FOREWIND

DOGGER BANK
TEESSIDE A & B

March
2014

Environmental Statement Chapter 13 Appendix A Fish and Shellfish Ecology Technical Report

Application Reference 6.13.1

Brown & May Marine

Dogger Bank Teesside A & B Offshore Wind Farm

Fish and Shellfish Technical Report

PROJECT REF:	REPORT TITLE: TEESSIDE FISH ECOLOGY BASELINE				
DATE	VERSION	DESCRIPTION	PREPARED	CHECKED	APPROVED
28/05/2013	V 1.0		PO		
01/07/13	V1.1		PO/JL		
04/07/13	V1.2	Reference list updated	PO/JL/	LH/CF	SJA
17/07/13	V1.3	Client comments	JL		SJA
28/01/14	V1.4	Stakeholder comments	PO/LH		SJA
03/02/14	V1.5	Corrections	PO		

Contents

List of Acronyms

BAP – Biodiversity Action Plan
BGS - British Geological Survey
BTS - Beam Trawl Survey
Cefas – Centre for Environment, Fisheries and Aquaculture Science
CITES - Convention for International Trade in Endangered Species of Wild Fauna and Flora
COWRIE - Collaborative Offshore Wind Research into the Environment
CPA - Coast Protection Act
DATRAS – Database of Trawl Surveys
DEFRA – Department for Environment, Food and Rural Affairs
ES - Environmental Statement
FEPA - Food and Environment Protection Act
GOV - Grande Ouverture Verticale
IBTS - International Bottom Trawl Survey
ICES - International Council for the Exploration of the Sea
IHLS - International Herring Larvae Survey
IMARES - Institute for Marine Resources and Ecosystem Studies (Netherlands)
IPC - Infrastructure Planning Commission
IUCN - International Union for the Conservation of Nature
JNCC – Joint Nature Conservation Committee
MMO - Marine Management Organisation
MSW - multi-sea-winter
OSPAR - Oslo and Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
PSA - Particle Size Analysis
RBD - River Basin District
RTM - Real Time Monitoring
SA – Sandeel Area
SAC – Special Area of Conservation
SSB - Spawning Stock Biomass
TAC - Total Allowable Catch

1.0 Introduction

1. The following Fish and Shellfish Technical Report provides a description of the existing environment in the area of the proposed Dogger Bank Teesside A & B offshore wind farms and the Dogger Bank Teesside A & B Export Cable Corridor in relation to fish and shellfish resources and ecology. It provides supporting information to the Fish and Shellfish Environmental Statement (Chapter 13) and has been undertaken by Brown and May Marine Ltd.

2.0 Guidance

2. The principal guidance used to undertake this Report includes:
   - Overarching National Policy Statement for Energy (EN-1) DECC 2011a;
   - National Policy Statement for Renewable Energy Infrastructure (EN-3) DECC 2011b;
   - Centre for Environment, Fisheries and Aquaculture Science (Cefas) Guidance note for Environmental Impact Assessment In respect of Food and Environment Protection Act (FEPA) and Coast Protection Act (CPA) requirements. Version 2 – June 2004; [and]
   - Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Judd 2012);

3. The guidelines listed have identified the most likely receptors of impacts, which include impacts to:
   - Spawning grounds;
   - Nursery grounds;
   - Feeding grounds;
   - Overwintering grounds for crustaceans;
   - Migration routes;
   - Species of commercial importance;
   - Species of conservation interest; [and]
   - Species abundant in the area of the developments.

4. Planning Inspectorate scoping responses and outputs from stakeholder consultation has also provided further guidance. In addition, baseline information provided by stakeholders has been integrated where relevant.

.

3.0 Consultation

5. Consultation was undertaken with a number of statutory and non-statutory stakeholders. A summary of the consultation undertaken to date is given in **Table 3.1**.

Table 3.1 Consultation summary table

Consultee	Date	Comments/Contents	Action Taken/Output
Joint Nature Conservation Committee (JNCC) (IPC Scoping Opinion)	01/11/2010	Both European eel and smelt are listed as Marine Conservation Zones (MCZ) features of conservation importance and both have been known to occur within the cable corridor. Net Gain will therefore be considering their inclusion in a possible MCZ.	The potential for diadromous species (including European eel and smelt) to transit areas relevant to the Teesside Export Cable Corridor has been included in Section 6 and 7. The occurrence of smelt in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor is considered less likley than for Dogger Bank Creyke Beck A&B as the species is less abundant in rivers and estauries further north such as the Tess and Esk.
Marine Management Organisation (MMO) (IPC Scoping	01/11/2010	Sandeel is abundant and not necessarily adequately sampled using demersal or pelagic gear.	Sandeel was sampled using a modified scallop dredge as agreed during consultation with MMO/Cefas and Dr. Henrik Mosegaard (DTU-Aqua).

Consultee	Date	Comments/Contents	Action Taken/Output
Opinion)			
Joint Nature Conservation Committee (JNCC) (IPC Scoping Opinion)	01/11/2010	Suggest the use of International Beam Trawl Survey (IBTS) data to characterise the area.	IBTS and Dutch Beam Trawl Survey (BTS) data have been used to inform the Fish and Shellfish Technical Report.
Marine Management Organisation (MMO) (IPC Scoping Opinion) MMO/Cefas Cefas (E-mail)	01/11/2010 18/04/2011 21/07/2011	A wide variety of species have at least part of their life cycle in the area. It would therefore be advisable to have quarterly surveys to adequately describe the seasonal variation of species. It is also important to remember that spawning ranges will vary, temporally and spatially, from one year to another.	Three fish characterisation surveys were carried out (August, October and April) within Tranche A as agreed with Cefas (16/08/2012 meeting).
		A short-snouted seahorse was caught in the Dogger Bank area (Pinnegard *et al.* 2008). This is a species of conservation value and relevant considerations should be observed.	The record of a short-snouted seahorse specimen was noted in Appendix 13A (section 5.5). This species was not recorded in the surveys carried out in Tranche A and along the Dogger Bank Teesside A & B Export Export Cable Corridor.
		We would recommend that separate demersal and pelagic (with acoustic support) surveys are considered. We endorse the use of gear types operated by fishermen in the area, also, we recommend, if possible, using the local fishing community and fishing methods to	Both demersal and pelagic fish surveys were undertaken within Tranche A in order to appropriately characterise the fish

Consultee	Date	Comments/Contents	Action Taken/Output
		survey the area.	assemblage in the area.
		The Environmental Impact Assessment (EIA) must include an assessment of the environmental effects of those species and habitats on the Oslo and Paris Conventions (OSPAR) list of Threatened and Declining species.	Species included in the OSPAR list have been included for assessment within Section 5.5 of the Fish and Shellfish Technical Report.
		"Dogger Bank Wind Farm Project - Fish Ecology Survey Methodology", was submitted by Forewind to the MMO and its advisors, Cefas.	The MMO provided a formal response on 19/10/2011) – see below.
		Cefas preliminary feedback in relation to the proposed fish ecology survey methodology: The overall approach to sampling appears to be well conceived and the proposed surveys are considered to provide a good characterisation and an adequate baseline of the area to inform the EIA. The Dogger Bank is an area of high fishing value because there is a high diversity of species inhabiting the area, stages in their life cycle and at various times of year. For this reason we strongly recommend that quarterly surveys would be needed to fully represent this species diversity and enable an adequate impact assessment to be carried out.	A meeting was arranged with Cefas (16/08/2011) to discuss the key points raised in their email response (21/07/2011). See Section 5.3of this report for details on survey methodology.

Consultee	Date	Comments/Contents	Action Taken/Output
		Furthermore, Cefas recommend using local fishing community to gain information on fishing methods, populations and create communication channels with potentially affected fishermen. Other recommendations: Referential evidence is necessary to support the reason for choosing 30km buffer to account for 'typical piling noise ranges and typical significant behavioural responses of fish'; In relation to pelagic trawl sampling, for the method to fully work acoustic data needs to be recorded and analysed in addition to sampling data. In addition, ideally the whole area would need to be surveyed and not just the 'Coull et el 'area. Several surveys would need to be carried out throughout the spawning season and over several years to properly address the timing and extent of peak spawning; Explain the justification behind surveying herring at night; and It is proposed the sandeel survey is carried out at night time during the beam and otter trawl survey cruises in March.	

Consultee	Date	Comments/Contents	Action Taken/Output
Cefas (Meeting)	16/08/2011	Presentation of fish ecology assessment methodology and planned surveys to support the EIA to Cefas. Discussion of Cefas written responses received (email 21st July 2011): -Use of 30km buffer zone around the site as sampling area of herring survey and night sampling. -Need of more than one herring survey to be undertaken and discussion on the former status of the Dogger Bank grounds -The need to survey wider areas than those depicted by the Danish fishing grounds in the sandeel survey and the need of substrate data to support the findings of the survey. Discussion of nearshore survey methodology. Presentation of noise modelling methodology and assumptions. Presentation of herring spawning and sandeel survey methodologies.	The 30km buffer zone during the herring survey was used as a conservative indication of the distance at which piling noise may result in behavioural responses in herring. This is supported by the results of the noise modelling presented in Section 5.2 of Chapter 13 Fish and Shellfish Ecology (21.5km was the maximum modelled range of behavioural responses for pelagic fish). The suitability for the herring survey to be carried out at night was agreed. Information to support the current former status of the Dogger Bank herring spawning grounds is provided within Section 6.2.1. During the sandeel survey, in addition to areas of high sandeel fishing activity, sampling was undertaken in the wider area (Tranche A and Tranche B). The outputs of the Particle Size Analysis (PSA) from grab samples collected during the benthic

Consultee	Date	Comments/Contents	Action Taken/Output
			survey have been integrated in the Impact Assessment (Sections 6 and 7 of Chapter 13 Fish and Shellfish Ecology).
MMO (Written response)	19/10/2011	MMO formal response to the "Dogger Bank Fish Ecology Wind Farm Project-Fish Survey methodology submitted by Forewind to the MMO on the 18th April 2011. Response included: Information on herring spawning, survey methods, the International Council for the Exploration of the Sea (ICES) International Herring Larval Survey (IHLS) and stock recovery; The MMO and its advisors Cefas suggest that as no current larvae data for the Dogger Bank has been collected, similar methodology to the IHLS (Ichthyoplankton surveys section) could be employed to determine the present level of herring spawning at the proposed Dogger Bank wind farm site. The collection of this data, together with analysis of sediment type (see Ichthyoplankton PSA analysis) would inform the advice given with regard to any potential temporal piling restrictions.Information on how Ichthyoplankton surveys and particle size analysis could be valuable; and Information on sandeel and suggestions relating to survey methodology.	The MMO written response in relation to the herring spawning sampling methodologies could not be taken into account for the undertaking of the herring survey, as the response from the MMO was received after the survey had been completed. However in relation to the above data collected by IMARES in 2011 (van Damme *et al.* 2011) was used to inform the ichthyoplankton and herring spawning assessment (see Section 4.8.4 of Chapter 13 Fish and Shellfish Ecology in the Environmental Statement). The advice given on the sandeel survey methodology was taken into account for survey planning. The results of the PSA derived from grab samples from the benthic survey undertaken in Tranche A together

Consultee	Date	Comments/Contents	Action Taken/Output
			with British Geological Survey (BGS) sediment data have been integrated in to this report and the impact assessment within Chapter 13 Fish and Shellfish Ecology, in respect of both, sandeels and herring.
DTU-Aqua (Meeting)	22/11/2011	Meeting with Dr. Henrik Mosegaard (Head of fish population dynamics and Genetics, DTU) to discuss sandeel ecology on the Dogger Bank and the most appropriate sandeel sampling methodology and timings.	The feedback obtained in relation to survey gear, timing and sandeel ecology was taken into account for definition of the sandeel specific survey methodology.
MMO (PEI1 Response)	20/01/2012	Whilst a desktop study has identified most of the main commercial fish species utilising the area. In the Dogger Bank Project One scoping report, (p63), the MMO highlighted that further investigation of Electromagnetic Fields (EMF) through the EIA in context of High Voltage Direct Current (HVDC) cables. However, there is no mention of elasmobranchs or consideration of EMF in the offshore PEI1. It is recommended that this is addressed and any impacts considered and mitigation measures proposed i.e. cable depth, EMF emissions etc. Commercial finfish fishing in the area appears to have been adequately covered, but there is no mention of shellfisheries. The corridor cuts across Bridlington Bay and this area is important for crab and lobster fisheries. A full impact assessment addressing these issues should be carried out in consultation with the local fishing industry.	The potential for EMF derived from the export cable and array cables have been addressed in the Section 7.4, of Chapter 13 Fish and Shellfish Ecology of the Environmental Statement including potential impacts on elasmobranch species. The Teesside Export Cable does not pass through Bridlington Bay although it does transect grounds which record significant shellfish landings. Therefore,(in addition to fisnfish) a review of shellfisheries has is included within this report. Potential impacts associated with the construction,

Consultee	Date	Comments/Contents	Action Taken/Output
			operational and decommissioning phase of Dogger Bank Teesside A & B have been assessed for both, finfish and shellfish species within the corresponding ES chapter (Chapter 13 Fish and Shellfish Ecology) Commercial fishing activity is reveiwed in Appendix 15A. The potential impacts of Dogger Bank Teesside A&B on commercial fishing are assessed in Chapter 15 Commercial Fisheries.
Institute for Marine Resources and Ecosystem Studies (IMARES) (Meeting)	02/02/2012	Meeting with research team to gather information on IMARES current research on the effect of piling noise on fish larvae.	IMARES feedback, information and suggested research publications have been included in within this reprt and in the corresponding impact assessment presented in Chapter 13 Fish and Shellfish Ecology.
MMO	09/03/2012	The following survey reports were sent by Forewind to the MMO for comment: Otter and beam trawl survey report (August 2011) Otter and beam trawl survey report (October/November 2011)	The MMO provided feedback as below on 06/07/2012.

Consultee	Date	Comments/Contents	Action Taken/Output
		Pelagic Fish Survey Report (September 2011)	
Cefas/JNCC (Workshop)	10/04/2012	Workshop to discuss the main concerns in relation to fish and shellfish, particularly sandeel and spawning herring. Presentation of the preliminary results of the sandeel survey. Presentation of current state of knowledge in relation to herring and the use of the former spawning grounds in the Dogger Bank area. Presentation of results of preliminary noise modelling.	Feedback from the regulator provided in relation to the key areas discussed in the workshop (See MMO written response 25/07/2012 below).
Environment Agency (written response to scoping opinion)	01/06/2012	Migratory fish such as salmon and sea trout use the study area to transit through. Consideration must be given to these when assessing the impact of the works on fish.	The ecology of migratory species such as salmonids and eels is considered within the technical report. Where available (e.g for salmon and sea trout) EA data describing hsitorical and contemporary patterns in the size and timing of runs in those rivers in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor has been included. Information on the North East net fishery and associated data has been included within Appendix 15A.
MMO (written	06/07/2012	Comments on the survey reports sent by Forewind to the MMO on	Production of a sandeel and herring key

Consultee	Date	Comments/Contents	Action Taken/Output
response to survey reports)		the 09/03/2012. General Comments The reports reviewed above provide good information on the survey methodology and species captured. We appreciate that the data has been presented in a standardised format. For the pelagic survey previous advice suggested and we maintain the advice that the survey coverage should cover the entire site (especially if a larval survey is not carried out), not just spawning grounds identified by the Coull *et al.*, (1998) spawning maps in order to highlight if herring are found across the site and potentially identify if they are in spawning state. The fish ecology EIA methodology submitted alongside the above is appropriate. Comments on April 10th Environmental Workshop During the Dogger Bank Teesside Environmental Workshop a point was raised if Forewind needed to continue with the adult herring surveys. If as suggested, a herring larval survey is conducted, the	impacts and baseline information report to be submitted to the MMO for further discussion on key issues in relation to these species. This included integration of PSA data, sandeel survey results, sandeel fisheries data and recent larval surveys carried out in the Dogger Bank, including the distribution of herring larvae in the area (Van Damme *et al.* 2011). This report was sent to the MMO/Cefas on 13th August 2012.

Consultee	Date	Comments/Contents	Action Taken/Output
		need for the adult herring surveys can be reviewed.	
MMO (written response to survey reports)	25/07/2012	As an output from the Dogger Bank Teesside Workshop of the 10th of April 2012 and the discussions held in relation to the fisheries survey results from the first years sampling, the MMO have produced the following response in consultation with our advisors the Cefas. One of the outcomes from the meeting was to discuss whether continued adult herring sampling (acoustic and trawl) was a suitable approach for the developer to collect data in order to potentially avoid a temporal piling restriction for herring. A sampling regime for sandeel was also discussed. In addition, herring surveying and modelling parameters, liaison with pelagic fisheries & to obtain landings data, sandeel sample areas and need for PSA to aid identification of habitat were all outlined.	Production of a sandeel and herring key impacts and baseline information report to be submitted to the MMO for further discussion on key issues in relation to these species. This included the integration of PSA data, sandeel survey results, sandeel fisheries data and recent larval surveys carried out in the Dogger Bank, including the distribution of herring larvae in the area (van Damme *et al.*, 2011). This report was sent to the MMO/Cefas on 13th August 2012. Extensive consultation has been undertaken with UK and non-UK fishing fleets which operate in the Dogger Bank area. In addition, landings and VMS data were obtained to further describe UK and non-UK fishing activity in the area (See Chapter 15 Commercial Fisheries). The information provided in Appendix 15A, has been cross- referenced in Appendix 13A and the draft ES Chapter to inform the

Consultee	Date	Comments/Contents	Action Taken/Output
			assessment on sandeel and herring.
MMO/Cefas (Meeting)	15/08/2012	Meeting to discuss the main concerns in relation to spawning herring and sandeel after MMO/Cefas review of the sandeel and herring key impacts and baseline information report sent for consultation by Forewind (report sent by Forewind on 13th August 2012).	Feedback provided by MMO/Cefas in a written response (12/09/2012).
MMO (Written response to herring spawning and sandeel report)	12/09/2012	Written response from MMO to Forewind in relation to the herring spawning and sandeel report sent by Forewind and the discussions in relation to these species during the 15/08/2012 meeting with MMO/Cefas. Specific Comments: The addition of PSA data has been noted; The data with regard to sandeel is improved for Tranche A and the inclusion of the 2m beam trawl data is useful and the acknowledgment of the limitations of this data has been noted; With regards to the sandeel data all the information must be pulled together to create a vulnerability assessment within Tranche A (this could be used to identify the higher abundance of sandeel within A & B Sites and surrounding them).	The results of the PSA have been included within this report and the draft ES chapter. Data on sandeel derived from 2m beam trawl sampling has also been included within this report. All available data on sandeel (fisheries, surveys and sediment type) have been integrated to inform the impact assessment on this species. The presence of gravelly areas within Dogger Bank Teesside A & B and the wider area has been taken into account in the undertaking of the impact assessment (Environmental Statement, Chapter 13

Consultee	Date	Comments/Contents	Action Taken/Output
		A further sandeel survey for Tranche A is not required as Forewind have reduced the boundary to exclude most of the sandeel ground to the west and the information provided does characterise the area, with the additional 2m beam trawl and PSA data; The inclusion of herring PSA data is useful. We agree that limited spawning is likely to take place within the Dogger Bank region and the spawning ground is likely to be historic. Therefore there is no need for further surveys for Tranche A; The southern portion of Area B (where four PSA samples have high gravel content) must be avoided for construction during the spawning season using engineering solutions. This is due to the proximity to spawning ground to the south and the historic and low level occurrence of spawning in the vicinity. This may change if there is a change in the state and use of the spawning ground; Given captured herring in the survey, they are likely to be in vicinity at spawning time – therefore impact of noise should be fully considered; and	Fish and Shellfish Ecology) in the former herring grounds. The potential for construction noise to have an impact on herring spawning in the former grounds (under the assumption these are recolonized) has been included in the impact assessment within Chapter 13 Fish and Shellfish Ecology. It should be noted that it is assumed that the MMO response referencing Dogger Bank Teesside B is assumed to be an error and to mean Dogger Bank Teesside A as this is the area which has four PSA samples of high gravel content and which is closest to the historic herring spawning area. Similarly, the potential use of the inshore area of the Export Cable Corridor for herring spawning has been included for assessment in Chapter 13 Fish and Shellfish Ecology.

Consultee	Date	Comments/Contents	Action Taken/Output
		Herring are spawning in cable corridor – therefore the impact assessment should fully consider this for laying cable – the engineering solution will not be decided until post consent, although we recommend that this is scheduled for outside the spawning period and one month lead in before to allow settlement of the spawning grounds.	
JNCC/Natural England (written response)	17/12/12	Written response from JNCC Natural England with reference to the Habitat Regulations Assessment (HRA) Screening Report. In reference to protected fish species linked to Special Protection Area (SPA) greater clarity is needed with reference to; The impact of construction of the Export Cable Corridor and landfall; The impact from the use of scour protection (rock protection); Determining the thresholds of suspended sediment concentrations over which there may be an impact on the respiratory and reproductive functions of sensitive fish species; The potential impact on habitats supporting fish species (i.e. Special Area of Conservation (SAC) sites and fish species) in	This has been addressed in sections 6-8 of Chapter 13 Fish and Shellfish Ecology and in the HRA draft report (HRA Appendix B Draft HRA Report).

Consultee	Date	Comments/Contents	Action Taken/Output
		relation to the export cable and potential rock protections needs to be considered; and A consideration of the potential impact of the development on allis and twaite shad and river and sea lamprey should be included in the assessment.	
MMO (written response)	17/12/12	Written response from MMO to Forewind in relation to the herring spawning and sandeel report sent by Forewind and the discussions in relation to these species during the 15/08/2012 meeting with MMO/Cefas. Specific Comments: The addition of PSA data has been noted; The data with regard to sandeel is improved for Tranche A and the inclusion of the 2m beam trawl data is useful and the acknowledgment of the limitations of this data has been noted; With regards to the sandeel data all the information must be pulled together to create a vulnerability assessment within Tranche A (this could be used to identify the higher abundance of sandeel within	The results of the PSA have been included within this ES chapter. Data on sandeel derived from 2m beam trawl sampling is presented in 6.1.1. All available data on sandeel (fisheries, surveys and sediment type) have been integrated to inform the impact assessment on this species. The presence of gravelly areas within Dogger Bank Teesside A & B and the wider area has been considered.

Consultee	Date	Comments/Contents	Action Taken/Output
		Tranches A & B and those sites surrounding them). A further sandeel survey for Tranche A is not required as Forewind have reduced the boundary to exclude most of the sandeel ground to the west and the information provided does characterise the area, with the additional 2m beam trawl and PSA data; The inclusion of herring PSA data is useful. We agree that limited spawning is likely to take place within the Dogger Bank region and the spawning ground is likely to be historic. Therefore there is no need for further surveys for Tranche A; The southern portion of Area B (where four PSA samples have high gravel content) must be avoided for construction during the spawning season using engineering solutions. This is due to the proximity to spawning ground to the south and the historic and low level occurrence of spawning in the vicinity. This may change if there is a change in the state and use of the spawning ground; Given captured herring in the survey, they are likely to be in vicinity at spawning time – therefore impact of noise should be fully considered; and	The potential for construction noise to have an impact on herring spawning in the former grounds (under the assumption these are recolonized) has been included in the impact assessment Within Section 6 to 8 in this Chapter. It should be noted that it is assumed that the MMO response referencing Dogger Bank Teesside B is assumed to be an error and to mean Dogger Bank Teesside A as this is the area which has four PSA samples of high gravel content and which is closest to the historic herring spawning area. Similarly, the potential use of the inshore area of the Dogger Bank Teesside A & B Export Cable Corridor for herring spawning has been included for assessment in Sections 6 to 8 of Chapter 13 Fish and Shellfish Ecology.

Consultee	Date	Comments/Contents	Action Taken/Output
		Herring are spawning in cable corridor – therefore the impact assessment should fully consider this for laying cable – the engineering solution will not be decided until post consent, although we recommend that this is scheduled for outside the spawning period and one month lead in before to allow settlement of the spawning grounds.	
MMO/Cefas meeting	10 /04/13	Meeting to discuss the approach to methodology and impact assessment for Dogger Bank Teesside A & B. Presentation on results of the fish and shellfish characterisation surveys in Tranche B. Cefas indicated that grey gurnard were not currently considered to be a species of interest but this position may change in the future if the species becomes increasingly commercially important. Presentation of the sandeel survey results showing some concentration of sandeels in Dogger Bank Teesside A and very low densities of sandeels in Dogger Bank Teesside B. Cefas indicated that sandeels in Tranche B must be included for assessment. Presentation of herring survey results showing no evidence of	

Consultee	Date	Comments/Contents	Action Taken/Output
		spawning activity on the historic spawning grounds near Tranche B.	
MMO (written response to PEI3)	20/12/13	Advised that Ellis *et al.* 2012 and Coull *et al.* 1998 be used to define spawning and nursery grounds in addition to Ellis *et al.* 2010.	Ellis et *al.* 2010 is referenced in chapter 13 as it provides a comprehensive description of the datasets used to derive mapping layers for the distribution of eggs and larvae of fish and shellfish. Ellis *et al.* 2010 and Ellis *et al.* 2012 are considered to provide the same information on the spatial extent of spawning and nursery habitats, albeit in different formats. Coull *et al.* 1998 is referenced throughout chapter 13 and is also reviewed in Appendix 13A
		Advised that the current ICES advice for herring in the North Sea be considered.	Current ICES advice is reviewed in Section 6.2 and Chapter 13 Fish and Shellfish Ecology Section 6.3.
		Advised that the northern section of the herring spawning area should not be disturbed through the peak spawning period (mid-Aug to mid-Oct) and that it is not necessary to restrict activity during the whole spawning period.	Comments noted. Section 4.2 of Chapter 13
		Advised that data from the International Herring Larval Survey (IHLS) should be considered over a series of years.	IHLS data for the ten year period 2002-2011 is presented in Figures 6.40-6.48..
		Suggested a consistent naming convention with 'sandeels' used when referring to more than one species of sandeel.	Report updated in line with the naming convention used in the international body of literature

Consultee	Date	Comments/Contents	Action Taken/Output
		Requested the application be supported by specific sandeel surveys to cover the whole project and not just the area described by the fishery.	Additional text provided in Section 3.2, paragraph 3.2.20 of Chapter 13
		Queried the methodology for estimating spatial extent of sandeel and herring habitat.	The approach used to estimate the spatial extent of sandeel and herring habitat is based on the approach of Jensen et al. 2011 and is further described in Appendix 13G Habitats disturbance calculations report. Section 6.3 of Chapter 13
		Request clarification on the methodology to define the spatial extent of habitat.	Additional text added to paragraph 6.3.31. See also Appendix 13G Habitats disturbance calculations report. Section 6.3 of Chapter 13
		Clarification requested to whether the impact assessment for sediment includes deposition from disposal.	Additional information provided in 6.4.14 of Chapter 13. Chapter 9 Marine Physical Processes
		Requested further information on piling durations.	Updated information in **Table 5.1** of Chpt 13
		Queried whether noise impacts to sandeels during their period of dormancy were assessed.	Additional information added to 6.8.5
		Suggested a consistent naming convention with ‘sandeels’ used when referring to more than one species of sandeel.	Chapter updated in line with the naming convention used in the international body of literature

Consultee	Date	Comments/Contents	Action Taken/Output
		Suggested *Nephrops* be listed as of 'regional' importance and not just 'local'.	Valuation of *Nephrops* amended to 'regional'.
		Requested further detail on the distribution of brown crab in the western North Sea.	Update to Table 4.6. Figure 6.70 in **Appendix 13A Fish and Shellfish Ecology Technical Report** also provided to show *C. pagurus* distribution in the central North Sea.
		Suggested reference to The Marine Life Information Network (MarLIN) sensitivity assessment for Nephrops be reviewed. MarLIN concluded that Nephrops have a 'high' tolerance to substrate loss.	Chapter updated. Section 6.3 of Chapter 13
		Additional information requested regarding the effects of sediment on the nursery habitat of Nephrops.	Additional text added to Section 6.5 of Chapter 13
		Suggested ovigerous brown crab are likely to be more sensitive to re-deposition of fine sediment as they are effectively sessile whilst brooding their egg mass.	Additional text added to Section 6.5 of Chapter 13
		Advised that the chapter be updated to recognise that brown crab is of regional importance.	Comments accepted. Section 7.11 of Chapter 13
		Requested clarification on whether unbundling of cables has been considered.	Cables are to be assumed unbundled as a worst case scenario. **Table 5.2** updated and text added to clarify in chapter 13.
		Requested further detail on the distribution of brown crab in the western North Sea.	Figure 6.70 shows *C. pagurus* distribution in the central North Sea.

Consultee	Date	Comments/Contents	Action Taken/Output
JNCC/Natural England (section 42 consultation on the draft ES, statutory)	20 December 2013	Noted that the maximum area for physical disturbance/habitat loss during construction was inconsistent.	Amendment made.in section 6.2 of chapter 13
		Suggested the relative distribution of sediment should be provided for the inshore area close to landfall and the export cable.	Information on the inshore area and export cable study area is provided in Section 6.4.16 of chapter 13
		Requested clarification on the figures quoted for the total area of preferred habitat within the Dogger Bank SA1 sandeel management area.	Methodology used to derive the estimates of sandeel habitat are provided in Appendix 13G Habitats disturbance calculations report.
		Clarification requested on the maximum sediment thickness used in modelling.	Comments noted in section 6.5 of chapter 13
		Requested clarification on information provided based on the reference Bone & Moore 2008 on larvae.	Clarification provided in Section 6.5.9 of chapter 13
		Requested information on where hard structures are likely to be introduced along the export cable corridor.	Comments noted in Sections 7.5 and 7.6 of chapter 13
		Raised questions regarding sensitivity of Nephrops in relation to physical disturbance to their spawning and nursery grounds, given their mobility and occupation of burrows.	Report updated with habitat preference and the spawning and nursery areas for *Nephrops* based on Coull *et al*. 1998 and Ellis *et al*. 2012. Section 3.3 and 4.2 of Chapter 13
		Suggests a review of MarLIN information for *Nephrops* sensitivity and recoverability i.e. in relation to suspended sediment on eggs, larvae and adult.	Report updated to include information from MarLIN. Section 6.3&Section 6.5 of chapter 13

Consultee	Date	Comments/Contents	Action Taken/Output
EPIC Regeneration Consultants LLP for Hartlepool Fishermen's Society Ltd. (section 42 consultation on the draft ES, statutory)	20 December 2013	The inshore element of the Export Cable Corridor shows an area of the highest concentration over a known *Nephrops* habitat.	The importance of *Nephrops* in inshore areas is noted in **Table 4.6** of Chapter 13
		Concerned that so little is understood about the impact of EMF and heating effects from HVDC cabling on commercial fish stocks and any potential for EMF to create barriers to fish stock migration.	Comments noted. A review of the EMF impacts and effects is provided in Section 7.10- 7.12 of Chapter 13. Also see **Chapter 5 Project Description** Section 3
		Request for further information on the use of bundling of cables to mitigate the effects of EMF on receptors.	Text to clarify has been added to section 3.3 of chapter 13
		Request further information on the research undertaken by Bochert and Zettler, (2004) as cited.	Comments noted. Further text has been added to clarify in section 7.11 of chapter 13.
		Lack of seabed samples inadequate given there are previously used spoil dumping areas in proximity	Contaminant concentrations along the cable corridor are described in paragraph 6.6.4 of chapter 13

4.0 Methodology

4.1 Sources of data and information

The principal sources of data and information to inform this report are:

- Results of the Tranche B Fish and Shellfish Characterisation Survey (**Appendix 13B);**
- Results of the Tranche A Fish and Shellfish Characterisation Survey (**Appendix 13D);**
- Results of the Nearshore Fish and Shellfish Survey (**Appendix 13C);**
- Results of the site specific pelagic fish survey (**Appendix 13E);**
- Results of the site specific sandeel survey (**Appendix 13F);**
- Results of the site specific epibenthic survey (**Appendix 12A**);
- Results of the site specific benthic survey (**Appendix 12D**);
- Results of the 2010 Dutch International Bottom Trawl Survey (IBTS) and the Dutch Beam Trawl Survey (BTS) (Wageningen Ur, 2012a; 2012b);
- MMO landings data (weight and value) by species for the period 2008-2012 (MMO, 2011);
- Information provided in the Commercial Fisheries Technical Report (**Appendix 15A Commercial Fisheries Technical Report**)
- Cefas publications and International Council for Exploration of the Sea (ICES) publications;
- Results of the International Herring Larvae Survey (IHLS) (ICES HAWG, 2010; 2011)
- Results of the 2010 ICES International Bottom Trawl Survey (IBTS) and the ICES Beam Trawl Survey (BTS);
- Distribution of Spawning and Nursery Grounds as defined in Coull *et al.et al.* 1998 (Fisheries Sensitivity Maps in British Waters) and in Ellis *et al.et al.* 2010 (Mapping spawning and nursery areas of species to be considered in Marine Protected Areas (Marine Conservation Zones);
- Results of recent Ichthyoplankton surveys undertaken in the North Sea (van Damme *et al.et al.* 2011;
- Collaborative Offshore Wind Research into the Environment (COWRIE) reports;
- Results of monitoring programmes undertaken in operational wind farms in the UK and other European countries; and
- Other relevant research publications and stock assessments.

4.2 Data Limitations, Sensitivities and Gaps

4.2.1 Distribution of spawning and nursery grounds

6. The description of spawning and nursery grounds provided in this report is primarily based on the information presented in Ellis *et al.et al.* 2010 and Coull *et al.et al.* 1998. The limitations of these sources of information should, however, be recognised. These publications provide an indication of the general location of spawning and nursery grounds. They do not define precise boundaries of spawning and nursery grounds, particularly in the context of the relatively small footprint of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. Similarly, the spawning times given in these publications represent the maximum duration of spawning on a species/stock basis. In some cases, the duration of spawning may be much more contracted, on a site specific basis, than reported in Ellis *et al.et al.*2010 and Coull *et al.et al.*1998. Therefore, where available, additional research publications have also been reviewed to provide site specific information.

4.2.2 Landings data

7. The fisheries landings data presented in this report are based on MMO data by species and ICES rectangle. For the purposes of this document only landings by UK vessels (irrespective of port of landing) have been included.
8. The Dogger Bank area supports important non-UK fisheries and, therefore, the fisheries data provided below may underestimate/misrepresent the overall importance of some species to non-UK fishing interests. Data on non-UK fishing activity is described in detail in **Appendix 15A: Commercial Fisheries Technical Report** and has been cross-referenced in this document where appropriate.
9. Landings statistics provide a good indication of the principal species targeted in a given area. Extrapolation of the relative abundance and the distribution of the species based on fishing activity should however be made with caution as market driven factors, substrate characteristics and the introduction of fisheries legislation (i.e. fishing closures, Total Allowable Catches (TACs), among other factors, may all have an effect on the degree of exploitation of a given species in a given area.

4.2.3 ICES (International Council for the Exploration of the Sea) Survey Data

4.2.3.1 IBTS

10. The International Bottom Trawl Survey (IBTS) data accessed from the DATRAS on-line database (http://datras.ices.dk) contains haul information and biological

data from all surveys conducted by the ICES IBTS sampling programme. Since 1997 these surveys have employed a standardised fishing method using a GOV[1] trawl to sample a series of fixed stations, twice per year in the 1st and 3rd quarters (ICES 2010c). The species abundance data presented in this report refers to the average number of fish per standardised 30 minute haul during IBTS North Sea surveys 1992 to 2011.

4.2.3.2 IHLS

11. International Herring Larval Survey (IHLS) data was accessed via the ICES Data Portal (http://eggsandlarvae.ices.dk). The IHLS surveys routinely collect information on the size, abundance and distribution of herring larvae in the North Sea. The values for larval abundance presented in this report refer to the number of herring larvae in the smallest reported size category (<10mm total length) caught per square metre at each site sampled per fortnight in the 3rd quarter in each year between 2002 and 2012.

4.2.4 Site Specific Surveys

12. As described in **Chapter 5: Project Description**, the Dogger Bank Zone has been divided into a number of "tranches". The dimensions of each tranche provide sufficient area to allow for some flexibility in the lay-out of the separate wind farm projects. The exact location of individual wind farm projects within tranches has been defined through the Environmental Impact Assessment and the consultation process.

13. Dogger Bank Teesside A is located wholly within Tranche B. Dogger Bank Teesside B overlaps tranches A and B. The surveys undertaken to provide site specific information on fish and shellfish species were designed and planned prior to the boundaries of Dogger Bank Teesside A and B being defined. As a result the areas sampled in these surveys were comparatively wide, covering the whole of tranches A and B. Tranche A was surveyed between 2011 and 2012. Tranche B was surveyed between 2012 and 2013.

4.2.5 Knowledge Gaps

14. It is recognised that there are gaps in the understanding of the distribution, behaviour and ecology of certain fish and shellfish species. This is particularly evident for a number of migratory species including several species of known conservation importance (e.g. lampreys and salmonids). Knowledge gaps often relate to migration routes and use of discrete sea areas such as those within

[1] GOV - "Grande Ouverture Verticale": Standard otter trawl gear used in the IBTS

Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor.

4.3 Study Area

15. For the purpose of this document, two study areas have been defined (**Figure 4.1**). These are:

- A wind farm specific study area ("Wind Farm Study Area") comprising the six ICES rectangles which tranches A and B overlaps and within which Teesside A & B are located (i.e. 38F1, 38F2, 38F3, 39F1, 39F2 and 38F3); [and]
- An offshore Dogger Bank Teesside A & B Export Cable Corridor specific study area ("Export Cable Corridor Study Area") which comprises the four ICES rectangles in which the Dogger Bank Teesside A & B Export Cable Corridor is located (i.e. 38E8, 38E9, 38F0 and 38F1).

16. The study areas defined above provide context in terms of the location of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. The geographic areas are grid referenced by ICES rectangles; a standard geographical unit for the reporting of fisheries data of approximately 30 by 30 nautical miles (one degree longitude by 0.5 degree latitude). The fish and shellfish resources in these areas are also reviewed in a wider context in terms of their distribution and population dynamics in the central North Sea.

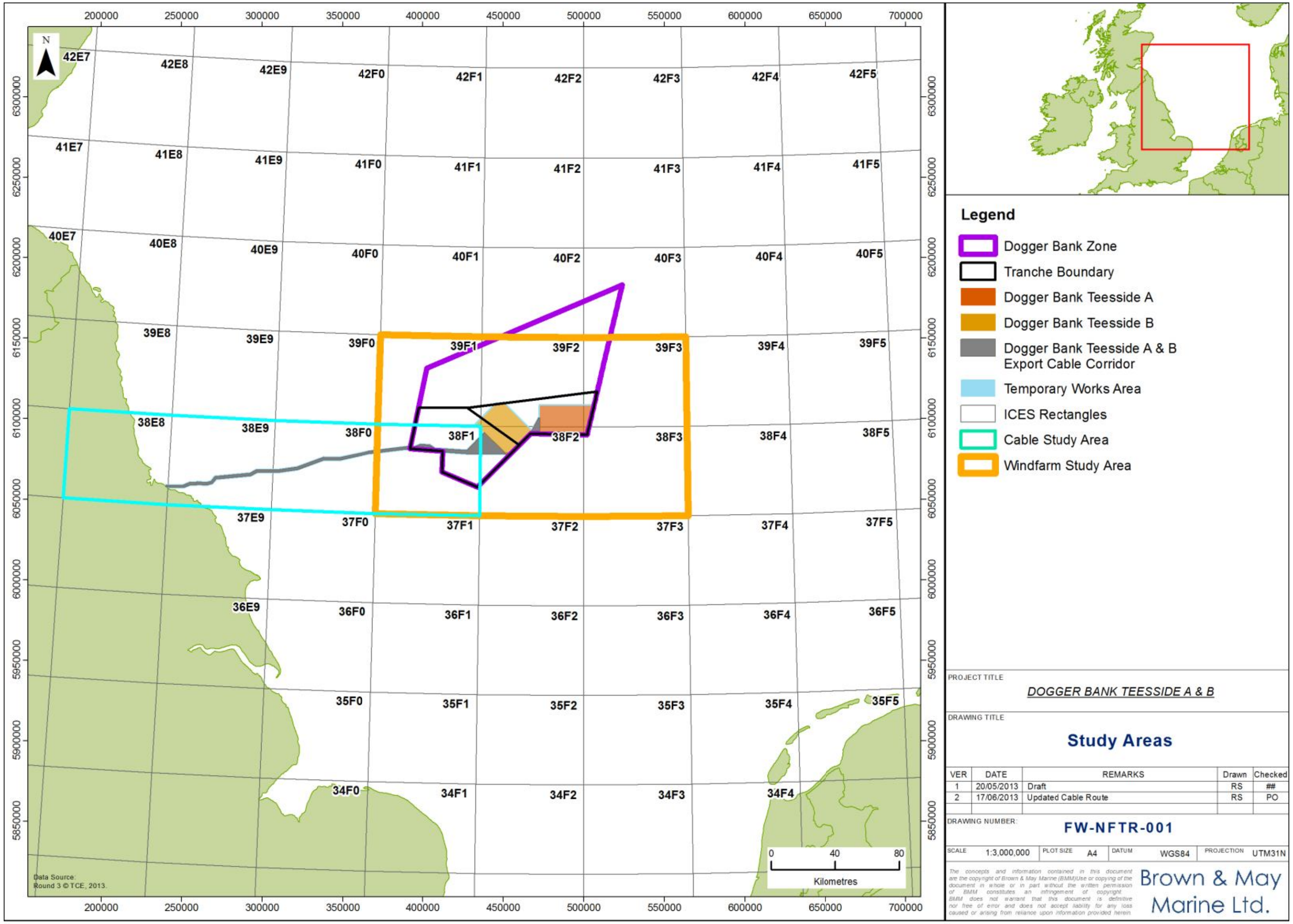


Figure 4.1 The location of the Study Areas

5.0 Background Information

5.1 Fish distribution

17. The distribution of fish communities in the North Sea is broadly related to changes in water depth and temperature (Daan *et al.et al.* 1990). In shallow waters (50-100m depth) in the central and northern North Sea (ICES Divisions IVa and IVb) the fish assemblage are dominated by haddock *Melanogrammus aeglefinus*, whiting *Merlangius merlangus*, herring *Clupea harengus*, dab *Limanda limanda* and plaice *Pleuronectes platessa*. At greater depths (100-200m), Norway pout *Trisopterus esmarkii* dominate (ICES 2005).

18. The southern North Sea (ICES Division IVc) is generally shallower with dominant fish species more characteristic of inshore waters (<50m depth) such as plaice, sole *Solea solea*, dab, whiting, and non-commercial species such as lesser weever *Echiichthys vipera*, grey gurnard *Eutrigla gurnardus* and solenette *Buglossidium luteum*. In addition, species poorly sampled by trawls, such as sandeels *Ammodytidae spp.* and sand gobies *Pomatoschistus* spp.*,* are also abundant (ICES 2005c).

19. Based on catches of the fifty most abundant fish species found in English groundfish surveys (1982-1986), Harding *et al.et al.* (1986) divided the fish assemblage of the North Sea into three community groups: the shelf edge community, the North Central community, and the Southeastern community. The spatial distribution of these communities is illustrated in **Figure 5.1**, together with ICES Divisions.

20. Dogger Bank Teesside A & B fall within the Southeastern community, being immediately adjacent to the boundary of North Central community defined in Harding *et al.et al.* 1986. The Dogger Bank Teesside A & B Export Cable Corridor falls partly in the Southeastern fish community with the longest section traversing the North Central community.

21. The principal fish species associated with the North Central and Southeastern communities are given in **Table 5.1**. Haddock, whiting, cod *Gadus morhua*, Norway pout, saithe *Pollachius virens* and dab are the principal species of the North Central community; whilst dab, whiting, grey gurnard, horse mackerel *Trachurus trachurus*, plaice and cod are the principal species in the Southeastern community.

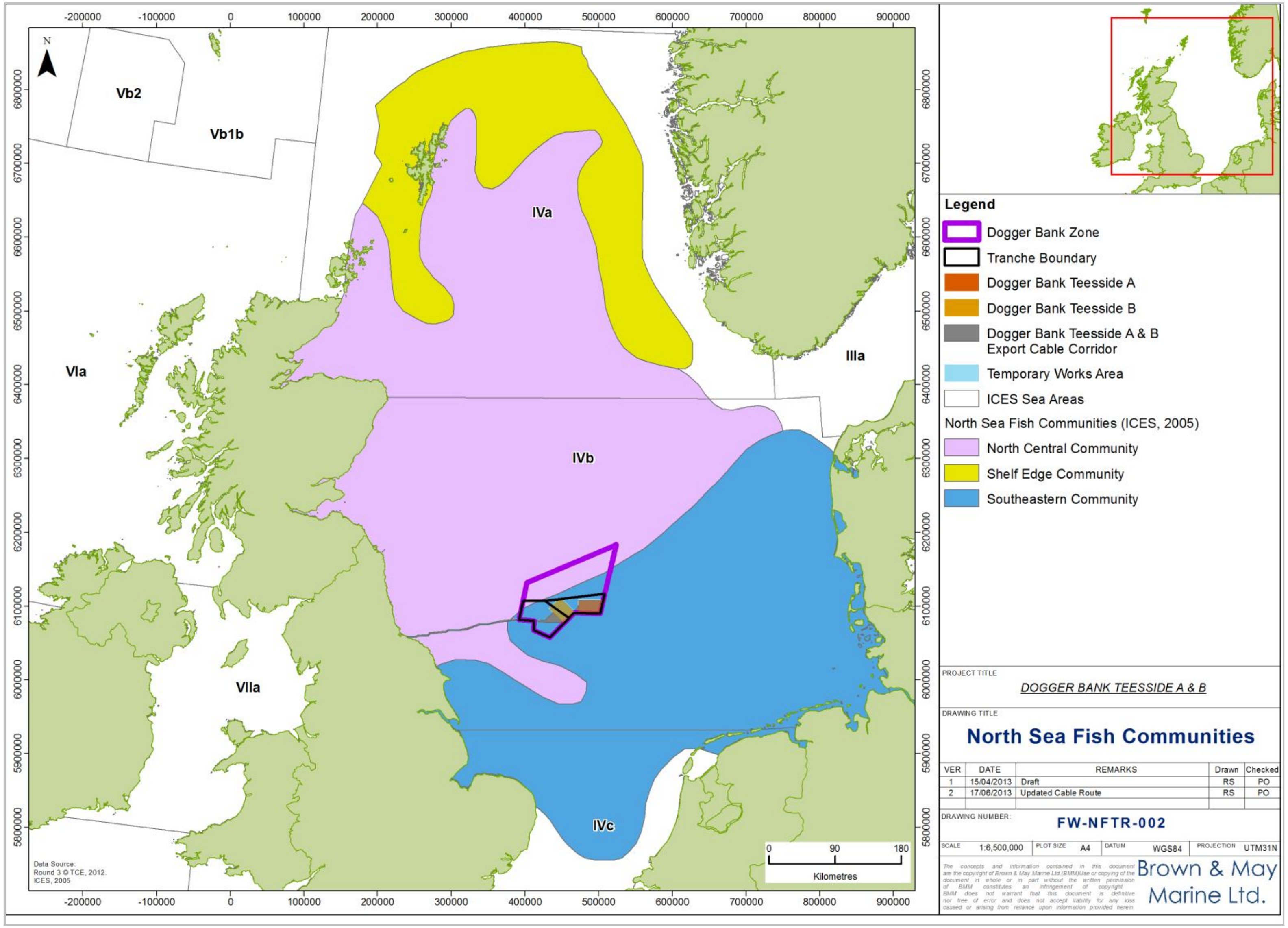


Figure 5.1 Distribution of three fish communities of the North Sea, based on average catches of the fifty most abundant species in the English Groundfish Survey in the years 1982-1986 (Adapted from ICES 2005)

Table 5.1 Species composition of the North Central and South-eastern North Sea fish communities (Harding *et al.et al.* 1986)

North Central Community		Southeastern Community	
Species	**Percentage Weight**	**Species**	**Percentage Weight**
Haddock	42.4	Dab	21.8
Whiting	13.9	Whiting	21.6
Cod	9.2	Grey Gurnard	12.8
Norway pout	4.7	Horse Mackerel	10.1
Saithe	4.5	Plaice	6.3
Dab	3.7	Cod	5.5
Remainder	21.6	Remainder	21.9

22. Research on benthic fish assemblages on the Dogger Bank from a research cruise undertaken in 2006 (Sell *et al.et al.* 2007) found grey gurnard, dab and, to a lesser extent, plaice to be the dominant species in GOV otter trawl samples. In 2m beam trawl samples, solenette, scaldfish *Arnoglossus laterna,* dab, sand goby and snake pipefish *Entelurus aequoreus* were the five most abundant species, with dab, solenette, lemon sole *Microstomus kitt,* scaldfish and plaice being the dominant species in terms of weight.

23. The fish assemblage in the area of Dogger Bank Teesside A & B is, therefore, expected to be similar to that described above in Harding *et al.et al.* (1986) for the North Central and Southeastern fish communities and in Sell *et al.et al.* (2007) for the Dogger Bank.

5.2 Shellfish Distribution

24. The North Sea supports important stocks of several commercially exploited shellfish species including *Nephrops*, *Nephrops norvegicus*, king scallop *Pecten maximus*, lobster *Homarus gammarus*, edible crab *Cancer pagurus*, velvet crab *Necora puba*, common whelk *Buccinum undatum*, brown shrimp *Crangon crangon* and pink shrimp *Pandalus montagui*. The majority of these species are distributed throughout all three North Sea areas and it is therefore not possible to classify distributions in the same manner as for fish communities (e.g. after Harding *et al.et al.*1986; see above). For this reason, distribution has been described primarily by the occurrence of significant fisheries. The ecology of these species is then described in further detail within Section 6.5.

25. *Nephrops* distribution is dictated by the availability of cohesive mud, muddy sand and sandy mud substrates suitable for the construction of burrows. *Nephrops* are non-migratory and inhabit the area in which they settled throughout their life-cycle. Population density and individual body size may also vary in response to substrate type; coarser sediments can support larger *Nephrops* but in lower numbers compared to finer sediments (Rogers and Stocks 2001).

26. There are significant *Nephrops* fisheries in the northern North Sea including the Moray Firth, Fladen Ground, the Noup (North of Orkney) and Norwegian Deeps. The Fladen Ground represents Europe's most spatially extensive and commercially valuable *Nephrops* fishery. In the central North Sea (ICES area IVb), commercially targeted populations are found in the Firth of Forth, Farn Deeps, Devils Hole, Horns Reef and Botney Gut/Silver Pit (ICES 2012). Parts of the Farn Deeps and Devil's Hole fisheries are located immediately north and east of the Tranche A boundary, respectively. Landings from grounds adjacent to the boundary are relatively low compared to other areas of these fisheries. The Botney Gut/Silver pit Fishery is located immediately south of the Tranche boundary (ICES 2012a). The Dogger Bank Teesside A & B Export Cable Corridor intersects the Farn Deeps fishery. *Nephrops* is the most valuable species landed within the Dogger Bank Teesside A & B Export Cable Corridor (**Table 5.11** and **Table 5.16**).

27. King scallops are found on a variety of substrate types, from rocks and stones to fine silty mud, although typically most abundant in areas with rocky outcrops or boulders on silty sand mixed with shell substrates (Pawson 1995, Franklin *et al.et al.* 1980, Brand 2006). Depths inhabited range from below mean low water (MLW) to in excess of 100m.

28. Within the northern North Sea, king scallop stocks support directed fisheries around the Orkney and Shetland Islands and within and around the Moray Firth (Keltz and Bailey 2012). In the central North Sea, king scallops are distributed along the Scottish and English coasts with significant fisheries located south of the Moray Firth, Firth of Forth and Northumbrian and East Yorkshire coasts. Average landings from the Export Cable Study area are approximately 46 tonnes a year (**Table 5.16**).

29. Queen scallops have similar habitat requirements to king scallops although the species is more mobile due to an increased swimming capability (Jenkins *et al.et al.* 2003). Walmsey and Pawson (2007) report the existence of a directed queen scallop fishery off the Yorkshire coast. However, based on MMO data, commercial landings of the species are negligible and it is assumed that productive grounds are located outside of the Teesside study areas.

30. Edible crab is found on a range of habitats, over bedrock, mixed coarse grounds and offshore on muddy sand (Neal and Wilson 2008). The species is widely distributed throughout the northern, central and southern North Sea. Gravid ('berried') females are known to undertake long distance migrations to offshore overwintering grounds where the eggs are hatched (Edwards 1979, Bennett 1995).

31. Nationally, the highest edible crab landings weights are recorded from fisheries around the Orkneys (northern North Sea) and East Coasts of Scotland and Yorkshire (central and northern North Sea) and northern East Anglia (southern North Sea).

32. Velvet crab inhabits rocky and stony substrates and areas of dense macroalgae growth from the intertidal to depths of around 80 m (Wilson 2008). The North Sea population has increased in recent years (Lawler *et al.et al.* 2006) and the

species is now widely distributed throughout the north, central and southern areas.

33. The most productive velvet crab fisheries are located in the northern North Sea around Orkney and the Shetlands (Keltz and Bailey 2012). Other significant fisheries are located along the east coast of Scotland and Yorkshire (central North Sea) and off the coast of North Norfolk in the Greater Wash area (southern North Sea). The commercial importance of velvet crab has increased concomitantly with rises in abundance and catch rates now exceed that of edible crab in some pot fisheries (Lawler *et al.et al.* 2006). MMO data indicates that velvet crab landings from the Dogger Bank Teesside A & B Export Cable Corridor are approximately 25 tonnes a year on average (see **Table 5.16**). Landings of velvet crab from the Wind Farm Study Area are negligible.

34. Lobsters are common in the North Sea, particularly where habitat is characterised by areas of rough ground along rocky coastlines, from below MLW to depths of 150m (Bennett *et al.et al.* 2006). Habitat type influences population density, and abundance may be increased where there is a prevalence of crevices and ledges which provide refuge. Other substrate types may be colonised in the presence of rocks, boulders or other suitable structure such as wrecks (Beard and McGregor 1991). Lobsters migrate less extensively than edible crab and a number of studies have demonstrated strong site fidelity of tagged individuals (Bannister *et al.et al.* 1994, Smith *et al.et al.* 2001). Localised movements are driven by competition for food and the necessity to access different habitats during moulting and as body size increases (Pawson *et al.et al.* 1995). Lobster is an important commercial species in the Export Cable Corridor Study Area where average landings values are in excess of £1.5 million a year (**Table 5.16**).

35. The common whelk is found over a variety of sub-tidal habitat with substrate types of muddy sand, gravel and rock down to depths of around 180m (Ager, 2008). The species is common throughout all three North Sea areas although populations are believed to be declining in some areas (DEFRA 2007).

36. Whelk are targeted throughout the North Sea where sufficiently abundant to support commercially viable landings. Significant fisheries are located around the Shetlands in the north, along the Holderness coast in the central North Sea and off the coast of East Anglia in the southern North Sea (Walmsey and Pawson, 2007). With reference to Dogger Bank Teesside A & B, low landings of whelk are recorded within the Wind Farm Study Area only (average annual landings 16.3 tonnes, see **Table 5.13**).

37. Brown shrimp (*Crangon* spp.) are common throughout the North Sea and are generally found over soft sediments in relatively shallow water (Hosie 2009). Commercial fisheries occur in the central North Sea in the Humber estuary, along the Lincolnshire coast and the Wash (Walmsey and Pawson, 2007). Despite occurrence during epibenthic surveys (**Appendix 12A: Epibenthic Survey Report**), MMO landings data indicates that there are currently no significant fisheries within either the Wind Farm or Export Cable Study Areas.

5.3 Site Specific Surveys

38. In order to inform the fish and shellfish baseline characterisation a number of surveys were undertaken in and around tranches A and B and along the Dogger Bank Teesside A & B Export Cable Corridor in 2012 and 2013. The site specific surveys are listed in **Table 5.2**. The survey methodologies adopted were devised in consultation with Cefas and the MMO.

Table 5.2 Summary of site specific survey work carried out to inform the Fish and Shellfish Assessment

Survey	Area Surveyed	Survey Dates	Survey Reports
Adult and juvenile Fish Characterisation Surveys	Tranche A and adjacent control locations	August 2011 October 2011 April 2012	Appendix 13D
	Tranche B, Dogger Bank Teesside A & B Export Cable Corridor and adjacent control locations	April 2012 July 2012 October 2012	Appendix 13B
Pelagic Fish Characterisation Survey	Dogger Bank former herring spawning grounds (as defined by Coull *et al.et al.* 1998) and export cable corridor	September 2011	Appendix 13E
Sandeel Survey	Tranches A and B	March/April 2012	Appendix 13F
Shellfish (potting) survey	Inshore export cable corridor	September 2012 April 2013	Appendix 13C
Trammel Net Surveys	Inshore export cable corridor	September 2012 April 2013	Appendix 13C

39. In addition to the fish and shellfish specific surveys detailed in **Table 5.2** the results of benthic and epibenthic surveys carried out in tranches A and B have also been cross-referenced, where relevant, to inform this chapter (**Appendix 12A and Appendix 12B**).

5.3.1 Adult and Juvenile Fish Characterisation Surveys (Offshore Otter and Beam Trawl Survey)

40. Baseline information on the fish assemblage in and around tranches A and B was collected by a series of demersal otter trawl and scientific 2m beam trawl surveys carried out during August and October in 2011 and during April, July and October 2012. Sampling was conducted at a number of fixed stations within tranches A and B, at adjacent control locations and along the Dogger Bank Teesside A & B

Export Cable Corridor. The location of the stations sampled in the offshore otter trawl and beam trawl fish characterisation surveys are given in **Figure 5.2**. Due to the presence of high density static fishing gear in the inshore area of the Dogger Bank Teesside A & B Export Cable Corridor, survey work was undertaken using only the 2m scientific beam trawl, in order to avoid disturbance to normal fishing activity.

41. A summary of the results of the otter and beam trawl surveys in tranches A and B is given in **Table 5.3, Table 5.4**, **Table 5.5** and **Table 5.6** respectively. These provide the catch rates (individuals caught per hour) by species and sampling location.

42. Grey gurnard, dab, plaice and whiting had the highest catch rates in all otter trawl surveys in tranches A and B while other species were caught in comparatively low numbers.

43. In beam trawl surveys, the most abundant species in Tranche A was solenette, dab, lesser sandeel *Ammodytes marinus* Raitt and sand goby. In Tranche B samples were dominated by solenette, dab and sand goby. The abundance of lesser sandeel was considerably lower in Tranche B compared to Tranche A.

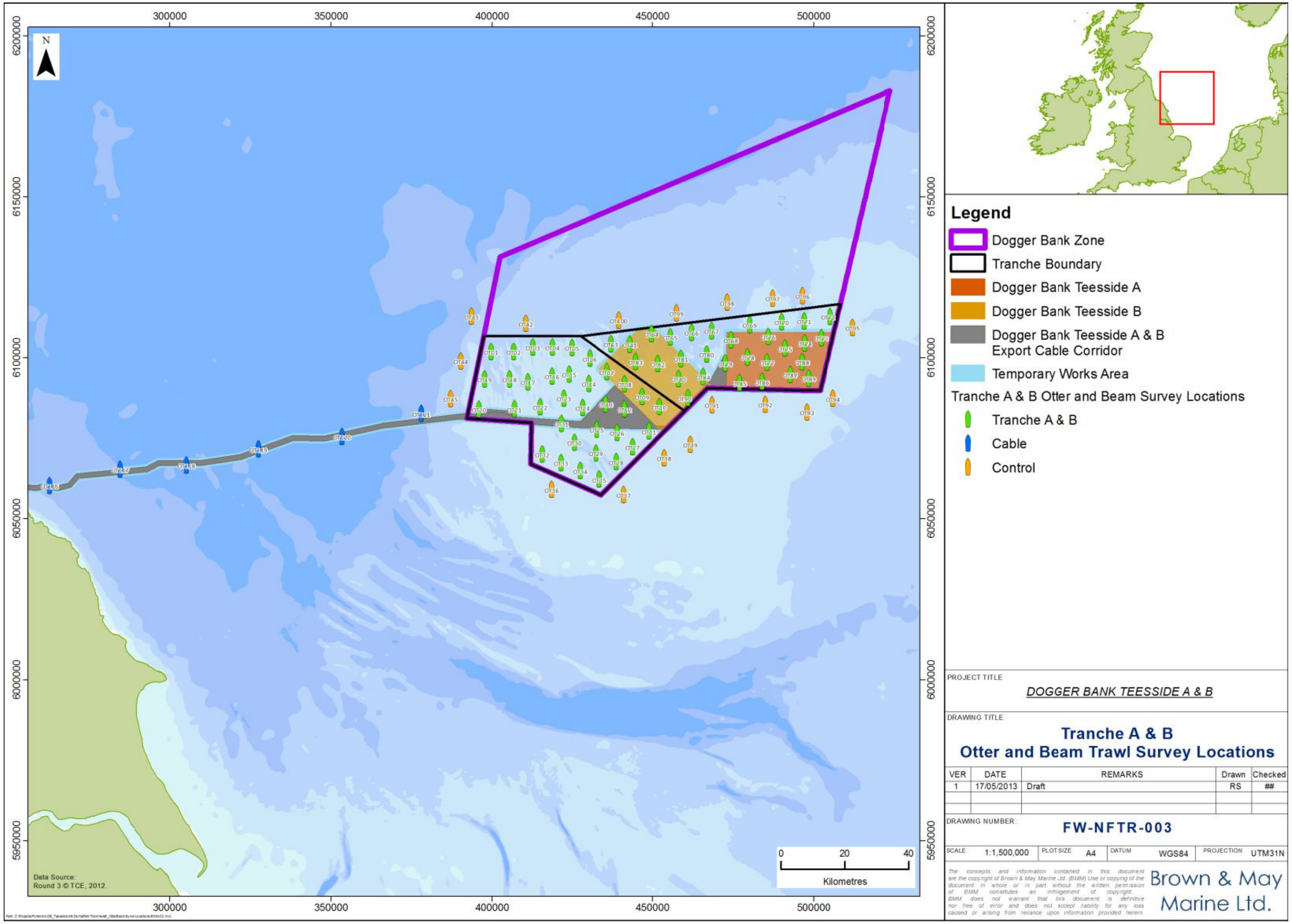


Figure 5.2 Location of offshore Otter and Beam Trawl Survey sampling locations

Table 5.3 Tranche A Otter Trawl Survey catch rate (individuals/hour) by species

Species		August 2011 Otter Trawl Catch Rate (individuals caught/hour)		October 2011 Otter Trawl Catch Rate (individuals caught/hour)		April 2012 Otter Trawl Catch Rate (individuals caught/hour)	
Common Name	**Scientific Name**	**Control**	**Tranche A**	**Control**	**Tranche A**	**Control**	**Tranche A**
Grey Gurnard	*Eutrigla gurnardus*	475.3	399.2	362.0	306.3	270.0	176.9
Dab	*Limanda limanda*	178.2	79.8	353.1	351.9	239.5	185.2
Plaice	*Pleuronectes platessa*	96.2	78.2	87.9	77.6	161.4	157.9
Whiting	*Merlangius merlangus*	97.1	16.0	95.0	87.0	85.8	105.2
Mackerel	*Scomber scombrus*	12.4	50.1	0.4	1.2	0.0	0.0
Lemon Sole	*Microstomus kitt*	19.2	8.0	11.2	7.4	8.7	4.8
Cod	*Gadus morhua*	41.4	3.1	5.2	3.9	0.9	0.6
Edible Crab	*Cancer pagurus*	0.0	0.0	6.0	8.0	0.0	0.0
Brill	*Scophthalmus rhombus*	0.0	4.3	2.2	2.6	2.1	2.3
Long-finned squid	*Loligo forbesii*	0.0	0.0	7.8	4.3	0.0	0.0
Velvet crab	*Necora puber*	0.0	0.0	6.7	5.4	0.0	0.0
Starry Ray	*Amblyraja radiata*	0.0	0.0	1.5	0.1	5.4	0.2
Horse Mackerel	*Trachurus trachurus*	0.0	0.6	3.7	0.1	0.0	0.1
Hake	*Merluccius merluccius*	3.6	0.2	0.4	0.0	0.0	0.0
Lesser Spotted Dogfish	*Scyliorhinus canicula*	0.6	0.5	0.7	0.3	1.5	0.1
Spotted Ray	*Raja montagui*	0.0	0.0	0.7	0.6	1.8	0.2
Haddock	*Melanogrammus*	1.5	0.0	0.4	1.3	0.0	0.1
Queen scallop	*Aequipecten opercularis*	0.0	0.0	1.9	0.9	0.0	0.0
Lesser Sandeel	*Ammodytes marinus* Raitt	0.0	0.0	0.0	0.0	2.1	0.6
Common Dragonet	*Callionymus lyra*	0.3	0.6	0.4	0.5	0.0	0.4
Sprat	*Sprattus sprattus*	0.9	0.0	0.0	0.3	0.9	0.1
Lesser Weever	*Echiichthys vipera*	0.0	0.4	0.0	0.7	0.0	0.9
Sea Scorpion	*Taurulus bubalis*	0.0	0.1	0.0	0.0	0.0	1.7
Smooth sandeel	*Gymnammodytes semisquamatus*	0.0	0.0	0.0	1.8	0.0	0.0
Red Gurnard	*Aspitrigla cuculus*	0.6	0.2	0.4	0.0	0.0	0.0
Ling	*Molva molva*	0.3	0.0	0.7	0.0	0.0	0.0
Turbot	*Psetta maxima*	0.3	0.3	0.4	0.0	0.0	0.0
Red Mullet	*Mullus surmuletus*	0.3	0.6	0.0	0.0	0.0	0.0
Long Rough Dab	*Hippoglossoides*	0.0	0.0	0.7	0.0	0.0	0.0
Poor Cod	*Trisopterus minutus*	0.3	0.0	0.4	0.0	0.0	0.0
Lumpsucker	*Cyclopterus lumpus*	0.0	0.0	0.0	0.0	0.0	0.6
Bib	*Trisopterus luscus*	0.6	0.0	0.0	0.0	0.0	0.0
Anglerfish	*Lophius piscatorius*	0.3	0.3	0.0	0.0	0.0	0.0
Thornback Ray	*Raja clavata*	0.0	0.2	0.0	0.0	0.3	0.0
Herring	*Clupea harengus*	0.0	0.0	0.4	0.0	0.0	0.1
Spurdog	*Squalus acanthias*	0.3	0.0	0.0	0.1	0.0	0.0
John Dory	*Zeus faber*	0.0	0.1	0.0	0.1	0.0	0.1

Species		August 2011 Otter Trawl Catch Rate (individuals caught/hour)		October 2011 Otter Trawl Catch Rate (individuals caught/hour)		April 2012 Otter Trawl Catch Rate (individuals caught/hour)	
Common Name	Scientific Name	Control	Tranche A	Control	Tranche A	Control	Tranche A
Greater Sandeel	*Hyperoplus lanceolatus*	0.0	0.1	0.0	0.1	0.0	0.0
Tub Gurnard	*Trigla lucerna*	0.0	0.2	0.0	0.0	0.0	0.0
Flounder	*Platichthys flesus*	0.0	0.0	0.0	0.0	0.0	0.1
Scaldfish	*Arnoglossus laterna*	0.0	0.1	0.0	0.0	0.0	0.0

Table 5.4 Tranche B Otter Trawl Survey catch rate (individuals/hour) by species

Species		April 2012 Catch Rate (Individuals Caught per Hour)			July-August 2012 Catch Rate (Individuals Caught per Hour)			October 2012 Catch Rate (Individuals Caught per Hour)		
Common Name	**Scientific Name**	**Control**	**Tranche B**	**Cable**	**Control**	**Tranche B**	**Cable**	**Control**	**Tranche B**	**Cable**
Grey Gurnard	*Eutrigla gurnardus*	356.7	250.7	128.2	703.0	702.4	102.9	987.4	733.8	723.1
Plaice	*Pleuronectes platessa*	245.0	250.8	80.3	176.4	159.8	223.1	372.5	327.1	122.8
Dab	*Limanda limanda*	139.8	120.8	64.6	106.1	119.7	142.9	154.3	162.8	140.2
Whiting	*Merlangius merlangus*	31.1	28.2	166.1	21.7	26.5	143.5	3.3	7.9	476.3
Haddock	*Melanogrammus aeglefinus*	0.0	0.2	40.4	0.0	0.0	116.0	0.0	0.0	197.7
Lemon Sole	*Microstomus kitt*	21.8	17.1	27.8	25.3	25.6	29.9	24.3	20.4	31.8
Mackerel	*Scomber scombrus*	0.0	0.0	0.0	35.0	54.5	0.0	0.6	0.7	0.0
Long-finned Squid	*Loligo forbesi*	0.0	0.0	0.0	0.0	0.0	0.0	10.2	19.0	21.0
Long Rough Dab	*Hippoglossoides platessoides*	0.0	0.2	10.6	0.0	0.0	9.0	0.0	0.0	19.8
Hake	*Merluccius merluccius*	0.0	0.0	5.6	0.0	0.2	3.6	0.0	0.0	22.8
Bib	*Trisopterus luscus*	0.0	0.0	30.8	0.0	0.0	0.0	0.0	0.0	0.0
Poor Cod	*Trisopterus minutus*	0.3	0.0	20.7	0.0	0.1	1.2	0.0	0.0	5.4
Cod	*Gadus morhua*	0.9	2.6	2.5	0.6	3.8	6.0	0.0	0.5	2.4
Bullrout	*Myoxocephalus scorpius*	1.8	5.6	0.0	0.3	0.7	0.0	0.0	1.3	0.0
Herring	*Clupea harengus*	0.0	0.0	0.5	0.0	0.0	0.6	0.0	0.1	5.4
Edible Crab	*Cancer pagurus*	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.7	3.0
Starry Ray	*Raja radiata*	0.3	0.2	2.5	0.0	0.0	1.8	0.0	0.1	0.6
Queen Scallop	*Aequipecten opercularis*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	4.8
Anglerfish	*Lophius piscatorius*	0.0	0.0	1.0	0.3	0.1	0.6	0.0	0.1	1.2
Common Dragonet	*Callionymus lyra*	0.3	0.3	0.0	0.6	0.7	0.6	0.6	0.1	0.0
Sprat	*Sprattus sprattus*	0.0	0.1	0.0	0.0	0.0	0.6	2.4	0.1	0.0
Sea Scorpion	*Taurulus bubalis*	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.1	0.0
Starry Smoothhound	*Mustelus asterias*	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.1	2.4
Norway Pout	*Trisopterus esmarkii*	0.0	0.0	2.5	0.0	0.2	0.0	0.0	0.2	0.0
Flounder	*Platichthys flesus*	0.3	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0
Witch	*Glyptocephalus cynoglossus*	0.0	0.0	1.0	0.0	0.0	0.6	0.0	0.0	1.2
Turbot	*Psetta maxima*	0.3	0.1	0.0	1.2	0.1	0.6	0.3	0.2	0.0
Lesser Spotted	*Scyliorhinus canicula*	0.0	0.3	0.5	0.0	0.7	0.0	0.0	0.1	0.6
Spurdog	*Squalus acanthias*	0.0	0.2	0.0	0.0	0.6	0.0	0.3	0.8	0.0
Brill	*Scophthalmus rhombus*	0.0	0.0	0.0	0.0	0.1	0.6	0.0	0.0	1.2
Red Mullet	*Mullus surmuletus*	0.0	0.0	0.0	0.6	1.0	0.0	0.0	0.0	0.0
Lesser Weever	*Echiichthys vipera*	0.6	0.1	0.0	0.0	0.1	0.0	0.6	0.0	0.0

Species		April 2012 Catch Rate (Individuals Caught per Hour)			July-August 2012 Catch Rate (Individuals Caught per Hour)			October 2012 Catch Rate (Individuals Caught per Hour)		
Common Name	Scientific Name	Control	Tranche B	Cable	Control	Tranche B	Cable	Control	Tranche B	Cable
Tub Gurnard	*Trigla lucerna*	0.0	0.0	0.5	0.6	0.1	0.0	0.0	0.0	0.0
Red Gurnard	*Aspitrigla cuculus*	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Spotted Ray	*Raja montagui*	0.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.6
Velvet Crab	*Necora puber*	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0
Squid	*Loligo sp.*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
Horse Mackerel	*Trachurus trachurus*	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.0
Lumpsucker	*Cyclopterus lumpus*	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Common Squid	*Loligo vulgaris*	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Whelk	*Buccinum undatum*	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Saithe	*Pollachius virens*	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
John Dory	*Zeus faber*	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spiny Spider Crab	*Maja squinado*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Scaldfish	*Arnoglossus laterna*	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5.5 Tranche A Beam Trawl Survey catch rate (individuals/hour) by species

ecies		August 2011 Beam Trawl Catch Rate (individuals caught/hour)		October 2011 Beam Trawl Catch Rate (individuals caught/hour)		April 2012 Beam Trawl Catch Rate (individuals caught/hour)	
Common Name	**Scientific Name**	**Control**	**Tranche A**	**Control**	**Tranche A**	**Control**	**Tranche A**
Solenette	*Buglossidium luteum*	110.7	189.9	106.1	106.2	50.1	66.2
Dab	*Limanda limanda*	5.9	15.4	38.1	36.2	68.1	10.3
Lesser Sandeel	*Ammodytes marinus* Raitt	2.2	110.1	4.5	43.0	3.7	2.9
Sand Goby	*Pomatoschistus minutus*	8.9	11.7	21.7	9.7	10.5	5.6
Painted Goby	*Pomatoschistus pictus*	3.0	0.5	0.0	36.2	0.0	2.7
Scaldfish	*Arnoglossus laterna*	7.4	13.5	5.2	5.1	3.7	1.5
Lemon Sole	*Microstomus kitt*	0.0	0.0	0.7	2.0	0.7	3.3
Common Dragonet	*Callionymus lyra*	0.7	0.2	0.7	1.7	1.5	1.2
Smooth Sandeel	*Gymnammodytes semisquamatus*	0.0	0.0	0.0	1.0	0.0	4.3
Plaice	*Pleuronectes platessa*	0.0	0.0	0.0	0.3	3.0	0.9
Lesser Weever	*Echiichthys vipera*	0.0	0.0	0.7	2.0	0.0	0.9
Sculpin juv.	*Cottidae sp.*	0.0	0.0	2.2	0.7	0.0	0.0
Pogge	*Agonus cataphractus*	0.0	0.3	0.0	1.7	0.0	0.7
Megrim	*Lepidorhombus whiffiagonis*	0.7	0.8	0.0	0.3	0.0	0.0
Sandeel	Ammodytidae *sp.*	0.0	0.0	0.0	0.0	0.7	0.0
Whiting	*Merlangius merlangus*	0.0	0.0	0.0	0.0	0.7	0.0
Grey Gurnard	*Eutrigla gurnardus*	0.0	0.0	0.0	0.7	0.0	0.0
Reticulated Dragonet	*Callionymus reticulatus*	0.0	0.0	0.0	0.0	0.0	0.5
Nilson's Pipefish	*Syngnathus rostellatus*	0.0	0.0	0.0	0.2	0.0	0.3
Goldsinny	*Ctenolabrus rupestris*	0.0	0.0	0.0	0.2	0.0	0.2
Sea Scorpion	*Taurulus bubalis*	0.0	0.0	0.0	0.3	0.0	0.0
Two-spotted	*Diplecogaster bimaculata*	0.0	0.0	0.0	0.3	0.0	0.0
Juvenile Goby	*Gobiidae sp. juvenile indet*	0.0	0.0	0.0	0.0	0.0	0.2
Spotted Dragonet	*Callionymus maculatus*	0.0	0.0	0.0	0.0	0.0	0.2
Bullrout	*Myoxocephalus scorpius*	0.0	0.0	0.0	0.2	0.0	0.0
Butterfish	*Pholis gunnellus*	0.0	0.0	0.0	0.2	0.0	0.0
Gadoid juv.	*Gadidae sp.*	0.0	0.0	0.0	0.2	0.0	0.0

Table 5.6 Tranche B Beam Trawl Survey catch rate (individuals/hour) by species

Species		April 2012 Catch Rate (Individuals Caught per Hour)			July-August 2012 Catch Rate (Individuals Caught per Hour)			October 2012 Catch Rate (Individuals Caught per Hour)		
Common Name	Scientific Name	Control	Tranche B	Export Cable	Control	Tranche B	Export Cable	Control	Tranche B	Export Cable
Solenette	*Buglossidium luteum*	63.4	82.4	1.2	222.3	303.8	9.6	74.9	109.9	9.6
Dab	*Limanda limanda*	19.1	39.9	2.4	32.4	48.3	9.6	10.8	21.7	28.8
Sand Goby	*Pomatoschistus minutus*	6.6	4.6	0.0	5.4	12.6	1.2	9.6	15.6	20.4
Scaldfish	*Arnoglossus laterna*	0.0	0.6	1.2	13.2	7.4	1.2	1.8	2.4	0.0
Lemon Sole	*Microstomus kitt*	1.8	2.6	1.2	3.6	4.8	2.4	0.6	2.0	7.2
Plaice	*Pleuronectes platessa*	2.4	0.8	0.0	1.8	5.2	2.4	1.8	2.6	4.8
Lesser sandeel	*Ammodytes marinus* Raitt	1.2	6.6	0.0	5.4	2.4	0.0	1.8	0.8	0.0
Long Rough Dab	*Hippoglossoides platessoides*	0.0	0.2	0.0	0.0	0.0	6.0	0.0	0.0	6.0
Common Dragonet	*Callionymus lyra*	0.0	0.4	0.0	0.0	1.2	0.0	1.2	0.8	6.0
Pogge	*Agonus cataphractus*	0.0	0.0	0.0	1.2	0.8	1.2	0.0	0.0	2.4
Whiting	*Merlangius merlangus*	0.0	0.0	1.2	0.0	0.0	2.4	0.0	0.0	0.0
Hagfish	*Myxine glutinosa*	0.0	1.2	0.0	0.0	0.0	2.4	0.0	0.0	0.0
Painted Goby	*Pomatoschistus pictus*	0.0	0.6	0.0	0.0	0.4	0.0	0.0	1.8	0.0
Nilson's Pipefish	*Syngnathus rostellatus*	0.0	0.4	0.0	1.2	0.0	0.0	0.0	0.0	0.0
Bullrout	*Myoxocephalus scorpius*	1.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goby (indet.)	*Gobiidae sp.*	0	0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Norway Pout	*Trispoterus esmarkii*	0	0	0.0	0	0	0.0	0.0	0.0	1.2
Sea Snail	*Liparis liparis*	0	0	0.0	0	0	0.0	0.0	0.0	1.2
Thornback Ray	*Raja clavata*	0	0	0.0	0.0	0.0	1.2	0.0	0.0	0.0
Megrim	*Lepidorhombus whiffiagonis*	0	0	0.0	0.0	1.0	0.0	0.0	0.2	0.0
Grey Gurnard	*Eutrigla gurnardus*	0	0	0.0	0.0	0.4	0.0	0.6	0.0	0.0
Sea Scorpion	*Taurulus bubalis*	0	0	0.0	0.0	0.8	0.0	0.0	0.2	0.0
Juvenile dragonet	*Callionymus sp.*	0.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dover Sole	*Solea solea*	0	0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
Gadoid (indet.)	*Gadidae sp.*	0	0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Gurnard (indet.)	*Triglidae sp.*	0	0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
Lesser Weever	*Echiichthys vipera*	0.0	0.2	0.0	0.0	0.4	0.0	0.0	0.0	0.0

5.3.2 Pelagic Fish Characterisation Survey (Pelagic Otter Trawl)

44. The pelagic fish survey targeted herring aggregations in the historic/former Dogger Bank spawning grounds with the primary aim of determining if herring were actively spawning in the area. The pelagic survey also provided information on the relative abundance and species composition of other pelagic fish species in the vicinity of the proposed Dogger Bank Zone. Fish from each haul were counted, identified and measured. Herring were also examined for sex and maturity stage. Hauls were carried out at fixed sites in three transects (A, B and C) which were located in the area of the historic herring spawning grounds (Coull *et al.et al.* 1998). Sampling was also conducted at seven inshore sites (Transect D). Opportunistic tows, additional to those at fixed sites, were carried out when the acoustic equipment on board the survey vessel indicated the presence of schools of pelagic fish.

