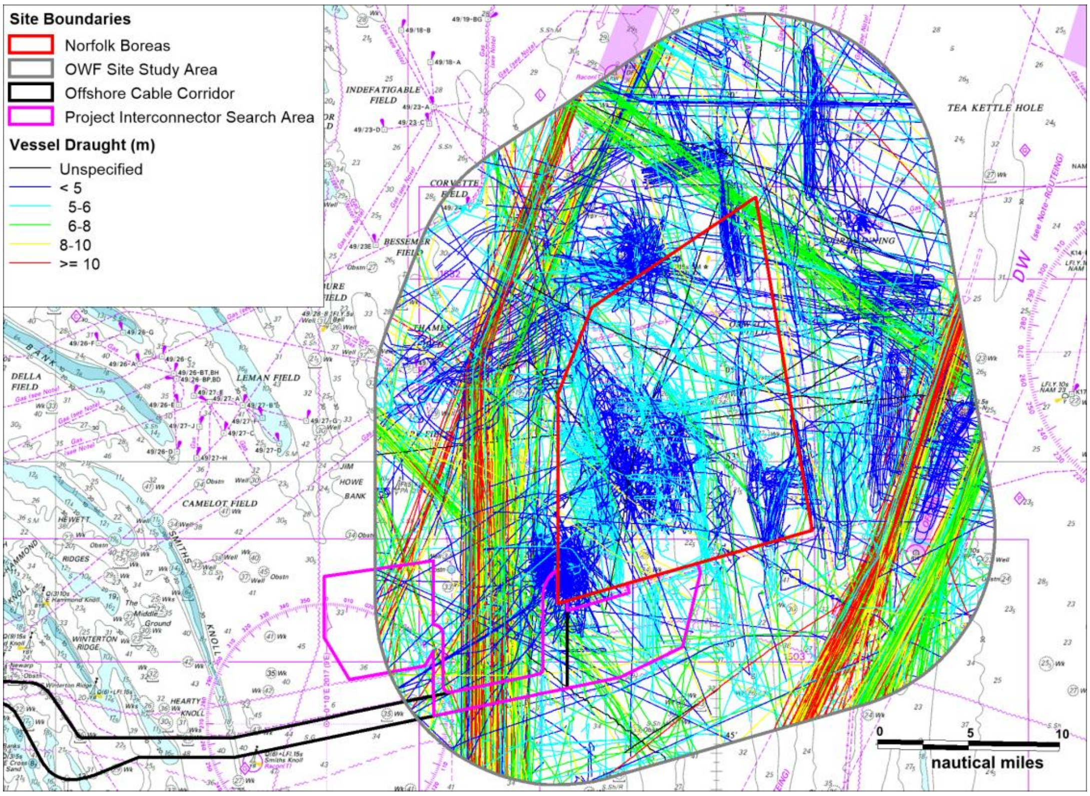


Figure 12.23 AIS and Radar Data within OWF Site Study Area by Vessel Draught (14 Days Summer 2018)

171. It can be seen that during the summer survey period, vessels broadcasting a draught of 8m or over typically utilised the routeing measures within the OWF site study area compared to lower draught vessels which typically tended to avoid the routeing measures and were either transiting through the site without using them or engaged in an activity such as fishing or oil and gas work. This mirrors the traffic patterns observed in the vessel length analysis.

172. The summer 2017 (see section 12.3.3.2) and summer 2018 survey periods recorded the same average vessel draughts (7m) with the most frequently recorded vessel ranges of less than 5m and between 6-8m in both surveys. The distribution of the larger vessels within the routeing measures and smaller vessels actively engaged was also reflected during both summer periods.

12.3.4 Vessel Speeds

173. Figure 12.24 illustrates the distribution of average vessel speeds recorded throughout both survey periods. It should be noted that 1% of the total number of vessel tracks recorded within the OWF site study area during the summer period did not broadcast a valid speed on AIS or Radar. These tracks have therefore been excluded from the following speed analysis.

174. The average speed recorded within the OWF site study area throughout the summer 2018 survey period was 9.9 knots.

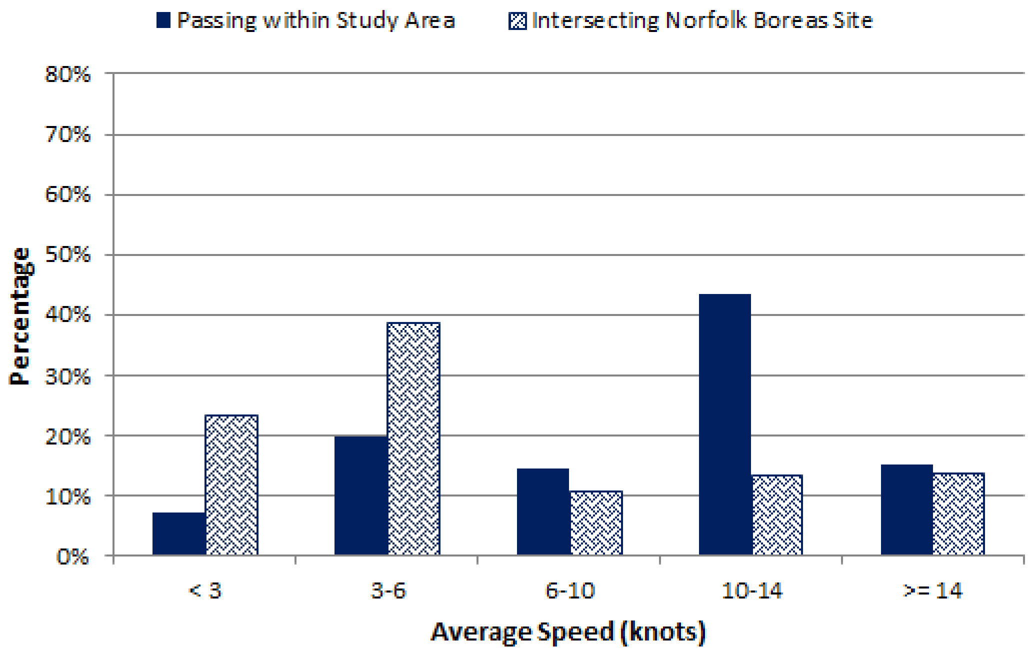


Figure 12.24 Average Vessel Speed Distribution within the OWF Site Study Area during 14 Days Summer 2018

175. Figure 12.25 presents an overview of the vessel tracks (excluding temporary tracks) recorded within the OWF site study area throughout the summer 2018 survey period, colour-coded by average speed.

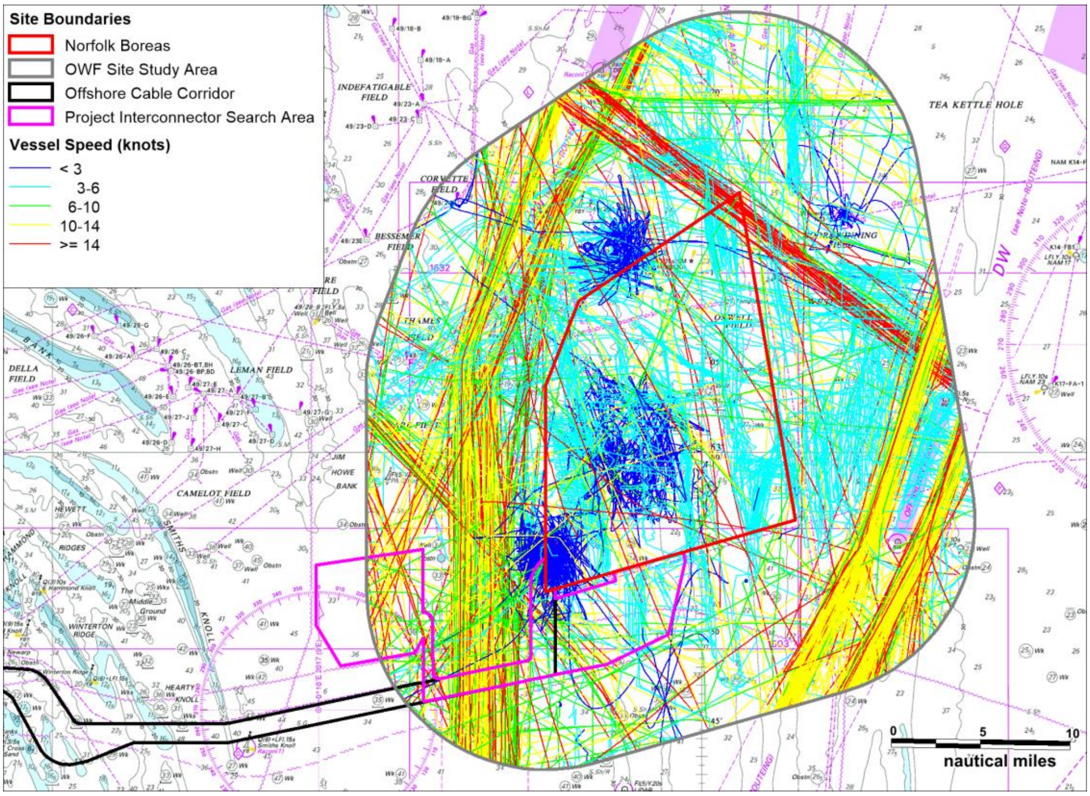


Figure 12.25 AIS and Radar Data within OWF Site Study Area by Average Speed (14 Days Summer 2018)

176. It can be seen that during the summer period, vessels transiting at average speeds of 10 knots or over typically utilised the routeing measures within the OWF site study area compared to lower speed vessels which typically tended to avoid the routeing measures and were either transiting through the site without using them or engaged in an activity such as fishing or oil and gas work. However routeing traffic transiting at higher speeds was also observed outside of the routeing measures, in particular passing through the north eastern corner of the Norfolk Boreas site.

177. The summer 2017 and summer 2018 survey periods recorded similar average vessel speeds (9.2 knots and 9.9 knots respectively) with the most frequently recorded vessel speed range between 10-14 knots in both surveys. The distribution of the higher speed vessels within the routeing measures and lower speed vessels actively engaged or transiting out with the routeing measures was also reflected during both summer periods.

12.3.5 Vessel Density

178. Figure 12.26 presents the vessel density (excluding temporary tracks) recorded in the summer 2018 survey period. This is based on the number of track intersects per cell of a 0.5×0.5nm grid covering the OWF site study area.

179. The high traffic density recorded during summer particularly within the Norfolk Boreas site is due to increased fishing vessel activity within the Norfolk Boreas site during the summer. High density areas were also recorded within the routeing measures.

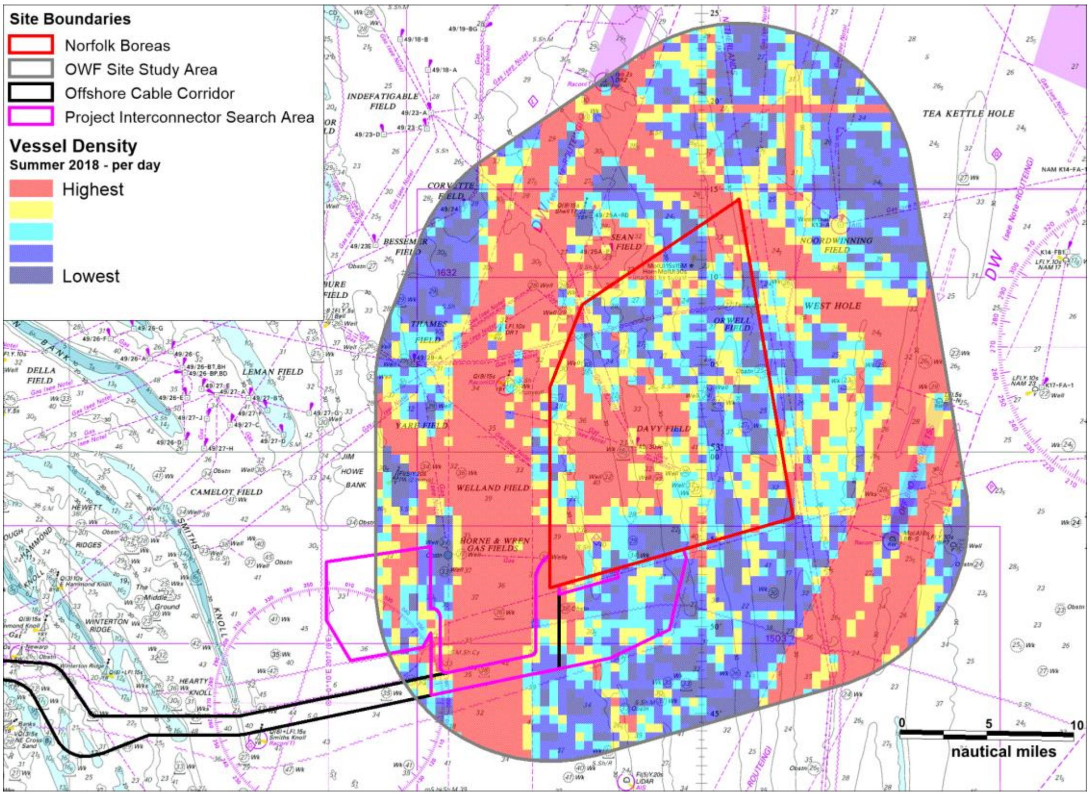


Figure 12.26 Vessel Density within the OWF Site Study Area Excluding Temporary Tracks (14 Days Summer 2018)

180. The summer 2017 (see section 12.2.5) and summer 2018 vessel densities can be considered comparable. While summer 2018 recorded a higher number of vessels overall, the busiest areas during both summer periods were the two DWRs within the OWF site study area, the passenger vessel route intersecting the north east corner of the Norfolk Boreas site and the area within the Norfolk Boreas site itself.

12.4 Comparison with Summer 2017 Data

181. The key difference between the two summer surveys was observed to be an increased number of vessels during the 2018 survey compared to the summer 2017 survey (79 vessels per day in summer 2018 compared to 63 in 2017). This was observed to be due to the following:

- An increase in vessels utilising the northbound lane of the West Friesland associated routeing measures (see Section 17.2);
- An increase in fishing vessels within the OWF Site study area; and

- An increase in oil and gas vessels both within the Norfolk Boreas site (6% in 2017 and 36% in 2018) and the OWF Site study area in general (5% in 2017 and 11% in 2018).

182. This increase and the associated factors are discussed in relation to the impact assessment in Section 27.3.

183. The only other notable difference was that certain main routes identified were observed to drop in vessel numbers during 2018 when compared to 2017. As discussed further in section 18, the higher numbers recorded during 2017 have still been assumed in these cases to ensure the assessment remains worst case.

13 Marine Traffic Analysis – Offshore Cable Corridor

13.1 Overview

184. This section provides assessment of 42 days of marine traffic survey data collected from on-site survey vessels at Norfolk Boreas during 2017 and 2018 (note this is the same data used to assess traffic relative to the Norfolk Boreas site in Section 12) combined with data collected from coastal AIS receivers. The 42 days of data was recorded over two 14 day summer periods and one 14 day winter period to account for seasonal variations (as required under MGN 543) as follows:

- Winter survey (8th and 9th February, and 15th to 27th February 2018); and
- Summer survey – 2017 (4th to 17th August 2017).
- Summer Survey – 2018 (2nd to 16th August 2018).

185. It is noted that the two 2018 surveys spanned 15 days each, however the first and last days were partial, giving 14 day effective periods.

As presented in detail in section 6.1, the PEIR (submitted in 2018) and initial NRA were informed by the summer 2017 and winter 2018 surveys. However, given that the summer 2017 survey falls outside of the required timeframe for data detailed in MGN 543 (data collected within 24 months of submission of the ES), the additional summer 2018 survey was undertaken in August 2018. This data has been used to validate the findings of the PEIR and associated draft of the NRA (see section 13.2), and to refresh the marine traffic assessment in Chapter 15: Shipping and Navigation.

186. As per section 27.3, no findings associated with the summer 2018 survey validation exercise are deemed as affecting the outcome of the assessment within the PEIR, and thus the impact assessment in Chapter 15: Shipping and Navigation remains unchanged from the PEIR stage.

13.2 Summer 2017 and Winter 2018 Analysis

13.2.1 Vessel Counts

187. For the 14 days analysed in summer 2017, there were an average of 104 unique vessels per day passing within the offshore cable corridor study area, recorded on AIS. In terms of vessels intersecting the offshore cable corridor, there was an average of 86 unique vessels per day.

188. Figure 13.1 presents the daily number of unique vessels passing through the offshore cable corridor study area and intersecting the offshore cable corridor during summer 2017. The busiest day recorded throughout the survey period was the 15th August 2017 when 132 unique vessels were recorded within the offshore cable corridor study area. The quietest day recorded was the 13th August 2017, when 47 unique vessels were recorded within the offshore cable corridor study area.

189. During the summer survey period, approximately 69% of traffic recorded within the offshore cable corridor study area also intersected the offshore cable corridor.

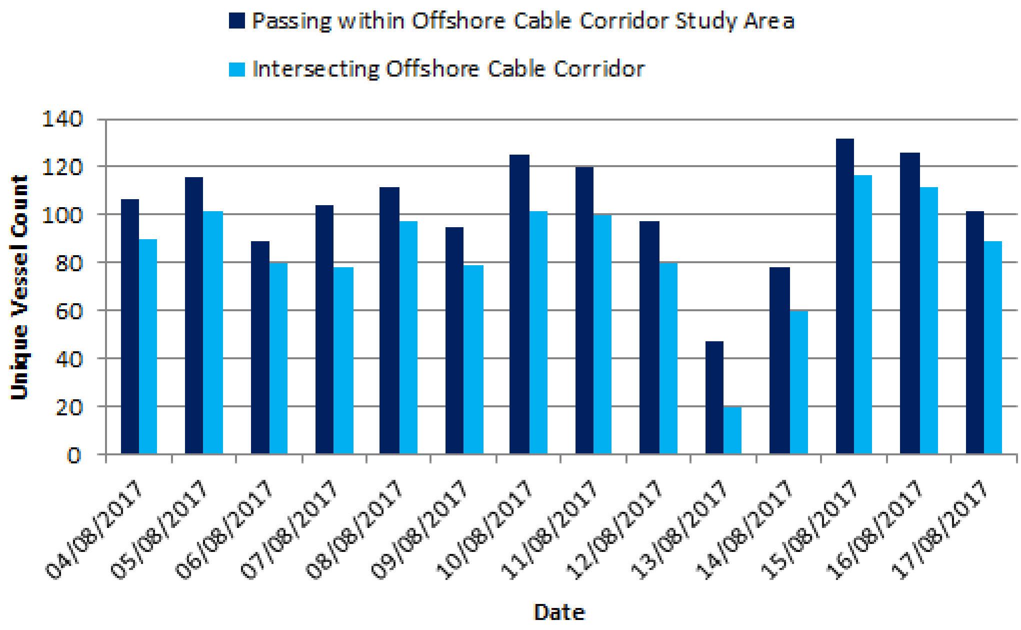


Figure 13.1 Unique Vessels per Day within Offshore Cable Corridor Study Area during 14 Days Summer 2017 (AIS)

190. For the 14 days analysed in winter 2018, there was an average of 93 unique vessels per day passing within the offshore cable corridor study area, recorded on AIS. In terms of vessels intersecting the offshore cable corridor, there was an average of 84 unique vessels per day.

191. Figure 13.2 presents the daily number of unique vessels passing through the offshore cable corridor study area and intersecting the offshore cable corridor during the winter survey period in 2018. The busiest day was the 21st February 2018 when 107 unique vessels were recorded within the offshore cable corridor study area. The quietest day was the 26th February 2018 when 78 unique vessels were recorded.

192. Throughout the winter survey period, approximately 81% of traffic recorded within the offshore cable corridor study area intersected the offshore cable corridor.

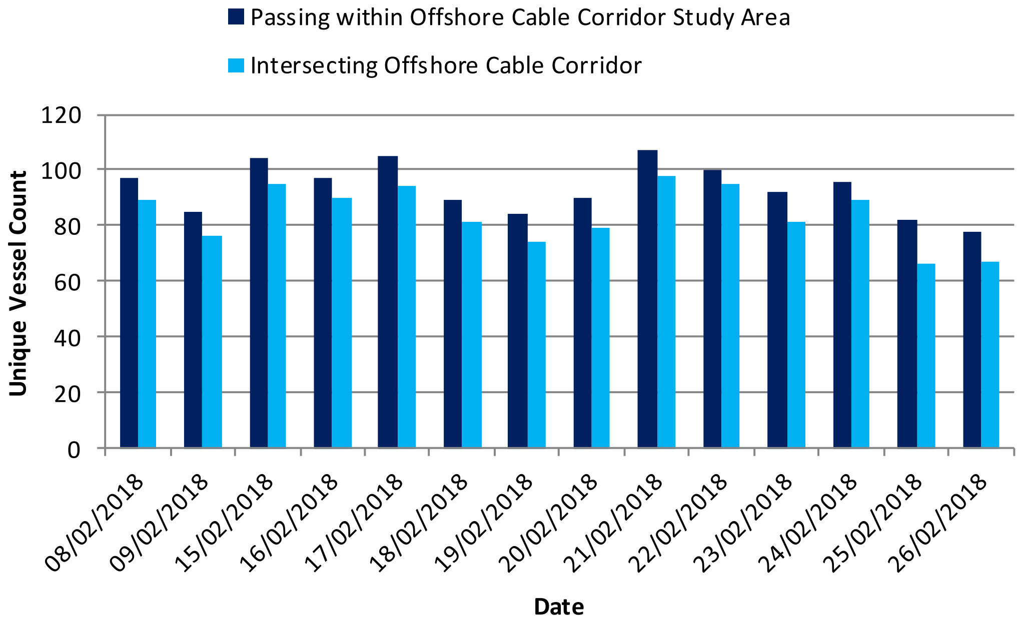


Figure 13.2 Unique Vessels per Day within Offshore Cable Corridor Study Area during 14 Days Winter 2018 (AIS)

13.2.2 Vessel Types

Figure 13.3 and Figure 13.4 present an overview of the AIS tracks (excluding temporary tracks) recorded within the offshore cable corridor study area during the summer 2017 and winter 2018 survey periods, colour-coded by vessel type.

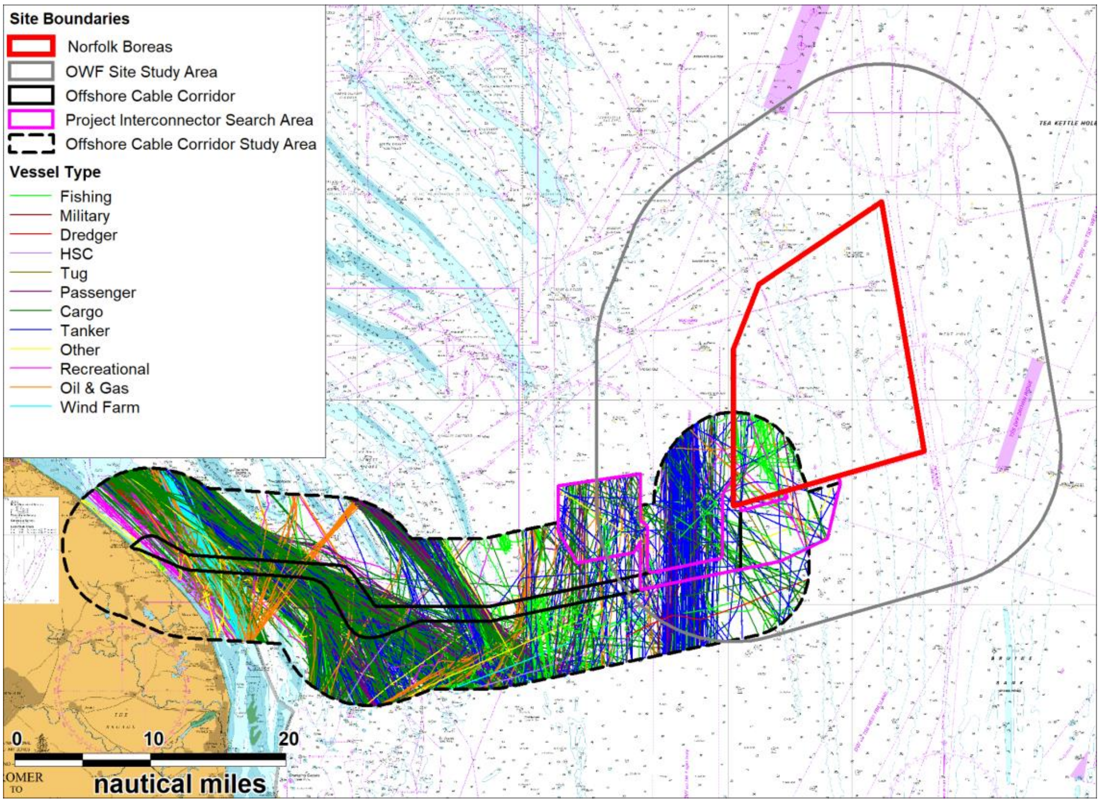


Figure 13.3 AIS data within Offshore Cable Corridor Study Area (14 Days Summer 2017)

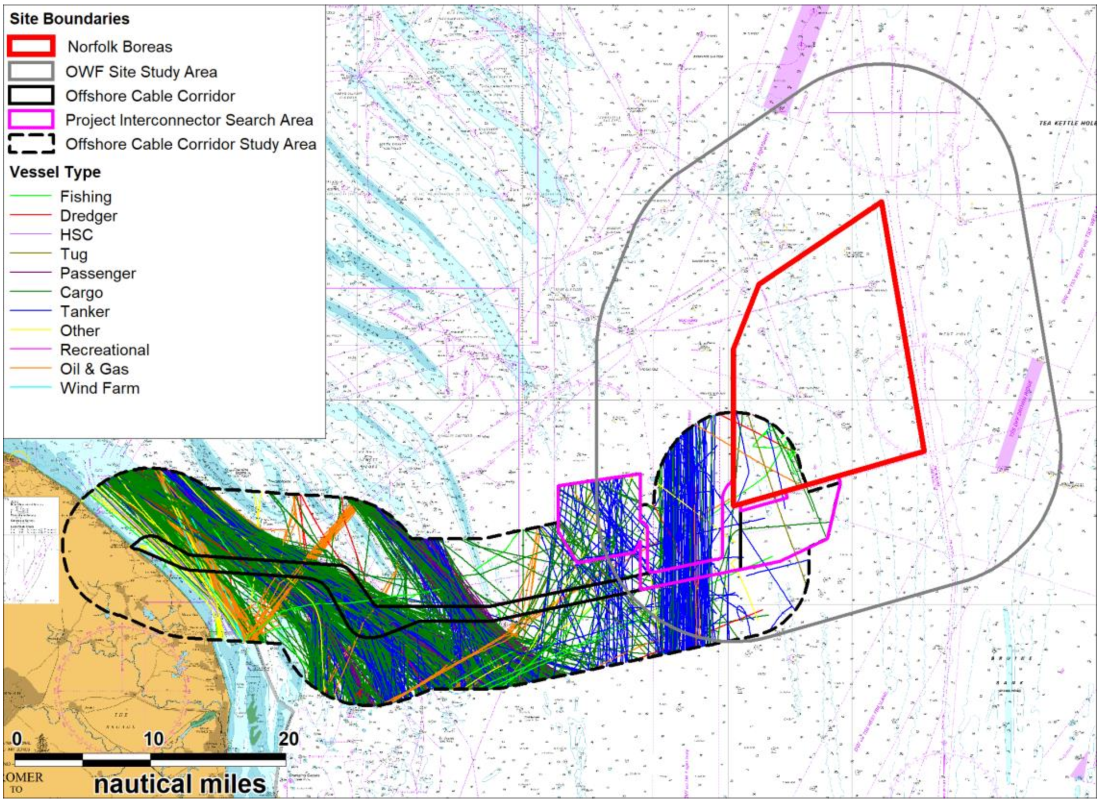


Figure 13.4 AIS data within Offshore Cable Corridor Study Area (14 Days Winter 2018)

193. Figure 13.5 presents analysis of the vessel types recorded within the offshore cable corridor study area and intersecting the offshore cable corridor during both survey periods. The category of "other" vessels includes those that are not large enough in quantity to merit their own separate category (e.g. survey vessels, SAR vessels, fishery patrol etc.).

194. Throughout the summer period, the majority of tracks within the offshore cable corridor study area were cargo vessels (44%) and tankers (22%). The majority of vessels recorded within the offshore cable corridor itself were also cargo vessels (49%) and tankers (24%). Throughout the winter period the majority of tracks within the offshore cable corridor study area were cargo vessels (54%) and tankers (27%). The majority of vessels recorded within the offshore cable corridor itself were also cargo vessels (53%) and tankers (25%).

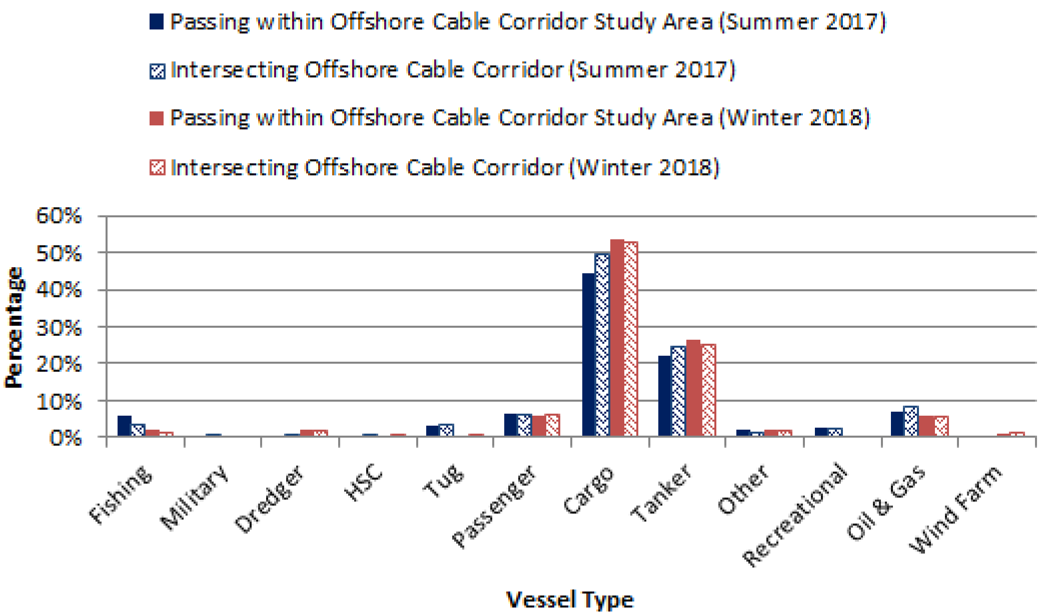


Figure 13.5 Distribution of Vessel Types within the Offshore Cable Corridor Study Area during 14 Days Summer 2017 and 14 Days Winter 2018

13.2.3 Vessel Sizes

13.2.3.1 Vessel Length

195. Figure 13.6 illustrates the distribution of vessel lengths recorded throughout both the summer 2017 and winter 2018 survey periods. It should be considered that during the survey periods less than 1% of vessels did not broadcast a length on AIS. These tracks have therefore been excluded from the length distribution analysis.

196. The average lengths of vessels within the offshore cable corridor study area throughout the summer and winter survey periods were 115m and 125m, respectively. It should be considered that smaller vessels are less likely to broadcast

information via AIS (including length), and that such vessels are therefore likely to be underrepresented within the length analysis.

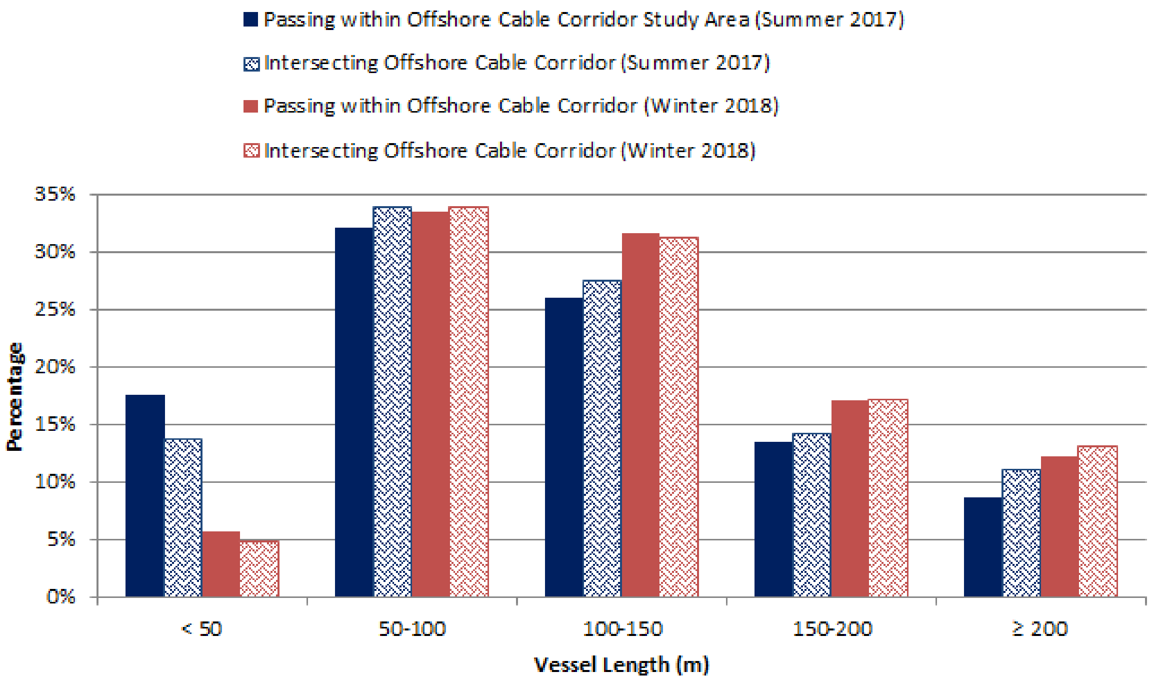


Figure 13.6 Vessel Length Distribution within the Offshore Cable Corridor Study Area during 14 Days Summer 2017 and 14 Days Winter 2018

197. Figure 13.7 and Figure 13.8 present an overview of the vessel tracks (excluding temporary traffic) colour-coded by vessel length, recorded within the offshore cable corridor study area during the summer 2017 and winter 2018 survey periods, respectively.

