DTU Aqua

Cruise Report

F/V Ceton S205

”IESSNS 2024 DK”

Danmarks Pelagiske Producentorganisation

DTU Aqua
Section for Monitoring and Data Hirtshals

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29-07-2024

Vessel: F/V Ceton S205

Cruise dates: 4/7 – 13/7 2024

Participants

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

Kai Wieland (Cruise leader),
Per Christensen,
Brian Thomsen

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 juvenile mackerel 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 - 2023, the survey was conducted in 2024 using again the fishing vessel F/V Ceton. The methods were the same as in previous years except for a slightly changed layout of the sampling locations. The stratum limits were kept unchanged but the average distance between the stations with randomly selected positions was increased from 45 to 50 nautical miles to ensure that all planned stations can be covered in the available survey period of 10 days.

Itinerary (local time)

1/7		Transport of equipment from Hirtshals to Skagen
4/7	09:00	Loading of remaining scientific equipment in Hirtshals and transport to Skagen
	11:00	Preparing vessel and installing of equipment
	19:30	Departure from Skagen
5/7	00:05	Start of the survey sampling (at station 1), 1 station dropped due to bad weather in the afternoon (the station was done at the end of the survey)
9/7		1 invalid station (sweeps broken), station repeated at original position after 5 hours when repair and fixing of the trawl was finished
13/7	03:00	Survey sampling finished (at station 35)
	08:45	Arrival Hirtshals, Unloading of equipment and samples in Hirtshals
	09:45	Storage of equipment and samples at DTU Aqua Hirtshals completed.

Achievements

Weather conditions were acceptable throughout most of the survey period and seven transects between about 59°23' and 54°53' N and 1°33' W and 10°17'E were covered in the Skagerrak and the northwestern North Sea (Fig. 1) with the following activities conducted:

- 34 CTD profiles (down to 100 m or to about 5 m above bottom, prior to each fishing operation) with a memory Sea-Bird Seacat19Plus probe equipped with sensors for pressure, temperature and conductivity,
- 34 valid (and 1 invalid) tows with a Multpelt 832 Pelagic Trawl (cod end mesh size 22 mm) and 7 m^2 Thyborøn type 15 doors.

The overall length of the cruise track (as given in Fig. 1) amounted to 1850 nm.

Results

Sampling and gear performance

The survey was conducted with the 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 315 and 350 m with a difference between SB and BB of 5 - 10 m in general. Average depth of the SB and BB doors ranged from 5 - 32 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 4.1 to 5.5 kn, 25 to 34 m and 110 to 126 m between the stations (Fig. 2) and amounted to 4.9 kn, 28.9 m and 121 m on average for all stations.

Bottom depth and distance of footrope to bottom were between 58 and 347 m and between 29 and 318 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 63.5 to 70.0 m. Towed distance was received from the fishing plotter based on the continuously recorded GPS positions during the tow and ranged between 3.7 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 almost all stations. Most catches were between 250 and 500 kg, and seven catches exceeded 1000 kg with the highest catch of 4.6 tons (Fig. 3). The total catch of mackerel amounted to 21.5 tons (Tab. 1) and average mackerel density was 2004 kg/km^2, which is somewhat lower than in the last year (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 6.8 and 4.1 tons at two stations (Fig. 5) that were both in the early evening. The total catch of herring amounted to 19.4 tons (Tab. 1) and average density was 1797 kg/km^2. However, at several locations echo traces which presumably belong to herring were observed below 30 m depth and thus the results of the surface layer catches of herring should be interpreted with caution.

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. In contrast, blue whiting was only found in the surface layer during night at deep water stations in the Norwegian trench.

Mackerel mean weight, length, and age distribution

Mackerel length was between 22 and 44 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.

In total, 1003 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 2.94, and the overall Fulton and Le Crens condition factors were among the highest in the time series indicating a good condition of mackerel in the surveyed area.

Mean individual weight by station ranged from 199 to 360 g and was highest in the northeastern and northwestern part of the survey area (Fig. 7). The lowest values were found in the southwestern part of the survey area at stations where small individuals dominated the catch (Fig. 8).

The heads of each individual mackerel for which fish length and weight was recorded were frozen on board for later otolith extraction in the lab. Ages 1 to 14 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 and age 2 mackerel were most abundant in the southwestern part of the survey whereas older fish (age 3 and 4+) were more scattered prevailing in the central 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 lower amount of small (<25 cm, age 1) individuals this year (Fig. 10). It appears noteworthy that maximum and mean length of the 1-and the 2-group was higher than in previous years.

Temperature conditions

CTD profiles were successfully recorded for all the 34 stations conducted. Sea surface temperature ranged from 11.1 to 16.1 °C with the highest values in the eastern part of the survey area. A pronounced thermocline in the upper 20 to 30 m was found for all stations except for two stations off

the Scottish coast (Fig. 11). Below the thermocline, i.e., at depths > 40 m, temperature was between 7.2 and 8.8 °C in the most cases.