45. The position of the survey transects and the trawl tow tracks of the pelagic fish survey are presented in **Figure 5.3** together with the distribution of herring spawning grounds as defined in Coull *et al.et al.* 1998. The survey design and location of transects were agreed in consultation with Cefas as sufficient to capture potential spawning activity within the Dogger Bank Zone. Further, it was also agreed that transect locations were therefore also appropriate to Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. As shown in **Figure 5.3** the areas sampled are those within a 30km buffer zone from Tranche A, where spawning grounds have been defined for herring. The 30km buffer area was agreed following consultation with Cefas as a conservative indication of the distance at which piling noise may result in behavioural responses in herring (see Error! Reference source not found.).

46. Five pelagic species were recorded during the survey: sprat *Sprattus sprattus*, herring *Clupea harengus*, mackerel *Scomber scombrus,* anchovy *Engraulis encrasicolus* and garfish *Belone belone* in addition to several demersal fish species. The number of individuals caught and catch rates by species and transect are shown in **Table 5.7**. The full results of the pelagic fish survey are provided in **Appendix 13E: Pelagic Fish Survey Report.**

Table 5.7 Summary of the Pelagic Fish Survey

	Species		Number of Individuals Caught					Catch Rate (Number of Individuals/per Hour)			
			Transect				Total	Transect			
	Common	Scientific Name	A	B	C	D		A	B	C	D
Pelagic	Sprat	*Sprattus sprattus*	1	0	32 047	1	3 049	<1	0	5 873	<1
	Herring	*Clupea harengus*	0	1	11 673	0	11 674	0	0.5	2 139	0
	Mackerel	*Scomber scombrus*	373	74	234	86	767	159	36.9	43	37
	Anchovy	*Engraulis encrasicolus*	1	0	0	0	1	<1	0	0	0
	Garfish	*Belone belone*	0	0	1	0	1	0	0	<1	0
Demersal	Whiting	*Merlangius merlangus*	0	0	8	2 482	2 490	0	0	2	1 061
	Grey Gurnard	*Eutrigla gurnardus*	0	0	47	7	54	0	0	9	3
	Haddock	*Melanogrammus*	0	0	0	4	4	0	0	0	2
	Dab	*Limanda limanda*	0	0	2	0	2	0	0	<1	0
	Lumpsucker	*Cyclopterus lumpus*	0	1	0	0	1	0	<1	0	0
	Tub Gurnard	*Trigla lucerna*	0	0	1	0	1	0	0	<1	0

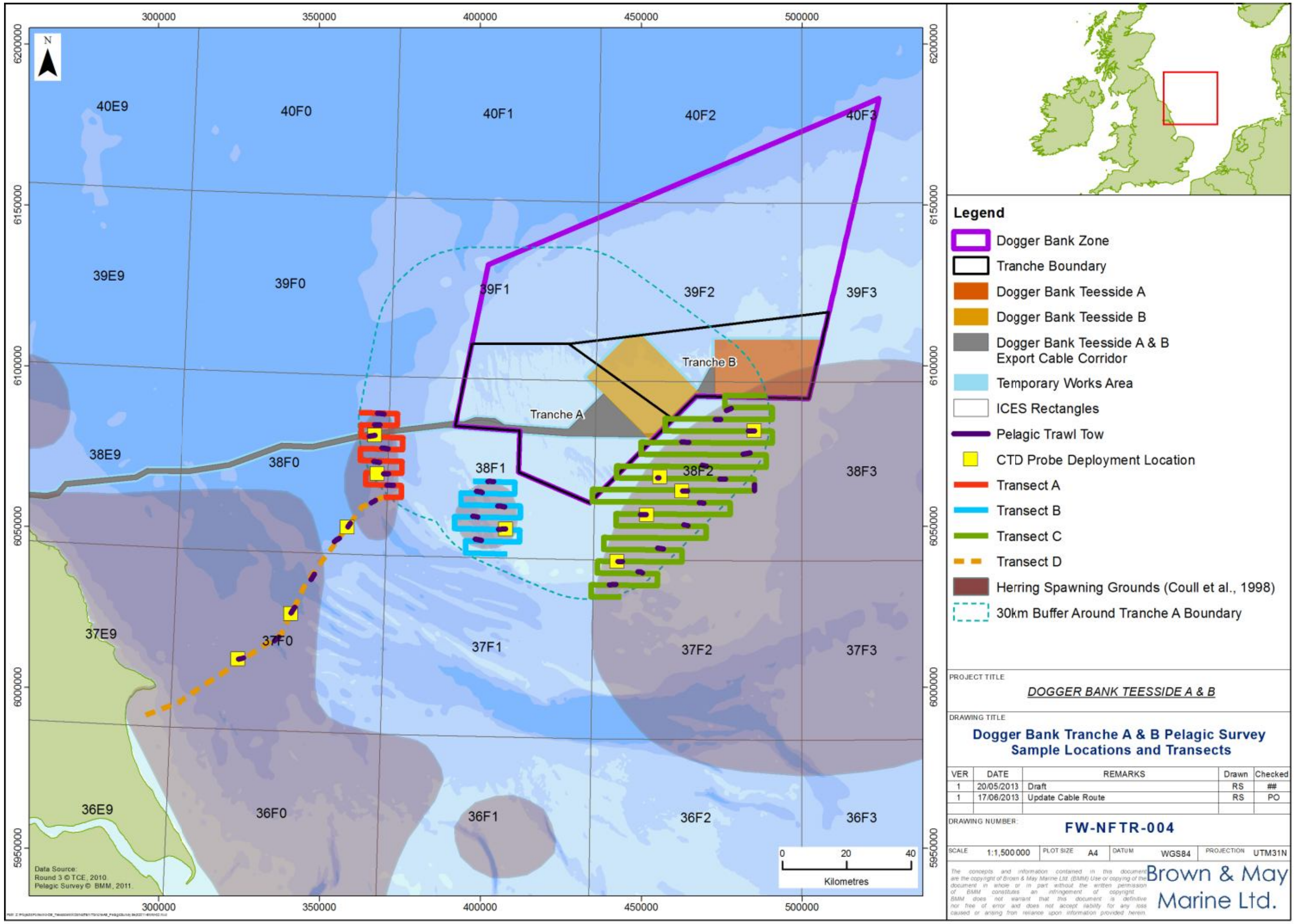


Figure 5.3 Pelagic survey transects and location of Pelagic trawl tows

47. Sprat was the species caught in greatest numbers, particularly in Transect C (32,047 individuals).

48. Herring were found in two of the four transects sampled, with 11,673 individual herring recorded in Transect C whereas only one individual was recorded in Transect B. The majority of the herring caught were 'virgin' juvenile fish. As described in **Appendix 13E - Pelagic Fish Survey Report**, the pelagic survey was undertaken during the spawning season of the Banks herring stock (August-October). The temperatures and salinities recorded during the survey correspond with those when large herring spawning aggregations are expected to occur. No herring in spawning condition or recovering from spawning was found over the historic herring grounds of the Dogger Bank. This suggests that there was no herring spawning activity in this area either during the time of the survey or during the period immediately prior to the commencement of the survey.

49. Mackerel was recorded in all four transects, occurring in the highest numbers in transects A and B.

50. Other fish species caught during the pelagic survey were all demersal species and caught in relatively small numbers with the exception of whiting. Large numbers of whiting (2,482 fish) were caught along the inshore corridor (Transect D).

5.3.3 Sandeel Specific Survey

51. A sandeel specific survey, using a modified scallop dredge, was undertaken in tranches A and B in March 2012. The full results of the survey are provided in **Appendix 13F: Sandeel Survey Report** and are summarised below.

52. A total of 110 stations were sampled, 47 of which were located in Tranche A, 20 in Tranche B and 43 at adjacent control areas. Given the patchy distribution of sandeels and the large area to be surveyed, the sampling effort was concentrated in the vicinity of known fishing grounds, since the level of commercial fishing activity is considered to reflect sandeel habitat distribution (Jensen 2001, van der Kooij *et al.et al.* 2008, Jensen and Christensen 2008, Mosegaard, H. Personal meeting, November 2011). Stations outside the main fishing grounds were also sampled, although less intensively.

53. The relative abundance of sandeels (individuals caught per hour) by station and species across tranches A and B is shown in **Figure 5.9.**

54. Three species of sandeel were recorded: lesser sandeel *Ammodytes marinus* Raitt, greater sandeel *Hyperoplus lanceolatus* and smooth sandeel *Gymnammodytes semisquamatus*. Of these, lesser sandeel was the dominant species in the majority of stations and accounted for 98.2% of the total sandeel catch.

55. Sandeels were found in highest numbers in stations located along the western boundary of Tranche A. They were also relatively abundant within Tranche A at stations to the west of Teesside B. Fewer sandeels were present in Tranche B and were mainly concentrated in the central sector and at two sites along the eastern boundary of Teesside A (**Figure 5.9**).

5.3.4 Inshore Shellfish (Potting) Survey

56. The inshore shellfish survey was carried out over two four-day periods in September 2012 and April 2013, with soak periods ranging from 68 to 122 hours. The location of the stations sampled is given in Figure 5.4Two fleets were positioned across the inshore cable corridor (2 and 4) and three at adjacent control locations (1, 3 and 5). A summary of the results of the survey is given in **Table 5.8**.

57. Edible crab *Cancer pagurus* was the most numerous of all species recorded. Moderate numbers of lobster *Homarus gammarus* and velvet crab *Necora puber* were caught at both inshore cable and control stations. The hermit crab *Pagurus bernhardus* was did not appear in autumn samples but was present in reasonably large numbers in samples from April 2103.

5.3.5 Trammel Net survey

58. Five fleets of trammel nets were deployed, with one fleet 'shot' close to the shore along each of the proposed cable routes, a second was laid along the mid-section of the inshore cable route, to account for varying depth and habitat, and two fleets 'shot' randomly within the central nearshore region, but within comparable water depths, to act as a controls. The location of the stations sampled is given in Figure 5.5. Two fleets were positioned across the inshore cable corridor (2 and 3) and three at adjacent control locations (1, 4 and 5). A summary of the results of the trammel net surveys is given in Table 5.9.

59. Edible crab *C. pagurus* was the most abundant species in samples, followed by dab *Limanda limanda* and cod *Gadhus morhua*. Lesser spotted dogfish *Scyliorhinus canicula* was caught in both sampling periods but was more numerous in the spring survey compared to that undertaken during autumn.

60. Single specimens of thornback ray *Raja clavata* were recorded in both sampling periods at sites along the cable route and one spotted ray *Raja montagui* was caught in the inshore area in April 2013.

61. One lesser sandeel was caught in the inshore area in April 2013.

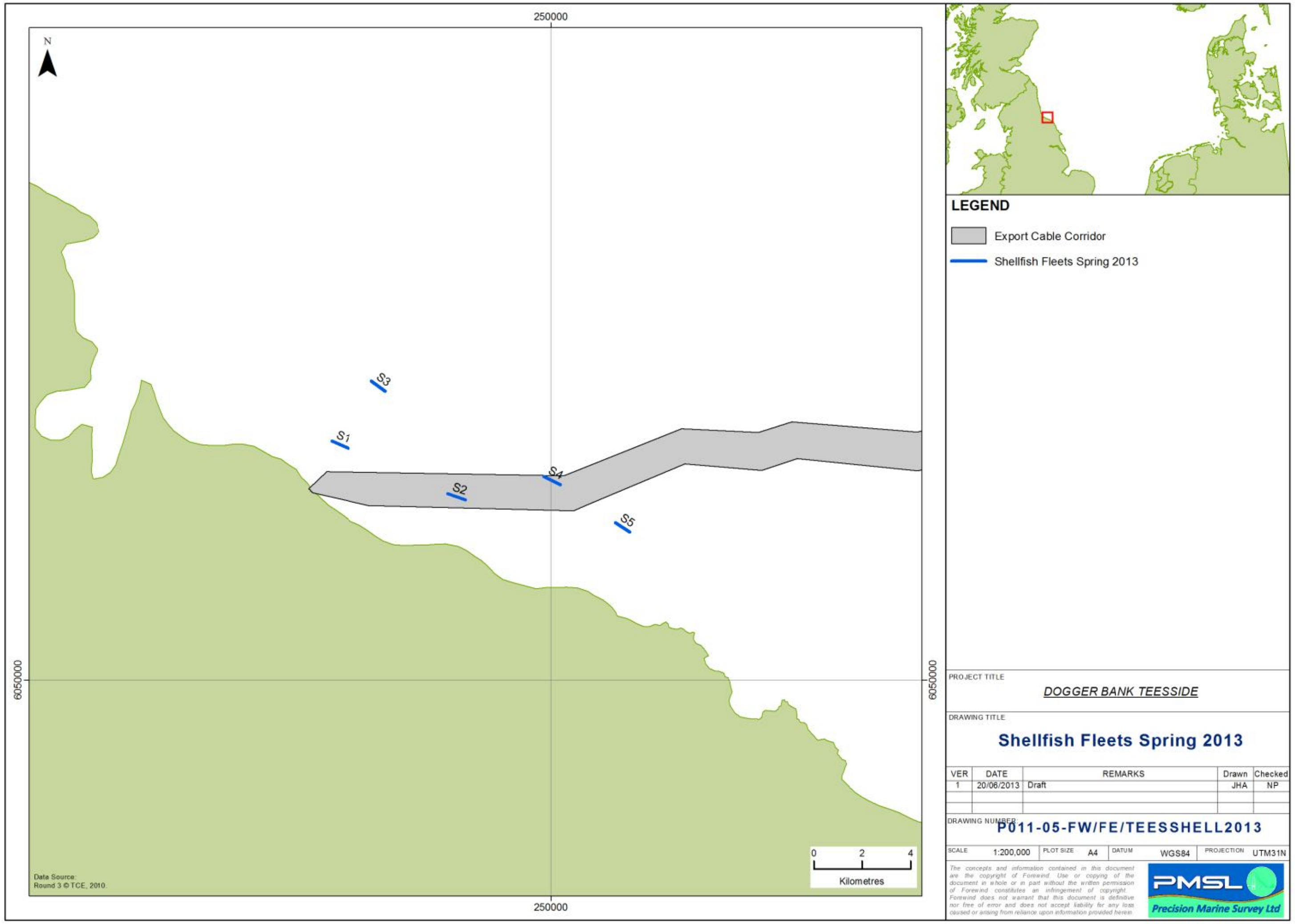


Figure 5.4 Location of April 2013 potting survey fleets

Table 5.8 Summary of Inshore potting survey results

Species		No. of individuals caught			
		September 2012		April 2013	
Common name	Scientific name	Inshore Cable Route	Inshore Area	Inshore Cable Route	Inshore Area
Edible crab	*Cancer pagurus*	449	170	367	169
Hermit crab	*Pagurus bernhardus*	0	0	34	175
Lobster	*Homarus gammarus*	42	66	17	38
Velvet crab	*Necora puber*	20	61	22	56
Whelk	*Buccinum undatum*	2	22	22	87
Star fish	*Asterias rubens*	0	0	25	90
Cod	*Gadus morhua*	1	0	2	2
Pouting	*Trisopterus luscus*	0	2	1	2
Sea urchin	*Echinus esculentus*	1	0	2	1
Squat lobster	*Galathea intermedia*	0	0	0	3
Whiting	*Merlangius merlangus*	0	0	2	0
Dab	*Limanda limanda*	0	0	0	1
Octopus	*Octopus vulgaris*	0	1	0	0
Sea scorpion	*Taurulus bubalis*	0	0	0	1
Swimming crab	*Liocarcinus holsatus*	0	0	1	0

5.3.6 Prawn trawl survey

62. Following discussions with local fishermen it was decided to allocate three prawn trawling stations to an area within an important *Nephrops* fishing ground (Figure 5.6). *Nephrops* were caught in large numbers in both sampling periods. The most abundant fish species recorded was whiting followed by Dover sole, cod and haddock. A summary of the results of the prawn trawl survey is given in **Table 5.10**.

5.3.7 Otter trawl survey

63. A total of 10 otter trawl stations were assigned to the survey area; ten were located in the inshore zone and two were positioned across the cable route corridor (see **Figure 5.7**). The most abundant species recorded was whiting *M. merlangus* followed by haddock *Melanogrammus aeglefinus,* dab *L. limanda,* plaice *P. platessa* and grey gurnard *Eutrigla gurnardus.* A summary of the results of the otter trawl survey is given in **Table 5.11**.

5.3.8 Beam trawl survey

64. Gear problems prevented the successful completion of an autumn beam trawl survey in September 2012. It was originally intended to sample twelve stations in April 2013 but one sampling station (BT6) was abandoned due to the presence of fishing gears positioned directly across the trawl path. The location of the otter trawl stations is shown in **Figure 5.8**.

65. The results of the April 2013 beam trawl survey are presented in **Table 5.12**. The most numerous species was krill caught at station BT7. Pink shrimp *Pandalus montagui* was caught in relatively large numbers at station BT1 and was also present in samples form the majority of inshore stations as well as the single station located within the cable corridor.

66. The most numerous fish species were dab *L. limanda*, pouting *Trisopterus luscus*, whiting *M. merlangus* and lemon sole *Microstomus kitt* which were all recorded in low to very low numbers in the inshore and cable route stations.

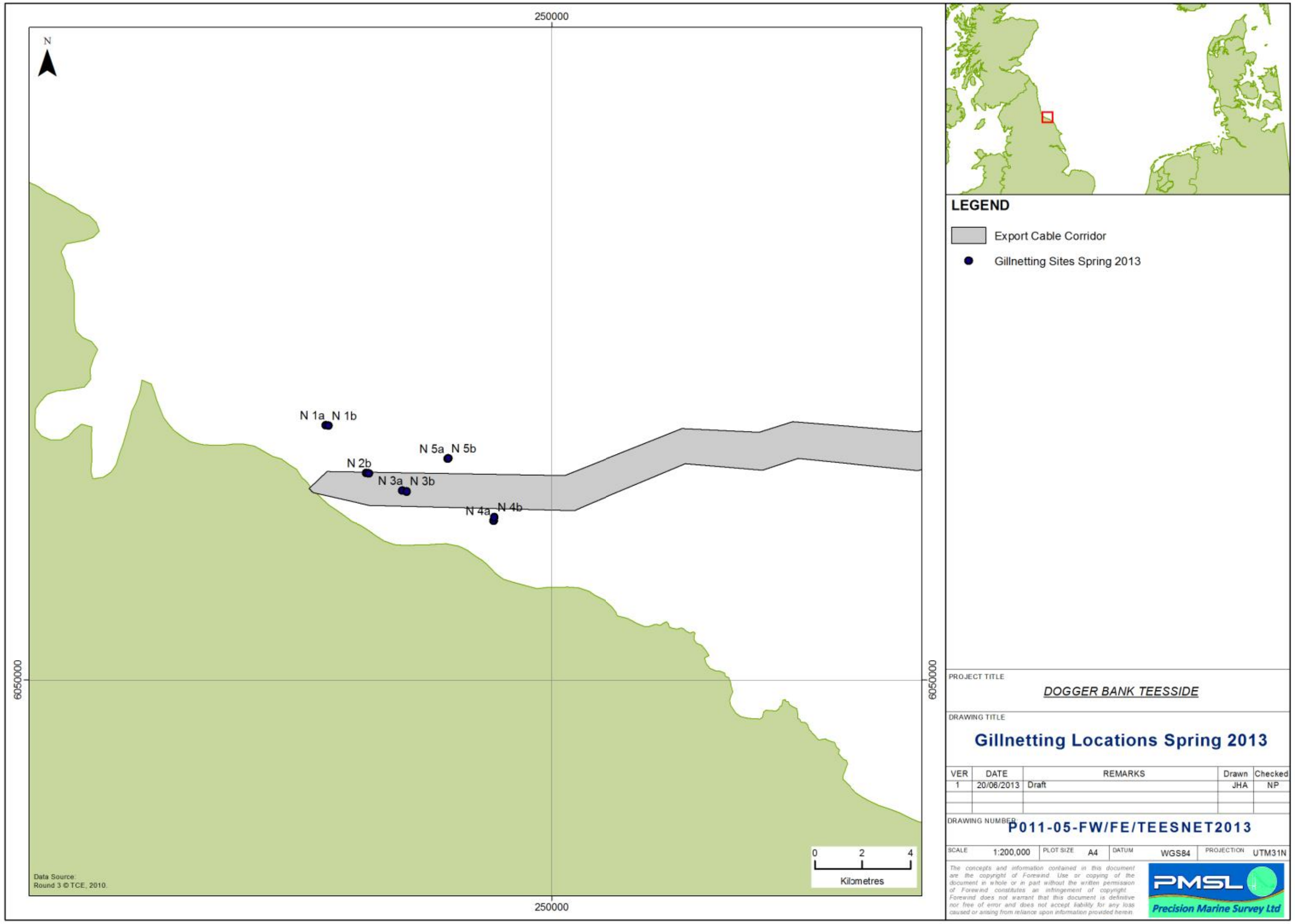


Figure 5.5 Location of April 2013 trammel netting stations

Table 5.9 Summary of inshore trammel survey results

Species		No. of individuals caught			
		September 2012		April 2013	
Common name	Scientific name	Cable Route	Inshore Area	Cable Route	Inshore Area
Edible crab	*Cancer pagurus*	298	17	145	109
Dab	*Limanda limanda*	26	21	90	40
Cod	*Gadus morhua*	3	5	3	31
LSD	*Scyliorhinus canicula*	1	2	10	31
Velvet crab	*Necora puber*	1	11	0	27
Lobster	*Homarus gammarus*	11	3	2	8
Whiting	*Merlangius merlangus*	7	3	6	3
Dover sole	*Solea solea*	6	2	2	3
Plaice	*Pleuronectes platessa*	2	2	2	4
Sea urchin	*Echinus esculentus*	0	0	0	10
Pouting	*Trisopterus luscus*	1	1	0	6
Pollack	*Pollachius pollachius*	0	0	0	6
Flounder	*Platichthys flesus*	0	0	2	2
Lumpsucker	*Cyclopterus lumpus*	0	0	3	0
Scorpion fish	*Taurulus bubalis*	0	0	1	2
Whelk	*Buccinum undatum*	0	0	0	3
Coalfish	*Pollachius virens*	0	0	0	2
Lemon sole	*Microstomus kitt*	1	0	0	1
Ling	*Molva molva*	0	0	0	2
Thornback ray	*Raja clavata*	1	0	1	0
Turbot	*Psetta maxima*	2	0	0	0
Brill	*Scophthalmus rhombus*	0	1	0	0
Hermit crab	*Pagurus bernhardus*	0	0	0	1
Herring	*Clupea harengus*	0	0	0	1
Mackerel	*Scomber scombrus*	1	0	0	0
Sandeel	*Ammodytes tobianus*	0	0	0	1
Spotted Ray	*Raja montagui*	0	0	0	1

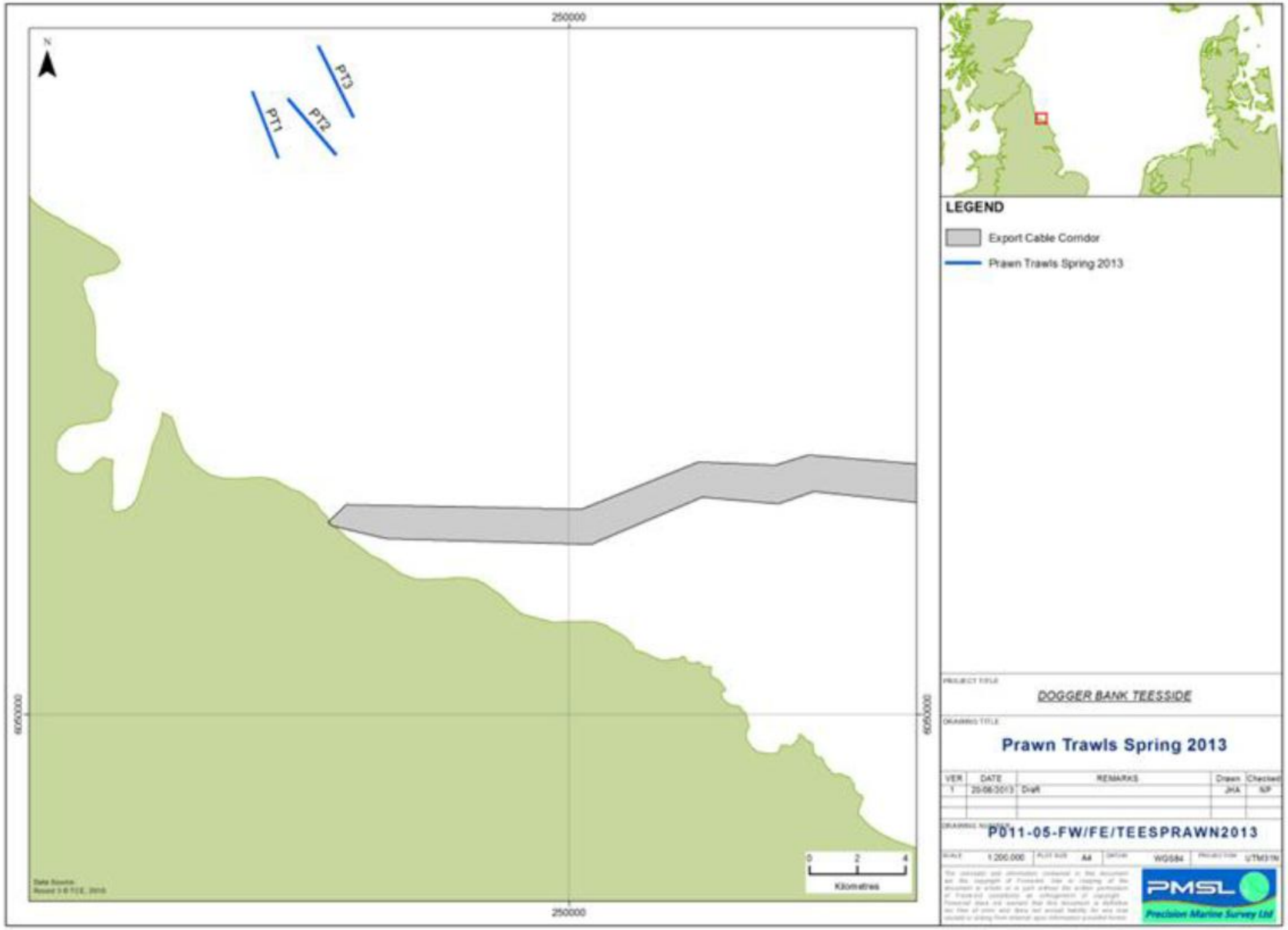


Figure 5.6 Location of April 2013 prawn trawl stations

Table 5.10 Summary of inshore prawn trawl survey results

Species		No. of individuals caught in the *Nephrops* Fishing Grounds	
Common name	Scientific name	September 2012	April 2013
Nephrops	*Nephrops norvegicus*	2394	1885
Whiting	*Merlangius merlangus*	665	349
Dover Sole	*Solea solea*	147	10
Cod	*Gadus morhua*	111	12
Dab	*Limanda limanda*	29	67
Long rough dab	*Hippoglossoides platessoides*	41	33
Dragonet	*Callionymus lyra*	33	35
Haddock	*Melanogrammus aeglefinus*	49	13
Plaice	*Pleuronectes platessa*	37	10
Pouting	*Trisopterus luscus*	24	18
Brown crab	*Cancer pagurus*	11	22
Grey Gurnard	*Eutrigla gurnardus*	22	11
Hake	*Merluccius merluccius*	33	0
Harbour crab	*Liocarcinus depurator*	11	21
Lemon Sole	*Microstomus kitt*	8	23
Tub Gurnard	*Trigla lucerna*	28	0
Livid swimming crab	*Liocarcinus holsatus*	7	18
Pogge	*Agonus cataphractus*	0	25
Red whelk	*Neptunea antiqua*	0	17
Cuckoo Ray	*Raja naevus*	2	11
Little cuttlefish	*Sepiola atlantica*	13	0
Flounder	*Platichthys flesus*	0	12
Herring	*Clupea harengus*	4	7
Starry Ray	*Raja radiata*	0	11
Turbot	*Psetta maxima*	11	0
Sea Scorpion	*Taurulus bubalis*	0	10
Five bearded rockling	*Ciliata mustelus*	5	4
Spotted Ray	*Raja montagui*	1	8
Whelks	*Buccinum undatum*	0	9
Squid	*Loligo vulgaris*	8	0
Brill	*Scophthalmus rhombus*	4	2
Hermit Crab	*Pagurus bernhardus*	0	6
Lesser Spotted Dogfish	*Scyliorhinus canicula*	1	3
Sea urchin	*Echinus esculentus*	0	4
Ling	*Molva molva*	2	1
Red Mullet	*Mullus surmuletus*	3	0
Angler fish	*Lophius piscatorius*	1	1

Species		No. of individuals caught in the *Nephrops* Fishing Grounds	
Common name	**Scientific name**	**September 2012**	**April 2013**
Edible clam	*Arctica islandica*	2	0
Thornback Ray	*Raja clavata*	0	2
Three bearded rockling	*Gaidropsarus vulgaris*	1	0
Angular crab	*Goneplax rhomboides*	1	0
Bass	*Dicentrarchus labrax*	1	0
John dory	*Zeus faber*	1	0
Lobster	*Homarus gammarus*	1	0
Mackerel	*Scomber scombrus*	1	0
Megrim	*Lepidorhombus whiffiagonis*	1	0
Mullet	*Mullus surmuletus*	1	0
Starry Smoothhound	*Mustela asterias*	0	1
Three Bearded Rockling	*Gaidropsarus vulgaris*	0	1

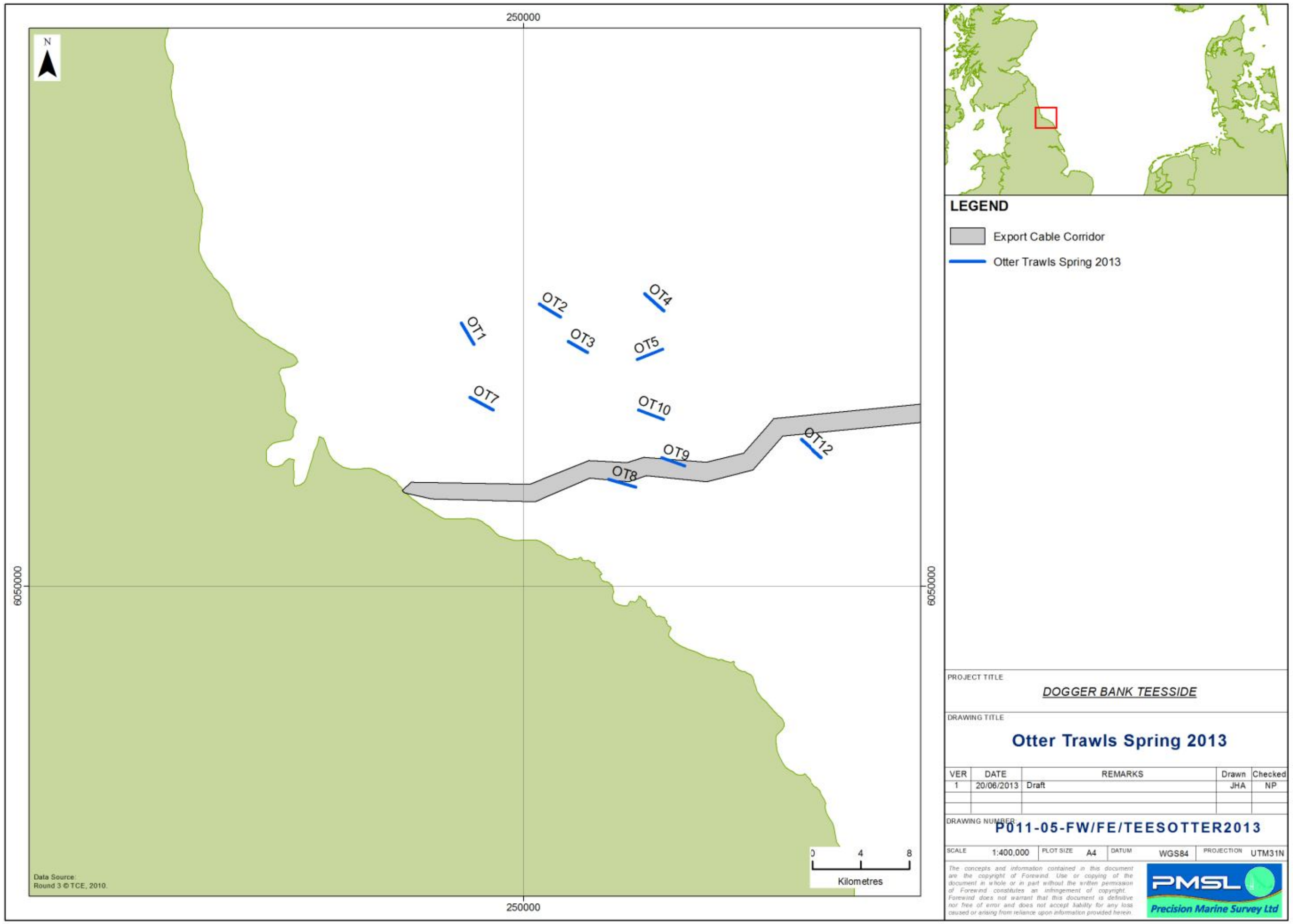


Figure 5.7 Location of April 2013 Otter Trawl tows

Table 5.11 Summary of inshore otter trawl survey results

Species		No. of individuals caught			
		September 2012		April 2013	
Common name	Scientific name	Cable Route	Inshore Area	Cable Route	Inshore Area
Whiting	*Merlangius merlangus*	0	201	15	795
Haddock	*Melanogrammus aeglefinus*	20	102	4	169
Dab	*Limanda limanda*	0	36	27	127
Plaice	*Pleuronectes platessa*	0	20	10	148
Grey Gurnard	*Eutrigla gurnardus*	0	9	5	125
Lemon sole	*Microstomus kitt*	2	64	16	57
Pouting	*Trisopterus luscus*	2	23	27	78
Cod	*Gadus morhua*	9	13	2	28
Prawn	*Nephrops norvegicus*	0	1	0	33
Long Rough Dab	*Hippoglossoides platessoides*	0	1	2	30
Mackerel	*Scomber scombrus*	1	26	0	1
Herring	*Clupea harengus*	1	8	2	15
Sea Urchin	*Echinus esculentus*	8	4	1	1
Queen Scallop	*Aequipecten opercularis*	0	6	0	0
Lesser spotted dogfish	*Scyliorhinus canicula*	0	0	0	4
Scad	*Trachurus trachurus*	1	3	0	0
Turbot	*Psetta maximus*	0	0	0	3
European squid	*Loligo vulgaris*	0	2	0	0
Hake	*Merluccius merluccius*	0	2	0	0
Brill	*Scophthalmus rhombus*	0	0	0	1
Cuckoo Ray	*Raja naevus*	0	1	0	0
Dover sole	*Solea solea*	0	0	0	1
Smoothhound	*Mustelus mustelus*	0	0	0	1
Squid	*Loligo vulgaris*	0	0	0	1
Alcyonium	*Alcyonium digitatum*	0	0	0	0

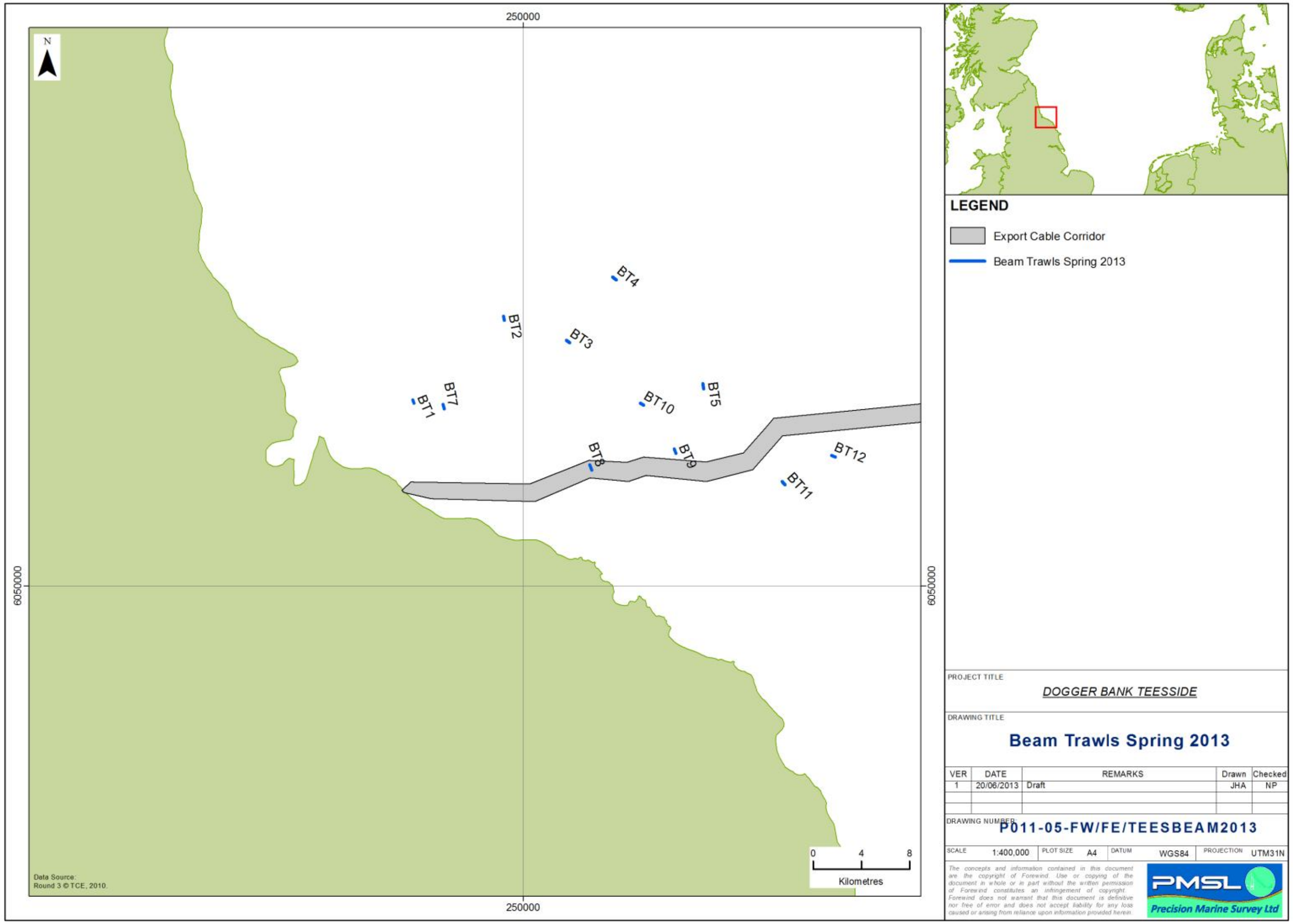


Figure 5.8 Location of April 2013 Beam Trawl tows

Table 5.12 Summary of Spring inshore beam trawl survey results

Species		Inshore										Cable Route
Common name	**Scientific name**	**BT 1**	**BT 2**	**BT 3**	**BT4**	**BT 5**	**BT 7**	**BT 9**	**BT 10**	**BT 11**	**BT 12**	**BT 8**
Krill	*Euphausiidae sp. Indet*	0	0	0	29	0	492	8	0	1	5	0
Pink Shrimp	*Pandalus montagui*	53	2	6	1	2	0	16	0	3	11	3
Sea Gooseberry	*Pleurobranchia pileus*	0	0	5	0	0	0	3	2	15	0	1
Brittle star	*Ophiothrix fragilis*	3	15	1	0	0	0	2	0	3	0	1
Sea urchin	*Echinus esculentus*	15	0	1	0	0	0	0	4	4	P	0
Hermit crab	*Pagurus prideaux*	15	3	0	0	0	0	2	0	2	0	1
Dab	*Limanda limanda*	0	0	6	1	4	0	2	2	2	1	4
Brittle star	*Ophiura albida*	17	0	0	0	1	0	0	0	1	0	3
Pouting	*Trisopterus luscus*	3	1	1	0	4	0	3	2	1	2	2
Whiting	*Merlangius merlangus*	0	0	2	3	3	3	0	1	3	2	1
Arrow worm	*Sagitta elegans*	0	6	0	0	0	9	0	0	0	0	1
Plaice	*Pleuronectes platessa*	0	0	3	3	1	0	1	1	1	1	3
Amphipod	*Abludomelita gladiosa*	0	10	3	0	0	0	0	0	0	0	1
Polychaete worm	*Spirorbidae sp. Indet*	0	3	1	3	0	0	4	0	1	0	0
Lemon sole	*Microstomus kitt*	0	0	2	1	1	0	2	1	1	1	2
Long Rough dab	*Hippoglossoides platessoides*	0	0	3	0	1	0	1	1	1	2	2
Hermit crab	*Pagurus bernhardus*	0	3	1	0	1	0	0	0	1	5	0
Brittle star	*Amphipholis squamata*	0	3	0	1	1	0	5	0	0	0	1
Polychaete worm	*Syllis armilliaris*	0	8	0	1	0	0	0	0	0	0	0
Grey gurnard	*Eutrigla gurnardus*	0	0	2	0	1	0	2	1	0	1	1
Shrimp	*Philocheras sp. Indet*	0	6	0	1	0	0	1	0	0	0	0
Star fish	*Asterias rubens*	0	2	0	0	0	1	1	1	0	1	2
Skeleton shrimp	*Pariambus typicus*	0	0	1	2	0	1	0	0	0	0	2
Shore sea urchin	*Psammechinus miliaris*	1	1	0	0	0	0	1	0	1	0	2

Species		Inshore										Cable Route
Common name	Scientific name	BT 1	BT 2	BT 3	BT4	BT 5	BT 7	BT 9	BT 10	BT 11	BT 12	BT 8
Polychaete worm	*Polychaetae spp. indet*	0	0	1	2	0	0	2	0	0	0	0
Amphipod	*Abludomelita obstusata*	0	5	0	0	0	0	0	0	0	0	0
Squat lobster	*Galathea strigosa*	4	0	1	0	0	0	0	0	0	0	0
Spider carb	*Macropodia linaresi*	0	3	0	0	0	0	1	0	0	0	1
Netted dog whelk	*Hinia reticulata*	0	1	0	0	0	0	1	0	0	1	2
Whelk	*Buccinum undatum*	0	0	0	0	0	0	0	0	0	5	0
Painted goby	*Pomatoschistus pictus*	0	0	0	1	0	1	2	0	0	0	0
Nemertean	*Nemertea sp. Indet*	0	1	0	0	0	3	0	0	0	0	0
Mysid shrimp	*Mysidae sp. Indet*	2	0	0	1	0	0	0	0	1	0	0
Livid swimming crab	*Liocarcinus holsatus*	1	0	2	0	0	0	0	0	0	1	0
Polychaete worm	*Harmothoe impar*	2	0	1	0	0	0	0	0	0	0	0
Polychaete worm	*Lepidonotus squamatus*	1	0	1	0	1	0	0	0	0	0	0
Polychaete worm	*Serpulidae sp. Indet*	0	2	0	1	0	0	0	0	0	0	0
Mysid shrimp	*Schistomysis kervillei*	3	0	0	0	0	0	0	0	0	0	0
Shrimp	*Philocheras bispinosus*	1	1	0	0	0	0	0	0	1	0	0
Nephrops	*Nephrops norvegicus*	0	0	0	0	0	0	0	0	0	3	0
Spider carb	*Macropodia sp. Indet*	0	1	0	0	0	0	0	0	0	0	2
Brown Crab	*Cancer pagurus*	0	0	0	0	0	0	0	0	0	3	0
Haddock	*Melanogrammus aeglefinus*	0	0	1	1	0	0	0	0	0	0	0
Sprat	*Sprattus sprattus*	0	0	1	0	0	1	0	0	0	0	0
Polychaete worm	*Harmothoe Juv sp. Indet*	2	0	0	0	0	0	0	0	0	0	0
Harbour crab	*Liocarcinus depurator*	0	0	1	0	0	0	0	0	0	0	1
Velvet crab	*Necora puber*	0	0	1	0	0	0	0	0	1	0	0
Cod	*Gadus morhua*	1	0	0	0	0	0	0	0	0	0	0
Norway pout	*Trisopterus esmarkii*	1	0	0	0	0	0	0	0	0	0	0
Polychaete worm	*Lepidathenia argus*	1	0	0	0	0	0	0	0	0	0	0

Species		Inshore										Cable Route
Common name	**Scientific name**	**BT 1**	**BT 2**	**BT 3**	**BT4**	**BT 5**	**BT 7**	**BT 9**	**BT 10**	**BT 11**	**BT 12**	**BT 8**
Isopod	*Gnathia dentata*	0	1	0	0	0	0	0	0	0	0	0
Shrimp	*Caridion gordoni*	1	0	0	0	0	0	0	0	0	0	0
Shrimp	*Thoralus cranchii*	1	0	0	0	0	0	0	0	0	0	0
Squat lobster	*Galathea intermedia*	0	0	1	0	0	0	0	0	0	0	0
Bivalve sp.	*Nucula hanleyi*	1	0	0	0	0	0	0	0	0	0	0
Queen scallop	*Aequipecten opercularis*	1	0	0	0	0	0	0	0	0	0	0
Green sea urchin	*Strongylocentrus droebochiensis*	1	0	0	0	0	0	0	0	0	0	0
Dead mans finger	*Alcynonium digitatum*	0	0	P	0	0	0	P	0	P	P	0
Cnidarian	*Hydrozoa sp. Indet*	0	0	P	P	0	0	P	0	0	P	P
Cnidarian	*Lafoea dumosa*	0	P	0	0	0	0	0	0	0	0	0
Cnidarian	*Halecium halecinum*	0	P	P	P	P	0	0	0	P	0	0
Cnidarian	*Abietinaria abietina*	0	P	P	P	0	0	P	0	0	P	0
Cnidarian	*Sertularella tenella*	0	P	0	P	P	0	P	0	0	P	0
Bryozoan sp.	*Bryozoa spp. indet*	0	0	P	P	P	0	P	0	P	0	P
Bryozoan sp.	*Vesicularia spinosa*	0	P	P	P	0	0	0	0	0	0	P
Bryozoan sp.	*Eucratea loricata*	0	P	0	0	0	0	0	0	0	0	0
Horn wrack	*Flustra foliacea*	0	P	P	0	0	0	P	0	P	P	P
Bryozoan sp.	*Securiflustra securifrons*	0	P	0	0	0	0	0	0	P	0	0
Bryozoan sp.	*Notoplites jeffreysii*	0	P	0	0	0	0	0	0	0	0	0
Bryozoan sp.	*Celleporina hassallii*	0	P	0	0	0	0	0	0	0	0	0
Foraminifera	*Astrorhiza sp. Indet*	0	P	0	0	0	0	0	0	0	0	0

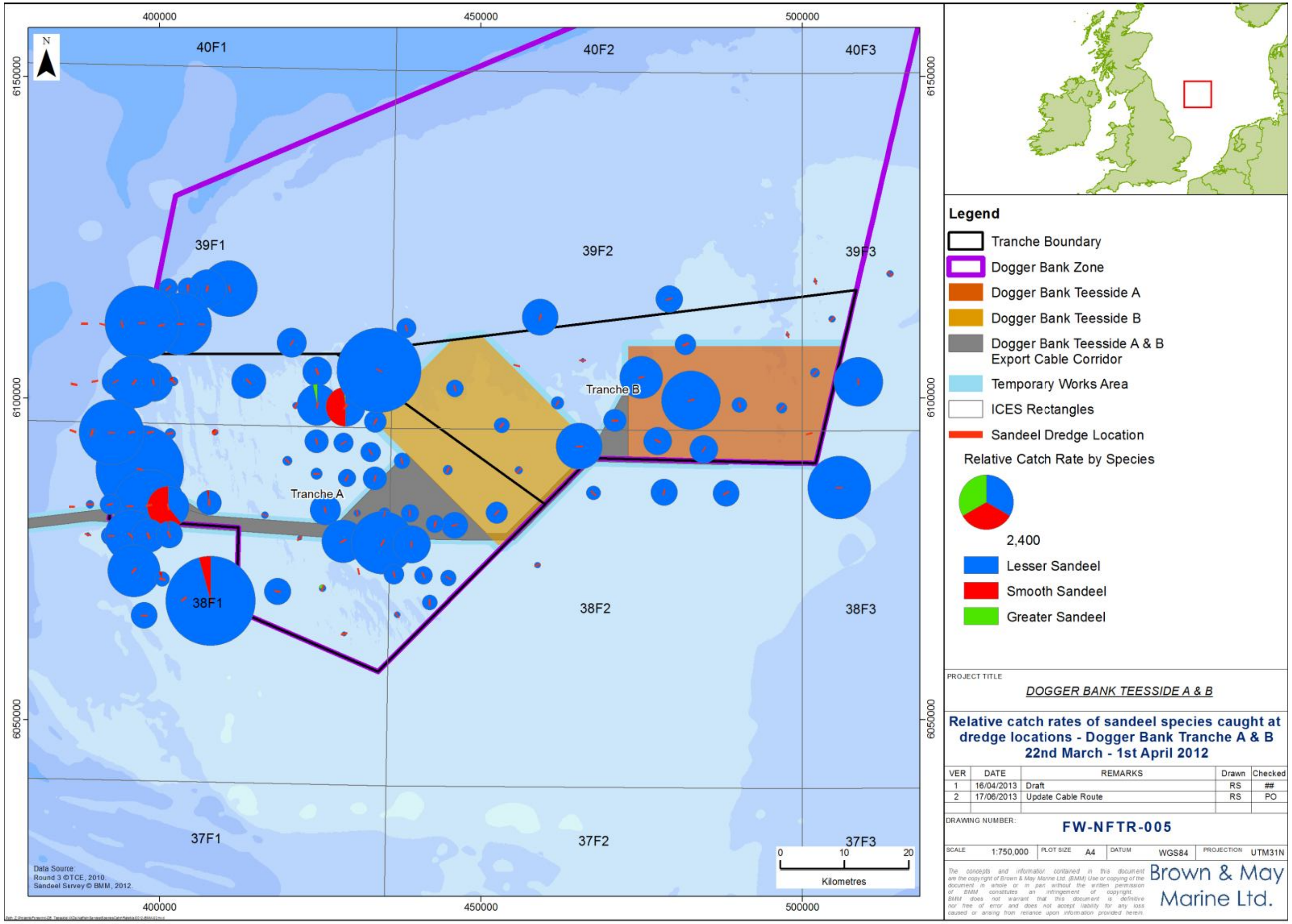


Figure 5.9 Relative abundance of sandeel by station and species (individuals caught per hour) in tranches A and B

5.4 Landings Data-Commercial Fish and Shellfish Species

67. An indication of the principal commercial fish and shellfish species in the Wind Farm and Export Cable Corridor Study Areas, based on landings by weight (tonnes) and value (£), is given below. The charts and tables have been derived from the MMO landings data for the period 2008-2012 (provided by MMO 2013). Only landings from UK vessels (irrespective of port of landing) have been included in the charts and tables provided in this section.

68. It should be noted that the landings data shown below are aimed at identifying the principal commercial fish and shellfish species in the area of Dogger Bank Teesside A & B and along the Dogger Bank Teesside A & B Export Cable Corridor, rather than providing an accurate assessment of the relative commercial importance or degree of exploitation. It is also recognised that significant non-UK fishing activity takes place in the Dogger Bank area and, therefore, the landings weights and values given below will underestimate the overall importance of some species. Information provided in *Chapter 15: Commercial Fisheries*, particularly in relation to non-UK fishing activity, has been cross-referenced to further inform this section.

5.4.1 Wind Farm Study Area

69. An indication of the principal species landed from the Wind Farm Study Area by weight and value is presented in **Figure 5.10** and **Figure 5.11**. These show annual average (2008-2012) landings weight (tonnes) and value (£) by species and ICES rectangle as derived from MMO landings data (MMO 2013).

70. In addition, the percentage contribution of each rectangle to the total landings from the Wind Farm Study Area is given in **Table 5.13** and **Table 5.14** for the top 20 species landed by weight and value, respectively.

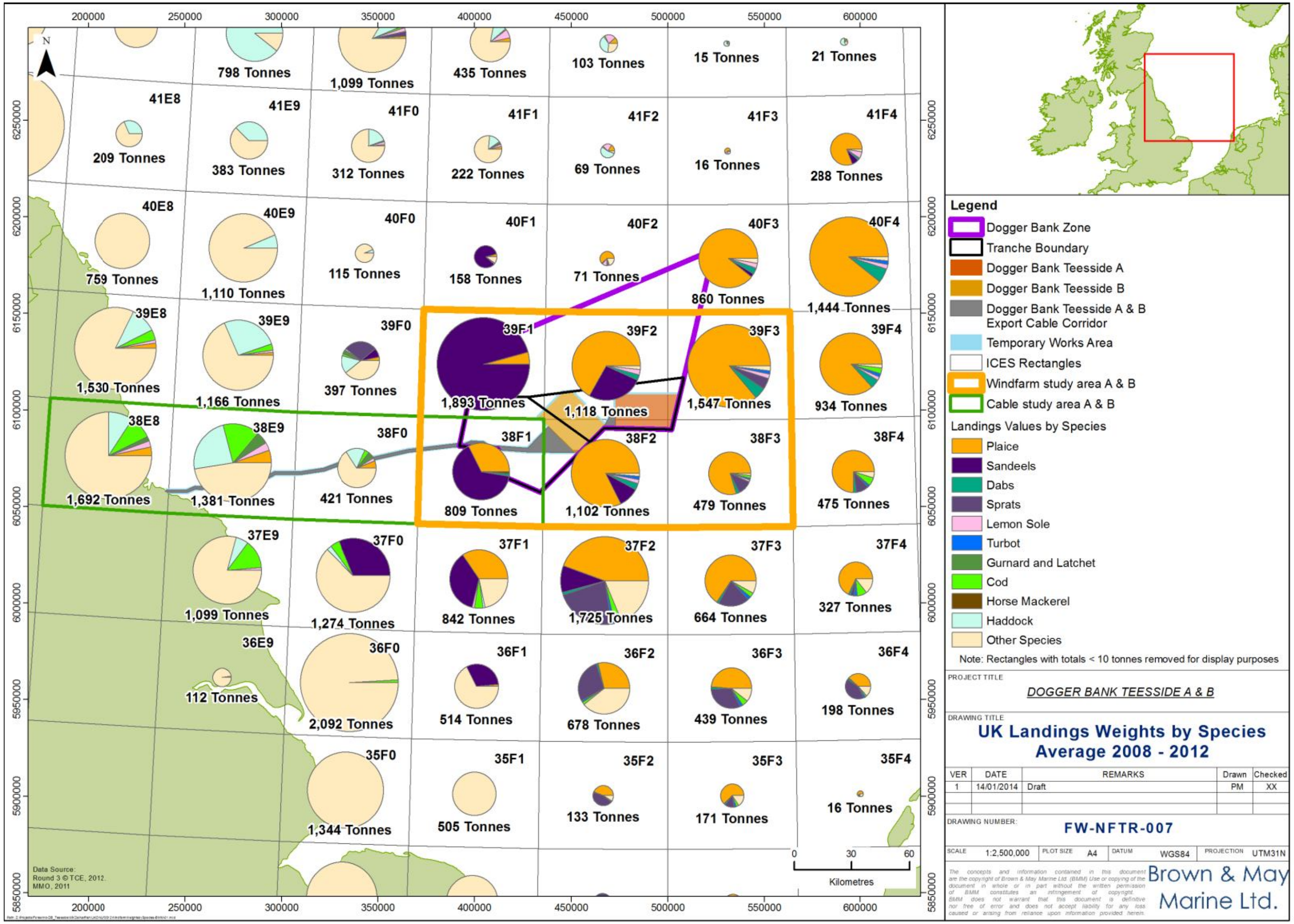


Figure 5.10 Percentage distribution of landings weights (tonnes) by species in the Wind Farm Study Area (average 2008-2012) (MMO 2013)

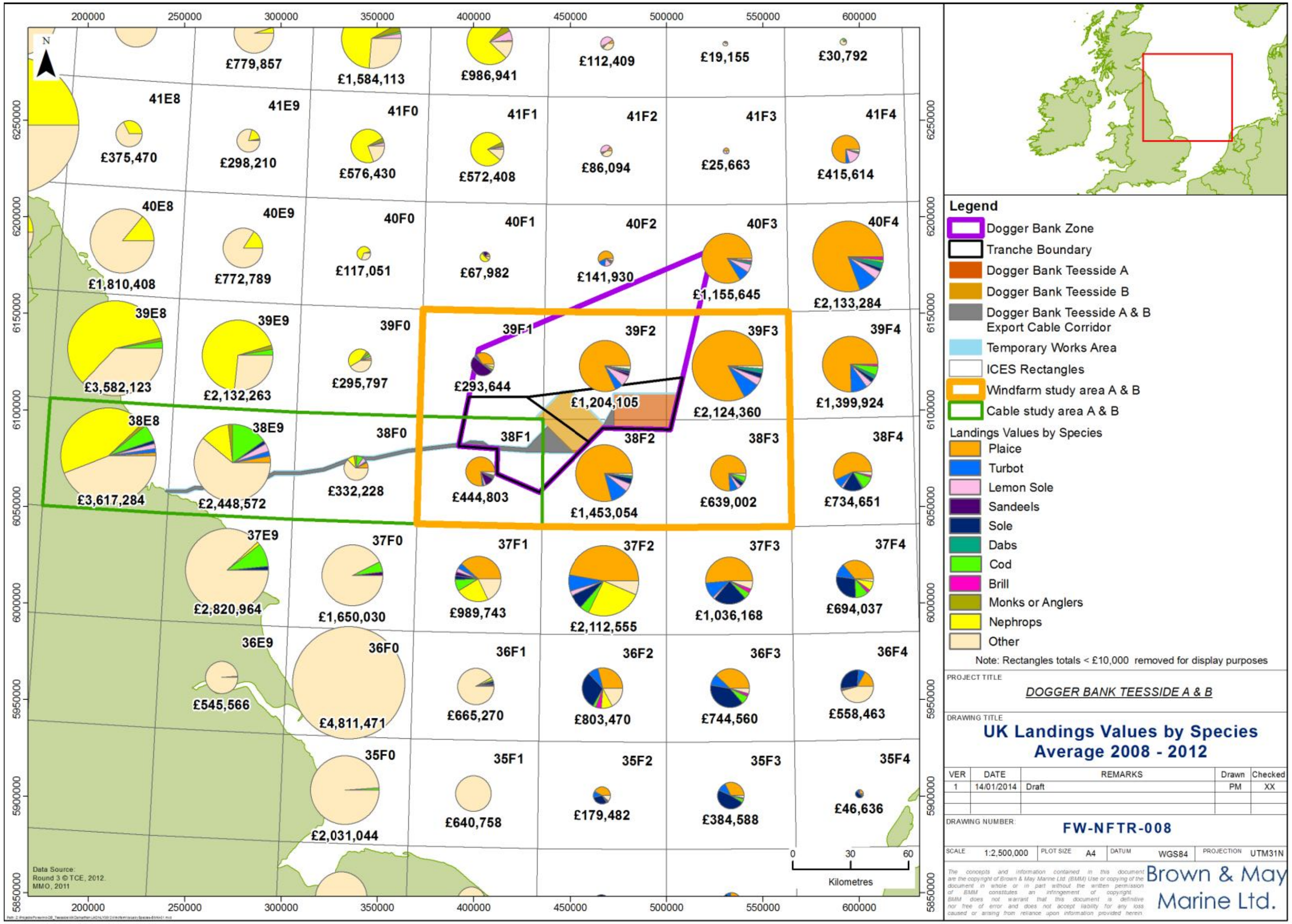


Figure 5.11 Percentage distribution of landings values (£) by species in the Wind Farm Study Area (average 2008-2012) (MMO 2011)

Table 5.13 Percentage contribution of each ICES Rectangle in the Wind Farm Study Area to the Total Average Annual Landings by weight (Tonnes) (2008-2012) (MMO 2013)

Species	Average Annual Landings (tonnes) in the Wind Farm Study Area	38F1		38F2		38F3		39F1		39F2		39F3	
		Average Annual Landings (tonnes)	Percentage of total landings in the Wind Farm study area from this rectangle	Average Annual Landings (tonnes)	Percentage of total landings in the Wind Farm study area from this rectangle	Average Annual Landings (tonnes)	Percentage of total landings in the Wind Farm study area from this rectangle	Average Annual Landings (tonnes)	Percentage of total landings in the Wind Farm study area from this rectangle	Average Annual Landings (tonnes)	Percentage of total landings in the Wind Farm study area from this rectangle	Average Annual Landings (tonnes)	Percentage of total landings in the Wind Farm study area from this rectangle
Plaice	3648.4	255.8	7.0%	896.9	24.6%	379.5	10.4%	79.1	2.2%	731.9	20.1%	1305.2	35.8%
Sandeels	2706.2	511.9	18.9%	104.8	3.9%	0.0	0.0%	1786.0	66.0%	289.5	10.7%	14.0	0.5%
Dab	161.5	10.7	6.6%	32.6	20.2%	13.9	8.6%	8.0	4.9%	27.7	17.1%	68.6	42.5%
Sprat	116.2	0.0	0.0%	0.0	0.0%	50.5	43.5%	0.0	0.0%	0.0	0.0%	65.7	56.5%
Lemon Sole	92.0	4.2	4.6%	21.6	23.5%	7.8	8.5%	1.8	2.0%	28.9	31.4%	27.7	30.1%
Turbot	52.9	1.2	2.2%	17.5	33.0%	6.1	11.6%	1.3	2.5%	6.3	11.9%	20.5	38.8%
Gurnard and Latchet	30.5	2.0	6.6%	10.2	33.5%	2.3	7.5%	1.2	4.1%	4.5	14.9%	10.2	33.5%
Cod	27.6	2.7	9.8%	3.1	11.1%	11.4	41.3%	1.3	4.8%	2.1	7.5%	7.0	25.4%
Horse Mackerel*Nephrops*	16.4	9.2	55.9%	0.0	0.0%	0.0	0.0%	0.0	0.0%	7.2	44.0%	0.0	0.0%
Haddock	15.1	5.2	34.7%	0.4	2.5%	0.0	0.3%	7.6	50.7%	1.7	11.0%	0.1	0.8%
Whelk	14.2	0.1	0.9%	0.5	3.5%	0.9	6.2%	0.1	0.8%	4.6	32.7%	7.9	55.8%
Edible Crab	14.1	0.7	4.7%	2.4	17.1%	0.7	4.9%	0.9	6.3%	6.6	46.4%	2.9	20.6%
Sole	12.3	0.2	1.6%	4.2	34.4%	2.2	18.2%	0.1	0.7%	1.2	10.1%	4.3	34.9%
Monks or Anglers	6.9	0.6	9.0%	0.6	8.2%	0.4	6.3%	0.4	6.3%	2.1	30.3%	2.7	39.9%
Nephrops	6.0	2.0	32.7%	0.6	10.6%	0.1	1.2%	3.3	54.6%	0.1	0.9%	0.0	0.1%
Brill	4.3	0.2	3.8%	0.7	15.3%	0.5	11.0%	0.0	1.2%	0.9	22.0%	2.0	46.8%
Gurnards - Grey	4.2	0.1	1.5%	1.4	34.2%	0.2	5.0%	0.0	0.7%	0.6	15.5%	1.8	43.2%
Herring	3.5	0.0	0.0%	0.0	0.0%	0.6	16.6%	0.0	0.0%	0.0	0.0%	2.9	83.4%
Hake	3.1	0.3	9.8%	0.5	16.2%	0.4	11.9%	0.1	4.4%	0.6	20.7%	1.2	37.0%
Other Species	12.3	2.0	16.6%	4.0	32.3%	1.2	10.0%	1.5	12.2%	1.4	11.1%	2.2	17.7%

Table 5.14 Percentage contribution of each ICES Rectangle in the Wind Farm Study Area to the Total Average Annual Landings by Value (£) (2008-2012) (MMO 2013)

Species	Average annual value (£) in the Wind Farm Study Area	38F1		38F2		38F3		39F1		39F2		39F3	
		Average annual value (£)	Percentage of total value in the Wind Farm study area from this rectangle	Average annual value (£)	Percentage of total value in the Wind Farm study area from this rectangle	Average annual value (£)	Percentage of total value in the Wind Farm study area from this rectangle	Average annual value (£)	Percentage of total value in the Wind Farm study area from this rectangle	Average annual value (£)	Percentage of total value in the Wind Farm study area from this rectangle	Average annual value (£)	Percentage of total value in the Wind Farm study area from this rectangle
Plaice	£4,759,862	£338,704	7.1%	£1,135,489	23.9%	£483,802	10.2%	£99,807	2.1%	£971,482	20.4%	£1,730,579	36.4%
Turbot	£428,146	£8,816	2.1%	£140,325	32.8%	£48,053	11.2%	£8,778	2.1%	£55,912	13.1%	£166,261	38.8%
Lemon Sole	£265,239	£11,147	4.2%	£67,410	25.4%	£23,189	8.7%	£4,751	1.8%	£83,059	31.3%	£75,684	28.5%
Sandeels	£223,271	£45,563	20.4%	£8,676	3.9%	£0	0.0%	£146,537	65.6%	£21,235	9.5%	£1,260	0.6%
Sole	£139,675	£1,436	1.0%	£49,583	35.5%	£23,222	16.6%	£956	0.7%	£16,364	11.7%	£48,114	34.4%
Dab	£100,629	£7,294	7.2%	£19,594	19.5%	£8,292	8.2%	£5,700	5.7%	£17,227	17.1%	£42,523	42.3%
Cod	£66,152	£4,755	7.2%	£6,322	9.6%	£31,287	47.3%	£3,143	4.8%	£4,096	6.2%	£16,549	25.0%
Brill*Nephrops*	£23,819	£829	3.5%	£3,744	15.7%	£2,651	11.1%	£257	1.1%	£5,506	23.1%	£10,831	45.5%
Monks or Anglers	£19,312	£1,671	8.7%	£1,722	8.9%	£1,308	6.8%	£1,208	6.3%	£6,001	31.1%	£7,401	38.3%
Nephrops	£18,252	£4,995	27.4%	£1,597	8.7%	£277	1.5%	£11,166	61.2%	£206	1.1%	£11	0.1%
Sprat	£17,386	£0	0.0%	£0	0.0%	£10,942	62.9%	£0	0.0%	£0	0.0%	£6,444	37.1%
Haddock	£15,143	£6,082	40.2%	£243	1.6%	£73	0.5%	£7,490	49.5%	£1,142	7.5%	£112	0.7%
Horse Mackerel	£13,942	£7,798	55.9%	£1	0.0%	£1	0.0%	£0	0.0%	£6,142	44.1%	£1	0.0%
Edible Crab	£13,136	£411	3.1%	£2,416	18.4%	£683	5.2%	£579	4.4%	£6,503	49.5%	£2,545	19.4%
Gurnard and Latchet	£12,869	£814	6.3%	£4,255	33.1%	£937	7.3%	£480	3.7%	£2,124	16.5%	£4,258	33.1%
Squid	£8,203	£360	4.4%	£3,261	39.8%	£875	10.7%	£427	5.2%	£1,631	19.9%	£1,648	20.1%
Whelk	£6,336	£58	0.9%	£221	3.5%	£393	6.2%	£57	0.9%	£2,074	32.7%	£3,532	55.7%
Hake	£4,464	£454	10.2%	£846	18.9%	£518	11.6%	£185	4.1%	£795	17.8%	£1,666	37.3%
Red Mullet	£2,734	£725	26.5%	£990	36.2%	£197	7.2%	£202	7.4%	£413	15.1%	£207	7.6%
Other Species	£20,399	£2,888	14.2%	£6,360	31.2%	£2,301	11.3%	£1,921	9.4%	£2,194	10.8%	£4,736	23.2%

71. As shown in **Figure 5.10** and **Figure 5.11,** plaice *Pleuronectes platessa* caught in the Wind farm study area is ranked highest in terms of both landed weight and value. Landings by weight of sandeels (i.e. North Sea genera of the family Ammodytidae including *Ammodytes marinus* Raitt, *Ammodytes tobianus*, *Gymnammodytes semisquamatus, Hyperlopus lanceolatus* and *Hyperoplus immaculatus)* and dab *Limanda limanda* are ranked second and third respectively. Turbot *Psetta maxima* and lemon sole *Microstomus kitt* are amongst the principal species landed by value. The highest landings are recorded in ICES rectangle 39F3 (**Table 5.13** and **Table 5.14** along the eastern boundary of tranche B.

72. In addition, other species, including sprat, haddock, cod, gurnard, sole, horse mackerel, brill *Scophthalmus rhombus*, monkfish *Lophius spp.,* herring and hake *Merluccius merluccius* are of commercial importance in the Wind Farm Study Area. These species are among the top 20 species landed by weight and value (**Table 5.13** and **Table 5.14**).

73. Landings of elasmobranch and shellfish are comparatively low. In the Wind Farm Study Area spurdog *Squalus acanthias* was the most abundant elasmobranch landed. Shellfish landings were dominated by Edible crab, *Cancer pagurus*, *Nephrops norvegicus* and whelk *Buccinum undatum*.

5.4.2 Dogger Bank Teesside A & B Export Cable Study Area

74. An indication of the principal species landed from the Export Cable Study Area in terms of weight (tonnes) and value (£) by ICES rectangles is given in **Figure 5.12.**

75. In general terms, *Nephrops,* whiting *Nephrops* and haddock are the three main species landed by weight from the Export Cable Study Area. However, catch composition varies considerably between ICES rectangles. For example, *Nephrops* dominates inshore landings in ICES rectangle 38E8, herring accounts for a relatively high percentage of the landings by weight in ICES rectangle 38F0 while landings of plaice dominate catches from ICES rectangle 38F1. Landings by weight for cod and sprat caught in rectangles 38E9 and 39F0 are also comparatively high (**Table 5.15**).

76. The most valuable species caught in the Export Cable Study Area are *Nephrops* and lobster (**Table 5.16**). Cod, haddock, plaice and whiting are also ranked highly as commercially valuable fish species. Whiting is also targeted in this area by French registered vessels (**Appendix 15A: Commercial Fisheries Technical Report**).

5.5 Species with Defined Spawning and Nursery Grounds

77. A number of fish species have defined spawning and nursery grounds within and in the vicinity of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. These are listed in **Table 5.17,** based on information provided in Ellis *et al.et al.,* (2010) and Coull *et al.et al.* 1998.

78. In addition to the species listed below, other fish and shellfish species may spawn or use Dogger Bank Teesside A & B and/or the Dogger Bank Teesside A & B Export Cable Corridor as a nursery ground. The ecology of the principal fish and shellfish species identified in the Wind Farm and Export Cable Study Areas, including spawning, is described in further detail in Section 6.0.

