WORKING GROUP ON BALTIC INTERNATIONAL FISH SURVEY (WGBIFS; outputs from 2022 meeting)

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Contents

i Executive summary

The Baltic International Fish Survey Working Group (WGBIFS) plans, coordinates, and implements demersal trawl surveys and hydroacoustic surveys in the Baltic Sea including the Baltic International Acoustic Survey (BIAS), the Baltic Acoustic Spring Survey (BASS), and the Baltic International Trawl Surveys (BITS) in the 1st and 4th quarter on an annual basis. The group compiles results from these surveys and provides the herring, sprat, cod and flatfish abundance indices for the Baltic Fisheries Assessment Working Group (WGBFAS) to use as tuning fleets.

In 2022, WGBIFS completed the following tasks: (1) compiled survey results from 2021 and the first half of 2022, (2) planned and coordinated all Baltic fish stocks assessment relevant surveys for the second half of 2022 and the first half of 2023, (3) updated the common survey manuals according to decisions made during the annual WGBIFS meeting. Data from the recent BITS was added to the ICES Database of Trawl Surveys (DATRAS). The Tow-Database, which allows planning the spatial distribution of hauls in the areas where the seabed is suitable for safety trawling, was corrected and updated. The Access-databases for aggregated acoustic data and the ICES database of acoustic-trawl surveys for disaggregated data were also updated. All countries also registered collected litter materials to DATRAS.

The area coverage and the number of control hauls in the BASS and in the BIAS in 2021 were considered to be appropriate to the calculation of tuning indices and the data can be used for the assessment of Baltic herring and sprat stocks. The number of valid hauls accomplished during the 4th quarter 2021 and 1st quarter 2022 BITS were considered by the group as appropriate to tuning series and the data can be used for the assessment of Baltic and Kattegat cod and flatfish stocks. BIAS and BASS survey sampling variance calculation questions were discussed and standard deviation for Central Baltic herring acoustic index series calculated.

A preliminary comparison exercise between the StoX survey computational method and traditional IBAS calculation methods was performed for the Central Baltic herring and Baltic sprat. It was found that the StoX project, developed for the WGBIFS, has small methodological differences compared to the standard calculation method used by the group, as specified in the Manual for the International Baltic Acoustic Surveys, (IBAS) and is thereby causing a small difference in the total number of herring and sprat. Larger differences appear in abundance estimates at the ICES Subdivision and rectangle level and in the age composition as well, These differences together with errors found in database will be mapped before the next meeting and the work towards a possible transitioning to StoX software will continue.

A further comparison exercise between the StoX method and traditional Gulf of Riga Herring Survey calculation method was performed using data from 11 last years. It showed no major differences in herring total abundance estimates for most of the years. However, notable differences were in the age compositions of those two methods. Some errors and differences in input data (uploaded into the ICES database) were found and therefore the further analysis was postponed until these issues are fixed.

WGBIFS is planning to continue with analogical comparison exercises in the coming years before the final transition to StoX and to a transparent reproducible pathway into the ICES Transparent Assessment Framework (TAF) can be done. Work towards transitioning to TAF will continue before and during the next meeting until all methodological and database differences are resolved.

Inquiries from other ICES expert groups were discussed and addressed.

ii Expert group information

Expert group name	Baltic International Fish Survey Working Group (WGBIFS)
Expert group cycle	Multiannual fixed term
Year cycle started	2021
Reporting year in cycle	2/3
Chair(s)	Olavi Kaljuste, Sweden, Elor Sepp, Estonia
Meeting venue(s) and dates	4–6 April 2022, web meeting, (22 participants)
	7–11 November 2022, Copenhagen, Denmark, hybrid meeting, (20 participants)

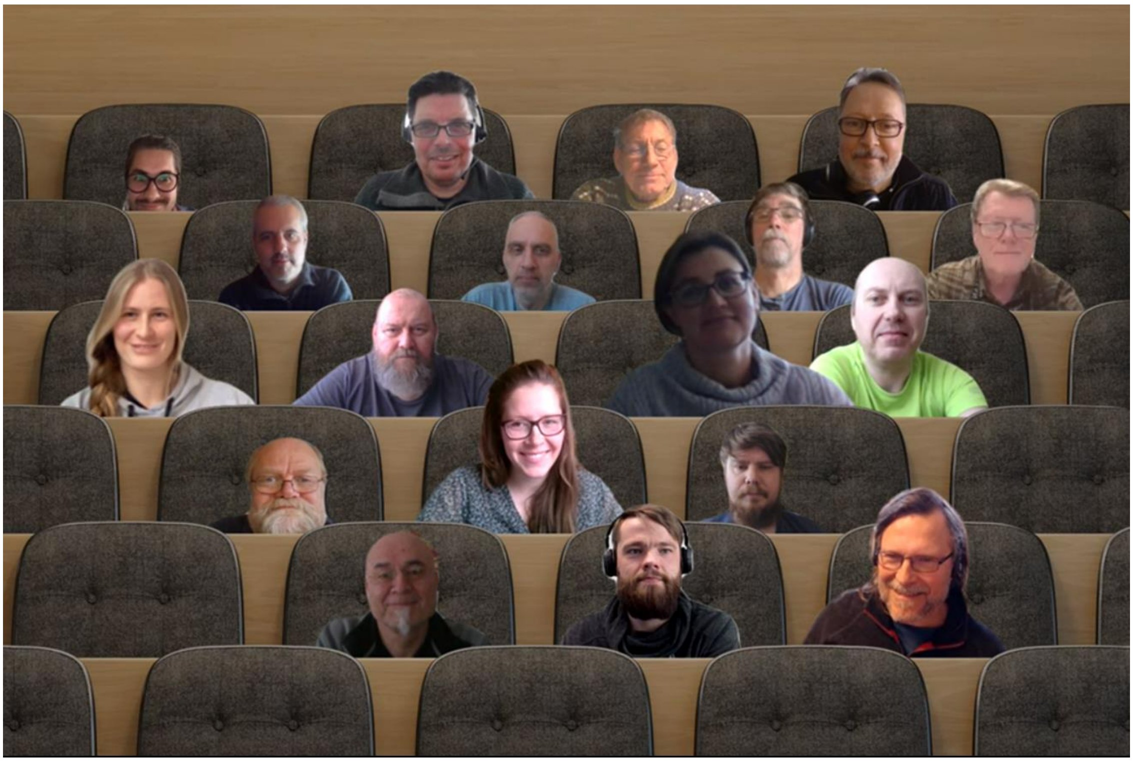


Photo: Participants for WGBIFS online meeting in April 2022

1 Terms of Reference

TOR	Description	Background	Science plan codes	Duration	Expected deliverables
a	Combine and analyse the results of spring and autumn acoustic surveys and experiments	Acoustic surveys provide important fishery-independent stock estimates for Baltic herring and sprat stocks	3.1	Annually Year 1, 2 and 3	Updated acoustic tuning index for WGBFAS
b	Update the BIAS, BASS and GRAHS hydroacoustic databases and ICES database for acoustic-trawl surveys	The aim of BIAS, BASS and GRAHS databases is to store the aggregated data. The aim of ICES database is to ensure that the standardized and quality-controlled scrutinized data from the acoustic-trawl surveys will be stored centrally in a safe way and enables easy access to the data, which will facilitate usage for many different analyses by a wider range of users.	3.1	Annually Year 1, 2 and 3	Updated databases with acoustic and biotic data for WGBIFS
c	Coordinate and plan acoustic surveys including any experiments to be conducted	Acoustic surveys provide important fishery-independent stock estimates for Baltic herring and sprat stocks	3.1	Annually Year 1, 2 and 3	Finalized planning for the surveys for WGBIFS
d	Review the results of BITS surveys and evaluate the characteristics of TVL and TVS standard gears used in BITS	Demersal trawl surveys provide important fishery-independent stock estimates for Baltic cod and flatfish stocks	3.1	Annually Year 1, 2 and 3	Updated BITS data in DATRAS database for ICES Data Centre and WGBFAS
e	Coordinate and plan demersal trawl surveys and experiments to be conducted, and update and correct the Tow Database	Demersal trawl surveys provide important fishery-independent stock estimates for Baltic cod and flatfish stocks	3.1	Annually Year 1, 2 and 3	Finalized planning for the surveys for WGBIFS, updated and corrected Tow Database
f	Conduct the analyses related to the improvement of quality of acoustic indices and estimation of the uncertainty in the acoustic surveys coordinated by WGBIFS	Acoustic surveys provide important fishery-independent stock estimates for Baltic herring and sprat stocks	3.1, 3.2, 3.3	Year 1-3	Improved quality of acoustic indices with estimates of the uncertainty for WGBFAS
g	Update on progress in development of the StoX software and implementation of it for the calculation of	StoX software produces fish abundance estimations in a transparent and reproducible way. Planned development of the StoX	3.1, 3.2	Year 1-3	Improved transparency and reproducibility of acoustic indices, improved pace of work on the level of national data compilation and verification

	WGBIFS acoustic stock estimates.	post-processing program should allow implication this software by WGBIFS using the acoustic and biotic data from ICES database for acoustic-trawl surveys. Comparisons will be performed to validate whether the StoX software provides us similar results as the current IBAS calculation method in order to allow WGBIFS to use it as a new standard tool for the calculation of annual acoustic survey estimates.			
h	Coordinate the marine litter-sampling programme within the Baltic International Trawl Survey and registering the data in the ICES database.	Collected and registered information about the marine litter (mostly anthropogenic origin), occasionally appeared in the ground trawl fish control-catches, are additional source of data about present ecological status of marine seabed in investigated areas of the Baltic.	3.1	Annually Year 1, 2 and 3	Coordinated the marine litter sampling programme in the Baltic International Trawl Survey (BITS).
i	Agree a standard pelagic trawl gear used the acoustic surveys	Acoustic surveys provide important fishery-independent estimates for Baltic herring and sprat stocks size and possible uncertainties, which result from, e.g. different type of fishing gears applied for fish control-catches, should be eliminated.	3.1, 3.2	Year 1-3	Agreement on the standard pelagic fishing gear which will be used in the BIAS and BASS surveys
j	Review and update the manual for International Baltic Acoustic Surveys (IBAS; former SISP 8) and address methodological question raised at the last review of the SISP	Acoustic surveys provide important fishery-independent stock estimates for Baltic herring and sprat stocks	3.1, 3.2	Year 3	Updated IBAS manual for publication in TIMES
k	Review and update the manual for Baltic International Trawl Survey (BITS; former SISP 7) and address methodological question raised at the last review of the SISP	Demersal trawl surveys provide important fishery-independent stock estimates for Baltic cod and flatfish stocks	3.1, 3.2	Year 3	Updated BITS manual for publication in TIMES
l	Conduct analyses related to the uncertainties in the Gulf of Riga Acoustic Herring Survey (GRAHS) in order to improve the quality of	Until now, the preparation of the survey data for stock assessment is the responsibility of the Latvian and Estonian national laboratories. The methodology and consistency of results of this survey should	3.1, 3.2	Year 1-3	Improved quality, transparency and reproducibility of acoustic indices, updated databases with acoustic and biotic data from GRAHS

	the GRAHS and subsequent indices.	be evaluated by the wider international scientific expertise available.			
m	Evaluate if there are methodological and/or environmental reasons for different survey catchabilities in different ICES Sub-divisions and what may be magnitude of these differences	Within the INSPIRE project assessments of herring and sprat stocks were conducted by former assessment units (AUs) instead of currently used central Baltic herring (CBH) and sprat in the entire Baltic. It was dis-covered in these assess-ments that catchabilities (q) (understood as ratio between the acoustically estimated and the model assessed stock sizes in given area/AU) of acoustic surveys estimated by applied assessment models differed by AUs, and usually q's were higher in northern than in southern waters. The question is if these differences may to some extent be caused by "environmental" differences, acoustic methodologies, area coverages etc. in the surveyed areas. This information is important to have if ICES is asked to develop/evaluate a spatial management plan for sprat and herring, as has been suggested for several years in the sprat advice.	3.1, 3.2	Year 1-3	Improved quality and transparency of acoustic indices

2 Summary of the Work Plan for Year 2

- Compilation the survey results from 2021 and the first quarter of 2022 and reporting to WGBFAS. (ToR a and d).
- Updated databases with acoustic and biotic data (ToR b).
- Finalized coordination and planning for the BASS, BIAS and BITS surveys in 2022 and first half of 2023, updated and corrected Tow Database (ToR c and e).
- Questions related to BIAS and BASS survey uncertainties estimates were discussed and standard deviation for Central Baltic herring acoustic index series calculated (ToR f).
- Uploading the data from the Gulf of Riga Acoustic Herring Survey into the ICES database for acoustic and trawl surveys and screening of the data. Analyses related to the uncertainties in the Gulf of Riga Acoustic Herring Survey. (ToR g and l).
- Coordinated marine litter sampling programme in the BITS surveys and registered data in the ICES database (ToR h).
- Progress towards an agreement in the standard pelagic fishing gear to be used in the acoustic surveys (ToR i).
- Second review and update of the IBAS and BITS manuals (ToR j and k).
- Possible reasons for different survey catchabilities were discussed. (ToR m)

3 List of outcomes and achievements of the WG in this delivery period

Indices for the pelagic and demersal fish stocks in the Baltic Sea from annual surveys as fishery-independent data for analytical assessment purposes in WGBFAS:

- Calculated BASS tuning fleet index for Baltic sprat in SDs 24–26 and 28.2 (abundance per age in the age groups 1-8+).
- Calculated BIAS tuning fleet index for Baltic sprat in SDs 22–29 (abundance per age in the age groups 1-8+).
- Calculated BIAS tuning fleet index for Baltic sprat recruitment in SDs 22–29 (abundance at age 0).
- Calculated BIAS tuning fleet index for Baltic herring in SDs 25–29 (abundance per age in the age groups 1-8+).
- Calculated BIAS tuning fleet index for Baltic herring recruitment in SDs 25–29 (abundance at age 0).
- Calculated BIAS tuning fleet index (in StoX) for Baltic herring in SD 30 (abundance per age in the age-groups 0-15+).
- Uploaded data from the 1st and 4th quarter BITS surveys to the DATRAS database to be used for the calculation of survey indices for the relevant cod and flatfish stocks.

Other survey-derived products:

- Annual maps of BASS and BIAS area coverage.
- Annual geographical distribution maps of sprat abundance in the Baltic Sea (May-June; BASS surveys).
- Annual geographical distribution maps of sprat, herring and cod abundance in the Baltic Sea (September-October; BIAS surveys).
- Geographical CPUE distribution map of cod and different flatfish species in the Baltic Sea based on the recent BITS surveys.
- Updated Access-databases for aggregated acoustic data (BASS_DB.mdb, BIAS_DB.mdb, BIAS_HERR_SD30_DB.mdl and GRAHS_DB.mdb).
- Updated ICES database of acoustic-trawl surveys for disaggregated data.
- Updated and corrected the Tow-Database which allows planning the spatial distribution of hauls in the areas, where the seabed is suitable for safety trawling.
- Alternative acoustic index series for the pelagic fish stocks in the Baltic Sea as fishery-independent data for benchmark assessment purposes in WKBALTPEL.

Other outcomes and achievements:

- Agreed plans (time and spatial coverage by countries) for the next standard acoustic surveys.
- Agreed plans (time and number of planned stations by countries) for the next standard BITS surveys.
- 3 recommendations (Annex 4) were made to ICES Data Centre and to other ICES Working Groups.
- Updated action list (Annex 5) for WGBIFS members.

4 Progress report on ToRs and Work Plan

4.1 ToR a) Combine and analyse the results of acoustic surveys and experiments

4.1.1 Combined results of the Baltic International Acoustic Survey (BIAS)

In September - October 2021, the following acoustic surveys were conducted in the ICES Subdivisions 21-32 (excl. ICES Subdivision 31). Some subdivisions were only partly covered.

Country	Data	Vessel	ICES SDs	Length of acoustic transects [NM]	Number of hauls	Number of hydrological stations
Finland	21.09-04.10.2021	Aranda	30, parts of 29 and 32	1512	44	48
Poland	13-29.09.2021	Baltica	Parts of 25 and 26	715	29	39
Latvia-Poland	12-21.10.2021	Baltica	Parts of 26 and 28	407	13	17
Estonia-Poland	22.10-01.11.2021	Baltica	Parts of 28.2, 29 and 32	430	20	20
Sweden	25.09-08.10.2021	Svea	27, parts of 25, 26, 28 and 29	1304	47	47
Lithuania	14-15.11.2021	F/V 1113 NZ55	Part of 26	129	7	7
Germany	08-28.10.2021	Solea	22, 23, 24 and parts of 21	1124	50	90

4.1.1.1 Area under investigation and overlapping areas

Each of the ICES statistical rectangles of the area under investigation was allocated to one country during the WGBIFS meeting in 2021. Thus, each country has a mandatory responsible area. Each rectangle should be covered by an acoustic transect of about 60 NM per 1000 NM^2 area and at least two fishing hauls. Nations can also cover areas outside their mandatory areas but the results from the responsible country are used in these cases.

During the BIAS 2021 survey almost all rectangles were covered as planned during the WGBIFS 2020 meeting (Fig. 4.1). Overall, 113 statistical ICES rectangles were inspected and reported. 108 ICES rectangles were investigated by one country. One ICES rectangle was inspected and reported by two countries, namely 48H4 by Estonian and Finland. Also, four ICES rectangles were additionally inspected by another country, namely 41G8, 42G8 and 43G9 by Latvia and 48H5 by

Finland, however, these data were not considered in the final analysis. ICES statistical rectangle 39H0 in ICES Subdivision 26 was not investigated as Russia did not take part in the BIAS 2021 sampling. Rectangles 38G9, 39G9 and 40G9 were inspected only partly, i.e. inside the Polish and Lithuanian EEZ but included in the final analyses. Investigations in the eastern part of ICES Subdivision 32 (the Russian zone) were not planned.

In total, 5621 NM of acoustic transects were recorded. Moreover, 210 and 331 catch and hydrological stations, respectively, were inspected.

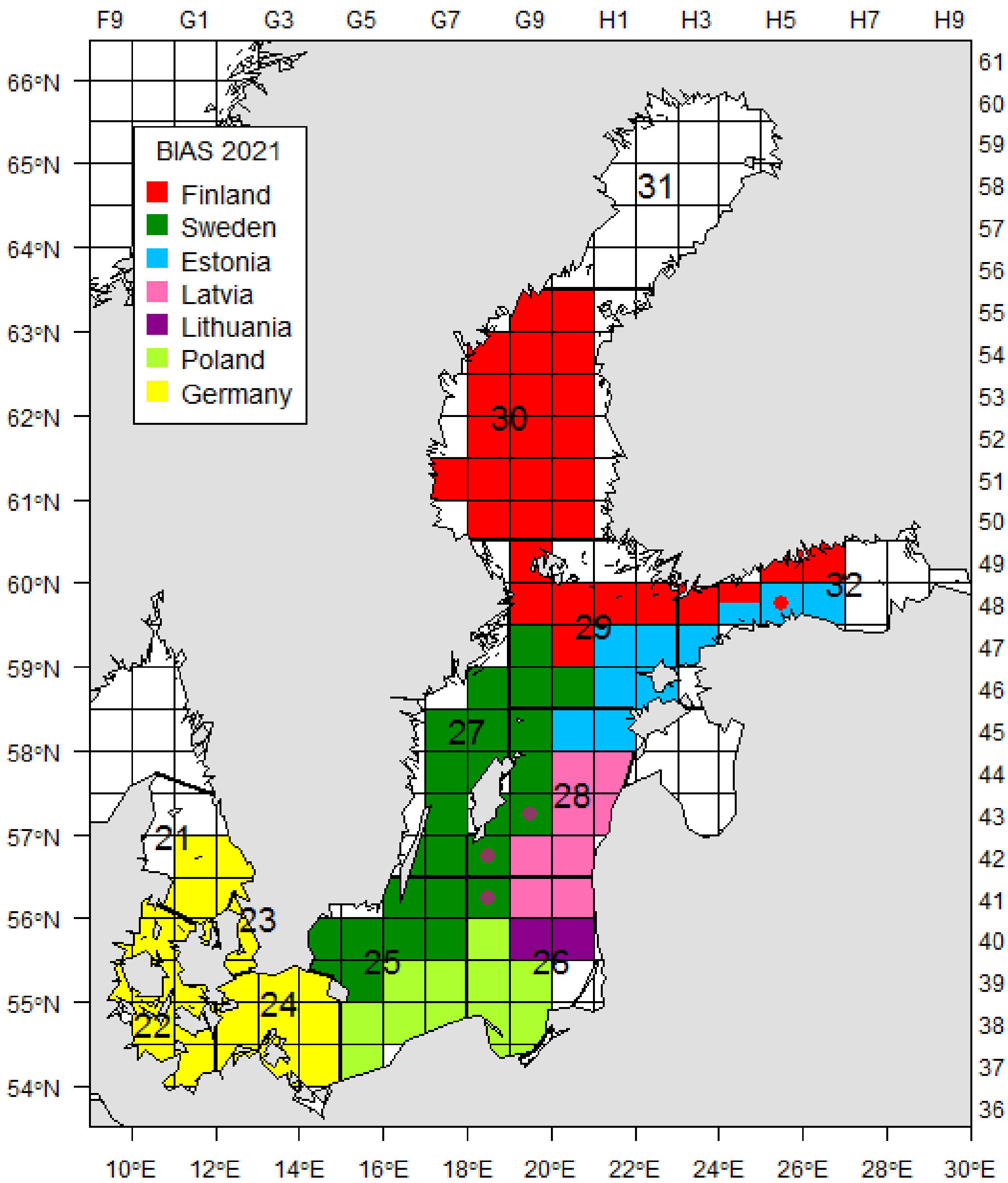


Figure 4.1. Map of the BIAS survey conducted in September-October 2021. Various colours indicate the responsible countries for that ICES rectangle which finally also delivered data to the BIAS-database. Dots with different colours within a rectangle indicate that the rectangle was partly or completely covered by another country and data are available in the BIAS-database (but not included in the final analysis).