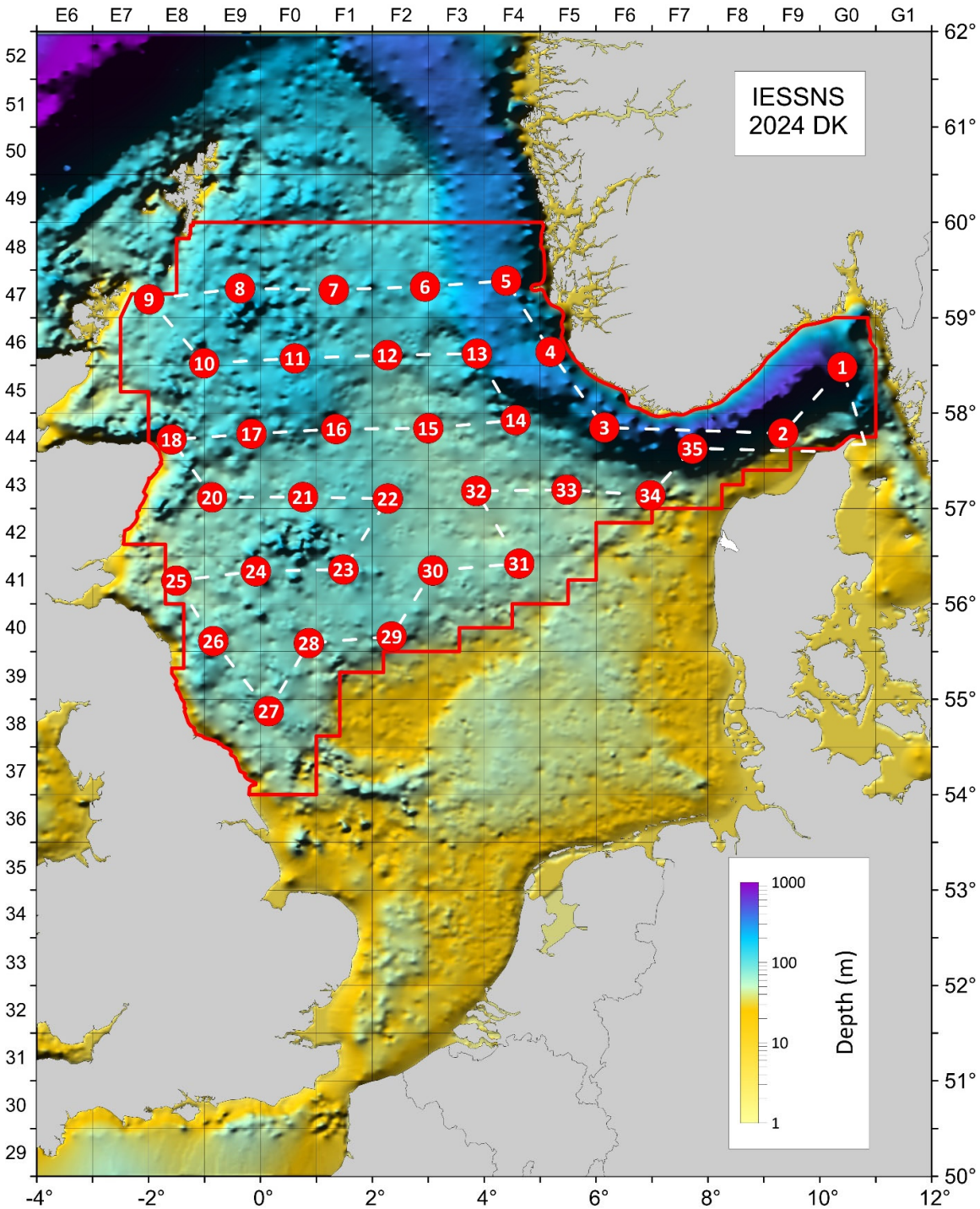

Fig. 1: Survey map with sampling locations, cruise track and stratum limit (Note: numbers refer to running tow number; Haul 19 was invalid and repeated at its original positions as haul 20).

