

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

2014 RESEARCH VESSEL PROGRAMME

REPORT: RV CEFAS ENDEAVOUR: SURVEY 17/14

STAFF:

Part A

Fishing:

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Part B

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Plus:

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DURATION: 7 August – 3 September 2014

LOCATION: North Sea (ICES area IV)

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:
 - 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 and Niskin Bottle.
 - f) Length weight & maturity information using individual fish measurements, in support of the EU Data Regulation.
2. Total alkalinity and dissolved inorganic carbon analysis of seawater by filtration at every station.
3. Carry out water sampling for Caesium/Tritium for an internal Cefas contract (SLA21).

SECONDARY AIMS:

4. 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.
5. To freeze any unusual fish species for subsequent identification / verification in the laboratory, including specimens of eelpout (*Zoarces*, *Lycodes* and *Lycenchelys*), sea scorpions (*Cottidae*, sub-area IVa only), *Sebastes* spp., and any unusual fish species, which may also be used in otolith research.
6. To freeze samples of starry smooth-hound for biological studies.
7. Record litter caught in the trawl in support of Defra projects.
8. Retain all dead species of diadromous fish for study by Cefas scientists.
9. Collect plankton biodiversity samples from selected stations for pigment and analytical flow cytometry analysis, in support of the EU project, HIGHROC. *If* time and conditions allow, additional profiles to be completed with the ESM2 logger.
10. Collect Ferrybox measurements and water samples of *Karenia mikimotoi* (a red tide species) blooms, for supporting PML satellite algorithm validation for detection of harmful algal blooms.
11. To develop capabilities using the new litter/ plankton passive sampler system and collect zooplankton samples for size spectra analysis in support of DEVOTES.
12. Collecting, preserving and analysing samples of seawater in order to determine the spatial-temporal variability of Transparent Exopolymer Particles (TEP) and DOM in the North Sea. Incubation experiments will be conducted for TEP detection.
13. Collect continuous fisheries acoustic data at four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333 kHz), using the Simrad EK60 split beam sounder. The data will contribute to the existing 13 year time series of acoustic data in the North Sea and will be used as part of the Defra funded project Poseidon to extract information on mackerel distribution and abundance.
14. Retain and freeze whole specimens of mackerel (*Scomber scombrus*), herring (*Clupea harengus*), sardines/pilchard (*Sardina pilchardus*), sprat (*Sprattus sprattus*), sea bass (*Dicentrarchus labrax*), dogfish (*Scyliorhinus* spp.), halibut (*Hippoglossus hippoglossus*), turbot (*Scophthalmus maximus*) and blue whiting (*Micromesistius poutassou*) (where above minimum landing sizes if applicable) for testing tissue samples for contaminants, in support of the EU Marine Strategy Framework Directive, descriptor 9 (relating to levels of contaminants in fish and shellfish for human consumption).
15. To retain empty skate and ray egg cases with corresponding positional information for subsequent identification by the Shark Trust.

16. Collect, enumerate and process (weight and umbrella lengths) jellyfish caught in the GOV trawl.
17. To update the distribution and relative density maps of medusae in the North Sea.
18. Seabird and cetacean observations will be carried out in suitable conditions by an ESAS accredited observer, using standard ESAS methods. The data will be incorporated into the JNCC administered ESAS database, contributing to the dataset used for marine planning by UK government, statutory nature conservation bodies, and the offshore energy industry.

NARRATIVE:

(All times GMT)

RV Cefas Endeavour sailed from Lowestoft at 05:00h on Thursday 7 August. Onboard were six Cefas fisheries staff, a further two Cefas staff (one collecting and analysing jellyfish and plankton samples, and the other collecting and analysing water samples), two environmental PhD students (one from the University of East Anglia and the other from the University of Essex), a masters student from Padova University, Italy, and a JNCC seabird and marine mammal observer. Before work on the primary stations commenced, a 'shakedown' tow was carried out to allow for the deployment of the gear, to check that all sensors were working correctly and to allow scientists and crew to familiarise themselves with their particular work areas. A standard station consisted of a cast to collect surface and bottom water samples, with a single 10-litre Niskin bottle along with an ESM2 logger, measuring additional parameters throughout the water column (temperature, salinity, fluorescence, light, turbidity and oxygen). These deployments were then followed by a 30-minute tow with the standard IBTS rigged GOV (Grand Overture Verticale) trawl. From 2014 onwards a net variation was made during this survey, with a poly net with nylon lower panels being employed.

From the start of the survey, whilst steaming between and on every station, fisheries acoustic data were continuously collected at four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333 kHz), using the Simrad EK60 split beam sounder. The shakedown tow was carried out at prime station 1. The net was shot away successfully, with all rigging in correct order, thus good readings were obtained from all Scanmar units. The accurate fishing of this tow and a good catch of thornback ray (*Raja clavata*), some sole (*Solea solea*), smooth hounds (which were tagged and released) and whiting (*Merlangius merlangus*) allowed us to count this as a valid tow, and thus was our first prime station completed. We then steamed eastwards to prime station 2 which yielded a small catch of herring and mackerel. The following day we fished prime stations 3, 6 and 5 off the Dutch coast. Station 3 despite being a small catch was rich in diversity, and of particular note was 5 river lamrey (*Lampetra fluviatilis*; Figure 2), along with 8 smooth hounds which were all tagged and released. Stations 6 and 5 were mainly sprat (200kg and 1.5 t respectively) along with some horse mackerel (*Trachurus trachurus*) and herring.



Figure 2: River lamprey caught at prime station 3, off the Dutch coast.

The 9 August got off to a windy start but with little swell we managed to fish prime stations 4, 8 and 7 back towards the UK coast (Flamborough Head) in preparation for the storm (ex-hurricane Bertha tracking across the Atlantic) due the following night. The first two stations were small catches of dab (*Limanda limanda*), gurnards and lesser spotted dogfish (*Scyliorhinus canicula*), along with some large female smooth hounds (up to 110cm; Figure 3) which were all tagged and released. The last station of the day was a large catch (~1 t) of whiting, mackerel and horse mackerel. With the weather remaining reasonable the morning of 10 August we managed to fish prime stations 15, 14 and 13 with each station yielding catches of 100-150kg of mixtures of dab, grey gurnard (*Eutrigla gurnardus*), whiting, haddock (*Melanogrammus aeglefinus*), mackerel and some cod (*Gadus morhua*) at station 13. True to the forecast, the weather deteriorated that evening with ex-hurricane winds due the following day. We therefore headed into anchor off Amble to shelter overnight. The following day the winds were in excess of 50 knots even within the shelter of the bay and thus made fishing unfeasible.



Figure 3: Starry smooth-hound caught at prime station 4, tagged and released.

With the winds due to diminish to a force 6 on 12 August, we started steaming for prime station 22 at midnight to allow us to be on station at first light. Though a 2-3m sea remained, the winds had dropped away sufficiently to allow fishing. This haul consisted of 150 kg of herring and 50 kg of whiting. We then moved on to prime station 23 to fish 'Swallow Hole', however by the time we moved further offshore to this station, the swell was too large to allow safe deployment of the gear. We therefore, sat and waited for the swell to die down before we could fish. Finally by early evening we were able to fish across this hole (~100-155m) and caught a small amount of herring, whiting and dab. The following day the swell had dropped away enough to enable us to fish prime stations 24, 25 and 26 eastwards across the north

Dogger Bank. The first two stations consisted of whiting, dab, herring and some haddock. The final station saw a large catch of mackerel (1.2t), grey gurnards (300kg) and around 50 kg of spurdog. Eight of these spurdog were large, heavy (presumed to be pregnant) females (90-111cm; Figure 4), which were all tagged and released. There were another three juvenile spurdog (two male and one female). Also of note was one of the largest plaice (*Pleuronectus platessa*) seen in this survey (58cm L_T; Figure 4).



Figure 4: Plaice of 58 cm (left pane), and large (presumed pregnant) female spurdog tagged and released (right pane), both caught at prime station 26 (north Dogger bank).

Overnight, RV Cefas Endeavour moved south to prime station 17 and brought in a modest catch of sprat (100kg) and dab (80kg) on the morning of August 14th. We spent the rest of the day moving west, south and then east to successfully complete prime stations 16, 9 & 10. Prime station 16 saw a heavy dab catch (200kg), but interestingly also provided 8 garfish (*Belone belone*; 60-71cm; Figure 5). Dab and sprat were also prevalent at Prime stations 9 & 10, although the majority of our last catch of the day was mackerel (250kg+). Four stations were to be attempted the next day but delays due to the weather meant this was soon reduced to three. We had moved west overnight and fished prime station 11 in the morning of August 15th, which provided a large bag of dab (350kg+) and mixed clupeids, plus a few turbot. We moved further west and successfully completed prime station 12 catching a mix of dab and clupeids (less than 100kg combined), before heading north to prime station 18. This catch matched the previous, with large numbers of juvenile fish, including red mullet (*Mullus surmeletus*), herring, mackerel, grey gurnard and whiting '0' groups, plus adult sprat, and less than 100kg of larger dab and whiting.



Figure 5: Some of the garfish caught at prime station 16.

We then moved west to fish stations on the north German coast on August 16th. Prime stations 19 & 20 saw similar catches to the previous day; mixed amounts of dab,

whiting and clupeids, although prime station 20 brought in a larger catch of over 600kg of sprat and herring. Upon reaching prime station 21 it emerged that commercial boats had shot static gear across our tow co-ordinates. After contacting one of the boats, it became clear that ICES rectangle 38F7 did not have many clear places to fish, due to local flatfish and seabird sanctuaries, a submarine training ground, commercial fishing pots and rocky ground that could not be fished safely. A clear tow position was obtained from a previous German IBTS survey, which meant a 17 nautical mile detour. Although the position was fished successfully and provided another 650kg+ of clupeids and juvenile roundfish, the delay meant that this became the last catch of the day.

We headed north to prime station 30, looking to complete the stations immediately west of Denmark by the end of 17 August. While prime station 30 was completed successfully and yielded yet another bag of mixed dab and clupeids (<200kg dab, 50kg sprat and over 100kg of herring), a problem with the codend liner meant prime station 29 was fished unsuccessfully four times before a decision was made to process the final attempt (due to daylight restrictions) as an additional tow, with no otoliths taken from the mixed dab (100kg), herring (150kg) and sprat (<450kg) catch. We then headed west to pick up the final two stations on line 40. Overnight the swell increased and prevented us from being on station for first light. Prime station 27 was fished successfully yielding a mixed bag of dab, sprat, herring and grey gurnard (approximately 50-70kg of each). By the afternoon the weather had worsened; prime station 28 had been completed successfully (yielding another 200kg of dab and clupeids) but the swell increased after this to 6-8m and prevented further fishing. The weather forecast indicated this to be worse at our planned stations for the next day, and thus it was deemed best to head west back towards the UK, where the swell had diminished.

