DTU Aqua

Cruise Report

F/V Ceton S205

”IESSNS 2023 DK”

Gifico Pelagic | Fiskeri AB Ginneton

Danmarks Pelagiske Producentorganisation

DTU Aqua
Section for Monitoring and Data Hirtshals

Kai Wieland

16-08-2023

Vessel: F/V Ceton S205

Cruise dates: 4/7 – 13/7 2023

Participants

Scientific team (DTU Aqua, Section for Monitoring and Data, Hirtshals):

Kai Wieland (Cruise leader),
Per Christensen,
Dirk Tijssen (4/7),
Kasper Schaltz (5/7 – 13/7)

Fishing vessel Ceton S205 (Gifico Aps):

Johannes Claeson (Skipper) and crew

Objectives

The main objective of the IESSNS (International Ecosystem Summer Survey in the Nordic Seas) is to estimate mackerel abundance per age class, but also CTD and plankton samples are being collected. The survey is carried out during July and a special designed gear, the Multpelt 832 pelagic trawl with Dynema warps, is used to catch the mackerel. The trawl fishery takes place at a combination of random stations located along transects, and fishing depth is from surface to about 30 – 35 m depth.
Even though the importance of the IESSNS survey for the mackerel assessment has recently increased, one criticism of the survey that has been raised several times is that the survey does not cover the southern edge distribution. Only samples taken north of 60° N are included in the index, thus the entire North Sea, Waters around the British Isles and the Bay of Biscay are not sampled. There are two reasons for that. First, the survey is designed and performed by Norway, Iceland, Faeroes, and Greenland with focus on their waters. Secondly, there is concern to what extent the survey design are applicable in more shallow areas like the North Sea. The reason for this concern is the absence of a thermocline in the southern and shallower waters, which is dividing the water column into a warmer upper layer and a colder deeper layer. The presence of a thermocline in the northern waters (at around 30 m depth) is believed to limit the habitat of the mackerel, as the fish are unlikely to cross the thermocline and dive into the cold deeper waters. If such a thermocline is not present the depth range of the mackerel south of 60°N may extend beyond the layer fished by the trawl
Despite the concern about the applicability of the survey design south of 60°N, there appears to be a potential in expanding the survey as this might improve the index, especially for the younger year classes which are expected to be located more southerly than older and larger individuals.

With this background, Denmark joined the IESSNS in 2018 using a commercial vessel to investigate whether the applied methods in the IESSNS would also work for the North Sea. Based on the positive results in the years 2018 - 2022, the survey was conducted in 2023 using again the fishing vessel F/V Ceton. The methods were the same as in the previous years except for a slightly changed layout of the sampling locations and a redefinition of the stratum limit.

Itinerary (local time)

3/7		Transport of equipment from Hirtshals to Skagen
4/7	09:00	Loading of remaining scientific equipment in Hirtshals and transport to Skagen
	15:40	Departure from Skagen
	18:30	Start of the survey sampling (at station 1)
5/7	07:45	Interruption of field work (after station 3) and heading to Hirtshals
	11:30 – 11:35	Hirtshals
	16:00	Continuing field work (station 4)
12/7	22:00	Survey sampling finished (at station 38)
13/7	07:45	Arrival Hirtshals,
	08:00	Unloading of equipment and samples in Hirtshals
	08:30	Storage of equipment and samples at DTU Aqua Hirtshals completed.

Achievements

Weather conditions were excellent and eight transects between about 59°45’ and 54°30’ N and 1°30’ W and 11°00’E were covered in the Skagerrak and the northwestern North Sea (Fig. 1) with the following activities conducted:

- 36 CTD profiles (down to 100 m or to about 5 m above bottom, prior to each fishing operation) with a memory Sea-Bird SeacatPlus probe equipped with sensors for pressure, temperature and conductivity,
- 36 valid (and 2 invalid) tows with a Multpelt 832 Pelagic Trawl (cod end mesh size 22 mm) and 7 m^2 Thyborøn type 15 doors

An accident happened when emptying the cod-end of the first haul and a member of the scientific crew had to be transported by helicopter to hospital treatment in Sweden. At station 9, the tow was invalid due to problems with the kite, and a series of trials for the re-adjustment of the trawl geometry took about 4 hours before a valid tow could be achieved at this position (haul 10 in Fig. 1). The delay caused by the two incidents meant that 3 stations had to be cancelled due to missing time because the financial equivalent to the available research quota did not allow an extension of the survey period. Another invalid tow was recorded at the end of the survey, but this caused only a minor delay.

The overall length of the cruise track (as given in Fig. 1) amounted to 1987 nm.

Results

Sampling and gear performance

The survey was conducted with the new F/V Ceton (69.90 m length, 14 m width, max. draught 7.5 m) in 24 h operation covering almost equally all times of the day (Fig. 2). Tow duration measured from the time at which vessel speed and trawl geometry was stable until hauling back the warp was 30 min in all cases. So-called banana tows were conducted in which heading was constantly changed with a turn radius of 5 to 10° and a curvature between 80 and 120° in total. On average, warp length during towing was between 270 and 320 m with a difference between SB and BB of 5 - 10 m in general. Average depth of the SB and BB doors ranged from 6 - 26 m.

Position, course, speed (GPS) and trawl geometry (Marport sensors, acoustic data transmission) were protocolled every 5 minutes. Average values by haul for towing speed over ground (SOG), vertical net opening and door spread ranged from 4.5 to 5.8 kn, 24 to 38 m and 118 to 133 m between the stations (Fig. 2) and amounted to 5.1 kn, 30 m and 125 m on average for all stations. There were some deviations from the survey manual (Wire length: 350 m; vertical net opening: 30 – 35 m; door spread: 120 m). The wider door spread, however, is accounted for through standardization of the catches by swept area and thus the focus was on achieving correct vertical opening and speed over ground as close as possible.

Bottom depth and distance of footrope to bottom were between 58 and 544 m and between 26 and 509 m, respectively, during nominal tow duration. However, during setting the trawl, the footrope shortly came close to the bottom at the shallowest stations.

Horizontal trawl opening (Wingspread) calculated according to the equation from the IESSNS manual for an average towing speed of 5 kn based on flume tank simulations, i.e.

$$WS = 0.3959 * \text{Door spread} + 20.094,$$

ranged from 67 to 73 m. Towed distance was received from the fishing plotter based on the continuously recorded GPS positions during the tow and ranged between 4.2 and 5.2 km per banana tow. These values were used to compute swept area converting total catch (kg) to densities (kg/km^2) per tow for mackerel and herring.

Catches and species distribution

Mackerel was caught on all stations. Most catches were between 250 and 500 kg, and nine catches exceeded 1000 kg with the highest catch of 3.5 tons (Fig. 3). Catches were relatively small in the central part of the survey area. Mackerel catches of more than 1.5 tons were wider distributed than in previous years occurring at five stations. The total catch of mackerel amounted to 27.2 tons (Tab. 1) and average mackerel density was 2362 kg/km^2, which is considerably higher than in the last year, being the second highest value in the time series (Fig. 4).

Herring was mainly restricted to the northern and northeastern part of the survey area and were scattered distributed the with maximum catches of 11.4 and 7.3 tons at two stations (Fig. 5) that were both in the early evening. The total catch of herring amounted to 33.1 tons (Tab. 1) and average density was 2822 kg/km^2.

