Working Document to

ICES Working Group on Widely Distributed Stocks (WGWIDE, No. 1)
ICES HQ, Copenhagen, Denmark, (hybrid meeting)
27. August – 2. September 2025

Cruise report from the International Ecosystem Summer Survey in the Nordic Seas (IESSNS) 30th June – 3rd August 2025

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1 Executive summary

The International Ecosystem Summer Survey in the Nordic Seas (IESSNS) was performed within approximately 5 weeks from June 30th to August 3rd in 2025 using five vessels from Norway (2), Iceland (1), Faroe Islands (1) and Denmark (1). The main objective is to provide annual age-segregated abundance index with start in 2010, with an uncertainty estimate, for northeast Atlantic mackerel (*Scomber scombrus*) using a standardised pelagic swept area trawl method. Another aim is to construct abundance indices for blue whiting (*Micromesistius poutassou*) and for Norwegian spring-spawning herring (NSSH) (*Clupea harengus*). This is obtained by utilizing standardized acoustic methods to estimate their abundance in combination with biological trawling on acoustic registrations. The time series for blue whiting and NSSH now consists of 10 years (2016-2025).

The geographical distribution of the mackerel during 2025 was similar to 2024. Nevertheless, the abundance or density of mackerel was considerably lower, particularly in the western areas compared to last year. The regions with higher abundance were found more to the east along the Norwegian coast (from 62° to 70° N) without the elevated presence found in the central part of the Norwegian Sea as documented in 2024.

The total swept-area mackerel index in 2025 was 1.7 million tonnes in biomass and 3.8 billion in abundance. This is a decrease of 35% and 32%, respectively compared to 2024, and are also the lowest values in the time series. The uncertainty in the abundance index during 2025 was higher than observed last year, with a CV= 0.28 compared with CV = 0.19 in 2024.

The most abundant year-classes were from 2020 (age 5) and 2019 (age 6). The internal consistency between cohorts ranged from good to strong for all ages, similar to last year.

A new recruitment index for age 2, combining both the Nordic Seas and the North Sea from the IESSNS for the period 2018-2025, was accepted as the only recruitment time series to be included in future stock assessments following the conclusions from the ICES benchmark on NEA mackerel in March 2025. The recruitment index was highest in 2022 followed by 2018. Recruitment has decreased substantially during the last few years (2023-2025). Despite an increase in mackerel recruitment by a factor of two compared to last year, the 2025 estimate is still below the average for the period 2018-2025.

Norwegian spring-spawning herring (NSSH) was predominantly recorded in the northeastern part of the Norwegian Sea in 2025. The total biomass index of NSSH recorded during IESSNS 2025 was 4.57 million tonnes, 21% higher biomass than in 2024. An increase of 24% was recorded in the abundance of adult fish age 4+. The 2016 year-class (9-year-olds) dominated in the stock and contributed 33% to the total biomass. However, the 2021 and 2022 year-classes are now coming into the spawning stock with increasing strength in abundance. The 2016 year-class is fully recruited to the adult stock, whereas the younger fish is not fully recruited to the adult stock and those estimates are uncertain. The zero-boundary of the distribution of the mature part of NSSH was reached in all directions. The herring was mainly observed in the upper surface layer as relatively small schools. A shallow distribution of herring might have led to an unknown portion of herring being in the "blind zone" above the transducer depth of the vessels (i.e., shallower than 10-15 m depth).

Blue whiting was distributed in parts of the survey area dominated by warm Atlantic waters and had a continuous distribution from the southern boundary of the survey area (60° N) to Bear Island (74.30° N). The total biomass index of blue whiting was 2.42 million tons in 2025 which is a 24% increase compared to 2024. Estimated stock abundance (ages 1+) was 23.3 billion compared to 17.7 billion in 2024 (31% increase). Ages 1 and 4 dominated the estimate in 2025 as they contributed to 39% and 26% (abundance) and 24% and 32% (biomass), respectively. Interestingly, 0-group contributed significantly also in 2025 (16% in total abundance), mainly recorded in the southwestern survey area.

Other fish species such as lumpfish (*Cyclopterus lumpus*), capelin (*Mallotus villosus*), polar cod (B*oreogadus saida*), and Atlantic salmon (*Salmo salar*) were also monitored.

Sea surface temperatures in July 2025 were 1 to 3 degrees above long-time average (July 1990-2009) in all the surveyed area, with the highest anomalies off the Norwegian coast.

The zooplankton biomass was patchy throughout the survey area, with high concentrations north of Iceland, close to the Iceland-Faroe Ridge and in the central part of the Norwegian Sea. In the northernmost part of the survey area, concentrations were generally low and the average zooplankton weight for the whole survey was 6.1 g/m^2, which is a decrease of 13% compared to last year.

2 Introduction

During approximately five weeks of survey in 2025 (30^{th} of June to 3^{rd} of August), five vessels; the M/V "Eros" and M/V "Vendla" from Norway, R/V "Jákup Sverri" from Faroe Islands, the R/V "Árni Friðriksson" from Iceland and M/V "Ceton" operating in the North Sea by Danish scientists, participated in the International Ecosystem Summer Survey in the Nordic Seas (IESSNS).

The major aim of the coordinated IESSNS is to collect data on abundance, distribution, migration, and ecology of Northeast Atlantic (NEA) mackerel (*Scomber scombrus*) during its summer feeding migration phase in the Nordic Seas and surrounding coastal and offshore waters. The resulting abundance indices by age are used in the stock assessment of NEA mackerel at the annual meeting of ICES working group of widely distributed stocks (WGWIDE). The IESSNS mackerel index goes back to 2010. It was decided and concluded during the ICES benchmark meeting on NEA mackerel in March 2025 (ICES 2025), that the established time series surveying the North Sea annually from 2018 onwards, will be included for the first time as the new and only recruitment index for 2 years-old mackerel, together with the rest of the overall survey area, in future stock assessments Since 2016, systematic acoustic abundance estimation of both Norwegian spring-spawning herring (*Clupea harengus*) and blue whiting (*Micromesistius poutassou*) have also been conducted. During the ICES benchmark meeting on Norwegian spring spawning herring (*Clupea harengus*) in March 2025 (ICES 2025) it was decided that the established acoustic time series for herring will not be used in future stock assessment. The major reason for not including the timeseries on NSS herring from IESSNS, was that this time series did not provide any additional information as input to the NSS herring stock assessment, compared to the results from the IESNS survey earlier in the season in May. Nevertheless, the time series from the acoustic recordings of NSS herring will be executed and continued in the future to be used for important ecological purposes. Furthermore, the systematic acoustic abundance estimation and time series on blue whiting between 2016-2025, will be evaluated for inclusion in the stock assessment during the upcoming benchmark in 2026. This is considered as potential input for stock assessment since the time series are sufficiently long. Furthermore, the IESSNS is a pelagic ecosystem survey collecting data on physical oceanography, plankton, and other fish species such as lumpfish, capelin, polar cod, and Atlantic salmon. In 2025 systematic whale observations applying one specific platform and four observers, were conducted by the Norwegian vessels Eros and Vendla. The wide geographical coverage, standardization of methods, sampling on many trophic levels and international cooperation around this survey facilitates research on the pelagic ecosystem in the Nordic Seas, see e.g. Nøttestad et al. (2016), Jansen et al. (2016), Bachiller et al. (2018), Ólafsdottir et al. (2019), Nikolioudakis et al. (2019), Løviknes et al. (2021), dos Santos Schmidt et al. (2024), and Ono et al. (2024).

The methods have evolved over time since the survey was initiated by Norway in the Norwegian Sea in the beginning of the 1990s. The main elements of international standardization were conducted in 2010. Minor improvements have been implemented since 2010. Faroe Islands and Iceland have participated in the joint mackerel-ecosystem survey since 2009. Greenland participated between 2013-2020 and again in 2022 with their new research vessel R/V "Tarajoq" whereas Denmark has participated with surveys in the North Sea from 2018 onwards.

The North Sea was included in the survey area for the 8th time in 2025, following the recommendations of WGWIDE. This was done by scientists from DTU Aqua, Denmark. The commercial fishing vessels "Ceton S205" was used. No problems applying the IESSNS methods were encountered. Area coverage, however, was restricted to the northern part of the North Sea at water depths deeper than 50 m (see Appendix 1 for comparison of the 2018 - 2025 results).

3 Material and methods

Coordination of the IESSNS 2025 was done during the WGIPS meeting in January 2025, and by correspondence in December 2024 and during spring and summer 2025. The participating vessels together with their effective survey periods are listed in Table 1.

Five vessels participated in the survey and covered the IESSNS survey area in the Nordic Seas and the North Sea. Weather conditions in the Nordic Seas were generally fair with some fog, which provided favourable conditions for vessels to collect acoustic recordings, conduct surface trawling, and sample WP2-nets and CTDs. However, the fog hampered marine mammal observations, which were performed exclusively on the two Norwegian vessels. In the North Sea, weather conditions were moderate to good.

The survey, which covered an area of 2.6 million km^2 (excluding North Sea) over a period of 36 days, was well synchronized in time (Figure 3). This aligns with the recommendations from the mackerel benchmark in 2016, which suggested the survey period should be around four weeks with mid-point around 20th of July. The main argument for this time-period was to make the IESSNS survey as synoptic as possible in space and time, and at the same time be able to finalize data and report for inclusion in the assessment for the same year.

In 2025, survey coverage in strata 5 (west of Iceland) and 6 (south of Iceland) was reduced due to limited presence of mackerel with only 42% of predetermined stations sampled.

During the IESSNS, the special designed pelagic trawl, Multpelt 832, has been applied by all participating vessels since 2012. This trawl is a product of cooperation between participating institutes in designing and constructing a standardized sampling trawl for the IESSNS. The work was led by trawl gear scientist John Willy Valdemarsen, Institute of Marine Research (IMR), Bergen, Norway (Valdemarsen et al. 2014). The design of the trawl was finalized during meetings of fishing gear experts and skippers at meetings in January and May 2011. Further discussions on modifications in standardization between the rigging and operation of Multpelt 832 was done during a trawl expert meeting in Copenhagen 17-18 August 2012, in parallel with the post-cruise meeting for the joint ecosystem survey, and then at the WKNAMMM workshop and tank experiments on a prototype (1:32) of the Multpelt 832 pelagic trawl, conducted as a sequence of trials in Hirtshals, Denmark from 26 to 28 February 2013 (ICES 2013a). The swept area methodology was presented and discussed during the WGISDAA workshop in Dublin, Ireland in May 2013 (ICES 2013b). The standardization and quantification of catchability from the Multpelt 832 pelagic trawl was further discussed during the mackerel benchmark in Copenhagen in February 2014. Recommendations and requests coming out of the mackerel benchmark in February 2014, were considered and implemented during the IESSNS survey in July-August 2014 and in the surveys thereafter. Furthermore, recommendations and requests resulting from the mackerel benchmark in January-February 2017 (ICES 2017), were carefully considered and implemented during the IESSNS survey in July-August 2017. In 2018, the Faroese and Icelandic vessels employed new, redesigned cod-ends with the capacity to hold 50 tonnes. This was done to avoid the cod-end from bursting during hauling of large catches as occurred at three stations in the 2017 IESSNS. During the last few years with significantly reduced spatial distribution, densities and abundance of NEA mackerel, such issues have not been present to any extent during the pelagic swept-area trawling.

Table 1. Survey effort by each of the five vessels during the IESSNS 2025. The number of predetermined ("fixed") trawl stations being part of the swept-area stations for mackerel in the IESSNS are shown after the total number of trawl stations. *The CTD probe didn't measure properly at one of the stations, therefore the number of CTD stations is less than the number of plankton stations and fixed trawl stations.

Vessel	Effective survey period	Length of cruise track (nmi)	Total trawl stations/ Fixed stations	CTD stations	Plankton stations
Árni Friðriksson	30/6-25/7	5010	56/46	46	46
Jákup Sverri	3/7-20/7	3260	35/29	28*	29
Ceton	4/7-14/7	1800	40/40	40	-
Vendla	30/6-24/7	4450	63/52	51	51
Eros	10/7-3/8	3989	47/42	41	41
Total	30/6-3/8	18509	241/209	206	167

3.1 Hydrography and Zooplankton

The hydrographical and plankton stations by all vessels combined are shown in Figure 1. Eros, Vendla, Árni Friðriksson and Jákup Sverri were all equipped with a SEABIRD CTD sensor and Árni Friðriksson and Jákup Sverri also had a water rosette. Ceton used a Seabird SeaCat offline CTD. The CTD-sensors were used for recording temperature, salinity, and pressure (depth) from the surface down to 500 m or to the bottom when at shallower depths.

Zooplankton was sampled with a WP2-net on 4 vessels, excluding Ceton which operates in the North Sea. Mesh sizes were either 180 μm (Eros and Vendla) or 200 μm (Árni Friðriksson and Jákup Sverri). The net was hauled vertically from a depth of 200 m (or bottom depth at shallower stations) to the surface at a speed of 0.5 m/s. All samples were split in two, one half preserved for species identification and enumeration, and the other half dried and weighed. The zooplankton was sorted into three size categories (μm), > 2000, 1000–2000, 180/200–1000, on the Norwegian and Faroese vessels; and two size fractions (μm), > 1000 and 200–1000, on the Icelandic vessel. Detailed description of the zooplankton and CTD sampling is provided in the survey manual (ICES 2014a).

Three planned CDTs and two WP2-plankton stations were not taken due to bad weather and technical issues. The number of stations taken by the different vessels is provided in Table 1.

3.2 Trawl sampling

All vessels used the standardized Multpelt 832 pelagic trawl (ICES 2013a; Valdemarsen et al. 2014; Nøttestad et al. 2016) for trawling, both for fixed surface stations and for trawling at greater depths to confirm acoustic registrations. Standardization of trawl deployment was emphasised during the survey as in previous years (ICES 2013a; ICES 2014b; ICES 2017). Sensors on the trawl doors, headrope and ground rope of the Multpelt 832 trawl recorded data, and allowed live monitoring of door spread, used with trawling speed to calculate effective trawl width, and trawl depth. The properties of the Multpelt 832 trawl and rigging on each vessel is reported in Table 2.

Trawl catch was sorted to the highest taxonomical level possible, usually to species level for fish, and total weight per species was recorded. The processing of trawl catch varied between nations. The Norwegian vessels sorted the whole catch to species but the Faroese vessel sub-sampled the catch before sorting if catches were more than 500 kg. Sub-sample size ranged from 60 kg (if it was clean catch of either herring or mackerel) to 200 kg (if it was a mixture of herring and mackerel); however, other species were mostly sorted out of the full catch. On the Icelandic vessel, the whole catch was sorted to species for all species.

The biological sampling protocol for trawl catch varied between nations in number of specimens sampled per station (Table 3).

The ICES mackerel benchmark conducted in March 2025 concluded that two age-segregated index time series from IESSNS should be used for stock assessment:
a) A time series for ages 3 and older, derived from IESSNS surface trawl data collected in the Nordic Seas.
b) A time series for age 2, derived from surface trawl data collected from both the Nordic Seas and the North Sea (ICES, 2025).

Table 2. Trawl settings and operation details during the international mackerel survey in the Nordic Seas from 30th June to 3rd August 2025. The column for influence indicates observed differences between vessels likely to influence performance. Influence is categorized as 0 (no influence) and + (some influence).

Properties	**Árni Friðriksson**	**Vendla**	**Ceton**	**Jákup Sverri**	**Eros**	**Influence**
Trawl producer	Ísfell and Hampiðjan	Egersund Trawl AS	Egersund Trawl AS	Vónin (2024)	Egersund Trawl AS	0
Warp in front of doors	Dynex-34 mm	Dynex -34 mm	Dynex	Dynex – 38 mm	Dynex-34 mm	+
Weight at the lower wing ends (kg)	2×400	2×400	2×400	2×400	2×400	0
Setback (m)	6	6	6	8.5	6	+
Type of trawl door	Hampidjan Polyice Jupiter	Seaflex 7.5 m^2 adjustable hatches	Thybron type 15	Twister	Seaflex 7.5 m^2 adjustable hatches	0
Weight of trawl door (kg)	2200	1700	1970	1650	1700	+
Area trawl door (m^2)	7	7.5 with 25% hatches (effective 6.5)	7	4.5	7 with 50% hatches (effective 6.5)	+
Turn radius (degrees)	5 BB/SB turn	5-12 SB turn	5-10	5 BB/SB turn	5-8 SB turn	+
Fish lock front of cod-end	Yes	Yes	Yes	Yes	Yes	+
Float arrangements on the headline	Kite + 1 buoy on each wingtip	Kite with fender buoy +2 buoys on each wingtip	Kite with fender buoy + 2 buoys on each wingtip	Kite + float array together with kites on each wingtip	Kite + 2 buoy on each wingtip	+
Weighing of catch	All weighed	All weighted	All weighed	All weighed	All weighted	+

Table 3. Protocol of biological sampling during the IESSNS 2025. Numbers denote the maximum number of individuals sampled for each species for the different determinations by station.

	Species	Faroes	Iceland	Norway	Denmark
Length measurements	Mackerel	200/100*	150	100	≥ 125
	Herring	200/100*	200	100	75
	Blue whiting	200/100*	100	100	75
	Lumpfish	all	all	all	all
	Salmon	all	all	all	-
	Capelin	-	100	25-30	-
	Other fish sp.	20-50	50	25	As appropriate
Weight, sex and maturity determination	Mackerel	15-50	50	25	***
	Herring	15-50	50	25	0
	Blue whiting	15-50	100	25	0
	Lumpfish	20	1-5	25	0
	Salmon	20	0	25	0
	Capelin	20	50	25	
	Other fish sp.	0-20	0-50	0	0
Otoliths/scales collected	Mackerel	15-25	50	25	***
	Herring	15-50	25	25	0
	Blue whiting	15-50	25	25	0
	Lumpfish	0	1-5	0	0
	Salmon	-	0	0	0
	Capelin	-	50		
	Other fish sp.	0	0	0	0
Fat content	Mackerel	0	10	0	0
	Herring	0	10	0	0
	Blue whiting	0	10	0	0
Stomach sampling	Mackerel	5	10	10	0
	Herring	5	10	10	0
	Blue whiting	5	10	10	0
	Other fish sp.	0	0	10	0
Tissue for genotyping	Mackerel	0	0	0	0
	Herring	up to 25	25	25	0

*Length measurements / weighed individuals

**Sampled at eight stations but not stations with herring present.

*** Up to one fish per cm-group < 25 cm, two fish 25 – 30 cm and three fish > 30 cm from each station was weighed and aged.

Underwater camera observations during trawling

Onboard M/V "Vendla" a stereo camera system (Mohn Technology AS) was used to collect image data from the entire cruise and include daytime hauls (~ 30, 30 min hauls). The camera system was positioned in the last part of the trawl, attached slightly ahead of the extension. The objective of this activity is to evaluate the feasibility for fish sizing and counting during the pelagic trawling. A system was set-up with ad-hoc software to process images from the camera and insert manual annotations of single fish. These annotations will be used as input to a machine learning algorithm for automatic species identification and fish sizing.

3.3 Marine mammals

Systematic observations of marine mammals using one specific platform at the roof of the bridge, involving four dedicated observers on each vessel, were conducted onboard M/V "Eros" and M/V "Vendla" from Norway during IESSNS 2025. Continuous observations were carried out from 5 am to 11 pm, except during pre-defined stations including pelagic trawling.

3.4 Acoustics

Multifrequency echosounder

The acoustic equipment onboard Vendla was calibrated 30th of June and Eros was calibrated 2nd of August 2025 for 18, 38, 70, 120 and 200 kHz. Árni Friðriksson was calibrated 15th of January 2025 for frequencies 18, 38, 70, 120 and 200 kHz. Jákup Sverri was calibrated on 27th of March 2025 for 38, 70 and 200 kHz. Ceton did not conduct any acoustic data collection because no calibrated equipment was available, and acoustics are done in the same area and period of the year during the ICES coordinated North Sea herring acoustic survey (HERAS). All the other vessels used standard hydro-acoustic calibration procedure for each operating frequency (Foote 1987). CTD measurements were taken in order to get the correct sound velocity as input to the echosounder calibration settings.

Acoustic recordings were scrutinized to herring and blue whiting on daily basis using the post-processing software (LSSS, see Table 4 for details of the acoustic settings by vessel). Species were identified and partitioned using catch information, characteristic of the recordings, and frequency between integration on 38 kHz and on other frequencies by a scientist experienced in viewing echograms.

To estimate the abundance from the allocated NASC-values the following target strengths (TS) relationships were used.

Blue whiting: TS = 20 log(L) – 65.2 dB (rev. acc. ICES CM 2012/SSGESST:01)
Herring: TS = 20 log(L) – 71.9 dB (Foote, 1987)

Table 4. Acoustic instruments and settings for the primary frequency (38 kHz) during IESSNS 2025.

	R/V Árni Friðriksson	M/V Vendla	R/V Jákup Sverri	M/V Eros
Echo sounder	Simrad EK80	Simrad EK80	Simrad EK80	Simrad EK80
Frequency (kHz)	18, **38**, 70, 120, 200	18, **38**, 70, 120, 200	18, **38**, 70, 120, 200, 333	18, **38**, 70, 120, 200, 333
Primary transducer	ES38-7	ES38B	ES38-7	ES38B
Transducer installation	Drop keel	Drop keel	Drop keel	Drop keel
Transducer depth (m)	9.6	8.5	6-9	6-8
Upper integration limit (m)	15	15	15	15
Absorption coeff. (dB/km)	10.5	8.8	10.2	10.0
Pulse length (ms)	1.024	1.024	1.024	1.024
Band width (kHz)	2.425	2.425	3.064	2.425
Transmitter power (W)	2000	2000	2000	2000
Angle sensitivity (dB)	18	21.9	21.9	23.0
2-way beam angle (dB)	-20.30	-20.70	-20.4	-20.7
TS Transducer gain (dB)	27.06	26.87	26.84	25.49
s_A correction (dB)	-0.02	-0.65	0.07	-0.66
3 dB beam width alongship:	6.43	7.10	6.49	6.92
3 dB beam width athw. ship:	6.43	7.02	6.53	6.75
Maximum range (m)	50	500	500	500
Post processing software	LSSS 3.0.0	LSSS 3.0.0	LSSS 3.0.0	LSSS 3.0.0

M/V Ceton: No acoustic data collection because other survey in the same area in June/July (HERAS).

Multibeam sonar

Both M/V Eros and M/V Vendla were equipped with the Simrad fisheries sonar. Low frequency SU90 sonar (frequency range: 20-30 kHz) on M/V Eros and low frequency ST90 sonar (frequency range: 14-24 kHz) on M/V Vendla with a scientific output incorporated which allow the storing of the beam data for post-processing. Acoustic multibeam sonar data in netCDF data format was stored continuously onboard Eros and Vendla for the entire survey.

Cruise tracks

The five participating vessels followed predetermined survey lines with predetermined surface trawl stations (Figure 1). Calculations of the mackerel index are based on swept area approach with the survey area split into 10 strata, of which 6 are permanent (1, 2, 3, 7, 10 and 13) and four dynamic (4, 5, 6 and 9) (Figure 2). Distance between predetermined surface trawl stations is constant within stratum but variable between strata and ranged from 40 to 70 nmi. The survey design using different strata is done to allow the calculation of abundance indices with uncertainty estimates, both overall and from each stratum in the software program StoX (see Salthaug et al. 2017). Temporal survey progression by vessel along the cruise tracks in June-August 2025 is shown in Figure 3. The cruising speed was between 10-11 knots if the weather permitted, otherwise the cruising speed was adapted to the weather situation.

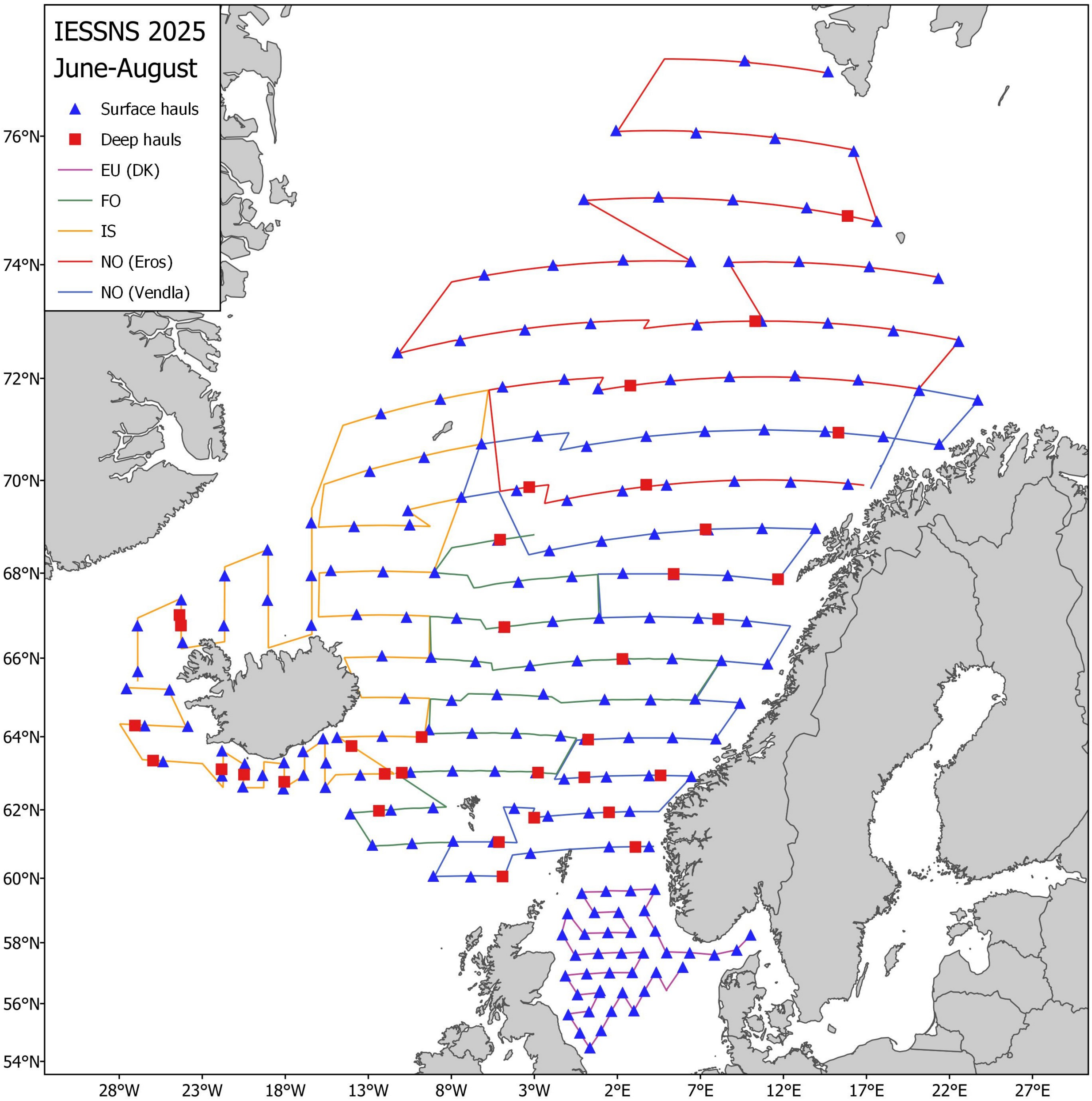


Figure 1 a. Fixed predetermined trawl stations and additional deep hauls included in the IESSNS from June 30th to August 3rd, 2025. At each station a 30 min surface trawl haul was performed.