After a 16-hour journey to prime station 33, the swell was found to be too dangerous to deploy the net. Therefore we continued heading west to station 32, where the swell had dropped to 3-4m. The tow was completed successfully, with 160kg of large herring caught and some haddock, many of which were '0' groups. On August 20th, prime stations 31 and 40 were fished successfully before we began heading into Aberdeen for the mid-survey changeover. Prime station 31 yielded 120kg of haddock (mainly juveniles) and 70kg of larger herring, while prime 40 was a mixed catch of herring (120kg), mackerel (100kg+), whiting (150kg) and more juvenile haddock, with some adult fish too (150kg). Overnight RV Cefas Endeavour moved to just off Aberdeen and docked at 0800hrs on 21 August.

Part 2

After supplies were taken onboard and some crew and scientists were changed over, RV Cefas Endeavour left Aberdeen harbour at 13:30hrs on 22 August and proceeded to travel north towards prime station 52, managing to haul just before sun down. This provided a mixed bag of haddock, herring and whiting (100kg-250kg of each) and a male spurdog, which was tagged and released. Overnight we moved northwest and started at on prime station 51, moving northeast and successfully completing 51, 59, 60 and 61. Prime station 59 yielded our largest catch of the survey so far with 3.5t, which was mostly made up of herring. By the end of the day we were catching Norway pout (*Trisopterus esmarkii*) and the first appearance of large saithe (*Pollachius virens*) (80kg+ caught on Prime Station 61). That night we moved north to prime station 66 the following day where the catch was dominated by mackerel (240kg). We then caught some larger cod (80cm+, 60kg in total) and hake

(*Merluccius merluccius*) at prime station 67. At this location, a discarded net and ground gear became hooked on to the GOV whilst hauling and this was cut away by the deck crew. Our last station of the day (prime station 68) saw a successful tow resulting in 400kg of saithe (43cm-108cm). Unfortunately, the inclement weather encountered earlier on the survey meant that prime stations 71 and 72 were not fished and this ensured that the priority prime stations used in survey indices were.

The most northerly stations were fished on 25 August, starting at prime station 73 and moving east through 74 and 75. Norway pout were still in abundance, along with horse mackerel (240kg at Prime Station 74) but bigger hake, cod and saithe were not seen in the same quantities as the day before. Prime station 73 also provided our first blue whiting of the survey, and these increased in quantity through the day with 40kg of adults and juveniles in the catch at prime Station 75.

On 26 August, prime station 69 (where two pair trawl teams were observed) was successfully completed and the catch was dominated by Norway pout, (adults and juveniles); 60kg of haddock and a number of small urchins (*Psammechinus miliaris*). We then moved southeast to fish prime station 70 before heading south to station 65. These catches yielded some mackerel (Stn 70; 50kg), saithe and blue whiting (Stn 65; 70kg and 50kg respectively). Overnight the survey moved northwest to complete prime stations 62, 63 & 64 on 27 August. Again, Norway pout and urchins were our most abundant species but some redfish (*Sebastes viviparus*) were also caught at Prime Station 62.

After completing the more northerly stations, we headed southeast in order to benefit from the better weather on the eastern side of the North Sea. On 28 August, prime station 57 was first to be fished, continuing with a catch of Norway Pout and urchin mix but also providing over 250kg of saithe (mainly juveniles). We then moved west to prime station 56 and then southeast to station 48, picking up small catches of haddock and cod (<50kg of each) despite the presence of a pelagic trawler in the area. By 29 August, the vessel had moved further southeast where the wind had picked up but was still fishable. The close proximity of the stations (Prime Stations 58, 49 & 50) meant catches were similar with varying amounts of small-medium sized saithe and small amounts of haddock. Prime Station 49 was of interest with a number of fishing vessels in the area. Here, we also caught some cod, one large (98cm) and some smaller fish (40kg in total).

Overnight we moved further southeast, starting at prime station 39 on the morning of 30 August. This catch saw the return of the clupeids, with 200kg of herring and over 100kg of sprat caught. Dab was also in evidence, with just under 200kg caught. We moved west during the day, through prime station 38 (small catch; 50kg of dab) to prime station 37, which was successfully completed and yielded just under 150kg of dab as the main species. By the end of the following day the survey had moved further westwards, having successfully fished prime stations 36, 44, 43 & 35. Prime 36 saw a large catch made up of grey gurnard (600kg) and dab (300kg); this composition continued through the day but with smaller catches. We caught two juvenile spurdog at prime 44 (a male and female, 39cm and 36cm respectively) and station 35 yielded a larger catch of mackerel (150kg+). Of further note were sightings of two white beaked dolphin (*Lagenorhynchus albirostris*) pods during the day.

By 1 September, the survey had moved to the western side of the grid, working our way eastwards. Prime station 41 was completed successfully with a catch of herring (70kg) and Norway pout. This trend continued throughout the day with herring being

present in all catches. Prime station 33 was dominated by nearly 300kg of haddock, plus some whiting (80kg) and herring (50kg). By early afternoon we had fished prime station 34 and caught more herring (225kg) and Norway pout (100kg), and we finished the day on Prime 42. This yielded a smaller catch comprising 150kg of herring and 40kg of Norway pout. Herring continued to be caught the next day at prime station 47, which was completed successfully with a large catch of just under 600kg of the clupeid. After that, RV Cefas Endeavour moved north to prime 55 for a much smaller catch, mainly consisting of haddock (50kg). By early afternoon we had reached prime station 54 which yielded a substantial bag of mixed herring (430kg) and Norway Pout (230kg), this was repeated later on after we had steamed west to Prime 53 but with less herring (360Kg and 250Kg respectively).

The following day, 3 September began with a pleasant surprise: a Common Skate (*Dipturus batis* (cf. *intermedia*)) on prime station 45. This large female was 217cm long, and was successfully tagged and released (Figure 6). Whiting and herring made up the rest of the catch. We then sailed southeast to prime 46 and suffered our first major gear damage of the survey; ripping the belly of the net. Thankfully it was a quick repair job thanks to the deck crew and an alternative tow position was successfully completed with herring and haddock as the main species caught - approximately 100kg of each.



Figure 6: *Dipturus batis* (cf. *intermedia*) having an approximate wing width measurement

Prime station 76, was a short steam south and this final station was fished with no problems, yielding a catch of mainly haddock (<350kg) and herring (<500kg). With the final survey station completed we began her voyage back to Lowestoft, taking a detour to sample a bloom of *Karenia mikimotoi*, a red tide plankton species, in the area between prime stations 22 and 13. Two niskin deployments were made and water collected from the surface and at 4m depth. With this final part of the survey complete we headed for home port at Lowestoft, docking at 05:00hrs, 5 September.

Results

Aim 1: A valid GOV trawl haul was successfully completed at 73 of the 76 primary station positions (Table 1, Figure 1). Time restrictions and the impact of weather and

gear problems meant that stations 71 & 72 were missed in order to ensure stations of a higher priority were completed. Prime Station 29 was recorded as an additional station after three consecutive invalid attempts. There were seven invalid tows in total, which, aside from the above, were all repeated to obtain valid samples. The survey was fished using GOV hybrid trawl number 1. A chart indicating the position of each trawl station is attached (Figure 6). Scanmar equipment was used to monitor headline height, wing width and door spread. At each station, the catch of each species was weighed and all fish, or representative samples, were measured. Table 2 lists the species caught that are sampled for length and Table 3 ranks the top 15 species by weight compared with the last three year's survey. Samples of otoliths for age determination were taken (Table 4) as specified in standard instructions. Benthos and crustacea were identified to the species wherever possible and recorded as present. The resultant data were input to computer database using the Cefas Electronic Data Capture (EDC) System. This data will be analysed at Cefas Lowestoft and will provide a major input to the ICES assessment of North Sea gadoids and pelagic species. Once checked and validated, all data will also be input to the ICES Datras database.

Surface and bottom salinity samples and a water column ESM2 logger profile were taken on all of the primary stations fished, with profiles obtained, of temperature, salinity, fluorescence, light, turbidity and oxygen. In addition to this, measurements of water transparency were also taken using Secchi disk (white).

A total of 83 fish species were recorded during the survey. Species of note caught this year during the survey are Common Skate, river lamrey, and garfish. Two redfish were caught, but were the more common *Sebastes viviparous*. In keeping with previous year's surveys 19 fish were measured in greater detail to improve length-weight relationship data including some of those mentioned above and also a sea snail (*Liparis liparis*), small sandeel (*Ammodytes tobianus*) and greater weever (*Trachinus draco*).

Figures 7-16 show distribution and relative abundance (kg per hour) of cod, haddock, whiting, saithe, Norway pout, herring, mackerel, sprat, plaice and hake, respectively, over the last 4 years.

There has been a marked increase in cod seen on this year's survey compared to 2013, up from 343.5kg to 501.9kg, although it should be noted many of these were juvenile fish (<40cm). This would support a potential good recruitment year as seen in 2011. The distribution of cod has increased in line with weight caught, with the species seen on 47 stations in 2014, compared to 37 the previous year. Haddock is another groundfish species that seems to have increased with the largest weight caught in the last 4 years (see table 3); over a tonne more than the 2013 survey, which had been noted for its poor catch. Interestingly, the disease noted for rotting away the nasal area which was reported on last year seems to have diminished, with little to no individuals seen suffering from it.

This year's survey saw over double the amount of whiting caught, compared to 2013 (1129.2kg to 2355.4kg) over a similar number of stations fished (69 to 70). Saithe catches were also up by 323kg from last year, although still not at the levels of 2012 and 2011. Norway pout was seen in similar quantities to 2013, although its distribution has increased from 34 stations to 42 stations this year.

The pelagic species unfortunately seemed to have fallen compared to the ground fish; herring was still our most abundant species but was found to have fallen by nearly half (8887kg this year, compared to 15035kg in 2013 – although this was the highest seen in recent years). Mackerel was also down by over 600kg from last year with the lowest catch seen for the species in four years; however mackerel has not seen drastic changes in catches over these years which indicate stable recruitment. Sprat have continued their recovery from a poor 2012 with catches back to the levels seen in 2011 (3.72t) and were found on 29 stations compared to only 20 on last year's survey.

After a time series high last year (705.46kg), hake are back to levels seen in 2012 with nearly 550kg caught this year. The majority of hake caught this year found between 40cm and 60cm. Plaice have seen their numbers rise back to those seen in 2012 (548kg 2014 to 523kg 2012) and are still one of the most widespread species found on the survey after herring and grey gurnard. Dab, grey gurnards and lemon sole are all up this year compared to 2013, while horse mackerel has fallen slightly to 1115.05kg but is still higher than the catches reported in 2011 & 2012.

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

Gear	Valid	Additional	Invalid	Total
GOV (IBTS Standard gear)	73	1	7	81
Niskin Bottle + CTD	78	0	0	78

Table 2. List of measured species caught during the survey and number of stations at which they were recorded.