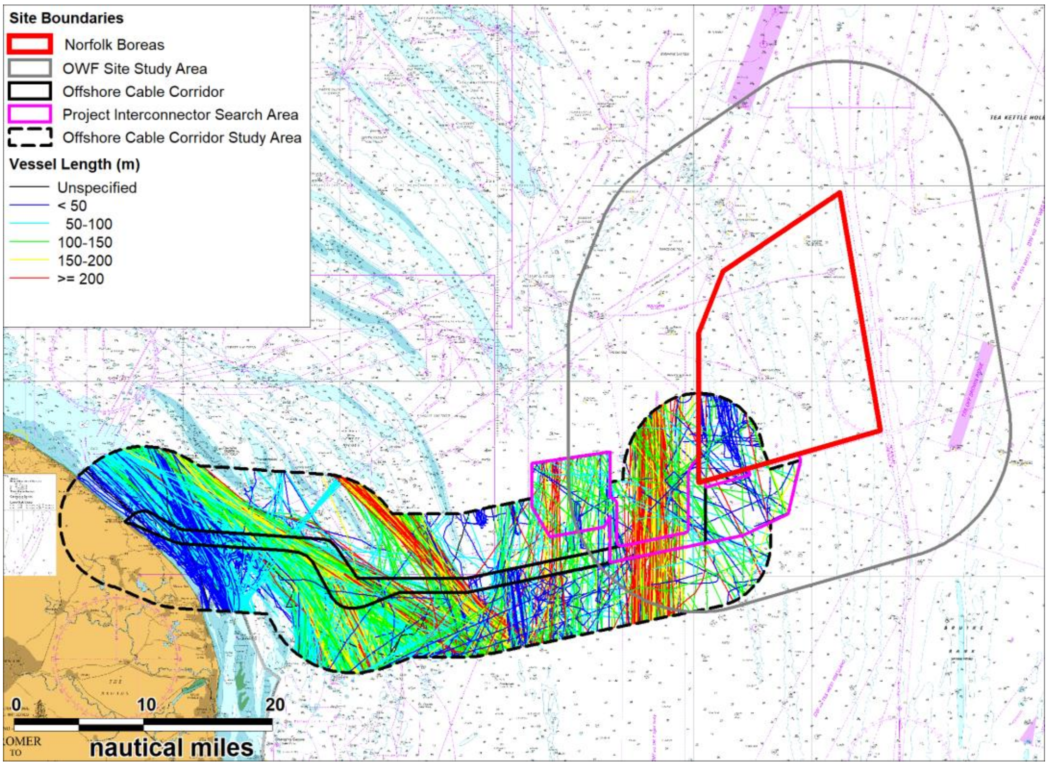


Figure 13.7 AIS Data within Offshore Cable Corridor Study Area by Vessel Length (14 Days Summer 2017)

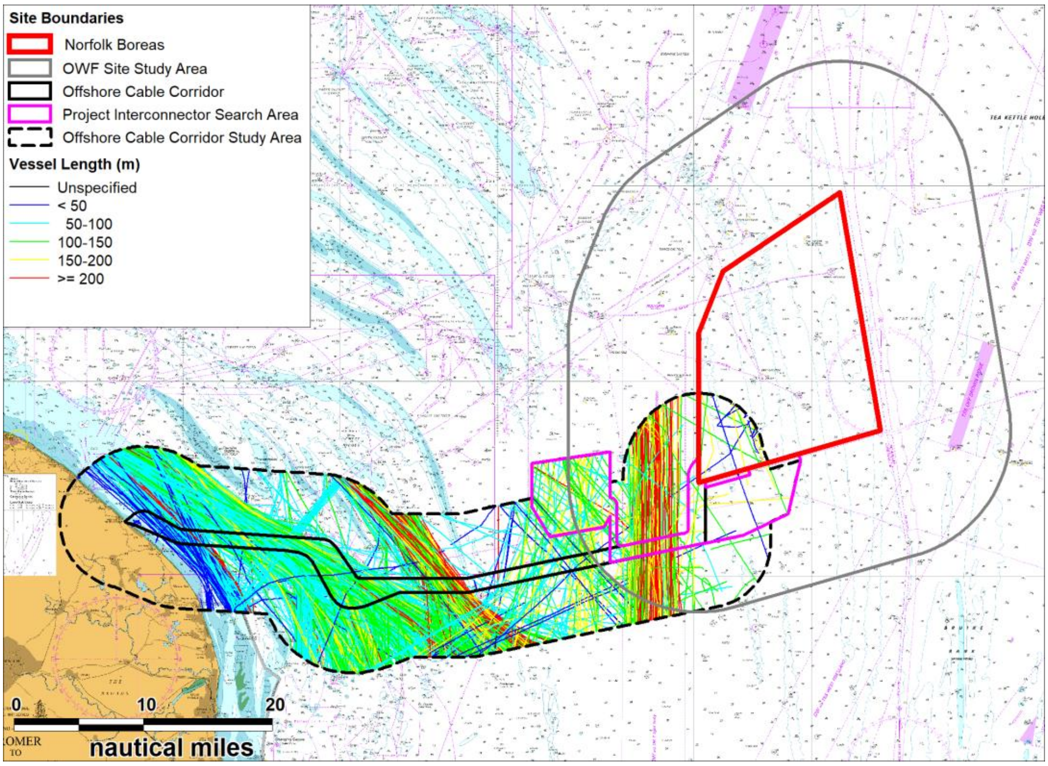


Figure 13.8 AIS Data within Offshore Cable Corridor Study Area by Vessel Length (14 Days Winter 2018)

198. It can be seen that during both the summer and winter survey periods, vessels of 100m length or over typically utilised the DR1 Lightbuoy DWR or transited a north west to south east route passing through the offshore cable corridor, compared to smaller vessels which typically tended to avoid the DWR and were observed most regularly within the nearshore area.

13.2.3.2 Vessel Draught

199. Figure 13.9 illustrates the distribution of vessel draughts recorded during each survey period. It should be noted that 4% of the total number of unique vessels recorded within the offshore cable corridor study area during the summer period and 2% during the winter period did not broadcast a draught on AIS. These tracks have therefore been excluded from the draught distribution analysis.

200. The average draughts of vessels within the offshore cable corridor study area throughout the summer 2017 and winter 2018 survey periods were 5.6m and 5.7m respectively. As with length, smaller vessels have historically been observed to be less likely to transmit draught information via AIS, and it is therefore likely that such vessels are underrepresented within the draught analysis.

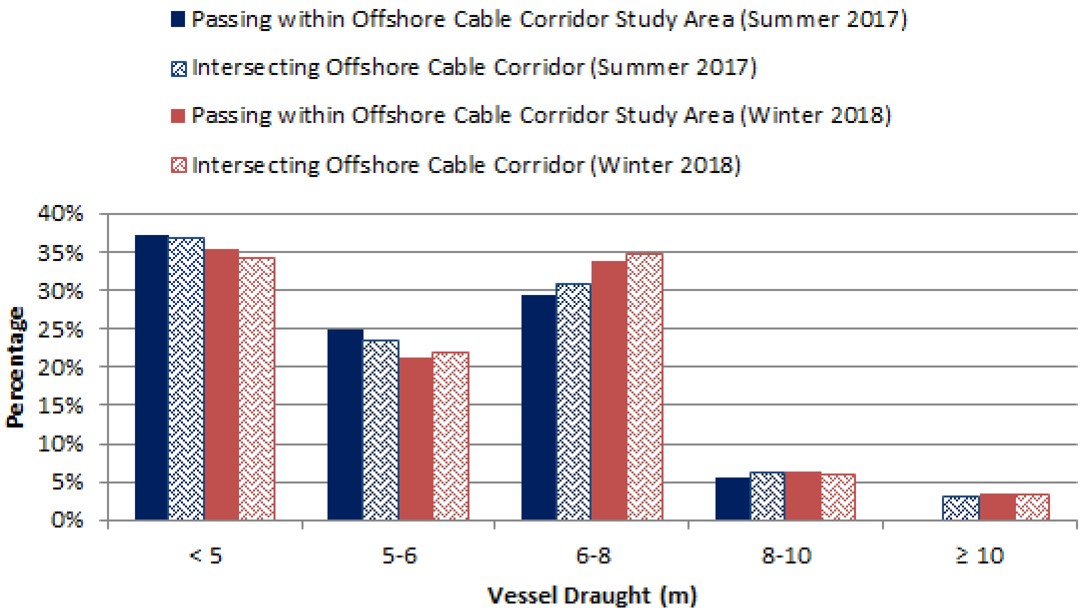


Figure 13.9 Vessel Draught Distribution within the Offshore Cable Corridor Study Area during 14 Days Summer 2017 and 14 Days Winter 2018

201. Figure 13.10 and Figure 13.11 present an overview of the vessel tracks (excluding temporary traffic) colour-coded by vessel draught, recorded within the offshore cable corridor study area throughout the summer 2017 and winter 2018 survey periods, respectively.

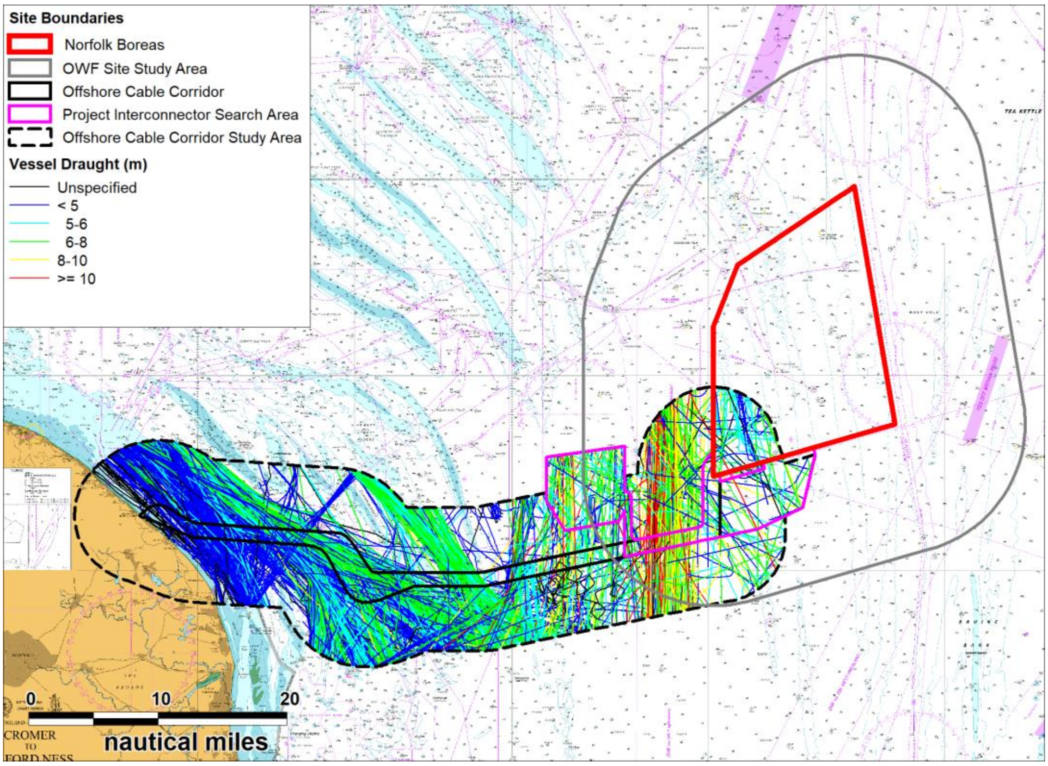


Figure 13.10 AIS Data within Offshore Cable Corridor Study Area by Vessel Draught (14 Days Summer 2017)

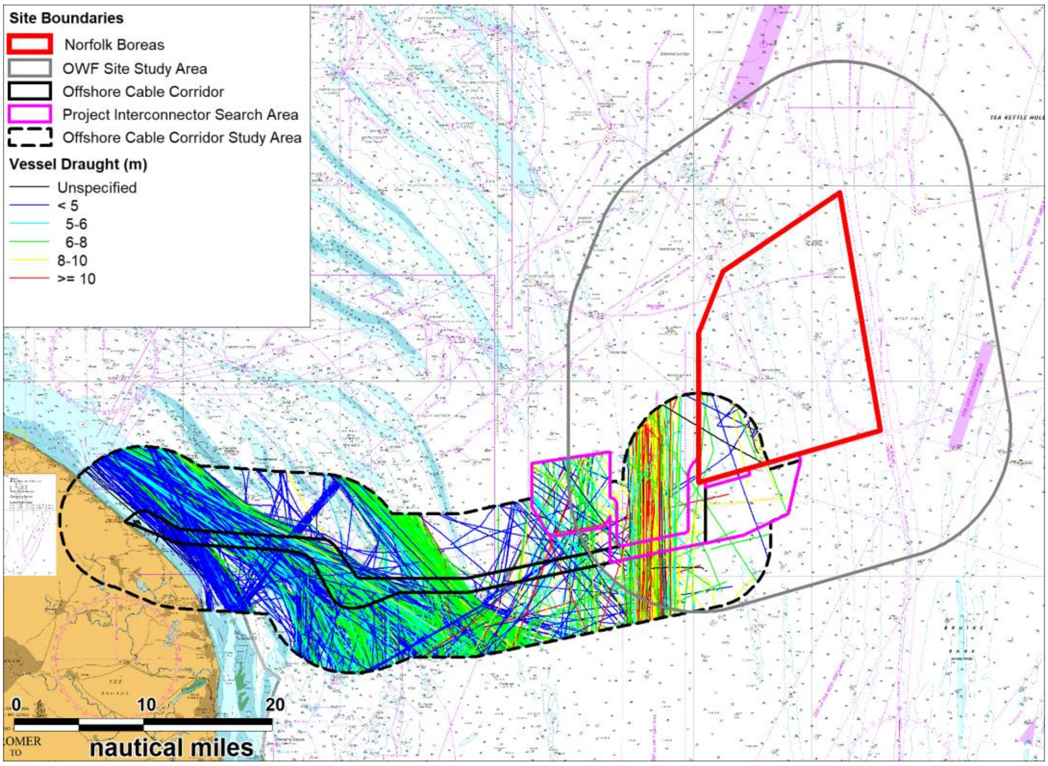


Figure 13.11 AIS Data within Offshore Cable Corridor Study Area by Vessel Draught (14 Days Winter 2018)

202. It can be seen that during both the summer and winter survey periods, vessels broadcasting a draught of 8m and over typically utilised the DR1 Lightbuoy DWR, compared to lower draught vessels which typically tended to avoid the DWR and were observed most regularly within the nearshore area. This largely mirrors the traffic patterns observed in the vessel length analysis in section 12.2.3.1.

13.2.4 Vessel Speed

203. Figure 13.12 illustrates the distribution of average vessel speeds recorded throughout both survey periods. It should be noted that 3% of the total number of vessel tracks recorded within the offshore cable corridor study area during the summer period and 1% during the winter period did not broadcast a valid speed on AIS. These tracks have therefore been excluded from the following speed analysis.

204. The average speeds recorded within the offshore cable corridor study area throughout the summer 2017 and winter 2018 survey periods were 11.7 knots and 12.5 knots.

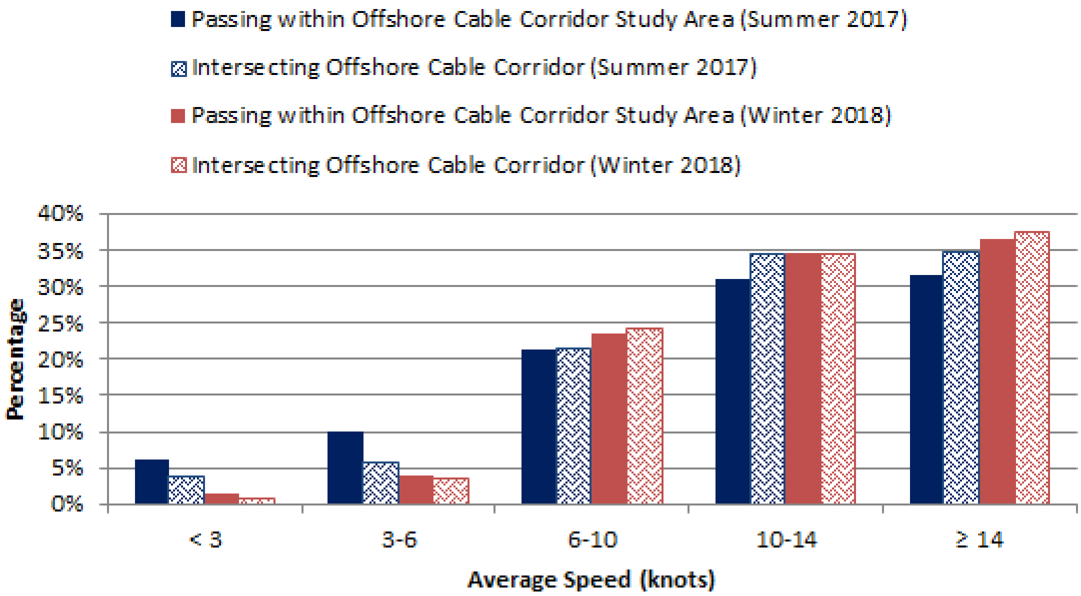


Figure 13.12 Average Vessel Speed Distribution within the Offshore Cable Corridor Study Area during 14 Days Summer 2017 and 14 Days Winter 2018

205. Figure 13.13 and Figure 13.14 present an overview of the vessel tracks (excluding temporary tracks) recorded within the offshore cable corridor study area throughout the summer 2017 and winter 2018 survey periods, colour-coded by average speed.

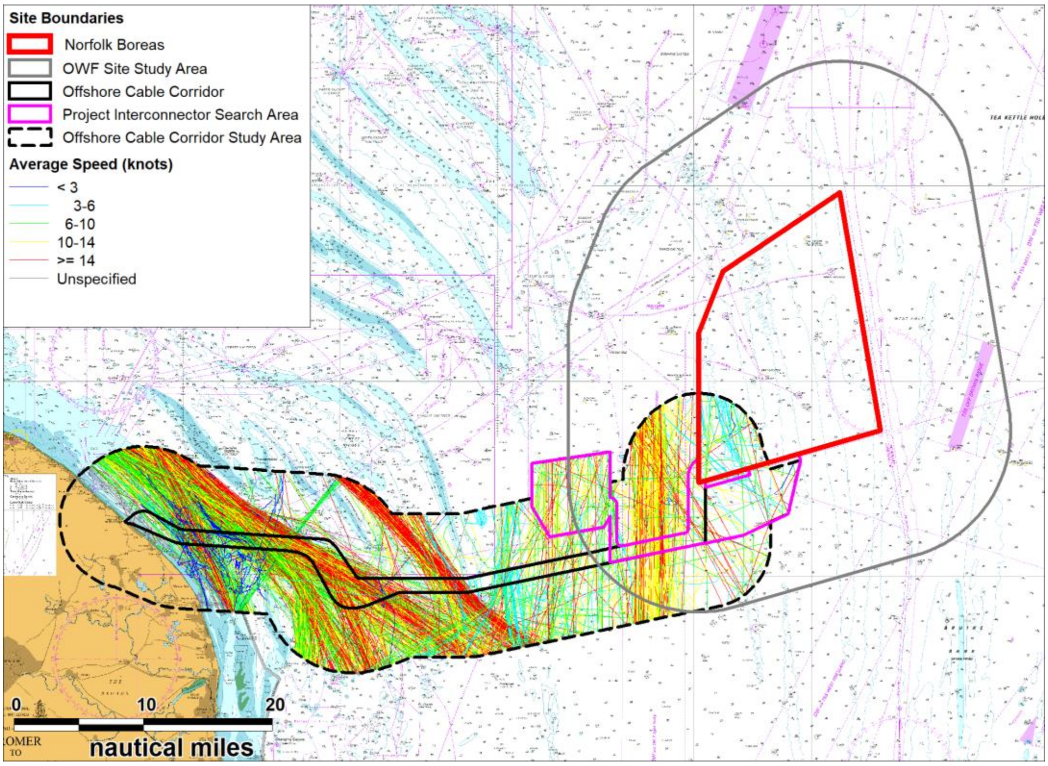


Figure 13.13 AIS Data within Offshore Cable Corridor Study Area by Average Speed (14 Days Summer 2017)

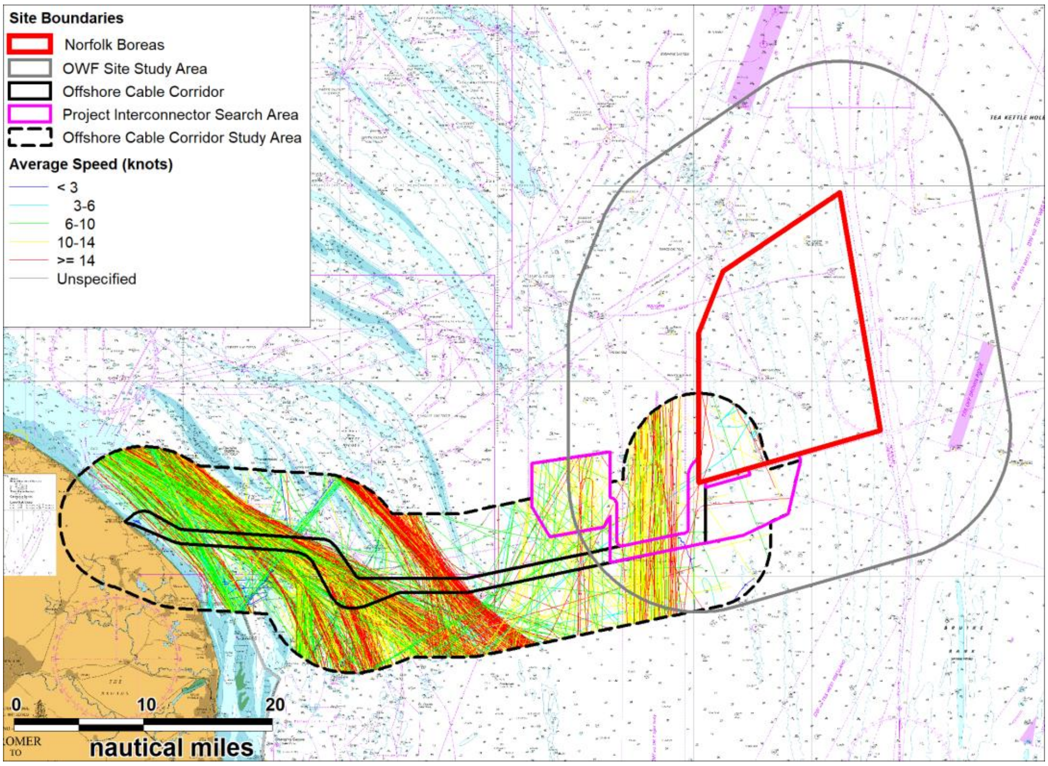


Figure 13.14 AIS Data within Offshore Cable Corridor Study Area by Average Speed (14 Days Winter 2018)

206. It can be seen that during both the summer and winter survey periods, vessels transiting at average speeds of 10 knots or over typically utilised the DR1 Lightbuoy DWR or transited a north west to south east route passing through the offshore cable corridor. Lower speed vessels were (< 3 knots) were only prevalent in the summer period in the nearshore area.

13.2.5 Vessel Density

207. Figure 13.15 and Figure 13.16 present the vessel density (excluding temporary tracks) recorded in the summer 2017 and winter 2018 survey periods, respectively. This is based on the number of track intersects per cell of a 0.5×0.5nm grid covering the offshore cable corridor study area.

208. Comparing the summer and winter survey periods, there was a higher traffic density recorded during summer than winter within the Norfolk Boreas site and the east of the offshore cable corridor study area. This is due to higher levels of fishing vessel activity within these areas during the summer when compared to the winter period (see section 13.2.2). Commercial vessel activity was more consistent between the surveyed periods (noting that larger vessels are less affected by adverse weather).

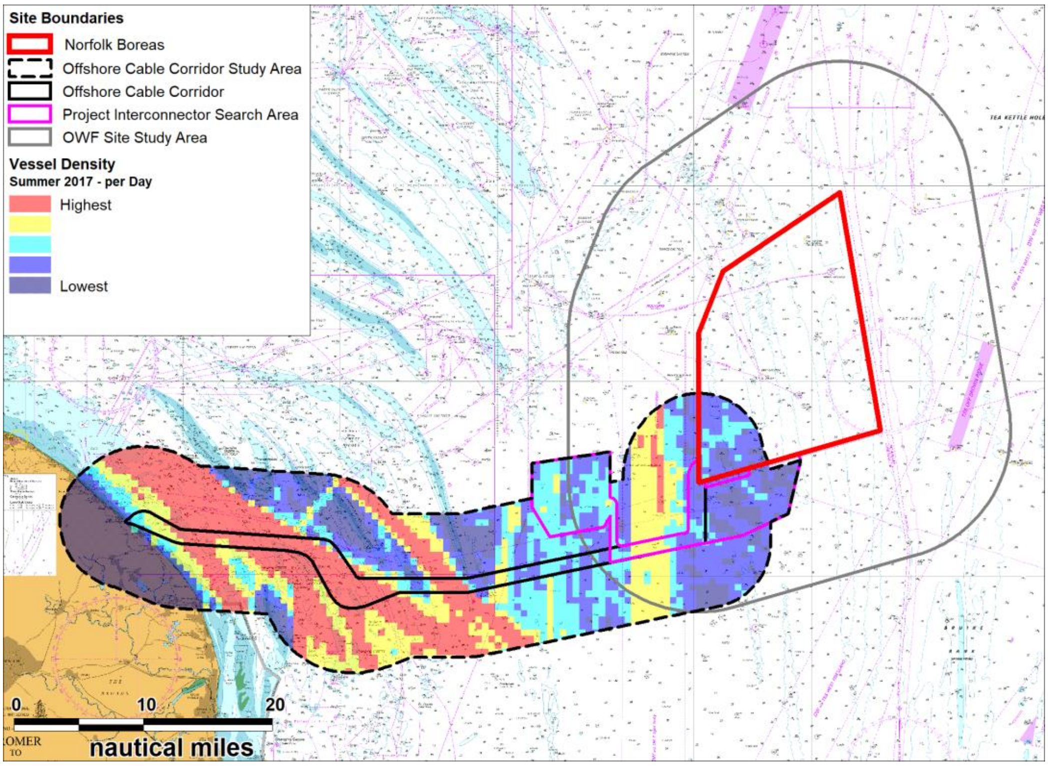


Figure 13.15 Vessel Density within the Offshore Cable Corridor Study Area Excluding Temporary Tracks (14 Days Summer 2017)

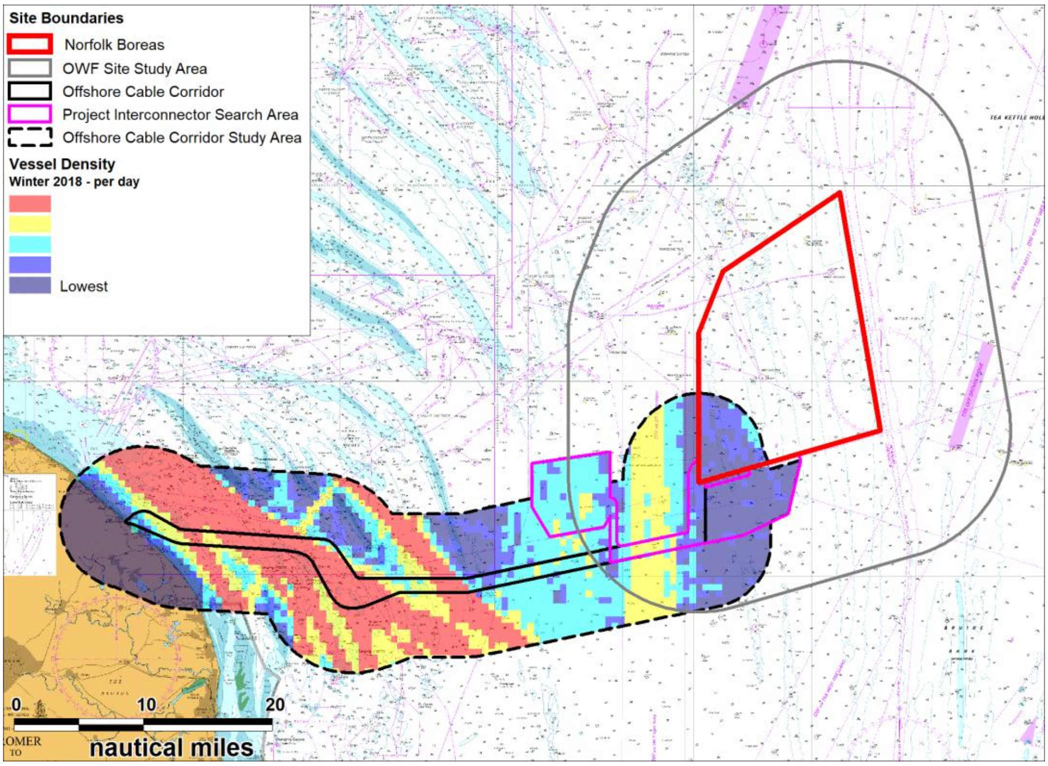


Figure 13.16 Vessel Density within the Offshore Cable Corridor Study Area Excluding Temporary Tracks (14 Days Winter 2018)

13.3 Additional Summer 2018 Analysis

209. This section presents the findings of the assessment of the summer 2018 marine traffic survey data. The findings have been compared against the summer 2017 data where relevant.

13.3.1 Vessel Counts

210. For the 14 days analysed in summer 2018, there were an average of 106 unique vessels per day passing within the offshore cable corridor study area, recorded on AIS. In terms of vessels intersecting the offshore cable corridor, there was an average of 92 unique vessels per day.

211. Figure 13.17 presents the daily number of unique vessels passing through the OWF site study area and intersecting the Norfolk Boreas site during summer 2018. The busiest day recorded throughout the survey period was the 7th August 2018 when 119 unique vessels were recorded within the offshore cable corridor study area. The quietest day recorded was the 12th August 2018, when 92 unique vessels were recorded within the OWF site study area.

212. Approximately 74% of traffic recorded within the offshore cable corridor study area during summer also intersected the offshore cable corridor.

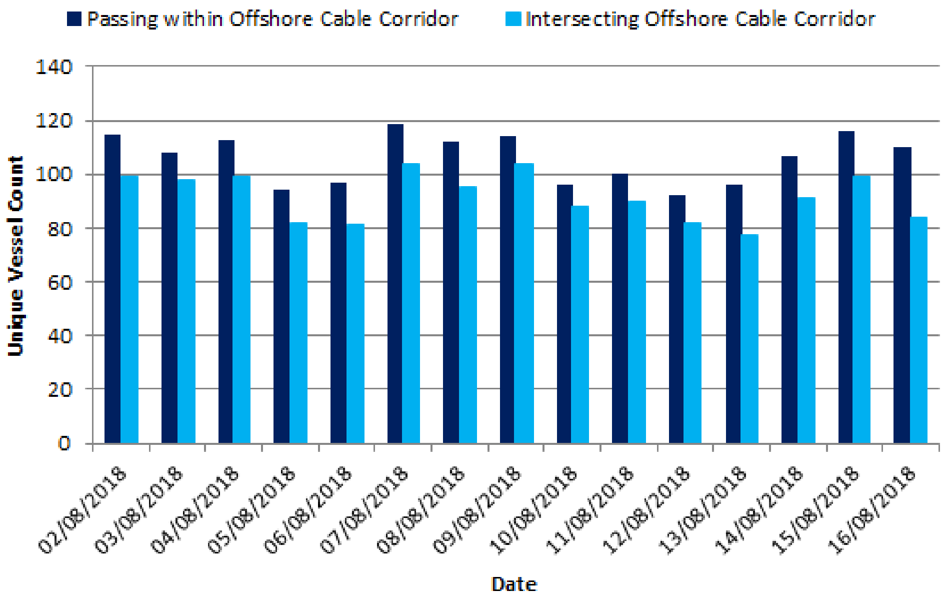


Figure 13.17 Unique Vessels per Day within Offshore Cable Corridor Study Area during 14 Days Summer 2018 (AIS)

13.3.2 Vessel Types

213. Figure 13.18 presents an overview of the AIS tracks (excluding temporary survey vessel tracks) recorded within the offshore cable corridor study area during the summer 2018 survey period, colour-coded by vessel type.

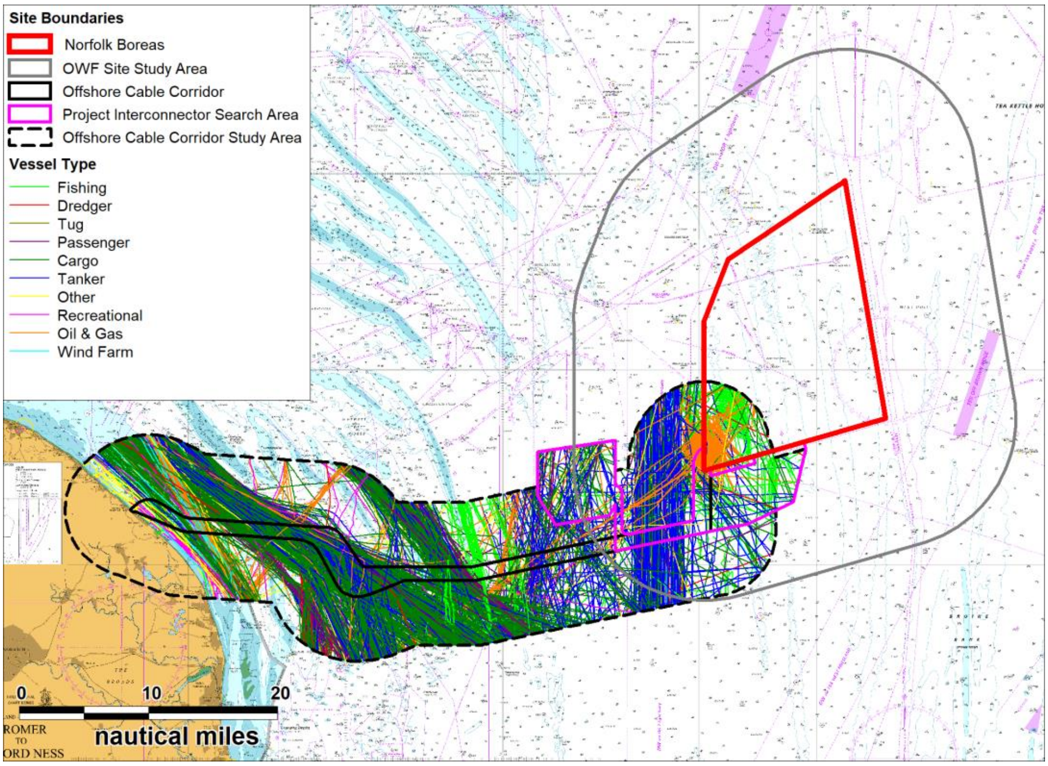


Figure 13.18 AIS data within Offshore Cable Corridor Study Area (14 Days Summer 2018)

214. Throughout the summer 2018 period, the majority of tracks within the offshore cable corridor study area were cargo vessels (45%) and tankers (23%). The majority of vessels recorded within the offshore cable corridor itself were also cargo vessels (47%) and tankers (24%).

215. Figure 13.19 presents the vessel type distribution within the offshore cable corridor study area and intersecting the offshore cable corridor during 2017 and 2018 for comparison.

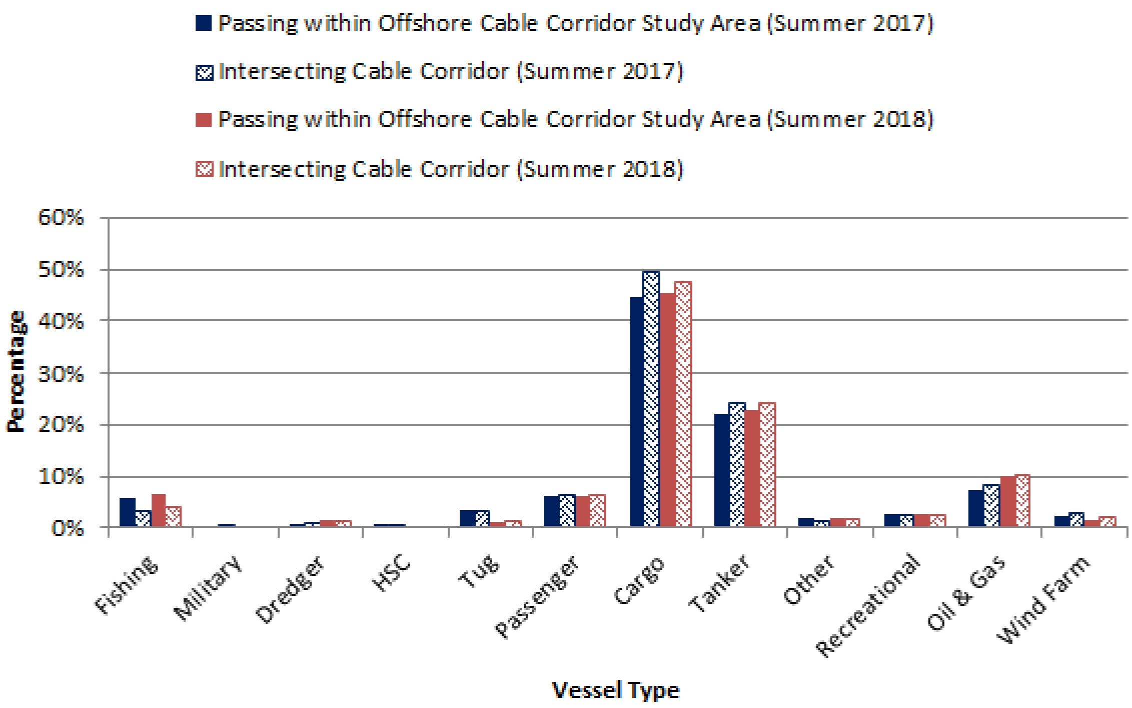


Figure 13.19 Distribution of Vessel Types within the Offshore Cable Corridor Study Area during 14 Days Summer 2017 and 14 Days Summer 2018

216. It can be seen that the summer 2017 (see Figure 13.3) and summer 2018 data sets are comparable in terms of vessel type and the distribution of vessels throughout the offshore cable corridor study area. In both 2017 and 2018, cargo vessels and tankers were the most commonly recorded vessel tracks within the offshore cable corridor study area and intersecting the offshore cable corridor itself.

217. It is noted that the summer 2018 marine traffic recorded oil and gas activity at the Ensco 72 mobile offshore platform however this activity was associated with well abandonment activity which commenced in August 2018 therefore was not reflected during summer 2017.

13.3.3 Vessel Sizes

13.3.3.1 Vessel Length

218. Figure 13.20 illustrates the distribution of vessel lengths recorded throughout both the summer 2017 and summer 2018 survey periods for comparison.

219. The average length of vessels within the offshore cable corridor study area throughout the summer 2018 survey period was 117m compared to 115m during summer 2017.

