

**CENTRE FOR ENVIRONMENT, FISHERIES
AND AQUACULTURE SCIENCE**

LOWESTOFT LABORATORY, LOWESTOFT, SUFFOLK NR33 0HT

2017 RESEARCH VESSEL REPORT

REPORT: RV CEFAS ENDEAVOUR: SURVEY 17/17

STAFF:

Part A (4—18 August)

B Hatton (SIC)
L Cox (2IC)
J Ellis
R Humphreys
M Eade
E Capuzzo
N Hampton
C Bird

Part B (18 August—3 September)

B Hatton (SIC)
L Cox (2IC)
I Holmes
R Humphreys
M Eade
P White
C Marshall
L Aislabie

Plus:

R Wright (University of East Anglia)

G Hunt (Newcastle University)
J Van Der Kooij (18—19 August)
M Whybrow (18—19 August)
D Burggraaf (18—19 August)
O Beijert (18—19 August)

DURATION: 4 August — 3 September

LOCATION: North Sea

PRIMARY AIMS:

1. To carry out a groundfish survey of the North Sea (Figure 7) as part of the ICES coordinated IBTS, using a hybrid GOV trawl 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 and anthropogenic debris.
 - e) Surface and bottom temperature and salinity data using ESM2 profiler/mini-CTD logger and Niskin Bottle.
 - f) Length, weight and maturity information using individual fish measurements, in support of the EU Data Regulation.
2. To carry out additional ‘zero minute’ tows to investigate the potential catch during deployment and retrieval of hauls that may fall outside tow duration.
3. To install and test a new calibration rig, which is designed to provide a robust, semi-automated calibration of the four drop-keel mounted split-beam transducers aboard the RV Cefas Endeavour. At a suitable location in a fjord

outside Bergen, Norway, the equipment will be set up, tested and utilized to perform a calibration.

SECONDARY AIMS:

4. Tag and release specimens of smooth-hound (*Mustelus asterias*), greater-spotted dogfish (*Scyliorhinus stellaris*), spurdog (*Squalus acanthias*), tope (*Galeorhinus galeus*), flapper skate (*Dipturus intermedius*), and blonde ray (*Raja brachyura*), in support of the ICES Working Group for Elasmobranch Fishes work to inform on stock units for demersal elasmobranchs.
5. 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), and any unusual fish species, which may also be used in otolith research.
6. To collect dead specimens of smooth-hound (*Mustelus* spp.), if over 60cm, and tope (*Galeorhinus galeus*) for biological studies.
7. Collect dead specimens of shad (*Alosinae*) and lamprey (*Petromyzontiformes*) for biological studies.
8. Collect fisheries acoustic data continuously at four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333kHz), 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 and ray egg cases with corresponding positional information for subsequent identification by the Shark Trust.
10. Cetacean observations will be recorded where possible and sent to the SeaWatch Foundation.
11. Identification, count, measure and weight of all jellyfish caught in GOV trawl will allow the continuation of the North Sea August Jellyfish dataset started in 2012. As the dataset grows from year to year, this should allow the evaluation of changes in jellyfish community and biomass with time.
12. To collect maturity and life history information for lesser-spotted dogfish (*Scyliorhinus canicular*) from the southern and northern North Sea.
13. To collect and filter on board water samples for determination of chlorophyll and suspended particulate materials; data collected will be used for validation of Ferrybox and ocean colour space-born data (SLA25).
14. Collect squid egg samples to map spawning grounds. This could be highly relevant in studying squid stock structure.

15. Collection of samples to measure carbon dioxide, methane and nitrous oxide in surface waters across the North Sea, with a view to developing and refining these techniques for future use.
16. To collect biological information from four-bearded rockling (*Enchelyopus cimbrius*). Including length, weight and maturity information.
17. Collection of stomach samples and dorsal muscle tissues of various finfish for stable isotope analysis to analyse long-term changes in abundance and shifts in diet composition in the English north-east and Dogger Bank regions of the North Sea.
18. Recording evidence of *Ichthyophonous* infestation on herring.
19. Collection of a selection of different species (whole fish) to be used in a species identification display during the RV Cefas Endeavour visit to London as part of the Cefas 20th anniversary event.
20. Collection of finfish for otolith extraction training of new fisheries stock monitoring staff.
21. Near bed water samples will be collected using a niskin at seasonally stratified sites. These data will be used in the assessment of eutrophication under MSFD and OSPAR for which near bed oxygen concentrations are an indicator.

NARRATIVE

(All times GMT, prime stations referred to can be seen in Figure 7.)

RV Cefas Endeavour sailed from Lowestoft at 08:00 hrs on Friday August 4th. On board were eight Cefas scientific staff and Rebecca Wright, a student from University of East Anglia. Upon departure, the ship immediately travelled south toward prime station 1. 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 profiler, 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 at 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.

By 12:30 hrs, the ship had arrived on prime station 1 ready for the 'shakedown' tow, which would allow for the deployment of the gear, to check that all sensors were working correctly and to allow scientists and crew to familiarise themselves with their work areas. The station yielded a small catch of mainly benthic invertebrates and elasmobranchs (thornback ray - *Raja clavata*, lesser-spotted dogfish - *Scyliorhinus canicula* and smooth-hound - *Mustelus asterias*). Eleven smooth-hounds were tagged and released, as well as two thornback rays. A medium sea bass (*Dicentrarchus labrax*) was also caught (69 cm, ~3 kg). With no problems encountered, this 'shakedown' tow was deemed successful and taken as the first valid tow of the survey. The ship then steamed east to fish prime station 2, where a small catch of fish, mainly mackerel (*Scomber scombrus*, 65 kg) was taken.

Overnight, the ship travelled east to prime station 3. As in 2016, the major component of the catch was horse mackerel (*Trachurus trachurus*), with a good proportion of that being 0-group juveniles. Of further note was a large specimen of snake pipefish (*Entelerus aequoreus*, 49 cm, 0.15 kg). The survey then moved north to prime 6 and fished west, successfully completing prime stations 6, 5 and 4. Horse mackerel was prevalent, as well as mackerel, whiting (*Merlangius merlangus*) and dab (*Limanda limanda*). The tow at prime station 5 was along sand banks and, as a result, many lesser weever fish (*Echiichthys vipera*) were caught (12 kg).

August 6th began a short distance further north at prime 9. Just under 100 kg of dab and 75 kg of whiting were the main components of the catch, although many four-bearded rockling (*Enchelyopus cimbrius*, 2.6 kg; 85 individuals) were also caught and analysed towards secondary aim 16. Further east at prime stations 10 and 11 saw similar catches of dab and sprat (*Sprattus sprattus*, ~115 kg and ~230 kg across both stations, respectively). The final completed station of the day off the Dutch coast (prime station 12) saw similar amounts of dab and horse mackerel brought on board (~50 kg of each).

RV Cefas Endeavour moved north-east to start at prime station 21 the next day. This station saw a small catch of mainly dab, but also a range of female edible crab (*Cancer pagurus*, 7.5 kg, 119–183 mm). The ship moved west to prime station 20, the resulting station yielded more dab (~70 kg) and some sprat (~35 kg), but prime station 19 saw the biggest haul of the survey so far, with over 1 t of fish caught, with sprat in abundance (924 kg). At prime station 18, further west, a small bag of mainly dab (<30 kg) was brought aboard. With time in hand, a zero-minute tow was then conducted, a short distance further north, with small quantities of dab and lemon sole (*Microstomus kitt*) caught.

By August 8th the survey had moved around 50 nm west to prime station 17 and successfully completed this, plus prime stations 16 and then 15. All had varying quantities of dab and grey gurnard (*Eutrigula gurnardus*), although prime station 16 also saw nearly 500 kg of mackerel caught. Of note, at prime station 15 was a large number of juvenile northern squid (*Loligo forbesi*, 11 kg, 3 cm–13 cm), which were also recorded in smaller quantities in a zero-minute tow completed soon after.

The next day began at prime station 25, to the north-west, with a medium-sized catch of whiting (~70 kg), dab (~50 kg) and lemon sole (~40 kg). Further east, after a small catch of dab at prime station 26, prime station 27 yielded 230 kg of grey gurnard and more juvenile northern squid (24 kg). Towards the end of the day a large catch was brought in at prime station 28, with over 500 kg of sprat, 250 kg of dab and just under 200 kg of herring (*Clupea harengus*).

RV Cefas Endeavour steamed to the most easterly station of the survey, prime station 30 near Denmark and fished north, completing primes stations 30, 29 and 39. Again, dab was abundant, making up a large proportion off all catches. During the course of the day, a zero-minute additional tow was completed at both prime stations 29 and 39, with catches showing similar species composition to what had been caught in the 30-minute tows; constituting mostly dab. At prime station 39 however, 340 kg of mackerel was caught in addition to the ~100 kg of dab.

Fishing then moved west to prime station 38. The first catch of the day was small, only 50 kg of dab, but it did contain the first cod (*Gadus morhua*) of the survey (19–27cm, 0.248 kg in total). Prime station 37, to the west, yielded a larger catch of

dab (~120 kg) and some mackerel, while prime station 44 resulted in ~175 kg of dab and 30 kg of mackerel caught. Before this, however, at prime station 36, a noticeable number of juvenile gadoids were caught, including cod (7–12 cm), haddock (*Melanogrammus aeglefinus*, 8–13 cm), and Norway pout (*Trisopterus esmarkii*, 5–19 cm).

By August 12th, the ship was further west again, fishing the most central stations of the grid. Prime stations 35, 34, 42 and 43 were all fished successfully. Prime station 35 saw a catch similar to that seen further east, with 175 kg of dab, plus some grey gurnard and long-rough dab (*Hippoglossoides platessoides*). By prime station 34, however, herring began to become more abundant, with almost 500 kg caught there. This was followed by a zero-minute tow which brought in 5.7 t of herring. A short distance north, at prime station 42, another 875 kg of herring was caught, although by prime station 43 dab became the more abundant species again (~100 kg). It was interesting to note the abundance of herring in the more easterly tows during the day, compared to those in the west, which yielded less pelagic fish.

Also of note at prime station 43 was the observation of two rarely seen species of epibenthos – *Eunoe nodosa*, a large scale worm, and *Geryon tridens*, a species of crab only captured very occasionally in this survey (Figure 1).