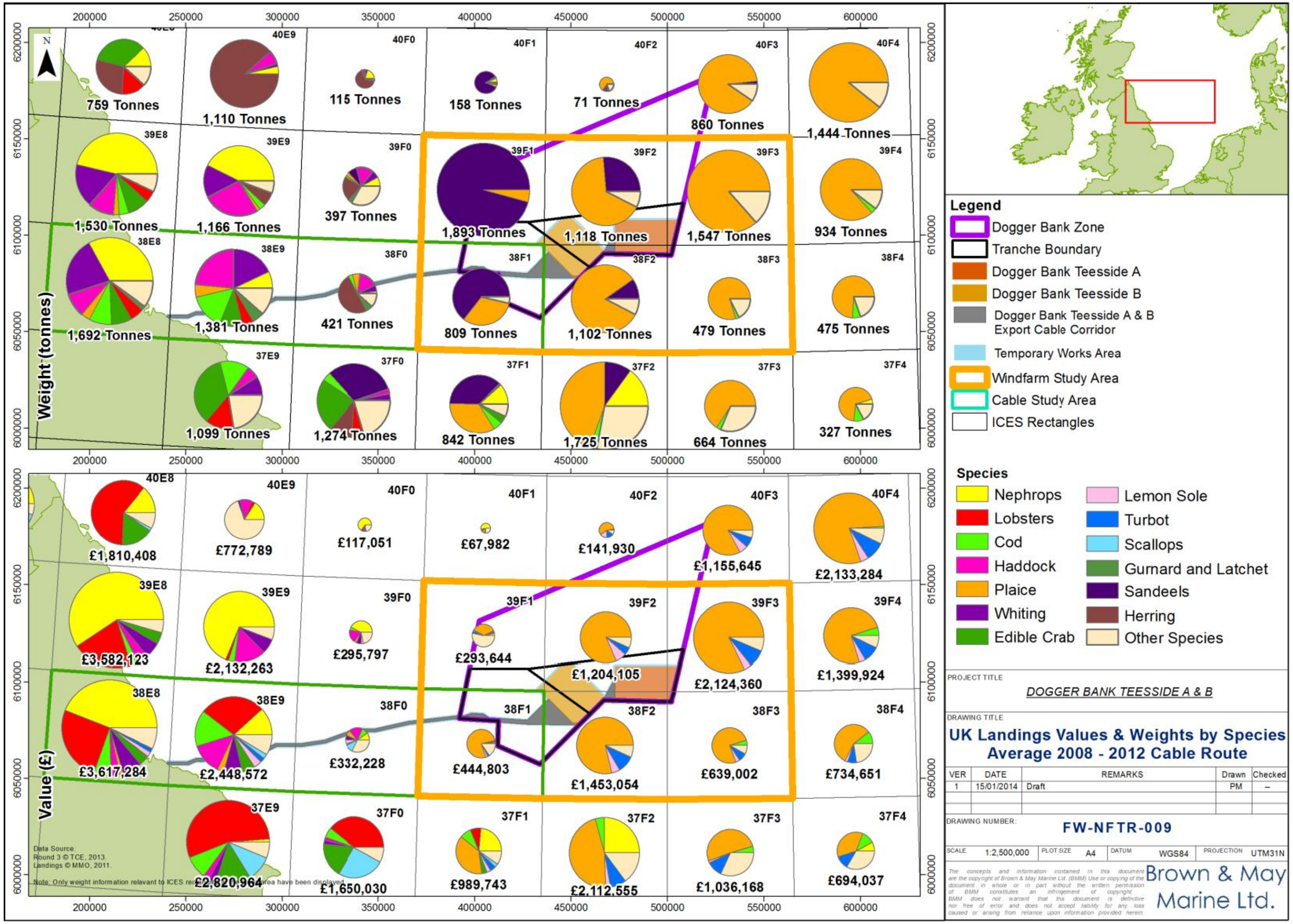


Figure 5.12 Percentage distribution of landings weights (Tonnes) and values (£) by species in the Export Cable Study Area (average 2006- 2010) (MMO 2011)

Table 5.15 Percentage contribution of each ICES Rectangle in the Export Cable Study Area to the Total Average Annual Landings by weight (Tonnes) (2008-2012) (MMO 2011)

Species	Average Annual Landings (Tonnes) in the Cable Study Area	38E8		38E9		38F0		38F1	
		Average Annual Landings (tonnes)	Percentage of total landings in the Cable Route study area from this rectangle	Average Annual Landings (tonnes)	Percentage of total landings in the Cable Route study area from this rectangle	Average Annual Landings (tonnes)	Percentage of total landings in the Cable Route study area from this rectangle	Average Annual Landings (tonnes)	Percentage of total landings in the Cable Route study area from this rectangle
Nephrops	665.8	558.2	83.8%	97.2	14.6%	8.4	1.3%	2.0	0.3%
Whiting	641.8	370.1	57.7%	249.6	38.9%	21.1	3.3%	1.0	0.2%
Haddock	547.7	153.2	28.0%	322.5	58.9%	66.8	12.2%	5.2	1.0%
Sandeels	511.9	0.0	0.0%	0.0	0.0%	0.0	0.0%	511.9	100.0%
Plaice	407.5	53.9	13.2%	72.7	17.8%	25.1	6.2%	255.8	62.8%
Cod	370.2	142.7	38.5%	209.2	56.5%	15.6	4.2%	2.7	0.7%
Edible Crab	264.2	128.4	48.6%	134.8	51.0%	0.4	0.1%	0.7	0.3%
Herring	211.9	0.9	0.4%	0.5	0.2%	210.6	99.4%	0.0	0.0%
Lobster	153.7	88.8	57.8%	64.8	42.2%	0.0	0.0%	0.0	0.0%
Gurnard and Latchet	122.8	27.6	22.5%	69.7	56.7%	23.6	19.2%	2.0	1.6%
Lemon Sole	101.9	39.5	38.8%	46.1	45.3%	12.1	11.8%	4.2	4.1%
Scallops	58.0	9.3	16.0%	27.5	47.5%	21.2	36.5%	0.0	0.0%
Monks or Anglers	42.9	19.7	46.0%	17.2	40.2%	5.3	12.4%	0.6	1.4%
Squid	27.9	19.0	68.1%	8.4	30.0%	0.4	1.6%	0.1	0.3%
Turbot	19.0	9.1	47.8%	8.0	42.1%	0.7	3.9%	1.2	6.2%
Dab	18.7	2.5	13.3%	3.3	17.6%	2.2	11.6%	10.7	57.5%
Velvet Crab	17.1	14.2	83.4%	2.8	16.6%	0.0	0.0%	0.0	0.0%
Sole	16.2	9.6	59.0%	6.3	38.9%	0.1	0.9%	0.2	1.2%
Thornback Ray	11.0	2.1	19.1%	8.3	75.2%	0.5	4.3%	0.2	1.4%
Other Species	92.3	43.3	46.9%	32.0	34.6%	6.5	7.0%	10.6	11.5%

Table 5.16 Percentage contribution of each ICES Rectangle in Export Cable Study Area to the Total Average Annual Landings by Value (£) (2008-2012) (MMO 2011)

Species	Average annual value of landings (£) in the Export Cable Study Area	38E8		38E9		38F0		38F1	
		Average annual value (£)	Percentage of total value of landings in the Export Cable Study Area from this rectangle	Average annual value (£)	Percentage of total value of landings in the Export Cable Study Area from this rectangle	Average annual value (£)	Percentage of total value of landings in the Export Cable Study Area from this rectangle	Average annual value (£)	Percentage of total value of landings in the Export Cable Study Area from this rectangle
Nephrops	£1,907,086	£1,578,469	82.8%	£291,747	15.3%	£31,875	1.7%	£4,995	0.3%
Lobster	£1,596,551	£921,830	57.7%	£674,114	42.2%	£549	0.0%	£58	0.0%
Cod	£611,631	£204,493	33.4%	£374,349	61.2%	£28,034	4.6%	£4,755	0.8%
Haddock	£499,385	£111,676	22.4%	£323,262	64.7%	£58,364	11.7%	£6,082	1.2%
Plaice	£474,186	£39,585	8.3%	£70,404	14.8%	£25,493	5.4%	£338,704	71.4%
Whiting	£443,596	£231,850	52.3%	£191,304	43.1%	£19,380	4.4%	£1,062	0.2%
Edible Crab	£275,743	£138,712	50.3%	£136,200	49.4%	£420	0.2%	£411	0.1%
Lemon Sole	£170,575	£57,406	33.7%	£81,596	47.8%	£20,425	12.0%	£11,147	6.5%
Turbot	£111,632	£48,256	43.2%	£49,394	44.2%	£5,166	4.6%	£8,816	7.9%
Scallops	£110,439	£27,006	24.5%	£47,413	42.9%	£35,976	32.6%	£44	0.0%
Monks or Anglers	£102,059	£43,529	42.7%	£43,943	43.1%	£12,916	12.7%	£1,671	1.6%
Sole	£78,817	£41,455	52.6%	£34,475	43.7%	£1,451	1.8%	£1,436	1.8%
Squid	£73,316	£49,148	67.0%	£22,534	30.7%	£1,274	1.7%	£360	0.5%
Herring	£67,341	£733	1.1%	£288	0.4%	£66,320	98.5%	£0	0.0%
Halibut	£58,520	£21,707	37.1%	£25,674	43.9%	£10,587	18.1%	£552	0.9%
Sandeels	£45,563	£0	0.0%	£0	0.0%	£0	0.0%	£45,563	100.0%
Gurnard and Latchet	£33,832	£7,547	22.3%	£18,122	53.6%	£7,348	21.7%	£814	2.4%
Brill	£28,605	£12,827	44.8%	£13,718	48.0%	£1,230	4.3%	£829	2.9%
Salmon	£19,200	£19,100	99.5%	£99	0.5%	£0	0.0%	£0	0.0%
Other Species	£134,811	£61,953	46.0%	£49,935	37.0%	£5,421	4.0%	£17,502	13.0%

Table 5.17 Species with defined spawning and nursery grounds within or in the vicinity of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor (based on Coull *et al.et al.* 1998 and Ellis *et al.et al.* 2010)

Species	Spawning Grounds			Spawning Season												Nursery Grounds		
	Project A	Project B	Export Cable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Project A	Project B	Export Cable
Herring -Banks stock	*	*										●	●					
Cod					●	●												
Plaice				●	●											*	*	
Whiting																		
Sole		*					●											
Lemon sole	n/a															n/a		
Sandeels																		
Mackerel								●	●	●								
Sprat								●	●									
Nephrops							●	●	●									
Hake	n/a																	
Blue Whiting	n/a																	
Anglerfish	n/a																	
Ling	n/a																	
Spurdog	n/a																	
Tope	n/a																n/a	

Key	
	High Intensity
	Low Intensity
	Level of intensity is not specified
	Spawning Period
●	Peak Spawning Period
	Former/Historic Grounds
*	Grounds in the vicinity but not within the Project
n/a	Insufficient information available

5.6 Species of Conservation Interest

5.6.1 Diadromous migratory species

79. A number of diadromous species of conservation importance may transit the Wind Farm and Export Cable Study Areas as part of their migration or foraging activity (see **Table 5.18**).

Table 5.18 Principal diadromous migratory species relevant to Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor

Common Name	Scientific name	Conservation Status				
		UK BAP[2]	OSPAR[3]	IUCN[4] Red list	Bern Convention	Habitats Directive
European eel	*Anguilla anguilla*	✓	✓	Critically endangered	-	-
Allis shad	*Alosa alosa*	✓	✓	Least concern	✓	✓
Twaite shad	*Alosa fallax*	✓	-	Least concern	✓	✓
Sea lamprey	*Petromyzon marinus*	✓	✓	Least concern	✓	✓
River lamprey	*Lampetra fluviatilis*	✓	-	Least concern	✓	✓
Salmon	*Salmo salar*	✓	✓	Lower risk/least concern	✓	✓
Sea trout	*Salmo trutta*	✓	-	Least concern	-	-
Smelt	*Osmerus esperlanus*	✓	-	Least concern	-	-

80. The diadromous species listed are expected to transit Dogger Bank Teesside A & B on an occasional basis. Some may regularly cross the Dogger Bank Teesside A & B Export Cable Corridor as part of their migration and/or transit adjacent areas as part of their foraging activity. Further information on the ecology and potential site-use in proximity to the Dogger Bank Teesside A & B Wind Farm Study Area and Dogger Bank Teesside A & B Export Cable Study Area is provided in Section 6.0.

5.6.2 Elasmobranchs

81. Sharks and rays have slow growth rates and low reproductive output compared to other species groups (Camhi *et al.et al.* 1998). This results in slow rates of stock increase and low resilience to fishing mortality (Holden 1974). Directed fisheries have caused stock collapse for many species (Musick 2005), although

[2] Biodiversity Action Plan

[3] Oslo and Paris Convention for the Protection of the Marine Environment of the North-East Atlantic

[4] International Union for the Conservation of Nature

at present, mortality in mixed-species and by-catch fisheries appears to be a more significant threat (Bonfil 1994). As a result the stocks of most elasmobranch species are currently at low levels and spatial management measures have been introduced to protect the remaining stocks (ICES 2008a).

82. A summary of the principal species with conservation status and/or declining stocks potentially using the Wind Farm and Export Cable Study Areas is given in **Table 5.19.**

Table 5.19 Principal elasmobranch species of conservation interest potentially present in the Wind Farm and Export Cable Study Areas

Common Name	Scientific Name	Present in Teesside fish characterisation surveys	Conservation Status		
			UK BAP	OSPAR	IUCN Red List
Basking shark	*Cetorhinus maximus*	x	✓	✓	Vulnerable
Smooth-hounds	*Mustelus asterias/ M. mustelus*	✓	-	-	Least concern/ Vulnerable
Spurdog	*Squalus acanthias*	✓	✓	✓	Vulnerable
Thresher shark	*Alopias vulpinus*	x	-	-	Vulnerable
Tope	*Galeorhinus galeus*	x	✓	-	Vulnerable
Blonde ray	*Raja brachyura*	✓	-	-	Near Threatened
Cuckoo ray	*Leucoraja naevus*	x	-	-	Least concern
Common Skate Complex[5]	*Dipturus intermedia/ Dipturus flossada*	x	✓	✓	Critically endangered
Spotted ray	*Raja montagui*	x	-	✓	Least concern
Thornback ray	*Raja clavata*	✓	-	✓	Near Threatened
Undulate ray	*Raja undulata*	x	✓	-	Endangered

83. The ecology of the principal elasmobranch species potentially found in the Wind Farm and Export Cable Study Areas is described in detail in Section 6.0 below.

5.6.3 Other Species of Conservation Interest

84. A number of species commercially exploited in the North Sea and expected to be found in the Wind Farm and Export Cable Study Areas are of conservation interest, being listed as UK BAP priority species. These are shown in **Table 5.20**.

[5] A recent study by Iglésias et. al. (2010) has revealed that common skate actually comprises two species: Dipturus intermedia and Dipturus flossada. Common names already in use for these species are the flapper skate and blue skate respectively, although it remains to be seen if these become widely accepted (Iglésias et. al., 2010, Shark Trust, 2009).

Where applicable, other conservation designations' status (OSPAR and IUCN) are also given.

Table 5.20 Commercial fish species of conservation interest potentially present in the Wind Farm and Export Cable Study Areas

Common name	Scientific Name	Present in Teesside fish characterisation surveys	Conservation status		
			UK BAP	OSPAR	IUCN Red list
Lesser sandeel	*Ammodytes marinus* Raitt	✓	✓	-	-
Herring	*Clupea harengus*	✓	✓	-	Least concern
Cod	*Gadus morhua*	✓	✓	✓	Vulnerable
Whiting	*Merlangius merlangus*	✓	✓	-	-
Plaice	*Pleuronectes platessa*	✓	✓	-	Least concern
Mackerel	*Scomber scombrus*	✓	✓	-	Least concern
Sole	*Solea solea*	✓	✓	-	-
Horse mackerel	*Trachurus trachurus*	✓	✓	-	-
Anglerfish	*Lophius piscatorius*	✓	✓	-	-
Ling	*Molva molva*	✓	✓	-	-
Hake	*Merluccius merluccius*	✓	✓	-	-

85. Non-commercial fish species of conservation interest, such as sand gobies, are also found in the Wind Farm and Export Cable Study Areas. This species is protected under the Bern Convention, Appendix III, and was recorded in relatively high numbers in the fish characterisation 2m beam trawl surveys carried out in tranches A and B (**Table 5.5** and **Table 5.6**).

86. It should also be noted that a short-snouted seahorse *Hippocampus hippocampus* was captured in 2006 as part of a Cefas research survey on the Dogger Bank (Pinnegar *et al.et al.,* 2008). This species is of conservation importance, being protected under the Wildlife and Countryside Act (1981) since 2008 (Natural England 2012). The record of this specimen was, however, made at considerable distance from Dogger Bank Teesside A & B, being found in ICES rectangle 37F1, approximately 30km south of the Dogger Bank Teesside A & B Export Cable Corridor (at its closest point). No evidence of the presence of this species was found in Dogger Bank Teesside A & B or along the Dogger Bank Teesside A & B Export Cable Corridor in any survey work.

5.7 Key Species in the Food Web

87. Fish that occur in the Wind Farm and Export Cable Study Areas such as sandeels, herring and sprat are key species linking trophic levels in the North Sea (Furness 2002). They are both major predators of zooplankton and also the principal prey of many top predators such as birds, marine mammals and piscivorous fish.

88. Sandeels are most vulnerable to predation when they are in transit to, or feeding in the water column (Hobson 1986, Furness 2002, van der Kooij *et al.et al.* 2008) and it is also during this free-swimming period that they are targeted by commercial pelagic trawlers (van der Kooij *et al.et al.* 2008). Sandeels constitute an important prey species for a number of fish predators such as herring, salmon, sea trout, cod, haddock, whiting, grey gurnard, saithe, mackerel, horse mackerel and starry ray as well as squid (Collins and Pierce 1996, Mills *et al* 2003, Greenstreet *et al.et al.* 1998, Wright & Kennedy 1999, ICES 2005c, ICES 2006, ICES 2008a, ICES 2009b, ICES 2010b, Walters 2010, Walters 2011). Salmon post smolts are known to largely feed on small fish such as 0-group sandeels (Haugland *et al.et al.* 2006). Marine mammals such as common seals (ICES 2006, Thompson *et al.et al.* 2003), grey seals (McConnell *et al.et al.* 1999), harbour porpoise (Santos *et al.et al.* 2005, Thompson *et al.et al.,* 2007) and minke whale (Olsen and Holst 2001, Pierce *et al.et al.* 2004) also feed on sandeels.

89. Sandeels are a key component of the diet of many birds, such as kittiwake, razorbill, puffin, common tern, arctic tern, European shag, great skua and common guillemot, which are all known to rely on sandeel consumption during the breeding season (Wright and Bailey 1993, Furness 1999, Wanless *et al.et al.* 1998, Wanless *et al.et al.* 1999, Wanless 2005).

90. Herring is an important prey species for fish such as whiting, cod, mackerel and horse mackerel (ICES 2008b, ICES 2005b, ICES 2005c). Predation mortality of one year old herring in the North Sea is mainly a result of consumption by cod, whiting, saithe and seabirds, Younger herring (0-group individuals) are largely preyed upon by horse mackerel (ICES 2008b). Herring egg mats are also known to attract a number of predators such as spurdog, haddock, mackerel, lemon sole and other herring (de Groot 1980, Mills *et al* 2003, Haugland *et al.et al.* 2006, Skaret *et al.et al.* 2002, Richardson *et al.et al.* 2011).

91. Similarly, sprat is important as prey to other fish species including cod, grey gurnard, herring, sandeels, spurdog, horse mackerel, mackerel, sea trout *Salmo trutta* and whiting (ICES 2005b, ICES 2009) and many seabirds (Wanless *et al.et al.* 2005). In addition, as described for sandeels, both herring and sprat are also known to be important in the diet of marine mammals such as seals and harbour porpoise (Santos and Pierce 2003, Wood 2001, Santos *et al.et al.* 2004).

6.0 Principal Fish and Shellfish Species Identified

92. A review of the ecology of the principal fish and shellfish species identified in the area of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor on the basis of their commercial importance, relative abundance in the area, role in the ecosystem and conservation status is given below.

6.1 Demersal Fish

6.1.1 Sandeels

6.1.1.1 General

93. While sandeels are generally referred to as bentho-pelagic or semi-pelagic species, for the purposes of this document and, given their dependence on the seabed, they have been included within the demersal fish species section

94. Sandeels are small, short-lived, lipid-rich, shoaling fish. As such, they represent high quality food for many predatory fish, seabirds and marine mammals (Greenstreet *et al.et al.* 1997, 1998; Brown *et al.et al.* 2001; Stafford *et al.et al.* 2006; Macleod *et al.et al.* 2007; Daunt *et al.et al.* 2008).

95. Sandeels (Ammodytidae) are amongst the most abundant fish species in the North Sea (Heath *et al.et al.,* 2012). The main species of sandeels in the North Sea are:

- Lesser sandeel *Ammodytes marinus* Raitt;
- Greater sandeel *Hyperoplus lanceolatus*;
- Smooth sandeel *Gymnammodytes semisquamatus*;
- Sandeel *Ammodytes tobianus;* and
- Corbin's Sandeel *Hyperoplus immaculatus*.

Of these, the lesser sandeel *A. marinus* Raitt is by far the most abundant (Heath *et al.et al.,* 2011).

96. Sandeel is an important prey species for a range of natural predators (Hislop *et al.et al.* 1991; WGSAM 2008) including predatory fish, seabirds and marine mammals (Greenstreet *et al.* 1997; 1998; Brown *et al.* 2001; Stafford *et al.* 2006; Macleod *et al.* 2007; Daunt *et al.* 2008). Predation rates of seabirds and marine mammals on sandeels are trivial by comparison with predation rates by large fish (ICES 2012d). There is no evidence for depletion of sandeels by seabirds or marine mammals, even locally at major breeding colonies. However, some predatory fish consume very large amounts of sandeels and there is evidence that sandeel stocks increased in abundance in the North Sea following major reductions in the stocks of cod, haddock, whiting, herring, and mackerel, apparently a top-down effect resulting from reduced predation by these fish (Sherman *et al.* 1981).

6.1.1.2 Distribution

97. Due to the variable distribution of their preferred habitat in the North Sea (Wright *et al.* 1998), the distribution of post-settled sandeels is widespread but very patchy (Macer, 1966; Wright *et al.* 2000; Freeman *et al.* 2004; Holland *et al.* 2005, Jensen and Christensen 2008). Jensen *et al.* (2011) identified 217 individual sandeel habitat areas resulting in a total area of 33 566 km^2 or 5% of the combined area of the North Sea and Skagerrak with habitat areas varying greatly in size, from 1 to 4023 km^2. Given the average estimated biomass of sandeels in the North Sea the density within habitat areas averaged 58t km^{-2} (ICES 2008). Sandeels are site-specific demersal spawners therefore the area defined by the spawning grounds reflects the distribution of the adults. Most sandeel species are found along the sloping edges of sandbanks (Greenstreet *et al* 2010) and they typically inhabit shallow, turbulent sandy areas, located at depths of 20–70 m where the content of the finest particles of silt and clay is low (Macer, 1966, Wright *et al.,* 2000). Research has shown that lesser sandeel require a very specific substratum, favouring seabed habitats containing a high proportion of medium and coarse sand (particle size ≥ 0.25 to < 2 mm) and low silt content (Holland *et al.,* 2005). Sandeels are rare in sediments where the silt content (particle size < 0.63 µm) is greater than around 4 % and absent where the silt content is greater than 10 % (Holland *et al* 2005, Wright *et al* 2000).

98. Although their requirement for specific habitat is likely to limit sandeel movement, little direct information exists on the extent of horizontal movements of post-settled sandeels within or between habitat areas. Sandeels display a high level of site fidelity in terms of habitat preference, but it is not known whether post-settlement sandeels return to the same burrowing site each day (van der Kooij 2008). The few mark– recapture experiments that have been conducted were restricted to small regions because of the difficulty of marking a representative number of individuals (Jensen *et al.,* 2011).

99. An indication of the distribution of spawning and nursery grounds of sandeels is provided in **Figure 6.1**, as defined in Ellis *et al.,* (2010). In addition, recent larval distribution charts for *A. marinus* Raitt, the principal sandeel species found in the Dogger Bank area, as recorded by IMARES in recent ichthyoplanton surveys (van Damme *et al.,* 2011), is given in **Figure 6.2**.

6.1.1.3 Life History

100. Sandeel activity patterns have strong seasonal and diurnal components. Adult sandeels remain burrowed in the substrate during winter in response to decreased food availability, day length and temperature (Wright *et al.,* 2000, Holland *et al.,* 2005) only emerging briefly to spawn in the water column in winter (November-February).

101. During spring and summer sandeels exhibit diurnal movements between the seafloor, where they bury themselves at night, and the water column, where they feed on plankton during daylight (Winslade 1974, Freeman *et al.,* 2004, van Deurs *et al.,* 2008, van der Kooij *et al.,* 2008). Research has shown that sandeels

on the Dogger Bank are capable of diurnal migrations during spring and summer (from their burrowing sites to deeper waters off the bank) which range in extent from 5km (van der Kooij *et al.,* 2008) up to 15km (Engelhard *et al.,* 2008). There is considerable mixing of sandeels within fishing grounds at scales < 28km (Jensen *et al.,* 2011).

102. Unlike the majority of fish species, sandeels are demersal spawners and lay their eggs on the seabed. The demersal eggs of *A. marinus* Raitt typically reside until hatching in the habitat of adult sandeels. In the North Sea, it has been documented that lesser sandeel hatch from February to May and the duration of the larval phase is between 1 and 3 months; larvae are planktonic, until reaching a length of ~ 25mm (Nichols *et al.,* 1993; Wright and Bailey, 1996).

103. Juvenile *A. marinus* Raitt seem to recruit directly to the habitat of adult sandeels (Jensen 2001, Wright *et al.,* 2000). There is only limited movement of post-settled sandeels between habitat areas and it, therefore, is assumed that the demersal habitat of sandeels broadly represents their spawning grounds (Jensen and Christensen 2008).

6.1.1.4 Exploitation

104. Sandeel are exploited by a substantial industrial fishery for fishmeal and fish-oil. Since 1983, annual landings have ranged from 180 000 tons (2005) to 1.2 million tons (1997) (ICES 2012), higher than for any other North Sea species (Englehard *et al.,* 2008). The Dogger Bank is the main fishing area contributing ~ 65% of the entire North Sea sandeel catch taken during the period 2003 to 2009 (ICES 2010).

105. As suggested by the fisheries data collected to inform *Chapter 15 - Commercial Fisheries*, sandeels in the Dogger Bank area are targeted predominantly by the Danish fleet and to a lesser extent by German, Swedish, Norwegian and UK vessels.

106. The seasonality of the sandeel fishery is a consequence of the availability of sandeels in the water column. The fishery usually starts in March, peaking in May-June (Jensen and Christensen 2008), coinciding with the feeding season. The species is only targeted during the day since sandeels remain in burrows during the night and are, therefore, inaccessible to trawl gear (Jensen and Christensen 2008). Fishing grounds are used as a proxy for the distribution of sandeel habitat (van der Kooij *et al.,* 2008) and known fishing grounds are believed to represent the major areas of sandeel distribution in the North Sea (Jensen and Christensen 2008). The potential for small sandeel patches of suitable habitat to exist in areas which cannot be trawled efficiently should, however, be recognised (Bergstad *et al.,* 2001).

107. The distribution of sandeel fishing in the Dogger Bank and the wider North Sea, based on Danish VMS data (average 2008-2012), is given in **Figure 6.3** and **Figure 6.4** respectively. As shown in **Figure 6.3**, the highest fishing intensity in the Dogger Bank Zone is distributed along the western boundary of the zone. In

general terms, there is little sandeel fishing conducted in Tranche B while relatively high levels of intensity are recorded in discrete sections of Tranche A, particularly along the western and eastern sections, with fishing also occurring in the northern section of the Dogger Bank Zone. A low level of fishing intensity occurs within Dogger Bank Teesside A & B with the exception of a localised patch of high intensity fishing focused in a small area in the upper, western corner of Dogger Bank Teesside B. It should be noted that sandeel fishing also takes place, at similar intensities to those recorded in the western boundary of the Dogger Bank Zone, in other areas of the North Sea, particularly off the west coast of Denmark (**Figure 6.4**).

108. The majority of sandeel fishing grounds within the Norwegian EEZ have been depleted by commercial fishing (ICES 2010). Sustained levels of over-fishing have prevented the recovery of stocks despite instances of re-colonisation of depleted areas by new recruits.

109. While some research has shown that the re-colonisation rate is affected by factors such as hydrographical features and the distribution of sandeel spawning populations (Proctor *et al.,* 1998; Christensen *et al.,* 2008), possibly some of the variation in re-colonisation of banks after depletion may reflect the movement of sandeels from areas of sub-optimal habitat into areas of preferred habitat (Wright *et al.,* 2000, Jensen *et al.,* 2011).

110. Sandeel populations can exhibit high levels of resilience as evidenced by the immediate recovery of sandeels in the southeast of Scotland following the closure of the local fishery (Greenstreet *et al.,* 2000).

111. An extensive post-construction study by van Deurs *et al.,* (2011) showed a positive short-term effect (after 2 years) on the densities of both adult and juvenile sandeels in the vicinity of the Horns Rev offshore wind farm and in the long-term (after seven years of operation) there was neither a direct benefit nor a definite threat to sandeels and their habitat.

6.1.1.5 Management

112. ICES ceased to treat lesser sandeels (*A. marinus* Raitt) in the North Sea as a single stock in 2011, following a review of evidence on habitat, larval drift, and regional growth differences that indicated that there were seven subpopulation regions that differed in their vulnerability to exploitation (ICES, 2010). Although there is some spatial dispersal of larvae between banks up to 300 km apart, most dispersal is <100 km (Proctor *et al.,* 1998; Christensen *et al.,* 2008) thus the seven subpopulations are considered to be reproductively isolated and the assessment areas chosen by ICES (2012) were determined in order to relate local recruitment with spawning-stock biomass (SSB). The scientific and fishery information available to inform the assessment differs by region, consequently analytical assessments are only available for the most commercially important sandeel species (ICES, 2012).

113. Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within the extensive boundaries of the Dogger Bank Sandeel Area (SA1) (ICES 2010).

114. ICES reports that sandeel recruitment has been low in 2010 and 2011 and thus recent advice reflects the general deterioration in stock status (ICES 2012). ICES advice for 2012 (ICES 2012a) determined that the catch in 2012 should not be more than 23,000 tonnes. Updated advice (Special request, Advice 2012) following the results of Real Time Monitoring (RTM) undertaken in the Dogger Bank area, concluded that a zero catch of sandeel in SA1 would be required in 2012 in order to retain a stock of sandeel that is sufficient for successful recruitment.

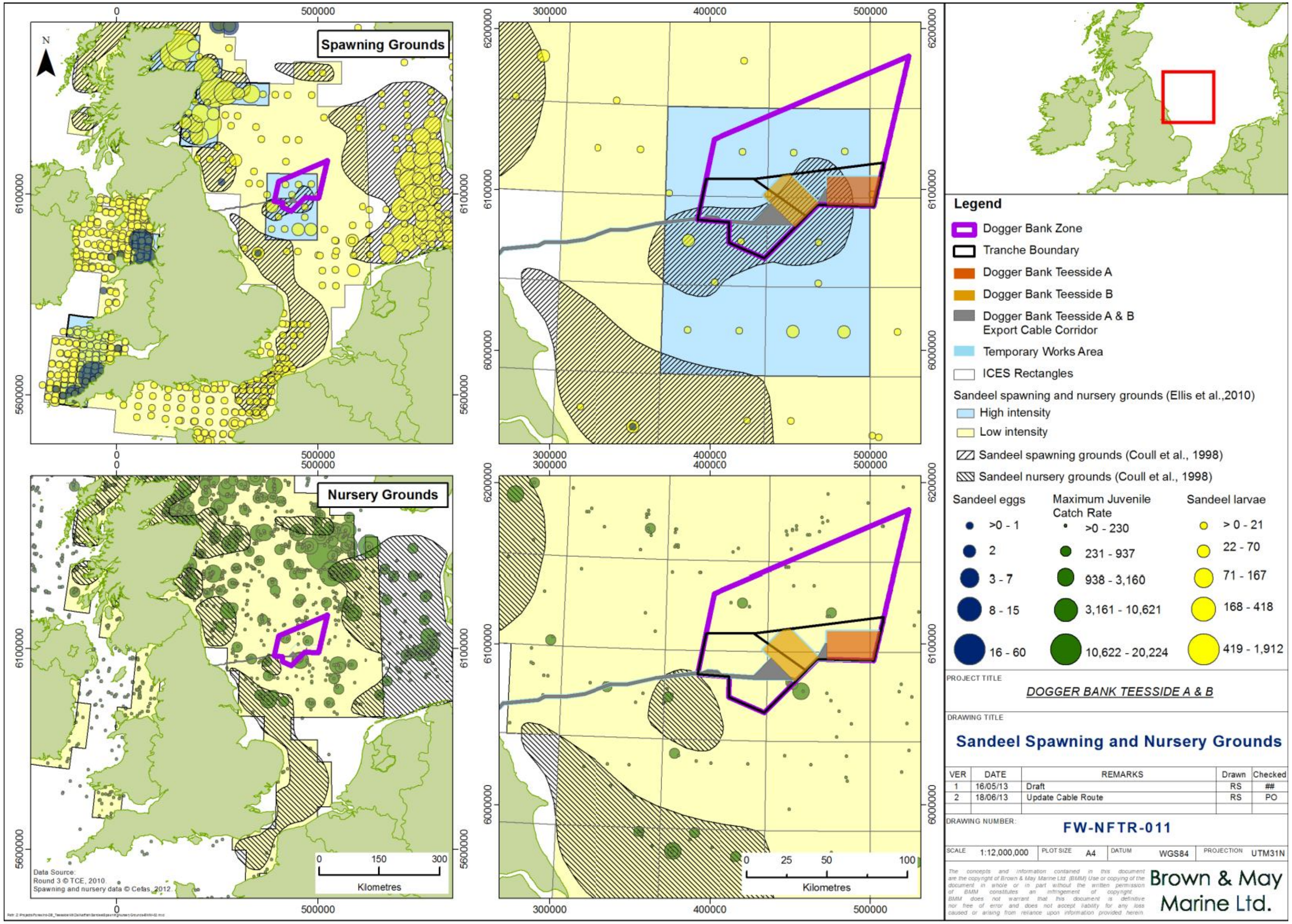


Figure 6.1 Sandeel (Ammodytidae) Spawning and Nursery Grounds (Modified from Ellis *et al.,* 2010 and Coull *et al.,* 1998)

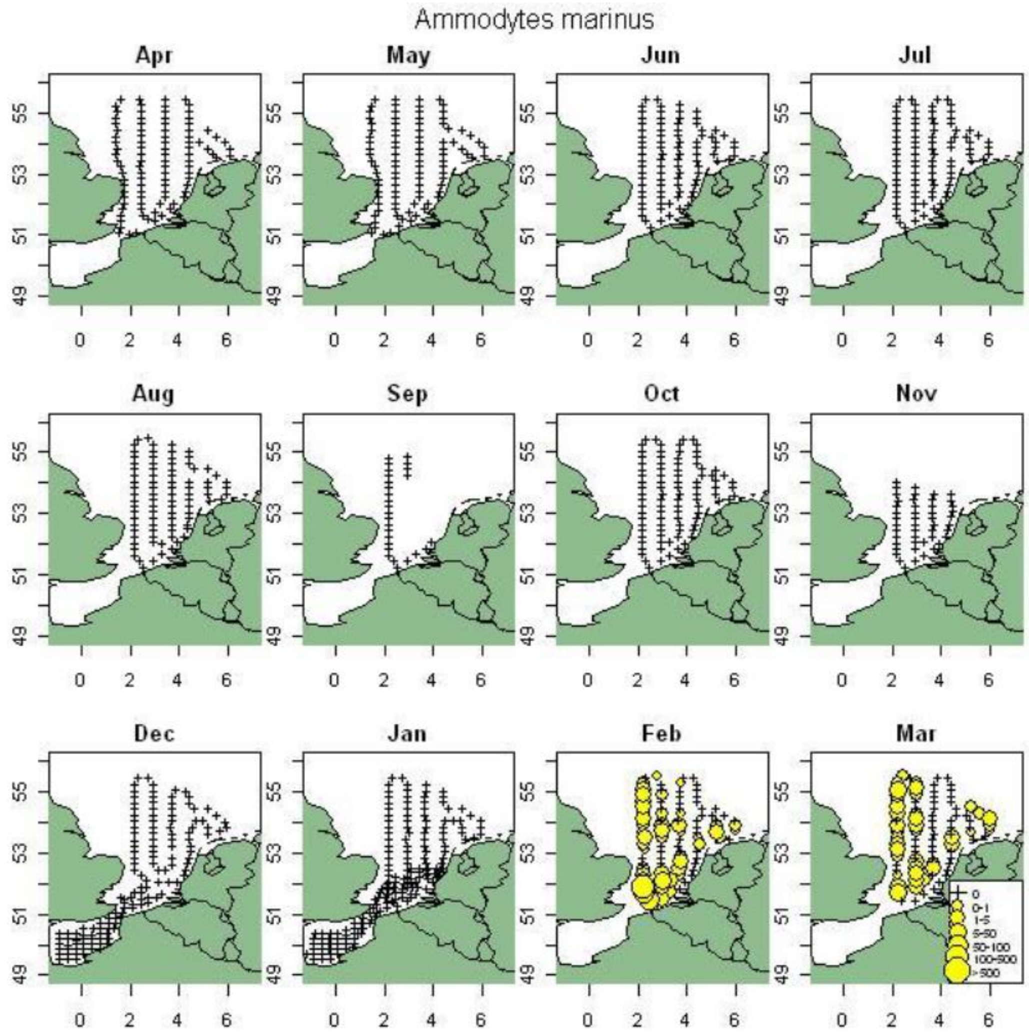


Figure 6.2 Lesser sandeel (*A. marinus* Raitt) Yolk Sac Larvae Spatial and Temporal Distribution (Van Damme *et al.,* 2011)

6.1.1.6 Site Specific Information

115. The distribution of fishing effort in tranches A and B described above is in line with the results of the sandeel specific survey (**Appendix 13F: Sandeel Survey Report**) where areas of high sandeel density were found in the western boundary of the Dogger Bank Zone and, to a lesser extent, in the eastern section of Tranche A. In the northern boundary of Tranche A, where some degree of fishing may also occur, as suggested by fisheries data, relatively high sandeel catch rates were also recorded during the sandeel specific survey (**Figure 6.5**).

116. Further site specific data on the distribution of sandeels in Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor is provided in **Figure 6.6**, based on the results of the 2m scientific beam trawl surveys undertaken in tranches A and B. It should be noted that these surveys were not designed to gather sandeel specific information (i.e. timing of the surveys and gear used) and, therefore, the limitations of the data derived from these should be recognised. The results do, however, provide a rough indication of the distribution of sandeels and their seasonal presence in the Project area.

117. As shown in **Figure 6.6**, the highest numbers of *A. marinus* Raitt were caught in Tranche A in August 2011, while catches were lower in October 2011 and relatively few sandeel were caught in April 2012. In Tranche B, however, the highest catches of sandeel were recorded in April 2012 while catches decreased markedly in July and October 2012. Considering the timing of the surveys and the seasonal cycle of the species, it is likely that the results of the August 2011 survey and July 2012 survey (carried out at the end of the feeding season) provide the most representative indication of the distribution of sandeels in the sediment in the Wind Farm area.

118. As previously mentioned, sandeels are highly substrate specific. Holland *et al.,* (2005) analysed 2,885 grab-samples to determine sandeel (*A. marinus* Raitt) sediment preference in terms of its particle size composition and defined eight particle size classes. This study found that sandeels avoided settling in substrate with a high proportion of fine sand, coarse silt, medium silt and fine silt. Conversely, as the percentage of coarse sand and medium sand increased, sandeels showed increased preference for the habitat.

119. Taking the above into consideration, Greenstreet *et al.,* (2010) aggregated the sediment categories used by Holland *et al.,* (2005) into two simplified classifications of ‘‘coarse sands’’ and ‘‘silt and fine sands’’ (see **Table 6.1** below). It was concluded that the greater the percentage of “coarse sands” relative to the percentage of ‘‘silt and fine sands’’ the greater the potential for the substrate in a given area to constitute preferred sandeel habitat.

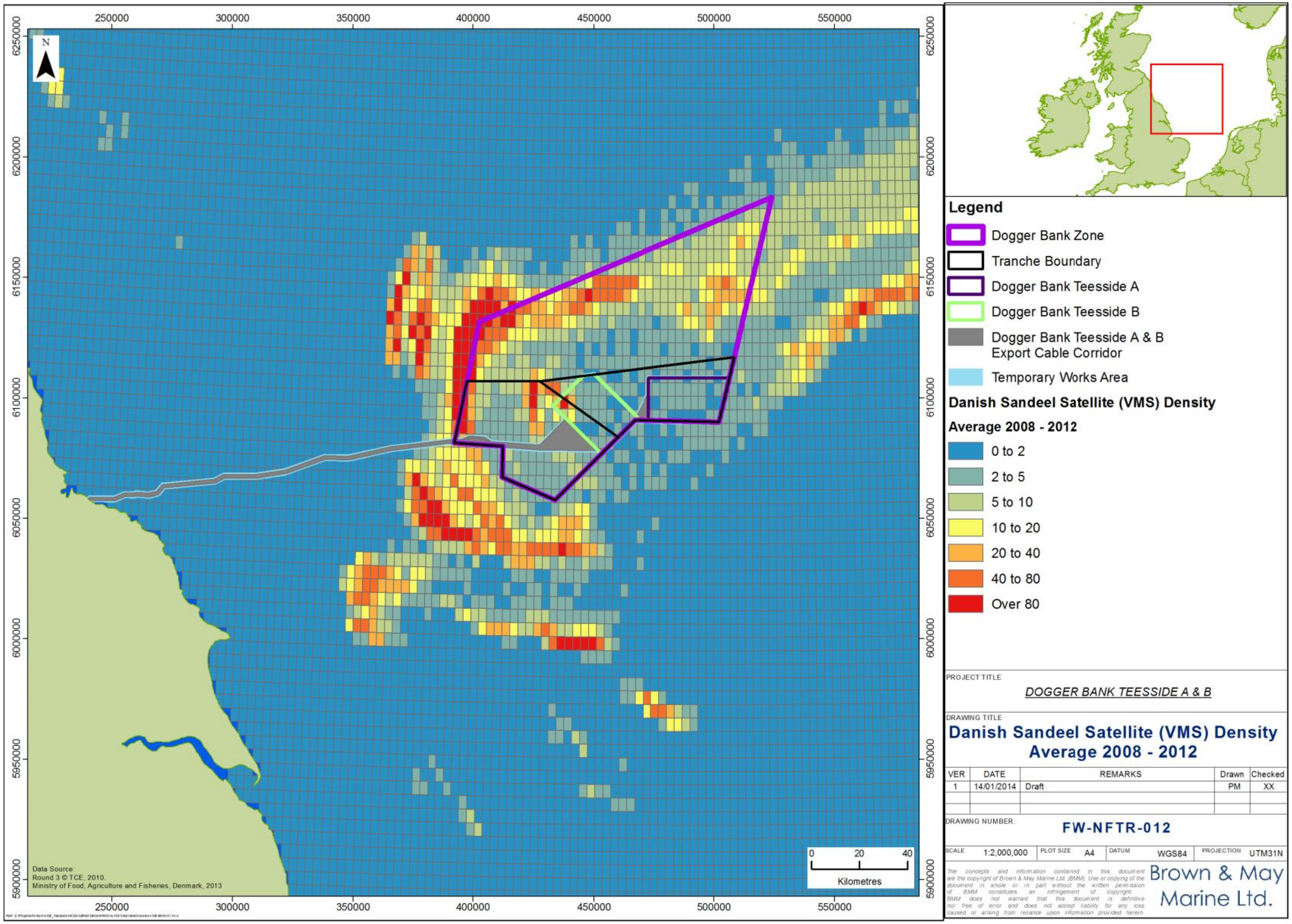


Figure 6.3 Danish sandeel fishing VMS Data (2008-2012) in the Dogger Bank Area

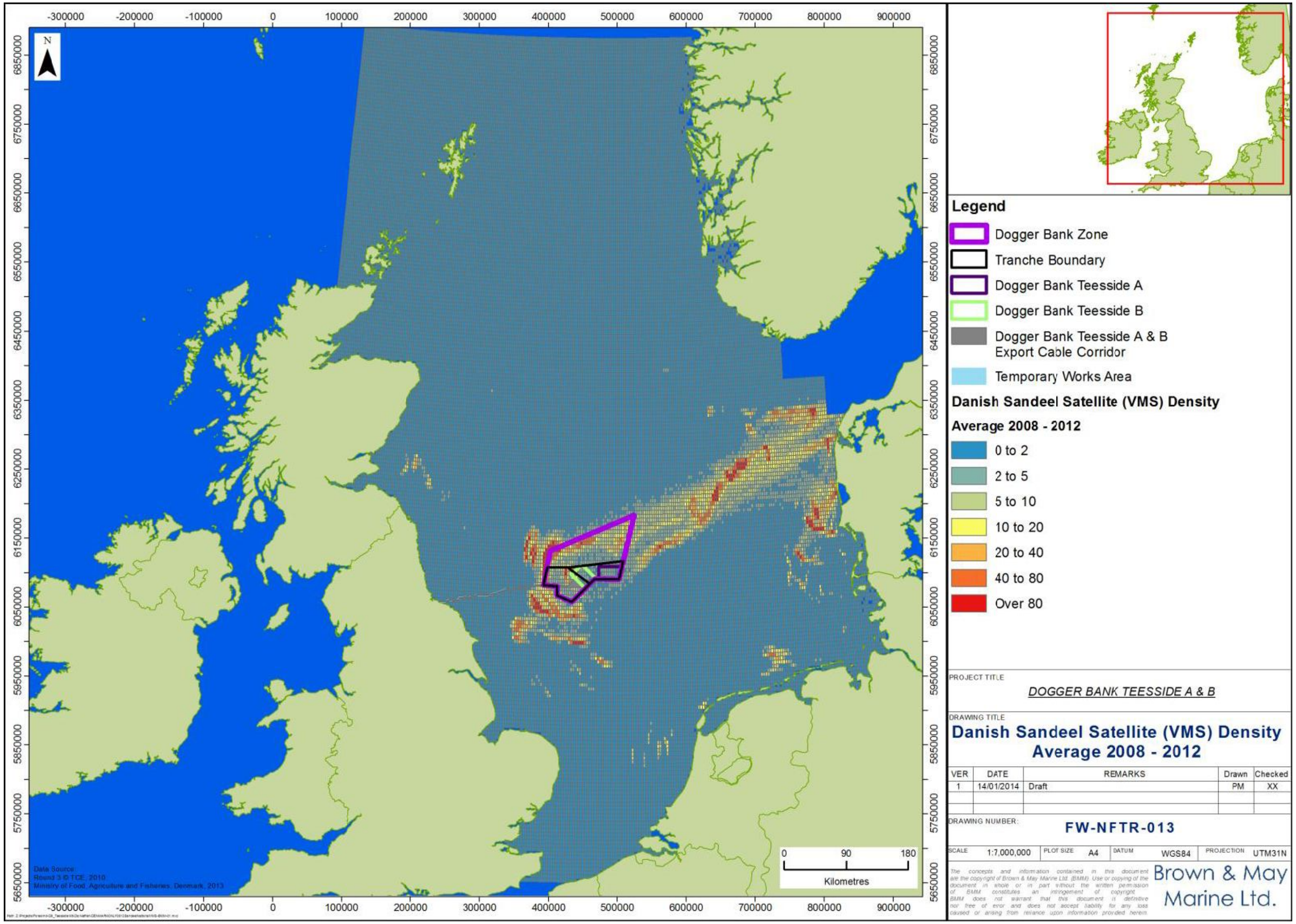


Figure 6.4 Danish Sandeel Fishing VMS Data (2008-2012) in the North Sea

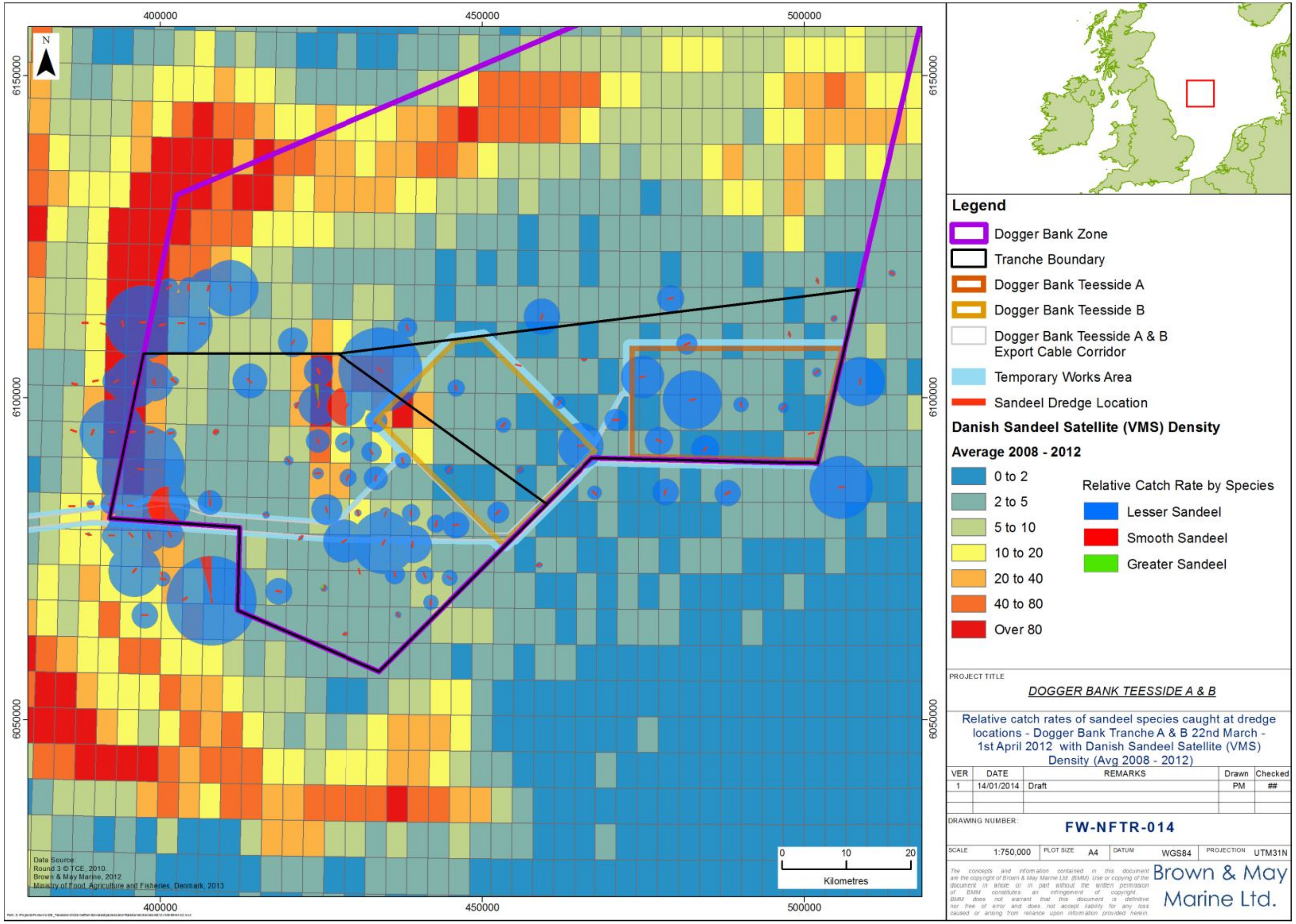


Figure 6.5 Danish sandeel fishing VMS Data (average 2008-2012) and results of the sandeel specific survey

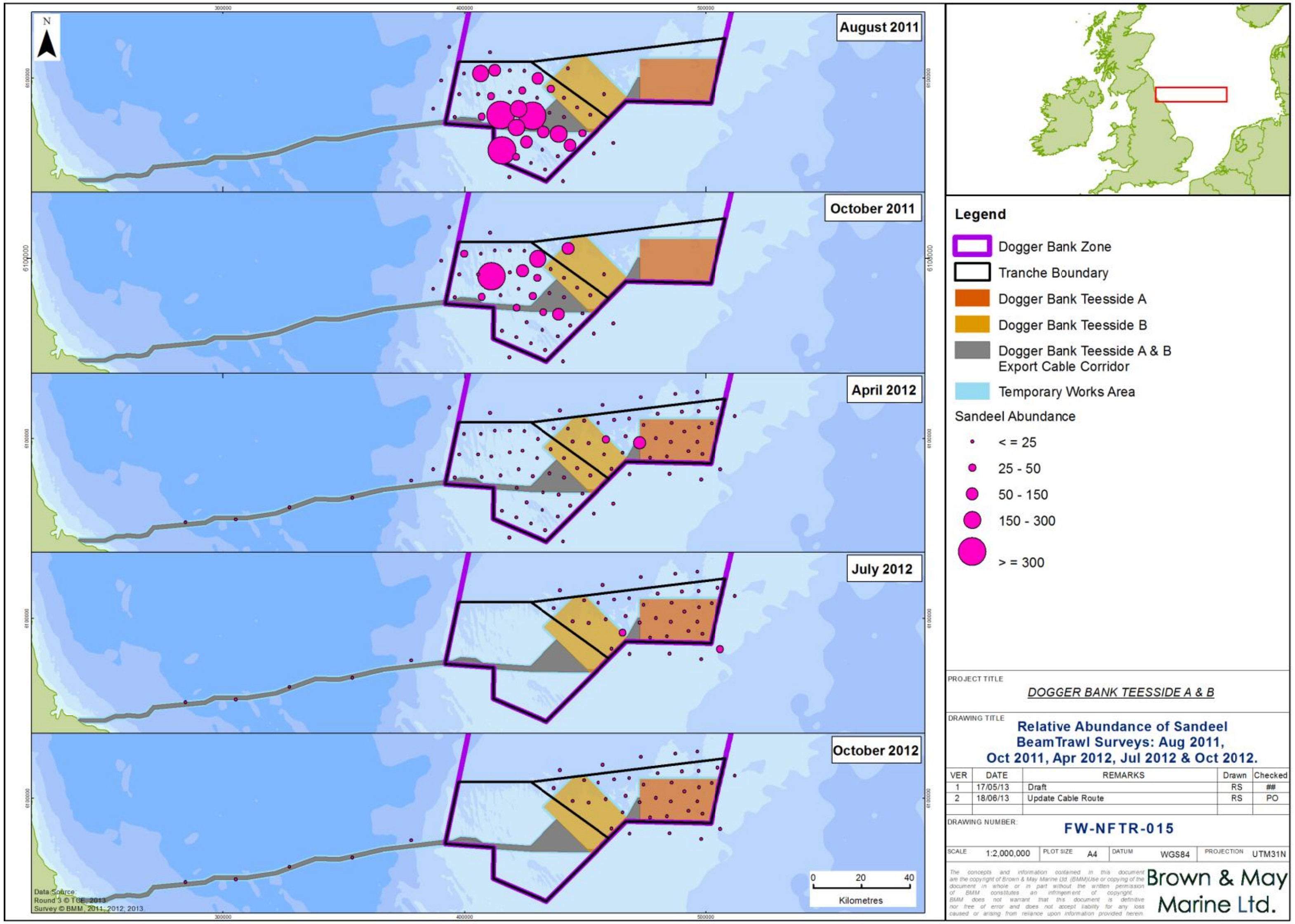


Figure 6.6 Beam Trawl Survey catch rates of lesser sandeel *A. marinus* Raitt at stations in tranches A and B

Table 6.1 Holland *et al.*, (2005) and Greenstreet *et al.*2010 sandeel sediment categories

Particle Size Range	Sediment Category (Holland *et al.*, 2005)	Sediment Category (Greenstreet *et al.*, 2010)
≥ 8mm	Coarse Gravel	n/a
≥ 2 to < 8mm	Fine Gravel	
≥ 710 µm to < 2mm	Coarse Sand	Coarse Sands
≥ 250 to < 710 µm	Medium Sand	
≥ 63 to < 250 µm	Fine Sand	Silt and Fine Sands
≥ 16 to < 63 µm	Coarse Silt	
≥ 3.9 to < 16 µm	Medium Silt	
≥ 0.1 to < 3.9 µm	Fine Silt	

120. An indication of the suitability of Tranche A and Tranche B as sandeel habitat, based on the distribution of “coarse sands” and “silt and fine sands” is given in **Figure 6.7** as derived from Particle Size Analysis (PSA) of grab samples collected in the benthic survey carried out in Tranche A (**Appendix 12D: Dogger Bank Offshore Wind Farm. Benthic Ecology Characterisation Survey**).

121. As described previously, stations in which the proportion of ‘‘coarse sands’’ is high are more likely to constitute suitable sandeel habitats than those characterised by a high proportion of ‘‘silts and fine sands’’. In the majority of the stations sampled the percentage contribution of ‘‘silts and fine sands’’ was comparatively higher than the proportion of ‘‘coarse sands’. Exceptions to this were found in five of the stations sampled in the western edge of Tranche A (coinciding with known high density sandeel grounds) and at a number of other stations dispersed across Tranche A (**Figure 6.7**).

122. Sandeels are generally rare in sediments where the silt content (particle size <0.63µm) is greater than 4%, and absent where the silt content is greater than 10% (Holland *et al.*, 2005, Wright *et al.*, 2000). Based on these definitions, unsuitable sandeel habitat was present at only seven stations, all of which fell outside the boundaries of Dogger Bank Teesside A & B (**Figure 6.7)**.

123. The distribution of seabed sediment types in the Dogger Bank and the wider area as described by the British Geological Survey (BGS) and based on Folk’s classification system (Folk 1954) is shown in **Figure 6.8**. Coarse sandy sediments are more likely to constitute preferred sandeel habitat than finer sediment classes (Holland *et al.* 2005; Greenstreet *et al.* 2010). It can therefore be assumed that that those areas (including those within Teesside A and B) classified by the BGS as sandy gravel, gravelly sand, and (to a lesser extent) sand have the potential to support sandeel populations. It should be considered that suitable substrate types are not restricted to these areas and are distributed throughout the Dogger Bank and wider Central North Sea (**Figure 6.8**). Furthermore, the availability of suitable sandeel habitat does not necessarily imply that sandeels will be present in a given area. Even assuming a population is below the area’s carrying capacity, it is unlikely that all suitable habitat will be fully occupied (Greenstreet 2007).

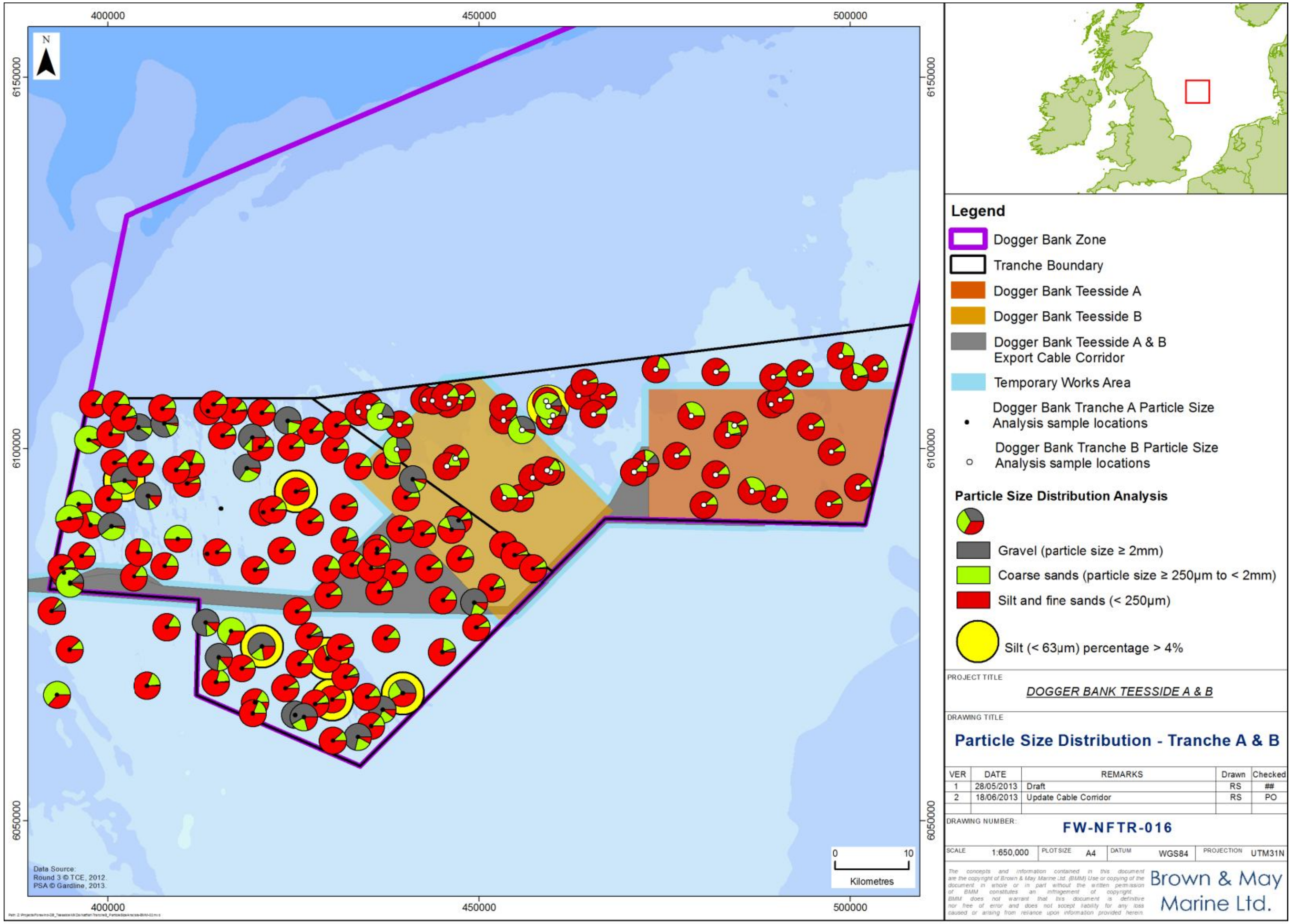


Figure 6.7 Relative distribution of sediment categories from PSA of grab samples

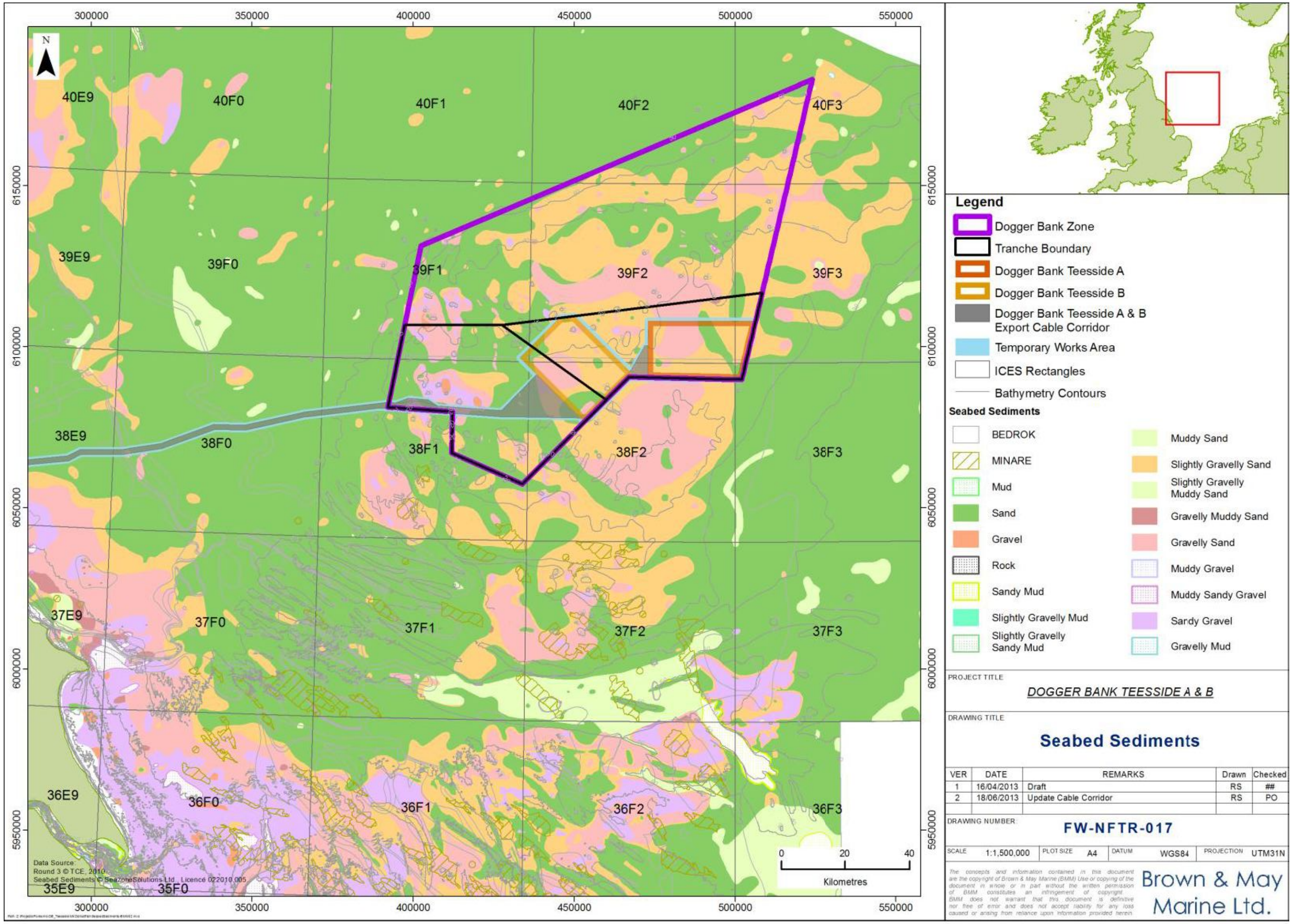


Figure 6.8 Seabed sediment in the central North Sea (Source: BGS Data)

6.1.1.7 Conservation status

124. In addition to their importance to commercial fisheries, sandeels are of importance in the food web being a key prey species for a number of other species including piscivorous fish, seabirds and marine mammals. Furthermore, they are of conservation interest with *A. marinus* Raitt being listed as a UK BAP priority species (**Table 5.20**).

6.1.2 Plaice

6.1.2.1 General

125. Plaice is an important species in European waters that has been exploited for centuries (Gulland 1968). Tagging experiments have shown that plaice demonstrate high level of site fidelity and individual fish return to the same areas to spawn and feed (de Veen 1978, Hunter *et al.* 2003).

126. Plaice feed on a wide range of benthic and epibenthic species, particularly molluscs, including burrowing species (i.e. cockles, razor shells). They are also known to feed on crustaceans and worms and occasionally on brittle stars and sandeels (Ruiz 2007b, Wheeler 1978).

6.1.2.2 Distribution

127. Plaice are widely distributed in the North Sea. They mostly occupy sandy substrates, although they are also found over gravel and mud, and typically inhabit depths between 10 and 50m (Ruiz 2007a). In the Central North Sea adult plaice undertake highly directed seasonal migrations from the winter spawning area south of the Dogger Bank Tail End, to summer feeding grounds 250km to the north (Hunter *et al.* 2003).

128. Juvenile plaice are concentrated in the Southern and German Bights, and also occur along the east coast of Britain and in the Skagerrak and Kattegat in the summer. Coastal and inshore waters of the North Sea represent essential nursery areas, with the Wadden Sea being the most important. Juveniles utilise shallow coastal waters as nursery areas and move into deeper cooler waters as they grow (Teal 2011). One year old plaice show a strictly coastal distribution, whilst the older age classes gradually disperse further offshore, away from nursery areas (ICES 2005).

129. An indication of the distribution of plaice in the North Sea is given in **Figure 6.9** and **Figure 6.10**. These show the distribution of undersized and marketable plaice in the North Sea based on the results of the Dutch BTS in 2010 and average abundance from North Sea IBTS surveys over the period 2003-2012by ICES rectangle over the period 2003 to 2012.

6.1.2.3 Life History

130. Plaice spawning may occur over most of the offshore and deeper parts of the southern North Sea and off the east coast of Britain from Flamborough head to

the Moray Firth. Centres of high egg production are the eastern Channel and the Southern Bights, while egg production around the Dogger Bank and in the German Bight is more diffuse (ICES 2005). Tagging experiments have shown strong spawning area fidelity, with individual fish returning to the same spawning areas (Hunter *et al.* 2003).

131. As indicated in **Table 5.17**, Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable corridor fall within defined spawning grounds for plaice. The distribution of these, as defined in Ellis *et al.* 2010 is illustrated in **Figure 6.11**. Only a small section along the western edge of Dogger Bank Teesside A overlaps an area defined as a high intensity spawning ground for plaice. The majority of Dogger Bank Teesside A, all of Dogger Bank Teesside B and the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor fall within low intensity spawning grounds for this species. There are no defined nursery grounds within tranches A or B or the immediate vicinity of the Dogger Bank Teesside A & B Export Cable Corridor. Low intensity nursery grounds are defined to the north of the Project area with a discrete inshore nursery ground to the south of the Dogger Bank Teesside A & B Export Cable corridor.

6.1.2.4 Exploitation

132. Plaice is one of the principal commercial species in European waters, especially for the Dutch beam trawl fleet (Teal 2011). In the Central North Sea, directed fisheries are also carried out with Danish seines and gillnets and plaice are caught as by-catch in otter trawl fisheries (ICES 2005). Plaice is exploited in a mixed fishery for flatfish, which also targets sole. Due to the small mesh size needed to catch the latter, a large amount of the plaice caught is undersized and therefore discarded (Beare *et al.* 2010). As indicated in Section 5.4, and further described in *Chapter 15 - Commercial Fisheries*, plaice is the principal commercial species landed from the Wind Farm Study Area and the Export Cable Study Area.

6.1.2.5 Management

133. A two-stage multiannual plan for plaice and sole in the North Sea was adopted by the EU Council in 2007 (ICES 2012). The North Sea stock is well within precautionary boundaries and has reached its highest levels in recorded history. Fishing mortality is estimated to be at the historic low. ICES have advised that landings should not exceed 97,070 tonnes in 2013

6.1.2.6 Site Specific Information

134. Plaice was one of the commonly occurring species encountered during the tranche A and B fish characterisation surveys. An indication of the seasonal distribution of plaice, based on the results of these surveys, is given in **Figure**

6.12. Plaice were abundant in tranches A and B, as well as occurring at sites along the length of the Dogger Bank Teesside A & B Export Cable corridor.

135. It should be noted that whilst plaice was found in relatively high numbers in the surveys undertaken in tranches A and B; the species is also abundant in other areas of the North Sea, (**Figure 6.9** and **Figure 6.10**). This is also supported by the distribution of commercial landings, which are widespread throughout the North Sea (See Section 5.4, **Figure 5.10** and **Figure 5.11**).

6.1.2.7 Conservation status

136. In addition to its commercial importance, plaice is of conservation interest, being listed as a UK BAP priority species. The IUCN red list of threatened species defines its conservation status as of "Least Concern" (**Table 5.20**).

