NORTH FALLS

Offshore Wind Farm

ENVIRONMENTAL STATEMENT

Appendix 11.1 Fish and Shellfish Ecology Technical Report

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NORTH FALLS
Offshore Wind Farm

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North Falls Wind Farm

Fish and Shellfish Ecology Technical Report

Brown & May Marine Ltd.

North Falls Wind Farm

Fish and Shellfish Ecology Technical Report

Undertaken by

Brown & May Marine Limited

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Abbreviations

Abbreviation	Description
BMM	Brown and May Marine Limited
CFFPB	Cockle Fishery Flexible Permit Byelaw
CP-EGGS	North Sea cod and plaice egg surveys
CPUE	Catch per Unit Effort
DATRAS	Database of Trawl Surveys
EPP	Evidence Plan Process
GGOW	Greater Gabbard Offshore Wind Farm
GWF	Galloper Wind Farm
IBTS	International Bottom Trawl Survey
ICES	International Council for the Exploration of the Sea
IHLS	International Herring Larval Survey
IMARES	Institute for Marine Resources and Ecosystem Studies
IUCN	International Union for the Conservation of Nature
JNCC	Joint Nature Conservation Committee
KEIFCA	Kent and Essex Inshore Fisheries and Conservation Authority
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MPA	Marine Protected Area
OSPAR	Oslo Paris Convention
PINS	Planning Inspectorate
SAC	Special Area of Conservation
SPA	Special Protected Area
TAC	Total Allowable Catch
UK	United Kingdom

Terminology

Terminology	Description
Array area	The offshore wind farm area, within which the wind turbine generators, array cables, platform interconnector cable, offshore substation platform(s) and/or offshore converter platform will be located.
Array cables	Cables which link the wind turbine generators with each other, the offshore substation platform(s) and/or the offshore converter platform.
Beam trawl	A trawl net whose lateral spread during trawling is maintained by a beam across its mouth.
Benthic	Relating to or occurring at the sea bottom.
Bioelectric	Relating to electricity or electrical phenomena produced within living organisms.
Bony fish	Any of a major taxon (class Osteichthyes or superclass Teleostomi) comprising fishes with a bony rather than a cartilaginous skeleton.
Clupeid	Any of various fishes of the family Clupeidae, which includes the herrings, sprats, sardines and shads.
Crustacean	An arthropod of the large, mainly aquatic group Crustacea, such as a crab, lobster, shrimp, or barnacle.
Demersal	Living on or near the seabed.
Diadromous	Migrating between fresh and salt water.
Elasmobranch	Any cartilaginous fish of the subclass Elasmobranchii which includes the sharks, rays and skates.
Electro-receptive	Ability to perceive electrical stimuli.
Epibenthic	Relative to the flora and fauna living on the surface of the sea bottom.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and information to support HRA.
Gadoid	A bony fish of an order (Gadiformes) that comprises the cods, hakes, and their relatives.
Geomagnetic field	The Earth's magnetic field.
Gravid	Carrying eggs or young.
Horizontal directional drill	Trenchless technique to bring the offshore cables ashore at the landfall. The technique will also be used for installation of the onshore export cables at sensitive areas of the onshore cable route.
Landfall	The location where the offshore cables come ashore at Kirby Brook.
Offshore cable corridor	The corridor of seabed from array area to the landfall within which the offshore export cables will be located.

Terminology	Description
Offshore converter platform	Should an offshore connection to an HVDC interconnector cable be selected, an offshore converter platform would be required. This is a fixed structure located within the array area, containing HVAC and HVDC electrical equipment to aggregate the power from the wind turbine generators, increase the voltage to a more suitable level for export and convert the HVAC power generated by the wind turbine generators into HVDC power for export to shore via an HVDC interconnector cable.
Offshore export cables	The cables which bring electricity from the offshore substation platform(s) to the landfall.
Offshore project area	The overall area of the array area and the offshore cable corridor.
Offshore substation platform(s)	Fixed structure(s) located within the array area, containing HVAC electrical equipment to aggregate the power from the wind turbine generators and increase the voltage to a more suitable level for export to shore via offshore export cables.
Otter trawl	A trawl net fitted with two 'otter' boards which maintain the horizontal opening of the net.
Ovigerous	Carrying or bearing eggs.
Pelagic	Living in the water column.
Piscivorous	Feeding on fish.
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area
Scour protection	Protective materials to avoid sediment being eroded away from the base of the wind turbine generator foundations and offshore substation platform foundations as a result of the flow of water.
Swim bladder	A gas-filled sac present in the body of many bony fish, used to maintain and control buoyancy.
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project Or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Wind turbine generator	Power generating device that is driven by the kinetic energy of the wind.

1.0 Introduction

This Technical Report describes the fish and shellfish ecology existing environment in relation to the North Falls Offshore Wind Farm ('the Project'). The areas of the project relevant to this baseline characterisation are the array area and the offshore cable corridor. Collectively, these project components are referred to as the 'offshore project area'.

The characterisation of the fish and shellfish ecology baseline has been derived using data and information from a number of sources of information, including the scientific literature, fisheries statistical datasets, and available information from the International Bottom Trawl Survey (IBTS) and fish surveys undertaken for other projects in the vicinity of the offshore project area, specifically in the Galloper and Greater Gabbard Offshore Wind Farms.

2.0 Guidance

Key guidance used to compile this report includes:

- Centre for Environment, Fisheries and Aquaculture Science (Cefas), Department for Environment, Food and Rural Affairs (DEFRA), Department of Trade and Industry (DTI) and Marine Consents and Environment Unit (MCEU) (2004) Offshore Wind Farms - Guidance note for Environmental Impact Assessment In respect of FEPA and CPA requirements, Version 2;
- Cefas (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Contract report: ME5403, May 2012; and
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2018). Guidelines for ecological impact assessment in the UK and Ireland: Terrestrial, Freshwater, Marine and Coastal.

In addition, in compiling this report, due consideration has been given to the feedback received from stakeholders during consultation carried out in respect of the project. To date, consultation regarding fish and shellfish ecology has been conducted through the North Falls Environmental Impact Assessment Scoping Report (Royal HaskoningDHV 2021), the North Falls Preliminary Environmental Impact Report (PEIR) (Royal HaskoningDHV, 2023) and the Seabed Expert Topic Group (ETG) as part of the Evidence Plan Process (EPP).

3.0 Data and Information Sources

3.1 Key Datasets

Key sources of data and information used to characterise the fish and shellfish ecology baseline for the project are outlined in Table 3.1.

Table 3.1 Data Sources

Data Set	Year	Spatial Coverage	Notes
Marine Management Organisation (MMO) UK Landings Data (weight) by species (MMO 2021)	2016-2020	ICES rectangles in the study area (32F1 and 32F2), and adjacent rectangles (33F1, 34F0, 34F1, 34F2, 34F3, 33F2, 33F3, 32F0,31F1, 31F1, 31F2)	Provides an indication of the principal species targeted around the project.
International Bottom Trawl Survey (IBTS) data	2017 -2021	ICES Rectangles in the study area (32F1 and 32F2) and wider North Sea	IBTS data has been accessed via the ICES Data Portal (DATRAS, the Database of Trawl Surveys: http://datras.ices.dk). The data has been presented as catch per unit effort (CPUE) (individuals caught per hour) for the period 2017-2021
North Falls ECR and Intertidal Benthic Ecology Survey	2021	Offshore cable corridor and array area	Benthic survey carried out by Fugro in 2021 to provide a baseline characterization of the benthic ecology in the offshore project area. The survey included subtidal sampling at 49 stations, including grab sampling and seabed video and photography data collections.
ICES International Herring Larvae Survey (IHLS) data	December 2012 to January 2022	Southern North Sea and English Channel (Downs herring)	IHLS data has been accessed via the ICES Data Portal (http://eggsandlarvae.ices.dk). The IHLS surveys routinely collect information on the size, abundance and distribution of herring eggs and larvae (and other species) in the North Sea.
North Sea Cod and Plaice Egg (CP-EGGS) Surveys in the North Sea	2003 – 2004, 2008 - 2009	North Sea	CP-EGGS data has been accessed via the ICES Data Portal (http://eggsandlarvae.ices.dk). CP-EGGS aim to studying fish egg and larval distributions in the North Sea.
Cefas Blackwater Herring Survey	1989 - 2009	Thames Estuary	Surveys in the Thames Estuary from 1989 to 2009 each November on the INA-K using a Larson sprat trawl net. The aim was to assess the state of Blackwater herring (*Clupea harengus*) stocks. Data on fish length, age, maturity and stock identification were obtained during the surveys (https://data.cefas.co.uk/view/5).

Data Set	Year	Spatial Coverage	Notes
Distribution of Spawning and Nursery Grounds as defined in Coull et al. (1998) and in Ellis et al (2010, 2012)	Coull et al., 1991 - 1996 Ellis et al., varies by species but generally includes data between 1983 and 2008	UK territorial waters and the North Sea	Coull et al (1998) and Ellis et al (2010, 2012) are the standard references that provide broad scale overviews of the potential spatial extent of nursery grounds, spawning grounds and the relative intensity and duration of spawning. Both Coull et al (1998) and Ellis et al (2010, 2012) are based on a compilation of a variety of data sources.
Galloper Offshore Wind Farm Adult and Juvenile Fish Surveys (BMM 2009)	October/November 2008 and April 2009	Galloper Offshore Wind Farm array area, cable corridor and adjacent locations.	Baseline adult and juvenile fish surveys undertaken for the Galloper Offshore Wind Farm using a commercial otter trawl and a 2-m scientific beam trawl, respectively.
Greater Gabbard Offshore Wind Farm Epibenthic Surveys (CMACS 2014)	2009 and 2013	Greater Gabbard Offshore Wind Farm array area, export cable corridor and adjacent locations.	Epibenthic baseline and post-construction surveys undertaken as part of the monitoring of benthic communities following construction of the Greater Gabbard Offshore Wind Farm. Dataset includes information on the principal fish species recorded in 2-m scientific beam trawl samples.
Greater Gabbard Offshore Wind Farm Elasmobranch survey (BMM 2014)	2014	Greater Gabbard Offshore Wind Farm array area, export cable corridor and adjacent locations.	Post-construction surveys carried out using longlines to determine the distribution and abundance of elasmobranch species in and around the wind farm.

In addition to the data sources described above, the following resources have been accessed to inform this report:

- Kent and Essex Inshore Fisheries and Conservation Authority (KEIFCA) publications;
- Cefas publications;
- Joint Nature Conservation Committee (JNCC) publications;
- Institute for Marine Resources and Ecosystem Studies (IMARES) publications;
- International Council for the Exploration of the Sea (ICES) stock assessments and publications; and
- Other relevant peer-review publications.

3.2 Data Limitations and Sensitivities

The available sources of data and information used to inform the fish and shellfish baseline are subject to a range of limitations and sensitivities. These are outlined separately by data source below.

Whilst the limitations of the various datasets are recognised, the combination of sources of data and information used is considered suitable for baseline characterisation of the fish and shellfish ecology in the study area and to enable a robust EIA.

The suitability of the proposed data and information sources to appropriately characterise the fish and shellfish ecology baseline was agreed with the Seabed ETG during a consultation meeting held on 20th June 2022. During this meeting it was confirmed that the undertaking of additional site-specific fish surveys was not required for baseline characterisation.

3.2.1 Spawning and Nursery Grounds

Coull et al (1998) and Ellis et al (2010, 2012) provide a broad scale overview of the potential spatial extent of spawning/nursery grounds and the relative intensity and duration of spawning for a range of fish species. The spawning and nursery grounds described in Coull et al (1998), are based on historic research and may in some instances not account for recent trends in the distribution of fish species and preferred spawning and nursery grounds. The information in Ellis et al (2010, 2012) whilst based on more recent data, is also subject to limitations such as the wide distribution of sampling sites used in the surveys which inform the report. This results in broad scale grids of spawning and nursery grounds.

3.2.2 Landings Data

Fishing activity is normally not equally distributed across the whole area of an ICES rectangle and therefore overall activities identified for a given rectangle may not be necessarily representative of the activity that the offshore project area sustains.

Furthermore, it is important to consider that commercial fisheries landings data do not provide an accurate picture of the fish and shellfish community or species composition, relative abundance or biomass. In many cases the amount available to land by fisheries is determined through Total Allowable Catches (TACs) and quota allocations. Therefore, landings do not necessarily reflect either abundance or biomass. In addition, only a limited number of species are targeted by commercial fisheries, and therefore reflected in landings statistics. Commercial landings data have therefore only been used to provide an indication of key commercial species targeted in the study area, rather than to provide an accurate description of the fish and shellfish assemblage.

The last five years of available landings data (2018 to 2022) have been used to inform this report. It is noted, however, that as described in the UK Sea Fisheries Statistics 2020 Report (MMO 2021), the ongoing Covid-19 pandemic where effects were felt from March 2020 onwards resulted in significant impacts on commercial fishing over 2020. Therefore, the landings data from 2020 may not be fully representative of normal levels of fishing activity.

3.2.3 Fish Surveys undertaken in the Greater Gabbard and Galloper Offshore Wind Farms

Whilst the data available from the surveys carried out in the Greater Gabbard and Galloper Offshore Wind Farm provides valuable site-specific information for the project, surveys were undertaken in 2008, 2009, 2013 and 2014 and therefore do not provide recent data for the area.

In addition, these surveys were aimed at demersal fish species (including elasmobranchs) and do not provide an accurate representation of the distribution and abundance of pelagic species, diadromous fish, sandeels or shellfish species.

In the particular case of 2-m scientific beam trawl surveys, the data collected may not be representative of the distribution of adult fish for some species, as large fish are able to escape 2-m scientific beam trawl gear.

3.2.4 ICES Survey Data

3.2.4.1 International Bottom Trawl Survey (IBTS)

IBTS data provides valuable information on the distribution and relative abundance of demersal fish species and is available for recent years up to 2021. However, as described above for the surveys carried out for the Galloper and Greater Gabbard Offshore Wind Farms, the limitations of bottom trawl gear used in the IBTS to adequately target some species (i.e. shellfish species, pelagic species, sandeels and diadromous migratory fish) should be recognised.

3.2.4.2 International Herring Larval Survey (IHLS)

The IHLS is undertaken on an annual basis with sampling undertaken during December and January in the grounds of relevance to the offshore project area (the Downs herring spawning grounds). Data available from December 2012 up to January 2022 has been included in this report. It should be noted however, that sampling in the Downs herring grounds has not been undertaken consistently in recent years with no data available for the following periods: December 2014, December 2017, January and December 2018 and January 2019.

3.2.4.3 North Sea Cod and Plaice Egg Surveys (CP-EGGS)

There is no recent data available from the North Sea cod and plaice egg surveys. Whilst sampling for eggs is undertaken annually samples are not often processed due to budgetary constraints. Publicly available survey data covers the following years: 2003, 2004, 2008 and 2009.

3.2.5 Cefas Blackwater Herring Survey (FSS: INA K HER)

The sampling locations were not undertaken in areas relevant to the North Falls project and there have been no surveys in recent in the last ten years. It should also be noted that there is only limited publicly survey data available. The only survey data that has been consistently provided by survey are the survey dates, number of sampling locations and total number of species caught.

4.0 Study Area

The project offshore area is situated in ICES division IVc (southern North Sea) with the array area located approximately 20nm from shore.

The study area used to characterise the fish and shellfish ecology baseline (Figure 4.1) has been defined with reference to the ICES rectangles that overlap with the offshore project area. These are as follows:

- ICES rectangle 32F1, where the majority of the offshore project area is located (including the whole offshore cable corridor and interconnector cable corridor and practically the totality of the array area);
- ICES rectangle 32F2 – where a small section of one of the array area is located.

Where appropriate, broader geographic areas have been used to provide additional information in the wider context of the southern North Sea, particularly with reference to important life history aspects for fish and shellfish species, such as the distribution of spawning grounds and migration routes.

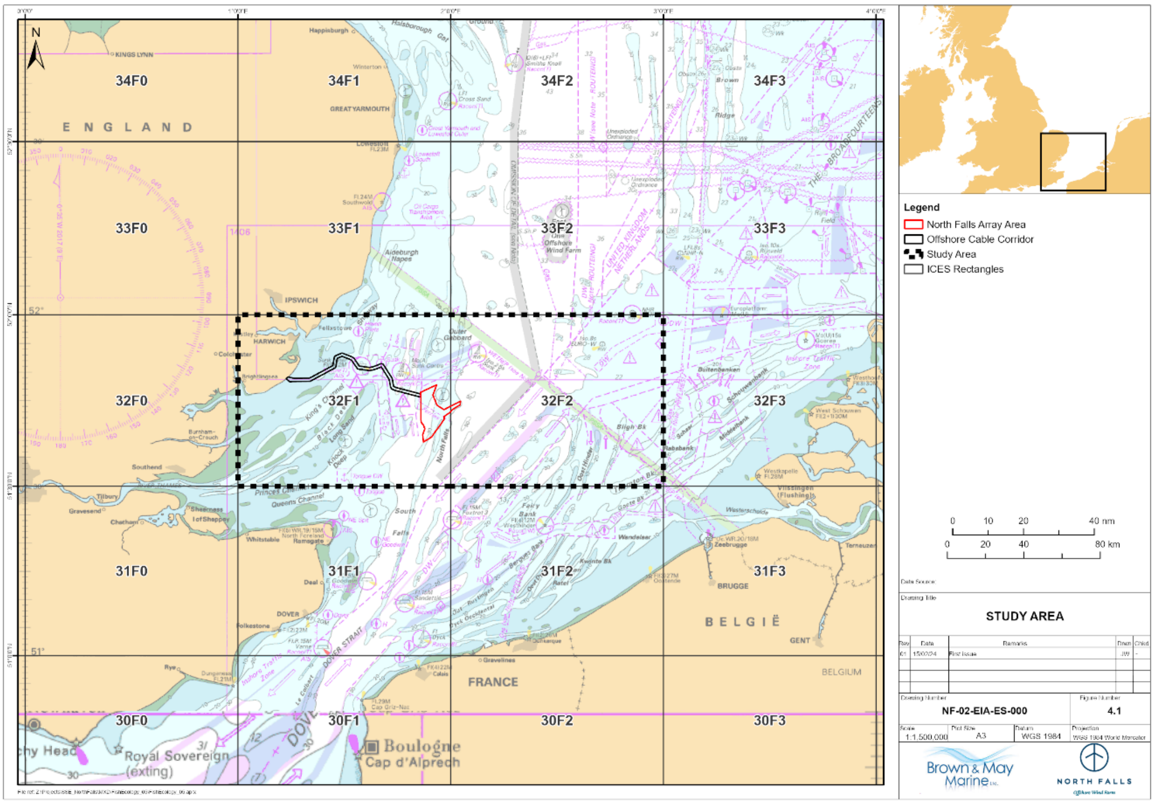

Figure 4.1 Study Area

5.0 Designated Areas

5.1 Marine Protected Areas (MPAs)

The location of Marine Protected Areas (MPAs), including Special Areas of Conservation, (SACs), Special Protection Areas (SPAs) and Marine Conservation Zones (MCZs), found in the study area is illustrated in Figure 5.1.

As shown, the offshore project area overlaps with the Southern North Sea SAC and is located in close proximity to the Margate and Long Sands SAC. Qualifying features in these sites include Annex II species (harbour porpoise *Phocoena phocoena)* and Annex I habitats (Sandbanks which are slightly covered by sea water at all times*)*, respectively.

The array area is also in close proximity to the the Kentish Knock East MCZ (designated for subtidal coarse sediment, subtidal sand and subtidal mixed sediments) and the inshore section of the offshore cable corridor is in the proximity of the Blackwater, Crouch, Roach and Colne Estuary MCZ. Protected features in the latter include native oyster *Ostrea edulis* and native oyster beds, as well as intertidal mixed sediments and cliffs and foreshore.

In addition, the inshore section of the offshore cable corridor overlaps with the Outer Thames Estuary SPA which is designated for the protection of various Annex I bird species, including Red-throated diver *Gavia stellata*, Common tern *Sterna hirundo* and Little tern *Sternula albifrons*.

With the exception of the Blackwater, Crouch, Roach and Colne Estuary MCZ, where shellfish species (native oyster/oyster beds) are protected features for designation, the MPAs mentioned above are not designated for the protection of fish or shellfish species per se. These MPAs, however, provide habitat and support a wide range of crustaceans and fish and in some cases include foraging areas of importance for marine mammals and birds.

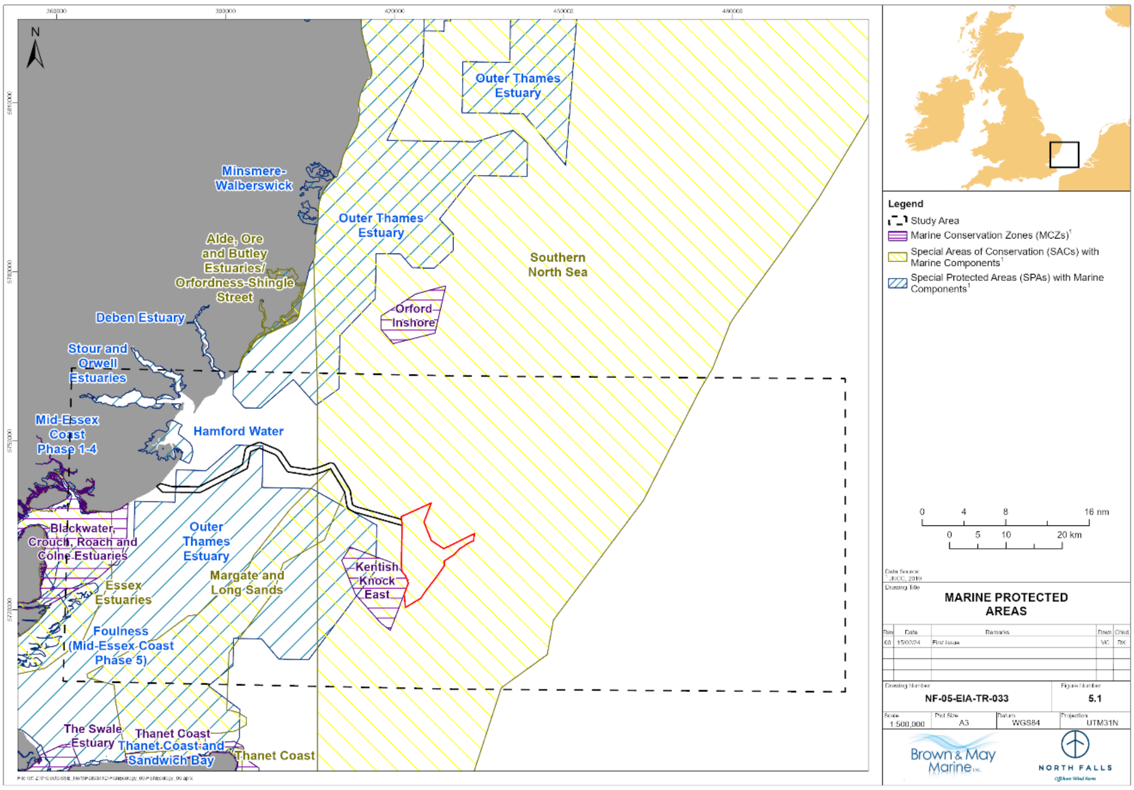

Figure 5.1 MPAs found in the Study Area

5.2 Shellfish Water Protected Areas

A number of coastal areas, referred to as "Shellfish Water Protected Areas", have been designated in England and Wales under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[1], in order to protect or develop economically significant shellfish production.

Shellfish Water Protected Areas found in the study area are illustrated in Figure 5.2. As shown, the offshore project area does not overlap with any of these, however the inshore section of the offshore cable corridor is in the proximity of the following:

- Walton Backwaters;
- Colne Estuary;
- Dengie;
- Foulness; and
- Outer Thames.

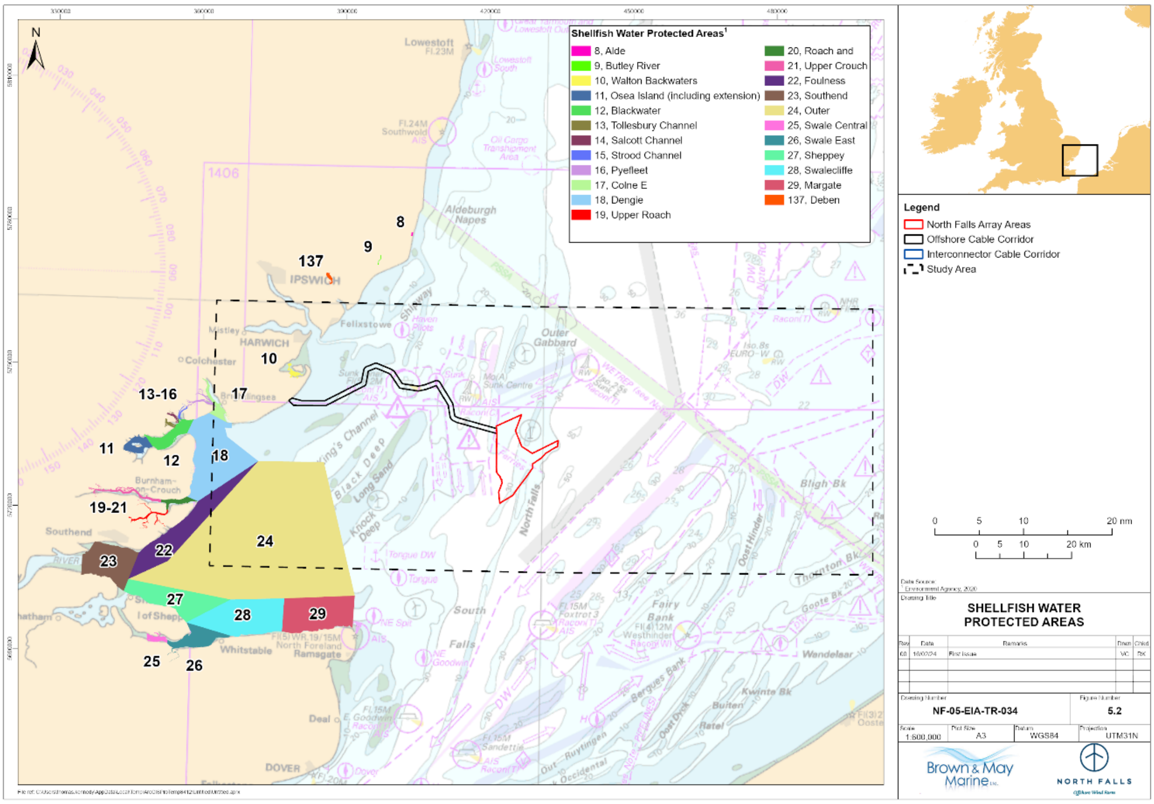

Figure 5.2 Shellfish Water Protected Areas

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[1] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017: https://www.legislation.gov.uk/uksi/2017/407/regulation/37/made. The 2017 Regulation revokes the 2003 Regulation under which Shellfish Water Protected Areas were originally designated.

6.0 Existing Environment

6.1 Overview

6.1.1 Surveys undertaken in the Greater Gabbard and Galloper Offshore Wind Farms

The results from surveys carried out in the Greater Gabbard and Galloper Offshore Wind Farms in which fish species were sampled have been used to inform the baseline characterisation of the study area. These are relevant to the project due the overlap and/or close proximity between the offshore project area and the areas where these surveys were undertaken.

A description of these surveys is given in Table 6.1, including gear type, survey area, sampling effort and timing of the surveys. A summary of the survey results is provided in the following sections.

Table 6.1 Surveys undertaken in the Galloper and Greater Gabbard Offshore Wind Farms

Survey	Gear Type	Survey Area	Sampling Effort	Time of Surveys
Adult and Juvenile Fish Survey (BMM, 2009)	Otter trawl and 2-m scientific beam trawl	Galloper Offshore Wind Farm array areas, export cable corridor and adjacent areas	15 x 25-minute otter trawls 18 x 5-minute beam trawls	October/November 2008 and April 2009
Epibenthic Survey (CMACS, 2014)	2-m scientific beam trawl	Greater Gabbard Offshore Wind Farm array area, export cable corridor and adjacent areas	21 x 300m tows	Spring/Summer 2009
			26 x 300m tows	Spring/Summer 2013
Elasmobranch Survey	Longlines	Greater Gabbard Offshore Wind Farm array, export cable corridor and adjacent locations	14 x 300m longlines (100 hooks per line, 3 m apart)	May 2014

6.1.1.1 Galloper Offshore Wind Farm Beam Trawl and Otter Trawl Surveys (2008 and 2009)

A summary of the results of the otter trawl and beam trawl surveys is provided in Table 6.2 and Table 6.3, respectively.

As shown in Table 6.2, during the otter trawl surveys, whiting *Merlangius merlangus*, cod *Gadus morhua* and small-spotted catshark *Scyliorhinus canicula* were the species caught in highest numbers. In addition, species such as dab *Limanda limanda*, bib *Trisopterus luscus*, plaice *Pleuronectes platessa*, thornback ray *Raja clavata,* starry smoothound *Mustelus asterias*, poor cod *Trisopterus minutus,* lemon sole *Microstomus kitt* and tub gurnard *Chelidonichthys lucerna* were also recorded in relatively high numbers.

In beam trawl samples the sand goby *Pomatoschistus minutus* was the species found in greatest numbers followed by Dover sole *Solea solea,* Northern rockling *Ciliata septentrionalis,* dragonet *Callionymus lyra,* bib, poor cod and lesser sandeel *Ammodytes marinus* to a lesser extent. The remaining species were all found in low numbers (Table 6.3).

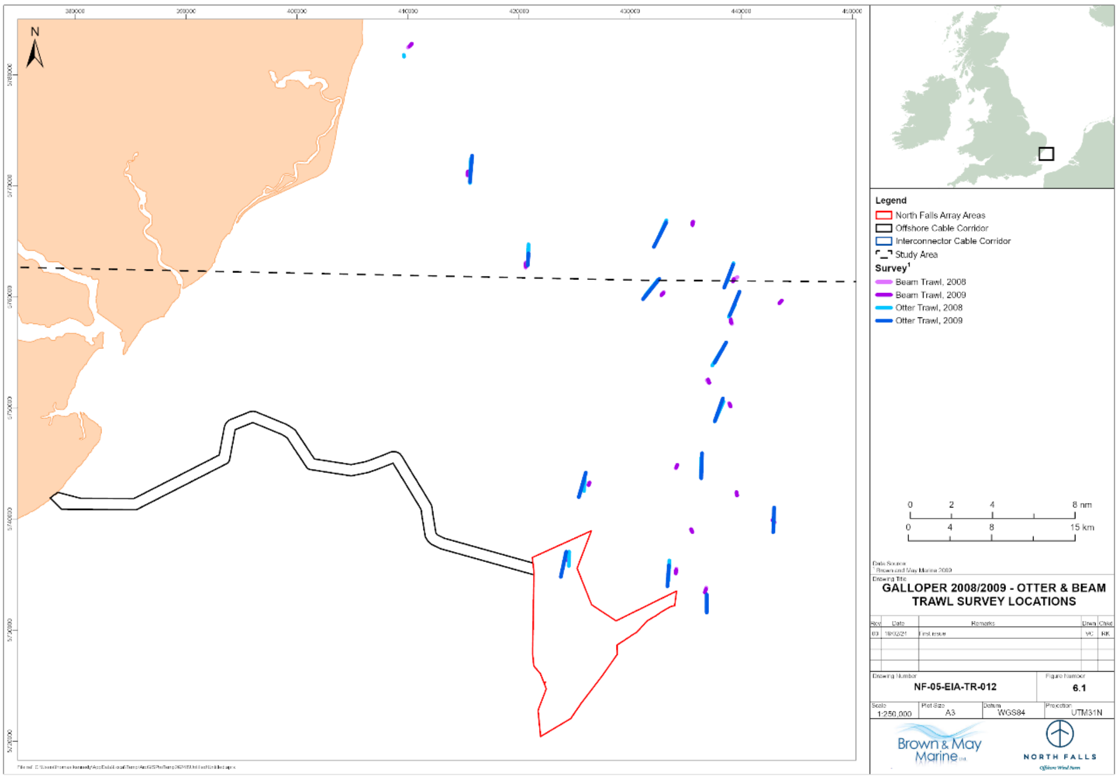

Figure 6.1 Sampling Locations of the Galloper Offshore Wind Farm 2008/2009 Otter and Beam Trawl Surveys (BMM 2009)

Table 6.2 Summary of the Results of the Otter Trawl Surveys (BMM 2009)

Common Name	Latin Name	Total number of individuals caught (all tows combined)	
		Autumn 2008	Spring 2009
Whiting	*Merlangius merlangus*	395	395
Cod	*Gadus morhua*	336	179
Small-spotted catshark	*Scyliorhinus canicula*	171	308
Dab	*Limanda limanda*	126	260
Bib (Pout)	*Trisopterus luscus*	303	22
Plaice	*Pleuronectes platessa*	87	43
Thornback ray	*Raja clavata*	42	82
Starry smoothhound	*Mustelus asterias*	70	19
Poor cod	*Trisopterus minutus*	64	17
Lemon sole	*Microstomus kitt*	29	34
Tub gurnard	*Chelidonichthys lucerna*	52	1
Velvet crab	*Necora puber*	31	2
Smoothhound	*Mustelus mustelus*	19	8
Dover sole	*Solea solea*	14	11
Squid	*Unidentified*	0	20
Common dragonet	*Callionymus lyra*	13	2
Grey gurnard	*Eutrigla gurnardus*	3	5

Common Name	Latin Name	Total number of individuals caught (all tows combined)	
		Autumn 2008	Spring 2009
Sea bass	*Dicentrarchus labrax*	2	4
Spotted ray	*Raja montagui*	2	4
Herring	*Clupea harengus*	2	3
Sprat	*Sprattus sprattus*	5	0
Flounder	*Platichthys flesus*	1	2
Lobster	*Homarus gammarus*	3	0
Streaked gurnard	*Chelidonichthys lastoviza*	0	3
Twaite shad	*Alosa fallax*	3	0
Edible crab	*Cancer pagurus*	2	0
Red gurnard	*Chelidonichthys cuculus*	0	2
Blonde ray	*Raja brachyura*	0	1
Horse mackerel	*Trachurus trachurus*	1	0
John dory	*Zeus faber*	0	1
Lesser weever	*Echiichthys vipera*	1	0
Spurdog	*Squalus acanthias*	0	1
Tope	*Galeorhinus galeus*	1	0
Turbot	*Psetta maxima*	0	1

Table 6.3 Summary of the Results of the Beam Trawl Surveys (BMM 2009)

Common Name	Latin Name	Total No. of Individuals Caught (All Tows Combined)	
		2008	2009
Sand goby	*Pomatoschistus minutus*	34	17
Dover sole	*Solea solea*	19	7
Northern rockling	*Ciliata septentrionalis*	19	1
Goby family	*Gobiidae indet.*	18	0
Common dragonet	*Callionymus lyra*	16	23
Bib	*Trisopterus luscus*	14	1
Poor cod	*Trisopterus minutus*	13	6
Lesser sandeel	*Ammodytes marinus*	11	21
Painted goby	*Pomatoschistus pictus*	9	0
Fivebeard rockling	*Ciliata mustela*	8	0
Sprat	*Sprattus sprattus*	8	1
Transparent goby	*Aphia minuta*	7	0
Norway pout	*Trisopterus esmarkii*	6	0
Striped sea snail	*Liparis liparis*	3	5
Whiting	*Merlangius merlangus*	3	4
Greater sandeel	*Hyperoplus lanceolatus*	2	2
Lesser weever fish	*Echiichthys vipera*	2	9
Scaldfish	*Arnoglossus laterna*	2	1
Herring family	*Clupeidae indet.*	1	0
Pogge	*Agonus cataphractus*	1	8

Common Name	Latin Name	Total No. of Individuals Caught (All Tows Combined)	
		2008	2009
Thickback sole	*Microchirus variegatus*	1	0
Indeterminate	Indeterminate	1	0
Sandeel family	Ammodytidae indet.	0	5
Solenette	*Buglossidium luteum*	0	1
Reticulated dragonet	*Callionymus reticulatus*	0	1
Two-spotted clingfish	*Diplecogaster bimaculata*	0	1
Black goby	*Gobius niger*	0	1
Smooth sandeel	*Gymnammodytes*	0	1
Dab	*Limanda limanda*	0	4
Plaice	*Pleuronectes platessa*	0	8
Tub gurnard	*Trigla lucerna*	0	1
Small-spotted catfish	*Scyliorhinus canicula*	1	6

6.1.1.2 Greater Gabbard Offshore Wind Farm Epibenthic Surveys

The location of the stations sampled during the 2-m scientific beam trawl surveys undertaken in the Greater Gabbard Offshore Wind Farm in 2009 and 2013 is illustrated in Figure 6.2.