Species	Common Name	Stns	Species	Common Name	Stns
<i>Agonus cataphractus</i>	Pogge (Armed bullhead)	17	<i>Mullus surmuletus</i>	Red Mullet	8
<i>Alloteuthis subulata</i>	European common squid	28	<i>Mustelus asterius</i>	Starry Smooth-hound	4
<i>Arctica islandica</i>	Ocean Quahog	1	<i>Myoxocephalus scorpius</i>	Bullrout	6
Argentinidae	Argentine	30	<i>Myxine glutinosa</i>	Hagfish	8
<i>Arnoglossus laterna</i>	Scaldfish	16	<i>Nephrops norvegicus</i>	Norway lobster	13
<i>Aspitrigula cuculus</i>	Red gurnard	2	Ocopodidae	Octopus	11
<i>Belone belone</i>	Garfish	4	<i>Todarpsis eblanae</i>	Lesser flying squid	14
<i>Buglossidium luteum</i>	Solonette	19	<i>Ommastrephes sagittatus</i>	Flying squid	1
<i>Callionymus lyra</i>	Common Dragonette	48	<i>Pecten maximus</i>	Scallop	2
<i>Callionymus maculatus</i>	Spotted Dragonette	17	<i>Phycis blennoides</i>	Greater Forkbeard	1
<i>Cancer pagurus</i>	Edible Crab	13	<i>Phrynorhombus norvegicus</i>	Norwegian topknot	1
<i>Clupea harengus</i>	Herring	69	<i>Platichthys flesus</i>	Flounder	5
<i>Cyclopterus lumpus</i>	Lumpsucker	1	<i>Pleuronectes platessa</i>	Plaice	61
<i>Enchelyopus cimbrius</i>	Four-bearded rockling	12	<i>Pollachius virens</i>	Saithe	21
<i>Eutrigula gurnardus</i>	Grey Gurnard	65	<i>Raja clavata</i>	Thornback ray	4
<i>Engraulis encrasicolus</i>	European anchovy		<i>Maurollicus muelleri</i>	Pearlside	2
<i>Gadiculus argenteus</i>	Silvery Pout	13	<i>Raja montagui</i>	Spotted ray	3
<i>Gadus morhua</i>	Cod	47	<i>Amblyraja radiata</i>	Starry Ray	30
<i>Gymnammodytes semisquamatus</i>	Smooth sandeel	1	<i>Rossia macrostoma</i>	Stout bobtail squid	8
<i>Glyptocephalus cynoglossus</i>	Witch	10	<i>Scomber scombrus</i>	European mackerel	55

<i>Gobius spp.</i>	Gobies	4	<i>Scophthalmus rhombus</i>	Brill	2
<i>Hippoglossoides platessoides</i>	American plaice (long rough dab)	52	<i>Scyliorhinus canicula</i>	Lesser Spotted Dogfish	13
<i>Homarus gammarus</i>	Lobster	1	<i>Sebastes viviparus</i>	Redfish	2
<i>Hyperoplus lanceolatus</i>	Greater sandeel	14	<i>Ammodytes tobianus</i>	Small sandeel	2
<i>Illex (loligo) illecebrosus</i>	Northern Shortfin Squid	1	<i>Sepia elegans</i>	Elegant cuttlefish	1
<i>Lepidorhombus whiffiagonius</i>	Megrim	10	<i>Sepiolo atlantica</i>	Atlantic bobtail squid	13
<i>Leucoraja naevus</i>	Cuckoo ray	6	<i>Solea solea</i>	Dover sole	6
<i>Limanda limanda</i>	Dab	63	<i>Sprattus sprattus</i>	Sprat	29
<i>Lithodes maja</i>	Stone crab	13	<i>Squalus acanthias</i>	Spurdog	6
<i>Loligo forbesi</i>	Northern squid	34	<i>Syngnathus acus</i>	Greater pipefish	6
<i>Lophius piscatorius</i>	Anglerfish (monkfish)	25	<i>Trachinus vipera</i>	Lesser weever	12
<i>Lophius budegassa</i>	White anglerfish (black bellied)	2	<i>Trachinus draco</i>	Greater weever	3
<i>Lumpenus lampretaeformis</i>	Snake Blenny	2	<i>Trachurus trachurus</i>	Horse mackerel	45
<i>Melanogrammus aeglefinus</i>	Haddock	50	<i>Trigla lucerna</i>	Tub gurnard	10
<i>Merlangius merlangus</i>	Whiting	70	<i>Trisopterus esmarkii</i>	Norway pout	42
<i>Merluccius merluccius</i>	Hake	33	<i>Trisopterus luscus</i>	Bib pouting	5
<i>Microchirus variegates</i>	Thickback Sole	2	<i>Trisopterus minutus</i>	Poor cod	21
<i>Micromesistius poutassou</i>	Blue Whiting	6	<i>Zeus faber</i>	John Dory	2
<i>Microstomus kitt</i>	Lemon Sole	57	<i>Dipturus batis</i> (cf. <i>intermedia</i>)	Common skate	1
<i>Molva molva</i>	Common ling	10	<i>Scophthalmus maximus</i>	Turbot	6

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

Species common name	Scientific name	2014 weight (kg)	2013 weight (kg)	2012 weight (kg)	2011 weight (kg)
Herring	<i>Clupea harengus</i>	8887	15036	9402	5310
Sprat	<i>Sprattus sprattus</i>	3725	2129	456	3644
Mackerel	<i>Scomber scombrus</i>	3215	3826	3822	3564
Dab	<i>Limanda limanda</i>	3090	2136	2466	2403
Haddock	<i>Melanogrammus aeglefinus</i>	2542	1626	2265	3234
Whiting	<i>Merlangius merlangus</i>	2355	1129	2258	2163
Norway Pout	<i>Trisopterus esmarkii</i>	1713	1732	1182	1454
Grey Gurnard	<i>Eutrigla gurnardus</i>	1639	1041	1000	1020
Saithe	<i>Pollachius virens</i>	1189	866	1427	1597
Horse Mackerel	<i>Trachurus trachurus</i>	1115	1325	869	970
Hake	<i>Merluccius merluccius</i>	548	705	589	465
Plaice	<i>Pleuronectes platessa</i>	529	453	523	592
Cod	<i>Gadus morhua</i>	502	343	486	627
Long-Rough Dab	<i>Hippoglossoides platessoides</i>	305	147	281	333
Lemon Sole	<i>Microstomus kitt</i>	222	128	225	250

A total of 8023 biological samples were taken for the primary target species (Table 4). In addition, a total of 208 samples were also taken from elasmobranchs captured during the survey.

Table 4. The number of biological samples taken by species

Species	Number of samples taken
Plaice	1353
Whiting	1408
Herring	1119
Haddock	1152
Hake	397
Mackerel	372
Saithe	495
Dab	279
Cod	381
Lemon Sole	222
Norway Pout	429
Grey Gurnard	233
Ling	29
Monkfish	54
Witch	25
Tub Gurnard	26
Turbot	8
Brill	2
Black Bellied anglerfish	2
Red Gurnard	2
Red Mullet	33
John Dory	2

Aim 2: A total of 74 water stations had total alkalinity and dissolved inorganic carbon analysis of seawater completed.

Aim 3: Water samples were collected 38 dedicated stations for caesium and tritium analysis.

SECONDARY AIMS:

Aim 4: Overall 32 elasmobranchs were in good enough condition to be tagged and released with length, sex and weight recorded, as well as position of release including 15 starry smooth-hounds (9 males, 6 females), 13 spurdog (4 males, 9 females), 6 of the females of which were suspected to be pregnant, and 3 Spotted ray (*Raja montagui*; 2 males, 1 female). The common skate (was a 217cm long female with a wing span of 167cm and was tagged and released straight after capture. Its weight could not be recorded as there was not a balance on board with the capability to accurately weigh such a large fish.

Aim 5: Species including *Ammodytes marinus* and *Myxine glutinosa* and were retained and frozen for subsequent identification / verification in the laboratory, which may also be used in otolith research.

Aim 6: One starry smooth-hound (dead on retrieval of the GOV net) was retained and frozen for biological studies.

Aim 7: Litter caught in the trawl was recorded at every station, and overall, 224 pieces of litter were recorded at 62 stations. As can be seen in Figure 17; plastics made up the majority of the litter caught.

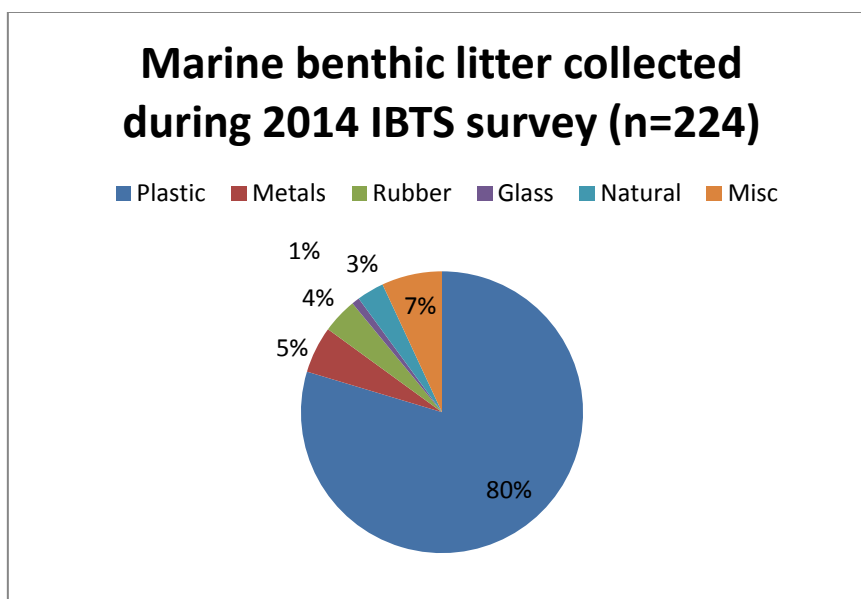


Figure 17: Breakdown by category of the marine litter collected during the survey

Aim 8: As there were no catches of dead diadromous fish (alive fish were returned in good condition), none were retained for study by Cefas scientists.

Aim 9: Physical, chemical and biological variables were investigated at each of the sampling stations. In particular, CTD casts (with an ESM2 profiler) were carried out for determining temperature, salinity, density, fluorescence, dissolved oxygen and PAR (Photosynthetically Active Radiation) profiles of the water column. PAR profiles are going to be analysed for calculating the vertical light attenuation coefficient (K_d) and the depth of the photic zone (under the HIGHROC project, EU). Estimates of the light penetration through the water column were also obtained from the measurement of the Secchi disk depth.

Discrete water samples were collected at the subsurface (from 4 m depth from a continuous water supply) and at the bottom (using Niskin bottles) to estimate salinity, Total Alkalinity (TA), Dissolved Inorganic Carbon (DIC), Dissolved Organic Matter (DOM), dissolved inorganic nutrients concentration, chlorophyll and pigments concentration, as well as phytoplankton size and composition for analysis via flow cytometry. Collection of TA/DIC, DOM and inorganic nutrients samples was carried out as part of the Shelf Sea Biogeochemistry project (NERC), while collection of chlorophyll samples was carried out as part of HIGHROC.

