Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Environmental Statement

Volume 3

Appendix 9. 1 - Fish and Shellfish Ecology Baseline Technical Report

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Glossary of Acronyms

Cefas	Centre for Environment, Fisheries and Aquaculture Science
cm	Centimetre
CPUE	Catch Per Unit Effort
DCO	Development Consent Order
DEP	Dudgeon Extension Project
DOW	Dudgeon Offshore Wind Farm
EPP	Evidence Plan Process
ES	Environmental Statement
EU	European Union
GOV	Grande Ouverture Verticale (trawl)
IBTS	International Bottom Trawl Survey
ICES	International Council for the Exploration of the Sea
IHLS	International Herring Larval Survey
IUCN	International Union for the Conservation of Nature
km	Kilometre
m	Metre
MMO	Marine Management Organisation
MSY	Maximum Sustainable Yield
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
SEP	Sheringham Shoal Extension Project
SNS	Southern North Sea
SSB	Spawning Stock Biomass
TAC	Total Allowable Catch
UK	United Kingdom

Glossary of Terms

Anadromous	Fish born in freshwater that spend most of their lives in saltwater and return to freshwater to spawn, such as salmon and some species of sturgeon.
Beam trawl	A trawl net whose lateral spread during trawling is maintained by a beam across its mouth.
Benthic	Species that inhabit on or near the sea bed.
Catadromous	Fish born in saltwater that spend most of their lives in freshwater and return to saltwater to spawn, such as eels.
Crustacean	An arthropod of the large, mainly aquatic group Crustacea, such as a crab, lobster, shrimp, or barnacle.
Demersal	Species that inhabit and feed on or near the sea bed.
Diadromous	Migrating between fresh and salt water.
Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
DEP offshore site	The Dudgeon Offshore Wind Farm Extension consisting of the DEP wind farm site, interlink cable corridors and offshore export cable corridor (up to mean high water springs).
DEP onshore site	The Dudgeon Offshore Wind Farm Extension onshore area consisting of the DEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
DEP North array area	The wind farm site area of the DEP offshore site located to the north of the existing Dudgeon Offshore Wind Farm
DEP South array area	The wind farm site area of the DEP offshore site located to the south of the existing Dudgeon Offshore Wind Farm
DEP wind farm site	The offshore area of DEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area. This is also the collective term for the DEP North and South array areas.
Epibenthos	All organisms living on the surface of the sea bed.
Gadoid	A family of marine fish containing several commercially important species including cod, haddock, whiting, and pollock.
ICES Rectangle	ICES rectangles are the smallest spatial unit used to collate commercial fisheries data and data from certain national and international fish surveys. The boundaries of each

	ICES rectangle align to 0.5° latitude by 1.0° longitude, giving whole rectangle dimensions of approximately 30 by 30 nautical miles, at UK latitudes.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the EIA and HRA for certain topics.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Infield cables	Cables which link the wind turbine generators to the offshore substation platform(s).
Interlink cables	Cables linking two separate project areas. This can be cables linking: 1) DEP South array area and DEP North array area 2) DEP South array area and SEP 3) DEP North array area and SEP 1 is relevant if DEP is constructed in isolation or first in a phased development. 2 and 3 are relevant where both SEP and DEP are built.
Interlink cable corridor	This is the area which will contain the interlink cables between offshore substation platform/s and the adjacent Offshore Temporary Works Area.
Landfall	The point at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water.
Local study area	The area including the offshore elements of the SEP and DEP include extension arrays, project interlink and offshore cable corridors, within the boundaries of ICES rectangles 34F1 and 35F1.
Mollusc	An invertebrate of a large phylum which includes snails, slugs, mussels, and octopuses. They have a soft unsegmented body and live in aquatic or damp habitats, and most kinds have an external calcareous shell.
Offshore cable corridors	This is the area which will contain the offshore export cables or interlink cables, including the adjacent Offshore Temporary Works Area.
Offshore export cable corridor	This is the area which will contain the offshore export cables between offshore substation platform/s and landfall, including the adjacent Offshore Temporary Works Area.

Offshore export cables	The cables which would bring electricity from the offshore substation platform(s) to the landfall. 220 – 230kV.
Offshore scoping area	An area presented at Scoping stage that encompassed all planned offshore infrastructure, including landfall options at both Weybourne and Bacton, allowing sufficient room for receptor identification and environmental surveys. This has been refined following further site selection and consultation for the PEIR and ES.
Offshore substation platform (OSP)	A fixed structure located within the wind farm site/s, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Order Limits	The area subject to the application for development consent, including all permanent and temporary works for SEP and DEP.
Otter trawl	A trawl net fitted with two 'otter' boards which maintain the horizontal opening of the net.
Oviparous	Producing eggs that develop and hatch outside the maternal body.
Ovoviviparous	Producing eggs that develop within the maternal body and hatch within or immediately after extrusion from the parent.
Pelagic	Species that inhabit and feed in the water column.
PEIR boundary	The area subject to survey and preliminary impact assessment to inform the PEIR.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
SEP offshore site	Sheringham Shoal Offshore Wind Farm Extension consisting of the SEP wind farm site and offshore export cable corridor (up to mean high water springs).
SEP onshore site	The Sheringham Shoal Wind Farm Extension onshore area consisting of the SEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
SEP wind farm site	The offshore area of SEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area.
The Applicant	Equinor New Energy Limited

9.1 FISH AND SHELLFISH ECOLOGY BASELINE TECHNICAL REPORT

9.1.1 Introduction

1. This report describes the fish and shellfish ecology baseline in the vicinity of the proposed Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and the Dudgeon Offshore Wind Farm Extension Project (DEP). It has been produced in support of the Environmental Statement (ES) which has been submitted to the Planning Inspectorate as part of the application for a Development Consent Order (DCO).
2. The closest point to the coast is 15.8 kilometres (km) from SEP and 26.5km from DEP. The DEP wind farm site shares a boundary with the operational Dudgeon Offshore Wind Farm (OWF) and the SEP wind farm site shares a boundary with the operational Sheringham Shoal OWF. The offshore export cable corridor makes landfall near Weybourne as shown in **Figure 9.1 (Annex 3).**

9.1.1.1 Study Area

3. The International Council for the Exploration of the Sea (ICES) divides the northeast Atlantic into areas for fisheries reporting purposes. SEP and DEP are located within the Southern North Sea (SNS) (Division IVc). The divisions are further divided into ICES statistical rectangles measuring 30 minutes of latitude by 1 degree of longitude in size (approximately 30 nautical miles by 30 nautical miles). ICES rectangles are the smallest spatial unit for which fisheries data is collected.
4. The SEP and DEP wind farm sites and part of the offshore export cable corridor are located within rectangle 35F1, with the remainder of the export cable (nearshore section) located within rectangle 34F1. These rectangles define the local study area as shown in **Figure 9.1** which is the primary focus of this baseline report. Further to the west ICES rectangles 34F0 and 35F0 are also considered as part of the wider regional area. Fish and shellfish landings data are presented for these areas to provide context (**Section 9.1.2**). ICES rectangles are used to define the study areas because they are used for reporting by several data sources, as described in **Section 9.1.1.2**. Historic fish and shellfish surveys conducted at the existing Dudgeon and Sheringham Shoal OWFs are the primary sources of information used in this report because they were designed to characterise the fish and shellfish communities at the existing projects' wind farm sites. However, although they sampled inside the SEP and DEP wind farm sites, surveys focused on the Dudgeon and Sheringham Shoal OWF sites and were undertaken over short periods several years ago, between 2005 and 2015. Other information collected at the ICES rectangle scale offers more survey data collected over a wider area and longer (and more recent) period, and therefore provides useful additional context to the Sheringham Shoal OWF and Dudgeon OWF site surveys.

9.1.1.2 Data Sources, Limitations and Gaps

5. To date, consultation regarding fish and shellfish ecology has been undertaken through the Dudgeon and Sheringham Shoal OWF Extensions Scoping Report (Royal HaskoningDHV, 2019) and through the on-going Evidence Plan Process (EPP). It was agreed with stakeholders in the Scoping Opinion and through the EPP (Sea bed Expert Topic Group (ETG)) that there is sufficient existing information to describe the fish and shellfish ecology baseline and that site specific fish characterisation surveys are not required for the assessment. It should however be acknowledged that, as described in **Section 9.1.1.2.5**, there are some limitations to the existing data.

6. As such, information sources describing the fish and shellfish ecology baseline have been derived from a number of scientific literature sources, industry guidance and statistical data. Regional datasets are presented first where they include information in the regional or local study areas, followed by the more focused surveys of the Dudgeon and Sheringham Shoal OWFs and the local study area. Information sources presented include:

- UK Marine Management Organisation (MMO) landings data 2009 to 2019;
- International Bottom Trawl Survey (IBTS) 2010 to 2020;
- International Herring Larval Survey (IHLS) 2008 to 2022;
- Fish spawning and nursery grounds (Coull *et al.*, 1998; Ellis *et al.*, 2012; Aires *et al.*, 2014));
- Historic Dudgeon and Sheringham Shoal OWF site surveys including:
    - Site characterisation surveys (beam and otter and epibenthic trawls)
    - Pre-construction fish surveys
    - Pre and post-construction herring spawning surveys
    - Pre and post-cable installation elasmobranch surveys
- SEP and DEP aerial surveys.

9.1.1.2.1 UK MMO landings data

7. Fisheries data available through the MMO describes the broad scale spatial and temporal distribution of fishing effort and species landed by UK registered vessels by ICES rectangle. Many fish and some shellfish species are highly mobile and range over large areas. Therefore, data sets with large spatial coverage are useful in characterising the community in the wider area together with species that may be present within the SEP and DEP offshore sites. However, fisheries reporting is largely limited to commercial species with many non-commercial species discarded at sea. In addition to this, the landings data records catches from vessels >10m in length, whereas the majority of the local fleet is <10m and historically operate within 2nm of the shore. Gear advancements have led to increases in operational range, but smaller vessels still tend to keep inshore with larger ones going further afield (Bridges 2017).

8. Landings by non-UK registered vessels are also excluded from the data. Furthermore, a system of Total Allowable Catches (TACs) and quotas (see **Chapter 12 Commercial Fisheries, Appendix 12.1**) means that landings do not necessarily reflect either abundance or biomass, and in any case are not corrected for fishing effort. Therefore, fisheries landings data have only been used in the fish and shellfish ecology baseline to indicate what key commercial species are present in the study area.

9.1.1.2.2 International Bottom Trawl Survey

9. IBTS have been conducted since the 1960s, although there was no consistency in sampling gear or method between different vessels and nationalities until 1997. Since then surveys have been conducted by a standardised method with a Grande Ouverture Verticale (GOV) trawl, sampling at a series of fixed station locations that are repeated twice a year (first and third quarters) (ICES, 2020a). IBTS data from 2010 to 2020 has been analysed to determine the average number of fish caught per hour, or catch per unit effort (CPUE), as a measure of relative abundance. The data has been used to characterise the fish and shellfish community, including non-commercial species, at locations around SEP and DEP and CPUE has also been averaged for each ICES rectangle. IBTS sample stations that are in close proximity to SEP and DEP are shown in **Figure 9.2**. There are no IBTS stations within the SEP or DEP boundaries. The closest station is 10.12km to the northeast of the DEP North array area.

10. It should be acknowledged that some benthic species are not always effectively caught from GOV trawls, so they cannot be used for quantitative sampling (ICES, 2015). Despite this the data from these surveys provide important contextual information on the distribution and relative abundance of demersal fish species in the local study area, if not within the project boundaries.

9.1.1.2.3 Fish spawning and nursery grounds

11. Coull *et al.* (1998) and Ellis *et al*. (2010; 2012) are often considered the standard references to be used to provide broad scale overviews of the potential spatial extent of spawning grounds, the relative intensity and duration of spawning, and the distribution of nursery areas. Both studies are based on a compilation of a variety of data sources. In the case of Coull *et al.* (1998), many of the conclusions are based on historic research and therefore may not take account in recent changes in fish distributions and spawning behaviour. Whilst more recent, Ellis *et al.* (2010; 2012) are constrained by the wide scale distribution of the sampling sites used for the annual international larval survey data, resulting in broad scale grids of spawning and nursery grounds based on half ICES rectangles.

12. Aires *et al.* (2014) conducted a study to update fisheries sensitivity maps in British waters. This report focuses on aggregations of 0 group fish (fish in their first year of their lives) rather than specifically ‘nursery areas’. Various species distribution models used in this study (e.g. MAXENT based on presence-only data; and Random Forest based on presence-absence data) were based primarily on survey data. It is important to note that the Aires *et al.* (2014) study does not replace existing materials, and the authors encourage the findings to be used in conjunction with them.

13. The spatial extent of the spawning grounds and the duration of spawning periods given in these publications are therefore likely to represent the maximum theoretical extent of the areas and periods within which spawning occurs. Therefore spawning grounds are likely to be smaller and/or of a patchy distribution, with shorter spawning periods, or in certain cases they may no longer be active spawning grounds at all.

9.1.1.2.4 International Herring Larval Survey

14. The IHLS has been undertaken since 1967. The surveys are carried out in specific periods and areas, following autumn and winter spawning activity of herring *Clupea harengus* from north to south, collecting information on the size, abundance and distribution of herring eggs and larvae (and other species) in the North Sea that are used in stock assessments and fisheries management. Catch data together with specific information like haul position, survey area etc. are reported to the ICES International Herring Larvae database annually.

15. The abundance of larvae presented refers to the number of herring larvae from the smallest reported size category (<11mm total length in the SNS, <10mm in other North Sea areas) (ICES, 2019a). Smaller larvae are of most interest because it can be inferred that they have hatched most recently and have had less time to disperse away from spawning grounds. The most recent IHLS data covering the period 2008 to 2022 have been used to inform the baseline description.

16. The extent of recent surveys does not cover the study areas, except for 2009, and sampling is focused to the northwest and south. The last IHLS to sample in the local study area (rectangle 35F1) was undertaken in 1976.

9.1.1.2.5 Historic site surveys

17. A summary of previous OWF related surveys undertaken in and around SEP and DEP between April 2005 to March 2020 is provided in **Table 9.1.1**. These historic surveys were undertaken before and after construction of the Dudgeon and Sheringham Shoal OWFs as part of the consent application process and to comply with monitoring requirements.

18. Data gathered from these surveys represent a snapshot of species present at the time of sampling. It should be noted that the distribution and abundance of species may vary considerably both seasonally and annually. In addition to this, the effectiveness of different survey methods in catching and recording different species also varies (e.g. demersal or pelagic). It is also worth noting that some of the previous OWF related surveys were not always consistent for some campaigns and also encountered access problems on export cable routes due to fishing activity and deployed fishing gear, resulting in some stations being missed.

19. The historic survey data has been used in conjunction with the available literature and data to provide a robust baseline of fish and shellfish for the purposes of the baseline assessment.

Table 9.1.1: Overview of historic site surveys

OWF	Purpose	Method	Survey Detail	Period	Referenced Reports
Sheringham Shoal	Fish Survey	Otter Trawl	12 x ~30 minute tows	05-06 April 2005	(IECS, 2005a)
	Epifaunal Survey	Epibenthic 2m Beam Trawl	24 x 5 minute tows	06-07 April 2005	(IECS, 2005b)
	Characterisation of area	Demersal 7m Beam Trawl	12 x ~30 minute tows	28 July 2005	(IECS, 2005c)
		Pelagic Beam Trawl	12 x ~15 minute tows	22 September 2005	(IECS, 2005d)
		Demersal 7m Beam Trawl	12 x ~30 minute tows		
Dudgeon	Characterisation of area	Otter Trawl	10 x ~25 minute tows	28 May 2008	(Brown and May Marine, 2008a)
		Demersal 2m Beam Trawl	10 x ~5 minute tows		
		Otter Trawl	10 x ~25 minute tows	14-16 October 2008	(Brown and May Marine, 2008b)
		Demersal 2m Beam Trawl	10 x ~5 minute tows		
	Herring Spawning Survey	Comet sandeel trawl with 18mm mesh cod end	3 x ~40 to 60 minute tows	16-17 October 2008	
Sheringham Shoal	Pre-construction Herring Spawning Survey	Pelagic trawl with 35mm cod-end	Up to 28 tows on each trip	21-24 September 2009	(Brown and May Marine, 2009)
				5-8 October 2009	
				19-22 October 2009	

OWF	Purpose	Method	Survey Detail	Period	Referenced Reports
				02-06 November 2009	
				16-17 November 2009	
				02-08 December 2009	
Sheringham Shoal	Post-construction Herring Spawning Survey	Pelagic trawl with 35mm cod-end	Up to 22 x ~20 minute tows on each trip	27 September - 01 October 2010	(Brown and May Marine, 2010b)
				11-14 October 2010	
				25-28 October 2010	
				20-23 November 2010	
	Pre-cable Installation Elasmobranch Survey	Longline	10 x ~3 hour soak	03-05 August 2010	(Brown and May Marine, 2010a)
	Post-cable Installation Elasmobranch Survey	Longline	10 x ~3 hour soak	09-11 November 2012	(Brown and May Marine, 2012)
	Post-construction Benthic Survey	2m beam trawl with 5mm cod-end mesh	15 x ~10 minute tows	14-18 December 2012	(Fugro EMU LTD, 2013)
	Post-cable Installation Elasmobranch Survey	Longline	10 x ~2 hours soak	27-29 August 2013	(Brown and May Marine, 2013)
	Post-construction second Benthic Survey	2m beam trawl with 5mm cod-end mesh	5 x ~10 minute tows	16-17 April & 22-23 April 2014	(MESL, 2014)
	Post-cable Installation Elasmobranch Survey	Longline	16 x ~2 hours soak	16-21 August 2015	(Brown and May Marine, 2015)
Dudgeon	Pre-construction Benthic Survey	2m beam trawl with 5mm cod-end mesh	10 x ~10 minute tows	07-10 September 2014	(Fugro EMU LTD, 2015)

9.1.1.2.6 Aerial surveys

20. Monthly aerial surveys of the SEP and DEP wind farm sites (including a 4km buffer) were conducted at least monthly between May 2018 and April 2020 inclusive. The primary purpose of these surveys was to collect data on the distribution and abundance of seabirds and marine mammals. However, they also identify any large fish (namely elasmobranchs) near the sea surface.

9.1.2 Summary of Data Sources

9.1.2.1 UK MMO Landings Data

21. **Table 9.1.2** shows landings of commercial fish species from ICES rectangles 34F1 and 35F1 (local area incorporating SEP and DEP), and 34F0 and 35F1 (regional area to the west), for the period 2009 to 2019[1]. Only species that have a landed weight in excess of one tonne over the 10 year period are listed. Species in each group are presented in descending order of total landings from the local area rectangles (34F1 and 35F1) combined.

[1] Landings data from 2020 and 2021 have not been included due to the potential influence of the Covid 19 pandemic on landings of commercial fish species.

Table 9.1.2: UK MMO landings from 2009 to 2019[2].

Species Name	Local				Regional			
	35F1 (Offshore)		34F1 (Nearshore)		35F0		34F0 (incl. The Wash)	
	Landings (tonnes)	Contribution to total landings in 35F1	Landings (tonnes)	Contribution to total landings in 34F1	Landings (tonnes)	Contribution to total landings in 35F0	Landings (tonnes)	Contribution to total landings in 34F0
Molluscs								
Whelks	8382.65	80.80%	1042.11	36.81%	3570.60	15.79%	1780.98	13.97%
Cockles	46.52	0.45%	54.48	1.92%	12017.89	53.16%	5599.65	43.93%
Scallops	6.52	0.06%	0.00	0.00%	201.97	0.89%	4.95	0.04%
Mussels	0.00	0.00%	149.95	5.30%	637.09	2.82%	608.56	4.77%
Crustaceans								
Brown Shrimp	6.93	0.07%	64.43	2.28%	2944.77	13.02%	4349.49	34.12%
Brown Crab	1594.33	15.37%	985.03	34.79%	2568.50	11.36%	302.87	2.38%
Lobsters	254.51	2.45%	257.10	9.08%	372.45	1.65%	12.27	0.10%

[2] 35F1 and 34F1 overlap the SEP and DEP sites. Species in each group are presented in descending order of total landings from these rectangles combined.

Species Name	Local				Regional			
	35F1 (Offshore)		34F1 (Nearshore)		35F0		34F0 (incl. The Wash)	
	Landings (tonnes)	Contribution to total landings in 35F1	Landings (tonnes)	Contribution to total landings in 34F1	Landings (tonnes)	Contribution to total landings in 35F0	Landings (tonnes)	Contribution to total landings in 34F0
Pink Shrimp	0.00	0.00%	0.00	0.00%	92.01	0.41%	50.60	0.40%
Green Crab	0.00	0.00%	0.00	0.00%	1.60	0.01%	0.51	0.00%
Velvet Crab	6.36	0.06%	0.63	0.02%	64.72	0.29%	1.16	0.01%
Mixed Crabs	0.51	0.00%	0.34	0.01%	1.23	0.01%	0.00	0.00%
Finfish								
Herring	5.68	0.05%	171.54	6.06%	42.29	0.19%	0.94	0.01%
Cod	3.81	0.04%	32.92	1.16%	41.90	0.19%	2.69	0.02%
Sole	21.40	0.21%	5.86	0.21%	8.63	0.04%	8.69	0.07%
Plaice	20.51	0.20%	2.73	0.10%	2.14	0.01%	7.75	0.06%
Bass	3.48	0.03%	16.93	0.60%	3.06	0.01%	1.68	0.01%
Mackerel	0.20	0.00%	8.78	0.31%	0.58	0.00%	0.02	0.00%

Species Name	Local				Regional			
	35F1 (Offshore)		34F1 (Nearshore)		35F0		34F0 (incl. The Wash)	
	Landings (tonnes)	Contribution to total landings in 35F1	Landings (tonnes)	Contribution to total landings in 34F1	Landings (tonnes)	Contribution to total landings in 35F0	Landings (tonnes)	Contribution to total landings in 34F0
Sprats	0.00	0.00%	7.27	0.26%	0.00	0.00%	0.04	0.00%
Whiting	2.31	0.02%	0.71	0.02%	13.69	0.06%	0.40	0.00%
Horse Mackerel	0.00	0.00%	1.87	0.07%	0.00	0.00%	0.00	0.00%
Flounder or Flukes	0.05	0.00%	1.81	0.06%	3.40	0.02%	0.83	0.01%
Brill	1.72	0.02%	0.14	0.00%	0.76	0.00%	0.40	0.00%
Turbot	1.44	0.01%	0.11	0.00%	0.09	0.00%	0.62	0.00%
Dabs	0.43	0.00%	1.16	0.04%	0.13	0.00%	1.03	0.01%
Gurnard and Latchet	0.09	0.00%	0.48	0.02%	0.02	0.00%	1.03	0.01%
Elasmobranchs								
Thornback Ray	10.04	0.10%	12.22	0.43%	17.55	0.08%	2.69	0.02%
Blonde Ray	4.81	0.05%	3.34	0.12%	0.07	0.00%	0.32	0.00%

Species Name	Local				Regional			
	35F1 (Offshore)		34F1 (Nearshore)		35F0		34F0 (incl. The Wash)	
	Landings (tonnes)	Contribution to total landings in 35F1	Landings (tonnes)	Contribution to total landings in 34F1	Landings (tonnes)	Contribution to total landings in 35F0	Landings (tonnes)	Contribution to total landings in 34F0
Lesser Spotted Dog	0.15	0.00%	2.52	0.09%	0.00	0.00%	4.94	0.04%
Smoothhound	0.20	0.00%	6.66	0.24%	1.61	0.01%	1.31	0.01%

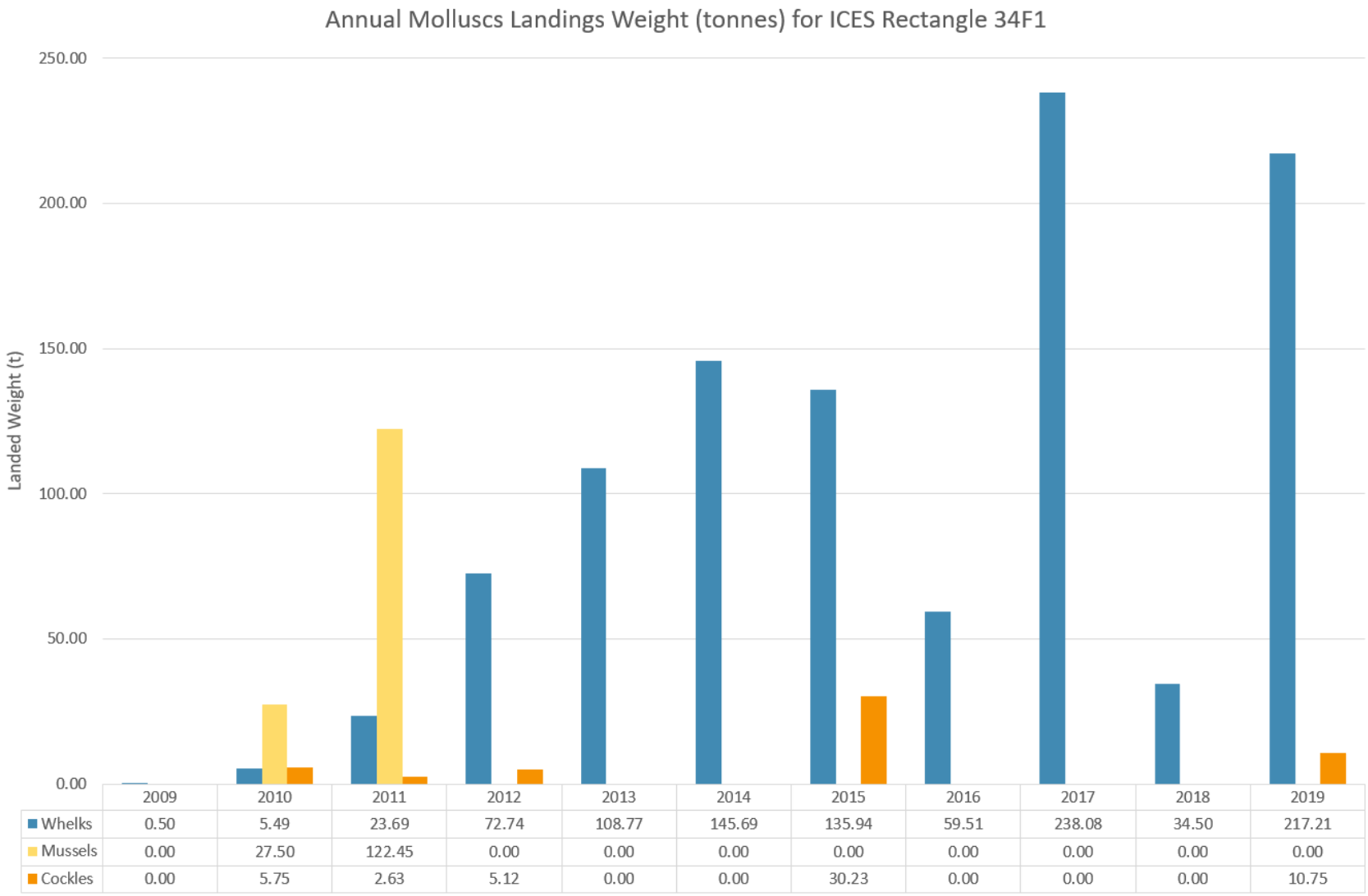
The colour intensity illustrates landings quantity from high (dark) to low (light).

>5000	1000-5000	500-1000	100-500	50-100	<50

22. **Plate 9.1.1** to **Plate 9.1.8** present the UK annual landings (tonnes) for the SEP and DEP offshore area between 2009 and 2019. Foreign landings are discussed in **Chapter 12 Commercial Fisheries**.

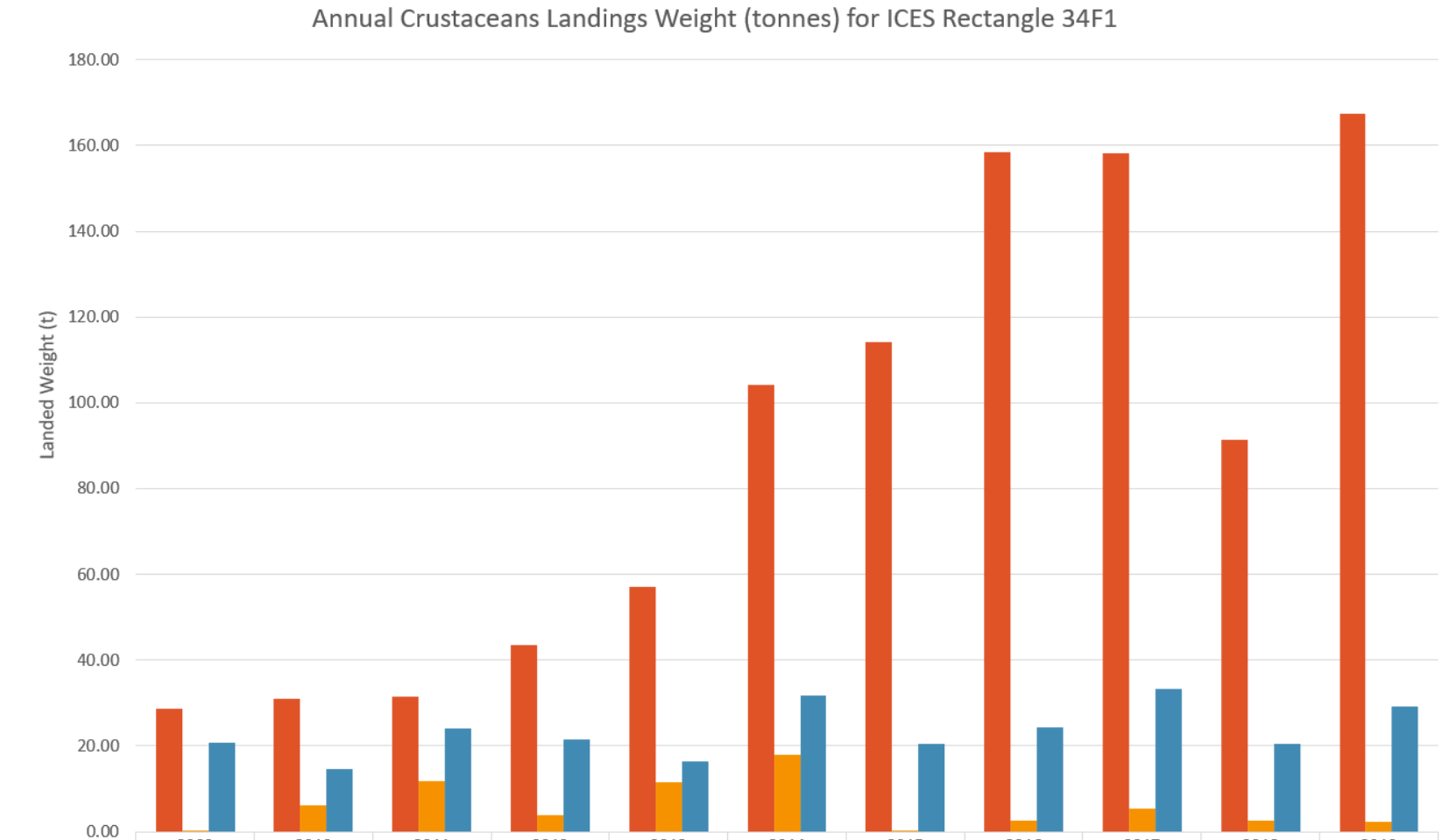
23. **Plate 9.1.1** to **Plate 9.1.4** present annual landings from ICES rectangle 34F1, which overlaps with the offshore export cable corridor. From this area, brown crab was landed in the greatest quantities, followed by whelks, then lobster and herring. Whelk and brown crab landings have generally increased over the period, although brown crab landings were high in the first year of the period. Conversely, landings of cod, mackerel and sprat have decreased over the decade. Lobster landings have been relatively consistent.

24. **Plate 9.1.5** to **Plate 9.1.8** present annual landings from ICES rectangle 35F1 which overlaps with the SEP and DEP wind farm sites and the part of the offshore export cable corridor furthest from shore. From this rectangle, landings are dominated by whelk followed by brown crab, then lobster. Sole, plaice, cod, thornback ray and velvet swimmer crab landings were variable over the ten year period.



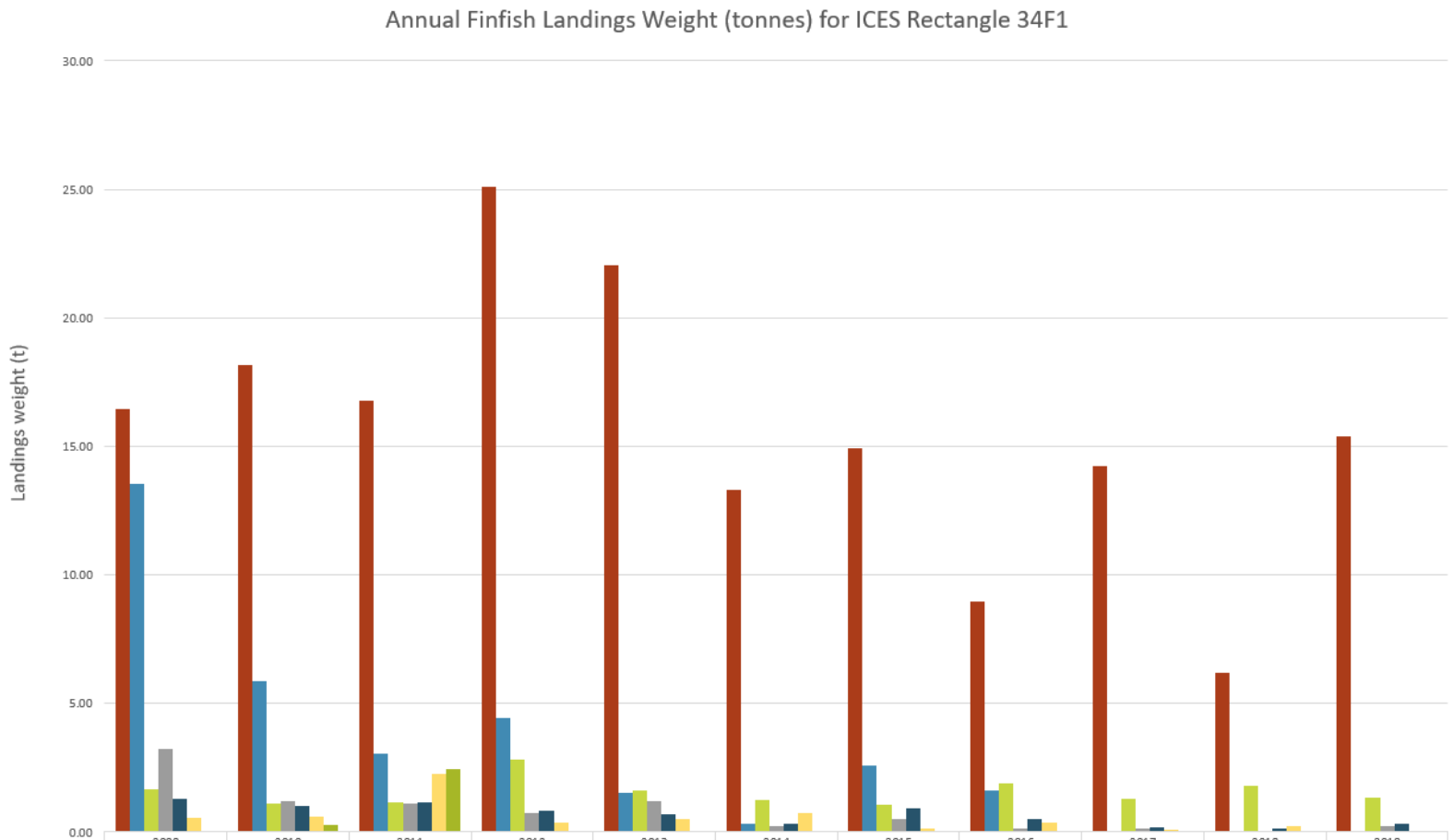
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Whelks	0.50	5.49	23.69	72.74	108.77	145.69	135.94	59.51	238.08	34.50	217.21
Mussels	0.00	27.50	122.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cockles	0.00	5.75	2.63	5.12	0.00	0.00	30.23	0.00	0.00	0.00	10.75

Plate 9.1.1: Mollusc landings from ICES rectangle 34F1



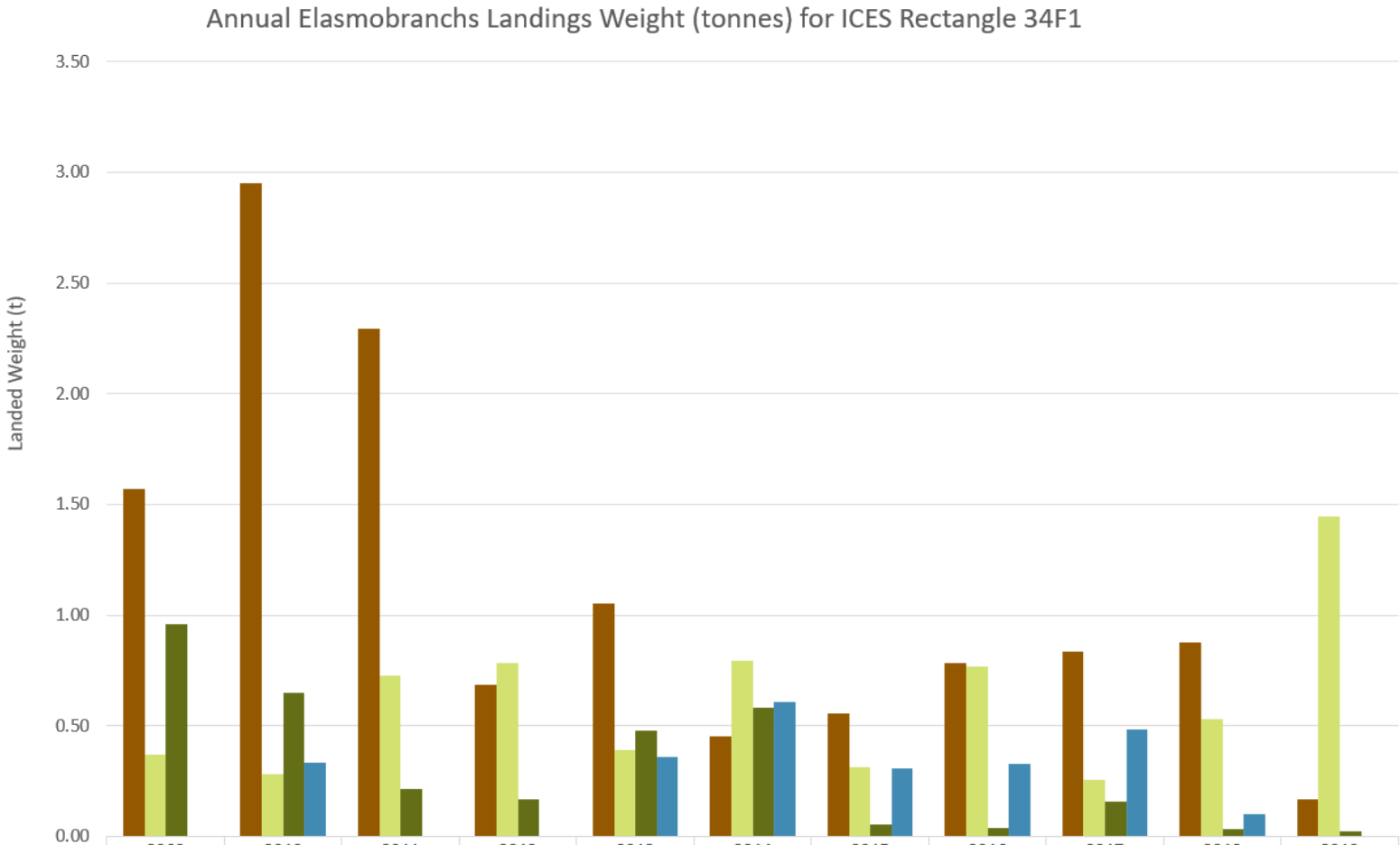
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Brown Crab	28.64	30.88	31.41	43.41	57.13	104.17	114.21	158.44	158.15	91.33	167.28
Brown Shrimp	0.19	6.24	11.70	3.81	11.59	17.83	0.17	2.68	5.35	2.68	2.19
Lobster	20.84	14.68	24.13	21.58	16.41	31.83	20.50	24.36	33.27	20.43	29.06

Plate 9.1.2: Crustacean landings from ICES rectangle 34F1



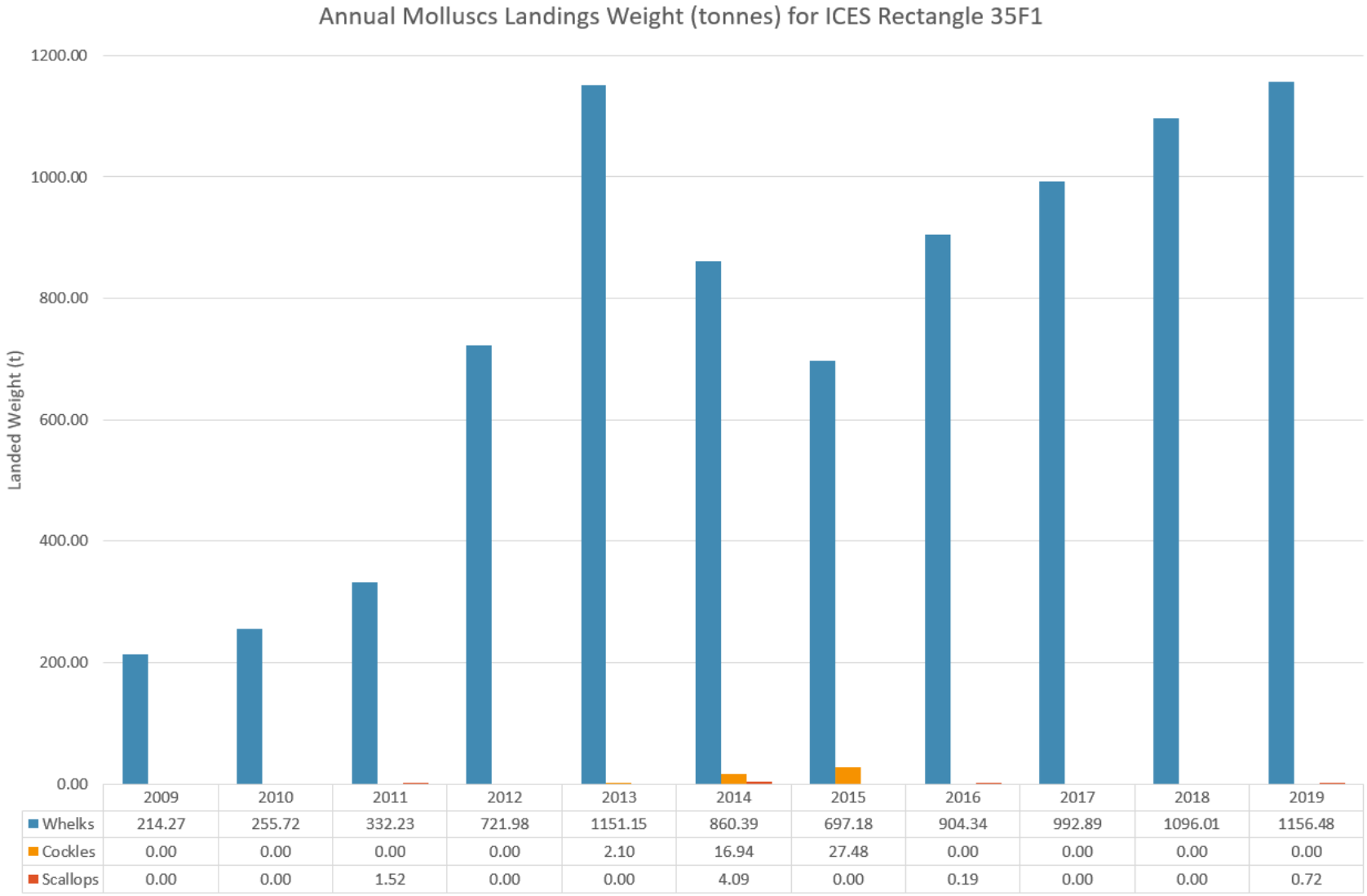
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Herring	16.46	18.16	16.75	25.12	22.04	13.30	14.93	8.97	14.24	6.19	15.38
Cod	13.52	5.86	3.03	4.41	1.51	0.32	2.58	1.61	0.05	0.02	0.01
Bass	1.66	1.11	1.13	2.82	1.59	1.22	1.04	1.91	1.29	1.81	1.35
Mackerel	3.24	1.21	1.11	0.73	1.18	0.25	0.52	0.13	0.13	0.06	0.24
Sprats	1.27	1.01	1.15	0.81	0.67	0.31	0.92	0.52	0.17	0.12	0.33
Dover Sole	0.55	0.60	2.26	0.38	0.52	0.72	0.12	0.37	0.08	0.22	0.05
Plaice	0.00	0.29	2.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Plate 9.1.3: Finfish landings over 1 tonne from ICES rectangle 34F1