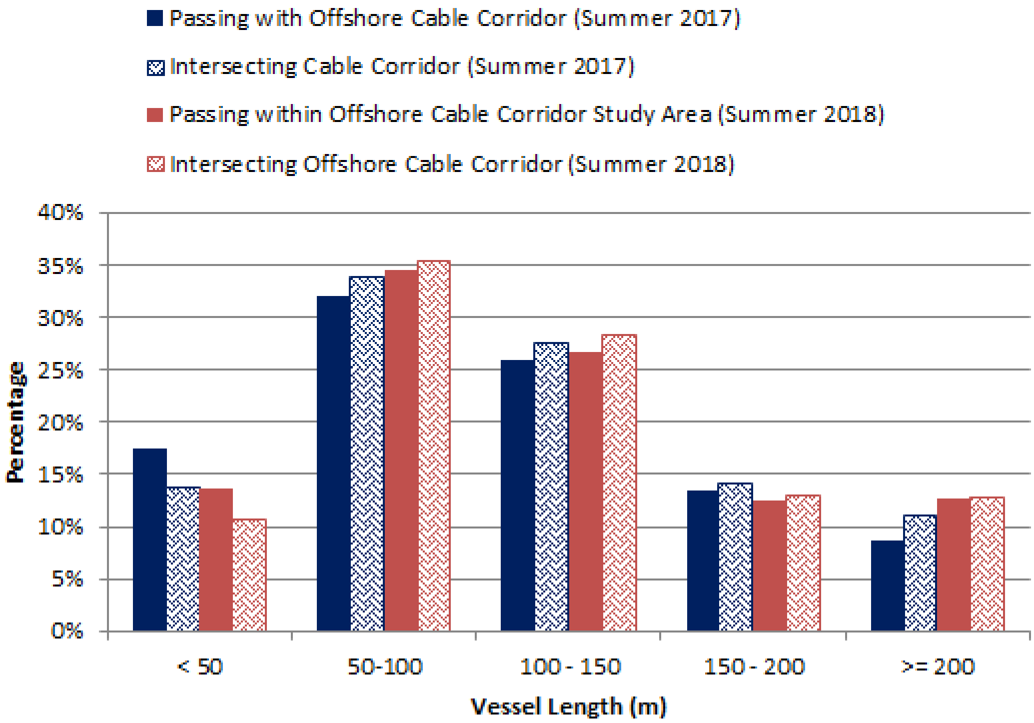


Figure 13.20 Vessel Length Distribution within the Offshore Cable Corridor Study Area during 14 Days Summer 2017 and 14 Days Summer 2018

13.3.3.2 Vessel Draught

220. Figure 13.21 illustrates the distribution of vessel draughts recorded throughout both the summer 2017 and summer 2018 survey periods for comparison.

221. The average draught of vessels within the offshore cable corridor study area throughout both the summer 2018 and summer 2017 survey periods was 5.6m.

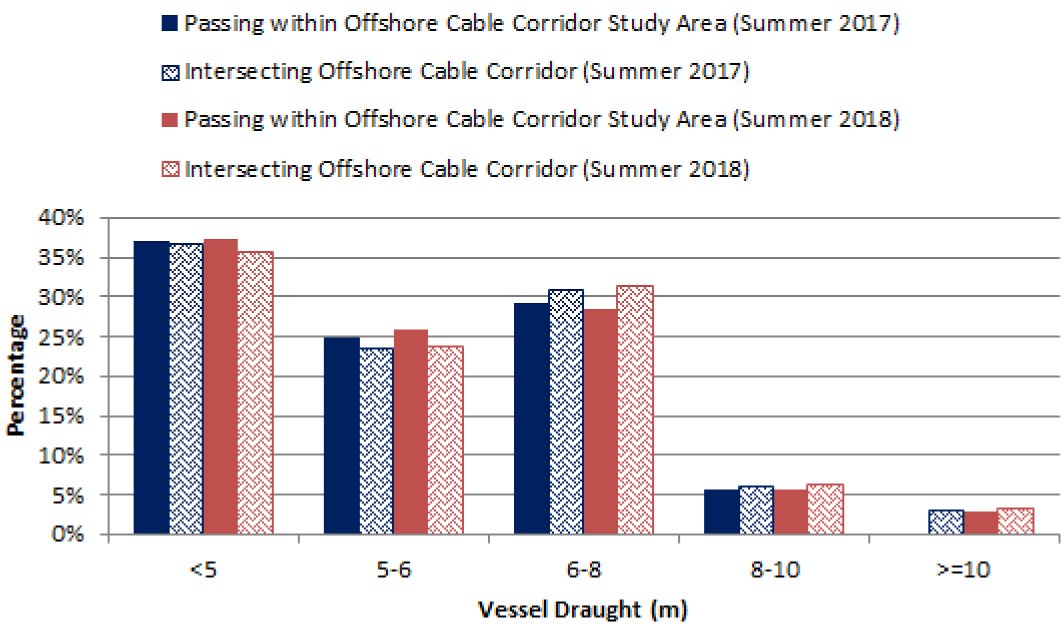


Figure 13.21 Vessel Draught Distribution within the Offshore Cable Corridor Study Area during 14 Days Summer 2017 and 14 Days Summer 2018

13.3.4 Vessel Speed

222. Figure 13.22 illustrates the distribution of vessel speeds recorded throughout both the summer 2017 and summer 2018 survey periods for comparison.

223. The average speed of vessels within the offshore cable corridor study area throughout the summer 2018 survey period was 11.2 knots compared to 11.7 knots in summer 2017.

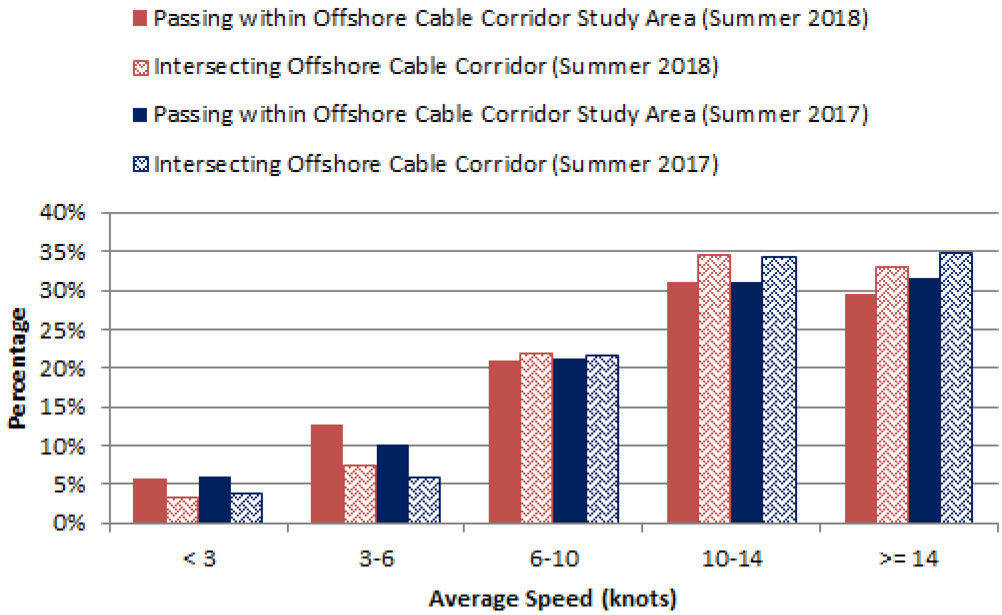


Figure 13.22 Average Vessel Speed Distribution within the Offshore Cable Corridor Study Area during 14 Days Summer 2017 and 14 Days Summer 2018

13.3.5 Vessel Density

224. Figure 13.23 presents the vessel density (excluding temporary tracks) recorded in the summer 2018 survey period. This is based on the number of track intersects per cell of a 0.5×0.5nm grid covering the offshore cable corridor study area.

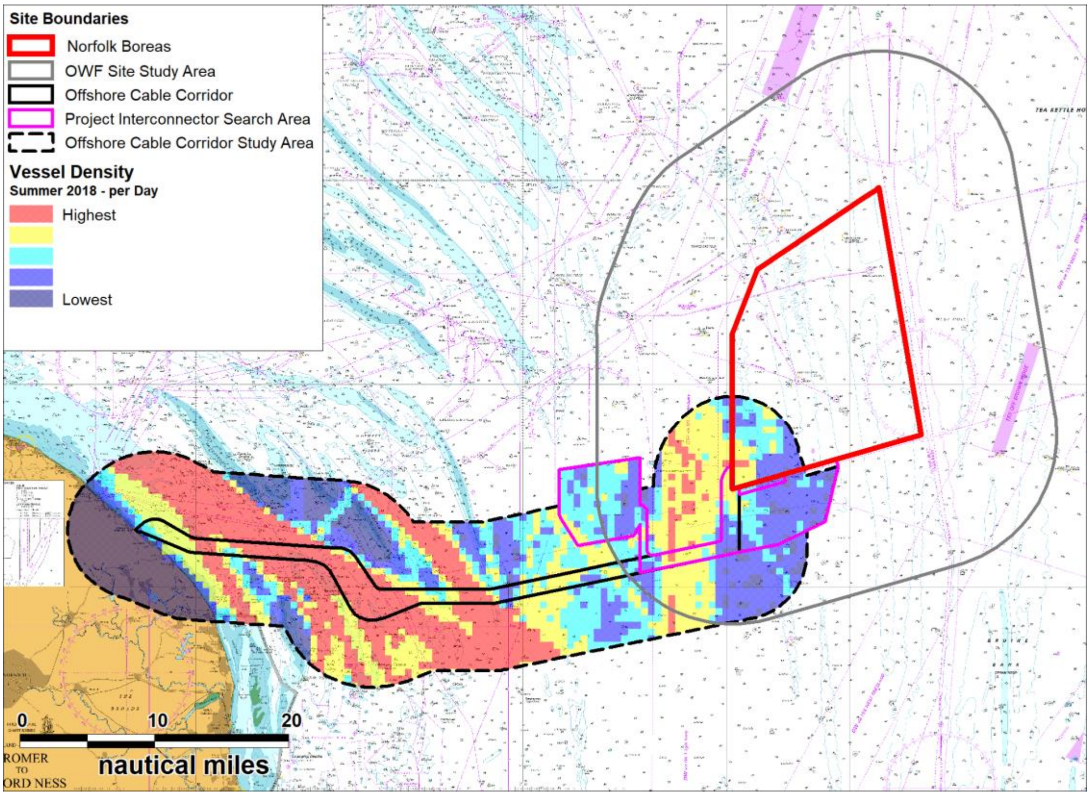


Figure 13.23 Vessel Density within the Offshore Cable Corridor Study Area Excluding Temporary Tracks (14 Days Summer 2018)

225. The summer (see section 13.2.5) and summer 2018 vessel densities can be considered comparable. The busiest areas during both summer periods were within the east of the offshore cable corridor study area due to the high density commercial vessel routes recorded as well as the west of the offshore cable corridor study area where the DWR is located.

13.4 Comparison with Summer 2017 Data

226. As observed for the marine traffic assessment of the Norfolk Boreas Site, an increase in vessel numbers was observed during summer 2018 when compared to the corresponding summer 2017 survey, with the number of unique vessels per day in the offshore cable corridor study area rising from 104 to 106. This is not considered a significant increase, and is deemed as having no effect on the impact assessment already undertaken as per section 27.3.

227. Overall, the average vessel sizes and vessel speeds recorded have not changed significantly since the summer 2017 survey.

14 Recreational Activity

228. This section provides an assessment of the recreational vessel activity within the OWF site study area and the offshore cable corridor study area. The data collected during the summer 2017 and winter 2018 surveys is presented as well as the up to date summer 2018 survey.

229. The RYA Coastal Atlas (2016) has been used to illustrate recreational traffic within the UK's 12nm limit as well as to present the locations of clubs, training centres, marinas and offshore routes.

14.1 Marine Traffic Data

14.1.1 Norfolk Boreas Site

230. The tracks from recreational vessels recorded during the summer 2018 marine traffic survey are shown in Figure 14.2. Following this, the tracks recorded during summer 2017 are presented in Figure 14.2 (note no recreational tracks were recorded during the winter survey period).

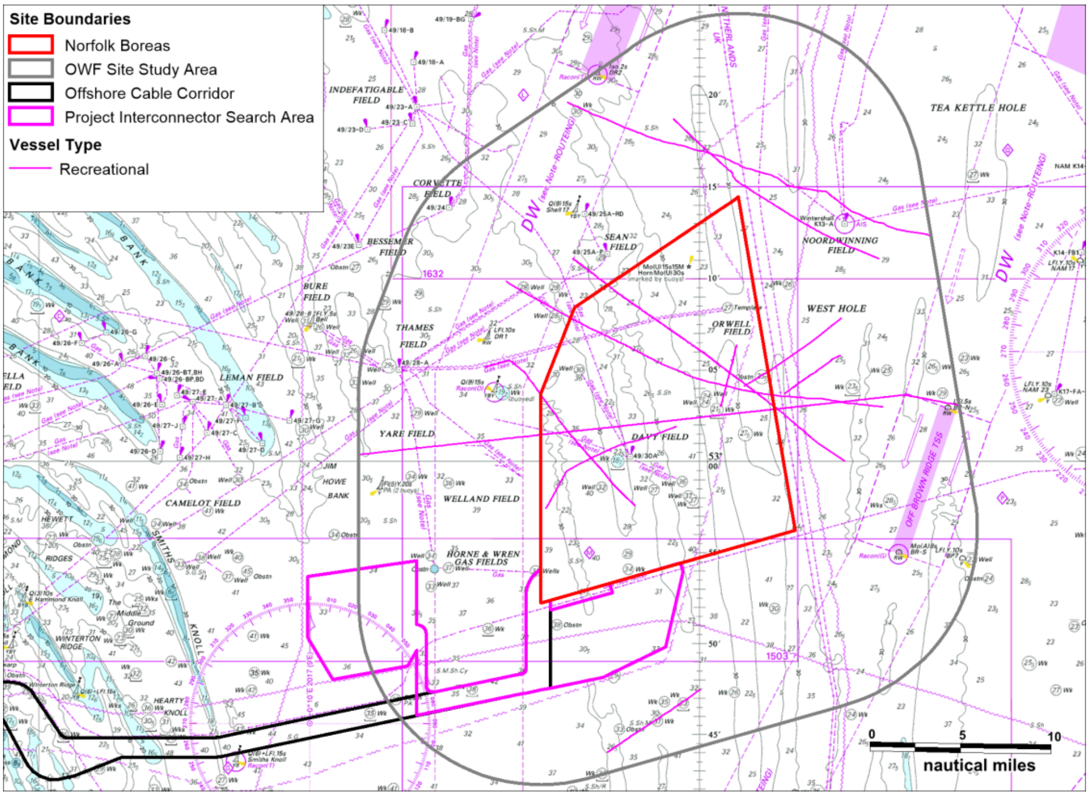


Figure 14.1 Recreational Vessels within OWF Site Study Area (14 Days Summer 2018)

231. Less than one recreational vessel per day was recorded during the summer 2018 survey. All vessel lengths identified were between 10 and 13m. Only one of the vessels transmitted destination information (Ijmuiden); however based on

consultation and assessment of the RYA Coastal Atlas (see section 14.1.2) (RYA, 2016) it is likely these vessels were on cross continent transits between the UK and mainland Europe.

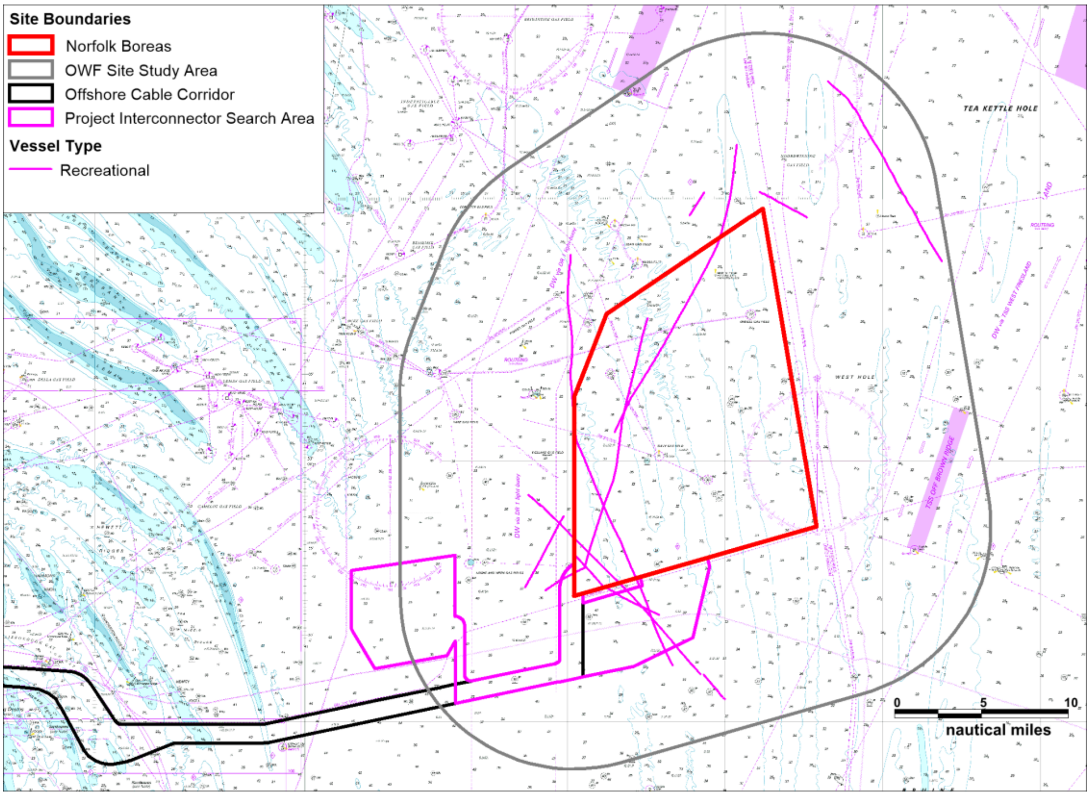


Figure 14.2 Recreational Vessels within OWF Site Study Area (14 Days Summer 2017)

232. A recreational vessel was recorded less than once a day during the summer 2017 survey. All vessels recorded were between 11 and 13m in length, and those vessels able to be identified were all confirmed as being sailing vessels. None of the vessels transmitted destination information; however based on consultation and assessment of the RYA Coastal Atlas (see section 14.1.2) (RYA, 2016) it is likely these vessels were on cross continent transits between the UK and mainland Europe.

233. Comparing the 2017 and 2018 summer data, there has been no change in the number of recreational vessels recorded between the survey periods. Vessel lengths remain comparable and tracks are recorded intersecting the Norfolk Boreas site in 2017 and 2018.

14.1.2 Offshore Cable Corridor

234. The tracks recorded from recreational vessels within the offshore cable corridor study area during the summer 2018 survey period are presented in Figure 14.3. Following this, the tracks recorded during summer 2017 are presented in Figure 14.4. Just one recreational track was recorded during winter, however this track was only

recorded for a short period of time (less than ten minutes) and has not been presented on this basis.

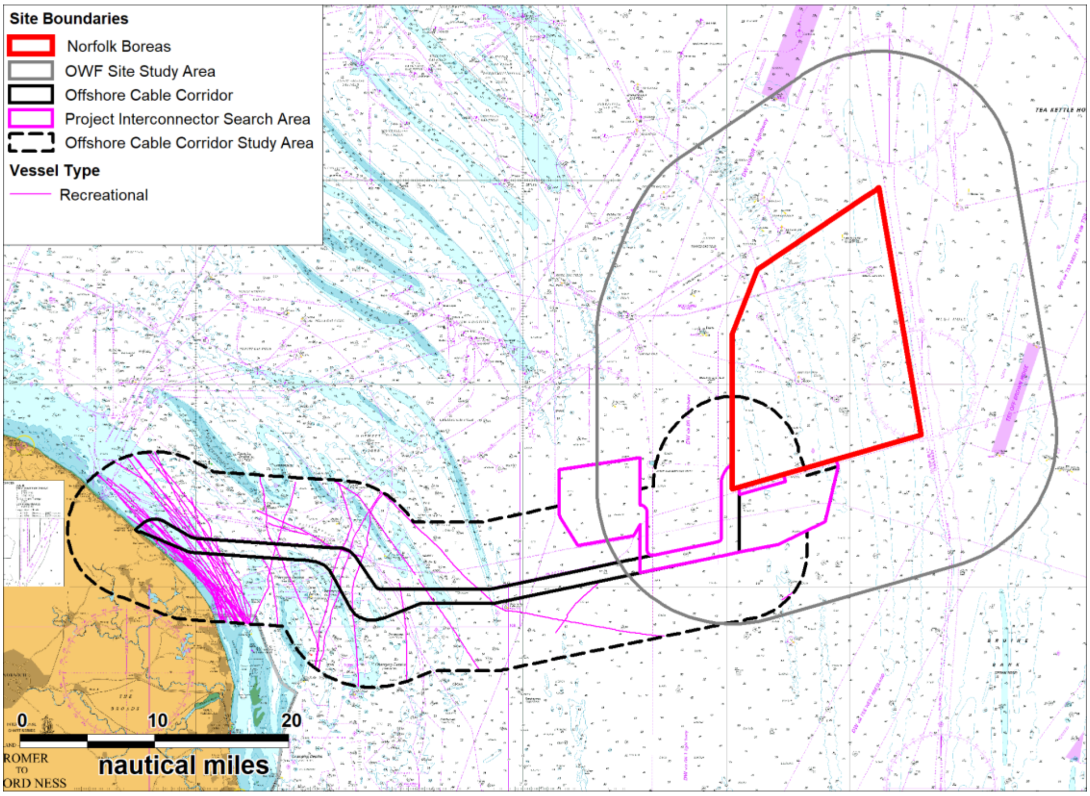


Figure 14.3 Recreational Vessels within Offshore Cable Corridor Study Area (14 Days Summer 2018)

235. An average of three recreational vessels per day was recorded within the offshore cable corridor study area during the summer 2018 survey period, with the majority of this activity observed to be coastal transits. Vessel length ranged from 8m to 14m, and no destination information was transmitted via AIS by any vessels (noting all were fitted with Class B AIS units).

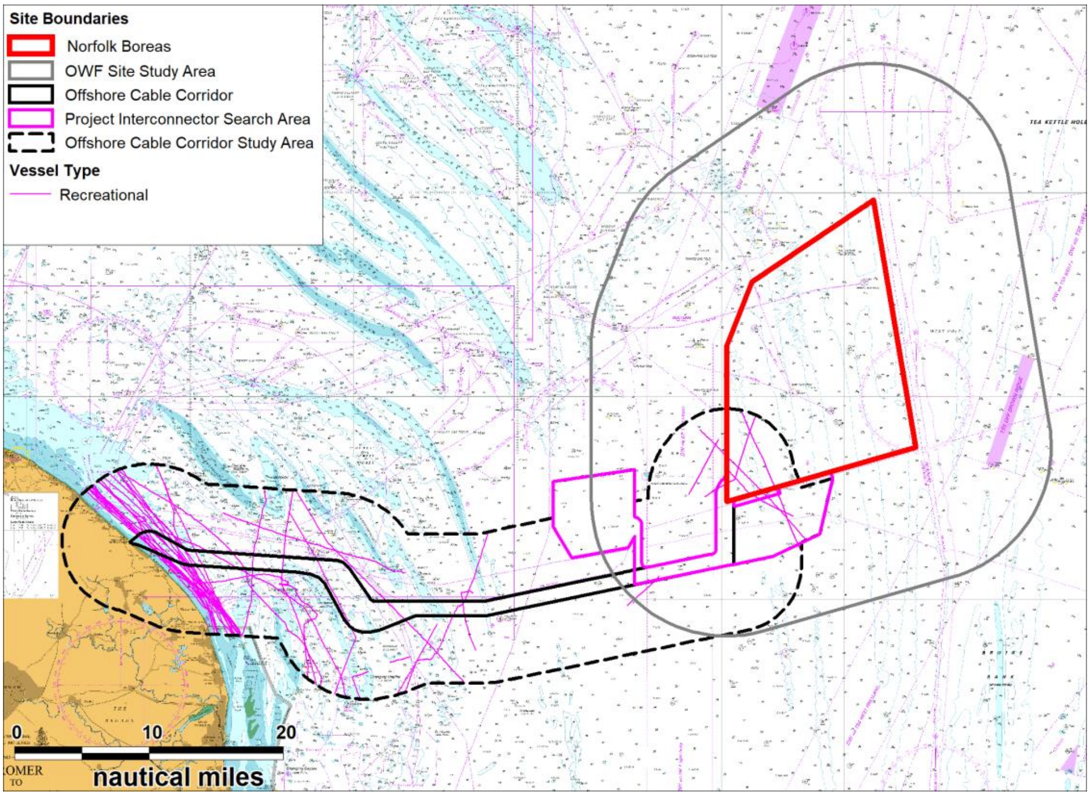


Figure 14.4 Recreational Vessels within Offshore Cable Corridor Study Area (14 Days Summer 2017)

236. An average of three unique vessels per day were recorded within the offshore cable corridor study area during the summer 2017 survey period, with the majority of this activity observed to be coastal transits. Vessel length ranged from 7m to 23m, and no destination information was transmitted via AIS by any vessels (noting all were fitted with Class B AIS units).

237. Comparing the 2017 and 2018 summer data, there has been no change in the number of recreational vessels recorded between the survey periods. Vessel lengths recorded were higher during 2017 (maximum of 23m) compared to 2018 (maximum of 14m). Tracks were recorded intersecting the offshore cable corridor during both 2017 and 2018.

14.2 RYA Coastal Atlas

238. The RYA Coastal Atlas (RYA, 2016) is presented relative to Norfolk Boreas in Figure 14.5. This includes a recreational density grid up to the 12nm territorial limit, and the locations of clubs, training centres, and marinas. To illustrate offshore routeing, the Coastal Atlas also provides offshore route indicators, showing typical known recreational routes beyond the 12nm limit.

239. For reference, historic cruising routes (RYA, 2009) are also included in Figure 14.5; however it is noted that RYA preference is that the current Coastal Atlas (2016) be used as the primary recreational activity assessment tool.

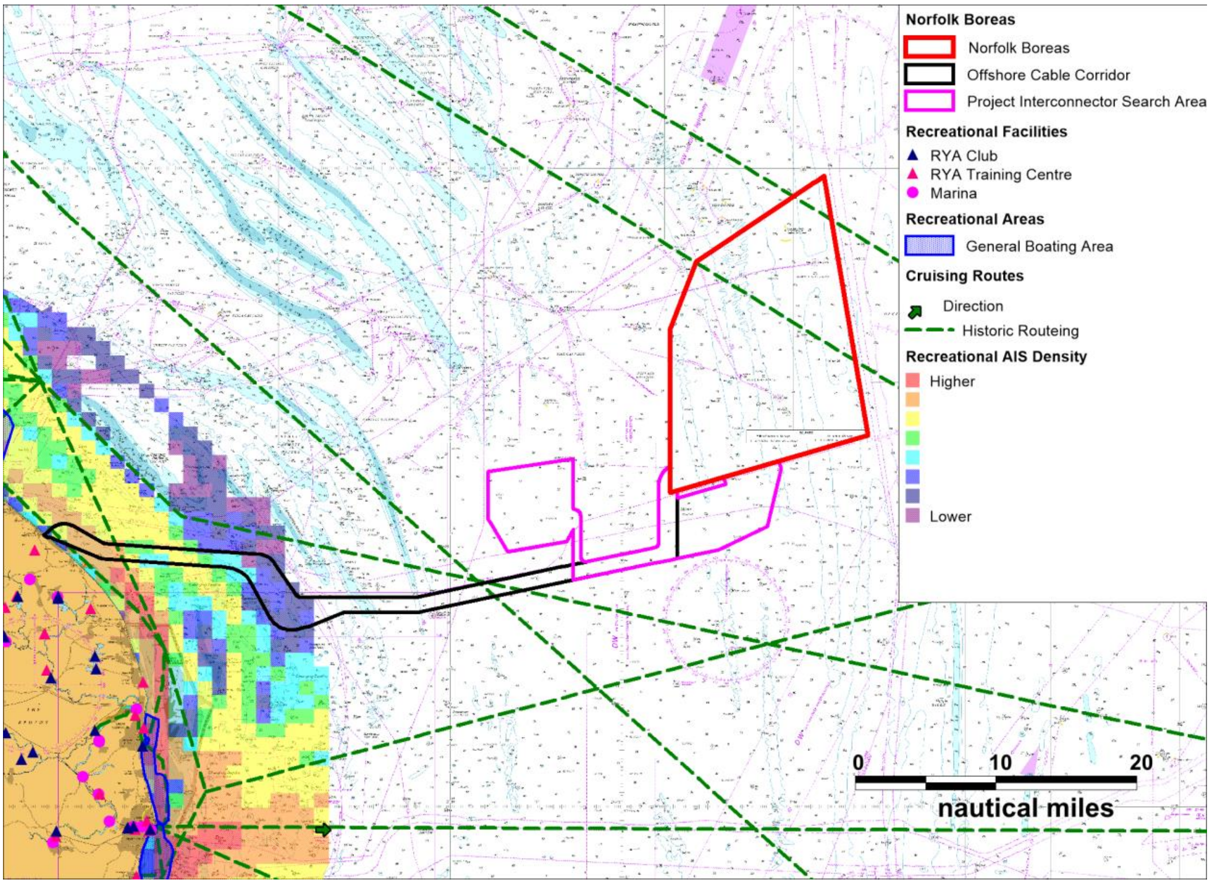


Figure 14.5 RYA Coastal Atlas (2016) and Historic Cruise Routeing

240. Higher recreational density was observed to be largely coastal, with the landfall area at Happisburgh categorised as medium to high density. There were no offshore route indicators near the project boundaries, however two historic cruising routes intersected the Norfolk Boreas site, and four intersected the offshore cable corridor.

14.3 Impacts on Recreational Vessels

14.3.1 Impacts of Structures on Wind Masking / Turbulence or Shear

241. The offshore wind turbines have the potential to affect vessels under sail when passing through the Norfolk Boreas site from impacts such as wind shear, masking and turbulence.

242. From previous studies of OWFs it was concluded that wind turbines do reduce wind velocity by the order of 10% downwind of a wind turbine. The temporary effect is not considered as being significant and similar to that experienced passing a large vessel or close to other large structures (e.g. bridges) or the coastline. In addition,

practical experience to date from RYA members taking vessels into other sites indicates that this is not likely to be an issue. A number of OWFs are operational within UK waters and no impacts have been reported by recreational users.

14.3.2 Recreational Vessel Blade and Mast Allision

243. The RYA considers the largest risk to recreational craft from offshore wind developments to be the risk of rotor blade allision and under keel allision associated with scour protection, cable protection or floating foundation moorings which reduces the keel clearance. An allision between a wind turbine blade and the mast of a yacht or damage to the keel could result in the structural failure and foundering of the yacht.

244. It should be noted that following submission of the PEIR, floating tension leg foundations are no longer being considered within the design envelope therefore there is no longer the associated risk of under keel allision.

14.3.2.1 Air Clearance

245. In order to mitigate the risk of blade allision, the project will adhere to guidance on the construction of OWFs including ensuring that the minimum rotor blade clearance (air draught) for the wind turbines is at least 22m above MHWS. This is the clearance when the blade is in its lowest (six o'clock) position. The actual clearance at a given time would depend upon the prevailing tide and wave conditions, i.e. lower clearance at high water and rough seas, greater clearance at low water and calm seas.

246. To determine the extent to which yacht masts could interact with the rotor blades, details on the air draughts of the International Racing Certificate (IRC) fleet are provided in Figure 14.6 based on a fleet size of over 3,000 vessels (study undertaken in 2002 however values are not expected to have significantly changed). IRC is a rating used worldwide which allows boats of different sizes and designs to race on equal terms. The UK IRC fleet, although numerically only a small proportion of the total number of sailing yachts in the UK, is considered representative of the range of modern sailing boats in general use in UK waters.

247. From this data, fewer than 4% of boats have air draughts exceeding 22m. Therefore, only a fraction of vessels could potentially be at risk of dismasting if they were directly under a rotating blade in the worst-case conditions. It is further noted that the project will be designed and constructed to satisfy the requirements of the MCA in respect to control functions and safety features, as specified in MGN 543 (MCA 2016).

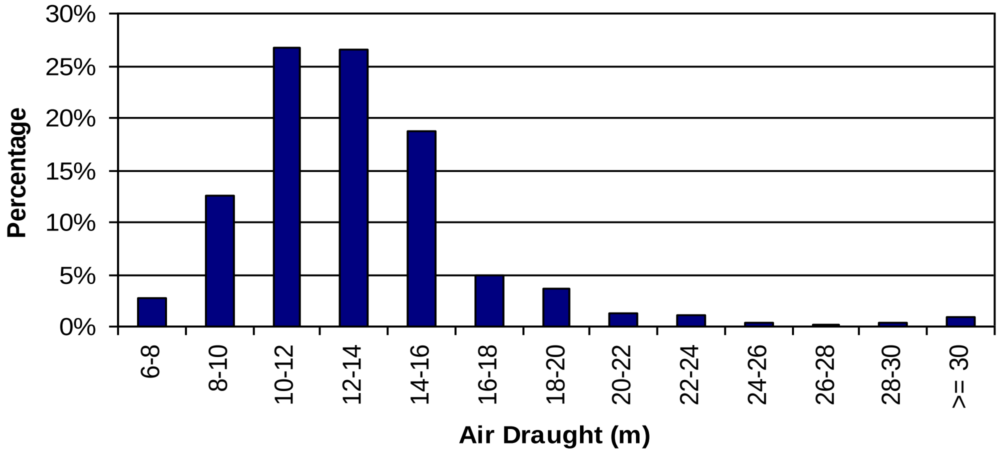


Figure 14.6 Air Draught Data – IRC Fleet

248. These measures mean that whilst the blade allision risk cannot be completely eliminated it would be reduced to ALARP levels. In terms of consequences, most allisions with the wind turbines should be relatively low speed and hence low energy. If the seaworthiness of the recreational craft was threatened by the impact, the wind turbines would be equipped with access ladders for use in an emergency, placed in the optimum position taking into account the prevailing wind, wave and tidal conditions, as required by the MCA. This should provide a place of safety / refuge until such time as the rescue services arrive.

14.3.2.2 Under Keel Clearance and Allision Risk

249. Given the water depths there are not expected to be any impacts associated with scour protection affecting under keel clearance.

250. A cable burial risk assessment will be undertaken post consent to ensure that under keel clearance of transiting vessels is considered when selecting cable burial and protection methods.

15 Fishing Vessel Activity

15.1 Introduction

251. This section provides an assessment of the fishing vessel activity within the OWF site study area and the offshore cable corridor study area. The data collected during the summer 2017 and winter 2018 surveys is presented as well as the up to date summer 2018 survey.

252. Longer term satellite and sightings surveillance archive data provided by the MMO has been used for the purposes of validation, and further detailed assessment of fishing activity is provided in Chapter 14 Commercial Fisheries.

253. It is noted that impacts specifically related to commercial fishing rather than navigational safety are assessed within Chapter 14 Commercial Fisheries, rather than in Chapter 15 Shipping and Navigation; however gear type assessment has still been undertaken within this NRA for completeness.

15.2 Marine Traffic Data

15.2.1 Norfolk Boreas Site

254. The tracks recorded from fishing vessels during the summer 2018 marine traffic survey are shown in Figure 15.1. Following this, the tracks recorded during summer 2017 and winter 2018 are presented in Figure 15.2 and Figure 15.3respectively.