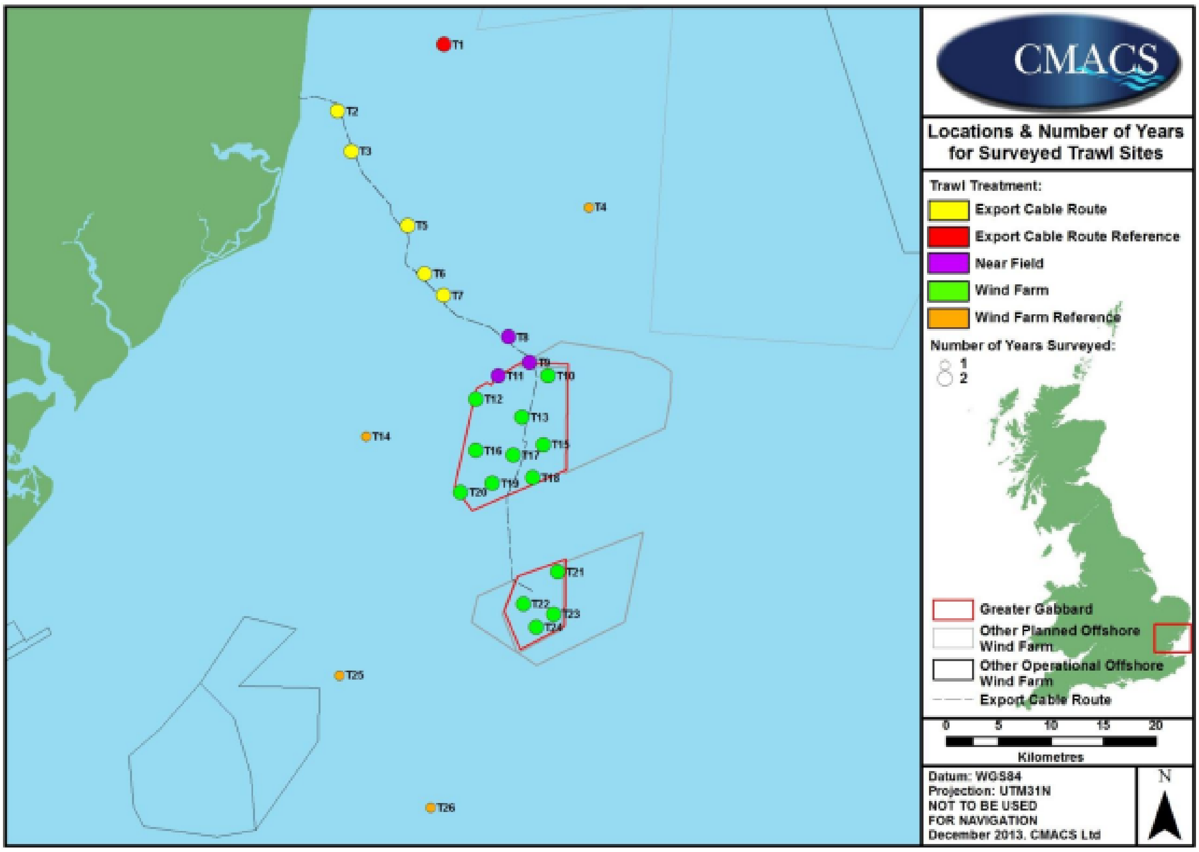

Figure 6.2 Location of the 2-m Scientific Beam Trawl Sampling Stations (Source: CMACS 2014)

In 2009, 30 different fish species were found, with 25 different species found in 2013. The total number of fish recorded was 299 in 2009 and 273 in 2013 (CMACS 2014).

A summary of the principal fish species found in these surveys is provided in Table 6.4. As shown, the most commonly recorded fish were dragonet, lesser weever *Echiichthys vipera*, sea snail *Liparis liparis*, dab, Dover sole, sand goby, pogge *Agonus cataphractus,* and small-spotted catshark. Species such as lemon sole, common goby *Pomatoschistus microps,* whiting, solenette, plaice, ling *Molva molva* and various other species of goby were also caught in some numbers.

Table 6.4 Most Commonly Recorded Fish Species in the Greater Gabbard Epibenthic Surveys (CMACS 2014)

2009 Baseline Survey			2013 Post Construction Survey		
Common Name	**Latin Name**	**Total No.**	**Common Name**	**Latin Name**	**Total No.**
Common dragonet	*Callionymus lyra*	47	Lesser weever	*Echiichthys vipera*	41
Lesser weever	*Echiichthys vipera*	38	Dover sole	*Solea solea*	30
Sea snail	*Liparis liparis*	36	Sand Goby	*Pomatoschistus minutus*	29
Dab	*Limanda limanda*	22	Common dragonet	*Callionymus lyra*	28
Small-spotted catshark	*Scyliorhinus canicula*	19	Small-spotted catshark	*Scyliorhinus canicula*	28
Lemon sole	*Microstomus kitt*	19	Pogge	*Agonus cataphractus*	25
Common goby	*Pomatoschistus microps*	17	Whiting	*Merlangius merlangus*	17
Pogge	*Agonus cataphractus*	14	Dab	*Limanda limanda*	13
Dover sole	*Solea solea*	12	Lemon sole	*Microstomus kitt*	12
Unidentified fish sp.	*n/a*	12	Sea snail	*Liparis liparis*	8
Black goby	*Gobius niger*	10	Solenette	*Buglossidium luteum*	8
Painted goby	*Pomatoschistus pictus*	7	Black goby	*Gobius niger*	7
Goby sp.	*Pomatoschistus sp*	6	Plaice	*Pleuronectes platessa*	6
Ling	*Molva molva*	5	Rock Goby	*Gobius paganellus*	4

6.1.1.3 Greater Gabbard Offshore Wind Farm Elasmobranch Survey

A summary of the results of the elasmobranch survey is provided in Table 6.5. As shown, small-spotted catshark was the species recorded in greatest numbers (274). Thornback ray and spurdog were also found to be relatively abundant during the survey (64 and 30 individuals, respectively). The remaining species of elasmobranchs recorded (smoothounds *Mustelus sp.* and tope *Galeorhinus galeus),* were found in lower numbers (11 and 1 individuals respectively).

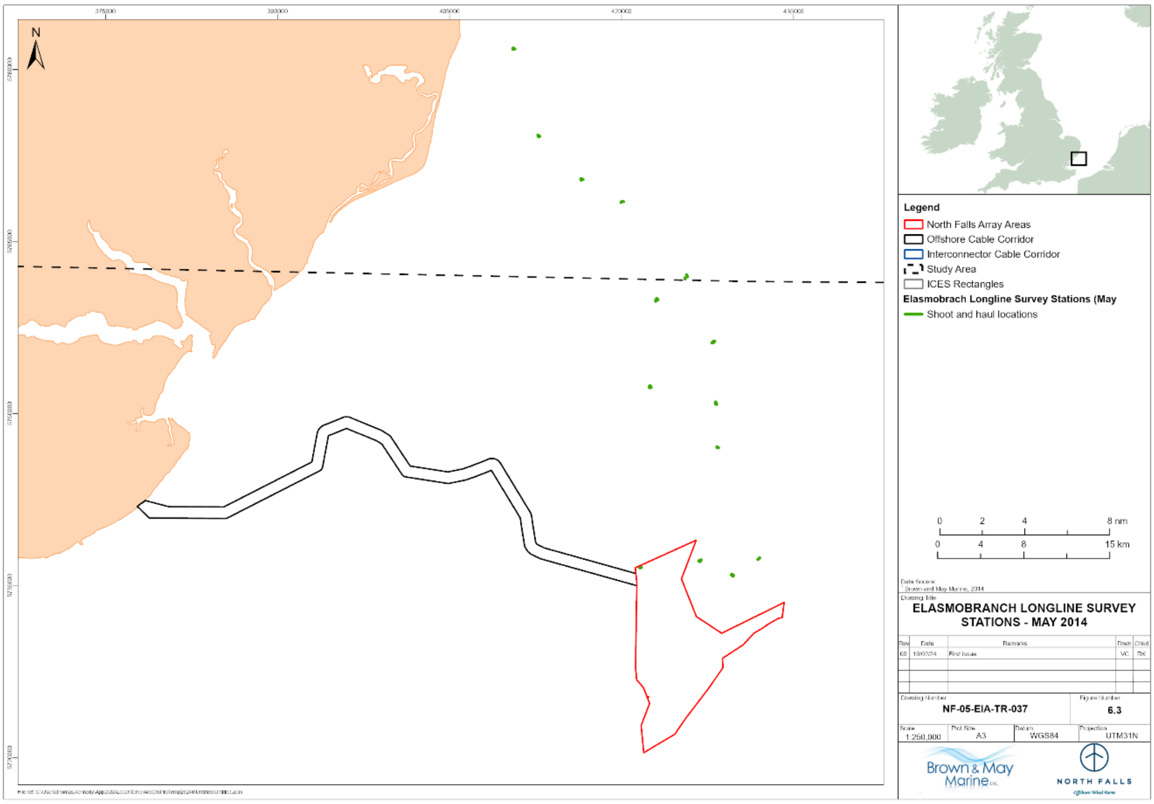

Figure 6.3 Greater Gabbard Offshore Wind Farm Elasmobranch Longline Survey Stations (BMM 2014)

Table 6.5 Results of Elasmobranch Survey (BMM 2014)

Common Name	Latin Name	No. Individuals Caught
Elasmobranchs		
Small-spotted catshark	*Scyliorhinus canicula*	274
Thornback ray	*Raja clavata*	64
Spurdog	*Squalus acanthias*	30
Smoothhound	*Mustelus sp.*	11
Tope	*Galeorhinus galeus*	1
Other Fish and Shellfish Species noted during the Survey		
Whiting	*Merlangius merlangus*	4
Whelk	*Buccinum undatum*	25
Hermit Crab	*Paguroidea*	6
Common starfish	*Asterias rubens*	2
Green Urchin	*Psammechinus miliaris*	1
Spider Crab	*Hyas sp.*	1

6.1.2 International Bottom Trawl Surveys (IBTS)

The catch per unit effort (CPUE) of the 50 most common species found in the study area during the IBTS (2017 to 2021) is given in Table 6.6 by ICES rectangle.

As shown, the demersal bony fish species recorded in the study area by the IBTS in greatest numbers was whiting. Other species found in relatively high numbers include dab *Limanda limanda*, bib, poor cod, plaice and Dover sole. Species such as lesser weever, grey gurnard *Eutrigla gurnardus,* lemon sole and striped red mullet *Mullus surmuletus* were also relatively abundant but for the most part their catches were concentrated in rectangle 32F2, with relatively low numbers found in 32F1, where the majority of the offshore project area is located. The remaining species of demersal bony fish were all recorded in relatively low numbers.

Small-spotted catshark was the elasmobranch found in greatest numbers, followed by thornback ray and smoothhounds. Although in lower numbers, blonde ray *Raja brachyura* and spotted ray *Raja montagui* were also recorded in the study area.

Whilst the main focus of the IBTS survey is on demersal fish sampling, shoaling pelagic species, particularly, sprat *Sprattus sprattus* and to a lesser extent herring *Clupea harengus* and mackerel *Scomber scombrus* were recorded in relatively high numbers over the 2017 to 2021 period. In addition, some shellfish, primarily squid and crab species and lobster *Homarus gammarus*, were also caught in some numbers.

Table 6.6 CPUE (number/hour) of the Principal Species recorded in the IBTS in the Study Area by ICES Rectangle (2017-2021) (Source: DATRAS 2022)

Common Name	Latin Name	CPUE (No. Individuals/Hour)	
		32F1	32F2
Whiting	*Merlangius merlangus*	550.8	2,628.8
Dab	*Limanda limanda*	78.0	243.7
Bib	*Trisopterus luscus*	62.7	109.3
Poor cod	*Trisopterus minutus*	18.3	120.7
Plaice	*Pleuronectes platessa*	60.9	64.5
Dover sole	*Solea solea*	63.2	3.1
Lesser weever	*Echiichthys vipera*	10.0	51.1
Stripped red mullet	*Mullus surmuletus*	3.4	42.0
Lemon sole	*Microstomus kitt*	1.3	30.2
Grey gurnard	*Eutrigla gurnardus*	5.7	32.3
Pogge	*Agonus cataphractus*	7.4	2.2
Cod	*Gadus morhua*	0.0	10.9
Common dragonet	*Callionymus lyra*	4.8	6.3
Weevers	*Echiichthys*	2.8	9.0
Bull rout	*Myoxocephalus scorpius*	0.0	0.9
Great sandeel	*Hyperoplus lanceolatus*	1.1	2.9
Fivebeard rockling	*Ciliata mustela*	1.6	0.9
Tub gurnard	*Chelidonichthys lucerna*	2.4	1.5
Solenette	*Buglossidium luteum*	3.7	0.3
Sea bass	*Dicentrarchus labrax*	1.3	1.7
Lesser sandeel	*Ammodytes marinus*	0.1	0.4
Small sandeel	*Ammodytes tobianus*	0.3	0.0
Northern rockling	*Ciliata septentrionalis*	0.6	0.1
Lozano's goby	*Pomatoschistus lozanoi*	2.0	0.0
Gobies	*Pomatoschistus*	1.3	0.2
Flounder	*Platichthys flesus*	1.3	0.4
Haddock	*Melanogrammus aeglefinus*	0.0	1.6
Scaldfish	*Arnoglossus laterna*	0.1	0.5

Common Name	Latin Name	CPUE (No. Individuals/Hour)	
		32F1	32F2
Black goby	*Gobius niger*	0.0	0.2
Small spotted catshark	*Scyliorhinus canicula*	260.6	65.1
Thornback ray	*Raja clavata*	87.1	3.0
Starry smoothhound	*Mustelus asterias*	51.9	11.5
Smoothhound	*Mustelus mustelus*	0.0	8.1
Blonde ray	*Raja brachyura*	2.6	4.0
Spotted ray	*Raja montagui*	2.9	1.2
Smoothhounds	*Mustelus sp.*	3.2	0.0
Sprat	*Sprattus sprattus*	2155.1	114.9
Horse mackerel	*Trachurus trachurus*	118.1	3308.4
Herring	*Clupea harengus*	692.2	6.5
Mackerel	*Scomber scombrus*	171.2	108.8
Clupeids	*Clupeidae sp*	269.2	0.0
Anchovy	*Engraulis encrasicolus*	111.6	0.5
Pilchard	*Sardina pilchardus*	0.6	20.5
European common squid	*Alloteuthis subulata*	98.9	51.0
Squid	*Loligo*	46.2	4.2
Common squid	*Loligo vulgaris*	4.5	32.1
Edible crab	*Cancer pagurus*	0.9	1.3
Velvet crab	*Necora puber*	1.7	0.0
Spider crab	*Maja brachydactyla*	1.6	0.1
Lobster	*Homarus gammarus*	0.3	0.7

6.1.3 Commercial Species in the Study Area

Commercial fishing within the study area is undertaken by UK vessels in addition to foreign vessels of Belgian, Dutch and French nationality where Belgian and French vessels have historic fishing rights to fish between the UK's 6 and 12nm limit. A summary of fishing activity is provided for these national fleets in this section with further information in Appendix 14.1: Commercial Fisheries Technical Report.

6.1.3.1 UK Landings Statistics

An indication of the principal species of commercial importance in the study area is given below based on analysis of annual landings by weight (average 2018-2022) by species and ICES rectangle (Table 6.7 and Figure 6.4) for UK vessels. As shown in Table 6.7, the principal species landed by weight by UK vessels from the study area are molluscs, predominantly cockle *Cerastoderma edule* and whelk *Buccinum undatum.* Fish species such as horse mackerel *Trachurus trachurus*, Dover sole, herring, sprat, thornback ray, whiting, mullets and squid are also landed from the study area.

ICES rectangle 32F1, where the majority of the offshore project area is located, records considerably higher landings by weight than the other rectangles in the study area (Figure 6.4). The cockle fishery accounts for the majority of landings by weight within this rectangle (67.11%). Cockles, however, are not fished in the vicinity of the offshore cable corridor, as any cockle grounds that do overlap have been closed under the Cockle Fishery Flexible Permit Byelaw for the last 10 years. Further information on this is provided in section 6.2.5.1 and in Appendix 14.1: Commercial Fisheries Technical Report.

The species of commercial importance from the ICES rectangle 32F1 are considered to be Dover sole, whelk, thornback ray, horse mackerel, herring and whiting. Local vessels to the offshore cable corridor are reported as targeting species such as sea bass, Dover sole, skate, herring, turbot, brill, lobster and crab from a mix of trawling, netting and potting.

Table 6.7 Percentage Contribution by Species to the Total Landings (Tonnes) (2016 -2020) from ICES Rectangles in the Study Area (Source: MMO 2021)

Common Name	Latin Name	ICES Rectangle 32F1	ICES Rectangle 32F2
Cockle	*Cerastoderma edule*	67.11%	0.61%
Whelk	*Buccinum undatum*	13.39%	42.23%
Horse mackerel	*Trachurus trachurus*	7.39%	13.21%
Whiting	*Merlangius merlangus*	3.54%	6.67%
Red Mullet	*Mullus surmuletu*	0.06%	9.81%
Herring	*Clupea harengus*	0.12%	9.27%
Squid	-	1.69%	5.38%
Sole	*Solea solea*	0.03%	6.49%
Thornback ray	*Raja Clavata*	3.18%	2.35%
Tub gurnard	*Chelidonichthys lucerna*	3.41%	0.78%
Other	-	0.08%	3.18%

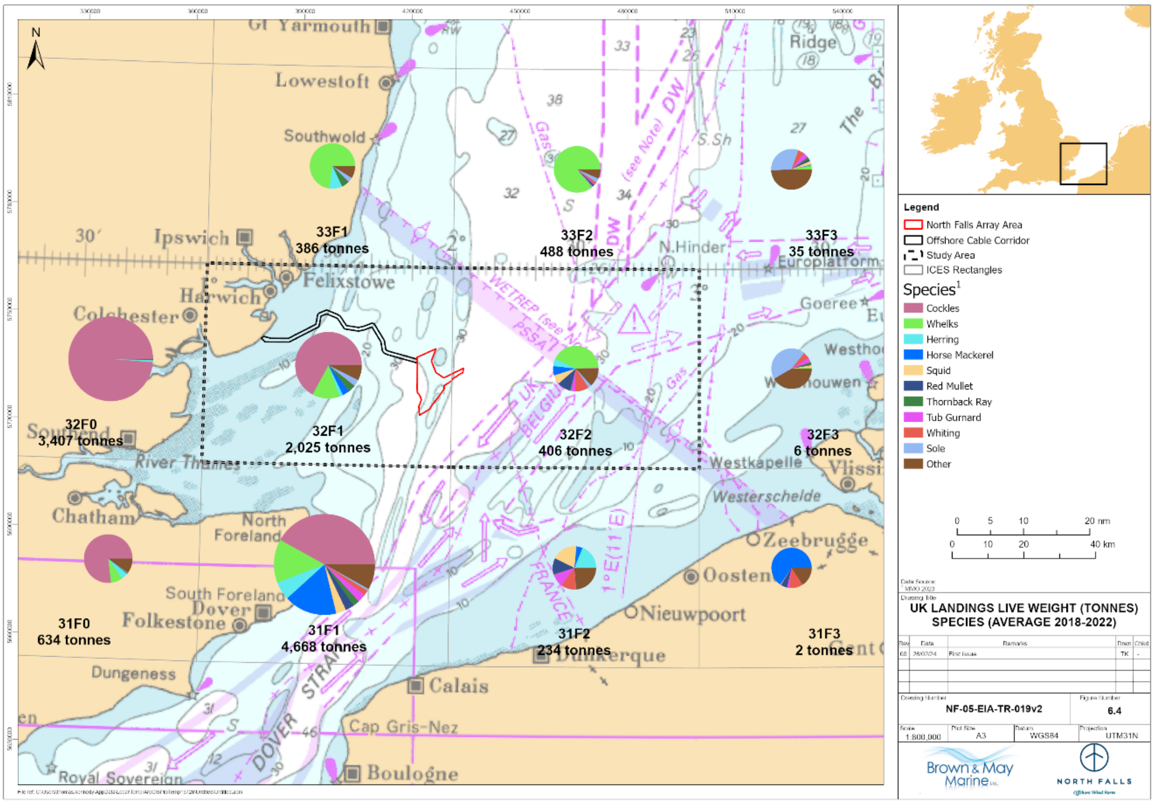

Figure 6.4 UK Landings (Tonnes) by Species (Average 2018-2022) (Source: MMO 2023)

6.1.3.2 Belgian landings statistics

The principal species targeted in the study area are plaice and Dover sole. In rectangles 32F1 and 32F2, other species of importance include thornback ray, cod, small spotted catshark and tub gurnard.

ICES rectangle 32F1, where the majority of the offshore project area is located, records moderate landings by weight (307 tonnes) in comparison to ICES rectangles to the south and south east with the highest landings weights recorded in 31F2 (1,341 tonnes).

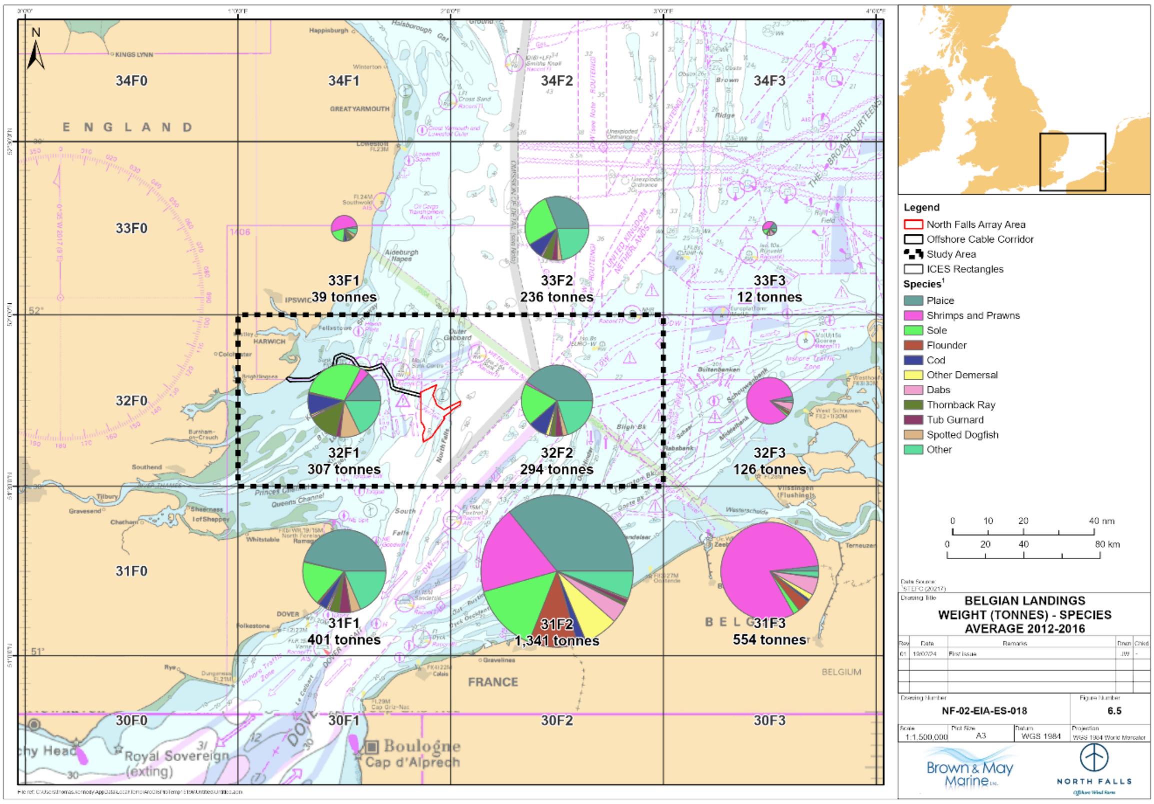

Figure 6.5 Belgian landings (tonnes) by Species (Average 2012 - 2016) (Source: STECF, 2017)

6.1.3.3 Dutch landings statistics

An overview of landings by Dutch vessels in each of the ICES rectangles within the study area is given by species in Figure 6.6. The highest value landings within the study area are found in ICES rectangle 32F2 (€12,928,492), around 10 times higher than the next highest value in 32F1 (€1,268,022). Landings values of Dutch vessels from the study area are predominantly from beam trawling.

The principal species landed in value by Dutch vessels from the study area is sole, with lower landings values from plaice and turbot (Figure 6.6).

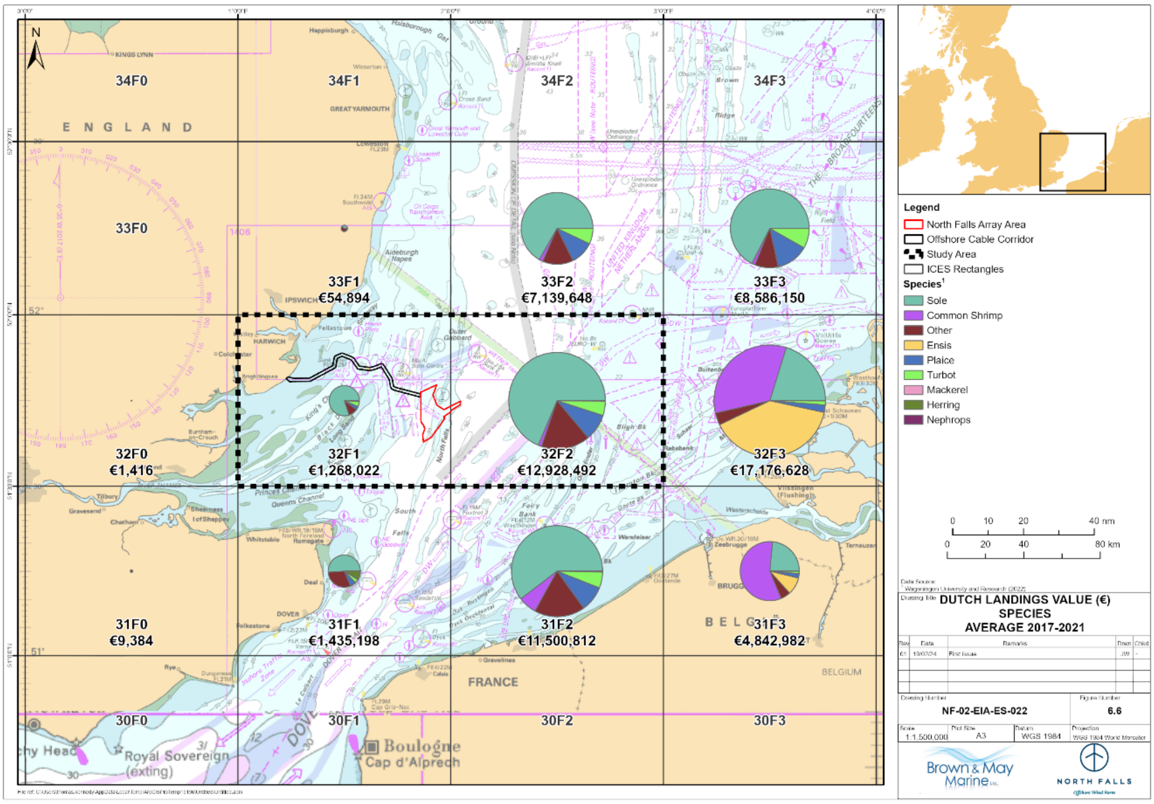

Figure 6.6 Dutch Landings (€) by Species (Average 2017 - 2021) (Source: WUR, 2022)

6.1.3.4 French landings statistics

In the study area French pelagic trawlers principally target herring, and at significantly lower levels mackerel, horse mackerel and sardine.

French landings in each of the ICES rectangles within the study area is given by species in Figure 6.7. The highest value landings in the southern North Sea are outwith the study area (ICES rectangle 31F1). Landings from 32F1 are mainly from pelagic trawlers targeting herring, and at significantly lower levels mackerel, horse mackerel and sardine. Whiting is the principal species targeted by bottom trawlers in ICES rectangles 32F2, as well as squid, cod, and lesser spotted catfish.

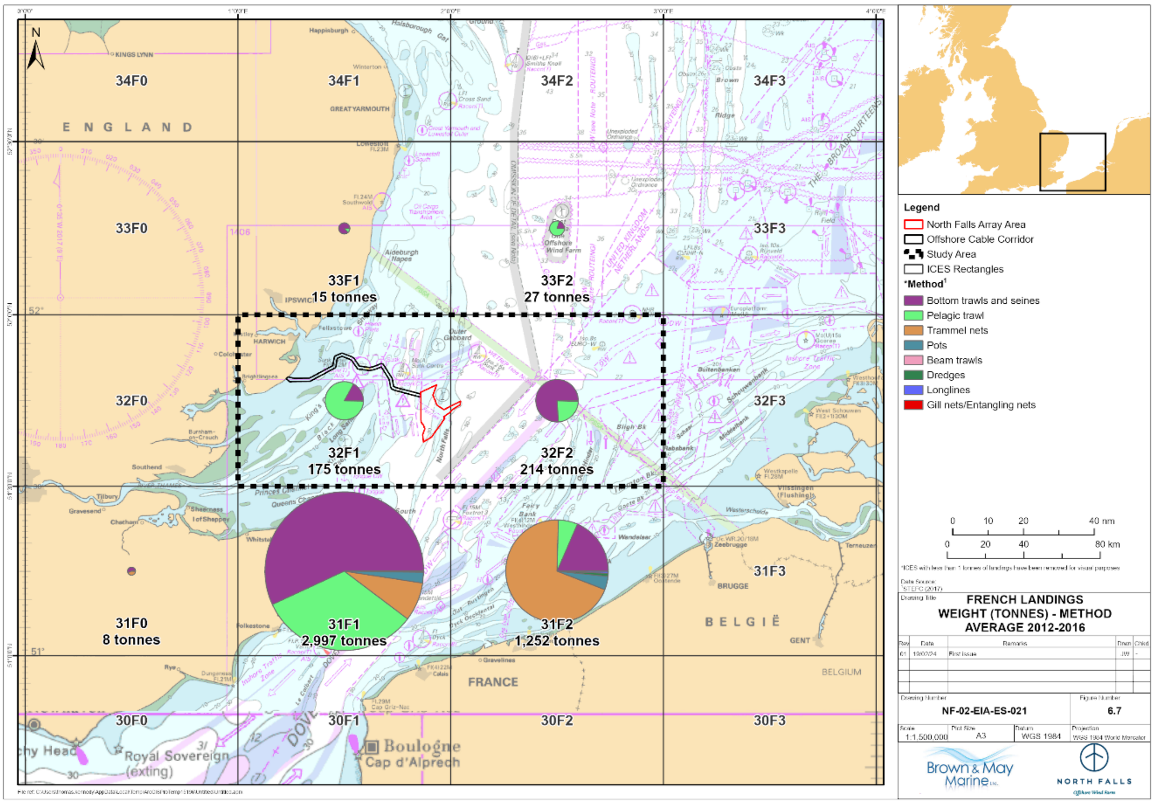

Figure 6.7 French Landings (tonnes) by Species (Annual Average 2012 - 2016) (Source: STECF 2017)

6.1.4 Spawning and Nursery Grounds

Species for which spawning or nursery grounds have been defined in areas that overlap with the array area and offshore cable corridor are listed in Table 6.8 based on information provided in Coull et al (1998) and Ellis et al (2010, 2012).