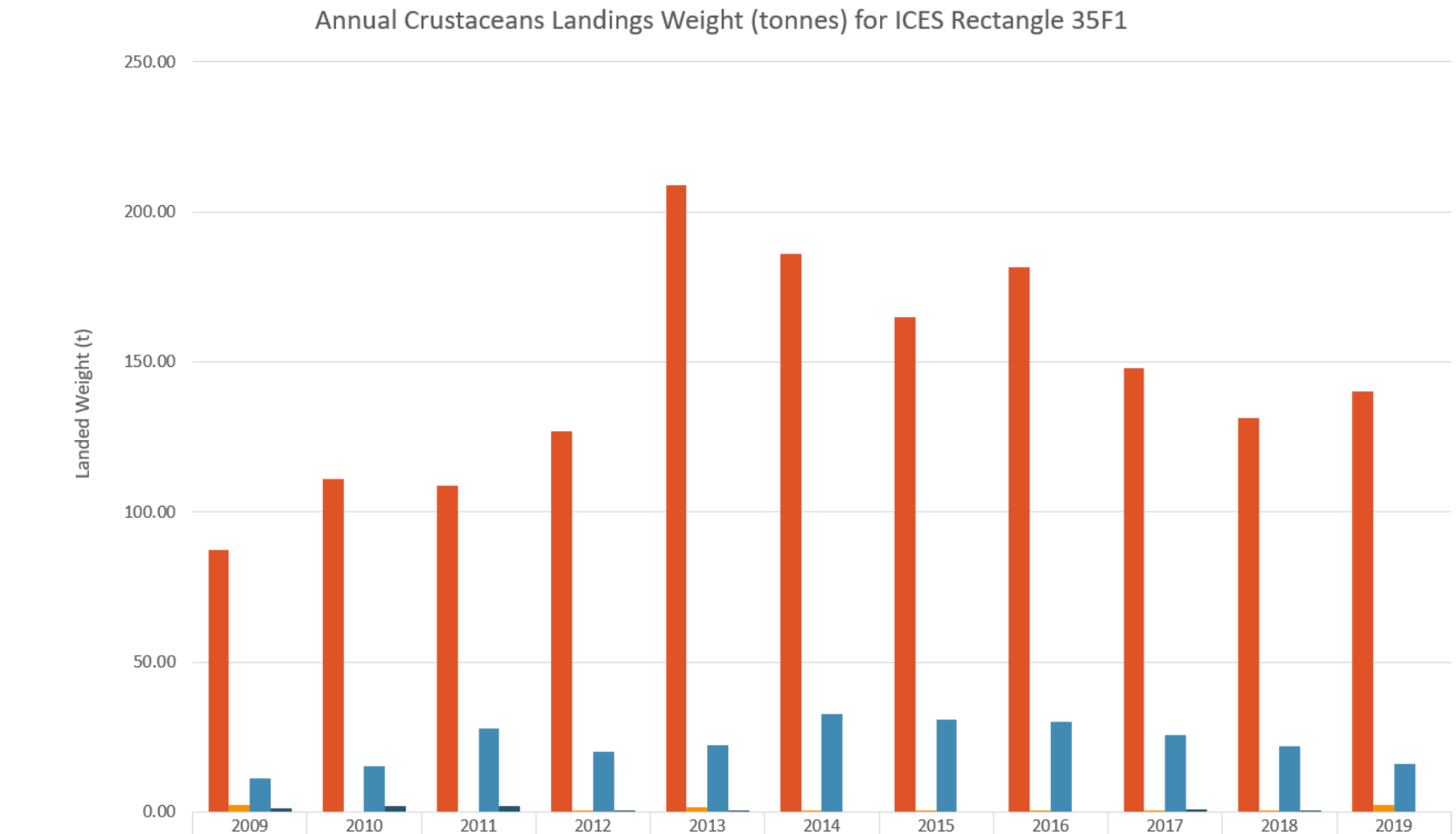
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Thornback Ray	1.57	2.95	2.29	0.68	1.05	0.45	0.56	0.78	0.84	0.88	0.17
Smoothhound	0.37	0.28	0.73	0.79	0.39	0.79	0.31	0.77	0.26	0.53	1.44
Blonde Ray	0.96	0.65	0.21	0.17	0.48	0.58	0.05	0.04	0.16	0.03	0.02
Lesser Spotted Dogfish	0.00	0.33	0.00	0.00	0.36	0.61	0.31	0.33	0.48	0.10	0.00

Plate 9.1.4: Elasmobranch landings from ICES rectangle 34F1



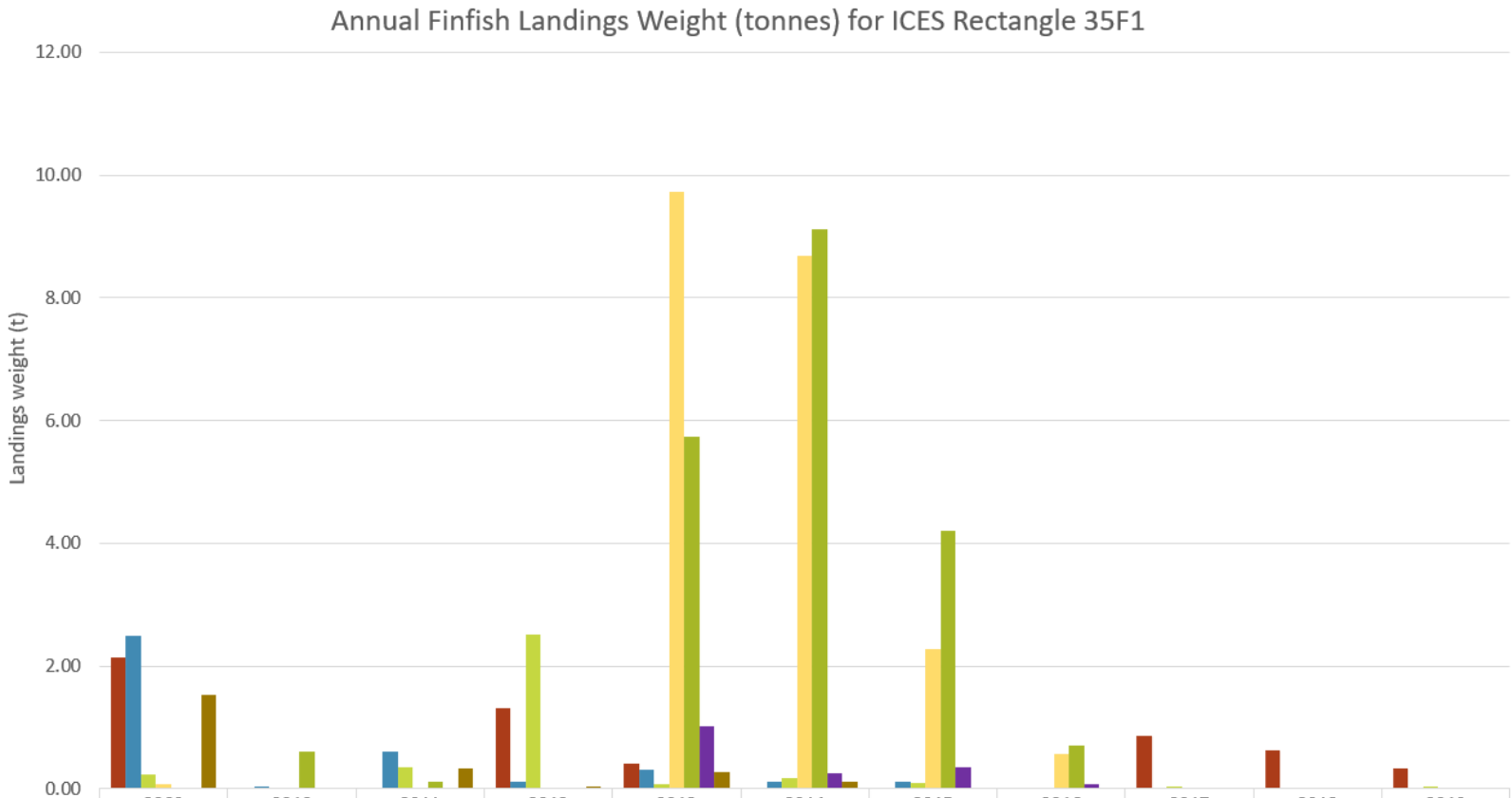
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Whelks	214.27	255.72	332.23	721.98	1151.15	860.39	697.18	904.34	992.89	1096.01	1156.48
Cockles	0.00	0.00	0.00	0.00	2.10	16.94	27.48	0.00	0.00	0.00	0.00
Scallops	0.00	0.00	1.52	0.00	0.00	4.09	0.00	0.19	0.00	0.00	0.72

Plate 9.1.5: Mollusc landings from ICES rectangle 35F1



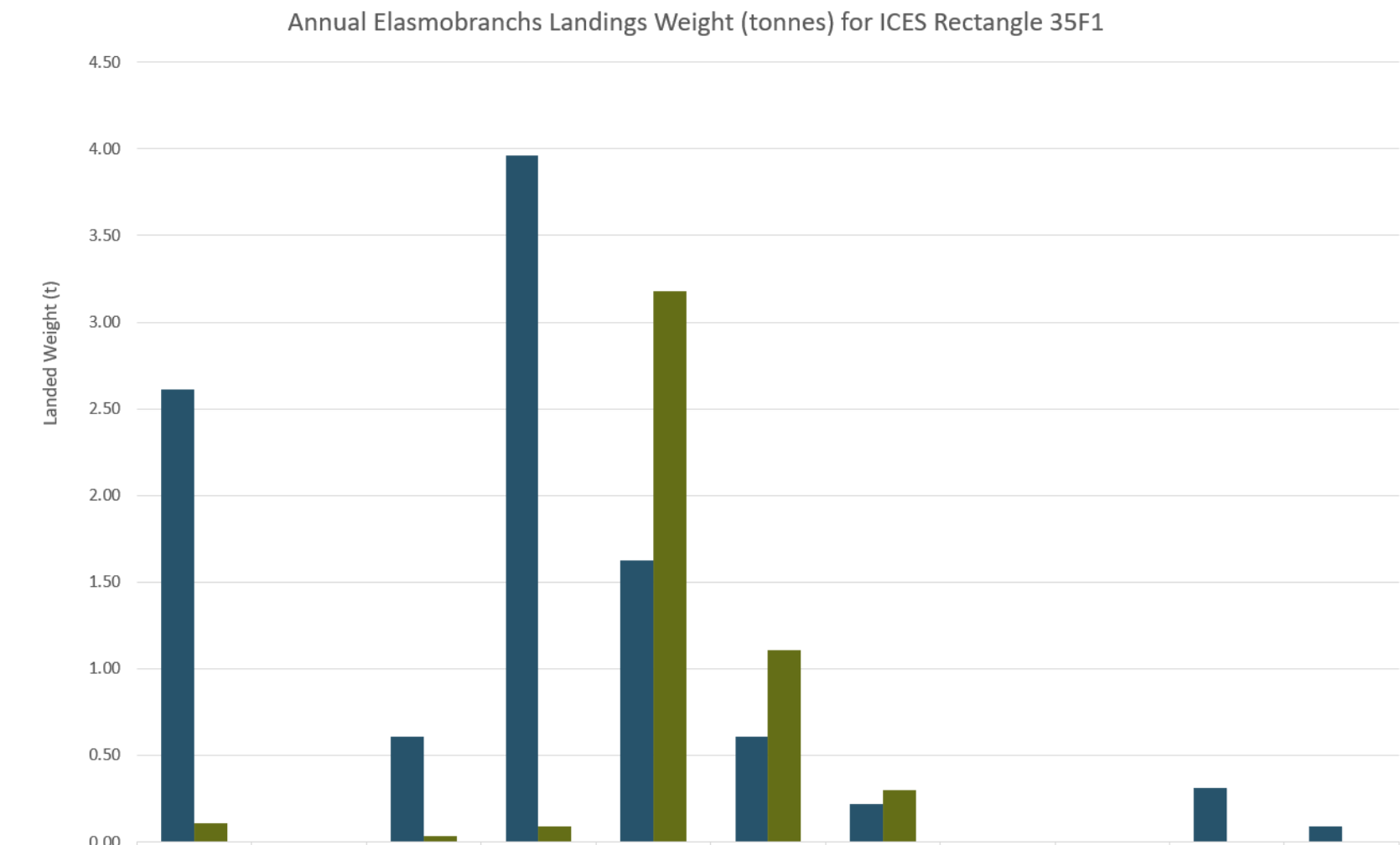
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Brown Crab	87.24	110.86	108.88	126.88	209.06	185.95	164.76	181.38	147.82	131.26	140.24
Brown Shrimp	2.48	0.00	0.00	0.10	1.46	0.19	0.01	0.23	0.10	0.14	2.22
Lobster	11.29	15.29	28.03	20.12	22.23	32.69	30.98	30.07	25.80	22.13	15.88
Velvet Swimmer Crab	1.20	2.11	2.02	0.09	0.11	0.00	0.00	0.00	0.74	0.09	0.00

Plate 9.1.6: Crustacean landings from ICES rectangle 35F1



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Herring	2.13	0.00	0.00	1.32	0.40	0.00	0.02	0.00	0.86	0.63	0.32
Cod	2.50	0.03	0.60	0.12	0.30	0.12	0.12	0.00	0.00	0.01	0.01
Bass	0.22	0.00	0.34	2.52	0.08	0.18	0.09	0.00	0.03	0.00	0.03
Dover Sole	0.08	0.00	0.01	0.02	9.72	8.69	2.27	0.57	0.00	0.02	0.03
Plaice	0.02	0.60	0.11	0.01	5.74	9.13	4.21	0.69	0.00	0.00	0.00
Brill	0.02	0.00	0.00	0.00	1.02	0.25	0.36	0.07	0.00	0.00	0.00
Whiting	1.53	0.00	0.33	0.04	0.26	0.11	0.01	0.00	0.00	0.02	0.00

Plate 9.1.7: Finfish landings over 1 tonne from ICES rectangle 35F1



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Thornback Ray	2.61	0.00	0.61	3.96	1.62	0.61	0.22	0.00	0.00	0.31	0.09
Blonde Ray	0.11	0.00	0.03	0.09	3.18	1.11	0.30	0.00	0.00	0.00	0.00

Plate 9.1.8: Elasmobranch landings from ICES rectangle 35F1

9.1.2.2 International Beam Trawl Survey

9.1.2.2.1 Local Study Area

25. Eighty-one fish and shellfish species were recorded in the local study area as defined by ICES rectangles 34F1 and 35F1 from stations shown in **Figure 9.2**. CPUE data for the principal species recorded between 2010 and Q1 2020 is shown in **Table 9.1.3**. Greater sandeel CPUE was the highest in ICES rectangle 35F1 (**Figure 9.26**). Sprat had the highest CPUE in ICES rectangle 34F1 (**Figure 9.23**). As described in **Section 9.1.1.2.2** there are no IBTS stations within the SEP or DEP sites and the closest station is 10.12km northeast of the DEP North array area.

9.1.2.2.2 Regional Study Area

26. The regional study area is defined by ICES rectangles 34F0 and 35F0. There are no IBTS survey data for ICES rectangle 34F0. As shown in **Figure 9.1** this area is inshore and a large proportion is over-land and therefore no IBTS data are available for this ICES rectangle. **Figure 9.2** shows the IBTS sample stations for ICES rectangle 35F0 between 2010 and 2020. **Table 9.1.3** shows that, of the fish species, Raitt's sandeel had the highest CPUE in ICES rectangle 35F0 (**Figure 9.26**).

Table 9.1.3: Average CPUE (number/hour) for principal species recorded in the IBTS in ICES rectangles 34F1, 35F1 and 35F0 (2010-Q1 2020) (DATRAS, 2021).

Common name	Scientific name	CPUE (individuals per hour)		
		34F1	35F1	35F0
Greater sandeel	*Hyperoplus lanceolatus*	6.5071	443.7867	56.2047
Sprat	*Sprattus sprattus*	69.9862	295.1327	115.8455
Mackerel	*Scomber scombrus*	0.0000	116.1353	2.9307
Herring	*Clupea harengus*	9.8833	106.6844	7.4480
Raitt's sandeel	*Ammodytes marinus*	1.0556	83.7856	1489.9288
Lesser weever	*Echiichthys vipera*	2.4780	66.8199	1.5008
Whiting	*Merlangius merlangus*	13.8378	51.1092	127.8195
Dab	*Limanda limanda*	4.8491	32.8362	14.9715
European common squid	*Alloteuthis subulata*	0.0000	16.6171	1.6324
Solenette	*Buglossidium luteum*	4.7059	12.8668	0.1539
Horse mackerel	*Trachurus trachurus*	0.0000	12.0962	1.7895
Atlantic Cod	*Gadus morhua*	2.0741	1.1335	2.6473
Plaice	*Pleuronectes platessa*	14.5102	10.3517	3.9260
Grey gurnard	*Eutrigla gurnardus*	0.9375	9.0816	1.9360
Veined squid	*Loligo forbesi*	0.0000	8.9542	7.9290
Pogge	*Agonus cataphractus*	4.3879	8.5325	9.2864
Lemon sole	*Microstomus kitt*	4.5737	8.2117	6.5097
Poor cod	*Trisopterus minutus*	1.8378	7.8926	10.2489

Common name	Scientific name	CPUE (individuals per hour)		
		34F1	35F1	35F0
Lesser spotted dogfish	*Scyliorhinus canicula*	0.4615	5.3086	5.5745
Brown crab	*Cancer pagurus*	11.6889	4.8947	8.9619
Butterfish	*Pholis gunnellus*	17.5385	1.3403	4.1693
Lesser sandeel	*Ammodytes tobianus*	18.6667	0.9778	0.0000
Corbain's sandeel	*Hyperoplus immaculatus*	8.2632	0.0500	0.0000

The colour intensity illustrates CPUE from high (dark) to low (light)

Greater than 100	
Between 30 and 100	
Between 10 and 20	
Between 5 and 10	
<5	

9.1.2.3 Spawning and Nursery Grounds

27. Spawning and nursery grounds defined by Coull *et al.* (1998), Ellis *et al.* (2012) and Aires *et al.* (2014) have been used to indicate which species may have spawning and nursery grounds in the SEP and DEP sites. As presented in **Table 9.1.4**, these data indicate that herring, Dover sole, whiting, sandeel and lemon sole may have spawning grounds that overlap with SEP and DEP, with their seasonal spawning periods illustrated in **Table 9.1.5**. These species also have nursery grounds in the SEP and DEP areas, as do cod, plaice, mackerel and thornback ray (**Table 9.1.4**). It should be noted that Dover sole and thornback ray nursery areas are restricted to shallower inshore waters (see also **Figure 9.14** and **Figure 9.34**).

Table 9.1.4: Species that may have spawning / nursery grounds in the SEP and DEP sites.

Species	Spawning				Nursery			
	DEP wind farm site	Interlink Cable Corridor	SEP wind farm site	Offshore Export Cable Corridor	DEP wind farm site	Interlink Cable Corridor	SEP wind farm site	Offshore Export Cable Corridor
Herring					L-M	L-M	L-M	L-M
Cod					L	L	L	L**
Dover Sole					L	L	L	L**
Plaice					L	L	L	L**
Mackerel					L	L	L	L
Whiting					L-M	L-M	L-M	L-M
Sandeel					M-H	M-H	M-H	M-H
Lemon sole								
Thornback ray	Not defined							

Source	Symbol	Key
Ellis *et al.* (2012)		Low intensity
Coull *et al.* (1998)		Undefined intensity
Aires *et al.* (2014)	L-M/M-H	Probability presence of 0-group fish
Ellis *et al.* (2012) & Coull *et al.* (1998)		No overlap

Table 9.1.5: Spawning Periods of Species Present in and Around the SEP and DEP Sites.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Herring												
Cod		*	*									
Dover sole				*								
Plaice	*	*										
Mackerel					*	*	*					
Whiting												
Sandeel												
Lemon sole												
Thornback ray				*	*	*	*	*				
Spawning												
Peak spawning	*											

9.1.2.4 Historic Site Surveys

28. As described in **Section 9.1.1.2**, a variety of surveys have been undertaken in relation to the existing Dudgeon and Sheringham Shoal OWFs. Although these surveys were undertaken some time ago, the results provide an indication of the fish and shellfish assemblage that is likely to be present in the vicinity of SEP and DEP.

9.1.2.4.1 Otter Trawl Surveys

29. Otter trawl surveys were conducted in the Sheringham Shoal OWF area in April 2005 and in the Dudgeon OWF area in May and October 2008. Over 43 fish and shellfish species were recorded, as summarised in **Table 9.1.6**.

30. The April 2005 Sheringham Shoal OWF survey recorded a total of 30 species. Herring was the most abundant species caught, followed by velvet crab *Necora puber*, whiting *Merlanguis merlangus*, harbour crab *Liocarcinus depurator*, pink shrimp *Pandalus montagui* and flying crab *Liocarcinus holsatus* (**Table 9.1.6**).

31. Thirteen species were recorded in otter trawls undertaken in May 2008 at the Dudgeon OWF with velvet swimming crab and dab the most abundant. A greater diversity and abundance was recorded by the autumn survey of the same year with 27 species recorded. Whiting was by far the most abundant species in the October catches, followed by dab and velvet swimming crab. Herring was only recorded at Dudgeon from the autumn survey. Veined squid *Loligo forbesi* was moderately abundant in the October survey having been absent from other spring otter trawl surveys at both the Sheringham Shoal and Dudgeon OWFs. Brown crab was also landed by the Dudgeon OWF autumn survey. Harbour crab and pink shrimp, which were abundant in the Sheringham Shoal OWF survey, were not recorded at Dudgeon.

32. A summary of species recorded, and their abundance, is provided in **Table 10.1.6**

Table 9.1.6: Summary of species and individuals recorded by otter trawl surveys.

Common name	Scientific name	Sheringham Shoal	Dudgeon		TOTAL
		Apr-05	May-08	Oct-08	
Whiting	*Merlanguis merlangus*	293	4	1752	2049
Velvet crab	*Necora puber*	494	28	119	641
Herring	*Clupea harengus*	565		71	636
Dab	*Limanda limanda*	32	11	504	547
Harbour crab	*Liocarcinus depurator*	185			185
Pink shrimp	*Pandalus montagui*	103			103
Flying crab	*Liocarcinus holsatus*	95			95
Veined squid	*Loligo forbesi*			59	59
Brown crab	*Cancer pagurus*	1		54	55
Grey gurnard	*Eutrigla gurnhardus*	24	4	25	53
Lesser weever fish	*Echiichthys vipera*	37	2	10	49
Pout	*Trisopterus luscus*	13		32	45
Starry smoothhound	*Mustelus asterias*			44	44
Bull rout	*Myoxocephalus scorpius*		1	39	40
Long-spined sea scorpion	*Taurulus bubalis*	35			35
Cod	*Gadus morhua*	5	1	27	33
Common dragonet	*Callionymus lyra*	8		23	31
Lobster	*Homarus gammarus*	17	2	12	31
Plaice	*Pleuronectes platessa*			18	18
Pogge / hook-nose	*Agonus cataphractus*	16			16
Red mullet	*Mullus surmuletus*			15	15
Thornback ray	*Raja clavata*	11	1	2	14
Lemon sole	*Microstomus kitt*	1		12	13
Tub gurnard	*Chelidonichthys lucerna*			11	11
Less. spotted dogfish	*Scyliorhinus canicula*	2		9	11
Poor cod	*Trisopterus minutus*			8	8
Squid	*Loligo spp.*		7		7
Queen scallop	*Aequipecten opercularis*			5	5
Mussel	*Mytilus edulis*	3	1		4
Smoothhound	*Mustelus mustelus*			3	3
Brill	*Scophthalmus rhombus*	1		2	3
Common crab	*Carcinus maenas*	3			3
Fivebeard rockling	*Ciliata mustela*	3			3
Brown shrimp	*Crangon cragon*	3			3
Spider crab	*Macropodia linaresi*	3			3
Sole	*Solea solea*	3			3
Sprat	*Sprattus sprattus*	1	2		3

Common name	Scientific name	Sheringham Shoal	Dudgeon		TOTAL
		Apr-05	May-08	Oct-08	
Mackerel	*Scomber scombrus*			2	2
Spotted ray	*Raja montagui*	1	1		2
Sandeel	*Amodytes spp.*			1	1
Bass	*Dicentrarchus labrax*			1	1
Sea snail	*Liparis liparis*	1			1
Flounder	*Platichthys flesus*	1			1

The colour intensity illustrates CPUE from high (dark) to low (light)	>10,000	
	1,000 - 10,000	
	100 - 1,000	
	10 - 100	
	1 - 10	
	<1	

9.1.2.4.2 Beam Trawl Surveys

33. Eight beam trawl surveys recording fish and epibenthos have been conducted at the Sheringham Shoal and Dudgeon OWF areas between 2005 to 2014 (2m and 7m beams). Over 115 fish and shellfish species were recorded as summarised in **Table 9.1.7**.

34. Crustaceans, and particularly shrimp species, dominated catches. Pink shrimp was the most abundant species recorded. Across all the surveys, 908,216 individuals were caught and recorded, totalling almost ten times the next most abundant species, brown shrimp *Crangon crangon* (**Table 9.1.7**). The shrimp *Pandalina brevirostris* was also recorded in abundance from those surveys conducted in October 2008 and September 2014 at Dudgeon, and the December 2012 survey at Sheringham Shoal.

35. Crabs were also abundant, particularly swimming crab species. The harbour crab *Liocarcinus depurator* was the third most commonly recorded species across the surveys, and the velvet swimming crab *Necora puber* and flying crab *Liocarcinus holsatus* were also common. Long-clawed porcelain crab *Pisidia longicornis* was the fourth most common species recorded and the closely related spider crabs *Macropodia parva* and *Macropodia rostata* were also recorded in high numbers by the October 2008 and September 2014 surveys at Dudgeon and the December 2012 survey at Sheringham Shoal.

36. The most prevalent fish species caught was the lesser weever fish *Echiichthys vipera*, followed by dragonet *Callionymus lyra* and the painted goby *Pomatoschistus pictus*. The abundance of these species varied across the surveys, with some species being completely absent from some (**Table 9.1.7**). The non-native invasive slipper limpet *Crepidula fornicata* was the most abundant mollusc recorded across all surveys. It was recorded by all but the December 2012 post-construction survey for Sheringham Shoal and was the fifth most abundant species across all beam trawl surveys.

Table 9.1.7: Summary of the most abundant species and number of individuals recorded by beam trawl surveys.

Common name	Scientific name	Sheringham Shoal						Dudgeon				TOTAL
		Apr-05	Jul-05	Sep-05	Dec-12	Apr-14	Total	May-08	Oct-08	Sep-14	Total	
Pink shrimp	*Pandalus montagui*	91	11466	437173	4227		452,957		1,338	5,282	6,620	**459,577**
Brown shrimp	*Crangon crangon*	24	50	4014	421	29	4,538	7	626	235	868	**5,406**
Harbour crab	*Liocarcinus depurator*	69	216	113	2688		3,086	34	709	241	984	**4,070**
Long-clawed porcelain crab	*Pisidia longicornis*	634	243		809	4	1,690		1,381	435	1,816	**3,506**
Slipper limpet / shell	*Crepidula fornicata*	304	135	183		9	631	19	1,257	1,171	2,447	**3,078**
Shrimp	*Pandalina brevirostris*				1153		1,153		1,584	324	1,908	**3,061**
Lesser weever fish	*Echiichthys vipera*	2	987	518		1	1,508	31	34		65	**1,573**
Velvet swimming crab	*Necora puber*	101	386	878		6	1,371		22	60	82	**1,453**
Dragonet	*Callionymus lyra*	6	97	912	102	21	1,138	14	147		161	**1,299**
Painted goby	*Pomatoschistus pictus*		4	9	305		318		706		706	**1,024**
Flying crab	*Liocarcinus holsatus*	23	68	415			506	10	352	56	418	**924**
Spider crab	*Macropodia sp.*		9	20			29		796		796	**825**
Spider crab	*Macropodia parva/rostrata*	10			472	1	483			269	269	**752**
Sand goby	*Pomatoschistus minutus*			6			6		604		604	**610**
Shrimp	*Crangon allmanni*					2	2		555		555	**557**
Discord mussel	*Musculus discors*	498					498				0	**498**
Long-spined sea scorpion	*Taurulus bubalis*		2	171	255		428		61		61	**489**
Swimming crab	*Liocarcinus*					361	361				0	**361**
Painted top shell	*Calliostoma zizyphinum*	15	54	152		1	222		128		128	350

The colour intensity illustrates total landings from high (dark) to low (light).

>10,000	1,000 – 10,000	100 – 1,000	10 - 100	1 - 10	<1

9.1.2.4.3 Summary of Otter and Beam Trawl Surveys

37. **Table 9.1.8** presents the most abundant species recorded by historic otter trawl and beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas. It is important to note that the ranking should not be considered a wholly accurate reflection of the relative abundances of the recorded species because surveys were not designed to obtain this information. The demersal trawls used differ in their ability to sample certain species, and there has been more survey effort using beam trawls (eight surveys) than otter trawls (three surveys). Some species which are not efficiently sampled by these gears may be underreported (e.g. sandeels). Nevertheless these surveys, in addition to the other historic site surveys described in **Sections 9.1.2.4.4** and **9.1.2.4.5** below, provide the best indication of the fish and shellfish species expected to be present in the SEP and DEP offshore sites due to their geographical proximity to SEP and DEP. The species in **Table 9.1.8** are presented in descending order of individuals recorded across all the otter and beam trawl surveys as an indication of likely relative abundance, noting the caveats described above.

Table 9.1.8: Most abundant combined species totals from historic beam and otter trawl surveys of the Sheringham Shoal (SS) and Dudgeon OWF areas. See Annex 2 for full list (colour intensities follow the same range as Table 9.1.7).

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Pink shrimp	*Pandalus montagui*	452,957	6,620	459,577	103	0	103	**459,680**
Brown shrimp	*Crangon crangon*	4,538	868	5,406	3	0	3	**5,409**
Harbour crab	*Liocarcinus depurator*	3,086	984	4,070	185	0	185	**4,255**
Long-clawed porcelain crab	*Pisidia longicornis*	1,690	1,816	3,506				**3,506**
Slipper shell	*Crepidula fornicata*	631	2,447	3,078				**3,078**
Shrimp	*Pandalina brevirostris*	1,153	1,908	3,061				**3,061**
Whiting	*Merlangius merlangus*	80	2	82	293	1756	2049	**2,131**
Velvet swimming crab	*Necora puber*	1,371	82	1,453	494	147	641	**2,094**
Lesser weever fish	*Echiichthys vipera*	1,508	65	1,573	37	12	49	**1,622**
Dragonet	*Callionymus lyra*	1,138	161	1,299	8	23	31	**1,330**
Painted goby	*Pomatoschistus pictus*	318	706	1,024				**1,024**
Flying crab	*Liocarcinus holsatus*	506	418	924	95	0	95	**1,019**
Spider crab	*Macropodia sp.*	29	796	825				**825**
Dab	*Limanda limanda*	186	34	220	32	515	547	**767**
Spider crab	*Macropodia parva/rostrata*	483	269	752				**752**
Herring	*Clupea harengus*				565	71	636	**636**
Sand goby	*Pomatoschistus minutus*	6	604	610				**610**
Shrimp	*Crangon allmanni*	2	555	557				**557**
Long-spined sea scorpion	*Taurulus bubalis*	428	61	489	35	0	35	**524**
Discord mussel	*Musculus discors*	498	0	498				**498**
Veined squid	*Loligo forbesii*	316	0	316		59	59	**375**

9.1.2.4.4 Elasmobranch surveys

38. Pre-cable installation elasmobranch surveys were undertaken in August 2010 at the Sheringham Shoal OWF, followed by post-cable installation elasmobranch surveys in November 2012, August 2013 and August 2015. The surveys were aimed at assessing whether operational export cables had an effect on the local distribution of elasmobranchs and the feeding behaviour of lesser spotted dogfish (Brown and May Marine, 2010a). Feeding behaviour of lesser spotted dogfish was obtained by analysis of stomach contents of individuals caught during the surveys.

39. **Table 9.1.9** summarises the landings recorded by the four elasmobranch surveys.

Table 9.1.9: Total and Average Number of Individuals Caught for Each Species in Elasmobranch Surveys at Sheringham Shoal OWF

Species	2010		2012	2013	2015	
	Total Caught	Average Catch Rate			Total Caught	Average Catch Rate
Starry smoothhound	82	2.2	0	1	13	0.5
Lesser spotted dogfish	47	1.7	0	0	15	0.42
Thornback ray	39	1.4	0	0	4	0.12
Spotted ray	5	0.2	0	0	3	0.8
Tope	0	0	0	0	2	0.04
Total	**173**	**-**	**0**	**1**	**37**	**-**

40. The August 2010 survey recorded a total of 173 elasmobranch individuals across four[3] species. No elasmobranchs were recorded during the November 2012 survey, with only whiting (>250) landed; and the August 2013 survey recorded one elasmobranch, a starry smoothhound, and one dab. As there were no lesser spotted dogfish caught in either of those surveys, their feeding behaviour could not be assessed. The final post-construction survey in August 2015 recorded five species and at total of 37 individuals, including 15 lesser spotted dogfish. Bycatch species included 19 seabass *Dicentrarchus labrax*, nine whiting, three dab and one of grey gurnard *Eutrigla gurnardus*, red gurnard *Chelidonichthys cuculus*, sea scorpion *Taurulus bubalis* and tub gurnard *Chelidonichthys lucerna* (Brown and May Marine, 2015).

[3] Original report states five species were recorded. At the time of survey, it was deemed that starry smoothhounds and common smoothhounds could be easily identified visually. However, there are no recent confirmed records of common smoothhounds being captured in UK waters (Planning Inspectorate, 2019). Farrell *et al*. (2009) confirmed the difference between the species can only be verified through genetics. (Section 9.1.3.4.3).

41. In addition, it is notable that Brown and May Marine (2013) concluded, from the studies and the MMO's 2014 review of environmental data associated with post consent monitoring, that the electromagnetic fields (EMFs) produced by offshore electricity cables may cause behavioural effects, but that these are not significant enough to alter feeding or migratory behaviour. However it was also noted that biological and / or environmental factors are likely to determine the abundance of elasmobranchs (Brown and May Marine, 2013).

42. Prey species recorded from the stomach contents of 17 of the lesser spotted dogfish caught by the 2010 survey were diverse and included cephalopods, crustaceans, polychaete worms and molluscs. **Table 9.1.10** shows that veined squid (which were used as the bait) and the hermit crab *Pagurus bernhardus* were the dominant species found. The stomach contents of 15 specimens caught by the 2015 survey are not quantified in the survey report, but prey species were similar to the 2010 survey with *P. bernhardus* and veined squid (Brown and May Marine, 2015).

Table 9.1.10: Summary of Identified Species in the Contents of Lesser Spotted Dogfish.

Common Name	Scientific Name	Total
Veined squid	*Loligo forbesii*	19
Hermit crab	*Pagurus bernhardus*	19
Cephalopods (unclassified)	*Cephalopoda*	16
Crustaceans (unclassified)	*Crustacea*	12
Peanut worm	*Golfingia vulgaris*	11
Polychaete worm	*Polychaeta*	10
Shrimp	*Callianassidae*	8
Brown crab	*Cancer pagurus*	8
Swimming crab	*Liocarcinus sp.*	6
Peanut worms (other)	*Sipunculidea*	5
Molluscs (unclassified)	*Mollusca*	4
Ray-finned fish	*Actinopterygii*	2
Pink shrimp	*Pandalus montagui*	2
Bivalve mollusc (unclassified)	*n/a*	1
Spider crab	*Majidae*	1
Polychaete worm	*Phyllodocidae*	1
Flounder	*Pleuronectidae*	1

9.1.2.4.5 Herring spawning surveys

43. SEP and DEP are located within a potential herring spawning area identified by Coull *et al.,* (1998) as the southern limit of the Banks group spawning area where spawning occurs from August to October. Site specific herring spawning surveys were conducted at the Dudgeon and Sheringham Shoal OWFs with transects and trawls overlapping with the SEP and DEP wind farms and the offshore section of the offshore export cable corridor north of the Sheringham Shoal sandbank feature (Brown and May Marine, 2009; 2010b).

44. Herring spawning surveys were undertaken in October 2008 at the Dudgeon OWF (**Table 9.1.1**). The surveys did not record many herring and the catches were predominantly sprat. The majority of herring caught were not ripe and were in "maturing virgin stage". Only one was "recovering" and another in "virgin" stage. The surveys did not identify any spawning aggregations in the area.

45. Similarly, herring spawning surveys were undertaken at the Sheringham Shoal OWF at regular intervals between September to December 2009, and again between September and November 2010 (**Table 9.1.1**).

46. In the 2009 surveys, sprat was the dominant species caught. The greatest number of herring were caught from October to early November (**Table 9.1.11**) and these catches were collected from significant shoals observed on the echo-sounder (on trips 3 and 4 only). The majority of herring caught by trip 3 and 4 were at the sexual maturity stage of "ripening" and when the average sea temperature ranged between 12.25 to 13.14°C.

47. Temperature is considered a factor influencing the timing of herring spawning with studies finding the presence of large herring aggregations associated with surface temperatures between 11°C and 12.5°C and to a lesser extent around 14°C (Maravelias & Reid, 1997; Maravelias, 1997; Maravelias & Reid, 1995). The larger catches from trips 3 and 4 may correlate with the temperature declining, providing ideal conditions for larvae (~11°C (Rockmann *et al*., 2011)). Furthermore, the male to female ratio reached approximately 50:50 by trip 3, and may have remained so for the remainder of the survey period although this is uncertain because of the higher proportions of individuals for which gender was unidentified (**Table 9.1.11**).

48. It was expected that on trips 4 to 6, samples would show a gradual maturing of the herring caught. However, this was not the case, with samples comprising of immature fish and either ripening or late ripening fish. Over the six surveys in 2009, around two thirds of herring caught were sexually immature, and found to be "virgin" or "late virgin". Only six "ripe" herring were caught during the survey periods (Brown and May Marine, 2009).

49. The report concluded that there were no significant herring spawning in the survey area, and that the stock collapse in the 1970s changed spawning patterns in the North Sea (Brown and May Marine, 2009).

50. Post-construction surveys in 2010 showed a similar pattern to the pre-construction surveys in 2009, with herring numbers peaking in late October and sprat the dominant species caught throughout these surveys in terms of numbers, with the exception of trip 3 where large numbers of herring were caught. However, the sea temperature declined earlier during the 2010 surveys (**Table 9.1.11**). As with the pre-construction surveys, the sex ratio was almost equal during peak abundance in late October (Trip 3).

51. Although there was an increase in the average age of herring recorded over the 2010 survey period, almost 79% of the total herring caught were sexually immature and found to be “virgin” with 18% being “ripening”. Only two “ripe” herring were caught over the 2010 survey period (Brown and May Marine, 2010b).

52. As with the pre-construction survey, the 2010 survey report concluded that herring spawning did not occur in the survey area (Brown and May Marine, 2010b).

53. An assessment of the suitability of the sea bed in the SEP and DEP areas for herring spawning is summarised in **Section 9.1.3.3.1**.

Table 9.1.11 Summary of herring survey data

Phase	Date of Survey Trip	Number of Trawls	Number of Herring Caught	Catch Rate of Individuals per hour	Sex Ratio %			Average	
					Male	Female	UND[4]	Temp (°C)	Salinity (‰)
Dudgeon (2008)	14th to 17th October	3	102	43.1	55.9	44.1	0.0	n/a	n/a
Sheringham Shoal Pre-construction (2009)	Trip 1 (21st - 24th Sept)	22	22	65.3	45.5	54.5	0.0	15.27	34.36
	Trip 2 (5th - 8th Oct)	26	889	2,654.0	52.1	34.9	13.0	14.34	34.23
	Trip 3 (19th - 22nd Oct)	22	46,377	1,909.2[5]	48.8	49.9	1.3	13.14	34.43
	Trip 4 (2nd - 6th Nov)	28	1,029	3,820.5	33.8	32.5	33.7	12.25	34.27
	Trip 5 (16th - 17th Nov)*	5	77	230.3	5.2	3.9	90.9	11.46	34.39
	Trip 6 (2nd - 8th Dec)	23	340	1,020.7	29.7	25.3	45.0	9.29	34.16
Sheringham Shoal Post- construction (2010)	Trip 1 (27th Sep - 1st Oct)	22	1,750	220.7	1.4	1.3	97.4	14.2	34.3
	Trip 2 (11th - 14th Oct)	22	1,439	190.2	1.9	2.1	96.0	13.8	34.4
	Trip 3 (25th - 28th Oct)	20	18,458[6]	2,930.9	49.2	44.3	6.5	11.7	34.3
	Trip 4 (20th - 23rd Nov)	21	55	8.1	61.8	38.2	0	9.4	34.0

*Survey trip abandoned

[4] Undetermined
[5] Excluding samples caught from station OT02a, the catch rate of individuals per hour including those from that station is 354,585.8
[6] Estimated number of herring caught

9.1.2.5 Aerial surveys

54. As described in **Section 9.1.1.2**, digital aerial baseline surveys of the SEP and DEP array sites have run since May 2018 to April 2020 for the identification of offshore ornithology and marine megafauna, but have also recorded some unidentified fish and sharks swimming at the surface (**Table 9.1.12**).

Table 9.1.12: Summary of fish and sharks recorded from aerial surveys

Observation	Date	Identification
Shark	06th August 2018	No ID
Fish	10th May 2019	No ID
Fish	03rd July 2019	No ID
Shark	03rd July 2019	No ID
Shark	08th August 2019	Lesser spotted dogfish
Shark	08th August 2019	Lesser spotted dogfish

9.1.3 Commercial Species

55. The ecology of commercially important fish and shellfish species present in the local study area are described in this section. These are defined as those species with UK landings totalling more than two tonnes between 2008 and 2018 (as set out in **Table 9.1.2**).

9.1.3.1 Molluscs

56. The following sections describe commercially exploited mollusc species in the local study area, their ecology and evidence of their presence in the Project areas. Species are discussed in descending order of landings over the period 2009 to 2019.

9.1.3.1.1 Whelks

57. The common whelk *Buccinum undatum* is a gastropod mollusc, common in the subtidal waters of the northeast Atlantic, including the North Sea. Whelks are generally found from the shallow subtidal down to depths of a few hundred metres on a range of hard and soft subtidal substrates and occasionally in intertidal fringes (Haig *et al*., 2015). MMO landings data show that whelks are abundant in the local area as defined by ICES rectangles 35F1 and 34F1, supporting a significant fishery.

58. Populations vary in their length frequencies, genetic structure, and size of maturity (SoM) over very small spatial scales. Whelks from The Wash to Lowestoft reach SoM at 55mm (EIFCA, 2019). They have limited dispersal potential and display little adult movement (Pálsson *et al*., 2014). They are slow to mature and show a distinct breeding seasonality (Haig *et al*., 2015).

59. Females release pheromones to attract males to reproduce. Females may store sperm for up to eight weeks until the eggs are ready to fertilise (Haig *et al*., 2015). In UK coastal waters egg capsules are laid on hard sea bed areas during the autumn and winter months (predominantly late November to January) when water temperatures drop below 9°C. Whelk eggs and larvae do not enter the plankton layer, limiting dispersal, and therefore they are vulnerable to over-exploitation and are slow to recover in over-fished areas (EIFCA, 2019).

60. The largest fisheries for this species occur in Northern Europe and particularly the United Kingdom which landed 22,700 tonnes in 2016 (£22.9 million, MMO, 2017), more than half of the worldwide total of over 41,000 tonnes (FAO, 2018). Whelks are targeted using pots and whelk fisheries are among the most important in the UK (after nephrops, scallop, crab, and lobster). A mapping project completed by the Eastern Inshore Fisheries and Conservation Authorities (EIFCA) identified whelk fishing grounds that overlap with the Dudgeon North extension and parts of the SEP wind farm (see **Chapter 12 Commercial Fisheries, Appendix 12.1**).

61. It has also been suggested that the absence of cod, a predator of whelks, might partly explain the abundance of whelks (REAF, 2019). There is also some concern that a large transfer of effort in recent years from other stocks into whelk fishing may be depleting the stock.

62. **Plate 9.1.1** shows that whelk landings from 34F1 (nearshore section of the export cable corridor) were low in 2009, increasing from 2001 up to a peak of 145 tonnes in 2014. Landings decreased in 2015 and reduced substantially to 60 tonnes in 2016. This was likely to be the result of implementation of the emergency Whelk Permit Byelaw within the 6nm limit in April 2015 by EIFCA, followed by the Whelk Permit Byelaw in October 2016. These byelaws were introduced due to fears that the stock could crash (EIFCA, 2019). Since then whelk landings have fluctuated, from 34F1 increasing to 238 tonnes in 2017, followed again by a substantial decrease to 35 tonnes in 2018, then an increase to 217 tonnes in 2019.