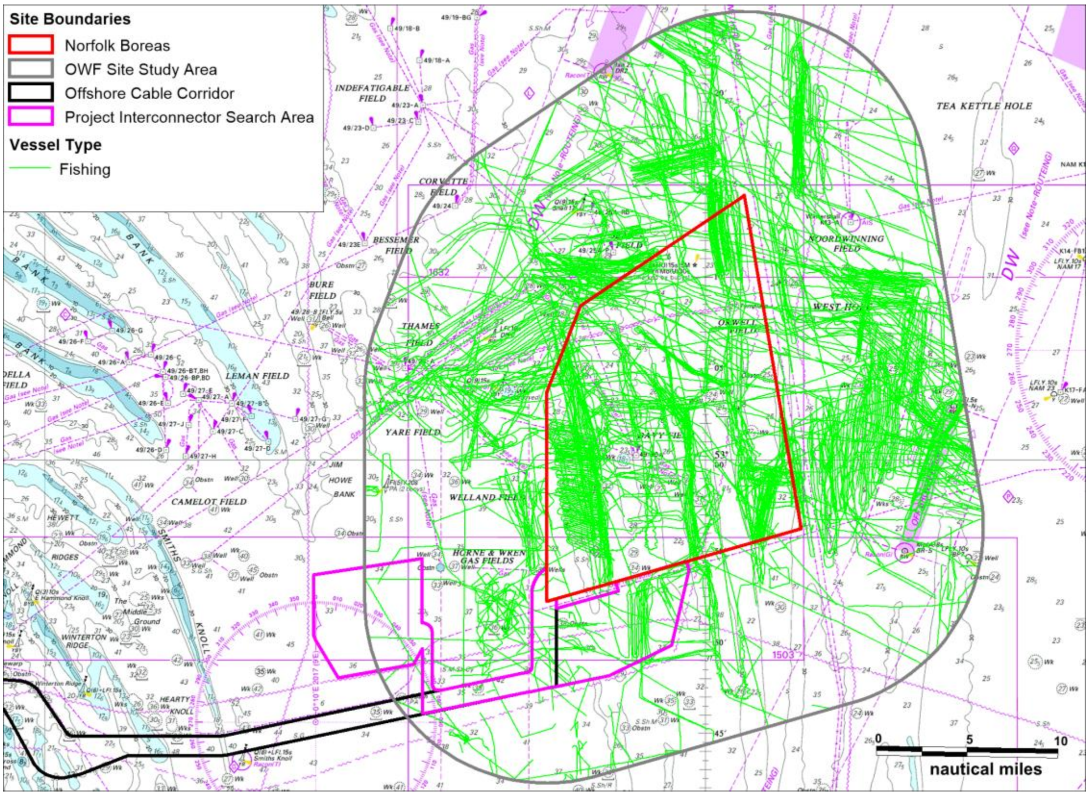


Figure 15.1 Fishing Vessels within OWF Site Study Area (14 Days Summer 2018)

255. During the summer survey period, approximately 12 unique fishing vessels were recorded per day within the OWF site study area. Approximately six fishing vessels per day intersected the Norfolk Boreas site itself during summer. As visible in Figure 15.2, active fishing (as opposed to fishing vessels in transit) was recorded within the Norfolk Boreas site.

256. The majority of vessel activity recorded was from beam trawlers (81% of activity. During summer, limited levels of demersal trawlers, pelagic trawlers, pair trawlers, unspecified trawlers, potter / whelkers, seiners, and seiner / surrounding nets were also recorded.

257. The majority of vessels were Dutch registered (85%), with UK, French, German, Belgian, Norwegian and Belizean vessels also recorded.

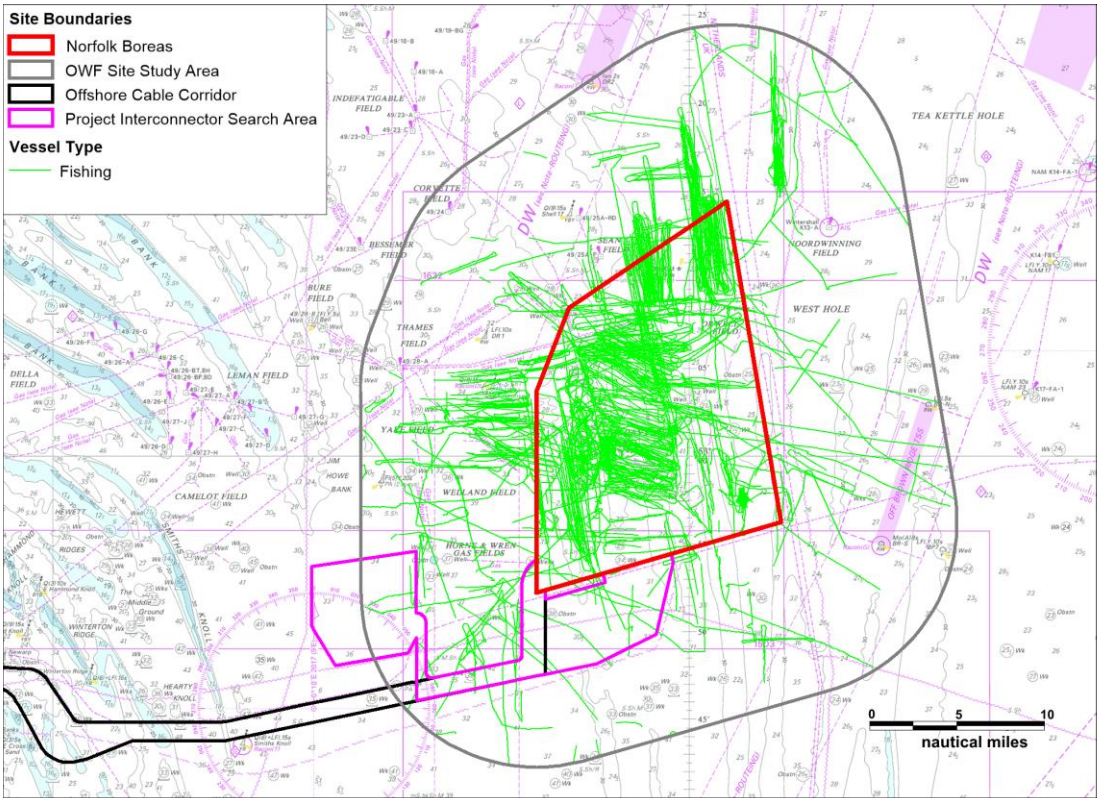


Figure 15.2 Fishing Vessels within OWF Site Study Area (14 Days Summer 2017)

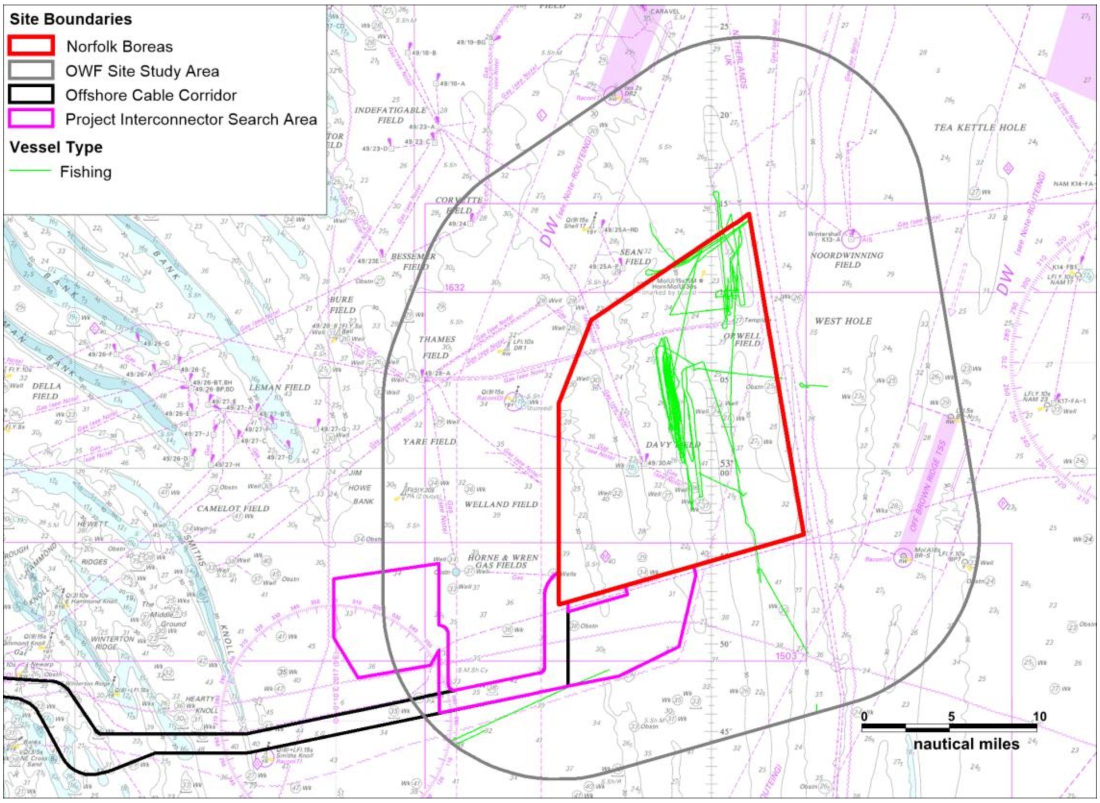


Figure 15.3 Fishing Vessels within OWF Site Study Area (15 Days Winter 2018)

258. During the summer 2017 survey period, approximately eight unique fishing vessels were recorded per day within the OWF site study area, falling to one per day during winter. Approximately six fishing vessels per day intersected the Norfolk Boreas site itself during summer, and one in winter. As visible in Figure 15.2 and Figure 15.3, active fishing (as opposed to fishing vessels in transit) was recorded within the Norfolk Boreas site during both summer and winter.

259. The majority of vessel activity recorded was from beam trawlers (85% of activity during summer, and all activity during winter). During summer, limited levels of demersal otter trawlers, pelagic trawlers, seiners, and gill netters were also recorded.

260. In summer, the majority of vessels were Dutch registered (82%), with UK, French, German and Belgian vessels also recorded. Similarly, in winter the majority of activity was from Dutch registered vessels, with one UK registered vessel also recorded.

261. Comparing the 2017 and 2018 summer data, there has been an increase in the number of fishing vessels recorded between the survey periods within the OWF site study area as a whole; however vessel numbers within the Norfolk Boreas Site itself remain unchanged. Fishing vessel gear types and nationalities recorded were similar between the two surveys, with Dutch beam trawlers the most commonly recorded. Vessels actively engaged in fishing were recorded within the Norfolk Boreas Site during both 2017 and 2018 however more activity was recorded within the west and north of the OWF site study area during 2018. It should be noted that fishing vessel activity can vary year to year depending on fish movements and stock levels.

15.2.2 Offshore Cable Corridor

262. The tracks recorded from fishing vessels during the summer 2018 marine traffic survey within the offshore cable corridor study area are shown in Figure 15.4. Following this, the tracks recorded during summer 2017 and winter 2018 are presented in Figure 15.5 and Figure 15.6 respectively.

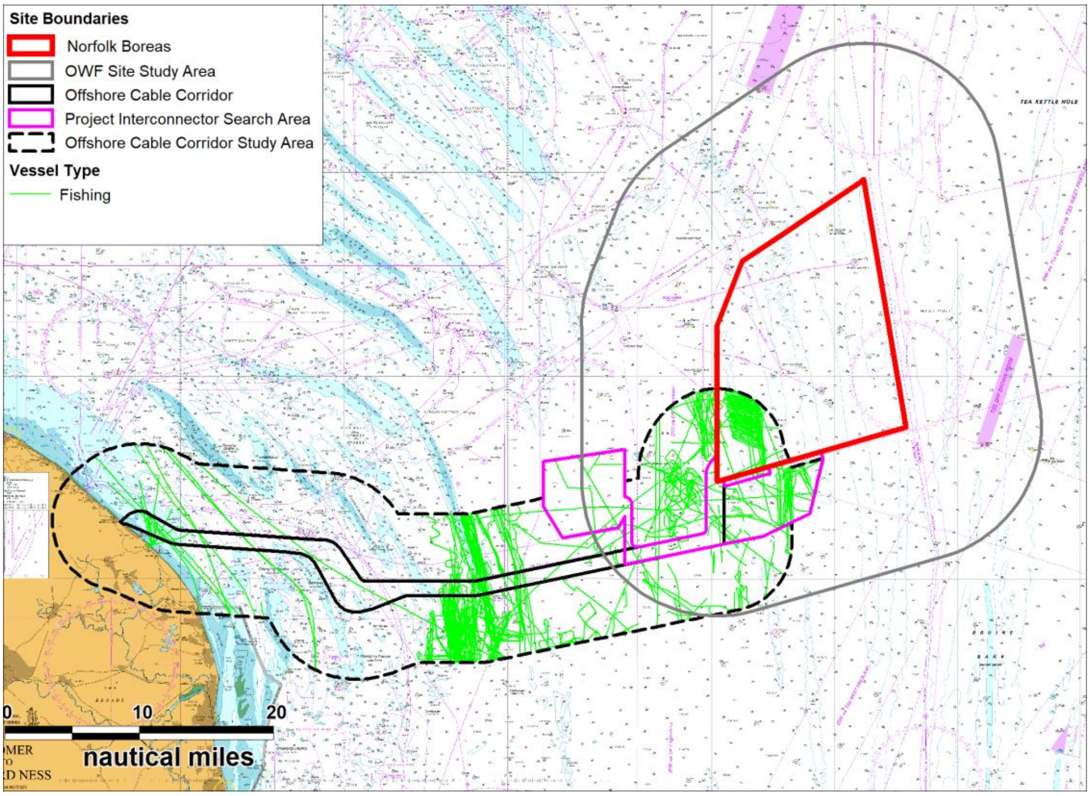


Figure 15.4 Fishing Vessels within Offshore Cable Corridor Study Area (14 Days Summer 2018)

263. During the summer 2018 survey period, approximately seven unique fishing vessels were recorded per day within the offshore cable corridor study area with four per day intersecting the offshore cable corridor itself. As visible in Figure 15.4, active fishing (as opposed to fishing vessels in transit) was recorded within the offshore cable corridor.

264. The majority of vessel activity recorded was from beam trawlers (66% of activity). During summer, limited levels of demersal trawlers, pelagic trawlers, unspecified trawlers, dredgers, seiner/surrounding nets and potter/whelkers were also recorded.

265. The majority of vessels were Dutch registered (76%) with UK, French, Belgian, Norwegian and Russian vessels also recorded.

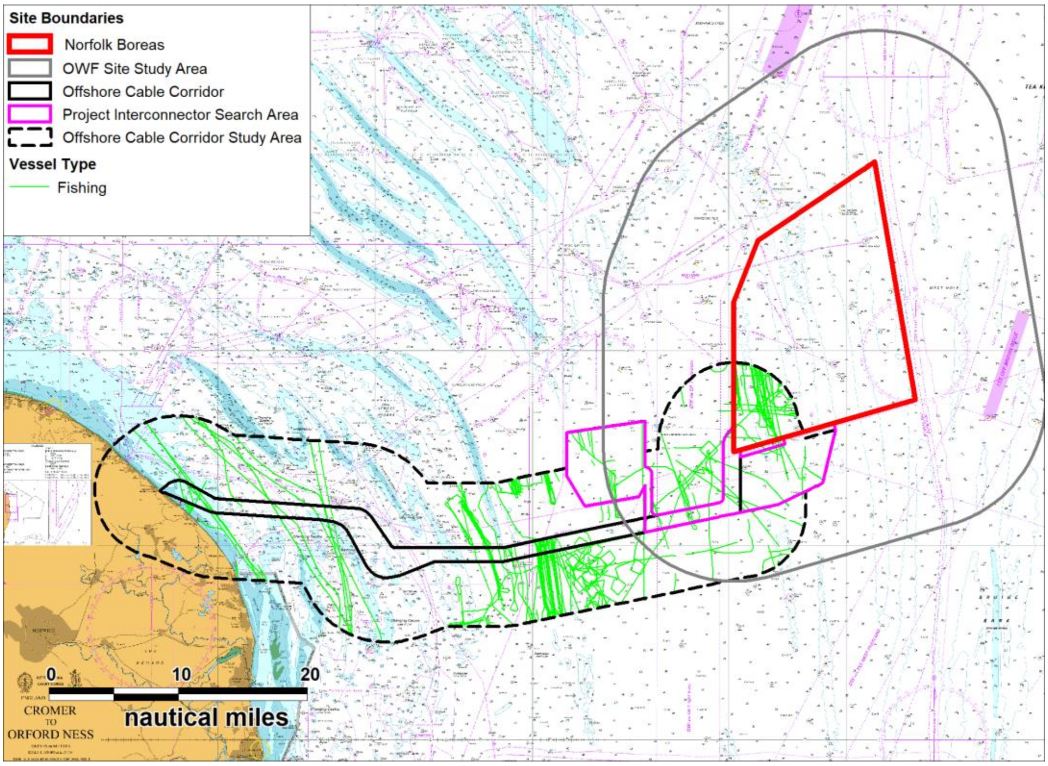


Figure 15.5 Fishing Vessels within Offshore Cable Corridor Study Area (14 Days Summer 2017)

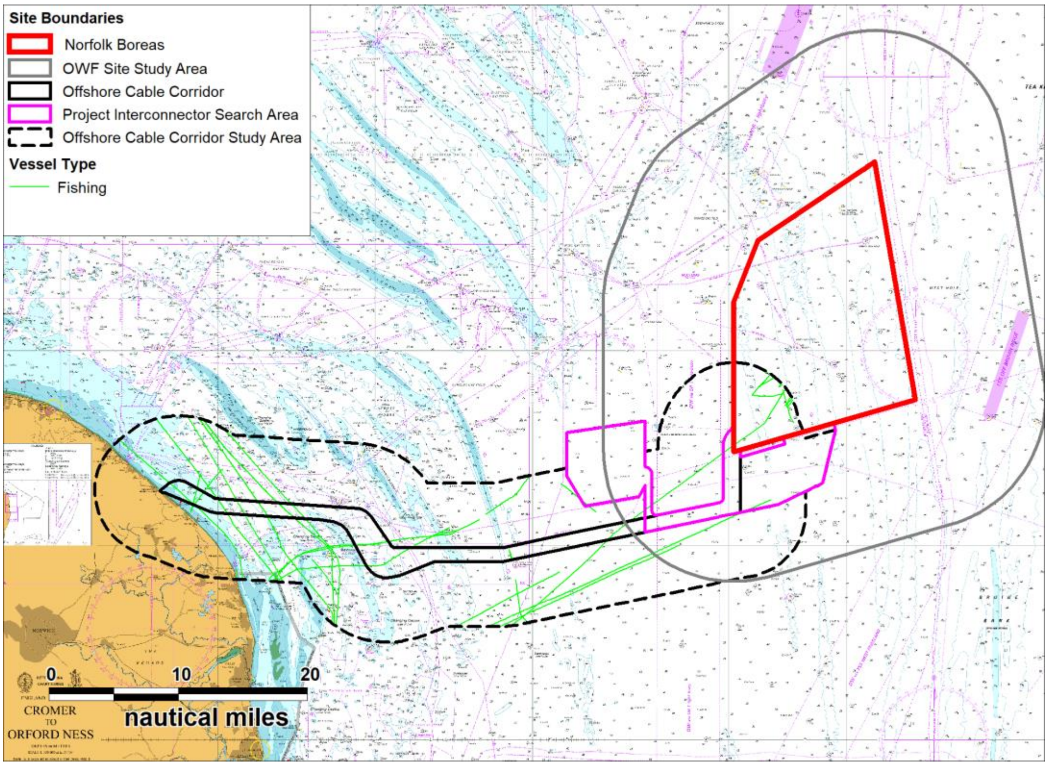


Figure 15.6 Fishing Vessels within Offshore Cable Corridor Study Area (14 Days Winter 2018)

266. During summer, an average of six unique vessels per day was recorded within the offshore cable corridor study area, with three per day intersecting the offshore cable corridor itself. During winter this fell to two per day within the offshore cable corridor study area, and one per day within the offshore cable corridor itself. The majority of vessels during winter were in transit based on their behaviour, whereas notable levels of active fishing were recorded during summer, including within the offshore cable corridor.

267. During summer the most common nationality recorded was the Netherlands, with approximately 70% of vessels being Dutch registered. However, during winter the most common registration was UK vessels at approximately 86%, with Dutch vessels comprising just 10% of traffic. This is likely due to seasonal variations in fishing, with transits to UK waters less likely for Dutch vessels during winter given the potential for adverse conditions. The most common gear type observed was beam trawlers (67% in summer and 33% in winter). Demersal otter trawling, pair trawling, pelagic trawling and dredging were also recorded during both survey periods. Limited levels of gill netting and potting was recorded during winter, however this activity was not reflected within the summer data.

268. Comparing the 2017 and 2018 summer data, there has been a small increase in the average number of fishing vessels recorded within the offshore cable corridor study area between the survey periods (six in 2017 compared to seven in 2018). During both survey periods, beam trawlers were the most commonly recorded fishing gear type and Dutch registered vessels were the most frequently recorded nationality.

269. Fishing vessels were recorded intersecting the offshore cable corridor during both 2017 and 2018 with a slight increase in 2018 (average of three in 2017 to four in 2018).

15.3 Long Term Surveillance Data

270. Long term data in the form of sightings and satellite surveillance data recorded by the MMO has been assessed for the purposes of validating the findings of the marine traffic survey analysis. Sightings data is collected via vessels or aircraft on patrol, and was available between 2005 and 2009. Satellite data is comprehensive for vessels of 12m and above, and was available for 2009. Neither data set is considered suitable for baseline establishment given its age and the vessel anonymisation applied by the MMO; however it is useful in providing confidence in the marine traffic survey data.

271. Both the sightings and satellite data correlated well with the findings of the marine traffic survey assessment, showing Dutch beam trawlers to be the most common vessel type in the area. Additionally, an assessment of vessel speeds within both validation data sets indicated that active fishing occurs within the Norfolk Boreas site, as was shown in the marine traffic survey data.

272. Further assessment of sightings and satellite surveillance data is available within Chapter 14 Commercial Fisheries.

16 Anchoring Activity

16.1 Introduction

273. A vessel can transmit their current status via AIS, and anchoring activity has primarily been identified on this basis. However, the status transmitted will not necessarily be accurate (for example, a crew may neglect to update the vessel's status once anchor has been deployed), and the marine traffic data has therefore also been run through Anatec's SpeedAnalysis software which identifies potential additional anchoring activity based on a predefined set of speed and timestamp parameters.

274. Tracks identified using either method were then manually examined to ensure any vessels clearly not at anchor were removed from the anchoring assessment.

16.2 Norfolk Boreas Site

275. Two vessels were deemed to be at anchor within the OWF site study area during the summer 2018 marine traffic survey (noting that neither were within the Norfolk Boreas site itself) while no vessels were recorded during the winter survey. The two vessels at anchor are presented in Figure 16.1. These vessels were not at anchor within the Norfolk Boreas site.

276. It should be noted that no vessels were recorded at anchor during the summer 2017 survey however tankers were observed to be 'waiting for orders / berths' in the area prior to transit to their next destination. These manoeuvres were undertaken out with the routeing measures, but did intersect the Norfolk Boreas site. From analysis of the AIS tracks it was clear the vessels did not anchor. A sample of this activity is presented in Figure 16.2. Such manoeuvres serve a similar purpose to anchoring, but are preferable in the area given the water depths and traffic densities. It is emphasised that anchors are not deployed during these manoeuvres.

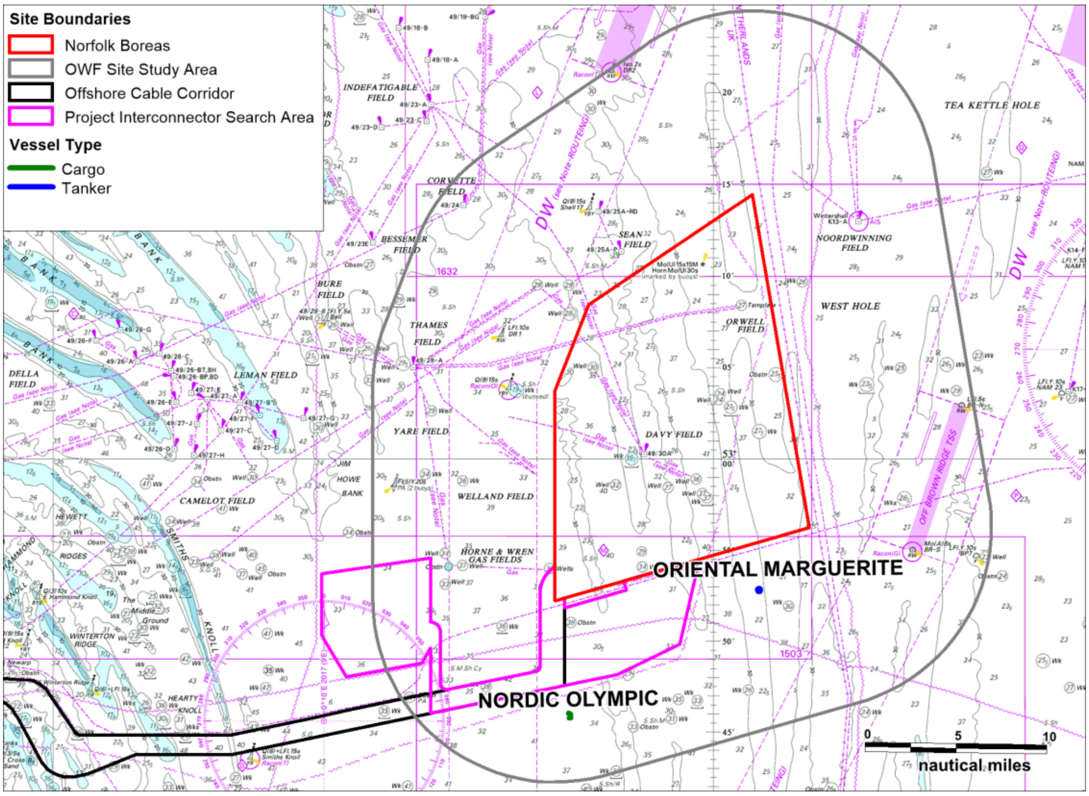


Figure 16.1 Anchored Vessels within OWF Site Study Area (14 Days Summer 2018)

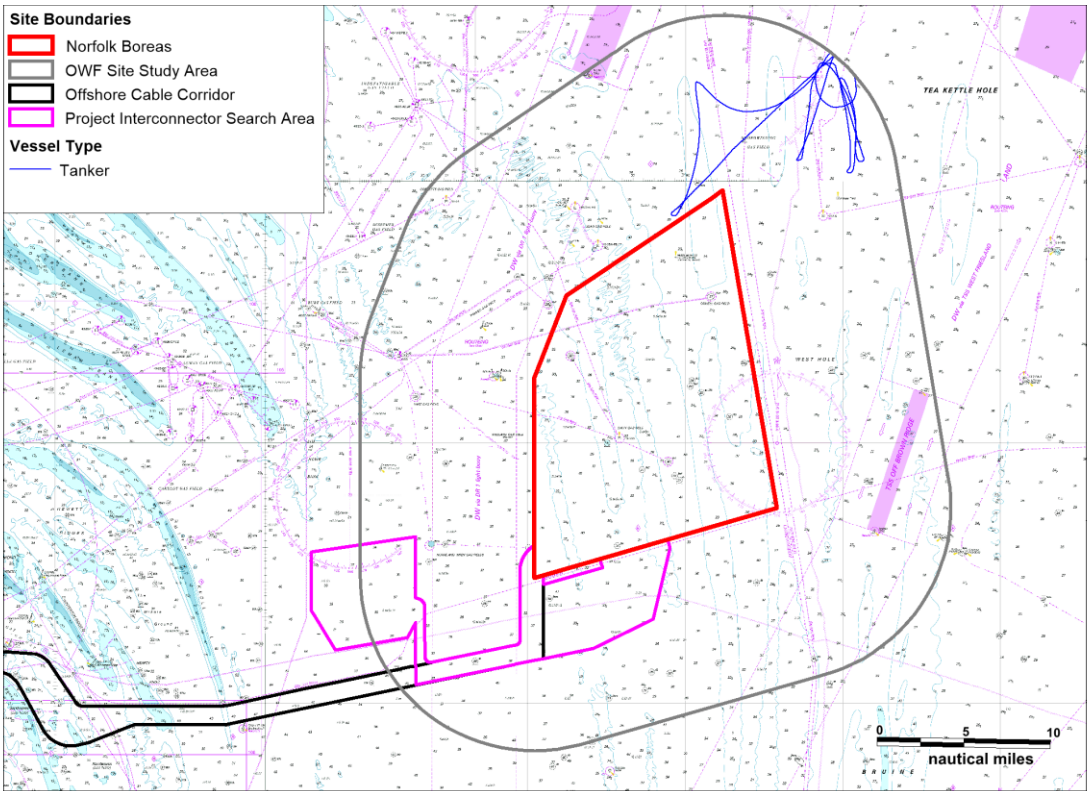


Figure 16.2 Sample Tanker 'Waiting' Manoeuvre (14 Days Summer 2017)

16.3 Offshore Cable Corridor

277. Anchoring activity was also observed to be limited within the offshore cable corridor study area, with three vessels identified during summer 2018 and just one vessel during winter 2018. Figure 16.3 presents the anchored vessels recorded during summer and following this, Figure 16.4 presents the individual vessel recorded during winter.

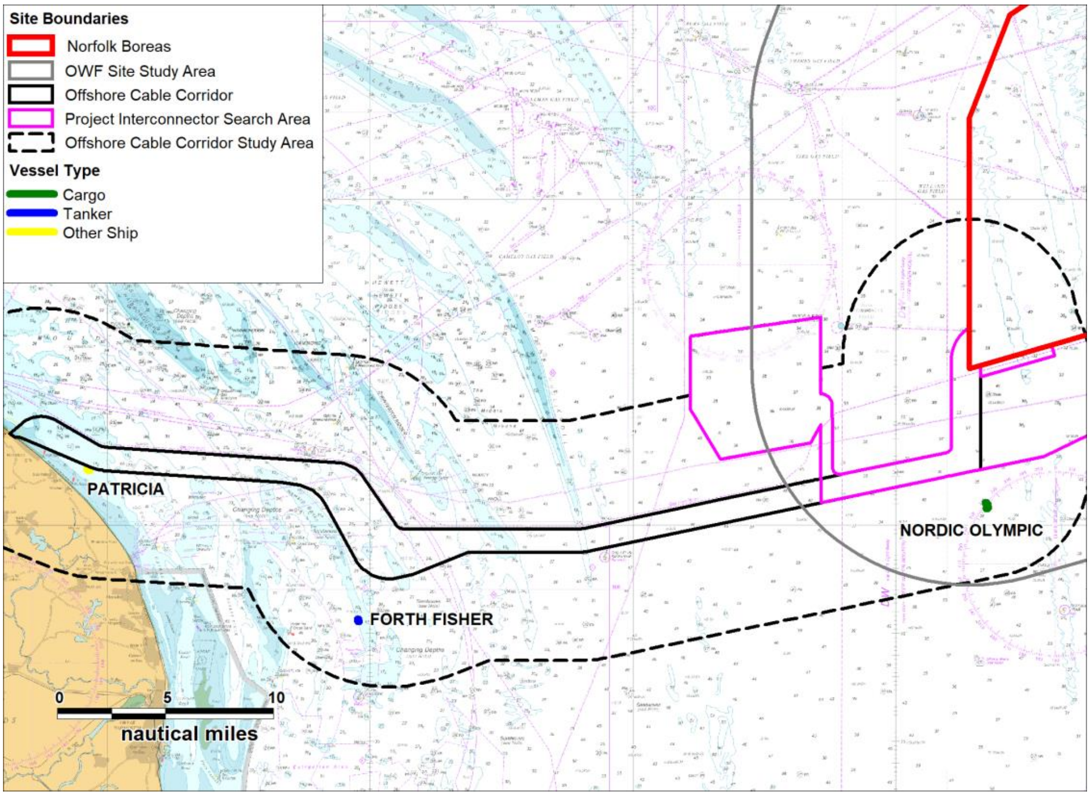


Figure 16.3 Anchoring Vessels within Offshore Cable Corridor Study Area (14 Days Summer 2018)

278. The three vessels recorded were not at anchor within the offshore cable corridor itself. However the buoy-laying vessel, *Patricia* was located 190m south of the offshore cable corridor.

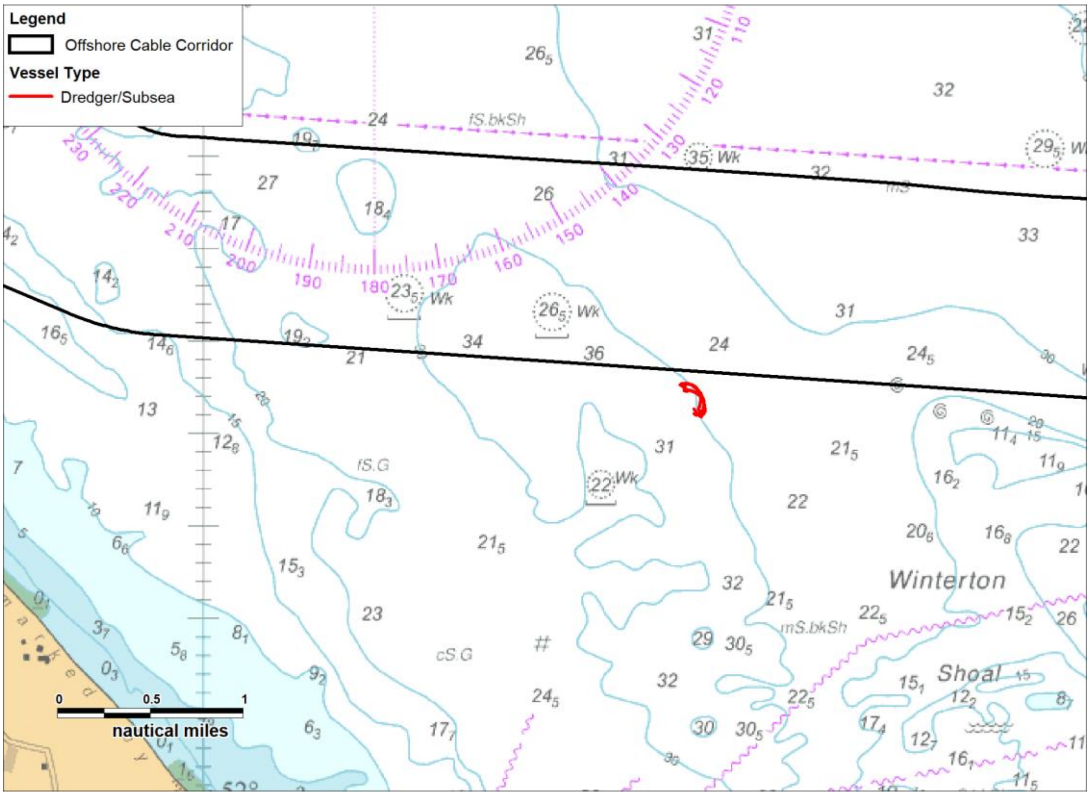


Figure 16.4 Anchored Vessel – '*Reimerswaal*' – 17th and 18th Feb 2018

279. The 130m marine aggregate dredger Reimerswaal, anchored within 200m, south of the offshore cable corridor as shown in Figure 16.4. It is unclear if the vessel was engaged in any activities associated with dredging at the time.

280. As per section 6.1.1, traffic considered temporary has been excluded from the baseline assessment. The excluded traffic was observed to include notable levels of tugs anchoring off the Winterton Ness coast during the summer 2017 survey period. The activity was identified as likely being associated with a salvage operation following a collision incident in July. Given that such activity was not reflected within the winter surveys, or the baseline established for Norfolk Vanguard (Anatec, 2018), the associated traffic has not been considered as baseline.

17 DWR Assessment

17.1 Introduction

281. The DR1 Lightbuoy DWR is considered a key navigational feature to traffic navigating within the vicinity of Norfolk Boreas, and concerns over vessels being displaced into the DWR was raised as an issue during consultation. This section presents an analysis of vessel numbers within the two bordering DWRs, and compares the separation distances between the Norfolk Boreas site and the DR1 Lightbuoy DWR against the relevant MCA guidance.

282. It is noted that during consultation undertaken for Norfolk Vanguard (Anatec, 2017), Rijkswaterstaat (2014) provided guidance on recommended safe separation distances between wind farms and shipping traffic lanes, which has therefore also been considered for Norfolk Boreas. As the project is within UK waters, the MCA guidance remains the primary assessment tool of this section; however the Rijkswaterstaat guidance has also been considered to demonstrate that transboundary concerns have been addressed.

17.2 DWR Numbers

283. As part of the Norfolk Vanguard NRA, long term data collected from the Met Mast during 2016 was considered when assessing traffic levels within the DR1 Lightbuoy DWR and West Friesland DWR. The results are summarised in Table 17.1, which show traffic levels within both DWRs estimated from the long term Met Mast data, the Norfolk Vanguard survey data, and the Norfolk Boreas survey data.

