CENTRE FOR ENVIRONMENT, FISHERIES AND AQUACULTURE SCIENCE
LOWESTOFT LABORATORY, LOWESTOFT, SUFFOLK NR33 0HT

2015 RESEARCH VESSEL PROGRAMME

PROGRAMME: RV CEFAS ENDEAVOUR: SURVEY 18/15

STAFF:

Part A	**Part B**
Fishing:	
S McCully Phillips (SIC)	J Ellis (SIC)
B Hatton (2IC)	B Hatton (2IC)
R Humphreys	R Humphreys
M Eade	D Brown
L Cox	J Silva
A Ribeiro Santos	G Greenhalgh
R Masefield	N Hampton
Plus:	
J Fox (University of Essex)	J Fox (University of Essex)
G Anastasi (University of East Anglia)	G Anastasi (University of East Anglia)
P Gardiner	K Bradley (Southampton University)
W Dawson	
N Pearson	
K St John Glew (Southampton University)	

DURATION: 8th August – 6th September

LOCATION: North Sea (IV)

PRIMARY AIMS:

1. To carry out a groundfish survey of the North Sea as part of the ICES coordinated IBTS, using a hybrid GOV trawl in order to obtain information on:
   a) Distribution, size composition and abundance of all fish species caught;
   b) Age-length distribution of selected species;
   c) Distribution of fish in relation to their environment;
   d) Distribution of macrobenthos;
   e) Surface and bottom temperature and salinity data using the ESM2 profiler/mini-CTD logger and Niskin Bottle.
   f) Length, weight and maturity information from individual fish, in support of the EU Data Regulation.

2. Total alkalinity and dissolved inorganic / organic carbon analysis of seawater by filtration at selected stations.

SECONDARY AIMS:

3. Tag and release specimens of starry smooth-hound (*Mustelus asterias)*, greater-spotted dogfish (*Scyliorhinus stellaris),* spurdog (*Squalus acanthias)*, tope (*Galeorhinus galeus)*, common skate (*Dipturus batis)* species-complex, and blonde ray (*Raja brachyura),* in support of the ICES Working Group for Elasmobranch Fishes work to inform on stock units for demersal elasmobranchs.

4. To freeze any unusual fish species for subsequent identification / verification in the laboratory, including specimens of eelpout (*Zoarces, Lycodes* and *Lycenchelys*), sea scorpions (Cottidae, sub-area IVa only), *Sebastes* spp., and any unusual fish species, which may also be used in otolith research.

5. To freeze samples of smooth-hound (*Mustelus* spp.) for biological studies.

6. Record litter caught in the trawl in support of Defra projects.

7. Retain all dead specimens of shad (*Alosa* spp.) and lamprey (*Lampetra fluviatilis)* for study by Cefas scientists.

8. Collect fisheries acoustic continuously data at four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333 kHz), using the Simrad EK60 split beam sounder. The data will contribute to the existing 15 year time series of acoustic data in the North Sea and will be used as part of the Defra funded project Poseidon (MF1112) to monitor changes in mackerel distribution and abundance.

9. To retain empty skate egg cases with corresponding positional information for the Shark Trust.

10. Collect plankton biodiversity samples from selected stations for pigment and analytical flow cytometry analysis. *If* time and conditions allow, additional profiles to be completed with the ESM2 logger.

11. Collecting, preserving and analysing samples of seawater in order to determine the spatial-temporal variability of Transparent Exopolymer Particles (TEP) and DOM in the North Sea. Incubation experiments will be conducted for TEP detection.

12. Cetacean observations will be recorded where possible and send to the SeaWatch Foundation.

13. Collect data on incidental mortality of crabs caught in the trawl in support of Defra projects.

14. Obtain jellyfish samples from the North Sea to allow baseline isotopic signature to be determined in order to compare these with the isotopic signatures of higher trophic level species. Using these isotope maps it should be possible to geolocate different commercially important and ecologically important species to their feeding origins within UK waters.

15. To retain samples of *Alloteuthis subulata* where possible for further biological study.

16. To collect tissue samples of thornback ray (*Raja clavata)* in Divisions IVa and IVb for genetic studies

NARRATIVE:
(All times GMT)

RV Cefas Endeavour sailed from Lowestoft at 03:00hrs on Saturday August 8th. On board were nine Cefas fisheries staff, including Paul Gardiner, who was technical software support for the updated and newly implemented electronic data collection (EDC) system. Also on board were Cefas' lead in Health and Safety (to observe operations and conduct a safety audit on board), and three PhD students (from the University of East Anglia, University of Essex and Southampton University). A standard station normally consisted of collecting surface water and a cast with a single 10-litre Niskin bottle (to collect bottom water samples) and an ESM2 logger, to measure additional parameters through the water column (temperature, salinity, fluorescence, light, turbidity and oxygen). These deployments were then followed by a 30 minute tow with the standard IBTS rigged GOV (Grand Overture Verticale) trawl. From 2014 onwards a net variation has been used during this survey, with a polyethylene net with nylon sleeve and codend being employed. From the start of the survey, whilst steaming between and on every station, fisheries acoustic data were continuously collected at four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333 kHz), using the Simrad EK60 split beam sounder.

Before work on the primary stations commenced, a 'shakedown' tow was carried out to allow for the deployment of the gear, to check that all Scanmar sensors were working correctly and to allow scientists and crew to familiarise themselves with their particular work areas. The shakedown tow was carried out at prime station 1. The successful completion of this tow, resulting in a diverse catch dominated by elasmobranchs -lesser-spotted dogfish (*Scyliorhinus canicula)* and thornback ray (*Raja clavata*) meant this could be counted as valid, and thus was the first prime station completed. Species of note in this first haul were two river lamprey (*Lampetra fluviatilis)*. The ship then steamed eastwards to prime station 2 which yielded a small catch of mackerel (*Scomber scombrus)* and more thornback ray, before continuing east to prime station 3 off the Dutch coast where the catch comprised mostly whiting (*Merlangius merlangus)* and starry smooth-hound (*Mustelus asterias)*, the latter being tagged and released.

Overnight, RV Cefas Endeavour moved north and the ship worked from east to west the following day, fishing prime stations 6, 5 and 4. Station 6 saw a large catch of horse mackerel (*Trachurus trachurus)* (750 kg), and it was quite unusual to find this species in such quantities this far south. A significant number of pilchard (*Sardina pilchardus)* were also caught at prime station 6 (50 kg), much more than is usually seen historically on this survey. In addition, a twaite shad (*Alosa fallax)* was caught, a relatively rare occurrence on this survey. Catches at stations 5 and 4 were much smaller (<150 kg) of mackerel and whiting. After completing prime station 4, RV Cefas Endeavour then steamed east towards Lowestoft in order to transfer two Cefas staff back to land via small boat, as had been planned before sailing. Once this has been completed at 17:30hrs, the survey resumed, moving northeast to prime station 9.

The morning of August 10th saw the largest catch of the survey so far, with nearly one and a half tonnes brought aboard. This catch was dominated by dab (*Limanda limanda)* and whiting, just under 400 kg and 700 kg respectively, along with a sizeable amount of sprat (*Sprattus sprattus) of* >150 kg. The ship then headed east, successfully completing prime stations 10, 11 and 12, all of which were dominated by dab, although not at the level seen at prime 9. Overnight the ship moved northeast towards Denmark and began August 11th with a much smaller catch than the first tows of the last couple of days with 30 kg of dab being the main catch component at prime station 18. RV Cefas Endeavour then headed northeast, sampling prime stations 19, 20 and 21. All had a significant amount of dab, although prime 20 also yielded over 350 kg of sprat. Also there were a number of edible crab (*Cancer pagurus)*, more than are usually caught by this type of gear, which were also analysed as part of an ongoing Defra project concerning incidental mortality.

With fine weather continuing, RV Cefas Endeavour headed north to fish stations closer to the Danish coast on August 12th. The catch at prime station 30 weighed nearly 500 kg, comprising mainly of dab and mackerel, with the latter being much more prevalent a little further west at prime 29, where over a tonne was caught. Further north, at prime station 39, the day ended with a modest catch of herring (> 100 kg), mackerel (ca. 40 kg) and dab (>65 kg). By the next day, RV Cefas Endeavour had moved southwest and fished prime stations 25-28, heading west. These catches all yielded similar species, although in varying compositions. Dab and herring featured consistently, with over 300 kg of sprat also seen on prime 28. Prime station 25 also yielded the first white-bellied anglerfish (*Lophius piscatorius)* -a maturing male at 44 cm, in a catch that also had sizeable components of grey gurnard (*Eutrigla gurnardus)* (>125 kg) and mackerel (>180 kg).

Overnight the ship moved south to prime 17. On 14th August, the station was fished successfully at first light to find only a very small amount of dab (ca. 40 kg) and benthos. As RV Cefas Endeavour moved westwards and completed prime stations 16 and 15, catches increased, with catches of dab and mackerel both nearly doubling in weight. The final catch of the day (prime station 14) was by far the largest of the 2015 survey, with ca. 4.5 t of herring successfully brought on board (Plate 1).

Plate 1: Codend being lifted into the hopper at prime station 14.

Sunday August 15th began in stark contrast to the previous large haul, with very little caught further south at prime station 8, with lesser-spotted dogfish (10 kg) being the main part of the catch. The ship then steamed west to prime 7, which yielded over a tonne of horse mackerel, whiting and mackerel. There was also a large benthic component to the catch (ca. 180 kg), with a large amount of sponges evident. RV Cefas Endeavour then headed north to successfully fish prime station 13, where a modest catch of haddock (*Melanogrammus aegelfinus)* and whiting (approximately 80 kg and 115 kg, respectively) was made.