63. Whelk landings from 35F1 (arrays and interlink corridors) increased from 2008 to 2013 (peaking at 1,151 tonnes), then declined in 2014 and 2015 before increasing again, reaching 1,156 tonnes in 2019 (**Plate 9.1.5**).

64. Whelks were present in every year of the IBTS data from 35F1 but only in 2008 from 34F1, however CPUE was not recorded. Data from the historic site surveys did not record many whelks. Sheringham Shoal OWF beam trawl surveys in April and September 2005 recorded seven individuals. During Dudgeon OWF beam trawl surveys, 20 individuals were caught in 2008. However, the presence of a significant whelk fishery suggests that the species is relatively common in the Project areas, and that demersal trawls may under-record the species.

9.1.3.1.2 Mussels

65. The blue mussel (*Mytilus edulis*), also known as the common mussel, is very common around the coast of the British Isles, occurring from the high intertidal to the shallow subtidal zones. *M. edulis* can form tightly packed beds of one or more (up to five or six) layers attached by fibrous byssus threads to suitable substrata. Young mussels colonise spaces within the bed increasing the spatial complexity, and the bed provides numerous niches for other organisms. Overcrowding results in mortality as underlying mussels are starved or suffocated by the accumulation of silt and faeces, especially in rapidly growing populations. Death of underlying individuals may detach the mussel bed from the substratum, leaving the bed vulnerable to tidal scour and wave action (Tillin and Mainwaring, 2016).

66. The species reproduces by means of a planktonic larval stage. Eggs are fertilised in the water column and develop through several stages, until conditions are favourable to settle when larvae attach to the substrate by the secretion of the byssus and start to secrete the adult shell (Gazeau *et al*. 2010).

67. Spawning is protracted in many populations, with a peak of spawning in spring and summer when larvae can take advantage of seasonal phytoplankton blooms. In the Wash the main spawning season is in April and May and primary settlement is on the subtidal and secondary settlement usually takes place on the low-mid intertidal. Longevity of individuals is 8-10 years and beds can persist from <1 to 40+ years (Dare *et al*., 2004).

68. MMO landings data show that mussels were only landed in coastal waters within ICES rectangle 34F1 (containing the export cable corridor nearshore section), contributing an average of 5.30% of landings from 34F1 by tonnage. Similarly mussels contributed 2.82% and 4.77% of landings from rectangles 34F0 and 35F0 respectively, to the west of SEP and DEP (**Table 9.1.2**).

69. **Plate 9.1.1** shows that no mussels have been landed from 34F1 since 2011 and no mussels were landed from 35F1 (**Plate 9.1.5**). Blue mussels were present in 35F1 in 2013, 2014, 2016, 2017, 2019 and 2020 of the IBTS data, they were only present in 2019 and 2020 in 34F1 but CPUE was not recorded. Similarly blue mussels were recorded by historic site surveys in low numbers. Sheringham Shoal OWF surveys recorded only three individuals in otter trawls (**Table 9.1.6**) and 28 recorded in the beam trawls (**Table 10.1.A.1**). Dudgeon OWF otter trawl surveys recorded a single individual (**Table 9.1.6**) and Dudgeon beam trawl surveys did not record any mussels. Therefore the evidence suggests that the blue mussel is present in low abundance in the vicinity of SEP and DEP, particularly in the offshore area. However, there is the possibility that mussels are present in the form of high density beds in discrete areas. The presence or absence of such beds, which can form biogenic reefs, will be confirmed by project sea bed characterisation surveys. It is also possible that mussels may have colonised the surface of Sheringham Shoal and Dudgeon OWF subsea infrastructure.

9.1.3.1.3 Cockles

70. *Cerastoderma edule* (common cockle) is one of the most common and widely distributed bivalve species on tidal flats along the coast of most European countries. It is a ubiquitous species which can be found in estuaries and sandy bays, particularly in sandy mud, sand or fine gravel. Densities can vary from a few individuals per square meters to thousands. Higher densities are often observed around the mid-tidal level. The main stocks in the UK are The Wash, the Thames estuary, Morecambe and Caernarfon bays (Dabouineau and Alain, 2009).

71. MMO data show that cockles were only landed in some years between 2009 and 2019 in the area local to SEP and DEP (34F1 and 35F1) and were not landed from 2016 to 2018, however almost 11 tonnes were landed in 2019 (**Plate 9.1.1** and **Plate 9.1.5**). Cockles make a very small contribution to total landings in these areas whereas they are the most important fishery in terms of quantity landed in the region to the west (35F0 and 34F0) that incorporates The Wash (**Table 9.1.2**). No cockles were present in any of the IBTS data or the historic site surveys. The ecology of cockles and data show that they are restricted to coastal intertidal areas.

9.1.3.1.4 Scallops

72. King scallop *Pecten maximus* and queen scallop *Aequipecten opercularis* are found with The Wash estuary embayment. They are generally aggregated in clumps (cm^2), patches (m^2), beds (km^2) and grounds (>10 km^2). Distribution and densities of scallops from clumps to beds are associated with sand/gravel substrate, low decapod and fish predation, and high abundances of filamentous fauna that often grow on scallop shells (Stokesbury *et al*., 2007). The areas with highest abundance and the fastest growth rates of scallops are usually in areas with little mud (Brand, 2006).

73. Minchin (2003) states that the maximum age for the king scallop is about 22 years. However, in heavily fished areas, the average age / size is reduced and those caught commercially rarely exceed 16cm (Minchin, 2003). The timing of spawning is highly variable and may be influenced by both internal and external factors such as age and temperature respectively (Barber & Blake, 1991). King scallop have demonstrated differences in spawning cycles between populations which reflect not only differences in their responses to local environmental variables but are also a consequence of genetic adaptation.

74. Mature scallops spawn from April or May to September. They are highly fecund broadcast spawners and abundances may increase dramatically when conditions favour reproduction and survival. It takes between one to two days for fertilised eggs to develop into pelagic larvae. Approximately three weeks after they become larvae, they settle onto the sea bed before undergoing metamorphosis to their final form (Le Pennec *et al*., 2003).

75. Scallops have distinct habitat preferences, live in aggregated distributions and are relatively immobile so they are easily detected, and caught in commercial or recreational fisheries. Ease of capture, combined with variable recruitment patterns, make scallops very vulnerable to overfishing and lead to “boom and bust” fisheries (Brand, 2006).

76. MMO landings data for 'scallops' (**Table 9.1.2**, **Plate 9.1.1**, **Plate 9.1.5**) suggest that scallop fisheries are restricted to the offshore part (35F1) of the local study area but contribute only 0.06% of total landings from 35F1. Landings were sporadic and only recorded in 2011, 2014, 2016 and 2019. No scallops were landed from 34F1 between 2009 and 2019. Landings were more significant (averaging >200 tonnes) from the area to the west defined by 35F0.

77. Both king and queen scallops were present almost every year of the IBTS data in both 34F1 and 35F1, however CPUE was not recorded. King scallops were not present in 2009 from 34F1. Queen scallops were recorded in the beam trawl surveys undertaken in the Sheringham Shoal OWF area in July and September 2005 (21 and 87 respectively) (Table 9.1.7). In October 2008, five queen scallops were recorded by the otter trawl survey in the Dudgeon OWF area (Table 9.1.6). Therefore based on available evidence it is likely that the queen scallop is part of the fish and shellfish community in the SEP and DEP area, although the species does not support a significant fishery in the area. There are no records of king scallop from historic site surveys.

9.1.3.2 Crustaceans

78. The following sections describe commercially exploited crustacean species in the local study area, their ecology and evidence of their presence in the Project areas. Species are discussed in descending order of landings over the period 2009 to 2019.

9.1.3.2.1 Brown crab

79. Brown crabs *Cancer pagurus* are found in a range of intertidal and subtidal habitats to a depth of approximately 100m, on bedrock, under boulders, mixed coarse grounds and offshore in muddy sand (Neal and Wilson, 2008) feeding mainly on benthic invertebrates (particularly bivalves, small crabs and barnacles) although their capture in baited traps indicates that they will also scavenge for food. They move widely within a broad population range extending from Scandinavia to Portugal (Bridges, 2018). Recent research by Natural England suggests that in North Norfolk coastal waters adult brown crab are found primarily in areas of higher complexity chalk bed, whereas juveniles are found in all areas including flat areas of flint and chalk cobbles, sand and gravel where chalk bed is not exposed (Tibbitt *et al*., 2020).

80. They sustain an important crab potting fishery in the area local to SEP and DEP. Brown crab is the most important crustacean species landed from rectangles 34F1 and 35F1 targeted primarily by UK potting fleets (see **Chapter 12 Commercial Fisheries, Appendix 12.1**), contributing 985.03 tonnes (34.8%) and 1,594.33 tonnes (15.4%) of total landings respectively between 2009 and 2019 (**Table 9.1.2**). It was the species landed in the greatest quantity (tonnage) over the period in the nearshore area (34F1) with a general trend of increasing landings from 2009 to 2019 (**Plate 9.1.2**).

81. Total brown crab landings were second only to whelks in the offshore area (35F1), showing an increasing trend from 2009 to 2013 than declining slightly until 2018 before increasing in 2019 (**Plate 9.1.6**). Brown crab was also landed in significant quantities from rectangle 35F0 to the west of the local area.

82. Adults have a distinct carapace that is orange-brown colour, broadly oval with a pie-crust edge that a carapace width of 150-300mm (Tonk and Rozemeijer, 2019). They undertake wide-ranging migrations over considerable distances to offshore overwintering grounds where eggs are hatched, moving back to coastal areas around May (Edwards, 1979; Bennett, 1995; Tonk and Rozemeijer, 2019). The findings of tagging studies suggest that mature females undertake long-distance migrations whilst the movements of males and immature females is more random, in local areas (Edwards, 1979; Bennett, 1995). The results of suture tagging experiments carried out off the Norfolk coast (Edwards, 1979) suggest a northerly long-distance movement of mature females.

83. Brown crab mating occurs in spring and summer with activity peaking between July and September, after females have moulted. Females are 'berried' (carrying eggs under the abdomen) for 6-9 months after copulation. They do not feed, remaining in pits dug in the sediment or under rocks over the winter period and are unlikely to be caught in a baited pot (Thompson *et al*., 1995). In the North Sea, berried females then migrate offshore to release larvae in late spring/early summer and then move back inshore to feed (Slijkerman, 2008).

84. The larvae are transported in the local hydrological environment for around two months before the crab larvae settle in an intertidal habitat. Juvenile growth then occurs in this intertidal habitat on shallow hard substrate areas along the coastline. Once the juveniles reach sexual maturity after about three years, they move offshore into deeper waters. This growth is then dictated by the moulting frequency which occurs on a yearly cycle (Cefas, 2017a).

85. Brown crab was present in every year of the IBTS data with an average CPUE of 11.6889 in rectangle 34F1 (nearshore) and 4.8947 in 35F1 (offshore) between 2010 and 2020 (**Figure 9.3** and **Table 9.1.3**) (DATRAS, 2020).

86. All but one of the five beam trawl surveys completed in the Sheringham Shoal OWF area recorded brown crab (maximum of 40 individuals in April 2014), and two of the three beam trawl surveys of the Dudgeon OWF area recorded brown crab (maximum of 33 individuals in October 2008). The April 2005 otter trawl survey of the Sheringham Shoal OWF area recorded one individual. Of the two otter trawl surveys of the Dudgeon OWF area in 2008, none were recorded in May, but 54 individuals were recorded in October (**Table 9.1.6**). A mapping project completed by the EIFCA identified crab fishing grounds that overlap with SEP and DEP (see **Chapter 12 Commercial Fisheries, Appendix 12.1**).

87. The survey evidence, coupled with the presence of a significant brown crab fishery, suggests that brown crab is present and may be relatively abundant in the Project areas.

9.1.3.2.2 Lobster

88. European Lobster *Homarus Gammarus* has an extensive range from Scandinavia to North Africa, where they occupy solitary shelters in rocky substrates to depths of 150m. They are opportunistic scavengers, as well as preying on small crustaceans, molluscs and polychaete worms (Cefas 2017b). Unlike brown crabs, lobsters of both sexes are typically sedentary, occupying small territories, although some interaction between inshore to offshore and longshore migration has been recorded at certain locations (Cefas, 2014) possibly driven by local competition for food or requirements to move to a different habitat throughout their different life-stages.

89. Moulting occurs in summer approximately once a year for adults, becoming less frequent in older animals, and mating occurs soon after the female has moulted (Cefas, 2014). Berried females generally appear from September to December in areas where lobsters are normally present, with eggs carried externally on females until April/May. As they do not carry out extensive migrations, hatching normally takes place in the same grounds (in spring and early summer) (Pawson, 1995). The distribution of the larvae and abundance is dictated by a combination of the local hydrological environment and individual behaviour (Pawson, 1995). Nursery grounds are thought to occur on rocky grounds in coastal waters that provide suitable protection from predators (Howard & Bennet, 1979; Bannister *et al*, 1994; Pawson, 1995).

90. MMO landings data show that the area sustains an active commercial lobster fishery (**Table 9.1.2**), dominated by the UK potting fleet (see **Chapter 12 Commercial Fisheries, Appendix 12.1**). The landed weight of lobsters between 2009 and 2019 in rectangles 34F1 and 35F1 is similar at 257.1 tonnes and 254.51 tonnes respectively. However, lobster landings contribute a greater proportion of total landings from 34F1 at 9.08% compared to 2.45% to 35F1. Landings were relatively consistent from 2008 to 2019 (**Plate 9.1.2** and **Plate 9.1.6**). A mapping project completed by the EIFCA identified lobster fishing grounds that overlap with SEP and DEP (see **Chapter 12 Commercial Fisheries, Appendix 12.1**).

91. The IBTS recorded lobsters every year from stations in rectangle 35F1 (offshore area) between 2010 and 2020 with an average CPUE of 3.63261 (**Figure 9.4**). The IBTS recorded lobsters in 2014 (2) and 2016 (6) from stations in rectangle 34F1, with an average CPUE is 0.5333 (DATRAS, 2020). However it is worth noting that the IBTS stations in 34F1 are further from the SEP and DEP area (**Figure 9.4**).

92. Lobsters were recorded in historic site otter trawl surveys at the Sheringham Shoal and Dudgeon OWF areas (**Table 9.1.6**), including from trawls on the export cable corridor and the array area. They were recorded in the July and September 2005 beam trawl surveys of the Sheringham Shoal OWF area but not in the Dudgeon OWF beam trawl surveys (**Table 9.1.7**). The survey evidence, coupled with the presence of a significant fishery, suggests that lobster is present and may be relatively abundant in the Project areas.

9.1.3.2.3 Shrimp

93. Two species of shrimp, the brown shrimp *Crangon crangon*, and the pink shrimp *Pandalus montagui*, are commercially exploited in the region.

Brown shrimp

94. Brown shrimp *Crangon crangon* is one of the most abundant benthic species found in shallow soft bottom areas along the European coast with a wide geographical range which extends from Baltic and Mediterranean (NWIFCA, 2020) and is an important food source for fish, crustaceans and birds (Campos *et al*., 2010; Green *et al*, 2012). Most commonly found within intertidal areas, it can also be found at depths up to 150m (BSF, 2020). This depth variation is influenced by the mobility of the species in foraging and lifecycle processes. The key areas for brown shrimp in the region are shallow channels and nearshore grounds around The Wash and along adjacent coasts (Brown and May Marine, 2018). A mapping project completed by the EIFCA identified shrimp fishing grounds that overlap with the shallow nearshore section of the offshore export cable corridor (see **Chapter 12 Commercial Fisheries, Appendix 12.1**).

95. Brown shrimp spawning occurs throughout most of the year with the females carrying between 2,000 to 10,000 eggs until they hatch (Addison *et al*, 2017; Dipper, 2003). Once the eggs hatch, local hydrological conditions carry the larvae in the current for around one month before they settle on the sea bed. Juvenile brown shrimp have a rapid growth rate as the species is short-lived, between 1.5 and 2 years.

96. Brown shrimp represents a small proportion of landings from the 'local' area ICES rectangles 34F1 (2.28%) and 35F1 (0.07%) (**Table 9.1.2**). It is a much more important component of landings from rectangles 34F0 and 35F0 to the west. Brown shrimp contributed 34.12% of landings between 2009 and 2019 from 34F0, and is second only to cockle landings in this area. In 35F0 the species contributed 13.02% of landings over the period. The significance of brown shrimp from 34F0 and 35F0 which cover The Wash reflect the abundance of this species in shallow soft bottom areas.

97. Brown shrimp were present every year in the IBTS data in both 34F1 and 35F1, however CPUE was not recorded (DATRAS, 2020).

98. Historic site otter trawl surveys only recorded three individuals during the April 2005 survey of the Sheringham Shoal OWF area (**Table 9.1.6**), however, the species was recorded in all historic site beam trawl surveys across both the Sheringham Shoal and Dudgeon OWF areas. The Sheringham Shoal surveys in September 2005 recorded particularly high abundance (>4,000 individuals).

99. The evidence confirms that brown shrimp is present and occasionally abundant in both the SEP and DEP areas.

Pink shrimp

100. Pink shrimp *Pandalus montagui* has a large geographical range extending across the north Atlantic from as far north as the north coast of Norway, around the British Isles to Iceland, Greenland, west to the coasts of Canada and the northeast United States. Typically having a preferred habitat of hard substrates, the species can also be found on rock, gravel, sand and mud at a depth range of between 20-100m (FAOUN, 2020). Pink shrimp is generally found in deeper water than brown shrimp (Brown and May Marine, 2018) and has also been reported to have a strong affinity with *Sabellaria spinulosa* reefs (Green *et al.*, 2012).

101. Offshore migration to deeper waters begins for adults during October to November, where eggs are laid in a single batch (2000 to 3000) between November and February. A subsequent inshore migration to shallower waters commences during spring. The eggs hatch between April and May, with larvae dispersed and distributed by the hydrological environment before settling on to the sea bed between July and August (Rogers and Stocks, 2001). Growth rate is dependent on temperature and salinity, but brown shrimp typically mature within a year. The species is a protandrous hermaphrodite, meaning that juveniles are male, later developing into females after 13 to 16 months (de Kluijver and Ingalsuo, 2000).

102. Pink shrimp is no longer the target of a significant commercial fishery and landings have declined substantially since 1970, due largely to changes in market demand. In recent years it has only been occasionally fished to satisfy specific orders (Brown and May Marine, 2018). No pink shrimp was landed from the 'local' area ICES rectangles 34F1 and 35F1 and they contributed a small proportion of landings from rectangles 34F0 (0.40%) and 35F0 (0.41%) to the west of the Project area (**Table 9.1.2**).

103. Pink shrimp were present every year in the IBTS data in 35F1, and in 34F1 in 2013 to 2015 and 2019, however CPUE was not recorded (DATRAS, 2020).

104. Historic otter trawl surveys recorded pink shrimp in relatively high abundance (>100 individuals) in the Sheringham Shoal OWF area during the April 2005 surveys but not in the Dudgeon OWF otter trawl surveys in 2008 (**Table 9.1.6**). Although pink shrimp were not recorded on every historic site beam trawl survey, they were the most abundant species caught across both the Sheringham Shoal and Dudgeon OWF areas (**Table 9.1.7**). The September 2005 Sheringham Shoal survey recorded >437,000 individuals.

105. Although there were no recorded commercial landings from with local area, the evidence from site surveys confirms that pink shrimp is present and often very abundant in both the SEP and DEP areas.

9.1.3.2.4 Velvet crab

106. The velvet swimming crab *Necora puber* is an abundant species in the subtidal rocky zones of the northeast Atlantic, where it may be one of the dominant epibenthic predators regulating the abundance and distribution of prey populations. Evidence suggests that the diet of this species is highly variable depending on the crab's life history stage and habitat, (Freire *et al.*, 1995).

107. The velvet crab is the largest of the seven portunid (swimming crab) species native to the British Isles, reaching a maximum size of around 100mm CW or 250g (Hearn, 2004). Growth is seasonal; males moult between April to July and females moult between May to August, reaching sexual maturity around 1.5 years (The Scottish Government, 2018). Due to egg bearing phase, females tend to be smaller than males.

108. After females have moulted, mating occurs when their shells are still soft. Fertilised eggs hatch early in the year, peaking in spring. Clutch sizes have been found to range between 5000 and 278,000 eggs (Hearn, 2004). The velvet swimming crab displays a bi-phasic life cycle, with a pelagic larval phase developing in open ocean waters and a benthic post-larval phase that occurs in coastal and estuarine habitats (Rey *et al*., 2015).

109. Velvet crabs are a commercially exploited species in the UK (Small *et al*., 2010). However, MMO data show that velvet crab landings are <0.1% of the total landings from rectangles 34F1 and 35F1 (**Table 9.1.2**).

110. Velvet crabs were present from 2008 to 2019 in 35F1 of the IBTS data although CPUE was not recorded (DATRAS, 2020), they were the second most abundant species recorded in historic site otter trawl surveys (**Table 9.1.6**) and were abundant in historic beam trawl surveys (**Table 9.1.7**), indicating that they are an abundant component of the fish and shellfish community in both the SEP and DEP areas.

9.1.3.3 Fish

111. The following sections describe commercially exploited fish species in the local study area, their ecology and evidence of their presence in the Project areas. Species are discussed in descending order of landings over the period 2009 to 2019.

9.1.3.3.1 Herring

112. Herring is a schooling pelagic fish species found mostly in continental shelf seas to depths of 200m and present throughout the North Sea, as shown in **Figure 9.5**, with greatest abundances ranging from the English Channel, German Bight, Kattegat up to the northern North Sea (ICES Fishmap, 2006). Juvenile fish inhabit shallower waters to depths of 100m, moving to deeper waters once they reach two years of age. Shoals generally remain in deep water or close to the sea bed during the day and migrate vertically towards the sea surface at night (ICES Fishmap, 2006). Herring are an important prey species for piscivorous fish (including cod, whiting and other large gadoids), sharks, marine mammals and seabirds. The species is also targeted by commercial fisheries, placing additional pressure on stocks (ICES, 2018a).

113. Although herring abundance has declined over recent decades, the species is a component of the regional fish and shellfish community, comprising a relatively small proportion of landings from the area (6.06% of UK landings from 34F1 and <0.1% of landings from 35F1 between 2009 to 2019 (**Table 9.1.2**)) and was recorded every year in the IBTS in 34F1 and 35F1 except for 2016 in 34F1 (**Table 9.1.3**). Within ICES rectangle 35F0 herring was recorded in every year except 2010.

114. The Sheringham Shoal and Dudgeon OWF baseline fish surveys recorded an abundance of herring during the otter trawls in April 2005 and October 2008 (**Table 9.1.6**). Herring was also recorded at varying abundances by Sheringham Shoal and Dudgeon OWF herring spawning surveys (**Section 9.1.2.4.5**).

115. Herring is listed as a species of principal importance for the purpose of conserving biodiversity in the UK although its conservation status is defined as of 'Least Concern' in the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (**Table 9.1.17**).

116. SEP and DEP are located in an area identified as a low intensity herring nursery ground (Ellis *et al*., 2010) and also an area which has previously been identified as a herring spawning ground (Coull *et al*., 1998) (**Figure 9.6**).

Herring spawning

117. Herring are demersal spawners, showing a preference to lay their eggs on gravel and other coarse sediments and substrates (e.g. maerl or shell), characterised by a low proportion of fine sediment and well-oxygenated water (Fugro, 2020a; 2020b). Eggs can take up to two weeks to hatch, after which the larvae enter a planktonic stage, rising to the surface and drifting to the coastal waters of the eastern North Sea.

118. The North Sea consists of several discrete stocks of either spring-spawning or autumn-spawning herring. SEP and DEP are in proximity to the spawning grounds of the autumn-spawning Banks sub-population which spawns from August to October (**Plate 9.1.9**; Payne, 2010) and the SEP wind farm site, parts of the DEP wind farm site, interlink cable and export cable corridors are located in an area identified as a herring spawning ground by Coull *et al*. (1998) (**Figure 9.6**).

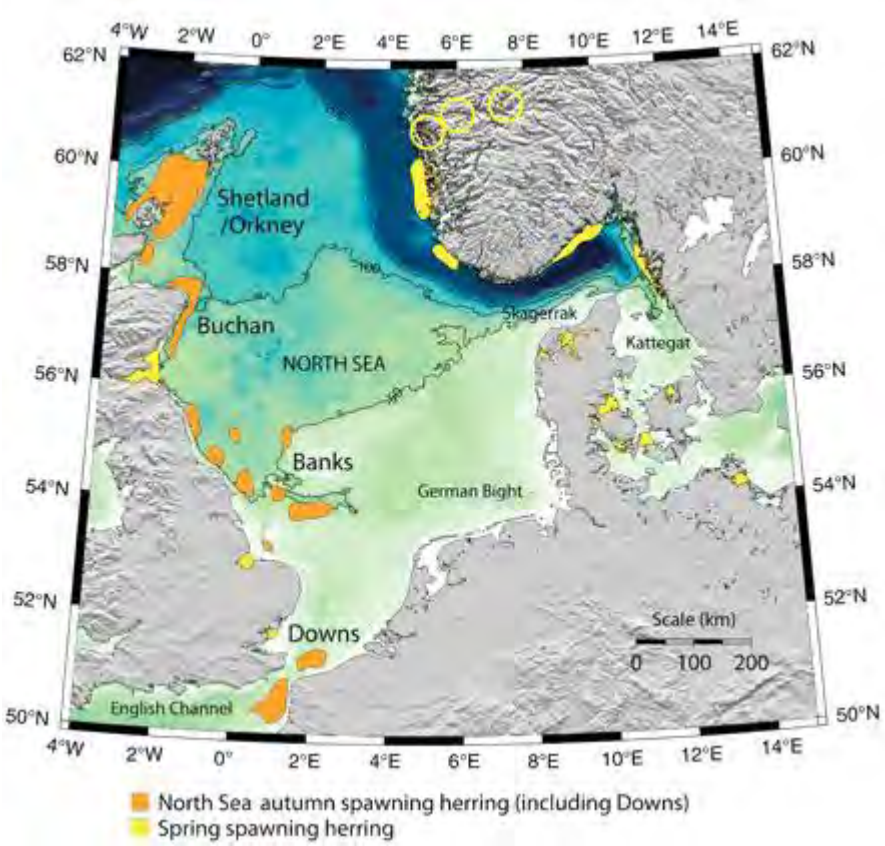


Plate 9.1.9 Atlantic herring spawning sub-populations in the North Sea (Payne, 2010)

119. The SNS IHLS has not sampled the local study area since 1976. Surveys conducted between 2008 and 2022[7] recorded no larvae (<11mm in length) from the closest samples to the local study area (**Figures 9.7**, **9.8** and **9.9**). The September 1976 survey sampled 20 locations in 35F1, some in close proximity to SEP and DEP, but recorded no herring larvae at any of the locations except at one station 3.86km west of the DEP North array area, recording low abundance (4 larvae/m^2). The IHLS indicates that herring spawning activity is concentrated to the northwest off the North Yorkshire coast (Banks herring) as well as further south in the North Sea (Downs herring).

120. The ICES Herring Assessment Working Group (HAWG) 2013 report states that the Banks "*spawning grounds have now all but disappeared and spawning is confined to small areas along the English east coast, from the Farne Islands to the Dowsing area, from August to October*" (ICES, 2013). This evidence is consistent with feedback from the Scoping Opinion which states that "*The nearest herring spawning ground to the SEP and DEP sites, is that of the Banks/Dogger population off the coast of Flamborough Head. Some smaller, localised herring spawning grounds also exist at locations along the Norfolk and Lincolnshire coasts and outside the Wash, although due to a lack of recent larval data for these locations it is not known whether these sites are currently 'active'*" (The Planning Inspectorate, 2019).

121. A benthic characterisation survey of the SEP and DEP areas was completed between the 10th and 19th August 2020 (Fugro, 2020a; 2020b). The presence of preferable grounds for herring spawning has been assessed based on the distribution of sediment particle sizes in grab samples, using categories defined by MarineSpace *et al*. (2013), adapted from Reach *et al*. (2013). The methodology outlined by MarineSpace *et al*. (2013) considers the recommendations of Reach *et al*. (2013), aligned with the Folk (1954) sediment classification. The herring spawning preference classifications of MarineSpace *et al*. (2013) range from 'Preferred' (sediment structure with highest percentage of gravel and very little mud content) through 'Marginal' (adequate sediment structure with reduced gravel content) to 'Unsuitable' (**Table 9.1.13**).

Table 9.1.13: Sediment Types Indicating 'Preferred' Spawning Habitat

Reach *et al*., 2013			**MarineSpace *et al*., 2013**		
Fractional Composition	Folk (1954) Description	Herring Preference	Fractional Composition	Folk (1954) Description	Herring Preference
<5% muds and >50% gravel	Gravel (G) and part of sandy gravel (sG)	Prime	≤10% muds and >30% gravel	Gravel (G) and sandy gravel (sG)	Preferred
<5% muds and >25% gravel	Part of sandy gravel (sG) and part of gravelly sand (gS)	Sub-prime			

[7] No IHLS survey was undertaken in 2018.

Reach *et al*., 2013			MarineSpace *et al*., 2013		
Fractional Composition	Folk (1954) Description	Herring Preference	Fractional Composition	Folk (1954) Description	Herring Preference
<5% muds and >10% gravel	Part of gravelly sand (gS)	Suitable	≤10% muds and 5% to 30% gravel	Gravelly sand (gS)	Marginal
>5% muds and <10% gravel	All other sediment types*	Unsuitable	>10% muds or ≤10% gravel	All other sediment types*	Unsuitable

Notes

Adapted from MarineSpace *et al*., 2013

* = Other sediment types include mud (M), sandy mud (sM), muddy sand (mS), sand (S), slightly gravelly mud ((g)M), slightly gravelly sandy mud ((g)sM), slightly gravelly sandy mud ((g)mS), gravelly mud (gM), gravelly muddy sand ((g)mS), muddy gravel (mG) and muddy sandy gravel (msG) (and for Reach *et al*., 2013 part of sand gravel (sG) and gravelly sand (gS))

122. As discussed above, the existence of suitable herring spawning habitat does not necessarily mean that this habitat is used as a herring spawning ground. Herring spawning surveys were conducted at the Dudgeon and Sheringham Shoal OWFs both pre and post-construction (**Section 9.1.2.4.5**) to confirm the presence of herring spawning activity. It was concluded that herring spawning did not occur in the survey area, and that the stock collapse in the 1970s had changed spawning patterns in the North Sea (Brown and May Marine, 2009).

123. **Table 9.1.14** summarises the number of samples in the different project areas within each herring spawning preference category. Note that at some stations there was duplicate or triplicate sampling. Each sample was assessed separately.

Table 9.1.14: Herring Preference Sediment Categories in SEP and DEP areas

Fractional Composition	Folk (1954) Description	Folk (BGS Modified) Description	Herring Preference (MarineSpace *et al*., 2013)	Export cable corridor	SEP wind farm array	Interlink cable corridors	DEP wind farm arrays
≤10% muds and >30% gravel	Gravel (G) and sandy gravel (sG)	Gravel (G) and sandy gravel (sG)	Preferred	19	9	10	4
≤10% muds and 5% to 30% gravel	Gravelly sand (gS)	Gravelly sand	Marginal	4	1	7	9
>10% muds or ≤10% gravel	All other sediment types	All other sediment types	Unsuitable	8	7	6	14

124. The locations and distribution of preferred herring spawning habitat in the SEP and DEP project areas is illustrated in **Figure 9.10**.

125. Within the DEP wind farm areas, most stations are classified as being ‘Unsuitable’ for herring spawning. Nine samples across four stations are considered ‘Marginal’ and four stations sampled ‘Preferred’ habitat. The ‘Preferred’ sites, with a larger gravel component and very little or no mud content are located in the south of the DEP North and DEP South array areas (Fugro, 2020b) (**Figure 9.10**).

126. Within the SEP wind farm site, the majority of the sediments towards the northwest were considered 'Unsuitable'. However, samples in the southeast and most easterly extent of the wind farm area are classified as 'Preferred' herring spawning habitat (Fugro, 2020a) (**Figure 9.10**).

127. Along the offshore export cable corridor and interlink cable corridors, the areas of 'Preferred' herring spawning habitat followed the pattern of alternating sand and coarse/mixed sediments observed. Where the sediment was predominantly sand, the habitat is classed as 'Unsuitable' or 'Marginal', however where the sediment was coarse or mixed with a large gravel component, the habitats are classed as 'Preferred' (Fugro, 2020a; 2020b) (**Figure 9.10**).

9.1.3.3.2 Cod

128. Atlantic cod *Gadus morhua* is a demersal gadoid species with an extensive population range across the North Atlantic, including the North Sea and extending into the Arctic, typically found at depths of up to 500m within 30-80m of the sea bed. Sub-adults occupy a wide range of habitat types but are often found in shallower waters than adults (Hedger *et al*. 2004; ICES Fishmap, 2006). The results of the quarterly IBTS show that adults occur extensively during the colder, winter months but their range contracts during spring and summer as they retreat northwards in response to increasing water temperatures in the English Channel and Southern Bight.

129. Cod is a commercially important species which has declined sharply in abundance in the North Sea over the past 20 years. For management purposes, ICES currently define three separate assessment areas for North Sea cod: Divisions IIIa (Skagerrak), VIId (English Channel) and Sub-Area IV (southern and northern North Sea). ICES has advised, based on the EU-Norway management plan, that landings of cod in the North Sea should not exceed 13,686 tonnes in 2020 (ICES, 2019b). Fishing mortality has increased since 2016 and spawning stock biomass (SSB) has decreased since 2015 with recruitment being generally poor since 1998 (ICES, 2019b).

130. Survival of larval cod is shown to depend on three key biological parameters of their prey: the mean size of prey, seasonal timing and abundance. Long-term changes in cod recruitment in the North Sea have been attributed to fluctuations in the plankton ecosystem, connected to rising temperature since the mid-1980s (Beaugrand *et al.,* 2003). Cod larvae consume small organisms in the plankton including diatoms and dinoflagellates before moving on to the nauplii (first larval stage) of small crustaceans such as isopods and small crabs. As juvenile cod gradually move from inshore areas into deeper offshore waters, they target larger, benthic prey (Demain *et al*., 2011).

131. Males and females are similar in size and weight living for up to approximately 25 years with sexual maturity reached between the ages of two and four. The reproductive lifecycle begins with adult cod forming spawning aggregations from late winter to spring, in the southern North Sea this varies from the last week of January to mid-February (**Table 9.1.5**) (Fox *et al*., 2008). Cod undergo an extensive spawning migration, returning to the southern North Sea during autumn (NVL, 2018). Studies have shown that cod tagged and released at spawning locations will roam for hundreds of kilometres but will return to the same area they were initially caught (Heath *et al*., 2014). As pelagic spawners, cod spawning grounds are not substrate specific. However, temperatures around 5-7°C and high salinities have been found to be of preference (González-Irusta, 2015). Females release eggs in batches, where males compete to fertilize the eggs. Fertilised eggs then hatch into larvae after approximately 8 to 23 days.

132. Cod were present in every year of the IBTS data with an average CPUE of 2.0741 (34F1), 1.1335 (35F1) and 2.6473 (35F0) between 2010 and 2020 (**Table 9.1.3** and **Figure 9.11**). The results of quarterly IBTS surveys show that adults occur extensively during the colder, winter months but that their range contracts during spring and summer as they retreat northwards in response to increasing water temperatures in the English Channel and Southern Bight.

133. SEP and DEP are located within an extensive low intensity cod nursery ground defined by Ellis *et al.* (2010) but SEP and DEP are not located within cod spawning grounds (**Figure 9.12**).

134. Cod landings contributed to a small percentage of the total landings from 34F1 and 35F1 between 2009 and 2019, 1.16% and 0.05% respectively (**Table 9.1.2**), being predominantly targeted by Dutch vessels (see **Chapter 12 Commercial Fisheries, Appendix 12.1**). Landings from these areas have declined since 2008 to low levels in recent years (**Plate 9.1.3**, **Plate 9.1.7**).

135. Cod were also recorded in the historic surveys at the Sheringham Shoal and Dudgeon OWFs, including otter trawl surveys of both areas (**Table 9.1.6**) and the July and September 2005 beam trawl surveys of the Sheringham Shoal OWF, in relatively low numbers. The evidence shows that cod is present in the fish and shellfish community in both the SEP and DEP areas.

136. Cod is listed as a species of principal importance, included in the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) list of threatened and / or declining species. The IUCN defines the species' status as 'Vulnerable' (Hutchinson *et al.*, 2003).

9.1.3.3.3 Dover sole

137. Dover sole *Solea solea* is a commercially exploited flatfish usually found on sandy and muddy sea beds including estuarine habitats, feeding primarily on polychaete worms (ICES Fishmap, 2006; Limpenny *et al*., 2011). Sole is typically present in relatively shallow waters from depths of 1m to around 70m (Eastwood *et al*., 2000; Limpenny *et al*., 2011). In winter they move offshore in response to reducing water temperatures and can be found at depths of up to 150m (Kay and Dipper, 2009; Reeve, 2007). Bottom sea temperatures determine the population's northern limit in the North Sea, with sole requiring temperatures above 3-4°C (Burt and Millner, 2008). This generally restricts the population to the southern and eastern North Sea (ICES Fishmap, 2006; Limpenny *et al*., 2011), although they have been found as far north as southern Norway and Shetland (Burt and Millner, 2008).

138. In spring, mature fish return to shallow coastal waters to spawn. Spawning areas include those with relatively higher water temperatures, such as the mouths of estuaries including as The Wash, and shallow waters including sand banks, which also provide nursery areas for juveniles (Limpenny *et al*., 2011).

139. Dover sole was present in every year of the IBTS data with an average CPUE of 3.9756 (34F1) and 2.0843 (35F1) between 2010 and 2020 (**Figure 9.12**) (DATRAS, 2020). Sole were recorded in the historic site surveys, including otter trawls (**Table 9.1.6**) and beam trawls, although in small numbers.

140. The Sheringham Shoal and Dudgeon OWFs are located in an area identified as part of low intensity sole spawning grounds (Coull *et al*, 1998; Ellis *et al*., 2010) (**Figure 9.14**). Sole spawning is considered to begin in March in the southern North Sea, once sea temperatures reach around 7°C (Limpenny *et al*., 2011). Spawning peaks in April but has been known to continue sporadically until June (**Table 9.1.5**).

141. Part of the offshore export cable corridor overlaps with identified low intensity sole nursery grounds (Coull *et al*., 1998; Ellis *et al*., 2010) (**Figure 9.14**).

142. Dover sole is a commercial species targeted by Dutch and Belgian fleets in the area, see **Chapter 12 Commercial Fisheries, Appendix 12.1**. However, total landings from 34F1 between 2009 and 2019 are relatively low at 5.86 tonnes (see **Table 9.1.2**) with landings recorded each year over the period (**Plate 9.1.3**). Total landings from 35F1 are higher at 21.40 tonnes, although the species was not landed every year and the total is largely due to landings between 2013 and 2015 (**Plate 9.1.7**).

143. The evidence shows that Dover sole is present in the fish and shellfish community in both the SEP and DEP areas, although in relatively low abundance.

144. Dover sole is of conservation interest, being listed as a species of principal importance (**Table 9.1.17**).

9.1.3.3.4 Plaice

145. Plaice *Pleuronectes platessa* is a flatfish which occupies sandy bottoms of the European shelf but ranges geographically from the Barents Sea to the Mediterranean. Plaice bury themselves in sand during the day and move to shallower waters to feed at night. Commonly living up to eight years, sexual maturity typically occurs around three years old. Plaice are widespread throughout the North Sea, most commonly found between 10-50m but potentially occurring from 0-200m. Although they exhibit a preference for sand and gravel substrates, but are also found on mud (Ruiz, 2007).

146. Tagging studies have shown that plaice divide into three sub-populations during summer months for feeding in the Southern and German Bights; along the east coast of the UK; and in the Skagerrak and Kattegat (Hunter *et al*. 2004).

147. Plaice were present in every year of the IBTS data (except 2010 in 35F0) with an average CPUE of 14.5102 (34F1), 10.3517 (35F1) and 3.9260 (35F0) between 2010 and 2020 (**Table 9.1.3** and **Figure 9.15**).

148. Spawning occurs between December and March when females release eggs in the water column periodically over a period of approximately one month (**Table 9.1.5**). After two weeks, the eggs hatch and the larvae disperse for a period of between 8 to 10 weeks. Juveniles will then spend a year in shallower water before migrating offshore to deeper waters when they reach adult size.

149. Spawning in the North Sea is widespread, with high intensity grounds across most of the offshore and deeper areas of the southern North Sea (**Figure 9.16**). Plaice show strong spawning fidelity returning to the same areas in successive spawning seasons (Hunter *et al*., 2003). Plaice nursery areas are generally in shallow (<10m), sandy or muddy areas. **Figure 9.16** shows that the project overlaps with low intensity plaice nursery grounds (Ellis *et al*, 2010), although juveniles are likely to be concentrated in shallower coastal waters.

150. Plaice are a commercially exploited species in the area, targeted mainly by Dutch and Belgian beam trawlers (see **Chapter 12 Commercial Fisheries, Appendix 12.1**). Plaice contributes a small percentage to landings from 35F1 and 34F1 (**Table 9.1.2**) and is absent from landings in some years, particularly in 34F1 (inshore area) (**Plate 9.1.3**). Like sole, total plaice landings from 35F1 are largely due to landings between 2013 and 2015 which peaked at 9.13 tonnes in 2014 (**Plate 9.1.7**).

151. The historic site surveys recorded plaice in the October 2008 otter trawl survey and in low numbers in all beam trawl surveys of the Dudgeon OWF area (**Table 9.1.6**). Beam trawls of the Sheringham Shoal OWF area recorded 39 and 43 individuals in July and September 2005 respectively, but plaice was absent from the December and April beam trawl surveys.

152. The evidence shows that plaice is present in the fish and shellfish community in both the SEP and DEP areas, and based on historic site surveys may be more abundant than Dover sole in these areas.

153. Plaice is listed as a species of principal importance and its conservation status is defined as of ‘Least Concern’ in the IUCN Red List of Threatened Species (**Table 9.1.17**).

9.1.3.3.5 Seabass

154. The European seabass *Dicentrarchus labrax* is a predatory species of fish found in coastal waters, estuaries and lagoons of the north-east Atlantic, Mediterranean Sea and increasingly within the North Sea (Fritsch *et al*., 2007). A highly mobile species, seabass is a partially migratory species, in that it can undertake long distance migrations, or exhibit residency behaviour (Quayle *et al*., 2009; de Pontual *et al*., 2019). Evidence suggests the use of shallow, inshore feeding grounds in summer and a move to deeper, warmer waters over the winter (beginning in October) where they spawn (Fritsch *et al*., 2007; de Pontual *et al*., 2019; Goossens *et al.,* 2019). Tagging studies have shown that sea bass have a strong fidelity to summer feeding grounds, where they will return year on year (Claridge and Potter, 1983; Pawson *et al*., 1987; Kelley, 1988; Pawson *et al*., 2007). Adults feed primarily on shrimps, molluscs and fishes, whilst juveniles feed on invertebrates, taking increasingly more fish with age. European seabass is a slow growing, late maturing fish (Beraud *et al*., 2018) taking four to seven years to reach sexual maturity (IFM, 2016). These life history characteristics along with the strong fidelity to specific summer feeding areas means the species is vulnerable to over exploitation (Kelley, 1988).

155. Seabass is a group spawner, releasing pelagic eggs into the water column once a year, usually in spring. Eggs and larval bass remain in the plankton for approximately two months, during which time they are transported inshore by currents into nurseries in estuaries and shallow coastal waters where juveniles stay for four to five years (Kennedy and Fitzmaurice, 1972; Jennings and Pawson, 1992). Studies have shown that juvenile sea bass off the East Anglian coast show less movement and greater site fidelity than populations off the west coast of Britain (Pawson *et al*., 2007).

156. Until the 1970s seabass was primarily a sports fish targeted recreationally in the UK, after which a commercial fishery developed (Kelley, 1988). There has been a dramatic stock decline since 2010 (Williams *et al*., 2018) following a period of poor recruitment due to adverse environmental conditions, along with unchecked expansion of fishing efforts, and unsustainable catches (Williams *et al*., 2018). In response, fishing regulations have been put in place to limit landings of seabass by commercial and recreational vessels. These restrict commercial vessels from fishing for seabass during February and March 2021. Commercial vessels must have permission to target seabass and are limited by gear restrictions including a ban on drift nets. Landings by recreational anglers are limited to two bass per day, a minimum landing size of 42cm using of a rod or handline, and mandatory catch and release in January, February and December (Council Regulation 2020/123/EC, 2020). **Figure 9.18** shows the extent of historic fishing grounds based on information gathered by the EIFCA, some of which traverse the export cable corridor.

157. Seabass contributed 0.63% of total landings from 34F1 (nearshore) between 2009 and 2019 totalling 16.93 tonnes over the period (**Table 9.1.2**), making it the third most important finfish species in terms of landings after herring and cod. Landings from 35F1 (offshore) were less significant in terms of total (3.48 tonnes) and proportion (0.03%). **Plate 9.1.3** shows that bass landings from 34F1 were relatively consistent each year, whereas landings from 35F1 fluctuated over the period (**Plate 9.1.7**).

