Centre for Environment Fisheries & Aquaculture Science

Cefas

RESEARCH VESSEL SURVEY REPORT

RV CEFAS ENDEAVOUR
Survey: CEND 08/2022
International Triennial England (Cefas) 2022 Mackerel Egg Survey (MEGS)

STAFF:

Name	Role
Linford Mann	SIC
Richard Nash	2IC
Matthew Eade	Shift lead, adult fish Deckmaster and plankton taxonomist
James Pettigrew	Shift lead and plankton taxonomist
Samantha Barnett	Adult fish Deckmaster and plankton taxonomist
Nevena Almeida	Data manger and plankton taxonomist
Robert Van Ree	Deputy data manager and plankton taxonomist
Amy Larter	plankton taxonomist
Chyanna Allison	Statistician, data quality manager and plankton taxonomist
Emanuele Reggiani	Instrument engineer
Axayacatl Molina-Ramirez	Instrument engineer
Nuala Campbell	MARINElife surveyor

DURATION: 04 - 28 June (24-days)

LOCATION: North Sea (ICES Sub-Area 4)

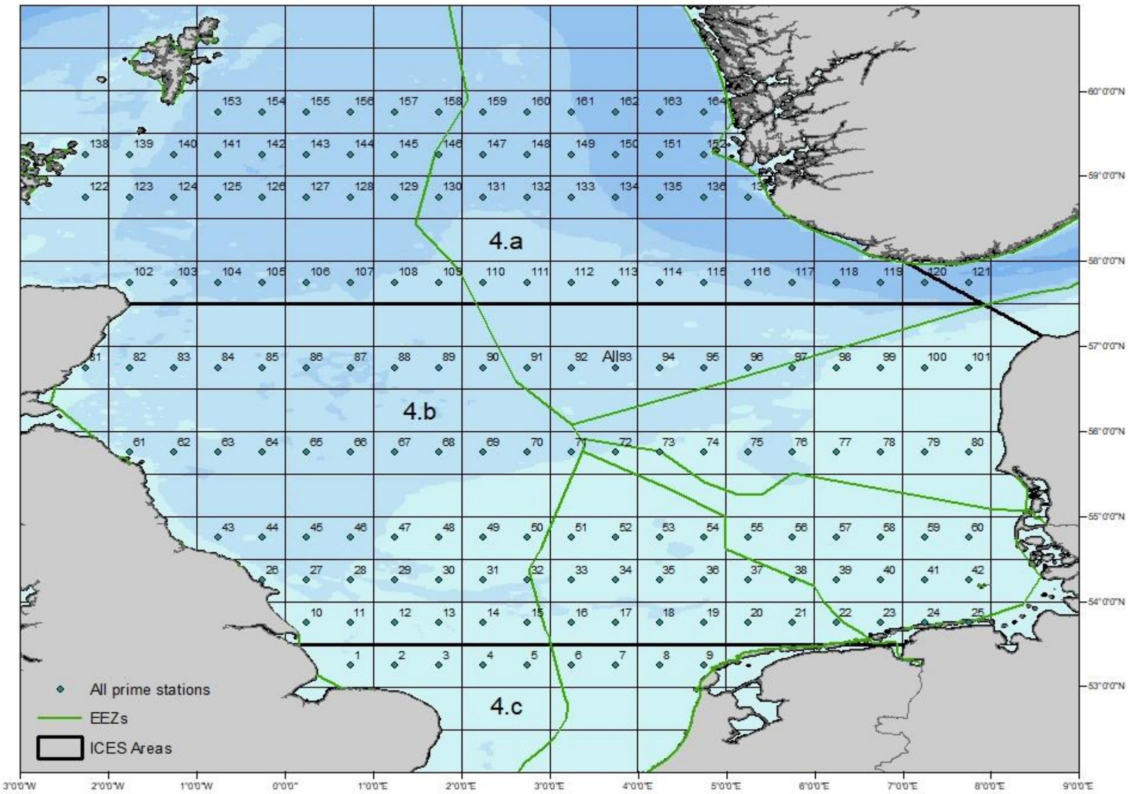

Figure 1. England (Cefas) 2022 MEGS planned survey area. Ichthyoplankton Prime station locations indicated with green diamonds.

AIMS:

PRIMARY:

1. To collect ichthyoplankton samples with the Gulf VII high-speed plankton sampler at all 164 Prime stations. Analysis to be conducted and completed onboard.

2. To conduct rod and line fishing at 10 non-fixed-position stations to collect a minimum of 45 adult female Atlantic mackerel per station. Ideally, fishing will occur once per transect line. Full biological data and fecundity samples to be collected onboard.

SECONDARY:

3. To collect microzooplankton 'PUP' samples via the Gulf VII high-speed plankton sampler at all 164 Prime stations.

4. To conduct Plankton Image (PI) sampling via the onboard flowthrough system.

5. To collect cetacean and seabird data via the onboard MARINElife surveyor.

NARRATIVE: (ALL TIMES ARE GMT)

Scientific crew joined the vessel at Lowestoft port at 0800hr 4 June, proceeding with COVID-19 lateral flow testing as required. The RV Cefas Endeavour (CEND) sailed from Lowestoft at 1300hr 4 June, steaming to a location 2 NM North of Overstrand, Norfolk to conduct a shakedown tow. The Gulf VII high-speed plankton sampler was deployed to fully test the instruments' hardware (winch operation and response, main net, PUP net and external electronic flowmeters) and software (altitude, depth, temperature, and salinity sensors). On successful completion of the shakedown tow, CEND began survey at Prime 1, completing Prime 2 before 2400hr.

On 5 June, work continued east, completing Primes 3, 4, 5 in the United Kingdom (UK) Exclusive Economic Zone (EEZ). CEND continued east completing Primes 6 and 7 in the Netherlands EEZ. The presence of a shipwreck as well as feeding lesser black-backed gulls at Prime 7 prompted rod and line fishing. Unfortunately, no mackerel or other species were caught over two 20-minute attempts. Work continued east, completing Primes 8 and 9 in the Dutch EEZ in the Texel Traffic Separation Scheme (TSS). Upon completion of the transect line, CEND transited northeast to a new transect line and completed Primes 20 and 21 before 2400hr.

On 6 June, CEND continued east and completed Prime 22 in the Dutch EEZ before continuing east and completing Prime 23 in the German EEZ. CEND transited northeast to a new transect line and completed Prime 42 in the German EEZ. CEND then turned west and completed Primes 41, 40 and 39 in the German EEZ, continuing west and completing Primes 38 in The Dutch EEZ before 2400hr. As a secondary aim, the Plankton Imager (PI) sampler was started.

On 7 June, operations were paused between 2400 and 0300hr due to poor weather conditions (Force 9 severe gale). CEND resumed operations and continued west completing Primes 37, 36, 35, 34 and 33 in The Dutch EEZ. CEND continued west and completed Prime 32. The presence of commercial purse seine fishing vessels south of Prime 32 prompted rod and line fishing. Unfortunately, only non-target species were caught (whiting *Merlangius merlangus* and grey gurnard *Eutrigla gurnardus*). CEND continued west and completed Prime 31. At Prime 31, opportunistic rod and line fishing was conducted. Mackerel *Scomber scombrus* were caught, with full biological sampling and fecundity sampling conducted. Work continued at Prime 30 in the UK EEZ before 2400hr.

On 8 June, CEND continued west and completed Primes 29, 28, 27 and 26. At Prime 26 opportunistic rod and line fishing was conducted. Mackerel were caught and full biological sampling and fecundity sampling was achieved. Non-target species were also caught (whiting). CEND transited northwest to a new transect line and completed Prime 43. CEND again transited northwest to a new transect line and completed Prime 61 before tuning east and completing Primes 62 and 63 before 2400hr.

On 9 June, CEND continued east completing Primes 64, 65, 66, 67, 68, 69, 70 and 71 in the UK EEZ. CEND continued east and completed Primes 72 and 73 in the Germany EEZ before continuing east and completing Prime 74 in the Denmark EEZ before 2400hr.

On 10 June, CEND continued east completing Primes 75, 76, 77, 78 and 79. At Prime 79 rod and line fishing was conducted. Unfortunately, no fish were caught. CEND continued east and completed Prime 80 before transiting north to a new transect line and completing Prime 101 in the Danish EEZ. While transiting between Primes 80 and 101, acoustic sensors detected shoaling pelagic fish so rod and line fishing was conducted. Mackerel were caught and full biological sampling and fecundity sampling was achieved. Non-target species were also caught (grey gurnard). CEND continued north and completed Prime 121 in the Norwegian EEZ before 2400h. The PI sampler was restarted due to image quality issues (abundance of bubbles in the water) as well as a lack of available file memory.

On 11 June, the Gulf VII unfortunately experienced issues with the main net electronic flow meter. The Gulf VII was retrieved and inspected, with various components replaced to resolve the issue. With the Gulf VII fully operational, CEND transited west and completed Primes 120, 119, 118 and 117. Between Primes 121 and 117, high numbers of euphausiids were caught due to sampling at depths of ~200m. At these stations, a thermocline was also detected via the Gulf VII temperature sensor. To avoid issues with the Gulf VII sensors at greater depths and to reduce the catches of euphausiids, sampling depth was limited to 20m below the base of thermoclines, where temperature change was observed greater than 2.5°C across a 10m depth interval. CEND continued west and completed Primes 116, 115, 114 and 113 before 2400hr.

On 12 June, CEND continued west and completed Primes 112, 111 and 110 in the Norwegian EEZ. At Prime 111, the main net electronic flow meter was damaged due to unsecure fittings. The equipment was repaired, and the station was repeated. Prior to the survey, the Prime stations located south of Shetland Island, east of Orkney Island, and east of Aberdeenshire and Angus that historically contained low numbers of mackerel eggs were discussed with the survey co-ordinator for The Working Group on Mackerel and Horse Mackerel Egg Surveys (WGMEGS). With preliminary data from the DTU-Aqua 2022 MEGS also confirming this information it was agreed that the Cefas MEGS would discount every other Prime station towards of the western end of the transect line (removing Primes 107, 105 and 103). CEND continued west and completed Primes 109, 108, 106 and 104 in the UK EEZ before 2400hr.

On 13 June, CEND completed Prime 102, transiting northwest to a new transect line and completing Prime 122. CEND again transited northwest to a new transect line and completed Prime 138 before turning east and completing Prime 139. After completing Prime 139, acoustic sensors detected shoaling pelagic fish near the seabed so rod and line fishing was conducted. Mackerel were caught and full biological sampling and fecundity sampling was achieved. Non-target species were also caught (whiting, grey gurnard, Atlantic cod *Gadus morhua*, and haddock *Melanogrammus aeglefinus*). CEND continued east and completed Primes 140, 141, 142 and 143 before 2400hr.

On 14 June, CEND continued east and completed Primes 144 and 145 in the UK EEZ. CEND continued east completing Primes 146, 147, 148, 149, 150, 151 and 152, before transiting north to a new transect line and completing Prime 164 in the Norwegian EEZ. At Prime 149 two calibration tows were conducted to review the Gulf VIIs electronic flow meters. Calibration data will be used to calculate flow rates and sample volumes. During transit between Primes 152 and 164 an additional assessment tow was also conducted to test the Gulf VIIs electronic sensors in deeper waters (254m). The tow was also conducted to resolve wire spooling issues which had occurred in deep waters but could not be addressed until the vessel had returned to deeper waters. All tests were successful and all issues were resolved as expected before 2400hr.

On 15 June, CEND turned west to a new transect line and completed Primes 163, 162, 161, 160 and 159 in the Norwegian EEZ. CEND continued west and completed Primes 158, 157, 156, 155, 154 and 153 in the UK EEZ. At Prime 162, rod and line fishing was conducted in the upper water column, yielding 64kg of mackerel. Full biological sampling and fecundity sampling was achieved, with processing of catch continuing across shift handover at 2400hr.

On 16 June, CEND turned southwest to a new transect line and completed Prime 123, before turning east and completing Primes 124, 125, 126, 127 and 128. At 1300, a ringed feral pigeon landed on the vessel. The pigeon was dehydrated and malnourished and was kept onboard for rehoming upon return to port. At Primes 123, 124 and 126 the Gulf VII suffered data transmission issues which delayed progress. All issues were resolved, and the Prime stations repeated. While transiting between Primes 126 and 127, acoustic sensors detected the presence of shoaling pelagic fish. As such, rod and line fishing was conducted but unfortunately, only non-target species were caught (haddock). CEND continued east and completed Prime 129 in the UK EEZ before 2400hr.

On 17 June, CEND continued east completing Primes 130, 131, 132 and 133 in the Norwegian EEZ. At Prime 131 rod and line fishing was conducted but unfortunately, only non-target species were caught (haddock). During deployment of the Gulf VII at Prime 134, the instrument suffered data transmission issues resulting in an invalid tow. Software and hardware adjustments were conducted to rectify the issue. To utilise downtime, rod and line fishing was conducted, yielding 11.8kg of mackerel. Full biological sampling and fecundity sampling was achieved, with processing of catch continuing across shift handover at 2400hr.

On 18 June, following 23hrs of software and hardware adjustments as well as calibration trails, both Gulf VIIs were again operating to acceptable parameters. To utilise the downtime, station data was QCed, several preserved backlog samples were analysed, and data visualisations (flow meter, 'V' profile deployment, temperature, and salinity profiles) were produced. When survey operations resumed, CEND continued east and completed Primes 134, 135, 136 and 137 before 2400hr.

On 19 June, CEND transited southwest to a new transect line and completed Primes 100, 99, 98 in the Danish EEZ. CEND continued west and completed Primes 97 and 96 in the Norwegian EEZ. At Prime 96, rod and line fishing was conducted but only non-target species were caught (grey gurnard).

On 20 June, CEND continued west completing Primes 95, 94, 93 and 92 in the Norwegian EEZ. At Prime 92, rod and line fishing was conducted but only non-target species were caught (haddock). At Prime 91, during standard deployment of the Gulf VII, the Rochester wire pulled through the cheek of the aft gantry suspended block, dropping the Gulf VII 30cm onto the deck. No injury to crew was reported and no damage to the Gulf VII was sustained. An incident investigation was conducted, which confirmed that the deployment Risk Assessment (RA) and Standard operating Procedure (SOP) had been followed correctly as required during normal deployment conditions and favourable weather. Investigation of the incident identified minor damage to the Rochester wire. A data communication test highlighted continued working connectivity of the wire. However, as the integrity of the wire and the internal cables could not be guaranteed the wire was re-terminated to remove the crushed point. The connection cable was spliced and moulded with resin requiring 24hrs cure time. To utilise the 24hr downtime, the Gulf VII was connected to the onboard sidescan sonar wire. Following a toolbox talk and review of sidescan sonar wire RA and SOP, a trial deployment was successfully conducted. With the Gulf VII and wire working as required, CEND continued operations and completed Prime 91 in the Norwegian EEZ before 2400hr.

On 21 June, CEND continued west and completed Primes 90, 89, 88, 87, 86, 85, 84, 83 and 82 in the UK EEZ. During transit between Primes 86 and 85 two calibration tows were conducted to review the Gulf VIIs electronic flow meters. Calibration data will be used to calculate flow rates and sample volumes. At Prime 82, decision was made to revert to the re-terminated, repaired and load cell tested Rochester wire. Following a toolbox talk, deployment of the Gulf VII was successfully conducted. At Prime 82, rod and line fishing was conducted but only non-target species were caught (whiting and haddock).

On 22 June, CEND transited southeast to a new transect line. During transit, four calibration tows were conducted to review electronic flow meter and KC Denmark mechanical flow meter data. Information will be used to calculate flow rates and sample volumes. At the new transect line, CEND completed Prime 44 however the Gulf VII main net electronic flow meter readings became inconsistent and unreliable. To resolve the issue, the electronic flow meter was removed and replaced by a KC Denmark mechanical flow meter. Following successful deployment, the mechanical flow meter in the Gulf VII main net was used for the remainder of the survey. CEND transited east and completed Primes 45 and 46 in UK waters before 2400hr.

On 23 June, CEND transited east to a new transect line and completed Primes 48, 49 and 50 in the UK EEZ. At Prime 49, data via the re-terminated Rochester wire became inconsistent and unreliable. To resolve the issue, operations again reverted to the onboard sidescan sonar wire for deployment of the Gulf VII. To utilise wire change downtime, opportunistic rod and line fishing was conducted at Prime 49, yielding a single mackerel. CEND continued east and completed Primes 51, 52, 53 and 54 in the Dutch EEZ, before continuing east and completing Primes 55 and 56 in the German EEZ. At Prime 55, the presence of early life stage mackerel eggs from the analysed Prime 54 sample prompted rod and line fishing, yielding a single mackerel.

On 24 June, CEND continued east and completed Primes 57, 58, 59 and 60 in the German EEZ before transiting southwest to a new transect line. At 1730hr, all survey operations were suspended following instruction from Cefas in Lowestoft in order to resolve some outstanding operational health and safety concerns. CEND therefore began the 2-day transit to Lowestoft under economic speed.

On 25 June, CEND continued transit southeast to Lowestoft port. To utilise downtime, station metadata was reviewed and QCed, several preserved and backlogged samples were analysed, and visualisations of data (flow meter, 'V' profile deployment, temperature, and salinity profiles) were completed.

On 26 June, CEND returned to Lowestoft port at 0800hr. Cefas staff remained onboard to conduct final reanalysis of ichthyoplankton outliers highlighted from QC review.

On 27 June, Cefas staff completed final review of ichthyoplankton outliers. Data were consolidated to meet MEDIN metadata requirements. MEGS and fisheries survey gear was cleaned, labelled, and stored in calicos. Fisheries calicos were moved to the CEND Net Store for future fishing surveys, and MEGS calicos were removed from the vessel during demobbing. All Cefas staff disembarked at 1400hr.

RESULTS:

Primary aims

Aim 1
Ichthyoplankton samples

The primary aim of the International Triennial Cefas (England) 2022 Mackerel Egg Survey (MEGS) is to collect Atlantic mackerel (*Scomber scombrus*) and Atlantic horse mackerel (*Trachurus trachurus*) egg data to estimate the total annual egg production and Spawning-Stock Biomass (SSB) for the western and North Sea mackerel stock. The survey also provides a relative abundance index of spawning for horse mackerel in the northeast Atlantic.

To collect ichthyoplankton data, the MEGS used a Gulf VII high-speed plankton sampler (Figure 2). To provide contingency, two Gulf VIIs (A and B) were on-board for the survey and substituted during periods of equipment maintenance, calibration, and repair. Each Gulf VII was equipped with three Valeport electronic flow meters (internal, external and PUP), a Conductivity-Temperature-Depth (CTD) unit (including fluorescence), an altimeter sensor, and a tilt/roll sensor. Both Gulf VIIs included variations in design specification (Table 1).

Data were transmitted from the Gulf VII via the Rochester wire to the CEND. This allowed data to be displayed in real-time for observing double oblique haul profiles and associated physical data (temperature, salinity, and fluorescence) as well as flow rates from the Valeport electronic flow meters. For each deployment, a specific summary file was compiled:

- Tow identifier number (Prime No. and STN No.)
- Date
- Time
- Shoot and haul latitude and longitude

- ICES Statistical rectangle
- Bottom depth (from CEND sounder)
- Haul duration
- Distance over ground
- Maximum sampled depth
- Water volume filtered (internal, external and PUP)
- Temperature
    - 5m
    - 20m
    - 50m
    - 100m
    - Maximum sampled depth
- Salinity
    - Surface (5m)
    - 20m
    - Maximum sampled depth

A typical operation consisted of the Gulf VII high-speed sampler, attached to the Rochester wire via the aft gantry suspended block and Gilson winch, being deployed from the stern of CEND. A warp length appropriate to the depth of water (generally using a ratio of 3:1) was used. The sampler was deployed at an appropriate speed for the depth and conditions (~0.5-1.5m/s). When the maximum sampling depth was achieved (5-10m from the seabed) the sampler was hauled at an appropriate speed to the surface (~0.5-1.5m/s) to create an even double oblique haul profile (Figure 4). An even double oblique haul profile was required to filter the same volume of water from each depth band. For shallow depth stations, multiple double oblique hauls were conducted until the minimum sampling time (15 minutes) was achieved (Figure 5).

