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Environmental Statement

Technical Appendix 4.3 A - Fish and Shellfish Ecology Technical Report

Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement

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1.0 Introduction

The following report details the current Fish and Shellfish Ecology baseline assessment for the three proposed wind farm sites (Telford, Stevenson and MacColl Offshore Wind Farm Sites). Site specific information on the distribution of fish and shellfish species in areas relevant to the Offshore Transmission Infrastructure (OfTI) is provided in Annex I.

For the purposes of this report the fish and shellfish species have been separated into four main categories:

- Species of commercial interest.
- Species potentially using the development area as a spawning or nursery ground.
- Key prey species.
- Species of conservation importance, including migratory species.

It should be noted that certain species are relevant within more than one of the categories given above. As a result, some overlap is to be expected.

Given the socio-economic and conservation importance of salmon and sea trout in Scotland, their ecology and fisheries have been separately assessed in a standalone document (Salmon and Sea Trout Ecology and Fisheries Technical Report), and are not covered in this document.

2.0 Methodology

2.1 Guidance

The following documents have provided guidance for the undertaking of the Fish and Shellfish Ecology baseline assessment:

- Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Volume I: Environmental Report (Marine Scotland, 2010).
- Habitats Regulations Appraisal of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters. Appropriate Assessment Information Review (Marine Scotland, 2011).
- CEFAS Guidance Note for Environmental Impact Assessment in Respect of the FEPA and CPA Requirements (CEFAS 2004).
- Marine Scotland Science (MSS) Scoping Opinion.
- Scottish Natural Heritage (SNH) and Joint Nature Conservation Committee (JNCC) Scoping Advice (14.05.2010).

2.2 Sources of Data and Information

Establishing Fish and Shellfish Ecology baseline requires an approach that incorporates a number of different data and information sources. The principal sources of information used were as follows:

- Marine Scotland Science (MSS) publications.
- International Council for the Exploration of the Sea (ICES) publications.
- Marine Management Organisation (MMO) Landings Data by ICES rectangle for the period 2000-2009.
- Centre for Environment, Fisheries and Aquaculture (CEFAS) publications.
- Fisheries Sensitivity Maps in British Waters (Coull *et al* 1998).
- Mapping spawning and nursery areas of species to be considered in Marine Protected Areas

(Marine Conservation Zones). Report No 1 (Ellis et al 2010a).
- Results of Benthic Surveys undertaken in the area (EMU, 2011)
- Other relevant research publications.

2.3 Data sensitivities, Gaps and Limitations

2.3.1 MMO Landings Data

ICES statistical rectangles are the smallest spatial unit used for the collation of fisheries statistics by the European Commission (EC) and Member States. The boundaries of ICES rectangles align to 1˚ of longitude and 30' of latitude, and are large in relation to the area of the three proposed wind farm sites, which represents approx. 9.1 % of the area of the ICES rectangle within which it is located. In addition, fishing activity is rarely evenly distributed throughout the area of a rectangle. The analysis of the fisheries statistics provided below should therefore be taken in the context of the spatial limitations of the dataset.

Furthermore, whilst landings data provide a good indication of the commercial species present by ICES rectangle, in some cases their relative abundance and importance may be misrepresented as a result of factors, such as: low quota allocations, fisheries closures, changes in demand, etc. In addition, the presence and distribution of fish and shellfish species are dependent on a number of biological and environmental factors that interact with each other in direct and indirect ways, and are subject to seasonal and annual variations.

2.3.2 Spawning and Nursery Grounds

The assessment of the area of the three proposed wind farm sites as a potential spawning and nursery ground has primarily been undertaken using the charts provided in Coull *et al* (1998) and Ellis *et al* (2010a). It should be noted that although these are useful sources to identify broad spawning and nursery grounds they do not allow for definition of exact grounds, especially in relation to discrete areas such as that of the proposed Telford, Stevenson and MacColl sites. Where available, alternative publications have been used to help define the extension of the grounds on a site specific basis.

2.3.3 Gaps in Current Knowledge

It is recognised that there are gaps in the understanding of the distribution, behaviour and ecology of certain species. This is particularly evident for a number of migratory species and species of conservation importance (e.g. sea lamprey, European eel) for which little is known in relation to migration routes and the use they may make of coastal areas. Salmon and Sea Trout are also species that fall in this category (See Technical Appendix 4.3 B)

2.4 Study Area

The three proposed wind farm sites are located off the north east coast of Scotland (ICES Division IVa) on the north western point of the Smith Bank in depths of 30 m to 70 m.

The local study area has been defined as ICES rectangle 45E7, the rectangle within which the three proposed wind farm sites are located. The regional study area comprises rectangle 45E7 and all adjacent rectangles, including rectangle 45E6 where the southern section of the MORL Western Development Area is located. The local and regional study areas together with the boundary of ICES Division IVa are shown in Figure 2.1.

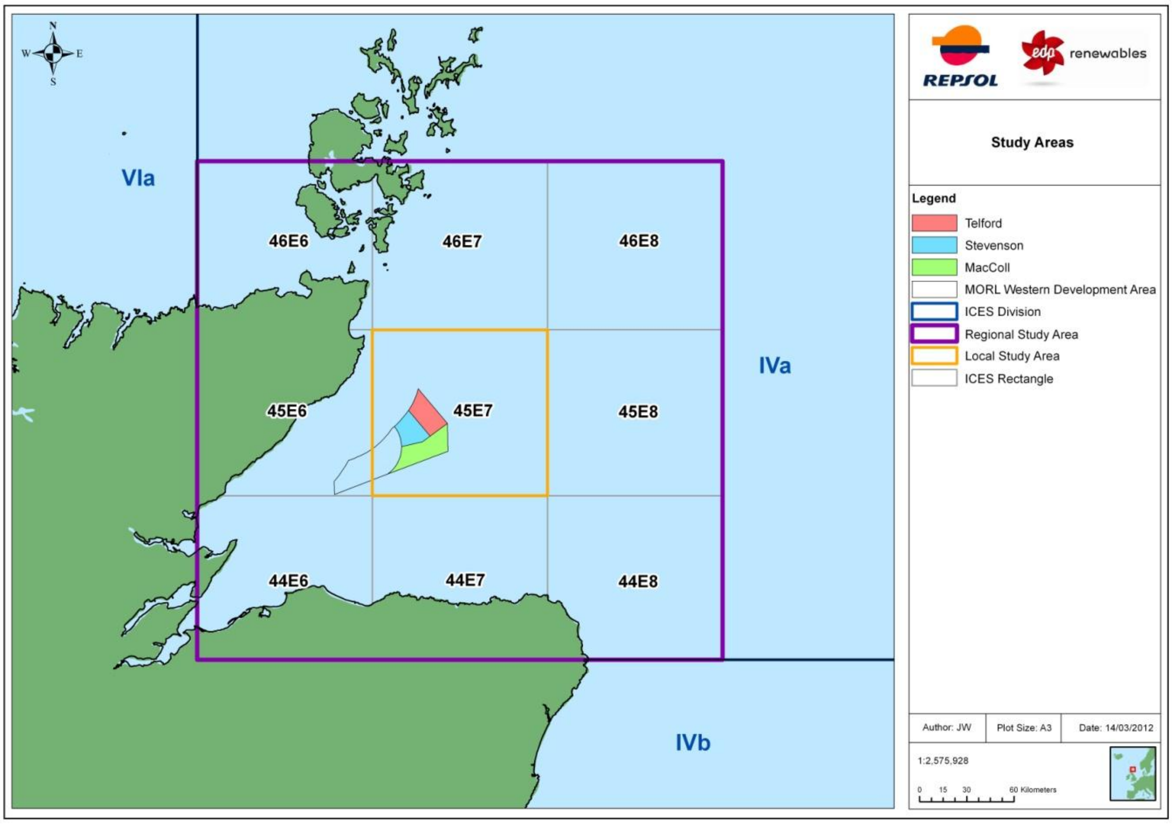

Figure 2.1 Study areas

3.0 Baseline Assessment

3.1 Introduction

In ICES Divisions IVa and IVb (northern and central North Sea), fish populations are dominated by haddock, whiting, herring, dab and plaice in shallower waters (50-100 m depth), whilst at greater depths, species such as Norway pout dominate. The fish assemblages of these Divisions differ from those of areas further south principally as a result of changes in water depth and temperature (ICES, 2011c).

In Division IVa shellfish species are widely distributed, being more prevalent in coastal areas, where they support commercial fisheries of importance (e.g. *Nephrops*, scallops, crabs, squid) (Commercial Fisheries Report BMM 2011).

In addition to depth and temperature, sediment type affects the distribution of certain species. Seabed sediment types in the Moray Firth are given in Figure 3.1. It can be seen that muddy substrates dominate in the inner and southern area, whilst sand, gravelly sand and to a lesser extent sandy gravel and slightly gravelly sand, are prevalent in the northern and central areas of the Firth including the area of the three proposed wind farm sites. As shown in Figure 3.1, the more southern areas of the development site are characterised by coarser substrate.

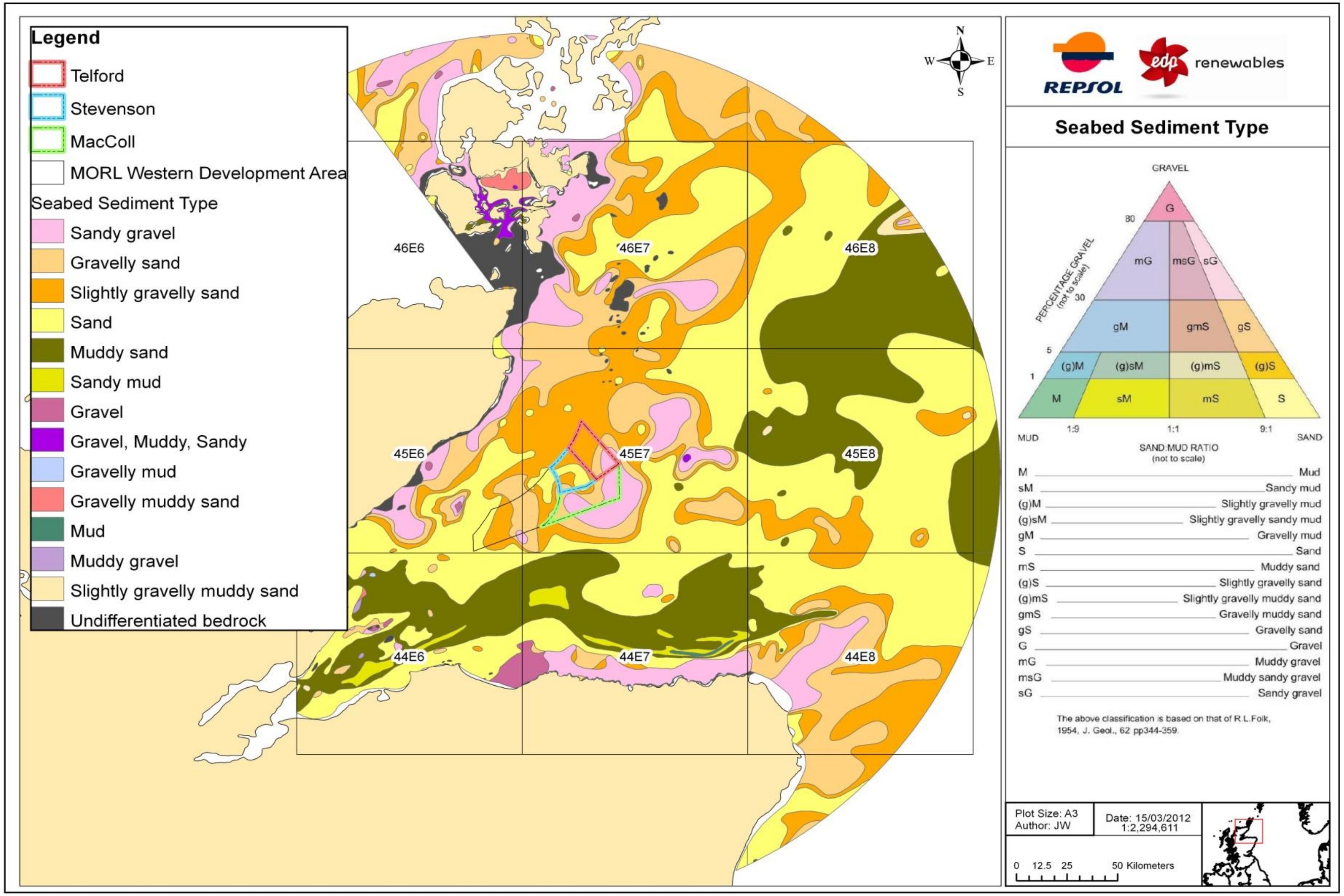

Figure 3.1 BGS (British Geological Survey) seabed sediment chart with ground type

3.2 Commercial Species

The principal commercial species present in the regional study area are given in Figure 3.2, based on annual average (2000-2009) landings weights by species and ICES rectangle (MMO 2010).

Scallops, *Nephrops*, edible crab and squid are the principal shellfish species landed. Haddock, herring, monks and whiting account for the majority of the fish landings. The relative importance of each species to the total landings weights varies depending on the ICES rectangle under consideration. *Nephrops* for example, are of greatest importance in the southern (44E6, 44E7 and 44E8) and eastern (46E8, 45E8) rectangles. Haddock accounts for a percentage of the total landings in the majority of rectangles, although the highest landings by weight for this species are recorded in the eastern rectangles of the regional study area. In the case of scallops, landings values by weight are particularly high in the local study area (45E7) and in adjacent rectangles 46E7, 45E6 and 44E6.

It should be noted that sharks and rays (elasmobranchs) constitute a very small percentage of the total landings both in the regional and in the local area, being included (together with other fish species) under the category "Other" in the chart below.

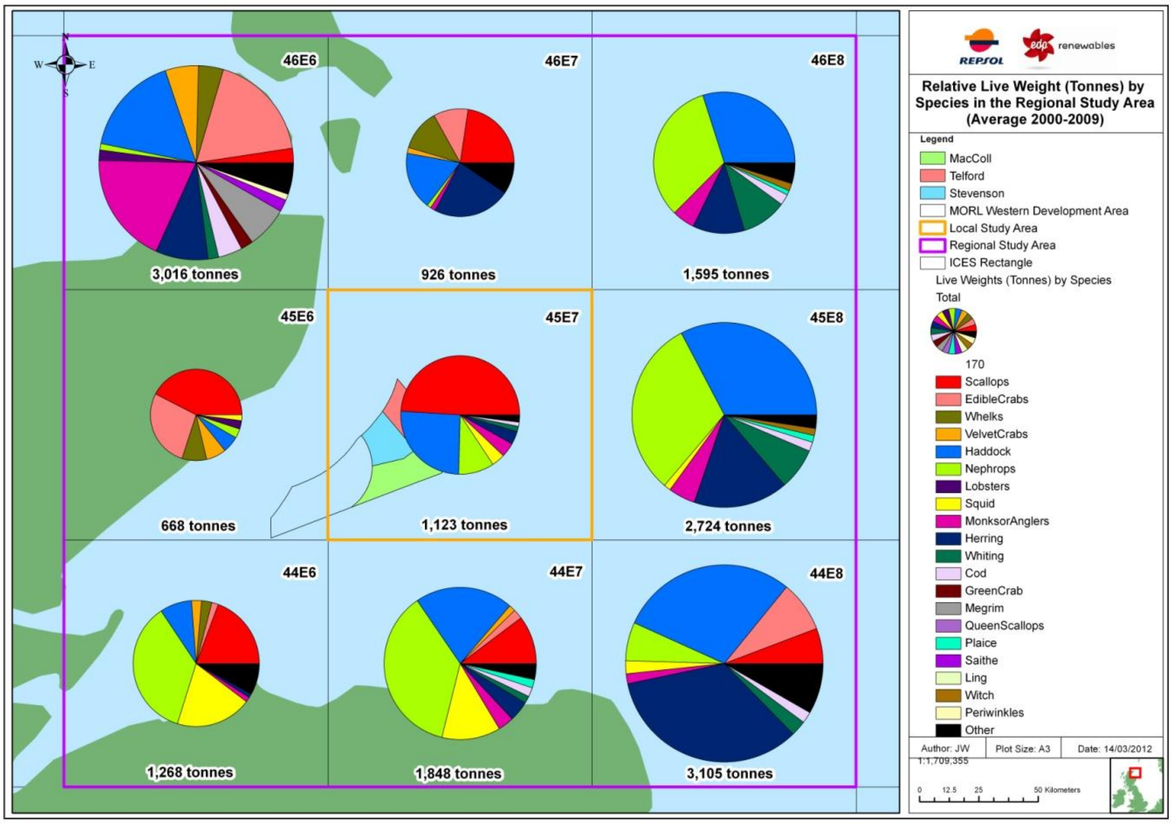

Figure 3.2 Live weight (tonnes) by species in the regional and local study area (MMO landings data)

An indication of species presence/absence by ICES rectangle within the regional study area, based on MMO landings data for the period 2000-2009 (MMO 2010), is given in Table 3.1 and Table 3.2 for fish and shellfish species respectively. Species presence in the local study area is highlighted in yellow.

Table 3.1 List of fish species in the local (light yellow) and regional study area (MMO landings data)

Species		Presence (✓) within ICES Rectangles								
Common Name	Scientific Name	44E6	44E7	44E8	45E6	45E7	45E8	46E6	46E7	46E8
Teleosts										
Albacore	*Thunnus alalunga*	-	-	-	-	-	-	-	✓	-
Bass	*Dicentrarchus labrax*	-	✓	✓	-	-	-	✓	-	-
Black Scabbardfish	*Aphanopus carbo*	-	-	-	✓	✓	-	✓	✓	-
Blue Ling	*Molva dipterygia*	✓	✓	✓	✓	-	-	✓	✓	-
Blue Mouth Redfish	*Helicolenus dactylopterus*	-	-	-	-	-	-	✓	-	-
Ray's bream	*Brama brama*	-	-	✓	-	-	-	-	-	-
Brill	*Scophthalmus rhombus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Catfish	*Anarhichas spp.*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cod	*Gadus morhua*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Common Mora	*Mora moro*	-	-	-	-	-	-	✓	-	-
Conger Eels	*Conger conger*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dabs	*Limanda limanda*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Eels	*Anguilliformes spp.*	-	-	✓	-	-	-	✓	-	-
Four-Spotted Megrim	*Lepidorhombus boscii*	-	✓	✓	-	-	✓	-	-	-
Greater Forked Beard	*Phycis blennoides*	✓	-	✓	✓	-	-	✓	✓	-
Greater Silver Smelt	*Argentina silus*	✓	-	-	-	✓	-	✓	-	-
Gurnards - Grey	*Eutriglia gurnardus*	-	✓	✓	-	✓	✓	✓	✓	✓
Gurnards - Red	*Aspitrigla cuculus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Haddock	*Melanogrammus aeglefinus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hake	*Merluccius merluccius*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Halibut - Atlantic	*Hippoglossus hippoglossus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Halibut - Greenland	*Reinhardtius hippoglossoides*	✓	-	✓	✓	✓	-	✓	-	-
Herring	*Clupea harengus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Horse Mackerel	*Trachurus trachurus*	-	-	-	-	✓	✓	✓	✓	✓
John Dory	*Zeus faber*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lemon Sole	*Microstomus kitt*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ling	*Molva molva*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Long Rough Dabs	*Hippoglossoides platessoides*	-	-	-	-	✓	-	-	-	-
Mackerel	*Scromber scrombus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Megrim	*Lepidorhombus whiffiagonis*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monks or Anglers	*Lophius piscatorius*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Plaice	*Pleuronectes platessa*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pollock	*Pollachius pollachius*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rabbit Fish (Rattail)	*Macrouridae spp.*	-	-	✓	✓	-	-	✓	✓	-
Red Mullet	*Mullus surmeletus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Redfish	*Sebastes marinus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Roughead Grenadier	*Macrourus berglax*	-	-	-	-	-	-	✓	-	-
Roundnose Grenadier	*Coryphaenoides rupestris*	-	✓	✓	✓	-	✓	✓	✓	✓
Saithe	*Pollachius virens*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sole	*Solea solea*	✓	✓	✓	✓	-	✓	✓	-	-
Torsk (Tusk)	*Brosme brosme*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Turbot	*Psetta maxima*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Whiting	*Merlangius merlangus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Witch	*Glyptocephalus cynoglossus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Elasmobranchs (Sharks and Rays)										
Birdbeak Dogfish	*Deania calcea*	-	-	-	-	-	-	✓	-	-
Common Skate	*Dipturus batis*	-	-	-	-	-	-	✓	-	-
Gulper Shark	*Centrophorus granulosus*	-	-	-	-	-	-	✓	-	-
Leafscale Gulper Shark	*Centrophorus squamosus*	✓	✓	-	-	-	-	-	-	-
Long-nosed Skate	*Dipturus oxyrinchus*	-	-	-	-	-	-	✓	-	✓
Portuguese Dogfish (Shark)	*Centroscymnus coelolepis*	✓	✓	-	✓	-	-	✓	✓	-
Sailfin Roughshark	*Oxynotus paradoxus*	-	-	-	-	-	-	✓	-	-
Sharks	-	✓	✓	✓	✓	✓	✓	✓	✓	✓
Skates and Rays	-	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spurdog	*Squalus sp.*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Thornback Ray	*Raja clavata*	-	-	-	-	-	-	✓	-	-
Tope	*Galeorhinus galeus*	-	-	-	-	-	-	-	-	✓
Unidentified Dogfish	*Squalidae spp.*	-	-	-	✓	✓	✓	✓	✓	-
White Skate	*Rostroraja alba*	-	-	-	-	-	-	✓	-	-

Table 3.2 List of shellfish species in the local (light yellow) and regional study area (MMO landings data)

Species		Presence (✓) within ICES Rectangles								
Common Name	Scientific Name	44E6	44E7	44E8	45E6	45E7	45E8	46E6	46E7	46E8
Crustaceans										
Brown Shrimp	*Crangon crangon*	✓	✓	✓	-	-	-	-	-	-
Velvet Crab	*Necora puber*	✓	✓	✓	✓	✓	-	✓	✓	✓
Edible Crab	*Cancer pagurus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Crawfish	*Palinurus spp.*	-	-	✓	-	-	-	✓	-	-
Green Crab	*Carcinus maenas*	✓	✓	✓	✓	✓	-	✓	✓	-
Squat Lobster	*Galatheoidea sp.*	✓	--	✓	✓	-	-	✓	✓	-
Lobsters	*Homarus gammarus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nephrops	*Nephrops norvegicus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pink Shrimp	*Pandalus montagui*	-	-	-	-	✓	✓	-	-	-
Spider Crabs	*Majidae spp.*	-	-	-	-	-	✓	-	-	-
Molluscs										
Bivalves										
Cockles	*Cardiidae spp.*	✓	-	-	✓	-	-	✓	✓	-
Oysters	*Ostreidae spp.*	✓	-	✓	-	-	-	-	-	-
Queen Scallops	*Aequipecten opercularis*	✓	✓	✓	✓	✓	✓	✓	✓	-
Razor Clam	*Ensis arcuatus*	✓	✓	-	✓	-	-	✓	✓	-
King Scallops	*Pecten maximus*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Surf Clams	*Spisula solida*	✓	-	-	-	-	-	✓	-	-
Cephalopods										
Cuttlefish	*Sepiida spp.*	-	-	-	-	-	-	-	✓	✓
Octopus	*Octopoda sp.*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Squid	*Teuthida spp.*	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gastropods										
Periwinkles	*Littorina littorea*	✓	-	✓	✓	✓	-	✓	✓	-
Whelks	*Buccinum undatum*	✓	✓	✓	✓	✓	✓	✓	✓	✓

3.2.1 Shellfish

King scallops are the main shellfish species landed by weight from the local study area, accounting for 78.1 % of total shellfish landings (average 2000-2009). *Nephrops* and squid account for 15.5 % and 5.8 % of the total shellfish landings weights respectively. It should be noted that these species account for a large percentage of the total landings (including fish) from the local study area (61.1 %).

In rectangles adjacent to the local study area, landings by weight for other shellfish species such as crabs (principally edible crab) and, to a lesser extent, whelks and lobster are of relative importance (Figure 3.2).

Table 3.3 Percentage distribution of the catch of shellfish species in the local area (45E7) (MMO landings data)

Species	Average (2000-2009) Landings Weight (t)	Percentage of Total Shellfish Landings Weight in the Local Study Area (45E7)	Percentage of Total Landings Weight (all fish and shellfish species combined) in the Local Study Area (45E7)
King Scallops	539.0	78.1%	48.0%
Nephrops	106.7	15.5%	9.5%
Squid	40.2	5.8%	3.6%
Edible Crab	2.5	0.4%	0.2%
Queen Scallops	1.2	0.2%	0.1%
Velvet Crab	0.3	<0.1%	<0.1%
Octopus	0.1	<0.1%	<0.1%
Whelks	< 0.1	<0.1%	<0.1%

Green Crab	< 0.1	<0.1%	<0.1%
Lobsters	< 0.1	<0.1%	<0.01%
Mixed Crabs	< 0.1	<0.01%	<0.01%
Periwinkles	< 0.1	<0.01%	<0.01%
Pink Shrimp	< 0.01	<0.01%	<0.01%

3.2.1.1 Scallops

The king scallop (*Pecten maximus*) is the main species of scallop in Scottish waters (Howell *et al* 2006). They can be found on a variety of substrate types, from rocks and stones to fine silty mud. They are most abundant in areas with rocky outcrops or boulders on silty sand mixed with shell substrates at depths of 15-75 m (Pawson 1995, Franklin *et al* 1980). Queen scallops (*Aequipecten opercularis*) occur in much the same areas as king scallops, but usually in somewhat deeper water, down to 200 m or more. They are also landed from the local study area, although to a lesser extent than king scallops. Both species were found in beam trawl samples during benthic surveys undertaken in the site. Queen scallops were one of the most abundant and frequent species in the benthic survey being recorded in all the beam trawl samples (385 individuals), whilst king scallops were only caught in small numbers at three stations (3 individuals) (EMU 2011). This is likely a result of the catchability of the species as a result of the gear used.

The highest scallop landings in the regional study area are recorded in ICES rectangle 45E7, within which the three proposed wind farm sites are located. In this rectangle king scallops account for 57 % of the total landings values and for 48 % of the total landings weights (Commercial Fisheries Report BMM 2011). Figure 3.3 to Figure 3.5 shows the location of the development relative to VMS and landings records.

Scallops have an aggregated distribution within their geographical range. Where the population is sufficiently abundant to support a commercial fishery, such areas are referred to as “grounds “and are usually widely separated by areas that are environmentally unsuitable for the species. The absolute size of grounds may vary substantially from a few km^2 to a few thousand km^2 (Brand 2006). Scallop grounds are located in areas of the Moray Firth, including the Smith Bank, the southern and western coastlines and in eastern, offshore areas (Commercial Fisheries Report BMM 2011). Scallop grounds appear to be absent from areas characterised by muddy sand substrates, where *Nephrops* are more prevalent (Figure 3.1, Figure 3.3-Figure 3.5).

Within each ground there are usually a number of areas of several km^2, where scallop abundance is higher than elsewhere, these are referred to as “beds”. Beds may be permanent aggregations, precise in their location and separated by areas that are unsuitable for scallops, or they may be temporary aggregations that vary in their location from year to year, resulting from uneven settlement or early survival. In addition, within each bed the distribution of scallops may be aggregated into “patches”, the scale of which is generally measured in terms of tens or hundreds of m^2 (Brand 2006).

The scallop fishery is cyclical and is often left to recover from intensive fishing periods while the fleet targets grounds elsewhere (Figure 3.3-Figure 3.5, pers. comm. scallop fisherman, December 2010). In the Moray Firth scallop stock levels are considered to be currently stable (Commercial Fisheries Report BMM 2011).