Figure 1. *Geryon tridens* (left) and *Eunoe nodosa* (right) recorded at prime station 43

The next day the survey had moved north-west to prime station 47. Fishing began at first light but the net sensor data showed the trawl had come into contact with something on the sea floor 6 minutes into the tow. The gear was hauled immediately to find significant damage to two belly panels, the starboard selvedge and the square behind the headline. The mend and replacement of panels took most of the day whilst travelling to prime station 55. There was time to complete prime station 55 before sunset, and the net had no further complications, with a catch of mainly green sea urchins (*Psammechinus miliaris*) and Norway pout. Some quantities of whiting (50 kg), haddock (50 kg) and hake (*Merluccius merluccius*, 70 kg) were also part of the catch.

Overnight, RV Cefas Endeavour moved east to prime station 56, bringing in approximately 200 kg from fishing there; haddock, whiting and grey gurnard being the most abundant species at this prime station. A short distance south-east to prime station 48 saw a smaller catch of less than 100 kg, with haddock the primary species. Further east at prime stations 49 and 50, with the two stations being relatively close together, saw catches that were quite similar in some respects; green sea urchin, Norway pout and haddock, although there was more mackerel in the western of the two stations, and a noticeable amount of juvenile Norway pout at the

more easterly prime station 50. Of further note was the small amounts of cod seen throughout the day's catches (6.52 kg, 4.12 kg, 32.40 kg, and 19.39 kg, respectively).

During that afternoon, at approximately 15:10 hrs en route to prime station 49, a superficial intrusion of fresher and warmer water was noted by the Ferrybox seawater analysis instrumentation (Figure 2). The temperature and salinity changes were thought to be associated to an increase in fluorescence (indicating chlorophyll concentration), likely because the less saline waters had higher levels of nutrients.

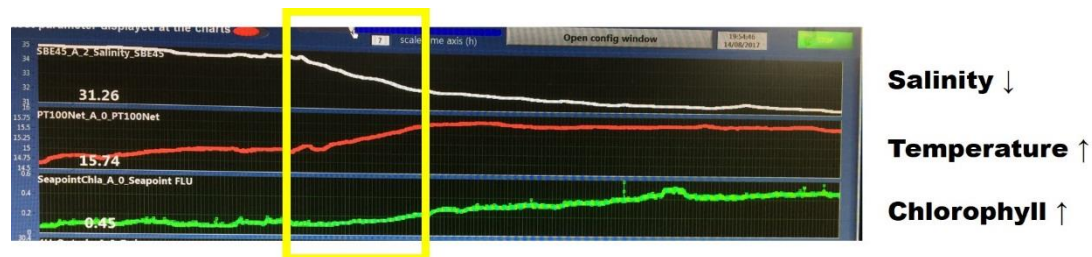


Figure 2. Image capture of Ferrybox instrumentation showing changes in salinity, temperature and fluorescence whilst en route to prime station 49.

Tuesday August 15th began at the close-by prime station 58 and the survey worked north-west throughout the day to prime stations 57 and 65. Norway pout and green sea urchin were seen at all three stations, as were a number of larger gadoids. Prime station 58 had some larger saithe (*Pollachius virens*), including one at 106 cm (13 kg), plus a cod at 86 cm (6.25 kg). Prime station 57 has seen large saithe catches in previous years, and this occurred here again with over 600 individuals (mainly juveniles, ~500 kg) brought on board here this year. Blue whiting (*Micromesistius poutassou*) was also a feature in catches around Norway, with over 300 kg seen at prime station 58. Also of note at prime stations 57 and 58 was the presence of velvet belly lanternsharks (*Etmopterus spinax*), one at each station (Figure 3, both 23 cm and approximately 50 g). Additionally, a 'zero-minute' tow was completed here, and at prime station 65.



Figure 3. *E. spinax* caught at prime station 58.

Overnight, the ship moved approximately 70 nm west to prime station 62. This was completed successfully and work then proceeded east through prime stations 63 and 64. Norway pout and green sea urchin were again the most abundant species seen, with larger saithe, hake and horse mackerel. Larger cod were also seen on each station, with prime stations 62, 63 and 64 yielding individuals of 94 cm, 77 cm and 80 cm, respectively. A 'zero-minute' tow was also completed at prime station 64. The ship steamed to the edge of the Hjeltefjorden area of the Norwegian fjords to meet the pilot at 06:00 hrs on August 16th to travel to Bergen for change of ship crew and scientists, and to take on supplies. RV Cefas Endeavour docked at the Festningskaaien quay at 09:00 hrs the next day.

PART TWO

Upon leaving Bergen on August 18th, Jeroen Van Der Kooij and Marc Whybrow of Cefas, plus Dirk Burggraaf of WMR and Oscar Beijert of BE Precision Technology, were on board for the installation and testing of a new acoustic calibration rig. The ship moved three nautical miles north from Bergen and anchored in a suitable area. During the course of the next day the work was successfully completed and these staff put ashore by 18:00 hrs.

Overnight, the ship moved out of the Norwegian fjords and arrived at prime station 75 for first light on August 20th. This was completed successfully and yielded 250 kg of horse mackerel and blue whiting, along with ~50 kg of hake and ~40 kg of greater argentine (*Argentina silus*). A shagreen ray (*Leucoraja fullonica*) was also part of the catch (male, 92 cm, 3.94 kg). Further south, at prime station 70, horse mackerel was again abundant, along with green sea urchins. This was found to be similar at prime station 69, although over 65 kg mackerel were also caught here.

The next day prime stations 67, 68 and 74 were successfully fished. Norway pout and green sea urchins were the most commonly seen species throughout the day, along with large gadoids such as hake, cod and saithe. Prime station 68 had to be fished twice due to unusual readings from the headline sensor, this was found to be due to a small hole and some twisting with the unit's bag attached to the headline. The second attempt resulted in a similar catch (over 200 kg of Norway pout) but also had a large ling (*Molva molva*, 132 cm, 11.15 kg). Despite the second attempt, there was still time before sunset to complete a 'zero minute' tow on prime station 74, which, along with Norway pout and green sea urchin, also had three large cod (84 cm—93 cm).

By August 22nd the survey was a short distance further west, at prime station 73. Again, Norway pout and green sea urchin were abundant, along with over 850 kg of horse mackerel and some hake and mackerel (>125 kg and <100 kg respectively). Fishing continued west to prime station 72 for a similar catch, albeit with less horse mackerel (<45 kg). Unfortunately, at prime station 75 a number of rocks were picked up by the gear, which damaged sections of the belly and lower nylon meshes, as well as creating a large hole in the cod-end. After repairing the damage, there was time to re-shoot on the station that day, catching over 250 kg of saithe.

The next day began further south, 20 nm east of Lerwick, Shetland Isles, at prime station 66. As with catches in previous days, Norway pout and green sea urchin were abundant here, along with over 180 kg saithe, 115 kg cod and a male shagreen ray (85 cm, 3.08 kg). A 'zero minute' tow was also completed, before moving south to prime station 61. This yielded a larger catch of Norway pout (<500 kg) and saithe (>220 kg). A smaller catch of haddock and mackerel (80 kg and 40 kg, respectively) was sampled at prime station 60, whilst a 'zero minute' tow at this location comprised mainly mackerel.

Overnight, RV Cefas Endeavour steamed west towards the Orkney Isles. At prime station 59 over 500 kg of herring was caught, along with 130 kg of cod and almost 30 kg of plaice (*Pleuronectes platessa*). Two female flapper skate (*Dipturus intermedius*) were also caught here (110 cm, 954 g and 161 cm, 1860 g), which were tagged and released (Figure 4). Further to the south-west, prime station 51 took two attempts to complete successfully, having come aboard initially with the cod-end liner out of place. The repeated haul resulted in a small catch of haddock (<100 kg) and mackerel (<60 kg). By the end of the day the ship had reached prime station 52 to the south-

west. Most of the 1 t catch here was herring, with over 200 kg of Norway pout and over 130 kg of whiting also caught.



Figure 4. Flapper skate *Dipturus intermedius* being tagged at prime station 59

August 25th comprised three successfully fished prime stations; 45, 53 and 54. Whilst prime 45 yielded similar amounts of haddock and whiting (125 kg and 80 kg, respectively), along with over 160 kg of mackerel. Herring was abundant at prime stations 53 and 54, with 5.4 t (the largest amount seen in a 30-minute tow during the survey) and 1.8 t recorded at prime stations 53 and 54, respectively. A 'zero-minute' tow was also completed at prime station 54, yielding a more modest 250 kg.

By the next day, the survey had moved south-east to prime station 47; where significant gear damage had occurred on the first attempt during the first part of the survey. This time, the prime station was fished successfully with a small catch of ~25 kg herring and a similar quantity of whiting. To the south-west, prime stations 46 and 76 showed similar species composition due to the short distance between them; prime station 46 saw just under 3 t of herring and <190 kg of haddock. At prime station 76 less was caught; just under 1 t of herring and ~185 kg of haddock, along with almost 20 kg of plaice. There was time to complete an additional 'zero minute' tow at prime station 76, where another >300 kg of herring was caught.

A short distance to the south, herring was abundant in the next morning's catch at prime station 33, with over 1.6 t was caught. Moving west-north-west, prime stations 41 and 40 were both successfully completed; prime station 41 yielded just under 200 kg of haddock, around 50 kg of whiting and almost 16 kg of plaice, whilst prime station 40 (off Aberdeen) resulted in a smaller catch of whiting (<60 kg) and long-rough dab (<30 kg). Of note here was a significant number of haddock showing skeletal deformities (Figure 5). This phenomenon has been seen on this survey in a small number of individuals in the past, but this constituted a large component of the haddock caught (51 out of 132 individual fish, 10.26 kg, 11cm—35 cm). Another 150 kg of herring was caught in an additional 'zero minute' tow on prime station 40, shortly before sun down.



Figure 5. Skeletal deformities in *M. aeglefinus* found at prime 40

By August 28th RV Cefas Endeavour had moved south-east to prime station 32, where gadoids were the main component of the catch (>75 kg haddock and >80 kg whiting). Also, part of the catch were several juvenile spurdog (*Squalus acanthias*) (6.7 kg, 25 cm—41 cm). Further west, at prime station 32, over 60 kg of haddock were sampled, which were also mainly juveniles (12—18 cm), along with ~50 kg dab. Unfortunately, further south at a new tow position for the survey at prime station 77, the starboard wing of the net was damaged and needed replacing. This could not be completed before sun down and fishing had to be suspended for the day.

Overnight, the survey moved east to prime station 24. Fishing worked east during the day, completing prime stations 24, 23, and 22. The most common species seen during the day was whiting (~90 kg, ~90 kg and 110 kg, respectively), with haddock and Norway pout caught in smaller numbers. At prime station 22, over 550 kg of herring was also caught. The final station of the day was prime station 77, with an alternative tow position attempted. This was successful, with a small catch of gadoid juveniles (12 kg each of Norway pout and whiting), and a similar weight of dab (>20 kg).