Table 17.1 Estimated DWR Vessels Numbers

DWR		Estimated Vessels per Day			
		Met Mast	NRA Marine Traffic Survey (Norfolk Vanguard)	NRA Marine Traffic Survey (Norfolk Boreas)	Summer 2018 Marine Traffic Update (Norfolk Boreas)
DR1 Lightbuoy	Northbound	4 to 5	5 to 6	5 to 6	5
	Southbound	5	5 to 6	5 to 6	5
West Friesland	Northbound	12	11 to 12	9	16
	Southbound	16	17	13	17

284. Vessel numbers within the West Friesland DWR (and Off Brown Bridge TSS) were observed to be lower when estimated from the Norfolk Boreas marine traffic survey data than from the Met Mast and Norfolk Vanguard survey data. It was unclear if this is a genuine reduction or if data coverage was a factor. To ensure conservatism, the higher vessel numbers estimated from the Met Mast and Norfolk Vanguard data were assumed throughout the initial NRA submitted with the PEIR, both in the establishment of the baseline and the allision and collision modelling.

285. As can be seen from Table 17.1, the 2018 summer survey subsequently revealed vessel numbers on the West Friesland DWR had increased since summer 2017. These increases were in line with that assumed for the southbound lane however were higher than that assumed for the northbound lane (16 vessels per day based on the summer 2018 survey data compared to 12 per day assumed within the NRA). This increase is discussed relative to the findings of the initial impact assessment at the PEIR stage in Section 27.3.

286. Vessel numbers within the DR1 Lightbuoy DWR were comparable between the data sets (and it is noted that the primary stakeholder concern was this routeing measure, rather than the West Friesland DWR).

17.3 DWR and Wind Farm Separation Distances

17.3.1 MCA Guidance

287. Annex 3 of MGN 543 (MCA, 2016) provides a template from which the required width of shipping lanes located in a corridor between two or more wind farm sites can be calculated. Where such a lane exists, the MCA require that there is room within the corridor between the wind farms for a vessel to deviate up to 20°. Norfolk Boreas and Norfolk Vanguard form a corridor around the DR1 Lightbuoy DWR, and it was therefore necessary to check the DWR against the guidance.

288. Given a corridor is only formed if Norfolk Vanguard is also considered, the calculations have been undertaken cumulatively, with the corridor defined as running between the southernmost point of Norfolk Vanguard East, and the northernmost point of the western Norfolk Boreas boundary (see Figure 17.1). This ensures Norfolk Boreas is incorporated into the calculations given its entire western boundary (i.e. the boundary forming the eastern edge of the corridor) is accounted for. This should be considered a conservative approach given that the northern and southern extents of the corridor as defined for the purpose of this assessment are only bordered by wind turbines on one side. The conservative approach is considered appropriate, as MGN 543 does not provide a definitive definition of what constitutes a corridor other than that it would be bordered by turbine arrays.

289. As shown in Figure 17.1, the corridor is required to be of width at least 6.77nm, based on corridor length of 18.6nm, and the required 20° deviation. The actual width

of the corridor is 6.84nm, and therefore is compliant with the MGN 543 corridor guidance.

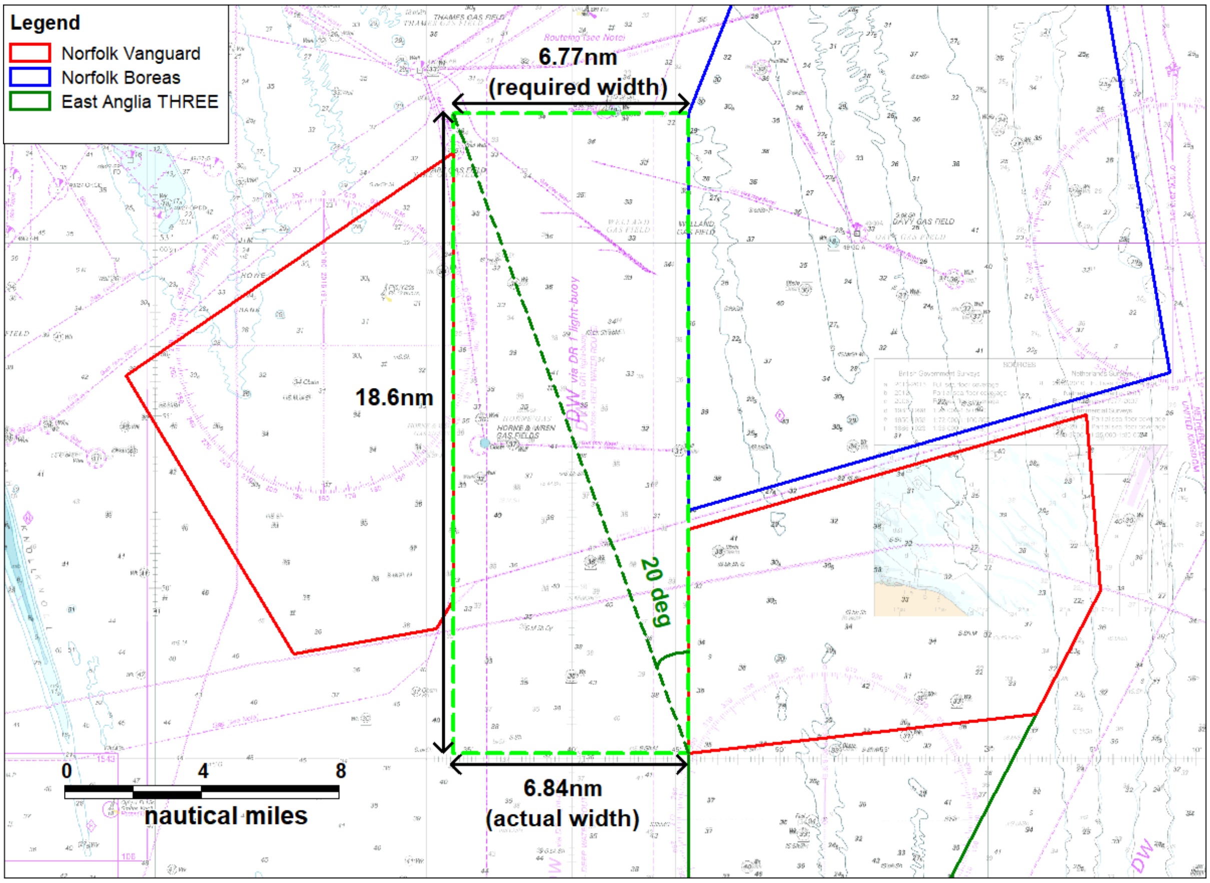


Figure 17.1 Cumulative Assessment of Corridor Width

17.4 Rijkswaterstaat Guidance

290. During consultation undertaken for Norfolk Vanguard (Anatec, 2018), Rijkswaterstaat provided Anatec with guidance relating to recommended separation distances between wind farms and passing traffic (Rijkswaterstaat, 2014). The guidance is considered pertinent to Norfolk Boreas; however it should be noted that as the project is within UK waters it is primarily subject to MCA requirements. It is also noted that separation distances between the Norfolk Boreas site and the DWRs have been agreed with both TH and the MCA, on the basis that the peripheral turbines facing the DWRs must align with those of Norfolk Vanguard and East Anglia THREE to ensure there are no isolated turbines. However, to ensure transboundary issues and concerns are addressed, the project has been compared with the Dutch guidance in this section.

291. The guidance provides a recommendation of safe separation distances based on the spacing required to perform a round turn, the most expansive manoeuvre a vessel may be required to undertake. The separation distances are found as follows:

- To starboard: six vessel lengths + 0.3nm + 500m safety zone; and
- To port: six vessel lengths + 500m safety zone.

292. The maximum vessel length recorded within the DR1 Lightbuoys DWR during the marine traffic surveys was 336m (noting that the longer term Met Mast data recorded during 2016 recorded a 396m vessel within the DWR). However, during consultation, it was raised that the potential for maximum vessel length to increase over baseline levels must be accounted for. A length of 500m was proposed as an acceptable length for this purpose by the Chamber of Shipping (CoS) at the Hazard Consultations held for Norfolk Boreas (see section 5.6). Based on this 500m length, the required separation distances to port and starboard are:

- To starboard: (6 × 500m) + 0.3nm + 500m = 2.2nm; and
- To port: (6 × 500m) + 500m = 1.9nm.

293. The 2.2nm separation distance to starboard is illustrated within the context of the corridor between Norfolk Boreas and Norfolk Vanguard in Figure 17.2. As observed in the figure, assuming the required separation to starboard (2.2nm), a clear space of 2.4nm still remains to the port side. The corridor is therefore considered compliant with the Rijkswaterstaat guidance.

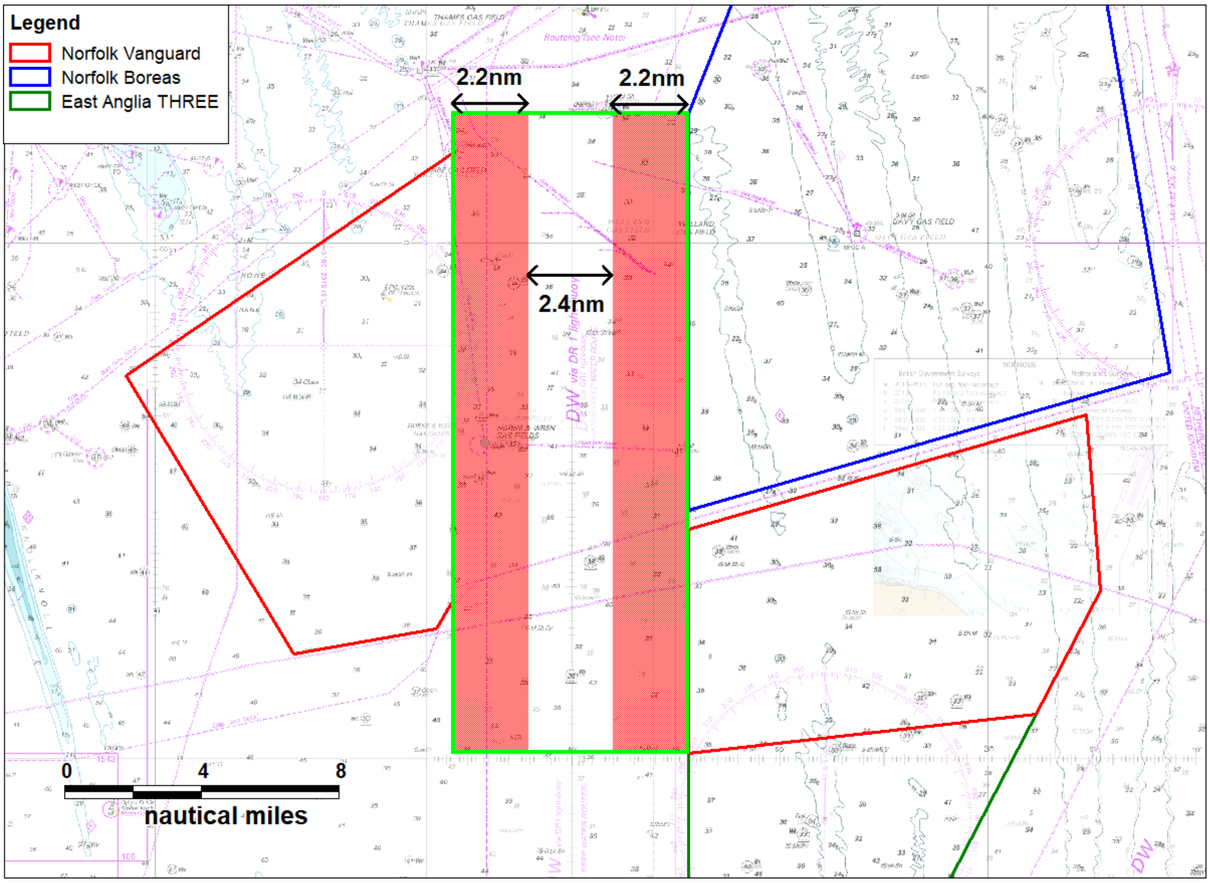


Figure 17.2 DR1 Lightbuoy DWR - Separation Distance based on Rijkswaterstaat Guidance

294. The Norfolk Boreas site is 3.4nm from the West Friesland routeing measures to the east (at its closest), which is in excess of the recommended 2.2nm.

17.5 Structure Alignment on DWR Boundaries

295. It will be ensured that structure alignment on the boundary facing the DR1 Lightbuoy DWR will be consistent with East Anglia ONE and East Anglia THREE. Lighting and marking of the project will include consideration of lighting at East Anglia THREE, including within the DWR.

296. It will also be ensured that mooring buoys within the Norfolk Boreas site will not be placed on the boundary facing the DWRs.

18 Pre Wind Farm Routeing

18.1 Introduction

297. The information transmitted via AIS was used to estimate the types and sizes of vessels using each route, and the origin / terminus ports. Vessel numbers per route have also been estimated; however it is noted that these are primarily based on the summer 2017 data, given that the winter data did not provide extensive coverage of the entire OWF site study area (and may therefore underestimate vessel numbers). Anatec's internal UK-wide route database and the charted IMO routeing measures were then used to validate the findings further, and to extend the routes beyond the 10nm threshold of the AIS data.

298. In addition to being the basis for the 90th percentile analysis provided below, the final routes were also used as input to the collision and allision risk modelling for the proposed project, as summarised in section 20.

299. It should be noted that the summer 2018 data was not available at the PEIR stage (i.e., when the routeing assessment was undertaken), therefore the summer 2017 and winter 2018 marine traffic survey data assessed in section 12.2 was used to identify the main vessel routes within the OWF site study area, and estimate vessel numbers. Subsequent assessment of the summer 2018 data indicated that, other than for the northbound lane of the West Friesland TSS (which is discussed in Section 17.2), vessel numbers on all main routes have either remained static or dropped between 2017 and 2018. Where drops were observed, vessel numbers have not been changed from those estimated at the PEIR stage.

18.2 Main Routes

300. The main routes identified are presented in Figure 18.1, with a summary of each route then presented in Table 18.1. It is noted that the origin and destination ports for each route shown represent the most common destinations transmitted via AIS by vessels using those routes within the study area. Actual terminus ports may vary per route.

301. As per section 17.2, the vessel numbers on the routes associated with the West Friesland routeing measures identified at the PEIR stage have been factored up to take into account the output of the corresponding Norfolk Vanguard assessment (Anatec, 2018) and the updated summer 2018 survey data. However, as per section 27.3, this increase does not affect the outcome of the impact assessment (as presented in Chapter 15 Shipping and Navigation).

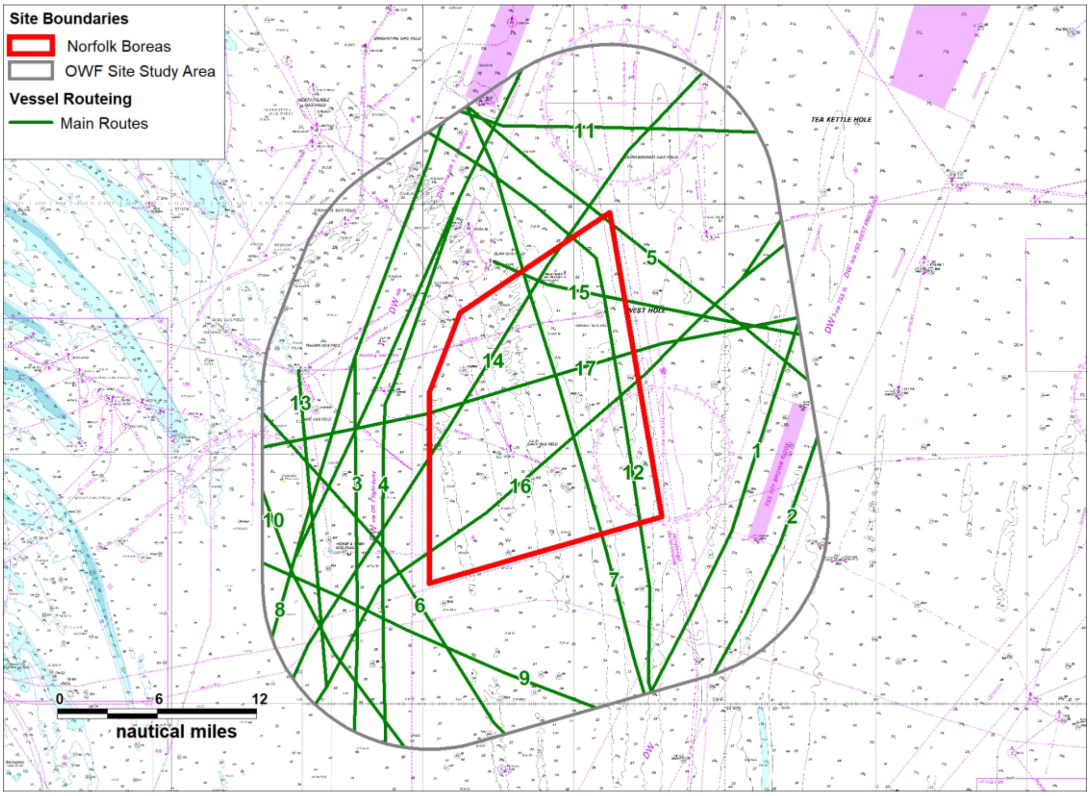


Figure 18.1 Main Routes – Pre Wind Farm

Table 18.1 Main Route Details

Route	Terminus Ports	Vessels per Day	Intersects Site?	Description
1	TSS West Friesland – Rotterdam (Netherlands)	17	No	Southbound traffic associated with the West Friesland TSS.
2	Rotterdam (Netherlands) – TSS West Friesland	16	No	Northbound traffic associated with the West Friesland TSS.
3	TSS Off Botney – Rotterdam (Netherlands)	6	No	Southbound traffic associated with the Off Botney TSS.
4	Rotterdam (Netherlands) – TSS Off Botney	6	No	Northbound traffic associated with the Off Botney TSS.
5	Newcastle (UK) / Amsterdam	1-2	Yes	DFDS operated Newcastle / Amsterdam cruise ferry route.

Route	Terminus Ports	Vessels per Day	Intersects Site?	Description
	(Ijmuiden) (Netherlands)			
6	Rotterdam (Netherlands) / Forth Ports (UK)	1	No	Cargo and tanker route between Scottish ports and Rotterdam.
7	Rotterdam (Netherlands) / Tees (UK)	1	No	Route between Rotterdam and Tees, traffic comprised mainly of cargo vessels. Limited tanker and oil and gas vessels.
8	TSS Off Botney / Thames Ports (UK)	< 1	No	Cargo tanker route associated with the Off Botney TSS.
9	Ijmuiden (Netherlands) / Humber (UK)	< 1	No	Cargo vessel route between Ijmuiden and Humber ports.
10	Tees (UK) / Rotterdam (Netherlands)	< 1	No	Cargo and tanker route between Tees and Rotterdam.
11	Humber (UK) / Cuxhaven (Denmark)	< 1	No	Cargo traffic between Humber ports and Cuxhaven. Includes DFDS operated Immingham / Cuxhaven RoRo ferry route.
12	Forth Ports (UK) / Rotterdam (Netherlands)	< 1	Yes	Low use route, cargo traffic.
13	Great Yarmouth or Lowestoft (UK) / Thames Field	< 1	No	Oil and gas traffic to the Thames field.
14	Rochester (UK) / TSS West Friesland	< 1	Yes	Cargo and tanker traffic from Rochester.
15	Den Helder (Netherlands) / Sean Field	< 1	Yes	Oil and gas traffic to the Sean field.

Route	Terminus Ports	Vessels per Day	Intersects Site?	Description
16	Great Yarmouth or Lowestoft (UK) / Esbjerg (Denmark)	< 1	Yes	Low use cargo / tanker traffic route.
17	The Wash (UK) / Cuxhaven (Denmark)	< 1	Yes	Low use cargo / tanker traffic route.

18.3 90th Percentiles

302. The marine traffic data (section 12) and Anatec's internal ShipRoutes database (Anatec, 2018) were used to estimate the 90th percentiles within the OWF site study area, based on the principles set out in MGN 543 (MCA, 2016). The resultant 90th percentiles are presented in Figure 18.2.

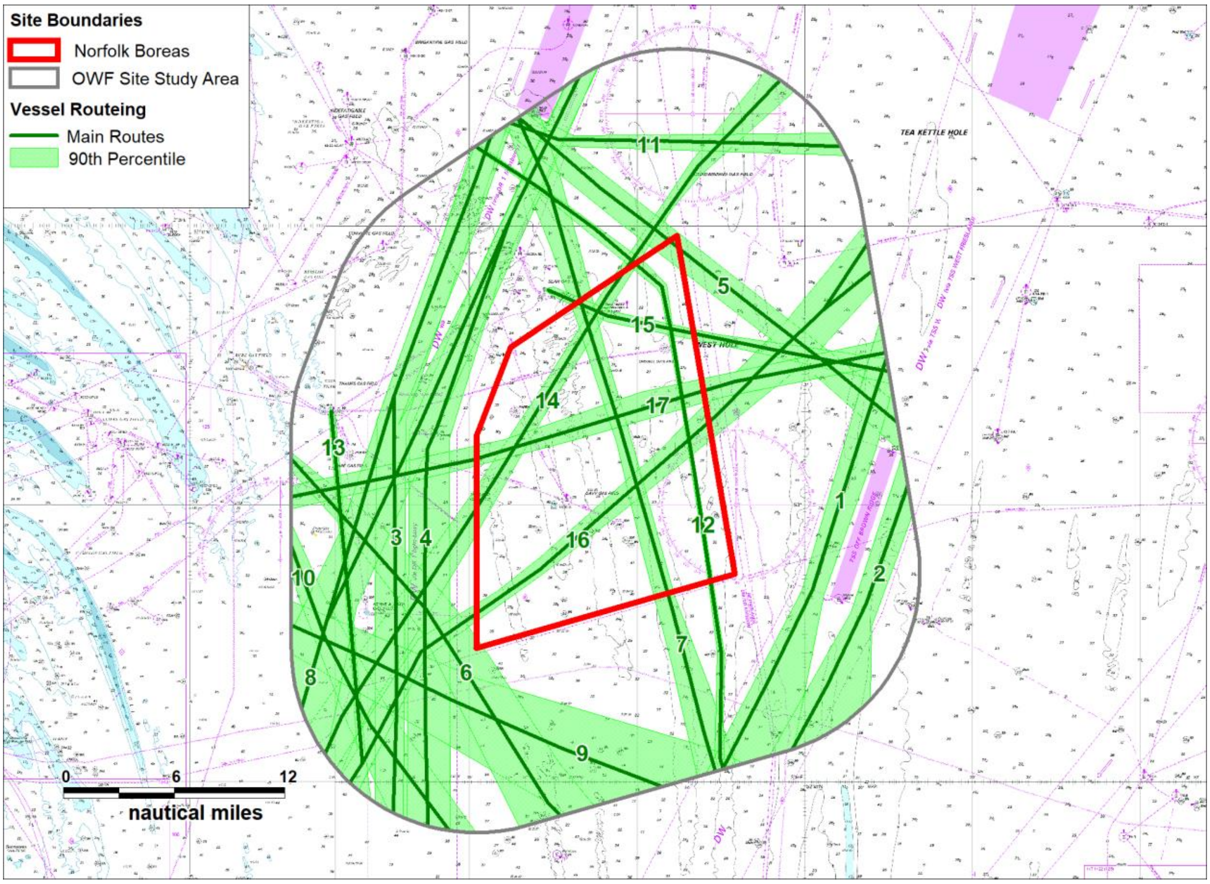


Figure 18.2 Main Routes – 90th Percentiles

18.4 Adverse Weather Routeing

303. It should be noted that during periods of adverse weather, vessels may be required to take alternate routes to those shown in section 18.2. Adverse weather is defined as wind, wave, tidal, or visibility conditions considered unfavourable for navigation, resulting in course deviations or adjustments from the established route. When transiting in adverse weather conditions, a vessel is likely to encounter various kinds of weather and tidal phenomena, which may lead to severe roll motions, potentially causing damage to cargo, equipment and / or danger to persons on board. The sensitivity of a vessel to these phenomena will depend on the actual stability parameters, hull geometry, vessel type, vessel size and speed.

304. The probability of occurrence in a particular sea state may differ for each vessel. Adverse weather is considered most significant for passenger vessels, due to the potential health and safety risks (as well as the effect on passenger comfort) to people on board (such as sea sickness and difficulty moving around the vessel). This can also have implications for regular timetabled vessels, due to increases in journey time and potential cancellations. Mitigations for vessels include adjusting their heading to position themselves 45° to the wind, altering or delaying sailing times, reducing speed and potentially cancelling journeys.

305. Adverse weather routeing was raised as a concern during the regular operators consultation process (see section 5.4), given that a common adverse weather routeing option for vessels running between the UK and mainland Europe is to cross where passage in open waters is at its shortest. This sea area is where Norfolk Boreas is to be built, and when considered cumulatively with other Southern North Sea wind farms (notably Norfolk Vanguard and East Anglia THREE), vessels choosing to use this transit option may be required to deviate further south (i.e. south of East Anglia THREE).

306. For the purposes of assessing adverse weather routeing currently being employed by vessels in the area, additional longer term AIS data recorded during 2017 has been reviewed at a high level to identify any regular deviations from the routes identified in section 18.2. Such cases were identified by vessels using the DFDS operated routes (Routes 5 and 11 in Figure 18.1). The tracks identified are presented in Figure 18.3, which includes the corresponding main routes for reference. As indicated during consultation, the vessels transit further south than the main routes identified.

307. Impacts on adverse weather routeing are assessed in Chapter 15 Shipping and Navigation on both an in-isolation and cumulative basis.

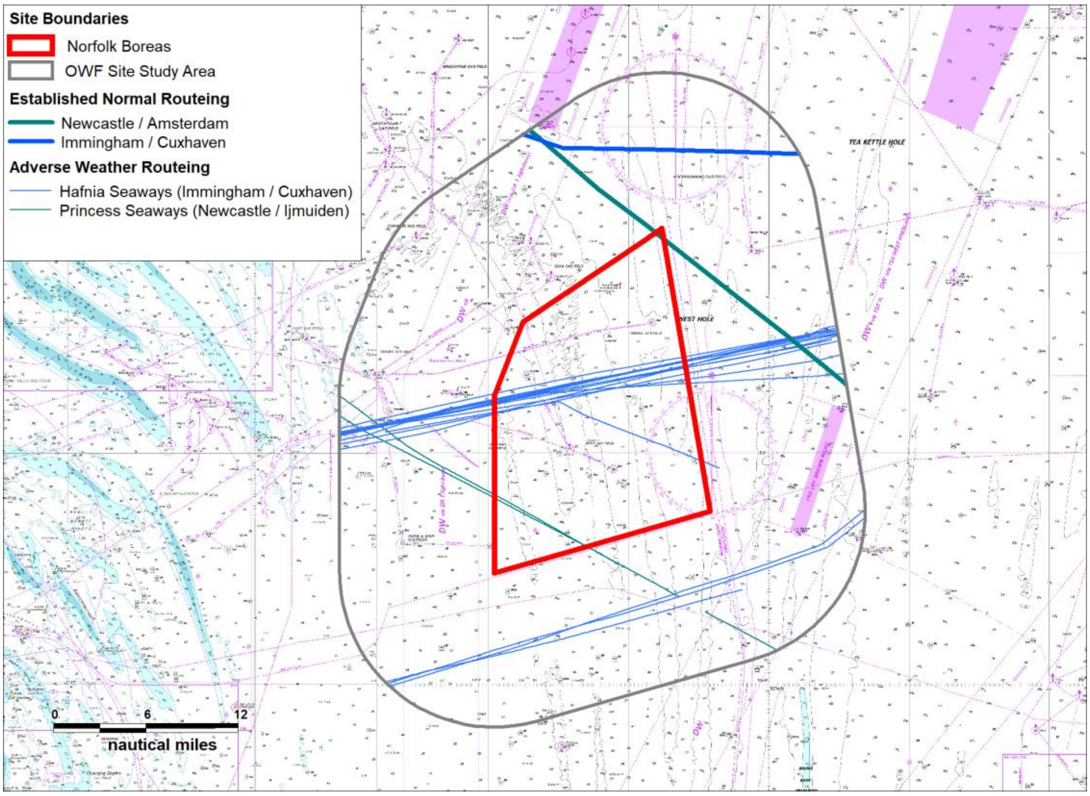


Figure 18.3 Adverse Weather Routeing (Long Term 2017 AIS Data)

19 Post Wind Farm Routeing

19.1 Introduction

308. This section provides assessment of the likely impacts of Norfolk Boreas on the base case routeing identified, as per section 18.2. Each route identified has been deviated to take the project into account on both an in-isolation and cumulative basis.

309. For the in-isolation case, any route identified as intersecting a 1nm buffer of the Norfolk Boreas site has been deviated on a worst case basis, in that it has been assumed that the vessel will approach the wind farm on its established route, deviate around the wind farm keeping a 1nm distance from the site boundary and then re-join the established route within the OWF site study area once clear. Routes deviated into the routeing measures have been assumed to join the existing traffic centrally within the lanes (as this is the worst case in terms of collision risk); however all other deviated routes have been kept at a distance of 1nm from the site boundary. The presence of oil and gas platforms, buoys, and shallow banks have been considered and accounted for within these deviations where appropriate.

310. For the cumulative assessment of routeing, a 25nm buffer of Norfolk Boreas has been considered in order that other key wind farm projects in the area are accounted for. As for the in-isolation assessment it has been assumed that deviated vessels will maintain a 1nm separation from wind farm boundaries, or if deviated into the routeing measures, then join the traffic centrally within the lanes. The cumulative deviations have been primarily informed by the updated SNSOWF routeing work discussed in section 3.2 (Anatec, 2018).

311. It should be considered that routes passing nearby a wind farm, but outwith the 1nm buffer considered may also deviate, however any such deviations would be expected to be minor shifts away from the peripheral structures. For conservatism within the allision modelling, such routes have not been deviated.

19.2 In-Isolation

19.2.1 Rerouteing

312. The deviated routes are presented in Figure 19.1 relative to the Norfolk Boreas site. Following this, 28 days of simulated AIS is shown, based on these deviated routes (tracks created through Anatec's AIS Simulator software).

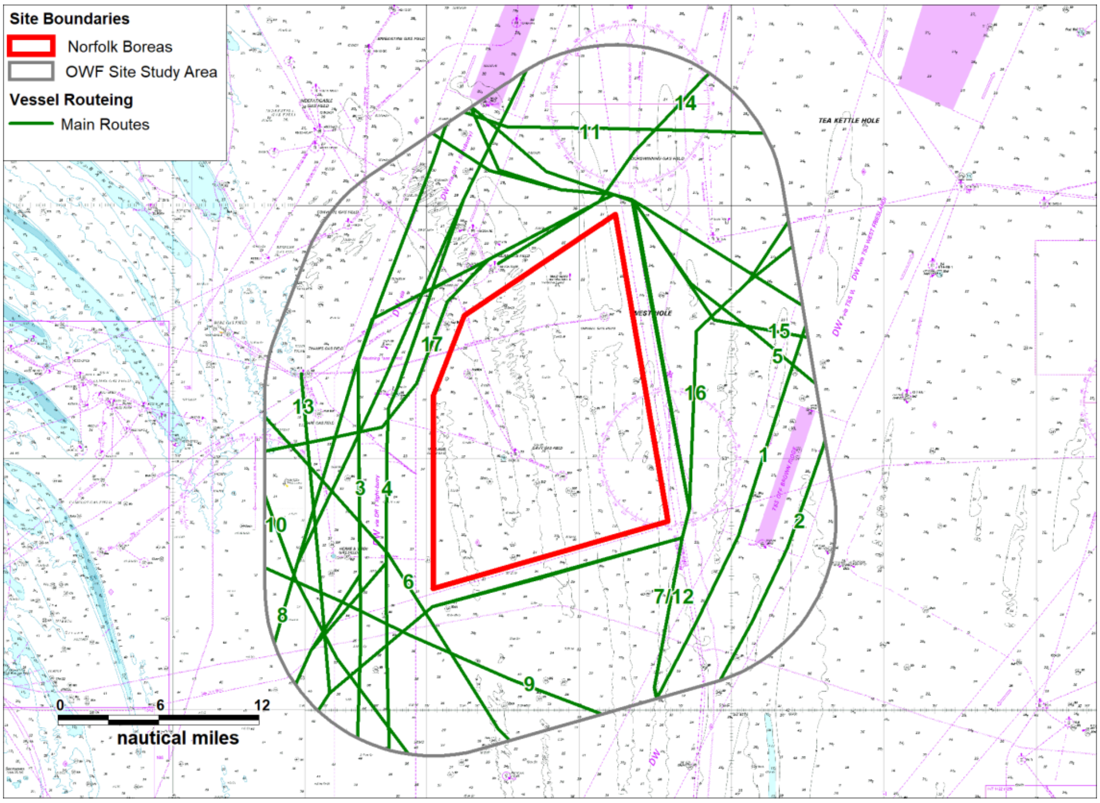


Figure 19.1 Main Routes – Post Wind Farm

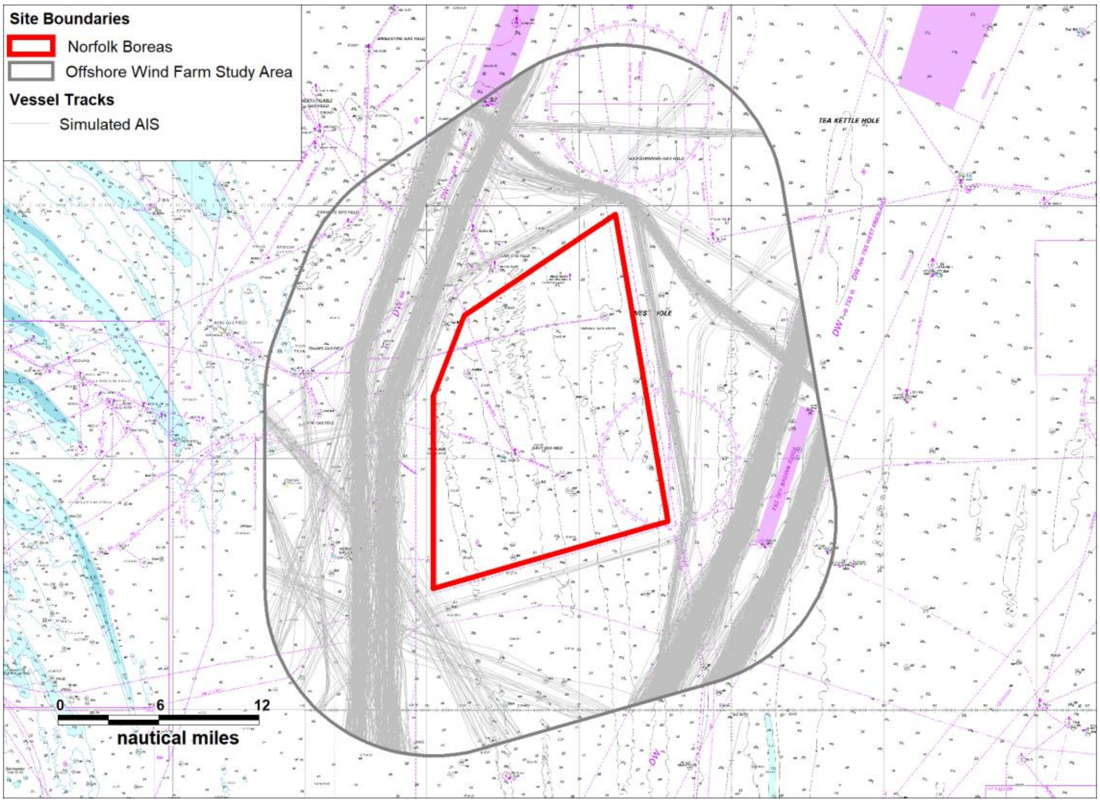


Figure 19.2 Simulated AIS – 28 Days

19.2.2 Deviation Distances

313. The increased distances of the deviated routes over the base case routes are shown in Table 19.1 (note only routes required to deviate have been included). These are based on the worst case deviations over the entire route lengths. As previously discussed, terminus ports listed represent common destinations transmitted via AIS by vessels on a given route, and for this reason deviations will not be representative of every transit, instead serving to provide indicative results that could be expected for common journeys observed within the marine traffic survey data.