Several other species were caught (Tab. 1) and it appears remarkable that classical demersal species such as grey gurnard, lumpfish and spurdog occurred in the surface layer catches even at deep stations and this was observed both during night and day.

Mackerel mean weight, length, and age distribution

Mackerel length was between 20 and 43 cm. Single fish weight was initially recorded for one specimen per cm group < 25 cm, two individuals between 25 and 30 cm and three individuals per cm group > 30 cm on each station as far as present. This stratification was later changed to one specimen per cm group < 27 cm, two individuals between 28 and 34 cm and three individuals per cm group > 34 cm on each station as far as present.

In total, 999 individuals were sampled for a length-weight relationship (Fig. 6) and an age-length key (Fig. 8). The exponent of the length-weight relationship was 2.79, which is similar to the last year (2.76) but slightly lower than the values from the previous years (2018: 2.88, 2019: 2.94, 2020: 2.83, 2021: 2.90) The overall condition factor K was 0.87 indicating a somewhat poorer average condition of the mackerel this year (2018: 0.87, 2019: 0.84, 2020: 0.88, 2021: 0.87, 2021: 0.93).

Mean individual weight by station ranged from 97 to 473 g and was highest in the northeastern and northwestern part of the survey area (Fig. 7). The lowest values were found in the southeastern part of the survey area at stations where 1-group individuals dominated the catch (Fig. 8).

The heads of each individual mackerel for which single fish length and weight was recorded were frozen on board for later otolith extraction in the lab. Ages 1 to 13 were identified in the single fish data of which fish at age 8 and older were pooled into a plus-group (Fig. 8).

Age 1 mackerel was most abundant in the southwestern and southeastern part of the survey whereas older fish (age 2, 3 and 4+) were more scattered prevailing in the northern and northeastern part of the survey area (Fig. 9). This pattern, i.e., the presence of small individuals (age 1) together with the

absence of large individuals (age 3 and age 4+) explains the geographical differences in the distribution of mackerel mean weight (Fig. 7).

Overall, the length and age composition for the survey indicate a considerably higher amount of small (<28 cm, age 1) individuals this year and the abundance of older mackerel, notably age 2 and age 3, was higher than in the previous year as well (Fig. 10). It appears noteworthy that the mean length of the 1-group was higher than in 2022 and more like the years 2021 and 2020.

Temperature conditions

CTD profiles were successfully recorded for all the 36 stations conducted. Sea surface temperature ranged from 11.7 to 16.5 °C with the highest values in the southeastern part of the survey area. A pronounced thermocline in the upper 20 to 30 m was found for all stations (Fig. 11). Below the thermocline, i.e., at depths > 40 m, temperature was between 7 and 9.6 °C.

Acknowledgements

Many thanks to skipper Johannes Claeson and his in all aspects competent crew for the good atmosphere and the very successful cooperation onboard. Further thanks to Claus Sparrevohn, 'Danmarks Pelagiske Producent Organisation' (DPPO), for organizational issues and logistics prior to the survey.

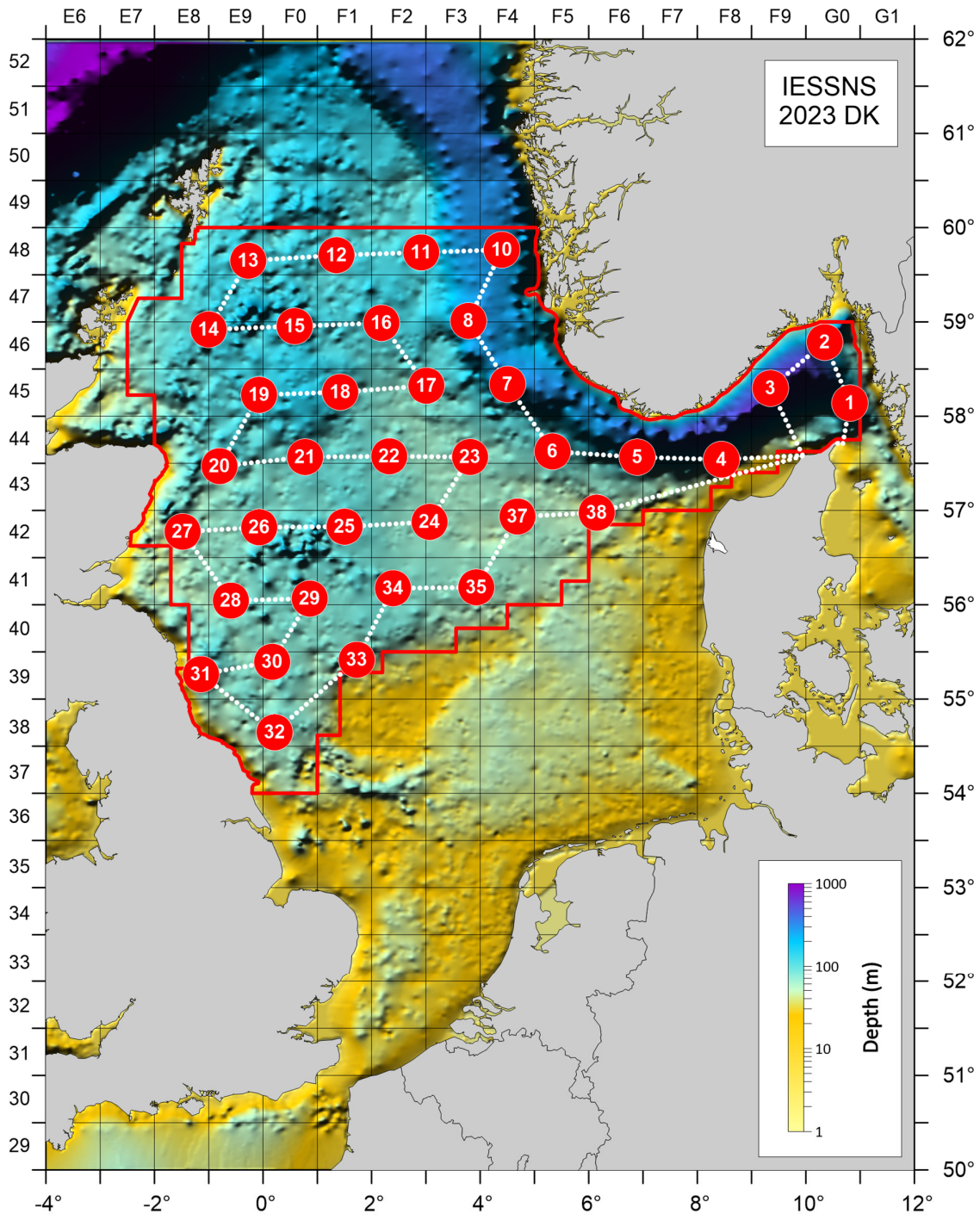

Fig. 1: Survey map with sampling locations, cruise track and updated stratum limit (Note: numbers refer to running tow number; Hauls 9 and 36 were invalid and repeated at its original positions as tows 10 and 37, respectively).