In Scottish waters, scallops spawn for the first time in the autumn of their second year, and subsequently spawn each year in the spring or autumn (Keltz & Bailey 2010). Following external fertilisation eggs remain on or near the sea bed for a number of days and then develop into free-swimming larvae (veliger larvae) that migrate towards the sea surface, and spend three weeks or more in the water column (Keltz & Bailey 2010, Pawson 1995). Pelagic veliger larvae eventually descend towards the seabed where they develop into pediveliger larvae (Pawson 1995, Franklin *et al* 1980). It is at this stage of the larval cycle that substrate preference is of most importance with larvae alternatively swimming and crawling over the seabed testing surfaces upon which to settle (Franklin *et al* 1980). When a suitable settling surface such as algae, hydroids or bryozoans is found the scallop anchors itself by means of sticky threads (byssus threads) from a gland at the base of the foot (Franklin *et al* 1980). The larvae then undergo a complete metamorphosis of internal anatomy and become what is termed “spat”. It then feeds until the shell is strong and thick enough for the scallop to inhabit sand and gravel on the sea bed (Franklin *et al* 1980).

Spat (juvenile scallops) settlement and/or survival appear to be extremely irregular, with certain age classes often entirely absent from a population. It has been suggested that a minimum of spawning adults is necessary to ensure good recruitment of spat, and productive spawning areas may therefore be more restricted than the overall distribution of the species would indicate (Pawson 1995).

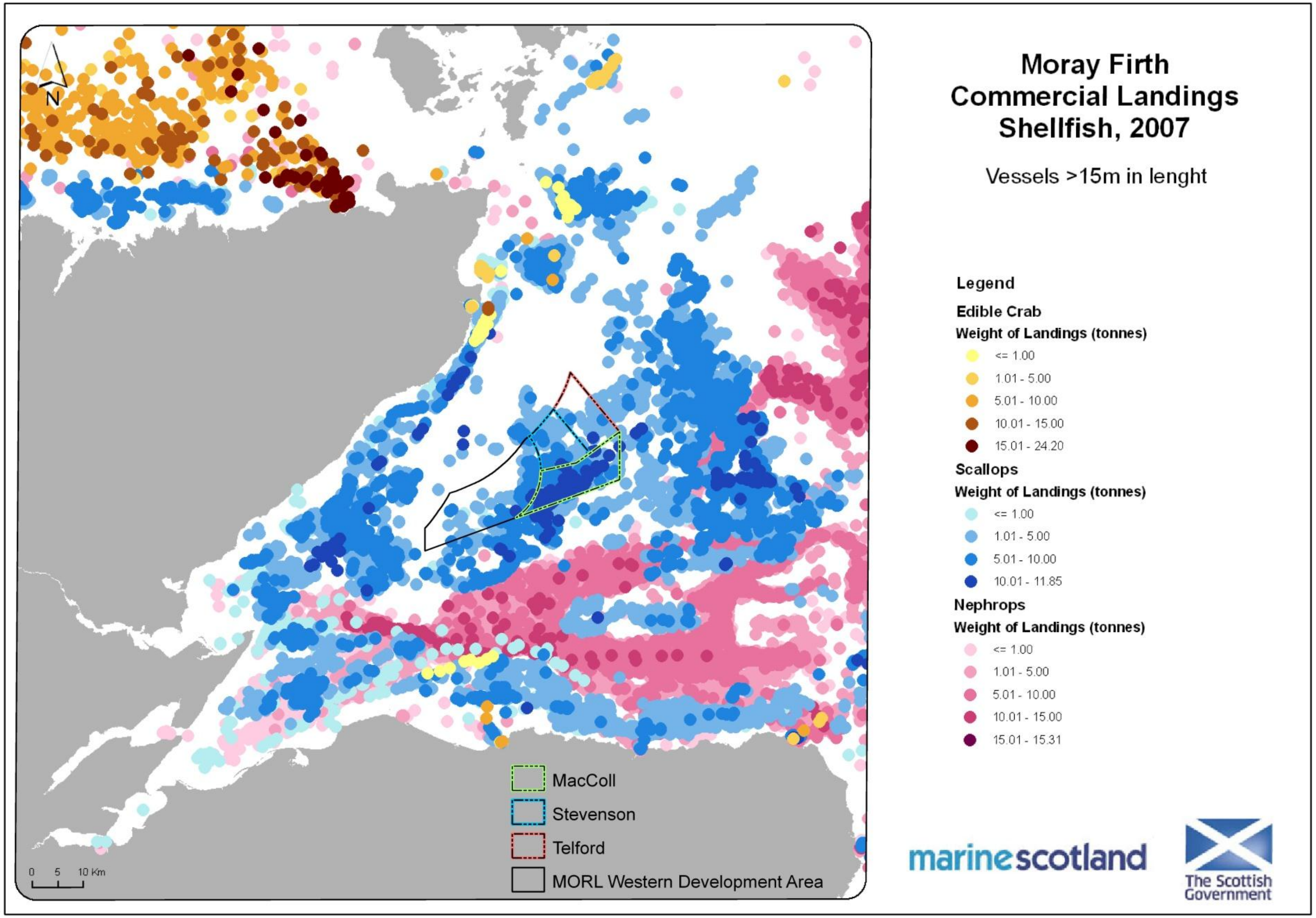

Figure 3.3 Commercial landings of shellfish (edible crab, scallops and *Nephrops*) for over-15 metre vessels in the Moray Firth, 2007 (Source: Marine Scotland)

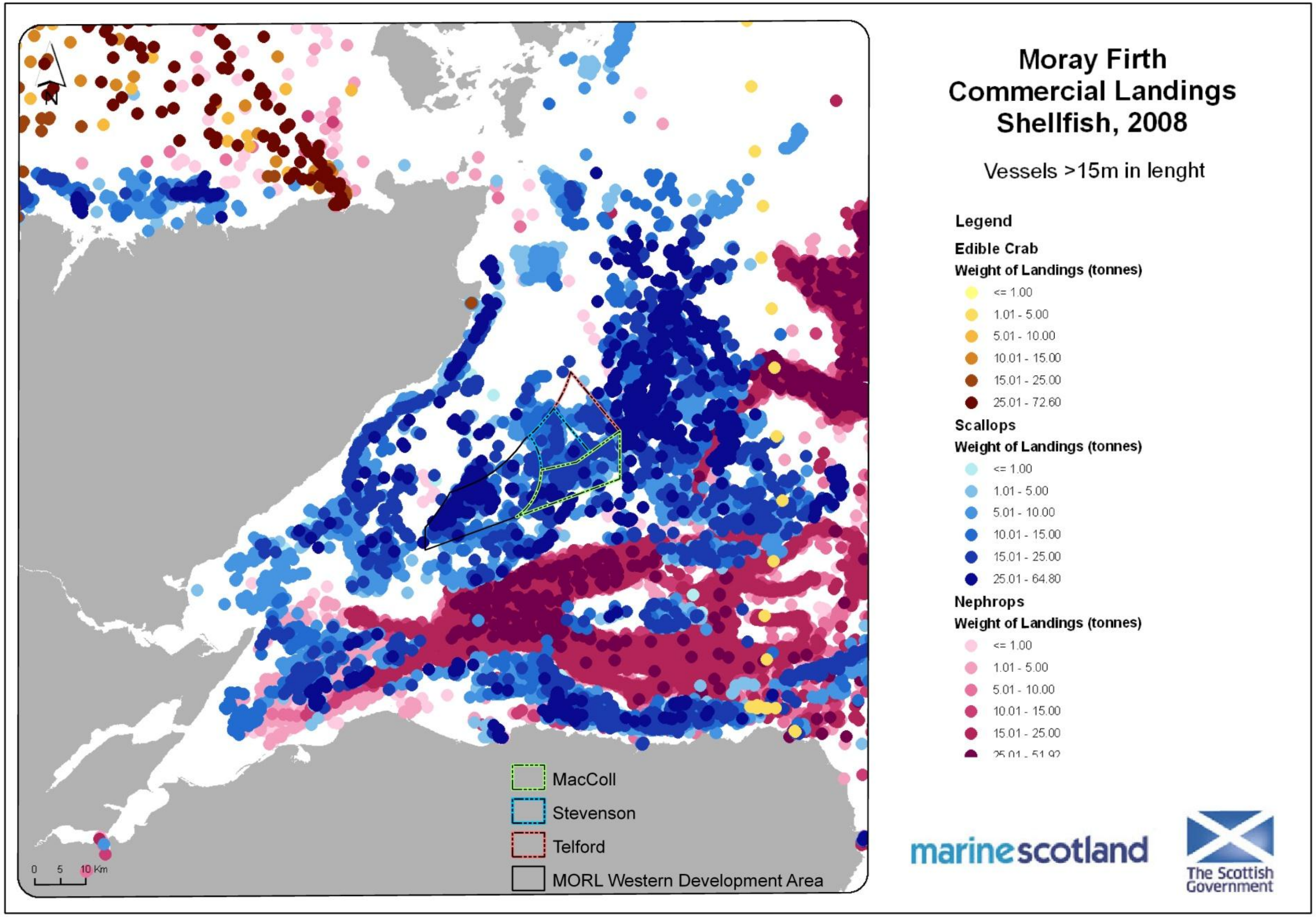

Figure 3.4 Commercial landings of shellfish (edible crab, scallops and *Nephrops*) for over-15 metre vessels in the Moray Firth, 2008 (Source: Marine Scotland)

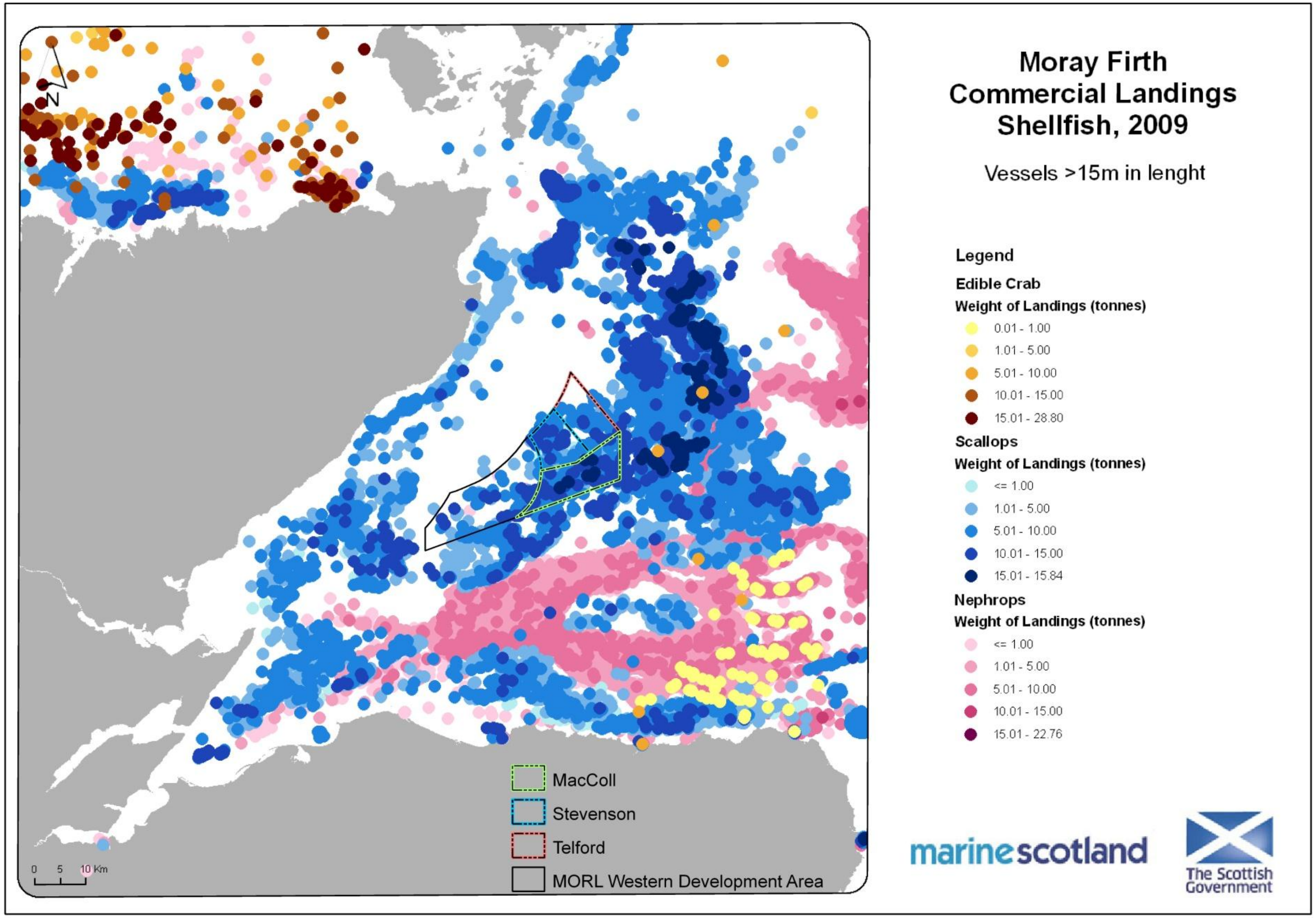

Figure 3.5 Commercial landings of shellfish (edible crab, scallops and Nephrops) for over-15 metre vessels in the Moray Firth, 2009 (Source: Marine Scotland)

3.2.1.2 Nephrops

In the local study area, *Nephrops* (*Nephrops norvegicus*) landings weight represents 15.5 % of shellfish landings and 9.5 % of the total. They are found at depths ranging from 15 m to more than 800 m. They are more commonly found in Scottish waters at a depth between 40 and 200 m (Howard 1989).

Nephrops distribution is dependent upon the availability of seabed habitats composed of fine cohesive mud in which they can construct burrows, although the precise nature of the sediment can vary markedly. Sediment type also appears to affect the structure of *Nephrops* populations, with areas of fine sediment being characterised by the presence of large *Nephrops* and low population densities, and areas of coarser sediment showing higher population densities and *Nephrops* smaller in size (Howard 1989).

Although an important fishery to the local area in terms of landings, the Moray Firth *Nephrops* fishery is on a much smaller scale compared to fisheries in the Minches and the Fladen Grounds (Southhall & Hambrey 2005). *Nephrops* in the Moray Firth, as suggested by landings statistics, are principally distributed in the southern area and eastern rectangles in muddy sand areas and not within the three proposed wind farm sites (Figure 3.1, Figure 3.2, Figure 3.3-Figure 3.5).

3.2.1.3 Squid

Squid account for 5.8 % of the total shellfish landings. A substantial proportion of Scottish squid landings (*Loligo forbesi*) come from the Moray Firth (Young *et al* 2006). The species is typically found on the continental shelf and offshore banks. Although spawning grounds have not yet been documented, it is very likely that the Moray Firth includes spawning grounds for this species (Young *et al* 2006). Fishermen have reported finding squid eggs off Burghead and Buckie in May and June in waters 5 to 6 m deep. Eggs have also been encountered on lobster creels shot on hard ground in the Moray Firth (Young *et al* 2006).

In Scottish waters spawning occurs over an extended period from December to June, with peak spawning reported from December to March (Lum-Kong *et al* 1992, Pierce *et al* 1994, Boyle *et al.* 1995, Collins *et al* 1997). The winter breeding cohort appears to spawn in inshore waters and some evidence suggests that the spawning grounds of the summer breeders are also inshore (Viana *et al* 2009). All individuals are semelparous and die after spawning (Rocha *et al* 2001). Recruitment of juvenile squid to the adult population has been reported to peak in spring (April) and in autumn (July to October) (Boyle *et al.* 1995, Viana *et al* 2009, Pierce *et al* 1994), the latter being the main recruitment period (Viana *et al* 2009).

The main Scottish fishery for *L. forbesi* occurs in coastal waters and usually exhibits a marked seasonal peak around October and November, corresponding to the occurrence of pre-breeding squid. In the Moray Firth, a directed fishery for squid has developed in late summer and autumn in coastal waters between Troup Head and Spey Bay in the south of the Moray Firth, with additional activity recorded on parts of the Smith Bank and along the north coast (pers. comm. squid fisherman, December 2010, Young *et al* 2006, Campbell & McLay 2007).

At the beginning of the season, catches are best in shallow water over hard (even rocky) ground close inshore, in depths of around 10 m. As the season progresses, the fishery gradually moves further offshore to a sandy/muddy bottom in waters of around 55 m depth (Young *et al* 2006).

It is noted that the squid fishery records highly variable annual fluctuations in landings weights (i.e.

4.9 tonnes in 2006 and 265.7 tonnes in 2009). Furthermore, the fishing may also vary seasonally, depending upon the arrival of the species in the Moray Firth. Anecdotal evidence suggests that in 2011 the fishery commenced in late May, several months in advance of previous years (Commercial Fisheries Report BMM 2011).

3.2.1.4 Crab

In the Moray Firth, crabs are mainly targeted in coastal waters located to the south and west of the site. Landings weights for edible crab and velvet crab are particularly high in inshore ICES rectangle 45E6 adjacent to the site, representing 26.3 % and 6.8 % of the landings. In the local study area (45E7) landings weights for these species are comparatively low, with edible crabs representing 0.2 % and velvet crabs less than 0.1 % of the total.

Edible crabs (*Cancer pagurus*) are found around the Scottish coast on the lower shore and shallow sub-littoral areas and in offshore waters at depths of up to 200 m (Mill *et al* 2009, Pawson 1995). They are often associated with rocky reefs but also inhabit mixed coarse grounds and soft sediments (muddy sand) particularly offshore (Hall 1993). Adult female crabs undertake seasonal inshore and offshore migrations of 20 to 70 km (Ungfors *et al* 2007, Jones *et al* 2010). A total of seven individuals were recorded in beam trawl samples in the benthic survey (EMU 2011).

Velvet crabs (*Necora puber*) are fast moving, swimming species which inhabit grounds from the intertidal areas down to about 80 m, but are most commonly found at depths of about 25 m (Norman & Jones 1992). They are typically found in areas of hard substratum where rocky reef and boulders provide crevices for shelter (Jessop *et al* 2007). Females are thought to move offshore during the winter (Norman & Jones 1993), however, long distance migrations such as those observed in edible crabs, have not been recorded for this species (Kinnear & Mason 1987).

3.2.1.5 Lobster

Lobster (*Homarus gammarus*) is found on rocky grounds from the intertidal zone to depths up to 200 m, although most commonly in waters less than 30 m (Pawson 1995, Mill *et al* 2009, Howard & Nunny 1983). Unlike edible crabs, lobsters are not thought to undertake extensive migrations and will only move a few miles along the shore (Pawson 1995, Smith *et al* 2001, Thomas 1955, Keltz & Balley 2010). Recent studies of the north east coast of England have however indicated seasonal offshore movements of berried females (Keltz & Balley 2010).

Lobsters are mainly targeted in coastal waters of the Moray Firth (Commercial Fisheries Report BMM 2011). Landings weights represent 2.9 % of the total in ICES rectangle 45E6, and less than 0.1% in the local study area (45E7).

3.2.1.6 Whelk

Whelk (*Buccinum undatum*) is found throughout the littoral zone. Landings weights within the regional study area are relatively high in ICES rectangle 45E6, representing 8.3 % of total landings weights, and comparatively low in the local study area (45E7), accounting for less than 0.1 % of total landings weights in this rectangle. This species was found (17 individuals) in beam trawl samples at 14 stations in the benthic survey (EMU 2011).

3.2.2 Fish

An indication of the principal commercial fish species in the local study area (45E7) is given in Table 3.4 based on the percentage distribution of landings weights by species for the period 2000-2009.

Table 3.4 Percentage distribution of the catch of fish species in the local area (45E7) (MMO landings data)

Species	Average (2000-2009) Landings Weight (t)	Percentage of Total Fish Landings Weight in the Local Study Area (45E7)	Percentage of Total Landings Weight (all fish and shellfish species combined) in the Local Study Area (45E7)
Haddock	280.6	65.2%	25.0%
Monks /Anglers	43.1	10.0%	3.8%
Herring	39.1	9.1%	3.5%
Whiting	16.4	3.8%	1.5%
Cod	12.4	2.9%	1.1%
Horse Mackerel	8.2	1.9%	0.7%
Megrim	7.3	1.7%	0.6%
Plaice	6.7	1.6%	0.6%
Witch	2.8	0.7%	0.3%
Spurdog	2.3	0.5%	0.2%
Hake	2.0	0.5%	0.2%
Skates and Rays	1.8	0.4%	0.2%
Ling	1.8	0.4%	0.2%
Lemon Sole	1.6	0.4%	0.1%
Saithe	1.4	0.3%	0.1%
Other	3.2	0.8%	0.3%

Haddock accounts for the majority of fish landings by weight in the local study area (65.2 %) followed by monks (10 %), herring (9.1 %) and whiting (3.8 %) with cod, horse mackerel, megrim and plaice being landed to a lesser extent. The remaining 31 species account together for only 4.7 % of the total average fish weight landings in ICES rectangle 45E7.

Spurdog is the most prevalent elasmobranch species accounting for 0.2 % of total landings weights from the local study area, followed by “skates and rays” (0.2 %). “Dogfish and sharks” are relatively scarce in the landings weights and are included under the category “other”.

3.2.2.1 Demersal Species

Haddock

Immature and adult haddock (*Melanogrammus aeglefinus*) are found in northerly areas of the North Sea (Hedger *et al* 2004). Shoals are typically found in colder waters at depths from 40 to 300 m, over rock, sand, gravel or shells (ICES 2011b, FAO 2011). Haddock shoals show a preference for depths between 75 and 125 m, bottom temperatures greater than 6° C and salinities greater than 35.5 ppt (Hedger *et al* 2004).

Haddock is the second most important species landed by weight in ICES rectangle 45E7, accounting for 65.2 % of total fish landings weights and 25.0 % of the total in this rectangle (Table 3.4). Haddock landings are recorded at relatively low levels in the south of the Moray Firth in an area which broadly corresponds to *Nephrops* fishing grounds. This species is targeted by a local whitefish fishery that operates on grounds at depths greater than 45 m to the north of the three proposed wind farm sites (Commercial Fisheries Report BMM 2011). This species was recorded in beam trawl samples in the benthic survey (5 individuals) (EMU 2011).

Monks

Monkfish (*Lophius piscatorius, Lophius budegassa*), also called anglerfish, occur in shallow waters to depths of approximately 1000 m on muddy/gravelly bottoms of the continental shelf (CEFAS 2011). *L. piscatorious* is usually caught at depths between 20 and 150 m, whereas *L. budegassa* occurs mostly at depths greater than 100 m. Spawning takes place largely in deep waters, from February to August, off the edge of the continental shelf and recruitment occurs in relatively inshore areas such as the Moray Firth and along the Norwegian coast in the northern North Sea (ICES 2009c, Pawson 1995).

This species constitutes 3.8 % of total landings by weight and 6.7 % of the total landings by value in ICES rectangle 45E7 (Table 3.4, Commercial Fisheries Report BMM 2011). Two individuals of *L. piscatorius* were recorded in beam trawl samples in the benthic survey (EMU 2011).

Whiting

Whiting (*Merlangius merlangus*) is widely distributed throughout the North Sea, Skagerrak and Kattegat (ICES 2011b). The species is typically found near the seafloor in waters from 10 to 200 m, but may move into midwater in the pursuit of prey (ICES 2011b).

In the Moray Firth landings weights for this species are comparatively low. This species constitutes 3.8 % of total fish landings weights and 1.5 % of the total in ICES rectangle 45E7 (Table 3.4). One whiting was caught in beam trawl samples in the benthic survey (EMU 2011).

Cod

Cod (*Gadus morhua*) is found from shallow coastal waters to the shelf edge (200 m depth) and beyond with catches reported from depths of 600 m (ICES 2011b, Hedger *et al* 2004). Hedger *et al* (2004) found that the greatest abundances of mature cod were in depths less than 50 m or greater than 150 m (along the Norwegian Trench) over the entire temperature and salinity range of the North Sea. Cod in the Moray Firth is believed to be a sedentary residential population that provides year round site fidelity (Wright *et al* 2007).

Cod was historically commercially targeted in the Moray Firth. A series of quota reductions in the 1980s restricted the fishermen's ability to legally land cod, rendering the fishery presently unviable in the Moray Firth (Commercial Fisheries Report BMM 2011). Landings weights for this species are therefore relatively low, representing 2.9 % of total fish landings weights and 1.1 % of the total within ICES rectangle 45E7. Five cod were caught in beam trawl samples during the benthic survey (EMU 2011).

Megrim

Megrim (*Lepidorhombus whiffiagonis*) accounts for 1.7 % of total fish landings and for 0.7 % of the total landings weights in ICES rectangle 45E7.

Megrim are found mainly in muddy seabed habitats at around 100 to 300 m depths, but can occur at depths ranging from 50 to 800 m. Megrim show a gradual expansion in bathymetric distribution throughout their lifetimes. Mature males and juveniles tend to occupy deep waters, while mature females are found in shallower waters outside the spawning season (CEFAS 2009).

Plaice

Plaice (*Pleuronectes platessa*) are generally found in shallow waters less than 50 m deep. Juveniles are found in shallow coastal waters and outer estuaries. As they grow older they gradually move into deeper water (ICES, 2011b).

The results of a tagging study in the Central North Sea conducted by Hunter *et al* (2003) showed directed seasonal migrations of plaice from winter spawning grounds to summer feeding grounds 250 km to the north. The timing of the migration was considered to be synchronous and characterized by a 100 % spawning site fidelity.

Plaice accounts for 1.6 % of total fish landings and for 0.6 % of the total landings weights in ICES rectangle 45E7. Plaice were found in beam trawl samples in the benthic survey (a total of 74 individuals across 14 stations) (EMU 2011).

3.2.2.2 Pelagic Species

Herring

In ICES rectangle 45E7 herring (*Clupea harengus*) account for 9.1 % of total fish landings weights and for 3.5 % of the total. Herring is a migratory species targeted by a seasonal fishery. Adult herring migrate considerable distances in large shoals to feeding and spawning grounds (Munro *et al* 1998). Juvenile fish generally remain up to two years in nursery areas before joining adult fish on their migration.

Herring's migration is divided into three phases: The Over-wintering phase (O), the Feeding phase (F) and the Reproduction/Spawning phase (R). The distribution of different migration phases of North Sea herring is shown in Figure 3.6. They spawn off the Scottish and English east coast, migrate east to the Skagerrak and Kattegat where they overwinter and then move to the feeding grounds in the Fladen Grounds and Viking Bank before returning to the spawning grounds.

In the Moray Firth juveniles are present throughout the year, whilst adults are more prevalent during the spawning season. Herring's spawning behaviour and distribution and nursery areas, as well as its role in the North Sea's food-web are further discussed in Section 4.3 and Section 5.2 respectively.

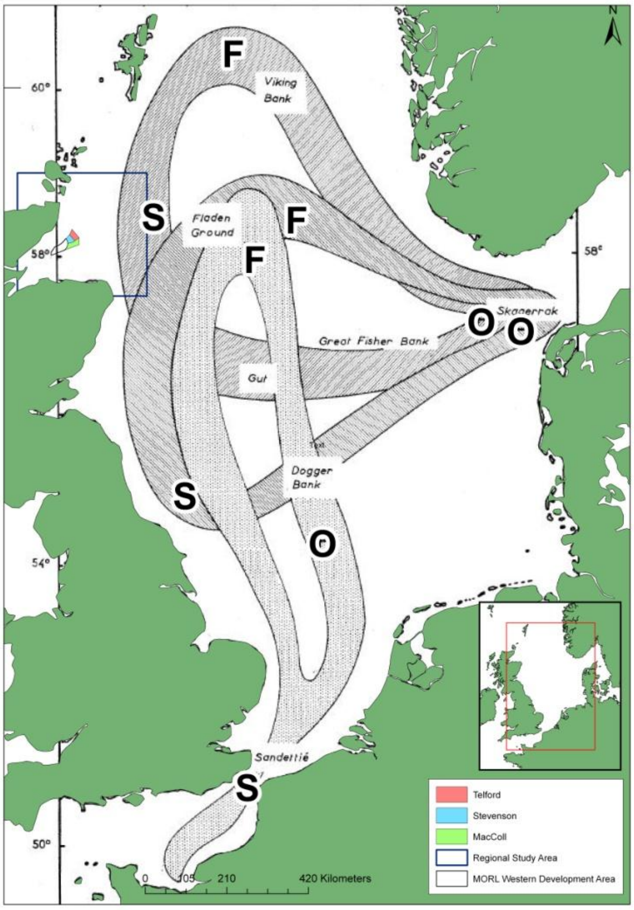

Figure 3.6 Herring migration routes in the North Sea, between (S) Spawning, (O) Over-Wintering and (F) Feeding grounds (Modified from Cushing & Bridger 1966, Maucorps 1969)

Horse Mackerel

Horse Mackerel (*Trachurus trachurus*) account for 1.9 % of total fish landings weights and for 0.7 % of the total in the ICES rectangle 45E7.

