Centre for Environment Fisheries & Aquaculture Science

Cefas

RESEARCH VESSEL SURVEY REPORT

RV CEFAS ENDEAVOUR
Survey: C END 11 - 2021

STAFF:

Name	Role
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DURATION: 21 July – 17 August 2021 (28 days)

LOCATION: North Sea (ICES Divisions 4.a–c)

PRIMARY AIMS:

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

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.

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, Division 4.a only), and any unusual fish species, which may also be used in otolith research.

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

5. Retain any dead specimens of shad and lamprey for biological studies.

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 the Defra-funded project Poseidon (MF1112) to monitor changes in mackerel distribution and abundance.

7. To record sightings of cetaceans (where possible) and sent data to the Sea Watch Foundation.

8. Identify, count, measure and weigh all jellyfish caught in GOV trawl, to 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.

9. Collect squid egg samples to map spawning grounds. This could be highly relevant in studying squid stock's structure. Retain any specimens of *Loligo* (not *L. forbesii* – keep all if in doubt) and all ommastrephid squids (*Illex, Todaropsis, Todarodes*) for maturity and age analysis, respectively. 25 *Alloteuthis* are to be retained for maturity and age analysis.

10. Collect, retain and filter surface water samples from Ferrybox underway water supply every 12 hours (or once a day) for subsequent chlorophyll sampling in support of SLA25.

11. Zooplankton plankton sampling using ringnets to collect samples from the Gabbard smart buoy site.

12. Visual examination of livers for liver worm conducted on all cod selected for individual fish measurements over 25 cm, work completed for IBTS.

13. Collection of queen scallops *Aequipecten opercularis* for experimental work on ageing, for length-weight analysis, development of length to height parameters and finally as well as Cefas' aims, to provide some specimens to Bangor University for further work which will be made available to ICES WGScallop.

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NARRATIVE
All times stated are GMT.

After completing all UK Government and CEFAS requirements for COVID-19 protocol and testing, RV Cefas Endeavour, henceforth referred to as CEND 11/21, sailed from Lowestoft at 2200hr on Wednesday 21 July. There were seven Cefas scientific staff on board.

A standard day consisted of collecting surface and bottom water at the start and end of the day to provide salinity samples and water samples for additional aims, along with deployment of an ESM2 profiler to measure environmental parameters through the water column (temperature, salinity, fluorescence, light, turbidity and dissolved oxygen). Between these deployments, up to four 30-minute tows with the standard IBTS rigged GOV (Grand Overture Verticale) trawl were planned. Since 2014, the net used during this survey has been a polyethylene net with nylon sleeve and cod-end. Throughout the survey, fisheries acoustic data were collected continuously at three operating frequencies (38 kHz, 120 kHz and 200 kHz), using the Simrad EK60 split beam sounder.

By 0430hr on 22 July, CEND 11/21 had arrived on prime station 1 (Figure 7) ready to begin this year's survey. Following a "toolbox talk" the ESM2 profiler and Niskin water sampler were deployed and retrieved before proceeding with the GOV tow. After a successful trawl at prime station 1, CEND 11/21 travelled east to prime station 2 and finishing the day at prime station 3, off the Dutch coast. Relatively small catches were observed at both prime stations 1 and 2 with a large haul of sprat *Sprattus sprattus*, with 1325 kg observed at prime station 3. Of note, blue whiting *Micromesistius poutassou* (2.4 kg) and a blue-mouth redfish *Helicolenus dactylopterus* (0.048 kg) were observed at prime station 1.

Overnight, the ship headed north to prime station 6 and resumed fishing activity at first light, before continuing west towards the English coast successfully completing GOV trawls at prime stations 5 and 4. The largest catch of the day came at prime station 6 (3906 kg) with epibenthos (Figure 1) making up most of the catch (3133 kg), this is the first time that this quantity of epibenthos has been observed at this station. Prime stations 5 and 4 yielded relatively small catches that were consistent with previous years. Of note, one tope (146 cm, 15.1 kg) was tagged and released at prime station 4.

Figure 1. Epibenthos at prime station 6

CEND 11/21 began the next day 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 stations samples were completed successfully. Relatively small catches were observed at all prime stations throughout the day, although

without the abundance of sprat at prime station 12 as seen in previous years (1619 kg in 2020 and 570 kg in 2019). Of note were increasing numbers of 0-group whiting *Merlangius merlangus* throughout the day's trawls and four spurdog that were tagged and released at prime station 9.

25 July began at prime station 18 and CEND 11/21 worked eastwards over the course of the day, completing prime stations 19, 20 and 21. Relatively small catches were observed at all prime stations, mainly consisting of dab *Limanda limanda* and sprat, consistent with what had been observed in previous years. Prime station 20 yielded the largest catch of the day (571 kg) with the catch dominated by sprat (446 kg).

Overnight, CEND 11/21 moved north to prime station 30 and completed a GOV trawl at first light before continuing west to prime station 29 and then north to prime stations 39 and 38, successfully completing all GOV trawls. The catches at all four stations contained varying amounts of dab, grey gurnard *Eutrigla gurnardus*, sprat and whiting, consistent with previous years catch compositions. The largest haul of the day was at prime station 30 (586 kg, of which 517 kg was dab). Of note, juvenile plaice *Pleuronectes platessa* were sampled at both 30 and 29.

The next day began at prime station 28 before moving east throughout the day, completing valid GOV trawls at prime stations 28, 27, 26 and 25. Catches on prime stations 28, 27 and 26 were similar to previous years catch weights and species compositions. Prime station 25 only varied from previous years due to a small number of herring Clupea harengus being caught in comparison to the larger catch made in 2020 (712 kg). The largest catch of the day was at prime station 28 (492 kg) consisting mainly of dab (115 kg) and sprat (230 kg). Of note, 14 snake blenny *Lumpenus lampretaeformis* were caught at prime station 27, this is the second year in a row the survey has sampled them only at this prime station.

By first light on 28 July, CEND 11/21 was in position to complete the first of two GOV trawls requested by IBSTWG to be completed on behalf of Germany. The first (at rectangle 38F4) returned with the kite having fouled and was considered 'Invalid', it's repeat and the second tow at 38F3 were completed successfully, with the first consisting mainly of whiting (180 kg) and haddock *Melanogrammus aeglefinus* (54 kg) and the second sprat (187 kg) and dab (36 kg). Once these GOV trawls were completed, CEND 11/21 resumed survey completing prime stations 17 and 16, recording similar species compositions to previous years, although the catch weights were slightly lower. Of note, 0-group whiting were recorded in the first two catches and 0-group cod *Gadus morhua*, haddock and whiting were all caught on the first GOV trawl of the day (38F4).

Overnight, CEND 11/21 travelled west to prime station 14 completing a GOV trawl at first light before continuing to prime stations 8 and 7. The catch at prime station 15 was consistent with 2020, with dab (108 kg) the main catch component. Prime station 8 saw a large catch of whiting (627 kg), the largest quantity of whiting caught at this prime station for nearly 20 years, with prime station 7 also producing a large catch of whiting (884 kg) that was more consistent with catches in 2019 (722 kg) and 2018 (1200 kg). Of note, 0-group haddock were sampled at prime station 15.

CEND 11/21 began the day at prime station 14 with a GOV trawl before completing GOV trawls at prime stations 13, 23 and 24. All four catches consisted of mainly whiting and haddock, with catches at prime stations 14 (271 kg), 23 (120 kg) and 24 (176 kg) relatively small and the largest catch coming at prime station 13 (1226 kg, of which whiting and haddock comprised 959 kg and 57 kg, respectively). Of note, four juvenile cod were caught at prime station 13 and cod liver work was carried out as per secondary aim 12 (Figure 2.).

At prime station 23, two 0-group cod, two snake blennies, five blue-mouth redfish and one hagfish *Myxine glutinosa* were also recorded

Figure 2. Cod liver worm work being undertaken at prime station 13.

Overnight, CEND 11/21 travelled to prime station 35 for first light where a GOV trawl was completed, before moving to complete prime stations 44, 36 and 37. All four prime stations were relatively small and consisted mainly of dab, consistent with previous years catches. The largest catch of the day was at prime station 44 (293 kg, of which 151 kg was dab). Of note, three juvenile (<25 cm) cod were caught at prime station 35 and 0-group haddock caught at prime station 36.

On 1 August, CEND 11/21 started the day at prime station 49 and travelling between stations was hampered by a spell of bad weather. Despite the poor weather conditions CEND 11/21 still achieved successful GOV trawls at three prime stations (49, 50 and 58). Catches at prime station 49 consisted mainly of haddock (225 kg) and whiting (23 kg), prime station 50 was abundant in herring (147 kg) while prime station 58 contained mackerel *Scomber scombrus* (48 kg). Of note, cod were caught at all three prime stations (4.195 kg, 46.134 kg and 6.150 kg, respectively). These cod were a mix of 0-group, juveniles, and some mature fish. Cod <25 cm were retained for genetic studies (an aim added to the survey shortly before sailing) and cod >25 cm were sampled for liver parasite work (secondary aim 12). Wolf fish *Anarhichas lupus* were caught at all three prime stations, with one tagged and released at prime station 50. Also of note were 0-group whiting and haddock (prime station 49) and 0-group Norway pout *Trisopterus esmarkii* at all prime stations.

With poor weather overnight and in the early morning, CEND 11/21 began the day slowly with a GOV trawl at prime station 57 before completing prime stations 56 and 48 as well. The catches were primarily of gadoid species, with prime station 57 made up of saithe *Pollachius virens* (53 kg) and blue whiting (162 kg from a 300 kg catch) and both prime stations 56 and 48 were abundant in haddock and some whiting. All three prime stations yielded cod, with ~36 kg caught in total across all catches. All cod <25 cm were retained for genetic studies and liver parasite work was completed for cod >25 cm. Of note, viviparous eelpout *Zoarces viviparus* were caught at prime stations 57 and 56, both retained for further studies.

CEND 11/21 began the day at first light with a GOV trawl at prime station 43. Once completed, CEND 11/21 travelled southwest through the day completing prime stations 42 and 34 before finishing the day. Prime station 43 was the largest catch of the day (406 kg), consisting mainly of haddock (262 kg) and dab (62 kg). Prime stations 42 (30 kg) and 34 (42 kg) produced very small catches due to the smaller numbers of herring compared to the larger catches sampled at these stations in previous years. Of note, 0-group Norway pout were caught at all three prime stations, 0-group haddock, whiting and cod were caught at prime station 34, and snake blennies and a slender pinnate seapen *Pennatula* spp. caught at prime station 34.

Overnight, CEND 11/21 travelled down to prime station 22 for first light, successfully completing a GOV trawl. This was the largest catch of the day, and consisted mainly of whiting (187 kg from a 285 kg catch). Once the station was completed, CEND 11/21 travelled to Seahouses, Northumberland for a pre-arranged sample drop-off. The survey recommenced at prime station 77, just to the north of Seahouses, where there was a small catch (76 kg) of dab (14 kg), sprat (12 kg) and whiting (9 kg). Of note, two juvenile and one 0-group cod were caught at prime station 22 and 0-group Norway pout, haddock and a juvenile cod at prime station 77.

On the 5 August, work started at first light at prime station 31 with a successful GOV trawl which produced the smallest catch of the day (275 kg) that contained whiting (60 kg), haddock (53 kg) and epibenthos (65 kg), consistent with 2020. Once completed, CEND 11/21 moved on to complete GOV trawls at prime stations 32 and 40. These catches comprised mainly haddock (745 kg) and whiting (672 kg), with prime station 32 also producing some of the largest individual herring (58 kg, ranging between 18.0 to 32.5 cm) of the survey so far. Juvenile cod, 0-group Norway pout, cod, haddock and whiting were caught at all prime stations, with six moustache sculpin *Triglops murrayi* (Figure 3) and a blue-mouth redfish caught at prime station 40.

