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Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Annex 6-2: Site Characterisation Fish Survey Report - Autumn 2016

June, 2018, Revision A

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June, 2018

Drafted By:	Ocean Ecology Ltd
Approved By:	Helen Jameson
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Revision	A

Thanet Extension Offshore Wind Farm

Site Characterisation Autumn Fish Survey Report 2016

Ref: VATTE1116_SR

Prepared for

Vattenfall Wind Power Limited

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Executive Summary

This report summarises the first of two site characterisation surveys for commercial fish and epifaunal communities at the proposed Thanet Extension Offshore Wind Farm undertaken by Ocean Ecology Limited on behalf of Vattenfall Wind Power Limited. This survey was undertaken in the autumn, between the 19th and 25th November 2016 aboard the *Seiont-A*. During the surveys a total of 16 otter trawl and 16 2 m beam trawl stations were sampled, encompassing the development site, the cable route, the zone of potential secondary impacts and a reference area, where no impacts from the proposed development are anticipated.

This report aims to provide a summary of the methods employed and present preliminary high level results of the commercial fish, juvenile fish and epifaunal communities within and adjacent to the proposed development. Detailed analysis of data will be presented in a final technical report following the spring survey, to be undertaken in April 2017 and therefore only initial observations are presented here.

LIST OF ABBREVIATIONS

BT	Beam Trawl
CPUE	Catch per Unit Effort
DPR	Daily Progress Report
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
FLO	Fisheries Liaison Officer
IMCA	International Marine Contractors Association
KEIFCA	Kent and Essex Inshore Fisheries and Conservation Authority
MCA	Marine Contractors Association
MESH	Mapping European Seabed Habitats
MMO	Marine Management Organisation
N	Abundance
NMBAQC	National Marine Biological Analytical Quality Control
OT	Otter Trawl
OWF	Offshore Wind Farm
PRIMER	Plymouth Routines in Multivariate Ecological Research
ROG	Recommended Operating Guidelines
S	Diversity
SE	Standard Error
SSS	Side Scan Sonar
MCA	Maritime and Coastguard Agency
MBES	Multi-Beam Echosounder
TCE	The Crown Estate
TE	Thanet Extension
TFA	Thanet Fishermen's Association
UK	United Kingdom
UXO	Unexploded Ordinance
WoRMS	World Register of Marine Species

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1. INTRODUCTION

1.1. Thanet Extension Offshore Wind Farm

Vattenfall Wind Power Ltd. (Vattenfall), are investigating the possibility of developing an extension (Thanet Extension (TE)) (the Project) to the operational Thanet Offshore Wind Farm (OWF), a 35 km^2, 300MW development located approximately 10-20 km from the Kent coastline, east of Foreland Point (Figure 1). At present, plans include an array of 40 turbines within an area of up to 80 km^2 that will extend from the current Thanet OWF in all directions. An export cable will be installed to transport generated power back to shore and proposals indicate this will follow the existing Export Cable Corridor (ECC) for Thanet OWF making landfall at one of two proposed locations between Ramsgate and Sandwich. The TE site is situated in the vicinity of nearby operational wind farms: London Array to the north, Greater Gabbard and Galloper to the northeast, Gunfleet Sands I, II and Demonstration to the northwest and Kentish Flats I and II to the west.

1.2. Project Description

The project will require an Environmental Impact Assessment (EIA) within which the environmental impacts of the Project on fish communities in the area will be assessed. Vattenfall therefore require robust characterisation information on the important fish and shellfish communities within and immediately adjacent to the Project area to inform the impact assessment. Vattenfall have commissioned Ocean Ecology to undertake a programme of fish characterisation surveys during the autumn of 2016 and spring 2017 to correspond with peak periods of interest with respect to fish. This included a combination of commercial otter trawl and 2 m scientific beam trawl sampling to characterise both adult and juvenile fish and epifaunal communities within the proposed footprint of the Project, as agreed with the local fishing industry and statutory advisors. The survey programme will be underpinned by the TE Fish Ecology Characterisation Strategy (CMACS, 2016).

1.3. Baseline Conditions

1.3.1. Abiotic Conditions

The wind farm is situated in an area of water varying in depth from 13 m to 33 m with the shallowest areas recorded on the inshore, western edge of the wind farm site and deeper areas extending offshore to the east of the site. On review of EMODnet online data (www.emodnet.eu) and baseline Side Scan Sonar (SSS) and Multi-Beam Echosounder (MBES) data made available during the 2016 geophysical survey programme at the proposed site, the seabed appears complex with areas of finer sand and muds in deeper waters to the north, northwest and east of the site, mixed sediments within the central region and isolated patches of sands and muddy sands in places. The seabed along the ECC also appears relatively heterogeneous with mixed and coarse sediments located in the central and offshore end with rocky substratum identified along the inshore end.

The baseline geophysical data further correlates the EMODnet mapping with respect to potential areas of Ross worm (*Sabellaria spinulosa*) reefs across the TE development area particularly in the northwest corner and north eastern areas of the proposed extension. The data corroborates findings of a recent study on the existing Thanet OWF which identified dense reef across the existing site by repeated high resolution mapping and subsequent ground-truthing (Pearce et al., 2014). This suggests that these areas of potential *S. spinulosa* reef identified across the TE development area may represent extensions of the reef known to occur within the existing Thanet OWF area. Further investigation into the potential areas of *S. spinulosa* reef was undertaken during a conflicts check of proposed trawl locations, as described in Section 14.

1.3.2. Fish Communities

Fish monitoring undertaken at the existing Thanet OWF recorded numerous flatfish; particularly dab, *Limanda limanda*, plaice, *Pleuronectes platessa* and Dover sole, *Solea solea*, and to a lesser extent, flounder, *Platichthys flesus* and lemon sole, *Microstomus kitt*. Round fish included whiting, (*Merlangius merlangus*), pouting (*Trisopterus luscus*), goby spp., Gobidae and Clupidae (the family that herring belong to) (Royal Haskoning 2013a). Dover sole, *S. solea* have known spawning and nursery grounds nearby as do herring (*Clupea harengus*) which spawn within Herne Bay, to the west of the development in the spring. In discussion with the Thanet Fishermen's Association (TFA) seabass is thought to be most prevalent about the Project site during the spring. The Project's Fisheries Liaison Officer (FLO) also confirmed that as well as Dover sole, rays are significant commercial species at the Project site along with cod (*Gadus morhua*) and seabass (*Dicentrarchus labrax*). These waters are considered important for elasmobranch species, particularly the thornback ray, *Raja clavata* which is known to have inshore nursery grounds in the region (Ellis et al. 2012). In addition to thornback rays, a number of other elasmobranch species occurred during monitoring surveys for the Thanet OWF but most notably the small-spotted catshark (*Scyliorhinus canicula)*, and to a lesser extent, the starry smoothhound (*Mustelus asterias*) (Royal Haskoning, 2013b).

Important shellfish resources are also known to include lobster, *Homarus gammarus*, edible crab, *Cancer pagurus,* brown shrimp*, Crangon crangon,* king scallop*, Pecten maximus* and queen scallop*, Aequipecten opercularis*. There is also significant fisheries in the area targeting the common whelk, *Buccinum undatum* and more recently along the ECC, blue mussel, *Mytilus edulis*.

A number of species of conservation and commercial interest that are thought to potentially be present in the vicinity of the Project are presented in Table 1.

Table 1 List of commercially important species and species of conservation interest potentially present within the proposed TE wind farm and surrounding areas as informed by a review undertaken as part of the characterisation survey strategy (CMACS, 2016), monitoring undertaken at the existing Thanet OWF (Royal Haskoning, 2013a and 2013b) and through discussion with the Thanet Fisherman's Association (TFA).

Common Name	Scientific Name	Species of Conservation Interest	Commercially Important in Area of Interest	Notes
Marine Fish				
Dover sole	*Solea solea*	✓	✓	Significant commercial species in survey area. TE close to spawning and nursery grounds
Cod	*Gadus morhua*	✓	✓	Significant commercial species in survey area. Prefer soft sandy sediments.
Whiting	*Merlangius merlangus*	✓	✓	Prefer sand or sand mud. TE close to spawning areas
Pouting	*Trisopterus luscus*	×	✓	Prefer coarser ground.
Plaice	*Pleuronectes platessa*	✓	✓	Prefer soft sediments.
Dab	*Limanda limanda*	×	✓	Prefer soft sandy sediments
Seabass	*Dicentrarchus labrax*	✓	✓	Significant commercial species in survey area. Abundant throughout spring / summer when targeted commercially
Flounder	*Platichthys flesus*	✓	✓	Common over numerous substrates
Lemon sole	*Microstomus kitt*	×	✓	Recorded at Thanet OWF in fewer abundances
Herring	*Clupea harengus*	✓	✓	Spawn within Herne Bay to the west of TE in spring. Known to aggregate between Ramsgate and Foreland Point.
Gobies	*Pomatoschistus spp.*	✓	×	Common throughout UK waters
Elasmobranchs				
Thornback ray	*Raja clavata*	✓	✓	Predominant species in monitoring surveys at Thanet OWF. Prefer soft sand and muddy sediments. Significant commercial species in survey area.
Smallspotted catshark	*Scyliorhinus canicula*	×	×	Predominant species in monitoring surveys at Thanet OWF
Starry smoothhound	*Mustelus asterias*	×	✓	Predominant species in monitoring surveys at Thanet OWF
Spurdog	*Squalus acanthias*	✓	✓	Common over numerous sediments
Tope	*Galeorhinus galeus*	✓	✓	Recorded at Thanet OWF
Diadromous Fish				
Allis shad	*Alosa alosa*	✓	×	Rare in the UK and not confirmed in the TE area
Twaite shad	*Alosa fallax*	✓	×	Present in Thames estuaries but not in the vicinity of the TE area
Salmon	*Salmo salar*	✓	✓	Very unlikely but present in rivers of near to TE, may pass through site.
Sea trout	*Salmo trutta*	✓	✓	Very unlikely but present in rivers of near to TE, may pass through site.
Smelt	*Osmerus eperlanus*	✓	✓	Mid water species. Enter rivers in the vicinity of TE and the Thames estuary
Shellfish				
Common whelk	*Buccinum undatum*	×	✓	Targeted within survey area
Edible crab	*Cancer pagurus*	×	✓	Prefer rock or hard substrate. Targeted within survey area
Lobster	*Homarus gammarus*	×	✓	Prefer rock or hard substrate. Targeted within survey area
Blue mussel	*Mytilus edulis*	In reef form	✓	Commercially harvested along Export Cable Corridor
Brown shrimp	*Crangon crangon*	×	✓	Burrows in sand and muddy sand
King scallop	*Pecten maximus*	×	✓	Epibenthic species. Prefers firm sand, fine or sandy gravel and muddy sand
Queen scallop	*Aequipecten opercularis*	×	✓	Epibenthic species. Prefers sand or gravel

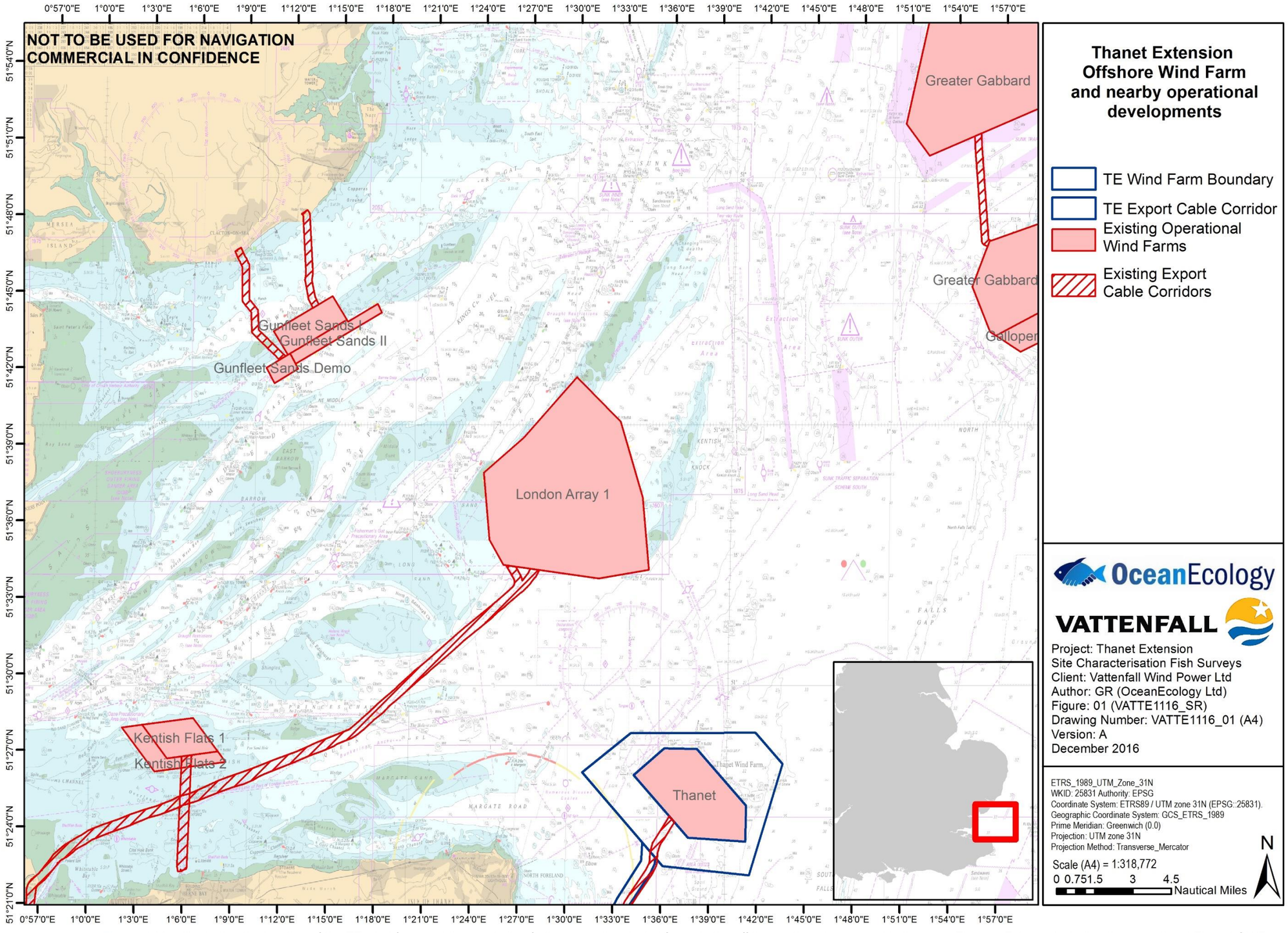


Figure 1 *Map illustrating the location of the TE wind farm and the proximity of other operational wind farms in the off the southeast coast and in the outer Thames Estuary, including the operational Thanet OWF.*

2. METHODS

2.1. Timing

Fish characterisation surveys are to be undertaken twice annually with one survey in the autumn and one survey in the following spring. This report summarises the findings of the autumn survey which was undertaken early in November 2016 following a geophysical programme at the TE site which was used to further inform the conflicts check and overall sample design. Detailed survey logs including dates and times for each tow location is provided in Appendix 1.

2.2. Sampling Rationale

2.2.1. Sampling Method

The aim of these characterisation surveys is to establish the abundance and composition of adult and juvenile fish and epibenthic species within the area of the proposed TE wind farm. These surveys have been designed in consultation with Vattenfall, the project FLO, members of the TFA and the Kent and Essex Inshore Fisheries and Conservation Authority (KEIFCA) and in line with current best practice guidelines (Cooper & Coggan, 2006). With the primary aim to characterise commercial fish communities across the Project site, a standard demersal otter trawl was employed supported by 2 m beam trawl sampling to characterise juvenile fish and epibenthic species.