Adult horse mackerel are widespread in the North Sea, whilst juvenile fish are absent from the northern part of the North Sea (Teal *et al* 2009). Horse mackerel form large shoals that remain close to the bottom during the day. During the night they rise a few metres off the seabed and then gradually disperse laterally to merge with neighbouring shoals to form a continuous layer (Lockwood & Johnson 1977). The species typically occupies continental shelf areas, and has been reported at depths between 180 and 250 m (Lockwood & Johnson 1977).

In autumn, as temperatures fall below ca. 10°C, fish retreat from feeding areas in the North Sea and migrate to over-wintering areas further south in the English Channel and along the continental slope in the Bay of Biscay and Celtic Sea. In spring, spawning commences and the shoals begin to disperse and migrate northward again with increasing water temperature (Lockwood & Johnson 1977).

Sprat

Sprat (*Sprattus sprattus*) does not appear in the MMO landings data from the regional area (Table 3.1). This is likely due to the closure of its fishery in the inner waters of the Moray Firth west of longitude 3°00’ W, which was implemented in order to protect juvenile herring from exploitation. This restriction has been active since 1998 (ref EC 850/98).

Sprat is widely distributed in the North Sea being most abundant in the Dogger Bank and the Kattegat (ICES 2011b). They largely stay within the 50 m depth contour and are also common in inshore waters (ICES 2011b). Fish migrate inshore during the winter months in the North Sea and secondary concentrations are found in the Firth of Forth and in the Moray Firth (Wright & Begg 1997, ICES 2011b).

3.2.2.3 Sharks and Rays (Elasmobranchs)

The principal elasmobranch species present in the local area, based on records from landings data (2000-2009), are listed in Table 3.5 below.

Spurdog is the principal elasmobranch species landed, followed by "skates and rays", "unidentified dogfish" and "sharks". Elasmobranchs account for a very small percentage of the total catch in the Moray Firth, and are generally landed as by-catch.

Table 3.5 Percentage distribution of the catch of elasmobranch species in the local area (45E7) (MMO landings data)

Species	Average (2000-2009) Landings Weight (t)	Percentage of Total Elasmobranch Landings Weight in the Local Study Area (45E7)	Percentage of Total Landings Weight (all fish and shellfish species combined) in the Local Study Area (45E7)
Spurdog	2.3%	54.6%	0.2%
Skates and Rays	1.8%	42.5%	0.2%
Unidentified Dogfish	0.1%	2.2%	< 0.1%
Sharks	< 0.1%	0.6%	< 0.1%

Cuckoo ray, *Leucoraja naevus,* was the only elasmobranch species found in beam trawl samples in the benthic survey (three individuals across three stations) (EMU 2011).

It should be noted that the majority of elasmobranch species are of concern from a conservation point of view as stocks have been severely depleted. The conservation status and state of the stocks of the principal shark and ray species potentially present in areas relevant to the site is further discussed in Section 6.0.

3.2.2.4 Other Species

In addition to the above, a number of other commercial species are likely to be present in the local study area as identified by MMO landings data (Table 3.1, Table 3.2). Demersal species include brill, catfish, conger eel, dab, long rough dab, gurnards, hake, halibut, Greenland halibut, megrim, pollak, red mullet, redfish, saithe, tusk, turbot and witch. Pelagic species include mackerel, greater silver smelt and black scabbardfish. Mackerel, saithe, ling and hake are known to use the general area of the Eastern Development Area as a nursery ground (see Figure 4.15).

A number of other commercial fish and shellfish species were recorded in beam trawl samples from the benthic survey including John Dory (also recorded in low numbers in the landings data). For a full species list of fish and shellfish species found in the site during the beam trawl survey (including non-commercial species) see the Benthic Ecology Technical Report.

4.0 Species with Spawning and Nursery Grounds

The three proposed wind farm sites fall within, and are in close proximity to, the spawning and nursery grounds of a number of species (Coull *et al* 1998, Ellis *et al* 2010a). These are listed in Table 4.1 below, together with their spawning times and intensity of spawning (where it has been defined). The spawning times are given as provided in Coull *et al* (1998) and the spawning/nursery intensity as described in Ellis *et al* (2010a).

Sandeel, *Nephrops*, cod, plaice, lemon sole, sprat and whiting spawning grounds have all been defined within the area of the three proposed wind farm sites. In the case of herring, the sites do not fall within the spawning grounds but in their vicinity (to a distance of approx. 5.5 km at the closest point).

Table 4.1 Species with spawning and nursery areas within the three proposed wind farm sites and their vicinity, together with spawning times and intensity (Coull *et al* 1998, Ellis *et al* 2010a).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Nursery
Sandeel													
Nephrops				*	*	*							
Herring													
Cod		*	*										
Plaice	*	*											
Lemon Sole													
Sprat					*	*							
Whiting													
Spurdog	n/a												
Thornback Ray	n/a												
Spotted Ray	n/a												
Blue Whiting	n/a												
Ling	n/a												
Hake	n/a												
Anglerfish	n/a												
Mackerel	n/a												
Haddock	n/a												
Saithe	n/a												

Colour key: (red) = high intensity spawning/nursery ground, (yellow) = low intensity spawning/nursery ground, (green) = unknown spawning/nursery intensity, (*) = peak spawning

A review of spawning activity by species with known spawning and nursery grounds in the general area of the site is given below. Where alternative grounds to those provided in Coull *et al* (1998) and Ellis *et al* (2010a) and/or additional information in relation to spawning in the Moray Firth has been published, this has also been included.

4.1 Sandeels

The North Sea sandeel stock has been divided into seven sub-stocks which are reproductively isolated from each other (ICES 2009). The sandeel population of the Moray Firth is part of the Central Western North Sea sandeel sub-stock (ICES 2009).

Sandeels spend most of the year buried in the sea bed and only emerge into the water column briefly in winter for spawning and for an extended feeding period in spring and summer (Van der Kooij *et al* 2008). Spawning principally takes place in December and January (Gauld & Hutcheon 1990, Bergstad *et al* 2001, Winslade 1974b). Females lay demersal eggs and after several weeks planktonic larvae hatch, usually in February-March (Macer 1965, Langham 1971, Wright & Bailey 1996). After spawning sandeels remain buried in sand until April (Winslade 1974b).

The local study area has been identified as a high intensity spawning ground and a low intensity nursery ground for sandeels (Ellis *et al* 2010a). Spawning grounds are shown in Figure 4.1 together with the results of recent egg and larval surveys, as presented in Ellis *et al* (2010a). In addition, Figure 4.1 shows the extent of sandeel nursery grounds and juvenile catch rates recorded in groundfish surveys (Ellis *et al* 2010a).

As previously mentioned, sandeels require a suitable substrate in which to bury themselves. It is therefore expected that sandeels' distribution and spawning grounds will occupy discrete patchy areas rather than be continuous throughout the Moray Firth and the three proposed wind farm sites. This is further discussed in Section 5.1.

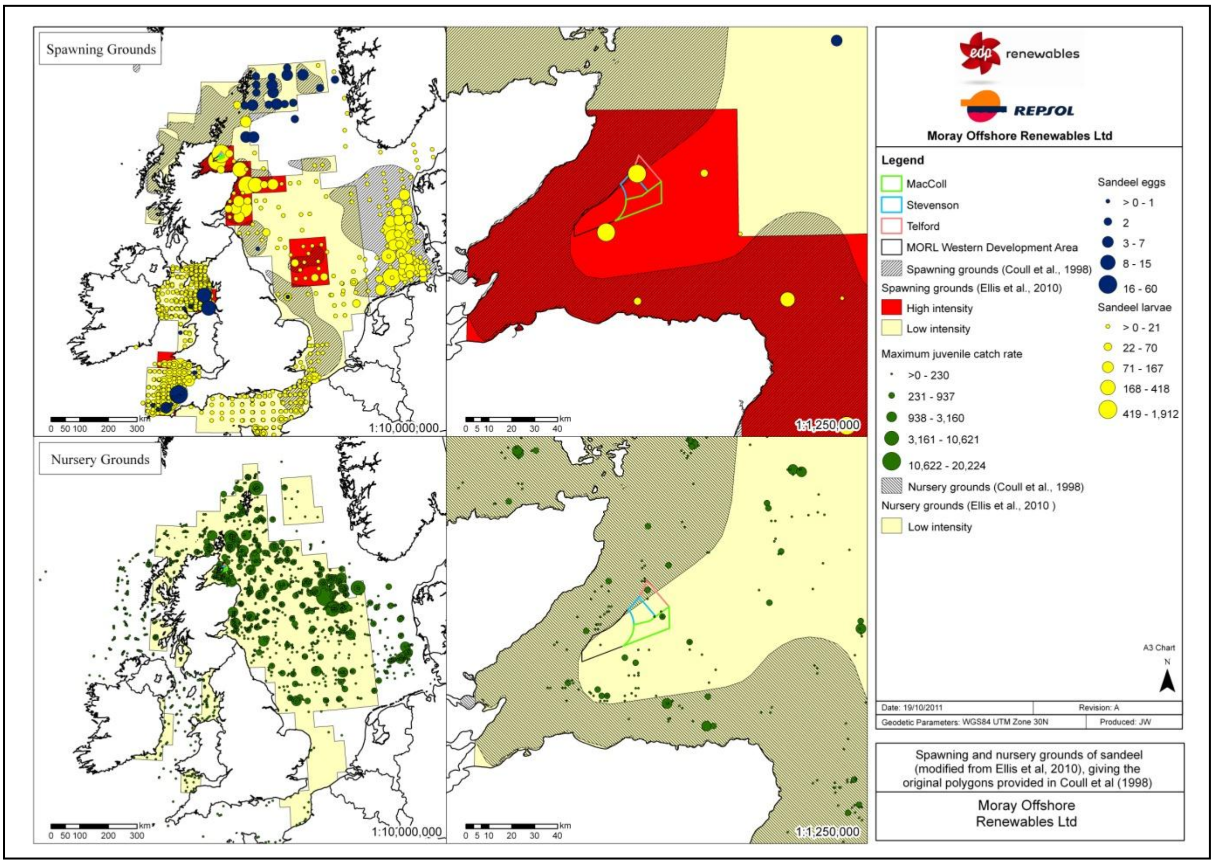

Figure 4.1 Sandeel spawning and nursery grounds (Modified from Ellis et al 2010a)

4.2 Nephrops

Nephrops spend most of their time in burrows, only coming out to feed and look for a mate (Keltz & Bailey 2010). In Scottish waters, spawning occurs from August to November (Keltz & Bailey 2010, Howard 1989).

Females carry eggs under their tails (described as being "berried") until they hatch from late April to August (Howard 1989). The egg-berried females stay in their burrows during egg incubation (Howard 1989). Larvae develop in the plankton before settling to the seabed six to eight weeks later as juveniles (Keltz & Bailey 2010). The juveniles enter the burrows of adults and remain there for approximately one year (Howard 1989).

The three proposed wind farm sites fall within the *Nephrops* spawning and nursery grounds defined by Coull *et al* (1998) (Figure 4.2). However, given the substrate requirements of this species, it is unlikely that spawning will occur throughout the area defined. As previously mentioned in Section 3.1, areas of muddy sand and sandy mud are located to the south, and to a lesser extent to the east, of the site. It is therefore likely that there will not be significant *Nephrops* spawning within the development area.

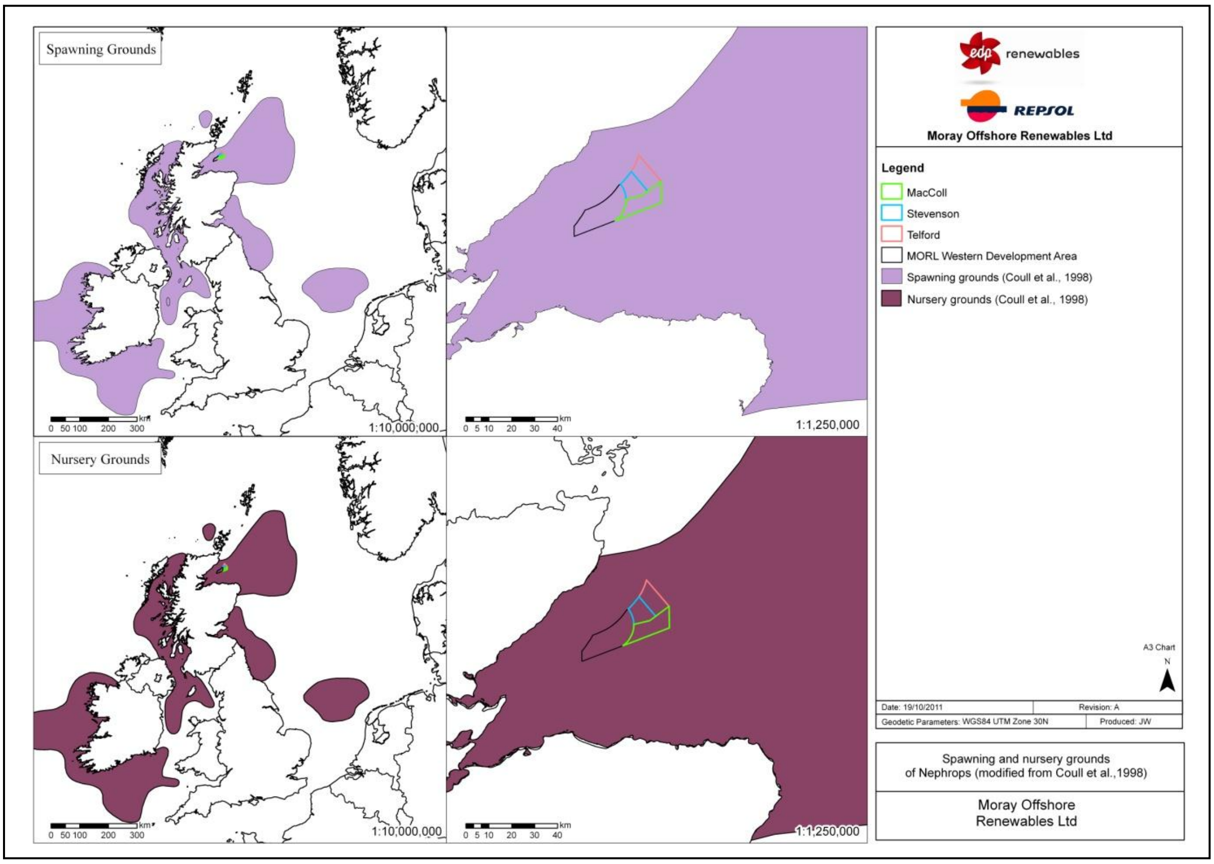

Figure 4.2 *Nephrops* spawning and nursery grounds (Modified from Coull *et al* 1998)

4.3 Herring

North Sea herring is divided into four sub-stocks on the basis of areas used for spawning. The spatial limits of these sub-stocks are shown in Figure 4.3. The sub-stock relevant to the three proposed wind farm sites is the Orkney/Shetland stock, which spawns off the Scottish east coast and in Shetland/Orkney waters.

Herring are demersal spawners and show a high preference for coarse grounds and high energy environments when selecting spawning grounds (Keltz & Bailey 2010, de Groot 1980, Maucorps 1969, Munro *et al* 1998, Parrish *et al* 1959, Blaxter 1985). Females deposit sticky eggs in single batches directly onto the seabed in areas of coarse sand, gravel, small stones or rocks (Keltz & Bailey 2010, Munro *et al* 1998, Hodgson 1957).

Spawning of the Shetland-Orkney sub-stock occurs between August and September (Coull *et al* 1998) and shoals of herring arrive at traditional spawning grounds in a series of waves, where they congregate (Lambert 1987). It has been suggested that herring are able to discriminate sources of sound emitted by various sediment types, each being characterized by its own specific noise spectrum. Herring would in this way be able to use the sound characteristics of the seabed as a clue to recognise their spawning sites in addition to homing (Enger 1967).

Herring larvae hatch after approximately three weeks, depending on sea temperature (Keltz & Bailey 2010, Maucorps 1969, Munro *et al* 1998, Hodgson 1957). Hatched larvae measure between 6 and 10 mm and depend on their yolk-sac until first feeding (Hodgson 1957). Once this has been absorbed larvae become pelagic and feed on plankton. They are then passively carried by prevailing currents before arriving at nursery grounds (Keltz & Bailey 2010, Maucorps 1969, Munro *et al* 1998, Hodgson 1957).

Herring larvae from the Orkney/Shetland stock drift south into nursery grounds in the Moray Firth and east into nursery grounds in the Skagerrak and Kattegat. Herring larvae of the Buchan stock drift south into nursery grounds in the Firth of Forth and east to Skagerrak and Kattegat nursery grounds. Heath *et al* (1989) found that herring larvae from a spawning site at Clythness in the Moray Firth drifted from the spawning grounds at a rate of 1-2 km/day.

4.3.1 Spawning Grounds and Larval Distribution

Herring spawning grounds as presented in Ellis *et al* (2010a), including larval densities recorded in the 2008 International Herring Larvae Survey (IHLS) and the grounds as defined in Coull *et al* (1998) are given in Figure 4.3.

In addition, Figure 4.3 shows the extent of herring nursery grounds, together with juvenile catch rates recorded in groundfish surveys (Ellis *et al* 2010a).

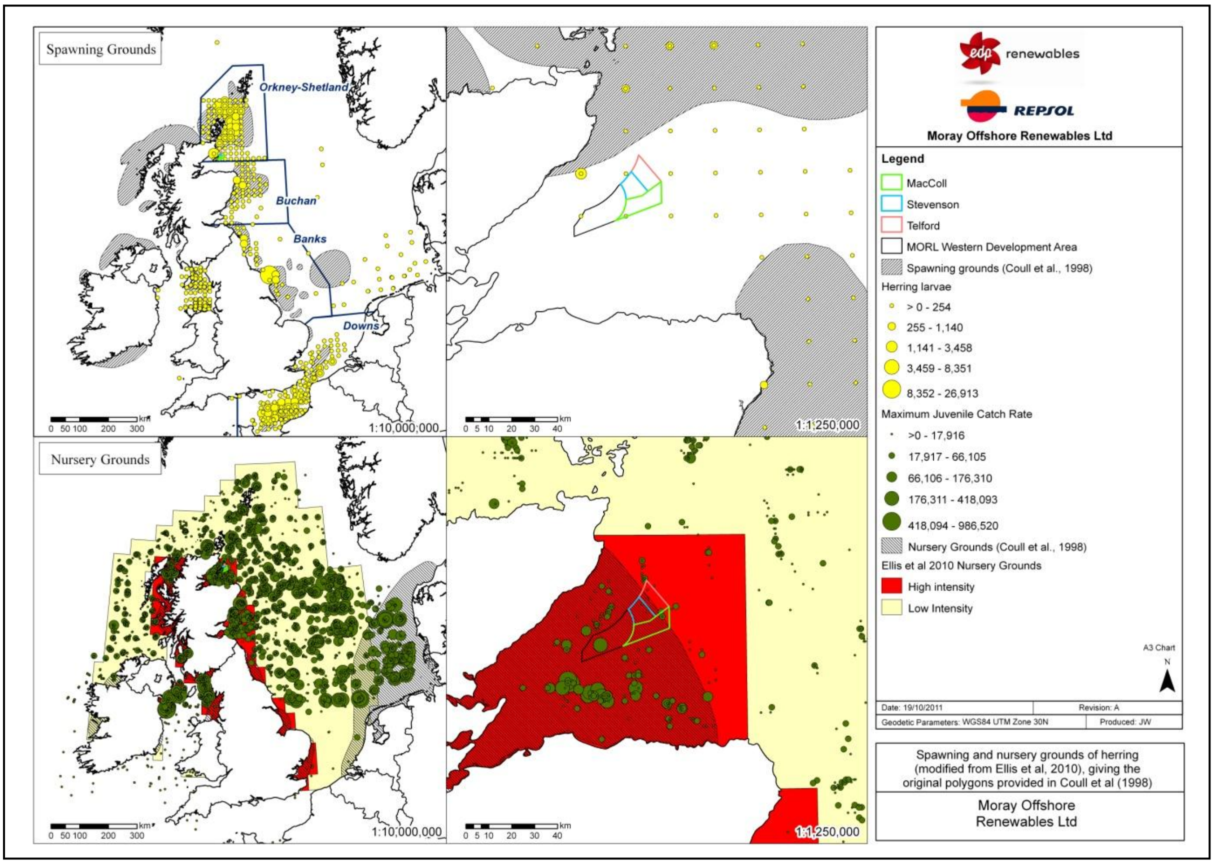

Figure 4.3 Herring spawning and nursery grounds (Modified from Ellis *et al* 2010a)

Herring spawning grounds as defined by Coull *et al* (1998) are located at approx. 5.5 km from Telford. Alternative publications however suggest that the development site is adjacent to defined herring spawning grounds (e.g. Payne 2010). In addition, the development site falls within high intensity nursery grounds as defined by Ellis *et al* (2010a) (Figure 4.3). It should be noted that given the substrate requirements of spawning herring it is very unlikely that the whole area defined in Coull *et al* (1998) will be used for spawning.

The definition of herring spawning grounds is principally based on the results of the IHLS, which has been undertaken since 1972. A time series of larval densities of the Orkney-Shetland stock based on data from the IHLS (MSS 2011a) is provided in Figure 4.4 and Figure 4.5. These show newly hatched larvae (< 10 mm) densities from 1973-1994 (1-15 September) and from 1973 to 2004 (16-30 September), respectively. The distribution of larval densities in recent years (2005, 2006, 2008, 2009) is illustrated in Figure 4.6, as provided in Rohlf & Gröger (2006, 2009, 2010) and Schmidt *et al* (2007, 2008).

Spawning intensity in areas relevant to the site and in the wider area varies considerably depending on the year under consideration. From the time series provided below it appears that spawning activity in the vicinity of the Eastern Development site tends to be concentrated in coastal areas off Caithness. Spawning activity in this area is however comparatively lower than that recorded between the Orkney and Shetlands, where the bulk of spawning appears to take place in most years.

It should be noted that not all stations are sampled each year during the IHLS survey and therefore the lack of larvae in some locations for a particular year does not necessarily imply that spawning did not occur.

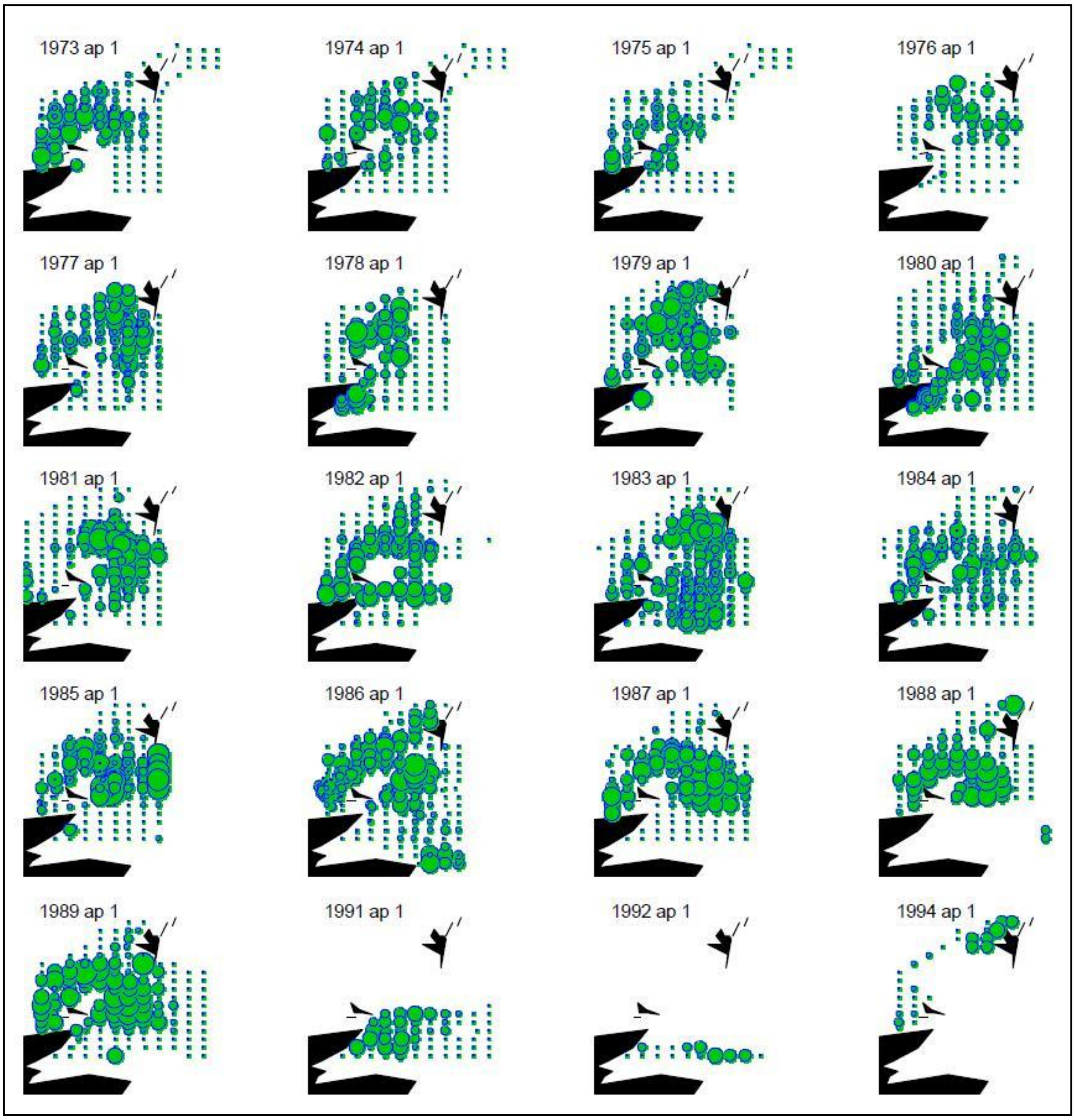

Figure 4.4 International Herring Larvae Surveys charts (1973-1994) of the Orkney/Shetland stock for the period 1 (1-15 September) (Source: MSS 2011a)

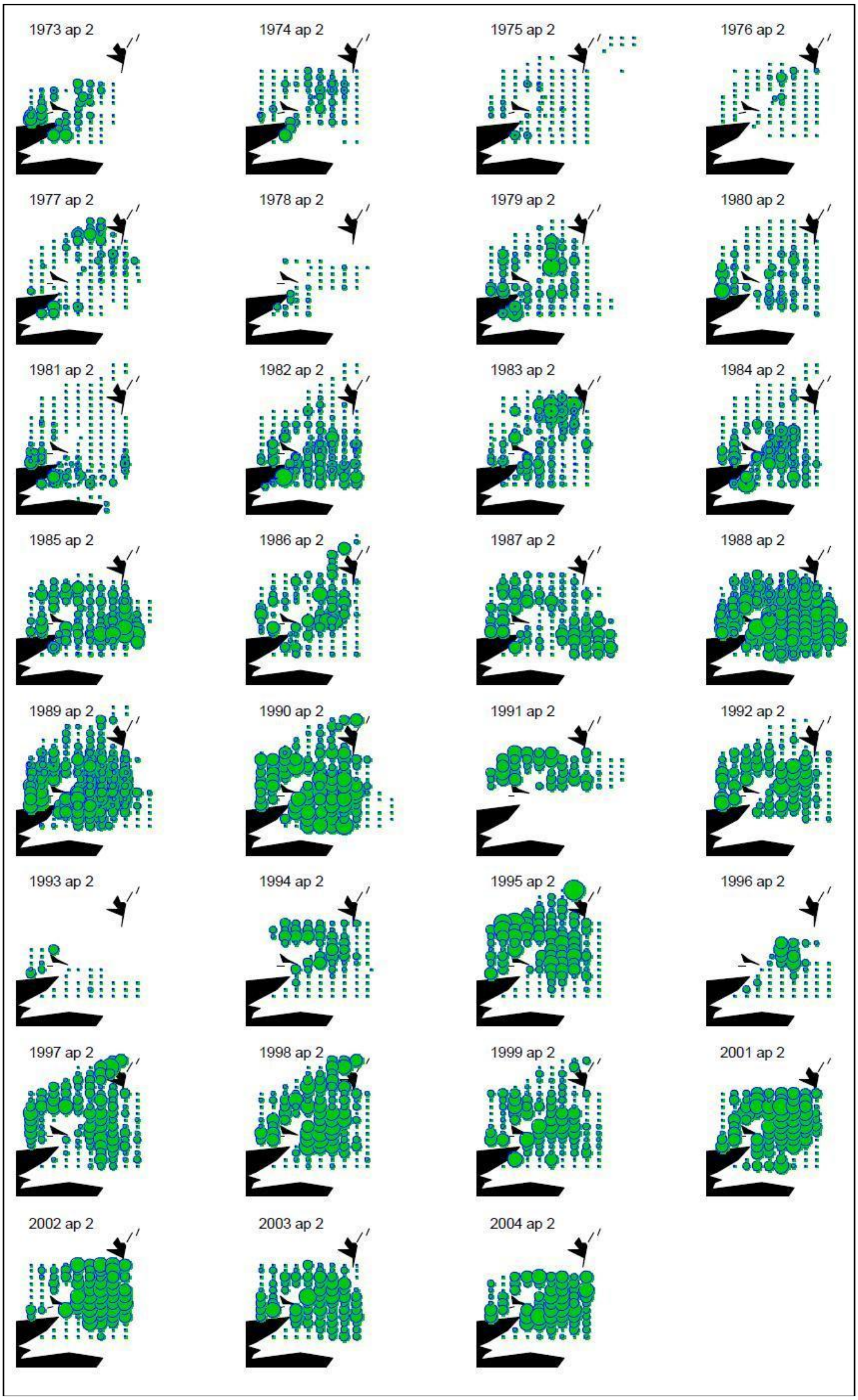

Figure 4.5 International Herring Larvae Surveys charts (1973-2004) of the Orkney/Shetland stock for the period 2 (16-30 September) (Source: MSS 2011a).