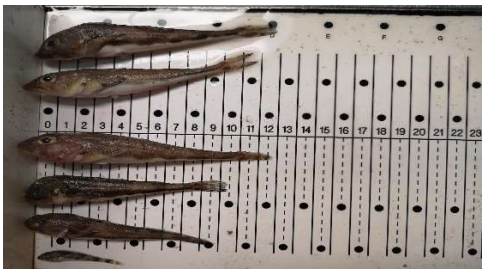


Figure 3. Moustache sculpin *Triglops murrayi* caught at prime station 40.

The following day, CEND 11/21 began at prime station 33 and, despite poor weather conditions, successfully completed a GOV trawl before continuing to complete prime stations 76, 41 and 46. Haddock and whiting were caught on all these prime stations, consistent with the previous year's catch compositions. The largest catch of the day came at prime station 76 (735 kg), with the majority of the catch being epibenthos (321 kg, mainly purple heart urchin *Spatangus purpureus*) and haddock (253 kg).

Overnight, CEND 11/21 moved to prime station 47 for first light, completing a GOV trawl before moving north to complete prime stations 55 and 54. Catches got progressively larger as the day continued (277 kg at prime station 47; 924 kg at prime station 55; 1380 kg at prime station 54) as more herring and Norway pout were caught. Prime station 47 consisted mainly of haddock, whiting and epibenthos, as in previous years but large quantities of herring were also caught at prime stations 55 (449 kg) and 54 (783 kg). Adult Norway pout were also present (122 kg at prime station 55; 504 kg at prime station 54). Of note, juvenile cod were present at all prime stations and seven adult cod were caught at prime station 54 (10.47 kg. 42–72 cm).

On 8 August, CEND 11/21 began the day at prime station 45, before continuing westwards, successfully completing prime stations 53 and 52. All yielded large catches, with 1133 kg at prime station 45, 1849 kg at prime station 53 and 849 kg at prime station 52. The catch weights had decreased compared to 2020 but yielded similar species compositions. Prime stations 45 and 53 consisted mainly of herring (764 kg at prime station 45 and 1571 kg at prime station 53), and prime station 52 consisted of haddock (499 kg) mainly. Of note, cod and blue-mouth redfish were sampled at all stations.

Overnight, CEND 11/21 moved to prime station 51 for first light and completed a GOV trawl before moving north-east over the course of the day to complete prime stations 59, 60 and 61. Haddock was the main species caught at prime stations 51 (185 kg), 59 (299 kg) and 60 (166 kg). Prime station 61 was the largest catch of the day (>1.5 t) and comprised mainly herring (848 kg) and adult Norway pout (513 kg). Of note, cod were caught on all prime stations, the largest amount being caught at prime station 59 (44 kg; n = 63; 24–68 cm. Four flapper skate *Dipturus intermedius* were also caught, tagged, and released (Figure 4) at prime station 59, with a total catch weight of 97 kg.

Figure 4. Tagging flapper skate *Dipturus intermedius* at prime station 59.

CEND 11/21 began the next day at prime station 66, before moving eastwards that day, successfully completing prime stations 67 and 68. All three GOV trawls produced reasonable catches (885 kg, 501 kg and 601 kg, respectively) consisting mainly of herring and adult Norway pout. Adult herring was the main catch component (546 kg, 128 kg and 259 kg at prime stations 66, 67 and 68, respectively). Of note, cod were caught at all prime stations, with the largest amount (45.5 kg) at prime station 66.

On 11 August, CEND 11/21 began at prime station 62 before heading east to complete prime stations 63, 64 and 65. The first three catches were dominated by herring (<1 t, 252 kg and 321 kg at prime stations 62, 63 and 64, respectively), whilst the final catch of the day was dominated by mackerel (107 kg). Species compositions were similar to previous years. The largest catch of the day was at prime station 62 (~1.4 t) and consisted mainly of herring and adult Norway pout. Of note, juvenile and adult cod were caught at all prime stations and two male black-mouth dog fish *Galeus melastomus* were caught at prime station 65 (and retained for further studies).

Overnight, CEND 11/21 transited to prime station 66 (Figure 5) for the second tow required in rectangle 49E9. The catch was smaller (394 kg) in comparison to the first trawl (853 kg) in the same rectangle four days earlier. The catch compositions were very similar with the only weight difference being due to the amounts of herring caught with 546 kg on 10 August (trawl 1) in comparison to 48 kg being caught on 14 August (trawl 2). Of note, cod catches at both trawls were almost identical (45 kg on trawl 1 and 46 kg on trawl 2)

Figure 5. Shetland Islands in the distance on route to prime station 66.

Overnight, CEND 11/21 travelled south, back to prime station 16 to re-sample the station (due to unusually high headline readings on the first attempt on 28 July). The GOV trawl produced a larger catch of dab and mackerel, more consistent with the previous year and the net geometry was in the accepted range. Once the gear was retrieved, and the survey complete, CEND 11/21 began the final journey to Lowestoft and docked at 0300hr on 17 August.

Special thanks are given to the scientists and ship's crew of the RV Cefas Endeavour (CEND 11/21) 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 haul with the GOV trawl was completed at 80 prime stations (Table 1; Figure 7). This is three more valid prime stations than were completed in 2020, including a second tow from ICES rectangle 49E9 and two on behalf of Germany (Rectangles 38F3 and 38F4) and these catches will be reflected in the results presented here. Surface and bottom salinity samples were collected at 47 sites by ESM2+Niskin.

Gear: The survey was fished using a GOV trawl (polyethylene trawl with a nylon sleeve and cod-end). GOV working trawl #1 was used for the entire survey. Net geometric sensors were used to monitor headline height, wing spread and door spread (Figure 8).

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). Figure 9 shows the length distribution of cod, haddock, whiting, saithe, Norway pout, herring, mackerel, sprat, plaice and hake (*Merluccius merluccius*), with the distribution and relative abundance (raised numbers per hour) of these species given in Figures 10–19.

Table 1: Gear deployments on the English IBTS Q3 2021 survey.

Gear	Valid	Additional	Invalid	Total
GOV (IBTS standard gear)	78	1	0	79
Extra valid stations fished on behalf of other IBTS parties	3	0	1	4
ESM2+Niskin	47	0	0	47

Table 2: Top 15 fish species (by total catch weight) in 2021 and corresponding catch weights in preceding years. Note: Species that were ranked in the top 15 species in earlier years, but were outside the top 15 in 2021, are not shown.

Common English Name	Scientific Name	2021 weight (kg)	2020 weight (kg)	2019 weight (kg)	2018 weight (kg)	2017 weight (kg)
Herring	*Clupea harengus*	7821	16338	4545	10380	24940
Haddock	*Melanogrammus aeglefinus*	6161	8252	2746	2267	2803
Whiting	*Merlangius merlangus*	5464	4940	3652	3944	2812
Mackerel	*Scomber scombrus*	4776	3861	2237	2336	2367
Sprat	*Sprattus sprattus*	3431	2730	5859	1983	1868
Dab	*Limanda limanda*	3038	3218	3532	3365	3200
Norway pout	*Trisopterus esmarkii*	2188	3513	1198	1087	2828
Horse mackerel	*Trachurus trachurus*	955	1986	3542	1635	4426
Blue whiting	*Micromesistius poutassou*	714	370	240	296	620
Grey gurnard	*Eutrigla gurnardus*	552	782	768	1359	1106
Cod	*Gadus morhua*	519	340	312	372	683
Plaice	*Pleuronectes platessa*	377	283	374	561	426
Saithe	*Pollachius virens*	319	271	955	1908	2263
Long-rough dab	*Hippoglossoides platessoides*	259	370	315	395	389
Lesser-spotted dogfish	*Scyliorhinus canicula*	216	140	230	288	227

Table 3: Fish, cephalopods and commercial shellfish caught and number of prime stations where they were recorded.

Scientific Name	Common English Name	Stns	Scientific Name	Common English Name	Stns
Aequipecten	queen scallop	8	Merlangius merlangus	whiting	76
Agonus cataphractus	pogge (Armed bullhead)	17	Merluccius merluccius	hake	30
Alloteuthis subulata	european common squid	14	Microchirus variegates	thickback sole	2
Amblyraja radiata	starry ray	30	Micromesistius poutassou	blue whiting	23
Ammodytes tobianus	small Sandeel	3	Microstomus kitt	lemon sole	64
Anarhichas lupus	wolf-fish	4	Molva molva	common ling	11
Arctica islandica	ocean quahog	1	Mullus surmuletus	red mullet	9
Argentinidae	argentines	35	Mustelus asterius	starry smooth-hound	3
Arnoglossus laterna	scaldfish	23	Myoxocephalus scorpius	bullrout	4
Aspitrigula cuclus	red gurnard	2	Myxine glutinosa	hagfish	5
Belone belone	garfish	1	Necora puber	velvet swimming crab	1
Buglossidium luteum	solonette	20	Nephrops norvegicus	norway lobster	13
Callionymus lyra	common dragonette	38	Ocopodidae		16
Callionymus maculatus	spotted dragonette	30	Pecten maximus	scallop	9
Cancer pagurus	edible crab	14	Phrynorhombus norvegicus	Norweigian topknot	2
Capros aper	boarfish	1	Phycis blennoides	greater forkbeard	1
Clupea harengus	herring	57	Platichthys flesus	flounder	2
Dicentarus labrax	European sea bass	2	Pleuronectes platessa	plaice	57
Dipturus intermedia	flapper skate	1	Pollachius pollachius	pollock	2
Enchelyopus cimbrius	four-bearded rockling	11	Pollachius virens	saithe	24
Engraulis encrasicolus	european anchovy	2	Raja clavata	thornback ray	5
Entelurus aequoreus	snake pipefish	2	Raja montagui	spotted ray	7
Eutrigula gurnardus	grey gurnard	74	Rossia macrostoma	Stout bobtail	12
Gadiculus argenteus	silvery pout	15	Sardinia pilchardus	pilchards	4
Gadus morhua	cod	48	Scomber scombrus	European mackerel	54
Galeorhinus	tope	1	Scophthalmus maximus	turbot	7
Galeus melastomus	black-mouth dogfish	2	Scophthalmus rhombus	brill	3
Glyptocephalus cynoglossus	witch	20	Scyliorhinus canicula	lesser spotted dogfish	21
Gobius spp.	gobies	6	Sepiolidae		7
Helicolenus dactylopterus	blue mouth redfish	22	Solea solea	dover sole	5
Hippoglossoides platessoides	american plaice (long rough dab)	56	Sprattus sprattus	sprat	32
Homarus gammarus	lobster	2	Squalus acanthias	spurdog	7
Hyperoplus lanceolatus	greater sandeel	12	Syngnathus acus	greater pipefish	1
Illex coindetii	broadtail shortfin squid	32	Syngnathus rostellatus	nilsson's Pipefish	1
Lepidorhombus whiffiagonius	megrim	10	Todarodes sagittatus	european flying squid	1
Leucoraja naevus	cuckoo ray	9	Todaropsis eblanae	lesser flying squid	10
Limanda limanda	dab	63	Trachinus draco	greater weever	1
Lithodes maja	stone crab	21	Trachinus vipera	lesser weever	11
Loligo forbesi	northern shortfin squid	33	Trachurus trachurus	horse mackerel	26
Loligo vulgaris	european squid	1	Trigla lucerna	tub gurnard	2
Lophius budegassa	white anglerfish (black bellied)	5	Triglops murrayi	moustache sculpin	1
Lophius picatorius	anglerfish (monkfish)	38	Trisopterus esmarki	norway pout	43
Lumpenus lampretaeformis	snake blenny	5	Trisopterus luscus	bib pouting	2
Maja squinado	european spider crab	1	Trisopterus minutus	poor cod	24
Maurolicus mulleri	pearlside	3	Zeus faber	john dory	1
Melanogrammus aegelfinus	haddock	67	Zoarces viviparus	viviparous eelpout	2

Table 4: Number of biological samples taken for ageing by species.