Despite an abundance of data collected during the fish monitoring programme for the existing Thanet OWF, it was considered that a targeted programme of surveys specific to the TE footprint area be undertaken to further support the wider impact assessment. It is also noted that the proposed footprint of TE includes areas of different substratum (notably sandy mud and muddy sand) which could potentially support different communities of fish (CMACS, 2016) and therefore these surveys have been aimed at characterising the fish communities in these areas. As a result of the monitoring programme at Thanet OWF there is considerable knowledge on fish communities within and immediately adjacent to the site and therefore the number of tows proposed (16 per gear) was deemed to be sufficient (CMACS, 2016).

The previous monitoring programme for the Thanet OWF included the deployment of set nets specifically targeting elasmobranchs (sharks, skates and rays) however these did not provide significant additional information as both the set net and otter trawl survey showed the predominance of the same three elasmobranch species (*R. clavata, S. canicula* and *M. asterias*). It was therefore considered unnecessary to undertake dedicated elasmobranch surveys for the Project at this stage.

Juvenile fish and epifauna are not sampled effectively using demersal otter trawls and therefore 2 m beam trawl sampling has been included as it is an effective gear for sampling both mobile and colonial epibenthic megafauna from discrete sites.

2.2.2. Proposed Tow Locations

In March 2016, CMACS Ltd were commissioned by Vattenfall to prepare a strategy for characterising fish communities within the proposed Project site as part of the wider EIA process. It was proposed in the fish characterisation strategy document (CMACS, 2016) that 16 otter trawl and 16 2 m beam trawls; four each along the ECC and 12 each within the proposed wind farm array footprint be undertaken. These proposed tow locations were selected according to known sediment types and to avoid shallow waters where trawling would not be possible whilst ensuring the range of seabed habitats inferred from EMODNet data were sampled. Tow orientation akin to that used during existing fish monitoring surveys (northwest to southeast) of the existing Thanet OWF were retained and three tow locations (OT06, BT06 and BT14), including their identifiers matched

tows undertaken during these surveys to allow for comparisons between acquired data and historical data. The four tow locations along the ECC were located beyond a 200 m buffer both from and parallel to the existing Thanet OWF cable to avoid potential damage.

Prior to autumn fish surveys, the proposed tow locations were subject to change following a review of data made available from the baseline geophysical programme and a detailed conflicts check (Section 2.2.3).

2.2.3. Conflicts Check

As part of preparations for the survey, a full conflicts check of the 16 proposed otter trawl and beam trawl locations was undertaken, along with a review of the overall survey design, informed by the latest geophysical data collected across the Project site and adjoining cable corridor in summer 2016. As a result of limited data availability, only a partial conflicts check (admiralty chart and habitat type data) was undertaken on the four tow locations along the ECC.

Any potential conflicts with shallow water, subsea cables, marked wrecks, dangerous areas (e.g. military practice, mine disposal, spoil grounds), other marine infrastructure (buoys, channel markers), archaeological features and potential Unexploded Ordnance (UXO) were identified. Full details of this conflicts check including a detailed review of potential *S. spinulosa* reef areas and survey design review are detailed in a report provided to Vattenfall in October 2016 (Ocean Ecology, 2016), provided as Appendix 2 to this report.

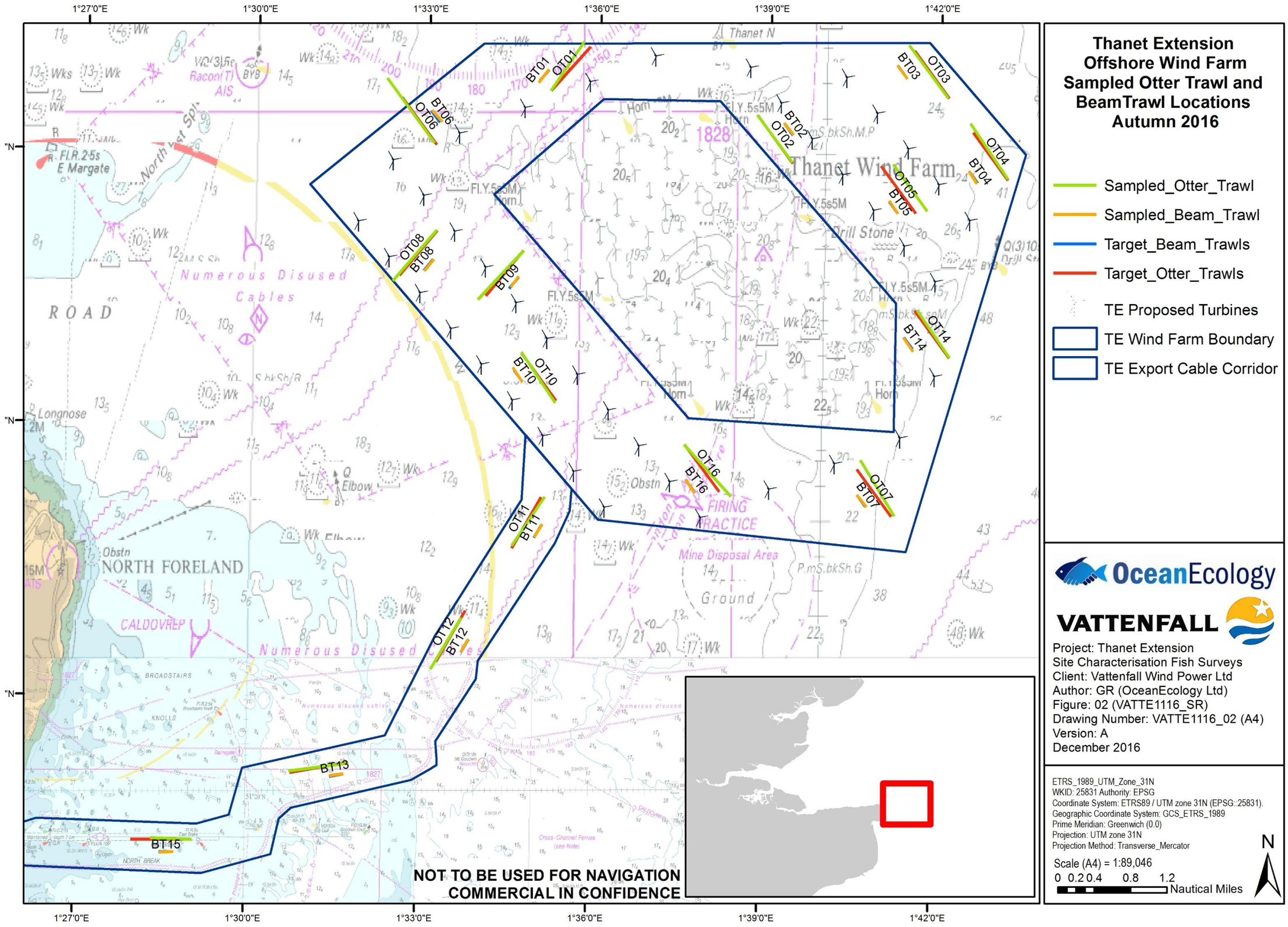
In summary, 9 of the 12 wind farm beam trawl locations and 10 of the 12 otter trawl locations were revised due to conflicts with the proposed TE infrastructure (limiting future monitoring at these locations), a concurrent metocean campaign, *S. spinulosa* reef, subsea cables and unfavourable ground. Two of the originally proposed otter trawl locations were positioned outside the revised footprint boundary and therefore required relocating to within the revised Project boundary. Where possible, the distance at which tow locations were relocated was kept to a minimum, the orientation of the tow was kept consistent and the target substrate/sediment type was maintained.

2.2.4. Final Trawl Locations

Following the conflicts check, a final survey array of 16 otter trawl and 16 beam trawl locations was agreed with Vattenfall and targeted during the autumn survey within the proposed wind farm array and export cable corridor (Table 2). The distribution of these tow locations in relation to the Project footprint including as sampled locations (autumn 2016) is mapped in Figure 2.

Table 2 Summary of the trawl samples belonging to each treatment.

	Otter Trawl	Beam Trawl
Wind Farm	**OT01, OT02, OT03, OT04, OT05, OT06, OT07, OT08, OT09, OT10, OT14, OT16**	**BT01, BT02, BT03, BT04, BT05, BT06, BT07, BT08, BT09, BT10, BT14, BT16**
Cable Route	**OT11, OT12, OT13, OT15**	**BT11, BT12, BT13, BT15**



Thanet Extension Offshore Wind Farm Sampled Otter Trawl and BeamTrawl Locations Autumn 2016

- Sampled_Otter_Trawl
- Sampled_Beam_Trawls
- Target_Beam_Trawls
- Target_Otter_Trawls
- TE Proposed Turbines
- TE Wind Farm Boundary
- TE Export Cable Corridor

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Project: Thanet Extension
Site Characterisation Fish Surveys
Client: Vattenfall Wind Power Ltd
Author: GR (OceanEcology Ltd)
Figure: 02 (VATTE1116_SR)
Drawing Number: VATTE1116_02 (A4)
Version: A
December 2016

ETRS_1989_UTM_Zone_31N
WKID: 25831 Authority: EPSG
Coordinate System: ETRS89 / UTM zone 31N (EPSG::25831).
Geographic Coordinate System: GCS_ETRS_1989
Prime Meridian: Greenwich (0.0)
Projection: UTM zone 31N
Projection Method: Transverse_Mercator

Scale (A4) = 1:89,046
0 0.2 0.4 0.8 1.2 Nautical Miles

N

Figure 2 Target trawl locations and as-sampled trawl locations during the autumn 2016 fish surveys at the TE wind farm.

2.3. Dispensations

A dispensation from the MMO for the Provisions of Council Regulation 850/98 article 19 (3) to catch and retain undersize fish for scientific research specifically relating to days at sea was obtained prior to commencement of both surveys. A byelaw derogation from the KEIFCA was obtained for all trawl locations within the six nautical mile fishery limit and a small works consent licence was obtained from The Crown Estate (TCE) as part of the wider programme of surveys at the Project site.

2.4. Overview of Progress

The fish surveys were undertaken between the 14th and 18th of November 2016. A summary of daily activity for the survey period is provided in Table 3 below and Daily Progress Reports (DPRs) are provided as Appendix 3 to this report.

Table 3 Progress log for the TE Site Characterisation fish surveys, undertaken in Autumn 2016.

DATE	ACTIVITY
13/11/16	Survey team mobilised to Ramsgate and met with the survey vessel, *Seiont-A*, to finalise mobilisation of survey gear and equipment. Vessel was moved from home port in Whitstable to Ramsgate earlier in the day.
14/11/16	12 out of the 16 otter trawls sampled. Only 4 cable corridor locations remain with a successful sample obtained at all 12 sampled locations. Generally hauls were low in abundance of individuals and often of low diversity dominated by a few key species that were sampled at the majority of trawl locations. **Otter Trawls Complete: 1,2,3,4,5,6,7,8,9,10,14,16** NB Trawl location OT05 was moved 200m NE to avoid potential conflict with static gear but all other trawl locations were sampled to target locations. Weather consistent throughout the day and workable during all hours of daylight. Light SW / W winds F2-3.
15/11/16	The otter trawl survey was completed with all 16 samples obtained successfully. **Otter Trawls Complete: 11,12,13,15** **Beam Trawls Complete: 1, 6, 9** NB Trawl station 15 had to be terminated after 15 minutes and approximately ¾ through the survey line due to extremely rough ground and significant seabed hazards unsuitable for trawling. Weather consistent throughout the day and workable during all hours of daylight. Light W / WSW winds F2.
16/11/16	The beam trawl survey continued today with a further 6 beam trawls successfully sampled. One beam trawl failed due to increasing wave height and the inability to keep the trawl on the seabed throughout the tow however inshore cable route stations remained suitable for sampling. **Beam Trawls Complete: 2, 8, 11, 12, 13, 15** Weather conditions worsened throughout the day with unfavourable conditions suspending survey from approximately midday. Strong westerly winds and a strong ebbing tide meant for significant wave heights in the eastern area of the survey area. Strong W / WSW winds F4-6.
17/11/16	Survey operations suspended all day – waiting on weather.
18/11/16	The remaining 7 beam trawls were completed despite weather conditions remaining marginal. Survey was completed at approximately 1230 and the decision was made to demobilise the boat straight to Whitstable with the incoming gale force weather over the weekend. The vessel was alongside in Whitstable at 1430 and all survey team and equipment demobilised by 1600. **Beam Trawls Complete: 3, 4, 5, 7, 10, 14, 16**

Tidal Limitations

The *Seiont-A* could access Ramsgate at all states of the tide and was therefore not restricted in this regard during the surveys. There was also no shallow access sites within the survey area and therefore no tidal restrictions in terms of accessing tow locations. Due to the survey period coinciding with spring tides there was some downtime as a result of strong and unfavourable tides for the lighter beam trawl tows. The beam trawl survey commenced approximately 1300 hrs on the 15th November however several hours were lost waiting for the tide to ease and allowing for the crew to add additional weight to the beam trawl to ensure it was sampling properly on the seabed.

Weather Downtime

During the survey, there was periods of unfavourable weather during which time the survey approach has to be revised and work continued on the most inshore tow locations only. There was one full day of weather downtime on the 17th November when the vessel remained in port as a result of strong southerly winds making conditions onsite unfavourable for survey operations.

2.5. Field Methods

2.5.1. Survey Vessels

The autumn fish surveys were undertaken aboard a local commercial fishing vessel, the *Seiont-A* (Plate 1), working out of Ramsgate. The *Seiont-A* underwent International Marine Contractors Association (IMCA) M149 and Vattenfall vessel safety audits prior to mobilising to the TE site.

A summary vessel specification for the *Seiont-A* is provided in Table 4.

The *Seiont-A* is a reliable and comfortable fishing vessel with experience of undertaking commercial otter trawl, scientific beam trawl, benthic grab surveys, marine mammal and ornithological surveys in the past to support offshore wind developers through EIAs and monitoring programmes. The skipper of the *Seiont-A,* Matthew Barnes, is an experienced and well respected fisherman and member of the TFA and therefore has an excellent understanding of the commercial fisheries and fishing activity in the area.

All crew and scientific personnel were required to undertake Vattenfall safety inductions prior to boarding the survey vessel and held a minimum of ENG1 seafarers medical and STCW 95 sea survival certificates (or equivalent).

Table 4 Vessel specification for the commercial fishing vessel, *Seiont-A*, chartered to undertake the TE Autumn fish surveys 2016.

	Seiont-A
Length	17.00 m
Beam	5.10 m
Draft	2.30 m
Main Engine	Cummins NT855

Plate 1. The commercial fishing vessel, *Seiont-A*, chartered to undertake the autumn 2016 TE Site Characterisation fish survey.

2.5.2. Sampling

Methods for both commercial otter trawls and 2 m scientific beam trawls were consistent with those used during the existing Thanet OWF monitoring programme, as outlined below.

2.5.2.1. Commercial Otter Trawl

Otter trawl tows were undertaken for a duration of 20 minutes at a towing speed of 2.5 - 3.0 knots over the ground for a distance of approximately 1.2 km. Tow start times and position were taken at the point when the trawl made contact with the seabed and end times and positions were taken when hauling of the trawl commenced. Otter trawl specifications were kept in line with those used during the existing Thanet OWF monitoring programme and a full specification of gear used is provided in Table 5 below.

2.5.2.2. Scientific Beam Trawl

Beam trawl tows were undertaken in line with the guidelines set out by Ware et al. (2011) and further detailed in the Recommended Operating Guidelines (ROG) for MESH trawls and dredges (MESH, 2007). Tows were undertaken for a duration of 10-15 minutes on the seabed, at a speed over the ground of 1.0 - 1.5 knots that gave an average distance towed of approximately 300 m. The direction of each trawl was dependent on tide and wind conditions, with each trawl generally taking place against the prevailing direction of the tide. Beam trawl specifications were kept in line with those used during the existing Thanet OWF monitoring programme and a full specification of gear used is provided in Table 5 below.