Overnight, the ship moved northeast to prime station 22 and proceeded to move east during the day, successfully sampling prime stations 22, 23 and 24. Herring, whiting and Norway pout *(Trisopterus esmarki)* were all prevalent across the three stations in varying amounts. Indeed, the herring catch increased dramatically further east, from 30 kg at prime station 22, to over 650 kg at prime station 23, to over a tonne at prime station 24. Prime station 23, known as Swallow Hole (the depth range over the tow is from 90 m to 150 m; Plate 2), yielded herring and a sizeable amount of whiting (> 250kg).

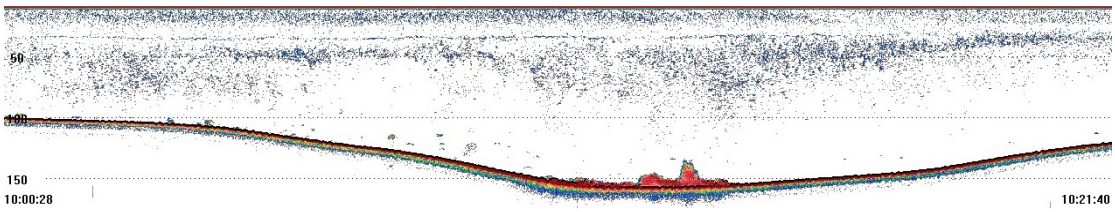

Plate 2: Prime station 23 'Swallow Hole' EK60 split beam sounder image

August 17th started further west at prime station 31. This provided a modest catch of approximately 300 kg, mainly made up of mackerel (ca. 220 kg) and haddock (~60 kg). The ship then moved east to prime station 32 and a smaller catch of broadly similar

composition was recorded, although this time haddock was the more abundant, and again further north at prime 41 (>150 kg and just under 100 kg, respectively). The final station of the day (prime station 33) yielded a much larger catch of nearly 900 kg of herring, along with smaller amounts of whiting and haddock. Over the course of the day the swell had started to pick up and by the next day this was very noticeable, with sea heights of ca. 5 m, and 40 knot winds. This had an effect on the progress RV Cefas Endeavour could make on August 18th. Despite starting with the successful completion of fishing prime station 76 and a catch of over 100 kg of haddock, vessel speed was hampered as the ship headed east into the swell, but prime stations 46 and 42 were both completed successfully, with herring dominating these two catches (>100 kg and >400 kg respectively).

The next day started on prime station 34 with a modest catch of herring (>200 kg) and Norway pout (ca. 60 kg), then, east to prime station 35 a similar amount of herring was seen, but with more dab (ca. 140 kg). Herring was again the most abundant species at prime station 43, where one tonne was caught, but there were few other species of note. August 19th ended with a smaller catch, mainly of dab (ca. 100 kg). Overnight, RV Cefas Endeavour moved south-east to prime station 36 and brought in a successful catch, this time consisting mainly of grey gurnard (ca. 770 kg) and dab (ca. 330 kg). The ship moved westwards during the day, recording catches of >150 kg of dab at prime station 37 and <400 kg of herring at prime station 38. Also of note at this station was the presence of two gravid spurdog (83 cm and 107 cm), who were released in good health after processing (Plate 3).

Plate 3: Gravid spurdog caught at prime station 38

By August 21st, RV Cefas Endeavour had moved to the prime stations southwest of Norway. These deeper tows provided a different species composition to what had been seen in previous days. Prime stations 50, 49, 58 and 57 were composed mainly of Norway pout and sea urchins, alongside bigger fish such as juvenile saithe (*Pollachius virens)*, cod (*Gadus morhua)*, haddock and some wolf-fish (*Anarchichas lupus)*, the latter on prime stations 50 and 49. The number of adult saithe increased, as did their presence in the catch as the ship moved northwest during the day, with >200 kg caught on both prime stations 58 and 57. The next day started further west,

at prime station 48, which yielded a small catch of approximately 100 kg, made up of similar amounts of haddock, whiting and grey gurnard. This was followed by a larger catch (ca. 500 kg) of herring at prime station 56, along with approximately 50 kg each of grey gurnard and haddock. The final station of the day (prime station 47) was another large catch, including about 4.1 t of herring.

Overnight the ship moved north to prime station 55 and fished the station successfully. Unfortunately mechanical trouble began with the single net drum upon hauling the net in. Whilst the catch (<70 kg hake *(Merluccius merluccius)*, some herring and Norway pout and green sea urchins) was able to be brought on board, the net drum was assessed and could not be repaired at sea. As a result, RV Cefas Endeavour sailed for Aberdeen, coming into harbour at 20:30hrs on August 23rd.

On August 26th RV Cefas Endeavour left the port of Aberdeen at 06:00hrs, having changed the majority of scientific staff and crew, as well as taken on fresh supplies. In addition, an improvised way of shooting and hauling the net using the split net drums was in place to finish the rest of the survey. The ship moved east to prime station 40 for a shake-down tow to familiarise ourselves with the alternative net drums, which was successful, with the catch including haddock and Norway pout (ca. 130 kg each) and a smaller amount of herring (<75 kg). With no problems encountered, this was accepted as a valid tow, and the vessel moved north to prime station 52, which yielded a catch of over 200 kg of haddock and 60 kg of whiting.

By the next day the ship had moved north-east to prime station 53, where the first tow of the day included >150 kg of Norway pout, similar amounts of whiting, and haddock (<45 kg). This was followed by a large catch of herring further south-east at prime station 45 (<1.5 t), with whiting, haddock and Norway pout also taken. The latter species dominated the catch at the next stations (>150 kg), with 30 kg of cod also caught. By August 28th, RV Cefas Endeavour had steamed over 60 nm northeast to prime 65, and the vessel worked eastwards, completing prime stations 63, 64 and 65. The catches were characterised by a mix of Norway pout (80-200 kg) and benthos, including the urchin (*Echinus acutus)*, and larger fish such as hake, cod and saithe. Of note, prime station 65 included over 70 kg of juvenile saithe and one large male (109 cm, 11.12 kg). Prime station 63 had to be repeated as a twist in the sleeve of the net was found on hauling, which was blocked with larger fish. The catch contained only a small amount of juvenile and small fish, which were assumed to have escaped the trawl at the blockage in the sleeve. As a result the station was treated as additional and only catch biomass and length data were recorded. This prime station was then repeated successfully.

August 29th began further north-east at prime station 70, where over 500 kg of horse mackerel were accompanied in the catch by some large saithe and mackerel. RV Cefas Endeavour then moved westwards during the day; first completing prime station 69 (heavy benthic catch with some saithe), before a large catch of horse mackerel (1.7 t) was made at prime station 68. During the course of deploying the GOV on this station a peak of hard ground appeared on the EK60 sounder, the net was kept in midwater for a few minutes until there was no risk of trawling over it, the station was then completed successfully. Prime station 67 was fished but unfortunately, when the net

was brought back there was found to be extensive damage to the belly and the tow was deemed invalid, and so just the catch biomass was recorded. With little daylight left and the threat of winds picking up in the east, it was decided to move north-east to prime station 75 and complete the eastern stations in the area before the weather became too bad. This was completed the next morning and yielded an unusual catch of over 300 kg of large argentines (*Argentina* spp.) and blue whiting *(Micromesistius poutassou)*, along with a few baskets of hake and saithe. Further west at prime station 74, more hake and saithe were evident (ca. 65 kg and 80 kg, respectively), while hake (ca. 150 kg) dominated the catch at prime station 73. Of note at prime 73 was an adult chub mackerel (*Scomber colias*; Plate 4). Horse mackerel dominated the catch at the last station of the day, prime 72, with a little under 0.5 t brought aboard, along with approximately five baskets of mackerel.

Plate 4: Chub mackerel *Scomber colias* (39 cm total length, 0.625 kg)

August 31st began at prime station 71, north of the Shetland Isles. This yielded a modest catch of mainly horse mackerel (ca. 150 kg), the ship then steamed south-east to repeat prime 67 where there had been gear damage previously. A tow was selected further south of where the damage was thought to occur and brought in a large bag of mainly horse mackerel (0.5 t), plus over 200 kg of Norway pout and just under 150 kg of saithe. Norway pout and benthos were a large component of the catch at prime station 66, with 100 kg of herring in the codend as well. Overnight, RV Cefas Endeavour moved south-east to prime station 62 and moved west through the day, completing primes 60-62. Norway pout and benthos were characteristic of all the tows, alongside larger cod and hake. Station 60 provided over 120 kg of cod, 67 individuals, mainly juveniles but with a couple of large adults up to 89 cm.

By the end of Tuesday September 1st the wind had moved round to the north and had increased to nearly 30 knots, the increased swell as a result of this made deployment of the gear difficult the next morning at prime station 51. Despite this the net was shot away and a full tow completed. A very benthic heavy catch was brought back, along with over 250 kg of haddock. In addition, two juvenile common skate (*Dipturus batis* cf. *intermedia)*) were tagged and released in good condition (Plate 5).

Plate 5: Male flapper skate caught at prime 59

The ship then steamed south-east to the final station of the survey; prime 51. Almost immediately after the GOV was on the bottom the weather deteriorated further and so the tow duration was shorted to 20 minutes and the net retrieved successfully. The catch was comprised primarily of haddock, including a large number of 1-2 yr. old fish. With the survey grid complete, RV Cefas Endeavour then steamed southwards. The large swell prevented further trawling being undertaken on 3rd and 4th of September, with the vessel dodging off Bridlington on the night of the 3rd. By the morning of September 5th, however, swell had dropped enough for a 15 minute additional tow to be completed in ICES rectangle 34F2. Once this was completed, with the weather due to once again worsen the decision was taken to head towards Lowestoft. The ship came into port Saturday September 5th at 14:30hrs.

RESULTS:

Aim 1: A valid GOV trawl haul was successfully completed at all 76 prime stations (Table 1; Figure 1). Prime station 63 was recorded as an additional station after a problem with the net prevented a representative sample to be collected. There was also an invalid tow at prime 67 due to gear damage. Both were repeated to obtain valid samples. Surface and bottom salinity samples and a vertical cast of the ESM2 logger profile were undertaken at taken on 64 of the prime stations fished (Figure 2).

