Hornsea Project Four:

Navigational Risk Assessment (Part 3)

Deadline 4, Date: 10 May 2022
Document reference: A5.7.1
Revision: 02

Prepared	Anatec Ltd. May 2022.
Checked	GoBe Consultants Ltd. May 2022
Accepted	David King, Orsted. May 2022
Approved	Julian Carolan, Orsted. May 2022

A5.7.1
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Revision Summary				
Rev	*Date*	*Prepared by*	*Checked by*	*Approved by*
01	29/10/2022	Anatec	GoBe Consultants	Julian Carolan, Orsted
02	10/05/2022	Anatec	GoBe Consultants	Julian Carolan, Orsted

Revision Change Log			
Rev	*Page*	*Section*	*Description*
01	NA	NA	Original version submitted at application
02	Throughout	Throughout	Revised at Deadline 4 to adopt MCA preferred methodology including risk control log

Appendix A Consequences Assessment

665. This appendix presents an assessment of the consequences of collision and allision incidents, in terms of people and the environment, due to the presence of the Hornsea Four wind farm structures.

666. The significance of the presence of the Hornsea Four array area is also assessed based upon risk evaluation criteria and comparison with historical accident data in UK waters[6].

A.1 Risk Evaluation

A.1.1 Risk to People

667. With regard to the assessment of risk to people, two measures are considered, namely:

- Individual risk; and
- Societal risk.

A.1.1.1 Individual Risk

668. Individual risk considers whether the risk from an incident to a particular individual changes significantly due to the presence of the wind farm structures. Individual risk considers not only the frequency of the incident and the consequence (likelihood of death), but also the individual's fractional exposure to that risk, i.e. the probability of the individual being in the given location at the time of the incident.

669. The purpose of estimating the individual risk is to ensure that individuals who may be affected by the presence of the wind farm structures are not exposed to excessive risks. This is achieved by considering the significance of the change in individual risk resulting from the presence of Hornsea Four relative to the background individual risk levels.

670. Annual individual risk levels to crew (the annual fatality risk of an average crew member) for different vessel types are presented in Figure A.1, which also highlights the upper and lower bounds for risk acceptance criteria as suggested in the IMO MSC 72/16. The annual individual risk level to crew falls within the ALARP region for each of the vessel types presented.

[6] For the purposes of this assessment, UK waters is defined as the UK Exclusive Economic Zone (EEZ) and UK territorial waters refers to the 12 nm limit from the British Isles, excluding the Republic of Ireland.

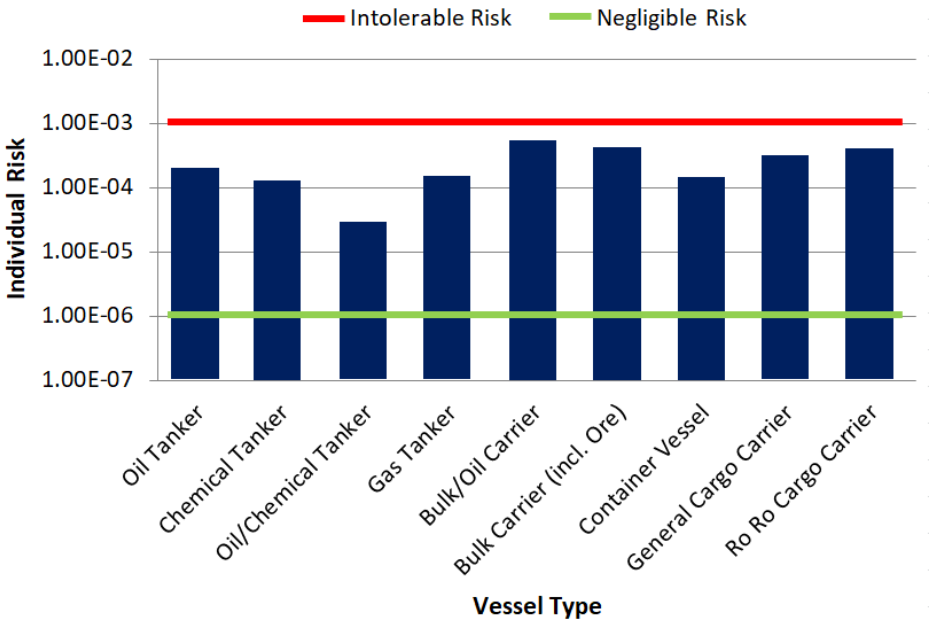


Figure A.1 Individual risk levels and acceptance criteria per vessel type

671. Typical bounds defining the ALARP regions for decision making within shipping are presented in Table A.1. It can be seen that for a new vessel the target upper bound for ALARP is set lower since new vessels are expected to be safer.

Table A.1 Individual risk ALARP criteria

Individual	Lower Bound for ALARP	Upper Bound for ALARP
To crew member	10^{-6}	10^{-3}
To passenger	10^{-6}	10^{-4}
Third party	10^{-6}	10^{-4}
New vessel target	10^{-6}	Above values reduced by one order of magnitude

672. On a UK basis, the MCA website presents individual risks for various UK industries based upon HSE data from 1987 to 1991. The risks for different industries are presented in Figure A.2.

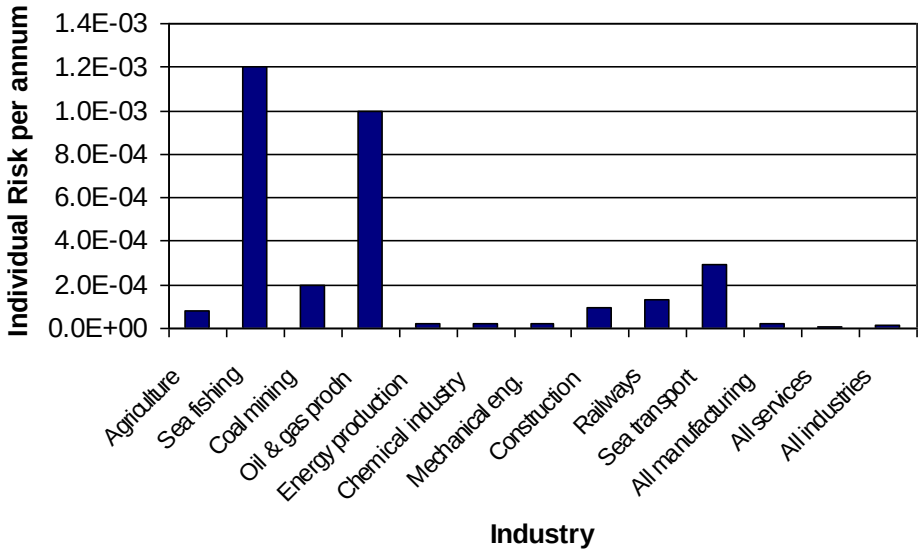


Figure A.2 Individual risk per year for various UK industries

673. The individual risk for sea transport of 2.0×10^{-4} per year is consistent with the worldwide data presented in Figure A.1, whilst the individual risk for sea fishing of 1.2×10^{-3} per year is the highest across all of the industries included.

A.1.1.2 Societal Risk

674. Societal risk is used to estimate risks of accidents affecting many persons (catastrophes), and acknowledging risk adverse or neutral attitudes. Societal risk includes the risk to every person, even if a person is only exposed on one brief occasion to that risk. For assessing the risk to a large number of affected people, societal risk is desirable because individual risk is insufficient in evaluating risks imposed on large numbers of people.

675. Within this assessment societal risk (navigation based) can be assessed for the Hornsea Four array area, giving account to the change in risk associated with each accident scenario caused by the installation of the wind farm structures. Societal risk may be expressed as:

- Annual fatality rate where frequency and fatality are combined into a convenient one-dimensional measure of societal risk also known as PLL; and
- FN-diagrams showing explicitly the relationship between the cumulative frequency of an accident and the number of fatalities in a multi-dimensional diagram.

676. When assessing societal risk this study focuses on PLL, which takes into account the number of people likely to be involved in an incident (which is higher for certain vessel types), and assesses the significance of the change in risk compared to background risk levels for the UK.

A.1.2 Risk to Environment

677. For risk to the environment the key criteria considered in terms of the effect of Hornsea Four is the potential quantity of oil spilled from a vessel involved in an incident.

678. It is recognised that there will be other potential pollution, e.g. hazardous containerised cargoes; however oil is considered the most likely pollutant and the extent of predicted oil spills will provide an indication of the significance of pollution risk due to Hornsea Four compared to background risk levels for the UK.

A.2 Marine Accident Investigation Branch Incident Analysis

A.2.1 All UK Waters Incidents

679. All UK-flagged commercial vessels are required to report accidents to the MAIB. Non-UK flagged vessels do not have to report unless they are at a UK port or within 12 nm territorial waters and carrying passengers to a UK port. There are no requirements for non-commercial recreational craft to report accidents to the MAIB; however, a significant proportion of these incidents are reported to and investigated by the MAIB.

680. Only incidents occurring in UK waters have been considered within this assessment for which the MAIB data is most comprehensive. It is also noted that incidents occurring in ports/harbours and rivers/canals have been excluded since the causes and consequences may differ considerably from an accident occurring offshore, which is the location of most relevance to Hornsea Four.

681. Taking into account these criteria, a total of 12,093 accidents, injuries and hazardous incidents were reported to the MAIB between 2000 and 2019 involving 13,965 vessels (some incidents such as collisions involved more than one vessel).

682. The locations of all incidents reported in proximity to the UK are presented in Figure A.3, colour-coded by incident type. It is noted that the MAIB aim for 97% accuracy in reporting the location of incidents.

683. The distribution of unique incidents by year in UK waters is presented in Figure A.4.

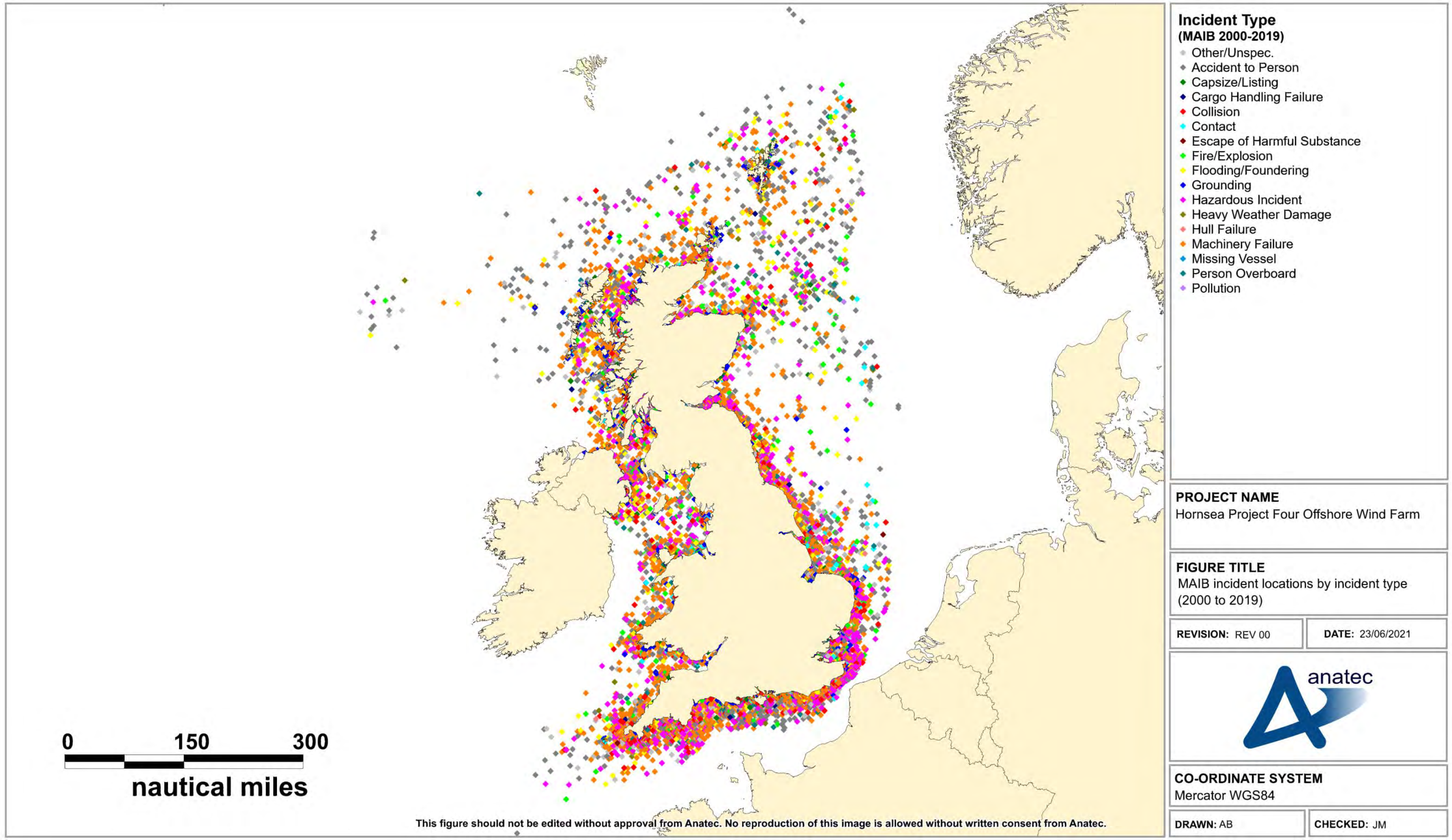


Figure A.3 MAIB incident locations by incident type within UK waters (2000 to 2019)

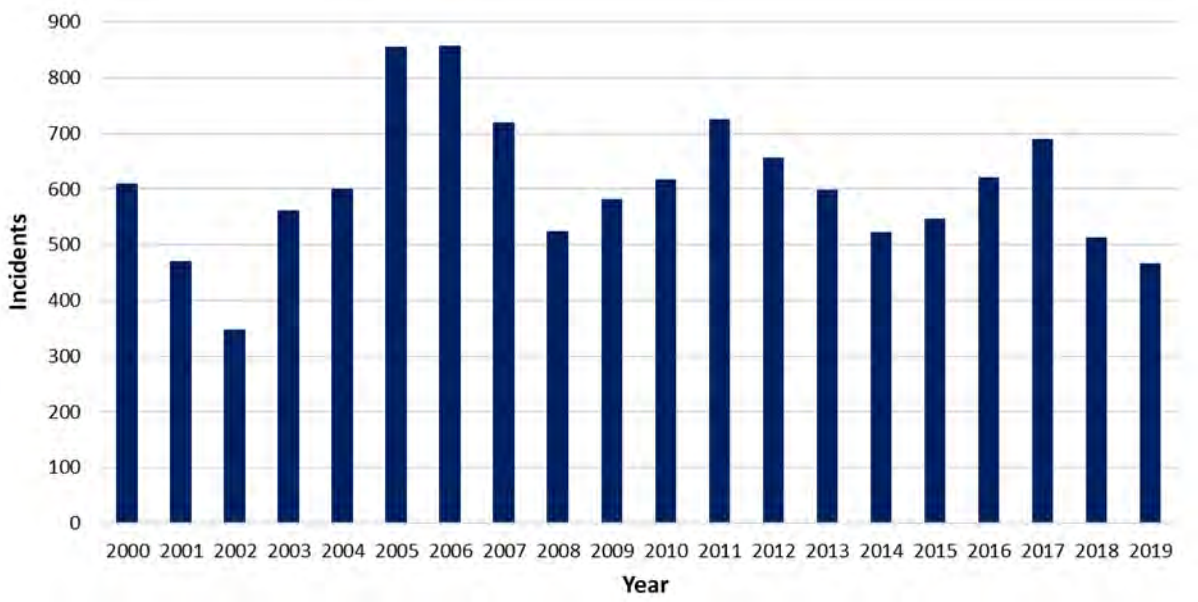


Figure A.4 MAIB unique incidents per year within UK waters (2000 to 2019)

684. The average number of unique incidents per year was 605. There has generally been a fluctuating trend in incidents over the 20-year period.

685. The distribution of incidents in UK waters by incident type is presented in Figure A.5.

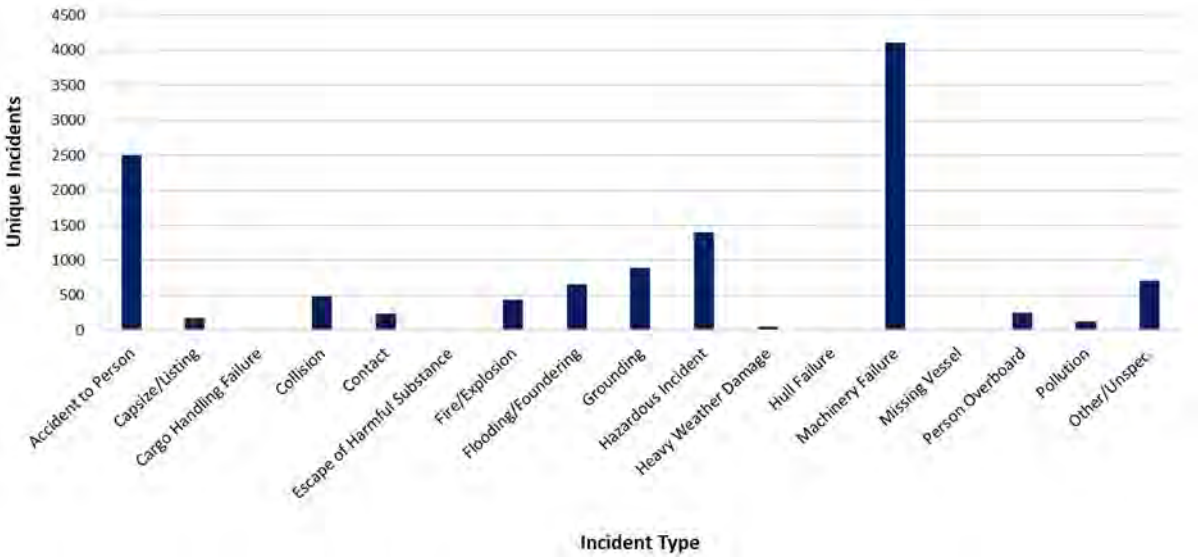


Figure A.5 MAIB incident types breakdown within UK waters (2000 to 2019)

686. The most frequent incident types were "*machinery failure*" (34%), "*Accident to Person*" (21%) and "*Hazardous Incident*" (12%). "*Collision*" and "*Contact*" incidents represented 4% and 2% of the total incidents, respectively.

687. The distribution of incidents in UK waters by vessel type is presented in Figure A.6.

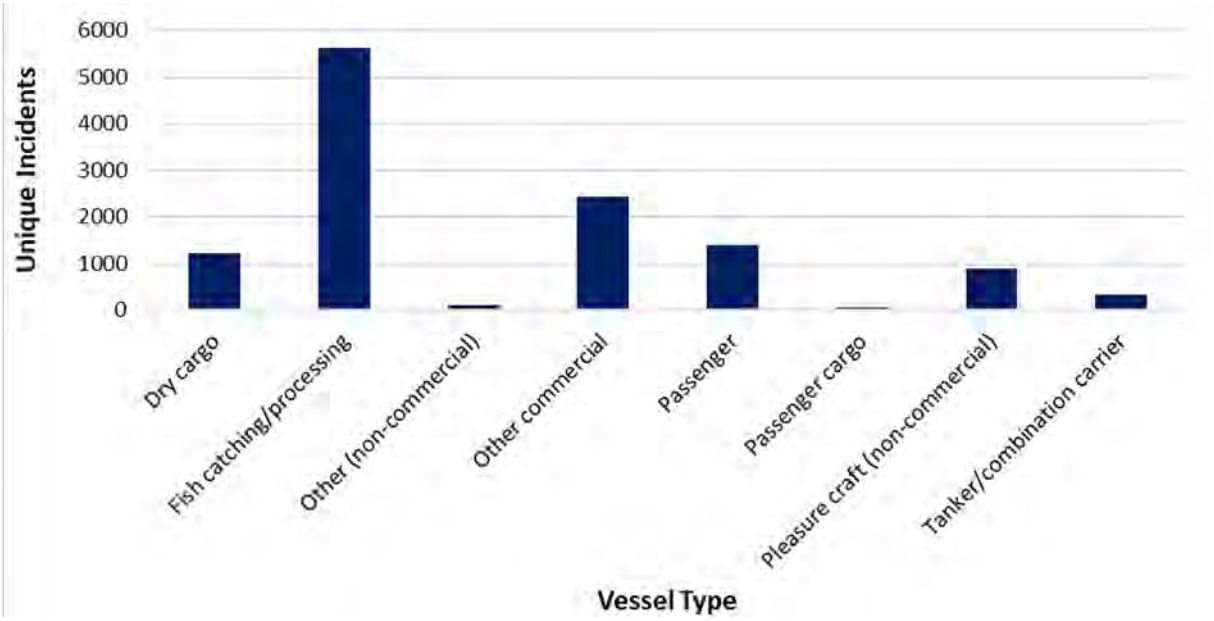


Figure A.6 MAIB incident vessel types breakdown within UK waters (2000 to 2019)

688. The most frequently involved vessel types in incidents were fishing vessels (46%), other commercial vessels (20%) (including offshore industry vessels, tugs, workboats and pilot vessels) and dry cargo vessels (10%).

689. The total number of fatalities reported in the MAIB incidents within UK waters from 2000 to 2019 was 373, giving an average of 19 fatalities per year.

690. The distribution of fatalities in UK waters by vessel type and person category (namely crew, passenger and other) is presented in Figure A.7.

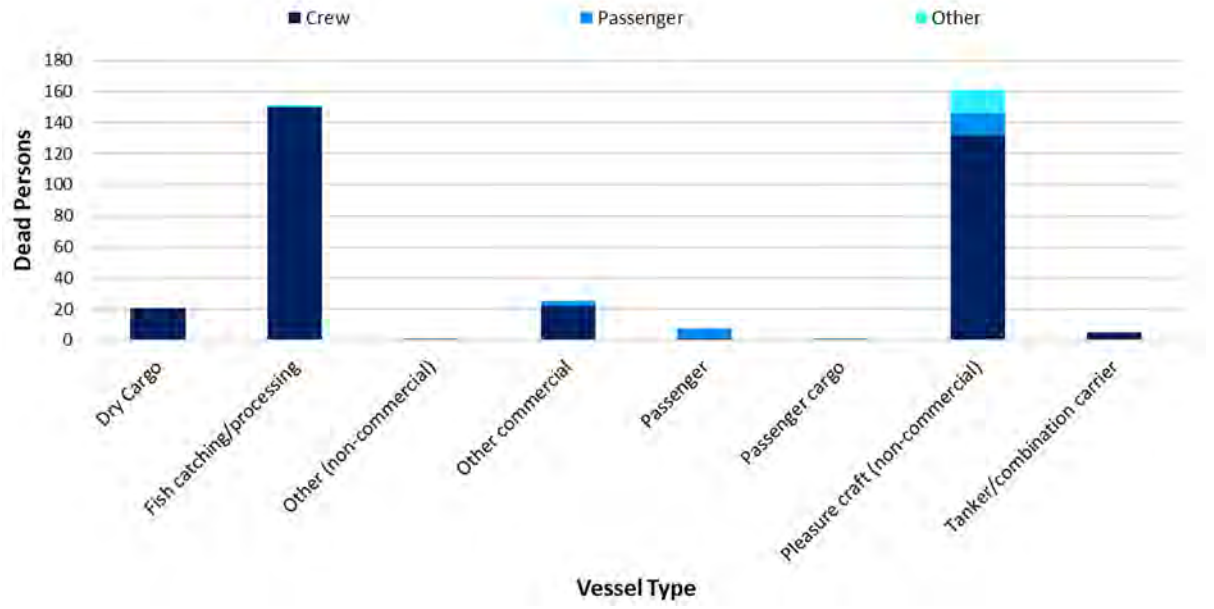


Figure A.7 MAIB fatalities by vessel type within UK waters (2000 to 2019)

691. The majority of fatalities occurred to fishing vessels and pleasure craft, with crew members the main people involved.

A.2.2 Collision Incidents

692. The MAIB define a collision incident as when a "*vessel hits another vessel that is floating freely or is anchored (as opposed to being tied up alongside)*".

693. A total of 481 collision incidents were reported to the MAIB in UK waters between 2000 and 2019 involving 1,090 vessels (in a small number of cases the other vessel involved was not logged).

694. The locations of collision incidents reported in proximity to the UK are presented in Figure A.8.

695. The distribution of collision incidents by year is presented in Figure A.9.

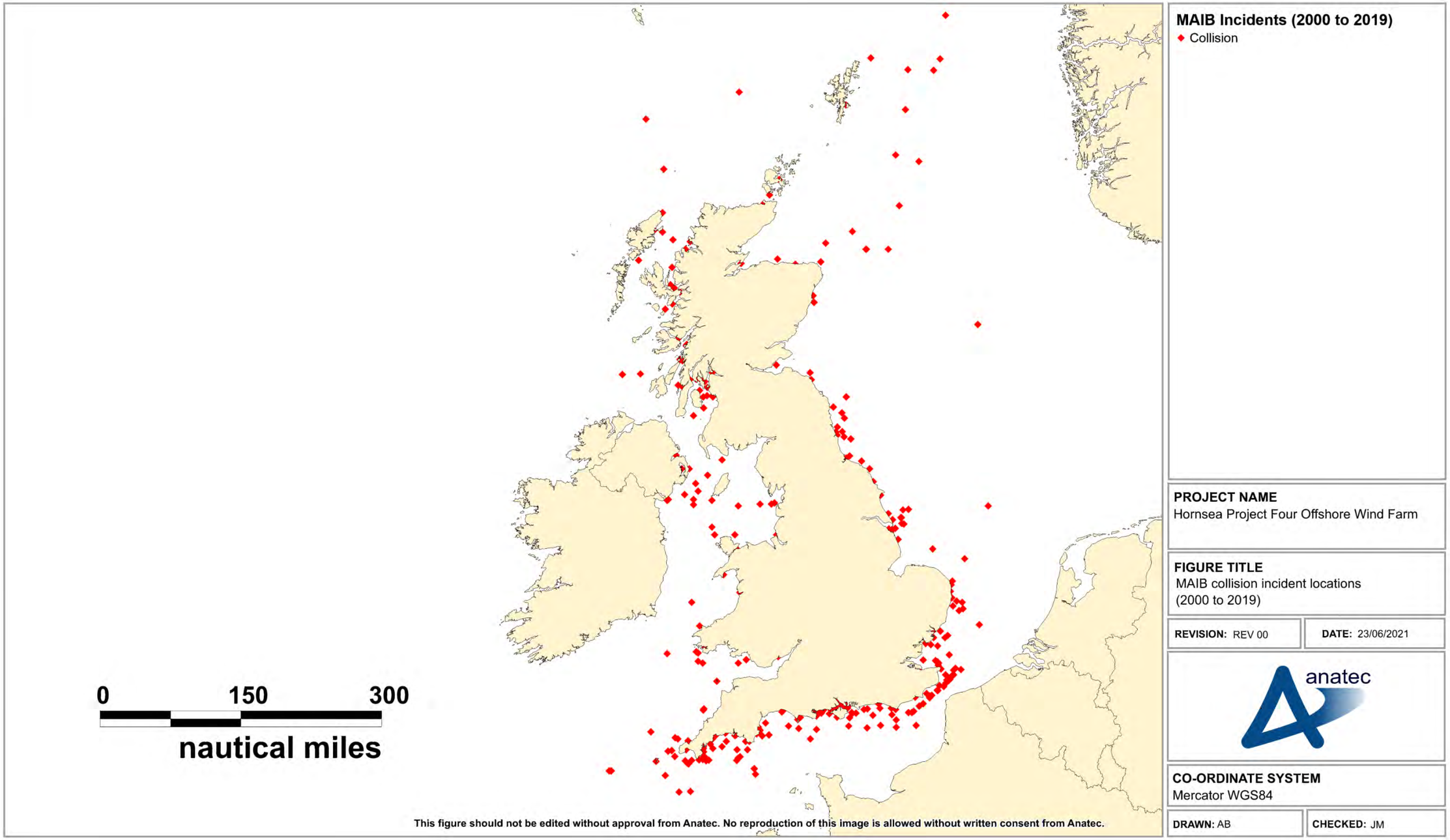


Figure A.8 MAIB collision incident locations within UK waters (2000 to 2019)

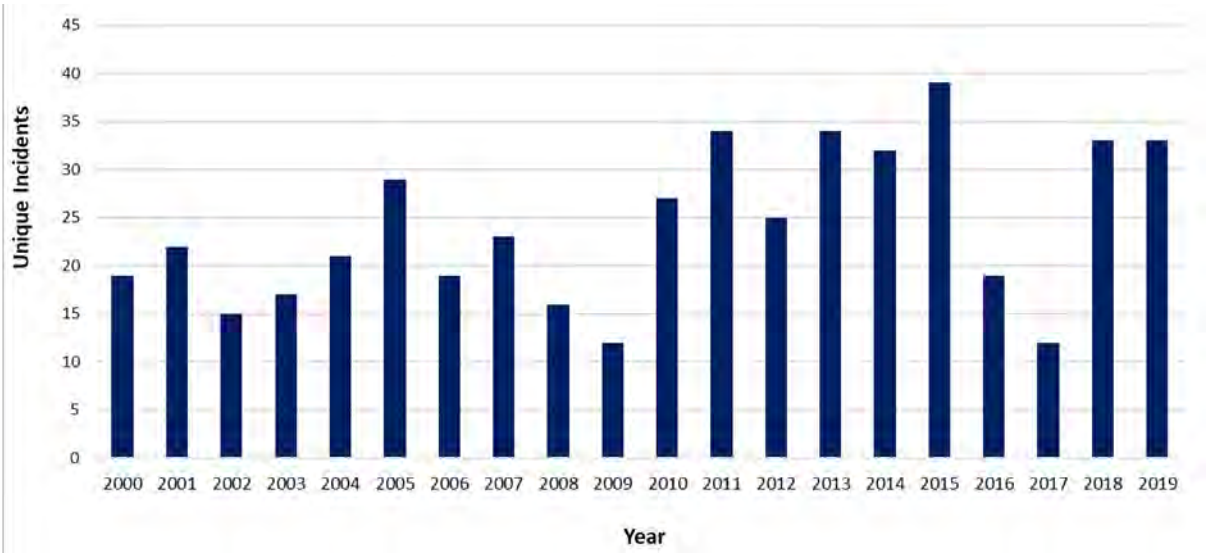


Figure A.9 MAIB collision incidents per year within UK waters (2000 to 2019)

696. The average number of unique collision incidents per year was 14. There has been an overall slight increasing trend in collision incidents over the 20-year period, which may be due to better reporting of less serious incidents in recent years.

697. The most common vessel types involved in collision incidents were other commercial vessels (29%), fishing vessels (24%), non-commercial pleasure craft (23%) and dry cargo vessels (12%).

698. The total number of fatalities per year reported in MAIB collision incidents within UK waters between 2000 and 2019 was six. Details of each of these fatal incidents reported by the MAIB are presented in Table A.2.

Table A.2 Description of fatal MAIB collision incidents (2000 to 2019)

Date	Description	Fatalities
October 2001	A dry cargo vessel and a chemical tanker collided in the south west traffic lane of the Dover Strait TSS to the south east of Hastings. Although the weather and visibility were good, both watchkeepers were too late to take effective avoiding action. The collision resulted in the sinking of the dry cargo vessel from which five out of six crew members were rescued.	1
July 2005	A collision between two powerboats near Castle Point, St. Mawes resulted in the death of one of the helmsmen. The incident occurred during the night with both vessels unlit whilst transiting through the area. Both helmsmen had consumed alcohol prior to the incident which is suspected to have caused reduced peripheral vision, deterioration of judgment and slower reaction times from both helmsmen, resulting in the collision.	1

Date	Description	Fatalities
October 2007	A fishing vessel was involved in a collision with a coastal general cargo vessel. The collision took place about 21 miles off the Humber near the Rough gas field. Neither of the vessels was found to be keeping an effective lookout. The weather at the time was good with fair to good visibility. As a result of the collision, the fishing vessel suffered major structural damage and sank within seconds. Of the four crew onboard, three managed to get into a life raft and abandon the vessel; sadly the fourth member of crew was not recovered.	1
August 2010	An Italian registered Ro Ro passenger ferry collided with a UK registered fishing vessel around four miles off St Abb's Head. As a result of the collision, the fishing vessel sank. The skipper was recovered from the sea but, despite an extensive search by the rescue services and a large number of local fishing vessels, the remaining crew member was lost.	1
June 2015	A collision occurred between a Rigid-hulled Inflatable Boat (RIB) and the yacht that had been carrying the RIB earlier the same day. One 36-year old man was seriously injured as a result of the incident and was airlifted to hospital before being pronounced dead later in the evening. It is believed that there were originally a dozen or so people aboard the motorboat, with the majority being taken ashore by the Cowes and Gosport lifeboats. Local rescue crews towed the RIB from the scene into Cowes, with the larger motorboat being escorted by a police launch.	1
June 2018	Emergency services were called to West Bay, Bridport following a fatal crash during a power boat race. One of the power boats taking part in the offshore circuit racing event overturned after colliding with another. A man from Canterbury, understood to be the boat's pilot, was pronounced dead at the scene.	1

A.2.3 Contact Incidents

699. The MAIB define a contact incident as when "*a vessel hits an object that is immobile and is not subject to the collision regulations, e.g. buoy, post, dock (too hard) etc. Also, another vessel if it is tied up alongside. Also, floating logs, containers etc.*"

700. A total of 235 contact incidents were reported to the MAIB within UK waters between 2000 and 2019 involving 270 vessels (in a small number of cases the contact involved a moving vessel and a stationary vessel).

701. The locations of contact incidents reported in proximity to the UK are presented in Figure A.10.

702. The distribution of contact incidents is presented in Figure A.11.

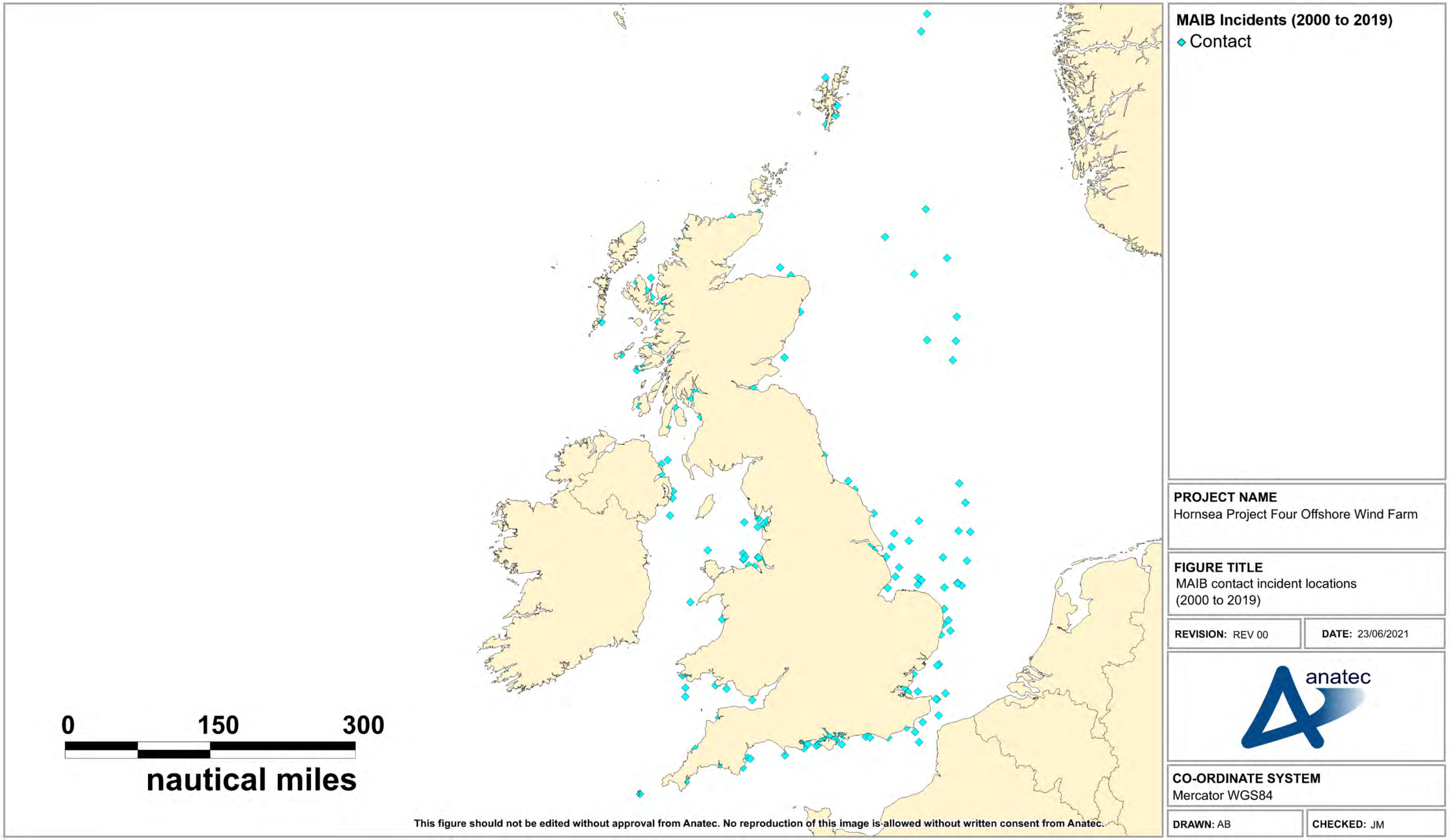


Figure A.10 MAIB contact incident locations within UK waters (2000 to 2019)

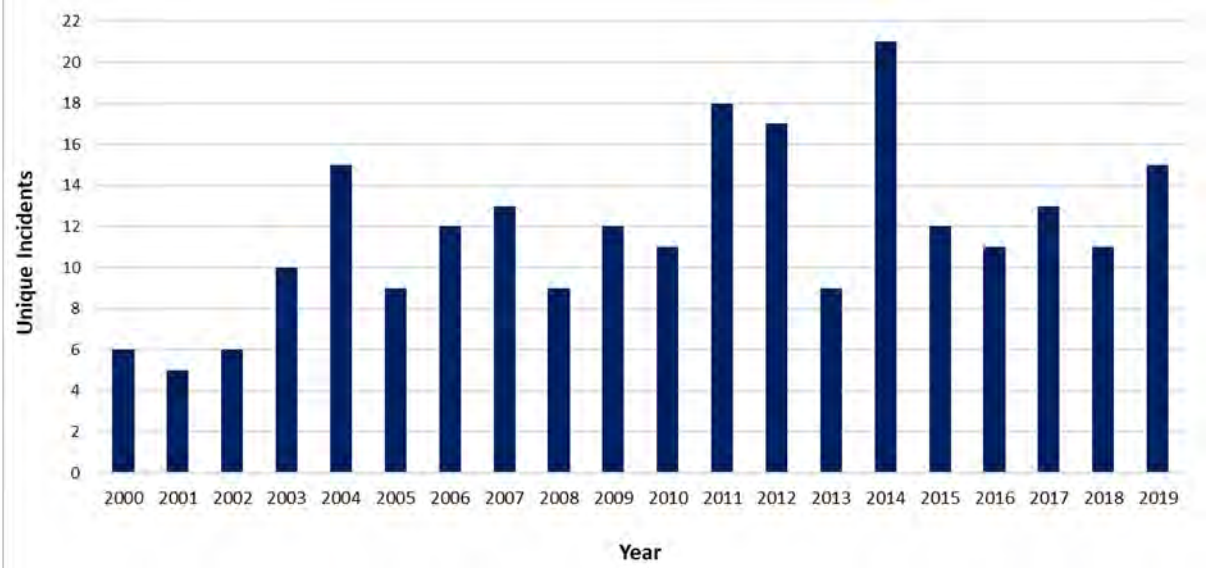


Figure A.11 MAIB contact incidents per year within UK waters (2000 to 2019)

703. The average number of contact incidents per year was 12. As with collision incidents, there has been an overall slight increasing trend over the 20-year period, which may be due to better reporting of less serious incidents in recent years.

704. The distribution of vessel types involved in contact incidents is presented in Figure A.12.

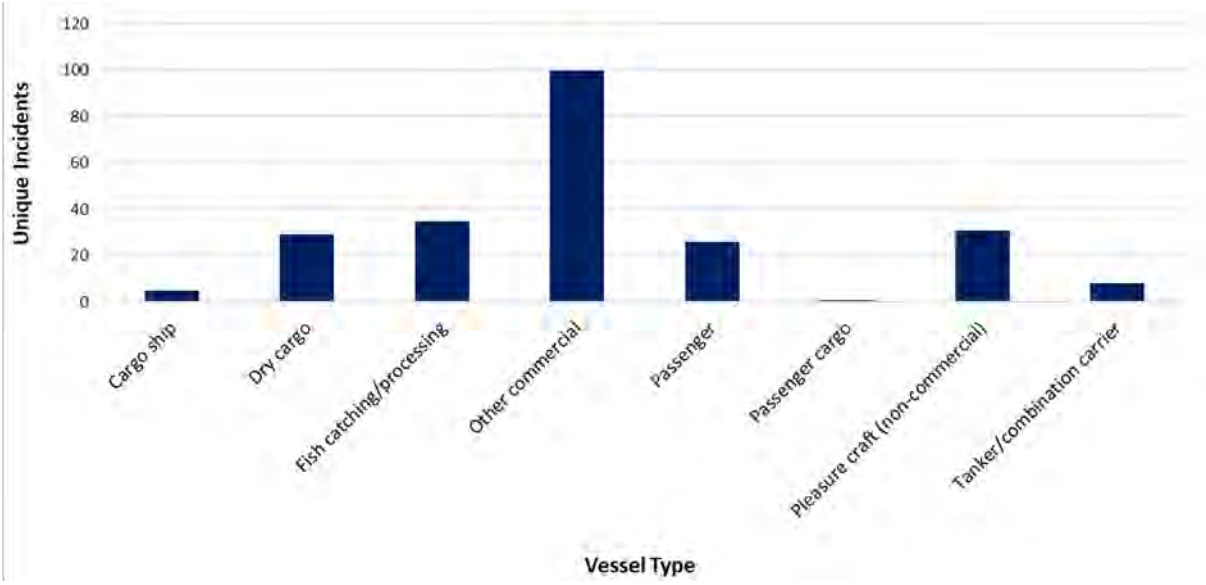


Figure A.12 MAIB contact incidents by vessel type within UK waters (2000 to 2019)

705. The most common vessel types involved in contact incidents were other commercial vessels (43%), fishing vessels (15%), and non-commercial pleasure craft (13%).

706. The total number of fatalities reported in MAIB contact incidents within UK waters between 2000 and 2019, when excluding incidents occurring in ports and harbours, was one. Details of the fatal incident reported by the MAIB is presented in Table A.3, noting that although not a port/harbour incident, the incident did occur on approach to a harbour.

Table A.3 Description of fatal MAIB contact incidents (2000 to 2019)

Date	Description	Fatalities
June 2012	A local ferryman saw a RIB approaching a harbour at about 40 kt and later heard a loud bang. When he moved his ferry he saw a damaged RIB and a body floating in the water. The alarm was raised and the body was recovered. The RIB owner had suffered fatal head injuries as a result of hitting the RIB's console on impact with the jetty. The RIB was badly damaged around the bow and the fenders on the jetty were also damaged.	1

A.3 Fatality Risk

707. This section uses the MAIB incident data along with information on average manning levels per vessel type to estimate the probability of a fatality in a marine incident associated with Hornsea Four.

708. The wind farm structures are assessed to have the potential to affect the following incidents:

- Vessel to vessel collision;
- Powered vessel to structure allision;
- Drifting vessel to structure allision; and
- Fishing vessel to structure allision.

709. Of these incident types, only vessel to vessel collisions match the MAIB definition of collisions and hence the fatality analysis presented in Section A.2.2 is considered to be directly applicable to these types of incidents.

710. The other scenarios of powered vessel to structure allision, drifting vessel to structure allision and fishing vessel to structure allision are technically contacts since they involve a vessel striking an immobile object in the form of a WTG or other wind farm structure. From Section A.2.3 it can be seen that only one of the 235 contact incidents reported by the MAIB between 2000 and 2019 resulted in a fatality, with the contact occurring with a jetty in the approaches to a harbour.

711. As the mechanics involved in a vessel contacting a WTG may differ in severity from hitting, for example, a buoy, quayside or moored vessel, the MAIB collision fatality risk rate has also been conservatively applied for the allision incident types.

A.3.1 Fatality Probability

712. Six of the 481 collision incidents reported by the MAIB within UK waters between 2000 and 2019 resulted in one or more fatalities. This gives a 1.2% probability that a collision incident will lead to a fatal accident.

713. To assess the fatality risk for personnel on-board a vessel (crew, passenger or other) the number of persons involved in the incidents needs to be estimated. From analysis of the MAIB incident data, the average commercial passenger vessel had approximately 223 people on board (POB) (total of crew and passengers). For commercial cargo/freight vessels there was an average of 13 POB. For fishing vessels and recreational vessels, the average POB was 3.1 and 2.8, respectively.

714. It is recognised that these numbers can be substantially higher or lower on an individual vessel basis depending upon the size, subtype, etc. but applying reasonable averages is considered sufficient for this analysis.

715. Using the average number of persons carried along with the vessel type information involved in collision incidents reported by the MAIB (see Figure A.8) there were an estimated 10,533 POB the vessels involved in the collision incidents.

716. Based upon four fatalities, the overall fatality probability in a collision for any individual on board is approximately 5.7×10^{-4} per collision.

717. It is considered inappropriate to apply this rate uniformly as the statistics indicate that the fatality probability associated with smaller craft, such as fishing vessels and recreational vessels, is higher. Therefore, the fatality probability has been subdivided into three categories of vessel as presented in Table A.4.

Table A.4 Collision incident fatality probability by vessel category (2000-2019)

Vessel Category	Sub Categories	Fatalities	People Involved	Fatality Probability
Commercial	Dry cargo, passenger, tanker, etc.	1	9,847	1.0×10^{-4}
Fishing	Trawler, potter, dredger, etc.	2	115	1.5×10^{-2}
Pleasure craft	Yacht, small commercial motor yacht, etc.	3	571	5.3×10^{-3}

718. The risk is higher by up to two orders of magnitude for POB small craft compared to larger commercial vessels.

A.3.2 Fatality Risk Due to Hornsea Four

719. The base case and future case annual collision and allision frequency levels pre and post wind farm for the Hornsea Four array area are summarised in Table A.5.

Table A.5 Summary of annual collision and allision risk results

Collision/ Allision Scenario	Base Case			Future Case		
	Pre Wind Farm	Post Wind Farm	Change	Pre Wind Farm	Post Wind Farm	Change
Vessel to vessel collision	5.81×10^{-3} (1 in 172 years)	6.64×10^{-3} (1 in 151 years)	8.35×10^{-4} (1 in 151 years)	7.04×10^{-3} (1 in 142 years)	8.06×10^{-3} (1 in 124 years)	1.01×10^{-3} (1 in 987 years)
Powered vessel to structure allision	N/A	1.08×10^{-3} (1 in 929 years)	1.08×10^{-3} (1 in 929 years)	N/A	1.19×10^{-3} (1 in 843 years)	1.19×10^{-3} (1 in 843 years)
Drifting vessel to structure allision	N/A	1.16×10^{-3} (1 in 866 years)	1.16×10^{-3} (1 in 866 years)	N/A	1.27×10^{-3} (1 in 785 years)	1.27×10^{-3} (1 in 785 years)
Fishing vessel to structure allision	N/A	4.51×10^{-2} (1 in 22 years)	4.51×10^{-2} (1 in 22 years)	N/A	4.96×10^{-2} (1 in 21 years)	4.96×10^{-2} (1 in 21 years)
Total	**5.81×10^{-3} (1 in 172 years)**	**5.40×10^{-2} (1 in 19 years)**	**4.82×10^{-2} (1 in 21 years)**	**7.04×10^{-3} (1 in 142 years)**	**6.01×10^{-2} (1 in 17 years)**	**5.31×10^{-2} (1 in 19 years)**

720. Table A.6 presents the estimated average number of POB for the local vessels operating in proximity to the Hornsea Four array area.

Table A.6 Average number of POB for different vessel types

Vessel Type	Collision/Allision Scenarios	Average Number of POB
Cargo vessel	▪ Vessel to vessel collision; ▪ Powered vessel to structure allision; and ▪ Drifting vessel to structure allision.	15
Tanker	▪ Vessel to vessel collision; ▪ Powered vessel to structure allision; and ▪ Drifting vessel to structure allision.	21

Vessel Type	Collision/Allision Scenarios	Average Number of POB
Passenger vessel	▪ Vessel to vessel collision; ▪ Powered vessel to structure allision; and ▪ Drifting vessel to structure allision.	2,000
Fishing vessel	▪ Vessel to vessel collision; and ▪ Fishing vessel to structure allision.	3
Recreational vessel	▪ Vessel to vessel collision.	3

721. From the detailed results of the collision and allision risk modelling, the distribution of the predicted change in annual collision and allision frequency by vessel type due to Hornsea Four for the base and future cases are presented in Figure A.13.

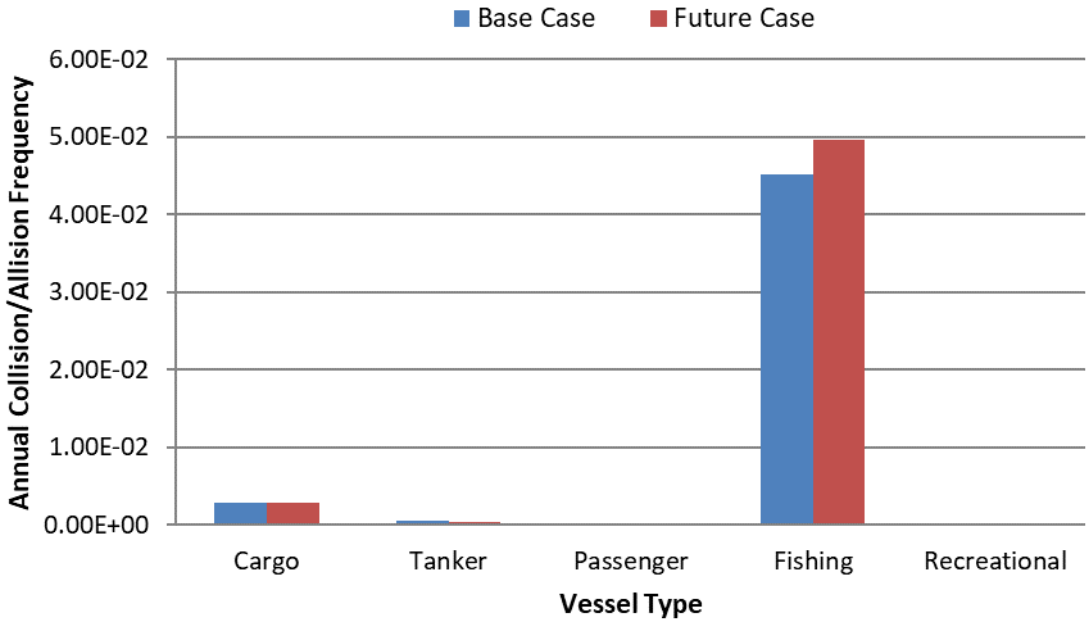


Figure A.13 Change in annual collision and allision frequency by vessel type

722. It can be seen that the change in collision and allision frequency is dominated by fishing vessels, owing to the greater duration spent in proximity to the array by fishing vessels engaged in fishing activities and the possibility of fishing occurring internally within the array itself. Cargo vessels had the second greatest change in collision and allision frequency, with the other vessel categories significantly lower.

723. Combining the annual collision and allision frequency, estimated number of POB for each vessel type and estimated fatality probability for each vessel category, the annual increase in PLL due to the presence of Hornsea Four for the base case is estimated to be 2.37×10^{-3}, which equates to one additional fatality in 420 years.

The annual increase in PLL due to the presence of Hornsea Four for the future case is estimated to be 2.61×10^{-3}, which equates to one additional fatality in 384 years.

724. The estimated incremental increases in PLL due to Hornsea Four, distributed by vessel type for the base and future cases, are presented in Figure A.14.