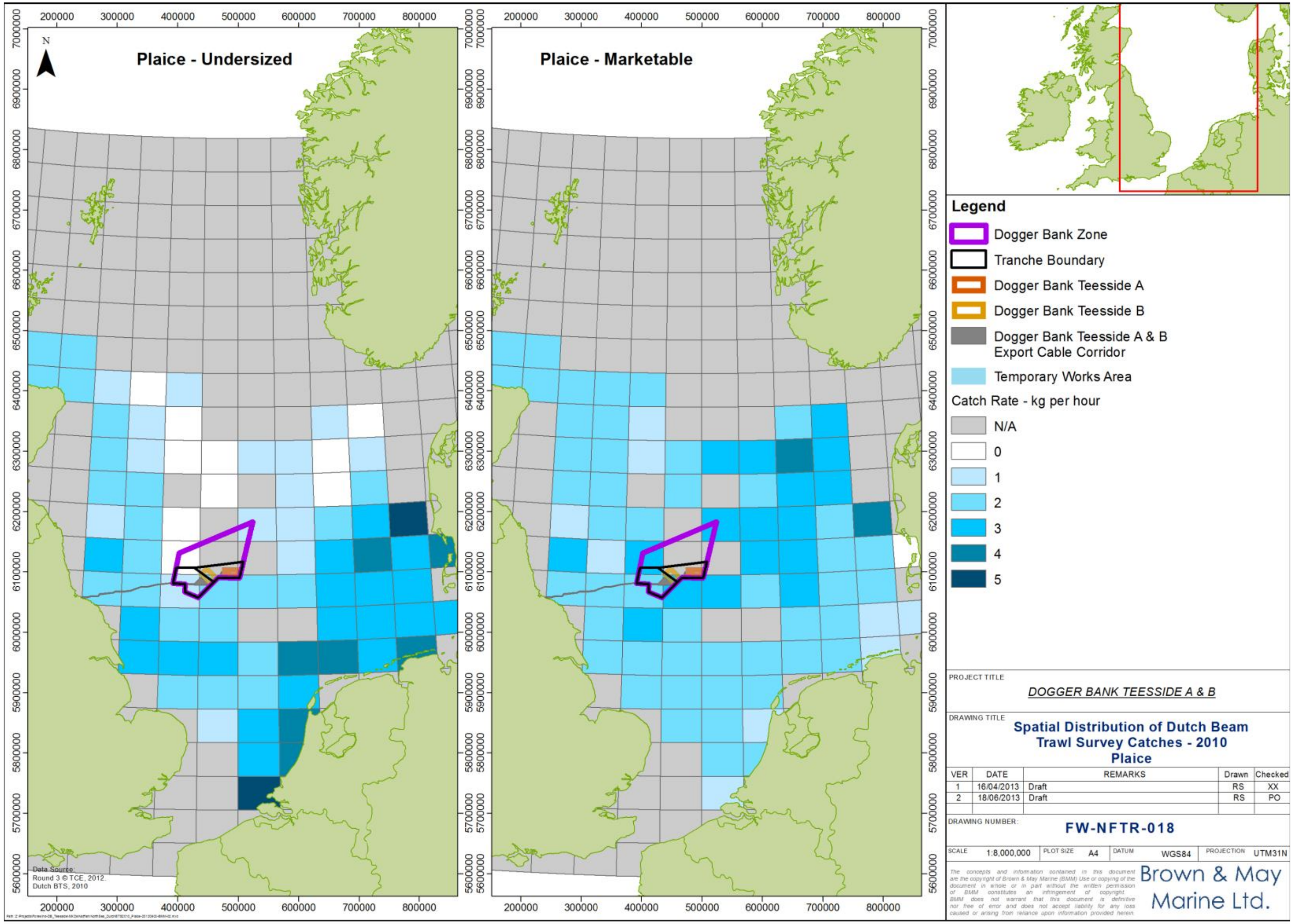


Figure 6.9 Distribution of undersized and marketable plaice in the North Sea (Dutch BTS 2010)

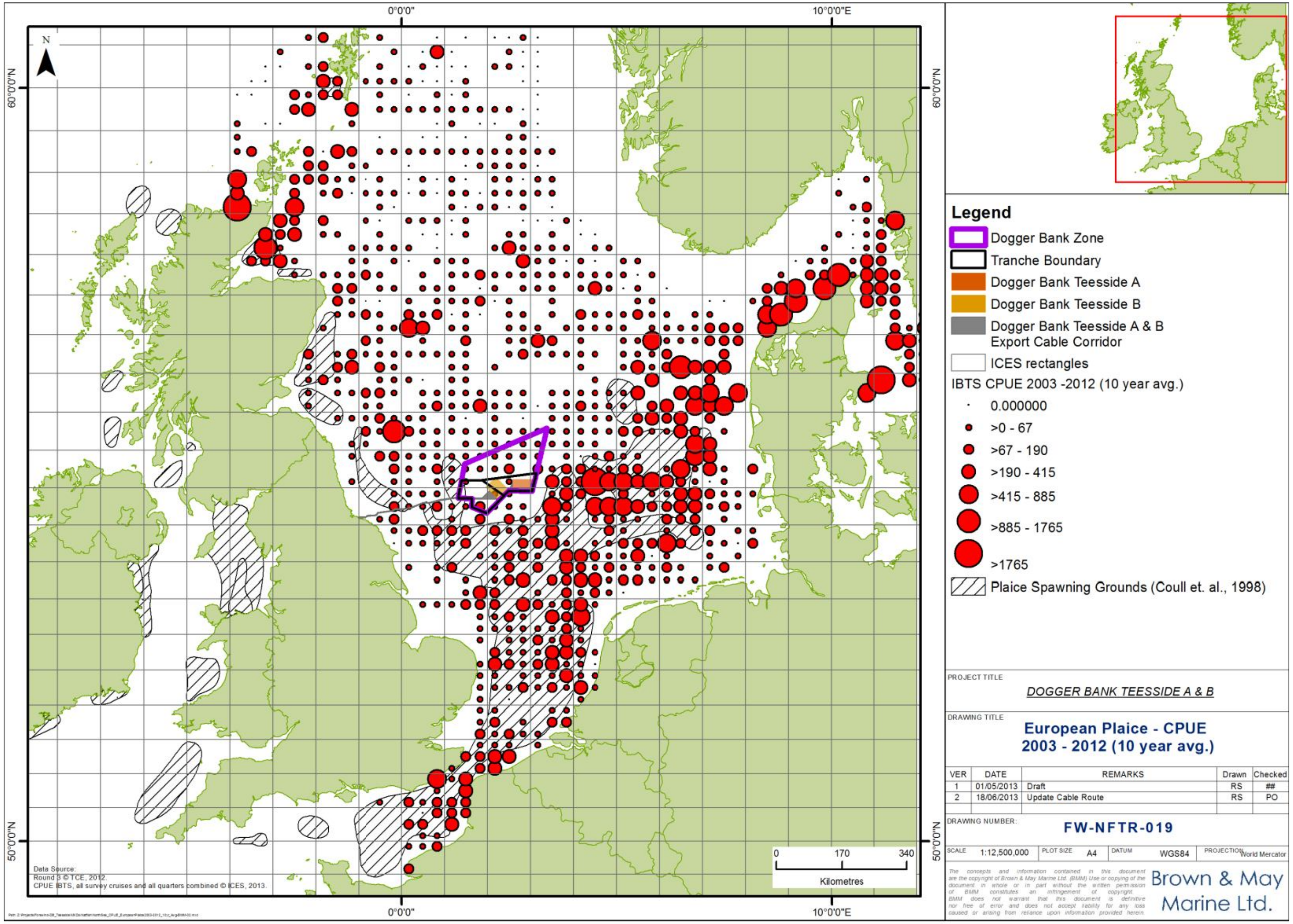


Figure 6.10 Average number (catch per standardised haul) of plaice from IBTS survey data 2003-2012

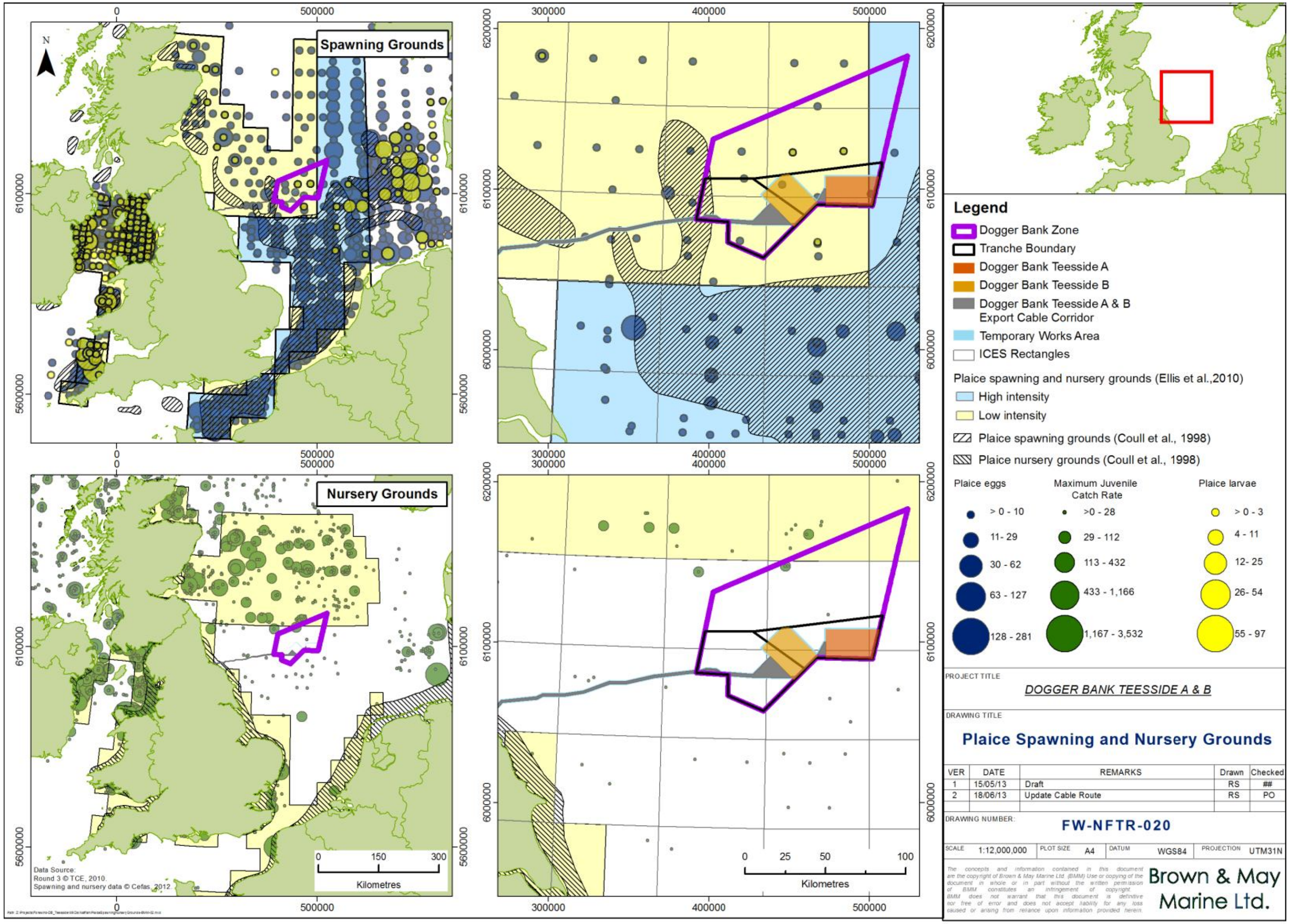


Figure 6.11 Plaice spawning and nursery grounds (modified from Ellis *et al.* 2010 and Coull *et al.* 1998)

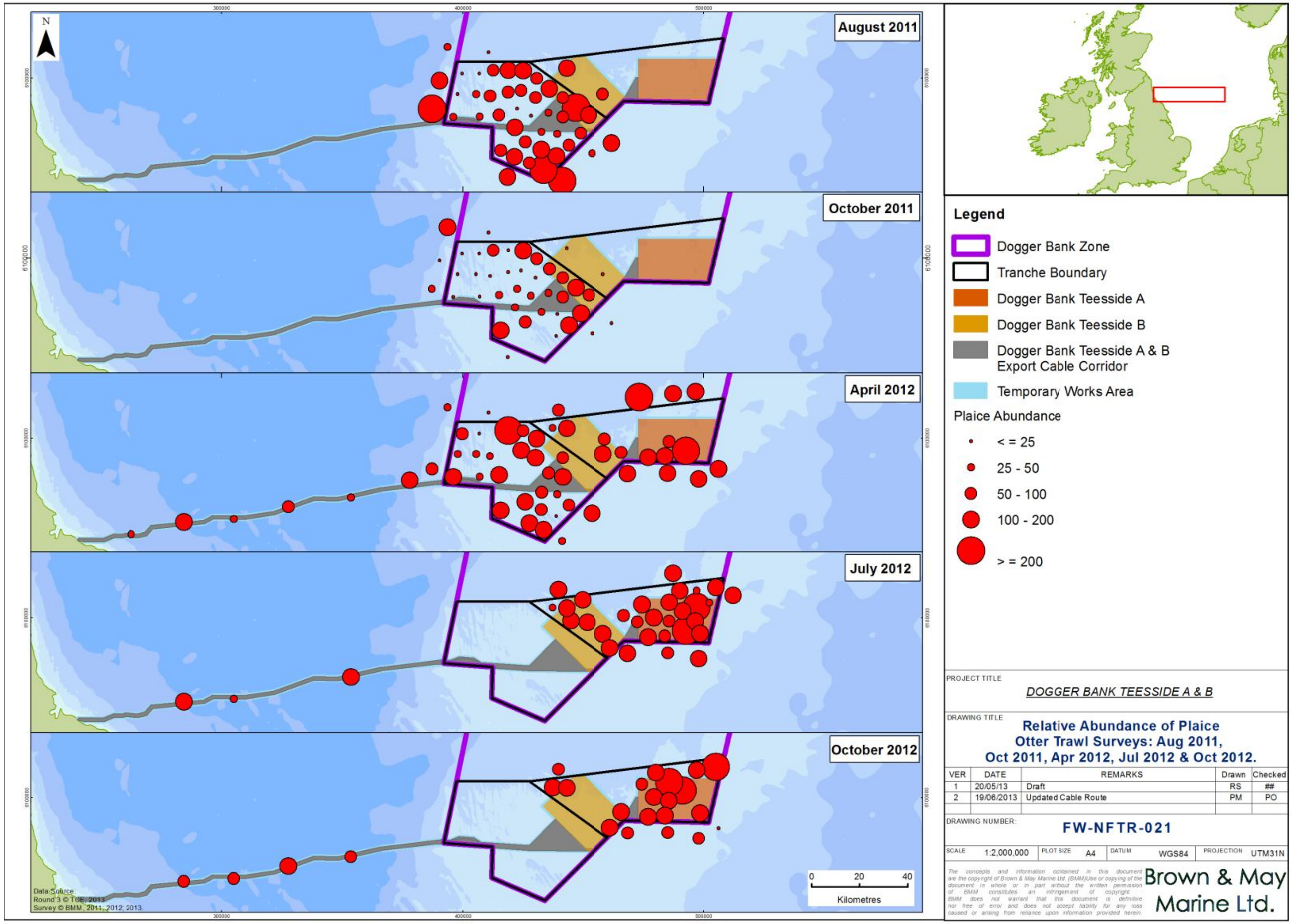


Figure 6.12 Distribution of plaice from Otter Trawl surveys undertaken in tranches A and B.

6.1.3 Dab

6.1.3.1 General

137. Distributed throughout the northeast Atlantic, dab is an abundant fish on shallow, sandy grounds of the coasts of northern Europe. The species is particularly abundant in the North Sea (Daan *et al.* 1990, Callaway *et al.* 2002).

6.1.3.2 Distribution

138. Dab is abundant throughout the southern, central and northern North Sea, and is most commonly encountered at depths from 20-40m. As suggested in **Figure 6.13**, dab appear to be particularly abundant in ICES rectangles located off the Danish coast and to the south of the Project area.

6.1.3.3 Life History

139. Adults move inshore in the summer in a seasonal migration. Spawning occurs in the North Sea from April to June. They generally feed on bottom-living invertebrates including small crustaceans, polychaete worms and molluscs (Wheeler 1978, Ruiz 2008d).

6.1.3.4 Exploitation

140. Dab are of commercial importance in the Wind Farm Study Area, accounting for high landings by weight (**Table 5.13**), although their commercial value is relatively low (**Table 5.14**).

6.1.3.5 Management

141. ICES has advised for 2012 and 2013, on the basis of precautionary considerations, that dab catches in the North Sea should not increase (ICES 2012). The stock status of dab is not formally assessed and no reference points have been defined for this species due to the lack of data.

6.1.3.6 Site Specific Information

142. The seasonal distribution of dab, as recorded in fish characterisation surveys, is shown in **Figure 6.14.** Dab were found in relatively higher numbers in Tranche A compared to Tranche B, being caught in greatest numbers in the October 2011 otter trawl survey. Lower numbers of dab were caught at stations in Dogger Bank Teesside A & B and dab were also found in otter trawls at stations in the offshore sector of the Dogger Bank Teesside A & B Export Cable Corridor.

6.1.3.7 Conservation status

143. Dab is not listed for conservation status.

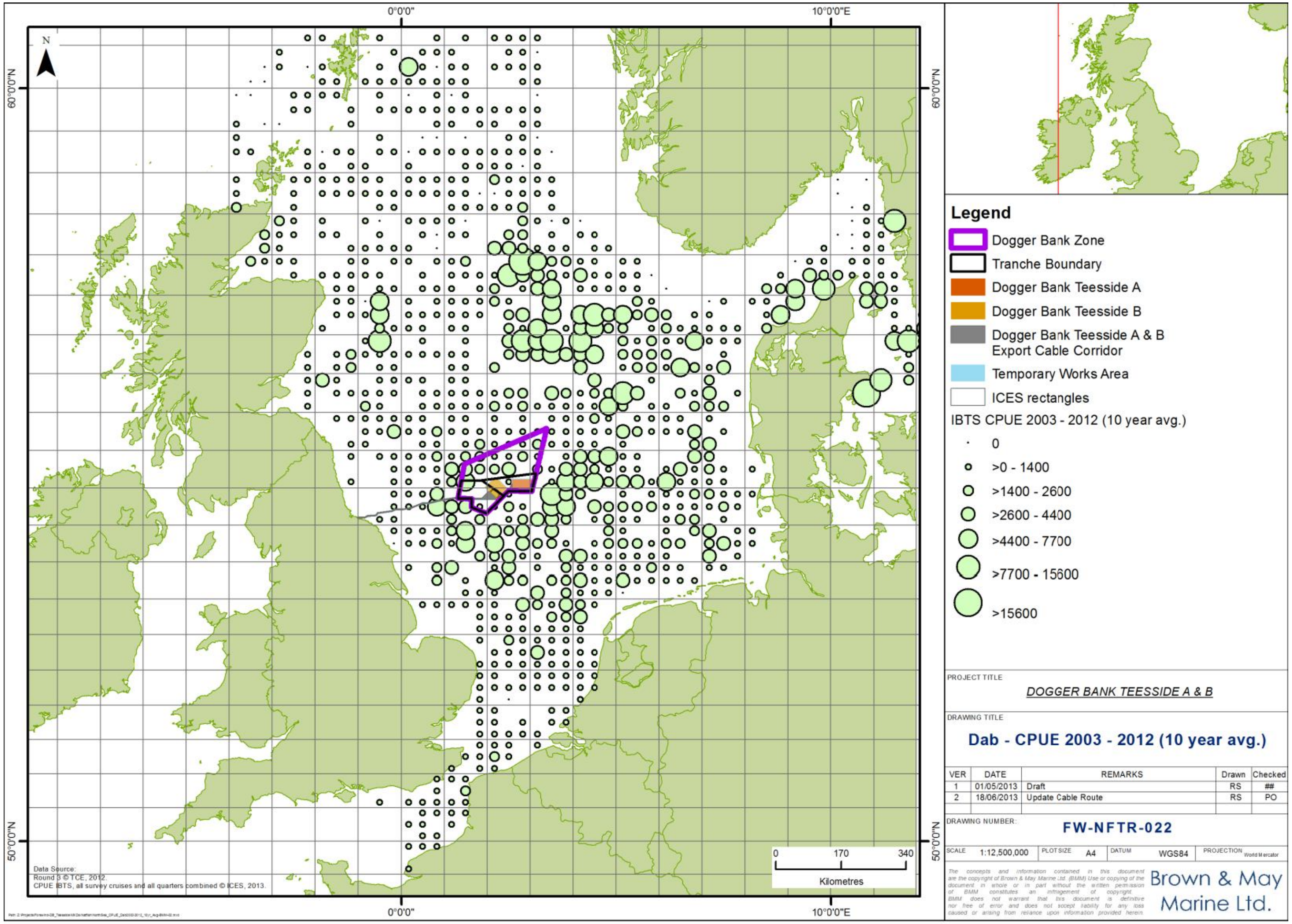


Figure 6.13 Average number (catch per standardised haul) of Dab from IBTS survey data 2003-2012

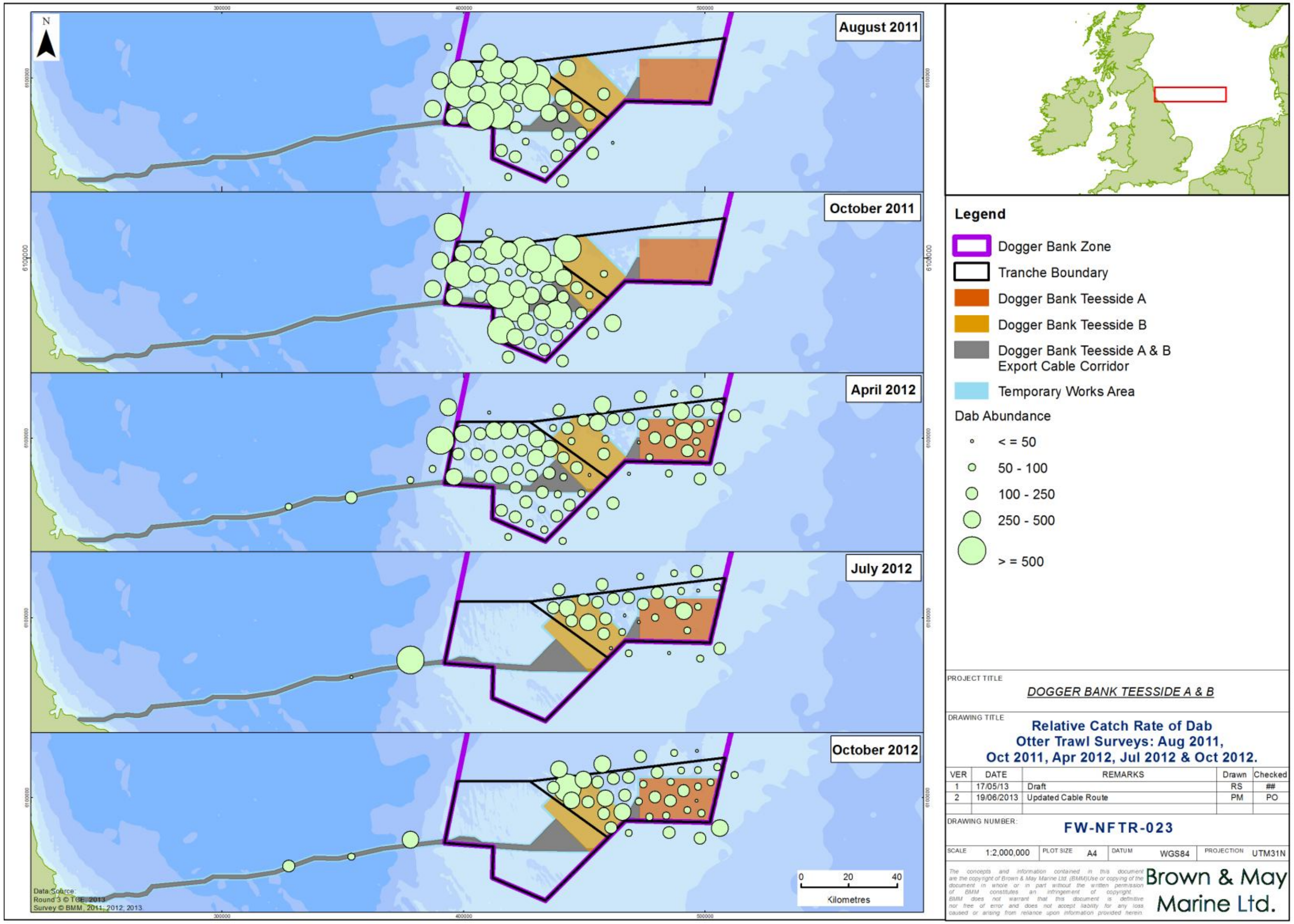


Figure 6.14 Distribution of Dab from Otter Trawl surveys undertaken in tranches A and B.

6.1.4 Sole

6.1.4.1 General

144. Sole feed mainly on small crustaceans, although they may also eat small molluscs and sometimes fish (Wheeler 1978). In Dutch coastal waters they have been found feeding on polychaetes such as *Arenicola marina*, *Lanice* spp., and *Nereis* spp.; however, small echinoderms (i.e. brittle stars and the small sea urchin *Echinocyamus pussilus*) are also thought to represent important prey for adults in some areas (ICES 2005).

6.1.4.2 Distribution

145. Sole are widely distributed in the shallow southern North Sea (mainly south of 56N), the English Channel and the Irish Sea (Limpenny *et al.,* 2011). They prefer sandy and muddy grounds (Eastwood *et al.,* 2000, Limpenny *et al.,* 2011) and are normally present at depths from 1m to 70m. In the winter, they move offshore and can be found at depths up to 120m (Reeve 2007). The northern limit of their distribution is determined by sea temperature, the lethal limit for the species being around 3- 4ºC (Burt and Millner 2008).

146. The distribution of sole in the North Sea from IBTS survey data is shown in **Figure 6.15.** Sole occurred predominantly along the east coast of England and in the Channel. Sole were not caught at any site within Dogger Bank Teesside A & B wind farm areas.

6.1.4.3 Life History

147. The majority of spawning occurs from March to May, peaking in April and lasting sporadically until late June. It mainly takes place inshore, particularly near the mouths of estuaries and in protected bays, including The Wash and the Thames (Limpenny *et al.,* 2011).

148. The distribution of sole spawning grounds is illustrated in **Figure 6.16.** As shown, spawning and nursery grounds for this species have not been defined in Dogger Bank Teesside B or within the Dogger Bank Teesside A & B Export Cable Corridor. The southern boundary of Teesside A overlaps an area defined as a low intensity spawning ground. Low intensity spawning grounds are also located in the vicinity of tranches A and B and the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor. Low intensity nursery grounds are defined in the vicinity of the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor.

6.1.4.4 Exploitation

149. Low landings weights of sole are recorded from the Wind Farm Study Area, although the contribution to total value is proportionally much greater as a result of high commercial value (see Section 5.4). These landings are likely to originate

largely from the beam trawl fishery targeting plaice on the Dogger Bank. Landings from the Export Cable Study Area are negligible (see Section 5.4).

6.1.4.5 Management

150. ICES have advised that landings of this species in 2013 should not be above 14,000 tonnes (ICES 2012). The North Sea stock has been fluctuating around target reference points for the last decade but the flatfish management plan adopted in 2007 is considered to be sufficiently precautionary as to prevent the stock dropping below safe biological limits in the next decade.

6.1.4.6 Site Specific Information

151. Sole were not caught in the otter or beam trawl surveys but were recorded in inshore trammel net surveys (**Table 5.9**).

6.1.4.7 Conservation status

152. In addition to its commercial importance, sole is of conservation interest being listed as a UK BAP priority species.

6.1.5 Lemon sole

6.1.5.1 General

153. Lemon sole is usually found over mud, sand and gravelly substrates and occasionally over rougher rocky ground. Typical depths inhabited range from 40m to 200m and the species is frequently found on offshore banks (Wheeler 1978). Lemon sole feed on a variety of benthic prey, including polychaete worms, crustaceans, molluscs and echinoderms (Wheeler 1978, Rogers and Stocks 2001).

6.1.5.2 Distribution

154. The distribution of lemon sole in the North Sea shown in **Figure 6.17** is based on average abundance recorded in IBTS surveys between 2003 and 2012. Lemon sole have been found mainly in the north-western North Sea, with the highest densities located around the Shetland Isles (Greenstreet *et al.,* 2007).

6.1.5.3 Life History

155. Little is known of the spawning habits of lemon sole. They are, however, thought to spawn everywhere they are found (Rogers and Stocks 2001). The spawning season is long, extending from April to September (Coull *et al.,* 1998, Wheeler 1978).

156. The distribution of lemon sole spawning and nursery grounds is illustrated in **Figure 6.18** (Coull *et al.,* 1998). The inshore section of the Dogger Bank Teesside A & B Export Cable Corridor overlaps with the broad spawning and nursery grounds defined for this species.

6.1.5.4 Exploitation

157. Lemon sole forms part of a mixed flat fish fishery targeted by beam and otter trawls. As suggested by landings data, lemon sole is of commercial importance in the Wind Farm Study Area, particularly in rectangles 39F2 and 39F3 in which the most northerly areas of Dogger Bank Teesside A & B are situated (**Table 5.13** and **Table 5.15**).

6.1.5.5 Management

158. There is no formal assessment of lemon sole in EU waters. Landings data shows a long-term declining trend and ICES advice for 2012 and 2013 recommends that catches should not increase.

6.1.5.6 Site Specific Information

159. Lemon sole were caught during adult and juvenile fish surveys undertaken in tranches A and B and at sites situated along the Dogger Bank Teesside A & B Export Cable Corridor in relatively high numbers, particularly in the otter trawl samples.

6.1.5.7 Conservation status

160. Lemon sole is not listed for conservation status.

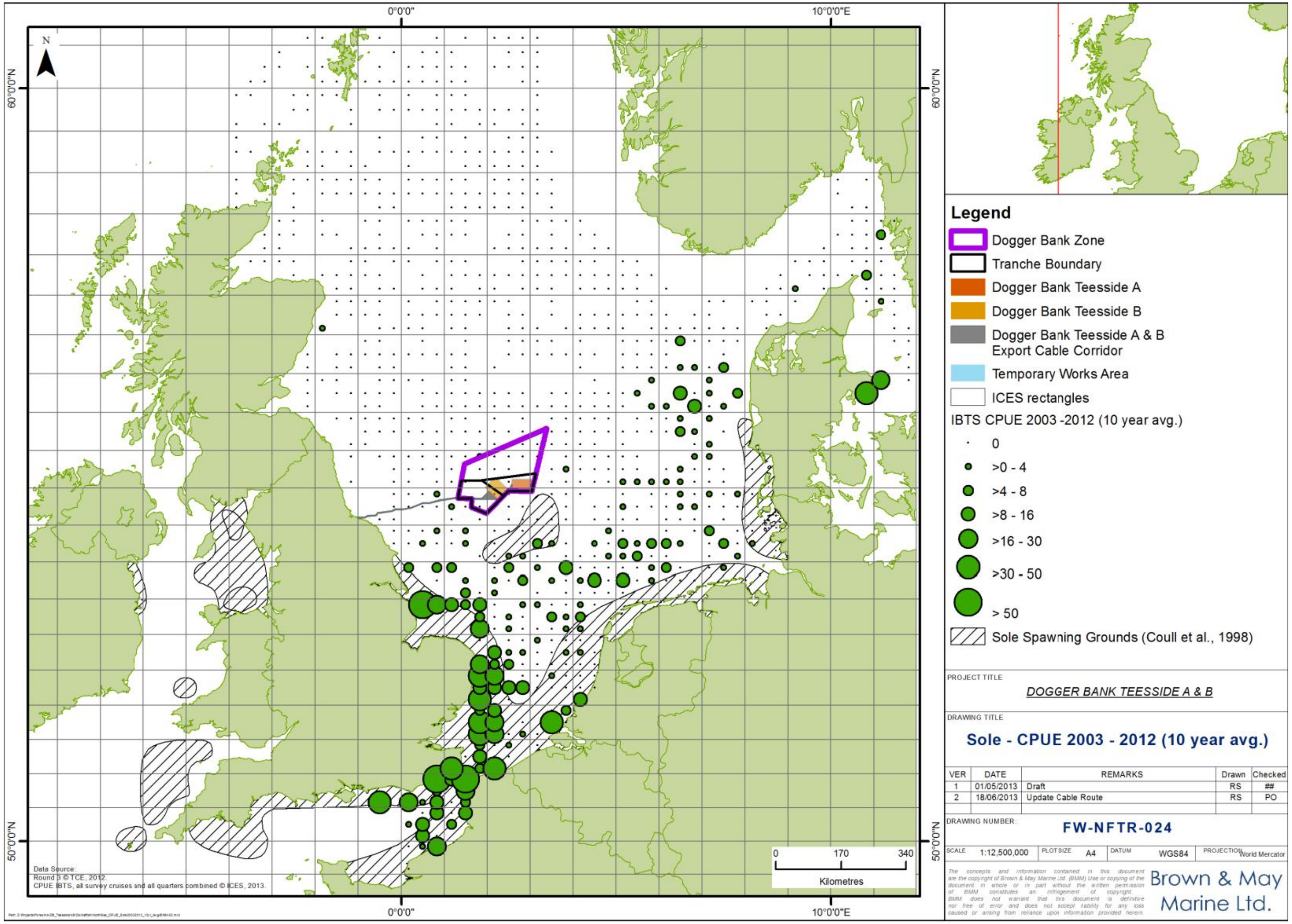


Figure 6.15 Average number (catch per standardised haul) of sole from IBTS survey data 2003-2012

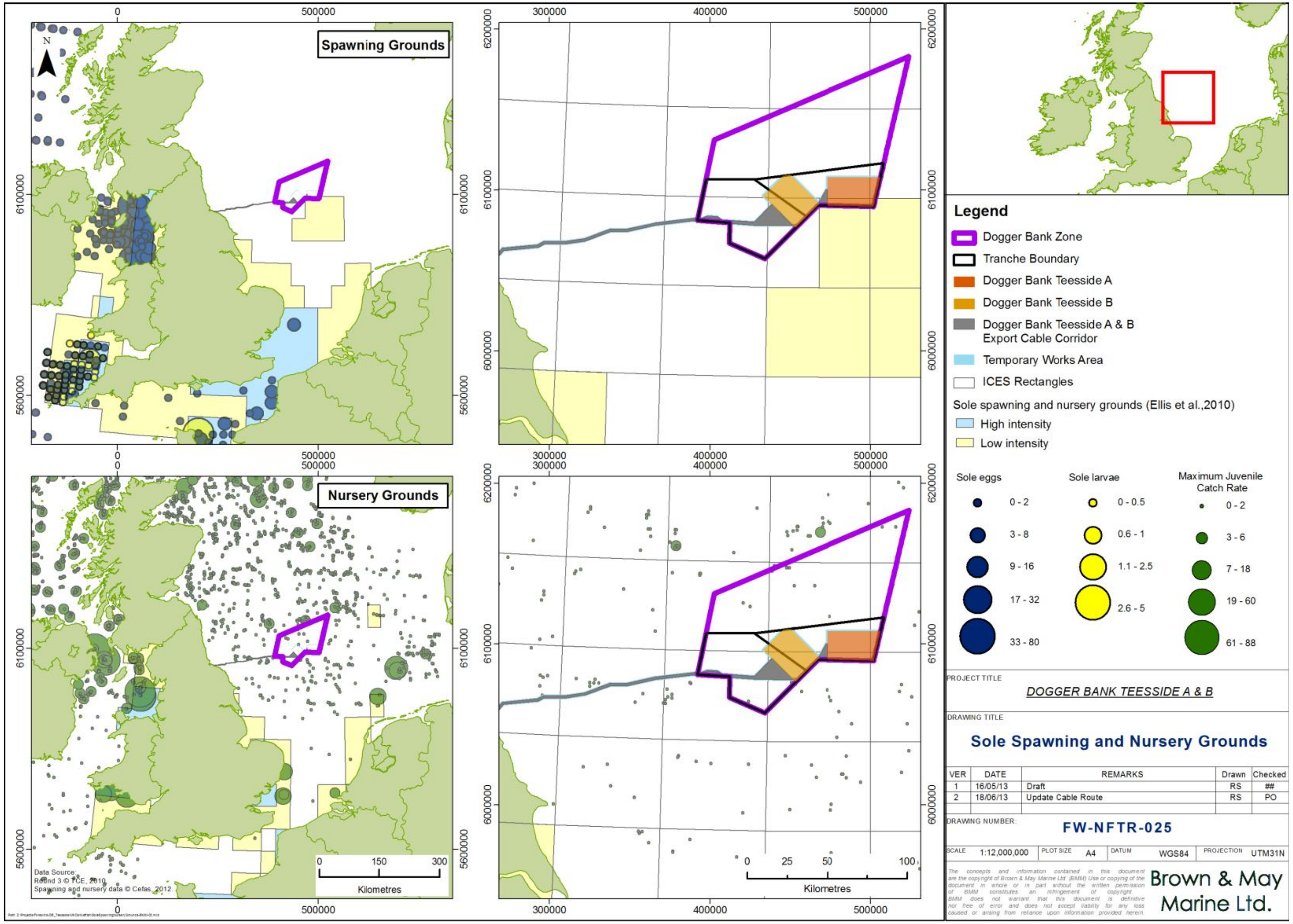


Figure 6.16 Sole spawning and nursery grounds (Modified from Ellis *et al.* 2010 and Coull *et al.* 1998)

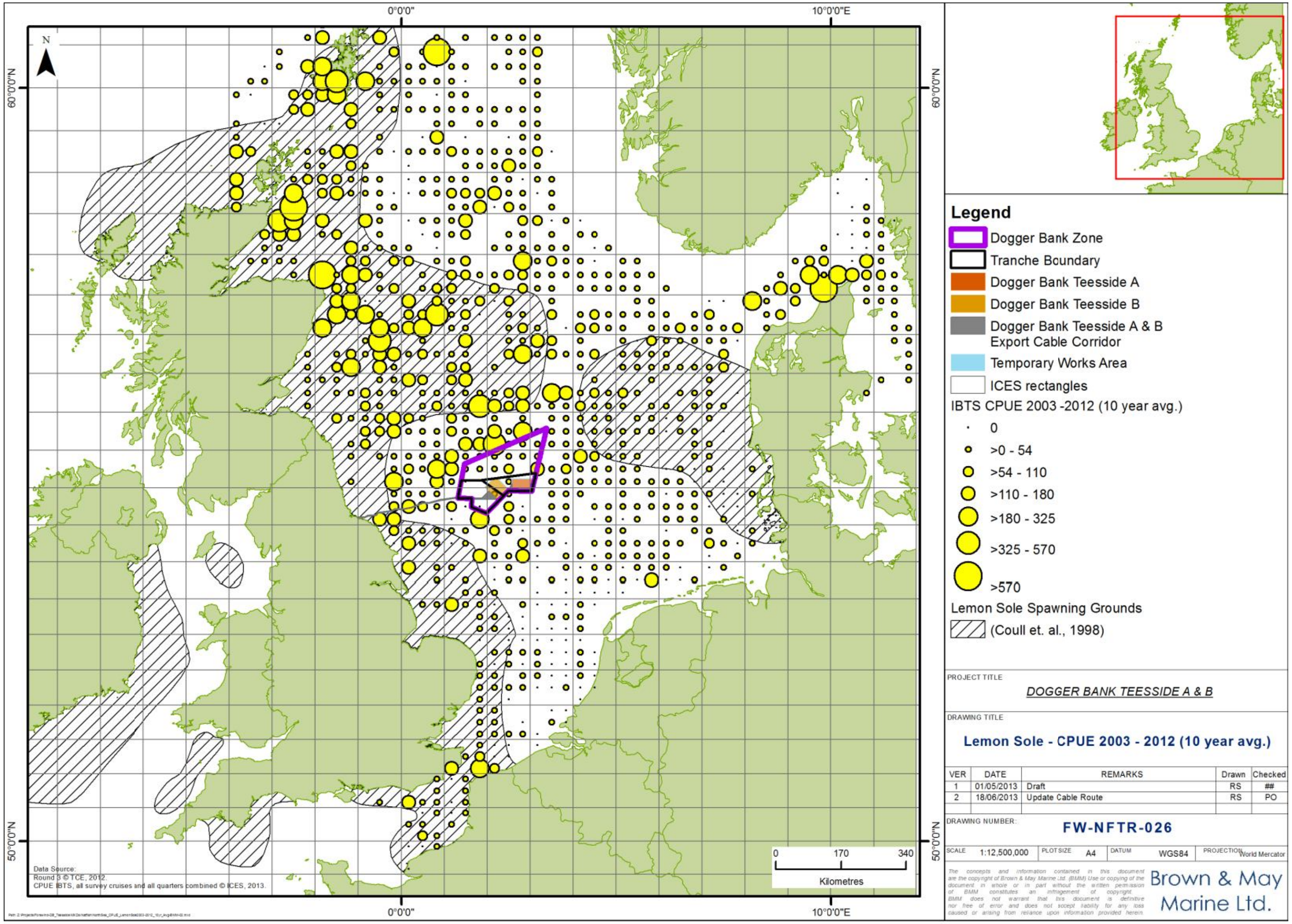


Figure 6.17 Average number (catch per standardised haul) of lemon sole from IBTS survey data 2003-2012

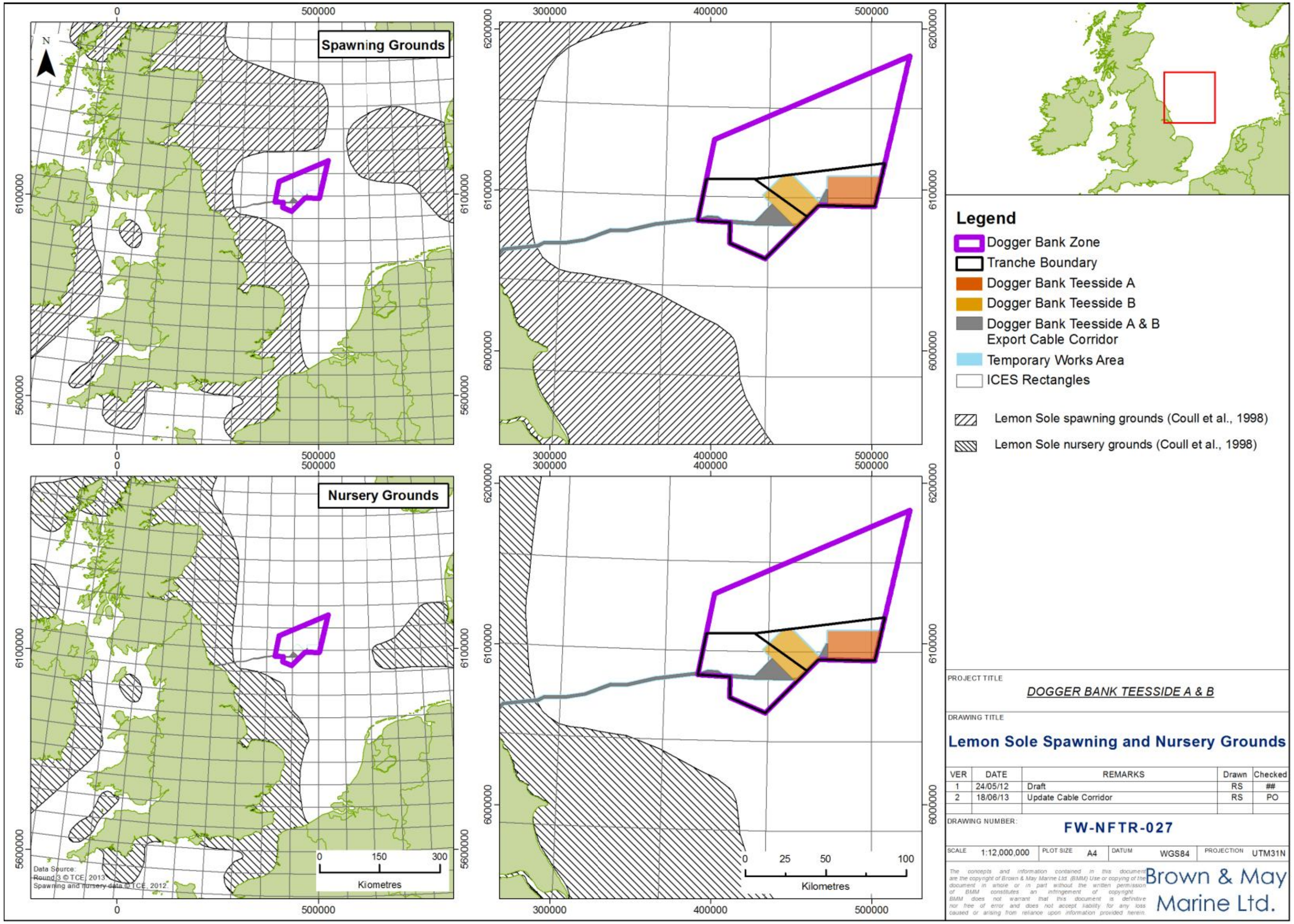


Figure 6.18 Distribution of lemon sole spawning and nursery grounds (Coull *et al.* 1998)

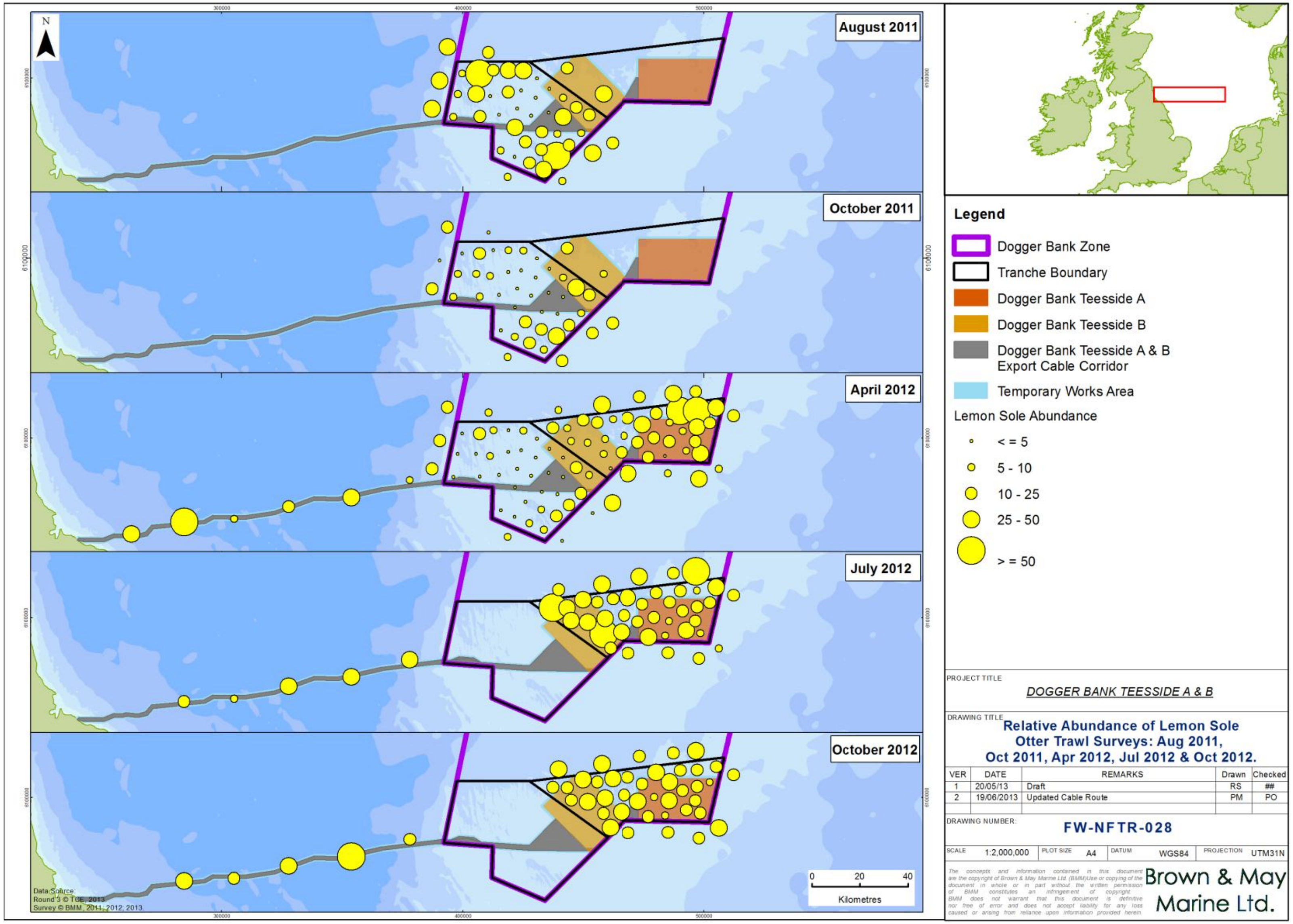


Figure 6.19 Average number (catch per standardised haul) of Lemon sole from IBTS survey data 2003-2012

6.1.6 Grey Gurnard

6.1.6.1 General

161. Grey gurnard are a demersal species found on sand, rock or mud down to depths of 140m (Barnes 2008a). The species is typically associated with offshore areas (such as the Dogger Bank) where they are most common at depths in the 20-50m range (Wheeler 1978). Grey gurnard is the most common gurnard species found in the North Sea.

162. Grey gurnard eat benthic crustaceans, such as brown and pink shrimp, small crabs, and fish, such as gobies and dragonets (Wheeler 1978). Research examining the diet of grey gurnard on the Dogger Bank (Weinert *et al.,* 2010) found that shrimp *Crangon allmani* and sandeels were the most common prey items observed in stomach contents of fish captured from shallow areas. In contrast, the most frequently observed prey in samples from deeper regions was the amphipod *Hyperia galba.* Accordingly, *C. allmani* was one of the more abundant species recorded during the Tranche B epibenthic survey (**Appendix 12A Epibenthic Survey Report**).

6.1.6.2 Distribution

163. An indication of the distribution of grey gurnard in the North Sea is given in **Figure 6.20** based on average abundances recorded from 2003 to 2012 in IBTS surveys. The species is abundant at sites to the north and east of the Wind farm area but very few individuals were captured at sites within tranche A or tranche B, where Dogger Bank Teesside A & B are located. Large numbers of grey gurnard were also found at sites in the vicinity of the offshore section of the Dogger Bank Teesside A & B Export Cable corridor.

6.1.6.3 Life History

164. Grey gurnard is thought to concentrate in the central western North Sea in the winter and spread into the southern part during spring to spawn (ICES 2005). Spawning is thought to occur from April to August (Wheeler 1978).

165. Gurnards have a strong seasonal migration through the North Sea and forms dense semi-pelagic aggregations to the northwest of Dogger Bank (ICES 2005, Greenstreet *et al.,* 2007) in winter, before dispersing and becoming more widespread during summer months.

6.1.6.4 Exploitation

166. Grey gurnard is taken as by-catch in demersal fisheries, part of which is landed for human consumption (Heessen and Daan 1996). As suggested by the landings data shown in Section 5.4, grey gurnard are recorded in commercial landings in the Export Cable Study Area and, more significantly, in the Wind

Farm Study Area (particularly in ICES rectangle 38F2 where Dogger Bank Teesside B is located).

6.1.6.5 Management

167. There is currently no management for any of the gurnard species in the EU. The status of the stock of grey gurnard is unknown and reference points are not defined. ICES advises that catches should not be allowed to increase in 2013 (ICES 2012). Survey indices for the North Sea suggest that the abundance of this species has been increasing since the late 1980s.

6.1.6.6 Site Specific Information

168. Grey gurnard were the most abundant species found in the otter trawl surveys carried out in tranches A and B (**Table 5.3** and **Table 5.4**). An indication of its seasonal spatial distribution as derived from the results of the otter trawl surveys is given in **Figure 6.21** below. As shown, grey gurnard were found at sites in Dogger Bank Teesside A & B and along the route of the Dogger Bank Teesside A & B Export Cable Corridor in all otter trawl surveys.

169. In addition to grey gurnard, other species of gurnard were found in the otter trawl surveys carried out in tranches A, and B including red gurnard *Aspitrigla cuculus* and tub gurnard *Trigla lucerna.* These were, however, recorded in very low numbers.

6.1.6.7 Conservation status

170. Grey gurnard is not listed for conservation status.

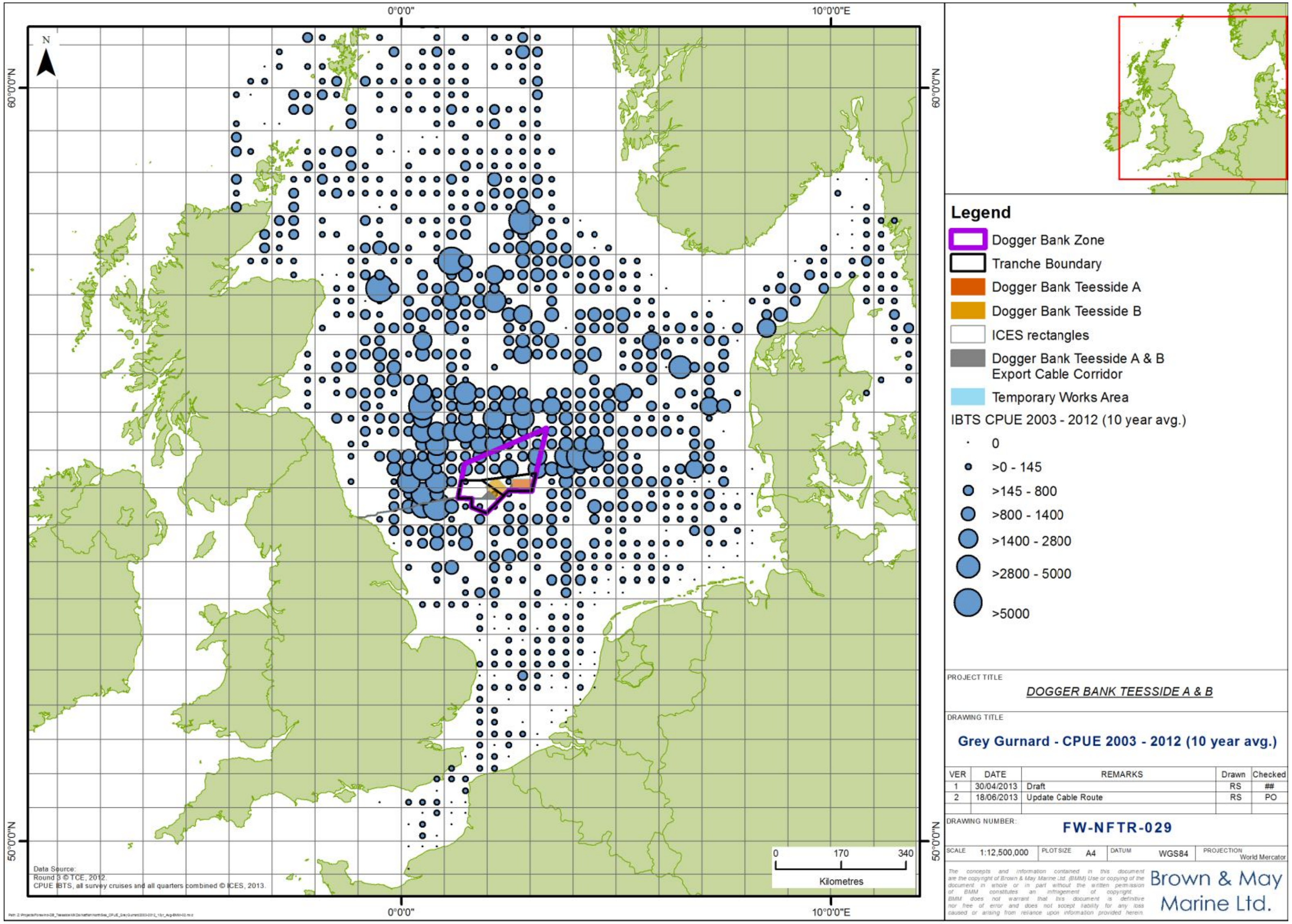


Figure 6.20 Average number (catch per standardised haul) of Grey gurnard from IBTS survey data 2003-2012

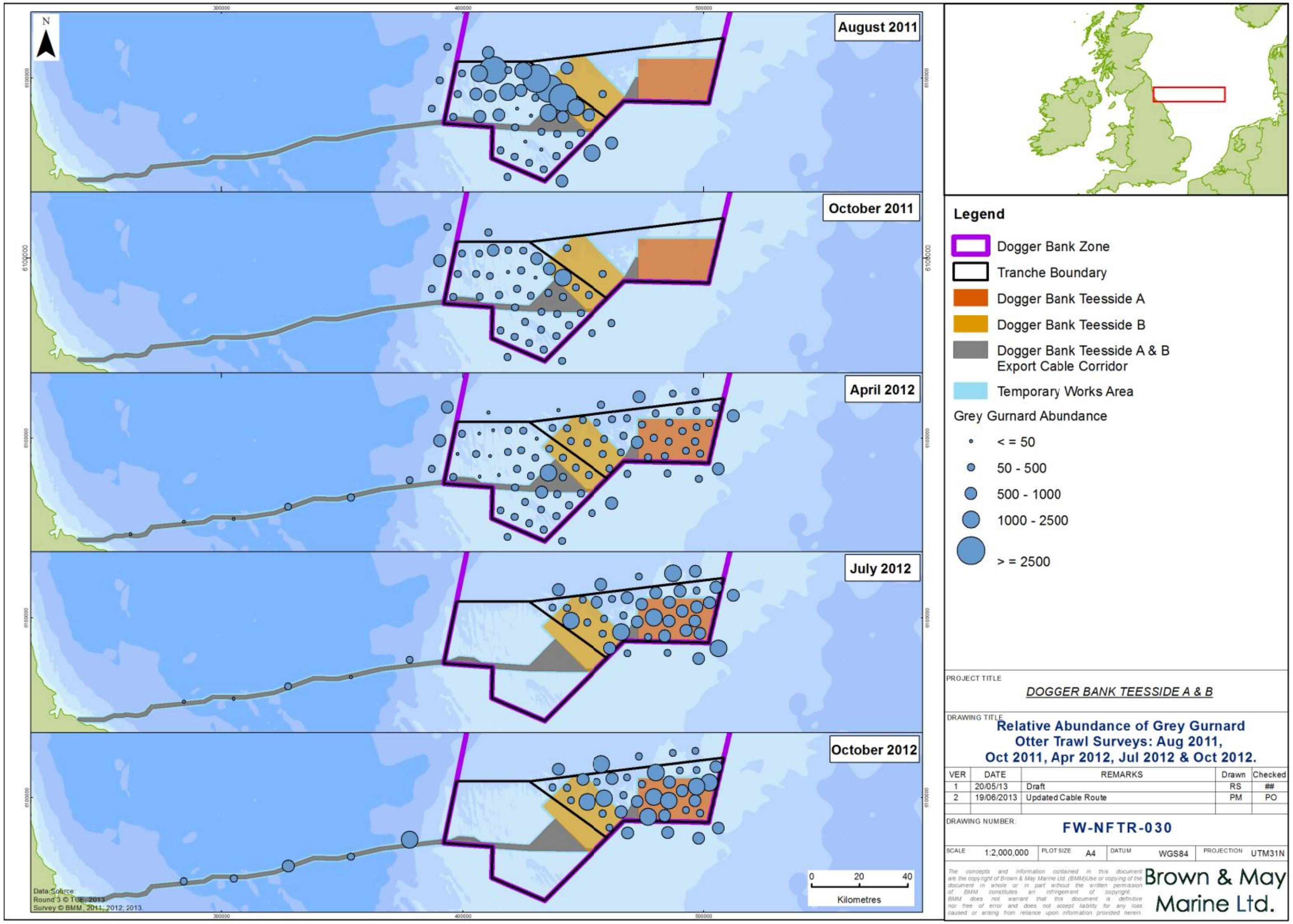


Figure 6.21 Seasonal Distribution of Grey Gurnard within tranches A and B and along the Teesside Export Cable Corridor

6.1.7 Whiting

6.1.7.1 General

171. Whiting is a bentho-pelagic species very common in shallow waters, being most abundant between 30m and 100m. They are generally found near mud and gravel substrates, but also on sandy and rocky areas (Wheeler 1978, Barnes 2008b).

172. Adult whiting feed almost entirely on fish, including a variety of small species such as Norway pout, sprat and sandeel, and the younger age classes of larger species such as herring, cod, and haddock. Immature fish feed primarily on crustaceans such as euphausiids, mysids and crangonid shrimps (Hislop *et al.,* 1991, ICES 2005, Wheeler 1978). During the night they primarily feed on bottom-dwelling prey, whilst feeding on pelagic prey during daylight (ICES 2005).

6.1.7.2 Distribution

173. Whiting are widely distributed throughout the North Sea with high densities of both juvenile and adult whiting being found almost anywhere. An exception to this is the Dogger Bank area, which generally shows a marked gap in their distribution (ICES 2005).

174. The distribution of whiting in the North Sea, based on average abundance in IBTS surveys for the period 2003 to 2012, is given in **Figure 6.22**. As shown, whiting tend to be present in relatively high numbers to the east and south of the Dogger Bank Zone and in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor. Relatively few whiting were recorded within tranches A and B.

6.1.7.3 Life History

175. Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within defined spawning and nursery grounds for whiting as illustrated in **Figure 6.23** (Ellis *et al.,* 2010). Spawning takes place from February to June (Coull *et al.,* 1998) but mostly in spring, in shallow water (Wheeler 1978).

6.1.7.4 Exploitation

176. Whiting is generally considered of secondary commercial importance. They are caught in large numbers throughout the entire North Sea; however, large quantities of the catch tend to be discarded (ICES 2005). As suggested by UK landings data (Section 5.4), whiting is one of the main species landed from the Export Cable Study Area. This species is also of commercial importance to non-UK fleets, particularly the French, which hold historic fishing rights between the 6 and 12nm limits off the east coast of England (see *Chapter 15 - Commercial Fisheries*).

6.1.7.5 Management

177. Reference points for whiting are not defined but ICES is currently developing and evaluating a management plan for this stock. ICES has advised that landings of whiting in the North Sea and Eastern Channel should not exceed 26,000 tonnes in 2013 (ICES 2012a).

6.1.7.6 Site Specific Information

178. An indication of the seasonal distribution of whiting in tranches A and B and along the Dogger Bank Teesside A & B Export Cable Corridor, as recorded in site specific otter trawl surveys, is given in **Table 5.3** and **Table 5.4**. In general terms, the highest catch rates were found at sites along the western edge of tranche A and within Dogger Bank Teesside A & B. Whiting were also recorded in relatively high numbers in a number of stations along the Dogger Bank Teesside A & B Export Cable Corridor. During the pelagic fish survey carried out in September, they were also recorded in high numbers at stations located along the Dogger Bank Teesside A & B Export Cable Corridor (**Figure 6.24** Similarly, they were one of the most abundant species recorded in the trammel net surveys carried out in the inshore area of the Dogger Bank Teesside A & B Export Cable Corridor (**Table 5.9**)

6.1.7.7 Conservation status

179. Whiting is listed as a UK BAP priority species (see **Table 5.20**)

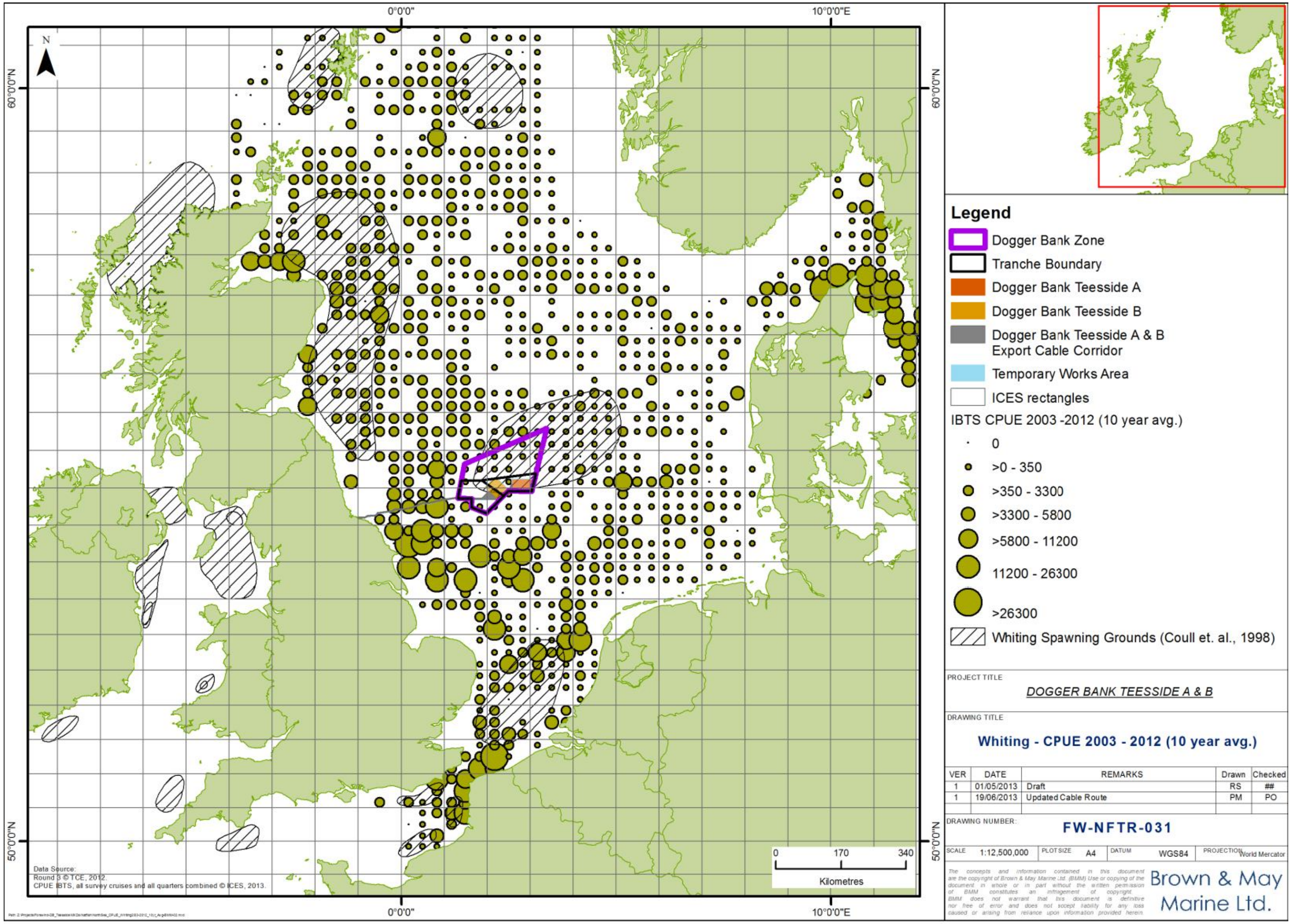


Figure 6.22 Average number (catch per standardised haul) of Whiting from IBTS survey data 2003-2012

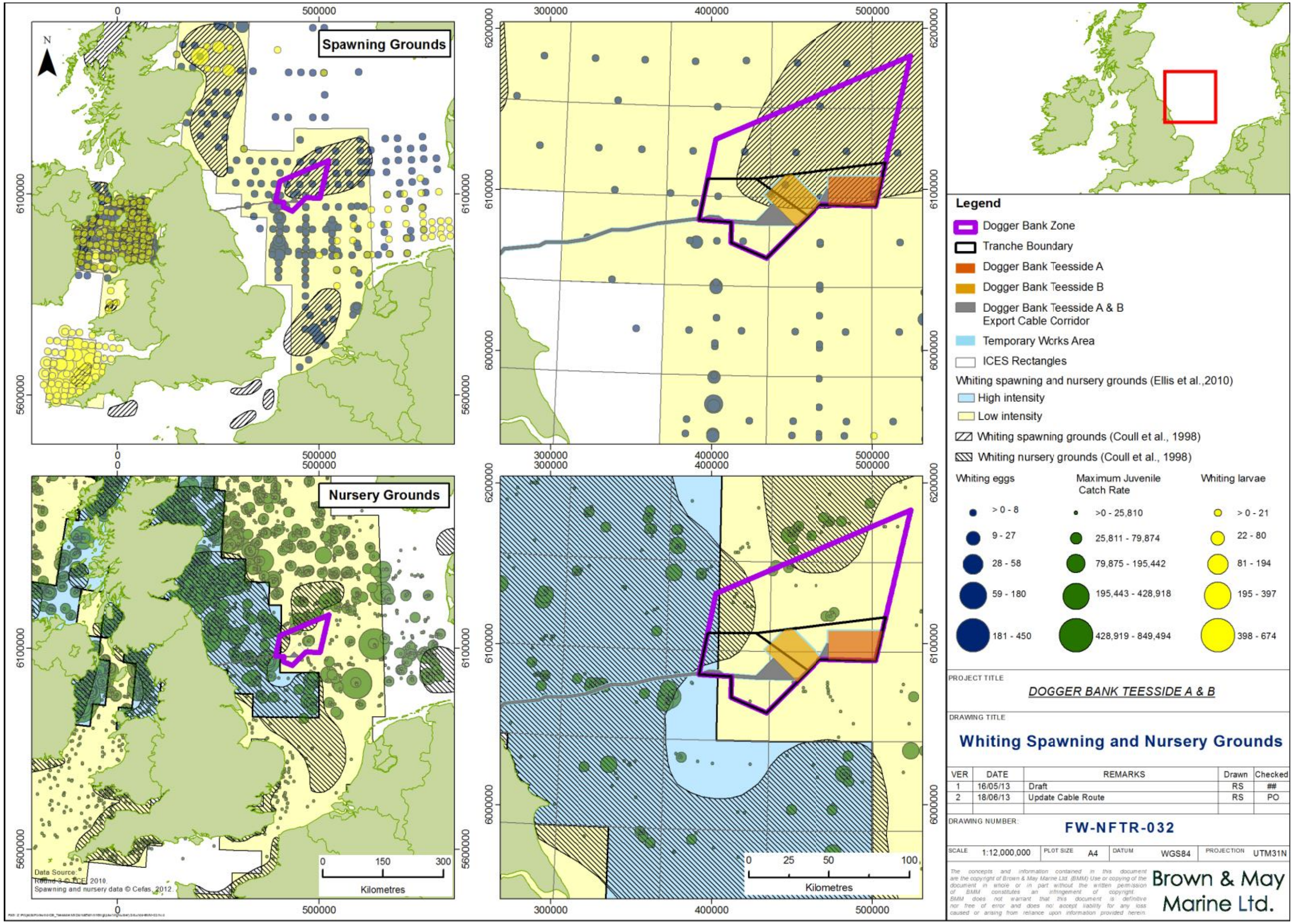


Figure 6.23 Whiting Spawning and Nursery Grounds (Modified from Ellis *et al.,* 2010 and Coull *et al.,* 1998)

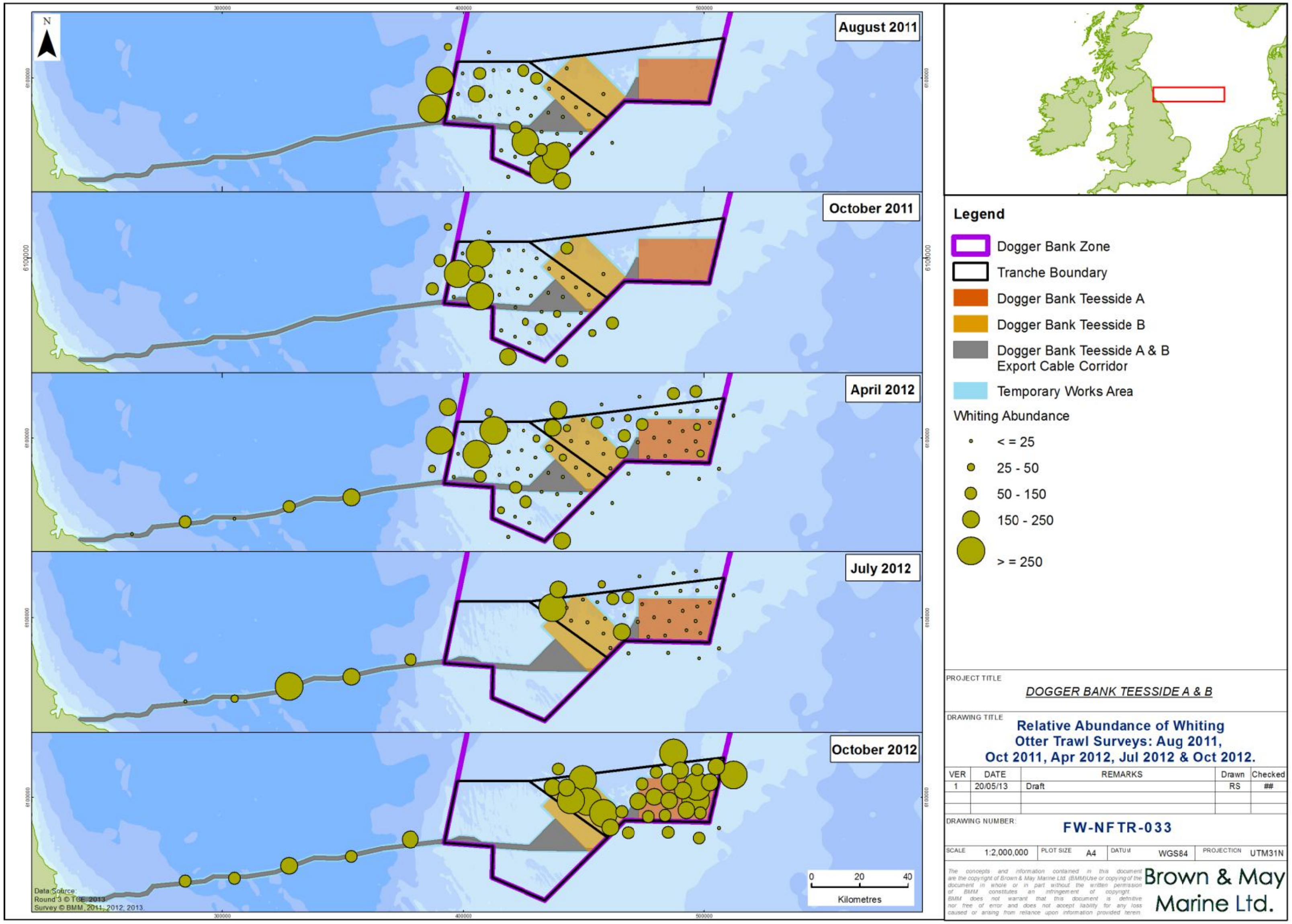


Figure 6.24 Seasonal Distribution of Whiting within tranches A and B and along the Dogger Bank Teesside A & B Export Cable Corridor

6.1.8 Cod

6.1.8.1 General

180. Cod feed mainly on copepods when young, becoming increasingly dependent on fish as they age, preying on herring, poor cod, haddock and even other cod (Wilding and Heard 2004, Wheeler 1978, Arnett and Whelan 2001).

6.1.8.2 Distribution

181. Cod is widely distributed in the North Sea (Heessen 1993), being found from shallow coastal waters to the shelf edge (200m depth) and even beyond (ICES 2005) (**Figure 6.25**). South of the Dogger Bank, adult cod are thought to migrate southward for spawning during autumn and north again to feeding grounds in the spring (ICES 2005).

6.1.8.3 Life History

182. The distribution of spawning and nursery grounds for cod is illustrated in **Figure 6.26**.Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within defined low intensity spawning grounds for this species.

183. The distribution of stage I cod eggs derived from the first ichthyoplankton survey (Fox *et al.,* 2008) to cover the whole North Sea, undertaken in 2004, is illustrated in **Figure 6.27**. As shown, Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor are located at considerable distance from areas of high cod egg production. This was also the first survey to make extensive use of DNA-based molecular methods to identify early developmental stage cod eggs. Fox *et al.,* (2008) compared the findings of the ichtyoplankton survey with estimated egg production inferred from the distribution of mature cod in contemporaneous trawl surveys and found that hot spots of cod egg production were located around the southern and eastern edges of the Dogger Bank, in the German Bight, the Moray Firth and to the east of the Shetlands. Significant numbers of cod eggs at the historic spawning ground off Flamborough (northeast coast of England) were not found. The results suggest that most of the major spawning grounds of cod in the North Sea are still active but that some localised populations may have been reduced to the point where it is now difficult to detect the presence of eggs in the plankton (Fox *et al.,* 2008).

6.1.8.4 Exploitation

184. As suggested by landings data, cod is, in general terms, of secondary commercial importance in the Wind Farm Study Area (See **Table 5.13**,

185.

186. Table 5.14 and **Chapter 15 Commercial Fisheries**). Landings for this species are, however, of relative importance in the Export Cable Study Area, particularly in rectangles 38E8 and 38E9 (**Table 5.15** and **Table 5.16**).

6.1.8.5 Management

187. ICES has advised that landings of cod in the North Sea, Eastern Channel and Skagerrak should not exceed 25,441 tonnes in 2013. There has been a gradual improvement in the status of the stock over the last few years but the North Sea stock is classified as suffering from reduced reproductive capacity and depleted to a level at which productivity is impaired. Recruitment since 2000 has been poor (ICES 2012).

6.1.8.6 Site Specific Information

188. Cod was among the principal species caught in the otter trawl surveys in tranche A but relatively few individuals were recorded in tranche B and along the Export Cable Corridor (**Figure 6.28**). Cod were also captured during trammel net surveys (**Table 5.9**).

6.1.8.7 Conservation status

189. As shown in **Table 5.20**, cod is listed as a UK BAP priority species. In addition, they are included in the OSPAR list of threatened and/or declining species. The IUCN defines the status of the species as “Vulnerable”.