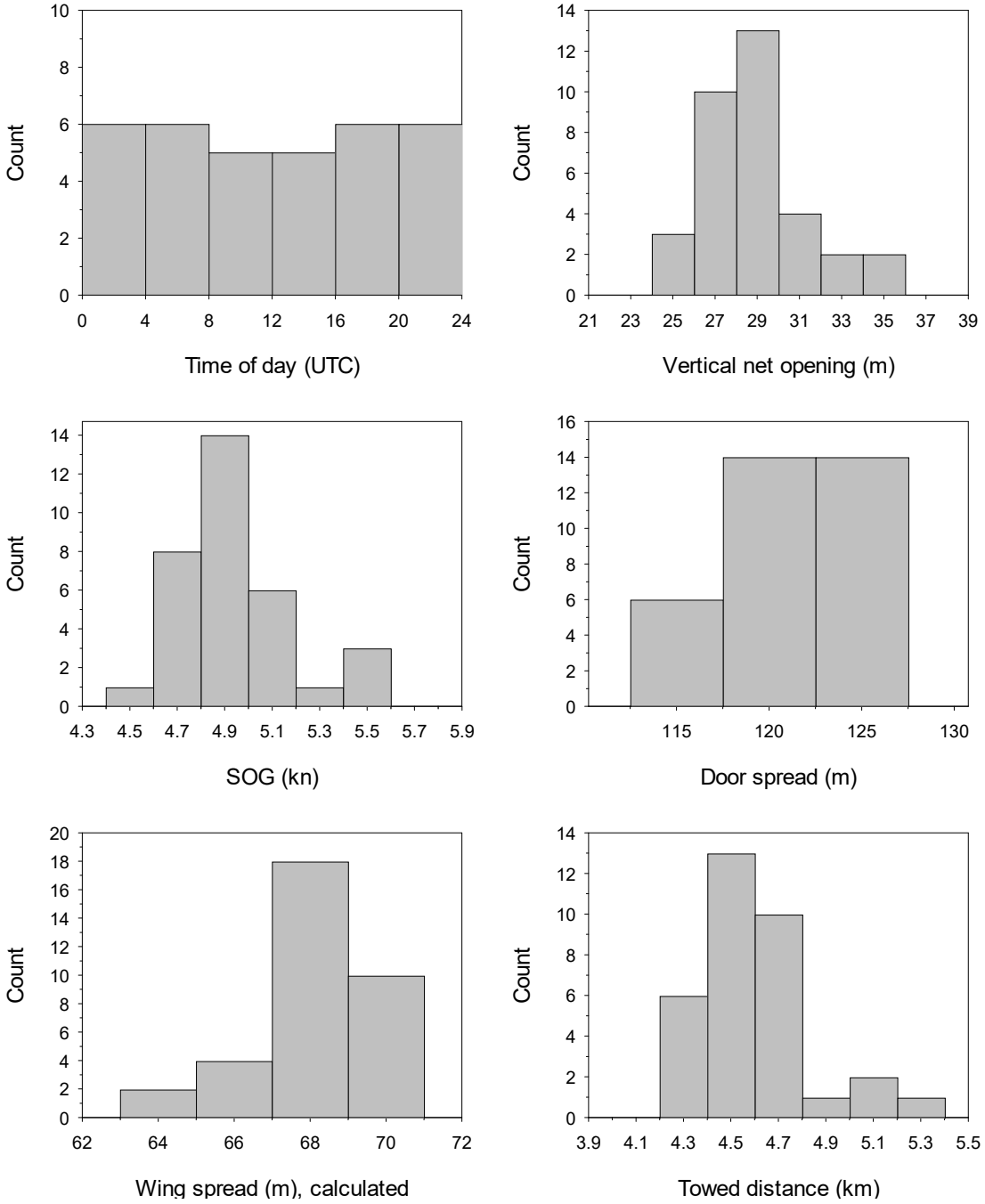

Fig 2: Times of day fished, vessel and gear performance (mean values by station).

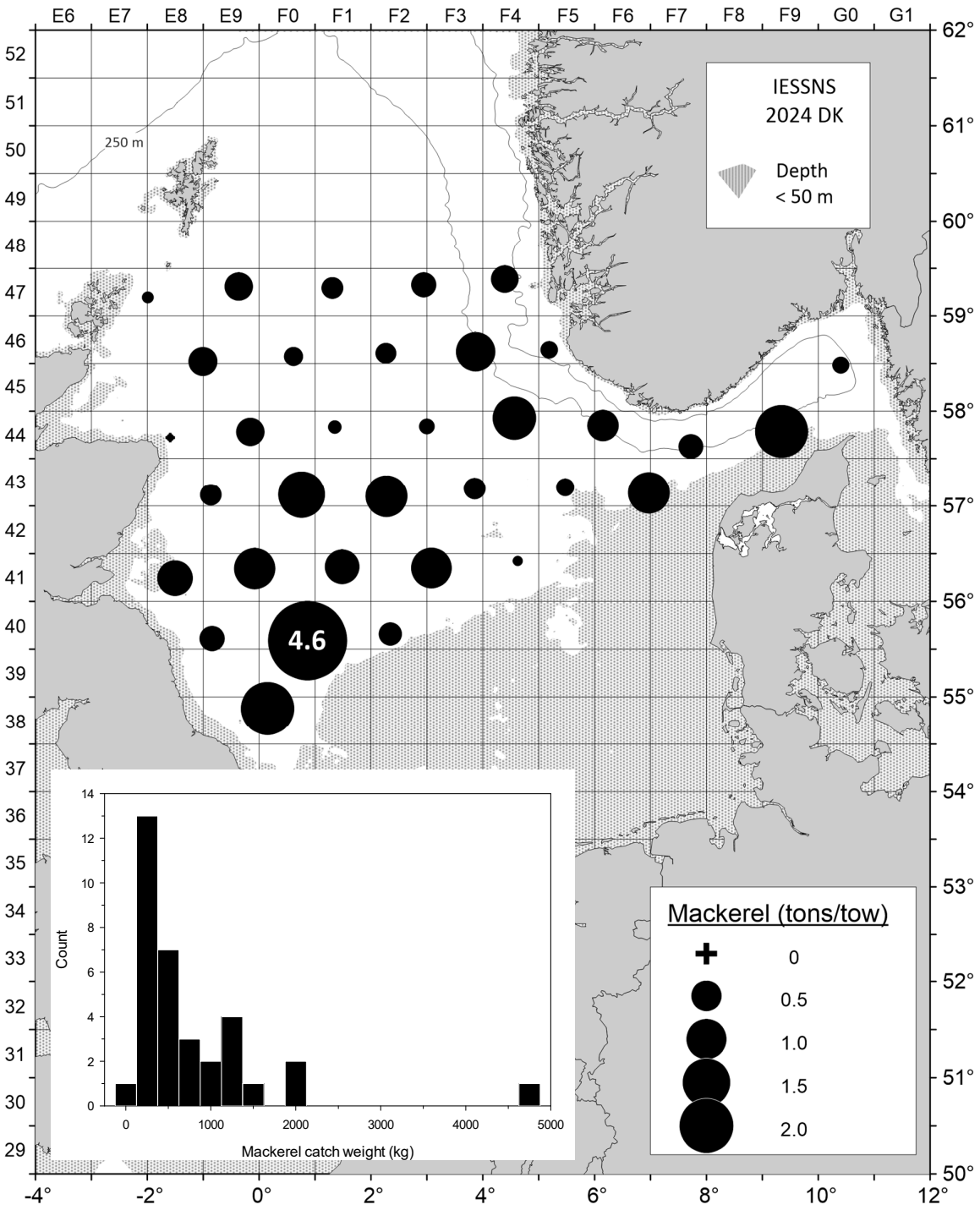

Fig. 3: Distribution of mackerel catches.