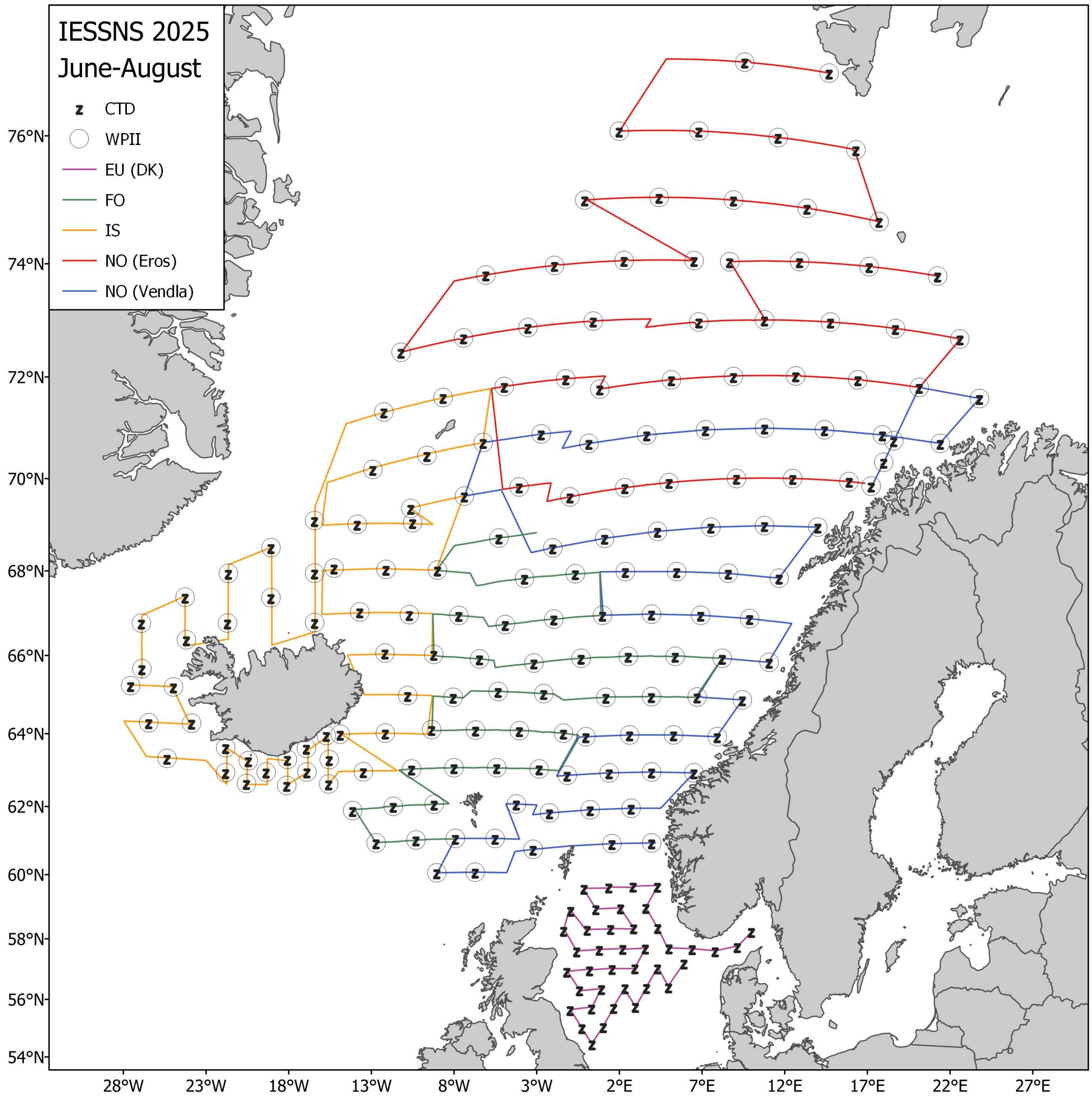


Figure 1 b. Fixed predetermined hydrographic stations (CTD and WP2) included in the IESSNS from June 30th to August 3rd, 2025. CTD station (0-500 m, and 0-750 m for Iceland) and WP2 plankton net samples (0-200 m depth).

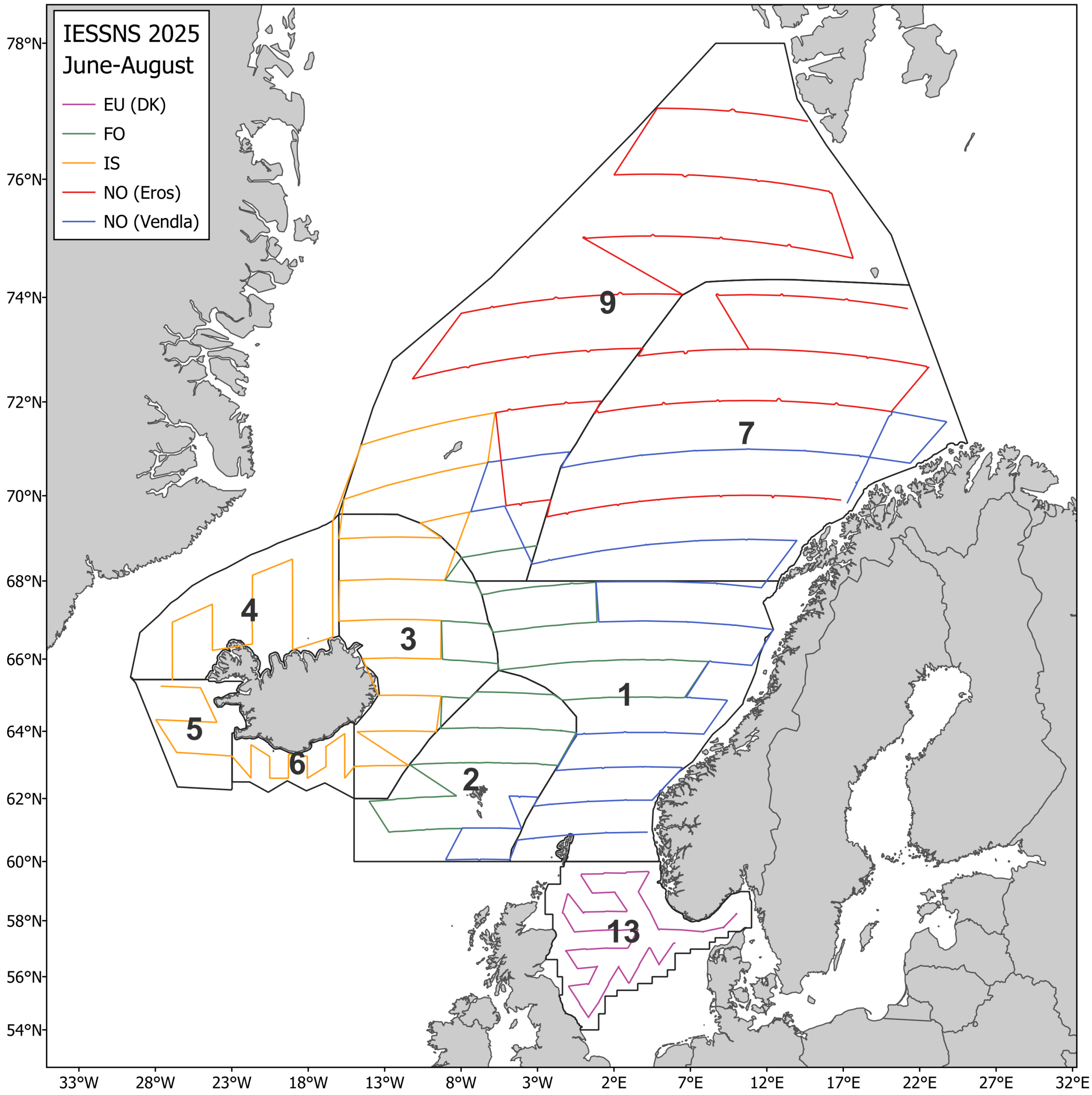


Figure 2. Permanent and dynamic strata used in StoX for IESSNS 2025. The survey area is split into 10 strata, of which 6 are permanent (1, 2, 3, 7, 10 and 13) and four dynamic (4, 5, 6 and 9). The former stratum 8 (along the Norwegian coast) was merged into adjacent strata 1 and 7. Stratum 10 (northern Greenland waters) and 11 (southern Greenland waters) were not surveyed in 2025 and are not displayed. The former stratum 12 (offshore south of Iceland) is not used any longer, since the southern boundaries of strata 5 and 6 have been converted to dynamic boundaries. For original strata boundaries see WGIPS manual (ICES 2014a). In 2023, stratum 2 was split in two strata, 2 and 14, as two predetermined surface trawl stations were not sampled on the western end of the 2nd transect from the south, see Figure 1a. Due to large variability in mackerel density within in stratum 2, the area around the skipped predetermined stations was defined as a separated stratum to reflect the mackerel density in the area. This was done to prevent inflation on mackerel abundance in the stratum 2 due to under sampling in a low-density part of stratum 2.

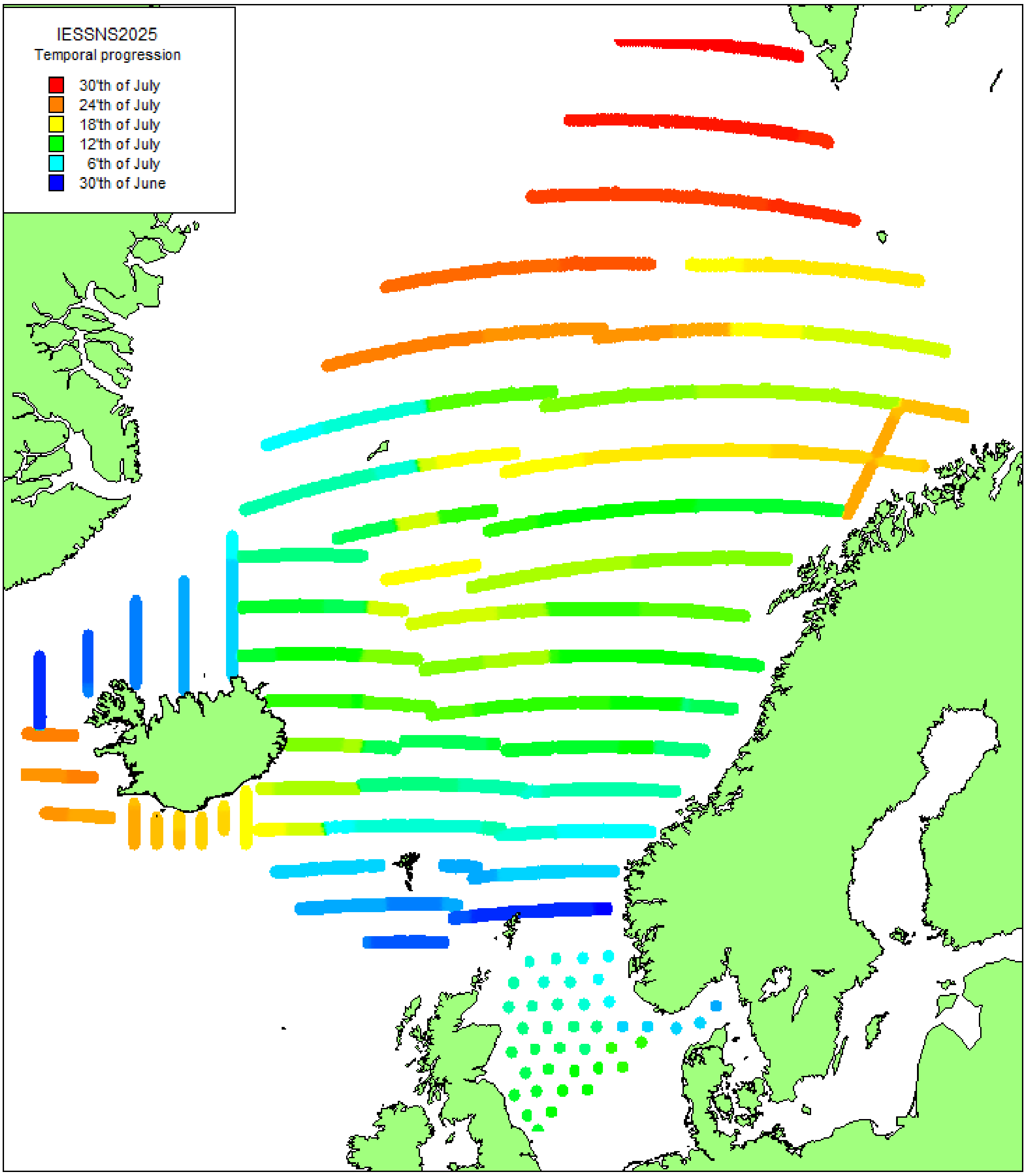


Figure 3. Temporal survey progression by vessel along the cruise tracks during IESSNS 2025: Blue represents effective survey start (30th of June) progressing to red representing a five-week span (survey ended 3rd of August). As Ceton did not submit acoustics, they have been represented by station positions.

3.5 StoX

The recorded acoustic and biological data were analysed using the StoX software package which has been used for some years now for WGIPS coordinated surveys. A description of StoX can be found in Johnsen et al. (2019) and here: www.imr.no/forskning/prosjekter/stox. Mackerel swept-area abundance indices, excluding the North Sea, including the North Sea and separately for the North Sea, were calculated using StoX version 4.1.4 Also herring and blue whiting acoustic abundance indices were calculated using StoX version 4.1.4.

During the recent benchmark workshop on Mackerel and Norwegian spring-spawning herring (ICES, 2025) was decided that the input for the mackerel assessment model will be based in the results of the bootstrap process and not from the baseline as previously. Therefore, from this year, the results from age structure abundance and biomass of mackerel will be based in the bootstrap results.

3.6 Swept area index and biomass estimation

As in 2024, the input data for the swept area calculations in 2025 were obtained from the ICES acoustic trawl surveys database.

The swept area age segregated index is calculated separately for each stratum for the Nordic Seas (Figure 2, Table 5 and Appendix 2). Only the southern borders of strata 5 and 6 were modified from the original design to adjust to the survey coverage, using the half distance of the station separation in the strata (i. e. 40 nmi) to trace the new border from the last trawl station done in the transect. Individual stratum estimates are added together to get the total estimate for the Nordic Seas area which is approximately defined by the area between 60°N and 77°N and 40°W and 20°E. Two additional estimates are calculated, for only the North Sea, and one combined of the Nordic and North Sea (Table 5).

The distance between predetermined trawl stations in the stratum that covers most of the survey area (strata 1, 2, 7 and 9) was 70 nmi, with reduced distance south and southwest of Iceland and in the North Sea (Table 5).

Table 5. Strata, distance between stations per strata and area used for the index calculated for the Nordic Seas, North Sea and combined Nordic and North Seas (Strata numbering is shown in Figure 2).

Stratum number	Interstation distance (nmi)	Area (nmi^2)	Total areas (nmi^2)	
1	70	150763	Nordic Seas 684582	Total surveyed area
2	70	84510		
3	70	74282		
4	70	45056		
5	65	24985		
6	40	17890		
7	70	144644		
9	70	142451		
13	45	83320	North Sea 83320	

The density of mackerel on a trawl station is calculated by dividing the total number caught by the assumed area swept by the trawl. The area swept is calculated by multiplying the towed distance by the horizontal opening of the trawl. The horizontal opening of the trawl is vessel specific, and the average value across all hauls is calculated based on door spread (Table 6 and 7). An estimate of total number of mackerel in a stratum is obtained by taking the average density based on the trawl stations in the stratum and multiplying this with the area of the stratum.

Table 6. Detailed descriptive statistics for trawl operation for each vessel during IESSNS 2025 at predetermined surface trawl stations. The presented numbers indicate mean, standard deviation and min-max. *Horizontal trawl opening was calculated using average vessel values for trawl door spread and tow speed (details in Table 7).

Variable mean (st.dev., min-max)	**Jákup Sverri**	**RV Árni Friðriksson**	**Eros**	**Vendla**	**Ceton**
Trawl doors horizontal spread (m)	120 (4.1, 115-134)	114 (7.8, 78-116)	135 (3.4, 124-142)	115 (2.3, 109-123)	128 (3.1, 118-132)
Vertical trawl opening (m)	35 (2.2, 35-39)	31 (7.5, 25-61)	26 (1.2, 24-29)	32 (2.7, 28-42)	30 (2.0, 24-33)
Horizontal trawl opening (m)*	65.4	62.1	74.1	64.5	70.5
Speed (over ground, nmi)	4.3 (0.2, 3.9-5.0)	5.0 (0.3, 4.2-5.5)	4.6 (0.2, 4.1-5.3)	4.5 (0.3, 3.9-5.4)	4.9 (0.2, 4.4-5.7)
Trawl door depth, starb. (m)	10 (3.2, 7-19)	12 (4.8, 6-31)	14 (5.1, 6-18)	11 (4.5, 3-28)	
Trawl door depth, port (m)	13 (3.3, 9-21)	12 (3.6, 5-22)	15 (4.6, 8-20)	13 (3.9, 4-30)	
Headline depth (m)	0	0 (0.2, 0-10)	0 (0.3, 0-6)	0 (0.1, 0-4)	
Warp length during towing (m)	371 (7.4, 350-395)	305 (21.8, 240-340)	370 (17.2, 350-380)	360 (18.5, 340-380)	
Difference in warp length port/starboard (m)	0 - 10		5 - 10	2 - 10	5 - 10

Horizontal trawl opening was calculated using average vessel values for trawl door spread and tow speed (Table 7). The estimates in the formulae were based on flume tank simulations in 2013 (Hirtshals, Denmark) where formulas were developed from the horizontal trawl opening as a function of door spread, for two towing speeds, 4.5 and 5 knots:

Towing speed 4.5 knots: Horizontal opening (m) = 0.441 × Door spread (m) + 13.094

Towing speed 5.0 knots: Horizontal opening (m) = 0.3959 × Door spread (m) + 20.094

Table 7. Horizontal trawl opening as a function of trawl door spread and towing speed. Relationship based on simulations of horizontal opening of the Multpelt 832 trawl towed at 4.5 and 5 knots, representing the speed range in the 2014 survey, for various door spread. See text for details. In 2017, the towing speed range was extended from 5.0 to 5.2, in 2020 the door spread was extended to 122 m and in 2022 the towing speed range was extended down to 4.3 knots and up to 5.5 knots. The door spread was furthermore extended to 135 m in 2023. See also Appendix 3.

	Towing speed (knots)												
Door spread(m)	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5	5.1	5.2	5.3	5.4	5.5
100	56.5	56.9	57.2	57.7	58.2	58.7	59.2	59.7	60.2	60.7	61.2	61.7	62.2
101	56.9	57.3	57.6	58.1	58.6	59.1	59.6	60.1	60.6	61.1	61.5	62.0	62.5
102	57.3	57.7	58.1	58.6	59.0	59.5	60.0	60.5	60.9	61.4	61.9	62.4	62.9
103	57.7	58.1	58.5	59.0	59.5	59.9	60.4	60.9	61.3	61.8	62.3	62.8	63.2
104	58.1	58.5	59.0	59.4	59.9	60.3	60.8	61.3	61.7	62.2	62.7	63.1	63.6
105	58.6	59.0	59.4	59.9	60.3	60.8	61.2	61.7	62.1	62.6	63.0	63.5	63.9
106	59.0	59.4	59.8	60.3	60.7	61.2	61.6	62.1	62.5	62.9	63.4	63.8	64.3
107	59.5	59.9	60.3	60.7	61.2	61.6	62.0	62.5	62.9	63.3	63.8	64.2	64.6
108	59.9	60.3	60.7	61.1	61.6	62.0	62.4	62.9	63.3	63.7	64.1	64.6	65.0
109	60.4	60.8	61.2	61.6	62.0	62.4	62.8	63.2	63.7	64.1	64.5	64.9	65.3
110	60.9	61.2	61.6	62.0	62.4	62.8	63.2	63.6	64.1	64.5	64.9	65.3	65.6
111	61.3	61.7	62.0	62.4	62.8	63.2	63.6	64.0	64.4	64.8	65.2	65.6	66.0
112	61.8	62.1	62.5	62.9	63.3	63.7	64.0	64.4	64.8	65.2	65.6	66.0	66.3
113	62.2	62.6	62.9	63.3	63.7	64.1	64.4	64.8	65.2	65.6	66.0	66.3	66.7
114	62.7	63.0	63.4	63.7	64.1	64.5	64.9	65.2	65.6	66.0	66.3	66.7	67.0
115	63.1	63.5	63.8	64.2	64.5	64.9	65.3	65.6	66.0	66.3	66.7	67.0	67.3
116	63.6	63.9	64.3	64.6	65.0	65.3	65.7	66.0	66.4	66.7	67.0	67.4	67.7
117	64.0	64.4	64.7	65.0	65.4	65.7	66.1	66.4	66.8	67.1	67.4	67.7	68.0
118	64.5	64.8	65.1	65.5	65.8	66.1	66.5	66.8	67.2	67.5	67.8	68.1	68.4
119	64.9	65.3	65.6	65.9	66.2	66.6	66.9	67.2	67.6	67.9	68.1	68.4	68.7
120	65.4	65.7	66.0	66.3	66.6	67.0	67.3	67.6	67.9	68.2	68.5	68.8	69.1
121	65.8	66.1	66.5	66.8	67.1	67.4	67.7	68.0	68.3	68.6	68.9	69.1	69.4
122	66.3	66.6	66.9	67.2	67.5	67.8	68.1	68.4	68.7	69.0	69.2	69.5	69.8
123	66.7	67.0	67.3	67.6	67.9	68.2	68.5	68.8	69.1	69.3	69.6	69.9	70.1
124	67.2	67.5	67.8	68.0	68.3	68.6	68.9	69.2	69.5	69.7	70.0	70.2	70.4
125	67.6	67.9	68.2	68.5	68.8	69.0	69.3	69.6	69.8	70.1	70.3	70.6	70.8
126	68.1	68.4	68.7	68.9	69.2	69.5	69.7	70.0	70.2	70.5	70.7	70.9	71.1
127	68.6	68.8	69.1	69.4	69.6	69.9	70.1	70.4	70.6	70.9	71.1	71.3	71.5
128	69.0	69.3	69.5	69.8	70.0	70.3	70.5	70.8	71.0	71.2	71.4	71.6	71.8
129	69.5	69.7	70.0	70.2	70.5	70.7	71.0	71.2	71.4	71.6	71.8	72.0	72.1
130	69.9	70.2	70.4	70.7	70.9	71.1	71.4	71.6	71.8	72.0	72.2	72.3	72.5
131	70.4	70.6	70.9	71.1	71.3	71.6	71.8	72.0	72.2	72.3	72.5	72.7	72.8
132	70.8	71.1	71.3	71.5	71.8	72.0	72.2	72.4	72.5	72.7	72.9	73.0	73.1
133	71.3	71.5	71.7	72.0	72.2	72.4	72.6	72.7	72.9	73.1	73.2	73.3	73.4
134	71.7	71.9	72.2	72.4	72.6	72.8	72.9	73.1	73.3	73.4	73.5	73.6	73.7
135	72.1	72.4	72.6	72.8	73.0	73.1	73.3	73.5	73.6	73.7	73.8	73.9	74.0

An additional scientific task was included in the last minute before survey started. It was decided to conduct MIK sampling for cod larvae in combination with pelagic trawling for mackerel at six predetermined stations in northern Norway onboard M/V Vendla from Norway (see Appendix 4).

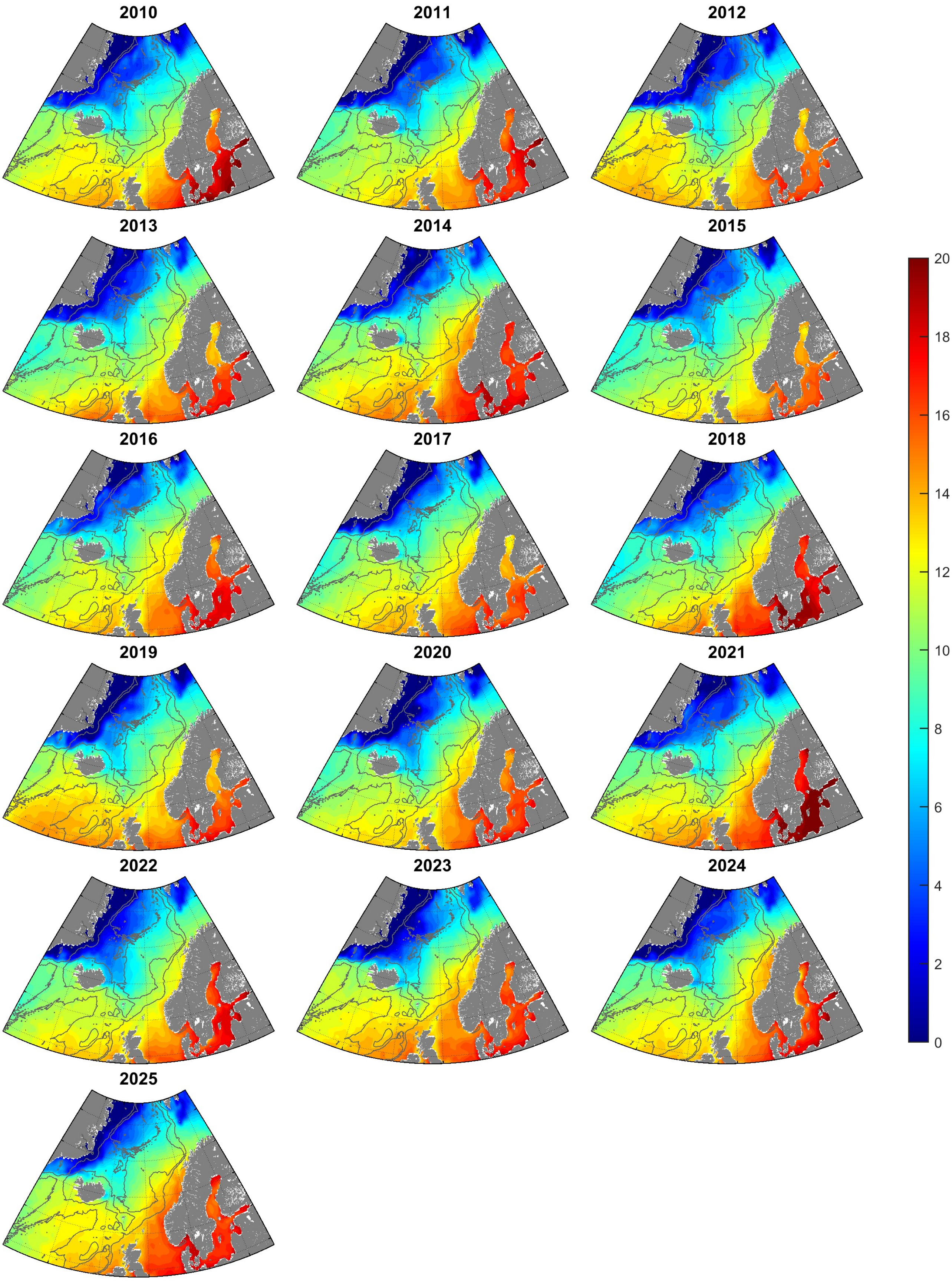
4 Results and discussion

4.1 Hydrography

Satellite measurements (NOAA OISST) of sea surface temperature in July 2025 (SST, Figure 4a) were above long-time average (July 1990-2009) in all the surveyed area, with the highest anomalies off the Norwegian coast (Figure 4b). This is in line with other temperature observations from the Northeast Atlantic which indicate a warm year (e.g. https://www.hav.fo/heitt-var-a-landgrunninum/, https://www.mercator-ocean.eu/bulletin/mid-year-highlights-2025-north-atlantic/).

It should be mentioned that the NOAA SST are sensitive to the weather conditions (i.e. wind and cloudiness) prior to and during the observations and do therefore not necessarily reflect the oceanographic condition of the water masses in the areas, as seen when comparing detailed *in situ* features of SSTs between years (Figures 4a,b-5). However, since the anomaly is based on the average for the whole month of July, it should give representative results of the surface temperature.