The next day started at prime station 13, off the English north-east coast. This tow resulted in the largest catch of whiting of the survey at just under 500 kg, as well as haddock (<200 kg) and herring (60 kg). Prime station 14, further east, was abundant with herring. Over six tonnes were caught in a 27-minute tow, hauling slightly early to ensure the safe retrieval of the net. Fishing then moved 50 nm to the south, to prime station 7, which yielded a benthos-heavy catch with a large number of velvet swimming crab *Necora puber* and just over a tonne of horse mackerel. With time left in the day, a 'zero-minute' tow was completed here as well.

August 31st began a short distance east at prime station 8. Over 230 kg of whiting, over 100 kg of dab and almost 16 kg of plaice were caught here, with a large tope (*Galeorhinus galeus*, Figure 6, male, 156 cm, 19.24 kg), which was tagged and released. Similar composition was seen, albeit with more sprat (36 kg), in an additional 'zero minute' tow completed following the standard 30-minute tow.



Figure 6. *G. galeus* caught on prime station 8

At the request of the Danish Institute, a tow in 35F1 was then targeted. Upon arrival at the position, however, the ground looked very uneven, with steep inclines to shallower water close to the tow. A tow completed by the Dutch in Q1 2016 was located further to the north and fished successfully for a small catch of mainly dab and lesser-spotted dogfish (>35 kg of each species). With the distance travelled to the new position there was not enough time to reach the next planned fishing at prime station 4. Instead, once an appropriate amount of time had passed, the station was re-fished as a 'zero minute' tow.

Overnight, RV Cefas Endeavour steamed to prime station 1 to continue additional 'zero minute' tows. One each were completed at prime stations 1–3, with catch composition ranging throughout the day. Prime station 1 was abundant in whiting, with over 30 kg caught, prime station 2 yielded two male smooth-hound (63–73 cm, 2.25 kg), whilst prime station 3, close to Belgium, comprised of 75 kg juvenile pelagic fish – mainly sprat, but with some herring, pilchard *Sardinia pilchardus*, European anchovy *Engraulis encrasicolus* and horse mackerel.

During the morning of September 2nd, a 'zero minute' tow was completed at prime stations 5 and 4. The first was a small catch, mainly comprising lesser weever fish and mackerel (>3 kg and >4 kg, respectively). The second was mainly dab (12 kg) and whiting (23 kg). With the survey complete, RV Cefas Endeavour travelled back to Lowestoft, UK, to dock at 19:00 hrs.

RESULTS

Aim 1: A valid GOV trawl haul was completed at all 77 prime stations (Table 1; Figure 7). An additional 23 fishing stations were completed, with four invalidated due to gear damage – all of which were repeated again to gain valid samples. An extra station was completed by request of the Danish Institute of Fisheries Research for a repeat of their own tow in ICES rectangle 35F1. This was classed as 'Valid', and processed in the same way as an English prime station. Surface and bottom salinity samples, along with a vertical cast of the ESM2 logger profiler were completed at 50 of the prime stations, with an additional 14 ESM2 profiles taken at separate prime stations (Figure 8).

Gear: The survey was fished using GOV hybrid trawl number 1. Electronic net geometry sensors were used to monitor headline height, wing spread and door spread (Figure 9).

Catches: At each station, the catch of each species was weighed and all fish, or representative sub-samples, were measured. Table 2 ranks the top 15 species by weight, compared to that seen over the previous four years, whilst Table 3 lists the species that were weighed and measured/counted across the survey's prime stations. Table 4 ranks the number of fish sampled for otoliths for age determination and other biological information. All data were recorded to computer database using Cefas' Electronic Data Capture (EDC) system.

Gear	Valid	Additional	Invalid	Total
GOV (IBTS standard gear)	78 ^[1]	23 ^[2]	4	105
Niskin bottle / ESM2 profiler	50	0	0	50
ESM2 only	0	14 ^[3]	0	14

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

^[1] Includes all 77 prime stations targeted plus one additional tow carried out for Denmark

^[2] 22 were 'zero minute' tows, the other showed poor headline sensor readings throughout tow and was re-fished.

^[3] Requested in association to aim 13

Figures 10—19 show distribution and relative abundance (raised numbers per hour) of cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius 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.

English name	Scientific name	2017 weight (kg)	2016 weight (kg)	2015 weight (kg)	2014 weight (kg)	2013 weight (kg)
Herring	<i>Clupea harengus</i>	24963	34945	17522	8887	15035
Horse mackerel	<i>Trachurus trachurus</i>	4395	1905	5596	1115	1324
Dab	<i>Limanda limanda</i>	3201	3587	3102	3089	2135
Whiting	<i>Merlangius merlangus</i>	2858	2468	2974	2355	1129
Haddock	<i>Melanogrammus aeglefinus</i>	2845	2525	2240	2542	1625
Norway pout	<i>Eutrigla gurnardus</i>	2793	1813	2320	1712	1732
Saithe	<i>Pollachius virens</i>	2563	2349	1470	1189	866
Mackerel	<i>Scomber scombrus</i>	2365	3450	3597	3214	3825
Sprat	<i>Sprattus sprattus</i>	1868	2367	1920	3724	2128
Grey gurnard	<i>Eutrigla gurnardus</i>	1108	1301	1488	1638	1041
Cod	<i>Gadus morhua</i>	723	753	624	501	343
Hake	<i>Merluccius merluccius</i>	718	1084	767	548	705
Plaice	<i>Pleuronectes platessa</i>	425	506	469	529	452
Long-rough dab	<i>Hippoglossoides platessoides</i>	397	305	170	305	146
Lemon sole	<i>Microstomus kitt</i>	326	336	234	222	128

Table 2. Top 15 species by weight, English IBTS Q3 survey 2013—2017

Species	Common Name	Stns	Species	Common Name	Stns
<i>Aequipecten opercularis</i>	Queen scallop	23	<i>Loligo vulgaris</i>	European squid	5
<i>Agonus cataphractus</i>	Pogge (Armed bullhead)	22	<i>Lophius budegassa</i>	Black-bellied anglerfish	4
<i>Alloteuthis subulata</i>		34	<i>Lophius picatorius</i>	Anglerfish (monkfish)	34
<i>Alosa fallax</i>	Twait shad	2	<i>Lumpenus lampretaeformis</i>	Snake blenny	2
<i>Amblyraja radiata</i>	Starry ray	31	<i>Lycodes gracilis</i>	"Vahl's eelpout"	1
<i>Ammodytes marinus</i>	Lesser sandeel	2	<i>Maurolicus mulleri</i>	Pearlside	3
<i>Anarhichas lupus</i>	Wolf-fish	6	<i>Melanogrammus aeglefinus</i>	Haddock	53
<i>Arctica islandica</i>	Ocean quahog	4	<i>Merlangius merlangus</i>	Whiting	74
Argentinidae	Argentines	33	<i>Merluccius merluccius</i>	Hake	37
<i>Arnoglossus laterna</i>	Scaldfish	25	<i>Microchirus variegatus</i>	Thickback sole	2
<i>Aspitrigula cuclius</i>	Red gurnard	4	<i>Micromesistius poutassou</i>	Blue whiting	9
<i>Buglossidium luteum</i>	Solonette	23	<i>Microstomus kitt</i>	Lemon sole	66
<i>Callionymus lyra</i>	Common dragonette	37	<i>Molva molva</i>	Common ling	16
<i>Callionymus maculatus</i>	Spotted dragonette	34	<i>Mullus surmuletus</i>	Red mullet	10
<i>Cancer pagurus</i>	Edible crab	25	<i>Mustelus asterius</i>	Starry smooth-hound	6
<i>Capros aper</i>	Boarfish	6	<i>Myoxocephalus scorpius</i>	Bullrout	8
<i>Ciliata mustela</i>	Five-bearded rockling	1	<i>Myxine glutinosa</i>	Hagfish	6
<i>Clupea harengus</i>	Herring	65	<i>Necora puber</i>	Velvet swimming crab	8
<i>Cyclopterus lumpus</i>	Lumpsucker	1	<i>Nephrops norvegicus</i>	Norway lobster	18
<i>Dicentrarchus labrax</i>	European sea bass	1	<i>Ommastrephes sagittatus</i>	Flying squid	10
<i>Dipturus intermedius</i>	Flapper skate	1	<i>Pecten maximus</i>	Scallop	4
<i>Eledone cirrhosa</i>	Curled octopus	38	<i>Pholis gunnellus</i>	Butterfish	1
<i>Enchelyopus cimbrius</i>	Four-bearded rockling	15	<i>Phycis blennoides</i>	Greater forkbeard	2
<i>Engraulis encrasicolus</i>	European anchovy	5	<i>Platichthys flesus</i>	Flounder	2
<i>Entelurus aequoreus</i>	Snake pipefish	1	<i>Pleuronectes platessa</i>	Plaice	60
<i>Etmopterus spinax</i>	Velvet belly	2	<i>Pollachius virens</i>	Saithe	29
<i>Eutrigula gurnardus</i>	Grey gurnard	75	<i>Raja clavata</i>	Thornback ray	4
<i>Gadiculus argenteus</i>	Silvery pout	16	<i>Raja montagui</i>	Spotted ray	5
<i>Gadus morhua</i>	Cod	57	<i>Rossia macrostoma</i>		17
<i>Galeorhinus galeus</i>	Tope	3	<i>Sardinia pilchardus</i>	Pilchards	5
<i>Galeus melastomus</i>	Black-mouth dogfish	3	<i>Scomber scombrus</i>	European mackerel	67
<i>Glyptocephalus cynoglossus</i>	Witch	26	<i>Scophthalmus maximus</i>	Turbot	9
<i>Gobius spp.</i>	Gobies	4	<i>Scophthalmus rhombus</i>	Brill	4
<i>Gymnammodytes semisquamatus</i>	Smooth sandeel	1	<i>Scyliorhinus canicula</i>	Lesser spotted dogfish	27
<i>Hippoglossoides platessoides</i>	American plaice (long rough dab)	56	<i>Sebastes viviparus</i>	Redfish	7
<i>Hippoglossus hippoglossus</i>	Halibut	3	<i>Sepia elegans</i>	Cuttlefish	1
<i>Homarus gammarus</i>	Lobster	5	Sepiolidae		13
<i>Hyperoplus lanceolatus</i>	Greater sandeel	10	<i>Solea solea</i>	Dover sole	10
<i>Illex (loligo) coindetii</i>	Northern shortfin squid	30	<i>Sprattus sprattus</i>	Sprat	23
<i>Lampetra fluviatilis</i>	Lamprey	1	<i>Squalus acanthias</i>	Spurdog	8
<i>Lepidorhombus whiffiagonius</i>	Megrim	12	<i>Trachinus vipera</i>	Lesser weever	15
<i>Leucoraja fullonica</i>	Shagren ray	2	<i>Trachurus trachurus</i>	Horse mackerel	53
<i>Leucoraja naevus</i>	Cuckoo ray	14	<i>Trigla lucerna</i>	Tub gurnard	10
<i>Limanda limanda</i>	Dab	68	<i>Trisopterus esmarki</i>	Norway pout	41
<i>Lithodes maja</i>	Stone crab	24	<i>Trisopterus luscus</i>	Bib pouting	3
<i>Loligo forbesi</i>	Northern squid	27	<i>Trisopterus minutus</i>	Poor cod	15
			<i>Zeus faber</i>	John dory	8

Table 3. List of fish, cephalopods and commercial shellfish caught during the survey and number of stations at which they were recorded.