Common English Name	Number of samples taken
Haddock	1940
Whiting	1706
Plaice	1305
Herring	907
Cod	437
Norway pout	429
Mackerel	380
Lemon sole	228
Dab	211
Grey gurnard	211
Saithe	168
Hake	154
Anglerfish (monkfish)	67
Witch	37
Common ling	26
Striped red mullet	21
Sole	19
Turbot	10
Red Gurnard	7
Black-bellied anglerfish	6
Brill	5
Tub gurnard	4
John dory	1
Starry ray	147
Starry smooth-hound	58
Spotted ray	47
Spur dog	44
Cuckoo ray	40
Black-mouth dogfish	40
Thornback ray	17
Flapper skate	4
Tope	1
Total	8677

Gadiformes

Total cod catches during the 2021 survey (519 kg; Table 2) were higher compared to the preceding three years, although not too dissimilar to that of 2017 (683 kg total catch). This was also true of their distribution (Table 3), seen on one more station than last year (48, compared to 47 in 2020). Whilst the total weight caught was up from 2020, the number of individuals caught across the survey was lower (513, compared to 640 in 2020). The numbers of <15 cm cod was down in comparison to 2020 (n = 76 individuals compared to n = 263 individuals), with these juvenile cod only making up 14.8% of the total catch, compared with 79.2% in 2020. The increase in catch weight can be attributed to the two distinct year classes from 2020 still present in the 2021 length distributions, making three visible year classes this year (Figure 9a). With more specimens being caught from year classes two and three this year, this resulted in the greater catch weights despite the reduced numbers caught. Cod <12 cm are not sampled for age (assigned as 0-groups), however, with 2020's 0-group cod now over 12 cm, more biological samples were collected this year, with 437 taken, compared to 339 in 2020 (Table 4).

Haddock catches were down to 6.161 t compared to 2020's five year high of 8.252 t, but this weight was still over double the total caught in 2019 (2.746 t). Despite haddock catch weight being down from 2020, the overall distribution was greater this year, with haddock caught at 67 prime stations (eight more than in 2020). The larger spatial distribution and relatively high catch weights resulted in 1940 haddock otoliths being collected, compared to 1685 in 2020, despite the lower total catch weight. The abundance of 0-group and juvenile haddock last year has continued and was evident in the length distribution observed from the survey, with 3 distinct cohorts (5–15, 16–26 and 26–45 cm; Figure 9b) with ~91.8% of the haddock caught over 15 cm. Haddock <12 cm were caught at only 46 prime stations, compared to 49 stations on last year's survey.

The trend of rising whiting catch weights over the last five years continued with another increase this year (5.463 t, compared to 4.940 t in 2020). It remained the most widely seen fish species on the survey, caught at 76 of the 80 prime stations fished, four more than last year. The increase in catch weight and large distribution at stations was reflected in the increased biological samples collected (1706 in 2021 compared to 1628 in 2020). As in 2020, two distinct length classes were seen in the length distribution plot (4–14 cm (0-group) and 15–30 cm; Figure 9c). Only 6.3% of whiting caught this year were under <14 cm. Whiting <12 cm were caught at 48 of the 80 prime stations this year, compared to 60 in 2020.

The total saithe catch weight was slightly up from a five year low in 2020, with 319 kg total weight compared to 271 kg recorded in 2020. However, this is still lower than the catch weights recorded in 2017–2019. Although the distribution had increased from 2020 (24 prime stations, compared to 16 last year), no large catches of saithe were recorded at any single station, as had been seen in those recent years with higher catch weights. The increased distribution and catch weight this year resulted in an increase in biological samples with 168 otoliths collected, compared to 132 the previous year.

Norway pout catches (2.187 t) were lower than to the peak of 3.513 t caught in 2020. Despite lower catch weights, the distribution was up from previous years, with Norway pout caught at 43 prime stations compared to 38 last year. Norway pout have a limited length range and so otolith numbers are normally consistent year on year, but with an increased distribution this year more otoliths were taken (429 compared to 333 in 2020). As with whiting, Norway pout had two distinct cohorts (4–10 cm and 11–19 cm; Figure 9e) as in previous years.

Hake caught this year has continued a trend from previous years, producing the lowest total weight in six years (138 kg compared to 162 kg in 2020) and, for the second year in a row, was no longer in the top 15 fish species by total catch weight (ranked 18, the same rank as in 2020). This follows a declining trend since 2016 (when 1.084 t were caught). The distribution of hake however, had slightly increased, being seen at 30 prime stations, compared to 26 last year. The numbers of individuals caught (n = 171) and biologically sampled (n = 154) in 2021 were both slightly higher than in 2020, (n = 153 and 132, respectively).

Pleuronectiformes

Plaice catches were slightly up on a previous five-year low, with catch weights up to 377 kg compared to 283 kg last year. This was despite the distribution being slightly down from last year at 57 stations (59 stations in 2020, 60 stations in 2019 and 2018). Maturity stages for plaice remained mixed, as also observed in 2020 and 2019, with stages at this time of year normally spent, however maturing, hyaline and running individuals were all recorded. The number of individuals measured increased from the previous year (n = 2533 compared to n = 1886 in 2020) providing a larger length range this year (6–53 cm compared to 12–50 cm in 2020). With larger catch weights and a larger length range, the numbers of otoliths taken increased to 1305 (cf. 1229 in 2020).

Total lemon sole catch weight this year followed a trend from the previous five years with a low of 199 kg, compared to the 250 kg caught in 2020. This decrease was despite lemon sole being recorded at 64 stations this year, compared to 62 stations last year. A decrease in numbers measured at length was also recorded this year n= 1740 (cf. n = 2011 in 2020). Consequently, fewer otoliths were collected (n = 228) compared 2020 (n = 235).

Dab catch weights were down for a third year (3037 kg compared to 3218 kg in 2020), with a somewhat decreased distribution (63 stations this year, compared to 65 last) and fewer numbers measured (n = 7388 compared to n = 7125). This resulted in the number of otoliths taken being marginally down as well (211, compared to 229 last year).

Pelagic fish

The most marked change in catch weight in this year's survey compared to previous years was with herring. The total catch weight of herring was 7.821 t, over 8.5 t less than seen in 2020, however, herring was still the highest species by catch weight on the survey. One reason for the decrease in catch weight could be that herring were recorded further north (Figure 15) and were not yet on the spawning grounds (where there is a larger concentration of the survey's prime stations), this could also be due to the survey starting earlier than in previous years. The herring being further north would also explain the drop in distribution to a five-year low (57 prime stations compared to 69 in 2020). The reduced distribution, catch weights and numbers measured this year (n = 4845 compared to n = 6841 in 2020) resulted in a reduced number of biological samples being collected (907 compared to 1209 last year). It is worth noting that the large herring catches were all recorded further north, the same as in 2020, with 77% of all the herring caught on just seven prime stations (Prime stations 45, 55, 54, 53, 66, 61 and 62).

Sprat catches were up compared to catches observed during the 2020 survey (2.730 t), with 3.431 t caught in total and with a slightly higher occurrence (32 prime stations compared to 30 last year). A higher number of stations with catch weights over 100 kg was also observed this year with eight, compared to four last year. These eight prime stations made up 94% of the total catch of the survey, with 38.6% (1.327 t) being caught at prime station 3 in the southern North Sea.

Mackerel catch weights were at a five-year high, with a total catch weight of 4.776 t recorded (cf. 3.86 t in 2020). This increase in catch weight was despite a decreased occurrence, with mackerel recorded at 54 stations (65 station in 2020). With 66% of all the mackerel caught at just two stations (prime stations 72 and

73) and the decreased distribution, the numbers measured at length were also reduced (n = 2298 compared to 4166 in 2020) which in turn resulted in fewer otoliths being collected (380, cf. 426 in 2020).

Total catches of horse mackerel *Trachurus trachurus* in 2021 (955 kg) were the lowest observed in the last five years, and more than one tonne less than the previous year (1.986 t). It is also worth noting that 81% of the total catch weight came from just a single tow (775 kg at prime station 72), otherwise the species would have hardly featured this year. Occurrence was at a five-year low and a drastic drop to 26 stations this year, compared to the 50 stations in 2020.

Elasmobranchs

562 kg of elasmobranchs were caught this year, which is an increase from 306 kg seen in 2019. Lesser-spotted dogfish *Scyliorhinus canicula* was the main elasmobranch (total catch weight = 216 kg, up 77 kg on 2020), followed by four flapper skate (97 kg; none caught in 2020) and starry smooth-hound *(*75 kg compared to 27 kg in 2020). A total of nine individuals were tagged with Petersen discs and released (four spurdog, four flapper skate and one tope)

Cephalopods and commercial shellfish

The highest catch weight this year was northern shortfin squid *Loligo forbesii*, with very similar amounts seen compared to last year (25 kg compared to 27 kg in 2020). Of note, more large adults were recorded with 25% of individuals recorded over 13 cm compared to 5% last year. One large flying squid *Todarodes sagittatus* was caught at prime station 75 (1.58 kg, 37 cm mantle length). Northern shortfin squid *Illex coindetii* catch weights were up slightly up at 14.7 kg compared to 10.6 kg in 2020. European common squid *Alloteuthis subulata* weights were down significantly from last year (5.96 kg compared to 21.83 kg in 2020). Curled octopus *Eledone cirrhosa* numbers have declined compared to last year, with only 16 individuals recorded compared to 19 in 2020.

Edible crab *Cancer pagurus* catch weight wa down from 30 kg last year to 25 kg this year and velvet swimming crab *Necora puber* catches were very small compared to that seen in 2020 (0.141 kg compared to 1.512 kg last year). Seven European lobster *Homarus gammarus* were caught on the survey this year (7.16 kg compared to 1.28 kg in 2020) and all were berried females. Stone crab *Lithodes maja* catch weights were higher than in previous years (28 kg compared to 10 kg last year). Of note this year, a European spider crab *Maja squinado* was recorded at prime station 65.

Ichthyological observations

75 fish species were recorded on the survey this year, six less than in 2019. Species of note were the moustache sculpin, blue-mouth redfish and a large wolf-fish (up to 95 cm).

Macrobenthos

131 taxa of macrobenthos were recorded on this year's survey. The sand star *Astropecten irregularis* was the most widely distributed, with presence recorded at 60 of the 80 prime stations.

Marine litter

Litter was recorded at 76 out of the 80 stations completed, with four prime stations having no litter by-catch in the GOV trawl. As can be seen in Figure 20, 255 individual pieces of litter were detailed, an increase from the 231 seen in 2020, with plastics comprising 87% of the total items recorded.

Surface and bottom temperature and salinity

Environmental data, including surface water samples, vertical profiles from the ESM2 profiler/mini-CTD logger and bottom water samples from Niskin bottle, were collected at 47 planned stations.

***F**) Length weight & maturity information using individual fish measurements, in support of the EU Data Regulation.*

As Table 5 shows, 38 fish from nine species were measured for additional length/weight & maturity data.

Table 5 : Number of length weights recorded.

Scientific Name	Common English Name	Number measured
Myxine glutinosa	hagfish	6
Galeus melastomus	blackmouthed dogfish	3
Pollachius virens	saithe	3
Phycis blennoides	greater forkbeard	2
Belone belone	garfish	2
Helicolenus dactylopterus	blue-mouth redfish	2
Zoarces viviparus	eelpout (viviparus blenny)	1
Lumpenus lampretaeformis	snake blenny	4
Anarhichas lupus	wolf fish (catfish)	14
Total		37

SECONDARY AIMS:

2. Tag and release specimens… 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, 10 individuals were deemed appropriate to attach Petersen discs, tagged and release (Table 6).

Table 6: Species tagged and released.