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

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

	Total	Surface Ferrybox	Bottom Niskin
Salinity	159	79	80
TA/DIC	50	25	25
Dissolved inorganic nutrients	50	25	25
Dissolved organic nutrients	50	25	25
Dissolved inorganic nutrients	76	76	
Chlorophyll/Pigments analysis	80	80	
Flow Cytometry	80	80	
Secchi depth	11	#	#
CTD casts with ESM2	76	#	#

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

Aim 10: Synoptic view of the Greater North Sea was provided by remote sensed images of sea surface temperature, chlorophyll concentration and frontal systems, from Neodaas (www.neodaas.ac.uk), as well as distribution maps of *Karenia mikimotoi*, a HAB (Harmful Algal Bloom) species, responsible for red tides. In particular, for supporting PML satellite algorithm validation for detecting HABs, multiple samples were collected within a bloom of *K. mikimotoi* on 4 September 2014 (Figure 18).

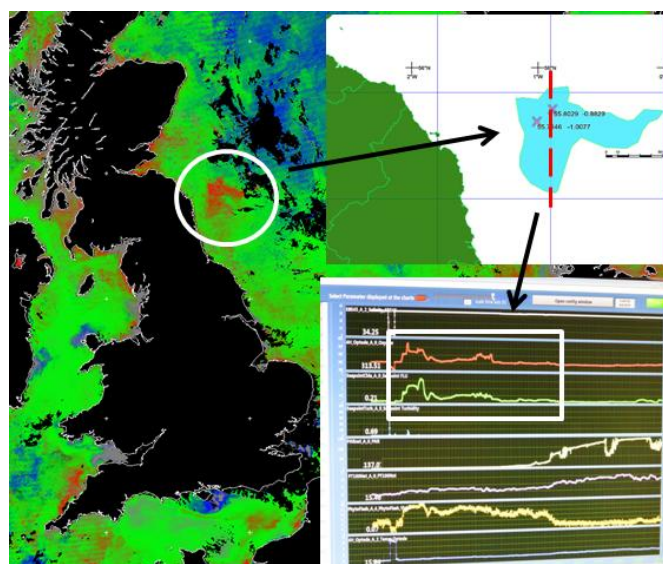


Figure 18 A bloom of *Karenia mikimotoi* was identified by remote sensing images; based on the contour of the bloom a transect crossing the bloom (red fragmented line) and 2 sampling stations were selected. While steaming along the transect the Ferrybox recorded changes in chlorophyll and oxygen concentration (green and red lines respectively in the white rectangles).

Aim 11: A new continuous plankton and litter sampler has been installed onboard and this survey was the first to test its performance. All began well but unfortunately technical issues meant that the automatic trap system started to fail. By the start of the second half of the survey the traps had to be deployed manually. Flow rates failed to

be detected by the bespoke software and so were monitored manually to ensure end volumes could be estimated. This ensured that, despite failures, good samples were obtained for size spectra analysis for the EU project, DEVOTES.

An 80 micron mesh was used to sample across all 74 fished prime stations, coinciding with the GOV tow: between prime stations a 270 micron mesh was used. These latter tows were often over three hours long. Over the course of the survey 111 samples were taken. Satellite imagery of chlorophyll distribution showed that for the second part of survey, RV Cefas Endeavour was in an oligotrophic area – a “desert” in terms of phytoplankton abundance. This was reflected in the zooplankton abundance; despite three hours of sampling the zooplankton was sparse. There was no mucus in the samples or clogging of the nets which might indicate certain phytoplankton species.

In addition, another objective of this aim was supporting James Fox’s PhD project: to map the variability of phytoplankton productivity and light induced fluorescence parameters across the North Sea using a continuous, semi-automated fast repetition rate (FRR) fluorometry approach. To achieve this two FASTtrack II FRR fluorometers (Chelsea Technologies Group Ltd, CTG) each fitted with a FASTact (CTG) laboratory system were linked to the ships non-toxic underway system to provide continuous measurements (20-30 minute sample resolution) for water taken from 4m depth. These data supported by further continuous measurements (SST, salinity, O₂ saturation, PAR) from the ships *Ferrybox* system and discrete sampling opportunities, will be used to shed light on the causes and extent of the variability observed. Comparisons between estimates of phytoplankton photochemical efficiency and non-photochemical quenching from satellite detected fluorescence will also be made using FRRf data collected and measurements derived from remote sensing imagery.

Over the course of the survey 390000+ single light response acquisitions were made during 2000+ fluorescence light curve procedures. Additional samples for chlorophyll concentration and phytoplankton absorption spectrum were also taken from surface waters at each of the 73 stations.

Aim 12: During the Survey as part of his PhD project Gianfranco Anastasi aimed to address key unknowns in the continental shelf carbon pump (CSCP), by quantifying the role of dissolved organic matter (DOM) and transparent exopolymer particles (TEP) production in the 'over-consumption'; the following scientific activities were carried out:

- Collection and analyses of seawater samples in order to determine the spatial-temporal variability of TEP and DOM in the Greater North Sea (samples collected = 104).
- Preservation of seawater samples with two different methods of preservation (Formalin 4% and Mercuric chloride) in order to determine the best way to preserve long term TEP for future analysis (samples collected = 76).
- Incubation experiment for TEP detection. Different concentrations of nutrients were added to seawater samples, which were incubated on deck for up to 3 days. On a daily base, subsamples were collected from the incubated seawater samples in order to study the temporal evolution of TEP and nutrient concentration (samples collected = 4).

Aim 13: Throughout the survey, fisheries acoustic data was continuously collected at four operating frequencies (38 kHz, 120 kHz, 200 kHz and 333 kHz), using the Simrad EK60 split beam sounder.

Aim 14: In support of the EU Marine Strategy Framework Directive, descriptor 9 (relating to levels of contaminants in fish and shellfish for human consumption), a total of 238 specimens of mackerel, herring, sprats, and turbot were retained and frozen for testing tissue samples for contaminants.

Aim 15: A total of 12 samples of empty skate and ray egg cases with corresponding positional information were retained for subsequent identification by the Shark Trust.

Aim 16: Biometric data on pelagic cnidarians (jellyfish) caught in the GOV has been recorded to contribute to an ongoing seedcorn project ACOJEL. ACOJEL aims to map the summer distribution in the North Sea of these jellyfish. A rough evaluation of the raw data suggests that species numbers are lower than those recorded in previous years. Jellyfish data from the GOV trawl were collected at 73 of the 74 stations fished (only one catch had no jellyfish at all), also two of the stations only provided fragments that couldn't be identified as a particular species.

Eight species were identified and counted, with *Cyanea capillata* – the lions mane jellyfish – being the most abundant (33%). The heaviest specimen weighed 3.5 kg and the largest diameter recorded was 55 cm. The least abundant species recorded was *Rhizostoma spp.* - the barrel jellyfish – which is more frequently found on western UK shores. Despite the quantity of fish caught in the GOV the jellyfish were on the whole in good condition.

Aim 17: The distribution and relative density maps of medusae in the North Sea will be updated post survey following data QA and analyses.

Aim 18: During the first half of the survey, bird surveys accumulated 72 hours 40 minutes, equating to 1482.3 kms of steamed survey effort, and 444.7 km² surveyed. During this period, 2994 birds of 23 species and 23 marine mammals of three species were observed. During the second half of the survey, 85 hours of observations, covering a transect length of about 1750km was surveyed. The second half of this survey was typified by some very sizeable quiet spells, including several whole days where extremely few birds were recorded. Approximately 20 species of bird were recorded, along with 67 marine mammals, which included individual sightings of minke whale (*Balaenoptera acutorostrata*) and harbour porpoise (*Phocoena phocoena*), with white-beaked dolphins account for the remaining records.

Special thanks are given to the officers and crew of RV Cefas Endeavour and the scientists for all of their enthusiasm and hard work in making this survey a success even when the weather was against us.

Sophy McCully Phillips and Richard Ayers
Scientists in Charge
04/09/14

DISTRIBUTION:

S McCully Phillips	R Ayers
R Humphreys	B Hatton
M Eade	L Cox
L Mann	S Davies
C Firmin	E Capuzzo
P Bouch	R Beckett
C Sguotti	C Lynam
G Anastasi	L Rutterford
E Hunter	N Greenwood
J Van Der Kooij	J Ellis
M Nicolaus	V Creach
R Forster	R Law
M Lewis	J Fox
B Harley	I Holmes
G Burt	

Cefas fisheries survey's SICs and 2ICs
Cefas Trim
J Maitland (P&O)
Master (Cefas Endeavour)
FCO
Marine Management Organisation
The Crown Estate

Inshore Fisheries and Conservation Authorities (IFCA's): East, North-east, Northumberland, Essex and Kent.