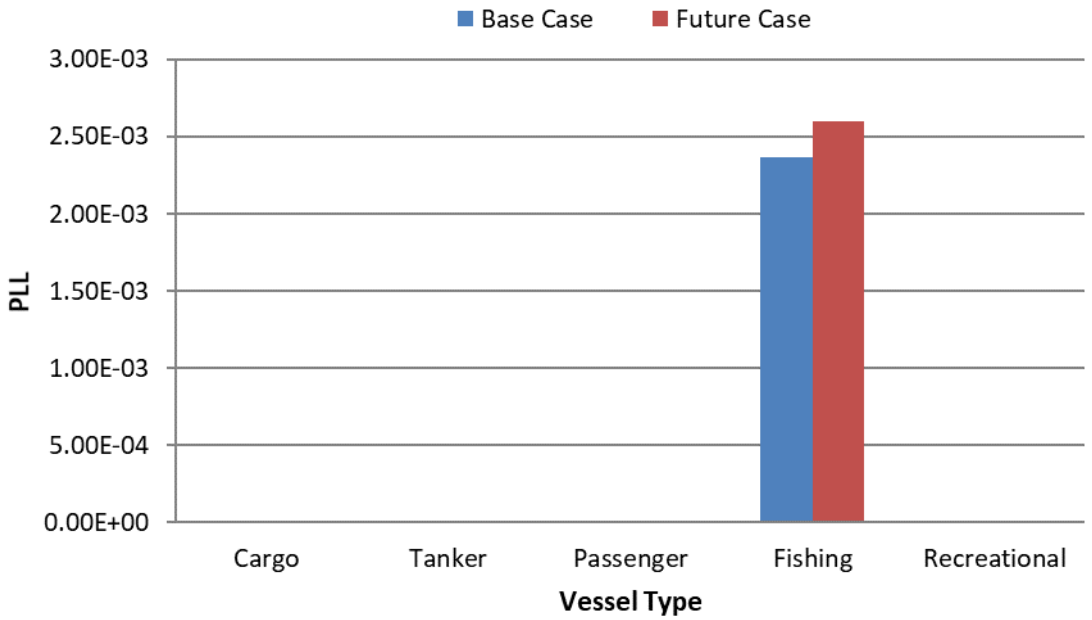


Figure A.14 Estimated change in annual PLL by vessel type

725. As with the change in annual collision and allision frequency, it can be seen that the change in annual PLL is dominated by fishing vessels, which historically have a higher fatality probability than commercial vessels.

726. Converting the PLL to individual risk based upon the average number of people exposed by vessel type, the results are presented in Figure A.15.

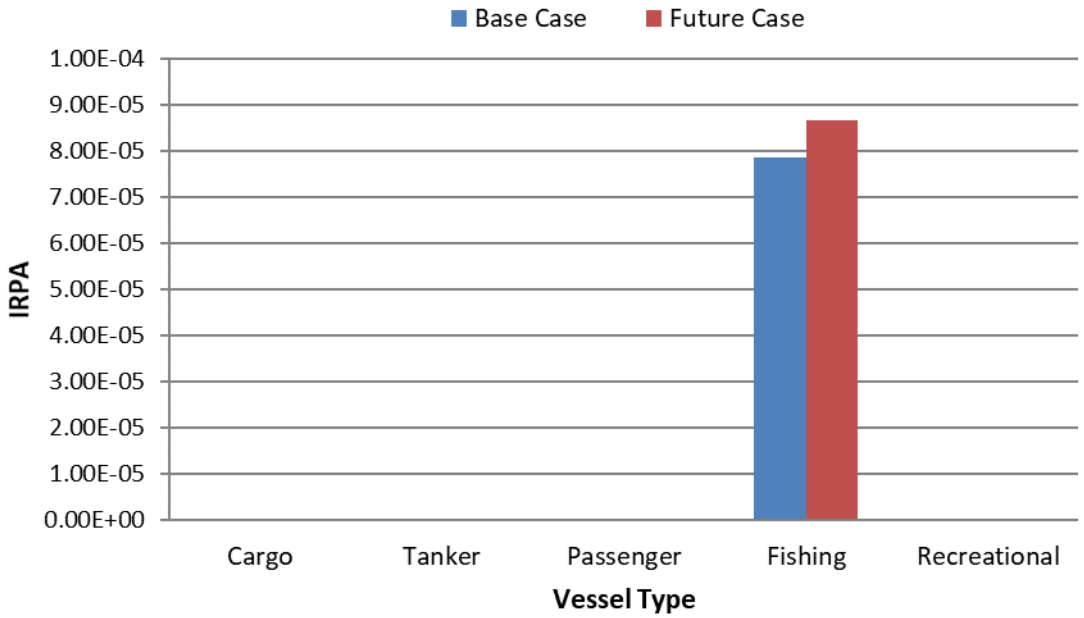


Figure A.15 Estimated change in individual risk by vessel type

727. It can be seen that the individual risk is highest for people on fishing vessels, which is related to the higher probability of a fatality occurring in the event of an incident involving a fishing vessel.

A.3.3 Significance of Increase in Fatality Risk

728. In comparison to MAIB statistics, which indicate an average of 19 fatalities per year in UK territorial waters, the overall increase for the base case in PLL of one additional fatality in 420 years represents a small change.

729. In terms of individual risk to people, the change for commercial vessels attributed to Hornsea Four (approximately 4.53×10^{-8} for the base case) is very low compared to the background risk level for the UK sea transport industry of 1.02×10^{-4} per year.

730. For fishing vessels, the change in individual risk attributed to Hornsea Four (approximately 7.88×10^{-5} for the base case) is very low compared to the background risk level for the UK sea fishing industry of 1.74×10^{-2} per year.

A.4 Pollution Risk

A.4.1 Historical Analysis

731. The pollution consequences of a collision in terms of oil spill depend upon the following criteria:

- Spill probability (i.e. likelihood of outflow following an incident); and
- Spill size (quantity of oil).

732. Two types of oil spill are considered within this assessment:

- Fuel oil spills from bunkers (all vessel types); and
- Cargo oil spills (laden tankers).

733. Research undertaken as part of the UK's DfT MEHRAs project (DfT, 2001) has been used as it was comprehensive and based upon worldwide marine oil spill data analysis. From this research, the overall probability of a spill incident per accident was calculated based upon historical accident data for each accident type as presented in Figure A.16.

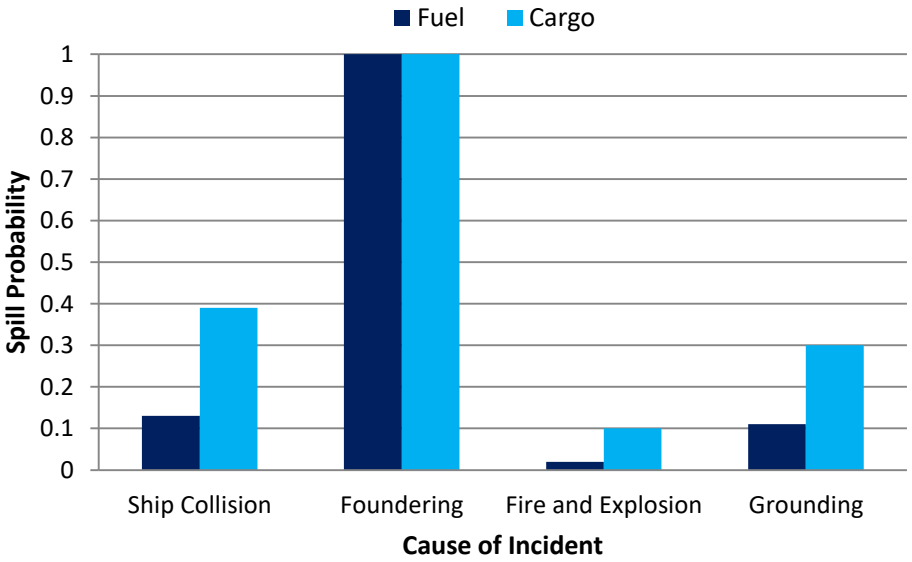


Figure A.16 Probability of an oil spill resulting from an incident

734. Therefore, it was estimated that 13% of vessel collisions result in a fuel oil spill and 39% of collisions involving a laden tanker result in a cargo oil spill.

735. In the event of a bunker spill, the potential outflow of oil depends upon the bunker capacity of the vessel. Historical bunker spills from vessels have generally been limited to a size below 50% of the bunker capacity, and in most incidents much lower.

736. For the types and sizes of vessels exposed to Hornsea Four, an average spill size of 100 tonnes of fuel oil is considered to be a conservative assumption.

737. For cargo spills from laden tankers, the spill size can vary significantly. The International Tanker Owners Pollution Federation (ITOPF) reported the following spill size distribution for tanker collisions between 1974 and 2004:

- 31% of spills below seven tonnes;
- 52% of spills between seven and 700 tonnes; and
- 17% of spills greater than 700 tonnes.

738. Based upon this data and the tankers transiting in proximity to the Hornsea Four array area, an average spill size of 400 tonnes is considered conservative.

739. For fishing vessel collisions comprehensive statistical data is not available. Consequently, it is conservatively assumed that 50% of all collisions involving fishing vessels will lead to oil spill with the quantity spilled being on average five tonnes. Similarly, for recreational vessels, owing to a lack of data 50% of collisions are assumed to lead to a spill with an average size of one tonne.

A.4.2 Pollution Risk to Due to Hornsea Four

740. Applying the above probabilities to the annual collision and allision frequency by vessel type and the average spill size per vessel, the estimated amount of oil spilled per year due to the presence of Hornsea Four would equate to 0.46 tonnes of oil per year for the base case and 0.52 tonnes of oil per year for the future case.

741. The estimated increase in tonnes of oil spilled distributed by vessel type for the base and future cases are presented in Figure A.17.

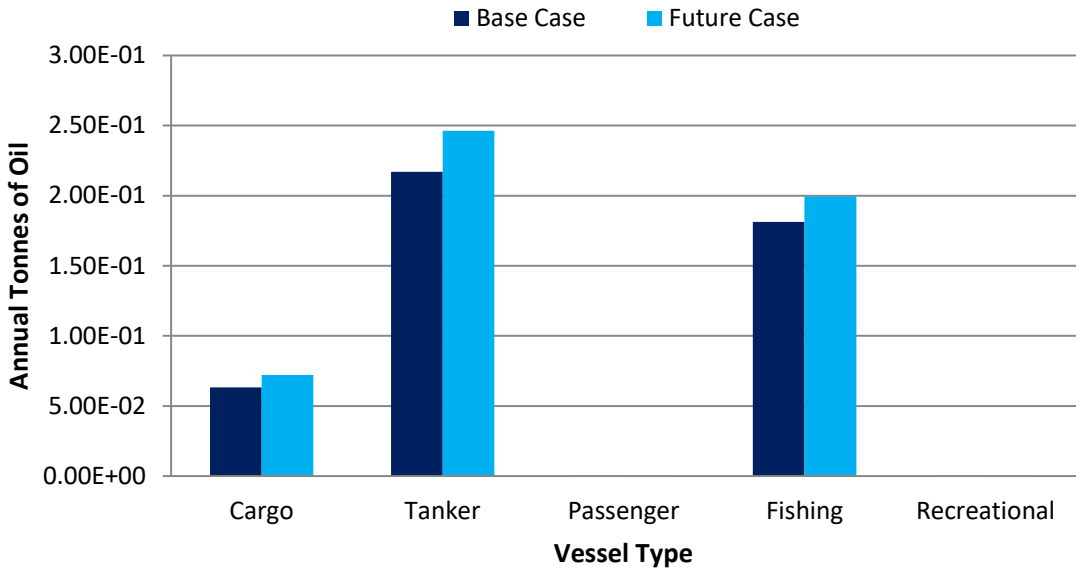


Figure A.17 Estimated change in pollution by vessel type

742. The annual oil spill results are contrary to the PLL results, where fishing vessels had the highest PLL; this is a reflection of the greater anticipated size of a tanker oil spill compared to a fishing vessel oil spill.

A.4.3 Significance of Increase in Pollution Risk

743. To assess the significance of the increased pollution risk from vessels caused by Hornsea Four, historical oil spill data for the UK has been used as a benchmark.

744. From the MEHRAs research, the annual average tonnes of oil spilled in UK waters due to maritime incidents in the 10-year period from 1989 to 1998 was 16,111. This is based upon a total of 146 reported oil pollution incidents of greater than one tonne (smaller spills are excluded as are incidents which occurred within port or harbour areas or as a result of operational errors or equipment failure).

Commercial vessel spills accounted for approximately 99% of the total while fishing vessel incidents accounted for less than 1%.

745. The overall increase in pollution estimated due to Hornsea Four of 0.46 tonnes for the base case represents a 0.003% increase compared to the historical average pollution quantities from marine incidents in UK waters.

A.5 Conclusion

746. This appendix has quantitatively assessed the fatality and pollution risk associated with Hornsea Four in the case of a collision or allision incident occurring. It is concluded, based upon the results, that the collision and allision risk of Hornsea Four on people and the environment is very low compared to the existing background risk levels.

Appendix B Risk Control Log

747. The complete risk control log is presented in Table B.1. The risk control log reflects the hazard log created during the NRA process and the outputs of the FSA undertaken in **Volume A2, Chapter 7: Shipping and Navigation**. The risk control log was first produced (as the hazard log) following the first Hazard Workshop, updated following the second and reviewed following a further change to the Hornsea Four array area boundary. It has been reviewed again following comments received by the MCA during the examination process.

748. For each identified hazard, the risk control log details:

- The **user** affected;
- **Embedded mitigation measures** adopted to reduce the significance of risk;
- Possible **causes**;
- The assessed **frequency of occurrence** and **severity of consequence**;
- The resulting **significance of risk**;
- Any **additional mitigation measures**; and
- The **residual significance of risk**.

749. The embedded mitigation measures listed for each hazard are described in full in Section 23, with all Hornsea Four embedded mitigation measures detailed in **Volume A4, Annex 5.2: Commitments Register**. The only additional mitigation measure proposed is a note to work with the MCA post consent in relation to the gap between Hornsea Four and Hornsea Project Two.

Table B.1 Risk control log

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Realistic Worst Case Consequences	Frequency of Occurrence	Additional Mitigation Measures and Comments	Residual Significance of Risk
						Severity of Consequence		Severity of Consequence		
					Description	Significance of Risk	Description	Significance of Risk		
Construction activities associated with the Hornsea Four array area, offshore ECC and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore may also lead to increased vessel to vessels collision risk for commercial vessels in all weather conditions.	Commercial vessels	C	▪ Promulgation of information ▪ Aids to navigation ▪ MGN 654 compliance ▪ Application for Safety Zones ▪ Marine coordination ▪ Traffic monitoring	Presence of construction activities, buoyed construction areas and safety zones will cause commercial vessels to be displaced from historical routes, creating new areas of high density traffic or congestion points for third party vessels. This hazard could also include causes associated with navigational error, human error or adverse weather.	Increased encounters and therefore more collision avoidance action required by commercial vessels as per the Convention on the International Regulations for Preventing Collisions at Sea (COLREGs) but does not result in a collision.	Frequent Negligible Tolerable	Collision occurs involving commercial vessels due to deviations associated with construction activities.	Extremely Unlikely Moderate Broadly Acceptable	None proposed beyond embedded mitigation measures.	Tolerable
Pre commissioned structures within the Hornsea Four array area and HVAC booster station search area will create powered and drifting allision risk for commercial vessels.	Commercial vessels	C	▪ Promulgation of information ▪ Aids to navigation ▪ Marine coordination ▪ Traffic monitoring	Presence of newly installed infrastructure poses an allision risk to commercial vessels. This hazard could also include cases associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	Near miss or entrance into safety zones by commercial vessel or drifting commercial vessel is on a closing point of approach with a newly installed structure but regains power or undertakes other evasive action prior to any allision.	Remote Negligible Broadly Acceptable	Commercial vessel allides with a newly installed structure.	Extremely Unlikely Moderate Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Pre commissioned cables associated with the Hornsea Four array area and offshore ECC may increase anchor snagging risk for commercial vessels.	Commercial vessels	C	▪ Promulgation of information ▪ Cable protection in line with MGN 654 requirements ▪ Cable burial ▪ Cable Specification and Installation Plan	Presence of partially installed cables could pose a risk to commercial vessels anchoring (routine or emergency). This hazard could also include causes associated with navigational error or human error.	Commercial vessel anchors on or drags anchor over a partially installed cable but no damage occurs.	Extremely Unlikely Negligible Broadly Acceptable	Commercial vessel anchors on or drags anchor over a partially installed cable resulting in damage to the cable and/or anchor.	Negligible Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Presence of structures within the Hornsea Four array area, offshore ECC and HVAC booster station search area and activities associated with the Hornsea Four array area, offshore ECC and HVAC booster station search area may cause vessels to be	Commercial vessels	O	▪ MGN 654 compliance ▪ Application for Safety Zones ▪ Marine coordination	Presence of structures will cause commercial vessels to be displaced from historical routes, creating new areas of high density traffic or congestion points for third party vessels. This hazard could also include causes associated	Increased encounters and therefore more collision avoidance action required by commercial vessels as per COLREGs but does not result in a collision.	Reasonably Probable Negligible	Collision occurs involving commercial vessels due to deviations associated with operation and maintenance activities.	Remote Moderate	Assumes gap between Hornsea Four and Hornsea Project Two has been designed to allow self-managed safe navigation.	Tolerable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Realistic Worst Case Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
					Description		Description			
deviated leading to increased vessel to vessel collision risk for commercial vessels in all weather conditions.				with navigational error, human error or adverse weather.		Broadly Acceptable		Tolerable		
Operational structures including ancillary operations within the Hornsea Four array area and HVAC booster station search area may create powered and drifting allision risk for commercial vessels.	Commercial vessels	O	▪ Promulgation of information ▪ Aids to navigation ▪ Charting of infrastructure ▪ Layout Principles ▪ Application for Safety Zones	Presence of infrastructure including temporary operations poses an allision risk to commercial vessels. This hazard could also include causes associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	Near miss by commercial vessel on the periphery of the array area, including within the gap between Hornsea Four and Hornsea Project Two, or drifting commercial vessel is on a closing point of approach with a structure but regains power or undertakes other evasive action prior to any allision.	Reasonably Probable Negligible Broadly Acceptable	Commercial vessel allides with a structure on the periphery of the array area, including within the gap between Hornsea Four and Hornsea Project Two.	Remote Moderate Tolerable	None proposed beyond embedded mitigation measures.	Tolerable
Operational cables within the Hornsea Four array area and offshore ECC may increase anchor snagging risk for commercial vessels and cable protection used may reduce navigable water depths for commercial vessels.	Commercial vessels	O	▪ Cable protection in line with MGN 654 requirements ▪ Cable burial ▪ Cable Specification and Installation Plan	Presence of cables could pose a risk to commercial vessels anchoring (routine or emergency) and any reduced navigable water depth could pose a risk of under keel allision. This hazard could also include causes associated with navigational error or human error.	Commercial vessel anchors on or drags anchor over a cable but no interaction occurs or a near miss by commercial vessel with an under keel hazard.	Remote Negligible Broadly Acceptable	Commercial vessel anchors on or drags anchor over a cable resulting in damage to the cable and/or anchor or experiences under keel allision resulting in grounding.	Remote Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Operational structures within the Hornsea Four array area and offshore ECC may impact a commercial vessel's use of its Radar, communications and navigation equipment during navigational transits.	Commercial vessels	O	▪ None	Human error relating to adjustment of Radar controls.	Infrastructure has no effect upon the Radar, communications and navigation equipment on a commercial vessel.	Extremely Unlikely Negligible Broadly Acceptable	Minor level of Radar interference due to the wind farm infrastructure.	Remote Negligible Broadly Acceptable	None.	Broadly Acceptable
Decommissioning activities associated with the Hornsea Four array area and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore may	Commercial vessels	D	▪ Promulgation of information ▪ Aids to navigation ▪ MGN 654 compliance ▪ Marine coordination ▪ Traffic monitoring ▪ Offshore Decommissioning Plan	Presence of decommissioning activities, buoyed decommissioning areas and safety zones will cause commercial vessels to be displaced from historical routes, creating new areas of	Increased encounters and therefore more collision avoidance action required by commercial vessels as per COLREGs but does not result in a collision.	Frequent Negligible	Collision occurs involving commercial vessels due to deviations associated with decommissioning activities.	Extremely Unlikely Moderate	None proposed beyond embedded mitigation measures.	Tolerable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Realistic Worst Case Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
					Description	Significance of Risk	Description	Significance of Risk		
also lead to increased vessel to vessel collision risk for commercial vessels in all weather conditions.				high density traffic or congestion points for third party vessels. This hazard could also include causes associated with navigational error, human error or adverse weather.		Tolerable		Broadly Acceptable		
Decommissioning structures within the Hornsea Four array area and HVAC booster station search area will create powered and drifting allision risk for commercial vessels.	Commercial vessels	D	▪ Promulgation of information ▪ Aids to navigation ▪ Traffic monitoring ▪ Offshore Decommissioning Plan	Presence of pre decommissioning infrastructure poses an allision risk to commercial vessels. This hazard could also include causes associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	Near miss or entrance into safety zones by commercial vessel or drifting commercial vessel is on a closing point of approach with a structure but regains power or undertakes other evasive action prior to any allision.	Remote Negligible Broadly Acceptable	Commercial vessel allides with a structure.	Extremely Unlikely Moderate Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Decommissioned cables left in situ within the Hornsea Four array area and offshore ECC may increase anchor snagging risk for commercial vessels.	Commercial vessels	D	▪ Promulgation of information ▪ Cable protection in line with MGN 654 requirements ▪ Cable burial ▪ Cable Specification and Installation Plan Offshore Decommissioning Plan	Presence of partially decommissioned cables or cables left in situ could pose a risk to commercial vessels anchoring (routine or emergency). This hazard could also include causes associated with navigational error or human error.	A commercial vessel drops anchor on or drags anchor over a cable left in situ but no interaction occurs or a near miss by a commercial vessel with an under keel hazard.	Remote Negligible Broadly Acceptable	Commercial vessel anchors on or drags anchor over a cable left in situ resulting in damage to the cable and/or anchor.	Extremely Unlikely Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Construction activities associated with the Hornsea Four array area, offshore ECC and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore may also lead to increased vessel to vessel collision risk for fishing vessels in all weather conditions.	Fishing vessels	C	▪ Promulgation of information ▪ Aids to navigation ▪ MGN 654 compliance ▪ Marine coordination ▪ Traffic monitoring	Presence of construction activities, buoyed construction areas and safety zones will cause fishing vessels to be displaced from historical routes, creating new areas of high density traffic or congestion points for third party vessels. This hazard could also include causes associated with navigational error, human error or adverse weather.	Increased encounters and therefore more collision avoidance action required by fishing vessels as per COLREGs but does not result in a collision.	Frequent Negligible Tolerable	Collision occurs involving fishing vessels due to deviations associated with construction activities.	Extremely Unlikely Moderate Broadly Acceptable	None proposed beyond embedded mitigation measures.	Tolerable
Pre commissioned structures within the Hornsea Four array	Fishing vessels	C	▪ Promulgation of information ▪ Aids to navigation	Presence of newly installed infrastructure poses an allision	Near miss or entrance into safety zone by fishing vessel or	Remote	Fishing vessel allides with a newly installed structure.	Extremely Unlikely	None proposed beyond	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Realistic Worst Case Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
area and HVAC booster station search area will create powered and drifting allision risk for fishing vessels.			▪ Marine coordination ▪ Traffic monitoring	risk to fishing vessels. This hazard could also include causes associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	drifting fishing vessel is on a closing point of approach with a newly installed structure but regains power or undertakes other evasive action prior to any allision.	Negligible Broadly Acceptable		Moderate Broadly Acceptable	embedded mitigation measures.	
Pre commissioned cables associated with the Hornsea Four array area and offshore ECC may increase anchor snagging risk for fishing vessels.	Fishing vessels	C	▪ Promulgation of information ▪ Cable protection in line with MGN 654 requirements ▪ Cable burial ▪ Cable Specification and Installation Plan	Presence of partially installed cables could pose a risk to fishing vessels anchoring (routine or emergency). This hazard could also include causes associated with navigational error or human error.	A fishing vessel anchors on or drags anchor over a partially installed cable but no damage occurs.	Remote Negligible Broadly Acceptable	Fishing vessel anchors on or drags anchor over a partially installed cable resulting in damage to the cable and/or anchor.	Extremely Unlikely Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Presence of structures within the Hornsea Four array area, offshore ECC and HVAC booster station search area and activities associated with the Hornsea Four array area, offshore ECC and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore increased vessel to vessel collision risk for fishing vessels in all weather conditions.	Fishing vessels	O	▪ MGN 654 compliance ▪ Marine coordination	Presence of structures will cause fishing vessels to be displaced from historical routes, creating new areas of high density traffic or congestion points for third party vessels. This hazard could also include causes associated with navigational error, human error or adverse weather.	Increased encounters and therefore more collision avoidance action required by fishing vessels as per COLREGs but does not result in a collision.	Frequent Negligible Tolerable	Collision occurs involving fishing vessels due to deviations associated with operation and maintenance activities.	Extremely Unlikely Moderate Broadly Acceptable	None proposed beyond embedded mitigation measures.	Tolerable
Operational structures within the Hornsea Four array area and HVAC booster station search area may create powered and drifting allision risk for fishing vessels.	Fishing vessels	O	▪ Aids to navigation ▪ Charting of infrastructure ▪ Layout Principles	Presence of infrastructure poses an allision risk to fishing vessels. This hazard could also include causes associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	Near miss by fishing vessel or drifting fishing vessel is on a closing point of approach with a structure but regains power or undertakes other evasive action prior to any allision.	Frequent Negligible Tolerable	Fishing vessel allides with a structure.	Remote Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Tolerable
Operational cables within the Hornsea Four array area and	Fishing vessels	O	▪ Cable protection in line with MGN 654 requirements	Presence of cables could pose a risk to fishing vessels anchoring	A fishing vessel anchors on or drags anchor over a cable but	Reasonably Probable	Fishing vessel anchors on or drags anchor over a cable	Remote	None proposed beyond	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Realistic Worst Case Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
					Description		Description			
offshore ECC may increase anchor snagging risk for fishing vessels and cable protection used may reduce navigable water depths for fishing vessels.			▪ Cable protection in line with MGN 654 requirements ▪ Cable burial ▪ Cable Specification and Installation Plan	(routine or emergency) and any reduced navigable water depth could pose a risk of under keel allision. This hazard could also include causes associated with navigational error or human error.	no interaction occurs or a near miss by a fishing vessel with an under keel hazard.	Negligible Broadly Acceptable	resulting in damage to the cable and/or anchor or experiences under keel allision resulting in grounding.	Minor Broadly Acceptable	embedded mitigation measures.	
Operational structures within the Hornsea Four array area and offshore ECC may impact a fishing vessel's use of its Radar, communications and navigation equipment during navigational transits.	Fishing vessels	O	▪ None	Human error relating to adjustment of Radar controls.	Infrastructure has no effect upon the Radar, communications and navigation equipment on a fishing vessel.	Frequent Negligible Tolerable	Minor level of Radar interference due to the wind farm infrastructure.	Reasonably Probable Negligible Broadly Acceptable	None.	Tolerable
Decommissioning activities associated with the Hornsea Four array area and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore may also lead to increased vessel to vessel collision risk for fishing vessels in all weather conditions.	Fishing vessels	D	▪ Promulgation of information ▪ Aids to navigation ▪ MGN 654 compliance ▪ Marine coordination ▪ Traffic monitoring ▪ Offshore Decommissioning Plan	Presence of decommissioning activities, buoyed decommissioning areas and safety zones will cause fishing vessels to be displaced from historical routes, creating new areas of high density traffic or congestion points for third party vessels. This hazard could also include causes associated with navigational error, human error or adverse weather.	Increased encounters and therefore more collision avoidance action required by fishing vessels as per COLREGs but does not result in a collision.	Frequent Negligible Tolerable	Collision occurs involving fishing vessels due to deviations associated with decommissioning activities.	Extremely Unlikely Moderate Broadly Acceptable	None proposed beyond embedded mitigation measures.	Tolerable
Decommissioning structures within the Hornsea Four array area and HVAC booster station search area will create powered and drifting allision risk for fishing vessels.	Fishing vessels	D	▪ Promulgation of information ▪ Aids to navigation ▪ Traffic monitoring ▪ Offshore Decommissioning Plan	Presence of pre decommissioning infrastructure poses an allision risk to fishing vessels. This hazard could also include causes associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	Near miss or entrance into safety zone by fishing vessel or drifting fishing vessel is on a closing point of approach with a structure but regains power or undertakes other evasive action prior to any allision.	Remote Negligible Broadly Acceptable	Fishing vessel allides with a structure.	Extremely Unlikely Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Decommissioned cables left in situ within the Hornsea Four array area and offshore ECC may increase anchor snagging risk for fishing vessels.	Fishing vessels	D	▪ Promulgation of information ▪ Cable protection in line with MGN 654 requirements ▪ Cable burial	Presence of partially decommissioned cables could pose a risk to fishing vessels anchoring (routine or emergency). This hazard could	A fishing vessel anchors on or drags anchor over a cable left in situ but no damage occurs.	Reasonably Probable Negligible	Fishing vessel anchors on or drags anchor over a cable left in situ resulting in damage to the cable and/or anchor.	Remote Minor	None proposed beyond embedded mitigation measures.	Broadly Acceptable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Realistic Worst Case Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
			▪ Cable Specification and Installation Plan ▪ Offshore Decommissioning Plan	also include causes associated with navigational error or human error.		Broadly Acceptable		Broadly Acceptable		
Construction activities associated with the Hornsea Four array area, offshore ECC and HVAC booster station search area may cause vessels to be deviated leading to increased encounters and therefore may also lead to increased vessel to vessel collision risk for recreational vessels in all weather conditions.	Recreational vessels	C	▪ Promulgation of information ▪ Aids to navigation ▪ MGN 654 compliance ▪ Marine coordination ▪ Traffic monitoring	Presence of construction activities, buoyed construction areas and safety zones will cause recreational vessels to be displaced from historical routes, creating new areas of high density traffic or congestion points for third party vessels. This hazard could also include causes associated with navigational error, human error or adverse weather.	Increased encounters and therefore more collision avoidance action required by recreational vessels as per COLREGs but does not result in a collision.	Frequent Negligible Tolerable	Collision occurs involving recreational vessels due to deviations associated with construction activities.	Extremely Unlikely Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Tolerable
Pre commissioned structures within the Hornsea Four array area and HVAC booster station search area will create powered and drifting allision risk for recreational vessels.	Recreational vessels	C	▪ Promulgation of information ▪ Aids to navigation ▪ Marine coordination ▪ Traffic monitoring	Presence of newly installed infrastructure poses an allision risk to recreational vessels. This hazard could also include causes associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	Near miss or entrance into safety zone by recreational vessel or drifting recreational vessel is on a closing point of approach with a newly installed structure but regains power or undertakes other evasive action prior to allision.	Remote Negligible Broadly Acceptable	Recreational vessel allides with a newly installed structure.	Extremely Unlikely Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Pre commissioned cables associated with the Hornsea Four array area and offshore ECC may increase anchor snagging risk for recreational vessels.	Recreational vessels	C	▪ Promulgation of information ▪ Cable protection in line with MGN 654 requirements ▪ Cable burial ▪ Cable Specification and Installation Plan	Presence of partially installed cables could pose a risk to recreational vessels anchoring (routine or emergency). This hazard could also include causes associated with navigational error or human error.	A recreational vessel anchors on or drags anchor over a partially installed cable but no damage occurs.	Remote Negligible Broadly Acceptable	Recreational vessel anchors on or drags anchor over a partially installed cable resulting in damage to the cable and/or anchor.	Extremely Unlikely Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Presence of structures within the Hornsea Four array area, offshore ECC and HVAC booster station search area and activities associated with the Hornsea Four array area, offshore ECC and HVAC	Recreational vessels	O	▪ MGN 654 compliance ▪ Marine coordination	Presence of structures will cause recreational vessels to be displaced from historical routes, creating new areas of high density traffic or congestion points for third party vessels. This hazard could	Increased encounters and therefore more collision avoidance action required by commercial vessels as per COLREGs but does not result in a collision.	Frequent	Collision occurs involving recreational vessels due to deviations associated with operation and maintenance activities.	Extremely Unlikely	None proposed beyond embedded mitigation measures.	Tolerable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Realistic Worst Case Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
booster station search area may cause vessels to be deviated leading to increased encounters and therefore increased vessel to vessel collision risk for recreational vessels in all weather conditions.				also include causes associated with navigational error, human error or adverse weather.		Negligible / Tolerable		Minor / Broadly Acceptable		
Operational structures within the Hornsea Four array area and HVAC booster station search area may create powered and drifting allision risk for recreational vessels.	Recreational vessels	O	▪ Aids to navigation ▪ Charting of infrastructure ▪ Layout Principles	Presence of infrastructure poses an allision risk to recreational vessels. This hazard could also include causes associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	Near miss by recreational vessel or drifting recreational vessel is on a closing point of approach with a structure but regains power or undertakes other evasive action prior to any allision.	Frequent / Negligible / Tolerable	Recreational vessel allides with a structure.	Remote / Minor / Broadly Acceptable	None proposed beyond embedded mitigation measures.	Tolerable
Operational cables within the Hornsea Four array area and offshore ECC may increase anchor snagging risk for recreational vessels and cable protection used may reduce navigable water depths for recreational vessels.	Recreational vessels	O	▪ Cable protection in line with MGN 654 requirements ▪ Cable burial ▪ Cable Specification and Installation Plan	Presence of cables pose a risk to recreational vessels anchoring (routine or emergency) and any reduced navigable water depth could pose a risk of under keel allision. This hazard could also include causes associated with navigational error or human error.	Recreational vessel anchors on or drags anchor over a cable but no damage occurs or a near miss by recreational vessel with an under keel hazard.	Remote / Negligible / Broadly Acceptable	Recreational vessel anchors on or drags anchor over a cable resulting in damage to the cable and/or anchor or experiences under keel allision resulting in grounding.	Remote / Minor / Broadly Acceptable	None proposed beyond embedded mitigation measures..	Broadly Acceptable
Operational structures within the Hornsea Four array area and offshore ECC may impact a recreational vessel's use of its Radar, communications and navigation equipment during navigational transits.	Recreational vessels	O	▪ None	Human error relating to adjustment of Radar controls.	Infrastructure has no effect upon the Radar, communications and navigation equipment on a recreational vessel.	Frequent / Negligible / Tolerable	Minor level of Radar interference due to the wind farm infrastructure.	Reasonably Probable / Negligible / Broadly Acceptable	None proposed beyond embedded mitigation measures.	Tolerable
Decommissioning activities associated with the Hornsea Four array area and HVAC booster station search area	Recreational vessels	D	▪ Promulgation of information ▪ Aids to navigation ▪ MGN 654 compliance ▪ Marine coordination	Presence of decommissioning activities, buoyed decommissioning areas and safety zones will cause	Increased encounters and therefore more collision avoidance action required by recreational vessels as per	Frequent	Collision occurs involving recreational vessels due to deviations associated with decommissioning activities.	Extremely Unlikely	None proposed beyond embedded	Tolerable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Realistic Worst Case Consequences	Frequency of Occurrence / Severity of Consequence / Significance of Risk	Additional Mitigation Measures and Comments	Residual Significance of Risk
					Description		Description			
may cause vessels to be deviated leading to increased encounters and therefore may also lead to increased vessel to vessel collision risk for recreational vessels in all weather conditions.			▪ Traffic monitoring ▪ Offshore Decommissioning Plan	recreational vessels to be displaced from historical routes, creating new areas of high density traffic or congestion points for third party vessels. This hazard could also include causes associated with navigational error, human error or adverse weather.	COLREGs but does not result in a collision.	Negligible Tolerable		Minor Broadly Acceptable	mitigation measures.	
Decommissioning structures within the Hornsea Four array area and HVAC booster station search area will create powered and drifting allision risk for recreational vessels.	Recreational vessels	D	▪ Promulgation of information ▪ Aids to navigation ▪ Traffic monitoring ▪ Offshore Decommissioning Plan	Presence of pre decommissioning infrastructure poses an allision risk to recreational vessels. This hazard could also include causes associated with lack of or failure of navigational marking, navigational error, equipment failure, human error or adverse weather.	Near miss or entrance into safety zone by recreational vessel or drifting recreational vessel is on a closing point of approach with a structure but regains power or undertakes other evasive action prior to any allision.	Remote Negligible Broadly Acceptable	Recreational vessel allides with a structure.	Extremely Unlikely Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	Broadly Acceptable
Decommissioned cables left in situ within the Hornsea Four array area and offshore ECC may increase anchor snagging risk for recreational vessels.	Recreational vessels	D	▪ Promulgation of information ▪ Cable protection in line with MGN 654 requirements ▪ Cable burial ▪ Cable Specification and Installation Plan ▪ Offshore Decommissioning Plan	Presence of partially decommissioned cables could pose a risk to recreational vessels anchoring (routeing or emergency). This hazard could also include causes associated with navigational error or human error.	Recreational vessel anchors on or drags anchor over a cable left in situ nut no interaction occurs.	Reasonably Probable Negligible Broadly Acceptable	Recreational vessel anchors on or drags anchor over a cable left in situ resulting in damage to the cable and/or anchor.	Remote Minor Broadly Acceptable	None proposed beyond embedded mitigation measures.	
Construction activities associated with the Hornsea Four array area and offshore ECC may restrict the emergency response capability of existing resources.	Emergency responders	C	▪ MGN 654 compliance ▪ Marine coordination	Presence of construction activities could impact the ability of emergency responders to respond to incidents, with the increased level of activity relating to Hornsea Four likely to increase demands on Search and Rescue (SAR) facilities within the area.	Negligible increase in demands on SAR facilities with limited resulting impact on emergency response resources.	Reasonably Probable Negligible Broadly Acceptable	Significant incident occurs on site with response levels such that standby resources are insufficient.	Negligible Serious Tolerable	None proposed beyond embedded mitigation measures.	Tolerable
Operation and maintenance activities associated with the Hornsea Four array area and offshore ECC may restrict the emergency response capability of existing resources.	Emergency responders	O	▪ Layout Principles ▪ MGN 654 compliance ▪ Marine coordination	Presence of maintenance activities could impact the ability of emergency responders to respond to incidents, with the increased level of activity relating to	Negligible increase in demands on SAR facilities with limited resulting impact on emergency response resources.	Reasonably Probable Negligible	Significant incident occurs on site with response levels such that standby resources are insufficient.	Negligible Serious	None proposed beyond embedded mitigation measures.	Tolerable

Hazard	User	Phase (C/O/D)	Embedded Mitigation Measures	Possible Causes	Realistic Most Likely Consequences	Frequency of Occurrence	Realistic Worst Case Consequences	Frequency of Occurrence	Additional Mitigation Measures and Comments	Residual Significance of Risk
						Severity of Consequence		Severity of Consequence		
					Description	Significance of Risk	Description	Significance of Risk		
				Hornsea Four likely to increase demands on SAR facilities within the area.		Broadly Acceptable		Tolerable		Tolerable
Decommissioning activities associated with the Hornsea Four array area and offshore ECC may restrict the emergency response capability of existing resources.	Emergency responders	D	▪ MGN 654 compliance ▪ Marine coordination ▪ Offshore Decommissioning Plan	Presence of decommissioning activities could impact the ability of emergency responders to respond to incidents, with the increased level of activity relating to Hornsea Four likely to increase demands on SAR facilities within the area.	Negligible increase in demands on SAR facilities with limited resulting impact on emergency response resources.	Reasonably Probable	Significant incident occurs on site with response levels such that standby resources are insufficient.	Negligible	None proposed beyond embedded mitigation measures.	Tolerable
						Negligible		Serious		
						Broadly Acceptable		Tolerable		

Appendix C Marine Guidance Note 654 Checklist

750. The MGN 654 checklist can be divided into two distinct checklists, one considering the main MGN 654 guidance document and one considering the *Methodology for Assessing Marine Navigational Safety and Emergency Response Risks of OREIs* (MCA, 2021) which serves as Annex 1 to MGN 654.

751. The checklist for the main MGN 654 guidance document is presented in Table C.1. Following this, the checklist for the MCA's methodology annex is presented in Table C.2. For both checklists, references to where the relevant information and/or assessment is provided in the NRA is given, noting that in some cases information and/or assessment has been included in **Volume A2, Chapter 7: Shipping and Navigation** only as part of the proportionate approach being applied to the ES.

Table C.1 MGN 654 checklist for main document

Issue	Compliance	Reference and Notes
Site and Installation Co-ordinates. Developers are responsible for ensuring that formally agreed coordinates and subsequent variations of site perimeters and individual OREI structures are made available, on request, to interested parties at relevant project stages, including application for consent, development, array variation, operation and decommissioning. This should be supplied as authoritative GIS data, preferably in Environmental Systems Research Institute (ESRI) format. Metadata should facilitate the identification of the data creator, its date and purpose, and the geodetic datum used. For mariners' use, appropriate data should also be provided with latitude and longitude coordinates in WGS84 (European Terrestrial Reference System 1989 (ETRS89)) datum.		
Traffic Survey. Includes:		
All vessel types	✓	**Section 15: Vessel Traffic Surveys** All vessel types are considered with specific breakdowns by vessel type given for the Hornsea Four array area (see Section 15.1), offshore ECC (see Section 15.2) and HVAC booster station search area (see Section 15.3) shipping and navigation study areas.
At least 28 days duration, within either 12 or 24 months prior to submission of the ES.	✓	**Section 7: Vessel Traffic Survey Methodology** A total of 28 full days of vessel traffic survey data from July/ August 2020 and February/March 2021 has been assessed within the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas.
Multiple data sources	✓	**Section 7: Vessel Traffic Survey Methodology** The vessel traffic survey data includes AIS, visual observations and Radar for the winter periods in order to ensure maximal coverage of vessels not broadcasting on AIS. Additional summer vessel traffic surveys including AIS, visual observations and Radar were undertaken in June/July 2021 with analysis of the data collected to be presented as a validation addendum to the NRA.

Issue	Compliance	Reference and Notes
Seasonal variations	✓	**Section 7: Vessel Traffic Survey Methodology** A total of 28 full days of vessel traffic survey data from July/ August 2020 and February/March 2021 has been assessed within the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas. Additional summer vessel traffic surveys were undertaken in June/July 2021 with analysis of the data collected to be presented as a validation addendum to the NRA.
MCA consultation	✓	**Section 4: Consultation** The MCA has been consulted as part of the NRA process. **Section 14: Key Consultation Overview** A summary of key issues raised during consultation with the MCA is provided in **Volume A2, Chapter 7: Shipping and Navigation**. **Section 18: Hazard Workshop Overview** The MCA attended both Hazard Workshops.
General Lighthouse Authority (GLA) consultation	✓	**Section 4: Consultation** Trinity House has been consulted as part of the NRA process. **Section 14: Key Consultation Overview** A summary of key issues raised during consultation with Trinity House is provided in **Volume A2, Chapter 7: Shipping and Navigation**. **Section 18: Hazard Workshop Overview** Trinity House attended both Hazard Workshops.
UK Chamber of Shipping consultation	✓	**Section 4: Consultation** The UK Chamber of Shipping has been consulted as part of the NRA process. **Section 14: Key Consultation Overview** A summary of key issues raised during consultation with the UK Chamber of Shipping is provided in **Volume A2, Chapter 7: Shipping and Navigation**. **Section 18: Hazard Workshop Overview** The UK Chamber of Shipping attended both Hazard Workshops.

Issue	Compliance	Reference and Notes
Recreational and fishing vessel consultation	✓	**Section 4: Consultation** The RYA, CA, VISNED and NFFO have been consulted as part of the NRA process. **Section 14: Key Consultation Overview** A summary of key issues raised during consultation with VISNED is provided in **Volume A2, Chapter 7: Shipping and Navigation**. **Section 18: Hazard Workshop Overview** The RYA, CA and NFFO were invited to both Hazard Workshops. None were able to attend the first Hazard Workshop but the CA attended the second Hazard Workshop.
Port and navigation authorities consultation, as appropriate	✓	**Section 4: Consultation** ABP, UKMPG and Danish Shipping have been consulted as part of the NRA process. **Section 14: Key Consultation Overview** A summary of key issues raised during consultation with ABP, UKMPG and Danish Shipping is provided in **Volume A2, Chapter 7: Shipping and Navigation**. **Section 18: Hazard Workshop Overview** ABP and PD Ports were invited to both Hazard Workshops but did not attend. ABP and Danish Shipping attended the second Hazard Workshop.
Assessment of the cumulative and individual effects of (as appropriate):		
i. Proposed OREI site relative to areas used by any type of marine craft.	✓	**Section 15: Vessel Traffic Surveys** Vessel traffic data in proximity to Hornsea Four has been analysed. **Section 22: Hazard Identification** The risks due to the presence of Hornsea Four have been identified for each phase.
ii. Numbers, types and sizes of vessels presently using such areas.	✓	**Section 15: Vessel Traffic Surveys** Vessel traffic data in proximity to Hornsea Four has been analysed and includes breakdowns of daily count, vessel type and vessel size.
iii. Non-transit uses of the area, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, personal watercraft etc.	✓	**Section 10: Existing Environment** Section 10.9.2 identifies marine aggregate dredging areas in proximity to Hornsea Four based upon data provided by TCE and activity characterised using the transit routes of marine aggregate dredgers supplied by BMAPA. **Section 15: Vessel Traffic Surveys** Non-transit users were identified in the vessel traffic survey data and included fishing vessels engaged in fishing activities.

Issue	Compliance	Reference and Notes
iv. Whether these areas contain transit routes used by coastal or deep-draught or international scheduled vessels on passage.	✓	**Section 15: Vessel Traffic Surveys** Main routes have been identified using the principles set out in MGN 654 in proximity to the Hornsea Four array area (see Section 15.1.5) and HVAC booster station search area (see Section 15.3.5) with these routes taking into account coastal, deep-draught and internationally scheduled vessels.
v. Alignment and proximity of the site relative to adjacent shipping routes.	✓	**Section 10: Existing Environment** Section 10.6 identifies IMO routeing measures in proximity to Hornsea Four.
vi. Whether the nearby area contains prescribed routeing schemes or precautionary areas.	✓	**Section 10: Existing Environment** Section 10.6 identifies IMO routeing measures in proximity to Hornsea Four and Section 10.9 identifies precautionary areas such as military practice and exercise areas and foul and spoil grounds in proximity to Hornsea Four.
vii. Proximity of the site to areas used for anchorage (charted or uncharted), safe haven, port approaches and pilot boarding or landing areas.	✓	**Section 10: Existing Environment** Section 10.9.1 identifies designated anchorage areas in proximity to Hornsea Four and Section 10.7 identifies nearby ports.
viii. Whether the site lies within the jurisdiction of a port and/or navigation authority.	✓	**Section 10: Existing Environment** Section 10.7 identifies nearby ports and port authority jurisdiction.
ix. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✓	**Section 15: Vessel Traffic Surveys** Fishing vessel movements are considered within the Hornsea Four array area (Section 15.1.8), offshore ECC (Section 15.2.6) and HVAC booster station search area (Section 15.3.8) shipping and navigation study areas.
x. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓	**Section 10: Existing Environment** Section 10.9.3 identifies military practice and exercise areas in proximity to Hornsea Four.
xi. Proximity of the site to existing or proposed submarine cables or pipelines, offshore oil/gas platform, marine aggregate dredging, marine archaeological sites or wrecks, Marine Protected Area or other exploration/exploitation sites.	✓	**Section 10: Existing Environment** Section 10.4 identifies existing and proposed submarine cables and pipelines in proximity to Hornsea Four, Section 10.2 identifies oil and gas features in proximity to Hornsea Four, Section 10.9.2 identifies marine aggregate dredging areas in proximity to Hornsea Four, Section 10.5 identifies charted wrecks in proximity to Hornsea Four and Section 10.8 identifies MEHRAs in proximity to Hornsea Four.
xii. Proximity of the site to existing or proposed OREI developments, in cooperation with other relevant developers, within each round of lease awards.	✓	**Section 10: Existing Environment** Section 10.1 identifies other offshore wind farm developments in proximity to Hornsea Four.

Issue	Compliance	Reference and Notes
xiii. Proximity of the site relative to any designated areas for the disposal of dredging spoil or other dumping grounds.	✓	**Section 10: Existing Environment** Section 10.9.4 identifies foul and spoil ground in proximity to Hornsea Four.
xiv. Proximity of the site to aids to navigation and/or VTS in or adjacent to the area and any impact thereon.	✓	**Section 10: Existing Environment** Section 10.3 identifies aids to navigation in proximity to Hornsea Four.
xv. Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of "choke points" in areas of high traffic density and nearby or consented OREI sites not yet constructed.	✓	**Section 21: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the Hornsea Four array area and HVAC booster stations.
xvi. With reference to xv. above, the number and type of incidents to vessels which have taken place in or near to the proposed site of the OREI to assess the likelihood of such events in the future and the potential impact of such a situation.	✓	**Section 13: Maritime Incidents** Historical vessel incident data published by the MAIB (Section 13.1), RNLI (Section 13.2) and DfT (Section 13.3) in proximity to Hornsea Four has been considered alongside historical offshore wind farm incident data throughout the UK (Section 13.4).
xvii. Proximity of the site to areas used for recreation which depend on specific features of the area.	✓	**Section 15: Vessel Traffic Surveys** Non-transit users were identified in the vessel traffic survey data and included limited recreational activity.
Predicted effect of OREI on traffic and interactive boundaries. Where appropriate, the following should be determined:		
a. The safe distance between a shipping route and OREI boundaries.	✓	**Section 20: Future Case Vessel Traffic** A methodology for post wind farm routeing is outlined and includes a minimum distance of 1 nm from offshore installations and WTG boundaries.
b. The width of a corridor between sites or OREIs to allow safe passage of shipping.	✓	**Section 9: Maximum Design Scenario** It is not planned to include a defined corridor (parallelogram) between structures for the purpose of allowing safe passage of shipping, but a gap between Hornsea Four and Hornsea Project Two (incorporated for this purpose) has been included. **Section 19: Cumulative and Transboundary Overview** Section 19.3 provides a justification for the gap between Hornsea Four and Hornsea Project Two to ensure its presence does not result in a significant risk to navigational safety.

Issue	Compliance	Reference and Notes
OREI structures. The following should be determined:		
a. Whether any feature of the OREI, including auxiliary platforms outside the main generator site, mooring and anchoring systems, inter-device and export cabling could pose any type of difficulty or danger to vessels underway, performing normal operations, including fishing anchoring and emergency response.	✓	**Section 21: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the Hornsea Four array area and HVAC booster stations. **Section 22: Hazard Identification** Based upon the baseline data and consultation undertaken hazards have been identified and fed into the risk assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation**, including hazards involving anchoring and emergency response.
b. Clearances of fixed or floating wind turbine blades above the sea surface are not less than 22 m (above Mean High Water Springs (MHWS) for fixed). Floating turbines allow for degrees of motion.	✓	**Section 9: Maximum Design Scenario** The minimum blade tip height is included in the MDS for WTGs (see Table 9.2).
c. Underwater devices: i. Changes to charted depth; ii. Maximum height above seabed; and iii. Under keel clearance.	✓	**Section 9: Maximum Design Scenario** Inter array, interconnector and export cable specifications are included in the MDS for cables (see Section 9.3.2).
d. Whether structure block or hinder the view of other vessels or other navigational features.		**Section 17: Navigation, Communication and Position Fixing Equipment** Risks associated with the use of existing aids to navigation are considered (see Section 17.10). **Section 19: Cumulative and Transboundary Overview** Effects of non-transit users on vessels navigating through the gap between Hornsea Four and Hornsea Project Two and the detection of such vessels has been considered (see Section 19.3.6).

Issue	Compliance	Reference and Notes
The effects of tides, tidal streams and weather. It should be determined whether:		
a. Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide, i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✓	**Section 9: Maximum Design Scenario** The range of water depths within the Hornsea Four array area is provided in the MDS for the Hornsea Four development boundaries (see Section 9.1). **Section 11: Meteorological Ocean Data** Various states of the tide local to Hornsea Four are provided. **Section 15: Vessel Traffic Surveys** Vessel traffic data in proximity to Hornsea Four has been analysed. **Section 21: Collision and Allision Risk Modelling** Collision and allision risk models take into account tidal conditions.
b. The set and rate of the tidal stream, at any state of the tide, has a significant effect on vessels in the area of the OREI site.	✓	**Section 11: Meteorological Ocean Data** Various states of the tide local to Hornsea Four are provided. **Section 21: Collision and Allision Risk Modelling** The collision and allision risk models take into account tidal conditions.
c. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✓	
d. The set is across the major axis of the layout at any time, and, if so, at what rate.	✓	
e. In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream, including unpowered vessels and small, low speed craft.	✓	**Section 11: Meteorological Ocean Data** Various states of the tide local to Hornsea Four are provided and it is noted that hazards are not anticipated at high or low water only. **Section 21: Collision and Allision Risk Modelling** The drifting allision risk model takes into account tidal conditions and assesses whether machinery failure could cause vessels to be set into danger.
f. The structures themselves could cause changes in the set and rate of the tidal stream.	✓	**Section 11: Meteorological Ocean Data** No effects are anticipated.
g. The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the wind farm area or adjacent to the area.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including compliance with MGN 654 with respect to use of scour protection and production of a Cable Specification and Installation Plan.

