Centre for Environment Fisheries & Aquaculture Science

Cefas

RESEARCH VESSEL SURVEY REPORT

RV CEFAS ENDEAVOUR
Survey: C END 12 - 2019

STAFF:

Name	Role	Name	Role
B Hatton	**SIC**	**L Cox**	**2IC**
R Humphreys	**2IC**	**J Ellis**	
N Hampton		**L Aislabie**	
G Burt		**S Barnett**	
G Robson		**D Clarke**	
M Eade		**L Possenti**	**Student**
F Pallottino	**Student**		

DURATION:

7 August – 5 September 2019

LOCATION:

North Sea (ICES areas IVa, b and c)

AIMS:

PRIMARY AIMS:

1. To carry out a groundfish survey of the North Sea (Figure 1) as part of the ICES coordinated IBTS, using a GOV trawl (polyethylene trawl with nylon sleeve and cod-end) 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 and anthropogenic debris.
   e) Surface and bottom temperature and salinity data using ESM2 profiler/mini-CTD logger and Niskin Bottle.
   f) Length weight & maturity information using individual fish measurements, in support of the EU Data Regulation.

SECONDARY AIMS:

2. 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. (J Ellis – Cefas, Lowestoft)

3. 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. (J Ellis – Cefas, Lowestoft)

4. To retain any dead specimens of tope *Galeorhinus galeus* and common skate *Dipturus batis* species-complex for biological studies. (J Ellis – Cefas, Lowestoft)

5. Retain any dead specimens of diadromous fish for the DiadES Interreg project (T Basic, Cefas, Lowestoft)

6. Collect fisheries acoustic continuously data 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 a time series monitoring changes in mackerel *Scomber scombrus* distribution and abundance. (J Van Der Kooij – Cefas, Lowestoft)

7. Cetacean observations will be recorded where possible and sent to the Sea Watch Foundation.

8. Identification, count, measure and weight 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. S Pitois – Cefas, Lowestoft

9. Collect squid egg samples to map spawning grounds. This could be highly relevant in studying squid stock's structure. (V Laptikovksy – Cefas, Lowestoft)

10. Retain any specimens of *Loligo vulgaris* and all *ommastrephid* squids *Illex, Todaropsis, Todarodes* for maturity and age analysis, respectively. (V Laptikovksy – Cefas, Lowestoft)

11. To collect biological information from four-bearded rockling *Enchelyopus cimbrius*. Including length, weight & maturity information. (L Cox – Cefas, Lowestoft)

12. Collect chlorophyll samples to test for nutrients from the surface water collected once a day for the ASMIAC project. (N Greenwood – Cefas, Lowestoft)

13. Zooplankton plankton sampling using ringnet to collect samples from the Gabbard smart buoy site. (S Pitois – Cefas, Lowestoft)

14. Collect vitality assessment data to better inform on the discard survivability of starry smooth-hound under EMFF project C7246 (S. Phillips/C. Griffiths – Cefas Lowestoft).

15. Collect suitable examples of benthic organisms from a select number of prime stations to test for Paralytic Shellfish Poisoning toxins. This is with a view to assessing ongoing presence and geographical extent of PSP following evidence of consumption from an unusual source on the East Anglian coastline (A. Turner – Cefas, Weymouth).

16. Sample for dissolved oxygen as part of the OSPAR assessment for eutrophification.

17. Test the new hardware/software for the Marport Trawleye sensor during an additional tow.

NARRATIVE:
All times stated are GMT.

PART ONE
RV Cefas Endeavour (CEND 12/19) sailed from Lowestoft at 0000hr on Wednesday, 7 August. There were seven Cefas scientific staff on board plus Francesco Pallottino and Luca Possenti, students from University of East Anglia (UEA). During the night the ship travelled south toward the west Gabbard to collect a zooplankton sample for later analysis, before continuing south towards prime station 1 (Aim 13). A standard station normally consists of a 30-minute tow with the standard IBTS rigged GOV (Grand Overture Verticale) trawl #1. Since 2014, a net variation has been used during this survey, by means of a polyethylene net with nylon sleeve and cod-end being employed. At the start and end of each day deployment of a CTD Rosette to measure additional parameters throughout the water column (temperature, salinity, fluorescence, light, turbidity and dissolved oxygen) and provide salinity samples and water samples for our additional aims was be completed. Throughout the survey, fisheries acoustic data were continuously collected at three operating frequencies (38 kHz, 120 kHz, and 200 kHz), using the Simrad EK60 split beam sounder.

By 0800hr on August 7, 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. Following a “toolbox talk” the net was deployed and due to some small issues with the gear geometric sensors the station was classed as an additional tow. By 1030hr the alterations were completed, and the trawl was redeployed at prime station 1. After a successful tow, the survey moved to the east to prime station 2. A large catch of horse mackerel *Trachurus trachurus* was captured (1520 kg) in contrast to very small catches of this species recorded here in previous years. No further sampling took place on August 7 due to failing light.

Overnight, the ship moved east to prime station 3 and then headed up the Belgium coast to prime station 6 and continued to work west throughout the day, successfully completing prime stations 3, 6, 5 and finishing on prime station 4. Prime station 4 resulted in the largest

haul of the day mainly consisting of sprat *Sprattus sprattus* 558 kg. Of note here, were single specimens of both male tope, (36 cm) and one twaite shad *Alosa fallax*, (45 cm), and these dead specimens were retained for further study (Aims 4 & 5).

The next day began at prime station 9 and continued to move to the east through prime stations 9, 10, 11 and 12 ending the day north of the Dutch West Frisian islands. All fishing stations and two CTD rosette casts were completed successfully. Small catches were observed at prime stations 9, 10 and 11, with a large haul of sprat (1620 kg) caught at prime station 12. Of note, was one twaite shad (29 cm) which was captured at prime station 11 and retained for further study (Aim 5).

By August 10, CEND 12/19 was at prime station 17 south-east of the Dogger Bank. After successfully completing this station, weather conditions had begun to deteriorate on transit to prime station 16. At prime station 16 the weather conditions were likely to cause problems in attaining acceptable parameters for a valid tow so the decision was made to travel south west to prime station 8, where weather conditions were more favorable. This was completed by the end of the day. A male tope (159 cm, 19.6 kg) was tagged and released here (Aim 2; Figure 1).

Figure 1. Male tope (159 cm, 19.6 kg) being tagged.

Overnight, the ship moved west to prime station 7 off the English coast. After successfully completing prime stations 7 and 14, CEND 12/19 had to abandon work at prime 13 due to seismic work operating in the area. A new position was located, 20 nm to the southeast. On attempting to sample at this new location, damage was sustained which invalidated the tow, and fishing activity was not possible for the remainder of the day whilst repairs were completed. The largest catch component of the day was whiting *Merlangius merlangus,* (719 kg) caught on prime 7.

On August 12 CEND 12/19 returned to the original position at prime station 13 due to the seismic activity moving away from the area overnight. With net repairs completed, a GOV trawl was successfully completed and CEND 12/19 headed east towards the Dogger Bank and prime stations 15 and 16. These were completed successfully with a large amount of juvenile whiting (87 kg) being caught at prime station 15 and a large catch of sprat (1573 kg) caught at prime station 16 (Figures 2_3).

Figure 2. EK60 readings show sprat on prime station 12

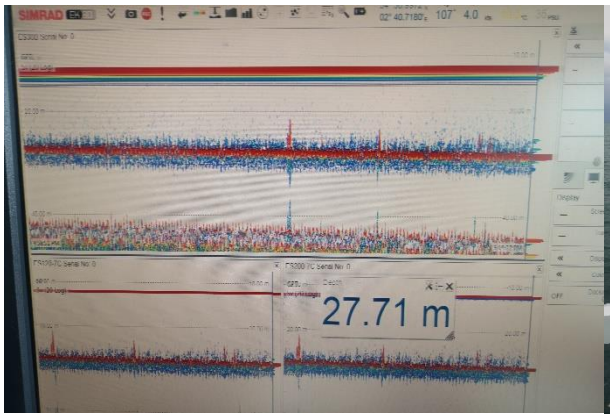


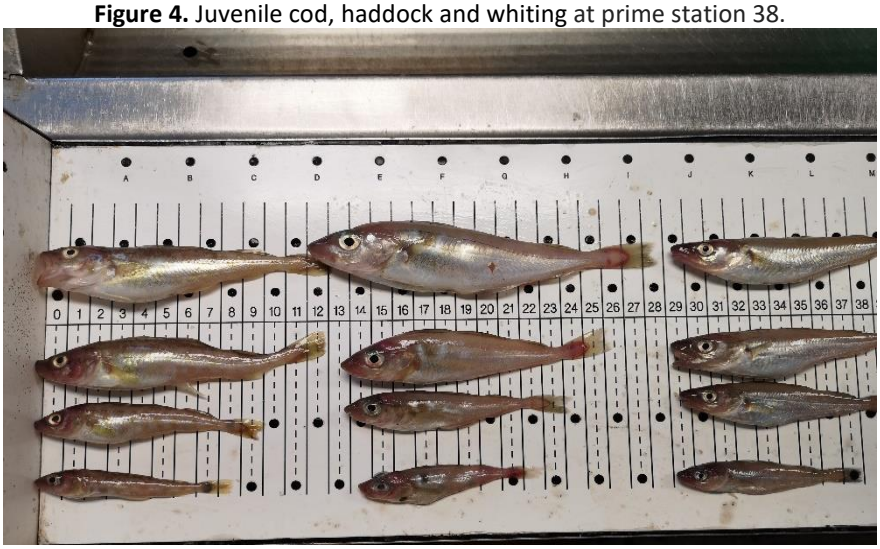
Figure 3. Hauling catch onboard vessel on prime station 12.

