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Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Annex 6-1: Site Characterisation Fish Survey Report - Spring 2017

June, 2018, Revision A

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June, 2018

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Thanet Extension Offshore Wind Farm

Site Characterisation Spring Fish Survey Report 2017

Ref: VATTE0517_SR

Prepared for

Vattenfall Wind Power Limited

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Executive Summary

This report summarises the second 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. The survey was undertaken in the spring, between the 6th and 12th May 2017 aboard the *Seiont-A*. During the survey, a total of 16 otter trawl and 16 2 m beam trawl stations were sampled across the proposed development site and the export the cable route.

This report provides a summary of the methods employed and presents preliminary high-level results on the commercial fish, juvenile fish and epifaunal communities within and adjacent to the proposed development. Detailed analysis of the data collected during both the autumn 2016 and spring 2017 surveys will be presented in a final technical report.

LIST OF ABBREVIATIONS

BT	Beam Trawl
CPUE	Catch per Unit Effort
DPR	Daily Progress Report
ECC	Export Cable Corridor
FLO	Fisheries Liaison Officer
IMCA	International Marine Contractors Association
KEIFCA	Kent and Essex Inshore Fisheries and Conservation Authority
MESH	Mapping European Seabed Habitats
MMO	Marine Management Organisation
NMBAQC	National Marine Biological Analytical Quality Control
OEL	Ocean Ecology Limited
OT	Otter Trawl
OWF	Offshore Wind Farm
PRIMER	Plymouth Routines in Multivariate Ecological Research
ROG	Recommended Operating Guidelines
SE	Standard Error
SSS	Side Scan Sonar
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 Offshore Wind Farm (TEOW)) (the Project) to the operational Thanet Offshore Wind Farm (OWF), a 35 km^2, 300 MW 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 Limited (OEL) 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 has 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 predicted Zone of Influence of the Project, as agreed with the local fishing industry and statutory advisors and set out in the TEOW Fish Ecology Characterisation Strategy (CMACS 2016).

1.3. Baseline Conditions

1.3.1. Abiotic Conditions

The Project 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 site and deeper areas extending offshore to the east of the site. On review of EMODnet online data[1], Side Scan Sonar (SSS) and Multi-Beam Echosounder (MBES) data made available from the 2016 TEOW geophysical survey, 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 across the central and offshore areas with rocky substratum identified along the inshore areas.

The baseline geophysical data further correlates the EMODnet mapping with respect to potential areas of Ross worm (*Sabellaria spinulosa*) reefs across the area particularly in the northwest corner and north-eastern areas of the site. 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 TEOW site may represent extensions of the reef known to occur within the existing Thanet OWF area.

[1] www.emodnet.eu

1.3.2. Fish Communities

Fish monitoring undertaken at the existing Thanet OWF recorded numerous flatfish; particularly dab, *Limanda limanda*, plaice, *Pleuronectes platessa*, 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 have known spawning and nursery grounds nearby as do herring, *Clupea harengus*, which spawn within Herne Bay, to the west of the TEOW site in the spring. In discussion with the Thanet Fishermen's Association (TFA), European bass, *Dicentrarchus labrax*, is thought to be most prevalent about the TEOW site during the spring. The Project's Fisheries Liaison Officer (FLO) also confirmed that as well as Dover sole, cod, *Gadus morhua,* are significant commercial species at the TEOW site. The area is also 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, several other elasmobranch species were recorded during monitoring surveys for the Thanet OWF but most notably the small-spotted catshark, *Scyliorhinus canicula*, and to a lesser extent, the starry smooth-hound, *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 are also significant fisheries in the area targeting the common whelk, *Buccinum undatum*, and more recently along the ECC, the blue mussel, *Mytilus edulis*.

Several 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 TEOW 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, b) 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. TEOW 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. TEOW close to spawning areas
Pouting	*Trisopterus luscus*	×	✓	Prefer coarser ground.
Plaice	*Pleuronectes platessa*	✓	✓	Prefer soft sediments.
Dab	*Limanda limanda*	×	✓	Prefer soft sandy sediments
European bass	*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 TEOW in spring. Known to aggregate between Ramsgate and Foreland Point.
Goby	*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.
Small-spotted catshark	*Scyliorhinus canicula*	×	×	Predominant species in monitoring surveys at Thanet OWF
Starry smooth-hound	*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 TEOW area
Twaite shad	*Alosa fallax*	✓	×	Present in Thames estuaries but not in the vicinity of the TEOW area
Salmon	*Salmo salar*	✓	✓	Very unlikely but present in rivers of near to TEOW, may pass through site.
Sea trout	*Salmo trutta*	✓	✓	Very unlikely but present in rivers of near to TEOW, may pass through site.
Smelt	*Osmerus eperlanus*	✓	✓	Mid water species. Enter rivers in the vicinity of TEOW 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

1.4. Autumn Survey 2016 Conditions

The data collected during the first site characterisation fish survey conducted in autumn 2016 are presented in a survey report (Ocean Ecology Limited 2016) and are summarised below.

1.4.1. Commercial Fish and Shellfish

The otter trawl surveys undertaken across 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. Total abundance per trawl was also relatively low and mostly constituted by the small-spotted catshark and thornback ray. A total of 14 species of fish (including two elasmobranch species) and four species of shellfish were recorded within the survey area.

The commercial fish community was dominated by pouting and whiting with moderate abundances of Dover sole and plaice. The most frequently recorded shellfish species was the commercially targeted common whelk. Other fish and shellfish were present sporadically and in comparatively low numbers. Pouting was the most abundant and one of the most widespread fish species sampled and exhibited a clear trend in its distribution with abundances focused along the ECC and within the eastern extent of the development site footprint. Whiting was widely distributed across the site whereas Dover sole and plaice showed an opposite trend to pouting being most abundant in areas further offshore.

There were only two species of elasmobranch recorded across the survey area, the small-spotted catshark and the thornback ray. The small-spotted catshark was the more abundant of the two and was widespread, recorded across a range of habitat types. Abundances were generally lower in the northern area of the survey area 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 Ross worm, *Sabellaria spinulosa,* reef sampled in the northeast 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. 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). In contrast, the thornback ray exhibited a much-reduced spatial distribution and abundances were generally higher in the northern area of the wind farm with no apparent trend in distribution of males and females.

1.4.2. Demersal/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 invertebrate taxa were recorded with the most abundant invertebrate species being the brittlestar, *Ophiura albida* and the most abundant fish species being the Dover sole.

In general, communities across the survey area were typical of soft 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. 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 Dover sole, thornback ray and the small-spotted catshark dominating communities in soft sediment locations. Dominant invertebrates included the brittlestar, the common starfish, *Asterias rubens,* and hermit crabs, Paguridae.

Abundances per trawl were variable, driven by large numbers of a few species (e.g. the brittlestar and the queen scallop) at a relatively small number of locations. The greatest abundances of individuals were recorded in soft and mixed sediment habitats in the north and western extent of the proposed wind farm footprint. 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.

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.

1.4.3. *Sabellaria spinulosa* Reef

There was evidence of *S. spinulosa* reef recorded at three of the 16 trawl locations sampled, in the north and north-eastern areas of the proposed wind farm footprint. A substantial quantity, estimated at 200 l, 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 (Pearce et al. 2014). A diverse assemblage of fish and invertebrates was associated with this sample including juvenile and adult fish (Dover sole, small-spotted catshark, thornback ray and solenette) as well as various invertebrates including the commercially important edible crab, common prawn, *Palaemon serratus,* and pink shrimp, *Pandalus montagui*. Other abundant invertebrates included several crab species (*Pilumnus hirtellus, Liocarcinus* spp*., Macropodia spp.* and Pagurid hermit crabs), the common starfish and various sea anemones (Actiniaria).

1.4.4. Other Species of Interest

The total abundance of species of commercial and/or conservation interest are summarised in Table 2.

These species were identified as being likely to occur or known to occur in the baseline review 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[2]. Only five individuals were recorded in a typical stack formation on a single cobble retrieved at trawl location BT12.

Most of the species listed are considered to be incidental catches with only a very small number of sporadic records across the site. Both the common whelk and the common prawn were regularly sampled across the site in the beam trawls (10 of the 16 trawl locations sampled). The tub gurnard, *Chelidonchthys lucerna*, was present across the site in relatively low but consistent numbers whilst the edible crab 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.

[2] http://www.marlin.ac.uk/species/detail/1554

Table 2 Summary of the total abundance of species of commercial or conservation interest recorded in otter and beam trawls sampled during the autumn 2016 survey.

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
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

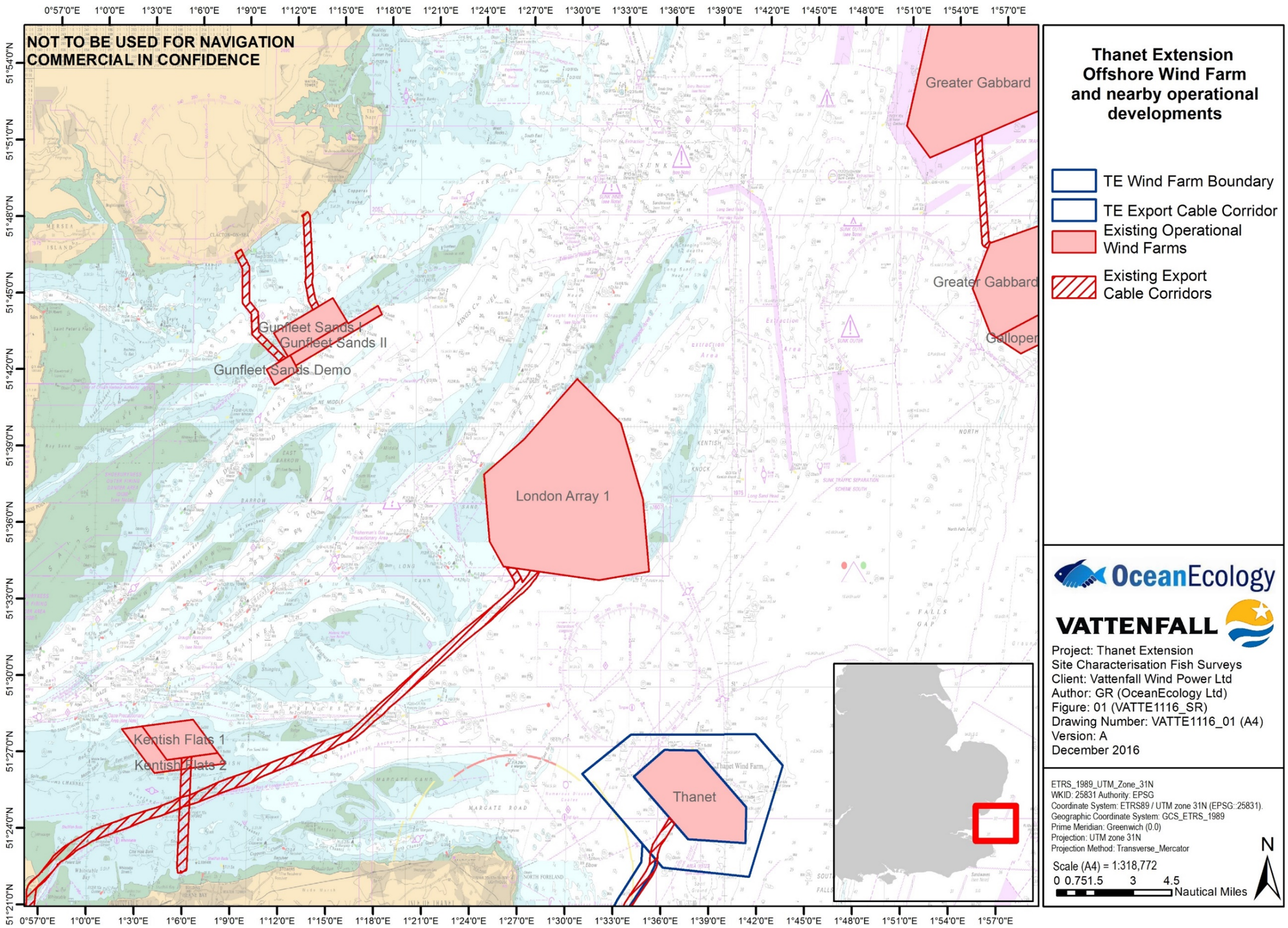

Figure 1 Map illustrating the location of TEOW and the proximity of other operational wind farms located in the outer Thames Estuary region, including the operational Thanet OWF.