Issue	Compliance	Reference and Notes
h. The site, in normal, bad weather, or restricted visibility conditions, could present difficulties or dangers to craft, including sailing vessels, which might pass in close proximity to it.	✓	**Section 11: Meteorological Ocean Data** Weather and visibility data local to Hornsea Four is provided. **Section 15: Vessel Traffic Surveys** Vessel traffic data in proximity to Hornsea Four has been analysed including recreational vessels. **Section 16: Adverse Weather Risks for Routeing** Alternative routeing used by Regular Operators during periods of adverse weather have been identified. **Section 22: Hazard Identification** Based upon the baseline data and consultation undertaken hazards have been identified and fed into the risk assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation**.
i. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓	**Section 22: Hazard Identification** Based upon the baseline data and consultation undertaken hazards have been identified and fed into the risk assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation**.
j. In general, taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set such as referred to above.	✓	**Section 21: Collision and Allision Risk Modelling** The drifting allision risk model takes into account weather and tidal conditions and assesses whether machinery failure could cause vessels to be set into danger.
Assessment of access to and navigation within, or close to, an OREI. To determine the extent to which navigation would be feasible within the OREI site itself by assessing whether:		
a. Navigation within or close to the site would be safe:		
i. For all vessels.	✓	**Section 14: Key Consultation Overview** Section 14.2 outlines Regular Operator consultation undertaken following the vessel traffic surveys. **Section 16: Adverse Weather Risks for Routeing** Alternative routeing used by Regular Operators during periods of adverse weather have been identified.
ii. For specified vessel types, operations and/or sizes.	✓	
iii. In all directions or areas.	✓	
iv. In specified directions or areas.	✓	

Issue	Compliance	Reference and Notes
v. In specified tidal, weather or other conditions.	✓	**Section 21: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the Hornsea Four array area and HVAC booster stations and includes use of post wind farm routeing and takes account of tidal and weather conditions. **Section 22: Hazard Identification** Based upon the baseline data and consultation undertaken hazards have been identified and fed into the risk assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation**.
b. Navigation in and/or near the site should be prohibited or restricted:		
i. For specified vessel types, operations and/or sizes.	✓	**Section 17: Navigation, Communication and Position Fixing Equipment** Potential risks associated with navigation of the different communications and position fixing devices used in and around offshore wind farms are assessed. **Section 21: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the Hornsea Four array area and HVAC booster stations and includes use of post wind farm routeing which assumes commercial vessel traffic avoids the development area. **Section 22: Hazard Identification** Based upon the baseline data and consultation undertaken hazards have been identified and fed into the risk assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation**.
ii. In respect of specific activities.	✓	
iii. In all areas or directions.	✓	
iv. Prohibited in specified areas or directions.	✓	
v. In specified tidal or whether conditions.	✓	
c. Where it is not feasible for vessels to access or navigate through the site it could cause navigational, safety or routeing problems for vessels operating in the area e.g. by preventing vessels from responding to calls for assistance from persons in distress.	✓	**Section 21: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the Hornsea Four array area and HVAC booster stations and includes use of post wind farm routeing which assumes commercial vessel traffic avoids the development area. **Section 22: Hazard Identification** Based upon the baseline data and consultation undertaken hazards have been identified and fed into the risk assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation**.
d. Guidance on the calculation of safe distance of OREI boundaries from shipping routes has been considered.	✓	**Section 20: Future Case Vessel Traffic** The methodology applied when considering the safe distance at which main routes should be deviated around offshore installations has been described and includes consideration of the Shipping Route Template (see Section 20.5.1).

Issue	Compliance	Reference and Notes
SAR, maritime assistance service, counter pollution and salvage incident response.		
The MCA, through HM Coastguard, is required to provide SAR and emergency response within the sea area occupied by all OREIs in UK waters. To ensure that such operations can be safely and effectively conducted, certain requirements must be met by developers and operators.		
a. An ERCoP will be developed for the construction, operation and decommissioning phases of the OREI.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including compliance with MGN 654, which requires the creation of an ERCoP.
b. The MCA's guidance document *Offshore Renewable Energy Installations: Requirements, Guidance and Operational Considerations for Search and Rescue and Emergency Response* (MCA, 2018) for the design, equipment and operation requirements will be followed.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including compliance with MGN 654, which requires the fulfilment of requirements in the stated guidance document.
c. A SAR checklist will be completed to record discussions regarding the requirements, recommendations and considerations outlined in Annex 5 (to be agreed with MCA).	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including compliance with MGN 654, which expects the SAR checklist to be completed.
Hydrography. In order to establish a baseline, confirm the safe navigable depth, monitor seabed mobility and to identify underwater hazards, detailed and accurate hydrographic surveys are included or acknowledged for the following stages and to MCA specifications:		
Pre construction: The proposed generating assets area and proposed cable route.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including compliance with MGN 654, which requires the specified hydrographic surveys to be undertaken.
ii. One a pre-established periodicity during the life of the development.	✓	
ii. Post construction: Cable route(s).	✓	
iii. Post decommissioning of all or part of the development: the installed generating assets area and cable route.	✓	

Issue	Compliance	Reference and Notes
Communications, Radar and positioning systems. To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether:		
a. The structures could produce radio interference such as shadowing, reflections or phase changes, and emissions with respect to any frequencies used for marine positioning, navigation and timing (PNT) or communications, including Global Maritime Distress and Safety System (GMDSS) and AIS, whether ship borne ashore or fitted to any of the proposed structures, to:		
i. Vessels operating at a safe navigational distance.	✓	**Section 17: Navigation, Communication and Position Fixing Equipment** Potential risks associated with navigation of the different communications and position fixing devices used in and around offshore wind farms are assessed.
ii. Vessels by the nature of their work necessarily operating at less than the safe navigational distance to the OREI, e.g. support vessels, survey vessels, SAR assets.	✓	
iii. Vessels by the nature of their work necessarily operating within the OREI.	✓	
b. The structures could produce Radar reflections, blind spots, shadow areas or other adverse effects:		
i. Vessel to vessel	✓	**Section 17: Navigation, Communication and Position Fixing Equipment** Potential risks associated with navigation of the different communications and position fixing devices used in and around offshore wind farms are assessed.
ii. Vessel to shore	✓	
iii. VTS Radar to vessel	✓	
iv. Racon to/from vessel	✓	
c. The structures and generators might produce SONAR interference affecting fishing, industrial or military systems used in the area.	✓	**Section 17: Navigation, Communication and Position Fixing Equipment** Section 17.8 assesses the potential risk of SONAR interference due to Hornsea Four.
d. The site might produce acoustic noise which could mask prescribed sound signals.	✓	**Section 17: Navigation, Communication and Position Fixing Equipment** Section 17.9 assesses the potential risk of noise due to Hornsea Four.
e. Generators and the seabed cabling within the site onshore might produce EMFs affecting compasses and other navigation systems.	✓	**Section 17: Navigation, Communication and Position Fixing Equipment** Section 17.6 assesses the potential risk of electromagnetic interference due to Hornsea Four.

Issue	Compliance	Reference and Notes
Risk mitigation measures recommended for OREI during construction, operation and decommissioning.		
Mitigation and safety measures will be applied to the OREI development appropriate to the level and type of risk determined during the EIA. The specific measures to be employed will be selected in consultation with the MCA and will be listed in the developer's ES. These will be consistent with international standards contained in, for example, Chapter V of SOLAS (IMO, 1974), and could include any or all of the following:		
i. Promulgation of information and warnings through notices to mariners and other appropriate MSI dissemination methods.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including the promulgation of information.
ii. Continuous watch by multi-channel VHF, including DSC.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including marine coordination.
iii. Safety Zones of appropriate configuration, extent and application to specified vessels[7].	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including use of Safety Zones.
iv. Designation of the site as an area to be avoided (ATBA)	✓	It is not planned to designate the Hornsea Four array area as an ATBA.
v. Provision of aids to navigation as determined by the GLA.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including the provision of aids to navigation in accordance with Trinity House and MCA requirements.
vi. Implementation of routeing measures within or near to the development.	✓	It is not planned to implement any new routeing measures within or near to Hornsea Four.
vii. Monitoring by Radar, AIS, Closed Circuit Television (CCTV) or other agreed means.	✓	**Section 25: Through Life Safety Management** Section 25.7 outlines plans to monitor vessel movements by AIS during the construction and operation and maintenance phases.
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of Safety Zones.	✓	Means for notifying and providing evidence of the infringement of Safety Zones will be provided in the Safety Zone Application, submitted post consent.
ix. Creation of an ERCoP with the MCA's SAR branch for the construction phase onwards.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including compliance with MGN 654, which requires the creation of an ERCoP.
x. Use of guard vessels, where appropriate.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including the use of guard vessels.

[7] As per SI 2007 No 1948 "The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

Issue	Compliance	Reference and Notes
xi. Update NRAs every two years, e.g. at testing sites.	✓	Not applicable to Hornsea Four.
xii. Device-specific or array-specific NRAs.	✓	**Section 9: Maximum Design Scenario** All offshore elements of Hornsea Four have been considered in this NRA including array area and offshore ECC (surface and subsea) infrastructure. **Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1, including a Cable Specification and Installation Plan undertaken prior to construction which will serve as additional assessment relating to shipping and navigation.
xiii. Design of OREI structures to minimise risk to contacting vessels or craft.	✓	There is no additional risk posed to craft compared to previous offshore wind farms and so no additional measures are identified.
xiv. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	**Section 23: Embedded Mitigation Measures** Embedded mitigation measures have been proposed and are summarised in Table 23.1. **Section 24: Cost Benefit Analysis** Additional mitigation measures included as part of Hornsea Four have been proposed.

Table C.2 MGN 654 Annex 1 checklist

Item	Compliance	Comments
A risk claim is included that is supported by a reasoned argument and evidence.	✓	The risk assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation** provides a risk claim for a range of hazards identified in this NRA which is based on a number of inputs including (but not limited to) baseline data, expert opinion, outputs of the Hazard Workshops, stakeholder concern and lessons learnt from existing offshore developments.

Item	Compliance	Comments
Description of the marine environment.	✓	**Section 10: Existing Environment** Relevant navigational features in proximity to Hornsea Four have been described including (but not limited to) other offshore wind farm developments, oil and gas features, aids to navigation, submarine cables and pipelines, charted wrecks, IMO routeing measures, ports and MEHRAs. **Section 19: Cumulative and Transboundary Overview** Potential future developments have been screened in to the CEA where a cumulative or in combination activity has been identified based upon the location and distance from Hornsea Four, including consideration of other offshore wind farms, oil and gas infrastructure and carbon capture infrastructure (surface piercing). Potential future developments have also been screened in to the CEA where a concern has been raised during consultation.
SAR overview and assessment.	✓	**Section 12: Emergency Response Overview** Existing SAR resources in the southern North Sea are summarised including the UK SAR operations contract, RNLI stations and assets and HMCG stations. The risk assessment undertaken in **Volume A2, Chapter 7: Shipping and Navigation** includes an assessment of how activities associated with Hornsea Four may restrict emergency response capability of existing resources.
Description of the OREI development and how it changes the marine environment.	✓	**Section 9: Maximum Design Scenario** The maximum extent of Hornsea Four for which any shipping and navigation hazards are assessed is provided including a description of the development boundaries, array area and offshore ECC infrastructure, construction phase programme and indicative vessel and helicopter numbers during the construction and operation and maintenance phases. **Section 20: Future Case Vessel Traffic** Worst case alternative routeing for commercial traffic has been considered.
Analysis of the marine traffic, including base case and future traffic densities and types.	✓	**Section 15: Vessel Traffic Surveys** Vessel traffic data in proximity to Hornsea Four has been analysed. **Section 20: Future Case Vessel Traffic** Future vessel traffic levels have been considered, broken down as increases in traffic associated with ports, commercial fishing vessel activity, recreational vessel activity and traffic associated with Hornsea Four operations. Additionally, worst case alternative routeing for commercial traffic has been considered.

Item	Compliance	Comments
Status of the hazard log: ▪ Hazard identification; ▪ Risk assessment; ▪ Influences on level of risk; ▪ Tolerability of risk; and ▪ Risk matrix.	✓	**Section 3: Navigational Risk Assessment Methodology** A tolerability matrix has been defined to determine the tolerability of hazards (see Section 3.2.1). **Appendix B: Risk Control Log** A risk control log based on the complete hazard log is presented and includes a description of the hazards considered, possible causes, consequences (most likely and worst case) and relevant embedded mitigation measures. Using this information, each hazard is then ranked in terms of frequency and consequence to give a tolerability level (significance of risk).
NRA: ▪ Appropriate risk assessment; ▪ MCA acceptance for assessment techniques and tools; ▪ Demonstration of results; and ▪ Limitations.	✓	**Section 2: Guidance and Legislation** MGN 654 and the IMO's FSA guidelines are the primary guidance documents used during the assessment. **Section 21: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the Hornsea Four array area and HVAC booster stations with the results outlined numerically and graphically (where appropriate).
Risk control log	✓	**Appendix B: Risk Control Log** A risk control log has been produced reflecting the hazard log created during the NRA process and the outputs of the FSA undertaken in **Volume A2, Chapter 7: Shipping and Navigation**.

Appendix D Regular Operator Consultation

752. As part of the consultation process for Hornsea Four, Regular Operators identified (from the vessel traffic survey data) that would be required to deviate their routes due to the Hornsea Four array area or HVAC booster station search area were consulted via electronic mail. An example of the correspondence sent to the Regular Operators prior to PEIR is presented below, noting that the Hornsea Four array area boundary shown in the accompanying figure was the boundary under consideration prior to submission of the PEIR.

753. Further correspondence was sent to the Regular Operators post-PEIR following the change to the Hornsea Four array area boundary resulting in the gap between Hornsea Four and Hornsea Project Two, and consisted of a similar correspondence to that presented below.

Hornsea 4 Ørsted

Stakeholder Consultation on Impacts Relating to Shipping and 07/05/2019

Navigation for the Proposed Hornsea Project Four Offshore Wind Farm

Dear Stakeholder,

As you may be aware, Orsted Hornsea Project Four UK Ltd. is the developer of the Hornsea offshore wind farms located off the Yorkshire coast. There are three existing Hornsea developments: Hornsea Project One is currently under construction, Hornsea Project Two was awarded consent in August 2016 and Hornsea Three submitted an application for Development Consent in May 2018.

Following a Scoping Report submitted to the Planning Inspectorate in October 2018, Hornsea Four is the fourth and final site from the original Hornsea Zone being developed and consists of offshore wind turbines and associated infrastructure located in a defined area to the west of the other Hornsea sites, as well as export cables to shore, associated infrastructure and an onshore grid connection.

The Hornsea Four array area is located approximately 35 nm (65 km) from the Yorkshire coast and covers an area of 247 nm^2 (846 km^2). Figure 1 presents the location of the Hornsea Four array area alongside the wind farm areas for the other Hornsea developments.

Further information relating to Hornsea Four is available at: https://hornseaprojects.co.uk/en/Hornsea-Project-Four.

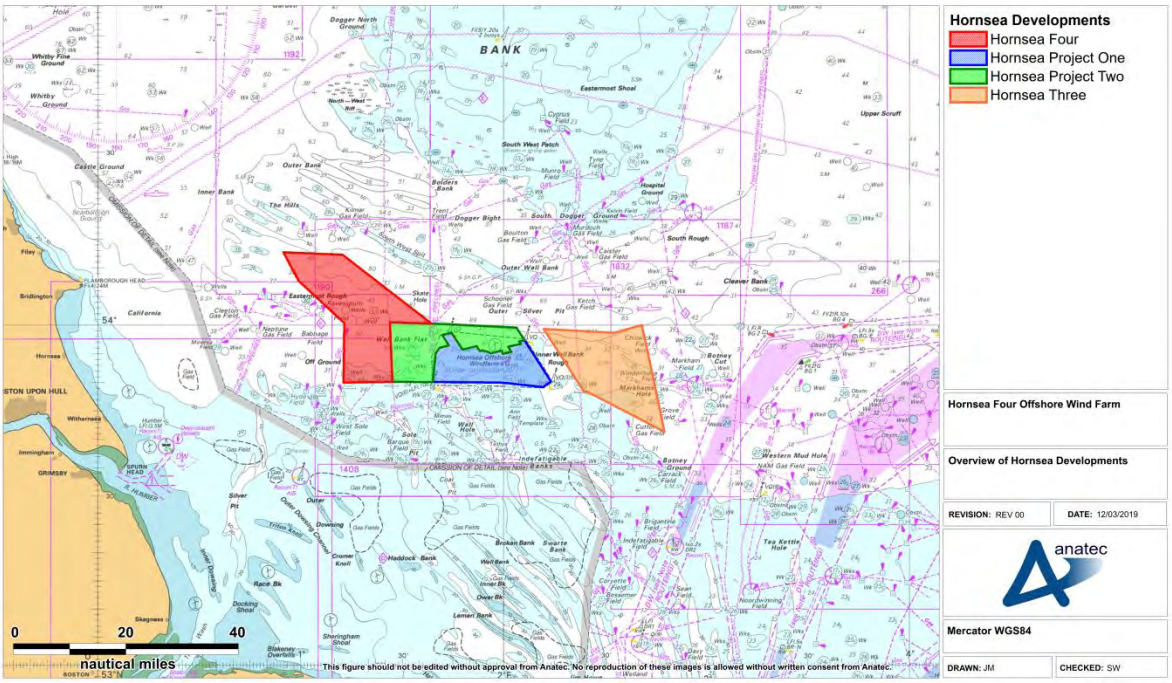


Figure 1. Overview of Hornsea developments

Anatec has been contracted by Orsted Hornsea Project Four UK Ltd. to provide technical support on shipping and navigation during the consent process, and to coordinate consultation with stakeholders. Therefore, we are writing to you on behalf of Orsted A/S to inform you of our relationship with Hornsea Four and to kindly request your comments, which will help inform the proposed development.

The Environmental Impact Assessment process requires Orsted Hornsea Project Four UK Ltd. to identify impacts that Hornsea Four may potentially have upon shipping and navigation, and to ensure consultation is carried out comprehensively and consistently. In order to analyse shipping movements within and in the vicinity of the Hornsea Four array area, Automatic Identification System (AIS), visual observations, and Radar data obtained from vessel-based surveys has been collected and assessed, and will feed into the Navigational Risk Assessment (NRA) required by the Maritime and Coastguard Agency (MCA).

According to the assessment of AIS, visual and Radar data, your company's vessel(s) has regularly navigated within, and/or in the vicinity of, the Hornsea Four array area and consequently your company has been identified as a potential Marine Stakeholder for Hornsea Four. We therefore invite your feedback on the potential development including any impact it may have upon the navigation of vessels.

We would be grateful if you could provide us with any comments or feedback that you may have by the 31st May 2019. This will allow us to assess your feedback as part of the NRA which is currently being undertaken. We would also be grateful if you could forward a copy of this information to any vessel operators/owners you feel may be interested in commenting.

In particular, we are keen to receive comments on the following:

1. Whether the proposal to construct Hornsea Four is likely to impact the routeing of any specific vessels, including the nature of any change in regular passage;
2. Whether any aspect of Hornsea Four poses any safety concerns to your vessels, including any adverse weather routeing;

3. Whether you would choose to make passage internally through the array;
4. Whether you wish to be retained on our list of Marine Stakeholders and consulted throughout the NRA process; and
5. Whether you wish to attend a Hazard Workshop being held in central London in June where impacts relating to shipping and navigation will be discussed.

Responses should be sent via email to [redacted]. Should you have any queries about the published information or require any further information to support your review, please do not hesitate to contact us.

Yours sincerely,

[redacted]

Anatec Ltd

cc. [redacted] - Orsted Hornsea Project Four UK Ltd

Appendix E Vessel Traffic Surveys 2019

754. As with Section 15, this appendix presents shipping data in relation to three areas – the Hornsea Four array area, offshore ECC and HVAC booster station search area shipping and navigation study areas. The data is intended to serve as a secondary source for characterising vessel traffic movements within and in proximity to the Hornsea Four array area, offshore ECC and HVAC booster station search area.

755. It is noted that throughout this appendix current UKHO Admiralty Charts reflecting the baseline features as described in Section 10. The 2019 vessel traffic survey data does not reflect some of the changes in the baseline since the time of collection. In particular, Hornsea Project One was under construction (not operational), Hornsea Project Two was not yet under construction and the Tolmount surface platform was not yet in situ.

E.1 Vessel Traffic Survey Methodology

756. As with the 2020/21 vessel traffic surveys analysed in Section 15, baseline shipping activity for the Hornsea Four array area and HVAC booster station search area was assessed using AIS, visual observations and Radar track data recorded from the Karima survey vessel located at the Hornsea Four array area and HVAC booster station search area. In line with standard practice, a vessel-based traffic survey of the sections of the Hornsea Four offshore ECC outside of the Hornsea Four HVAC booster station area shipping and navigation study area was not required.

757. The vessel traffic data for the 2019 baseline navigation review of the Hornsea Four array area includes a combined dataset of 28 full days of AIS, visual observations and Radar across two survey periods:

- 11th January to 1st February 2019 (14 days winter); and
- 19th July to 2nd August 2019 (14 days summer).

758. The vessel traffic data for the 2019 baseline navigation review of the Hornsea Four HVAC booster station search area includes a combined dataset of 28 full days of AIS, visual observations and Radar across two survey periods:

- 13th January to 15th February 2019 (14 days winter); and
- 3rd to 17th August 2019 (14 days summer).

759. For the Hornsea Four offshore ECC, AIS data from onshore sources has been used given the large extent covered by the Hornsea Four offshore ECC shipping and navigation study area.

E.2 Hornsea Four Array Area

760. A number of tracks recorded during the Hornsea Four array area survey periods were classified as temporary (non-routine), such as the tracks of the survey vessel

and tracks of vessels associated with the construction of Hornsea Project One. These have therefore been excluded from the analysis. Oil and gas vessels operating at permanent installations were retained in the analysis.

761. A plot of the vessel tracks recorded during a 14-day survey period in July and August 2019 (summer), colour-coded by vessel type and excluding temporary traffic, is presented in Figure E.2. A plot of the vessel tracks recorded during a further 14-day survey period in January and February 2019 (winter), colour-coded by vessel type and excluding temporary traffic, is presented in Figure E.3.

762. Plots of the vessel tracks for the summer and winter survey periods converted to a density heat map are presented in Figure E.4 and Figure E.5, respectively.

E.2.1 Vessel Counts

763. For the 14 days analysed in the summer survey period, there were an average of 27 unique vessels per day recorded within the Hornsea Four array area shipping and navigation study area. In terms of vessels intersecting the Hornsea Four array area itself, there was an average of 11 unique vessels per day.

764. Figure E.1 illustrates the daily number of unique vessels recorded within the Hornsea Four array area shipping and navigation study area and the Hornsea Four array area itself during the summer survey period. Throughout the summer survey period approximately 39% of unique vessel tracks recorded within the Hornsea Four array area shipping and navigation study area intersected the Hornsea Four array area itself.

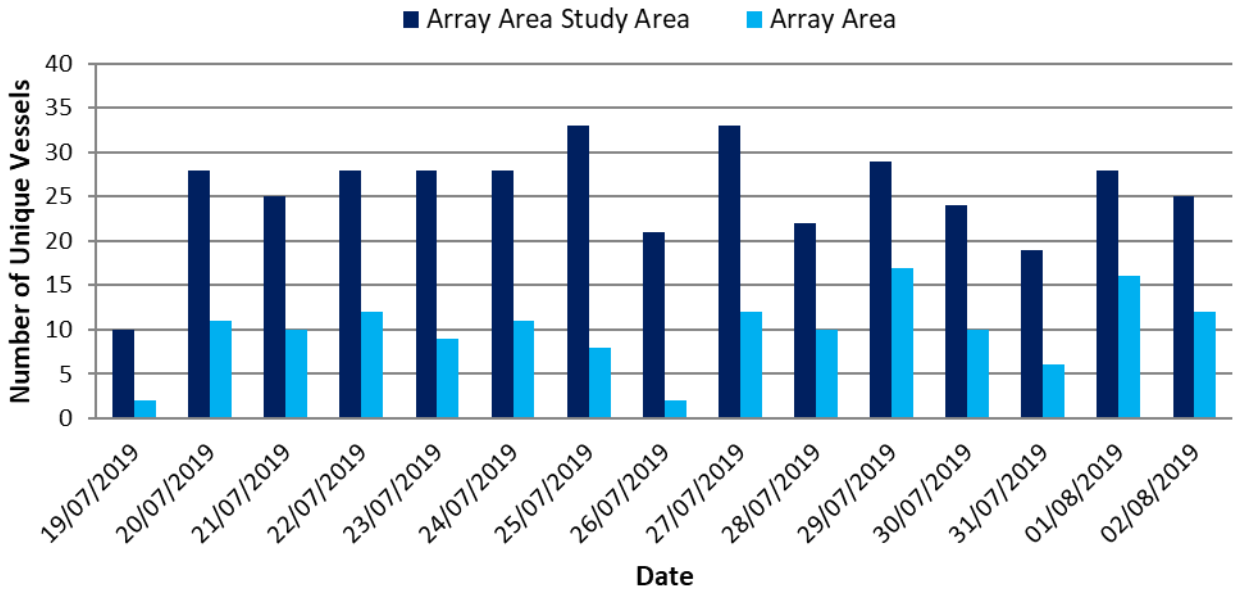


Figure E.1 Unique vessels per day within Hornsea Four array area and shipping and navigation study area (14 days summer 2019)

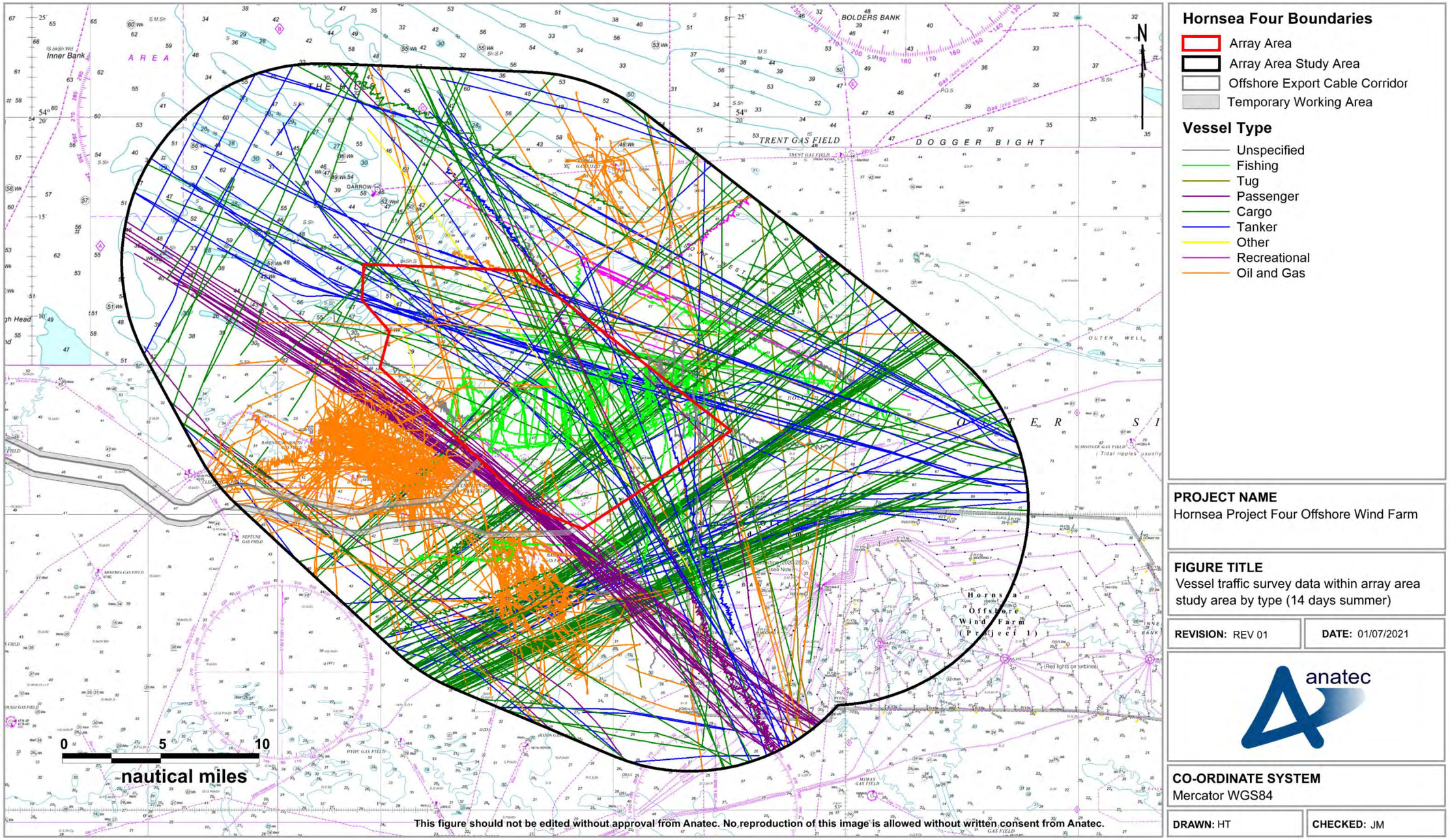


Figure E.2 **Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel type (14 days summer 2019)**

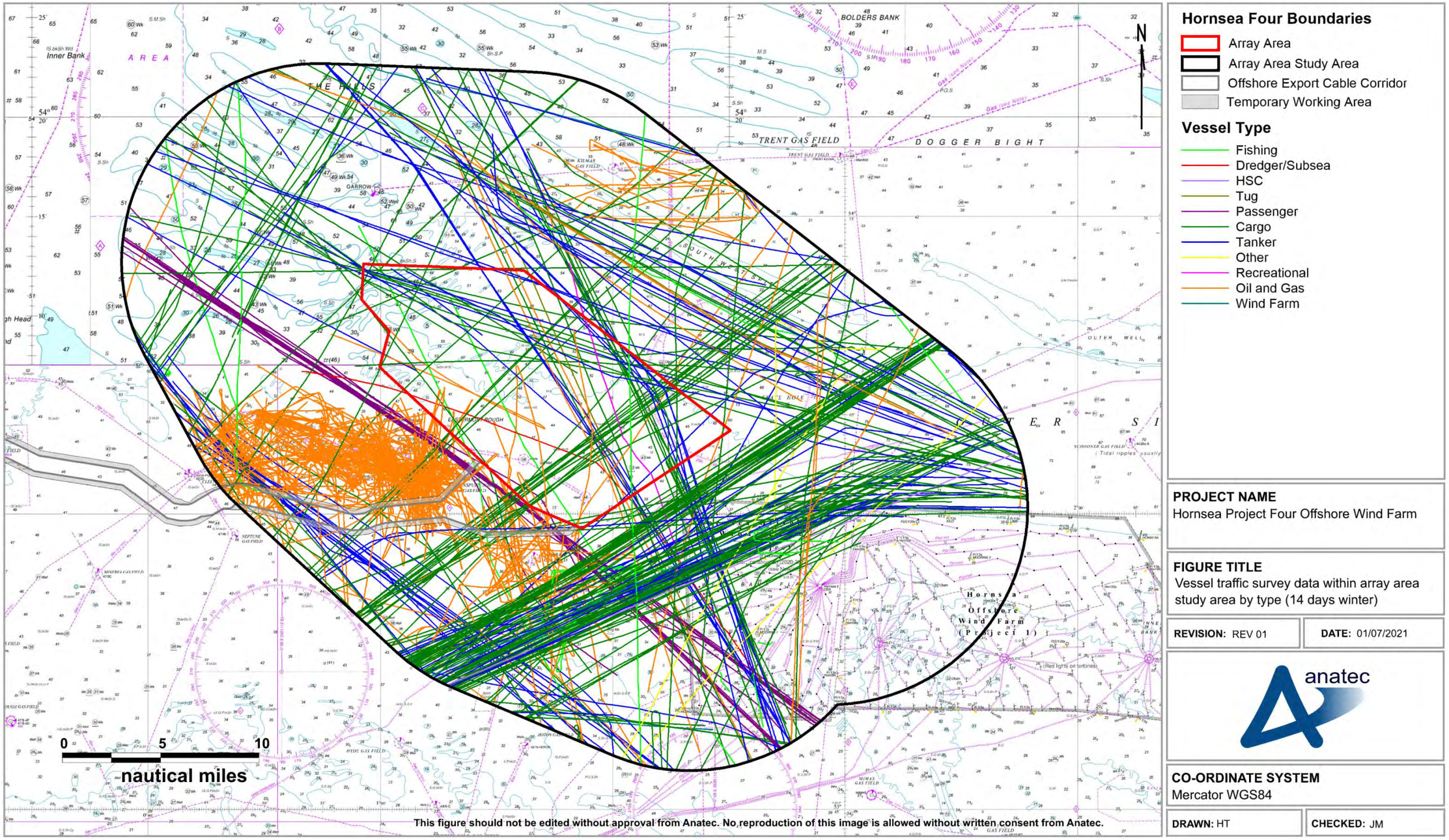


Figure E.3 **Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel type (14 days winter 2019)**

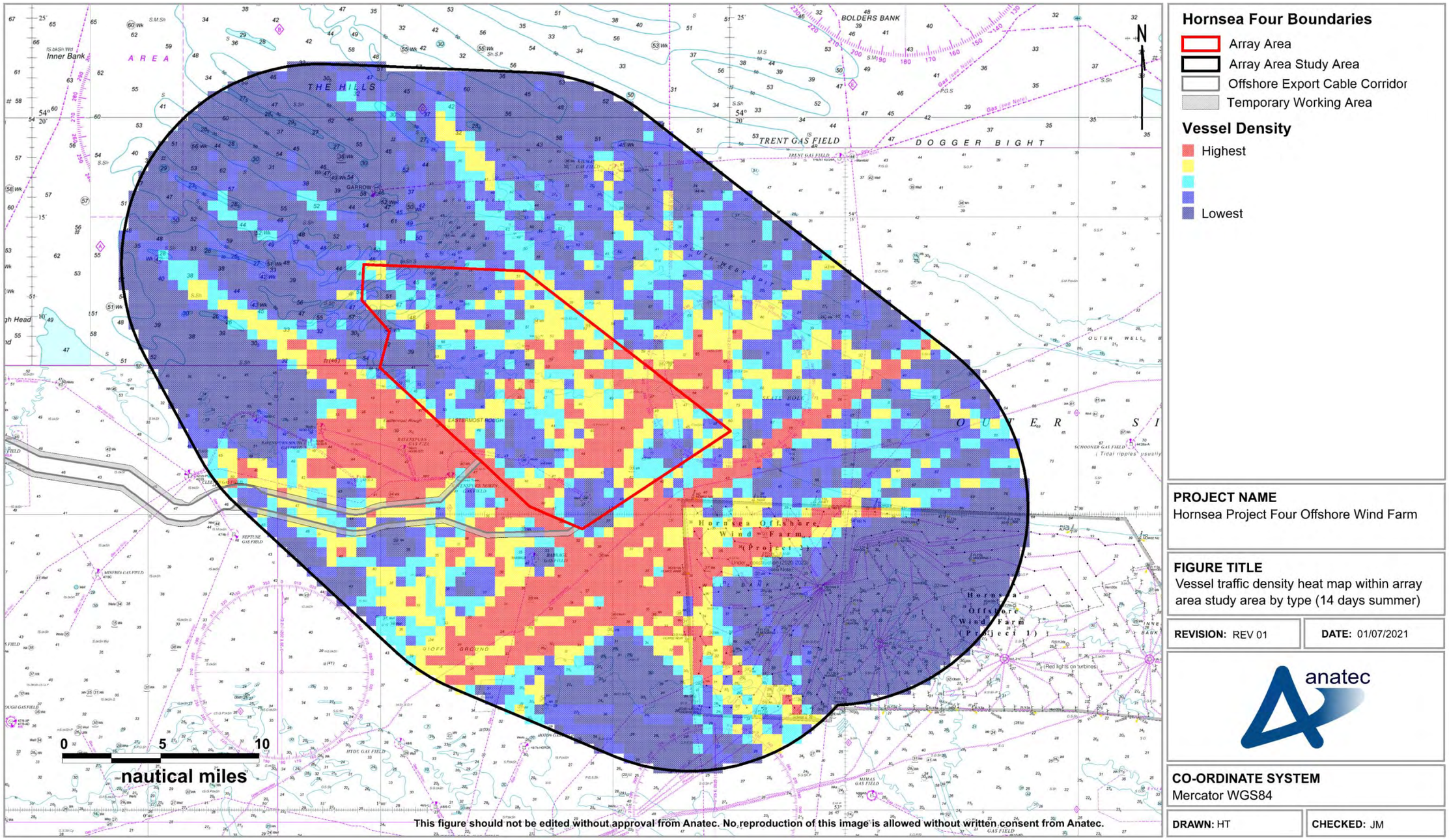


Figure E.4 **Vessel traffic density heat map within Hornsea Four array area shipping and navigation study area excluding temporary traffic (14 days summer 2019)**

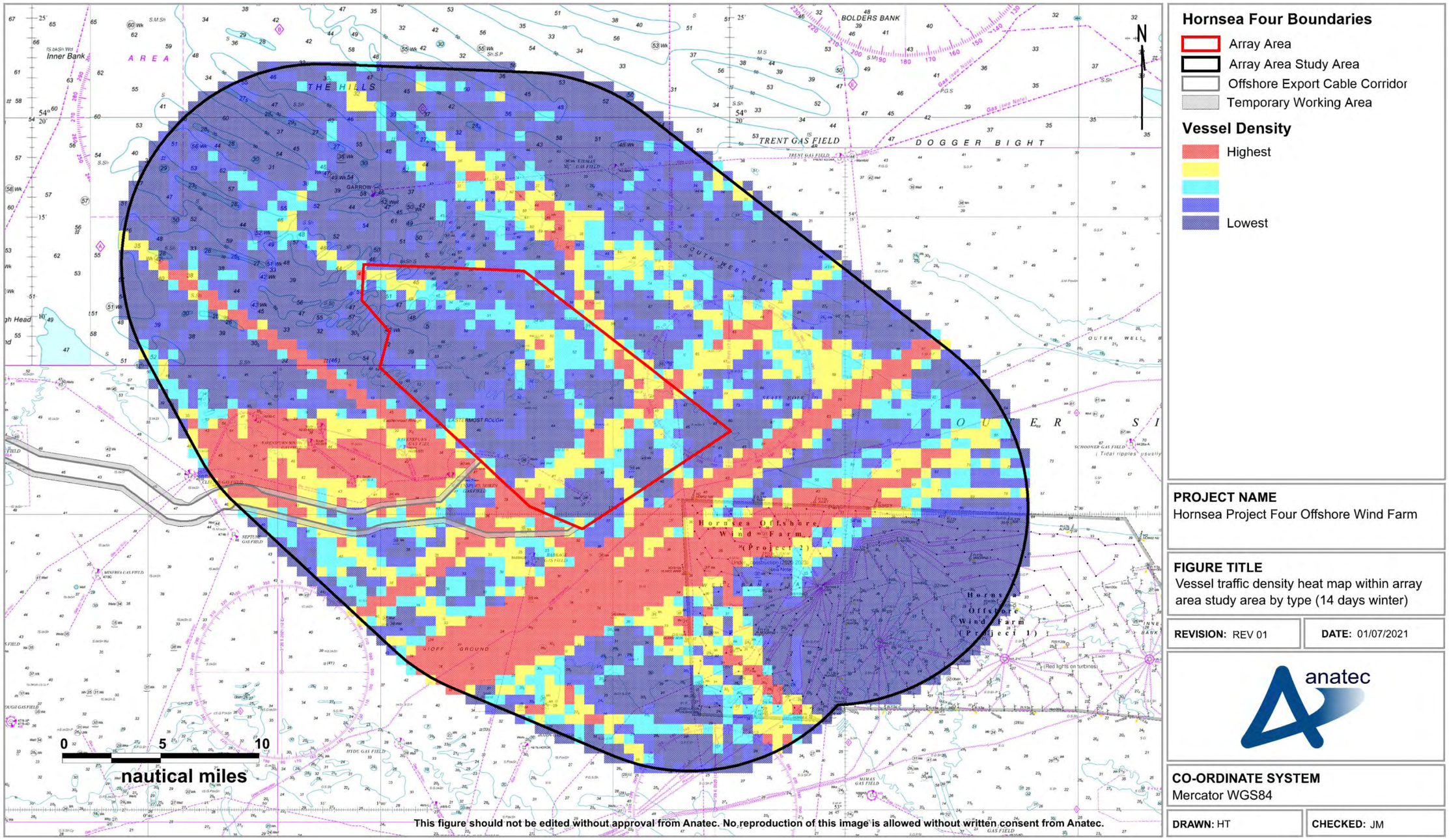


Figure E.5 **Vessel traffic density heat map within Hornsea Four array area shipping and navigation study area excluding temporary traffic (14 days winter 2019)**

765. The busiest days recorded within the Hornsea Four array area shipping and navigation study area throughout the summer survey period were 25th and 27th July 2019 when 33 unique vessels were recorded. The busiest day recorded within the Hornsea Four array area itself throughout the summer survey period was 29th July 2019 when 17 unique vessels were recorded.

766. The quietest full day recorded throughout the summer survey period was 31st July 2019 when 19 unique vessels were recorded within the Hornsea Four array area shipping and navigation study area. The quietest full day recorded within the Hornsea Four array area itself throughout the summer survey period was 26th July 2019 when two unique vessels were recorded.

767. For the 14 days analysed in the winter survey period, there were an average of 26 unique vessels per day recorded within the Hornsea Four array area shipping and navigation study area. In terms of vessels intersecting the Hornsea Four array area itself, there was an average of seven unique vessels per day.

768. Figure E.6 illustrates the daily number of unique vessels recorded within the Hornsea Four array area shipping and navigation study area and the Hornsea Four array area itself during the winter survey period. Throughout the winter survey period approximately 25% of unique vessel tracks recorded within the Hornsea Four array area shipping and navigation study area intersected the Hornsea Four array area.

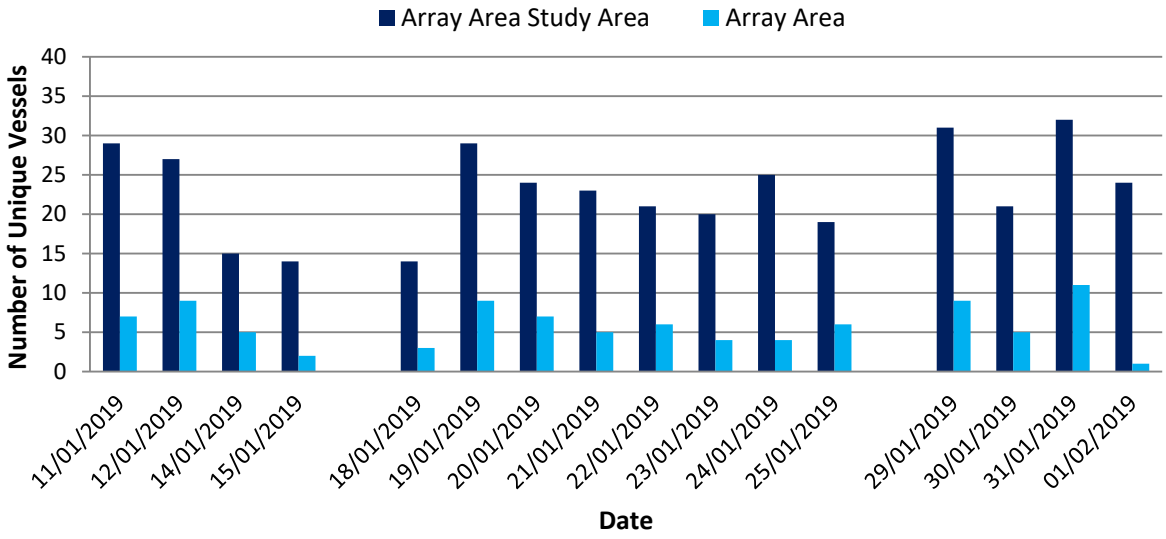


Figure E.6 Unique vessels per day within Hornsea Four array area and shipping and navigation study area (14 days winter 2019)

769. The busiest day recorded within the Hornsea Four array area shipping and navigation study area throughout the winter survey period was the 31st January 2019 when 32 unique vessels were recorded. The busiest day recorded within the Hornsea Four array area itself throughout the winter survey period was the and 31st January 2019 when 11 unique vessels were recorded.

770. The quietest full days recorded throughout the winter survey period were the 15th and 18th January 2019 when 14 unique vessels were recorded within the Hornsea Four array area shipping and navigation study area. The quietest day recorded for the array area itself was the 1st February 2019 when one vessel was recorded.

E.2.2 Vessel Types

771. The percentage distribution of the main vessel types recorded passing within the Hornsea Four array area shipping and navigation study area is presented in Figure E.7.

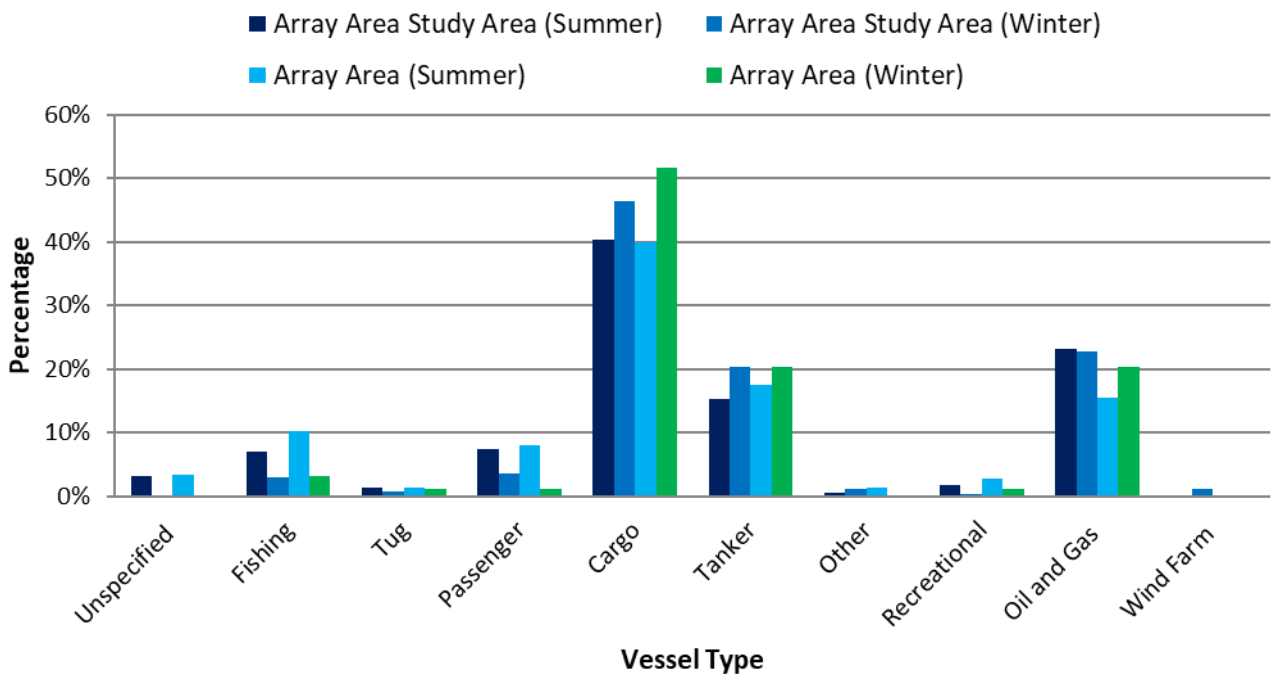


Figure E.7 Vessel type distribution within Hornsea Four array area and shipping and navigation study area (28 days summer and winter 2019)

772. Throughout the summer period, the main vessel types were cargo vessels (40% within the Hornsea Four array area), tankers (18%) and oil and gas vessels (16%). Throughout the winter period, the main vessel types were also cargo vessels (52% within the Hornsea Four array area), tankers (20%) and oil and gas vessels (20%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo. Details specific to commercial ferries are presented in Section E.2.5.

E.2.2.1 Cargo Vessels

773. Figure E.8 presents a plot of cargo vessels, including commercial ferries, recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

774. Throughout the survey period an average of 12 unique cargo vessels per day passed within the Hornsea Four array area shipping and navigation study area. Regular cargo vessels operating in proximity to the Hornsea Four array area include Ro Ro vessels primarily operated by DFDS Seaways running routes between Immingham and Esbjerg, Immingham and Gothenburg and North Shields and Ijmuiden.

E.2.2.2 Oil and Gas Vessels

775. Figure E.9 presents a plot of oil and gas vessels recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

776. Throughout the survey periods, an average of six unique oil and gas vessels per day passed within the Hornsea Four array area shipping and navigation study area. The majority of these vessels were on passage to/from oil and gas installations in the region. Oil and gas vessels which were not transient included the *Island Condor* acting as a walk to work vessel for the nearby Ravenspurn gas field and the *Putford Defender* and *Putford Saviour*, both acting as ERRV for Ravenspurn. Vessel activity was also present at the Babbage and Kilmar gas fields.

E.2.2.3 Tankers

777. Figure E.10 presents a plot of tankers recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

778. Throughout the survey period, an average of five unique tankers per day passed within the Hornsea Four array area shipping and navigation study area. All of the tankers recorded throughout the survey period were on passage to oil and gas terminals throughout the UK and mainland Europe including Rotterdam and Antwerp.