Species	Number of samples taken
Whiting	1567
Plaice	1338
Herring	1299
Haddock	1200
Saithe	842
Cod	725
Mackerel	450
Hake	445
Norway pout	371
Lemon sole	278
Dab	239
Grey gurnard	233
Four-bearded rockling	146
Anglerfish (monkfish)	82
Witch	51
Red mullet	35
Red gurnard	29
John dory	17
Tub gurnard	15
Turbot	15
Brill	5
Black-bellied anglerfish	4
Starry ray	130
Spurdog	73
Cuckoo ray	48
Starry smooth-hound	37
Black-mouth dogfish	23
Thornback ray	12
Tope	12
Shagreen ray	2
Common skate	2
Velvet-belly lanternshark	2
Common ling ^[1]	47
Total	9779

Table 4. Number of biological samples taken by species

^[1]No otoliths were taken from common ling this year, only individual weight.

Gadiformes

As can be seen in Table 2, cod catch weight was slightly lower than in 2016 (723 kg, compared to 753 kg), although still higher than the previous three years. There was a marked increase, however, in distribution as seen by the number of stations cod were recorded at; the greater catch weight in 2016 was seen at 38 stations, whilst cod was recorded at 57 stations in 2017 (Table 3). This can also be seen by the number of biological samples taken from cod this year (Table 4; 725 otoliths, compared to 420 in 2016).

Total haddock weight caught this year was the highest for five years (2845 kg), up 320 kg from 2016. Despite the increase in weight caught, haddock distribution was similar to that seen in last year's survey (53 stations, compared to 54 in 2016), whilst the number of biological samples taken was down (1200, compared to 1393 in 2016). Of note was the abundance of haddock with skeletal deformities found at prime station 40.

Whiting catch weight also increased from last year (2858 kg, compared to 2468 kg), although not quite at the level of 2015 (2974 kg). Found at 74 stations out of 78 this year, whiting is still one of the most widely distributed species seen in the North Sea on this survey. A large increase was recorded in the total weight of Norway pout caught, up by 980 kg (2793 kg, compared to 1813 kg in 2016), across the same number of stations fished (41). This is the greatest catch weight in the last five years, although it should be noted that two stations attributed to over 930 kg of this year's catch (prime stations 73 and 108).

After a notable high in 2016 (1084 kg), hake weight caught this year was back at comparable levels to that seen in 2013 and 2015 (718 kg, compared to 705 kg and 767 kg, respectively). This reduction in catch weight is despite an increase of recorded distribution, with hake seen at more stations this year (37) than in 2016 (32). In contrast, saithe catch weight increased again for the fifth year in a row to 2563 kg, but being recorded at slightly fewer stations than last year (29, compared to 32 in 2016). Of note was the number of juvenile fish caught, with over half measuring 60 cm or under (613 out of 1138 individuals).

Pleuronectiformes

Plaice catch weight was the lowest seen in the past five years at 425 kg. Despite the drop in catch weight, the number of biological samples were only slightly reduced to that seen last year (1338, compared to 1408 in 2016), indicating a similar size range was seen. Distribution remained high, recorded at 60 stations. Lemon sole was one of the most widely distributed flatfish seen on the survey this year, seen on 66 stations (up from 60 in 2016). However, catch weight was reduced slightly this year (326 kg), albeit still higher than weights recorded before 2016.

Still one of the most ubiquitous species seen in the North Sea, dab were recorded on 68 prime stations this year, similar to that seen in 2016 (67). Catch weight, whilst down slightly from 2016 (3201 kg, compared to 3587 kg), was still higher than the previous three years. In contrast, there was a five-year high in long-rough dab catches (397 kg), with increased distribution from last year as well (56 stations, compared to 50 in 2016).

Pelagic fish

Herring were, once again, the most abundant species caught by weight on this year's survey. Whilst the 24.96 t was less than the near 35 t caught in 2016, this is still much higher than the previous year's catches before it. As in 2016, large catches at a few prime stations (this year prime stations 14, 33, 53 and 54) accounted for a large proportion of the total survey catch - nearly 15 t. In terms of its distribution, herring was seen on fewer stations this year (65, compared to 71 in 2016). Sprat catch weight this year was reduced (1868 kg, compared to 2367 kg in 2016). It should be noted, however, that nearly 1 t of the total catch this year came from a single station; prime 19. Comparisons can be drawn from the reduced catch weight, with the number of stations it was seen at; 23, compared to 35 in 2016.

Mackerel catch weight was the lowest recorded in the last five years (2365 kg), having dropped by over 1 t since last year (3450 kg). Despite being seen at 65 prime stations (similar to the 63 recorded on in 2016), in previous years, there has been one or two large mackerel catches which have impacted on total catch weight figures. This year only six prime stations (5, 6, 16, 45, 72 and 78) saw catches over 100 kg, with prime station 16 having the largest catch weight of nearly 500 kg. Conversely, horse mackerel catch weight (4395 kg) was back up to abundances to those seen in 2015 (5596 kg). The distribution is also much wider, with horse mackerel recorded at 21 more stations this year, compared to the 32 seen in 2016.

Elasmobranchs

Elasmobranch catches were higher this year (~470 kg), compared to those seen in 2016 (387 kg) and 2015 (362 kg). Once again, lesser-spotted dogfish was the most abundant elasmobranch species on the survey, with total catch weight of nearly 238 kg greater than the 147 kg seen in 2016. Starry ray was caught in similar amounts to last year (49 kg, compared to 55 kg), but greater catch weights of spurdog and smooth-hound were found this year (up 11 kg and 20 kg to 23 kg and 60 kg, respectively). Of note this year was the presence of two shagreen ray, two juvenile common skate at prime station 59, and two velvet belly lanternsharks at prime stations 57 and 58.

Cephalopods and commercial shellfish

Northern squid (*Loligo forbesi*) catch weight saw a marked increase from 2016 (up 72%), with over 110 kg compared with the 31 kg in 2016 and 16 kg seen in 2015. European common squid (*Alloteuthis subulata*) catch weight was also much greater this year, with nearly 17.6 kg recorded across the survey from ~11.5 kg last year. Northern short-fin squid (*Illex coindetii*) also showed an increase in catch weight as well, from 2.4 kg in 2016 to 13.8 kg this year. Of note was the increase in curled octopus (*Eledone cirrhosa*) as well, with catch weight tripled from 2.5 kg last year to 7.5 kg.

The distribution of edible crab (*Cancer pagurus*) was found to be similar this year as to 2016 (26 stations, compared to 25 last year), as was weight caught (77 kg this year, compared to 70 kg in 2016). Of note was a large increase in velvet swimming crab (*Necora puber*) from 6.8 kg last year, to over 50 kg this year, albeit most being caught on a single station (prime station 7).

Ichthyological observations

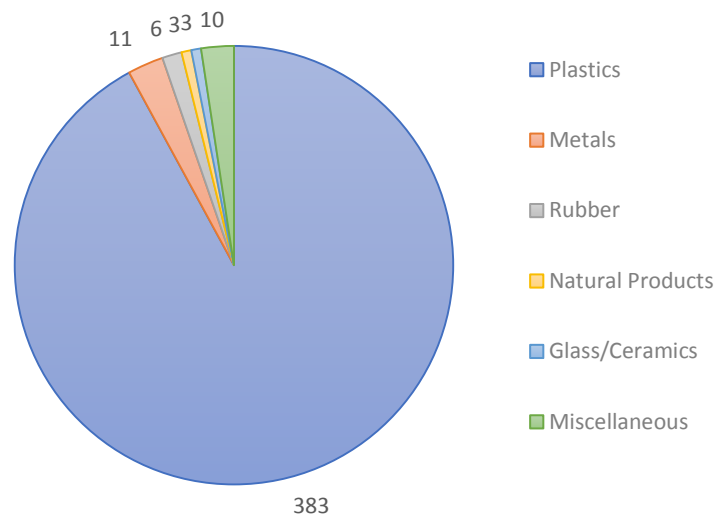
A total of 77 fish species were recorded on this year's survey, increasing from 66 in 2016. Of note was the eelpout (*Lycodes gracilis*), twaite shad (*Alosa fallax*), snake pipefish (*Entelurus aequoreus*), and many, mainly juvenile, redfish (*Sebastes viviparus*). As in previous years, length-weight data were collected for lesser seen species, such as the snake pipefish and juvenile horse mackerel.

Macrobenthos

150 species of macrobenthos were observed during the survey, with the common starfish (*Asterias rubens*) seen on the most stations; 60. Six species, including (*Eunoe nodosa*) and (*Geryon tridens*), were brought back for verification or to add to the reference collection.

Marine litter

Marine litter collected during IBTS Q3 GOV survey 2017
(n =416)



Litter was recorded across all 78 prime stations, with 416 pieces detailed. As in previous years, plastics make up a large proportion of total litter examined on the survey. The most notable example during the survey was seen on prime station 4, where two spent shell casings from a 47 calibre gun were brought aboard.

Aim 2: A total of 22 'zero minute' tows (Figure 1) were completed during the survey, with catch weights ranging from 8.8 kg to 5789 kg.

Aim 3. The installation of the semi-automated calibration rig was successfully completed just north of Bergen on August 19th.

SECONDARY AIMS:

Aim 4: A total of 59 elasmobranchs were tagged and released during the survey. Length, sex and weight were recorded for each individual before a Petersen disk was attached to the dorsal fin, or in the case of skates and rays, the wing. Positional information of site of release was also recorded. Smooth-hound was the main species tagged (n = 35). Additionally, six wolf-fish (*Anarhichas lupus*) were also tagged and released.