The temperature distribution at 10, 50, 100, and 400 m depths based on CTD casts is shown in Figure 5. At 10 m depth, the temperatures ranged from less than 5°C in the Greenland Sea to 14°C in the North Sea. Below the surface layer, there is a clear signal from the cold East Icelandic Current which carries cold and fresh water into the central and south-eastern part of the Norwegian Sea. Along the Norwegian Shelf and in the southernmost areas, the water masses are dominated by warmer waters of Atlantic origin. The CTD measurements at 50 m and 100 m depths clearly showed the front between the colder east Greenlandic water and the warmer North Atlantic water.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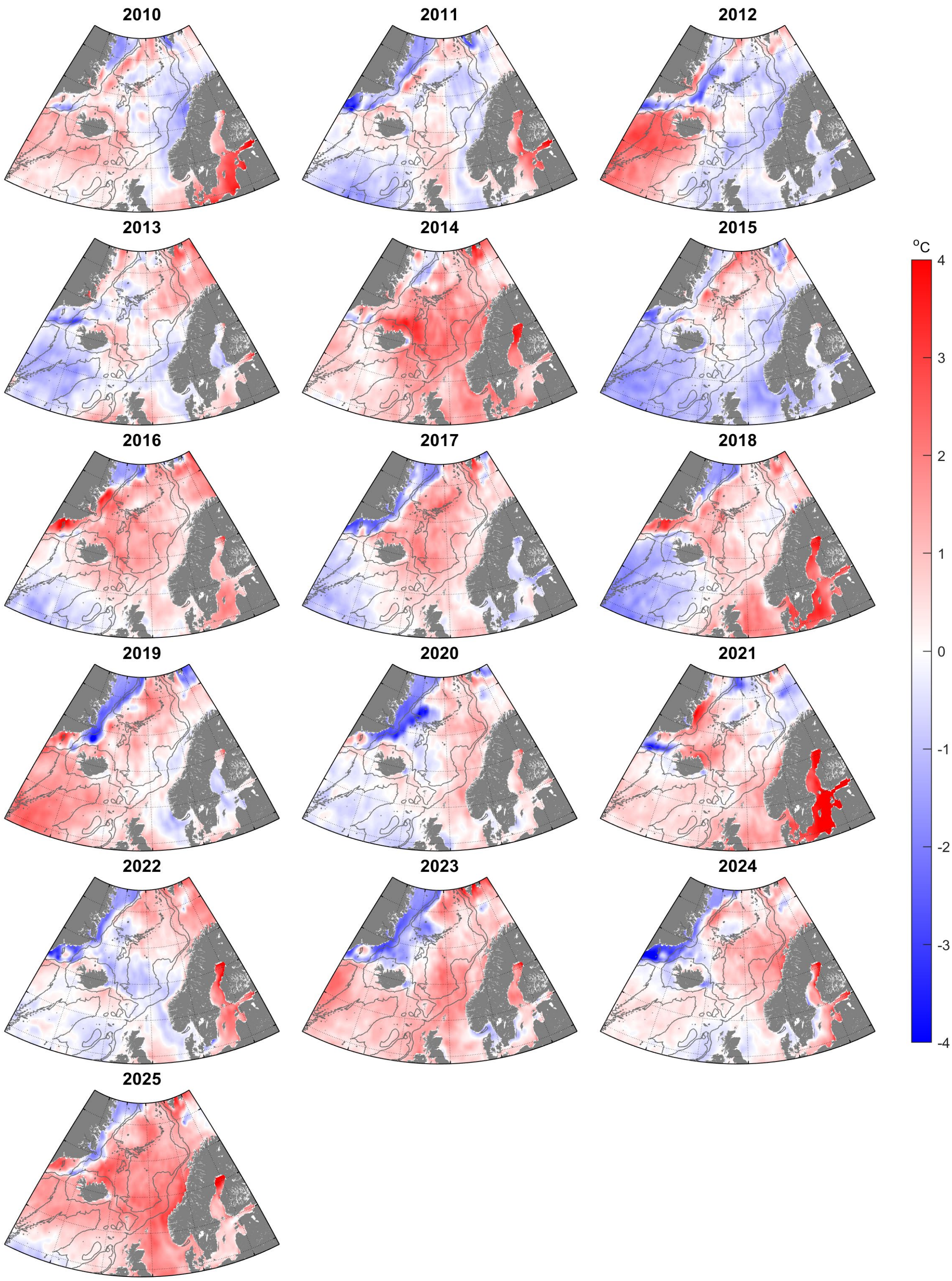

Figure 4. Annual sea surface temperature (a; top panel) and its anomaly (b; lower panel; -4 to +4°C) in Northeast Atlantic for the month of July from 2010 to 2025 showing warm and cold conditions in comparison to the average for July 1990-2009. Based on monthly averages of daily Optimum Interpolation Sea Surface Temperature (Ver. 2.1 NOAA OISST, AVHRR-only, Banzon et al. 2016, https://www.ncei.noaa.gov/products/optimum-interpolation-sst).

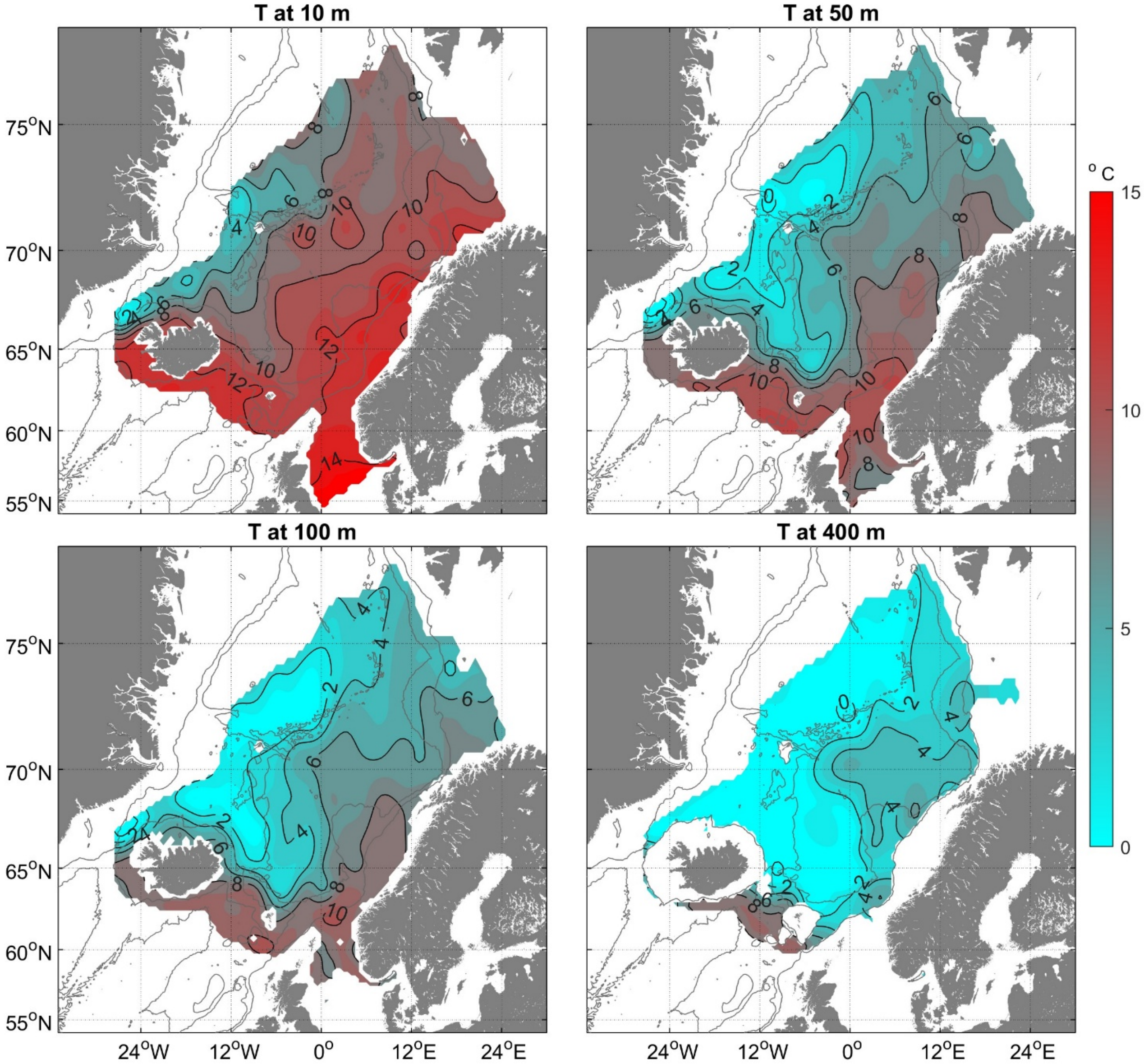

Figure 5. Interpolated temperature (°C) at 10, 50, 100 and 400 m depth in Nordic Seas and the North Sea in July 2025. 500 m and 2000 m depth contours are shown in light grey.

4.2 Zooplankton

The zooplankton biomass varied between areas with a patchy distribution throughout the area, with high concentrations north of Iceland, close to the Iceland-Faroe Ridge and in the central part of the Norwegian Sea (Figure 6). In the northernmost part of the survey area concentrations were generally low (below 10 g/m^2). The average zooplankton weight for the whole survey was 6.1 g/m^2, which is a decrease compared to the last two years.

The time-series of zooplankton biomass was averaged by three subareas: Greenland region (not covered since 2023), Iceland region, and the Norwegian Sea region (Figure 7; see definitions in legend). In the Icelandic region and the Norwegian Sea, the level was lower than in 2023 and 2025 and comparable to 2021-2022 (Figure 7). The lower variability over time in the Norwegian Sea might in part be explained by the more homogeneous oceanographic conditions in the area defined as Norwegian Sea.

These plankton indices should be treated with some caution as it is only a snapshot of the standing stock biomass, not of the actual production in the area, which complicates spatio-temporal comparisons.

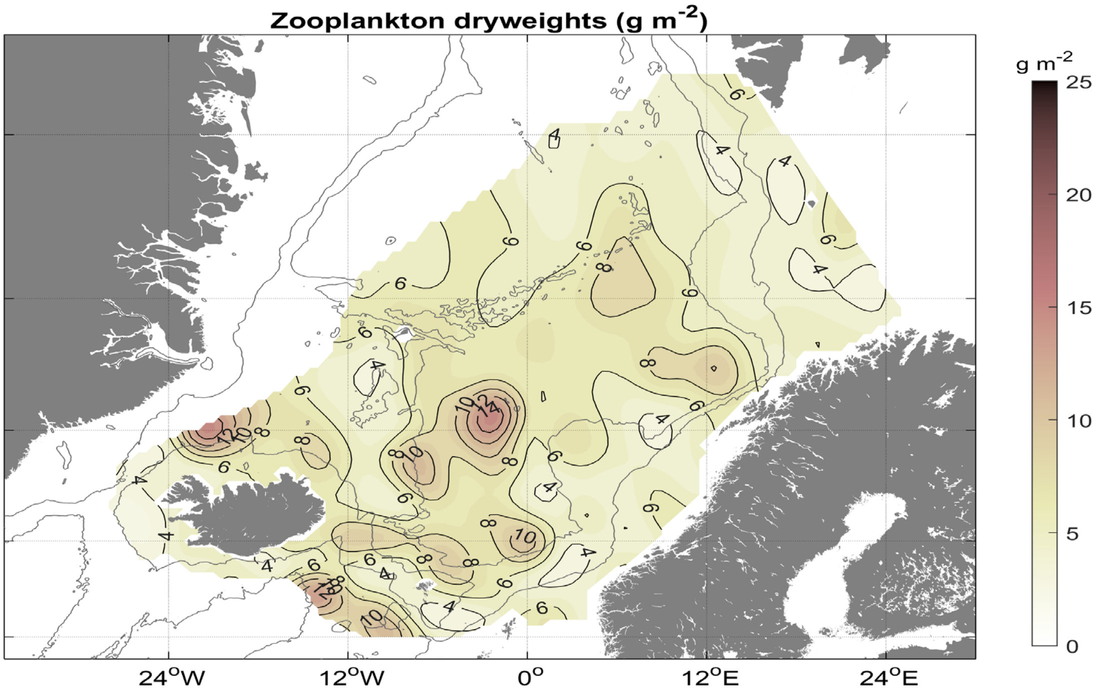

Figure 6. Interpolated zooplankton biomass (g dw/m², 0-200 m) in Nordic Seas in July-August 2025. 500 m and 2000 m depth contours are shown in light grey.

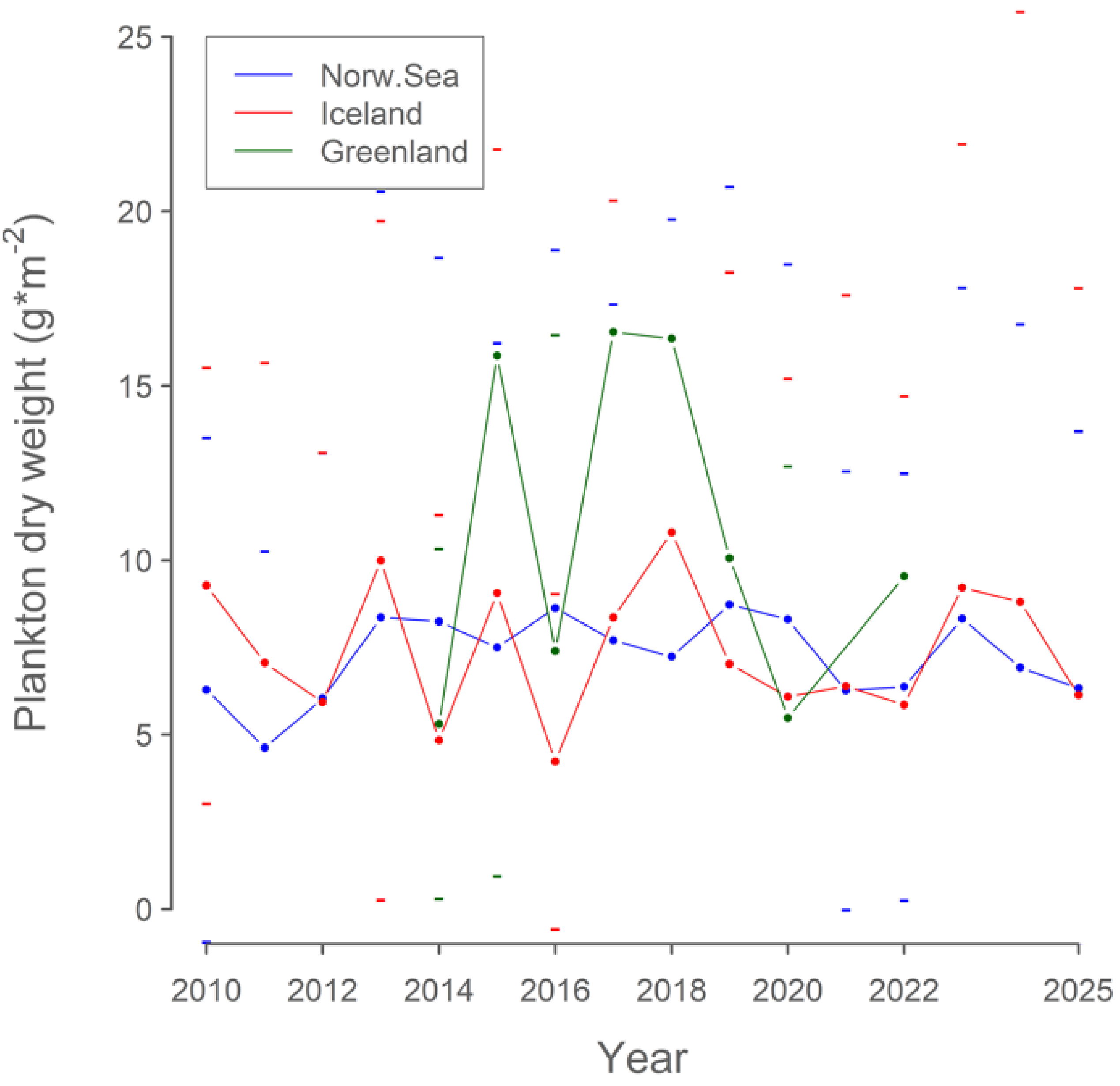

Figure 7. Zooplankton biomass indices (g dw/m², 0-200 m). Time-series (2010-2025) of mean zooplankton biomass for three subareas within the survey range: Norwegian Sea (between 14°W-17°E & north of 61°N), Icelandic waters (14°W-30°W) and Greenlandic waters (2014-2022, west of 30°W).

4.3 Mackerel

The geographical distribution of the mackerel during 2025 was similar as in 2024 (Figure 8), with a more contracted distribution than in 2023 (Figure 9 to 10). Nevertheless, the abundance or densities of mackerel were considerably lower, particularly in the western areas, whereas the regions with higher abundance were found more to the east along the Norwegian coast (from 62° to 70° N), without the elevated presence found in the central part of the Norwegian Sea documented in 2024.

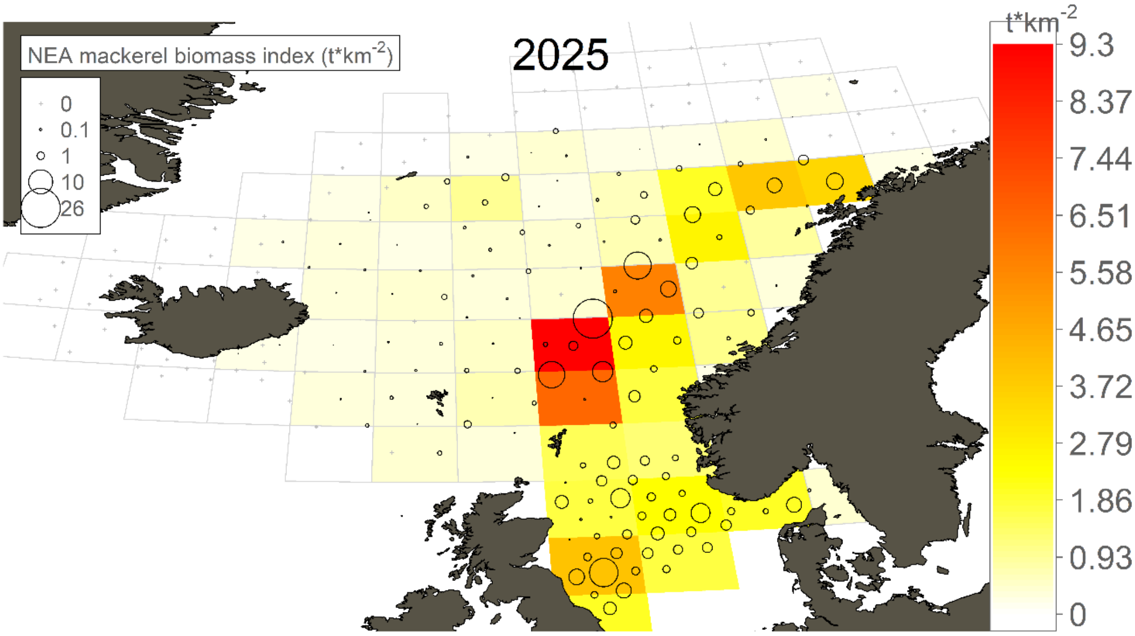

Figure 8. Mackerel catch rates by pelagic trawl haul at predetermined surface trawl stations (circle areas represent catch rates in kg/km^2) overlaid on mean catch rates per standardized rectangles (2° lat. x 4° lon.) in Nordic Seas in July-August 2025.

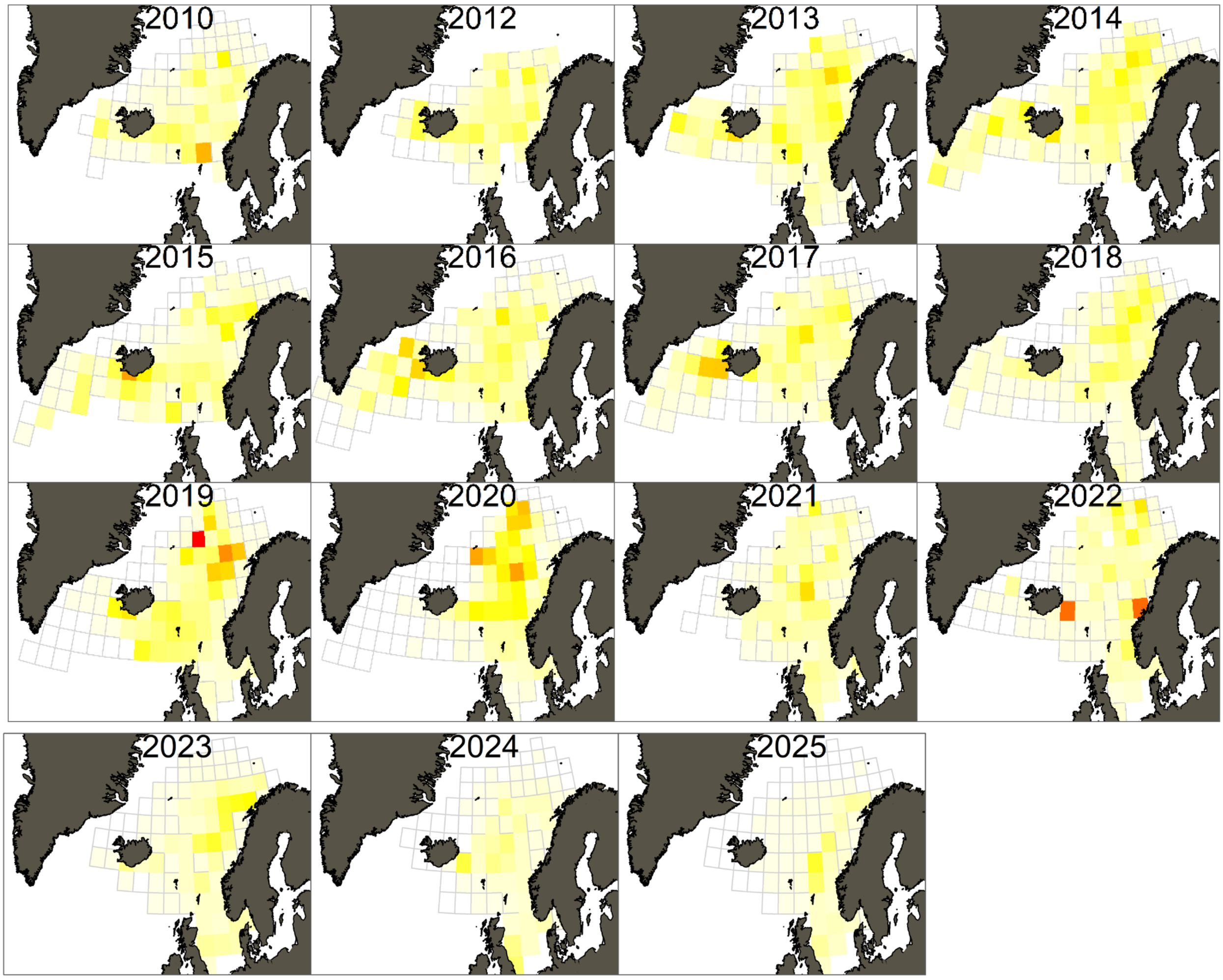

Figure 9. Annual distribution of mackerel proxied by the absolute distribution of mean mackerel catch rates per standardized rectangles (2° lat. x 4° lon.), from Multpelt 832 pelagic trawl hauls at predetermined surface trawl stations in Nordic Seas in June-August 2010-2025. Colour scale goes from white (= 0) to red (= maximum value for the highest year).

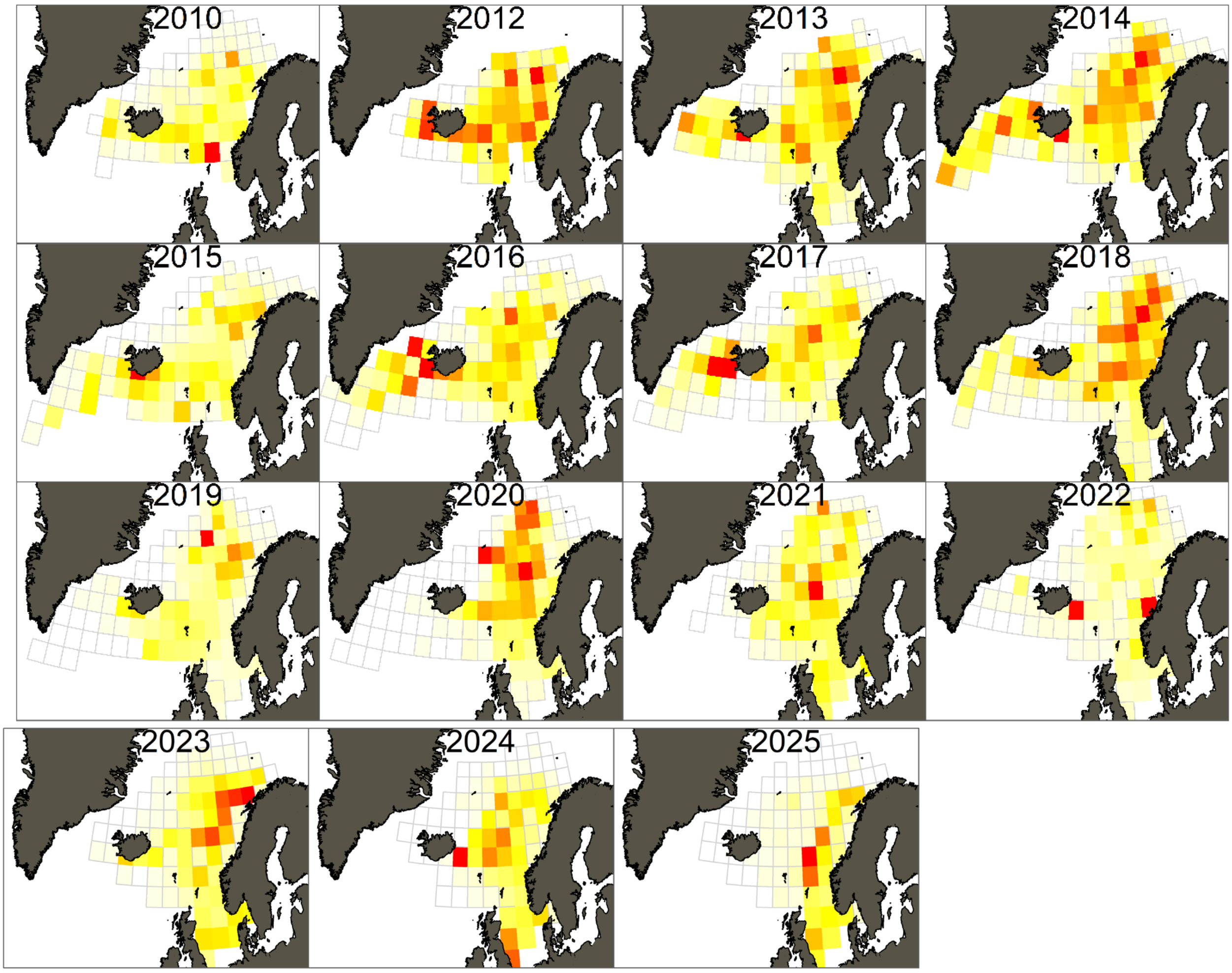

Figure 10. Annual distribution of mackerel proxied by the relative distribution of mean mackerel catch rates per standardized rectangles (2° lat. x 4° lon.), from Multpelt 832 pelagic trawl hauls at predetermined surface trawl stations stations in Nordic Seas in June-August 2010-2025. Colour scale goes from white (= 0) to red (= maximum value for the given year).