The next day began at prime station 25 and continued east to prime stations 26, 27 and 28. All fishing stations were completed successfully. Catches consisted mainly of dab *Limanda limanda* and sprat, with the largest catch of the day at prime station 27 (353 kg of sprat).

Overnight, the ship moved south to prime station 18 and successfully completed this before continuing east and completing GOV trawls at prime stations 19 and 20, before heading to prime station 21. On arrival at prime station 21 static gear was observed at the original tow location, so a new position was found due east and a successful GOV trawl was completed. The largest catch of the day was sprat (657 kg) at prime station 20. On August 15 CEND 12/19 began the day at prime station 30 due west of Denmark before heading north-west to prime station 29 and north to prime station 39. Successful completion of GOV trawls at prime stations 30 and 29 was followed by gear failure of newly rigged GOV trawl #2 at prime station 39, leading to the tow being invalidated and the GOV trawl needing to be replaced.

Overnight a new clear tow was found east of the original tow position and the GOV trawl was replaced with GOV trawl #3. After a successful trawl at prime station 39, CEND 12/19 headed east to prime stations 38 and 37. Successful trawls were completed at both stations. Juvenile gadoids being observed throughout the day; haddock *Melanogrammus aeglefinus, (*93.7 kg), whiting (2.995 kg) and cod *Gadus morhua, (*2.835 kg) were caught at prime station 38 (Figure 4). One adult cod (51 cm, 1.156 kg) was also present in the catch at prime station 39.

Figure 4. Juvenile cod, haddock and whiting at prime station 38.



On August 17, CEND 12/19 began the day at prime station 36 and then continued east completing GOV trawls at prime stations 36, 44, 35 and 33. Catches of juvenile gadoids and dab were observed at all stations throughout the day's surveying. The largest catch of the day was dab (629 kg) observed at prime station 36. Of note here was one blue-mouth redfish *Helicolenus dactylopterus,* and two snake pipefish *Entelurus aequoreus*.

Overnight, CEND 12/19 travelled south east to prime station 24 and continued west throughout the day toward the English coast. Successful GOV trawls were completed at prime stations 24 ,23, 22 and 77. Juvenile gadoids were observed throughout the day with the highest abundance at prime station 22 with whiting (83 kg), haddock (41 kg), cod and Norway pout *Trisopterus esmarkii* all being observed. At prime station 23 ("Swallow hole"; a geological glacial tunnel valley) the GOV was recovered early at 24 minutes due to large acoustic mark on the EK60 echo sounder that would have caused a safety issue if fishing had continued (Figure 5). Of note, blue-mouth redfish (0.355 kg) were caught at prime station 23 (Figure 6).

Figure 5. EK60 readings at prime station 23

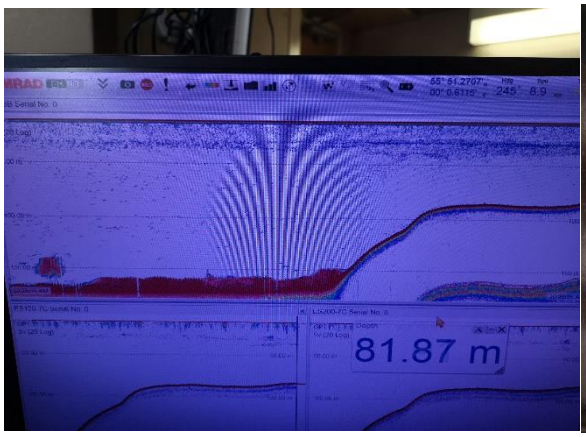
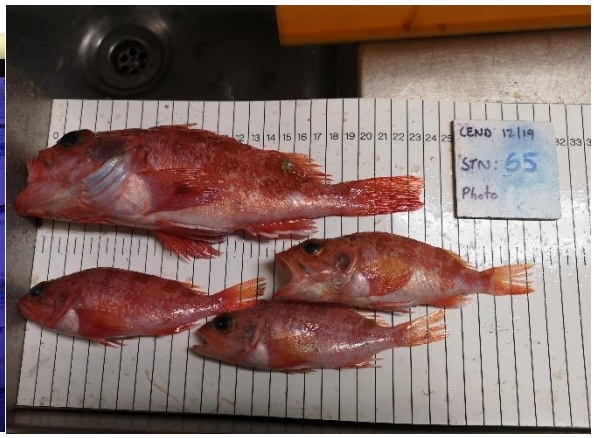


Figure 6. Redfish caught at prime station 23

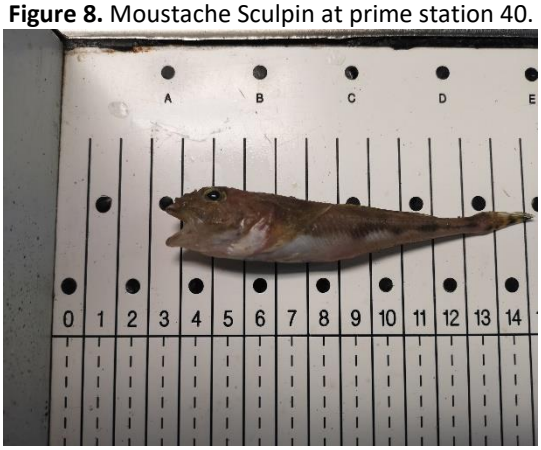


Sampling started at prime station 31 on 19 August, with CEND 12/19 moving east throughout the day, completing successful GOV trawls at prime stations 31, 32 and 33. As with the previous day, juvenile gadoids were observed at all prime stations with the largest catch being haddock (51 kg) at prime station 32. Ten deceased juvenile spurdog (8x female 1.335 kg, 2x male 0.735 kg) were caught at prime station 32 and retained for further analysis. Once fishing was complete, a sea glider was deployed at prime station 32 (Figure 7) by Luca Possenti in association with the University of East Anglia, with retrieval planned for the second half of the survey.

Figure 7. Sea Glider being deployed.

The next day, prime station 40 was completed before heading west towards Aberdeen for a scientific crew change. This was abundant in epibenthos with only small quantities of fish; the largest of which being haddock (52 kg). Ross coral *Pentapora foliacea* and one moustache sculpin *Triglops murrayi, (*11 cm; Figure 8) were present here. CEND 12/19 then sailed to Aberdeen, arriving at 1300hr.

Figure 8. Moustache Sculpin at prime station 40.



PART TWO :

At approximately 1800hr on 21 August, the survey resumed and CEND 12/19 made passage north overnight to prime station 51 to commence fishing at first light. Successful GOV trawls were completed at prime stations 51, 59, 60 and 61. The largest catch of the day was haddock (237 kg) sampled at prime station 51. Of note, five flapper skate *Dipturus intermedius,* 79.92 kg, 107 – 170 cm total length, Figure 9) were tagged and released at prime station 59 (Aim 2).

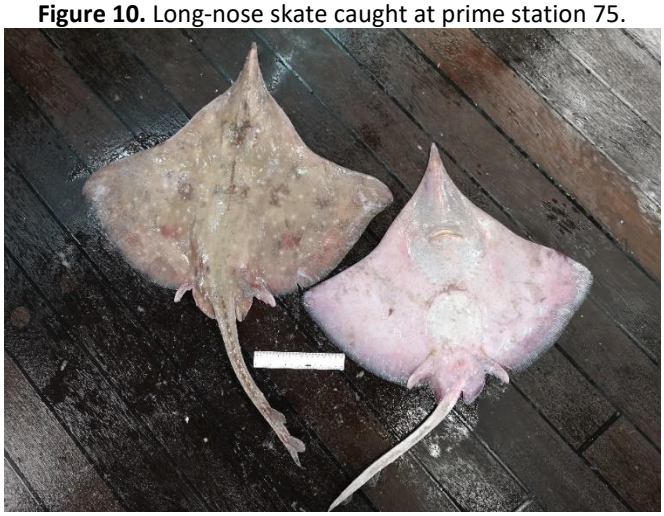
Figure 9. Flapper skate tagged and ready for release at prime station 59.

The next day began in poor weather at prime station 66, therefore CTD rosette casts were changed to a Niskin and mini-CTD due to safety concerns. CEND 12/19 then completed prime stations 66_68 successfully, the largest catch of the day being herring *Clupea harengus,* (121 kg) caught at prime station 66, with large numbers of juvenile Norway pout being caught at all three prime stations. Of note, two wolf fish *Anarhichas lupus* were caught, both tagged and released, one at prime station 66 (66 cm, 3.0 kg) and one at prime station 67 (66 cm, 2.64 kg). Further, one torsk *Brosme brosme,* 58 cm, 1.82 kg) was caught at prime station 67.

Overnight, CEND 12/19 travelled to prime station 71, due north of the Shetland Isles, and with more favourable weather conditions, allowed the deployment of the CTD rosette. After completing a GOV trawl at prime station 71, CEND 12/19 continued east through to prime stations 72_ 74, successfully completing GOV trawls at all stations. The largest catch of the day was saithe *Pollachius virens, 593 kg*) with catches of juvenile Norway pout and epibenthos present at each station. Twenty-one blue-mouth redfish (0.390 kg) were caught at prime station 71 and one torsk (49 cm, 1.181 kg) was caught at prime station 74.