Aim 5: Species retained for further identification included eelpout, various macrobenthos, as mentioned above, specimens of red whelks (*Neptuna* spp.) from the north-eastern sector of the survey grid, and large examples of greater argentine.

Aim 6: Four spurdog (two female), were found to be dead on hauling and retained for further study, as were two tope.

Aim 7: One river lamprey (*Lampetra fluviatilis*) and two twaite shad were dead on capture, and retained for further study.

Aim 8: Continuous data were collected throughout the survey from the Simrad EK60 split beam sounder at four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333kHz).

Aim 9: Empty ray egg cases were retained at 29 different fishing stations, these will be sent to the Shark Trust for subsequent verification of species.

Aim 10: Without a dedicated observer, only three cetacean sightings were logged during the survey; a minke whale (*Balaenoptera acutorostrata*) during hauling at prime station 34, and two sightings of Risso's dolphins (*Grampus griseus*). The first was a pair en route between prime stations 45 and 53 on August 25th, then a pod of four were spotted two days later en route between prime stations 33 and 41. Positional information will be sent to the Sea Watch Foundation.

Aim 11: Jellyfish were recorded during the survey to better understand the species distributions and abundance in the North Sea, and how this changes in relations to fishing practices, the abundance of other organisms, hydrological conditions and climate change. Jellyfish were sampled at each station of the survey; the term 'jellyfish' is used broadly to cover all 'gelatinous organisms' caught in the fishing net. This includes scyphozoans, hydrozoans, ctenophores and salps. For each station jellyfish were first separated into species, or species groups. Then each species was bulk weighed, and the number of individuals counted. Finally, specimens with a good enough body condition were individually weighed and measured (by diameter). Any specimens too damaged to identify were bulk weighed and recorded. The results can be seen in Table 5.

Lion's mane (*Cyanea capillata*) was the most dominant species surveyed, making up 85.4% of the total weight of jellyfish caught. *C. capillata* were also present at 58 of the 78 prime stations.

Jellyfish species/group	Total weight (g)	Number of Individuals	Weight range (g)	Length range (cm)	Prime station with highest	
					Weight	# of Individuals
<i>Aurelia aurita</i> Moon jellyfish	903.6	10	2.2—226.7	3 - 17	14	19
<i>Cyanea lamarckii</i> Blue jellyfish	1 471.8	15	31—250.8	10 - 19	17	51
<i>Cyanea capillata</i> Lion's mane jellyfish	205 247.1	718	5.3—3044	5 - 51	37	37
<i>Cyanea</i> species	7 656.2	364	1.1—153.2	2 - 19	40	40
<i>Chrysaora hysocella</i> Compass jellyfish	16 323.4	352	1.5—461.2	3 - 28	2	3
<i>Aequorea</i> species Cristal jellies	747.4	7	3.6—540.8	5 - 24	59	-
<i>Pleurobrachia pileus</i> Sea Gooseberry	8.8	8	0.8—1.5	2 - 3	3	3
<i>Pelagia noctiluca</i> Mauve stinger	76.6	2	27.2—49.2	7	71	-
Unidentified species	7 814.8	-	-	-	59	-

Table 5. Details of jellyfish caught during the survey

Aim 12: Due to time constraints, there was no life-history information collected from lesser-spotted dogfish this year.

Aim 13: Ferrybox systems, such as the one mounted on the RV Cefas Endeavour, are autonomous measuring systems that provide continuous measurements of standard oceanographic variables such as temperature, salinity, phytoplankton fluorescence and turbidity. Environmental variables are measured every few seconds and while the vessel is underway, hence providing very high spatial coverage and temporal resolution of observations. These can then be used for assessment of the state of the marine environment, and for validation of models and/or remote sensing. It is important then that the sensors of the Ferrybox are regularly validated against discrete samples to ensure all measurements are correct and the sensors are not drifting. As can be seen from table 6, during the survey 19 chlorophyll samples were collected from the subsurface (4 m depth). Chlorophyll-a concentration will be determined by HPLC analysis by DHI in Denmark and results will be used for validation of the Ferrybox fluorescence measurements.

	Total	Surface	Bottom
		Ferrybox	Niskin
Salinity	100	50	50
Chlorophyll (duplicates)	19	19	0
CTD casts with ESM2	64		

Table 6. Details of CTD deployments and associated salinity and chlorophyll samples collected

Aim 14: No squid eggs were caught in the GOV trawl this year.

Aim 15: Due to illness of staff before the survey, this work could not take place.

Aim 16: Over the course of the survey 146 four-bearded rocklings were caught, with biological information, including otoliths, collected from each one.

Aim 17: Four species (grey gurnard, dab, whiting, and herring) were sampled at six fishing stations off the north-east of England to examine how the use of benthic and pelagic pathways changes with size.

At each of these stations, approximately 20 individuals of each species were measured, weighed, and stomach contents extracted along with 2g of white dorsal muscle and liver for stable isotope analysis. Approximately 5 individuals of each species in 5 – 10 cm length classes spanning their entire observed range were sampled. Benthic invertebrates (e.g. queen scallop - *Aequipecten opercularis*) were also collected at each station to characterise isotopic values of basal food webs sources. Observed length ranges sampled at each station is summarised in Table 7.

Species	Station (prime)					
	77	23	13	14	8	7
Grey gurnard	15-34 cm	15-29 cm	15-29cm	15-29 cm	15- 34 cm	10-34 cm
Dab	10-24 cm	15-24 cm	10-24 cm	10-24 cm	10-29 cm	10-29 cm
Herring	5-34 cm	25- 34 cm	15-29 cm	15-34 cm	10-14 cm	25-29 cm
Whiting	5-29cm	20-39 cm	20-39 cm	20-34 cm	15-29cm	20-24 cm

Table 7. Observed size ranges for each species in each north-east England fishing station.

Generally, similar size ranges were observed for dab and grey gurnard among fishing stations, whereas sizes for whiting and herring appear more variable. At station 7, only a small number of herring were caught by the GOV, which were also within a small size range of between 25 to 29 cm. Conversely, vast numbers of herring were caught at other north-east stations.

Aim 18: Over 11,000 herring were sampled during the survey, no evidence of *Ichthyophonous* spp. was found.

Aim 19: Following on from 46 fish species collected on the preceding beam trawl survey, a further 15 species were collected on this survey, including silvery pout (*Gadiculus argenteus*), hagfish (*Myxine glutinosa*), snake blenny (*Lumpenus lampretaeformis*) and butterfish (*Pholis gunnellus*).

Aim 20: A selection of both flatfish and round fish were collected for otolith extraction training at a later date. In addition, some training was conducted during the survey.

Aim 21: 27 bottom water samples were collected on the first part of the survey for analysis of dissolved oxygen. These were fixed using manganous sulphate and alkaline iodide at sea before being processed for oxygen concentration on land. Dissolved oxygen concentration near the bottom is an important indicator in the assessment of the marine environment in OSPAR's waters. Oxygen depletion could be the result of decomposition of accumulated organic materials (e.g. from algal blooms), caused by excessive nutrient enrichment. Reduction in oxygen can lead to behavioural changes or death of fish or other species, hence the importance of monitoring oxygen levels.

Special thanks are given to the officers and crew of the RV Cefas Endeavour for their enthusiasm and hard work in making this survey a success. Also, to Jim Ellis, Ian Holmes, Sophy Phillips and Flavia Flaviani for their support before, during and after the survey was completed.