Gear: The survey was fished using GOV hybrid trawl number 1. Scanmar equipment was used to monitor headline height, wing spread and door spread (Figure 3).

Catches: At each station, the catch of each species was weighed and all fish, or representative sub-samples, were measured. Table 2 lists the species caught that are sampled for length and Table 3 ranks the top 15 species by weight compared with the

last three year's survey. Samples of otoliths for age determination and other biological information were taken for a range of commercial species (Table 4). All data were input to computer database using Cefas' new Electronic Data Capture System.

Gear	Valid	Additional	Invalid	Total
GOV (IBTS Standard gear)	76	2	1	79
Niskin Bottle + CTD	64	0	0	64

Table 1. Number of trawls, and CTD casts made during the survey

Figures 4-13 show distribution and relative abundance (raised numbers per hour) of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Melangius merlangus*), saithe (*Pollachius virens*), Norway pout (*Trisopterus esmarkii*), herring (*Clupea harengus*), mackerel (*Scomber scombrus*), sprat (*Sprattus sprattus*), plaice (*Pleuronectes platessa*) and hake (*Merluccius merluccius*), respectively.

Gadiformes

As can be seen in Table 3, cod was seen at its highest catch rate for four years; 624 kg, close to what was seen in 2011 and up from last year (501 kg). Although a majority of the fish caught were juveniles, a number of large adults were also caught. Compared to 2014, however, cod distribution seems to have been reduced with catches on only 39 stations in 2015, compared to 47 last year (Table 2). Haddock catches were slightly down from 2014 (2240 kg, compared with 2542 kg last year), but still much higher than the 1625 kg seen in 2013. Their distribution however, has changed very little from last year, still found across 50 of the 76 stations.

Whiting was seen in the largest catch quantities for the last four years, up to nearly 3 tonnes this year, over double that recorded by this survey in 2013. As with haddock, the distribution of whiting seen by this survey has remained largely unchanged, seen at 70 out of the 76 stations and remaining one of the North Seas most ubiquitous fish species. Norway pout also saw its largest catches in four years, although at a greater proportion compared to whiting. Catches this year were over two tonnes and were one of the most frequent species in the northern North Sea, albeit at fewer stations than in 2014 (36 compared to 42).

Hake saw a large increase in catches, up over 25% compared to last year with 767 kg recorded, more than the previous high in 2013 (705 kg). Saithe were also found to be at a four year high in catch weight, with 1470 kg seen this year, compared to 1189 kg last year, much improved from the 866 kg in 2013. Saithe's distribution has also imcreased from being caught on 21 stations last year, to 28 this year.

Pleuronectiformes

Plaice catch total was reduced this year, down to 469 kg from 529 kg in 2014, in similar numbers to the three year low in 2013. The number of stations plaice were caught on, however, was the same as last year (61). The total catch of lemon sole *(Mricostomus kitt)* increased slightly since last year, with catch weight increasing by 12 kg, and its

distribution was found to have increased from 57 stations in 2014 to 61 stations this year.

The total catch of dab was 3102 kg, a five year high for the species, and a slight increase from 2014 (3089 kg). The species has maintained the level observed in 2014, where catches were up by nearly a tonne from 2013. Despite the increase, occurrence of the species has stayed similar to last year; seen at 61 stations this year.

Pelagic fish

Herring again accounted for the largest catch weight of the survey, with over 17.5 t recorded. This was twice the weight recorded last year, and more than triple what was caught in 2011. However, nearly nine tonnes of this catch weight were from just two stations (prime stations 14 and 47).

The total catch of mackerel was also higher than recorded in 2014 and more in line with what was seen in previous years, not varying by much more than 600 kg over the last five years. The 3597 kg seen at 61 stations this year is more widespread than the 55 stations last year though.

Horse mackerel had possibly the most surprising change in terms of catch weight, over five times what was seen in 2014 and much more than has been seen in the last five years. A majority of this weight was seen at some of the most northerly of stations fished, with 1.7 t caught at prime station 68 (almost as much as 2011 and 2012 catches combined), and a number of 0.5t — 1t catches around the same area. Indeed, distribution of the species has also increased, from 45 stations in 2014 to 52 this year.

Sprat catches were nearly half of what was seen last year with only 1920 kg recorded this year. While still much better than the low seen in 2012, the amount of sprat caught in the previous two years seems to have declined (3724 kg and 2128 kg in 2014 and 2013 respectively). Distribution, in contrast, has become more widespread, with sprat seen at 36 stations this year, compared to 29 stations in 2014.

Pilchards were much more evident on this year's survey than has been observed on previous years. Total catch weight for this species was 54 kg, albeit a vast majority of this was caught at a single station; prime station 6.

Elasmobranchs

In total, 387 kg of elasmobranchs were caught in this year's survey, with lesser-spotted dogfish the dominant species (112 kg). This was a slight decrease from the 151 kg recorded in 2014. While the observed total catches of cuckoo ray and starry ray were similar to that noted in 2014, total recorded biomass of thornback ray and spotted ray both increased slightly (14 kg and 17 kg, respectively), although the distribution of thornback rays was restricted to the southern North Sea (see aim 18). An interesting observation was a larger number of black-mouth dogfish (*Galeus melastomus*) seen this year than in previous years, with 19 individuals recorded this year (nine individuals last year). Two immature common skate were caught off north-east Scotland at prime station 59 (one male at 133 cm, 18.12 kg, and a female at 90 cm, 4.88 kg).

Cephalopods and commercial shellfish

The most notable observation for cephalopods this year was the drop in catches for *Alloteuthis subulata*, with nearly five times more caught in 2014 (over 3 kg in 2015, compared to nearly 16 kg last year). Northern squid (*Loligo forbesi*) were also much reduced; down from 42 kg to only 16 kg. The lesser flying squid (*Todarpsis eblanae*), in contrast, saw catches increase by nearly five times (over 2 kg in 2014 to nearly 12 kg in 2015).

Edible crab catch weight nearly doubled compared to 2014, with over 60 kg recorded. Stone crab catches were very similar compared to last year (24.77 kg in 2015, 25.44 kg in 2014) but there was a return for the velvet swimming crab, which wasn't seen at all last year. Only a single lobster was caught this year (male, 74mm).

Ichthyological observations

A total of 65 fish species were recorded during the survey. Species of note caught this year during the survey are common skate (*Dipturus batis* (cf. *intermedia*)), river lamprey (*Lampetra fluviatilis*) and chub mackerel (*Scomber colias*). Five redfish were caught, and all were the more common *Sebastes viviparus*.

In keeping with previous year's surveys, additional length-weight data were collected for infrequent species, mostly compromising black-mouth dogfish and greater forkbeard (*Phycis blennoides*). Also, 98 lesser spotted dogfish (39 females and 59 males) caught in the northern North Sea were assessed for biological parameters, including length, weight, maturity, gonad weight and (for males) inner clasper length and (for females) shell gland width and maximum follicle diameter.

A total of 64 of the prime stations had surface and bottom temperature and salinity recorded using an ESM2 profiler and a mini-CTD logger was used on the GOV trawl for 70 of the 76 stations for additional profiles.

Aim 2: All 76 water stations had total alkalinity and dissolved in/organic carbon analysis of seawater completed.

Species	Common Name	Stns	Species	Common Name	Stns
Agonus cataphractus	pogge (Armed bullhead)	14	*Merluccius merluccius*	hake	30
Alosa fallax	twait shad	3	*Micromesistius poutassou*	blue whiting	10
Amblyraja radiata	starry ray	28	*Microstomus kitt*	lemon sole	61
Anarhichas lupus	wolf-fish	4	*Molva molva*	common ling	10
Arctica islandica	ocean quahog	2	*Mullus surmuletus*	red mullet	12
Argentinidae	argentines	34	*Mustelus asterius*	starry smooth-hound	4
Arnoglossus laterna	scaldfish	14	*Myoxocephalus scorpius*	bullrout	9
Aspitrigula cuclus	red gurnard	5	*Myxine glutinosa*	hagfish	5
Buglossidium luteum	solonette	16	*Nephrops norvegicus*	Norway lobster	10
Callionymus lyra	common dragonette	27	*Ocopodidae*		16
Callionymus maculatus	spotted dragonette	22	*Ommastrephes saggittatus*	flying squid	2
Cancer pagurus	edible crab	17	*Pecten maximus*	scallop	4
Clupea harengus	herring	67	*Phycis blennoides*	greater forkbeard	2
Cyclopterus lumpus	lumpsucker	1	*Platichthys flesus*	flounder	2
Dipturus batis (cf. intermedia)	common skate	1	*Pleuronectes platessa*	plaice	62
Enchelyopus cimbrius	four-bearded rockling	12	*Pollachius pollachius*	pollack	2
Engraulis encrasicolus	european anchovy	10	*Pollachius virens*	saithe	28
Eutrigla gurnardus	grey gurnard	73	*Raja clavata*	thornback ray	4
Gadiculus argenteus	silvery pout	8	*Raja montagui*	spotted ray	2
Gadus morhua	cod	39	*Rossia macrostoma*		8
Galeus melastomus	black-mouth dogfish	2	*Sardinia pilchardus*	pilchards	6
Glyptocephalus cynoglossus	witch	24	*Scomber japonicus*	chub mackerel	1
Gobius spp.	gobies	2	*Scomber scombrus*	European mackerel	61
Hippoglossoides platessoides	American plaice (long rough dab)	56	*Scophthalmus maximus*	turbot	4
Hippoglossus hippoglossus	halibut	2	*Scophthalmus rhombus*	brill	6
Homarus gammarus	lobster	1	*Scyliorhinus canicula*	lesser spotted dogfish	10
Hyperoplus lanceolatus	greater sandeel	15	*Sebastes viviparous*	redfish	2
Illex (loligo) illecebrosus	northern shortfin squid	1	*Sepiolidae*		3
Lampetra fluviatilis	lamprey	1	*Solea solea*	dover sole	6
Lepidorhombus whiffiagonius	megrim	13	*Sprattus sprattus*	sprat	36
Leucoraja naevus	cuckoo ray	7	*Squalus acanthias*	spurdog	9
Limanda limanda	dab	61	*Todarpsis eblanae*	lesser flying squid	27
Lithodes maja	stone crab	18	*Trachinus vipera*	lesser weever	14
Loligo forbesi	northern squid	23	*Trachurus trachurus*	horse mackerel	52
Loligo vulgaris	European squid	2	*Trigla lucerna*	tub gurnard	11
Lophius picatorius	anglerfish (monkfish)	29	*Trisopterus esmarki*	Norway pout	36
Lumpenus lampretaeformis	snake blenny	2	*Trisopterus luscus*	bib pouting	2
Melanogrammus aegelfinus	haddock	50	*Trisopterus minutus*	poor cod	17
Merlangius merlangus	whiting	70			