4.1.1.2 Total results

Geographical distribution of herring, sprat and cod abundance in the Baltic Sea, accordingly to the ICES rectangles inspected in September-October 2021, is illustrated in Figures 4.2 - 4.6.

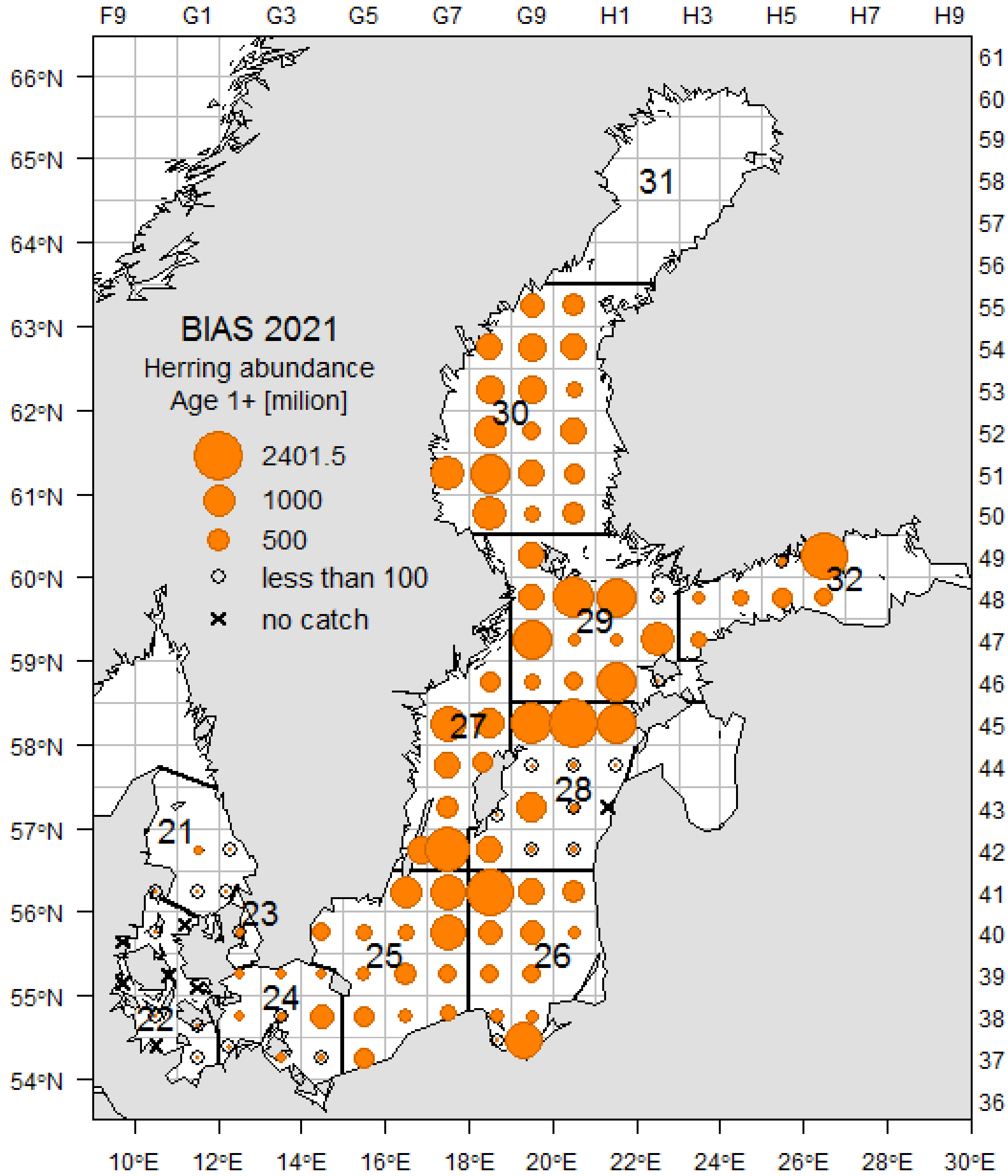


Figure 4.2. The abundance of herring (age 1+) per ICES rectangle monitored in September-October 2021 (the size of a circle indicates estimated numbers of specimens x10^6 in a given rectangle).

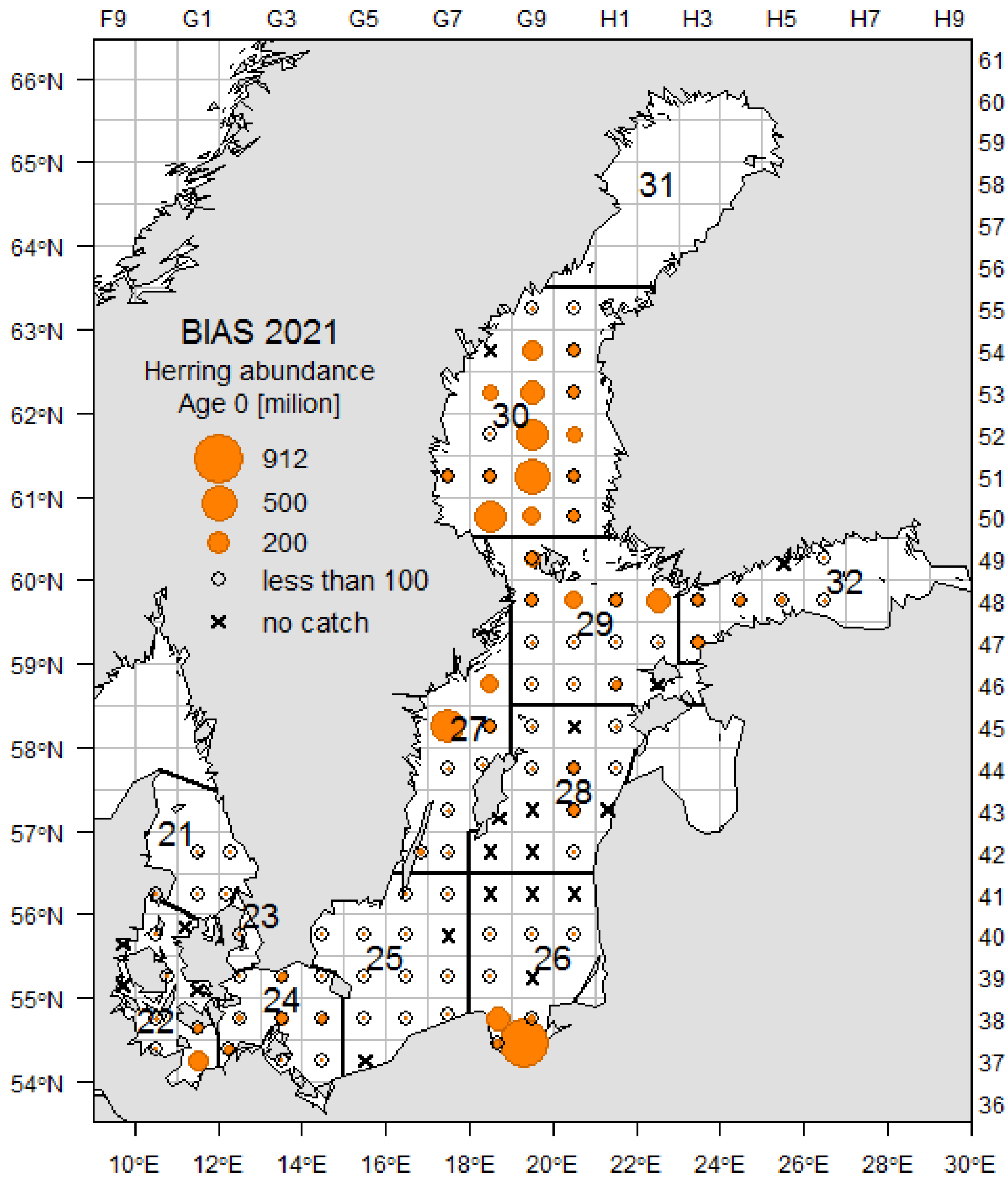


Figure 4.3. The abundance of herring (age 0) per ICES rectangle monitored in September-October 2021 (the size of a circle indicates estimated numbers of specimens x10^6 in a given rectangle).

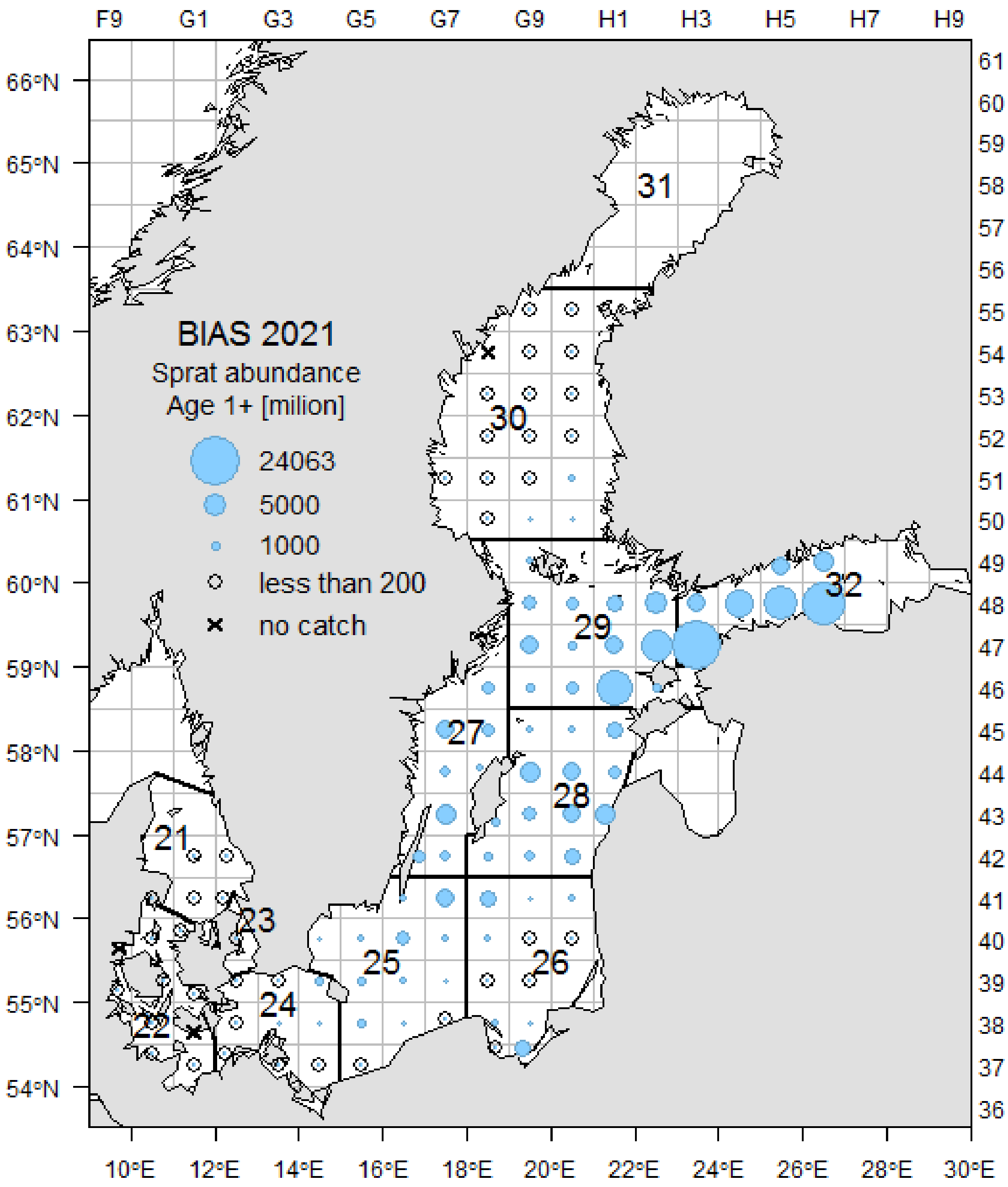


Figure 4.4. The abundance of sprat (age 1+) per ICES rectangle monitored in September-October 2021 (the size of a circle indicates estimated numbers of specimens x10^6 in a given rectangle).

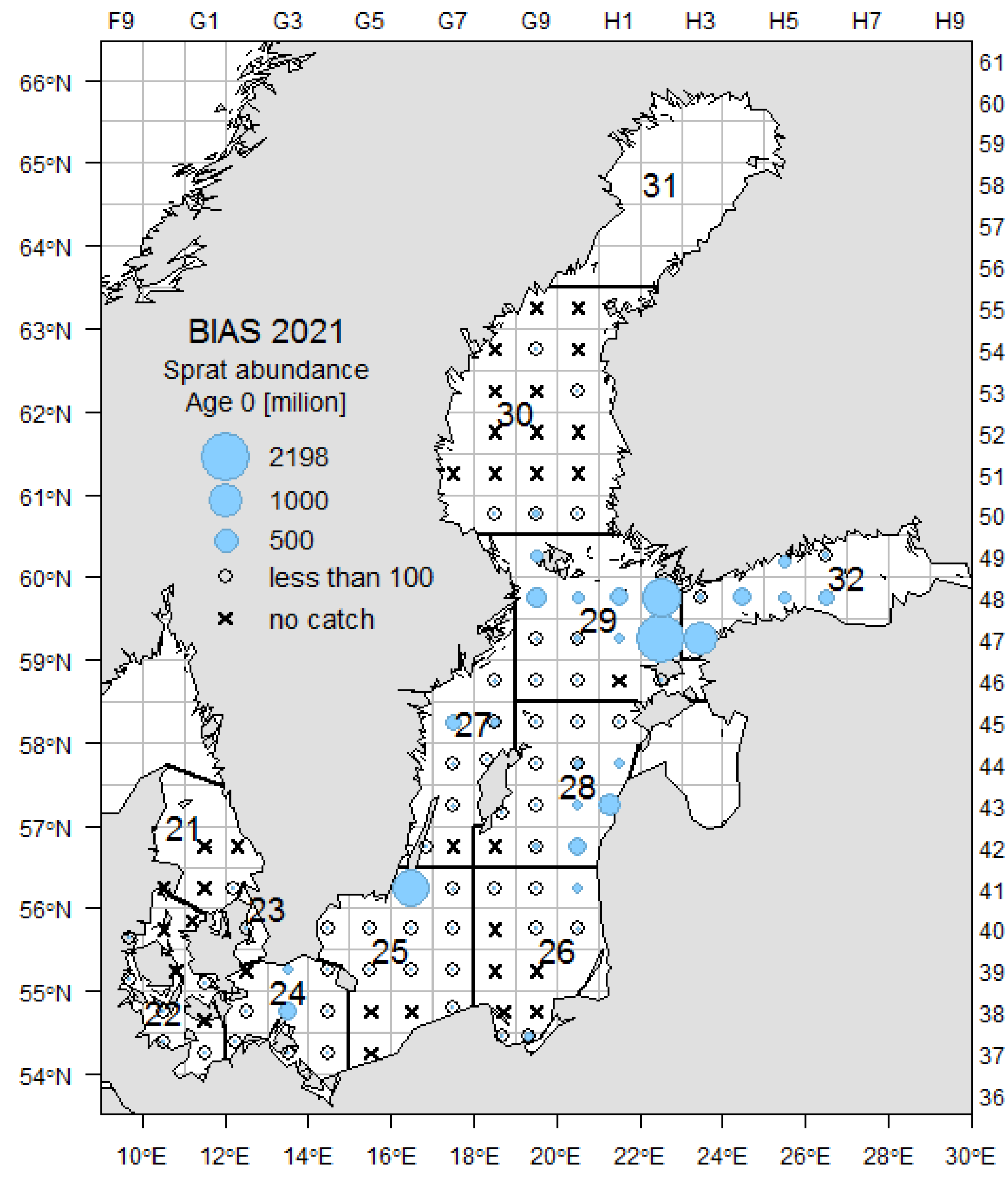


Figure 4.5. The abundance of sprat (age 0) per ICES rectangle monitored in September-October 2021 (the size of a circle indicates estimated numbers of specimens x10^6 in a given rectangle).

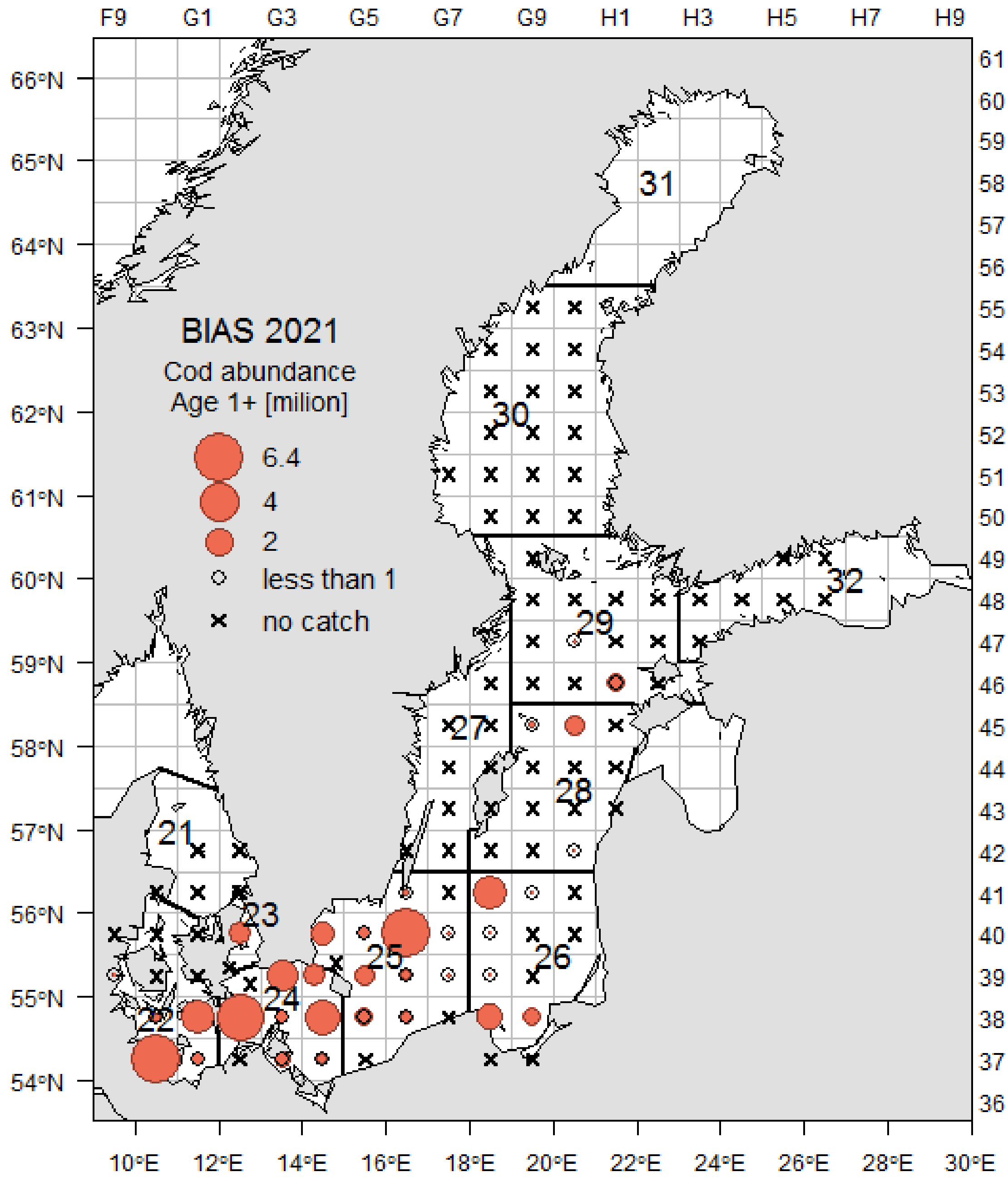


Figure 4.6. The abundance of cod (age 1+) per ICES rectangle monitored in September-October 2021 (the size of a circle indicates estimated numbers of specimens x10^6 in a given rectangle).

The fish abundance estimates, which are based on the BIAS survey in September-October 2021 are presented per ICES rectangle and age-group and are specified in Tables 4.1, 4.2 and 4.3 for herring, sprat and cod, respectively. In addition, the abundance estimates for herring and sprat aggregated per ICES Subdivisions and fish age-groups are presented in Tables 4.4 and 4.5.