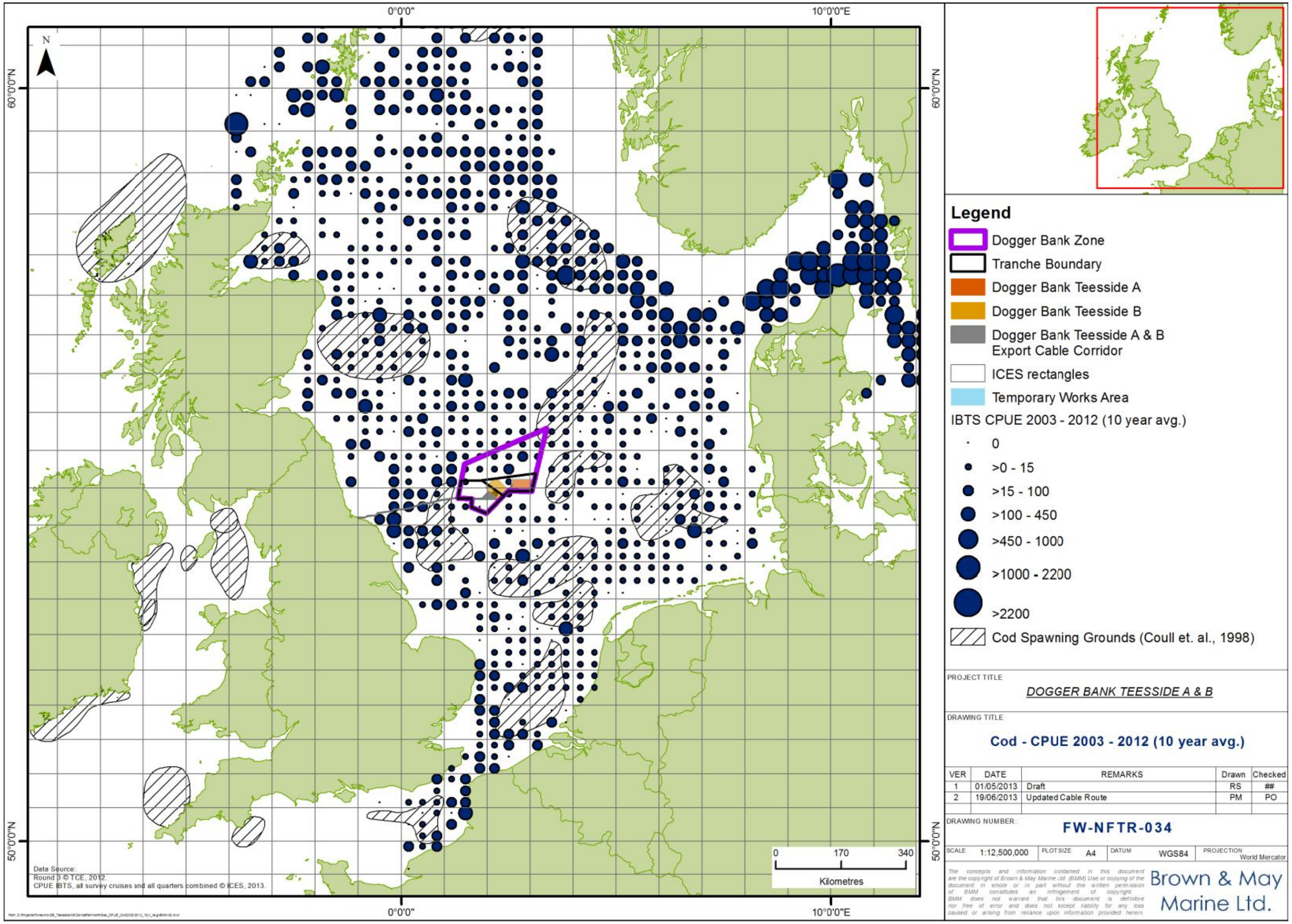


Figure 6.25 Average number (catch per standardised haul) of Cod from IBTS survey data 2003-2012

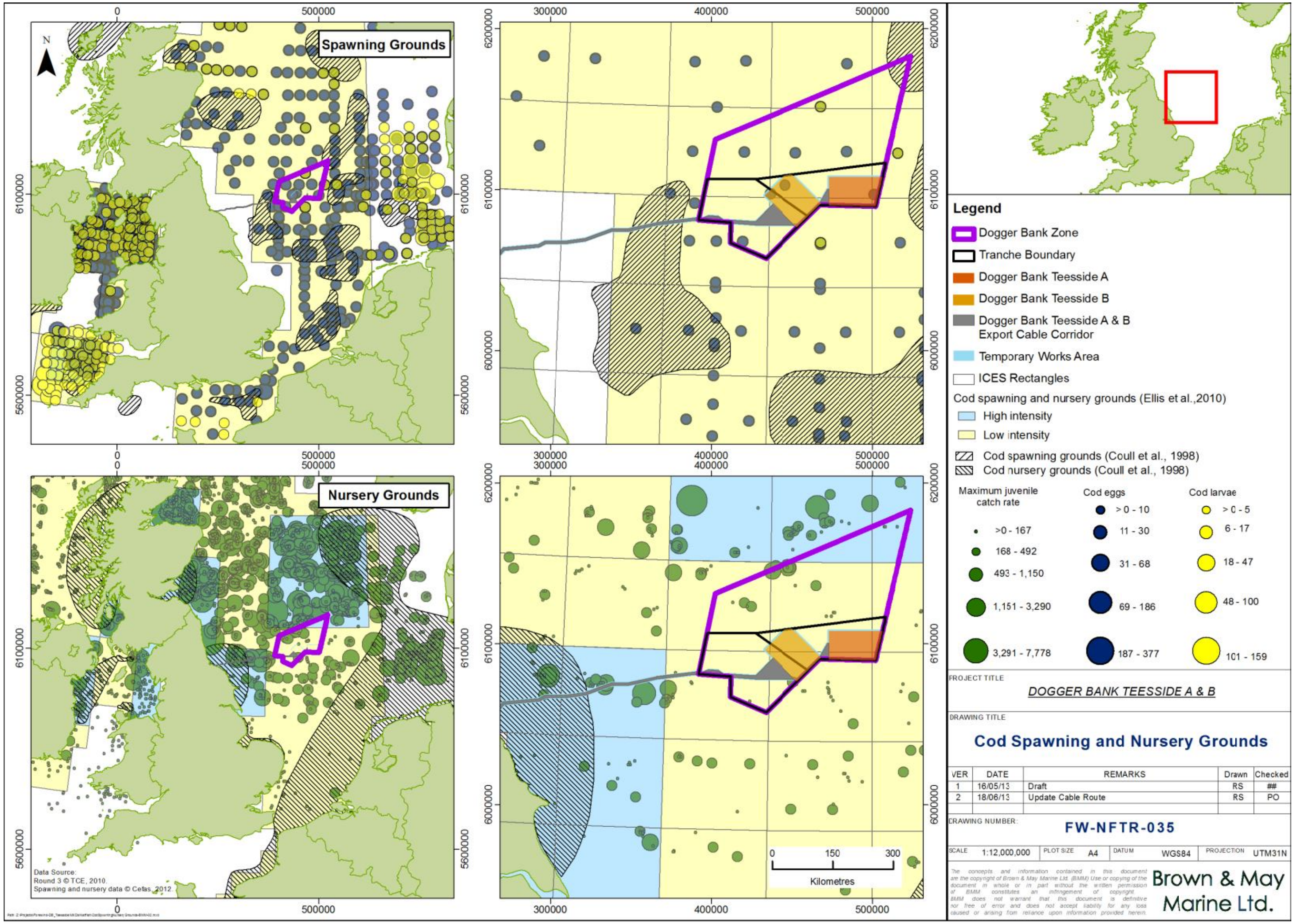


Figure 6.26 Cod Spawning and Nursery Grounds (Modified from Ellis *et al.*, 2010 and Coull *et al.*, 1998)

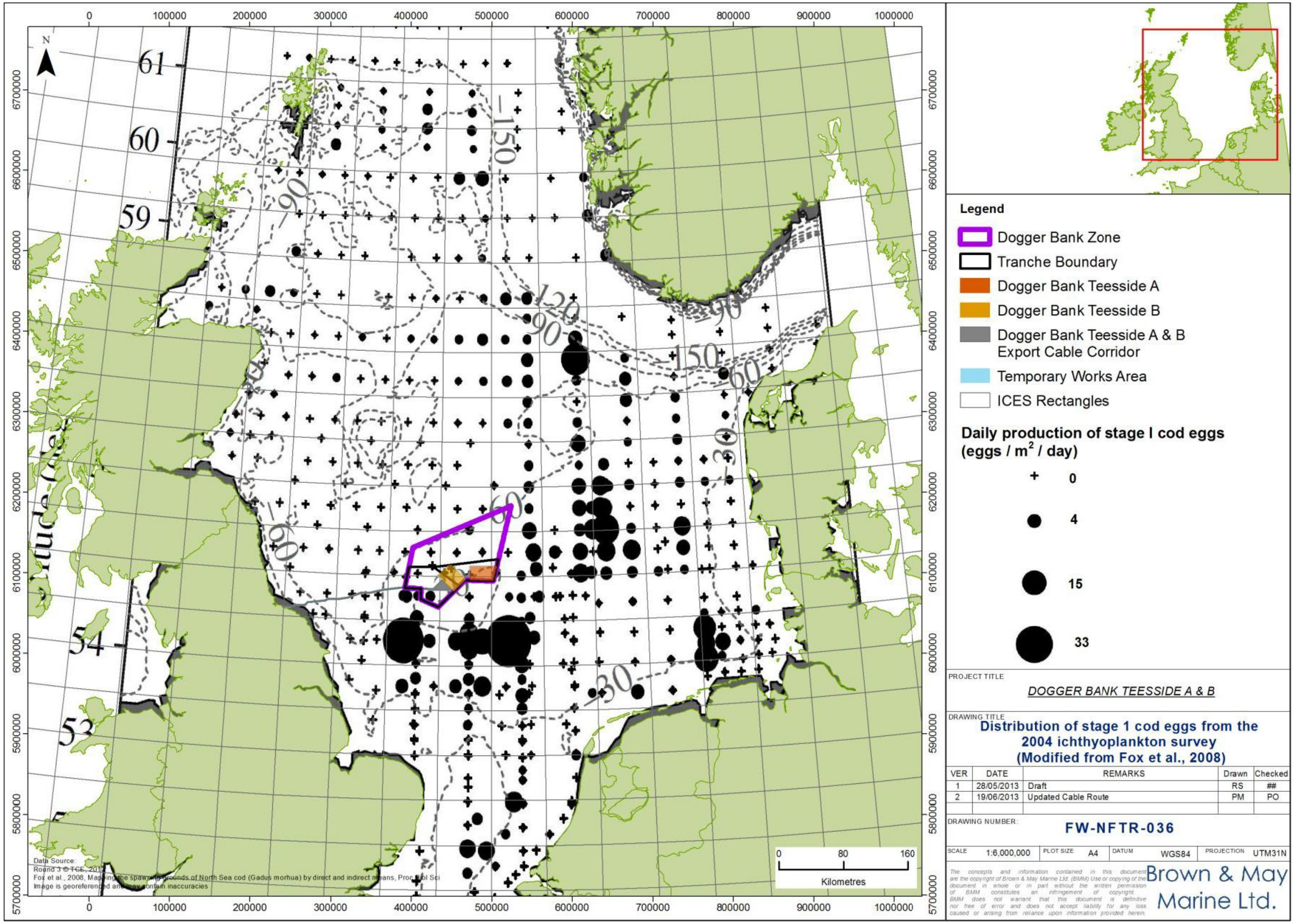


Figure 6.27 Distribution of Stage I Cod Eggs from the 2004 Icthyoplankton Surveys (modified from Fox *et al.,* 2008)

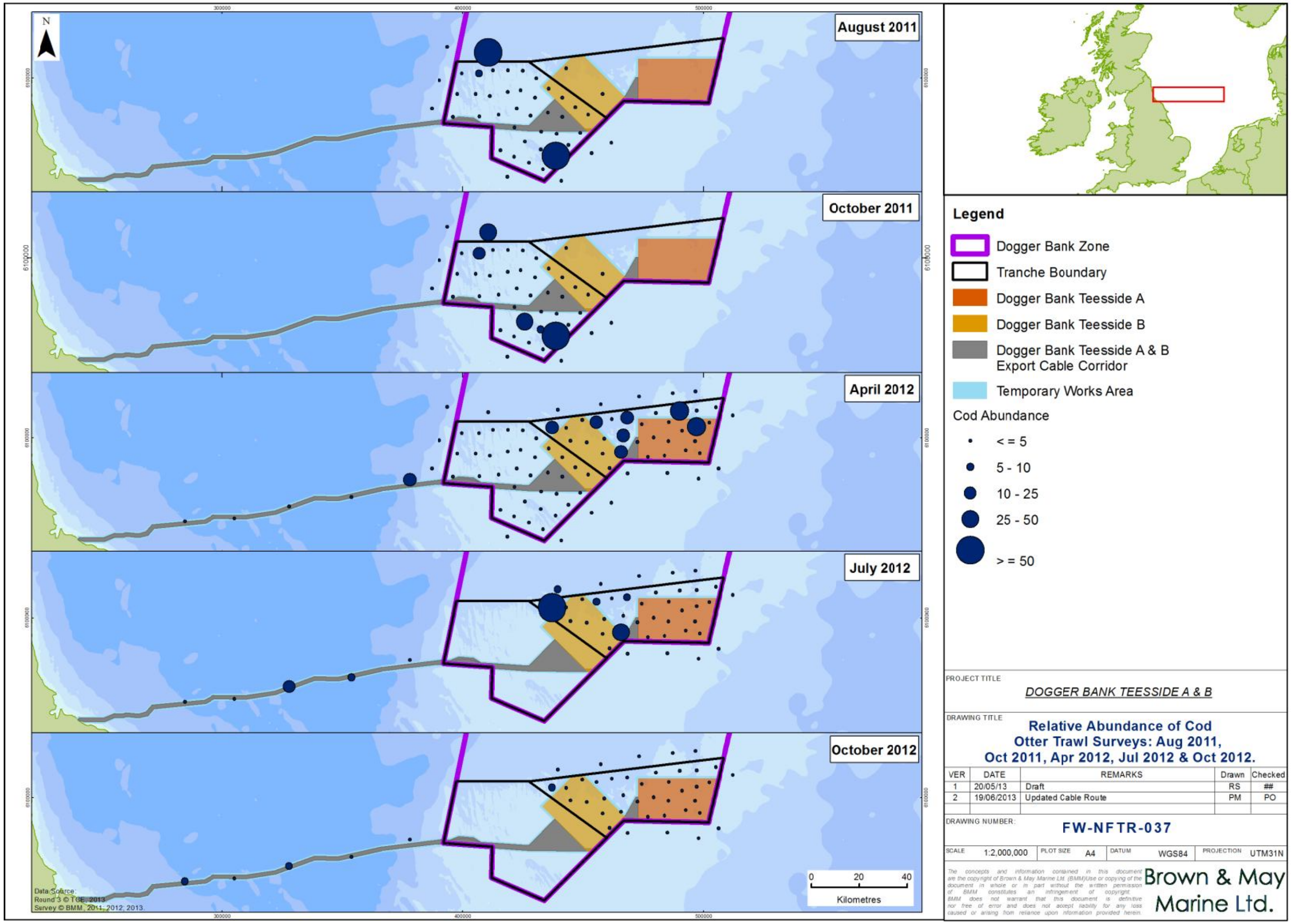


Figure 6.28 Seasonal Distribution of Cod within tranches A and B and along the Dogger Bank Teesside A & B Export Cable Corridor

6.1.9 Turbot

6.1.9.1 General

190. Turbot are visual feeders and mainly feed on other benthic fishes and small pelagic species(ICES 2011a) including sandeels, sprat, herring, whiting, pouting *Trisopterus luscus* and less often other flatfish species, dragonets and gobies (Wheeler 1987).

6.1.9.2 Distribution

191. Turbot is most usually associated with sandy, gravel or shell gravel and occasionally muddy substrates or areas of mixed sand and rocks (Walters 2008) from 20m to 800m. They are distributed throughout the North Sea and occur within the Dogger Bank Zone Project area as shown in **Figure 6.29**. They are generally considered sedentary, although there are some indications of migratory patterns.

6.1.9.3 Life History

192. In the North Sea, migrations from the nursery grounds in the south-eastern part to more northerly areas have been recorded. Adult turbot are more tolerant of the colder conditions in the northern areas of the North Sea where temperatures are too low for juveniles to survive (ICES 2011a).

6.1.9.4 Exploitation

193. Turbot are a valuable by-catch in the fishery for flatfish and demersal species (ICES 2011a). The highest landings for this species are recorded in rectangle 38F2 (**Table 5.13** and

194.

195. **Table** 5.14) where Dogger Bank Teesside A & B are located. In addition to occurring as by catch from mixed flat fish fisheries prosecuted by demersal towed gear fisheries, turbot are also targeted directly by Danish vessels operating gill nets (*See Appendix 15: Commercial Fisheries Technical Report*).

6.1.9.5 Management

196. ICES have advised for 2012 and 2013 on the basis of precautionary consideration that catches should not increase (ICES 2012a).

6.1.9.6 Site Specific Information

197. Turbot were found in low numbers in the otter trawl surveys carried out in tranches A and B. However, as suggested in Section 5.4, they are of commercial

importance in the Wind Farm Study Area where they record the second highest landings by value after plaice.

6.1.9.7 Conservation status

198. Turbot is not listed for conservation status.

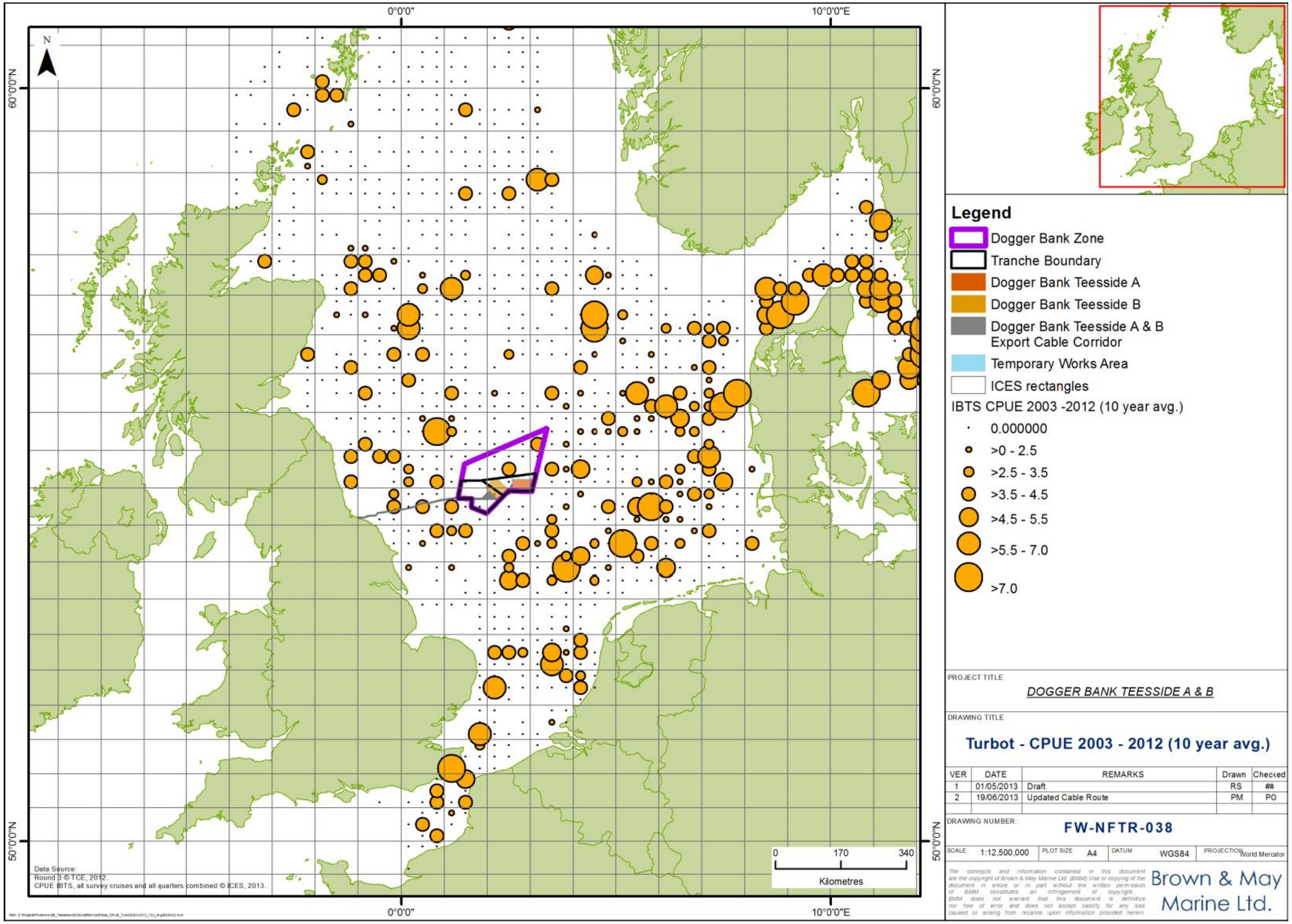


Figure 6.29 Average number (catch per standardised haul) of Turbot from IBTS survey data 2003-2012

6.1.10 Other demersal Species

6.1.10.1 Haddock

199. Haddock are demersal fish which shoal in colder waters at depths 40-300m. They can be found over rock, sand, gravel or shells (Barnes 2008c). In the North Sea, the bulk of haddock is found in the northerly areas. The southern distribution border extends from north-east England, along the Dogger Bank, to Skagerrak and Kattegat and closely follows the 50m depth contour (ICES 2005). They mainly feed on brittlestars, worms and molluscs although occasionally they eat small fish such as sandeels (Wheeler 1978).

200. They were recorded in relatively low numbers in the otter trawl surveys carried out in tranches A and B. As shown in Section 5.4, haddock are, however, amongst the principal fish species landed by weight and to a lesser extent by value in the Wind Farm Study and Export Cable Study Area. Haddock is a specific target for some fleets, although it is also caught as part of a mixed fishery catching cod, whiting and *Nephrops* (ICES 2012a).

201. ICES has advised (June 2012), on the basis of the EU-Norway management plan, that landings of North Sea haddock should not be more than 47,811 tonnes in 2013 (ICES 2012a).

6.1.10.2 Angler Fish

202. Anglerfish *Lophius piscatorius* occur in coastal waters all around Britain and Ireland, being most common on the west coast of England, Wales and Scotland and north, south and east coasts of Ireland (Reeve 2008). Relatively few anglerfish were recorded by IBTS surveys in the central and southern sectors of the North Sea and few fish were caught in the Project area (**Figure 6.30**). They are found on sandy, shell or gravel substrates being less frequently found on muddy or rough grounds and generally feed on smaller fish (Wheeler 1978).

203. Spawning takes place in spring and early summer (Wheeler 1978). It appears to occur mainly in deep water off the edge of the continental shelf, although mature females are rarely encountered (ICES 2012b). The area of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within the broad low intensity nursery grounds defined for this species (Ellis *et al.,* 2010). The distribution of these is shown in **Figure 6.31.**

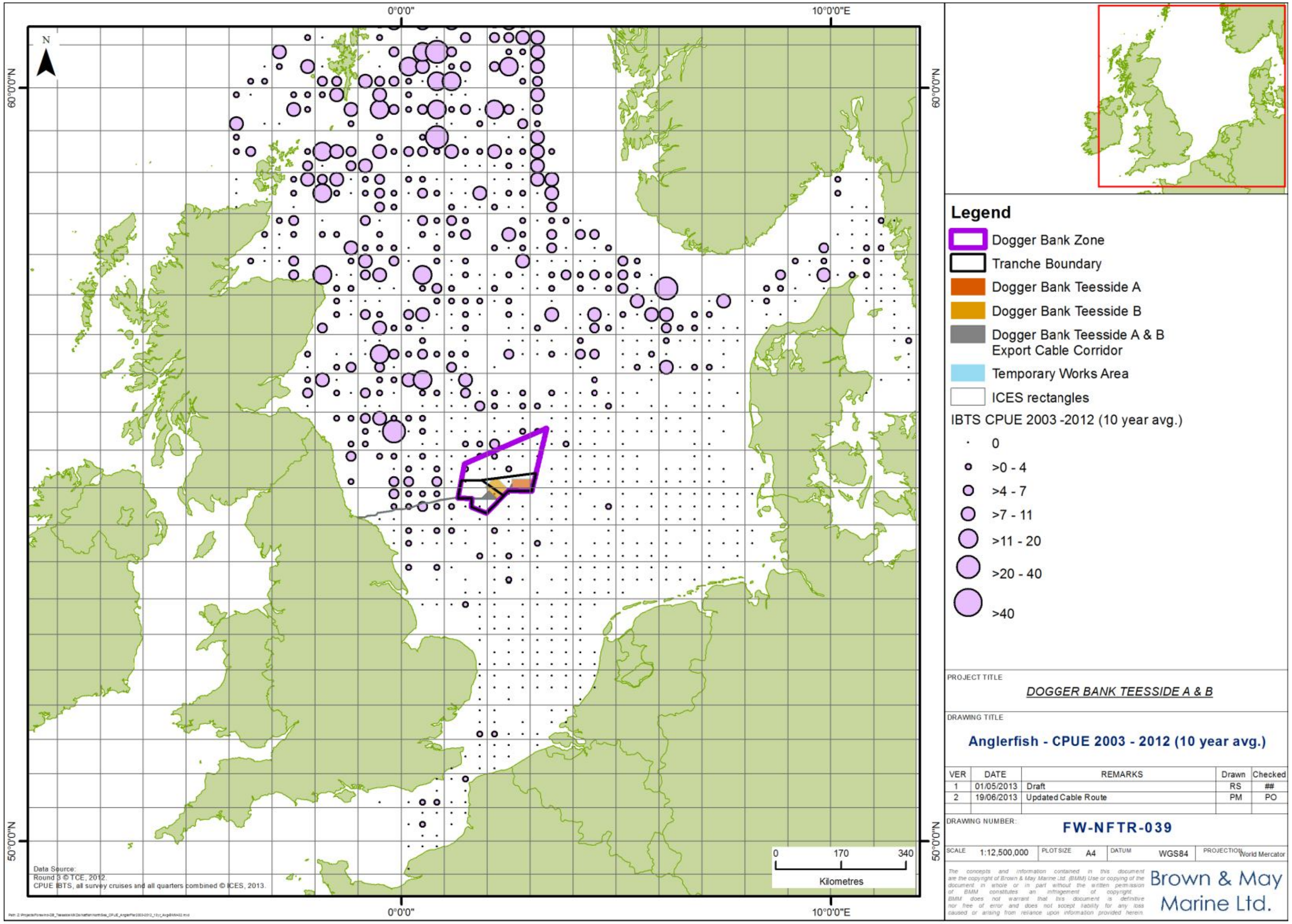


Figure 6.30 Average number (catch per standardised haul) of Anglerfish from IBTS survey data 2003-2012

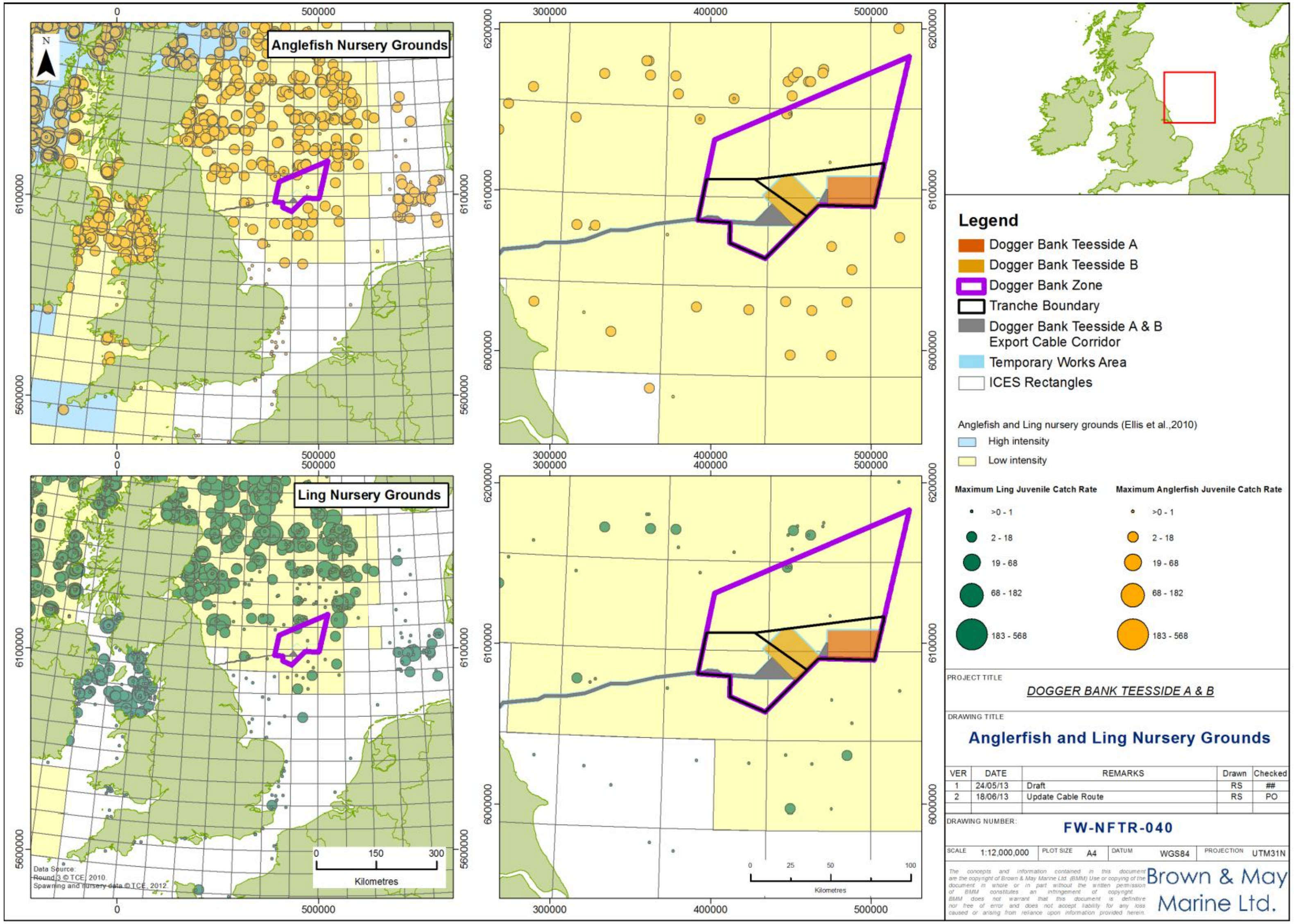


Figure 6.31 Distribution of Anglerfish and Ling Nursery Grounds (Ellis *et al.,* 2010)

204. In the North Sea, anglerfish are mainly caught as bycatch in demersal fisheries for mixed roundfish and *Nephrops* (ICES 2012b). As shown in Section 5.4, they record relatively low landings weights and values in the Wind Farm and Export Cable Study Areas. They were found in comparatively low numbers in the August 2011 otter trawl surveys carried out in Tranche A and were recorded in all otter trawl surveys conducted in Tranche B.

205. As shown in **Table 5.20,** they are of conservation interest being listed as UK BAP species.

6.1.10.3 Ling

206. Ling *Molva molva* is mainly a deep-water fish, being most abundant at depths of 300-400m and on rocky substrates (Wheeler 1978). Juveniles, and occasionally adults, are however found in shallow waters (Rowley 2008).

207. Ling are primarily piscovorous feeding on a variety of species including Norway pout, cod, blue whiting *Micromesistius poutassou* and herring. Invertebrates such as large crustaceans may also be consumed less frequently . Spawning occurs between March and August at depths of 100m to 300m. The principal spawning grounds are found to the North of the British Isles (Wheeler 1978, Rowley 2008). As illustrated in **Figure 6.31**, Dogger Bank Teesside A & B and the offshore section the Dogger Bank Teesside A & B Export Cable Corridor fall within the broad nursery grounds defined for this species (Ellis *et al.,* 2010).

208. Ling were found in very low numbers in the otter trawl surveys carried out in Tranche A. MMO landings data (Section 5.4) suggests the species is of little commercial importance within either the Wind Farm or Export Cable Study Areas.

209. As shown in **Table 5.20** ling is currently listed as UK BAP species.

6.1.10.4 Blue Whiting

210. Blue whiting is a bentho-pelagic species found off northern Scotland, in the North Sea and off the southern and western coasts of Ireland and the British Isles (Barnes 2008d). Spawning generally takes place along the shelf edge and on banks west of the British Isles. Juveniles are also widely distributed, with the main nursery area believed to be in the Norwegian Sea (ICES 2011 Book 9 advice). Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within the broad low intensity nursery grounds defined for this species (**Figure 6.32**). Blue whiting feeds primarily on crustaceans and it is important as prey for a larger fish species such as ling, cod, hake and deep water sharks (Wheeler 1978). In addition, as shown in **Table 5.20**, it is of conservation interest, being listed as a UK BAP species.

211. Blue whiting are not of commercial importance in the Wind Farm and the Export Cable Study Areas. This species is, however, commercially targeted both for human consumption and industrial purposes in other areas (i.e. south of the Faroes, west of Scotland and around the Porcupine Bank) (ICES 2011 Book 9). This species was not recorded in either the otter trawl surveys or in the pelagic survey.

6.1.10.5 Hake

212. Hake are usually found at depths of 70-350m, feeding alone on the seabed, or in shoals in the water column (Barnes 2008e). They may, however, be found in shallower waters in the summer. They primarily feed on fish and squid with crustaceans also being an important dietary component, particularly for young fish (Wheeler 1978).

213. Spawning takes place in spring and summer at depths of around 200m. The eggs and larvae then drift into inshore waters, where juvenile fish remain during their first year of life (Wheeler 1978). As shown in **Figure 6.32**,Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within low intensity nursery grounds defined for this species (Ellis *et al.,* 2010).

214. Hake were found in very low numbers in the otter trawl surveys carried out in tranches A and B. As suggested by MMO landings data (Section 5.4) hake are of secondary importance in the Wind Farm Study Area (**Figure 4.1**), with the landings by value and weight being comparatively low (**Table 5.13** and **Table 5.14**) The majority of the landings of hake within the Wind Farm Study Area are recorded in ICES rectangles 38F2 and 39F2.

215. Hake is of conservation interest, being listed as a UK BAP species (**Table 5.20**).

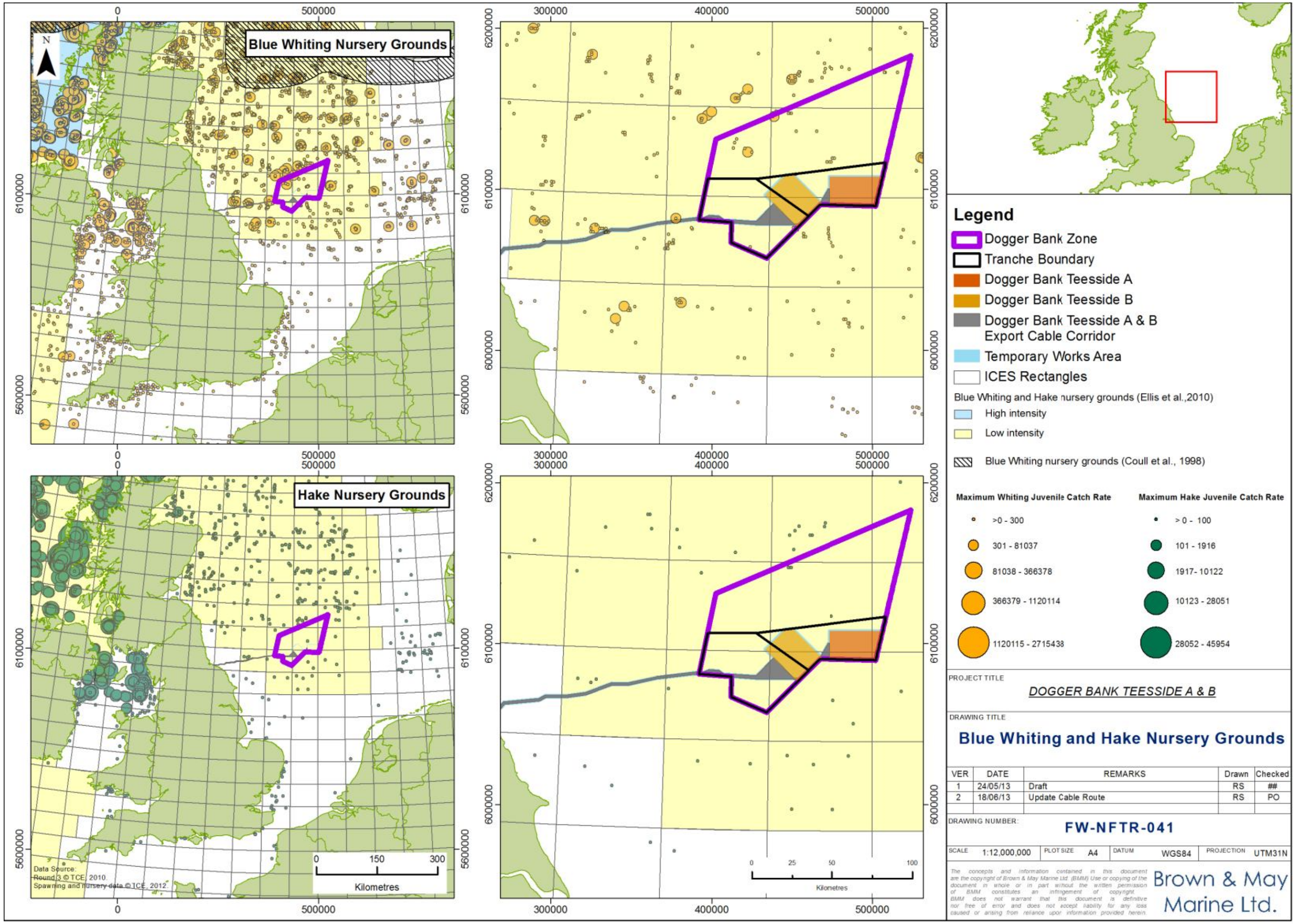


Figure 6.32 Distribution of Blue Whiting and Hake Nursery Grounds (Ellis *et al.,* 2010)

6.1.11 Non–Commercial Species

216. In addition to the species above, non-commercial demersal species such as solenette and gobies constitute an important component of the fish assemblage of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. These were among the principal species found in the 2m beam trawl surveys carried out in tranches A and B (**Table 5.5** and **Table 5.6**).

217. Solenette are common on sandy substrates, offshore in depths of 5m to 40m (Wheeler 1978, Ruiz 2007d). They are principally present in waters moderately influenced by estuaries, being rare in very estuarine and shallow waters (Amara *et al.,* 2004). They feed on small, bottom-living animals, particularly small crustaceans and worms, but also molluscs and fish (Ruiz 2007b, Amara *et al.,* 2004). Spawning takes place in the summer and both the eggs and larvae are pelagic (Wheeler 1978).

218. An indication of the seasonal distribution of solenette in Dogger Bank Teesside A & B and along the Dogger Bank Teesside A & B Export Cable Corridor is given in **Figure 6.33,** based on catch (catch rates) by sampling station recorded in the 2m beam trawl surveys carried out in tranches A and B (**Table 5.6**).

219. A number of species of goby were recorded in the area during the beam trawl survey including sand goby *Pomatochistus minutus*, painted goby *Pomatochistus pictus* and transparent goby *Aphia minuta*. Of these, sand goby and painted goby were the species found in greatest numbers (**Table 5.5** and **Table 5.6).**

220. Sand goby are abundant along all British coasts and are found on sandy or muddy substrates, generally at depths of about 20m (Riley 2007).The species was one of the most abundant recorded in Tranche A, Tranche B and along the Dogger Bank Teesside A & B Export Cable Corridor (**Table 5.5** and **Table 5.6**) . They move into deeper waters in the winter and spawn from March to July. Females lay their eggs in empty bivalve shells where they are guarded by the male (Wheeler 1978, Hamerlynck and Catrijsse 1994). Sand goby are important prey for many demersal fish (ICES 2005), being consumed by 0-group gadoids and a number of other species including bullrout *Myoxocephalus scorpius*, pouting and bass *Dicentrarchus labrax* (Hamerlynck and Catrijsse 1994). They are also preyed upon by sea birds such as terns (Hamerlynck and Catrijsse 1994, Wheeler 1978). In addition, sand goby are of conservation interest, being protected under the Bern Convention, Appendix III. They primarily feed on small crustaceans, particularly copepods, amphipods and brown shrimps (Wheeler 1978).

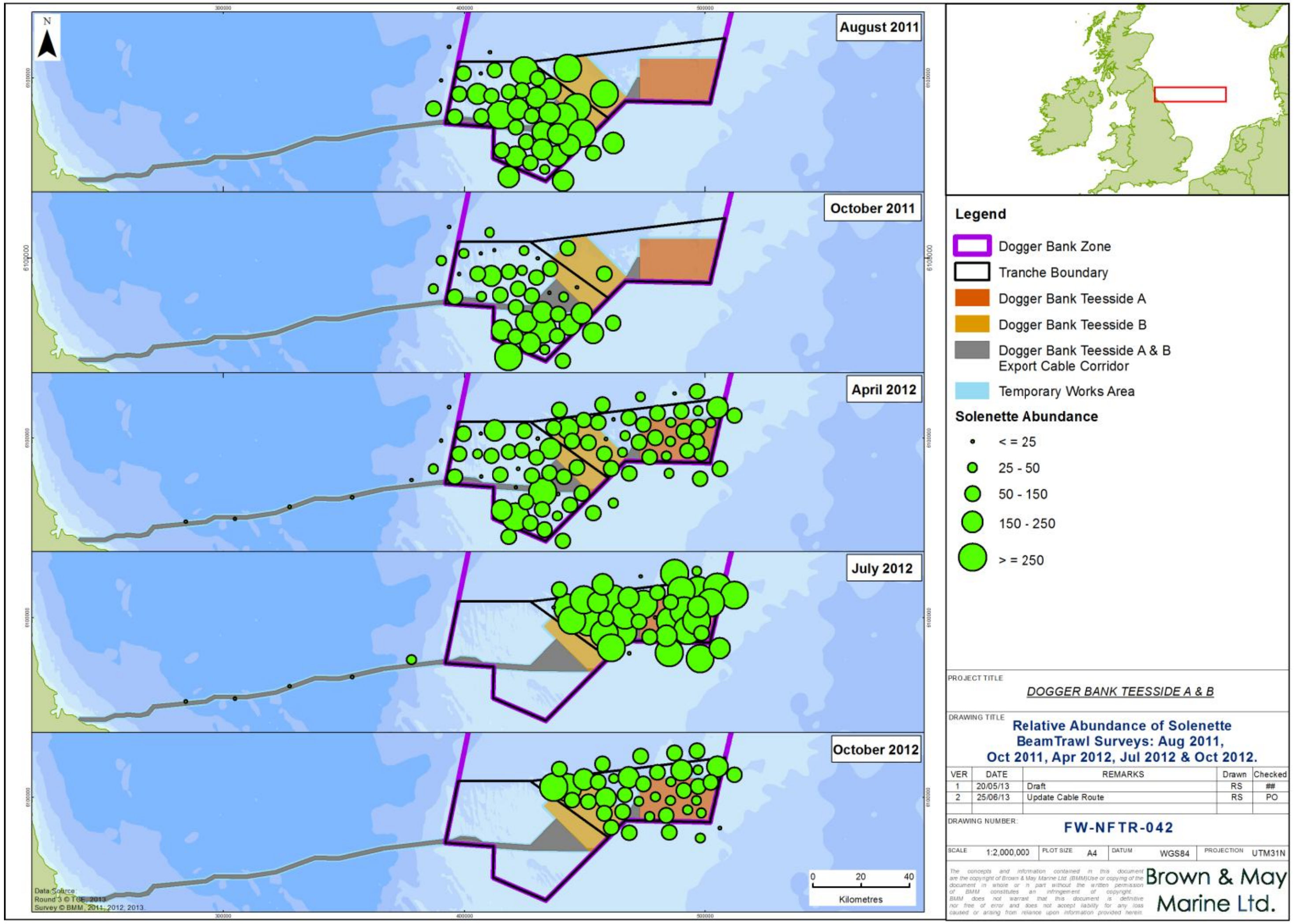


Figure 6.33 Relative Distribution of Solenette in Beam Trawl Samples

221. Painted goby are found in inshore waters up to 50m depth. They are generally found on gravel, shell or coarse sand mixed with shells and stones. Spawning takes place from April to July, and as described above for sand gobies, eggs are laid on bivalve shells and guarded by the male (Wheeler 1978).

222. Other non-commercial fish species found in the 2m beam trawl surveys include scaldfish, lesser weever, pogge *Agonus cataphractus* and common dragonet *Callionymus lyra*. For a full list of fish species recorded in these surveys, see **Table 5.5** and **Table 5.6**.

6.2 Pelagic Species

6.2.1 Herring

6.2.1.1 General

223. Herring is numerically one of the most important pelagic species in the North Sea and this species has been intensively exploited for several centuries.

224. As previously mentioned, herring are important prey not only for piscivorous fish but also for marine mammals and seabirds (Section**.5.7**), they mainly feed on Calanoid copepods during their early juvenile life, and also consume euphausids, hyperiid amphipods, juvenile sandeels, sea-squirts (*Oikopleura spp*.) and fish eggs. Larger herring predominantly consume copepods in conjunction with small fish, arrow worms and ctenophores (ICES 2005). Herring move to the central and northern North Sea to feed in spring (Corten 2001).

6.2.1.2 Distribution

225. Herring are widely distributed throughout the Northwest and Northeast Atlantic. Herring occur throughout the North Sea but 1-group herring are generally restricted to within the 100m depth contour. Adult fish are found mostly on the continental shelf to depths of 200m. The distribution of herring from IBTS surveys is shown in **Figure 6.34**.

226. Juvenile herring are found along the east coast of England, down to The Wash, and also off the west coast of Denmark (ICES 2010b). They generally remain for up to two years in nursery areas before joining adult fish migrations (ICES 2010b).

6.2.1.3 Life History

227. Herring are substrate specific spawners. They produce benthic eggs which are attached to gravely substrate on the seabed. Spawning typically occurs on coarse gravel (0.5-5cm) to stone (8-15cm) substrates and often on the crest of a ridge rather than hollows. As a result of the requirement for a very specific substrate, spawning occurs in small discrete areas (ICES 2010b).

228. The distribution of herring spawning and nursery grounds in relation to the location of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B

Export Cable Corridor is shown in **Figure 6.35** as defined in Ellis *et al.,* (2010). Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within broad low intensity herring nursery grounds, as defined in Ellis *et al.,* (2010). As shown, the Dogger Bank Teesside A & B Export Cable Corridor falls within the defined Flamborough coastal herring spawning grounds. In addition, herring grounds have been defined in the vicinity of Dogger Bank Teesside A & B in the Dogger Bank area (**Figure 6.35**). It should be noted, however, that these offshore grounds are now considered to be former (historic), with herring spawning being currently confined to small areas along the English east coast, from the Farne Islands to the Dowsing area, from August to October (ICES 2010b).

229. The distribution of sediment types based on PSA of grab samples collected along the Dogger Bank Teesside A & B Export Cable Corridor during the benthic survey is shown in **Figure 6.36**. As shown in the majority of stations in the Dogger Bank Teesside A & B Export Cable Corridor the substrate was characterised by the presence of fine sediment classes, including areas which overlap with areas defined as herring spawning grounds. It is, however, recognised that coarser substrate suitable for herring spawning may be available in the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor, where sediment samples were not collected. As illustrated in **Figure 6.37,** where the distribution of sediment types in the active inshore herring grounds in the area relevant to the Dogger Bank Teesside A & B Export Cable Corridor is shown, suitable coarse substrates for spawning herring (gravelly sand and sandy gravel) are widespread within the spawning grounds defined in Coull *et al.* (1998). The coarser sediments, most likely preferred by spawning herring, are located close inshore, along the Dogger Bank Teesside A & B Export Cable Corridor but also in the wider area.

230. The distribution of substrate sediment types over the former Dogger Bank herring spawning grounds and the wider North Sea is given in **Figure 6.38**. As shown, some sections of the defined spawning grounds overlap with areas of coarse sediment (gravel, sandy gravel, gravelly sand). It should be noted that these types of substrate are available in other areas of the North Sea, where spawning grounds have not been defined for herring, and that the sole presence of adequate coarse sediment may not necessarily imply that herring will use a given area for spawning.

231. An indication of the spatial distribution of sediment types within tranches A and B, derived from the results of PSA of grab samples collected during the benthic survey is given in **Figure 6.39**. As shown, samples of coarse sand (with a relatively high percentage of gravel) were found mainly in the western section of Tranche A and in the northern section of Dogger Bank Teesside B. However, the majority of samples collected with Dogger Bank Teesside A & B, were characterised by the presence of finer sediment classes.

6.2.1.4 IHLS and IMARES larval surveys

232. The spawning grounds of the Banks herring in the North Sea are surveyed annually as part of the IHLS. The distribution of herring larvae recorded in 3rd quarter IHLS surveys conducted in each year between 2002 and 2011 is given in **Figure 6.40** to **Figure 6.48.** As shown, the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor falls in an area where relatively high herring larval densities may be present.

233. Given the current lack of spawning activity in the grounds around the Dogger Bank, ICES rectangles in the vicinity of the Project area are not routinely surveyed as part of the IHLS. In 2007, however, after anecdotal reporting of spawning on these grounds, the Netherlands extended their IHLS stations grid towards the Dogger Bank. No larvae were found in the area (Schmidt *et al.,* 2008) as shown in **Figure 6.45.**

234. The Dogger Bank area was also sampled in 2011 by IMARES as part of a monthly ichthyoplankton survey (van Damme *et al.,* 2011). The distribution of yolk sac herring larvae recorded in this survey is given in **Figure 6.49**. As shown, no herring larvae were found in the area and there was no evidence of re-colonisation of the Dogger Bank spawning grounds.

235. Based on the results of ICES larval surveys, the Dogger herring have largely disappeared.

6.2.1.5 Exploitation

236. Herring landings are low in the Wind Farm and Export Cable Corridor Study Area and this species is not ranked amongst the main species in terms of either landings or catch value.

6.2.1.6 Management

237. The North Sea herring stock collapsed in the late 1970's. The initial recovery was almost entirely due to an increase in biomass of the Orkney/Shetland herring sub-stock. In recent years, however, larval abundance appears to have been more significant in the Downs sub-stock, which has produced the majority of herring larvae in the North Sea (Schmidt *et al.,* 2009). Overall, recruitment in the North Sea has been low in recent years. This is thought to be related to a decrease in survival rates during the larval overwintering phase associated with contemporary warming of the North Sea and changes in the plankton community (Payne *et al.,* 2009).

238. The North Sea herring stock is divided into four main "races" on the basis of the areas used for spawning. The component relevant to Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor is the Banks or Central North Sea herring.

239. ICES currently classify the North Sea stock as being at full reproductive capacity and harvested sustainably. The stock is however still considered to be in a low productivity phase (ICES 2012a).

6.2.1.7 Site Specific Information

240. The pelagic fish survey undertaken in the Dogger Bank former grounds in September 2011 as part of the baseline characterisation for tranches A and B, found no evidence of spawning herring in the area. The majority of the herring caught in this survey were juvenile fish.

241. As previously mentioned, in the pelagic survey, herring were found in some numbers, with the majority of the catch being recorded in Transect C and characterised by the presence of juvenile fish. They were also recorded, although in small numbers, in the three otter trawl surveys carried out, particularly in stations located along the Dogger Bank Teesside A & B Export Cable Corridor.

6.2.1.8 Conservation status

242. Herring is of conservation interest, being listed as a UK BAP priority species (**Table 5.20**).

243. Herring are regarded as a species that are sensitive to anthropogenic noise disturbance and deposition of their eggs in dense mats on the seabed makes this species particularly susceptible to activities such as offshore oil and gas industries, marine aggregate extraction and eutrophication (ICES 2012).

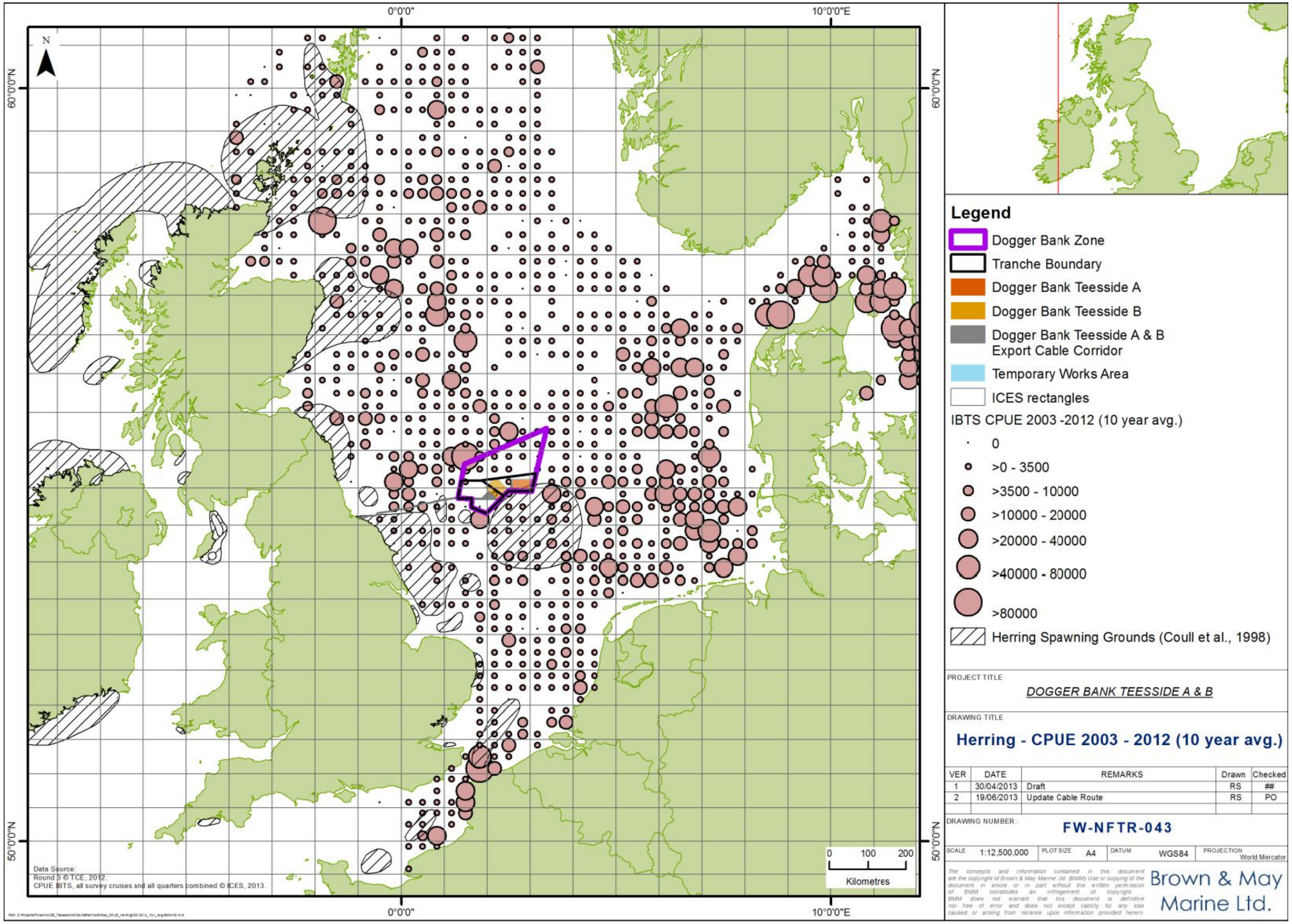


Figure 6.34 Average number (catch per standardised haul) of Herring from IBTS survey data 2003-2012

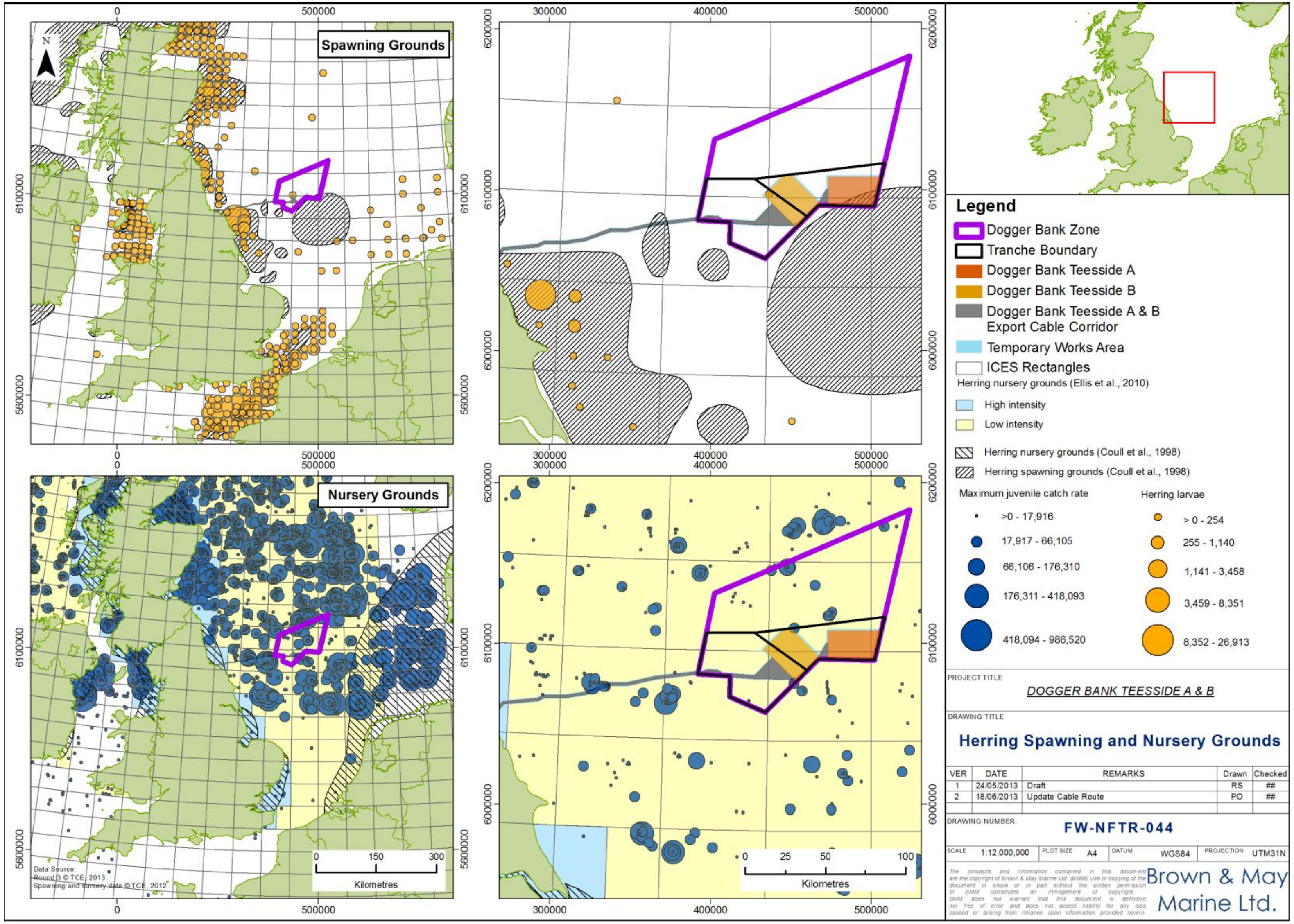


Figure 6.35 Distribution of Herring Spawning and Nursery Grounds (Ellis *et al.*, 2010)

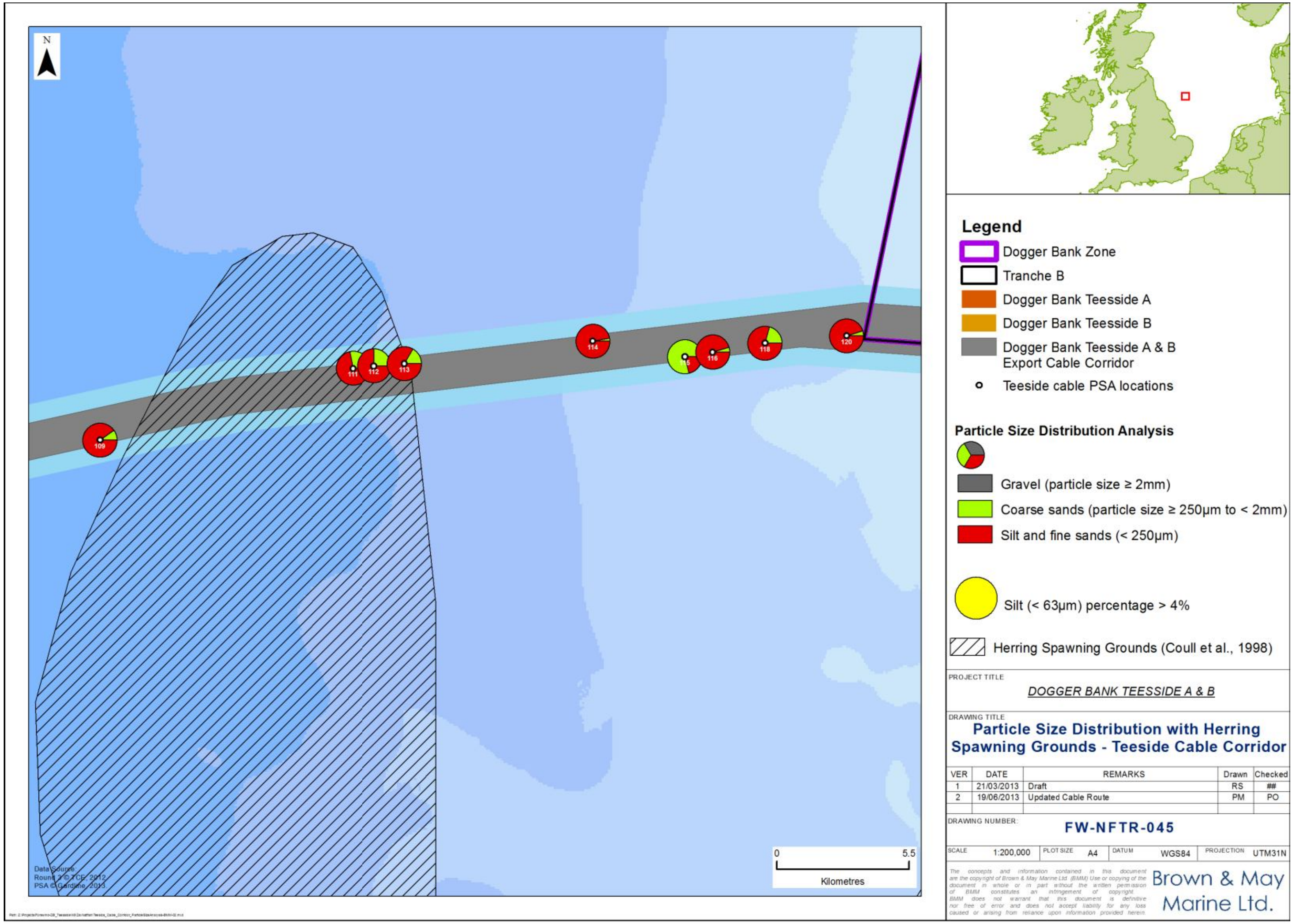


Figure 6.36 Distribution of Sediment Types along the Dogger Bank Teesside A & B Export Cable Corridor

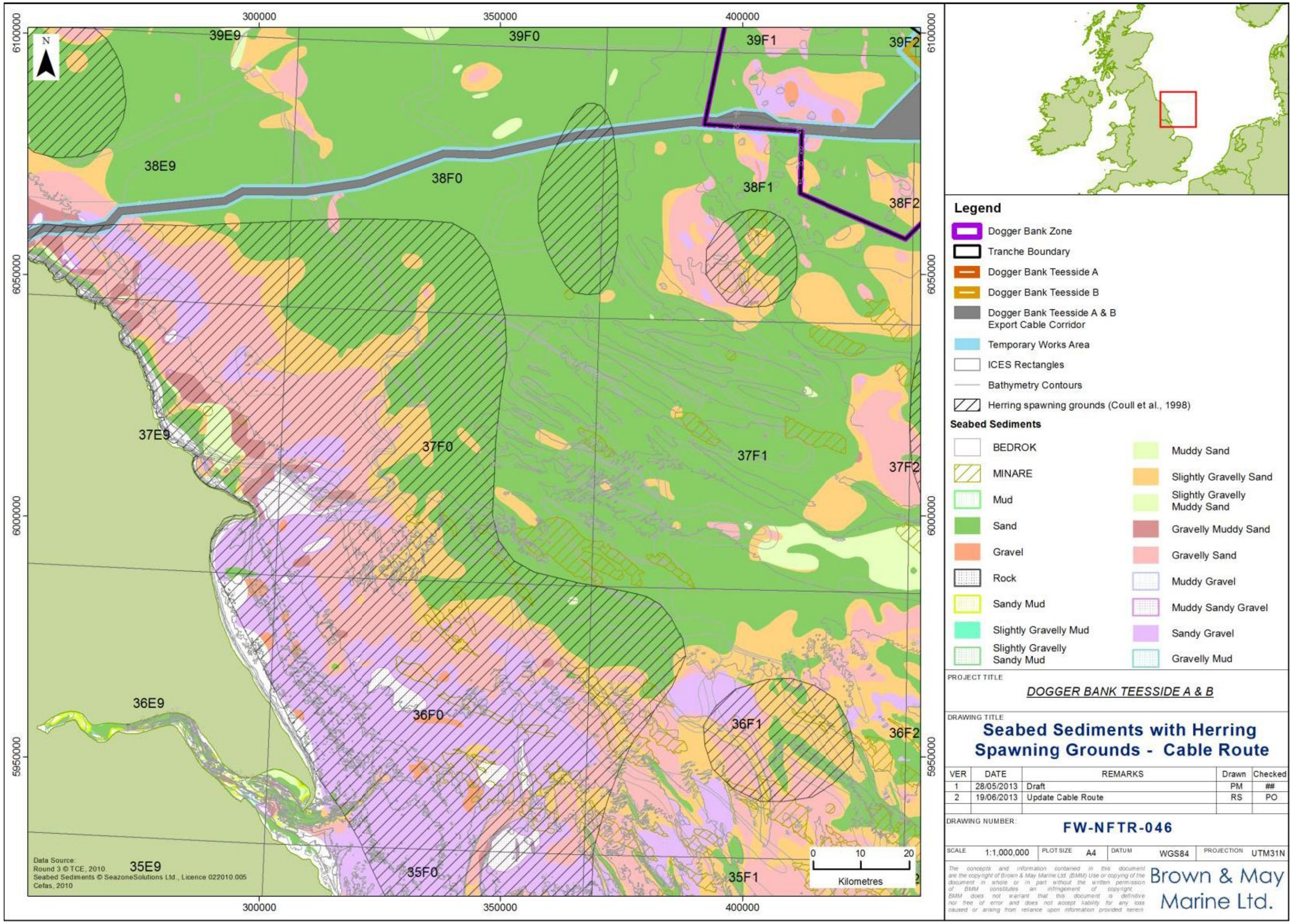


Figure 6.37 Distribution of Sediment and Herring Spawning Grounds Along the Dogger Bank Teesside A & B Export Cable Corridor

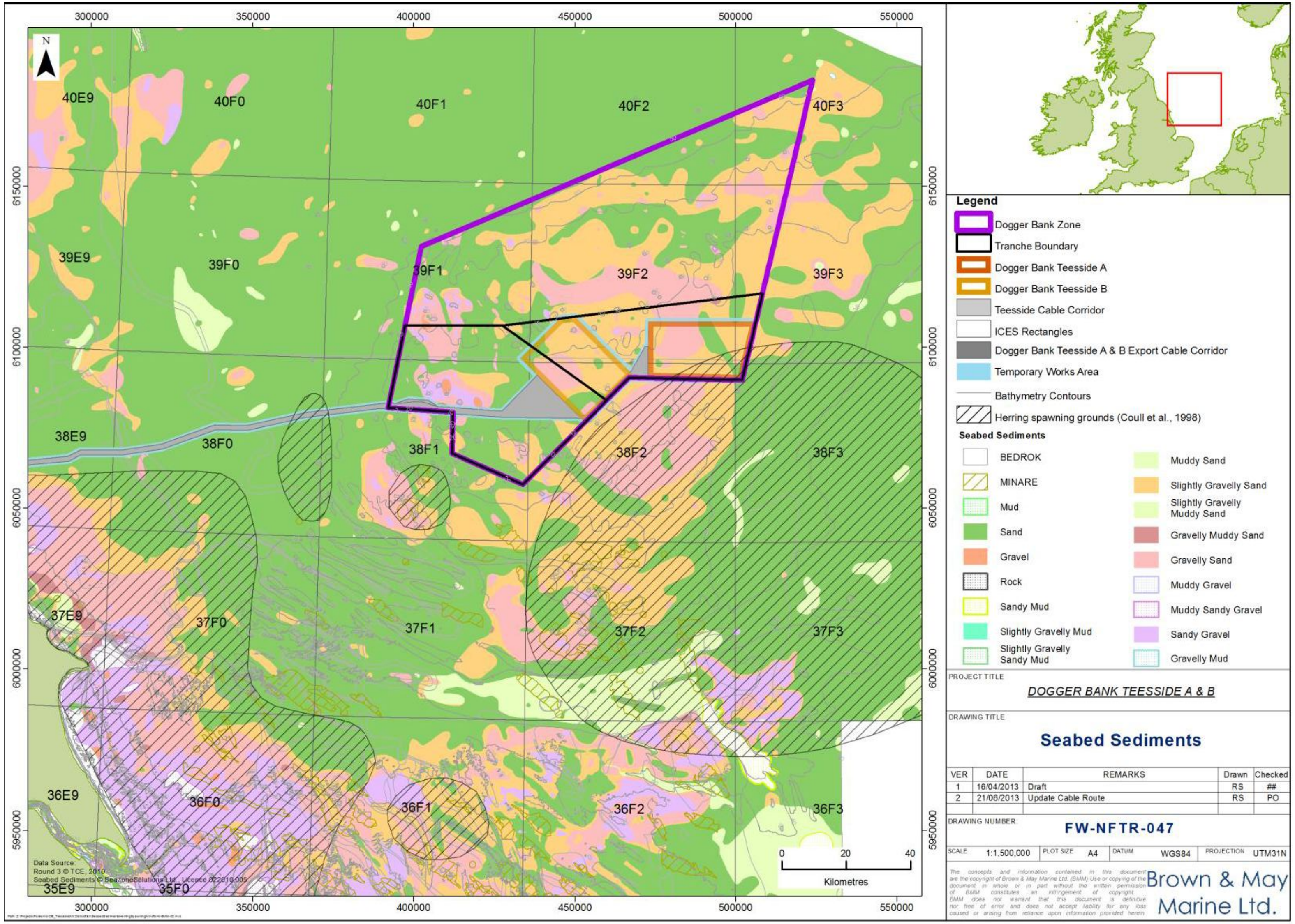


Figure 6.38 Distribution of Sediment Types and Herring Spawning Grounds

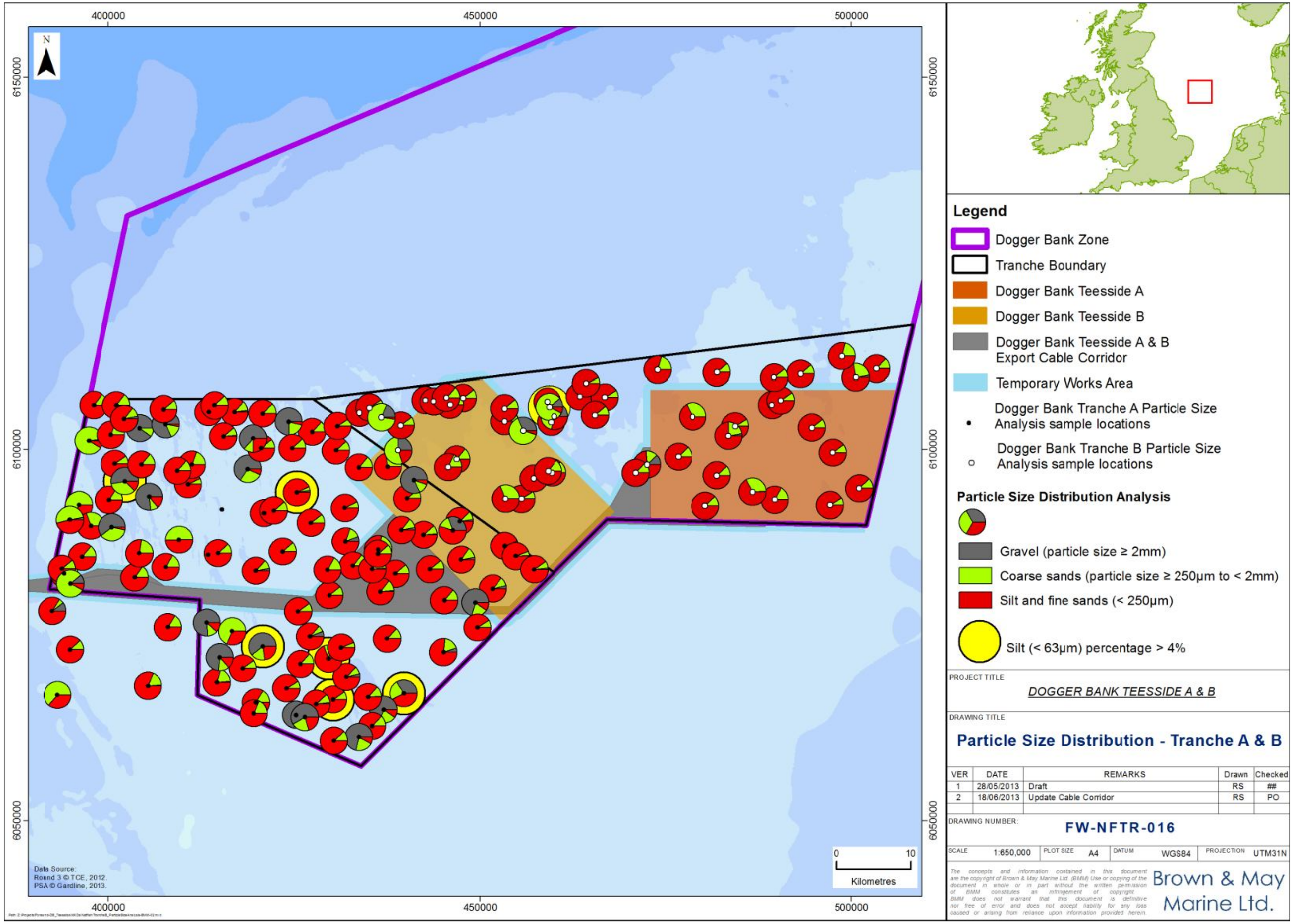


Figure 6.39 Distribution of Sediment Types in Tranche A and Tranche B and former Herring Spawning Grounds

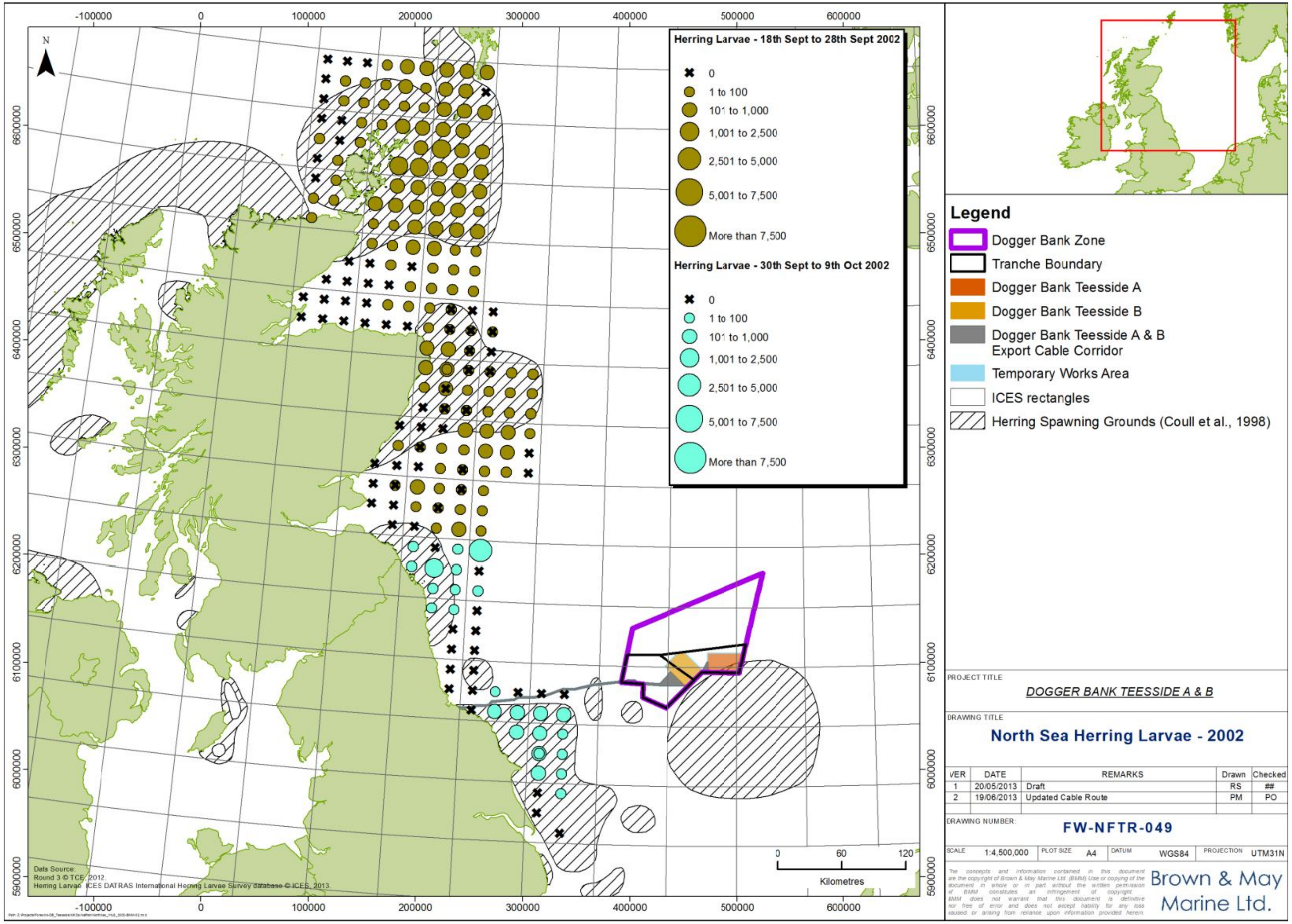


Figure 6.40 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2002)