Table 2. List of fish, cephalopods and commercial shellfish caught during the survey and number of stations at which they were recorded

Species common name	Scientific name	2015 weight (kg)	2014 weight (kg)	2013 weight (kg)	2012 weight (kg)
Herring	*Clupea harengus*	17522	8887	15035	9402
Horse mackerel	*Trachurus trachurus*	5596	1115	1324	868
Mackerel	*Scomber scombrus*	3597	3214	3825	3821
Dab	*Limanda limanda*	3102	3089	2135	2466
Whiting	*Merlangius merlangus*	2974	2355	1129	2257
Norway pout	*Trisopterus esmarkii*	2320	1712	1732	1182
Haddock	*Melanogrammus aeglefinus*	2240	2542	1625	2264
Sprat	*Sprattus sprattus*	1920	3724	2128	456
Grey gurnard	*Eutrigla gurnardus*	1488	1638	1041	1000
Saithe	*Pollachius virens*	1470	1189	866	1426
Hake	*Merluccius merluccius*	767	548	705	588
Cod	*Gadus morhua*	624	501	343	485
Plaice	*Pleuronectes platessa*	469	529	452	522
Lemon sole	*Microstomus kitt*	234	222	128	225
Long-rough dab	*Hippoglossoides platessoides*	170	305	146	280

Table 3. Top 15 species by weight compared with the last three years surveys

Species	Number of samples taken
Whiting	1478
Herring	1296
Haddock	1265
Plaice	1249
Saithe	502
Cod	450
Hake	399
Norway pout	379
Mackerel	352
Dab	238
Grey gurnard	235
Lemon sole	233
Monkfish	70
Witch	41
Red gurnard	40
Tub gurnard	27
Ling	23
Red mullet	20
Brill	11
Turbot	3

Table 4. The number of biological samples taken by species

A total of 8311 biological samples were taken for the primary target species (Table 4). In addition, a total of 275 samples were also taken from elasmobranchs captured during the survey and a further 464 sprat retained for otolith extraction at a later date.

SECONDARY AIMS:

Aim 3: Overall 21 elasmobranchs were in good enough condition to be tagged and released with length, sex and weight recorded, as well as position of release including 17 starry smooth-hounds (*Mustelus asterias*; 13 males, four females) and two spurdog (*Squalus acanthias*; both males). The common skate (*Dipturus batis* (cf. *intermedia*)) caught on prime station 59 were a pair of male and female juveniles (90-133cm), the male was tagged and released immediately, whilst the female was left to recover before release. Also a lively wolf-fish (*Anarchichas lupus*; 54cm, unsexed) was tagged and released at prime station 62.

Aim 4: Species including *Lampetra fluviatilis* and *Sebastes viviparous* were retained and frozen for subsequent identification / verification in the laboratory, which may also be used in otolith research.

Aim 5: Three starry smooth-hounds (dead on retrieval of the GOV net) were retained and frozen for biological studies.

Aim 6: Litter caught in the trawl was recorded at every station, and overall, 198 pieces of litter were recorded at 67 stations. As can be seen in Figure 16; plastics made up the majority of the litter caught (87%).

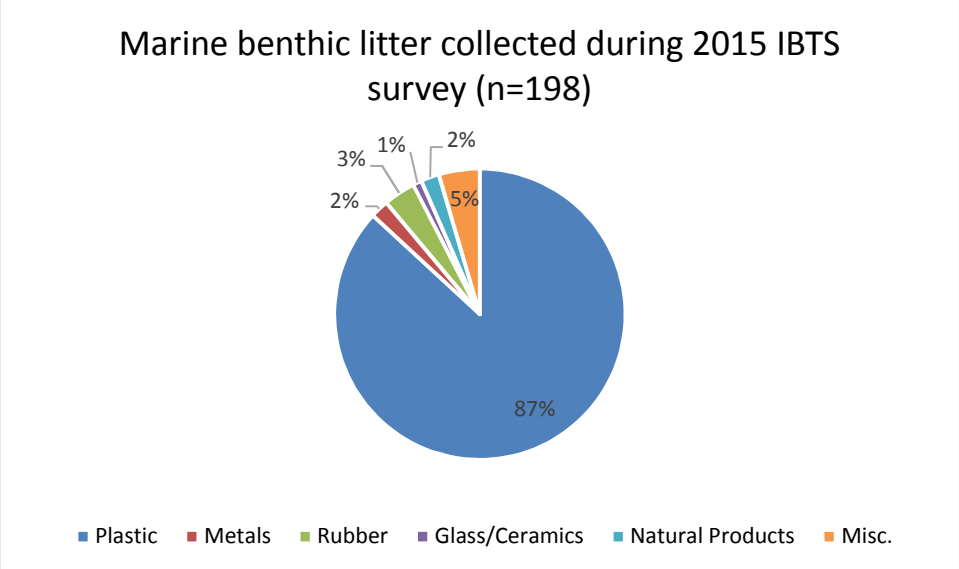

Figure 16: Breakdown by category of the marine litter collected during the survey

Aim 7: Three twaite shad (*Allosa fallax*) were retained for further study.

Aim 8: Acoustic data was recorded throughout the survey for all four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333 kHz), using the Simrad EK60 split beam sounder.

Aim 9: Empty skate and ray egg cases were collected at 13 stations with corresponding positional information were retained for subsequent identification by the Shark Trust

Aim 10: Physical, chemical and biological variables were investigated at each of the sampling stations. In particular, CTD casts (with an ESM2 profiler) were carried out for determining temperature, salinity, density, fluorescence, dissolved oxygen and PAR (Photosynthetically Active Radiation) profiles of the water column. Discrete water samples were collected at the subsurface (from 4 m depth from a continuous water supply) and at the bottom (using Niskin bottles) to estimate salinity, Total Alkalinity (TA), Dissolved Inorganic Carbon (DIC), Dissolved Organic Matter (DOM), dissolved inorganic nutrients concentration, chlorophyll and pigments concentration, as well as phytoplankton size and composition for analysis via flow cytometry. Total number of samples collected and CTD profiles carried out during the cruise are given in Table 5.

	Total	Surface	Bottom
		Ferrybox	Niskin
Salinity	90	45	45
TA/DIC	48	24	24
Dissolved inorganic nutrients	48	24	24
Dissolved organic nutrients	48	24	24
Dissolved inorganic nutrients	60	60	#
Chlorophyll/Pigments analysis	60	60	#
Flow Cytometry	60	60	#
CTD casts with ESM2	64	#	#

Table 5. Total number of samples collected and CTD profiles carried out during the survey.

During the survey, continuous measurements of different environmental variables (e.g. temperature, salinity, fluorescence, oxygen saturation, pH, pCO_2) were carried out by a Ferrybox and a pCO2 analyser.

Aim 11: During the survey discrete samples of seawater were collected to determine the spatial-temporal variability of Transparent Exopolymer Particles (TEP) and Dissolved Organic Matter (DOM) in the North Sea. In particular at each of the sampling stations, water samples were collected at the subsurface (from 4 m depth from a continuous water supply) and at the bottom (using Niskin bottles) in order to estimate TEP and Particulate Organic Carbon (POC) concentrations.

These samples along with Dissolved Inorganic Carbon (DIC), Dissolved Organic Matter (DOM), chlorophyll and CTD casts (temperature, salinity, density, fluorescence, dissolved oxygen and PAR (Photosynthetically Active Radiation), will be used to investigate distribution of TEP in summer in the North Sea, when nutrient levels are low and carbon overconsumption is likely to be at its highest. Total number of samples collected during the cruise are given in Table 6.

Sample ID	Total	Number of samples	Number of replicates
Transparent Exopolymer Particles	423	141	3
Particulate Organic Carbon	91	91	#

Table 6: Total number of samples collected during the survey

Aim 12: With no dedicated observer on board, and with scientific staff not made aware of any sightings, no cetacean observations were recorded on this year's survey.

Aim 13: Data was collected for an ongoing project investigating the incidental mortality of brown crab (*Cancer pagurus*) and lobsters (*Homarus gammarus*) in towed fishing gear. Length (carapace width for crab and carapace length for lobster), sex and vitality were recorded for all brown crabs caught. Vitality was assigned to one of five categories (table 7).

Vitality	A	B	C	D	E
Description	Alive, no visible damage, responsive	Minor carapace, some legs/claw missing. Still responsive	Major carapace cracks OR very little response to stimuli OR at least five legs and both claws missing	Dead/crushed	Dead, no visible damage

Table 7: Vitality scores for brown crabs caught

In total 88 crabs and one lobster were caught across 19 stations of 53 completed on the first half. The carapace width for crabs ranged from 56mm to 217mm and carapace length of 84mm for the one lobster recorded. More than half of the crabs caught (45 of 88) were assigned a vitality score of A. The category with the lowest number of crabs was C (Table 8).