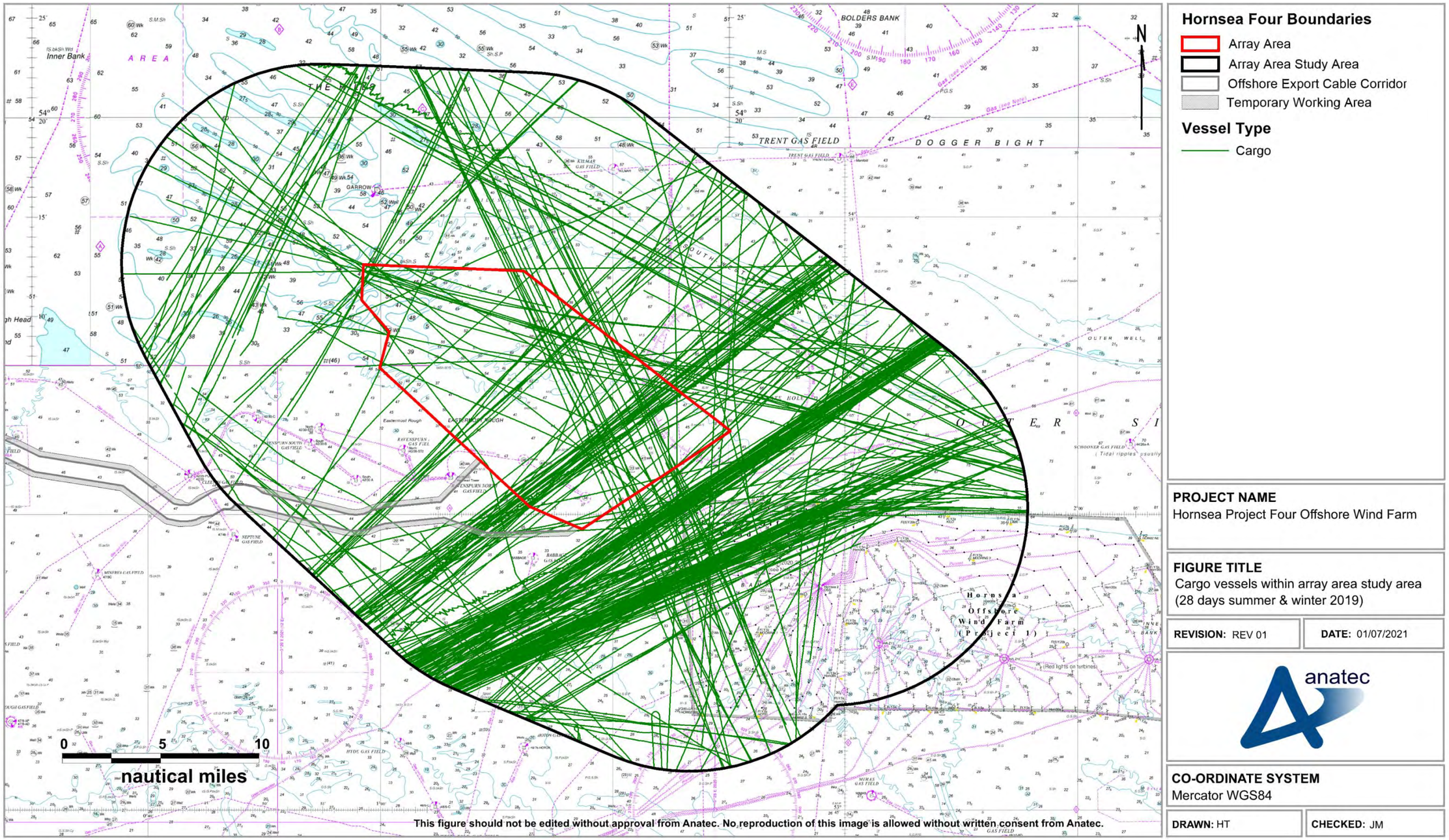
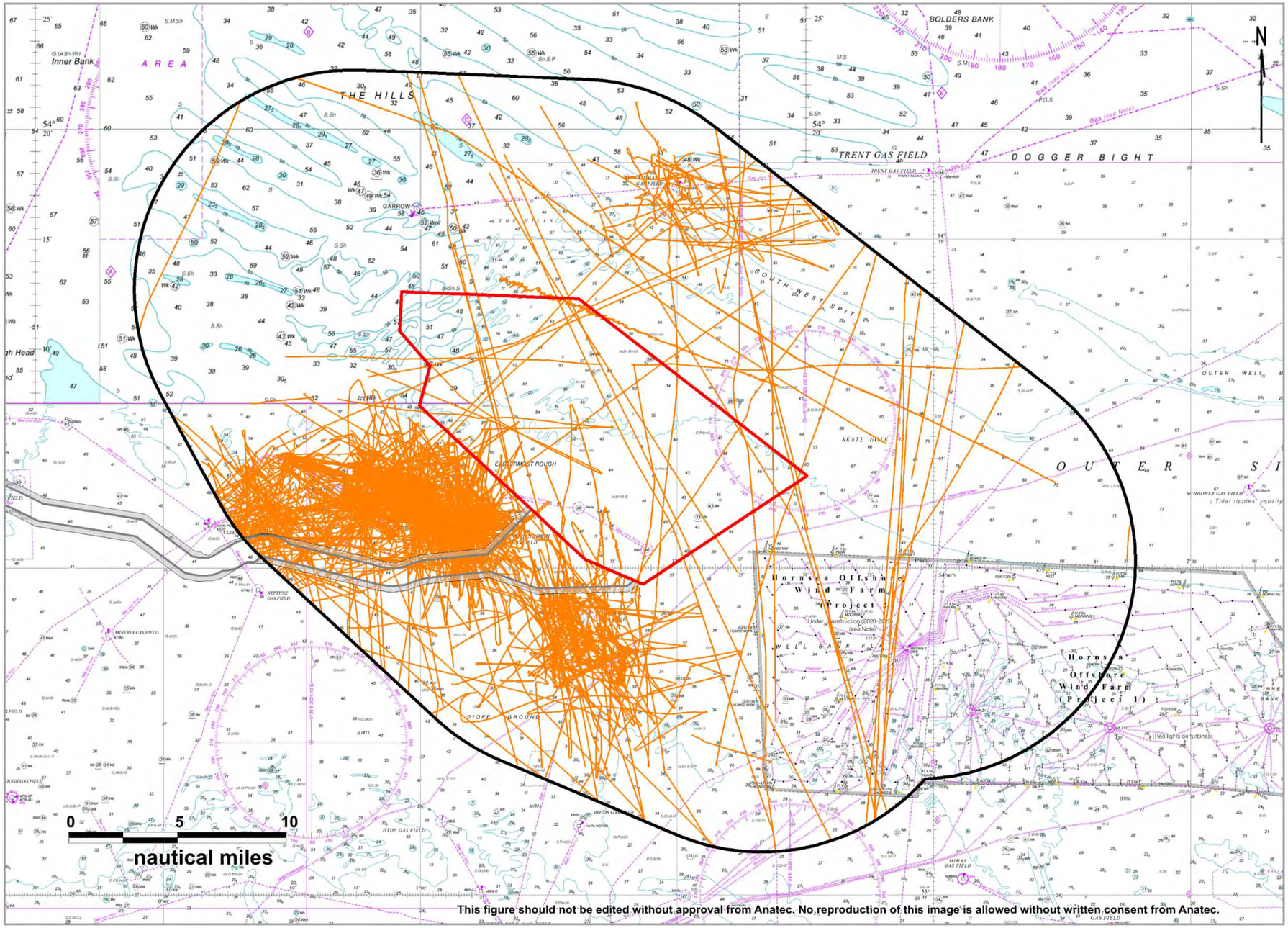


Figure E.8 Cargo vessels within Hornsea Four array area shipping and navigation study area (28 days summer and winter 2019)



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Hornsea Four Boundaries

- Array Area
- Array Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Vessel Type

- Oil and Gas

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Oil and gas vessels within array area study area (28 days summer & winter 2019)

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Figure E.9 Oil and gas support vessels within Hornsea Four array area shipping and navigation study area (28 days summer and winter 2019)

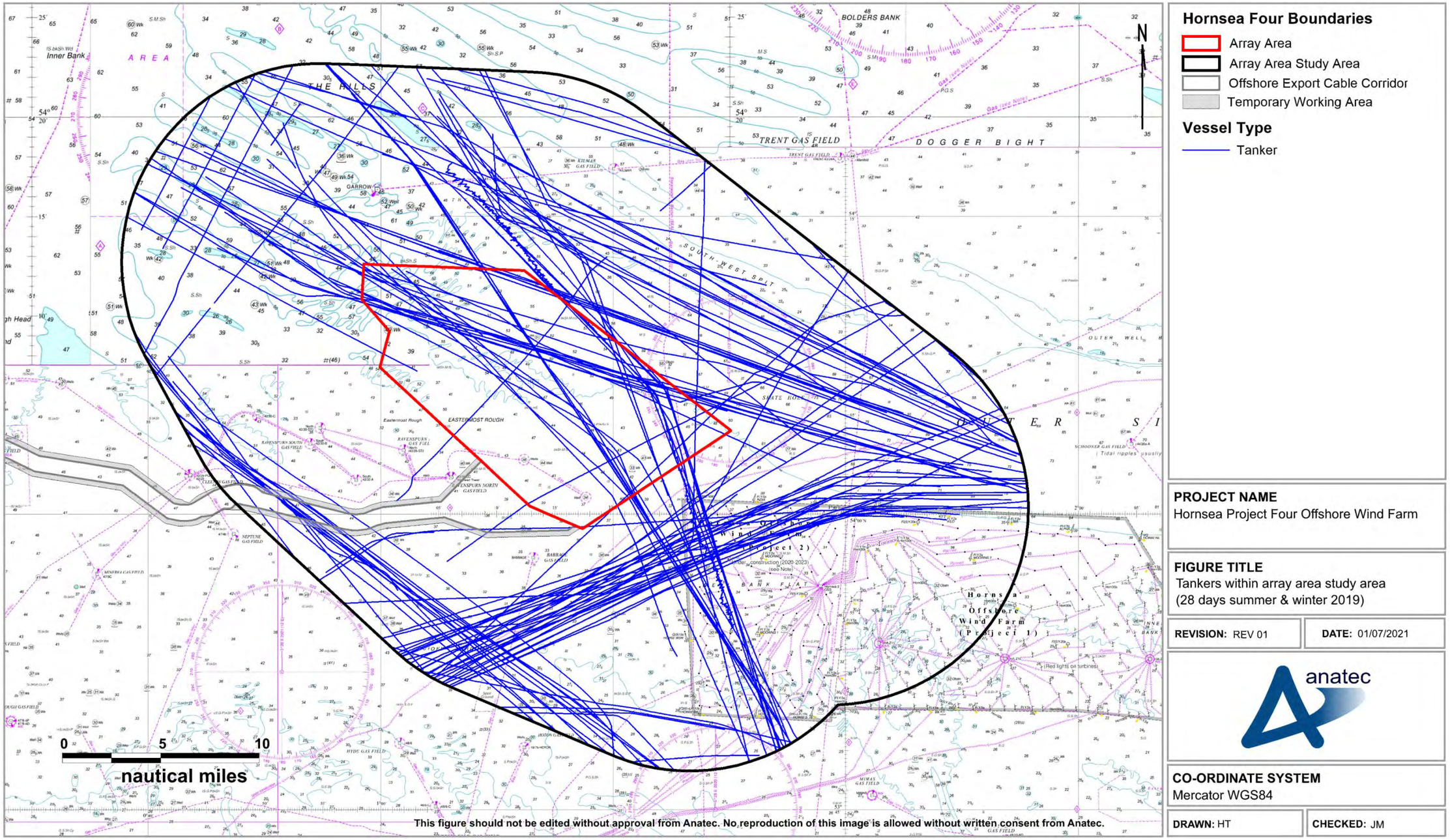


Figure E.10 Tankers within Hornsea Four array area shipping and navigation study area (28 days summer and winter 2019)

E.2.3 Vessel Sizes

E.2.3.1 Vessel Length

779. Vessel LOA was available for approximately 96% of vessels recorded throughout the survey periods and ranged from 10 m for a small yacht to 294 m for a large cruise ship. Figure E.11 illustrates the distribution of vessel lengths recorded throughout each survey period.

780. Excluding the small proportion of vessels for which a length was not available the average length of vessels within the Hornsea Four array area shipping and navigation study area throughout the summer and winter survey periods were 121 m and 133 m, respectively. The proportion of smaller vessels (<50 m) indicated limited seasonal variation for fishing vessels.

781. Figure E.12 presents a plot of all vessel tracks (excluding temporary traffic) recorded within the Hornsea Four array area shipping and navigation study area throughout the survey periods, colour-coded by vessel length.

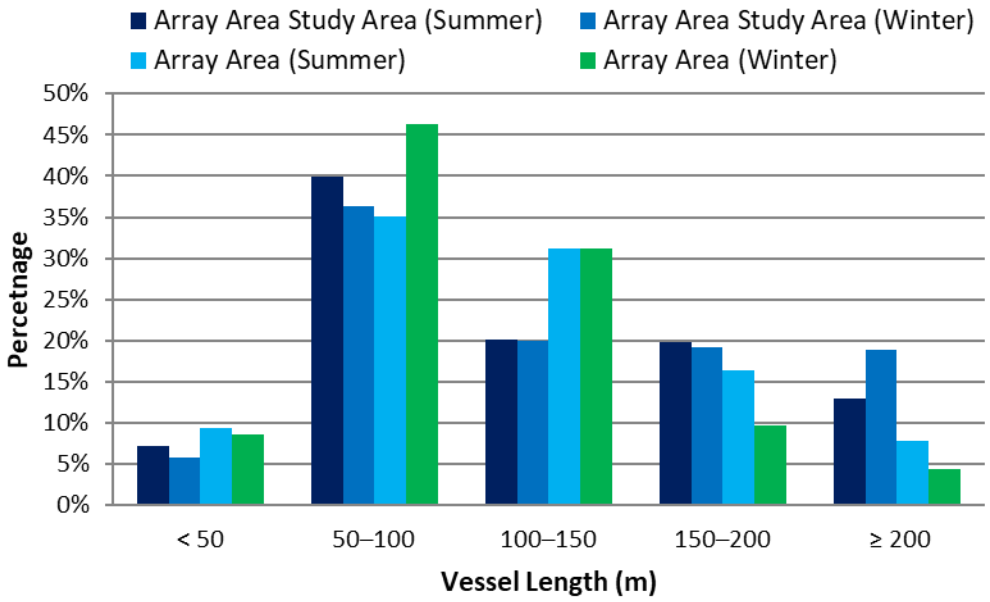
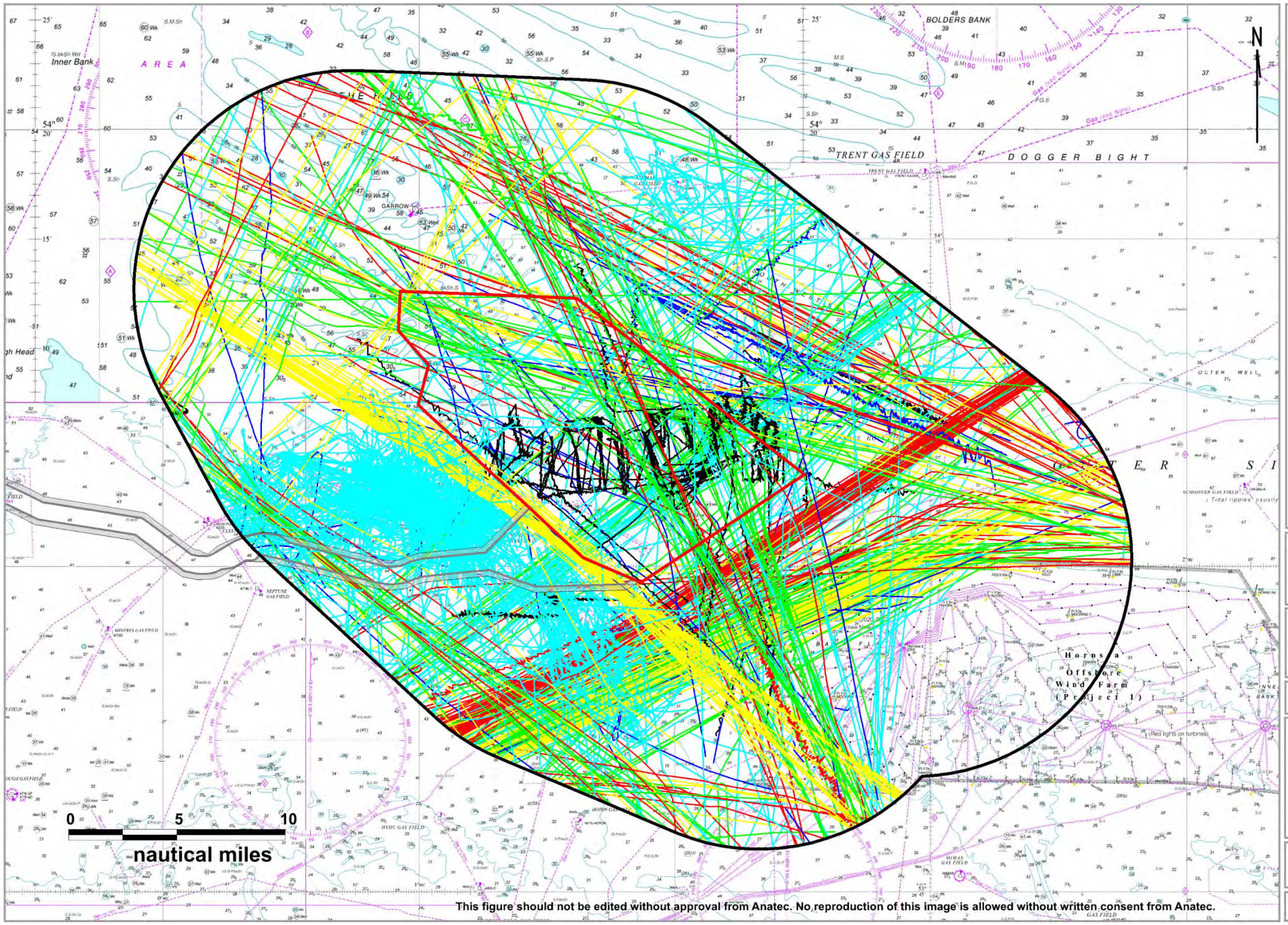


Figure E.11 Vessel length distribution within Hornsea Four array area and shipping and navigation study area (28 days summer and winter 2019)



Hornsea Four Boundaries

- Array Area
- Array Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Vessel Length (m)

- Unspecified
- < 50
- 50-100
- 100-150
- 150-200
- >= 200

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Vessel traffic survey data within array area study area by length (28 days summer & winter)

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Figure E.12 Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel length (28 days summer and winter 2019)

E.2.3.2 Vessel Draught

782. Vessel draught was available for approximately 91% of vessel tracks recorded on AIS throughout the survey periods and ranged from 0.4 m for a fishing vessel to 14.3 m for a large bulk carrier (noting that a draught of 0.4 m is exceptionally low – the second lowest draught was 2.0 m for a grab dredger). Figure E.13 illustrates the distribution of vessel draughts recorded throughout each survey period.

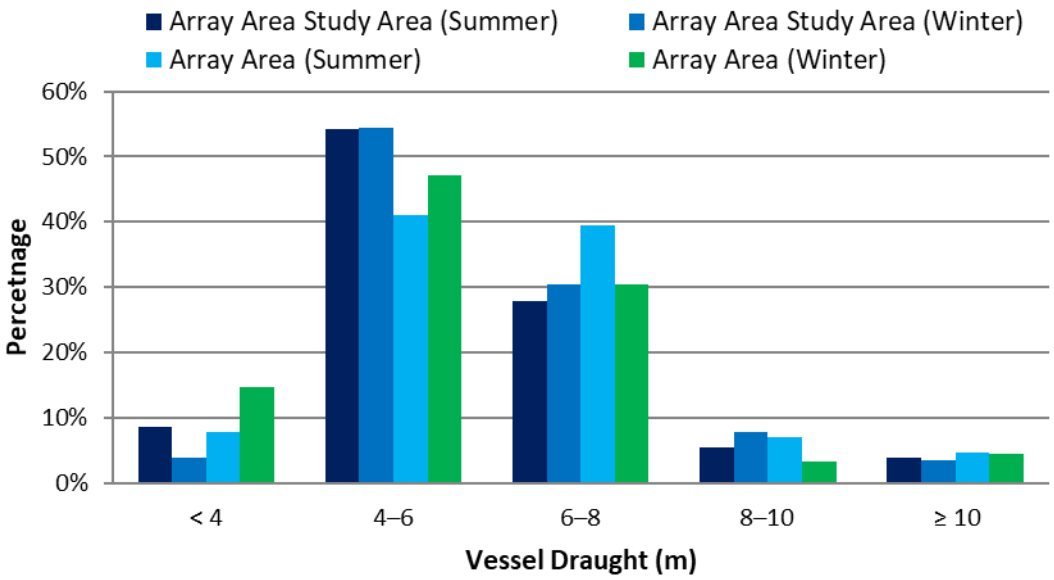

Figure E.13 Vessel draught distribution within Hornsea Four array area shipping and navigation study area (28 days summer and winter 2019)

783. Excluding those vessels for which a draught was not available (mainly non-AIS vessels) the average draught of vessels within the Hornsea Four array area shipping and navigation study area throughout the summer and winter survey periods were 5.7 m and 6.0 m, respectively. There was limited seasonal variation with slightly more vessels with draughts less than 4 m observed in the summer survey period within the Hornsea Four array area shipping and navigation study area.

784. Figure E.14 presents a plot of AIS, visual and Radar vessel tracks (excluding temporary traffic) recorded within the Hornsea Four array area shipping and navigation study area throughout the survey periods, colour-coded by vessel draught.

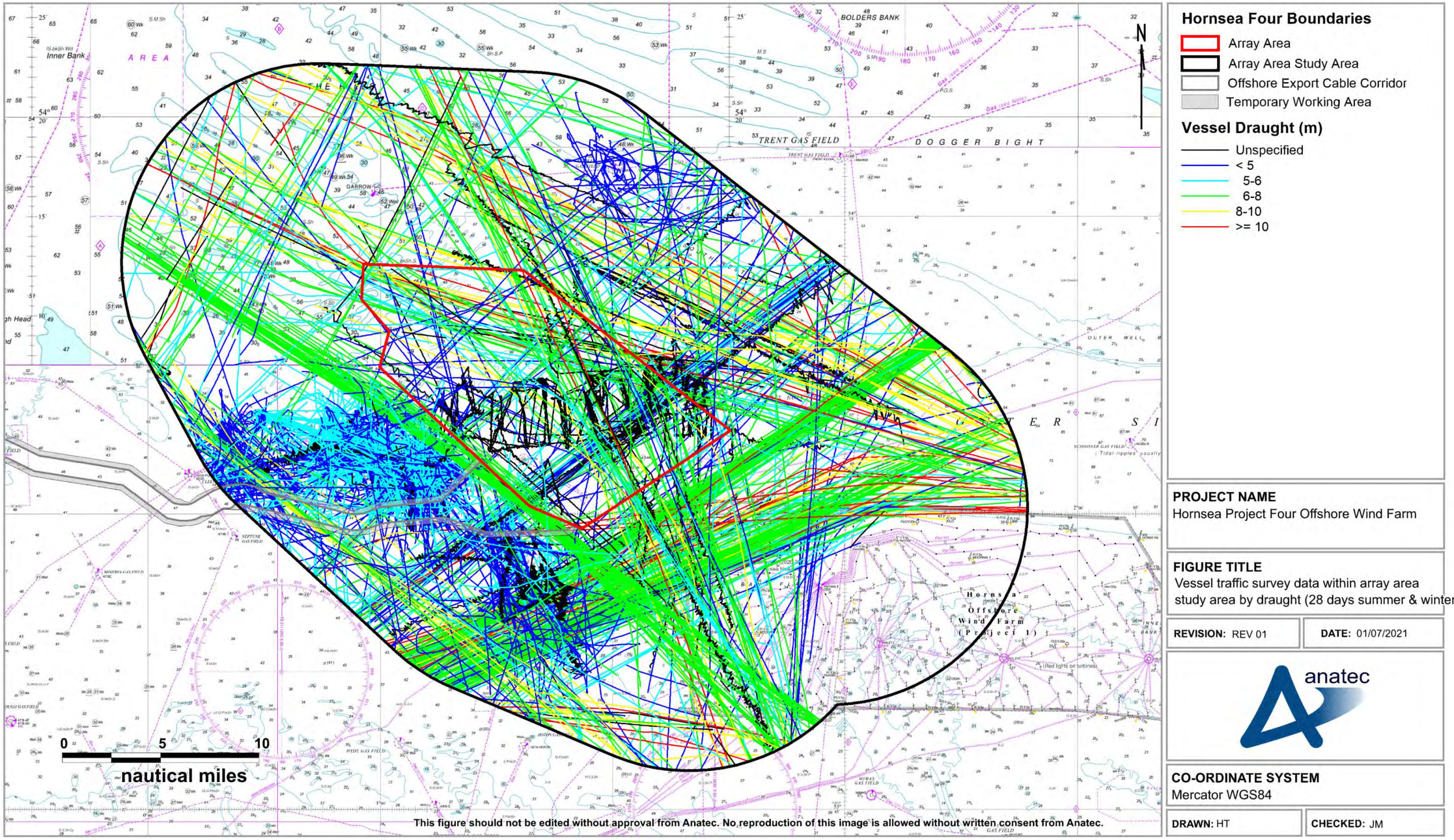

Figure E.14 Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel draught (28 days summer and winter 2019)

E.2.4 Anchored Vessels

785. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS equipment, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

786. For this reason, those vessels which travelled at a speed of less than 1 kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. After applying these criteria, only one vessel was deemed to be at anchor. This was an offshore supply vessel operating at the Ravenspurn Charlie platform approximately 6.2 nm west of the Hornsea Four array area.

E.2.5 Commercial Ferry Activity

787. Throughout the survey periods 16 unique commercial ferries were identified, with 14 undertaking regular routes. Figure E.15 presents a plot of commercial ferries recorded within the Hornsea Four array area shipping and navigation study area throughout the survey periods, colour-coded by route.

788. The most frequently transited commercial ferry route was a DFDS Seaways operated route between Immingham and Esbjerg, with the *Ark Dania* and *Ark Germania* making between one and two transits per day between them within the Hornsea Four array area shipping and navigation study area throughout the survey periods. Two other DFDS Seaways commercial ferry routes were also relatively prominent, with these operating between Immingham and Gothenburg and North Shields and Ijmuiden.

E.2.6 Recreational Vessel Activity

789. For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive and fishing charter trips) of between 2.4 and 24 m LOA.

790. Figure E.16 presents a plot of recreational vessels recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

791. An average of one unique recreational vessel every three to four days passed within the Hornsea Four array area shipping and navigation study area. It is noted that all recreational craft recorded throughout the 28 days (including winter survey period) were recorded on AIS, with no recreational craft recorded on Radar.

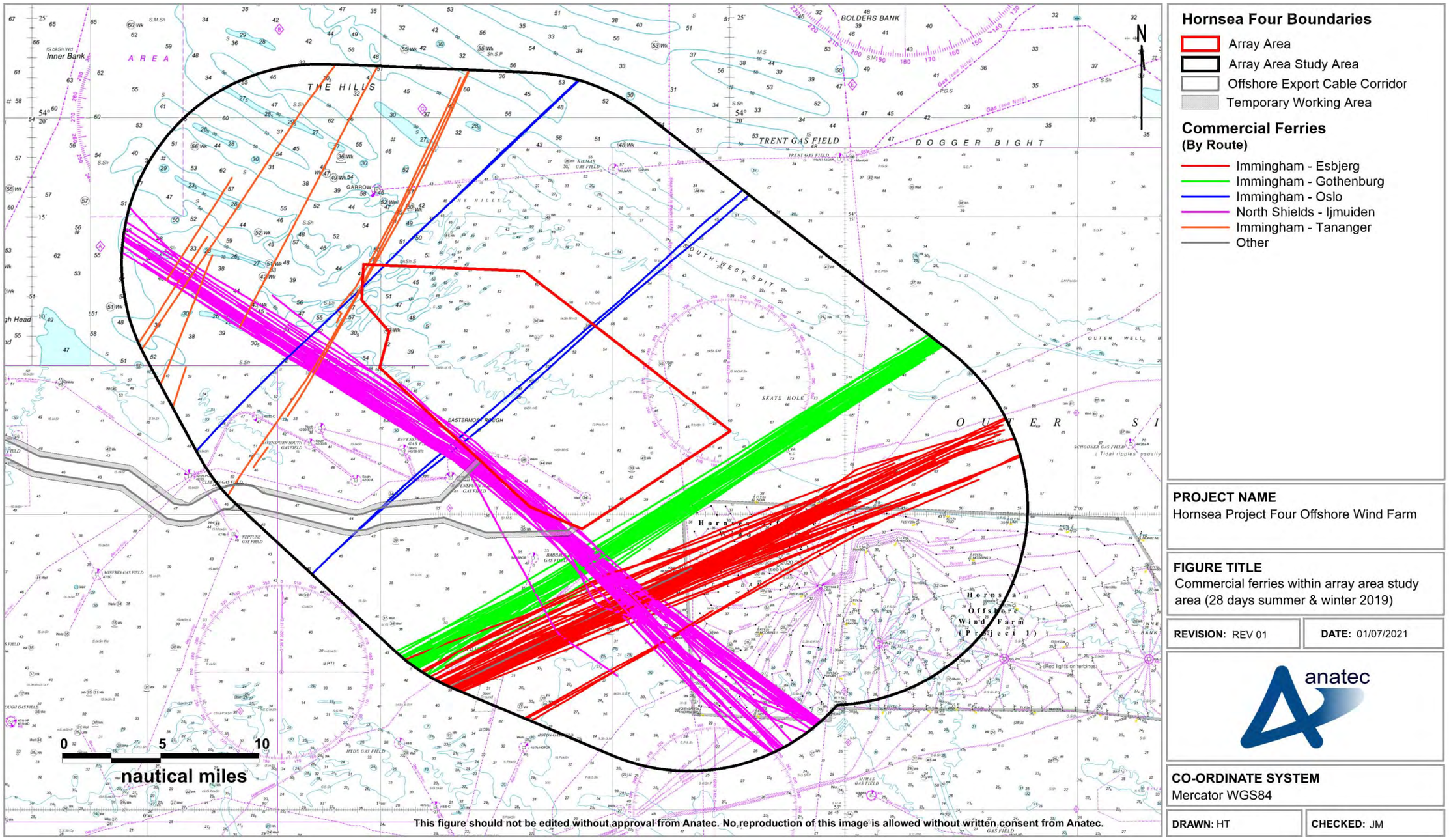

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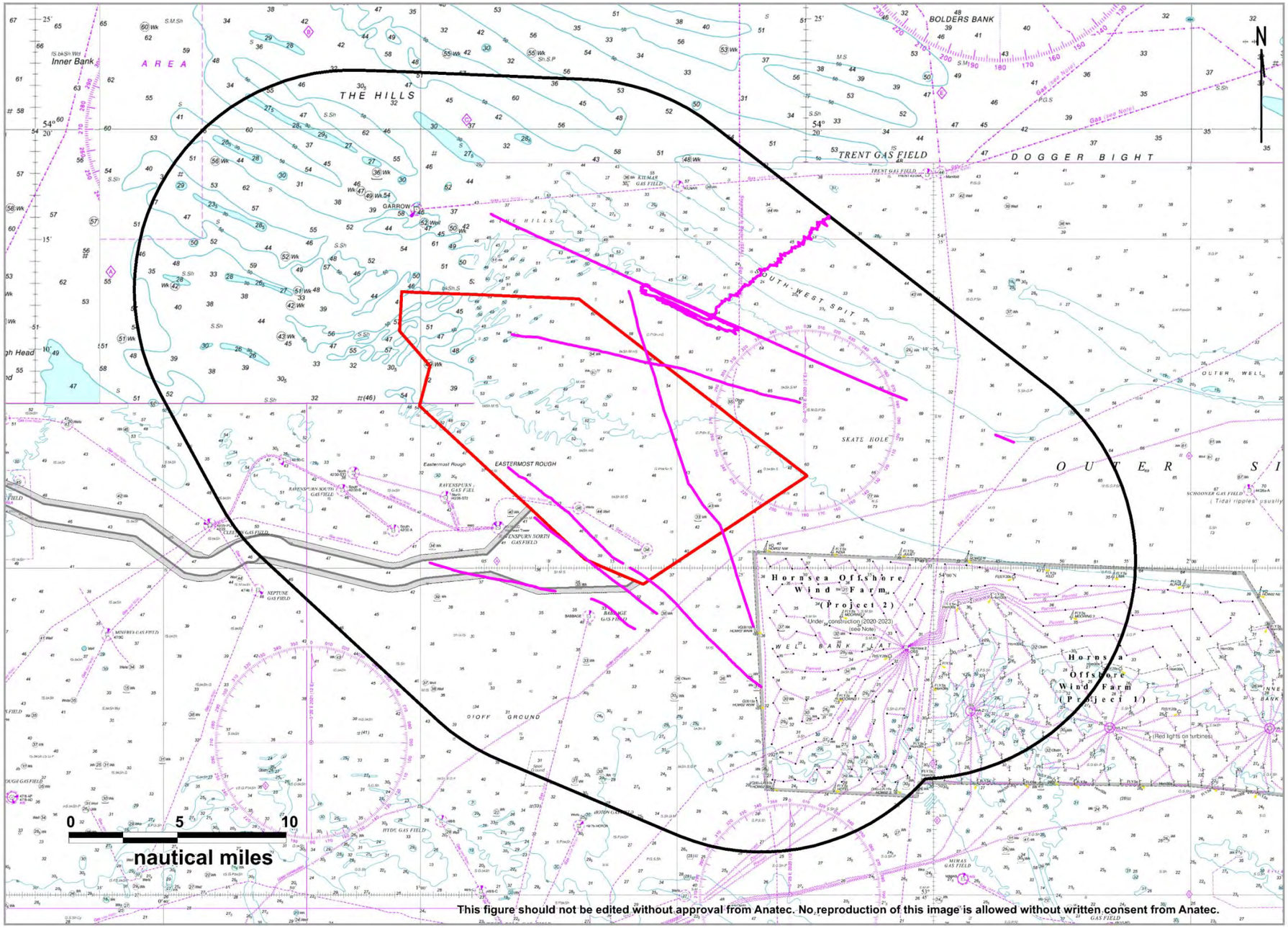
Figure E.15 Commercial ferries within Hornsea Four array area shipping and navigation study area by route (28 days summer and winter 2019)



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Hornsea Four Boundaries
- Array Area
- Array Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Vessel Type
- Recreational

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Recreational vessels within array area study area (28 days summer & winter 2019)

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CO-ORDINATE SYSTEM
Mercator WGS84

DRAWN: HT | **CHECKED:** JM

Figure E.16 Recreational vessels within Hornsea Four array area shipping and navigation study area (28 days summer and winter 2019)

E.2.7 Commercial Fishing Vessels

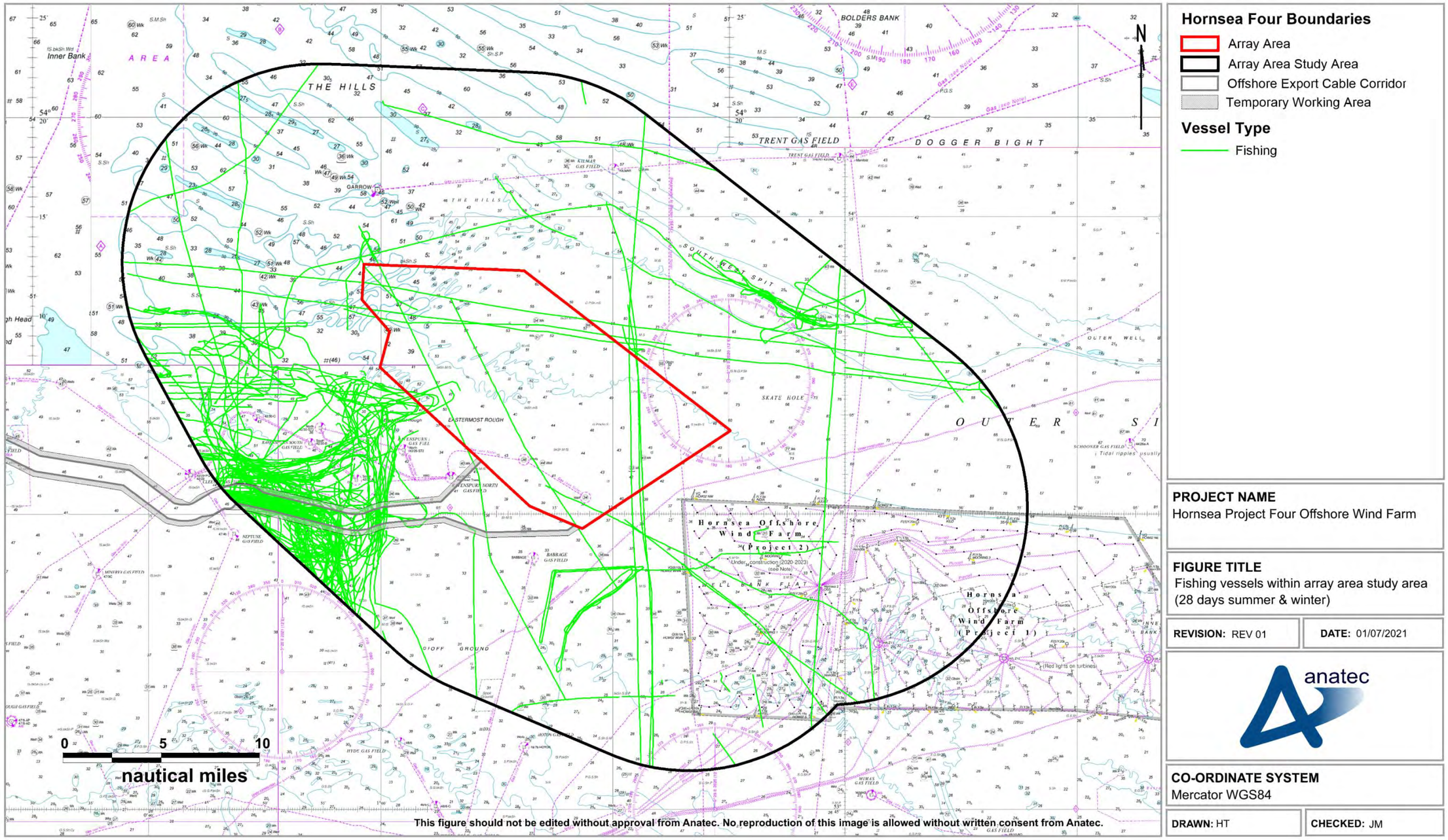
792. Figure E.17 presents a plot of fishing vessels recorded within the Hornsea Four array area shipping and navigation study area throughout both survey periods.

793. An average of one to two unique fishing vessels per day passed within the Hornsea Four array area shipping and navigation study area. It is noted that only one fishing vessel was recorded on Radar throughout the winter survey period, with the rest recorded on AIS. During the summer survey period 11 fishing vessels were recorded on Radar, corresponding to 24% of all fishing vessel traffic recorded. It is noted that AIS is only mandatory for fishing vessels greater than 15 m LOA and fishing vessels smaller than this are less likely to be far offshore i.e. in the proximity of the Hornsea Four array area.

794. Fishing vessel movements were characteristic of both fishing vessels in transit and engaged in fishing activity. Fishing activity both in transit and gear deployed was observed within the Hornsea Four array area.

795. Flag State (nationality) information was available for all fishing vessels recorded on AIS within the Hornsea Four array area shipping and navigation study area. Of the nationalities identified, the most common recorded on AIS were UK (42%), Belgium (23%), and the Netherlands (19%).

796. Primary fishing method information was researched for all fishing vessels recorded on AIS within the Hornsea Four array area shipping and navigation study area. Of the fishing vessel methods identified, the most common were beam trawlers (54%) and demersal trawlers (35%).



Hornsea Four Boundaries

- Array Area
- Array Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Vessel Type

- Fishing

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Fishing vessels within array area study area (28 days summer & winter)

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Figure E.17 Fishing vessels within Hornsea Four array area shipping and navigation study area (28 days summer and winter 2019)

E.3 Hornsea Four Offshore Export Cable Corridor

797. A number of tracks recorded during the Hornsea Four offshore ECC survey periods were classified as temporary (non-routine), such as the tracks of the survey vessel for the Hornsea Four array area and HVAC booster station search area. These have therefore been excluded from the analysis. Oil and gas vessels operating at permanent installations were retained in the analysis.

798. A plot of the vessel tracks recorded during a 28-day survey period in August 2019 (summer) and February 2019 (winter), colour-coded by vessel type and excluding temporary traffic, is presented in Figure E.18.

E.3.1 Vessel Count

799. For the 14 days analysed in the summer survey period, there were an average of 58 unique vessels per day recorded within the Hornsea Four offshore ECC shipping and navigation study area, recorded on AIS. In terms of vessels intersecting the Hornsea Four offshore ECC itself, there was an average of 49 unique vessels per day.

800. Figure E.19 illustrates the daily number of unique vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area and the Hornsea Four offshore ECC itself during the summer survey period. Throughout the summer survey period approximately 86% of vessel tracks recorded within the Hornsea Four offshore ECC shipping and navigation study area intersected the Hornsea Four offshore ECC itself.

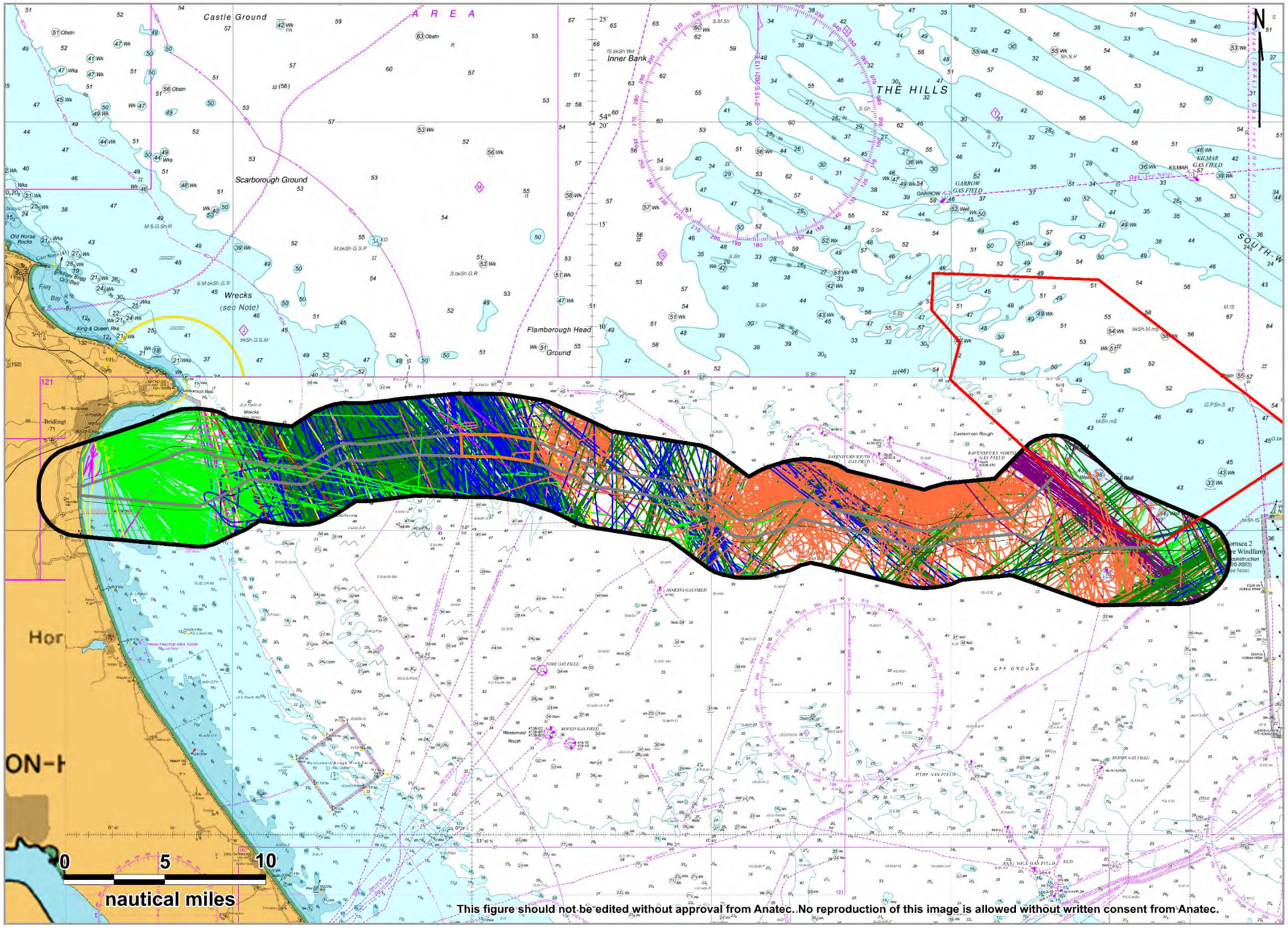

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Figure E.18 **Vessel traffic survey data within Hornsea Four offshore ECC shipping and navigation study area colour-coded by vessel type (28 days summer and winter 2019)**

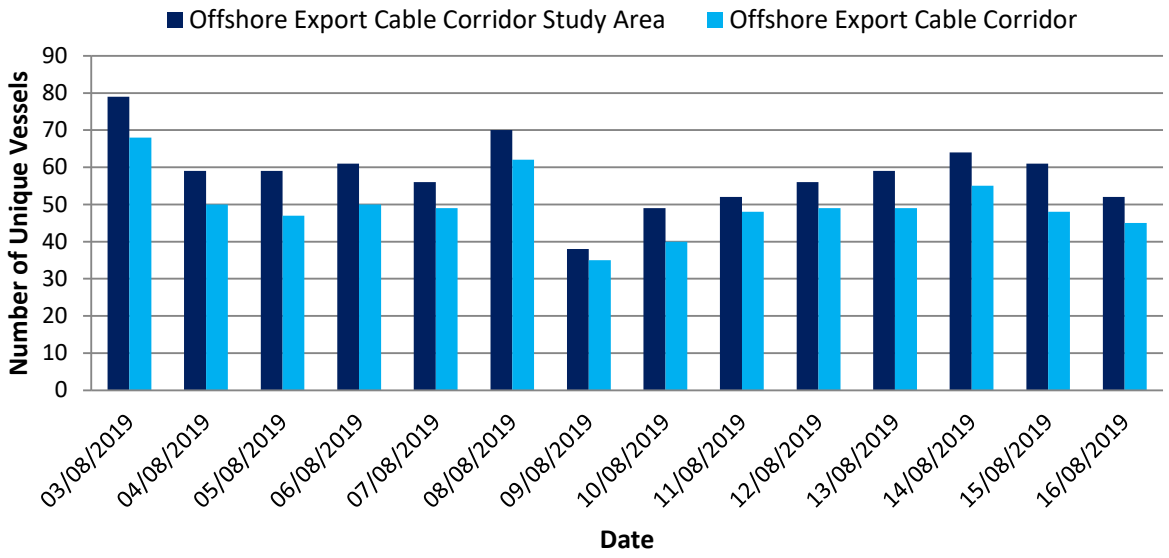


Figure E.19 Unique vessels per day within Hornsea Four offshore ECC and shipping and navigation study area (14 days summer 2019)

801. The busiest day recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the summer survey period was 3rd August 2019 when 79 unique vessels were recorded. This was also the busiest day recorded within the Hornsea Four offshore ECC itself throughout the summer survey period with 69 unique vessels recorded.

802. The quietest day recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the summer survey period was 9th August 2019 when 38 unique vessels were recorded. This was also the quietest day recorded within the Hornsea Four offshore ECC itself throughout the summer survey period with 35 unique vessels recorded.

803. For the 14 days analysed in the winter survey period, there were an average of 49 unique vessels per day recorded within the Hornsea Four offshore ECC shipping and navigation study area, recorded on AIS, visual and Radar. In terms of vessels intersecting the Hornsea Four offshore ECC itself, there was an average of 42 unique vessels per day.

804. Figure E.20 illustrates the daily number of unique vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area and the Hornsea Four offshore ECC itself during the winter survey period. Throughout the winter survey period approximately 87% of vessel tracks recorded within the Hornsea Four offshore ECC shipping and navigation study area intersected the Hornsea Four offshore ECC.

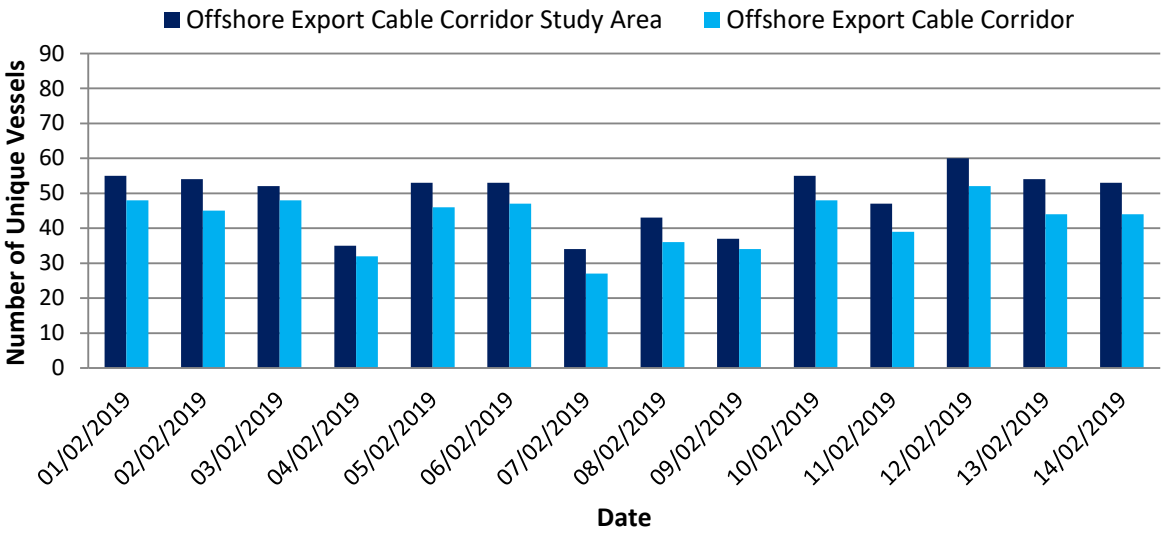


Figure E.20 Unique vessels per day within Hornsea Four offshore ECC and shipping and navigation study area (14 days winter 2019)

805. The busiest day recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the winter survey period was 12th February 2019 when 60 unique vessels were recorded. This was also the busiest day recorded within the Hornsea Four offshore ECC itself throughout the summer survey period with 52 unique vessels recorded.

806. The quietest day recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the winter survey period was 7th February 2019 when 34 unique vessels were recorded. This was also the quietest day recorded within the Hornsea Four offshore ECC itself throughout the winter survey period with 27 unique vessels recorded.

E.3.2 Vessel Types

807. The distribution of the main vessel types recorded passing within the Hornsea Four offshore ECC shipping and navigation study area is presented in Figure E.21.

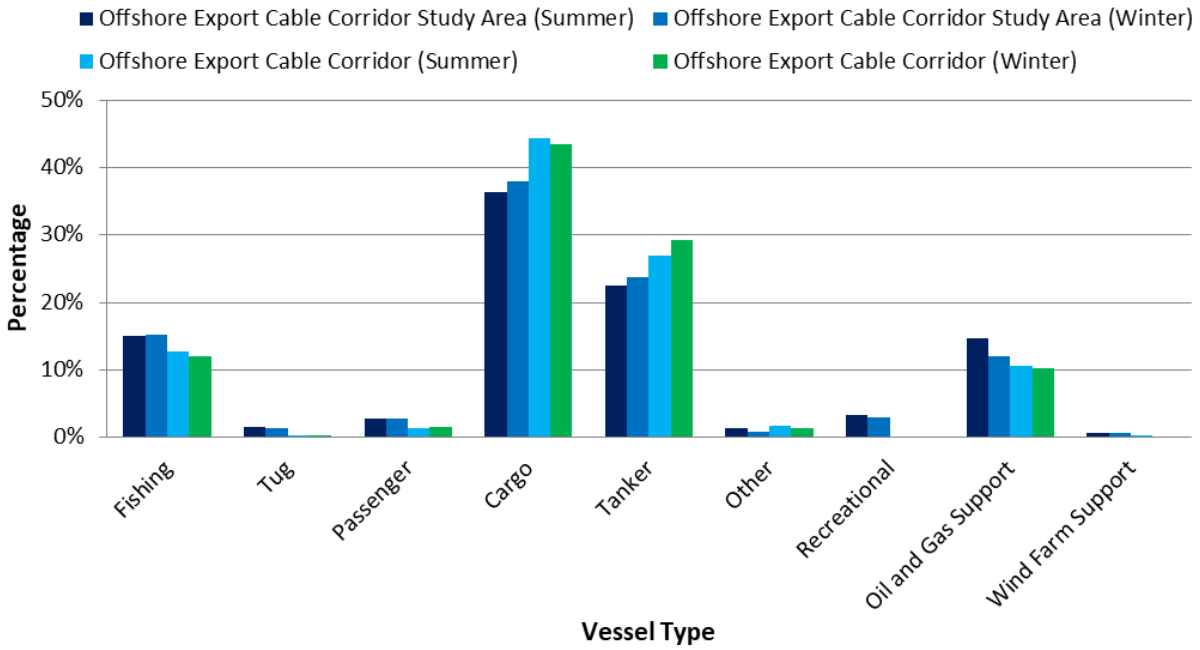


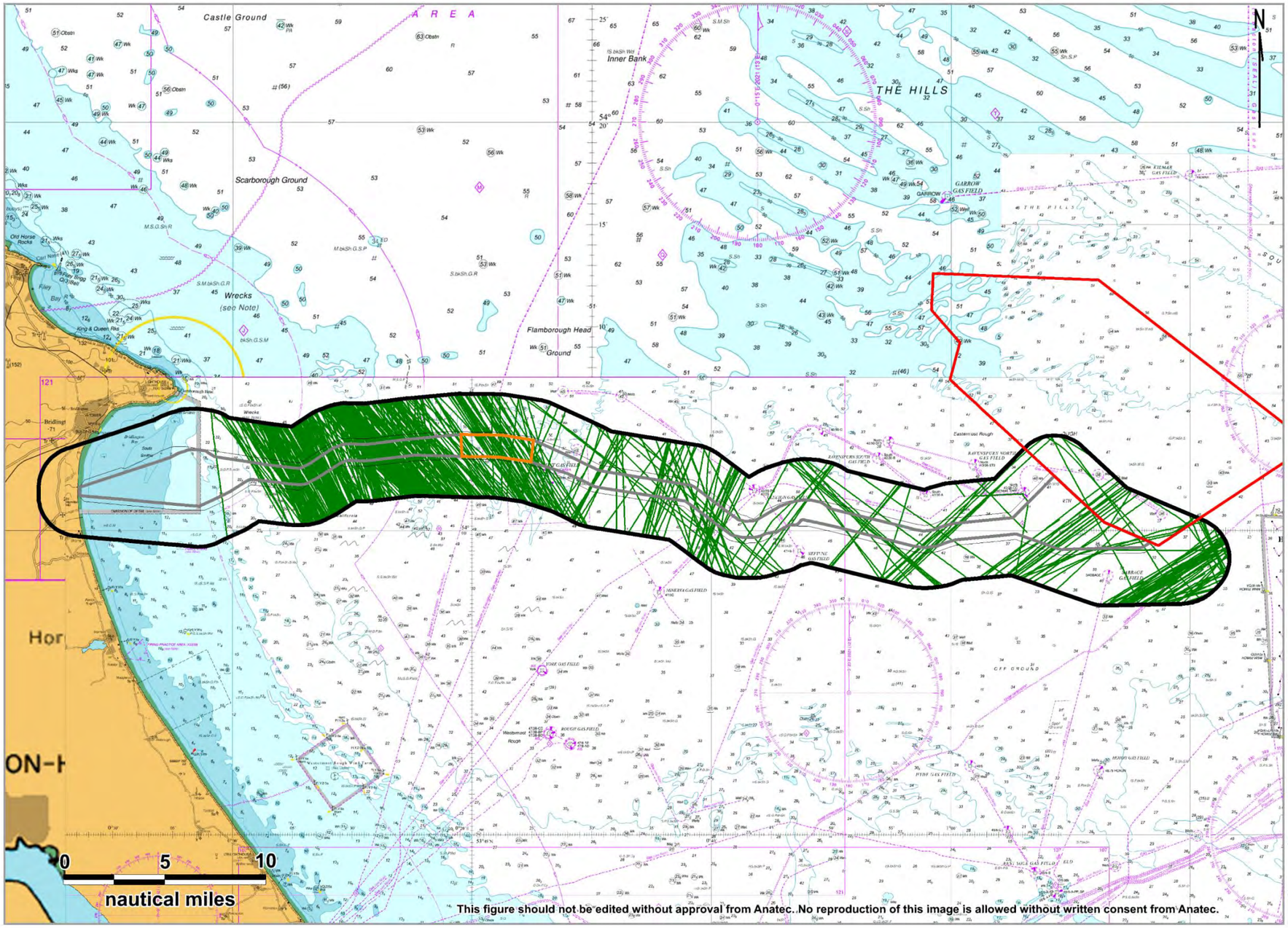
Figure E.21 Vessel type distribution within Hornsea Four offshore ECC shipping and navigation study area (28 days summer and winter 2019)

808. Throughout the summer survey period, the main vessel types were cargo vessels (44% within the Hornsea Four offshore ECC), tankers (27%) and fishing vessels (13%). Throughout the winter survey period, the main vessel types were cargo vessels (44%), tankers (29%) and fishing vessels (12%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo.