A detailed survey log and positional data for all otter and beam trawls is provided in Appendix 1.

Table 5 Specifications of the otter and beam trawls used during the autumn 2016 TE Site Characterisation fish surveys.

Otter Trawl		Beam Trawl	
Towing warp	16 mm, 50 fathoms	Beam width	2 m
Depth: Payout ratio	3:5:1	Headline height	55 cm
Trawl doors	6 ft Dunbar	Shoe length	77 cm
Net	Rockhopper trawl with a 80 mm mesh cod end	Shoe width	15 cm
Ground line length	25 fathoms	Cod-end liner	5 mm
Est. Headline height	1.05 fathoms		
Distance between doors (est.)	25-26 fathoms		

2.5.3. Sample Processing

Processing of hauls from both otter and beam trawls were undertaken immediately after the nets were retrieved to deck and emptied into fish boxes for sorting. Example imagery taken during the otter trawl and beam trawl surveys is provided in Plate 2.

2.5.3.1. Otter Trawl Sample Processing

Processing of the otter trawl samples was undertaken at sea with all species identified and enumerated. All commercially important fish and shellfish were measured and all elasmobranchs measured and sexed. Fish species were identified according to the Environment Agency Key to the Marine and Freshwater Fishes of Britain and Ireland (Maitland & Herdson, 2009) and the Identification Guide to the Inshore Fish of the British Isles (Henderson, 2014).

Given the small and relatively homogenous catches sampled during the surveys, all fish were returned alive and *en masse*. There were no unidentified fish from the otter trawl surveys that needed to be returned to the Ocean Ecology laboratory. Each haul was subject to the following processing:

- Entire catch (labelled) photographed prior to sorting.
- Catch sorted into the following four major groups: fin fish, sharks, rays, invertebrates.
- Elasmobranchs and larger teleost fish were processed first and returned to the sea immediately *(en masse)* to maximise survival rates, followed by all remaining commercially targeted fish and shellfish. All adult and juvenile fish and shellfish in each otter trawl sample were identified and measured to the nearest cm below. Total length (T_L) (tip of snout to the tip of the caudal fin) measurements were taken for all finfish whilst both T_L and wing width (W_W) (tip to tip) were taken for rays.
- Invertebrates were processed last with all identified and counted where possible. Carapace length (C_L) (rear of eye socket to the rear of the carapace) was taken for lobsters whilst carapace width (C_W) was taken for all crab species. Shell height (S_H) (from tip of the spire to the bottom edge of the body whorl) was taken for whelks and bivalves (e.g. *Mytilus edulis*) were measured using the length parallel to the ventral surface.

- There were no unidentified fish or invertebrates and therefore no additional processing in this respect was required. Any remaining colonial organisms (hydroids, soft corals and bryozoans) were simply recorded as present or absent.
- Only when all individuals were identified, enumerated and measured was the sample returned to the water (*en masse*) to maximise survival rates.

Due to the relatively small hauls retained, there was no requirement for sub-sampling.

At each station detailed field notes were taken on waterproof paper including fix number at the start and end of trawling on the seabed, time down, time up, depth, weather conditions / sea state and recording of notable species. A survey log is provided in Appendix 1.

2.5.3.2. Beam Trawl Sample Processing

Processing of beam trawl samples was undertaken in line with the guidelines set out by Ware et al. (2011) and further detailed in the ROG for MESH trawls and dredges (MESH, 2007). In summary, following a labelled sample photograph being taken, all fish and epibenthic fauna were transferred to a fish table for sorting, identification and enumeration (presence / absence for colonial / encrusting species) in the field. Length measurements (to the nearest cm) were also taken for all commercial fish (rays also measured for wing width) and shellfish species, as described in Section 2.5.3.1 and further photographs were taken of cryptic specimens. When identification required clarification, individuals were transferred to a labelled sample container and identified on return to Ocean Ecology's NMBAQC scheme participating laboratory. The entire sample was returned to the water, only once all individuals were identified, enumerated and measured (where required).

Photographs for all otter and beam trawl samples are provided in Appendix 4 a-d.

Plate 2. Top left: commercial otter trawl being hauled. Top right: otter trawl catch retrieved to deck. Bottom left: measurement of large Tub gurnard (*Chelidonichthys lucerna*). Bottom right: sorting of beam trawl to major groups.

2.5.4. Alternative Sampling in Areas of *S. spinulosa* Reef

It is identified that considerable areas of *S. spinulosa* reef are likely to be present within the TE fish survey area (Section 1.3), particularly in the northwest and northeast corners of the site. Areas of dense reef have also been identified across the existing Thanet OWF site by repeated high resolution mapping and subsequent ground-truthing (Pearce et al., 2014) suggesting that areas of reef may extend into the east and south east of the proposed extension. Trawl sampling over areas of both *S. spinulosa* and stony reef can cause damage to both the reef (Collins 2003; Pearce et al., 2007; Hendrick et al., 2011; Last, 2012) and trawl nets (Defra, 2004 JNCC, 2013) and can therefore have significant conservation and financial implications. To minimise potential interaction of trawl sampling and areas of *S. spinulosa* reef and/or stony reef within the survey area, a review of the side-scan sonar (SSS) and multibeam echo sounder (MBES) data collected during the baseline geophysical survey was undertaken (Section 2.2.3).

In areas where trawl sampling could not be adopted, it was proposed that additional information to further support these surveys would be collected through the use of non-intrusive Baited Underwater Remote Video (BRUV) systems. These systems have recently been shown to be capable of collecting accurate relative abundance and length data of fish and other motile species in low visibility conditions at other offshore windfarm sites in a non-intrusive and repeatable manner (Griffin et al., 2016). Due to time and weather constraints, BRUVs were not deployed during the autumn 2016 surveys however these will be deployed (water clarity permitting)

during future surveys at the site, notably the spring 2017 surveys. Further details on the use of BRUVs at TE is described in the alternative sampling protocol provided to Vattenfall in September 2016 (Ocean Ecology, 2016) and provided as Appendix 5 to this report.

If large quantities of *S. spinulosa* reef were sampled during either the otter or beam trawl sampling an adaptation of the sub-sampling protocol set out in the Recommended operating guidelines (ROG) for MESH trawls and dredges (MESH, 2006) was employed as outlined in the alternative sampling protocol (Appendix 5).

2.6. Data Analysis

2.6.1. Quality Control, Data Truncation & Standardisation

All field notes were cross-checked between ecologists in the field and signed off by the lead ecologist. On return to the laboratory, all field data was entered into an electronic database and checked by a senior ecologist before undergoing nomenclature checks, data truncation and standardisation.

2.6.1.1. Species Nomenclature Checks

The species nomenclature was standardised for all species recorded in the autumn 2016 fish surveys, t to ensure there is consistency with nomenclature of future characterisation and monitoring surveys. Each of the species lists were checked using the World Register of Marine Species (WoRMS) match taxon tool. The resulting species name check matrices are provided in Appendix 6 – Raw Fish Data.

2.6.1.2. Data Truncation

The standardised species lists were examined carefully by a senior ecologist in order to truncate the data, excluding incidental catches that might skew the data analysis. Species records were also combined where differences in taxonomic level were apparent but not consistent (e.g. single *Metridium senile* raised to be included within ACTINIARIA grouping). The rationale used for data truncation is summarised below in Table 6 and the full species lists with notes detailing the rationale for removing and combining each species is provided in Appendix 7 – Abundance and CPUE Data. Raw data, prior to rationalisation is provided in Appendix 6 – Raw Fish Data.

Table 6 Summary of the data truncation rationale.

Truncation Action	Otter Trawl Examples	Beam Trawl Examples
Species removed where they were not adequately / consistently sampled with an otter trawl	**Pelagic shoaling species** e.g. Herring **Burrowing infaunal species** e.g. Spiny Cockle	**Pelagic species** e.g. Ctenophores (comb jellies) **Small infaunal species <5mm** e.g. Amphipods, Polychaetes
Species / groups of particular conservation interest analysed and / or reported separately	**Elasmobranchs** e.g. Thornback ray and small-spotted catshark	N/A
Taxa combined where there were often differences in the way they were recorded between surveys	E.g. *M. senile* to ACTINIARIA	**Inconsistent recording of taxa that could not be identified to the species level** e.g. *Liocarcinus sp.* raised and combined with Portunidae **Differences in analytical methodology** e.g. Hydroids

2.6.1.3. Catch per Unit Effort (CPUE)

In order to standardise the trawl catch data for variable effort, abundances were transformed to Catch per Unit Effort (CPUE) (i.e. catch per hour) using the recorded trawl durations rounded to the nearest minute. Calculations and resulting CPUE abundances are provided in Appendix 7 – Abundance and CPUE Data.

3. PROVISIONAL RESULTS

A provisional summary of the autumn 2016 survey data is presented below. Raw fish data is provided in Appendix 6 and Abundance and CPUE data is provided in Appendix 7. Abundance and distribution for both commercial fish (otter trawls) and juvenile / demersal fish and epibenthic invertebrates (beam trawl) have been discussed and mapped below. An in-depth review of communities is beyond the scope of this survey report. A full interpretation and discussion of the data will be provided in the final technical report following the spring 2017 survey.

3.1. Commercia Fish and Shellfish

3.1.1. Overview of site

The otter trawl surveys undertaken at the Project site revealed an assemblage of fish species of relatively low diversity with a total of 17 taxa recorded and a mean (± SE) of 7.25 ± 0.40 taxa per sample with several taxa seemingly representative of incidental catches at a very small number of sites. A total of 13 species of fish (including two elasmobranch species) and four species of shellfish were recorded with the most frequently recorded fish species being the pouting, *T. luscus* and the most frequently recorded shellfish species being the commercially targeted common whelk, *B. undatum*. Total abundance per tow was also low and largely restricted to higher numbers of the elasmobranch small-spotted catshark, *S. canicula* and thornback ray, *R. clavata*.

Full matrices are provided in Appendix 3 and 4 presenting the raw abundance and weighted CPUE abundance (catch per hour) of each taxon in all trawl samples acquired across the survey area. A summary of abundances and distribution across the TE development site are described below and presented in

Figure 3 to Figure 10.

3.1.2. Community Composition and Distribution

A shade plot was generated based on species abundance data using PRIMER as a means of elucidating differences in the composition of fin fish, shellfish and elasmobranch species associated with the TE development site as presented in

Figure 3Figure 11. Despite a relatively uniform number of taxon per tow (Figure 5), there was a noticeable difference in community composition across the site which correlated well with the range in seabed types, particularly between offshore locations within the wind farm footprint and inshore cable route locations. In general, communities within the wind farm footprint were typical of soft sediment or mixed sediment habitats whilst those on the ECC were more typical of hard substrate communities.

Fish communities reflected this gradient in seabed type with species such as the pouting, *T. luscus* and the small-spotted catshark, *S. canicula* dominating areas of coarser ground and hard substrate in the east of the wind farm site and along the ECC and the thornback ray, *R. clavata* and Dover sole, *S. solea*, dominating communities in soft sediment locations.

3.1.1. Abundance and Diversity

Total abundance of individuals (expressed as CPUE) was generally low and uniform across the survey area (Figure 4). Elevated abundances were largely driven by pouting, *T. luscus*, small-spotted catshark, *S. canicula* and whiting, *M. merlangus*. Despite distinct differences in the communities distributed across the TE site, overall species diversity was largely consistent between tow locations. The diversity of fin fish was much greater than

shellfish or elasmobranch diversity at all tow locations (Figure 5). Abundances of fin fish, shellfish and elasmobranchs are discussed in more detail in the following sections 3.2 and 3.3.

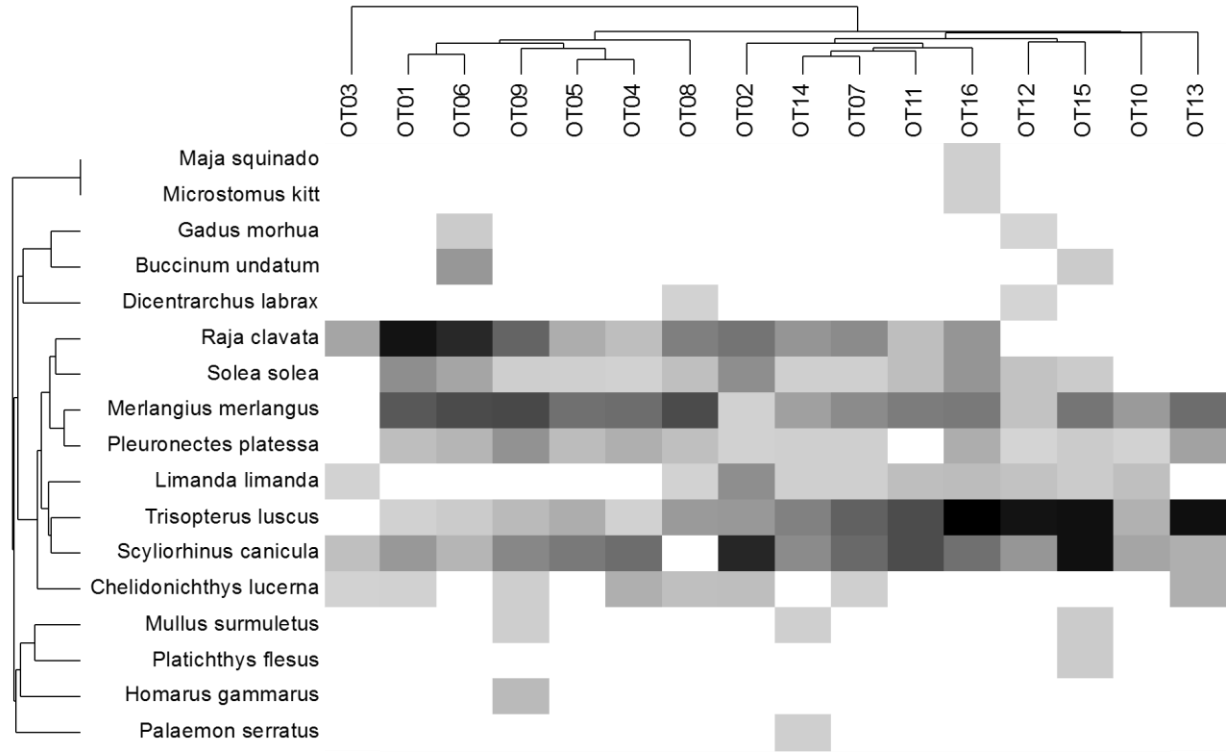


Figure 3 Shade plot generated using forth-root transformed CPUE data to show commercial fish and shellfish community similarity sampled during the autumn 2016 fish survey.