As shown, spawning grounds for herring, lemon sole, plaice, sandeel (*Ammodytidae* spp.), Dover sole, sprat, whiting and cod have all been defined in the offshore project area.

Nursery grounds for the species mentioned above as well as mackerel, thornback ray, and tope have also been defined within the offshore project area. It should be noted that in the case of thornback ray and tope, there is currently insufficient data on the occurrence of egg-cases or egg-bearing females in the spawning season with which to define spawning grounds. In the case of thornback ray, it is considered that these are likely to broadly overlap with nursery grounds (Ellis et al 2012).

Most of the species listed in Table 6.8 are pelagic spawners, which release their eggs in the water column. Exceptions to this are herring and sandeel, which are substrate specific demersal spawners. Thornback ray also lay eggs on benthic substrates although they are not known to have the same degree of substrate-specific spawning requirements as herring and sandeels.

Table 6.8 Species with Spawning and/or Nursery Grounds in the Offshore Project Area (Coull et al 1998, Ellis et al 2012)

Species	Spawning Season												Spawning Intensity		Nursery Intensity	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Array Area	Offshore Cable Corridor	Array Area	Offshore Cable Corridor
Herring														n/a		
Lemon Sole																
Plaice	*	*														
Sandeel																
Dover sole				*												
Sprat					*	*										
Whiting																
Mackerel					*	*	*						n/a	n/a		
Cod		*	*													
Tope	Gravid females found all year												n/a	n/a		
Thornback ray				*	*	*	*						n/a	n/a		

Spawning times and intensity colour key: orange = high intensity spawning/nursery grounds, yellow= low intensity spawning/nursery grounds, blue= spawning/nursery intensity not defined, grey= spawning period, * = peak spawning, n/a= no overlap with spawning/nursery grounds

6.1.5 Species of Conservation Interest

Fish and shellfish species of conservation importance with potential to make use of the offshore project area are outlined below under the following categories:

- Diadromous fish species;
- Elasmobranchs; and
- Other species with designated conservation status.

6.1.5.1 Diadromous Species

Various diadromous species have the potential to transit parts of the offshore project area, during certain periods of their life cycle. These are listed in Table 6.9 with their conservation status including European eel *Anguilla anguilla*, shads (*Alosa alosa* and *Alosa fallax*), river and sea lampreys *(Lampetra fluviatilis and Petromyzon marinus),* Atlantic salmon *Salmo salar,* sea trout *Salmo trutta* and smelt *Osmerus eperlanus*.

6.1.5.2 Elasmobranchs

The principal elasmobranch species potentially found in areas of relevance to the offshore project area are listed in Table 6.10 together with their conservation status. Sharks, skates and rays are considered particularly vulnerable to anthropogenic pressures due to their slow growth rates, late age at maturity and low reproductivity, resulting in slow increases in their population (Ellis et al., 2008; Sguotti et al., 2016). Stock levels of many elasmobranch species are considered low and are therefore the focus of conservation efforts including international advice and management measures (Dulvey et al 2017, ICES 2021a).

6.1.5.3 Other Species of Conservation Interest

In addition to diadromous fish and elasmobranchs, a number of fish and shellfish species found in the study area are of conservation interest, being listed as species of principal importance under the UK Post-2010 Biodiversity Framework and Section 41 of the Natural Environment and Rural Communities Act 2006 (England). In addition, some fish and shellfish species are protected features in MCZs. These are presented in Table 6.11, along with other conservation designations (e.g. OSPAR and IUCN listings). It should be noted that many of these species are commercially exploited in the area, either directly or indirectly as by-catch.

Table 6.9 Conservation Status of Diadromous Migratory Species

Common Name	Scientific name	Conservation Status						
		IUCN Red List	Species of Principal Importance	OSPAR	Bern Convention	CITES	Wildlife & Countryside (W&C) 1981	Habitats Regulations
European eel	*Anguilla anguilla*	Critically Endangered	✓	✓	-	✓	-	-
Allis shad	*Alosa alosa*	Least Concern	✓	✓	✓	-	✓	✓
Twaite shad	*Alosa fallax*	Least Concern	✓	-	✓	-	✓	✓
Sea lamprey	*Petromyzon marinus*	Least Concern	✓	✓	✓	-	-	✓
River lamprey	*Lampetra fluviatilis*	Least Concern	✓	-	✓	-	-	✓
Atlantic salmon	*Salmo salar*	Vulnerable	✓	✓	✓	-	-	✓
Sea trout	*Salmo trutta*	Least Concern	✓	-	-	-	-	-
Smelt (sparling)	*Osmerus eperlanus*	Least Concern	✓	-	-	-	-	-

Table 6.10 Conservation Status of Elasmobranch Species

Common Name	Scientific name	Conservation Status						
		IUCN Red List	Species of Principal Importance	OSPAR	[4]Bern Convention	CITES	W&C 1981	Habitats Regulations
Sharks								
Basking shark	*Cetorhinus maximus*	Endangered	✓	✓	✓	✓	✓	-
Starry smoothhound	*Mustelus asterias*	Near Threatened	-	-	-	-	-	-
Smoothhound	*Mustelus mustelus*	Endangered	-	-	-	-	-	-
Spurdog	*Squalus acanthias*	Endangered	✓	✓	-	-	-	-
Thresher shark	*Alopias vulpinus*	Vulnerable	-	-	-	✓	-	-
Tope	*Galeorhinus galeus*	Critically	✓	-	-	-	-	-
Skates and Rays								
Blonde ray	*Raja brachyura*	Near Threatened	-	-	-	-	-	-

Common Name	Scientific name	Conservation Status						
		IUCN Red List	Species of Principal Importance	OSPAR	[4]Bern Convention	CITES	W&C 1981	Habitats Regulations
Cuckoo ray	*Leucoraja naevus*	Least Concern	-	-	-	-	-	-
Common skate	*Dipturus*	Critically	✓	✓	-	-	-	-
Spotted ray	*Raja montagui*	Least Concern	-	✓	-	-	-	-
Thornback ray	*Raja clavata*	Near Threatened	-	✓	-	-	-	-
Undulate skate	*Raja undulata*	Near Threatened	✓	-	-	-	-	-
White skate	*Rostroraja alba*	Critically	✓	✓	-	-	✓	-

Table 6.11 Conservation Status of Fish and Shellfish Species of Relevance to the Offshore Project Area (excluding Diadromous and Elasmobranch Fish)

Common Name	Scientific name	Conservation Status						
		IUCN Red List	Species of Principal Importance	OSPAR	Bern Convention	CITES	W&C 1981	Habitats Regulations
Demersal Fish Species								
Cod	*Gadus morhua*	Vulnerable	✓	✓	-	-	-	-
Plaice	*Pleuronectes platessa*	Least concern	✓	-	-	-	-	-
Lemon Sole	*Microstomus kitt*	Least concern	-	-	-	-	-	-
Gobiidae –sand goby and common goby	*Pomatoschistus minutus* *Pomatoschistus microps*	Least concern	-	-	✓	-	-	-
Lesser sandeel	*Ammodytes marinus*	Least concern	✓	-	-	-	-	-
Dover sole	*Solea solea*	Least concern	✓	-	-	-	-	-
Whiting	*Merlangius merlangus*	Least concern	✓	-	-	-	-	-
Pelagic Fish Species								
Herring	*Clupea harengus*	Least concern	✓	-	-	-	-	-
Horse mackerel	*Trachurus trachurus*	Least concern	✓	-	-	-	-	-

Common Name	Scientific name	Conservation Status						
		IUCN Red List	Species of Principal Importance	OSPAR	Bern Convention	CITES	W&C 1981	Habitats Regulations
Mackerel	*Scomber scombrus*	Least concern	✓	-	-	-	-	-
Shellfish								
Native oyster[2]	*Ostrea edulis*	-	✓	✓	-	-	-	-

[2] Native oyster is also a protected feature in the Blackwater, Crouch, Roach and Colne Estuaries MCZ.

6.1.5.4 Prey Species and Food Web Linkages

Various fish species found in the study area, particularly sandeels, herring and sprat, play an important role in the North Sea's food web as prey to predators such as birds, marine mammals and piscivorous fish (ICES, 2019a).

Sandeels provide lipid-rich food for a wide range of predators, (Van der Kooij et al 2008, Howells et al 2017, Furness 2020), including other fish species such as whiting, haddock *Melanogrammus aeglefinus*, herring, cod, and grey gurnard (Furness 1990, Englehard et al 2008, Engelhard et al 2014). They also represent a key component in the diet of some seabirds in the North Sea, such as kittiwakes *Rissa tridactyla*, puffins *Fratercula arctica* and common guillemots *Uria aalge*, (Furness 1990, Furness and Tasker 2000, Lynam et al 2017, Walness et al 2018). Sandeels are also of importance to marine mammals and can make up a significant portion of the forage fish within their diet (Engelhard et al 2013, Macleod et al 2014).

Herring is preyed upon by a variety of bird species and fish species such as whiting, haddock, cod, mackerel and horse mackerel (ICES 2019a, Fauchald et al 2011, Bentley et al 2018). Predation mortality of one-year old herring in the North Sea is thought to be largely driven by consumption by cod, whiting, saithe *Pollachius virens*, cod, and seabirds, whilst younger herring (0 group herring) are primarily preyed by horse mackerel, mackerel and grey gurnard (Dickey-Collas et al 2010, ICES 2018). Herring egg mats are also known to attract a range of predators such as spurdog, mackerel, lemon sole and other herring (Richardson et al 2011).

Sprat constitute important prey for fish species such as whiting, cod, herring, horse mackerel, mackerel, grey gurnard, sandeels, spurdog *Squalus acanthias*, sea trout *Salmo trutta* and salmon *Salmo salar*, as well as many seabirds (Mackinson and Daskalov 2007, Bentley et al 2018, ICES 2018).

Both herring and sprat form part of the diet of marine mammals such as seals, harbour porpoise and minke whales (Agnes et al 2020, Nachtsheim et al 2021).

6.2 Key Fish and Shellfish Species in the Study Area

The principal species identified in the study area are listed in Table 6.12. These have been selected on the basis of:

- Presence/abundance in the study area;
- Location of spawning and nursery grounds;
- Commercial importance; and
- Conservation interest.

In addition, in order to identify key species, due regard has been given to the feedback provided by stakeholders on fish and shellfish ecology related issues in the Scoping Opinion issued by PINS (PINS 2021) and during ETG meetings as part of the EPP.

Table 6.12 Principal Fish and Shellfish Species in the Study Area

Relevant Fish and Shellfish Species	Rationale
Principal Demersal Bony Fish	
Cod	• Common in the study area • Species of conservation interest (Principal Importance, OSPAR, IUCN) • Commercially important in the study area • Low intensity spawning and nursery areas overlap with offshore project area
Whiting	• Common in the study area • Species of Principal Importance

Relevant Fish and Shellfish Species	Rationale
	• Low intensity spawning and nursery areas overlap with the offshore project area
Dover sole	• Common in the study area • Species of Principal Importance • Commercially important in the study area • High intensity spawning area overlaps with the offshore project area • High intensity nursery area overlaps with the inshore section of the offshore cable corridor; low intensity nursery area overlaps with the array area.
Plaice	• Common in the study area • Species of Principal Importance • Commercially important in the study area • High intensity spawning area and low intensity nursery area overlap with the offshore project area
Lemon sole	• Common in the study area • Undefined intensity spawning area and nursery area overlaps with the offshore project area
Sea bass	• Common in the study area • Of importance to commercial and recreational fisheries in the study area • Sea bass fishing heavily regulated due to stock concerns
Other Species (i.e dab, gobies, gurnards)	• Species characteristic of the southern North Sea fish assemblage • Common species in the study area • Possible prey items for fish, bird and marine mammal species
Ammodytidae (Sandeels)	
Lesser sandeel Small sandeel Greater sandeel	• Found in the study area • Species of Principal Importance • Key prey species for fish, birds and marine mammals • Low intensity spawning and nursery areas overlap with the offshore project area
Principal Pelagic Fish Species	
Herring	• Common in the study area • Species of Principal Importance • Commercially important in the study area • Spawning grounds of Downs herring located in areas adjacent to the southern array area • Spawning grounds of Blackwater herring located in the proximity of the inshore section of the offshore cable corridor. • High intensity nursery area overlaps with the offshore project area. • Key prey species for fish, birds and marine mammals
Sprat	• Common in the study area • Low commercial importance in the study area • Undefined intensity spawning grounds and nursery grounds overlap with the offshore project area • Key prey species for fish, birds and marine mammals
Horse Mackerel	• Common in the study area • Species of Principal Importance • Commercial importance in the study area
Mackerel	• Found in the study area • Species of Principal Importance • Low commercial importance in the study area

Relevant Fish and Shellfish Species	Rationale
	• Low intensity nursery area overlaps with the offshore project area
Elasmobranchs	
Thornback ray	• Abundant in the study area • Commercially important in the study area • Conservation importance ('Near Threatened' IUCN status and OSPAR list) • Low intensity nursery area overlaps with the offshore project area
Other Rays, Skates and Sharks (e.g spotted ray, common skate, blonde ray, small spotted catshark, smoothhounds, spurdog, tope)	• Present in the vicinity of the study area • Some species are Species of Principal Importance or OSPAR listed, and several are classified Endangered or Critically Endangered on the IUCN Red List with landings restricted or prohibited • Some species are of commercial importance in the study area • Tope have low intensity nursery grounds overlapping with the offshore project area
Diadromous Fish Species	
European eel	• Present in rivers in the proximity of the study area • Species of conservation importance (Species of Principal Importance, OSPAR list, listed as 'Critically Endangered' by IUCN) • May transit/feed in the study area during marine migration
European smelt	• Populations of smelt reported from estuaries in the proximity of the project • Species of Principal Importance • May transit/feed in vicinity of the inshore section of offshore cable corridor
Twaite shad Allis shad	• Species of conservation interest (Species of Principal Importance, protected under Bern Convention, Wildlife and Countryside Act, Habitats Regulations and included in OSPAR list (allis shad). • May transit/feed in vicinity of the study area during marine phase. • Caught in surveys carried out in the Galloper Offshore Wind Farm
River lamprey Sea lamprey	• Species of conservation interest (Species of Principal Importance, protected under the Habitats Regulations, the Bern Convention and listed by OSPAR as declining and/or threatened (sea lamprey only). • May transit/feed in vicinity of the study area during marine migration
Atlantic salmon	• Species of conservation interest (Species of Principal Importance, protected under the Habitats Regulations, the Bern Convention, listed by OSPAR as declining and/or threatened and classified as "vulnerable" by IUCN. • May occasionally transit/feed in the study area during marine migration
Sea trout	• Reported from estuaries in the proximity of the offshore project area • Species of Principal Importance • May transit/feed in the study area during marine migration
Shellfish species	
Cockle	• Commercially important in the study area • Managed by the Cockle Flexible Permit Byelaw and the Thames Estuary Cockle Fisheries Order 1994
Whelk	• Commercially important in the study area • Managed by the Whelk Fishery Flexible Permit Byelaw
Native oyster	• Species of Principal Importance and protected in the Blackwater, Crouch, Roach and Colne Estuary MCZ • Managed by Native Oyster Fishery Flexible Permit Byelaw

Relevant Fish and Shellfish Species	Rationale
Lobster	• Commercial importance in the study area
Crab	• Commercial importance in the study area • May overwinter within the study area and the wider area

6.2.1 Demersal Fish Species

6.2.1.1 Cod

Cod are widely distributed in the North Sea. They are typically found in depths under 200m and have a preferred temperature range of 3-7°C. Juvenile cod target larger benthic prey such as crustaceans and small fish, whereas adult cod feed predominantly on fish including sandeels, haddock, herring, flatfish and other cod, as well as squid and crustaceans and (ICES 2005b, Magnussen 2011).

Distinct sub-populations of cod have been found in the North Sea with limited degrees of mixing, leading to slow recolonisation of depleted areas (ICES 2020a). The reproductively isolated populations have been nicknamed 'Viking Cod', 'Dogger Cod' and 'Celtic Cod'. The Dogger cod population inhabits the south and central North Sea, the northern North Sea up the Scottish coast and the eastern English Channel. Within the Dogger population there may be two phenotypic stocks, one in the northern North Sea and one in areas of the southern North Sea. Cod in the southern North Sea predominantly occur in colder, less saline and shallower water (<50m) than those in the northern North Sea (Hedger et al 2004, ICES 2020a). An indication of the spatial distribution of cod in the North Sea based on IBTS data is provided in Figure 6.8. As shown, cod are widely distributed in the southern North Sea and have been recorded in the study area, particularly in its eastern section.

Cod reach maturity between 2-7 years. Factors such as temperature, high salinity levels, presence of coarse sand habitats and areas with low tidal flow are thought to be of importance in relation to cod spawning (Hutchings et al 1999, ICES 2020a). Spawning occurs between January and April with the peak spawning generally taking place in February and March (Table 6.8).

As shown in

Figure 6.9, the array area and the offshore cable corridor all fall within defined low intensity spawning and nursery grounds for cod (Ellis et al 2010, 2012). The more discrete spawning grounds identified in Coull et al (1998), however, are located to the east of the array area, with no overlap with the offshore project area. In line with this, analysis of data from the North Sea cod egg surveys (2004 and 2009) (Figure 6.10) indicates the presence of cod stage 1 &2 eggs in the eastern edge of the study area but with no overlap with the offshore project area.

Cod was the second most abundant species caught during the otter trawl surveys undertaken in the Galloper Offshore Wind Farm (Table 6.2) and is a species of commercial importance to the fisheries in the study area (Table 6.7). In addition, it has been found in some numbers in the IBTS survey in the study area, particularly in stations within ICES rectangle 32F2 (Table 6.6).

Cod are of conservation importance, being defined as 'vulnerable' by the IUCN, listed as a Species of Principal Importance and included in OSPAR's list of threated and/or declining species (Table 6.11). To support the recovery of North Sea cod and manage fisheries, an UK National North Sea Cod Avoidance Plan has been set out (MMO 2020). The plan includes seasonal closures to protect spawning cod between 1st January – 30th April in the southern North Sea. Closures in the proximity of the offshore project area are illustrated in Figure 6.11. As shown, they are located outside of the study area, in ICES rectangle 33F2 and 34F3, with no overlap with the offshore project area.

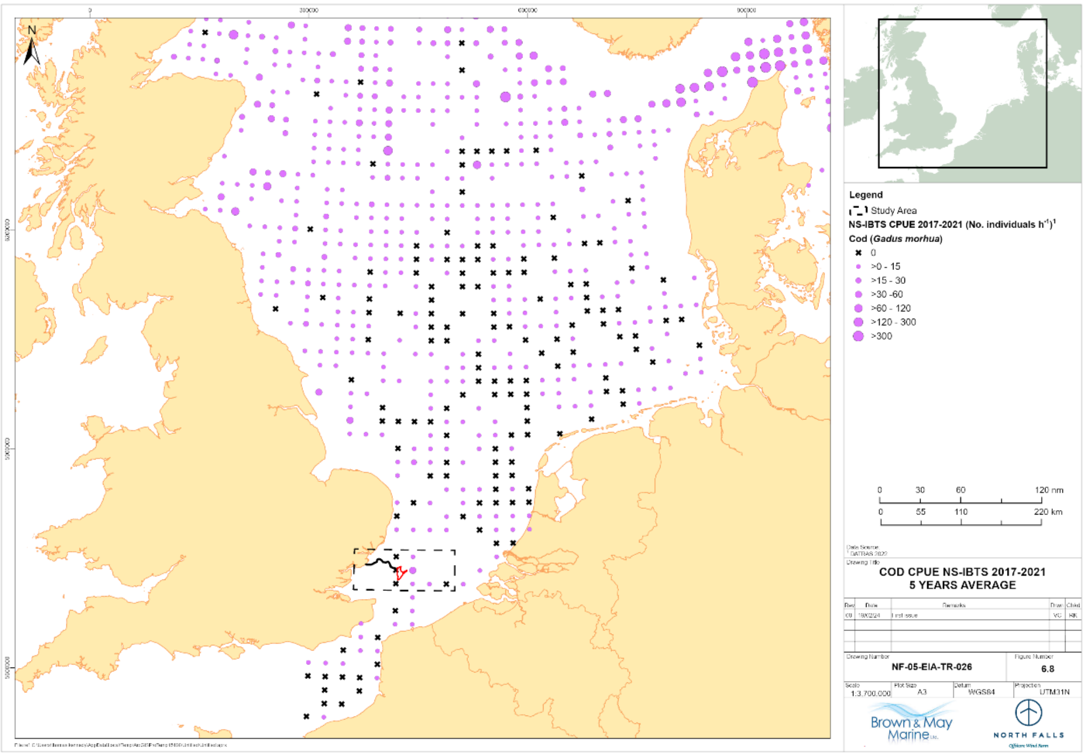

Figure 6.8 IBTS Cod CPUE (average 2017-2021) (Source: DATRAS 2022)

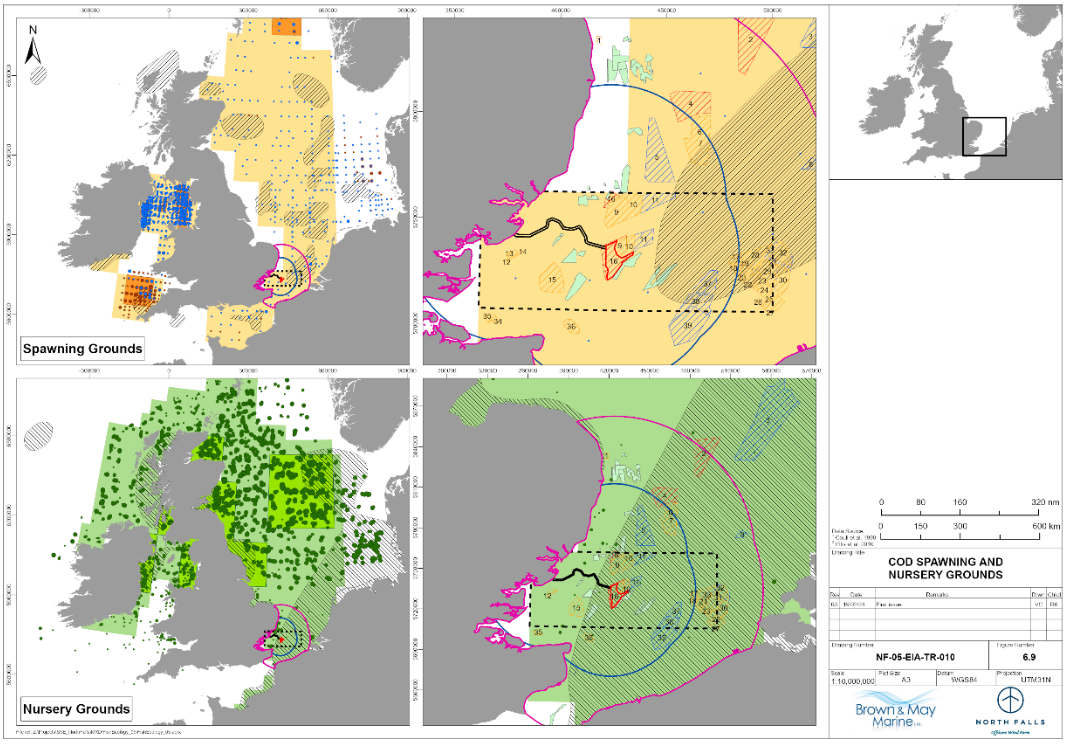

Figure 6.9 Cod Spawning and Nursery Grounds (Source: Coull et al 1998, Ellis et al 2010)

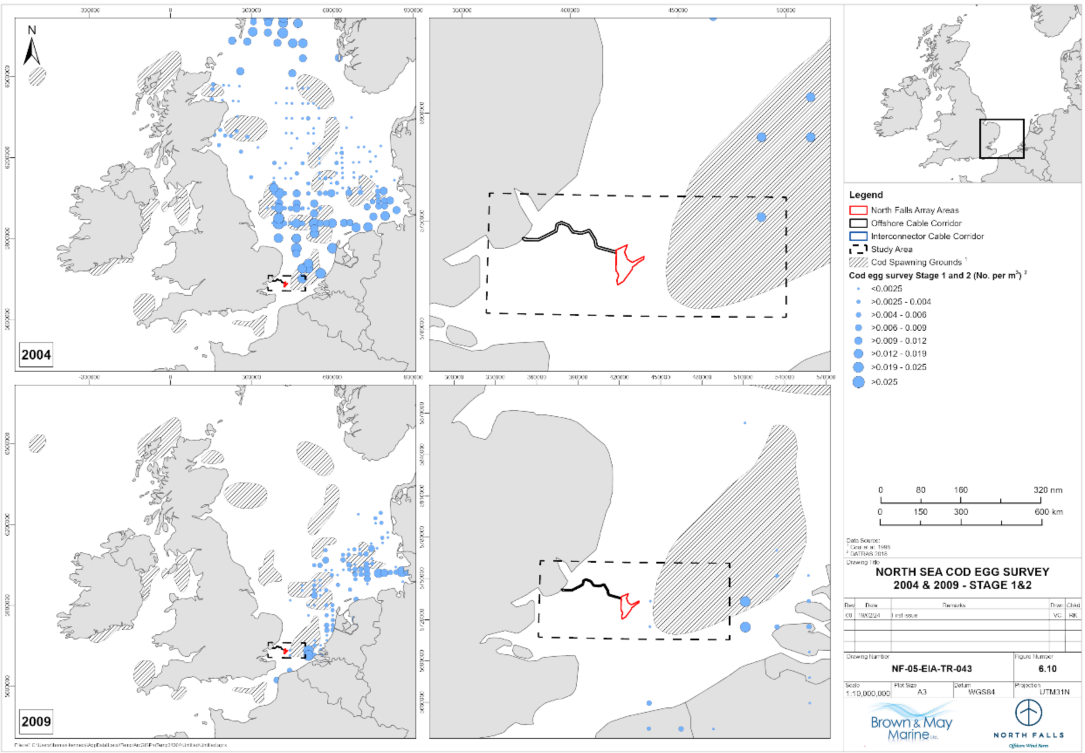

Figure 6.10 North Sea Cod Egg Survey (CP-EGGS) Data (2004 and 2009) (Source: DATRAS 2022)

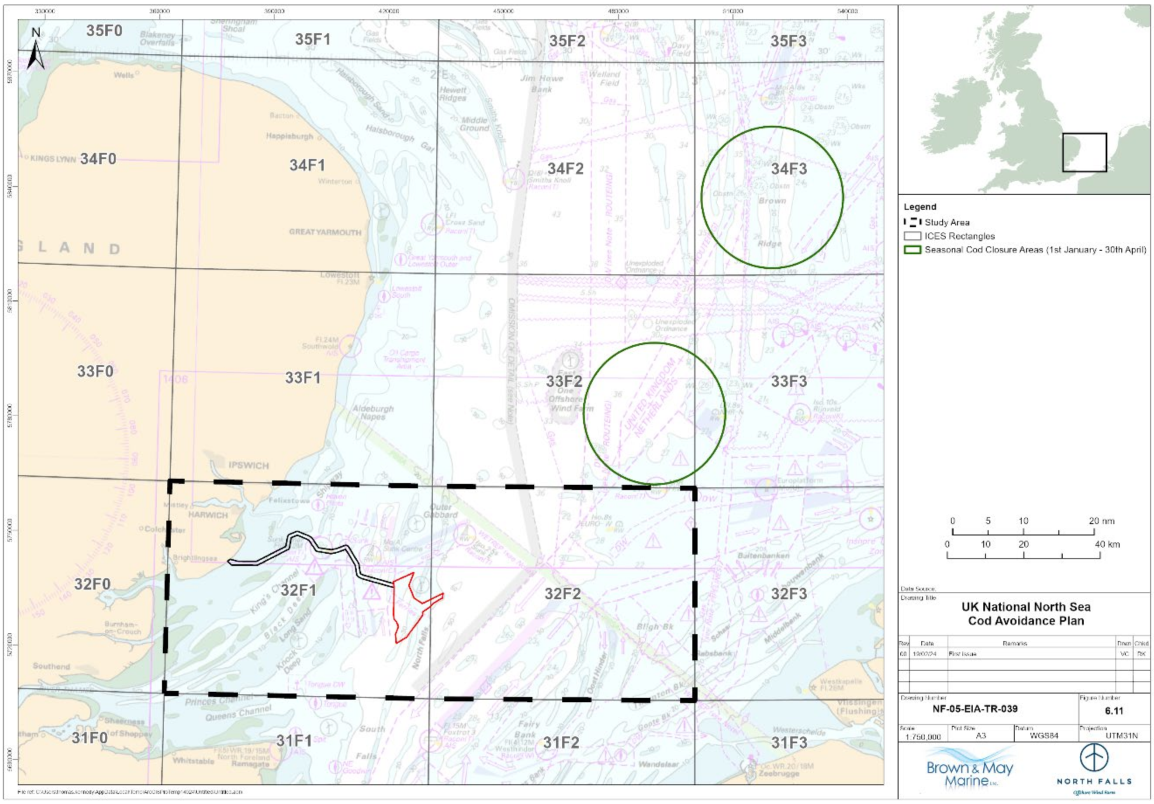

Figure 6.11 Seasonal Cod Closure Areas under the UK National North Sea Cod Avoidance Plan

6.2.1.2 Whiting

Whiting is abundant across the North Sea and is usually found near the bottom in waters from 10 – 100m on mud, gravel, sand and rock (Barnes 2008a, ICES 2005d). The wide distribution of this species is apparent from the analysis of IBTS data presented in Figure 6.12.

Young whiting prey mostly on small crustaceans and annelids, whereas adults prey mostly on other species of fish including other whiting, sandeel, sprat, Norway pout *Trisopterus esmarkii* and young cod, herring and haddock (Hislop et al 1991, ICES 2005d).

Spawning takes place between February and June (Table 6.8). The study area overlaps with the wide areas that have been defined as low intensity spawning and nursery grounds for this species (Ellis et al 2010) (Figure 6.13).

Whiting was the demersal bony fish found in greatest numbers in the study area by the IBTS (Table 6.6). Similarly, it was the most abundant species found during the otter trawl surveys carried out in the Galloper Offshore Wind Farm (Table 6.2) and was recorded in some numbers in the 2-m scientific beam trawl surveys carried out in the Galloper and Greater Gabbard Offshore Wind Farms (Table 6.3 and Table 6.4). In addition, as shown in Table 6.11, whiting is considered a Species of Principal Importance.