Scientific Name	Common English Name	Cefas code	Length (cm)	Wing width (cm)	Weight (g)	Sex	Maturity
Galeorhinus galeus	tope shark	GAG	1460		15120	M	C
Squalus acanthias	spurdog (spiny dogfish)	DGS	1120		7260	F	U
Squalus acanthias	spurdog (spiny dogfish)	DGS	880		2520	M	C
Squalus acanthias	spurdog (spiny dogfish)	DGS	850		3140	F	U
Squalus acanthias	spurdog (spiny dogfish)	DGS	810		2400	M	C
Anarhichas lupus	wolffish (catfish)	CAA	950		9920	U	U
Dipturus intermedius (Intermedia)	flapper skate	SKF	1440	1050	20520	F	U
Dipturus intermedius (Intermedia)	flapper skate	SKF	1920	1500	44160	M	C
Dipturus intermedius (Intermedia)	flapper skate	SKF	1450	1180	22060	M	B
Dipturus intermedius (Intermedia)	flapper skate	SKF	1200	900	11100	F	U

3. To freeze any unusual fish species for subsequent identification / verification in the laboratory, …, which may also be used in otolith research. (J Ellis – Cefas, Lowestoft)

Thirty-one species of unusual fish/epibenthos were retained for further analysis, including greater weever fish *Trachinus draco* and hagfish.

4. To retain any dead specimens of tope and common skate for biological studies. (J Ellis – Cefas, Lowestoft)

Only live specimens were caught on this year's survey, all being tagged and released as per secondary aim number 2.

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

No specimens were caught during the survey.

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 were recorded continuously throughout the survey for 38 kHz, 120 kHz and 200 kHz frequencies.

7. *Cetacean observations will be recorded where possible and sent to MARINElife and the SeaWatch Foundation.*

With no dedicated marine mammal observer on board, observations were limited to *ad hoc* sightings by bridge crew and SICs.

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)*

In total, 1833 individual jellyfish (from a total of five species) were measured on the survey (Table 5). Total catch weight (278 kg) was noticeably lower than recorded in 2020 (377 kg). Lion's mane *Cyanea capillata* was the dominant species, with a total catch weight of 150.13 kg, and had the largest size and weight range (2.5–43.0 cm; 1–2586 g). Blue jellyfish *Cyanea lamarckii* and moon jellyfish *Aurelia aurita* saw increased catch weights this year, compared to 2020, however crystal jellyfish *Aequorea* spp., compass jellyfish *Chrysaora hysoscella* and lion's mane jellyfish all had lower catch weights than in previous years (Table 7).

Table 7. Details of jellyfish caught and measured during the survey.

Scientific Name	Common English Name	Total weight caught (g)	No. measured	Minimum length (cm)	Maximum length (cm)	Minimum weight (g)	Maximum weight (g)
Aurelia aurita	moon jellyfish	47345	277	2.5	22.5	3	486
Cyanea lamarckii	blue jellyfish	72144	634	1.5	20.5	1	291
Chrysaora hysoscella	compass jellyfish	5226	200	3.5	28.5	2	458
Aequorea spp.	crystal jellyfish	3650	139	2	14	1	131
Cyanea capillata	lion's mane jellyfish	150130	1538	2.5	43	1	2586
	Total	278495	2788				

Table 6. Jellyfish species (by total catch weight) in 2021 and corresponding catch weights in preceding years.

Scientific Name	Common English Name	2021 weight g	2020 weight g	2019 weigh g	2018 weight g
Aurelia aurita	moon jellyfish	47345	27234	11129	81830
Cyanea lamarckii	blue jellyfish	72144	27234	19796	89150
Chrysaora hysoscella	compass jellyfish	5226	24698	19046	2321
Aequorea spp.	crystal jellyfish	3650	15717	13125	1376
Cyanea capillata	lion's mane jellyfish	150130	285090	444581	355642
	Total	278495	379973	507677	530319

9) *Collect squid egg samples to map spawning grounds. This could be highly relevant in studying squid stock's structure. Retain any specimens of Loligo vulgaris and all ommastrephid squids (Illex, Todaropsis, Todarodes) for maturity and age analysis, respectively. (V Laptikovksy – Cefas, Lowestoft)*

No squid eggs were caught during the 2021 survey. Eleven samples of northern shortfin squid *Loligo forbesii* and twenty-five broadtail shortfin squid *Illex coindettii* were retained for further analysis.

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

Twenty-four chlorophyll samples were collected from surface water at the first prime station each day throughout the survey with additional samples from sites of interest.

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

A ringnet deployment at the West Gabbard site was not completed due to time constraints.

Richard Humphreys
Scientist in Charge
04/10/21

DISTRIBUTION:

Participants of survey
Marine Operations
D Pettengell (PM)
I Holmes (PI)
P Falconer (PL)
Cefas Fisheries surveys SICs/2ICs
Cefas CDP (Gary Burt)
AWSM - Pinbush
Fishing Skipper/Master Cefas Endeavour
FCO (Overseas EEZ's)

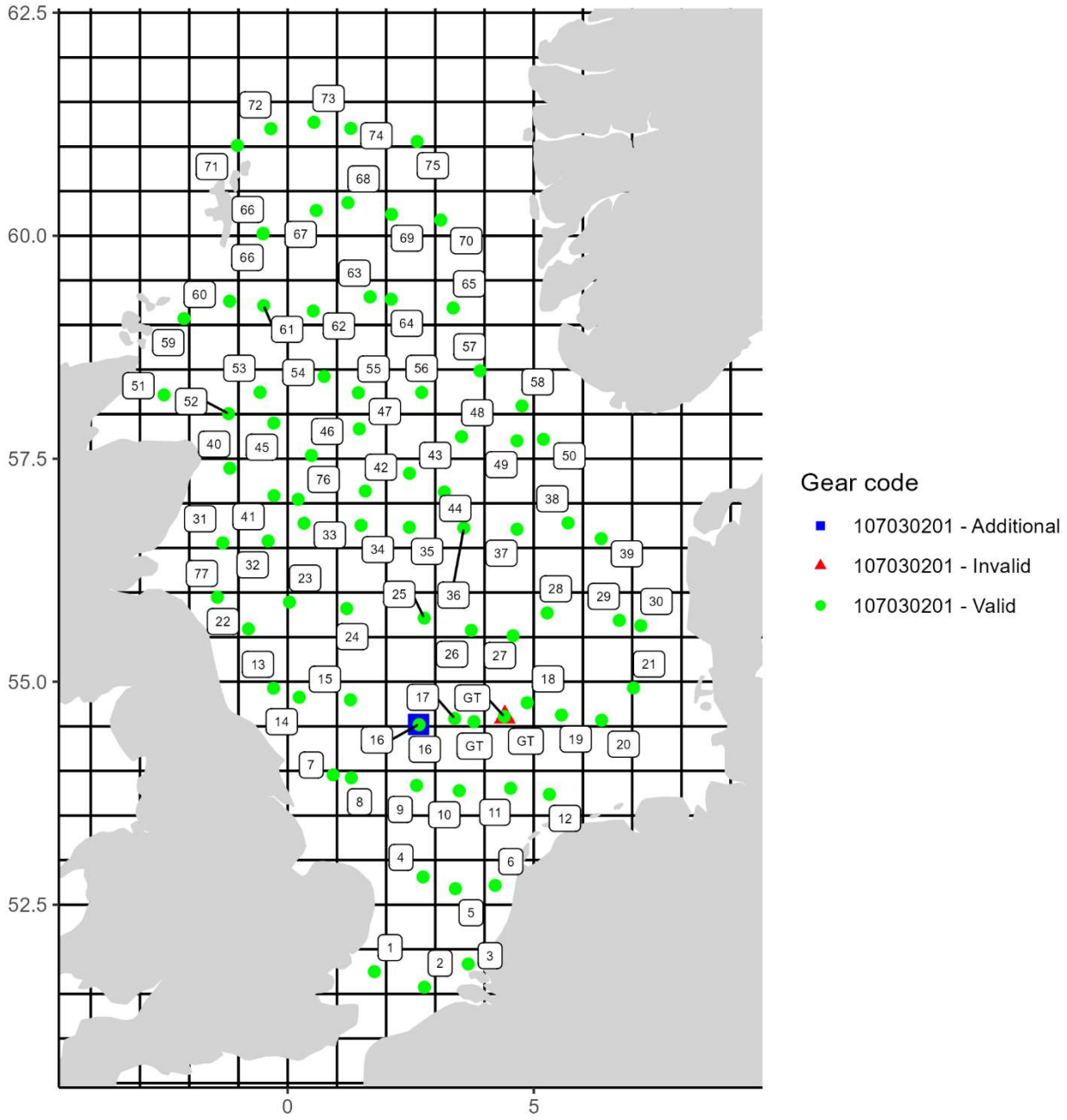
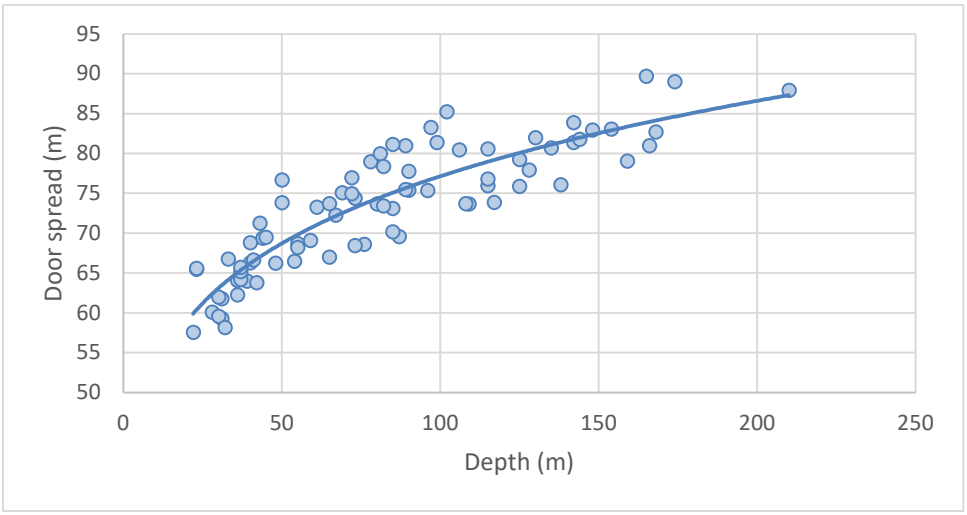
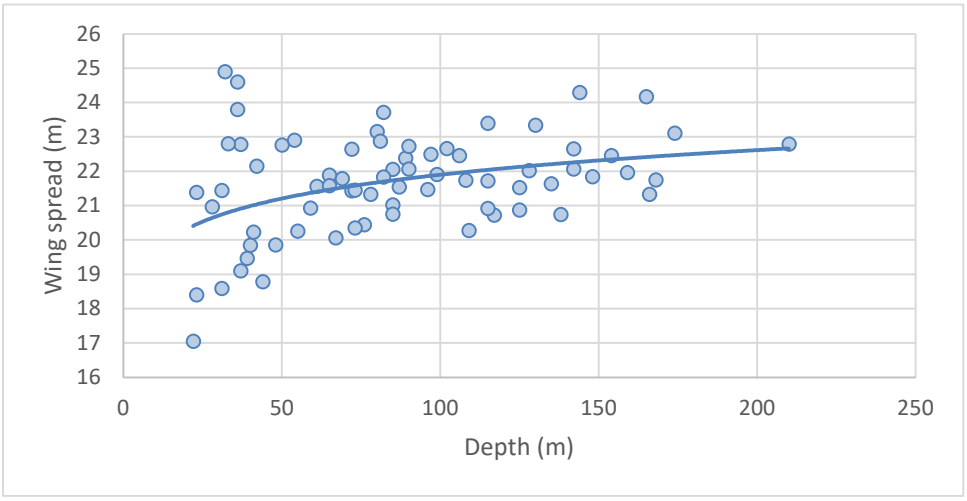


Figure 7. Deployment positions for valid and additional GOV trawl stations giving prime station numbers.