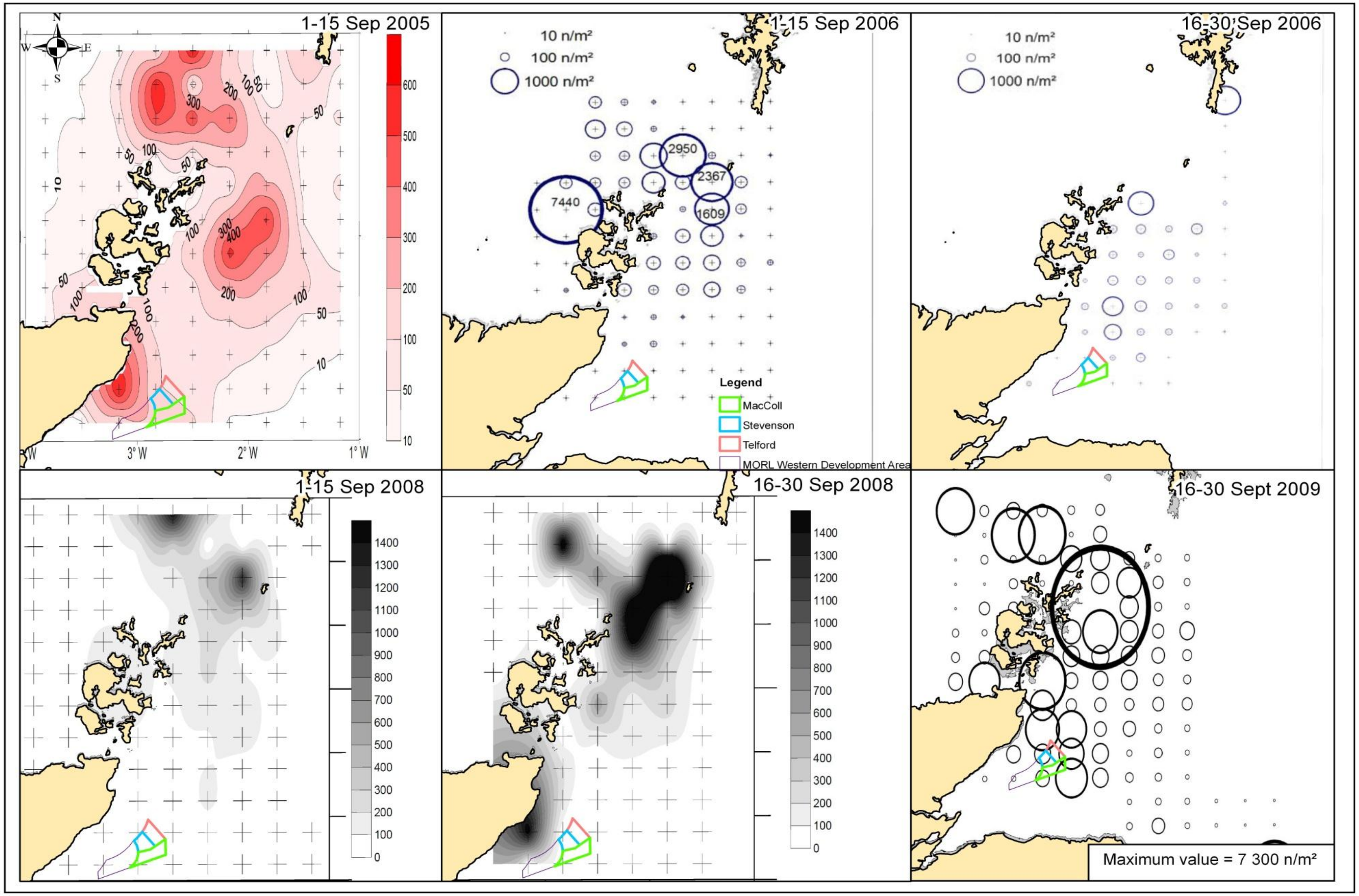

Figure 4.6 International Herring Larval Surveys charts (2005, 2006, 2008, 2009) of the Orkney/Shetland stock (Rohlf & Gröger 2006, 2009, 2010; Schmidt *et al* 2007, 2008)

4.3.2 Spawning Substrate Suitability

As previously mentioned herring show a high preference for coarse sediments and high energy environments when selecting spawning grounds. Areas characterised by a high proportion of coarse sands and gravels are therefore more likely to constitute a suitable herring spawning ground than those with a high proportion of silts and fine sands.

An indication of the suitability of the three proposed wind farm sites as spawning grounds for herring, based on the distribution of sediment classes from grab samples (EMU 2010) and the BGS seabed sediment data, is given in Figure 4.7 below. Grab samples recorded relatively high percentages of coarse sand and gravel in a number of areas within the site, and areas of sandy gravel and gravelly sand have been defined by the BGS in the eastern and southern section of the site. Both data sources suggest that there is potential for the site to support spawning herring on the basis of sediment type.

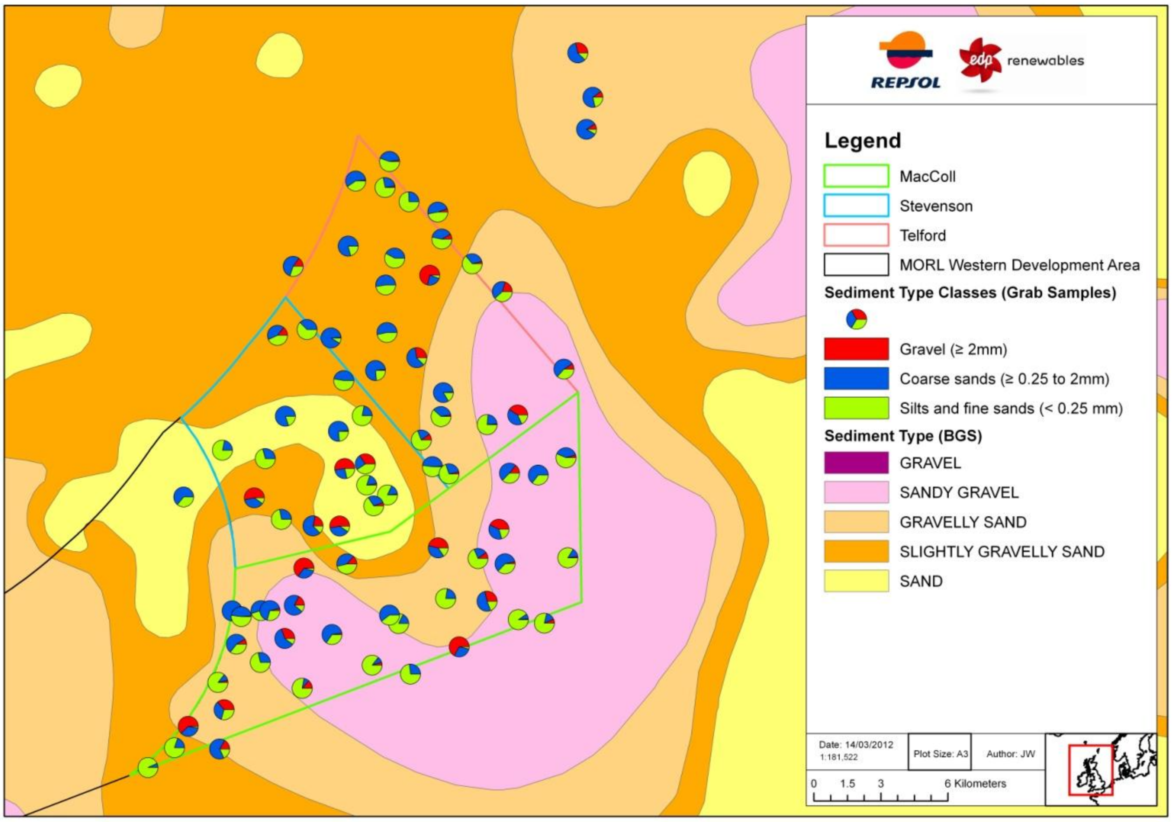

Figure 4.7 Sediment type distribution within the three proposed wind farm sites derived from grab samples (EMU 2010)

4.4 Cod

The cod population of the Moray Firth has been found to be genetically distinct from other North Sea populations (Hutchinson *et al* 2001). Cod spawn between January and April, with peak spawning taking place from February to March mainly in the evening and during the night (ICES 2005a, Coull *et al* 1998). Eggs are pelagic and hatch over a period of two to three weeks, depending on water temperature (Wright *et al* 2003). Male cod are known to produce a drumming sound during the spawning season (Nordeide & Kjellsby 1999, Fudge and Rose 2009) and it has been suggested that the sounds are used to defend territories and attract females during spawning (Brawn 1961).

The three proposed wind farm sites fall within a cod spawning area as defined in Coull *et al* (1998) and a low intensity spawning area as defined in Ellis *et al* (2010a). In addition, the Moray Firth has been defined as a high intensity nursery ground for cod. The extent of cod spawning and nursery grounds is shown in Figure 4.8, together with larvae and eggs densities recorded in recent surveys and juvenile catch rates recorded in groundfish surveys (Ellis *et al* 2010a).

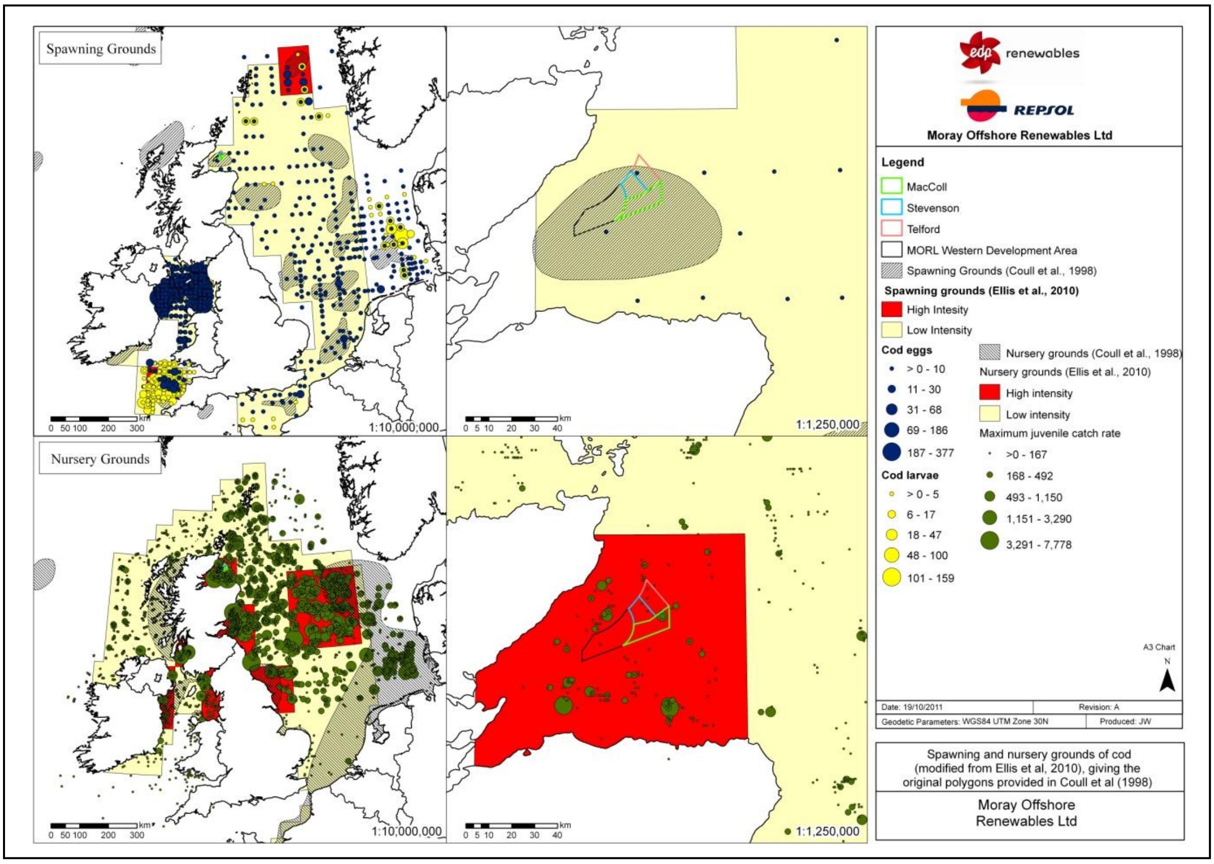

Figure 4.8 Cod spawning and nursery grounds (Modified from Ellis *et al* 2010a)

In the North Sea Egg Survey (2004), significant numbers of eggs were found off the Moray Firth and to the east of the Shetland Islands (Fox *et al* 2008). It has been suggested that passive transport of early life history stages could lead to a substantial advection of cod eggs and larvae from Shetland south to the Scottish east coast (Heath & Gallego 1997). Little cod spawning activity was observed in a "spawning area survey" carried out in March 2008 by the Fisheries Research Services (FRS) in the Moray Firth, during which relatively low numbers of running females were caught (Gibb *et al* 2008).

In 2002, the University of Aberdeen consulted 25 fishermen on the location and timing of cod spawning. Fishermen reported that significant aggregations of spawning fish were found to the east of Shetland. In addition, they identified the north east coast of Scotland between Fraserburgh and Banff (located within ICES rectangle 44E7) as a traditional cod spawning area, but one which is no longer used by the species. They commented that the stock in this area had been fished out in the early 1990s by seine netters and had not recovered since (Gibb *et al* 2008).

Gibb *et al* (2007) mapped the density distribution of 0-group cod in the North Sea and west coast of Scotland, in 2001 and 2002 to 2004. The combined survey data shows that, whilst 0-group cod occur over much of the studied region, the majority are confined to a few small coastal areas and overall densities are scarce, with median densities around 10 cod km^{-2}. High densities of more than 100 cod km^{-2} were only found within the Moray Firth, the Clyde and isolated sites off Mull in the Minch, west of Scotland, Shetland and St Andrews Bay, east of Scotland. In general terms sheltered areas (especially around Shetland) were found to have high juvenile abundance in comparison to exposed coastlines.

4.5 Plaice

The southern section of MacColl partly overlaps with the spawning grounds of plaice as defined by Coull *et al* (1998). The development site and its surroundings have been identified by Ellis *et al* (2010a) as a low intensity spawning and nursery ground (Figure 4.9).

The distribution of spawning grounds is shown in Figure 4.9 together with larvae and egg densities including those recorded during the 2004 North Sea Egg survey, as provided in Ellis *et al* (2010a).

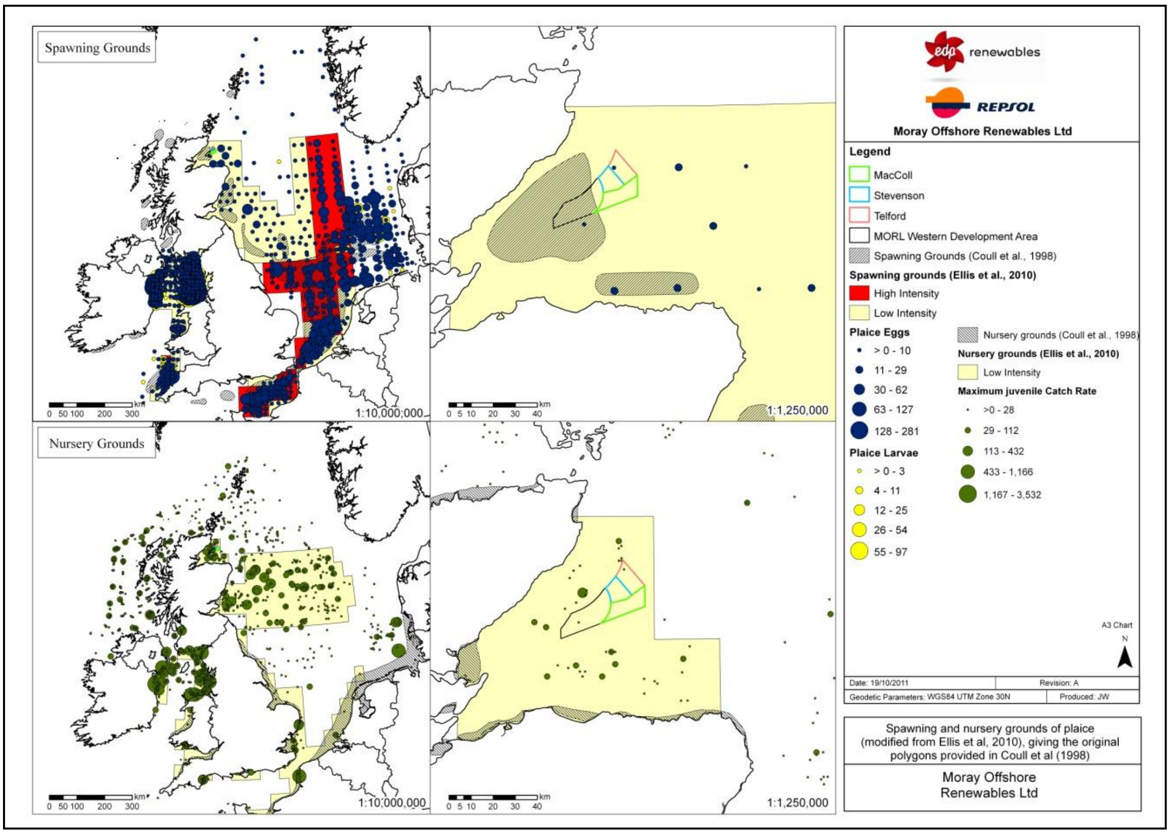

Figure 4.9 Plaice spawning and nursery grounds (Modified from Ellis *et al* 2010a)

Spawning takes place between December and March with peak spawning occurring in February/March (Rijnsdorp 1989, Simpson 1959, Harding *et al* 1978). During spawning pelagic eggs are released in batches (Rijnsdorp 1989, Armstrong *et al* 2001, Murua & Saborido-Rey 2003). Plaice rarely spawn beyond the 50 m depth contour (Harding *et al* 1978). Females spawn over a period of four to six weeks (Rijnsdorp 1989). Eggs hatch into pelagic larvae between seven to 21 days depending on temperature (Fox *et al* 2003).

The results of the North Sea Egg survey (2004) showed that plaice eggs north of the Dogger Bank were scarce except for isolated patches off Flamborough Head, off the Firth of Forth, the Moray

Firth and to the east of the Shetland Isles (ICES 2005b). Concerns have been raised, however, that the timing of the more northerly cruises may have been a little late to capture the peak of plaice egg production (ICES 2005b). Assuming spawning is relatively continuous, the centres of density of stage I eggs should be close to the sites of spawning although up to three days drift and dispersion may have occurred (ICES 2005b).

4.6 Lemon sole

The site lies within lemon sole (*Microstomus kitt*) spawning grounds defined by Coull *et al* (1998) (Figure 4.10). This species is widely distributed throughout the North Sea and is thought to spawn wherever it is found (Rogers & Stocks 2001). Spawning occurs from April until September (Coull *et al* 1998). In addition to spawning grounds, nursery grounds have also been identified by Coull *et al* (1998) in the area of the three proposed wind farm sites (Figure 4.10).This species was recorded (29 individuals) in beam trawl samples during the benthic survey (EMU 2011).

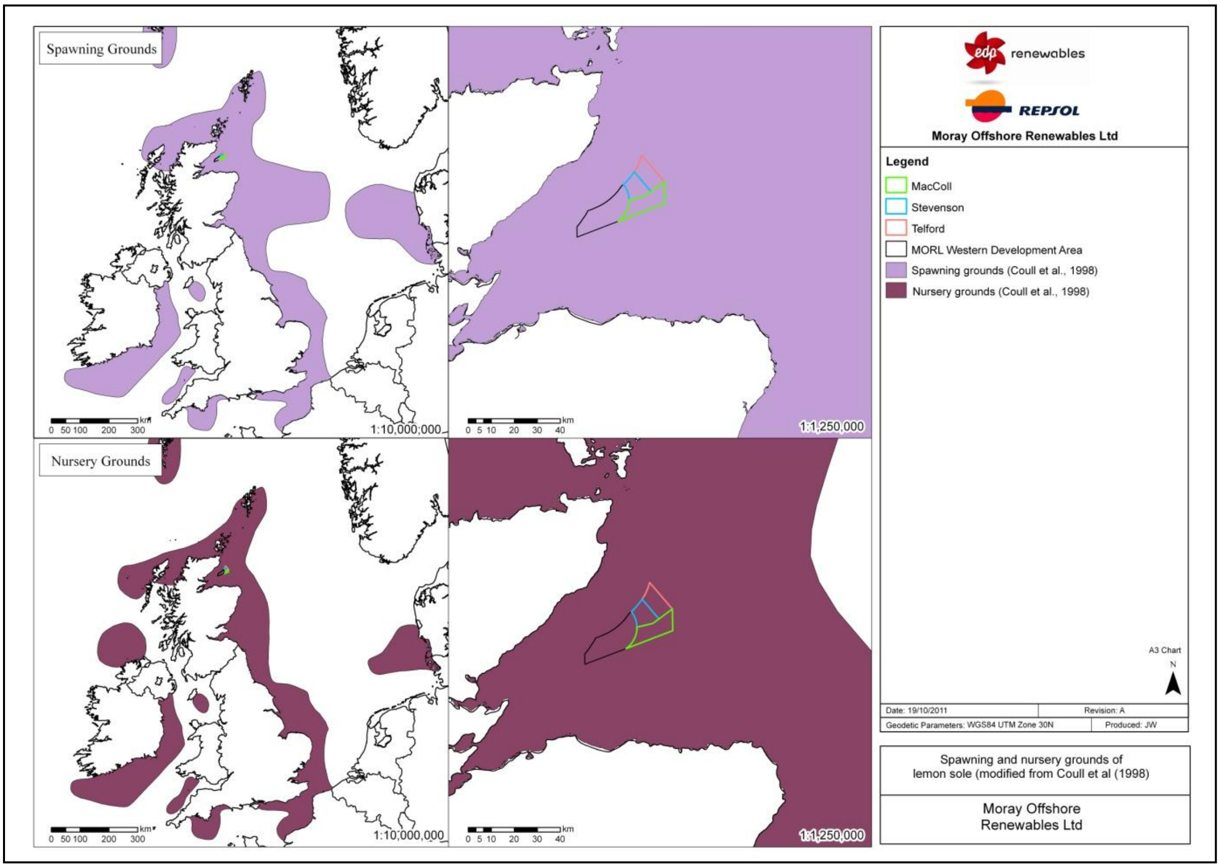

Figure 4.10 Lemon sole spawning and nursery grounds (Modified from Coull *et al* 1998)

4.7 Sprat

The three proposed wind farm sites fall within sprat spawning and nursery grounds defined by Coull *et al* (1998) (see Figure 4.11). As can be seen, sprat spawning grounds are widely distributed around the British Isles.

Spawning takes place from May to August (Coull *et al* 1998), with peak spawning observed from May to early July (Kraus & Köster 2001). Spawning occurs in both coastal and offshore waters, up to 100 km from the shore, in deep basins (Whitehead 1986, FAO, 2011, Nissling *et al* 2003).

Females spawn repeatedly in batches throughout the spawning season (Milligan 1986). Eggs and larvae of sprat are pelagic and so subject to larval drift, moving into coastal nursery areas, depending on the wind-driven currents (Hinrichsen *et al* 2005, Nissling *et al* 2003). Feeding larvae are mainly found in the upper part of the water column (Nissling *et al* 2003).