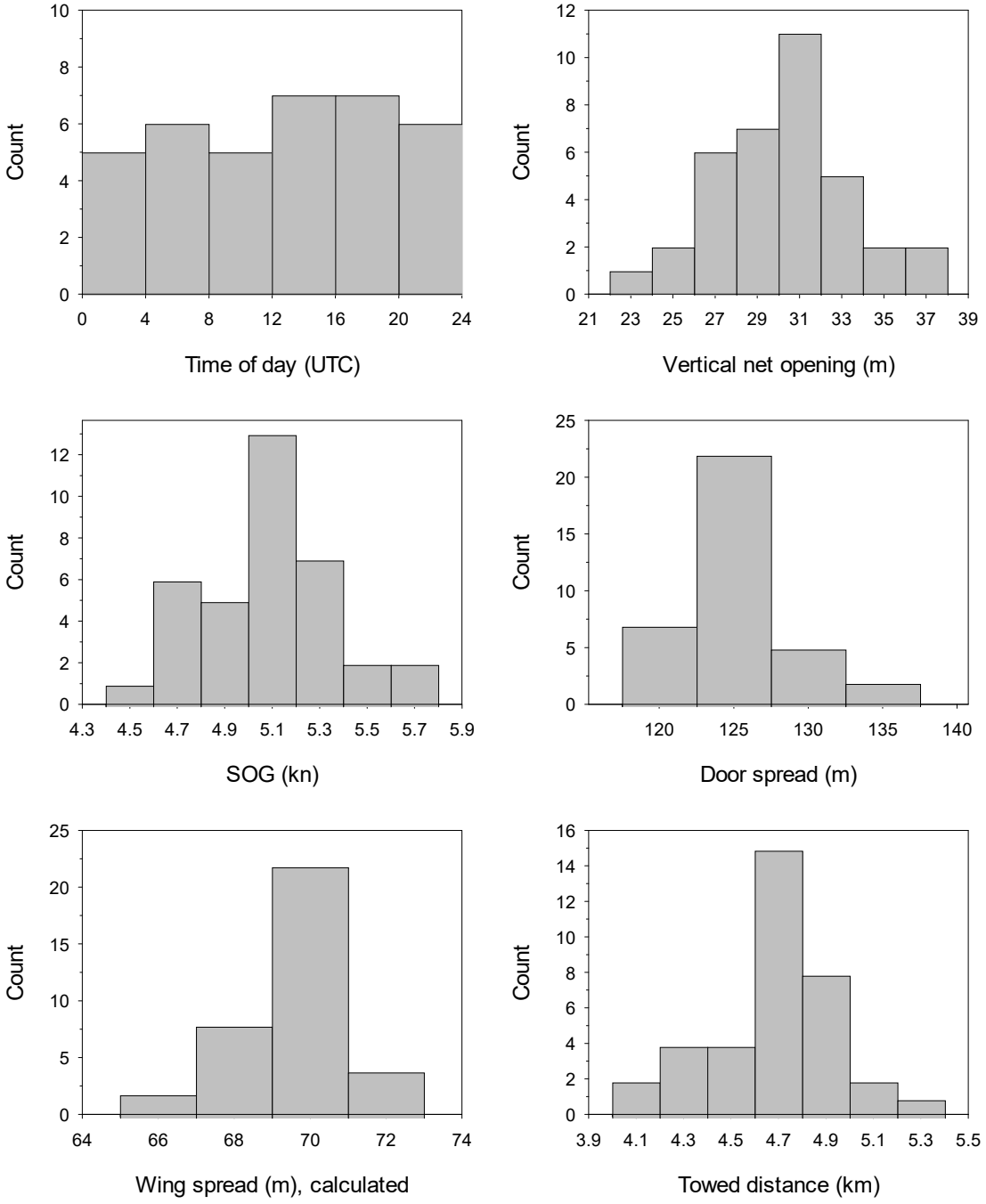

Fig 2: Times of day fished, vessel and gear performance (mean values by station).

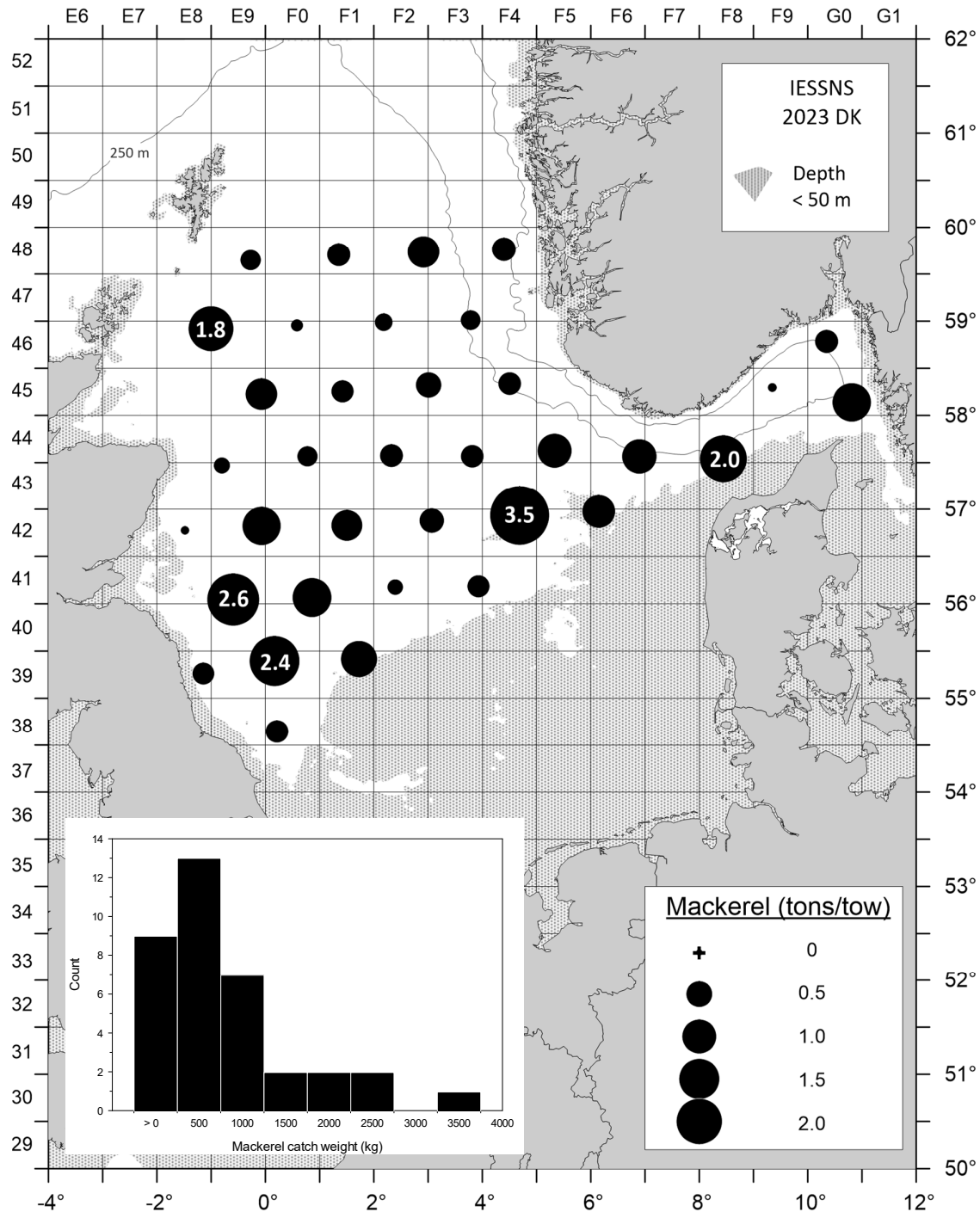

Fig. 3: Distribution of mackerel catches.