The highest herring (age 1+) stock abundance was observed in the northern part of the ICES Subdivision 28, in the ICES rectangle 45H0. A somewhat lower, but still significant abundance of the herring stock was assessed in the ICES Subdivision 26, 27 and 32. Herring (age 1+) was distributed in all except seven ICES rectangles of the inspected area (37G0, 39F9, 39G0, 39G1, 40F9 40G1 in the ICES Subdivision 22 and 43H1 in the ICES Subdivision 28). The highest concentrations of young of the year (YOY) herring (age-group 0, year class 2021) was detected in the ICES rectangle 37G9 in the Gulf of Gdansk (ICES Subdivision 26; Figure 4.3). Smaller 0-age-group herring concentrations were detected in the ICES Subdivision 30 (the Gulf of Bothnia) and in the northern part of the ICES Subdivision 27. YOY herring occurred also in others inspected waters of the Baltic, however levels were significantly lower (Figure 4.3).

The highest sprat (age 1+) stock abundance was observed in the ICES Subdivision 32 (the Gulf of Finland) and in the eastern part of the ICES Subdivision 29 (the Estonian inshore waters) (Figure 4.4). The highest concentration of YOY sprat (year class 2021) was detected in the eastern part of the ICES Subdivision 29 (the Estonian inshore waters). YOY sprat was not observed in significant amounts in ICES Subdivisions 25 and 30 (Figure 4.4).

The highest cod stock abundance (age 1+) was detected in the ICES Subdivisions 22, 24 and 25 (Figure 4.5). Cod in lower abundances were detected in some other areas of the Baltic, with exception of ICES Subdivisions 27, 30 and 32. It should be underlined that the cod stock abundance was **several** times lower than herring and sprat stocks abundance.

Table 4.1. Estimated numbers (millions) of herring in September-October 2021, by ICES rectangle and age-group.

YEAR	SD	RECT	TOTAL	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	21	41G0	1.00	0.37	0.30	0.16	0.16	0.01	0.00	0.00	0.00	0.00
2021	21	41G1	4.47	3.06	0.67	0.35	0.36	0.03	0.00	0.00	0.00	0.00
2021	21	41G2	6.86	2.70	3.71	0.14	0.17	0.11	0.00	0.03	0.00	0.00
2021	21	42G1	105.41	1.46	93.70	6.13	2.46	0.57	0.00	1.09	0.00	0.00
2021	21	42G2	7.18	4.56	1.98	0.42	0.15	0.06	0.00	0.01	0.00	0.00
2021	22	37G0	3.18	3.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	37G1	165.91	163.50	1.21	0.20	0.60	0.20	0.20	0.00	0.00	0.00
2021	22	38G0	15.61	12.57	0.91	0.34	1.11	0.34	0.34	0.00	0.00	0.00
2021	22	38G1	37.32	35.76	1.04	0.26	0.26	0.00	0.00	0.00	0.00	0.00
2021	22	39F9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	39G0	0.90	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	39G1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	40F9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	40G0	8.55	8.23	0.21	0.11	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	40G1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	41G0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	23	39G2	47.45	2.58	3.26	9.88	13.24	11.57	3.62	1.94	1.32	0.04
2021	23	40G2	91.84	0.35	7.07	33.16	23.83	15.70	8.42	2.42	0.65	0.24
2021	23	41G2	1.79	0.01	0.14	0.65	0.46	0.31	0.16	0.05	0.01	0.00
2021	24	37G2	52.31	28.24	9.26	3.05	4.87	4.85	1.38	0.49	0.17	0.00
2021	24	37G3	113.02	4.24	6.75	23.12	28.24	28.18	10.70	6.41	5.19	0.19
2021	24	37G4	70.05	4.62	3.87	17.29	18.06	15.84	5.17	2.91	2.22	0.07
2021	24	38G2	156.20	25.93	16.46	22.27	38.29	36.53	8.81	5.03	2.88	0.00
2021	24	38G3	154.19	72.83	20.88	15.12	20.07	18.21	4.34	2.08	0.66	0.00
2021	24	38G4	658.58	34.63	30.70	169.33	160.42	138.10	53.08	39.69	32.24	0.39
2021	24	39G2	82.99	4.51	5.70	17.27	23.16	20.24	6.34	3.39	2.31	0.07
2021	24	39G3	138.89	30.80	13.41	24.86	25.95	23.97	9.80	5.54	4.49	0.07
2021	24	39G4	83.74	3.12	3.34	21.75	20.97	18.62	7.39	4.22	4.15	0.18
2021	25	37G5	402.72	0.00	4.07	134.19	64.09	110.43	43.36	28.20	18.29	0.08
2021	25	38G5	429.70	7.71	5.30	140.46	67.95	111.01	45.26	28.66	20.88	2.45
2021	25	38G6	220.72	3.92	2.72	76.53	35.92	57.43	22.43	12.27	9.03	0.46
2021	25	38G7	255.73	3.08	2.58	97.12	38.40	62.88	25.35	15.16	10.76	0.40
2021	25	39G4	31.77	0.53	1.59	4.45	10.06	4.87	6.35	3.28	0.64	0.00
2021	25	39G5	231.00	4.35	8.76	89.22	45.19	28.33	32.84	12.56	9.75	0.00
2021	25	39G6	482.77	6.58	4.04	213.38	72.21	112.02	41.86	19.36	13.24	0.08
2021	25	39G7	375.21	5.49	4.21	147.89	53.43	88.68	34.92	22.77	16.58	1.24
2021	25	40G4	327.82	6.88	9.77	59.20	89.40	82.06	36.95	17.86	25.70	0.00
2021	25	40G5	287.69	2.45	43.90	77.03	64.62	44.86	13.78	22.27	17.06	1.73
2021	25	40G6	300.84	2.80	10.10	98.39	28.50	59.15	57.94	22.82	21.14	0.00
2021	25	40G7	1 263.11	0.00	45.24	432.96	225.38	263.50	81.73	127.79	86.51	0.00
2021	25	41G6	965.71	6.78	40.47	154.84	180.35	149.56	186.51	97.65	145.16	4.40
2021	25	41G7	1 293.38	3.65	12.79	540.74	168.34	187.89	240.24	82.66	42.82	14.24

Table 4.1. Continues

YEAR	SD	RECT	TOTAL	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	26	37G8	37.21	35.17	0.16	0.30	0.24	0.16	0.22	0.23	0.63	0.09
2021	26	37G9	2 251.57	911.99	60.06	164.25	154.06	197.70	159.77	166.90	348.52	88.32
2021	26	38G8	467.05	221.37	10.97	27.95	34.62	50.70	31.41	29.35	47.23	13.45
2021	26	38G9	184.69	23.40	3.18	13.05	12.77	25.28	19.55	22.39	44.31	20.76
2021	26	39G8	376.74	1.10	24.32	52.87	61.62	77.18	43.10	40.79	63.30	12.45
2021	26	39G9	377.77	0.00	13.47	34.63	46.09	85.38	49.24	49.87	80.34	18.76
2021	26	40G8	563.10	1.57	67.88	128.35	117.83	98.60	45.83	37.36	57.42	8.24
2021	26	40G9	619.53	1.89	5.66	141.81	200.13	109.36	80.25	59.22	9.12	12.10
2021	26	40H0	162.18	0.78	2.93	45.89	29.59	23.03	17.38	23.20	17.05	2.31
2021	26	41G8	2 196.31	0.00	23.19	673.07	411.16	488.49	290.72	153.51	149.87	6.29
2021	26	41G9	656.80	0.00	5.11	214.67	125.23	109.89	69.00	35.78	71.56	25.56
2021	26	41H0	518.12	0.00	6.21	173.74	102.38	89.97	58.95	24.82	43.44	18.62
2021	27	42G6	814.80	16.63	87.80	340.56	81.15	87.13	119.06	55.87	23.28	3.33
2021	27	42G7	2 070.71	12.71	72.07	684.37	345.04	465.93	260.17	116.27	102.48	11.67
2021	27	43G7	491.27	11.27	99.93	241.93	47.57	52.46	11.19	23.08	3.85	0.00
2021	27	44G7	722.75	13.34	170.84	297.00	40.98	81.75	41.99	73.21	3.64	0.00
2021	27	44G8	412.84	9.71	71.24	221.80	33.35	38.21	15.22	17.16	6.15	0.00
2021	27	45G7	1 693.26	437.56	400.75	451.47	128.88	100.55	93.86	41.69	38.50	0.00
2021	27	45G8	906.43	56.91	90.23	362.83	122.23	121.77	97.78	29.31	22.25	3.12
2021	27	46G8	543.28	141.37	103.85	148.09	46.15	69.35	22.26	9.11	2.22	0.88
2021	28_2	42G8	729.49	0.00	3.87	147.16	101.57	175.82	148.75	152.33	0.00	0.00
2021	28_2	42G9	56.63	0.00	0.65	19.53	11.07	10.42	4.56	1.95	6.51	1.95
2021	28_2	42H0	51.06	1.43	0.95	16.70	9.07	10.97	3.82	1.43	4.77	1.91
2021	28_2	43G8	0.87	0.00	0.00	0.43	0.43	0.01	0.00	0.00	0.00	0.00
2021	28_2	43G9	944.45	0.00	4.20	206.90	166.94	164.05	191.04	126.57	84.75	0.00
2021	28_2	43H0	137.70	58.67	2.44	35.04	9.78	17.11	2.44	3.26	6.52	2.44
2021	28_2	43H1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	28_2	44G9	46.46	9.29	1.38	17.20	11.87	3.96	1.38	1.38	0.00	0.00
2021	28_2	44H0	93.91	44.55	2.41	26.49	4.82	7.83	1.20	1.81	3.61	1.20
2021	28_2	44H1	2.08	0.58	0.23	1.15	0.00	0.12	0.00	0.00	0.00	0.00
2021	28_2	45G9	1 650.65	10.45	34.73	563.46	197.54	225.45	312.79	85.01	213.25	7.97
2021	28_2	45H0	2 401.52	0.00	50.41	931.86	493.03	325.02	198.60	327.64	59.89	15.06
2021	28_2	45H1	1 551.93	10.56	56.61	562.12	301.56	217.84	133.88	217.17	40.68	11.50
2021	29	46G9	270.88	2.32	19.27	127.68	22.92	23.96	20.87	27.29	26.58	0.00
2021	29	46H0	324.68	1.27	4.91	141.93	83.19	36.30	23.35	21.07	10.57	2.09
2021	29	46H1	1 617.07	27.48	56.87	731.12	261.29	153.72	119.35	204.67	43.24	19.32
2021	29	46H2	1.97	0.00	0.33	0.24	0.21	0.18	0.19	0.45	0.01	0.36
2021	29	47G9	1 593.17	11.76	121.18	740.20	252.86	270.11	116.32	80.74	0.00	0.00
2021	29	47H0	173.16	1.44	12.13	75.35	25.62	19.25	10.77	5.24	13.24	10.13
2021	29	47H1	160.14	6.48	6.85	88.02	17.78	11.31	8.68	16.81	2.80	1.41
2021	29	47H2	1 121.74	12.73	268.61	594.92	96.03	49.30	33.84	48.66	12.21	5.44
2021	29	48G9	806.71	93.64	226.95	272.66	54.72	47.78	26.85	14.87	29.91	39.33
2021	29	48H0	1 813.44	128.72	524.61	686.74	142.74	115.53	56.92	29.88	66.57	61.72
2021	29	48H1	1 589.14	63.29	254.16	376.28	129.09	152.32	118.81	83.86	118.42	292.91
2021	29	48H2	264.99	226.24	13.64	8.60	2.65	2.24	1.15	0.93	1.58	7.97

Table 4.1. Continues

YEAR	SD	RECT	TOTAL	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	29	49G9	760.61	95.70	210.08	243.31	50.65	49.77	27.70	17.51	32.41	33.49
2021	30	50G8	1 506.98	363.42	373.11	489.41	193.82	48.46	24.23	9.69	0.00	4.85
2021	30	50G9	432.18	134.39	108.27	105.44	30.53	15.18	11.07	13.74	3.94	9.63
2021	30	50H0	537.05	74.64	240.13	134.67	55.17	11.36	14.60	1.62	4.87	0.00
2021	30	51G7	1 142.02	44.05	206.72	447.32	138.94	111.83	54.22	50.83	47.44	40.67
2021	30	51G8	1 649.98	69.77	278.43	513.90	246.78	220.45	156.53	26.49	23.88	113.75
2021	30	51G9	1 156.71	479.25	198.38	230.82	96.36	23.16	32.66	48.04	11.53	36.51
2021	30	51H0	462.38	51.79	91.01	174.05	82.35	23.19	12.65	5.62	4.91	16.80
2021	30	52G8	1 040.99	3.48	114.34	454.03	259.02	39.28	59.74	70.08	5.13	35.90
2021	30	52G9	739.40	370.39	30.66	195.79	68.63	38.89	11.11	6.25	3.10	14.58
2021	30	52H0	771.48	114.76	44.74	324.68	99.95	69.96	48.69	23.68	25.03	20.00
2021	30	53G8	865.47	112.42	36.90	206.17	253.44	40.83	46.72	90.38	39.31	39.30
2021	30	53G9	971.98	214.27	14.19	182.95	182.79	154.44	83.44	72.32	18.91	48.68
2021	30	53H0	353.67	93.68	14.92	66.46	62.90	26.83	11.96	34.79	5.13	37.00
2021	30	54G8	686.72	0.00	30.75	231.64	200.89	82.00	43.05	63.55	14.35	20.50
2021	30	54G9	961.00	168.93	17.12	193.13	190.12	139.22	109.39	81.85	22.14	39.09
2021	30	54H0	695.33	56.85	58.39	145.54	130.77	94.34	65.64	35.61	14.95	93.23
2021	30	55G9	553.50	8.68	31.23	272.41	114.52	43.38	20.82	32.97	8.68	20.82
2021	30	55H0	537.34	1.63	14.70	129.03	227.02	70.23	26.13	34.30	4.90	29.40
2021	32	47H3	361.91	61.89	85.07	92.45	35.40	45.46	16.95	17.54	7.14	0.00
2021	32	48H3	205.17	52.96	36.28	61.62	4.22	21.61	8.22	1.75	12.31	6.21
2021	32	48H4	325.74	27.48	67.46	105.76	29.18	42.88	18.35	12.08	15.40	7.15
2021	32	48H5	418.71	21.62	195.47	138.65	25.27	23.05	6.11	4.39	2.25	1.90
2021	32	48H6	392.65	12.07	85.23	116.18	50.81	61.96	27.52	23.73	15.16	0.00
2021	32	49H5	80.58	0.00	35.81	31.69	1.30	5.26	1.61	1.23	2.17	1.52
2021	32	49H6	2 125.35	6.73	544.55	687.31	66.00	321.16	134.03	43.02	201.74	120.80

Table 4.2. Estimated numbers (millions) of sprat in September-October 2021, by ICES rectangle and age-group.

YEAR	SD	RECT	TOTAL	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	21	41G0	5.22	0.00	0.15	3.89	1.02	0.11	0.05	0.00	0.00	0.00
2021	21	41G1	25.21	0.00	7.03	15.00	2.77	0.28	0.13	0.00	0.00	0.00
2021	21	41G2	54.09	0.00	8.08	40.85	4.74	0.29	0.13	0.00	0.00	0.00
2021	21	42G1	70.07	0.00	0.86	30.54	31.62	5.53	1.07	0.45	0.00	0.00
2021	21	42G2	12.29	0.00	4.74	6.31	1.12	0.08	0.04	0.00	0.00	0.00
2021	22	37G0	20.14	9.28	3.15	5.78	0.79	0.43	0.71	0.00	0.00	0.00
2021	22	37G1	50.73	12.64	19.81	14.80	2.06	0.92	0.50	0.00	0.00	0.00
2021	22	38G0	19.66	7.14	7.73	2.52	1.96	0.06	0.25	0.00	0.00	0.00
2021	22	38G1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	39F9	0.65	0.60	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	39G0	3.44	0.00	0.38	1.99	0.67	0.19	0.21	0.00	0.00	0.00
2021	22	39G1	0.52	0.49	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	40F9	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	40G0	2.18	0.00	0.70	1.10	0.20	0.06	0.12	0.00	0.00	0.00
2021	22	40G1	1.31	0.00	0.75	0.56	0.00	0.00	0.00	0.00	0.00	0.00
2021	22	41G0	0.63	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00
2021	23	39G2	0.58	0.00	0.03	0.11	0.20	0.12	0.08	0.04	0.00	0.00
2021	23	40G2	58.41	1.42	5.01	28.84	13.02	6.97	0.93	1.86	0.18	0.18
2021	23	41G2	1.14	0.03	0.10	0.56	0.25	0.14	0.02	0.04	0.00	0.00
2021	24	37G2	14.33	8.58	1.72	1.30	1.19	0.84	0.50	0.15	0.05	0.00
2021	24	37G3	49.43	16.41	13.43	8.67	5.54	2.79	1.63	0.95	0.01	0.00
2021	24	37G4	50.38	8.36	10.60	12.28	8.12	4.87	3.94	2.12	0.09	0.00
2021	24	38G2	13.32	4.84	0.51	0.91	2.46	1.98	1.33	0.99	0.30	0.00
2021	24	38G3	686.64	289.18	134.22	120.73	75.10	35.98	19.56	11.70	0.17	0.00
2021	24	38G4	376.56	8.43	72.21	115.06	76.78	44.45	37.24	21.29	1.10	0.00
2021	24	39G2	1.04	0.00	0.06	0.20	0.35	0.22	0.15	0.06	0.00	0.00
2021	24	39G3	270.83	102.83	32.84	50.79	33.93	21.66	18.54	9.54	0.70	0.00
2021	24	39G4	85.89	0.00	10.08	25.42	18.49	13.45	11.47	6.41	0.57	0.00
2021	25	37G5	90.60	0.00	0.47	9.45	13.51	19.24	14.48	23.18	9.06	1.23
2021	25	38G5	767.40	0.00	15.30	136.94	149.31	170.50	105.22	118.18	65.41	6.54
2021	25	38G6	392.49	0.00	7.91	72.14	78.74	87.10	54.77	56.39	32.62	2.81
2021	25	38G7	133.48	0.02	3.66	30.09	26.71	28.85	16.89	17.38	9.16	0.74
2021	25	39G4	697.27	6.36	0.00	94.15	164.00	134.39	7.59	131.35	83.52	75.92
2021	25	39G5	786.27	2.03	37.93	109.97	157.46	195.54	88.06	152.47	7.07	35.74
2021	25	39G6	453.39	2.49	27.03	125.78	84.84	88.20	50.53	46.25	26.53	1.74
2021	25	39G7	339.76	0.04	12.47	85.81	67.74	70.85	41.07	39.00	21.38	1.39
2021	25	40G4	249.12	4.37	1.49	16.45	43.48	26.32	48.07	59.24	48.47	1.24
2021	25	40G5	454.59	11.83	37.55	57.09	143.63	54.45	56.31	27.08	55.34	11.30
2021	25	40G6	2 025.23	10.18	102.11	334.17	590.10	672.04	85.01	95.32	109.32	26.97
2021	25	40G7	672.01	6.24	81.92	161.58	172.44	108.99	105.89	4.05	18.89	12.00
2021	25	41G6	1 861.24	1 331.83	178.32	86.02	82.06	56.89	22.44	37.36	55.60	10.72
2021	25	41G7	3 230.88	26.24	726.01	321.86	782.23	342.22	206.80	309.94	499.61	15.98