On 25 August CEND 12/19 started the day at prime station 75 and after a successful GOV trawl, travelled south to prime station 70 and then west to prime station 69, attaining valid tows on both. The largest catch of the day was mackerel (539 kg) caught at prime station 69. Several notable species were recorded at prime station 75; one flapper skate (154 cm, 26.74) which was released, one greater forkbeard *Phycis blennoides*, 38 cm, 0.488 kg) and two long-nose skate *Dipturus oxyrinchus,* (one, 75 cm, 1.75 kg female, and one, 83 cm, 2.5 kg male). These dead specimens were biologically sampled (Figure 10).

Figure 10. Long-nose skate caught at prime station 75.



The following day CEND 12/19 completed prime station 62, before continuing east throughout the day to prime stations 63, 64 and 65. The largest catch of the day was horse mackerel (prime station 65) and juvenile Norway pout and epibenthos were present at all prime stations. Two wolf fish were tagged and released; one at prime station 62 (72 cm, 3.465 kg) and one at prime station 63 (59 cm, 1.855 kg).

Overnight, CEND 12/19 transited south-east to prime station 58, before moving to prime station 50 and continuing west to prime stations 49 and 48. Successful GOV trawls were conducted at all prime stations. Prime station 49 produced the largest catch, 313 kg herring. Juvenile cod were caught on prime stations 58, 50 and 49 (158, 37 and 39 individuals, respectively), with the largest cod captured at prime station 50 (107 cm, 11.45 kg). Additionally, two wolf fish (1 x 58 cm, 1 x 45 cm) were also present prime station 50, the largest of which was tagged and released.

On 28 August, CEND 12/19 began the day at prime station 43 before heading east to prime stations 42, 76 and then north to prime station 46. Again, all prime stations were completed successfully. The largest catch of the day was herring at prime station 42 (570 kg) with herring also being recorded in high abundance at prime stations 76 (250 kg) and 46 (322 kg). Of note, large amounts of epibenthos (369 kg) was caught at prime station 76, most of which was made up of purple heart urchins *Spatangus purpureus*. Sampling began the next day at prime station 41, before recovering the UEA sea glider that had been deployed on part-one of the survey. CEND 12/19 then travelled north to prime stations 45 and 53 and completed GOV trawls at both stations. Herring comprised the largest catch of the day (1226 kg) at prime station 45 and were also present at prime stations 45 (34 kg) and 53 (99 kg).

On 30 August, herring was the largest species by catch weight at prime station 52 (83.92 kg) and notably a lump sucker *Cyclopterus lumpus,* 9.0 cm) was also captured at this station. CEND 12/19 then headed to Peterhead for a planned ship crew change, docking at approximately 1100hr. CEND 12/19 departed Peterhead at approximately 1800hr and travelled east overnight to prime station 54 for first light. This station was attempted but, due to problems deploying the net, recovery and repair meant no further fishing could be completed that day.

By 1 September, with all gear repairs completed, CEND 12/19 continued to prime stations 55, 47 and 56, completing all successfully. The largest catch of the day was Herring (97 kg), caught at prime station 56. Of note, a large percentage of the catches at prime stations 55 and 47 was epibenthos with 60 kg and 45 kg, respectively. The next day began at prime station 57 and the successful completion of a CTD rosette cast and GOV trawl marked the completion of all survey prime stations. Following this, and over the next two days, ten additional GOV comparison tows were completed. These comprised 15 minute and "zero minute" tows at prime stations 57, 49, 24 and 7. One tow at prime station 7 had to be invalidated due to unacceptable net geometric sensor readings, which was re-fished successfully. CEND 12/19 then transited back to Lowestoft, docking at approximately 0015hr on 5 September.

Special thanks are given to the scientists and ship's crew of the RV Cefas Endeavour (CEND 12/19) for their enthusiasm and hard work throughout the survey.

RESULTS:

PRIMARY AIMS:

1. To carry out a groundfish survey of the North Sea as part of the ICES coordinated IBTS…

A valid 30-minute GOV trawl was completed at all 77 prime stations (Table 1; Figure 12). An additional 11 comparative tows were completed, which comprised of four 15-minute, and six "zero-minute" tows, plus one standard tow where net geometric sensors were not working as expected. This was re-fished as a valid tow. Three tows were deemed invalid due to gear damage, gear failure, or unacceptable net geometric sensor readings, all were re-fished successfully. Surface and bottom salinity samples were collected at 34 sites by CTD rosette, with an additional 13 collected by Niskin bottle when weather became inclement and the CTD rosette could not be deployed. Six additional CTD rosette deployments and nine Niskin bottle deployments were also completed on behalf of student projects.

Gear: The survey was fished using GOV trawl (polyethylene trawl with a nylon sleeve and cod-end). GOV trawl #1 was replaced after 27 tows due to lower than expected headline height sensor readings. GOV trawl #2 suffered gear failure on its first use, and so the remainder of the survey was completed with GOV trawl #3. Net geometric sensors were used to monitor headline height, wing end distance and door distance (Figure 13).

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 fish 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 shows the number of fish sampled for age determination and other biological information. All data were recorded to computer database using Cefas' Electronic Data Capture system and uploaded to the Fishing Survey System (FSS). Figures 14-23 show the distribution and relative abundance (raised numbers per hour) of cod, haddock, whiting, saithe, Norway pout, herring, mackerel, sprat, plaice and hake *Merluccius merluccius*, respectively.

Table 1: Gear deployments on the English IBTS Q3 2019 survey

Gear	Valid	Additional	Invalid	Total
GOV (IBTS standard gear)	77	11	3[1]	91
Niskin and SAIV mini CTD	11	9	0	20
Niskin Only[2]	2	0	0	2
CTD Rosette	34	6	0	40
Plankton ring net (200µm mesh)	2	0	0	2

[1]Gear damage, gear failure and unacceptable net geometrics

[2]when CTD rosette operator was unavailable

Table 2: Top 15 fish species (by total catch weight) in 2019 and corresponding catch weights in preceding years

English name	Scientific name	2019 weight (kg)	2018 weight (kg)	2017 weight (kg)	2016 weight (kg)	2015 weight (kg)
Sprat	*Sprattus sprattus*	5859	1983	1868	2367	1919
Herring	*Clupea harengus*	4545	10380	24963	34945	17520
Whiting	*Merlangius merlangus*	3652	3943	2858	2468	3002
Horse mackerel	*Trachurus trachurus*	3542	1635	4395	1905	5613
Dab	*Limanda limanda*	3532	3364	3201	3587	3101
Haddock	*Melanogrammus aeglefinus*	2746	2266	2845	2525	2432
Mackerel	*Scomber scombrus*	2237	2336	2365	3450	3597
Norway pout	*Trisopterus esmarkii*	1198	1086	2793	1813	2519
Saithe	*Pollachius virens*	955	1907	2563	2349	1497
Grey gurnard	*Eutrigla gurnardus*	768	1359	1108	1301	1490
Plaice	*Pleuronectes platessa*	374	561	425	506	467
Long-rough dab	*Hippoglossoides platessoides*	315	395	397	305	172
Cod	*Gadus morhua*	312	371	723	753	615
Lemon sole	*Microstomus kitt*	278	250	326	336	234
Blue Whiting	*Micromesistius poutassou*	240	296	620	281	323

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

Species	English Name	Stns	Species	English Name	Stns
Aequipecten opercularis	Queen scallop	12	*Lycodes gracilis*	"Vahl's eelpout"	2
Agonus cataphractus	Pogge (Armed bullhead)	14	*Maja squinado*	European spider crab	1
Alloteuthis subulata		21	*Maurolicus mulleri*	Pearlside	3
Alosa fallax	Twaite shad	3	*Melanogrammus aegelfinus*	Haddock	61
Amblyraja radiata	Starry ray	31	*Merlangius merlangus*	Whiting	74
Ammodytes marinus	Lesser sandeel	1	*Merluccius merluccius*	Hake	24
Ammodytes tobianus	Small Sandeel	2	*Microchirus variegatus*	Thickback sole	4
Anarhichas lupus	Wolf-fish	5	*Micromesistius poutassou*	Blue whiting	10
Argentinidae	Argentines	30	*Microstomus kitt*	Lemon sole	59
Arnoglossus laterna	Scaldfish	17	*Molva molva*	Common ling	13
Aspitrigula cuclus	Red gurnard	4	*Mullus surmuletus*	Red mullet	13
Brosme brosme	Torsk	2	*Mustelus asterius*	Starry smooth-hound	3
Buglossidium luteum	Solonette	22	*Myoxocephalus scorpius*	Bullrout	3
Callionymus lyra	Common dragonet	35	*Myxine glutinosa*	Hagfish	10
Callionymus maculatus	Spotted dragonet	32	*Necora puber*	Velvet swimming crab	4
Cancer pagurus	Edible crab	25	*Nephrops norvegicus*	Norway lobster	18
Capros aper	Boarfish	3	*Octopodidae*	Octopus	31
Ciliata mustela	Five-bearded rockling	2	*Ommastrephes saggittatus*	Flying squid	12
Clupea harengus	Herring	64	*Pecten maximus*	Scallop	6
Cyclopterus lumpus	Lumpsucker	1	*Pholis gunnellus*	Butterfish	2
Dicentarus labrax	European sea bass	1	*Phycis blennoides*	Greater forkbeard	2
Dipturus intermedia	Flapper skate	2	*Platichthys flesus*	Flounder	6
Dipturus oxyrinchus	Long-nose skate	1	*Pleuronectes platessa*	Plaice	60
Enchelyopus cimbrius	Four-bearded rockling	15	*Pollachius virens*	Saithe	16
Engraulis encrasicolus	European anchovy	3	*Raja clavata*	Thornback ray	4
Entelurus aequoreus	Snake pipefish	1	*Raja montagui*	Spotted ray	5
Eutrigula gurnardus	Grey gurnard	67	*Rossia macrostoma*		10
Gadiculus argenteus	Silvery pout	12	*Sardinia pilchardus*	Pilchard	7
Gadus morhua	Cod	43	*Scomber scombrus*	European mackerel	59
Galeorhinus galeus	Tope	2	*Scophthalmus maximus*	Turbot	7
Galeus melastomus	Black-mouth dogfish	3	*Scophthalmus rhombus*	Brill	4
Glyptocephalus cynoglossus	Witch	20	*Scyliorhinus canicula*	Lesser spotted dogfish	20
Gobius spp.	Gobies	6	*Sebastes viviparous*	Redfish	7
Gymnammodytes semisquamatus	Smooth sandeel	1	*Sepiolidae*		8
Helicolenus dactylopterus	Blue mouth redfish	14	*Solea solea*	Dover sole	6
Hippoglossoides platessoides	Long rough dab	55	*Sprattus sprattus*	Sprat	28
Hippoglossus hippoglossus	Halibut	1	*Squalus acanthias*	Spurdog	7
Homarus gammarus	Lobster	2	*Syngnathus acus*	greater pipefish	2
Hyperoplus lanceolatus	Greater sandeel	9	*Syngnathus rostellatus*	Nilsson's Pipefish	2
Illex coindetii	Northern shortfin squid	30	*Trachinus draco*	Greater weever	1
Lepidorhombus whiffiagonius	Megrim	10	*Trachinus vipera*	Lesser weever	13
Leucoraja naevus	Cuckoo ray	9	*Trachurus trachurus*	Horse mackerel	52
Limanda limanda	Dab	63	*Trigla lucerna*	Tub gurnard	9
Lithodes maja	Stone crab	18	*Triglops murrayi*	Moustache sculpin	3
Loligo forbesi	Northern squid	38	*Trisopterus esmarki*	Norway pout	39
Loligo vulgaris	European squid	5	*Trisopterus luscus*	Bib	3
Lophius budegassa	Black-bellied anglerfish	1	*Trisopterus minutus*	Poor cod	21
Lophius picatorius	Anglerfish (monkfish)	27	*Zeus faber*	John dory	4
Lumpenus lampretaeformis	Snake blenny	2			