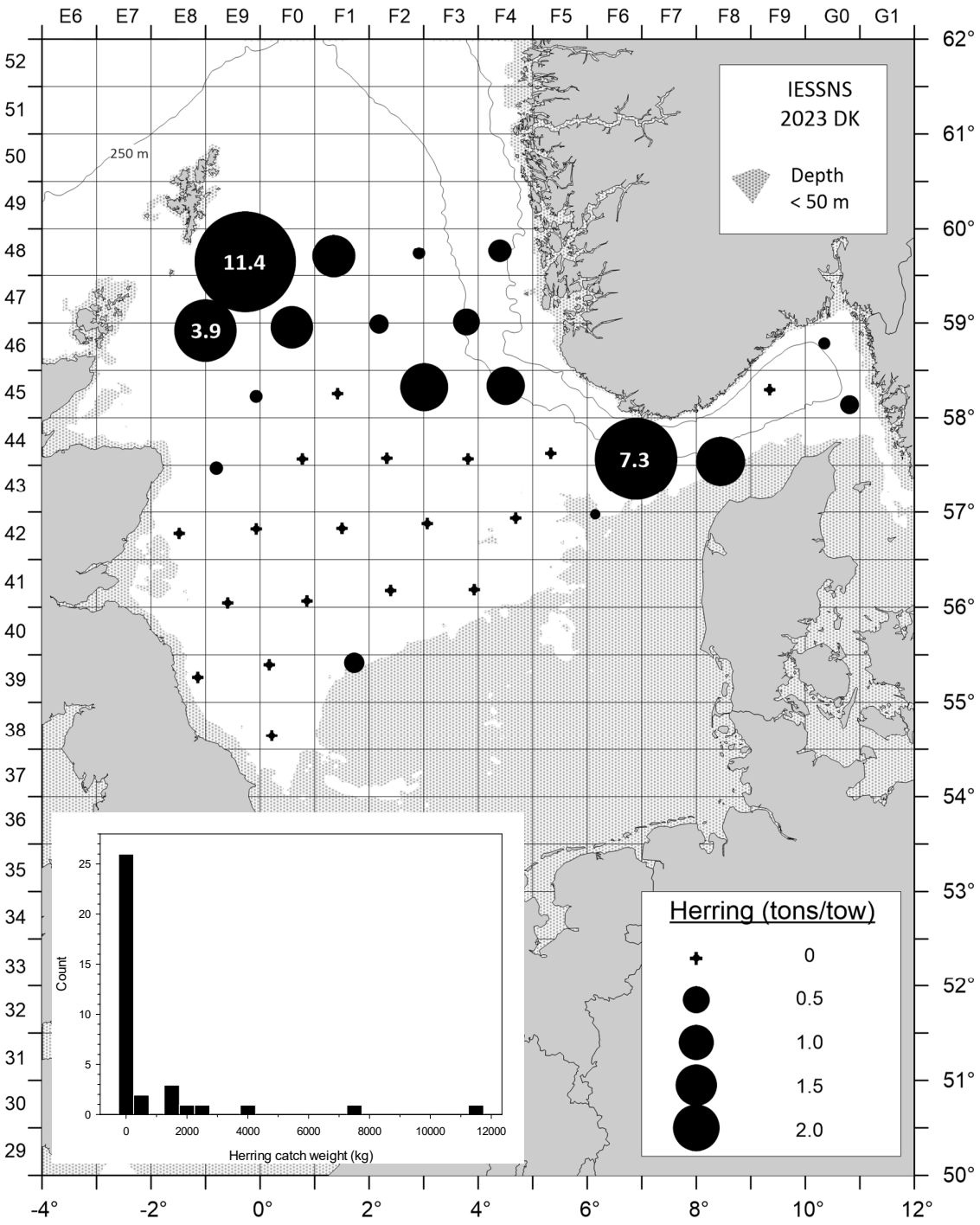

Fig. 4: Distribution of herring catches.

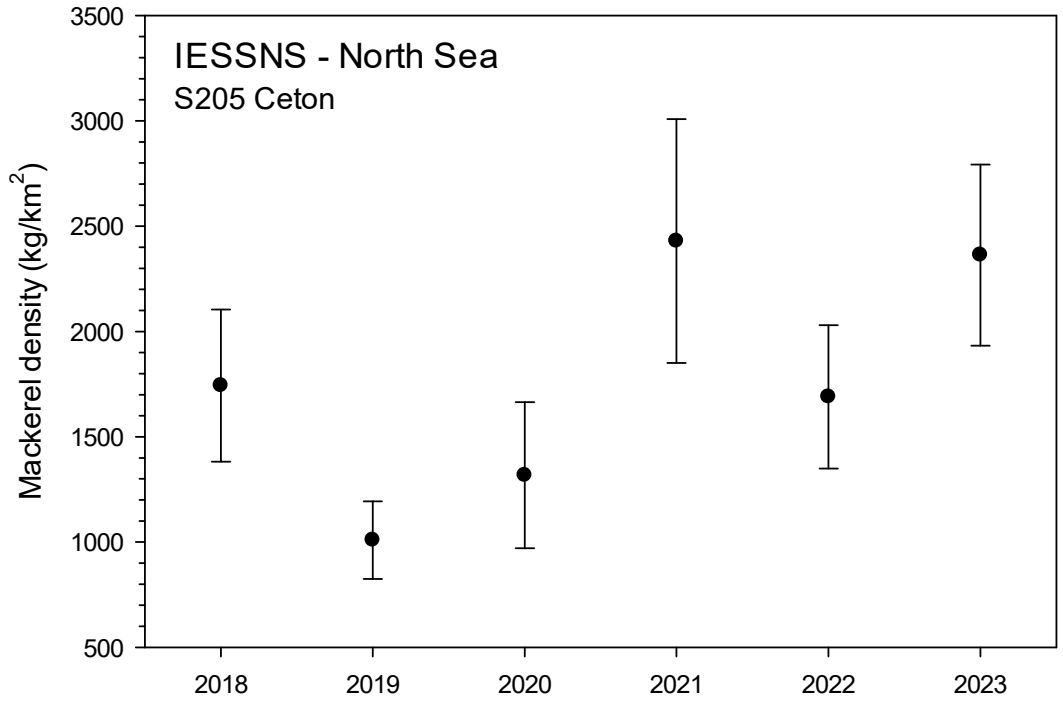

Fig. 5: Mackerel density (mean and standard error) in 2018 – 2023.