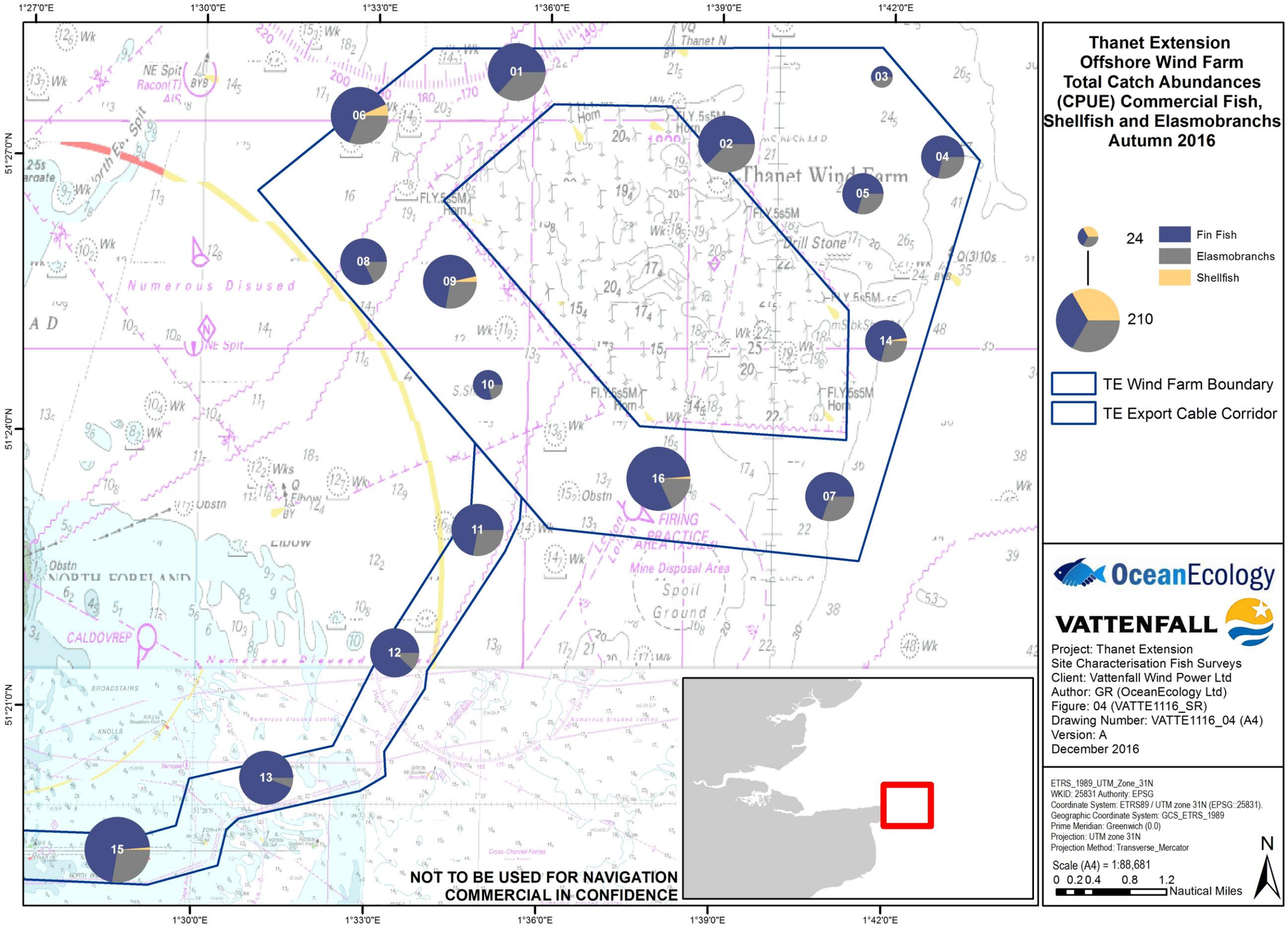


Figure 4 Total abundances (CPUE) of commercial fish, shellfish and elasmobranchs sampled during the autumn 2016 fish survey.

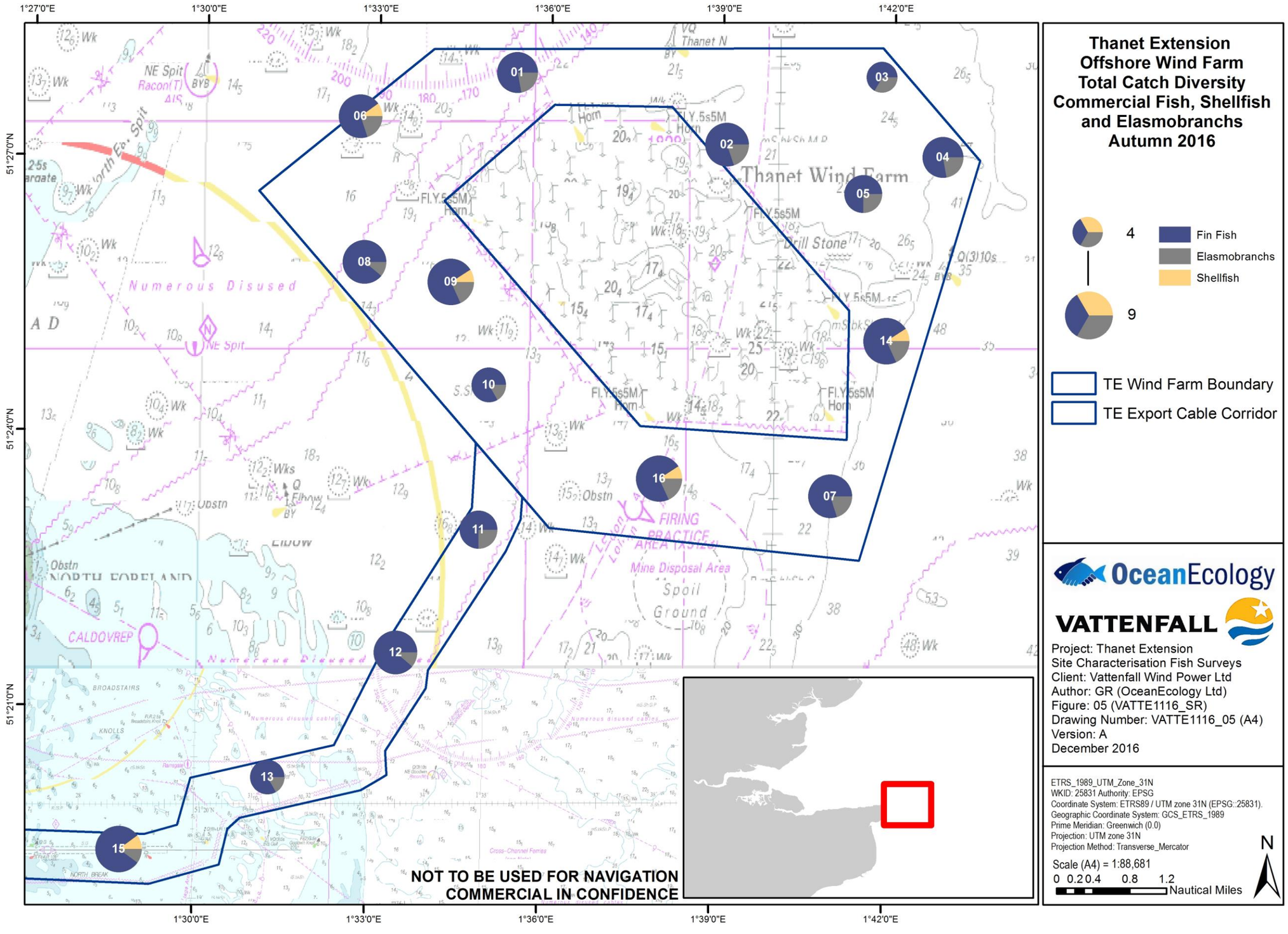


Figure 5 Species diversity and composition of commercial fish, shellfish and elasmobranchs sampled during the autumn 2016 fish survey.

3.2. Commercial Fish Species

Commercial fish species, in this context, include fish and large mobile shellfish that are targeted by commercial fisheries in the UK as well as those that are caught as bycatch by commercial fisheries, whether they are retained or not.

3.2.1. Abundance and Distribution

The total abundance (expressed as CPUE) of commercial fish and shellfish species recorded at each station during the autumn survey has been plotted with pie charts to show relative composition of catches in Figure 6.

The abundance of commercial fish caught across the survey area was found to be elevated at ECC locations, seemingly driven by the elevated numbers of pouting, *T. luscus* rather than an increased diversity and abundance of species. A total of 11 species of fish and four species of shellfish were recorded with the most abundant fish species being the pouting, *T. luscus* and the most abundant shellfish species being the common whelk, *B. undatum*, commercially targeted in the vicinity of the Project. With the exception of OT13 in the northeast corner of the site where only a single dab, *L. limanda* and tub gurnard, *Chelidonichthys lucerna* were recorded, an average of between four and seven commercial fish species were sampled per tow location whereas catches of shellfish species appeared to be incidental between sites (one or two individuals at single sites).

The commercial fish community in this area is dominated by pouting, *T. luscus* and whiting, *M. merlangus* with moderate abundances of Dover sole, *S. solea*, Plaice, *P. platessa*, Dab, *L. limanda* and the tub gurnard, *C. lucerna*. Other fish and shellfish are present only sporadically and in comparatively low numbers. The most diverse location was OT15 at the inshore end of the ECC characterised by hard substrate. Abundances at this location were dominated by pouting, *T. luscus* and to a lesser extent whiting, *M. merlangus* with only single individuals recorded for five other species. Pouting and whiting were also the most widespread of the commercial species being recorded at 15 of the 16 locations sampled. Plaice and dover sole were similarly widespread, recorded at 14 and 13 of the 16 locations sampled respectively. Incidental catches of cod, *G. morhua* and seabass, *D. labrax*, both of particular commercial interest in the area were recorded at just two of the 16 locations sampled.

3.2.2. Key Commercial Fish Species

Of the commercial fish species sampled during the fish and shellfish survey programme, four were sampled in notably higher abundances than any other fish species. These species were whiting, *M. merlangus,* pouting, *T. luscus, Dover sole, S. solea* and plaice, *P. platessa.* The total abundance (expressed as CPUE) and distribution of these key species at each station during the autumn survey is presented in Figure 7 and is summarised below.

3.2.2.1. Pouting

Pouting*, T. luscus* was the most abundant and one of the most widespread fish species sampled across the survey area with an average catch per hour of 34.8 individuals across all otter trawl samples. Pouting was one of few commercial fin fish to show a clear trend in its distribution across the area with abundances focused along the ECC and within the eastern extent of the wind farm footprint. Pouting was recorded at all but the most offshore location, OT03.

3.2.2.1. Whiting

Whiting, *M. merlangus,* was the second most abundant fish species sampled across the survey area also widespread being recorded at 15 of the 16 tow locations. Unlike the other most abundant fish species whiting showed no pattern in its distribution with abundances relatively uniform across the development site. Whiting demonstrated an average catch per hour of 27.8 individuals across all otter trawl samples.

3.2.2.2. Dover Sole

Dover sole, *S. solea* was recorded at 13 of the 16 locations sampled and seemingly favoured offshore areas in the wind farm footprint, in particular those to the north where soft sediments were present. The average catch per hour of *S. solea* was just eight individuals, largely attributed to very low numbers caught inshore along the ECC.

3.2.2.3. Plaice

Pplaice, *P. platessa* was recorded at 14 of the 16 locations sampled with an average catch per hour of 6.9 individuals across all otter trawl samples. Similar to the other flatfish species, plaice seemed to demonstrate a preference for areas of the wind farm footprint where the seabed was characterised by soft mobile sediments.

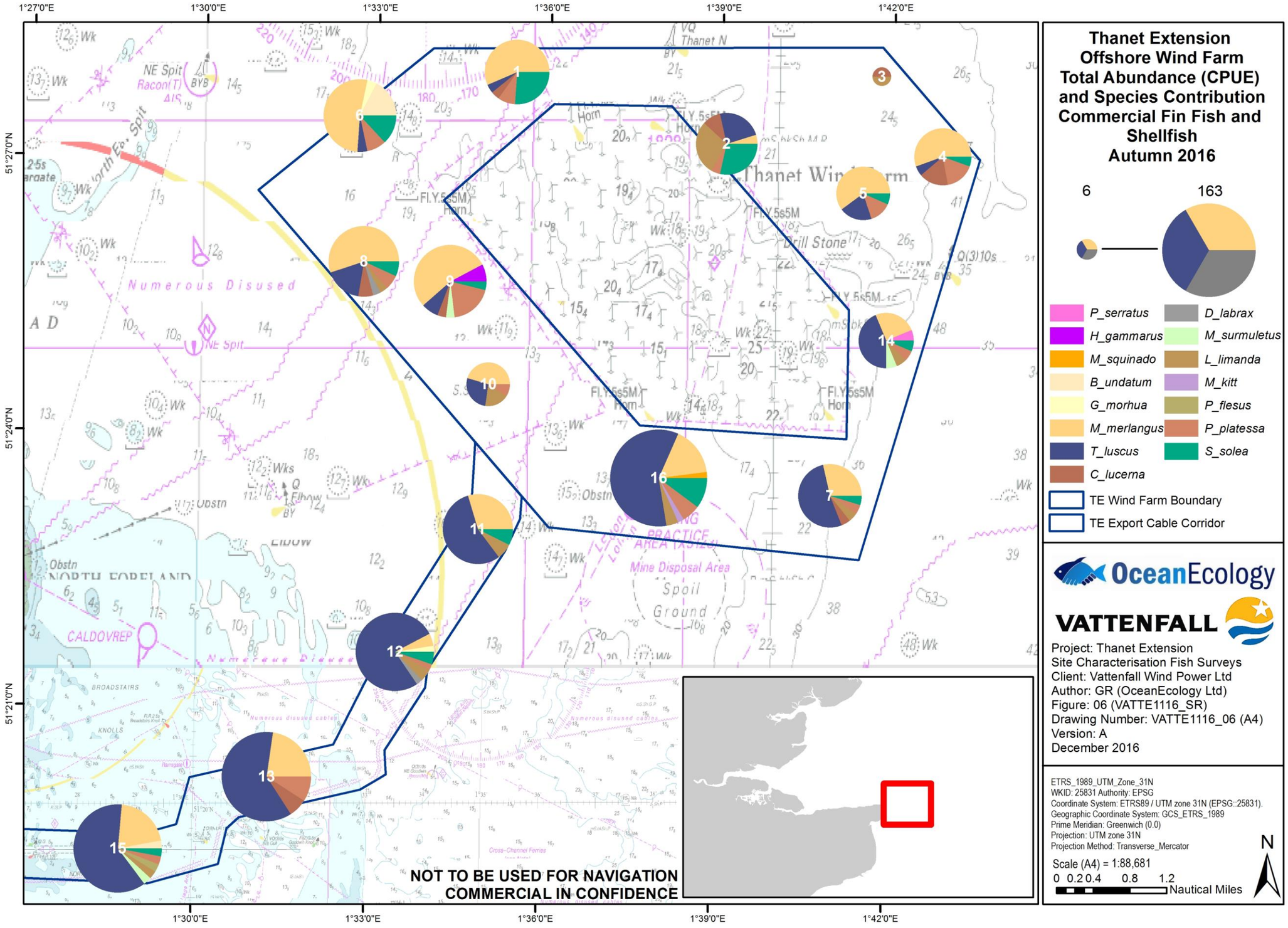


Figure 6 Total abundance (CPUE) and species contribution of commercial fish and shellfish sampled during the autumn 2016 fish survey.