2. METHODS

2.1. Timing

As set out in the TEOW Fish Ecology Characterisation Strategy (CMACS 2016) surveys in both autumn and spring were required to fully characterise the fish communities across the site and were timed to correspond with peak periods of interest with respect to fish. This report summarises the methodologies and preliminary findings of the spring survey which was undertaken early in May 2017. Detailed survey logs including dates and times for each trawl are provided in Appendix 1.

2.2. Sampling Rationale

2.2.1. Sampling Method

The aim of the characterisation surveys is to establish the abundance and composition of adult and juvenile fish and epibenthic species within the area of the proposed TEOW wind farm. The surveys were 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 (Curtis & Coggan 2006a). With the primary aim to characterise commercial fish communities across the Project site, a standard demersal otter trawl was employed supplemented 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 Project area were required to further support the wider impact assessment. 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 trawls 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 (Thornback ray, small-spotted catshark and starry smooth-hound). It was therefore considered unnecessary to undertake dedicated elasmobranch surveys for the Project.

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 epifauna.

2.2.2. Sampling 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 trawls and 16 2 m beam trawls be undertaken. Four of sampling positions for each trawl type were positioned along the ECC and 12 each within the proposed wind farm footprint. These proposed trawl 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. Trawl orientation akin to that used during existing fish monitoring surveys (northwest to southeast) of the existing Thanet OWF were retained and three trawl locations (OT06, BT06 and BT14), including their identifiers, matched trawls undertaken during these surveys to allow for comparisons between acquired data and historical data. The four trawl locations along the ECC were located beyond a 200 m buffer both from and parallel to the existing Thanet OWF cable to avoid potential conflicts.

Prior to the autumn fish survey 2016, the position of 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 TEOW infrastructure (limiting future monitoring at these locations), a concurrent metocean campaign, *S. spinulosa* reef, subsea cables and unfavourable ground (see description of full conflicts check conducted in Appendix 2). Two of the originally proposed otter trawl locations were positioned outside the revised wind farm footprint and therefore required relocating to within the revised footprint. Where possible, the distance at which trawl locations were relocated was kept to a minimum, the orientation of the trawl was kept consistent and the target substrate/sediment type was maintained. The sampled trawl locations for the autumn fish survey were used as the target sampling locations for the spring fish survey 2017. The distribution of these sampling locations in relation to the Project footprint including as-sampled locations (spring 2017) is mapped in Figure 2.

Table 3 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

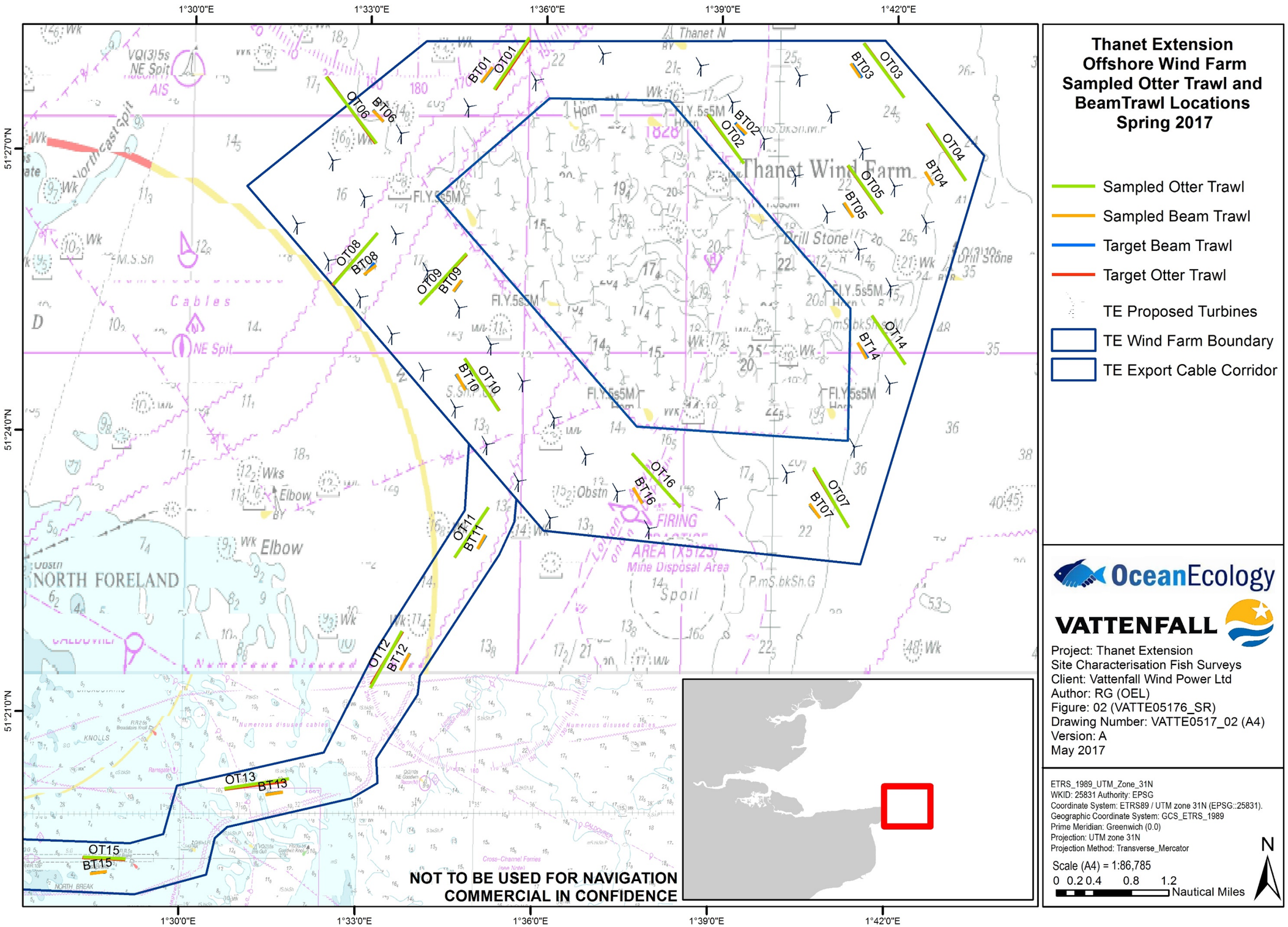

Figure 2 Target trawl locations and as-sampled trawl locations during the spring 2017 fish surveys at TEOW development site.

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 6th and 12th of May 2017. A summary of daily activity for the survey period is provided in Table 4 below and Daily Progress Reports (DPRs) are provided as Appendix 3 to this report.

Table 4 Progress log for the spring 2017 TEOW site characterisation fish survey.

DATE	ACTIVITY
06/05/17	Survey team mobilised to Whitstable and met with the survey vessel, *Seiont-A*, to finalise mobilisation of survey gear and equipment.
07/05/17	Survey team met the vessel and skipper at 0930 to reassess the weather conditions for the day. Unfavourable wave height for trawling due to sustained northerly/north easterly winds overnight so surveying delayed until a more suitable weather window opens. Vessel transited to Ramsgate arriving at 1330 ready to begin when conditions improve. Weather forecasts will be assessed throughout the evening.
08/05/17	Assessed weather forecast at 0600 and suspended survey operations for the day due to poor weather conditions reported on site. Wave height of 2.2m was reported on site during the morning with strong F 5-6 northerly winds forecast throughout the day.
09/05/17	Beam trawl survey commenced at 0730 hrs after a small delay in the morning due to unsuitable wave height on site. Once on site, steady progress was made with the 4 beam trawl stations completed by 1015, however due to increasing wave height (approx. 2m) at stations further offshore, conditions were unsuitable for continuing and the survey was suspended. Whilst waiting for the weather to improve, the vessel and crew transited back to Whitstable to load the otter trawl gear in preparation for the second phase of the survey. An additional beam trawl station was completed on the transit back to Ramsgate in the late afternoon. Beam trawls completed: 8, 11, 12, 13, 15 F 3-4 winds from the NNE throughout the day, with wave heights of approximately 2m throughout the morning dropping off to 0.5m by the late afternoon.
10/05/17	Beam trawling continued with all 11 remaining stations completed, gear changed and otter trawl survey underway, completing one station. Beam trawls completed: 1, 2, 3, 4, 5, 6, 7, 9, 10, 14, 16 Otter trawls completed: 13 Weather was favourable and consistent throughout the day with light F 2-3 easterly wind and >0.5m wave height.

11/05/17	12 of the otter trawls were completed, leaving only 3 to be completed. Otter trawls completed: 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 14. Weather was favourable throughout the day with F3-4 easterly winds and 1 – 1.7m wave height.
12/05/17	All three remaining otter trawl stations completed in the morning. Unfortunately, due to poor water clarity and strong tides, conditions were not suitable for the deployment of the BRUV cameras. Otter trawls completed: 7, 15, 16 Weather conditions were favourable with southerly winds, F3-4, and approximately 0.5m wave height on site. Survey was completed by 1030 and the vessel was demobilised straight to Whitstable on the high tide. Vessel was alongside at 1240 and all survey team and equipment demobilised by 1500

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 were also no shallow access sites within the survey area and therefore no tidal restrictions in terms of accessing sampling locations.

Weather Downtime

During the survey, there were two full days of weather downtime on the 7th and 8th May where the trawls were unable to be completed due to strong northerly/north easterly winds. There was one period of unfavourable weather during which time the survey approach was revised and work continued on the most inshore trawl locations.

2.5. Field Methods

2.5.1. Survey Vessels

The autumn and spring fish surveys were undertaken aboard a local commercial fishing vessel, the *Seiont-A* (Plate 1), working out of Ramsgate. The *Seiont-A* underwent IMCA M149 and Vattenfall vessel safety audits prior to mobilising to the Project site. A summary vessel specification for the *Seiont-A* is provided in Table 5.

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 seafarer's medical and STCW 95 sea survival certificates (or equivalent).

Table 5 Vessel specification for the commercial fishing vessel, *Seiont-A*, chartered to undertake the TEOW spring fish surveys 2017.

	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 spring 2017 TEOW site characterisation fish survey.

2.5.2. Sampling

Methods for both commercial otter trawling and 2 m scientific beam trawling were consistent with those used during the existing Thanet OWF monitoring programme and autumn 2016 TEOW site characterisation fish survey, as outlined below.

2.5.2.1. Commercial Otter Trawl

Otter trawl trawls were undertaken for a duration of 20 minutes at a towing speed of 2.5 - 3.0 knots over the ground for approximately 1.2 km. Trawl 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 the autumn 2016 TEOW site characterisation fish survey. Full specification of the gear used is provided in Table 6below.

2.5.2.2. Scientific Beam Trawl

Beam trawling was undertaken in line with the guidelines set out by Ware & Kenny (2011) and further detailed in the Recommended Operating Guidelines (ROG) for MESH trawls and dredges (Curtis & Coggan 2006b). Trawls 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 the

autumn 2016 TEOW site characterisation fish survey. Full specification of the gear used is provided in Table 6 below.

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

Table 6 Specifications of the otter and beam trawls used during the autumn 2016 TEOW 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 OEL 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 (Curtis & Coggan 2006b). 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 OEL'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.

Plate 2 Top left: Scientific beam trawl being shot. Top right: Measurement of large starry smooth-hound. Bottom left: measurement of small-spotted catshark. Bottom right: Commercial otter trawl being hauled.

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

When 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 ROG for MESH trawls and dredges (Curtis & Coggan 2006a) was employed as outlined in the alternative sampling protocol provided as Appendix 5.

It is identified that considerable areas of *S. spinulosa* reef are likely to be present within the TEOW 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. During the autumn fish surveys 2016, an estimated volume of 200 l of *S. spinulosa* reef was sampled at epibenthic beam trawl station BT02, located on the north-eastern side of the Project site, immediately adjacent to the existing Thanet OWF where *S. spinulosa* reef has previously been recorded. Due to the size of the trawl retrieved on deck a 10 l sub-sample was taken (along with all fish species) and analysed fully for all macrobenthos >5 mm at the OEL laboratory.

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 spring 2017 fish surveys, to ensure there is consistency with nomenclature between the two characterisation surveys and with data collected during any pre-construction baseline 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.

2.6.1.2. Data Truncation

The standardised species lists were examined carefully by a senior ecologist 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. *Pagurus bernhardus* raised to be included within Paguridae). Species not adequately sampled were also removed from the data analysis. The rationale used for data truncation is summarised below in Table 7 and the full species lists with notes detailing the rationale for removing and combining each species is provided in Appendix 7. Raw data, prior to rationalisation is provided in Appendix 6.

Table 7 Summary of the data truncation rationale.