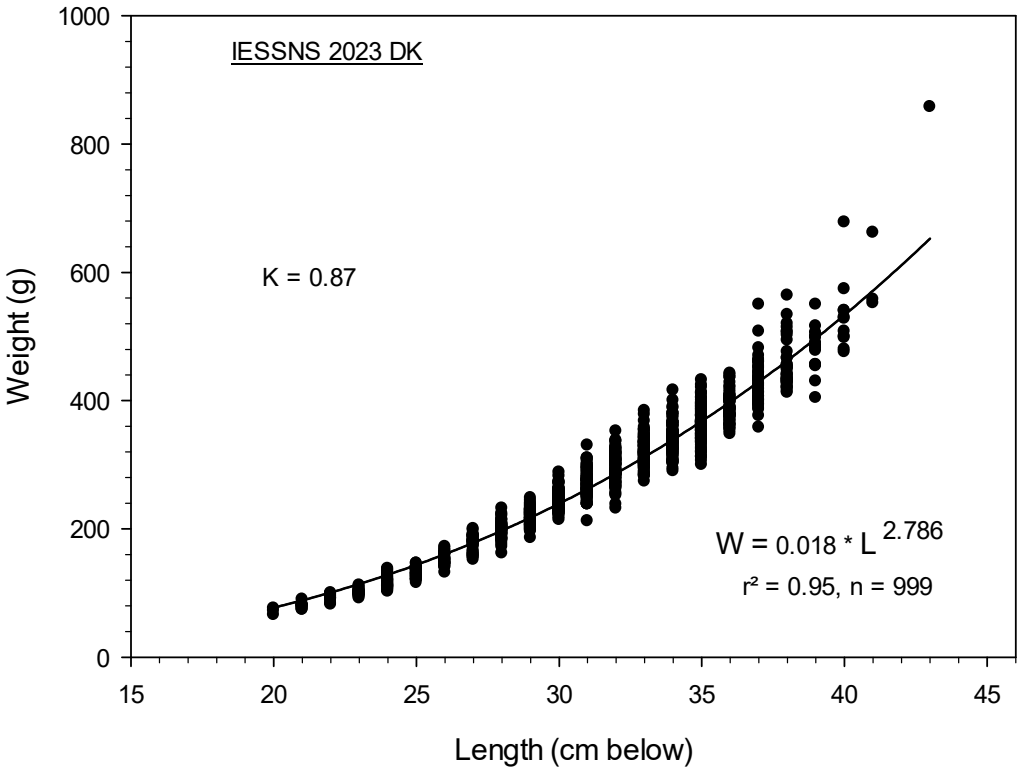

Fig. 6: Length-weight relationship for mackerel.

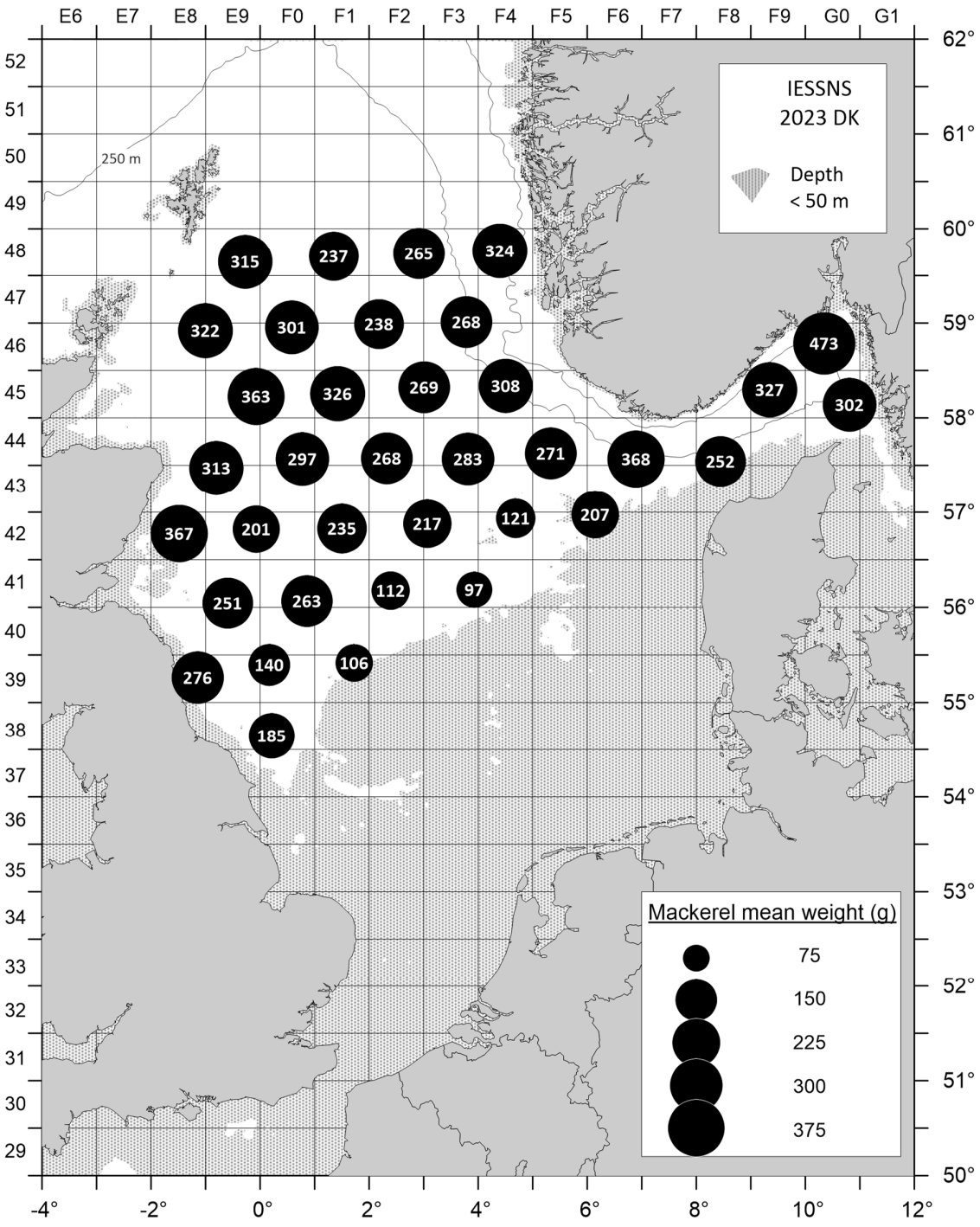

Fig. 7: Distribution of mean individual weight of mackerel.