Species	Vitality	Count
CRE	A	45
CRE	B	16
CRE	C	2
CRE	D	7
CRE	E	14
LBE	C	1

Table 8: Numbers of crabs and lobsters assigned to each vitality score

Aim 14: The majority of jellyfish caught this year were lion's mane (*Cyanea capillata*), making up 69% of the total cnidarian catch across the survey. The largest recorded individual was 5.85kg with a diameter of >58cm, present at Station 106 (Prime 54). The greatest abundance of cnidarians was recorded at station 79 (Prime 37) where >821kg bulk weight of *C. capillata* was landed with over 140 individual specimens present, however larger individuals at Station 106 (Prime 54) had a bulk weight of 151.8kg for 14 individuals. The next most abundant species was *Cyanea lamarckii*

(21%). Biodiversity decreased at more northern stations with primarily *Cyanea* spp. caught with sporadic instances of other species present. Other species recorded on this survey also included *Chrysaora hysoscella*, *Aurelia aurita* and two instances of *Peryphilla peryphilla* (Table 9). Condition of measured specimens was overall good, with 76% graded in good condition (GC), 20% damaged (DAM), 4% very damaged with many specimen's bell diameter unmeasurable. The only stations not to have cnidarians recorded were prime stations 6, 51, 53.

Species	**N**	**%**	**Total Bulk weight caught (g)**
A. aurita	99	2.87	8054.4
C. hysocella	607	4.47	14022.6
Cyanea spp.	68	1.97	865.6
Unknown	9	0.15	2940.7
C. lamarckii	818	21.25	36094.9
C. capillita	2721	69.03	545710
Aequora spp. *(gelatinous material)*	unknown	0.17	1147.5
P. peryphilla	2	0.06	238
Aqueora sp	1	0.03	331.8
Rhizostoma octopus	1	<0.00	3945

Table 9: Species recorded and percentage abundances of cnidarians recorded

Aim 15: Samples of *Alloteuthis subulata* were retained at 11 stations for further study, covering nearly half of the stations at which the species was recorded.

Aim 16: No thornback rays were caught in mid-to-northern North Sea stations, so no tissue samples were taken.

Special thanks are given to the officers and crew of RV Cefas Endeavour and the scientists for all of their enthusiasm and hard work in making this survey a success

Sophy McCully Phillips, Jim Ellis and Ben Hatton
Scientists in Charge
04/09/15

DISTRIBUTION:

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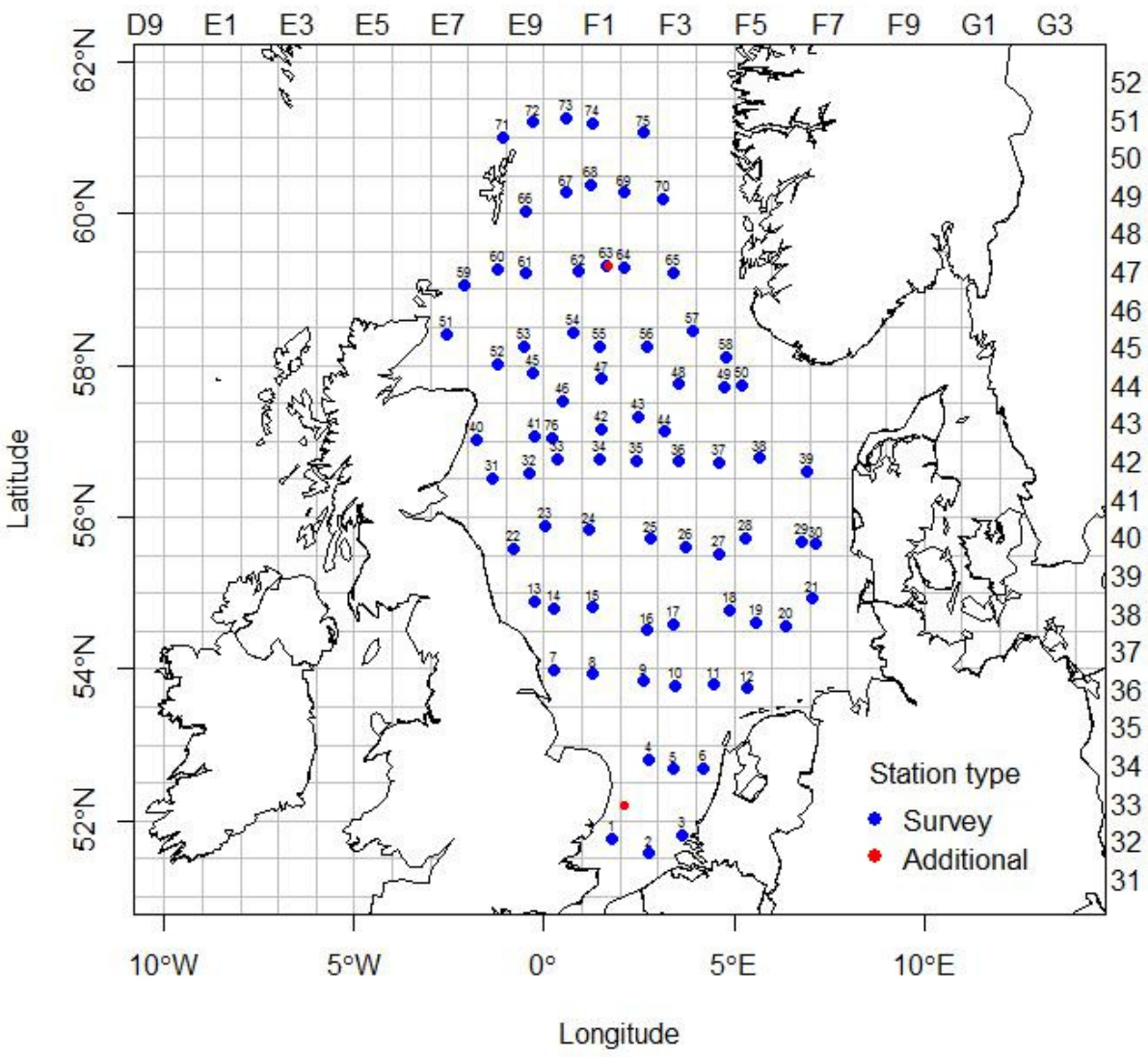

Figure 1: Station positions where valid GOV trawl sampled were collected during survey CEFAS Endeavour 18/15.

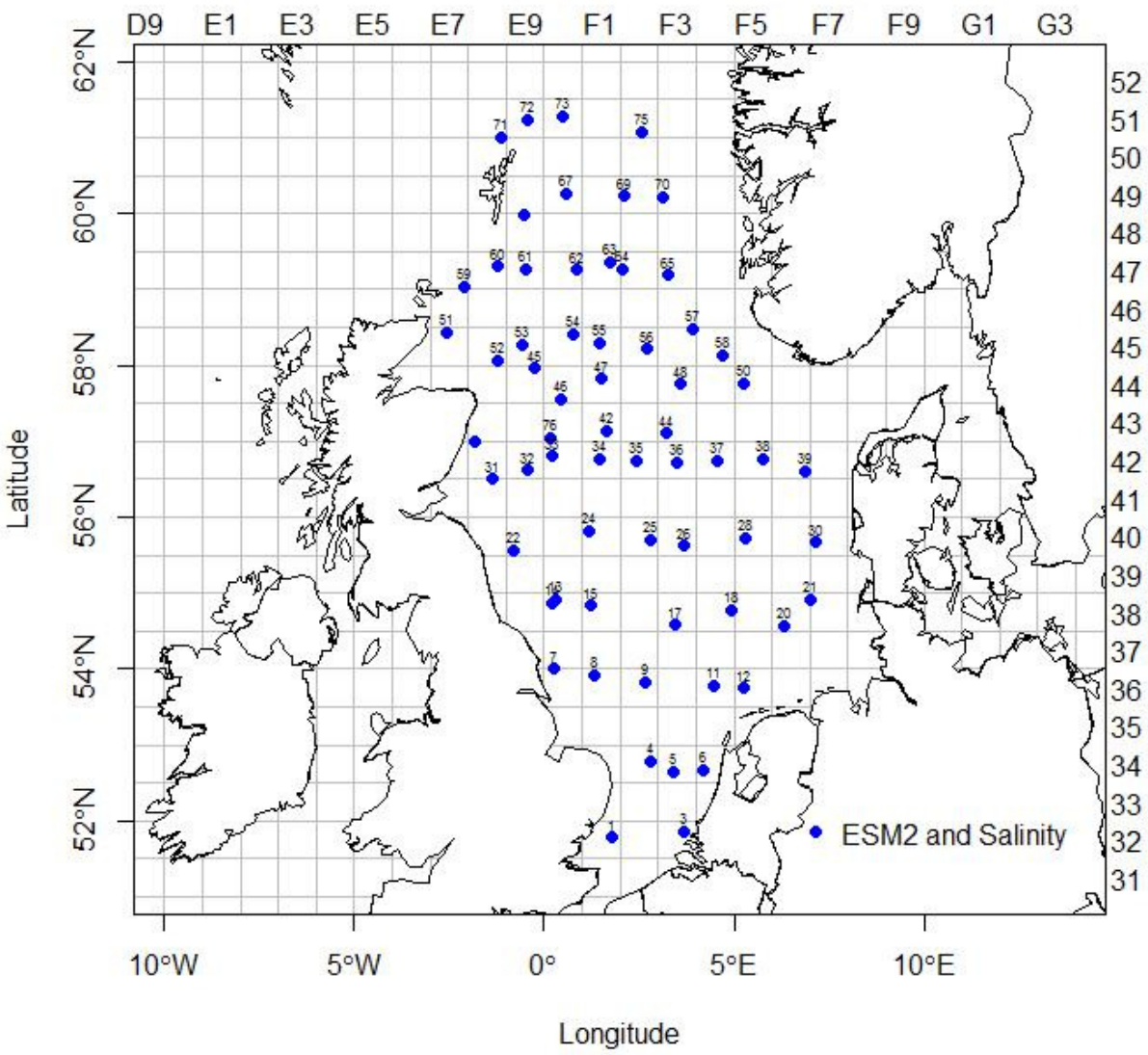

Figure 2: Station positions where vertical casts with ESM2 logger and Niskin bottle were undertaken during survey CEFAS Endeavour 18/15.