Table 19.1 Worst Case Route Deviations

ID	Port 1	Port 2	Vessels per Day	Pre Wind Farm Distance (nm)	Post Wind Farm Distance (nm)	% Increase
5	Newcastle	Ijmuiden	1-2	261.2	261.8	0.2%
	Ijmuiden	Newcastle		261.2	261.8	0.2%
7	Rotterdam	Tees	1	265.8	271.3	2.1%
	Tees	Rotterdam		265.8	271.7	2.1%
12	Forth Ports	Rotterdam	< 1	370.8	374.7	1.1%
	Rotterdam	Forth Ports		370.8	374.4	1.1%
14	Rochester	West Friesland TSS	< 1	241	244.1	1.3%
	West Friesland TSS	Rochester		222.2	226.3	1.9%
15	Sean Field	Den Helder	< 1	71.4	75.9	6.2%
	Den Helder	Sean Field		71.4	75.9	6.2%
16	Great Yarmouth	Esbjerg	< 1	147.6	152.3	3.2%
	Esbjerg	Great Yarmouth		137.1	141.7	3.4%
17	The Wash	Cuxhaven	< 1	323.6	331.3	2.4%
	Cuxhaven	The Wash		325.5	333.3	2.4%

19.3 Cumulative Deviations

314. Anticipated cumulative deviations of the identified main routes (i.e. taking consideration of other southern North Sea wind farm developments) are presented in Figure 19.3. These are primarily based on the findings of the updated SNSOWF routeing assessment (Anatec, 2018).

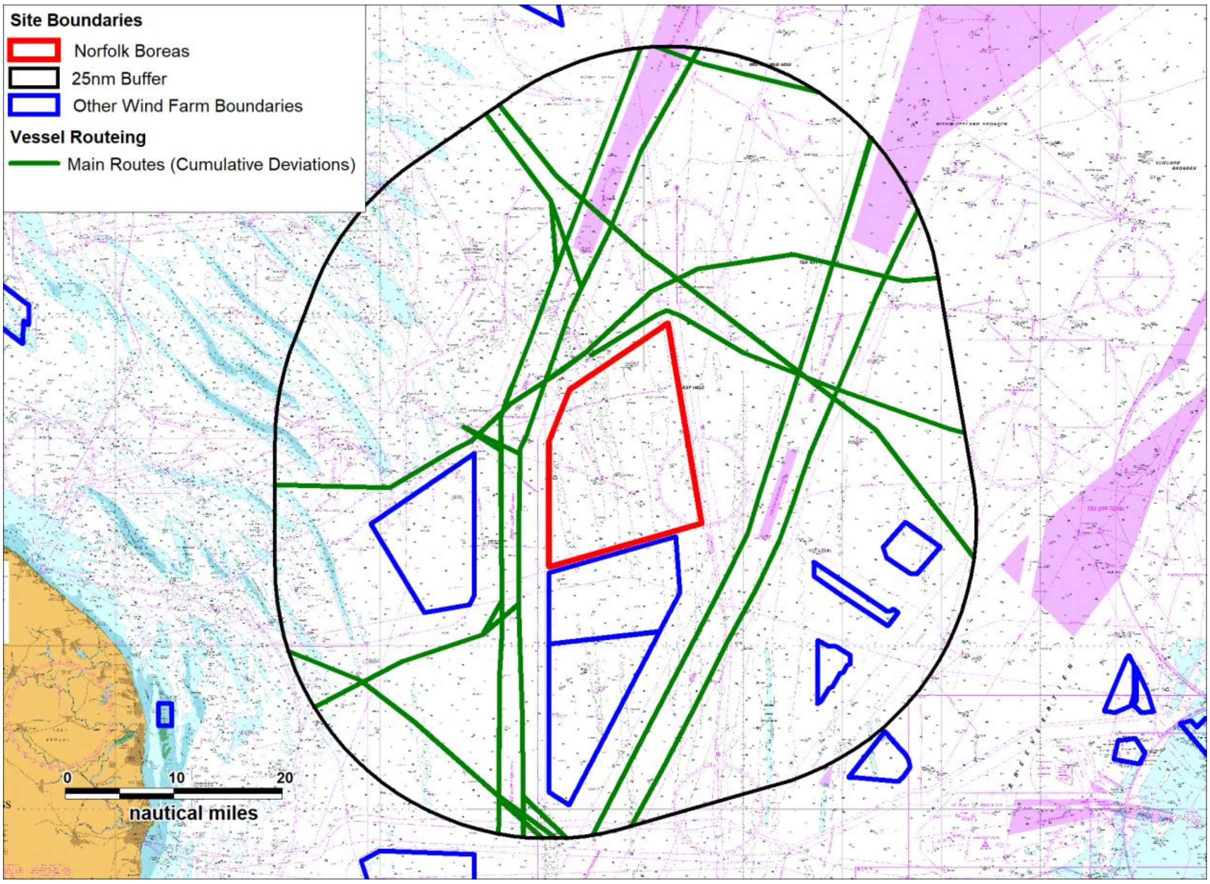


Figure 19.3 Main Routes – Cumulative Deviations

20 Collision and Allision Risk Modelling Overview

20.1 Modelling Scenarios

315. The following sections provide quantitative assessment of the major hazards associated with the development of Norfolk Boreas. This is divided into a pre wind farm and post wind farm assessment, and includes hazards associated with:

- Increased vessel to vessel collision risk;
- Additional vessel to structure allision risk;
- Additional fishing vessel to structure allision risk; and
- Additional drifting allision risk from vessels Not Under Command (NUC).

316. The pre wind farm assessment used the marine traffic survey data in combination with the consultation responses and other baseline data sources to estimate the current encounter probability, and vessel to vessel collision risk. Conservative assumptions of route deviations were then made to model the post wind farm results.

20.2 Marine Traffic Input

317. Modelling results have been based on the summer 2017 and winter 2018 surveys. As per section 27.3, the findings of the assessment of the 2018 summer survey data showed no change in outcome to the impact assessment already undertaken at the PEIR stage.

20.2.1 Commercial Vessel Future Case

318. Given the uncertainty associated with long-term predictions of traffic growth including the potential for any major new developments in UK or transboundary ports, a conservative (i.e. high) potential growth in shipping movements of 10% was estimated over the life of the wind farm. Based on consultation undertaken with CoS for Norfolk Vanguard, a vessel to vessel collision sensitivity analysis which considers an increase of 20% has also been undertaken for Norfolk Boreas (to ensure consistency between the assessments of the two projects).

319. It is noted that the growth rates have been applied to oil and gas routes, despite it being likely that oil and gas traffic will reduce over the lifetime of Norfolk Boreas (noting that this decrease may be offset by increased levels of wind farm traffic within the southern North Sea).

20.2.2 Commercial Fishing Future Case

320. The Commercial Fisheries Assessment (Chapter 14 Commercial Fishing) considered the potential changes to the fishing baseline over the life of the proposed project. It is recognised that this is a speculative exercise due to the numerous unpredictable

direct and indirect factors which could materially affect fisheries, including the presence of the structures within the Norfolk Boreas site.

321. A 10% increase in fishing activity has been assumed; it is considered that this value is extremely conservative, noting that fleet size and effort is observed to be on a general decline. Further details on fishing are provided in Chapter 14 Commercial Fisheries.

20.2.3 Recreational Vessel Future Case

322. In terms of recreational vessel activity, there are no major developments known of that would increase the activity of these vessels in the area. Based on the discussion presented, the future level of activity has been assumed to increase by 10% compared to the current levels and is assumed conservative.

20.3 Layout Assumptions

323. Modelling has been undertaken on an indicative worst case layout, based on the worst case parameters presented in the most up to date Project Design Envelope available at the time that modelling commenced. It is emphasised that this layout has been created purely for the purposes of modelling the worst case from a shipping and navigation perspective, and does not necessarily represent a layout under consideration.

324. The layout used is presented in Figure 20.1. It should be considered when viewing this layout that the significant structures in terms of collision and allision modelling to regular routed traffic are those on the periphery, and layout of additional structures placed within the wind turbine array will therefore have limited effect on the modelling.

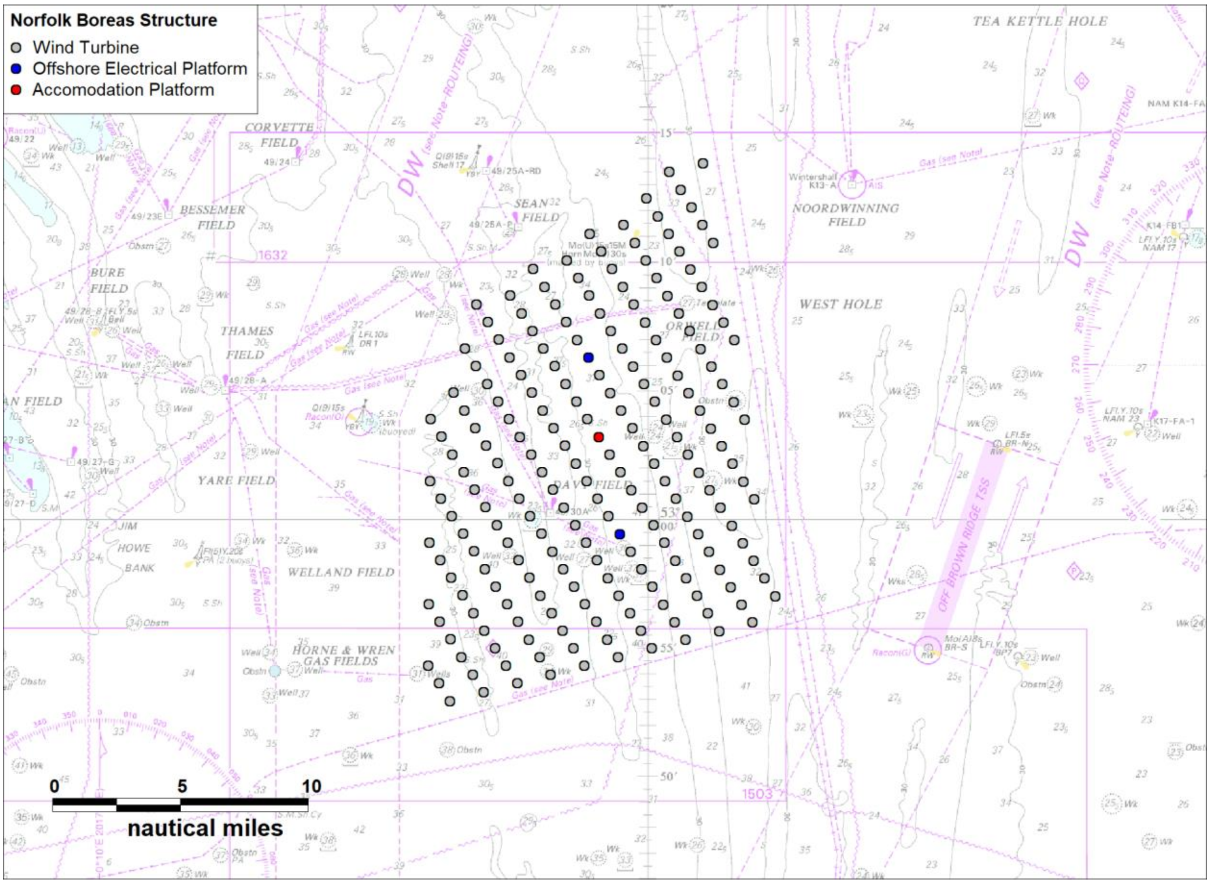


Figure 20.1 Modelling Layout

20.4 Modelled Dimensions

325. The dimensions assumed during the modelling are presented in Table 20.1. The worst case foundation type from a shipping and navigation perspective was a floating tension leg platform. Assuming the worst case layout shown in Figure 20.1 (200 × 9MW wind turbines), diameters of the floating foundations are estimated at 45m each[3]. As no orientation information was available, the rectangular platforms have been assumed to be oriented to 0° (noting that as these structures are not on the peripheral, their orientation is unlikely to have a noticeable effect on the modelling process).

326. Prior to submission of the ES, a helicopter platform was being considered in place of the offshore service platform. Precise dimensions of the helicopter platform were

[3] It is noted that since production of the initial NRA and PEIR, the design envelope has changed. Tension leg floating foundations are no longer being considered while the number of wind turbines has reduced to 180 × 10MW however these are still considered to be the worst case scenario therefore the modelling results remain valid.

unknown at the time of writing; however they were considered to be smaller than the offshore service platform. Therefore the offshore service platform dimensions were used within the modelling. Given that in both scenarios the platform in question is located internally within the array (not on or near the periphery), neither would be expected to significantly impact the modelling results.

Table 20.1 Modelled Structure Dimensions

Structure Type	Surface Dimensions	Shape
Wind Turbine	45m diameter	Circle
Offshore Electrical Platform	90×60m	Rectangle
Offshore Service Platform	90×60m	Rectangle

21 In-Isolation Assessment

21.1 Pre Wind Farm

21.1.1 Encounters

327. An assessment of current vessel to vessel encounters has been carried out by replaying at high speed the AIS and Radar data collected in the marine traffic surveys (summer 2017 and winter 2018). An encounter distance of 1nm has been considered, i.e. two vessels passing within 1nm of each other has been classed as an encounter. This helps to illustrate where existing shipping congestion is highest and therefore where offshore developments, such as OWFs, could potentially increase congestion and therefore also increase the risk of encounters / collisions.

328. It is noted that as not all vessels recorded by Radar during the marine traffic surveys could be identified, there were instances of there being doubt as to whether an identified encounter was actually a real event. Cases where an encounter was clearly false have been removed; however cases which could not be confirmed as false have been retained in the following analysis.

329. Encounters between oil and gas vessels have also been retained; however it should be considered that such vessels working at the same installations are likely to have additional procedures in place to mitigate against collisions while on site above those of passing traffic.

21.1.1.1 Overview

330. The tracks from each of the encounters identified within 10nm of Norfolk Boreas are presented in Figure 21.1, colour-coded by vessel type. It is noted that where only one transmitted data point from a vessel was recorded within an encounter zone, only the single point has been shown. Otherwise, the track created by joining the points transmitted within the zone has been shown.

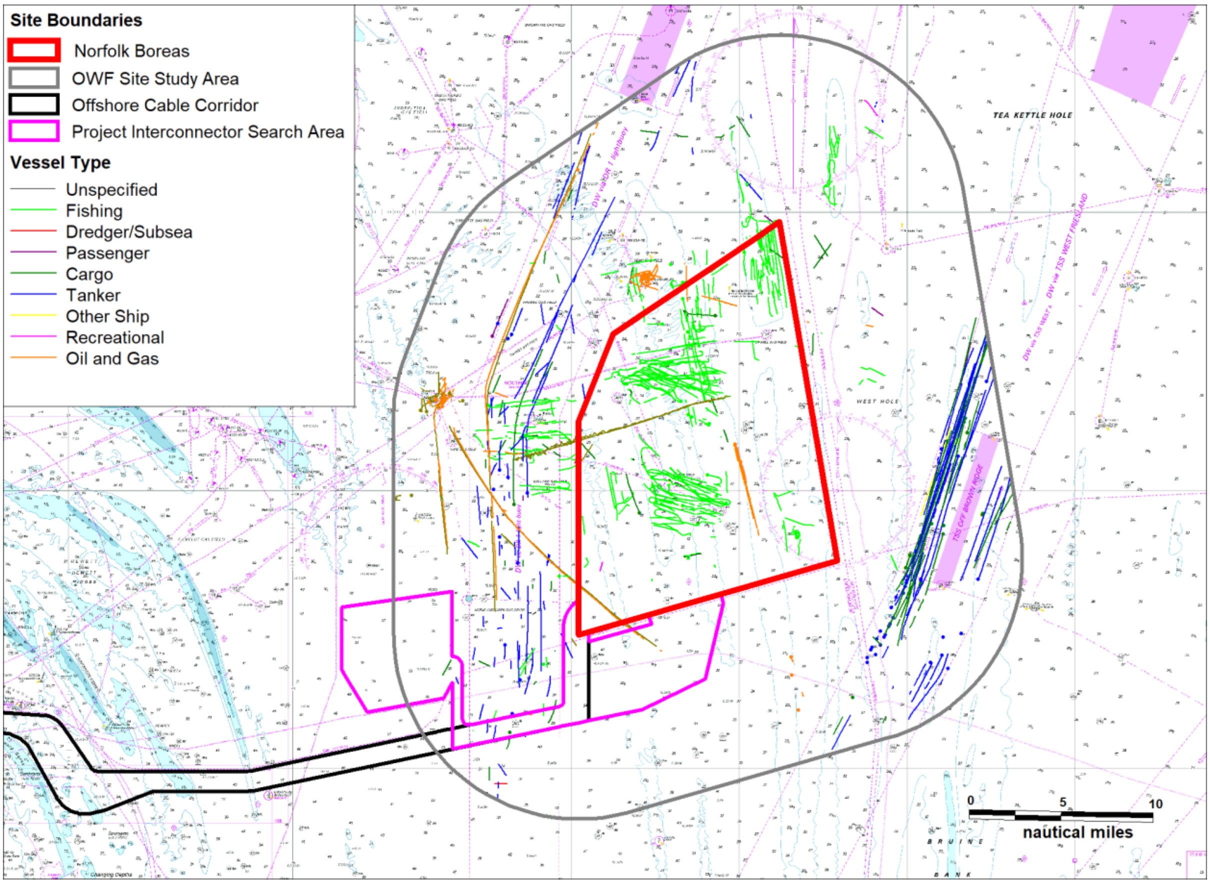


Figure 21.1 Encounters by Vessel Type (29 Days)

331. Encounters were observed to occur most prominently within the Norfolk Boreas site, and within the routeing measures. The majority of encounters within the Norfolk Boreas site were between fishing vessels; however encounters between fishing vessels and commercial vessels were also identified within the DR1 Lightbuoy DWR.

332. Encounters were also observed between oil and gas vessels at the Sean and Thames platforms.

21.1.1.2 Daily Counts

333. The number of encounters recorded per day during the marine traffic surveys is shown in Figure 21.2.

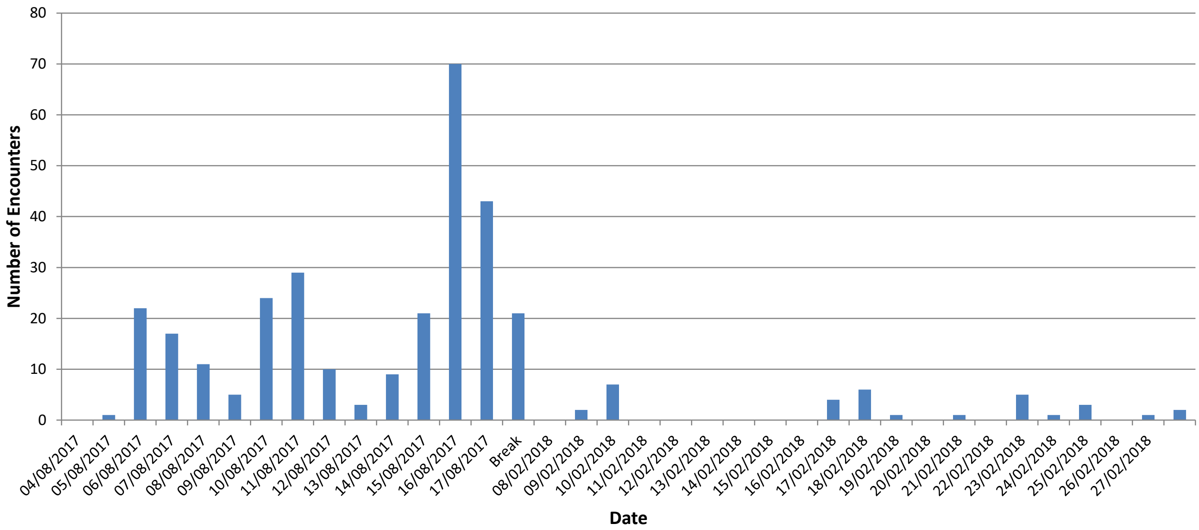


Figure 21.2 Encounter Daily Counts (29 Days)

334. There were an average of 20 encounters per day recorded during the summer 2017 survey, falling to one to two during the winter 2018 survey. The increased summer encounter average can largely be attributed to the levels of fishing when compared to those recorded during winter; however it should be considered that encounters outwith the Norfolk Boreas site may be underrepresented in winter given the coverage.

335. The maximum number of encounters recorded was 70, observed on the 15th August 2017. This was due to increased levels of fishing activity, largely within the Norfolk Boreas site (as shown in Figure 12.1, the 15th August 2017 was the busiest day of either survey in terms of vessel numbers).

21.1.1.3 Type Distribution

336. The vessel type distribution observed within the encounters identified is shown in Figure 21.3 (excluding 4% of vessels during summer that were unable to be identified).

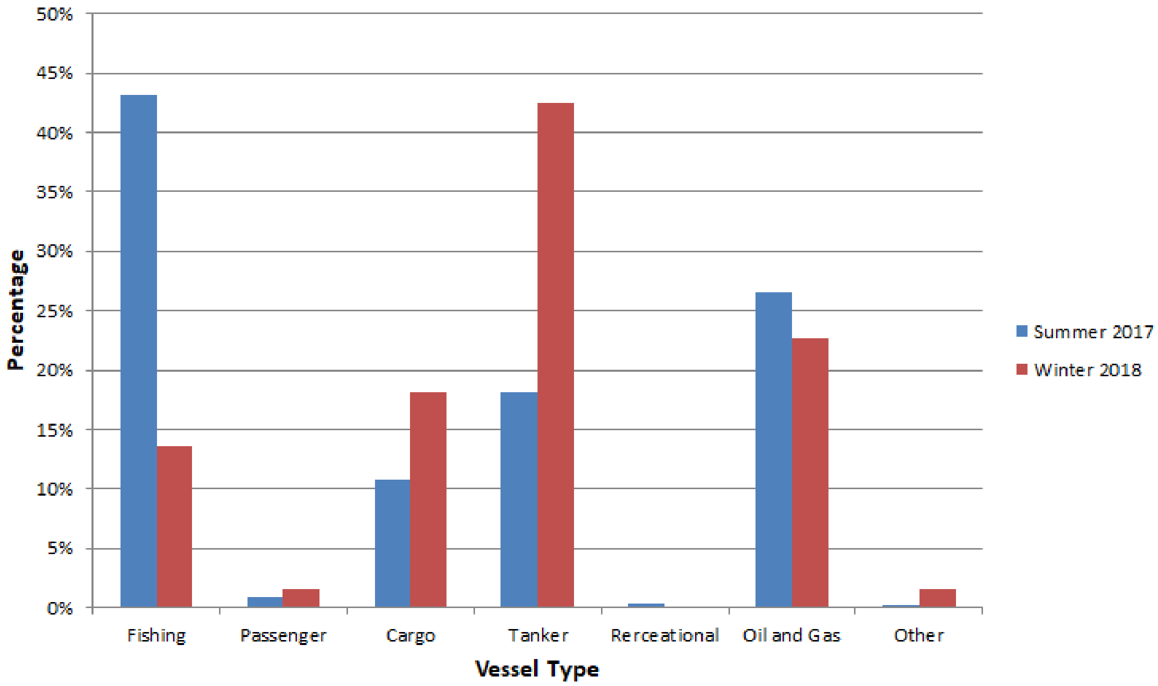


Figure 21.3 Encounter Vessel Type Distribution (29 Days)

337. During summer, fishing vessels were the most common vessel type to be involved in an encounter (approximately 43% of all summer encounter vessels). In winter, the most common type was tankers, comprising 42% of the winter encounter vessels. Approximately one quarter of vessels involved in encounters were oil and gas vessels during each of the two survey periods.

21.1.1.4 Encounter Density

338. Figure 21.4 and Figure 21.5 show the encounter densities observed during summer and winter respectively within the OWF site study area.

339. During summer the highest density areas were within the routeing measures and within the Norfolk Boreas site (as discussed previously the majority of these encounters were associated with fishing vessels). During winter the highest density was within the West Friesland associated routeing measures.

340. Density was observed to be higher in summer than winter, likely due to increased levels of fishing vessels during summer, noting that increased summer coverage may also have contributed.

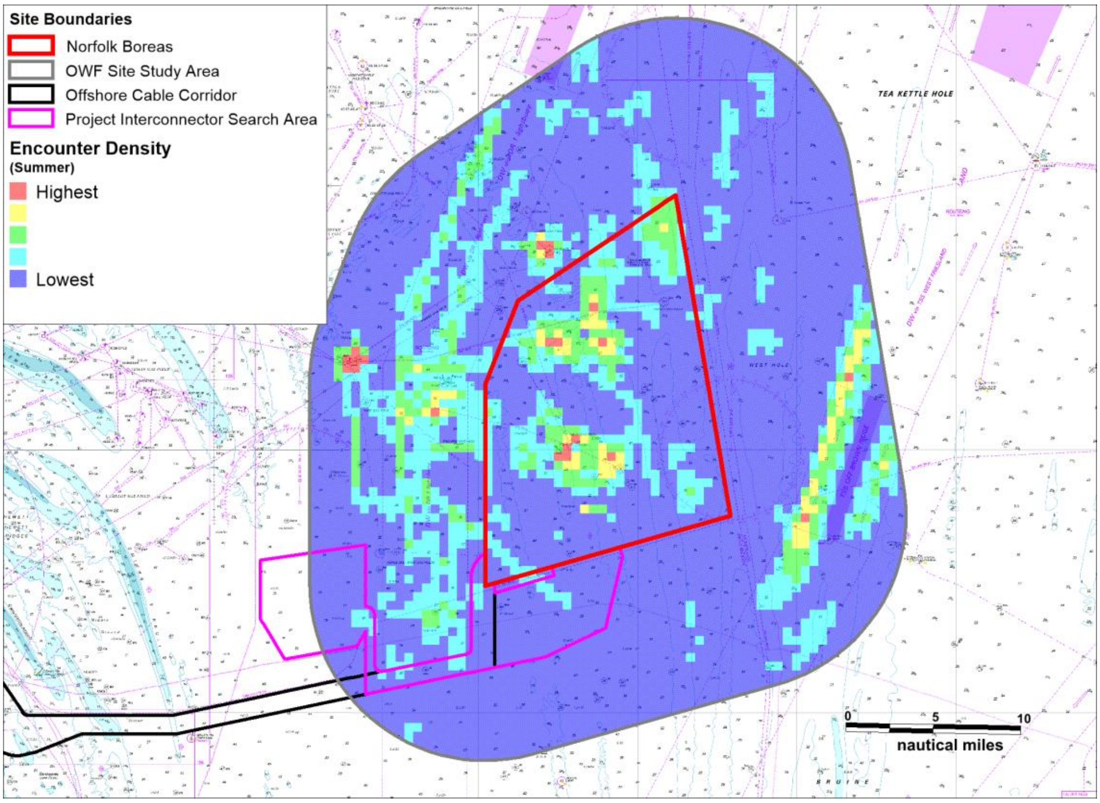


Figure 21.4 Encounter Density (Summer)

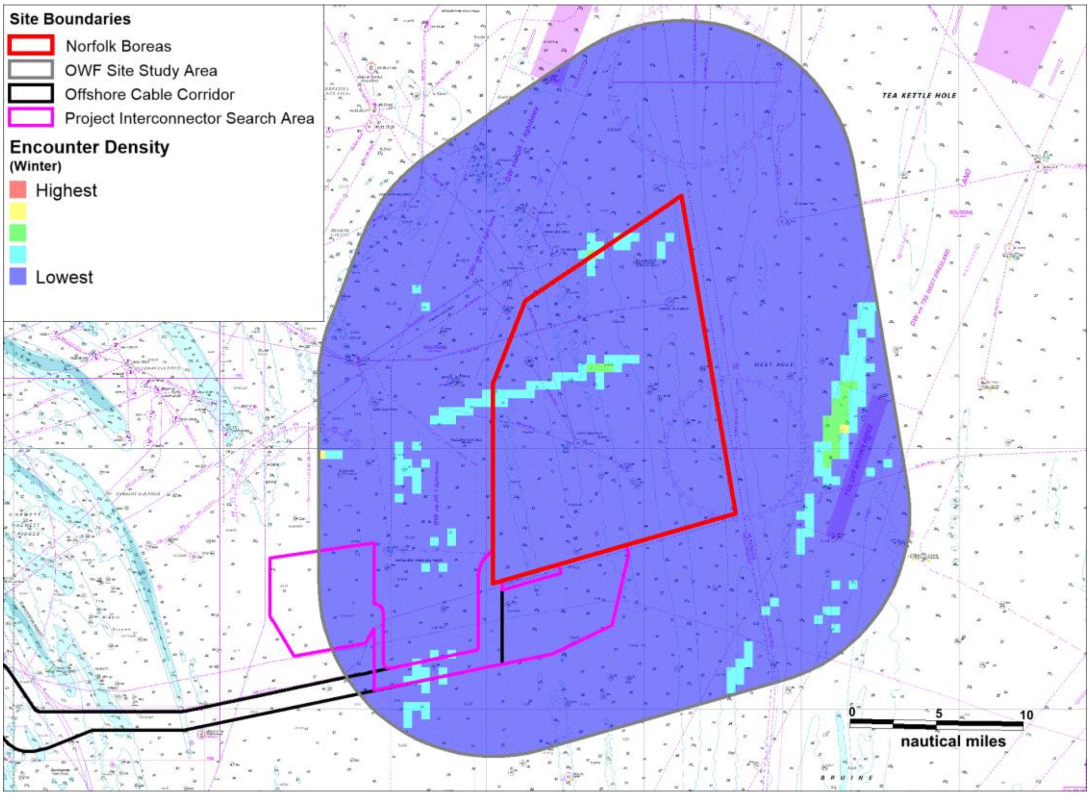


Figure 21.5 Encounter Density (Winter)

21.1.2 Vessel to Vessel Collisions

341. The baseline routeing was used as input to the vessel to vessel collision function of Anatec's CollRisk modelling suite to estimate the collision risk pre wind farm. The results are shown via a density grid in Figure 21.6.

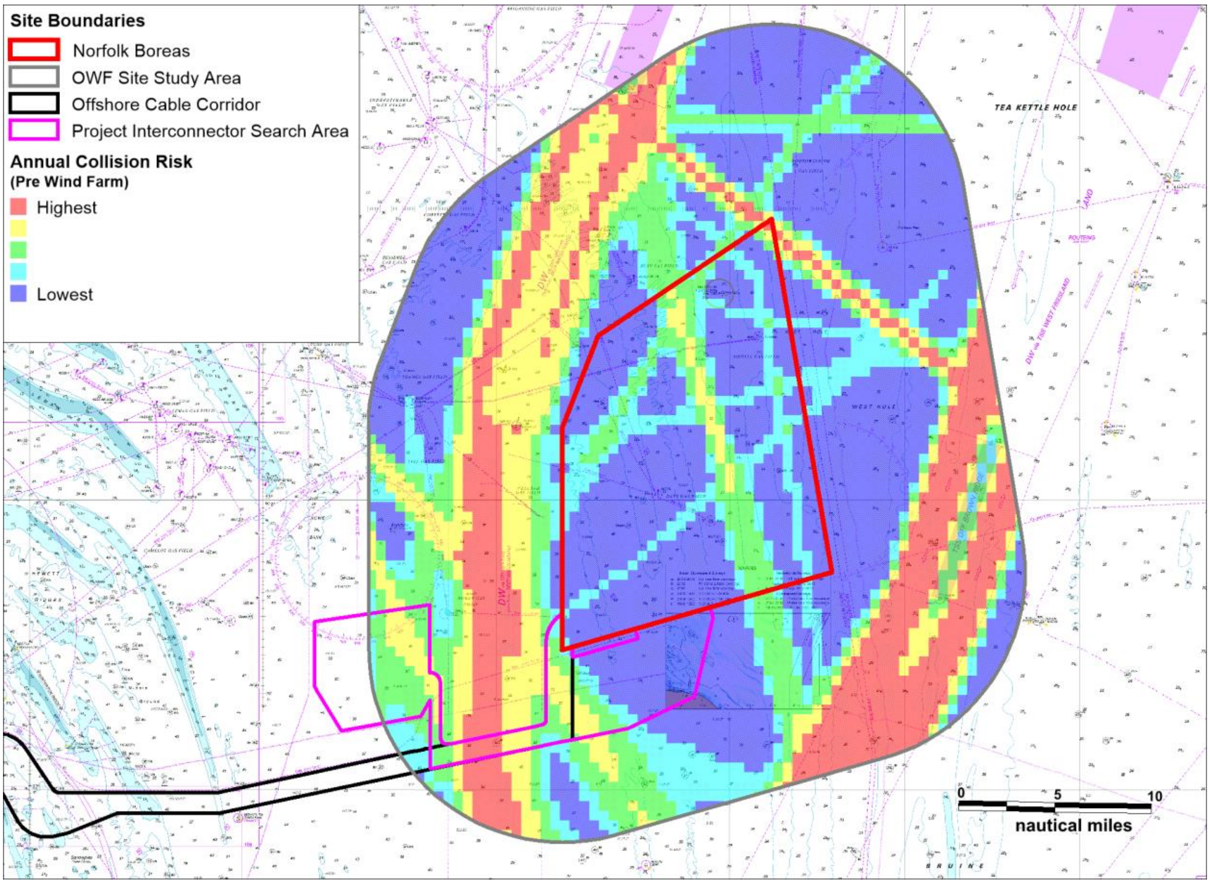


Figure 21.6 Vessel to Vessel Collision Risk (Pre Wind Farm)

342. It was estimated that a vessel would be involved in a collision within 10nm of the Norfolk Boreas site once every 19 years, assuming base case traffic levels and pre wind farm routeing. The majority of this risk (> 80%) was observed to be within the West Friesland associated routeing measures to the east, reflective of the traffic levels utilising the DWR and TSS. Higher risk areas were also observed within the DR1 Lightbuoy DWR, and from the Newcastle (UK) to Amsterdam ferry route intersecting the northern extent of the Norfolk Boreas site.

343. It is emphasised that the model is calibrated based on major incident data at sea which allows for benchmarking but does not cover all incidents, such as minor impacts. Other incident data, which includes minor incidents, is presented in section 11.

21.2 Post Wind Farm

21.2.1 Vessel to Vessel Collisions

344. The revised routeing pattern (i.e. post wind farm) shown in section 19.2.1 was used as input to the vessel to vessel collision model within Anatec's CollRisk model suite to estimate the potential rise in vessel to vessel collisions as a result of the proposed project. The results are presented in Table 21.1. Three traffic growth scenarios have been modelled (0%, 10% and 20%) for both the pre and post wind farm cases to allow direct comparison.

Table 21.1 Vessel to Vessel Collision Rate Increases

Scenario	Annual Frequency		Return Period		Increase from Base Case (No Traffic Growth)	
	Pre Wind Farm	Post Wind Farm	Pre Wind Farm	Post Wind Farm	Pre Wind Farm	Post Wind Farm
No traffic growth	5.28×10^{-2}	5.35×10^{-2}	18.9	18.7	n/a	1%
10% Traffic Growth	6.39×10^{-2}	6.48×10^{-2}	15.6	15.4	21%	23%
20% Traffic Growth	7.61×10^{-2}	7.72×10^{-2}	13.1	13.0	44%	46%

345. Assuming base case traffic levels remain, it is estimated that collision risk will rise by approximately 1% as a result of the post wind farm routeing. This is considered a low percentage increase, and is reflective of the base case collision risk already being high in the area.

346. Assuming traffic increases of 10% and 20%, collision rates were estimated to rise by 23% and 46% respectively over the pre wind farm case (at base case traffic levels). However, as indicated by the pre wind farm scenarios modelled for the 10% and 20% increase cases, the majority of this risk is associated with the increased traffic, rather than the post wind farm routeing (i.e. the wind farm has a low impact on collision rates based on the pre-existing collision risk being high).

347. The anticipated change in collision risk within the area is presented graphically in Figure 21.7. The results shown assume no growth in traffic to allow just the impact of the wind farm to be assessed.