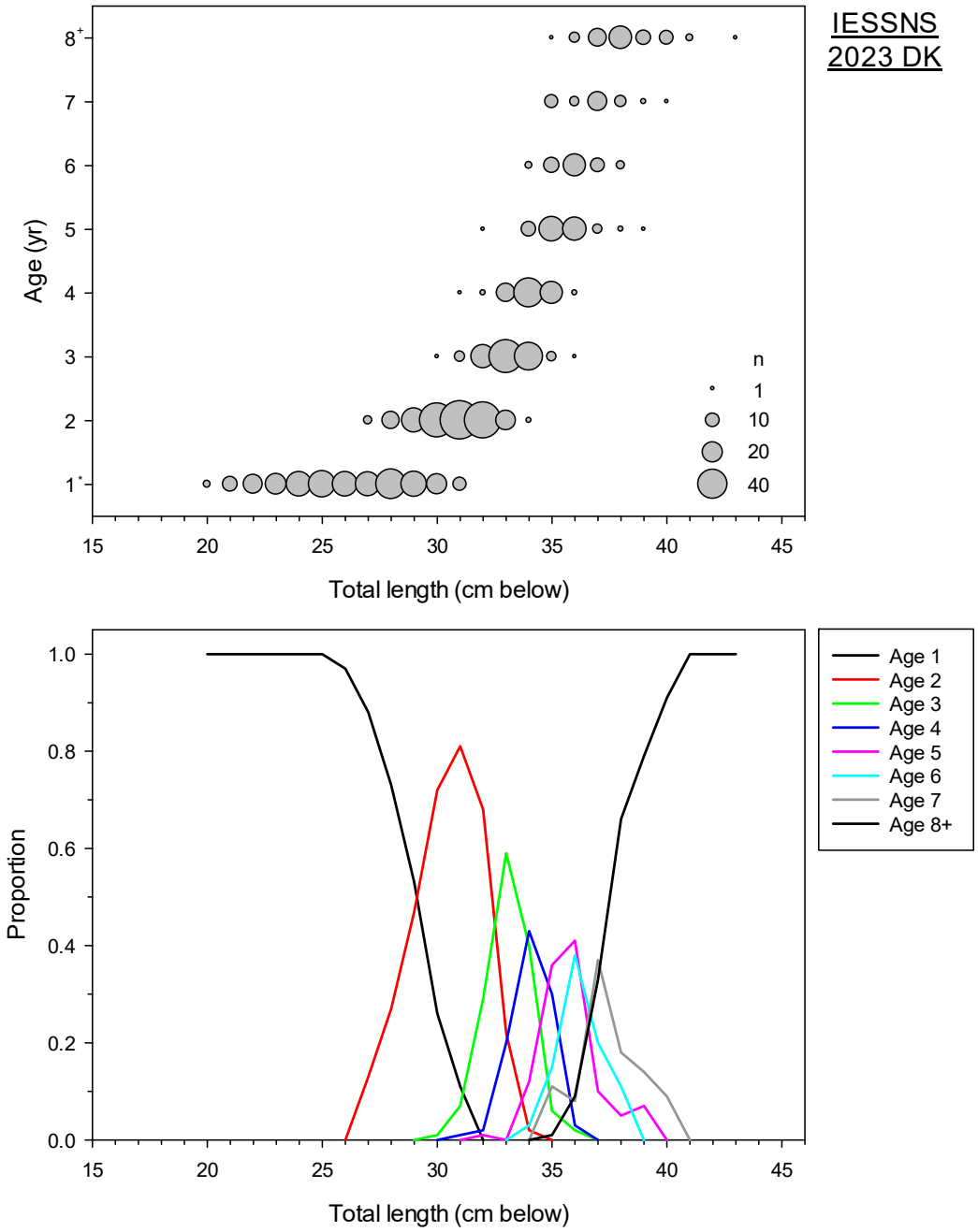

Fig. 8: Age-length key for mackerel (bubble size in upper panel refer to number of otoliths analyzed (n)).

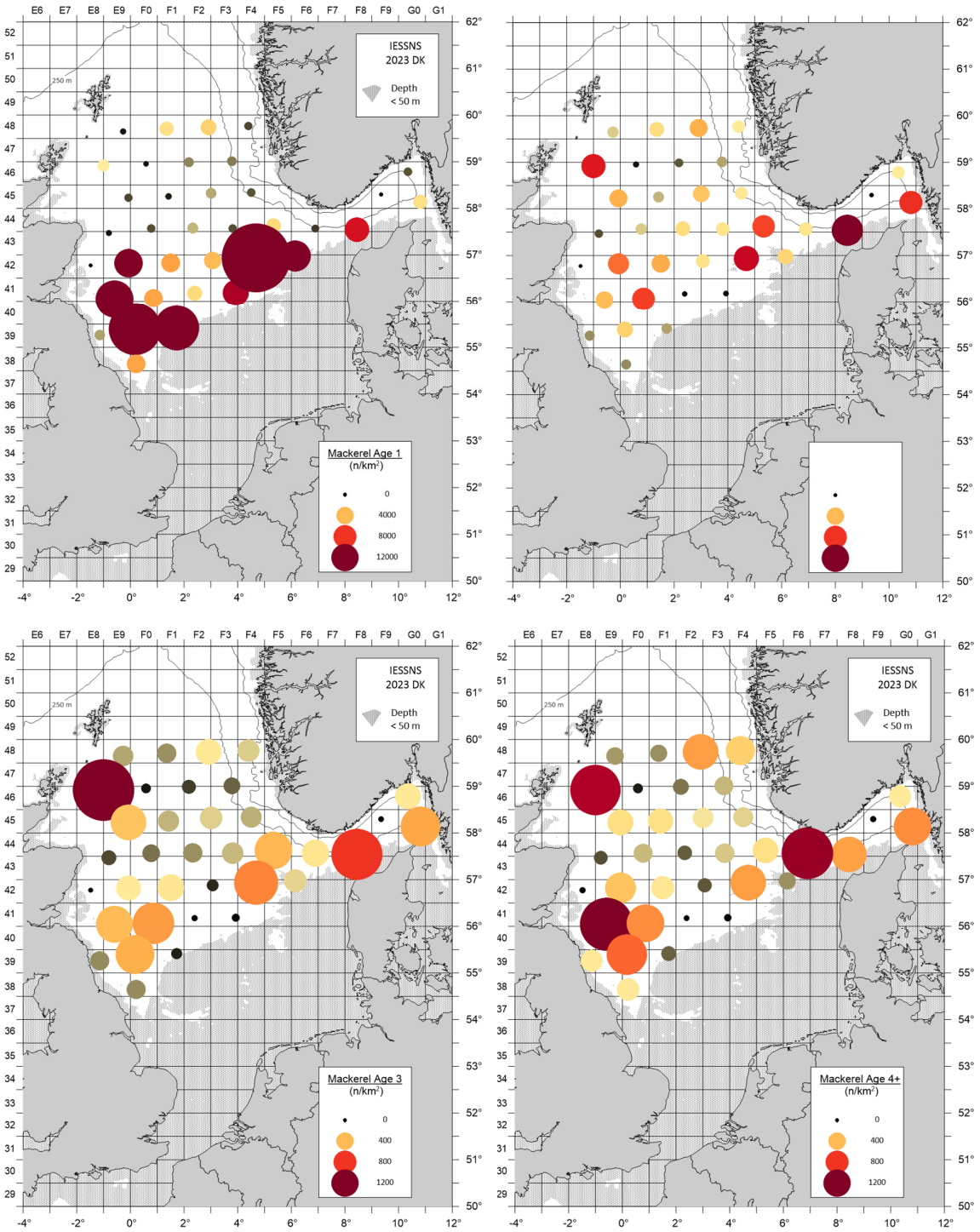

Fig. 9: Mackerel distribution by age.