Ben Hatton
Scientist in Charge
04/10/17

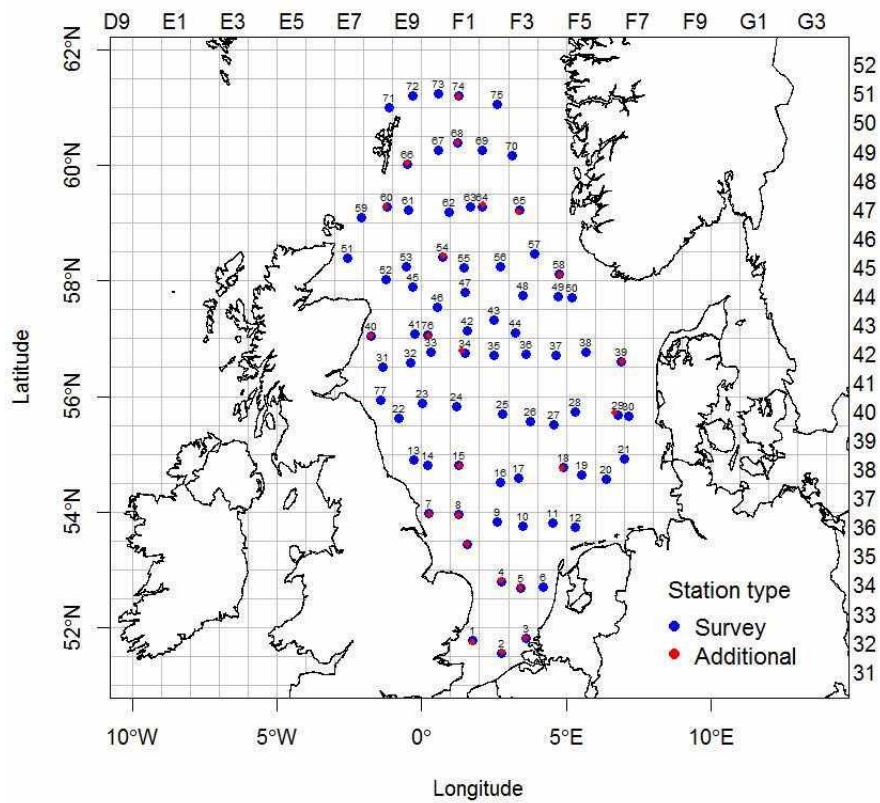


Figure 7. Fishing stations of English Q3 IBTS survey 2017

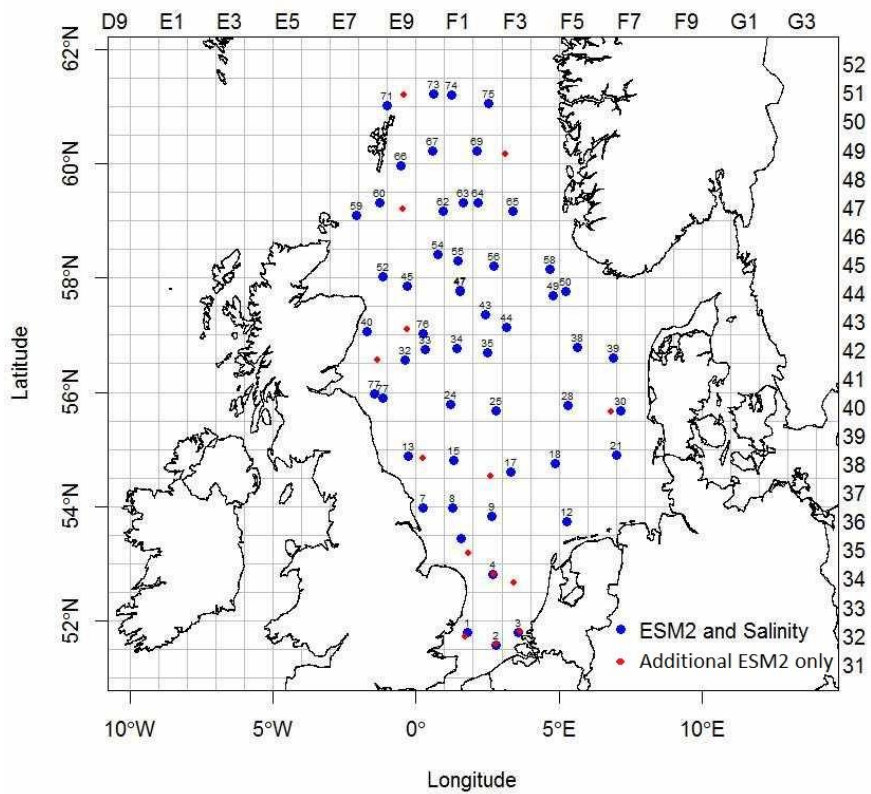


Figure 8. Station positions where vertical casts with the ESM2 profiler and niskin bottle were taken

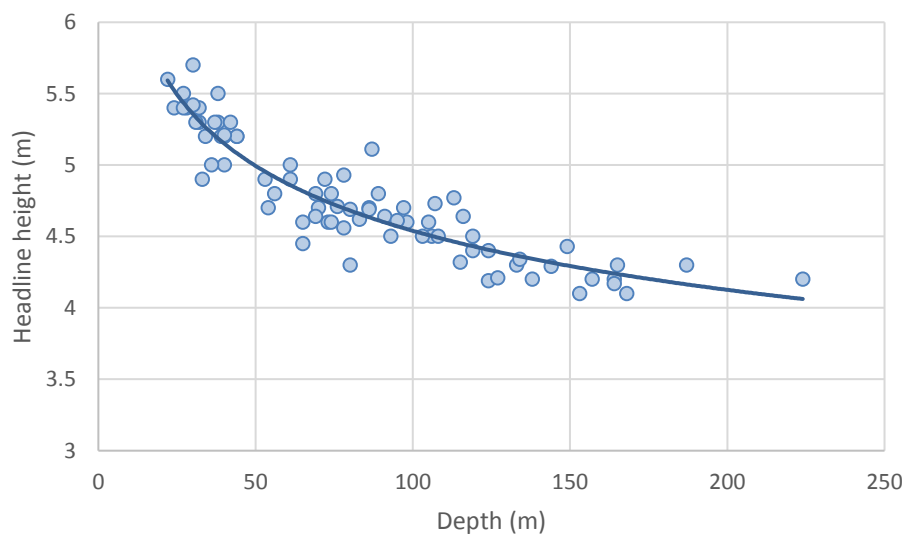
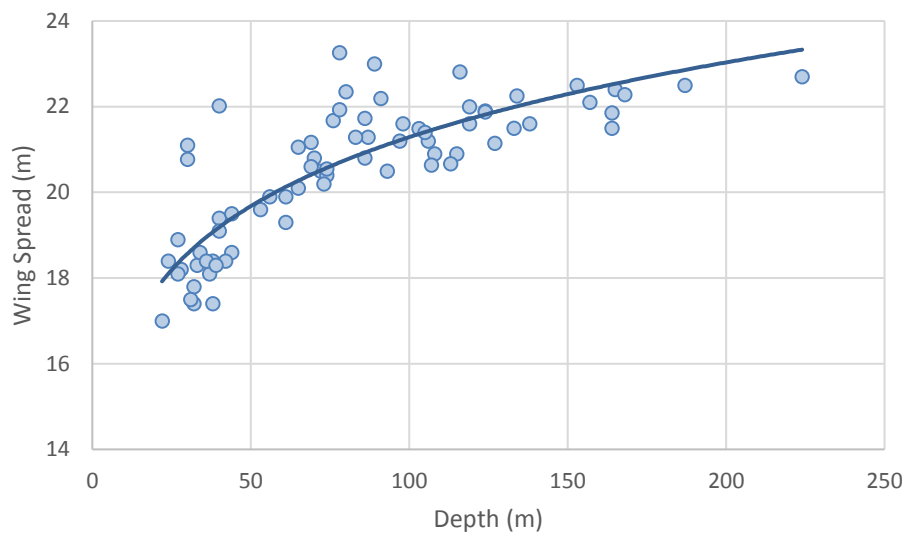
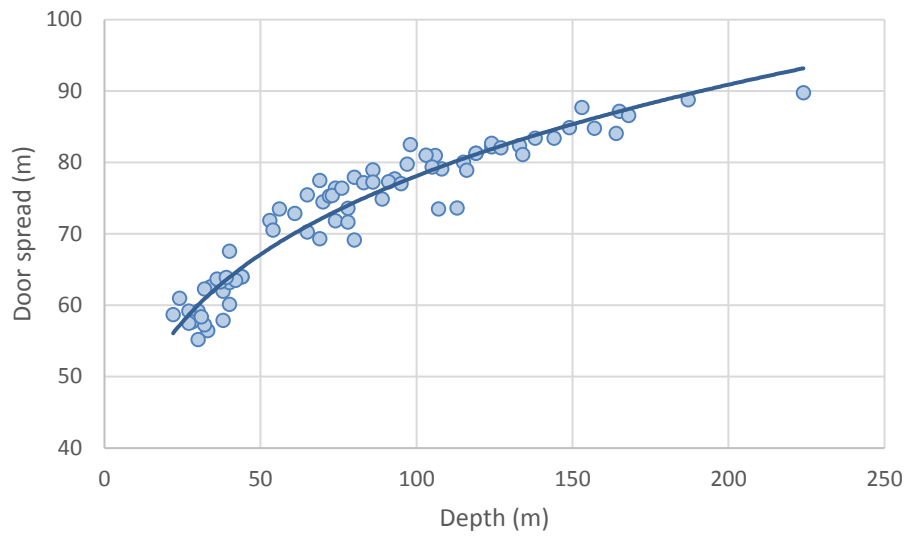


Figure 9. Relationships between mean headline height, wing spread and door spread with water depth, as recorded during valid hauls

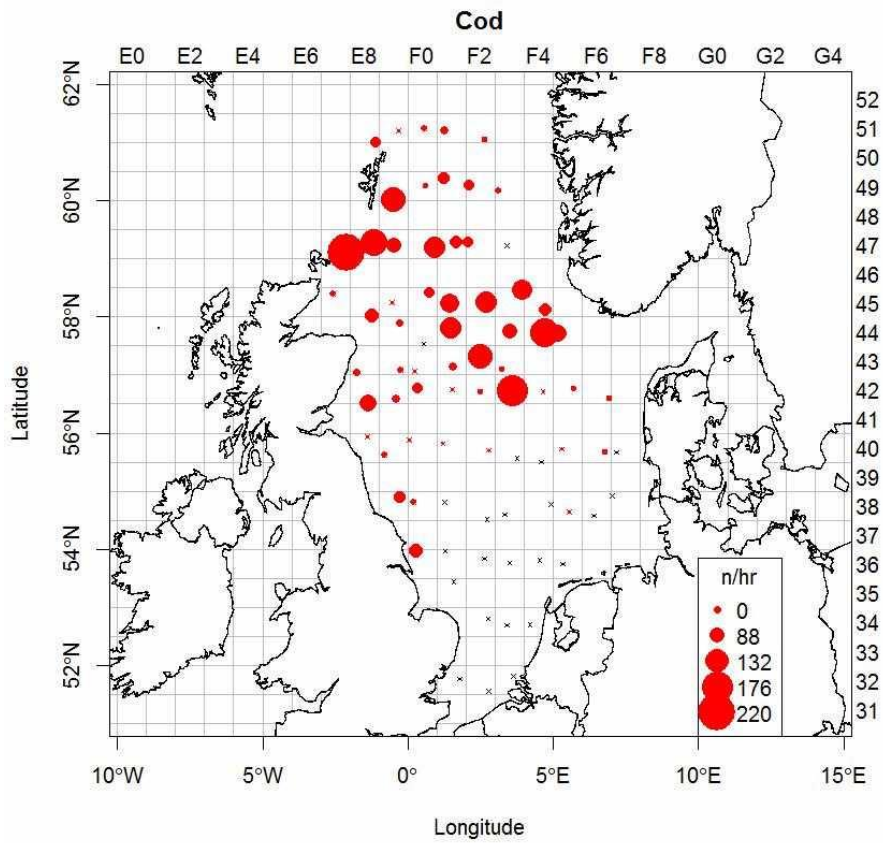


Figure 10. Distribution and relative abundance (raised numbers per hour) of cod (*Gadus morhua*)

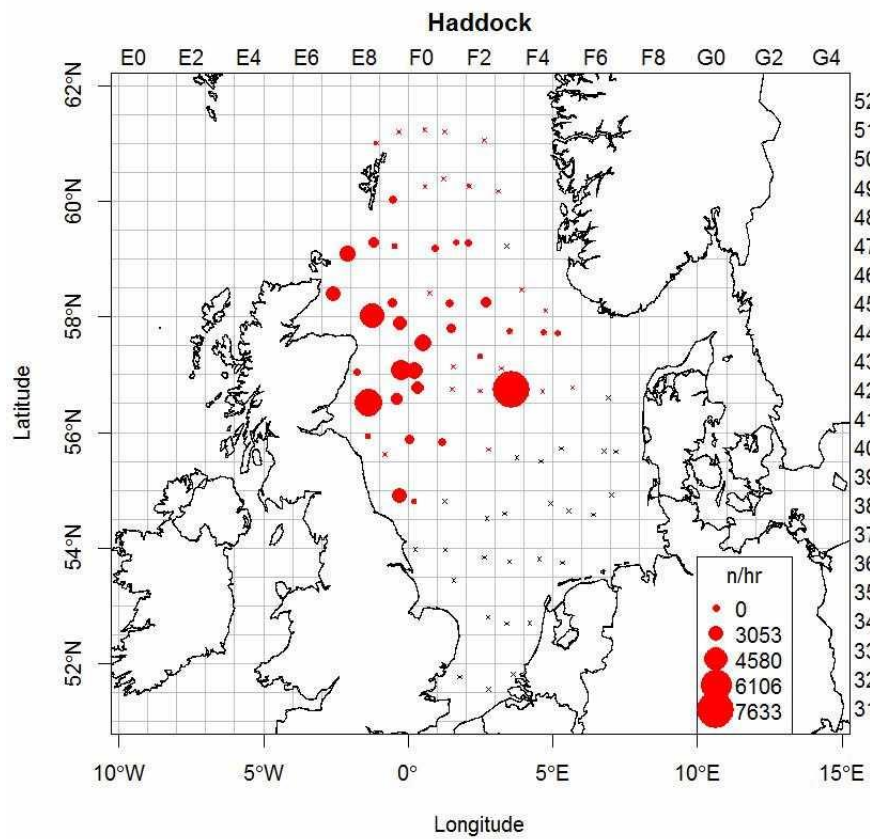


Figure 11. Distribution and relative abundance (raised numbers per hour) of haddock (*Melanogrammus aeglefinus*)