Table 4: Number of biological samples taken by species

English Name	Number of samples taken
Whiting	1465
Haddock	1323
Plaice	1221
Herring	1207
Mackerel	386
Norway pout	348
Cod	310
Lemon Sole	235
Hake	232
Dab	230
Grey gurnard	218
Saithe	195
Anglerfish (monkfish)	77
Four-bearded rockling	61
Witch	56
Red mullet	47
Common ling	33
Red gurnard	33
Tub gurnard	11
Turbot	11
Brill	7
John Dory	6
Wolf-fish	6
Black-bellied anglerfish	1
Starry ray	123
Spotted ray	122
Thornback ray	56
Spurdog	39
Cuckoo ray	35
Black-mouth dogfish	21
Starry smooth-hound	20
Flapper skate	6
Long-nose skate	2
Tope	2
Total	**8143**

Gadiformes

Cod catches during this year's survey (Table 2) were at a five-year low at 312 kg, although not too dissimilar to that seen in 2018. This was also true of their distribution (Table 3), seen on two less stations than last year (43, compared to 45 in 2018). Whilst total weight was down from 2018 the number of individuals caught across the survey was slightly more (651, compared to 599 in 2018). Interestingly, more juvenile cod (<13 cm) were caught this year, with nearly half (295) being in this size range, compared to only 96 last year. With cod otoliths only collected above 12 cm, this is reflected in a lower number of biological samples this year, with 310 taken, compared to 414 in 2018 (Table 4).

Haddock catch weight was up by 480 kg compared to 2018 and only bettered in the last five years by that seen in 2017 (2845 kg, compared to 2746 kg this year). The increased catch weight from last year is also reflected in haddock's distribution, being caught at 61 stations; nine more than in 2018. This is reflected in 1323 haddock otoliths collected, compared to 1110 last year, although a larger length range was seen in 2018 (7 – 61 cm, compared to 7 – 56 cm in 2019).

Whiting catch weight was down slightly from last year (3652 kg, compared to 3943 kg in 2018), although still higher than 2015-2017. It remained the most widely seen fish species on the survey, caught at 74 of the 77 prime stations fished, two fewer than last year. Biological samples collected were very similar to those taken in 2018 (1465, and the most of any species this year, compared to 1417 last year).

Saithe catch weight in 2019 was the lowest in five years, with 955 kg; nearly half seen in 2018 (1907 kg). It was noticeable that no large catches of saithe were recorded on any single station, as has been seen in previous years. The reduced catch weight can also be attributed to reduced distribution, with saithe seen on 16 stations, compared to 22 stations in 2018. Both reduced catch weight and distribution have resulted in lower biological samples, with 195 otoliths collected, compared to 306 taken last year.

Norway pout catches, however, were slightly up on 2018 with 1198 kg, although still less than half that seen in 2017. Distribution and otoliths collected were also slightly higher than 2018 (two more stations and 30 more otoliths, respectively). Hake caught were the lowest total weight for five years (187 kg) and no longer in the top 15 fish species by catch weight. This follows a declining trend since 2016 with 2019's result close to only 10% of weight caught in 2016 (1084 kg). Hake's distribution on the survey is also lower; seen at 22 prime stations, compared to 30 last year and 87 fewer otoliths were collected (232, compared to 319 in 2018).

Pleuronectiformes

Plaice catches were the lowest for five years, with catch weight down a third from 2018 at 374 kg. This is despite the presence remaining the same for the last three years at 60 stations. It was noticeable that larger plaice were caught on this year's survey, with 103 individuals measuring over 40 cm and a size range of 8 – 54 cm, compared to 80 in 2018 (8 – 48 cm) – this is despite the larger catch weight in 2018. The reduced catch weight is also reflected in the numbers of otoliths taken (despite the larger size range in 2019) with 1221 taken, compared to 1473 last year.

Total lemon sole catch weight this year was 278 kg, which was slightly up compared to the 250 kg caught in 2018. This increase was despite lemon sole being recorded at less stations this year (59), compared to last (63), and fewer biological samples collected (235, compared to 261 in 2018). Dab has seen a similar relationship this year as well, with a higher catch weight (3532 kg, compared to 3364 kg in 2018), but a reduced distribution (63 stations this year, compared to 66 last) and number of otoliths taken (230, compared to 251 last year).

Pelagic fish

The most marked change in catch weight in this year's survey, compared to previous years related to herring and sprat. Herring total catch weight (4545 kg) was less than half that seen in 2018. This is less than 15% of the total weight caught in 2016. The most notable reason for this difference has been the lack of large herring catches at single stations; the four largest catches of herring combined amounted to 2.63 t, in 2018 the single largest catch of herring was 2.71 t. The reduced catch weight is despite a wider distribution (recorded at 64 stations, compared to 62 in 2018) although the numbers of otoliths collected were similar (1207, compared to 1227 last year).

Conversely, sprat catches were nearly four times higher this year than that seen during the 2018 survey, with 5859 kg caught in total. This made sprat the top species by catch weight, displacing herring for the first time in over five years. This can be attributed to a larger number of stations with catch weight over 100 kg (nine, compared to two last year), plus two stations where catches were over one tonne (compared to only a single station in 2018). This is reinforced by a wider distribution compared to last year, with presence recorded at 28 stations (compared to 22 last year), including prime stations 27, 28 and 39, which is further north of areas sprat are usually seen in larger quantities.

Mackerel catches changed very little in 2019 from the previous two years, with 2237 kg total catch weight recorded (compared to 2336 kg in 2018 and 2365 kg in 2017). This is, however, still the lowest total catch weight for mackerel in the last five years. In terms of distribution, mackerel were recorded at two more stations than in 2018 (59) but less otoliths were collected (386, compared to 414 last year). After a lean year in 2018, horse mackerel catches were over twice that in 2019 with 3542 kg, although it is worth noting that nearly a quarter of this weight came from just a single tow at prime station 65 (839 kg). This corresponds with an increase in distribution, with presence recorded at 52 stations this year, compared to 42 in 2018.

Elasmobranchs

621 kg of elasmobranchs were caught this year, which is a decrease of 312 kg to that seen in 2018. This would be in large part explained to the large adult tope caught last year which were not seen again this time round. Lesser spotted dogfish *Scyliorhinus canicula* was the main elasmobranch in terms of catch weight (230 kg), followed by spotted ray *Raja montagui* (121 kg). Of note this year was the capture of two juvenile long-nose skate at prime station 75; a male at 83 cm (2.5 kg) and a female at 75 cm (1.75 kg). A total of 33 elasmobranchs were tagged with Petersen discs and released with starry smooth hound the most tagged species (n = 13).

Cephalopods and commercial shellfish

After a low total abundance in 2018 (10 kg), northern squid *Loligo forbesi* had a much larger total catch of 245 kg this year, although it should be noted that 166 kg of this came from a single station; prime station 51. While numbers of large adults still were noticeably absent (as in 2018), the abundance of juveniles (<15 cm) made up almost the entirety of this station and also at prime station 31, the second highest total catch weight of Northern squid on the survey at 37 kg. Catch weights of the European common squid *Loligo vulgaris* and flying squid *Ommastephes saggittatus* were small (~2 kg) but northern shortfin squid *Illex coindetii* catches were similar to that seen in 2017 at 8.7 kg, after only 5.2 kg was caught in 2018. Curled octopus *Eledone cirrhosa* catch weights were similar to that seen last year although it is worth noting that many more juveniles were caught this year with nearly double the number of individuals recorded (98, compared to 54 in 2018).