Truncation Action	Otter Trawl Examples	Beam Trawl Examples
Taxa / groups removed where they were not adequately / consistently sampled with an otter trawl	Pelagic species e.g. Long-finned squid Tube building Polychaetes e.g. Ross worm	Pelagic species e.g. Ctenophores (comb jellies) Small infaunal species <5mm e.g. Polychaetes Colonial Species e.g. Hydrozoa and Bryozoa Egg cases e.g. Mermaid's purse
Taxa / groups of 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	N/A	Inconsistent recording of taxa that could not be identified to the species level e.g. *Pagurus bernhardus* raised to Paguridae

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.

3. PROVISIONAL RESULTS

A provisional summary of the spring 2017 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 the communities present is beyond the scope of this survey report. A full interpretation and discussion of the data in the context of the autumn 2017 and existing datasets from the area will be provided in the final technical report.

3.1. Commercial Fish, Elasmobranchs and Shellfish

3.1.1. Overview of site

The otter trawl surveys undertaken across the Project site revealed an assemblage of fish species of relatively low diversity with a total of 13 taxa recorded and a mean (± SE) of 6.75 ± 0.23 taxa per sample. A total of 11 species of fish (including four elasmobranch species) and two species of shellfish were recorded. The most frequently recorded fish species was whiting and the most frequently recorded shellfish species was the common prawn. Total abundance was also low with a mean (± SE) of 50.31 ± 5.70 per trawl, driven largely by higher numbers of the small-spotted catshark.

Full matrices are provided in Appendix 6 and 7 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 survey area 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 v7 (Clarke & Gorley 2015) as a means of elucidating differences in the composition of fin fish, shellfish and elasmobranch species associated with the survey area Figure 3.

Despite a relatively uniform number of taxon per trawl (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. Fish communities reflected this gradient in seabed type with species such as the whiting and the small-spotted catshark dominating areas of coarser ground and hard substrate in the east of the wind farm site and along the ECC and flatfish, such as plaice, generally dominating communities in soft sediment locations to the north of the site.

3.1.3. Abundance and Diversity

Total abundance of individuals (expressed as CPUE) was generally low but with relatively higher abundances recorded along the ECC and most inshore areas of the wind farm footprint (Figure 4). Elevated abundances were largely driven by plaice, dab, whiting and the small-spotted catshark. Despite distinct differences in the communities distributed across the TEOW site, overall species diversity was largely consistent between sampling locations. The diversity of fin fish was generally greater than elasmobranch diversity and much greater than shellfish diversity at all locations (Figure 5). Abundances of fin fish and elasmobranchs are discussed in more detail in Sections 3.2 and 3.3.

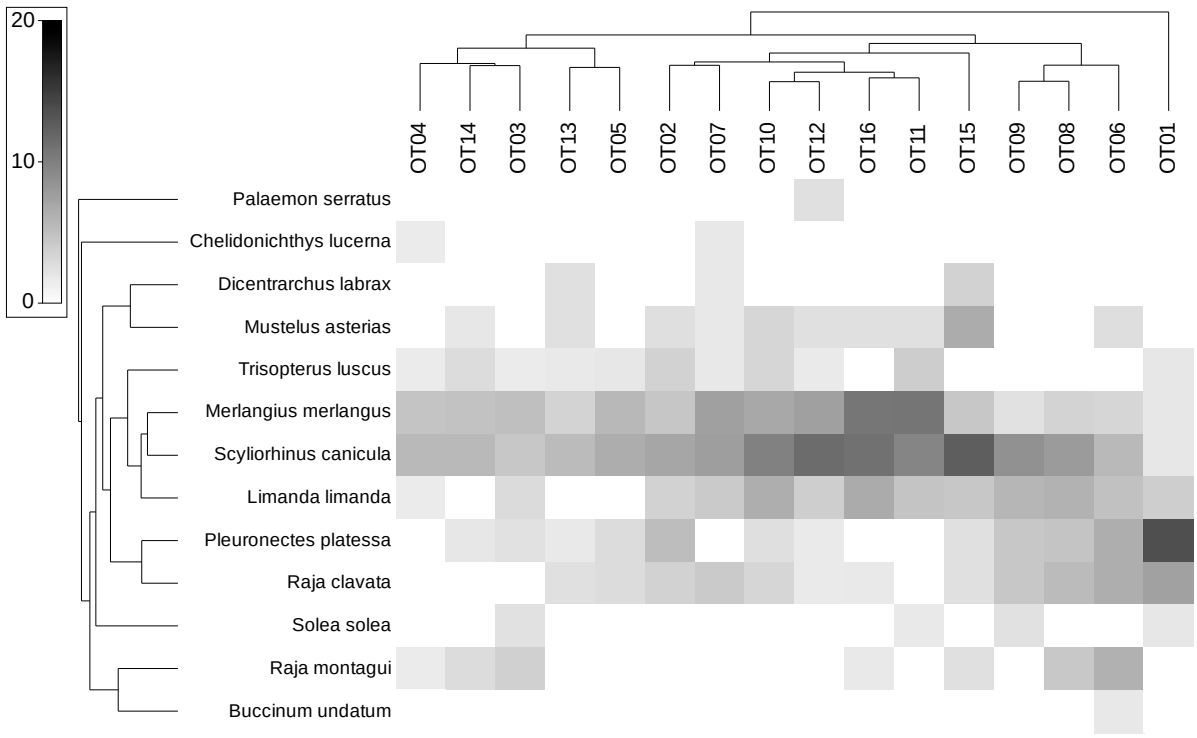

Figure 3 Shade plot generated using square-root transformed CPUE data to show commercial fish and shellfish community similarity sampled during the spring 2017 TEOW site characterisation fish survey.

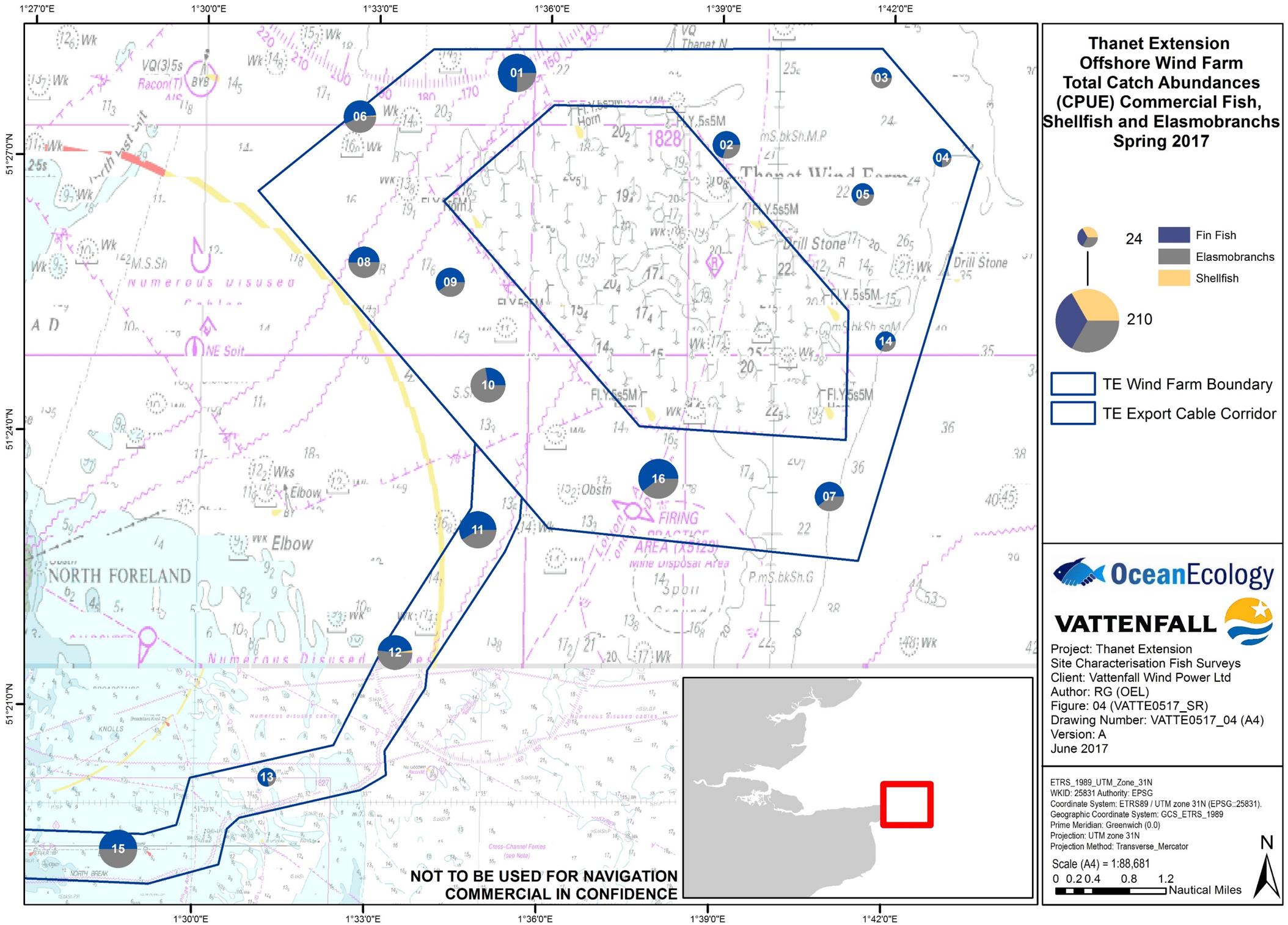

Figure 4 Total abundances (CPUE) of commercial fish, shellfish and elasmobranchs sampled during the spring 2017 fish survey.

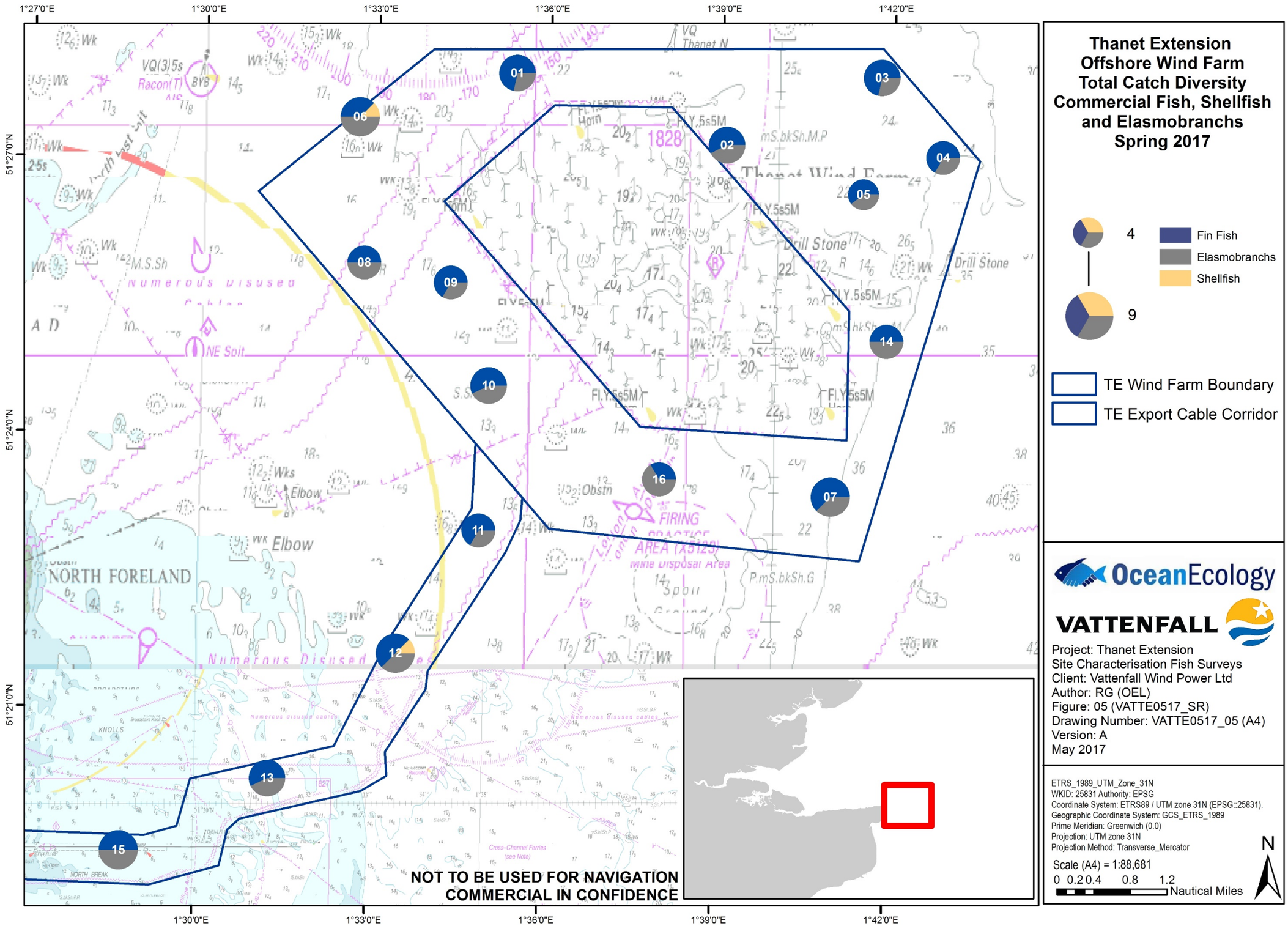

Figure 5 Species diversity and composition of commercial fish, shellfish and elasmobranchs sampled during the spring 2017 fish survey.