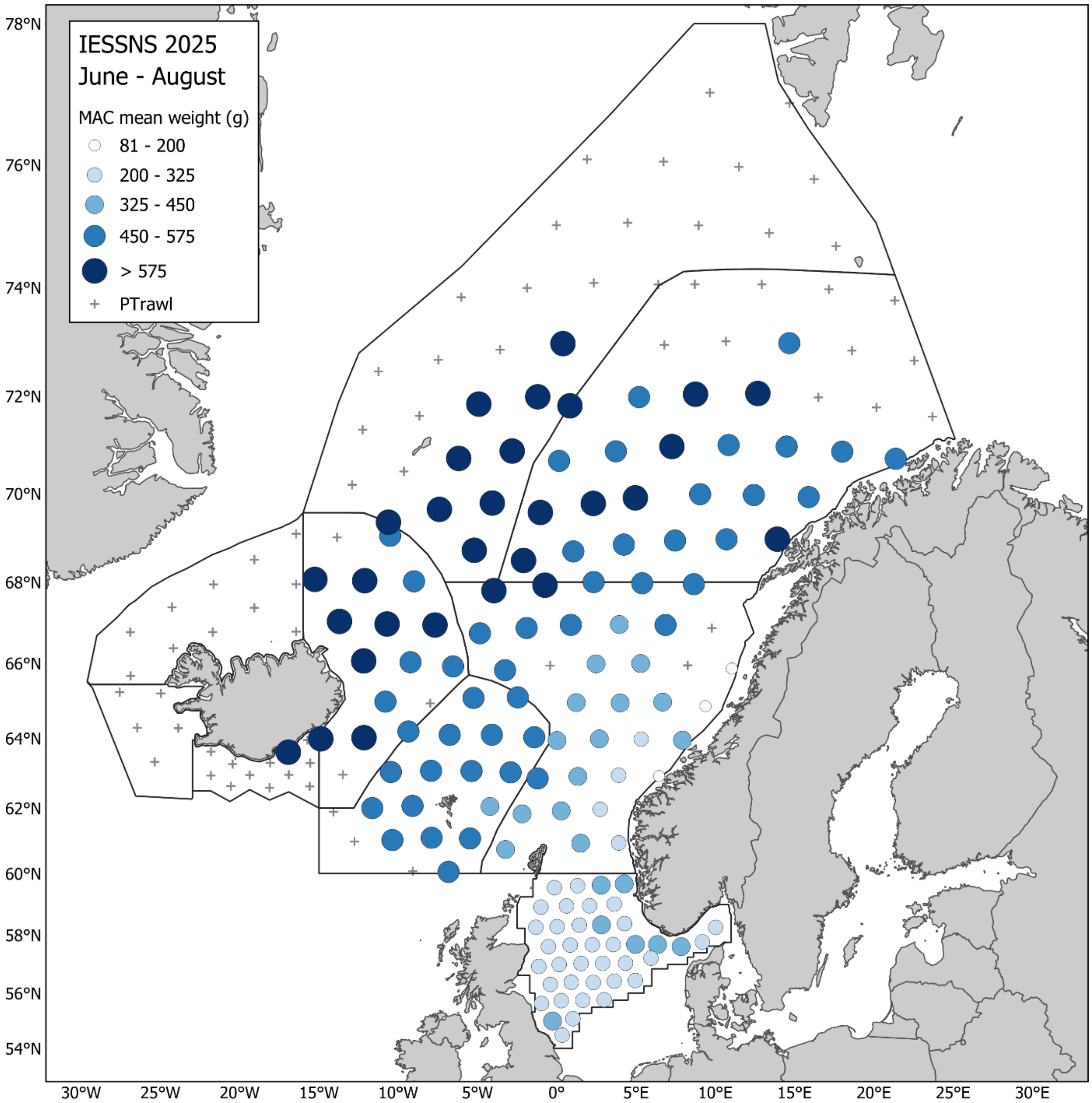

Figure 11. Average weight of mackerel at predetermined surface trawl stations during IESSNS 2025. The survey strata are shown in the map.

The mackerel weight varied between 48 to 1030 g with an average weight of 455 g. The length of mackerel caught in the pelagic trawl hauls onboard the five vessels varied from 18 to 46 cm, with an average of 33.7 cm. In total we measured 11468 mackerel. Mackerel size distribution followed the same overall pattern as previous years with increasing size from the central Norwegian Sea and the North Sea towards the westward and northward distribution boundaries (Figure 11). The spatial distribution and overlap between the major pelagic fish species (mackerel, herring, and blue whiting) in 2025 according to surface trawl catches are shown in Figure 12. In 2025 there was generally low overlap between NEA mackerel and NSS herring compared with previous years. Similar to previous years, herring are occupying larger areas of the Norwegian Sea compared to earlier period, where presence and density are highest in frontal areas. Mackerel, on the other hand, dominate in central areas with warmer Atlantic waters. The spatial contraction of the mackerel distribution in combination with the reduction in mackerel densities within the Nordic Seas have been massive during the last decade. In 2025, blue whiting was much more abundant in shallow waters, particularly in the northwestern part of the North Sea and southwestern part of the Norwegian Sea, compared to previous years.

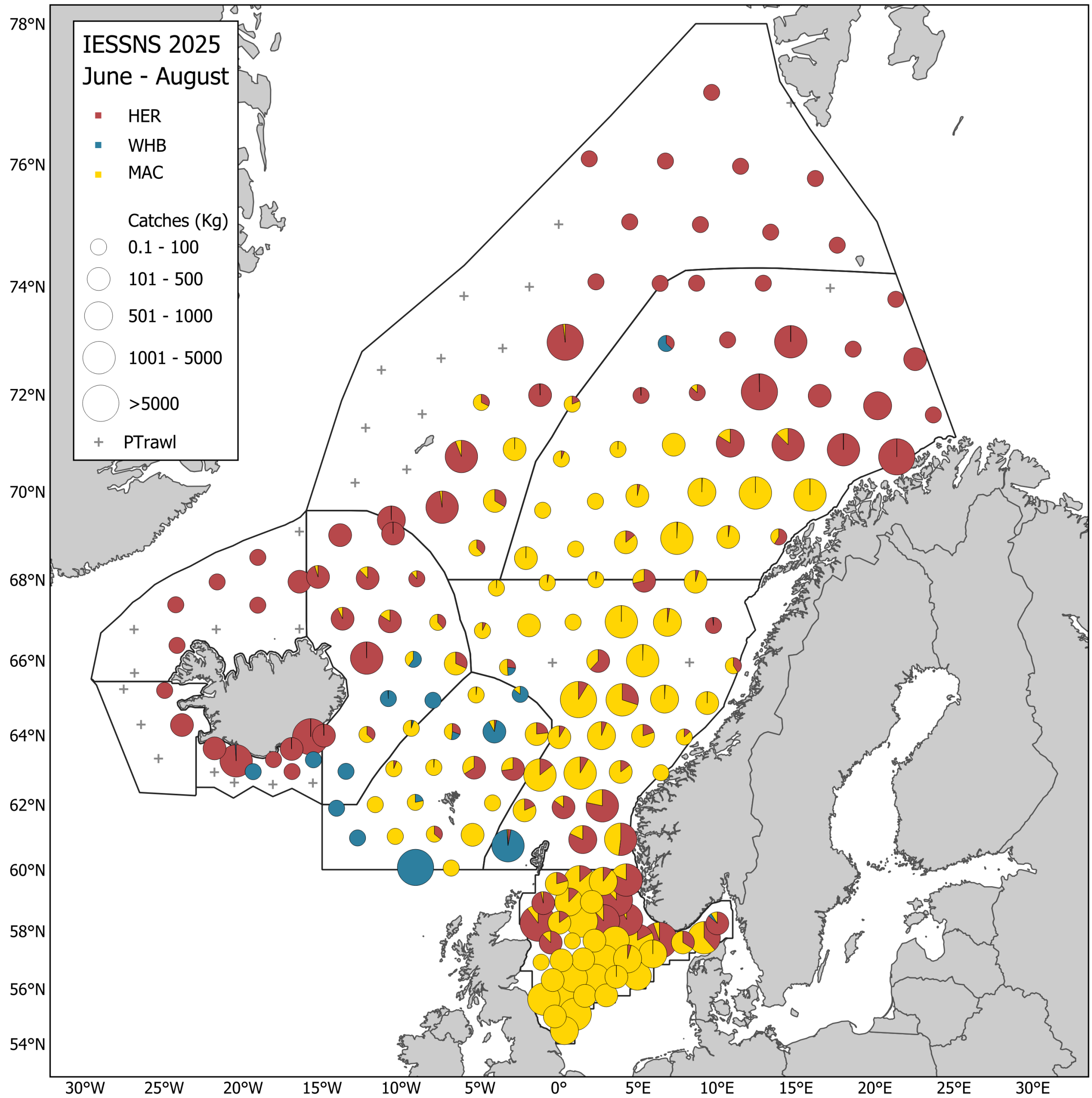

Figure 12. Distribution and spatial overlap between mackerel, herring, and blue whiting, at all surface trawl stations during IESSNS 2025. Predetermined surface trawl stations with no catch of the three species are displayed as +. The survey strata are shown in the map.

Swept area analyses of mackerel abundance in IESSNS

The total swept-area mackerel index in 2025 was 3.8 billion individuals in number (Table 8) and 1.7 million tonnes in biomass (Table 9) with a decrease of 32% in abundance and 35% in biomass compared to 2024 (Figure 13). The survey coverage area (excl. the North Sea, 0.28 million km^2) was 2.34 million km^2 in 2025, which is 5% larger compared to 2024. The zero-line was reached for the survey area (survey southern boundary is latitude 60° N). The uncertainty in the biomass index during 2025 was higher than observed last year, with a CV= 0.28 compared with CV=0.21 in 2024.

There is no pattern in changing size-at-age between years (Table 10). The largest year-classes observed in 2025 were from 2020 (age 5) and 2019 (age 6) (Figure 14). The 2020-year class contributed 21% of the total biomass and the total abundance. The 2019-year class contributed 17% of biomass and 16% of abundance. As in the last two years , these two year classes have been the most abundant in the survey area.

Mackerel of age 1 are not completely recruited to the survey (Figure 15a). Therefore, information on recruitment before age 2 is uncertain. The catch curves for the indices excluding the North Sea at age 1-2 is given for comparison (Figure 15b).

The NEA mackerel stock assessment in WGWIDE use two sets of data from the IESSNS (ICES WKBMACNSSH, 2025):

1. A recruit index consisting of number-at-age indices for age 2. The basis for this index includes the North Sea and starts in 2018 (Table 11).
2. A recruit index consisting of number-at-age indices for ages 3-11. The basis for this index excludes the North Sea and starts in 2010 (Table 8).

The internal consistency between cohorts of the indices used in NEA mackerel stock assessment in WGWIDE, ranged from good to strong for all ages (Figure 16a), and similar to last year ranging from 0.70 to 0.97 (Figure 16a). The internal consistency for indices only based data excluding North Sea is given for comparison (Figure 16b).

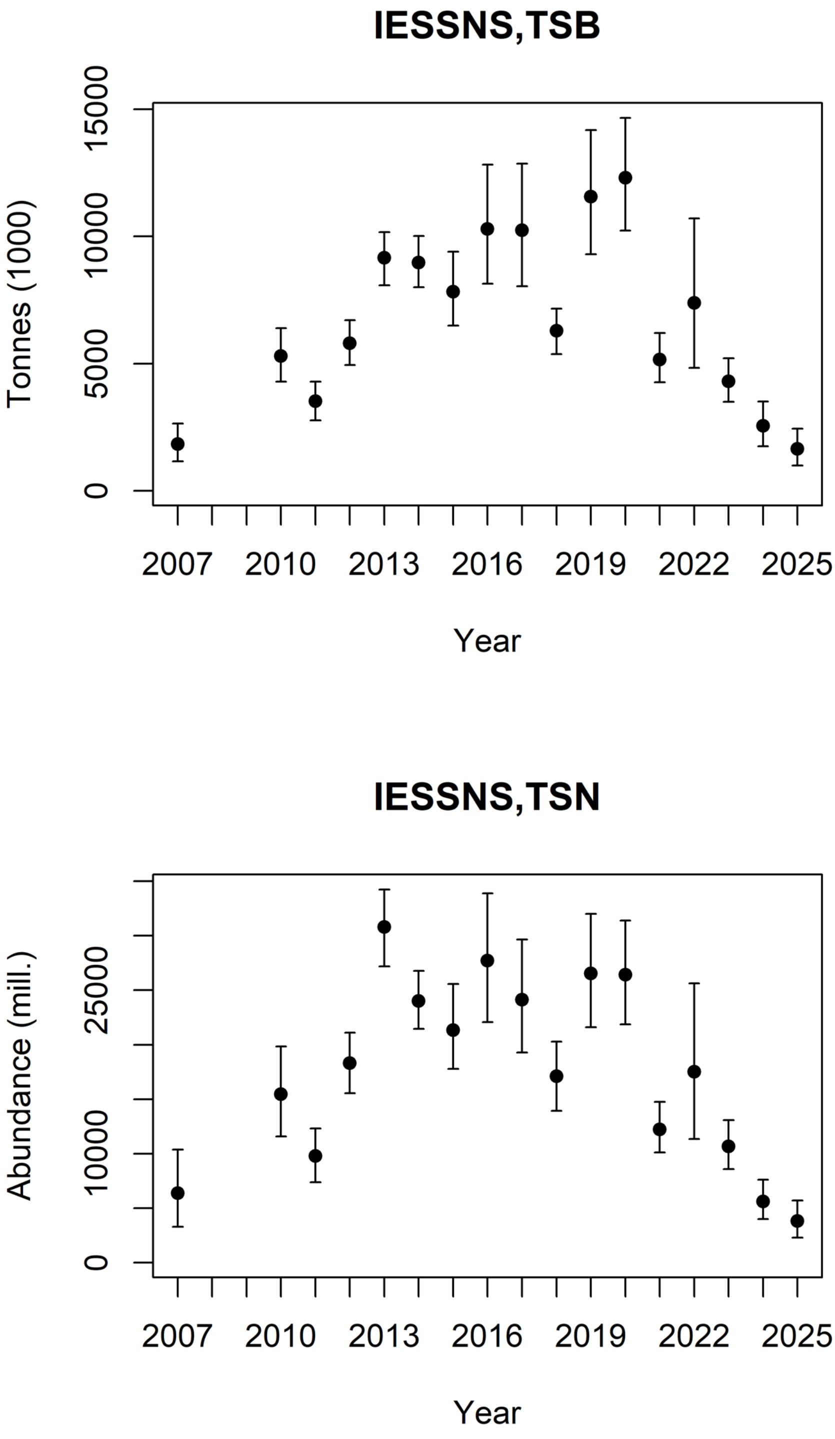

Figure 13. Estimated total stock biomass (upper panel) and total stock numbers (lower panel) of mackerel from StoX for the years 2007 and from 2010 to 2025 (excl. North Sea). The black dots are mean of 1000 bootstrap replicates while the error bars represent 90% confidence intervals based on the bootstrap. Note, in 2011 the northern part of the Norwegian was not surveyed, hence the index for that year is not representative of mackerel stock size. See IESSNS 2011 cruise report for details.

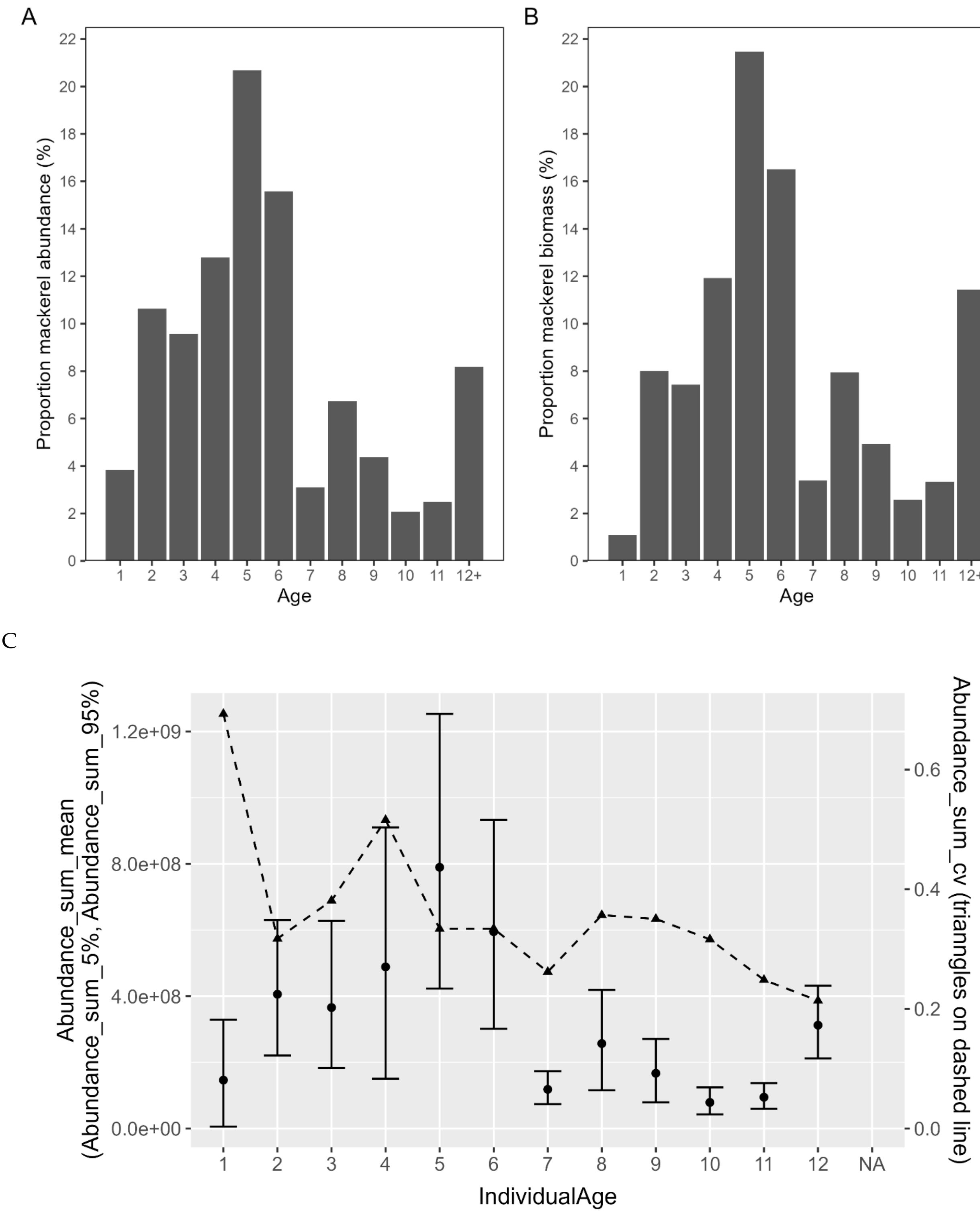

Figure 14. Age distribution of mackerel in 2025 (excl. North Sea). A) Relative abundance by age. B) Relative biomass by age. C) Absolute abundance by age (5% percentile, mean, 95% percentile) and relative standard error (CV) obtained by bootstrapping with 1000 replicates using the StoX software.

Table 8. StoX bootstrap time series of the IESSNS (excluding the North Sea) showing age-disaggregated abundance indices of mackerel (billions) in 2007 and from 2010 to 2025.

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12 (+)	Total
2007	1.34	2.29	1.04	0.30	1.06	0.16	0.06	0.04	0.03	0.02	0.01	0.01	6.35
2010	0.01	3.70	1.62	4.07	3.10	1.51	0.66	0.41	0.21	0.07	0.03	0.04	15.42
2011	0.50	0.80	1.93	1.38	2.29	1.34	0.69	0.28	0.19	0.13	0.02	0.03	9.60
2012	0.90	5.60	1.23	2.51	2.05	2.92	1.86	0.71	0.29	0.11	0.07	0.04	18.30
2013	0.07	7.71	9.78	2.41	3.15	3.21	2.56	1.14	0.38	0.16	0.14	0.07	30.77
2014	0.01	0.52	7.07	4.90	2.69	2.69	2.78	1.86	0.87	0.39	0.12	0.11	24.01
2015	0.89	0.85	2.42	6.54	4.84	1.87	1.61	1.22	0.71	0.27	0.06	0.05	21.33
2016	0.00	5.05	1.53	2.98	5.85	4.97	2.20	2.00	1.35	0.88	0.48	0.43	27.72
2017	0.88	0.10	3.50	1.90	3.19	4.45	4.56	1.83	2.05	0.86	0.54	0.25	24.11
2018	2.21	2.53	0.49	2.39	1.13	1.30	2.23	1.92	1.12	0.57	0.59	0.59	17.07
2019	0.07	1.31	3.85	1.16	2.95	2.90	1.89	3.97	4.08	1.41	1.29	1.66	26.54
2020	0.05	1.07	1.46	3.30	2.16	2.54	2.64	1.89	2.88	3.85	1.45	3.12	26.41
2021	0.08	2.14	0.68	1.26	1.53	0.34	1.34	0.74	1.03	1.03	0.95	1.09	12.22
2022	0.02	3.81	2.30	0.98	1.35	1.03	0.62	0.99	1.01	1.88	1.59	1.92	17.50
2023	0.20	0.68	3.54	1.73	0.53	0.44	0.83	0.34	0.48	0.37	0.43	1.11	10.67
2024	0.03	0.52	0.54	0.85	0.70	0.31	0.30	0.34	0.41	0.31	0.29	1.01	5.61
2025	0.15	0.41	0.37	0.49	0.79	0.60	0.12	0.26	0.17	0.08	0.09	0.31	3.82

Table 9. StoX baseline (point estimate) time series of the IESSNS showing age-disaggregated mackerel mean weight (grams) per age in 2007 and from 2010 to 2025 (excl. North Sea). * Mean weight of ages 12+.

Year\Age	1	2	3	4	5	6	7	8	9	10	11	12	13+
2007	133	233	323	390	472	532	536	585	591	640	727	656	685
2010	133	212	290	353	388	438	512	527	548	580	645	683	665
2011	133	278	318	371	412	440	502	537	564	541	570	632	622
2012	112	188	286	347	397	414	437	458	488	523	514	615	509
2013	96	184	259	326	374	399	428	445	486	523	499	547	677
2014	228	275	288	335	402	433	459	477	488	533	603	544	537
2015	128	290	333	342	386	449	463	479	488	505	559	568	583
2016	95	231	324	360	371	394	440	458	479	488	494	523	511
2017	86	292	330	373	431	437	462	487	536	534	542	574	589
2018	67	229	330	390	420	449	458	477	486	515	534	543	575
2019	153	212	325	352	428	440	472	477	490	511	524	564	545
2020	99	213	315	369	394	468	483	507	520	529	539	567	575
2021	140	253	357	377	409	451	467	487	497	505	516	523	544
2022	125	263	330	408	438	431	462	508	525	519	531	531	549
2023	128	269	347	371	416	435	462	484	506	526	517	533	557
2024	192	268	343	400	424	461	447	480	536	555	554	584	549
2025	113	314	338	418	475	473	492	526	538	557	581	606*	

Table 10. Bootstrap estimates from StoX (based on 1000 replicates) of mackerel in 2025 (excl North Sea). Numbers by age and total number (TSN) are in millions and total biomass (TSB) in million tons.

	Age	5th percentile	Median	95th percentile	Mean	SD	CV
	1	5.8	140.6	329.4	146.4	101.4	0.69
	2	220.5	395.7	630.4	406.0	128.9	0.32
	3	183.0	351.9	627.7	365.8	139.4	0.38
	4	150.7	479.7	910.4	488.7	252.0	0.52
	5	423.0	760.9	1253.5	789.8	263.6	0.33
	6	301.6	574.2	933.4	595.1	198.8	0.33
	7	73.8	116.5	173.1	118.5	31.0	0.26
	8	115.9	247.3	419.1	256.9	91.6	0.36
	9	79.4	162.0	270.8	167.1	58.5	0.35
	10	42.9	76.4	124.3	79.0	25.0	0.32
	11	60.0	93.2	137.4	94.7	23.5	0.25
	12	212.3	310.4	431.7	312.5	66.8	0.21
TSN		2304.8	3707.3	5690.8	3826.6	1070.2	0.28
TSB		1.00	1.62	2.44	1.65	0.46	0.28

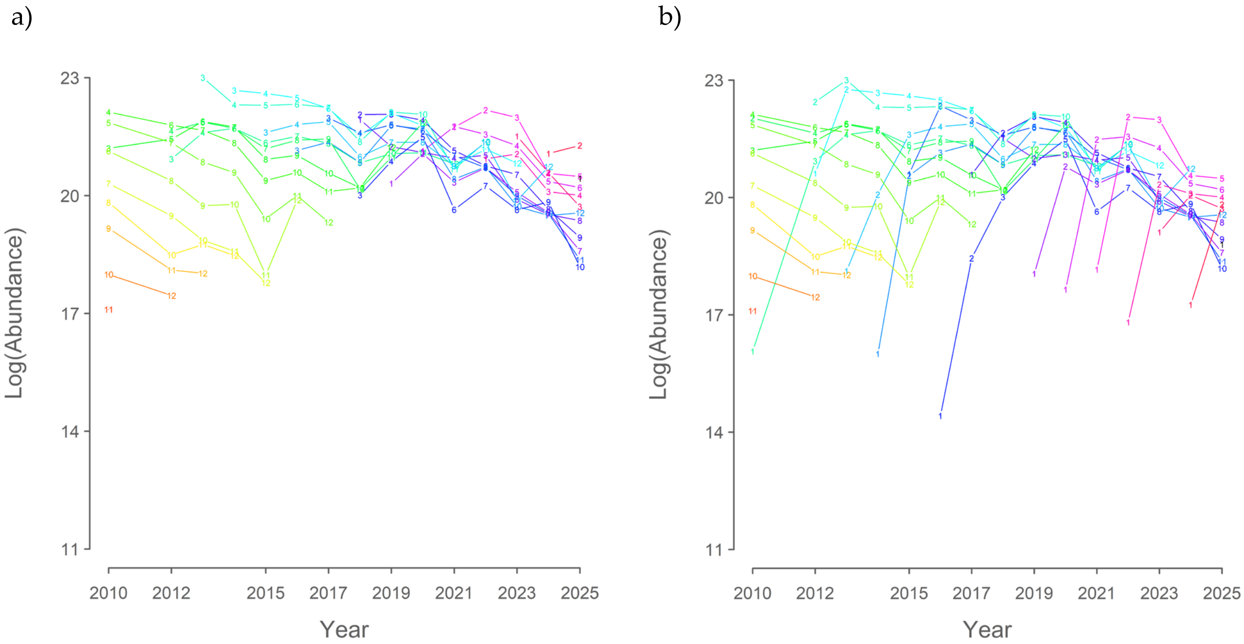

Figure 15. Catch curves of StoX estimates of mackerel density index in the Nordic Seas a) incl. ages 1 and 2 from the North Sea and b) excl. North Sea. Each cohort of mackerel is marked by a uniquely coloured line that connects the estimates indicated by the respective ages.