Expected filtered water volume via the electronic flow meters was also required (Figure 6). Temperature and salinity data was reported from double oblique haul ascension at 20m depth. If data was not available at 20m, the maximum sampled depth data was used. If multiple double oblique hauls were completed, an average temperature was obtained from all oblique haul ascensions at 20m depth.

Station and deployment details were manually entered into the Fishing Survey System (FSS) using information collected from the Transas bridge logging system and bridge logbook. All valid Prime station main net (and PUP net) deployment and environmental data was collated as required (Table 2).

Following successful deployment, the Gulf VII plankton sample was retrieved and appropriately handled. Depending on plankton sample mass and time availability samples were either analysed live or preserved for a minimum of 12hr in 4% buffered formaldehyde for later analysis. Analysis consisted of traditional taxonomic methods using a stereo microscope and reflected top and bottom light (Figure 7). All ichthyoplankton eggs and larvae were identified, removed, and placed in plankton viewing chambers for digital photography. A Single-Lens Reflex (SLR) camera, microscope arm and base configuration (Figure 8) was used to take photographs of all removed ichthyoplankton (Figures 9 & 10). ObjectJ (a plugin of ImageJ - a public domain Java image processing program) was used to digitally measure all ichthyoplankton eggs and corresponding oil globule diameters.

For each Prime station, ObjectJ was used to identify, development stage and count mackerel (Table 3) and horse mackerel (Table 4) eggs. All non-target species eggs were also measured and counted (Table 5).

All larvae were removed and photographed for potential subsequent analysis in the lab. At stations where high numbers of eggs were collected, a subsample was analysed, and an appropriate raising factor applied.

Over the 24-day survey period, a total of 135 out of a planned 164 Prime stations were successfully completed and valid (Table 2 & Figure 3). Unfortunately, 11 stations were unsuccessful and invalid (Primes 1, 2, 3, 4, 5, 6, 7, 9, 26, 43 and 81) due to technical issues with double oblique hauls, Valeport electronic flow meters, or the temperature sensor. Another 15 stations (Primes 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 24, 25 and 36) were not completed due to CEND returning to Lowestoft port 4-days earlier than planned. A further 3 stations (Primes 103, 105 and 107) were removed from survey plans due to anticipated low numbers of mackerel eggs in the geographic area (as agreed with WGMEGS).

Total mackerel egg abundance per square metre varied across the planned survey area (Table 3 & Figure 11). The greatest distribution and abundance per m² was present in the Norwegian EEZ (predominantly ICES Divisions 4a and b). Lower distribution and abundance per m² was also distributed across the UK EEZ (ICES Division 4b). As expected, geographic locations which displayed greatest distribution and abundance of total mackerel eggs (stage 1A-5) also displayed greater abundance of stage 1A mackerel eggs (Figure 12). Temperature did not appear to be a predictor of the distribution and abundance of stage 1A mackerel eggs as abundance and distribution was observed across a range of reported temperatures (7.2-14.3°C) (Figure 13).

Total horse mackerel egg abundance per square metre was low across the planned survey area (Table 4 & Figure 14), with slightly higher distribution and abundance per m² present in The Dutch, German, and Danish EEZs (ICES Division 4b). As expected, geographic locations which displayed greatest distribution and abundance of horse mackerel eggs also displayed greater abundance of stage 1A horse mackerel eggs (Figure 15). Temperature did not a predictor of the distribution and abundance of stage 1A horse mackerel eggs as distribution and abundance was observed across a range of reported temperatures (11.0-14.3°C) (Figure 16).

The total number of unidentified egg abundance per square metre varied across the planned survey (Figure 17), with highest abundance and distribution per m² present in UK, Norwegian, Danish, German, and the Dutch EEZs (ICES Division 4b).

Figure 2. Gulf VII high-speed plankton sampler.

Table 1. Gulf VII high-speed plankton A and B sampler specifications.

	Gulf VII - A	Gulf VII - B
Total Gulf VII length (cm)	282	277
Length of frame without nose cone (cm)	216	210
Diameter of frame (cm)	42	42
Length of nosecone (cm)	62	63
Diameter of nosecone opening (cm)	20	20
Length of stretched main plankton net (cm)	185	186
Diameter of main plankton net (cm)	42	42
Diameter of main plankton net cod end (mm)	850	800

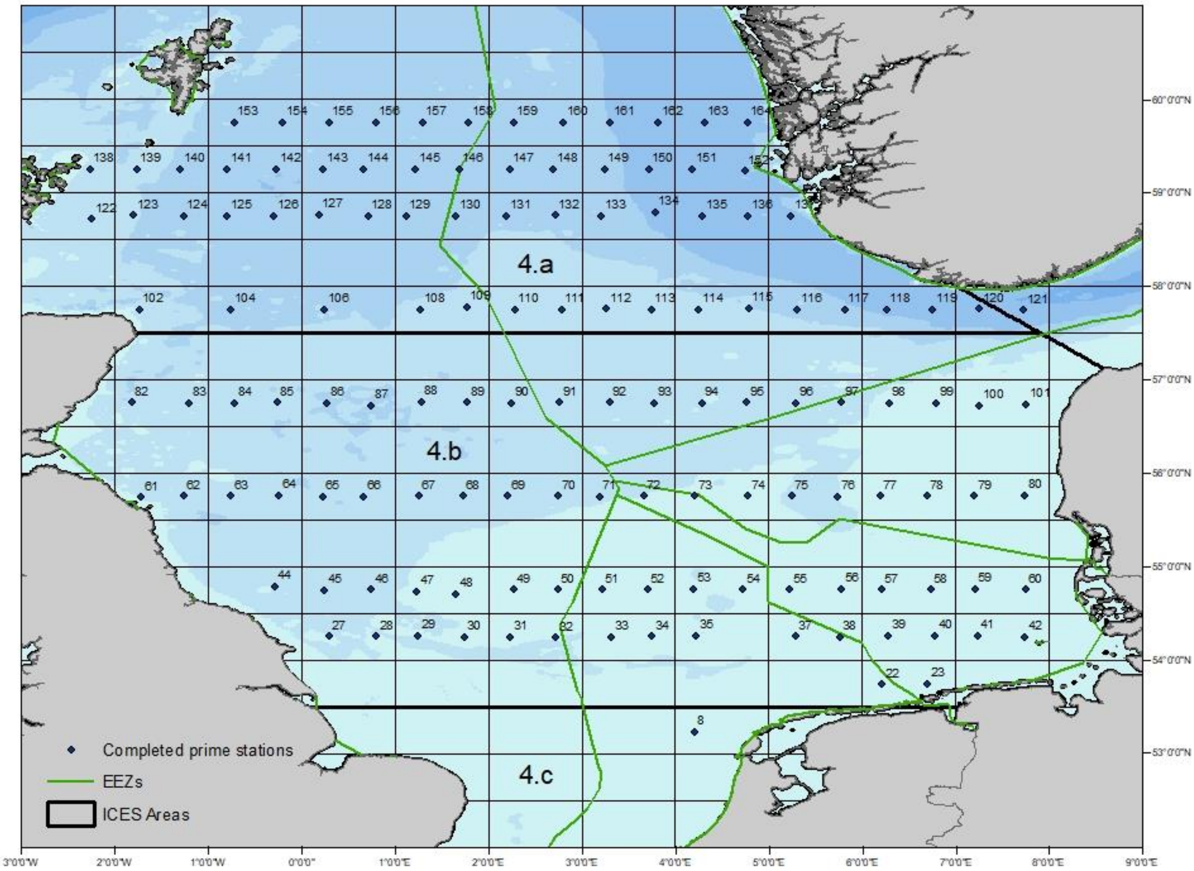

Figure 3. Valid Prime stations completed during the England (Cefas) 2022 MEGS.

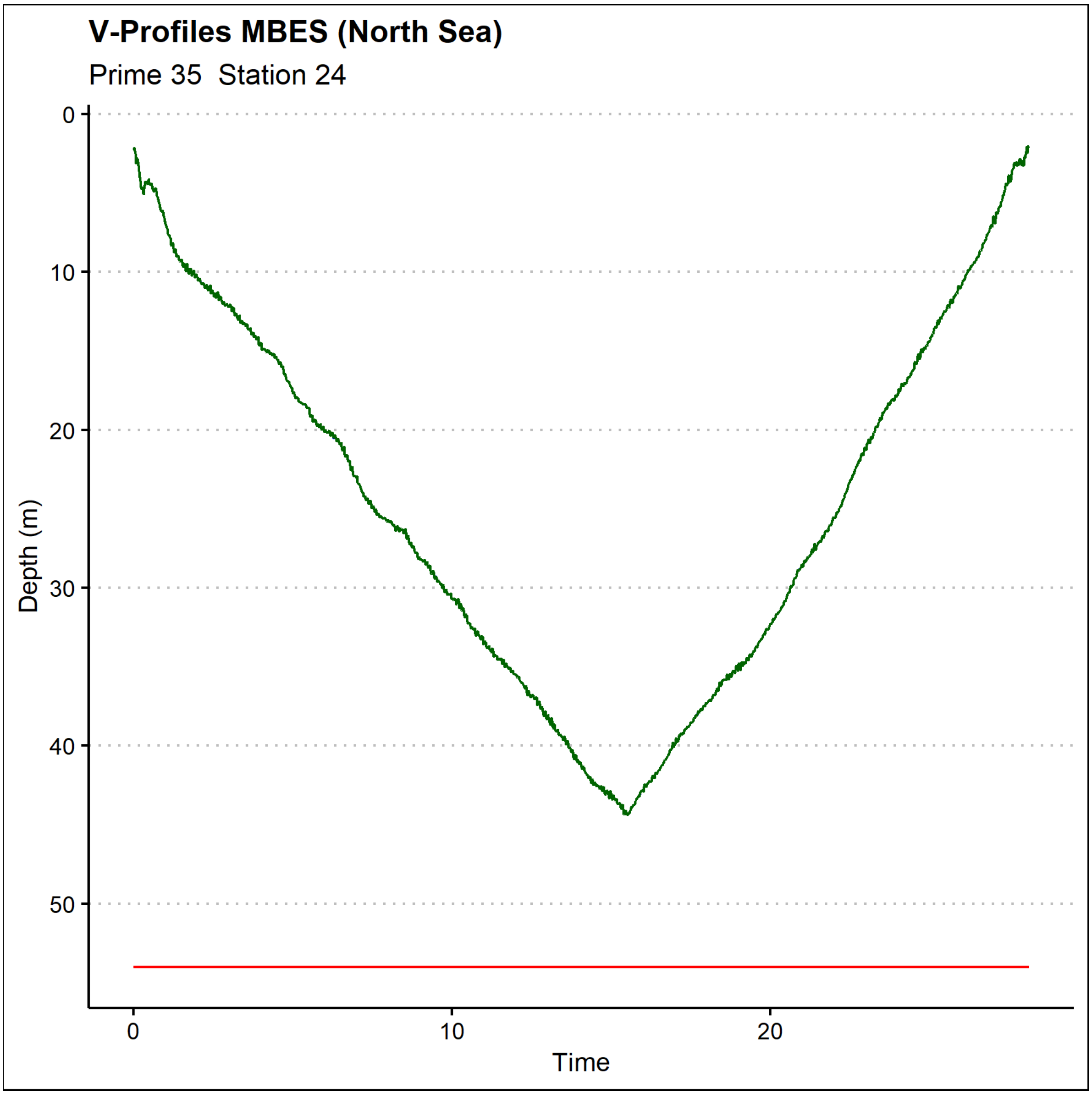

Figure 4. Example of a standard even double oblique haul profile (green) and seabed (red). Data from Prime 35.

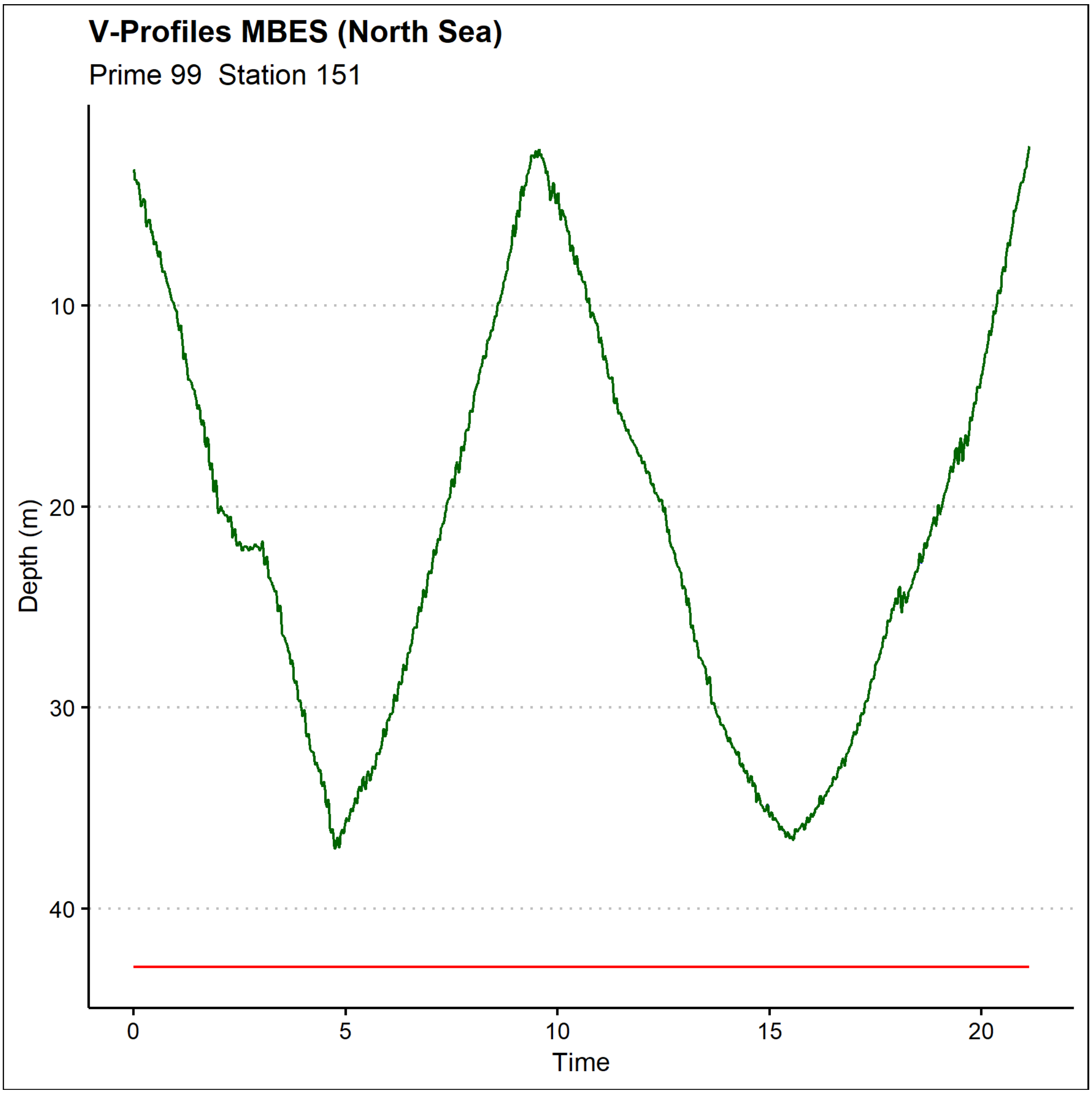

Figure 5. Example of a multiple double oblique haul profile (green) and seabed (red) from a shallow water station. Data from Prime 99.

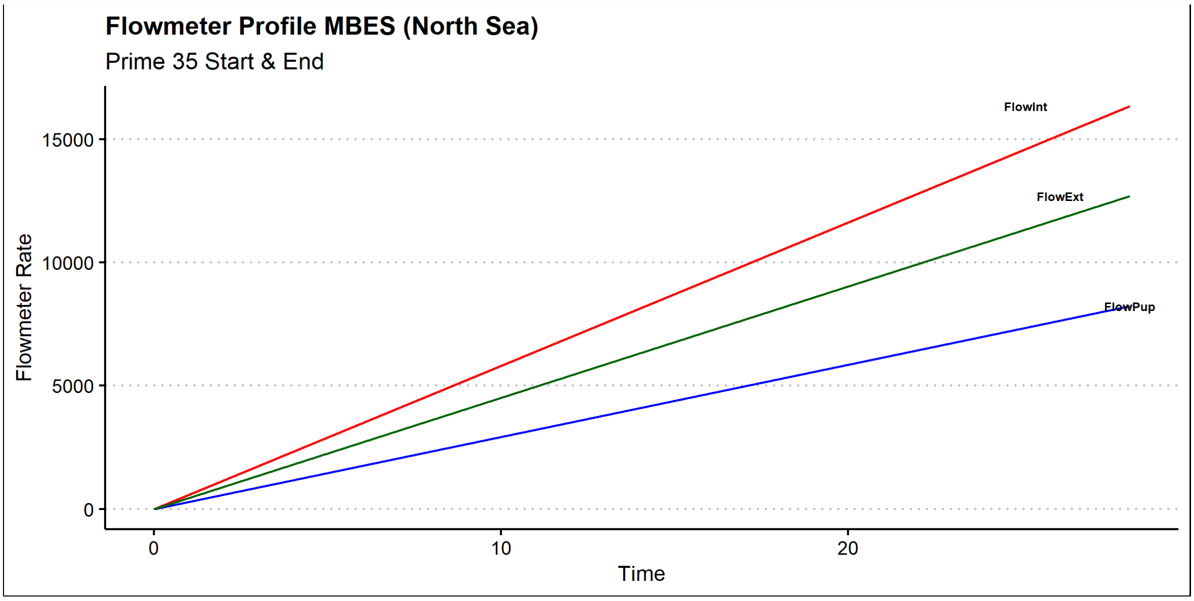

Figure 6. Example of expected filtered water volume via internal (red), external (green) and PUP (blue) Valeport electronic flow meters. Data from Prime 35.

Figure 7. Stereo microscope and reflected top and bottom light used to identify and remove all ichthyoplankton eggs and larvae from samples.