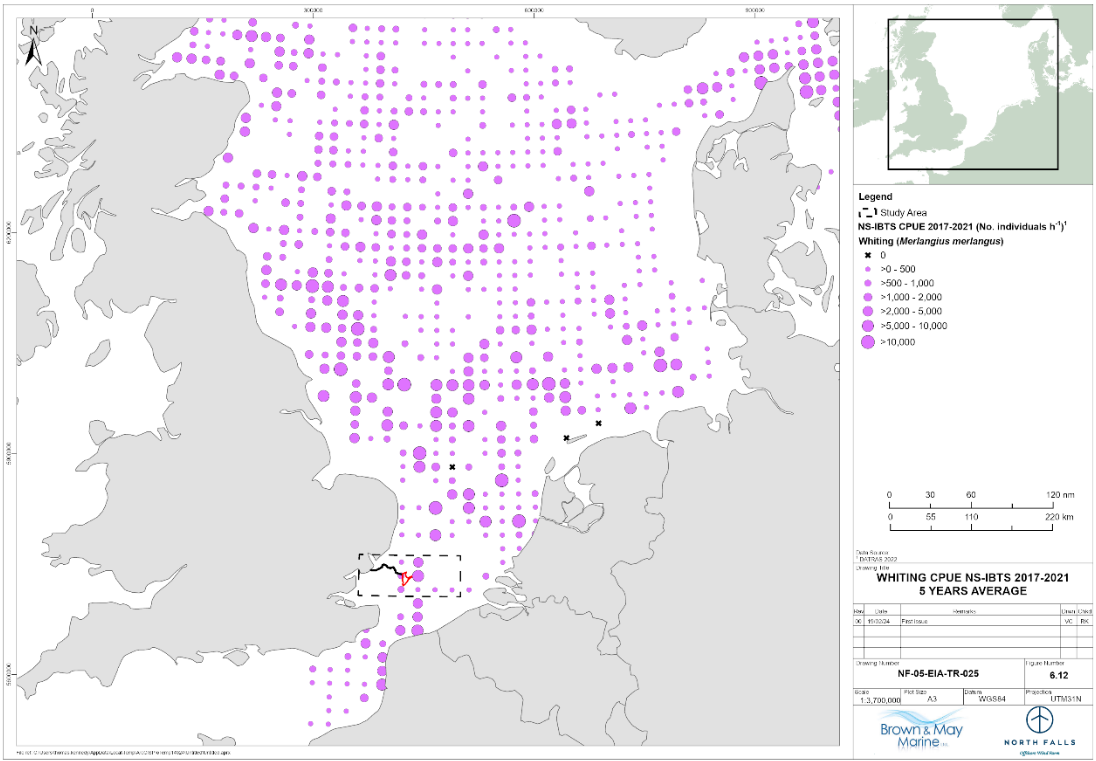

Figure 6.12 IBTS Whiting CPUE (average 2017-2021) (Source: DATRAS 2022)

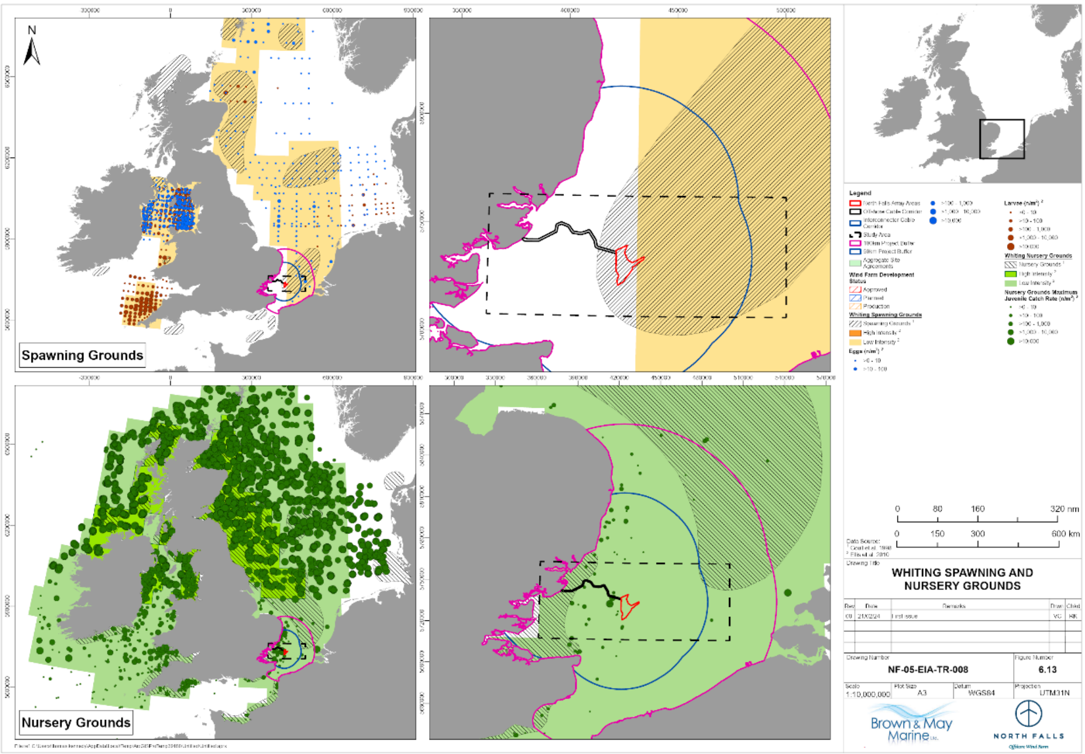

Figure 6.13 Whiting Spawning and Nursery Grounds (Source: Coull et al 1998, Ellis et al 2010)

6.2.1.3 Dover sole

Dover sole tend to inhabit shallow (<50m) sandy and muddy sediments and prey on benthic species such as polychaetes, crustaceans and small echinoderms (Rijnsdorp and Vingerhoed 2001, ICES 2005a).

In UK waters, they are found in the southern North Sea, the Irish Sea and the English Channel, generally in areas south of 56°N (Burt and Millner 2008). Sea temperature increases associated with climate change, however, appear to be expanding their range northwards (Brunel and Verkempynck 2018, Engelhard et al 2011). Records from the IBTS survey (Figure 6.14) indicate that this species is relatively abundant within the study area.

Spawning begins when sea temperatures reach around 7°C, which normally occurs in March, peaking in April and lasting until June (Burt and Milner 2008). They spawn in inshore areas such as the mouths of estuaries, where temperatures are higher, and larvae are surrounded by a highly productive environment and sheltered habitats. Juveniles are found in muddy or sandy substrate, as coarser sands increase difficulty and energy expenditure when burying and hunting (Post et al 2017). They tend to settle in coastal waters for 2-3 years before they reach maturity and move to deeper waters (Burt and Milner 2008).

Dover sole spawning occurs all along the southern North Sea coasts, however five main spawning grounds can be distinguished: the inner German Bight, off the Belgian coast, in the eastern Channel, in the Thames Estuary and the Norfolk Banks (ICES 2005a). As shown in Figure 6.15, spawning and nursery grounds in the Greater Thames area have been defined in areas of relevance to the offshore project area (Coull et al 1998, Ellis et al 2010); high intensity spawning grounds overlap with the array area and the offshore cable corridor; high intensity nursery grounds overlap with the inshore section of the offshore cable corridor; and low intensity nursery grounds overlap with the array area.

Dover sole is listed as a Species of Principal Importance (Table 6.11) and supports important commercial fisheries in the study area (Table 6.11). In addition, it is one of the main demersal bony fish recorded within the study area in the IBTS (Figure 6.14, Table 6.6) and was recorded in some numbers in the otter and beam trawl surveys undertaken in the Galloper Offshore Wind Fam (Table 6.2 and Table 6.3) and in epibenthic surveys carried out in the Greater Gabbard Offshore Wind Farm (Table 6.4).

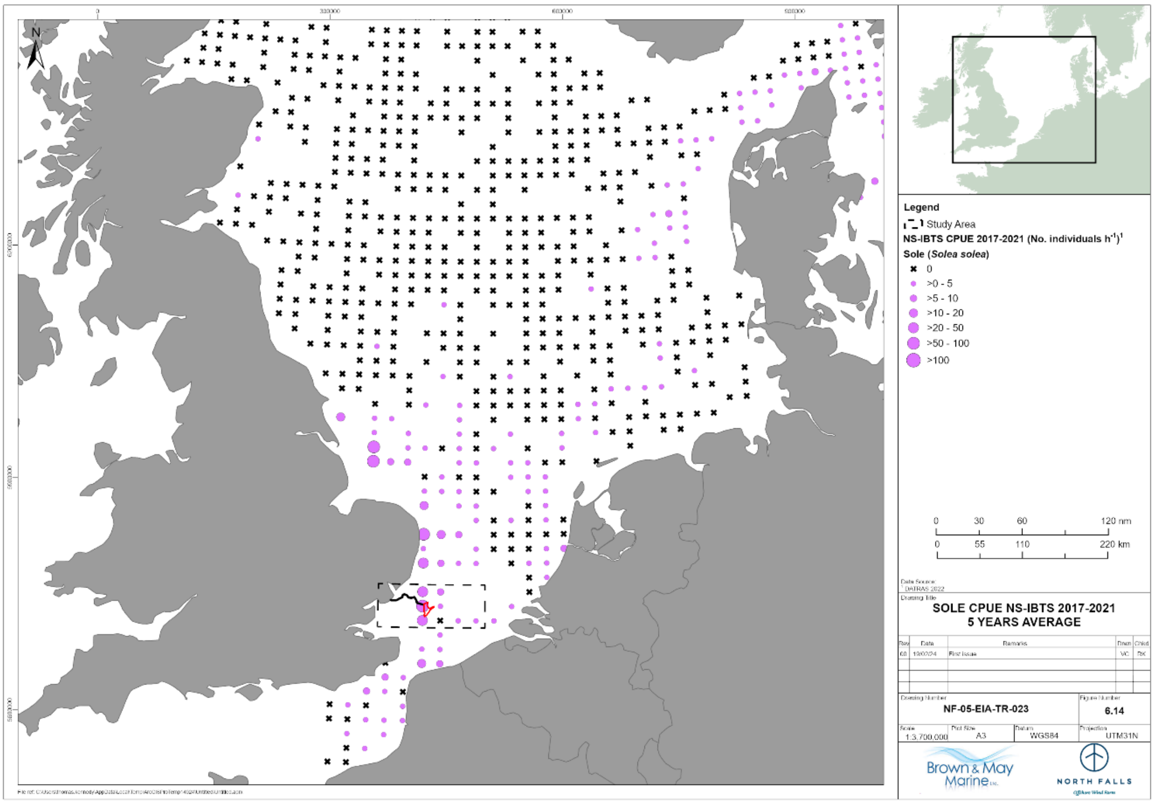

Figure 6.14 IBTS Dover Sole CPUE (average 2017-2021) (Source: DATRAS 2022)

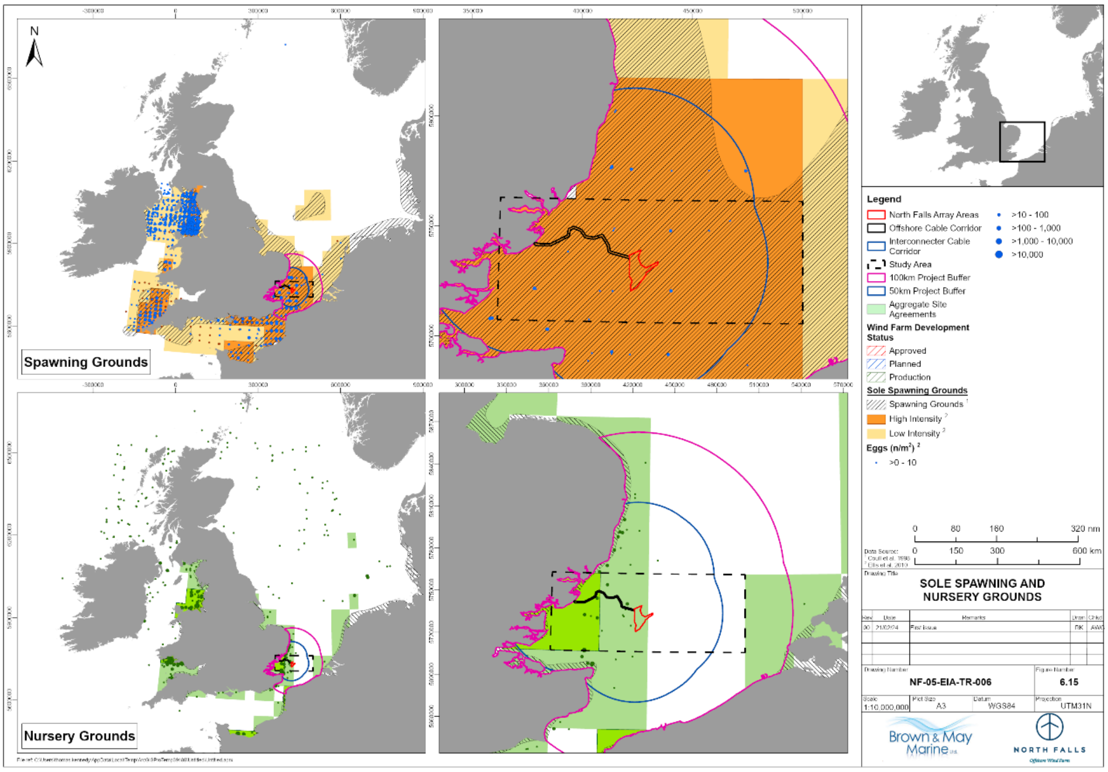

Figure 6.15 Dover Sole Spawning and Nursery Grounds (Source: Coull et al 1998, Ellis et al 2010)

6.2.1.4 Plaice

Plaice is a common species of flatfish that is widespread in the North Sea and around the UK. Plaice can be found in depths up to 200m but occurs more typically between 10 and 50m. They have a preference for sandy substrates, however, can also be found on mud and coarser sand (Ruiz 2007). Juveniles feed on polychaetes and bivalves whereas adults eat a larger proportion of epibenthic crustaceans, echinoderms and fish along with polychaetes and bivalves (ICES 2005c).

An indication of the distribution of plaice in the North Sea based on data from the IBTS is provided in Figure 6.16. As shown, plaice are widely distributed across the North Sea and have been recorded during the IBTS at moderate levels in the study area.

The southern North Sea is considered a major spawning ground for plaice in deeper offshore areas, with shallow coastal waters and estuaries providing juvenile plaice with nursery habitats. Young plaice tend to stay close to coastal regions whereas older age classes move further offshore (ICES 2005c).

As illustrated in Figure 6.13, the wide high intensity plaice spawning grounds identified in the North Sea (Ellis et al 2012) overlap with the array area and the offshore cable corridor. These areas have also been identified as low intensity nursery grounds for this species. Spawning takes place between January and March, with peak spawning during January and February (Table 6.8).

As it is apparent from information provided in Ellis et al (2010) (Figure 6.13) and in the North Sea plaice egg surveys (CP-EGGS) (Figure 6.18 and Figure 6.19,) the main areas of egg production are very extensive, covering large areas of the eastern English Channel, the Southern and Central North Sea.

Plaice was one of the principal species caught in the otter trawl surveys carried out in the Galloper Offshore Wind Farm (Table 6.2) and was recorded in some numbers in the 2-m scientific beam trawl surveys carried out in the Galloper and Greater Gabbard Offshore Wind Farms (Table 6.3 and Table 6.4).In addition, it was one of the main demersal bony fish species found in the IBTS in the study area, particularly in ICES rectangles 32F1 and 32F2.

Plaice is of importance to commercial fisheries in the study area (Table 6.7) and is listed as Species of Principal Importance (Table 6.11).

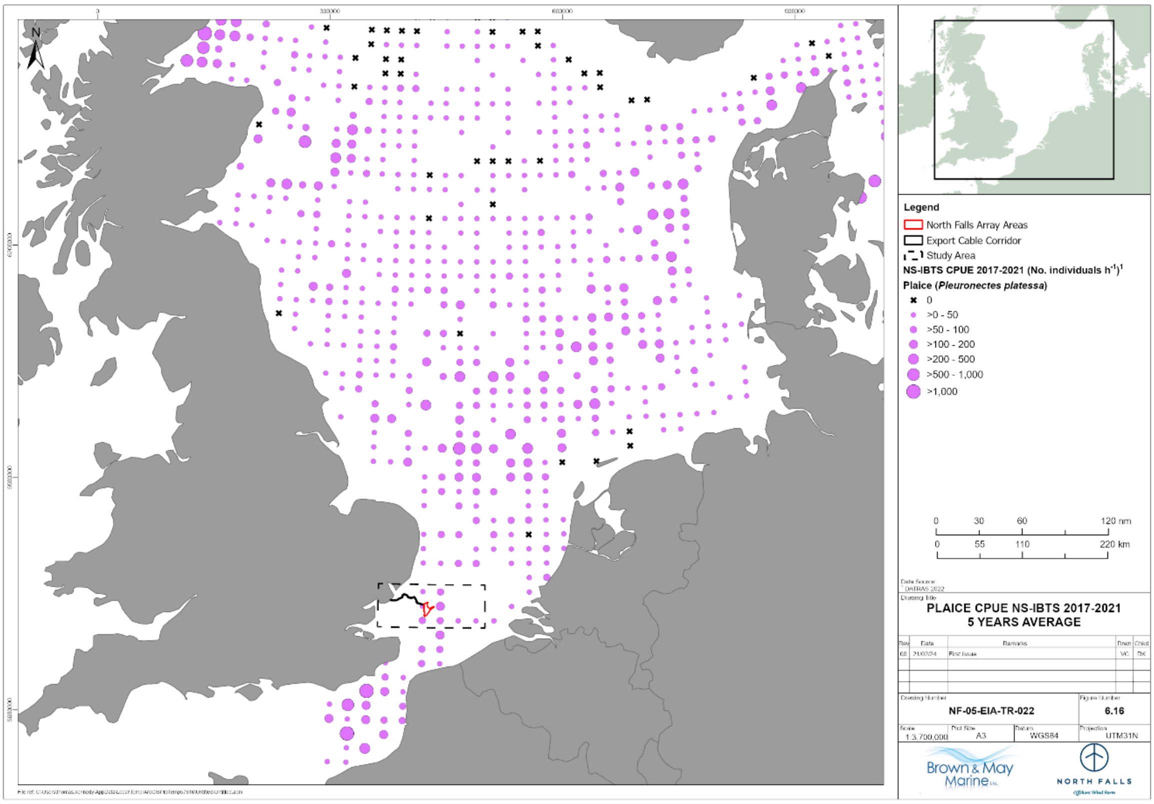

Figure 6.16 IBTS Plaice CPUE (average 2017-2021) (Source: DATRAS 2022)

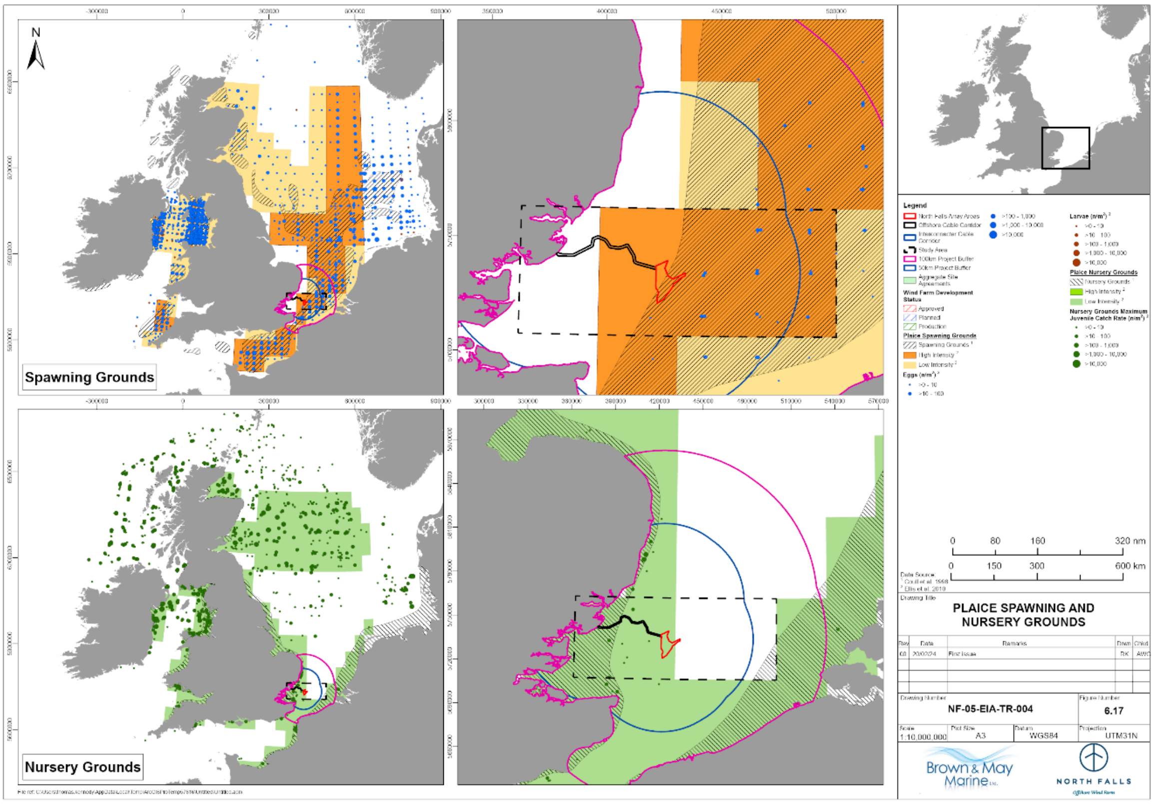

Figure 6.17 Plaice Spawning and Nursery Grounds (Source: Coull et al 1998, Ellis et al 2010)

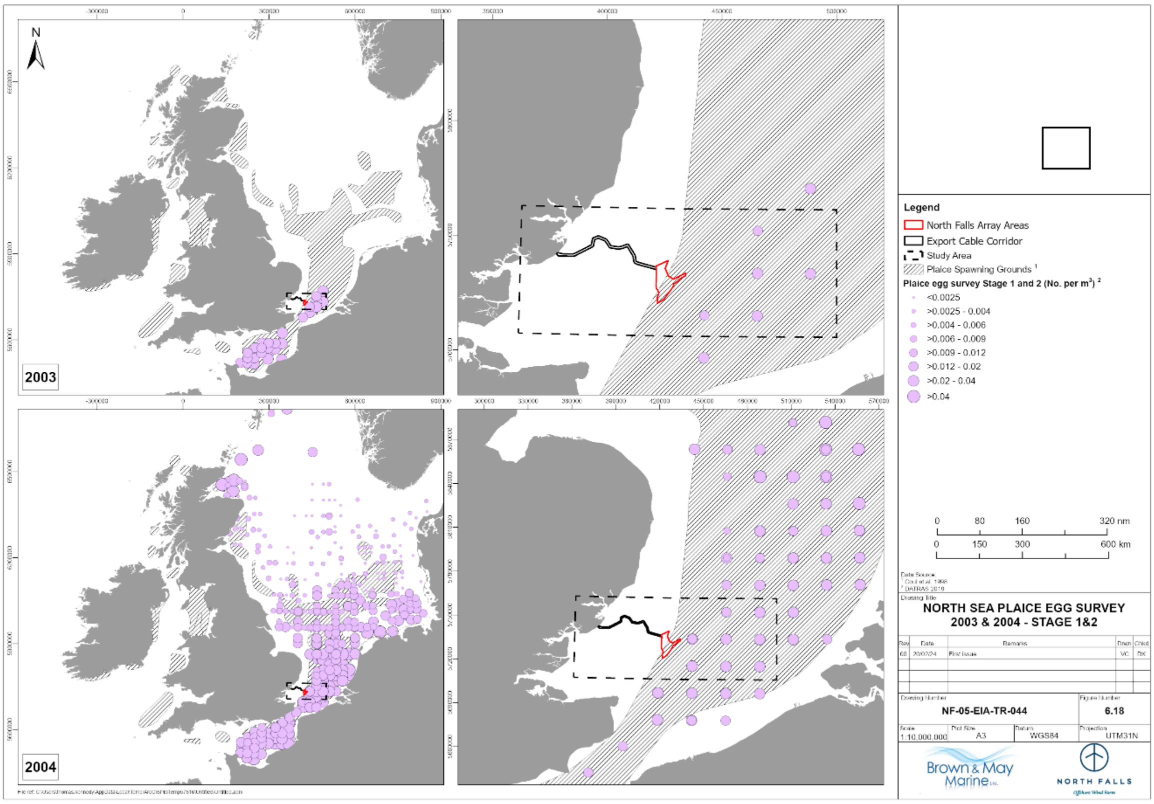

Figure 6.18 North Sea Plaice Egg Survey (CP-EGGS) (2003 and 2004) (Source: DATRAS 2022)

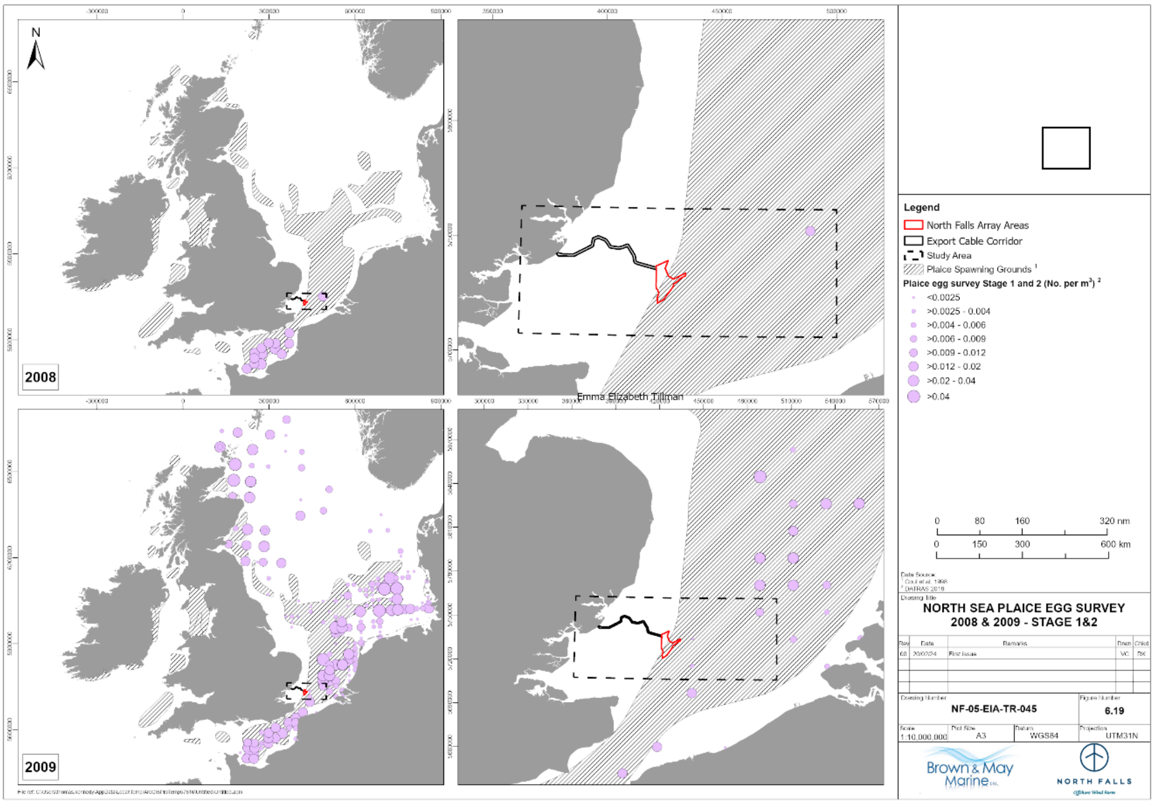

Figure 6.19 North Sea Plaice Egg Survey (CP-EGGS) (2008 and 2009) (Source: DATRAS 2022)

6.2.1.5 Lemon Sole

Lemon sole are most common in the central region of the North Sea and off the east coast of Scotland but are found all around the UK coast (Figure 6.20). Juveniles stay in shallow water (1-2m) whilst adults are usually found between 10 and 60m and move into deeper water in the winter (Geffen et al 2021). They can be found on a variety of habitats but seem to prefer larger substrate such as cobbles, gravel, maerl beds and sandy substrates with gravel (Hinz et al 2006, Sorensen and Pedersen 2021).

Lemon sole spawn between April and October period, and relatively little is known about their spawning compared to other species in the North Sea (Coull et al 1998, Geffen et al 2021). As shown in Figure 6.21, the wide spawning and nursery grounds that have been defined for this species (Coull et al 1998) overlap with the offshore project area.

Lemon sole were caught in some numbers in the otter trawl surveys undertaken in the Galloper Offshore Wind Farm (Table 6.2) and in the 2-m scientific beam trawl survey carried out in the Greater Gabbard Offshore Wind Farm (Table 6.4). In addition, they were recorded in the IBTS survey in the study area (Table 6.6), particularly in ICES rectangle 32F2.

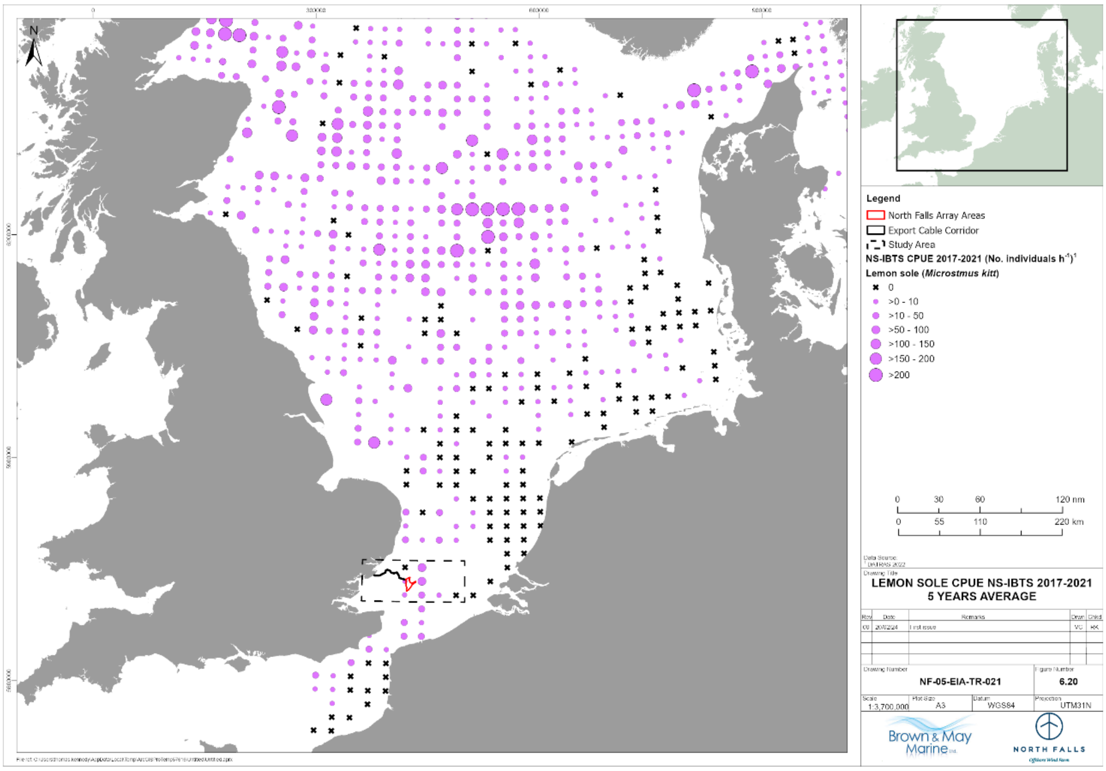

Figure 6.20 IBTS Lemon Sole CPUE (average 2017-2021) (Source: DATRAS 2022)

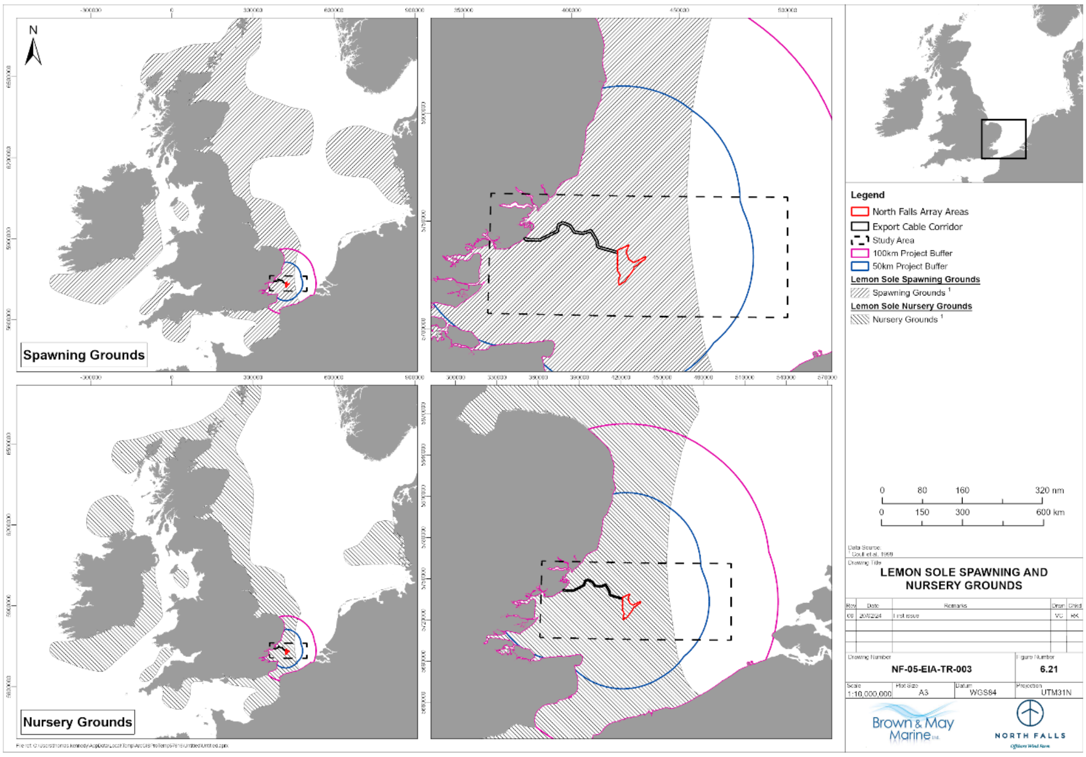

Figure 6.21 Lemon Sole Spawning and Nursery Grounds (Source: Coull et al 1998)

6.2.1.6 Sandeels

Sandeels are eel like fish and spend a large proportion of the year buried in the sediment, emerging into the water column to spawn briefly in winter and for an extended feeding period in spring and summer (Van der Kooij et al 2008). The North Sea sandeel population is considered to consist of several sub-populations rather than an individual homogeneous stock (ICES 2022). For the purposes of stock management, ICES has divided the North Sea into four Sandeel Assessment (SA) areas. As shown in Figure 6.24, the offshore project area falls within the boundaries of Sandeel Assessment Area 1r.