158. Seabass was infrequently recorded in IBTS data from ICES rectangles 34F1 and 35F1, present only once in 2011 with a CPUE of 2 (**Figure 9.17**) (DATRAS, 2020). **Figure 9.17** shows that no seabass were recorded at the IBTS locations nearest SEP and DEP. Historic site surveys recorded seabass once in the October 2008 otter trawl survey of the Dudgeon OWF area (**Table 9.1.6**). It should be noted the demersal trawls are unlikely to sample seabass effectively, and baited longlines used for the Sheringham Shoal OWF post-construction elasmobranch survey in 2015 recorded 19 seabass (**Section 9.1.2.4.4**). The evidence suggests that seabass is likely to be present in the fish and shellfish community in both the SEP and DEP areas. Its conservation status is defined as of 'Least Concern' in the IUCN Red List of Threatened Species

9.1.3.3.6 Mackerel

159. Atlantic mackerel *Scomber scombrus* is one of the most abundant and widely distributed migratory fish species in the North Atlantic. Mackerel, like most scombrids, are highly streamlined, quick-swimming, pelagic fish, and they are found in shelf seas, usually at depths of less than 200m. They are a classic schooling fish, with shoals of up to 9km long, 4km wide, and 40m deep being reported (Aiatt & Shalloof, 2020). Mackerel principally prey on small pelagic crustaceans in the zooplankon, the distribution of which influences migrations along with changes in water temperature, but they also prey upon fish such as herring, sprat, sandeel and Norway pout.

160. Mackerel live their entire life in the pelagic environment. Early life stages (eggs and young larvae) drift passively with the currents until they start undertaking vertical migrations through the water column. Young juveniles begin to migrate horizontally, and mature adult individuals perform extensive horizontal migrations between overwintering, spawning and feeding areas (Jansen and Gislason, 2013). A relationship is thought to exist between the timing of spawning and sea surface temperature. North Sea mackerel overwinter in the deep water to the east and north of the Shetland Islands, and on the edge of the Norwegian Deeps. In spring, they migrate south to spawn in the North Sea between May and July (**Table 9.1.5**, **Figure 9.20**), and by late summer disperse across the North Sea to feed (Cefas, 2010b; Rogers & Stocks, 2001).

161. Relatively low levels of spawning in the English and Fair Isle channels separates the main spawning areas in the North Sea from the western areas along the continental shelf edge (Jansen and Gislason, 2013). **Figure 9.20** shows that the SEP and DEP do not overlap with spawning grounds, they do coincide with a low intensity mackerel nursery ground (Coull *et al.*, 1998; Ellis *et al.*, 2010).

162. Mackerel made a relatively low contribution to landings, totalling 8.78 tonnes from 34F1 (nearshore) between 2009 and 2019 (0.31% of total landings) and only 0.2 tonnes from 35F1 (**Table 9.1.2**).

163. Mackerel was present in every year of the IBTS in 35F1 (offshore) with an average CPUE of 116.1353, but was absent from IBTS trawls in 34F1 (**Table 9.1.3** and **Figure 9.19**). At the regional scale, mackerel was present in 35F0 in every year except 2010, with a low average CPUE of 2.9307. Historic site surveys also recorded mackerel, albeit occasionally in low numbers. This is likely to be partly due to the demersal trawl methods which do not sample pelagic species like mackerel efficiently. Two individuals were observed in the October 2008 otter trawl survey of the Dudgeon OWF area (**Table 9.1.6**). Of the eight beam trawl surveys completed at the Dudgeon and Sheringham Shoal OWFs, mackerel was only recorded by the September 2005 survey of the Sheringham Shoal OWF area (four mackerel).

164. The evidence suggests that mackerel is likely to be present in the fish and shellfish community in both the SEP and DEP areas, including as juveniles in low abundance and seasonally in the form of migratory adult shoals.

165. Mackerel is listed as a species of principal importance and its population trends are demonstrating an increase and its conservation status is defined as of 'Least Concern' in the IUCN Red List of Threatened Species (**Table 9.1.17**).

9.1.3.3.7 Whiting

166. Whiting *Merlangius merlangus* is a demersal fish widespread across the North Sea, usually found at depths of 30-100m in a wide range of sea bed areas including mud, sand, gravel and rock (**Figure 9.21**). This gadoid is found at high densities across most of the North Sea, although separate populations exist to the north and south of the Dogger Bank, with abundance lower in the Dogger Bank area (Rogers & Stocks, 2001; Kerby *et al*. 2013). Whiting predate a range of decapod crustacean species including shrimps (Crangon spp.), amphipods, copepods and fish, including smaller individuals of commercial species such as sprat, sandeel, herring, cod, and haddock (Knijn *et al*., 1993; Derweduwen *et al*., 2012).

167. Juvenile fish occupy coastal nursery areas between 5 to 30m then migrate to deeper waters after the first year of life (Cohen *et al*., 1990). Sexual maturity is reached at two years (Knijn *et al*., 1993; Loots *et al*., 2011), and spawning commences from late-January / February in the SNS, continuing into June in northern areas, and peaking in April (**Table 9.1.5**) (Loot *et al*. 2011; Coull *et al*. 1998; van Damme *et al*. 2011). Spawning typically takes place in water between 20 and 150m depth (Cohen *et al*., 1990). There is some uncertainty about the distribution of spawning grounds because identification of the eggs of some gadoids is problematic, and therefore current evidence may underrepresent spawning activity (Ellis *et al*., 2012).

168. Along with temperature and salinity, high tidal streams are important physical determinant of whiting spawning distribution (Lauerburg *et al*., 2018), whereas local abundance levels are primarily controlled by internal factors, i.e., population size and spatial segregation between ages (Loots *et al*., 2011; Lauerburg *et al*., 2018). Whiting are pelagic spawners, releasing eggs into the water column where it takes approximately 10 days for the eggs to hatch into larvae. During the post-larval phase they are often associated with jellyfish before switching to a more demersal existence (Ellis *et al.,* 2012).

169. SEP and DEP are located within low intensity whiting spawning and nursery grounds (Ellis *et al.,* 2010) (**Figure 9.22**).

170. Whiting is a commercially important species, historically caught for fishmeal and pet food, but now targeted as a whitefish for human consumption. However, **Table 9.1.2** shows that whiting makes a small contribution (<0.05%) to the total landings from 34F1 and 35F1.

171. Whiting is present in every year of the IBTS data with an average CPUE of 13.8378 from 34F1 (nearshore), 51.1092 from 35F1 (offshore) and 127.8195 from 35F0 (offshore) between 2010 and 2020 (**Table 9.1.3** and **Figure 9.21**). Historic site surveys recorded whiting in all otter trawl surveys, and it was the most abundant species recorded in the October 2008 survey of the Dudgeon OWF area (1752) and across all three otter trawl surveys (**Table 9.1.6)**. Whiting were recorded in four of the eight beam trawl surveys of the Dudgeon and Sheringham Shoal OWFs (July and September 2005, October 2008 and September 2014).

172. The evidence suggests that whiting is part of the fish and shellfish community in both the SEP and DEP areas and is occasionally very abundant, with juveniles also present but at lower abundance

173. Whiting is listed as a species of principal importance and its Conservation status is defined as of 'Least Concern' in the IUCN Red List of Threatened Species.

9.1.3.3.8 Sprat

174. Sprat *Sprattus sprattus* is a shoaling pelagic fish species from the same family as herring (clupeids) found throughout the North Sea and Northeast Atlantic. They are in greatest abundance in the relatively shallow waters of the SNS around the Dogger Bank and German Bight, most commonly within the 50m depth contour and in inshore waters (ICES Fishmap, 2006; Rogers & Stocks, 2001; Solberg *et al.*, 2015) (**Figure 9.23**). Sprat is an important prey species in the food chain for predatory fish (larger gadoids) and seabirds, and is commercially landed mainly for industrial processing to produce fishmeal, with a small market for human consumption. It is also a key predator of zooplankton and plays an important role in the trophic structure of the pelagic ecosystems (Solberg *et al.*, 2015)

175. Once sprat have grown to 95-100mm, they have reached maturity. They are multiple batch spawners, with females spawning repeatedly throughout the season, (ICES Fishmap, 2006). Spawning occurs between spring to late summer, peaking in May and June, in both coastal and offshore waters. Approximately 14 days after spawning, the larvae hatch and remain in the pelagic zone feeding on diatoms, copepods and crustacean larvae. However, SEP and DEP do not overlap with any known sprat spawning or nursery grounds (**Figure 9.24**).

176. Sprat landings contributed only 0.26% of total landings from 34F1 (nearshore) between 2009 and 2019 (**Table 9.1.2**). The species has been landed in small quantities every year since 2009 but declining over recent years from 1.27 tonnes in 2009 (**Plate 9.1.3**). No sprat was landed from 35F1 over the period.

177. Sprat was present in every year of the IBTS data from the area between 2010 and 2020, with the highest average CPUE from the nearshore rectangle 34F1 (69.9862) and a higher average CPUE of 295.1327 from 35F1, which within that ICES rectangle, is second only to greater sandeel (35F1) (**Table 9.1.3** and **Figure 9.23**) (DATRAS, 2020). At the regional scale, within 35FO, sprat also had a high average CPUE of 115.8455.

178. Throughout the Sheringham Shoal herring spawning surveys in 2009 and 2010, sprat dominated the catch. However, numbers were very low in the historic site otter trawls (**Table 9.1.6**), and similarly in historic site beam trawl surveys, recorded only in July and September 2005 surveys of the Sheringham Shoal OWF area in low numbers.

179. The evidence suggests that sprat is part of the fish and shellfish community in both the SEP and DEP areas and is occasionally very abundant, although no sprat spawning or nursery areas are known to be in the Project areas.

9.1.3.3.9 Sandeels

180. There are five species of sandeel in the North Sea, though the majority of commercial landings are of Raitt's sandeel *Ammodytes marinus* (Rogers & Stocks, 2001). Sandeel distribution is limited to shallow, turbulent areas of suitable sediment at depths of 20-70m (**Figures 9.25** to **9.28**) (Greenstreet *et al*., 2010; Jensen *et al*., 2011). Due to high substrate specificity and limited larval exchange between sandeel populations, they are particularly vulnerable to overfishing (Jensen *et al*., 2011).

181. The TAC for sandeel in the study area has been set at zero since 2015 and there were no recorded commercial landings of sandeel by UK registered vessels in the study area in recent years (**Table 9.1.2**). However, in the past there has been a fishery for sandeel by Danish vessels to the north and west of SEP and DEP including in ICES rectangle 35F1, and a proportion of these sandeel fishing grounds overlap the DEP North array area (see **Chapter 12 Commercial Fisheries, Appendix 12.1, Figure 2.11**). However, the value of landings fell significantly from 2004 onwards and no sandeel landings have been reported since 2011.

182. Sandeels are a group of shoaling fish which lie buried in sea bed sediments at night and feed on planktonic prey such as copepods and crustacean larvae in mid-water during daylight hours. They have neither a swim bladder, nor fins capable of compensatory movements, and in order to remain clear of the bottom they must swim continually (Rogers & Stocks, 2001). Sandeels are an important trophic link in the North Sea food chain, between zooplankton and sandeel predators including piscivorous fish, most seabirds and mammals for which sandeels are a high-lipid food source (Davis *et al.*, 2005; Wanless *et al*., 2005; MCCIP, 2018). As a significant number of marine predators rely on the sandeel population, coupled with their vulnerability to changes in habitat, sandeels are of increasing conservation interest and listed as species of principal importance in the UK (Ormerod, 2003). Additionally, they are designated as a nationally important marine feature (Furness, 1990; Hammond *et al*. 1994; Tollit and Thompson 1996; Wright and Tasker, 1996; Greenstreet *et al.,* 1998; Kerby *et al*., 2013) and, as a prey source, are linked to protected and qualifying features of nearby Special Protection Areas (SPA) and Special Areas of Conservation (SAC) such as the Greater Wash SPA and The Wash & North Norfolk Coast SAC. For these reasons, sandeels are described further.

183. The various sandeel species found in the North Sea have similar ecology and life history characteristics. Lesser sandeel can live up to 10 years, reaching sexual maturity at around 2 years old (Green, 2017). Females usually spawn where they live, between November and February, laying their eggs in clumps on sandy sediment (Coull *et al*., 1998) where they remain until they hatch (Green, 2017). After hatching in February and March, larvae remain in the water column before eventually settling as juvenile fish in areas of suitable sea bed substrate where they can burrow and remain hidden when not foraging, between approximately two and five months later (Macer, 1965; Wright and Bailey, 1996; Green, 2017). Sandeel must generate enough energy reserves to survive their overwintering period between approximately August and April when they spend approximately eight months buried in sandy bottom habitats (Green, 2017).

184. The IBTS recorded greater sandeel *Hyperoplus lanceolatus* (**Figure 9.25**), Raitt's sandeel (**Figure 9.26**), lesser sandeel *Ammodytes tobianus* (**Figure 9.28**), and Corbin's sandeel *Hyperoplus immaculatus* (**Figure 9.29**, **Table 9.1.3**) from both 34F1, 35F1 and 35F0 but not (**Figure 9.27**). smooth sandeel *Gymnammodytes semisquamatus* was not recorded in 34F1 or 35F1 and was only recorded at one sample station in 35F0. Greater sandeel had a high CPUE at 443.7867 from 35F1, with high CPUE at stations to the north of the DEP wind farm areas (**Figure 9.25**), suggesting that this species is abundant to the north. Raitt's sandeel had a high CPUE of 1,489 within ICES rectangle 35F0 (i.e. the regional study area) at stations to the north west of the SEP and DEP wind farm sites also suggesting that this species is abundant to the north west of the wind farm areas.

185. Otter and beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas also recorded greater sandeel, lesser sandeel and Corbin's sandeel but in relatively low numbers, suggesting that these species are likely to be present although not in high abundance (**Table 9.1.6**, **Table 9.1.7**, **Table 9.1.8**). However, it should be noted that beam or otter trawls are not particularly effective for examining their relative abundance, especially for the smallest life-history stages (Ellis *et al*., 2012) and so the abundance of sandeels in the area may be underrepresented.

186. **Figure 9.30** shows that the SEP and DEP offshore areas are located within an identified low intensity sandeel (*A. marinus*) spawning area and with low intensity nursery grounds defined by Ellis *et al*. (2010). It should be noted however that the majority of the SNS is defined as a low intensity sandeeel spawning area (**Figure 9.30**).

Sandeel habitat assessment

187. Research on the lesser sandeel suggests sandeels require a very specific substratum, favouring sea bed habitats containing a high proportion of medium and coarse sand and low silt content (Holland *et al*., 2005). Additionally, lesser sandeel occupies areas with bottom temperatures of 8.5-9.0°C and surface salinities of 34.90-35.0 ppt (van der Kooij *et al*. 2008).

188. Sediment particle size can be used to determine sediment type preferences of sandeels (Ammodytidae) in relation to particle size. An increase of the percentage of fine sand, coarse silt, medium silt, and fine silt (sediments with a diameter less than 0.25mm) is associated with sandeels increasingly avoiding the habitat, while an increase of the percentage of medium sand and coarse sand (sediments with a diameter ranging from 0.25mm to 2.0mm) is associated with sandeels increasingly preferring the habitat (Holland *et al*., 2005; Greenstreet *et al*., 2010; Fugro, 2020a, 2020b).

189. Latto *et al*. (2013) reviewed the interpretations of Holland *et al*., (2005) and Greenstreet *et al*., (2010) for preferred sediments for sandeels, aligned with the Folk (1954) classification, and **Table 9.1.15** summarises the resultant sediment type preferences of sandeel.

Table 9.1.15: Sediment Classifications Indicating 'Preferred' Sandeel Sediment Habitat

Fractional Composition	Folk (1954) Description	Sandeel Preference (Latto et *al*., 2013)
≤10% mud and ≤30% gravel	Sand (S), slightly gravelly sand ((g)S) and gravelly sand (gS)	Preferred
≤10% mud and >30% to <80% gravel	Sandy gravel (sG)	Marginal
>10% mud or ≥80% gravel	All other sediment types*	Unsuitable
Notes * = Other sediment types include mud (M), sandy mud (sM), muddy sand (mS), slightly gravelly mud ((g)M), slightly gravelly sandy mud ((g)sM), slightly gravelly sandy mud (g)mS, gravelly mud (gM), gravelly muddy sand ((g)mS), muddy gravel (mG), muddy sandy gravel (msG) and gravel (G)		

190. Both Holland *et al*. (2005) and Greenstreet *et al*. (2010) concluded that suitable sandeel habitat can include a gravel component. However, there were discrepancies between the proportions of gravel considered in their assessments. Inclusion of the Folk (1954) sandy gravel (sG) with between 30% and 80% gravel fraction may overrepresent sandeel habitat but Latto *et al*., (2013) adopted a precautionary approach with sandy gravel considered to be 'Marginal' habitat with adequate sediment structure to support low numbers of sandeels (Fugro, 2020a, 2020b).

191. An assessment of the presence of suitable sandeel habitat in the SEP and DEP areas, derived from an analysis of sediment samples, has been undertaken as part of the benthic survey undertaken for SEP and DEP (Fugro, 2020a; 2020b). The number of samples in the different project areas within each sandeel preference category is presented in **Table 9.1.16**. Note that at some stations there was duplicate or triplicate sampling. Each sample was assessed separately.

Table 9.1.16: Sediment classifications indicating 'preferred' sandeel sediment habitat in Project areas

Fractional Composition	Folk (1954) Description	Folk (BGS Modified) Description	Sandeel Preference (Latto et *al*., 2013)	Export cable corridor	SEP wind farm array	Interlink cable corridors	DEP wind farm arrays
≤10% mud and ≤30% gravel	Sand (S), slightly gravelly sand ((g)S) and gravelly sand (gS)	Sand (S) and gravelly sand (gS)	Preferred	11	1	11	22
≤10% mud and >30% to <80% gravel	Sandy gravel (sG)	Sandy gravel (sG)	Marginal	19	9	19	4
>10% mud or ≥80% gravel	All other sediment types	All other sediment types	Unsuitable	1	7	1	1

192. The locations and distribution of 'Preferred' sandeel habitat in the SEP and DEP offshore areas is illustrated in **Figure 9.31**. It is important to note that the presence of suitable habitat does not necessarily imply that sandeels are present in significant numbers in a given area. Catches of sandeel observed in grabs provide anecdotal evidence of their presence in the Project areas. The large majority of sediment samples from the DEP wind farm sites are assessed as 'Preferred' sandeel habitat. Sandeels were present in grabs from stations D19 and D25 in DEP North, both of which have been classed as 'Preferred' sandeel habitat. Examples of 'Preferred' sandeel habitat, along with 'Marginal' or 'Unsuitable' areas were identified on the interlink cable corridors, including 'Preferred' habitat at stations at the northern end of DEP North to SEP interlink corridor **Figure 9.31**. Sandeels were also recorded in this area from the grab sample at station CC_19, which was also assessed as 'Preferred' habitat (Fugro, 2020b).

193. All but one sample from the SEP wind farm are assessed as 'Marginal' or 'Unsuitable' for sandeel (**Figure 9.31**). No sandeels were recorded in grabs or photographic data from the SEP wind farm (Fugro, 2020a). This suggests that although the SEP wind farm area may support some sandeels, it is likely to be less important for the species than the area around the DEP wind farm sites.

194. Stations in the export cable corridor are assessed predominantly as 'Preferred' and 'Marginal' sandeel habitat. Lesser sandeels were observed from the video transect at station EC_18 on the offshore export cable corridor, an area which has been classed as 'Marginal' sandeel habitat (Fugro, 2020a).

9.1.3.4 Elasmobranchs

195. The following sections describe commercially exploited elasmobranch species in the local study area, their ecology and evidence of their presence in the Project areas. Species are discussed in descending order of landings over the period 2009 to 2019.

9.1.3.4.1 Thornback ray

196. Thornback ray *Raja clavata* is a widespread and relatively abundant skate (Ellis *et al*., 2012) although its abundance and range decreased in the North Sea after 1950 due to overfishing (Chevolot *et al*., 2006; Ellis *et al*., 2008). It is thought that its slow growth rate, late maturity and low fecundity makes this species vulnerable to overexploitation. Despite this, IBTS catches in the south-western North Sea have increased in recent years with the stock concentrated in the Greater Thames Estuary (Ellis *et al*., 2008). The average CPUE of thornback ray and their distribution in the North Sea between 2010 and 2020 is illustrated in **Figure 9.32**, confirming higher abundance in the shallow waters of the SNS. Thornback ray inhabit a broad range of soft sediments at depths of 10-60m but are less frequently documented on coarse sediments (Wilding and Snowden, 2008; Shark Trust, 2009).

197. Thornback ray is the most important commercially exploited elasmobranch in the study area, often caught as bycatch in mixed demersal fisheries with landings concentrated in the south-western North Sea (ICES, 2018b) (**Table 9.1.2**). However, it contributes a small proportion to UK landings from the study area.

198. Thornback ray landings from 34F1 (nearshore) peaked in 2010 at 2.95 tonnes but since 2011 were at or below 1 tonne (**Plate 9.1.4**). Along with blonde ray *Raja brachyura*, thornback ray was the only elasmobranch species landed from 35F1 (offshore) and landings were inconsistent, peaking at 3.96 tonnes in 2012 but with zero landings reported in some years (**Plate 9.1.8**).

199. Thornback ray exhibit seasonal migration, occupying deeper waters in the winter (20-35m) and moving to shallower areas of less than 20m depth in spring to spawn, where they remain until September (Hunter *et al*., 2005). Males reach sexual maturity before females, at around seven years, whereas females mature around nine years old (NWIFCA, 2018). Up to 150 egg cases are laid per year, although it is more typically 48-74 (ICES Fishmap, 2006). Fertilised egg cases are deposited on the sea bed, incubating for 4 to 5 months after which juveniles emerge as fully formed rays (Chevolot *et al*. 2006). The offshore export cable corridor traverses an area identified as a low intensity thornback ray nursery ground close to landfall (**Figure 9.33**). There is insufficient data on thornback ray spawning areas however it is generally believed that spawning and nursery grounds broadly overlap (Ellis *et al*. 2012).

200. Thornback ray was present in every year of the IBTS in 35F1 between 2010 and 2020 with an average CPUE of 1.4892, was only present in 2013, 2016 and 2019 in 34F1 with an average CPUE of 0.8 and in 35F0 was present in all years except 2015 with an average CPUE of 2.0073 (DATRAS, 2020). IBTS trawls located approximately 12km northeast of DEP North had a maximum CPUE of <6 individuals per hour (**Figure 9.32**).

201. Similarly, thornback ray was recorded in relatively low numbers in the historic otter trawl (**Table 9.1.6**) and beam trawl (**Table 10.1.A.1**) surveys of the Sheringham Shoal and Dudgeon OWF areas, as well as the 2010 elasmobranch survey of the Sheringham Shoal OWF (**Table 9.1.9**).

202. In terms of conservation importance, thornback ray is included in the OSPAR list of threatened and / or declining species and has been classified as ‘Near Threatened’ by the IUCN.

9.1.3.4.2 Blonde ray

203. The blonde ray *Raja brachyura* is a large bodied skate inhabiting sandy sea bed areas of the north-east Atlantic, western Mediterranean Sea with a patchy distribution in the North Sea (ICES, 2018b) (**Figure 9.34**). They are common in inshore and shelf waters between 10 and 150m deep (Ellis *et al*., 2005), preferring soft substrates such as sand, and are often found near sandbanks. Blonde ray primarily feed on crustaceans, with adults also feeding on cephalopods and small fish.

204. Blonde ray is not as commercially important as thornback ray, however they are often landed together. They made a small contribution to total landings by UK vessels from 34F1 and 35F1 between 2009 and 2019, totalling of 3.34 tonnes and 4.81, respectively (less than 0.15% of landings (**Table 9.1.2**).

205. Blonde ray reaches sexual maturity around 8 to 9 years. They also have a low fecundity, laying around 30 egg cases per year between February and August, and a long incubation period of seven months. Like thornback ray, this makes them vulnerable to localised overexploitation (Kay and Dipper 2009). As a result, the species is classified as 'Near Threatened' in the IUCN Red List of threatened species.

206. The IBTS recorded blonde ray in the study area occasionally but not in all years, with a low average CPUE of 0.1538 and 0.2632 in 34F1 and 35F1 respectively between 2010 and 2020 (**Figure 9.34**). The species was not recorded in the historic otter trawl and beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas, or the elasmobranch surveys at the Sheringham Shoal OWF, suggesting it is rare in the study area.

9.1.3.4.3 Starry smoothhound

207. There are two species of smoothhound sharks recorded in the north-east Atlantic; the starry smoothhound *Mustelus asterias* and common smoothhound *Mustelus mustelus*. It was previously thought that the difference between the two species was easily identified: starry smoothhounds have white spots on their skin; and common smoothhounds do not. The recent application of molecular genetic identification techniques has facilitated more reliable identification of *Mustelus* species (Farrell *et al*., 2009) and it has since been found that starry smoothhound is the dominant species in northern European waters with common smoothhound having a range largely restricted to waters further south (ICES, 2018b). In fact Ellis *et al*. (2016) suggested the starry smoothhound is probably the only *Mustelus* species to occur in British waters. There have been no recent records of common smoothhound in the North Sea, and historical records are unreliable. As such, all datasets that have recorded the presence of smoothhound or starry smoothhound have been combined and relabelled as *Mustelus spp.*

208. Starry smoothhound is common inshore and offshore, found on or near the sea bed at depths from the intertidal down to at least 100m, preferring sandy and gravelly bottoms. It is a relatively large species with adults measuring up to 140cm in length, feeding primarily on species of crab and lobster (Compagno, 1984). Despite being of increased interest to UK fishermen, the biology and status of this species had been little studied (Ellis *et al*., 2016). IBTS surveys indicate that the species is widely distributed across the North Sea but at relatively low abundance, with an average CPUE of 1.3378 recorded from 35F1 and 3.5982 from 35F0 (**Figure 9.35**) (DATRAS, 2020). No starry smoothhounds were recorded in 34F1 between 2010 and 2020.

209. Starry smoothhound tends to be caught seasonally as bycatch and is landed, as opposed to discarded, where there is sufficient market demand. It is an important species for recreational anglers who often follow catch and release protocols (ICES, 2018b). The species made a small contribution to total UK landings from 34F1 (nearshore) (0.24%) and almost no landings from 35F1 in recent years (**Table 9.1.2**).

210. Starry smoothhound is oviviparous, giving birth to live fully developed young, with a gestation period of 12 months. There are no identified nursery areas, but young are thought to be dropped in inshore waters in summer with mating occurring in the same season (Compagno, 1984). Movements and migrations of starry smoothhound are not fully understood although studies have indicated annual migrations between summertime grounds in the southern North Sea and overwintering in the English Channel and Bay of Biscay (ICES, 2018b).

211. Starry smoothhound was recorded occasionally in historic surveys of the Sheringham Shoal and Dudgeon OWF areas, including the Dudgeon otter trawl survey in October 2008 which recorded 44 individuals (**Table 9.1.6**) and the September 2005 beam trawl survey of the Sheringham Shoal OWF which recorded four individuals. No other otter of beam trawl surveys recorded the species. Eighty starry smoothhound were caught in the Sheringham Shoal OWF pre-cable installation elasmobranch survey in August 2009, however the post-cable installation elasmobranch surveys recorded none in November 2012 and only one in August 2013 (**Section 9.1.2.4.4**). The evidence suggests that starry smoothhound is typically present in low abundance in the area, but can occasionally be abundant.

9.1.3.4.4 Lesser spotted dogfish

212. Lesser spotted dogfish *Scyliorhinus canicula*, also known as small spotted catshark, is one of the most abundant elasmobranch species in the north-east Atlantic and Mediterranean Sea and can be found on a range of sea bed, including rocky reefs, gravelly and muddy sediments (Kay and Dipper 2009). It is a demersal species, usually found in waters shallower than 150m around the British Isles (Ellis *et al*., 2005). Adults measure up to 1m in length, feeding on a variety of molluscs and crustaceans, especially whelks, and occasionally fish species (Compagno, 1984).

213. The lesser spotted dogfish is oviparous, depositing an egg-case in shallow subtidal waters anchored to (Compagno, 1984). Depending on sea temperature, pups hatch after 5 to 11 months. Spawning occurs year-round, although in several places spawning activity exhibits season patterns and peaks between November and July (Compagno, 1984; Ellis and Shackley, 1997). Young sharks and hatchlings are found in shallower water than adults, which often occur in unisexual schools.

214. Generally taken as bycatch in mixed fisheries, lesser spotted dogfish are of low commercial value. Larger individuals are landed for human consumption or as bait for whelk fisheries, however, most are discarded and studies have shown they possess a high survivorship (Revill *et al*., 2005). Only 2.52 tonnes were landed by UK vessels from 34F1 (nearshore) and 0.15 tonnes from 35F1 between 2009 and 2019 (**Table 9.1.2**).

215. Lesser spotted dogfish was recorded by the IBTS with an average CPUE of 0.3846, 5.4797 and 6.1615 from 34F1, 35F1 and 35F0 respectively (**Table 9.1.3** and **Figure 9.36**).

216. Lesser spotted dogfish was recorded by several of the historic surveys of the Sheringham Shoal and Dudgeon OWF areas, (**Table 9.1.6**). One of the objectives of the Sheringham Shoal OWF pre- and post-cable installation elasmobranch surveys was to determine if EMF affected the feeding behaviour of lesser spotted dogfish. However, the species was only caught in the pre-installation survey, although this survey recorded the species at relatively high abundance (47 individuals) (**Section 9.1.2.4.4**). Two individuals were also recorded by SEP and DEP aerial surveys on 8th August 2019 (**Table 9.1.12**)

9.1.4 Species of Conservation Importance and Migratory Species

9.1.4.1 Species of conservation importance

217. Various fish and shellfish species that have designated conservation status and are present (or potentially present) in the Project areas are listed in **Table 9.1.17**. It should be noted that a number of the species listed are targeted commercially in the Project areas as described in **Section 9.1.3**.

Table 9.1.17: Species of Conservation Interest Potentially Present in the Offshore Development Area

Species	Conservation Status								
	Recorded in local study area	UK BAP	OSPAR[8]	NERC 2006[9]	IUCN Red List[10]	Bern Convention	CITES	W&C 1981[11]	Habitats Directive
Herring	Y	✓	-	✓	Least concern	-	-	-	-
Atlantic cod	Y	✓	✓	✓	Vulnerable	-	-	-	-
Dover sole	Y	✓	-	✓	-	-	-	-	-
Plaice	Y	✓	-	✓	Least concern	-	-	-	-
Mackerel	Y	✓	-	✓	Least concern	-	-	-	-
Whiting	Y	-	-	✓	Least concern	-	-	-	-
Lesser sandeel	Y	-	-	✓	-	-	-	-	-
River lamprey	Y	✓	✓	✓	Least concern	✓	-	-	✓
Sea lamprey	N	✓	✓	✓	Least concern	✓	-	-	✓
European eel	Y	✓	✓	✓	Critically Endangered	-	✓	-	-
Allis shad	Y	✓	✓	✓	Least concern	✓	-	✓	✓
Twaite shad	Y	✓	-	✓	Least concern	✓	-	✓	✓
Atlantic salmon	N	✓	✓	✓	Least concern	✓	-	-	✓
Sea trout	Y	✓	-	✓	Least concern	✓	-	-	-

[8] OSPAR - Oslo and Paris Convention for the Protection of the Marine Environment of the North-East Atlantic – Threatened or declining species
[9] NERC Act 2006
[10] IUCN - International Union for the Conservation of Nature – Red-listed species
[11] Wildlife and Countryside Act 1981

Species	Conservation Status								
	Recorded in local study area	UK BAP	OSPAR[8]	NERC 2006[9]	IUCN Red List[10]	Bern Convention	CITES	W&C 1981[11]	Habitats Directive
Horse mackerel	Y	-	-	✓	Vulnerable	-	-	-	-
Thornback ray	Y	-	✓	-	Near threatened	-	-	-	-

9.1.4.2 Diadromous fish species

9.1.4.2.1 River and sea lamprey

218. Lampreys belong to a group of jawless fish known as Agnatha. Lampreys are demersal parasitic anadromous fish with long elongated eel-like bodies and a mouth comprising a toothed circular sucking disk. They can also be recognised by their gills which open directly to each side of the head in the form of a line of seven gill holes behind the eye (Johnson *et al.*, 2015).

219. The European river lamprey *Lampetra fluviatilis* inhabits coastal waters, estuaries and accessible rivers, although some populations are known to be permanent freshwater residents. Most adults predate on marine fishes including young herring, sprat and flounder. Following one to two years occupancy in an estuarine environment, river lamprey cease feeding in the autumn and move upstream to fresh water to spawn between October and December (Maitland, 2005).

220. Sea lamprey *Petromyzon marinus* is recorded in low abundance in estuarine and inshore waters (Maitland, 2005). Relatively little is known about the precise habitats occupied by adult sea lamprey and although adults are sometimes caught at sea, the precise conditions in which they occur have not been described. Most adults are found in freshwater where spawning and larval life history stages occur. Sea lamprey habitat seems only to be important in relation to their ability to get to the spawning beds (Maitland, 2003). In the open sea, adults attach to host species, becoming parasitic on a variety of marine megafauna (Nichols and Tscherter, 2011). Therefore, distribution may largely dictated by their hosts. Homing behaviour is not apparent in this species and unlike salmonids and shads, lamprey do not have specific river populations (Waldman *et al.*, 2008).

221. River lamprey and sea lamprey are qualifying features of the Humber Estuary SAC, approximately 60km north west of the SEP wind farm area at its closest point. Both species breed in the River Derwent, a tributary of the River Ouse and ultimately the Humber, and both these species are qualifying features of the River Derwent SAC. Records of river and sea lamprey in rivers in Norfolk (and East Anglia as a whole) are relatively scarce compared with other areas of the UK (Kelly and King, 2001).

222. Neither river or sea lamprey were recorded in any of the historic site surveys of the Sheringham Shoal and Dudgeon OWF areas. However river lamprey was recorded by the IBTS in 35F1 (offshore) at a low average CPUE of 0.1250 (recorded in a trawls in 2016 and 2018). It is somewhat surprising to record river lamprey in the fully marine environment of the offshore ICES rectangle in the local study area.

9.1.4.2.2 European eel

223. European eel *Anguilla anguilla* is a catadromous migratory species found all around the UK and Europe. In early autumn, from the coasts of Europe, the mature adults known as silver eels carry out long-distance migrations (over 5,000 km) to Sargasso Sea where they spawn and die (ICES, 2020). Following spawning, eggs and larvae are transported eastwards by the Gulf Stream towards the European coast and metamorphose into glass eels as they arrive on the continental shelf from February to March. Upon entering estuaries, pigmentation and further metamorphosis takes place and glass eels become 'elvers', miniature versions of the adult eels, from May to September (SNH, 2019). As the eel grows, it becomes known as a "yellow eel" due to the brownish-yellow colour of their sides and belly. Yellow eels generally do not undertake migrations, however they will redistribute seasonally, this can be in coastal and estuarine waters or into freshwater (ICES, 2020). After 5 to 20 years in fresh or brackish water, the eels become sexually mature, develop in to silver eels and begin their breeding migration.

224. The European eel is widely distributed throughout the Anglian region, including Norfolk. A fishery for adult eels existed in the past, although few records were kept (DEFRA, 2010).

225. No European eel were recorded in any of the historic site surveys of the Sheringham Shoal and Dudgeon OWF areas. However the species was recorded by the IBTS in 34F1 (nearshore) in all years except 2018 and 2019, but CPUE was not recorded. Two eels have been recorded from the IBT surveys, in 2017 and 2020 from 35F1 with an average CPUE of 0.1111.

9.1.4.2.3 Allis and twaite shad

226. The allis shad *Alosa alosa* and the twaite shad *Alosa fallax* are both closely related members of the herring family, Clupeidae. The shads form a large group of pelagic fishes found in seas all over the world and many species have a high economic value. Most are marine, but some enter fresh water to spawn, their young subsequently returning to the sea to grow, and a few live permanently in fresh waters. Allis and twaite shad are the only two members of the family found in fresh water in the UK, migrating from coastal waters and estuaries into rivers to spawn (Natural England, 2003). Population declines in many parts of Europe have been attributed to the effects of pollution, overfishing and river obstructions to migration.

227. Designated sites for allis shad or twaite shad are located in river systems where the species have been recorded and where there is previous evidence of breeding, and where there still appear to be favourable conditions for breeding. However there are no UK designated sites for allis shad or twaite shad on the UK coast of the SNS.

228. UK vessels landed a total of 0.03 tonnes of shad (species not identified) from ICES rectangle 34F1 (nearshore) between 2008 and 2018, recorded in 2009, 2010 and 2016. No allis shad or twaite shad were recorded in historic site surveys of the Sheringham Shoal and Dudgeon OWF areas. Twaite shad was recorded by the IBTS in 2013 from 34F1 and in 2019 from 35F1, with average CPUEs of 0.1538 and 0.0976 respectively. The evidence suggests that shad are occasionally present in the study area but are generally in low abundance.

9.1.4.2.4 Atlantic salmon

229. Atlantic salmon *Salmo salar* is an anadromous fish that is widely distributed in the North Atlantic Ocean, with spawning occurring in rivers but individuals spending most of their lives at sea. Atlantic salmon has been harvested for many years by anglers in freshwater, by commercial fishers in fjords and coastal areas as well as at feeding areas in the high seas. Salmon return to the river of their birth after a period one to three years at sea (JNCC, 2020). The species is subject to many pressures in Europe, including pollution, the introduction of non-native salmon stocks, physical barriers to migration, exploitation from netting and angling, physical degradation of spawning and nursery habitat, and increased marine mortality (JNCC, 2020).

230. The oceanic phase of the salmon lifecycle begins in spring when juveniles, known as smolts, leave freshwater after between one and six years in the river system and commence their downstream migration to the sea. The salmon spend normally one to three years, occasionally up to five years feeding in the open ocean, before returning to their "home" river to spawn (Jacobsen, 2000). Growth is slow in freshwater, but rapid in the marine environment (Chaput, 2012). Atlantic salmon can be highly migratory in the ocean undertaking feeding migrations and aggregating in a broad range of geographic areas, including around Greenland and the Faroe Islands. These feeding aggregations result in fisheries on mixed stocks (many individual river populations) (Chaput, 2012).

231. Returning to the river of their birth to spawn has resulted in genetically distinct stock between rivers and even within individual rivers. Salmon spawn in shallow excavations made in gravelly areas of clean rivers and streams with high water flow rates water (JNCC, 2020).

232. The Atlantic salmon is a widespread species in the UK and is found in several hundred rivers, many of which have adult runs in excess of 1,000 (JNCC, 2020). Scottish rivers are the most important in terms of spawning sites. There are 79 rivers in England and Wales that support salmon populations. No rivers south of the Esk in Yorkshire or east of the Itchen in Hampshire are classified as salmon rivers, hence East Anglian (including Norfolk) rivers do not support important salmon populations (Salmon Atlas, 2011). The nearest UK designated site for salmon is the River Avon SAC on the west coast of Britain.

233. Despite this, there is potential for salmon to be present in the marine environment in the vicinity of SEP and DEP. However, no Atlantic salmon were recorded in any of the historic site surveys of the Sheringham Shoal and Dudgeon OWF areas, or by the IBTS.

9.1.4.2.5 Sea trout

234. Sea trout *Salmo trutta* are the migratory populations of the common and widely distributed brown trout. Although the same species, sea trout are anadromous with a similar life cycle to that of Atlantic salmon, whereas brown trout populations are entirely resident in freshwater habitats. Progeny of sea trout and brown trout have been shown to become both forms (Pawson, 2013). There is considerable variation in life-history strategies among individuals and populations and in the timing and duration of marine migrations. Females tend to adopt the anadromous strategy more than males.

235. Like Atlantic salmon, juvenile sea trout begin their life cycle in freshwater habitats, from which they migrate to sea as smolts to mature and subsequently return to spawn in freshwater (Ferguson *et al.*, 2019). Smolts typically leave European rivers between March and June, but also at other times of the year.

236. Since the late 1980s and early 1990s, some sea trout populations in western European countries including Norway, Scotland and Ireland have suffered severe stock declines that have been linked to the development of open net cage salmon farming in coastal waters and resultant salmon lice infestation on local wild sea trout stocks (Thorstad *et al.*, 2015). Sea trout were once targeted by local fisheries off Norfolk but these declined from the 1950s (Pawson, 2013). Sea trout fisheries are being phased out given sea trout is a species of conservation importance (**Table 9.1.17**).

237. Although sea trout are present in East Anglian rivers, those found off the East Anglian coast, including off Norfolk, are generally thought to originate from the rivers in northeast England and southeast Scotland such as the Esk, Wear, Coquet, Tyne and Tweed (Pawson, 2013). No sea trout were recorded in any of the historic site surveys of the Sheringham Shoal and Dudgeon OWF areas, nor the IBTS in the local study area. However, the species has been recorded occasionally in MMO landings by UK vessels from ICES rectangles 34F1 and 35F1.

9.1.5 Non Commercial Species

238. The ecology of abundant non-commercial fish and shellfish species present in the local study area are described in this section. These are defined as those species recorded in highest abundance by otter and beam trawl surveys of the existing Dudgeon and Sheringham Shoal OWFs combined.

9.1.5.1 Molluscs

239. This section describes the most abundant non-commercial mollusc species in the Project areas. Mollusc species are presented in descending order of combined abundance in **Table 9.1.18**. Commercial species are described in **Section 9.1.3**.

Table 9.1.18: Combined Mollusc Species Abundance Totals from Historic Beam And Otter Trawl Surveys of the Sheringham Shoal (SS) and Dudgeon OWF areas.

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Slipper shell	*Crepidula fornicata*	631	2,447	3,078				**3,078**
Discord mussel	*Musculus discors*	498	0	498				**498**
Veined squid	*Loligo forbesii*	316	0	316		59	59	**375**
Painted top shell	*Calliostoma zizyphinum*	222	128	350				**350**
Minute sea snail	*Rissoa parva*	154	0	154				**154**
Queen scallop	*Aequipecten opercularis*	108	0	108		5	5	**113**
Bobtail squid	*Sepiola atlantica*	50	34	84				**84**
Horse mussel	*Modiolus modiolus*	8	26	34				**34**
Mussel	*Mytilus edulis*	28	0	28	3	1	4	**32**
Ribbed crenella	*Musculus costulatus*	0	28	28				**28**
Common whelk	*Buccinum undatum*	7	20	27				**27**
Banded carpet	*Tapes rhomboides*	1	20	21				**21**
Arctic cowrie	*Trivia arctica*	1	18	19				**19**
Atlantic oyster	*Urosalpinx cinerea*	0	18	18				**18**
n/a	*Anomiidae sp.*	15	0	15				**15**
Truncate softshell	*Mya truncata*	15	0	15				**15**
Grey top shell	*Gibbula cineraria*	12	0	12				**12**
Wrinkled rock-borer	*Hiatella arctica*	11	0	11				**11**
Razor shell	*Ensis arcuatus*	0	10	10				**10**
Squid	*Loligo spp.*					7	7	**7**
n/a	*Modiolarca tumida*	4	0	4				**4**
Sting winkle	*Ocenebra erinacea*	4	0	4				**4**
Dog whelk	*Nucella lapillus*	2	0	2				**2**
Common razorshell	*Ensis ensis*	1	0	1				**1**

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
n/a	*Brachystomia sp.*	1	0	1				**1**
n/a	*Gammarellus*	1	0	1				**1**
n/a	*Gibbula tumida*	1	0	1				**1**
n/a	*Onoba semicostata*	1	0	1				**1**
Yellow carpet shell	*Venerupis rhomboides*	0	1	1				**1**

The colour intensity illustrates CPUE from high (dark) to low (light)

>10,000	
1,000 – 10,000	
100 – 1,000	
10 - 100	
1 - 10	
<1	

240. The slipper limpet or slipper shell *Crepidula fornicata* dominated the existing Sheringham Shoal and Dudgeon OWF surveys in terms of abundance. This invasive, non-native species originates from the east coast of the Americas between Canada and Mexico and has spread across European waters since its accidental introduction at end of the 19th century, believed to be associated with the import of the American oyster (*Crassostrea virginica*). It is a gastropod mollusc with an oval shell, up to 5cm in length, that is smooth with irregular growth lines. Slipper limpets are commonly found in curved chains of up to 12 animals. Large shells are found at the bottom of the chain, with the shells becoming progressively smaller towards the top. Slipper shells are typically found attached to other shells (e.g. scallops) and stones from the low water mark to 60m (Rayment, 2008). This protandrous hermaphrodite spawns at least once a year, with large numbers of eggs produced and a long planktonic larval stage giving the species high dispersal potential. Settling juveniles locate a suitable site for attachment and growth, either a stone or a chain of other slipper shells (conspecifics). The shell then grows to fit the substratum and consequently most animals are incapable of further movement at the age of about 2 years (Fretter & Graham, 1981). In some areas, particularly sheltered bays, slipper shells can reach densities of up to 10,000 individuals/m^2 (Blanchard, 2009), and severe and irreversible impacts can occur on the sediment, on the biodiversity or on the concentration of suspended matter. Slipper limpet abundance was similar between Dudgeon OWF pre and post-construction surveys, and its recorded abundance was higher in the Sheringham Shoal pre-construction survey than the post construction survey.