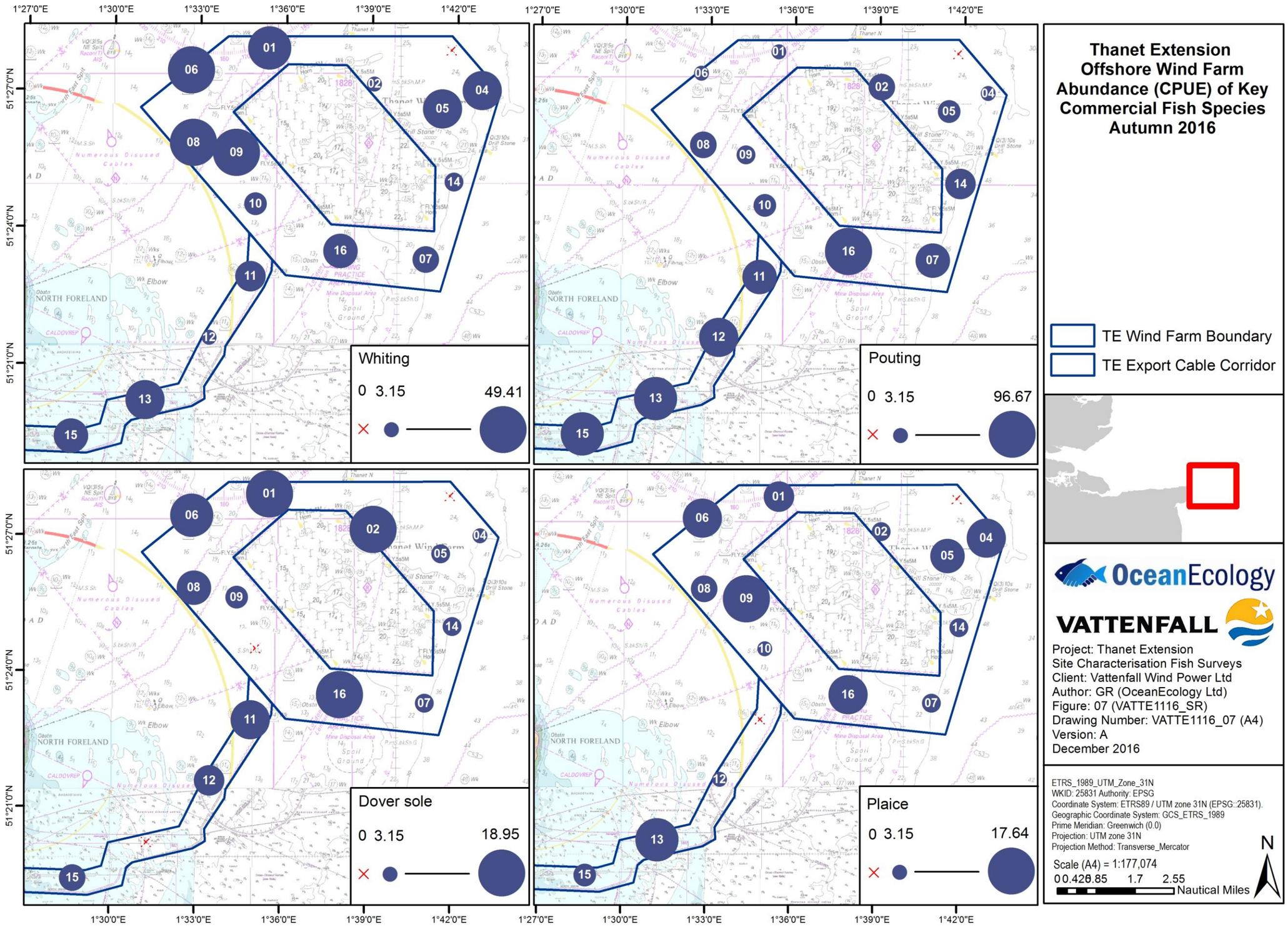


Figure 7 Total abundance (CPUE) of key commercial fish species sampled during the autumn 2016 fish survey.

3.3. Elasmobranchs

Like commercial fin fish, there is a possibility that elasmobranchs (skates and rays) could be impacted by the construction of the Project, and indeed it is thought that this group may be more susceptible to such developments since their sensory systems detect and use electro-magnetic fields in navigation and hunting (Gill, 2005). As such, elasmobranchs have been considered separately to other fin fish and shellfish species.

3.3.1. Abundance & Composition

The total abundance (expressed as CPUE) of elasmobranchs recorded at each station during the autumn survey has been plotted with pie charts showing the relative composition of catches in Figure 8.

There were only two species of elasmobranch recorded during the autumn fish surveys at TE, the small-spotted catshark, *S. canicula* and the thornback ray, *R. clavata* despite a number of other species thought to occur within the area including the starry smoothhound, *M. asterias.* These two species were recorded in comparable abundances with small-spotted catshark exhibiting slightly elevated abundances than thornback ray, likely as a result of its more widespread distribution across the site (Section 3.3.2). Combined abundances of elasmobranch species was greatest in offshore wind farm areas largely due to the restricted abundance of thornback ray on soft sediment areas away from the ECC.

3.3.2. Species Distribution and Sex Ratios

3.3.2.1. Lesser-spotted catshark

The total abundance (expressed as CPUE) of small-spotted catshark, *S. canicula* at each station during the autumn survey has been plotted with pie charts showing male:female sex ratios in Figure 9.

The small-spotted catshark was the more abundant of the two elasmobranch species sampled from the Project site with an average catch per hour of 28.75 individuals across all otter trawl samples. The abundance of catshark was greatest at tow location OT15, the most inshore end of the ECC where the seabed is known to be characterised by hard substrate, however notable abundances were also recorded at tow location OT02 which sampled an area of *S. spinulosa* reef (Section 3.5). Whilst absent from tow location OT08 in the west of the proposed wind farm footprint, the small-spotted catshark was widespread and recorded across a range of habitat types but reduced abundances were observed in the northern area of the windfarm where sediments consist of sands and muddy sands.

The small-spotted catshark is oviparous and therefore lays egg cases onto the seabed (Castro et al. 1988) which may suggest areas of fine sediment, with little suitable flora or fauna for egg attachment, are of less importance particularly during periods of breeding. Catsharks can breed almost year round although the majority of the UK population are thought to lay their eggs in spring with a gap between August and October (Ellis & Shackley, 1997). Indications of seasonal distribution therefore will be better reviewed following the spring 2017 survey.

Also apparent was a distinct spatial segregation between males and females across the site. Figure 9 shows a clear distribution of males in offshore areas and an exclusively female population at inshore locations along the ECC. This correlates well with a known sexually monomorphic trait in small-spotted catshark whereby habitat segregation exists with males living in open seabed areas and females living in more rocky, caved areas (Sims et al. 2001, Wearmouth et al. 2012). This sexually distinct distribution across the TE site is likely to correlate with the greater amount of coarse and rocky substratum habitats inshore.

3.3.2.2. Thornback Ray

The total abundance (expressed as CPUE) of thornback ray, *R. clavata* at each station during the autumn survey has been plotted with pie charts showing male:female sex ratios Figure 10.

The thornback ray, *R. clavata* was caught in relatively high numbers during the survey with an average catch per hour of 27.15 individuals across all otter trawl samples. In contrast to the small-spotted catshark and in line with known distributions on sediments in UK waters (Picton and Morrow, 2016), abundances were generally higher in the northern area of the wind farm where sediments consist of sands and muddy sands. Thornback ray had much reduced distribution in comparison to the small-spotted catshark and with the exception of two individuals caught at tow location OT11, the thornback ray was completely absent from inshore stations along the ECC known to be predominantly hard substrate. The abundance of thornback ray was greatest at tow location OT01, the most northern tow location in an area of sands and muddy sands.

Unlike the small-spotted catshark, there was no apparent trend in distribution of male and female thornback ray across the site nor did either sex predominate over the other in terms of abundance (Figure 10).

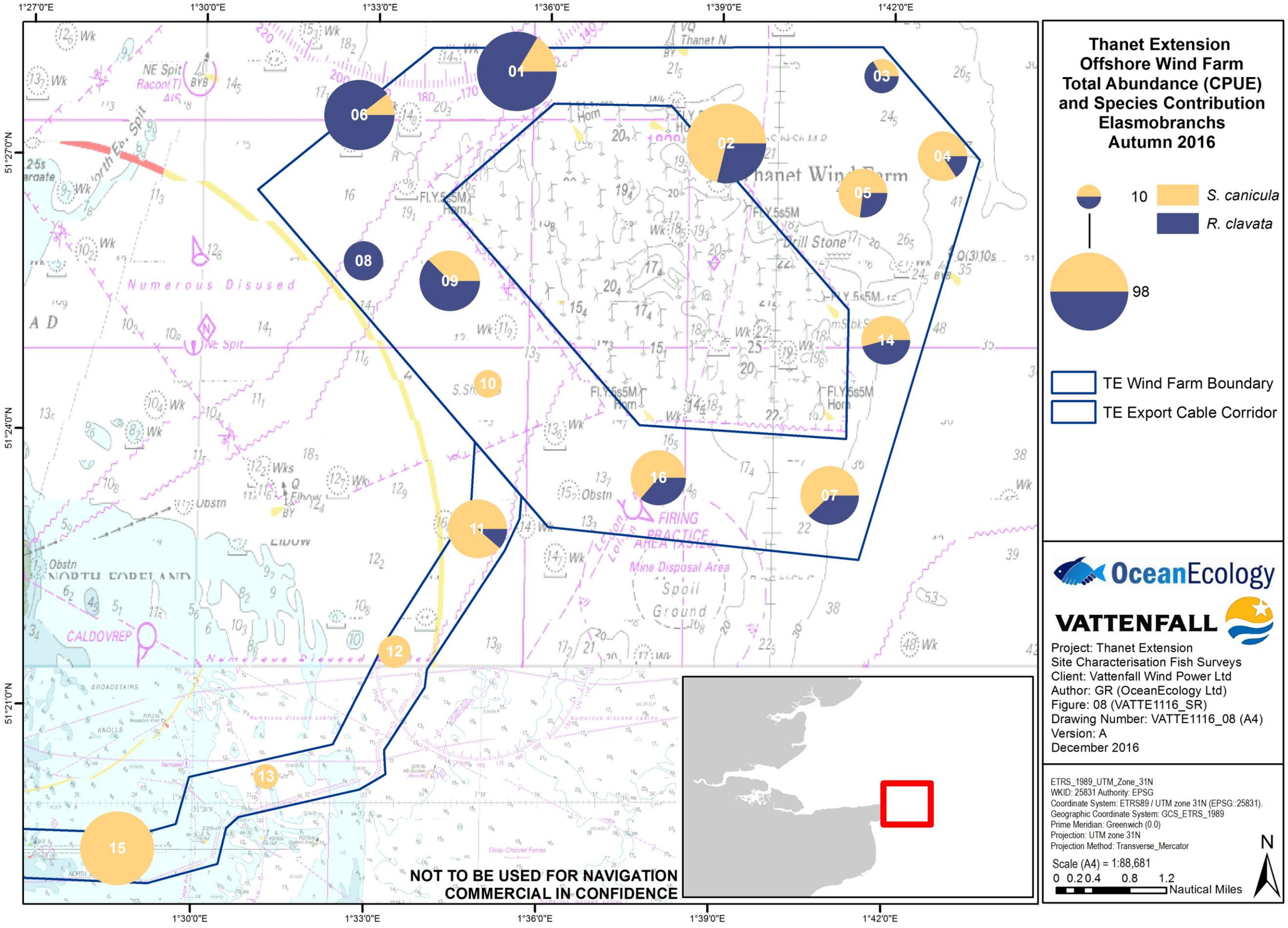


Figure 8 Chart showing the total abundance (expressed as CPUE or Catch per Hour) and species composition of elasmobranchs at each station sampled during the autumn 2016 fish survey.

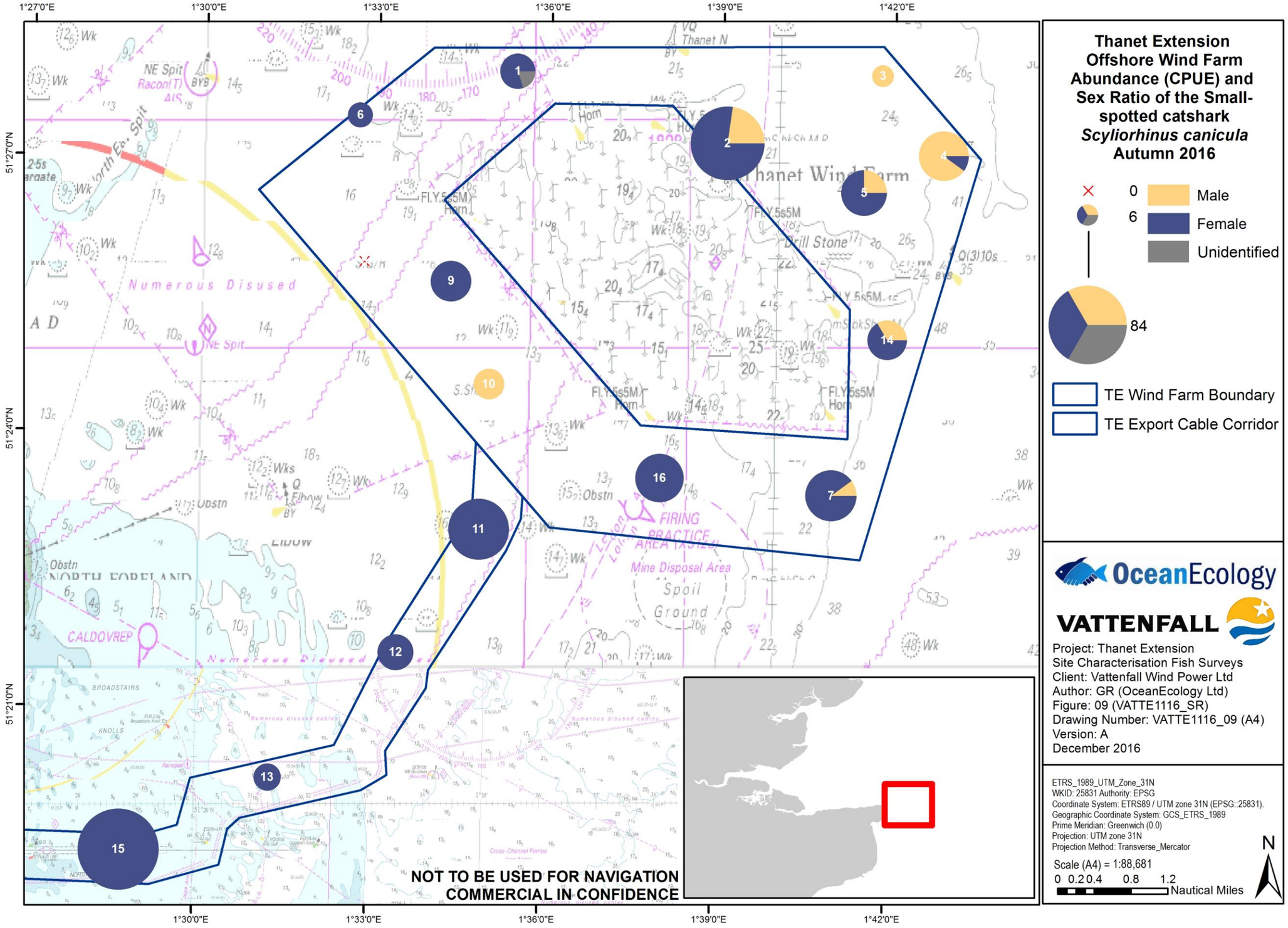


Figure 9 Distribution and abundance (CPUE) with male: female sex ratio of the small-spotted catshark, *S. canicula* sampled during the autumn 2016 fish survey.