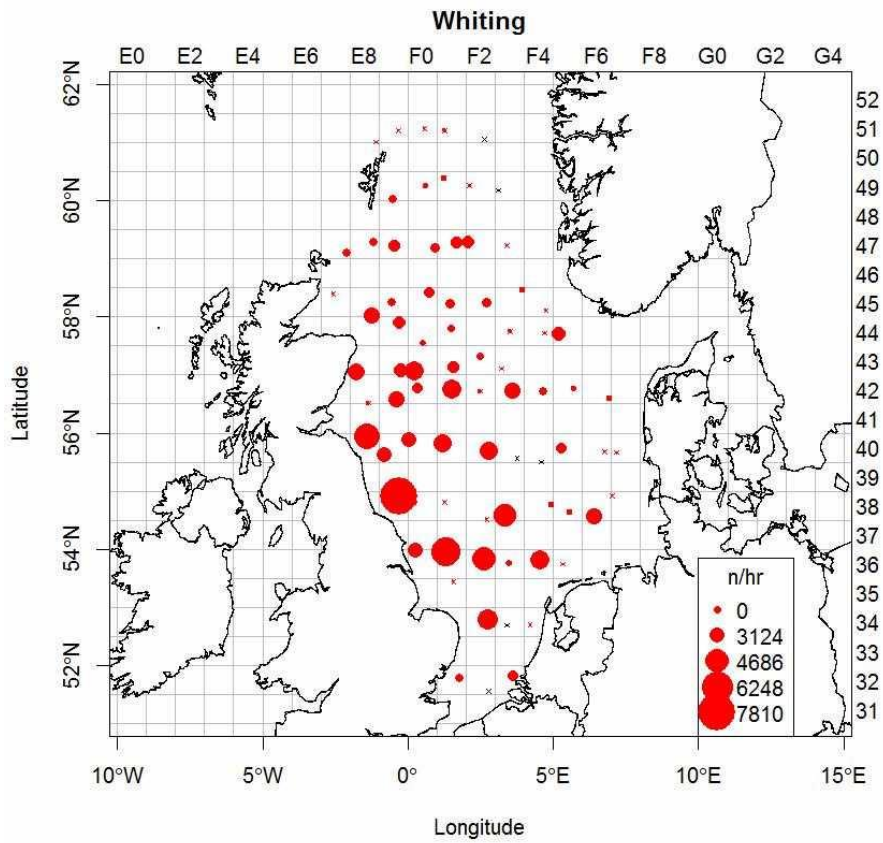


Figure 12. Distribution and relative abundance (raised numbers per hour) of whiting (*Merlangius merlangus*)

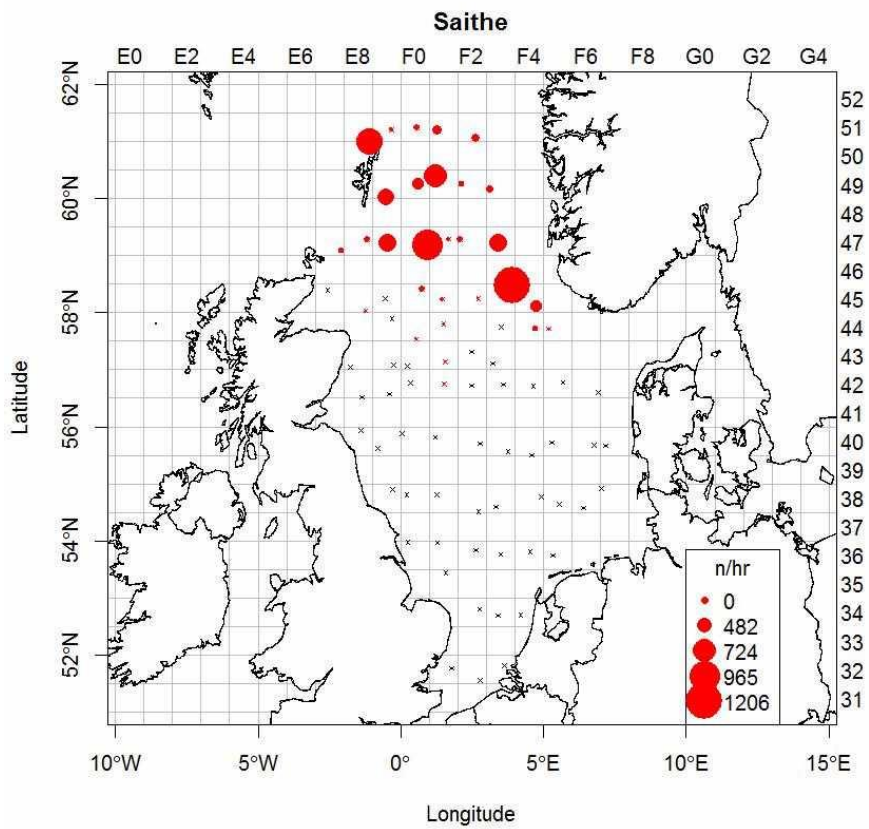


Figure 13. Distribution and relative abundance (raised numbers per hour) of saithe (*Pollachius virens*)

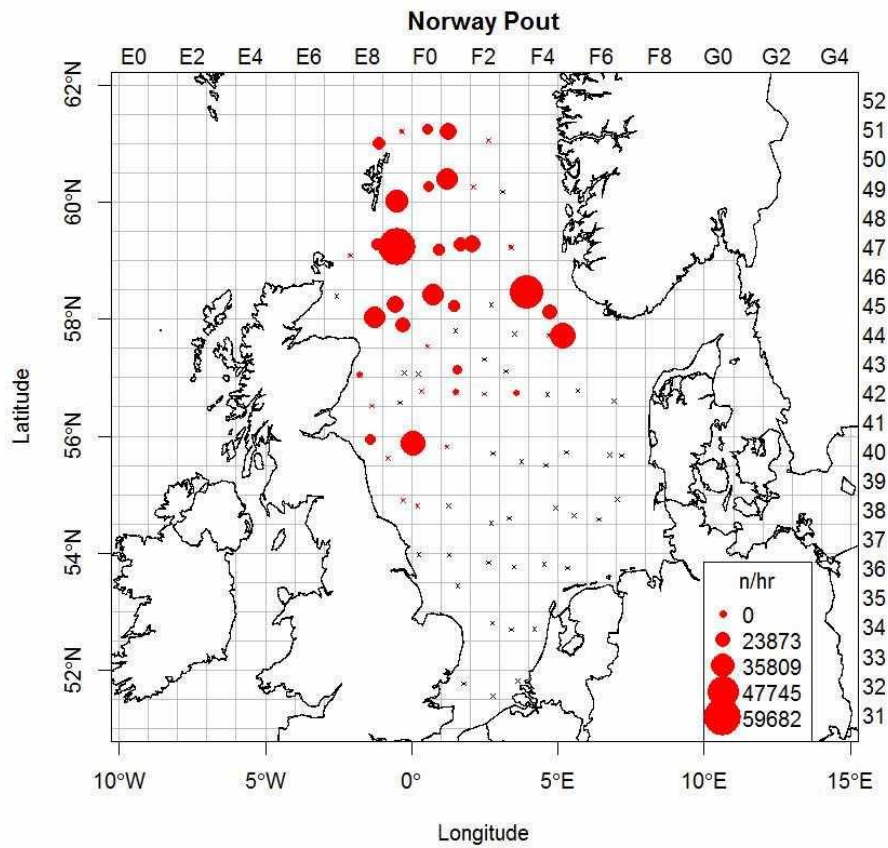


Figure 14. Distribution and relative abundance (raised numbers per hour) of Norway pout (*Trisopterus esmarkii*)

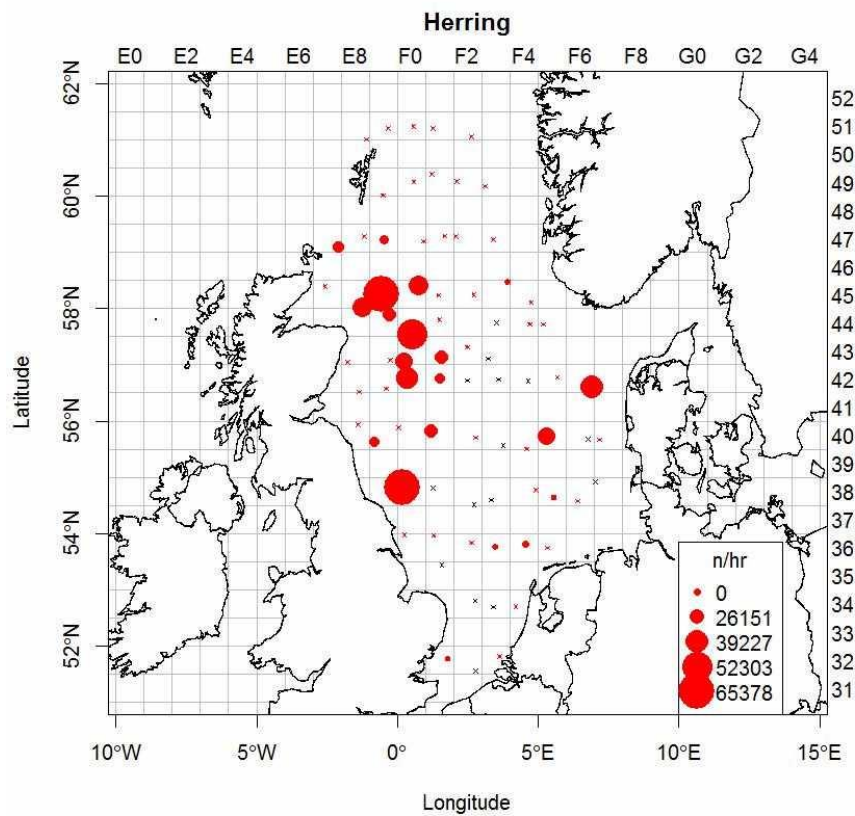


Figure 15. Distribution and relative abundance (raised numbers per hour) of herring (*Clupea harengus*)