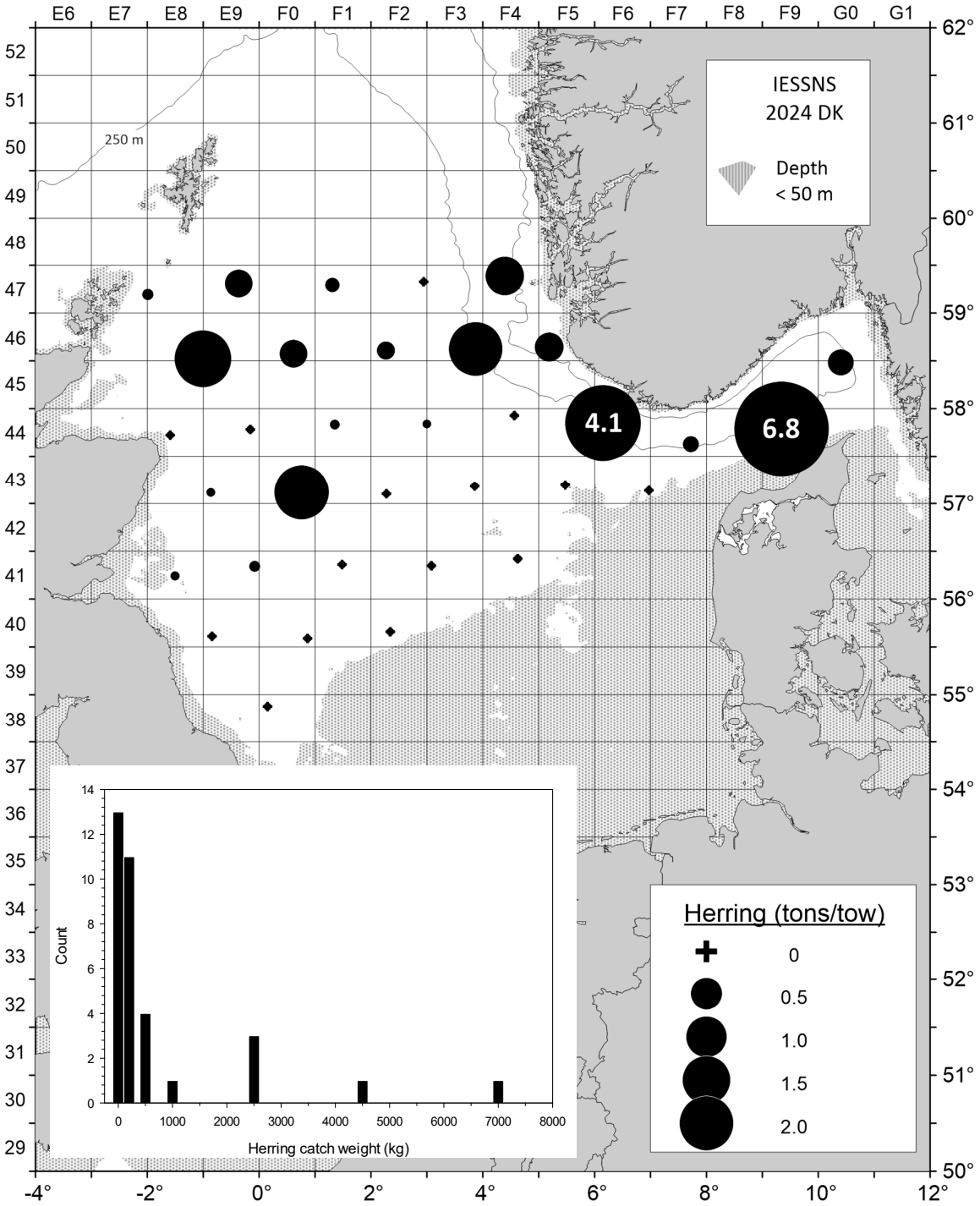

Fig. 4: Distribution of herring catches.

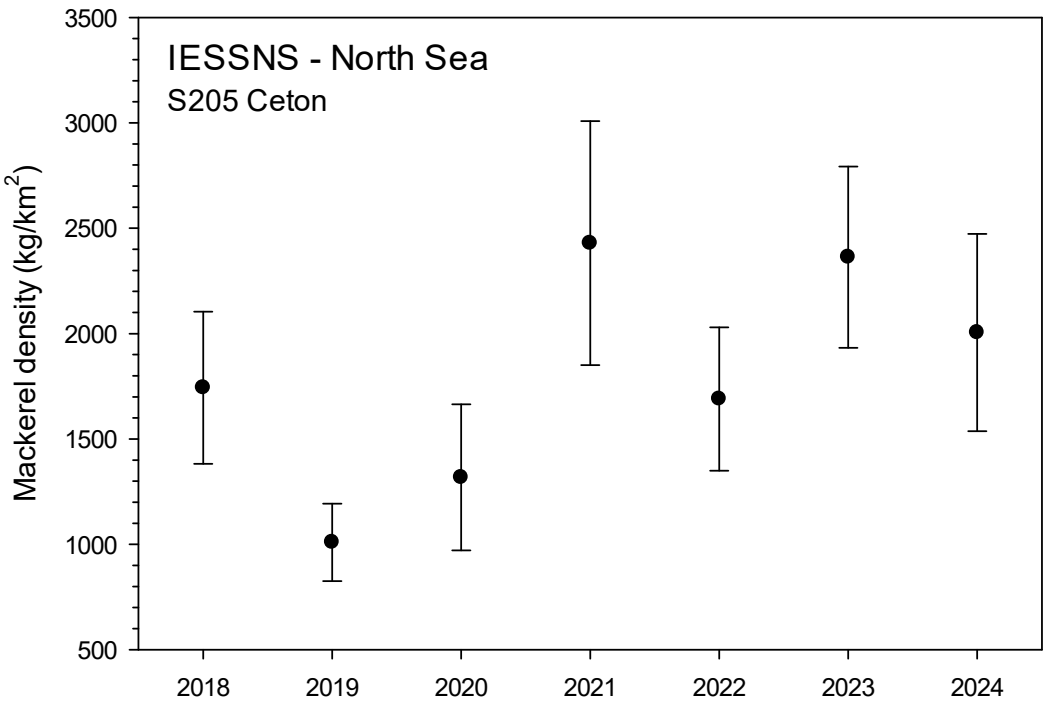

Fig. 5: Mackerel density (mean and standard error) in 2018 – 2024.