241. Other than the slipper limpet the only marine invasive non-native species recorded in the Sheringham Shoal and Dudgeon OWF areas (based on Harrower *et al.*, 2019) is the American oyster drill *Urosalpinx cinerea*. Externally this species appears similar to the native dog whelk *Nucella lapillus* and has previously been found on the Essex and Kent coasts, especially in estuaries and is associated with oysters on which it feeds by boring through the oyster's shell. It was unintentionally introduced with American oysters *Crassostrea virginica* but its limited adult mobility and the lack of a free-swimming larval stage prevents it spreading quickly (Oakley, 2006). The American oyster drill was only recorded by the October 2008 Dudgeon pre-construction beam trawl survey (Brown & May Marine, 2008b) with 24 individuals recorded from a 'control' trawl outside of the Dudgeon footprint approximately 3 to 4km to the south of the wind farm array area.

242. The discord mussel *Musculus discors* or green crenella was the most abundant bivalve in surveys. It is a small bivalve common around the British Isles, usually in clumps but occasionally found in dense, extensive beds from the intertidal to approximately 50m (Tyler-Walters, 2001).

243. The veined or long finned squid *Loligo forbesii* was the most abundant cephalopod recorded by historic beam and otter trawl surveys of the area, with the bobtail squid *Sepiola atlantica*, also known as the little cuttlefish, also recorded. Pelagic trawls undertaken for herring spawning surveys (**Section 9.1.2.4.5**) also recorded common squid *Alloteuthis subulata* and Northern squid *Loligo vulgaris* in the area, although abundance was not recorded. Long finned squid aggregate near the sea bed at depths of 10 to 500 metres during the day, and disperse into the water column at night to feed on fish, polychaetes, crustaceans, and other cephalopods. Adults migrate to shallow waters to spawn with females laying clumps of eggs on the sea bed. Long finned squid is the largest species of squid found around the UK, growing up to one metre in length. Along with the northern squid it is commercially valuable, but neither species are commercially important in the study area.

244. Several gastropod species were common in site historic surveys including the painted top shell, minute sea snail and other sea snails (**Table 9.1.17**).

9.1.5.2 Crustaceans

245. This section describes the most abundant non-commercial crustacean species in the Project areas. Crustacean species are presented in descending order of combined abundance in **Table 9.1.19**. Commercially important species are described in **Section 9.1.3**.

246. Crustaceans are the most abundant group recorded by nearby site surveys in the form of shrimps and crabs, as illustrated in **Table 9.1.8**. The crustacean component of the fish and shellfish community in the vicinity of SEP and DEP as evidenced by nearby beam and otter trawl surveys is summarised in **Table 9.1.19**. The pink shrimp and the brown shrimp are the first and second most abundant species recorded respectively. These are commercially exploited and are discussed in **Section 9.1.3.2.3**. Other shrimps recorded in abundance by historical surveys are *Pandalina brevirostris*, and *Crangon allmanni* which is closely related to the brown shrimp.

247. The harbour crab *Liocarcinus depurator* and long-clawed porcelain crab *Pisidia longicornis* are the third and fourth most abundant species recorded by historic site beam and otter trawl surveys, respectively (**Table 9.1.8**). The harbour crab is a swimming crab, a family of crabs with a fifth pair of legs flattened into broad paddles which are used for swimming. This ability, together with their strong, sharp claws, allows many species of swimming crab to be fast and aggressive predators. However, swimming crabs may exploit a wide range of dietary items including algae, sponges and many small invertebrates and may be considered omnivorous (Hill, 2008). Surveys also recorded other swimming crabs in abundance including the velvet swimming crab, discussed in **Section 9.1.3.2.4**, and the flying crab *Liocarcinus holsatus* (**Table 9.1.19**).

248. The long-clawed porcelain crab is a small crab (less than 1cm across the carapace) found under boulders and among bryozoan turfs. Porcelain crabs are not true crabs but superficially resemble them, and have a similar body plan of a squat lobster, with long claws used for territorial struggles rather than catching food. Spider crabs from the genus Macropodia were also abundant, recorded as the closely related *Macropodia parva;* or *Macropodia rostrata* (commonly known as the common or long-legged spider crab). These are relatively small crabs, differing in this respect from the commercially valuable common or spiny spider crab (*Maja squinado*).

Table 9.1.19: Combined Crustacean Species Abundance Totals from Historic Beam and Otter Trawl Surveys of the Sheringham Shoal (SS) and Dudgeon OWF Areas.

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Pink shrimp	*Pandalus montagui*	452957	6620	459577	103	0	103	**459680**
Brown shrimp	*Crangon crangon*	4538	868	5406	3	0	3	**5409**
Harbour crab	*Liocarcinus depurator*	3086	984	4070	185	0	185	**4255**
Long-clawed porcelain crab	*Pisidia longicornis*	1690	1816	3506				**3506**
Shrimp	*Pandalina brevirostris*	1153	1908	3061				**3061**
Velvet swimming crab	*Necora puber*	1371	82	1453	494	147	641	**2094**
Flying crab	*Liocarcinus holsatus*	506	418	924	95	0	95	**1019**
Spider crab	*Macropodia sp.*	29	796	825				**825**
Spider crab	*Macropodia parva/rostrata*	483	269	752				**752**
Shrimp	*Crangon allmanni*	2	555	557				**557**
Swimming crab	*Liocarcinus*	361	0	361				**361**
Shrimp	*Pandalus*	315	0	315				**315**
n/a	*Pontophilus trispinosus*	0	294	294				**294**
Squat lobster	*Galathea intermedia*	9	249	258				**258**
n/a	*Pontophilus fasciatus*	0	176	176				**176**
Common hermit	*Pagurus bernhardus*	69	100	169				**169**
Brown crab	*Cancer pagurus*	54	35	89	1	54	55	**144**
Right-handed hermit	*Paguridae indet.*	0	137	137				**137**
Lobster	*Homarus gammarus*	71	0	71	17	14	31	**102**
Drawf swimming crab	*Liocarcinus pusillus*	0	80	80				**80**
n/a	*Hippolytidae indet.*	0	66	66				**66**

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Common crab	*Carcinus maenas*	49	0	49	3	0	3	**52**
Spider crabs	*Macropodia sp. Indet*	49	0	49				**49**
Shrimp	*Caridea indet.*	0	48	48				**48**
Great spider crab	*Hyas araneus*	3	38	41				**41**
n/a	*Processa sp.*	0	33	33				**33**
Pennant's nut crab	*Ebalia tuberosa*	23	10	33				**33**
Bryer's nut crab	*Ebalia tumefacta*	3	26	29				**29**
n/a	*Polybiinae indet.*	0	29	29				**29**
Arctic lyre crab	*Hyas coarctatus*	28	0	28				**28**
Chameleon prawn	*Hippolyte varians*	0	28	28				**28**
n/a	*Pandalidae indet.*	0	24	24				**24**
Spider crabs	*Macropodia linaresi*	20	0	20	3	0	3	**23**
Bristly crab	*Pilumnus hirtellus*	9	12	21				**21**
Shrimp	*Crangon sp.*	0	21	21				**21**
n/a	*Processa nouveli*	0	14	14				**14**
Leach's spider crab	*Inachus phalangium*	11	0	11				**11**
Spider crabs	*Inachus sp.*	0	6	6				**6**
Swimming crab	*Liocarcinus juvenile*	0	6	6				**6**
n/a	*Modiolarca tumida*	4	0	4				**4**
Cranchs spider crab	*Achaeus cranchii*	2	0	2				**2**
Hermit crab	*Pagurus pubescens*	2	0	2				**2**

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Hairy hermit crab	*Pagurus cuanensis*	1	0	1				**1**
Mud shrimp	*Upogebia*	1	0	1				**1**
Squat lobster	*Galathea nexa*	1	0	1				**1**

The colour intensity illustrates CPUE from high (dark) to low (light)

>10,000	
1,000 – 10,000	
100 – 1,000	
10 - 100	
1 - 10	
<1	

9.1.5.3 Fish

249. This section describes the most abundant non-commercial fish species in the Project areas as evidenced by nearby beam and otter trawl surveys as summarised in **Table 9.1.20**. The ten most abundant species are described, with commercially important species (whiting and herring) covered in **Section 9.1.3**. Horse mackerel is also described because, although not abundant or commercially important in the study area, it is listed as a species of conservation importance (**Section 9.1.4.1**).

250. Historic site surveys also recorded anchovy *Engraulis encrasicolus*, greater pipefish *Syngnathus acus*, lesser sandeel *Ammodytes tobianus* and sardine *Sardina pilchardus* in the area, caught in pelagic trawls undertaken for herring spawning surveys (**Section 9.1.2.4.5**) although abundance was not recorded. Whiting was the most abundant fish species reported, described in **Section 9.1.3.3.7**. Other abundant species are described briefly in this section.

Table 9.1.20: Combined Species Abundance Totals from Historic Beam and Otter Trawl Surveys of the Sheringham Shoal (SS) and Dudgeon OWF Areas.

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Whiting	*Merlangius merlangus*	80	2	82	293	1756	2049	2131
Lesser weever fish	*Echiichthys vipera*	1508	65	1573	37	12	49	1622
Dragonet	*Callionymus lyra*	1138	161	1299	8	23	31	1330
Painted goby	*Pomatoschistus pictus*	318	706	1024				1024
Dab	*Limanda limanda*	186	34	220	32	515	547	767
Herring	*Clupea harengus*				565	71	636	636
Sand goby	*Pomatoschistus minutus*	6	604	610				610
Long-spined sea scorpion	*Taurulus bubalis*	428	61	489	35	0	35	524
Butterfish	*Pholis gunnellus*	249	92	341				341
Pogge / hook-nose	*Agonus cataphractus*	162	80	242	16	0	16	258
Pout	*Trisopterus luscus*	111	0	111	13	32	45	156
Montagu's seasnail	*Liparis montagui*	95	0	95				**95**
Seasnail	*Liparis liparis*	44	28	72	1	0	1	73
Greater sand eel	*Hyperoplus lanceolatus*	112	2	114				114
Plaice	*Pleuronectes platessa*	82	2	84		18	18	102
Lemon sole	*Microstomus kitt*	45	32	77	1	12	13	90
Grey gurnard	*Eutrigla gurnhardus*	13	0	13	24	29	53	66
Cod	*Gadus morhua*	29	0	29	5	28	33	62
Snake pipefish	*Entelurus aequoreus*	2	47	49				49
Bull rout	*Myoxocephalus scorpius*					40	40	40
Fivebeard rockling	*Cilata mustela*	1	24	25	3	0	3	28
Short-spined sea scorpion	*Myoxocephalus scorpius*	27	0	27				27
Goby	*Gobiidae*	13	10	23				23

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Goby	*Pomatoschistus*	23	0	23				23
Sprat	*Sprattus sprattus*	14	0	14	1	2	3	17
Dover Sole	*Solea solea*	16	0	16				16
Lesser or Raitt's sand eel	*Ammodytes marinus*	0	15	15				15
Red mullet	*Mullus surmuletus*					15	15	15
Tub gurnard	*Trigla lucerna*	1	0	1		11	11	12
Poor cod	*Trisopterus minutus*					8	8	8
Atlantic horse mackerel	*Trachurus trachurus*	6	0	6				6
Brill	*Scophthalmus rhombus*	3	0	3	1	2	3	6
Mackerel	*Scomber scombrus*	4	0	4		2	2	6
Flounder	*Platichthys flesus*	3	0	3	1	0	1	4
Solenette	*Buglossideum luteum*	0	4	4				4
Sole	*Solea solea*				3	0	3	3
Two-spotted clingfish	*Diplecogaster bimaculata*	0	3	3				3
Three-spined stickleback	*Gasterosteus aculeatus*	2	0	2				2
Black goby	*Gobius niger*	1	0	1				1
Bass	*Dicentrarchus labrax*				0	1	1	1
Corbin's sandeel	*Hyperoplus immaculatus*	0	1	1				1
Fourbeard rockling	*Rhinonemus cimbrius*	1	0	1				1
Goby	*Gobiidae larvae*	0	1	1				1
Sandeel	*Amodytes spp.*				0	1	1	1
Scaldfish	*Arnoglossus laterna*	1	0	1				1
Striped red mullet	*Mullus surmuletus*	1	0	1				1

The colour intensity illustrates total landings from high (dark) to low (light).

>10,000	1,000 – 10,000	100 – 1,000	10 - 100	1 - 10	<1

9.1.5.3.1 Lesser weever

251. Lesser weever *Echiichthys vipera* is the ninth most abundant species recorded by historic site beam and otter trawl surveys (**Table 9.1.8**) and the second most abundant fish species (**Table 9.1.20**). It can be found around the British coastline from the shallow sublittoral to over 150m, but usually to 50m, and is most abundant in the south and west. Preferred habitats are clean sand sea bed where it can bury itself with only the head and back uncovered. The lesser weever grows up to 18cm long, but generally less than 15cm. The spines of the first dorsal fin and gill covers release a poison, delivering a painful sting to bathers that tread on the buried fish. Lesser weever feeds mainly on small bottom living organisms, especially crustaceans such as amphipods and young brown shrimps, as well as fishes such as sandeels and gobies; and marine worms (Pizzolla, 2002; Maitland *et al*., undated).

252. The lesser weever spawns in the summer, with eggs and larvae entering the plankton (Maitland *et al*., undated). Nursery grounds are commonly found along sandbank habitats in the SNS (Heesen *et al.*, 2015).

253. Lesser weever was recorded in the IBTS from both 34F1 (nearshore), 35F1 (offshore) and 35F0, with an average CPUE of 2.4780, 66.8199 and 1.5008 respectively (**Table 9.1.3**). It was recorded in otter and beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas, but was most abundant in the pre-construction Sheringham Shoal beam trawl surveys in July and September 2005, with 987 individuals recorded in July.

9.1.5.3.2 Dragonet

254. Dragonet *Callionymus lyra*, also known as the common dragonet, is the tenth most abundant species recorded by historic site beam and otter trawl surveys (**Table 9.1.8**) and the third most abundant fish species (**Table 9.1.20**). Like the lesser weever, dragonets are adapted to lie buried in the sea bed with just the top of the head and back exposed. Dragonet males are brilliantly coloured, especially in the breeding season, and spawning is accompanied with elaborate courtship displays (Maitland *et al*., undated). In the common dragonet, males reach up to 30cm, females 20cm in length. This species is the most common dragonet in British waters and is very abundant in some areas, particularly sandy or muddy sea bed at depths of 20 to 100m. It feeds on polychaete worms, small crustaceans and molluscs. Spawning takes place from February to March with planktonic eggs and larvae (Maitland *et al*., undated).

255. Common dragonet was recorded in both otter and beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas, but like lesser weever was most abundant in the beam trawls. It was recorded in greatest abundance by the September 2005 Sheringham Shoal pre-construction beam trawl survey, which caught 912 individuals.

9.1.5.3.3 Painted goby

256. Painted goby *Pomatoschistus pictus* is the eleventh most abundant species recorded by historic site beam and otter trawl surveys (**Table 9.1.8**) and the fourth most abundant fish species (**Table 9.1.20**). Gobies are one of the most successful families of bony fishes in terms of number of species, and are typically small and adapted to a demersal existence. The painted goby is a moderately common goby in northern European seas, found in inshore waters from around low-tide mark down to a depth of approximately 50m. Its distribution is restricted to areas of gravel, shell, or coarse sand mixed with shells and stone, sand in close proximity to rocks, and in eel-grass beds (Maitland *et al*., undated).

257. The painted goby breeds from April to July, laying eggs in bivalve mollusc shells which are guarded by the male. After hatching, larvae are pelagic.

258. The species was not recorded at all by otter trawls surveys of the Sheringham Shoal and Dudgeon OWF areas and was absent from most beam trawl surveys. However it was very abundant in the December 2012 Sheringham Shoal OWF post-construction beam trawl survey (305 individuals) (Fugro EMU, 2013); and particularly the October 2008 Dudgeon OWF pre-construction beam trawl survey (706 individuals) where painted goby was well represented along the cable route, the wind farm and the control sites (Brown and May Marine, 2008b).

9.1.5.3.4 Dab

259. The dab *Lamanda limanda* is a very common flatfish, occurring all around Britain and Ireland and is particularly abundant in the North Sea. It was the fifth most abundant fish species recorded by historic site beam and otter trawl surveys (**Table 9.1.20**).

260. Dab is a member of the family Pleuronectidae, a large family of flatfishes which all have both eyes on the right side of their body, the left eye moving over the head during metamorphosis from post-larva to bottom-living young (Maitland *et al*., undated). It is a relatively small flatfish growing to approximately 42cm in length, found mainly on sandy sea bed between 20m and 40m deep, although adults have been recorded as deep as 150m and juveniles are typically found in shallower nursery areas as shallow as 2m, particularly estuaries. Dab will eat almost any bottom-living animal small enough to be captured including brittlestars, small sea urchins, fish, worms, crustaceans and molluscs.

261. Spawning depends on water temperature and therefore on latitude but is in spring and early summer around Britain (Ruiz, 2008). Eggs and larvae are pelagic (Maitland *et al*., undated).

262. They are a popular food fish with a good flavour and are moderately important commercially, caught mainly as by-catch in trawls and seines, but landings from the local study area are small (**Table 9.1.2**).

263. Dab was recorded in the IBTS from both 34F1, 35F1 and 35F0 with an average CPUE of 4.8491, 32.8362 and 14.9715 respectively (**Table 9.1.3**). It was abundant in otter and beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas (**Table 9.1.20**).

9.1.5.3.5 Sand goby

264. The sand goby *Pomatoschistus minutus* is a small, extremely common goby that inhabits inshore sandy and muddy sea bed areas from the intertidal to 20m, but is most common in waters shallower that 10m. It feeds on small crustaceans, particularly copepods, amphipods, and young brown shrimp, and is often caught in great quantities by shrimp nets and trawls. It is also a prey species for several demersal fish especially the bull rout, codling, pouting, and even sea bass, and is also taken by terns (Riley, 2007; Maitland *et al*., undated).

265. The sand goby spawns between March and July and like the painted goby the female lays eggs in empty bivalve shells where they are guarded by the male. Larvae are pelagic (Maitland *et al*., undated). Again like painted goby, the sand goby was largely absent from otter and beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas. It was not recorded at all by otter trawls surveys (**Table 9.1.20**) and although present in the September 2005 survey of the Sheringham Shoal OWF area, was only recorded in abundance by the October 2008 Dudgeon OWF pre-construction beam trawl survey (604 individuals). In this survey the sand goby was well represented along the cable route, the wind farm and the control sites (Brown and May Marine, 2008b).

9.1.5.3.6 Long spined sea scorpion

266. The long spined sea scorpion *Taurulus bubalis*, also known as the longspined bullhead, is a member of the diverse order Scorpaeniformes or 'mail-cheeked fishes' which all have a bony strut which runs under the eye across the cheek. Many species have spines attached to this bone which protect the eye (Maitland *et al*., undated). The order includes the scorpionfish family, but the long spined sea scorpion is a member of the bullheads (Cottidae), an abundant family of fishes with stout bodies and broad spiny heads that also includes the bull rout *Myoxocephalus scorpius*, recorded by previous otter trawl surveys of the Dudgeon OWF area. The long spined sea scorpion is a relatively small demersal fish (up to 17.5cm long) with a very long, strong cheek spine. It feeds on fishes and crustaceans, mainly blennies, gobies, amphipods, shrimps and crabs; and is common from the intertidal zone to approximately 30m, in rocky infralittoral areas with sufficient light for algae to grow.

267. Spawning takes place in early spring, the eggs being deposited in clumps amongst algae. The young are pelagic until the reach 13-14mm in length when they adopt a demersal existence (Maitland *et al*., undated).

268. The long spined sea scorpion has been recorded in greatest abundance by beam trawl surveys, present in four of the eight beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas and particularly abundant in the surveys of the Sheringham Shoal OWF areas in September 2005 and December 2012 (171 and 251 individuals respectively). However, although recorded in several trawls the totals were skewed by particularly high abundance in particular trawl stations (IECS, 2005d). Otter trawl surveys did not record this species at Dudgeon (**Table 9.1.6**). The evidence suggests that the long spined sea scorpion is present in the study area, generally at relatively low abundance but occasionally at higher abundance.

9.1.5.3.7 Butterfish

269. Butterfishes are a family of fishes with long slender bodies found in the cooler seas of the northern hemisphere. Most species inhabit inshore or shallow sea areas. The butterfish *Pholis gunnellus* is present all around Britain and Ireland and found on the shore from mid to low tide mark amongst seaweed, under rocks and in crevices down to 40m water depth. Offshore it occurs amongst rocky areas but also on sand and muddy substrata (Oakley, 2008). Its diet consists mainly small crustaceans, including amphipods and isopods, as well as polychaete worms and molluscs, and it can reach up to 25cm in length.

270. The butterfish, spawns from January to February, eggs being laid in clumps between stones or inside shells and guarded by an adult (Oakley, 2008; Jacob *et al*, 2013; Maitland *et al*., undated).

271. Butterfish was recorded in the IBTS in 34F1, 35F1 and 35F0 with an average CPUE of 17.5385, 1.3403 and 4.1693 respectively (**Table 9.1.3**). It was recorded in seven out of the eight historic beam trawl surveys undertaken for the Sheringham Shoal and Dudgeon OWFs but was not recorded by site otter trawl surveys.

9.1.5.3.8 Pogge

272. Pogge *Agonus cataphractus*, also known as hooknose, belongs to a family of demersal fishes that have several rows of overlapping armoured plates on their bodies (Maitland *et al*., undated). Pogge has a spine on each gill cover, a pair of hooks on the snout, and barbels on the underside of the head. It grows to 21cm in length but is more typically 10-15cm, and is usually found in inshore waters on sandy or muddy sea bed where it feeds primarily on small crustaceans. Although more common is shallow waters, it has been recorded in waters up to approximately 270m.

273. Females deposit eggs on kelp and other brown seaweeds from February to May. After up to 12 months the eggs hatch and begin a planktonic larval stage, after which larvae settle on the sea bed when they reach a length of 20mm. Juveniles inhabit shallower waters than adults, inshore and on offshore banks (Maitland *et al*., undated).

274. Pogge was recorded in the IBTS in 34F1, 35F1 and 35F0 with an average CPUE of 4.3879, 8.2117 and 9.2864 respectively (**Table 9.1.3**), in relative abundance by historic beam trawl surveys undertaken for the Sheringham Shoal and Dudgeon OWFs, and also by historic otter trawl surveys.

9.1.5.3.9 Horse mackerel

275. The horse mackerel *Trachurus trachurus*, also known as scad, is a schooling species with a range extending across the eastern Atlantic Ocean, from Norway to South Africa, around the including the Mediterranean and Marmara Seas. The species has a south-western distribution in UK waters and is most abundant in the English Channel and in the Irish Sea as far north as Lancashire (Barnes, 2008). It is a migratory species, moving northwards in the summer months and returning southwards when the sea temperature starts to fall. The North Sea stock spawns in the southern part of the North Sea during the summer and then migrates northwards into the central North Sea, the Skagerrak and the Kattegat. Typically found over sandy areas on continental shelves to depths of 200m and sometimes deeper, horse mackerel feed on a variety of pelagic and benthic fish, crustaceans and cephalopods.

276. Spawning is pelagic, and juveniles often shoal with the juveniles of other fish species, particularly Atlantic herring, and sheltering in the tentacles of jellyfish.

277. Horse mackerel has been assessed as vulnerable by the IUCN because the species is overfished across most of its range with the exception of the European northeast Atlantic including the North Sea (Smith-Vaniz *et al.*, 2015). However horse mackerel is not commercially important in the study area with less than two tonnes landed in total by UK vessels from 34F1 between 2009 and 2019, and no landings recorded for the period in the rest of the study area (**Table 9.1.2**).

278. Horse mackerel was recorded in the IBTS from both 35F1 and 35F0 with an average CPUE of 12.0962 and 1.7895 respectively (**Table 9.1.3**). The species was only recorded by historic site surveys in the September 2005 beam trawl survey of the Sheringham Shoal OWF area. The evidence suggests that horse mackerel is occasionally present in the study area but is generally in low abundance.

9.1.6 Summary

279. Regional and local data sources have been used to describe the fish and shellfish baseline in the study area, with a focus on the local study area defined as the area with ICES rectangles 34F1 and 35F1 which encompasses the offshore elements of SEP and DEP. Regional data includes: MMO landings, used to identify commercially important species; and the IBTS, which provides information about species present locally that are effectively sampled by beam trawls, including non-commercial species, but does not sample within the SEP or DEP boundaries. The baseline description has a focus on historic surveys undertaken before and after construction of the existing Dudgeon and Sheringham Shoal OWFs because they are in close proximity, and in some cases sampled within the SEP or DEP areas. These included several otter, beam and pelagic trawl surveys, and longline surveys for elasmobranchs.

280. The most important commercial species in the local study area, in descending order of UK reported landings, are whelk, brown crab, lobster and herring. Whelk, and to a lesser extent brown crab landings dominate, whereas the landings of herring as the most important commercial fish species, are comparatively small. Several other species are commercially exploited but make up a small proportion of landings from the study area. Whelk, brown crab, and lobster landings are important from both ICES rectangle 34F1 (which covers the nearshore section of the offshore export cable up to landfall) and 35F1, which encompasses an area further offshore including the SEP and DEP wind farms and part of the offshore export cable corridor. However, whelks contributed a greater proportion of landings from the offshore area (approximately 81%, compared to 37%), and an identified whelk fishing ground coincides with much of the DEP North array area. Brown crab is the most important commercial species in the nearshore area. Similarly, lobster contributes a greater proportion of landings from the nearshore area, but landed tonnage is similar from both 34F1 and 35F1. Crab and lobster potting grounds extend over an area that includes the SEP and DEP wind farm sites, interlink cable and export cable corridors.

281. There are occasional records of diadromous fish species in the study area but the evidence suggests the area is not of particular importance for these species. Similarly, there are records of several species of conservation importance in the study area but in low abundance, including possible spawning and nursery grounds of thornback ray, herring, Dover sole, plaice, mackerel, whiting and lesser sandeel.

282. A benthic characterisation survey of the SEP and DEP areas was completed in August 2020. The suitability of the sea bed for demersal spawning herring and as sandeel habitat, based on analysis of sediment samples, has been assessed. The assessment concludes that most of the sediments in the DEP wind farm site and in the northwest of the SEP wind farm site are unsuitable for herring spawning. Areas with a high percentage of gravel and very little mud content, considered preferred herring spawning habitat, are located in the southeast and most easterly extent of the SEP wind farm site and intermittently along the offshore cable corridors. However, the existence of suitable herring spawning habitat does not necessarily mean that the area is used as a herring spawning ground and, following pre- and post-construction herring spawning surveys at the Dudgeon and Sheringham Shoal OWF locations, it was concluded that herring spawning did not occur in the survey areas, possibly as a result of changes to North Sea herring spawning patterns in the 1970s (Brown and May Marine, 2009).

283. Sediment samples were also assessed for sandeel habitat suitability, with sea bed habitats containing a high proportion of medium and coarse sand being preferred. Most of the stations in the DEP wind farm sites have been assessed as preferred sandeel habitat whereas all but one sample from the SEP wind farm have been assessed as marginal or unsuitable. Stations in the offshore export cable corridor have been assessed predominantly as preferred or marginal. As with herring, the presence of suitable habitat does not necessarily mean that sandeels are present in significant numbers. Otter and beam trawl surveys of the Sheringham Shoal and Dudgeon OWF areas recorded sandeels in relatively low numbers, suggesting that these species are present but not abundant, although it should be noted that the abundance of sandeels in the area may be under-represented by these survey methods. Sandeels were present in two grabs in the DEP North array area, and one at the northern end of the DEP North to SEP interlink cable corridor, all of which have been classed as ‘Preferred’ sandeel habitat. IBTS data suggest that greater sandeel may be abundant to the north of the DEP wind farm areas, and the extent of a historical sandeel fishery overlapped with part of the DEP North array area. The presence of suitable sediments supports the possibility that the DEP wind farm site, and particularly the DEP North array area, support sandeel.

284. Previous surveys of the Sheringham Shoal OWF area recorded, in descending order of the number individuals landed across all surveys, pink shrimp, brown shrimp, harbour crab, velvet swimming crab, long-clawed porcelain crab, lesser weever fish, the shrimp *Pandalina brevirostris*, dragonet, slipper limpet, and flying crab. Some surveys also recorded herring and sprat in high abundance.

285. Surveys of the Dudgeon OWF area recorded, in descending order of the number individuals landed across all surveys, pink shrimp, slipper limpet, *Pandalina brevirostris*, long-clawed porcelain crab, whiting, harbour crab, brown shrimp, spider crabs of the genus *Macropodia*, painted goby, and sandy goby.

286. Two invasive non-native species have been recorded in the study area; the slipper limpet and the American oyster drill. Both these molluscs were unintentionally introduced from the western Atlantic with American oysters.

287. The Sheringham Shoal and Dudgeon OWF areas are broadly similar in terms of species composition, with crustaceans being the most abundant group. Variations in the abundance of species recorded may be attributed to differences in habitats between the SEP and DEP areas, but may also be the result of survey gaps and limitations, as well as seasonal and temporal changes in the distribution and abundance of species related to migrations or natural fluctuations in species abundances over time.

Table 9.1.21: Summary of the principal fish and shellfish species in the local study area

Species	Rational
Molluscs	
Whelk	• Commercially important in the study area • Recorded by Sheringham Shoal and Dudgeon OWF surveys
Slipper limpet	• Recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys • Invasive, non-native species
Crustaceans	
Brown crab	• Commercially important in the study area • Recorded by Sheringham Shoal and Dudgeon OWF surveys
Lobster	• Commercially important in the study area • Recorded by Sheringham Shoal and Dudgeon OWF surveys
Brown shrimp	• Recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys
Pink shrimp	• Recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys
Other shrimps	• *Pandalina brevirostris* and *Crangon allmanni* recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys
Swimming crabs	• Harbour crab, velvet crab and flying crab recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys
Long-clawed porcelain crab	• Recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys
Spider crabs	• *Macropodia parva* and *Macropodia rostrata* recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys

Species	Rational
Fish	
Whiting	• Recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys • Of some commercial importance in the study area • Species of Conservation Interest • Low intensity spawning and nursery areas overlap with the SEP and DEP wind farm sites, interlink and offshore export cable corridors
Herring	• Recorded in seasonally high abundance by Sheringham Shoal and Dudgeon OWF surveys • Of some commercial importance in the study area • Species of Conservation Interest • Key prey species for fish, birds and marine mammals • Demersal spawning species • Suitable spawning habitat within the southeast and most easterly extent of the SEP wind farm area and intermittently along the offshore cable corridors, but spawning surveys suggest no spawning activity • Low intensity nursery areas overlap with the SEP and DEP wind farm sites, interlink and offshore export cable corridors
Sandeels	• Historic sandeel fishing grounds overlap the DEP North array area • Greater sandeel, lesser sandeel and Corbin's sandeel recorded by Sheringham Shoal and Dudgeon OWF surveys and recorded in high abundance by nearby surveys to the north • Key prey species for fish, birds and marine mammals • Demersal spawning species • Low intensity sandeel (*A. marinus*) spawning area and with low intensity nursery areas overlap with the SEP and DEP wind farm sites, interlink and offshore export cable corridors • Suitable sandeel habitat in the DEP wind farm site areas and in the export cable corridor, but most of the SEP wind farm area is less suitable
Sprat	• Recorded in seasonally high abundance by Sheringham Shoal and Dudgeon OWF herring spawning surveys • Important prey species for fish, birds and marine mammal species
Lesser weever	• Recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys
Dragonet	• Recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys

Species	Rational
Gobies	• Painted and sand goby recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys
Dab	• Recorded in high abundance by Sheringham Shoal and Dudgeon OWF surveys
Elasmobranchs	
Starry smoothhound	• The most abundant elasmobranch recorded by Sheringham Shoal and Dudgeon OWF surveys, typically present at low densities, but can occasionally abundant
Thornback ray	• Present in the study area • Species of Conservation Interest • The most important commercially exploited elasmobranch in the study area, but landings are relatively small

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Annex 1

Table 10.1.A.1 Species and number of individuals recorded from beam trawl surveys between 2005 to 2014.

Common name	Scientific name	Sheringham Shoal					Dudgeon		
		Apr-05	Jul-05	Sep-05	Dec-12	Apr-14	May-08	Oct-08	Sep-14
Cranchs spider crab	*Achaeus cranchii*			2					
Queen scallop	*Aequipecten opercularis*		21	87					
Pogge / hook-nose	*Agonus cataphractus*	16	10	22	105	9	3	77	
n/a	*Alvania (Crisilla) semistriata*	1							
Lesser or Raitt's sand eel	*Ammodytes marinus*						2	13	
n/a	*Anomiidae sp.*	15							
Scaldfish	*Arnoglossus laterna*			1					
n/a	*Brachystomia sp.*	1							
Common whelk	*Buccinum undatum*	2		5			1	19	
Solenette	*Buglossideum luteum*						1	3	
Dragonet	*Callionymus lyra*	6	97	912	102	21	14	147	
Painted top shell	*Calliostoma zizyphinum*	15	54	152		1		128	
Brown crab	*Cancer pagurus*	4	5	5		40	2	33	
Common crab	*Carcinus maenas*	1	20	28					
Shrimp	*Caridea indet.*							48	
Fivebeard rockling	*Cilata mustela*			1				24	
Shrimp	*Crangon allmanni*					2		555	
Brown shrimp	*Crangon crangon*	24	50	4014	421	29	7	626	235
Shrimp	*Crangon sp.*							21	
Slipper limpet / shell	*Crepidula fornicata*	304	135	183		9	19	1257	1171
Two-spotted clingfish	*Diplecogaster bimaculata*							3	
Pennant's nut crab	*Ebalia tuberosa*		12	11				10	

Common name	Scientific name	Sheringham Shoal					Dudgeon		
		Apr-05	Jul-05	Sep-05	Dec-12	Apr-14	May-08	Oct-08	Sep-14
Bryer's nut crab	*Ebalia tumefacta*			3				26	
Lesser weever fish	*Echiichthys vipera*	2	987	518		1	31	34	
Razor shell	*Ensis arcuatus*							10	
Common razor shell	*Ensis ensis*		1						
Snake pipefish	*Entelurus aequoreus*			2			2	45	
Grey gurnard	*Eutrigla gurnhardus*		8	5					
Cod	*Gadus morhua*		6	23					
Squat lobster	*Galathea intermedia*		7			2		249	
Squat lobster	*Galathea nexa*	1							
n/a	*Gammarellus*					1			
Three-spined stickleback	*Gasterosteus aculeatus*			2					
n/a	*Gibbula (Colliculus) tumida*	1							
Grey top shell	*Gibbula (Steromphala) cineraria*	12							
Goby	*Gobiidae*				13			10	
Goby	*Gobiidae larvae*						1		
Black goby	*Gobius niger*			1					
Wrinkled rock-borer	*Hiatella arctica*	11							
Chameleon prawn	*Hippolyte varians*							28	
n/a	*Hippolytidae indet.*							66	
Lobster	*Homarus gammarus*		34	37					
Great spider crab	*Hyas araneus*	3					6	32	
Arctic lyre crab	*Hyas coarctatus*	2	3	4		19			
Corbin's sandeel	*Hyperoplus immaculatus*							1	
Greater sand eel	*Hyperoplus lanceolatus*		24	88			1	1	

Common name	Scientific name	Sheringham Shoal					Dudgeon		
		Apr-05	Jul-05	Sep-05	Dec-12	Apr-14	May-08	Oct-08	Sep-14
Leach's spider crab	*Inachus phalangium*	11							
Spider crabs	*Inachus sp.*							6	
Dab	*Limanda limanda*	2	80	102		2	5	29	
Swimming crab	*Liocarcinus*					361			
Harbour crab	*Liocarcinus depurator*	69	216	113	2688		34	709	241
Flying crab	*Liocarcinus holsatus*	23	68	415			10	352	56
Swimming crab	*Liocarcinus juvenille*						6		
Small swimming	*Liocarcinus pusillus*							80	
Seasnail	*Liparis liparis*	1	1	25	17			28	
Montagu's seasnail	*Liparis montagui*	1		6	87	1			
Veined squid	*Loligo forbesii*		121	195					
Spider crabs	*Macropodia linaresi*		10	10					
Spider crab	*Macropodia parva/rostrata*	10			472	1			269
Spider crab	*Macropodia sp.*		9	20				796	
Spider crabs	*Macropodia sp. Indet*		49						
Whiting	*Merlangius merlangus*		27	53				2	
Lemon sole	*Microstomus kitt*	3	18	12		12	1	31	
n/a	*Modiolarca tumida*	4							
Horse mussel	*Modiolus modiolus*	2	2	3		1	2	24	
striped red mullet	*Mullus surmuletus*			1					
Ribbed crenella	*Musculus costulatus*							28	
Discord mussel	*Musculus discors*	498							
Starry smoothhound	*Mustelus asterias*			4					
Truncate softshell	*Mya truncata*	15							
Short-spined sea scorpion	*Myoxocephalus scorpius*	8				19			

Common name	Scientific name	Sheringham Shoal					Dudgeon		
		Apr-05	Jul-05	Sep-05	Dec-12	Apr-14	May-08	Oct-08	Sep-14
Mussel	*Mytilus edulis*	28							
Velvet swimming crab	*Necora puber*	101	386	878		6		22	60
Dog whelk	*Nucella lapillus*	1	1						
Sting winkle	*Ocenebra erinacea*	3				1			
n/a	*Onoba semicostata*	1							
Right-handed hermit	*Paguridae indet.*							137	
Common hermit	*Pagurus bernhardus*	6	7	56			3	97	
Hairy hermit crab	*Pagurus cuanensis*	1							
Hermit crab	*Pagurus pubescens*			2					
n/a	*Pandalidae indet.*							24	
Shrimp	*Pandalina brevirostris*				1153			1584	324
Shrimp	*Pandalus*					315			
Pink shrimp	*Pandalus montagui*	91	11466	437173	4227			1338	5282
Butterfish	*Pholis gunnellus*		51	95	54	49	21	15	56
Bristly crab	*Pilumnus hirtellus*	9						12	
Long-clawed porcelain crab	*Pisidia longicornis*	634	243		809	4		1381	435
Flounder	*Platichthys flesus*		1			2			
Plaice	*Pleuronectes platessa*		39	43			1	1	
n/a	*Polybiinae indet.*							29	
Goby	*Pomatoschistus*				19	4			
Sand goby	*Pomatoschistus minutus*			6				604	
Painted goby	*Pomatoschistus pictus*		4	9	305			706	
n/a	*Pontophilus fasciatus*							176	
n/a	*Pontophilus trispinosus*							294	
n/a	*Processa nouveli*							14	

Common name	Scientific name	Sheringham Shoal					Dudgeon		
		Apr-05	Jul-05	Sep-05	Dec-12	Apr-14	May-08	Oct-08	Sep-14
n/a	*Processa sp.*							33	
Thornback ray	*Raja clavata*		2						
Spotted ray	*Raja montagui*	1	2	3					
Fourbeard rockling	*Rhinonemus cimbrius*			1					
Minute sea snail	*Rissoa parva*	154							
Mackerel	*Scomber scombrus*			4					
Brill	*Scophthalmus rhombus*		2	1					
Lesser spotted dogfish	*Scyliorhinus canicula*		8	3					
Bobtail squid	*Sepiola atlantica*		3	43		4	1	33	
Dover Sole	*Solea solea*	1	4	11					
Sprat	*Sprattus sprattus*		2	12					
Banded carpet	*Tapes rhomboides*	1						20	
Long-spined sea scorpion	*Taurulus bubalis*		2	171	255			61	
Atlantic horse mackerel	*Trachurus trachurus*			6					
Tub gurnard	*Trigla lucerna*		1						
Pout	*Trisopterus luscus*	7	6	85	13				
Arctic cowrie	*Trivia arctica*	1						18	
Mud shrimp	*Upogebia*					1			
American oyster drill	*Urosalpinx cinerea*							24	
Yellow carpet shell	*Venerupis rhomboides*						1		

The colour intensity illustrates total landings from high (dark) to low (light).

>10,000	1,000 – 10,000	100 – 1,000	10 - 100	1 - 10	<1

Annex 2

Table 10.1.A.2: Combined species abundance totals from historic beam and otter trawl surveys of the Sheringham Shoal (SS) and Dudgeon OWF areas (colour intensities follow the same range as Table 10.1.A.1).