Edible crab *Cancer pagurus* catch weight was down from 111 kg last year to 72 kg, although as noted last year, 64 kg were caught at one station fished on behalf of the Danish Institute of Fisheries Research, which wasn't repeated this year. Also, the distribution was reduced to presence at just 25 prime stations compared to 32 in 2018, the same as was seen in 2017. Velvet swimming crab *Necora puber* catches were slightly reduced, down six kilos from 2018 at 17 kg, but European lobster catches increased to 11 kg (from 8.7 kg), again only recorded at two prime stations, as in 2018. Of note this year was two juvenile European spider crabs *Maja squinado*, recorded at prime station 1.

Ichthyological observations

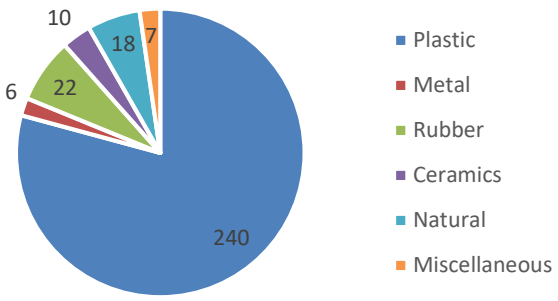
85 fish species were recorded on the survey this year, six more than in 2018. Species of note were the moustache sculpin, snake pipefish *Entelurus aequoreus* and torsk *Brosme brosme*. Length-weight relationships were recorded for 24 species due to their less frequent presence such as the blue mouth redfish *Helicolenus dactylopterus* and halibut *Hippoglossus hippoglossus*, or due to representing extremes of the expected length range (e.g. megrim *Lepidorhombus whiffiagonius* at 55 cm).

Macrobenthos

141 species of macrobenthos were recorded on this year's survey. The common starfish *Asterias rubens* was the most widely distributed, with presence recorded on 68 out of 77 prime stations.

Marine Litter

Figure 11. Marine Litter collected during English IBTS Q3 survey 2019 (n=303)



Litter was recorded at 75 out of the 77 stations completed, with prime stations 4 and 6 the only to have no litter by-catch in the GOV trawl. As can be seen in Figure 11, 303 individual pieces of litter were detailed, reduced from the 379 seen in 2018, with plastics comprising 79% of the total amount.

SECONDARY AIMS:

2. *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. (J Ellis – Cefas, Lowestoft)*

Of the species targeted for tagging, 21 individuals were deemed appropriate to attach Petersen discs and release. As stated above, starry smooth hound was tagged the most (n = 13). Five flapper skate, two spurdog and one tope were also tagged. In addition to the listed species, opportunity presented itself for 12 cuckoo rays *Leucoraja naevus* and six wolf fish to also be tagged.

3. *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. (J Ellis – Cefas, Lowestoft)*

Five species of unusual fish were retained for further analysis, including greater weever fish *Trachinus draco*, Nilsson's pipefish *Syngathus rostellatus* and snake blenny *Lumpenus lampretaeformis*. In addition, 173 fish were sampled for otoliths as part of the development of a reference collection.

4. *To retain any dead specimens of tope (Galeorhinus galeus) and common skate (Dipturus batis species-complex) for biological studies. (J Ellis – Cefas, Lowestoft)*

Additional biological sampling was undertaken for selected elasmobranchs that were dead on capture, with muscle samples and vertebrae collected for long-nosed skate (n = 2) and tope (n = 1), and muscle samples from spurdog and black-mouth dogfish *Galeus melastomus*.

5. *Retain any dead specimens of diadromous fish for the DiadES Interreg project (T Basic, Cefas, Lowestoft)*

Three specimens of twaite shad that were dead on capture at three stations were retained.

6. *Collect fisheries acoustic continuously data at four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333kHz), using the Simrad EK60 split beam sounder. (J Van Der Kooij – Cefas, Lowestoft)*

Acoustics data was recorded continuously throughout the survey for three of the four operating frequencies. Unfortunately, 333kHz was not accessible.

7. *Cetacean observations will be recorded where possible and sent to the Sea Watch Foundation.*

With no dedicated marine mammal observer on board, observations were limited to *ad hoc* sightings by bridge crew and SICs. This resulted in only two sightings; a pair of white beaked dolphins *Lagenorhynchus albirostris* near prime station 49 and a common dolphin *Delphinus delphis* near prime station 46.

8. *Identification, count, measure and weight all jellyfish caught in GOV trawl will allow the continuation of the North Sea August Jellyfish dataset started in 2012 (S Pitois – Cefas, Lowestoft)*

Table 5 details the 1500 individual jellyfish measured on the survey, comprising five species. Lion's Mane *Cyanea capillata* was the most abundant with a total catch weight of 444 kg, and also had the largest size range (3 cm – 70 cm and 2.8 g – 5500 g). This was noticeably greater than seen in 2018 (252 kg). Blues *Cyanea lamarckii*, compass *Chrysaora hysoscella*, crystal *Aequorea spp.* and moon jellyfish *Aurelia aurita* were much less in catch weight than Lion's Mane, but all had comparably similar catch weights, with 19.79 kg, 19.04 kg, 13.12 kg and 11.12 kg, respectively. Of interest were two Barrel jellyfish, caught on prime station 2, which were noticeably smaller in size than seen in previous surveys at 6 cm and 11 cm.

Table 5. Details of jellyfish caught and measured during the survey

Scientific Name	English Name	Total weight caught (g)	No. measured	Minimum length (cm)	Maximum length (cm)	Minimum weight (g)	Maximum weight (g)
Aurelia aurita	Moon jellyfish	11129	111	4	26	3	564
Cyanea lamarckii	Blue jellyfish	19796	275	2.5	30	2	1066
Chrysaora hysoscella	Compass jellyfish	19046	194	3	31.5	1	865
Aequorea spp.	Crystal jellyfish	13125	171	3	14.5	2.5	163
Cyanea capillata	Lion's Mane jellyfish	444581	766	3	70	2.8	5500
Rhizostoma octopus	Barrel jellyfish	121	2	6	11	-	-

9. *Collect squid egg samples to map spawning grounds. This could be highly relevant in studying squid stock's structure. (V Laptikovksy – Cefas, Lowestoft)*

One sample of squid eggs was collected at prime station 59.

10. *Retain any specimens of Loligo vulgaris and all ommastrephid squids (Illex, Todaropsis, Todarodes) for maturity and age analysis, respectively. (V Laptikovksy – Cefas, Lowestoft)*

Thirteen samples of *Loligo vulgaris* were collected for further analysis.

11. *To collect biological information from four-bearded rockling Enchelyopus cimbrius. Including length, weight & maturity information. (L Cox – Cefas, Lowestoft)*

All four-bearded rockling (n = 64) caught during the survey were processed for biological information and otoliths collected whilst on board.

12. *Collect chlorophyll samples to test for nutrients from the surface water collected once a day for the ASMIAC project. (N Greenwood – Cefas, Lowestoft)*

Chlorophyll samples (n = 29) were collected from surface Niskin bottles as part of the rosette CTD deployments.

13. *Zooplankton plankton sampling using ringnets to collect samples from the Gabbard smart buoy site. (S Pitois – Cefas, Lowestoft)*

A zooplankton collection at the West Gabbard was completed *en route* to prime station 1 at the start of the survey.

14. *Collect vitality assessment data to better inform on the discard survivability of starry smooth-hound (M. asterias) under EMFF project C7246 (PI Sophy Phillips/Chris Griffiths).*

Starry smooth-hounds (n = 19) were assessed, with one in good enough condition to collect detailed information from.

15. *Collect suitable examples of benthic organisms from a select number of prime stations to test for Paralytic Shellfish Poisoning toxins.*

Samples of various benthic invertebrates were collected at 10 sites (prime stations 1-4, 7, 13, 22, 43, 71, 77), with extra samples of starfish *Crossaster papposus, Hippasteria phrygiana* and *Leptasterias muelleri* collected at individual sites.

16. *Sample for dissolved oxygen as part of the OSPAR assessment for eutrophification.*

Bottom water samples were taken at 41 prime stations for processing for dissolved oxygen.

17. *Test the new hardware/software for the Marport Trawleye sensor during an additional tow.*

The Marport Trawleye was tested once all fishing had been completed *en route* back to Lowestoft.

In addition, two Phd students used the survey to collect valuable data for their projects;

The Spatial Distribution of North Sea oxygen concentration and production – Francesco Pallottino

Estimating rates of primary production not only provides key information on the productivity for the fishing industries but also to assess the health status of monitored regions while providing insights into eutrophication and oxygenation of bottom waters. Accurate estimates of productivity rates are therefore important for monitoring and protecting shelf sea environments. The use of triple oxygen isotope represents a direct measurement of the total gross oxygen production by primary producers living in the mixed layer. At present date this method, which has received significant attention and use in marine biogeochemistry, has unprecedented application in the North Sea.

A total of 46 stations were sampled by CTD casts across the North Sea. Water was collected at each CTD station at surface, bottom and mid depth at deep chlorophyll maxima (when detected by the CTD's fluorometer). This yielded 144 samples for triple oxygen isotopes and 189 samples for dissolved oxygen titrations.

Autonomous carbon system observations from gliders – Luca Possenti

North Atlantic water, Baltic water and German Bight water that are characterised by different oxygen and carbon signals. The stratified north side leads to a CO_2 drawdown during the summer, the south instead has low CO_2 concentrations in spring when the spring bloom finishes due to the limitation of nutrients. At the end of the summer there is an increase of CO_2 due to remineralisation, this CO_2 rich waters are transported north to the Atlantic Ocean by an anti-clockwise trajectory making the North Sea a continental shelf pump.