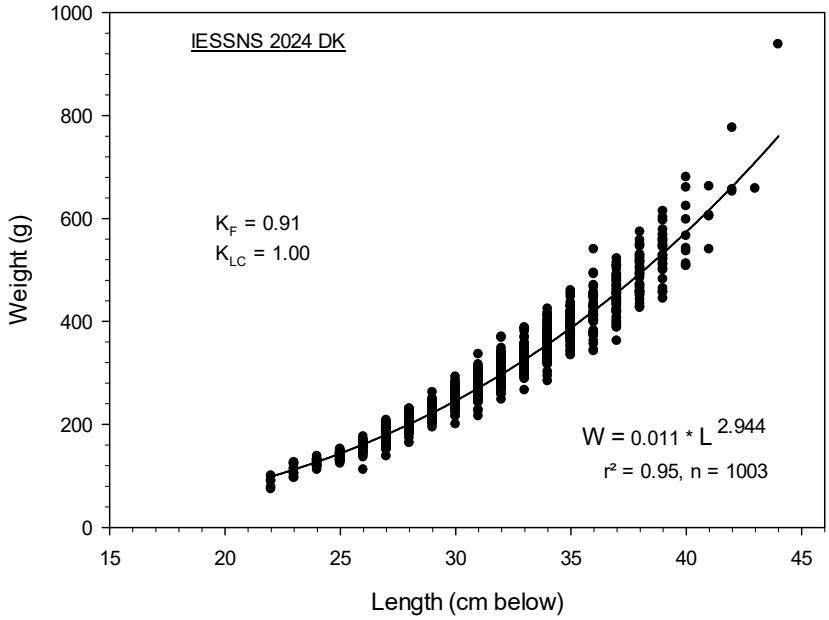

Fig. 6: Length-weight relationship for mackerel.

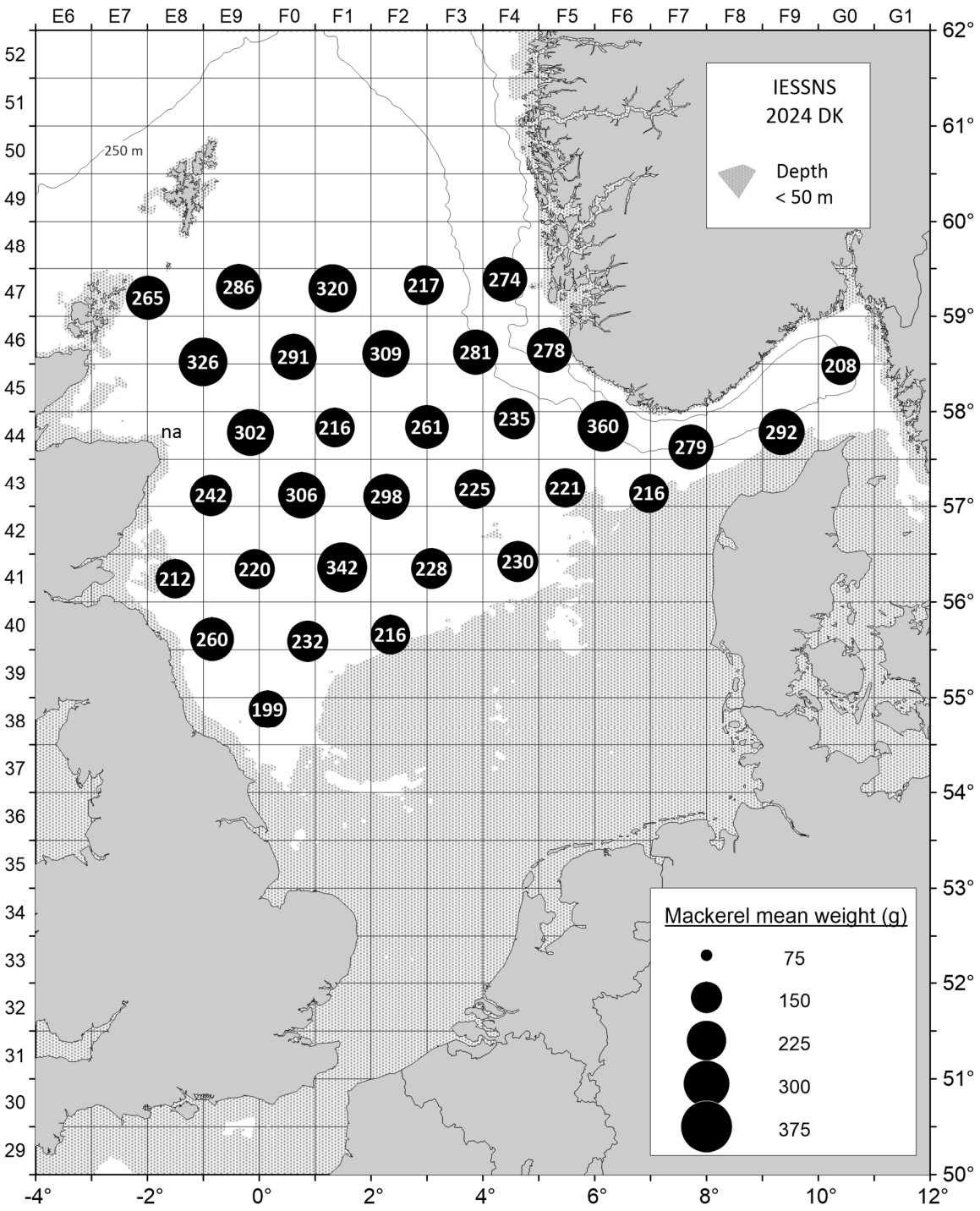

Fig. 7: Distribution of mean individual weight of mackerel.