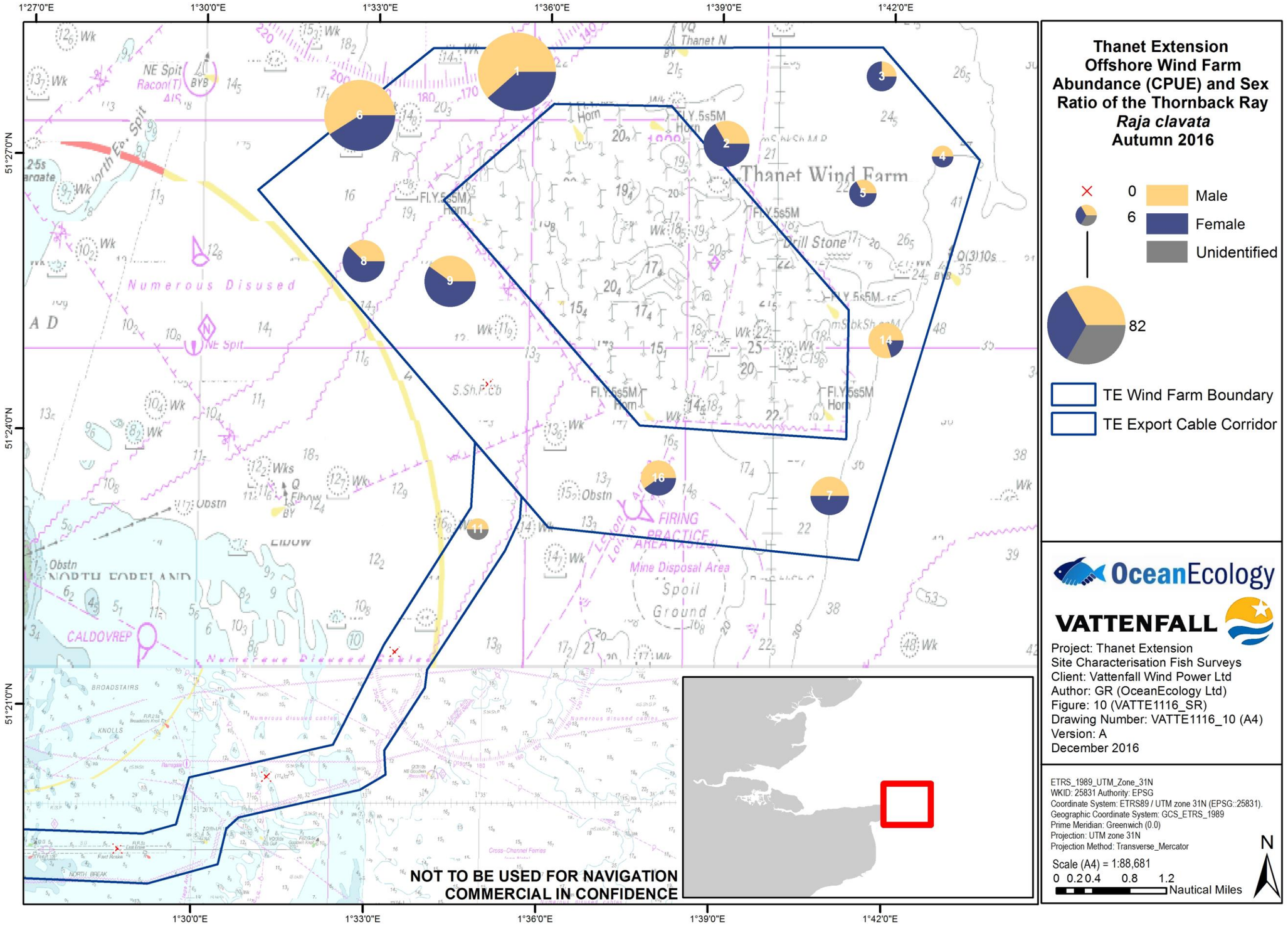


Figure 10 Distribution and abundance (CPUE) with male: female sex ratio of the thornback ray, *R. clavata* sampled during the autumn 2016 fish survey.

3.4. Demersal Fish and Epifaunal Invertebrates

3.4.1. Overview of Site

The beam trawl surveys undertaken at the Project site revealed a diverse fish and epifaunal assemblage with a total of 69 taxa recorded with a mean (± SE) of 17.88 ± 1.67 taxa per sample. Abundances per tow was variable, driven by extremely large numbers of a few species (e.g. the serpent's table brittlestar, *Ophiura albida* and the queen scallop, *Aequipecten opercularis*) at a relatively small number of locations. A total of 20 species of fish and 49 species of macroinvertebrate were recorded with the most abundant macroinvertebrate species being the brittlestar, *O. albida* and the most abundant fish species being the Dover sole, *S. solea*.

Full epifaunal matrices are provided in Appendix 3 and 4 presenting the raw abundance and weighted CPUE abundance (catch per hour) of each taxon in all trawl samples acquired across the survey area. A summary of abundances and distribution across the Project site are described below and presented in Figure 11 toFigure **16**.

3.4.2. Community Distribution

There was a noticeable difference between communities which correlated well with the range in seabed types across the survey area. In general, communities within the wind farm footprint were typical of soft sediment or mixed sediment habitats whilst those on the ECC were more typical of hard substrate communities, most notably further inshore. Although some demersal adult fish were caught using the beam trawl the majority of species caught were within juvenile size ranges or species of limited mobility and therefore would be expected to be more vulnerable to the impacts of the Project.

A shade plot was constructed based on species abundance data using PRIMER as a means of exploring differences in the composition of demersal fish and epibenthic species associated with the Project site as presented in Figure 11. Fish communities showed a clear trend between soft sediment habitats and hard substrates with species such as the butterfish, *Pholis gunnellus*, the common sea snail, *Liparis liparis liparis*, common dragonet, *Callionymus lyra* and the pogge, *Agonus cataphractus* dominating hard substrate locations along the ECC and the Dover sole, *S. solea*, thornback ray, *R. clavata* and the small-spotted catshark, *S. canicula* dominating communities in soft sediment locations. Dover sole was the most widespread fish species, present at all but one tow location. A similar relationship between invertebrate communities across seabed types was also apparent. Tow locations furthest offshore within the wind farm footprint and in particular to the north and northwest of the survey area were dominated by soft sediment fauna such as brittlestars, *O. albida*, queen scallops, *A. opercularis* and hermit crabs, Paguridae. The shade plot also shows a gradual change in communities with distance inshore and along the ECC. Cable route locations show a comparable level of composition similarity and were dominated by increased abundances in harder substrate species such as large swimming crabs, *Liocarcinus spp.*, the urchin, *Psammechinus miliaris*, painted topshells, *Calliostoma sp.* and spider crabs, *Macropodia spp.* and *Inachus sp.*. *Liocarcinus spp.* were the most widespread invertebrate species, present at all tow locations.

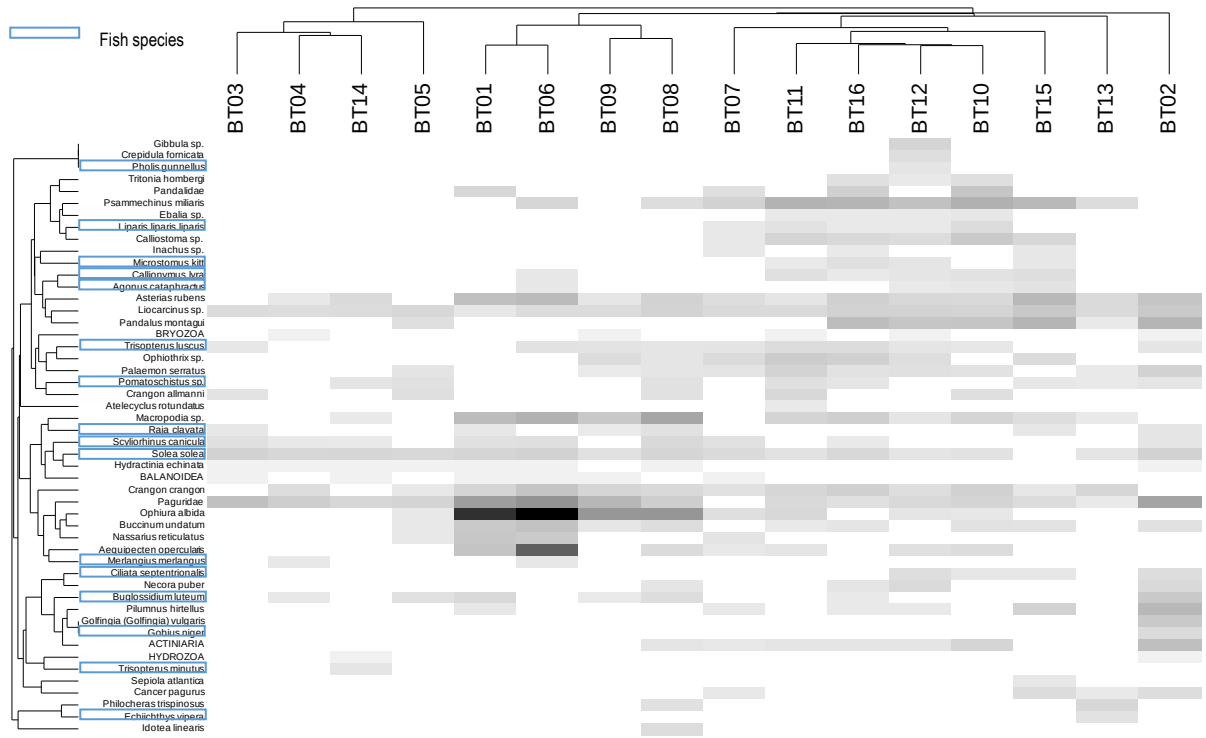


Figure 11 Shade plot generated using square-root transformed CPUE data to show demersal fish and epibenthic invertebrate community similarity (based on 50 most abundant species) sampled using a 2 m beam trawl at the TE development site during fish characterisation surveys, august 2016.

3.4.3. Abundance and Diversity

The greatest abundances (expressed as CPUE) of individuals (fish and invertebrates) were recorded in soft and mixed sediment habitats in the north and western extent of the survey area. These abundances were often heavily skewed by one or two species (e.g. *O. albida* and *A. opercularis*) present in high numbers, several orders of magnitude greater than most other species (Figure 12). To allow for easier comparison of trends in abundance, both *O.albida* and *A. opercularis* have been excluded from the mapped dataset in Figure 12. Generally, total abundances on the ECC were reduced in comparison to locations in the north and western extent of the wind farm footprint however this trend was reversed in terms of species diversity.

Whilst there was distinct differences in the communities distributed across the TE site, species diversity was generally consistent between tow locations with the exception of tow locations in the northeast corner, offshore in deep water showing reduced diversity of fish and invertebrates (Figure 13 and Figure 16). Invertebrate diversity was significantly greater than that of fish at all locations. Tow location BT02, which sampled an area of *S. spinulosa* reef represented the highest fish:invertebrate composition of all tow locations (see Section 3.5).

Whilst abundances of fish species mirrored trends in combined abundance and diversity, being greatest at locations in the north and northwest of the site on soft sediments, diversity of fish species, which ranged from three to eight species, was generally greatest along the ECC (Figure 14). Wind farm locations exhibited lower species diversity and areas of higher abundance were generally influenced by one or two numerous species, most notably Dover sole, *S. solea*, pouting, *T. luscus* and solenette, *Buglossidium luteum* (Figure 15).

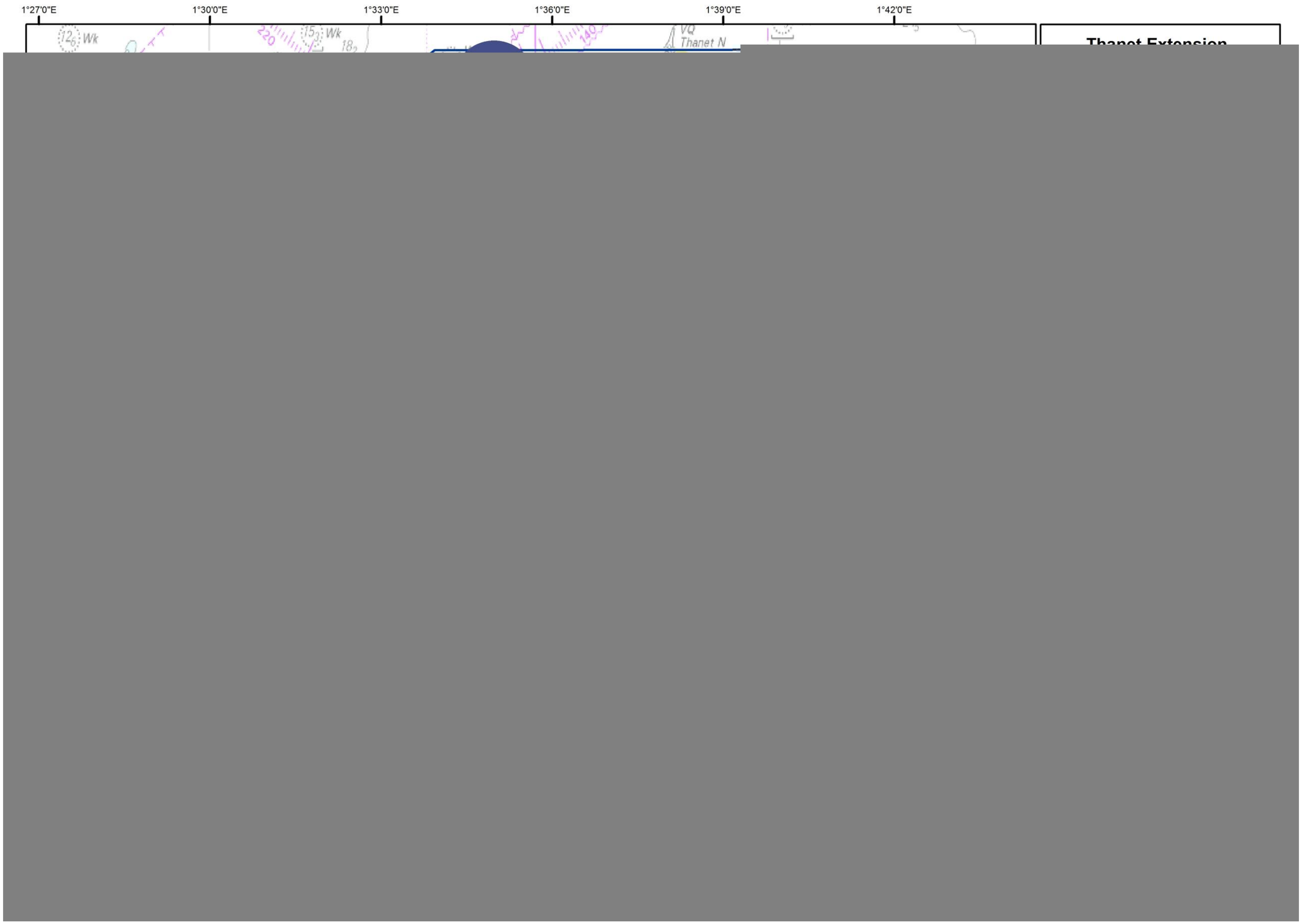


Figure 12 Abundance (CPUE) of demersal adult and juvenile fish and epibenthic invertebrates sampled during the autumn 2016 fish survey. NB Both brittlestar, *O.albida* and queen scallop, *A. opercularis* have been excluded for mapping purposes due to their extremely high abundances at a select few sites heavily masking abundances of other fish and invertebrates across the site.