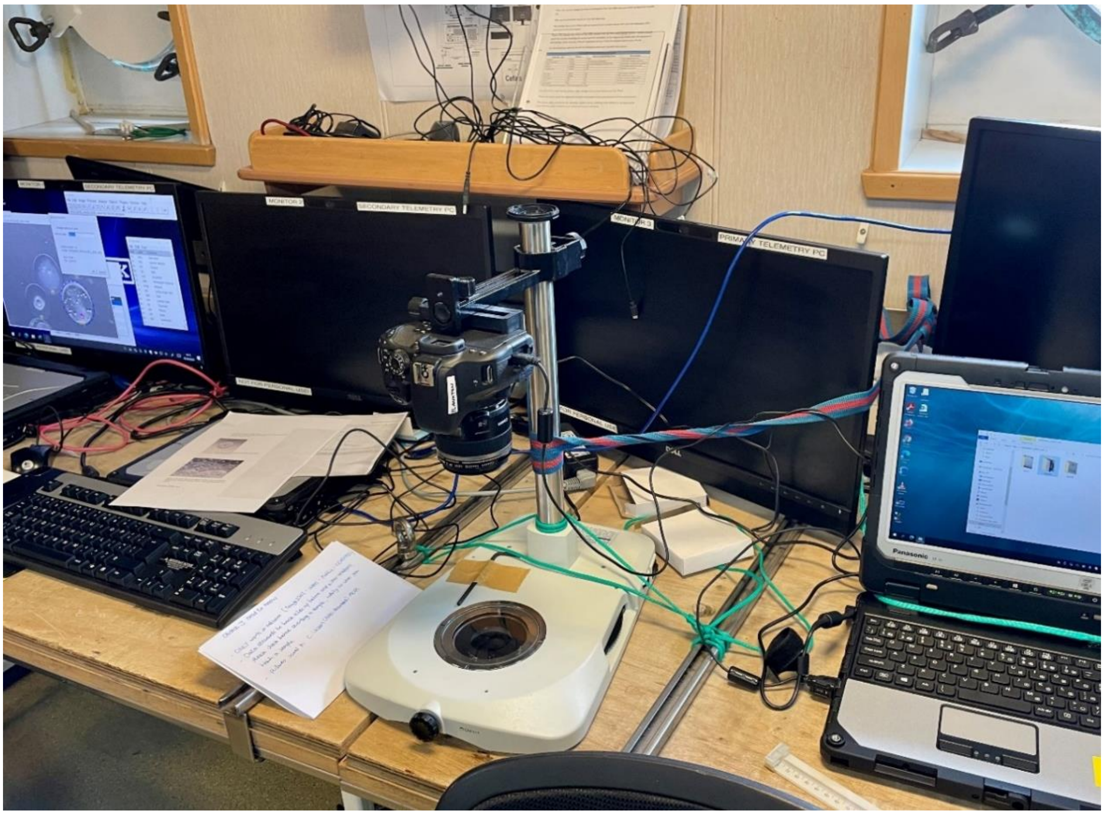

Figure 8. SLR camera, microscope arm and base configuration used to take photographs of ichthyoplankton samples for ObjectJ image analysis.

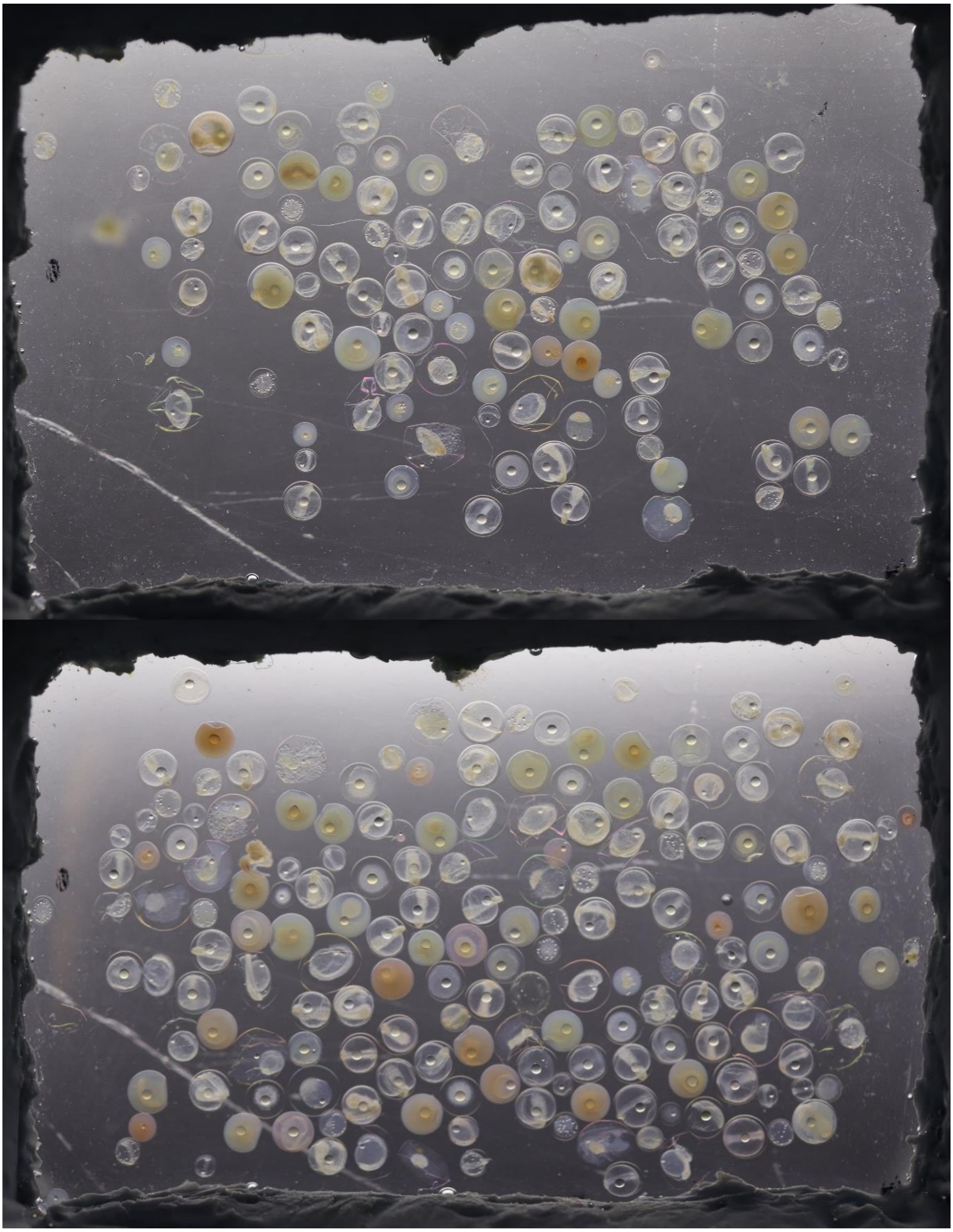

Figure 9. Photographs of all removed ichthyoplankton eggs from main sample. Images from Prime 58.

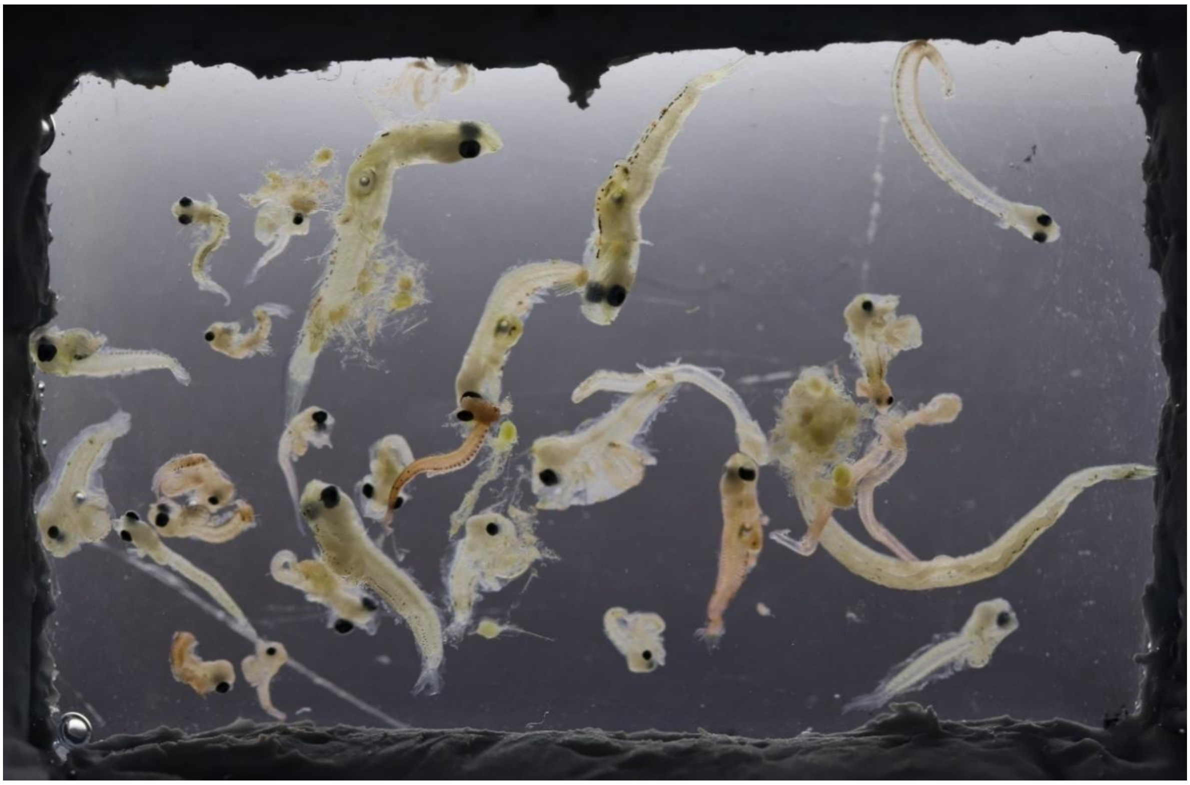

Figure 10. Photograph of unidentified ichthyoplankton larvae. Image from Prime 58.

Table 2. Valid Prime stations for main net (and PUP) samples. NA temperature and salinity figures represent data where bottom depth was less than the reporting depth requirement.

Prime No.	STN No.	Date	ICES Statistical Rectangle	Shot latitude	Shot longitude	E/W	Haul latitude	Haul longitude	Tow duration (m's")	Distance over ground (m)	Speed over ground (knots)	Guff VII maximum sampled depth (m)	Reported water temperature (°C)	Reported water salinity (g/kg)
8	12	05/06/2022	35F4	53°13.829	004°12.331	E	53°14.678	004°14.753	23'56"	3148	4.3	22	13.4	34.7
22	14	06/06/2022	36F6	53°44.020	006°13.079	E	53°44.301	006°15.332	18'17"	2408	4.6	20	13.6	32.9
23	15	06/06/2022	36F6	53°44.379	006°42.118	E	53°44.853	006°44.305	18'47"	2593	4.3	15	NA	NA
27	35	08/06/2022	37F0	54°14.995	000°17.841	E	54°15.091	000°14.084	31'5"	4260	4.3	51	10.2	34.5
28	34	08/06/2022	37F0	54°14.977	000°48.028	E	54°15.019	000°44.916	26'1"	3519	4.3	46	10.5	34.6
29	33	08/06/2022	37F1	54°15.358	001°15.275	E	54°15.310	001°11.716	28'57"	3889	4.7	47	10.5	34.6
30	32	07/06/2022	37F1	54°14.751	001°44.596	E	54°14.692	001°41.868	22'52"	2963	4.3	38	10.9	34.6
31	31	07/06/2022	37F2	54°14.682	002°14.482	E	54°14.073	002°12.481	19'9"	2408	3.9	33	12.5	34.6
32	28	07/06/2022	37F2	54°14.100	002°43.329	E	54°14.846	002°41.186	21'20"	2778	4.3	40	12.1	34.6
33	26	07/06/2022	37F3	54°14.377	003°19.030	E	54°14.842	003°16.194	24'57"	3148	4.3	38	11.2	34.5
34	25	07/06/2022	37F3	54°15.010	003°45.103	E	54°16.204	003°43.519	22'38"	2963	4.0	38	12.0	34.5
35	24	07/06/2022	37F4	54°15.355	004°13.827	E	54°15.940	004°10.677	28'52"	3519	3.9	44	11.8	34.4
37	21	07/06/2022	37F5	54°14.964	005°17.324	E	54°14.976	005°14.828	21'20"	2778	3.8	35	11.2	34.2
38	20	06/06/2022	37F5	54°14.665	005°45.733	E	54°14.734	005°43.615	18'16"	2408	3.4	33	11.7	34.0
39	19	06/06/2022	37F6	54°15.569	006°17.006	E	54°15.045	006°15.053	18'45"	2222	4.2	34	12.1	33.8
40	18	06/06/2022	37F6	54°15.464	006°46.860	E	54°14.806	006°44.924	19'15"	2408	3.8	33	11.7	33.4
41	17	06/06/2022	37F7	54°15.645	007°14.110	E	54°14.521	007°13.515	18'12"	2222	3.3	33	10.6	33.1
42	16	06/06/2022	37F7	54°14.735	007°44.681	E	54°13.717	007°43.511	17'22"	2222	4.3	33	11.7	32.2
44	186	22/06/2022	38E9	54°47.147	000°16.962	W	54°45.636	000°15.654	25'7"	2963	3.95	60	8.7	34.5
45	187	22/06/2022	38F0	54°44.493	000°15.048	E	54°44.662	000°17.791	23'29"	2963	4.00	64	11.1	36.8
46	188	22/06/2022	38F0	54°44.961	000°45.092	E	54°44.979	000°47.739	23'5"	2778	4.05	74	11.7	36.0
47	189	22/06/2022	38F1	54°43.976	001°14.045	E	54°44.171	001°11.901	18'57"	2222	4.00	39	NA	NA
48	190	23/06/2022	38F1	54°41.969	001°39.251	E	54°41.461	001°41.253	17'38"	2408	4.25	19	NA	NA
49	193	23/06/2022	38F2	54°44.969	002°16.447	E	54°44.984	002°19.540	26'33"	3519	3.70	16	NA	NA
50	194	23/06/2022	38F2	54°44.928	002°44.647	E	54°45.002	002°47.782	27'53"	3334	3.65	15	NA	NA
51	195	23/06/2022	38F3	54°44.946	003°13.069	E	54°44.995	003°14.907	15'55"	2037	4.20	35	12.4	34.9
52	196	23/06/2022	38F3	54°44.942	003°42.409	E	54°44.990	003°44.701	19'10"	2408	4.10	41	12.1	35.2
53	197	23/06/2022	38F4	54°45.607	004°12.228	E	54°45.643	004°15.125	21'41"	3148	4.10	48	11.1	36.0

54	198	23/06/2022	38F4	54°45.025	004°43.791	E	54°44.995	004°45.686	16'23"	2037	4.00	40	10.9	35.4
55	199	23/06/2022	38F5	54°45.041	005°13.627	E	54°45.109	005°15.693	17'40"	2222	4.00	39	10.5	35.2
56	201	23/06/2022	38F5	54°45.171	005°46.923	E	54°45.213	005°48.808	16'43"	2037	3.70	37	11.1	34.1
57	202	24/06/2022	38F6	54°45.027	006°12.499	E	54°45.051	006°14.569	17'27"	2408	4.05	36	12.2	34.0
58	203	24/06/2022	38F6	54°44.949	006°44.099	E	54°45.023	006°45.922	15'2"	2037	4.30	36	12.9	33.7
59	204	24/06/2022	38F7	54°45.254	007°12.592	E	54°45.283	007°14.692	16'54"	2222	4.20	21	14.3	32.6
60	206	24/06/2022	38F7	54°45.108	007°44.932	E	54°44.345	007°43.338	17'31"	2222	4.10	16	NA	NA
61	39	08/06/2022	40E8	55°44.233	001°42.836	W	55°45.292	001°44.354	19'26"	2408	4.00	58	10.3	34.3
62	40	08/06/2022	40E8	55°45.078	001°15.408	W	55°44.994	001°12.258	24'29"	3334	3.95	67	9.3	34.5
63	41	08/06/2022	40E9	55°44.979	000°45.054	W	55°46.192	000°42.073	28'30"	3704	4.70	78	12.2	34.7
64	42	09/06/2022	40E9	55°45.288	000°14.114	W	55°46.638	000°11.413	27'51"	3704	4.50	73	11.3	34.7
65	43	09/06/2022	40F0	55°44.557	000°13.893	E	55°45.557	000°16.475	24'1"	3148	4.45	68	12.0	34.8
66	44	09/06/2022	40F0	55°44.694	000°40.079	E	55°44.892	000°43.216	24'8"	3334	4.45	66	11.8	34.9
67	45	09/06/2022	40F1	55°44.988	001°15.300	E	55°45.543	001°18.461	27'58"	3519	3.80	74	11.9	34.9
68	47	09/06/2022	40F1	55°45.090	001°43.973	E	55°45.597	001°46.913	25'43"	3148	4.15	73	11.9	35.0
69	48	09/06/2022	40F2	55°45.154	002°12.547	E	55°45.856	002°16.089	29'11"	3889	4.60	79	11.9	35.0
70	49	09/06/2022	40F2	55°45.000	002°45.192	E	55°45.594	002°48.275	24'26"	3334	4.75	72	11.9	35.0
71	50	09/06/2022	40F3	55°44.622	003°11.404	E	55°44.799	003°13.418	15'40"	2222	4.45	50	11.8	34.9
72	51	09/06/2022	40F3	55°44.992	003°40.036	E	55°44.984	003°43.289	26'42"	3519	4.35	42	11.6	34.9
73	52	09/06/2022	40F4	55°45.027	004°13.004	E	55°45.015	004°14.821	15'6"	1852	4.10	32	11.4	34.8
74	53	09/06/2022	40F4	55°45.149	004°46.858	E	55°45.227	004°49.106	18'2"	2408	3.65	34	11.2	34.7
75	54	09/06/2022	40F5	55°44.974	005°14.776	E	55°44.928	005°16.953	17'54"	2222	4.15	49	11.5	34.5
76	55	10/06/2022	40F5	55°44.935	005°44.560	E	55°44.943	005°46.343	15'3"	1852	4.20	45	11.6	33.9
77	56	10/06/2022	40F6	55°44.973	006°11.773	E	55°45.015	006°14.593	22'23"	3148	4.45	40	11.7	33.7
78	57	10/06/2022	40F6	55°44.967	006°41.805	E	55°44.974	006°43.934	17'10"	2222	4.30	32	11.0	34.0
79	58	10/06/2022	40F7	55°45.140	007°12.324	E	55°44.980	007°15.192	23'45"	3148	4.35	25	12.3	32.4
80	60	10/06/2022	40F7	55°45.334	007°44.737	E	55°45.372	007°47.651	22'30"	3148	4.00	16	NA	NA
82	178	21/06/2022	42E8	56°45.018	001°48.806	W	56°44.936	001°43.569	41'44"	5371	4.5	65	9.9	34.4
83	175	21/06/2022	42E8	56°44.96	001°12.06	W	56°44.92	001°15.01	24'0"	1111	4.3	65	10.4	34.7
84	174	21/06/2022	42E9	56°44.990	000°42.510	W	56°44.951	000°46.051	26'50"	3519	4.3	70	11.2	35.0
85	173	21/06/2022	42E9	56°45.279	000°15.405	W	56°45.316	000°11.579	29'3"	3889	4.4	74	11.5	35.6
86	169	21/06/2022	42F0	56°44.927	000°16.776	E	56°45.078	000°13.131	29'41"	3889	4.3	99	12.2	35.3
87	168	21/06/2022	42F0	56°42.947	000°45.038	E	56°43.121	000°41.632	28'14"	3519	3.9	88	12.4	35.2
88	167	21/06/2022	42F1	56°45.600	001°17.079	E	56°45.098	001°13.661	27'42"	3519	4.2	88	12.5	35.4
89	166	21/06/2022	42F1	56°45.059	001°46.795	E	56°45.072	001°42.162	36'39"	4630	4.3	88	12.6	35.3
90	165	20/06/2022	42F2	56°44.855	002°15.257	E	56°44.923	002°12.268	24'29"	3148	4.0	74	12.4	35.6