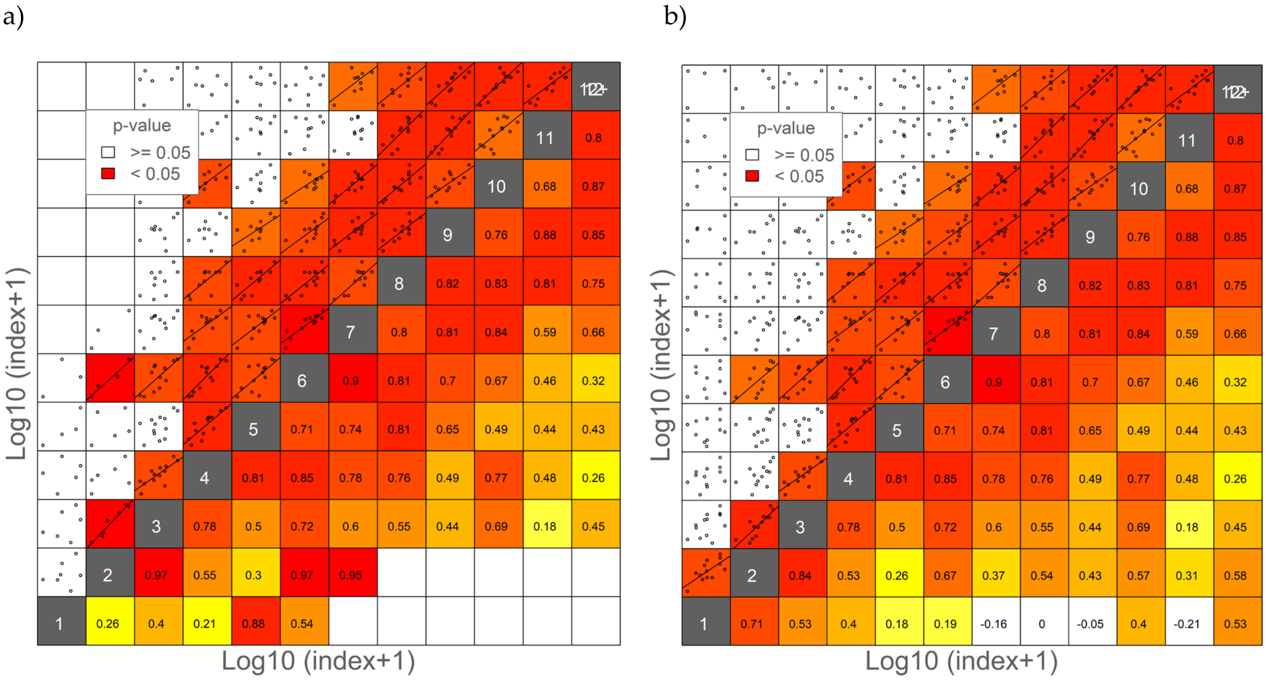

Figure 16. Internal consistency of StoX estimates of mackerel density index in the Nordic Seas a) incl. ages 1 and 2 from the North Sea and b) excl. North Sea. Ages indicated by white numbers in grey diagonal cells. Statistically significant positive correlations ($p<0.05$) are indicated by regression lines and red cells in upper left half. Correlation coefficients (r) are given in the lower right half.

A new recruitment index for age 2, combining both the Nordic Seas and the North Sea from IESSNS for the period 2018-2025, was accepted as the only recruitment time series to be included as input to future assessments following the conclusion from the ICES benchmark on NEA mackerel in March 2025 (ICES 2025). The recruitment index was highest in 2022 (Figure 17). Thereafter, recruitment decreased substantially. Despite an increase in mackerel recruitment by a factor of two compared to last year, the 2025 estimate is still below the average for the period 2018-2025 (Figure 17). In 2025, the abundance of this year-class was 1.74 billion individuals, 50% higher than 0.87 billion measured in 2024 (Table 11). In 2025, the contribution from the North Sea coverage was 77% of the abundance at age 2 (Figure 17).

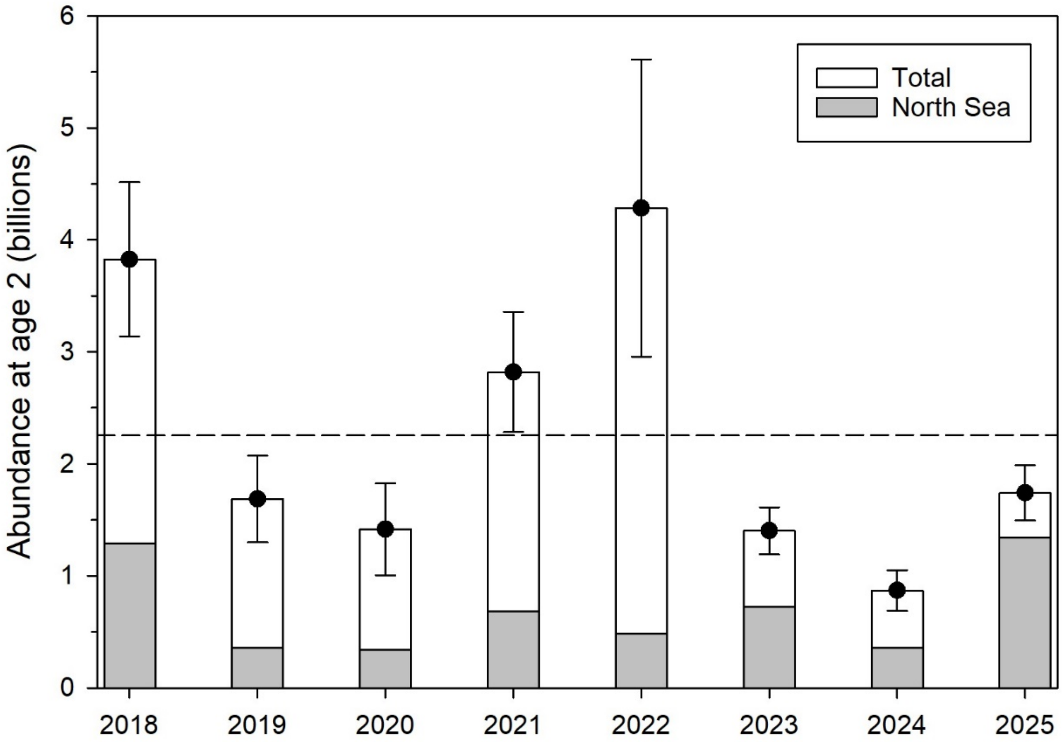

Figure 17. Annual mackerel recruitment index is shown as abundance at age 2 (billions) for the Nordic Seas and the North Sea combined (StoX bootstrap estimates of mean and standard error (SE), dashed line: average 2018-2025).

The swept area method assumes that potential distribution of mackerel outside the survey area – both vertically and horizontally – is a constant percentage of the total biomass. In some years, this assumption may be violated, e.g. mackerel may be distributed below the footrope of the trawl or if the proportion of mackerel outside the survey coverage varies among years. In order to improve the precision of the swept area estimate it would be beneficial to extend the survey coverage further south, such that it covers the southwestern waters south of 60°N, e.g. UK waters.

The standard swept area method using the average horizontal trawl opening by each participating vessel (ranging 62.1 - 74.1 m; Table 6), assuming that a constant fraction of the mackerel inside the horizontal trawl opening are caught. Further, that if mackerel is distributed below the depth of the trawl (footrope), this fraction is assumed constant from year to year.

Table 11. StoX bootstrap (point estimate) time series of the combined IESSNS (including the North Sea) showing age-disaggregated abundance indices of mackerel (billions) from 2018 to 2025.

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12 (+)	Total
2018	3.36	3.83	0.75	2.45	1.19	1.33	2.24	1.93	1.12	0.58	0.60	0.60	19.97
2019	0.66	1.69	4.02	1.28	3.00	2.93	1.91	3.99	4.08	1.41	1.28	1.65	27.90
2020	1.51	1.42	1.58	3.34	2.22	2.55	2.62	1.91	2.87	3.81	1.43	3.08	28.35
2021	2.77	2.82	0.77	1.39	1.61	0.40	1.37	0.75	1.05	1.05	0.95	1.10	16.02
2022	1.24	4.28	2.39	1.01	1.36	1.05	0.63	0.99	1.00	1.83	1.56	1.88	19.23
2023	2.20	1.40	3.87	1.86	0.61	0.49	0.86	0.37	0.49	0.37	0.43	1.11	14.08
2024	1.42	0.87	0.69	0.97	0.75	0.34	0.34	0.36	0.42	0.31	0.29	1.01	7.76
2025	0.75	1.74	0.51	0.60	0.90	0.63	0.14	0.27	0.17	0.08	0.09	0.32	6.20

4.4 Norwegian spring-spawning herring

Norwegian spring-spawning herring (NSSH) was this year predominantly recorded in the northeastern part of the Norwegian Sea (Figure 18a, b). The acoustic registrations in the southern and eastern parts of the Norwegian Sea were low. Herring registrations south of 62° N in the eastern part were allocated to a different stock, North Sea herring, while the herring to the south and west in Icelandic waters (west of 14° W south of Iceland) were allocated to Icelandic summer-spawners – these were removed from the biomass estimation of NSSH (Figure 18b), and not shown on the maps.

The total biomass index of NSSH recorded during IESSNS 2024 was 4.57 million tonnes, 21% higher biomass than in 2024. An increase of 24% was recorded in the abundance of adult fish age 4+.

The 2016 year-class (9-year-olds) dominated in the stock and contributed 33% to the total biomass. However, in abundance the 2021 and 2022 year-classes is now coming into the spawning stock with increasing strength. (Figure 19 and Table 12). The 2016 year-class is fully recruited to the adult stock, whereas the younger fish is not fully recruited to the adult stock and those estimates are uncertain.

Bootstrap estimates of numbers by age are shown in Figure 19. The uncertainty (CV) around the age disaggregated abundance indices from the 2025 survey was high. Only the dominating year-class (in biomass) had acceptable cv of approx. 25% (Figure 19).

The internal consistency among year classes was generally very high for age classes 4 years and older, with the lowest correlation, for the youngest year classes, as expected since they are not fully recruited into the survey (Figure 20).

The zero-boundary of the distribution of the mature part of NSSH was reached in all directions (Figure 18a, b). The herring was mainly observed in the upper surface layer as relatively small schools. A shallow distribution of herring might have led to an unknown portion of herring being in the "blind zone" above the transducer depth of the vessels (i.e., shallower than 10-15 m, Table 4), and therefore not being registered by the vessels. The group considered the acoustic biomass estimate of herring in 2025 to be of the similar quality as in the previous survey years.

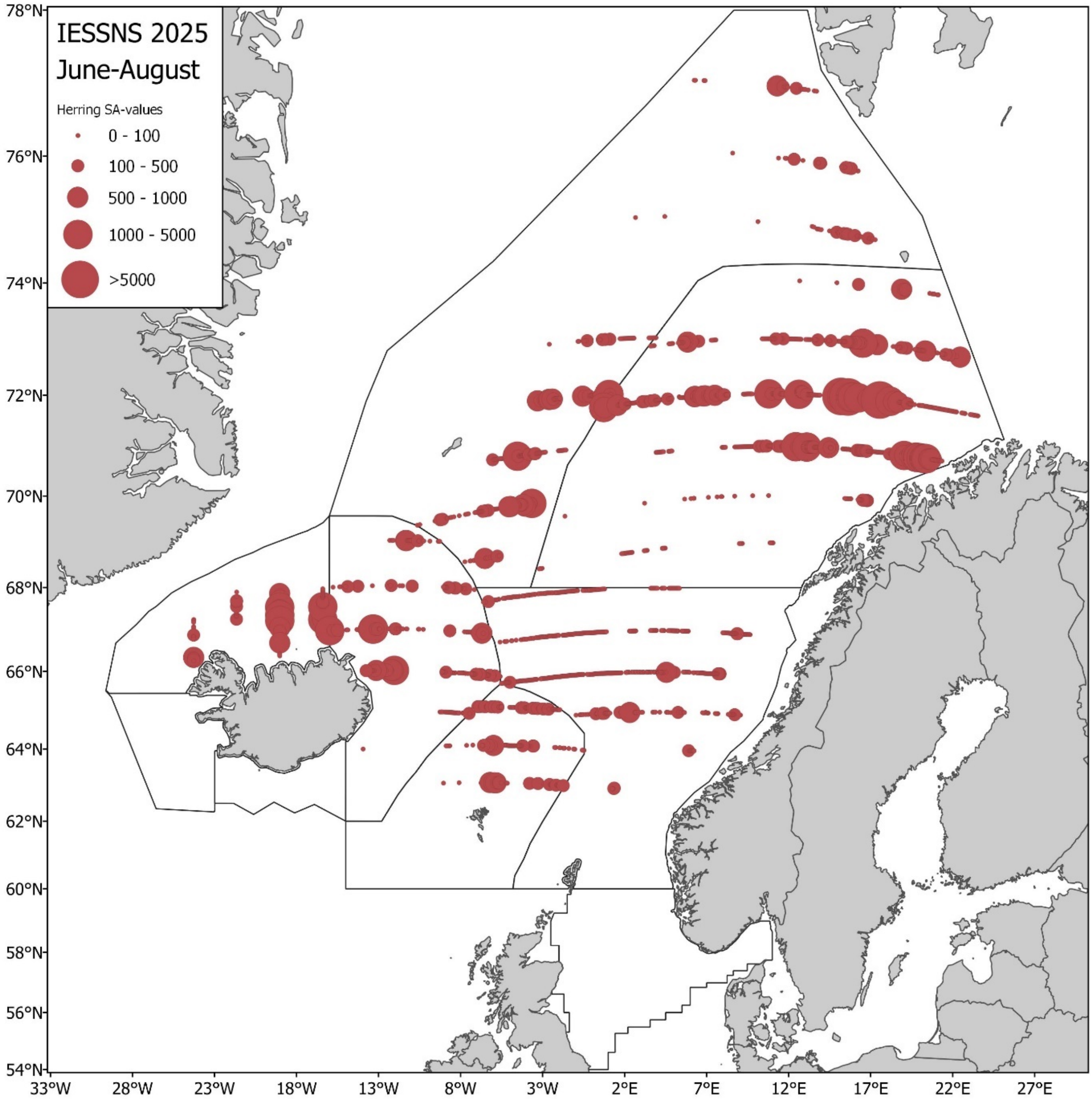

Figure 18a. The sA/Nautical Area Scattering Coefficient (NASC) values of herring along the cruise tracks in 2025 presented as contour lines. Values north of 62° N, east of 14° W to the south of Iceland, and all herring north of Iceland are considered to be Norwegian spring-spawning herring. South and west of this area the herring observed are other stocks, *i.e.* Icelandic summer spawners, Faroese autumn spawners and North Sea herring in the southeast; these have been omitted from the map.

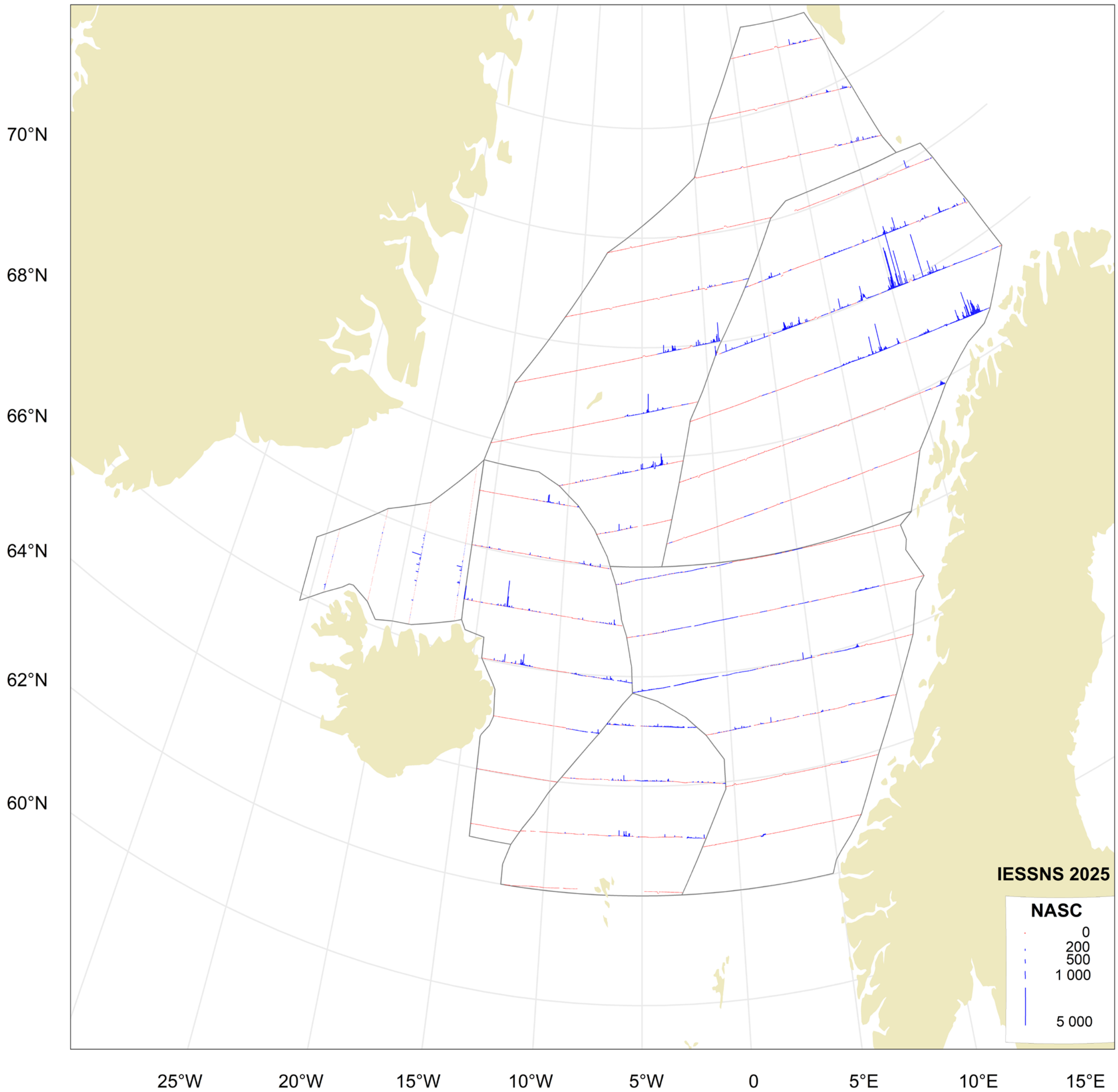

Figure 18b. The sA/Nautical Area Scattering Coefficient (NASC) values of Norwegian spring-spawning herring along the cruise tracks in 2025, presented as bar plot.

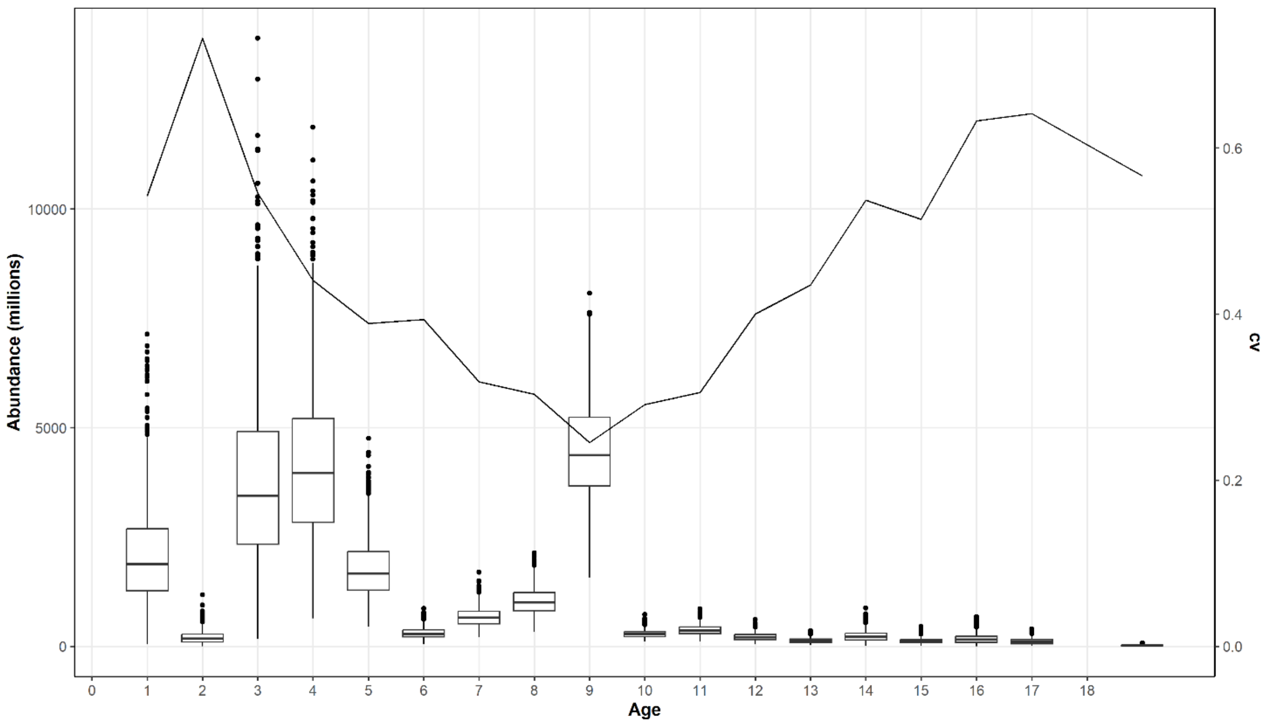

Figure 19. Abundance by age for Norwegian spring-spawning herring during IESSNS 2025. Boxplot of abundance and relative standard error (CV) obtained by bootstrapping with 1000 replicates using the StoX software.

Table 12. Estimates of abundance, mean weight and mean length of Norwegian spring-spawning herring based on calculation in StoX (bootstrap) for IESSNS 2025.

	Age in years (year class)																		Number	Biomass	Mean
Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			weight
(cm)	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	(10^6)	(10^6 kg)	(g)
9-10	92.9																		92.9	0.6	6.1
10-11	224.4																		224.4	1.9	8.4
11-12	552.0																		552.0	6.0	10.9
12-13	540.8	15.1																	555.8	7.5	13.6
13-14	220.7	13.0																	233.7	4.0	17.5
14-15	125.6	35.3																	160.9	3.6	22.5
15-16	57.5	51.2																	108.7	2.9	26.4
16-17	145.8	63.2																	209.0	7.0	32.8
17-18	82.9																		82.9	3.4	40.5
18-19	18.3																		18.3	0.9	46.5
19-20																				1.4	55.7
20-21			233.7																233.7	14.6	62.8
21-22		15.8	523.5																539.3	38.5	71.4
22-23		10.2	811.0	35.7															856.9	71.6	83.9
23-24			680.2	109.5															789.7	78.3	99.2
24-25			636.7	237.1															873.8	100.4	114.9
25-26			300.3	533.6	20.6														854.5	113.3	132.8
26-27			111.2	511.8															623.1	94.7	152.8
27-28			115.0	557.1	2.2		3.0	1.9	1.8										680.9	121.2	181.9
28-29			153.5	518.0	5.6	9.3	2.2	2.6	6.2	5.7									703.1	144.7	213.1
29-30			93.1	762.3	27.3	9.0	10.5	8.7	19.7	16.0	10.6	1.8	1.3						960.2	220.6	231.8
30-31			82.2	501.1	252.6	11.7	36.1	9.6	3.7	4.2	19.3		2.9						923.4	233.5	255.5
31-32				236.7	456.8	52.5	17.0	8.3	7.9	3.2	5.9	2.6	5.3	1.5					797.9	220.5	275.4
32-33				122.8	673.5	95.0	147.9	120.4	186.2	9.7	6.3	2.7							1,364.5	407.8	301.4
33-34				41.2	284.5	106.2	332.0	342.5	922.6	22.6	32.8	6.9	10.9	1.8					2,104.0	674.1	318.4
34-35					36.4	17.8	102.2	378.1	2159.0	93.3	25.3								2,812.1	948.5	334.2
35-36						2.2	19.7	164.5	948.9	80.7	82.1	11.6	7.7	1.6					1,318.9	470.2	351.2
36-37								3.4	183.0	34.2	61.4	126.7	15.7		22.0	2.8			449.2	166.1	364.7
37-38									34.8	10.4	97.2	19.0	49.9	148.4	20.2	37.5	14.0		431.4	178.5	404.6
38-39									15.4		18.6	42.9	37.7	40.4	30.5	59.3	79.6	13.8	338.2	146.3	429.7
39-40											14.7			41.3	50.0	61.2	10.5		177.8	81.3	455.9
40-41																0.0			0.0	3.8	507.4
41-42																					
42-43																					
TSN(mill)	2106.3	203.8	3740.3	4167.0	1759.4	303.7	670.7	1040.0	4489.1	280.1	374.4	214.2	131.4	235.0	122.7	168.2	104.0	13.8	20,124.2		
cv (TSN)	0.54	0.73	0.55	0.44	0.39	0.39	0.32	0.30	0.25	0.29	0.31	0.40	0.44	0.54	0.52	0.63	0.68		0.31		
TSB(1000 t)	33.2	6.6	410.5	808.0	504.0	91.6	209.1	339.9	1,522.9	92.9	139.4	80.2	51.8	98.7	53.5	72.7	45.4	5.4	4,565.8		
cv (TSB)	0.56	0.71	0.52	0.42	0.39	0.40	0.32	0.31	0.25	0.30	0.33	0.39	0.47	0.53	0.52	0.64	0.68		0.26		
Mean length(cm	11.8	15.4	23.8	28.0	31.3	31.4	32.4	33.5	34.0	34.0	34.8	35.7	35.2	37.1	37.5	37.7	37.9				
Mean weight(g)	14.4	32.0	118.5	204.8	279.5	290.0	306.6	324.3	336.3	329.4	357.7	356.9	358.6	410.4	424.8	410.6	437.8				

Table 13. IESSNS boostrap time series from 2016 to 2025. StoX biomass estimates of Norwegian spring-spawning herring (millions).

	Age												
Year	1	2	3	4	5	6	7	8	9	10	11	12+	TSB(1000 t)
2016	38	119	747	577	1,622	1,636	1,967	1,588	1,274	2,001	2,164	6,245	6,676
2017	1,232	240	1,318	4,653	1,003	1,184	795	1,716	1,004	1,115	1,657	4,040	5,821
2018	0	587	656	864	3,054	924	1,172	746	971	1,078	663	2,704	4,379
2019	0	143	1,910	616	1,101	3,487	814	751	510	780	470	4,660	4,794
2020	0	15	117	8,280	1,710	2,367	4,087	696	520	305	594	1,827	5,991
2021	1	4	184	398	12,117	1,045	1,398	2,226	502	361	393	1,641	6,103
2022	0	681	1,008	1,251	1,301	14,135	914	1,211	1,734	477	433	1,325	7,143
2023	6,034	817	6,377	321	725	1,335	7,360	503	711	807	291	780	4,989
2024	0	152	853	696	225	623	1,005	6,543	380	610	523	783	3,779
2025	2,106	204	3,740	4,167	1,759	304	671	1,040	4,489	280	374	989	4,566

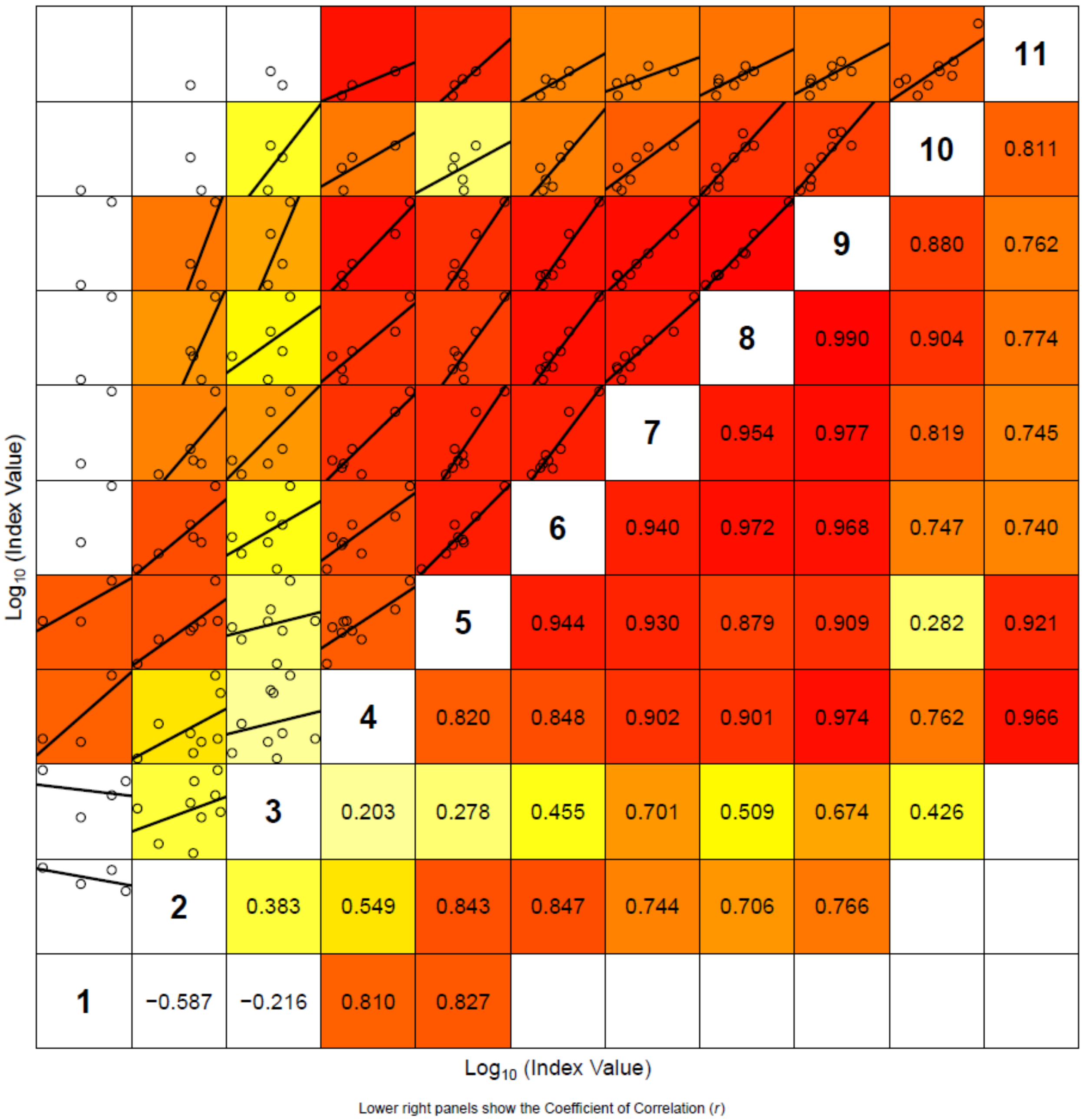

Figure 20. Internal consistency for Norwegian spring-spawning herring within the IESSNS 2025. The upper left part of the plots shows the relationship between log index-at-age within a cohort. Linear regression line shows the best fit to the log-transformed indices. The lower-right part of the plots shows the correlation coefficient (r) for the two ages plotted in that panel. The background colour of each panel is determined by the r value, where red equates to r=1 and white to r<0.