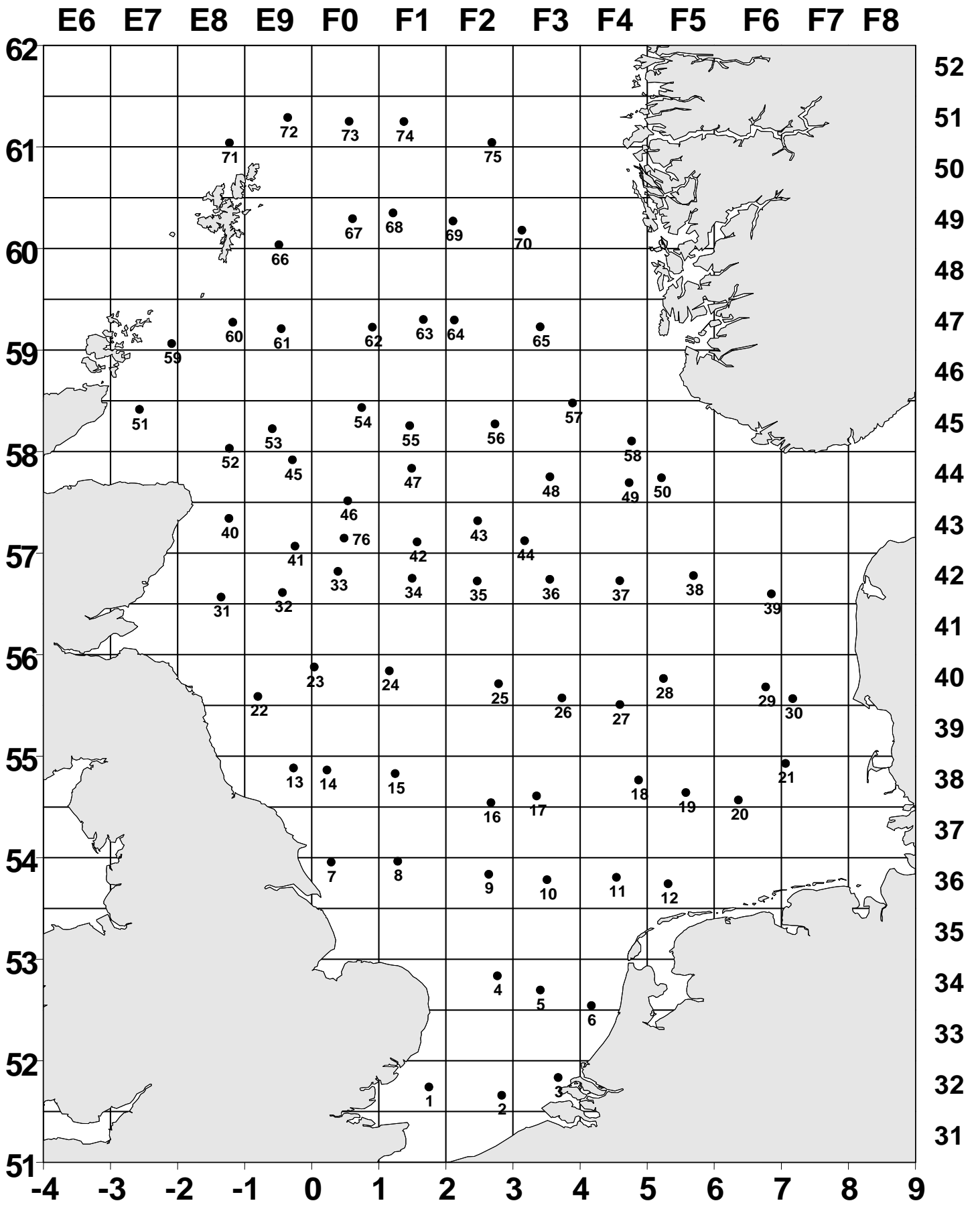


Figure 1: Fishing station of IBTS North Sea Groundfish Survey

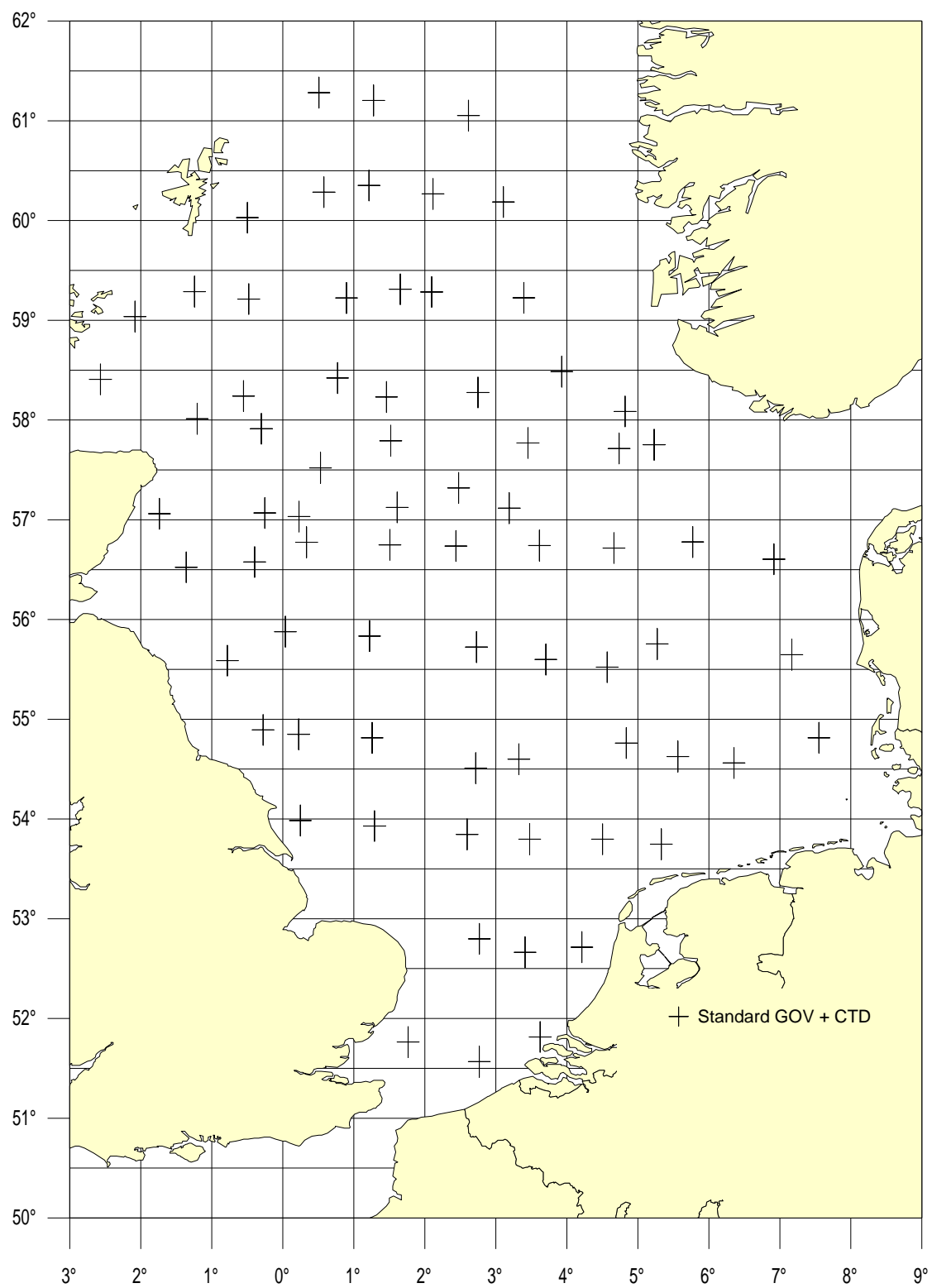


Figure 6: Station positions for primary aims on CEFAS Endeavour 17/14

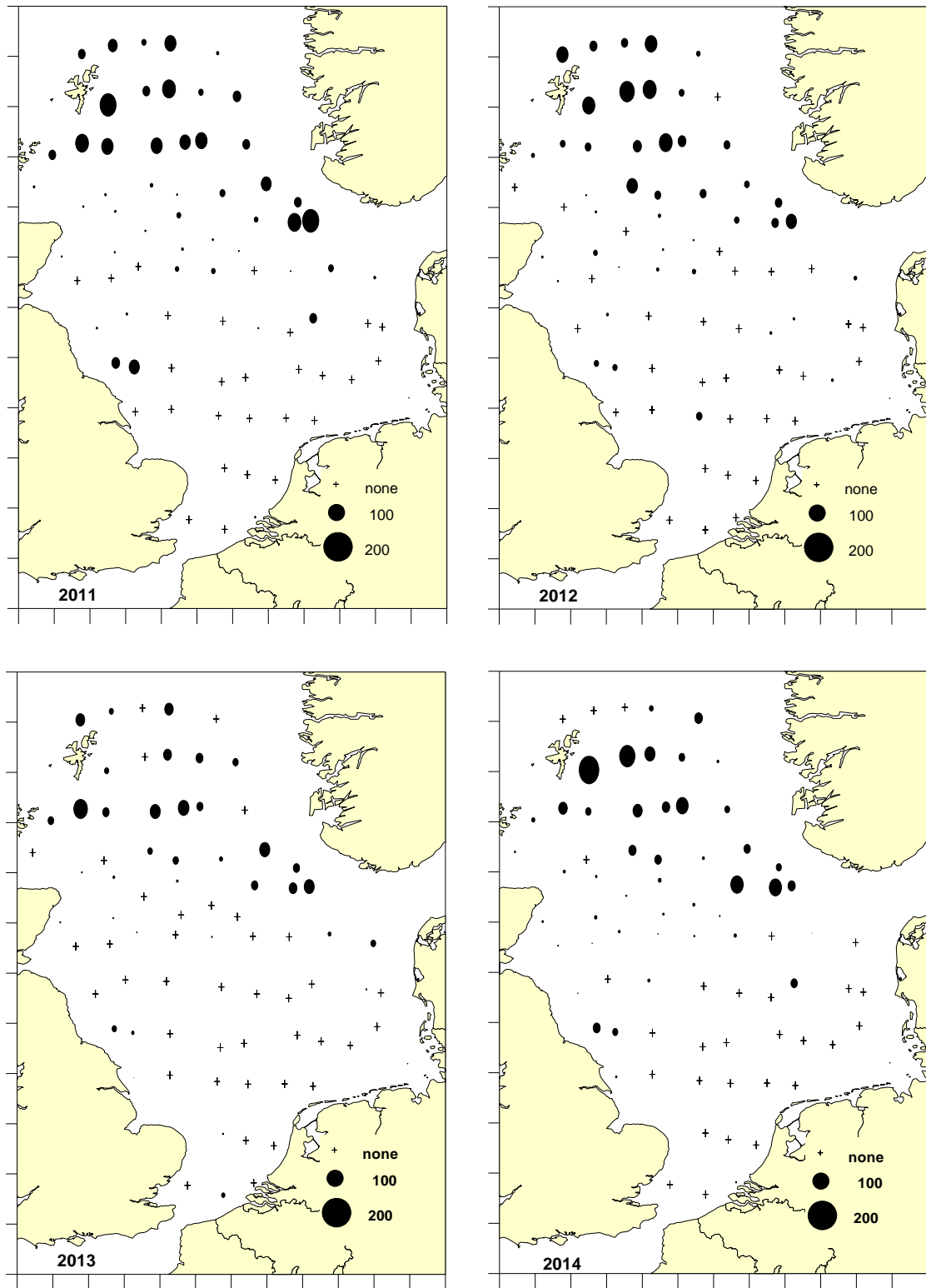


Figure 7: Distribution and relative abundance (kg) of cod for 2011 to 2014.