91	164	20/06/2022	42F2	56°45.097	002°46.117	E	56°45.276	002°43.498	22'2"	2778	3.9	66	11.5	35.8
92	161	20/06/2022	42F3	56°45.114	003°18.014	E	56°45.082	003°14.702	26'31"	3334	3.1	63	11.4	36.4
93	160	20/06/2022	42F3	56°44.922	003°47.070	E	56°44.932	003°44.924	17'13"	2222	3.7	52	10.8	35.4
94	158	20/06/2022	42F4	56°44.857	004°17.332	E	56°44.861	004°15.161	16'41"	2037	4.5	49	10.7	35.3
95	156	20/06/2022	42F4	56°45.052	004°46.139	E	56°45.005	004°43.475	21'17"	2593	4.5	58	10.4	35.2
96	155	19/06/2022	42F5	56°45.000	005°17.774	E	56°45.061	005°15.696	16'41"	2037	4.0	53	10.4	35.2
97	153	19/06/2022	42F5	56°45.036	005°46.832	E	56°45.040	005°44.632	17'19"	2408	4.1	53	10.7	35.0
98	152	19/06/2022	42F6	56°44.928	006°17.492	E	56°44.978	006°15.548	16'16"	1852	4.2	45	8.6	34.8
99	151	19/06/2022	42F6	56°44.724	006°47.615	E	56°44.980	006°44.969	22'3"	2778	4.3	37	9.5	34.1
100	150	19/06/2022	42F7	56°43.000	007°15.606	E	56°42.388	007°14.090	14'39"	1852	4.2	27	9.9	34.9
101	62	10/06/2022	42F7	56°43.790	007°45.526	E	56°44.941	007°44.904	15'48"	2408	5.4	28	10.9	33.2
102	83	13/06/2022	44E8	57°44.861	001°43.772	W	57°46.423	001°46.362	29'32"	3889	4.5	77	9.8	34.8
104	82	12/06/2022	44E9	57°44.806	000°45.189	W	57°44.819	000°49.639	32'11"	4445	4.1	114	11.2	34.8
106	81	12/06/2022	44F0	57°45.070	000°15.141	E	57°44.878	000°10.144	40'1"	5000	3.7	106	11.7	34.9
108	79	12/06/2022	44F1	57°44.823	001°16.583	E	57°44.795	001°12.692	29'2"	3889	4.5	83	11.9	34.8
109	78	12/06/2022	44F1	57°46.392	001°46.250	E	57°45.845	001°41.934	30'34"	4260	4.5	83	11.9	34.8
110	77	12/06/2022	44F2	57°44.870	002°17.038	E	57°44.859	002°13.036	29'20"	3889	4.2	77	11.8	35.1
111	76	12/06/2022	44F2	57°44.934	002°47.132	E	57°45.023	002°44.286	22'40"	2778	3.7	63	11.7	35.1
112	74	12/06/2022	44F3	57°45.142	003°16.098	E	57°45.134	003°12.907	23'30"	3148	4.6	59	11.1	35.1
113	73	11/06/2022	44F3	57°44.984	003°45.157	E	57°44.827	003°42.258	21'38"	2963	4.3	65	10.3	35.1
114	72	11/06/2022	44F4	57°44.937	004°15.420	E	57°44.675	004°11.876	25'49"	3704	3.6	66	10.3	35.1
115	71	11/06/2022	44F4	57°45.387	004°47.797	E	57°44.955	004°43.520	33'40"	4445	4.1	86	10.0	35.2
116	70	11/06/2022	44F5	57°44.751	005°18.752	E	57°44.700	005°13.535	37'29"	5186	4.3	107	9.7	35.1
117	69	11/06/2022	44F5	57°45.051	005°49.025	E	57°45.049	005°46.560	19'11"	2408	4.1	56	9.4	34.6
118	68	11/06/2022	44F6	57°44.936	006°16.010	E	57°45.075	006°13.439	20'16"	2593	3.9	60	9.1	33.7
119	67	11/06/2022	44F6	57°44.924	006°45.595	E	57°44.899	006°42.488	23'14"	3148	4.1	61	7.8	34.3
120	66	11/06/2022	44F7	57°45.179	007°15.537	E	57°45.248	007°12.670	20'17"	2778	4.2	66	11.0	33.0
121	65	11/06/2022	44F7	57°44.496	007°43.719	E	57°44.521	007°46.248	20'4"	2593	4.7	61	7.5	34.4
122	84	13/06/2022	46E7	58°42.785	002°14.266	W	58°44.483	002°14.750	25'30"	3334	4.2	67	10.5	34.9
123	120	16/06/2022	46E8	58°45.288	001°47.500	W	58°44.580	001°40.562	54'23"	6852	3.9	90	10.4	35.2
124	123	16/06/2022	46E8	58°44.855	001°15.624	W	58°45.560	001°09.438	46'25"	6297	4.3	110	10.4	35.3
125	124	16/06/2022	46E9	58°44.825	000°47.469	W	58°45.183	000°41.039	46'57"	6297	4.5	122	11.4	35.3
126	126	16/06/2022	46E9	58°44.936	000°17.386	W	58°45.675	000°11.885	43'32"	5556	4.1	123	11.7	35.2
127	128	16/06/2022	46F0	58°45.949	000°11.243	E	58°45.851	000°17.322	45'22"	5926	3.9	125	11.6	35.2
128	129	16/06/2022	46F0	58°45.151	000°42.921	E	58°45.341	000°48.890	46'4"	5741	4.2	133	11.6	35.1
129	130	16/06/2022	46F1	58°45.021	001°07.408	E	58°45.030	001°14.747	21'12"	7223	4.6	105	11.7	35.1

130	131	17/06/2022	46F1	58°44.994	001°39.582	E	58°45.011	001°47.628	56'55"	7778	4.4	109	11.6	35.1
131	133	17/06/2022	46F2	58°45.118	002°12.059	E	58°45.136	002°18.911	49'24"	6482	4.4	100	11.6	35.2
132	134	17/06/2022	46F2	58°45.153	002°43.043	E	58°45.359	002°49.421	47'56"	6112	3.9	111	11.4	35.2
133	135	17/06/2022	46F3	58°44.967	003°12.807	E	58°45.229	003°19.151	47'42"	6297	3.7	101	11.4	35.0
134	145	18/06/2022	46F3	58°47.232	003°47.089	E	58°46.768	003°38.943	63'5"	7964	3.3	190	11.3	35.2
135	146	18/06/2022	46F4	58°44.873	004°17.848	E	58°45.053	004°10.984	53'13"	6667	4.0	205	7.2	34.4
136	148	18/06/2022	46F4	58°45.047	004°46.901	E	58°45.472	004°34.548	29'33"	12038	3.9	205	7.3	34.1
137	149	18/06/2022	46F5	58°45.076	005°14.442	E	58°43.316	005°04.355	20'32"	10186	3.8	216	7.5	33.9
138	85	13/06/2022	47E7	59°15.139	002°15.717	W	59°16.745	002°15.415	22'38"	2963	4.4	61	10.6	34.8
139	86	13/06/2022	47E8	59°15.002	001°45.491	W	59°15.022	001°40.582	35'44"	4815	4.2	85	10.1	35.2
140	88	13/06/2022	47E8	59°15.019	001°17.539	W	59°15.052	001°11.238	42'49"	5926	4.8	107	10.0	35.3
141	89	13/06/2022	47E9	59°15.036	000°47.639	W	59°15.039	000°41.684	42'38"	5741	4.9	119	11.2	35.2
142	90	13/06/2022	47E9	59°14.963	000°15.649	W	59°15.572	000°08.650	50'12"	6852	4.2	134	11.5	35.2
143	91	13/06/2022	47F0	59°14.838	000°14.131	E	59°15.420	000°20.875	48'53"	6667	4.3	133	11.5	35.2
144	92	13/06/2022	47F0	59°14.902	000°40.085	E	59°14.735	000°47.477	20'48"	7038	4.6	136	11.4	35.2
145	93	14/06/2022	47F1	59°14.805	001°13.331	E	59°14.928	001°19.377	41'24"	5741	4.6	108	11.1	35.2
146	94	14/06/2022	47F1	59°14.972	001°41.366	E	59°15.004	001°47.155	40'58"	5556	4.2	111	11.2	35.1
147	95	14/06/2022	47F2	59°15.034	002°14.015	E	59°15.060	002°19.817	41'41"	5556	4.6	122	11.3	34.9
148	96	14/06/2022	47F2	59°15.067	002°41.831	E	59°14.993	002°47.074	38'58"	5000	4.7	114	11.4	34.8
149	99	14/06/2022	47F3	59°15.061	003°14.692	E	59°14.752	003°22.463	55'5"	7408	4.4	150	9.7	35.2
150	100	14/06/2022	47F3	59°14.926	003°43.359	E	59°15.164	003°53.582	71'42"	9630	4.4	202	7.7	33.8
151	101	14/06/2022	47F4	59°15.011	004°11.345	E	59°14.955	004°21.456	73'4"	9630	4.4	201	8.2	32.9
152	102	14/06/2022	47F4	59°13.646	004°44.836	E	59°18.484	004°45.125	67'56"	8890	4.6	208	8.1	33.4
153	117	15/06/2022	48E9	59°44.882	000°43.000	W	59°44.649	000°48.684	41'31"	5556	4.2	112	10.9	35.4
154	115	15/06/2022	48E9	59°45.159	000°11.830	W	59°45.179	000°18.862	51'6"	6667	4.1	129	11.2	35.3
155	114	15/06/2022	48F0	59°45.034	000°17.839	E	59°45.185	000°11.966	42'49"	5556	4.1	123	11.3	35.3
156	113	15/06/2022	48F0	59°44.987	000°47.904	E	59°45.019	000°41.758	42'33"	5556	4.4	117	11.4	35.3
157	112	15/06/2022	48F1	59°44.772	001°18.027	E	59°44.758	001°12.282	41'1"	5371	4.5	109	11.2	35.3
158	111	15/06/2022	48F1	59°44.748	001°47.350	E	59°46.112	001°41.471	46'3"	6112	4.2	119	11.2	35.1
159	110	15/06/2022	48F2	59°45.002	002°16.448	E	59°44.554	002°12.173	32'52"	4074	4.2	113	11.2	35.1
160	109	15/06/2022	48F2	59°45.004	002°48.490	E	59°45.201	002°43.872	34'26"	4445	4.1	111	11.0	35.1
161	108	15/06/2022	48F3	59°45.037	003°18.385	E	59°45.074	003°11.281	52'25"	6667	4.3	177	8.9	35.1
162	106	15/06/2022	48F3	59°44.991	003°49.184	E	59°44.915	003°40.413	61'20"	8149	4.5	200	9.9	35.1
163	105	15/06/2022	48F4	59°44.993	004°19.050	E	59°45.044	004°09.968	64'39"	8704	4.4	200	10.5	33.0
164	104	14/06/2022	48F4	59°44.707	004°46.455	E	59°46.291	004°37.524	70'38"	8890	3.8	201	8.7	33.0

Table 3. Mackerel egg counts per station with applied raising factor.

Prime No.	Date	ICES Statistical Rectangle	Raising factor	Stage 1A	Stage 1B	Stage 2	Stage 3	Stage 4	Stage 5
8	05/06/2022	35F4	4	424	8	0	4	0	12
22	06/06/2022	36F6	1	10	2	3	2	0	0
23	06/06/2022	36F6	1	0	0	1	1	0	0
27	08/06/2022	37F0	1	5	5	0	3	2	0
28	08/06/2022	37F0	1	9	8	10	2	2	0
29	08/06/2022	37F1	1	4	0	0	0	1	1
30	07/06/2022	37F1	1	6	4	4	8	0	0
31	07/06/2022	37F2	1	15	1	2	7	14	3
32	07/06/2022	37F2	1	18	11	8	11	1	0
33	07/06/2022	37F3	1	126	59	99	34	1	0
34	07/06/2022	37F3	1	294	11	7	7	1	2
35	07/06/2022	37F4	1	3	0	0	1	1	1
37	07/06/2022	37F5	1	20	7	0	4	3	2
38	06/06/2022	37F5	1	0	0	0	0	0	0
39	06/06/2022	37F6	1	3	0	0	1	0	0
40	06/06/2022	37F6	1	0	0	1	0	0	0
41	06/06/2022	37F7	1	80	13	4	0	0	0
42	06/06/2022	37F7	1	1	0	0	0	0	0
44	22/06/2022	38E9	1	12	2	3	3	4	8
45	22/06/2022	38F0	1	33	1	0	2	3	0
46	22/06/2022	38F0	1	49	20	21	15	5	0
47	22/06/2022	38F1	1	90	6	10	42	5	5
48	23/06/2022	38F1	1	0	0	0	0	0	0

49	23/06/2022	38F2	4	112	64	260	172	48	28
50	23/06/2022	38F2	1	10	0	0	0	0	0
51	23/06/2022	38F3	1	11	8	5	14	31	26
52	23/06/2022	38F3	1	3	2	0	2	2	0
53	23/06/2022	38F4	2	6	4	2	16	10	6
54	23/06/2022	38F4	2	2	2	0	2	0	0
55	23/06/2022	38F5	1	6	2	0	1	1	3
56	23/06/2022	38F5	1	12	0	6	14	9	4
57	24/06/2022	38F6	1	12	0	10	34	29	10
58	24/06/2022	38F6	1	68	0	29	33	17	5
59	24/06/2022	38F7	1	14	15	13	10	3	8
60	24/06/2022	38F7	1	5	4	1	1	1	1
61	08/06/2022	40E8	1	6	0	0	1	0	0
62	08/06/2022	40E8	1	8	0	0	3	1	1
63	08/06/2022	40E9	1	4	0	2	3	1	0
64	09/06/2022	40E9	1	0	0	2	4	0	0
65	09/06/2022	40F0	1	32	4	8	20	79	33
66	09/06/2022	40F0	1	14	15	16	190	282	5
67	09/06/2022	40F1	1	56	30	22	8	4	0
68	09/06/2022	40F1	1	137	53	43	18	9	5
69	09/06/2022	40F2	1	5	8	9	66	71	3
70	09/06/2022	40F2	4	20	24	32	176	104	20
71	09/06/2022	40F3	1	3	2	2	18	11	3
72	09/06/2022	40F3	1	7	1	1	0	0	0
73	09/06/2022	40F4	4	12	32	4	44	16	0
74	09/06/2022	40F4	1	9	13	3	4	0	0
75	09/06/2022	40F5	1	6	0	0	0	0	0
76	10/06/2022	40F5	1	3	1	10	6	2	1

77	10/06/2022	40F6	1	2	6	4	8	5	1
78	10/06/2022	40F6	1	7	6	15	240	193	26
79	10/06/2022	40F7	1	27	9	26	59	15	3
80	10/06/2022	40F7	1	8	4	0	1	2	0
82	21/06/2022	42E8	1	1	0	0	0	0	0
83	21/06/2022	42E8	1	0	0	0	0	0	0
84	21/06/2022	42E9	0	0	0	0	0	0	0
85	21/06/2022	42E9	1	0	0	0	0	0	0
86	21/06/2022	42F0	1	0	0	0	0	0	0
87	21/06/2022	42F0	1	2	0	1	0	0	0
88	21/06/2022	42F1	1	0	0	0	0	0	0
89	21/06/2022	42F1	1	6	0	0	0	0	0
90	20/06/2022	42F2	1	45	0	14	38	30	4
91	20/06/2022	42F2	1	10	2	0	1	0	1
92	20/06/2022	42F3	1	5	5	0	0	0	0
93	20/06/2022	42F3	1	0	0	0	0	0	0
94	20/06/2022	42F4	1	40	0	9	3	1	0
95	20/06/2022	42F4	1	33	1	8	28	9	7
96	19/06/2022	42F5	1	43	6	2	52	34	11
97	19/06/2022	42F5	1	5	4	8	0	4	8
98	19/06/2022	42F6	1	9	16	11	46	63	33
99	19/06/2022	42F6	1	14	9	13	9	11	16
100	19/06/2022	42F7	1	5	10	1	3	9	7
101	10/06/2022	42F7	1	39	16	22	46	40	15
102	13/06/2022	44E8	1	0	0	0	0	0	0
104	12/06/2022	44E9	1	0	0	0	0	0	0
106	12/06/2022	44F0	1	0	0	0	0	0	0
108	12/06/2022	44F1	1	3	0	0	0	0	1

109	12/06/2022	44F1	1	4	0	0	1	0	0
110	12/06/2022	44F2	1	36	1	9	29	3	0
111	12/06/2022	44F2	1	87	26	14	55	115	11
112	12/06/2022	44F3	2	64	32	10	50	58	36
113	11/06/2022	44F3	1	42	20	45	10	10	17
114	11/06/2022	44F4	1	26	25	64	31	22	6
115	11/06/2022	44F4	1	14	23	4	41	25	1
116	11/06/2022	44F5	1	18	20	10	47	17	11
117	11/06/2022	44F5	1	13	7	3	1	0	2
118	11/06/2022	44F6	1	20	11	8	35	52	3
119	11/06/2022	44F6	1	45	21	11	52	56	90
120	11/06/2022	44F7	1	42	16	9	16	31	21
121	11/06/2022	44F7	1	74	28	26	10	7	3
122	13/06/2022	46E7	1	12	0	2	0	0	0
123	16/06/2022	46E8	1	2	0	0	1	0	0
124	16/06/2022	46E8	1	2	0	0	1	0	0
125	16/06/2022	46E9	1	0	0	0	0	0	0
126	16/06/2022	46E9	0	0	0	0	0	0	0
127	16/06/2022	46F0	1	0	0	0	0	0	0
128	16/06/2022	46F0	1	0	0	0	0	0	0
129	16/06/2022	46F1	1	1	2	1	1	1	0
130	17/06/2022	46F1	1	12	0	1	2	0	0
131	17/06/2022	46F2	1	4	5	2	0	0	0
132	17/06/2022	46F2	1	0	1	2	1	1	0
133	17/06/2022	46F3	1	60	8	9	15	0	3
134	18/06/2022	46F3	1	10	17	7	18	18	20
135	18/06/2022	46F4	1	9	5	0	0	4	0
136	18/06/2022	46F4	1	119	15	9	36	33	18

137	18/06/2022	46F5	1	21	2	7	18	7	1
138	13/06/2022	47E7	1	0	0	0	0	0	0
139	13/06/2022	47E8	1	0	0	2	0	0	0
140	13/06/2022	47E8	1	3	0	0	0	0	0
141	13/06/2022	47E9	1	0	0	0	0	0	0
142	13/06/2022	47E9	1	0	0	0	0	0	0
143	13/06/2022	47F0	1	0	0	0	0	0	0
144	13/06/2022	47F0	1	0	0	0	1	0	0
145	14/06/2022	47F1	1	9	3	10	20	9	1
146	14/06/2022	47F1	1	8	6	2	6	4	7
147	14/06/2022	47F2	1	21	1	2	30	25	2
148	14/06/2022	47F2	1	3	2	5	24	49	8
149	14/06/2022	47F3	1	10	1	5	21	8	3
150	14/06/2022	47F3	1	44	19	25	19	15	7
151	14/06/2022	47F4	1	30	2	6	21	12	9
152	14/06/2022	47F4	1	9	2	9	7	2	11
153	15/06/2022	48E9	1	4	1	0	1	0	0
154	15/06/2022	48E9	1	0	0	0	0	0	0
155	15/06/2022	48F0	1	0	0	0	0	0	0
156	15/06/2022	48F0	1	0	1	0	0	2	0
157	15/06/2022	48F1	1	6	3	3	7	12	3
158	15/06/2022	48F1	1	8	12	29	20	31	28
159	15/06/2022	48F2	1	37	2	14	44	24	1
160	15/06/2022	48F2	1	83	8	28	33	23	3
161	15/06/2022	48F3	1	21	4	16	4	9	7
162	15/06/2022	48F3	1	29	22	3	14	11	8
163	15/06/2022	48F4	1	46	16	28	12	3	8
164	14/06/2022	48F4	4	28	28	96	68	72	36

Table 4. Horse mackerel egg counts per station with applied raising factor.