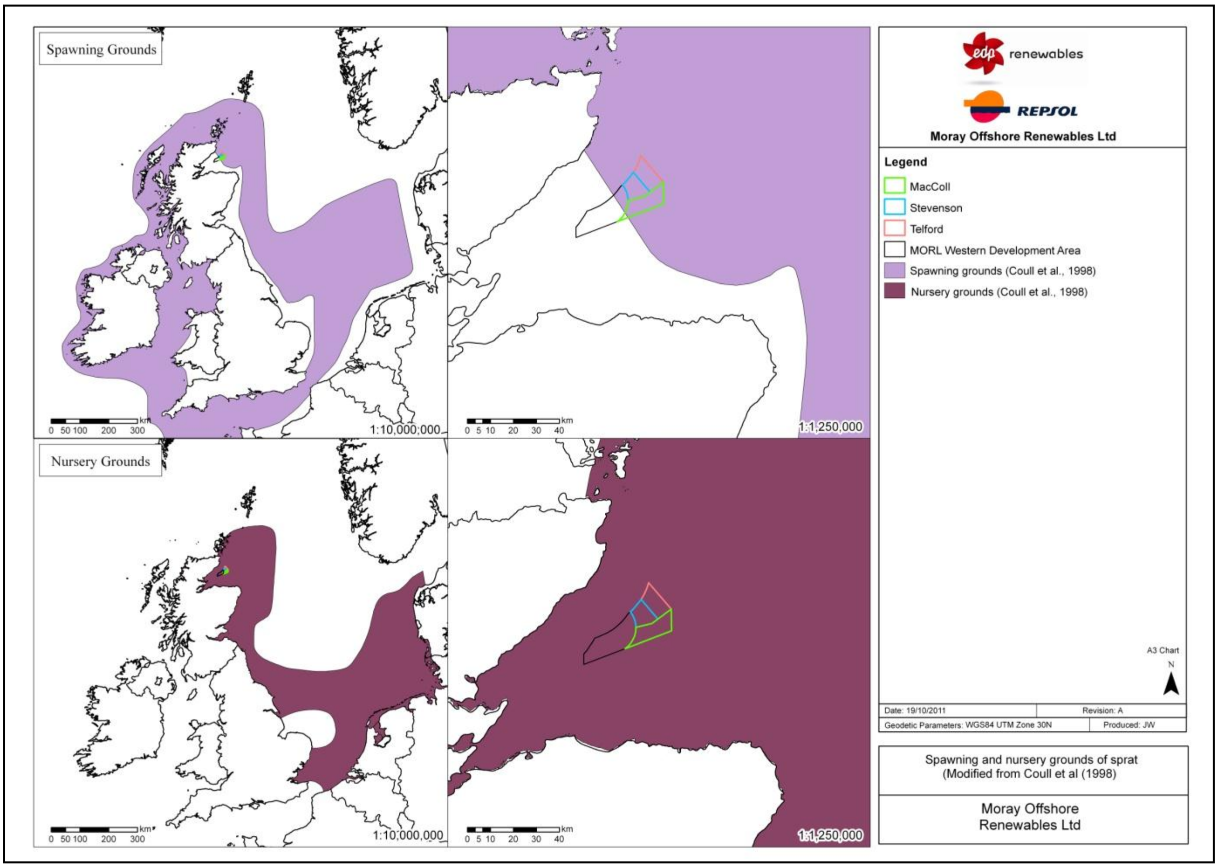

Figure 4.11 Sprat spawning and nursery grounds (Modified from Coull *et al* 1998)

4.8 Haddock

The site does not overlap with haddock spawning grounds as defined by Coull *et al* (1998), however, a recent publication of Marine Scotland Science (MSS) (Keltz & Bailey 2010) shows that spawning grounds are located in close proximity to the development (Figure 4.12 and Figure 4.13). In addition, the Eastern Development Area falls within haddock nursery grounds, as defined by Coull *et al* 1998 (Figure 4.12).

Results of international ichthyoplankton surveys carried out in 2004 found high concentrations of haddock stage I eggs in and off the Moray Firth (ICES 2005b). Similarly, significant spawning concentrations were noted historically to be located east of the Moray Firth (Gibb *et al* 2004).

Surveys conducted by the Fisheries Research Services (FRS) in 1999 found haddock spawning in both coastal and offshore areas (Gibb *et al* 2004). The highest densities of mature and spawning haddock were found in depths of around 100 m and most fish were associated with areas of mud or sand with few being caught in areas of harder substrate (Gibb *et al* 2004).

Spawning takes place between February and May (Coull *et al* 1998), at depths of 50 to 150 m (FAO 2011, Fillina *et al* 2009), with peak spawning occurring in March and April (Coull *et al* 1998, Fillina *et* *al* 2009). Haddock are serial spawners, releasing their eggs in batches over the spawning season (Gibb *et al* 2004, Fillina *et al* 2009). The eggs are laid at the bottom and after fertilisation rise into the water column where subsequent larval development occurs (Page & Frank 1989).

Haddock are capable of producing a wide range of sounds (Wahlberg & Westerberg 2005). Sounds produced by males during the spawning season are thought to serve to bring male and female fish together. In addition, it has been suggested that the sounds play a role in synchronising the reproductive behaviour of males and females (Hawkins & Amorim 2000).

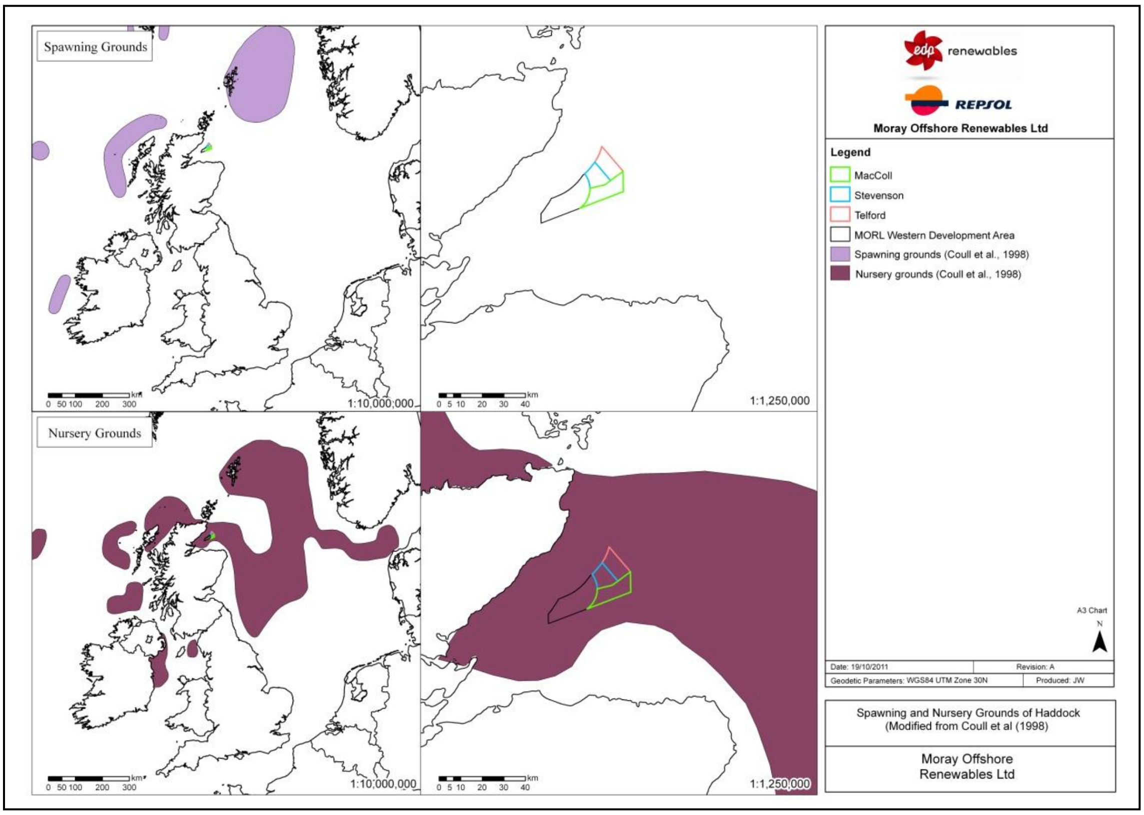

Figure 4.12 Haddock spawning and nursery grounds (Modified from Coull *et al* 1998)

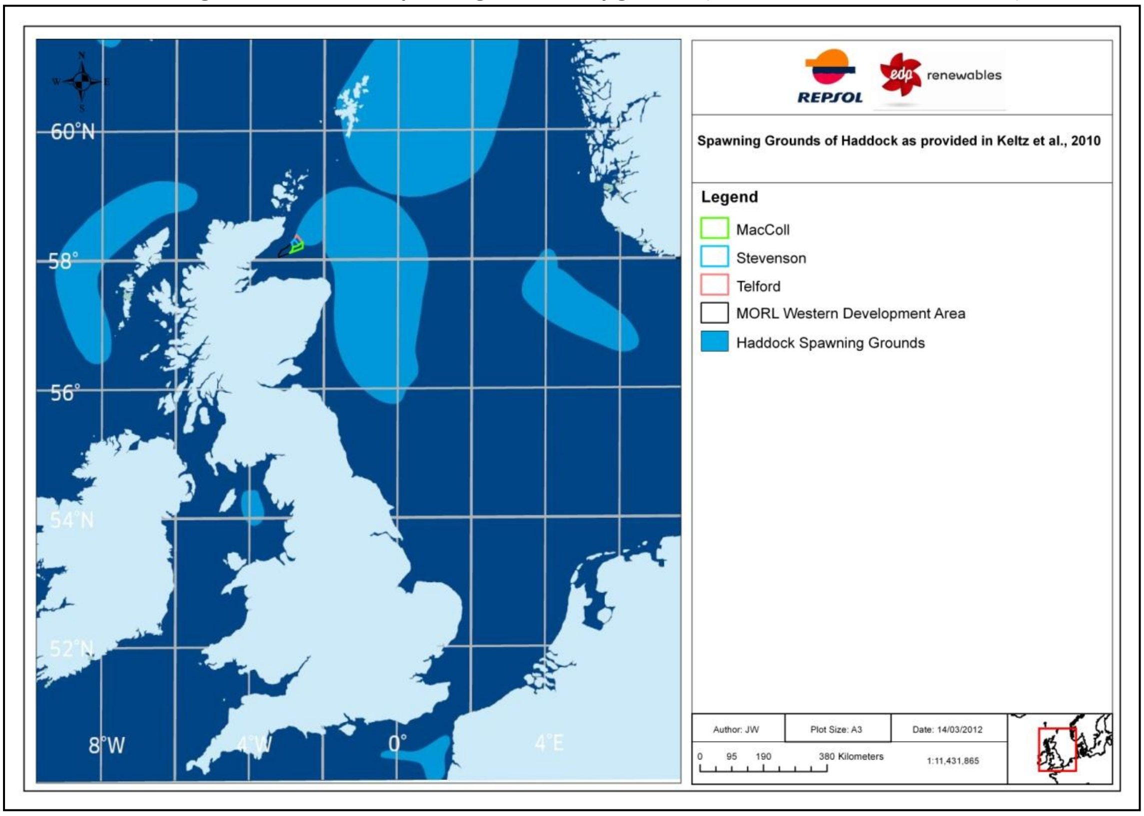

Figure 4.13 Haddock spawning grounds (Modified from Keltz & Bailey 2010)

4.9 Whiting

The three proposed wind farm sites are located in the vicinity of whiting spawning grounds defined by Coull *et al* (1998). Ellis *et al* (2010a) defined the area of the regional study area as a low intensity spawning ground and high intensity nursery ground. The spawning and nursery grounds as defined by Coull *et al* (1998) and Ellis *et al* (2010a) are illustrated in Figure 4.14.

Spawning occurs between February and June. Females release their eggs in numerous batches over a period that may last up to fourteen weeks (Teal *et al* 2009). Eggs are pelagic and take about ten days to hatch (Russel 1976).

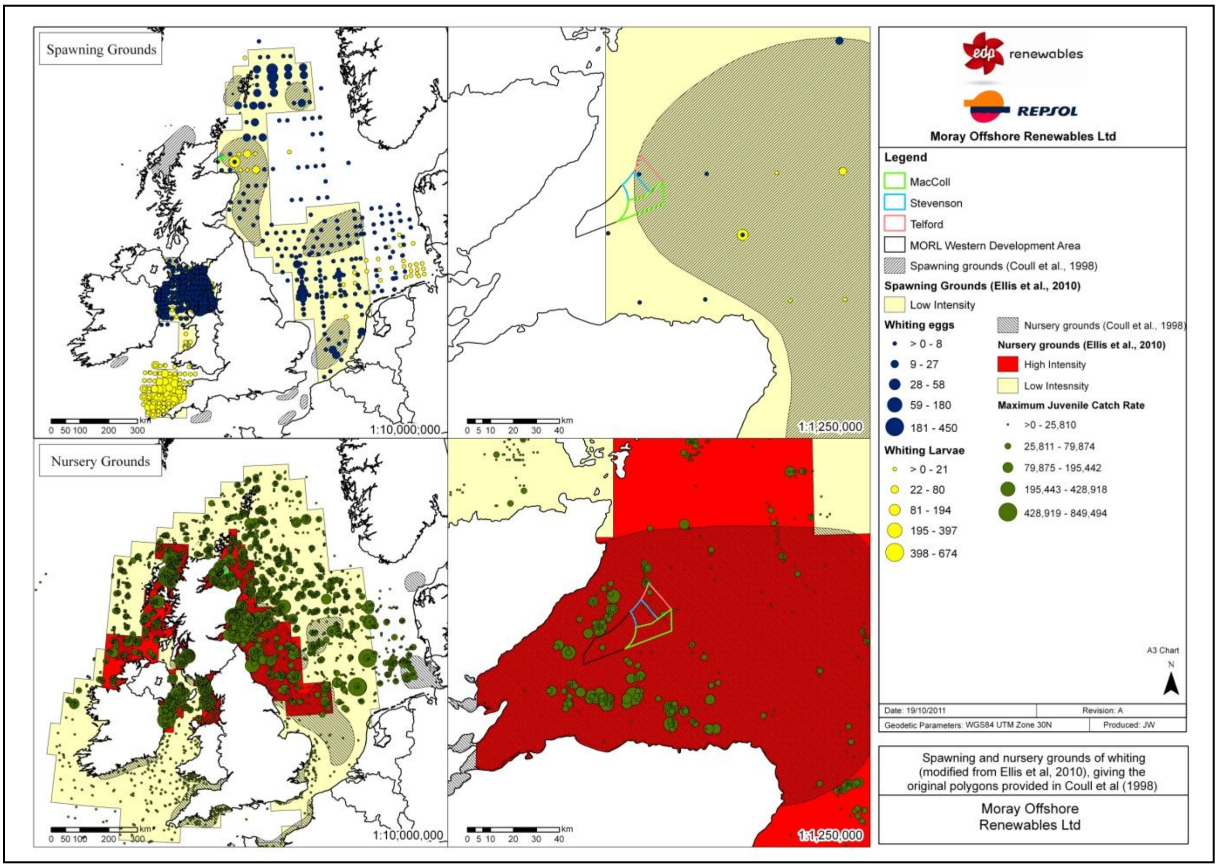

Figure 4.14 Whiting spawning and nursery grounds (Modified from Ellis et al 2010a)

4.10 Other Species with Nursery Grounds

Nursery grounds have been defined in the Eastern Development Area for a number of other species, in addition to those described in the sections above (See Table 4.1). These are shown in Figure 4.15 and Figure 4.16 as defined by Ellis *et al* (2010a) and Coull *et al* (1998).

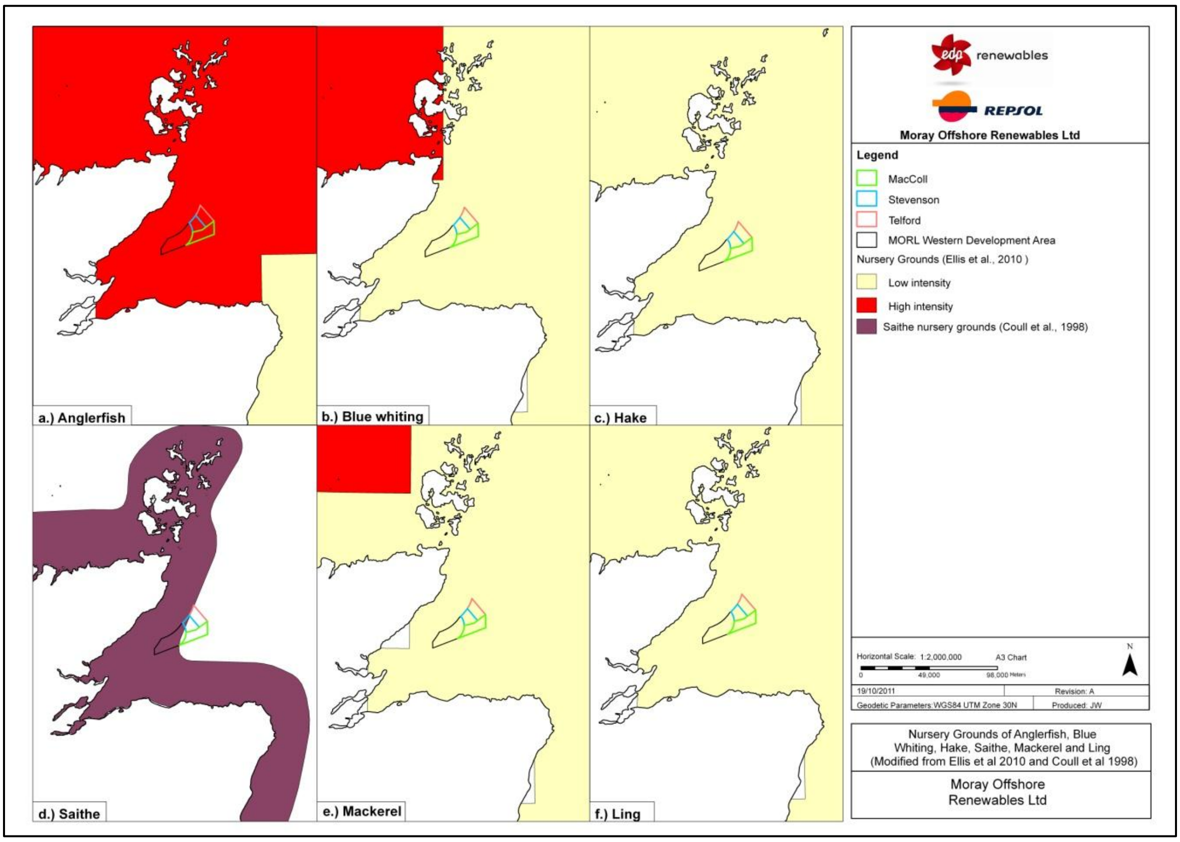

Figure 4.15Nursery grounds of anglerfish, blue whiting, hake, saithe, mackerel and ling (Modified from Ellis *et al* 2010a)

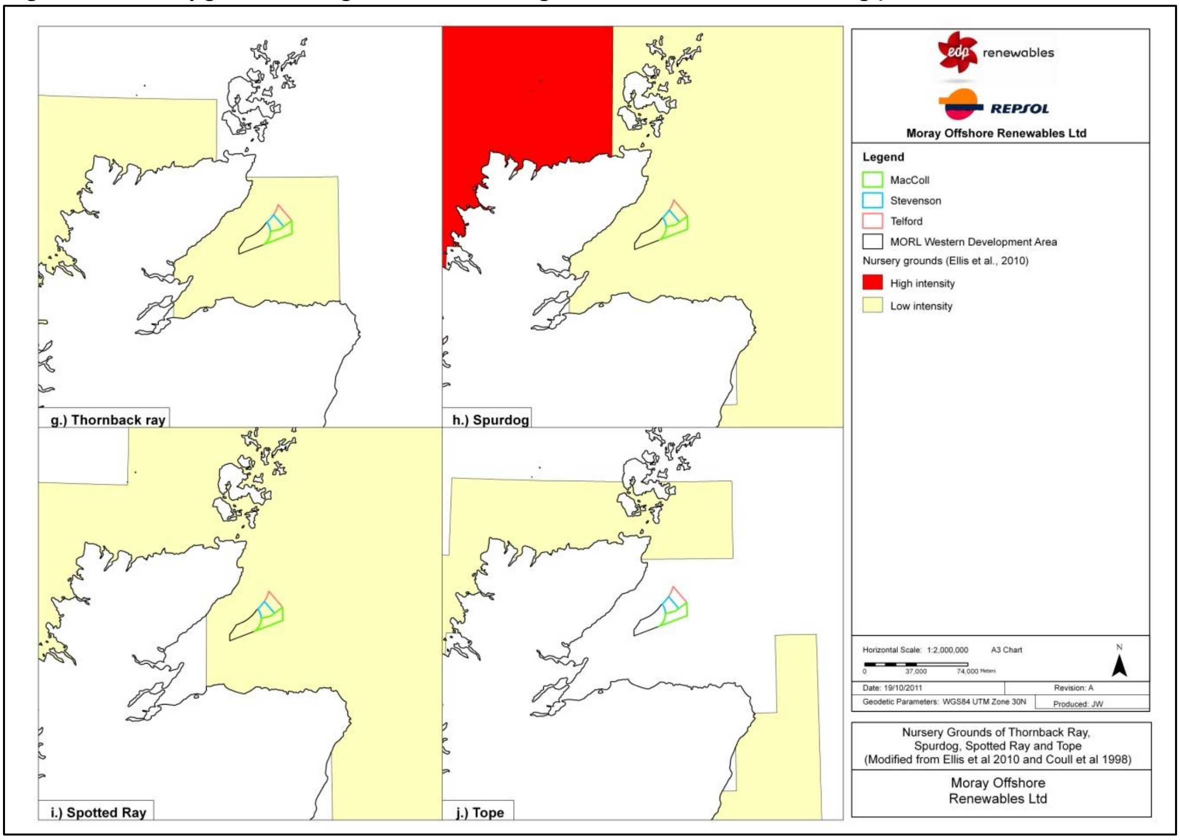

Figure 4.16 Nursery grounds of thornback ray, spurdog, spotted ray and tope (Modified from Ellis *et al* 2010a)

5.0 Key Species in the Food-web

Herring, sprat and sandeel, among other species, play a key role in the North Sea's food-web, being situated in a mid-trophic position. They are major predators of zooplankton and the principal prey of many top predators such as birds, marine mammals and piscivorous fish. Prey preference is subject to seasonal variation as a result of changes in prey availability throughout the year. In addition, different prey age classes/size classes are preferred by different predators.

5.1 Sandeels

Sandeels are relatively short lived (eight years), and spend most of the year buried in the seabed (Van der Kooij *et al* 2008). They prefer depths of 30 to 70 m, although they also occur between depths of 15 and 120 m (Wright *et al* 1998). They only emerge into the water column briefly in winter for spawning, from November until February, and for an extended feeding period in spring and summer (Van der Kooij *et al* 2008).

During the feeding period, occurring in spring and summer months, sandeel display a diurnal behavioural pattern: they emerge during the day to form large shoals feeding on a variety of zooplankton prey and bury themselves in the seabed at night (Van der Kooij *et al* 2008, Winslade 1974a, Kühlmann & Karst 1967, Arnott & Ruxton 2002). It is thought that the fish enter an overwintering stage between September and March, where they remain buried in the sand without feeding until the following spring (Wright & Bailey 1993, Winslade 1974b).

5.1.1 Sandeel sediment preference

Sandeels distribution is highly patchy and varies in relation to sediment type (Wright 1999a). Sandeels do not maintain permanent burrow openings and have to ventilate their gills with interstitial water. The presence of fine particles of silt rich sediments clogs gills and inhibits respiration. In addition, if the interstitial spaces between sand and gravel particles were occupied by silt particles the rate of exchange of interstitial water would be lower and oxygen supply inadequate (Holland *et al* 2005). Owing to their dependence on suitable sediment types, the distribution of post settled sandeels (late 0-group and older age classes) is restricted and constant through time (Wright & Begg 1997).

Sandeels tend to occupy areas on the sloping edges of sandbanks (Greenstreet *et al* 2010). Holland *et al* (2005) analysed 2885 grab-samples to determine sandeel (*A. marinus*) sediment preference in terms of its particle size composition and defined eight particle size classes (see Table 2 in Holland *et al*, 2005). The results show 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). Holland *et al* (2005) defined sediment characteristics for suitable and unsuitable habitats for sandeels. A habitat was defined as unsuitable for sandeels if all of the four sediment characteristics described below are present:

- >1% Medium Silt AND
- ≤55% Medium Sand AND
- >2% Coarse Silt AND
- ≤15% Coarse Sand

Suitable habitat was only broadly defined requiring one or more of the characteristics:

- ≤1% Medium Silt OR
- >55% Medium Sand OR
- ≤2% Coarse Silt OR
- >15% Coarse Sand

5.1.1.1 Site Specific Benthic Surveys (EMU 2010)

A number of sandeel species were recorded in the beam trawls: *Ammodytes sp.* (*A. marinus* and/or *A. tobianus*, nine stations), *Hyperoplus lanceolatus* (five stations) and *Gymnammodytes semisquamatus* (one station). *A. tobiabus* was the only sandeel species to be recorded in grab samples (six stations).

The distribution of trawl stations, together with the total abundance of sandeels in each trawl, is illustrated in Figure 5.1. As can be seen from Figure 5.1, sandeels were not found in the northern area of the development. Highest sandeel catches were found in grab samples undertaken in the southern west section and outside the area to the north east of the site.

The interpretation of the figures below should take account of the limitations of the data used. The number of sandeels caught in beam trawl samples and in grab samples are indicative of presence by species and are not to be used from a quantitative point of view, as sampling methods (e.g. beam trawl) and survey design (e.g. locations, sampling time, etc) were not selected taking account of the life cycle and catchability of sandeels.

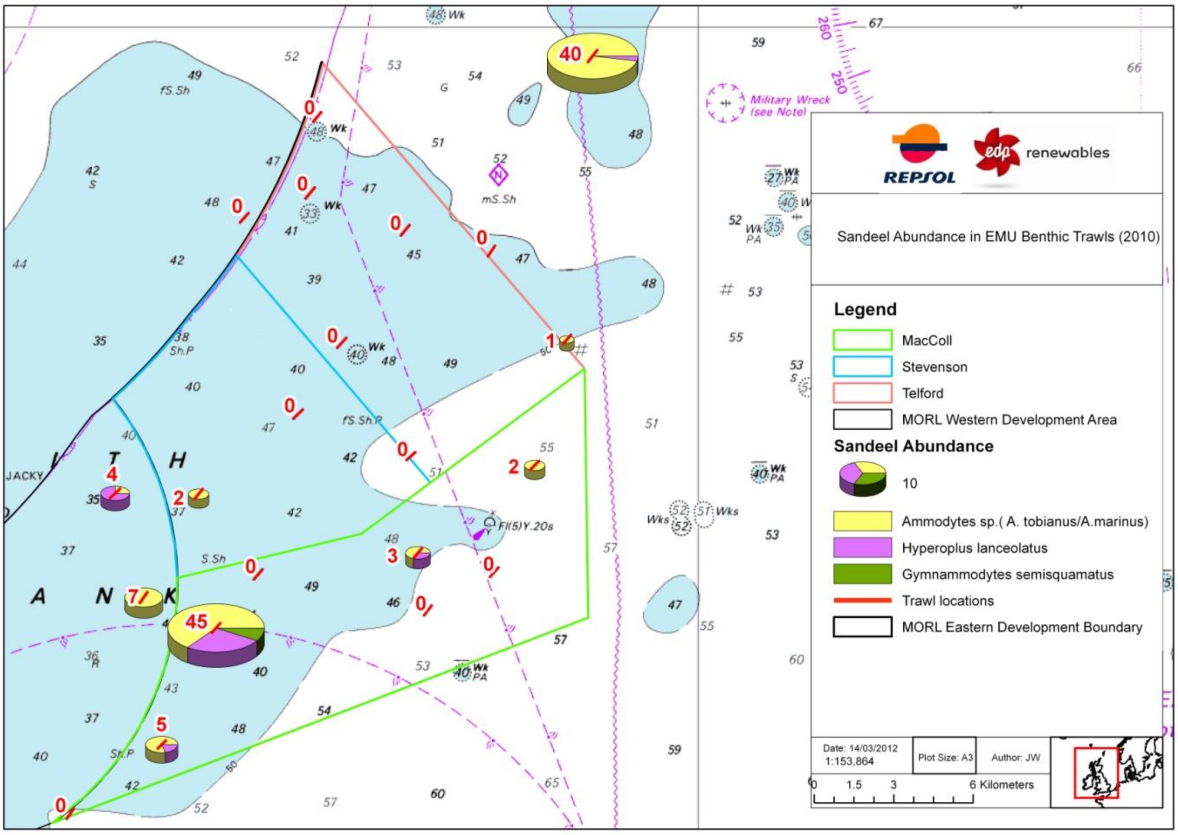

Figure 5.1 Distribution and abundance of sandeels in EMU benthic trawls (2010)

An indication of the suitability of the development site as a sandeel habitat based on the distribution of sediment classes from grab samples (EMU 2010) is given in Figure 5.2. In order to interpret the results of the particle size analysis (PSA) of grab samples two sediment categories were defined: coarse sands (particle size ≥ 0.25 to < 2 mm) and silts and fine sands (less than 0.25 mm) (Greenstreet *et al* 2010). Stations in which the proportion of "coarse sands" is high (larger pie charts

Figure 5.2) are more likely to constitute a suitable habitat for sandeels than those characterised by a high proportion of "silts and fine sands". Sandeel abundance at grab stations, samples where silt content was higher than 4% and presence recorded by video footage are also provided in Figure 5.2.