This study aims to quantify the inorganic carbon diversification in the North Sea using water samples and high-resolution data measured by a Seaglider. In particular, using 46 CTD casts to

collect 100 water samples using rosette or a Niskin bottle throughout the North Sea. These water samples were collected to measure Total Alkalinity (A_T), Dissolved Inorganic Carbon (DIC) and Nutrients. Moreover, the glider was equipped with a CTD, oxygen optode, a pH electrode and a pH spectrophotometer. The water samples will be used to quantify the diversity of CO_2 concentration in the North Sea, derive a relationship between A_T and salinity and calibrate the two pH sensors. Furthermore, the glider pH and the water samples A_T will be used to calculate DIC and $p(CO_2)$. These two variables are necessary to quantify the net community production (NCP) and air-sea exchange.

Figure 12. Deployment positions for valid and additional GOV tows

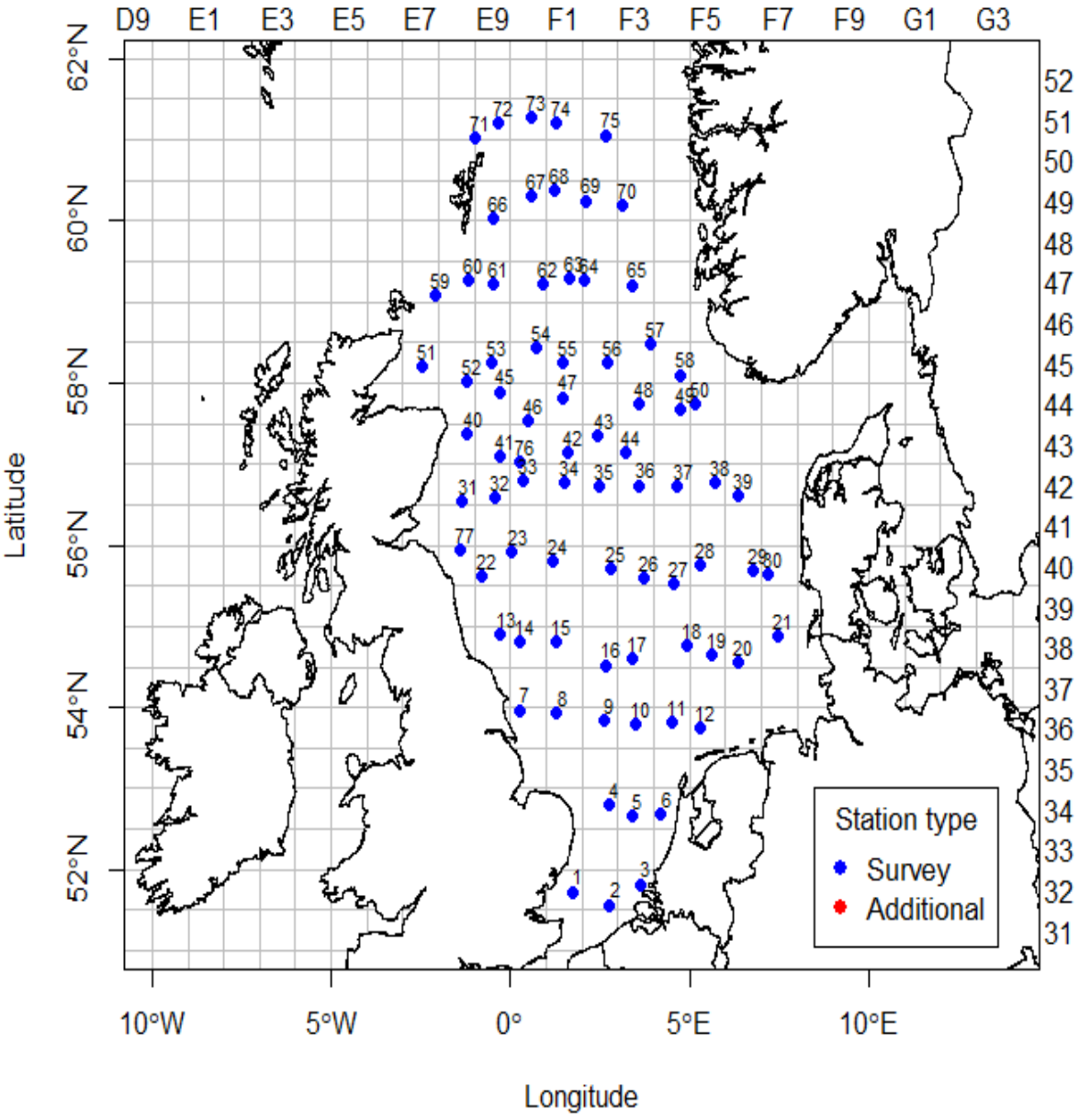
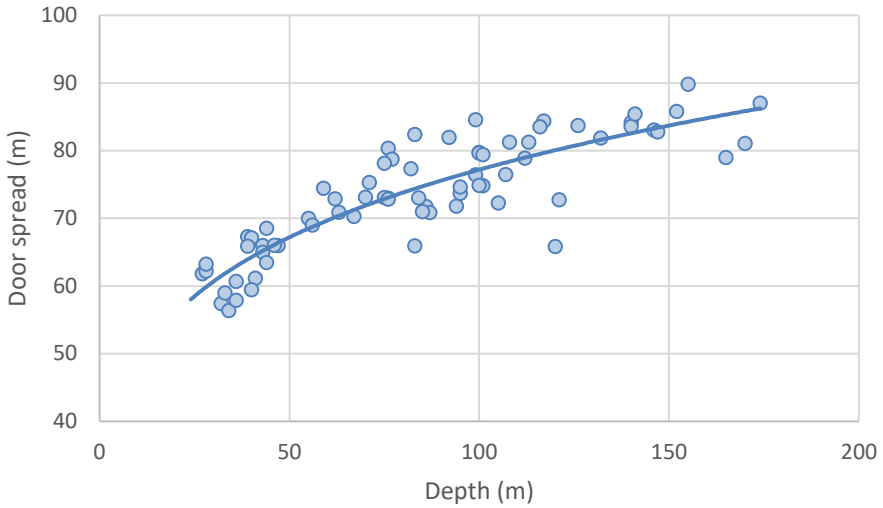
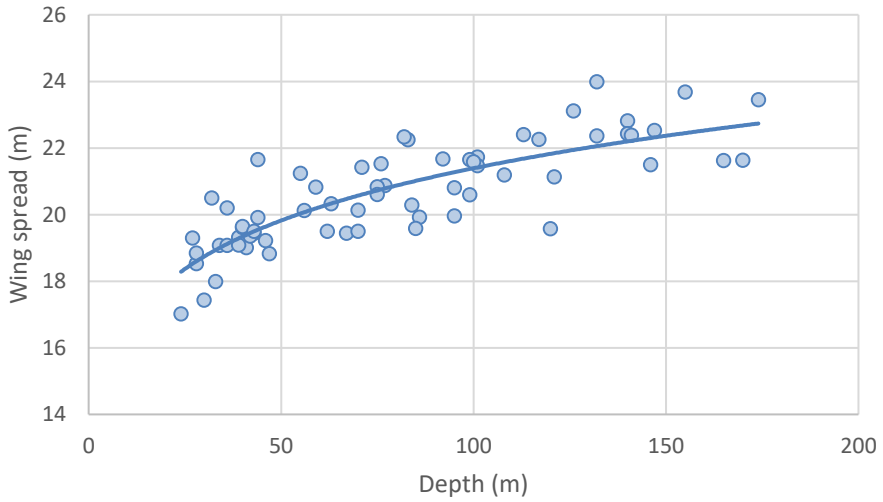


Figure 13. Relationships between door distance, wing end distance and headline height with water depth, as recorded on valid tows.