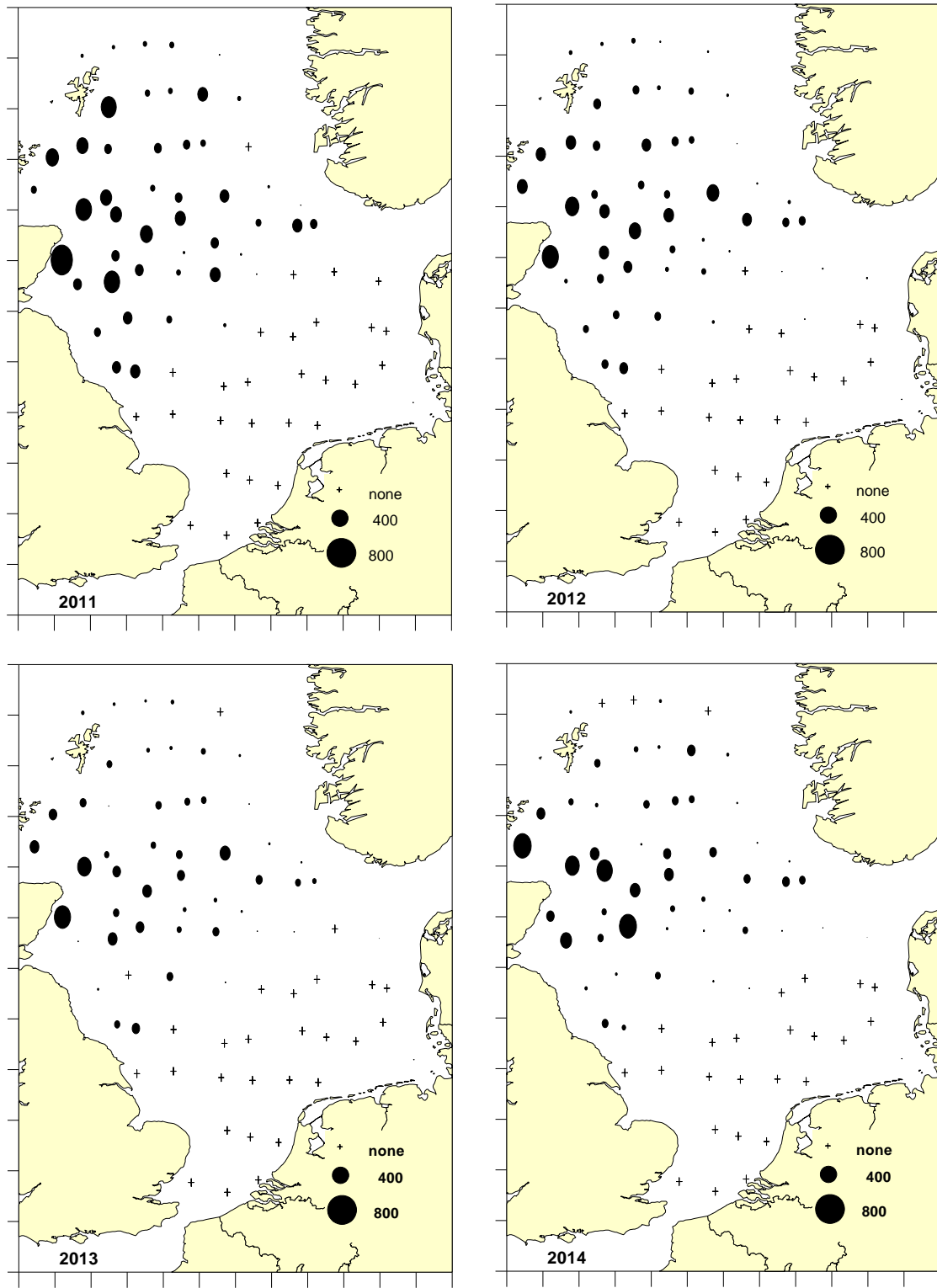


Figure 8: Distribution and relative abundance (kg) of haddock for 2011 to 2014.

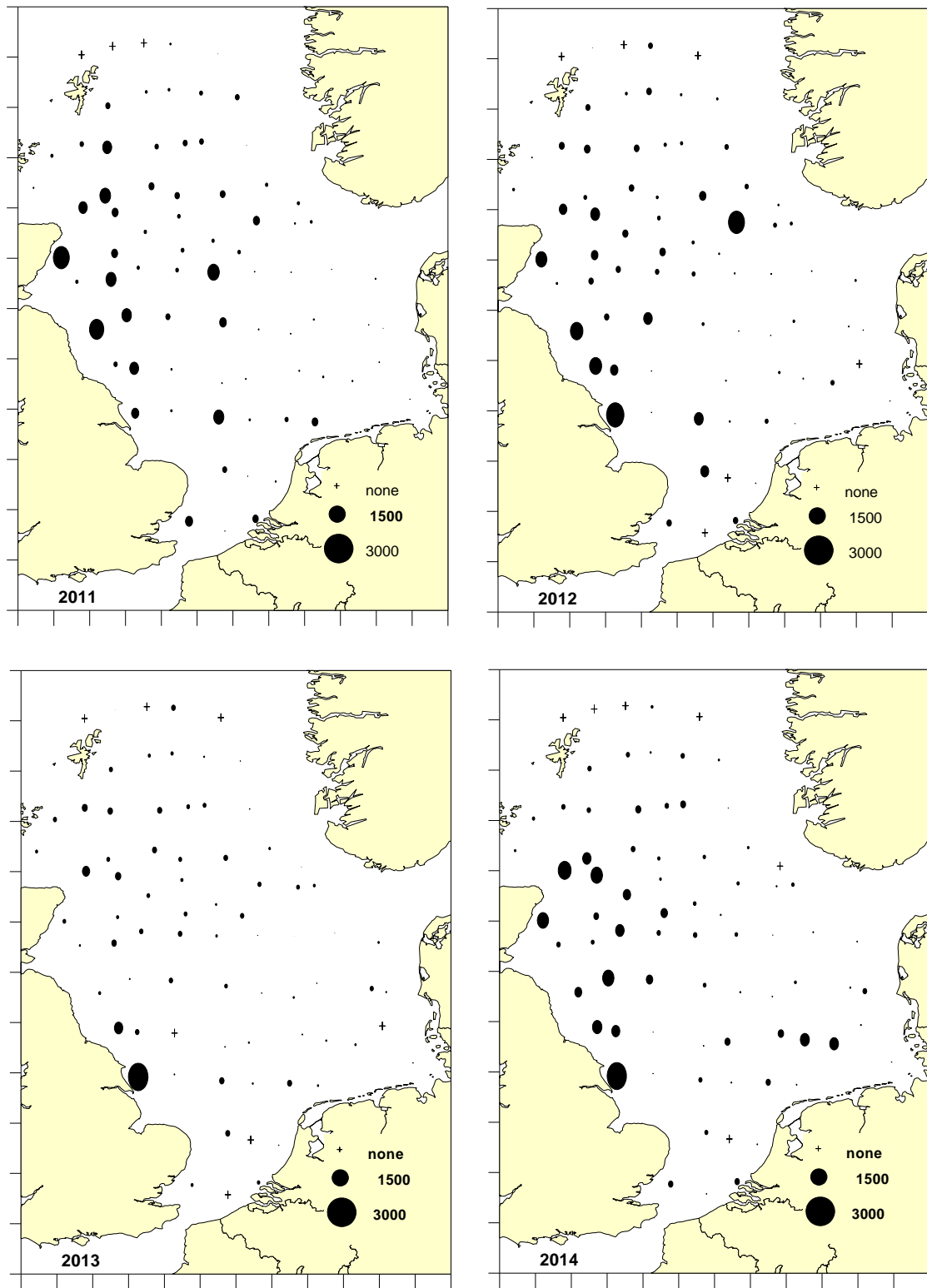


Figure 9: Distribution and relative abundance (kg) of whiting for 2011 to 2014.

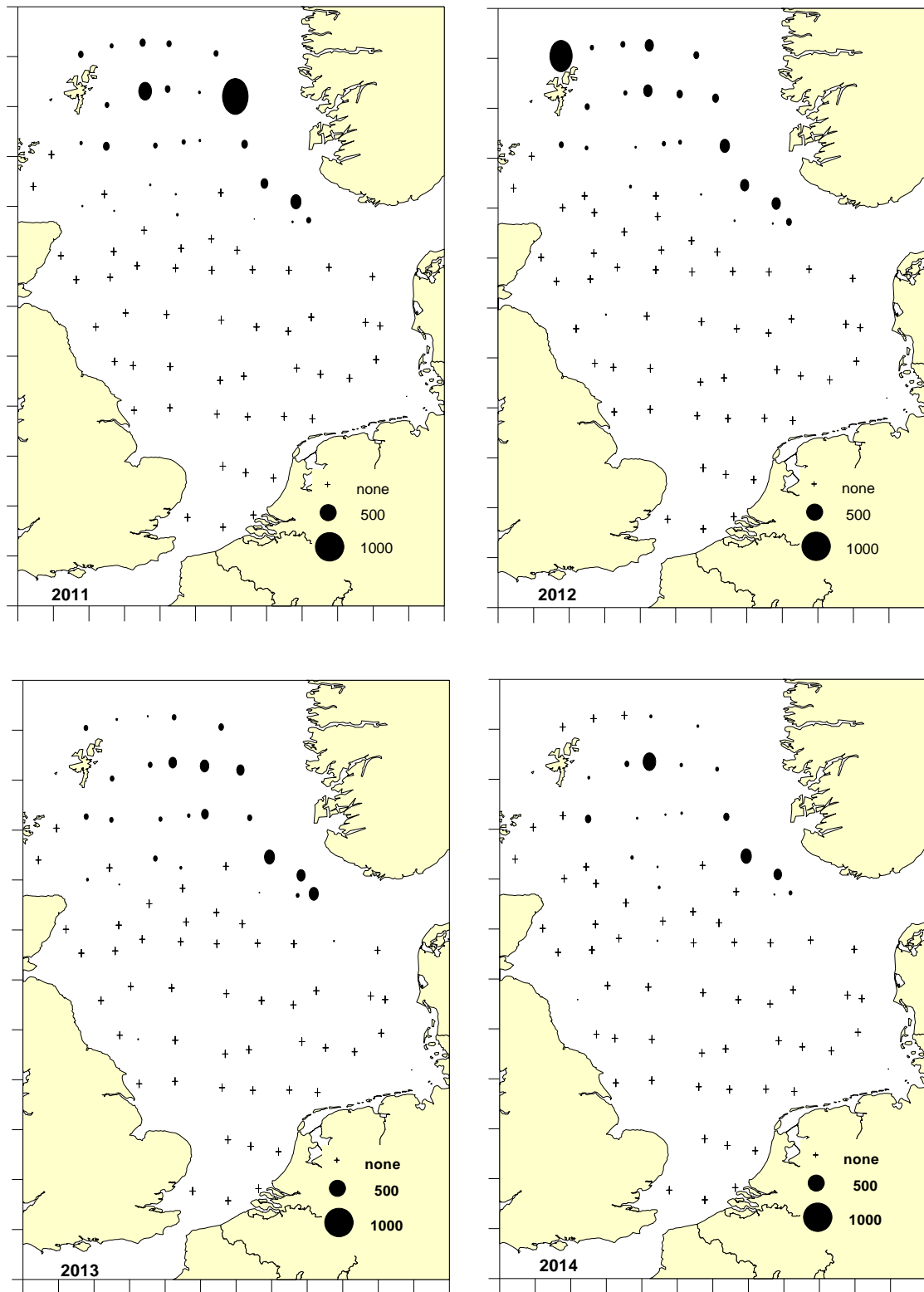


Figure 10: Distribution and relative abundance (kg) of saithe for 2011 to 2014.