Table 4.2. Continues

YEAR	SD	RECT	TOTAL	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	26	37G8	24.48	0.74	6.70	8.85	3.10	2.69	0.85	1.15	0.40	0.00
2021	26	37G9	2 743.50	95.70	1 102.82	887.49	274.06	210.58	63.22	77.27	32.36	0.00
2021	26	38G8	465.59	0.00	95.31	156.24	63.03	63.22	27.89	41.07	16.31	2.52
2021	26	38G9	411.87	0.00	42.34	147.84	65.80	68.27	32.69	40.53	14.04	0.36
2021	26	39G8	143.19	0.00	3.47	37.00	23.70	28.67	15.86	23.02	10.26	1.21
2021	26	39G9	22.22	0.00	1.73	6.51	3.66	3.90	2.16	2.87	1.39	0.00
2021	26	40G8	606.76	0.00	35.22	181.47	97.90	110.11	62.82	81.08	35.42	2.73
2021	26	40G9	82.98	1.89	0.00	2.83	11.32	22.63	31.12	8.49	2.83	1.89
2021	26	40H0	126.69	32.38	6.45	6.26	18.74	39.98	19.70	2.38	0.52	0.26
2021	26	41G8	2 574.04	7.22	338.10	395.79	731.35	526.03	253.42	46.22	259.24	16.67
2021	26	41G9	271.07	7.47	71.69	51.53	26.88	30.62	20.16	12.69	35.84	14.19
2021	26	41H0	749.23	106.63	120.66	115.05	75.76	98.21	53.32	33.67	103.83	42.09
2021	27	42G6	1 576.00	14.39	770.01	401.56	197.18	7.20	37.42	14.39	133.85	0.00
2021	27	42G7	1 103.06	0.00	234.68	438.23	87.98	74.55	100.20	26.28	122.82	18.32
2021	27	43G7	4 339.93	20.71	2 431.21	384.61	1 224.43	67.91	152.46	6.90	44.79	6.90
2021	27	44G7	1 278.02	20.65	636.80	208.33	174.16	54.59	45.54	26.38	88.57	23.01
2021	27	44G8	684.14	3.11	186.58	74.01	129.99	131.85	53.49	14.93	90.18	0.00
2021	27	45G7	3 581.67	277.09	2 106.65	301.71	430.30	181.50	71.76	138.70	55.60	18.37
2021	27	45G8	1 964.12	67.93	1 126.33	295.24	186.77	31.84	198.74	50.85	0.00	6.42
2021	27	46G8	1 891.02	28.40	643.04	489.86	76.11	315.92	2.56	223.88	108.69	2.56
2021	28_2	42G8	1 044.46	0.00	120.36	311.71	267.89	169.91	18.24	63.19	76.78	16.40
2021	28_2	42G9	1 397.56	40.24	435.37	310.98	124.39	117.07	87.80	62.20	171.95	47.56
2021	28_2	42H0	3 195.99	293.14	593.44	886.58	343.19	386.09	193.05	114.40	314.59	71.50
2021	28_2	43G8	899.02	4.52	255.70	440.93	116.56	9.04	18.07	18.07	27.11	9.04
2021	28_2	43G9	2 184.80	16.68	226.96	208.54	747.21	424.29	97.34	126.60	222.82	114.37
2021	28_2	43H0	3 652.79	102.32	716.23	941.33	511.59	532.06	112.55	133.01	429.74	173.94
2021	28_2	43H1	4 910.98	473.35	1 242.54	1 479.21	710.02	769.19	59.17	0.00	177.51	0.00
2021	28_2	44G9	4 286.56	1.98	443.32	1 500.07	928.31	374.65	132.53	573.79	215.43	116.48
2021	28_2	44H0	3 477.76	69.56	660.77	678.16	504.28	347.78	156.50	226.05	539.05	295.61
2021	28_2	44H1	1 862.48	122.13	457.99	498.70	284.97	223.91	61.07	40.71	152.66	20.36
2021	28_2	45G9	507.87	0.68	223.72	39.78	82.97	64.94	42.81	26.72	17.90	8.34
2021	28_2	45H0	497.27	11.01	243.71	85.79	32.66	38.84	23.38	21.33	29.51	11.04
2021	28_2	45H1	2 925.58	19.66	897.24	642.03	270.32	326.03	203.80	200.78	255.53	110.20
2021	29	46G9	935.38	10.00	230.85	193.01	143.64	239.78	18.04	49.50	48.35	2.22
2021	29	46H0	1 549.52	10.45	376.49	458.75	231.49	333.58	43.90	91.45	1.70	1.70
2021	29	46H1	13 017.22	0.00	3 917.64	3 940.14	1 632.42	1 533.57	669.97	369.04	818.87	135.57
2021	29	46H2	1 052.95	3.93	418.30	370.84	90.63	93.33	28.28	9.79	33.70	4.15
2021	29	47G9	3 466.79	29.17	614.07	904.39	849.46	690.94	98.70	148.30	98.70	33.06
2021	29	47H0	886.19	39.11	179.20	289.27	102.72	125.76	19.82	22.99	96.66	10.66
2021	29	47H1	3 329.22	127.73	1 608.85	873.74	238.57	238.66	84.12	38.80	104.06	14.69
2021	29	47H2	12 477.49	2 198.03	6 784.81	1 977.52	531.43	498.59	186.65	67.02	211.01	22.42
2021	29	48G9	2 624.49	375.30	1 674.77	411.12	51.73	53.19	7.37	6.57	40.16	4.28
2021	29	48H0	1 904.12	167.68	869.99	427.68	113.73	137.72	21.30	28.90	116.91	20.21
2021	29	48H1	3 026.83	294.62	1 418.31	615.37	182.71	219.18	33.92	45.19	186.19	31.34
2021	29	48H2	6 060.89	1 369.19	3 097.02	950.36	202.85	212.39	32.36	28.36	155.90	12.47
2021	29	49G9	717.47	137.09	381.76	109.72	20.86	26.91	4.33	6.78	25.63	4.39

Table 4.2. Continues

YEAR	SD	RECT	TOTAL	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	30	50G8	116.66	14.92	75.34	11.86	3.89	2.66	1.43	1.49	4.41	0.66
2021	30	50G9	372.18	44.98	90.03	107.10	23.01	35.69	13.21	12.79	39.92	5.45
2021	30	50H0	265.01	18.19	107.56	52.70	13.26	17.77	8.56	8.75	31.97	6.25
2021	30	51G7	150.30	0.00	13.66	32.00	11.46	18.89	10.27	12.00	42.52	9.50
2021	30	51G8	95.84	0.00	11.47	19.25	6.72	11.68	6.79	6.71	26.65	6.57
2021	30	51G9	48.57	0.00	5.80	15.22	3.82	6.50	3.13	2.64	9.43	2.04
2021	30	51H0	546.79	0.00	48.45	97.65	37.10	64.76	32.50	46.77	178.81	40.74
2021	30	52G8	49.42	0.00	6.60	9.20	3.11	5.40	3.13	3.69	14.63	3.66
2021	30	52G9	38.98	0.00	8.57	9.20	2.65	4.16	2.14	2.35	8.18	1.73
2021	30	52H0	42.52	0.00	12.56	10.61	2.55	4.28	1.83	1.90	7.32	1.47
2021	30	53G8	84.88	0.00	15.30	16.97	5.44	8.98	4.93	5.73	22.18	5.34
2021	30	53G9	13.58	0.00	3.86	2.33	0.77	1.10	0.72	0.79	3.21	0.80
2021	30	53H0	89.67	0.25	22.83	16.11	4.91	7.67	4.15	5.45	22.58	5.71
2021	30	54G8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2021	30	54G9	26.67	1.25	3.97	4.84	1.69	2.72	1.54	1.76	7.12	1.77
2021	30	54H0	53.24	0.00	2.12	7.67	3.62	6.66	4.00	4.63	19.48	5.06
2021	30	55G9	24.58	0.00	9.67	3.94	1.33	1.96	1.15	1.24	4.34	0.95
2021	30	55H0	9.05	0.00	1.19	2.20	0.70	1.16	0.64	0.58	2.09	0.49
2021	32	47H3	25 143.75	1 080.71	11 360.13	8 477.32	1 328.78	1 213.45	571.42	307.01	774.63	30.30
2021	32	48H3	3 315.51	57.58	1 468.40	1 009.72	199.41	202.25	60.29	52.09	254.13	11.64
2021	32	48H4	7 849.82	337.74	3 311.49	2 676.36	429.06	424.86	148.91	88.89	419.06	13.44
2021	32	48H5	11 333.99	139.26	4 263.09	4 546.30	723.75	724.47	334.92	141.27	460.92	0.00
2021	32	48H6	18 689.67	275.65	9 953.78	5 891.40	795.38	735.71	322.62	169.38	522.17	23.59
2021	32	49H5	3 783.10	171.96	1 605.93	1 188.47	187.61	211.25	58.41	70.83	263.38	25.27
2021	32	49H6	4 578.14	57.23	1 983.80	1 644.12	225.01	254.23	52.04	52.48	296.15	13.08

Table 4.3. Estimated numbers (millions) of cod in September-October 2005-2021, by ICES rectangle.

SD	RECT	Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
24	37G2	192.4	2.2	0.0	1.8	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	1.3	0.0	0.3	0.0	0.0	0.0
24	37G3	167.7	0.0	4.1	0.9	1.2	0.7	4.3	0.0	2.0	1.1	0.9	0.2	2.3	11.4	2.5	2.9	1.3	0.8
24	37G4	875.1	9.5	0.1	4.3	5.2	1.4	2.6	0.0	0.0	19.7	0.3	3.3	0.9	4.6	0.5	0.5	1.2	0.4
24	38G2	832.9	10.9	0.0	2.0	0.0	0.0	1.9	1.1	6.0	0.5	0.0	0.0	22.8	0.0	15.9	0.0	0.5	5.8
24	38G3	865.7	0.3	0.0	1.6	1.1	2.0	3.6	0.4	4.4	0.9	25.8	1.2	2.1	4.5	16.3	3.0	4.5	0.6
24	38G4	1034.8	6.2	0.5	9.7	13.7	1.0	4.4	0.4	2.1	1.7	0.6	14.1	1.9	20.1	5.6	0.9	0.2	3.4
24	39G2	406.1	1.5	3.9	1.8	0.4	1.3	3.8	0.1	0.9	0.0	1.7	0.1	2.3	2.5	0.4	0.0	0.4	0.0
24	39G3	765.0	17.9	3.8	13.9	2.8	0.6	3.8	0.3	2.1	5.1	18.7	2.2	1.1	1.7	9.1	2.8	0.4	2.8
24	39G4	524.8	2.7	1.8	2.4	1.2	1.6	7.1	0.2	0.4	1.2	4.2	1.1	7.9	3.0	1.4	1.9	1.8	1.3
25	37G5	642.2	17.8	0.3	1.3	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.1	0.2	0.0
25	38G5	1035.7	57.3	2.1	5.2	0.7	2.9	4.5	18.4	19.9	5.0	3.4	2.9	1.0	1.7	10.0	0.5	0.3	0.9
25	38G6	940.2	9.5	3.0	17.1	2.5	0.3	0.2	0.0	15.5	0.0	0.0	0.0	0.4	0.0	0.3	0.1	0.2	0.4
25	38G7	471.7	0.0	0.1	0.0	0.9	0.4	0.8	0.0	0.2	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	0.0
25	39G4	287.3	2.7	28.5	0.2	4.4	0.3	0.3	0.2	0.6	0.5	2.9	4.2	0.0	1.2	5.2	2.0	0.0	0.0
25	39G5	979.0	1.5	3.6	1.8	3.1	2.5	6.2	71.3	8.9	4.1	5.8	0.7	3.4	0.8	2.3	1.6	0.6	1.2
25	39G6	1026.0	0.9	6.5	0.7	4.1	0.5	16.7	3.5	0.0	0.0	0.2	0.1	0.1	0.9	0.9	0.1	0.1	0.4
25	39G7	1026.0	47.4	0.5	0.4	5.8	0.3	0.2	2.2	0.0	0.0	0.5	0.1	0.0	0.7	7.6	0.0	0.1	0.1
25	40G4	677.2	1.4	5.5	15.9	0.2	19.2	0.3	25.3	15.2	2.1	31.0	38.3	7.4	8.4	10.7	8.8	9.5	1.6
25	40G5	1012.9	2.4	7.6	4.9	25.1	1.8	0.8	14.0	5.5	1.2	8.0	31.0	3.1	0.3	1.2	56.3	1.8	0.5
25	40G6	1013.0	1.1	6.5	0.2	5.9	6.5	7.0	30.8	5.7	0.2	53.6	17.0	1.8	4.3	0.2	16.1	0.3	6.4
25	40G7	1013.0	5.7	5.8	0.0	6.3	3.5	0.5	18.6	42.7	0.3	7.8	0.0	3.1	2.7	0.0	0.0	0.0	0.1
25	41G6	764.4	2.7	14.8	0.0	2.5	0.6	0.4	0.0	1.0	0.0	0.8	0.2	18.9	0.0	0.2	2.2	3.1	0.1
25	41G7	1000.0	0.1	1.9	8.7	0.3	4.4	1.1	61.9	29.8	35.3	0.0	0.5	0.7	0.9	0.6	0.0	12.7	0.0
26	37G8	86.0	0.5	3.2	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0
26	37G9	151.6	37.6	0.9	1.6	1.0	0.3	0.2	0.5	0.6	0.0	0.2	0.2	0.1	2.5	0.0	0.0	0.0	0.0
26	38G8	624.6	37.1	5.0	1.7	3.4	2.0	1.4	1.3	7.2	0.0	1.0	7.1	0.1	2.0	15.1	0.0	0.3	1.7
26	38G9	918.2	0.0	0.0	0.0	0.0	0.5	0.0	2.6	4.5	49.2	6.5	0.3	0.6	0.5	0.1	1.7	1.9	1.0
26	39G8	1026.0	32.3	22.1	1.6	0.8	4.3	9.4	19.9	5.2	0.0	0.5	0.4	0.2	0.6	1.4	2.5	0.2	0.1
26	39G9	1026.0	0.0	0.0	0.0	0.0	0.7	0.0	1.8	0.0	3.1	4.7	7.3	0.3	1.2	0.4	0.2	0.7	0.0
26	39H0	881.6	-	-	-	-	0.0	0.0	0.0	-	-	-	-	0.3	0.1	-	0.0	-	-
26	40G8	1013.0	17.8	4.6	0.5	0.2	0.5	13.5	4.0	3.2	0.0	0.1	2.7	0.1	0.6	1.5	21.8	1.0	0.0
26	40G9	1013.0	0.0	-	0.0	0.0	3.0	0.0	0.4	5.9	9.1	0.8	-	0.8	1.4	0.1	0.1	0.0	0.0
26	40H0	1012.1	5.1	-	0.0	0.7	34.6	51.7	1.1	0.2	0.1	0.1	-	5.1	0.0	107.8	0.0	0.0	0.0
26	41G8	1000.0	0.0	2.6	-	0.0	2.3	3.2	21.9	19.2	0.9	1.3	0.0	1.5	0.7	1.2	9.1	5.5	2.8
26	41G9	1000.0	10.0	0.1	3.2	0.2	0.0	1.0	0.0	0.0	0.3	195.8	1.6	0.0	0.0	-	0.0	0.7	0.0
26	41H0	953.3	54.5	0.2	3.4	1.9	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0
27	42G6	266.0	-	2.2	0.0	0.0	1.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0
27	42G7	986.9	1.0	1.1	0.5	0.0	0.9	0.0	1.6	0.6	0.7	0.9	0.0	2.7	0.0	0.0	4.0	0.0	0.0
27	43G6	269.8	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-
27	43G7	913.8	0.0	22.0	0.0	0.1	0.0	0.5	0.1	0.0	1.9	2.7	0.0	3.2	0.0	0.0	0.0	0.0	0.0
27	44G7	960.5	0.0	1.2	1.3	0.4	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.5	0.1	0.2	0.0	0.0	0.0
27	44G8	456.6	0.0	0.0	0.0	0.0	0.5	0.2	0.1	0.0	0.2	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
27	45G7	908.7	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0
27	45G8	947.2	0.0	2.2	0.2	0.0	0.0	0.0	0.0	0.0	1.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	46G8	884.8	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0	0.0	0.2	0.1	0.0	0.0	0.0

Table 4.3. Continues

SD	RECT	Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
28_2	42G8	945.4	4.7	0.0	3.7	3.3	0.5	1.3	0.0	1.6	4.7	1.8	0.0	0.8	0.5	0.0	0.1	8.4	0.0
28_2	42G9	986.9	0.0	0.2	0.6	1.3	0.0	0.0	0.0	0.0	4.9	293.8	0.0	0.0	0.2	-	0.0	0.7	0.0
28_2	42H0	968.5	0.0	0.4	10.4	2.9	0.0	0.1	0.0	0.0	0.3	1.2	0.1	0.0	0.1	-	0.0	0.1	0.0
28_2	43G8	296.2	0.3	0.0	0.0	0.2	0.0	0.0	0.0	5.6	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28_2	43G9	973.7	0.0	0.2	12.7	2.1	1.4	0.0	0.0	8.2	11.8	0.0	0.0	0.0	3.9	0.0	0.0	11.1	0.0
28_2	43H0	973.7	0.0	0.1	3.6	0.0	0.0	0.1	0.0	0.0	0.6	3.6	0.3	0.0	0.1	-	0.0	0.2	0.0
28_2	43H1	412.7	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	-	0.0	-	-	0.0	0.1	0.0
28_2	44G9	876.6	0.0	0.0	0.5	0.6	0.0	0.9	2.3	2.6	2.7	2.9	0.0	3.3	0.1	0.1	0.0	0.0	0.0
28_2	44H0	960.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	238.7	11.7	0.0	0.2	-	0.0	0.0	0.0
28_2	44H1	824.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.0	0.0	0.0	-	-	0.0	0.0	0.0
28_2	45G9	924.5	0.3	0.0	0.1	0.0	0.4	0.0	0.0	0.6	0.6	0.0	0.0	0.9	0.1	0.6	0.3	24.9	0.2
28_2	45H0	947.2	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	13.2	0.0	0.1	1.1
28_2	45H1	827.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.7	0.6	0.0	0.0	0.0	0.0	0.0
29	46G9	933.8	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.1	0.3	0.0	0.0
29	46H0	933.8	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.2	0.0	0.0	0.0	0.0
29	46H1	921.5	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
29	46H2	258.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	47G9	876.2	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
29	47H0	920.3	0.0	0.0	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.1
29	47H1	920.3	0.0	0.0	0.0	0.0	0.0	0.0	8.8	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.8	0.0	0.0
29	47H2	793.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
29	48G9	772.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	48H0	730.3	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0
29	48H1	544.0	-	-	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	2.8	0.0
29	48H2	597.0	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0
29	49G9	564.2	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: The numbers for the year 2016 have changed in 9 rectangles as the corrected POL BIAS 2016 data were included into BIAS_db during WGBIFS meeting in 2020 - red coloured numbers.

Table 4.4. Estimated numbers (millions) of herring in September-October 2021 by ICES Subdivision and age-group.

YEAR	SD	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	21	12.15	100.36	7.20	3.30	0.78	0.00	1.13	0.00	0.00
2021	22	224.14	3.37	0.91	1.97	0.54	0.54	0.00	0.00	0.00
2021	23	2.94	10.47	43.69	37.53	27.58	12.20	4.41	1.98	0.28
2021	24	208.92	110.37	314.06	340.03	304.54	107.01	69.76	54.31	0.97
2021	25	54.22	195.54	2 266.39	1 143.84	1 362.67	869.55	513.32	437.56	25.08
2021	26	1 197.26	223.14	1 670.60	1 295.75	1 355.74	865.43	643.42	932.78	226.96
2021	27	699.50	1 096.71	2 748.03	845.34	1 017.15	661.53	365.71	202.37	19.00
2021	28_2	135.53	157.89	2 528.04	1 307.67	1 158.58	998.47	918.55	419.98	42.05
2021	29	671.05	1 719.58	4 087.04	1 139.75	931.77	564.81	551.99	357.55	474.17
2021	30	2 362.40	1 903.97	4 497.42	2 633.99	1 253.01	832.67	701.81	258.19	620.70
2021	32	182.74	1 049.87	1 233.67	212.18	521.38	212.79	103.74	256.16	137.58

Table 4.5. Estimated numbers (millions) of sprat in September-October 2021 by ICES Subdivision and age-group.

YEAR	SD	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	21	0.00	20.86	96.59	41.27	6.29	1.42	0.45	0.00	0.00
2021	22	30.18	32.53	27.45	5.68	1.66	1.79	0.00	0.00	0.00
2021	23	1.45	5.14	29.51	13.47	7.23	1.03	1.94	0.18	0.18
2021	24	438.63	275.67	335.36	221.96	126.24	94.36	53.21	2.99	0.00
2021	25	1 401.62	1 232.18	1 641.50	2 556.25	2 055.57	903.12	1 117.20	1 041.97	204.31
2021	26	252.02	1 824.50	1 996.86	1 395.31	1 204.92	583.20	370.46	512.43	81.92
2021	27	432.29	8 135.30	2 593.54	2 506.91	865.36	662.16	502.31	644.51	75.58
2021	28_2	1 155.26	6 517.34	8 023.81	4 924.35	3 783.80	1 206.31	1 606.85	2 630.58	994.82
2021	29	4 762.30	21 572.05	11 521.92	4 392.25	4 403.61	1 248.76	912.67	1 937.85	297.15
2021	30	79.59	438.97	418.85	126.04	202.04	100.11	119.27	444.86	98.19
2021	32	2 120.13	33 946.63	25 433.71	3 888.99	3 766.23	1 548.61	881.94	2 990.44	117.32

4.1.1.3 Area-corrected data

During the WGBIFS meeting in 2006, a possible improvement of presenting the results from acoustic surveys was discussed. As a result, a correction factor for each ICES Subdivision and year was introduced because of the different coverage of investigated areas between years. This factor is the proportion between the total area of the ICES Subdivision that are presented in the IBAS Manual and the area of the ICES rectangles, which was covered during the survey. Some disagreements appeared about the area of ICES Subdivision 28. It was agreed that the Gulf of Riga (ICES Subdivision 28_1) must be excluded from the total area. All other ICES Subdivisions kept their areas as specified in the IBAS manual (Table 2.2).

The area-corrected abundance estimates for herring and sprat per the ICES Subdivision and age-group are summarized in Tables 4.6 and 4.7, respectively. Biomass for herring and sprat per the ICES Subdivision and age-group are summarized in Tables 4.8 and 4.9, respectively.

Table 4.6. Area-corrected numbers (millions) of herring by ICES Subdivision and age-group (September-October 2021).