Prime No.	Date	ICES Statistical Rectangle	Raising factor	Stage 1A	Stage 1B	Stage 2	Stage 3	Stage 4
8	05/06/2022	35F4	4	132	0	4	0	0
22	06/06/2022	36F6	1	0	0	0	0	0
23	06/06/2022	36F6	1	0	0	1	7	4
27	08/06/2022	37F0	1	0	0	0	0	0
28	08/06/2022	37F0	1	0	0	0	0	0
29	08/06/2022	37F1	1	0	0	0	0	0
30	07/06/2022	37F1	1	0	0	0	0	0
31	07/06/2022	37F2	1	1	0	0	0	0
32	07/06/2022	37F2	1	2	5	0	0	0
33	07/06/2022	37F3	1	0	0	3	0	0
34	07/06/2022	37F3	1	2	0	1	0	0
35	07/06/2022	37F4	1	0	0	0	0	0
37	07/06/2022	37F5	1	0	0	0	0	0
38	06/06/2022	37F5	1	0	0	0	0	0
39	06/06/2022	37F6	1	0	0	0	0	0
40	06/06/2022	37F6	1	1	0	0	0	0
41	06/06/2022	37F7	1	0	0	0	0	0
42	06/06/2022	37F7	1	0	0	0	0	0
44	22/06/2022	38E9	1	0	0	0	0	0
45	22/06/2022	38F0	1	0	0	0	0	0
46	22/06/2022	38F0	1	0	0	0	0	0
47	22/06/2022	38F1	1	2	0	0	0	0
48	23/06/2022	38F1	1	0	0	0	0	0

49	23/06/2022	38F2	4	0	0	0	0	0
50	23/06/2022	38F2	1	0	0	0	0	0
51	23/06/2022	38F3	1	2	0	0	0	0
52	23/06/2022	38F3	1	0	0	0	0	0
53	23/06/2022	38F4	2	0	0	0	0	0
54	23/06/2022	38F4	2	0	0	0	0	0
55	23/06/2022	38F5	1	0	0	0	0	0
56	23/06/2022	38F5	1	0	0	0	0	0
57	24/06/2022	38F6	1	1	0	0	0	0
58	24/06/2022	38F6	1	0	0	0	0	0
59	24/06/2022	38F7	1	7	2	0	0	1
60	24/06/2022	38F7	1	0	0	0	0	0
61	08/06/2022	40E8	1	0	0	0	0	0
62	08/06/2022	40E8	1	0	0	0	0	0
63	08/06/2022	40E9	1	0	0	0	0	0
64	09/06/2022	40E9	1	0	1	1	2	0
65	09/06/2022	40F0	1	0	0	0	0	0
66	09/06/2022	40F0	1	0	0	0	0	0
67	09/06/2022	40F1	1	0	0	0	0	0
68	09/06/2022	40F1	1	0	0	0	0	0
69	09/06/2022	40F2	1	0	0	0	0	0
70	09/06/2022	40F2	4	0	0	0	0	0
71	09/06/2022	40F3	1	0	0	0	0	0
72	09/06/2022	40F3	1	0	0	0	0	0
73	09/06/2022	40F4	4	0	0	0	0	0
74	09/06/2022	40F4	1	0	0	0	0	0
75	09/06/2022	40F5	1	0	0	0	0	0
76	10/06/2022	40F5	1	0	0	0	0	0

77	10/06/2022	40F6	1	0	0	0	0	0
78	10/06/2022	40F6	1	2	0	0	0	0
79	10/06/2022	40F7	4	8	4	0	0	0
80	10/06/2022	40F7	4	4	4	0	0	0
82	21/06/2022	42E8	1	0	0	0	0	0
83	21/06/2022	42E8	1	0	0	0	0	0
84	21/06/2022	42E9	0	0	0	0	0	0
85	21/06/2022	42E9	1	0	0	0	0	0
86	21/06/2022	42F0	1	0	0	0	0	0
87	21/06/2022	42F0	1	0	0	0	0	0
88	21/06/2022	42F1	1	0	0	0	0	0
89	21/06/2022	42F1	1	0	0	0	0	0
90	20/06/2022	42F2	1	0	0	0	0	0
91	20/06/2022	42F2	1	0	0	0	0	0
92	20/06/2022	42F3	1	0	0	0	0	0
93	20/06/2022	42F3	1	0	0	0	0	0
94	20/06/2022	42F4	1	0	0	0	0	0
95	20/06/2022	42F4	1	0	0	0	0	0
96	19/06/2022	42F5	1	0	0	0	0	0
97	19/06/2022	42F5	1	0	0	0	0	0
98	19/06/2022	42F6	1	0	0	0	0	0
99	19/06/2022	42F6	1	0	0	0	0	0
100	19/06/2022	42F7	1	0	0	0	0	0
101	10/06/2022	42F7	1	0	0	0	0	0
102	13/06/2022	44E8	1	0	0	0	0	0
104	12/06/2022	44E9	1	0	0	0	0	0
106	12/06/2022	44F0	1	0	0	0	0	0
108	12/06/2022	44F1	1	0	0	0	0	0

109	12/06/2022	44F1	1	0	0	0	0	0
110	12/06/2022	44F2	1	0	0	0	0	0
111	12/06/2022	44F2	1	0	0	0	0	0
112	12/06/2022	44F3	2	0	0	0	0	0
113	11/06/2022	44F3	1	0	0	0	0	0
114	11/06/2022	44F4	1	0	0	0	0	0
115	11/06/2022	44F4	1	0	0	0	0	0
116	11/06/2022	44F5	1	0	0	0	0	0
117	11/06/2022	44F5	1	0	0	0	0	0
118	11/06/2022	44F6	1	0	0	0	0	0
119	11/06/2022	44F6	1	0	0	0	0	0
120	11/06/2022	44F7	1	0	0	0	0	0
121	11/06/2022	44F7	1	0	0	0	0	0
122	13/06/2022	46E7	1	0	0	0	0	0
123	16/06/2022	46E8	1	0	0	0	0	0
124	16/06/2022	46E8	1	1	0	0	0	0
125	16/06/2022	46E9	1	0	0	0	0	0
126	16/06/2022	46E9	0	0	0	0	0	0
127	16/06/2022	46F0	1	0	0	0	0	0
128	16/06/2022	46F0	1	0	0	0	0	0
129	16/06/2022	46F1	1	0	0	0	0	0
130	17/06/2022	46F1	1	0	0	0	0	0
131	17/06/2022	46F2	1	0	0	0	0	0
132	17/06/2022	46F2	1	0	0	0	0	0
133	17/06/2022	46F3	1	0	0	0	0	0
134	18/06/2022	46F3	1	0	0	0	0	0
135	18/06/2022	46F4	1	0	0	0	0	0
136	18/06/2022	46F4	1	0	0	0	0	0

137	18/06/2022	46F5	1	0	0	0	0	0
138	13/06/2022	47E7	1	0	0	0	0	0
139	13/06/2022	47E8	1	0	0	0	0	0
140	13/06/2022	47E8	1	0	0	0	0	0
141	13/06/2022	47E9	1	0	0	0	0	0
142	13/06/2022	47E9	1	0	0	0	0	0
143	13/06/2022	47F0	1	0	0	0	0	0
144	13/06/2022	47F0	1	0	0	0	0	0
145	14/06/2022	47F1	1	0	0	0	0	0
146	14/06/2022	47F1	1	0	0	0	0	0
147	14/06/2022	47F2	1	0	0	0	0	0
148	14/06/2022	47F2	1	0	0	0	0	0
149	14/06/2022	47F3	1	0	0	0	0	0
150	14/06/2022	47F3	1	0	0	0	0	0
151	14/06/2022	47F4	1	0	0	0	0	0
152	14/06/2022	47F4	1	0	0	0	0	0
153	15/06/2022	48E9	1	0	0	0	0	0
154	15/06/2022	48E9	1	0	0	0	0	0
155	15/06/2022	48F0	1	0	0	0	0	0
156	15/06/2022	48F0	1	0	0	0	0	0
157	15/06/2022	48F1	1	0	0	0	0	0
158	15/06/2022	48F1	1	0	0	0	0	0
159	15/06/2022	48F2	1	0	0	0	1	0
160	15/06/2022	48F2	1	0	0	0	0	0
161	15/06/2022	48F3	1	0	0	0	0	0
162	15/06/2022	48F3	1	0	0	0	0	0
163	15/06/2022	48F4	1	0	0	0	0	0
164	14/06/2022	48F4	4	0	0	0	0	0

Table 5. Unidentified egg counts per station with applied raising factor.

Prime No.	Date	ICES Statistical Rectangle	Raising factor	Count
8	05/06/2022	35F4	4	432
22	06/06/2022	36F6	1	248
23	06/06/2022	36F6	1	168
27	08/06/2022	37F0	1	222
28	08/06/2022	37F0	1	115
29	08/06/2022	37F1	1	132
30	07/06/2022	37F1	1	87
31	07/06/2022	37F2	1	149
32	07/06/2022	37F2	1	101
33	07/06/2022	37F3	1	55
34	07/06/2022	37F3	1	97
35	07/06/2022	37F4	1	1
37	07/06/2022	37F5	1	59
38	06/06/2022	37F5	1	66
39	06/06/2022	37F6	1	64
40	06/06/2022	37F6	1	100
41	06/06/2022	37F7	1	40
42	06/06/2022	37F7	1	126
44	22/06/2022	38E9	1	10
45	22/06/2022	38F0	1	11
46	22/06/2022	38F0	1	13
47	22/06/2022	38F1	1	188
48	23/06/2022	38F1	1	115

49	23/06/2022	38F2	4	256
50	23/06/2022	38F2	1	348
51	23/06/2022	38F3	1	93
52	23/06/2022	38F3	1	44
53	23/06/2022	38F4	2	42
54	23/06/2022	38F4	2	8
55	23/06/2022	38F5	1	77
56	23/06/2022	38F5	1	142
57	24/06/2022	38F6	1	156
58	24/06/2022	38F6	1	119
59	24/06/2022	38F7	1	617
60	24/06/2022	38F7	1	127
61	08/06/2022	40E8	1	3
62	08/06/2022	40E8	1	36
63	08/06/2022	40E9	1	6
64	09/06/2022	40E9	1	59
65	09/06/2022	40F0	1	18
66	09/06/2022	40F0	1	7
67	09/06/2022	40F1	1	46
68	09/06/2022	40F1	1	19
69	09/06/2022	40F2	1	19
70	09/06/2022	40F2	4	104
71	09/06/2022	40F3	1	23
72	09/06/2022	40F3	1	32
73	09/06/2022	40F4	4	144
74	09/06/2022	40F4	1	42
75	09/06/2022	40F5	1	10
76	10/06/2022	40F5	1	90

77	10/06/2022	40F6	1	133
78	10/06/2022	40F6	1	250
79	10/06/2022	40F7	4	932
80	10/06/2022	40F7	4	1351
82	21/06/2022	42E8	1	14
83	21/06/2022	42E8	1	0
84	21/06/2022	42E9	0	0
85	21/06/2022	42E9	1	0
86	21/06/2022	42F0	1	4
87	21/06/2022	42F0	1	9
88	21/06/2022	42F1	1	1
89	21/06/2022	42F1	1	6
90	20/06/2022	42F2	1	63
91	20/06/2022	42F2	1	61
92	20/06/2022	42F3	1	55
93	20/06/2022	42F3	1	196
94	20/06/2022	42F4	1	190
95	20/06/2022	42F4	1	115
96	19/06/2022	42F5	1	121
97	19/06/2022	42F5	1	70
98	19/06/2022	42F6	1	72
99	19/06/2022	42F6	1	93
100	19/06/2022	42F7	1	60
101	10/06/2022	42F7	1	228
102	13/06/2022	44E8	1	6
104	12/06/2022	44E9	1	23
106	12/06/2022	44F0	1	1
108	12/06/2022	44F1	1	16

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109	12/06/2022	44F1	1	15
110	12/06/2022	44F2	1	63
111	12/06/2022	44F2	1	141
112	12/06/2022	44F3	2	148
113	11/06/2022	44F3	1	109
114	11/06/2022	44F4	1	282
115	11/06/2022	44F4	1	115
116	11/06/2022	44F5	1	30
117	11/06/2022	44F5	1	14
118	11/06/2022	44F6	1	23
119	11/06/2022	44F6	1	58
120	11/06/2022	44F7	1	113
121	11/06/2022	44F7	1	83
122	13/06/2022	46E7	1	63
123	16/06/2022	46E8	1	42
124	16/06/2022	46E8	1	41
125	16/06/2022	46E9	1	4
126	16/06/2022	46E9	0	0
127	16/06/2022	46F0	1	0
128	16/06/2022	46F0	1	1
129	16/06/2022	46F1	1	20
130	17/06/2022	46F1	1	26
131	17/06/2022	46F2	1	16
132	17/06/2022	46F2	1	69
133	17/06/2022	46F3	1	16
134	18/06/2022	46F3	1	27
135	18/06/2022	46F4	1	119
136	18/06/2022	46F4	1	33

137	18/06/2022	46F5	1	12
138	13/06/2022	47E7	1	55
139	13/06/2022	47E8	1	26
140	13/06/2022	47E8	1	16
141	13/06/2022	47E9	1	3
142	13/06/2022	47E9	1	7
143	13/06/2022	47F0	1	14
144	13/06/2022	47F0	1	23
145	14/06/2022	47F1	1	29
146	14/06/2022	47F1	1	29
147	14/06/2022	47F2	1	21
148	14/06/2022	47F2	1	27
149	14/06/2022	47F3	1	106
150	14/06/2022	47F3	1	45
151	14/06/2022	47F4	1	18
152	14/06/2022	47F4	1	12
153	15/06/2022	48E9	1	9
154	15/06/2022	48E9	1	3
155	15/06/2022	48F0	1	5
156	15/06/2022	48F0	1	14
157	15/06/2022	48F1	1	19
158	15/06/2022	48F1	1	87
159	15/06/2022	48F2	1	89
160	15/06/2022	48F2	1	26
161	15/06/2022	48F3	1	52
162	15/06/2022	48F3	1	47
163	15/06/2022	48F4	1	16
164	14/06/2022	48F4	4	8

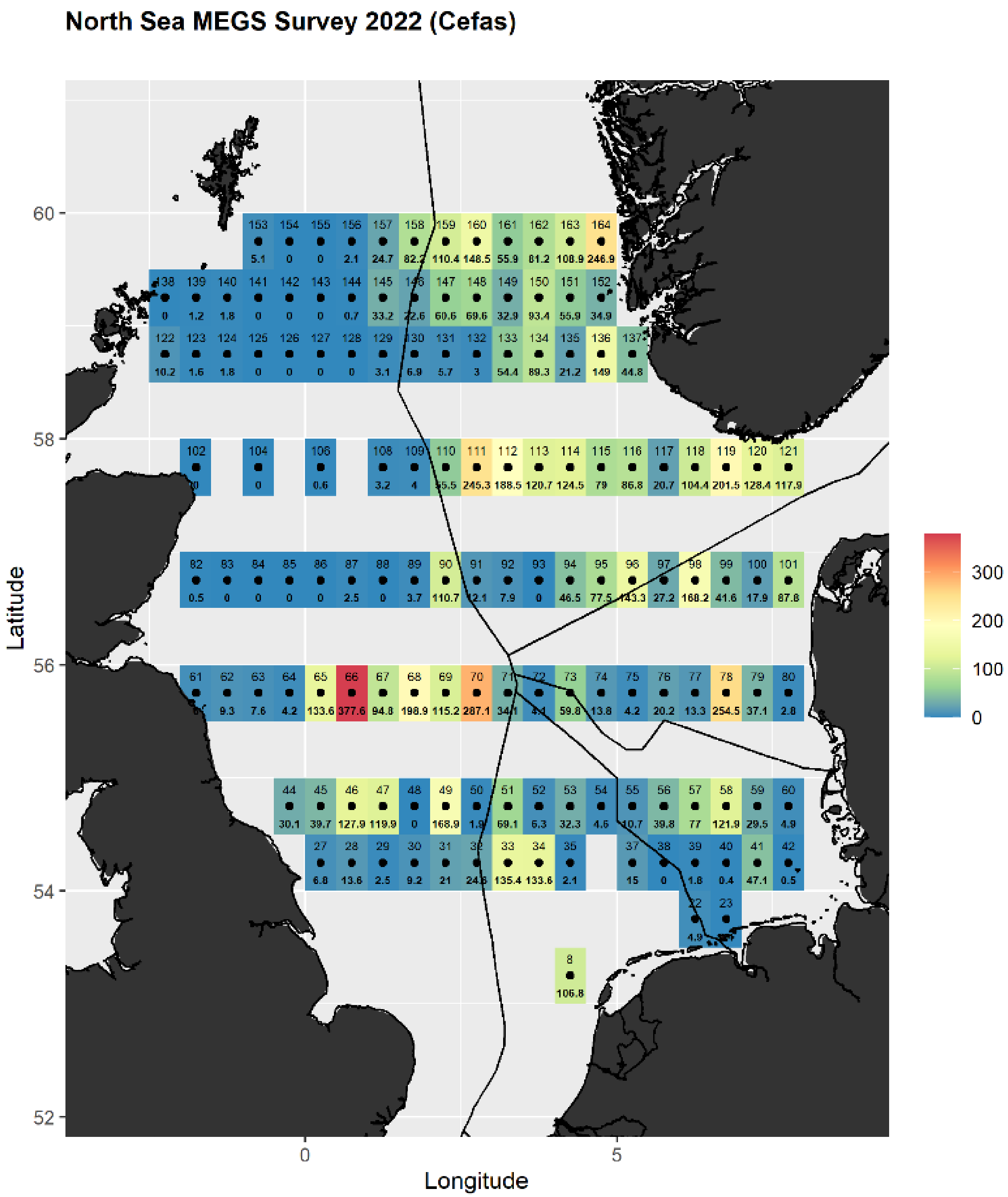

Figure 11. Total mackerel egg abundance per square metre.