Sandeels tend to prey on zooplankton such as copepods, large diatoms, small crustaceans, fish larvae and small fish. Calanus copepods are considered particularly important prey to sandeels and fluctuations in the abundance of copepod prey species (especially *Calanus finmarchicus)* is thought to be critical for the survival of sandeel larvae (van Deurs et al 2012).

Sandeels are most commonly found at depths of 30-70m in turbulent waters, such as on sandbanks (Green 2017). The distribution of sandeels in the North Sea is patchy as they are highly dependent on sediment type. Research undertaken on lesser sandeel suggests that they require a very specific substratum containing a high proportion of medium and coarse sand and low silt content (Holland et al 2005). This could be due to the greater permeability and therefore higher oxygen concentration of larger-grained sediments as opposed to silt sediments. Because of this, sandeels have rarely been recorded in sediments where the silt content (particle size <0.63µm) is greater than approximately 4% (Holland et al 2005, Wright et al 2000, Green 2017) and are generally absent where silt content is greater than 10% (Holland et al 2005, Wright et al 2000). Sediment categories first proposed by Holland et al (2005) and adapted by Greenstreet et al (2010) defined suitable sandeel substrate in terms of “coarse sands” (with a particle size between 250µm to 2mm) and “silt and fine sands” (with particles between 0.1 µm and 250µm). The greater the percentage of “coarse sands” relative to the percentage of ‘‘silt and fine sands’’, the greater the potential for the substrate in a given area to constitute a preferred sandeel habitat.

The suitability of the substrate in the offshore project area in terms of potential provision of sandeel habitat is illustrated in Figure 6.22, based on Marine Space et al (2013) sandeel habitat categorisation (Table 6.13). This has been derived from Particle Size Analysis (PSA) data from sediment samples collected across the offshore project area during the benthic baseline characterisation survey carried out in the offshore project area (Fugro 2021) in combination with PSA data from Cefas’ OneBenthic Data portal.

Table 6.13 The Partition of Sandel Species (Ammondytidae) Potential Habitat Sediment Classes (Source: Marine Space et al 2013)

% Particle Contribution (muds = clays and silts <63 µm)	Habitat Sediment Preference	Folk sediment unit	Habitat Sediment Classification
<1% muds, >85% Sand	Prime	Part Sand, Part slightly gravelly Sand and part gravelly Sand	Preferred
<4% muds, >70% Sand	Sub-prime	Part Sand, Part slightly gravelly Sand and part gravelly Sand	Preferred
<10% muds, >50% Sand	Suitable	Part gravelly Sand and part sandy Gravel	Marginal
>10% muds, <50% Sand	Unsuitable	Everything excluding Gravel, part sandy Gravel and part gravelly Sand	Suitable

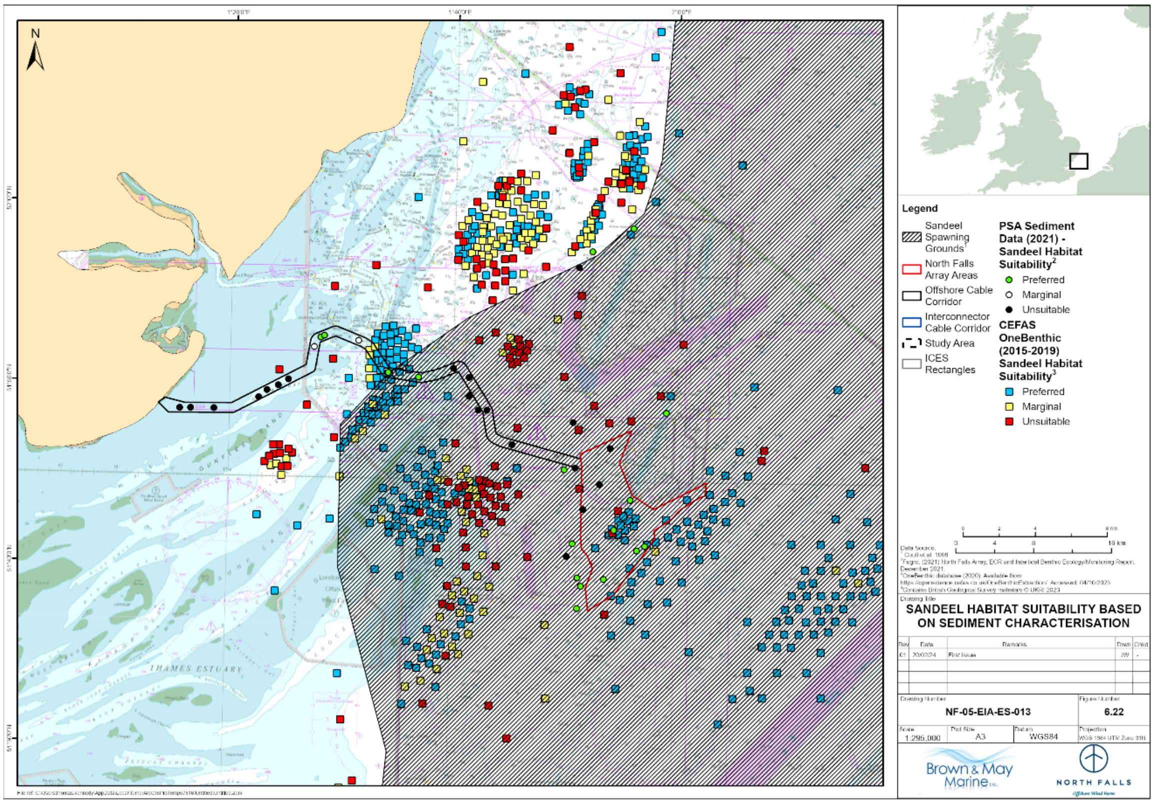

Figure 6.22 Sandeel Habitat Suitability based on Sediment PSA

As shown in Figure 6.22, the majority of samples collected in the offshore cable corridor correspond with sediments categorised as unsuitable, with the exception of some samples located in the central section of the offshore cable corridor which have been identified as preferred and marginal sandeel habitat. In the array area, the samples collected correspond with sediments which are either unsuitable or preferred sandeel habitat. In this context it is important to note that the presence of suitable habitat does not necessarily imply that sandeels are present in a given area.

As requested by the MMO during Scoping (Table 11.1, Fish and Shellfish Ecology, Volume 1), a sandeel habitat assessment has been undertaken using the MarineSpace Ltd (2013) guidance. MarineSpace et al. (2013a) identified a range of data sources to inform mapping of potential sandeel habitat. A 'confidence score' is assigned to data layers, and following scoring, data layers are analysed and combined in Geographic Information System (GIS) to produce a 'heat' map. The heat map represents the sum of the confidence score of all layers at any one location.

The spatial data sources used are referenced within MarineSpace et al. (2013a) and applied to this assessment as detailed in Table 6.14. Limitations associated with these data sources are discussed in detail in the MarineSpace et al. (2013a) guidance and incorporated into the resultant confidence scores. Table 6.14 also provides the sandeel confidence scores assigned to each data layer for the purposes of the assessment. The scoring methodology is provided within the MarineSpace et al. (2013a) guidance. The confidence scores represent the total normalised value for each dataset which is calculated using total weighted scores for the quality of evidence that each dataset represents (considering vintage, resolution, quality standards, and dataset source) and the suitability of the dataset as an indicator of sandeel presence. The 'maximum possible data layer scores' are 12 for sandeel.

Table 6.14 Summary of Data and Confidence Scores for Sandeel Habitat Assessment

Data Source	Summary	Confidence Score Sandeel
Sediment data – British Geological Survey (BGS) – 1:250,000 scale (BGS, 2023)	BGS sediment data was acquired for the study area, and categorises sediment types according to Folk (1954) classifications. The MarineSpace (2013a) guidance categorises the preference for sandeel habitat on a range from 'preferred' to 'unsuitable' based on Folk (1954) classifications: – Preferred habitat sediment class: Sand, slightly gravelly Sand and gravelly Sand – Marginal habitat sediment class: sandy Gravel – Unsuitable habitat sediment class: all other Folk (1954) classifications	Preferred = 4 Marginal = 2
Fisheries data – Danish Vessel Monitoring System (VMS) data (2014-2018)	Satellite tracking data (Vessel Monitoring System (VMS) recorded in 0.05° by 0.05° grids from Danish vessels in UK and European waters. VMS data is combined with log book data with values assigned to each cell in the grid in terms of effort and value (£). Fishing by demersal gears are considered an indicator of sandeel habitat. However, it should be noted that the confidence in this data is relatively low as this fishing method may target a range of species.	5
Spawning grounds – Coull et al. (1998)	Indicative spawning and nursery ground locations and timings around UK waters for sandeel.	3

As shown in Figure 6.23, the sandeel habitat assessment concluded that the array area is situated in an area of "medium" confidence in sandeel habitat, whereas the offshore cable corridor is located predominantly in an area of "low" confidence in sandeel habitat, with only a small identified as being in an area of "medium" confidence.

As previously mentioned, sandeels show a very patchy distribution. Fishing grounds are considered to provide reliable information on the distribution of sandeel habitat and are often used as an indicator of the distribution of sandeels (van de Kooij et al 2011). The location of sandeel grounds in the North Sea based on fisheries information (Jensen et al 2011) is illustrated in Figure 6.24. As shown, sandeel grounds are widespread within the North Sea. In SA area 1r (the SA area where the offshore project area is located), sandeel grounds concentrate around the Dogger Bank and no sandeel grounds have been identified within the offshore project area or within the study area (Figure 6.24).

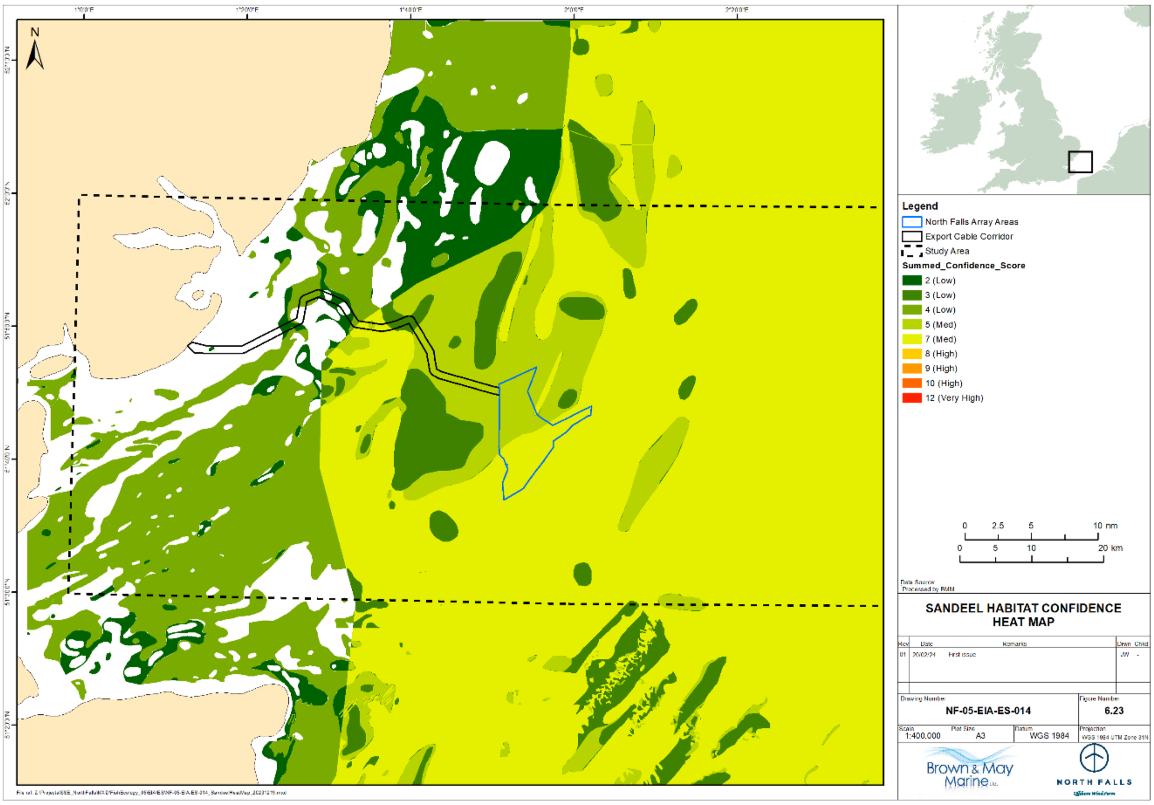

Figure 6.23 Sandeel Habitat Confidence Heat Map

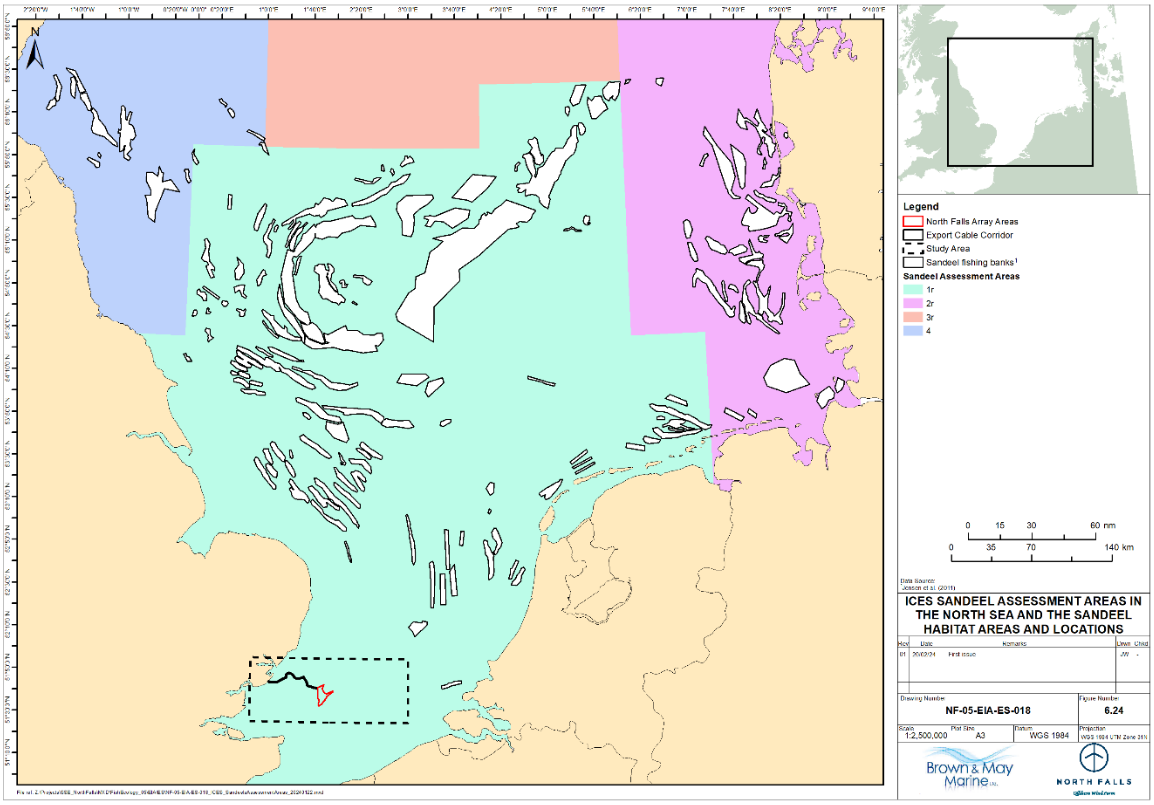

Figure 6.24 ICES Sandeel Assessment Areas in the North Sea (1-4) and the sandeel habitat areas and locations of fishing grounds described by Jensen et al (2011)

As mentioned in Section 6.1.4, sandeels are substrate specific spawners and lay their eggs on the seabed. Spawning takes place from November to February (Table 6.8). As shown in Figure 6.25, the offshore project area overlaps with the wide low intensity sandeel (*Ammodytidae* spp.) spawning and nursery grounds defined by Ellis et al (2010) that cover the majority of the southern North Sea. The closest high intensity sandeel spawning areas are found in the Dogger Bank area at considerable distance from the offshore project area.

Sandeels were recorded in the study area during the 2-m scientific beam trawl survey carried out in the Galloper Offshore Wind Farm (Table 6.3) and their presence was noted at three stations during the benthic baseline characterisation survey carried out in the offshore project area in 2021 (Fugro 2021). In addition, sandeels were recorded in some numbers in the study area in the IBTS in recent years. Analysis of IBTS data for lesser sandeel, the species of sandeel more abundant in the North Sea, shows low CPUE values in the study area, with other areas within SA area 1r, particularly the Dogger Bank recording considerably higher CPUEs values (Figure 6.26).

Sandeels are not targeted by commercial fisheries in the study area (Table 6.7 and Figure 6.24) but are of conservation interest, being listed as a Species of Principal Importance (Table 6.11). In addition, as mentioned in Section 6.1.5.4, they play an important role in the North Sea's foodweb being an important prey item for many fish species, seabirds and marine mammals. The UK government has confirmed the intention to prohibit the fishing of sandeels within English waters of ICES Area 4. This measure will apply to all vessels of any nationality, and it will be effective from 26 March 2024, before the start of the next sandeel fishing season (DEFRA, 2024).

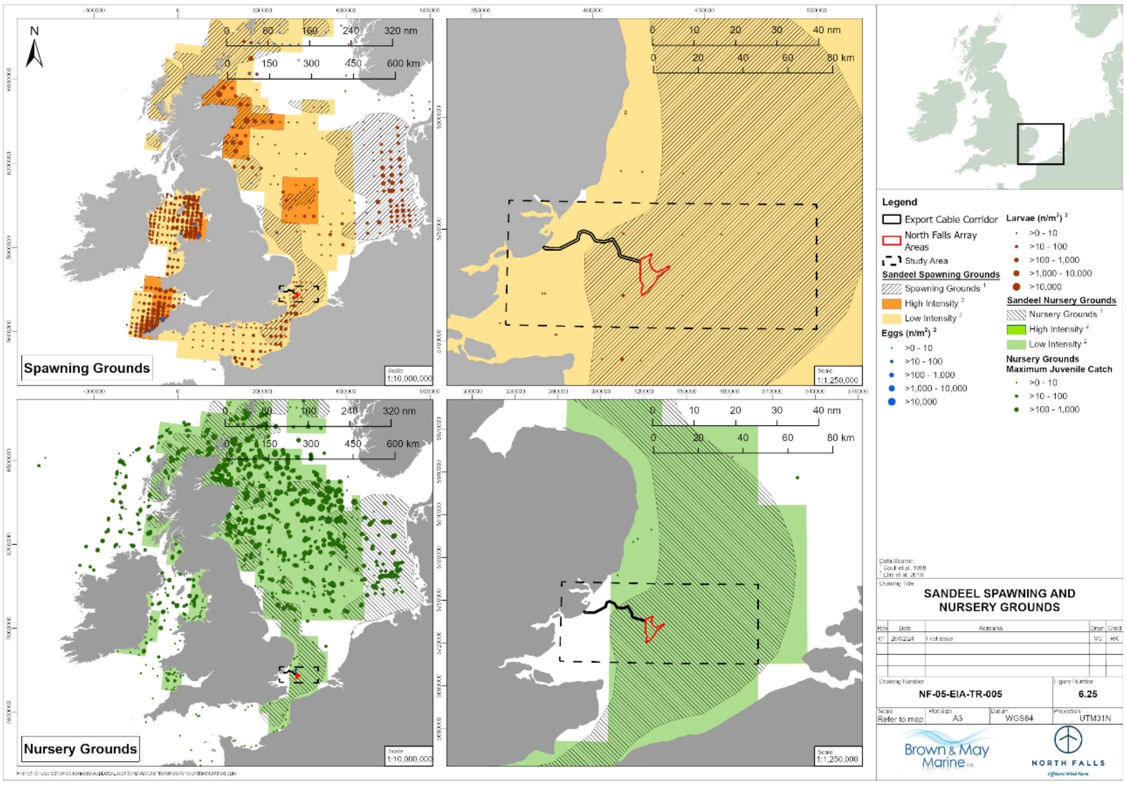

Figure 6.25 Sandeel Spawning and Nursery grounds (Source: Coull et al 1998, Ellis et al 2010)

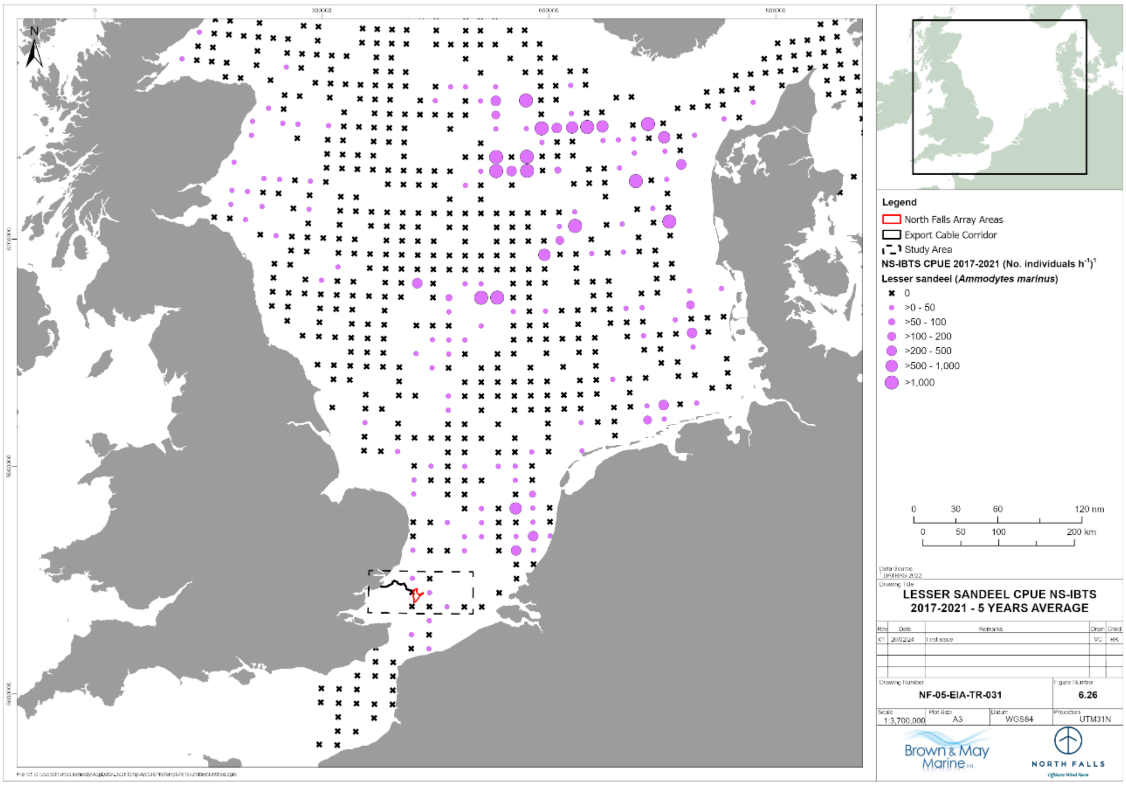

Figure 6.26 IBTS Lesser Sandeel CPUE (2017-2021) (Source: DATRAS 2022)

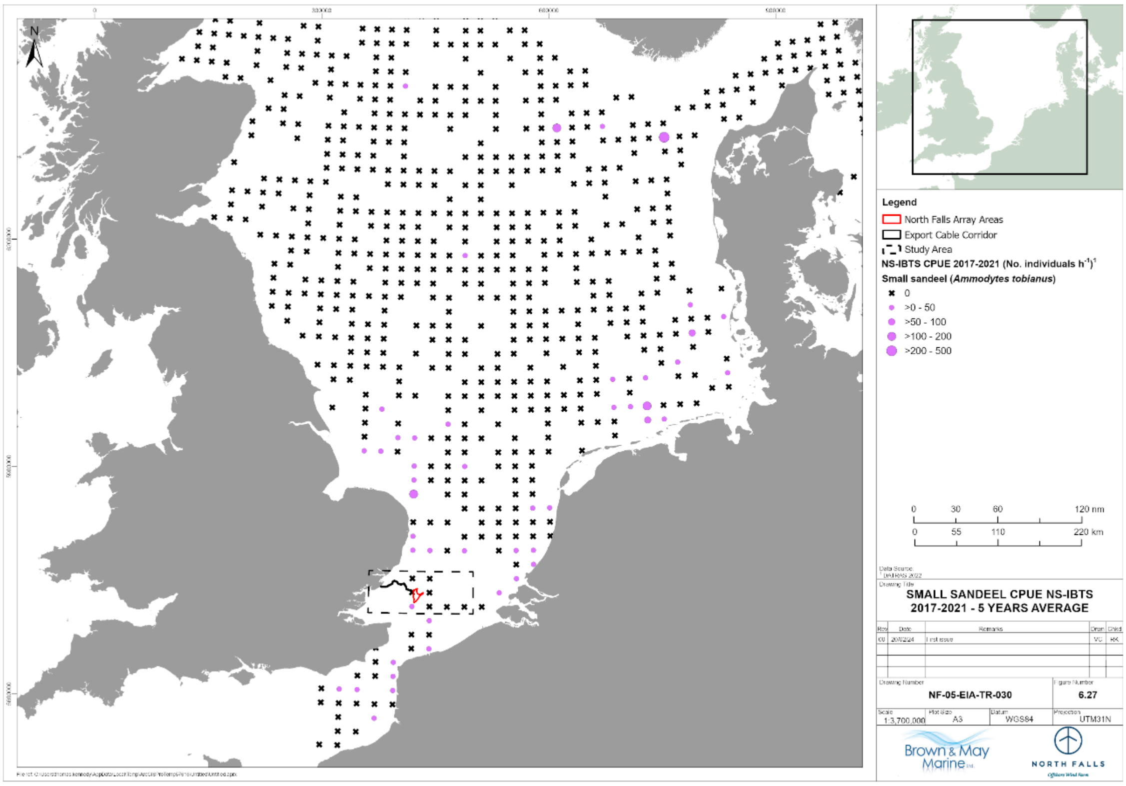

Figure 6.27 IBTS Small Sandeel CPUE (2017-2021) (Source: DATRAS 2022)

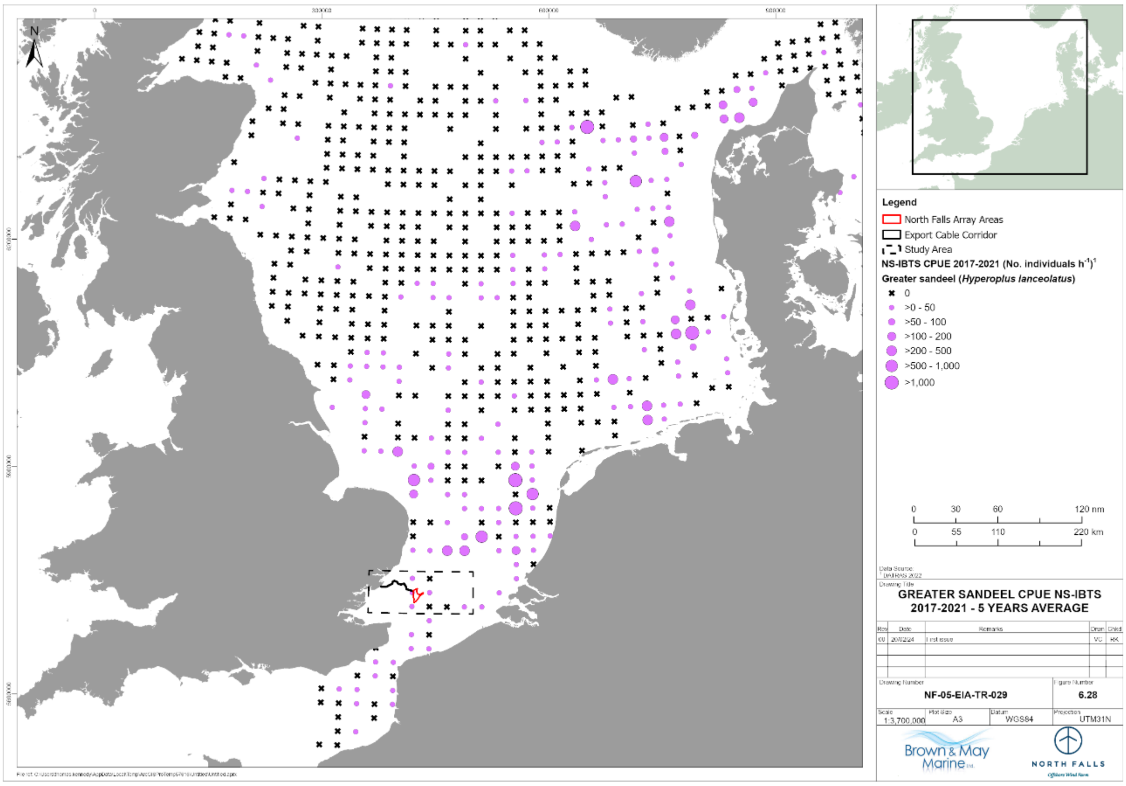

Figure 6.28 IBTS Greater Sandeel CPUE (2017-2021) (Source: DATRAS 2022)

6.2.1.7 Sea Bass

Young sea bass are often found schooling in shallow waters, estuaries and the lower reaches of rivers and are commonly seen in these areas in the KEIFCA district. Larger adults tend to be found on in deeper water but come closer inshore to warmer waters from March to Mid-June, peaking in May after spawning (KEIFCA 2022).

Being opportunistic feeders, sea bass consume a wide variety of prey. The consumption of fish increases with age (Cambiè et al 2016). Juveniles feed predominantly on invertebrates whereas, adult diets consist primarily of shrimps, molluscs and fishes.

Sea bass is of importance to commercial and recreational fisheries around the UK and has been recorded in the landings from the study area, particularly in rectangle 32F1 (Table 6.7). Due to concerns on the stocks both fisheries have been heavily regulated since 2017. Recreational fisheries, including from shore, are limited to catch-and-release during 1st January to 29th February and 1st to 31st December. In addition, from March to the end of November not more than two seabass may be retained per fishermen per day in recreational fisheries. Commercial fisheries are similarly restricted. In the southern North Sea (ICES Division IVc) commercial sea bass fishing is only permitted for certain methods (demersal trawls, seines, hooks and lines and fixed gillnets) with each method being subject to varying maximum catch restrictions and authorisation from the MMO required in the case of vessels using fixed gillnets, hooks and lines. In addition, the commercial fishery is closed from February to March for all methods (MMO 2021).

Sea bass was found in some numbers during otter trawl surveys undertaken in the Galloper Offshore Wind Farm and has been recorded in the study area by the IBTS (Table 6.6 and Figure 6.29).

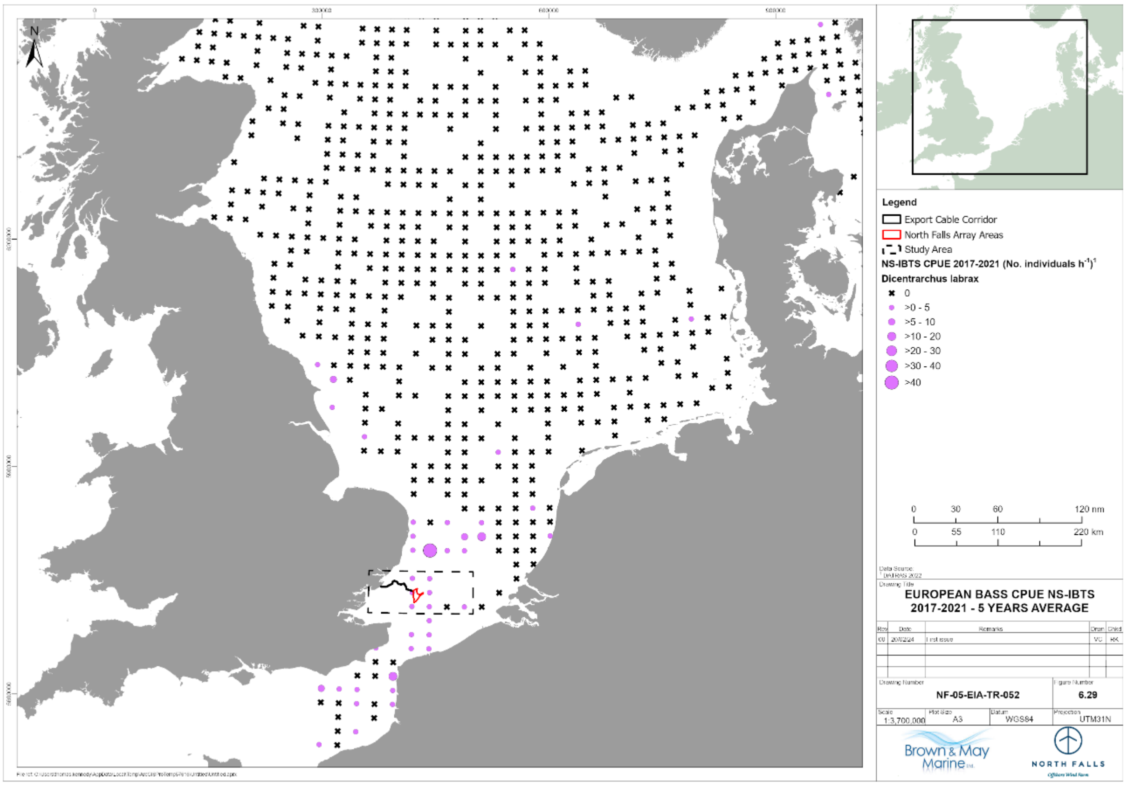

Figure 6.29 IBTS Sea Bass CPUE (2017-2021) (Source: DATRAS 2022)

6.2.1.8 Other Demersal Fish Species

Dab

Dab are the most abundant flatfish in the North Sea. They typically live at depths of 20 to 40m on sandy substrates but can be found at depths up to 150m (Maitland and Henderson 2009, Rijnsdorp Vethaak and van Leeuwen 1992). They feed on crustaceans, polychaetes, brittlestars, urchins and molluscs and other benthic invertebrates (Ruiz 2008).