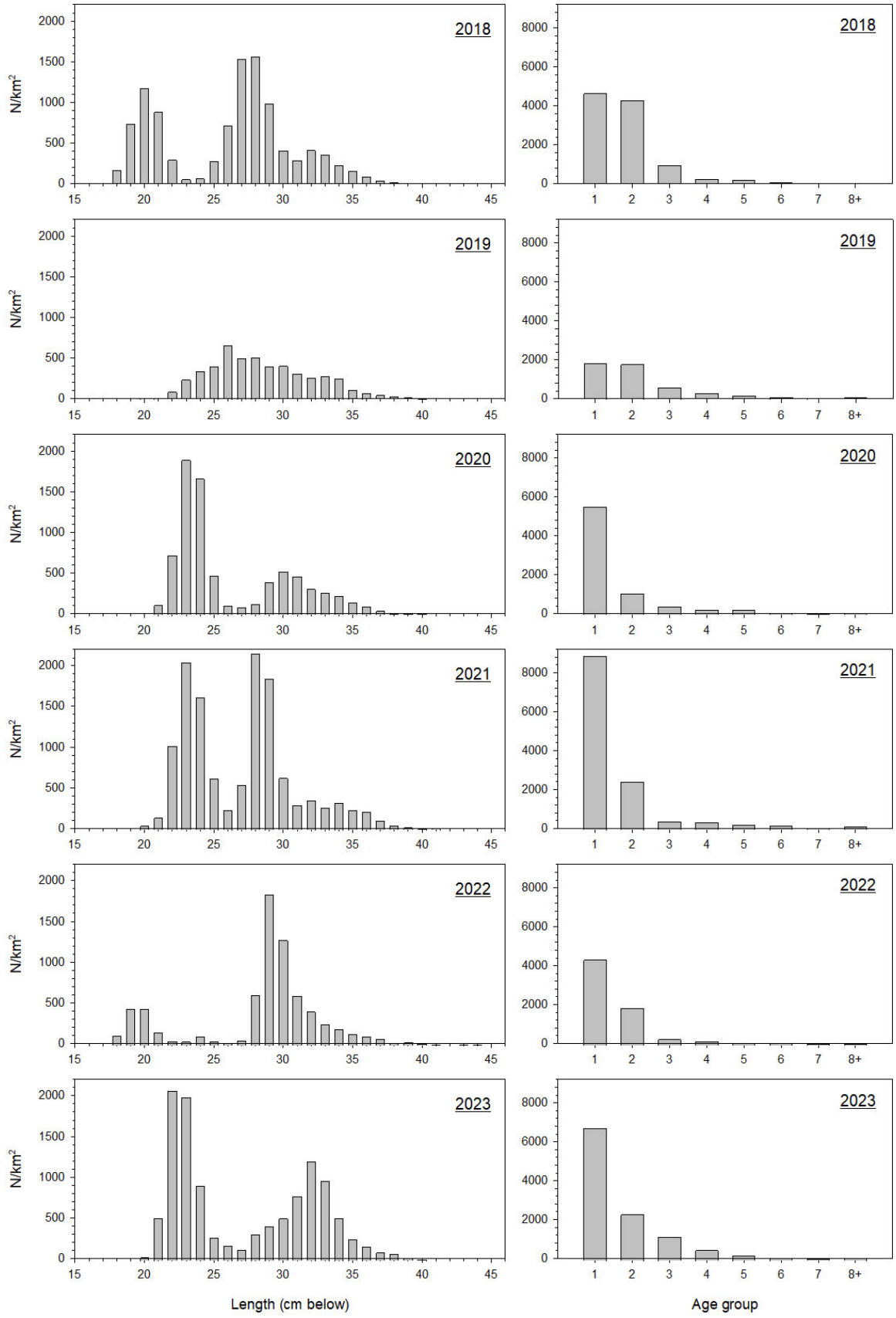

Fig. 10: Length and age composition of mackerel (based on all stations covered in the respective annual survey).

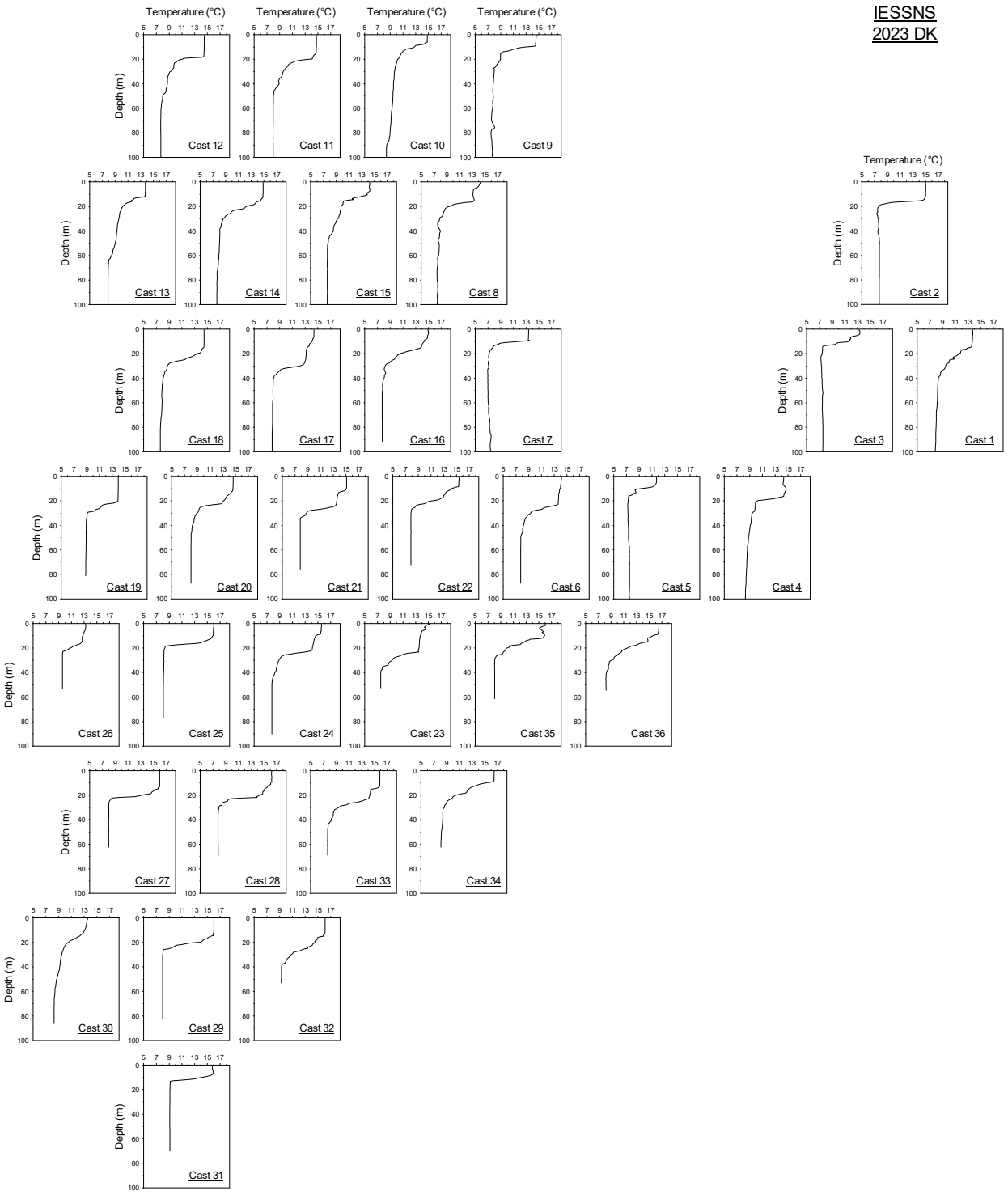

Fig. 11: Temperature conditions in the surface layer.