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Pink shrimp	*Pandalus montagui*	452957	6620	459577	103	0	103	**459680**
Brown shrimp	*Crangon crangon*	4538	868	5406	3	0	3	**5409**
Harbour crab	*Liocarcinus depurator*	3086	984	4070	185	0	185	**4255**
Long-clawed porcelain crab	*Pisidia longicornis*	1690	1816	3506				**3506**
Slipper shell	*Crepidula fornicata*	631	2447	3078				**3078**
Shrimp	*Pandalina brevirostris*	1153	1908	3061				**3061**
Whiting	*Merlangius merlangus*	80	2	82	293	1756	2049	**2131**
Velvet swimming crab	*Necora puber*	1371	82	1453	494	147	641	**2094**
Lesser weever fish	*Echiichthys vipera*	1508	65	1573	37	12	49	**1622**
Dragonet	*Callionymus lyra*	1138	161	1299	8	23	31	**1330**
Painted goby	*Pomatoschistus pictus*	318	706	1024				**1024**
Flying crab	*Liocarcinus holsatus*	506	418	924	95	0	95	**1019**
Spider crab	*Macropodia sp.*	29	796	825				**825**
Dab	*Limanda limanda*	186	34	220	32	515	547	**767**
Spider crab	*Macropodia parva/rostrata*	483	269	752				**752**
Herring	*Clupea harengus*				565	71	636	**636**
Sand goby	*Pomatoschistus minutus*	6	604	610				**610**
Shrimp	*Crangon allmanni*	2	555	557				**557**
Long-spined sea scorpion	*Taurulus bubalis*	428	61	489	35	0	35	**524**
Discord mussel	*Musculus discors*	498	0	498				**498**

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Veined squid	*Loligo forbesii*	316	0	316		59	59	**375**
Swimming crab	*Liocarcinus*	361	0	361				**361**
Painted top shell	*Calliostoma zizyphinum*	222	128	350				**350**
Butterfish	*Pholis gunnellus*	249	92	341				**341**
Shrimp	*Pandalus*	315	0	315				**315**
n/a	*Pontophilus trispinosus*	0	294	294				**294**
Pogge / hook-nose	*Agonus cataphractus*	162	80	242	16	0	16	**258**
Squat lobster	*Galathea intermedia*	9	249	258				**258**
n/a	*Pontophilus fasciatus*	0	176	176				**176**
Common hermit	*Pagurus bernhardus*	69	100	169				**169**
Pout	*Trisopterus luscus*	111	0	111	13	32	45	**156**
Minute sea snail	*Rissoa parva*	154	0	154				**154**
Brown crab	*Cancer pagurus*	54	35	89	1	54	55	**144**
Right-handed hermit	*Paguridae indet.*	0	137	137				**137**
Greater sand eel	*Hyperoplus lanceolatus*	112	2	114				**114**
Queen scallop	*Aequipecten opercularis*	108	0	108		5	5	**113**
Lobster	*Homarus gammarus*	71	0	71	17	14	31	**102**
Plaice	*Pleuronectes platessa*	82	2	84		18	18	**102**
Montagu's seasnail	*Liparis montagui*	95	0	95				**95**
Lemon sole	*Microstomus kitt*	45	32	77	1	12	13	**90**
Bobtail squid	*Sepiola atlantica*	50	34	84				**84**
Small swimming	*Liocarcinus pusillus*	0	80	80				**80**
Seasnail	*Liparis liparis*	44	28	72	1	0	1	**73**

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Grey gurnard	*Eutrigla gurnhardus*	13	0	13	24	29	53	**66**
n/a	*Hippolytidae indet.*	0	66	66				**66**
Cod	*Gadus morhua*	29	0	29	5	28	33	**62**
Common crab	*Carcinus maenas*	49	0	49	3	0	3	**52**
Snake pipefish	*Entelurus aequoreus*	2	47	49				**49**
Spider crabs	*Macropodia sp. Indet*	49	0	49				**49**
Shrimp	*Caridea indet.*	0	48	48				**48**
Starry smoothhound	*Mustelus asterias*	4	0	4		44	44	**48**
Great spider crab	*Hyas araneus*	3	38	41				**41**
Bull rout	*Myoxocephalus scorpius*					40	40	**40**
Horse mussel	*Modiolus modiolus*	8	26	34				**34**
n/a	*Processa sp.*	0	33	33				**33**
Pennant's nut crab	*Ebalia tuberosa*	23	10	33				**33**
Mussel	*Mytilus edulis*	28	0	28	3	1	4	**32**
Bryer's nut crab	*Ebalia tumefacta*	3	26	29				**29**
n/a	*Polybiinae indet.*	0	29	29				**29**
Arctic lyre crab	*Hyas coarctatus*	28	0	28				**28**
Chameleon prawn	*Hippolyte varians*	0	28	28				**28**
Fivebeard rockling	*Cilata mustela*	1	24	25	3	0	3	**28**
Ribbed crenella	*Musculus costulatus*	0	28	28				**28**
Common whelk	*Buccinum undatum*	7	20	27				**27**
Short-spined sea scorpion	*Myoxocephalus scorpius*	27	0	27				**27**
n/a	*Pandalidae indet.*	0	24	24				**24**

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Goby	*Gobiidae*	13	10	23				**23**
Goby	*Pomatoschistus*	23	0	23				**23**
Spider crabs	*Macropodia linaresi*	20	0	20	3	0	3	**23**
Lesser spotted dogfish	*Scyliorhinus canicula*	11	0	11	2	9	11	**22**
Banded carpet	*Tapes rhomboides*	1	20	21				**21**
Bristly crab	*Pilumnus hirtellus*	9	12	21				**21**
Shrimp	*Crangon sp.*	0	21	21				**21**
Arctic cowrie	*Trivia arctica*	1	18	19				**19**
Atlantic oyster	*Urosalpinx cinerea*	0	24	24				**24**
Sprat	*Sprattus sprattus*	14	0	14	1	2	3	**17**
Dover Sole	*Solea solea*	16	0	16				**16**
Thornback ray	*Raja clavata*	2	0	2	11	3	14	**16**
Lesser or Raitt's sand eel	*Ammodytes marinus*	0	15	15				**15**
n/a	*Anomiidae sp.*	15	0	15				**15**
Red mullet	*Mullus surmuletus*					15	15	**15**
Truncate softshell	*Mya truncata*	15	0	15				**15**
n/a	*Processa nouveli*	0	14	14				**14**
Grey top shell	*Gibbula (Steromphala) cineraria*	12	0	12				**12**
Tub gurnard	*Trigla lucerna*	1	0	1		11	11	**12**
Leach's spider crab	*Inachus phalangium*	11	0	11				**11**
Wrinkled rock-borer	*Hiatella arctica*	11	0	11				**11**
Razor shell	*Ensis arcuatus*	0	10	10				**10**
Poor cod	*Trisopterus minutus*					8	8	**8**

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Spotted ray	*Raja montagui*	6	0	6	1	1	2	**8**
Squid	*Loligo spp.*					7	7	**7**
Atlantic horse mackerel	*Trachurus trachurus*	6	0	6				**6**
Brill	*Scophthalmus rhombus*	3	0	3	1	2	3	**6**
Mackerel	*Scomber scombrus*	4	0	4		2	2	**6**
Spider crabs	*Inachus sp.*	0	6	6				**6**
Swimming crab	*Liocarcinus juvenile*	0	6	6				**6**
Flounder	*Platichthys flesus*	3	0	3	1	0	1	**4**
n/a	*Modiolarca tumida*	4	0	4				**4**
Solenette	*Buglossideum luteum*	0	4	4				**4**
Sting winkle	*Ocenebra erinacea*	4	0	4				**4**
Smoothhound	*Mustelus mustelus*				0	3	3	**3**
Sole	*Solea solea*				3	0	3	**3**
Two-spotted clingfish	*Diplecogaster bimaculata*	0	3	3				**3**
Cranchs spider crab	*Achaeus cranchii*	2	0	2				**2**
Dog whelk	*Nucella lapillus*	2	0	2				**2**
Hermit crab	*Pagurus pubescens*	2	0	2				**2**
Three-spined stickleback	*Gasterosteus aculeatus*	2	0	2				**2**
Black goby	*Gobius niger*	1	0	1				**1**
Bass	*Dicentrarchus labrax*				0	1	1	**1**
Common razor shell	*Ensis ensis*	1	0	1				**1**
Corbin's sandeel	*Hyperoplus immaculatus*	0	1	1				**1**
Fourbeard rockling	*Rhinonemus cimbrius*	1	0	1				**1**

Common name	Scientific name	Beam Trawl Surveys			Otter Trawl Surveys			TOTAL
		SS Total	Dudgeon Total	Beam Total	SS Total	Dudgeon Total	Otter Total	
Goby	*Gobiidae larvae*	0	1	1				**1**
Hairy hermit crab	*Pagurus cuanensis*	1	0	1				**1**
Mud shrimp	*Upogebia*	1	0	1				**1**
n/a	*Alvania (Crisilla) semistriata*	1	0	1				**1**
n/a	*Brachystomia sp.*	1	0	1				**1**
n/a	*Gammarellus*	1	0	1				**1**
n/a	*Gibbula (Colliculus) tumida*	1	0	1				**1**
n/a	*Onoba semicostata*	1	0	1				**1**
Sandeel	*Amodytes spp.*				0	1	1	**1**
Scaldfish	*Arnoglossus laterna*	1	0	1				**1**
Squat lobster	*Galathea nexa*	1	0	1				**1**
striped red mullet	*Mullus surmuletus*	1	0	1				**1**
Yellow carpet shell	*Venerupis rhomboides*	0	1	1				**1**

Annex 3

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.1 Study Area

Document:
Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm
- Existing Offshore Wind Farm Export Cable
- ICES Rectangle
- Local Study Area
- Regional Study Area

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 10 20 km
0 7.5 15 Miles

Scale: 1:450,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0057

REV	DATE	STATUS	DRW	CHK	APR
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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.2 Regional IBTS Sample Stations (2010 to 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle
- Sample Station

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 10 20 km
0 7.5 15 Miles

Scale: 1:450,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0091

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Title:

Figure 9.3 Average Number (Catch per Standardised Haul) of Brown Crab from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 20
- 21 - 30
- 31 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0058

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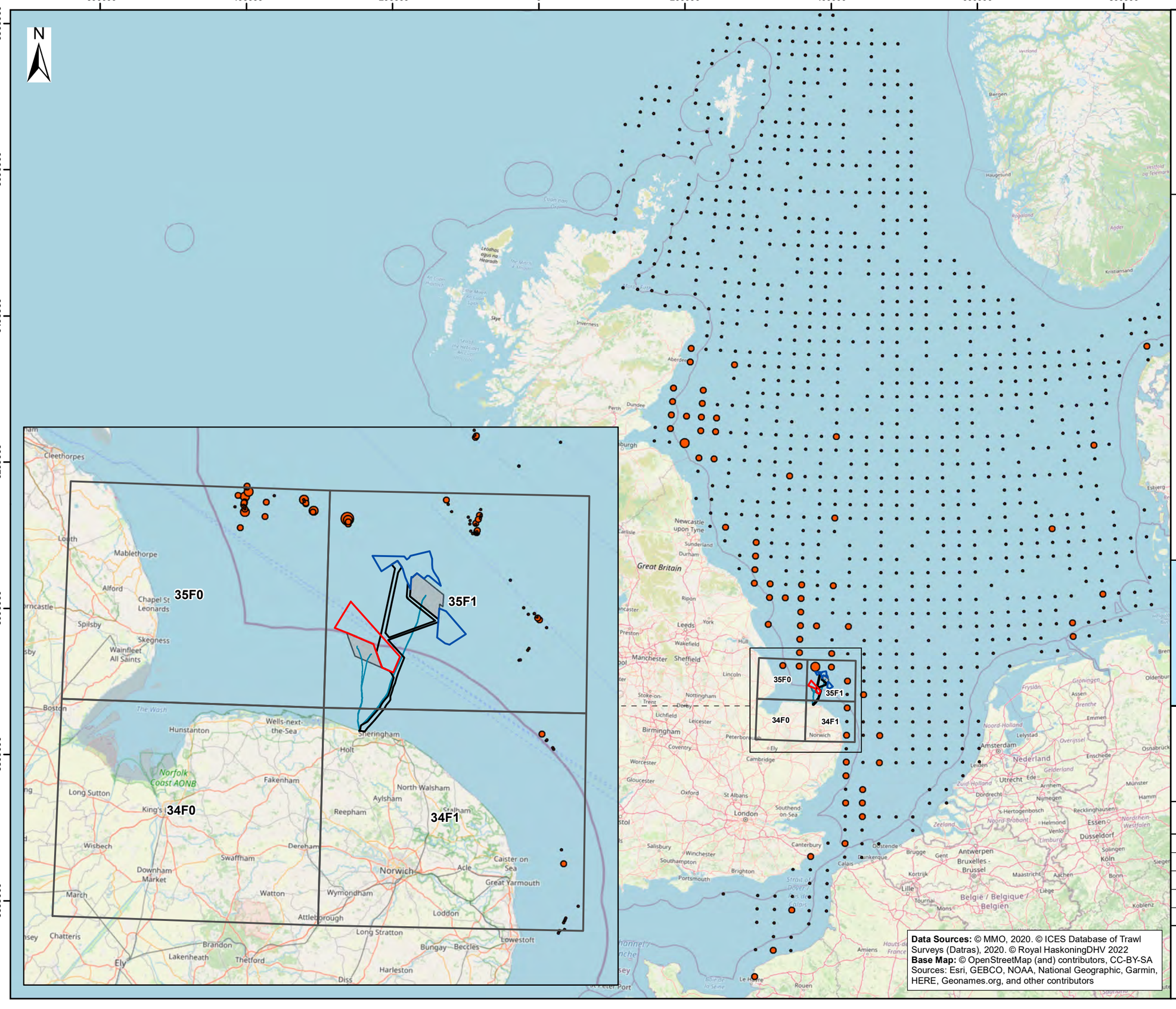

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.4 Average Number (Catch per Standardised Haul) of Lobster from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 +

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0059

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A	04/01/2022	First Issue	AZ	PM	PM

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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.5 Average Number (Catch per Standardised Haul) of Herring from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 50
- 51 - 100
- 101 - 500
- 501 - 1,000
- 1,001 - 5,000
- 5,001 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0073

REV	DATE	STATUS	DRW	CHK	APR
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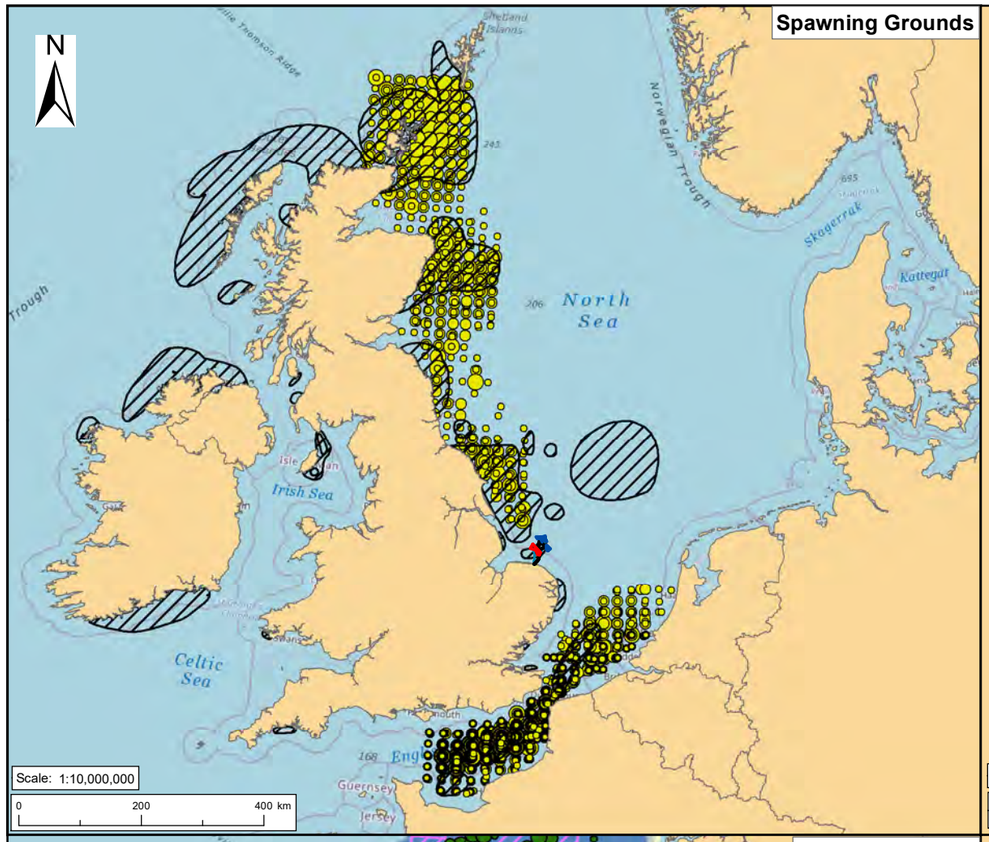

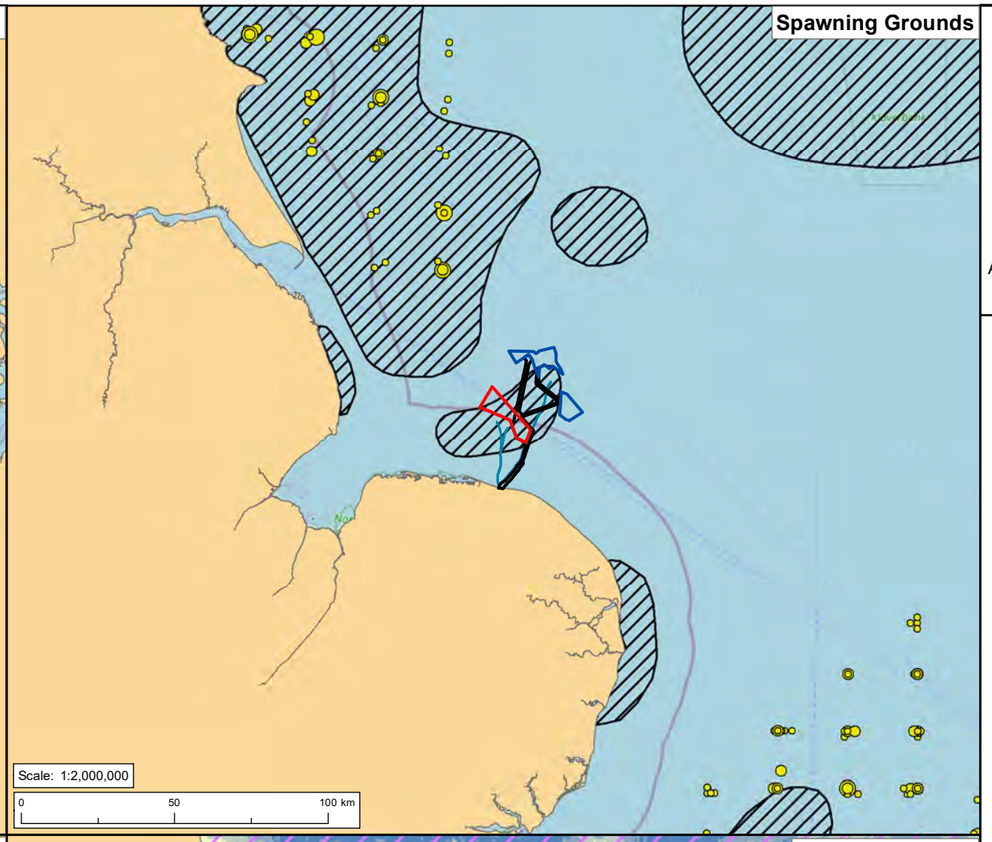

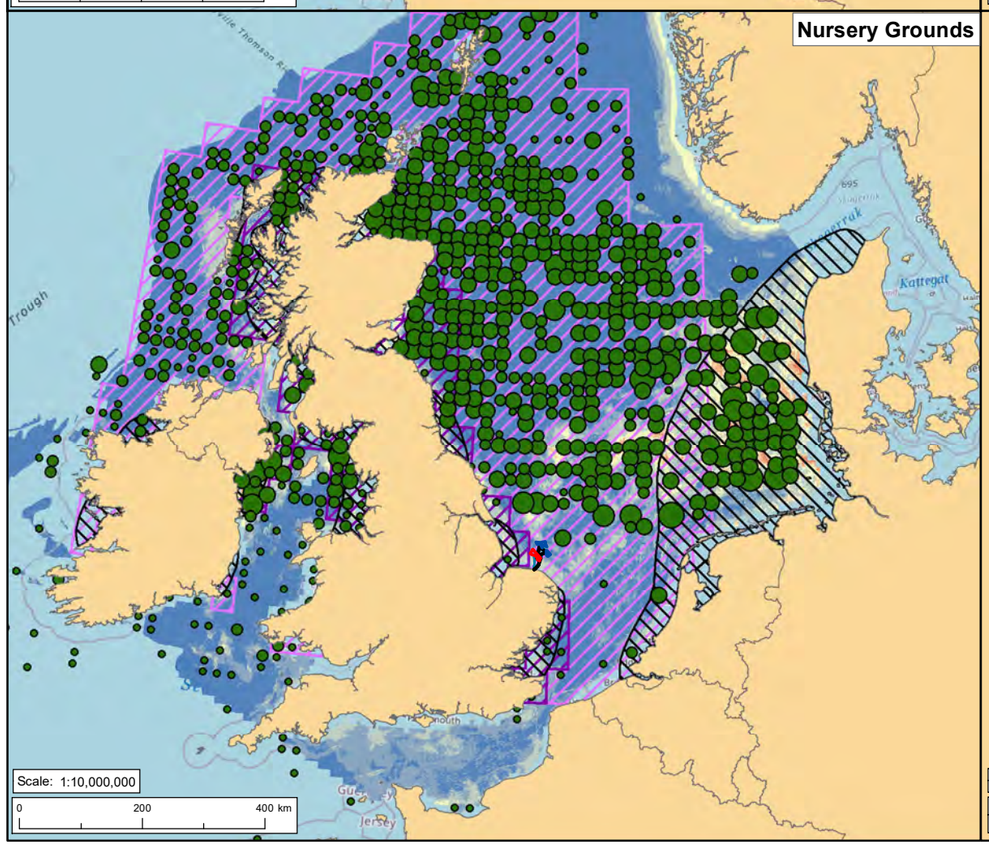

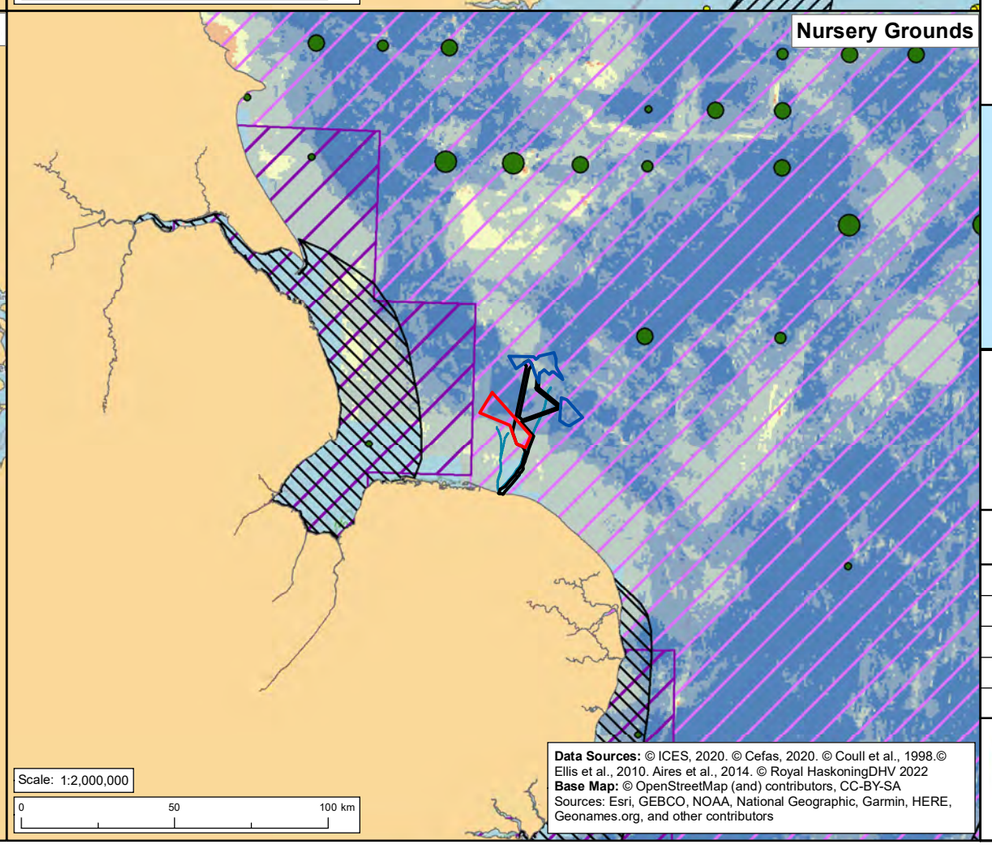

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.6 Herring Spawning and Nursery Grounds

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Herring Spawning Grounds

Larvae (n/m²) - IHLS 2008 - 2019

- 0 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 +

Coull *et al.* 1998

- Herring

Herring Nursery Grounds

Maximum Juvenile Catch Rate - Cefas 2010

- 1 - 1,000
- 1,001 - 10,000
- 10,001 - 50,000
- 50,001 - 100,000
- 100,001+

Coull *et al.* 1998

- Herring

Ellis *et al.* 2010

- High Intensity
- Low Intensity

Probability Presence of 0-Group Herring - Aires *et al.* 2014

- 0 - 0.05
- 0.06 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.53

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0074

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

Data Sources: © ICES, 2020. © Cefas, 2020. © Coull et al., 1998.© Ellis et al., 2010. Aires et al., 2014. © Royal HaskoningDHV 2022
Base Map: © OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

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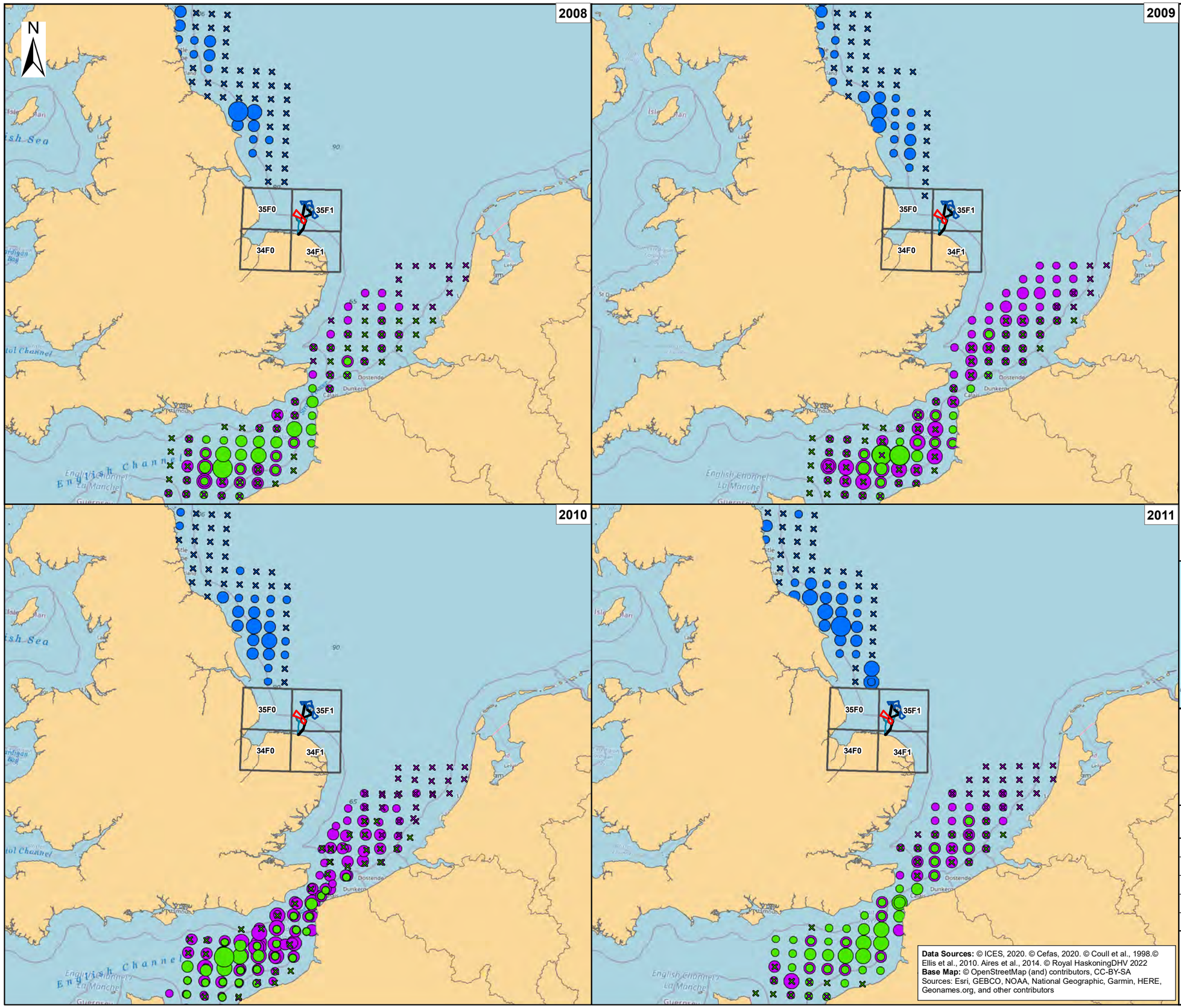


Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.7 IHLS Herring Small Larvae Abundance (2008 - 2011)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

Small Herring Larvae Abundance - ICES 2020

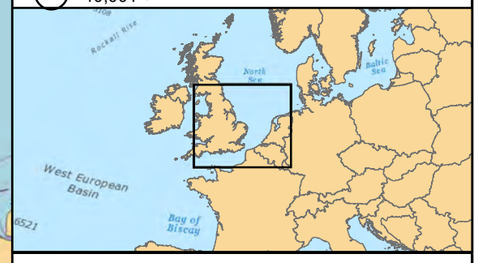
IHLS Survey Month

- January
- September
- December

Small Herring Larvae Abundance (n/m²)

Larvae <11mm (n/m²)

- 0
- 1 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 +



Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0075

A	04/01/2022	First Issue	AZ	PM	PM
REV	DATE	STATUS	DRW	CHK	APR

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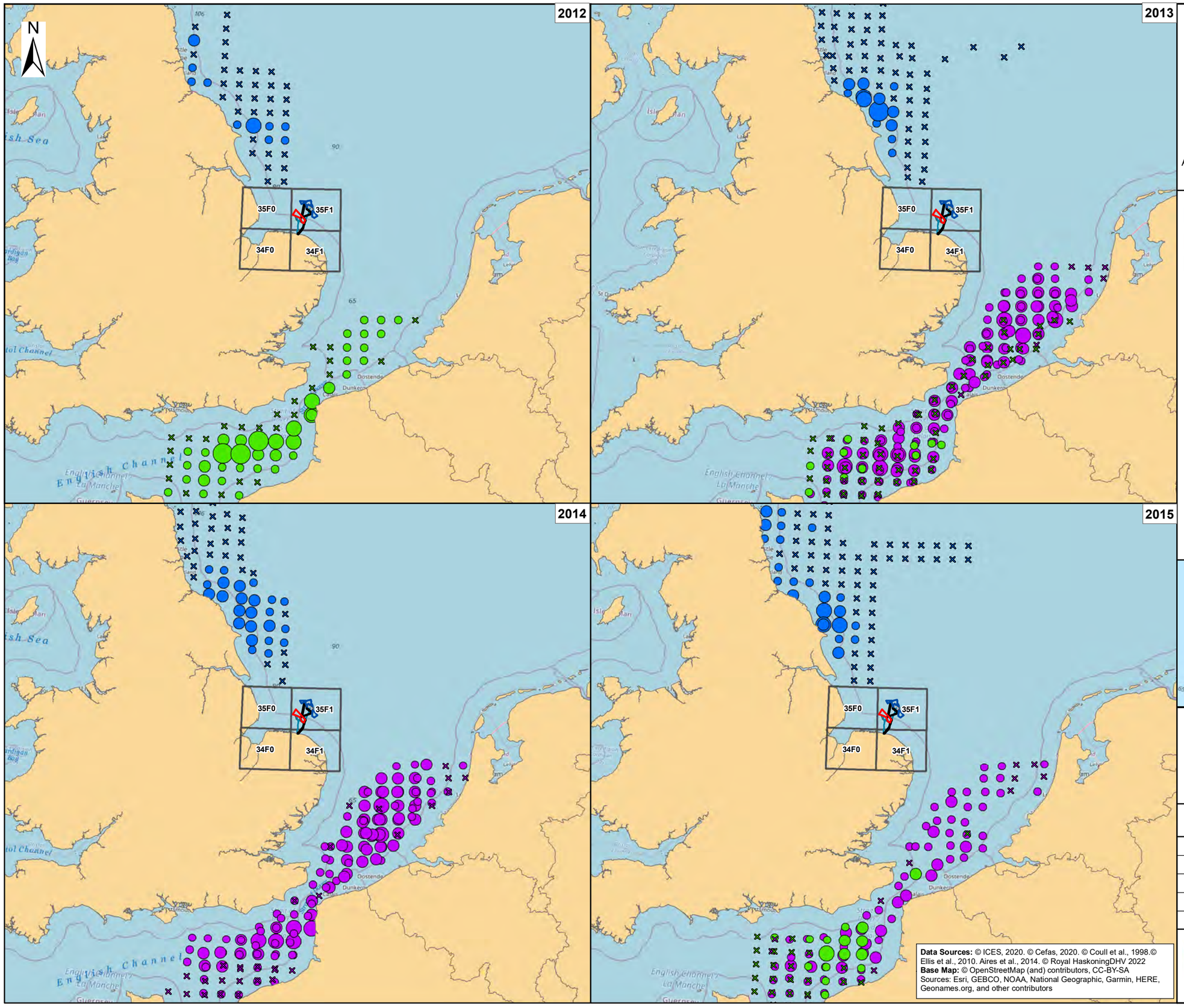


Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.8 IHLS Herring Small Larvae Abundance (2012 - 2015)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

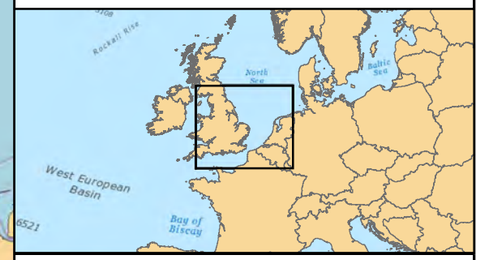
Small Herring Larvae Abundance - ICES 2020

IHLS Survey Month

- January
- September
- December

Larvae <11mm (n/m²)

- 0
- 1 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 +



Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0076

REV	DATE	STATUS	DRW	CHK	APR
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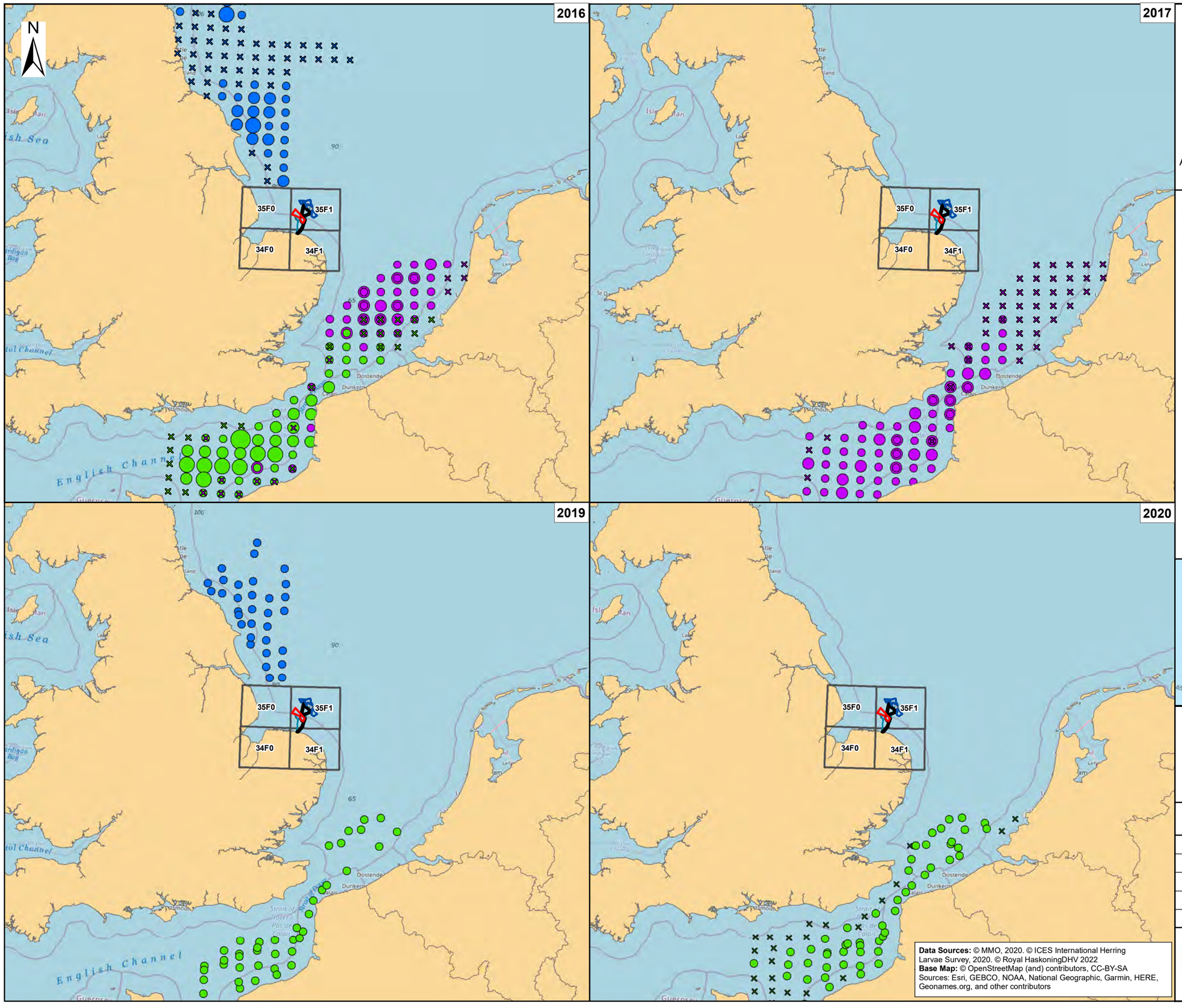
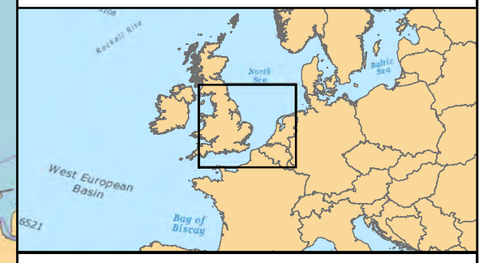
Figure 9.9 IHLS Herring Small Larvae Abundance (2016 - 2019 and 2008 - 2019)
Sheet 1 of 2

Document:
Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1





Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 70 140 Nautical Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0077

REV	DATE	STATUS	DRW	CHK	APR
A	04/05/2022	First Issue	AZ	PM	PM

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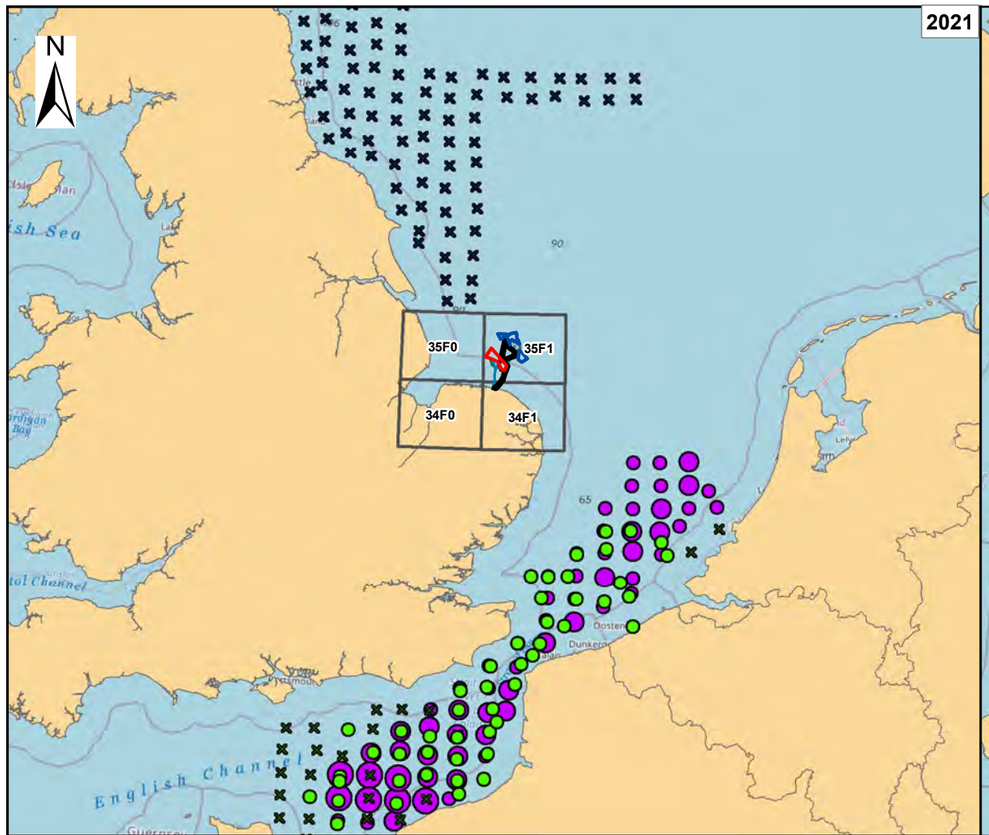
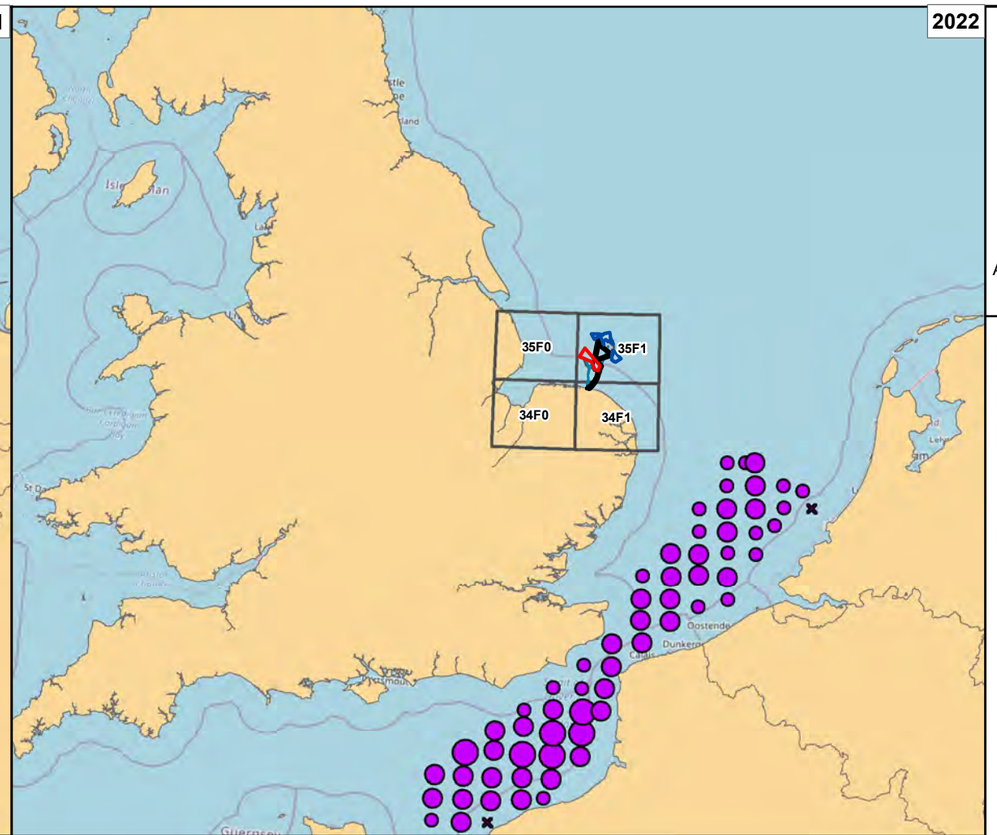
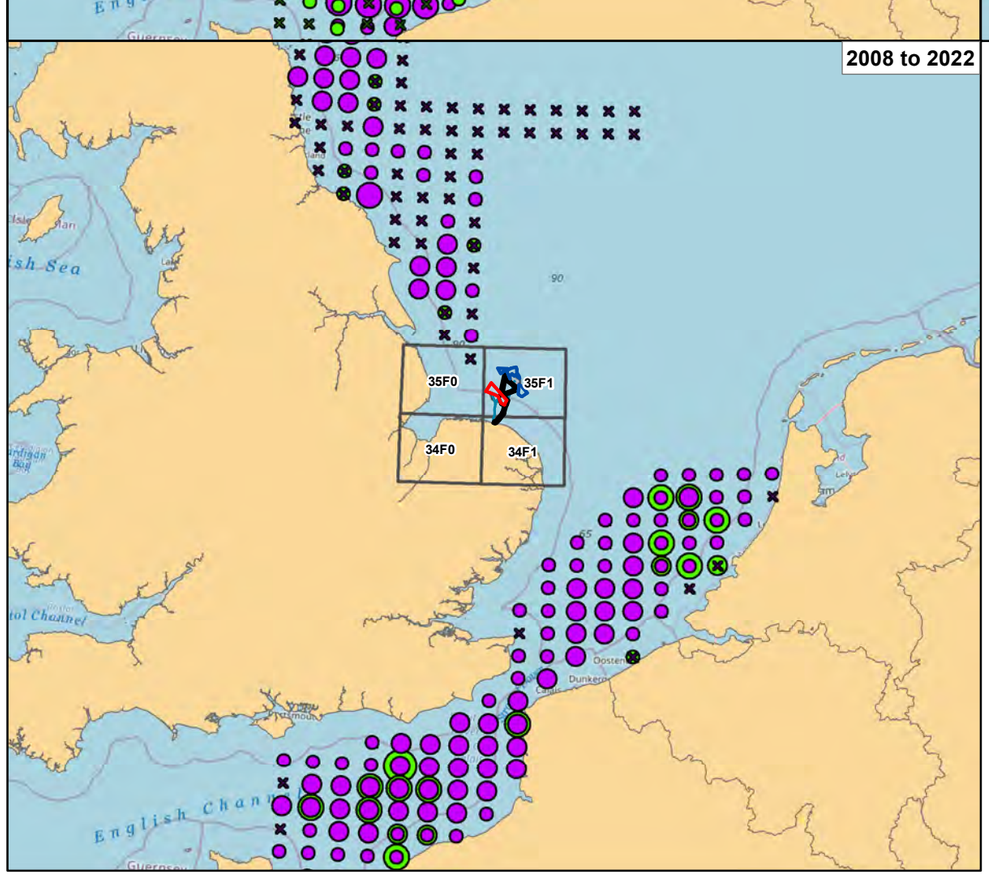






Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.9 IHLS Herring Small Larvae Abundance (2021 to 2022 and 2008 - 2022)
Sheet 2 of 2

Document:
Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

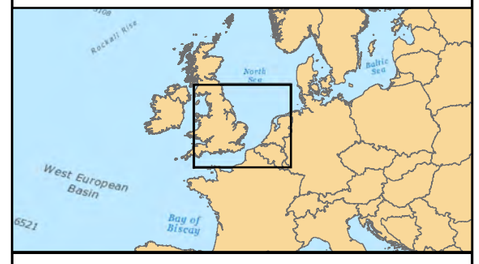
Small Herring Larvae Abundance - ICES 2020

IHLS Survey Month

- January
- September
- December

Larvae <11mm (n/m²)

- 0
- 1 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 +



Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 70 140 Nautical Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0233

REV	DATE	STATUS	DRW	CHK	APR
A	04/05/2022	First Issue	AZ	PM	PM

Data Sources: © MMO, 2020. © ICES International Herring Larvae Survey, 2020. © Royal HaskoningDHV 2022
Base Map: © OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

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Sheringham and Dudgeon Extension Projects

Figure 9.10

Assessment of Benthic Survey Grabs for Preferred Atlantic Herring Spawning Habitat Sediment Classes

Legend:

- Dudgeon Extension Project AfL Area
- Sheringham Extension Project AfL Area
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Herring Spawning Assessment

- Actual Survey Location
- Preferred
- Marginal
- Unsuitable

Data Sources: © Fugro, 2020.
Base Map: © British Crown and OceanWise, 2020. All rights reserved. License No. EMS-EK001-627782. Not to be used for Navigation; © OpenStreetMap (and) contributors, CC-BY-SA