E.3.2.1 Cargo Vessels

809. Figure E.22 presents a plot of cargo vessels, including commercial ferries, recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

810. Throughout the survey periods, an average of 20 unique cargo vessels per day passed within the Hornsea Four offshore ECC shipping and navigation study area. The majority of these vessels were transiting coastal routes between northern UK ports and southern North Sea ports. Regular cargo vessels operating within the Hornsea Four offshore ECC shipping and navigation study area include Ro Ro vessels primarily operated by P&O Ferries, DFDS Seaways and Sea-Cargo running routes between Tees and Zeebrugge (Belgium), Immingham and Gothenburg and Immingham and Tananger.



Hornsea Four Boundaries
- Array Area
- HVAC Booster Station Search Area
- Offshore Export Cable Corridor
- Offshore Export Cable Corridor Study Area
- Temporary Working Area

Vessel Type
- Cargo

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Cargo vessels within cable corridor study area
(28 days, summer & winter)

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Figure E.22 Cargo vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer and winter 2019)

E.3.2.2 Tankers

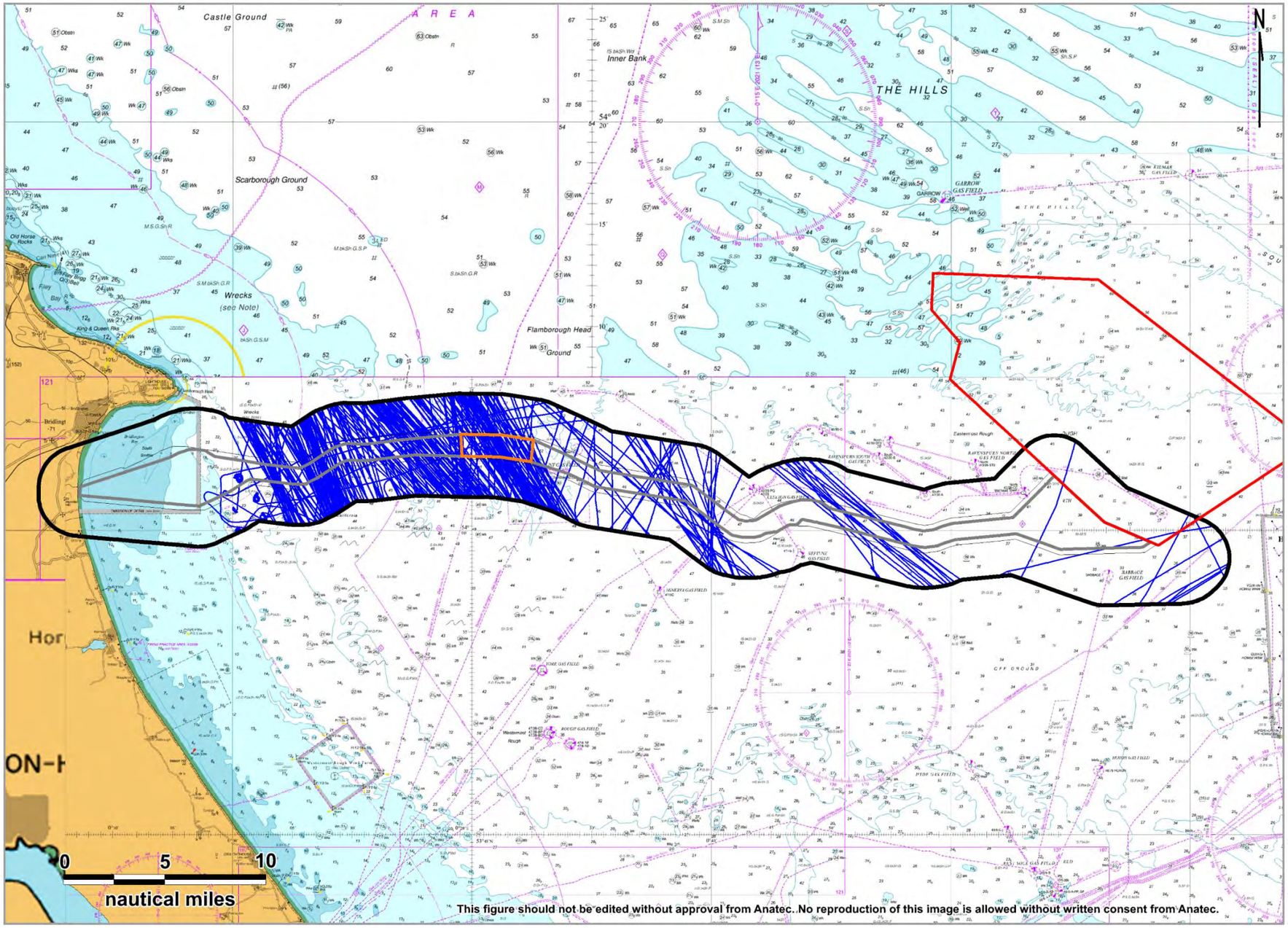
811. Figure E.23 presents a plot of tankers recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

812. Throughout the survey periods, an average of 13 unique tankers per day passed within the Hornsea Four offshore ECC shipping and navigation study area. The majority of these vessels were transiting coastal routes between northern UK ports (including Grangemouth, Tees and Aberdeen) and southern North Sea ports (including Immingham, Antwerp and Rotterdam).

E.3.2.3 Oil and Gas Vessels

813. Figure E.24 presents a plot of oil and gas vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

814. Throughout the survey periods, an average of seven unique oil and gas vessels per day passed within the Hornsea Four offshore ECC shipping and navigation study area. The majority of these vessels were undertaking operations for the platforms located at the Ravenspurn North, Ravenspurn South and Babbage gas fields, with minimal activity landward of this region since onshore bases are mainly at Great Yarmouth, Lowestoft and Grimsby.



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Hornsea Four Boundaries
- Array Area
- HVAC Booster Station Search Area
- Offshore Export Cable Corridor
- Offshore Export Cable Corridor Study Area
- Temporary Working Area

Vessel Type
- Tanker

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Tankers within cable corridor study area
(28 days, summer & winter)

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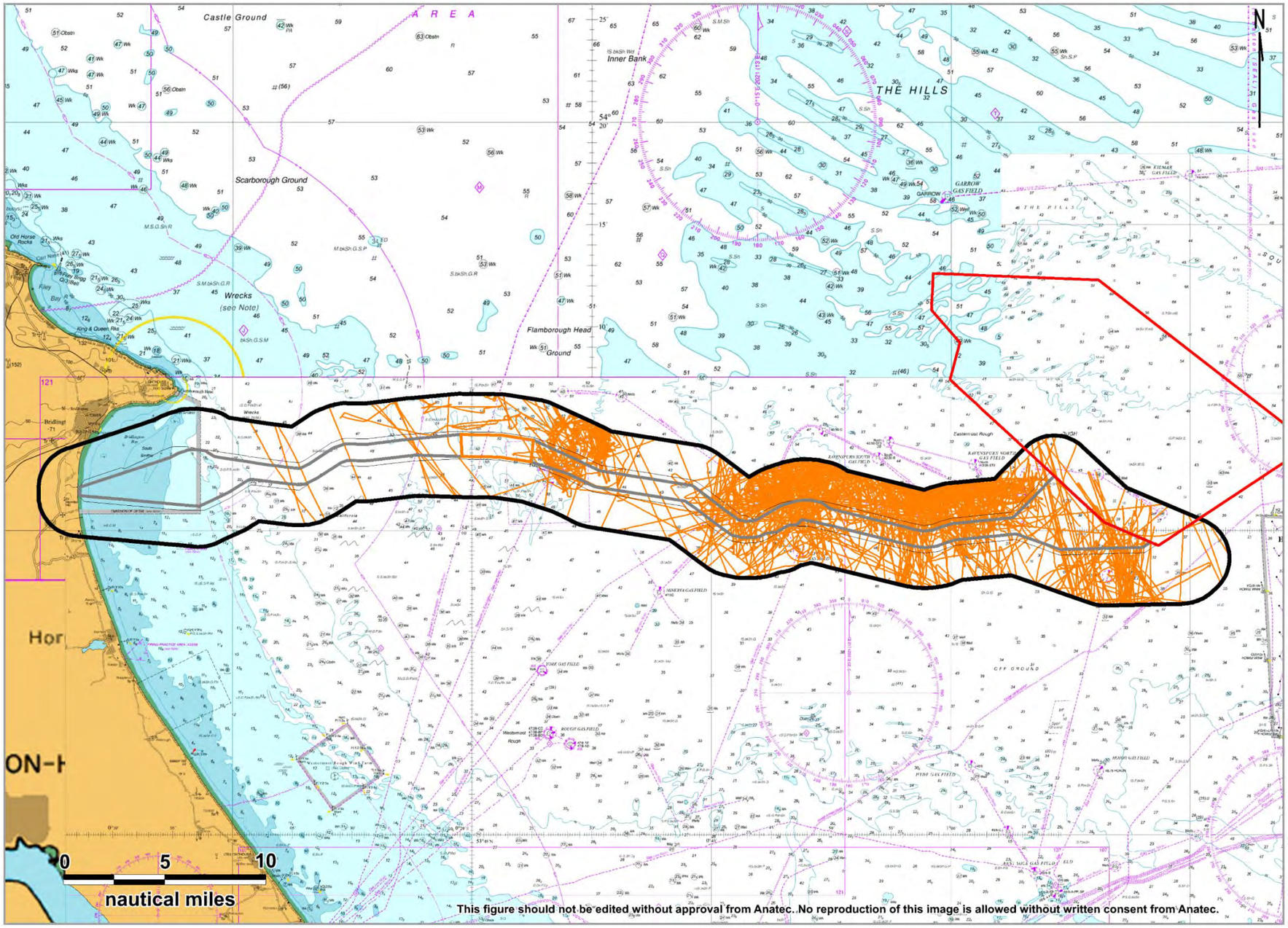
Figure E.23 Tankers within Hornsea Four offshore ECC shipping and navigation study area (28 days summer and winter 2019)



Hornsea Four Boundaries
- Array Area
- HVAC Booster Station Search Area
- Offshore Export Cable Corridor
- Offshore Export Cable Corridor Study Area
- Temporary Working Area

Vessel Type
- Oil and Gas

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Tankers within cable corridor study area
(28 days, summer & winter)

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Figure E.24 Oil and gas support vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer and winter 2019)

E.3.3 Vessel Sizes

E.3.3.1 Vessel Length

815. Vessel LOA was available for approximately 99% of vessels recorded throughout the survey periods and ranged from 5 m for two small craft including an RNLI lifeboat to 294 m for a large passenger vessel. Figure E.25 illustrates the distribution of vessel lengths recorded throughout each survey period.

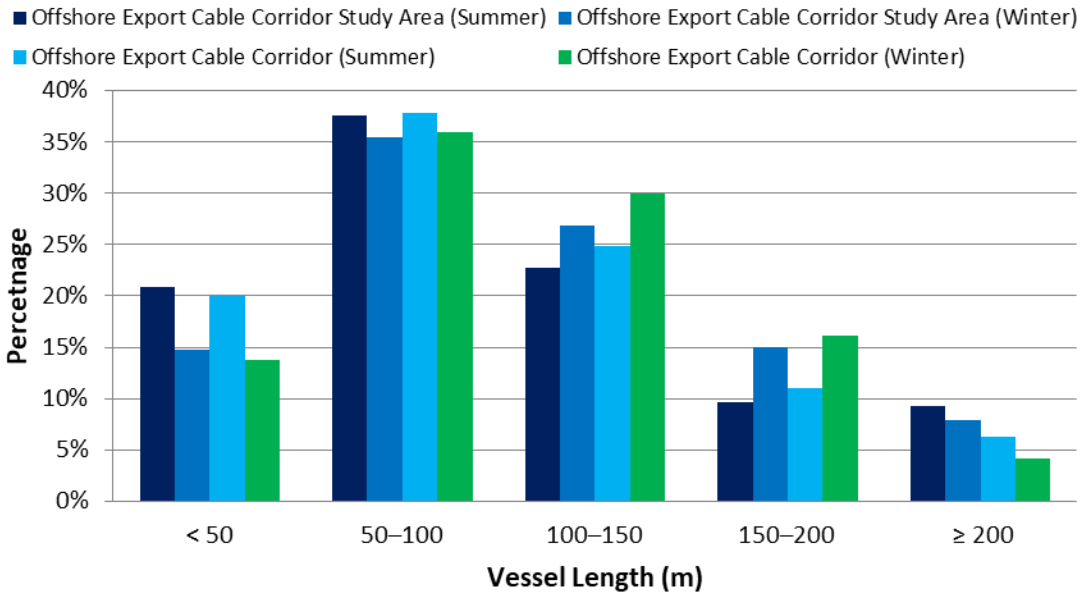
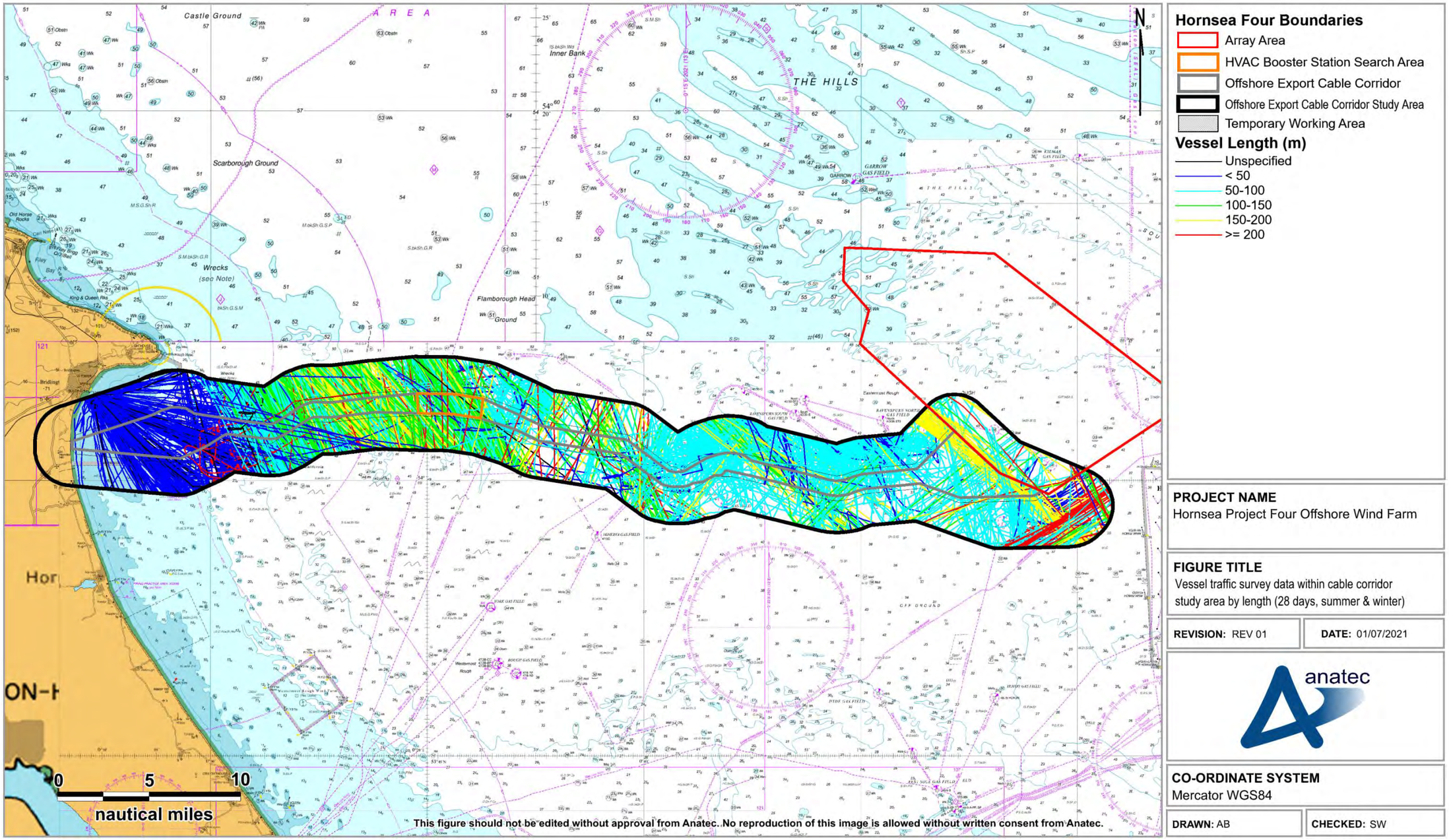


Figure E.25 Vessel length distribution within Hornsea Four offshore ECC and shipping and navigation study area (28 days summer and winter 2019)

816. Excluding the small proportion of vessels for which a length was not available, the average length of vessels within the Hornsea Four offshore ECC shipping and navigation study area throughout the summer and winter survey periods were 100 m and 108 m, respectively.

817. Figure E.26 presents a plot of vessel tracks (excluding temporary traffic) recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the survey periods, colour-coded by length. It can be seen that vessels near the landfall were primarily smaller vessels (fishing).



Hornsea Four Boundaries
- Array Area
- HVAC Booster Station Search Area
- Offshore Export Cable Corridor
- Offshore Export Cable Corridor Study Area
- Temporary Working Area

Vessel Length (m)
- Unspecified
- < 50
- 50-100
- 100-150
- 150-200
- >= 200

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Vessel traffic survey data within cable corridor study area by length (28 days, summer & winter)

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Figure E.26 **Vessel traffic survey data within Hornsea Four offshore ECC shipping and navigation study area colour-coded by vessel length (28 days summer and winter 2019)**

E.3.3.2 Vessel Draught

818. Vessel draught was available for approximately 78% of vessel tracks recorded throughout the survey periods and ranged from 1 m for a high speed craft (HSC) to 14.2 m for a large bulk carrier. Figure E.27 illustrates the distribution of vessel draughts recorded throughout each survey period.

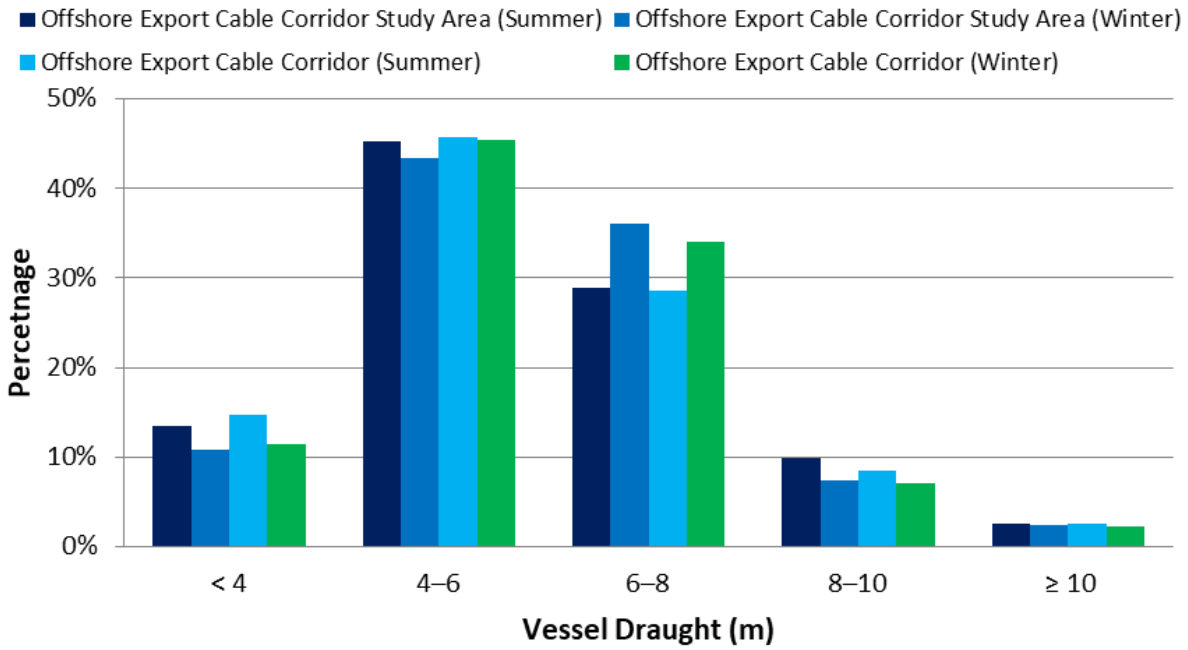
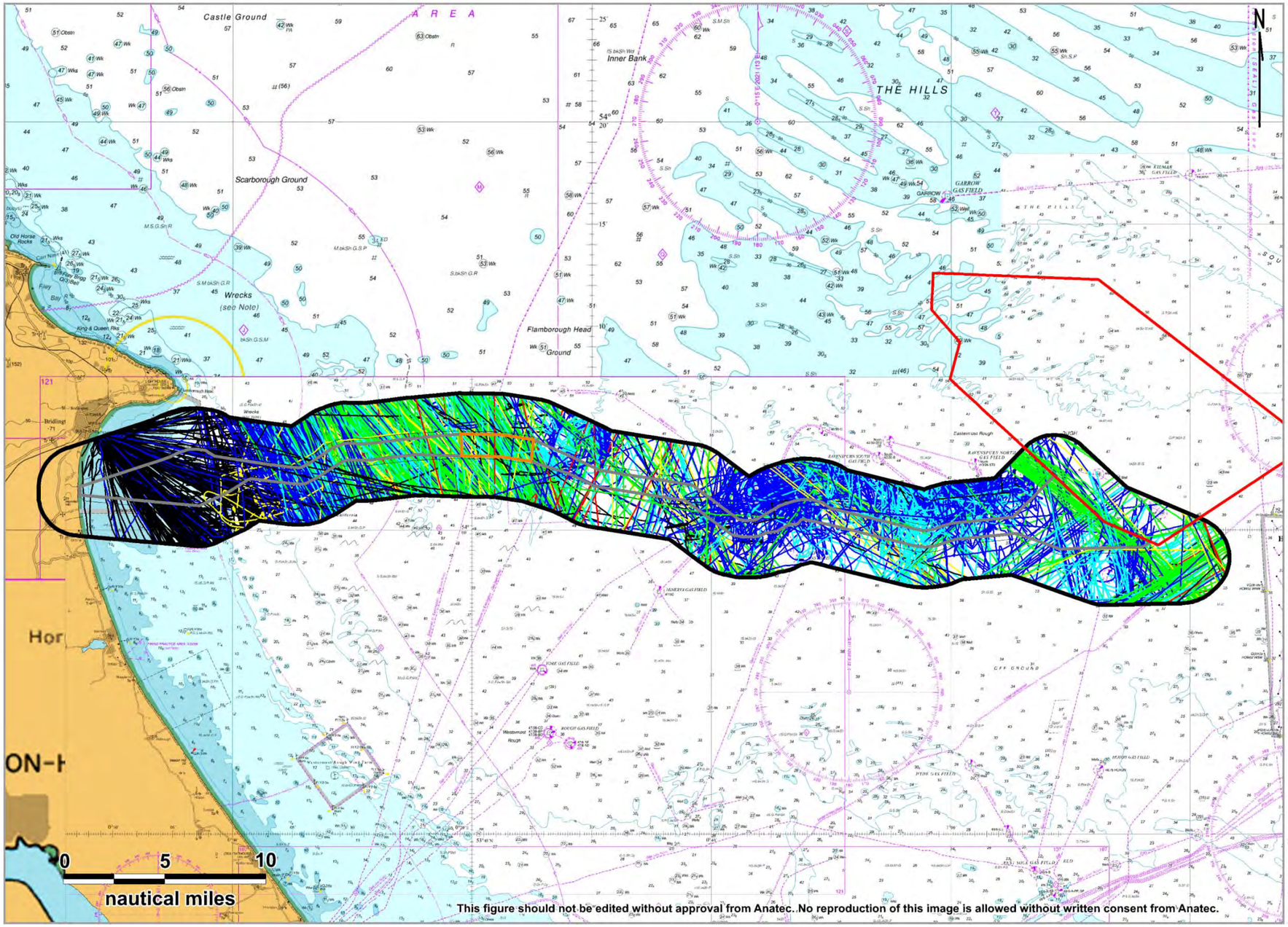


Figure E.27 Vessel draught distribution within Hornsea Four offshore ECC shipping and navigation study area (28 days summer and winter 2019)

819. Excluding those vessels for which a draught was not available, the average draught of vessels within the Hornsea Four offshore ECC shipping and navigation study area throughout the summer and winter survey periods were 5.5 m and 5.7 m, respectively.

820. Figure E.28 presents a plot of vessel tracks (excluding temporary traffic) recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the survey periods, colour-coded by vessel draught.



Hornsea Four Boundaries
- Array Area
- HVAC Booster Station Search Area
- Offshore Export Cable Corridor
- Offshore Export Cable Corridor Study Area
- Temporary Working Area

Vessel Draught (m)
- Unspecified
- < 5
- 5-6
- 6-8
- 8-10
- >= 10

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Vessel traffic survey data within cable corridor study area by draught (28 days, summer & winter)

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Figure E.28 Vessel traffic survey data within Hornsea Four offshore ECC shipping and navigation study area colour-coded by vessel draught (28 days summer and winter 2019)

E.3.4 Anchored Vessels

821. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

822. For this reason, those vessels which travelled at a speed of less than 1 kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. After applying these criteria, seven cases of anchored vessels were identified, with the vessel broadcasting an AIS navigational status of "*at anchor*" in each case. Figure E.29 presents a plot of anchored vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout the survey periods, colour-coded by vessel type.

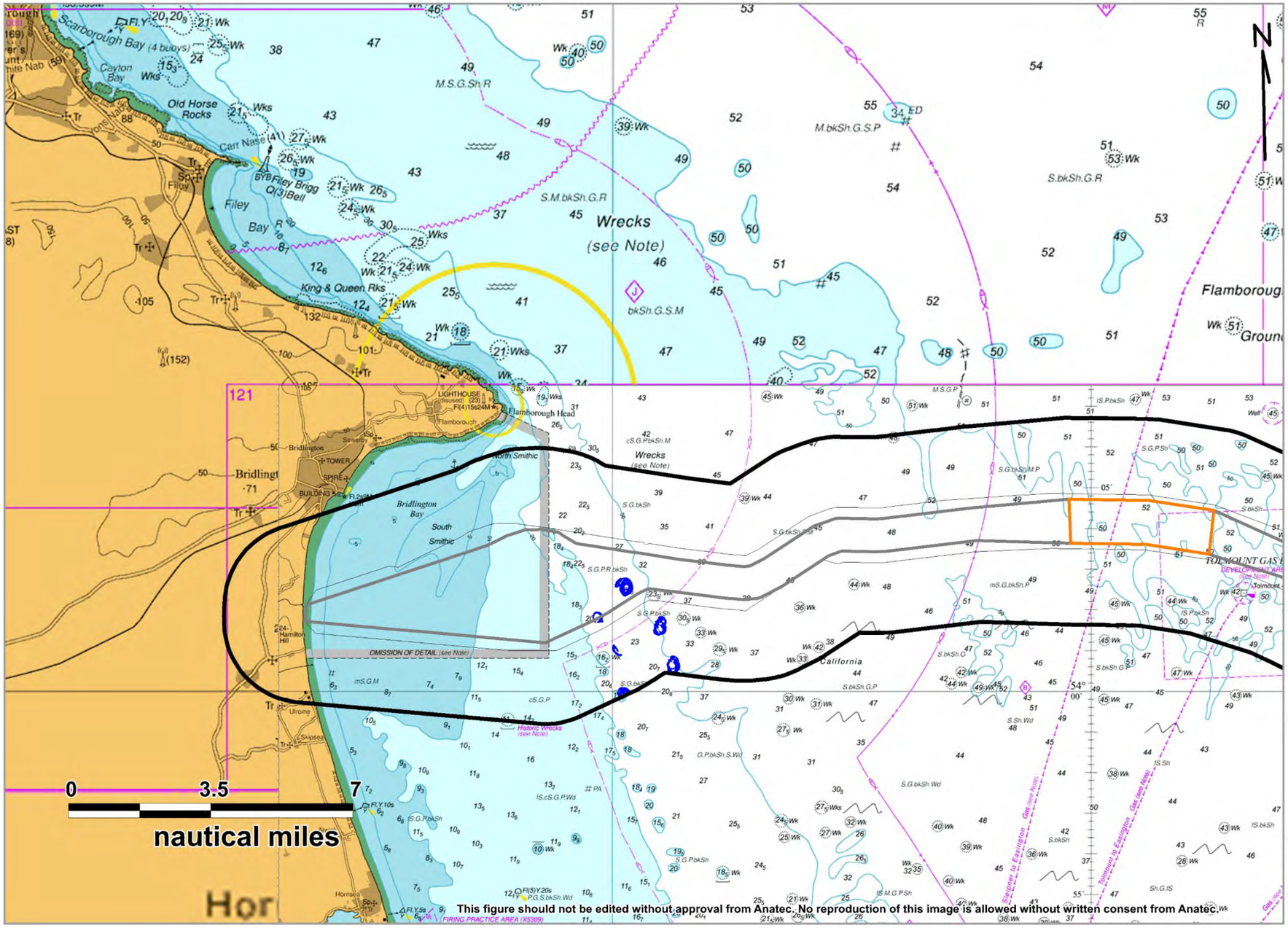
823. All seven anchored vessels were crude oil tankers with five broadcasting a destination of Flamborough Head.

E.3.5 Recreational Vessel Activity

824. For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive and fishing charter trips) of between 2.4 and 24 m LOA.

825. Figure E.30 presents a plot of recreational vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

826. Throughout the survey periods, an average of one unique recreational vessel per day passed within the Hornsea Four offshore ECC shipping and navigation study area. The majority of recreational vessels were transiting nearshore around Flamborough Head. Three recreational vessels were also recorded transiting through the Hornsea Four HVAC booster station search area.



Hornsea Four Boundaries
- Array Area
- HVAC Booster Station Search Area
- Offshore Export Cable Corridor
- Offshore Export Cable Corridor Study Area
- Temporary Working Area

Vessel Type
- Tanker

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Anchored vessels within within cable corridor study area by length (28 days, summer & winter)

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Figure E.29 Anchored vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer and winter 2019)

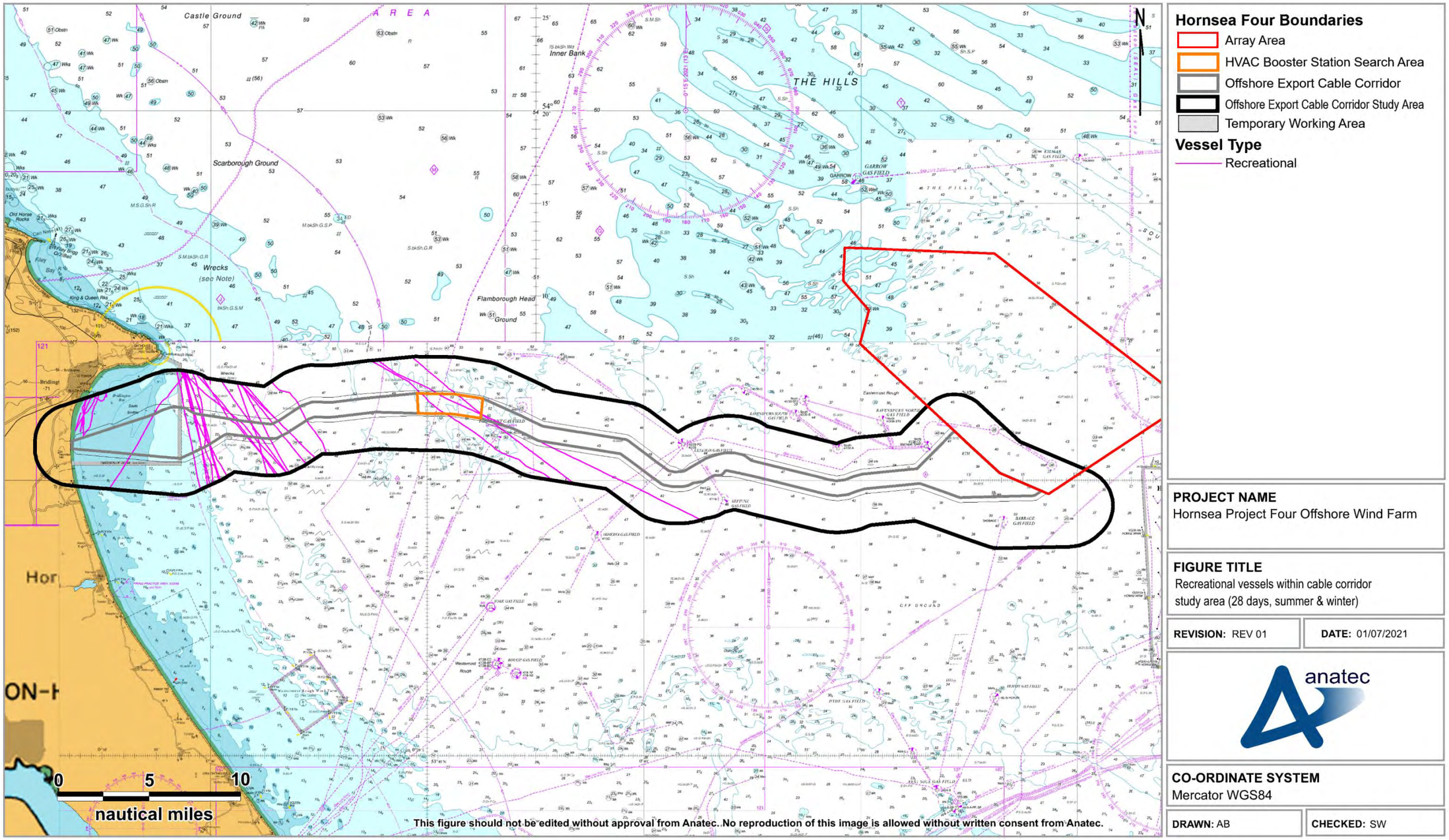


Figure E.30 Recreational vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer and winter 2019)

E.3.6 Commercial Fishing Vessel Activity

827. Figure E.31 presents a plot of fishing vessels recorded within the Hornsea Four offshore ECC shipping and navigation study area throughout both survey periods.

828. Throughout the survey periods, an average of eight unique fishing vessels per day passed within the Hornsea Four offshore ECC shipping and navigation study area. Fishing vessel movements were characteristic of both fishing vessels in transit and engaged in fishing activity. Fishing vessels were most prominent nearshore transiting in and out of Bridlington with low levels of fishing vessels further offshore where tracks were characteristic of active fishing.

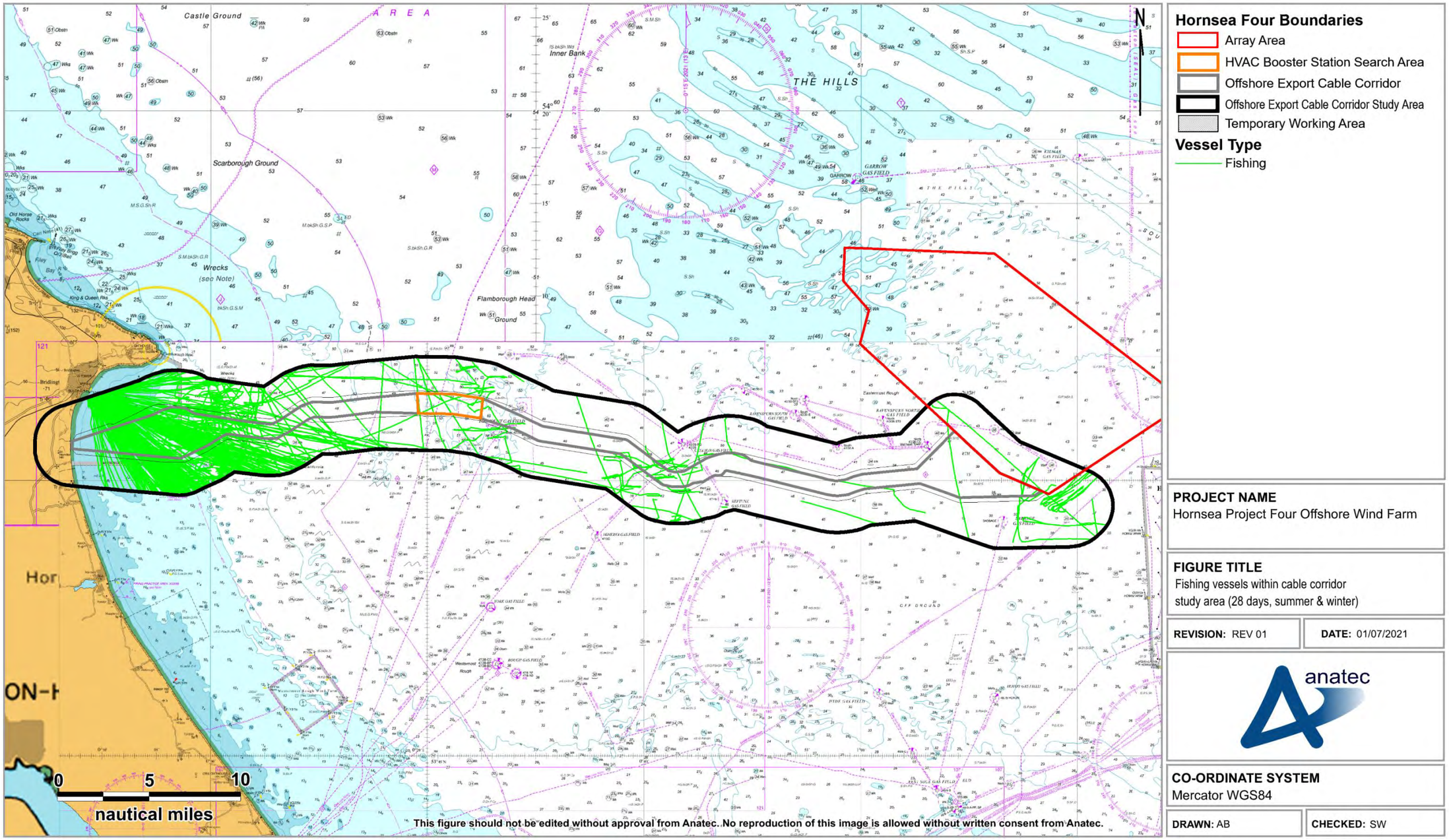


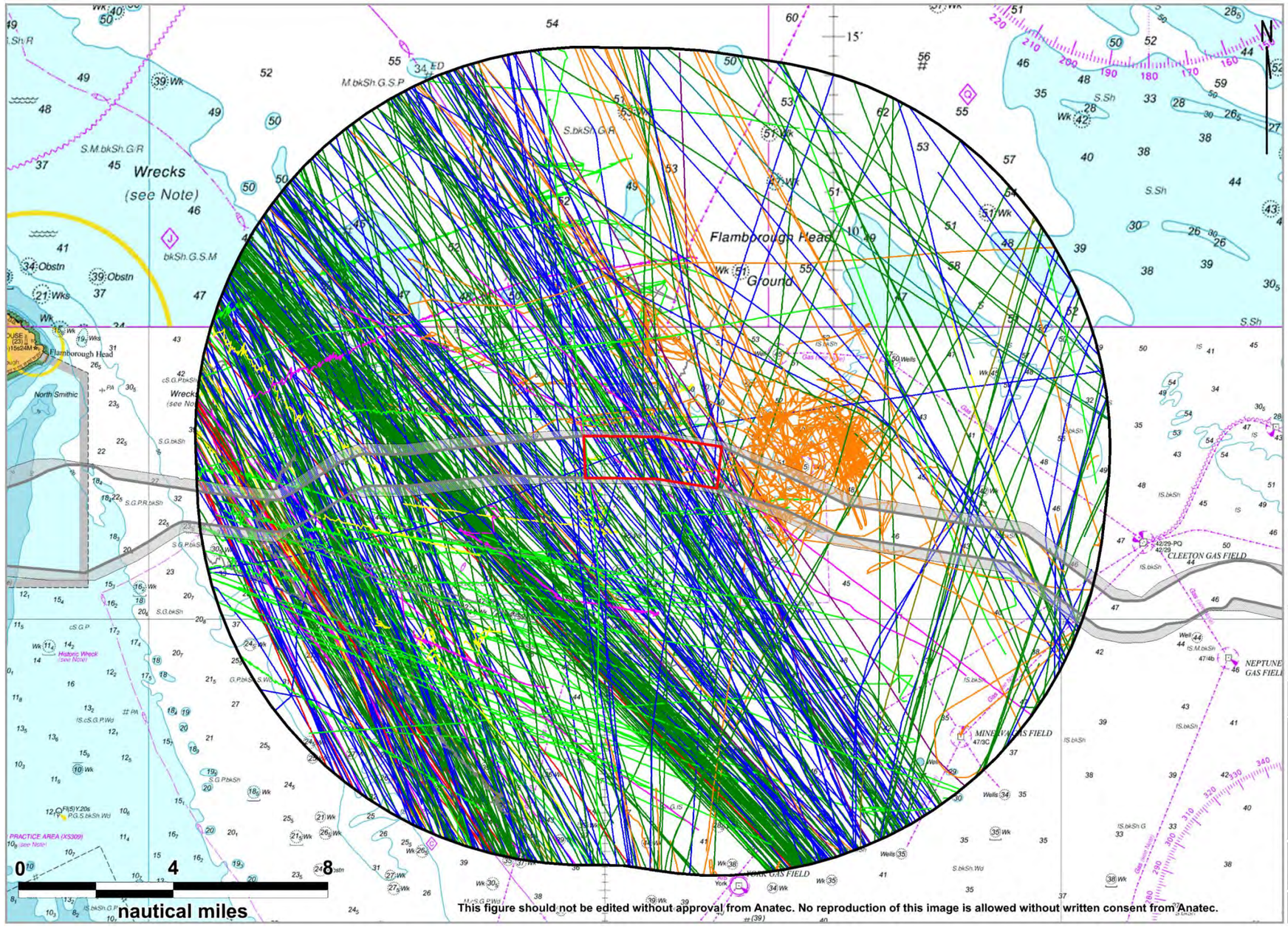
Figure E.31 Fishing vessels within Hornsea Four offshore ECC shipping and navigation study area (28 days summer and winter 2019)

E.4 Hornsea Four HVAC Booster Station Search Area

829. A number of tracks recorded during the Hornsea Four HVAC booster station search area survey periods were classified as temporary (non-routine), such as the tracks of the survey vessel; these have therefore been excluded from the analysis. Oil and gas vessels operating at permanent installations were retained in the analysis. Additionally, oil and gas vessels associated with the temporary drilling operation at the Tolmount gas field were retained in the analysis given that this vessel traffic is representative of oil and gas vessel activity which is present following the installation of the permanent Tolmount surface platform (see Section 10.2).

830. A plot of the vessel tracks recorded during a 14 day survey period in August 2019 (summer) colour-coded by vessel type and excluding temporary traffic, is presented in Figure E.32. A plot of the vessel tracks recorded during a further 14 day survey period in January and February 2019 (winter), colour-coded by vessel type and excluding temporary traffic, is presented in Figure E.33.

831. Plots of the vessel tracks for the summer and winter survey periods converted to a density heat map are presented in Figure E.34 and Figure E.35, respectively.



Hornsea Four Boundaries

- HVAC Booster Station Search Area
- HVAC Booster Station Search Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Vessel Type

- Unspecified
- Fishing
- Dredger/Subsea
- Tug
- Passenger
- Cargo
- Tanker
- Other
- Recreational
- Oil and Gas
- Wind Farm

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Vessel traffic survey data within HVAC booster station study area by type (14 days, summer)

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Figure E.32 Vessel traffic survey data within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel type (14 days summer 2019)

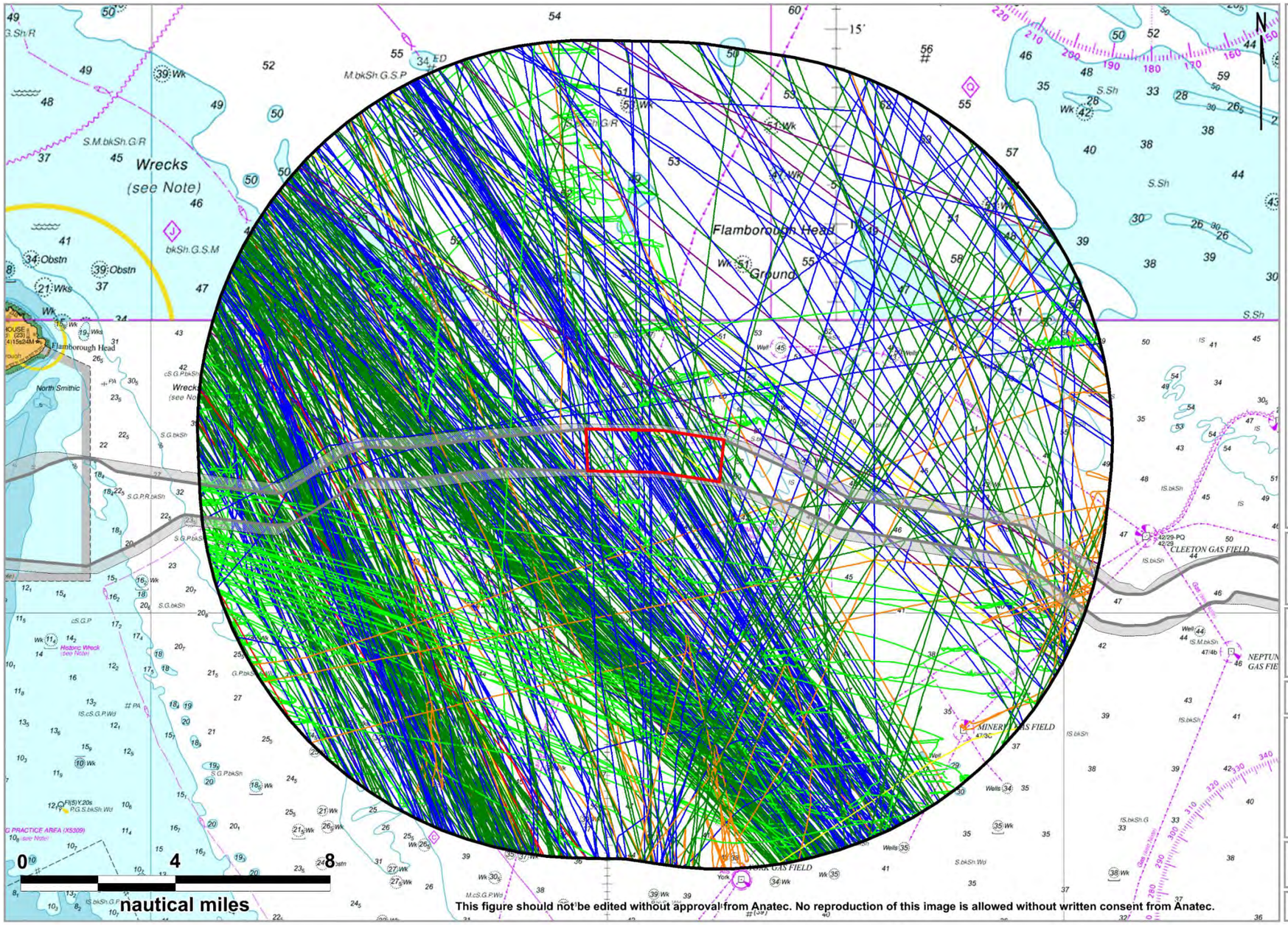


Figure E.33 Vessel traffic survey data within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel type (14 days winter 2019)

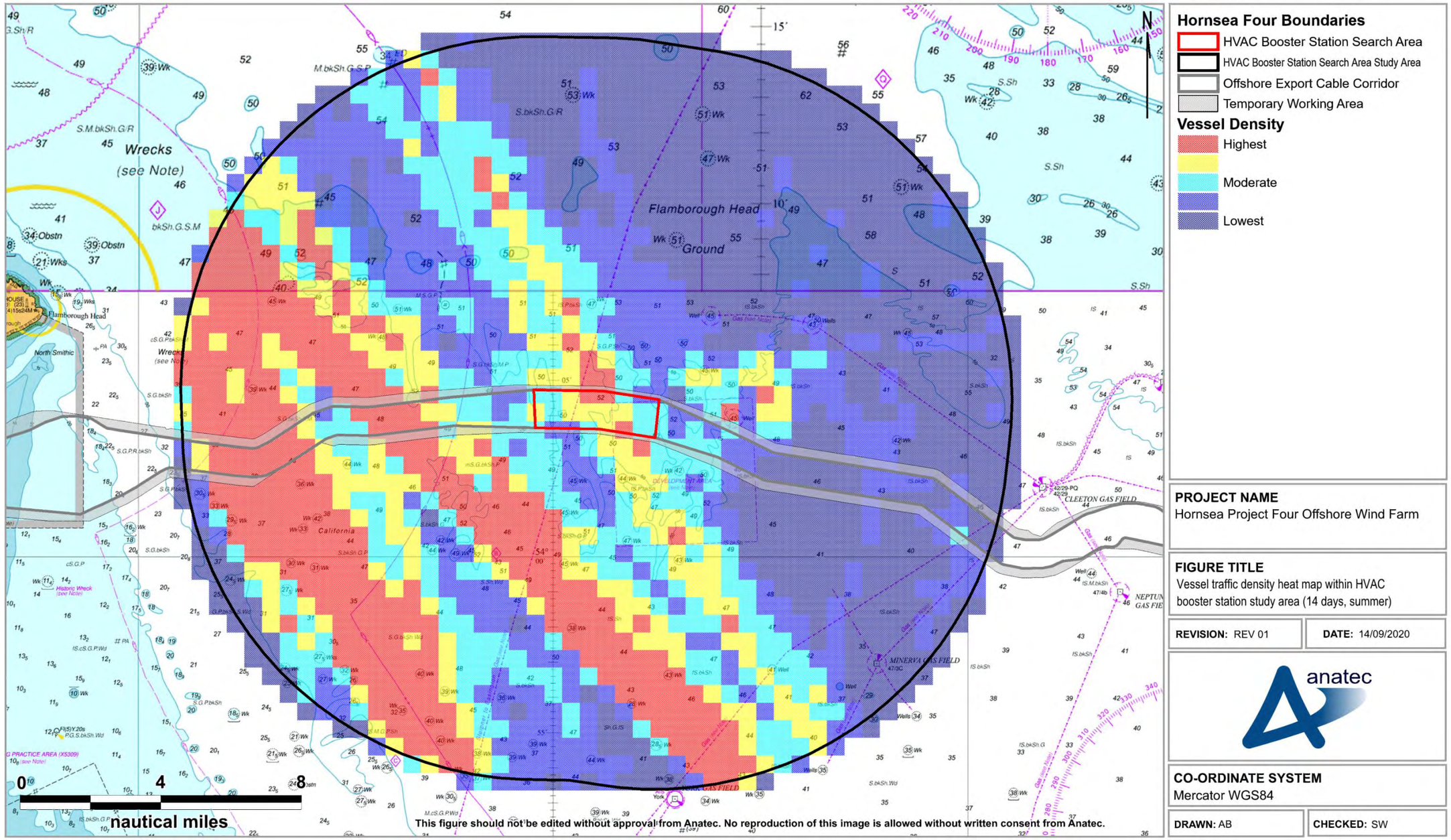


Figure E.34 Vessel traffic density heat map within Hornsea Four HVAC booster station search area shipping and navigation study area excluding temporary traffic (14 days summer 2019)

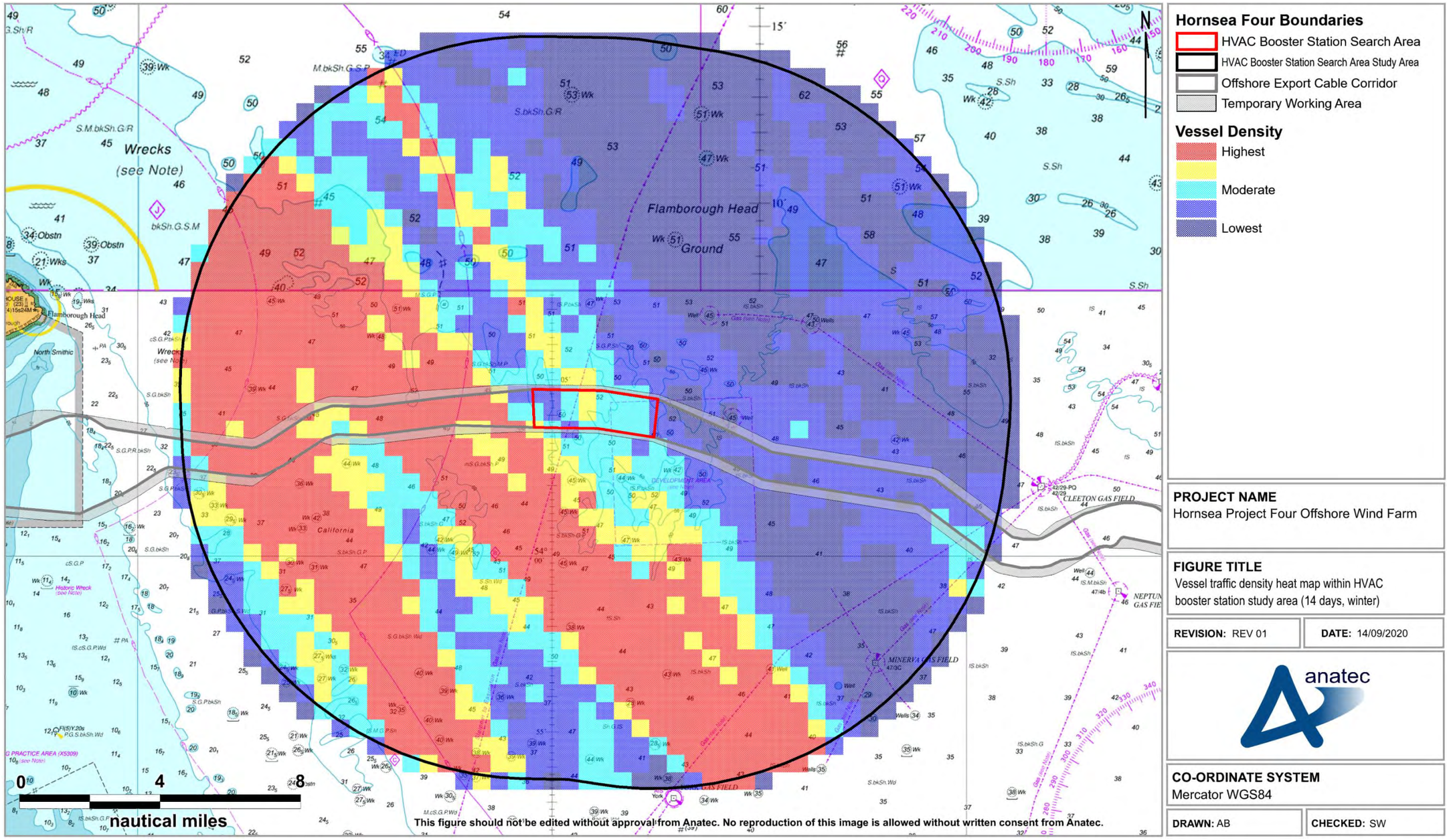


Figure E.35 Vessel traffic density heat map within Hornsea Four HVAC booster station search area shipping and navigation study area excluding temporary traffic (14 days winter 2019)

832. The busiest day recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the summer survey period was 8th August 2019 when 58 unique vessels were recorded. This was also the busiest day recorded within the Hornsea Four HVAC booster station search area itself throughout the summer survey period with 11 unique vessels recorded.