Tab. 1: Species list (L: total length in cm below (fish); ML: mantle length (cephalopods); Haul numbers as in Fig. 1).

Latin name	Danish name	English name	Weight (kg)	Number	L_{min} (cm)	L_{max} (cm)	Remark
Clupea harengus	Sild	Herring	33077.412	294878	16	32	
Scomber scombrus	Makrel	Mackerel	27219.678	136181	12	43	
Squalus acanthias	Pighaj	Spurdog	772.600	728	24	95	mainly from Skagerrak (Haul 1 and 2)
Melanogrammus aeglefinus	Kuller	Haddock	113.919	386	6	39	most fish in poor condition
Eutrigla gurnardus	Grå knurhane	Grey gurnard	47.349	383	18	30	
Micromesistius poutassou	Blåhvilling	Blue whiting	40.062	687	17	26	all from one haul at night (Haul 10)
Cyclopterus lumpus	Stenbider	Lumpfish	25.238	19	22	35	
Sprattus sprattus	Brisling	Sprat	24.343	1420	9	15	mainly from one tow (Haul 33)
Merlangius merlangus	Hvilling	Whiting	11.190	111	3	36	
Todaropsis eblanae		Lesser flying squid	8.666	43	7	19	ML
Salmo salar	Laks	Salmon	6.700	1	82	82	Haul 12
Illex coindetii		Southern shortfin squid	4.230	37	7	25	
Trachurus trachurus	Hestemakrel	Horse mackerel	1.284	4	25	39	
Loligo forbesii		Northern squid	0.298	2	11	18	ML
Belone belone	Hornfisk	Garfish	0.276	1	59	59	Haul 1
Todarodes sagittatus		European flying squid	0.200	4	8	11	ML
Sardina pilchardus	Sardin	Pilchard	0.122	1	22	22	Haul 7
Hippoglossoides platessoides	Håising	Long-rough dab	0.120	2	19	22	Haul 20 and 24
Ammodytes marinus	Havtobis	Lesser sandeel	0.026	28	5	8	

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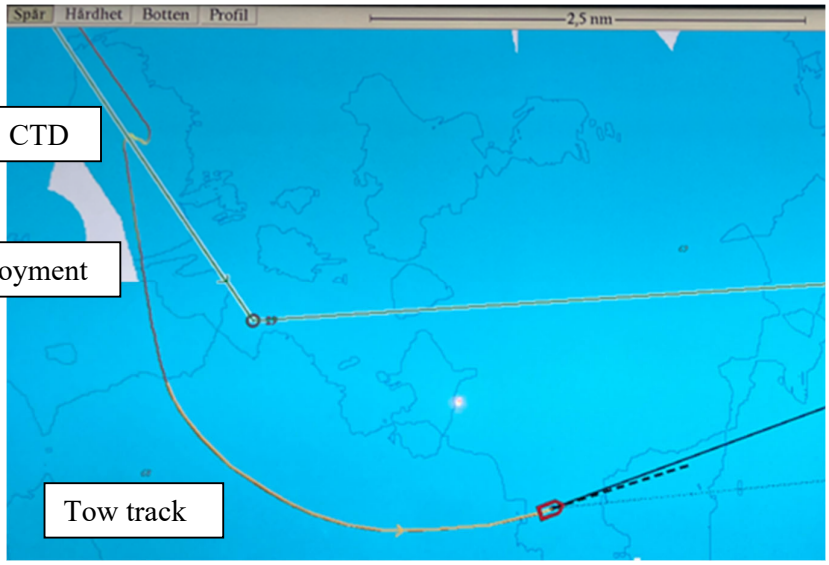

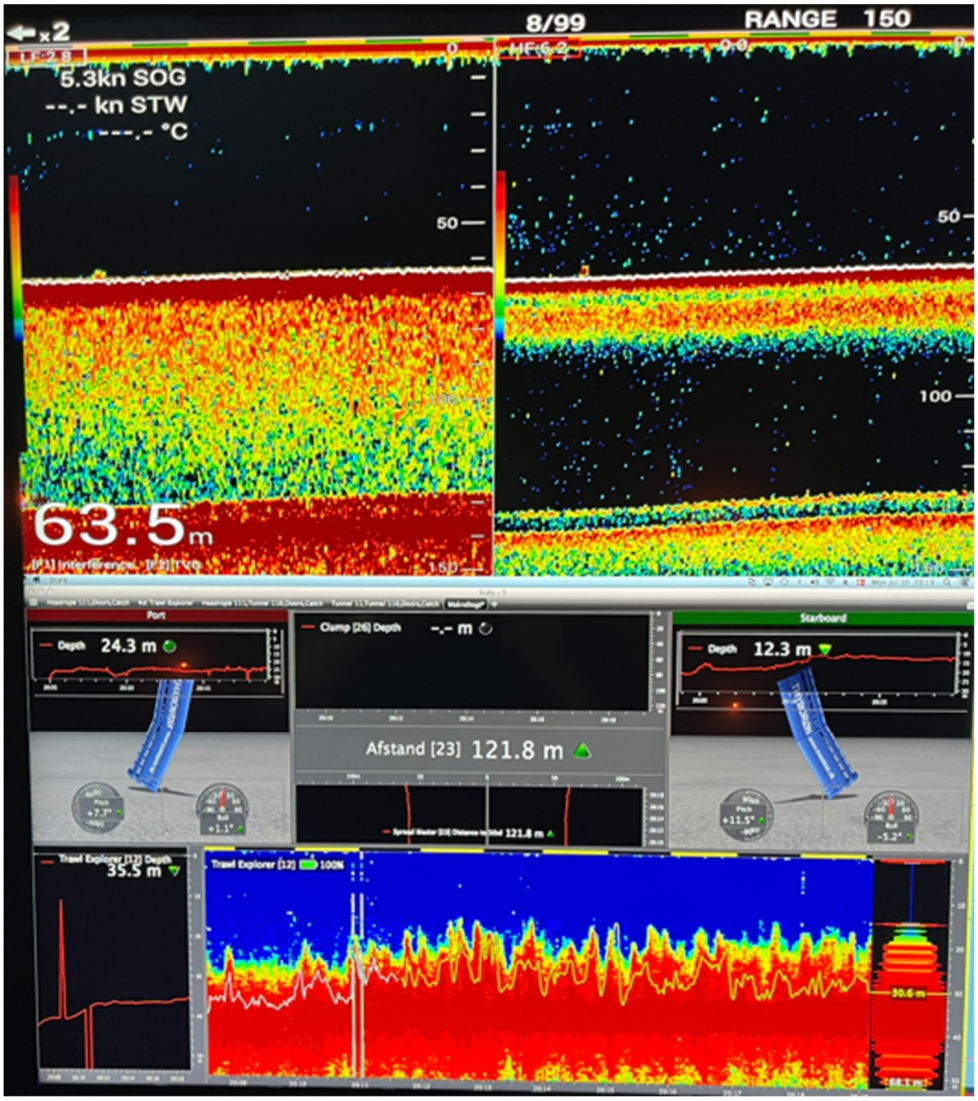

Vertical opening