Document No: PB8164-RHD-ZZ-OF-DR-Z-0105

Co-ordinate System: WGS 1984 UTM Zone 31N

0 6 12 km

0 4 8 Miles

A	09/12/2020	1:200,000	A3	AZ	RS	RS
REV	DATE	SCALE	SIZE	DRW	CHK	APR

Report:

Fish and Shellfish Technical Report

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-600000 -400000 -200000 0 200000 400000 600000 800000

6800000 6600000 6400000 6200000 6000000 5800000 5600000

N

35F0 35F1 34F0 34F1

Cleethorpes Louth Mablethorpe Alford Chapel St Leonards Spilsby Skegness Wainfleet All Saints Boston The Wash Hunstanton Wells-next-the-Sea Sheringham Holt Norfolk Coast AONB Fakenham North Walsham Aylsham Long Sutton King's Lynn Reepham Wisbech Dereham Swaffham Downham Market Norwich Acle Caister on Sea Great Yarmouth March Watton Wymondham Attleborough Loddon Long Stratton Chatteris Brandon Lakenheath Thetford Bungay Beccles Lowestoft Ely Diss Harleston

Great Britain Newcastle upon Tyne Sunderland Durham Ripon Leeds York Preston Wakefield Hull Manchester Sheffield Lincoln Stoke-on-Trent Nottingham Derby Lichfield Leicester Birmingham Peterborough Ely Coventry Cambridge Worcester Gloucester Oxford St Albans London Southend-on-Sea Salisbury Winchester Southampton Portsmouth Brighton Canterbury Norwich

Bergen Haugesund Rogaland Agder Kristiansand Esbjerg Oldenburg Groningen Fryslân Assen Drenthe Emmen Lelystad Amsterdam Overijssel Osnabrück Enschede Nederland Gelderland Utrecht Arnhem Zuid-Holland Dordrecht Nijmegen Münster Hamm 's-Hertogenbosch Noord-Brabant Helmond Venlo Limburg Recklinghausen Essen Nordrhein-Westfalen Düsseldorf Solingen Zeeland Köln Bonn Siegen Antwerpen Bruxelles - Brussel Gent Brugge Oostende Kortrijk Maastricht Aachen Lille Tournai Mons Liège België / Belgique / Belgien Koblenz Hauts-de-France Amiens Le Havre Rouen

35F0 35F1 34F0 34F1

Data Sources: © MMO, 2020. © ICES Database of Trawl Surveys (Datras), 2020. © Royal HaskoningDHV 2022
Base Map: © OpenStreetMap (and) contributors, CC-BY-SA Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

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Title:

Figure 9.11 Average Number (Catch per Standardised Haul) of Cod from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020
(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 20
- 21 +

North Sea Baltic Sea Rockall Rise West European Basin

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0064

A	04/01/2022	First Issue	AZ	PM	PM
REV	DATE	STATUS	DRW	CHK	APR

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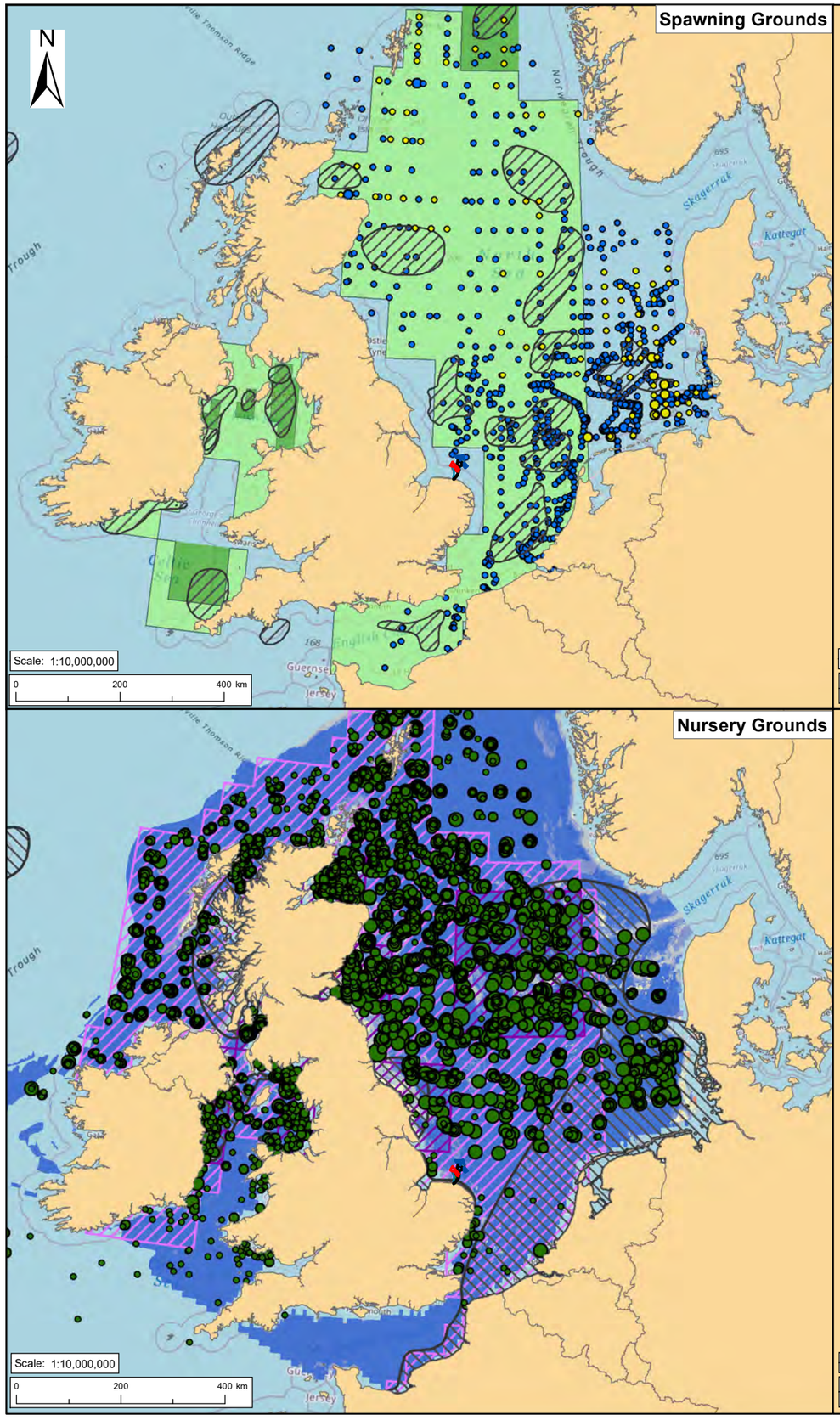

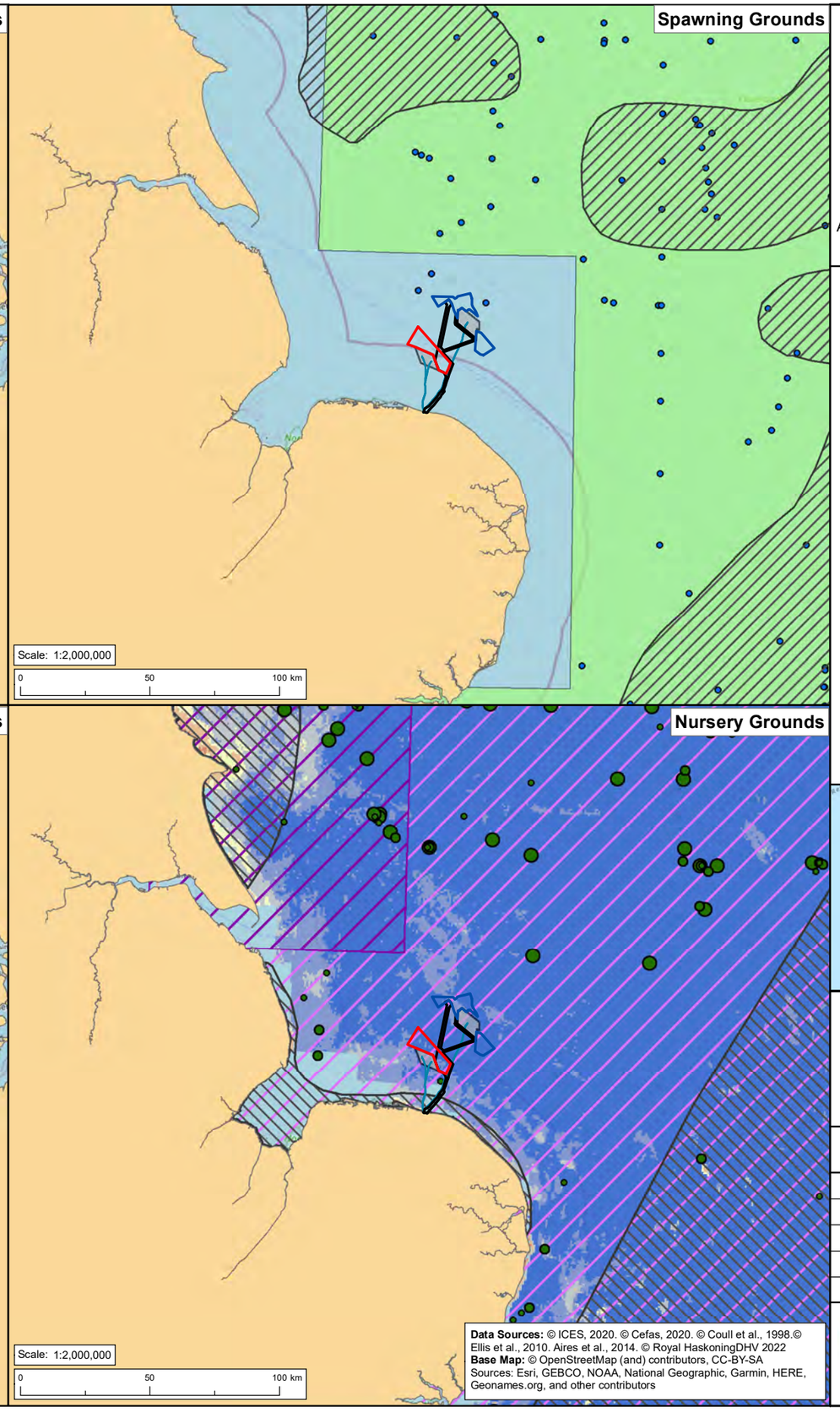

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.12 Cod Spawning and Nursery Grounds

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Cod Spawning Grounds

Eggs (n/m²) - CP-EGGS 2004, 2009

- 1 - 10
- 11 - 100

Larvae (n/m²) - CP-EGGS 2004, 2009

- 1 - 10
- 11 - 100

Coull *et al*. 1998

- Cod

Ellis *et al*. 2010

- High intensity
- Low Intensity

Cod Nursery Grounds

Maximum Juvenile Catch Rate - Cefas 2010

- 1 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000

Coull *et al*. 1998

- Cod

Ellis *et al*. 2010

- High Intensity
- Low Intensity

Probability Presence of 0-Group Cod - Aires *et al*. 2014

- 0 - 0.05
- 0.06 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.98

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0065

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

Data Sources: © ICES, 2020. © Cefas, 2020. © Coull et al., 1998.© Ellis et al., 2010. Aires et al., 2014. © Royal HaskoningDHV 2022
Base Map: © OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

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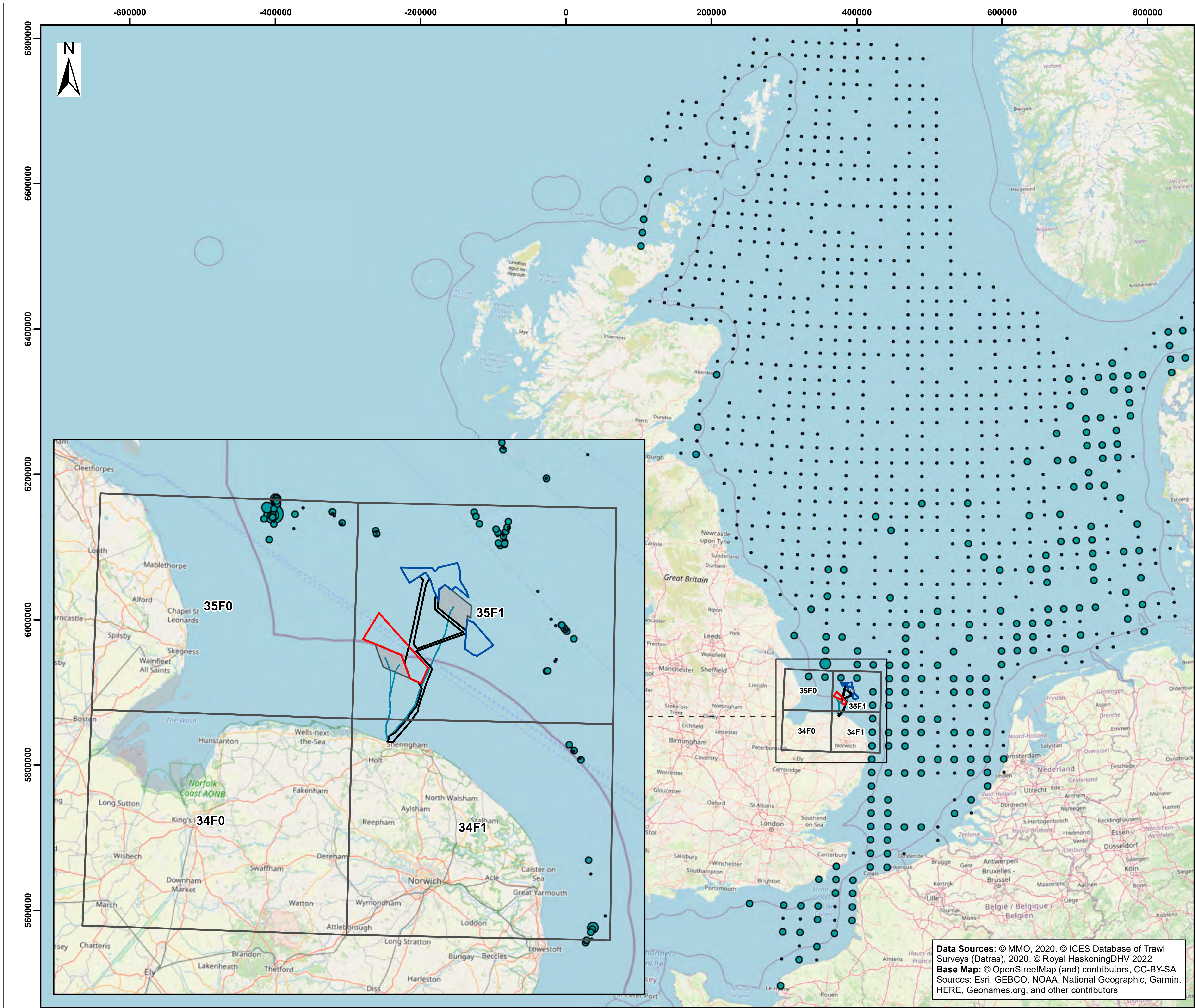

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.13 Average Number (Catch per Standardised Haul) of Dover Sole from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr⁻¹) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 20
- 21 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0060

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Base Map: © OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

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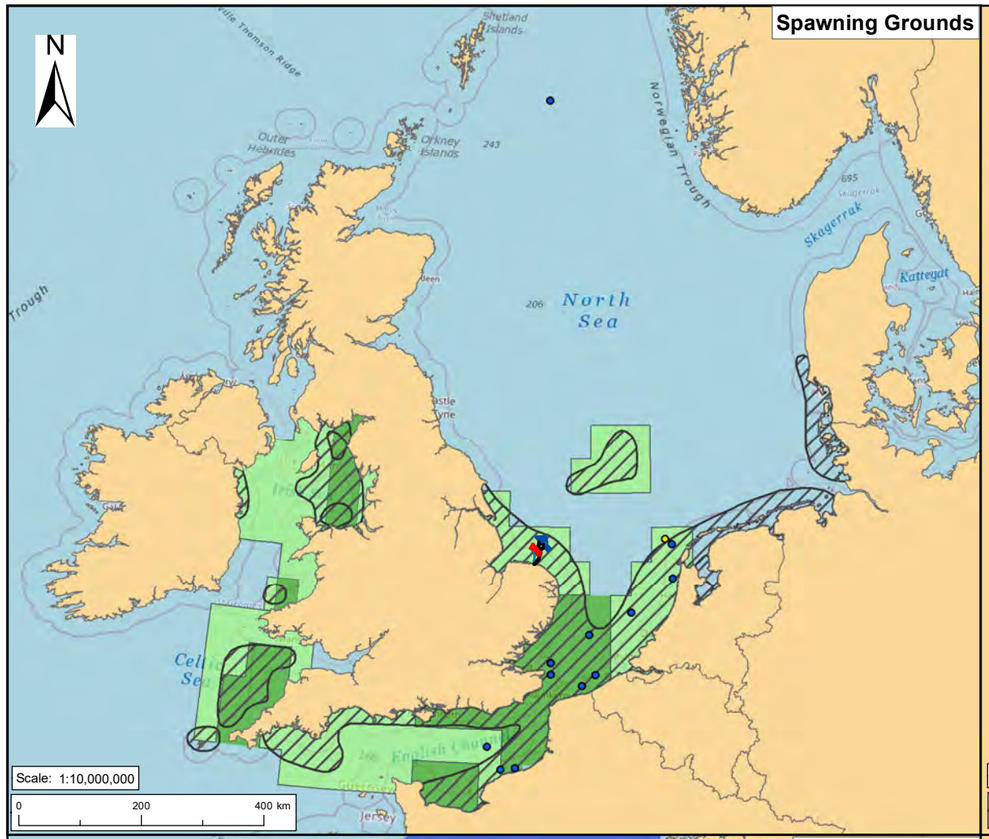

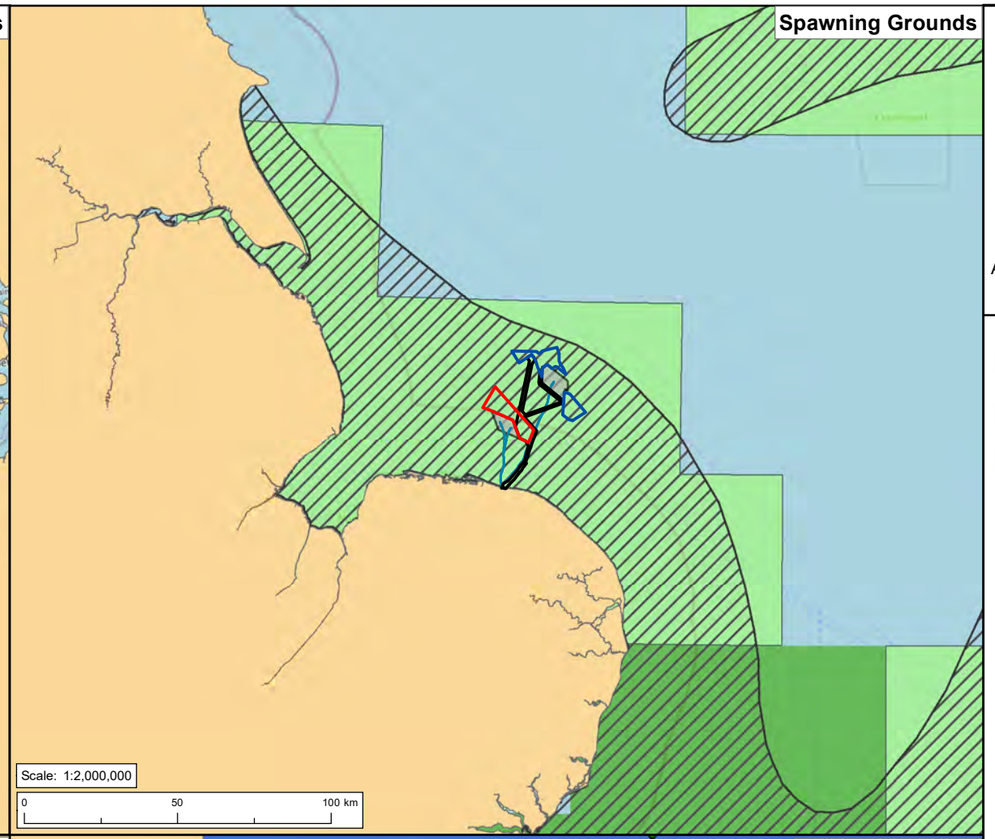

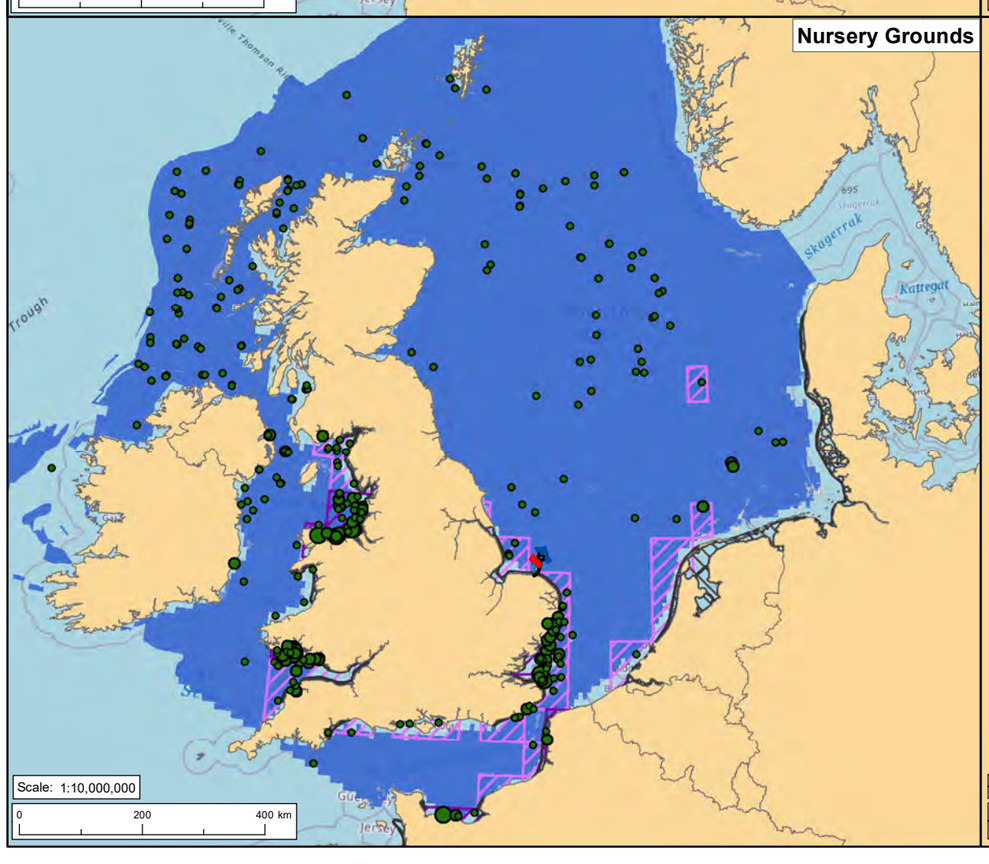

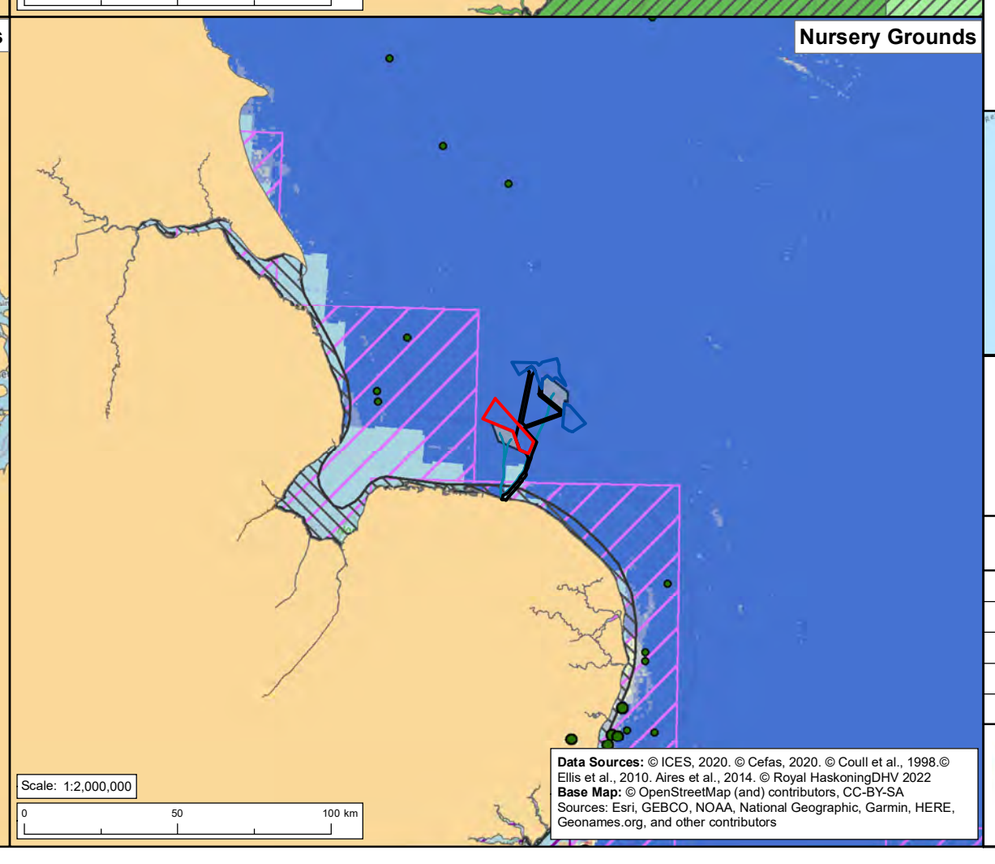

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.14 Dover Sole Spawning and Nursery Grounds

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Dover Sole Spawning Grounds

Eggs (n/m²) - CP-EGGS 2004

- 1 - 10

Larvae (n/m²) - CP-EGGS 2004

- 1 - 10

Coull *et al*. 1998

- Sole

Ellis *et al*. 2010

- High intensity
- Low Intensity

Dover Sole Nursery Grounds

Maximum Juvenile Catch Rate - Cefas 2010

- 1 - 10
- 11 - 100
- 101 - 1,000

Coull *et al*. 1998

- Sole

Ellis *et al*. 2010

- Low Intensity

Probability Presence of 0-Group Dover Sole - Aires *et al*. 2014

- 0 - 0.05
- 0.06 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.82

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0061

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Title:

Figure 9.15 Average Number (Catch per Standardised Haul) of Plaice from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 25
- 26 - 50
- 51 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0062

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Sheringham Shoal and Dudgeon Extension Projects

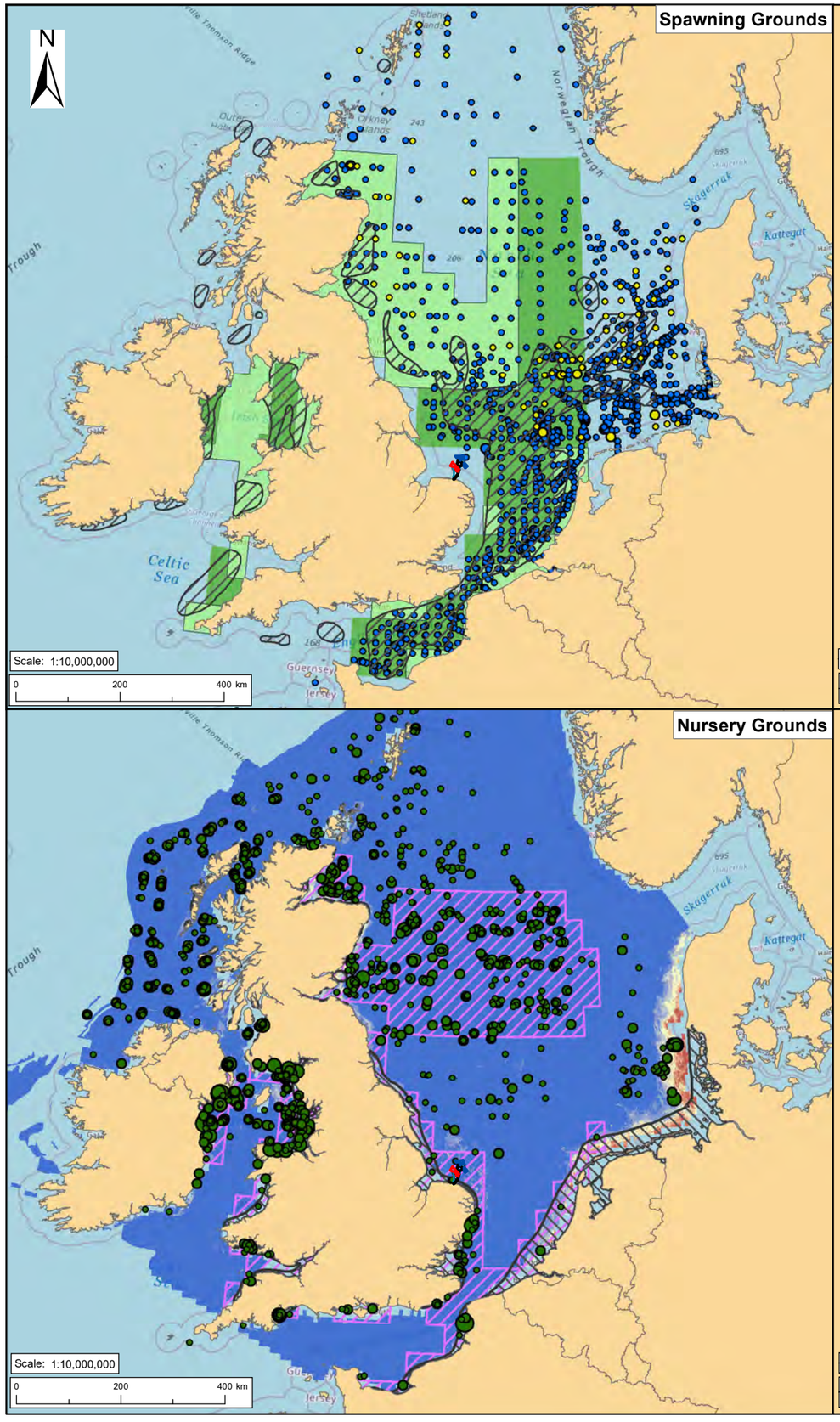
Title:

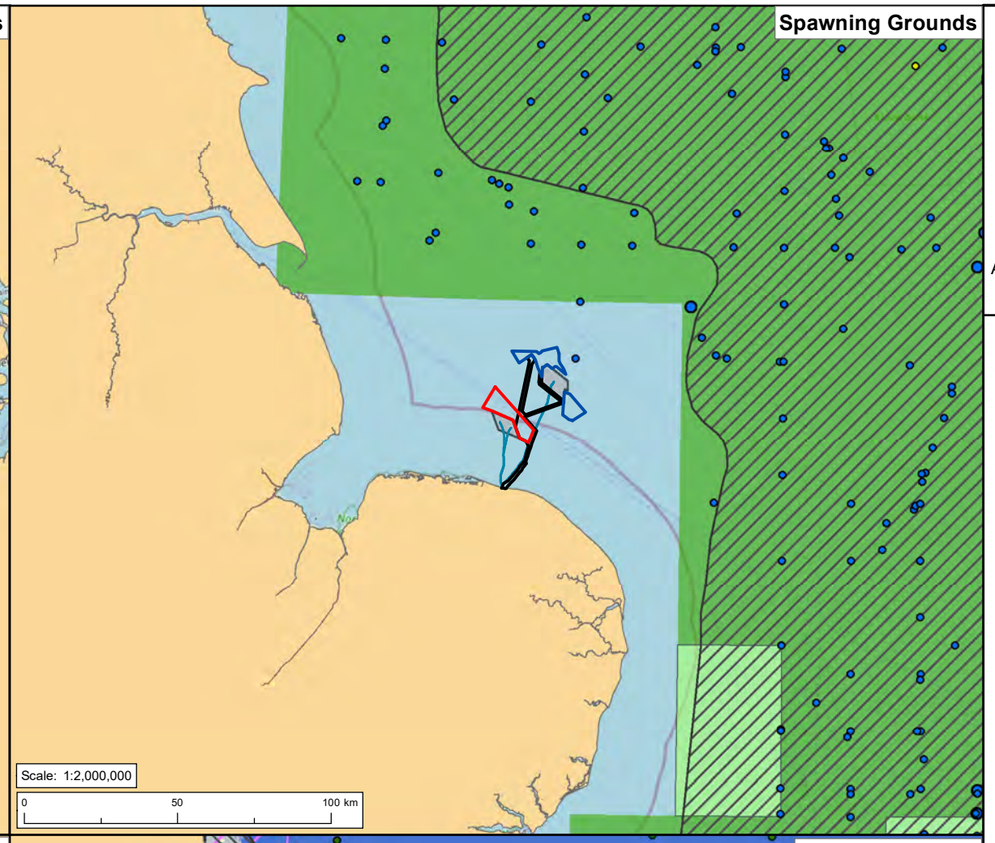
Figure 9.16 Plaice Spawning and Nursery Grounds

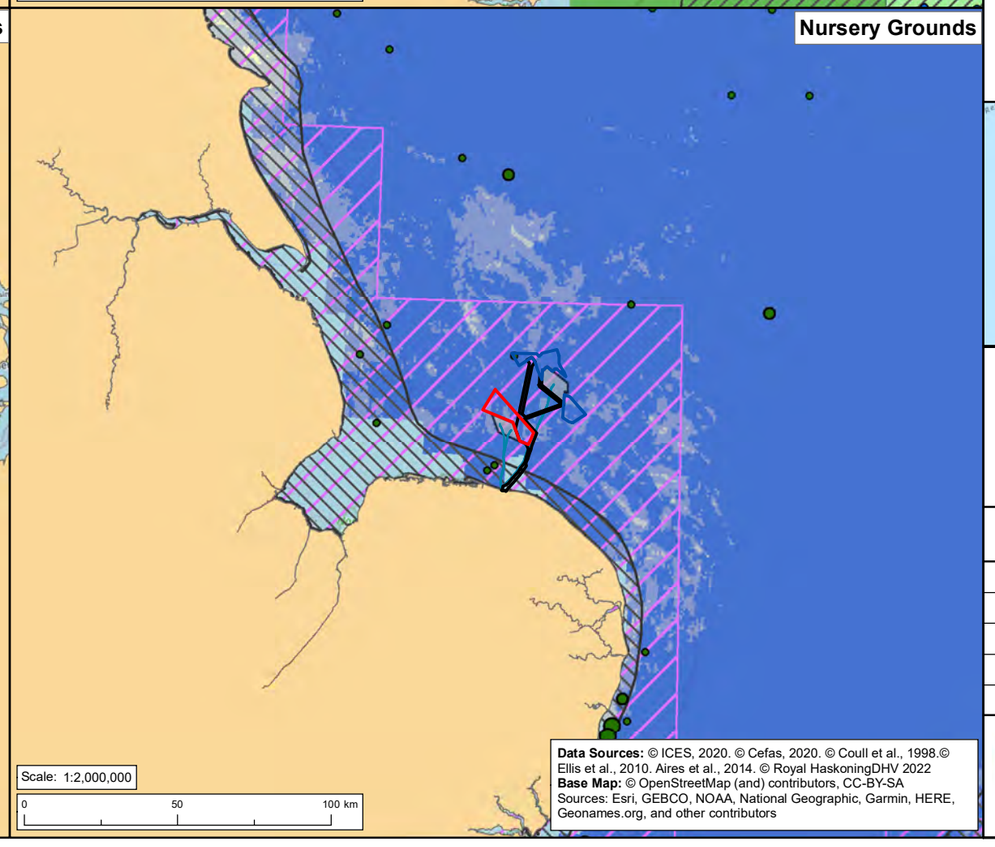
Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1







Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Plaice Spawning Grounds

Eggs (n/m²) - CP-EGGS 2003 - 2004, 2008 - 2009

- 1 - 10
- 11 - 100

Larvae (n/m²) - CP-EGGS 2003 - 2004, 2008 - 2009

- 1 - 10
- 11 - 100

Coull *et al*. 1998

- Plaice

Ellis *et al*. 2010

- High intensity
- Low Intensity

Plaice Nursery Grounds

Maximum Juvenile Catch Rate - Cefas 2010

- 1 - 10
- 11 - 100
- 101 - 1,000
- 1,001 -10,000

Coull *et al*. 1998

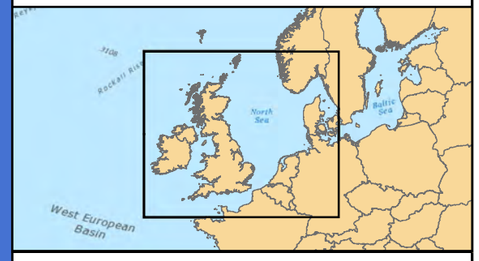
- Plaice

Ellis *et al*. 2010

- Low Intensity

Probability of Presence of 0-Group Plaice - Aires *et al*. 2014

- 0 - 0.05
- 0.06 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.81



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Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0063

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Title:

Figure 9.17 Average Number (Catch per Standardised Haul) of Bass from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 20
- 21 +

35F0
35F1
34F0
34F1

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0066

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.18 Sea Bass Historic Fishing Zones

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle
- Sea Bass Fishing Zone

35F0

35F1

34F0

34F1

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0067

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Title:

Figure 9.19 Average Number (Catch per Standardised Haul) of Mackerel from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 25
- 26 - 50
- 51 - 100
- 101 - 500
- 501 - 1,000
- 1,001 +

35F0 35F1 34F0 34F1

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0071

REV	DATE	STATUS	DRW	CHK	APR
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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.20 Mackerel Spawning and Nursery Grounds

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Spawning Grounds

Spawning Grounds

Nursery Grounds

Nursery Grounds

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Mackerel Spawning Grounds

Eggs (n/m²) - MEGS 1992 - 2018

- 1 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000

Coull *et al*. 1998

- Mackerel

Ellis *et al*. 2010

- High intensity
- Low Intensity

Mackerel Nursery Grounds

Maximum Juvenile Catch Rate - Cefas 2010

- 1 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 +

Coull *et al*. 1998

- Mackerel

Ellis *et al*. 2010

- High Intensity
- Low Intensity

Probability Presence of 0-Group Mackerel - Aires *et al*. 2014

- 0 - 0.05
- 0.06 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.86

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0072

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Title:

Figure 9.21 Average Number (Catch per Standardised Haul) of Whiting from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 25
- 26 - 50
- 51 - 100
- 101 - 500
- 501 - 1,000
- 1,001 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0068

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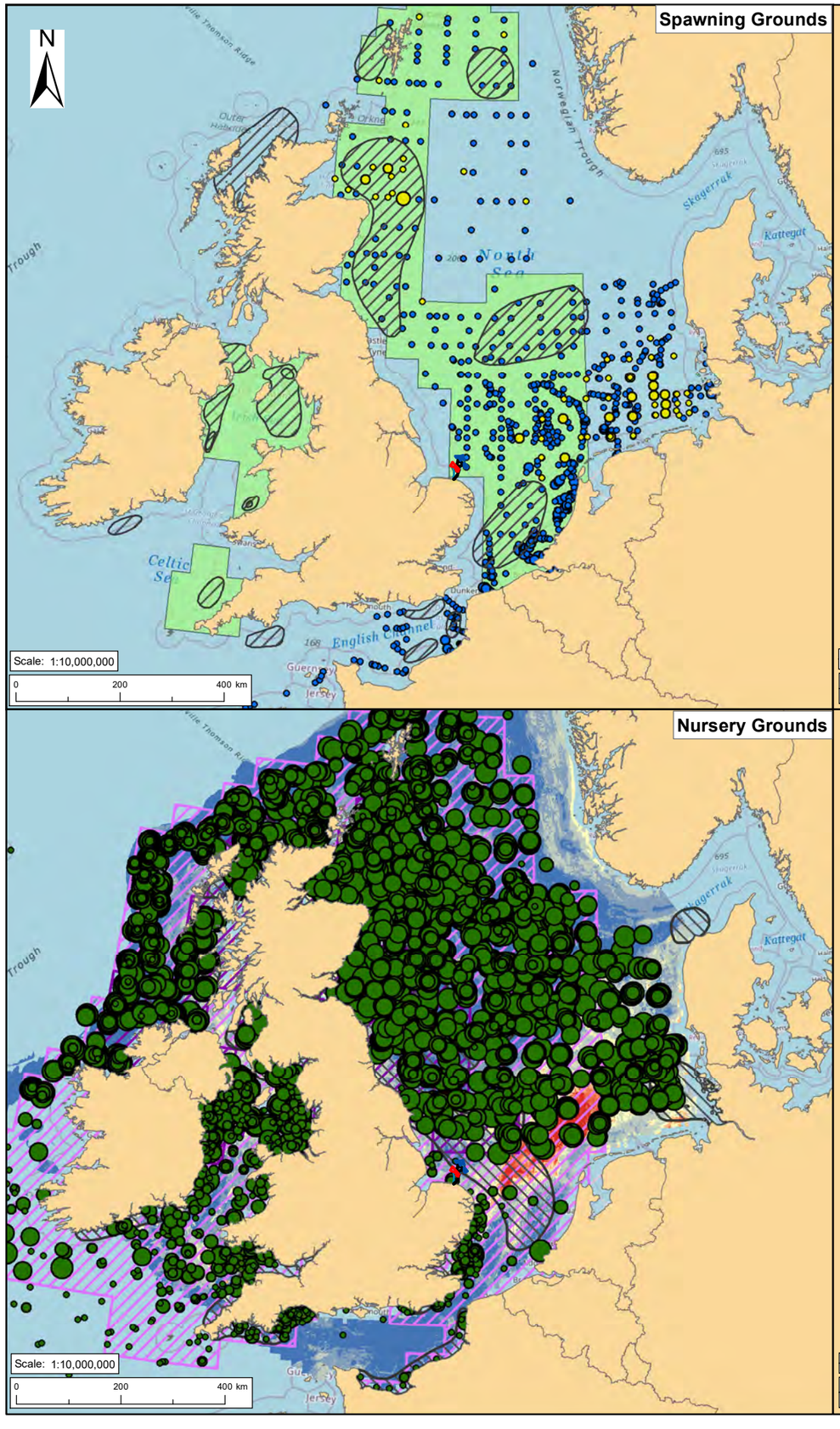

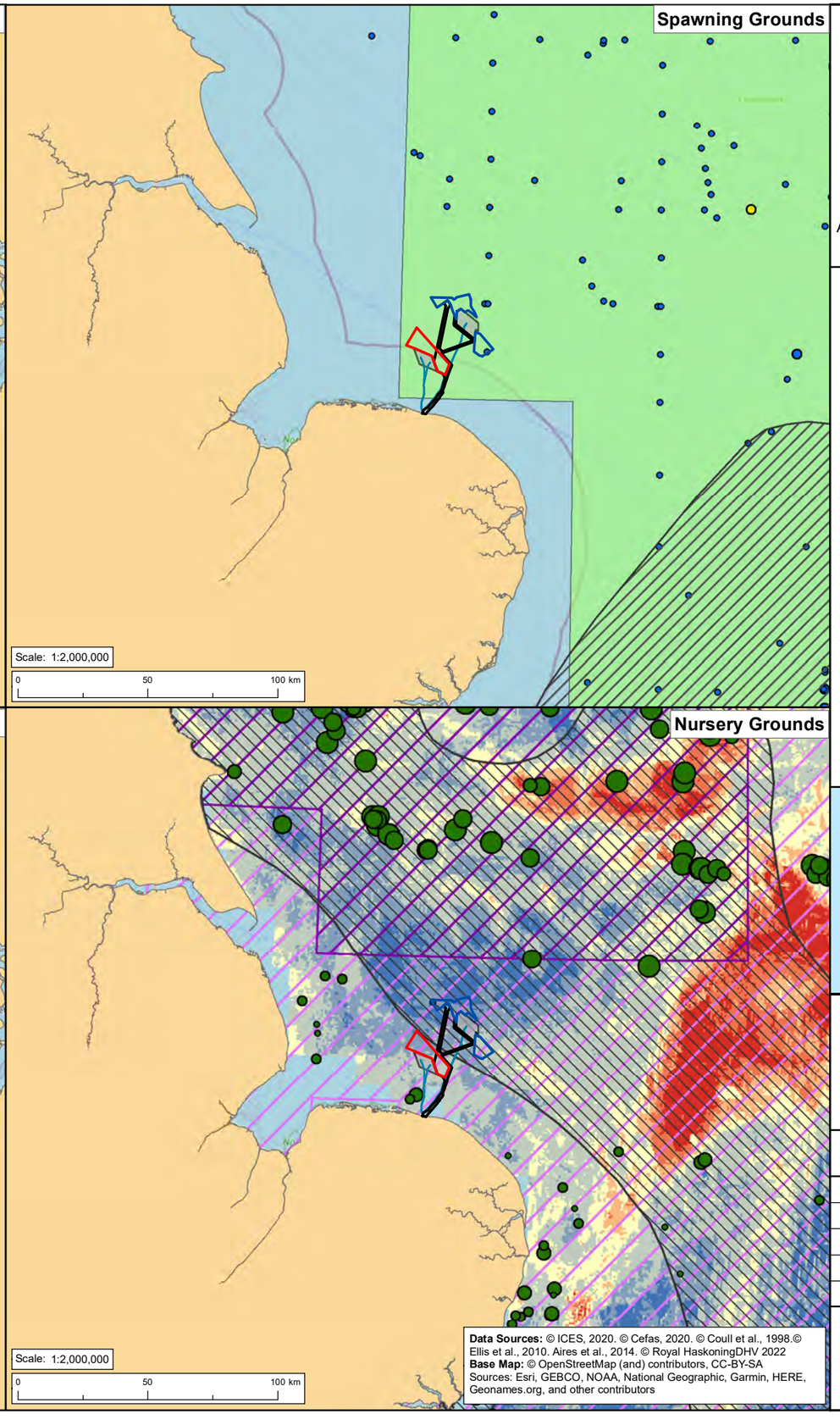

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.22 Whiting Spawning and Nursery Grounds