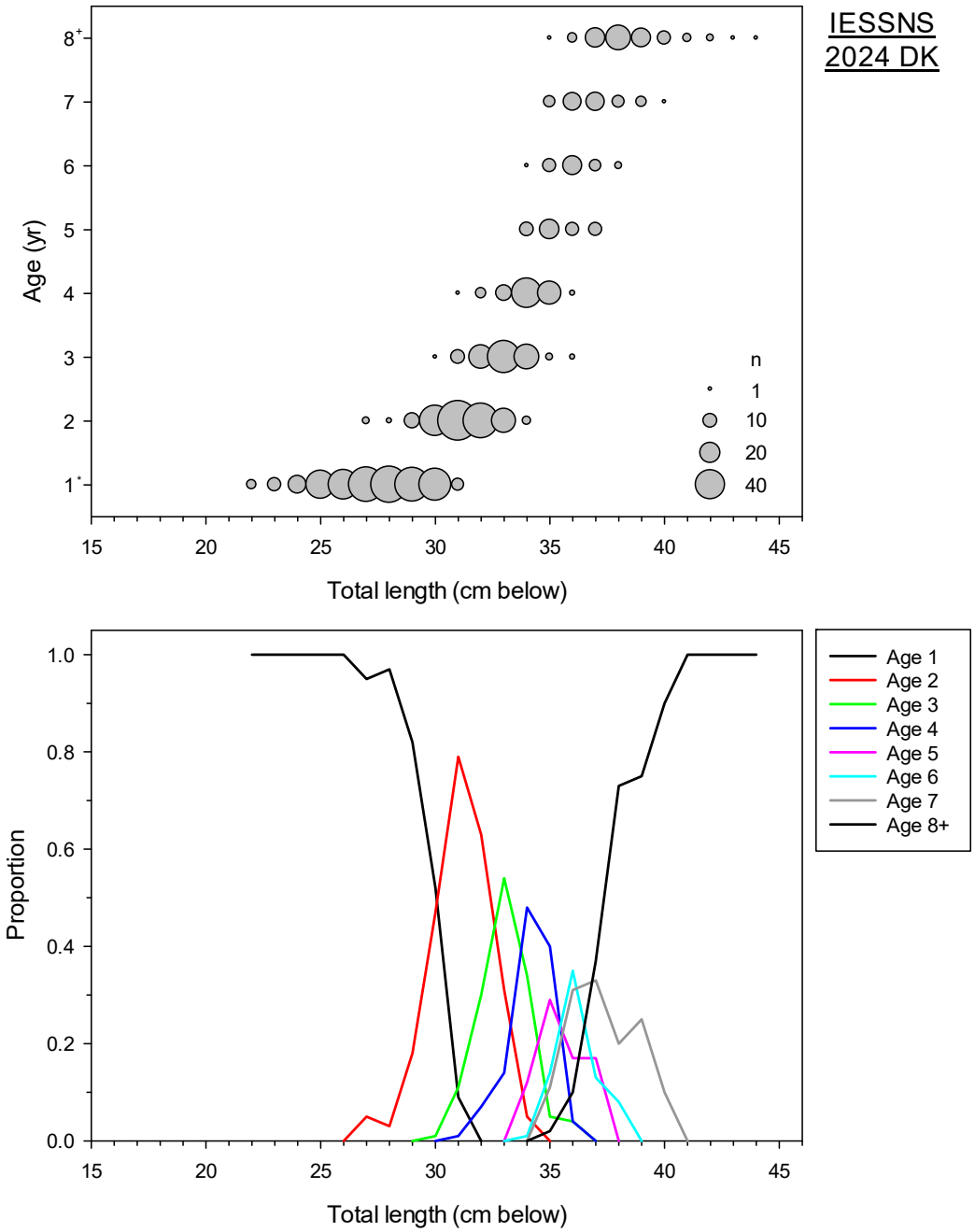

Fig. 8: Age-length key for mackerel (bubble size in upper panel refer to number of otoliths analyzed (n)).