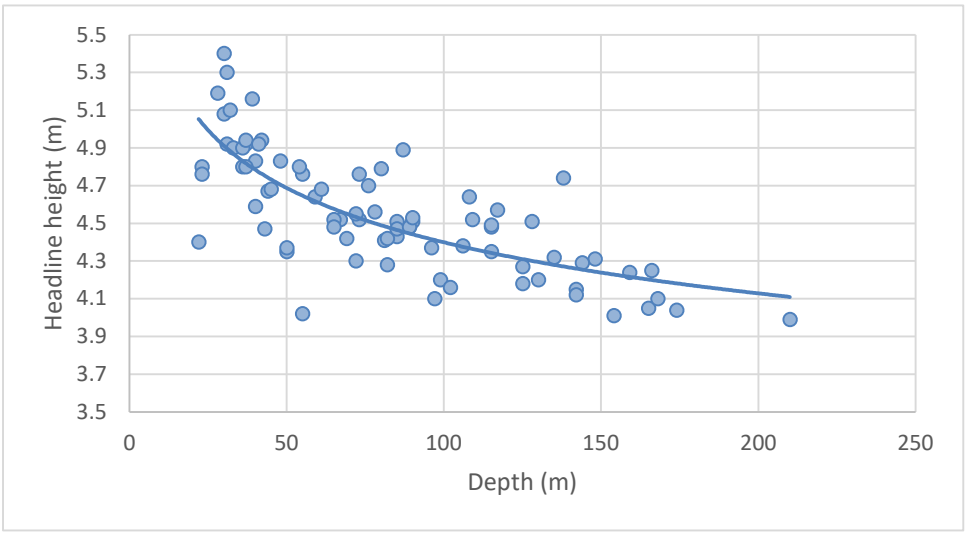


Figure 8. Relationships between door spread, wing spread and headline height with water depth (valid tows only).

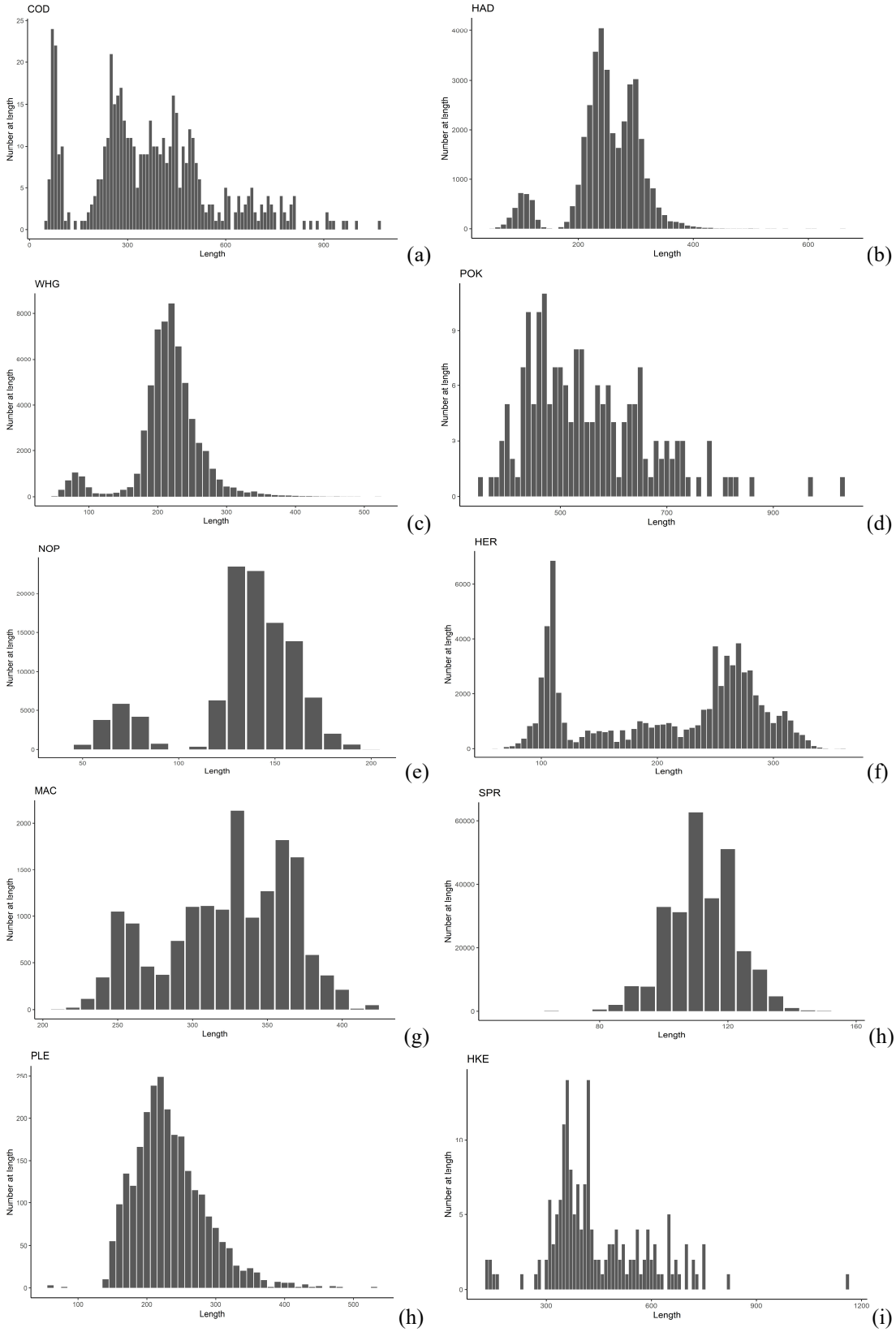


Figure 9. Length distribution plots for (a) cod, (b) haddock, (c) whiting, (d) saithe, (e) Norway pout, (f) herring, (g) mackerel, (h) sprat, (i) plaice and (j) hake.

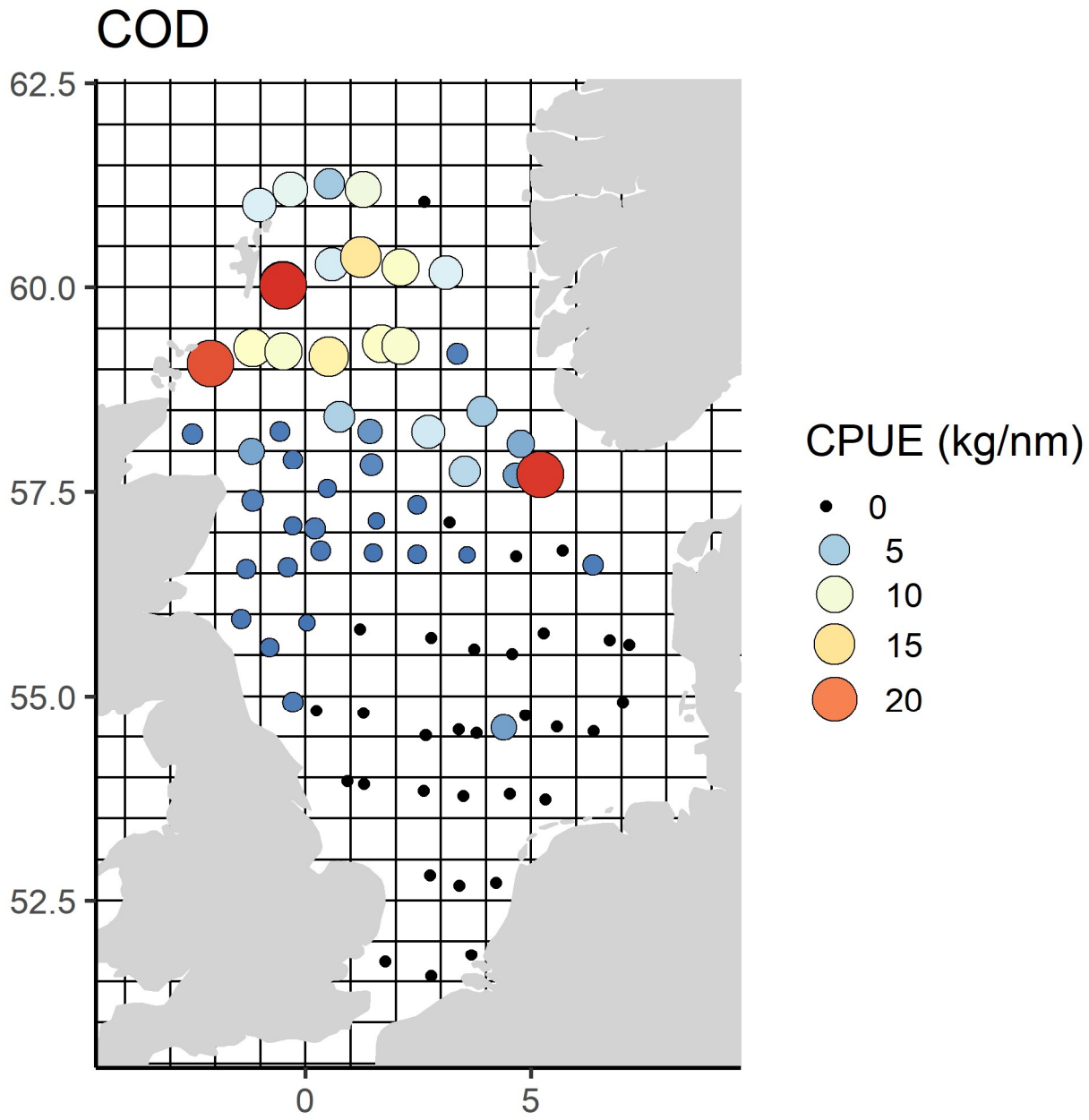


Figure 10. Distribution and relative abundance of cod (*Gadus morhua*) across the survey.