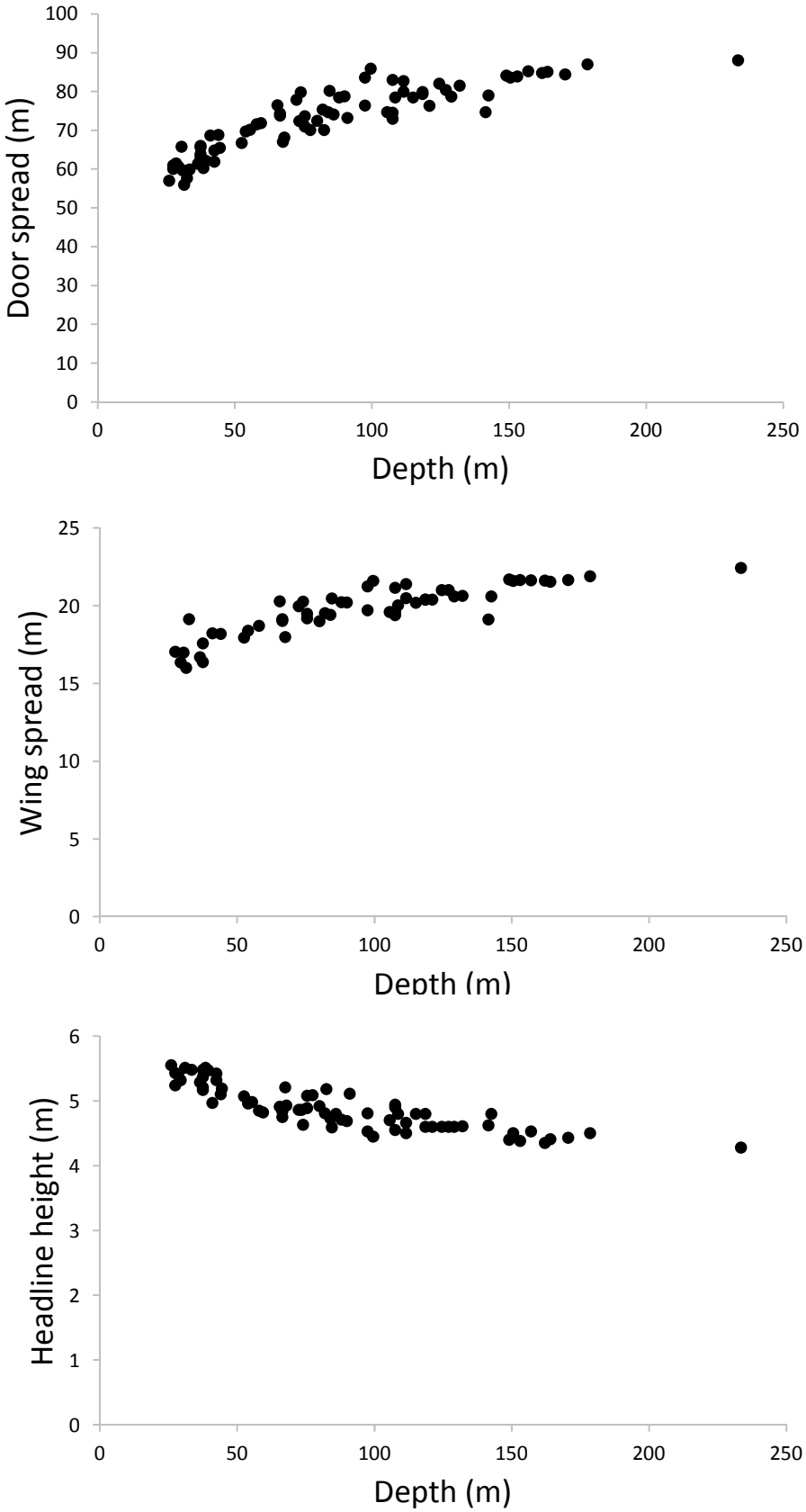

Figure 3: Relationships between mean headline height, wing spread and door spread with water depth, as recorded during valid hauls.

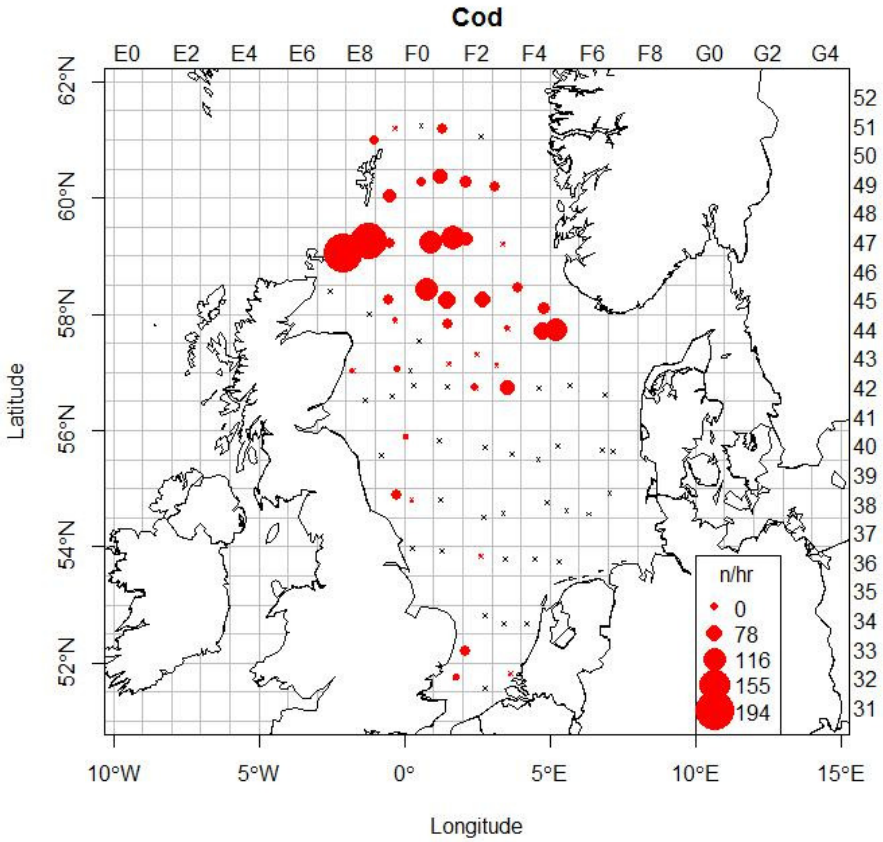

Figure 4: Distribution and relative abundance (raised numbers caught per hour) of cod.

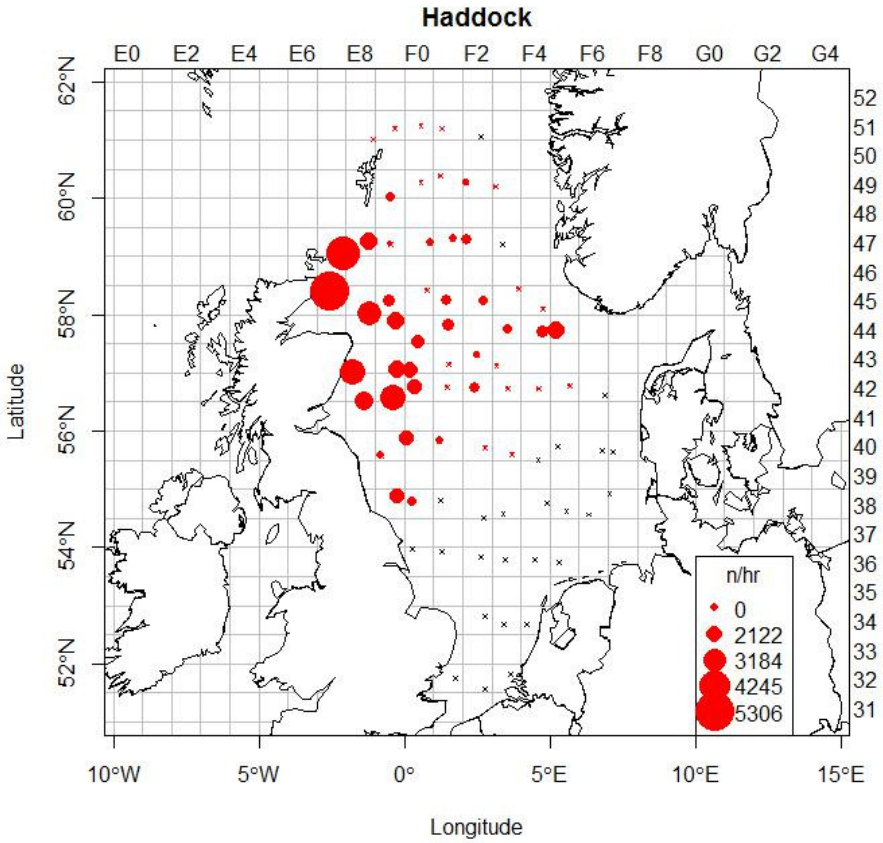

Figure 5: Distribution and relative abundance (raised numbers caught per hour) of haddock.