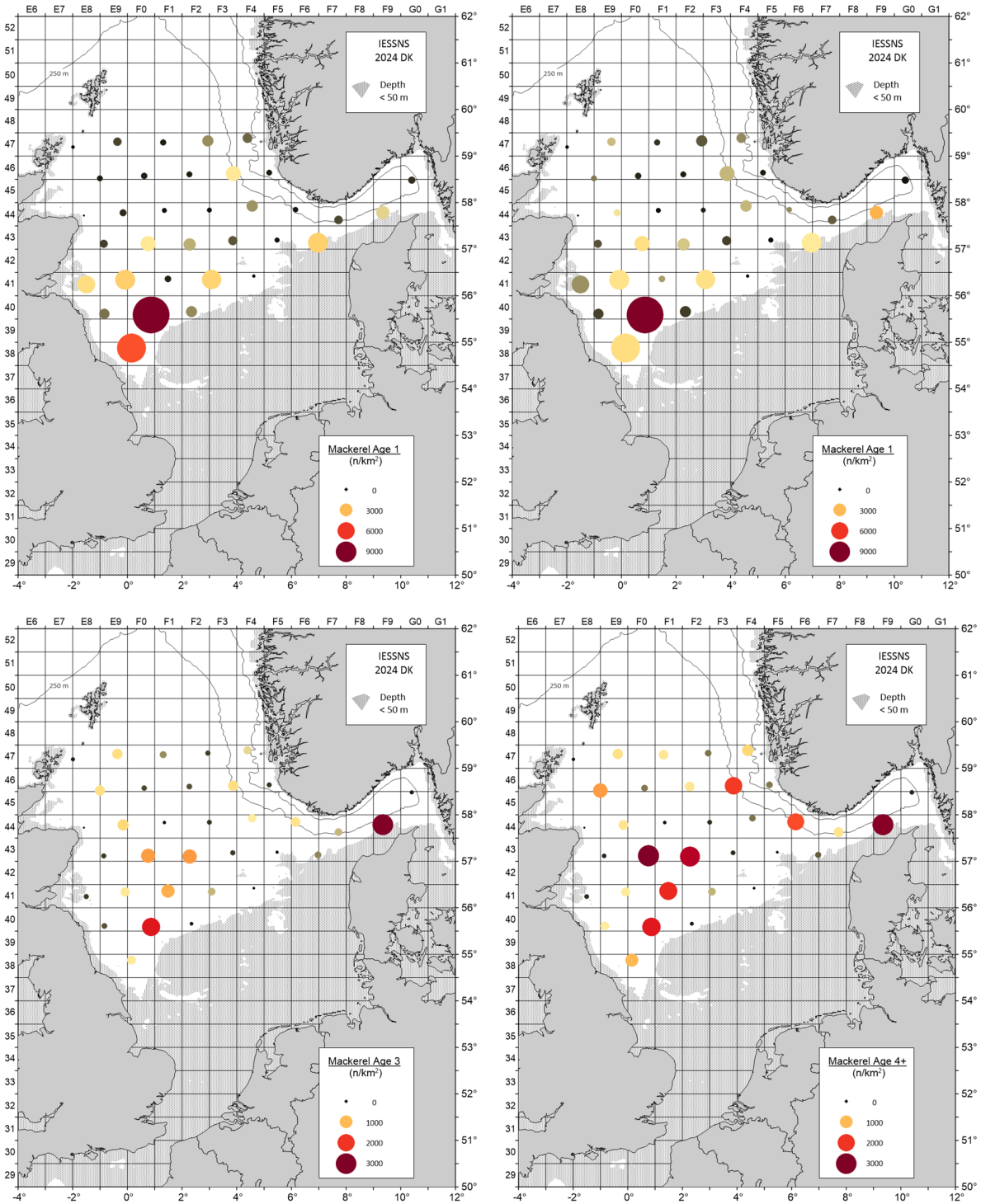

Fig. 9: Mackerel distribution by age.

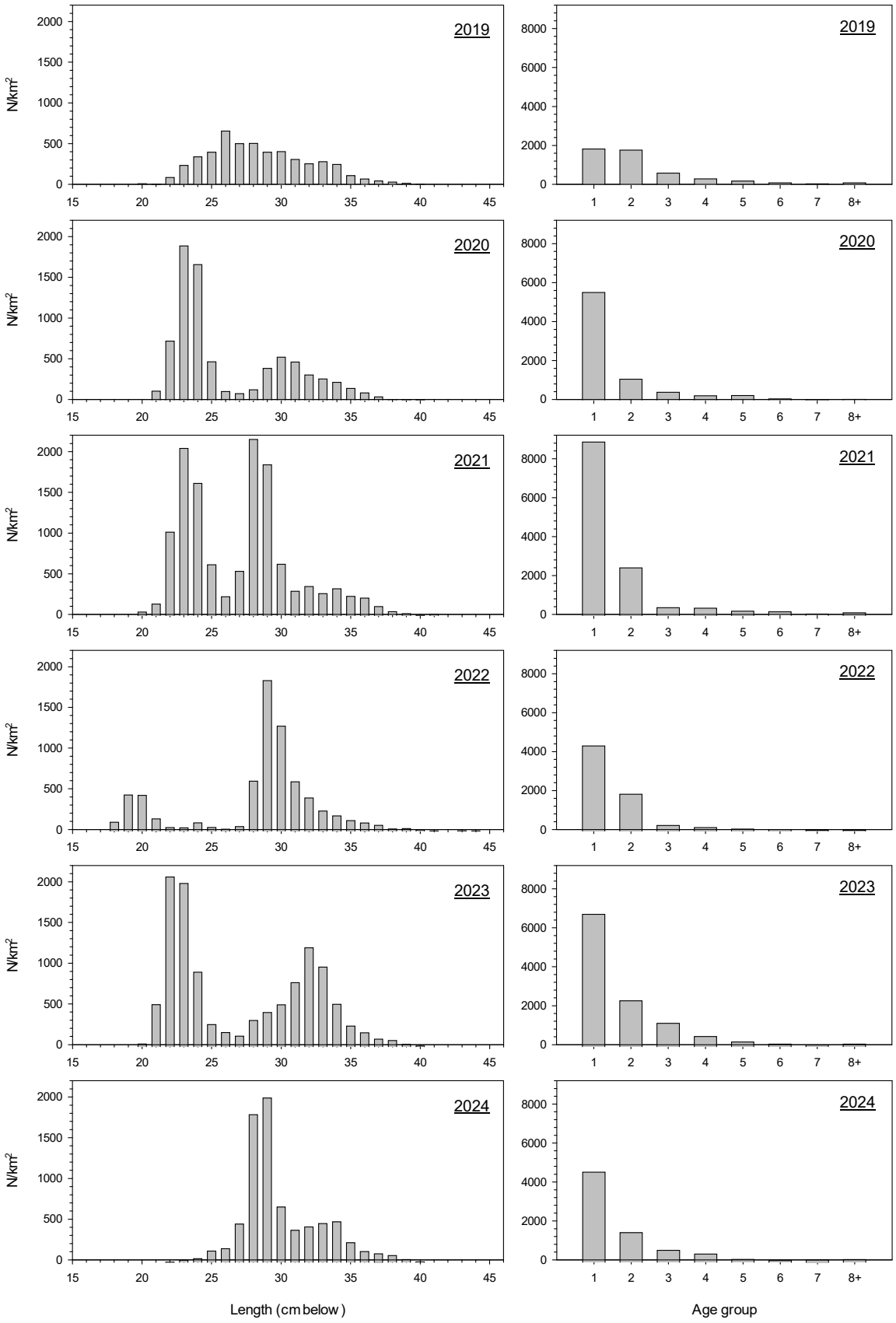

Fig. 10: Length and age composition of mackerel, 2019 - 2024 (based on all stations covered in the respective annual survey).