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 spring 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 offshore ECC, north-western wind farm and southern wind farm locations, seemingly driven by the elevated numbers of whiting rather than an increased diversity and abundance of species. Otter trawl location OT01 did however, exhibit the highest abundance of commercial fish driven by the large number of plaice sampled at this location. A total of seven species of fish and two species of shellfish were recorded with the most abundant fish species being whiting. With the exception of OT16, where only two fish taxa were recorded, between three and five commercial fish species were sampled per trawl location whereas catches of shellfish species appeared to be incidental (one or two individuals at single sites). Only three individuals of shellfish (two common prawn at OT12 and one common whelk at OT06) were recorded across all sampling locations.

The commercial fish community across the survey area was dominated by whiting, dab and plaice with moderate abundances of pouting. Other fish and shellfish were present only sporadically and in comparatively low numbers. Diversity was relatively uniform across the development site. Whiting and dab were also the most widespread of the commercial species being recorded at 16 and 13 of the 16 locations sampled, respectively. Plaice and pouting were similarly widespread, recorded at 12 and 11 of the 16 locations sampled respectively. Catches of Dover sole which are of particular commercial interest in this area, were recorded at just four of the 16 locations sampled in relatively low numbers. Incidental catches of European bass, also of commercial interest in the area, were recorded at just three of the 16 locations sampled.

3.2.2. Key Commercial Fish Species

Of the key commercial fish species sampled during the fish and shellfish survey programme, three were sampled in notably higher abundances than any other fish species. These species were whiting, plaice and pouting. The total abundance (expressed as CPUE) and distribution of the key species at each station during the spring survey is presented in Figure 7 and is summarised below.

3.2.2.1. Whiting

Whiting was the most abundant and widely distributed fish species sampled across the survey area being recorded at all of the 16 trawl locations. Whiting showed no clear patterns in its distribution with abundances relatively uniform across the survey area. The average catch per hour of whiting was 36 individuals across all otter trawl samples.

3.2.2.2. Plaice

Plaice was the second most abundant fish species sampled and was also widely distributed being recorded at recorded at 12 of the 16 locations sampled with an average catch per hour of 20.8 individuals across all otter trawl samples. Plaice seemed to demonstrate a preference for the more northern areas of the wind farm footprint where the seabed was characterised by soft mobile sediments, although it was also recorded on mixed and coarse sediments along the ECC.

3.2.2.3. Dover Sole

Dover sole was sampled in relatively low numbers and was recorded at just four of the 16 locations. Dover sole seemingly favoured offshore areas of the wind farm footprint particularly those to the north where soft sediments were present. The average catch per hour of Dover sole was just 1.13 individuals across all otter trawls samples.

3.2.2.4. Pouting

Pouting was recorded at 11 of the 16 locations sampled with an average catch per hour of just 4.4 individuals across all otter trawl samples. Pouting was recorded in relatively low numbers compared to the other key species, with generally only one individual per trawl. Pouting, along with whiting, showed no clear pattern in its distribution across the development site.

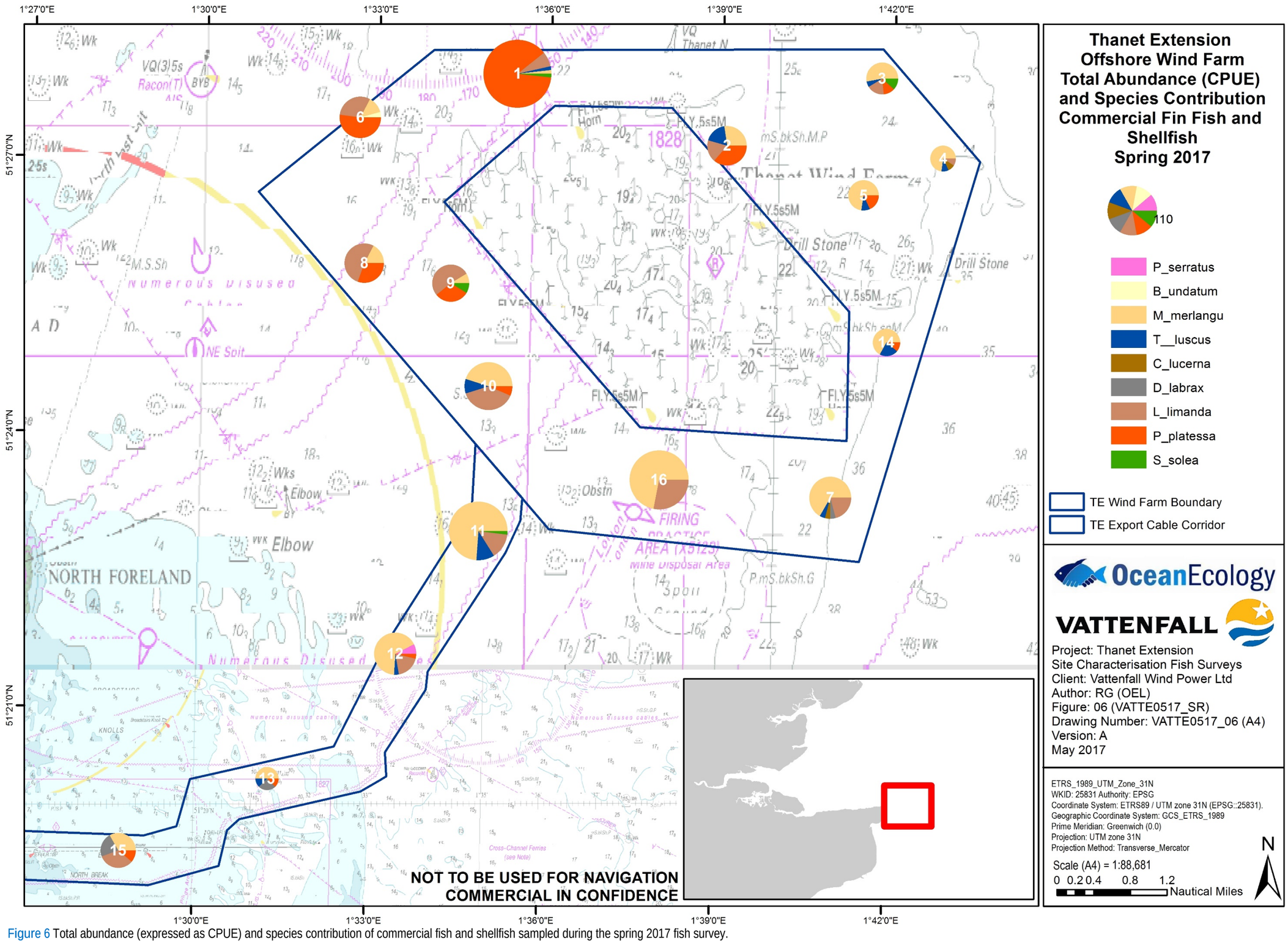

Figure 6 Total abundance (expressed as CPUE) and species contribution of commercial fish and shellfish sampled during the spring 2017 fish survey.

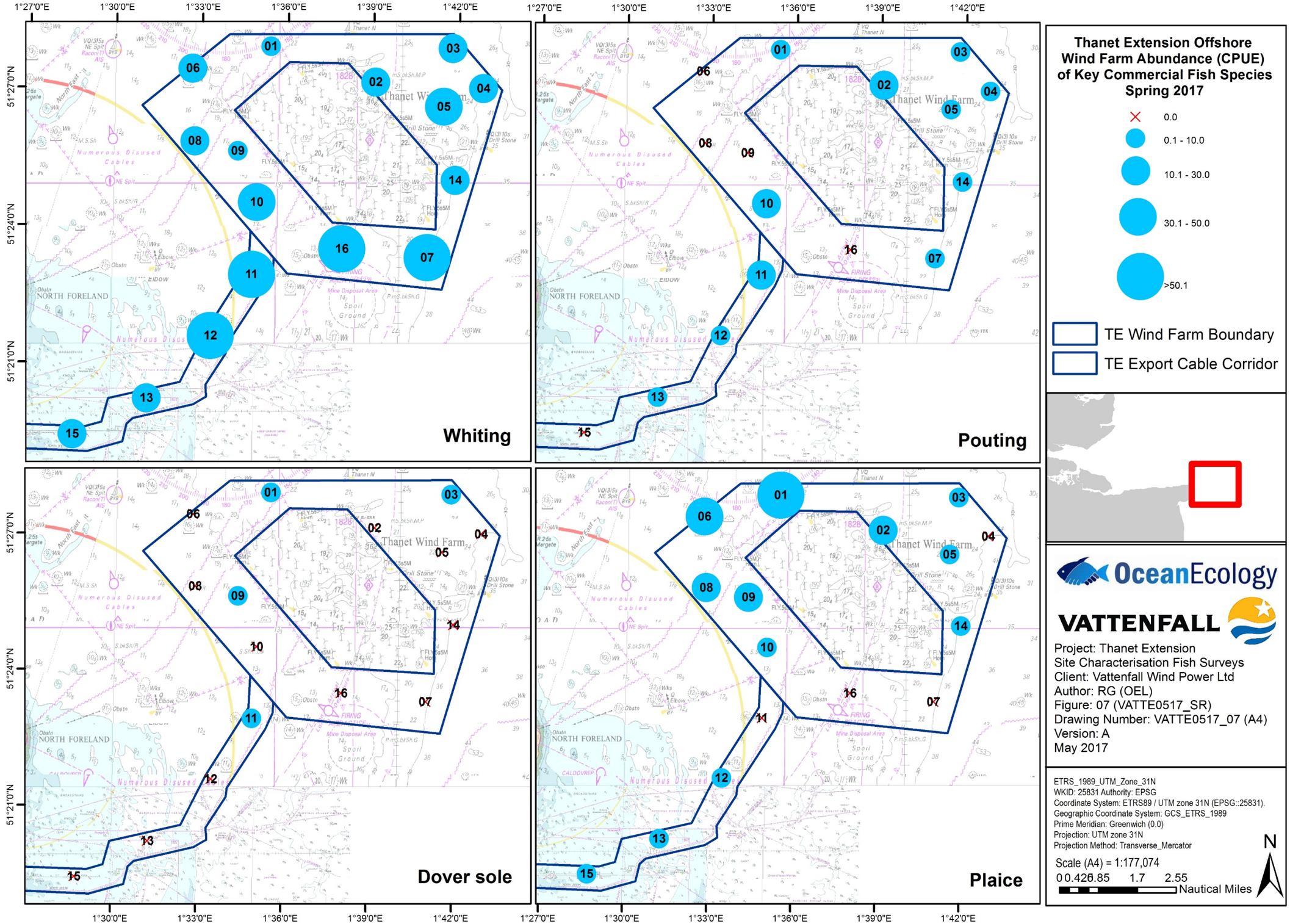

Figure 7 Total abundance (expressed as CPUE) of key commercial fish species sampled during the spring 2017 fish survey.

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 and Composition

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

There were four species of elasmobranch recorded during the spring fish surveys: the small-spotted catshark, the starry smooth-hound, the thornback ray and the spotted ray, *Raja montagui.* The small-spotted catshark was the most abundant elasmobranch species recorded with moderate abundances of the thornback ray and relatively low abundances of the starry smooth-hound and the spotted ray. Combined abundances of elasmobranch species were greatest in the more inshore wind farm footprint areas and along the ECC largely due to greater catches of small-spotted catshark in these areas.