4.5 Blue whiting

Blue whiting was distributed in parts of the survey area dominated by warm Atlantic waters and had a continuous distribution from the southern boundary of the survey area (60° N) to Bear Island (74.30° N) (Figure 21a, b). High blue whiting density (sA-values) was observed in the southern part of the Norwegian Sea, along the Norwegian continental slope and around the Faroe Islands. The 1-group (2024 year-class) dominated in terms of numbers, but still the 2020 year-class is numerous in the survey (Figure 22, Table 15).

As in previous years no blue whiting was registered in the cold East Icelandic Current, between Iceland and Jan Mayen.

The total biomass index of blue whiting increased compared to 2024, 2.42 million tons in 2025 compared to 1.96 million tons (24% increase). Estimated stock abundance (ages 1+) was 23.3 billion compared to 17.7 billion in 2024 (31% increase). Age 1 and 4 respectively, dominated the estimate in 2025 as they contributed to 39% and 26% (abundance) and 24% and 32% (biomass), respectively. Interestingly, 0-group contributed significantly also in 2025 (16% in total abundance), mainly recorded in the southwestern survey area (Table 14-15).

Bootstrap estimates of numbers by age, with uncertainty estimates, for blue whiting during IESSNS 2025 are shown in Figure 22. Low CV values for dominant ages 1-5, with values less than 0.25. The internal consistency among year classes is shown in Figure 23 and indicates good to very good internal consistency for ages 1-5, and moderate to low fit for other ages.

The group considered the acoustic biomass estimate of blue whiting to be of good quality in the 2025 IESSNS as in the previous survey years.

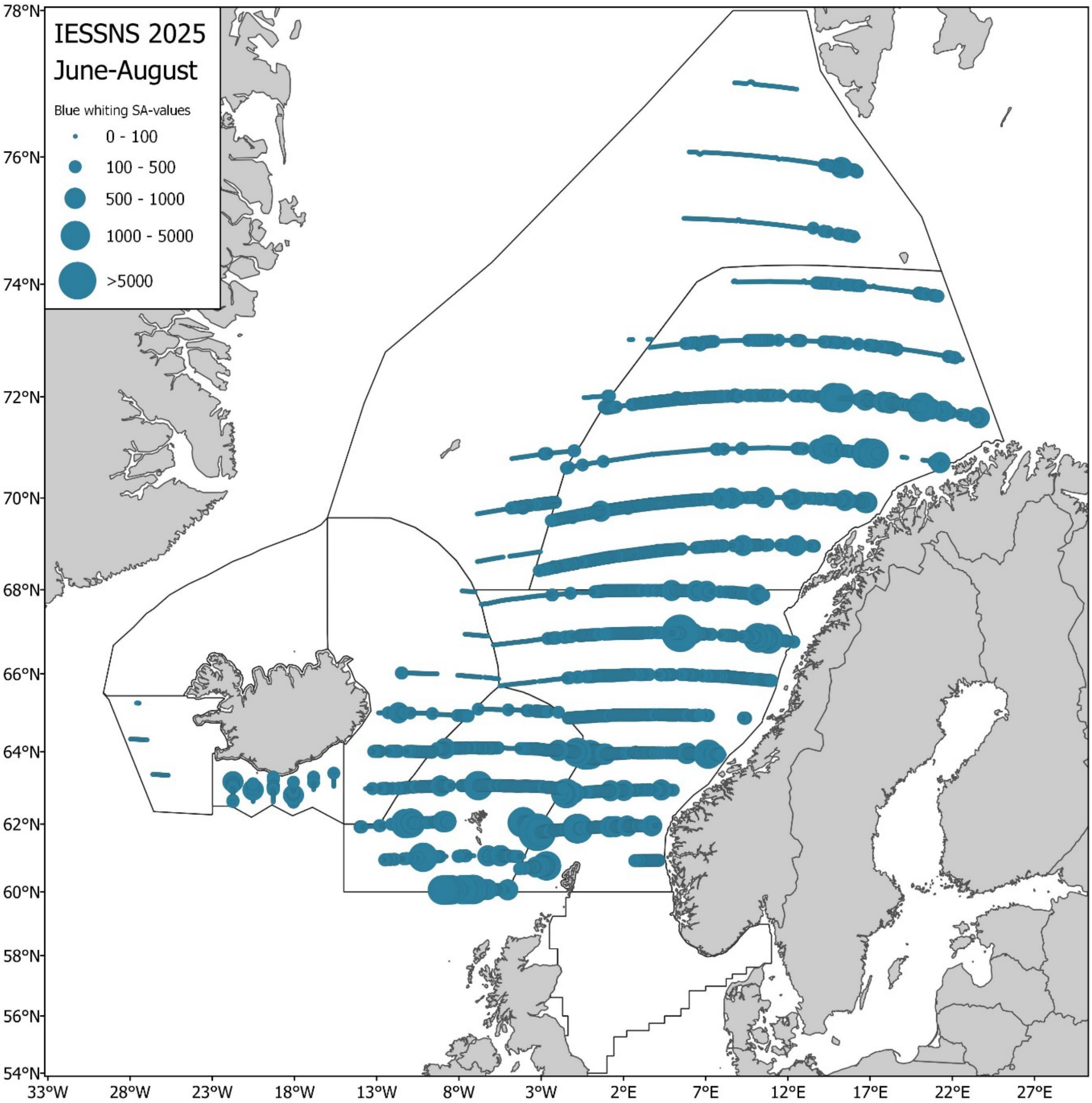

Figure 21a. The sA/Nautical Area Scattering Coefficient (NASC) values of blue whiting along the cruise tracks in IESSNS 2025.

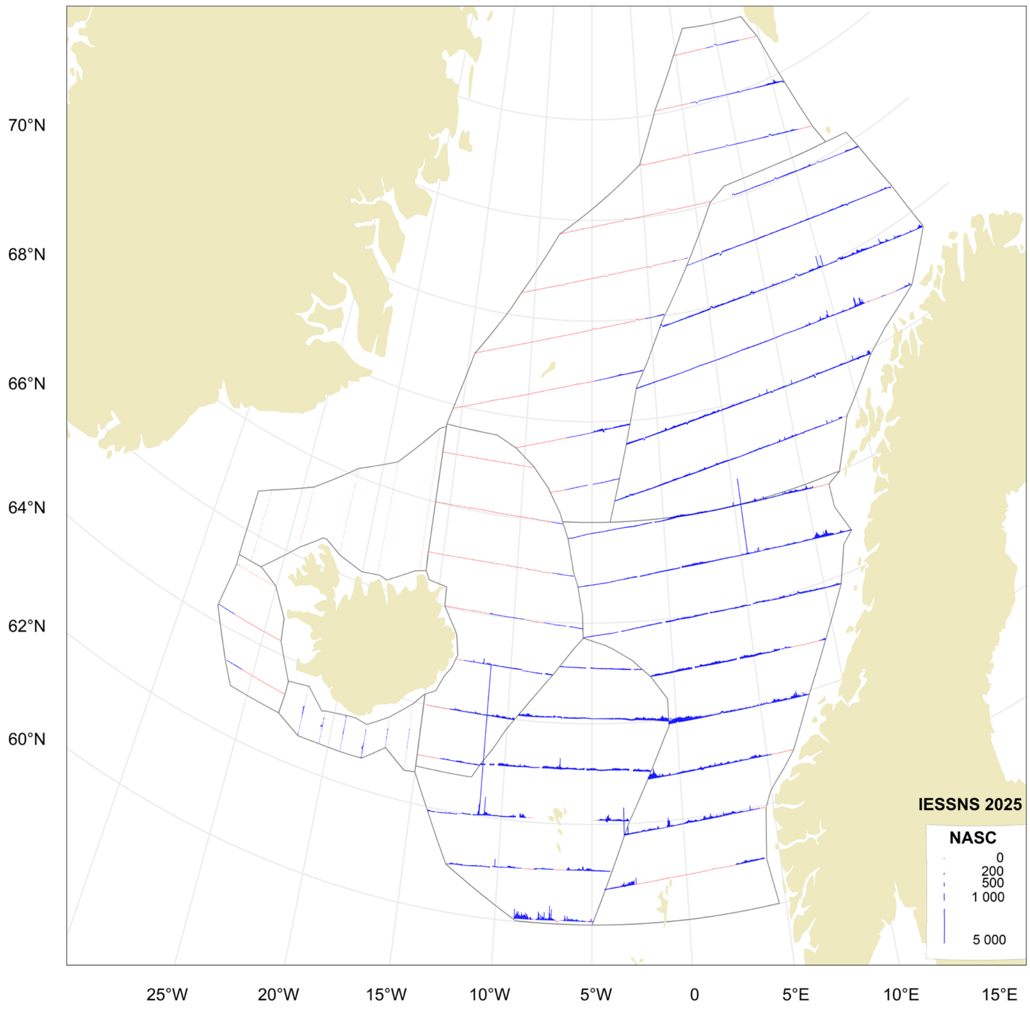

Figure 21b. The sA/Nautical Area Scattering Coefficient (NASC) values of blue whiting along the cruise tracks in IESSNS 2025. Presented as bar plot

Table 14. Estimates of abundance, mean weight and mean length of blue whiting based on calculation in StoX (bootstrap) for IESSNS 2025.

	Age in years (year class)													Number	Biomass	Mean
Length	0	1	2	3	4	5	6	7	8	9	10	11	12			weight
(cm)	2025	2024	2023	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	(10^6)	(10^6 kg)	(g)
10-11															0.2	6.7
11-12	205.9													205.9	1.7	8.8
12-13	760.3													760.3	8.0	10.8
13-14	822.3													822.3	12.1	14.7
14-15	899.0													899.0	15.6	17.4
15-16	756.9													756.9	17.0	22.4
16-17	517.6													517.6	14.0	27.0
17-18	244.8													244.8	7.8	32.4
18-19	143.1													143.1	5.6	39.3
19-20	11.4	408.8												420.3	20.1	46.8
20-21		1363.6												1,363.6	73.9	54.4
21-22		2583.9												2,583.9	153.4	59.4
22-23		2640.0	35.0											2,675.0	174.0	66.0
23-24		1416.3	142.3											1,558.6	113.4	75.6
24-25		404.1	167.3	221.3		55.1								847.7	72.1	87.3
25-26		129.6	608.1	593.9	611.0	74.0								2,016.6	197.3	98.5
26-27		36.5	401.9	895.4	1832.6	418.0								3,584.4	395.4	110.8
27-28			129.5	727.4	1587.0	684.8	100.4							3,229.1	387.1	120.8
28-29			12.9	361.5	1222.3	925.9	29.7							2,552.3	343.3	136.6
29-30			3.8	34.5	665.1	553.8	195.6							1,452.9	219.4	153.1
30-31				9.4	126.7	290.8	142.5		73.5		6.1			649.1	105.0	161.7
31-32			2.3	1.8	24.4	79.9	7.7	13.9	41.9		5.4			177.3	30.8	182.7
32-33						26.1	19.5	16.1	11.5					73.2	14.2	204.5
33-34						41.2	10.4		12.9		12.7			77.2	16.4	219.8
34-35															5.9	218.1
35-36															0.6	259.6
36-37															0.2	282.4
37-38							16.8							16.8	4.5	270.0
38-39															4.2	380.1
39-40																
40-41										8.6				8.6	3.7	426.0
TSN(mill)	4362	8983	1503	2845	6069	3150	523	30	140	9	24			27,706.6		
cv (TSN)	0.48	0.22	0.18	0.16	0.16	0.17	0.33	0.69	0.56	0.93	0.93			0.10		
TSB(1000 t)	82.3	569.7	147.8	316.2	747.8	424.9	78.4	5.4	24.6	3.7	4.7			2,416.6		
cv (TSB)	0.46	0.21	0.17	0.16	0.16	0.18	0.32	0.68	0.54	0.93	0.96			0.08		
Mean length(cm	15.1	22.5	25.5	26.4	27.2	28.2	29.5	31.5	31.4	40.0	31.4					
Mean weight(g)	24	73	106	115	126	141	154	193	191	426	188					

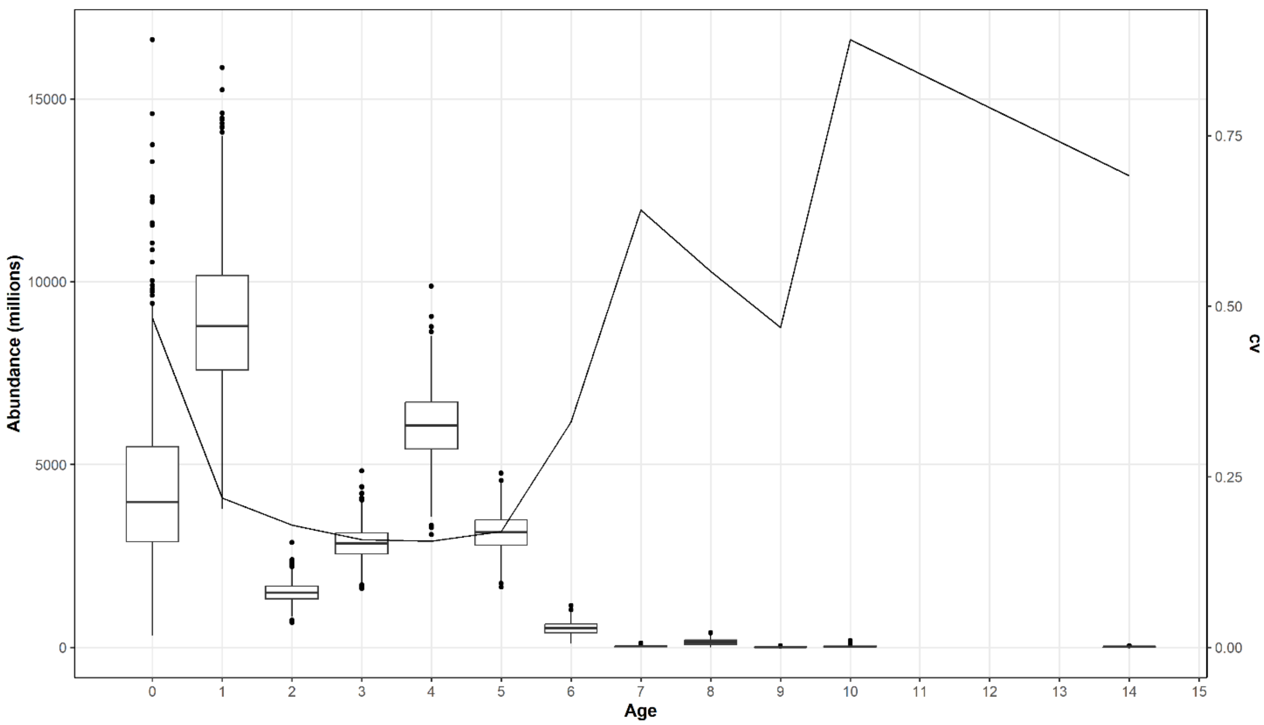

Figure 22. Number by age with uncertainty for blue whiting during IESSNS 2025. Boxplot of abundance and relative standard error (CV) obtained by bootstrapping with 1000 replicates using the StoX software.

Table 15. IESSNS bootsrap time series from 2016 to 2025. StoX biomass estimates of blue whiting (millions).

	Age											
Year		0	1	2	3	4	5	6	7	8	9	10+	TSB(1000 t)
2016	4,019	5,781	11,423	4,324	2,353	1,190	351	158	160	7	205	2,269
2017	20,547	2,423	5,901	10,066	2,172	626	238	15	29	0	17	2,618
2018	0	893	1,208	3,198	6,434	3,070	938	371	107	47	43	2,039
2019	2,471	704	1,906	2,254	4,317	5,318	1,174	181	186	9	9	2,023
2020	4,461	6,027	2,903	1,608	1,135	1,762	1,924	929	186	33	37	1,799
2021	4,470	18,484	2,372	1,494	845	851	1,493	635	71	79	84	2,237
2022	955	12,623	9,748	2,175	883	313	510	303	691	148	67	2,224
2023	3,141	3,765	9,925	5,555	721	199	196	131	45	282	24	1,983
2024	5,724	2,518	2,057	4,856	6,157	1,494	279	100	90	30	170	1,953
2025	4,362	8,983	1,503	2,845	6,069	3,150	523	30	140	9	32	2,417

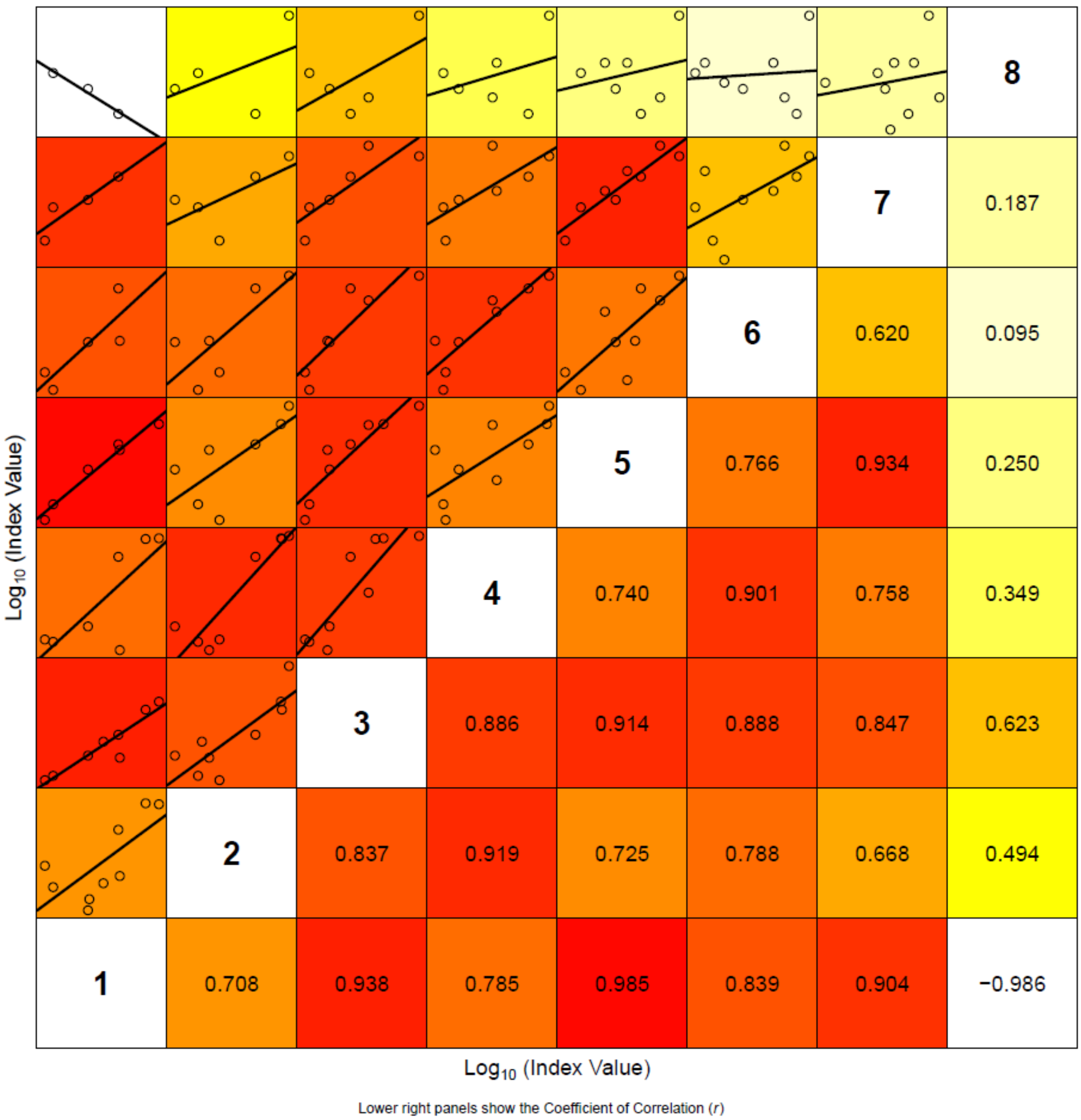

Figure 23. Internal consistency for blue whiting within the IESSNS. The upper left part of the plots shows the relationship between log index-at-age within a cohort. Linear regression line shows the best fit to the log-transformed indices. The lower-right part of the plots shows the correlation coefficient (r) for the two ages plotted in that panel. The background colour of each panel is determined by the r value, where red equates to r=1 and white to r<0.

4.6 Other species

Lumpfish (Cyclopterus lumpus)

Lumpfish was caught in 72% of trawl stations across the five vessels (Figure 24) and in 88% of these, the catches were ≤ 10kg. Lumpfish was distributed across the entire survey area, from west of Iceland to the

Barents Sea in the northeast, and from the northern part of the North Sea in the southern part of the covered area to west of Svalbard in the north. Abundance of lumpfish was greatest north of 73°N, particularly around Bear Island, with lower densities in the central Norwegian Sea and mostly absent south of 58°N. It is likely that the distribution of lumpfish extends beyond the survey coverage in northern areas. The lumpfish ranged between 11-43.5 cm in length and 47-3615 g, with the largest individuals found in the northernmost part.

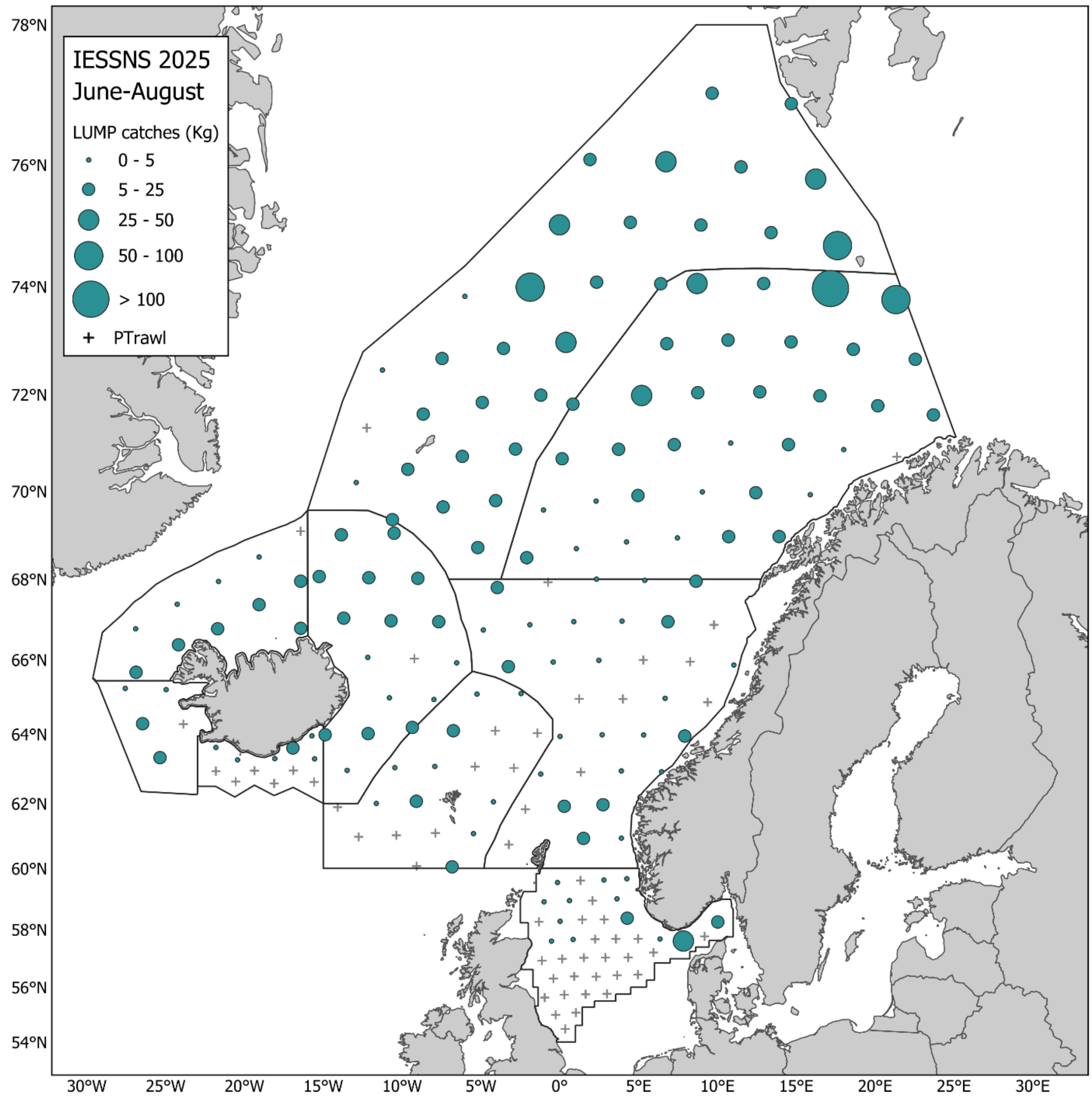

Figure 24. Lumpfish catches at surface trawl stations during IESSNS 2025. The survey strata are shown in the map.

Salmon (*Salmo salar*)

A total of 126 salmon were caught in 17 surface haul both in coastal and offshore areas between 64°N and 74°N . The highest concentrations of salmon were found along the major "highway" of the North Atlantic current from 64-69°N All the salmon will be genetically analysed to confirm whether all salmon are North Atlantic salmon (*Salmo salar*), or if some of the salmon may be pink salmon (O*nchorhynchus gorbuscha*). The salmon ranged from 0.056 kg to 3.256 kg in weight, dominated by post-smolt and 1 sea-winter individuals. Between 1 salmon and staggering 38 salmon were caught during individual surface trawl hauls. Most pelagic trawl stations containing salmon caught only 1 individual. The length of the salmon ranged from 18 cm to 65 cm, with the highest fraction between 20-29 cm.