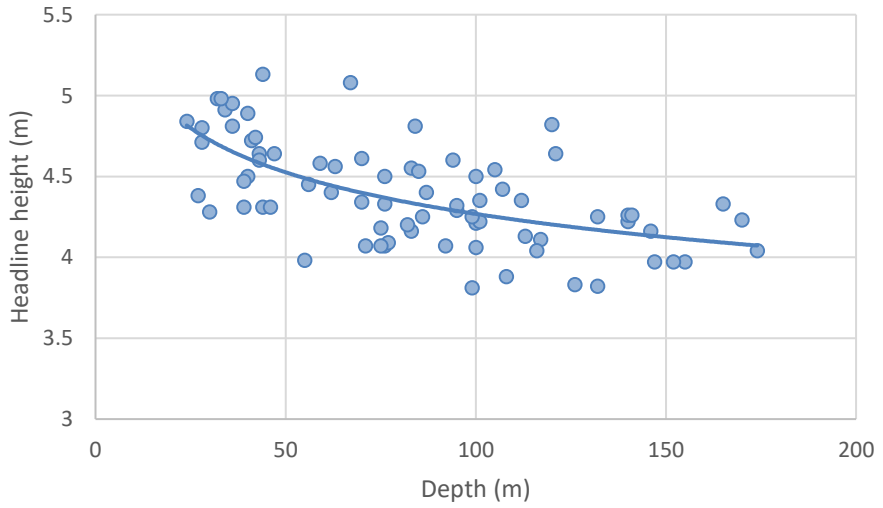


Figure 14. Abundance plots of cod *Gadus morhua* across the survey

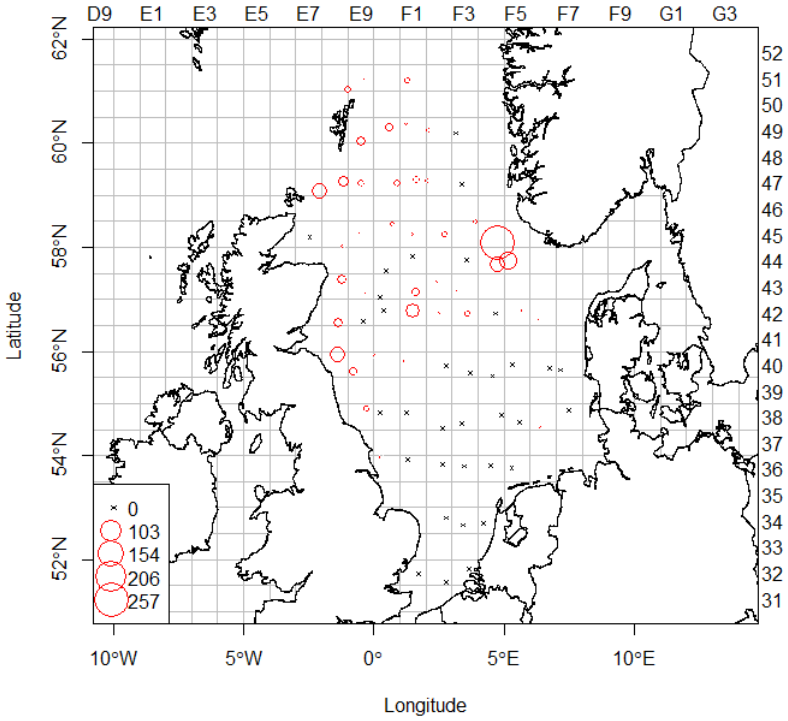


Figure 15. Abundance plots of haddock *Melanogrammus aegelfinus* across the survey

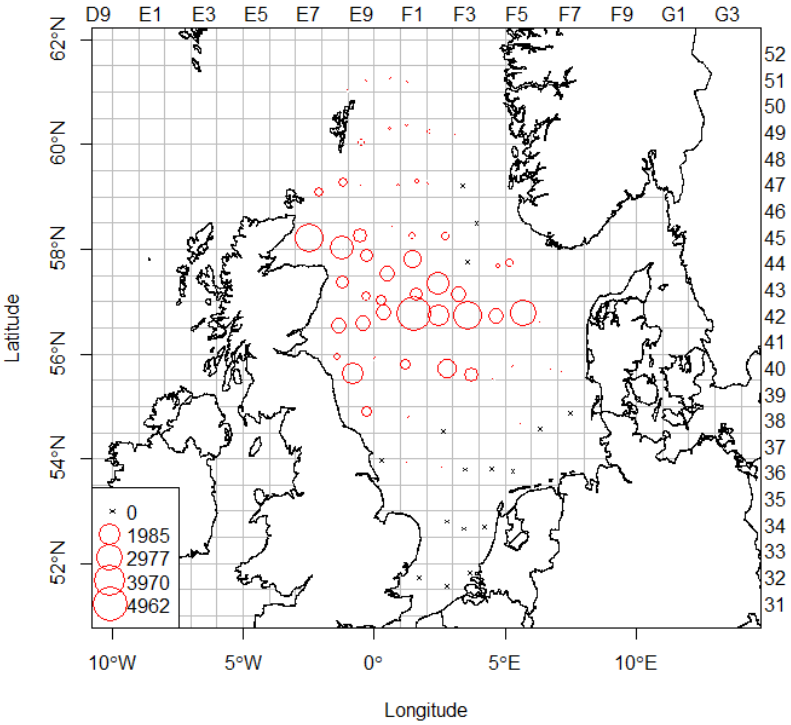


Figure 16. Abundance plots of whiting *Merlangius merlangus* across the survey

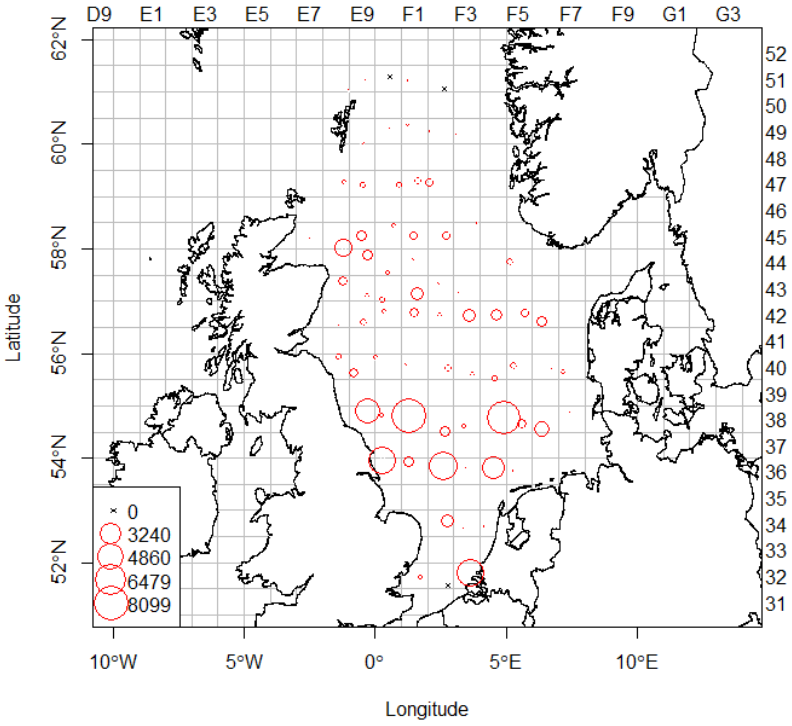


Figure 17. Abundance plots of saithe *Pollachius virens* across the survey

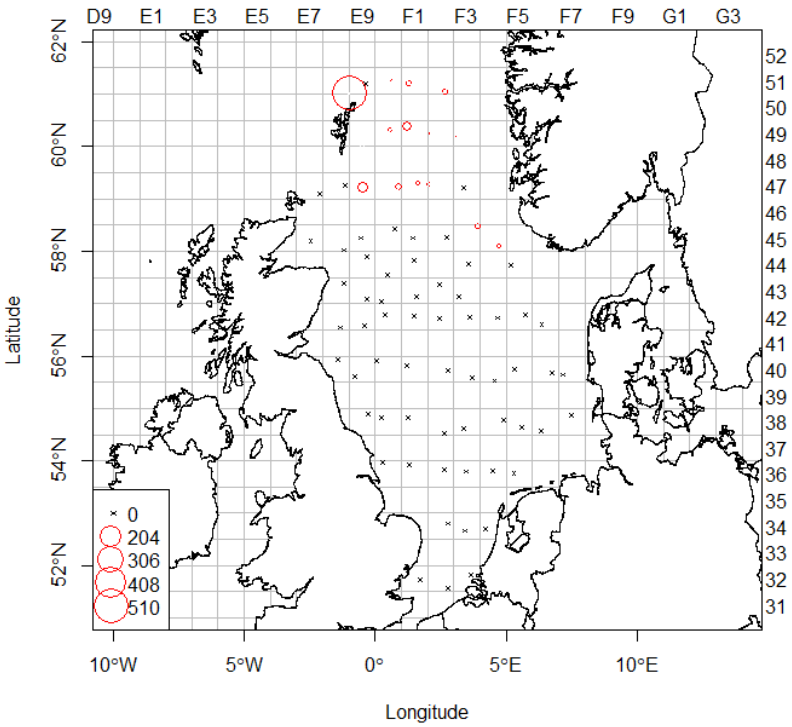


Figure 18. Abundance plots of Norway pout *Trisopterus esmarkii* across the survey