YEAR	SD	AREA CORR FACTOR	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	21	1.55	18.79	155.17	11.13	5.10	1.21	0.00	1.75	0.00	0.00
2021	22	1.02	228.76	3.44	0.93	2.01	0.55	0.55	0.00	0.00	0.00
2021	23	1.00	2.94	10.47	43.69	37.53	27.58	12.20	4.41	1.98	0.28
2021	24	1.00	208.92	110.37	314.06	340.03	304.54	107.01	69.76	54.31	0.97
2021	25	1.03	55.95	201.80	2 338.89	1 180.43	1 406.26	897.36	529.74	451.56	25.88
2021	26	1.10	1 319.76	245.97	1 841.52	1 428.32	1 494.45	953.97	709.25	1 028.22	250.18
2021	27	1.23	860.90	1 349.76	3 382.11	1 040.39	1 251.85	814.18	450.09	249.06	23.38
2021	28_2	1.01	137.31	159.96	2 561.17	1 324.81	1 173.77	1 011.56	930.59	425.48	42.60
2021	29	1.04	697.72	1 787.92	4 249.45	1 185.04	968.80	587.25	573.93	371.76	493.01
2021	30	1.15	2 711.58	2 185.39	5 162.17	3 023.31	1 438.22	955.74	805.54	296.35	712.45
2021	32	1.69	309.70	1 779.30	2 090.80	359.60	883.63	360.63	175.81	434.14	233.16

Table 4.7. Area-corrected numbers (millions) of sprat by ICES Subdivision and age-group (September-October 2021).

YEAR	SD	AREA CORR FACTOR	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	21	1.55	0.00	32.25	149.34	63.81	9.72	2.20	0.70	0.00	0.00
2021	22	1.02	30.80	33.20	28.02	5.80	1.69	1.83	0.00	0.00	0.00
2021	23	1.00	1.45	5.14	29.51	13.47	7.23	1.03	1.94	0.18	0.18
2021	24	1.00	438.63	275.67	335.36	221.96	126.24	94.36	53.21	2.99	0.00
2021	25	1.03	1 446.46	1 271.59	1 694.01	2 638.02	2 121.32	932.01	1 152.94	1 075.31	210.85
2021	26	1.10	277.81	2 011.17	2 201.16	1 538.07	1 328.19	642.87	408.36	564.86	90.31
2021	27	1.23	532.03	10 012.42	3 191.96	3 085.35	1 065.03	814.94	618.21	793.22	93.02
2021	28_2	1.01	1 170.40	6 602.76	8 128.98	4 988.90	3 833.40	1 222.12	1 627.92	2 665.06	1 007.86
2021	29	1.04	4 951.55	22 429.31	11 979.80	4 566.80	4 578.61	1 298.39	948.94	2 014.86	308.96
2021	30	1.15	91.35	503.85	480.76	144.67	231.90	114.91	136.90	510.61	112.70
2021	32	1.69	3 593.15	57 532.08	43 104.55	6 590.99	6 382.93	2 624.55	1 494.69	5 068.13	198.83

Table 4.8. Estimated biomass (in tons) of herring in September-October 2021.

YEAR	SD	AREA CORR FACTOR	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	21	1.55	300.5	6 859.6	673.0	334.2	40.5	0.0	78.7	0.0	0.0
2021	22	1.02	2 437.9	131.8	33.8	63.0	17.5	15.8	0.0	0.0	0.0
2021	23	1.00	47.4	601.0	3 842.5	3 099.2	2 346.9	1 245.8	391.8	137.9	40.8
2021	24	1.00	2 275.8	2 591.8	10 870.3	11 716.9	10 803.7	4 518.8	3 258.3	2 947.2	71.8
2021	25	1.03	675.0	3 693.4	53 523.4	33 504.6	44 595.9	30 843.7	19 227.4	17 236.5	1 051.0
2021	26	1.10	6 118.0	5 591.0	41 551.4	36 937.6	44 573.9	32 261.5	24 878.0	38 695.1	11 680.8
2021	27	1.23	4 212.4	16 019.3	60 684.7	23 323.1	31 289.9	21 309.3	11 566.8	7 202.8	822.5
2021	28_2	1.01	952.1	2 464.9	49 148.2	30 771.1	30 129.9	26 614.8	26 823.6	11 563.2	1 316.0
2021	29	1.04	2 789.5	22 991.4	74 071.5	24 893.4	21 783.9	14 002.6	14 255.9	8 716.3	15 649.3
2021	30	1.15	8 609.9	31 952.9	95 904.0	63 764.2	34 873.7	24 697.0	22 492.2	8 811.2	24 923.4
2021	32	1.69	1 320.9	20 920.8	34 169.1	7 268.9	18 270.9	7 868.6	3 833.0	9 669.8	5 554.4

Table 4.9. Estimated biomass (in tons) of sprat in September-October 2021.

YEAR	SD	AREA CORR FACTOR	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	21	1.55	0.0	370.0	2 265.7	1 238.1	207.3	41.0	16.7	0.0	0.0
2021	22	1.02	170.4	328.6	360.2	94.8	29.3	31.7	0.0	0.0	0.0
2021	23	1.00	6.7	80.3	521.2	255.1	148.8	24.8	43.1	4.6	4.3
2021	24	1.00	1 881.4	3 441.0	4 756.3	3 228.9	1 958.6	1 529.8	855.6	55.0	0.0
2021	25	1.03	4 948.7	10 156.7	18 307.2	31 257.5	27 634.0	12 069.8	16 240.2	14 335.8	3 442.2
2021	26	1.10	1 163.4	16 484.5	21 452.7	17 464.3	15 498.7	7 668.1	5 066.1	6 831.7	1 227.9
2021	27	1.23	2 017.6	69 820.4	30 517.2	29 187.1	11 546.7	8 774.3	6 669.9	8 724.2	1 120.3
2021	28_2	1.01	5 774.2	54 519.3	84 409.0	55 220.2	45 213.4	14 265.1	19 992.6	32 725.2	12 331.5
2021	29	1.04	18 272.7	157 972.4	108 827.6	46 183.1	46 752.0	13 948.4	10 996.8	21 625.5	3 662.2
2021	30	1.15	352.0	4 631.2	5 492.0	1 754.8	2 921.5	1 490.9	1 824.9	6 948.2	1 592.7
2021	32	1.69	14 058.1	386 908.0	361 327.9	60 881.9	60 712.2	24 781.5	15 750.4	45 646.2	2 195.5

4.1.1.4 Tuning fleets for WGBFAS

4.1.1.4.1 Herring in the ICES Subdivisions 25–29

The tuning fleet for the assessment of the Central Baltic herring (CBH) abundance in the ICES Subdivisions 25-29 per age-group and for the years 1991-2021 (BIAS) is presented in Figure 4.7, with inclusion of the data from the ICES Subdivision 29N. The area-corrected combined results (for age 1+ CBH) of the above-mentioned ICES Subdivisions are presented in Table 4.10. The recruitment index for herring (age 0) in the ICES Subdivisions 25-29 is presented in Table 4.11.

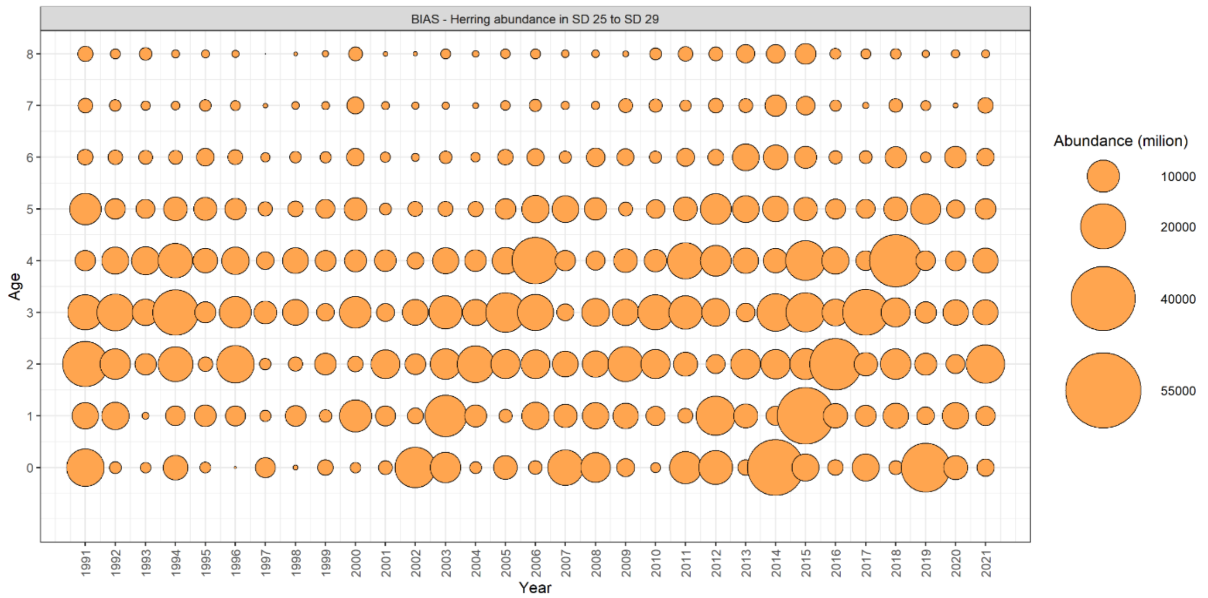


Figure 4.7. Autumn (BIAS) tuning fleet index (abundance per age-groups and years 1991-2021) for herring in the ICES Subdivisions 25-29.

Table 4.10. ***Whole time-series of tuning indices*****. Autumn acoustic (BIAS) tuning fleet index (numbers in millions) for the Central Baltic herring (the ICES Subdivisions 25–27, 28.2 and 29, including the existing data of the ICES Subdivision 29 North).**

YEAR	TOTAL AGE 1-8	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
1991	59 944.22	6 942.71	20 002.43	11 963.95	4 148.43	9 642.76	2 511.21	2 280.03	2 452.71
1992	45 994.83	7 416.92	9 155.99	13 177.55	7 156.18	4 107.91	2 273.74	1 539.52	1 167.03
1993	28 396.39	709.95	4 539.70	6 809.39	7 830.70	3 619.01	2 054.43	1 089.66	1 743.56
1994	57 157.97	3 924.41	11 881.25	20 303.84	11 526.53	5 653.24	2 098.90	940.75	829.04
1995	28 048.83	4 663.87	2 235.90	4 464.12	5 908.27	5 286.76	3 156.91	1 503.95	829.06
1996	43 944.57	3 985.13	13 761.96	9 989.35	7 360.96	4 532.76	2 358.59	1 178.87	776.94
1997	15 438.37	1 447.81	1 544.65	5 182.71	3 237.17	2 156.86	1 091.16	466.71	311.32
1998	24 922.96	4 285.08	2 170.72	6 617.17	6 520.67	2 584.07	1 523.58	791.27	430.41
1999	20 511.87	1 754.15	4 741.92	3 193.65	4 251.46	3 679.73	1 427.81	833.20	629.96
2000	40 924.36	10 151.18	2 560.04	9 873.66	4 837.59	5 200.35	3 234.04	3 006.83	2 060.67
2001	24 300.57	4 028.51	8 194.34	3 286.15	4 660.79	1 567.36	1 238.05	861.26	464.12
2002	20 672.28	2 686.92	4 242.02	6 508.41	2 842.26	2 326.29	869.78	741.28	455.30
2003	49 161.77	16 704.18	9 115.70	10 643.33	6 689.95	2 319.57	1 777.96	755.07	1 156.00
2004	34 519.87	4 913.56	13 229.49	6 788.89	4 672.24	2 500.08	1 132.10	603.52	679.98
2005	41 760.33	1 920.24	8 250.78	15 344.88	7 123.19	4 355.80	2 540.70	1 095.95	1 128.80
2006	62 514.29	7 316.60	8 059.84	12 700.27	21 120.77	7 336.31	3 068.12	1 700.65	1 211.72
2007	29 634.05	5 400.70	6 587.26	2 974.88	4 191.03	7 092.91	1 696.87	882.93	807.46
2008	35 039.19	6 841.54	6 822.40	7 588.80	3 612.67	4 926.52	3 563.14	877.07	807.05
2009	38 653.24	6 408.78	12 141.39	6 820.28	5 551.44	2 058.64	2 969.48	2 089.22	614.00
2010	37 891.76	3 829.47	8 278.75	12 047.60	5 006.24	3 542.80	1 684.71	1 901.90	1 600.30
2011	44 141.66	2 338.71	5 667.81	10 992.95	12 668.94	5 525.30	3 257.40	1 448.43	2 242.12
2012	51 695.69	14 947.97	3 630.05	7 544.67	9 345.39	9 199.52	2 684.65	2 261.89	2 081.55
2013	43 899.02	5 749.38	8 664.02	3 552.75	6 384.38	6 987.04	7 039.66	2 126.88	3 394.91
2014	52 626.21	3 675.26	8 562.66	13 769.67	5 860.66	6 584.71	5 993.28	4 619.10	3 560.88
2015	89 037.51	31 108.39	9 401.50	15 005.57	15 429.65	5 440.33	4 799.20	3 600.45	4 252.43
2016	54 980.13	5 965.99	25 967.18	7 044.23	7 216.67	4 018.13	1 945.89	1 415.40	1 406.65
2017	41 451.96	4 453.61	5 361.84	20 366.65	3 944.99	3 662.63	1 823.71	628.36	1 210.17
2018	64 019.78	6 305.59	9 085.34	8 407.83	26 662.55	5 605.84	4 625.35	2 016.14	1 311.15
2019	28 754.11	3 165.78	4 812.26	4 618.99	3 924.85	8 966.07	1 337.25	1 171.60	757.31
2020	30 285.30	6 915.52	3 725.40	6 332.15	3 984.91	3 269.78	4 662.04	487.86	907.63
2021	41 391.71	3 745.41	14 373.14	6 158.99	6 295.12	4 264.32	3 193.60	2 526.07	835.06

Note: The coverage of the ICES Subdivision 29N was very inconsistent until 2007. In the years, 1993, 1995 and 1997 the total coverage was very poor. It is recommended that these data should not be used. Also, the numbers for years 2013-2016 and 2018-2019 have changed after the corrected FIN BIAS 2013-2021 data and POL BIAS 2016 data were included into the BIAS database during the WGBIFS meeting in 2020 and 2022. These values are marked in blue.

Table 4.11. Autumn acoustic (BIAS) recruitment index (age 0; numbers in millions) for the Central Baltic herring (the ICES Subdivisions 25-27, 28.2 and 29, including the existing data of the ICES Subdivision 29 North).

YEAR	AGE 0
1991	13 732.73
1992	1 607.67
1993	1 297.73
1994	6 122.03
1995	1 356.71
1996	336.39
1997	4 050.41
1998	507.52
1999	2 591.05
2000	1 318.96
2001	2 122.76
2002	16 046.38
2003	9 066.54
2004	1 586.72
2005	5 567.63
2006	1 990.13
2007	12 197.22
2008	8 673.16
2009	3 365.99
2010	1 177.97
2011	10 098.28
2012	11 140.63
2013	2 582.46
2014	30 301.41
2015	7 174.81
2016	2 572.69
2017	7 183.88
2018	2 052.24
2019	23 348.25
2020	5 763.23
2021	3 071.64

Note: The coverage of the ICES Subdivision 29N has been very inconsistent until 2007. In the years, 1993, 1995 and 1997 the total coverage was very poor. It is recommended that these data should not be used. Also, the numbers for years 2013-2016 have changed after the corrected FIN BIAS 2013-2021 data and POL BIAS 2016 data were included into the BIAS database during the WGBIFS meeting in 2020 and 2022. These values are marked in blue.

4.1.1.4.2 Sprat in the ICES Subdivisions 22–29

The tuning fleet for the assessment of sprat abundance in the ICES Subdivisions 22-29 per age-group and for the years 1991-2021 (BIAS) is presented in Figure 4.8. The area-corrected combined results (for age 1+ sprat) of the above-mentioned ICES Subdivisions are presented in Table 4.12. The recruitment index for sprat (age 0) in the ICES Subdivisions 22-29 is presented in Table 4.13.

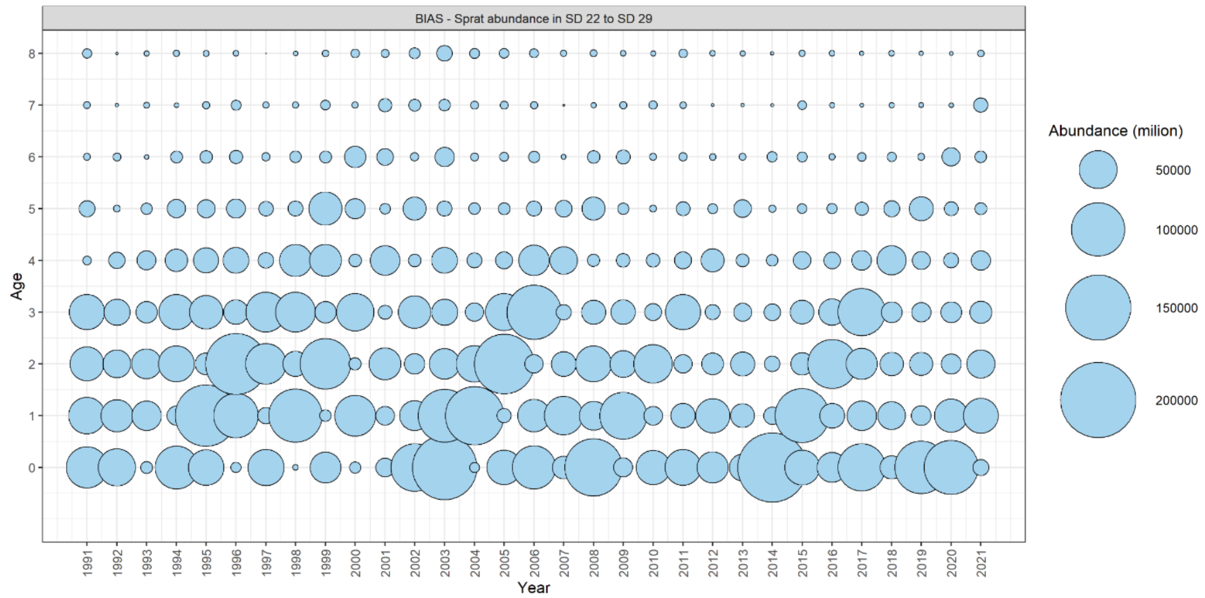


Figure 4.8. Autumn (BIAS) tuning fleet index (abundance per age-groups and years 1991-2021) for sprat in the ICES Subdivisions 22-29.

Table 4.12. ***Whole time-series of tuning indices*. Autumn acoustic (BIAS) tuning fleet index (numbers in millions) for Baltic sprat (ICES Subdivisions 22–29).**

YEAR	TOTAL AGE 1-8	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
1991	149 058.78	46 487.55	40 298.51	43 681.07	2 743.40	8 923.78	1 850.70	1 956.55	3117.22
1992	102 482.10	36 519.48	26 991.22	24 050.54	9 289.37	1 920.67	2 436.59	714.03	560.20
1993	98 533.51	30 598.67	30 890.12	16 143.51	12 681.94	4 602.94	989.26	1 451.80	1175.27
1994	137 290.10	12 531.57	44 587.69	43 274.48	17 271.54	11 924.82	5 111.65	1 028.95	1559.41
1995	231 515.93	133 193.30	16 471.15	39 297.74	22 146.93	11 336.09	5 565.78	2 104.11	1400.83
1996	268 983.16	69 994.44	130 760.26	20 797.14	23 240.90	12 777.76	6 405.11	3 696.69	1310.87
1997	143 508.24	9 279.48	57 189.82	56 067.88	8 711.23	7 627.08	2 577.01	1 638.94	416.80
1998	229 727.74	100 615.48	21 975.06	55 422.01	36 291.46	8 055.62	4 734.54	1 623.02	1010.56
1999	195 727.24	4 892.39	90 049.98	15 989.26	35 716.70	38 820.46	5 230.64	3 289.62	1738.19
2000	153 298.39	58 702.70	5 284.94	49 634.73	5 676.06	13 932.76	15 834.60	1 554.39	2678.20
2001	107 308.72	12 047.44	35 686.65	6 927.47	30 236.94	4 028.43	9 605.64	6 369.57	2406.58
2002	118 874.55	31 208.71	14 414.86	36 762.80	5 733.13	18 735.12	2 638.09	5 036.99	4344.84
2003	213 176.56	99 128.90	32 269.59	24 035.40	23 198.49	8 015.62	13 163.37	4 830.62	8534.58
2004	199 357.55	119 497.31	47 026.76	11 638.43	7 928.99	4 875.78	2 449.65	2 388.71	3551.91
2005	204 805.07	7 082.11	125 148.06	48 723.56	10 035.20	5 115.68	3 010.70	2 364.40	3325.36
2006	201 584.17	36 531.26	11 773.53	103 289.44	32 411.85	7 937.24	4 582.91	2 110.57	2947.37
2007	120 744.73	51 888.04	21 665.20	8 174.53	26 102.00	9 800.35	1 066.69	470.39	1577.52
2008	127 064.04	28 804.63	45 117.75	20 134.34	5 350.44	18 819.87	5 678.43	1 241.37	1917.21
2009	145 140.98	77 342.78	25 333.42	20 839.86	6 546.99	4 667.38	7 023.48	2 011.35	1375.72
2010	88 295.36	12 048.42	51 771.79	10 275.01	6 594.51	1 880.19	1 951.11	2 591.36	1182.97
2011	99 587.07	20 620.08	11 656.53	43 356.67	9 989.74	6 746.61	2 614.83	1 794.67	2807.94
2012	90 590.08	40 515.77	16 525.13	7 935.32	18 412.56	3 494.33	1 732.67	606.20	1368.12
2013	72 073.19	19 702.86	20 486.34	11 242.82	6 040.50	10 792.27	1 882.27	765.63	1160.51
2014	41 224.08	10 665.29	8 623.21	9 735.00	4 933.43	2 033.89	3 778.55	681.04	773.67
2015	162 095.71	102 246.65	17 405.51	19 931.64	11 138.29	3 456.30	3 574.47	2 795.32	1547.51
2016	147 014.76	21 095.23	83 781.72	24 620.95	9 567.92	3 890.70	1 540.00	1 220.12	1 298.10
2017	166 670.25	30 170.75	33 936.85	78 088.23	13 673.42	6 371.96	2 680.92	822.75	925.38
2018	105 294.21	26 878.92	19 204.34	14 849.34	29 574.50	9 134.61	3 134.31	1 182.26	1335.94
2019	81 137.73	13 606.28	18 830.75	13 161.85	11 293.49	20 375.77	1 837.61	1 119.01	912.97
2020	96 402.57	38 624.54	14 225.55	15 142.36	7 983.64	6 798.67	11 729.59	1 037.22	861.00
2021	118 996.84	42 641.27	27 588.79	17 058.36	13 061.71	5 007.55	4 811.51	7 116.48	1 711.18

Note: In the years, 1993, 1995 and 1997 the coverage was very poor. It is recommended that these data should not be used. Also, the numbers of the years 2013-2016 and 2019 have changed after the corrected FIN BIAS 2013-2021 data and POL BIAS 2016 data were included into the BIAS database during the WGBIFS meeting in 2021 and 2022. These values are marked in blue.