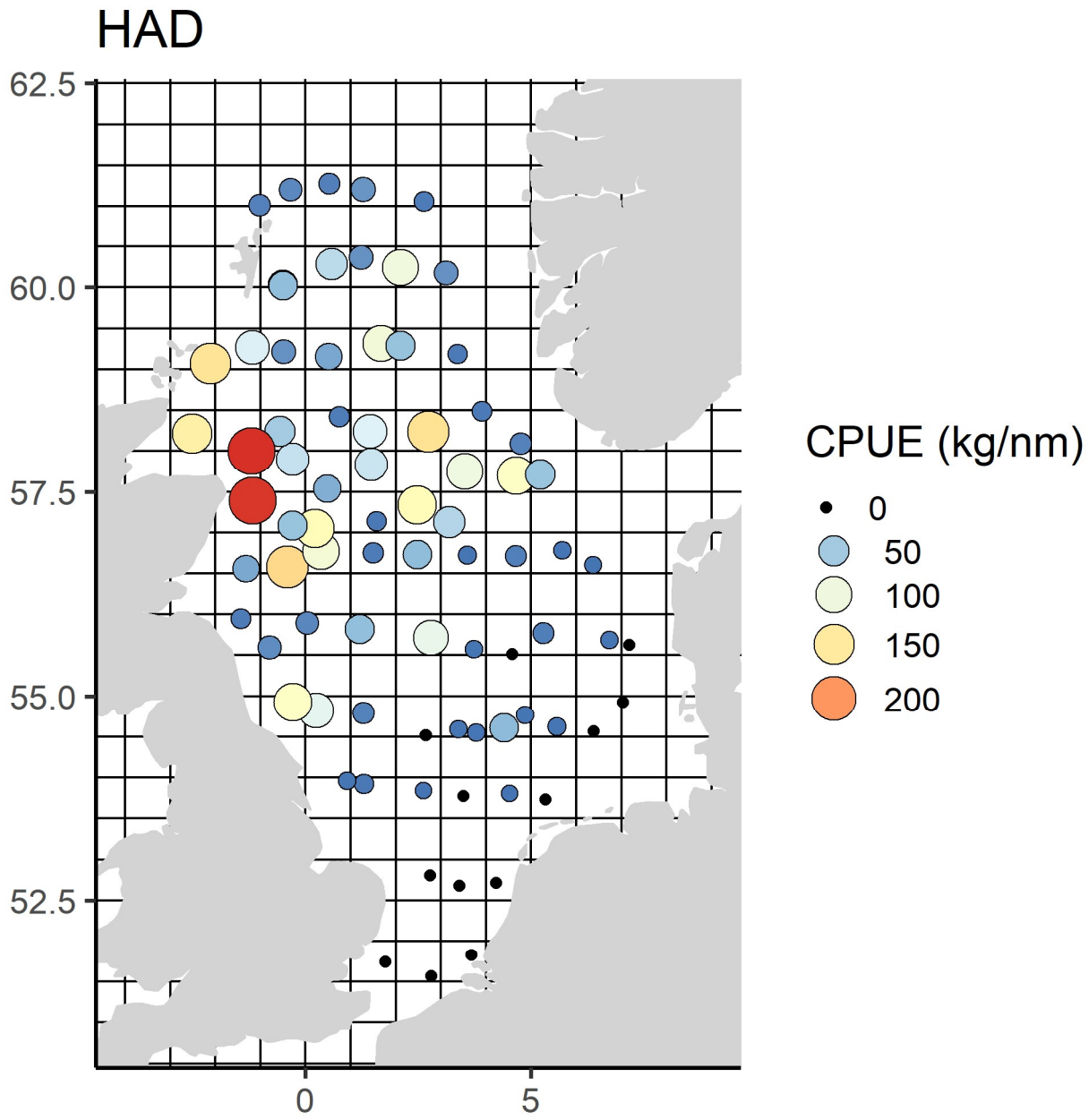


Figure 11. Distribution and relative abundance of haddock (*Melanogrammus aeglefinus*) across the survey.

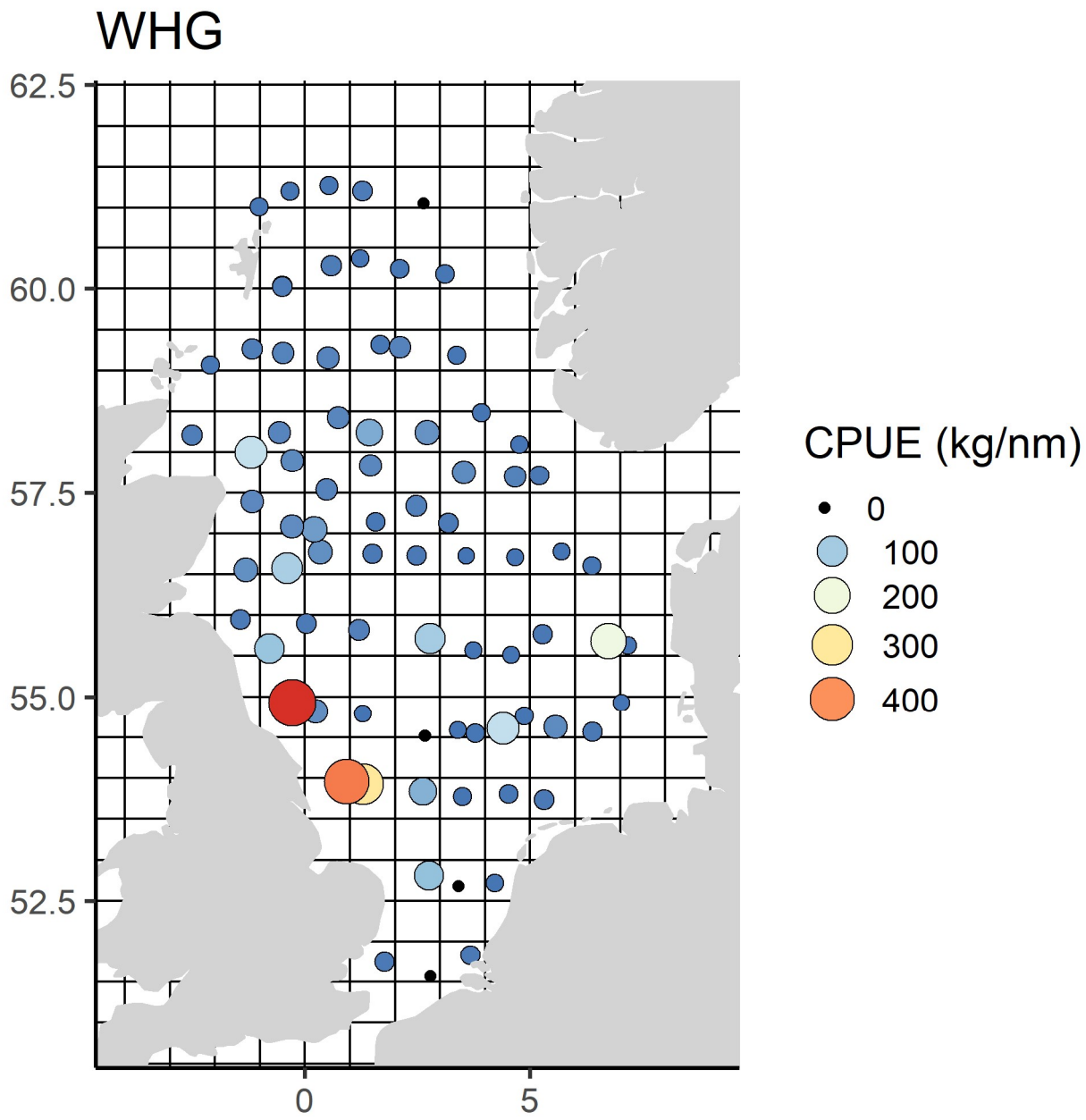


Figure 12. Distribution and relative abundance of whiting (*Merlangius merlangus*) across the survey.

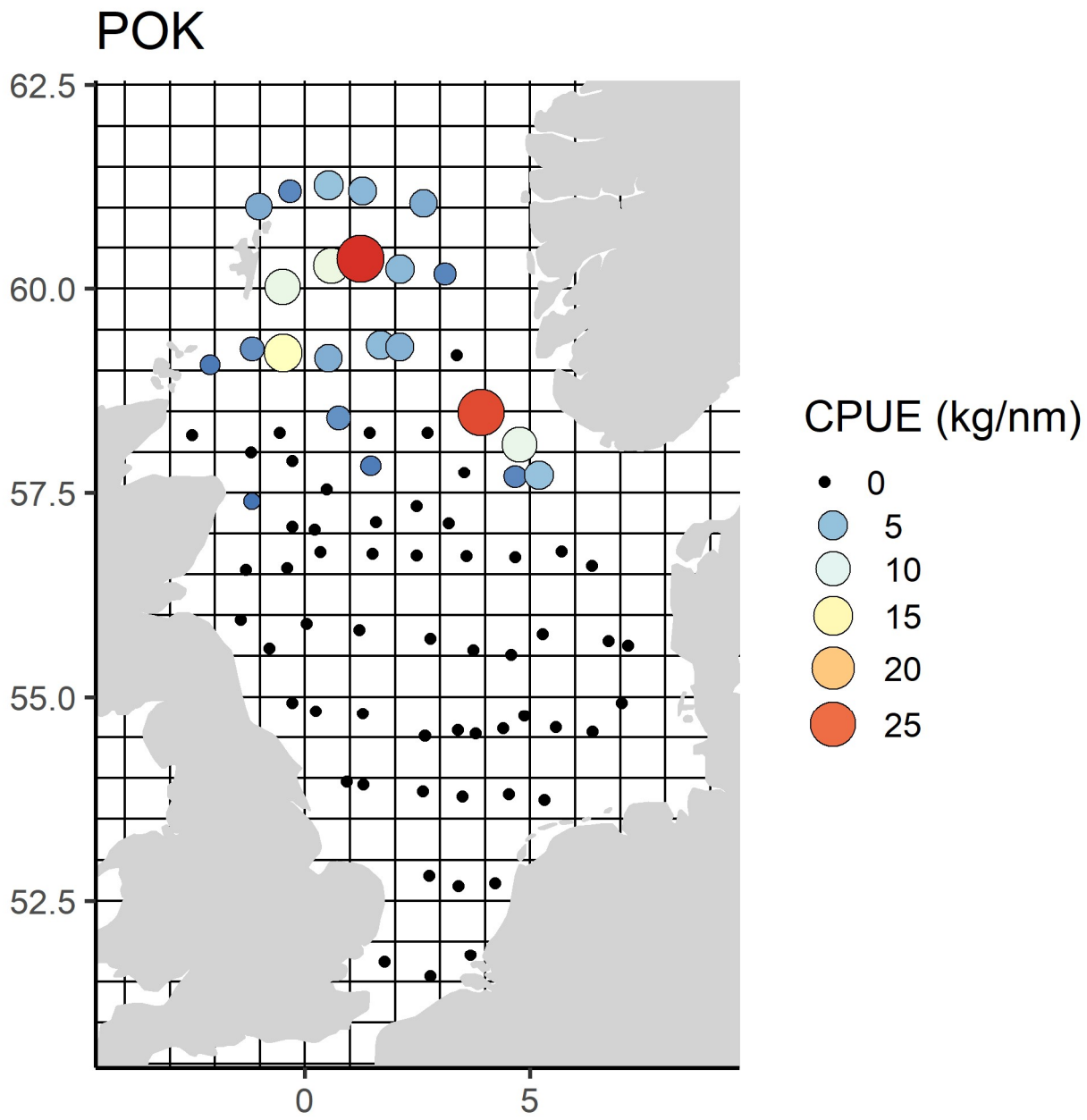


Figure 13. Distribution and relative abundance of saithe (*Pollachius virens*) across the survey.