3.3.2. Species Distribution

3.3.2.1. Small-spotted catshark

The total abundance (expressed as CPUE) of small-spotted catshark at each station during the spring 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 four elasmobranch species with an average catch per hour of 64.65 individuals across all otter trawl samples. The abundance of catshark was greatest at trawl location OT12 along the ECC where the seabed is known to be characterised by mixed sediments and coarse substrate. Notable abundances were also recorded at trawl locations OT16 and OT10, at the most inshore end of the wind farm footprint area, characterised by mixed sediments. The small-spotted catshark was present at all of the 16 sampling locations recorded across a range of habitat types. Reduced abundances were however noted 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. Small-spotted catshark 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).

There was a general spatial segregation between males and females across the site. Figure 9 shows a preference for the distribution of males in offshore areas and females 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 survey area 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 at each station during the spring survey has been plotted with pie charts showing male:female sex ratios in .

The thornback ray was caught in relatively low numbers during the survey with an average catch per hour of 13.10 individuals across all otter trawl samples. Abundances were generally higher in the northern area of the wind farm footprint where sediments consist of sands and muddy sands. Thornback ray exhibited a reduced distribution in comparison to the small-spotted catshark being recorded at only 12 of the 16 locations sampled. The abundance of thornback ray was greatest at sampling location OT01, the most northern trawl location in an area characterised by 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.

3.3.2.3. Spotted Ray

The spotted ray was recorded at seven of the 16 locations sampled with an average catch per hour of 5.67 individuals across all otter trawl samples. The abundance of the spotted ray was the greatest at OT06 and this species seemingly preferred the northern areas of the wind farm where characterised by sands and muddy sands, except for single individuals at stations OT15 and OT16 which are characterised by rocky substrate and mixed sediments respectively.

3.3.2.4. Starry Smooth-hound

The starry smooth-hound was recorded at 10 of the 16 locations sampled and was sampled mainly in areas of mixed and coarse sediments along the ECC and in the inshore areas of the wind farm footprint. The greatest abundance of starry smooth-hound was recorded at station OT15, the most inshore station along the ECC characterised by rocky substrate. An average catch per hour of 6.28 individuals was recorded across all otter trawl samples.

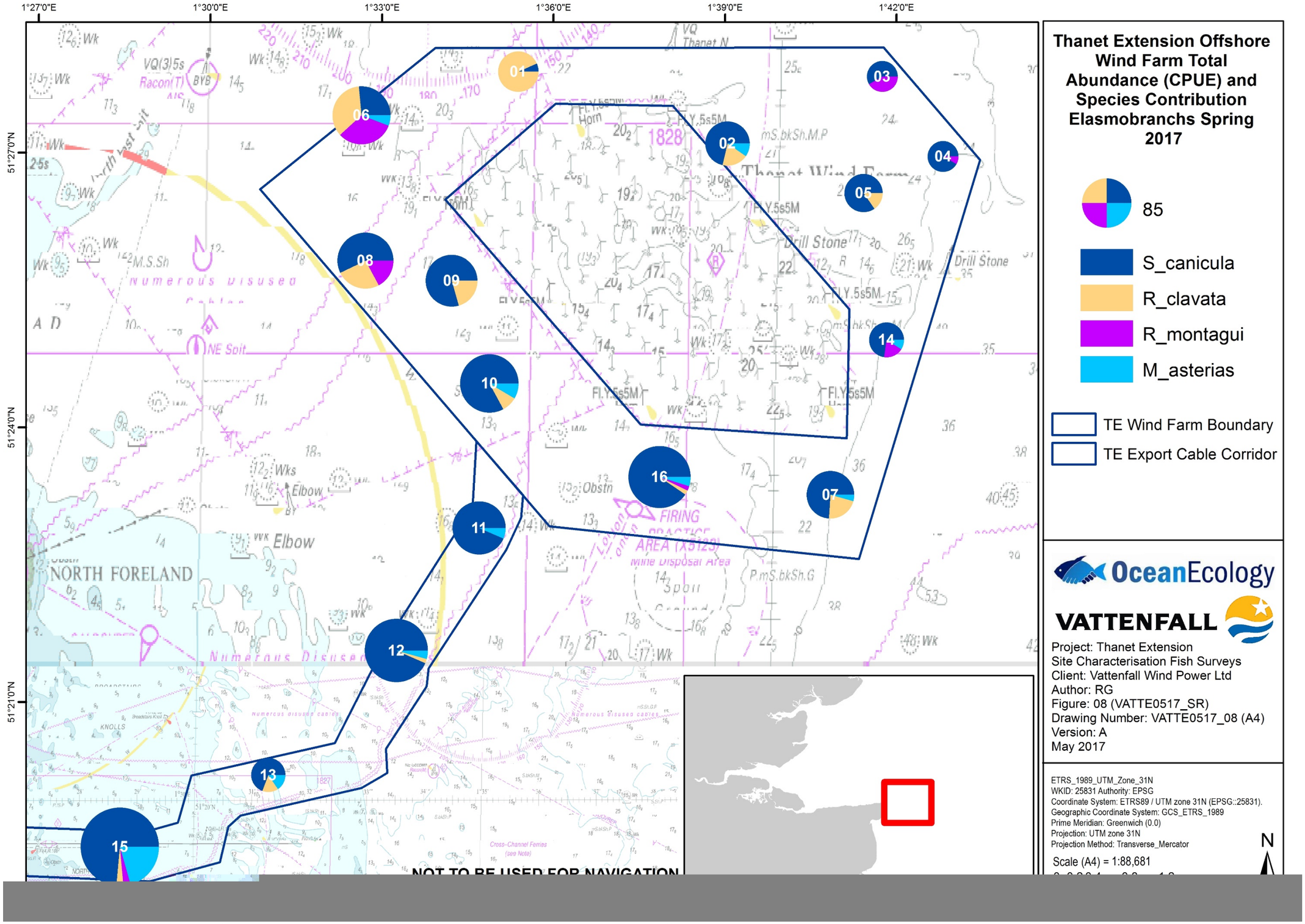

Figure 8 Total abundance (expressed as CPUE) and species composition of elasmobranchs at each station sampled during the spring 2017 fish survey.

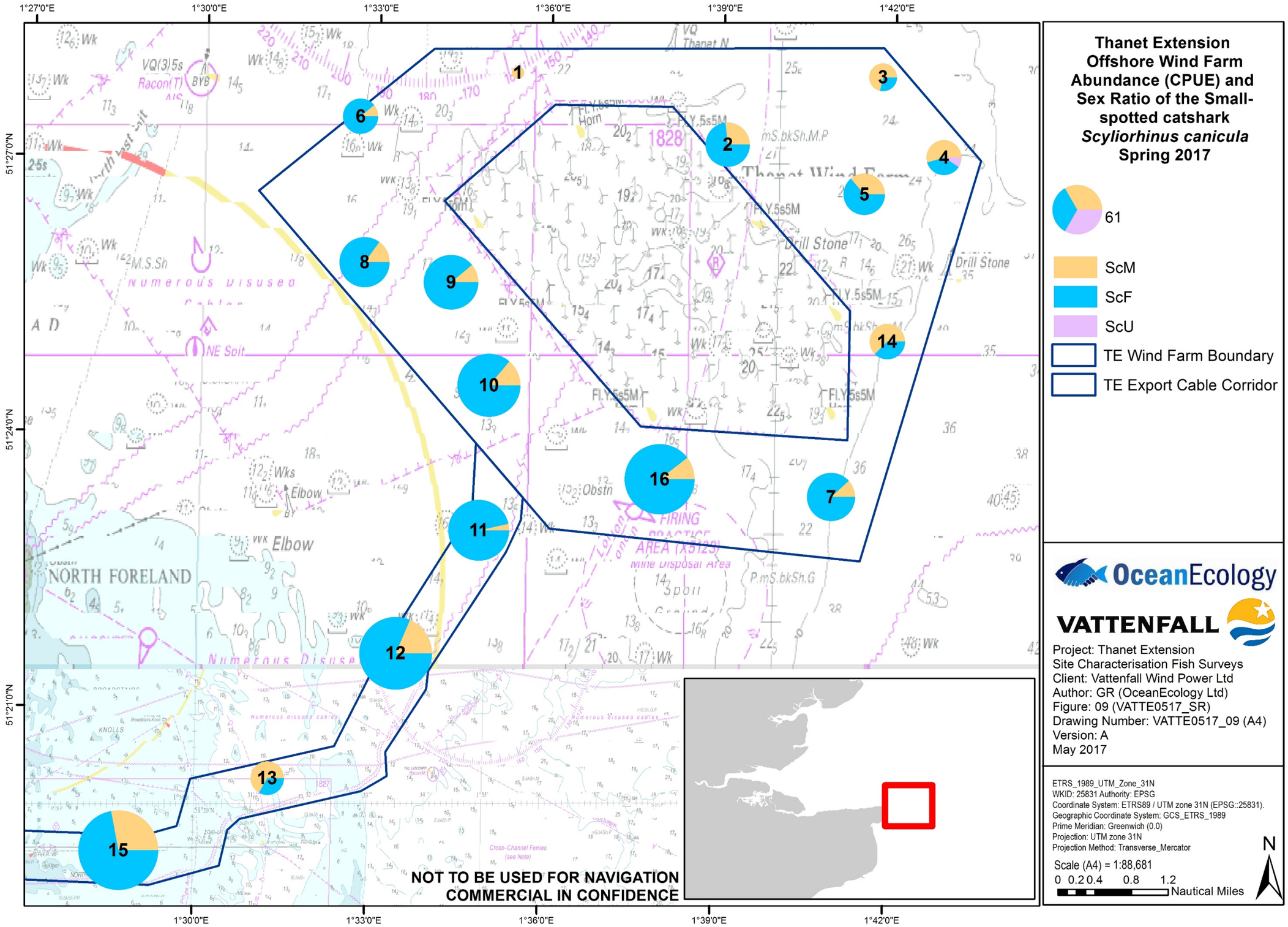

Figure 9 Distribution and abundance (expressed as CPUE) with male: female sex ratio of the small-spotted catshark, *S. canicula* sampled during the spring 2017 fish survey. M = male F = female U = unidentified sex

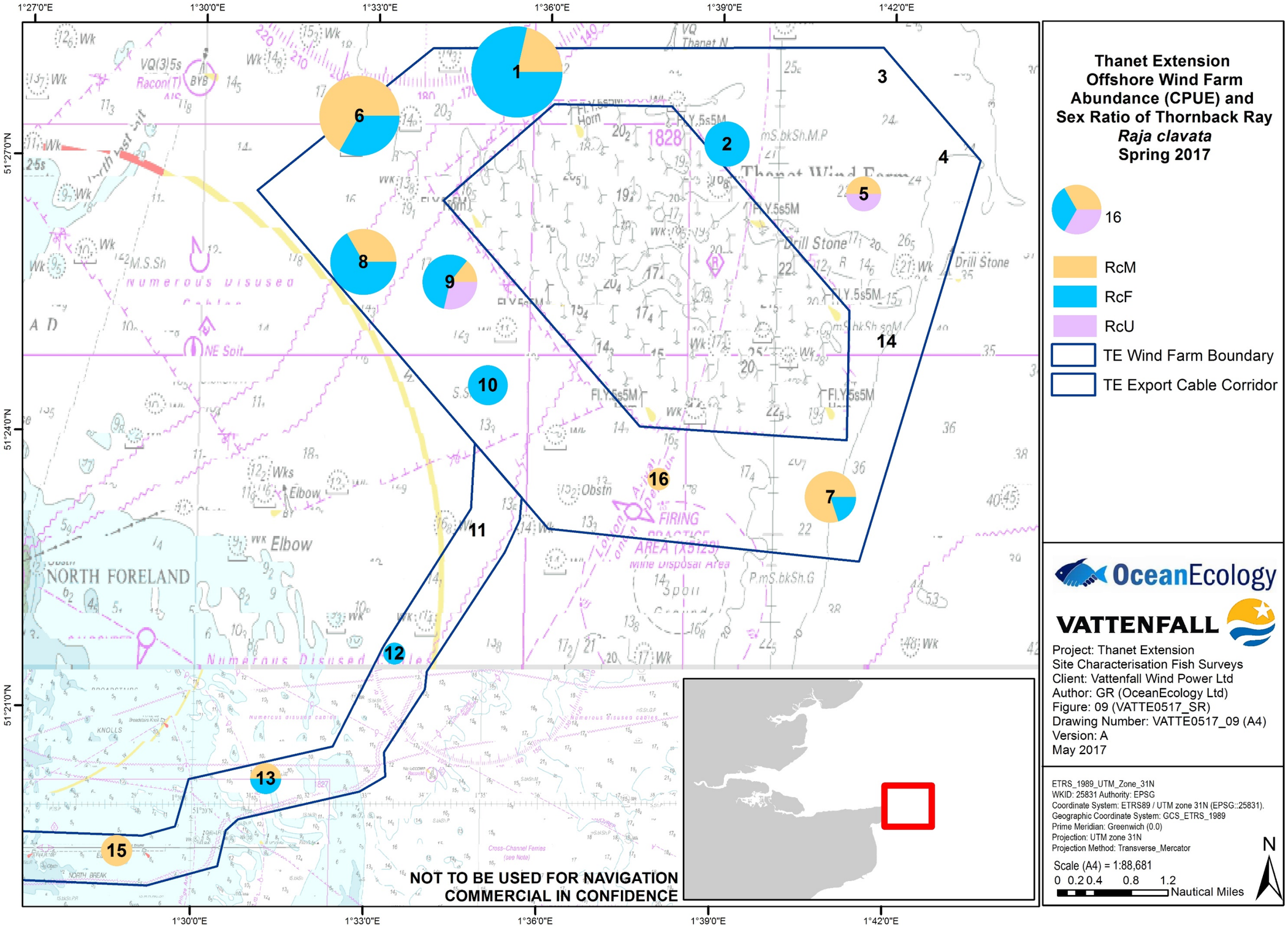

Figure 10 Distribution and abundance (expressed as CPUE) with male: female sex ratio of the thornback ray, *R. clavata* sampled during the spring 2017 fish survey.