Table 4.13. Autumn acoustic (BIAS) recruitment index (age 0; numbers in millions) for sprat (ICES Subdivisions 22-29).

YEAR	SPR_AGE0
1991	59 472.84
1992	48 035.33
1993	5 173.57
1994	64 092.10
1995	44 364.82
1996	3 841.55
1997	45 947.64
1998	1 279.14
1999	33 320.45
2000	4 601.26
2001	12 000.66
2002	79 550.86
2003	146 334.99
2004	3 562.32
2005	41 862.94
2006	66 125.22
2007	17 821.04
2008	115 698.22
2009	12 798.16
2010	41 158.22
2011	45 186.05
2012	33 653.39
2013	24 921.17
2014	168 124.77
2015	42 251.07
2016	31 145.60
2017	78 166.60
2018	18 541.96
2019	97 066.77
2020	102 931.23
2021	8 849.13

Note: In the years, 1993, 1995 and 1997 the coverage was very poor. It is recommended that these data should not be used. Also, the numbers of the years 2013-2016 and 2019 have changed after the corrected FIN BIAS 2013-2021 data and POL BIAS 2016 data were included into the BIAS database during the WGBIFS meeting in 2021 and 2022. These values are marked in blue.

4.1.1.4.3 Herring in ICES Subdivision 30

A comparison exercise between the StoX and traditional BIAS calculation methods was performed for the SD 30 herring acoustic abundance index during the WGBIFS meeting in 2020. It was found that the StoX project, developed for the WGBIFS, has small methodological differences compared to the standard calculation method used by the group, as specified in the Manual for the International Baltic Acoustic Surveys, (IBAS) and is thereby causing a small difference in the total number of herring. Nevertheless, WGBIFS decided to change to the StoX calculation method and recommended a new herring abundance time-series for the assessment purpose.

In 2021, the Finnish BIAS survey was realized on board of the r/v "Aranda". The distance of the acoustic transects and the numbers of realized fish control-hauls were conducted more or less as planned.

Tuning fleet data from October 2007-2021 BIAS surveys for the assessment of the Gulf of Bothnian herring stock (the ICES Subdivisions 30-31) are presented in Table 4.14. Estimates from the StoX calculations for the surveys covering the years 2007-2021 are presented in Figure 4.9.

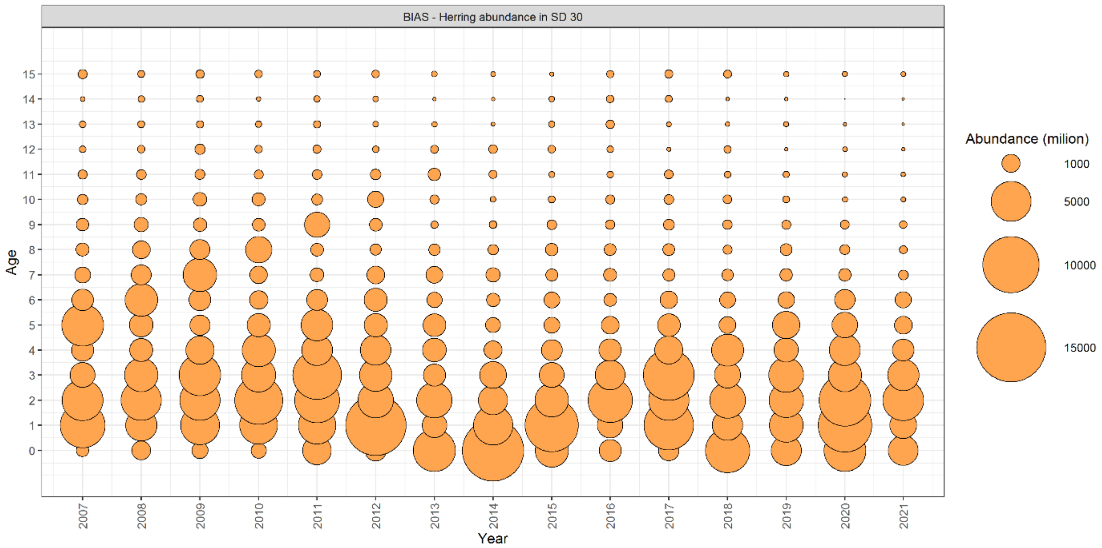


Figure 4.9. Autumn (BIAS) abundance of herring (per age-group for the years 2007-2021) in ICES Subdivision 30.

Table 4.14. Correction factor and area corrected numbers (millions) of herring per age-groups in the ICES Subdivision 30 (2007-2021) based on the StoX calculations.

YEAR	AREA CORR FACTOR	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9	AGE 10	AGE 11	AGE 12	AGE 13	AGE 14	AGE 15
2007	1.04	480	6346	5228	1902	1492	5449	1420	786	536	490	322	253	139	145	75	260
2008	1.21	1069	3074	5105	3478	1649	1707	3285	1235	987	630	396	292	173	155	145	147
2009	1.06	819	4667	5074	5358	2491	1259	1458	3525	1210	544	575	316	336	172	152	221
2010	1.06	712	4465	7189	3611	3424	1669	1055	931	2145	505	519	261	184	128	72	173
2011	1.06	2504	4412	6285	7406	2942	3127	1360	587	497	1949	379	288	202	164	133	149
2012	1.08	1398	11389	3905	3271	2902	1695	1627	962	382	504	817	344	140	104	103	178
2013	1.08	5567	1849	3889	1503	1717	1597	711	884	408	172	260	477	188	92	49	104
2014	1.08	11845	4839	2637	2193	1012	687	554	626	322	180	102	204	237	52	50	81
2015	1.22	3446	8863	3462	1912	1334	763	764	458	472	284	156	121	176	129	109	65
2016	1.08	1502	2003	6118	2778	1544	956	499	540	438	276	263	138	138	223	173	171
2017	1.08	1287	7732	5065	8105	2444	1595	927	449	426	368	294	238	62	82	148	207
2018	1.08	6174	2882	3937	2087	3158	869	767	412	262	275	245	137	161	68	48	190
2019	1.08	2798	3538	3682	3780	1834	2333	838	492	440	261	148	125	50	84	47	94
2020	1.08	5444	9016	8361	3422	2987	1993	1299	483	319	241	92	91	79	46	18	86

2021	1.16	2732	2202	5200	3046	1449	963	811	299	199	181	79	69	49	32	33	75

*** The abundance indices for age-groups 0 and 1 is underestimated in the survey and should therefore not be used for the assessment.**

4.1.2 Combined results of the Baltic Acoustic Spring Survey (BASS)

In May 2021, the following acoustic surveys were conducted:

Country	Data	Vessel	ICES SDs	Length of acoustic transects [NM]	Number of hauls	Number of hydrologi-cal stations
Latvia-Poland	16-26.05.2021	Baltica	Parts of 26, 28,and 32	583	19	22
Estonia-Poland	27.05-01.06.2021	Baltica	Parts of 28, 29, 32	499	14	14
Russia	17-23.05.2021	Runt	Parts of 26	291	13	13
Poland	01-14.05.2021	Baltica	Parts of 25 and 26	779	31	39
Germany	07-28.05.2021	Kristin NC336	24 and parts of 25, 26, 27, 28, 29	1053	52	118
Sweden	05-10.05.2021	Svea	Parts of 27 and 28	432	15	15

4.1.2.1 Area under investigation and overlapping areas

The BASS surveys were realized in May 2021 by the above-mentioned five countries in the ICES Subdivisions 24-32 (excl. ICES Subdivisions 30, 31), however, some ICES Subdivisions were only covered fragmentary (Figure 4.10). The area-coverage of the Baltic Sea with the BASS 2021 survey was very broad, however, the four rectangles namely 48 and 99% of the planned area was monitored with acoustic and trawling. ICES rectangle 40H0 (ICES Subdivision 26) was not investigated as Lithuania did not take part in BASS 2021 cruises. The ICES Subdivision 29 was monitored with acoustic-trawl investigations in the southern and middle parts moreover; only one ICES rectangle (47H3) was inspected in the ICES Subdivision 32. In May 2021, overall 62 ICES rectangles were covered with acoustic-biotic monitoring. Eleven ICES rectangles were inspected by two countries (Figure 4.10). Echointegration was recorded at a total linear distance of 3637 NM, moreover, 144 and 221 catch and hydrological stations, respectively, were inspected. Because of the relatively small portion of herring (<10%) compared to sprat (>90%) in most of the monitored areas during the BASS 2021 surveys, only the distribution of sprat is further examined.

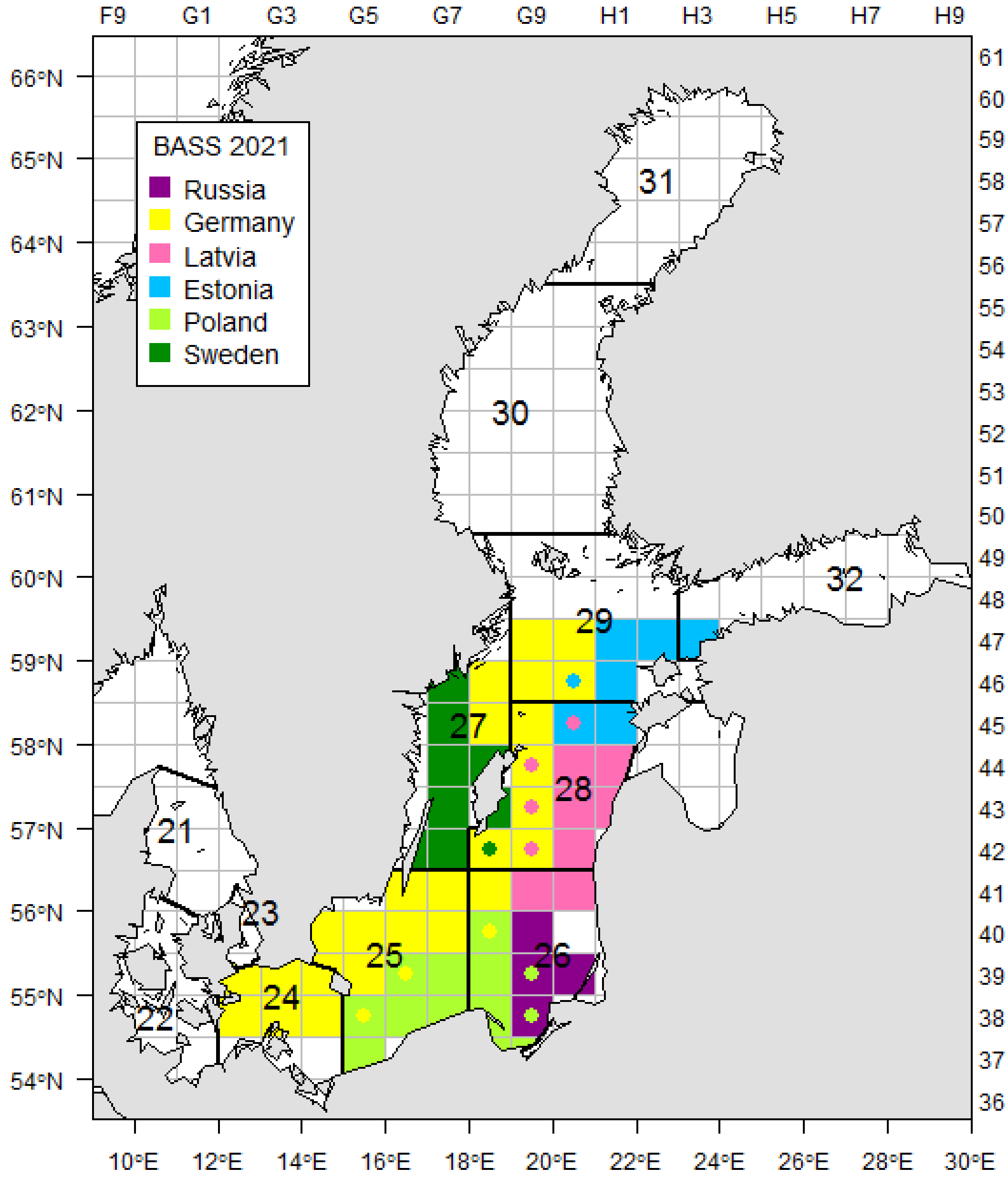


Figure 4.10. Map of the BASS survey conducted in May 2021. Various colours indicate the responsible countries for that ICES rectangle which finally also delivered data to the BIAS-database. Dots with different colours within a rectangle indicate that the rectangle was partly or completely covered by another country and data are available in the BIAS-database (but not included in the final analysis).

4.1.2.2 Combined results and area corrected data

The geographical distribution of the sprat abundance per ICES rectangles monitored in May 2021 is demonstrated in Figure 4.11. The Baltic sprat stock abundance estimates per ICES rectangles and ICES Subdivisions according to age-groups are presented in Tables 4.15 and 4.16. During the WGBIFS 2006 meeting, a possible improvement of the results from the acoustic surveys was discussed. As a result, a correction factor for each ICES Subdivision and year was introduced because the coverage of the investigated areas differed between years. This factor is the proportion to the total area of the ICES Subdivision (see the IBAS Manual) and the area of rectangles covered during the survey. The correction factors, calculated by ICES Subdivisions for 2021 are included.

In May 2021 sprat was very widely distributed in the Baltic Sea and occurred in each monitored ICES rectangle (Figure 4.11). The highest sprat (age 1+) stock abundance was observed in the ICES Subdivision 27 (the Swedish inshore waters) and in the western part of the ICES Subdivision 26.

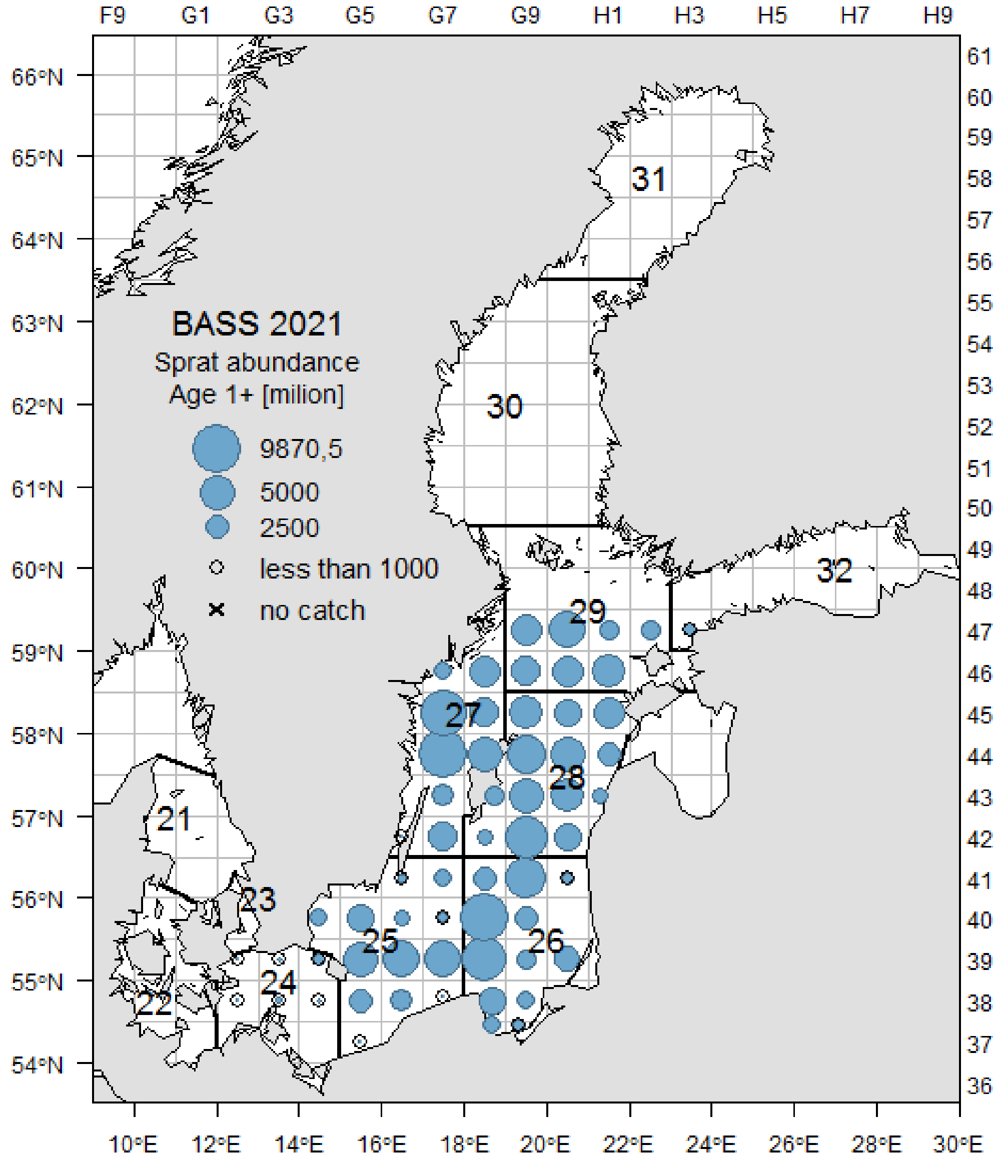


Figure 4.11. The abundance of sprat per ICES rectangles monitored in May 2021 (the size of the circle indicates the estimated numbers of specimens x10^6 in the given rectangle).

Table 4.15. Estimated abundance (millions) of sprat in May 2021 per age-group and ICES-rectangle in the given ICES Subdivisions.