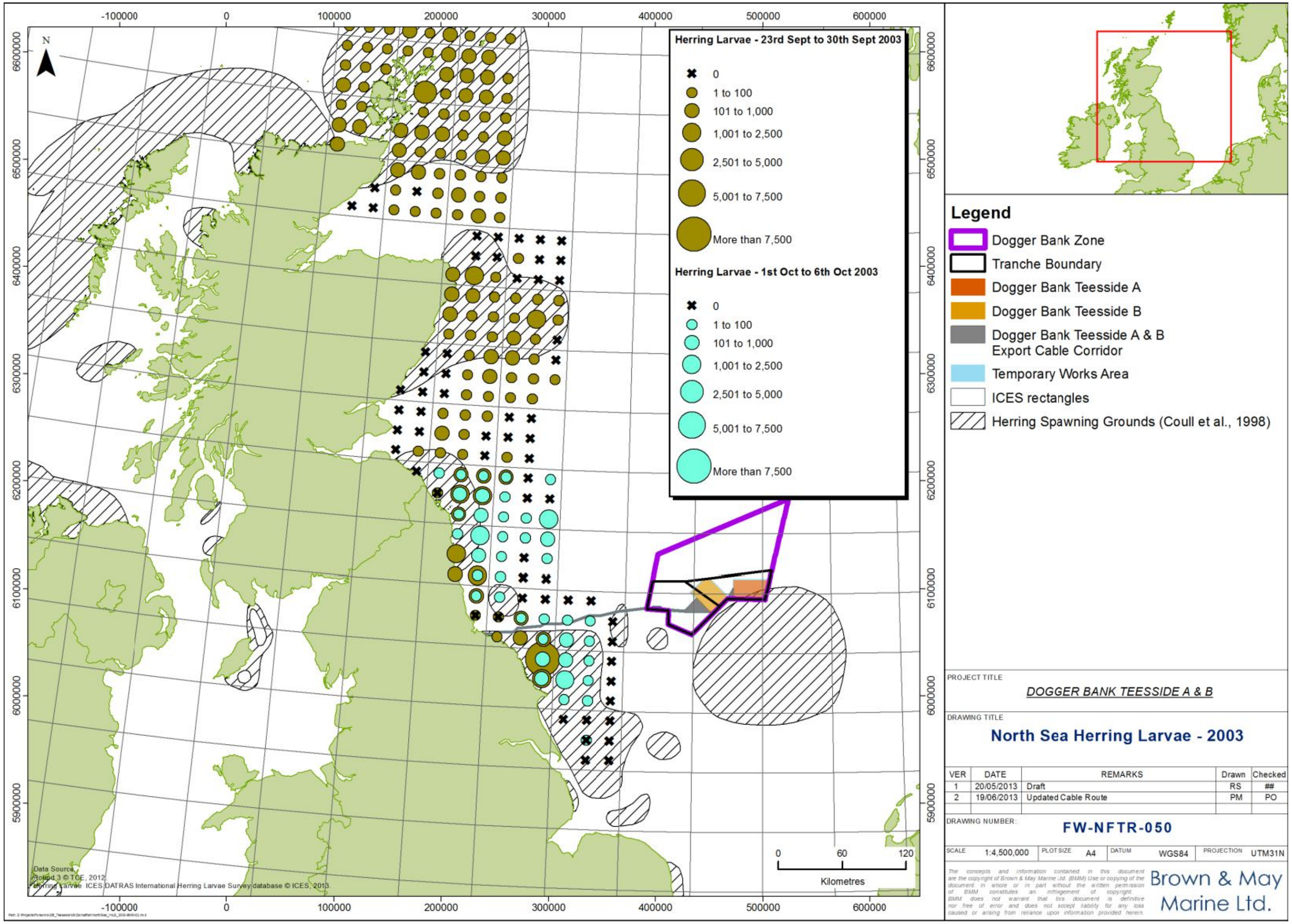


Figure 6.41 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2003)

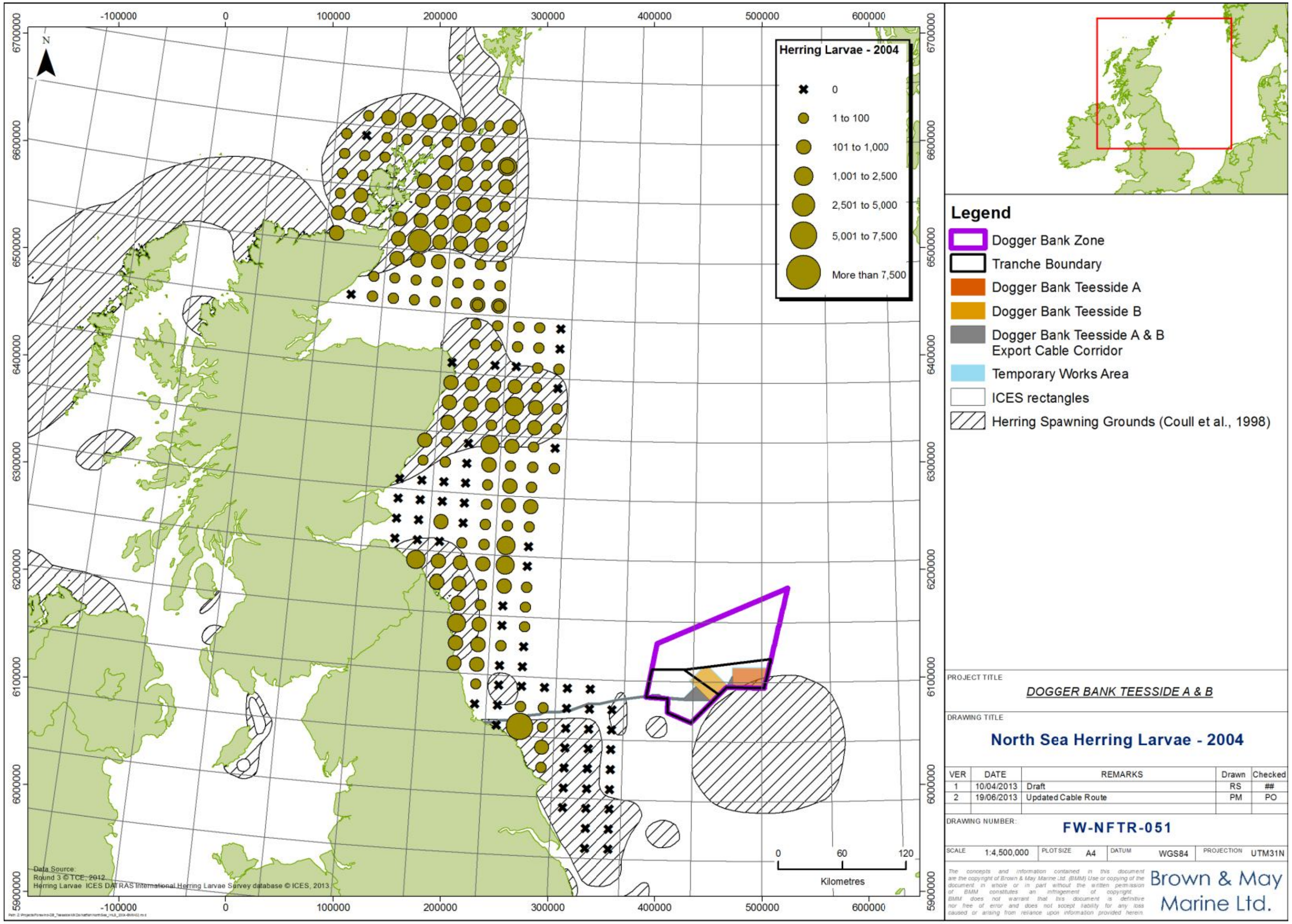


Figure 6.42 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2004)

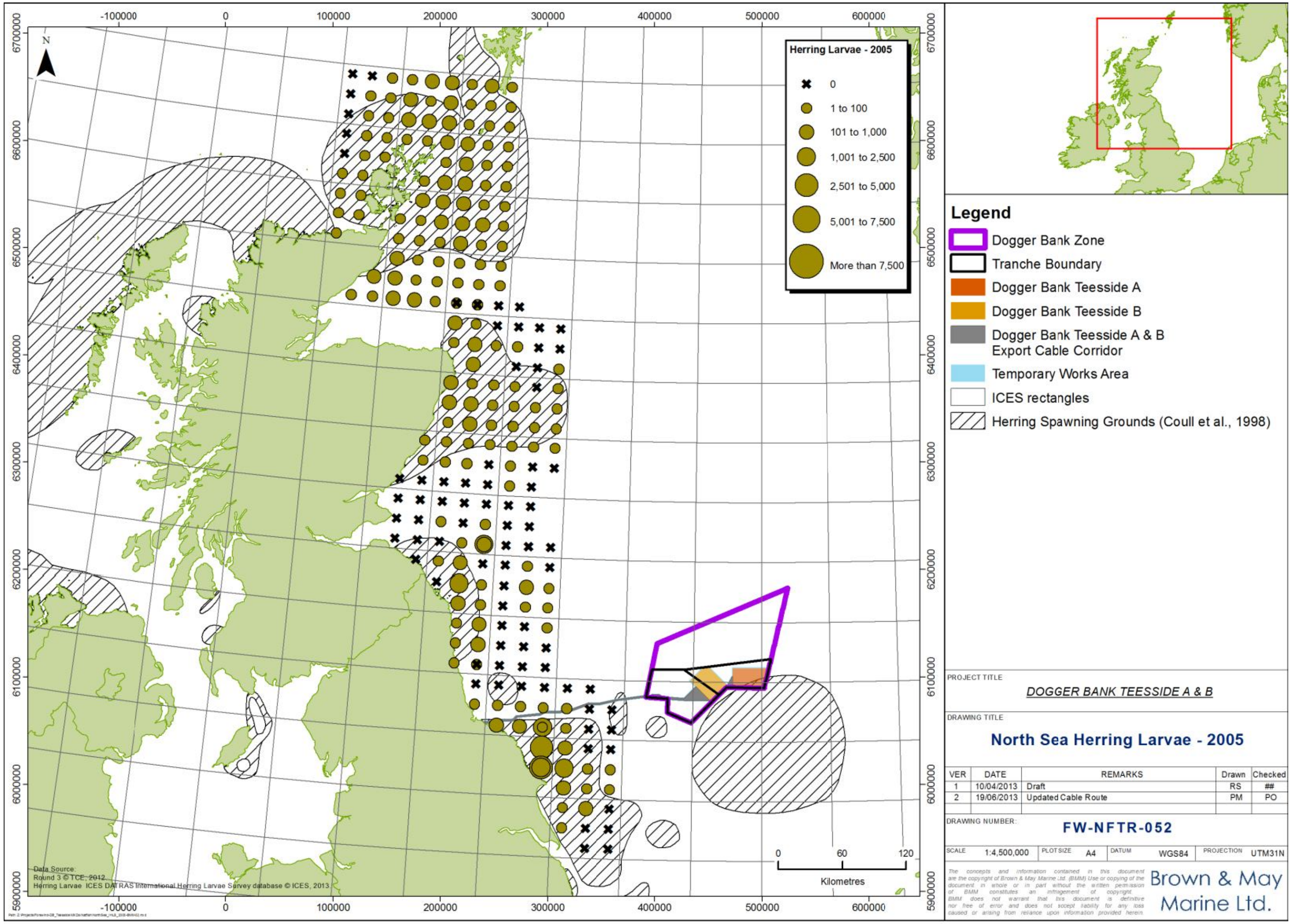


Figure 6.43 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2005)

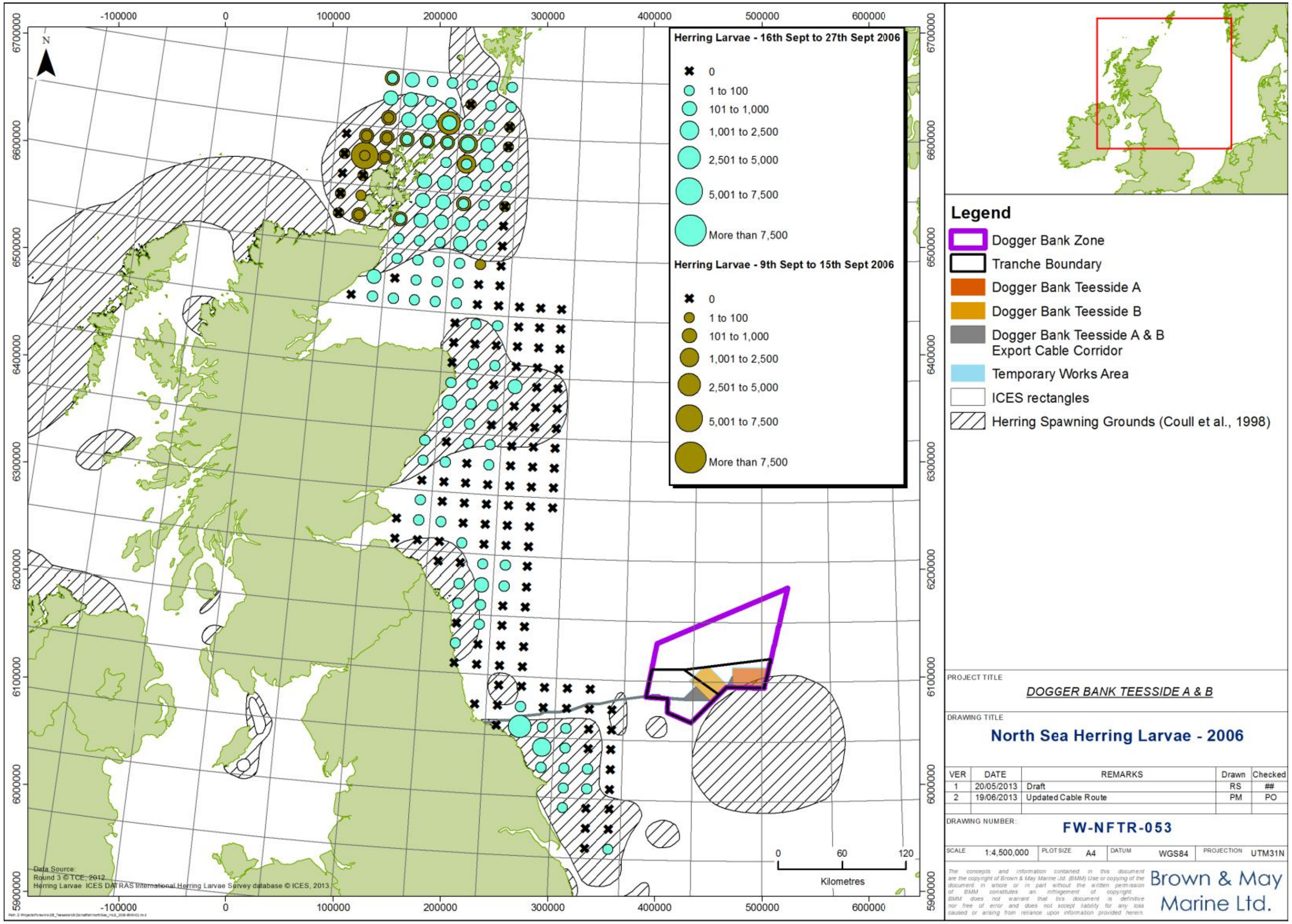


Figure 6.44 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2006)

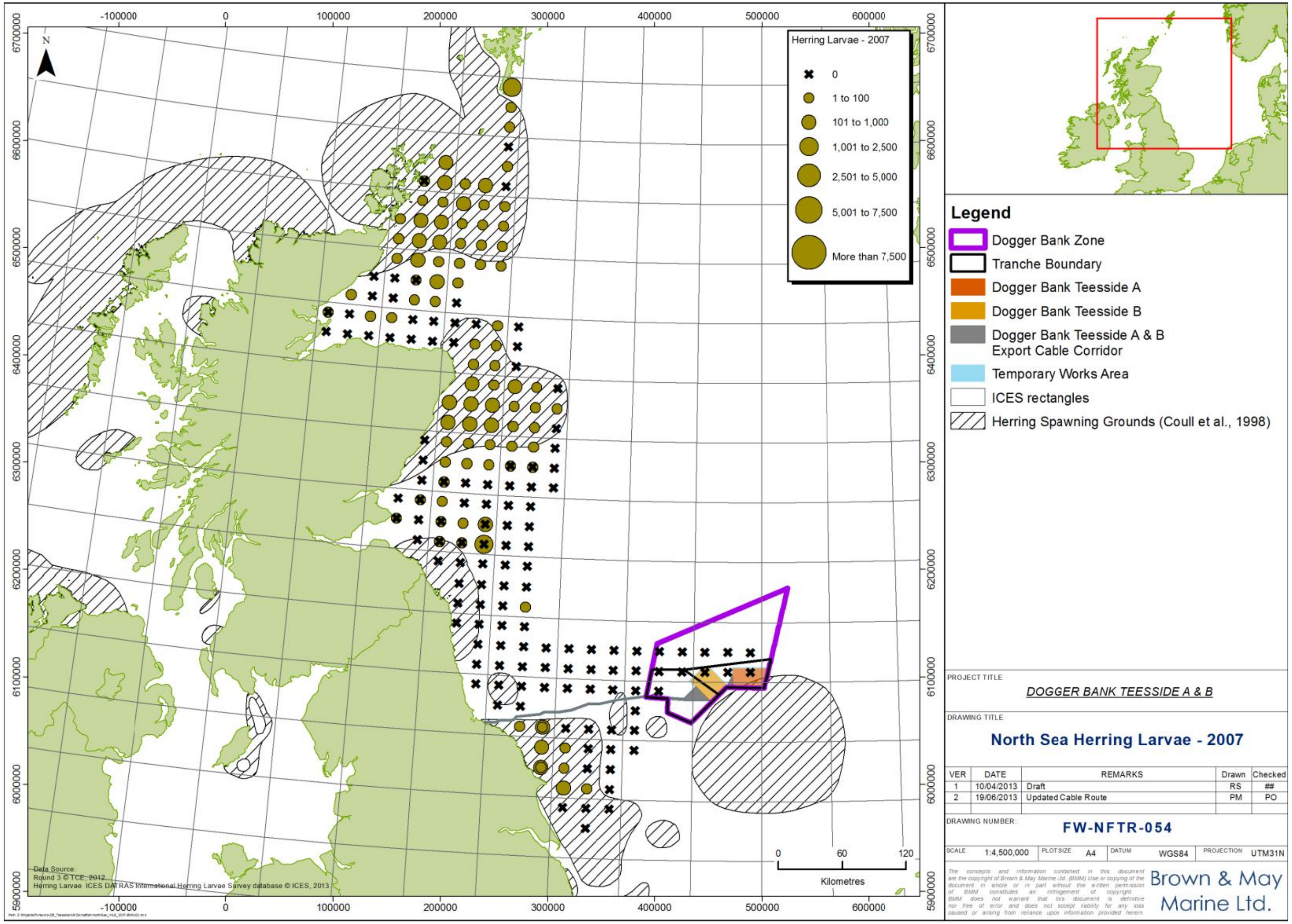


Figure 6.45 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2007)

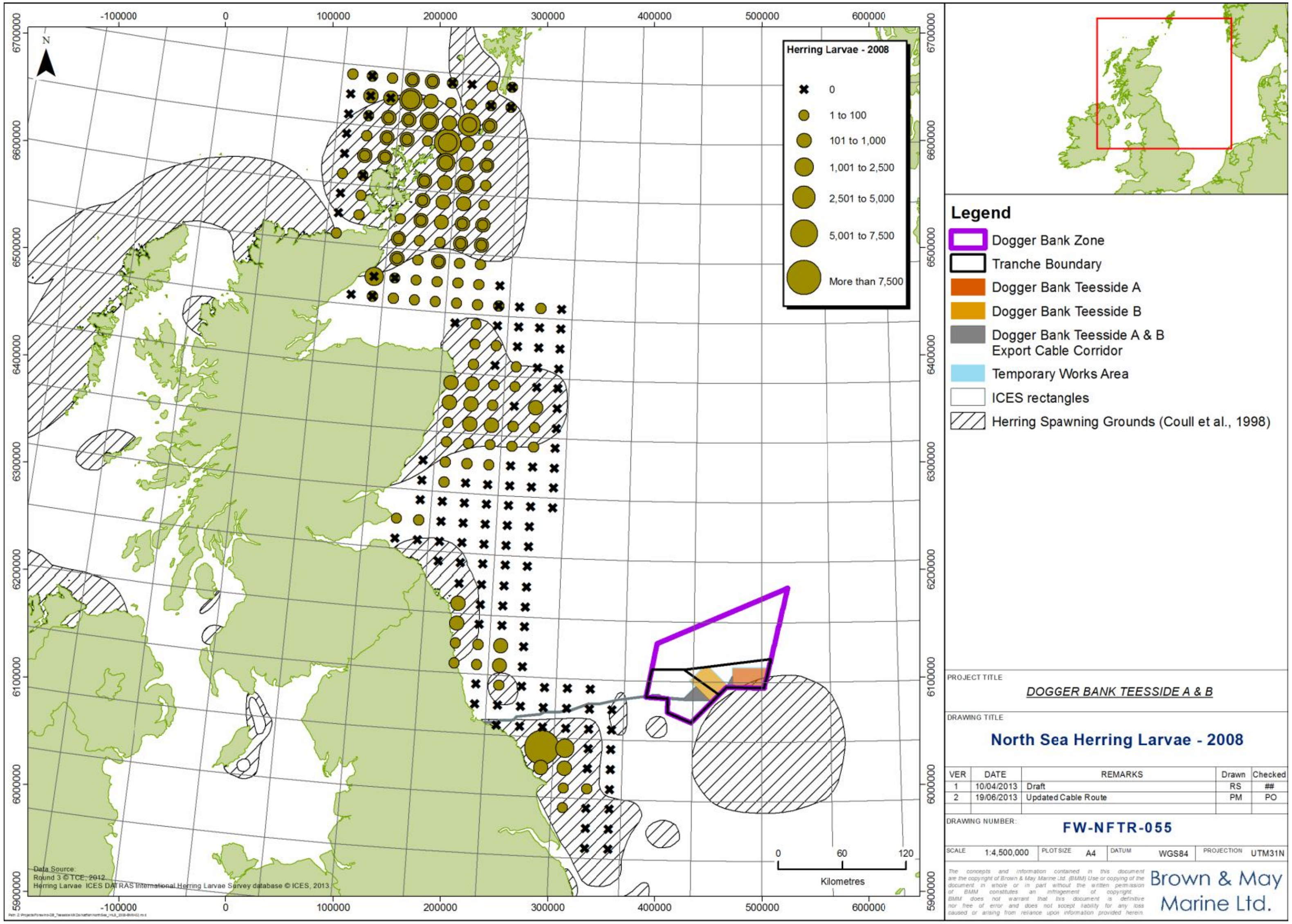


Figure 6.46 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2008)

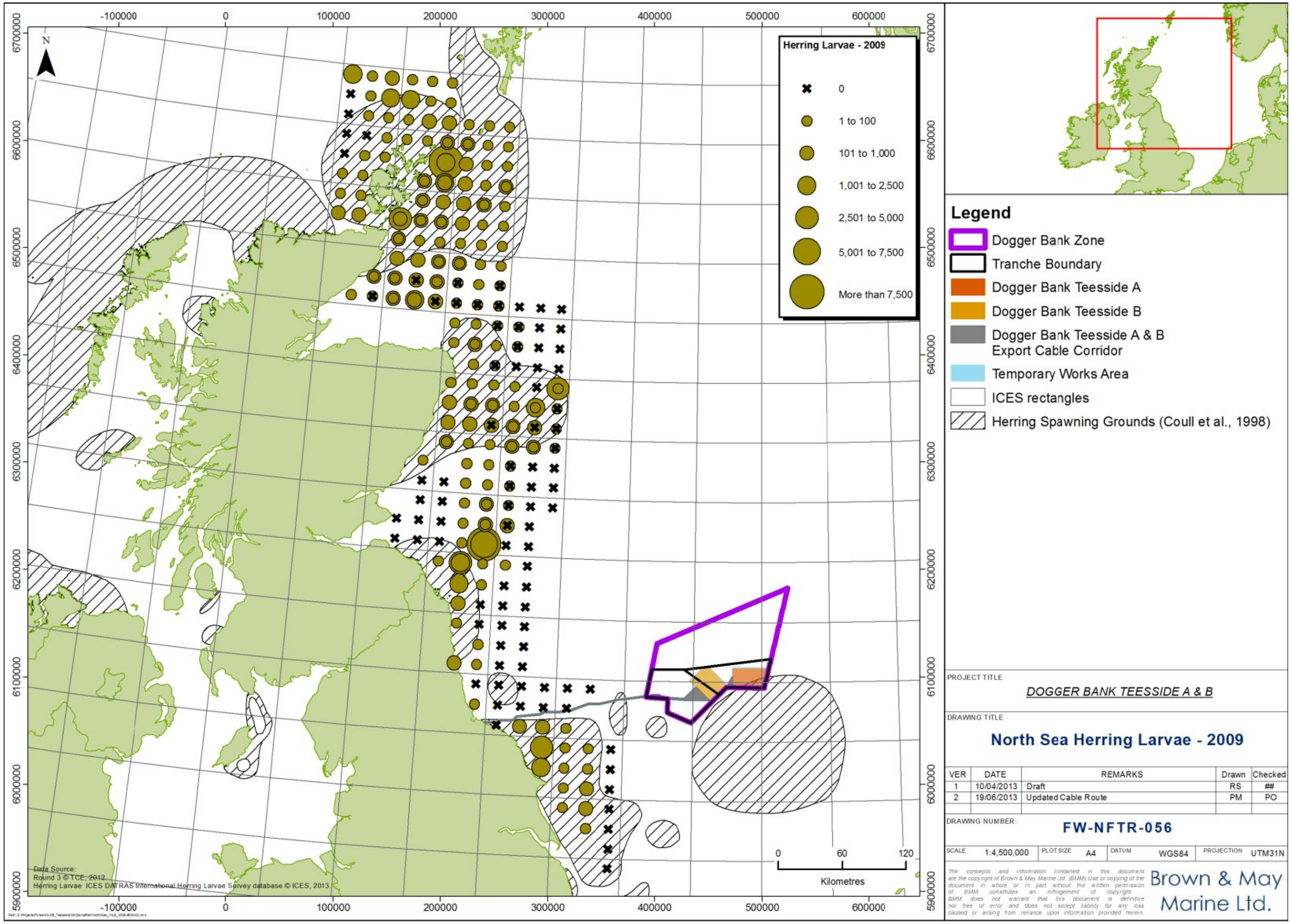


Figure 6.46 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2009)

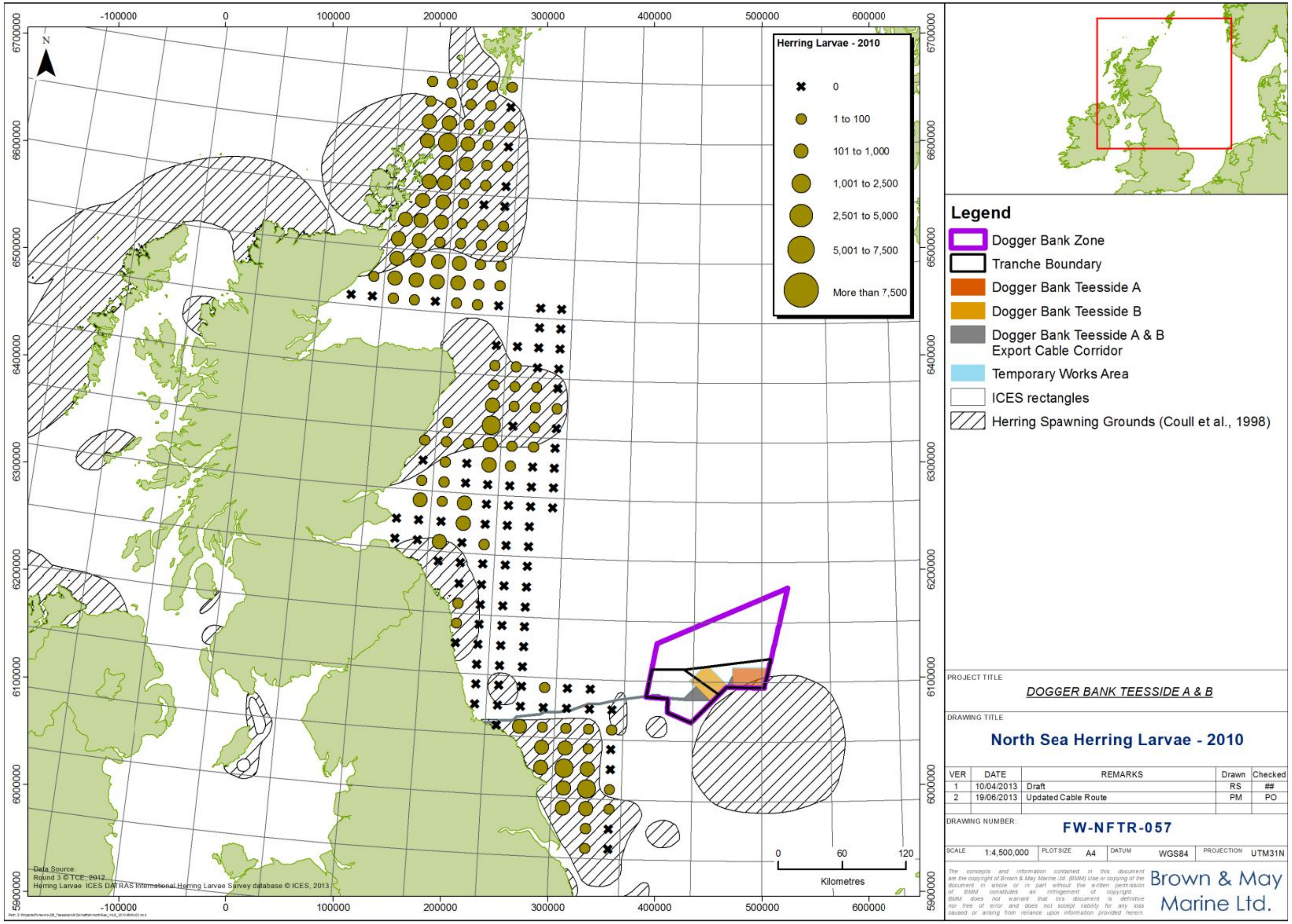


Figure 6.47 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2010)

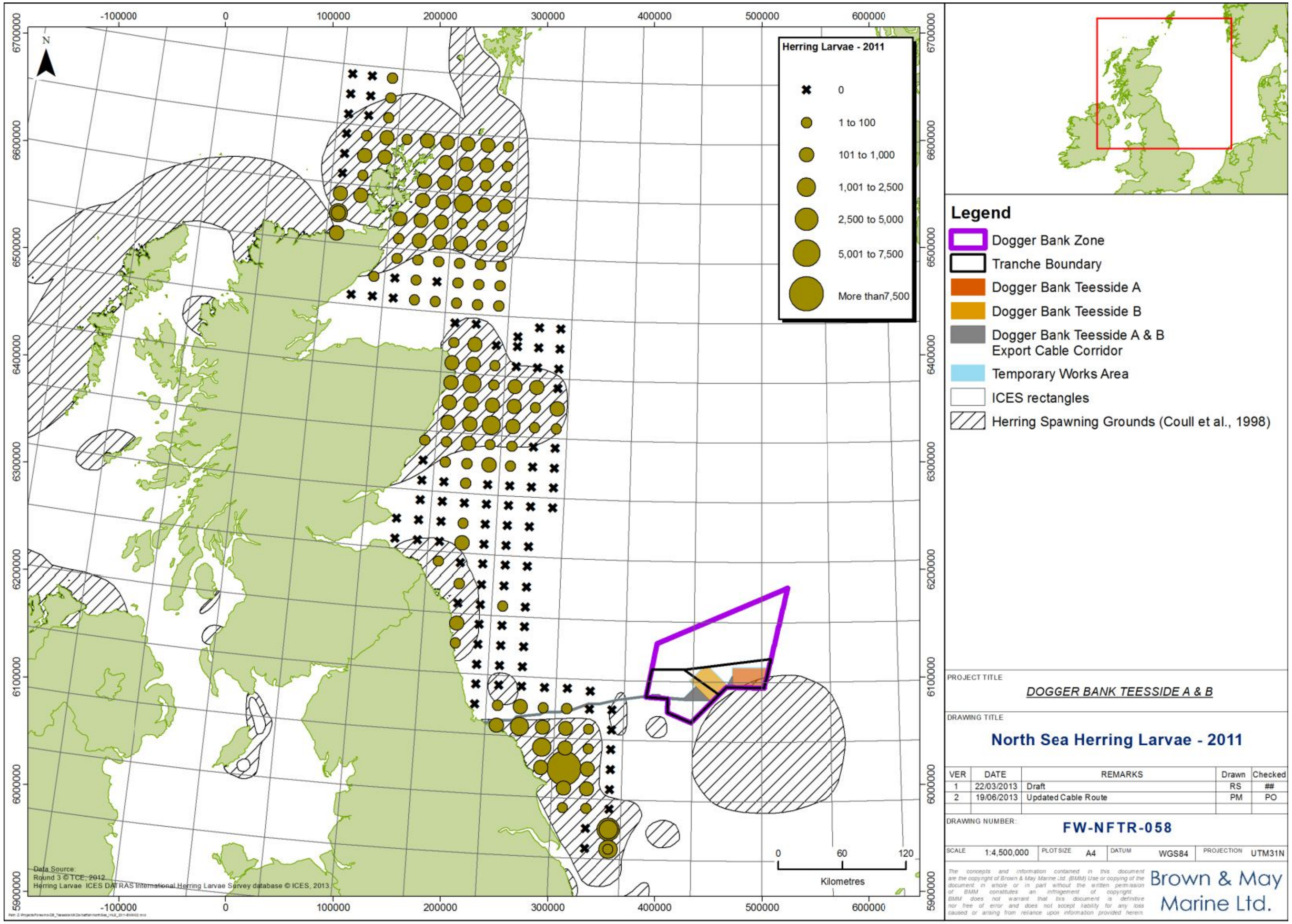


Figure 6.48 IHLS abundance of herring larvae <10 mm (n/m^2) in the Orkney, Buchan and Central North Sea area (2011)

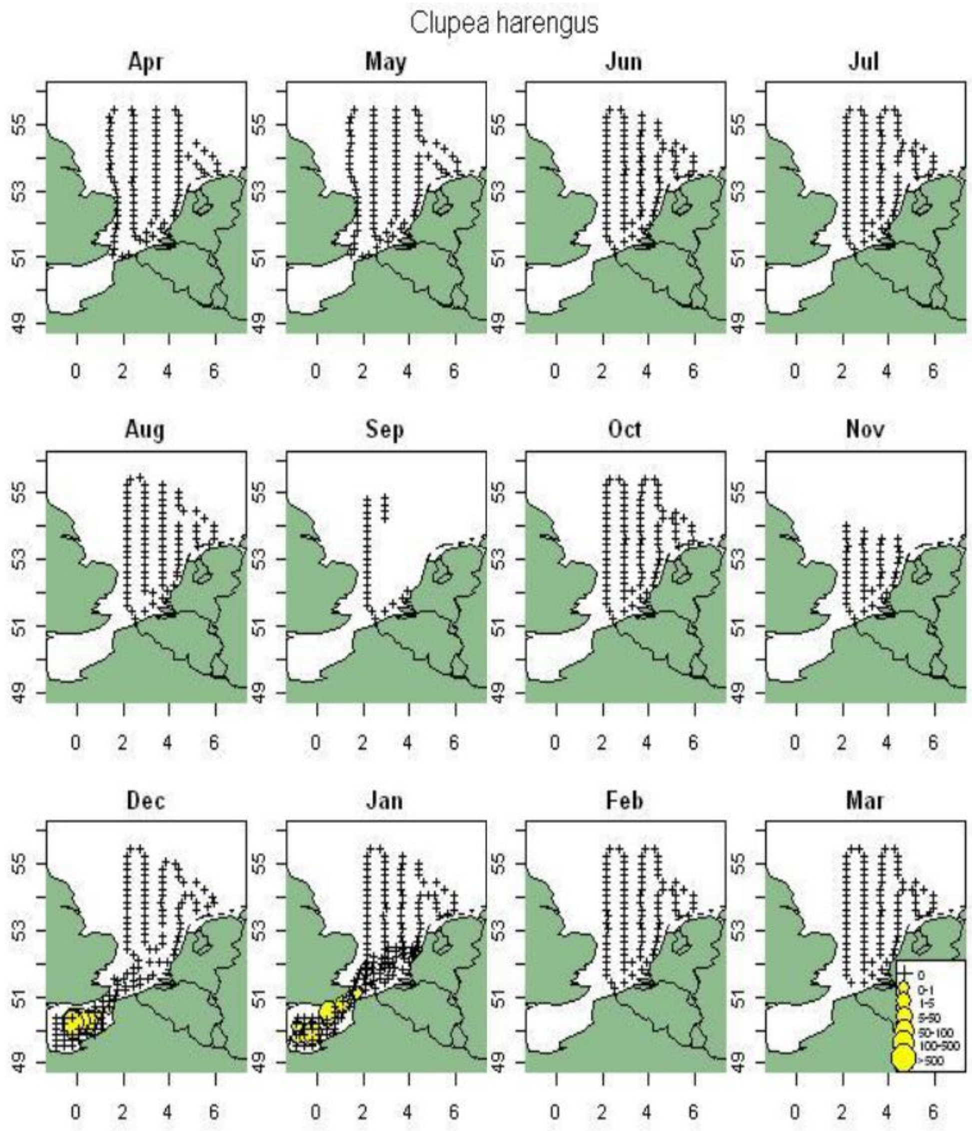


Figure 6.49 Monthly Distribution of Yolk Sac Herring Larvae (Van Damme *et al.,* 2011)

6.2.2 Sprat

6.2.2.1 General

244. Sprat is a short-lived, small-bodied pelagic schooling species that is relatively abundant in shallow waters. As previously mentioned (Section **5.7**), it is an important food resource for a number of commercially important predatory fish and sea birds. They primarily feed on copepods, cladocerans, sea-squirts, bivalve larvae, mysids and euphausids (Maes and Ollevier 2002, ICES 2005).

6.2.2.2 Distribution

245. Sprat is widely distributed in the North Sea, being most abundant south of the Dogger Bank and in the Kattegat (ICES 2005). They generally remain within the 50m depth contours and are more common in inshore waters. **Figure 6.50** illustrates the average abundance of sprat in IBTS trawl surveys between 2003 and 2002.

6.2.2.3 Life History

246. Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within the broad spawning and nursery grounds defined for this species (**Figure 6.51**). Spawning in the North Sea is thought to primarily occur from May to August, peaking between May and June (Coull *et al.,* 1998), in both coastal waters and up to 100km offshore, in deep basins (Whitehead 1986, Nissling *et al.,* 2003). Females spawn repeatedly in batches throughout the spawning season (Milligan 1986).

247. Eggs and larvae are pelagic and so subject to larval drift, moving into coastal nursery areas (Hinrichsen *et al.,* 2005, Nissling *et al.,* 2003).

6.2.2.4 Exploitation

248. As suggested by fisheries statistics, the Wind Farm and Export Cable Study Areas do not support important sprat fisheries.

6.2.2.5 Management

249. Explicit or implicit management objectives do not exist for this species due to a lack of data.

6.2.2.6 Site Specific Information

250. Sprat was the species caught in greatest numbers in the pelagic survey particularly along Transect C (see **Table 5.7**).

6.2.2.7 Conservation status

251. There is no conservation listing for this species.

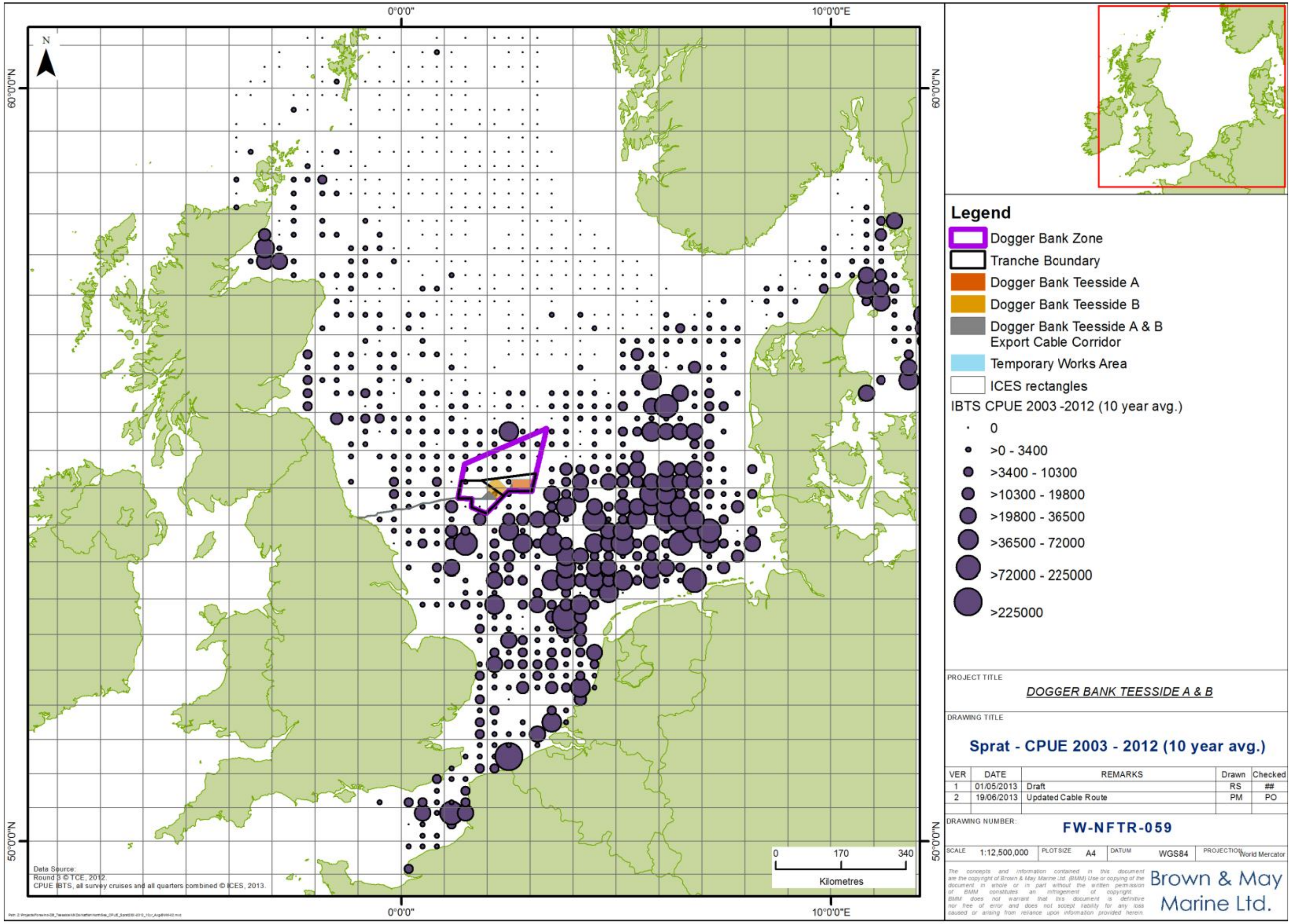


Figure 6.50 Average number (catch per standardised haul) of Sprat from IBTS survey data 2003-2012

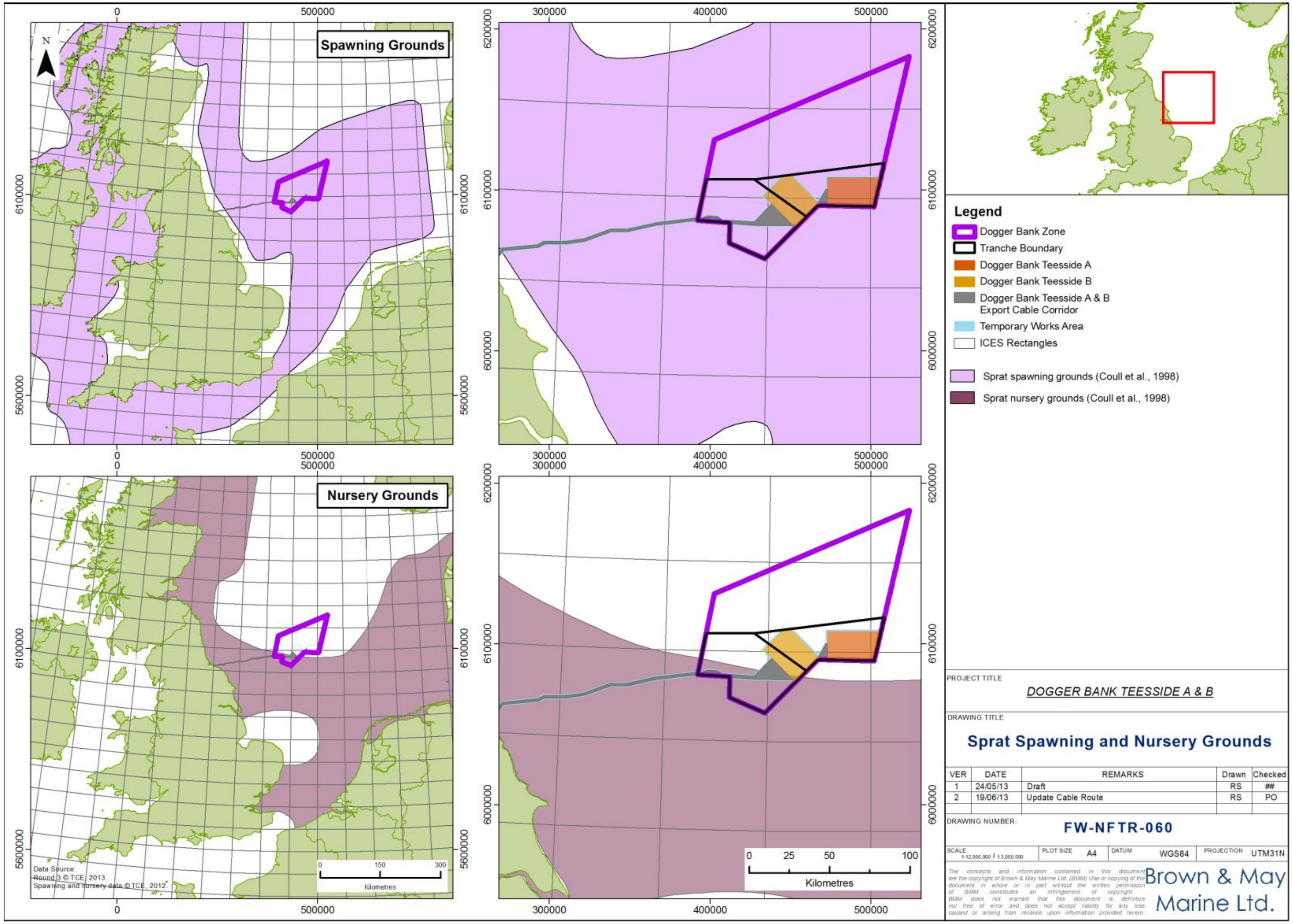


Figure 6.51 Sprat Spawning and Nursery Grounds (Coull *et al.,* 1998)

6.2.3 Mackerel

6.2.3.1 General

252. Mackerel eat large quantities of pelagic crustaceans and also prey on schools of smaller fish, particularly sprat, herring and sandeel (Wheeler 1978). They are also of importance as a food resource for larger pelagic predators, including sharks and marine mammals. In addition, they are consumed by a variety of seabirds (ICES 2005).

6.2.3.2 Distribution

253. As shown in **Figure 6.52**, Mackerel is wide spread in the North Sea. This species overwinters in deep water along the edge of the continental shelf. In the spring adults migrate south to the spawning areas in the Central North Sea. After spawning, the North Sea stock mixes with fish from the western stock on the feeding grounds in the southern Norwegian Sea and the northern North Sea, before returning to over-wintering areas (ICES 2005).

6.2.3.3 Life History

254. As illustrated by **Figure 6.53**,Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor fall within the broad spawning and nursery grounds defined for this species. In the North Sea spawning occurs from May to August, peaking from May to July (Coull *et al.,* 1998).

6.2.3.4 Exploitation

255. The landings data provided in Section 5.4 does not suggest this species to be of particular commercial importance in the Wind Farm and Export Cable Study Areas. As indicated in *Chapter 15 - Commercial Fisheries*, however, mackerel is known to be targeted by French trawlers over certain sections of the Dogger Bank Teesside A & B Export Cable Corridor.

6.2.3.5 Management

256. ICES advice for 2013 suggests that the existing measures to protect North Sea spawning mackerel should remain in place. On the basis of the Norway, Faroe Islands, and EU management plan ICES suggest that the catches in 2013 be between 497,000 and 542,000 tonnes (ICES 2012a).

6.2.3.6 Site Specific Information

Mackerel was caught in relatively high numbers in the pelagic survey and was one of the principal species found in tranche A and B otter trawl surveys (**Table 5.3** and **Table 5.4**).

6.2.3.7 Conservation status

257. This species is listed as a UK BAP priority species and classified as of 'Least Concern' in the IUCN Red List of Threatened Species (**Table 5.20**).

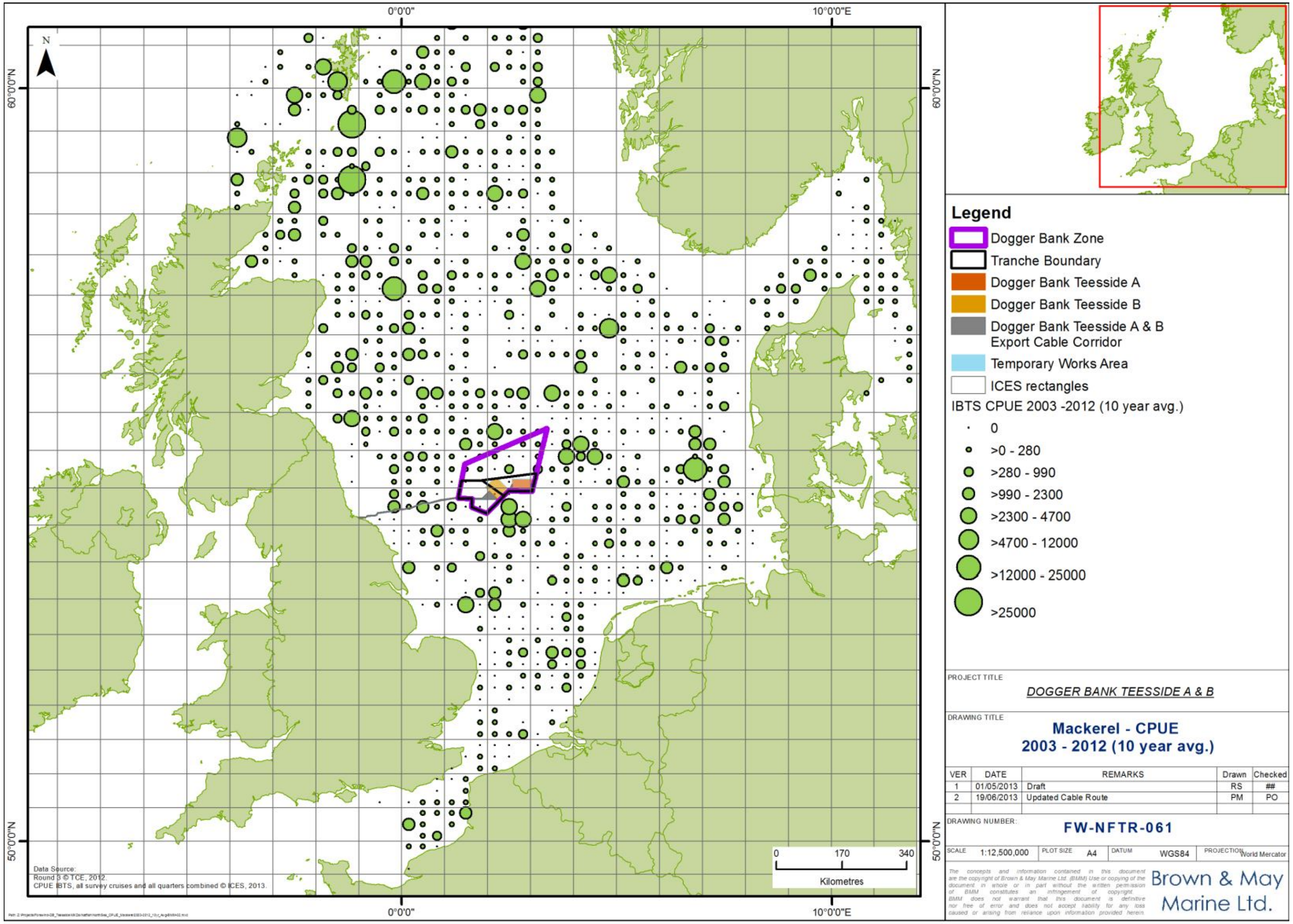


Figure 6.52 Average number (catch per standardised haul) of Mackerel from IBTS survey data 2003-2012

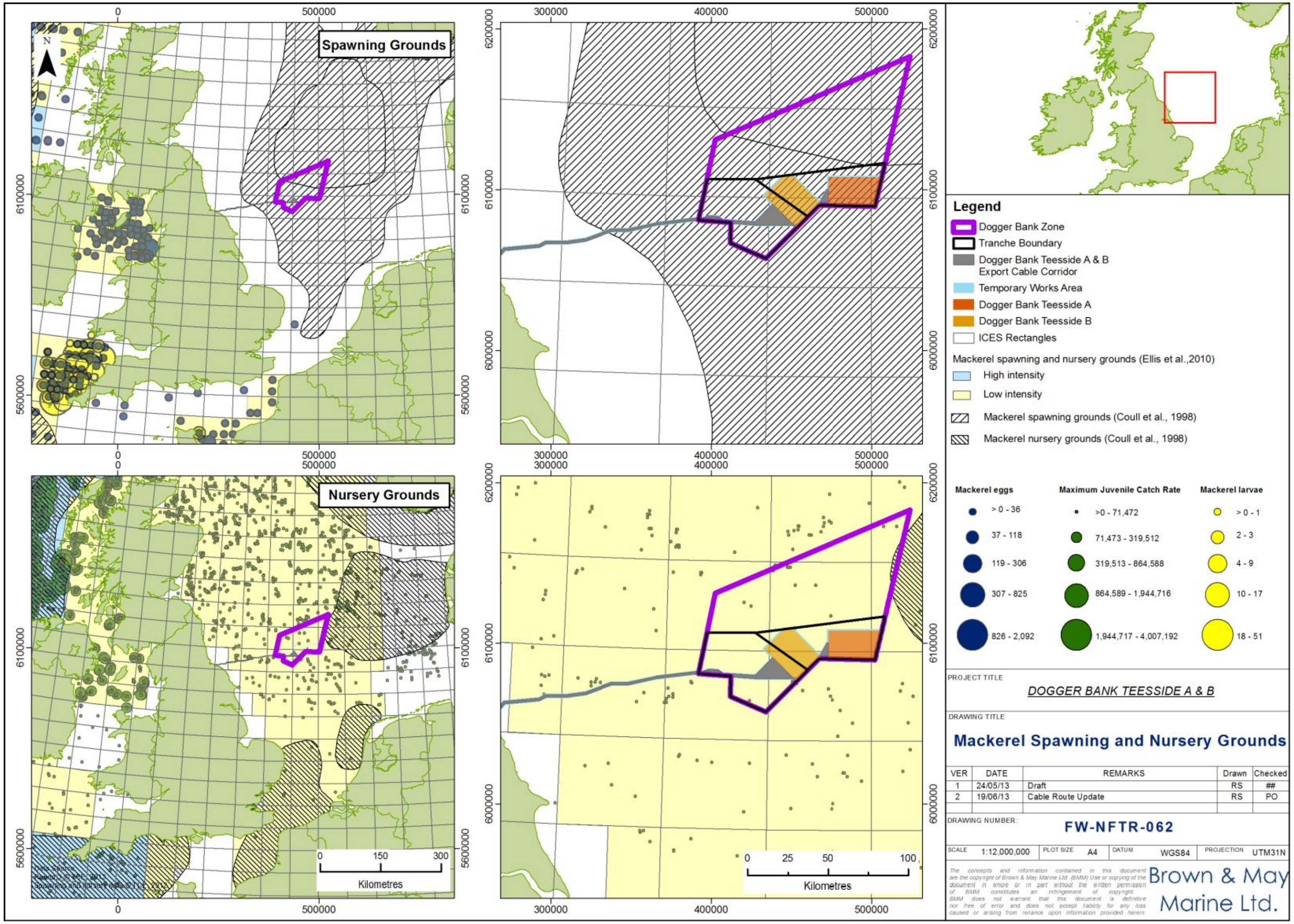


Figure 6.53 Mackerel Spawning and Nursery Grounds

6.2.4 Horse Mackerel

258. Horse mackerel is a southern species, reaching its northerly distribution limit in the northern North Sea (**Figure 6.54**). After spawning in the Southern Bight, they disperse into the German Bight and over adjacent areas. From October onwards, they leave the North Sea through the Dover Strait to overwinter in the Channel and the Celtic Sea (ICES 2005). Horse mackerel are of conservation importance, being listed as a UK BAP priority species (**Table 5.20**).

259. When young, they feed on planktonic invertebrates (Wheeler 1978). Larger individuals feed increasingly on fish with 0-group herring, cod and whiting representing major prey. Like the majority of pelagic fish, they are preyed upon by pelagic sharks, large teleosts, seabirds and marine mammals (ICES 2005).

260. Horse mackerel were caught in very low numbers in the otter trawl surveys carried out in tranches A and B and were not recorded in the pelagic trawl survey. As suggested by landings data (Section 5.4) and the information provided in *Chapter 15 - Commercial Fisheries,* this species is not of particular commercial importance in the area of the Wind Farm and Export Cable Study Areas.

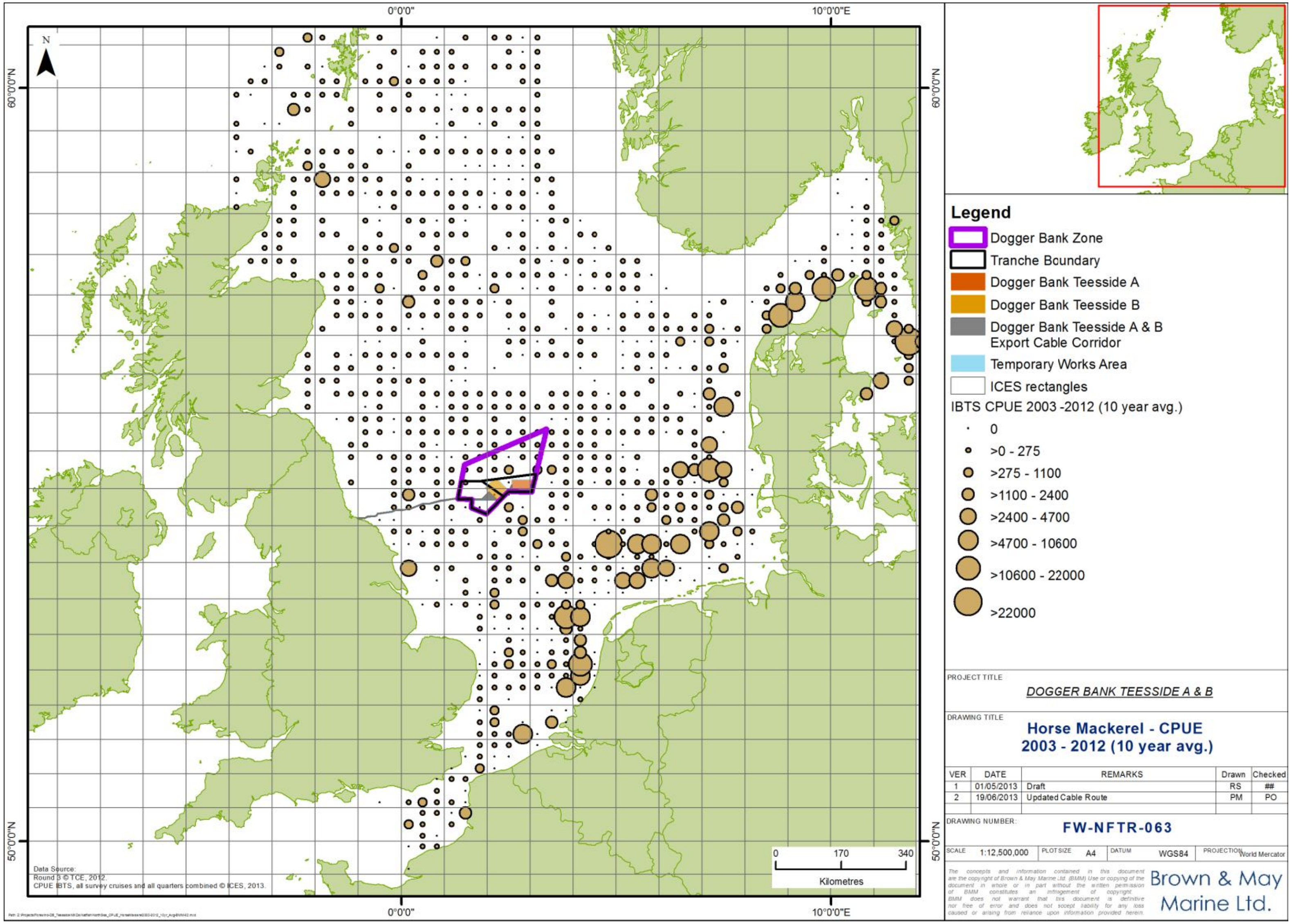


Figure 6.54 Average number (catch per standardised haul) of Horse Mackerel from IBTS survey data 2003-2012

6.3 Elasmobranchs

6.3.1 Thornback Ray

261. Thornback ray *Raja clavata* was formerly widespread and abundant in the North Sea, especially in the southern and central areas. This species is, however, currently most abundant in the south-western North Sea, particularly in the Outer Thames Estuary and The Wash (ICES 2005, ICES 2008b). A single thornback ray was recorded in two of the three otter trawl surveys carried out in Tranche B and along the Dogger Bank Teesside A & B Export Cable Corridor. In addition, a thornback ray was found in the trammel net surveys carried out in the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor (**Table 5.9**). The average distribution of this species between 2003 and 2012 in the North Sea from IBTS data is given in **Figure 6.55**).

262. Thornback ray is commercially important in the North Sea being the dominant ray species in commercial landings (ICES 2005). Landings of this species in both the Wind Farm and Export Cable Study Areas are, however, comparatively low (see values for grouped category "skates and rays" in **Table 5.13** and **Table 5.15**).

263. As shown in **Table 5.19** above, thornback ray is of conservation interest, being included in the OSPAR list of threatened and/or declining species and classified as 'Near Threatened' by the IUCN.

6.3.2 Spotted ray

264. Spotted ray *Raja montagui* is most commonly found in moderately deep water, mainly between 60m and 120m and on sandy substrates (Wheeler 1978). The distribution of the species around the British Isles is similar to that described for thornback ray (Ellis *et al.,* 2005). Spotted ray occurred in otter trawl surveys of tranches A and B and the Dogger Bank Teesside A & B Export Cable Corridor as well as in the trammel net surveys in relatively low numbers. The distribution of spotted rays in the North Sea is illustrated in **Figure 6.56** which shows that this species is poorly represented in the area of the Dogger Bank and therefore it is not expected to be found in high numbers within the Dogger Bank Teesside A & B Export Cable Corridor and the Wind Farm Study Areas.

265. Spotted ray are considered of secondary importance in UK landings in comparison to thornback ray. They are landed together with thornback ray and blonde ray by the Dutch beam trawl fleet (ICES 2007). In addition, they are of conservation interest, being included in the OSPAR list of threatened and/or declining species and classified as of "Least Concern" by the IUCN **Table 5.19**.

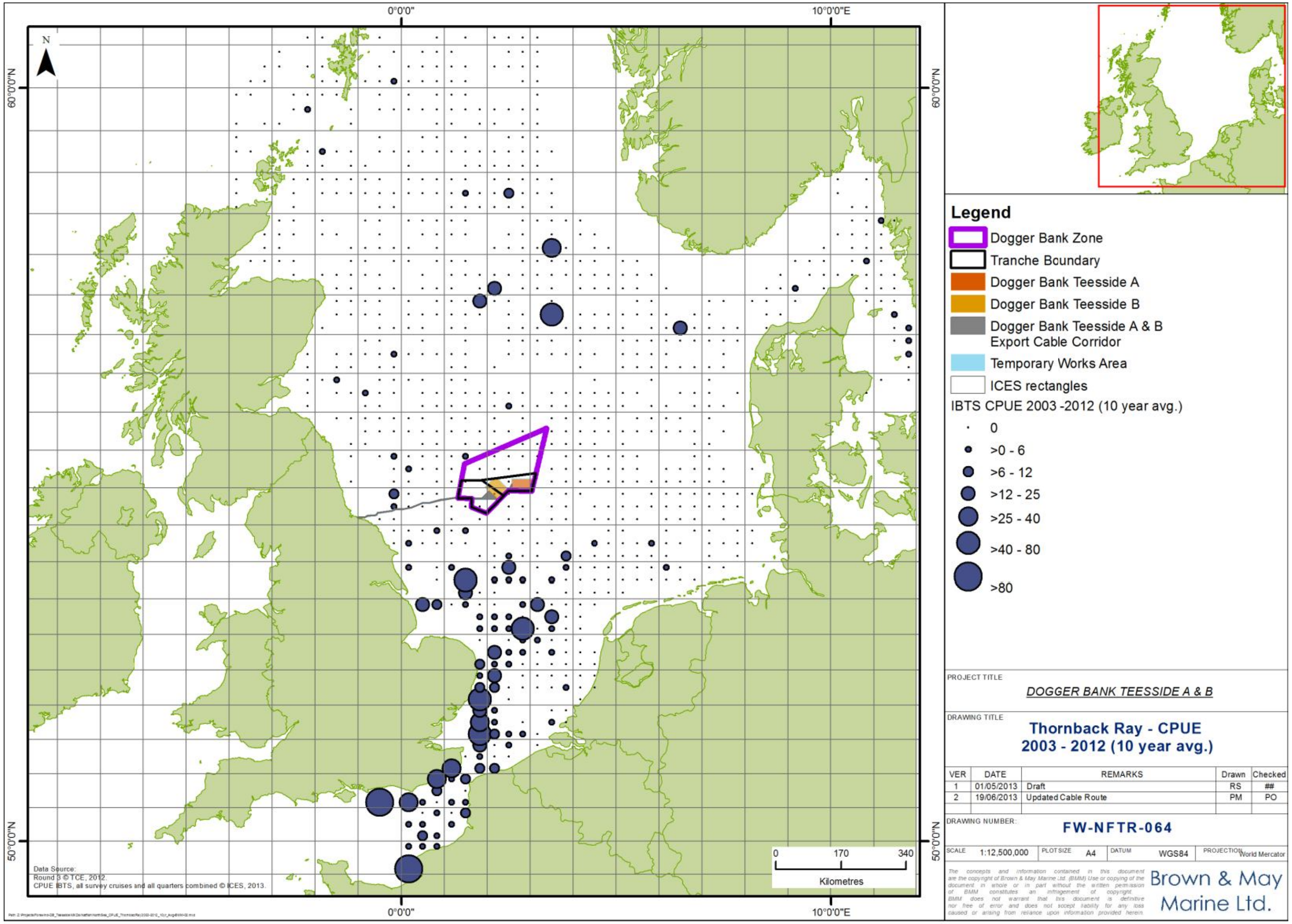


Figure 6.55 Average number (catch per standardised haul) of Thornback ray from IBTS survey data 2003-2012

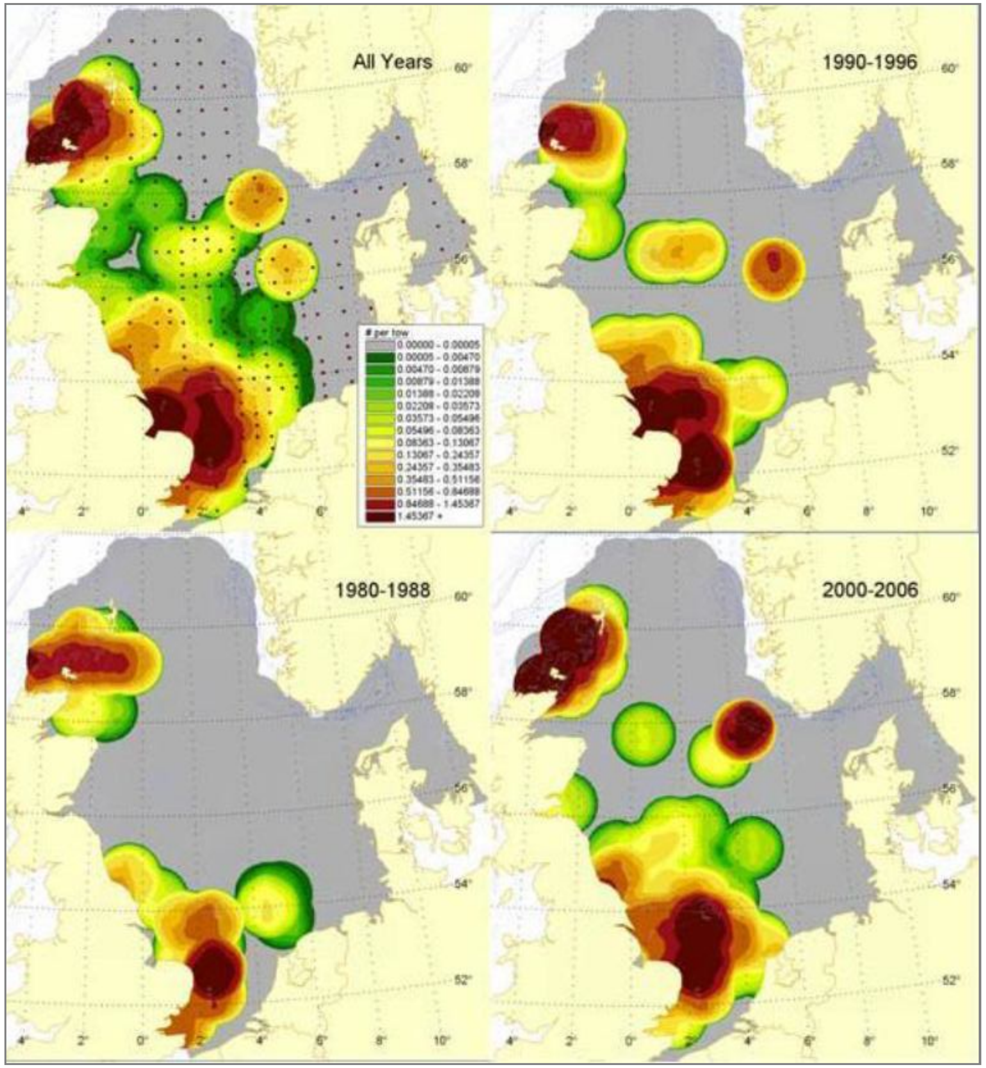


Figure 6.56 Distribution of Spotted Ray during three periods and averaged over the period 1980-2006 (Source: ICES 2007)

6.3.3 Blonde ray

266. Blonde ray *Raja brachyura* are common in inshore waters (14m to 146m) off southern and western England, being less frequent in the North Sea and Celtic Sea (Ellis *et al.,* 2005). This species feeds on a wide range of crustaceans, worms and fish, particularly herring, sprat, pouting, sandeels and sole (Wheeler 1978).

267. As shown by IBTS survey trawl results for the period 2003 to 2012, this species was not caught within the Project area (**Figure 6.57)**.

268. Blonde ray were not recorded in either the inshore trammel net or the offshore trawl surveys.

269. Blonde ray is considered of secondary importance in UK landings data in comparison to thornback ray and is also landed, together with thornback ray and spotted ray, by the Dutch beam trawl fleet (ICES 2007). As shown in **Table 5.19**, this species is of conservation interest being classified as 'Near Threatened' in the IUCN Red List of threatened species.

6.3.4 Other Ray Species

6.3.4.1 Starry Ray

270. Starry ray *Raja radiata* has been found to be abundant in the North Sea in waters of 32-209m (Ellis *et al.,* 2005). They prefer sandy and muddy bottoms but are occasionally found on shell and gravel. It is generally not found close inshore except in the north of its range (Wheeler 1978). Starry ray were recorded in relatively low numbers in the otter trawl surveys carried out in tranches A and B, the Dogger Bank Teesside A & B Export Cable Corridor and the inshore trammel net surveys.

6.3.4.2 Cuckoo Ray

271. Cuckoo Ray *Leucoraja naevus* has been found to be common in the Irish Sea, Celtic Sea and northern North Sea at depths of 12–290m and has been rarely recorded in the eastern English Channel and southern North Sea (Ellis *et al.,* 2005). This species was not present in surveys carried out in tranches A and B and along the Dogger Bank Teesside A & B Export Cable Corridor. As shown in **Table 5.19**, cuckoo ray is classified as "of Least concern" in the IUCN Red list of threatened species.

6.3.4.3 Undulate Ray

272. Undulate Ray *Raja undulata* has been recorded frequently in the English Channel and occasionally in the southern North Sea (Ellis *et al.,* 2005). It was not found during the otter trawl surveys carried out in tranches A and B. It is of conservation importance being classified as "Endangered" in the IUCN Red list of threatened species and listed as a UK BAP species (**Table 5.19**).

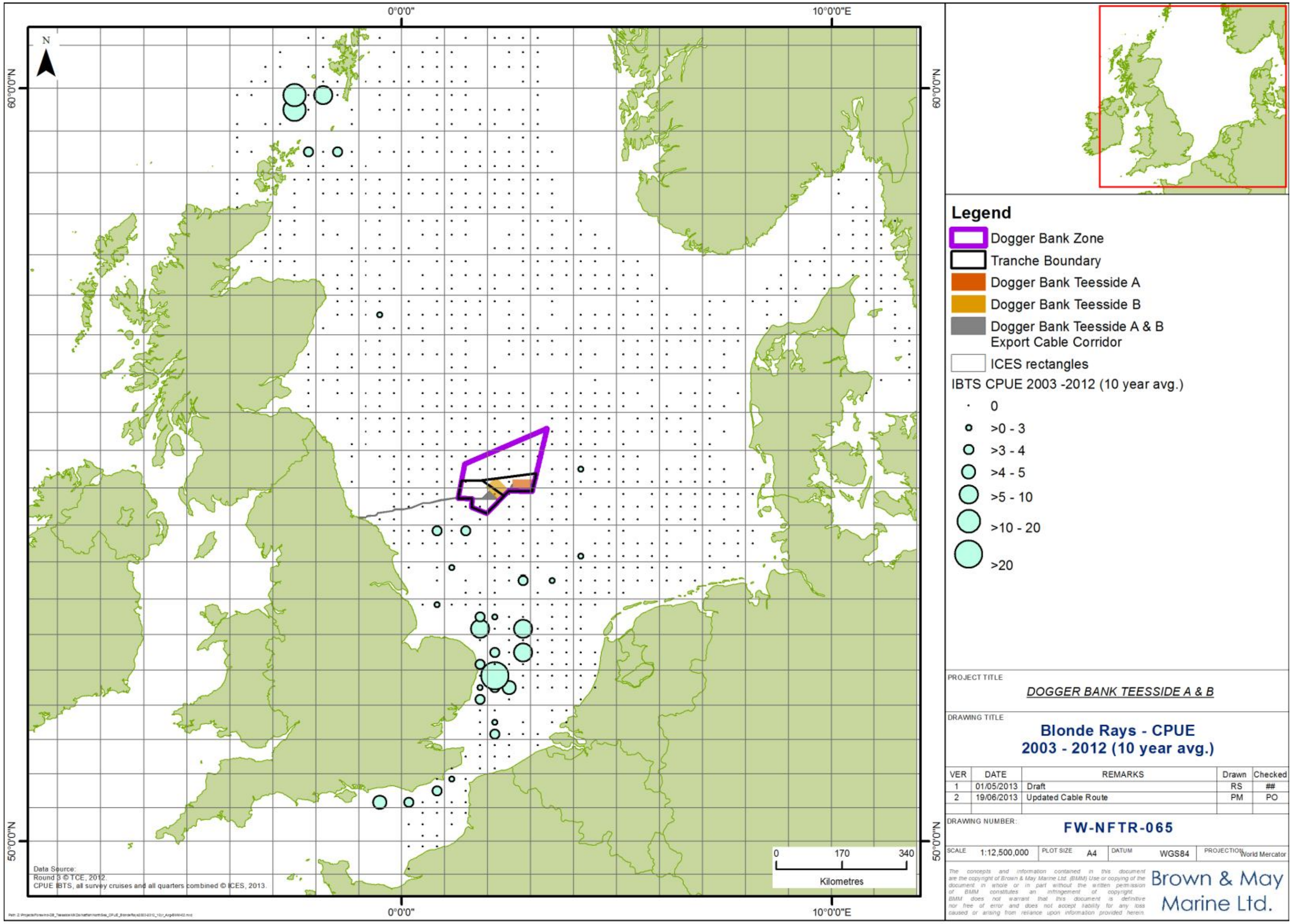


Figure 6.57 Average number (catch per standardised haul) of Blonde Ray from IBTS survey data 2003-2012

6.3.4.4 Common Skate Complex

273. The common skate complex *Dipturus intermedia* and *Dipturus flossada* were historically one of the most abundant rays in the north-east Atlantic, being widely distributed around the British Isles. They have now disappeared from the Irish Sea, English Channel and the southern and Central North Sea. Individual specimens are reported occasionally from these areas, however they are now only regularly observed off northern and north-western Scotland, in the Celtic Sea and along the edge of the continental shelf (more than 150m deep) (Dulvy *et al.,* 2006).