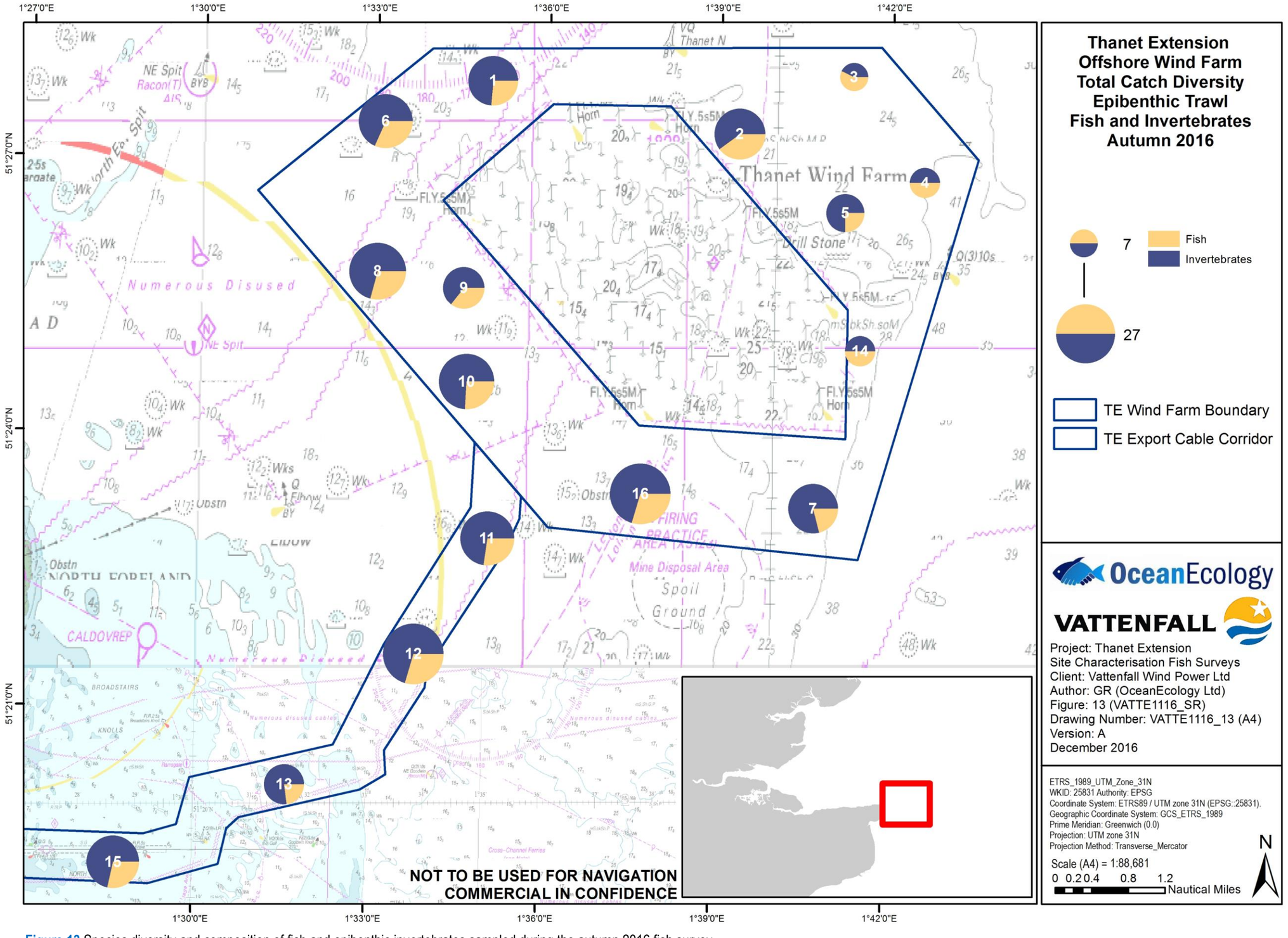


Figure 13 Species diversity and composition of fish and epibenthic invertebrates sampled during the autumn 2016 fish survey.

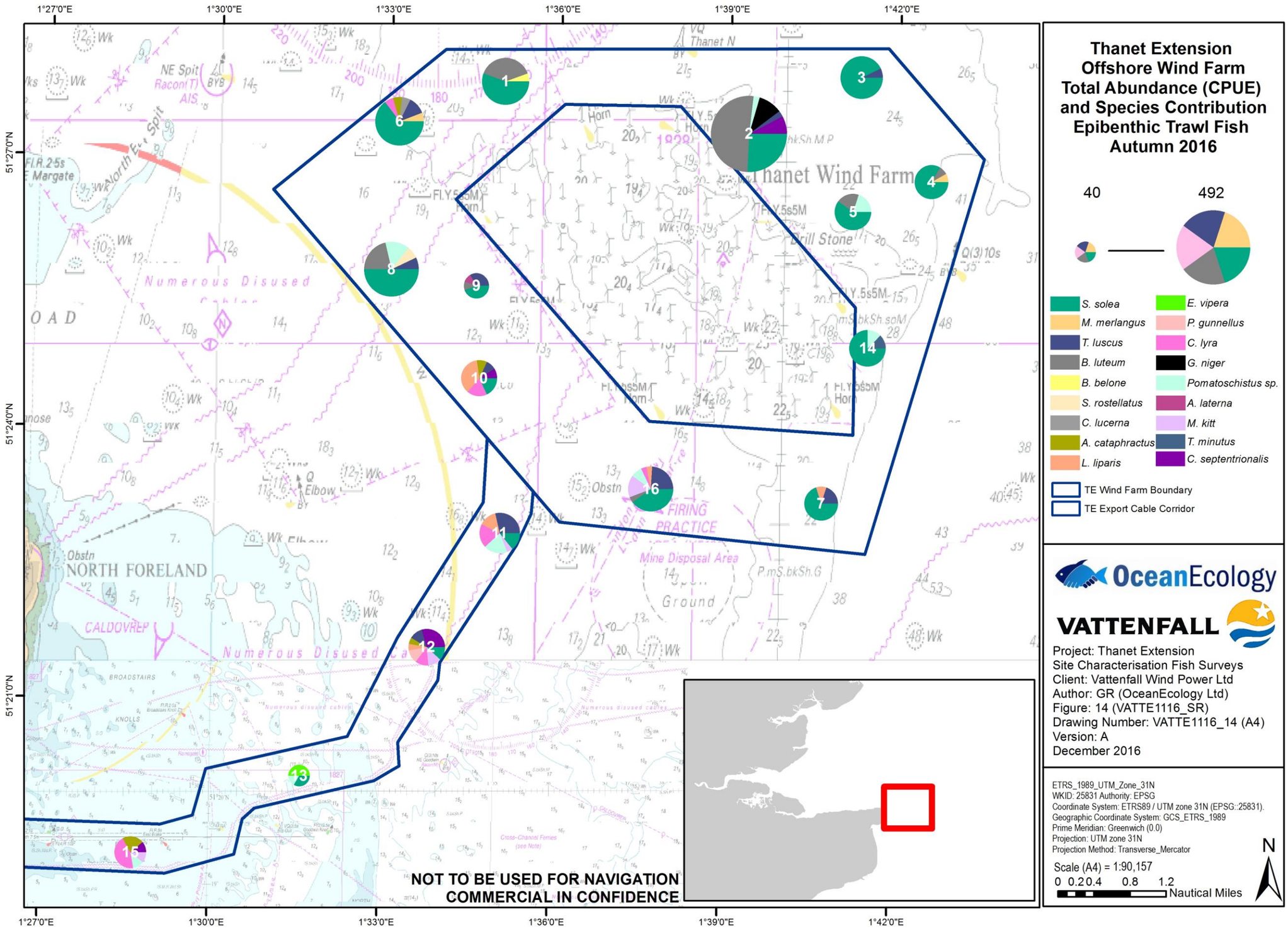


Figure 14 Total abundance (CPUE) and species contribution of demersal fish sampled during the autumn 2016 fish survey.

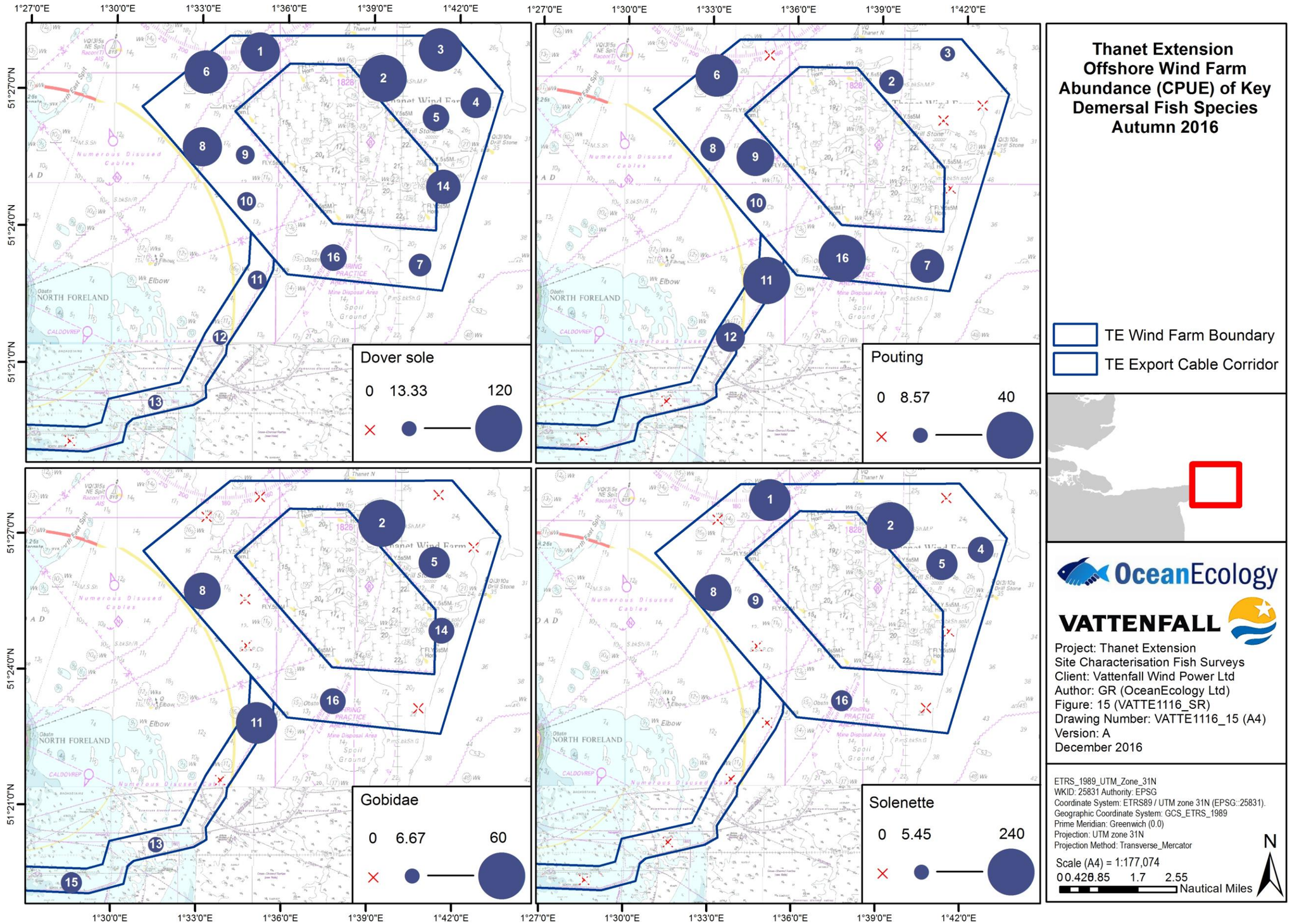


Figure 15 Total abundance (CPUE) of key demersal fish (including commercially targeted species) sampled during the autumn 2016 fish survey.

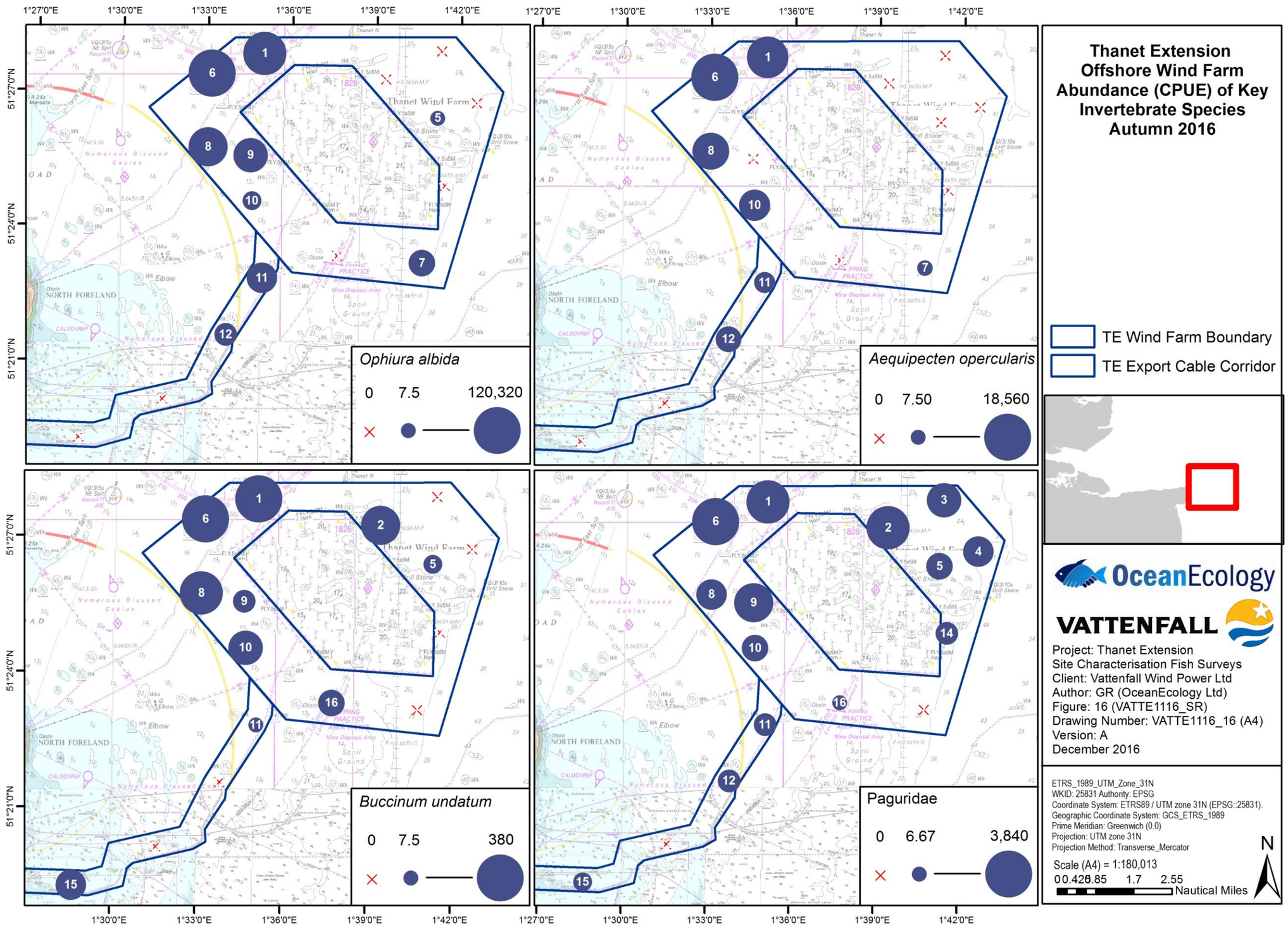


Figure 16 Total abundance (CPUE) of key invertebrate species (including commercial targeted species) sampled during the autumn 2016 fish survey.

3.5. *Sabellaria spinulosa* reef

Several epibenthic beam trawl locations, most notably BT05 and BT14, sampled during the 2015 surveys showed evidence of *S. spinulosa* aggregations including some live individuals. In general, these samples were not deemed to be characteristic of reef with only small fragments and aggregated clumps of *S. spinulosa* being recorded and therefore sampling continued as normal at these locations.

However, a substantial quantity of *S. spinulosa* reef was sampled at epibenthic beam trawl station BT02 located, on the northeastern side of the Project site, immediately adjacent to the existing Thanet OWF where *S. spinulosa* reef has previously been recorded (Pearce at al., 2014). Due to the size of the trawl retrieved to the deck, estimated at approximately 200 L by volume, a 1 0L sub-sample was taken in line with the alternative sampling methods proposed (Section 2.5.4) (along with all fish species) and was analysed fully for all macrobethos >5mm at the Ocean Ecology laboratory.