YEAR	SD	RECT	TOTAL	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	24	38G2	15.18	4.31	1.86	1.87	2.17	2.00	2.46	0.49	0.02
2021	24	38G3	232.74	3.83	39.29	43.60	49.43	41.38	44.92	10.12	0.17
2021	24	38G4	138.47	1.32	15.92	28.38	27.95	27.83	29.67	7.10	0.30
2021	24	39G2	25.72	8.11	3.71	2.87	3.59	2.97	3.70	0.77	0.00
2021	24	39G3	147.99	0.42	16.91	29.40	30.82	29.44	32.92	7.89	0.19
2021	24	39G4	432.33	36.77	178.41	69.49	77.70	30.69	28.50	10.77	0.00
2021	25	37G5	9.34	0.04	0.53	1.79	2.05	1.19	1.61	1.70	0.43
2021	25	38G5	2 240.89	57.64	155.81	484.76	538.44	271.18	328.53	325.36	79.16
2021	25	38G6	1 908.40	10.68	110.20	433.10	499.88	224.66	286.03	282.87	60.98
2021	25	38G7	66.25	0.08	1.27	12.03	14.78	9.95	11.28	13.98	2.87
2021	25	39G4	205.23	1.15	55.67	55.75	40.39	33.47	12.79	5.46	0.55
2021	25	39G5	5 218.50	41.13	1 515.35	1 404.52	949.83	838.83	301.33	147.17	20.34
2021	25	39G6	5 993.71	300.88	1 286.56	1 657.23	1 503.25	305.58	582.60	280.13	77.47
2021	25	39G7	5 814.07	437.48	1 730.04	1 564.58	1 228.67	194.69	454.88	158.02	45.70
2021	25	40G4	1 442.51	9.26	383.74	380.22	295.08	233.96	96.85	34.88	8.52
2021	25	40G5	3 052.21	116.89	1 610.11	563.14	287.41	307.88	77.56	88.17	1.05
2021	25	40G6	1 222.89	17.10	590.39	234.65	161.18	138.35	51.57	28.86	0.79
2021	25	40G7	506.18	3.44	176.28	122.43	89.67	74.69	27.26	11.92	0.49
2021	25	41G6	325.55	2.54	150.02	71.06	40.99	40.00	11.90	8.93	0.11
2021	25	41G7	1 406.66	218.85	508.42	244.99	207.87	157.18	49.07	19.68	0.60
2021	26	37G8	1 317.16	888.97	265.99	90.70	39.70	14.61	13.23	3.95	0.00
2021	26	37G9	606.25	253.10	194.54	78.51	39.56	18.10	15.60	6.83	0.00
2021	26	38G8	3 360.77	247.92	824.44	693.43	619.62	396.63	371.08	198.64	9.03
2021	26	38G9	1 312.28	74.03	583.67	300.02	223.24	61.32	44.97	25.02	0.00
2021	26	39G8	7 903.48	226.12	1 639.00	1 355.28	1 565.17	1 206.48	1 197.45	651.57	62.41
2021	26	39G9	1 678.46	96.32	738.08	433.34	210.91	102.97	68.10	14.56	14.19
2021	26	39H0	2 807.82	881.69	1 300.58	293.11	157.05	90.35	43.48	33.61	7.95
2021	26	40G8	9 870.54	1 083.28	3 902.63	1 934.82	1 265.92	702.35	651.09	323.12	7.33
2021	26	40G9	2 403.57	83.03	1 162.45	390.94	415.12	147.07	64.81	129.01	11.14
2021	26	41G8	2 373.31	741.10	1 038.32	222.30	256.08	60.30	26.25	28.96	0.00
2021	26	41G9	6 666.78	1 752.17	2 435.94	512.83	769.24	320.52	256.41	512.83	106.84
2021	26	41H0	748.22	228.75	245.43	54.81	57.19	42.89	26.21	81.02	11.91
2021	27	42G6	0.25	0.00	0.13	0.04	0.04	0.00	0.00	0.00	0.04
2021	27	42G7	3 733.60	191.52	1 820.03	735.73	664.77	0.00	290.87	0.00	30.67
2021	27	43G7	2 056.86	91.79	314.43	766.28	241.81	193.99	195.51	224.09	28.98
2021	27	44G7	9 819.86	4 546.18	2 573.73	1 458.24	927.60	63.56	111.63	114.89	24.04
2021	27	44G8	5 023.10	2 373.55	1 611.81	353.27	149.04	55.20	204.24	248.40	27.60
2021	27	45G7	8 668.95	3 564.23	2 560.95	1 253.67	742.29	121.18	38.18	350.27	38.18
2021	27	45G8	3 676.48	1 162.82	1 713.55	277.34	150.56	123.92	248.29	0.00	0.00
2021	27	46G7	1 452.12	41.69	355.73	498.86	168.14	31.96	112.56	226.50	16.68
2021	27	46G8	3 944.22	2 437.47	1 058.71	146.41	90.36	75.62	135.65	0.00	0.00

Table 4.15. Continues

YEAR	SD	RECT	TOTAL	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	28_2	42G8	1 139.91	58.82	337.20	177.88	310.69	106.44	148.88	0.00	0.00
2021	28_2	42G9	7 395.87	970.21	4 010.46	954.23	1 001.00	324.41	135.56	0.00	0.00
2021	28_2	42H0	3 415.61	847.35	1 310.34	366.89	384.37	157.24	148.50	183.45	17.47
2021	28_2	43G8	1 794.26	304.11	805.90	272.18	226.56	48.66	74.51	15.21	47.14
2021	28_2	43G9	5 166.81	1 809.90	1 932.75	517.50	589.98	190.76	125.92	0.00	0.00
2021	28_2	43H0	4 741.44	1 496.03	1 544.28	398.14	554.98	156.84	217.17	325.75	48.26
2021	28_2	43H1	1 145.23	395.88	268.63	197.94	113.11	42.42	56.55	56.55	14.14
2021	28_2	44G9	6 399.01	2 082.41	2 779.85	605.38	633.39	212.76	85.22	0.00	0.00
2021	28_2	44H0	4 927.19	1 736.16	1 726.46	300.68	339.47	193.98	126.09	407.37	96.99
2021	28_2	44H1	2 600.85	1 010.76	813.54	246.53	197.22	86.28	86.28	123.26	36.98
2021	28_2	45G9	4 667.18	1 131.51	2 211.22	515.30	552.19	175.51	81.45	0.00	0.00
2021	28_2	45H0	3 386.45	1 243.27	1 263.81	335.46	197.84	62.49	63.92	206.14	13.51
2021	28_2	45H1	3 951.10	1 286.50	1 396.87	385.18	287.18	114.99	137.43	278.70	64.26
2021	29	46G9	3 651.38	1 321.34	1 526.37	202.16	242.20	182.38	161.61	0.00	15.32
2021	29	46H0	4 159.44	1 072.95	2 044.53	264.29	305.68	245.21	212.64	0.00	14.14
2021	29	46H1	4 401.35	2 294.50	1 138.23	277.45	263.66	72.76	78.13	252.13	24.49
2021	29	47G9	4 302.71	967.09	2 048.67	341.24	360.35	318.05	239.18	0.00	28.13
2021	29	47H0	5 942.74	2 674.56	2 057.67	288.76	324.97	298.76	267.37	0.00	30.65
2021	29	47H1	1 888.72	129.88	740.65	247.41	256.75	99.19	100.06	271.97	42.80
2021	29	47H2	1 830.26	924.86	317.77	125.65	150.43	60.15	62.86	158.60	29.95
2021	32	47H3	890.76	204.65	294.08	101.26	90.30	36.26	27.43	122.85	13.95

Table 4.16. Estimated numbers of sprat (millions) by ICES Subdivision and age-group (May 2021).

YEAR	SD	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	24	54.76	256.10	175.61	191.66	134.31	142.17	37.14	0.68
2021	25	1 217.17	8 274.40	7 230.25	5 859.48	2 831.62	2 293.28	1 407.12	299.06
2021	26	6 556.49	14 331.08	6 360.09	5 618.79	3 163.58	2 778.69	2 009.12	230.81
2021	27	14 409.25	12 009.08	5 489.85	3 134.60	665.43	1 336.92	1 164.14	166.18
2021	28_2	14 372.91	20 401.30	5 273.28	5 387.97	1 872.78	1 487.49	1 596.43	338.74
2021	29	9 385.18	9 873.88	1 746.97	1 904.04	1 276.50	1 121.84	682.69	185.48
2021	32	204.65	294.08	101.26	90.30	36.26	27.43	122.85	13.95

4.1.2.3 Tuning fleets for WGBFAS

Sprat in the ICES Subdivisions 24 – 28

The area-corrected abundance estimates for sprat per ICES Subdivision are summarized in Table 4.17. The corresponding biomass estimates of sprat are given in the Table 4.18. The complete time-series (2001 - 2021) of the area-corrected sprat abundance of the ICES Subdivisions 24, 25 26 and 28_2 is given in the Table 4.19.

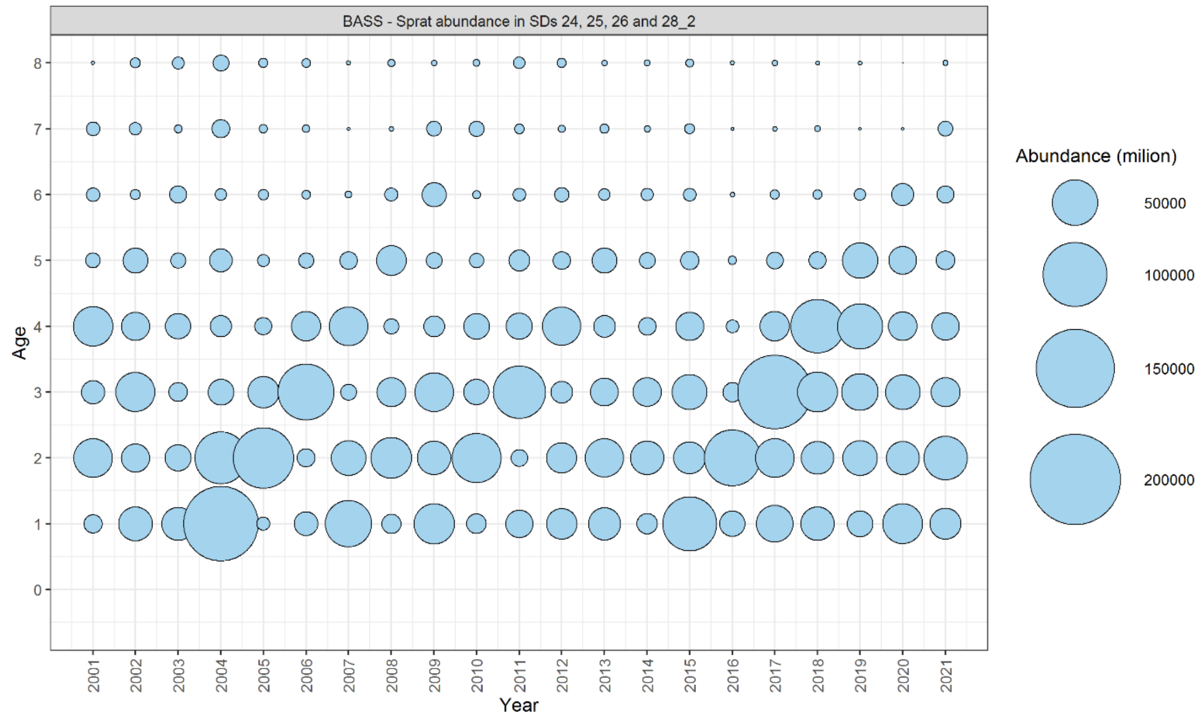


Figure 4.12. Spring (BASS) tuning fleet index (abundance per age-group and year 2001-2021) for sprat in the ICES Subdivisions 24, 25, 26 and 28_2.

Table 4.17. Area-corrected numbers (millions) of sprat by ICES Subdivision and age-group (May 2021).

YEAR	SD	AREA CORR FACTOR	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	24	1.28	70.03	327.52	224.58	245.11	171.77	181.82	47.50	0.87
2021	25	1.03	1 256.11	8 539.09	7 461.54	6 046.92	2 922.20	2 366.64	1 452.14	308.63
2021	26	1.12	7 324.60	16 010.01	7 105.20	6 277.05	3 534.20	3 104.23	2 244.49	257.85
2021	27	1.15	16 549.66	13 792.96	6 305.33	3 600.23	764.27	1 535.52	1 337.07	190.87
2021	28_2	1.01	14 561.30	20 668.70	5 342.40	5 458.60	1 897.33	1 506.98	1 617.35	343.18
2021	29	1.61	15 127.31	15 915.01	2 815.81	3 068.98	2 057.49	1 808.22	1 100.39	298.97
2021	32	13.98	2 861.37	4 111.84	1 415.78	1 262.52	507.02	383.46	1 717.64	195.11

Table 4.18. Area-corrected sprat biomass (in tonnes) according to ICES Subdivision and age-group (May 2021).

YEAR	SD	AREA CORR FACTOR	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2021	24	1.28	628.5	4250.7	3622.2	3963.6	3041.6	3313.3	842.4	23.6
2021	25	1.03	7449.1	78779.7	86017.8	73912.3	37839.1	30648.0	20207.1	4617.3
2021	26	1.12	33727.9	131177.0	68460.6	67027.8	40271.3	35699.3	25942.4	3473.5
2021	27	1.15	53039.6	99348.1	57319.6	36818.7	8246.5	15854.2	14949.3	2116.3
2021	28_2	1.01	59026.6	166251.5	50797.7	53910.4	18683.8	16677.0	16618.0	3965.0
2021	29	1.61	50201.0	124406.1	26406.4	29301.1	19978.5	17579.7	10547.3	3388.0
2021	32	13.98	8120.8	31790.6	13100.8	12267.9	5272.2	3705.6	17844.7	2250.4

Table 4.19. ***Whole time-series of tuning indices*****. Spring acoustic (BASS) tuning fleet index (numbers in millions) for Baltic sprat (ICES Subdivisions 24, 25, 26 and 28_2).**

YEAR	TOTAL AGE 1-8	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
2001	109 404.16	8 225.02	35 734.86	12 970.86	37 327.77	5 384.44	4 635.49	4 526.01	599.71
2002	125 782.95	27 412.11	18 982.00	36 813.57	19 044.89	14 758.59	2 517.12	3 669.81	2 584.85
2003	84 986.61	26 468.98	16 471.45	8 422.95	15 532.70	5 653.45	7 169.73	1 660.01	3 607.34
2004	258 606.73	136 162.06	65 565.92	15 783.74	11 042.29	12 655.24	3 270.65	7 805.79	6 321.05
2005	134 373.52	4 358.61	88 829.99	23 556.64	7 258.25	3 516.63	2 780.51	1 829.96	2 242.94
2006	130 287.13	13 416.63	7 980.49	76 703.20	21 045.81	5 701.71	1 970.41	1 525.76	1 943.11
2007	132 637.19	51 568.74	28 713.21	6 377.16	36 006.21	7 480.56	1 261.14	532.65	697.52
2008	102 722.51	9 029.20	40 269.65	20 164.14	5 627.08	21 187.94	4 209.97	757.16	1 477.38
2009	139 641.22	39 412.17	26 701.03	36 255.42	10 548.51	6 312.12	14 106.27	5 341.22	964.48
2010	112 784.60	9 387.20	58 680.01	15 199.18	15 963.48	5 061.93	1 653.59	5 566.35	1 272.87
2011	128 153.97	18 091.69	6 790.99	66 159.99	16 689.00	10 564.65	4 076.69	2 399.13	3 381.83
2012	107 660.52	22 699.62	22 079.78	11 274.09	35 541.24	7 515.42	5 024.69	1 367.20	2 158.48
2013	111 418.65	24 876.63	35 333.30	18 392.57	11 357.94	14 959.37	3 385.50	2 163.71	949.62
2014	76 549.35	10 144.65	26 906.62	19 857.10	7 457.71	6 098.20	3 810.12	1 217.38	1 057.57
2015	160 548.72	70 752.42	24 659.60	29 744.21	18 934.79	8 080.81	4 074.30	2 581.47	1 721.12
2016	108 392.40	15 554.71	75 824.12	9 121.48	3 989.53	1 894.54	791.08	513.72	703.20
2017	233 353.41	32 701.04	36 291.63	132 939.42	20 629.89	6 790.33	2 249.57	809.40	942.12
2018	171 723.01	27 208.85	25 641.68	38 632.38	69 259.39	7 250.77	2 086.13	1 025.15	618.66
2019	161 411.46	15 957.92	28 778.09	32 532.27	49 494.92	30 130.52	3 383.73	486.76	647.25
2020	144 014.72	38 096.31	26 252.28	29 053.64	19 630.48	18 376.79	11 755.96	473.01	376.26
2021	128 875.91	23 212.05	45 545.31	20 133.72	18 027.67	8 525.50	7 159.66	5 361.48	910.53

Note: In year 2016, the coverage was very poor. It is recommended that these data should not be used.

4.1.3 Combined results of the Gulf of Riga Acoustic Herring Survey (GRAHS)

In July-August 2021, a joint Latvian-Estonian survey was conducted in the Gulf of Riga as following.

Country	Data	Vessel	ICES SDs	Length of acoustic transects [NM]	Number of hauls	Number of hydrological stations
Latvia-Estonia	**28.07-03.08.2021**	**F/V Ulrika**	**28_1**	**445**	**14**	**14**

Whole area of the Gulf of Riga was covered with acoustic transect and hauls. The abundance estimates of Gulf of Riga herring per ICES rectangle in 2021 (calculated by Latvia) are summarized in the Table 4.20. Area corrected alternative Gulf of Riga herring abundance time-series based on the StoX calculations is given in the Table 4.21.

Table 4.20. Numbers (millions) of Gulf of Riga herring stock in July/August 2021.

YEAR	RECT	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9+
2021	43H3	696.23	1 477.13	1 439.50	263.44	630.37	244.62	197.58	94.09	56.45	122.31
2021	43H4	170.13	718.33	491.49	160.68	245.75	85.07	85.07	28.36	18.90	0.00
2021	44H2	438.78	458.72	398.89	24.93	94.74	34.90	29.92	0.00	0.00	4.99
2021	44H3	1 164.61	2 704.25	2 052.86	404.65	868.52	355.30	266.48	98.70	49.35	118.43
2021	44H4	48.10	421.57	248.98	76.39	138.64	48.10	36.78	19.81	11.32	16.98
2021	45H2	33.50	30.26	19.45	1.08	4.32	0.00	1.08	0.00	0.00	0.00
2021	45H3	149.47	361.22	233.54	59.16	102.76	24.91	52.94	15.57	3.11	3.11

Table 4.21. Area corrected numbers (millions) of herring per age-groups in the Gulf of Riga (the ICES Subdivision 28_1) based on the StoX calculations in 2011-2021.

YEAR	AGE 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8	AGE 9	AGE 10	AGE 11	AGE 12	AGE 13	AGE 14
2011	6138	2342	3424	2596	2213	754	1195	185	66	121	0	17	0	0	0
2012	1549	8072	1180	1739	1080	1174	543	483	198	13	54	8	4	2	0
2013	65	11767	6623	1345	1847	763	1203	288	474	92	14	60	2	0	0
2014	320	1561	3006	2444	419	765	393	409	87	234	99	4	50	0	13
2015	319	1392	998	1137	917	376	370	266	292	59	159	32	3	16	0
2016	946	8068	2247	1138	1984	1196	390	329	224	197	37	25	14	0	0
2017	271	5203	3702	1697	1014	1622	1030	270	373	222	159	0	11	0	0
2018	4219	20145	3746	2833	616	202	843	420	80	22	69	0	0	0	0
2019	4267	6305	8534	2396	1406	470	210	720	187	41	57	0	6	0	0
2020	2900	12518	3302	4231	1343	1265	437	244	660	192	0	27	0	0	0
2021	3369	7526	6360	1164	2186	668	600	197	117	126	90	0	0	0	0

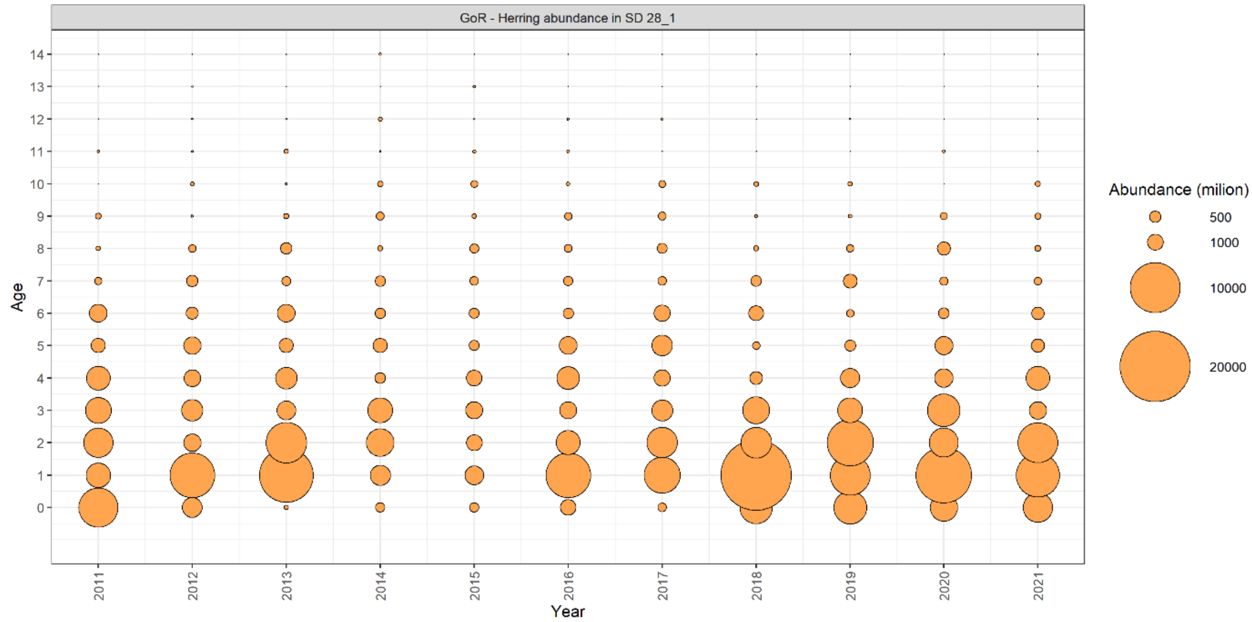


Figure 4.13. Gulf of Riga herring abundance per age-group in the ICES Subdivisions 28_1 based on the StoX calculations in 2011-2021.

4.2 ToR b) Update the BIAS BASS and GRAHS hydroacoustic databases and ICES database for acoustic-trawl surveys

After validation, the data from the Baltic International Acoustic Survey (BIAS), the Baltic Acoustic Spring Survey (BASS) and the Gulf od Riga Acoustic Herring Survey (GRAHS) carried out in 2021 were added to the BIAS_DB.mdb, the BIAS_HERR_SD30_DB.mdl, the BASS_DB.mdb, and GRAHS_DB.mdb access-databases, respectively. The specification of these databases is as following:

1. BIAS_DB is based on the country level made calculations according to IBAS methodology (fish up to 8+ age group) note: in SD30 the StoX calculations has been used for herring since 2020.