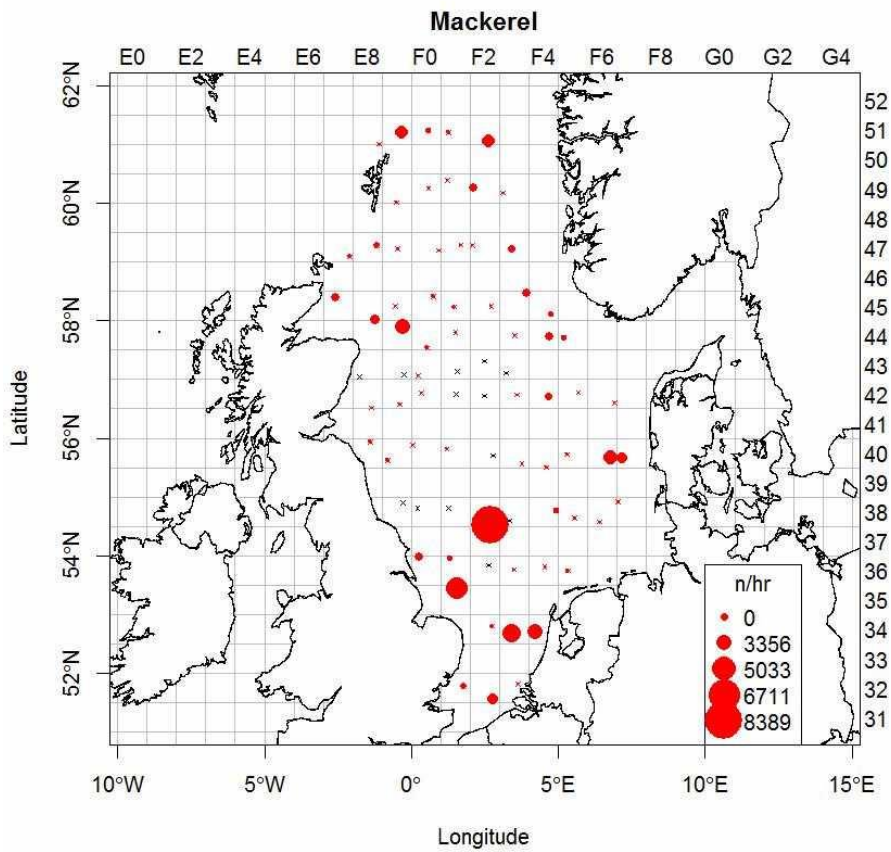


Figure 16. Distribution and relative abundance (raised numbers per hour) of mackerel (*Scorpaenopsis scorpaenoides*)

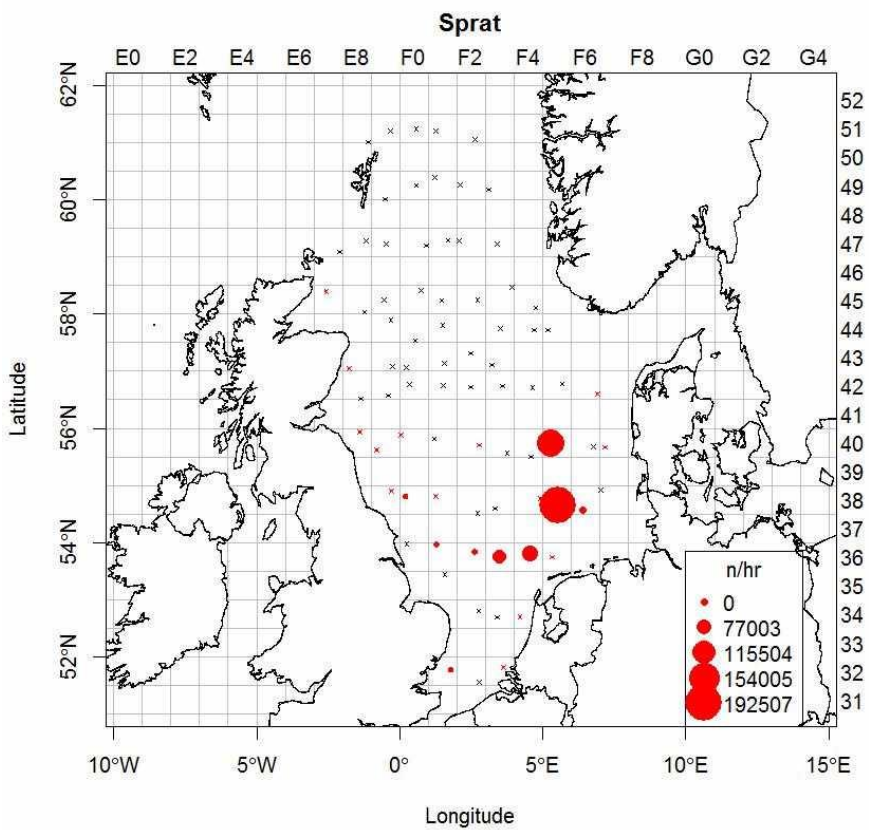


Figure 17. Distribution and relative abundance (raised numbers per hour) of sprat (*Sprattus sprattus*)

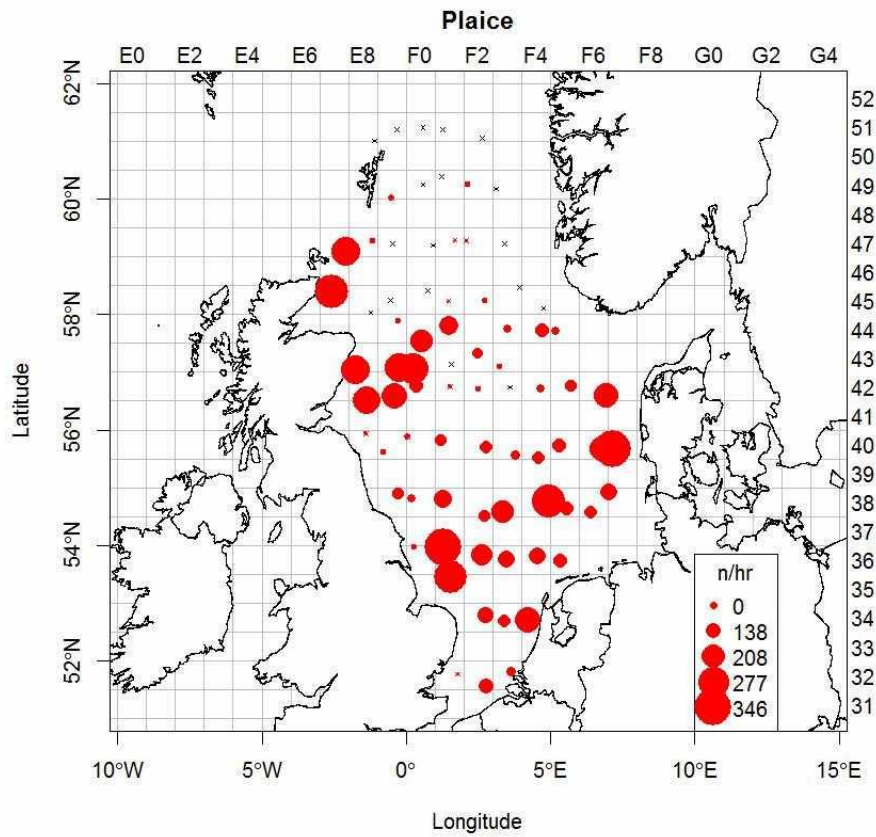


Figure 18. Distribution and relative abundance (raised numbers per hour) of plaice (*Pleuronectes platessa*)

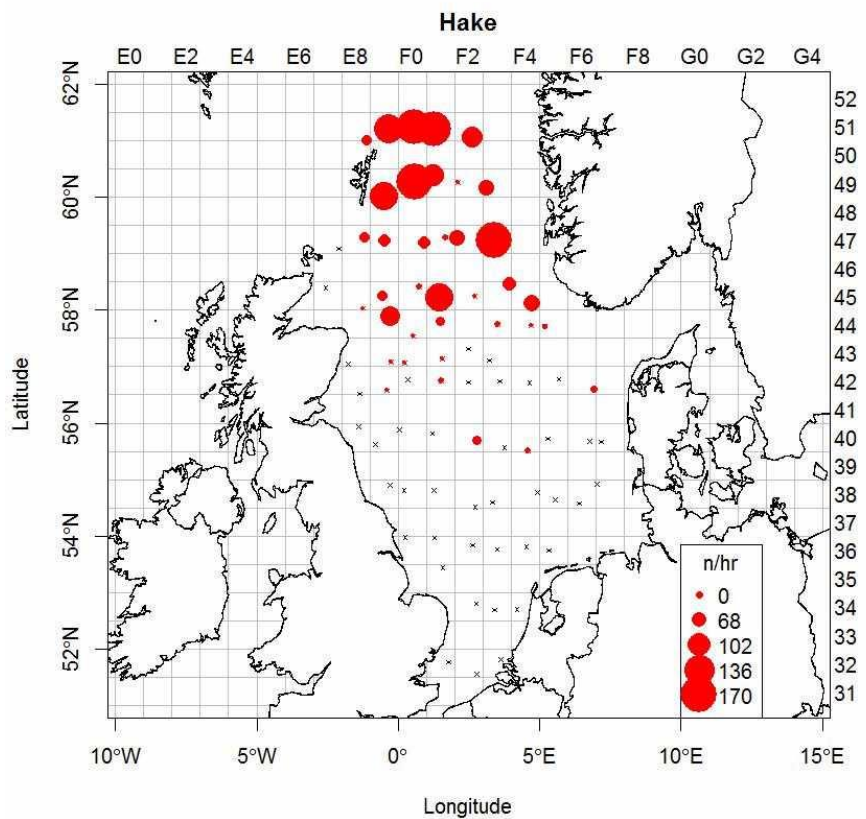


Figure 19. Distribution and relative abundance (raised numbers per hour) of hake (*Merluccius merluccius*)