833. The quietest full day recorded throughout the summer survey period was 9th August 2019 when 35 unique vessels were recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area. The quietest full days recorded within the Hornsea Four HVAC booster station search area itself throughout the summer survey period were 7th, 11th and 13th August 2019 when three unique vessels were recorded.

834. For the 14 days analysed in the winter survey period, there were an average of 36 unique vessels per day recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area. In terms of vessels intersecting the Hornsea Four HVAC booster station search area itself, there was an average of five unique vessels per day.

835. Figure E.36 illustrates the daily number of unique vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area and the Hornsea Four HVAC booster station search area itself during the winter survey period. Throughout the winter survey period 11% of vessel tracks recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area intersected the Hornsea Four HVAC booster station search area.

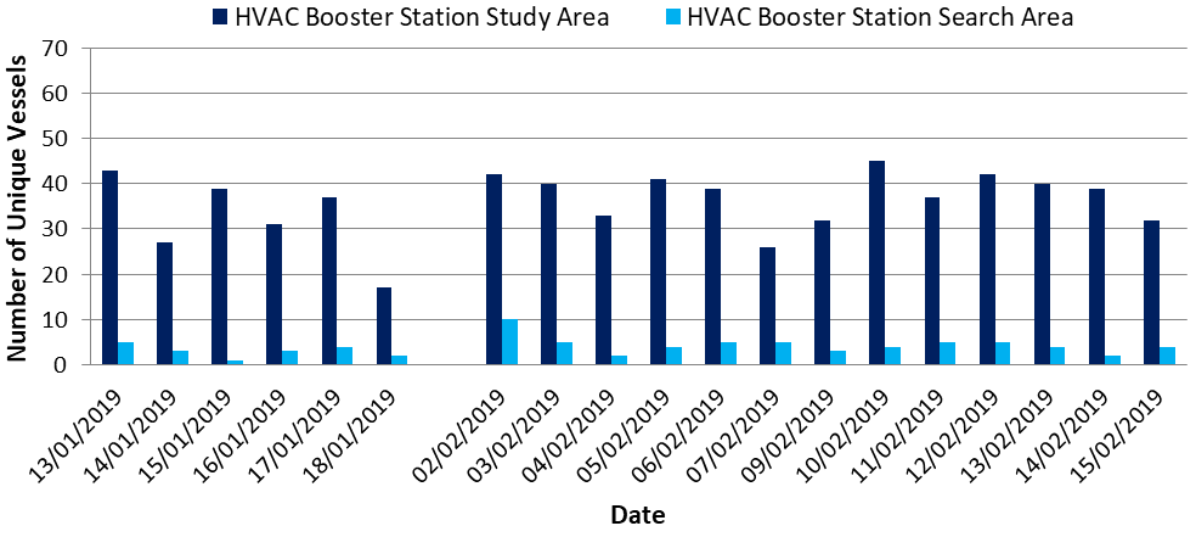


Figure E.36 Unique vessels per day within Hornsea Four HVAC booster station search area and shipping and navigation study area (14 days winter 2019)

836. The busiest day recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the winter survey period was 10th February 2019 when 45 unique vessels were recorded. The busiest day

recorded within the Hornsea Four HVAC booster station search area itself throughout the winter survey period was 2nd February 2019 when 10 unique vessels were recorded.

837. The quietest full day recorded throughout the winter survey period was 16th January 2019 when 31 unique vessels were recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area. The quietest full day recorded within the Hornsea Four HVAC booster station search area itself throughout the winter survey period was 14th February 2019 with two unique vessels recorded.

E.4.1 Vessel Types

838. The distribution of the main vessel types recorded passing within the Hornsea Four HVAC booster station search area shipping and navigation study area is presented in Figure E.37.

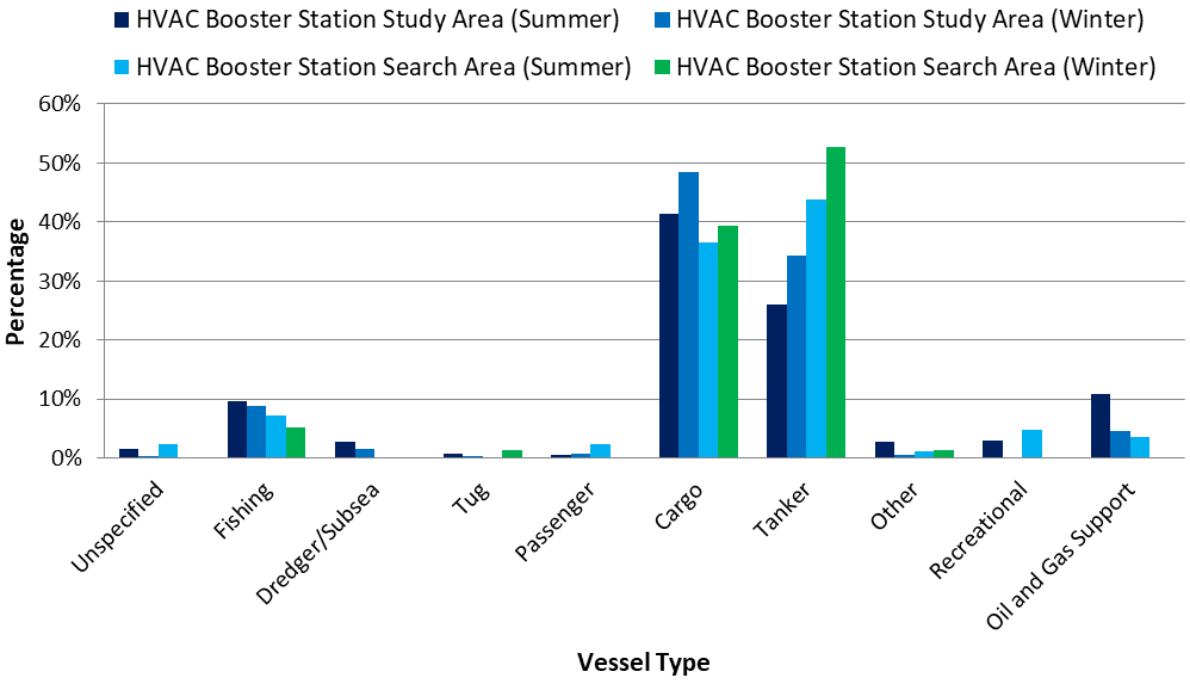


Figure E.37 Vessel type distribution within Hornsea Four HVAC booster station search area and shipping and navigation study area (28 days summer and winter 2019)

839. Throughout the summer period, the main vessel types were tankers (43% within the Hornsea Four HVAC booster station search area) and cargo vessels (36%). Throughout the winter period, the main vessel types were also tankers (53% within the Hornsea Four HVAC booster station search area) and cargo vessels (39%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo. Details specific to commercial ferries are presented in Section E.4.4.

E.4.1.1 Cargo Vessels

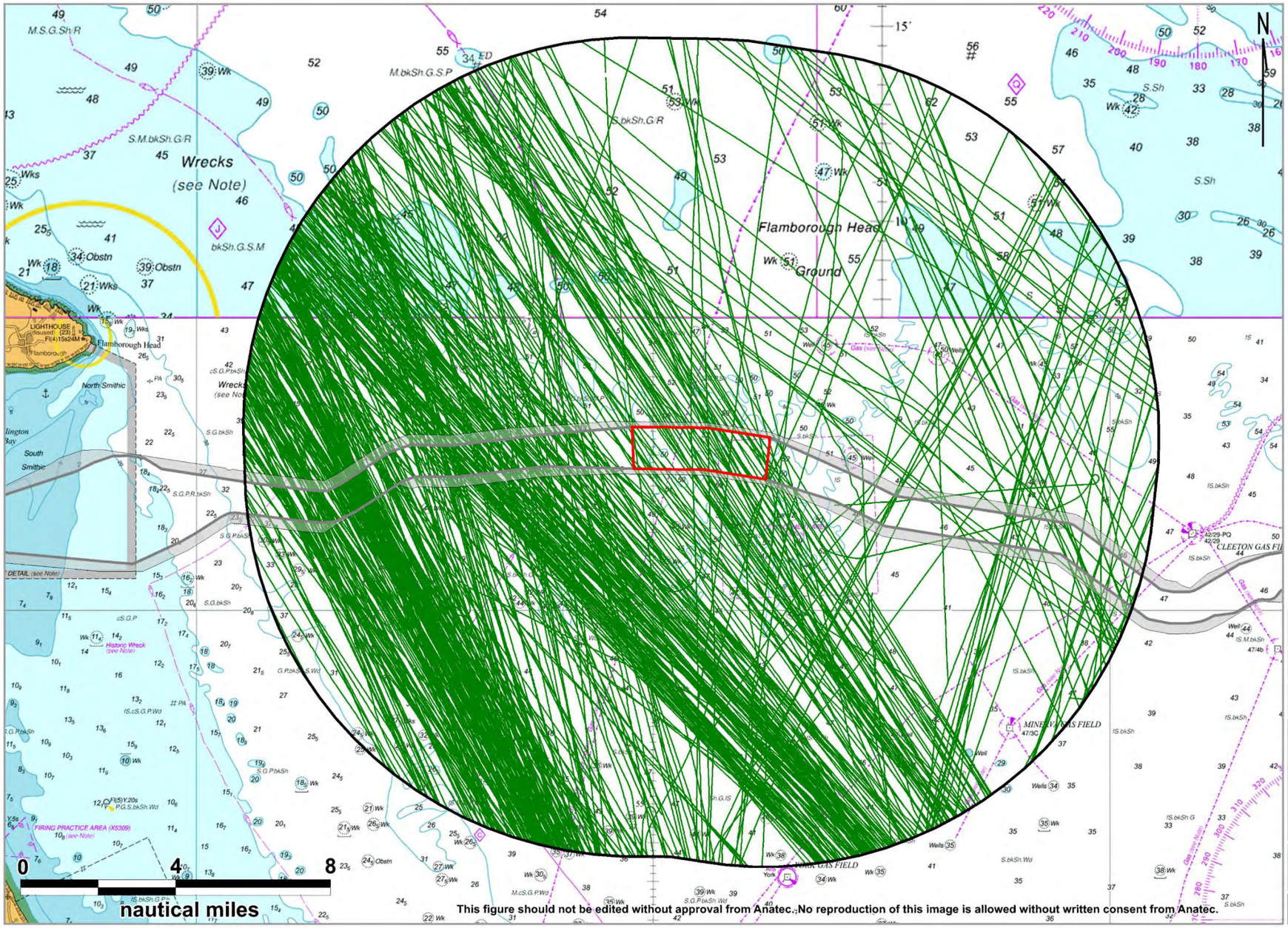
840. Figure E.38 presents a plot of cargo vessels, including commercial ferries, recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout both survey periods.

841. Throughout the survey periods, an average of 21 unique cargo vessels per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. Regular cargo vessels operating in proximity to the Hornsea Four HVAC booster station search area include Ro Ro vessels primarily operated by P&O Ferries running routes between Tees and Zeebrugge.

E.4.1.2 Tankers

842. Figure E.39 presents a plot of tankers recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area on AIS, visual and Radar throughout both survey periods.

843. Throughout the survey periods, an average of 14 unique tankers per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. The majority of tankers recorded throughout the survey period were on passage to oil and gas terminals throughout the UK and mainland Europe.



Hornsea Four Boundaries

- HVAC Booster Station Search Area
- HVAC Booster Station Search Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Vessel Type

- Cargo

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Cargo vessels within HVAC booster station study area by type (28 days summer & winter)

REVISION: REV 01 | **DATE:** 14/09/2020

CO-ORDINATE SYSTEM
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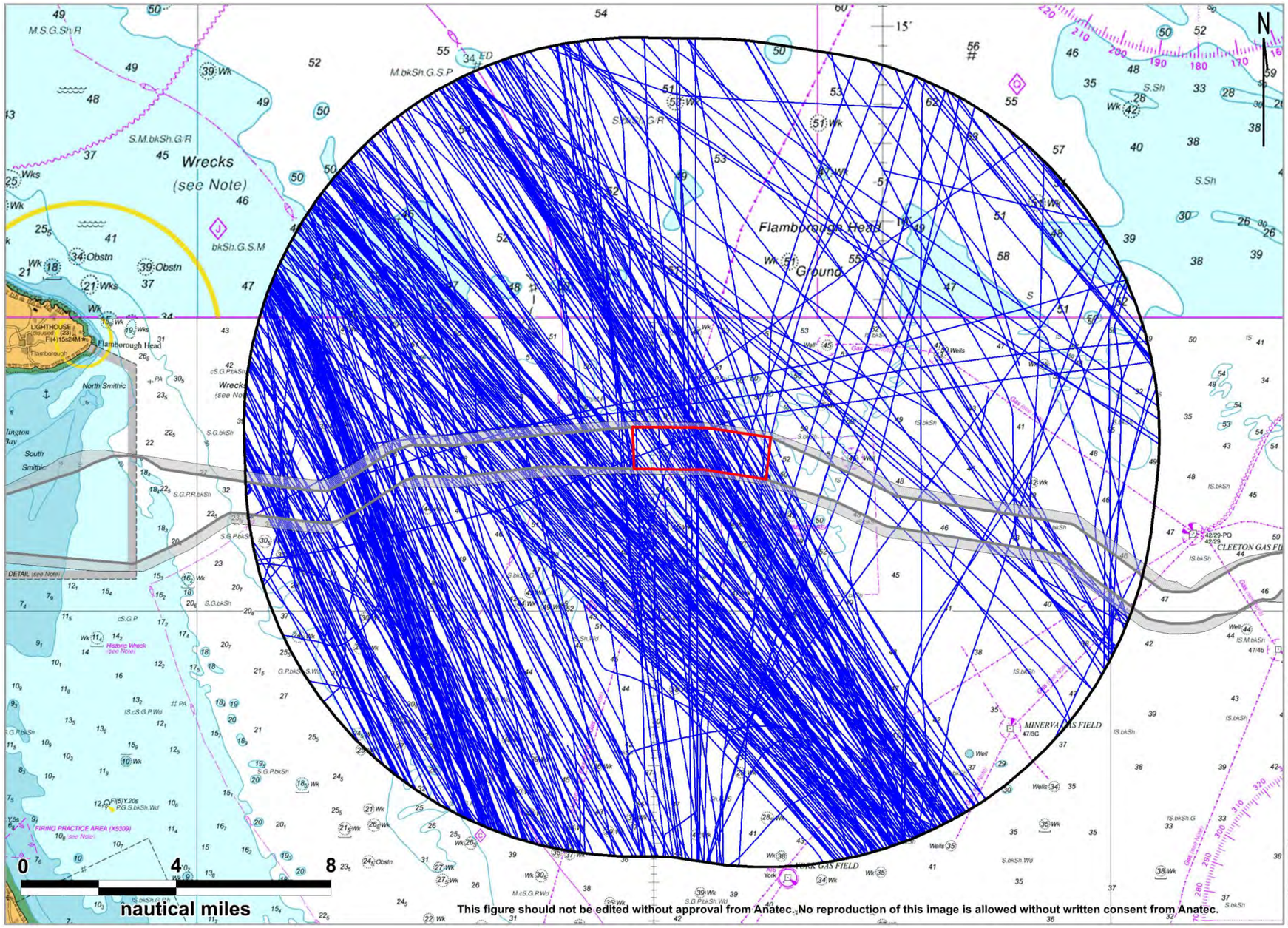
Figure E.38 Cargo vessels within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer and winter 2019)



Hornsea Four Boundaries

- HVAC Booster Station Search Area
- HVAC Booster Station Search Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Vessel Type

- Tanker

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Tankers within HVAC booster station study area by type (28 days summer & winter)

REVISION: REV 01 | **DATE:** 14/09/2020

CO-ORDINATE SYSTEM
Mercator WGS84

DRAWN: AB | **CHECKED:** SW

Figure E.39 Tankers within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer and winter 2019)

E.4.2 Vessel Sizes

E.4.2.1 Vessel Length

844. Vessel LOA was available for more than 99% of vessels recorded throughout the survey periods and ranged from 5 m for a small fishing vessel to 276 m for a shuttle tanker and crude oil tanker. Figure E.40 illustrates the distribution of vessel lengths recorded throughout each survey period.

845. Excluding the small proportion of vessels for which a length was not available the average length of vessels within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the summer and winter survey periods were 95 m and 111 m, respectively.

846. Figure E.41 presents a plot of all vessel tracks (excluding temporary traffic) recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the survey periods, colour-coded by vessel length.

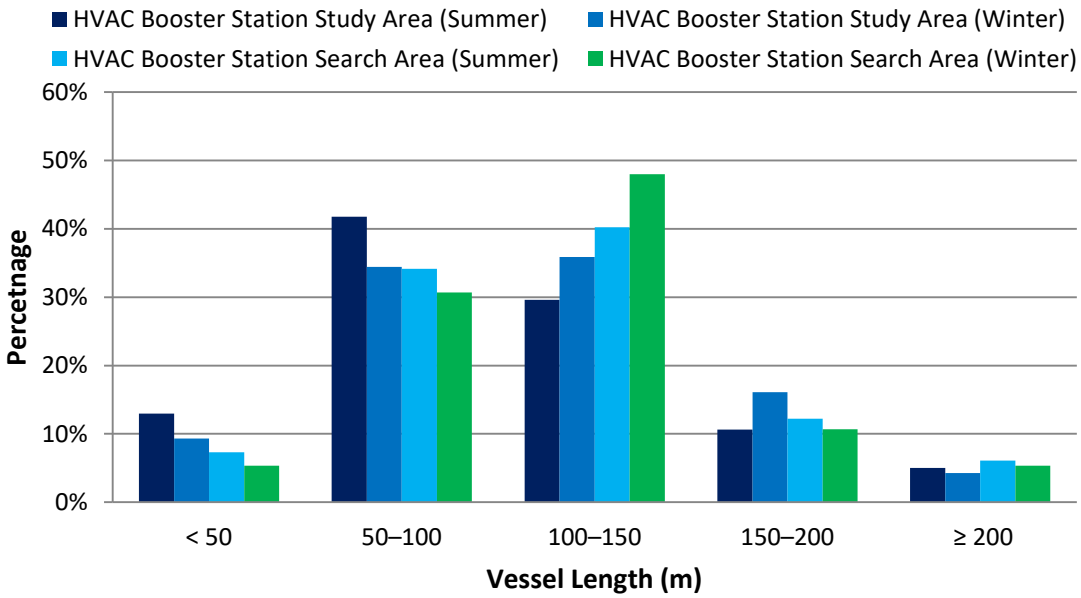


Figure E.40 Vessel length distribution within Hornsea Four HVAC booster station search area and shipping and navigation study area (28 days summer and winter 2019)

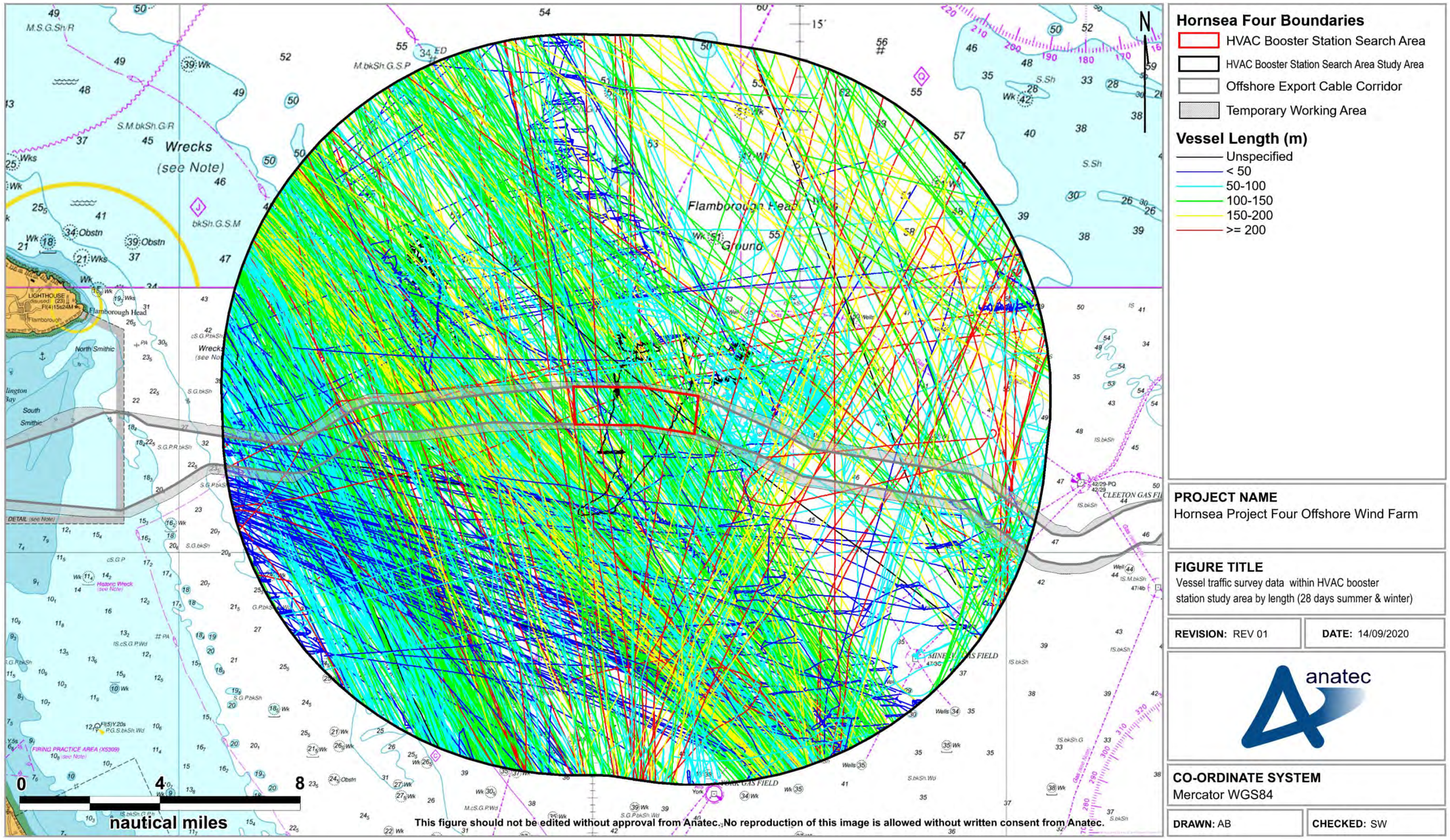


Figure E.41 Vessel traffic survey data within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel length (28 days summer and winter 2019)

E.4.2.2 Vessel Draught

847. Vessel draught was available for approximately 93% of vessel tracks recorded throughout the survey periods and ranged from 1.3 m for a catamaran to 14.2 m for a large bulk carrier. Figure E.42 illustrates the distribution of vessel draughts recorded throughout each survey period.

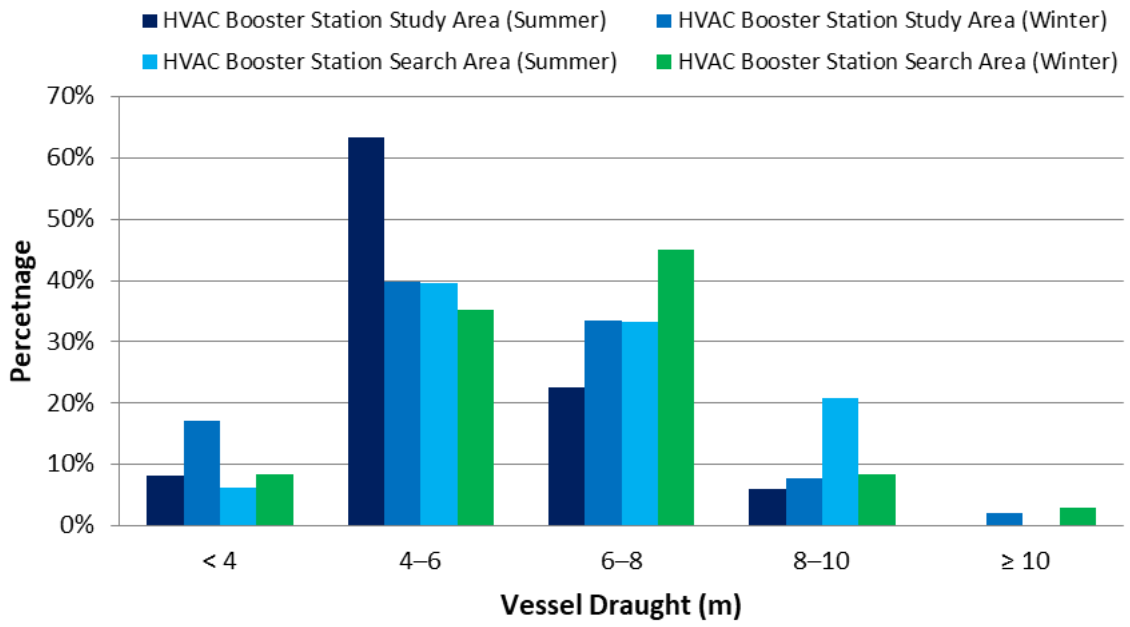


Figure E.42 Vessel draught distribution within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer and winter 2019)

848. Excluding unspecified, the average draught of vessels within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the summer and winter survey periods were 4.7 m and 5.6 m, respectively.

849. Figure E.43 presents a plot of all vessel tracks (excluding temporary traffic) recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the survey periods, colour-coded by vessel draught.

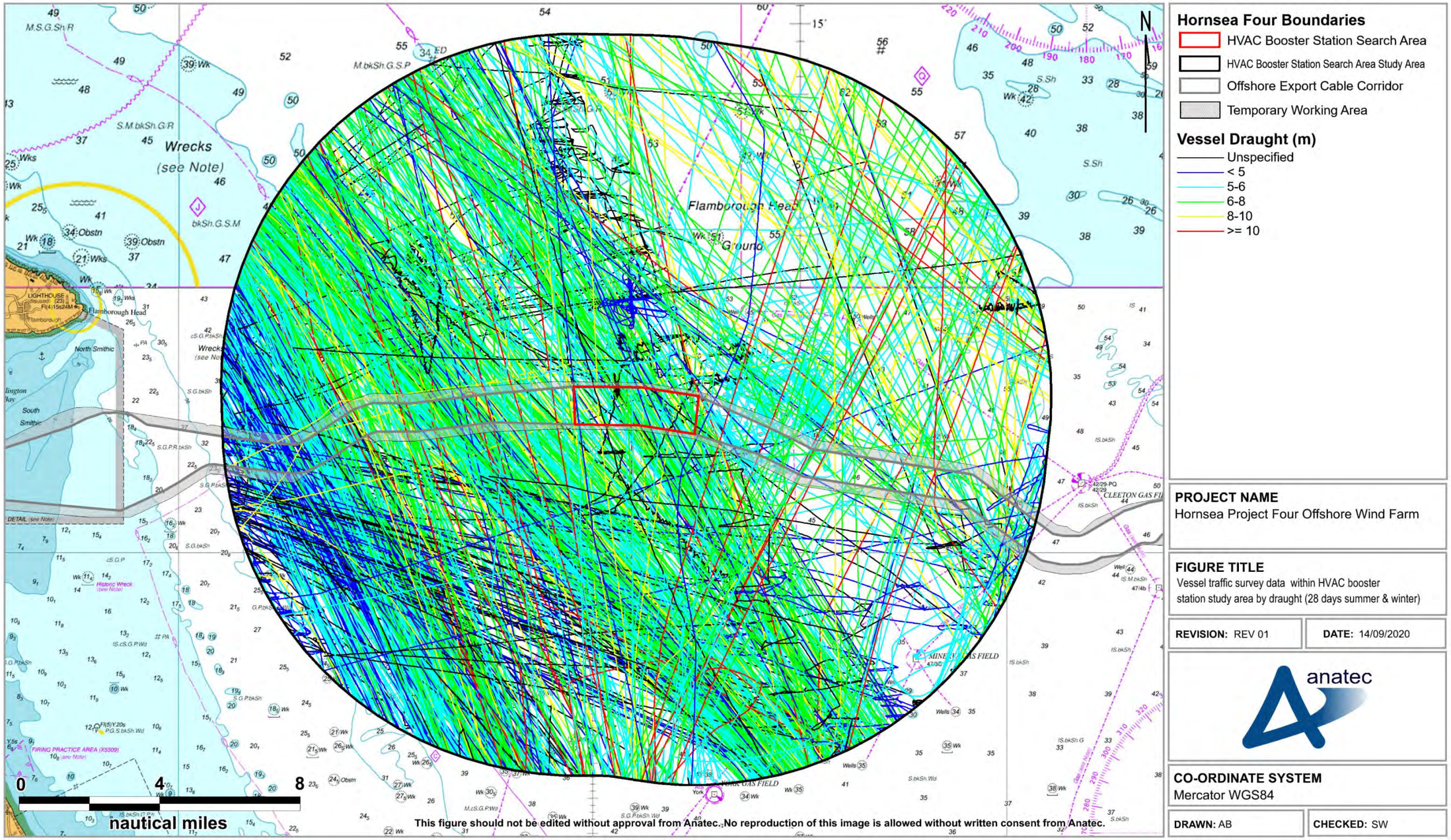


Figure E.43 **Vessel traffic survey data within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel draught (28 days summer and winter 2019)**

E.4.3 Anchored Vessels

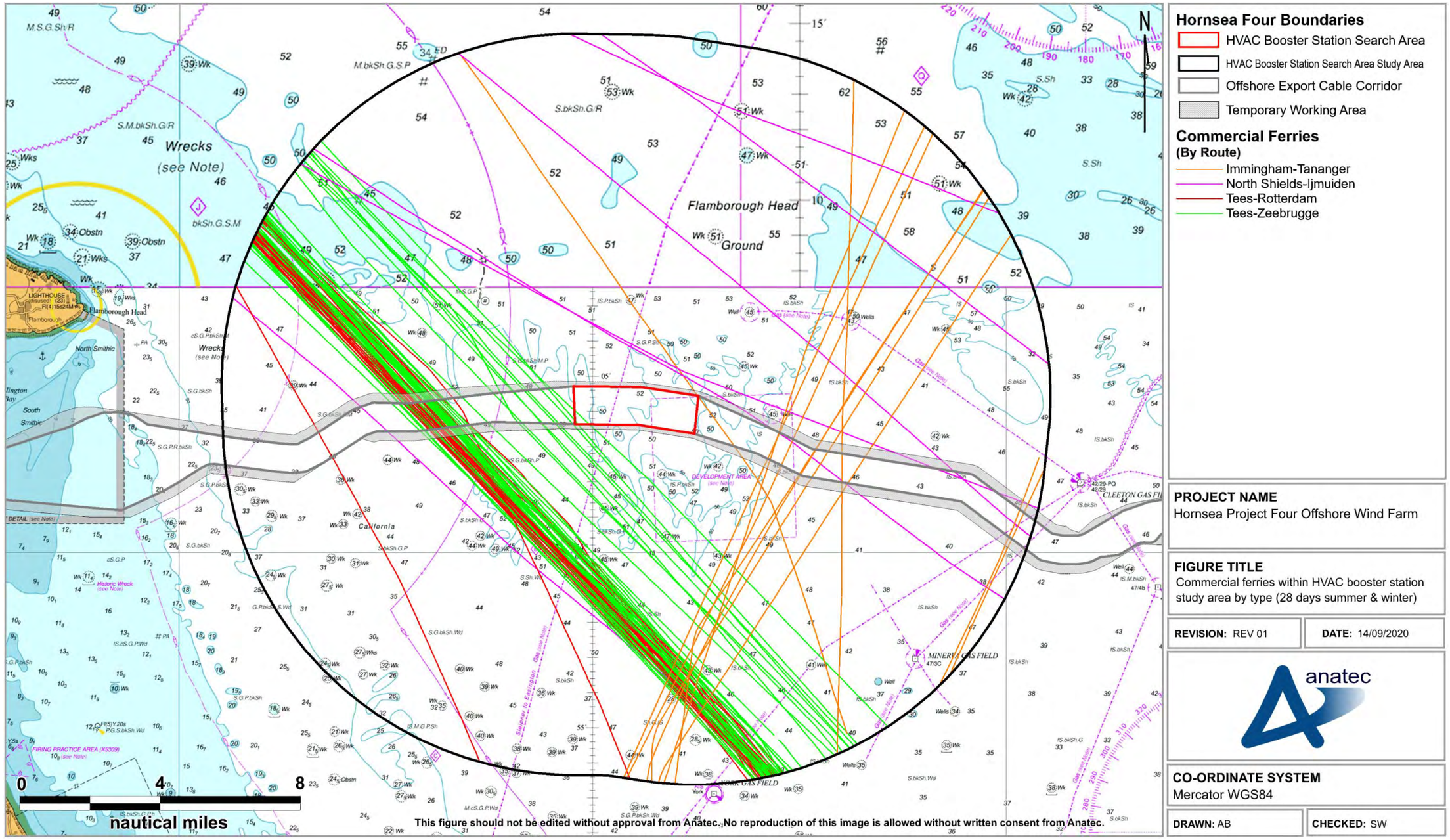
850. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

851. For this reason, those vessels which travelled at a speed of less than 1 kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. After applying these criteria, only one vessel was deemed to be at anchor. This was a crude oil tanker at the western extent of the Hornsea Four HVAC booster station search area shipping and navigation study area (this anchored tanker was also identified for the Hornsea Four offshore ECC vessel traffic analysis in Section E.3.4).

E.4.4 Commercial Ferry Activity

852. Throughout the survey periods nine unique commercial ferries were identified, with three undertaking regular routes in both survey periods. Figure E.44 presents a plot of commercial ferries recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the survey periods, colour-coded by route.

853. The most frequently transited commercial ferry route was a P&O Ferries operated route between the Tees and Zeebrugge/Rotterdam, with the *Estraden* and *Bore Song* making on average two transits per day between them within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the survey periods. A small number of tracks from the vessels on the DFDS Seaways commercial ferry route between North Shields and Ijmuiden identified in Section E.2.5 for the Hornsea Four array area vessel traffic analysis were also observed. These were primarily during the winter survey period and are considered to be adverse weather transits. These are considered further in Section 16.3.



PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Commercial ferries within HVAC booster station study area by type (28 days summer & winter)

REVISION: REV 01 | **DATE:** 14/09/2020

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Figure E.44 Commercial ferries within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer and winter 2019)

E.4.5 Recreational Vessel Activity

854. For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive and fishing charter trips) of between 2.4 and 24 m LOA.

855. Figure E.45 presents a plot of recreational vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout both survey periods.

856. All recreational vessels were detected during the summer survey period. Throughout the summer survey period, an average of one unique recreational vessel per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area.

E.4.6 Commercial Fishing Vessels

857. Figure E.46 presents a plot of fishing vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout both survey periods.

858. Throughout the survey periods, an average of four unique fishing vessels per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. A total of 13 fishing vessels were recorded on Radar, with the rest recorded on AIS, including a large proportion of fishing vessels under the mandatory 15 m length for AIS broadcast.

859. Fishing vessel movements were characteristic of both fishing vessels in transit and engaged in fishing activity. Fishing vessels were most prominent nearshore transiting in and out of Bridlington west of the Hornsea Four HVAC booster station search area and north of the Hornsea Four HVAC booster station search where a moderate density of active fishing was observed.

860. Flag State (nationality) information was available for all fishing vessels recorded on AIS within the Hornsea Four HVAC booster station search area shipping and navigation study area. The nationalities identified were the UK (97%), France (2%) and Denmark (1%).

861. Fishing method information was also researched and available for 89% of fishing vessels recorded on AIS within the Hornsea Four HVAC booster station search area shipping and navigation study area. Of the fishing vessel methods identified, the most common were pots and traps (86%), boat dredges (8%) and demersal trawlers (3%).

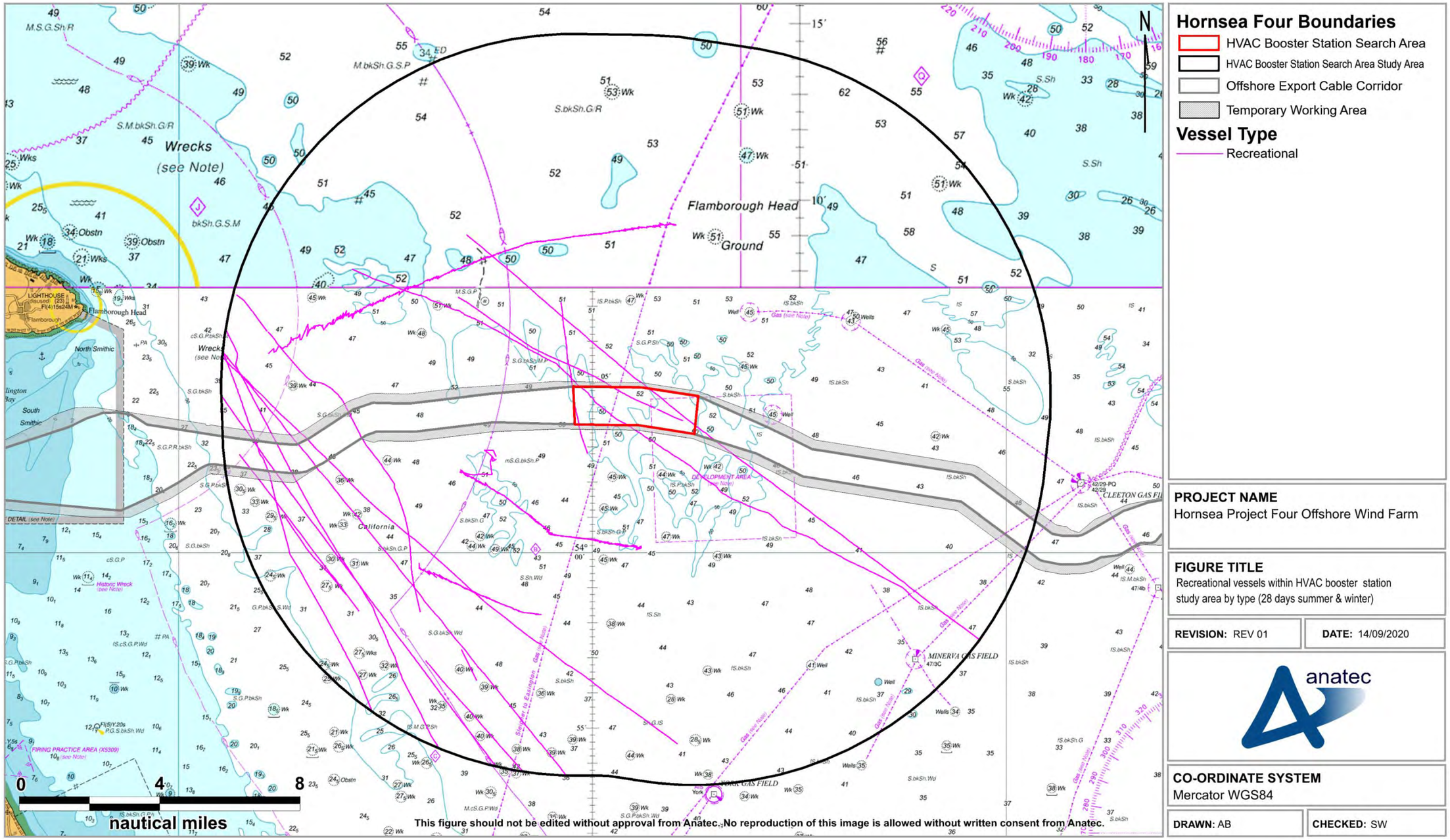


Figure E.45 Recreational vessels within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer and winter 2019)

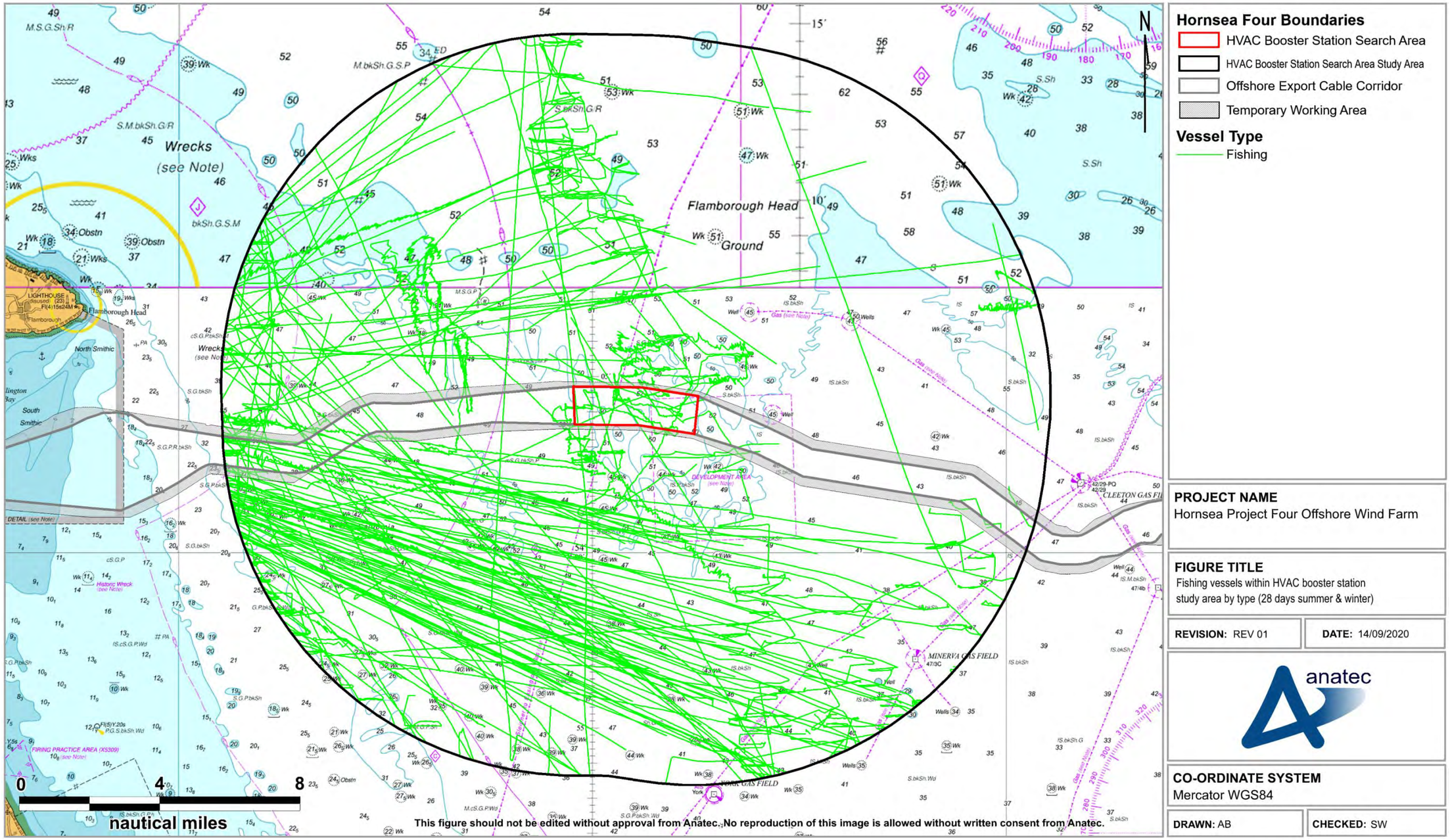


Figure E.46 Fishing vessels within Hornsea Four HVAC booster station search area shipping and navigation study area (28 days summer and winter 2019

Appendix F Vessel Traffic Surveys Summer 2021

862. As initially noted in Section 5.3.1, two additional vessel traffic surveys were undertaken in June and July 2021 to characterise vessel traffic movements within and in proximity to the Hornsea Four array area and HVAC booster station search area, respectively. Together with the vessel traffic surveys undertaken in February and March 2021, the full datasets covering 28 days at the Hornsea Four array area and HVAC booster station search area are compliant with the requirements of MGN 654 (MCA, 2021).

863. This appendix presents the shipping data for the summer 2021 surveys within the Hornsea Four array area and HVAC booster station search area shipping and navigation study areas. The data is intended to serve as a validation of the AIS only dataset analysed in Section 15 for characterising vessel traffic movements, with Section F.4 providing a comparison of the data with the AIS only dataset.

F.1 Vessel Traffic Survey Methodology

864. As with the 2020/21 vessel traffic surveys analysed in Section 15, baseline shipping activity for the Hornsea Four array area and HVAC booster station search area was assessed using AIS, visual observations, and Radar track data recorded from the *Karima* survey vessel located at the Hornsea Four array area and HVAC booster station search area. In line with standard practice, a vessel-based traffic survey of the sections of the Hornsea Four offshore ECC outside of the Hornsea Four HVAC was not required.

865. The vessel traffic data for summer 2021 within the Hornsea Four array area includes a dataset of 14 full days of AIS, visual observations, and Radar across one period:

- 6th July to 20th July 2021 (14 days).

866. The vessel traffic data for the 2021 within the Hornsea Four HVAC booster station search area includes a dataset of 14 full days of AIS, visual observations, and Radar across one survey period:

- 22nd June to 6th July 2021 (14 days).

F.2 Hornsea Four Array Area

867. A number of tracks recorded during the Hornsea Four array area summer survey period were classified as temporary (non-routine). These included the tracks of the survey vessel, as well as tracks associated with the construction of Hornsea Project Two. All temporary tracks have therefore been excluded from further analysis. Oil and gas vessels operating at permanent installations were retained in the analysis.

868. Figure F.1 presents the vessels recorded during the 14-day summer 2021 survey period, colour-coded by vessel type. Following this Figure F.2 presents a density plot of the summer 2021 data.

F.2.1 Vessel Counts

869. The daily number of unique vessels recorded within the Hornsea Four array area and the Hornsea Four array area shipping and navigation study area throughout the summer 2021 survey period is presented in Figure F.3. During the summer 2021 survey period, approximately 33% of unique vessel tracks recorded within the Hornsea Four array area shipping and navigation study area intersected the Hornsea Four array area itself.

870. For the 14 days analysed in the summer survey period, there was an average of 27 unique vessels recorded per day within the Hornsea Four array area shipping and navigation study area. There was an average of nine unique vessels recorded per day intersecting the Hornsea Four array area itself during the summer 2021 survey period.

871. The busiest days recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period were 10th and 12th July 2021, with 32 unique vessels recorded. The busiest day recorded within the Hornsea Four array area itself during the summer 2021 survey period was 16th July 2021, with 13 unique vessels recorded.

872. The quietest full day recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period was 9th July 2021, with 20 unique vessels recorded. The quietest full days recorded within the Hornsea Four array area itself during the summer 2021 survey period were 8th, 9th and 13th July 2021, with six unique vessels recorded each.