Tow location BT02 was associated with the joint most diverse community of fish species and also contained the highest abundance of fish of any other epibenthic trawl. A diverse assemblage of fish and invertebrates was associated with this sample including juvenile and adult fish (Dover sole, *S. solea*, small-spotted catshark, *S. canicula*, thornback ray, *R. clavata* and solenette, *B. luteum*) as well as various invertebrates including the commercially important edible crab, *C. pagurus*, common prawn, *Palaemon. serratus* and pink shrimp, *Pandalus montagui*. Other abundant invertebrates included several crab species (*Hirtellus pilumnus, Liocarcinus spp., Macropodia spp.* and Pagurid hermit crabs), the common starfish, *Asterias rubens* and various Actiniaria (sea anemones).

A summary of findings including length and aperture measurements for the three tow locations where *S. spinulosa* was evident is provided in Table 7. A detailed interpretation of the fish and epifauna data collected in relation to *S. spinulosa* reef distribution across the site will be included in the final technical report, following the spring 2017 survey.

Table 7 Length (mm) and aperture (mm) measurements of *S. spinulosa* reef / aggregations sampled during TE autumn 2016 survey.

	BT02	BT05	BT14
Aggregation type (% contribution) (reef, clumps, veneer, rubble)	Reef	Clumps	Clumps / Rubble (all tube fragments broken and empty, no live individuals)
Maximum tube length (mm)	10	6	n/a
Average tube length (mm) (n = 10)	5.8	5.05	n/a
Maximum tube aperture (mm)	2	3	n/a
Average tube aperture (mm) (n = 10)	1.5	2	n/a

Plate 3. Evidence of Ross worm, *S. spinulosa* reef at tow location BT02 collected during the TE Autumn fish surveys 2016.

3.6. Other Species of Particular Interest

The total abundance (not converted to CPUE due to low numbers) of species of particular commercial and / or conservation interest is summarised in Table 8.

All of these species were identified as being likely to occur or known to occur in the baseline review (Table 1) with the exception of the invasive slipper limpet, *Crepidula fornicata*, originally found on the east coast of America but now present along the southern coasts of Britain (Rayment, 2008). Only five individuals were recorded in a typical stack formation on a single cobble retrieved at trawl location BT12.

Most of the species listed in Table 8 are considered to be incidental catches with only a very small number of sporadic records across the site. Both the common whelk, *B. undatum* and the common prawn, *P. serratus* were regularly sampled across the site in the beam trawls (10 of the 16 trawl locations sampled). The tub gurnard, *C. lucerna*, seems to be present across the site in relatively low but consistent numbers whilst the edible crab, *C. pagurus* was recorded in similar numbers but across fewer trawl locations. The abundance of gobies, an important prey item for many commercially important fish species was recorded in relatively low numbers at eight of the 16 beam trawl locations sampled.

Table 8 Summary of the total abundance of species with a particular commercial or conservation interest recorded in otter and beam trawls sampled during the autumn 2016 survey which have not been analysed in detail in previous sections of this report.

Species	Common Name	Gear	Abundance	Distribution
Marine Fish				
Gadus morhua	Cod	Otter Trawl	2	OT06, OT12
Dicentrarchus labrax	Seabass	Otter Trawl	2	OT08, OT12
Microstomus kitt	Lemon sole	Otter Trawl	1	OT16
		Beam Trawl	8	BT11, BT12, BT15, BT16
Platichthys flesus	Flounder	Otter Trawl	1	OT15
Mullus barbatus	Red mullet	Otter Trawl	3	OT09, OT14, OT15
		Beam Trawl		
Chelidonichthys lucerna	Tub Gurnard	Otter Trawl	14	OT01, OT02, OT03, OT04, OT07, OT08, OT09, OT13
		Beam Trawl	1	BT06
Gobidae	Gobies	Beam Trawl	20	BT02, BT05, BT08, BT11, BT13, BT14, BT15, BT16
Shellfish				
Homarus gammarus	Lobster	Otter Trawl	2	OT09
Cancer pagurus	Edible crab	Beam Trawl	10	BT02, BT07, BT13, BT15
Maja squinado	Spiny Spider Crab	Otter Trawl	1	BT16
		Beam Trawl	1	BT16
Palaemon serratus	Common Prawn	Otter Trawl	1	OT14
		Beam Trawl	42	BT02, BT05, BT07, BT08, BT09, BT10, BT11, BT12, BT13, BT16
Buccinum undatum	Common Whelk	Otter Trawl	5	OT06, OT15
		Beam Trawl	81	BT01, BT02, BT05, BT06, BT08, BT09, BT10, BT11, BT15, BT16
Invasive Non-Native Species				
Crepidula fornicata	Slipper Limpet	Beam Trawl	5	BT12

4. SUMMARY

4.1. Survey Progress

This survey represents the first of two fish characterisation surveys to be undertaken at the TE development site during the autumn of 2016 and spring 2017. The survey was undertaken between the 14th and 18th of November 2016 and all 16 target otter trawl and beam trawl locations (12 wind farm and four ECC locations) were sampled successfully with only minor delays to survey progress as a result of adverse weather conditions and / or tide. With the exception of two tow locations, all target locations were sampled successfully and generally to within 50 m accuracy at all times throughout the tow. As a result of potential conflict with static fishing gear, tow location OT05 had to be moved 200 m NE of the target location and OT15 had to be terminated early due to rough ground.

4.2. Commercial Fish

Generally, hauls were low in abundance of individuals and often of low diversity dominated by a few key species that were sampled at the majority of trawl locations. The abundance of commercial fish was found to be slightly elevated at cable route locations, seemingly driven by the elevated numbers of pouting, *T. luscus* at these locations rather than increased diversity of species. A total of 11 species of fish and four species of shellfish were recorded with the most abundant fish species being pouting and the most abundant shellfish species being the common whelk, *B. undatum*.

The commercial fish community in this area was dominated by pouting, *T. luscus* and whiting, *M. merlangus* with moderate abundances of Dover sole, *S. solea* and Plaice, *P. platessa*. Other fish and shellfish were present only sporadically and in comparatively low numbers. Pouting was the most abundant and one of the most widespread fish species sampled from the TE development area and exhibited a clear trend in its distribution with abundances focused along the ECC and within the eastern extent of the wind farm footprint. Whiting showed no obvious spatial distribution and was widespread whereas Dover sole and plaice showed an opposite trend to pouting being most abundant in areas further offshore in the wind farm footprint.

4.3. Elasmobranchs

There were only two species of elasmobranch recorded across the survey area, the small-spotted catshark, *S. canicula* and the thornback ray, *R. clavata.* Combined abundances of elasmobranch species was greatest in offshore wind farm areas due largely in part to the restricted abundance of thornback ray on soft sediment areas away from the ECC.

The small-spotted catshark was the more abundant of the two elasmobranch species sampled from the survey area and was widespread, recorded across a range of habitat types. Abundances were generally lower in the northern area of the windfarm where sediments consist of sands and muddy sands and notable abundances were associated with the hard substrate area at the inshore end of the ECC and an area of *S. spinulosa* reef sampled in the northeast area of the Project site. Also apparent was a distinct spatial separation between male and female catshark with males in offshore areas and an exclusively female population at inshore locations along the ECC. In contrast, thornback ray, *R. clavata* exhibited a much reduced spatial distribution and abundances were generally higher in the northern area of the wind farm. There was no apparent trend in distribution of male and female thornback ray nor did either sex predominate over the other in terms of abundance.

4.4. Juvenile Fish and Epifaunal Invertebrates

The beam trawl sampling undertaken across the survey area revealed a diverse fish and epifaunal assemblage with a total of 69 taxa recorded with a mean (± SE) of 17.88 ± 1.67 taxa per sample. A total of 20 species of fish and 49 species of macroinvertebrate were recorded with the most abundant macroinvertebrate species being the brittlestar, *O. albida* and the most abundant fish species group being the Dover sole, *S. solea*.

In general, communities within the wind farm footprint were typical of soft sediment or mixed sediment habitats whilst those on the ECC were more typical of hard substrate communities, most notably towards the inshore end of the ECC. The greatest abundances of individuals were recorded in soft and mixed sediment habitats in the north and western extent of the wind farm footprint. These abundances however were often heavily skewed by one or two species (e.g. *O. albida* and *A. opercularis*) present in extremely high numbers.

Fish communities showed a clear trend between soft sediment habitats and hard substrates with species such as the butterfish, *P. gunnellus*, the common sea snail, *L. liparis liparis*, common dragonet, *C. lyra* and the pogge, *A. cataphractus* dominating hard substrate locations along the ECC and the Dover sole, *S. solea*, thornback ray, *R. clavata* and the small-spotted catshark, *S. canicula* dominating communities in soft sediment locations. Dominant invertebrates were the brittle star, *O. albida*, the common starfish, *A. rubens* and hermit crabs (Paguridae).

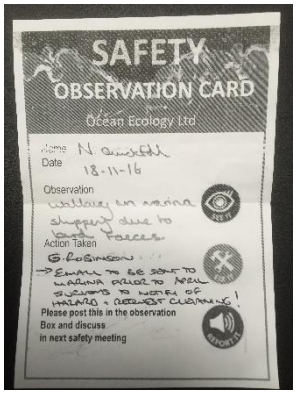
4.5. Other Species of Interest

There was evidence of *S. spinulosa* reef recorded at three of the 16 tow locations sampled, in the north and northeastern areas of the proposed TE wind farm footprint. A substantial quantity of *S. spinulosa* reef was sampled at epibenthic beam trawl station BT02 immediately adjacent to the existing Thanet OWF where *S. spinulosa* reef has previously been recorded. A diverse assemblage of fish and invertebrates was associated with this sample including juvenile and adult fish (Dover sole, *S. solea*, small-spotted catshark, *S. canicula*, thornback ray, *R. clavata* and solenette, *B. luteum*) and various invertebrates including the commercially important edible crab, *C. pagurus*, common prawn, *P. serratus* and pink shrimp, *P. montagui*.

5. HEALTH & SAFETY

The survey was undertaken with no Health and Safety incidents or accidents. There were two Safety Observations recorded during the survey as summarised in Table 9 below. All observations were recorded in the DPRs submitted to Vattenfall during survey operations and provided as Appendix 3 to this report.

Table 9 Thanet Extension Project Safety Observation Register – autumn 2016 fish survey.

ID NO.	DATE OPENED	NOTES	ACTIONS	RESPONSIBLE PERSON(s)	OPEN / CLOSED	DATE CLOSED / SIGNATURE
01 	11.14.2016	Faunal waste on deck a potential trip hazard during survey works due to slippery and / or wet organisms falling from trawl. 	It was agreed by all that better housekeeping between trawls is required and that the deck will be swilled following each haul so no debris remains on deck.	All onboard – better housekeeping	CLOSED	11.14.2016
02 	11.18.2016	Walkways in the marina slippery due to wet and significant amounts of bird faeces. 	G. Robinson will send an email to the marina management prior to next surveys in spring as the vessel has now demobilised from Ramsgate. This should be cleaned regularly.	G. Robinson	SUSPENDED	n/a

6. REFERENCES

Castro, J. I; Bubucis, P. M; Overstrom, N. A (1988). "The Reproductive Biology of the Chain Dogfish, Scyliorhinus retifer". Copeia.

CMACS (2016) Thanet Extension Offshore Wind Farm. Fish ecology characterisation strategy. Prepared by Centre for Marine and Coastal Studies Ltd for Vattenfall. 25pp.

Collins, K. (2003). Dorset marine habitat surveys: Maerl, worm reefs, bream nests, sea fans and brittlestars 2003 survey results.

Cooper, K.M. & Coggan, R.A. (2006) Recommended operating guidelines for MESH; trawls and dredges. 24pp.

DEFRA (2004). Review of Marine Nature Conservation. Working Group report to Government. 160 pp.

JNCC (2013). Progress towards the development of a standardised UK pressure-activities matrix. Briefing paper to UKMMAS evidence groups (presented 10/10/1013).

Ellis, J. R., Milligan, S. P., Readdy, L., Taylor, N., & Brown, M. J. (2012). Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147, 56.

Ellis, J. R and Shackley (1997). The reproductive biology of *Scyliorhinus canicula* in the Bristol Channel, U.K. J. Fish Biol. 51(2), 361-372.

Gill, A. B. (2005). Offshore renewable energy: ecological implications of generating electricity in the coastal zone. Journal of Applied Ecology. 42(4), 605-615.

Griffin R.A., Robinson G.J., West, A, Gloyne-Phillips I.T., Unsworth R.K.F. (2016). Assessing Fish and Motile Fauna around Offshore Windfarms Using Stereo Baited Video. PLoS ONE 11(3): e0149701. doi:10.1371/journal.pone.0149701

Henderson, P. (2014). Identification Guide to the Inshore Fish of the Bitish Isles. ISBN 978-1-904690-63-4.

Hendrick, V.J. & Foster-Smith, R.L. (2006). *Sabellaria spinulosa*: a scoring system for evaluating „reefiness" in the context of the Habitats Directive. Journal of the Marine Biological Association of the UK. 86, 665-677 Cambridge University Press.

Last, K., Hendrick, V., Sotheran, I., Foster-Smith, B., Foster-Smith, D. & Hutchison, Z. (2012). Assessing the impacts of shrimp fishing on *Sabellaria spinulosa* reef and associated biodiversity in The Wash and North Norfolk SAC, Inner Dowsing Race Bank North Ridge SAC and surrounding areas.

Maitland, P. S., & Herdson, D. (2009). Key to the marine and freshwater fishes of Britain and Ireland. Environment Agency, Bristol.

MESH (2007). Recommended operating guidelines (ROG) for MESH trawls and dredges. 24pp.

Ocean Ecology Limited (2016). Thanet Extension OWF Site Characterisation Fish Surveys - *Sabellaria spinulosa* Reef Sampling Protocol. Report prepared for Vattenfall Wind Power.

Pearce, B., Taylor, J., Seiderer, L.J. (2007). Recoverability of *Sabellaria spinulosa* Following Aggregate Extraction. Aggregate Levy Sustainability Fund MAL0027. Marine Ecological Surveys Limited, Bath.

Pearce, B., Farinas, J.M., Wilson, C., Pitts, J., de Burgh, A., Somerfield, P.J. (2014). Repeated mapping of reefs constructed by *Sabellaria spinulosa* Leuckart 1849 at an offshore wind farm site. Cont. Shelf Res. 83, 3-13.

Picton, B.E. & Morrow, C.C. (2016). *Raja clavata* (Linnaeus, 1758). [In] Encyclopedia of Marine Life of Britain and Ireland.http://www.habitas.org.uk/marinelife/species.asp?item=ZF1360 Accessed on 2016-12-22

Rayment, W.J. 2008. *Crepidula fornicata* Slipper limpet. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/species/detail/1554

Royal Haskoning (2013a) Thanet OWF second post-construction fish and epibenthic survey;

Royal Haskoning (2013b) Thanet OWF post-construction elasmobranch survey;

Wearmouth, V. J; Southall, E. J; Morritt, D; Thompson, R. C; Cuthill, I. C; Partridge, J. C.; Sims, D. W. (2012). "Year-round sexual harassment as a behavioural mediator of vertebrate population dynamics.". Ecological Monographs.

Sims, D., Nash, J., & Morritt, D. (2001). Movements and activity of male and female dogfish in a tidal sea lough: alternative behavioural strategies and apparent sexual segregation. Marine Biology. 139(6), 1165-1175.

Ware, S. J., & Kenny, A. J. (2011). Guidelines for the conduct of benthic studies at marine aggregate extraction sites. Marine Aggregate Levy Sustainability Fund, 80pp. ISBN, 978(0), 907545.