Dab was one of the principal species caught in otter trawl surveys carried out in the Galloper Offshore Wind Farm (Table 6.2) and were recorded in some numbers in the 2-m scientific beam trawl surveys carried in the Galloper and Greater Gabbard Offshore Wind Farms (Table 6.3 and Table 6.4). In addition, they are one of the main species recorded by the IBTS in the study area (Table 6.6).

Gobies

Gobies are found along the British coast, generally in inshore waters, with many species found in estuarine conditions and in fresh water (Maitland and Henderson 2009). Females of most species lay their eggs on the seabed which are guarded by males, often on shells (Maitland and Henderson 2009). Sand goby was the most abundant species found during beam trawls surveys carried out in the Galloper Offshore Wind Farm (Table 6.3) and common goby one of the main species recorded in the beam trawls undertaken in the Greater Gabbard Offshore Wind Farm (Table 6.5). Other species of goby recorded during these surveys include black goby *Gobius nige,* Transparent goby *Aphia minuta,* rock goby *Gobius paganellus* and painted goby *Pomatoschistus pictus* (Table 6.3 and Table 6.5). In addition, both black goby and Lozano's goby *Pomatoschistus lozanoi*, was recorded within the study area in some numbers in the IBTS (Table 6.6). These are all small species of goby (less than 8 cm in length) that lay eggs on the seabed.

Gobies are important prey for a number of demersal fish species (Riley 2007) and some of the species found in areas of relevance to the offshore project area (common goby and sand goby) are protected under the Bern Convention (Table 6.11).

Gurnards

Various species of gurnard are expected to be found in the study area. Tub gurnard and grey gurnard were found in some numbers during the otter trawl surveys undertaken in the Galloper Offshore Wind Farm, particularly tub gurnard, with streaked gurnard *Chelidonichthys lastoviza* and red gurnard *Chelidonichthys cuculus* also recorded although in lower numbers. In addition, grey gurnard and tub gurnard were recorded in the study area during the IBTS, particularly in rectangle 32F2.

Grey gurnard is one of the main demersal species in the North Sea and is the most common gurnard. The species shows a seasonal shift in distribution forming local aggregations in the western part of the Central North Sea and north-west of the Dogger Bank in winter months, before widespread summer dispersal, including to the southern North Sea (ICES 2005e).

Tub gurnard and red gurnard are widely distributed throughout the North Sea (McCarthy and Marriott 2017, Barnes 2008b) whilst streaked gurnards prefer warmer waters and are only found in the southern North Sea during the summer. All species inhabit sand, muddy sand or gravel bottoms and feed on juvenile fish, crustaceans and invertebrates.

Gurnards are of limited commercial importance and are predominantly caught as a by-catch species in demersal fisheries. Tub gurnard are recorded in landings from the study area (primarily in ICES rectangle 32F2) although at low levels.

6.2.2 Pelagic Fish Species

6.2.2.1 Herring

Herring can be found throughout the North Sea (Figure 6.37) from the sea surface to depths of 200m. They have a broad distribution and migrate considerable distances in large shoals between their feeding and spawning grounds (Munro et al., 1998). Adults feed mostly on copepods but their diet also consists of small fish, arrow worms and ctenophores, whilst juveniles feed on Calanoid copepods, fish eggs, euphausiids, hyperiid amphipods and juvenile sandeels (ICES 2005f).

The North Sea autumn spawning stock consists of four major sub-populations, each defined by distinct spawning times and grounds (Dickey-Collas et al., 2010). These are the Orkney-Shetland, Buchan, Banks and Downs herring populations (Figure 6.31). The population of interest to the offshore project area is the 'Downs herring' which spawn in the southern North Sea and the English Channel between December and January. The other three autumn herring sub-populations spawn in the central-northern North Sea between August and September (ICES, 2021g). In addition, in the Greater Thames area, there is a discrete separate population of spring spawning herring which spawns in inshore areas around the Blackwater Estuary (Blackwater herring) (Figure 6.31)(Fox and Aldridge 2000).

Spawning takes place in well-oxygenated waters on gravel, coarse sand, small stones, maerl and shell, in areas with low proportions of fine sediment (Ellis et al., 2012). An indication of the suitability of the substrate across the offshore project area in terms of provision of herring spawning habitat is given in Figure 6.32 based on the habitat criteria developed for the aggregate industry by Reach et al (2013) (Table 6.15). This has been derived from PSA data from sediment samples collected across the offshore project area during the benthic baseline characterisation survey carried out in the offshore project area (Fugro 2021), as well as PSA data from Cefas' OneBenthic Portal. As shown, sediment was identified as "unsuitable" for herring spawning in the majority of stations.

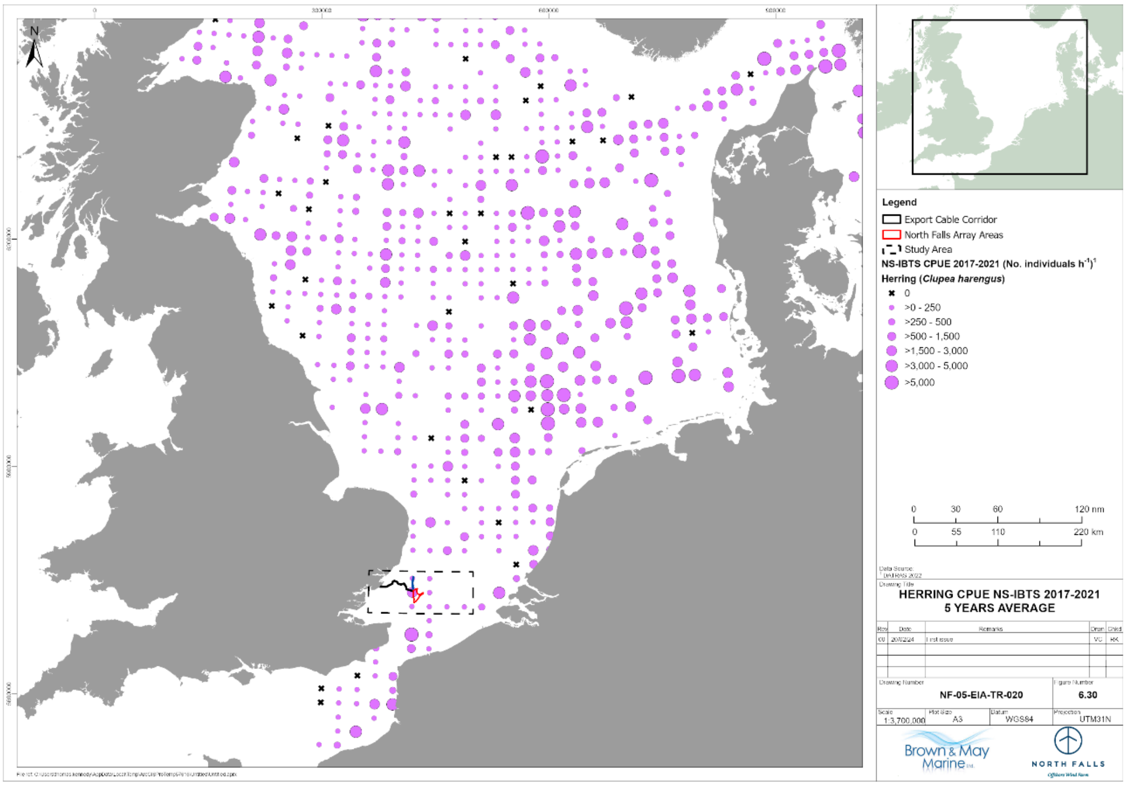

Figure 6.30 Average number (catch per standardised haul) of herring from IBTS data (2017-2021) (Source: DATRAS 2022)

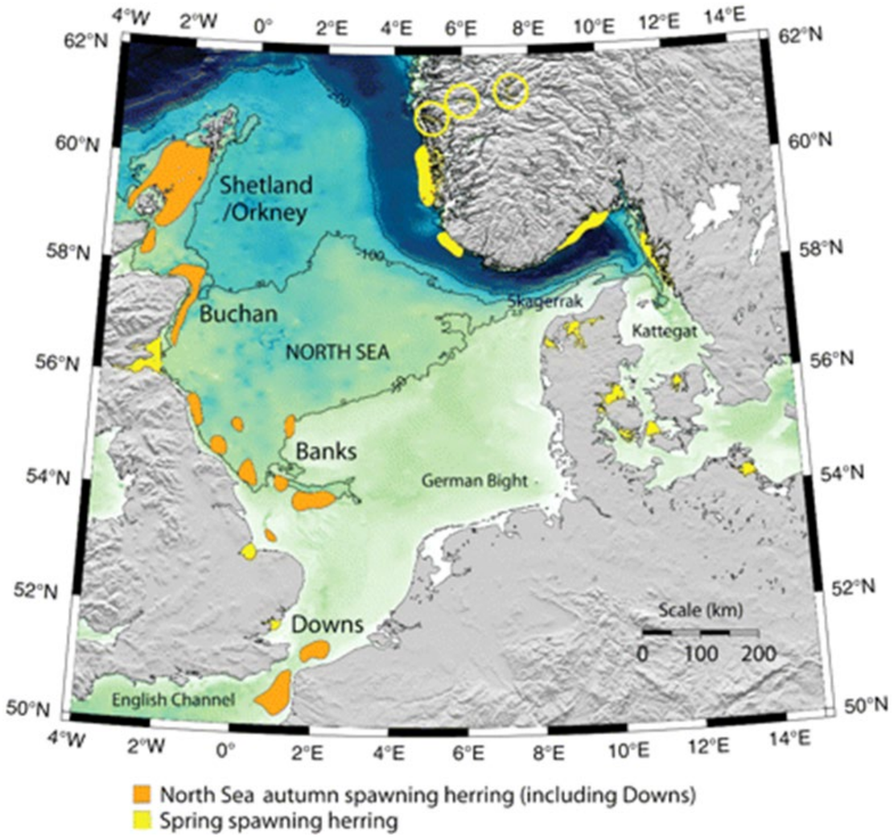

Figure 6.31 Atlantic Herring Spawning Sub-populations in the North Sea (Dickey-Collas et al 2010)

Table 6.15 The Partition of Atlantic Herring Potential Spawning Habitat Sediment Classes (Reach et al 2013)

% Particle contribution (Muds = clays and silts <63 µm)	Habitat sediment preference	Folk sediment unit
<5% muds, >50% gravel	Prime	Gravel and part sandy Gravel
<5% muds, >10% gravel	Sub-prime	Part sandy Gravel and part gravelly Sand
<5% muds, >25% gravel	Suitable	Part gravelly Sand
>5% muds, <10% gravel	Unsuitable	Everything excluding Gravel, part sandy Gravel and part gravelly Sand

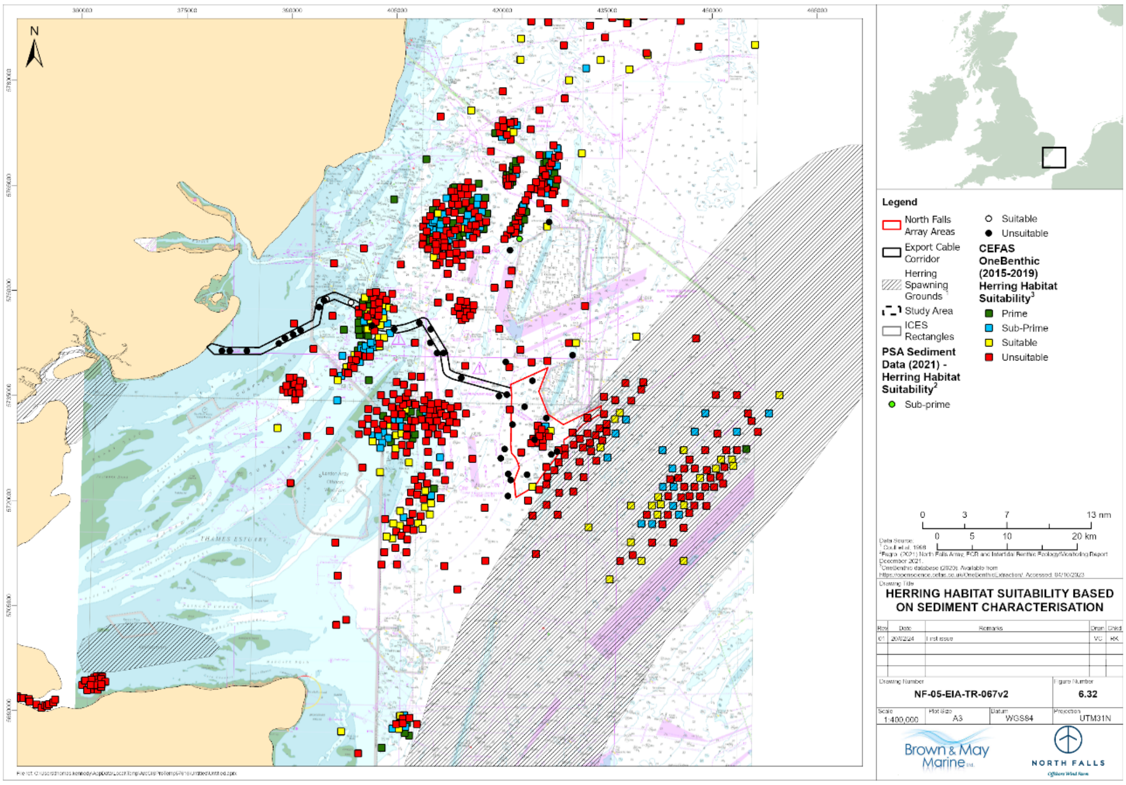

Figure 6.32 Herring Habitat Suitability for Spawning

As requested by the MMO during Scoping (Table 11.1, Fish and Shellfish Ecology, Volume 1), a herring spawning assessment has been undertaken using the MarineSpace Ltd (2013) guidance. The herring habitat assessment follows a similar methodology to the sandeel spawning assessment described in Section 6.2.1.6, producing a heat map indicating confidence in herring spawning habitat at a given location (Figure 6.33).

The spatial data sources used are referenced within MarineSpace et al. (2013b) and applied to this assessment as detailed in Table 6.14. Limitations associated with these data sources are discussed in detail in the MarineSpace et al. (2013b) guidance and incorporated into the resultant confidence scores. Table 6.14 also provides the herring confidence scores assigned to each data layer for the purposes of the assessment. The scoring methodology is provided within the MarineSpace et al. (2013b) guidance. The confidence scores represent the total normalised value for each dataset which is calculated using total weighted scores for the quality of evidence that each dataset represents (considering vintage, resolution, quality standards, and dataset source) and the suitability of the dataset as an indicator of herring spawning. The 'maximum possible data layer scores' are 13 for herring.

Table 6.16 Summary of Data and Confidence Scores for Herring Spawning Assessment

Data Source	Summary	Confidence Score
Sediment data – British Geological Survey (BGS) – 1:250,000 scale (BGS, 2023)	BGS sediment data was acquired for the study area, and categorises sediment types according to Folk (1954) classifications. The MarineSpace (2013b) guidance categorises the preference for herring spawning on a range from 'preferred' to 'unsuitable' based on Folk (1954) classifications: – Preferred habitat sediment class: Gravel and sandy Gravel; – Marginal habitat sediment class: gravelly Sand; and – Unsuitable habitat sediment class: all other Folk (1954) classifications.	Preferred = 3 Marginal = 2
Fisheries data – Danish Vessel Monitoring System (VMS) data (2014-2018)	Satellite tracking data (Vessel Monitoring System (VMS) recorded in 0.05° by 0.05° grids from Danish vessels in UK and European waters. VMS data is combined with log book data with values assigned to each cell in the grid in terms of effort and value (£). Fishing by pelagic gears are considered an indicator of herring spawning habitat. However, it should be noted that the confidence in this data is relatively low as these fishing methods may target a range of species.	2
Spawning grounds – Coull et al. (1998)	Indicative spawning and nursery ground locations and timings around UK waters for herring.	3
International Herring Larvae Survey (IHLS) data (2008 – 2017) (ICES, 2023)	The ICES programme of IHLS in the North Sea and adjacent areas has been in operation since 1967. The main purpose of this programme is to provide quantitative estimates of herring larval abundance, which are used as a relative index of changes of the herring spawning-stock biomass. This dataset also provides information regarding the number of larvae present within the areas surveyed during the IHLS survey campaigns. The number of larvae < 10 mm in length represent the number of 'newly hatched' larvae, and this	5

Data Source	Summary	Confidence Score
	can be used to inform the location or intensity of spawning grounds (ICES, 2022). IHLS data from 2008 – 2017 has been analysed in accordance with the Marine Space (2013a) guidance to create a contour plot by interpolating the maximum number of larvae per m^2 at each sample station and assigning values between sample points. Four percentiles categories were used for the contour plots (plus zero). More recent IHLS data after 2017 does not include the 'number of larvae caught per m^2 and therefore cannot be analysed in the same way.	

The herring habitat assessment concluded that the array area is situated in an area of "low" to "high" confidence in herring spawning, with confidence in herring spawning increasing in the northern sections of the array area. The nearshore section of the offshore cable corridor is situated in an area of "low" confidence in terms of herring spawning, with confidence in spawning increasing moving further offshore.

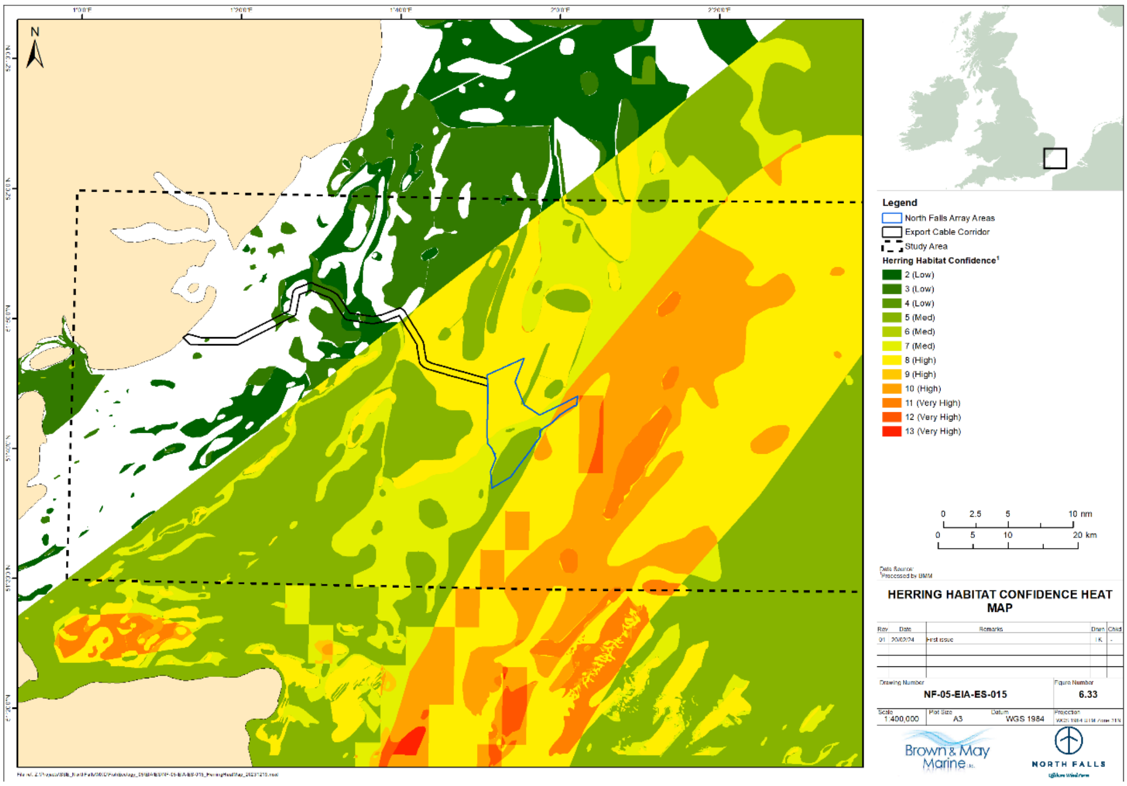

Figure 6.33 Herring Habitat Confidence Heat Map

The distribution of herring spawning grounds in the North Sea as defined in Coul et al (1998) and Ellis et al (2010) is illustrated in Figure 6.34. As shown, a small section of the array area overlaps with one of the discrete spawning grounds of the Downs herring and there is some overlap between the offshore cable corridor and high intensity nursery grounds defined for the species (Coull et al 1998, Ellis et al 2010).

More recent data on the distribution of the Downs herring spawning activity is provided in Figure 6.35 and Figure 6.36, based on data collected during International Herring Larval Survey (IHLS). This covers available data from surveys carried out over the months of December and January from 2012 to 2022. It should be noted that as outlined in Table 3.1, available data from recent years is quite patchy with no data available from December 2017 to January 2019. As shown, herring larvae have been consistently recorded in the spawning grounds east of the offshore project area during the IHLS (Figure 6.35 and Figure 6.36).

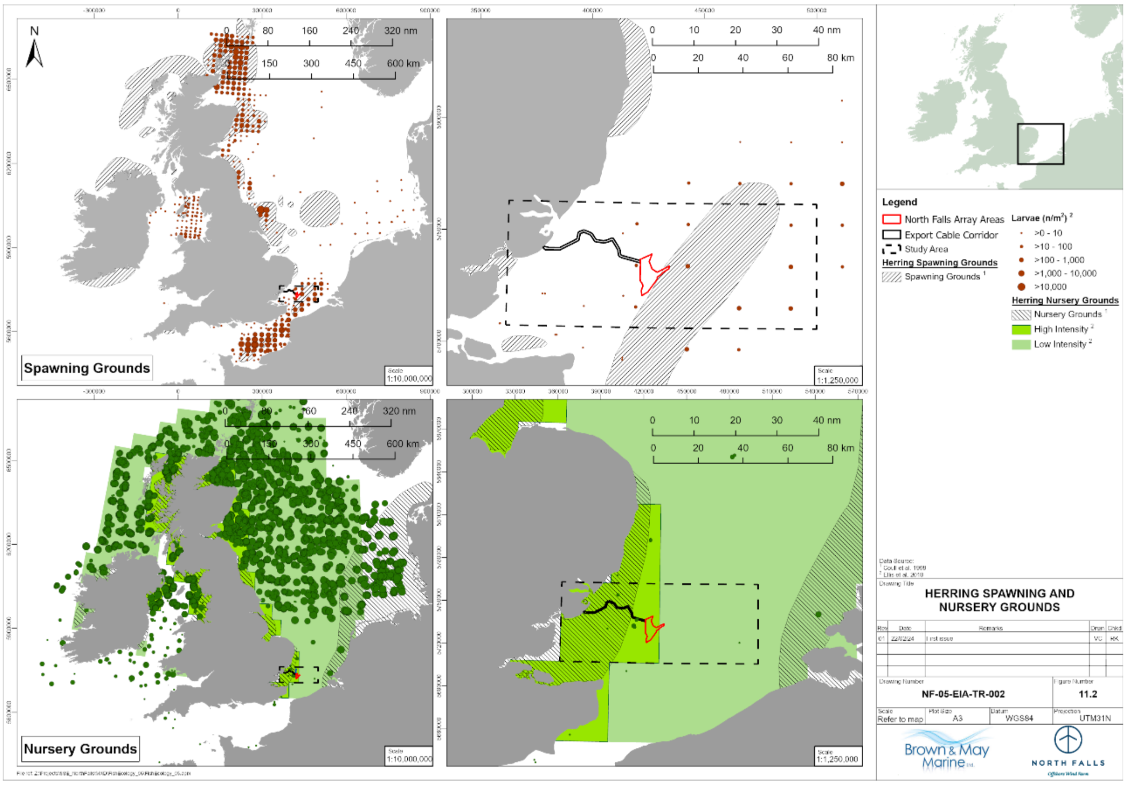

Figure 6.34 Herring Spawning and Nursery Grounds (Source: Coull et al 1998, Ellis et al 2010)

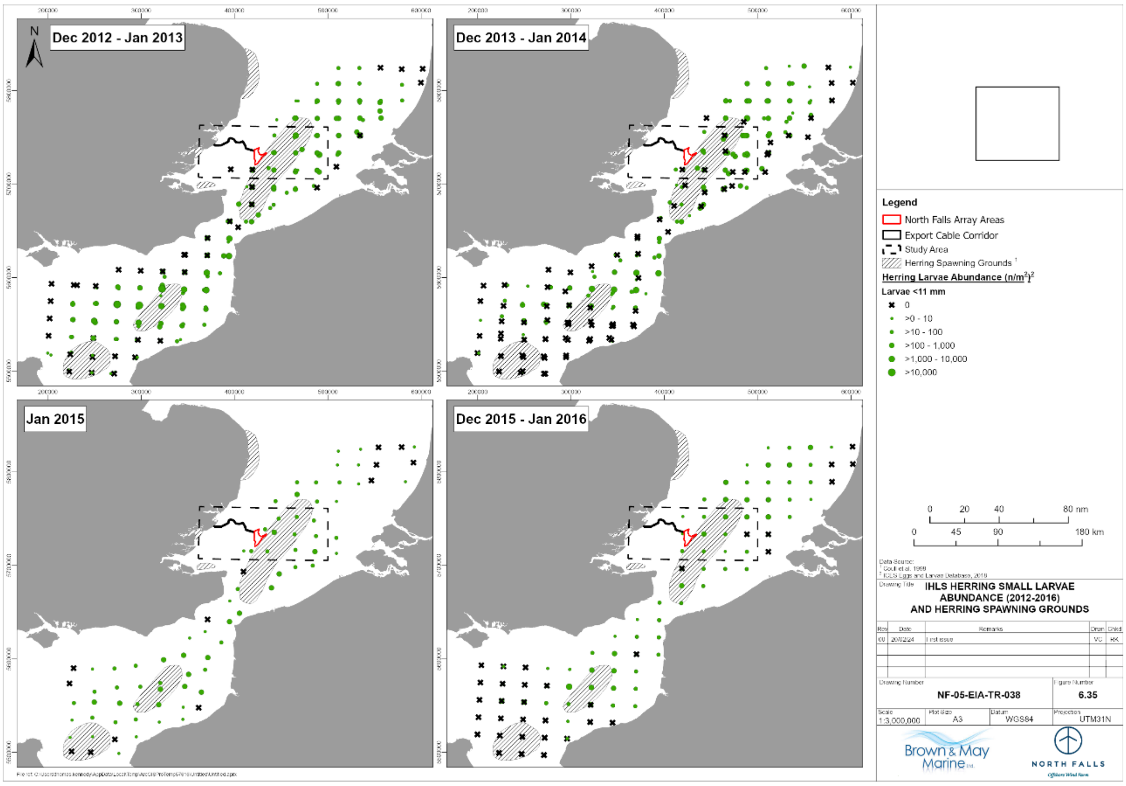

Figure 6.35 IHLS Herring Small Larvae Abundance (n/m²) (December 2012 to January 2016)

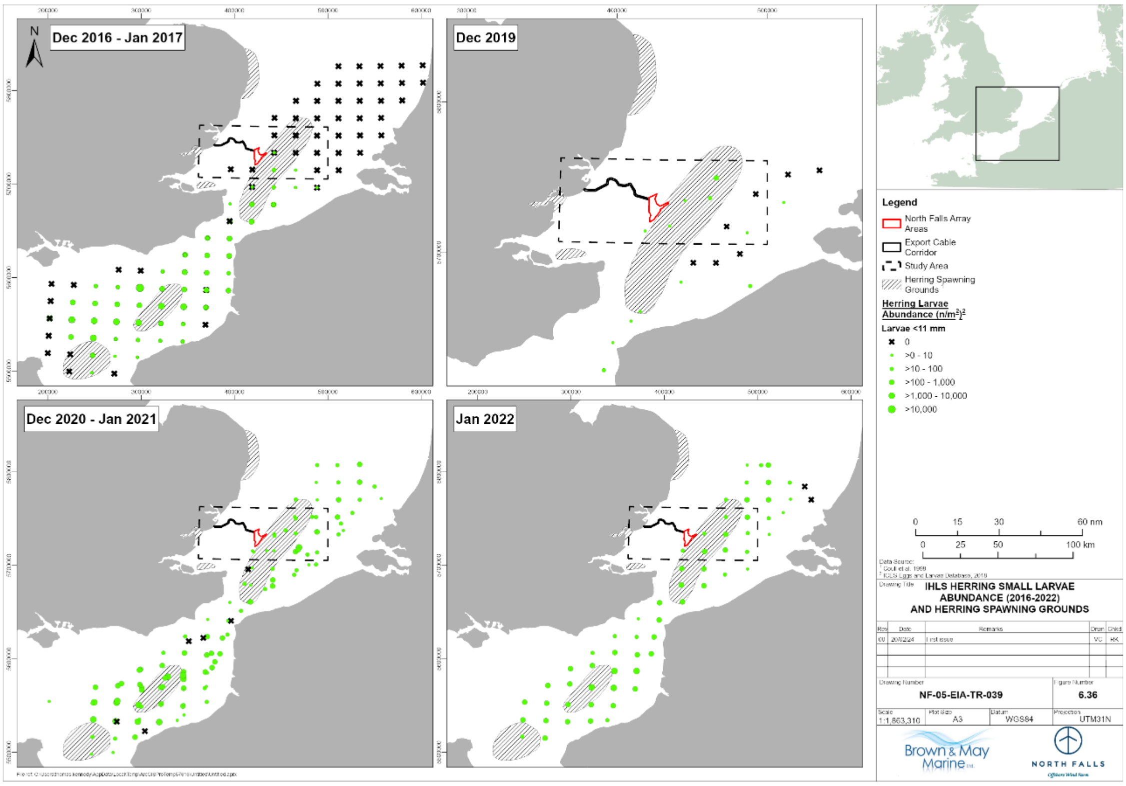

Figure 6.36 IHLS Herring Small Larvae Abundance (n/m²) (December 2016 to January 2022)

Whilst demersal trawl gear is not specifically designed to target pelagic species such as herring, they were recorded in the otter trawl surveys carried out in the Galloper Offshore Wind Farm (Table 6.2) and found in some numbers in the study area during the IBTS, particularly in ICES rectangle 32F1, where the majority of the offshore project area is located (Table 6.6).

Herring is of commercial importance in the study area (contributing 1.7% and 5.4% total landings by weight in ICES rectangles 32F1 and 32F2 respectively) (Table 6.7). In addition, as mentioned in Section 6.1.5.4, herring plays an important role in the North Sea's foodweb being an important prey item for many fish species, seabirds and marine mammals and is of conservation interest, being listed as a Species of Principal Importance (Table 6.11).

6.2.2.2 Sprat

Sprat are small schooling clupeids that are common in the North Sea, particularly around the Dogger Bank and the Kattegat (ICES 2005g). They typically live within shallow waters and coastal areas, feeding on plankton such as diatoms, copepods and crustacean larvae, as well as fish eggs (Dickmann et al 2007, Koster et al 2007).

Spawning occurs over broad areas, between May and August, peaking in May and June (Coull et al 1998;). The array area and a small section of the offshore cable corridor overlap with the wide spawning grounds that have been defined for sprat (Coull et al 1998) (Figure 6.38). In addition, the full offshore project area overlaps within the wide nursery grounds of this species (Coull et al 1998) (Figure 6.38).

Sprat was found in the study area during the IBTS, particularly in ICES rectangle 32F1 (Table 6.6). In addition, as mentioned in Section 6.1.5.4, this species plays an important role in the North Sea's foodweb being an important prey item for many fish species, seabirds and marine mammals.