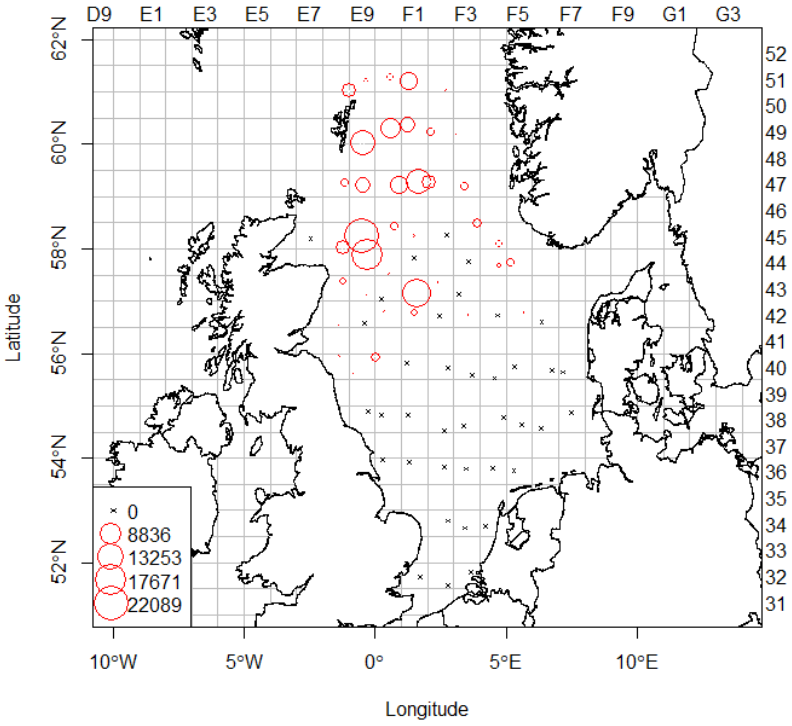


Figure 19. Abundance plots of herring *Clupea harengus* across the survey

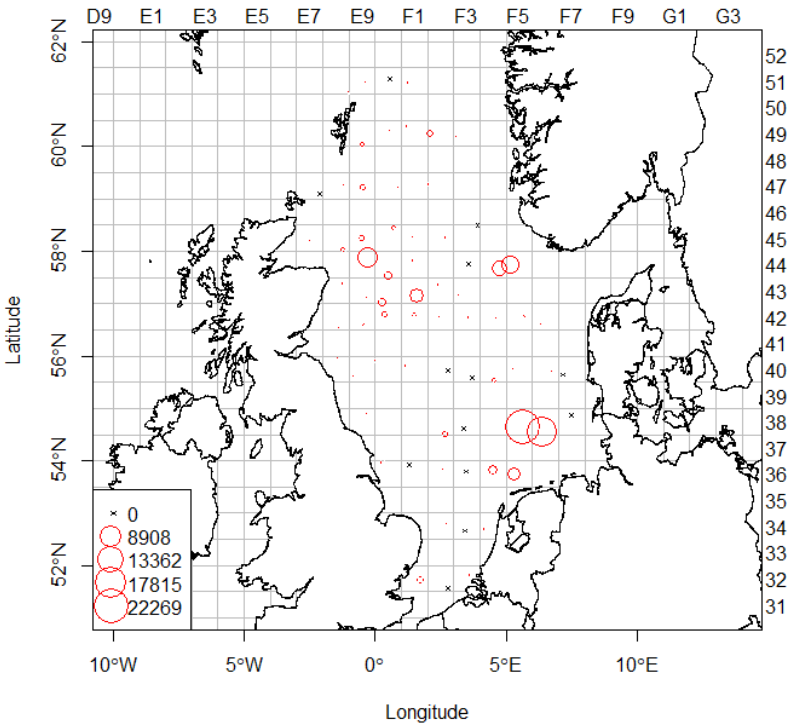


Figure 20. Abundance plots of mackerel *Scomber scombrus* across the survey

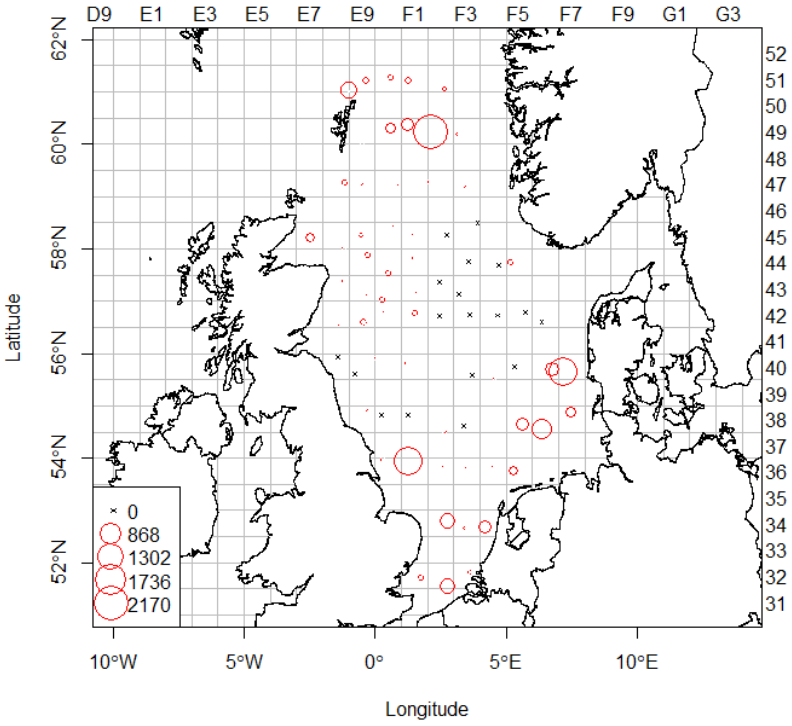


Figure 21. Abundance plots of sprat *Sprattus sprattus* across the survey

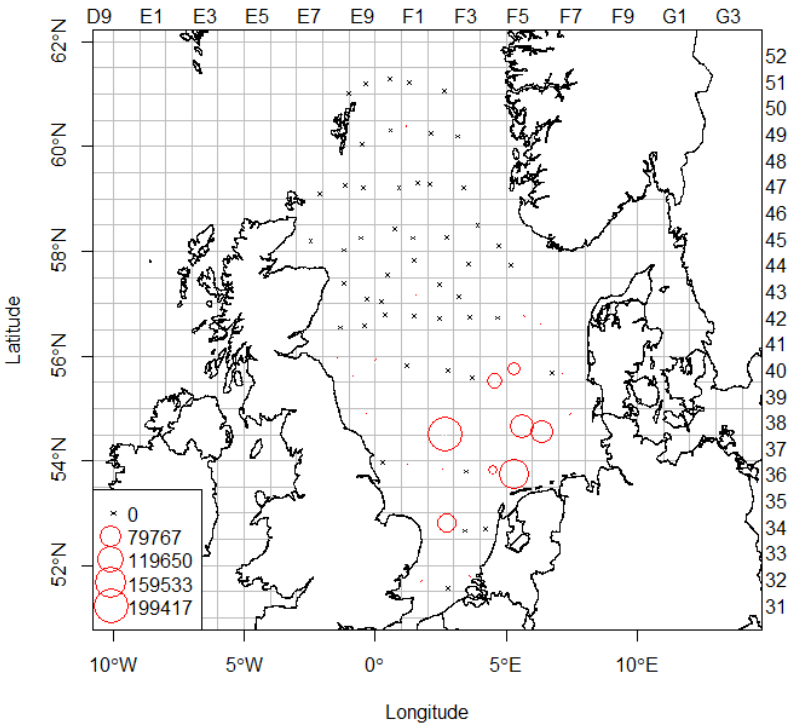


Figure 22. Abundance plots of plaice *Pleuronectes platessa* across the survey

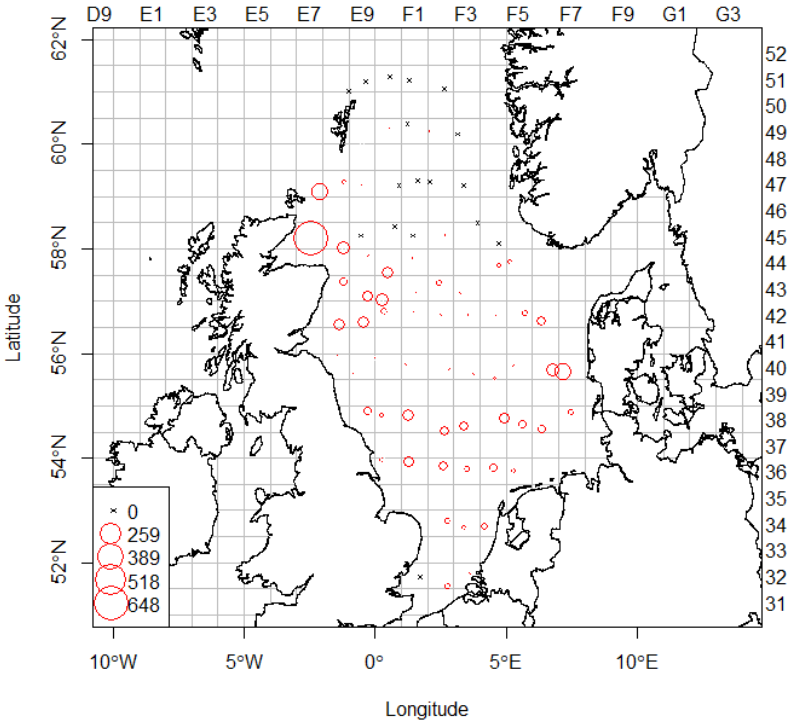
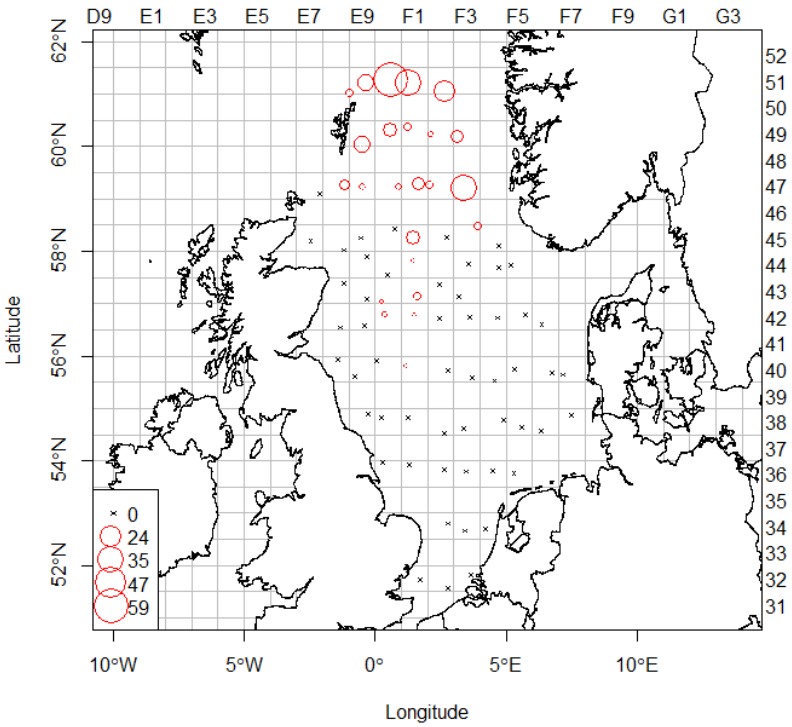


Figure 23. Abundance plots of hake *Merluccius merluccius* across the survey



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Scientist in Charge
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