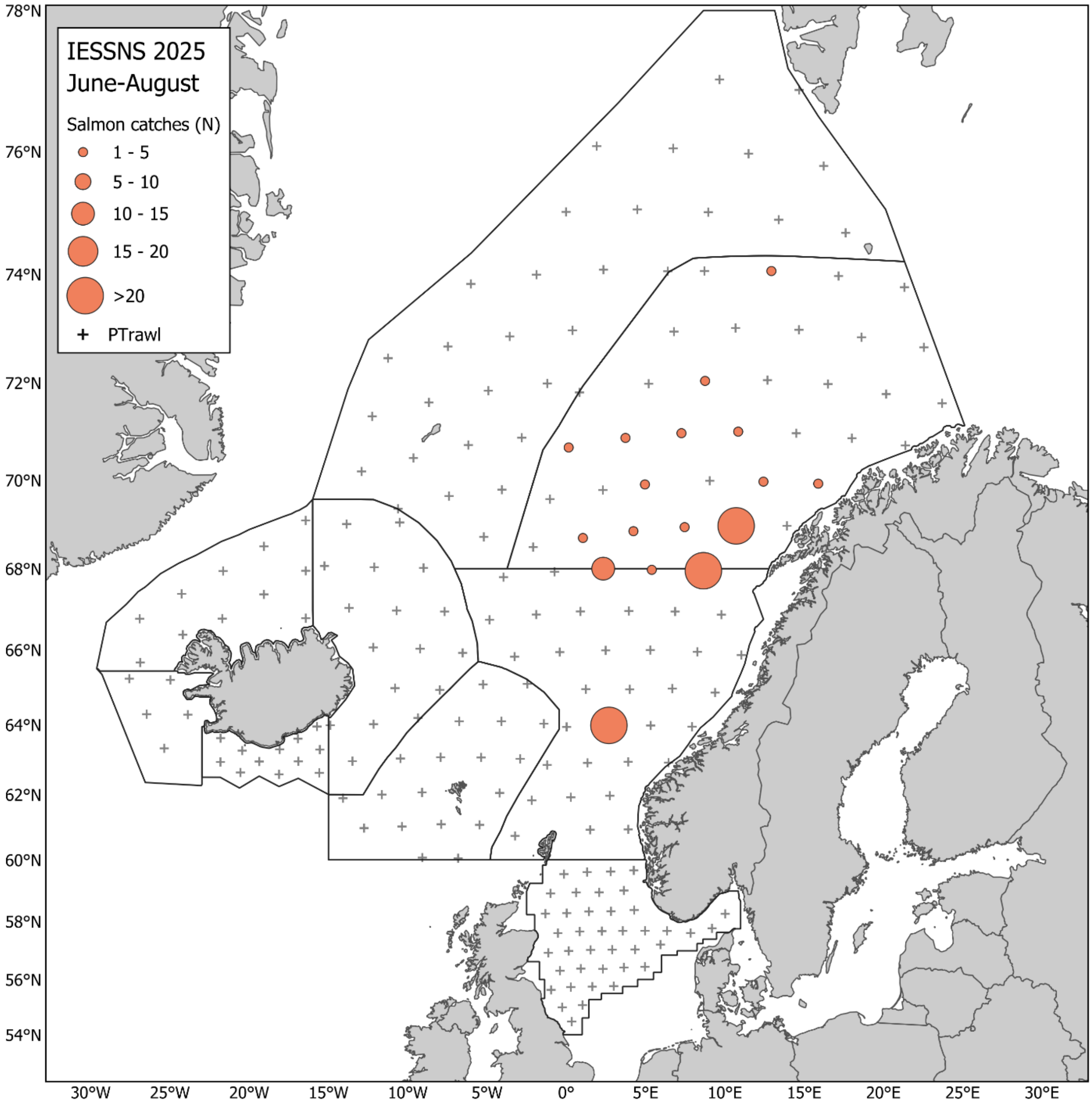

Figure 25. Catches shown as number of salmon caught at surface trawl stations during IESSNS 2025. The survey strata are shown in the map.

Capelin (*Mallotus villosus*)

Capelin was caught in the surface trawl on 30 stations along the cold fronts around Iceland, north of Jan Mayen and consistently along the north-eastern edge of the survey area (Figure 26a). The largest concentrations were caught between Bear Island and Svalbard (Figure 26a). Both juvenile and adult capelin were caught during the survey. The length ranged from 3.5 - 19.8 cm, and weight from 1 – 43.6 gram. The average length and weight of the measured individuals were 14.5 cm and 13.4 g, respectively.

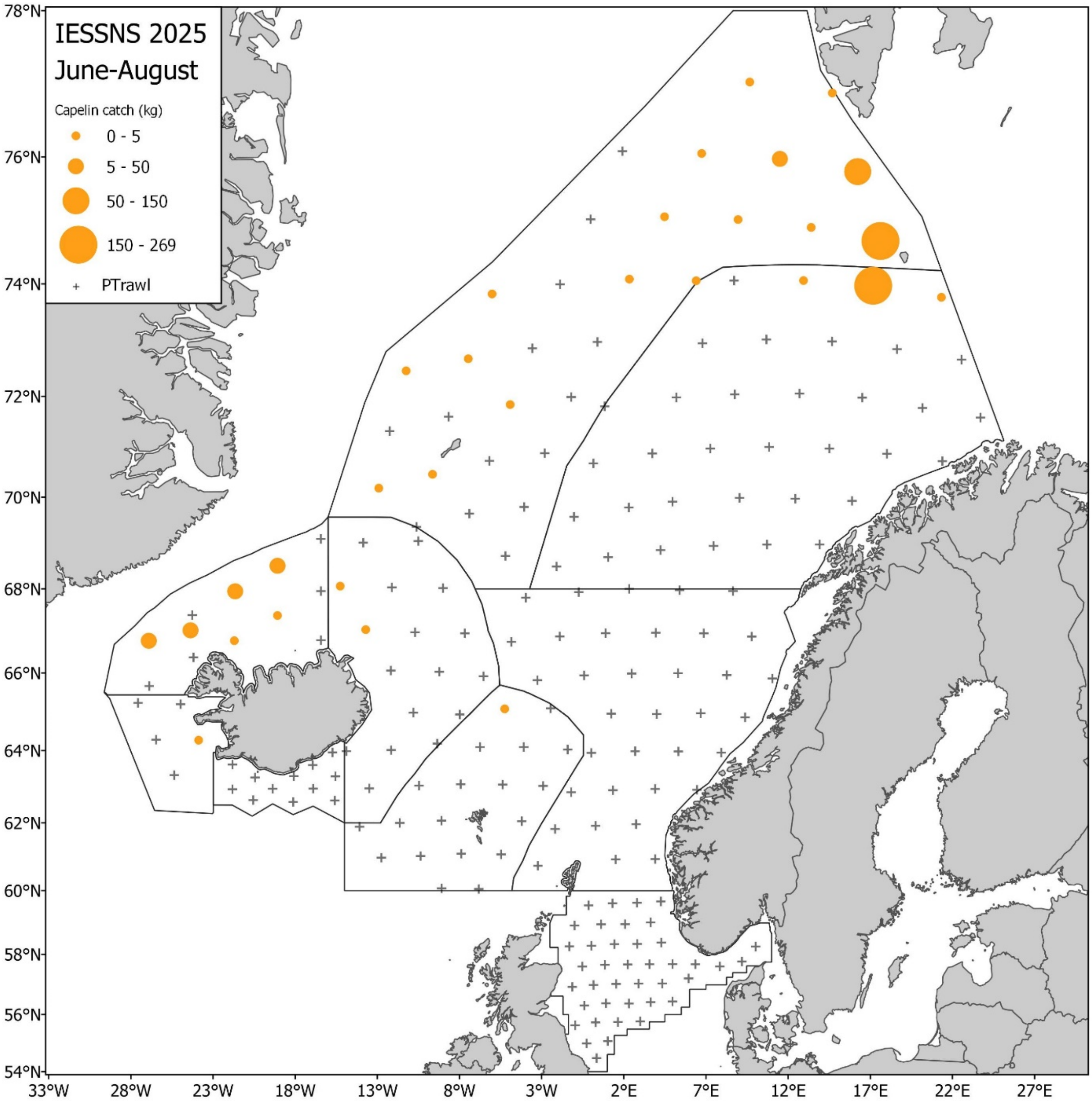

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Figure 26a. Catches (kg) of capelin in surface trawl stations during IESSNS 2025. The survey strata are shown in the map.

Polar cod (*Boreogadus saida*)

Polar cod was altogether caught in 34 surface trawl stations during IESSNS 2025 (Figure 26b), which is extensively more than last year when only 3 individual polar cod was caught at one station northwest of Iceland. Polar cod were located over a large area extending all the way from 60°N to 74.5°N in 2025. Both juveniles and adult polar cod were caught and the individuals ranged from 0.7 - 8.4 cm.

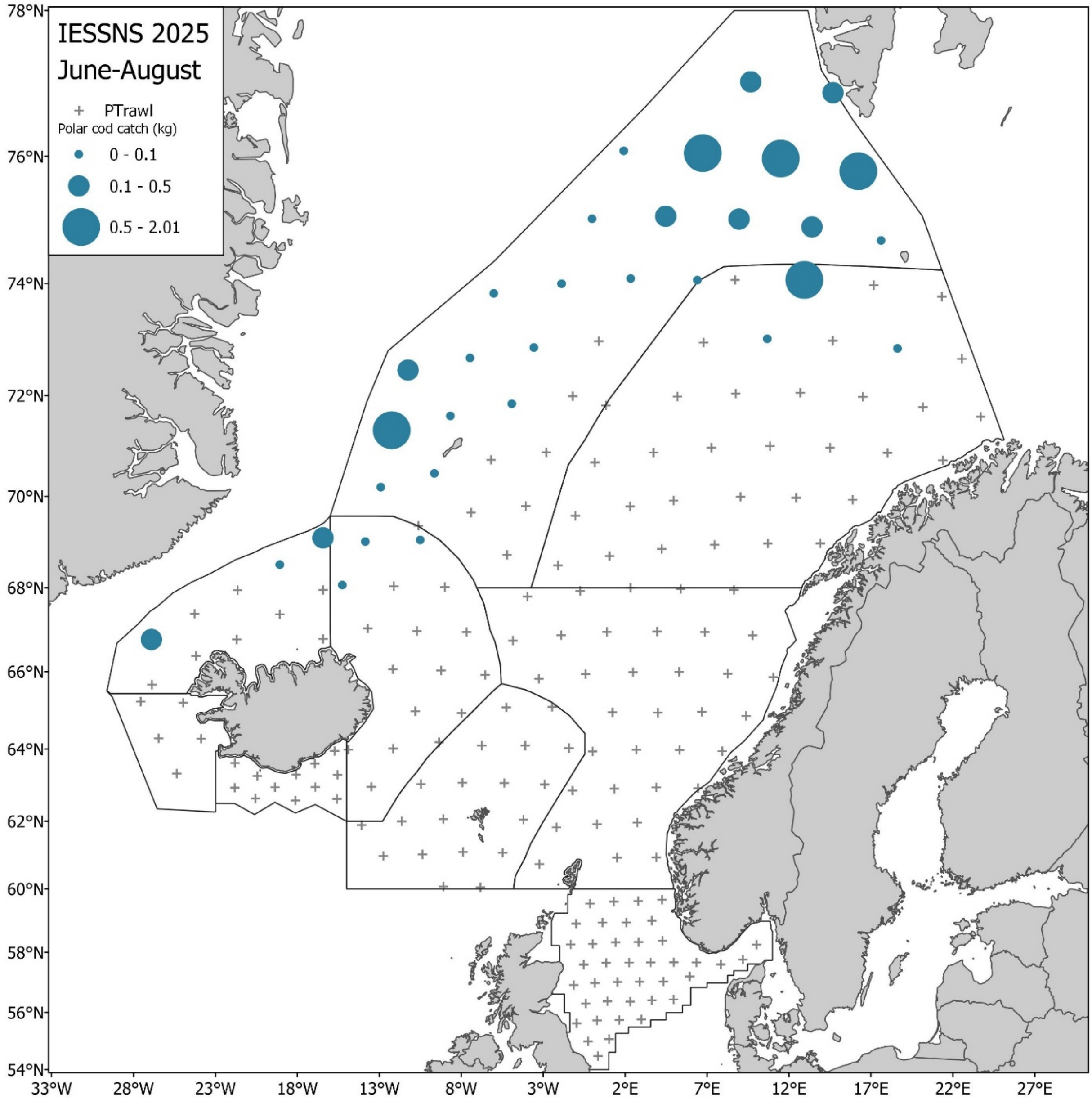

Figure 26b. Catches (kg) of polar cod in surface trawl stations during IESSNS 2025. The survey strata are shown in the map.

4.7 Marine Mammals

Results on abundance and distribution of marine mammals from the dedicated observations on the rooftop above the bridge onboard M/V "Eros", and "Vendla" have been requested, but not made available so far to be included in this report.

5 Recommendations

The group suggested the following recommendation from WGIPS	**To whom**
ICES clearly decided and recommended from the benchmark meeting on NEA mackerel in March 2025, that the timeseries from 2018 onwards on 2-years old mackerel from the North Sea will be the key time series and data input to future recruitment index to the assessment of NEA mackerel. The decision was that neither 0-groups nor 1-year old mackerel, as applied in previous years assessments, will be used in the future as a time series and abundance index for recruitment due to inconsistent and unreliable time series. In conclusion, if the IESSNS survey on NEA mackerel in the North Sea will not continue in the future, ICES will not have any reliable index and time series on recruitment available for one of the most important and valuable fish stocks in the Northeast Atlantic.	RCG NANSEA, DPPO
It is recommended that the spatial coverage of the IESSNS survey for future years remain consistent with the 2025 survey design, even as mackerel spatial distribution range declines. Maintaining consistency in the survey spatial coverage is crucial for providing a stable time series for acoustic measurements of the blue whiting stock and the Norwegian spring-spawning herring stock. The upcoming blue whiting benchmark will test if the IESSNS blue whiting abundance index is useful for stock assessment.	WGIPS
It is recommended that genetic samples of herring be collected for the entire IESSNS survey area will continue each year as a routine activity in the survey. The sampling effort should focus on collecting of DNA samples from herring specimen for which an age sample has been obtained. Samples should be collected at every station where a full age sample of herring is taken. DNA information from these samples will be used to determine the stock composition of herring. This information will then be used to allocate the acoustic backscatter to the appropriate herring stocks, providing a more accurate estimate of their individual abundance and biomass.	WGIPS
It is recommended that all vessels participating in the IESSNS survey include marine mammal observers in their sampling efforts. The Institute of Marine Research, Bergen, Norway, is currently developing and testing a new marine mammal observation protocol adapted for the current survey design and coverage of the IESSNS for the survey. This protocol involves a single observation platform with two observers present on each shift. The objective of collecting marine mammal observations is to provide data for future marine mammal assessments.	WGIPS, WGMME

6 Action points for survey participants

Action points	Responsible
We encourage registrations of opportunistic marine mammal observations.	All
It is recommended that the IESSNS survey strata system be revised prior to the 2026 survey. This revision should aim to optimize the use of survey time and reduce the distance between stations at adjacent stratum boundaries.	All
It is recommended that participants of the post-cruise meeting conduct a duplicate, independent StoX analysis of mackerel, herring, and blue whiting in advance of the meeting. This can be done prior to the meeting with preliminary data available.	All
It is recommended to add a table of mackerel biomass per age for the entire time series using a bootstrap method.	All
It is recommended that the cruise report structure be revised to move the North Sea results from an appendix to the main body of the report. This recommendation is to accommodate the use of North Sea results as input data for the mackerel stock assessment following the benchmark in March 2025.	All

7 Survey participants

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Lab team:
Tom Svoldgaard, National Institute of Aquatic Resources, Denmark (Mackerel otolith extraction)
Maria Jarnum, National Institute of Aquatic Resources, Denmark (Mackerel otolith extraction and age reading)

8 Acknowledgements

We greatly appreciate and thank skippers and crew members onboard M/V "Vendla", M/V "Eros", R/V " Jákup Sverri", R/V "Árni Friðriksson" and M/V "Ceton" for outstanding collaboration and practical assistance during the international mackerel-ecosystem (IESSNS) survey in the Nordic Seas from 30th of June to 3rd of August 2025.

9 References

Bachiller, E., Utne, K.R., Jansen, T., and Huse G. 2018. Bioenergetics modelling of the annual consumption of zooplankton by pelagic fish feeding in the Northeast Atlantic. PLOS ONE 13(1): e0190345. doi.org/10.1371/journal.pone.0190345.

Banzon, V., Smith, T.M., Chin, T. M., Liu, C., and Hankins, W. 2016. A long-term record of blended satellite and in situ sea-surface temperature for climate monitoring, modelling and environmental studies. Earth System Science Data. 8, 165-176, doi:10.5194/essd-8-165-2016.

dos Santos Schmidt, T.C., Slotte, A., Olafsdottir, A.H., Nøttestad, L., Jansen, T., Jacobsen, J.A., Bjarnason, S., Lusseau, S.M., Ono, K., Hølleland, S., Thorsen, A., Sandø, A.B., and Kjesbu, O.S. 2024. Poleward spawning of Atlantic mackerel (*Scomber scombrus*) is facilitated by ocean warming but triggered by energy constraints. ICES Journal of Marine Science 81: 600-615, doi: 10.1093/icesjms/fsad098

Foote, K. G. 1987. Fish target strengths for use in echo integrator surveys. Journal of the Acoustical Society of America. 82: 981-987.

ICES 2012. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 27–30 March 2012, Lorient, France. ICES CM 2012/SSGESST:03. 323 pp.

ICES 2013a. Report of the Workshop on Northeast Atlantic Mackerel monitoring and methodologies including science and industry involvement (WKNAMMM), 25–28 February 2013, ICES Headquarters, Copenhagen and Hirtshals, Denmark. ICES CM 2013/SSGESST:18. 33 pp.

ICES 2013b. Report of the Working Group on Improving Use of Survey Data for Assessment and Advice (WGISDAA), 19-21 March 2013, Marine Institute, Dublin, Ireland. ICES CM 2013/SSGESST:07.22 pp.

ICES 2014a. Manual for international pelagic surveys (IPS). Working document of Working Group of International Surveys (WGIPS), Version 1.02 [available at ICES WGIPS sharepoint] 98 pp.

ICES 2014b. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA), 17–21 February 2014, Copenhagen, Denmark. ICES CM 2014/ACOM: 43. 341 pp

ICES 2017. Report of the Benchmark Workshop on Widely Distributed Stocks (WKWIDE), 30 January-3 February 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:36. 196 pp.

ICES 2025. Benchmark workshop on Mackerel and Norwegian spring-spawning herring (WKMACNSSH). ICES Scientific Reports. 7:64. 509 pp. https://doi.org/10.17895/ices.pub.29279615

Jansen, T., Post, S., Kristiansen, T., Oskarsson, G.J., Boje, J., MacKenzie, B.R., Broberg, M., and Siegstad, H. 2016. Ocean warming expands habitat of a rich natural resource and benefits a national economy. Ecol. Appl. 26: 2021–2032. doi:10.1002/eap.1384

Johnsen, E., Totland, A., Skålevik, Å., Holmin, A.J., Dingsør, G.E., Fuglebakk, E., and Handegard, N.O. 2019. StoX: An open source software for marine survey analyses. Methods Ecol Evol. 2019: 10:1523–1528.

Løviknes; S.., Jensen, K.H., Krafft, B.A., and Nøttestad, L. 2021. Feeding hotspots and distribution of fin and humpback whales in the Norwegian Sea from 2013 to 2018. Frontiers in Marine Science 8:632720. doi.org/10.3389/fmars.2021.632720

Nikolioudakis, N., Skaug, H.J., Olafsdottir, A.H., Jansen, T., Jacobsen, J.A., and Enberg, K. 2019. Drivers of the summer-distribution of Northeast Atlantic mackerel (*Scomber scombrus*) in the Nordic Seas from 2011 to 2017; a Bayesian hierarchical modelling approach. ICES Journal of Marine Science. 76(2): 530-548. doi:10.1093/icesjms/fsy085.

Nøttestad, L., Utne, K.R., Óskarsson, G.J., Jónsson, S.Þ., Jacobsen, J.A., Tangen, Ø., Anthonypillai, V., Aanes, S., Vølstad, J.H., Bernasconi, M., Debes, H., Smith, L., Sveinbjörnsson, S., Holst, J.C., Jansen, T. and Slotte, A. 2016. Quantifying changes in abundance, biomass and spatial distribution of Northeast Atlantic (NEA) mackerel (*Scomber scombrus*) in the Nordic Seas from 2007 to 2014. ICES Journal of Marine Science. 73(2): 359-373. doi:10.1093/icesjms/fsv218.

Ólafsdóttir, A., Utne, K.R., Jansen, T., Jacobsen, J.A., Nøttestad, L., Óskarsson, G.J., Slotte, A., and Melle, W. 2019. Geographical expansion of Northeast Atlantic mackerel (*Scomber scombrus*) in the Nordic Seas from 2007 - 2014 was primarily driven by stock size and constrained by temperature. Deep-Sea Research Part II. 159, 152-168.

Ono, K., Katara, I., Eliasen, S.K., Broms, C., Campbell, C., dos Santos Schmidt, T.C., Egan, A., Hølleland, S.N., Jacobsen, J.A., Jansen, T., Mackinson, S., Mousing, E.A., Nash, R.D.M., Nikolioudakis, N., Nnanatu, C., Nøttestad, L., Singh, W., Slotte, A., Wieland, K., and Olafsdottir, A.H. 2024. Effect of environmental drivers on the spatiotemporal distribution of mackerel at age in the Nordic Seas during 2010-20. ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsae087.

Salthaug, A., Aanes, S., Johnsen, E., Utne, K. R., Nøttestad, L., and Slotte, A. 2017. Estimating Northeast Atlantic mackerel abundance from IESSNS with StoX. Working Document (WD) for WGIPS 2017 and WKWIDE 2017. 103 pp.

Valdemarsen, J.W., Jacobsen, J.A., Óskarsson, G.J., Utne, K.R., Einarsson, H.A. S. Sveinbjörnsson, L. Smith, K. Zachariassen and L. Nøttestad 2014. Swept area estimation of the North-East Atlantic mackerel stock using a standardized surface trawling technique. Working Document (WD) to ICES WKPELA. 14 pp.

10 Appendices

Appendix 1

Denmark joined the IESSNS in 2018 for the first time extending the original survey area into the North Sea. The commercial fishing vessels "Ceton S205" was used. No problems applying the IESSNS methods were encountered. Area coverage, however, was restricted to the northern part of the North Sea at water depths larger 50 m. No plankton samples were taken, and no acoustic data were recorded because this is covered by the HERAS survey in June/July in this area.

Based on the experiences made in the previous years, new limits for the stratum in the North Sea were defined in 2022 (Fig. 2, stratum 13). The northern limit for the North Sea and the Skagerrak were defined as 60 °N and 59 °N, respectively. The western geographical limit in the North Sea was set to 1 ° 30′ W in the north and 2 ° 30′ W further south following the UK coastline where the Inner Moray Firth and the Firth of Forth were excluded because mackerel was not recorded there and a high abundance of 0-group gadoids, sandeel and other species makes a quantitative analysis of the catches very time consuming. The easter limit in the Skagerrak was set to 11 °E, and the southern limit in the North Sea was approximated by the 50 m isobath, which is about the shallowest depth limit for a safe setting of the Multpelt 832 trawl.

In 2025, 40 valid stations were taken (PT and CTD). Average mackerel catch amounted to 2060 kg/km², which is similar to the past two years (2024: 2004 kg/km², 2023: 2362 kg/km²) and is among the highest in the time series (2021: 2429 kg/km², 2020: 1318 kg/km², 2019: 1009 kg/km², 2018: 1743 kg/km²) (Fig. A1-1).

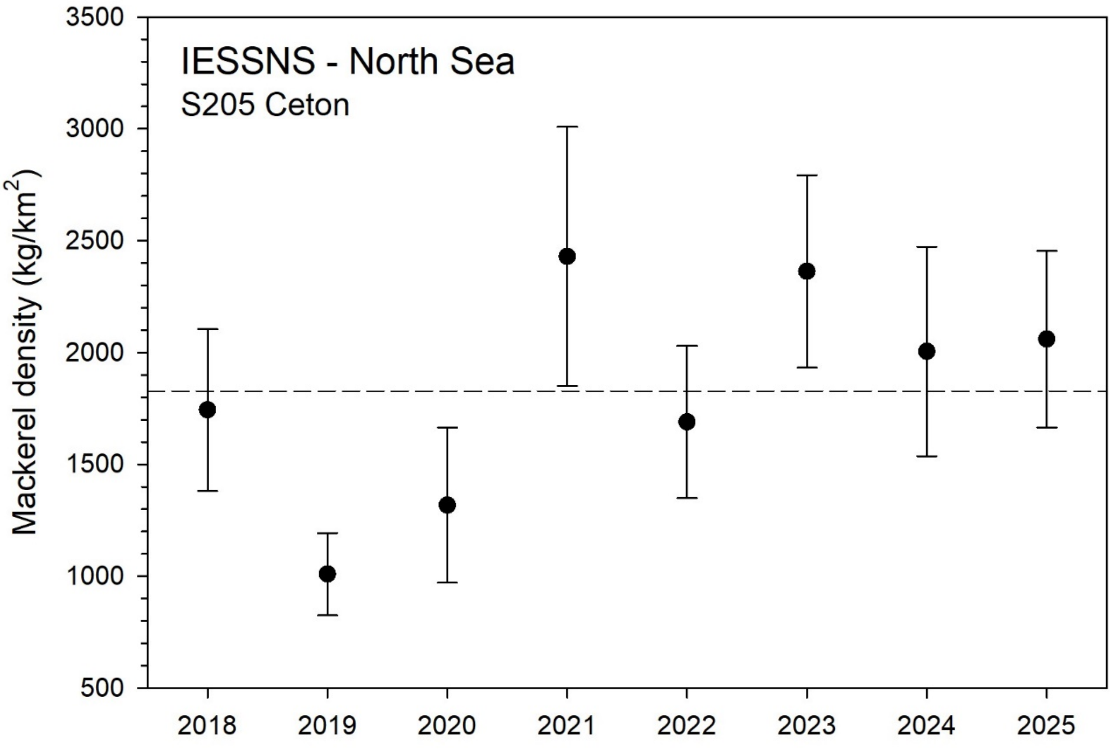

Fig. A1-1. Biomass density (mean and standard error) of mackerel in the North Sea 2018 to 2025 (dashed line: average 2018-2025).

The length and age composition indicate a considerable amount of small (< 28 cm, age 1) individuals and a high abundance at age 2 compared to the last year whereas the abundance of older (≥ age 3) mackerel was as low as in the previous years (Fig. A1-2).

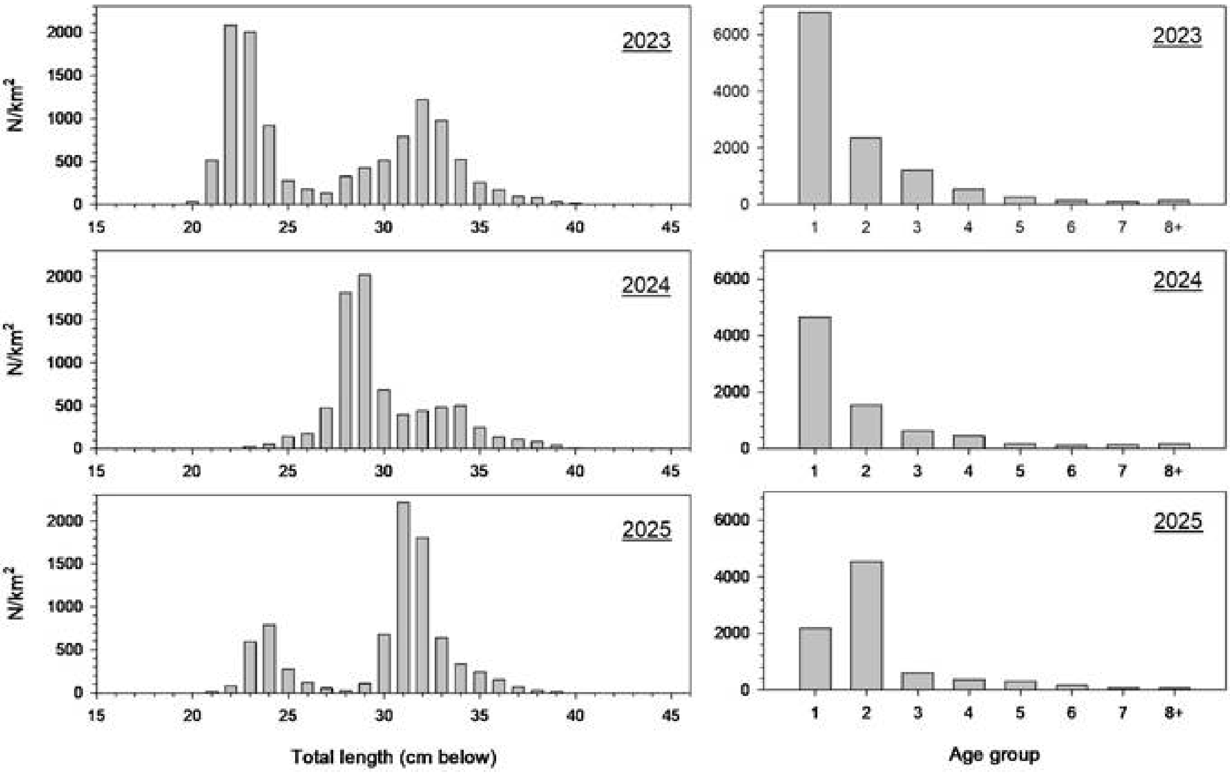

Fig. A1-2. Comparison of length and age distribution of mackerel in the North Sea 2023 to 2025.