3.4. Demersal Fish and Epifaunal Invertebrates

3.4.1. Overview of Site

The beam trawl sampling undertaken across the survey area revealed a diverse fish and epifaunal assemblage constituted by 59 taxa with a mean (± SE) of 16.00 ± 1.63 taxa sampled per trawl. Abundance per trawl was variable, largely attributable to large numbers of a few species (e.g. the brittlestar and the green sea urchin, *Psammechinus miliaris*) at a relatively small number of locations. A total of 20 species of fish (including two species of elasmobranchs) and 39 invertebrate taxa were recorded with the most abundant invertebrate species being the brittlestar and the most abundant fish species being Dover sole.

Full epifaunal matrices are provided in Appendix 6 and 7 presenting the raw abundance and weighted CPUE abundance (catch per hour) of each taxon in all trawl samples. A summary of abundances and distribution across the Project site are described below and presented in Figure 11 to Figure 16.

3.4.2. Community Distribution

There was marked spatial variability in the composition of the epifaunal communities across the survey area which seemingly correlated with the variability of sediment type. 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. 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 v7 (Clarke & Gorley 2015) 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, and the pogge dominating hard substrate locations along the ECC and the Dover sole and thornback ray dominating communities in soft sediment locations. The lesser weever, *Echiichthys vipera*, was also found to dominate the most offshore areas characterised by sandy sediments. Dover sole was the most abundant and widespread fish species sampled, present at 12 of the 16 beam trawl locations.

A similar relationship between invertebrate communities across seabed types was also apparent. Trawl locations furthest offshore within the wind farm footprint to the north and northwest of the survey area were dominated by the brittlestar. ECC sampling locations exhibited were characterised by a similar composition of epifaunal taxa and were dominated by high abundances of the green sea urchin. The brittlestar was the most abundant invertebrate species whilst hermit crabs were the most widespread invertebrate taxon, present at all sampling locations.

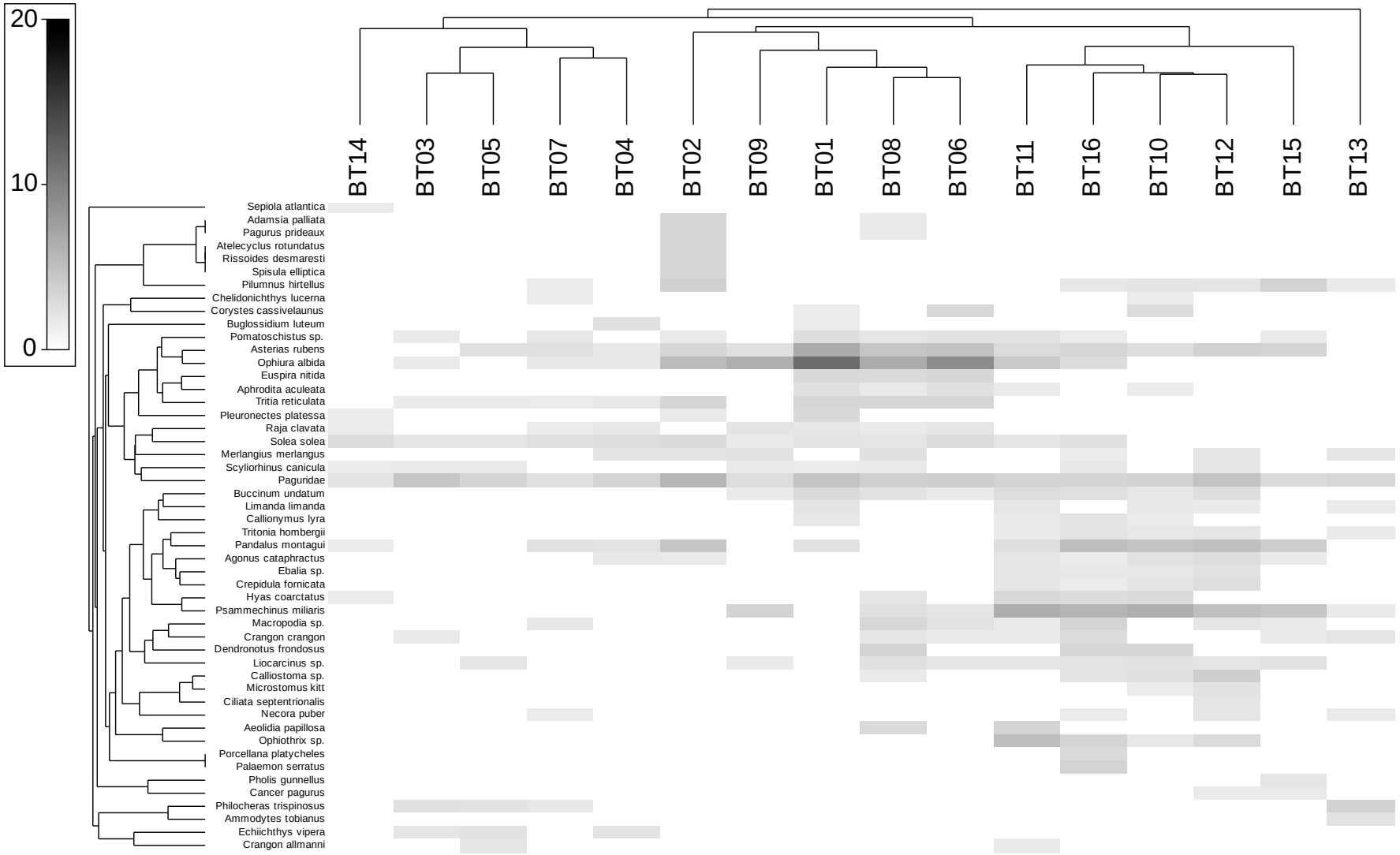

Figure 11 Shade plot generated using forth-root transformed CPUE data to show demersal fish and epibenthic invertebrate community similarity (based on 50 most abundant species) sampled using a 2 m beam trawl during the spring 2017 TEOW site characterisation survey.

3.4.3. Abundance and Diversity

The greatest abundances (expressed as CPUE) of individuals (fish and invertebrates) were generally recorded in soft and mixed sediment habitats in the north and western extent of the survey area (Figure 12). These abundances were often heavily skewed by one or two species (e.g. brittlestars or the green sea urchin) present in high numbers, several orders of magnitude greater than most other species. Generally, total abundances along the ECC and most offshore areas were lower in comparison to locations in the north and western extent of the wind farm footprint. Despite this, species diversity was relatively uniform across the development site.

Whilst there were differences in the communities distributed across the survey area, species diversity was generally consistent between sampling locations with the exception of sampling locations in deeper water to the northeast that showed lower diversity of fish and invertebrates (Figure 13 and Figure 14). Invertebrate diversity was generally greater than that of fish across the survey area. Sampling location BT16 represented the highest fish:invertebrate composition of all sampling locations (Figure 13). Sampling location BT02, which was located on an area of *S. spinulosa* reef is discussed in more detail in Section 3.5.

Abundance and diversity of fish species generally mirrored trends in combined abundance and diversity, being greatest at locations in the north and western areas of the site on soft and mixed sediments (Figure 14). Areas of higher abundance were generally influenced by one or two numerous species, most notably Dover sole, goby, *Pomatoschistus* sp., pogge and whiting (Figure 15).

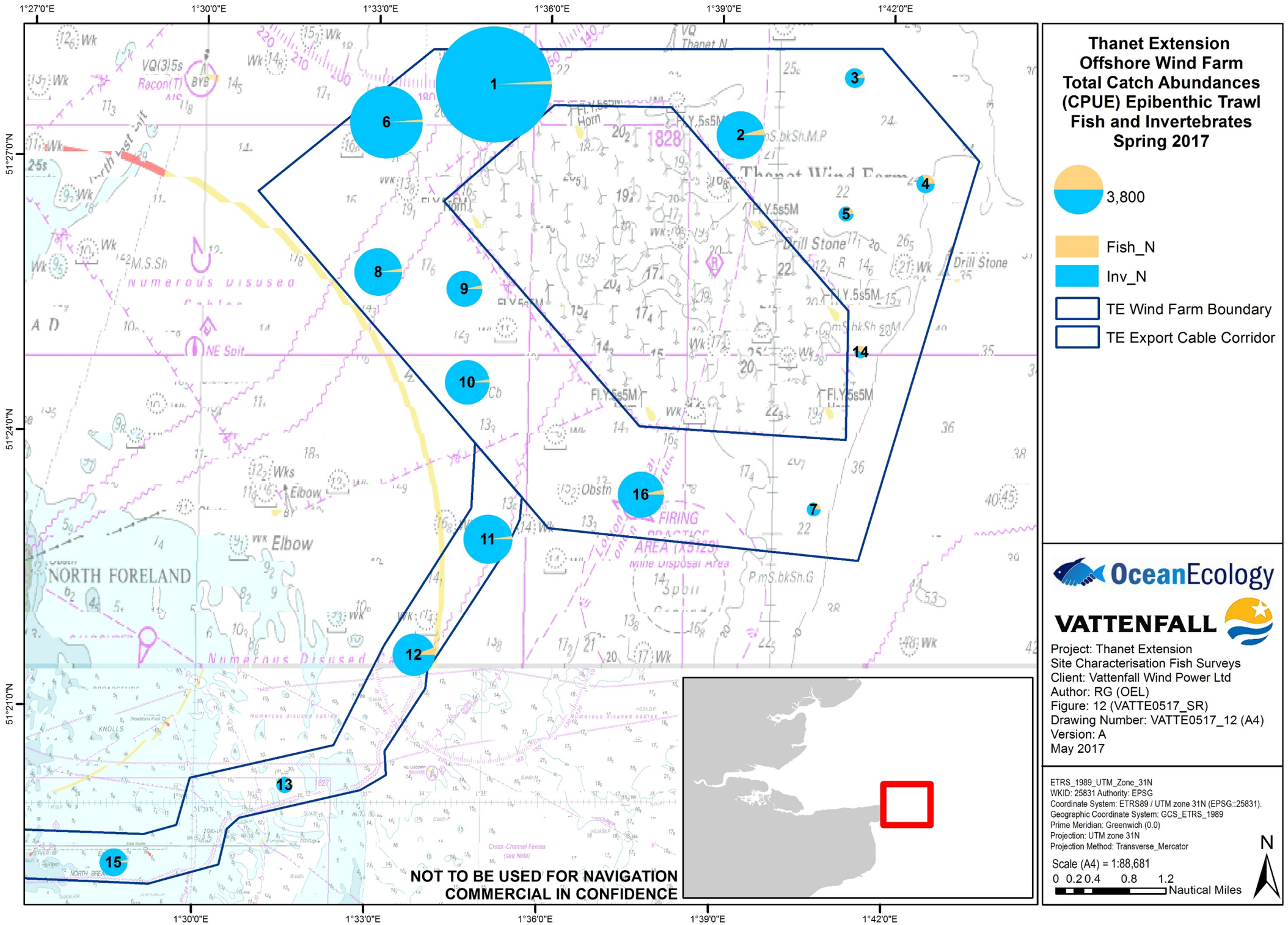

Figure 12 Abundance (CPUE) of demersal adult and juvenile fish and epibenthic invertebrates sampled during the spring 2017 TEOW site characterisation fish survey. N = Abundance