On the basis of the results of the PSA of grab samples it appears that the majority of the Eastern Development Area may potentially be suitable as a sandeel habitat. Silt contents higher than four percent, at which sandeels are considered to be rare, were only found at six stations.

Given the relatively small sampling effort (e.g. distance between grab samples) and the general patchiness of sandeel distribution, sediment types, and therefore habitat suitability, should not be assumed continuous between stations.

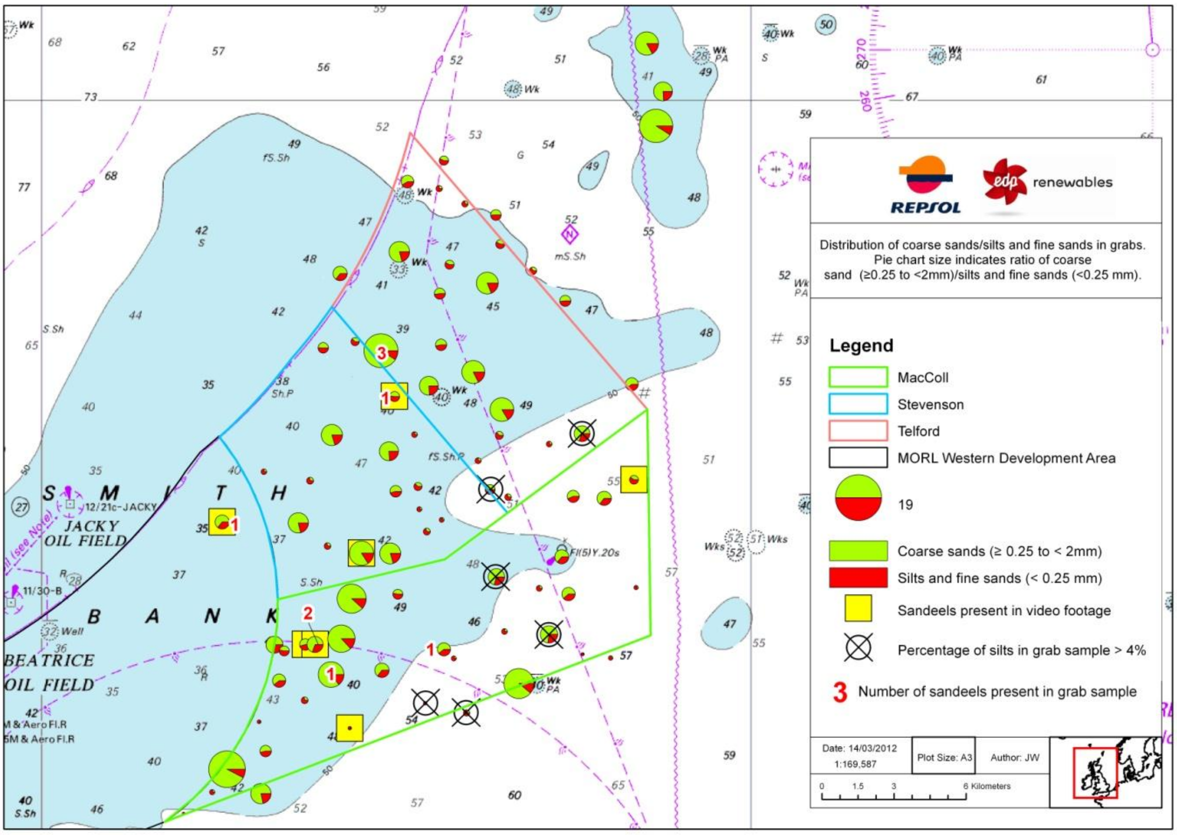

Figure 5.2 Sandeel Substrate Suitability: Distribution of coarse sands/ fine sands and silts proportion in EMU grab samples red.

5.1.2 Sandeel Predators

Sandeels are preyed upon in the sediment by a number of predators. They are however more commonly preyed upon when they are in transit to, or feeding in the water column (Van der Kooij *et al* 2008, Furness 2002, Hobson 1986), when they are more readily available. It is also during this period that they are targeted by pelagic trawls from the industrial fishery (Van der Kooij *et al* 2008).

Sandeels are a key component of the diet of many birds, such as kittiwakes, razorbills, puffins, common tern, arctic tern, European shag, great skuas and common guillemots, which are all known to rely on sandeel consumption during the breeding season (Wright & Bailey 1993, Furness 1999, ICES 2006b, Wanless *et al* 1998, Wanless *et al* 1999, Wanless 2005). In the Moray Firth, *Ammodytus* *marinus* is thought to support a large diversity and abundance of seabirds (Wrighjt & Begg 1997). Sandeels also constitute an important prey species for a number of piscean predators such as herring, salmon, sea trout, cod, haddock, whiting, grey gurnard, saithe, mackerel, horse mackerel and starry ray as well as for squid (Wright & Kennedy 1999, ICES 2006, ICES 2005c, ICES 2008a, ICES 2010b, Walters 2010, ICES 2009b, Mills *et al* 2003, MSS 2010a, Walters 2011, Collins & Pierce 1996, Haugland *et al* 2006). Marine mammals such as common seals (ICES 2006, Thompson *et al* 2003), grey seals (McConnell *et al* 1999), harbour porpoises (Santos *et al* 2005, ICES 2005) and minke whales (Olsen & Holst 2001, Pierce *et al* 2004) also feed on sandeels.

Different sandeel age/size classes are preferred by different predators at different times of the year (ICES 2005). Studies conducted by Greenstreet *et al* (1998) in the Inner Moray Firth showed that sandeels were almost the only fish prey taken by whiting and haddock of all size classes in June, whilst from October to January (when relative sandeel abundances declined) the proportion of this species in the diet of both fish species was gradually replaced by sprat.

5.2 Herring

Herring is fed on by a number of fish species such as salmon, sea trout, whiting, cod, saithe, mackerel, horse mackerel and starry ray (ICES, 2008c, ICES, 2005c, ICES 2005b, Mills et al 2003, Walters 2011). Different age classes are preferred by different predators, with preference subject to seasonal changes. In the North Sea for instance, predation mortality of one year old herring is mainly due to predation by cod, whiting, saithe and sea birds, whilst herring that is younger than one year, 0-group herring, is largely preyed upon by horse mackerel (ICES, 2008c).

0-group herring is also a preferred prey species for salmon post-smolts as suggested by the results of studies undertaken in the Norwegian Sea and in the North East Atlantic (Haugland *et al* 2006). Herring's egg mats attract a number of predators such as spurdog, haddock, mackerel, lemon sole, and other herring (Mills *et al* 2003, de Groot 1980, Skaret *et al* 2002).

Marine mammals such as harbour porpoises and bottlenose dolphins, grey seals and common seals also feed on herring in the Inner Moray Firth (Santos *et al* 2005, ICES 2005, Thompson *et al* 1991).

5.3 Sprat

Sprat is fed upon by a number of fish species such as cod, grey gurnards, haddock, herring, sandeels, spurdog, horse mackerel, mackerel, saithe, salmon, sea trout and whiting (ICES 2005c, ICES 2009b, Mills *et al* 2003, MSS, 2010a). Horse mackerel, for instance, largely feeds on 0-group sprat and is responsible for approximately 69 % of juvenile sprat predation mortality in the North Sea (ICES 2005c). Sprat older than one year is to a large extent preyed upon by cod and whiting, these two species are responsible for 12.7 % and 81.5 % respectively of this age group's predation mortality.

Studies carried out in the Inner Moray Firth by Greenstreet *et al* (1998) identified whiting and haddock as the main piscean predators. The species of fish prey taken varied considerably at different times of the year. Sprats were the preferred prey species for smaller whiting and haddock from October until January.

Sprat also represents a food source for marine mammals, such as harbour porpoises and common seals, and for squid (*L.forbesi*) (Thompson *et al* 1991, ICES 2005c, Collins & Pierce 1996).

6.0 Species of Conservation Importance

6.1 Diadromous Migratory Species

A number of diadromous species could potentially use areas in the vicinity of the three proposed wind farm sites during certain times of their life cycle. These are listed in Table 6.1, together with their conservation status.

Table 6.1 Diadromous species of conservation importance in the Moray Firth

Common Name	Scientific Name	Conservation Status								
		OSPAR	IUCN Red List	Bern Convention	Habitats Directive	The Wildlife & Countryside Act 1981	The Conservation (Natural Habitats, &c.) Regulations 1994	UK BAP species	Scottish Priority Marine Feature (PMF)	The Nature Conservation (Scotland) Act 2004
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	✓	✓	-	✓	✓	✓	-
Smelt	*Osmerus eperlanus*	-	Least concern	-	-	-	-	✓	✓*	-
Salmon	*Salmo salar*	✓	Lower Risk/least concern	✓	✓	-	✓	✓	✓	-
Sea Trout	*Salmo trutta*	-	Least concern	-	-	-	-	✓	✓	-
(*)= Due to be added to SNH PMF list (MS communication, 20/10/2011)										

The distribution and ecology of the diadromous species listed above is described in the following sections. In the case of salmon and sea trout, their distribution and ecology are separately described in the Salmon and Sea Trout Ecology and Fisheries Technical Report.

6.1.1 River and Sea Lamprey

River and sea lampreys are parasitic anadromous migratory species and have both been recorded in a number of rivers in the Moray Firth (Kelly & King 2001, JNCC 2011). Their distribution around the British Isles is given in Figure 6.1.

In the regional study area, sea lampreys (*Petromyzon marinus*) occur mainly in the River Spey, a designated Special Area of Conservation (SAC), but have also been recorded in the River Conon and Loch Ness (JNCC 2011, NBN Gateway 2011). Sea lamprey is a primary reason for the selection of the Spey SAC (JNCC 2011). River lamprey (*Lampetra fluviatilis*) has only been recorded in the rivers Conon and Spey (JNCC 2011).

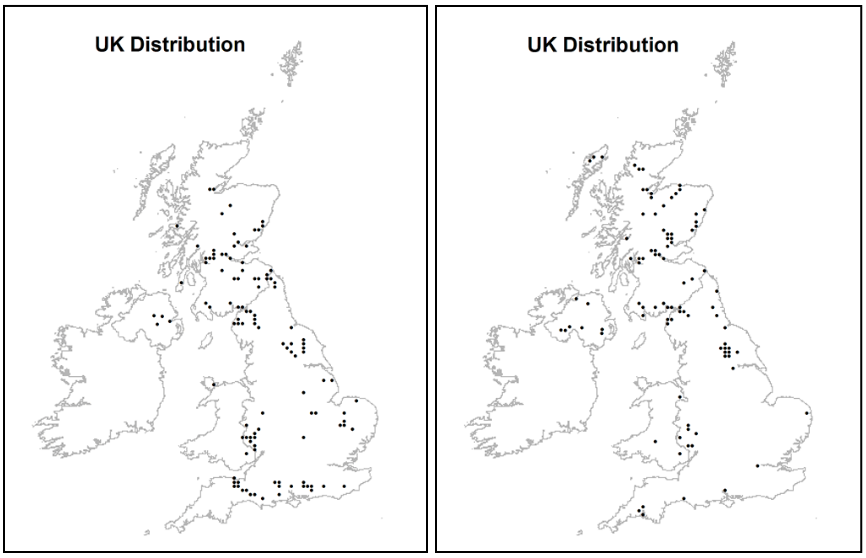

Figure 6.1 UK Distribution of river lamprey (left) and sea lamprey (right) (JNCC, 2011)

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 & Burns 2003). In the Spey sea lampreys have been recorded returning to the river in early summer, and spawning in rivers in June/July (pers. comm. Bob Laughton May 2011). All individuals die after spawning (Mailtland 2003). Ammocoetes can spend several years in these silt beds, feeding on organic detritus and eventually transforming into adults from late summer onwards (Laughton & 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 2003). After transformation, river and sea lampreys migrate to sea, where they use their suckers to attach to other fish (Maitland 2003). In the Spey this was noted as occurring in late summer (pers. comm. Bob Laughton May 2011). After several years in the marine environment the adults return to fresh water to spawn (Laughton & Burns 2003).

The distribution of sea lamprey is largely dictated by their host (Waldman *et al* 2008). At sea, lamprey feed on a variety of marine mammals and fish, including shad, herring, pollock, salmon, cod, haddock, swordfish and basking sharks (Kelly & King, 2001, ter Hofstede *et al* 2008). Homing behaviour is not apparent in this species (Waldman *et al* 2008). Thus, unlike salmonids and shads, lampreys do not have specific river populations (ter Hofstede *et al* 2008). The rarity of capture in coastal and estuarine waters suggests that marine lampreys are solitary hunters and widely dispersed at sea (MSS 2011). It is quite possible that they often feed in deeper offshore waters as they have been caught at considerable depths (as deep as 4100 m) (Moore *et al* 2003).

Unlike sea lamprey, river lampreys are generally found in coastal waters, estuaries and accessible rivers (Maitland 2003). In estuaries, they feed on a variety of fish, particularly on small fish such as young herring (*Clupea harengus)*, sprat (*Sprattus sprattus*) and flounder (*Platichthys flesus)* (Maitland 2003). After one to two years in estuaries, river lampreys stop feeding in the autumn and move upstream into medium to large rivers, usually migrating into fresh water between October and December (Maitland 2003).

6.1.2 European Eel

The European eel (*Anguilla anguilla*) stock has been assessed as being at a historical minimum and continuing to decline (ICES 2009). In 2007 an EU Regulation (EU 1100/2007) was established with the objective to protect and sustainably use the stock (ICES 2009). In the Moray Firth they are thought to be present in most rivers and streams.

European eel is a catadromous migratory species which is thought to spawn in the Sargasso Sea. The newly hatched larvae use oceanic currents to cross the Atlantic Ocean towards the European continental shelf and once there, metamorphose into glass eels (Malcolm *et al* 2010). All juvenile eels found in the shallower waters off Scotland are therefore likely to be glass eels, with larval eels occurring only to the west of the continental shelf (Tesch 2003). Glass eels generally migrate into fresh water in their first year after arrival, although some may remain in coastal waters until they mature, while others may move back and forth between coastal, estuarine and freshwaters throughout their lives (Daverat *et al* 2006). After living and growing in these various environments for up to 60 years, adult eels (yellow eels) turn silver and start their migration back to the Sargasso Sea to spawn and, presumably, die (Malcolm *et al* 2010).

Glass eels entering coastal waters use selective tidal stream transport to migrate to the coast and into river systems. They are transported by the flood stream in higher water levels and dwell near the bottom during the ebb stream (Creutzberg, 1985). To progress farther upstream, though, active migration into the river is required, swimming against the river flow (Bult & Dekker, 2007). The transition from selective tidal stream transport to active swimming has been related to a change in external factors (salinity or temperature; Creutzberg 1961), but also been described as an internally determined delay, allowing morphological and physiological adaptation (Deelder 1958; McCleave and Wippelhauser 1987).

Negative phototaxis is pronounced in eels of all stages and they are rarely found within a few meters of the surface during daylight, or even bright moonlight, if deeper water is available (Malcolm *et al* 2010).

The migratory behaviour of eels in Scottish coastal waters is poorly understood and migration seasons for both adults and juveniles are probably quite protracted. Tesch (2003), notes that eels typically arrive off Shetland and the Western Isles in September, Orkney and Caithness in November, and areas off the rest of eastern mainland Scotland in December. The first eels may, however, arrive as early as August and continuous glass eel arrival is likely to occur for several months after the mid-winter peak and perhaps even through the whole year, although in lower numbers.

It has been suggested that glass eels destined for Scottish rivers remain in coastal regions until April or May before river temperatures rise sufficiently for them to enter fresh water. The bulk of the return of silver eel migration is thought to extend from September to January (Malcolm 2010).

6.1.3 Allis Shad and Twaite Shad

Allis shad and twaite shad are anadromous migratory species occurring mainly in shallow coastal waters and estuaries, with a preference for water 10 to 20 m deep (MSS 2011). They are relatively scarce in the UK. The coastal distribution of allis shad and twaite shad is given in Figure 6.2. Allis shad has occasionally been recorded in the river Spey and estuarine and coastal areas of the Moray Firth (JNCC 2011, NBN Gateway 2011). No catches of twaite shad have been recorded in any rivers of the Moray Firth (JNCC 2011, NBN Gateway 2011), although this species has been recorded in coastal areas (Figure 6.2).

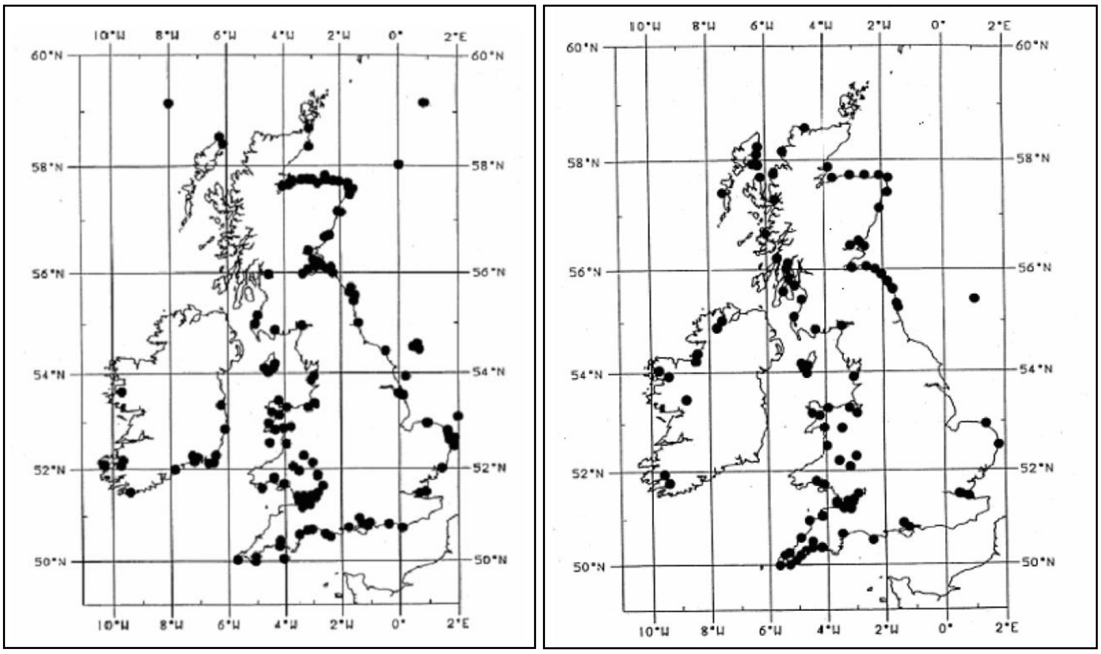

Figure 6.2 Coastal distribution of allis shad (left) and twaite shad (right) in the British Isles (date range unknown) from Potts and Swaby, 1993, as cited in Aprahamian et al, 1998 (JNCC 2011)

Migration into fresh water occurs during late spring (April to June) along the coast to watercourses of rivers to spawn from mid-May to mid-July (Maitland & Hatton-Ellis 2003, Acolas *et al* 2004, Patberg *et al* 2005). 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 regularly found around the British coast, including the Solway Firth (Maitland & Lyle 1995). Spawning populations of twaite shad are still found in a few rivers notably the Severn, Wye and Usk (Aprahamian & Aprahamian, 1990).

6.1.4 European Smelt

Smelt (*Osmerus eperlanus*) are diadromous migratory species. Adults congregate in estuaries during the winter, entering rivers in early spring to spawn during March and April over a period of only a few days. After spawning the adults return to sea whilst the juveniles remain in the estuary for the remainder of the summer. Most adults die after spawning although some fish do return to sea, recover and spawn again in later years.

Smelt populations have declined in Great Britain and are no longer present in many rivers. In Scotland there are only three populations left (in the rivers Cree, Tay and Forth) from the fifteen or more previously recorded (Maitland & Lyle 1995, Dumfries and Galloway Council 2011).

6.2 Sharks and Rays (Elasmobranchs)

Sharks and rays have slow growth rates and low reproductive output compared to other species groups (Camhi *et al* 1998). This results in slow rates of stock increase (Smith *et al* 1998) and low resilience to fishing mortality (Holden 1974). Directed fisheries have caused stock collapse for many species (Musick 2005), although at present, mortality in mixed-species and by-catch fisheries seems to be a more important threat (Bonfil 1994).

The principal species with conservation status and/or declining stocks, potentially transiting or inhabiting areas relevant to the three proposed wind farm sites are given in Table 6.2.

Table 6.2 Principal elasmobranch species with conservation status recorded in the Moray Firth

Common Name	Latin Name	MMO Landings Data	Recorded in the Moray Firth (Ellis *et al* 2005)	6.2.1 Conservation Status						
				OSPAR	IUCN Red List	The Wildlife & Countryside Act 1981	The Conservation (Natural Habitats, &c.) Regulations 1994	UK BAP species	Scottish Priority Marine Feature (PMF)	The Nature Conservation (Scotland) Act 2004
Sharks										
Basking shark	*Cetorhinus maximus*	-	-	✓	Vulnerable	✓	-	✓	✓	✓
Blue shark	*Prionace glauca*	-	-	-	Near threatened	-	-	✓	-	-
Gulper shark	*Centrophorus granulosus*	✓	-	✓	Vulnerable	-	-	✓	-	-
Leafscale gulper shark	*Centrophorus squamosus*	✓	-	✓	Vulnerable	-	-	✓	-	-
Porbeagle	*Lamna nasus*	-	-	✓	Vulnerable	-	-	✓	-	-
Portuguese dogfish	*Centroscymnus coelolepis*	✓	-	✓	Near threatened	-	-	✓	-	-
Sailfin Roughshark	*Oxynotus paradoxus*	✓	-	-	Data deficient	-	-	-	-	-
Spurdog	*Squalus acanthias*	✓	✓	✓	Vulnerable	-	-	✓	✓	-
Tope	*Galeorhinus galeus*	✓	-	-	Vulnerable	-	-	✓	-	-
Skates and Rays										
Common skate	*Dipturus batis*	✓	✓	✓	Critically endangered	-	-	✓	✓	-
Long-nosed skate	*Dipturus oxyrinchus*	✓	-	-	Near threatened	-	-	-	-	-
Sandy ray	*Leucoraja circularis*	-	-	-	Vulnerable	-	-	✓	-	-
Spotted ray	*Raja montagui*	-	✓	✓	Least concern	-	-	-	-	-
Thornback ray	*Raja clavata*	✓	✓	✓	Near Threatened	-	-	-	-	-
White skate	*Rostroraja alba*	✓	-	✓	Endangered	-	-	✓	-	--

6.2.1.1 Sharks

Spurdog (*Squalus acanthias*) are widely distributed around the British Isles and the Scottish coast (MSS 2011, Ellis *et al* 2005, ICES 2010c). They are commercially exploited, being principally caught as by-catch in mixed fisheries such as trawl fisheries, especially otter-trawl fisheries, and to a lesser extent gillnet and long line fisheries. In the local area (ICES rectangle 45E7) spurdog are the principal elasmobranch species landed by weight, although in relatively low levels. The wider Moray Firth area is considered to be a nursery ground for this species (Ellis *et al* 2010a) (Figure 4.16).

Although formerly abundant, the stock is now considered to be depleted and in danger of collapse (ICES 2010c). Exploitation has been reduced substantially in recent years as a result of decreasing quota allocations, with the Total Allowable Catch (TAC) reduced by approx. 99.7 % between 2000 and 2009 (Ellis *et al* 2010b). In addition, in 2010, the TAC for spurdog was set to zero. Landings are still permitted under a by-catch TAC (equal to 10% of the 2009 quotas), provided certain conditions are met including a maximum landing length and by-catch ratio limits (ICES 2010c).

Other shark species potentially present in the Moray Firth area are Portuguese dogfish (*Centroscymnus coelolepis*), porbeagle (*Lamna nasus*), tope (*Galeorhinus galeus)* and leafscale gulper shark (*Centrophorus squamosus*). With the exception of porbeagle, all have been recorded in the landings data from the regional study area (2000-2009). It should be noted that the majority of these species are either rare or tend to be more prevalent in offshore waters and the west and north coast of Scotland, than in the Moray Firth. Portuguese dogfish, for example, are principally found off the far west and north coasts of Scotland. Similarly, tope tend to be rarer in the east coast and leafscale gulper sharks are primarily found off the far west and north-west coast of Scotland. Porbeagles are widely distributed around Scotland, although currently considered to be rare. In 2010 zero EU-wide TAC was introduced for this species (MSS 2011).

The blue shark (*Prionace glauca*), whilst not present in the landings data (2000-2009), is also known to make use of Scottish coastal waters as part of their migration. They are more commonly recorded off the west coast of Scotland during the summer months (MSS 2011).

In addition to the species mentioned above, another species of conservation importance which could potentially transit areas relevant to the three proposed wind farm sites is the basking shark (*Cetorhinus maximus*). Basking sharks migrate from the western English Channel in spring to west Scottish waters, where they spend the summer and early autumn before moving offshore between November and March. Sightings for this species peak in the summer at a number of hot spots on the west coast. Sightings have also been recorded in the Moray Firth, however, to a much lesser extent. Increases in sea water temperatures are thought to be related to sightings being observed further north than in previous decades, with occasional records now around Shetland and Orkney north to the Norwegian coast and in the northern North Sea (Bloomfield & Solandt 2008, Solandt & Ricks 2009).

6.2.1.1.1 Skates and Rays

Thornback ray (*Raja clavata*) is considered to be the most important species of ray for commercial fisheries (ICES 2010c). The stock of this widely distributed species has steadily declined since the start of the 20th century resulting in a decreased distribution area, concentrated now in the southwest North Sea (from the Thames Estuary to the Wash) (ICES 2010c). The species is mostly found in shelf areas in depths of 10 to 60 m and remain resident within an average of 30 to 50 nautical miles (Walker *et al* 1997, Pawson 1995). They are considered to be one of the most abundant ray species through Scotland, being more common in the western and northern regions. The Moray Firth is considered a low intensity nursery area for this species (Ellis *et al* 2010a) (Figure 4.16).

Common skate (*Dipturus batis*) was historically one of the most abundant rays in the North-east Atlantic, being widely distributed around the British Isles. Current data indicates that they have disappeared from the English Channel and the southern and central North Sea, although they are regularly observed off northern and north-western Scotland, the Celtic Sea and along the edge of the continental shelf (Dulvy *et al* 2007, Ellis *et al* 2005).

Both the common skate and thornback ray have been recorded in the 2009 landings data in the regional study area together with the long-nosed skate (*Dipturus oxyrinchus*) and the white skate (*Rostroraja alba*).

Other species of conservation importance potentially present in the Moray Firth are sandy ray (*Leucoraja circularis*) and spotted ray (*Raja montagui*). Sandy ray are typically found on sandy or muddy seabeds of the north-west of Scotland although can occur elsewhere around the coast (MMS 2011). Spotted ray are widespread around the northern and western coasts of Scotland being rare in the North Sea (MSS 2011).

6.3 Other Species

In addition to the diadromous migratory species and elasmobranchs mentioned above, there are a number of other fish species with conservation status. The majority of these are commercially exploited in the Moray Firth having been recorded in landings data (2000-2009) within the regional study area. These are given in Table 6.3 below.