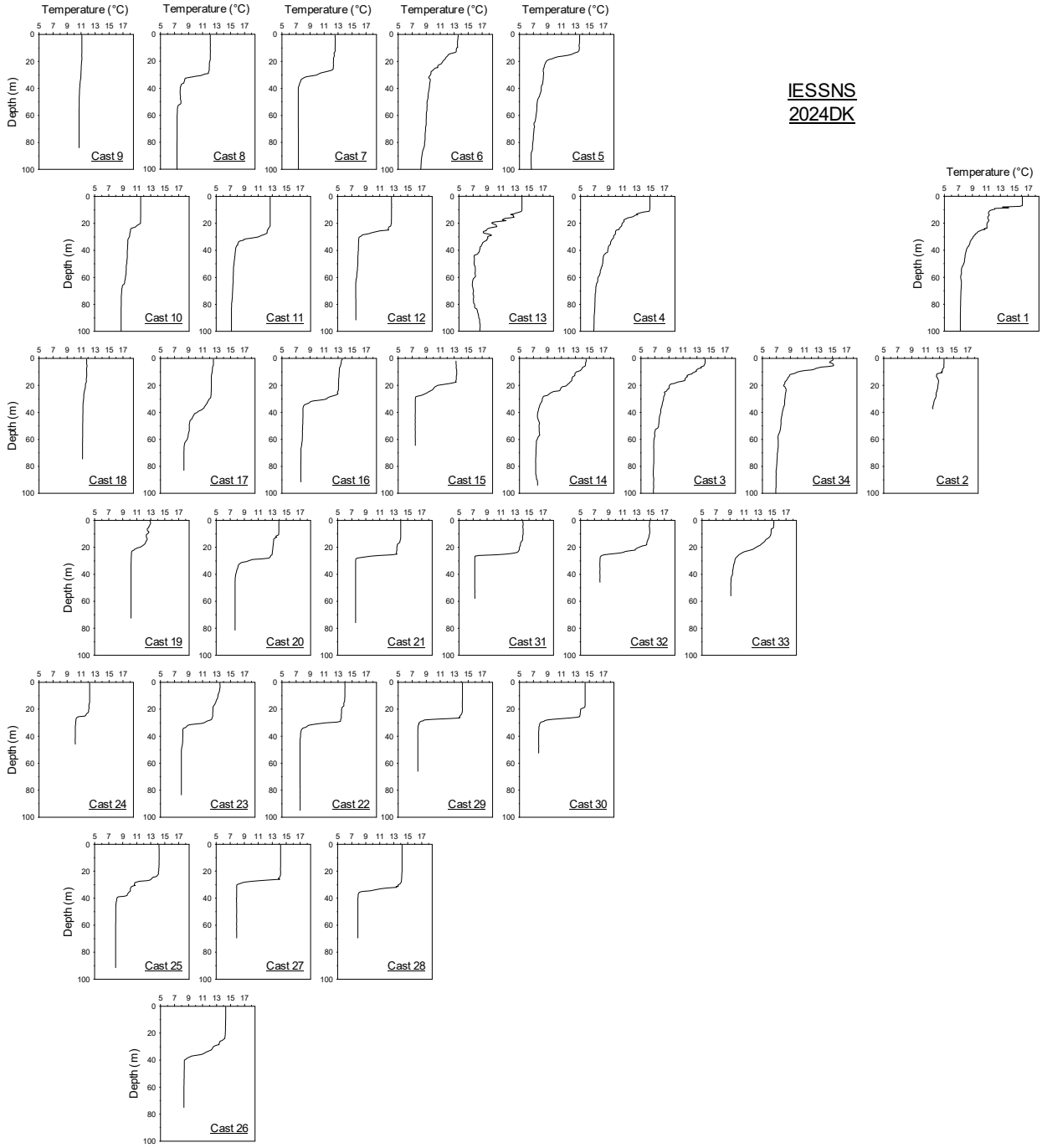

Fig. 11: Temperature conditions in the surface layer.

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
Scomber scombrus	Makrel	Mackerel	21479.298	82527	22	44	
Clupea harengus	Sild	Herring	19350.739	81746	13	32	
Merlangius merlangus	Hvilling	Whiting	630.418	3500	4	39	mainly from haul 26 (625 kg)
Micromesistius poutassou	Blåhvilling	Blue whiting	339.216	3273	17	29	Haul 1, 4 & 35; at night
Lamna nasus	Sildehaj	Porbeagle	270.000	3	148	220	Haul 16 & 27; released alive
Melanogrammus aeglefinus	Kuller	Haddock	158.939	479	26	41	present in 17 hauls
Squalus acanthias	Pighaj	Spurdog	55.840	46	24	93	from 9 different hauls
Cyclopterus lumpus	Stenbider	Lumpfish	43.272	38	5	34	present in 12 hauls
Eutrigla gurnardus	Grå knurhane	Grey gurnard	28.964	118	17	36	
Belone belone	Hornfisk	Garfish	9.138	22	52	73	
Illex coindetii	Rød blæksprutte	Southern shortfin squid	7.264	160	8	21	
Sprattus sprattus	Brisling	Sprat	6.756	379	11	16	all from haul 25
Salmo trutta	Ørred	Sea trout	4.380	4	25	60	Haul 2 & 25
Todaropsis eblanae	Todaropsis eblanae	Lesser flying squid	2.176	35	7	17	
Maurolicus muelleri	Laksesild	Pearlside	1.072	61	4	7	Haul 1, 4 & 35; at night
Ammodytes marinus	Havtobis	Lesser sandeel	0.980	72	13	17	all from haul 25
Trachurus trachurus	Hestemakrel	Horse mackerel	0.412	1	35	35	
Sardina pilchardus	Sardin	Pilchard	0.134	1	23	23	
Loligo forbesii	Loligoblæksprutte	Northern squid	0.006	1	4	4	

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.

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