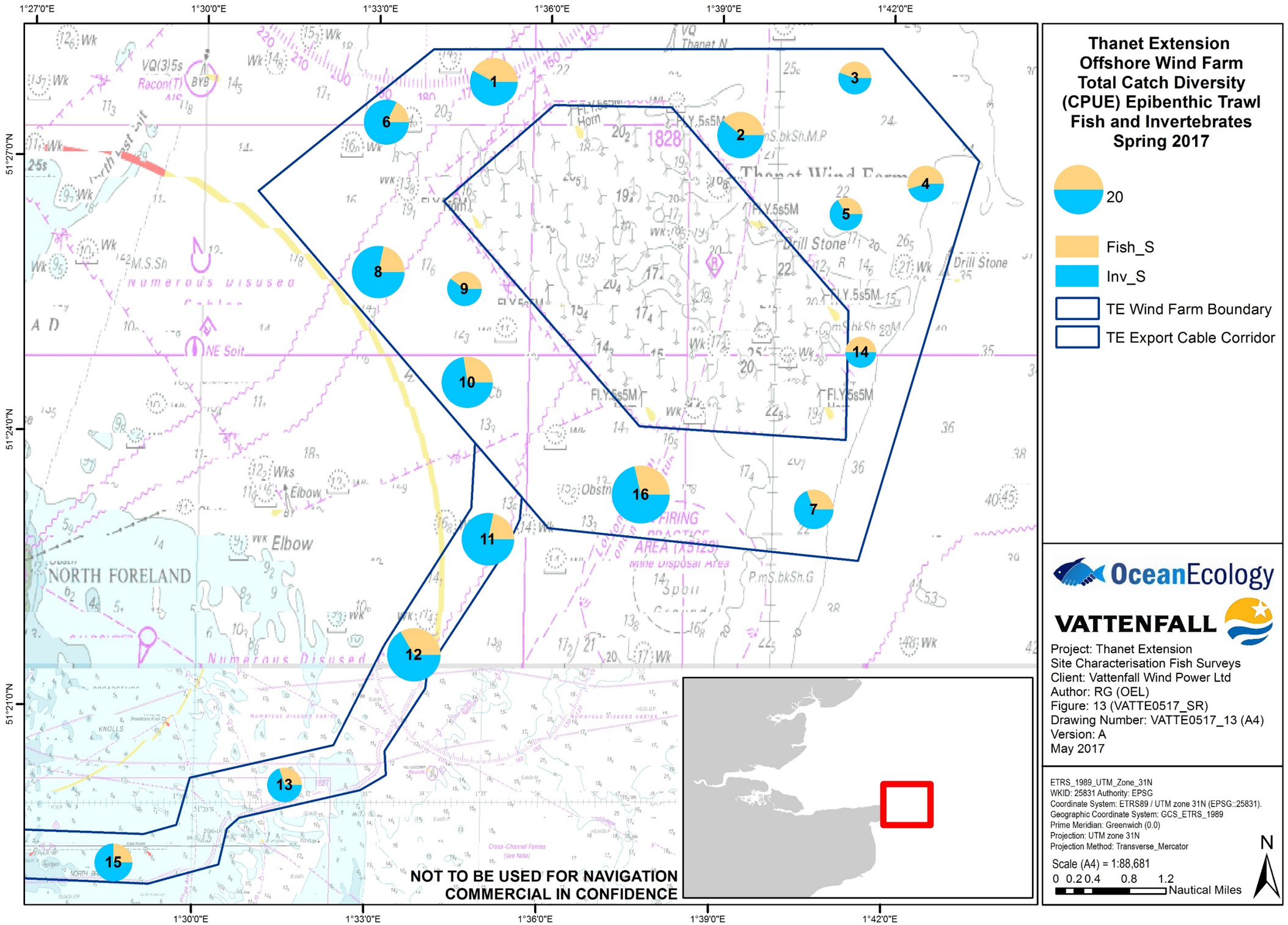

Figure 13 Species diversity and composition of fish and epibenthic invertebrates sampled during the spring 2017 TEOW site characterisation fish survey. S = No. of species

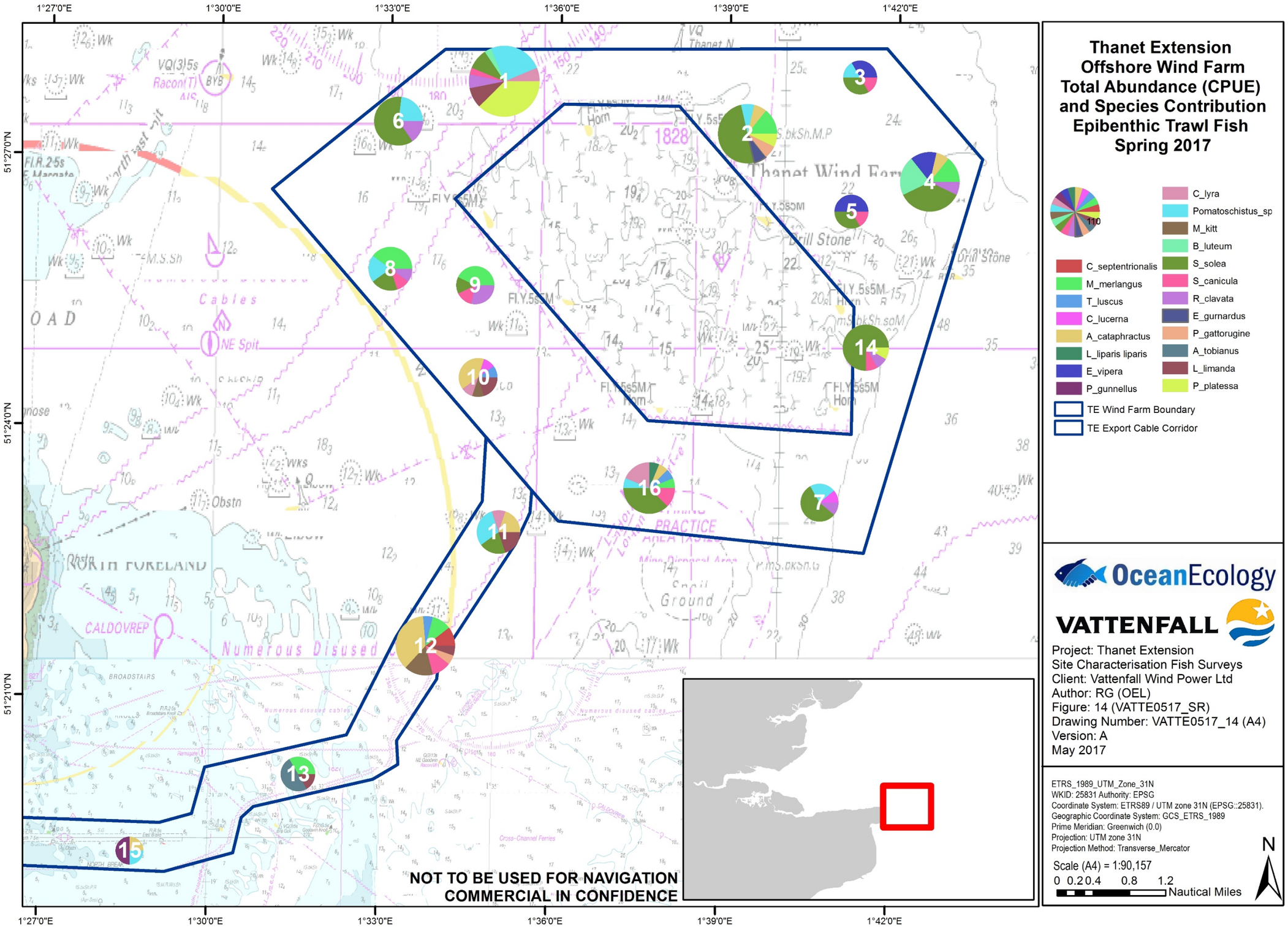

Figure 14 Total abundance (CPUE) and species contribution of demersal fish sampled during the spring 2017 TEOW site characterisation fish survey.

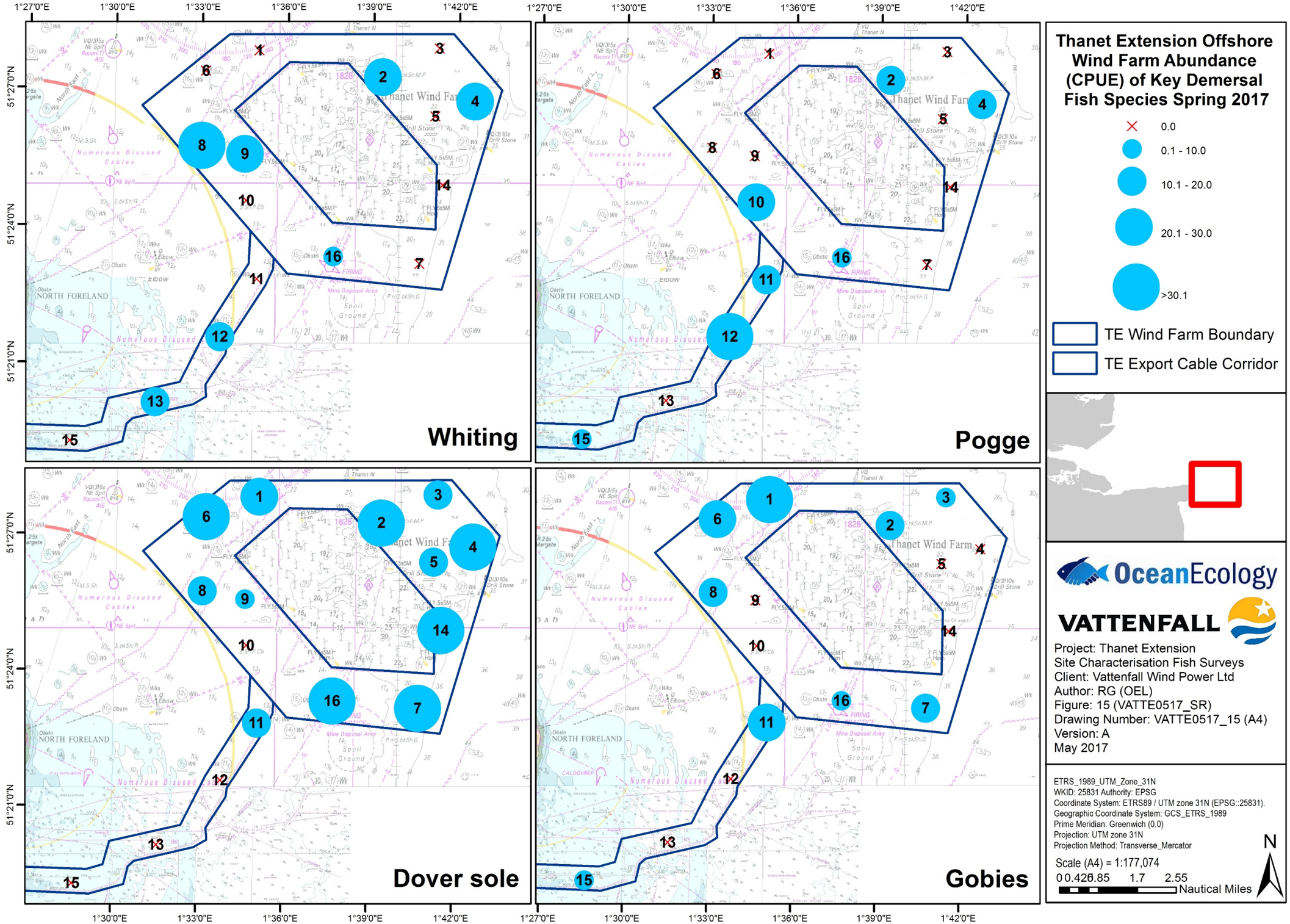

Figure 15 Total abundance (CPUE) of key demersal fish (including commercially targeted species) sampled during the spring 2017 TEOW site characterisation fish survey.