274. The common skate complex is of conservation importance, being classified as "Critically Endangered" by the IUCN Red List of Threatened Species, listed as a UK BAP priority species and in the OSPAR list of threatened and/or declining species (**Table 5.19**)

6.3.5 Lesser spotted dogfish

275. Lesser spotted dogfish is widespread and abundant along the southern and western seaboards of the British Isles at depths of 6m to 308m, showing a patchy distribution in the North Sea (Ellis *et al.,* 2005). They are most commonly found in the shallow sublittoral on muddy and sandy substrates to depths up to 100m (Pizzolla 2008).

276. They were found in very low numbers in the otter trawl surveys undertaken within tranches A and B, and were also present at stations sampled along the Dogger Bank Teesside A & B Export Cable Corridor. This species was, however, found in relatively high numbers in the trammel net survey carried out in the inshore area (**Table 5.9**).

6.3.6 Smoothhounds

277. Starry smoothhound *Mustelus asterias* is widely distributed around the British Isles in waters of 10m to 200m depth. They are, however, more abundant along the southern and western coast of the UK with high catch rates recorded in the outer Thames Estuary and Bristol Channel (Ellis *et al.,* 2005). Their average abundance in IBTS survey catches is shown in **Figure 6.58**. Smoothhound *Mustelus mustelus* are found less frequently than starry smoothhounds and have been rarely recorded in the North Sea (Ellis *et al.,* 2005).

278. *M. asterias* were found at otter trawl sites in Tranche B and along the Dogger Bank Teesside A & B Export Cable Corridor. *Mustelus sp*. were also found in inshore trammel net surveys (**Table 5.9**). They feed primarily on crustaceans, including hermit crabs, edible crabs, shore crabs, small lobsters and squat crabs (Wheeler 1978). This species is classified as of "Least Concern" in the IUCN Red List of Threatened Species (**Table 5.19**).

6.3.7 Spurdog

279. Spurdog were formerly widespread across most of the North Sea, however they are now most abundant in the western North Sea and off the isles of Orkney and Shetland (ICES 2005). Around the British Isles they are present at depths between 15m and 528m (Ellis *et al.,* 2005). Spurdog are found near the sea bed on soft substrates but also near the surface (Wheeler 1978). The average abundance of Spurdog from IBTS surveys conducted between 2003 and 2012 is presented in **Figure 6.59.**

280. Spurdog were recorded in otter trawl surveys undertaken in tranches A and B as shown in Section 5.4.1 (**Table 5.3** and **Table 5.4)** and they are the principal elasmobranch species recorded in commercial landings from the Wind Farm Study Area.

281. Both Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor are located within defined low intensity nursery grounds for this species (**Figure 6.60**).

282. Spurdog are of conservation interest, being listed as a UK BAP priority species and included in the OSPAR list of threatened and/or declining species. In addition, they are classified as "Critically Endangered" in the IUCN Red List of Threatened Species (**Table 5.19**). It should be noted, that the exploitation of this species has been reduced substantially in recent years as a result of decreasing quota allocations (Ellis *et al.,* 2009). In 2010, the TAC for spurdog was set to zero, landings were however still permitted under a by-catch TAC, provided certain conditions were met (ICES 2011b). In 2011, the TAC for spurdog was retained at zero and no landings (including by-catch) were permitted (ICES 2011b).

283. Spurdog are opportunistic feeders that take a wide range of predominantly pelagic prey. Important fish prey includes herring, sprat, small gadoids, sandeel, and mackerel; however, crustaceans (swimming crabs, hermit crabs and euphausids), squid and ctenophores also represent important prey to this species (ICES 2005).

6.3.8 Tope

284. Tope *Galeorhinus galeus* is regularly recorded around the British Isles (Ellis *et al.,* 2005). They are generally found in shallow waters down to 200m and usually live in small schools close to the sea bed, although when actively feeding they can be found in mid-water (Wheeler 1978). They eat a variety of fish, including pilchards, herring, anchovies, smelt, hake, cod sole, mackerel and gobies. They also consume invertebrates such as squid, octopus, crabs and marine snails (Shark Trust 2010).

285. Tope were not recorded in any of the fish characterisation surveys carried out in tranches A and B. Low intensity nursery grounds, have, however been defined for this species to the south of the Dogger Bank Zone overlapping with the southern section of Dogger Bank Teesside A & B (**Figure 6.60**). The location and temporal stability of specific parturition grounds are not well established for this viviparous species (Ellis *et al.,* 2012).

286. Tope are of conservation interest, being listed as a UK BAP priority species and classified as “Vulnerable” in the IUCN Red List of Threatened Species (**Table 5.19**).

6.3.9 Basking shark

287. Basking shark *Cetorhinus maximus* is of conservation importance being protected under the Wildlife and Countryside Act, 1981. In addition, they are listed as UK BAP priority species and under the OSPAR list of threatened and/or declining species. Furthermore, they have been assessed as ‘Vulnerable’ in the IUCN Red List of Threatened Species (**Table 5.19**).

288. Sightings of this species in coastal waters in the Wind Farm and Export Cable Study Areas are generally rare (Bloomfield and Soland 2006). High sightings density areas are found off the west coast of Scotland, around the Isle of Man, all around the south west of England, and along the middle of the western half of the English Channel (Bloomfield and Soland 2006). Three sightings were however recorded during aerial surveys conducted in September 2010 (Lat 55.066809 Long 2.498298), September (Lat 55.741304 Long 3.220443) and November 2011 (Lat 55.069800 Long 1.742822) indicating that the species may occasionally transit the Wind Farm and Export Cable Study Areas. Basking sharks migrate from the western English Channel in spring to western Scottish waters, where they spend the summer and early autumn before moving offshore between November and March (Evans *et al.,* 2011). Whilst they are rare off the east coast of England they may occasionally transit the Wind Farm and Export Cable Study Areas.

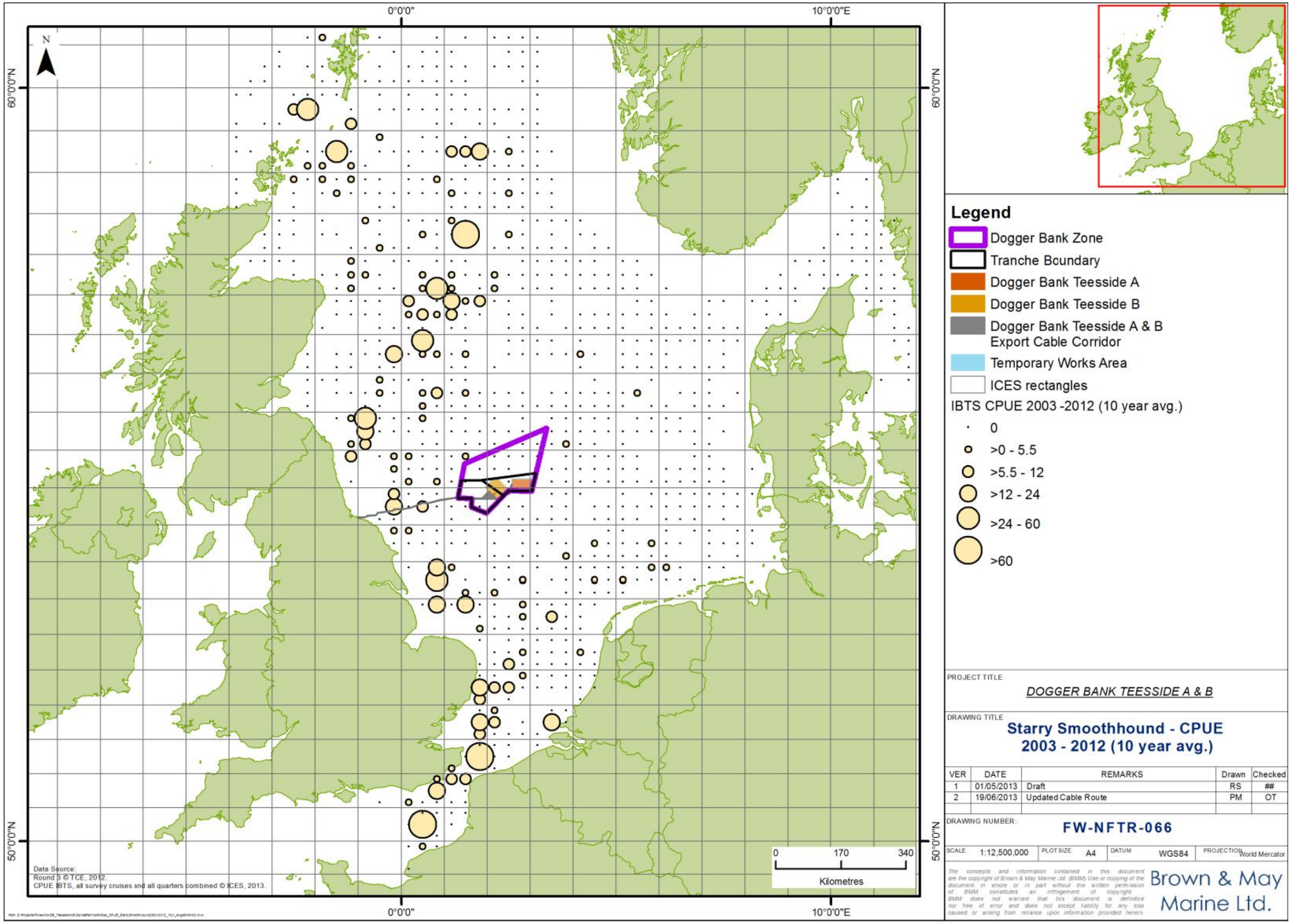


Figure 6.58 Average number (catch per standardised haul) of Starry smoothhound from IBTS survey data 2003-2012

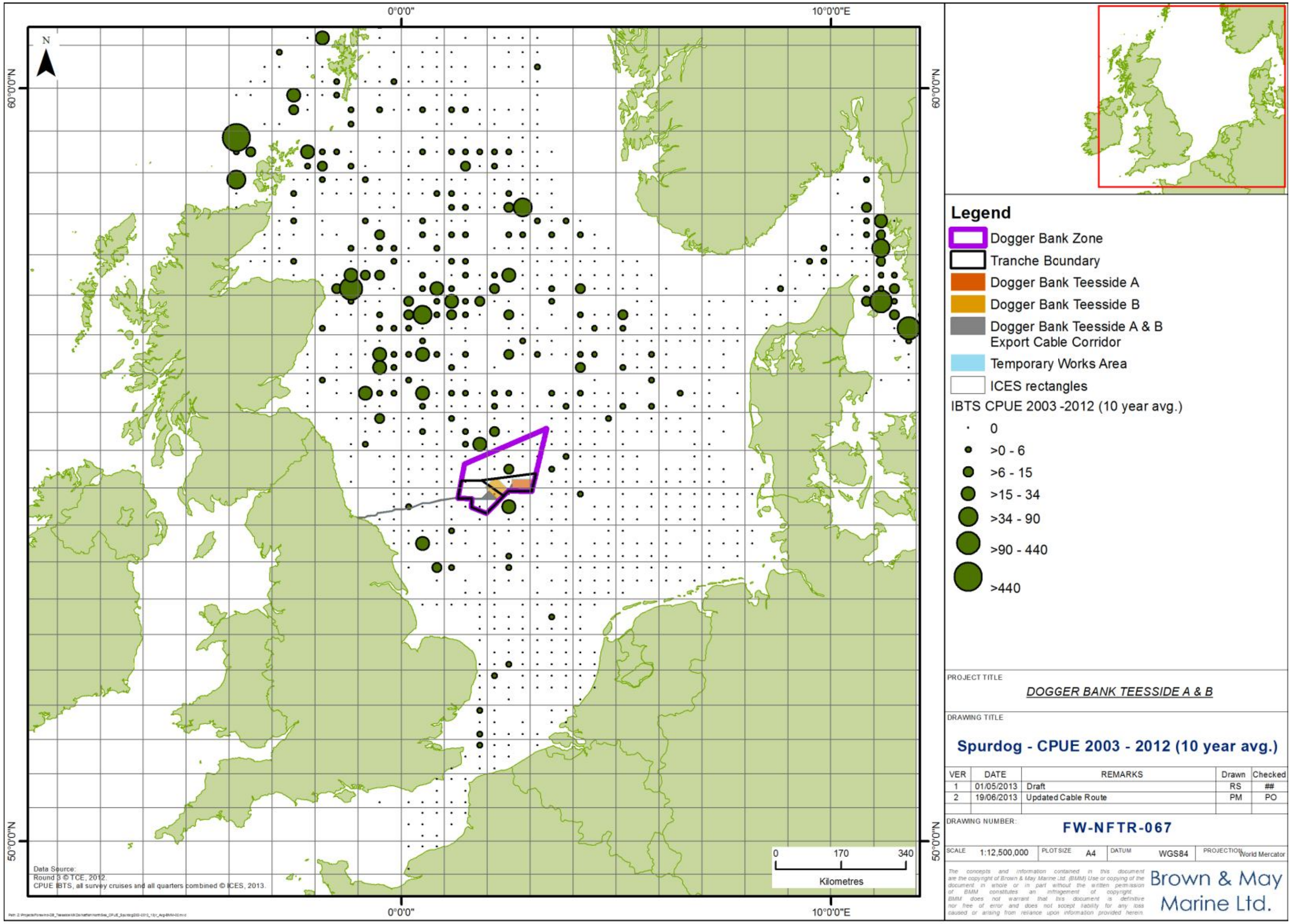


Figure 6.59 Average number (catch per standardised haul) of Spurdog from IBTS survey data 2003-2012

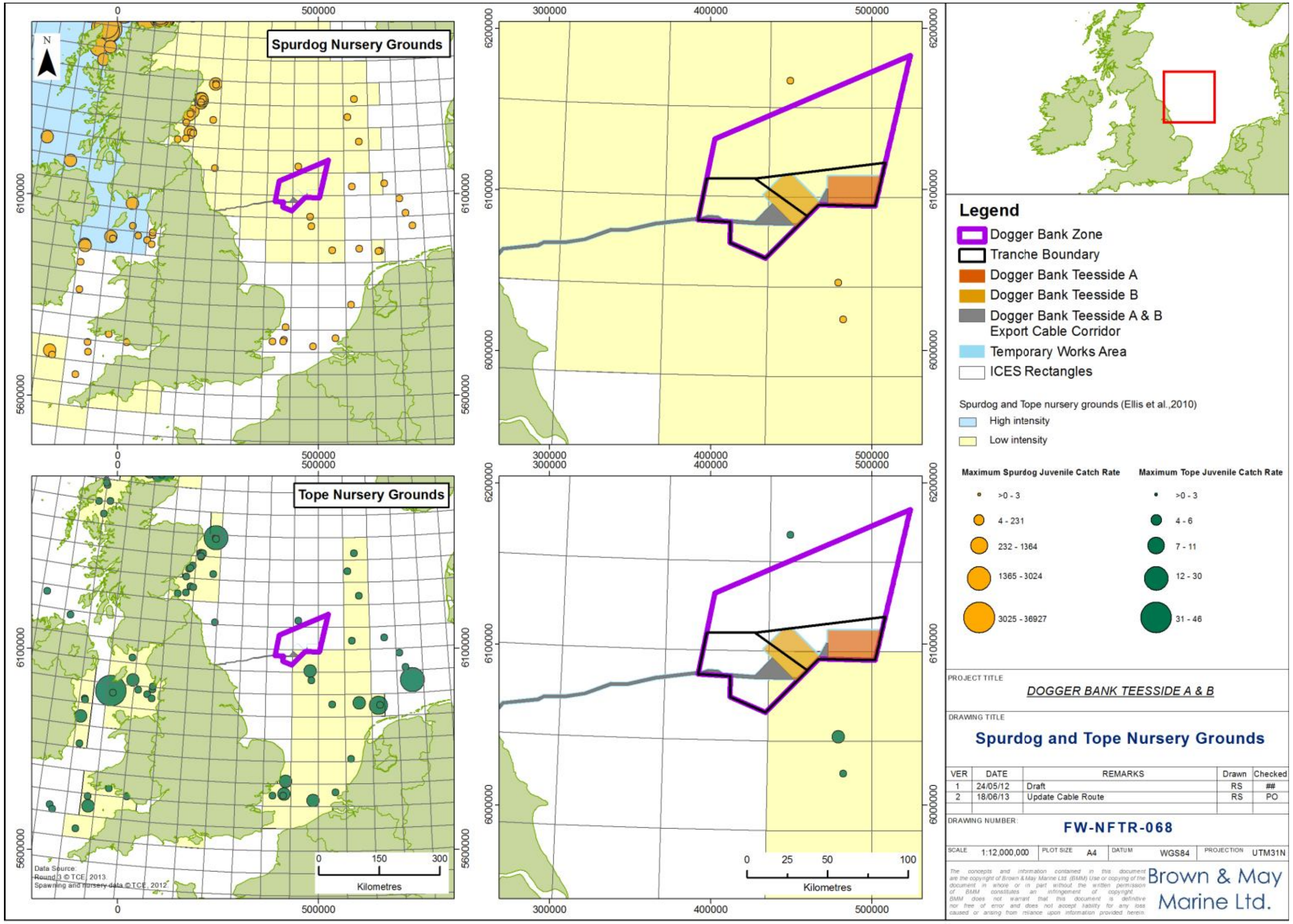


Figure 6.60 Distribution of Spurdog and Tope Nursery Areas (Ellis *et al.*, 2010)

6.4 Migratory Diadromous Species

6.4.1 European Eel

289. The European eel *Anguilla anguilla* is a catadromous migratory species. Spawning is thought to occur in the Sargasso Sea, with the newly hatched larvae being transported back towards the European coast by prevailing currents. They metamorphose into glass eels as they arrive on the continental shelf, and subsequently become pigmented ‘elvers’ (Aarestrup *et al.,* 2009, Potter and Dare 2003).

290. Adults are thought to migrate to sea from August to December. Glass eels arrive at coastal waters from February to March and migrate upstream as elvers from May until September (Environment Agency 2011b).

291. Eels are present in nearly all rivers throughout England, although numbers have declined dramatically in recent years. The main fisheries for eels are based in lowland areas in southern and eastern England. Eels are present in both the River Esk and River Tees (situated north and south of the Dogger Bank Teesside A & B Export Cable Landfall, respectively) although they are currently only targeted commercially in the Tees. Levels of commercial exploitation are however generally low in the North Eastern Environment Agency Region with a total catch of 160kgs of adult eels reported from eight commercial licenses issued in 2010 (Environment Agency 2010).There is at least one commercial fyke netter targeting eels in the tidal section of the River Tees (Walmsey and Pawson, 2007).

292. Recruitment of juvenile eels of the European stock is currently very low, with the decline in the eel stock being internationally recognised as a conservation priority as shown in **Table 5.18**. European eel are listed as UK BAP species and assessed as “Critically Endangered” by the IUCN. In addition, this species is listed in Appendix II of the Convention for International Trade in Endangered Species of Wild Fauna and Flora (CITES). ICES indicate that the stock continues in decline (ICES 2011c).

293. Very little is known about the sea phase of the spawning migration. Eels from the east coast of the UK, Scandinavia, the Baltic and the Low Countries have a choice of two major routes to reach the spawning grounds, via the English Channel or via the north of Scotland (Malcolm *et al.,* 2011).

294. In light of their migratory behaviour it is likely that eels occasionally transit the area of Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable corridor. This is likely to be of increased relevance to the Dogger Bank Teesside A & B Export Cable given the position of the Esk and Tees relative to the cable landfall.

6.4.2 River and Sea Lamprey

295. River lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* are parasitic anadromous migratory species. Both species spawn in fresh water in spring or early summer, followed by a larval phase (ammocoetes) spent in suitable silt beds in streams and rivers (Laughton and Burns 2003). All individuals die after spawning (Maitland 2003a). Ammocoetes can spend several

years in these silt beds, feeding on organic detritus and eventually transforming into adults from late summer onwards (Laughton and Burns 2003). The transformation into the adult stage is characterised by the development of functional eyes and the mouth changes into a fully formed sucker (Maitland 2003a). After transformation, river and sea lampreys migrate to sea, where they use their suckers to attach to other fish (Maitland 2003a). After several years in the marine environment the adults return to fresh water to spawn (Laughton and Burns 2003).

296. River lampreys are generally found in coastal waters, estuaries and accessible rivers. Young river lampreys are known to congregate in large numbers in the estuaries of major rivers, feeding on a variety of estuarine fish, particularly herring, sprat and flounder. After one to two years in estuaries, river lampreys stop feeding in the autumn and move upstream between October and December (Maitland 2003a, Natural England 2010).

297. The distribution of sea lamprey is largely dictated by their host (Waldman *et al.,* 2008). At sea, they feed on a variety of marine mammals and fish, including, shad, herring, Pollack *Pollachius pollachius*, salmon *Salmo salar*, cod, haddock and basking sharks (Kelly and King 2001, ter Hofstede *et al.,* 2008). The rarity of capture in coastal and estuarine waters suggests that sea lampreys are solitary feeders and widely dispersed at sea. It is possible that sea lamprey often feed in deeper offshore waters as they have been caught at considerable depths (4100m water depth) (Moore *et al.,* 2003).

298. As shown in **Figure 6.61** both species of lamprey are recorded in the River Tees (situated north of the Dogger Bank Teesside A & B Export Cable landfall). Although not recorded in the River Esk (**Figure 6.61**) it is likely that even if they do not spawn in-river both species are present occasionally as the river has a run of salmon and sea trout which are a common host/prey type. There is, therefore, potential for sea and river lamprey to occasionally transit the Dogger Bank Teesside A & B Export Cable Corridor and/or Dogger Bank Teesside A & B as part of their foraging or migratory behaviour. .

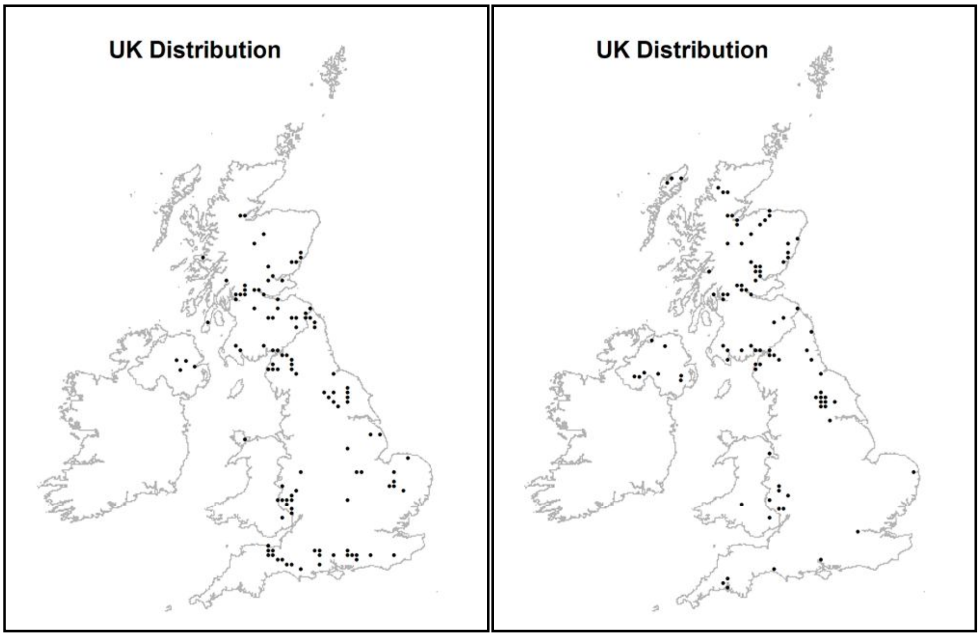


Figure 6.61 UK Distribution of River Lamprey (left) and Sea Lamprey (right) (JNCC 2007)

6.4.3 Atlantic Salmon and Sea Trout

299. Atlantic salmon (*Salmo salar*) is an anadromous migratory species which utilises both freshwater and marine habitats during its life cycle. The UK salmon population comprises a significant proportion of the total European stock, with Scottish rivers in particular being a European stronghold for this species (JNCC 2011).

300. Spawning occurs in the upper reaches of rivers during late autumn and winter when females cut nests (known as a 'redds') in gravelly substrates in which the eggs are deposited (NASCO, 2012). Larvae ('alevin') hatch the following spring, remaining within interstitial gravels where endogenous nutrients are absorbed from the attached yolk sac before emerging from the redd as fry and switching to invertebrate prey. The transition to the next life stage 'parr' is subject to geographical variations, occurring during the first summer in productive southern streams (Potter & Dare, 2003), and up to a year in upland systems.

301. After spending one to five years in freshwater salmon and sea trout parr undergo 'smoltification'; a process of physiological and morphological changes which prepare for ocean entry (McCormick *et al.*, 1998). Through late March to June smolts migrate down river and enter the ocean where they are known as 'post smolts', until the middle of their first winter at sea.

302. Salmon return to their natal rivers as adults after spending between one to five years feeding at sea. Depending on the length of time spent feeding, adults are known as either 'one–sea–winter' (1SW, also known as 'Grilse') or 'multi–sea–winter' (MSW) salmon. In the UK adult salmon generally return to spawn in the natal river between June and October although lower numbers of MSW fish may enter rivers all year round.

303. Sea trout are anadromous brown trout (*Salmo Trutta*) and migratory and non-migratory forms are recognised as a single species. The mechanisms controlling anadromy in brown trout are not fully understood but involve both genetic and environmental components (Malcolm *et al.* 2010). Their life cycle is very similar to that of Atlantic salmon although the marine feeding phase is generally shortened both spatially and temporally. A number of immature smolts ('whitling') return to freshwater to overwinter after a short spell of feeding at sea (Malcolm *et al.*, 2010). A further component of the stock, referred to as 'maidens', do not return to freshwater to spawn until at least a year after migration (Gargan *et al.*, 2004).

304. The rivers supporting salmon and sea trout rivers in England and Wales are illustrated in **Figure 6.62** (JNCC, 2011). Of the 80 rivers in which salmon are recorded, 64 are 'designated principal salmon rivers'. The performance of salmon stocks in these rivers is assessed against conservation limits (CL) which are identified by a target number of eggs deposited during spawning to ensure the status of the population remains favourable (Environment Agency & Cefas, 2012). A number of the remaining rivers such as the Severn and Yorkshire Ouse support salmon populations in the early stages of recovery but are not currently designated as principal salmon rivers. Those rivers which are suitable for salmon will in most, if not all, cases also support stocks of sea trout.

305. The Dogger Bank Teesside A & B Export Cable Corridor landfall is situated between two designated 'principal salmon rivers'; the Yorkshire Esk to the South and the Tees immediately to the north (**Figure 6.63**).

306. Following serious historical pollution the River Tees salmon population has increased since the early 1980's and now supports a small but increasing recreational rod and line fishery (APEM, 2009). The Tees does not currently meet its CL of 14.9 million eggs, although this is expected as recovery is still at an early stage (APEM, 2009). Declared rod and line catches of both salmon and sea trout have increased almost continually since the mid-1990s (**Figure 6.66**). This is particularly marked in numbers of recorded salmon which were an order of magnitude greater in 2011 than during the 1980s to mid- 1990s (**Figure 6.66**). Note that data from the rod and line fishery does not necessarily reflect abundance as it is not corrected for other variables, particularly effort. In addition, some migration occurs outside of the angling season. Such data is however useful for a general indication of historical trends.

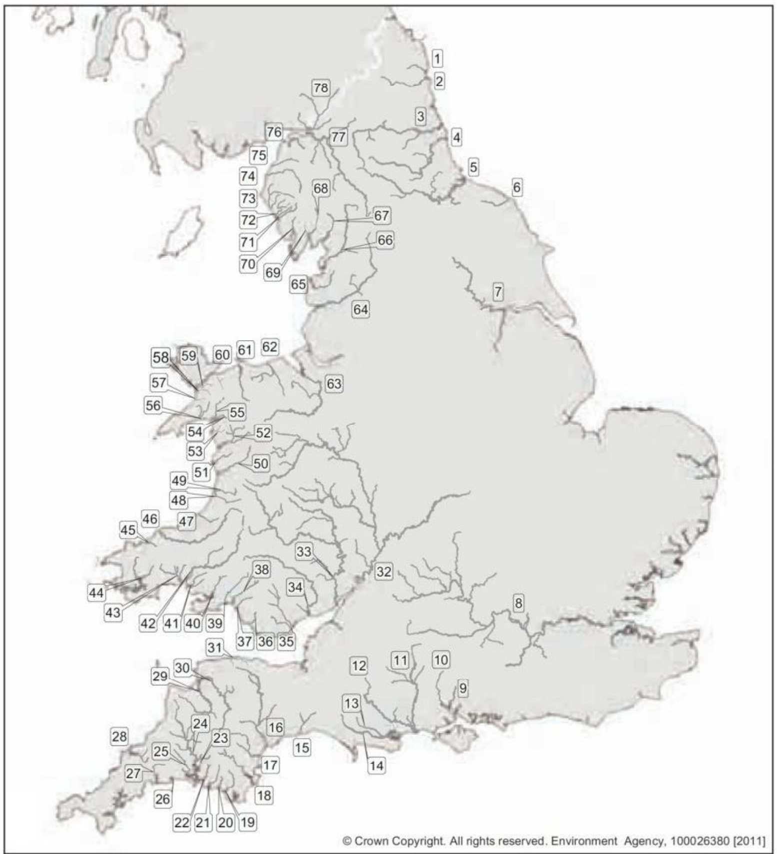
307. Monthly numbers of salmon and sea trout running the River Tees have also been recorded by Environment Agency operated fish counters at the Tees Barrage since 1995 (Environment Agency, 2013). Note that this data is derived from the number of fish which use the fish pass in which the trap is located and therefore represents a proportion of the run as opposed to total numbers. With the exception of a few years, there has been a general increase in numbers of salmon since 1995. In comparison, numbers of sea trout running the river show more variability **(Figure 6.64**). Particularly high numbers of salmon were recorded in the trap during 2004 (571) and 2008 (229). High numbers of sea trout were recorded during 2000 (866) and 2001(1104) but have generally been much lower in more recent years. From 1995 to 2010 the highest numbers of salmon and sea trout entering the river to spawn have been recorded during September and October (**Figure 6.65**). The historical fish trap operating in the barrage was

replaced by a resistivity counter in July 2011. The data available from this trap does not specify differences in counts between species and therefore has not been included here.

308. The River Esk has a long established rod and line fishery and is the only principal salmon river in Yorkshire (Environment Agency, 2011). The Esk does not have a fish counter or trap and information and assessment of stocks (including conservation limits) is derived from data from the rod and line fishery. Spawning escapement (number of eggs deposited) is currently below the target CL of 2.02 million eggs (Environment Agency, 2011).

309. Rod catch from the River Esk declined significantly throughout the 1960s, 1970s and 1980s, falling from a peak of 900 fish in 1966 to only 11 in 1989 (Environment Agency, 2011). Catches remained depleted throughout the 1990s before showing signs of recovery in 2004 (**Figure 6.67**). Over the same period this was the reverse of the pattern observed in other rivers in the North East where catches generally increased (e.g. in the Tees, see above). The principle factor in the decline of the Esk salmon population is believed to be heavy losses of returning spawning fish incurred from illegal poaching on entrance of the tideway. However, post 2003 increases in the salmon rod fishery are also likely to be associated at least in part with effort reductions in the regions drift net fishery as a result of EA license buy-outs (*see Appendix 15: Commercial Fisheries Technical Report*). Sea trout numbers from the Esk rod and line fishery have fluctuated considerably although at no point have they fallen as low those recorded for salmon (**Figure 6.68**).

310. Salmon and sea trout from the Esk and Tees are exploited by the North East drift net fishery which operates along the coast of Yorkshire and Northumberland. This fishery is the most significant extant commercial salmon and sea trout fishery in England and Wales (*see Appendix 15: Commercial Fisheries Technical Report*). The majority of salmon from this fishery result from the Northumbrian area, which accounts for 74% to 96% of the total. In 2011, the proportion of total salmon caught from each area was 94% in Northumbria and 6% in Yorkshire (Shelley, 2012). In the Yorkshire region sea trout form a greater proportion of the total annual landings than salmon, whilst in Northumberland the proportion of each species forming the total catch is more evenly distributed (Environment Agency, 2012 and F, Powell, pers comm).



1 Aln
2 Coquet*
3 Tyne*
4 Wear*
5 Tees*
6 Esk (Yorkshire)*
7 Ouse
8 Thames*
9 Itchen*$
10 Test*
11 Avon (Hants)*$
12 Stour (Dorset)*
13 Piddle*
14 Frome*
15 Axe*
16 Exe*
17 Teign*$
18 Dart*$
19 Avon (Devon)*
20 Erme*$
21 Yealm*$
22 Plym*
23 Tavy*$
24 Tamar*
25 Lynher*
26 Looe
27 Fowey*
28 Camel*$
29 Torridge*
30 Taw*$
31 Lyn*
32 Severn*
33 Wye*$
34 Usk*$
35 Taff*
36 Ogmore*
37 Afan*
38 Neath
39 Tawe*
40 Loughor*
41 Gwendraeth Fawr
42 Tywi*
43 Taf*
44 E & W Cleddau*
45 Nevern*
46 Teifi*$
47 Aeron
48 Ystwyth
49 Rheidol*
50 Dyfi*
51 Dysynni*
52 Mawddach*$ & Wnion*
53 Artro
54 Dwyryd*
55 Glaslyn*
56 Dwyfach & Dwyfawr*
57 Llyfni
58 Gwyrfai$
59 Seiont*
60 Ogwen*
61 Conwy*
62 Clwyd*
63 Dee*$
64 Ribble*
65 Wyre*
66 Lune*
67 Kent*
68 Leven*
69 Crake*
70 Duddon*
71 Esk (Cumbria)*
72 Irt*
73 Ehen & Calder*$
74 Derwent*$
75 Ellen
76 Wampool
77 Eden*$
78 Esk (Border)*

** River with Salmon Action Plan; $ River designated as a Special Area of Conservation*

Figure 6.62 Principal Salmon and Sea Trout Rivers in England and Wales (Source: JNCC 2011)

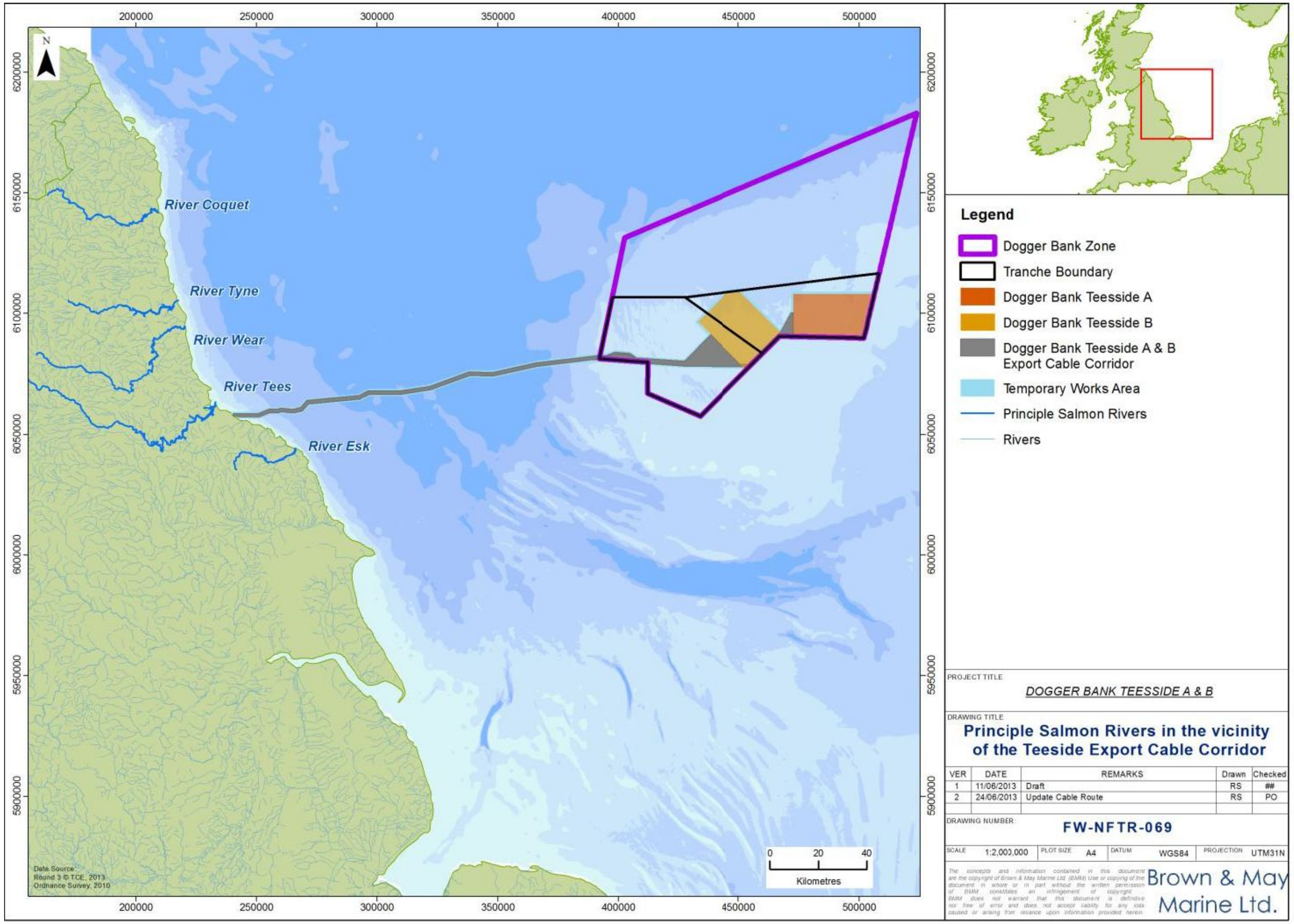
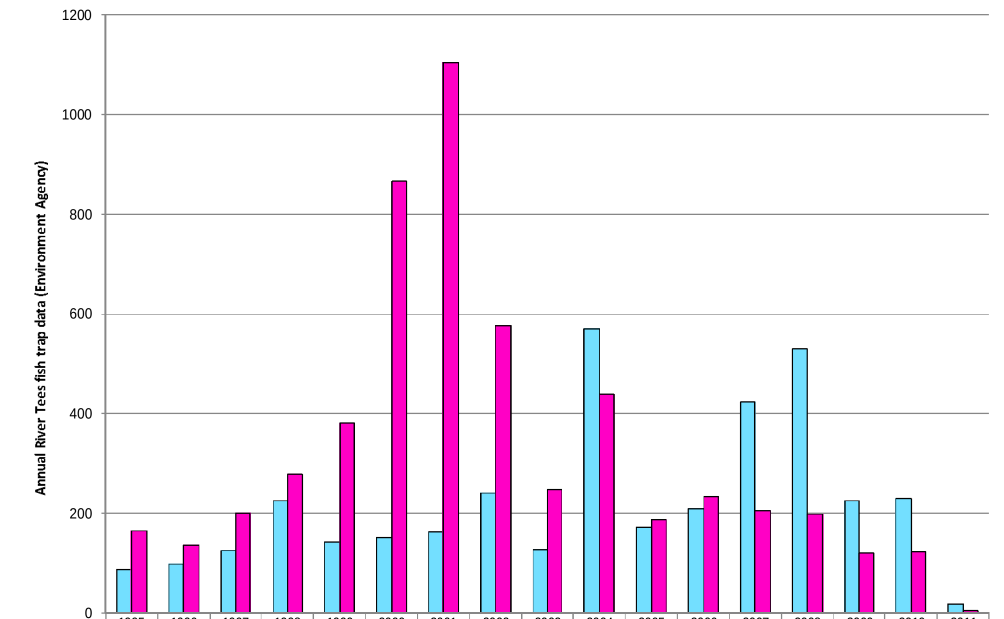


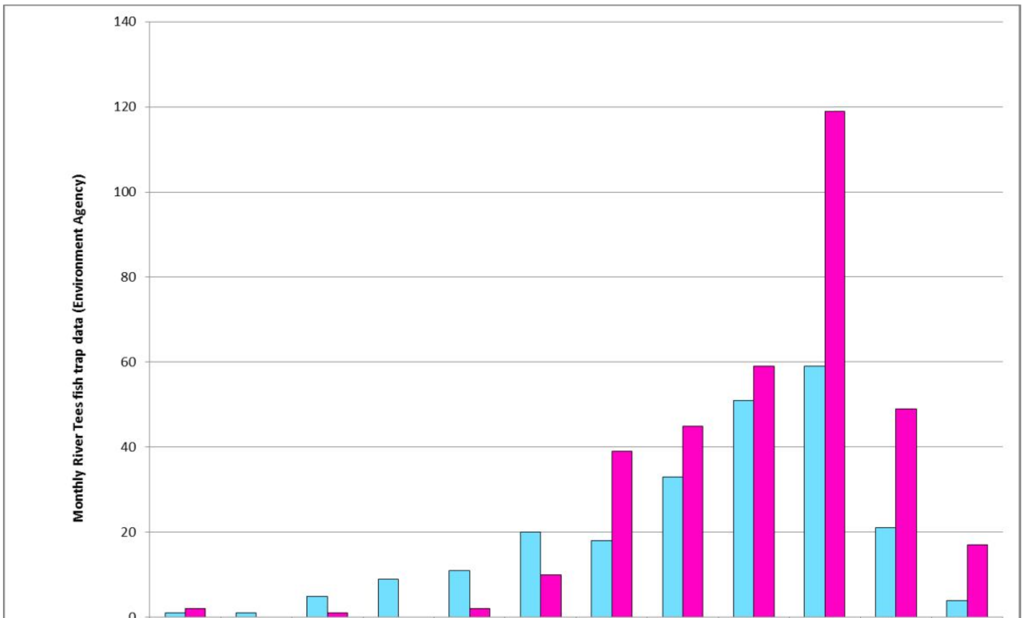
Figure 6.63 Principal Salmon Rivers in the Vicinity of the Dogger Bank Teesside A & B Export Cable Corridor



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Salmon	87	98	125	224	141	152	163	239	126	571	171	209	423	529	225	229	17
Sea Trout	164	136	200	279	381	866	1104	577	247	439	186	233	204	198	119	123	3

Year

Figure 6.64 Annual River Tees fish trap data (Source: Source Environment Agency)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Salmon	1	1	5	9	11	20	18	33	51	59	21	4
Sea Trout	2	0	1	0	2	10	39	45	59	119	49	17

Month (Average 1995-2011)

Figure 6.65 Monthly River Tees fish trap data (Average 1995-2011) (Source: Environment Agency, 2012)

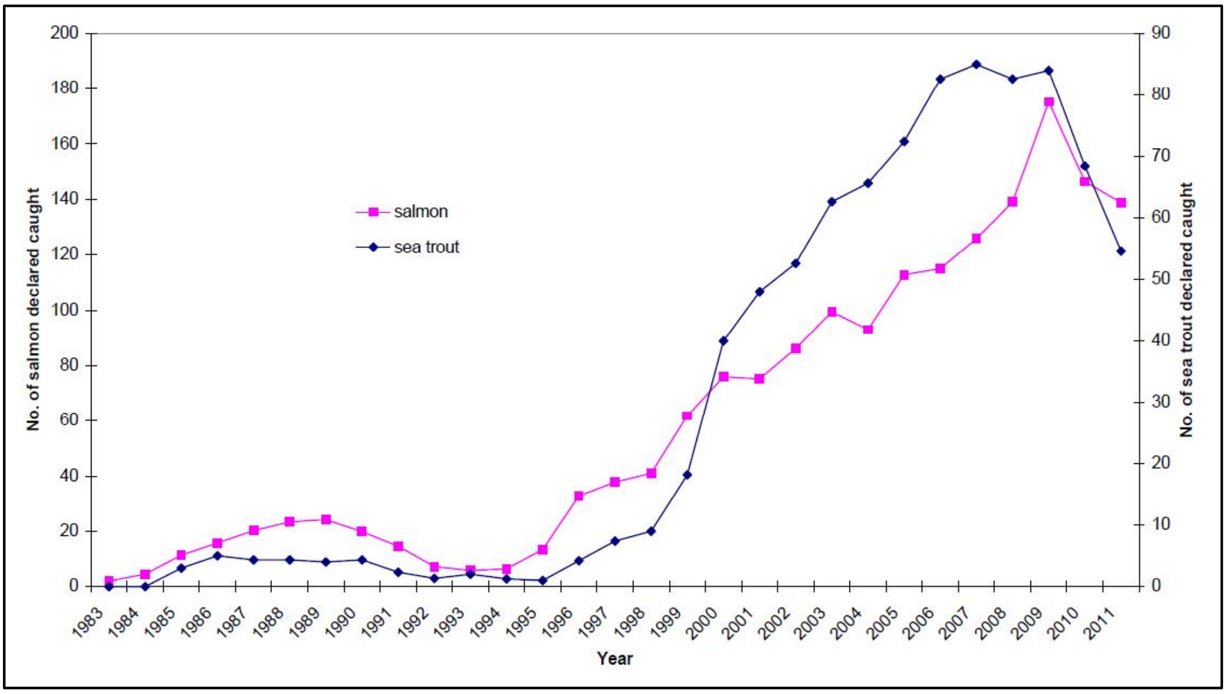


Figure 6.66 Rolling Five Year Average Salmon and Sea Trout Rod and Line Catch from the River Tees (1983-2011) (Source © Environment Agency)

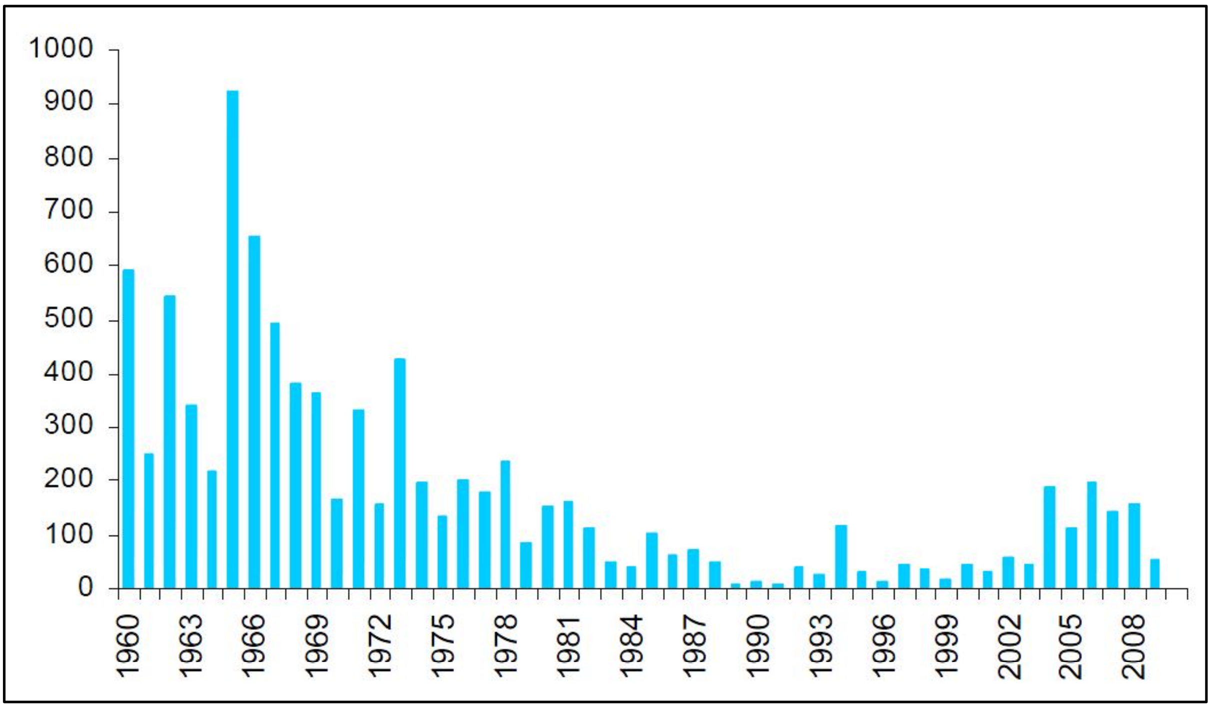


Figure 6.67 Salmon Rod and Line Catch from The River Esk (1960 – 2010) (Source © Environment Agency)

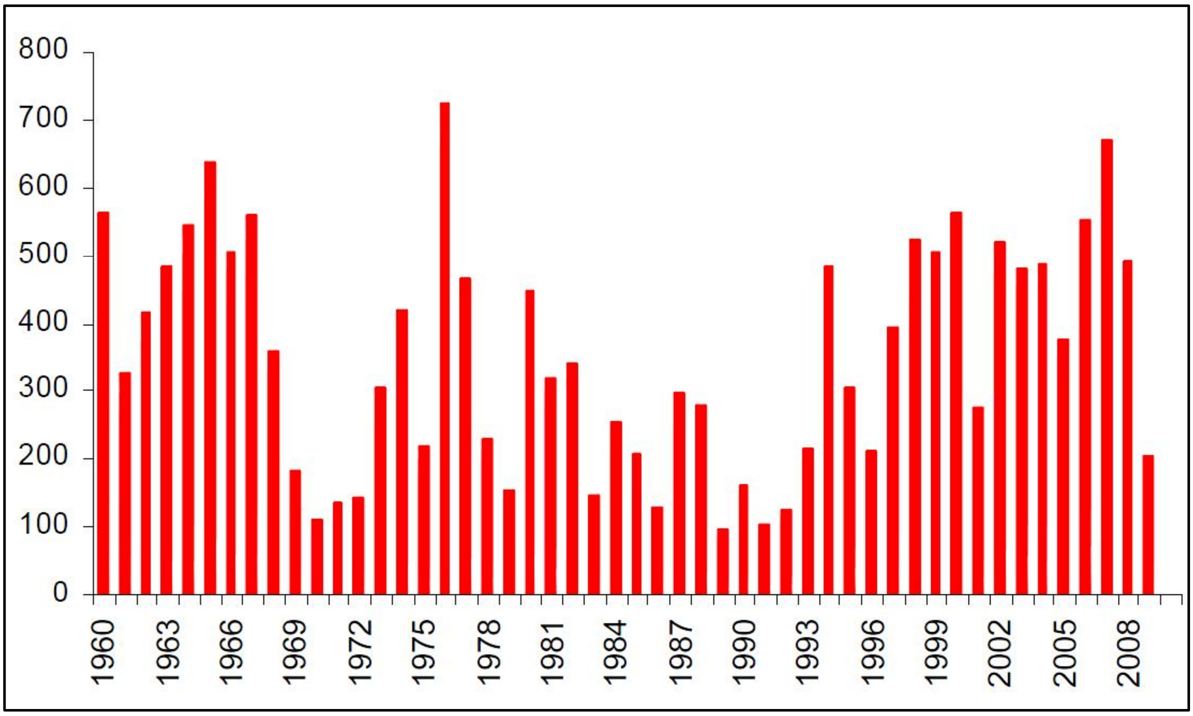


Figure 6.68 Rod and Line Sea Trout Catch from The River Esk (1960-2010) (Source © Environment Agency)

6.4.4 Allis and Twaite Shad

311. Allis shad *Alosa alosa* and twaite shad *Alosa fallax* are anadromous migratory species, occurring mainly in shallow coastal waters and estuaries, with a preference for water 10m to 20m deep. Migration into fresh water occurs during late spring (April to June) along the coast to higher, middle watercourses of rivers to spawn from mid-May to mid-July (Maitland and Hatton-Ellis 2003, Acolas *et al.,* 2004, Patberg *et al.,* 2005).

312. In contrast to twaite shad, the vast majority of allis shad only spawn once and then die (ter Hofstede *et al.,* 2008). There are no known spawning sites for allis shad in Britain, though both sub-adults and sexually mature adults are still regularly found around the British coast (Maitland and Lyle 1995). Spawning stocks of the twaite shad are only found in a few rivers in and around the southern Welsh border (JNCC 2007).

313. Given the offshore location of Dogger Bank Teesside A & B, it is not expected that these two species will be present in the sites. They may, however, occasionally transit the inshore area of the Dogger Bank Teesside A & B Export Cable corridor.

314. The UK distribution of allis shad and twaite shad is given in **Figure 6.69**. As shown these species have not been recorded in any river in the vicinity of the Dogger Bank Teesside A & B Export Cable Corridor.

Figure 6.69 UK Distribution Map of Twaite Shad (left) and Allis Shad (right) (JNCC 2007)

6.4.5 Smelt

315. Smelt *Osmerus eperlanus* are an anadromous species. Despite being widely distributed throughout the North Atlantic and European waters, they are considered to be threatened in UK waters. Smelt congregate in estuaries during the winter, entering rivers from February to April to spawn. After spawning the adults return to sea whilst the juveniles remain in the estuary for the remainder of the summer (Barnes 2008f). During their marine phase they are most commonly found next to river mouths and in estuaries (Wheeler 1978).

316. Very little is known about the distribution and likely spawning potential of smelts within English estuaries. In a review into the distribution of smelt in England and Wales, Maitland (2003b) reports the occurrence of smelt in Yorkshire rivers within the Humber River Basin District. However, no specific reference is given to the Esk and the species is believed to have been extirpated from the Tees as early as the 1930s (Maitland 2003b).

317. Based on the apparent rarity of smelt in rivers such as the Tees and Esk and in addition to their restricted marine migration it is not expected that the species will be to be present in Dogger Bank Teesside A or Dogger Bank Teesside B. For the same reasons smelt are not expected to regularly transit the Teesside Dogger Bank Teesside A & B Export Cable Corridor.

6.5 Shellfish

6.5.1 Edible Crab

318. Edible crabs were the most abundant species found during the shellfish (potting) survey carried out in the inshore Dogger Bank Teesside A & B Export Cable Corridor (**Table 5.8**). This species was also recorded in the epibenthic survey and at otter trawl survey sites in tranche A, tranche B and the Dogger Bank Teesside A & B Export Cable Corridor.

319. Edible crab is found on bedrock including under boulders, mixed coarse grounds and offshore in muddy sand (Neal and Wilson 2008). The edible crab is common along the coasts of the northeastern Atlantic Ocean and the North Sea in waters between 25 and 300 meters deep **Figure 6.70**. They are commercially important in the inshore section of the Export Cable Corridor (ICES rectangles 38E8 and 38E9), where they support important commercial fisheries (see Section 5.4.2 above and *Chapter 15 - Commercial Fisheries*).

320. Edible crab tagging studies suggest that mature females undertake long-distance migrations whilst males and immature females move randomly in local areas (Edwards 1979, Bennett 1995). The results[6] of suture tagging experiments carried out off the Norfolk coast (Edwards 1979) suggest a northerly long-distance movement of mature females. This is illustrated in **Figure 6.71**. Similarly, tagging experiments carried out off the Yorkshire coast also found female crabs migrating in a northerly direction, the longest movement recorded being that of a female released off Whitby and recaptured off Fraserburgh (Edwards 1979).

321. The movement of female crabs is related to their reproductive cycle. After pairing and mating (July-September) and subsequent spawning (October-December), egg bearing ("berried") females move to offshore over-wintering grounds to hatch their eggs. Throughout the spring and early summer, female adults migrate back inshore in preparation once again for pairing and mating. The hatched larvae remain in the water column offshore, indicating that once settlement has occurred, the young crabs migrate inshore (Proctor 2005).

322. The distribution of edible crab zoea I larvae recorded in surveys carried out in July in 1976, 1993, and 1999 are illustrated in **Figure 6.72** (modified from Eaton *et al.* 2003). The highest larval densities occurred offshore to the south west of Dogger Bank Teesside A & B. Zoea I larvae were also recorded in the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor and in the northern section of tranche A, although at comparatively low densities.

---

[6] Note that the lines drawn in Figure 6.71 show the shortest possible distance between the points of release and recapture and not a migration route.

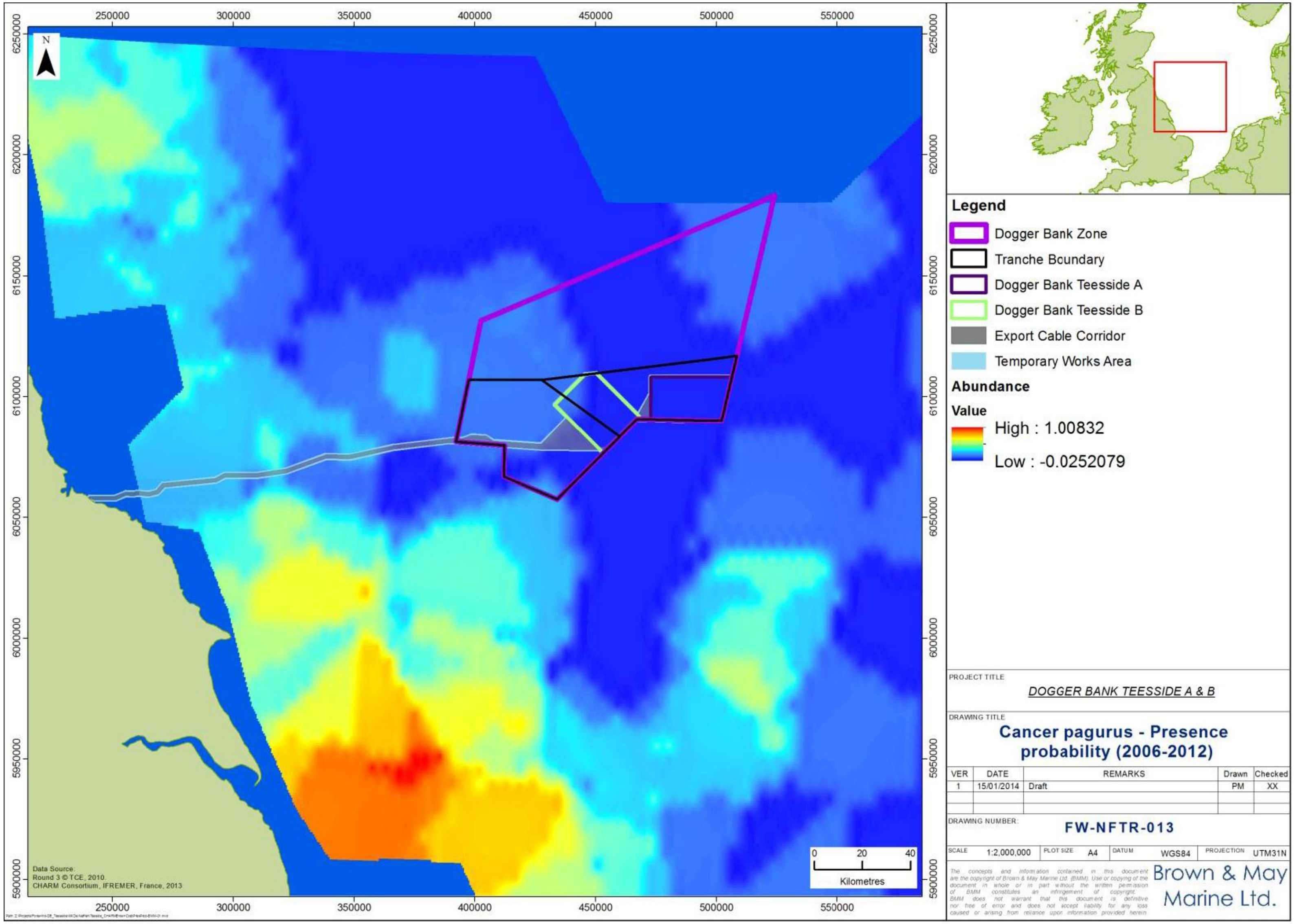


Figure 6.70 The relative distribution of Edible Crab (C. pagurus) in the central North Sea from IBTS survey data 2006-2012 (Source CHARM Consortium)

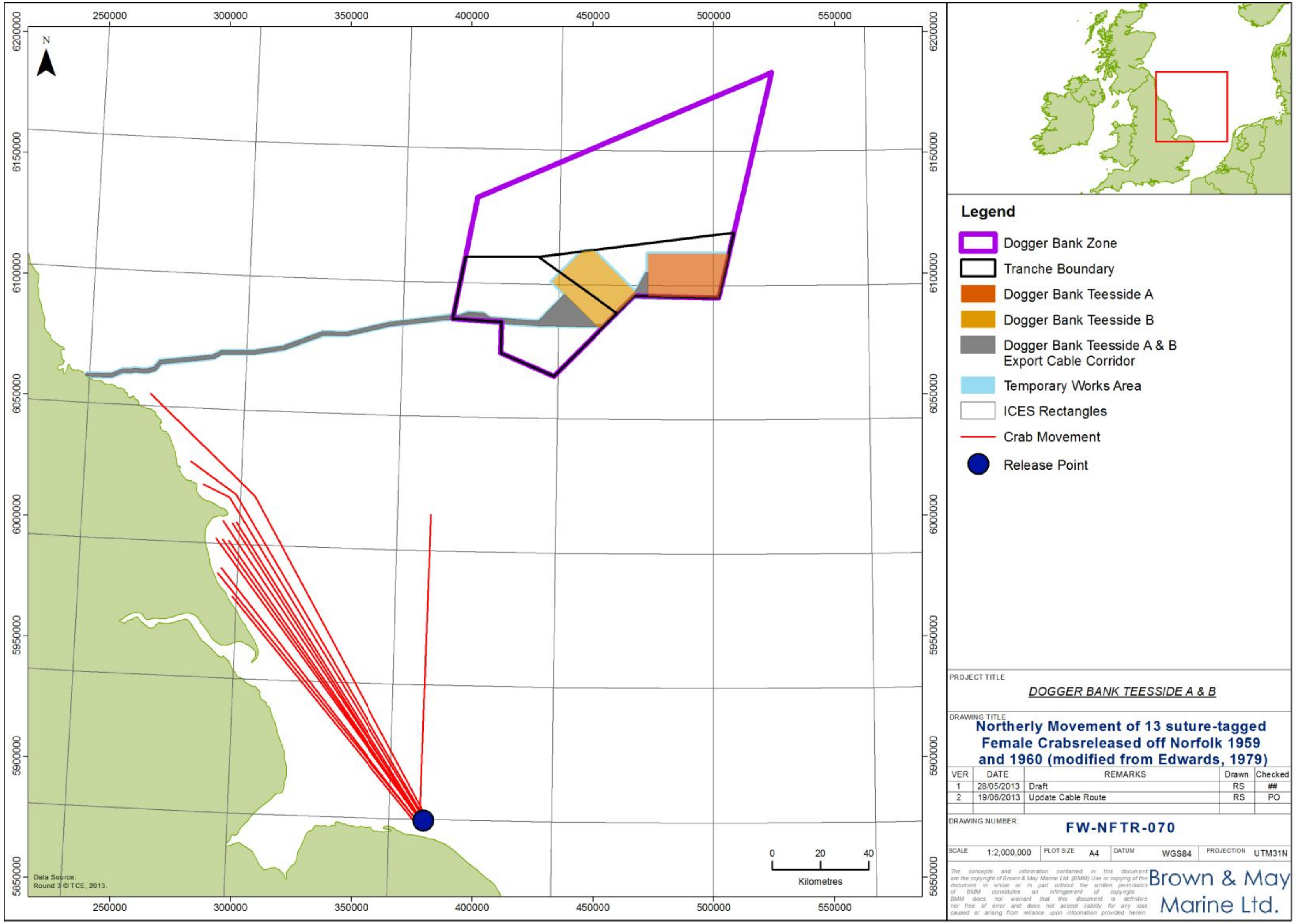


Figure 6.71 Northerly movement of 13 suture-tagged female crabs released off Norfolk 1959 and 1960 (Modified from Edwards 1979)

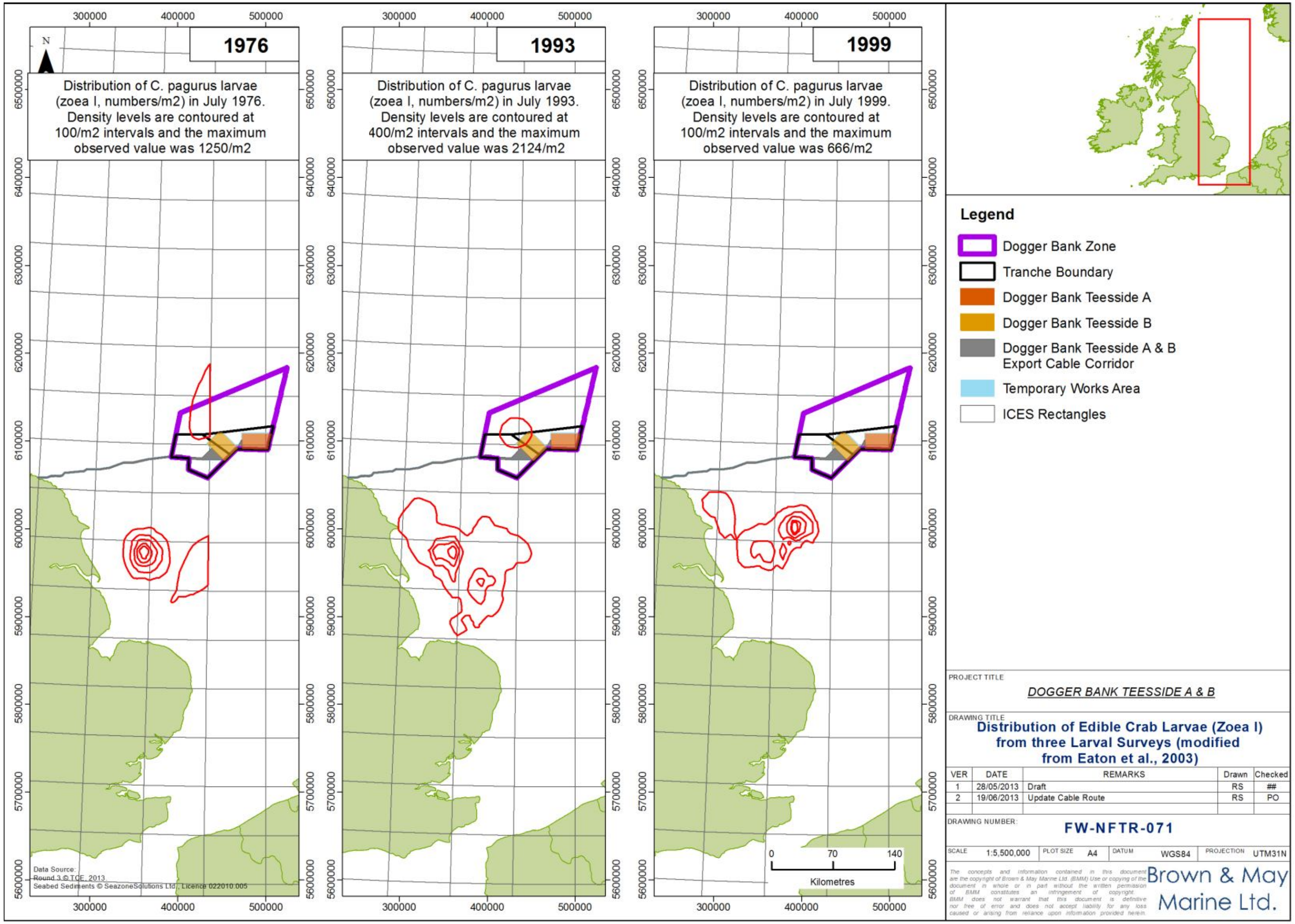


Figure 6.72 Edible crab larval distribution (modified from Eaton *et al.* 2003)

323. Studies carried out in the English Channel (Thompson *et al.* 1995) suggest that although berried female crabs may prefer to incubate their eggs whilst overwintering in hollows of sand and gravel, they are not necessarily confined to such areas, and eggs may be hatched over a wide variety of sediment types from fine sands to pebbles.

6.5.2 Velvet Crab

324. Velvet crab is primarily found on rock and stone substrates inter-tidally and in shallow waters (Wilson 2008).

325. The species has gained commercial importance in recent years and landings given in Section 5.4.2 (**Table 5.15** and **Table 5.16**) are recorded in the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor, particularly in rectangles 38E8 and 38E9.

326. Velvet crabs were caught in relatively moderate numbers in the shellfish (potting) survey carried out in the inner section of the Dogger Bank Teesside A & B Export Cable Corridor (**Table 5.8**). In Tranche A they were found in relatively high numbers during the epibenthic survey, with a total of 193 individuals recorded in stations sampled (**Appendix 12B - Epibenthic Survey Report**). In Tranche B catch rates were low (see **Table 5.4**).

6.5.3 Lobster

327. European lobster are widely distributed along the Eastern Atlantic coasts of Europe and are found in most areas of the British Isles, particularly off rocky coastlines (Bennett *et al.* 2006). They tend to be most abundant where there are crevices in which to shelter or hide, however, sandy areas may also be colonised if there are suitable stones or rocky outcrops under which they can burrow (Beard and McGregor 1991).

328. Unlike edible crab, lobsters are not known to undertake extensive alongshore or on/offshore migrations but more localised movements driven by local competition for food or the need to move to a different habitat as their size increases (Pawson *et al.* 1995). Tagging experiments carried out in the south coast of England (Smith *et al.* 2001) found that 95% of recaptured lobsters moved less than 3.8km from their original position over periods of 862 days. During these studies individuals however have travelled distances up to 45km with little difference between female and male movements. Similarly, tagging experiments using hatchery reared lobsters released into the wild suggest strong site fidelity, with most recaptures being recorded within six kilometres of release sites (Bannister *et al.* 1994).

329. Lobsters are of high commercial importance in the Export Cable Study Area and are the second most valuable species landed in monetary terms. A total of 163 lobsters were caught during the inshore potting survey (**Table 5.8**) but were not recorded offshore in the otter trawl surveys.

330. Mating usually occurs between a hard-shelled male and a soft, newly moulted female in summer (Bennett *et al.* 2006). Berried females generally appear from September to December in areas where lobsters are normally present. As extensive migrations are not undertaken, hatching normally takes place on the same grounds (in spring and early summer) (Pawson 1995).

331. Little is known about the distribution and abundance of lobster larvae. They are, however, thought to be released close inshore in July-October. Localised studies carried out in Bridlington Bay, suggest the existence of a persistent 'hot spot' of larval abundance, with possible hydrographic containment in the area (Bennett *et al.* 2006).

332. Information related to the distribution of juvenile lobster is also limited. The main lobster nurseries are thought to occur on rocky grounds in coastal waters (Pawson 1995) with most juveniles inhabiting rocky crevices although also capable of burrowing into soft sediment (Bennett *et al.,* 2006).

6.5.4 Other Shellfish Species

6.5.4.1 Whelks

333. The common whelk is commonly found around the British coasts on soft substrates in sub-tidal areas and occasionally in intertidal fringes (Ager *et al.,* 2008). The distribution of juvenile whelks tends to be limited to areas close to the adult stock (Lockwood 2005). Juveniles hatch from demersal egg cases as developed individuals (Hancock 1967).

334. Whelks are of commercial importance in the UK. Landings data (Section **5.4**) suggest that they are of secondary commercial importance in Dogger Bank Teesside A & B and the Dogger Bank Teesside A & B Export Cable Corridor. The highest landings for this species are recorded in the Wind Farm Study Area, particularly in rectangle 39F3 (**Table 5.13** and **Table 5.14**).

335. This species was caught in relatively small numbers in Tranche B. No whelks were recorded in the potting survey carried out in the inshore section of the Dogger Bank Teesside A & B Export Cable Corridor (**Appendix 13C - Shellfish (Potting) Survey Report**).

6.5.4.2 Scallops

336. Landings of king scallop from the Export Cable Study Area are of moderate importance in terms of weight and value (**Table 5.15** and **Table 5.16**). As indicated in **Appendix 15A**, scallop dredgers have been recorded in low numbers in inshore grounds to the south of the Dogger Bank Teesside A & B Export Cable Corridor.

337. Queen scallops *Aequipecten opercularis* are also expected to occur in the Wind Farm and Export Cable Study Areas. They were recorded in relatively low numbers as part of otter trawl surveys in tranches A and B (**Table 5.3** and **Table 5.4**).

338. Both species are found on a variety of substrate types, from rocks and stones to fine silty mud, although they are most abundant in areas with rocky outcrops or boulders on silty sand mixed with shell substrates (Pawson 1995, Franklin *et al.,* 1980, Brand 2006). They, however, differ in their propensity and ability to swim. King scallops are generally sedentary and usually found recessed in the sediment with the upper (left) valve level with the substrate, whilst queen scallops lay on top of the substratum and are considered to be a more mobile species (Jenkins *et al.* 2003).

6.5.4.3 *Nephrops*

339. The distribution of *Nephrops* is limited by the extent of cohesive muddy sediment suitable for burrow construction. Sediment type also appears to affect the structure of *Nephrops* populations, with areas of fine sediment being characterised by the presence of large-bodied individuals and low population densities, and areas of sandier mud showing higher population densities and *Nephrops* smaller in size (Howard 1989). They are opportunistic predators feeding on crustaceans, molluscs, polychaetes and echinoderms (Parslow-Williams *et al.,* 2002).

340. *Nephrops* are of commercial importance particularly north and west of the Dogger Bank in the Central North Sea, along the northeast coast of England, the eastern coast of Scotland, and on the Fladen ground in the northern North Sea (Rogers and Stocks 2001). As shown by landings data (Section 5.4) *Nephrops* is of only moderate importance in the Wind Farm Study Area (**Table 5.13** and

341.

342. **Table** 5.14). In the Export Cable Study Area, however, landings of *Nephrops* are considerably higher and this species is ranked first by value and landed weight (**Table 5.15** and **Table 5.16**)

343. The Dogger Bank Teesside A & B Export Cable Corridor passes through a small section in the inshore area designated as *Nephrops* spawning and nursery grounds by Coull *et al.* 1998 (**Figure 6.73** and **Figure 6.74**).

6.5.4.4 Shrimp

344. Brown shrimp *Crangon crangon* and the common shrimp *Crangon allmanni* were found in relatively high numbers in the epibenthic surveys (**Appendix 12A: Epibenthic Survey Report**).

345. *C. crangon* has very high productivity and is an important food source for many birds, fish and crustaceans. In addition it is commercially exploited for human consumption (Neal 2008). MMO landings data records no significant landings of shrimp either in the Wind Farm or Export Cable Study Areas (Section 5.4).

346. Pink shrimp (*Pandulus montagui*) is common in the North Sea at depths between 20 to100m (Ruiz, 2008a). The species is typically associated hard

substrates and *Sabellaria spinulosa* reef (Warren and Sheldon, 1967) but may also occur over sand, mud and gravel substrates. Diet consists principally of small polycheates, hydroids, copepods and other small invertebrates (Ruiz, 2008d). Migration to deeper offshore waters for spawning occurs during October and November (Ruiz, 2008d).