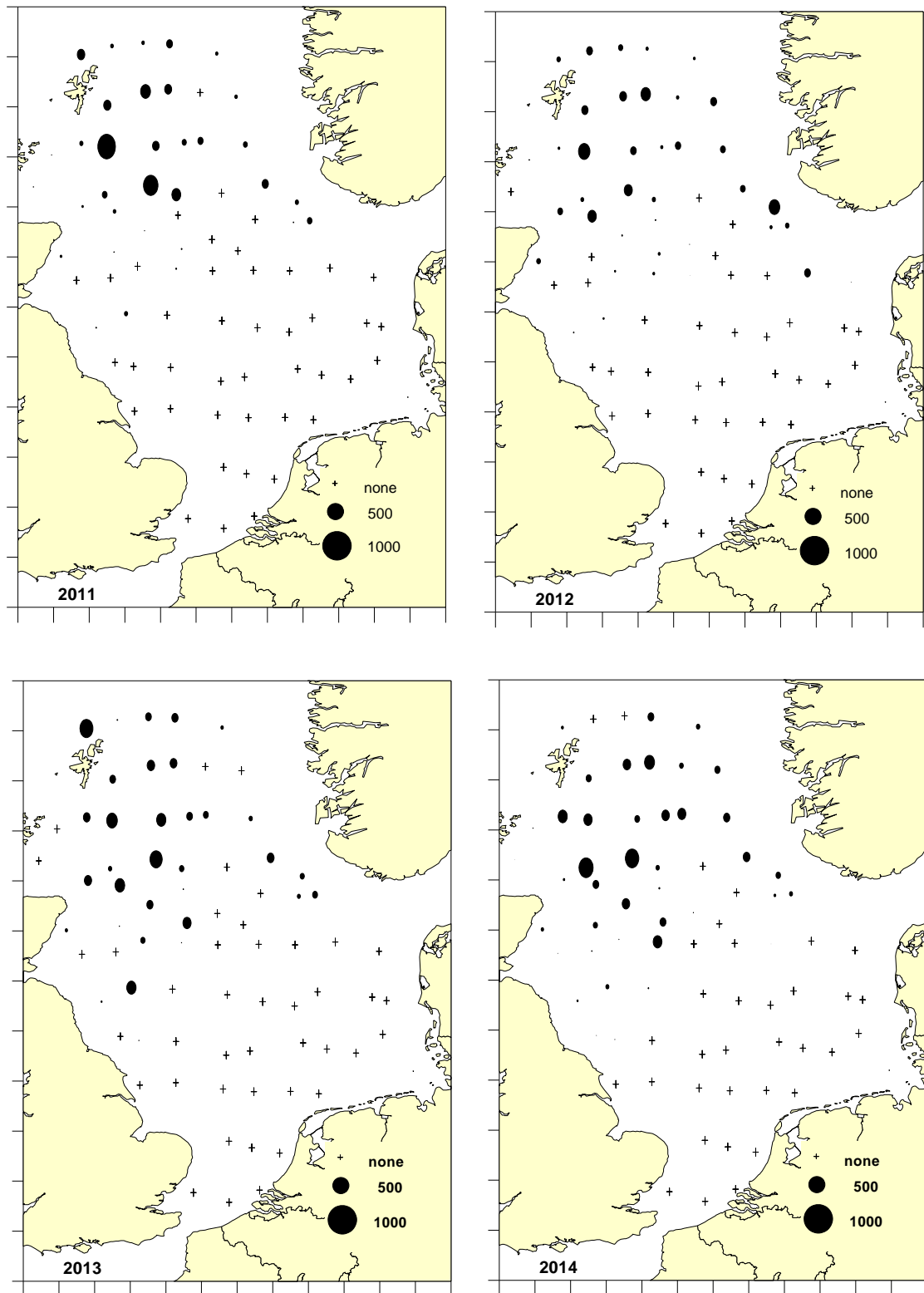


Figure 11: Distribution and relative abundance (kg) of Norway pout for 2011 to 2014.

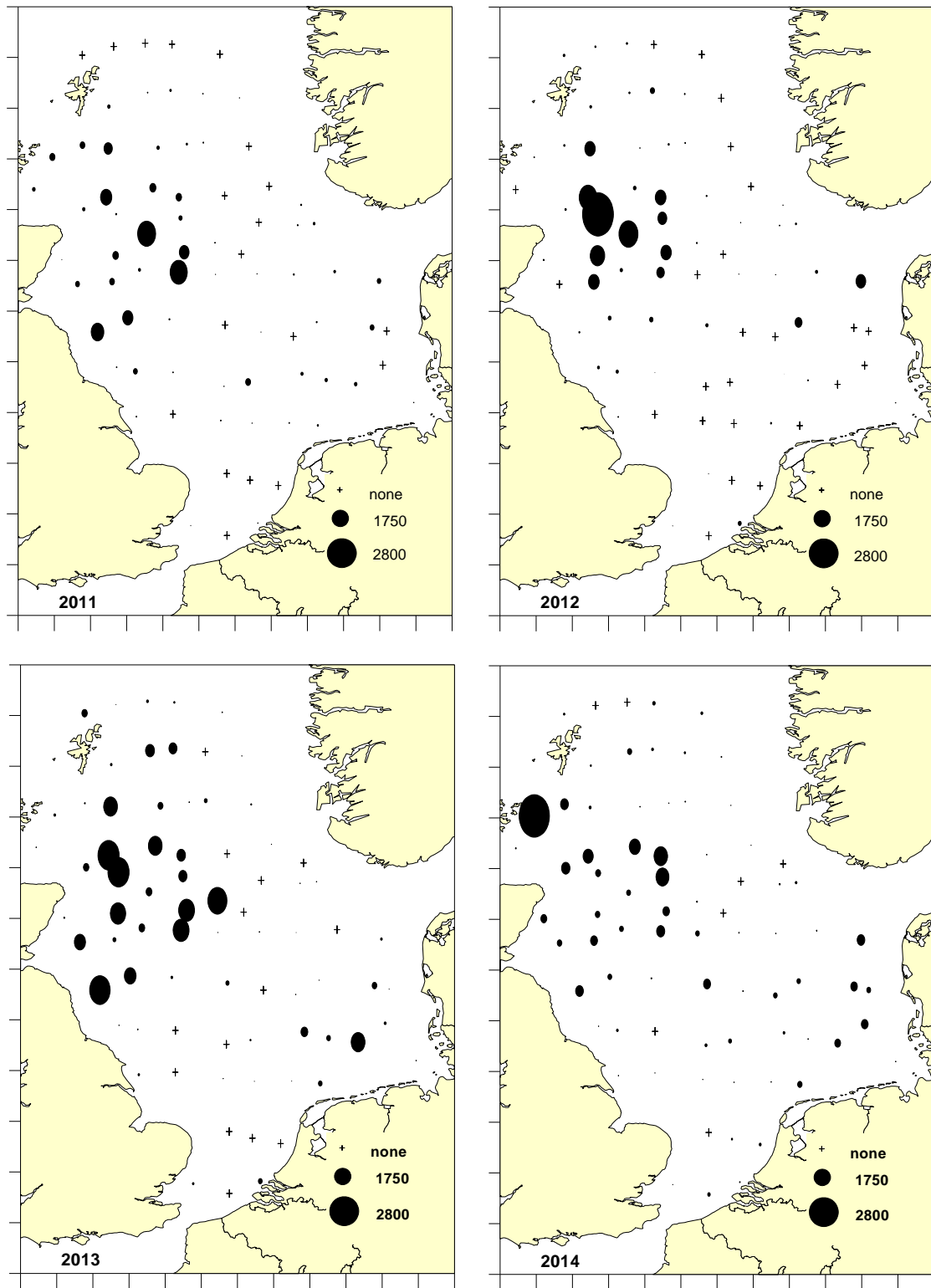


Figure 12: Distribution and relative abundance (kg) of herring for 2011 to 2014.

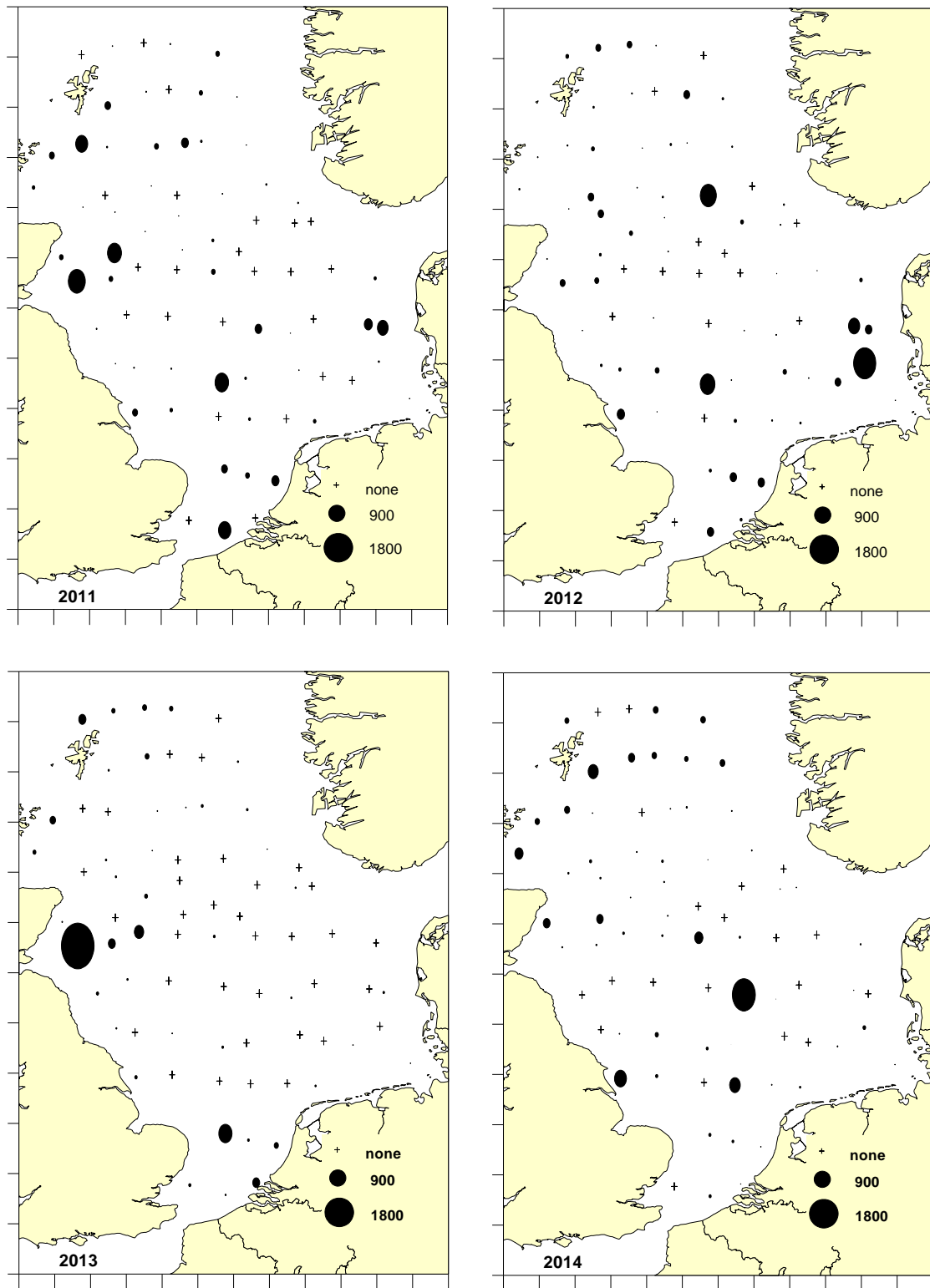


Figure 13: Distribution and relative abundance (kg) of mackerel for 2011 to 2014.