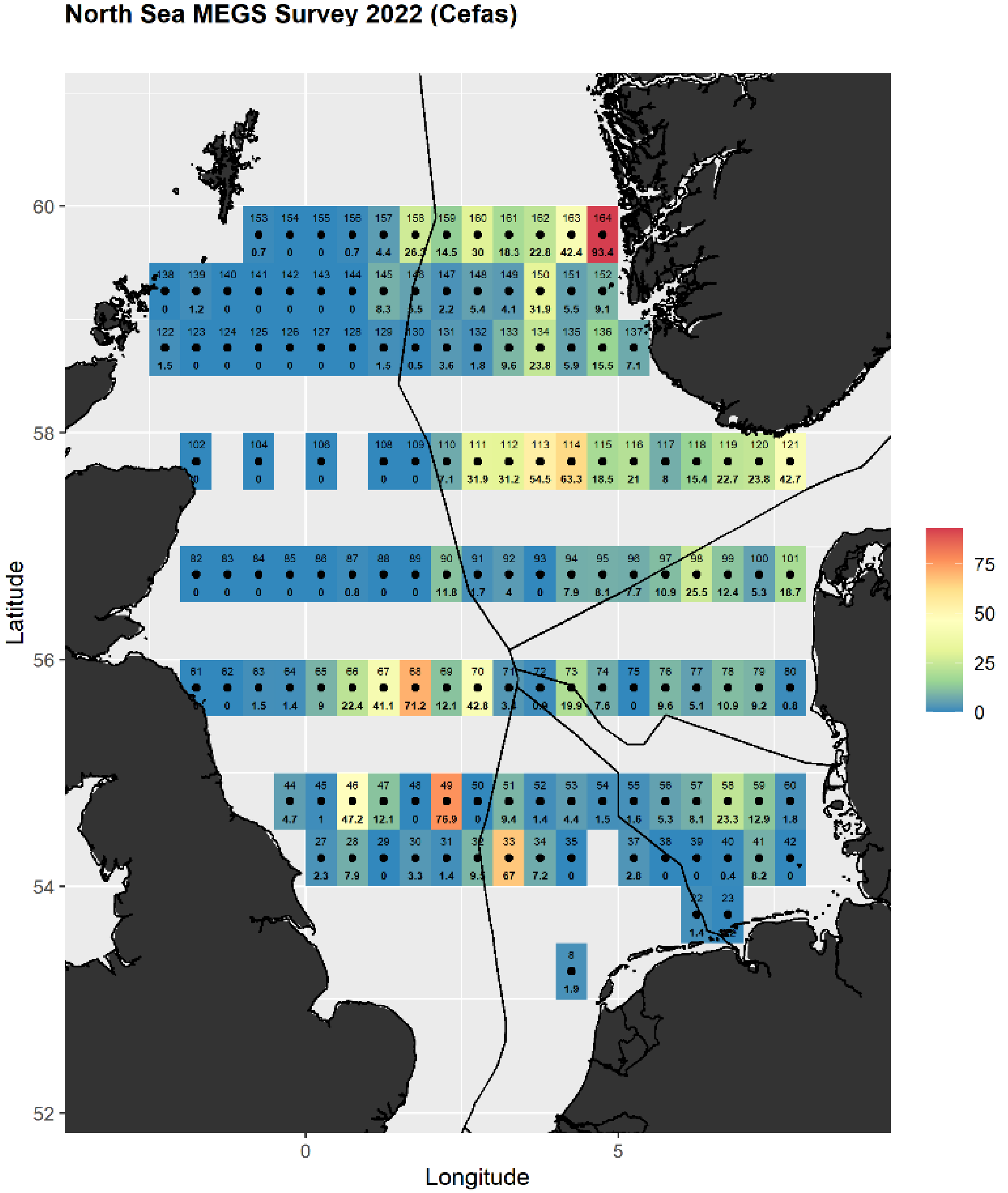

Figure 12. Total mackerel stage 1a egg abundance per square metre.

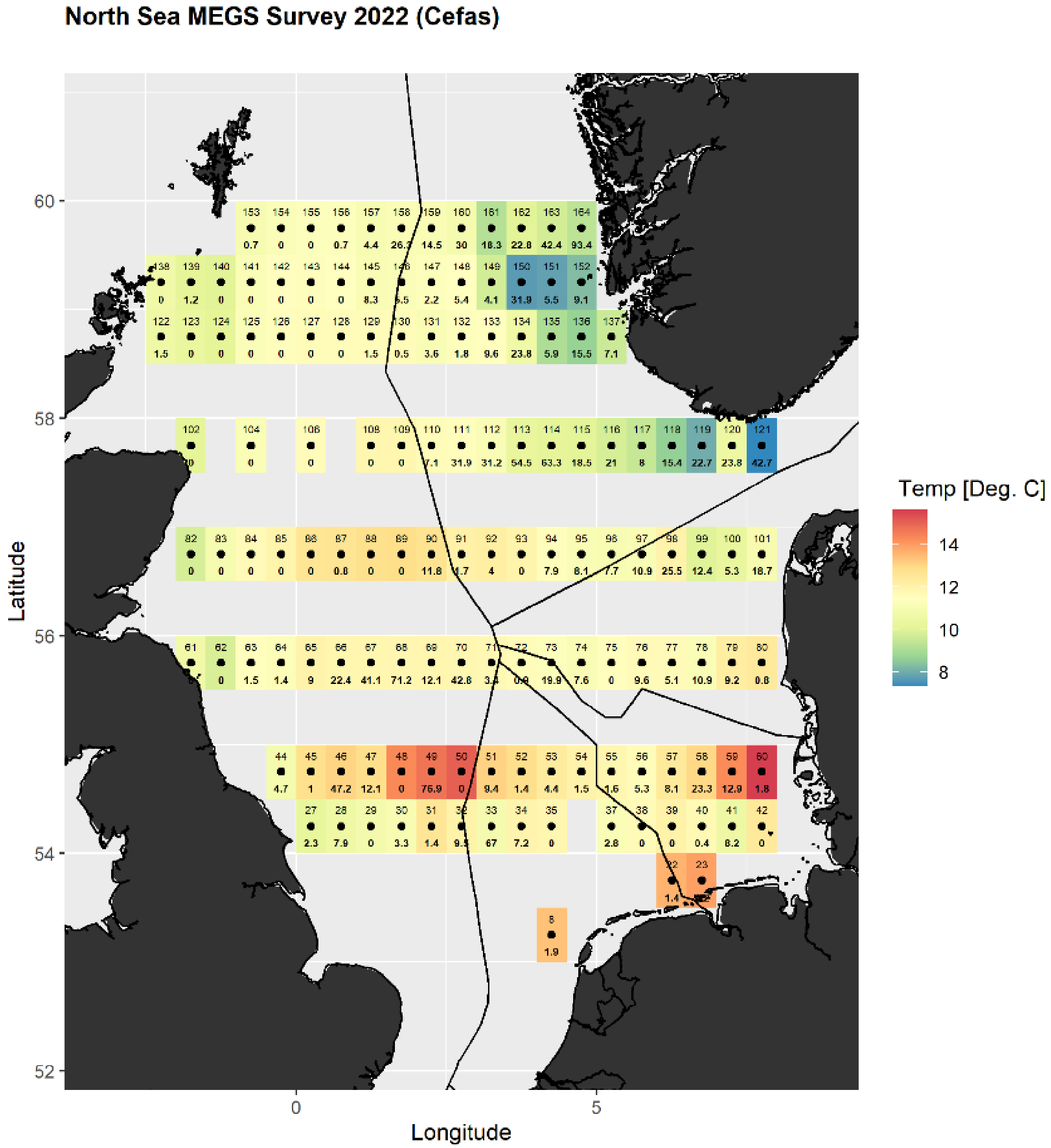

Figure 13. Total mackerel stage 1a egg abundance per square metre with water temperatures.

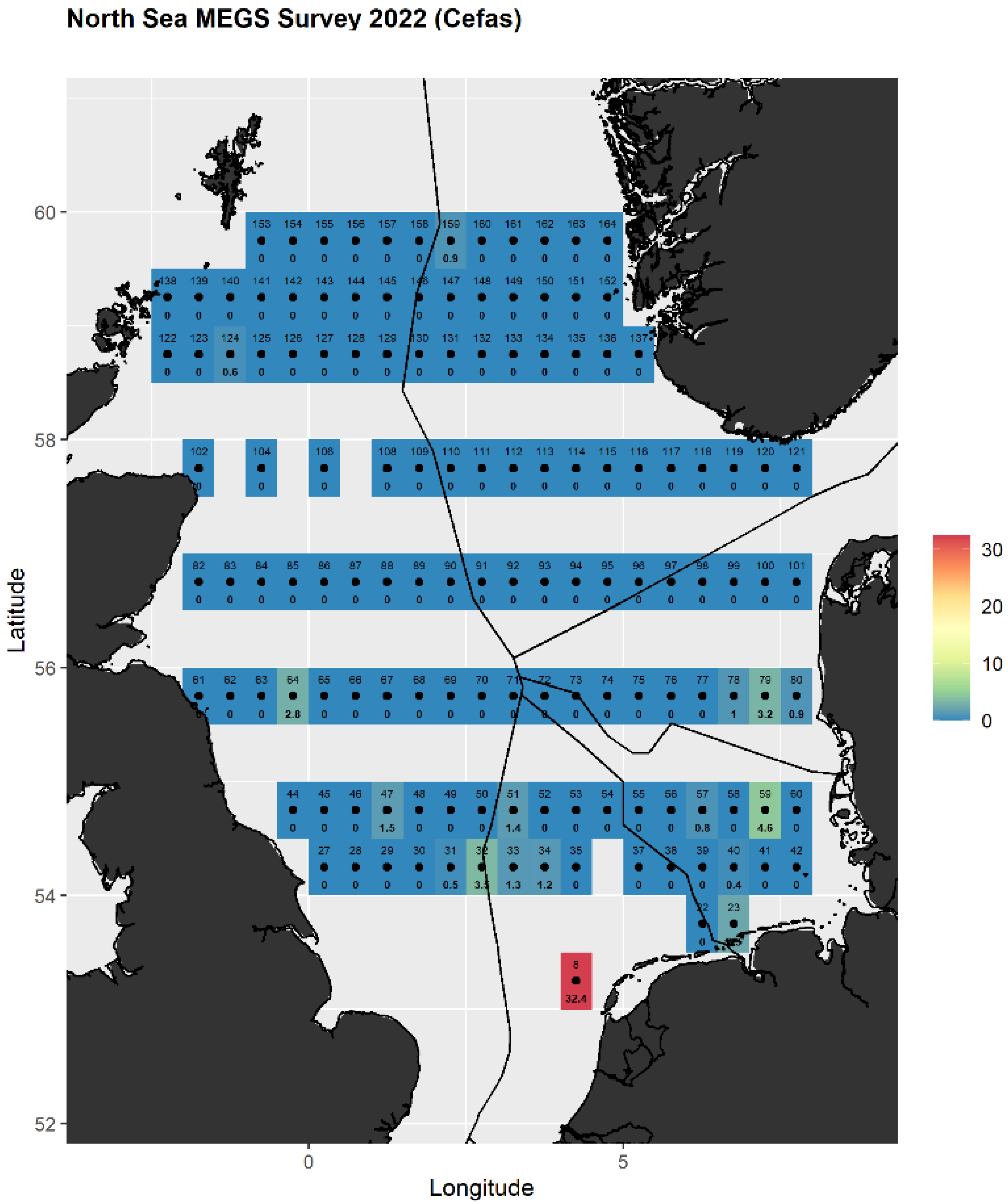

Figure 14. Total horse mackerel egg abundance per square metre.

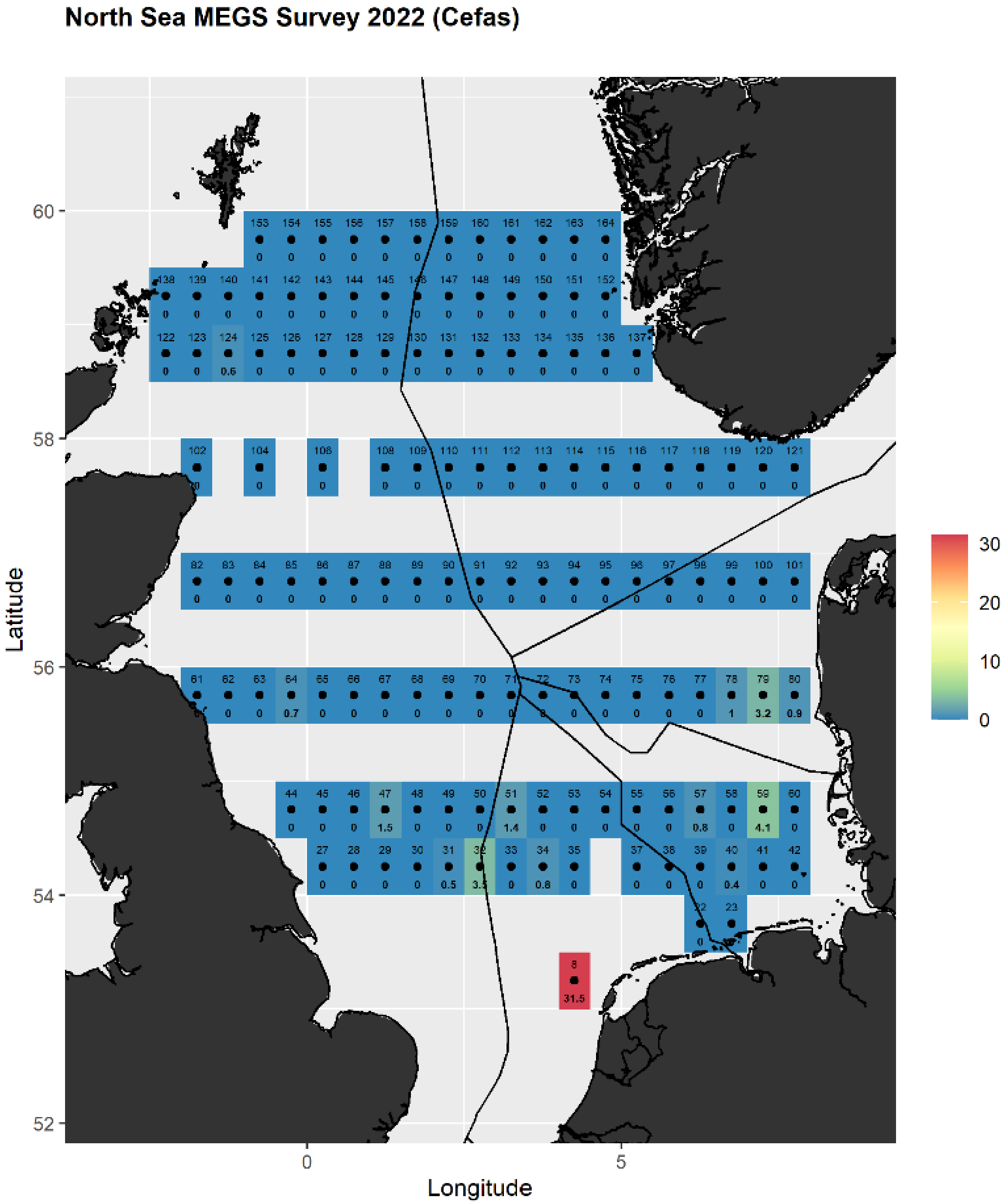

Figure 15. Total horse mackerel stage 1a egg abundance per square metre.

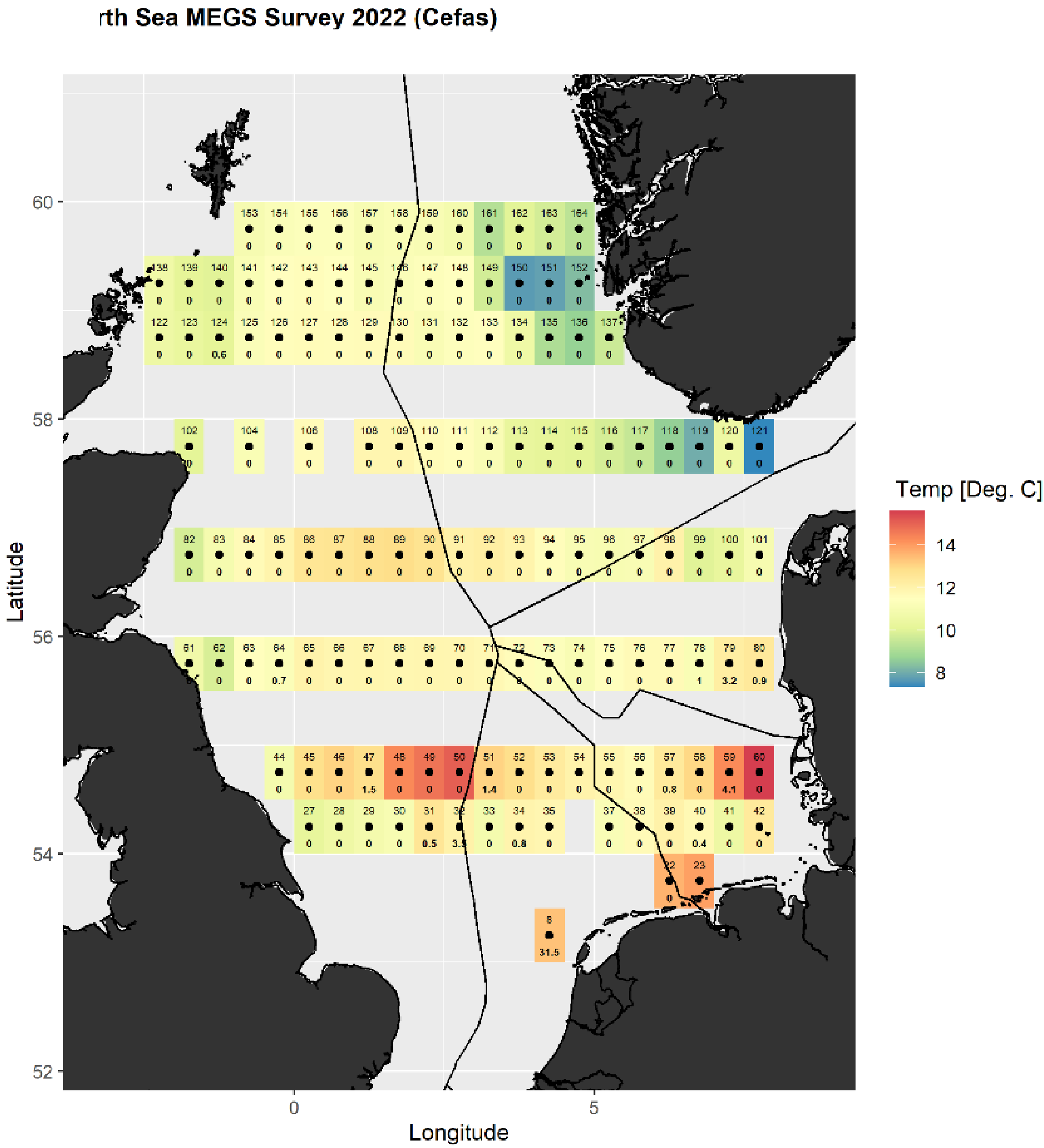

Figure 16. Total horse mackerel stage 1a egg abundance per square metre with water temperatures.