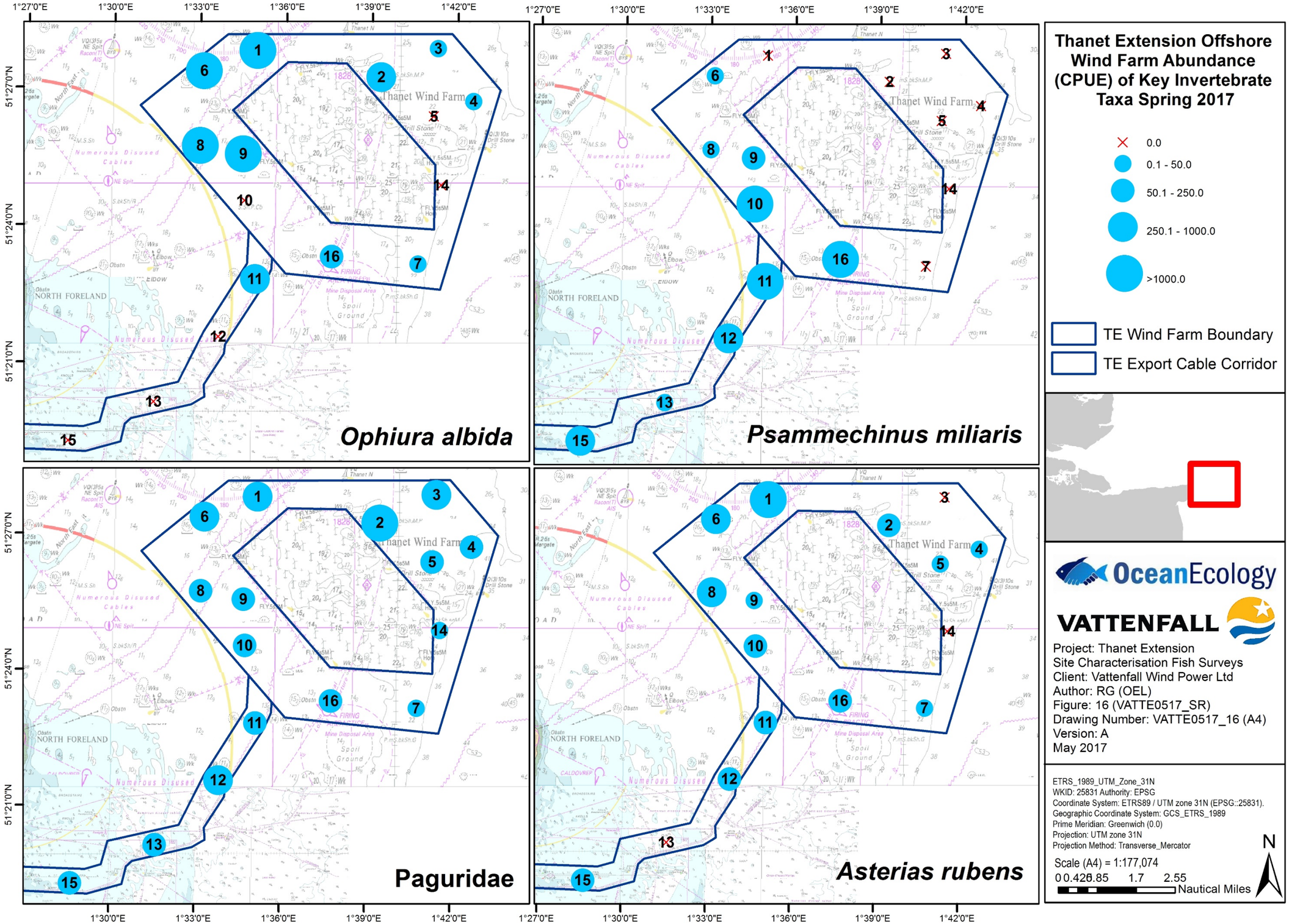

Figure 16 Total abundance (CPUE) of key invertebrate species (including commercial targeted species) sampled during the spring 2017 TEOW site characterisation fish survey.

3.5. *Sabellaria spinulosa* reef

Several epibenthic beam trawl locations, most notably BT02, showed evidence of *S. spinulosa* aggregations some likely to be representative of Annex I biogenic 'reef' in line with the criteria set out by Gubbay (2007). Sample locations BT04, BT05 and BT14 were not deemed to be characteristic of reef with only small fragments and aggregated clumps of *S. spinulosa* being recorded. Four other samples from stations BT11, BT12, BT15 and BT16 also contained *S. spinulosa* aggregations but this was identified as rubble with no live individuals and therefore these areas were not thought to be representative of Annex I reef. Therefore, sampling continued as normal at these locations.

A substantial quantity of *S. spinulosa* reef was sampled at epibenthic beam trawl station BT02 located on the north-eastern side of the wind farm footprint immediately adjacent to the area where *S. spinulosa* reef has previously been recorded within the existing Thanet OWF (Pearce et al. 2014). Similar quantities were also sampled at this sampling location during the autumn 2016 fish surveys (see Ocean Ecology Limited (2016)). Due to the size of the trawl retrieved to the deck, estimated at approximately 90 L by volume, a 10 l 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 >5 mm at the OEL laboratory.

Sampling location BT02 was associated with the second most diverse community of fish species and one of the highest abundance of fish of any other epibenthic trawl. BT02 also contained a relatively diverse and abundant community of invertebrates. The diverse assemblage of fish and invertebrates associated with this sample included juvenile and adult fish (Dover sole, plaice, goby, tompot blenny, *Parablennius gattorugine*, pogge, grey gurnard, *Eutrigla gurnardus*, and whiting) as well as various invertebrates such as the commercially important pink shrimp. Other abundant invertebrates included several crab species (Pagurid hermit crabs, *P. hirtellus* and *Atelecyclus rotundatus*), gastropods (*Tritia reticulata* and *Spisula elliptica*), the common starfish, the brittlestar and the cloak anemone, *Adamsia palliata*. Also recorded at sampling location BT02 was the mantis shrimp, *Rissoides desmaresti,* which is scarce around the UK and has only been recorded a small number of times off the east coast of the British Isles (Griffin et al. 2011).

A summary of findings including length and aperture measurements for the four sampling locations where live *S. spinulosa* was evident is provided in Table 8. 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.

Table 8 Length (mm) and aperture (mm) measurements of *S. spinulosa* reef / aggregations sampled during TEOW spring 2017 survey.

	BT02	BT04	BT05	BT14
Aggregation type (% contribution) (reef, clumps, veneer, rubble)	Reef	Clumps	Clumps	Clumps
Maximum tube length (mm)	170	40	50	50
Average tube length (mm) (n = 10)	58	30	30	32
Maximum tube aperture (mm)	3	2	2	3
Average tube aperture (mm) (n = 10)	2.1	1.6	1.6	1.9

Plate 3 Evidence of Ross worm, *S. spinulosa* reef at sampling location BT02 collected during the spring 2017 TEOW site characterisation fish survey.

3.6. Other Species of Interest

The total abundance (not converted to CPUE due to low numbers) of species of commercial and / or conservation interest is summarised in Table 9.

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, originally found on the east coast of America but now present along the southern coasts of Britain[3].

Some of the species listed in Table 9 are considered to be incidental catches with only a very small number of sporadic records across the site. The common whelk was sampled in half of the locations across the site in the beam trawls (eight of the 16 trawl locations sampled). The tub gurnard was recorded in few stations as single individuals only whilst the common prawn was recorded in relatively high numbers but at a single beam trawl location. The abundance of gobies, an important prey item for many commercially important fish species was recorded in relatively low numbers at nine of the 16 beam trawl locations sampled.

[3] http://www.marlin.ac.uk/species/detail/1554

Table 9 Summary of the total abundance of species of commercial or conservation interest recorded in otter and beam trawls sampled during the spring 2017 TEOW site characterisation fish survey.

Species	Common Name	Gear	Abundance	Distribution
Marine Fish				
Dicentrarchus labrax	European Bass	Otter Trawl	5	OT07, OT13, OT15
Microstomus kitt	Lemon Sole	Beam Trawl	4	BT10, BT12
Chelidonichthys lucerna	Tub Gurnard	Otter Trawl	2	OT04, OT07
		Beam Trawl	2	BT07, BT10
Pomatoschistus spp.	Goby	Beam Trawl	22	BT01, BT02, BT03, BT06, BT07, BT08, BT11, BT15, BT16
Shellfish				
Cancer pagurus	Edible Crab	Beam Trawl	2	BT12, BT15
Palaemon serratus	Common Prawn	Otter Trawl	2	OT12
		Beam Trawl	21	BT16
Buccinum undatum	Common Whelk	Otter Trawl	1	OT06
		Beam Trawl	37	BT01, BT06, BT08, BT09, BT10, BT11, BT12, BT16
Invasive Non-native Species				
Crepidula fornicata	Slipper Limpet	Beam Trawl	13	BT10, BT11, BT12, BT16

4. SUMMARY

4.1. Survey Progress

This survey represents the second of two site characterisation surveys for commercial fish and epifaunal communities undertaken across the TEOW development site. The survey was undertaken between the 6th and 12th of May 2017 with only minor delays to survey progress as a result of adverse weather conditions and / or tidal conditions. All 16 target otter trawl and beam trawl locations (were sampled successfully and generally to within 50 m accuracy of the target positions.

4.2. Commercial Fish

Otter trawl samples were generally low in abundance of individuals and often of low diversity dominated by a few key species sampled at the majority of trawl locations. Abundance was greater at sampling locations within offshore cable route, north-western and southern wind farm footprint areas seemingly attributable to high numbers of whiting. A total of nine species of fish and two species of shellfish were recorded. The most abundant fish species was whiting and the most abundant shellfish species was the common prawn.

The commercial fish community was dominated by whiting, dab and plaice with moderate abundances of pouting. Other fish and shellfish were present only sporadically and in comparatively low numbers. Whiting was one of the most widespread fish species sampled across the survey area but showed no clear trend in its distribution. Plaice was the second most abundant fish species sampled and seemed to demonstrate a preference for areas characterised by soft mobile sediments typical of more northern areas of the wind farm footprint. Dover sole was sampled in low numbers at just four of the 16 locations. Dover sole seemingly favoured areas characterised by sands and muds typical of offshore areas in the wind farm footprint. Pouting was recorded in relatively low numbers compared to the other key species.

4.3. Elasmobranchs

There were four species of elasmobranch recorded across the survey area, the small-spotted catshark, the starry smooth-hound, the spotted ray and the thornback ray. Combined abundances of elasmobranch species were greatest in the inshore wind farm footprint areas and along the ECC largely due to greater abundances of small-spotted catshark.

The small-spotted catshark was the most abundant of the four elasmobranch species recorded and was present at all 16 sampling locations being recorded across a range of sediment types. Lower abundances of the small-spotted catshark were noted in the northern area of the wind farm foot print where sediments consist of sands and muddy sands. This trend in abundance was also apparent for the starry smooth-hound. A clear spatial separation between male and female catshark was observed with males generally sampled in offshore areas and females sampled at inshore locations along the ECC.

In contrast, the thornback ray exhibited no such spatial distribution and abundances were generally higher in the northern area of the wind farm foot print. The spotted ray was also found to be more abundant in areas characterised by sands and muds at sampling locations in the north of the survey area.

4.4. Juvenile Fish and Epifaunal Invertebrates

The beam trawl sampling undertaken across the survey area revealed a relatively diverse fish and epifaunal assemblage with a total of 59 taxa recorded with a mean (± SE) of 16.00 ± 1.63 taxa per sample. A total of 20 species of fish and 39 invertebrate taxa were recorded with the most abundant invertebrate taxon being the brittlestar and the most abundant fish species being Dover sole.

In general, communities within the wind farm footprint were typical of soft sediment or mixed sediment habitats whilst those along the ECC were more typical of hard substrate communities. 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 were often heavily skewed by one or two species (e.g. the brittlestar and green sea urchin) present in extremely high numbers.

Fish communities showed a clear trend between soft sediment habitats and hard substrates with species such as the butterfish and the pogge dominating hard substrate locations along the ECC and Dover sole and thornback ray dominating communities in soft sediment locations. The lesser weever was also found to dominate the communities in most offshore areas characterised by sandy sediments. A similar relationship between invertebrate communities across seabed types was also apparent. The brittlestar was the most abundant invertebrate species whilst hermit crabs were the most widespread invertebrate taxa present at all sampling locations.

4.5. Other Species of Interest

There was evidence of *S. spinulosa* reef recorded at eight of the 16 sampling locations across the survey area. 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.

Sampling location BT02 was associated with the second most diverse community of fish species and one of the highest abundance of fish of any other sampling location. BT02 also contained a relatively diverse and abundant community of invertebrates. The diverse assemblage of fish and invertebrates associated with this sample included juvenile and adult fish, such as Dover sole, plaice and gobies as well as various invertebrates including the commercially important pink shrimp, several crab species (e.g. hermit crabs), gastropods (*T. reticulata* and *S. elliptica*), the common starfish, the brittlestar and the cloak anemone. Also recorded at sampling location BT02 was the mantis shrimp, which is scarce around the UK and has only been recorded a small number of times off the east coast of the British Isles.

5. HEALTH & SAFETY

The survey was undertaken with no Health and Safety incidents or accident

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