347. Pink shrimp was recorded during epibenthic survey surveys although not in particularly high numbers (**Appendix 12A: Epibenthic Survey Report**). MMO landings data do not indicate significant landings of the species from either the Export Cable or Wind Farm Study Areas.

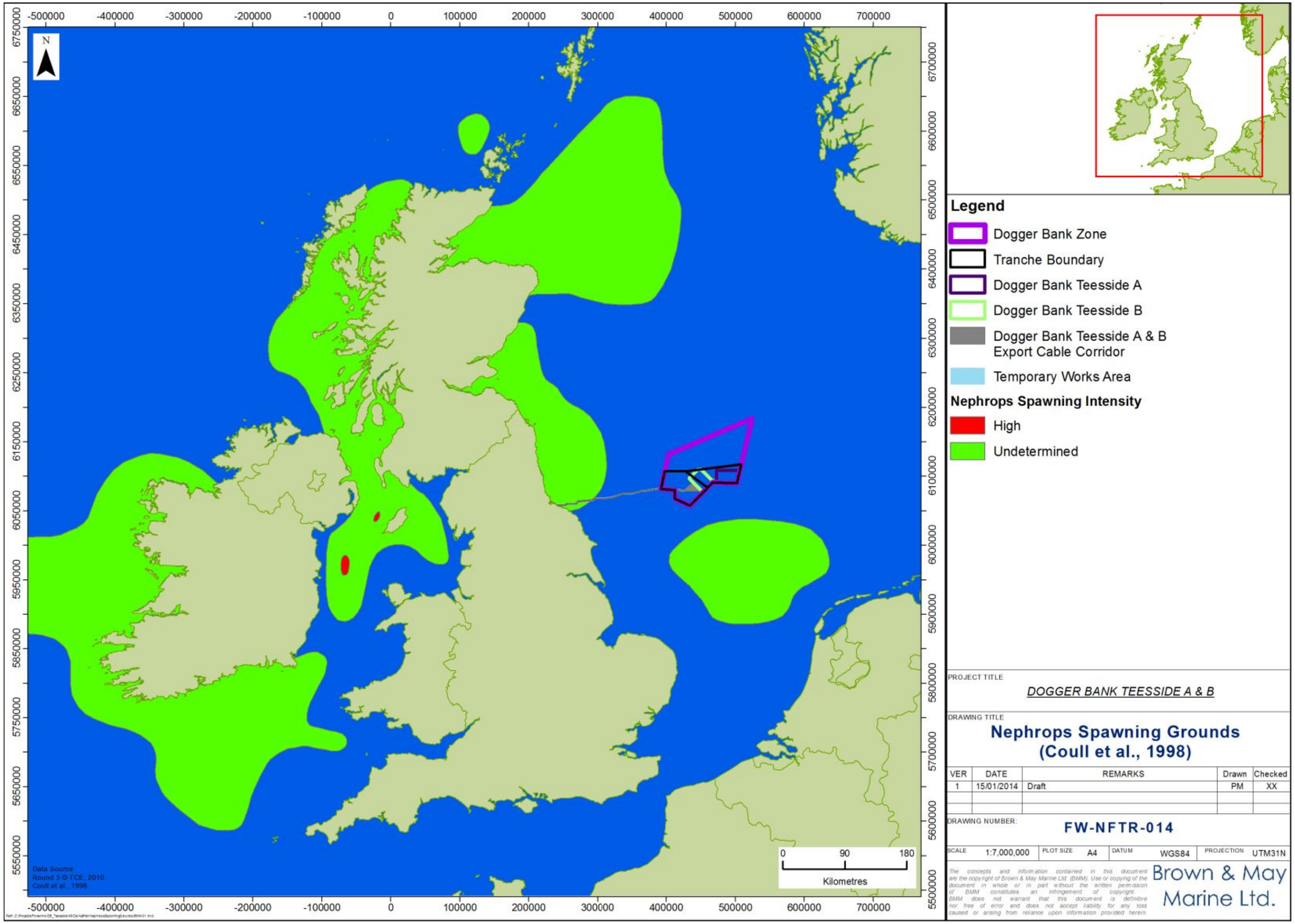


Figure 6.73 ***Nephrops*** **spawning grounds (from Coull *et al.* 1998)**

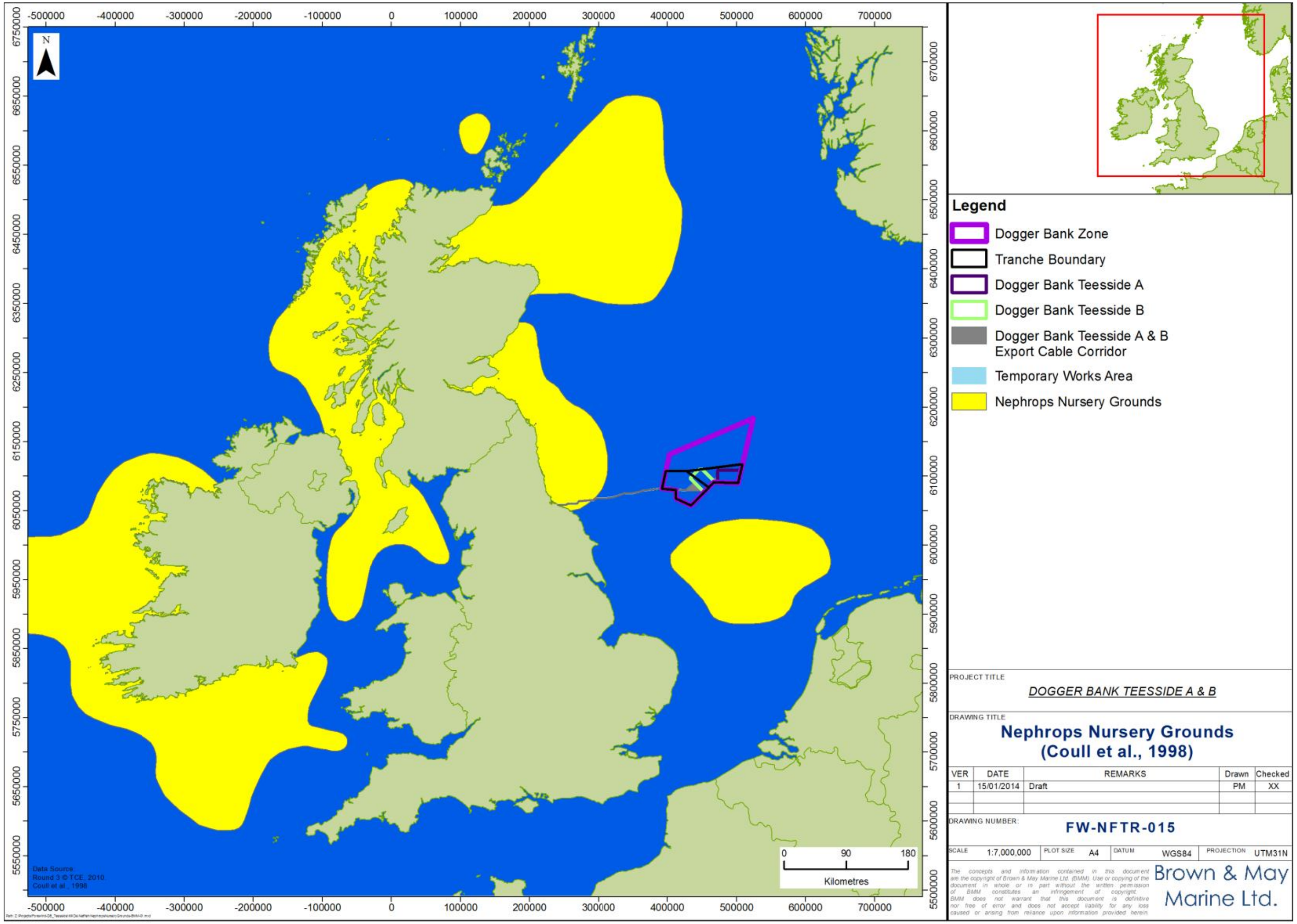


Figure 6.74 *Nephrops* nursery grounds (from Coull *et al.* 1998)

7.0 References

Aarestrup, K. Økland, F. Hansen, M.M. Righton, D. Gargan, P. Castonguay, M. Bernatchez, L. Howey, P. Sparholt, H. Pedersen, M.I. and McKinley, R.S. 2009. Oceanic spawning migration of the European eel *Anguilla anguilla*. *Science* 325, pp. 1660.

Acolas, M. L. Begout Anras, M. L. Veron, V. Jourdan, H. Sabatie, M. R. and Bagliniere, J. L. 2004. An assessment of the upstream migration and reproductive behaviour of allis shad *Alosa alosa* L. using acoustic tracking. *ICES Journal of Marine Science* 61, pp. 1291-1304.

Ager, O. 2008. *Buccinum undatum*. Common whelk. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [On-line]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=2815 [Accessed 17 September 2012].

Amara, R. Mahe, K. LePape, O. and Desroy, N. 2004. Growth, feeding and distribution of the solenette *Buglossidium luteum* with particular reference to habitat preference. *Journal of Sea Research* 51(3-4), pp. 211-217.

Andersson, M.H. Berggren, M. Wilhelmsson, D. and Ohman, M.C. 2009. Epibenthic colonization of concrete and steel pilings in a cold-temperate embayment: a field experiment. *Helgoland Marine Research* 63 (3), pp. 249-260.

Appleby, J.P. and Scarratt, D.J. 1989. Physical effects of suspended solids on marine an estuarine fish and shellfish with special reference to ocean dumping: a literature review. *Canadian Technical Report of Fisheries and Aquatic Science* 1681.

APEM, 2009. River Tees salmon action plan review. APEM scientific report EA 410441 [Online]. Available at: http://www.environment-agency.gov.uk/static/documents/Leisure/Tees_SAP_Final_Report_Feb_2009.pdf [Accessed 1 May 2013].

Amara, R. Mahe, K. LePape, O. Desroy, N. Growth, feeding and distribution of the solenette Buglossidium luteum with particular reference to its habitat preference. *Journal of Sea Research* 51(3-4), pp. 211-217.

Arnett, R.T.P. and Wheland, J. 2001. Comparing the diet of cod *Gadus morhua* and grey seals *Halichoerus grypus*: and investigation of secondary ingestion. *Journal of Marine Biological Association of the UK* 81, pp. 365-366.

Auld. A.H. and Schubel. J.R.1978. Effects of suspended sediment on fish eggs and larvae: A laboratory assessment. *Estuarine and Coastal Marine Science* 6(2), pp.153-164.

Bannister, R.C.A. Addison, J.T. and Lovewell, S.R.J. 1994. Growth, movement, recapture rate and survival of hatchery-reared lobsters *Homarus gammarus* released into the wild on the English East coast. *Crustaceana* 67(2), pp.156-172.

Barnes, M. 2008a. *Eutrigla gurnardus*. Grey gurnard. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. [On-line]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3327 [Accessed 13 June 2012].

Barnes, M. 2008b. *Merlangius merlangus*. Whiting. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [On-line]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3794 [Accessed 19 September 2012].

Barnes, M. 2008c. *Melanogrammus aeglefinus*. Haddock. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. [On-line]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3783 [Accessed 20 September 2012].

Barnes, M. 2008d. *Micromesistius poutassou*. Blue whiting. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. [On-line]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3808 [Accessed 27 September 2012].

Barnes, M. 2008e. *Merluccius merluccius*. European Hake. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. [On-line]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3797 [Accessed 27 September 2012].

Barnes, M. 2008f. *Osmerus eperlanus*. European smelt. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. [Online]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3993 [Accessed 11 September 2012].

Beard, T.W. and McGregor, M. 1991. Storage and care of live lobsters. Ministry of Agriculture, Fisheries and Food. Laboratory Leaflet 66.

Beare, D. Rijnsdorp, A. Van Kooten, T. Fock, H. Schroeder, A. Kloppman, M. Witbaard, R. Meesters, E. Schulze, T. Blaesbjerg, M, Damm, U. and Quirijns, F. 2010. Study for the Revision of the plaice box. Final Report. IMARES Report Number C002/10.

Behrens, J.W. Stahl, H.J. Steffensen, J.F. and Glud, R.N. 2007. Oxygen dynamics of buried lesser sandeels *Ammodytes tobianus* (Linnaeus 1785): mode of ventilation and oxygen requirements. *Journal of Experimental Biology* 210 (6), pp.1006-14.

Bennett, D.B. 1995. Factors in the life history of the edible crab *Cancer pagurus* that influence modelling and management. *ICES Marine Science Symposium* 199, pp. 89-98.

Bennett, D. Nichols, J and Huntington, T. 2006. Certification Report for NESFC Lobster Fishery. Moody Marine Ltd. Ref.802020 vl.

Berge, J.A. 1979. The perception of weak electric A.C. currents by the European eel, *Anguilla anguilla*. *Comparative Biochemistry and Physiology. Part A. Physiology*. 62(4), pp. 915-919.

Bergstad O.A., Hoines A.S. and Kruger J.E.M. 2001. Spawning time, age and size at maturity, and fecundity of sandeel, *Ammodytes marinus*, in the north-eastern North Sea and in unfished coastal waters off Norway. *Aquatic Living Resources* 14(5), pp. 293-301.

Birklund, J. Wijsman, J.W.M. 2005. Aggregate extraction: A review on the ecological functions. DHI water and environment report Z3297.

Birtwell, I.K. 1999. The effects of sediment on fish and their habitat. Fisheries and Oceans Canada. Canadian Stock Assessment Secretariat. Research Document 99/139.

Bloomfield, A. and Solandt, J.L. 2006. Basking Shark Watch 20 year report (1987-2006). The Marine Conservation Society. [Online]. Available at: http://www.mcsuk.org/downloads/wildlife/basking_sharks/BSW20%20Report.pdf [Accessed 19 September 2012].

Bochert, R. and Zettler, M.L. 2004. Long -term exposure of several marine benthic animals to static magnetic fields. *Bioelectromagnetics* 25, pp. 498-502.

Bodznick, D. and Preston, D.G.1983. Physiological characterization of electroreceptors in the lampreys *Ichthyomyzon uniscuspis* and *Petromyzon marinus*. *Journal of Comparative Physiology* 152, pp. 209-217.

Bodznick, D. and Northcutt, R.G.1981. Electroreception in lampreys: evidence that the earliest vertebrates were electroreceptive. *Science* 212, pp. 465-467.

Boehlert, G.W. and Morgan, J. B. 1985. Turbidity enhances feeding abilities of larval Pacific herring, *Clupea harengus* pallasi. *Hydrobiologia* 123, pp. 161-170.

Bohnsack, J.A. 1989. Are high densities of fishes at artificial reefs the result of habitat limitation or behavioural preference? *Bulletin of Marine Science* 44, pp. 631-645.

Bohnsack, J.A. and Sutherland, D.L.1985. Artificial reef research: a review with recommendations for future priorities. *Bulletin of Marine Science* 37, pp. 11-39.

Bolle, L.J. de Jong, C.A.F. Bierman, S. de Haan, D. Huijer, T. Kaptein, D. Lohman, M. Tribuhl, S. van Beek. P. van Damme, C.J.G. van den Berg, F. vand der Heul, J. van Keeken, O. Wessels, P. and Winter, E. 2011. Effect of piling noise on the survival of fish larvae (pilot study). Shortlist Masterplan Wind. Report number C092/22. IMARES.

Bone, Q. and Moore, R.H. 2008. Biology of fish. 3rd ed. Taylor and Francis Group.

Bonfil, R.1994. Overview of world elasmobranch fisheries. *FAO Fisheries Technical Paper* 341, pp. 119.

Bolle, L.J. de Jong, C.A.F. Bierman, S. de Haan, D. Huijer, T. Kaptein, D. Lohman, M. Tribuhl, S. van Beek. P. van Damme, C.J.G. van den Berg, F. vand der Heul, J. van Keeken, O. Wessels, P. and Winter, E. 2011. Effect of piling noise on the survival of fish larvae (pilot study). Shortlist Masterplan Wind. Report number C092/22. IMARES.

Boles, L.C. and Lohmann, K.J. 2003. True navigation and magnetic maps in spiny lobsters. *Nature* 421, pp. 60-63.

Brand, A. R. 2006. Scallop ecology: distribution and behaviour In: Shumway, S. E. and Parsons, G. J. eds.*Scallops: biology ecology and aquaculture*. Elsevier Press, pp. 651-744.

Brander, K.M. 1975. The population dynamics and biology of cod (Gadus morhua) in the Irish Sea. PhD thesis, University of East Anglia, Norwich. Cited in-
Hutchinson, W.F. Carvalho, G.R. Rogers, S.I. 2001. Marked genetic structuring in localised spawning populations of cod *Gadus morhua* in the North Sea and adjoining waters as revealed by microsatellites. *Marine Ecology Progress Series* 223, pp. 251–260.

Brown, E. Pierce, G. Hislop, J. Santos, B. 2001. Interannual variation in the summer diets of harbour seals *Phoca vitulina* at Mousa, Shetland (UK). Journal of the Marine Biological Association of the UK, volume 81, Issue 2, pp. 325-337.

Burt, G.J. and Millner, R.S. 2008. Movements of soles in the southern North Sea and eastern English Channel from tagging studies (1955-2004). *Science Series Technical Report* 44, Cefas, Lowestoft.

Cain, S.D. Boles, L.C. Wang, J.H. and Lohmann, K.J. 2005. Magnetic orientation and navigation in marine turtles, lobsters and molluscs: Concepts and conundrums. *Integrative and Comparative Biology* 45, pp. 539-546.

Callaway, R. Alsvag, J. de Boois, I. Cotter, J. Ford, A. Hinz, H. Jennings, S. Kroncke, I. Lancaster, J. Piet, G. Prince, P. Ehrich, S. 2002. Diversity and community structure of epibenthic invertebrates and fish in the North Sea. *ICES Journal of Marine Science* 59, pp. 1199- 1213.

Camhi, M. Fowler, S. Musick, J. Brautigam A. and Fordham S. 1998. Sharks and their relatives: Ecology and Conservation. Occasional Paper of the IUCN Species Survival Commission Occas. Paper 20.

Carlson, T. Hastings, M. and Popper, A. N. 2007. Memorandum **–** Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities, sent to California Dept. of Trans and Washington Department of Transport.

Carpentier, A. Martin, C.S. and Vaz, S. eds. 2009. Channel Habitat Atlas for marine Resource Management, final report / Atlas des habitats des ressources marines de la Manche orientale, rapport final (CHARM phase II). INTERREG 3a Programme, IFREMER, Boulogne-sur-mer, France. pp. 626.

Cefas. 2009. Strategic review of offshore wind farm monitoring data associated with FEPA licence conditions. Fisheries Contract ME1117.

Cefas. 2004. Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements, June 2004.

Chapman, C.J. and Ballantyne, K.A. 1980. Some observations on the fecundity of Norway lobsters in Scottish waters.International Council for the Exploration of the Seas Council Meeting Papers, C.M.1980/K:25.

Chung-Davidson, Y. Bryan, M.B. Teeter, J. Bedore, C.N. and Li, W. 2008 Neuroendocrine and behavioural responses to weak electric fields in adult sea lampreys (*Petromyzon marinus*). *Hormones and Behaviour*. 54(1), pp. 34-40.

Collins, K.J. Jensen, A.C. and Lockwood, A.P.M. 1992. Stability of a coal waste artificial reef. Chemical Ecology 6: 79-93. ***In***:- Pickering, H. and Whitmarsh, D. 1997. Artificial reefs and fisheries exploitation: a review of the attraction versus production debate, the influence of design and its significance for policy. *Fisheries Research* 31, pp. 39-59.

Conway, D. V. P. Coombs, S. H. and Smith, C. 1997. Vertical distribution of fish eggs and larvae in the Irish Sea and southern North Sea. *ICES Journal of Marine Science* 54(1), pp. 136-147.

Corten, A. 2001. *Herring and Climate. Changes in the distribution of North Sea herring due to climate fluctuations.* PhD Thesis. University of Groningen.

Coull, K.A. Johnstone, R. and Rogers, S.I. 1998. Fisheries Sensitivity Maps in British Waters. UKOOA Ltd.

Couperus, B. Winter, E. van Keeken, O. van Kooten, T. Tribuhl, S. and Burggraaf, D. 2010. Use of high resolution sonar for ner-turbine fish observations (DISSON) – We@Sea 2007-002. IMARES Report number C138/10.

Daan, N. Bromley, P. Hislop, J. Nielsen, N. 1990. Ecology of North Sea Fish. *Netherlands Journal of Sea Research* 26, pp. 343-386.

Daunt, F. Wanless, S. Greenstreet, S. Jensen, H. Hamer, K. Harris, M. 2008. The impact of the sandeel fishery closure on seabird food consumption, distribution, and productivity in the northwestern North Sea. *Canadian Journal of Fisheries and Aquatic Sciences* 65(3), pp. 362-381.

De Groot, S.J. 1980. The consequences of marine gravel extraction on the spawning of herring, *Clupea harengus* Linné. *Journal of Fisheries Biology* 16, pp. 605-611.

de Veen, J.F. 1978. On selective tidal transport in the migration of North Sea plaice *Pleuronectes platessa* and other flatfish species. *Netherlands Journal of Sea Research* 12, pp. 115-147.

Department of Energy and Climate Change. 2011a. Overarching National Policy Statement for Energy (EN1). July 2011.

Department of Energy and Climate Change. 2011b. National Policy Statement for Renewable Energy (EN3). July 2011.

DEFRA. 2010 Eel Management plans for the United Kingdom. Overview for England and Wales. [Online]. Available at: http://archive.defra.gov.uk/foodfarm/fisheries/documents/fisheries/emp/overview.pdf [Accessed 11 September 2012].

DEFRA. 2007. Science and research projects. Determination of the size at maturity of the whelk *Buccinum undatum* in English waters Avaliable at http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=2&ProjectID=17916 [Accessed 31 May 2013].

Dulvy, N.K. Notobartolo di Sciara, G. Serena, F. Tinti, F. Ungaro, N. Mancusi, C. and Ellis, J. 2006. *Dipturus batis*. ***In***: IUCN. 2011. IUCN Red List of Threatened Species. Version 2011(2) [Online]. Available at: www.iucnredlist.org [Accessed 22 March 2012].

Eastwood, P. D. and Meaden, G. J. 2000. Spatial modelling of spawning habitat suitability for the sole *Solea solea* in the eastern English Channel and southern North Sea. ICES. Theme Session (N) on Spatial and Temporal Patterns in Recruitment Processes CM2000/N:05.

Eaton, D.R. Brown, J. Addison, J.T. Milligan, S.P. and Fernand, L.J. 2003. Edible crab *Cancer pagurus* larvae surveys off the east coast of England: implications for stock structure. *Fisheries Research* 65(1), pp.191-199.

Edwards, E. 1979. The Edible Crab and its fishery in British Waters. Fishing News Books Ltd. Farnham, Surrey, England.

Ellis, J.R.A. Cruz-Martinez, A. Rackham, B.D. and Rogers, S.I. 2005. The distribution of Chondrichthyan Fishes Around the British Isles and Implications for Conservation. *Journal of Northwestern Atlantic Fisheries Science* 35, pp.195-223.

Ellis, J. Doran, S. Dunlin, G. Hetherington, S. Keable, J. and Skea, N. 2009. Programme 9: Spurdog in the Irish Sea. Final Report. Fisheries Science Partnership, Cefas Lowestoft.

Ellis, J. R. Milligan, S. Readdy, L. South, A. Taylor, N. and Brown, M. 2010. Mapping spawning and nursery areas of species to be considered in Marine Protected Areas (Marine Conservation Zones). Cefas, Lowestoft.

Ellis, J.R. Milligan, S.P. Readdy, L. Taylor, N. and Brown, M.J. 2012. Spawning and nursery grounds of selected fish species in UK waters. *Science Series Technical Report*. Cefas, Lowestoft 147, pp. 56

Emu Limited. 2012. Dogger Bank Offshore Wind Farm (Tranche A, Cable route and Nearshore) Benthic Ecology Characterisation Survey. Report for Forewind, September 2012.

Engell-Sørensen, K. and Skyt, P.H. 2001. Evaluation of the Effect of Sediment Spill from Offshore Wind Farm Construction on Marine Fish. **–** Report to SEAS, Denmark, pp. 18.

Engelhard, G. Kooij, J. Bell, E. Pinnegar, J. Blanchard, J. Mackinson, S. Righton, D. 2008. Fishing mortality versus natural predation on diurnally migrating sandeels *Ammodytes marinus*. *Marine Ecological Progress Series* 369, pp. 213-227.

Environment Agency. 2013. River Tees fish counts. [Online]. Available at: http://www.environment-agency.gov.uk/research/library/publications/138616.aspx [Accessed 10 June 2013].

Environment Agency. 2012. Provisional salmon and sea trout rod catch summary 2011. [Online]. Available at: www.environment-agency.gov.uk/static/documents/Lesiure/Rod_CR_Summary_2011_pdf [Accessed 22 June 2013].

Environment Agency. 2011a. River Esk (Yorkshire) Tideway Byelaw Report. Environment Agency. [Online]. Available at: http://www.environment-agency.gov.uk/static/documents/Research/Esk_byelaw_report_Final_June_2011.pdf [Accessed 1 July 2013].

Environment Agency. 2011b. Facts and figures about eels. [Online]. Available at: http://www.environmentagency.gov.uk/homeandleisure/recreation/fishing/38023.aspx [Accessed 22 August 2011].

Environment Agency. and Cefas. 2012. Annual Assessment of salmon stocks and fisheries in England and Wales 2011. Preliminary assessment prepared for ICES, March 2012. Environment Agency, Bristol.

Evans, P.G.H. Baines, M.E. and Coppock, J. 2011. Abundance and behaviour of cetaceans and basking sharks in the Pentland Firth and Orkney Waters. Report by Hebog Environmental Ltd & Sea Watch Foundation. Scottish Natural Heritage Commissioned Report 419.

Folk, R.L. 1954. The distinction between grain size and mineral composition in sedimentary rocks. *Journal of Geology* 62, pp. 344-359.

Formicki, K. Sadowski, M. Tanski, A. Korzelecka-Orkisz, A. and Winnicki, A. 2004. Behaviour of trout *Salmo trutta* larvae and fry in a constant magnetic field. *Journal of Applied Ichthyology* 20, pp. 290-294.

Formicki, K. and Winnicki, A. 2009. Reactions of fish embryos and larvae to constant magnetic fields. *Italian Journal of Zoology* 65, pp. 479-482.

Fox, C. Taylor, M. Dickey-Collas, M. Fossum, P. Kraus, G. Rohlf N. Munk, P. van Damme, C.J.G. Bolle, L.J. Maxwell, D.L and Wright, P.J. 2008. Mapping the spawning grounds of North Sea cod *Gadus morhua* by direct and indirect means. *Proceedings of the Royal Society of Biology* 275, pp. 1543-1548.

Franklin, A. Pickett, G. D. Connor, P. M. 1980. The Scallop and its fishery in England and Wales. Laboratory Leaflet 51.

Freeman, S. Mackinson, S. Flatt, R. 2004. Diel patterns in the habitat utilisation of sandeels revealed using integrated acoustic surveys. *Journal of Experimental Marine Biology and Ecology* 305(2), pp. 141–154.

Furness, R.W. 2002. Management implications of interactions between fisheries and sandeel-dependent seabirds and seals in the North Sea. ICES *Journal of Marine Science* 59, pp. 261-269.

Furness R. W.1999.Towards defining a sandeel biomass limit for successful breeding by seabirds. In P.J. Wright and F.M. Kennedy, 1999. Proceedings of a workshop held at FRS Marine Laboratory Aberdeen 22-24 February 1999. Fisheries Research Services Report No 12/99.

Gargan. P.G. Roche. Forde. G.P. and Ferguson. A. 2004. Characteristics of the sea trout *Salmo trutta* L. Stocks from the Owengola and Invermore Fisheries, Connemara, Western Ireland, and Recent Trends in Marine Survival pp. 60-76. ***In*** Harris, G. and Milner, N. eds. Sea Trout Biology: Conservation and Management: Proceedings of the First International Sea Trout Symposium . Blackwell, London.

Gill, A.B. and Bartlett, M. 2010. Literature review on the potential effects of electromagnetic fields and subsea noise from marine renewable energy developments on Atlantic salmon, sea trout and European eel. Scottish Natural Heritage Commissioned Report No.401.

Gill, A.B. Gloyne-Phillips, I. Neal, K.J. and Kimber, J.A. 2005. The Potential Effects of Electromagnetic Fields generated by Sub-Sea Power Cables associated with Offshore Wind Farm Development on Electrically and Magnetically Sensitive Marine Organism- a Review. COWRI.E. 1.5 Electromagnetic Fields Review. Final Report. COWRIE-EM FIELD 2-06-2004.

Gill, A.B. Huang, Y. Gloyne-Philips, I. Metcalfe, J. Quayle, V. Spencer, J. and Wearmouth, V. 2009. COWRIE 2.0 Electromagnetic Fields (EMF) Phase 2: EMF-sensitive fish response to EM emissions from sub-sea electricity cables of the type used by the offshore renewable energy industry. Commissioned by COWRIE Ltd. COWRIE-EMF-1-06.

Gill, A.B. and Taylor, H. 2001. The potential effects of electromagnetic fields generated by cabling between offshore wind turbines upon elasmobranch fishes. Countryside Council for Wales. Contract Science Report 488.

Greenstreet, S.P.R. 2007. Variation in the abundance and distribution of sandeels and clupeids in the Wee Bankie/Marr Bank region of the north-western North Sea over the period 1997 to 2003. Fisheries Research Services Internal Report No: 25/07.

Greenstreet, S. Fraser, H. Piet, G. Robinson, L. Callaway, R. Reiss, H. Ehrich, S. Kroncke, I. Craeymeersh, J. Lancaster, J. Jorgensen, L. and Goffin, A. 2007. Species composition, diversity, biomass and production of the demersal fish community of the North Sea. Fisheries Research Services Collaborative Report NO.07/07.

Greenstreet, S.P.R. Holland, G.J. Guirey, E.J. Armstrong, E. Fraser, H.M. and Gibb, I. M. 2010. Combining hydroacoustics seabed survey and grab sampling techniques to assess local sandeel population abundance*. ICES Journal of Marine Science* 67, pp. 971-984.

Greenstreet, S. McMillan, J. Armstrong, E. 1998. Seasonal variation in the importance of pelagic fish in the diet of piscivorous fish in the Moray Firth, NE Scotland: a response to variation in prey abundance? *ICES Journal of Marine Science* 55, pp. 121–133.

Griffin, F.J. Sith, E. H. Vines, C.A. and Cherr, G.A. 2009. Impacts of suspended sediments on fertilization embryonic development, and early larval life stages of the Pacific herring, *Clupea pallasi*. *Biological Bulletin* 216, pp.175-187.

Gulland, J. A., 1968. Recent changes in the North Sea Plaice Fishery. *ICES Journal of Marine Science* 31, pp.305-322.

Hamerlynck, O. and Cattrijsse, A. 1994. The food of *Pomatochistus minutus* (Pisces, Gobiidae) in Belgian coast waters, and a comparison with the food of ists potential competitor *P. Lozanoi*. *Journal of Fish Biology* 44, pp. 753-771.

Hancock, D. 1967. Whelks. Laboratory leaflet (new series) No. 15, Fisheries. Laboratory Ministry of Agriculture, Fisheries and Food, Burnham on Crouch, Essex, England.

Hanson, M. Karlsson, l. Westerberg, H. 1984 Magnetic material in European eel (*Anguilla anguillla* L.) Comparative Biochemistry and Physiology Part A. Physiology 77(2), pp. 221-224.

Hanson, M. and Walker, M.A. 1987 Magnetic particles in European eel *Anguilla anguilla* and carp *Cyprinus carpio*. Magnetic susceptibility and remanence. *Journal of Magnetism and Magnetic Materials* 66(1), pp. 1-7.

Harding, D. Woolner, L. and Dann, J. 1986. The English groundfish surveys in the North Sea, 1977–85. ICES CM 1986/G:13. 8 pp. In: ICES. 2005. The North Sea fish community ICES FishMap.

Hassel, A. Knutsen, T. Dalen, J. Løkkeborg, S. Skaar, K.Østensen, Ø. Haugland, E. K. Fonn, M. Høines, A. and Misund, O. A. 2003. Reaction of sandeel to seismic shooting: a field experiment and fishery statistics study. Institute of Marine Research. *Fisken og Havet* 4, pp. 63.

Haugland, M. Holst, J. Holm, M. Hansen, L. P. 2006. Feeding of Atlantic salmon *Salmo salar L.* post-smolts in the Northeast Atlantic*. ICES Journal of Marine Science Volume* 63 (8), pp. 1488-1500.

Hassel, A. Knutsen, T. Dalen, J. Skaar, K. Løkkeborg, S. Misund, O.A. Oivind, O. Fonn, M. and Haugland, E.K. 2004. Influence of seismic shooting on the lesser sandeel *Ammodytes marinus*. *ICES Journal of Marine Science* 61, pp.1165-1173.

Hastings, M.C. and Popper, A.N. 2005. Effects of sound on fish. Report to the California Department of Transportation Contract No. 43A0139. Task Order 1.

Heath, M. Rasmussen, J. Bailey, M. Dunn, J. Fraser, J. Gallego, A. Hay, S. Inglis, M. Robinson, S. 2012. Larval mortality rates and population dynamics of Lesser Sandeel *Ammodytes marinus* in the northwestern North Sea. *Journal of Marine Systems* 93, pp. 47–57.

Heath, M.R. Rasmussen, J. Bailey, M.C. Dunn, J. Fraser, J. Gallego, A. Hay, S.J. Inglis, M. Robinson, S. 2011. Larval mortality rates and population dynamics of Lesser Sandeel *Ammodytes marinus* in the northwestern North Sea. *Journal of Marine Systems* 93, pp. 47-57.

Heessen, H.J.L 1993. The distribution of Cod *Gadus morhua* in the North Sea. NAFO Sci. Counc. Studies 18, pp.56-65.

Heessen, H.J.L. and Daan, N. 1996. Longterm trends in ten non-target North Sea fish species. *ICES Journal of Marine Science* 53, pp. 1063-1078.

Hinrichsen, H-H. Kraus, G. Voss, R. Stepputtis, D. and Baumann, H.2005. The general distribution pattern and mixing probability of Baltic sprat juvenile populations. *Journal of Marine Systems* 58, pp. 52 – 66.

Hislop, J.R.G. Robb, A.P. Bell, M.A. and Armstrong, D.W. 1991. The diet and food consumption of whiting (*Merlangius merlangus*) in the North Sea. ICES *Journal of Marine Science* 48(2), pp.139-156.

Hobson, E.S. 1986. Predation on the Pacific sand lance, A. hexapterus (Pisces: Ammodytidae) during the transition between day and night in southeastern Alaska. *Copeia* 1, pp. 223–226.

Hoffman, E. Astrup, J. Larsen, F. and Munch-Petersen, S. 2000 Effects of marine windfarms on the distribution of fish, shellfish and marine mammals in the Horns Rev area. Baggrundsrapport nr 24 to ELSAMPROJEKT A/S: 42p.

Holden, M. J.1974. Problems in the rational exploitation of elasmobranch populations and some suggested solutions. Sea Fisheries Research (F. R. Harden Jones, ed). Elek: London, pp. 117-137.

Holland, G.J. Greenstreet, S.P.R. Gibb, I.M. Fraser, H.M. and Robertson, M.R. 2005. Identifying sandeel *Ammodytes marinus* sediment habitat preferences in the marine environment. *Marine Ecology Progress Series* 303, pp. 269-282.

Holt, T.J. Rees, E.I.S. Hawkins, R. and Seed, R. 1998 Biogenic Reefs (Volume IX): An overview of dynamic and sensitivity characteristics for conservation of marine SACs. Scottish Association for Marine Science (UK Marine SACs Project). [Online]. Available at: http://www.ukmarinesac.org.uk/pdfs/biogreef.pdf [Accessed 19 December 2012].

Hosie, A. 2009. Crangon allmanni. A shrimp. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. Plymouth: Marine Biological Association of the United Kingdom. [Online]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3077 [Accessed 2 December 2012].

Howard, F.G.1989. The Norway Lobster. Scottish Fisheries Information Pamphlet Number 7 1989 (Second Edition) ISSN 03099105.

Hunter, E. Buckley, A.A. Stewart, C. and Metcalfe, J.D. 2005. Repeated seasonal migration by a thornback ray in the southern North Sea. *Journal of Marine Biological Association of the UK* 85, pp.1199-1200.

Hunter, E. Metcalfe, J.D. Reynolds, J. 2003. Migration route and spawning fidelity by North Sea plaice. *Proceedings o the Royal SocietyLondon* B. 270, pp. 2097-2103.

Hvidt, C.B. Kaustrup, M. Leonhard, S.B. and Pedersen, J. 2005. Fish along the cable trace. Nysted Offshore Wind Farm. Final Report 2004.

ICES. 2013. Report of the Herring Assessment Group for the Area South of 62^{o}N, 12-21 March 2013. ICES CM.2013/ACOM:06.

ICES. 2012a. Report of the ICES Advisory Committee, 2012. ICES Advice, Book 6 North Sea.

ICES. 2012b. Report of the ICES Advisory Committee, 2012. ICES Advice, Book 5. The Celtic Sea and West of Scotland.

ICES. 2012c. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 27April -3 May 2012, ICES Headquarters, Copenhagen. ICES CM 2012/ACOM:13, pp.1346.

ICES. 2012d. Sandeel real-time monitoring assessment. Special request, Advice May 2012. Report of the ICES Advisory Committee, 2012. ICES Advice, Book 6 North Sea.

ICES. 2011a. Report of the ICES Advisory Committee, 2011. ICES Advice, Book 6 North Sea.

ICES. 2011b. Report of the Working Group on Elasmobranch Fishes (WGEF). [Online]. Available at: http://www.ices.dk/reports/ACOM/2011/WGEF/wgef_Sect_02_Spurdog.pdf [Accessed 23 March 2012].

ICES. 2011c. Report of the ICES Advisory Committee, 2011. ICES Advice, Book 9.

ICES. 2010a. Report of the ICES Advisory Committee, 2010. ICES Advice, Books 6 North Sea.

ICES. 2010b. Report of the Herring Assessment Working Group for the Area South of 62n (HAWG), 15 - 23 March 2010, ICES Headquarters, Copenhagen, Denmark, pp. 688.

ICES. 2010c. Manual for the International Bottom Trawl Surveys. Revision VIII. The International Bottom Trawl Survey Working Group. [Online]. Available at: http://datras.ices.dk/Documents/Manuals/Addendum_1_Manual_for_the_IBTS_Revision_VIII.pdf [Accessed 2 July 2013].

ICES. 2009. Report of the Working Group of Multispecies Assessment Methods (WGSAM), 5-9 October 2009. ICES Headquarters, Copenhagen. ICES CM 2008/RMC:06, pp. 113.

ICES. 2008a. North Sea-Ecosystems overview. ICES Advice 2008. Book 6.

ICES. 2008b. Report of the Working Group on Multispecies Assessment Methods (WGSAM), 6–10 October 2008, ICES Headquarters, Copenhagen. ICES CM 2008/RMC:06., pp. 113.

ICES. 2007. Report of the Working Group on Elasmobranch Fishes (WGEF). 22-27 June Galway, Ireland. ICES CM 2007/ACFM:27, pp. 318.

ICES. 2005a. ICES FishMap. [Online]. Available at: http://www.ices.dk/marineworld/fishmap/ices/ [Accessed 8 August 2012].

ICES. 2005b. Report of the Study Group of Multispecies Assessment ni the North Sea (SGMSNS), 5 -8 April 2005, ICES Headquarters. ICES CM 2005/D:06, pp. 163.

ICES.2005c. Report of the Planning Group on North Sea Cod and Plaice Egg Surveys in the North Sea (PGEGGS), 10 -12 May 2005, Lowestoft, UK. ICES CM 2005/G:11, pp. 85.

Institute for Ecology and Environmental Management (IEEM). 2010. Guidelines for ecological impact assessment in Britain and Ireland, Marine and coastal. Final Document, pp. 71.

Iglésias, S.P. Toulho at, L. and Sellos, D.Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. *Aquatic Conservation: Marine and Freshwater Ecosystems* 20, pp. 319–333.

IHLS. 2009 data : ICES HAWG, 2010. ICES Herring Assessment Working Group Report 2010.

IHLS. 2010 data : ICES HAWG, 2011. ICES Herring Assessment Working Group Report 2011.

Jenkins, S.R. Lart, W. Vause, B.J. and Brand, A.R. 2003. Seasonal swimming behaviour in the queen scallop *Aequipecten opercularis* and its effect on dredge fisheries. *Journal of Experimental Marine Biology and Ecology* 289, pp. 163-179.

Jensen, A.C. Collins, K.L. Free, E.K. and Bannister, R.C.A.1994. Lobster *Homarus gammarus* movement on an artificial reef: the potential use of artificial reefs for stock enhancement. Proceedings of the Fourth International Workshop on Lobster Biology and Management, 1993. *Crustaceana* 67(2), pp. 1994.

Jensen, A. C. Collins, K.L. Lockwood, A.P.M. and Mallinson, L.1992. Artificial reefs and lobsters: The Poole Bay Project. In: Proceedings of the 23rd Annual Shellfish Conference, 19-20 May 1992. The Shellfish Association of Great Britain, London, pp. 69-84. *In* Pickering, H. and

Whitmarsh, D. 1997. Artificial reefs and fisheries exploitation: a review of the attraction versus production debate, the influence of design and its significance for policy. *Fisheries Research* 31, pp. 39-59.

Jensen, H. 2001. Settlement dynamics in the lesser sandeel *Ammodytes marinus* in the NorthSea. PhD Thesis, University of Aberdeen.

Jensen, H. and Christensen, A. 2008. RECLAIM. Resolving Climatic Impacts on fish stocks. Specific Targeted Research Project on: Modernisation and sustainability of fisheries, including aquaculture-based production systems. 1.6 Report of WP1. Chapter 18-Sandeel.

Jensen, H. Rindorf, A. Wright, P.J. and Mosegaard, H. 2011. Inferring the location and scale of mixing between habitat areas of lesser sandeel through information from the fishery. *ICES Journal of Marine Science* 68(1), pp. 43–51.

JNCC. 2011. Principal salmon and sea trout rivers in England and Wales. [Online]. Available at: http://www.jncc.gov.uk [Accessed on 31 May 2011].

JNCC. 2007. Joint Nature Conservation Committee. Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2011 to December 2006. Peterborough. [Online]. Available at: www.jncc.gov.uk/article17 [Accessed at 31 May 2011].

Johnsen, S. and Lohmann, K. J. 2005. The physics and neurobiology of magnetoreception. *Nature Reviews Neuroscience* 6, pp. 703-712.

Johnston, D.W. and Wildish, D.J. 1981. Avoidance of dredge spoil by herring (*Clupea harengus harengus*). *Bulletin of Environmental Contamination and Toxicology* 26, pp. 307-314. Cited in Engell-Sørensen 2001.

Johnston, D.W and Wildish, D.J. 1982. Affect of suspended sediment on feeding larval herring *Clupea harengus harengus L. Bulletin of Environmental Contamination and Toxicology* 29, pp. 261-267.

Judd, A. 2012. Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects. Cefas contract report: ME5403-Module 15.

Kaiser, M.J. Collie, J.S. Hall, S.J. Jennings, S. and Poiner, I.R. 2003. Impacts of fishing gear on marine benthic habitats. ***In***: Responsible Fisheries in the Marine Ecosystem. CABI Publishing, Wallingford, pp. 197-217.

Kalmijn, A.J. 1982. Electric and magnetic field detection in elasmobranch fishes. *Science* 218, pp. 916-918.

Karlsson, L. 1985. Behavioural responses of European silver eels (*Anguilla anguilla*) to the geomagnetic field. *Helgolander Meeresuntersuchungen* 39, pp. 71-8.

Kelly, F. L. and King, J. J. 2001. A review of the ecology and distribution of three lamprey species, *Lampetra fluviatilis* (L), *Lampetra planeri* (L.), and *Petromyzon marinus* (L.): a context for conservation and biodiversity considerations in Ireland. Biology and Environment: *Proceedings of the Royal Irish Academy.*101B(3), pp. 165-185.

Keltz, S and Bailey, N. 2012. Fish and shellfish stocks 2012. Marine Scotland science, the Scottish Government. [Online]. Available at: http://www.scotland.gov.uk/Resource/0039/00392455.pdf [Accessed 30 May 2013].

Kennedy, F.M. 1999. Proceedings of a workshop held at FRS Marine Laboratory Aberedeen 22-24 February 1999. Fisheries Research Services Report No 12/99.

Kimber, J.A. Sims, D.W. Bellamy, P.H. and Gill, A.B. 2011. The ability of a benthic elasmobranch to discriminate between biological and artificial electric fields. *Marine Biology* 158(1), pp. 1-8.

Langham, N.P.E. 1971.The distribution and abundance of larval sand-eels Ammodytidae in Scottish waters. *Journal of the Marine Biological Association of the United Kingdom* 51, pp. 697-707. Cited In: Jensen *et al.* 2003.

Langhamer, O. and Wihelmsson, D. 2009. Colonisation of fish and crabs of wave energy foundations and the effects of manufactured holes - a field experiment. *Marine Environmental Research* 68(4), pp. 151-157.

Laughton, R. and Burns, S. 2003. Assessment of sea lamprey distribution and abundance in the River Spey: Phase III. Scottish Natural Heritage Commissioned Report No. 043 (ROAME No. F02AC604).

Lawler, A. Firmin, C. Bell, E. 2006. Programme 14: Yorkshire Coast Crustacea, Fisheries Science Partnership: 2006/7, Cefas, Lowestoft

Leonhard, S.B. and Pedersen, J. 2006. Benthic communities at Horns Rev before, during and after Construction of Horn Rev Offshore Wind Farm Vattenfall Report Number: Final. Report/Annual report 2005, pp. 134.

Leonhard, S.B. and Pedersen, J. 2005. Hard bottom substrate monitoring Horns Rev Offshore Wind Farm. Annual Status Report 2004.

Limpenny, S.E. Barrio Froján, C. Cotterill, C. Foster-Smith, R.L. Pearce, B. Tizzard, L. Limpenny, D.L. Long, D. Walmsley, S.Kirby, S. Baker, K. Meadows, W.J. Rees, J. Hill, J. Wilson, C. Leivers, M. Churchley, S. Russell, J. Birchenough, A.C. Green, S.L. and Law, R.J. 2011. The East Coast Regional Environmental Characterisation. Cefas Open report 08/04.pp. 287.

Lindeboom, H.J. Kouwenhoven, H.J. Bergman, M.J.N. Bouma, S. Brasseur, S. Daan, R.Fijn, R.C. de Haan, D. Dirksen, S. van Hal, R. Lambers, R.H.R. ter Hofsted, R. Krijgsveld, K.L. Leopold, M. and Scheidat, M. 2011. Short-term ecological effects of an Offshore Wind Farm in the Dutch coastal zone: a compilation. *Environ. Res. Lett*. 6.

Lockwood, S. J. 2005. A strategic environmental assessment of the fish and shellfish resources with respect to proposed offshore wind farms in the Eastern Irish Sea. Coastal Fisheries Conservation and Management Colwyn Bay.

Lohmann, K.J. Lohmann, M.F. and Putman, N.F.2007. Magnetic maps in animals: nature GPS's. *The Journal of Experimental Biology* 210, pp. 3697-3705.

Linley, E.A.S. Wilding, T.A. Hawkins, A. J.S. and Mangi, S. 2007. Review of the reef effects of offshore wind farm structures and their potential for enhancement and mitigation. Report from PML Applications Ltd and the Scottish Association for Marine Science to the Department for Business, Enterprise and Regulatory Reform (BERR), Contract No. RFA/005/0029P.

Lovell, J. M. Findlay, M.M. Moate, R.M. and Yan, H.Y. 2005. The Hearing Abilities of the Prawn *Palaemon serratus*. *Comparative Biochemistry and Physiology* 140(1), pp. 89-100.

Macer, C.T. 1965. The distribution of larval sand eels (Ammodytidae) in the southern North Sea. *Journal of the Marine Biological Association of the United Kingdom* 45, pp. 187-207. Cited in Jensen *et al.* 2003.

Macer, C.T. 1965. The distribution of larval sand eels (Ammodytidae) in the southern North Sea. *Journal of the Marine Biological Association of the United Kingdom* 45, pp. 187-207.

MacMullen, P.H. 1983. The fishery of the velvet swimming crab- *Necora puber.* Seafish. MAFF Commission. Technical Report No SR218.

MacLeod, S. Santos, M. B. Reid, R. Scott, B. Pierce, G. 2007. Linking sandeel consumption and the likelihood of starvation in harbour porpoises in the Scottish North Sea: could climate change mean more starving porpoises? *Biology Letters* 3(2) pp. 185-188.

Maes, J. and Ollevier, F. 2002. Size structure and feeding dynamics in estuarine clupeid fish schools: field evidence for the school trap hypothesis. *Aquatic Living Resources*15, pp.211-216.

Maitland, P. S. 2003a. Ecology of the River Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

Maitland, P. S. 2003b. The status of smelt *Osmerus eperlanus* in England. Report no. 516. English Nature, Peterborough.

Maitland, P. S. and Hatton-Ellis, T. W. 2003. Ecology of the Allis and Twaite Shad. Conserving Natura 2000 Rivers Ecology Series No. 3. English Nature, Peterborough.

Maitland, P. S. and Lyle, A. A.1995. Shad and smelt in the Cree Estuary, SW Scotland. Report to Scottish Natural Heritage, Edinburgh.

Malcolm, I.A. Godfrey, J. and Youngson, A.F. 2010. Review of migratory routes and behaviour of Atlantic salmon, sea trout and European eel in Scotland's coastal environment: implications for the development of marine renewables. Environmental Research Institute, Thurso. Published by Marine Scotland Science. ISSN:2043-7722.

MarLIN 2012. Available at: http://www.marlin.ac.uk/ [Accessed 25 June 2012]

McCauley, R. D. Fewtrell, J. Duncan, A. J. Jenner, C. Jenner, M-N. Penrose, J. D. Prince, R. I. T. Adhitya, A. Murdoch, J. and McCabe, K. 2000. Marine seismic surveys – A study of environmental implications. *Appea Journal* 2000 pp. 692-708.

McCormick, S. Hansen, L. Quinn, T. and Saunders, R. 1998. Movement, migration, and smolting of Atlantic salmon (*Salmo salar*). *Canadian Journal of Fisheries Aquatic Sciences* 55, pp.77-92

McConnell, B. Fedak, M.A. Lovell, P. Hammond, P. 1999 Movements and foraging areas of grey seals in the North Sea. *Journal of Applied Ecology* 36(4), pp. 573–590

McQuaid, N. Briggs, R.P. and Roberts, D. 2009. Fecundity of *Nephrops norvegicus* from the Irish Sea' *Journal of the Marine Biological Association of the United Kingdom* 89 (6), pp. 1181-1188

Messieh, S. N. Wildish, D. J. and Peterson, R. H. 1981. Possible impact from dredging and soil disposal on the Miramichi Bay Herring Fishery. *Can. Tech. Rep. Fish. Aquat. Sci*. 1008, pp. 33.

Cited in- Engell-Sørensen, K. and Skyt, P.H. 2001. Evaluation of the effect of sediment spill from offshore wind farm construction on marine fish. Report to SEAS, Denmark, pp. 18.

Meyer, C. G. Holland, K. N. and Papastamatiou, Y. P. 2005. Sharks can detect changes in the geomagnetic field. *Journal of the Royal Society Interface* 2, pp. 129-13.

Milligan, S. P. 1986. Recent studies on the spawning of sprat (*Sprattus sprattus* L.) in the English Channel. *Fisheries Research Technical Report* no. 83.

Mills, D.H., Hadoke, G.D.F., Shelton R.G.J., Read, J.B.D. (2003) Atlantic Salmon Facts. Atlantic Salmon Trust Booklet. Prepared in 1986. Revised in 2003.

Mooney, T.A. Hanlon, R.T. Christensen-Dalsgaard, J. Madsen, P.T. Ketten, D.R. and Nachtigall, P.E. 2010. Sound detection by the longfin squid (*Loligo pealeii*) studied with auditory evoked potentials: Sensitivity to low-frequency particle motion and not pressure. *The Journal of Experimental Biology* 213, pp. 3748-3759.

Moore, A. Freake, S.M. and Thomas, I.M. 1990. Magnetic particles in the lateral line of the Atlantic Salmon (*Salmo salar* L.). *Philosophical Transactions: Biological Sciences* 329(1252), pp. 11-15.

Moore, A. and Riley, W.D. 2009. Magnetic particles associated with the lateral line of the European eel *Anguilla Anguilla*. *Journal of Fish Biology* 74(7), pp. 1629-1634.

Moore, J. A. Hartel, K. E. Craddock, J. E. and Galbraith, J. K. 2003. An annotated list of deepwater fishes from off the New England region, with new area records. *Northeastern Naturalist* 10(2), pp.159–248.

Musick, J. A. 2005. Management techniques for elasmobranch fisheries. FAO Fisheries Technical paper 474. 2008. *Cancer pagurus*. Edible crab, 2008. Brown shrimp. Available at: http://www.marlin.ac.uk/taxonomyidentification.php?speciesID=3078. [Accessed 31 May 2012].

et al.et al.

NASCO. 2012. The Atlantic Salmon. Available at: http://www.nasco.int/atlanticsalmon.html [Accessed 1 July 2013].

Natural England. 2012. Seahorses and seagrass FAQ. Natural England. Available at: http://www.naturalengland.org.uk/regions/south_west/ourwork/seahorses.aspx#6 . [Accessed 15 June 2012].

Natural England. 2010. The Dee Estuary European Marine Site. Natural England & the Countryside Council for Wales‟ advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994.

Navarro, J.M. and Widdows, J. 1997. Feeding physiology of *Cerastoderma edule* (L.) in response to a wide range of seston concentrations. *Marine Ecology Progress Series* 152, pp. 175-186.

Neal, K. and Wilson, E. 2008. *Cancer pagurus*. Edible crab. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]Plymouth: Marine Biological Association of the United Kingdom[cited 31/08/2012] Available at: http://www.marlin.ac.uk/speciesfullreview.php?speciesID=2872. [Accessed 31 May 2012].

Neal, K. 2008. Brown shrimp. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line] Plymouth: Marine Biological Association of the United Kingdom[cited 25/09/2012] Available at: http://www.marlin.ac.uk/taxonomyidentification.php?speciesID=3078. [Accessed 31 May 2012].

Nedwell, J. and Howell, D. 2004. A review of offshore wind related underwater noise sources. Report No. 544 R 0308. Report Commissioned by COWRIE.

Nedwell, J.R. Edwards, B. Turnpenny, A.W.H. and Gordon, J, 2004. Fish and marine mammal audiograms: A summary of available information. Subacoustech Report ref: 534R0214.

Nedwell, J.R. Parvin, S.J. Edwards, B. Workman, R. Borkker, A.G. and Kynoch, J.E. 2007. Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters. Subacoustech Report No. 544R0738 to COWRIE ltd. ISBN: 978-0-9554279-5-4.

Newcombe, C. P. and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. *North American Journal of Fisheries Management* 16, pp. 693-727.

Nicholls, P. Hewitt, J. and Haliday, J. 2003. Effects of suspended sediment concentrations on suspension and deposit feeding marine macrofauna. NIWA Client Report ARC03267.

Nissling, A. Muller, A. Hinrichsen, H.-H. 2003. Specific gravity and vertical distribution of sprat (*Sprattus sprattus*) eggs in the Baltic Sea. *Fisheries Biology* 63, pp. 280–299.

Norman, C. P. and M. B. Jones (1993). Reproductive ecology of the velvet swimming crab, Necora puber (Brachyura: Portunidae), at Plymouth. Journal of the Marine Biological Association of the United Kingdom, 73, pp 379-389. doi:10.1017/S0025315400032938.

Normandeau, Exponent, Tricas, T. and Gill, A. 2011. Effects of EMF from undersea power cables on elasmobranchs and other marine species. U.S. Depart. of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09.

Öhman, C. Sigray, P. and Westerberg, H. 2007. Offshore windmills and the effects of electromagnetic fields on fish Royal Swedish Academy of Science. *Ambio* 36(8), pp. 630-633.

Olsen, E. and Holst, J. C. 2001. A note on common minke whale (Balaenoptera acutorostrata) diets in the Norwegian Sea and the North Sea. *Journal of Cetacean Research and Management*, 2(2) pp. 179–183

OSPAR. 2008. Background document on potential problems associated with power cables other than those for oil and gas activities. OSPAR Commission. Biodiversity Series.

Parslow-Williams, P. Goodheir, C. Atkinson, R.J.A. and Taylor, A.C. 2002. Feeding energetics of the Norway lobster, *Nephrops norvegicus* in the Firth of Clyde, Scotland. *Ophelia* 56, pp. 101-120.

Patberg, W. de Leeuw, J. J. Winter, H. V. 2005. Verspreiding van rivierprik, zeeprik, fint en elft in Nederland na 1970. Nederlands Instituut voor Visserij Onderzoek (RIVO) BV. Rapport Nummer: C004/05.

Pawson, M. G. 1995. Biogeographical identification of English Channel fish and shellfish stocks. *Fisheries Research Technical Report* No 99.

Payne, M. R. Hatfield, E. M. C. Dickey-Collas, M. Falkenhaug, T. Gallego, A. Gröger, J. Licandro, P. Llope, M. Munk, P. Röckmann, C. Schmidt, J. O. and Nash, R. D. M. 2009. Recruitment in a changing environment: the 2000s North Sea herring recruitment failure. *ICES Journal of Marine Science* 66, pp. 272–277.

Pearson, W. H. Skalski, J. R. and Malme, C. I. 1992. Effects of sounds from a geophysical survey device on behaviour of captive rockfish (Sebastes spp.). *Canadian Journal of Fisheries and Aquatic Sciences* 49, pp. 1343-1356.

Pierce, G. Santos, M. Reid, R. Patterson, I. Ross, H. 2004. Diet of minke whales Balaenoptera acutorostrata in Scottish (UK) waters with notes on strandings of this species in Scotland 1992–2002. *Journal of the Marine Biological Association of the UK*, Vol 84, issue 6 pp. 1242- 1244.

Pinnergar, J.K. Stelzenmuller, V. Van der Kooij, J. Engelhard, G.H. Garrick-Maidment, N. and Righton, D.A. 2008. Occurrence of the short-snouted seahorse *Hippocampus hippocampus* in the central North Sea. *Cybium* 32(4), pp. 343-346.

Pizzolla, P. 2008. *Scyliorhinus canicula*. Small-spotted catshark. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=4319. [Accessed 22 March 2012].

Popper A. Carlson T. J. Hawkins, A. D. Southall B. D. and Gentry R. L. 2006. Interim Criteria for injury of Fish Exposed to a pile Driving Operation: A white Paper, available from http://www.wsdot.wa.gov/NR/rdonlyres/84A6313A-9297-42C9-BFA6-750A691E1DB3/0/BA_PileDrivingInterimCriteria.pdf, 200

Potter E. C. E. and Dare, P.J. 2003. Research on migratory salmonids, eel and freshwater fish stocks and fisheries. *Sci. Ser. Tech Rep.,* Cefas Lowestoft, 119: 64pp.

Prins, T.C., van Beek J.K.L., Bolle, L.J. (2009) Modelschatting van de effecten van heien voor offshore windmolenparken op de aanvoer van vislarven naar Natura 2000. Deltares rapport Z4832

Proctor, N. V. 2005. Crustacean Stock Assessment at the Aldbrough Gas Storage Facility, Aldbrough. Report to Scottish & Southern Energy. Institute of Estuarine and Coastal Studies, University of Hull.

Rabaut, M., van de Morteel L., Vincx, M and Degraer, S. 2010. Biogenic reefs as structuring factor in *Pleuronectes platessa* (Plaice) nursery. *Journal of Sea Resarch* 64. 2010. 102-106

Reeve, A. 2007. Solea solea. Sole. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: www.marlin.ac.uk/speciesinformation.php?speciesID=4347. [Accessed 8 March 2012].

Reeve, A. 2008. *Lophius piscatorius*. Angler fish. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3728. [Accessed 27 September 2012].

Richardson, D. E. Hare, J. A. Fogarty, M. J. Link, J. S. 2011 Role of egg predation by haddock in the decline of an Atlantic herring population. Proceedings of the National Academy of Sciences, 2011; DOI:10.1073/pnas.1015400108

Riley, K. 2007. *Pomatoschistus minutus*. Sand goby. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/speciesimportance.php?speciesID=4182. [Accessed 21 March 2012].

Robertson, M. J. Scunton, R.S. Gregory, R.S. Clarke, K.D. 2006. Effect of suspended sediment on freshwater fish and fish habitat. *Canadian Technical Report of fisheries and Aquatic Sciences*, 2644, pp. 37.

Rogers, S. and Stocks, R. 2001. North Sea Fish and Fisheries. Technical Report TR_003. Strategic Environmental Assessment-SEA2.

Rommel, S.A. and McCleave, J.D.1973. Prediction of Oceanic Electric Fields in relation to fish migration. ICES *Journal of Marine Science*. 35(1), pp. 27-31.

Rönbäck, P. and Westerberg, H. 1996. Sedimenteffekter på pelagiska fiskägg och gulesäckslarver. Fiskeriverket, Kustlaboratoriet, Frölunda, Sweden. Cited in Engell-Sørensen, K. and Skyt, P.H., (2001) Evaluation of the effect of sediment spill from offshore wind farm construction on marine fish. Report to SEAS, Denmark: pp.18.

Rowley, S. 2008. *Molva molva*. Ling. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3826. [Accessed 27 September 2012].

Rowley, S. and Wilding, C. 2008. *Ammodytes tobianus*. Lesser sand eel. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=2480 [Accessed 10 February 2012].

Ruiz, A. 2007a. *Pleuronectes platessa*. Plaice. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=4144> [Accessed on 08/03/2012].

Ruiz, A. 2007b. *Buglossidium luteum*. Solenette. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=2817 [Accessed 27 September 2012].

Ruiz, A. 2008c. *Limanda limanda*. Dab. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 28/08/2012]. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3675

Ruiz, A. 2008d. *Pandalus montagui*. Pink shrimp. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 31/05/2013]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=4034>

Sadowski, M.A. Winnicki, A. Formicki, K. Sobocinski, A. and Tanski, A. 2007 The effect of magnetic field on permeability of egg shells of salmonid fishes. *Acta ichthyologica et piscatoria* 37, pp. 129-135.

Santos, M.B. and Pierce, G.J. 2003. The diet of Harbour porpoise (*Phocoena phocoena*) in the North East Atlantic. Oceanography and Marine Biology: An Annual Review 2003, 41, pp. 355-390.

Santos, M.B., Pierce, G.J., Learmonth, J.A., Reid, R.J., Ross, H.M., Patterson, I.A.P., Reid, D.G. and Beare, D.2004. Variability in the diet of h arbour porpoises (Phocoena phocoeana). *Marine Mammal Science*. 20(1), pp. 1-27.

Sayer, M. D. J., Magill, S., H., Pitcher, T. J., Morisette, L. and Ainsworth,C. 2005. Simulation-based investigations of fishery changes as affected by the scale and design of artificial habitats. *Journal of Fish Biology* 67 (Supplement B), pp. 218-243.

Schmidt, J. O., van Damme, C. J. G., Rockmann, C. and Dickey-Collas, M. 2009. Recolonisation of spawning grounds in a recovering fish stock: recent changes in North Sea herring. *Scientia Marina* 73(S1), pp.153-157.

Schmidt, J., Rohlf, N. and Groger, J. 2008. Report of the Herring Larvae Surveys in the North Sea in 2007/2008.

Seed, R. 1969 The ecology of *Mytilus edulis* on exposed rocky shores. *Oecologia* 3, pp. 317 - 350

Sell, A.F., Kroncke, I. and Ehrich, S. 2007. Linking the diversity of fish assemblages to habitat structure: A study on Dogger Bank (North Sea). ICES CM 2007/E:18.

Skaret, G., Axelsen, B.E., Nottestad, L., Ferno, A. and Johannessen, A.2005. The behaviour of spawning herring in relation to a survey vessel. *ICES Journal of Marine Science*. 62 (6), pp. 1061-1064.

Shark Trust, 2009. Common Skate Fact sheet. Available at: http://www.sharktrust.org/content.asp?did=33255. [Accessed on 18/06/2012].

Shark Trust. 2010. An Illustrated Compendium of Sharks, Skates, Rays and Chimaera. Chapter 1: The British Isles and Northeast Atlantic. Part 2: Sharks.

Shelley, J. 2012. Habitats Regulations Assessment of the North East Coast Limitation of Net Licences Order 2012. Supporting Technical Report. Impact on Anadromous fishes: Atlantic Salmon (*Salmo salar*). Environment Agency

Sherman, K. Jones, C. Sullivan, L. Smith, W. Berrien, P. Ejsymont, L. 1981. Congruent shifts in sand eel abundance in western and eastern North Atlantic ecosystems. *Nature*, 291 pp. 486-489.

Skaret, G. Axelsen, B. Nøttestad, L. Ferno, A. Johannessen, A. 2002. Herring as Cannibals. *Journal of Fish Biology* 61(4), pp. 1050–1052

Smith I.P, Jensen A. C., Collins K.J. and Mattey E.L. 2001. Movement of wild European lobsters Homarusgammarus in natural habitat. *Marine Ecology Progress Series* 222, pp. 177-186.

Stafford, R. Whittaker, C. Velterop, R. Wade, O. Pinnegar, J. Programme 13: North Sea Whiting Stomach Contents. Final Report. Fisheries Science Partnership: CEFAS, Lowestoft.

Stenberg, C., van Deurs, M., Stottrup, J., Mosegaard, H, Grome, T., Dinesen, G., Christensen, A., Jensen, H, Kaspersen, M., Berg, C.W., Leonhard, S.B., Skov, H., Pedersen, J., Hvidt, C.B. and Kaustrup, M. 2011. Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities. Follow-up Seven Years after Construction. DTU Aqua Report No 246-2011.

Tanski, A., Formicki, k. Korzelecka-Orkisz, A. and Winnicki, A. 2005. Spatial orientation of fish embryos in magnetic field. *Electronic Journal of Ichthyology* 1, pp. 14.

Teal, L.R. 2011. The North Sea fish community: past, present and future. Background document for the 2011 National Nature Outlook. Wageningen, Wettelijke Onderzoekstaken Natuur & Milieu, Wotwerkdocument 256. 64 p.

ter Hofstede, R. H., Winter, H. V. and Bos, O. G. 2008. Distribution of fish species for the generic Appropriate Assessment for the construction of offshore wind farms. IMARES Report C050/08.

Thompson, B.M. Lawler, A.R. and Bennett, D.B. 1995. Estimation of the spatial distribution of spawning crabs (Cancer pagurus) using larval surveys in the English Channel. *ICES mar. Sci. Symp*., 199, pp. 139-150.

Thompson, P. Ingram, S. Lonergan, M. and Northridge, S. 2007. Climate change causing starvation in harbour porpoises? *Biology Letters* 3, pp. 533–534.

Thompson, D. Moss, S. Lovel, P. 2003. Foraging behaviour of South American fur seals Arctocephalus australis: extracting fine scale foraging behaviour from satellite tracks. *Marine Ecology Progress Series* 260, pp. 285- 296.

Thomsen, F. Ludemann, K. Kafemann, R and Piper, W. 2006 Effects of offshore wind farm noise on marine mammals and fish, Biola, Hamburg, Germany on behalf of COWRIE Ltd.

Tougaard, J. and Henriksen, O.D. 2009. Underwater noise from three types of offshore wind turbines.: Estimation of impact zones for harbor porpoises and harbor seals. *Journal of the Acoustical Society of America* 126, pp. 11-14.

Tricas, T.C. and Sisneros, J.A. 2004. Ecological functions and adaptations of the elasmobranch electrosense. In: von der Emde, G., Mogdans, J. & Kapoor, B.G. eds. *The Senses of Fishes*: *Adaptations for the Reception of Natural Stimuli.* New Delhi: Narosa Publishing House. pp. 308-329.

Tyler-Walters H, 2008. *Mytilus edulis*. Common mussel. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: <http://www.marlin.ac.uk/speciesfullreview.php?speciesID=3848. [Accessed on 30/05/2013].

Ueno, S.P. Lövsund, P. and Öber, P.A.1986. Effect of time-varying magnetic fields on the action potential in lobster giant axon. *Med Biol Eng Comput* 25, pp. 521-526.

van Damme, C.J.G., Hoek, R., Beare, D., Bolle, L.J., Bakker, C., van Barneveld, E., Lohman, M., os-Koomen, E., Nijssen, P., Pennock, I. and Tribuhl, S. 2011. Shortlist Master plan Wind Monitoring fish eggs and larvae in the Southern North Sea; Final Report . Report number C098/11.

van Deurs M. Grome T.M. Kaspersen M. Jensen H. Stenberg, C. Sørensen, T.K. Stø ttrup, J. Warnar, T. and Mosegaard, H. 2012. Short- and long-term effects of an offshore wind farm on three species of sandeel and their sand habitat. *Mar. Ecol.Prog. Ser* 458, pp. 169-180 van Deurs, M. van Hal, R. Jensen, H. Tomczak, M.T. and Dolmer, P. 2008. A spatially and temporally explicit analysis of beam-trawling on sandeel fishing grounds in the North Sea. North Atlantic Case Study Appendix 1. A study part of the EU project INEXFISH financed by the RTD programme “Specific Support to Policies”, FP6 2004-SSP-4 “Integrating and Strengthening the European Research Area”.

van der Kooij, J., Scott, B.E. and Mackinson, S. 2008. The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. *Journal of Sea Research* 60, pp. 201-209.

Vandendriessche, S., Derweduwen, J and Hostens, K. 2012. Chapter 5-Monitoring the effects of offshore wind farms on the epifauna and demersal fish fauna of soft-bottom sediment. *In*- Degraer, S., Brabant, and Rumes.B. 2012. Offshore wind farms in the Belgian part of the North Sea: Heading for an understanding of environmental impacts. Royal Belgian Institute of Natural Science, Management Unit of the North Sea Mathematical Methods, Marine ecosystem management unit. 155pp. annexes.

Vriens, A.M. and Bretschneider, F.1979. The electrosensitivity of the lateral line of the European eels, Anguillla anguillla L. *Journal of Physiology*. 75 (4), pp. 341-342.

Wageningen Ur, 2012a. International Bottom Trawl surveys (IBTS) Results. 2010. Available online at: http://orca.wur.nl/surveys/survey_report_IBTS_2010/. [Accessed on 07/03/2012[.

Wageningen Ur, 2012b. Beam Trawl surveys (IBTS) Results. 2010. Available online at: http://orca.wur.nl/surveys/survey_report_BTS_2010/. [Accessed on 07/03/2012].

Wahlberg, M. and Westerberg, H., (2005). Hearing in fish and their reactions to sounds from offshore wind farms. *Marine Ecology Progress Series*. 288, pp. 295-309.

Waldman, J., Grunwald, C. and Wirgin, I. 2008. Sea lamprey *Petromyzon marinus*: an exception to the rule of homing in anadromous fishes. *Bioogy. Letters* 4, pp. 659–662.

Walmsley S.A. and Pawson, M.G., 2007. The coastal fisheries of England and Wales, Part V: a review of their status 2005–6. *Sci. Ser. Tech Rep*., Cefas Lowestoft, 140, pp. 83.

Walters, H.T.2008. *Psetta maxima*. Turbot. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=4218. [Accessed 7 September 2012].

Wanless, S., Wright, P.J., Harris, M.P. and Elston, D. A. 2005. Evidence for decrease in size of lesser sandeels *Ammodytes marinus* in a North Sea aggregation over a 30-yr period. *Marine Ecology Progress Series* 279, pp.237–246.

Wanless, S., Harris, M. and Rothery, P.1999. Intra-and Inter-Seasonal Variation in Sandeel, *Ammodytes marinus* consumption by Kittiwakes, *Rissa Tridactyla* on the Isle of May and Long-term Changes in Numbers, Reproductive Output and Adult Survival. In: Wright, P. J. and Kennedy, F. M., (eds.) *Sandeel biology and its implications to management.* Aberdeen, Fisheries Research Service, 14-15.

Wanless, S., Harris, M. P., and Greenstreet, S. P. R.1998. Summer sandeel consumption by seabirds breeding in the Firth of Forth, south-east Scotland. *ICES Journal of Marine Science* 55, pp.1141–1151.

Warren, P.J and Sheldon R. W. 1967. Feeding and migration patterns of the pink shrimp *Pandalus montagui*, in the estuary of the River Crouch, Essex, England. *Journal of the Fisheries Research Board of Canada* 24 (3), pp. 569–580.

Weinert, M., Floeter, J, Kroncke, I. and Sell, A.F. 2010. The role of prey composition for the condition of grey gurnard (*Eutrigla gurnardus*). *Journal of Applied Ichthyology*. 26 (Supplement s1), pp. 78-84.

Westerberg, H. and Lagenfelt, I. 2008. Sub-Sea Power Cables and the Migration Behaviour of the European Eel. *Fisheries Management and Ecology* 15 (1-5), pp. 369-375.

Wheeler, A. 1978. *Key to the fishes of Northern Europe*. Frederik Warne (Publishers) Ltd, London.

Whitehead, P.J.P., Bauchot, M.-L., Hureau, J.-C., Neilsen, J., and Tortonese, E. 1986. Clupeidae. In: Fishes of the North-eastern Atlantic and the Mediterranean Volume I. UNESCO, Paris, pp. 268-281.

Wilding., C. and Heard, J. 2004. *Gadus morhua*. Atlantic cod. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 21/03/2012]. Available from: <http://www.marlin.ac.uk/speciesinformation.php?speciesID=3359. [Accessed 221 March 2012].

Wilhelmsson, D., Malm, T. Ohman, M.C. 2006. The influence of offshore windpower on demersal fish. *ICES Journal of Marine Science* 63(5), pp. 775-784.

Wilson, E. 2008. Necora puber. Velvet swimming crab. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological

Association of the United Kingdom. Available at: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3858. [Accessed 14 September 2012].

Winter, HR., Aarts, G. and van Keeken, O.A. 2010. Residence time and behaviour of sole and cod in the Offshore Wind farm Egmond aan Zee (OWEZ). IMARES Report number OWEZ_R_265-TI_20100916.

Winslade, P. 1974. Behavioural studies on the lesser sandeel *Ammodytes marinus* (Raitt) II. The effect of light intensity on activity. Journal of Fish Biology, Volume 6, Issue 5, pp.577-586.

Wood, S.A. 2001. Summary of harbour seal (*Phoca vitulina concolor*) food habits in Mid-coast Maine: Summer 2000. Report to MERI: 1-11. Marine Environ. Research Institute.

Wright, P.J. Jensen, H. and Tuck, I. 2000. The influence of sediment type on the distribution of the lesser sandeel Ammodytes marinus. *J.Sea.Res*. 44, pp. 243-256.

Wright, P.J. and Bailey, M. C. 1996. Timing of hatching in *Ammodytes marinus* from Shetland waters and its significance to early growth and survivorship. *Marine Biology*, 126, pp.143-152. Cited in Jensen *et al.* 2003.

Wright, P. and Bailey, M. 1993. Biology of sandeels in the vicinity of seabird colonies at Shetland. Marine Laboratory Aberdeen, Fisheries Research Report No. 15/93.

Wright and F.M. Kennedy, 1999. Proceedings of a workshop held at FRS Marine Laboratory Aberedeen 22-24 February 1999. Fisheries Research Services Report No 12/99.

Wright, P. Verspoor, E. Anderson, C. Donald, L. Kennedy, F. Mitchell, A. Munk, P. Pedersen, S. Henrik, J. Lewy, P. 1998. Population structure in the lesser sandeel (*Ammodytes marinus*) and its implications for fishery-predator interactions. Final EC Report. DG XIV Contract, no. 94/071.