The StoX (version 4.1.4) bootstrap estimates of mackerel biomass and abundance in the North Sea for 2025 were 586 020 tonnes and 2.36 billion individuals which is a 5 % higher biomass and a 7 % higher abundance than the estimates for the last year. The biomass and abundance estimates are based on the stratum limits as shown in Fig. 2 (stratum 13). The area of this polygon is 285 781 km^2.

Catches curves indicate that all ages including ages 1 to 5 are usually well represented in the survey data, and the 2022-year class is the highest at age 1 in the time series (Fig. A1-3).

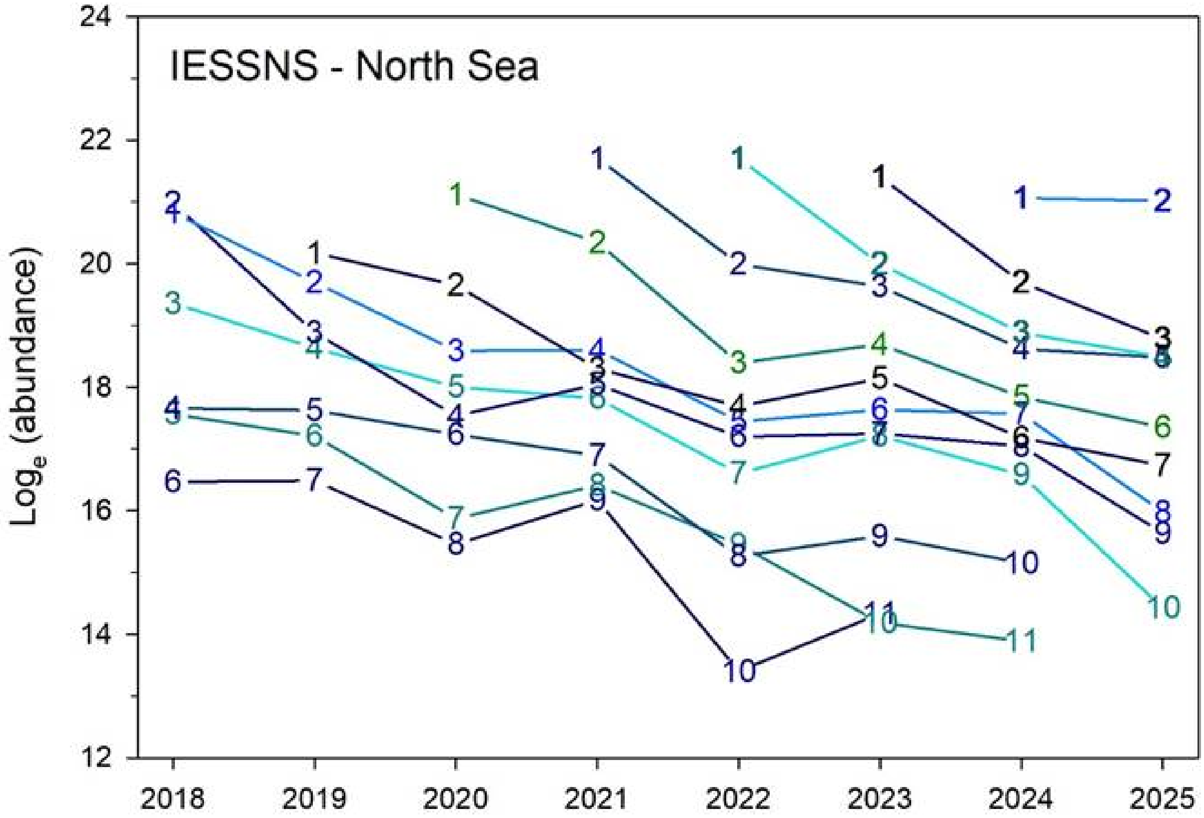

Fig. A1-3. Catch curves for mackerel year classes 2012 to 2024 in the North Sea (lines represents cohorts, numbers denote ages).

The internal consistency plots (Fig. A1-4), however, do not show any significant correlations. This is likely due to interannual variations in the migration of the cohorts in and out of the North Sea and may confirm that mackerel in the North Sea is not a separate stock.

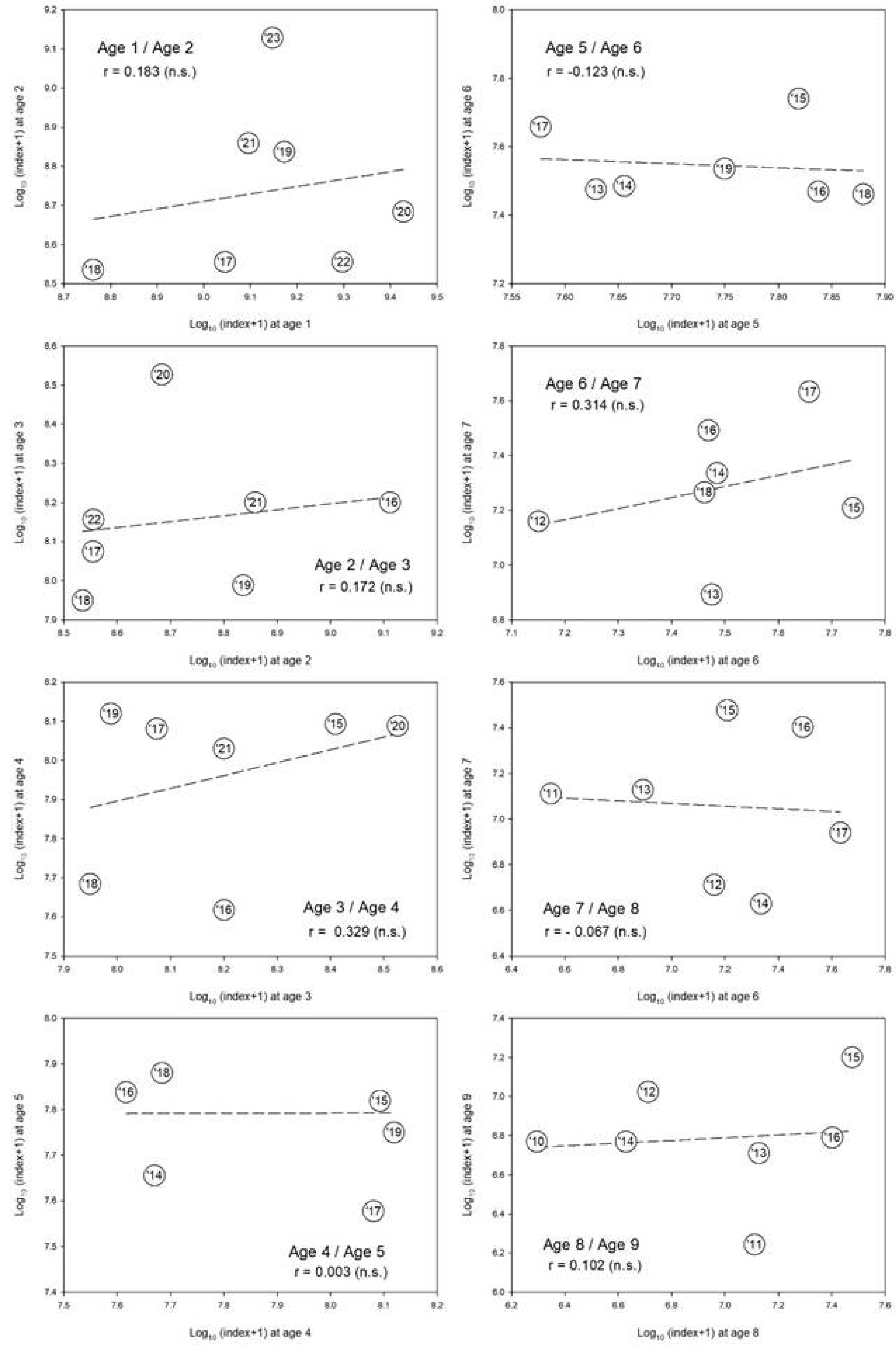

Fig. A1-4. Internal consistency of mackerel density indices ages 1 to 9 for the North Sea from 2018 to 2025 (numbers in symbols indicate 2000'er year classes).

Appendix 2

The mackerel index is calculated on all valid surface stations. That means, that invalid and potential extra surface stations and deeper stations need to be excluded. Below is the exclusion list used when calculating the mackerel abundance index for IESSNS 2025.

Vessel	Country	Horizontal trawl opening (m)	Exclusion list	
			Cruise	Stations
Vendla	Norway	64.5	2025203002	12, 15, 20, 22, 25 ,28, 31, 34, 43, 49, 51, 55, 67, 72, 73, 74
Eros	Norway	74.1	2025204002	14, 17, 22, 35, 49
R/V Árni Friðriksson	Iceland	62.1	A9-2025	285, 286, 310, 313, 314, 322, 326, 329, 332, 333
R/V Jákup Sverri	Faroe Islands	65.4	234-1005-2534	07, 12,21,44,55,65
Ceton	Denmark		IESSNS_DK_2025	none

* Observe that in PGNAPES and the national database station numbers are 4-digit numbers preceded by 2230 (e.g. ‘22300005’)

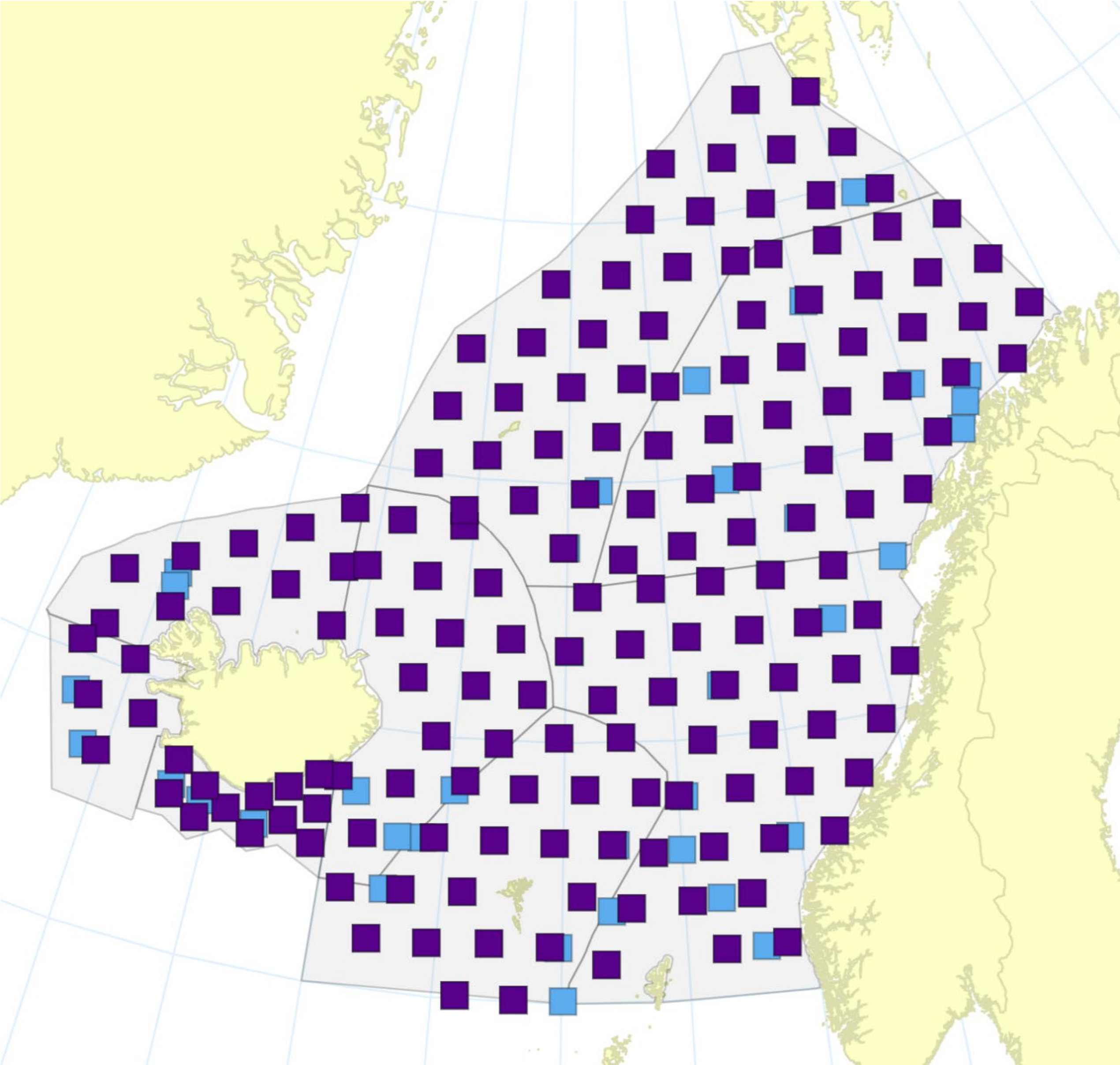

Fig. A2-1. IESSNS 2025. Surface trawl stations included (filled dark blue rectangle) and excluded (filled light blue rectangle) in calculations of mackerel age segregated index used in the assessment. Strata boundary also displayed (grey solid lines).

Appendix 3

Horizontal trawl opening of the Multpelt 832 trawl is a function of trawl door spread and tow speed (Table 6 in the 2022 report). The estimates in Table 6 are originally based on flume tank simulations in 2013 (Hirtshals, Denmark) where two formulas were empirically derived for two towing speeds, 4.5 and 5 knots:

Towing speed 4.5 knots: Horizontal opening (m) = 0.441 × Door spread (m) + 13.094

Towing speed 5.0 knots: Horizontal opening (m) = 0.3959 × Door spread (m) + 20.094

In 2017, the towing speed range was increased to 5.2 knots, i.e. an extrapolation of the trawl opening as a function of door spread and speed was performed. In 2022 the towing speed range was further extended down to 4.3 knots and up to 5.5 knots, using a kriging gridding method, see Figure A3-1. In 2023, the trawl opening was extended to 135m (Table 7).

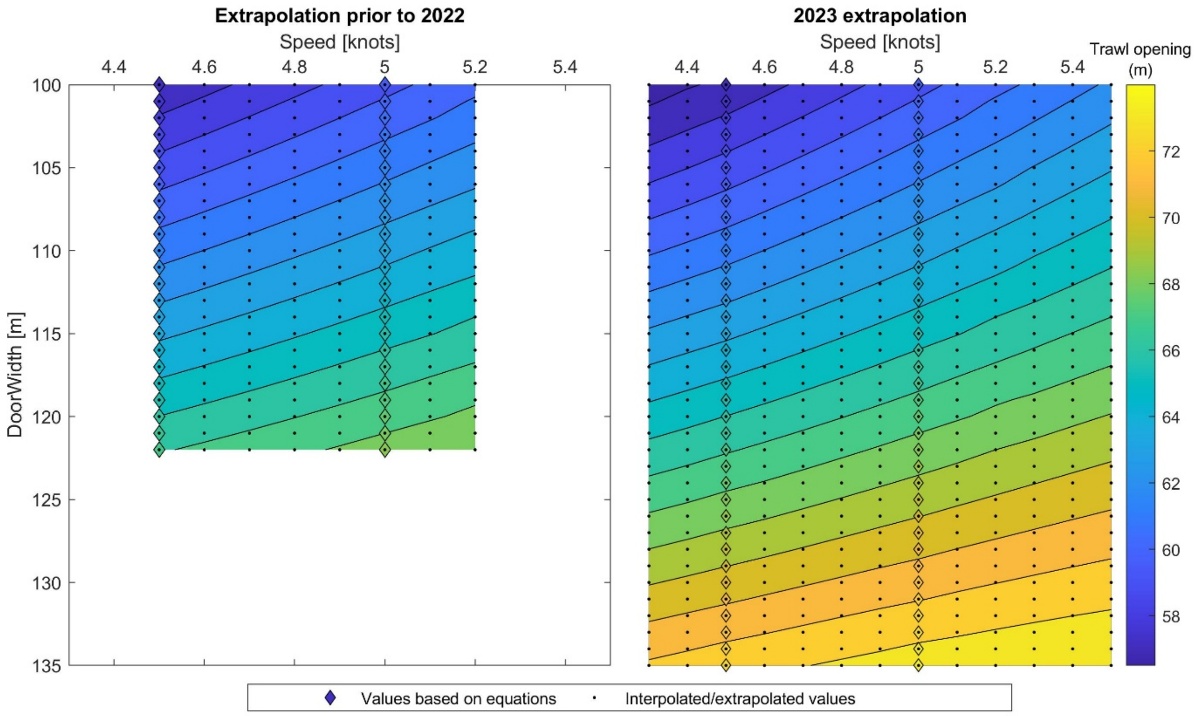

Fig. A3-1. Table 7 in the report shown as a plot.

Appendix 4

MIK sampling for cod larvae linked to pelagic trawling for mackerel

Main objective:

Explore the extent of adult mackerel predation on cod larvae during summer in northern Norway

Analyses:

The analysis of cod larvae from the MIK sampling and corresponding mackerel stomach content samples from pelagic trawling onboard Vendla at each station, will be conducted in the lab after the survey at the Institute of Marine Research in Tromsø.

Introduction

MIK sampling of cod larvae in relation to pelagic trawling for mackerel in northern Norway was requested from the Institute of Marine Research in Bergen, just prior to the start of the IESSNS survey. MIK trawl sampling from 0-50 m depth was conducted at six different locations during the mackerel-ecosystem (IESSNS) survey onboard the chartered fishing vessel M/V "Vendla" from 21-22 July 2025 (Figure 1).

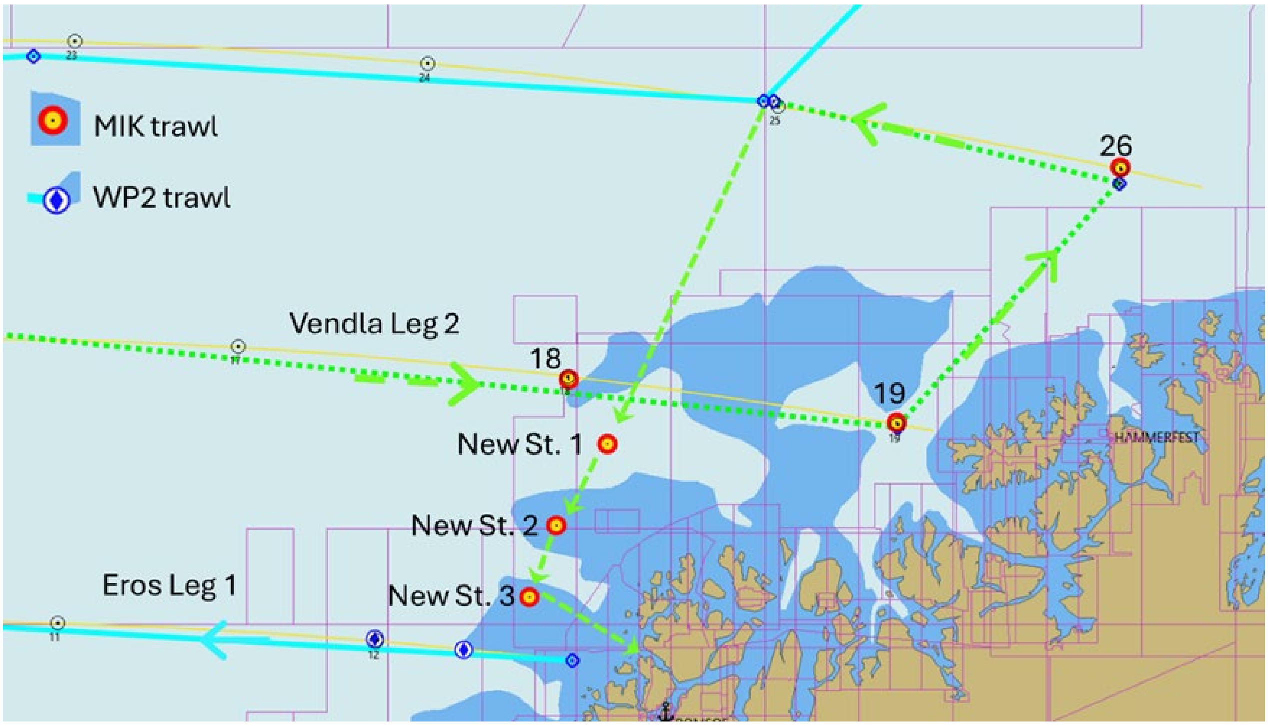

Figure 1. *Map showing the study area including six selected MIK trawl stations, which we conducted onboard M/V "Vendla" during leg 2 from 21st to 22nd of July. All the MIK stations were taken in relation to and accompanied with a complete station including, CTD casts, WP2 plankton sampling and 30 min pelagic trawling at the surface.*

Calibration of the MIK

Protocols for calibrating MIK and MIKeyM net flow meters (February 2018)

Main points:

NO codends to be on any of the nets during flow meter calibration.
Flow meter readings are taken for all three flow meters.
Distance run is recorded as accurately as possible. Log to be started when flow meter submerged and stopped when flow meter out of the water. THIS IS VERY IMPORTANT.
Alternating tows in opposite directions

Towing speed: 3 knots

Towing depth: 20m (lowered to 20m depth reasonably quickly), retrieval reasonably quickly.

Tow duration: Approximately 20 min at 20m depth

At least two calibrations to be undertaken throughout the cruise, more if possible

We conducted two calibrations in opposite directions using a flowmeter as reference (Figure 2).

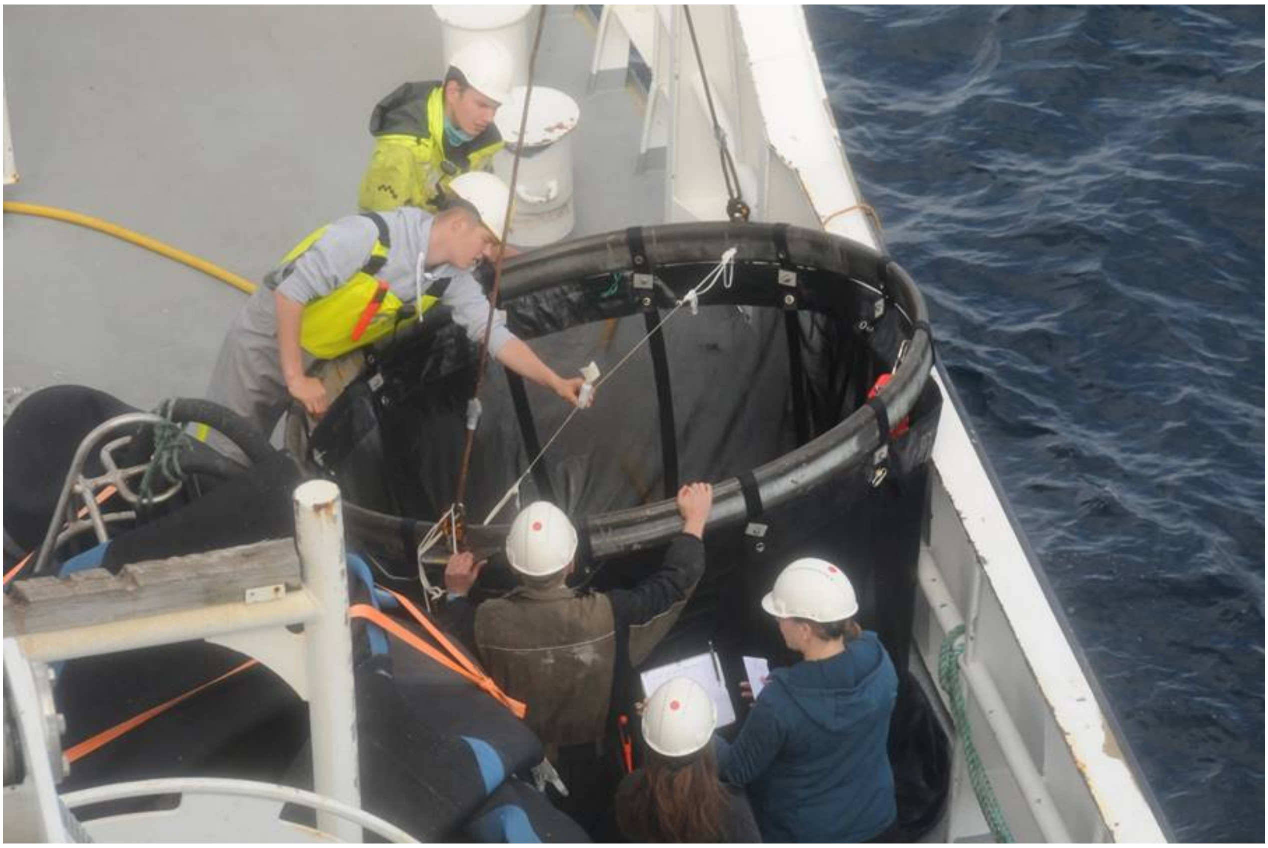

Figure 2. *Calibration of the MIK sampling device using a flowmeter according to standard procedures described above from 2018, prior to applying the MIK for quantitative sampling of cod larvae from 0-50 m depths. Photo: Leif Nøttestad, IMR.*

MIK sampling protocols

The MIK sampling protocols are summarized as follows:
Hauls: Double oblique
Ship's speed: 3 knots
Depth of sample: 5-10 m above bottom or a maximum of 100 m.
Wire: Out at 0.4 m.s^{-1} Hauled at 0.25 m.s^{-1},
Back end of all nets to be washed down at the end of each haul
Flow meter readings to be taken at the end of each haul.

We decided to collect cod larvae from the MIK between 0-50 m depths based on previous knowledge on vertical distribution of cod larvae at different periods of the year and different times of the day (see Eilertsen et al. 1984; Kristiansen et al. 2014).

Figure 3. *MIK sampling device for collecting cod larvae being taken onboard M/V "Vendla" after being sampled from 0-50 m depth. Photo: Leif Nøttestad, IMR.*

References

Eilertsen, B., P. Fossum, P. Solemdal, S. Sundby, S. Tilseth 1984. A case study on the distribution of cod larvae and availability of prey organisms in relation to physical processes in Lofoten. Flødevigen rapportserier 1:1984. ISSN 0333-2594. The propagation of the cod *Gadus morhua* L.

ICES. 2017. Manual for the Midwater Ring Net sampling during IBTS Q1. Series of ICES Survey Protocols SISP 2. 25 pp. http://doi.org/10.17895/ices.pub.3434.

Kristiansen, T., Vollset, K. W., Sundby, S., and Vikebø, F. Turbulence enhances feeding of larval cod at low prey densities. – ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu051.