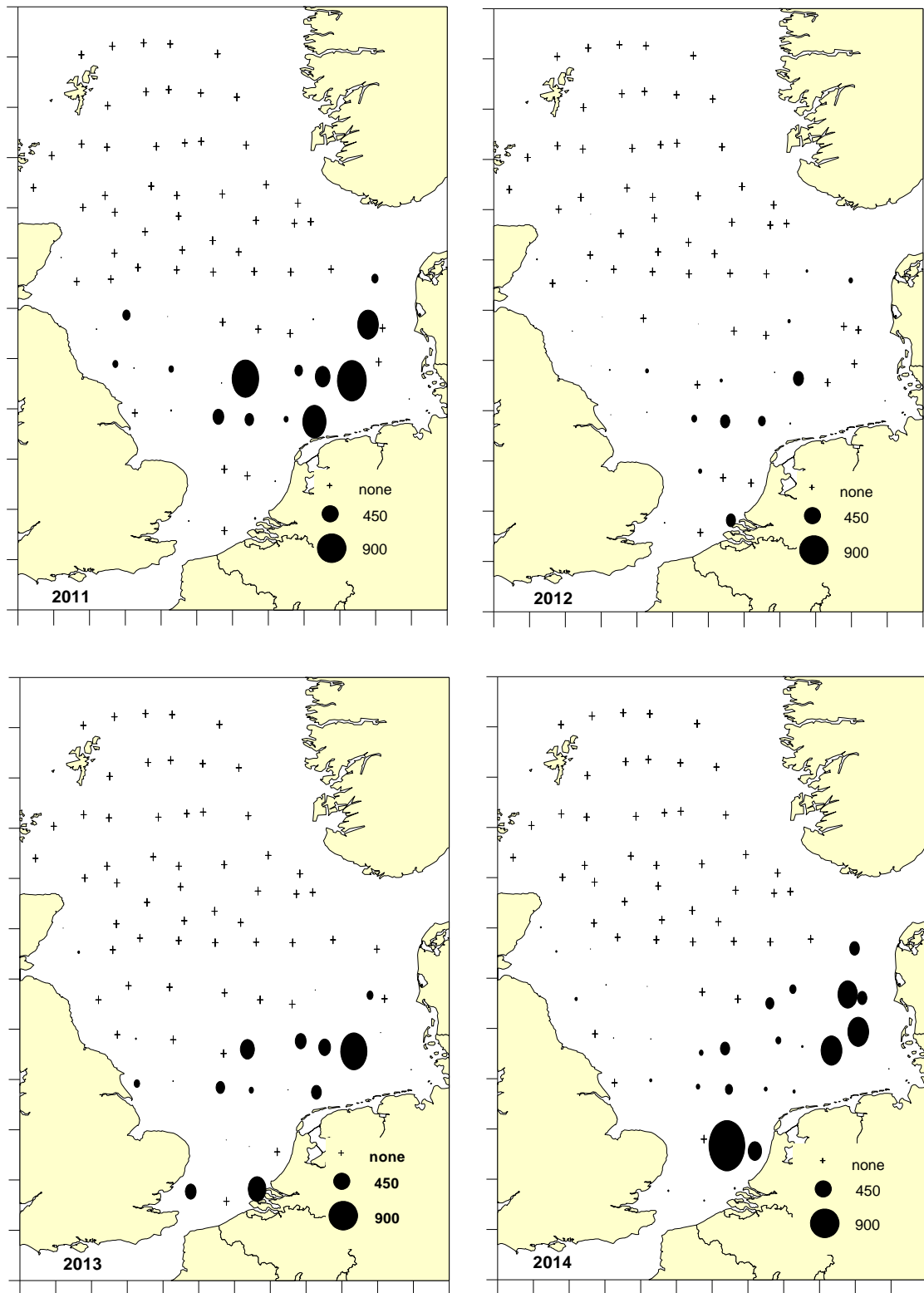


Figure 14: Distribution and relative abundance (kg) of sprat for 2011 to 2014.

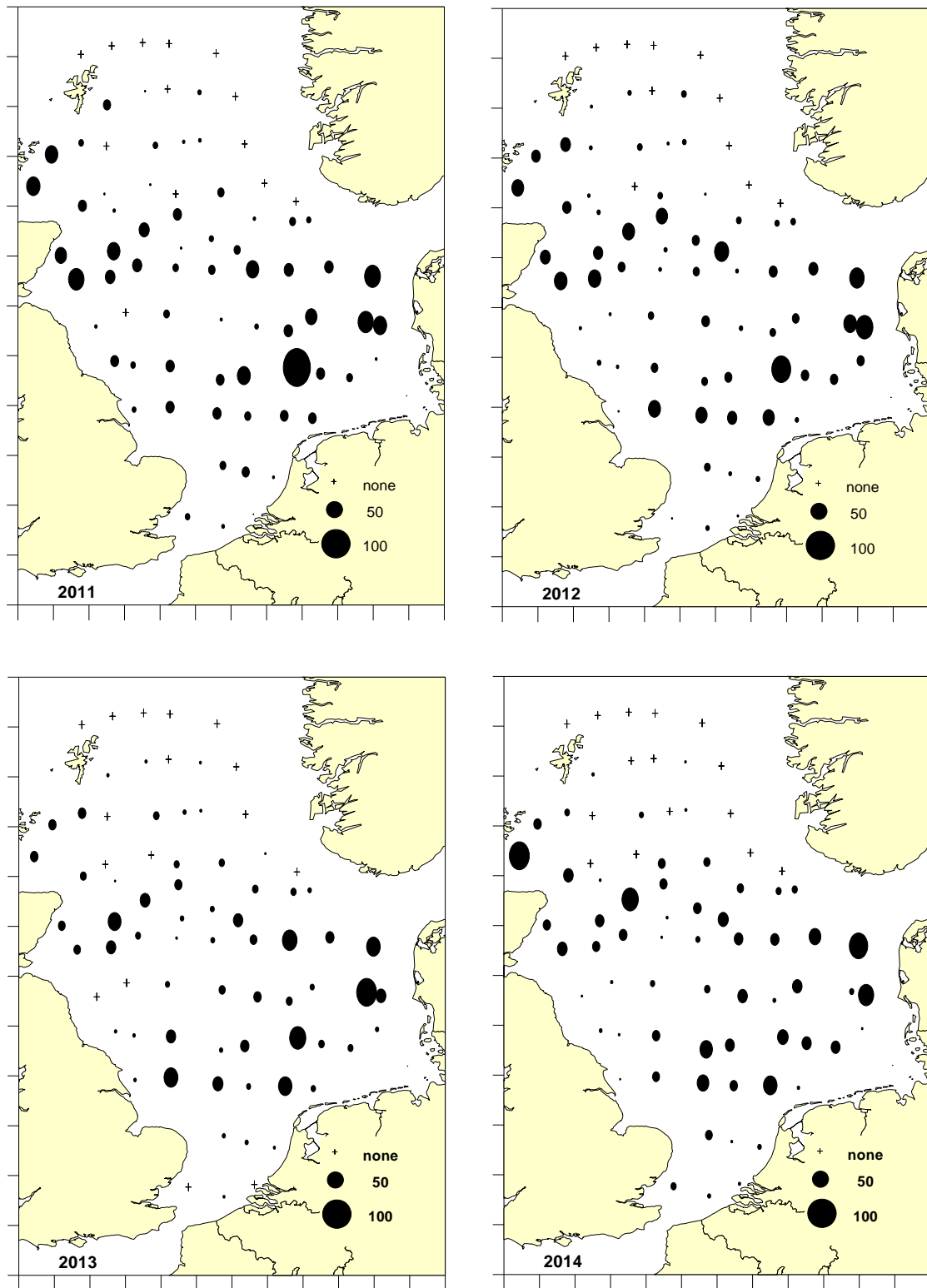


Figure 15: Distribution and relative abundance (kg) of plaice for 2011 to 2014.

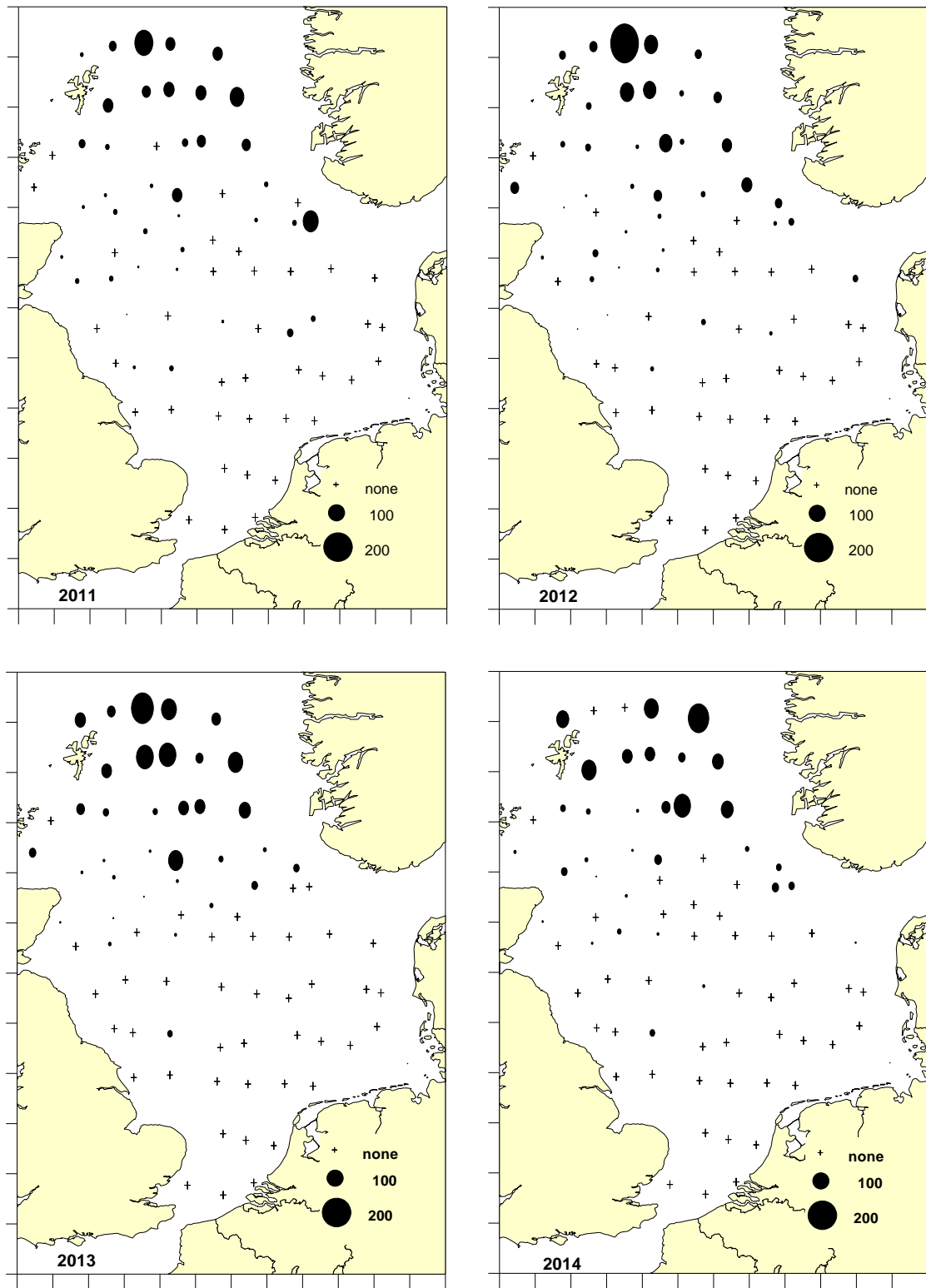


Figure 16: Distribution and relative abundance (kg) of hake for 2011 to 2014.