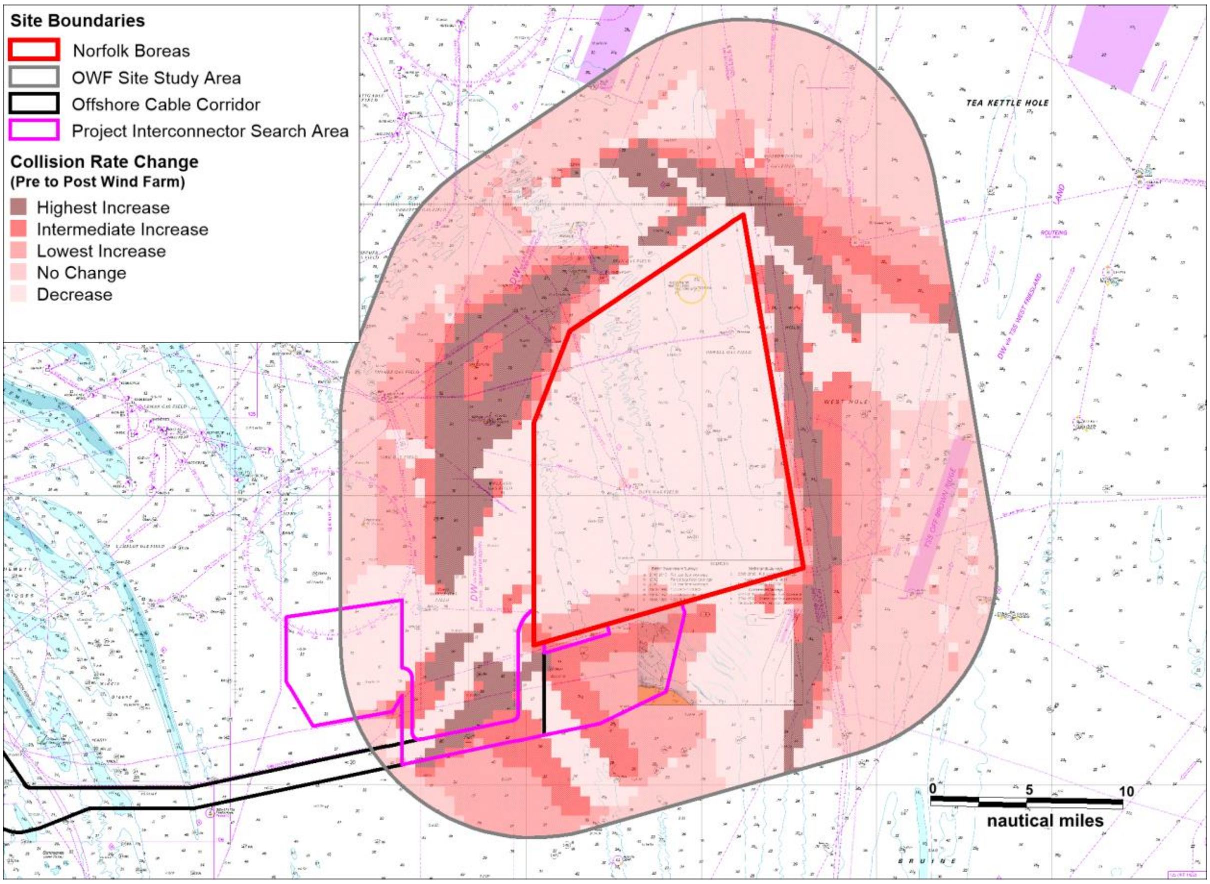


Figure 21.7 Vessel to Vessel Collision Risk Change (Pre to Post Wind Farm)

348. Risk was observed to increase around the Norfolk Boreas site periphery, (noting that worst case deviations have been assumed), notably within the DR1 lightbuoy DWR to the west, and to the north where the well-defined route is anticipated to deviate. However, risk within the West Friesland associated routeing measures was observed to remain largely static.

21.2.2 Vessel Allision with Structure

21.2.2.1 Powered Allision

349. Based on the vessel routeing identified for the area, the anticipated deviations due to the project, and assumptions that effective mitigation measures are in place, the frequency of an errant vessel under power deviating from its route to the extent that it comes into proximity with a structure is not considered to be low.

350. The deviated routes presented in section 19.2.1 were used as input to the powered allision function of Anatec's CollRisk modelling suite. This model estimates the likelihood that a vessel will allide with one of the structures within the Norfolk Boreas site whilst under power. It is noted that the model does not take account for the possibility of one structure shielding another.

351. The results of the assessment are summarised in Table 21.2 (noting that pre wind farm there is zero allision risk). Following this, the annual powered allision frequency is shown per structure in Figure 21.8 (assuming the 0% traffic increase scenario).

Table 21.2 Annual Allision Results (Powered)

Scenario	Annual Frequency	Return Period (Years)
Pre Wind Farm	0	n/a
Post Wind Farm – 0% Traffic Increase	2.49×10^{-4}	4,000
Post Wind Farm – 10% Traffic Increase	2.75×10^{-4}	3,600

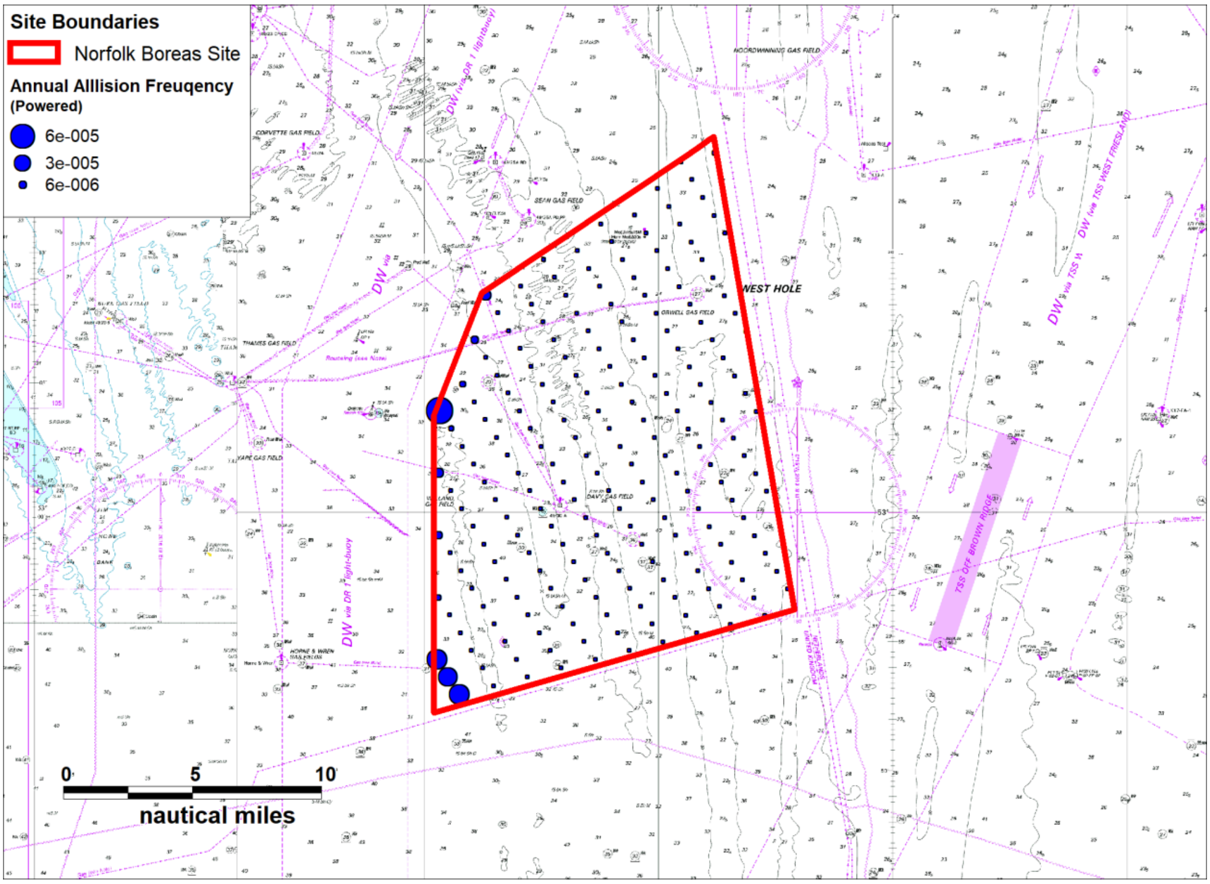


Figure 21.8 Annual Allision Results (Powered) – per Structure

352. The majority of the risk was observed to be from vessels in the northbound lane of the DR1 Lightbuoy DWR, and from vessels passing south west of the Norfolk Boreas site, prior to or after crossing the DR1 Lightbuoy DWR (Route 6 in section 19).

21.2.2.2 Drifting Allision

353. The deviated routes presented in section 19.2.1 were used as input to the NUC allision function of Anatec's CollRisk modelling suite. This model is based on the premise that propulsion on a vessel must fail before a vessel would drift. The model takes account of the type and size of the vessel, number of engines and the anticipated time needed to repair in different conditions.

354. The exposure times for a drifting scenario are based on the vessel-hours spent in proximity to the proposed wind farm (up to 10nm from perimeter). These have been estimated based on the traffic levels, speeds and revised routeing pattern. The exposure is divided by vessel type and size to ensure these factors, which based on analysis of historical accident data have been shown to influence accident rates, are taken into account within the modelling.

355. Using this information the overall rate of breakdown within the area surrounding the wind farm was estimated. The probability of a vessel drifting towards a structure and the drift speed are dependent on the prevailing wind, wave and tide conditions at the time of the accident.

356. The following drift scenarios were modelled:

- Wind;
- Peak spring flood tide; and
- Peak spring ebb tide.

357. The probability of vessel recovery is estimated based on the speed of drift and hence the time available before reaching the wind farm structure. Vessels that do not recover within this time are assumed to allide.

358. After modelling each of the drift scenarios it was established that the wind drift produced the worst case results. These results are presented in Table 21.3. Following this, risk is presented per structure in Figure 21.9.

Table 21.3 Annual Allision Results (Drifting)

Scenario	Annual Frequency	Return Period (Years)
Pre Wind Farm	0	n/a
Post Wind Farm – 0% Traffic Increase	9.14×10^{-5}	10,900
Post Wind Farm – 10% Traffic Increase	1.01×10^{-4}	9,900

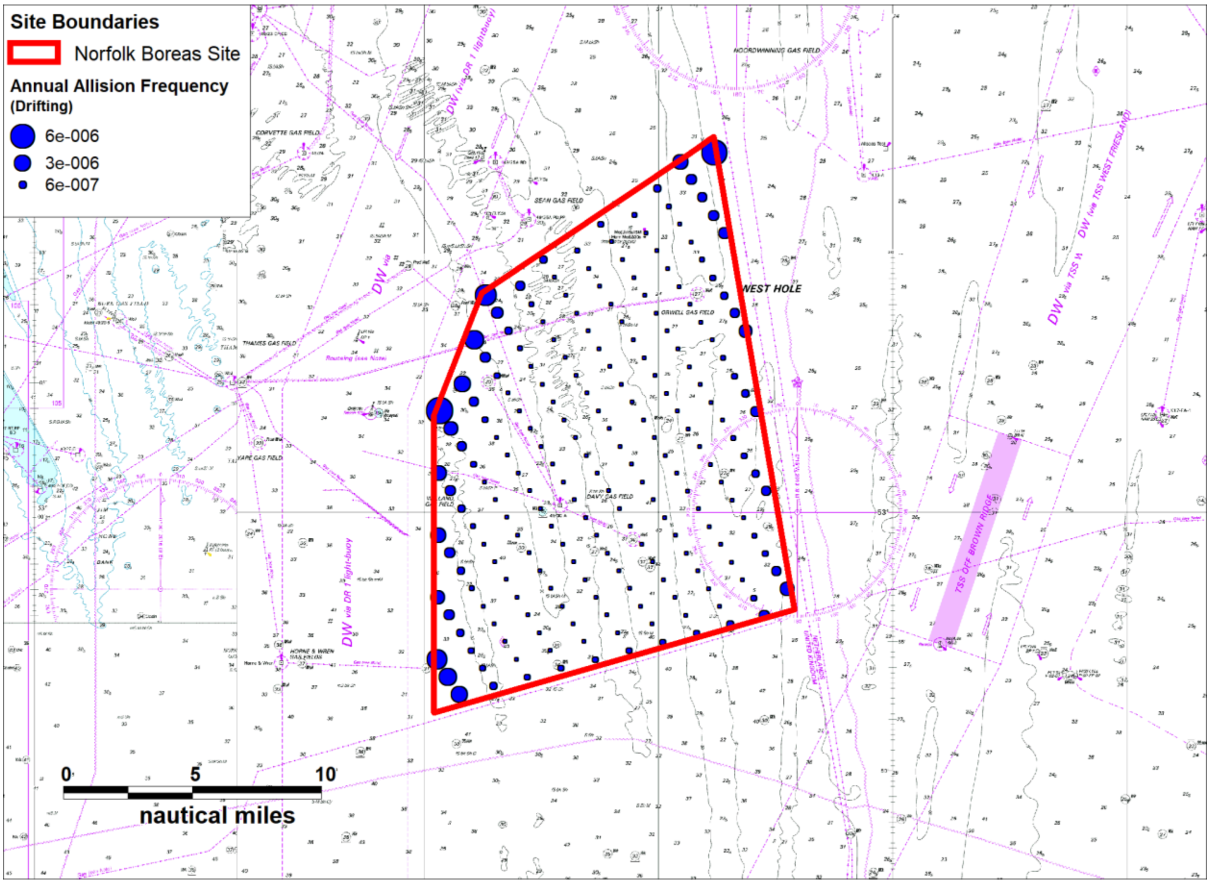


Figure 21.9 Annual Allision Results (Drifting) – per Structure

359. The majority of the risk was found to be from vessels within the DR1 Lightbuoy DWR. This was due to high traffic densities within the DWR, and the prevalent wind direction being from the south west and west (see section 9.1 for further details of wind direction probabilities)

21.2.3 Fishing Vessel Allision

360. Anatec's CollRisk fishing vessel risk model has been calibrated using fishing vessel activity data along with offshore installation operating experience in the UK (oil and gas) and the experience of allisions between fishing vessels and United Kingdom Continental Shelf (UKCS) offshore installations (published by the Health and Safety Executive (HSE)).

361. The two main inputs to the model are the fishing vessel density for the area and the structure details including the number and dimensions of the structures. The input fishing density has been estimated based on the marine traffic survey data (noting that densities were also estimated based on the long term sightings and satellite surveillance data; however both were lower than that based on the marine traffic survey data).

362. Results of the fishing allision modelling process are presented in Table 21.4.

Table 21.4 Fishing Vessel to Structure Allision Rate

Scenario	Annual Frequency	Return Period (years)
Pre Wind Farm	0	n/a
Post Wind Farm – 0% Traffic Increase	2.18×10^{-1}	4.6
Post Wind Farm – 10% Traffic Increase	2.40×10^{-1}	4.2

363. The estimated allision frequencies are high and reflect the maximum target area assumed for all the structures based on the installation of floating foundations. It is also assumed that the fishing vessel densities within the Norfolk Boreas site would remain at base case levels (i.e. as established within the baseline assessment).

364. In terms of the consequences of these impacts it is expected that the majority will be relatively minor during fishing itself and there will be low levels of risk to crew and of pollution. Quantitative consequence assessment has been undertaken in Appendix 15.3, with a summary provided in section 21.2.5 of this NRA.

21.2.4 Risk Results Summary

365. The outputs of the modelling process are summarised in Table 21.5.

Table 21.5 Summary of Annual Collision and Allision Frequency Results

Collision / Allision Scenario	Pre Wind Farm (Return Period)	Post Wind Farm (Return Period)		
		0% Increase	10% Increase	20% Increase
Vessel to Vessel Collision	5.28×10^{-2} (18.9 years)	5.35×10^{-2} (18.7 years)	6.48×10^{-2} (15.4 years)	7.72×10^{-2} (13.0 years)
Powered Allision	n/a	2.49×10^{-4} (4,000 years)	2.75×10^{-4} (3,600)	n/a
Drifting Allision	n/a	9.14×10^{-5} (10,900 years)	1.00×10^{-4} (10,000 years)	n/a
Fishing Allision	n/a	2.18×10^{-1} (4.6 years)	2.40×10^{-1} (4.2 years)	n/a
Total	**5.28×10^{-2} (18.9 years)**	**2.72×10^{-1} (3.7 years)**	**3.05×10^{-1} (3.3 years)**	**n/a**

366. Based on the output of the modelling it is estimated that allision and collision risk will rise from once every 18.9 years pre wind farm to once every 3.7 years post wind

farm (assuming no changes in traffic levels). Assuming a 10% increase in traffic the risk of a vessel being involved in an allision or collision rose to once every 3.3 years.

367. The majority of the increase was observed to be associated with fishing vessel allision with a wind farm structure. As per section 21.2.3 these are expected to be largely low speed low energy contacts, and the modelling process assumes no change to fishing vessel density or geographical location within the Norfolk Boreas site post wind farm.

21.2.5 Consequences

368. The probable outcomes for the majority of hazards are expected to be minor. However, the worst case outcomes could be severe, including events with potentially multiple fatalities.

369. An allision involving a larger vessel is likely to result in the collapse of a wind turbine with limited damage to the vessel. Breach of a vessel's fuel tank is considered unlikely and in the case of vessels carrying hazardous cargoes, e.g. tanker or gas carrier, the additional safety features associated with these vessels would further mitigate the risk of pollution (for example double hulls). Similarly, in a drifting allision the proposed wind farm structures are likely to absorb the majority of the impact energy, with some energy also being retained by the vessel in terms of rotational movement (glancing blow).

370. In terms of smaller vessels such as fishing and recreational craft, the worst case scenario would be risk of vessel damage leading to foundering of the vessel and Potential Loss of Life (PLL).

371. A quantitative assessment of the potential consequences of collision / allision for each of the scenarios is presented in Appendix 15.3. This assessment applies the site-specific collision / allision frequency results presented within this section with estimated outcomes in terms of fatalities on-board and oil pollution from the vessel based on research into historical collision incidents (MAIB, International Tanker Owners Pollution Federation, etc.). A summary of the assessment output is provided below.

372. The overall increase in PLL estimated due to the proposed project is 1.87×10^{-3} fatalities per year (base case), which equates to one additional fatality every 540 years. This is a very small change in comparison to MAIB statistics which indicate an average of 29 fatalities per year in UK territorial waters.

373. In terms of individual risk to people, the incremental increase for commercial vessels (in the region of 10^{-8}) is very low compared to the background risk level for the UK sea transport industry of 2.9×10^{-4} per year.

374. Similarly for fishing vessels, whilst the change in individual risk attributed to the proposed project is higher than for commercial vessels (in the region of 10^{-5}), it is

relatively low compared to the background risk level for the UK sea fishing industry of 1.2×10^{-3} per year.

375. The overall increase in oil spilled due to the project is 0.65 tonnes of oil per year (base case). From research undertaken as part of the DfT MEHRA project (DfT, 2001) the average annual tonnes of oil spilled in the waters around the British Isles due to marine accidents in the ten year period from 1989 to 1998 was 16,111. Therefore, the overall increase in pollution estimated for Norfolk Boreas is very low compared to the historical average pollution quantities from marine accidents in the UK waters.

376. On this basis, the incremental increase in risk to both people and the environment caused by the project is estimated to be low.

377. Impacts associated with allision and collision are assessed within Chapter 15 Shipping and Navigation. This includes consideration of the potential consequences, as per section 3 of this NRA.

22 Communication and Position Fixing

22.1 Introduction

378. The following section summarises the potential impacts from the project upon communication and position fixing devices used by vessels within the vicinity of the Norfolk Boreas site and offshore cable corridor.

22.2 Very High Frequency Communications including Digital Selective Calling

379. As part of the 2004 SAR provider (MCA and QinetiQ, 2004) trials at North Hoyle wind farm, tests were undertaken to evaluate the operational use of typical small vessel Very High Frequency (VHF) transceivers when operated close to wind farm structures.

380. The wind farm structures had no noticeable effect on voice communications within the wind farm or ashore. It was noted that if small craft vessel to vessel and vessel to shore communications were not affected significantly by the presence of wind turbines, then it is reasonable to assume that larger vessels with higher powered and more efficient systems would also be unaffected.

381. During this trial a number of mobile telephone calls were made from ashore, within the wind farm, and on its seawards side. No impacts were recorded using any system provider (MCA and QinetiQ, 2004).

382. Furthermore, as part of the SAR trials carried out at North Hoyle wind farm in 2005, radio checks were undertaken between the Sea King helicopter and both Holyhead and Liverpool coastguards. The aircraft was positioned to the seaward side of the wind farm and communications were reported as very clear, with no apparent degradation of performance. Communications with the service vessel located within the wind farm were also fully satisfactory throughout the trial (MCA, 2005).

383. Following consideration of these independent reports, the structures within the Norfolk Boreas site are anticipated to have no significant impact upon VHF communications as demonstrated at other operational sites.

22.3 VHF Direction Finding

384. During the 2004 trials at North Hoyle wind farm, the VHF direction equipment carried in the trial boats did not function correctly when very close to wind turbines (within approximately 50m). This is deemed to be a relatively small scale impact due to the limited use of VHF direction finding equipment and will not impact operational or SAR activities, especially as the effect is now recognised by the MCA (MCA and QinetiQ, 2004).

385. Throughout the 2005 SAR trials carried out at North Hoyle wind farm, the Sea King radio homer system was tested. The Sea King radio homer system utilises the lateral displacement of a vertical bar on an instrument to indicate the sense of a target relative to the aircraft heading. With the aircraft and the target vessel within the wind farm, at a range of approximately 1nm, the homer system operated as expected with no apparent degradation.

22.4 Automatic Identification System

386. In theory there could be interference when there is a structure located between the transmitting and receiving antennas (i.e. blocking line of sight) of the AIS. This was not evident in the trials carried out at the North Hoyle offshore wind farm site and no significant impact is anticipated for any AIS signals being transmitted and received within the Norfolk Boreas site (MCA and QinetiQ, 2004).

22.5 Navigational Telex Systems

387. The Navigational Telex (NAVTEX) system is used for the automatic broadcast of localised Maritime Safety Information (MSI) and either prints it out in hard copy or displays it on a Liquid-Crystal Display (LCD) screen, depending on the model.

388. There are two NAVTEX frequencies. All transmissions on NAVTEX 518 Kilohertz (kHz), the international channel, are in English. NAVTEX 518kHz provides the mariner (both recreational and commercial) with weather forecasts, severe weather warnings and navigation warnings such as obstructions or buoys off station. Depending on the users' location other information options may be available such as ice warnings for high latitude sailing.

389. The 490kHz national NAVTEX service may be transmitted in the local language. In the UK full use is made of this second frequency including useful information for smaller craft, such as the inshore waters forecast and actual weather observations from weather stations around the coast.

390. Although no specific trials have been undertaken, no significant effect has been noted at operational sites and therefore no impacts are expected to arise from the structures within the Norfolk Boreas site.

22.6 Global Positioning System

391. Global Positioning System (GPS) is a satellite based navigational system. GPS trials were also undertaken throughout the 2004 trials at North Hoyle wind farm and it was stated that "no problems with basic GPS reception or positional accuracy were reported during the trials".

392. The additional tests showed that "even with a very close proximity of a wind turbine to the GPS antenna, there were always enough satellites elsewhere in the sky to

cover for any that might be shadowed by the wind turbine tower" (MCA and QinetiQ, 2004).

393. Therefore there are not expected to be any significant impacts associated with the use of GPS systems within or in proximity to the Norfolk Boreas site.

22.7 Electromagnetic Interference (from Cables or Turbines) on Navigation Equipment

394. A compass, magnetic compass or mariner's compass is a navigational instrument for determining direction relative to the earth's magnetic poles. It consists of a magnetised pointer (usually marked on the north end) free to align itself with the earth's magnetic field. A compass can be used to calculate heading, used with a sextant to calculate latitude, and with a marine chronometer to calculate longitude.

395. Like any magnetic device, compasses are affected by nearby ferrous materials as well as by strong local electromagnetic forces, such as magnetic fields emitted from power cables. As the compass still serves as an essential means of navigation in the advent of power loss or a secondary source, it should not be allowed to be affected to the extent that safe navigation is prohibited. The important factors that affect the resultant deviation are:

- Water and burial depth;
- Current (whether alternating or direct) running through the cables;
- Spacing or separation of the two cables in a pair (balanced monopole and Bipolar designs); and / or
- Cable route alignment relative to the earth's magnetic field.

396. It is noted that DC cables may cause electromagnetic interference for vessels using magnetic compasses (Norfolk Boreas is currently only considering High Voltage Direct Current (HVDC) transmission options). However impacts on larger vessels using inertial navigation systems and GPS as their main navigational system are expected to be limited. Smaller craft which may only carry a magnetic compass and operate within near shore waters are likely to experience the highest effects but only for any period where they are directly above an unbundled DC cable.

397. No problems with respect to magnetic compasses have been reported to date in any of the trials carried out (inclusive of SAR helicopters). However, small vessels with simple magnetic steering and hand bearing compasses should be wary of using these close to wind turbines as with any structure in which there is a large amount of ferrous material (MCA and QinetiQ, 2004).

22.8 Impact on Marine Radar Systems

398. The 2004 MCA North Hoyle wind farm trials identified areas of concern with regard to the potential impact on marine and shore based Radar systems. This is due to the

large vertical extent of the wind turbines returning Radar responses strong enough to produce interfering side lobes, multiple and reflected echoes (ghosts). This has also been raised as a major concern by the maritime industry with further evidence of the problems being identified by the Port of London Authority (PLA) around the Kentish Flats offshore wind farm in the Thames Estuary. Based on the results of the North Hoyle trial, the MCA produced a wind farm / shipping route template to give guidance on the distances which should be established between shipping routes and offshore wind farms.

399. A second trial was conducted at Kentish Flats between the 30th April and 27th June 2006 on behalf of the British Wind Energy Association (BWEA, 2007). The project steering group had members from the BEIS, MCA and PLA. This trial was conducted in pilotage waters and in an area covered by the PLA VTS. It therefore had the benefit of pilot advice and experience but was also able to assess the impact of the generated effects on VTS Radars.

400. The trial concluded that:

- The phenomena referred to above detected on marine Radar displays in the vicinity of wind farms can be produced by other strong echoes close to the observing vessel although not necessarily to the same extent;
- Reflections and distortions by vessels' structures and fittings created many of the effects and the effects vary from vessel to vessel and Radar to Radar;
- VTS scanners static Radars can be subject to similar phenomena as above if passing vessels provide a suitable reflecting surface but the effect did not seem to present a significant problem for the PLA VTS; and
- Small vessels operating in or near the wind farm would be detectable by Radars located on vessels operating near the wind farm but would be less detectable when the vessel was operating within the wind farm.

401. Throughout the 2005 MCA SAR helicopter trials at the North Hoyle wind farm, side lobe returns were found to extend approximately 100m to either side of each wind turbine, with side lobe depth estimated at less than 50m. The Radar target, which was moving between the wind turbines within the wind farm, was tracked from an aircraft positioned in the 50 foot hover position between 0.25 and 0.5nm clear of the wind farm boundary. The target could be tracked to a distance of approximately 100m from each wind turbine. Beyond this point the target could be recognised at a slightly closer range to the wind turbine, but only if it had been previously identified at a greater separation and Radar processing continuously adjusted (MCA, 2005).

402. Theoretical modelling of the composite effects of the development of the Atlantic Array offshore wind farm on marine Radar systems was carried out by Ledwood Technology in October 2011 (Atlantic Array, 2012). The main outcomes of the modelling were as follows:

- "Multipath effects (false targets) were detected under all modelled parameters. The main effects noticed were stretching of targets in azimuth and appearance of more ghost targets due to multipath energy arriving through the side lobes. However, it was concluded that there was a significant amount of clear space amongst the returns to ensure recognition of vessels moving amongst the wind farm structures and safe navigation.
- Even in the worst case with Radar operator settings set artificially bad there is significant clear space around each wind turbine that does not contain any multipath or side lobe ambiguities to ensure safe navigation and allow differentiation between false and real (both static and moving) targets.
- Overall it can be concluded that the amount of shadowing observed was very little. However, it should be noted that this was modelled on lattice-type base structures which are sufficiently sparse to allow Radar energy to pass through. The lower the density of structures the easier it is to interpret the Radar returns and fewer multipath ambiguities are present.
- In dense, target rich environments S-Band Radar scanners suffer more severely from multipath effects in comparison to X-Band scanners.
- It is important for passing vessels to keep a reasonable separation distance between the wind farm structures in order to minimise the effect of multipath and other ambiguities.
- The potential Radar interference is mainly a problem during periods of reduced visibility when mariners may not be able to visually confirm the presence of other vessels in the vicinity (i.e. those without AIS installed which are usually fishing and recreational craft)".

403. Based on the trials carried out to date, the onset range from the wind turbines of false returns is approximately 1.5nm, with progressive deterioration in the Radar display as the range closes. If interfering echoes develop, the requirements of the International Convention for the Prevention of Collisions at Sea (COLREGS) (IMO, 1972) Rule 6 Safe speed are particularly applicable and must be observed with due regard to the prevailing circumstances. In restricted visibility, Rule 19 Conduct of vessels in restricted visibility applies and compliance with Rule 6 becomes especially relevant. In such conditions mariners are required, under Rule 5 Lookout to take into account information from other sources which may include sound signals and VHF information, for example from a VTS, or AIS.

404. It is noted that upon development of Norfolk Boreas, commercial vessels are likely to pass over 1nm from the site, and thereby potentially be subject to a minor level of Radar interference. Vessels utilising the northbound lane of the DR1 Lightbuoy DWR may have limited room to transit further west of the Norfolk Boreas site given the presence of southbound traffic, however there is considered to be sufficient sea room for vessels to increase their clearance if they consider it necessary to greater than 2nm and outwith the potential range of Radar interference.

405. Figure 22.1 presents a visual representation of the identified impacts.

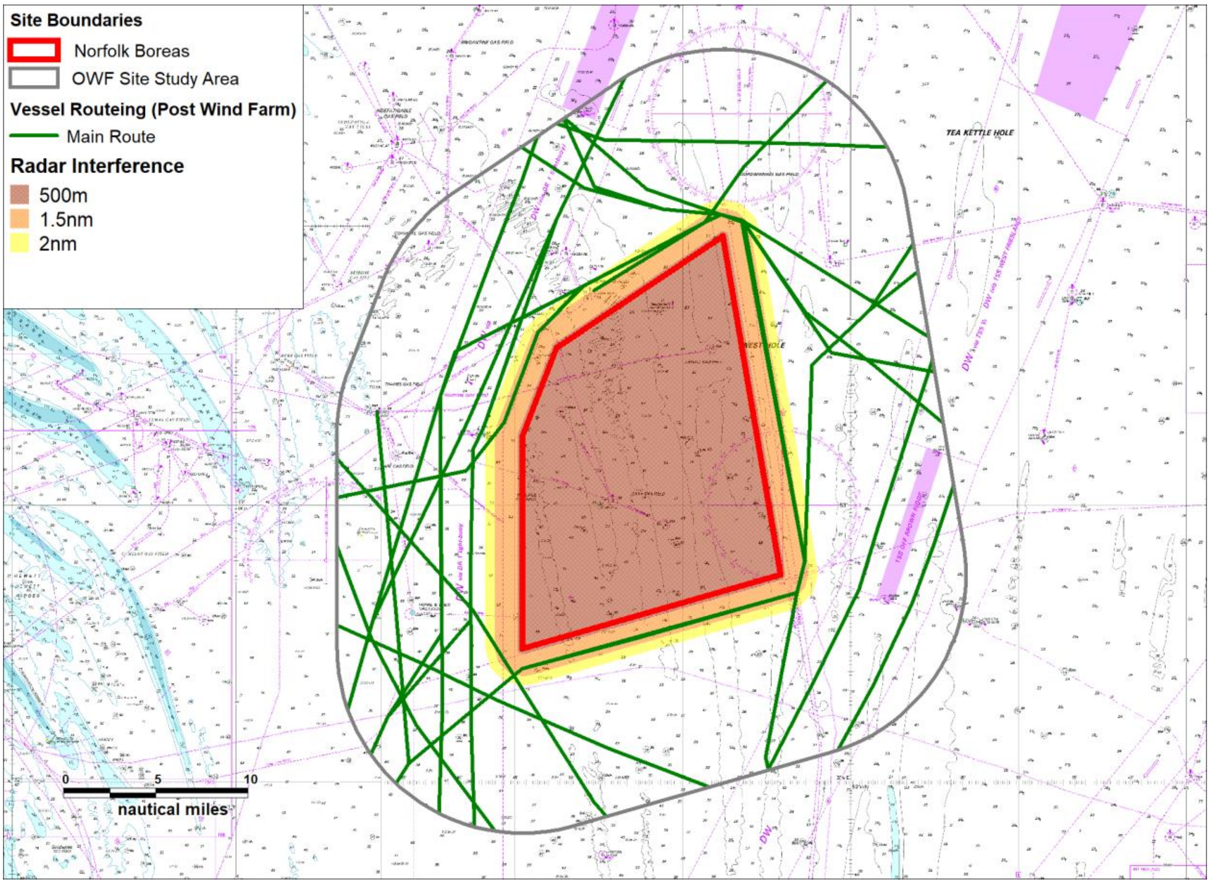


Figure 22.1 Radar Interference within 10nm

406. Experienced mariners should be able to suppress the observed problems to an extent and for short periods (a few sweeps) by careful adjustment of the receiver amplification (gain), sea clutter and range settings of the Radar. However, there is a consequential risk of losing targets with a small Radar cross section, which may include buoys or small craft, particularly yachts or Glass Reinforced Plastic constructed craft, therefore due care is needed in making such adjustments. The Kentish Flats study observed that the use of an easily identifiable reference target (a small buoy) can help the operator select the optimum Radar settings.

407. The performance of a vessel's Automatic Radar Plotting Aid could also be affected when tracking targets in or near the Norfolk Boreas site. However, although greater vigilance is required, it appears that during the Kentish Flats trials, false targets were quickly identified as such by the mariners and then by the equipment itself.

408. The evidence from mariners operating in the vicinity of existing wind farms is that they quickly learn to work with and around the effects. The MCA has produced guidance to mariners operating in the vicinity of UK OREIs which highlights Radar issues amongst others to be taken into account when planning and undertaking voyages in the vicinity of renewable energy installations off the UK coast (MCA, 2008).

409. AIS information can also be used to verify the targets of larger vessels (generally vessels above 300 tonnes) and fishing vessels of 15m length and over which are required to carry AIS. It is noted that no fishing vessels less than 15m in length were recorded within the Norfolk Boreas sites during the marine traffic surveys, however it should be considered that lengths could not be specified for 13% of fishing vessels during the summer period. Furthermore an increasing number of small fishing vessels (currently not required to carry AIS) and recreational craft are voluntarily utilising Class B AIS units thus enabling verification of these small craft when in proximity to a wind farm.

22.9 Increased Turbine Size

410. Following analysis of Radar interference studies and general Radar principles the following impacts associated with the use of the large wind turbines (maximum hub height of 198.5m and rotor tip of 350m above HAT) which could be used within the Norfolk Boreas site have been identified. This is specifically to identify potential impacts with the increasing size of wind turbines due to the operation of marine Radar beam widths and does not consider impacts associated with the total number of wind turbines or amount of exposure for transiting vessels passing within 2nm.

411. Figure 22.2 shows an example of how Radar range is determined – the curve of the earth plus the sum of the scanner and target height. A higher target height (point B in Figure 22.2) will result in a greater range of detection (point C) of the target, especially for larger vessels with a higher antenna (point A). However the increased distance would result in a weaker Radar return and therefore the effects recorded whilst operating in close proximity to a wind farm (e.g. interfering side lobes, multiple and reflected echoes), are not likely to occur at this increased range. Therefore the increased range of detection of larger wind turbines will not impact on a vessel’s ability to navigate safely.

412. Increased wind turbine size would mean that small craft transiting within the Norfolk Boreas site would be able to identify wind turbine targets at a greater distance, especially if they are not in rows. Consequently, the structures within the Norfolk Boreas site, ahead of the vessel, would be clear on the Radar screen.

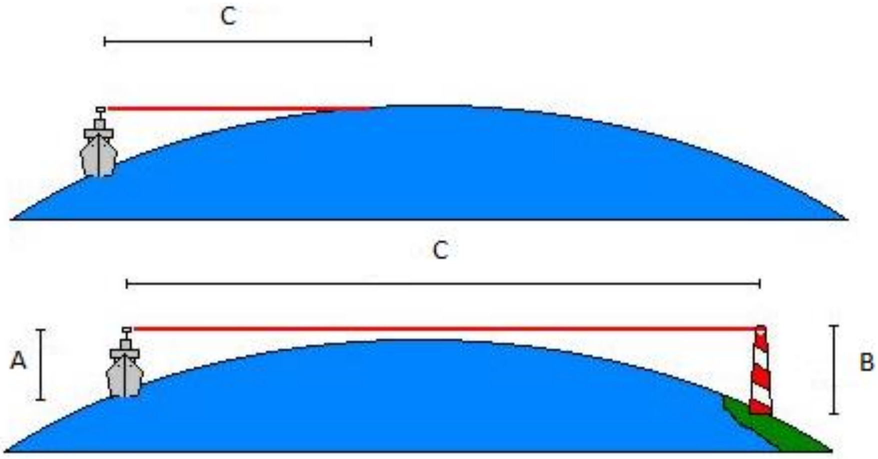


Figure 22.2 Determining Radar Range

22.10 Increased Target Returns

413. Beam width is the angular width, horizontal or vertical, of the path taken by the Radar pulse. Horizontal beam width ranges from 0.75 to 5°, and vertical beam width from 20 to 25°. How well an object reflects energy back towards the Radar depends on its size, shape and aspect angle.