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Whiting Spawning Grounds

Eggs (n/m²) - CP-EGGS 2004, 2009

- 1 - 10
- 11 - 100
- 101 - 1,000

Larvae (n/m²) - CP-EGGS 2004, 2009

- 1 - 10
- 11 - 100
- 101 - 1,000

Coull *et al*. 1998

- Whiting

Ellis *et al*. 2010

- Low Intensity

Whiting Nursery Grounds

Maximum Juvenile Catch Rate - Cefas 2010

- 1 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 +

Coull *et al*. 1998

- Whiting

Ellis *et al*. 2010

- High Intensity
- Low Intensity

Probability Presence of 0-Group Whiting - Aires *et al*. 2014

- 0 - 0.05
- 0.06 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.91

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0069

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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.23 Average Number (Catch per Standardised Haul) of Sprat from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 500
- 501 - 1,000
- 1,001 - 5,000
- 5,001 - 10,000
- 10,001 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km

0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0083

REV	DATE	STATUS	DRW	CHK	APR
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Sheringham Shoal and Dudgeon Extension Projects

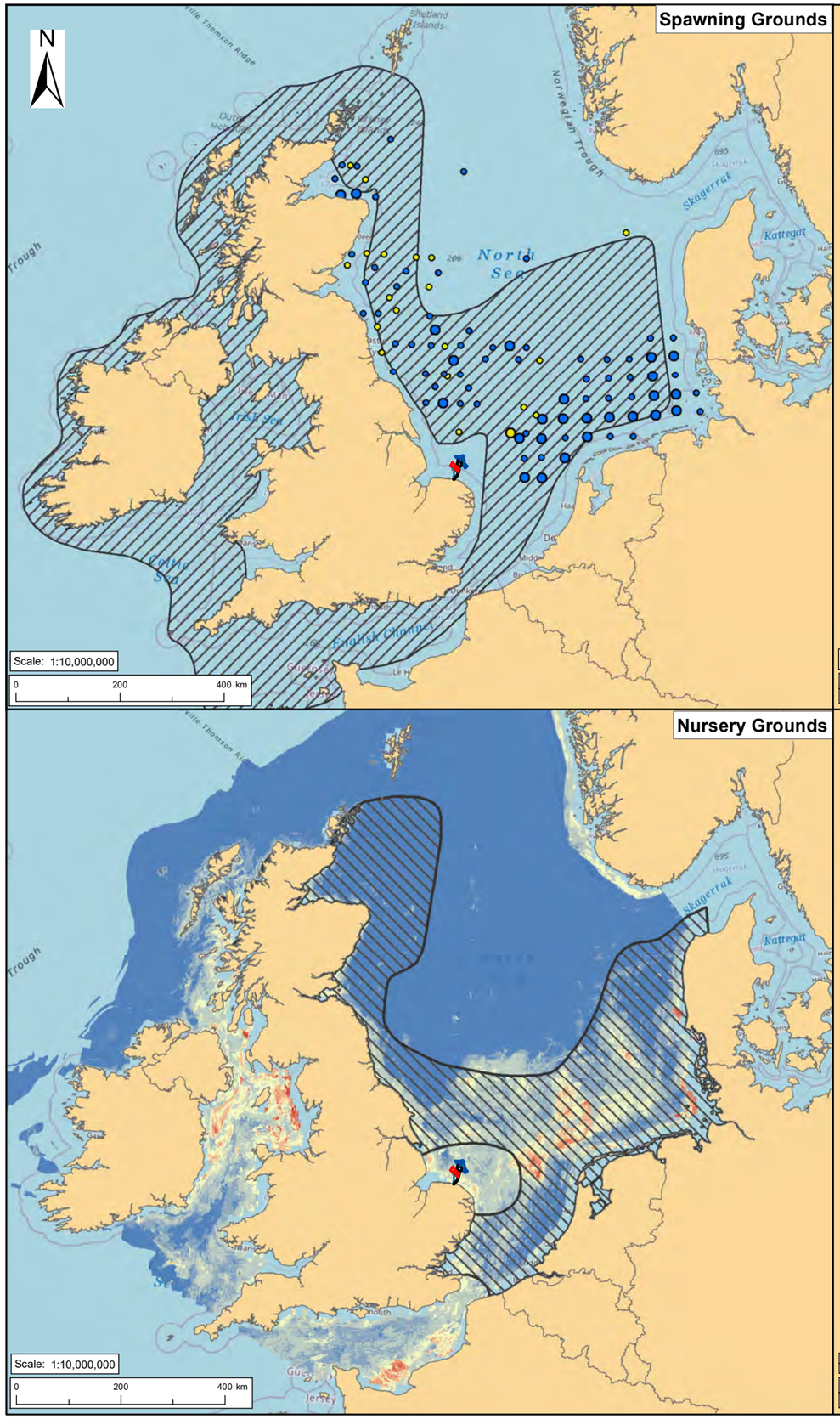
Title:

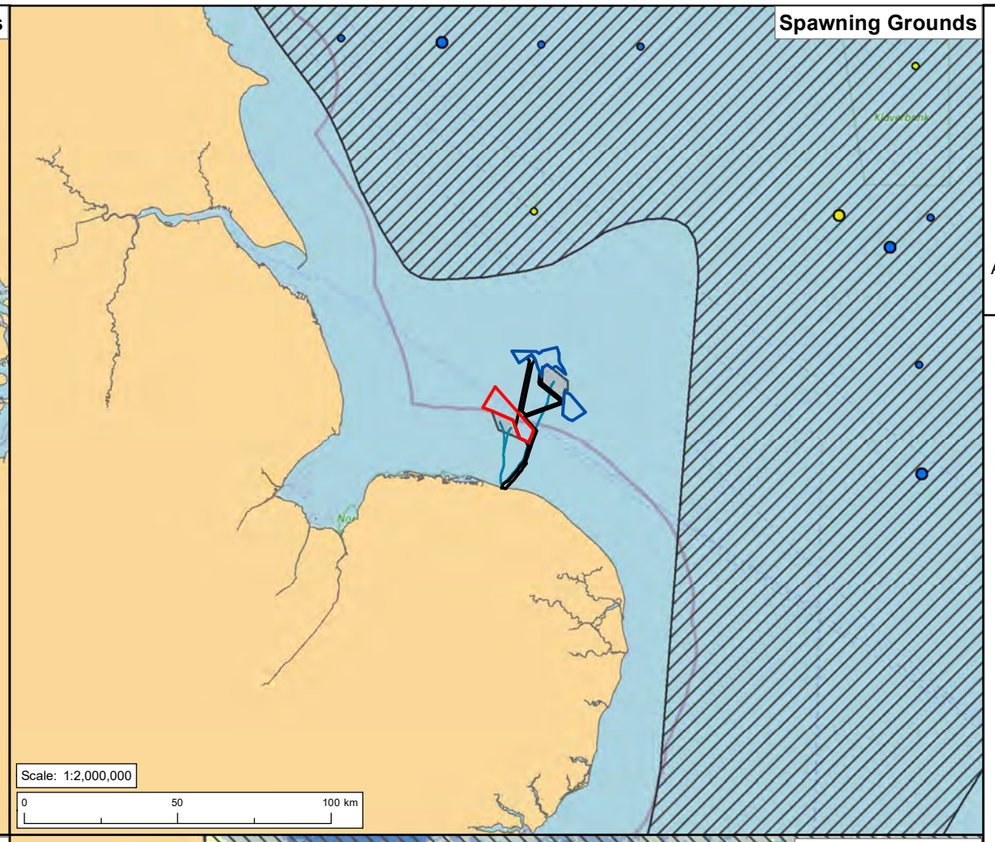
Figure 9.24 Sprat Spawning and Nursery Grounds

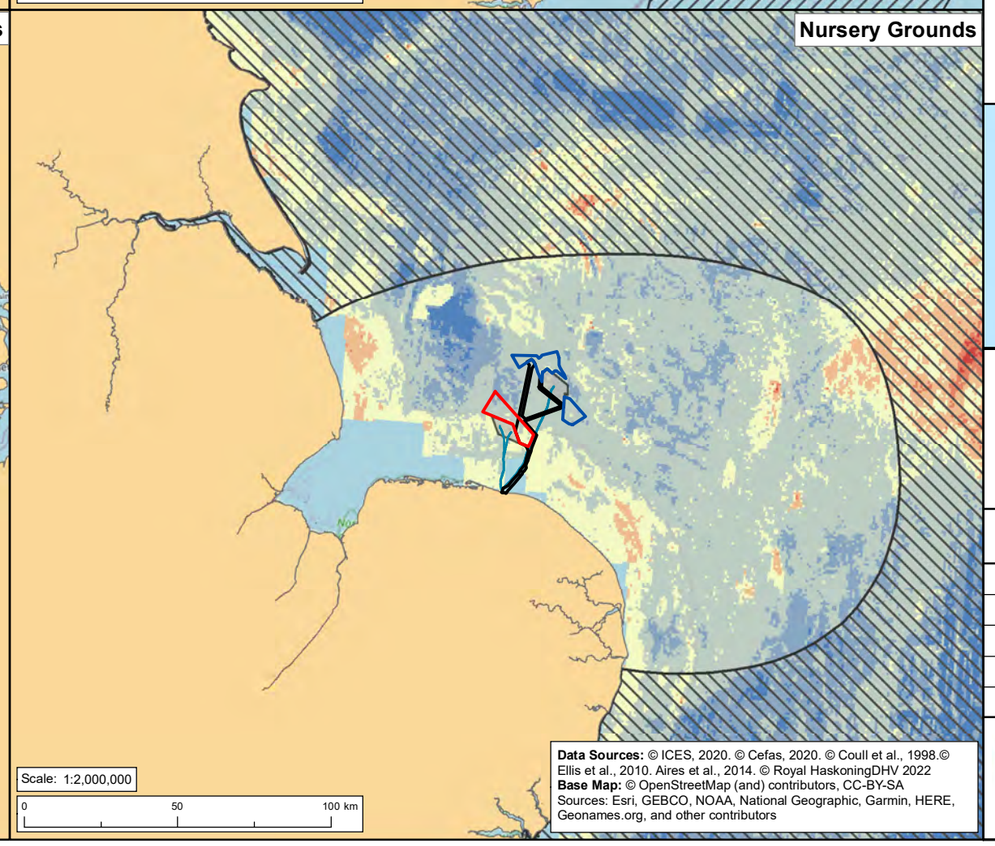
Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1







Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Sprat Spawning Grounds

Eggs (n/m²) - CP-EGGS 2004, 2009

- 1 - 10
- 11 - 100

Larvae (n/m²) - CP-EGGS 2004, 2009

- 1 - 10
- 11 - 100

Coull *et al*. 1998

- Sprat

Sprat Nursery Grounds

Coull *et al*. 1998

- Sprat

Probability Presence of 0-Group Sprat - Aires *et al*. 2014

- 0 - 0.05
- 0.06 - 0.1
- 0.11 - 0.2
- 0.21 - 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.87

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0084

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Base Map: © OpenStreetMap (and) contributors, CC-BY-SA
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

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Title:

Figure 9.25 Average Number (Catch per Standardised Haul) of Greater Sandeel from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 25
- 26 - 50
- 51 - 100
- 101 - 500
- 501 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0078

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.26 Average Number (Catch per Standardised Haul) of Raitt's Sandeel (A.marinus) from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 50
- 51 - 100
- 101 - 500
- 501 - 1,000
- 1,001 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0081

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.27 Average Number (Catch per Standardised Haul) of Smooth Sandeel from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 +

35F0
35F1
34F0
34F1

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0080

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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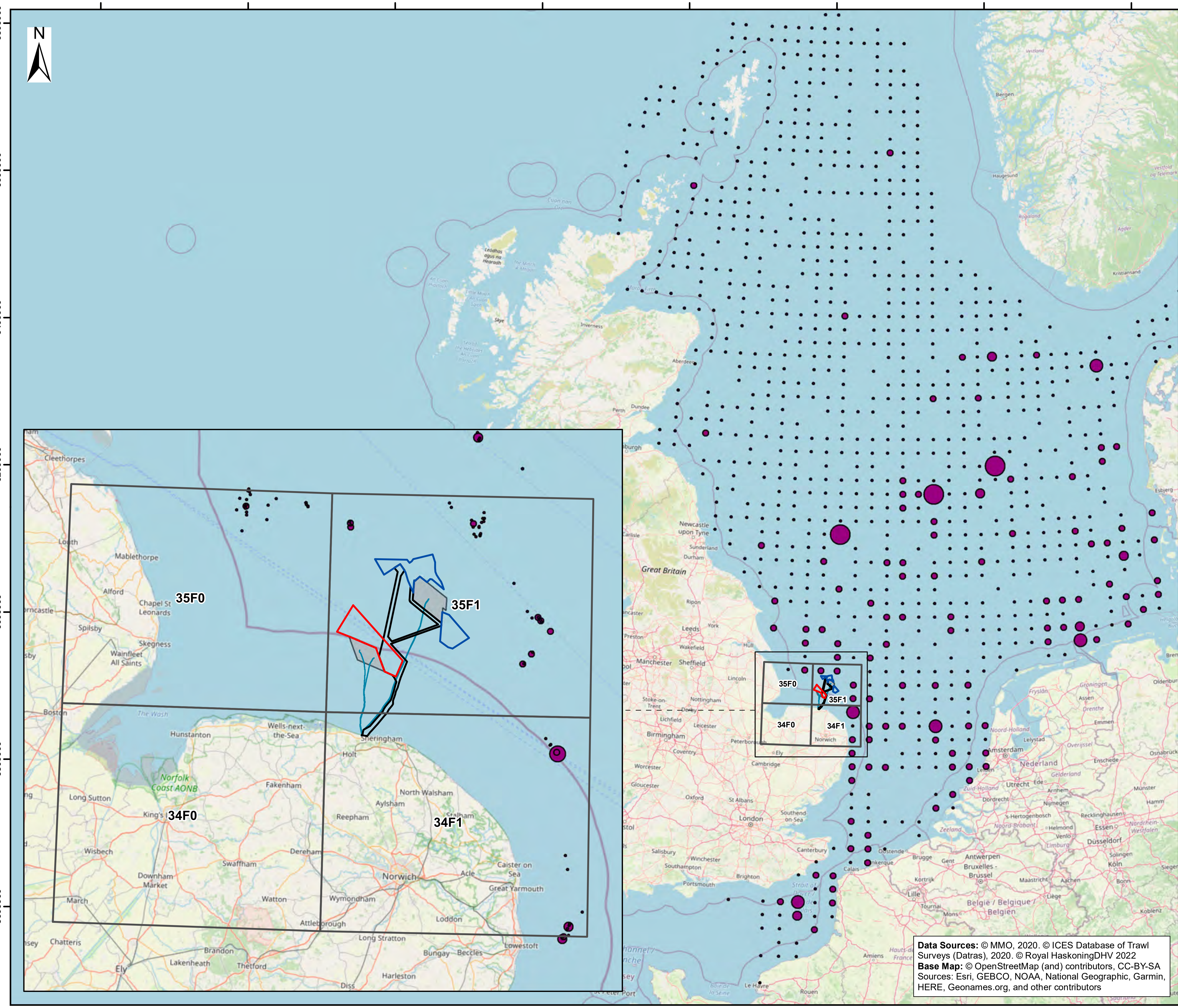

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Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.28 Average Number (Catch per Standardised Haul) of Lesser Sandeel (A.tobianus) from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr⁻¹) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 50
- 51 - 100
- 101 +

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0079

A	04/01/2022	First Issue	AZ	PM	PM
REV	DATE	STATUS	DRW	CHK	APR

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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.29 Average Number (Catch per Standardised Haul) of Corbin's Sandeel (H.immaculatus) from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 20
- 21+

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km

0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0114

REV	DATE	STATUS	DRW	CHK	APR
A	04/01/2022	First Issue	AZ	PM	PM

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Base Map: © OpenStreetMap (and) contributors, CC-BY-SA Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors

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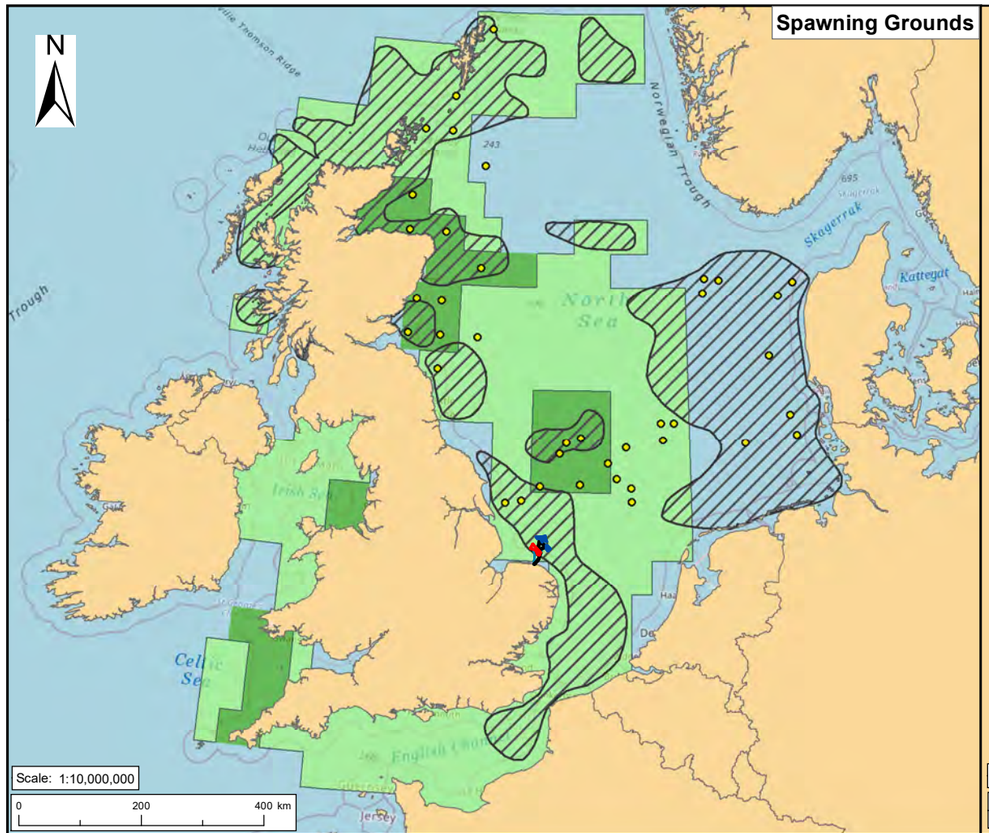

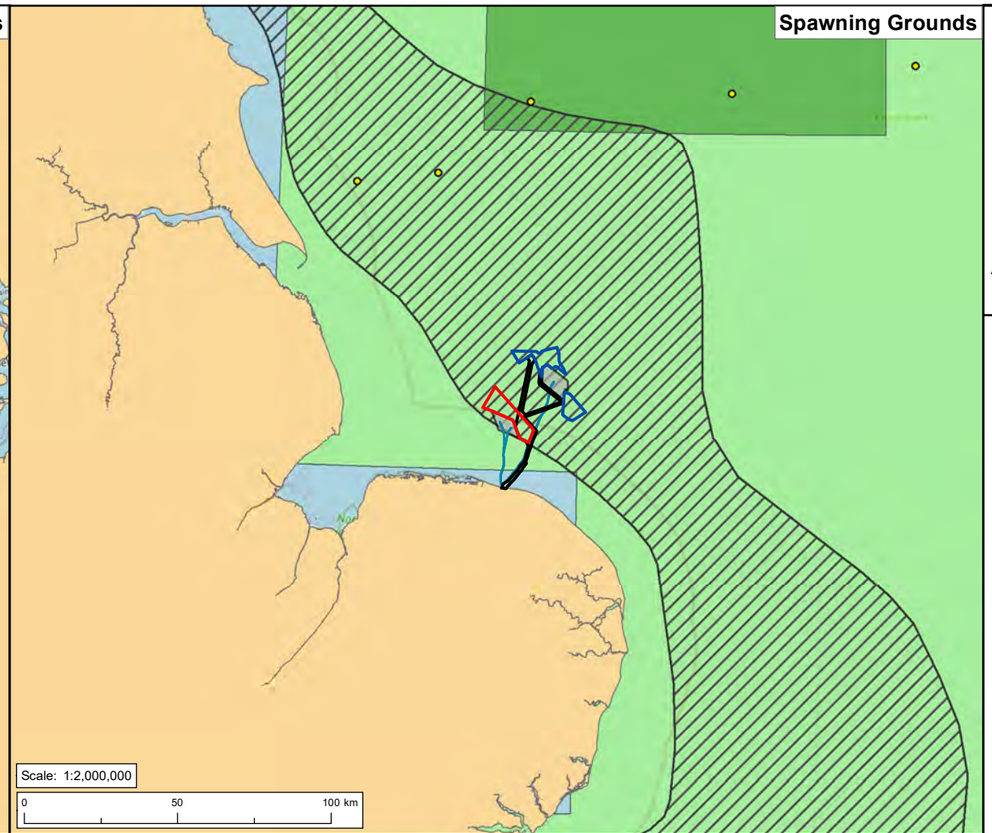

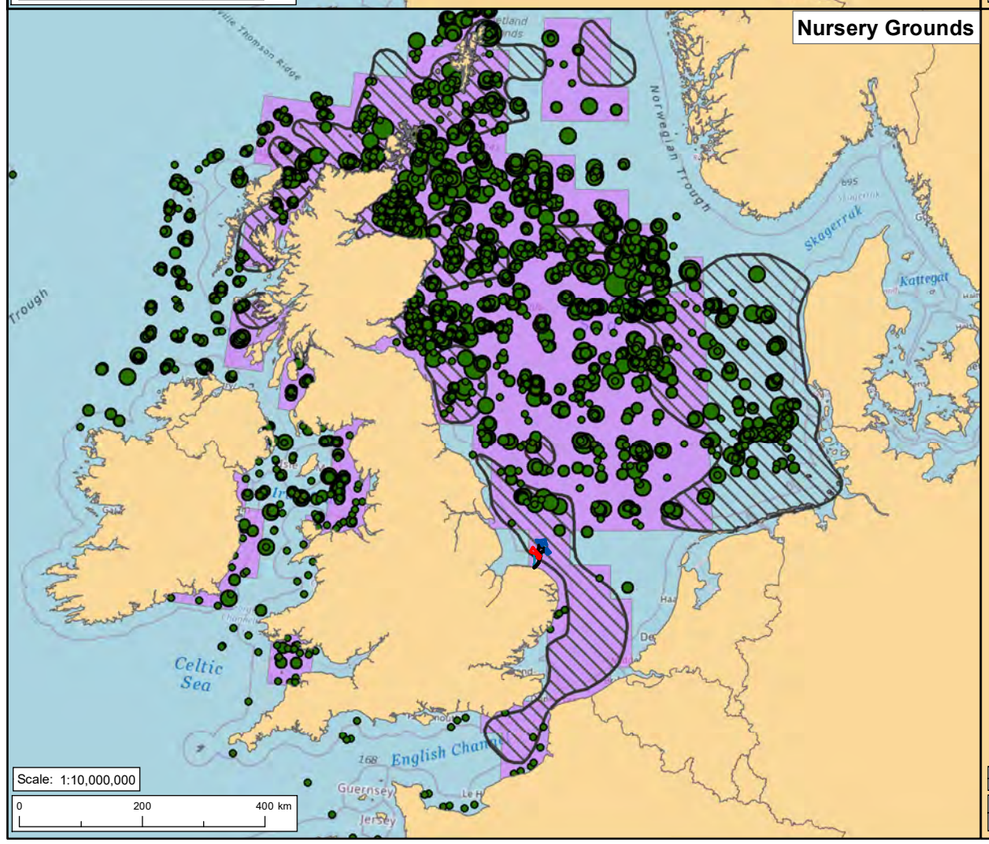

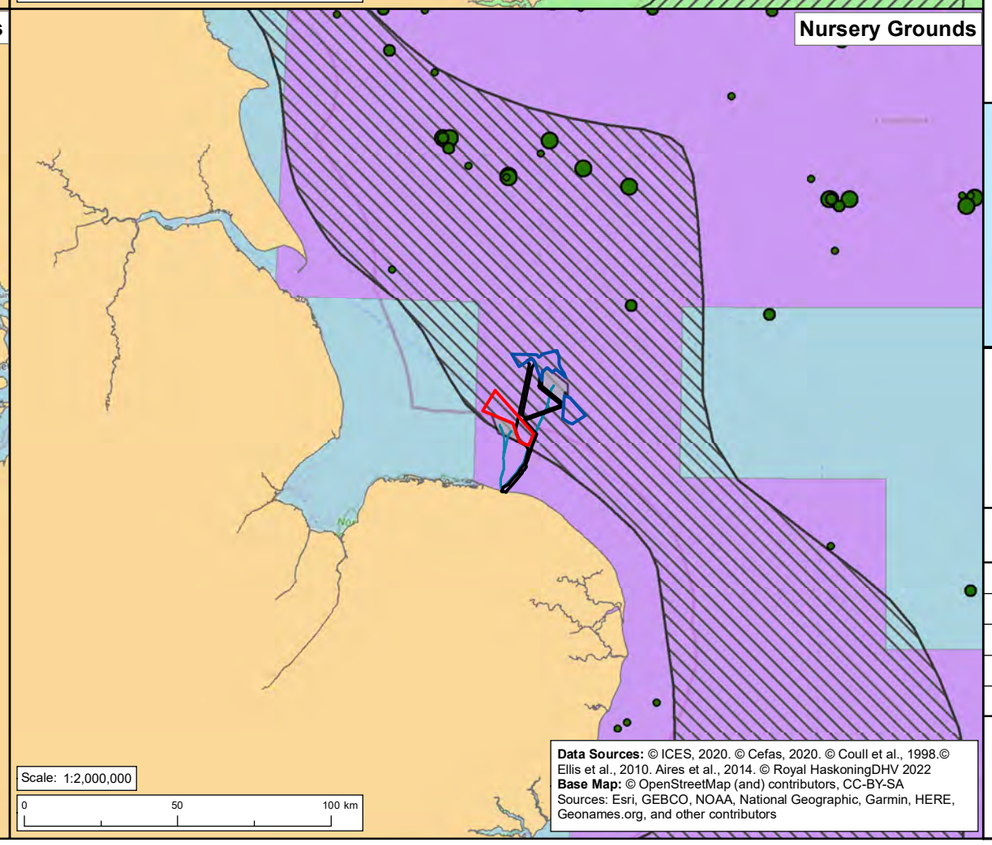

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.30 Sandeel Spawning and Nursery Grounds

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Sandeel Spawning Grounds

Larvae (n/m²) - CP-EGGS 2009; GORL 2004, 2013 (Ammodytidae including A.*marinus* and A.*tobianus*)

- 1 - 10
- 11 - 100
- 101 - 1,000

Coull *et al*. 1998

- Sandeel

Ellis *et al*. 2010

- High intensity
- Low Intensity

Sandeel Nursery Grounds

Maximum Juvenile Catch Rate (n/m²) - Cefas 2010

- 1 - 10
- 11 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 +

Coull *et al*. 1998

- Sandeel

Ellis *et al*. 2010

- Low Intensity

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0082

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A	04/01/2022	First Issue	AZ	PM	PM

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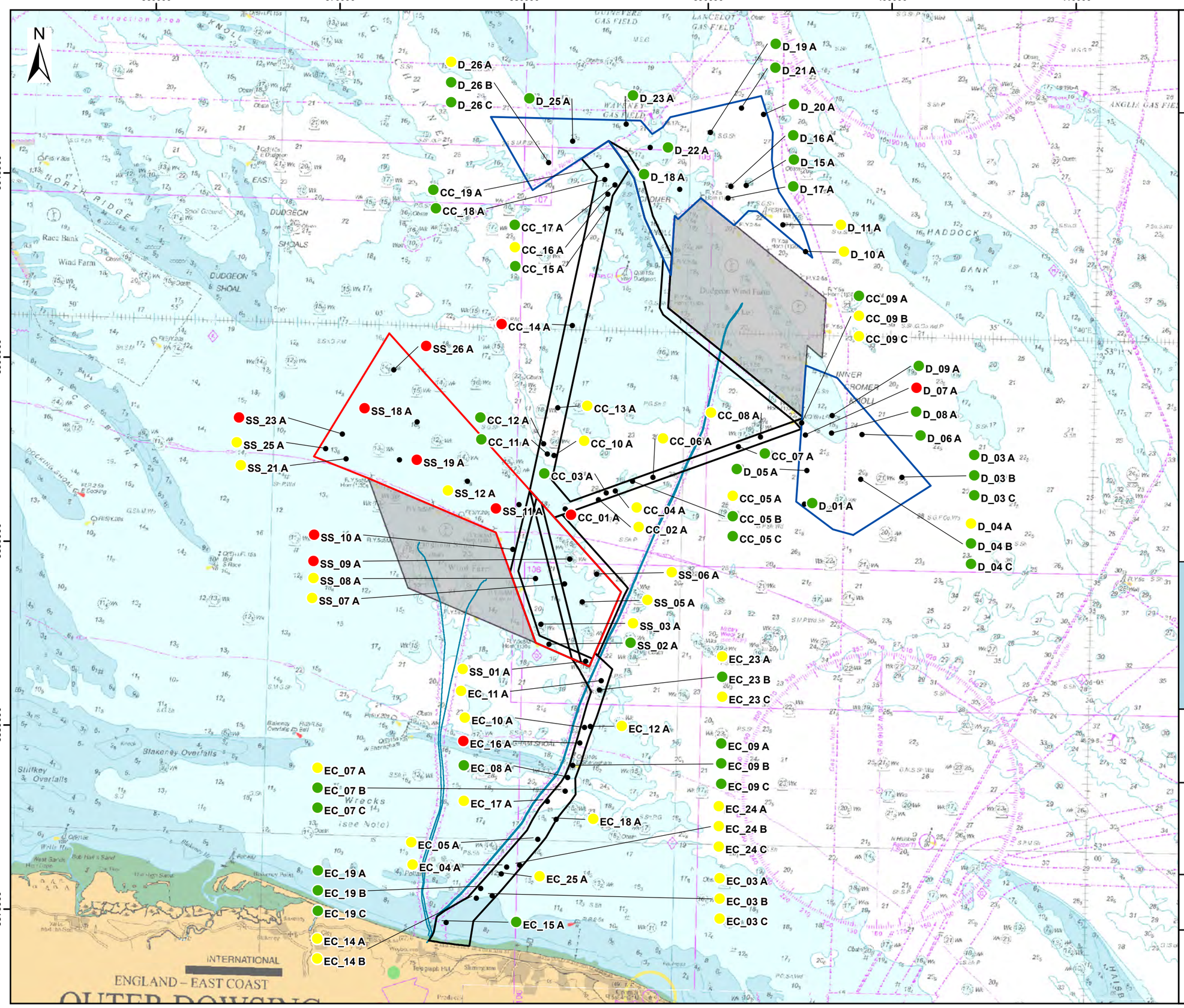
Sheringham and Dudgeon Extension Projects

Figure 9.31

Assessment of Benthic Survey Grabs for Sandeel Spawning Habitat Sediment Classes



Legend:

- Dudgeon Extension Project AfL Area
- Sheringham Extension Project AfL Area
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Sandeel Spawning Assessment

- Actual Survey Location
- Preferred
- Marginal
- Unsuitable

Document No: PB8164-RHD-ZZ-OF-DR-Z-0106

Co-ordinate System: WGS 1984 UTM Zone 31N

0 6 12 km

0 4 8 Miles

A	09/12/2020	1:200,000	A3	AZ	RS	RS
REV	DATE	SCALE	SIZE	DRW	CHK	APR

Report:

Fish and Shellfish Technical Report

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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.32 Average Number (Catch per Standardised Haul) of Thornback Ray from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 +

35F0 35F1 34F0 34F1

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0086

REV	DATE	STATUS	DRW	CHK	APR
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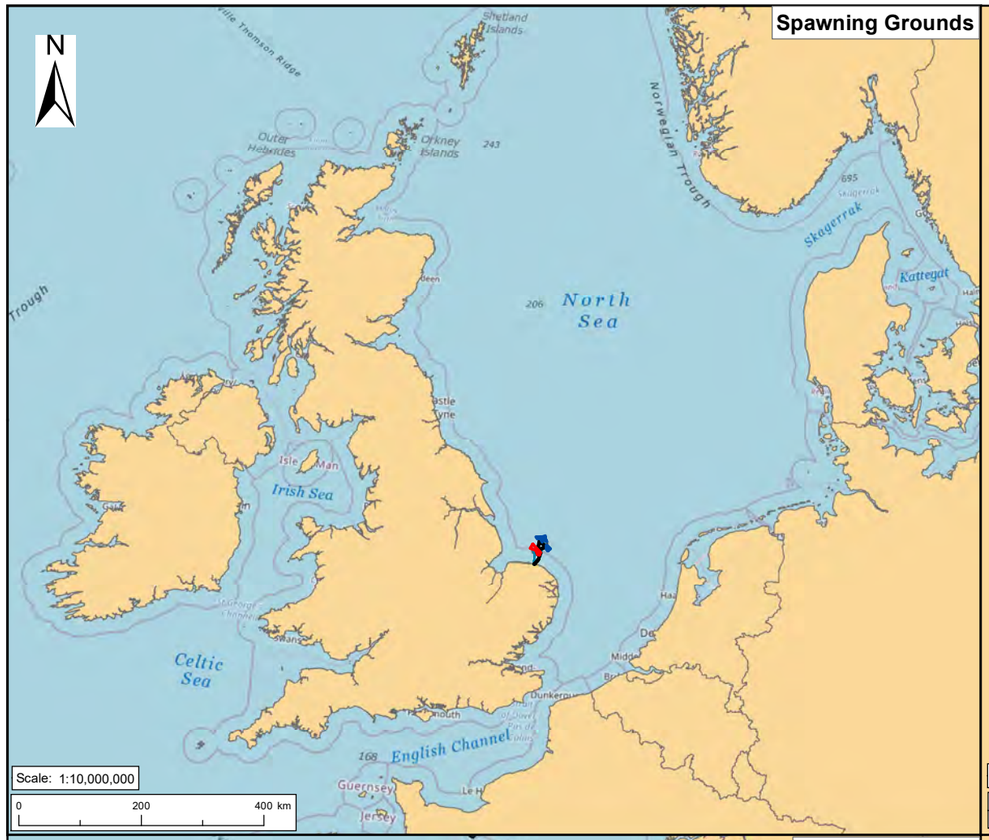

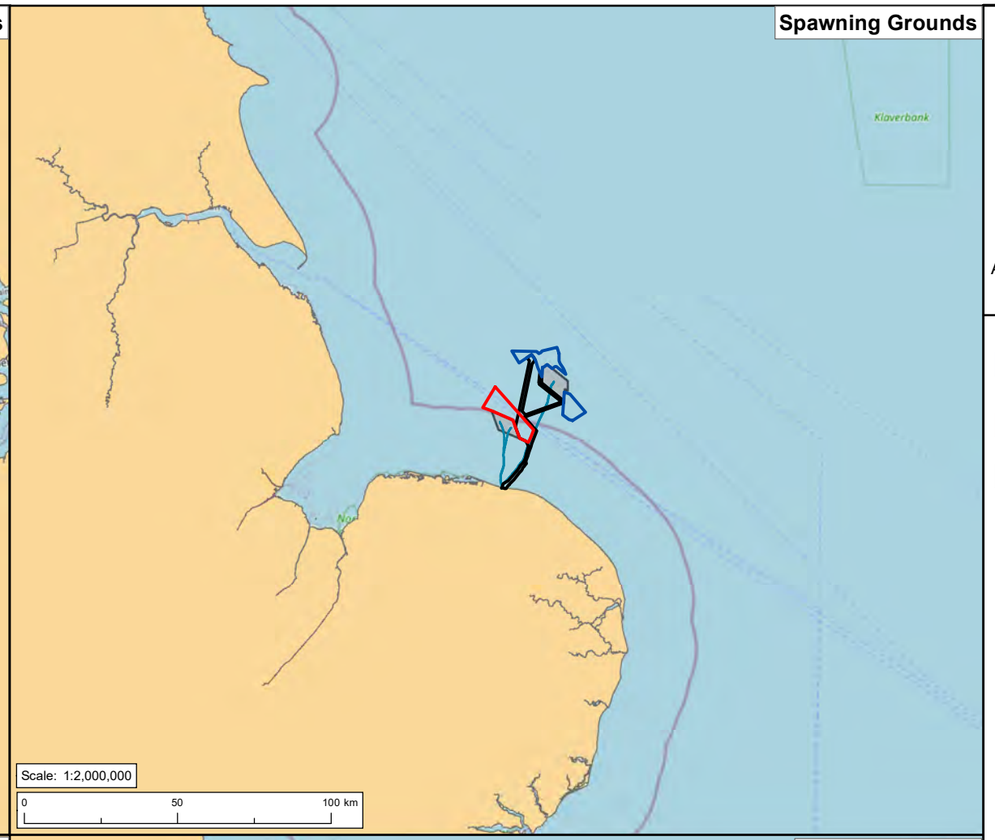

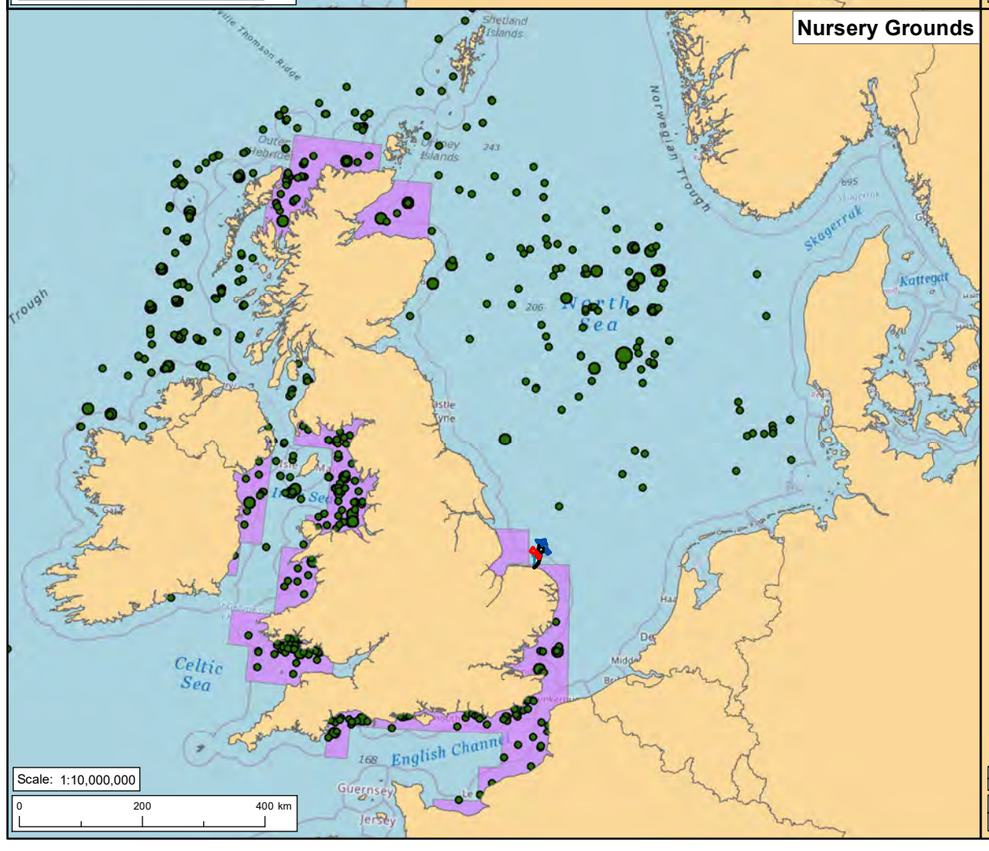

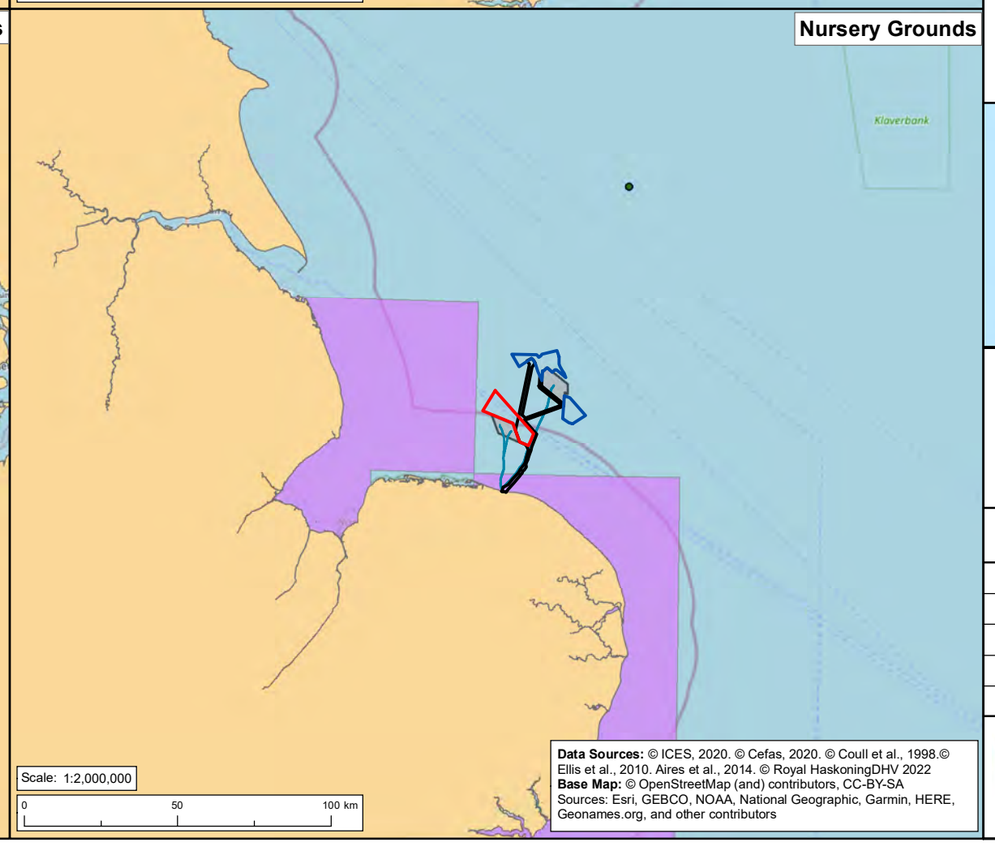

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.33 Thornback Ray Spawning and Nursery Grounds

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Thornback Nursery Grounds

Maximum Juvenile Catch Rate - Cefas 2010

- 1 - 10
- 11 - 100
- 101 - 1,000

Ellis *et al.* 2010

- Low Intensity

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

Scale: *refer to map* Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0087

A	04/01/2022	First Issue	AZ	PM	PM
REV	DATE	STATUS	DRW	CHK	APR

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Title:

Figure 9.34 Average Number (Catch per Standardised Haul) of Blonde Ray from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 3

35F0
35F1
34F0
34F1

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0088

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Figure 9.35 Average Number (Catch per Standardised Haul) of Starry Smoorthhound from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 3

35F0 35F1 34F0 34F1

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0089

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Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 9.36 Average Number (Catch per Standardised Haul) of Lesser Spotted Dogfish from IBTS Survey (2010 - 2020)

Document:

Environmental Statement (ES)
Appendix 9.1 Fish and Shellfish Ecology Technical Report

Application Doc. no.: 6.3.9.1

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridor
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm
- ICES Rectangle

IBTS CPUE 2010-2020 - DATRAS 2020

(No. individuals hr^{-1}) (10 year average)

- 0
- 1 - 5
- 6 - 10
- 11 - 25
- 26 - 50
- 51 +

35F0 35F1 34F0 34F1

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 150 300 km
0 80 160 Miles

Scale: 1:5,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00069
RHDHV Doc. no.: PB8164_RHD_ZZ_OF_DR_Z_0090

REV	DATE	STATUS	DRW	CHK	APR
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