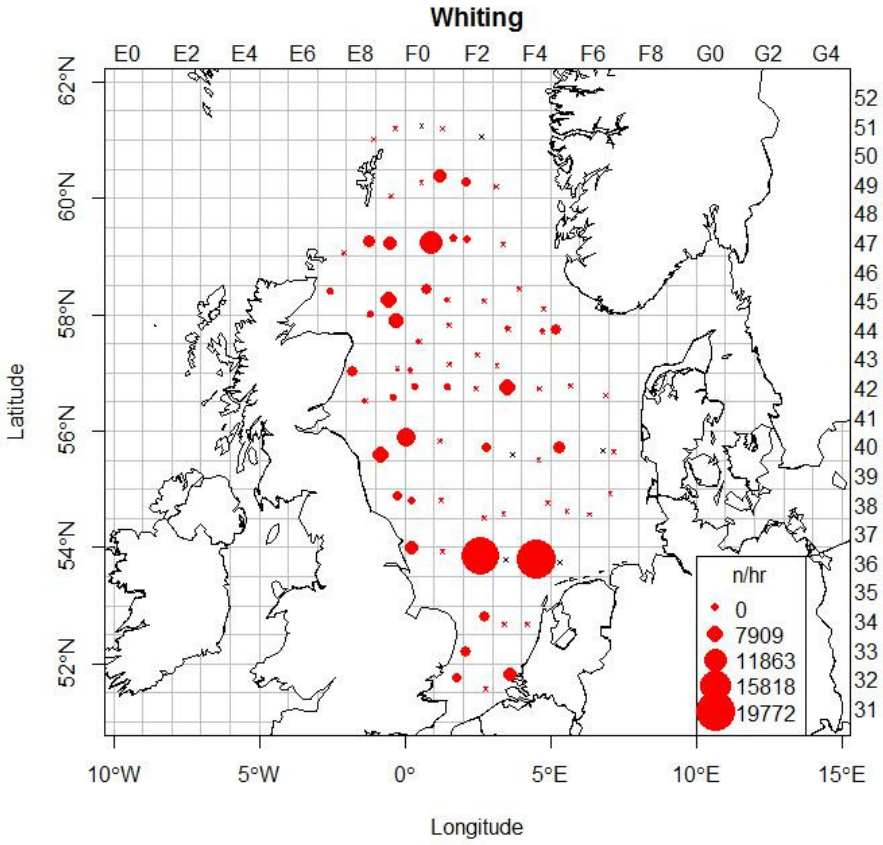

Figure 6: Distribution and relative abundance (raised numbers caught per hour) of whiting.

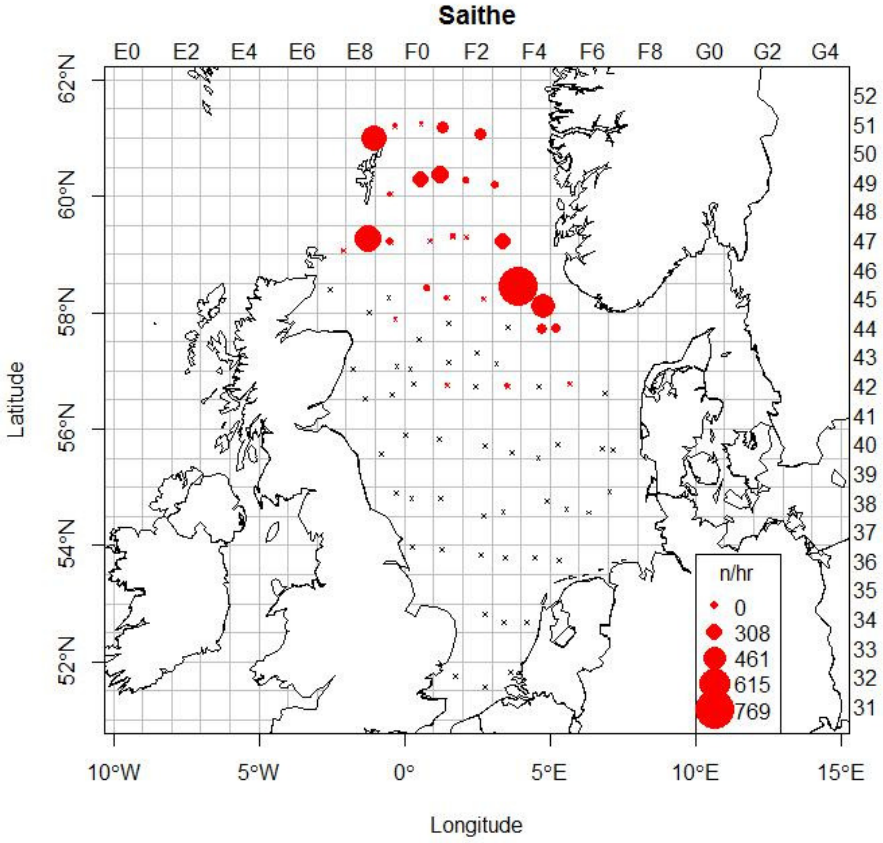

Figure 7: Distribution and relative abundance (raised numbers caught per hour) of saithe.

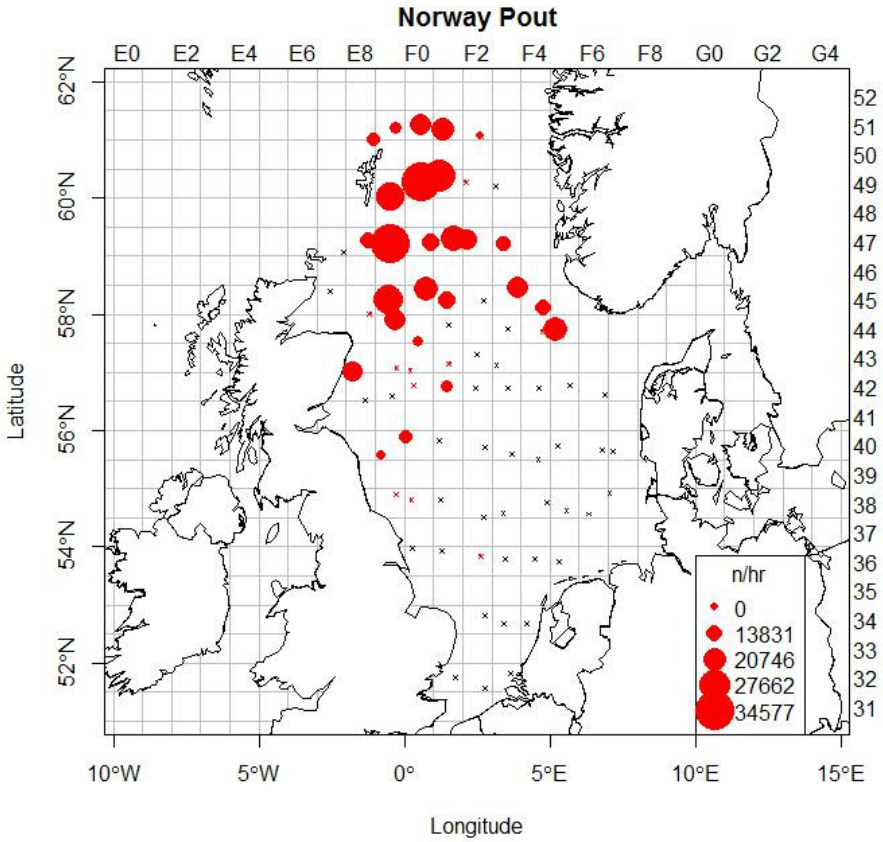

Figure 8: Distribution and relative abundance (raised numbers caught per hour) of Norway pout.

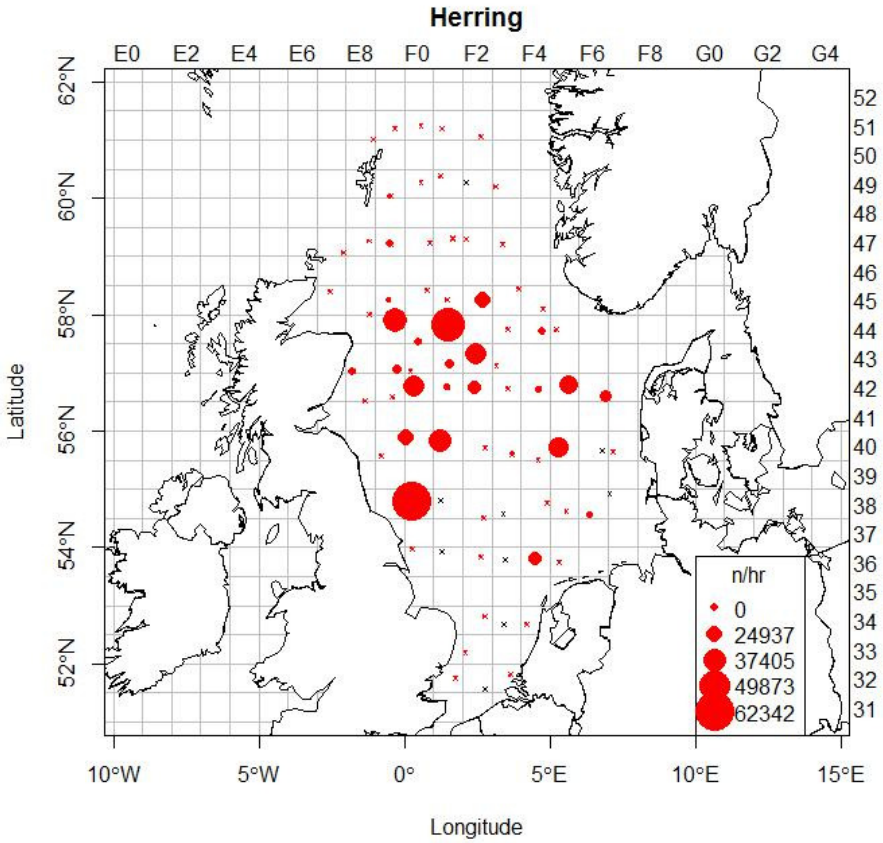

Figure 9: Distribution and relative abundance (raised numbers caught per hour) of herring.