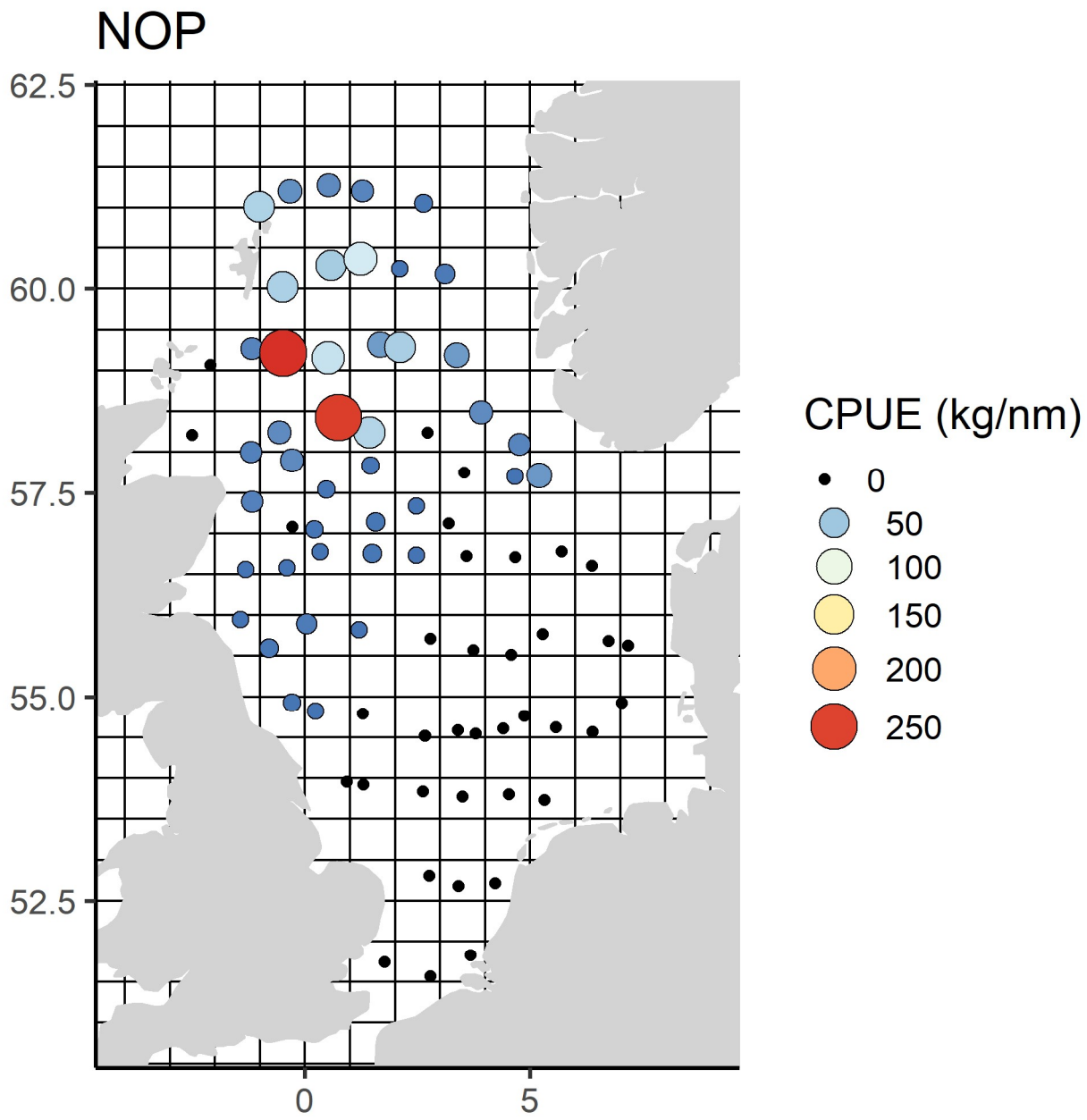


Figure 14. Distribution and relative abundance of Norway pout (*Trisopterus esmarkii*) across the survey.

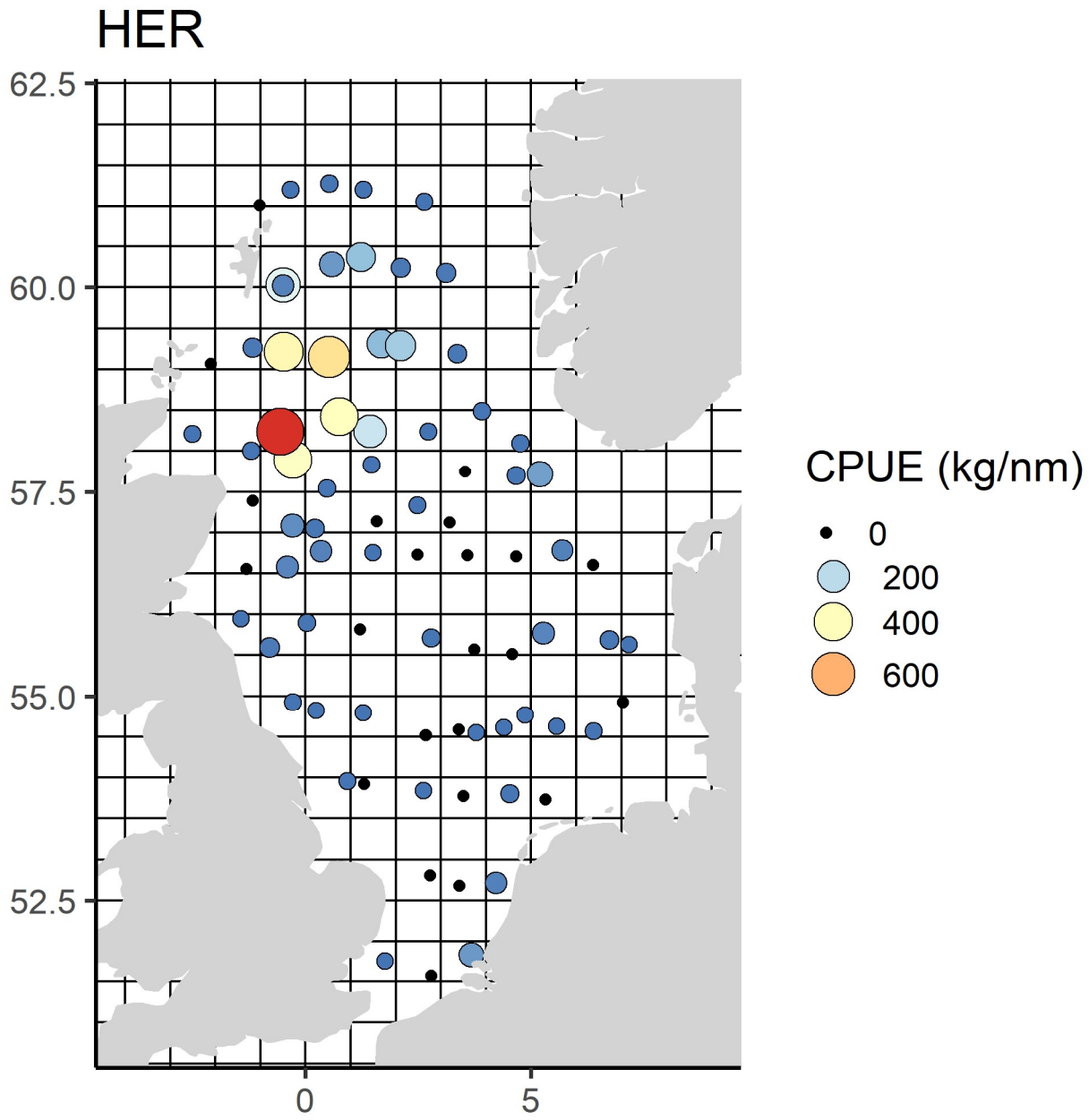


Figure 15. Distribution and relative abundance of herring (*Clupea harengus*) across the survey.

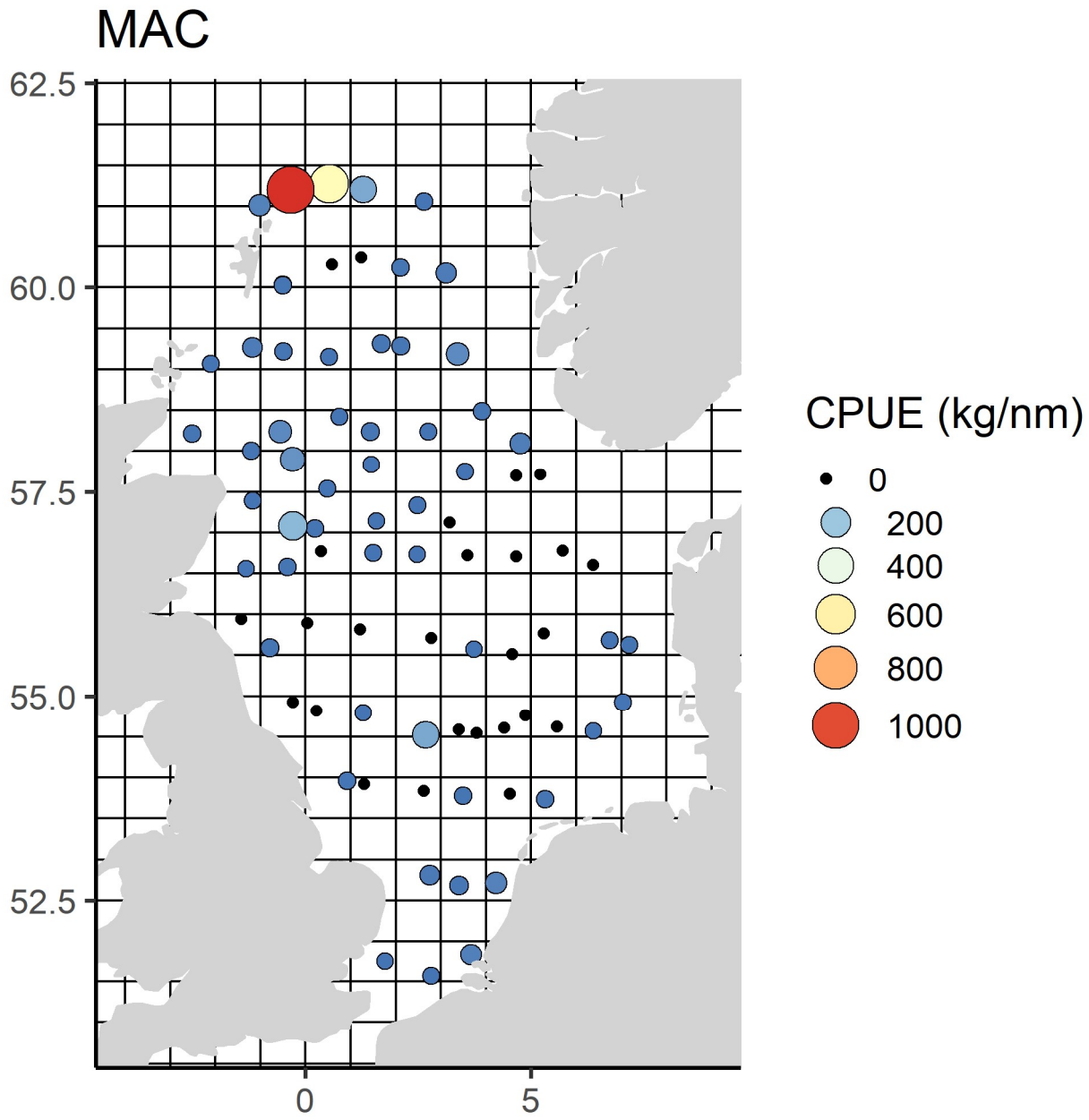


Figure 16. Distribution and relative abundance of mackerel (*Scomber scombrus*) across the survey.