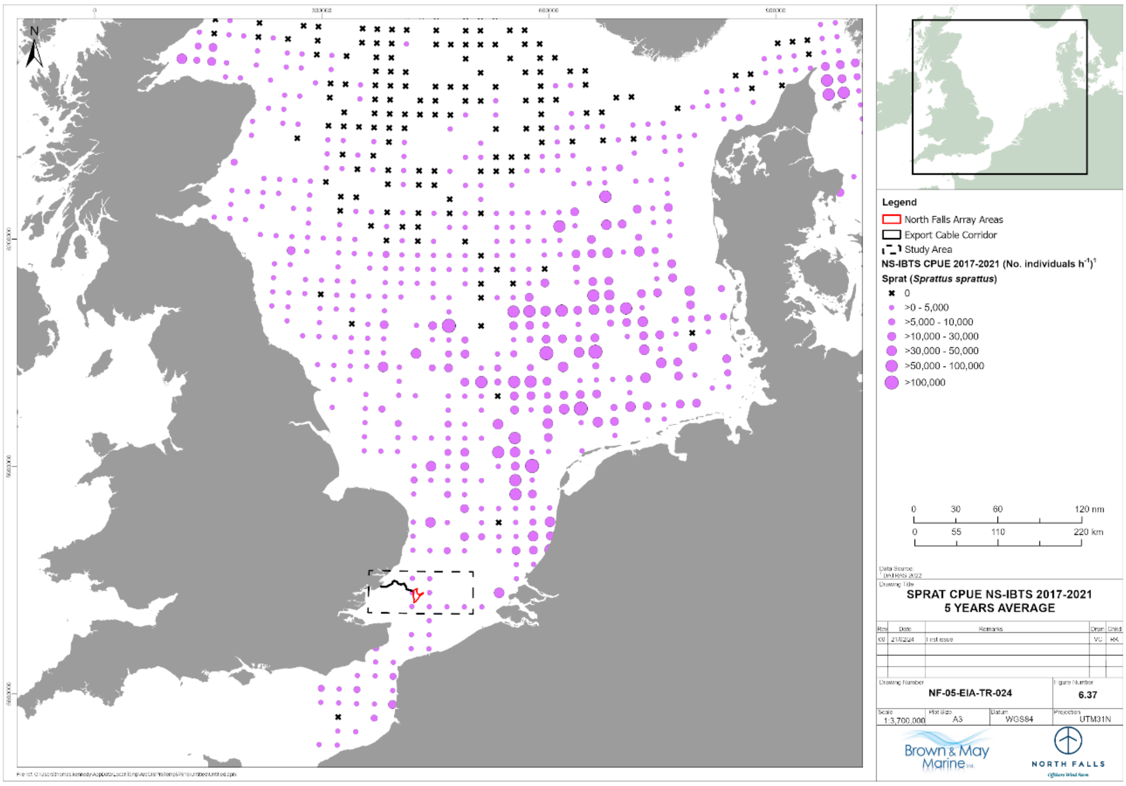

Figure 6.37 IBTS Sprat CPUE (2017-2021) (Source: DATRAS 2022)

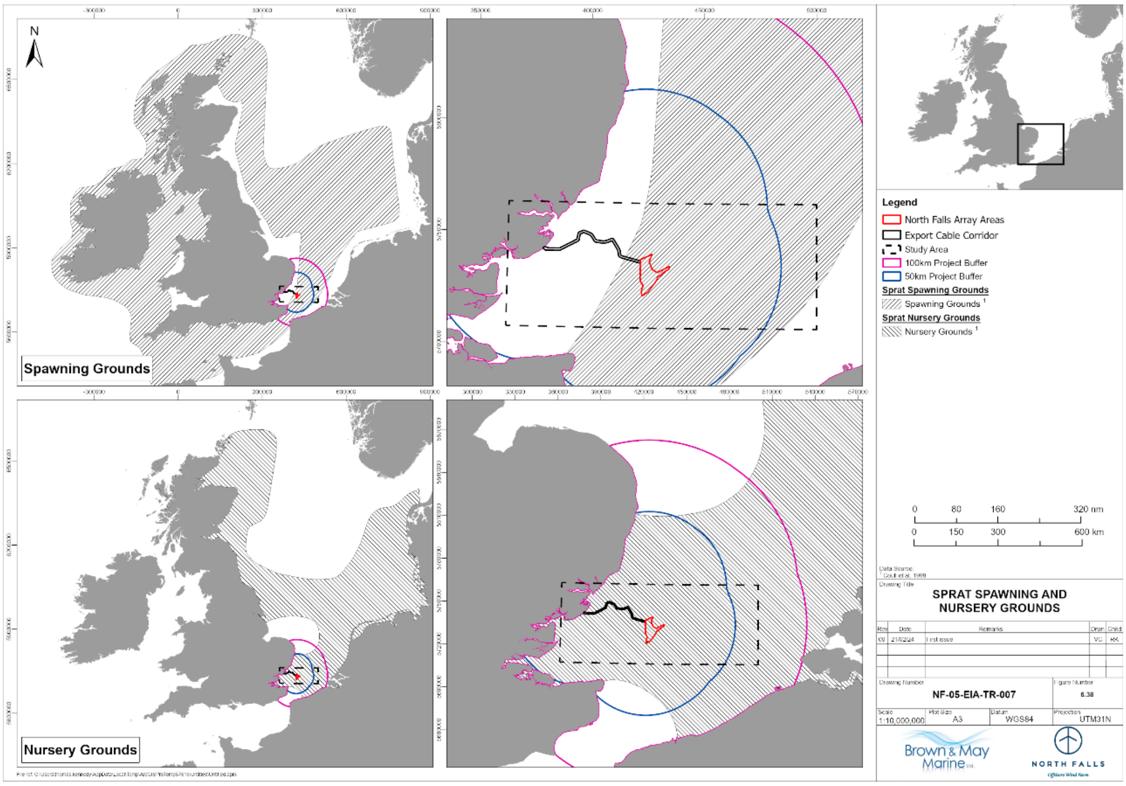

Figure 6.38 Sprat Spawning and Nursery Grounds (Source: Coull et al 1998)

6.2.2.3 Horse Mackerel

Horse mackerel are schooling fish that are widespread and abundant in the North Sea (Barnes 2008f, Figure 6.39). They largely prey on smaller fish such as young herring, cod and whiting.

The North Sea stock spawns in the southern North Sea, off the coast of Belgium and northern France between May and June and migrates south-west towards warmer waters in the English Channel and Celtic Seas during the winter (ICES 2005i).

Horse mackerel is of commercial importance in the study area, particularly in rectangles 32F1 and 32F2 where it contributes by 3.5% and 6.7% to the overall landings by weight, respectively (Table 6.7). In addition, it is a species considered of Principal Importance (Table 6.11) and was found in high numbers during the IBTS survey in the study area, particularly in rectangle 32F2 (Table 6.6, Figure 6.39).

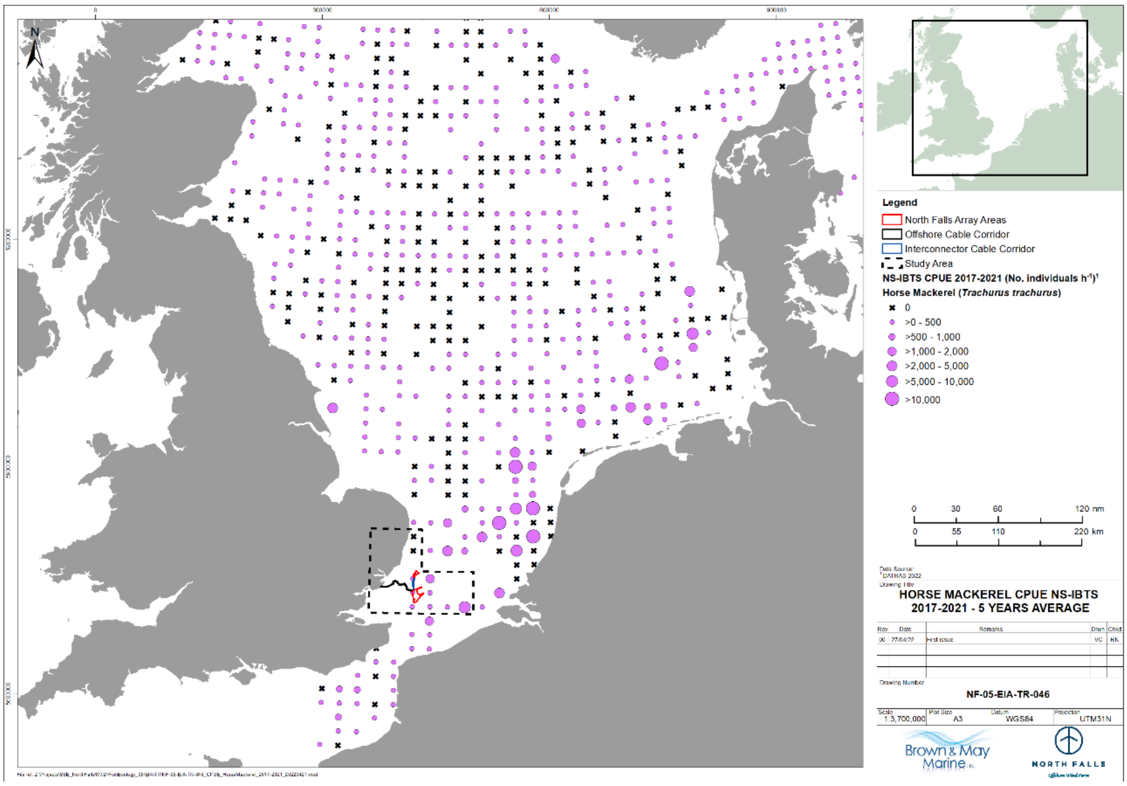

Figure 6.39 IBTS Horse Mackerel CPUE (2017-2021) (Source: DATRAS 2022)

6.2.2.4 Mackerel

Mackerel are wildly distributed in the North Sea and are usually found at depths of less than 200m (Barnes 2008e). Adult mackerel feed on smaller fish such as sprat, herring and sandeels and pelagic crustaceans such as prawns, whereas juvenile mackerel feed on larvae of fish and crustaceans (ICES 2005h, Skaret et al 2015).

Mackerel overwinter in Norwegian sea and northern North Sea between November and early March (Jansen et al., 2012). In the spring, they migrate back south in time to spawn and feed in the central North Sea in the summer before moving north again for the winter (ICES 2005h).

In the North Sea, mackerel spawning occurs from May to August, peaking between May and July (Ellis et al 2010). Spawning and nursery grounds defined for this species extend over wide areas of North Sea. As shown in Figure 6.41, the offshore project area does not overlap with mackerel spawning grounds, however, it overlaps with the broad low intensity spawning grounds identified for this species in the southern North Sea.

In addition, mackerel is a Species of Principal Importance (Table 6.11) and has been recorded during the IBTS within the study area in some numbers, particularly in rectangles 32F1 and 32F2 (Table 6.6, Figure 6.40).

Mackerel is a species of commercial importance in the North Sea however they do not contribute significantly to the overall landings from the study area (Table 6.7).

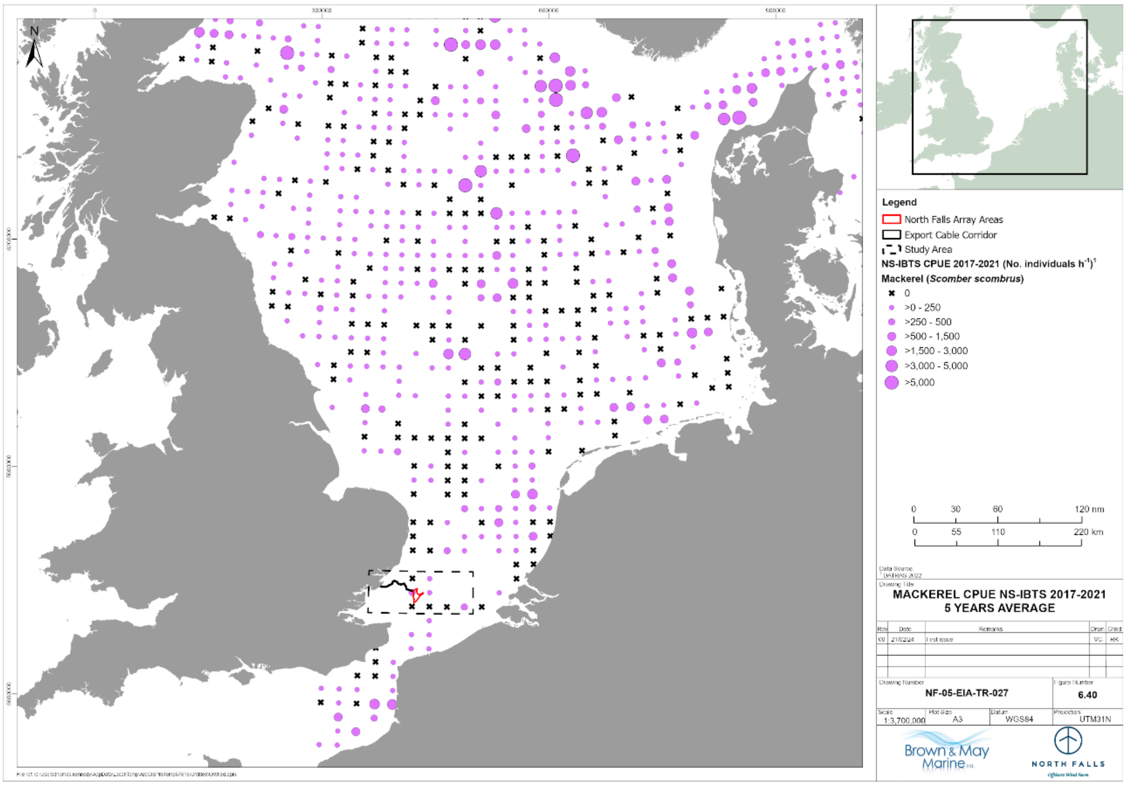

Figure 6.40 IBTS Mackerel CPUE (2017-2021) (Source: DATRAS 2022)

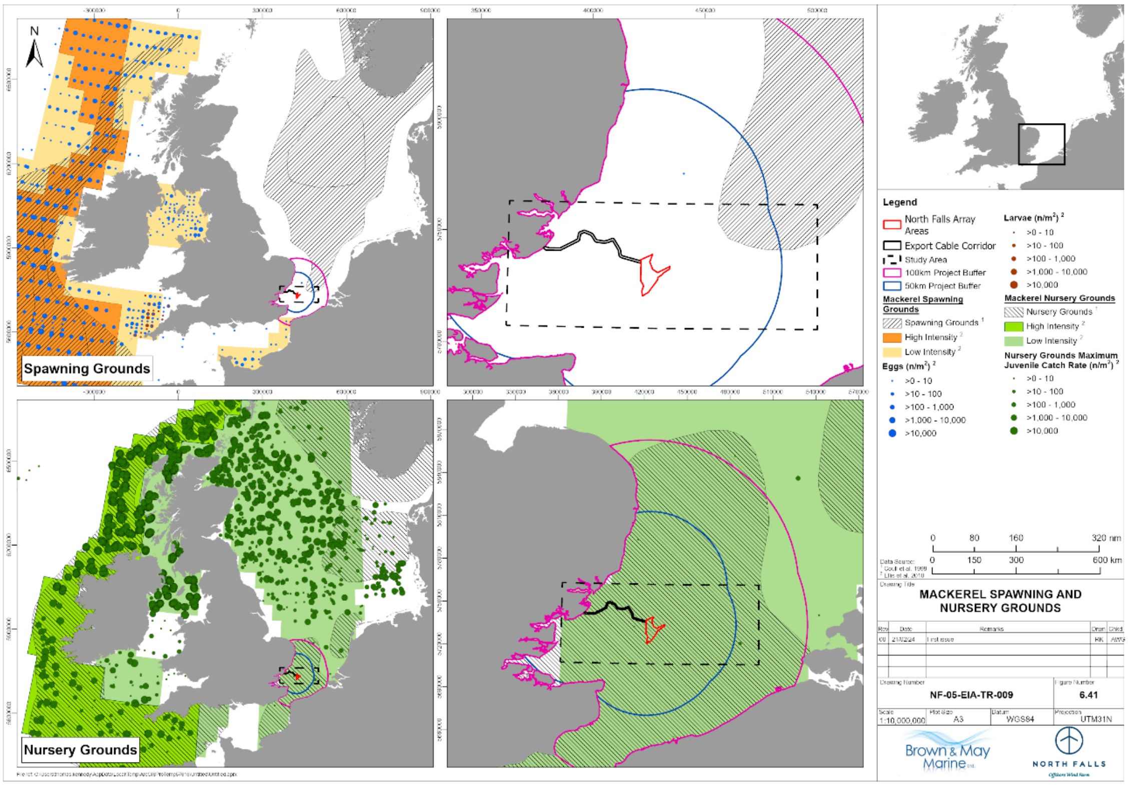

Figure 6.41 Mackerel Spawning and Nursery Grounds (Source: Coull et al 1998, Ellis et al 2010)

6.2.3 Elasmobranchs

6.2.3.1 Skates and Rays

Thornback ray

Thornback ray are common and widespread across the North Sea and are typically found in shallow waters between 10 and 60m (Snowdon 2008). Their slow growth rate, late maturity and low fecundity has rendered them vulnerable to fishing over-exploitation and they are less abundant and widespread as they once were (Chevolot et al 2006). Within the North Sea they are now most abundant in the south-western North Sea. An indication of the current distribution of thornback ray in the North Sea is provided in Figure 6.42 based on recent IBTS data.

They inhabit a broad range of fine sediment types including mud, sand, shingle and gravel, and are found less frequently on coarser sediments (Peverley and Stewart 2021). Adult thornback rays are feeding generalists, eating larger crustaceans, polychaetes, cephalopods and fish, whereas juveniles eat smaller crustaceans such as amphipods and mysids (Šantić et al 2012).

Thornback rays take nine to twelve years to mature, moving to shallower inshore waters to spawn in the spring between February and October, with peak spawning between April and July (Ellis et al 2012). Eggs take around 6 months to hatch with the juveniles using shallow coastal waters as nursery grounds for around two years before moving to deeper offshore water (Peverley and Stewart 2021).

As shown in Figure 6.43, the offshore project area overlaps with low intensity nursery grounds identified for thornback ray. It should be noted that spawning and nursery grounds for this species are considered to broadly overlap (Ellis et al 2012).

Thornback ray is of commercial importance in the study area and is predominantly landed from rectangle 32F1 (Table 6.7). In addition, this species was found in relatively high numbers in the otter trawl surveys carried out in the Galloper Offshore Wind Farm (Table 6.2) and in the elasmobranch surveys undertaken in the Greater Gabbard Offshore Wind Farm (Table 6.5). Similarly, it was found in some numbers in the study area during the IBTS, particularly in rectangle 31F1.

Thornback ray is included in the OSPAR list of threatened and/or declining species and has been classified as ‘Near Threatened’ by the IUCN (Table 6.10).

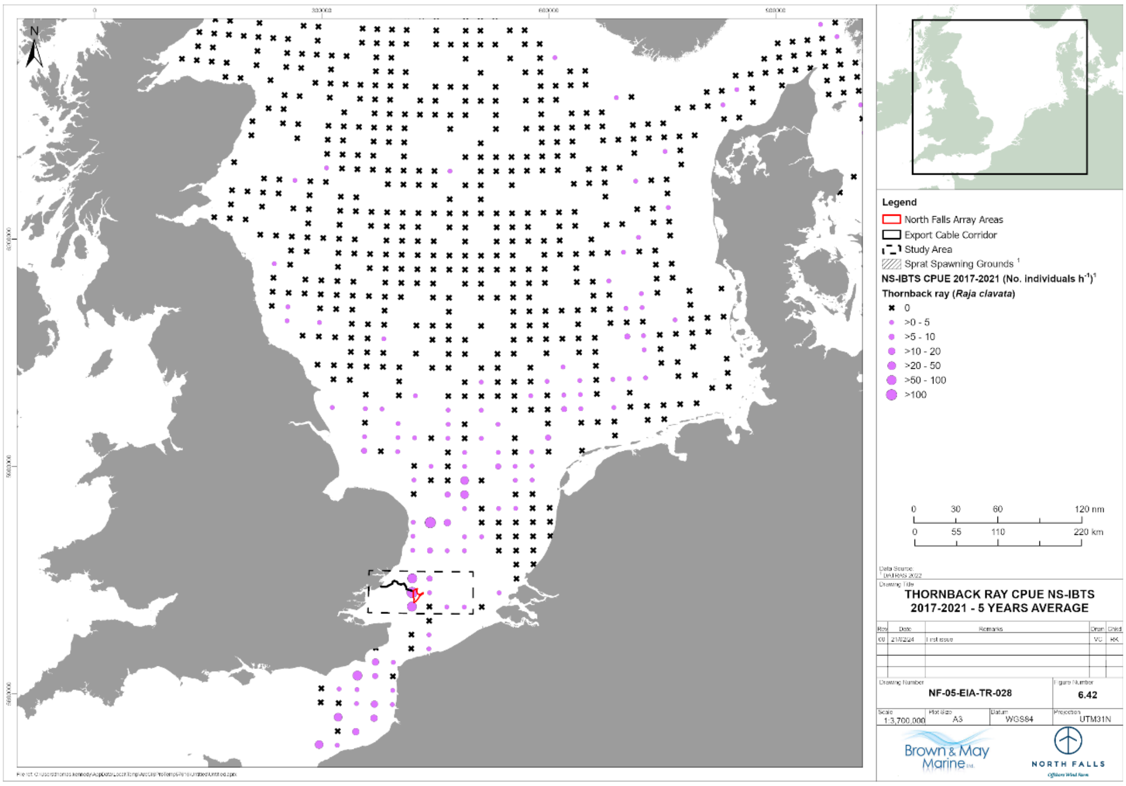

Figure 6.42 IBTS Thornback Ray CPUE (2017-2021) (Source: DATRAS 2022)

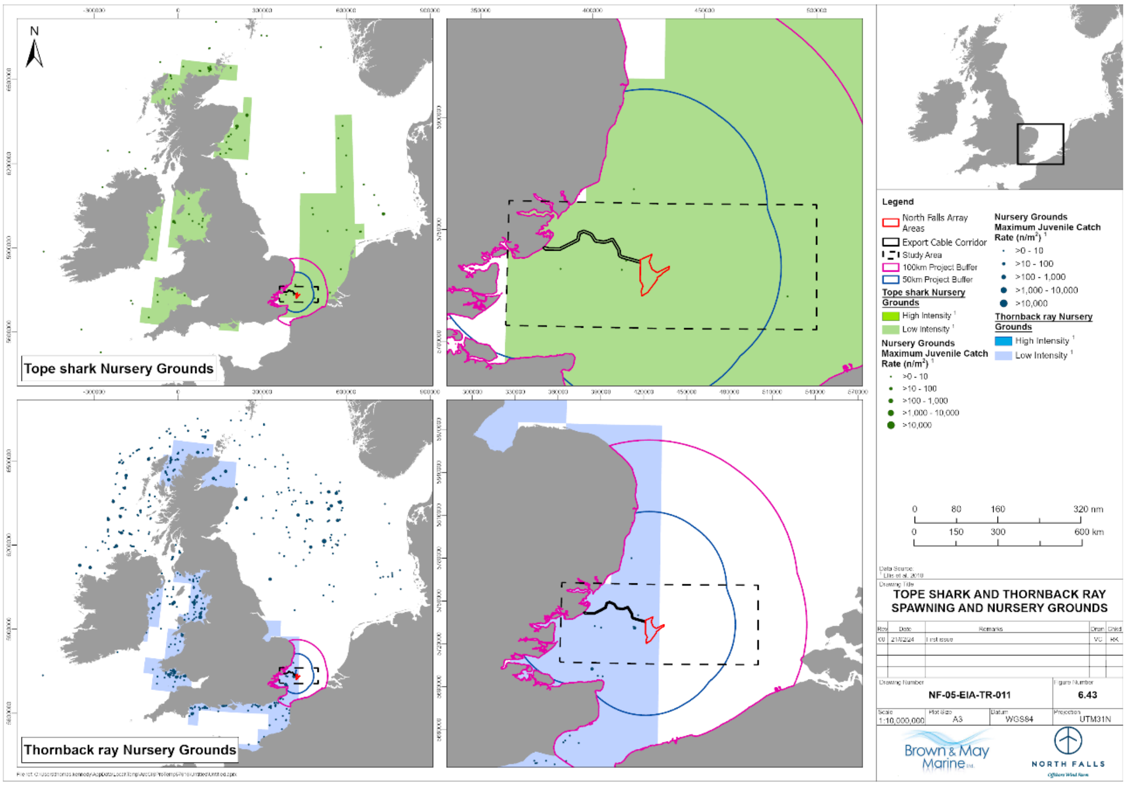

Figure 6.43 Tope and Thornback Ray Nursery Grounds (Source: Ellis et al 2010)

Spotted Ray

Spotted ray *Raja montagui* are found in moderately deep waters, ranging between 8 and 500m, most commonly on sandy and muddy sediment (Ellis et al 2005, Sguotti et al 2016, Gibson-Hall 2018a). They feed primarily on crustaceans, amphipods, isopods, polychaetes and shrimps (Gibson-Hall 2018a).

The distribution of spotted ray around the UK follows a similar trend to that of thornback ray (Ellis et al 2005, Sguotti et al 2016) (Figure 6.44). Nursery grounds for spotted ray are normally located in shallow waters, also broadly sharing a similar nursery ground to thornback rays (Ellis et al 2005, Stelzenmüller and Rogers 2010, Sguotti et al 2016).

Spotted rays are of conservation importance being included in the OSPAR list of threatened and/or declining species (Table 6.10) and were found in some numbers in the study area in the IBTS, particularly in rectangles 32F1 and 32F2 (Table 6.6).

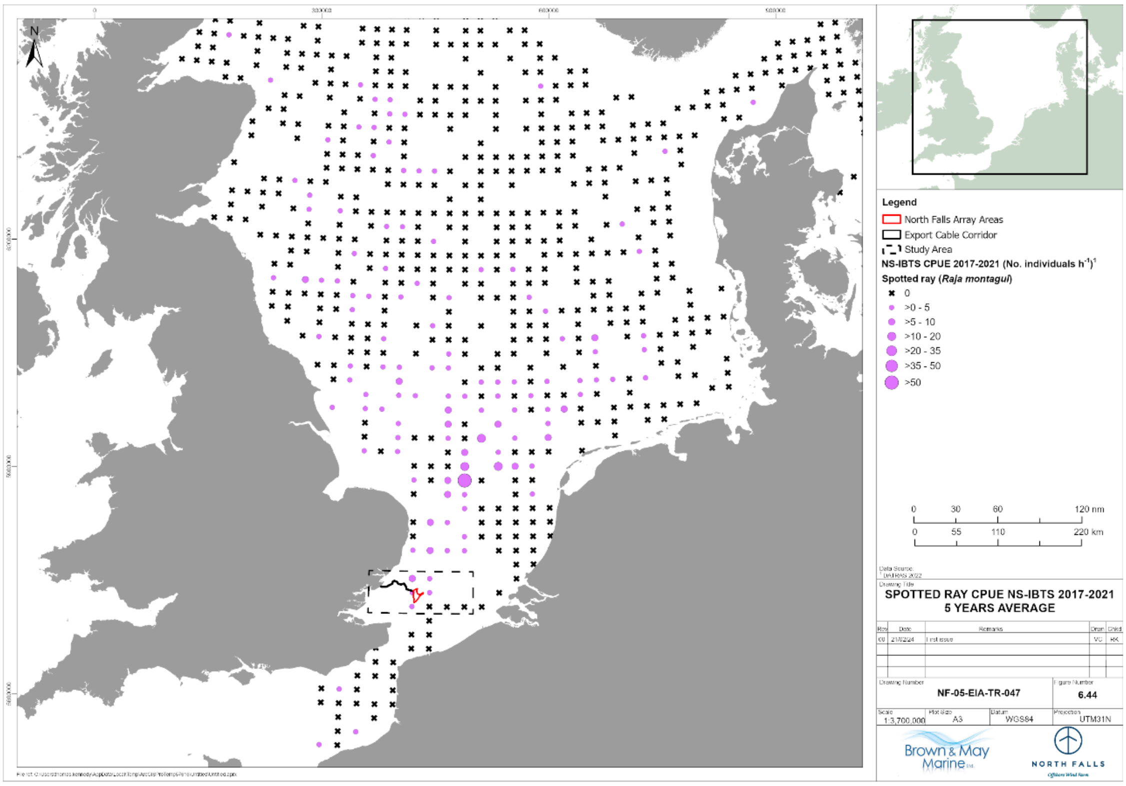

Figure 6.44 IBTS Spotted Ray CPUE 2017-2021) (Source: DATRAS 2022)

Blonde Ray

Blonde ray *Raja brachyura* live in shallow coastal waters on sandy substrate at depths of less than 150m (Ebert & Stehmann 2013, Gibson-Hall 2018b). The UK is at the northern extent of their range so they are mainly found in the southern and west of England (Ellis et al 2005). Adults feed on fish such as sandeels, herring, sprat and bib whereas juveniles feed upon crustaceans (Ebert and Stehmann 2013). They spawn in April to September, producing around 30 eggs which take around seven months to hatch (Ebert and Stehmann 2013, Small 2021a).

Blonde ray is a species of conservation interest, being classified as 'Near Threatened' by IUCN (Table 6.10). In addition, it was found in some number in the IBTS in the study area and was recorded during the otter trawl surveys carried out in the Galloper Offshore Wind Farm (Table 6.2, Table 6.6 and Figure 6.45).

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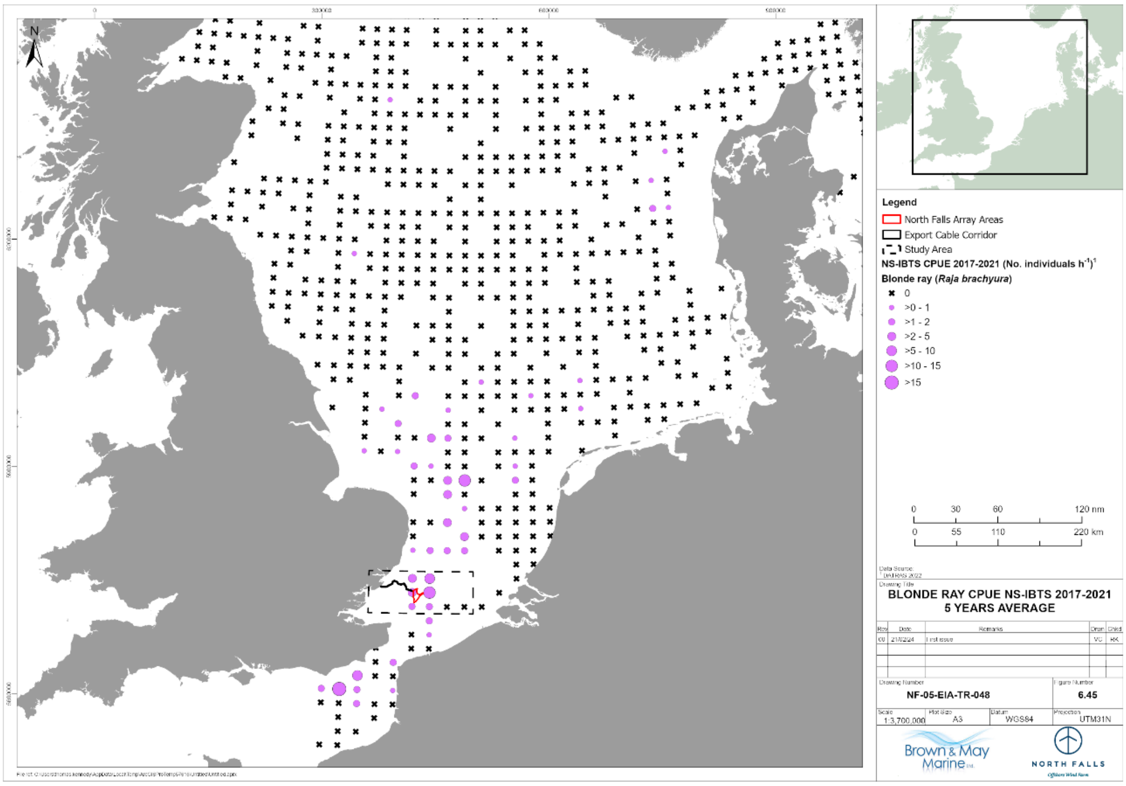

Figure 6.45 IBTS Blonde Ray CPUE (2017-2021) (Source: DATRAS 2022)

Common Skate

The common skate complex was once the most abundant ray species in the north-east Atlantic but with a broad distribution around the UK. At present, they have largely disappeared from the English Channel, Irish Sea and the southern and central North Sea (ICES, 2012).

The common skate complex is classified as 'Critically Endangered' by IUCN (Table 6.10). In addition, it is listed as a Species of Principal Importance and in the OSPAR list of threatened and/or declining species (Table 6.10). The landing of common skate complex by commercial vessels has been prohibited since 2009 (Garbett et al 2021).

6.2.3.2 Sharks

Small Spotted Catshark

Small spotted catshark, also known as lesser spotted dogfish, are widespread and abundant in the North Sea. They inhabit muddy and sandy substrates as well as rocky reefs to depths of 100m (Pizzolla 2008). They feed on a range of species including crabs, shrimps, molluscs, polychaetes and benthic fish. They spawn year-round but the peak egg laying season is between May and July, with the eggs hatching after around 5-8 months (Small 2021b).

They were the most abundant elasmobranch caught during the elasmobranch survey carried out in the Greater Gabbard Offshore Wind Farm and have been recorded in high numbers in the study area during recent IBTS sampling (Table 6.2, Table 6.5 and Figure 6.46). In addition, they were one of the main species found in the otter trawl surveys carried out in the Galloper Offshore Wind Farm and was recorded in beam trawl surveys carried out in both Galloper and Greater Gabbard (Table 6.3 and Table 6.4).

They are not generally a key target species in commercial fisheries being usually caught as bycatch in demersal fisheries and discarded.