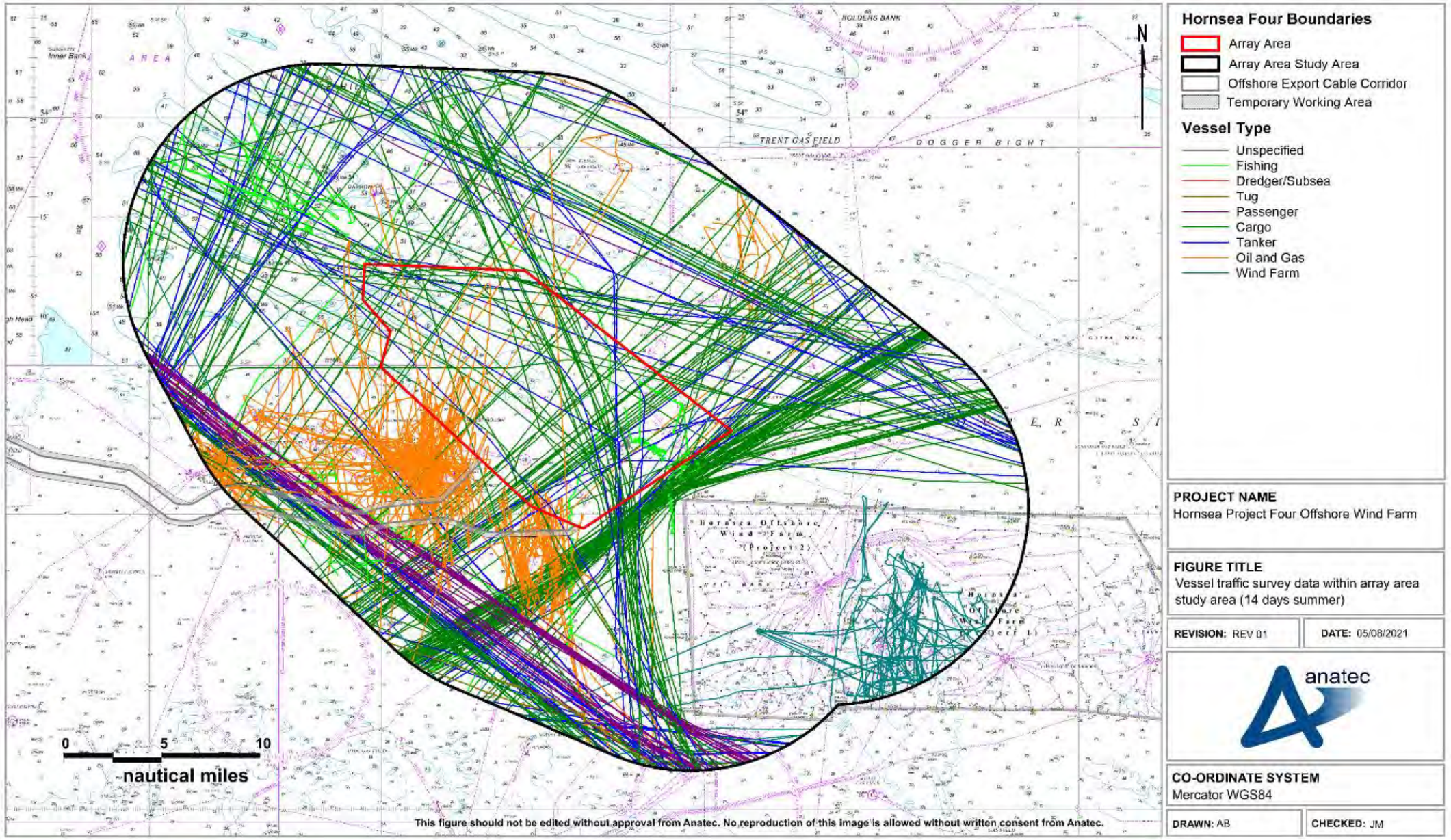


Figure F.1 Vessel traffic survey data within Hornsea Four array area shipping and navigation study area colour-coded by vessel type (14 days summer 2021)

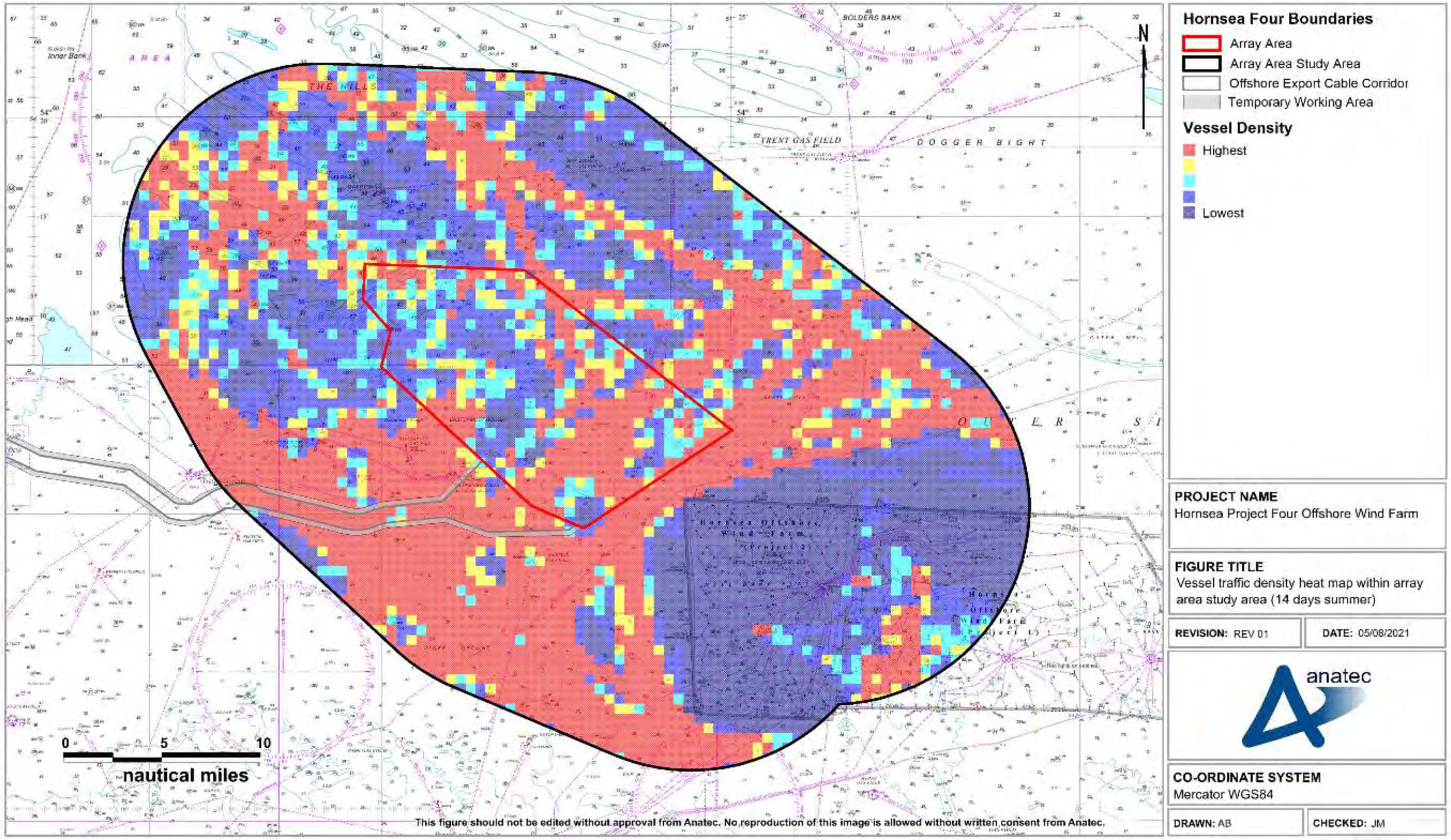


Figure F.2 Vessel traffic density heat map within Hornsea Four array area shipping and navigation study area excluding temporary traffic (14 days summer 2021)

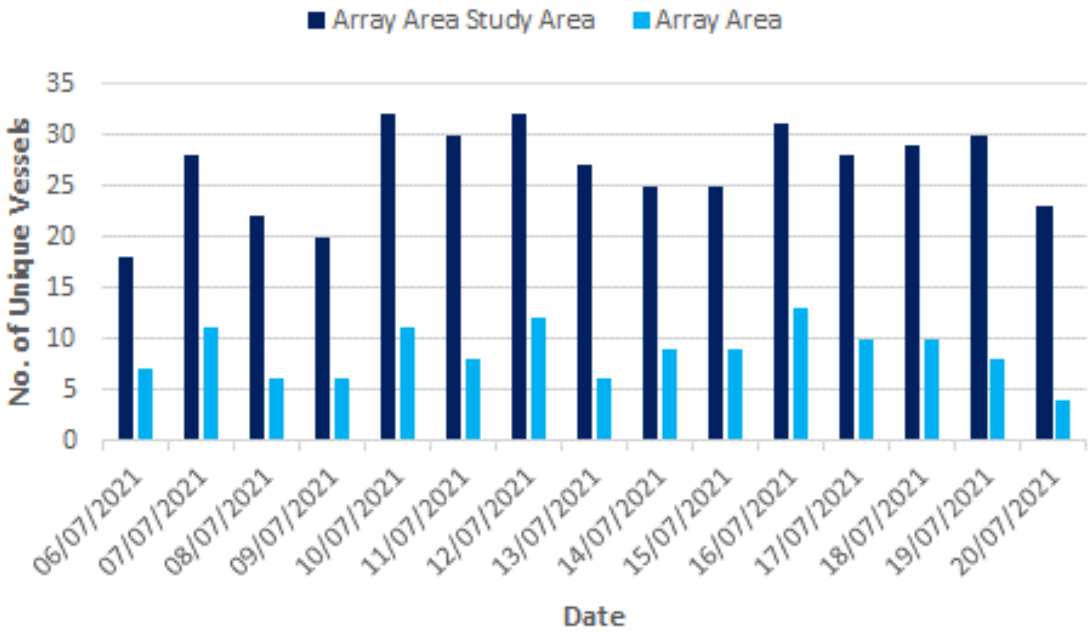


Figure F.3 Unique vessels per day within Hornsea Four array area and shipping and navigation study area (14 days summer 2021)

F.2.2 Vessel Types

873. The percentage distribution of the main vessel types recorded within the Hornsea Four array area shipping and navigation study area is presented in Figure F.4.

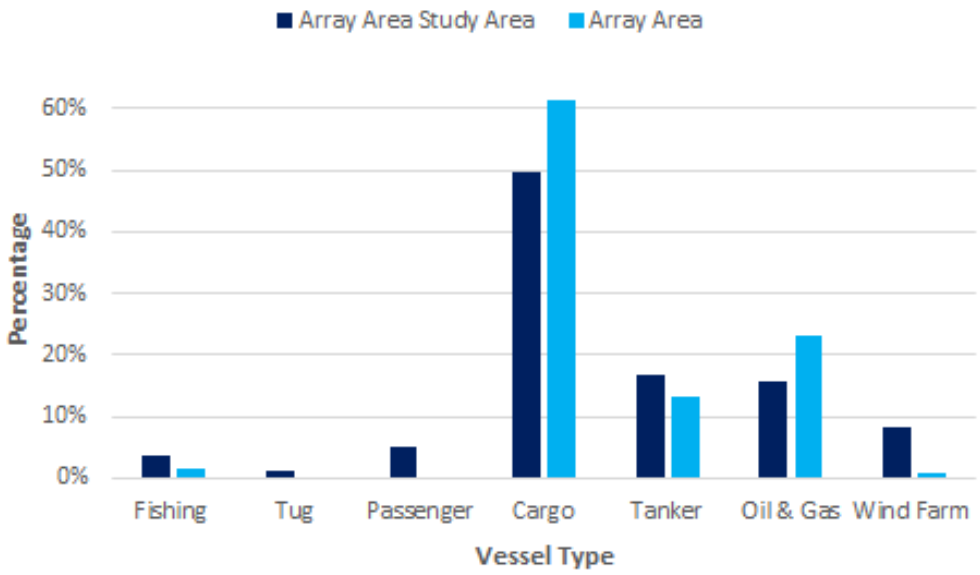


Figure F.4 Vessel type distribution within Hornsea Four array area and shipping and navigation study area (14 days summer 2021)

874. Throughout the summer 2021 survey period, the main vessel types were cargo vessels (61% of vessels within the Hornsea Four array area), oil and gas vessels (23%), and tankers (13%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo. Details specific to commercial ferries are presented in Section F.2.5.

F.2.2.1 Cargo Vessels

875. Cargo vessels, including commercial ferries, recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.5.

876. Throughout the summer 2021 survey period, an average of 14 unique cargo vessels per day passed within the Hornsea Four array area shipping and navigation study area. Regular cargo vessels operating in proximity to the Hornsea Four array area include Ro-Ro vessels primarily operated by DFDS Seaways running routes between Immingham and Esbjerg, and Immingham and Gothenburg.

F.2.2.2 Tankers

877. Tankers recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.6.

878. Throughout the summer 2021 survey period, an average of five unique tankers per day passed within the Hornsea Four array area shipping and navigation study area. All of the tankers recorded throughout the summer 2021 survey period were on passage to oil and has terminals throughout the UK and mainland Europe including Rotterdam and Antwerp.

F.2.2.3 Oil and Gas Vessels

879. Oil and gas vessels recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.7.

880. Throughout the summer 2021 survey period, an average of four unique oil and gas vessels per day passed within the Hornsea Four array area shipping and navigation study area. The majority of these vessels were on passage to/from oil and gas installations in the region. Oil and gas vessels which were not transient included the *Island Condor* acting as a walk to work vessel for the nearby Ravenspurn gas field and the *Putford Defender* and *Putford Saviour*, both acting as ERRVs for Ravenspurn. Vessel activity was also present at the Babbage gas field.

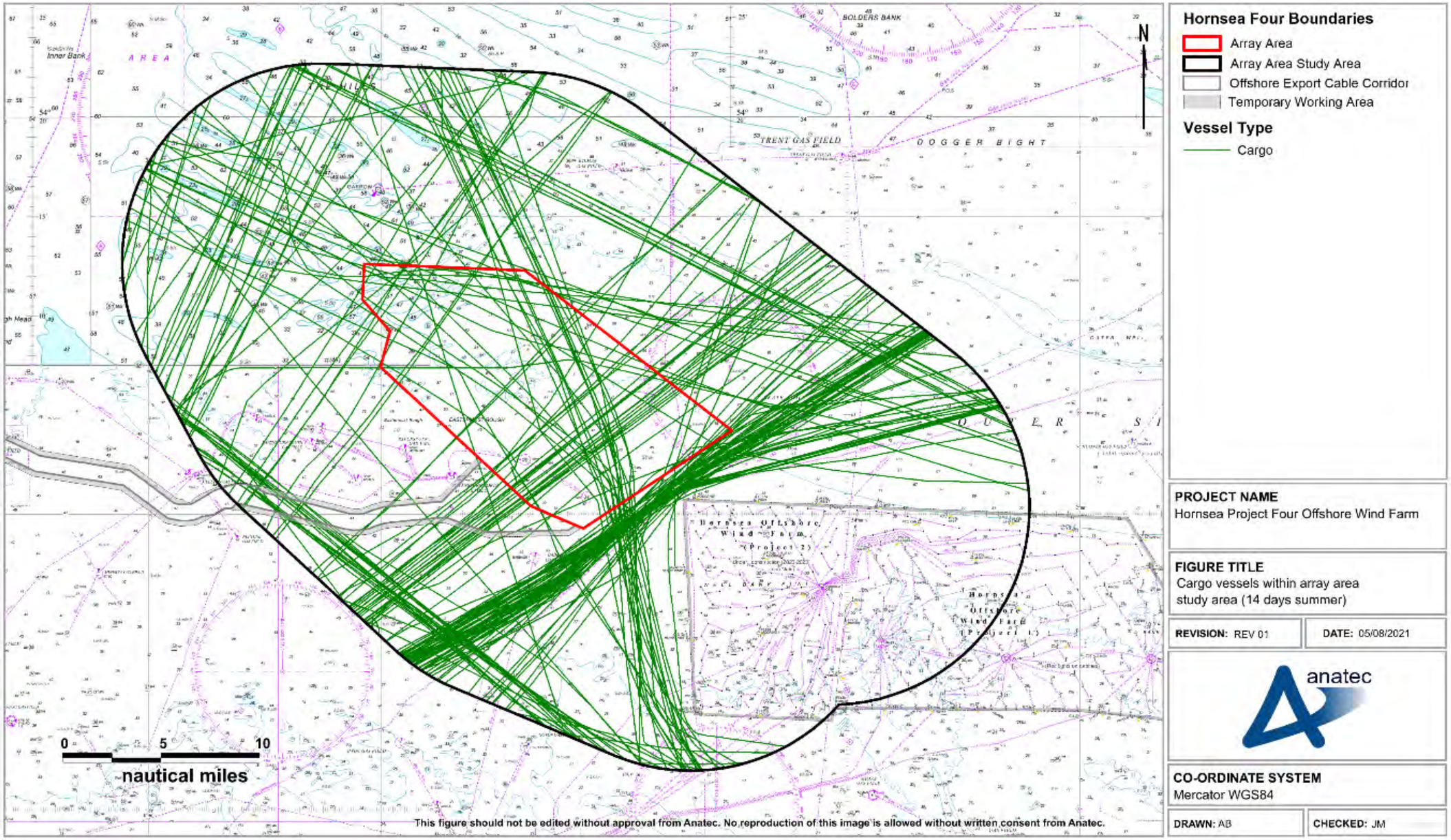


Figure F.5 Cargo vessels within Hornsea Four array area shipping and navigation study area (14 days summer 2021)

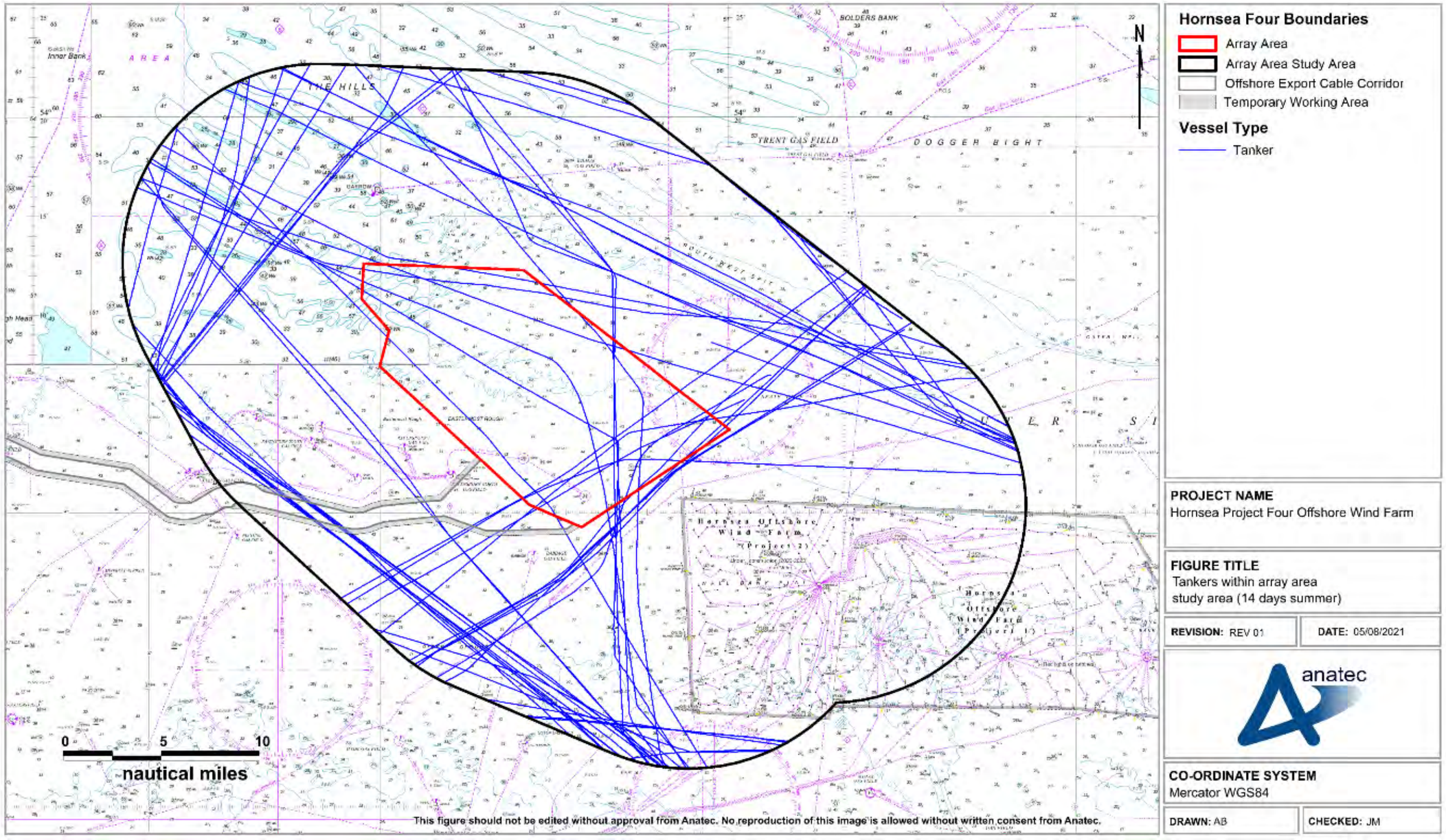


Figure F.6 Tankers within Hornsea Four array area shipping and navigation study area (14 days summer 2021)

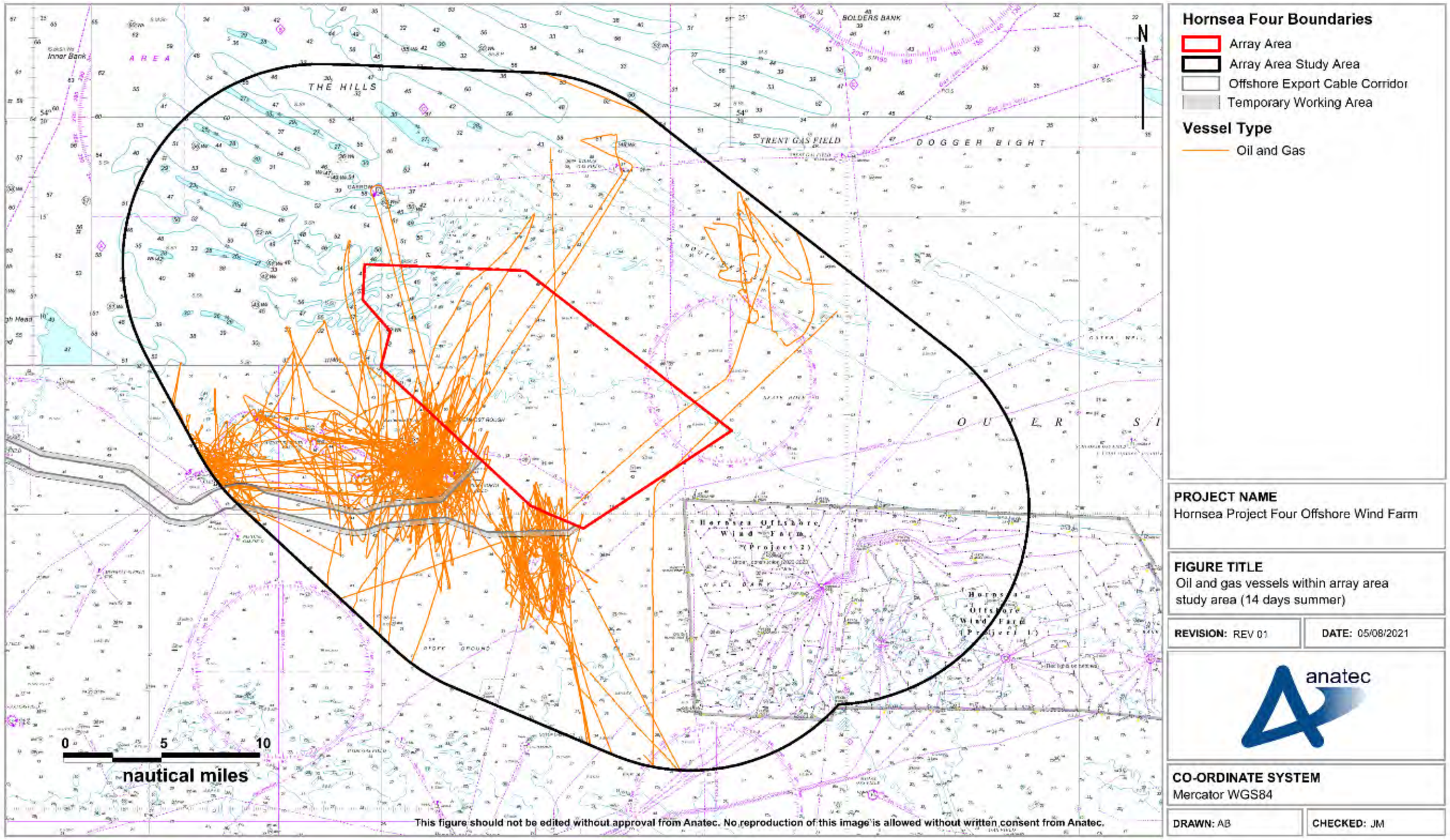


Figure F.7 Oil and gas vessels within Hornsea Four array area shipping and navigation study area (14 days summer 2021)

F.2.3 Vessel Sizes

F.2.3.1 Vessel Length

881. Vessel LOA was available for more than 98% of vessels recorded throughout the summer 2021 survey period and ranged from 15 m for a fishing vessel to 333 m for a crude oil tanker. The distribution of vessel lengths recorded throughout the summer 2021 survey period is presented in Figure F.8.

882. Excluding the small proportion of vessels for which length was not available, the average length of vessels within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period was 130 m.

883. The tracks of all vessels within the Hornsea Four array area shipping and navigation study area are presented in Figure F.9, colour-coded by length.

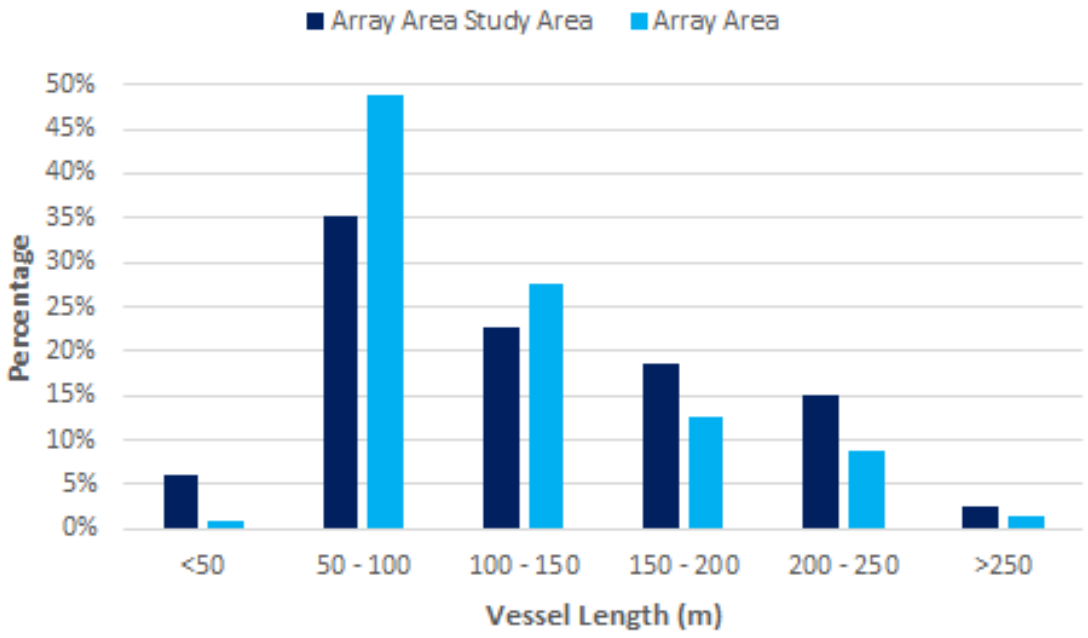


Figure F.8 Vessel length distribution within Hornsea Four array area and shipping and navigation study area (14 days summer 2021)

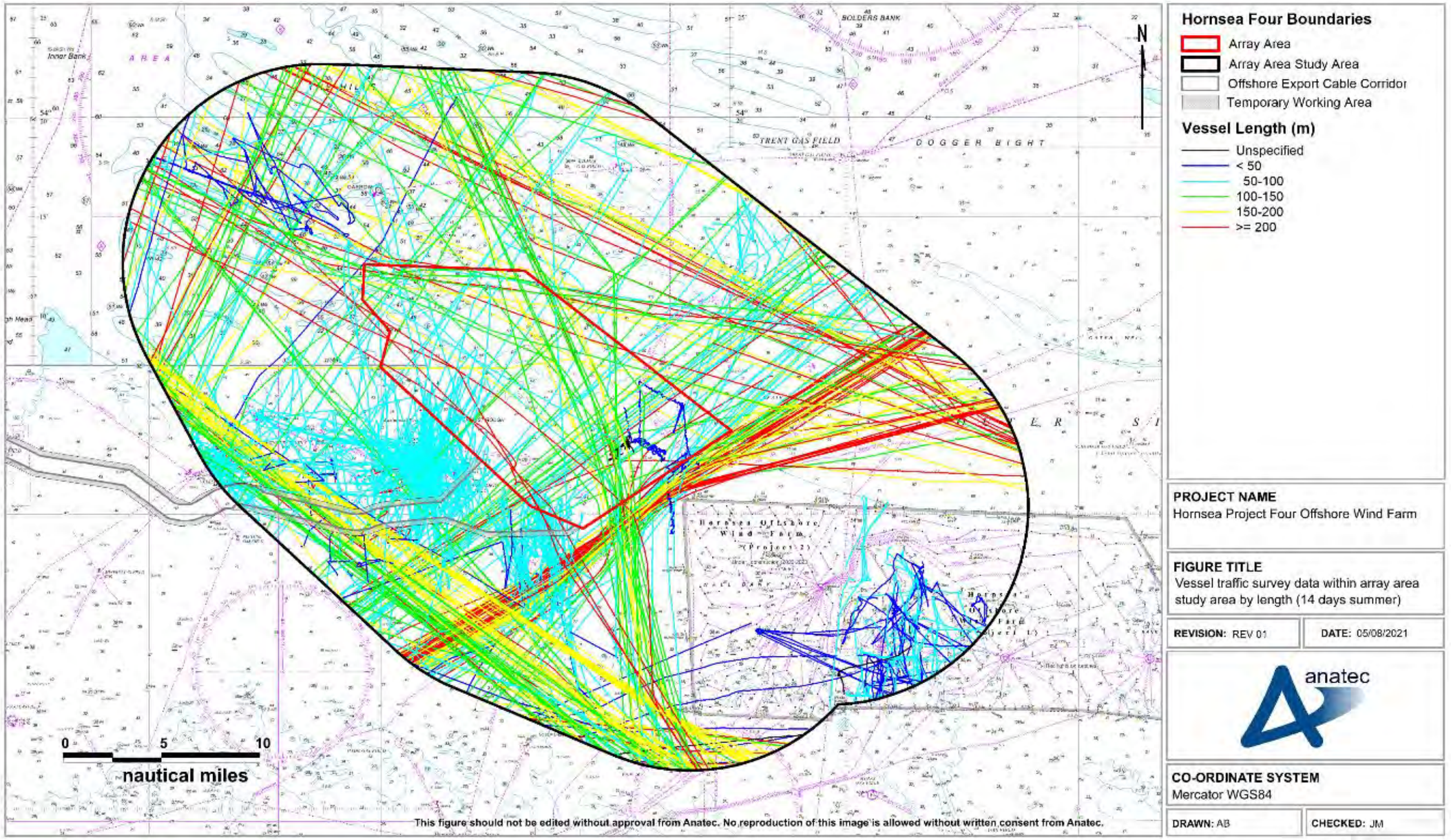


Figure F.9 Vessel traffic within Hornsea Four array area shipping and navigation study area by length (14 days summer 2021)

F.2.3.2 Vessel Draught

884. Vessel draught was available for approximately 96% of vessels recorded throughout the summer 2021 survey period and ranged from 1.5 m for a crew transfer vessel to 18.5 m for a crude oil tanker. The distribution of vessel draughts recorded throughout the summer 2021 survey period is presented in Figure F.10.

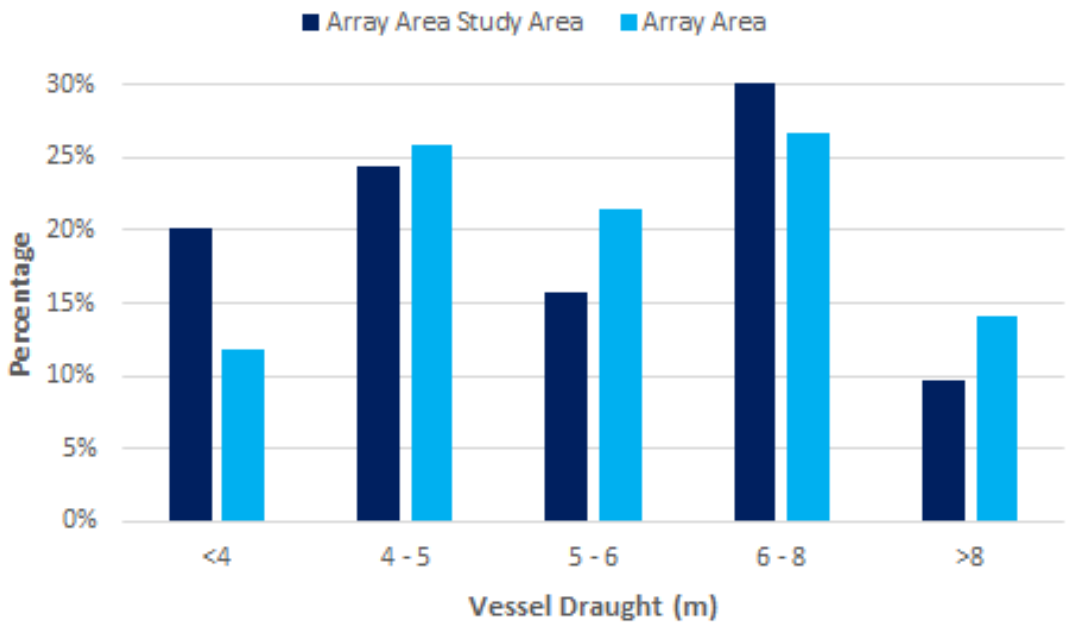
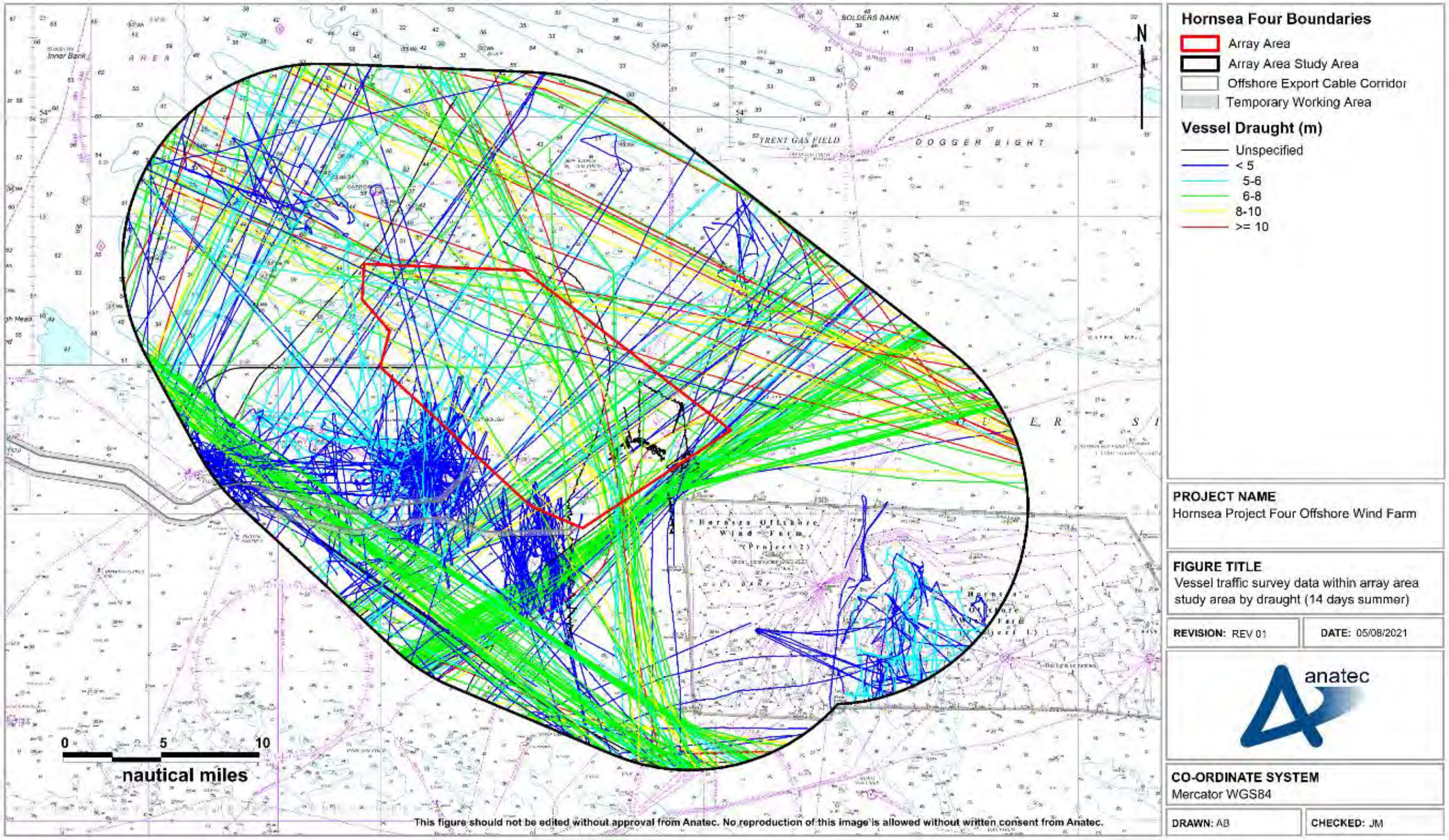


Figure F.10 Vessel draught distribution within Hornsea Four array area and shipping and navigation study area (14 days summer 2021)

885. Excluding those vessels for which a draught was not available (mainly non-AIS vessels), the average draught of vessels within the Hornsea Four array area shipping and navigation study area throughout the summer 2021 survey period was 6.1 m.

886. The tracks of all vessels within the Hornsea Four array area shipping and navigation study area are colour-coded by draught and presented in Figure F.11.



887.

Figure F.11 Vessel traffic within Hornsea Four array area shipping and navigation study area by draught (14 days summer 2021)

F.2.4 Anchored Vessels

888. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS equipment, and it is therefore common for vessels not to update their navigational status if only at anchor for a short period of time.

889. For this reason, vessels which travelled at a speed of less than 1 kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. After applying these criteria, no vessels were deemed to be at anchor within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period.

F.2.5 Commercial Ferry Activity

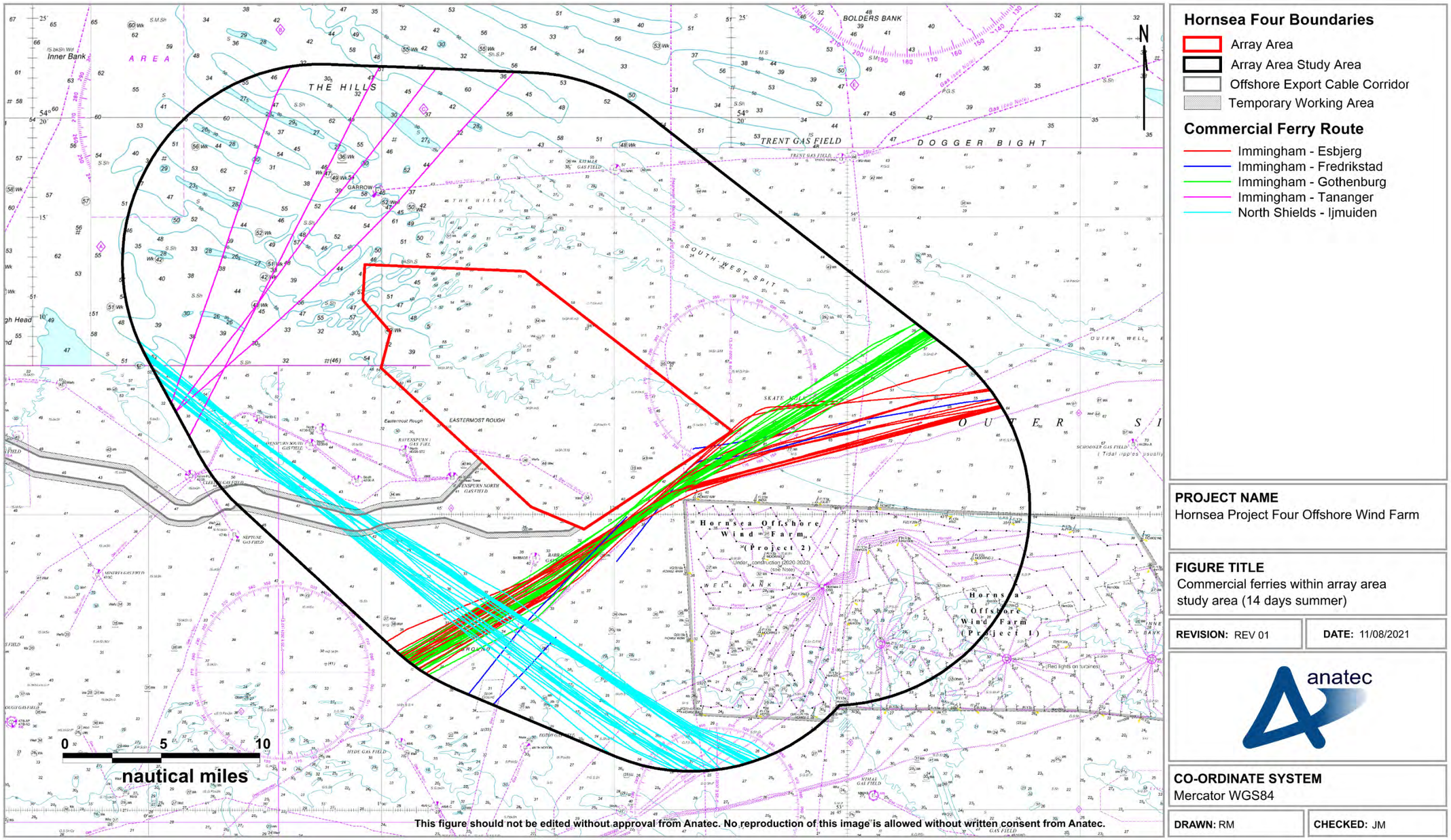
890. Throughout the summer 2021 survey period 13 unique commercial ferries were identified, with 10 undertaking regular routes. Commercial vessels recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.12.

891. The most frequently transited commercial ferry route was a DFDS Seaways operated route between Immingham and Esbjerg, with the *Ark Dania*, *Ficaria Seaways* and *Petunia Seaways* making two transits per day between them within the Hornsea Four array area shipping and navigation study area throughout the summer 2021 survey period. Two other DFDS Seaways commercial ferry routes were also relatively prominent, with these operating between North Shields and Ijmuiden and Immingham and Gothenburg.

F.2.6 Recreational Vessel Activity

892. For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive and fishing charter trips) of between 2.4 and 24 m LOA.

893. No recreational vessels were recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period.



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Hornsea Four Boundaries

- Array Area
- Array Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Commercial Ferry Route

- Immingham - Esbjerg
- Immingham - Fredrikstad
- Immingham - Gothenburg
- Immingham - Tananger
- North Shields - Ijmuiden

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Commercial ferries within array area study area (14 days summer)

REVISION: REV 01 | **DATE:** 11/08/2021

CO-ORDINATE SYSTEM
Mercator WGS84

DRAWN: RM | **CHECKED:** JM

Figure F.12 Commercial ferries within Hornsea Four array area shipping and navigation study area (14 days summer 2021)

F.2.7 Commercial Fishing Activity

894. Commercial fishing vessels recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.13.

895. An average of one fishing vessel per day passed within the Hornsea Four array area shipping and navigation study area. Three fishing vessels were recorded on Radar during the summer 2021 survey period, corresponding to 21% of all fishing traffic recorded during the summer 2021 survey period. It is noted that AIS is only mandatory for fishing vessels greater than 15m LOA, although fishing vessels smaller than this are less likely to be far offshore (i.e., in the proximity of the Hornsea Four array area).

896. Fishing vessel movements during the summer 2021 survey period were characteristic of both vessels in transit and engaged in fishing activity. Fishing activity both in transit and gear deployed was observed within the Hornsea Four array area.

897. Flag state (nationality) information was available for all fishing vessels recorded using AIS within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period. The most common nationalities identified were UK (86%), Belgium (7%) and Denmark (7%).

898. Primary gear type information was identified where possible for fishing vessels recorded within the Hornsea Four array area shipping and navigation study area during the summer 2021 survey period. The most common gear types identified excluding unidentifiable gear types were potters/whelkers (66%), demersal trawlers (17%) and beam trawlers (17%).

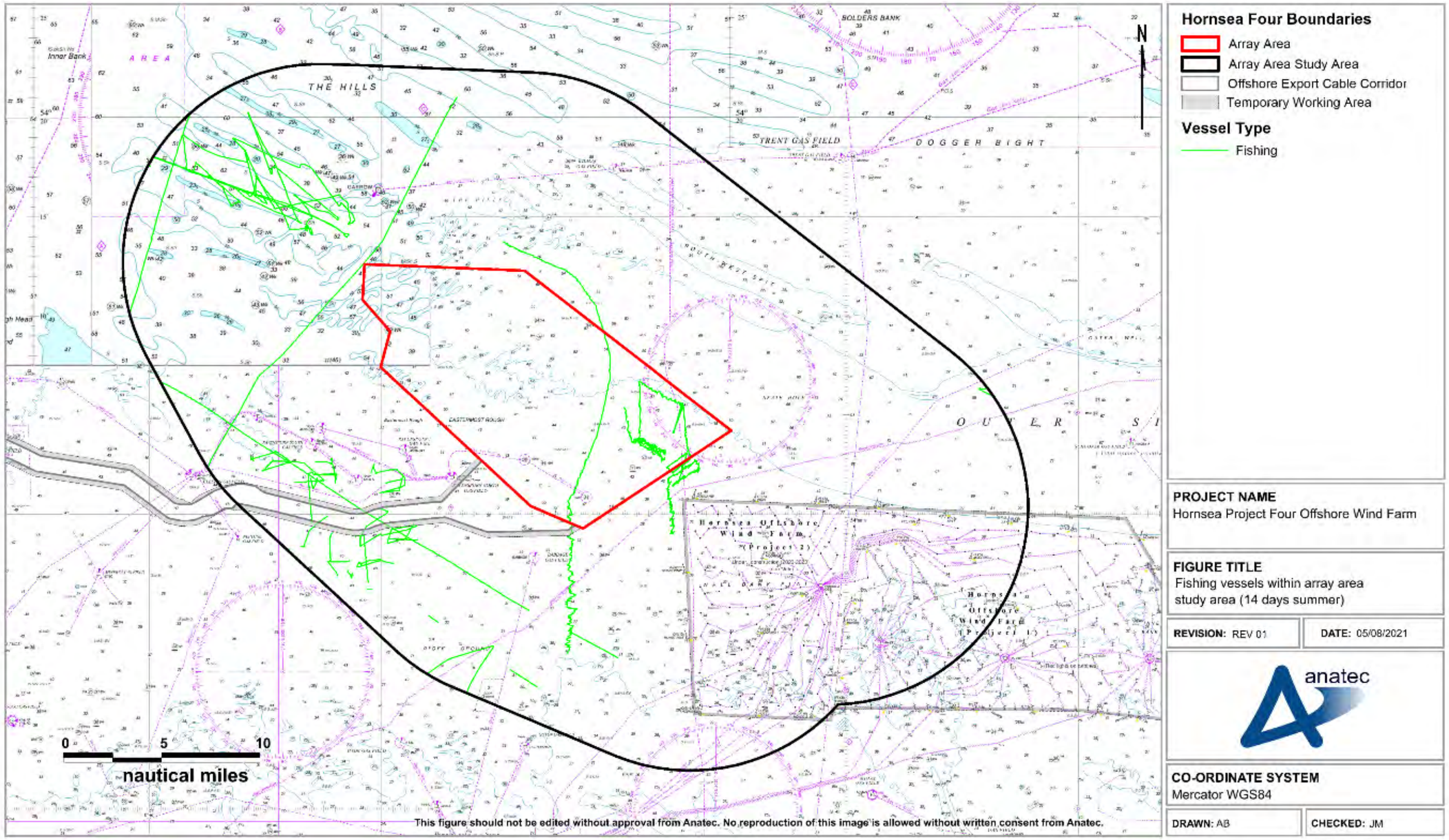


Figure F.13 Commercial fishing vessels within Hornsea Four array area shipping and navigation study area (14 days summer 2021)

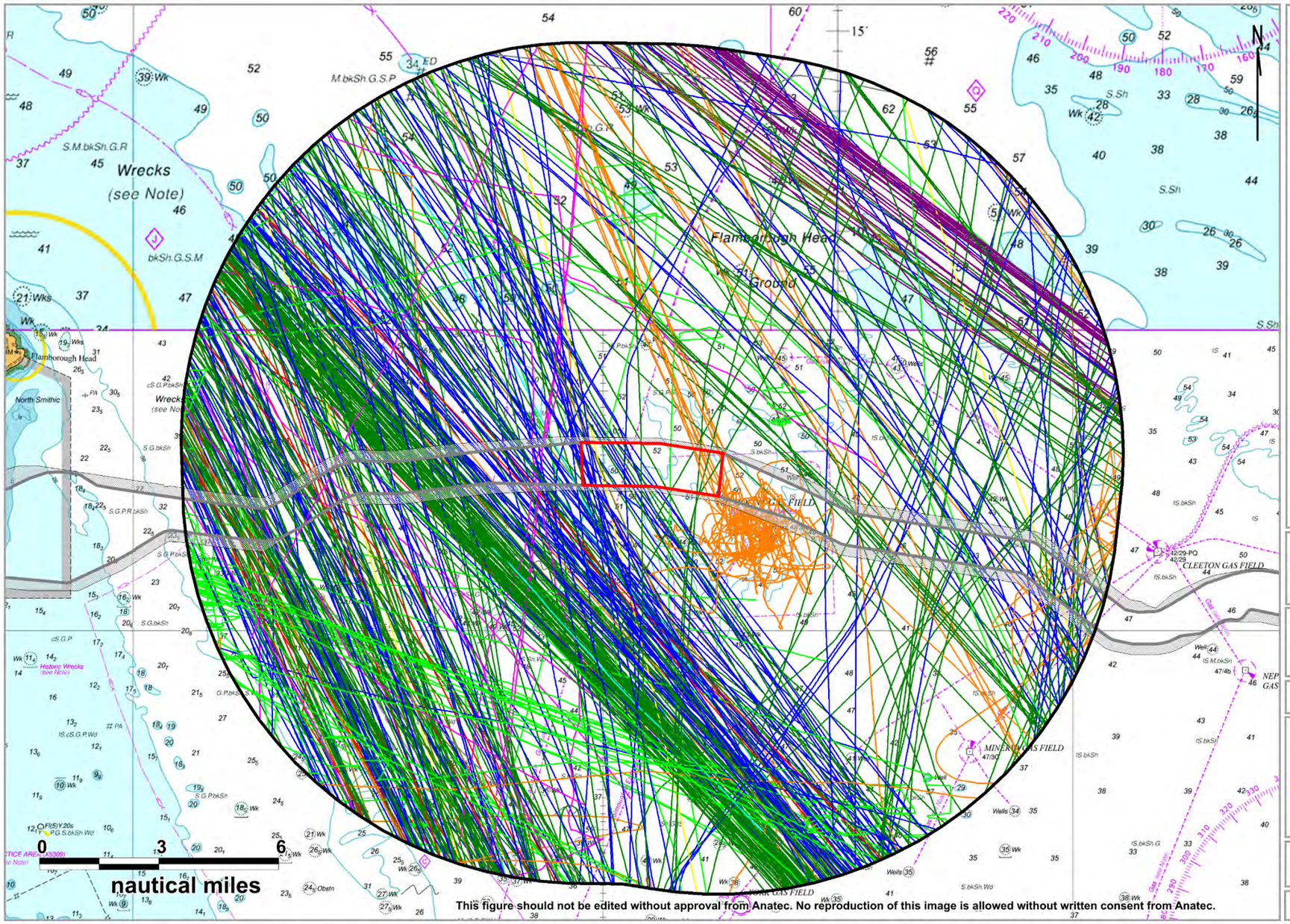
F.3 Hornsea Four HVAC Booster Station Search Area

899. A number of tracks recorded during the summer 2021 survey period within the Hornsea Four HVAC booster station search area shipping and navigation study area were classified as temporary (non-routine). These included the tracks of the survey vessel used in the study, other survey vessels, and a small number of vessels involved in the installation works at the Tolmount gas field. All temporary tracks have therefore been excluded from further analysis. Oil and gas vessels operating at permanent installations were retained in the analysis.

900. The vessel tracks recorded during the 14-day summer 2021 survey period are presented in Figure F.14, colour-coded by vessel type. Following this, Figure F.15 presents a density plot of the summer 2021 data.

F.3.1 Vessel Counts

901. The daily number of unique vessels recorded within the Hornsea Four HVAC booster station search area and the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the summer 2021 survey period is presented in Figure F.16. During the summer 2021 survey period approximately 8% of unique vessel tracks recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area intersected the Hornsea Four HVAC booster station search area itself.