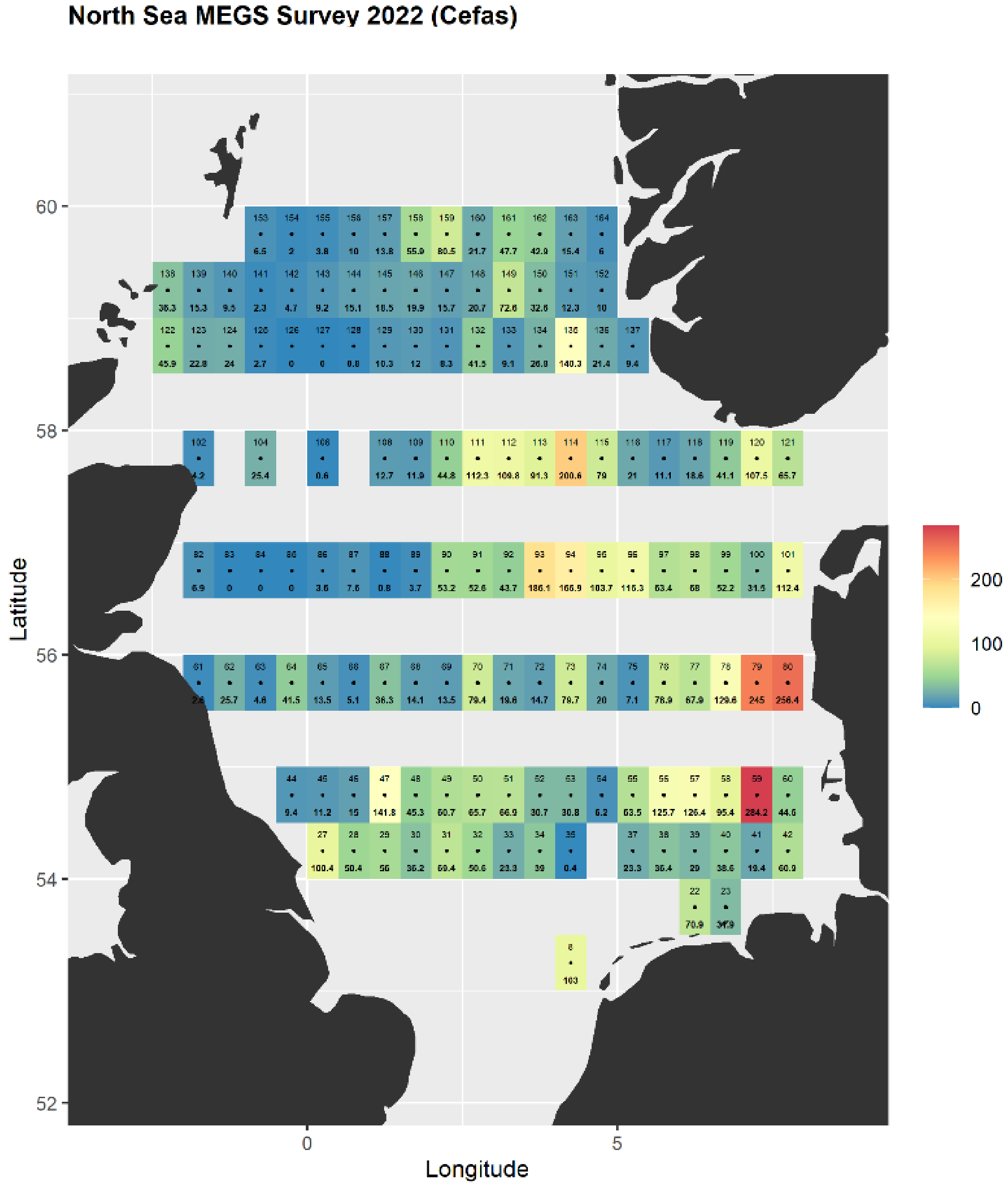

Figure 17. Total ‘other’ unidentified but counted ichthyo egg abundance per square metre.

Aim 2
Rod and line fishing

To conduct batch fecundity, oocyte hydration, Post-Ovulatory Follicles (POFs) and Daily Egg Production Method (DEPM) analysis of adult mackerel, 10 non-fixed-position fishing stations were planned across the survey area (1 per transect line). A minimum of 45 adult female mackerel were requested by WGMEGS per station for fecundity sampling.

To collect adult fish samples, a Cosmos FOTO trawl (Model 84) was intended but this proved to be unavailable to the survey. As a result, rod and line fishing was selected to collect adult fish samples (Figure 19). Attempted fishing stations were influenced by environmental conditions, survey plan timings, and the presence of shoaling fish on the CEND vertical split beam scientific echo sounder (Simrad EK80). Fishing was conducted on the drift, allowing CEND to travel at the same speed as the water column which permitted rod and line 'jigging.'

Over the 24-day survey period, 22 fishing stations were completed (Figure 18), with 9 stations being positive for mackerel. Overall, 92.887kg adult mackerel were caught across the survey area (Table 6). A total of 284 mackerel were measured, 225 mackerel were biologically sampled and otolith extracted, and 74 female mackerel were fecundity sampled. All other non-target species were recorded as observations only (Table 8 and Figure 20).

At each positive fishing station, all adult mackerel were bulk weighed (g) and biologically sampled (individually weighted (g), measured (to whole cm (Figure 21)), otolith extracted, sexed, and allocated a Walsh Key maturity stage (Annex 1, Page 98 in ICES, 2019)). Where possible, fecundity samples (2x25µl fecundity analysis samples, 2x100µl batch fecundity analysis samples, 1x0.5µm ovary screening analysis sample, and 1 x whole ovary atresia sample) for DEPM analysis were obtained from biologically sample female mackerel. Where large catches of adult mackerel were obtained, a well-mixed subsample was sampled. All station catch details and sample data was entered directly into the Electronic Data Capture (EDC) system and uploaded directly into the FSS.

Post-survey, age determination was conducted on all collected mackerel otoliths to determine age. To achieve this, the number of visible opaque rings were counted using a stereo microscope (between x2 and x10 magnification) and reflected top light. For each otolith, opaque growth rings from the nucleus to the edge were counted (Figure 22). Outlier ages were QCed with length data to ensure quality. Age data was entered into FSS to correspond with biological sampling data, and subsequent fecundity sampling data (Table 7). Biological data and corresponding fecundity samples will be sent to various participating WGMEGS North Sea institutes for analysis and subsequent reporting.

Table 6. Rod and line fishing samples.

STN No.	Date	ICES Statistical Rectangle	Start latitude	Start longitude	E/W	Fishing duration (minutes)	Total mackerel weight (g)
10	05/06/2022	35F3	53°13.79	003°51.34	E	19	0
11	05/06/2022	35F3	53°14.12	003°51.58	E	19	0
27	07/06/2022	37F2	54°12.03	002°48.23	E	86	0
29	07/06/2022	37F2	54°14.88	002°29.07	E	7	1180
30	07/06/2022	37F2	54°15.03	002°28.15	E	13	0
36	08/06/2022	37E1	54°14.99	000°6.34	W	87	7920
46	09/06/2022	40F1	55°45.07	001°43.13	E	28	0
59	10/06/2022	40F7	55°44.94	007°14.12	E	66	0
61	10/06/2022	41F7	56°13.1	007°44.93	E	27	244
87	13/06/2022	47E9	59°14.94	001°39.96	W	62	6780
107	15/06/2022	48F3	59°44.83	003°40.02	E	52	64000
116	15/06/2022	48E1	59°45.03	000°34.07	W	26	0
127	16/06/2022	46E1	58°45.4	000°10.09	E	33	0
132	17/06/2022	46F2	58°45.04	002°9.23	E	25	0
138	17/06/2022	46F3	58°45.84	003°44.83	E	101	11760
154	19/06/2022	42F5	56°44.9	005°31.19	E	27	0
159	20/06/2022	42F4	56°44.73	004°14.27	E	22	0
162	20/06/2022	42F3	56°45.05	003°14.69	E	25	0
179	21/06/2022	42E9	56°44.75	001°42.02	W	35	0
192	23/06/2022	38F2	54°45.18	002°11.05	E	24	300
200	23/06/2022	38F5	54°45.45	005°26.12	E	46	307
205	24/06/2022	38F7	54°45.35	007°15.15	E	34	396

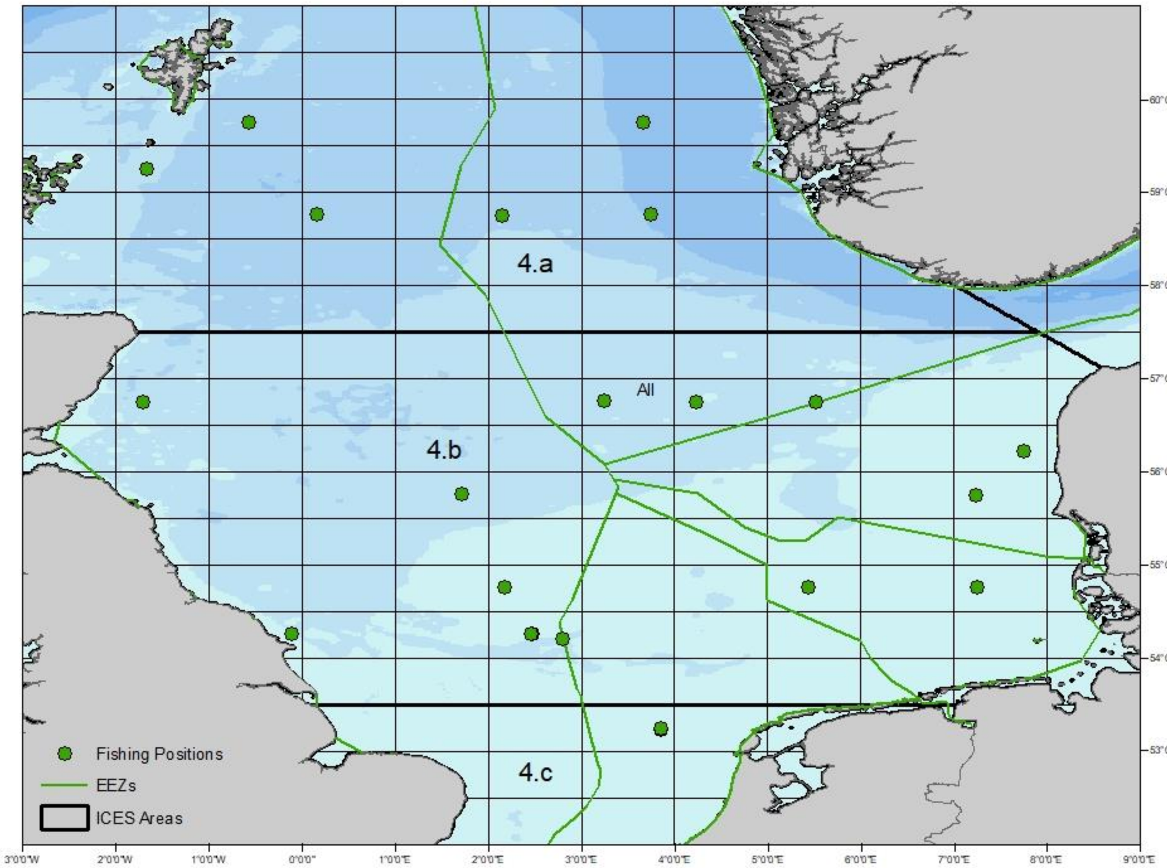

Figure 18. Rod and line fishing locations of the England (Cefas) 2022 MEGS.

Figure 19. Rod and line fishing operations on CEND to collect adult mackerel samples during the England (Cefas) 2022 MEGS.

Figure 20. Example rod and line fishing catch from STN 87, containing non-target Atlantic cod and haddock (top) and adult mackerel (bottom).

Table 7. Full biological and fecundity samples, with corresponding ages, collected during the England (Cefas) 2022 MEGS.

Fish No.	STN No.	Length (cm)	Fish weight (g)	Ovary weight (g)	Maturity stage	Age (years)
1	26	37	427	*Not available*	3	6
2	26	38	503	*Not available*	3	10
3	26	36	436	*Not available*	3	6
4	26	39	540	*Not available*	3	7
5	26	38	515	*Not available*	3	6
6	26	35	379	45.5	3	4
7	139	34	302	*Not available*	3	3
8	139	31	257	7.1	3	3
9	162	39	474	22.5	3	10
10	162	35	339	11.2	5	6
11	162	38	424	15.1	5	6
12	162	35	342	10.8	5	4
13	162	33	287	11.5	2	5
14	162	38	430	12.9	4	8
15	162	35	360	20.2	4	5
16	162	36	372	13.2	5	6
17	162	41	572	57.2	3	9
18	162	35	322	8.6	4	5
19	162	39	538	70.2	4	8
20	162	38	407	10.5	5	8
21	162	33	324	3.1	6	5
22	162	35	385	22	3	6
23	162	37	407	27.4	3	6
24	162	38	482	17	5	8
25	162	29	219	1.8	6	2
26	162	38	481	14.2	5	6
27	162	31	299	1.6	6	2
28	162	35	435	20.3	5	7
29	162	35	322	13.2	3	5
30	162	35	378	14	5	8
31	162	33	303	13.8	3	5
32	162	37	438	20.6	4	6
33	162	34	355	18.9	4	3
34	162	36	379	15.4	4	5
35	162	36	410	14.8	5	7
36	162	33	326	7.7	3	6
37	162	34	343	8.6	5	4
38	162	37	397	30.5	4	6
39	162	36	373	3.2	5	3

40	162	35	395	25.7	3	5
41	162	37	421	14.9	5	8
42	162	36	337	11.8	3	6
43	162	31	283	28	3	3
44	162	38	443	15.1	5	10
45	162	34	389	16.4	4	6
46	162	37	374	10.4	3	5
47	162	40	512	25.5	4	8
48	162	37	427	9.7	5	11
49	162	38	437	47.3	4	10
50	162	40	447	13.1	5	13
51	162	32	307	26	4	3
52	162	37	429	13	5	7
53	162	37	380	21.2	3	8
54	134	35	407	29.4	4	4
55	134	33	322	16.1	3	4
56	134	32	273	17	3	3
57	134	32	299	26	3	3
58	134	31	271	19.2	4	3
59	134	29	244	2.9	2	2
60	134	35	327	17.4	4	6
61	134	29	210	2.1	6	2
62	134	30	236	2.9	5	2
63	134	30	205	2.4	6	3
64	134	30	228	2.9	6	2
65	134	29	212	1.6	6	3
66	134	30	249	10.2	6	2
67	134	28	192	1.9	6	2
68	134	28	207	2	6	2
69	134	29	225	1.3	6	2
70	134	28	191	1.5	6	2
71	134	29	214	1.7	6	2
72	134	28	195	1.6	6	2
73	49	34	300	11.3	3	3
74	55	33	307	14.6	3	3

Table 8. List of species caught during the England (Cefas) 2022 MEGS.

Species name	**Common name**
Gadus morhua	Atlantic cod
Melanogrammus aeglefinus	Haddock
Merlangius merlangus	Whiting
Eutrigla gurnardus	Grey gurnard

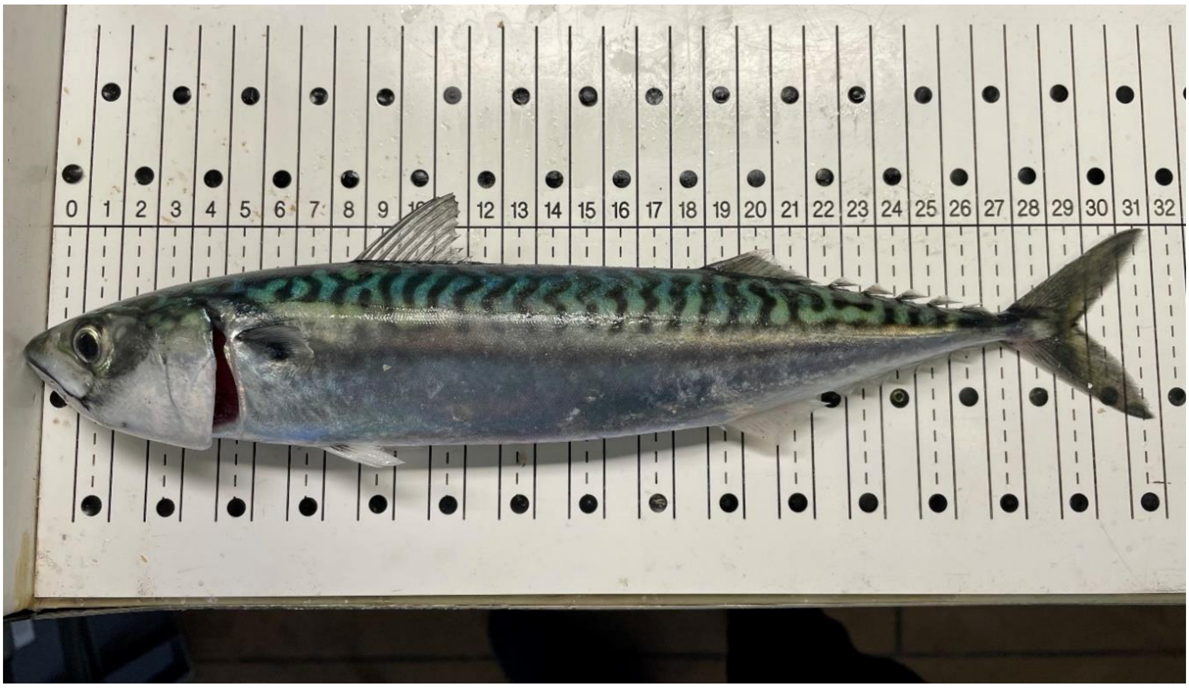

Figure 21. Example of sampled adult mackerel. Fish No. 56. STN 134, length 32cm, weight 273g, Walsh maturity stage 3, age 3 years old.

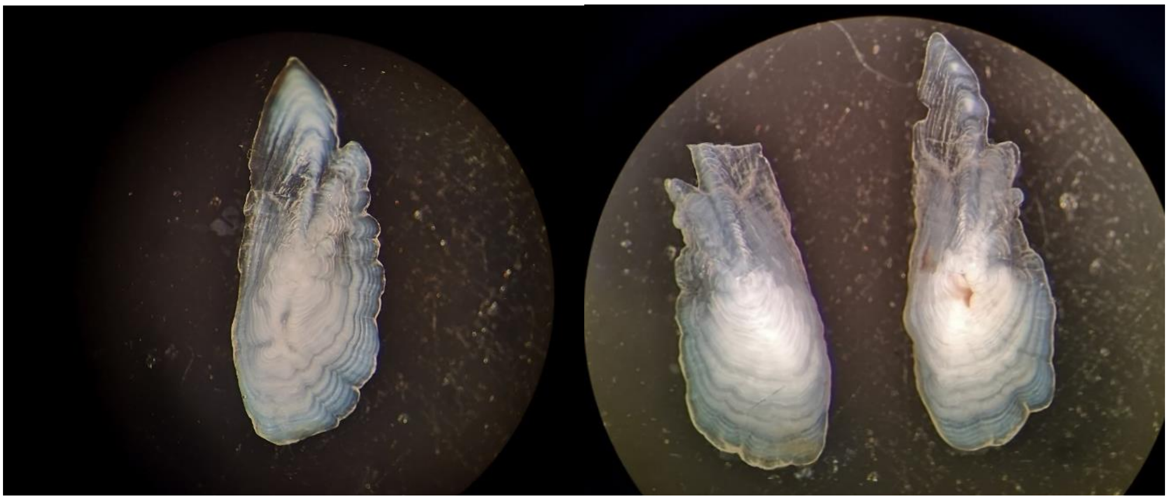

Figure 22. Examples of mackerel otoliths. Left: Fish No. 52. Prime 162, length 37cm, weight 429g, Walsh maturity stage 5, age 7 years old. Right: Fish No. 44. Prime 162, length 38cm, weight 443g, Walsh maturity stage 4, age 10 years old.

Secondary aims

Aim 3
PUP samples
Following successful Gulf VII deployment (determined by a correct double oblique haul and electronic flow meter data), the PUP plankton sample was retrieved and immediately preserved with 4% buffered formaldehyde for potential subsequent microzooplankton analysis in the lab. PUP samples were successfully obtained from a total of 135/164 Prime stations.

Aim 4
Plankton Imager data

The onboard Plankton Imager (PI) was used to collect mesozooplankton data to assess abundance and trophic interaction throughout the survey. The PI sampler (Figure 23) was started on 6 June. Unfortunately, due to image quality issues (abundance of bubbles in the water) and a lack of available file storage memory the PI needed to be restarted and this occurred on 10 June (55°45.36940 07°47.64680 E) at 0908. The PI sampler was stopped on 26 June (52°28.34880 01°45.23240 E) at 0555hr.