414. The larger wind turbines (either in height or width) will return a greater target size or stronger false targets. However there is a limit to which the vertical beam width would be affected (20 to 25°) dependent on the distance from the target. Therefore the increased wind turbine height at the Norfolk Boreas site will not create any effects in addition to those already identified from existing operational wind farms (e.g. interfering side lobes, multiple and reflected echoes).

415. The most likely occurrence will be a greater target return due to increased width of wind turbines and foundations resulting in similar effects to those previously described (e.g. interfering side lobes, multiple and reflected echoes). Again when taking into consideration the potential options available to marine users (e.g. reducing gain to remove false returns) and feedback from trials carried out to date that the effects of increased returns can be managed effectively, this effect is expected to be negligible and not further impact on navigational safety.

22.11 Structures Affecting Sonar Systems

416. No evidence has been found to date with regard to existing wind farms to suggest that they produce any kind of Sonar interference which is detrimental to the fishing industry, or to military systems. No impact is therefore anticipated from the project (including the offshore cable corridor).

22.12 Noise Impact

417. A concern which must be addressed under MGN 543 is whether acoustic noise from the wind farm could mask prescribed sound signals.

418. The sound level from a wind farm at a distance of 350m has been predicted to be 51 decibels (dB) to 54dB (A). Furthermore predictions of noise levels were carried out throughout the consenting process of the Atlantic Array offshore wind farm. Modelling shows that the highest predicted level due to operational wind turbine noise (for a 125m tall 8MW wind turbine) is around 60dB (Atlantic Array Offshore Wind Farm, 2012).

419. A vessel's whistle for a vessel of 7m should generate in the order of 138dB and be audible at a range of 1.5nm (IMO, 1972/77); hence this should be heard above the background noise of the wind turbines. Similarly, foghorns will also be audible over the background noise of the project.

420. There are therefore no indications that the sound level of the structures within the Norfolk Boreas site will have a significant influence on marine safety.

22.13 Underwater Noise

421. Underwater noise radiated from 110m tall, 2MW capacity wind turbines during the operation of the Horns Rev offshore wind farm (Denmark) was measured in November 2005. The maximum levels recorded at 100m from the wind turbines were a sound pressure of 122dB re 1µ pascals (Pa) (Institut für technische und angewandte Physik (ITAP), 2006).

422. During the operational phase of Norfolk Boreas, the subsea noise levels generated by wind turbines are not anticipated to have any significant impact on Sonar systems as they are designed to work in pre-existing noisy environments.

22.14 Impacts on Communications and Position Fixing

423. A summary of the assessment into impacts on communications and position fixing is provided in Table 22.1.

Table 22.1 Impacts on Communication and Position Fixing Summary

Topic		Sensitivity	Screen In / Out (Isolation)	Screen In / Out (Cumulative)
Type	Specific			
Communication	VHF	No anticipated impacts. Not impacted by layout design.	Screened Out	Screened Out
	VHF Direction Finding	No anticipated impacts. Not	Screened Out	Screened Out

Topic		Sensitivity	Screen In / Out	Screen In / Out
		impacted by layout design.		
	AIS	No anticipated impacts. Not impacted by layout design.	Screened Out	Screened Out
	Navtex	No anticipated impacts. Not impacted by layout design.	Screened Out	Screened Out
	GPS	No anticipated impacts. Not impacted by layout design.	Screened Out	Screened Out
Electromagnetic Field (EMF)	Cables	No anticipated impacts.	Screened Out	Screened Out
	Wind Turbines	No anticipated impacts. Not impacted by layout design.	Screened Out	Screened Out
Marine Radar	Use of Marine Radar	Vessels have sufficient sea room to distance themselves from Norfolk Boreas, in line with the shipping template, to mitigate any effects. There are not anticipated to be any impacts with floating foundations given the slow speed at which they would move within their excursion area. Cumulatively, vessels within the navigational corridor could be sensitive but have the ability to distance themselves further from the boundary or to make manual adjustments to mitigate any temporary impacts.	Screened Out	Screened Out

Topic		Sensitivity	Screen In / Out	Screen In / Out
Noise	Wind turbine generated noise	No anticipated impacts. Not impact by layout design.	Screened Out	Screened Out
	SONAR	No anticipated impacts. Not impact by layout design.	Screened Out	Screened Out

22.15 Impacts on Visual Collision / Allision Avoidance

22.15.1 Visual Impact (Other Vessels)

424. Consideration has been given to the alignment of wind turbines within the Norfolk Boreas site with regards to visual navigation. Based on the alignment, number of wind turbines and minimum spacing (720m) it is not considered there would be any significant impacts associated with visual “blind spots” between vessels on the main commercial shipping routes in the area, including small craft navigating within the array.

425. In the event of a small vessel emerging from within the Norfolk Boreas site towards shipping traffic, the vessel should be visible for the vast majority of the time, due to the size of the wind turbines and the spacing between them. Recreational traffic (small sailing vessels) were recorded within the Norfolk Boreas site during the summer 2017 marine traffic survey, and fishing vessels were recorded within the site during both the summer 2017 and winter 2018 surveys.

22.15.2 Visual Impact (Aids to Navigation or Landmarks)

426. Norfolk Boreas itself will form a significant AtoN, which will be very visible to shipping with lights on Significant Peripheral Structures (SPS) as well as selected Intermediate Peripheral Structures (IPS) in accordance with TH requirements (see section 25.4).

427. It is therefore considered that, provided suitable marking and lighting would be developed at the Norfolk Boreas site in consultation with TH and the MCA, it would not degrade the ability of vessels to navigate in the area through visual impairment.

428. It is also noted that the wind farm does not impact on any other pre-established navigational aids (as per section 8.3).

429. Allision and collision impacts are assessed fully in Chapter 15 Shipping and Navigation.

23 Hazard Log

23.1 Introduction

430. This section details the process by which the Norfolk Boreas Hazard Log has been created, as per the required NRA methodology (MCA, 2015). The Hazard Log lists potential impacts to shipping and navigation receptors that may arise from the project, and provides significance rankings based on stakeholder input. The full Hazard Log is provided in Appendix 15.5

431. It is emphasised that the Hazard Log rankings form only one input to the impact assessment undertaken in Chapter 15 Shipping and Navigation, which also considers outputs of the modelling process, the consultation process as a whole, and the baseline assessment findings.

23.2 Hazard Consultation Meetings

432. To inform the Hazard Log, Norfolk Boreas Limited hosted two Hazard Consultation meetings on the 23rd May 2018. Key marine stakeholders and regular operators were invited to attend these meetings to provide input into the Hazard Log and the project in general. Attending organisations are listed below:

- Norfolk Boreas Limited (hosts);
- Anatec Ltd (hosts);
- BP Shipping;
- CoS;
- RYA;
- CA;
- Scotline; and
- VISNED (unable to attend in person but requested a draft of the Hazard Log).

433. The Hazard Log was drafted following the Hazard Consultation meetings, and provided to the attending organisations for comment, prior to finalisation.

23.3 Results

434. The impacts identified as part of the Hazard Log process are listed below:

- Vessel displacement;
- Restriction of adverse weather routeing;
- Vessel to structure allision risk (powered and drifting);
- Anchor snagging on cables/mooring lines;
- Spatial restrictions from wind farm during SAR operations;
- Impacts on emergency response resources (via increased incident rates);
- Fishing gear snagging on cables/mooring lines; and

- Man overboard scenario within site from third party vessel or wind farm vessel (considered within emergency response).

435. Commercial fishing impacts are assessed in Chapter 14 Commercial Fisheries, and are therefore considered screened out of the NRA process (noting that navigation safety impacts to fishing vessels are still considered). The screening process of the other impacts listed is available in section 27.2, where each is screened in or out of the impact assessment carried out in Chapter 15 Shipping and Navigation.

24 Cumulative Impacts

24.1 Introduction

436. Cumulative impacts have been considered for the project including impacts on shipping and navigation arising from other proposed, consented, constructing or operational offshore wind projects and any impacts arising from other marine activities or users in the Southern North Sea.

437. Projects and proposed projects were screened into the assessment only where there was potential overlap between activities and receptors identified.

438. Vessel transits were considered in detail as part of the baseline for the NRA and therefore vessel traffic associated with marine aggregates dredging, oil and gas support, commercial fishing, recreational activity and MOD movements are effectively screened out of the cumulative assessment.

24.2 Cumulative Screening

439. Cumulative impacts have been considered for shipping and navigation and are assessed in section 15.8 of the ES and ranked as per the FSA process. The methodology used is detailed in section 3.2 of this NRA.

440. Projects within a 100nm buffer of the Norfolk Boreas site have been considered for the cumulative impact assessment in relation to shipping and navigation. Due to the location of the Norfolk Boreas site, this includes both UK wind farm projects and EU wind farm projects. Table 15.12 of the ES summarises the projects within 100nm and provides their current status.

25 Embedded Mitigation Measures

25.1 Overview

441. In addition to compliance with MGN 543 (as demonstrated in Appendix 15.3: MGN 543 Checklist), the following have been assumed as embedded mitigation within this NRA (and in the impact assessment undertaken in Chapter 15 Shipping and Navigation):

- Application for 'rolling' 500m safety zones surrounding all fixed structures where work is being undertaken by a construction vessel or maintenance vessel;
- Application for 50m safety zones around all surface structures up until the point of commissioning;
- Risk assessment of cable burial and protection undertaken pre-construction, including consideration of under keel clearance. All subsea cables suitably protected based on risk assessment, and the protection monitored and maintained as appropriate;
- Compliance with the Design Rules (see section 25.2), which have been agreed with the MCA and TH to provide a framework for post consent layout design and approval;
- Compliance from all vessels associated with the proposed project with international maritime regulations as adopted by the relevant flag state (most notably COLREGS (IMO, 1972) and SOLAS (IMO, 1974));
- Final site design to include consideration of lighting and marking. Suitable lighting and marking of the Norfolk Boreas site complying with IALA Recommendations O-139 (IALA, 2013), to be finalised in consultation with TH and the MCA;
- Final layout design to ensure no outlying or extreme peripheral turbines;
- Final layout would require alignment with the edge of the DWR. This would be considered with Norfolk Vanguard Limited to ensure any consistency required by regulators is addressed;
- Final foundations designs to be risk assessed post consent to ensure they do not impact on vessels transiting internally within the array;
- Information relevant to the proposed project to be promulgated via Notice to Mariners and other appropriate media;
- Floating foundations no longer under consideration, noting these were the worst case foundation from an under keel clearance perspective;
- Marine traffic coordination;
- Compliance with MGN 372 (MCA, 2008), COLREGs (IMO, 1972) and SOLAS (IMO, 1974) which set out rules and regulations for third party vessels operating in the area including advice on navigating in proximity to a wind farm to be followed;

- Structures and all cables (offshore export and array) to be clearly marked on appropriately scaled nautical charts and electronic charts;
- Wind turbines to be constructed in accordance with MGN 543 (MCA, 2016) where applicable;
- Use of guard vessel during the deployment of safety zones, and during any other key construction periods where identified by risk assessment; and
- Wind turbines to have at least 22m clearance above Mean High Water Spring (MHWS) as per RYA (2015) position paper and MGN 543 (MCA, 2016).

25.2 Design Rules

442. As noted within the embedded mitigations above, Vattenfall will comply with the Design Rules which have been agreed with the MCA and TH for the purpose of providing a framework for post consent layout approval. By ensuring the final layout complies with the Design Rules, Vattenfall are ensuring the safe navigation of third party surface vessels as well as SAR helicopters and surface vessels through the Norfolk Boreas site. The Design Rules are presented in Table 25.1.

Table 25.1 Design Rules

Rule Number	Design Rule	Reasoning
1	A minimum spacing of 720m shall be maintained between the centre points of all structures	*To assist internal surface navigation*
2	SAR Access Lanes of 500m width shall be maintained in at least one direction within the array, with a safety justification to support, as per MGN 543 justification would set out reasoning why a single line of orientation is considered sufficient and safe for SAR surface and air navigation. In the case of wind turbines this distance is measured from the blade tips that are transverse to the SAR lane.	*To facilitate SAR asset access*
3	The position of Structures, so far as is practicable, shall be arranged in straight lines (to a tolerance of between 50 and 100m either side of the centre line of an internal row for micro siting or wind energy capture; as rule 2 a safety justification will be provided) in an easily understandable pattern. Spacing between these straight lines is referred to as SAR Access Lanes.	*To facilitate SAR asset access and assist internal surface navigation; whilst accounting for micro siting, turbines foundation size and energy capture.*
4	As far as practicable, the position of all periphery structures around a windfarm area will be arranged in straight lines (to a tolerance of 50m either side of the centre line of the row) in an easily understandable pattern. Where routeing measures exist (e.g. the DWR), periphery structures must be aligned with it. There should be no outliers, or surface infrastructure isolated on the periphery. Should Norfolk Boreas be within 1nm (in line with design rule 6) and 3nm (based on maximum SPS spacing) of an existing offshore windfarm site (consented, constructed or layout agreed) then the	*To facilitate safe navigation for marine traffic navigating within routeing measures*

Rule Number	Design Rule	Reasoning
	peripheral turbine edge facing that site shall be reviewed with Trinity House and MCA to confirm required compliance with design rule 4 (peripheral alignment).	
5	Where SAR Access Lanes are more than 10nm, a Helicopter Refuge Area perpendicular to the SAR Access Lanes shall be included within the layout design. The Helicopter Refuge Area shall be at least 1nm (tip to tip) in width and allow access across the array.	*To facilitate SAR asset access*
6	Where an array is proposed to border another array with different alignment and/or spacing a minimum spacing of 1nm (blade tip to blade tip) must be maintained between the two arrays.	*To facilitate SAR asset access and to assist internal surface navigation*

25.3 Safety Zones

443. The safety zones that may be applied for are presented in Table 25.2.

Table 25.2 Safety Zone Application

Project Phase	Extent
Construction (Active)	500m 'rolling' safety zones around any structure where construction is active (as denoted by the presence of a large Restricted in Ability to Manoeuvre (RAM) vessel).
Construction (Pre-Commissioning)	50m around any partially completed structure where construction work is not active.
Operation (Normal Operations)	Potential application for up to 500m safety zone around permanently manned installations.
Operation (Major Maintenance)	500m around any structure where major maintenance is ongoing (defined as any work requiring the use of a large RAM vessel).
Decommissioning	Typically up to 500m at the end of the working life of a wind farm when it is being decommissioned. This should be evidenced by the presence of a jack-up rig or other large construction vessel.

25.4 Marine Navigational Marking

25.4.1 Summary

444. Throughout the life of the project marine navigational marking will be provided in accordance with the TH requirements, which will comply with IALA Recommendation O-139 on the Marking of Offshore Wind Farms (IALA, 2013) and the additional requirements of MGN 543 (MCA, 2016).

445. Aviation lighting will be as CAA requirements; however it is likely that specific requirements will be made with regards to flash sequences and SAR lighting. It is noted that SAR lighting falls under the MCA's remit.

446. All navigational aids will be suitably monitored and maintained to ensure the relevant IALA availability targets are met.

25.4.2 Construction and Decommissioning

447. During the construction / decommissioning of the project, working areas will be established and marked by a buoyed construction or decommissioning area as per TH requirements. In addition to this, where advised by TH, additional temporary marking will be applied including temporary lighting.

25.4.3 Operational Phase

448. The markings for the proposed project will be agreed in consultation with TH once the final wind turbine layout has been selected; however the following sections summarise likely scenarios.

25.4.3.1 Marking of Individual Structures

449. As per IALA Recommendations O-139 (IALA 2013), each structure within the Norfolk Boreas site will be painted yellow from the level of HAT, to 15m above HAT. Each structure will also be clearly marked with a unique alphanumeric identifier, which will be clearly visible in all directions. The identification characteristics will each be illuminated by a low-intensity light, so that the sign is visible from a vessel thus enabling the structure to be identified at a suitable distance to avoid a collision with it. This will be such that under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer (with the naked eye), stationed 3m above sea levels, and at a distance of at least 150m from the wind turbine. The light will be either hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation marks.

25.4.3.2 Marking of Entire Site

450. The markings for the proposed project will be agreed in consultation with TH once the final wind turbine layout has been selected and will be in line with IALA

Recommendation O-139. As per the IALA guidance and in consultation with TH, it will be ensured that:

- All corner wind turbines will be marked as an SPS. Where necessary, to satisfy the spacing requirements between SPSs, additional periphery structures may also be marked as an SPS. Depending on spacing, further intermediate wind turbines on each of the boundaries may be marked as an IPS.
- In all the layouts, wind turbines designated as an SPS are to exhibit flashing yellow five second (flash yellow every five seconds) lights of at least 5nm nominal range and omnidirectional fog signals as appropriate / where prescribed by TH. Wind turbines designated as an IPS are to exhibit flash yellow every 2.5 seconds lights of at least 2nm nominal range.
- All the lights are to be visible to shipping through 360 degrees and if more than one lantern is required on a wind turbine to meet the all-round visibility requirement, then all the lanterns on that wind turbine should be synchronised.
- All the lights are to be exhibited at the same height at least 6m above HAT and below the arc of the lowest wind turbine blades.
- All the lights are to be exhibited at least at night and when the visibility is reduced to 2nm or less. Fog signals will be fitted to select structures as necessary and in consultation with TH, and are to be sounded at least when the visibility is 2nm or less.
- Aviation lighting will be as per CAA requirements; however will likely be synchronised Morse “W” at the request of TH.
- All lighting of the proposed project will be considered cumulatively with existing AtoN to avoid the potential for light confusion to passing traffic.

451. Consideration will also be given to the use of marking via AIS, or other electronic means (e.g. Racon); however this will be agreed in consultation with TH.

26 Future Monitoring

26.1 Safety Management System and Emergency Response Planning

452. Health and safety documentation, including a policy statement, Safety Management System (SMS) and emergency response plans will be in place for the project post consent and prior to construction. This will be continually updated throughout the development process. The following sections provide an overview of this documentation and how it will be maintained and reviewed with reference where required to specific marine documentation.

453. Monitoring, reviewing and auditing will be carried out on all procedures and activities and feedback actively sought. Any designated person, managers and supervisors are to maintain continuous monitoring of all marine operations and determine if all required procedures and processes are being correctly implemented.

26.2 Future Monitoring of Marine Traffic

454. The Development Consent Order (DCO) is expected to include the requirement for construction traffic monitoring by AIS, including continual collection of data from a suitable location within the Norfolk Boreas site with an assessment of a minimum of 28 days submitted to the MCA annually. This is likely to continue through to the first year of operation to ensure mitigations put in place are effective.

455. The data collected will be compared against the results of the marine traffic analysis (section 12) and predicted future case routeing (section 19) to ensure the findings of the NRA remain valid. Details of this will be provided in the Marine Traffic Monitoring plan.

26.3 Subsea Cables

456. The subsea cable routes will be subject to periodic inspection post construction to monitor the cable protection, including burial depths. Maintenance of the protection will be undertaken as necessary.

457. If exposed cables or ineffective protection measures were to be identified during post construction monitoring, these would be promulgated to relevant sea users including via Notice to Mariners and Kingfisher bulletins. Where immediate risk was observed, Norfolk Boreas Limited would also employ additional temporary mitigation (such as a guard vessel or temporary buoyage) until such time as the risk was permanently mitigated.

458. Details will be included in full within the assessment of cable burial and protection document (document reference 8.16), to be produced post consent (as per the embedded mitigation listed in section 25). This is secured by condition 14(1)(e) in the generation DMLs (schedules 11 and 12), condition 9 (1)(e) in the transmission DMLs

(Schedules 11 and 12) and condition 7 (1) (e) in the project interconnector DML (schedule 13).

26.4 Hydrographic Surveys

459. As required by MGN 543, detailed and accurate hydrographic surveys will be undertaken periodically at intervals agreed with the MCA.

26.5 Decommissioning Plan

460. A decommissioning plan will be developed post consent. With regards to impacts on shipping and navigation this will also include consideration of the scenario where on decommissioning and on completion of removal operations, an obstruction is left on site (attributable to the wind farm) which is considered to be a danger to navigation and which it has not proved possible to remove. Such an obstruction may require marking until such time as it is either removed or no longer considered a danger to navigation, the continuing cost of which would need to be met by the operator.

27 Next Steps

27.1 EIA Summary

461. Following identification of both future case impacts and the outcomes of the FSA an impact assessment in line with EIA guidance has been undertaken. The impact assessment screens the identified impacts from the NRA with effective pathways to shipping and navigation receptors, and assumes the mitigation measures listed in section 25 will be in place. This EIA is presented in Chapter 15 Shipping and Navigation.

462. The EIA takes into consideration the baseline assessment including the marine traffic survey analysis in addition to the other contents of this NRA. This input is used to rank each impact identified for the construction, operation, and decommissioning phases of the project in terms of significance as per the FSA process described in section 3.

27.2 Impact Screening

463. Table 27.1 presents the impacts that have been identified during the scoping stage, and any additional impacts identified within the NRA process (including the baseline assessment, consultation, and production of the Hazard Log). The table indicates whether each impact has been screened out within this NRA stage (with justification), or whether further assessment is required within the EIA in Chapter 15 Shipping and Navigation. The impacts carried forward are the main output of the NRA process.

Table 27.1 Impact Screening (Construction, Operation, and Decommissioning)

Impact	Scoped In	Receptors	Justification
Vessel Displacement	Yes	▪ Commercial vessels; ▪ Recreational vessels; and ▪ Fishing vessels.	Section 18 shows established vessel routes intersect the Norfolk Boreas site, and therefore may be required to deviate as a result of the project.
Restrictions of Adverse Weather Routeing	Yes	▪ Commercial vessels; ▪ Recreational vessels; and ▪ Fishing vessels.	This was raised as a key concern during consultation. As shown in section 18.4 adverse weather routeing will be impacted on by the project and further assessment is therefore

Impact	Scoped In	Receptors	Justification
			required.
Increased Vessel to Vessel Collision Risk	Yes	▪ Commercial vessels; ▪ Recreational vessels; and ▪ Fishing vessels.	Vessel displacement may lead to increased encounter rates, which may lead to increased collision rates.
Vessel to Structure Allision Risk	Yes	▪ Commercial vessels; ▪ Recreational vessels; and ▪ Fishing vessels.	The structures are to be built within a previously open sea area, leading to an allision risk and further assessment is therefore required.
Anchor interaction/snagging risk	Yes	▪ Commercial vessels; ▪ Recreational vessels; and ▪ Fishing vessels.	The export cables, inter-array cables, and project interconnector create a snagging risk to vessel anchors.
Marine Radar Interference	No	▪ Commercial vessels; ▪ Recreational vessels; and ▪ Fishing vessels.	Provided in section 22; no safety related impacts are anticipated.
Effects on Emergency Response Resources	Yes	▪ Emergency response resources	Incident rates may increase as a result of the increased vessel and personnel presence on site.
Reduction in Under Keel Clearance	No	▪ Commercial vessels; ▪ Recreational vessels; and ▪ Fishing vessels.	Given the anticipated additional height from cable protection is limited, under keel clearance has been scoped out. Any unforeseen issues arising would be discussed with the MCA as per section 25.
Disruption to Port Access	No	▪ Local port traffic	This was raised during consultation. However given wind farm traffic will be managed via marine coordination no impact is anticipated.

27.3 PEIR Assessment Validation

464. As per section 6.1, the impact assessment undertaken at the PEIR stage was based on the summer 2017 and winter 2018 marine traffic surveys. This section presents assessment of the updated summer 2018 data in relation to each impact assessed within the PEIR, highlighting any key findings of the validation exercise as it pertains to the impact assessment presented in Chapter 15: Shipping and Navigation.

27.3.1 Commercial Vessels

465. As per section 12.4, an increase in commercial traffic was observed within the summer 2018 survey when compared against the summer 2017 survey. However, the majority of this increase was observed to be associated with the northbound lane of the West Friesland associated routeing measures. This route is not affected by the Norfolk Boreas site, and therefore no changes to the level of displacement are anticipated. It should also be noted that in terms of commercial traffic intersecting the Norfolk Boreas site, an average of four vessels per day was recorded during 2017 and five per day during 2018 therefore traffic has not changed considerably.

466. Given increased vessel numbers within the northbound lane of the West Friesland associated routeing measures, collision risk will be higher than that assessed at the PEIR stage. However, this increase will be due to the increased traffic levels, rather than Norfolk Boreas given that:

- The affected route is not required to deviate as a result of the Norfolk Boreas site (given its contained within a routeing measure); and
- Any routes that are required to deviate as a result of the Norfolk Boreas site do not interact with the northbound lane of the West Friesland associated routeing measures within the study area.

467. In terms of allision risk, the increased traffic within the northbound lane of the West Friesland associated routeing measures will have no effect given its distance to the Norfolk Boreas site (6.5nm).

468. It should be noted that an increase in oil and gas traffic was also observed, including from vessels working at the Davy platform within the Norfolk Boreas site. However, as per the consultation response from the Secretary of State within the Scoping Opinion (see section 5.2), the potential for the Norfolk Boreas site to impact upon such traffic assuming the platform was not decommissioned has already been assessed during the PEIR stage.

469. No significant differences were observed for commercial vessels within the offshore cable corridor study area.

470. Therefore, the observed changes to commercial traffic within the summer 2017 survey compared against the summer 2018 survey are not deemed as affecting the outcome of the assessment undertaken at the PEIR stage.

27.3.2 Recreational Vessels

471. As per section 14.1, no changes in terms of recreational vessel levels or behaviour were observed between the summer 2017 and summer 2018 surveys, and the outcome of the assessment undertaken at the PEIR stage is therefore still considered valid.

27.3.3 Fishing Vessels

472. As per section 15.2, an increase in fishing vessel activity was observed during the 2018 survey when compared to the 2017 survey within the OWF site study area, with an average of 12 unique fishing vessels recorded per day in 2018 compared to eight in 2017. However, vessel numbers within the Norfolk Boreas site itself did not change, with an average of six unique vessels per day recorded during both summer surveys.Given that the PEIR assessment of impacts to fishing vessels (in particular the allision modelling) was primarily based on vessel numbers within the site, the increase in fishing vessel numbers within the OWF site study area does not impact upon the original assessment, and the initial findings are considered as remaining valid.

473. Within the offshore cable corridor study area, there was a small increase in fishing vessel activity recorded during 2018 compared to the 2017 survey, with an average of seven unique fishing vessels recorded per day in 2018 compared to six in 2017. There was also a small increase in the number of vessels recorded within the offshore cable corridor itself, with an average of four unique fishing vessels per day in 2018 compared to three in 2017.

474. The PEIR assessment of impacts to fishing vessels (in transit) identifies that the installation of the offshore cable corridor will be temporary and therefore any deviations will be negligible or have no impact. No surface structures would be associated with the offshore cable corridor therefore no allision risk is associated with fishing vessels (in transit). The increase in fishing vessel numbers within the offshore cable corridor study area therefore does no impact upon the original assessment.

475. No anchoring activity was recorded from fishing vessels within the offshore cable corridor study area. Small fishing vessels would be expected to anchor coastally in sheltered waters (based on their size), rather than within the offshore cable corridor itself. Additionally, the fishing grounds of smaller vessels are likely to be coastal, and it is therefore unlikely that such vessels would need to transit further offshore (i.e., within the offshore cable corridor) therefore the original assessment remains valid.

27.3.4 Approach to Marine Traffic Data in ES

476. Based on the findings of the validation exercise, the changes observed in the 2018 summer survey data are not deemed as affecting the impact assessment already undertaken at the PEIR stage. On this basis, the quantitative allision and collision

modelling has not been refreshed using the summer 2018 data. However, the marine traffic assessment presented in Chapter 15 Shipping and Navigation has been refreshed to reflect the changes observed between the surveys.

28 Summary

28.1 Marine Traffic

477. Two marine traffic surveys of the Norfolk Boreas site were undertaken, during periods chosen to account for seasonal variations (July/August 2017 and February 2018). These data sets have informed the marine traffic assessment undertaken in this NRA and within Chapter 15 Shipping and Navigation of the PEIR. A summer 2018 survey undertaken in August 2018 has been presented alongside this data in order to validate the July/August 2017 marine traffic assessment within this NRA and Chapter 15 Shipping and Navigation of the ES.

478. It was estimated that an average of 63 unique vessels passed within 10nm of the Norfolk Boreas site during the summer 2017 survey, with an average of 14 per day intersecting the Norfolk Boreas site itself. During winter, 36 vessels per day passed within 10nm, with five intersecting the Norfolk Boreas site. For comparison, an average of 79 unique vessels passed within 10nm of the Norfolk Boreas site during the summer 2018 survey, with an average of 17 per day intersecting the Norfolk Boreas site.

479. The majority of traffic recorded during both summer surveys and the winter survey was from commercial vessels (cargo and tankers). This was mainly due to the high levels of commercial traffic utilising the DR1 Lightbuoy DWR to the west of the Norfolk Boreas site and the West Friesland associated routeing measures to the east. Commercial routes out with the routeing measures were also recorded, most notably the DFDS operated Newcastle to Amsterdam ferry route, which intersects the northern extent of the Norfolk Boreas site.

480. Approximately eight unique fishing vessels per day were recorded within 10nm of the Norfolk Boreas site during the summer 2017 survey period, falling to one during the winter 2018 survey. Approximately 12 unique fishing vessels were recorded within 10nm of the Norfolk Boreas site during the summer 2018 survey resulting in a small increase in the number of fishing vessels recorded between summer 2017 and summer 2018.

481. During the summer surveys and the winter survey, the majority of this activity was from Dutch beam trawlers, and included vessels engaged in active fishing within the Norfolk Boreas site (as opposed to vessels merely in transit).

482. Two vessels were deemed to be at anchor within the OWF site study area (bur not within the Norfolk Boreas site itself) during the summer 2018 marine traffic survey while no vessels were recorded during the winter survey. No vessels were recorded at anchor during the summer 2017 survey, however tankers were observed to perform waiting manoeuvres in the area (note that these manoeuvres did not

require anchor deployment based on the vessel behaviours observed). Anchoring activity within the vicinity of the offshore cable corridor was considered low.

28.2 Allision and Collision Modelling

483. Anticipated rerouteing densities during and following construction of the Norfolk Boreas site were used to model estimated increases in collision and allision risk within the area.

484. It was estimated that collision rates would increase by approximately 1% as a result of the project, assuming no growth in traffic. Cases of 10% and 20% traffic increases were also modelled, which yielded risk increases of 23% and 46% respectively; however in both cases the significant majority of this risk was observed to be due to the traffic increases rather than the vessel rerouteing.

485. It was estimated that a vessel would allide with a structure within the Norfolk Boreas site whilst under power once every 4,000 years following its construction, assuming no growth in traffic. A drifting (NUC) allision was deemed to be a lower frequency event, with such an allision estimated to occur once every 10,900 years, again assuming no growth in traffic. A traffic increase of 10% was also modelled for both scenarios, which increased the risk of each by approximately 10%.

28.3 Emergency Response

486. Under national and international law the operators of the project will be required to comply with existing emergency response requirements as well as giving consideration to other response groups within the area. Owing to the increased level of activity in and around the Norfolk Boreas site and offshore cable corridor there are expected to be some increased demands on SAR facilities within the area. The project could also increase traffic and activity to a level that self-help emergency response will be required and consideration in the ERCoP should be given to what resources would be required to provide a level of response that would ensure that response time and resources aren't impacted.

28.4 Cumulative Impacts

487. The cumulative impact of the proposed project upon vessel routeing when considered with other southern North Sea wind farms was raised as a key issue during consultation. For this reason vessel routeing patterns were predicted on a cumulative basis, based on routeing assessment work within the southern North Sea undertaken by Anatec on behalf of Vattenfall (Anatec, 2018).

488. Each impact carried forward to the ES has also been assessed for the potential for cumulative risk.

28.5 Impacts carried forward to the EIA

489. Impact screening has been undertaken based on the assessment included within this NRA, including consultation outputs, modelling, the Hazard Log process, and the baseline assessment. Based on the screening process, the following impacts have been carried forward to the EIA for further assessment (including on a cumulative basis):

- Commercial routeing displacement / deviation;
- Commercial routeing displacement / deviation;
- Displacement of fishing activity;
- Displacement of recreational vessel activity;
- Restriction to adverse weather routeing;
- Increase in vessel to vessel collision risk;
- Increase in vessel to structure allision risk;
- Anchor snagging risk (cables and other subsea infrastructure); and
- Impacts on emergency response capacity.

29 References

Anatec (2012). East Anglia ONE Offshore Windfarm NRA. Aberdeen: Anatec.

Anatec (2015). East Anglia THREE Offshore Windfarm NRA. Aberdeen: Anatec.

Anatec (2017). Norfolk Vanguard NRA. Aberdeen: Anatec.

Anatec (2018). Southern North Sea Offshore Wind Forum – Cumulative Navigational Issues in the Southern North Sea. Aberdeen: Anatec.

Atlantic Array (2012). Atlantic Array Offshore Wind Farm, Draft Environmental Statement (2012). Annex 18.3: Noise and Vibration (Anthropogenic Receptors): Predictions of Operational Wind Turbine Noise Affecting Fishing Vessel Crews. RWE npower renewables, Channel Energy Limited 2012.

BEIS (2011). Standard Marking Schedule for Offshore Installations, London: BEIS.

BWEA (2007). Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind Farm. London: BWEA (now RUK), DECC, MCA & PLA.

DfT (2001). Department for Transport, Identification of Marine Environmental High Risk Areas (MEHRA's) in the UK. 2001. Southampton: DfT

DfT (2004). Results of the Electromagnetic Investigations. 2nd ed. Southampton: MCA and QinetiQ. Southampton: DfT

DfT (2017). UK ship arrivals (PORT06). London: DfT.

IALA (2013). O-139 the Marking of Man-Made Offshore Structures. Edition 2. Saint Germain en Laye, France: IALA.

IMO (1972/77). Convention on the International Regulations for Preventing Collisions at Sea – Annex 3. London: IMO.

IMO (1974). International Convention for the Safety of Life at Sea. London: IMO.

IMO (2002). Guidelines for FSA – MSC/Circular 1023/MEPC/Circular 392.

ITAP (2006). Measurement of Underwater Noise Emitted by an Offshore Wind Turbine at Horns Rev. Germany: ITAP GmbH.

MCA (2005). Offshore Wind Farm Helicopter SAR – Trials Undertaken at the North Hoyle Wind Farm Report of helicopter SAR trials undertaken with Royal Air Force Valley "C" Flight 22 Squadron on March 22nd 2005. Southampton: MCA.

MCA (2008). MGN 372 (Merchant and Fishing) Guidance to Mariners Operating in the Vicinity of UK OREIs. Southampton: MCA.

MCA (2015) Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms, Southampton: MCA.

MCA (2016). MGN 543 (Merchant and Fishing) Safety of Navigation OREIs – Guidance on UK Navigational Practice, Safety and Emergency Response. Southampton: MCA.

NOREL (Unknown). A Report compiled by the Port of London Authority based on experience of the Kentish Flats Wind Farm Development. Norel Work Paper. WP4 (2nd).

PINS (2017). Norfolk Boreas Scoping Opinion. Bristol: PINS.

Renewables UK (2014 issue 2) Guidelines for Health and Safety in the Wind Energy Industry. London: Renewables UK.

Rijkwaterstraat (2014). Assessment Framework for Defining Safe Distances between Shipping Lanes and Offshore Wind Farms. Den Hague: Rijkwaterstaat.

Royal Haskoning DHV (2017). Norfolk Boreas Offshore wind farm Environmental Impact Assessment Scoping Report.

RYA (2009). UK Coastal Atlas of Recreational Boating, 2009 Edition. Southampton: RYA.

RYA (2015). The RYA's Position on Offshore Renewable Energy Developments Paper 1 – Wind Energy. Southampton: RYA.

RYA (2016). UK Coastal Atlas of Recreational Boating, 2016 Edition. Southampton: RYA.

RYA & CA (2004). Sharing the Wind. Identification of recreational boating interests in the Thames Estuary, Greater Wash and North West (Liverpool Bay). Southampton: RYA.

Scottish Power Renewables and Vattenfall (2012). East Anglia ONE Offshore Windfarm ES Volume 2 Offshore, Chapter 15 – Shipping and Navigation.

Scottish Power Renewables and Vattenfall (2015). East Anglia THREE ES Volume 1 Chapter 15 Shipping and Navigation.

SNSOWF (2013). Cumulative Navigational Issues in the Southern North Sea. Aberdeen, Anatec. 2013.

The Crown Estate (2012). Strategic assessment of impacts on navigation of shipping and related effects on other marine activities arising from the development of Offshore Wind Farms in the UK REZ. London: The Crown Estate.

UKHO (2016). Admiralty Sailing Directions – North Sea (West) Pilot NP54. Taunton: UKHO.