Table 6.3 Conservation status of fish species recorded in landings data (2000-2009) of the regional study area

Common Name	Latin name	Scottish Priority Marine Feature	UK BAP Species	OSPAR	IUCN Red List
Anglerfish	*Lophius piscatorius*	✓ (juveniles)	✓	-	-
Atlantic halibut	*Hippoglossus hippoglossus*	-	✓	-	Endangered
Atlantic mackerel	*Scomber scombrus*	✓	✓	-	-
Black scabbardfish	*Aphanopus carbo*	-	✓	-	-
Blue ling	*Molva dypterygia*	-	✓	-	-
Cod	*Gadus morhua*	✓	✓	✓	Vulnerable
Greenland halibut	*Reinhardtius hippoglossoides*	-	✓	-	-
Hake	*Merluccius merluccius*	-	✓	-	-
Herring	*Clupea harengus*	✓ (juveniles and spawning adults)	✓	-	Least concern
Horse mackerel	*Trachurus trachurus*	-	✓	-	-
Ling	*Molva molva*	✓	✓	-	-
Norway pout	*Trisopterus esmarkii*	✓	-	-	-
Plaice	*Peluronectes platessa*	-	✓	-	Least concern
Roundnoise Grenadier	*Coryphaenoides rupestris*	-	✓	-	-
Saithe	*Pollachius virens*	✓ (juveniles)	-	-	-
Sandeels	*Ammodytes marinus*	✓	✓	-	-
	Ammodytes tobianus	✓	-	-	-
Whiting	*Merlangius merlangus*	✓ (juveniles)	✓	-	-

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Environmental Statement

Technical Appendix 4.3 A: Annex 1 - Fish and Shellfish Ecology (Offshore Transmission Infrastructure)

Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement

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MORL-NFR03	31/05/2012	FINAL	JW/SX	SJA

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Tables

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1.0 Introduction

The following document provides site specific information on the distribution of fish and shellfish species in areas relevant to Offshore Transmission Infrastructure (OfTI). This document should be read in conjunction with the Fish and Shellfish Ecology Technical Report (Appendix 9.3A), where the ecology, life cycle and behaviour of the principal species present has been described in further detail.

2.0 Study Area

The study area used for this assessment is shown in Figure 2.1. This comprises the three ICES rectangles within which the OTI is located (45E7, 44E7 and 44E8). Rivers designated as Special Areas of Conservation (SACs) in the Moray Firth and the wider area are also shown in the figure.

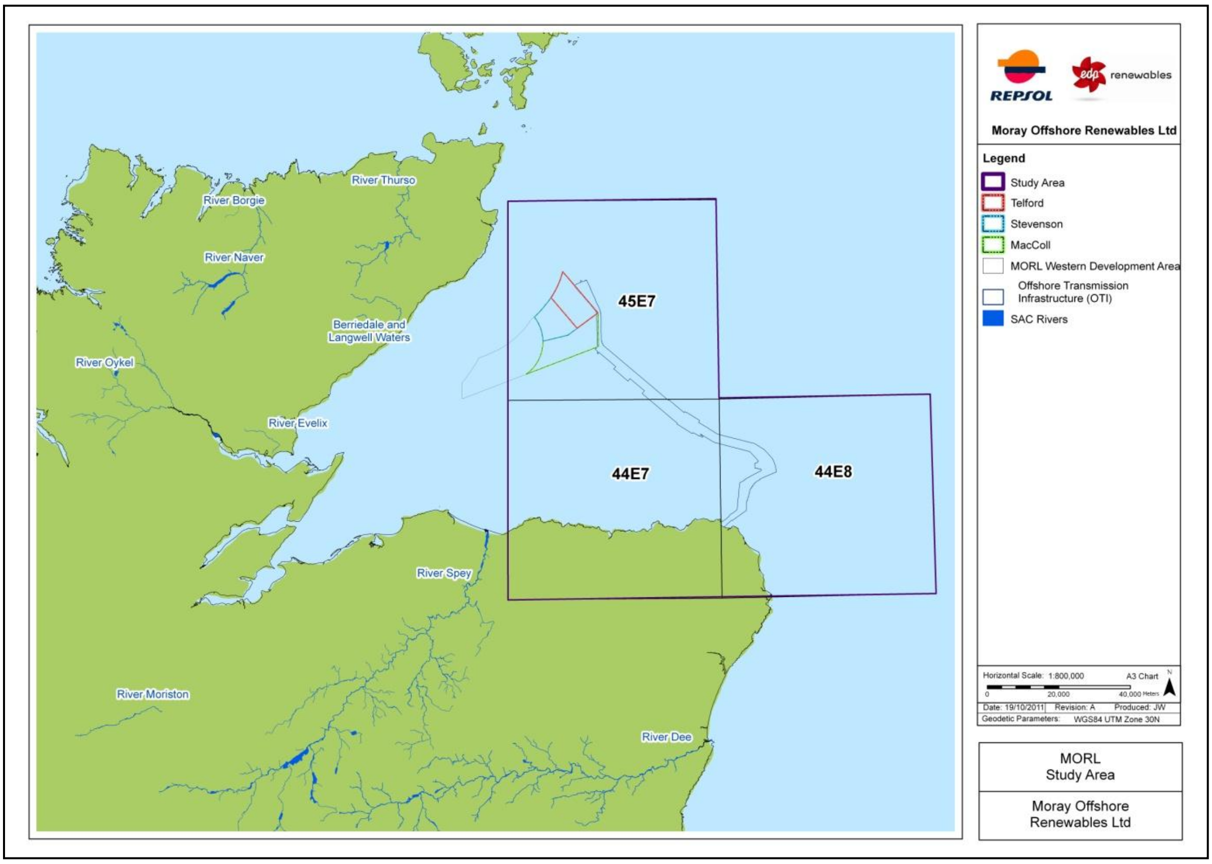

Figure 2.1 Offshore Transmission Infrastructure study area

3.0 Baseline Assessment

3.1 Seabed Sediment Types

The distribution of seabed sediment types in the Moray Firth is given in Figure 3.1. It can be seen that muddy substrates dominate in the inner and southern area, whilst sand, gravelly sand and to a lesser extent sandy gravel and slightly gravelly sand, are prevalent in the northern and central areas of the Firth.

The northern and southern sections of the OfTI are located in areas of coarser substrate, such as sandy gravel and gravelly sand, whilst the substrate in the middle section of the OTI is characterised by the presence of muddy sand and sand

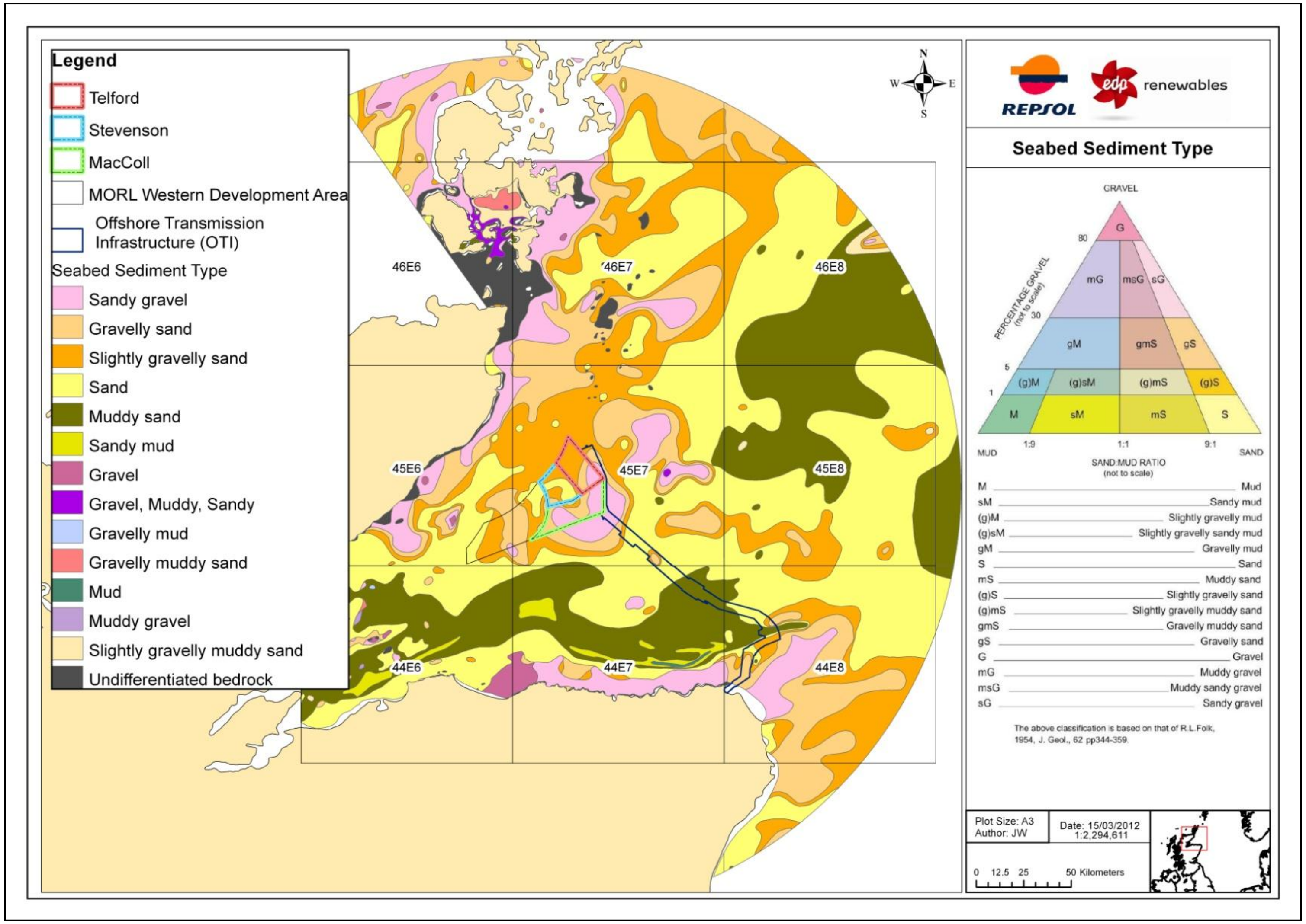

Figure 3.1 BGS (British Geological Survey) seabed sediment chart with ground type

3.2 Commercial Species

The Moray Firth supports a number of commercial fish and shellfish species. An indication of the relative importance of these in the study area is given in Figure 3.2, based on annual average (2000 to 2009) landings weights (tonnes) by species and ICES rectangle (MMO 2010).

The principal shellfish species landed are *Nephrops*, scallops, squid and edible crab. Haddock, herring, whiting, monks, mackerel and cod account for the majority of the fish landings.

The relative importance of each of these species to the total landings weights varies depending on the ICES rectangle under consideration. In the case of scallops, landings values by weight are particularly high in rectangle 45E7, whilst the highest landings for *Nephrops* and squid are recorded in rectangles 44E7. Edible crabs are principally caught in rectangle 44E8, where the landfall of the offshore export cable route is located.

Haddock contributes to a relatively high percentage of the total landings weights in all the rectangles whilst herring and mackerel are principally caught in rectangle 44E8. Landings weights for monks and cod are relatively low in all the rectangles.

Elasmobranch species (sharks and rays) constitute a very small percentage of the landings weights in the study area being included under the category "other" in Figure 3.2 and Table 3.2.

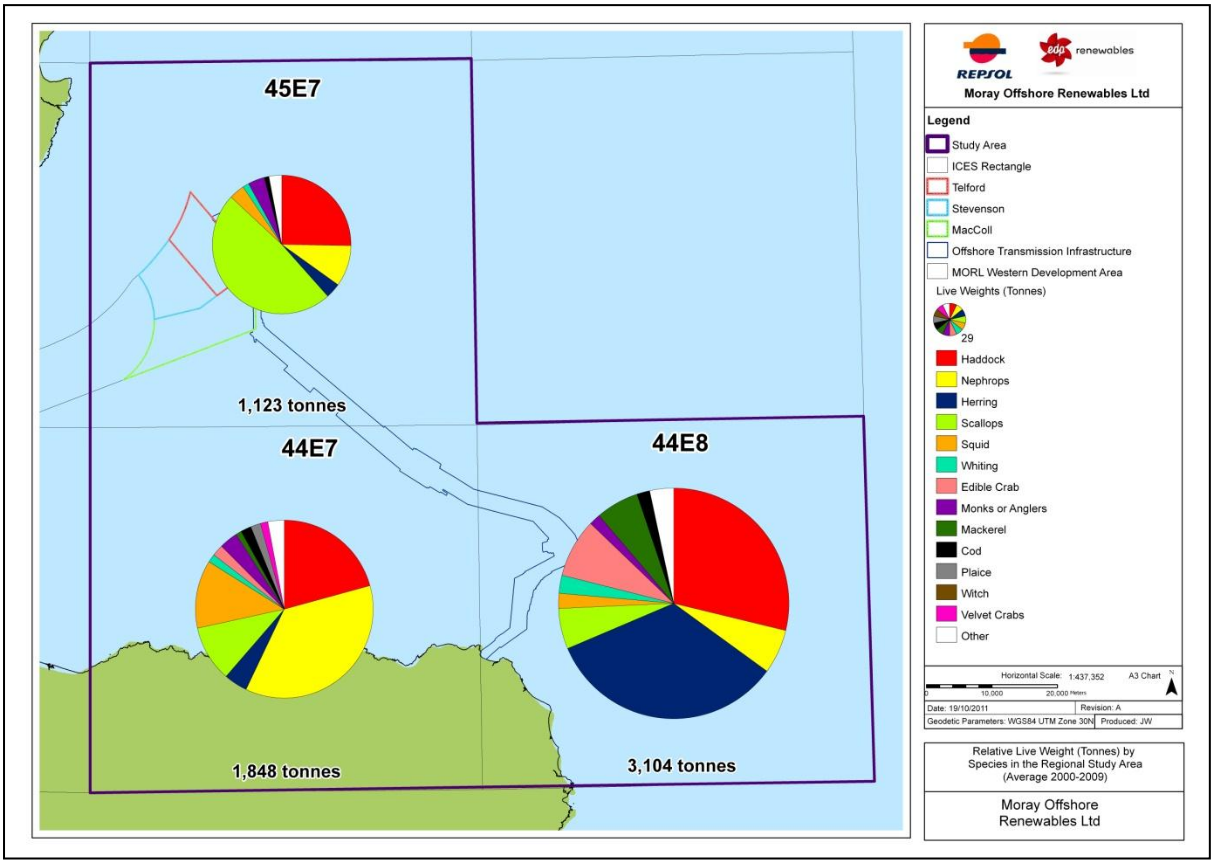

Figure 3.2 Live weight (tonnes) by species by ICES rectangle in the Study Area (MMO 2010)

The annual average landings weights (2000 to 2009) by species are shown in Table 3.1 and Table 3.2 for shellfish and fish species respectively.

Table 3.1 Annual average landings weights (2000 to 2009) of principal commercial shellfish species in the study area (MMO 2010)

Common Name	Latin Name	Average (2000-2009) Landings Weight (t)	Percentage of Total Shellfish Landings Weight in 44E7, 44E8 and 45E7 (%)	Percentage of Total Landings Weight (all fish and shellfish species combined) in 44E7, 44E8 and 45E7 (%)
Nephrops	*Nephrops norvegicus*	965	37.4	15.9
King Scallop	*Pecten maximus*	901	34.9	14.8
Squid	*Loligo forbesi*	333	12.9	5.5
Edible Crab	*Cancer pagurus*	293	11.3	4.8
Velvet Crabs	*Necora puber*	48	1.9	0.8
Mussels	-	12	0.5	0.2
Lobsters	*Homarus gammarus*	7	0.3	0.1
Octopus	-	2	0.1	< 0.1
Queen Scallops	*Aequipecten opercularis*	2	0.1	< 0.1
Whelks	*Buccinum undatum*	1	0.0	< 0.1
Periwinkles	*Littorina littorea*	< 0.1	< 0.01	< 0.01
Green Crab	*Carcinus maenas*	< 0.1	< 0.01	< 0.01
Brown Shrimp	*Crangon crangon*	< 0.1	< 0.01	< 0.01
Other	-	18	0.7	0.3

Table 3.2 Annual average landings weights (2000 to 2009) of principal commercial fish species in the study area (MMO 2010)

Common Names	Latin Names	Average (2000-2009) Landings Weight (t)	Percentage of Total fish Landings Weight in 44E7, 44E8 and 45E7 (%)	Percentage of Total Landings Weight (all fish and shellfish species combined) in 44E7, 44E8 and 45E7 (%)
Haddock	*Melanogrammus aeglefinus*	1543	44.2	25.4
Herring	*Clupea harengus*	1147	32.8	18.9
Mackerel	*Scomber scombrus*	205	5.9	3.4
Monks or Anglers	*Lophius piscatorius/L. budegassa*	154	4.4	2.5
Whiting	*Merlangius merlangus*	121	3.5	2.0
Cod	*Gadus morhua*	104	3.0	1.7
Plaice	*Pleuronectes platessa*	54	1.5	0.9
Saithe	*Pollachius virens*	26	0.7	0.4
Lemon Sole	*Microstomus kitt*	20	0.6	0.3
Witch	*Glyptocephalus cynoglossus*	18	0.5	0.3
Skates and Rays	-	15	0.4	0.2
Ling	*Molva molva*	13	0.4	0.2
Megrim	*Lepidorhombus whiffiagonis*	13	0.4	0.2
Spurdog	*Squalus acanthias*	10	0.3	0.2
Horse Mackerel	*Trachurus trachurus*	8	0.2	0.1
Hake	*Merluccius merluccius*	7	0.2	0.1
Other	-	37	1.1	0.6

3.3 Species with Spawning and Nursery Grounds

The OfTI falls within, and is in close proximity to, the spawning and nursery grounds of a number of species (Coull *et al* 1998, Ellis *et al* 2010). These are listed in Table 3.3 below, together with their spawning times and intensity of spawning (where it has been defined). The spawning times are given as provided in Coull *et al* (1998) and the spawning/nursery intensity as described in Ellis *et al* (2010).

The distribution of spawning and nursery grounds is illustrated by species in Figure 3.3 to Figure 3.12.

Table 3.3 Species with spawning and nursery areas within/in close proximity to the OTI, together with spawning times and intensity (Coull *et al* 1998; Ellis *et al* 2010).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Nursery
Sandeel	(red)	(red)									(red)	(red)	(yellow)
Nephrops	(green)	(green)	(green)	(green) *	(green) *	(green) *	(green)	(green)	(green)	(green)	(green)	(green)	(green)
Herring								(green)	(green)				(red)
Cod	(yellow)	(yellow) *	(yellow) *	(yellow)									(red)
Plaice	(yellow) *	(yellow) *	(yellow)									(yellow)	(yellow)
Lemon Sole				(green)	(green)	(green)	(green)	(green)	(green)				(green)
Sprat					(green) *	(green) *	(green)	(green)					(green)
Whiting		(yellow)	(yellow)	(yellow)	(yellow)	(yellow)							(red)
Spurdog	n/a												(yellow)
Thornback Ray	n/a												(yellow)
Spotted Ray	n/a												(yellow)
Blue Whiting	n/a												(yellow)
Ling	n/a												(yellow)
Hake	n/a												(yellow)
Anglerfish	n/a												(red)
Mackerel	n/a												(yellow)
Haddock	n/a												(green)
Saithe	n/a												(green)

Colour key: (red) = high intensity spawning/nursery ground, (yellow) = low intensity spawning/nursery ground, (green) = unknown spawning/nursery intensity, (*) = peak spawning

It should be noted that in addition to the species mentioned above, king scallop may also use areas relevant to the OfTI as a spawning and nursery ground. Post-plankton stages of this species are generally associated with coarse sand gravel substrates and bryozoans/hydroid communities. Similarly, squid are known to spawn in inshore areas from December to June, with peak spawning having been reported from December to March, laying eggs onto biogenic or manmade structures and surfaces. Fishermen have reported finding squid eggs off Burghead and Buckie in May and June in water depths 5-6m and eggs have also been found on lobster creels shot on hard ground in the Moray Firth. It is therefore considered that some degree of spawning may take place in areas relevant to the OfTI.

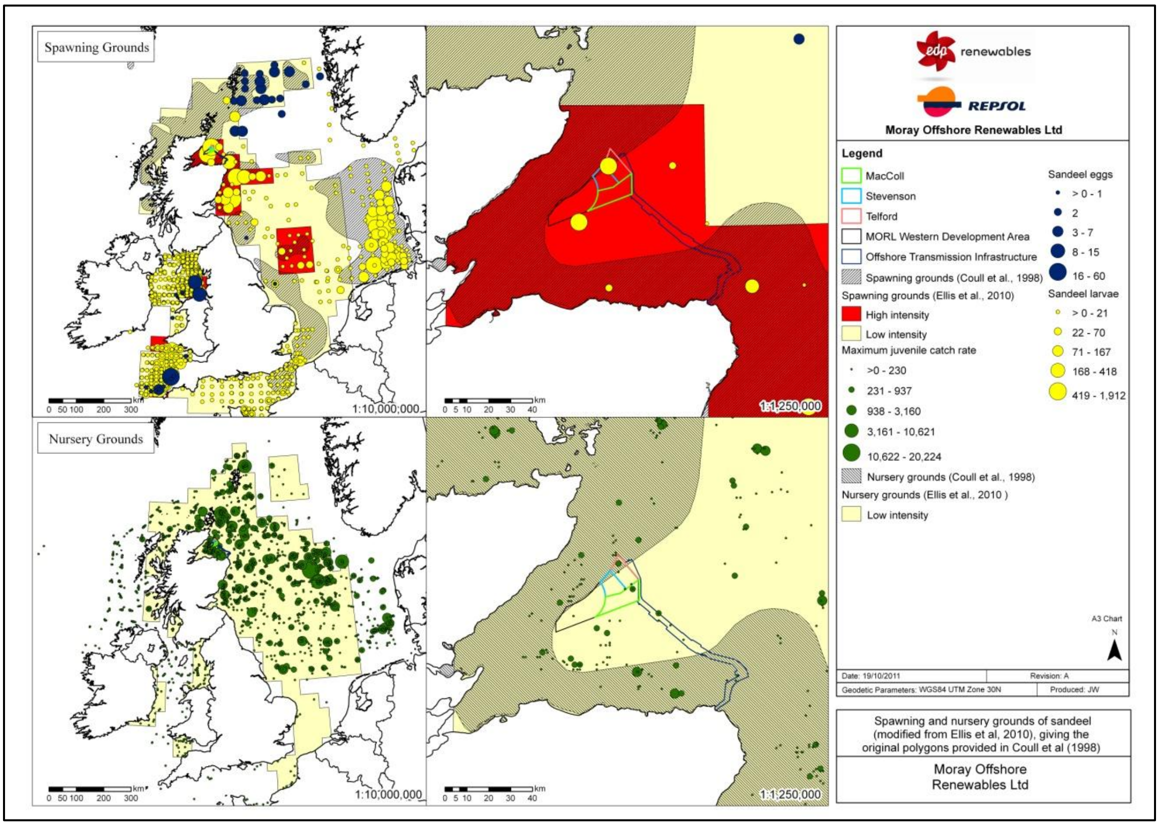

Figure 3.3 Sandeel spawning and nursery grounds (Modified from Ellis *et al* 2010)

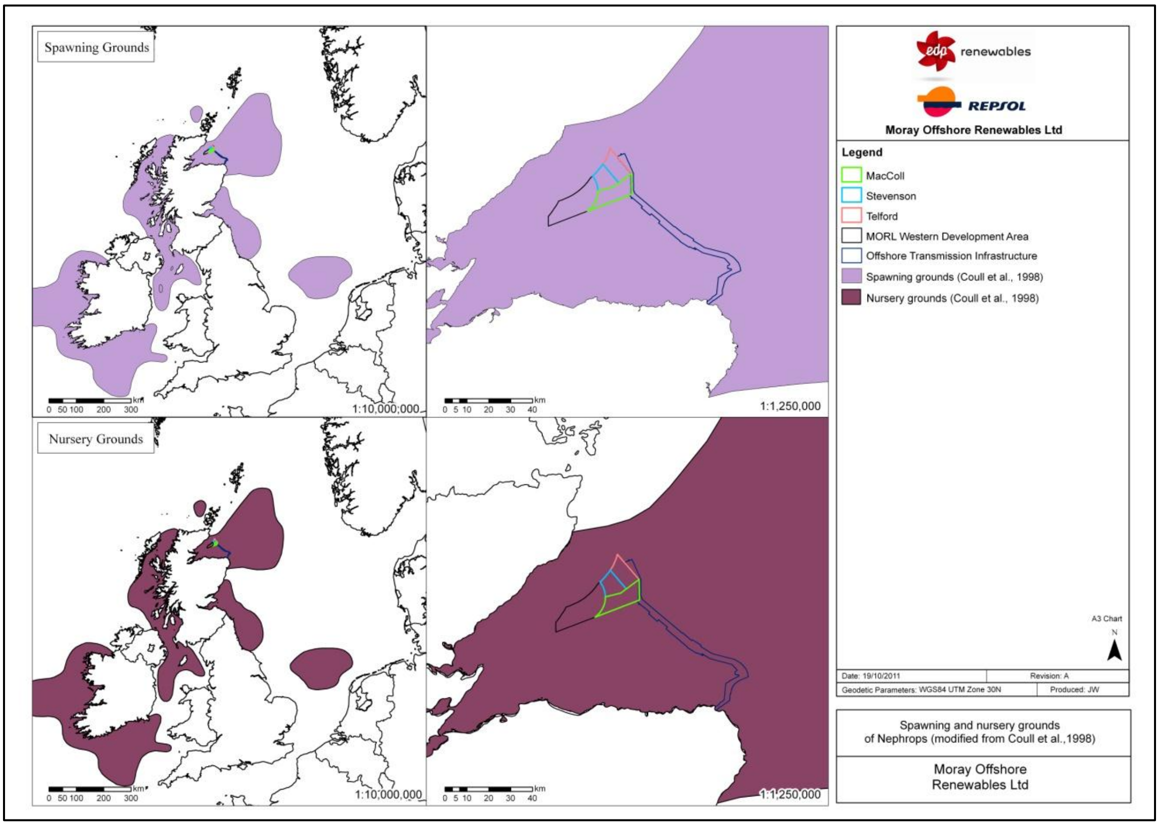

Figure 3.4 Nephrops spawning and nursery grounds (Modified from Coull *et al* 1998)

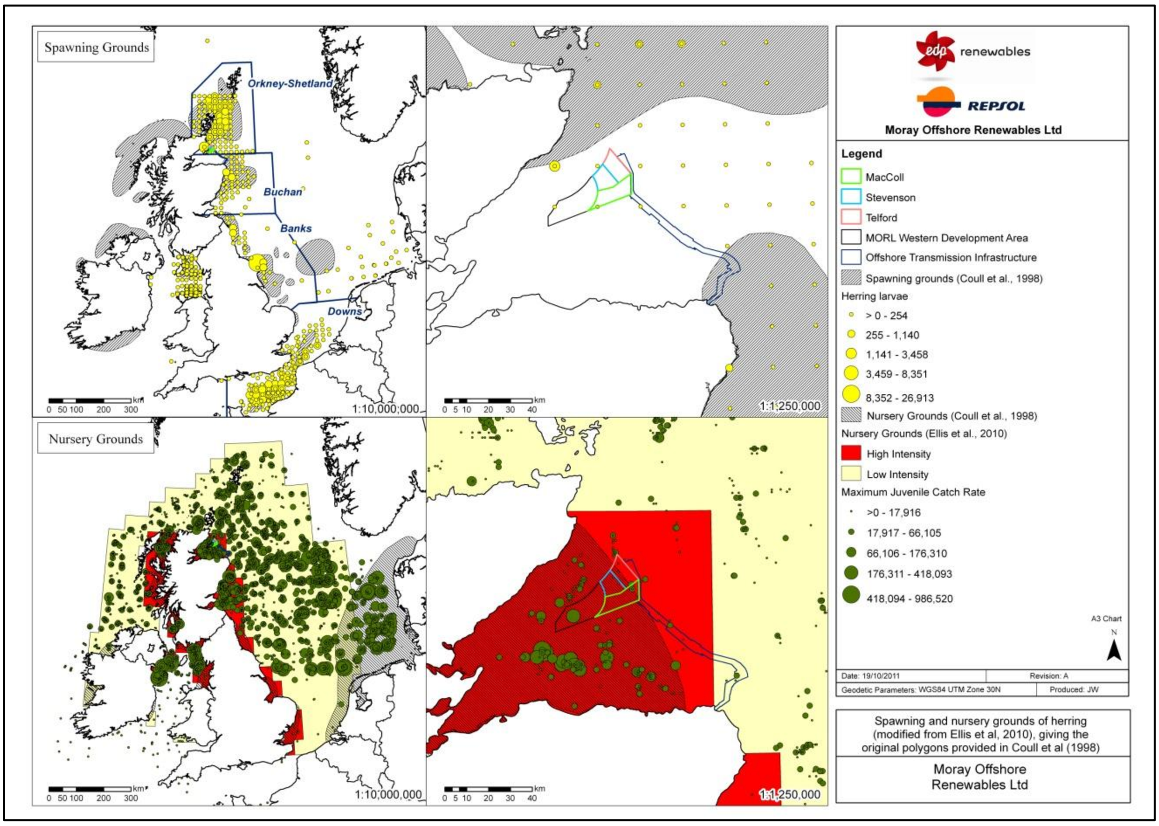

Figure 3.5 Herring spawning and nursery grounds (Modified from Ellis *et al* 2010)