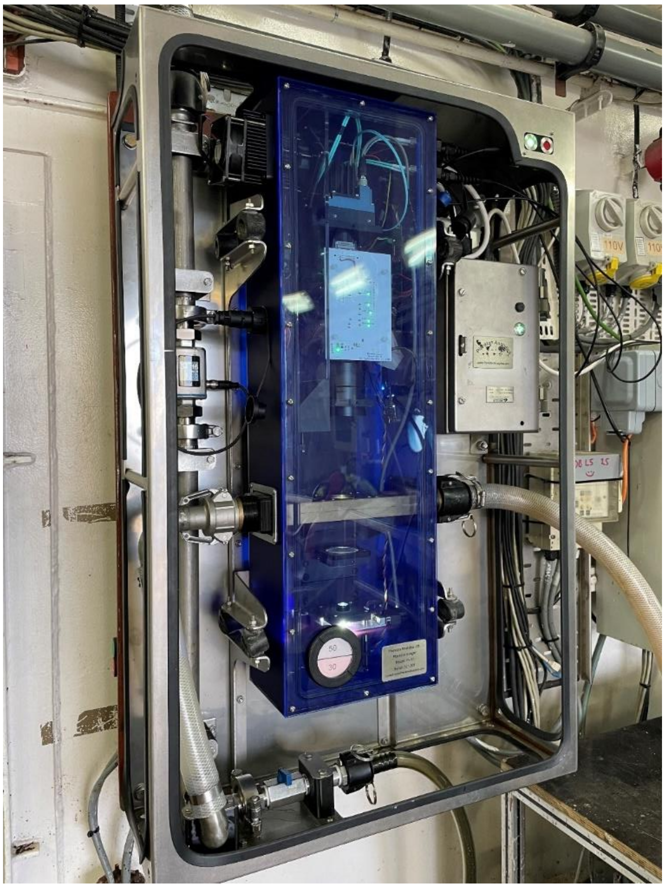

Figure 23. Photograph of the PI sampler on CEND during the England (Cefas) 2022 MEGS.

Aim 5
Cetacean and seabird surveyor data

One MARINElife surveyors was stationed on the CEND bridge in a central position and employed an effort-based 300m box methodology for recording birds (an adapted version of ESAS methodology), with an additional 180° area scanned to survey each transect line. During transits between transects, incidental observations were made where possible, logging significant species only. During survey transects, all species of birds (both seabirds and terrestrial migrants) were recorded, along with all sightings of marine mammals and surfacing pelagic fish (tuna). The effort-based 300m box methodology employed was developed by MARINElife for use on marine platforms to enable estimation of relative density. Utilising this method, the surveyor can record and identify as many seabirds and cetaceans as possible that pass through the 300m box, as well as outside the box to 1km.

Survey effort was made over 21-days between 4 and 24 June. A total of 3176km of trackline was sampled, with a mean Sea State of 4 (Table 9 & Figure 24). Viewing conditions were good to reasonable for surveying dolphins, whales, and seabirds (requiring Sea state 4 or less). Unfortunately viewing conditions were not good for Harbour porpoise (requiring Sea State 2 or less). Wind direction was variable, though south westerlies were most frequently recorded. Overall, Danish, German, Dutch, Norwegian, and UK EEZs were sampled.

Table 9. Survey effort and sea state conditions during the England (Cefas) 2022 MEGS.

Date	Distance surveyed (km)	Sea state	Wind direction
04/06/2022	9	4	NE
05/06/2022	126	4	NE
06/06/2022	167	6	SW
07/06/2022	145	5	NW
08/06/2022	25	4	E
09/06/2022	227	2	SW
10/06/2022	381	4	SW
11/06/2022	471	5	SW
12/06/2022	255	4	SW
13/06/2022	146	4	SW
14/06/2022	97	3	SW
15/06/2022	140	3	SW
16/06/2022	69	3	SW
17/06/2022	45	6	S
18/06/2022	77	5	WSW
19/06/2022	184	5	WSW
20/06/2022	63	6	NW
21/06/2022	114	3	N
22/06/2022	143	3	SW
23/06/2022	128	4	E
24/06/2022	163	4	SE
Sum	**3176**		
Mean		**4**	**SW**

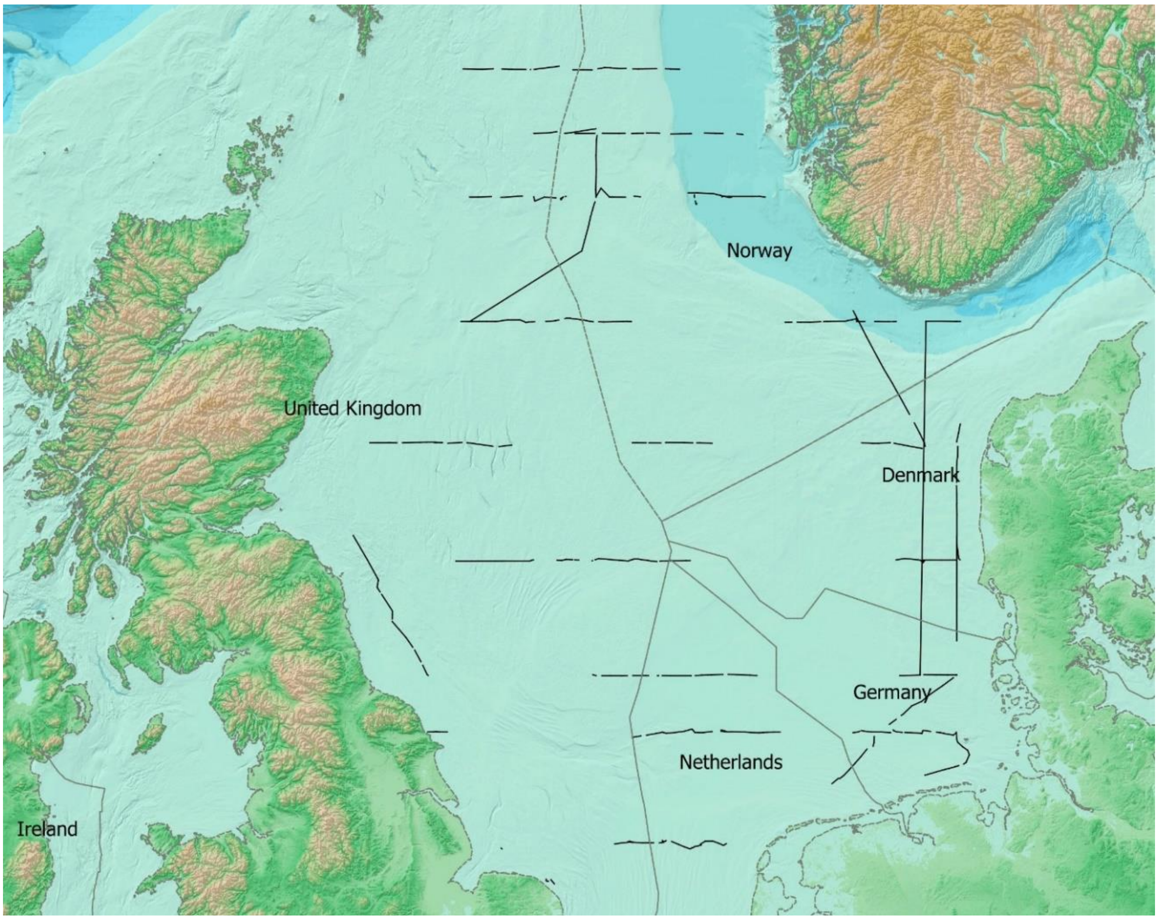

Figure 24. Distribution of survey effort (black lines) in relation to bathymetry (source: GEBCO) and EEZ boundaries (grey lines).

A total of 26 bird species were recorded on effort throughout the England (Cefas) 2022 MEGS, including 17 species of seabird. A total of 1,526 sightings of 2906 birds were recorded (Table 10). Two rare species were recorded yellow-legged gull and great shearwater.

The four main marine bird species recorded in descending order of abundance were gannet, fulmar, guillemot, and lesser black-backed gull. Differences in the spatial distribution of these species was observed. Fulmar and gannet were widely distributed, guillemot were predominantly observed in western and northerly areas, and lesser black-backed gull observed more frequently in eastern areas (Figure 25).

Table 10. List of all bird species recorded on effort during the England (Cefas) 2022 MEGS.

Seabird	**Species name**	**Common name**	**Sightings**	**Number counted**
N	Alcidae	Auk sp.	39	202
Y	*Cepphus grylle*	Black guillemot	1	1
Y	*Chroicocephalus ridibundus*	Black-headed gull	1	1
N	*Streptopelia decaocto*	Collared dove	1	1
Y	*Melanitta nigra*	Common scoter	1	7
Y	*Sterna hirundo*	Common tern	5	7
N	Gaviidae	Diver (Loon) sp.	1	1
Y	Procellariidae	Fulmar	320	617
Y	Sulidae	Gannet	550	671
N	Anatidae	Goose sp.	1	50
Y	*Larus marinus*	Great black-backed gull	45	69
Y	*Ardenna gravis*	Great shearwater	1	1
Y	*Stercorarius skua*	Great skua	15	16
Y	Alcidae	Guillemot	196	573
N	Laridae	Gull sp.	21	27
Y	*Larus argentatus*	Herring gull	2	2
Y	Laridae	Kittiwake	97	117
Y	*Larus fuscus*	Lesser black-backed gull	169	461
Y	*Puffinus puffinus*	Manx shearwater	2	2
N	Passeriformes	Passerine sp.	2	2
N	*Motacilla alba*	Pied wagtail	1	1
Y	Alcidae	Puffin	8	9
Y	*Alca torda*	Razorbill	33	53
N	*Columba livia domestica*	Feral pigeon	4	4
N	*Riparia riparia*	Sand martin	1	1
N	Fringillidae	Siskin	1	1
N	*Stercorariidae*	Skua sp.	1	1
N	Sturnidae	Starling	2	2
N	Hirundinidae	Swallow	2	3
N	*Streptopelia turtur*	European turtle dove	1	1
N	*Phylloscopidae*	Warbler Sp.	1	1
Y	*Larus michahellis*	Yellow-legged gull	1	1
Total			**1526**	**2906**

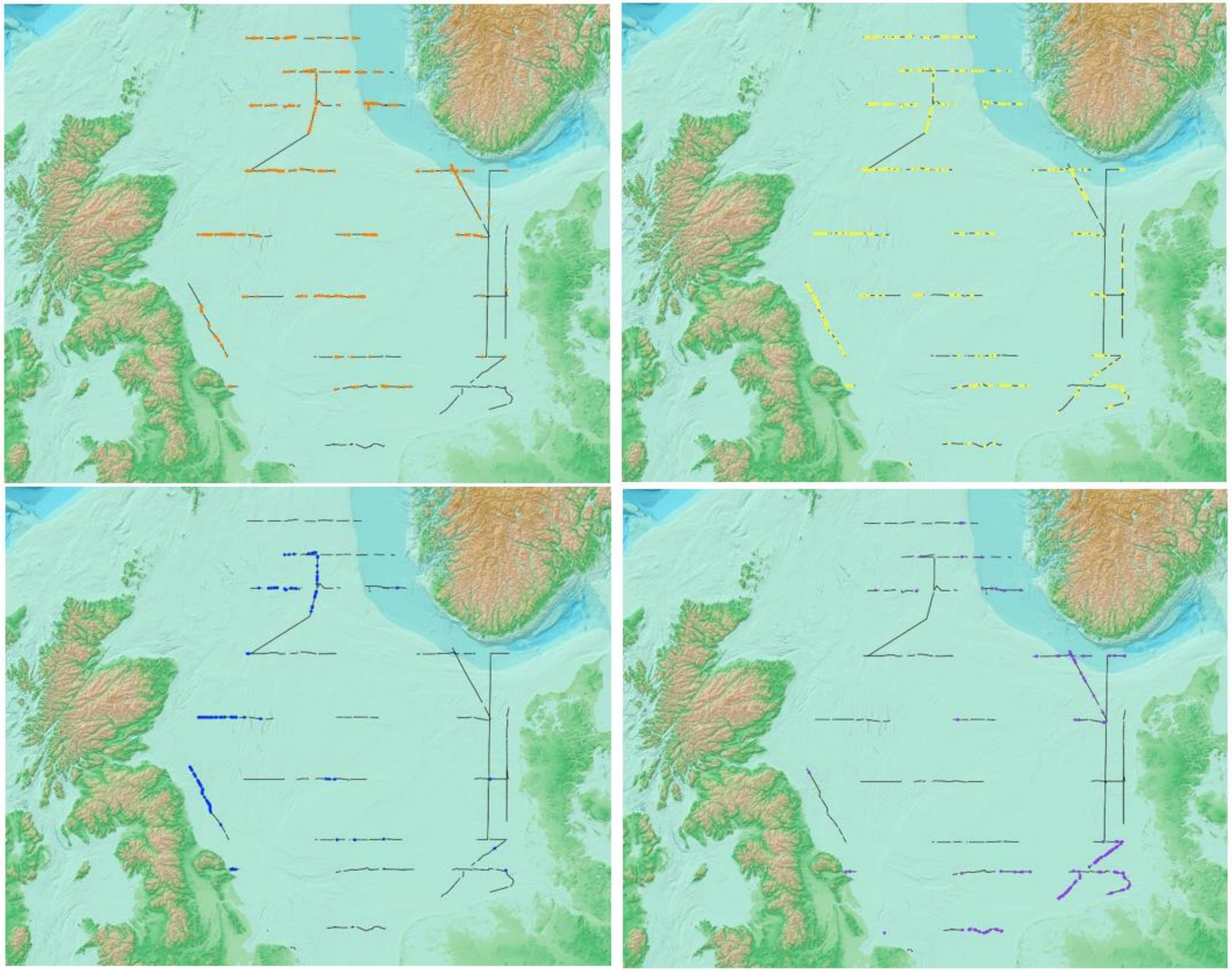

Figure 25. Distribution of fulmar (orange: top left), gannet (yellow: top right), guillemot (blue: bottom left) and lesser black-backed gull (purple: bottom right).

Throughout the survey five cetacean sightings were observed, four of which were identified to species including white-beaked dolphin, minke whale and bottlenose dolphin (Table 11 & Figure 26). All the encounters were comprised of singletons. Additionally grey seal was also observed.

Table 11. List of all marine mammals recorded on effort during the England (Cefas) 2022 MEGS.

Species name	Common name	Total number counted
Lagenorhynchus albirostris	White-beaked dolphin	2
Balaenoptera acutorostrata	Common minke whale	1
Tursiops truncatus	Common bottlenose dolphin	1
Halichoerus grypus	Grey seal	2

White-beaked dolphins were observed off the south coast of Norway. Bottlenose dolphin and minke whale were observed in UK EEZ, with the former in a known area of regular occurrence off the north coast of Northumberland. Minke whale was observed in an area of narrow deep-water trenches east of the Aberdeen Bank. Grey seal observations were geographically close to the bottlenose dolphin sighting.

The complete lack of harbour porpoise sightings is likely due to detectability issue as sea conditions were not conducive for spotting them. The number of cetacean sightings in general may have also been reduced for this reason, along with only having a single surveyor.

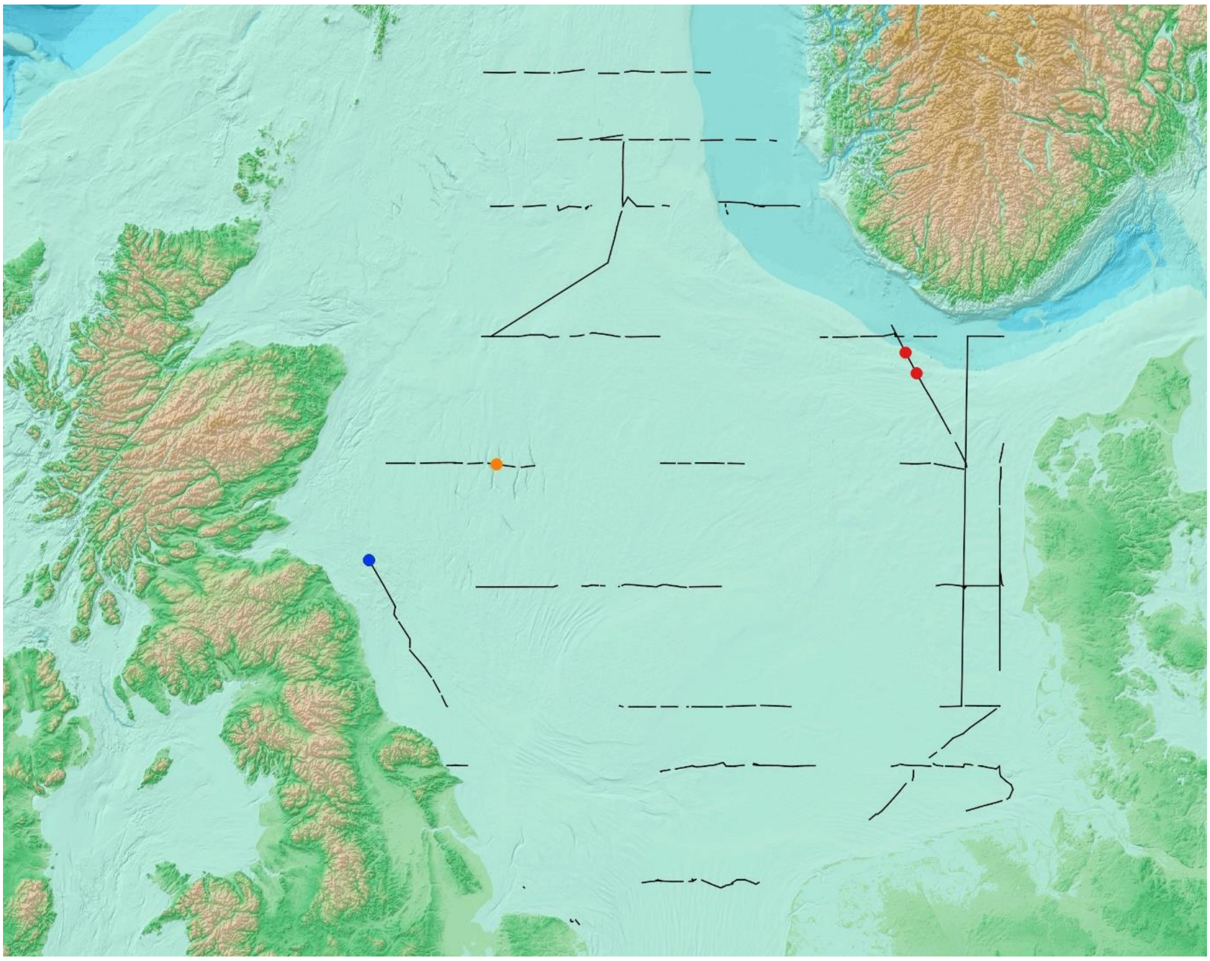

Figure 26. Cetacean sightings. White-beaked Dolphin (red), Bottlenose Dolphin (blue) and Minke Whale (orange).

Linford Mann
Scientist in Charge
14/09/2022

INITIALLED: L MANN

DISTRIBUTION:

Survey staff
I Holmes (Senior Fishing Survey Manager)
B Hatton (Deputy Fishing Survey Manager)
P Falconer (Portfolio Lead)
D Pettengell (Project Manager)
S Songer (Fisheries Director)
L Straker Cox (Aquatic Surveys, Evidence and Advice Group Manager)
J Eggleton (Ecology Group Manager)
Cefas Fisheries survey SICs/2ICs
Cefas CDP (G Burt)
AWSM - Pinbush
Master Cefas Endeavour
Scottish Government
WUR, The Netherlands
TISF, Germany
DTU-Aqua, Denmark
HI, Norway
FCO (for The Netherlands, Germany, Denmark and Norway)
IFCAs (Eastern, North Eastern, and Northumbria)

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