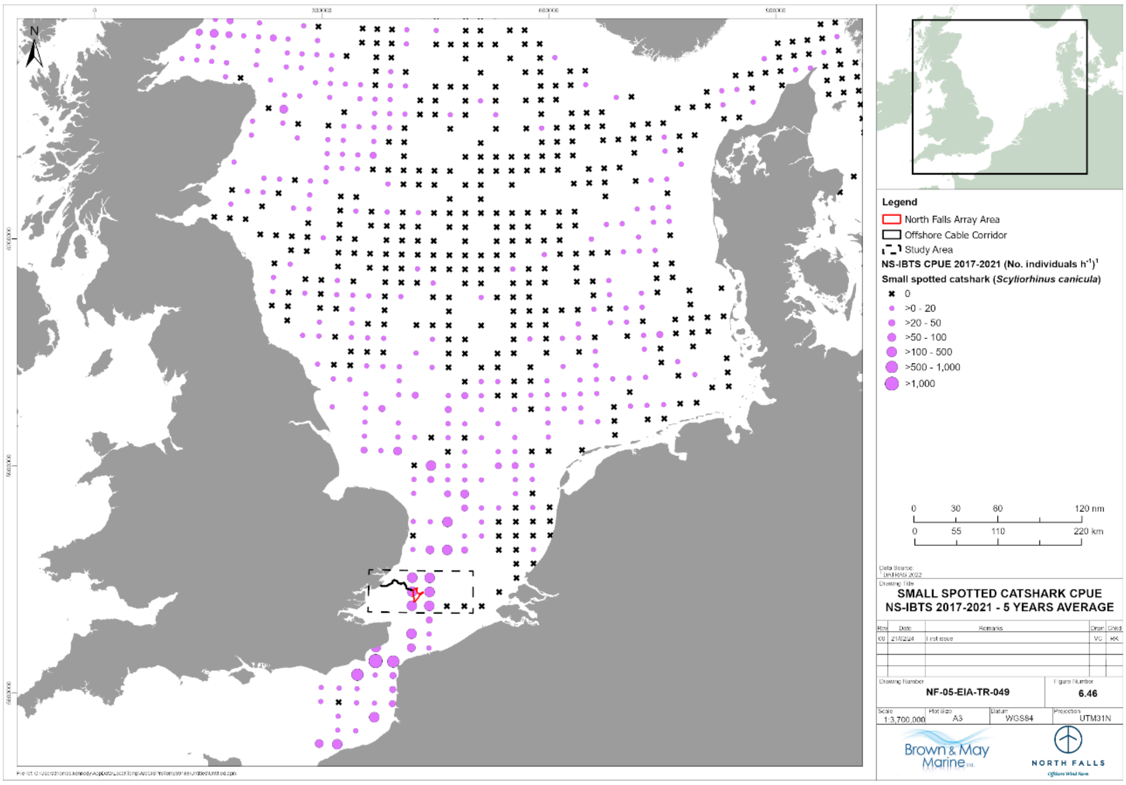

Figure 6.46 IBTS Small Spotted Catshark CPUE (2017-2021) (Source: DATRAS 2022)

Smoothhounds

Smoothhounds (*Mustelus* spp.) can be found down to 50m and feed primarily on crustaceans, including hermit crabs, flying crabs, edible crabs and velvet swimming crabs (Phillips et al 2019).

There are two species in the North Sea; the starry smoothhound and the smoothhound, with the starry smoothound being the most abundant. These species were found in some numbers in the Galloper Offshore Wind Farm otter trawl surveys and in the elasmobranch surveys undertaken in the Galloper Offshore Wind Farm (Table 6.2 and Table 6.5). In addition, they were found in some numbers in the IBTS (Table 6.6 and Figure 6.47).

Smoothounds have been reported in commercial landings from the study area, although at relatively low levels (Table 6.7). Both species are of conservation interest, with the starry smoothhound classified by IUCN as 'Near Threatened' and the smoothhound as 'Endangered' (Table 6.10).

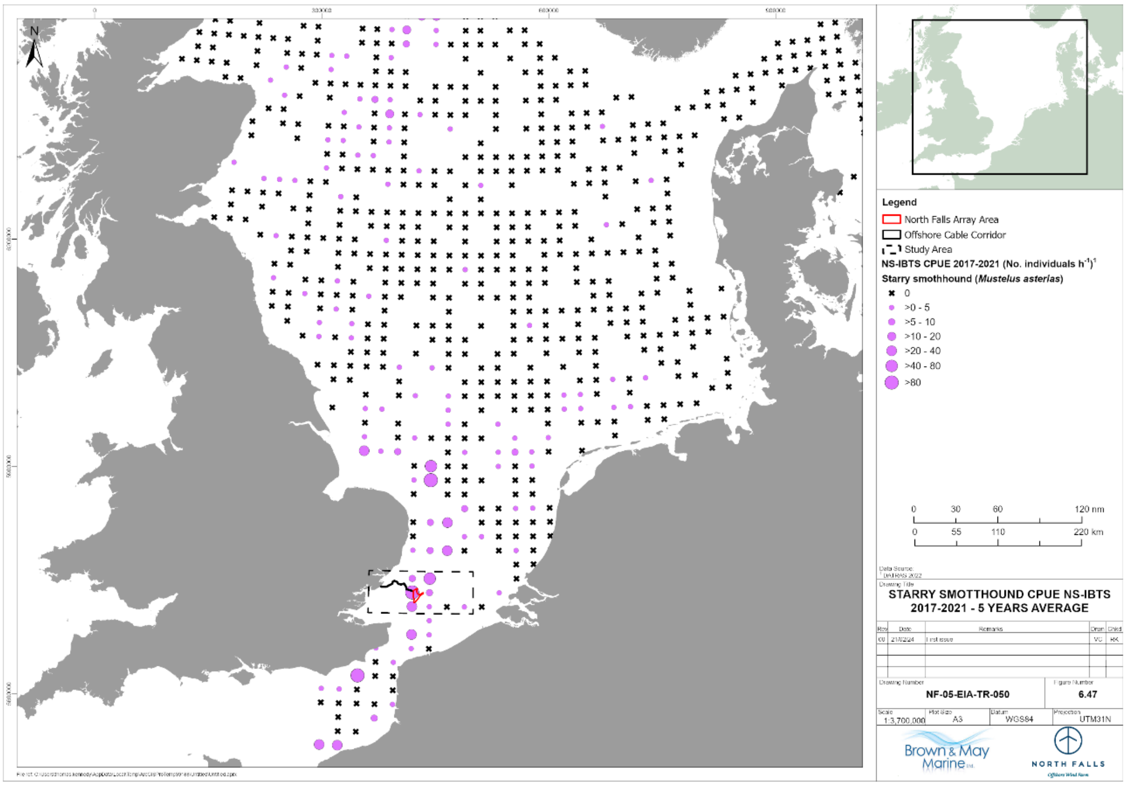

Figure 6.47 IBTS Starry Smoothhound CPUE (2017-2021) (Source: DATRAS 2022)

Spurdog

Spurdog are found typically at depths of 10-200m (ICES 2005j). It was one of the most common shark species in the North Sea but has now declined and is mainly found in the north western North Sea (Ellis et al 2012). Males exhibit seasonal north to south migrations whereas females may be found distributed evenly all year round (Thorburn et al 2015, Pawson 1995)

Spurdog are opportunistic feeders and consume a wide range of prey such as herring, sprat, small gadoids, sandeel, and mackerel, swimming crabs, hermit crabs, squid and ctenophores (Shark Trust 2010).

Due to their slow growth rate, late maturity and long reproductive cycle, they are prone to overfishing. ICES advice that there should not be targeted fisheries for this species in 2021 and 2022 and that bycatch should not exceed 2,468 tonnes (ICES 2020b). Following the reduction of TACS, landings have reduced from around 15,000 tonnes in the 2000, to less than 500 tonnes in 2018 and 2019.

Spurdog were found in relatively high numbers during the elasmobranch surveys carried out in the Greater Gabbard Offshore Wind Farm and was recorded in the Galloper Offshore Wind Farm otter trawl surveys (Table 6.2 and Table 6.6). As illustrated in Figure 6.48, this species has not been recorded in the study area during recent IBTS sampling (Figure 6.48).

Spurdog is of conservation importance, being listed as a Species of Principal Importance, included in the OSPAR list of threatened and/or declining species and assessed as ‘Endangered’ in the IUCN Red List of Threatened Species (Table 6.10).

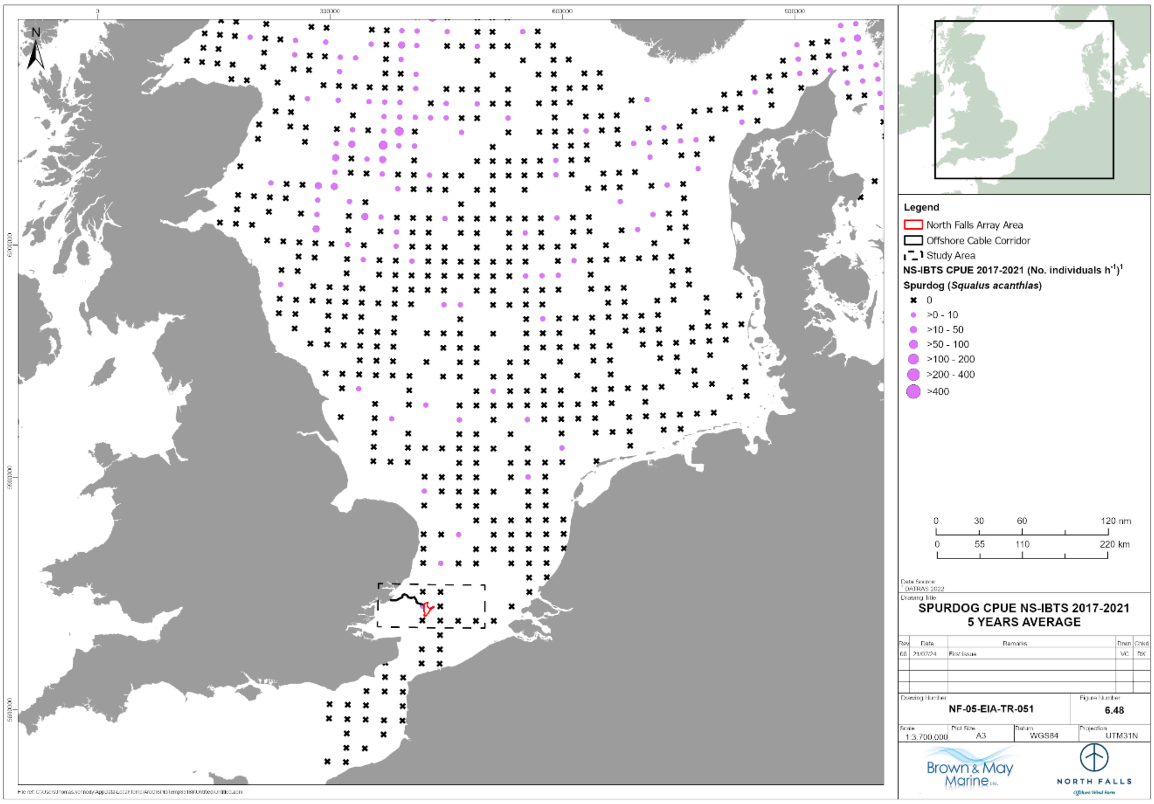

Figure 6.48 IBTS Spurdog CPUE (2017-2021) (Source: DATRAS 2022)

Tope

Tope are found in warmer shallower waters, typically less than 50m, and have been recorded in the southern North Sea but are rarely found in the northern North Sea (Sguotti et al 2016). Tope usually show aggregation behaviour, thus forming schools of similarly sized individuals, often segregated by sex (Kay and Dipper 2009). Larger individuals maybe occasionally solitary.

Tope was recorded in the otter trawl surveys undertaken in the Galloper Offshore Wind Farm and in the Greater Gabbard Offshore Wind Farm elasmobranch surveys (Table 6.2 and Table 6.5).

As illustrated in Figure 6.43, the offshore project area overlaps with an area identified as a low intensity nursery ground for this species.

Tope are of conservation interest, being listed as a species of principal importance. The species is classified as ‘Critically Endangered’ in the IUCN Red List of Threatened Species (Table 6.10). There is no commercial fisheries for tope but they are caught as bycatch. The Tope (Prohibition of Fishing) Order 2008 bans all fishing of tope except for rod and line and sets a 45kg per day limit of bycatch for commercial fisheries of other species.

Basking shark

Basking sharks *Cetorhinus maximus* are a filter feeding elasmobranch with wide distribution. They visit British waters during the summer but are usually only sighted on the south-west and western coasts of England and Scotland. They are rarely seen in the southern North Sea (Austin et al 2019) and therefore are not expected to occur in the offshore project area other than on a very occasional basis.

Basking sharks are of conservation importance, being protected under UK legislation (Wildlife and Countryside Act, 1981) as well as the Bern Convention and CITES, listed as a Species of Principal

Importance and in the OSPAR list of threatened and/or declining species. In addition, they have been assessed as 'Endangered' by the IUCN (Table 6.10).

6.2.4 Diadromous Migratory Species

6.2.4.1 European Eel

European eel is a catadromous migratory species found in the British Isles. Eels carry out long migrations (greater than 5000km) from the coasts of Europe to spawn in the Sargasso Sea (Cresci 2020, Miller et al 2019). The larvae are then transported towards Europe by prevailing currents and metamorphose into glass eels as they approach the continental shelf, developing then into elvers as they reach brackish water and move to fresh water (Friedland et al 2007, Cresci 2020).

Adult males are thought to leave the European coast from late August with females leaving one to two months later in September and October (Friedland et al 2007). Glass eels arrive back at coastal waters from February to March, migrating upstream as elvers from May until September (Environment Agency 2011).

The Thames has historically provided an important area of habitat for the growth stage of European eel (ZSL 2018). Due to the development of the surrounding area the habitat has become reduced with barriers blocking migration patterns such as flood defences and weir constructions (DEFRA 2010). In 2005, the Zoological Society of London (ZSL) established a monitoring project to determine the recruitment of elvers into the river Thames catchment. This study identified that there were 99% fewer eels arriving than in the 1980's (ZSL 2018).

European eels are of conservation interest, being listed as species of principal importance, classified as "Critically Endangered" by IUCN and listed as a threated or declining species by OSPAR (Table 6.9).

In England and Wales, eels are additionally protected by the Eels (England and Wales) Regulations 2009. These regulations establish measures for the recovery of the European eel stocks including the need to submit eel catch returns by fishers. The Eel Regulations further provide for close seasons, free passage of eels and enforcement.

6.2.4.2 Smelt

Smelt are widely distributed throughout the North Atlantic, with populations within UK waters being more frequent in estuaries (Quigley and O'Connor 2004). They are anadromous, shoaling in estuaries during the winter months and entering rivers between February to April to spawn (Tsai et al 2021). Adults return to sea after spawning with juveniles remaining in estuaries for the remainder of summer.

In the proximity of the project offshore area, smelt populations have been reported from the Blackwater and Crouch estuaries and the Thames (Maitland 2003, ZSL 2021, Natural England 2021). In addition, smaller smelt populations have also been reported from other areas along the English coast, namely within the Broads, Great Yarmouth, Lowestoft, Alde, Deben and Orwell (Maitland 2003). Smelt may transit areas in the proximity of the offshore project area at times, particularly the inshore section of the offshore cable corridor.

Smelt are species of conservation interest, being considered of Principal Importance (Table 6.9).

6.2.4.3 Allis and Twaite Shad

Allis shad and twaite shad are anadromous migratory species that belong to the herring family. They school in shallow coastal waters and estuaries at depths between 10 and 50m before entering rivers to spawn (Barnes 2008g, Reeve 2005). Both species live in coastal waters and estuaries but migrate into rivers in April-June to spawn in May-July. Twaite shad return to sea after spawning whilst allis shad usually die after spawning (JNCC 2022). Juveniles migrate to sea in autumn.

Spawning populations of twaite shad are limited to four rivers on the west coast of England (Davies et al 2020). The only confirmed spawning ground of allis shad is in the River Tamar in the south-west of

England, however both sub-adults and sexually mature adults are still regularly found around the UK coast (Everard 2021, Maitland and Lyle 2005).

Both species are of conservation interest being listed as a Species of Principal Importance, and protected under the Bern Convention, the Wildlife and Countryside Act (1981) and the Habitats Regulations and included in the OSPAR's list of threatened and/or declining species (allis shad only) (Table 6.9). Although in low numbers (three individuals), twaite shad were found during otter trawl surveys carried out in the Galloper Offshore Wind Farm (Table 6.2).

6.2.4.4 Lampreys

River lamprey and sea lamprey are parasitic anadromous migratory species. Both species spawn in freshwater environments in spring or early summer, dying after spawning (Larsen 2011). The larval stage is spent buried in muddy substrates in freshwater before they undergo metamorphosis and migrate to sea where they attach onto the skin of fish to feed off them (Kelly and King 2001).

River lamprey generally inhabits coastal waters, estuaries but after one or two years in this environment, they return to rivers between October and December to spawn. River lamprey have been historically abundant in the Thames supporting a large fishery in the 18th and 19th century, but they are now much less abundant (Almeida et al 2021). Eight individuals were caught in the Thames in recent site surveys (2017, 2018) for the Thurrock Flexible Generation Plant (APEM 2018).

Sea lamprey are rarely recorded in inshore and estuarine waters. Their distribution is determined by the distribution of their hosts which include a range of fish and marine mammals (Waldman et al 2008). Homing behaviour is not apparent in this species (Waldman et al 2008) and unlike salmonids and shads, lampreys do not have specific river populations (ter Hofstede et al 2008).

River and sea lamprey are both of conservation interest, being listed as Species of Principal Importance and protected under the Habitats Regulations and the Bern convention, as well being identified in the OSPAR list of Threatened and/or Declining Species (sea lamprey only).

Available UK distribution maps JNCC (2019a, 2019b), suggest that there is limited potential for river and sea lamprey to transit areas of relevance to the offshore project area, other than on an occasional basis given the limited records of these species in rivers in the proximity to the offshore project area. In line with this, lampreys were not recorded during survey work carried out at the Galloper and Greater Gabbard Offshore Wind Farm and have not been recorded in the study area in recent years by the IBTS (Table 6.2, Table 6.3, Table 6.4 and Table 6.6).

6.2.4.5 Atlantic Salmon

Atlantic salmon spend the early years of their life (between one and three years) in rivers before undergoing a change into smolts (young salmon), allowing them to adapt to salt water. They then migrate to the sea where they live for 1-3 years, undergoing large-scale migrations to feeding grounds, before returning to their natal river to spawn between October and January (Cefas 2019, NASCO 2019). Most salmon die after spawning, but some females will return to sea before spawning again.

Whilst still relatively abundant in Europe and the UK, the number of salmon halved between 1985 – 2016 and the species is listed as vulnerable in the IUCN red list. In recent years, there have been very low numbers of salmon reported in the Thames, for example, 16 individuals were counted between 2005 and 2008 in a tagging survey (Griffiths et al 2011) and between 2010-2020, three individuals were reported as caught by rod fishermen (Cefas 2020a).

They may occasionally transit the offshore project area, but the project is not considered to be located in important migratory pathways for current salmon populations. Salmon were not recorded at surveys undertaken in the Galloper and Greater Gabbard Offshore Wind Farms or during recent IBTS surveys (Table 6.2, Table 6.3, Table 6.4 and Table 6.6).

Salmon are of conservation importance, being designated as 'Vulnerable' in the IUCN Red List and are also a Species of Principal Importance, in OSPAR's List of Threatened and/or Declining species, in the Bern Convention and the Habitats Regulations (Table 6.9).

6.2.4.6 Sea Trout

Sea trout are the migratory counterpart of the common and widely distributed brown trout. Their life cycle, similar to that of Atlantic salmon, includes juvenile stages in freshwater, migration out to sea (as smolts), maturation at sea, and a return migration to freshwater for spawning (Pawson 2013). During their marine phase, they tend to remain in coastal waters rather than undertaking long distance offshore migrations like salmon (Nash 2021).

Sea trout have been reported from the Blackwater and Colne Estuaries and the Thames (KEIFCA 2015, ZSL 2016). In 2020, nine sea trout were reported caught by rod in the Thames (gov.uk, 2021). Whilst the study area is not considered a key migration or feeding area for sea trout, they may transit the offshore project area on an occasional basis. Sea trout were not recorded at surveys undertaken in the Galloper and Greater Gabbard Offshore Wind Farms or during recent IBTS surveys in the study area (Table 6.2, Table 6.3, Table 6.4 and Table 6.6).

Sea trout is not protected to the same level as Atlantic salmon but are listed as a Species of Principal Importance (Table 6.9).

6.2.5 Shellfish Species

6.2.5.1 Cockles

Cockles are widely distributed in estuaries and sandy bays around the UK coast. They are found buried on the top few centimetres of sediment on clean sand, muddy sand normally from the middle to lower intertidal (Tyler-Walters 2007). Cockles prefer inshore sand and mud flats which are stable as further offshore cockle beds are subject to a wider range of environmental conditions, high intensity wave action being a key factor (KEIFCA 2022).

Cockles are a species of commercial importance in the study area, accounting for the majority of landings by weight, particularly in ICES rectangle 32F1 (Table 6.7). The cockle fishery in the study area is managed by KEIFCA under the Thames Estuary Cockle Fishery Order (TECFO) 1994 and the Cockle Flexible Permit Byelaw (CFPB; KEIFCA 2009a). The distribution of cockle fishery areas within the KEIFCA district is illustrated in Figure 6.49. The inshore section of the offshore cable corridor overlaps with two cockle harvest areas (areas 18 and 20) Both of these areas are outside of the TECFO and are managed under the CFFPB (Haupt 2022).

Commercial landings of cockles under the CFPB have been predominantly from area 7 in the last ten years, whereas the main areas of cockle landings under TECFO are areas 4, 5, 6, 8, 9, 12 and 15. From consultation with KEIFCA it is understood that there is no overlap between harvested cockle areas and the offshore cable corridor for between ten and 20 years depending on management area (KEIFCA 2022).

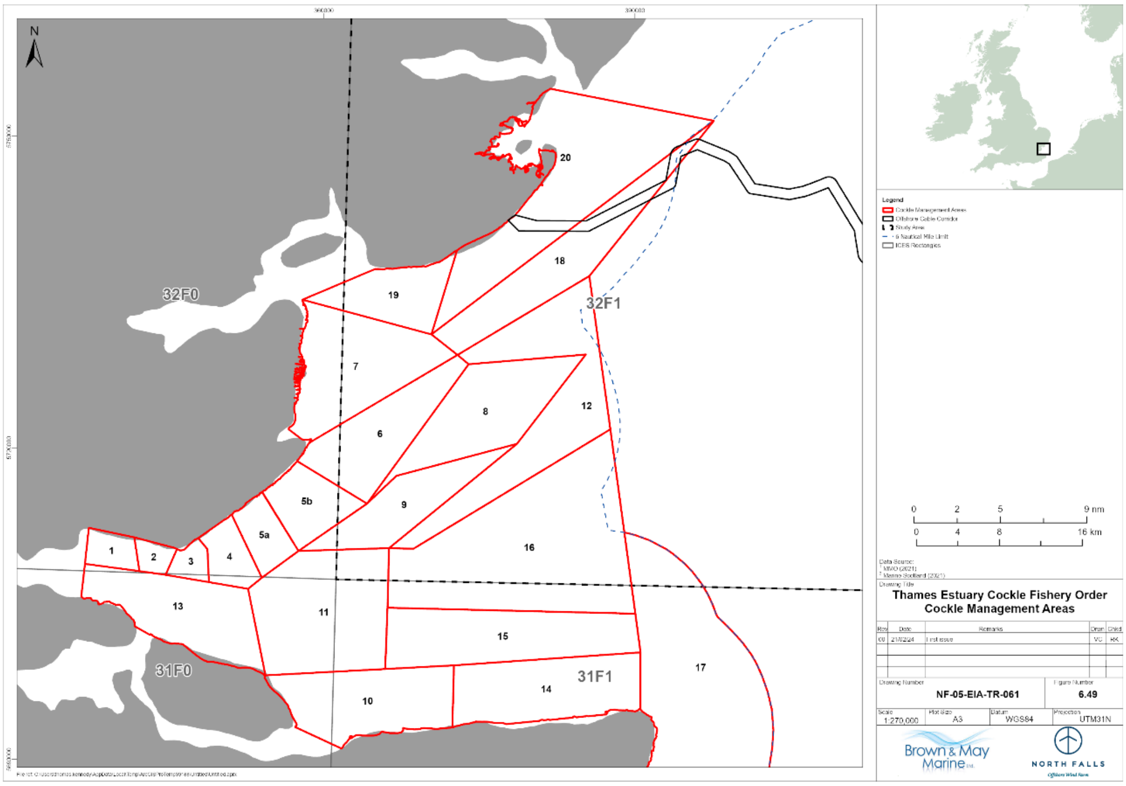

Figure 6.49 Cockle Management Areas (Haupt 2021)

6.2.5.2 Whelk

Whelk is common in the subtidal zone around the UK. They prefer soft subtidal substrates but can also be found on harder substrates and occasionally in the intertidal zone (Ager 2008). They show limited movements, and this could limit mixing between populations, meaning that localised populations could be susceptible to recovery issues if their stock is depleted (MRAG 2018).

Whelk are thought to spawn in late Autumn and lay their eggs when temperatures fall below 9°C, typically between November and April (Lawler and Vause 2009, MRAG, 2018). They lay clumps of demersal egg-cases on hard benthic substrata, meaning egg dispersal is limited. The eggs develop for 3-5 months before juveniles emerge as benthic dwellers.

Whelk are of commercial importance in the study area contributing to 13.4% and 42.2% of the overall landings by weight in rectangle 32F1 and 32F2. In the study area, whelks are managed by the Whelk Fishery Flexible Permit Byelaw which includes gear restrictions, landing restrictions, minimum catch sizes and the ability to introduce spatial and temporal limits (KEIFCA 2009b). These measures have been introduced after concern regarding the status of the whelk stocks in the region.

6.2.5.3 Native Oyster

Native oysters are a sessile, filter feeding bivalve mollusc that typically inhabit sheltered shallow estuaries but have also been recorded historically in waters up to 80m deep in the North Sea (OSPAR 2008, Preston et al 2020). They require mixed/hard substrate to settle, including silt or sand with shells, stones and debris, and larvae tend to settle where oysters are already present, forming large oyster beds made of dead shells and living oysters. Oysters reach sexual maturity three years after settling and spawn between June and September, requiring water temperatures of above 16°C (MMO 2019, Laing et al 2005). Once their eggs are fertilised, they hold the developing larvae for 6-15 days before releasing them into the water column where they drift for approximately two weeks before developing a 'foot' which they use to settle on appropriate substrate (Laing et al 2005).

Oyster beds provide habitat and nursery grounds for a wide range of other species including juvenile fish, crabs, snails and sponges, as well as providing other benefits such as water filtration which improves water clarity and removes excess nutrients from the water (Preston et al 2020).

The European native oyster was historically found throughout coastal waters in Europe but has undergone a serious decline in distribution and abundance since the mid-1800's due to intensive harvesting and recruitment issues caused by reduced populations and fragmentation (Allison et al 2019, Preston et al 2020). As well as fishing pressure, remaining populations of oysters are under threat from the risk of smothering by sediment, introduction of non-native oysters, the impacts of climate change, microplastics and infections of the disease *Bonamia ostreae* which can increase mortality rates (Pogoda 2019). They are now only found in a few locations in the England including the Solent, the River Fal and Essex Estuaries.

Native oysters have been listed as a Species of Principal Importance and on the OSPAR list of threatened and/or declining species (Table 6.11). In addition, as discussed in section 5.1, the offshore cable corridor is in the proximity of the Blackwater, Crouch, Roach and Colne Estuary MCZ (Figure 5.1), the only MCZ in the UK designated for the protection of native oysters/oyster beds.

Commercial harvesting of native oysters in the study area is managed by the Native Oyster Fishery Flexible Permit Bylaw (2018) which includes measures such as technical specifications of the vessels and gears that can be used, areas and time when they can be worked and a daily catch limit for native oysters. The byelaw provides the opportunity for native oysters to recover from fishing pressure whilst retaining the option to open the fishery when stocks are deemed to show a significant and sustained recovery. The fishery has remained closed in 2021 and 2022 as there is no evidence of sustained levels of recovery in the native oyster populations.

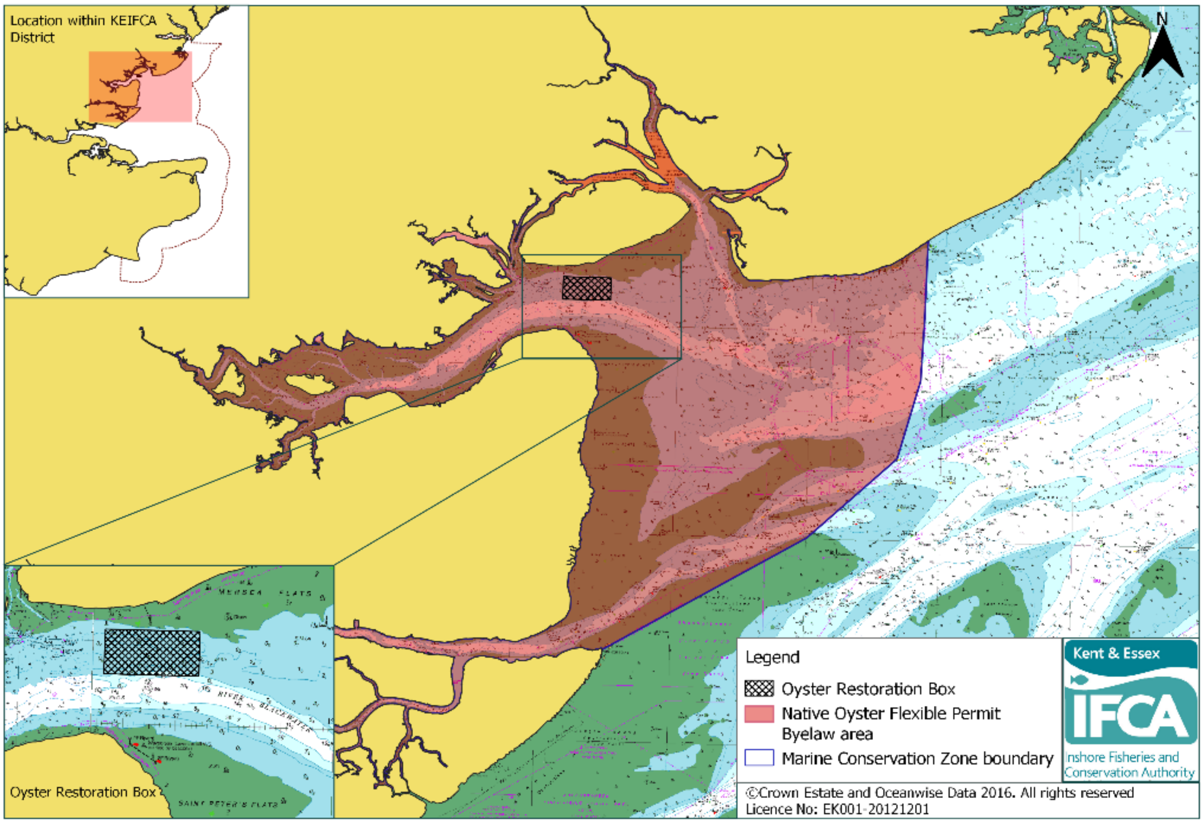

Figure 6.50 Native Oyster Flexible Permit Byelaw Area

6.2.5.4 Edible (Brown) Crab

The edible crab is common and wildly distributed in the UK and is found on a range of intertidal and subtidal habitats such as bedrock including under boulders, mixed coarse grounds, and offshore in muddy sand, up to 100m deep (Neal and Wilson 2008). They predate on a variety of other crustaceans such as other crabs, and molluscs including whelks, cockles and native oysters.

Brown crabs are very mobile and move into deeper water during colder months, returning to more coastal areas in the summer (Tonk and Rozemeijer 2019). They also undertake wide-ranging migrations for spawning over considerable distances to of 2-3km per day, venturing to offshore overwintering grounds where eggs are hatched. They spawn in late autumn and early winter, carrying 0.25-3 million eggs for 7-9 months until most larvae hatch between May and July (Bennett 1995). Juveniles are found in intertidal and shallow inshore waters.

Edible crabs are of importance to the local commercial fisheries in the study area, particularly in rectangle 32F1 (Table 6.7). Appendix 14.1: Commercial Fisheries Technical Report (Volume III) provides further information on the local fishery.

6.2.5.5 Lobster

Lobster is found on rocky grounds from the intertidal zone up to depths of 150m, although is most common in waters between 10-40m (Moland et al 2011, National Lobster Hatchery 2022). Adult lobsters are typically found on rocky ground and are sedentary, but will roam around 2km to find food (small crustaceans, molluscs and polychaetes), with some searching for up to 10km from their burrows. They do not undertake extensive migrations like edible crabs (Pavičić 2021, Smith et al 2001). Sexual maturity is reached between 5-7 years of age and they usually spawn in the summer, carrying their eggs under the abdomen for nine to twelve months (National Lobster Hatchery 2022).

Lobster are of local commercial importance to fisheries off the east coast of England. In the study area, the majority of lobster landings come from rectangle 32F1 (Table 6.7). Further information is provided on the fishery in Appendix 14.1: Commercial Fisheries Technical Report (Volume III).

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