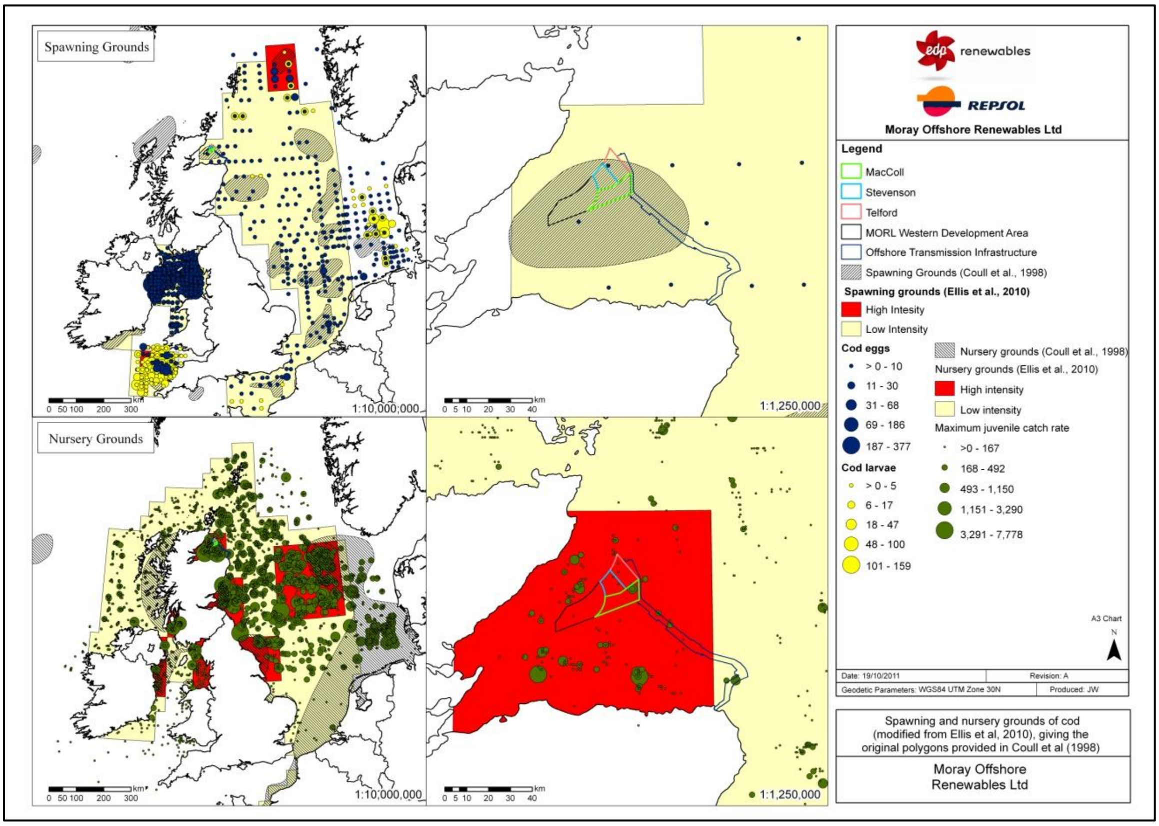

Figure 3.6 Cod spawning and nursery grounds (Modified from Ellis *et al* 2010)

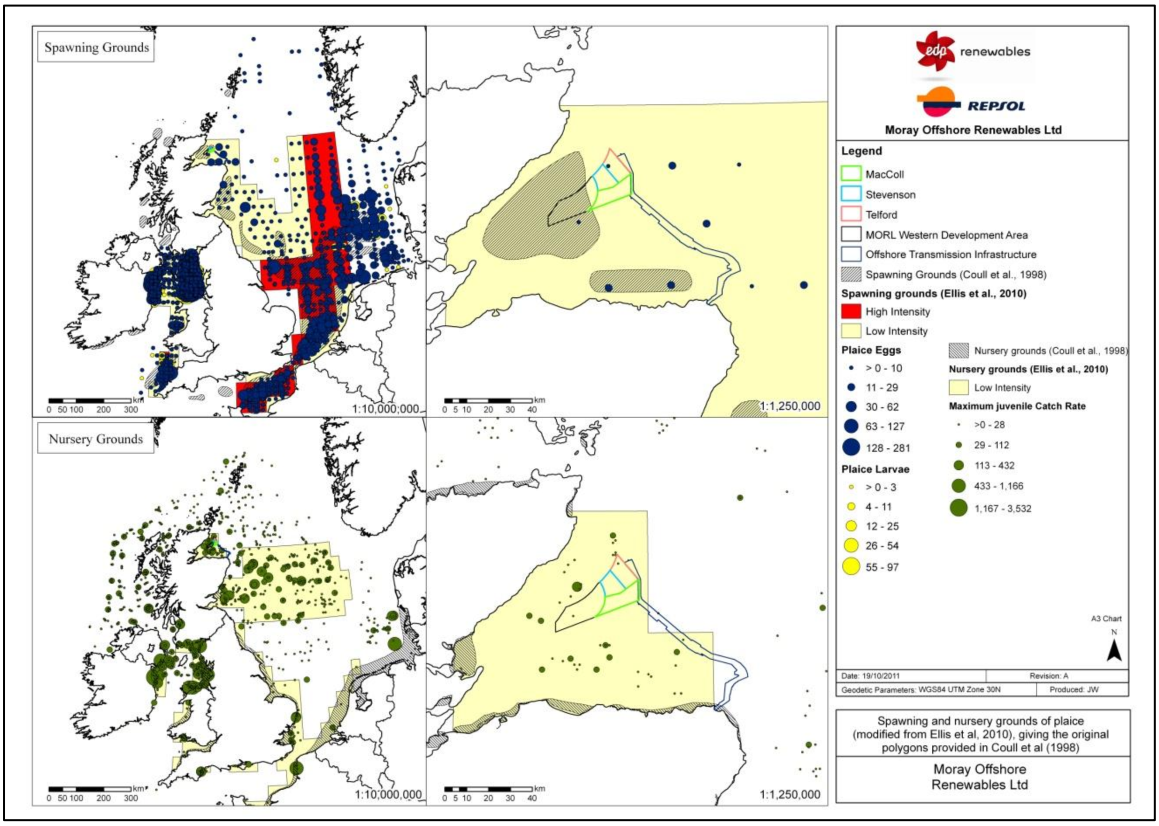

Figure 3.7 Plaice spawning and nursery grounds (Modified from Ellis *et al* 2010)

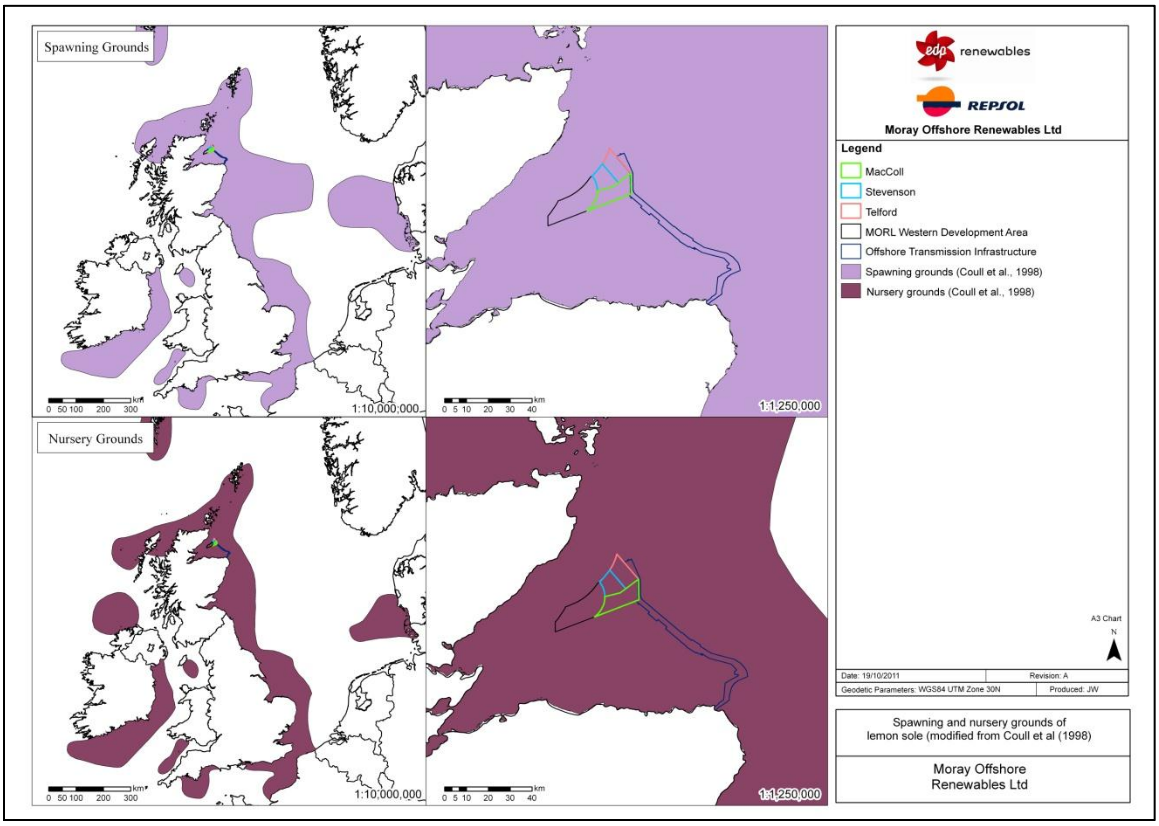

Figure 3.8 Lemon sole spawning and nursery grounds (Modified from Coull *et al* 1998)

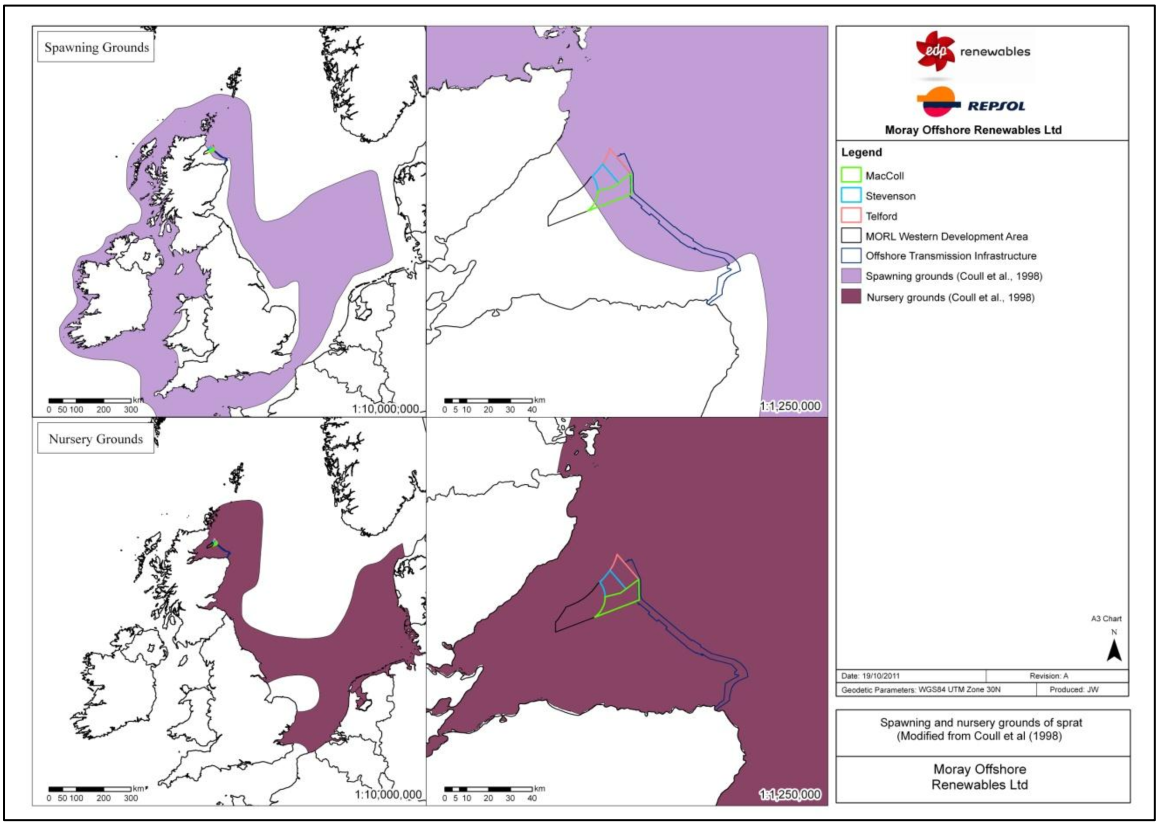

Figure 3.9 Sprat spawning and nursery grounds (Modified from Coull *et al* 1998)

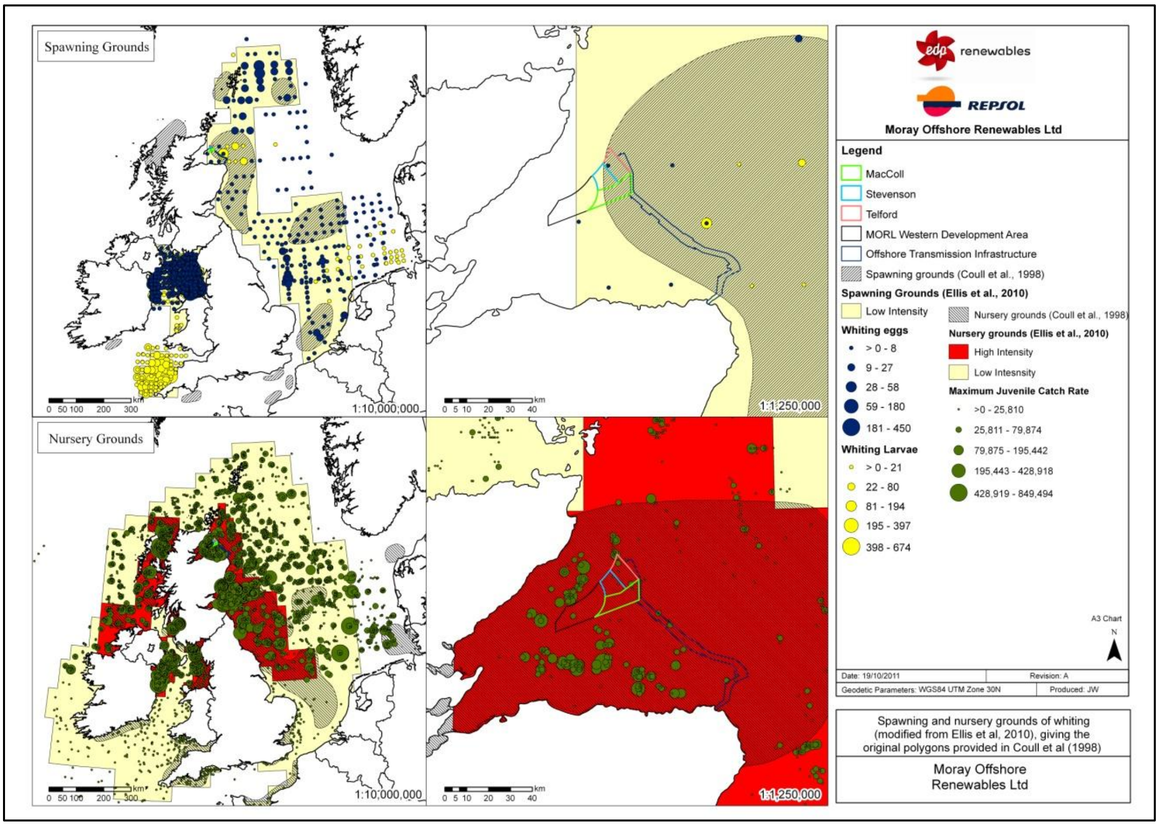

Figure 3.10 Whiting spawning and nursery grounds (Modified from Ellis *et al* 2010)

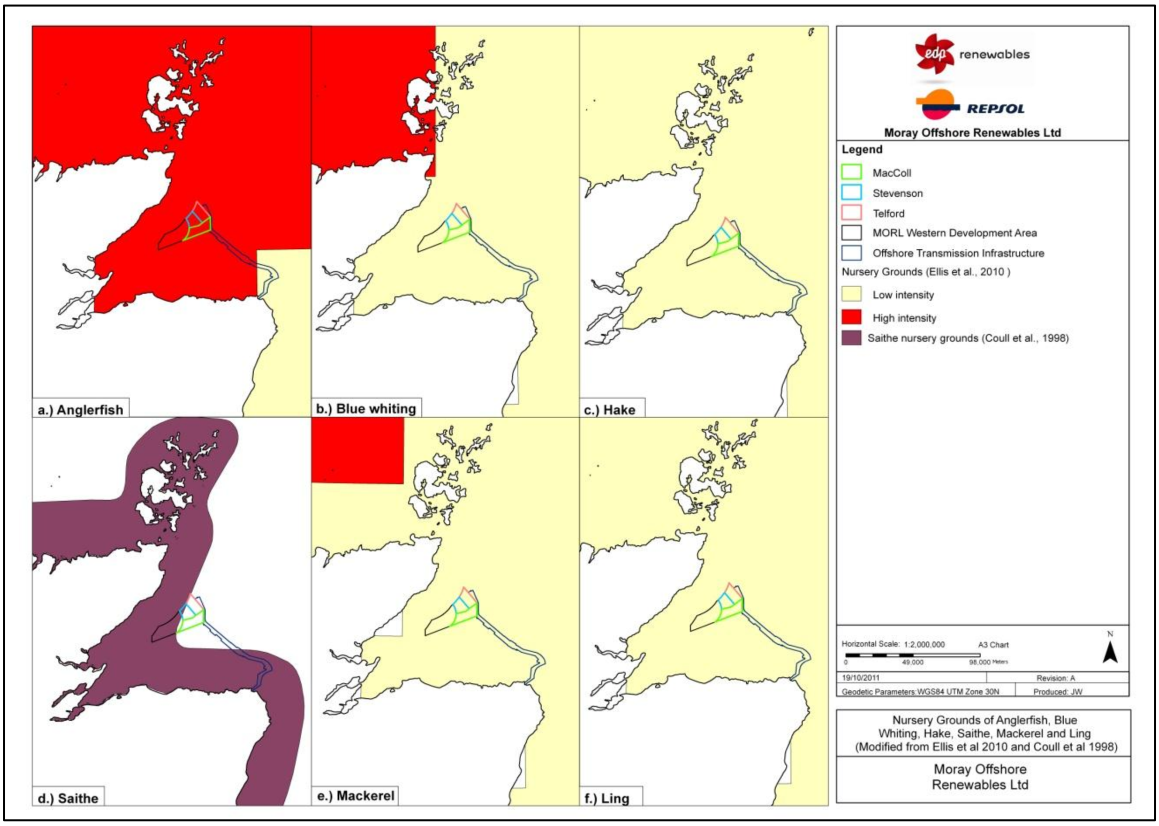

Figure 3.11 Nursery grounds of anglerfish, blue whiting, hake, saithe, mackerel and ling (Modified from Ellis *et al* 2010 and Coull *et al* 1998)

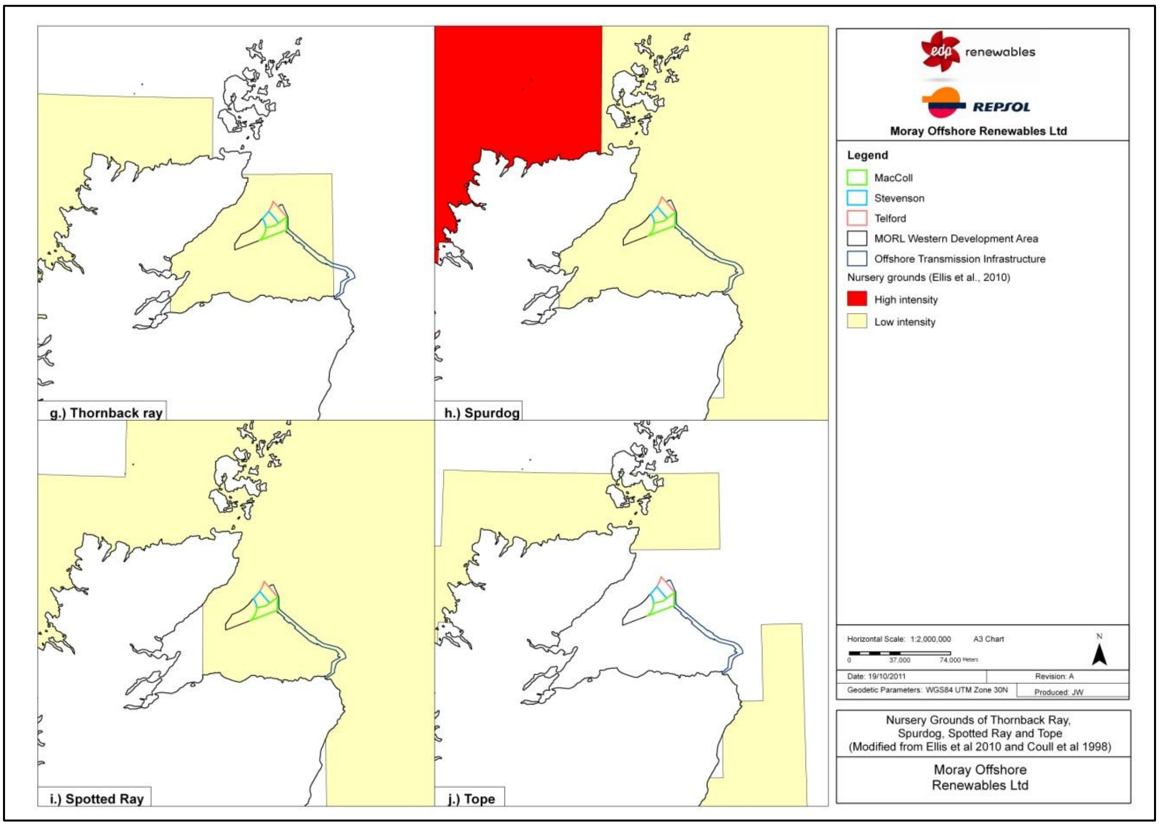

Figure 3.12 Nursery grounds of haddock, thornback ray, spurdog, spotted ray and tope (Modified from Ellis *et al* 2010 and Coull *et al* 1998)

3.4 Species of Conservation Importance

A number of species of conservation importance have been identified as potentially present in the Moray Firth and the wider area. These include diadromous migratory species, elasmobranchs and commercial fish species.

Diadromous migratory species potentially using areas relevant to the OfTI and their conservation status are given in Table 3.4. This includes European eel, allis and twaite shad, sea and river lamprey, smelt, salmon and sea trout.

Elasmobranch species with conservation status and/or declining stocks, may also use areas relevant to the OfTI, these are given in Table 3.5. Elasmobranchs have slow growth rates and low reproductive output compared to other species groups. This results in slow rates of stock increase and low resilience to fishing mortality. Directed fisheries have caused stock collapse for many species, although at present, mortality in mixed-species and by-catch fisheries seems to be a more important threat.

In addition to the above, a number of other fish species with conservation status may be present in the area of the OfTI. The majority of these are commercially exploited in the Moray Firth having been recorded in landings data (2000 to 2009) within the study area. These are given Table 3.6.

Table 3.4 Diadromous species of conservation importance in the Moray Firth

Common Name	Scientific Name	Conservation Status								
		OSPAR	IUCN Red List	Bern Convention	Habitats Directive	The Wildlife & Countryside Act 1981	The Conservation (Natural Habitats, &c.) Regulations 1994	UK BAP species	Scottish Priority Marine Feature (PMF)	The Nature Conservation (Scotland) Act 2004
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	✓	✓	-	✓	✓	✓	-
Smelt	*Osmerus eperlanus*	-	Least concern	-	-	-	-	✓	✓*	-
Salmon	*Salmo salar*	✓	Lower Risk/least concern	✓	✓	-	✓	✓	✓	-
Sea Trout	*Salmo trutta*	-	Least concern	-	-	-	-	✓	✓	-
(*)= Due to be added to SNH PMF list (MS communication, 20/10/2011)										

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Table 3.5 Principal elasmobranch species with conservation status recorded in the Moray Firth

Common Name	Latin Name	MMO Landings Data	Recorded in the Moray Firth (Ellis *et al* 2005)	Conservation Status						
				OSPAR	IUCN Red List	The Wildlife & Countryside Act 1981	The Conservation (Natural Habitats, &c.) Regulations 1994	UK BAP species	Scottish Priority Marine Feature (PMF)	The Nature Conservation (Scotland) Act 2004
Sharks										
Basking shark	*Cetorhinus maximus*	-	-	✓	Vulnerable	✓	-	✓	✓	✓
Blue shark	*Prionace glauca*	-	-	-	Near threatened	-	-	✓	-	-
Leafscale gulper shark	*Centrophorus squamosus*	✓	-	✓	Vulnerable	-	-	✓	-	-
Porbeagle	*Lamna nasus*	-	-	✓	Vulnerable	-	-	✓	-	-
Portuguese dogfish	*Centroscymnus coelolepis*	✓	-	✓	Near threatened	-	-	✓	-	-
Spurdog	*Squalus acanthias*	✓	✓	✓	Vulnerable	-	-	✓	✓	-
Skates and Rays										
Long-nosed skate	*Dipturus oxyrinchus*	✓	-	-	Near threatened	-	-	-	-	-
Sandy ray	*Leucoraja circularis*	-	-	-	Vulnerable	-	-	✓	-	-
Spotted ray	*Raja montagui*	-	✓	✓	Least concern	-	-	-	-	-
Thornback ray	*Raja clavata*	✓	✓	✓	Near Threatened	-	-	-	-	-

Table 3.6 Conservation status of fish species recorded in landings data (2000 to 2009) of the study area

Common Name	Latin name	Scottish Priority Marine Feature	UK BAP Species	OSPAR	IUCN Red List
Anglerfish	*Lophius piscatorius*	✓ (juveniles)	✓	-	-
Atlantic halibut	*Hippoglossus hippoglossus*	-	✓	-	Endangered
Atlantic mackerel	*Scomber scombrus*	✓	✓	-	-
Black scabbardfish	*Aphanopus carbo*	-	✓	-	-
Blue ling	*Molva dypterygia*	-	✓	-	-
Cod	*Gadus morhua*	✓	✓	✓	Vulnerable
Greenland halibut	*Reinhardtius hippoglossoides*	-	✓	-	-
Hake	*Merluccius merluccius*	-	✓	-	-
Herring	*Clupea harengus*	✓ (juveniles and spawning adults)	✓	-	Least concern
Horse mackerel	*Trachurus trachurus*	-	✓	-	-
Ling	*Molva molva*	✓	✓	-	-
Plaice	*Peluronectes platessa*	-	✓	-	Least concern
Roundnoise Grenadier	*Coryphaenoides rupestris*	-	✓	-	-
Saithe	*Pollachius virens*	✓ (juveniles)	-	-	-
Sandeels	*Ammodytes marinus*	✓	✓	-	-
	Ammodytes tobianus	✓	-	-	-
Whiting	*Merlangius merlangus*	✓ (juveniles)	✓	-	-

4.0 References

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