Hornsea Four Boundaries
- HVAC Booster Station Search Area
- HVAC Booster Station Search Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Vessel Type
- Unspecified
- Fishing
- Military
- Dredger/Subsea
- Tug
- Passenger
- Cargo
- Tanker
- Other
- Recreational
- Oil and Gas
- Wind Farm

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Vessel traffic survey data within HVAC booster station study area by type (14 days summer)

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Figure F.14 Vessel traffic within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel type (14 days summer 2021)

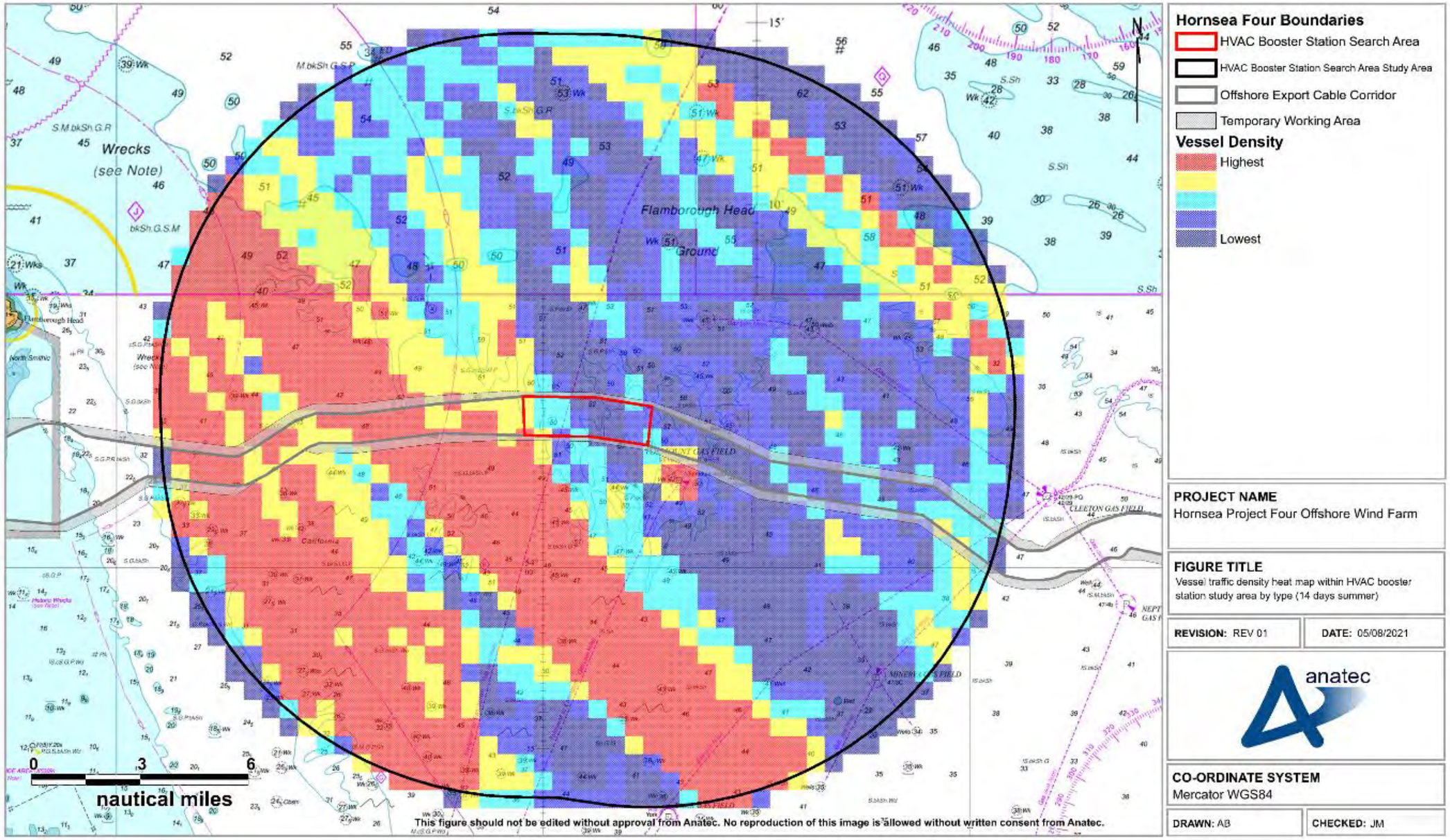


Figure F.15 Vessel traffic density heat map within Hornsea Four HVAC booster station search area shipping and navigation study area excluding temporary traffic (14 days summer 2021)

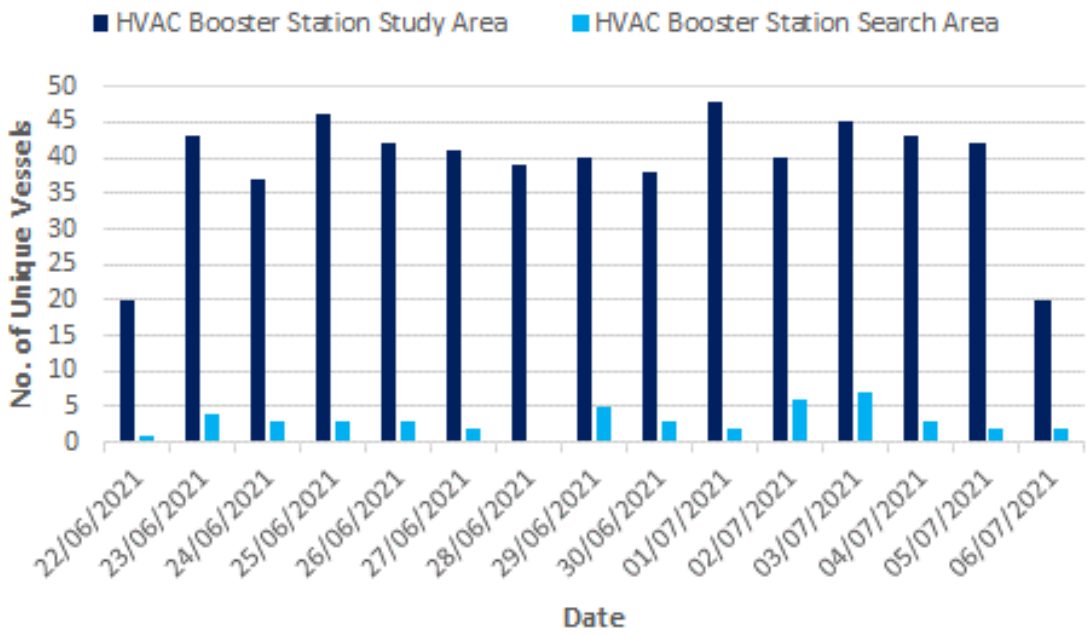


Figure F.16 Unique vessels per day within Hornsea Four HVAC booster station search area and shipping and navigation study area (14 days summer 2021)

902. For the 14 days analysed in the summer 2021 survey period, there was an average of 42 unique vessels recorded per day within the Hornsea Four HVAC booster station search area shipping and navigation study area. There was an average of three unique vessels recorded per day intersecting the Hornsea Four HVAC booster station search area itself.

903. The busiest day recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period was 1st July 2021, with 48 unique vessels recorded. The busiest day recorded within the Hornsea Four HVAC booster station search area itself during the summer 2021 survey period was 3rd July 2021, with seven unique vessels recorded.

904. The quietest full day recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period was 24th June 2021, with 37 unique vessels recorded. The quietest full day recorded within the Hornsea Four HVAC booster station search area itself during the summer 2021 survey period was 28th June 2021, with no vessels recorded.

F.3.2 Vessel Types

905. The percentage distribution of the main vessel types recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area is presented in Figure F.17.

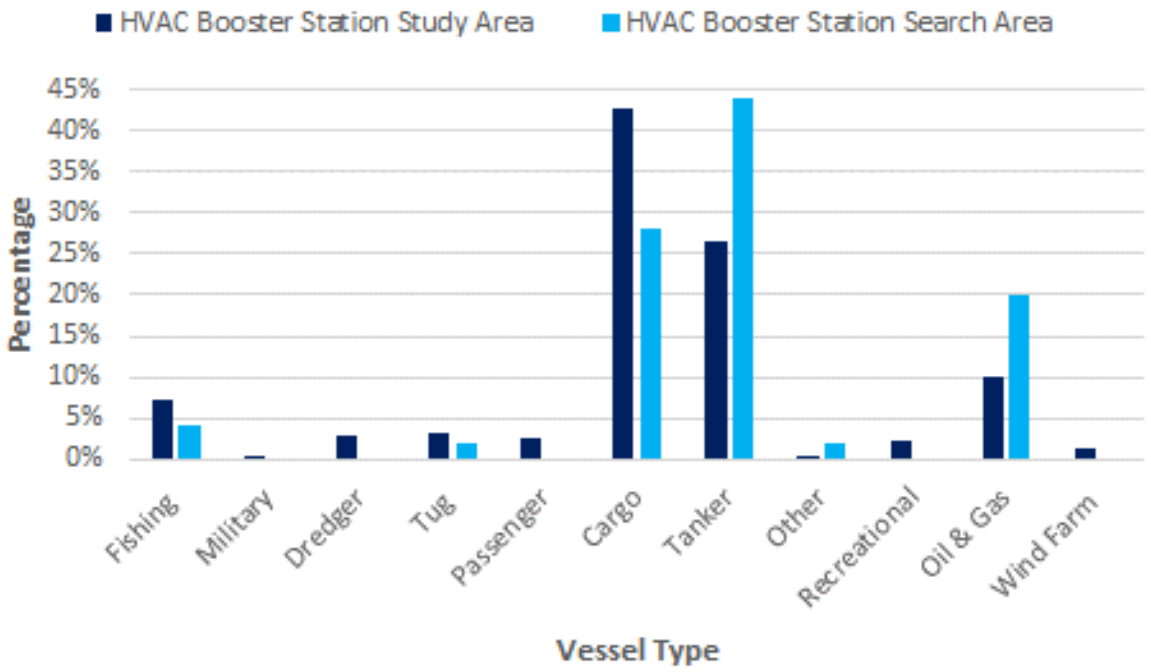


Figure F.17 Vessel type distribution within HVAC booster station search area and shipping and navigation study area (14 days summer 2021)

906. Throughout the summer 2021 survey period, the main vessel types were tankers (44% of vessels within the Hornsea Four HVAC booster station search area), cargo vessels (28%), and oil and gas vessels (20%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo. Details specific to commercial ferries are presented in Section F.3.5

F.3.2.1 Cargo Vessels

907. Cargo vessels, including commercial ferries, recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.18.

908. Throughout the summer 2021 survey period, an average of 18 unique cargo vessels per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. Regular cargo vessels operating in proximity to the Hornsea Four HVAC booster station search area include Ro-Ro vessels primarily operated by P&O Ferries running routes between Tees and Zeebrugge and by DFDS Seaways running routes between North Shields and Ijmuiden.

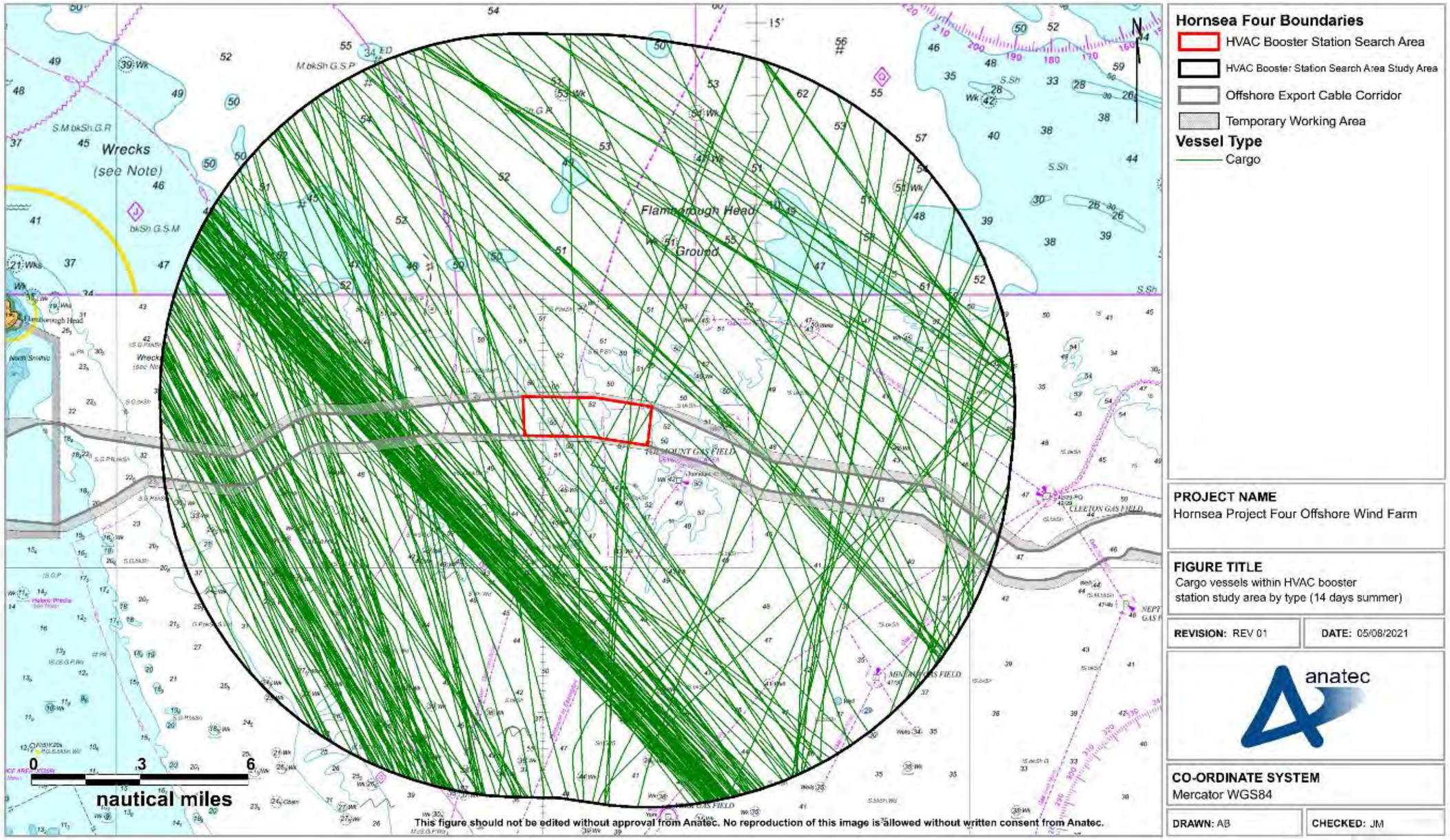


Figure F.18 Cargo vessels within the Hornsea Four HVAC booster station search area shipping and navigation study area (14 days summer 2021)

F.3.2.2 Tankers

909. Tankers recorded in the HVAC booster station search area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.19.

910. Throughout the 2021 survey periods, an average of 11 unique tankers per day passed within the HVAC booster station search area shipping and navigation study area. The majority of tankers recorded throughout the survey period were on passage to oil and gas terminals throughout the UK and mainland Europe.

F.3.2.3 Oil and Gas Vessels

911. Oil and gas vessels recorded in the HVAC booster station search area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.20.

912. Throughout the 2021 survey periods, an average of four unique oil and gas vessels per day passed within the HVAC booster station search area shipping and navigation study area. The majority of these vessels were on passage to/from oil and gas installations in the region including the Tolmount platform.

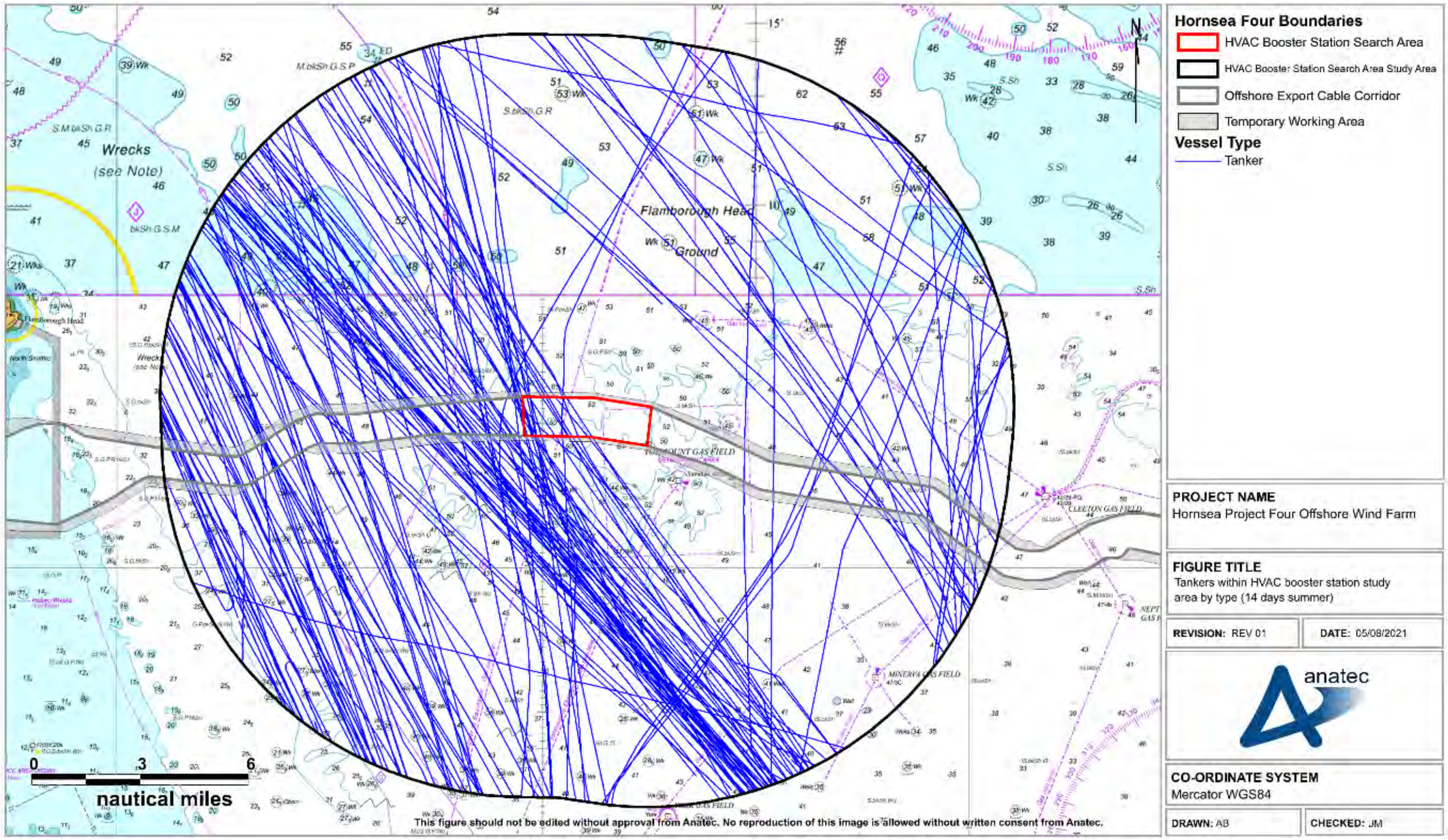


Figure F.19 Tankers within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel type (14 days summer 2021)

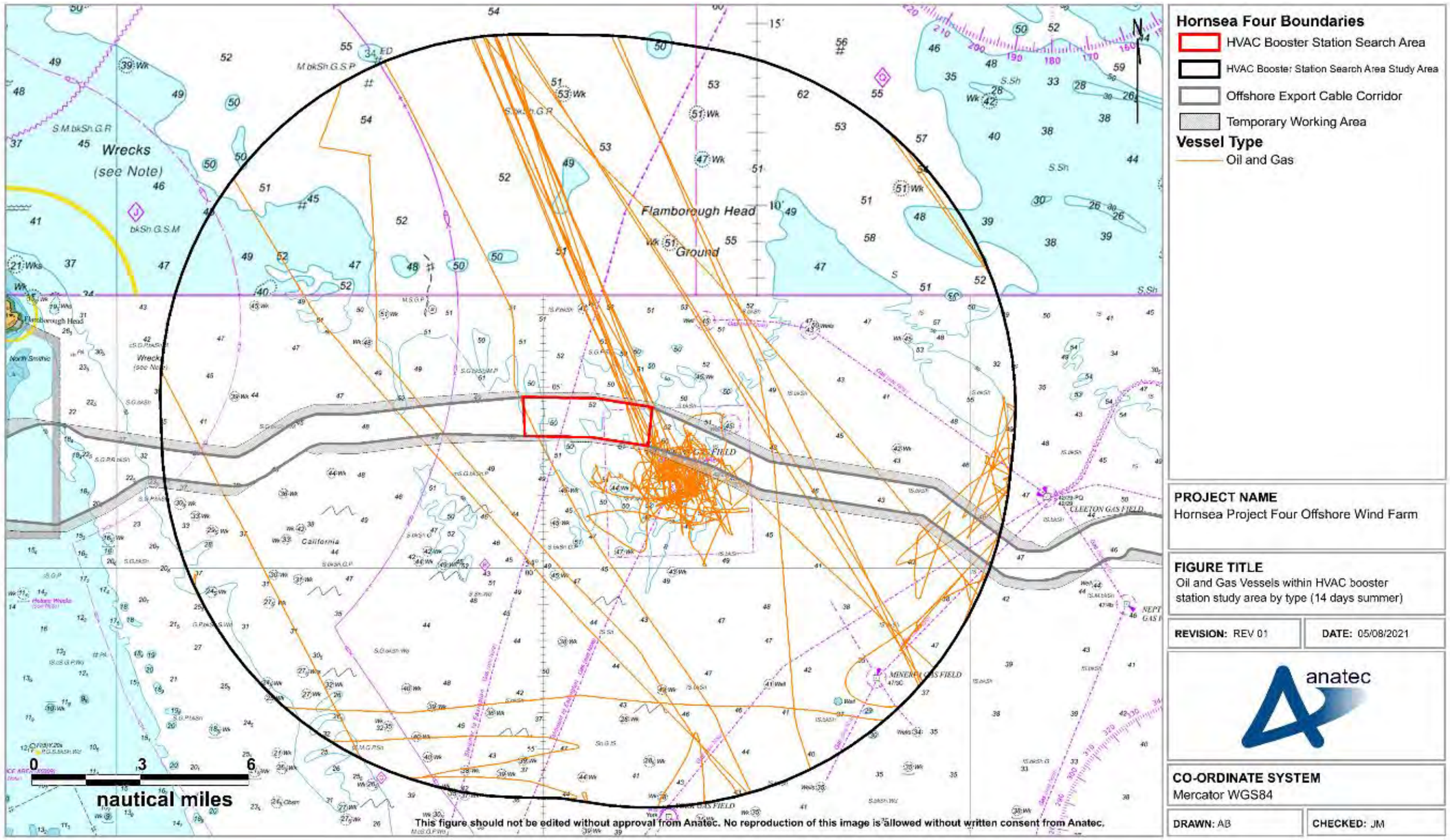


Figure F.20 Oil and gas vessels within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel type (14 days summer 2021)

F.3.3 Vessel Sizes

F.3.3.1 Vessel Length

913. Vessel LOA was available for more than 99% of vessels recorded throughout the summer 2021 survey period and ranged from 9 m for a small fishing vessel to 276 m for a crude oil tanker. The distribution of vessel lengths recorded throughout the summer 2021 survey period is presented in Figure F.21.

914. Excluding the small proportion of vessels for which length was not available, the average length of vessels within the HVAC booster station search area shipping and navigation study area during the summer 2021 survey period was 103m.

915. The tracks of all vessels within the Hornsea Four HVAC booster station search area shipping and navigation study area are presented in Figure F.22, colour-coded by length.

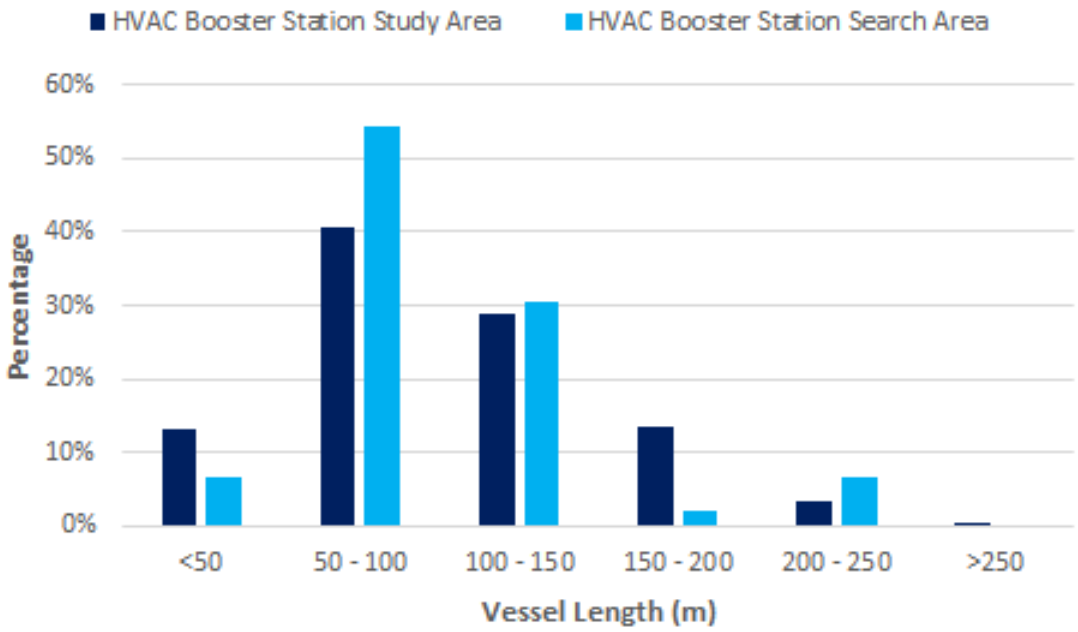


Figure F.21 Vessel length distribution within Hornsea Four HVAC booster station search area shipping and navigation study area (14 days summer 2021)

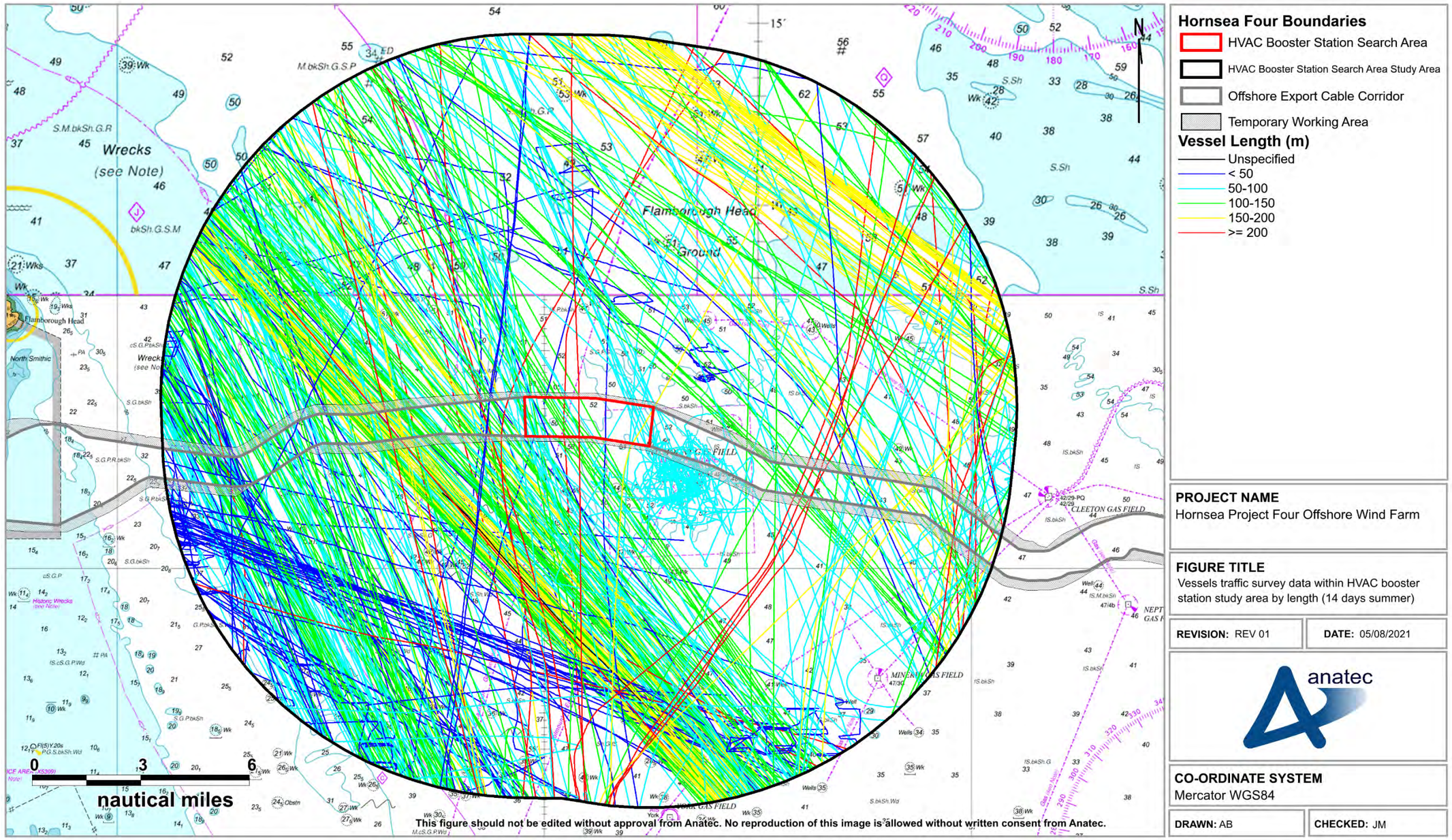


Figure F.22 **Vessel traffic within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by length (14 days summer 2021)**

F.3.3.2 Vessel Draught

916. Vessel draught was available for approximately 91% of vessels recorded throughout the summer 2021 survey period and ranged from 1.4 m for a wind farm vessel to 13.3 m for a shuttle tanker. The distribution of vessel lengths recorded throughout the summer 2021 survey period is presented in Figure F.23.

917. Excluding the vessels for which a draught was not available, the average draught of vessels within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period was 5.6 m.

918. The tracks of all vessels within the Hornsea Four HVAC booster station search area shipping and navigation study area are presented in Figure F.24, colour-coded by draught.

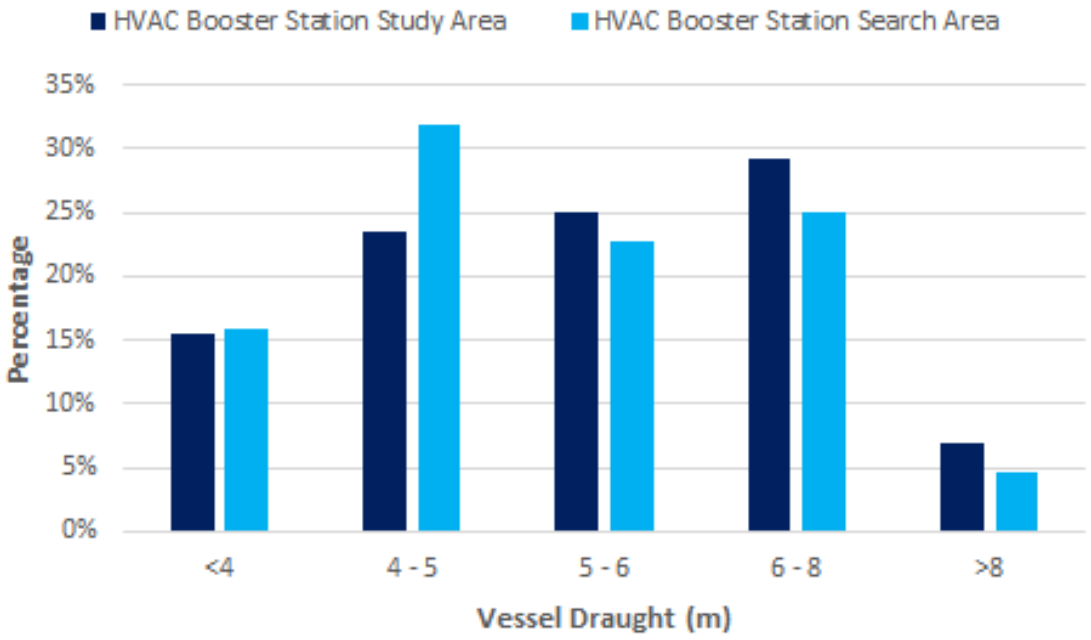


Figure F.23 Vessel draught distribution within Hornsea Four HVAC booster station search area shipping and navigation study area (14 days summer 2021)

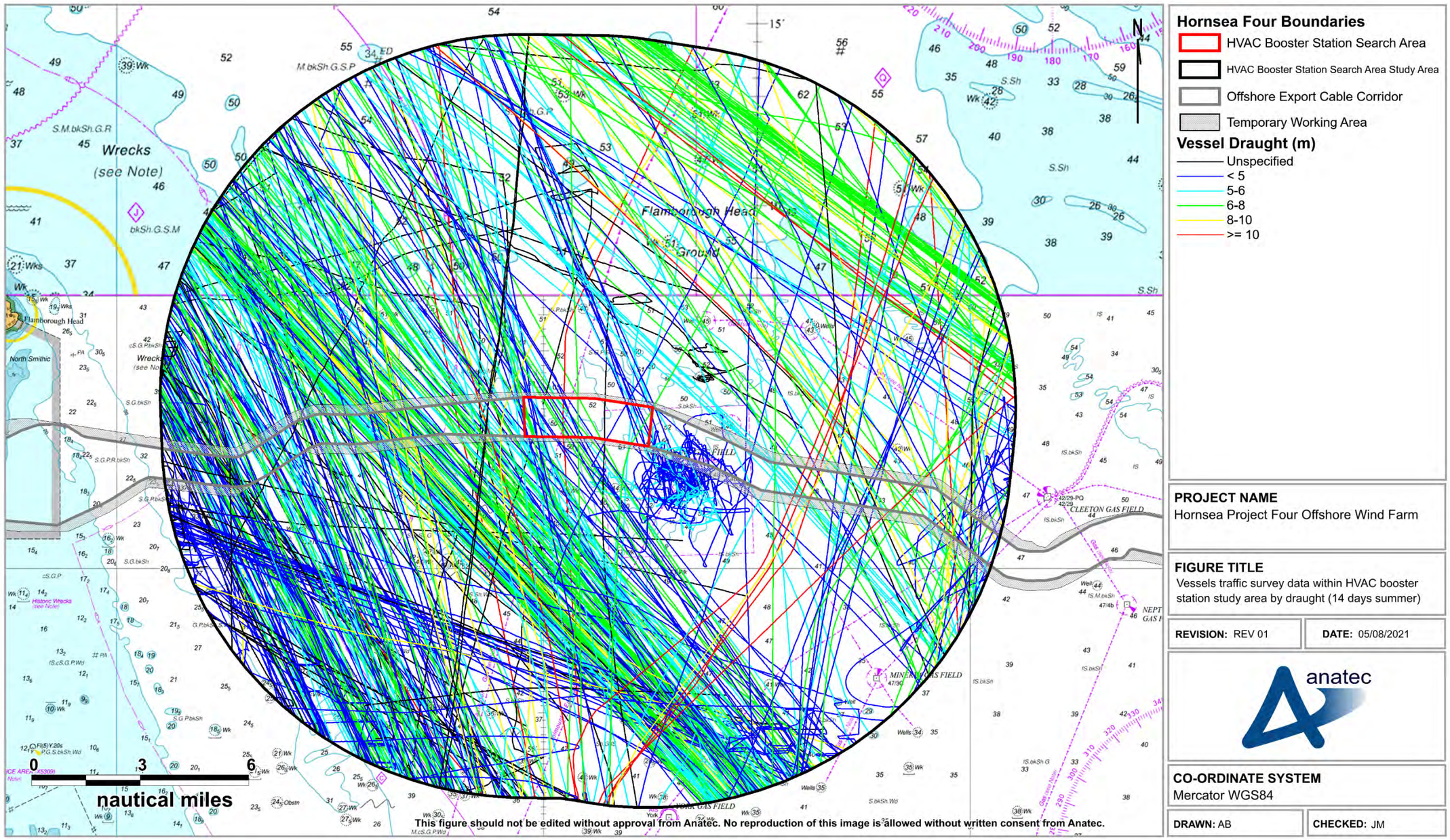


Figure F.24 **Vessel traffic within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by draught (14 days summer 2021)**

F.3.4 Anchored Vessels

919. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS equipment, and it is therefore common for vessels not to update their navigational status if only at anchor for a short period of time.

920. For this reason, vessels which travelled at a speed of less than 1 kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. After applying these criteria, no vessels were deemed to be at anchor within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period.

F.3.5 Commercial Ferry Activity

921. Throughout the summer 2021 survey period nine unique commercial ferries were identified, with four undertaking regular routes. Commercial ferries recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.25.

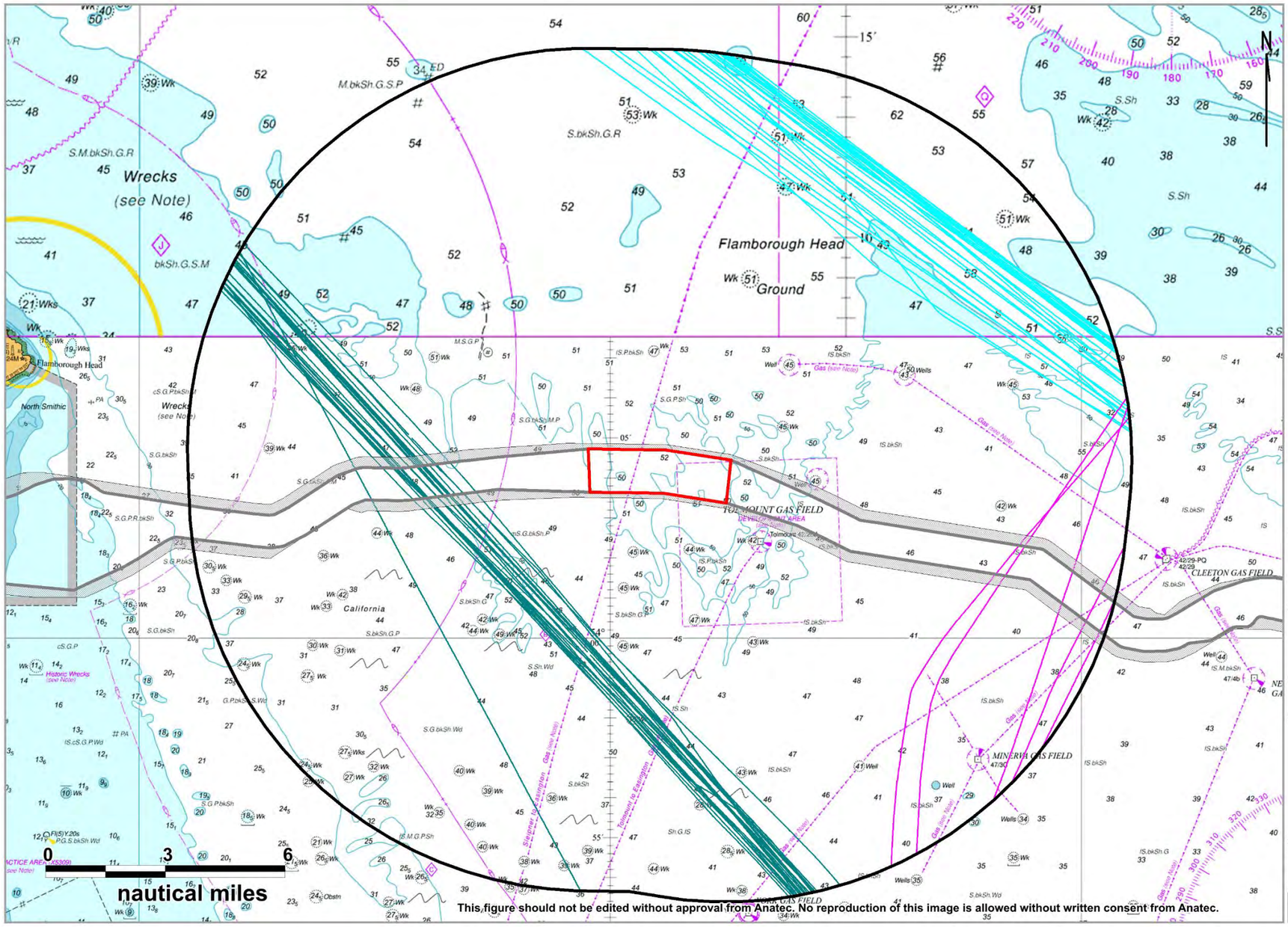
922. The most frequently transited commercial ferry was a P&O Ferries operated route between the Tees and Zeebrugge/Rotterdam, with the *Estraden* and *Bore Song* making on average two transits per day between them within the Hornsea Four HVAC booster station search area shipping and navigation study area throughout the summer 2021 survey period.

F.3.6 Recreational Vessel Activity

923. For the purposes of the NRA, recreational activity includes sailing and motor craft (including those undertaking dive and fishing charter trips) of between 2.4 and 24 m LOA.

924. Recreational vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.26.

925. An average of less than one unique recreational vessel per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. It is noted that all recreational craft recorded throughout the 14 days were recorded on AIS, with no recreational craft recorded on Radar.



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Hornsea Four Boundaries

- HVAC Booster Station Search Area
- HVAC Booster Station Search Area Study Area
- Offshore Export Cable Corridor
- Temporary Working Area

Commercial Ferry Route

- Immingham - Tananger
- North Shields - Ijmuiden
- Tees - Zeebrugge

PROJECT NAME
Hornsea Project Four Offshore Wind Farm

FIGURE TITLE
Commercial Ferries within HVAC booster station study area by type (14 days summer)

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Figure F.25 Commercial ferries within Hornsea Four HVAC booster station search area shipping and navigation study area (14 days summer 2021)

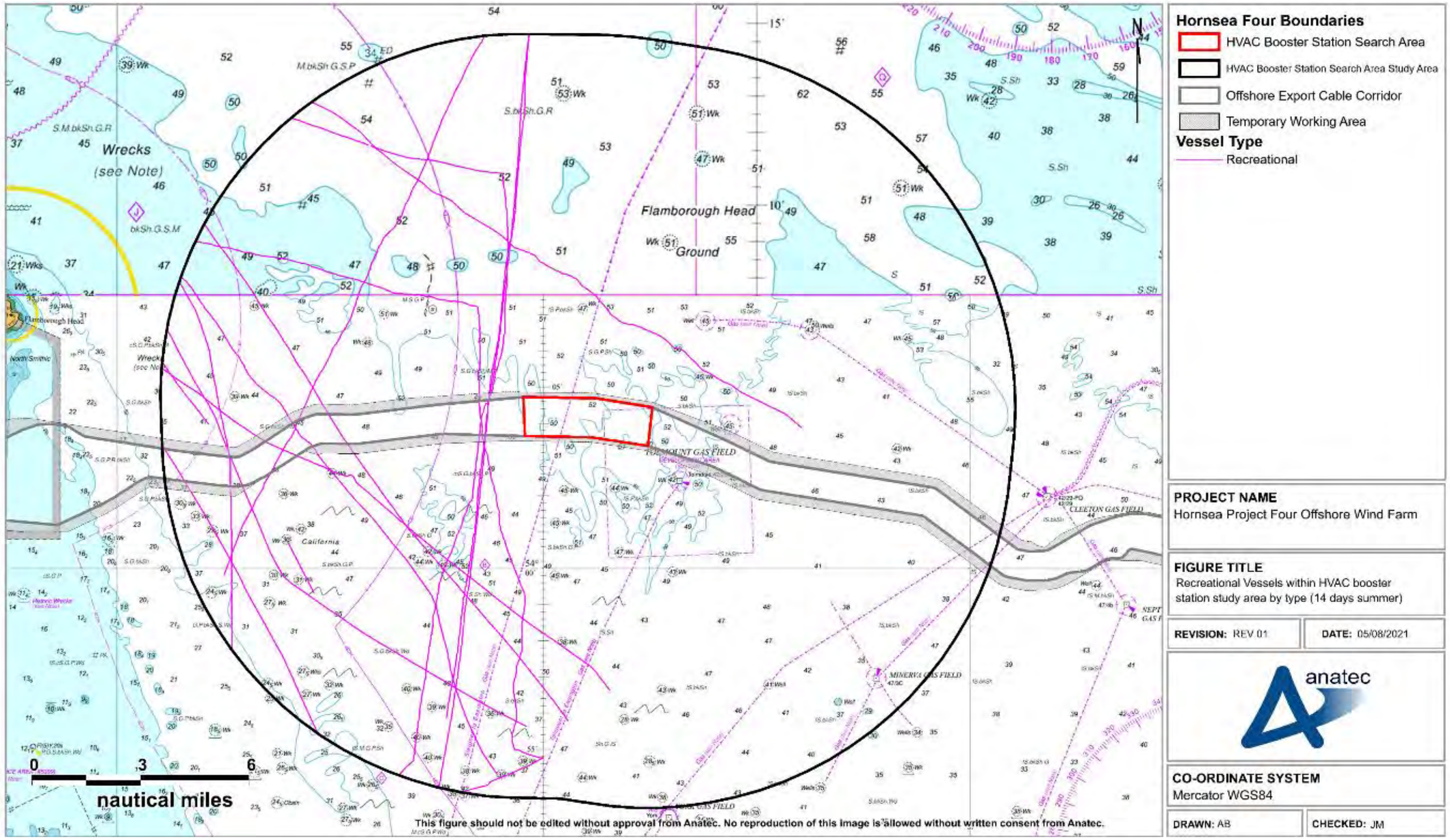

Figure F.26 Recreational vessels within Hornsea Four HVAC booster station search area shipping and navigation study area (14 days summer 2021)

F.3.7 Commercial Fishing Activity

926. Commercial fishing vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period are presented in Figure F.27.

927. An average of three unique fishing vessels per day passed within the Hornsea Four HVAC booster station search area shipping and navigation study area. No fishing vessels were recorded on Radar during the summer 2021 survey period.

928. Fishing vessel movements during the summer 2021 survey period were characteristic primarily of vessels in transit with limited activity characteristic of active fishing activity.

929. Flag state (nationality) information was available for approximately 98% of fishing vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area during the summer 2021 survey period. All nationalities identified were UK.

930. Primary gear type information was identified for 62% of fishing vessels recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area. The most common gear types identified were potter/whelkers (36%), and long liner/drift netters (14%).

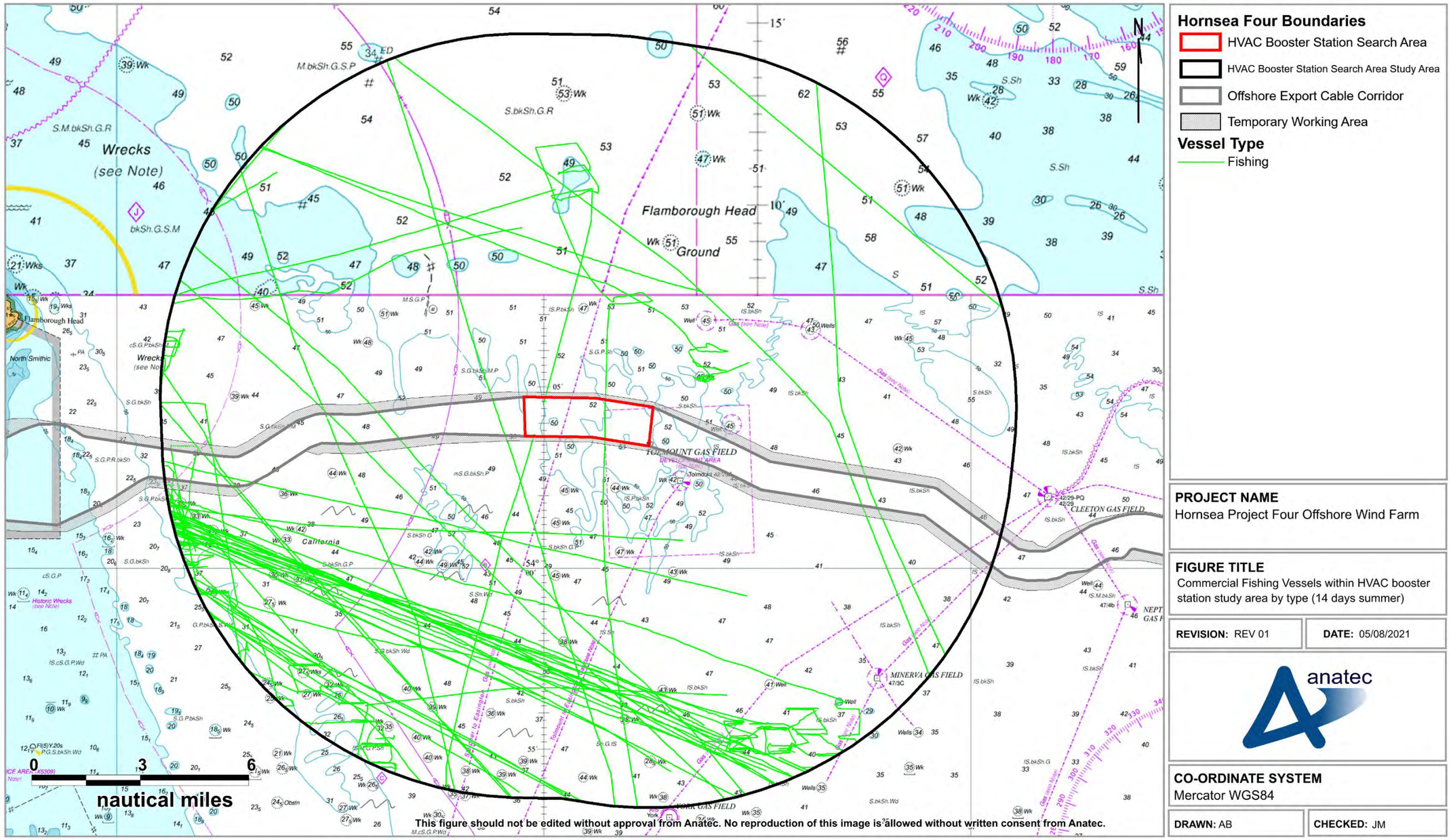

Figure F.27 Commercial fishing vessels within Hornsea Four HVAC booster station search area shipping and navigation study area colour-coded by vessel type (14 days summer 2021)

F.4 Comparison with Summer 2020 Vessel Traffic Survey Data

931. This section compares the vessel traffic survey data presented in this appendix with the AIS data collected during summer 2020 to validate the findings of the summer 2020 survey used within the NRA, and therefore justify the vessel traffic baseline presented in Section 15 of the NRA.

F.4.1 Hornsea Four Array Area

932. Over 99% of the vessel traffic recorded within the Hornsea Four array area shipping and navigation study area was recorded on AIS during the summer 2021 survey with only five vessel tracks recorded on Radar. Therefore, the absence of Radar data from the summer 2020 dataset is not considered to result in the data lacking comprehensiveness.

933. The main vessel types recorded within the Hornsea Four array area shipping and navigation study area during both summer survey periods (2020 and 2021) were cargo vessels, tankers, and oil and gas vessels, with the distribution of these vessel types similar across the two datasets.

934. The main routes transited by cargo vessels, tankers and passenger vessels (including commercial ferries) were similar in position and volume between both summer survey periods (2020 and 2021). This includes the commercial ferry routes identified between Immingham and Esbjerg, Immingham and Gothenburg and North Shields and Ijmuiden. It is noted that there have been some changes to the specific vessels operating these commercial ferry routes but the overall volumes of traffic on the routes are comparable.

935. Oil and gas vessel presence at the Ravenspurn and Babbage gas fields was comparable between the two summer survey periods (2020 and 2021). The summer 2020 dataset also featured oil and gas activities associated with the Garrow and Kilmar gas fields, a reflection of the inconsistent nature of vessel visits to Normally Unmanned Installations (NUI).

936. Recreational vessel activity was limited in both summer survey periods (2020 and 2021), noting that no recreational vessels were recorded on Radar in the summer 2021 dataset. Fishing vessel activity was also limited in both summer survey periods (2020 and 2021) with volumes marginally higher in the 2020 dataset despite the lack of Radar data, a reflection of the seasonal nature of fishing vessel activity (including year-on-year).

937. An anchoring assessment was performed on both datasets; one vessel was identified at anchor during the summer 2020 survey compared to none recorded at anchor during the summer 2021 survey.

938. Overall, the breakdown of vessel types, volumes and routeing within the Hornsea Four array area shipping and navigation study area are similar between the two

summer survey periods (2020 and 2021). Therefore, the vessel traffic baseline established for the Hornsea Four array area presented in Section 15 is considered to be accurate as validated by the summer 2021 dataset.

F.4.2 Hornsea Four HVAC Booster Station Search Area

939. Over 99% of the vessel traffic recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area were recorded on AIS during the summer 2021 survey with only one vessel track recorded on Radar. Therefore, the absence of Radar data from the summer 2020 dataset is not considered to result in the data lacking comprehensiveness.

940. The main vessel types recorded within the Hornsea Four HVAC booster station search area shipping and navigation study area during both study periods (2020 and 2021) were cargo vessels and tankers, with the distribution of these vessel types similar across the two datasets.

941. The main routes transited by cargo vessels, tankers and passenger vessels (including commercial ferries) were broadly similar in position and volume between both summer survey periods (2020 and 2021). This includes the commercial ferry routes identified between Tees and Zeebrugge and Tees and Rotterdam. However, a passenger ferry route between North Shields and Ijmuiden not observed in the summer 2020 dataset did appear in the summer 2021 dataset. This was due to the route shifting following the commencement of Hornsea Project Two construction (as highlighted in the footnote to Table 15.2) and is reflected in the overall volumes of traffic on this route established in the baseline.

942. Oil and gas vessel presence at the Tolmount gas field was comparable between the two summer survey periods (2020 and 2021).

943. Recreational vessel activity levels were similar in both summer survey periods (2020 and 2021), noting that no recreational vessels were recorded on Radar in the summer 2021 dataset. Fishing vessel activity was lower in the 2021 dataset, owing to a decrease in the volume of active fishing activity within the Hornsea Four HVAC booster station search area shipping and navigation study area. This reflects the seasonal nature of fishing vessel activity (including year-on-year).

944. An anchoring assessment was performed on both datasets; no vessels were recorded at anchor during either summer survey period.

945. Overall, the breakdown of vessel types, volumes and routeing within the Hornsea Four HVAC booster station search area shipping and navigation study area are similar between the two summer survey periods (2020 and 2021). Therefore, the vessel traffic baseline established for the Hornsea Four HVAC booster station search area in Section 15 is considered to be accurate as validated by the summer 2021 dataset.