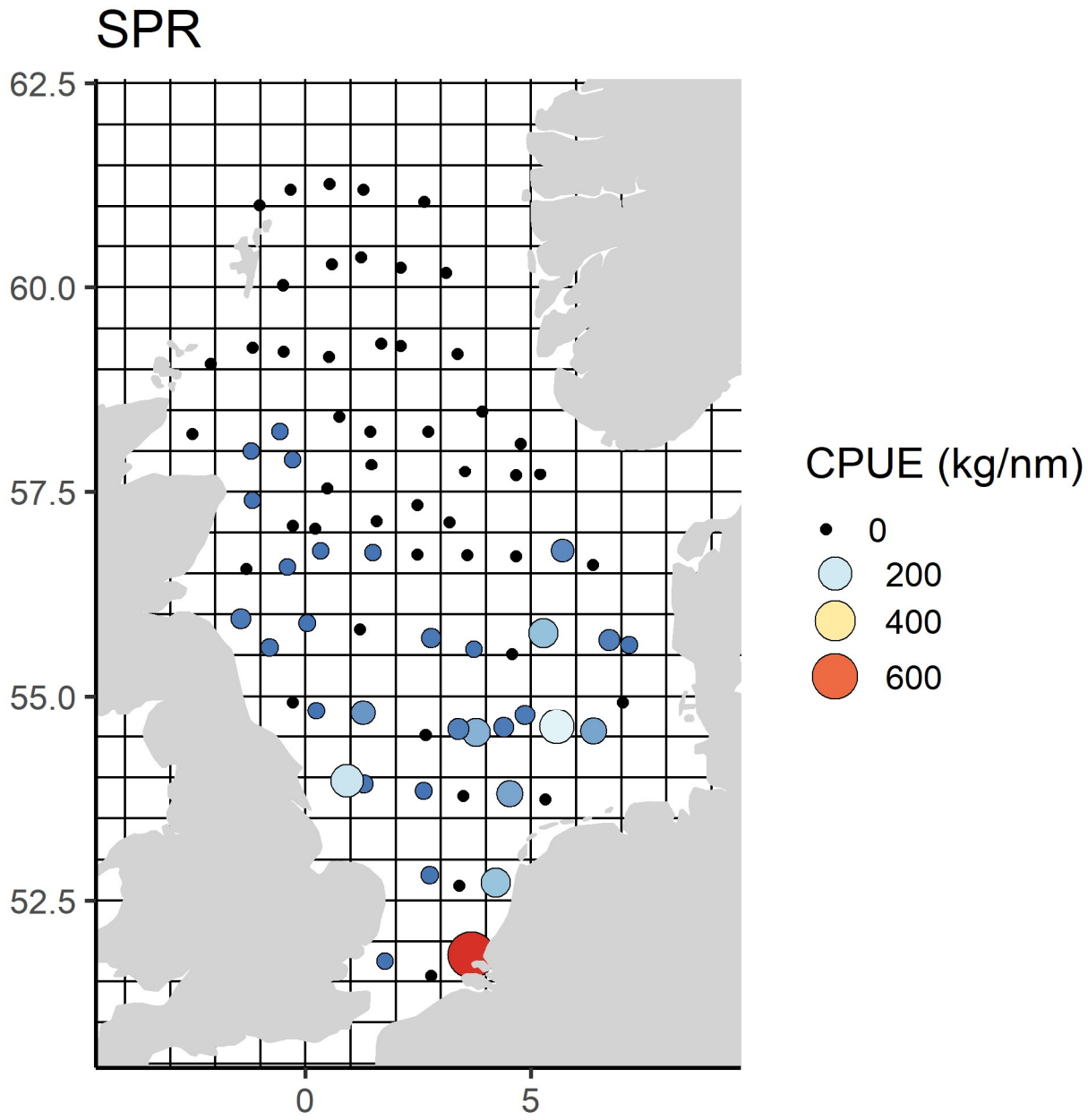


Figure 17. Distribution and relative abundance of sprat (*Sprattus sprattus*) across the survey.

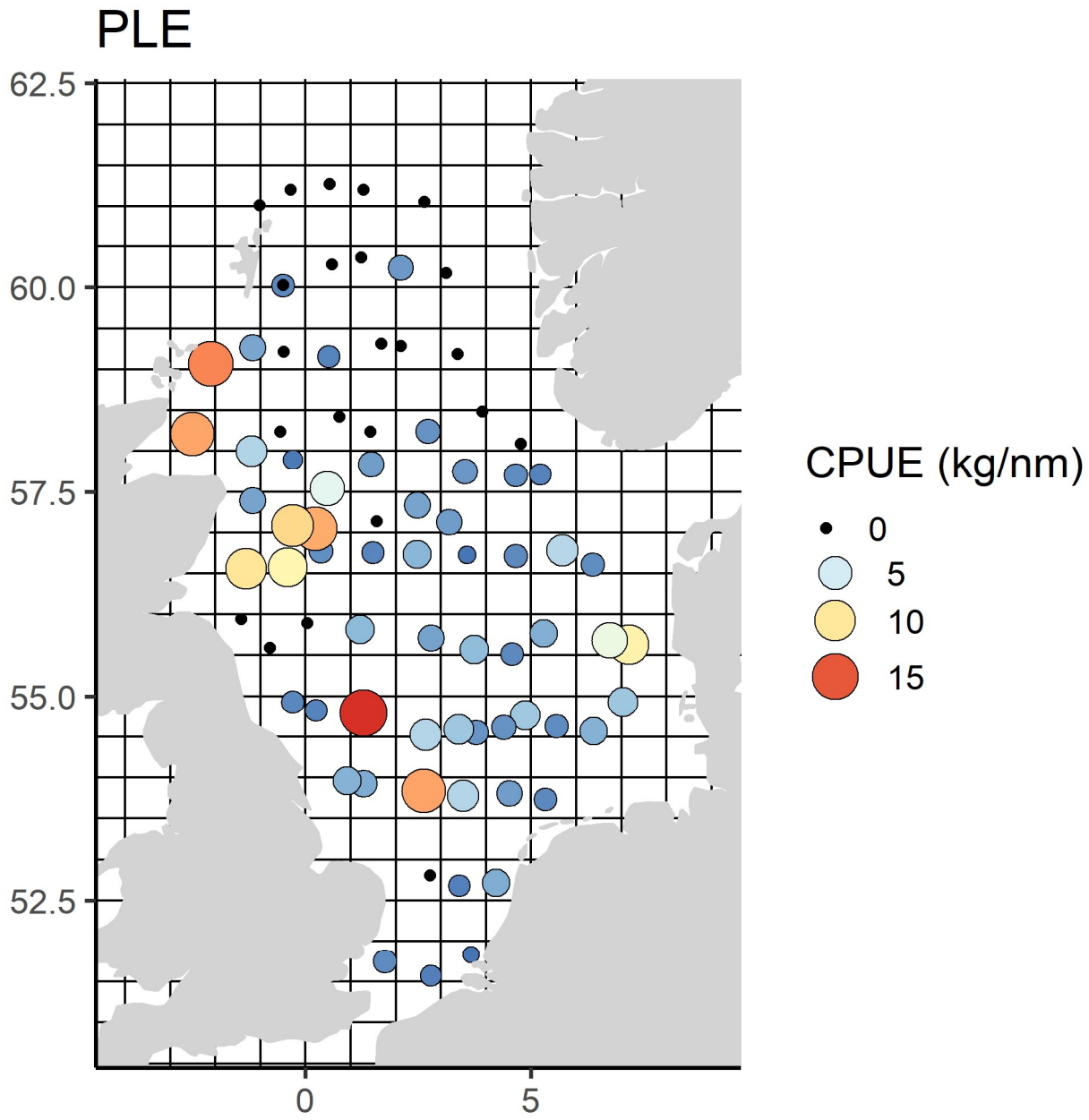


Figure 18. Distribution and relative abundance of plaice (*Pleuronectes platessa*) across the survey.

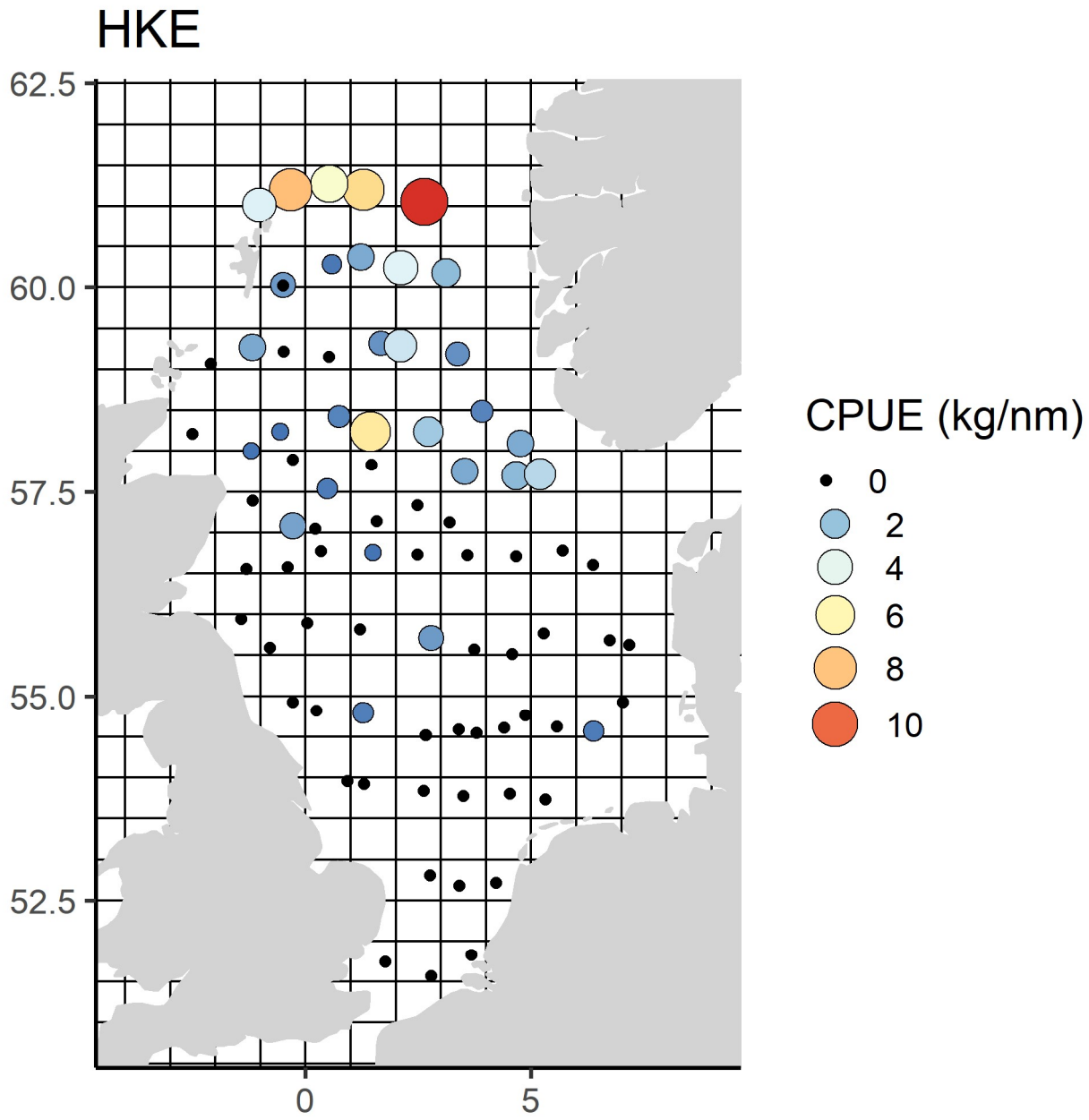


Figure 19. Distribution and relative abundance of hake (*Merluccius merluccius*) across the survey.

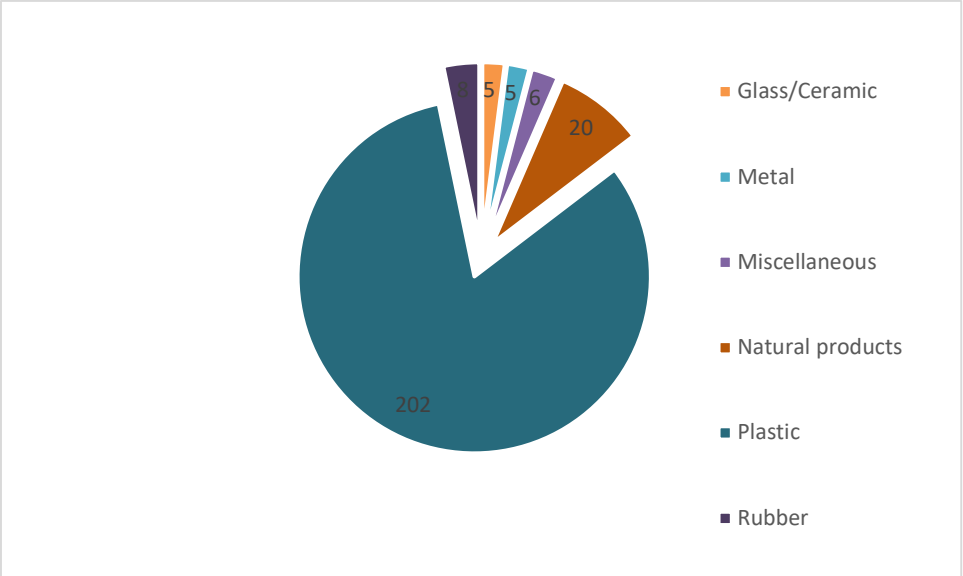


Figure 20. Marine litter collected during the English IBTS-Q3 trawl survey in 2021 (n = 231).