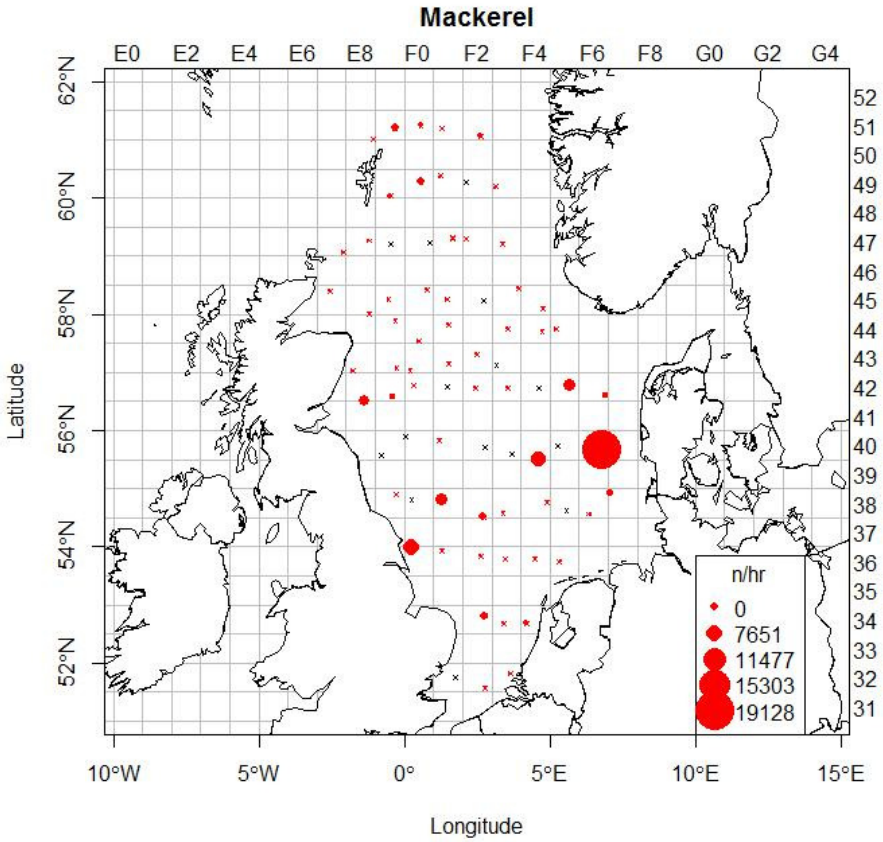

Figure 10: Distribution and relative abundance (raised numbers caught per hour) of mackerel.

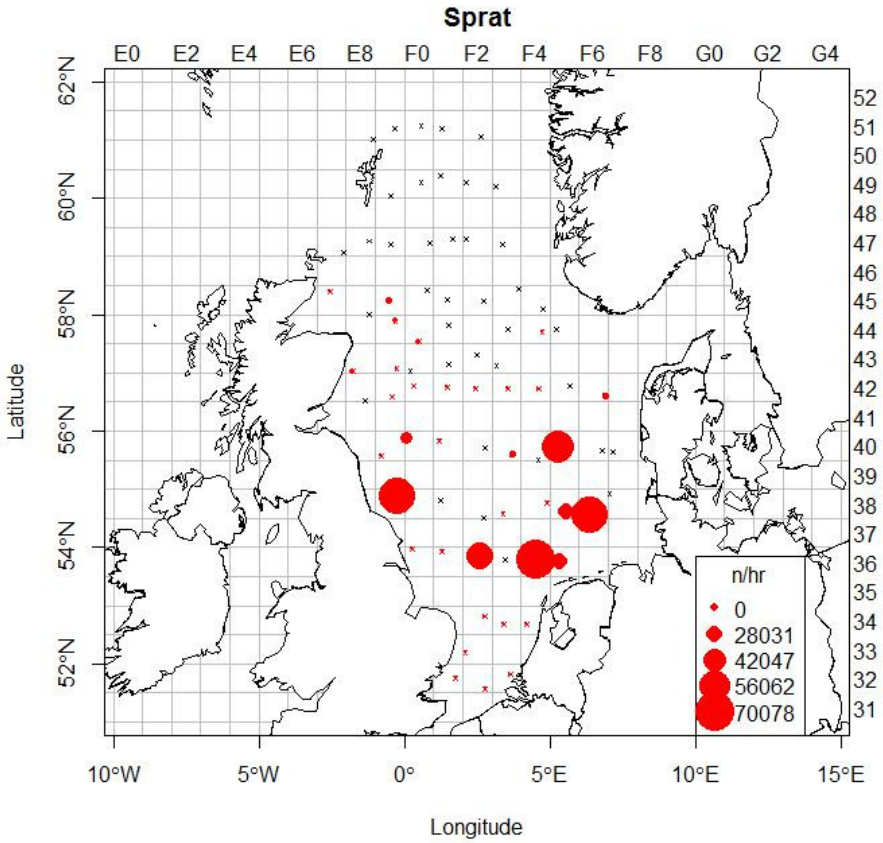

Figure 11: Distribution and relative abundance (raised numbers caught per hour) of sprat.

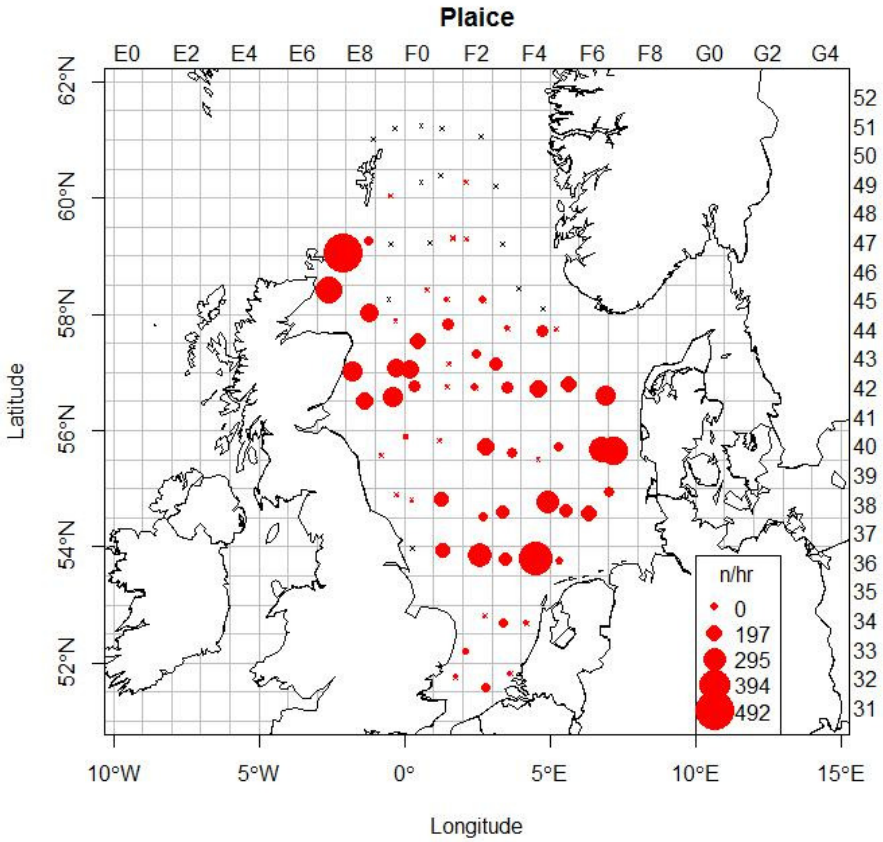

Figure 12: Distribution and relative abundance (raised numbers caught per hour) of plaice.

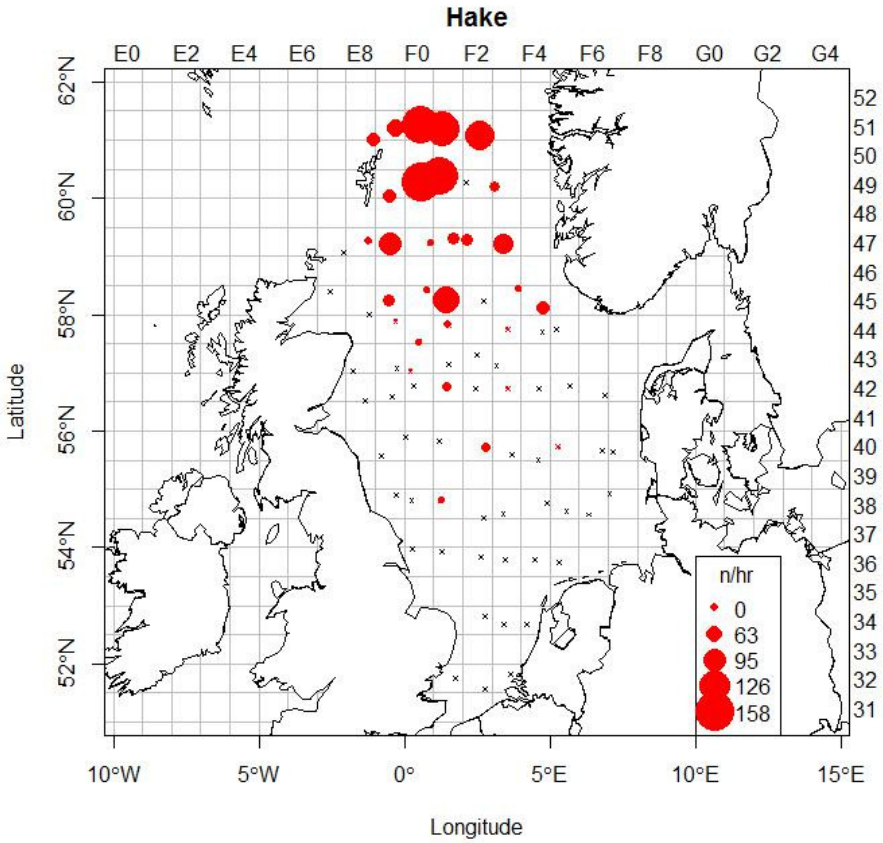

Figure 13: Distribution and relative abundance (raised numbers caught per hour) of hake.