2. BIAS_HERR_SD30_DB for herring based on StoX calculations (using StoX project for IBAS calculations, fish up to 15+ age group).

3. BASS_DB for sprat based on the country made calculations according to IBAS methodology (fish up to 8+ age group).

4. GRAHS_DB for herring based on StoX calculations (nearest haul method, fish up to oldest -14 age group).

All these databases also include queries with the used algorithms for creation of report tables and calculation of the different tuning fleets. The updated versions of the databases are located in the folder “Data” of the ICES WGBIFS 2022 SharePoint.

Additionally, Finland presented corrections for their BIAS 2016, 2018 and 2019 survey results, which were implemented in the BIAS_DB.mdb. access-database.

4.3 ToR c) Coordinate and plan acoustic surveys including any experiments to be conducted

All the Baltic Sea countries intend to take part in the BASS and BIAS (except Russia, for which no information is available) acoustic surveys and experiments in 2022 and 2023 (Figures 4.13 – 4.16). There is also an intention to conduct a Latvian/Estonian survey in the Gulf of Riga (GRAHS) in July-August 2023. The list of participating research vessels and initially planned periods of particular surveys are given in the following tables:

BASS/2022 surveys

Vessel	Country	Area of Investigation (ICES Subdivisions)	Period of Investigations	Duration (Days)
Svea	Sweden	27, partly 28	9-17.05.2022	8
Baltica	Estonia/Poland	28.2, 29 partly 32	27.05-01.06.2022	6
Walther Herwig III	Germany	24, 25, 26, 27, 28, 29 (for all SD: only part monitored)	2-27.05.2022	26
Baltica	Latvia/Poland	26 partly, 28 partly	19-26.05. 2022	8
Commercial Vessel	Lithuania	Part of 26	24-25.05.2022	2
Baltica	Poland	25 and 26	03-16.05.2022	14

BASS/2023 surveys

Vessel	Country	Area of Investigation (ICES Subdivisions)	Period of Investigations	Duration (Days)
Svea	Sweden	27, partly 28	16-24.05.2023	9
Baltica	Estonia/Poland	28.2, 29 partly 32	30.05-04.06.2023	6
Walther Herwig III	Germany	24, 25, 26, 27, 28, 29 (for all SD: only part monitored)	2-27.05.2023	26
Baltica	Latvia/Poland	26 partly, 28 partly	22-29.05. 2023	8
Commercial Vessel	Lithuania	Part of 26	08-09.05.2023	2
Baltica	Poland	25 and 26	04-17.05.2023	14

GRAHS/2022 survey

Vessel	Country	Area of Investigation (ICES Subdivisions)	(Preliminary) Period of Investigations	Duration (Days)
Urga	Latvia/ Estonia	28.1	27/7-2/8 2022	7

GRAHS/2023 survey

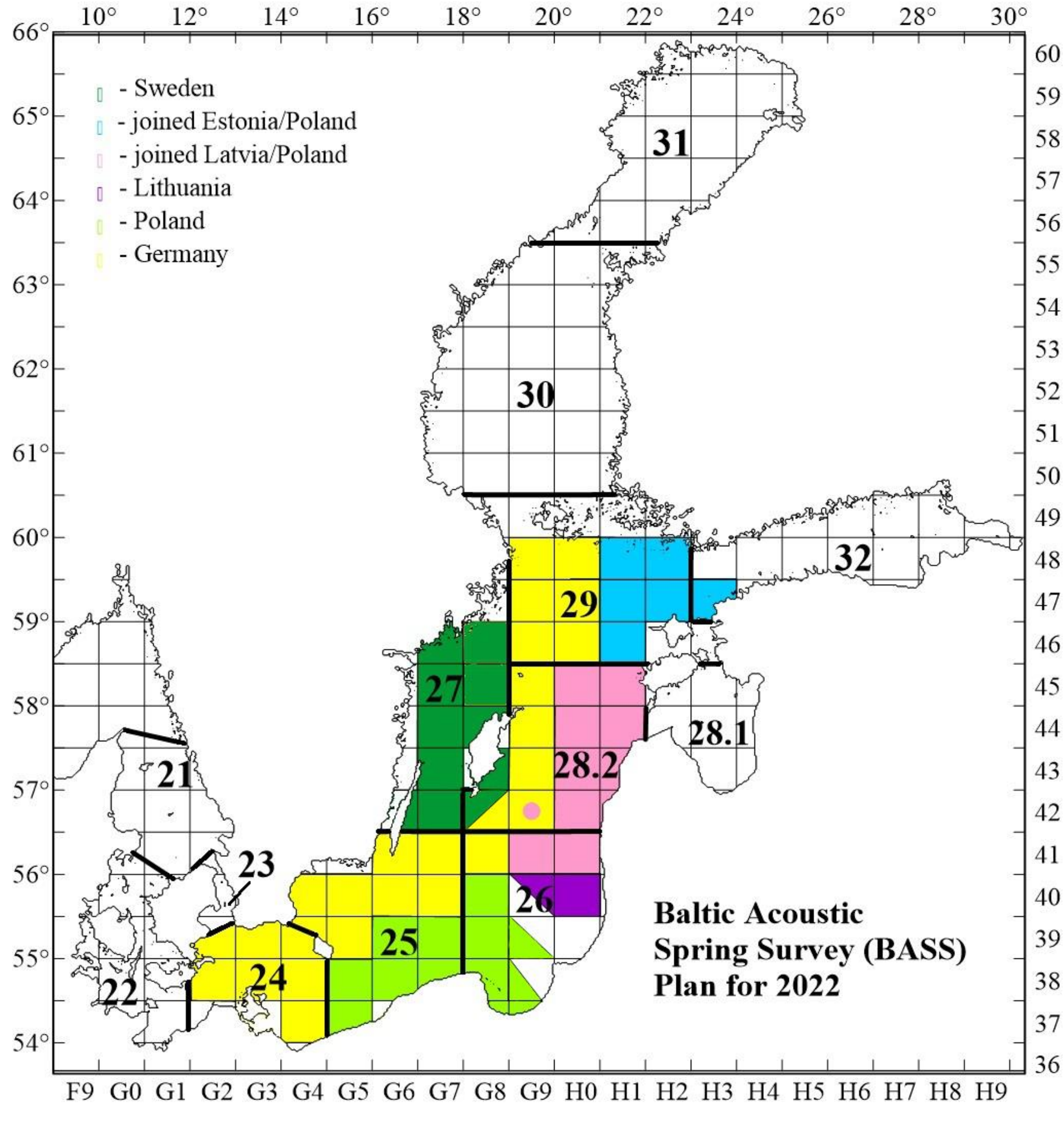
Vessel	Country	Area of Investigation (ICES Subdivisions)	(Preliminary) Period of Investigations	Duration (Days)
Ulrika	Latvia/ Estonia	28.1	July/August 2023	7

BIAS/2022 surveys

Vessel	Country	Area of Investigation (ICES Subdivisions)	(Preliminary) Period of Investigations	Duration (Days)
Svea	Sweden	27 and parts of 25,26,28,29	02 – 16.10 2022	15
Baltica	Estonia/Poland	28,29,32	23.10-04.11.2022	13
Aranda	Finland	29N, 30 and 32N	20.9.-5.10.2022	16
Baltica	Latvia/Poland	26 partly, 28 partly	10-22.10 2022	13
Commercial Vessel	Lithuania	Part of 26	04-05.10.2022	2
Baltica	Poland	Parts of 25 and 26	13-28.09.2022	16

BIAS/2023 surveys

Vessel	Country	Area of Investigation (ICES Subdivisions)	(Preliminary) Period of Investigations	Duration (Days)
Svea	Sweden	27 and parts of 25,26,28,29	2 – 16.10 2023	15
Baltica	Estonia/Poland	28,29,32	22.10-03.11.2023	13
Aranda	Finland	29N, 30 and 32N	20.9.-4.10.2023	16
Baltica	Latvia/Poland	26 partly, 28 partly	9-21.10 2023	13
Commercial Vessel	Lithuania	Part of 26	9-10.10.2023	2
Baltica	Poland	Parts of 25 and 26	20.09-05.10.2023	16



- Sweden
- joined Estonia/Poland
- joined Latvia/Poland
- Lithuania
- Poland
- Germany
Baltic Acoustic
Spring Survey (BASS)
Plan for 2022
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24
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26
27
28.1
28.2
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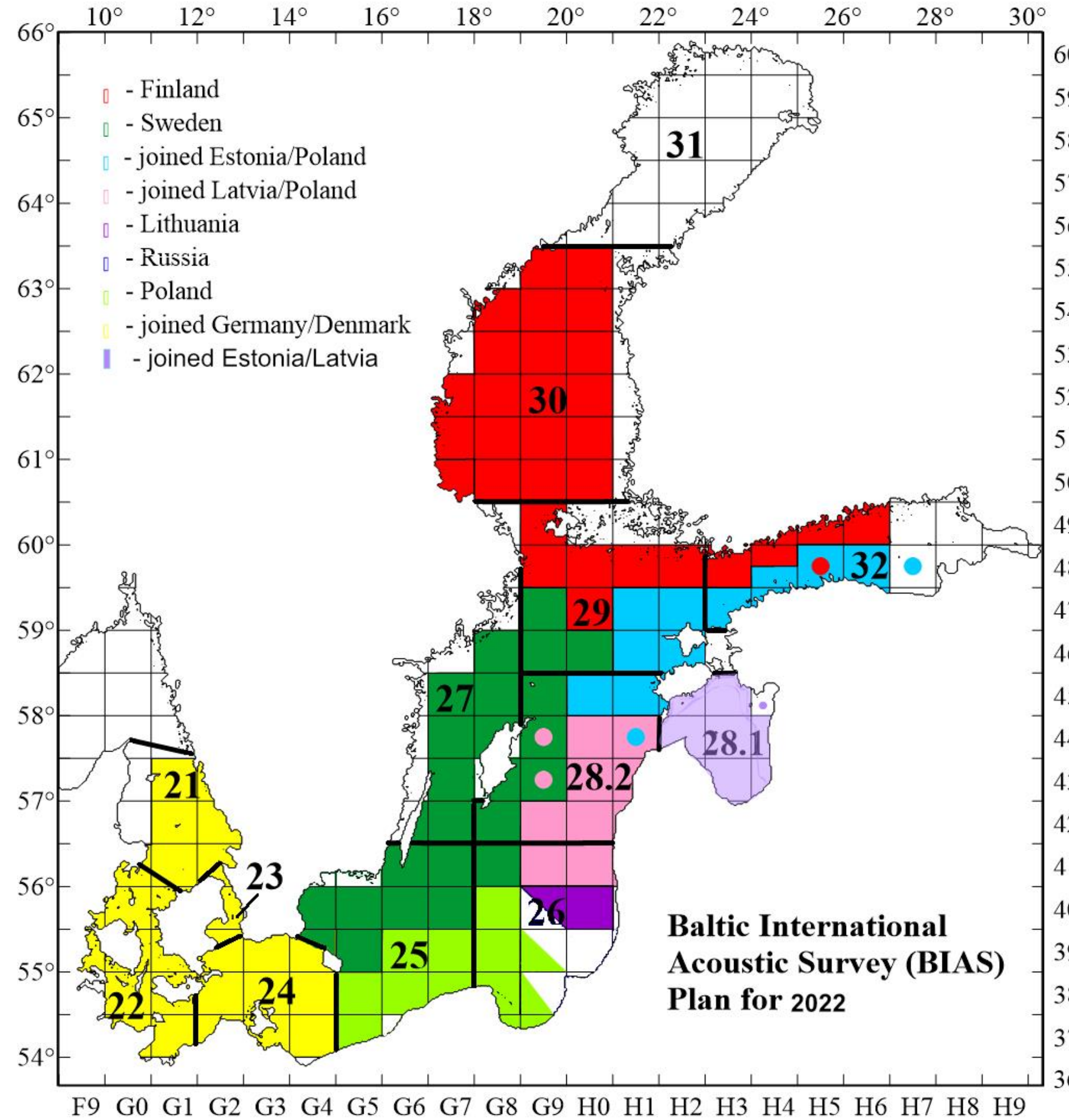
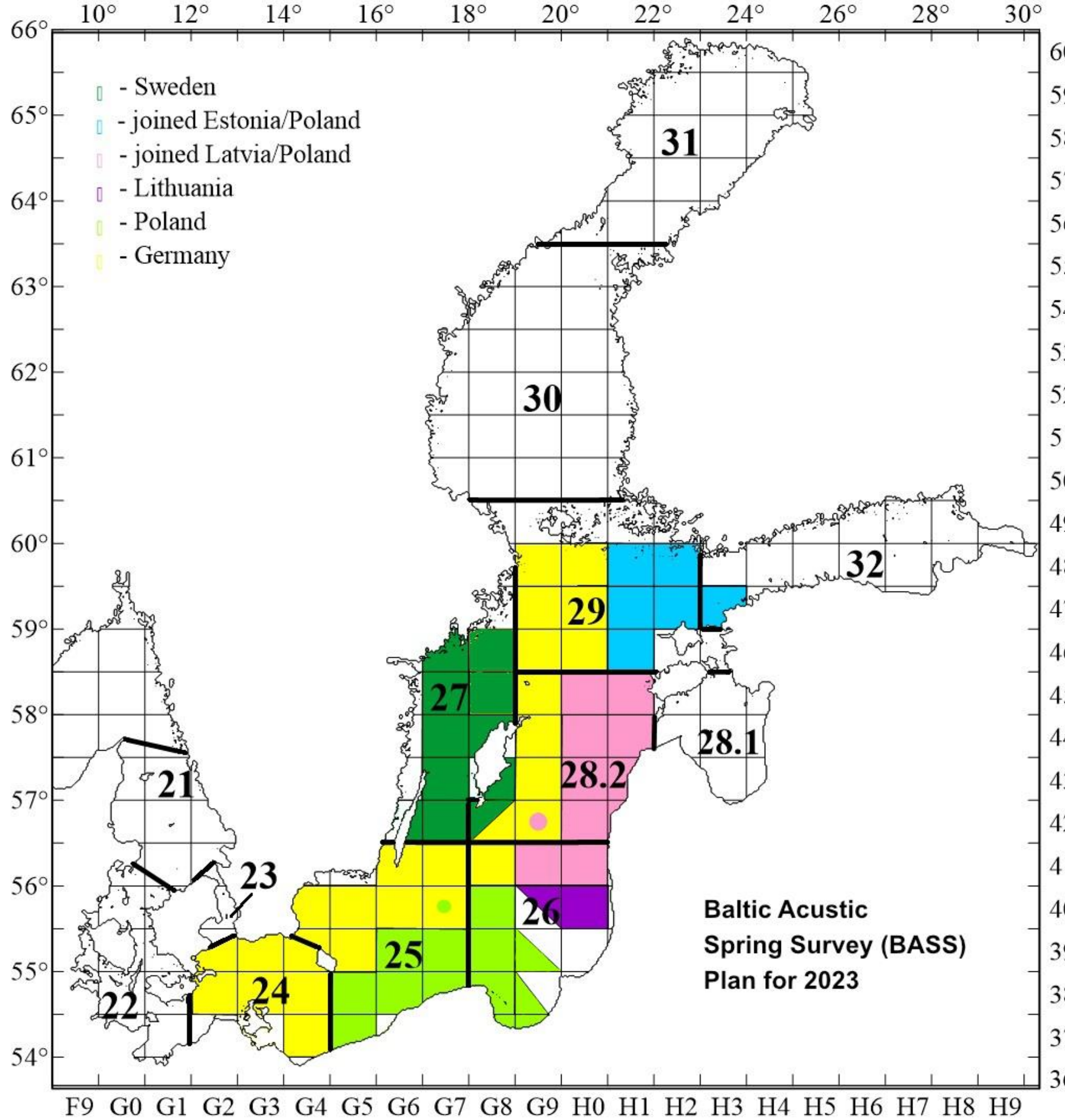
10° 12° 14° 16° 18° 20° 22° 24° 26° 28° 30°
66° 65° 64° 63° 62° 61° 60° 59° 58° 57° 56° 55° 54°
60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36
F9 G0 G1 G2 G3 G4 G5 G6 G7 G8 G9 H0 H1 H2 H3 H4 H5 H6 H7 H8 H9



- Finland
- Sweden
- joined Estonia/Poland
- joined Latvia/Poland
- Lithuania
- Russia
- Poland
- joined Germany/Denmark
- joined Estonia/Latvia
Baltic International Acoustic Survey (BIAS) Plan for 2022


- Sweden
- joined Estonia/Poland
- joined Latvia/Poland
- Lithuania
- Poland
- Germany
Baltic Acustic
Spring Survey (BASS)
Plan for 2023
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10° 12° 14° 16° 18° 20° 22° 24° 26° 28° 30°
66° 65° 64° 63° 62° 61° 60° 59° 58° 57° 56° 55° 54°
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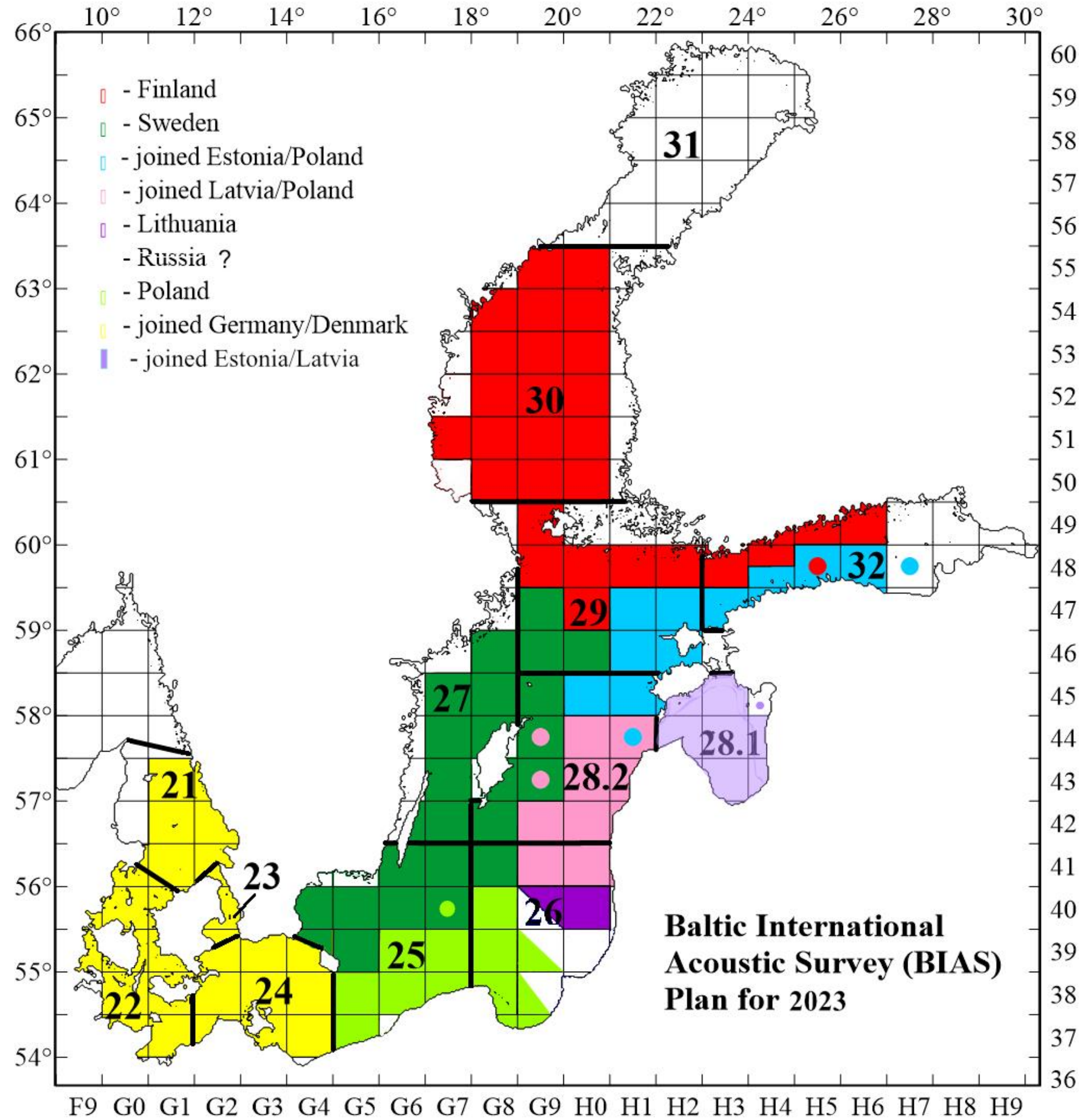
F9 G0 G1 G2 G3 G4 G5 G6 G7 G8 G9 H0 H1 H2 H3 H4 H5 H6 H7 H8 H9



Figures 4.13.–4.16. The planned coverage of the Baltic Sea and the assignment of the national/joint acoustic surveys to the ICES rectangles during the May 2022/2023 and September/October-2022/2023. Base colours of rectangles indicate the country or joint survey, which is responsible for given ICES-rectangle. Coloured dots indicate overlapping coverage by other countries (sometimes only parts of rectangle are covered).

4.5 ToR d) Review the results from BITS surveys and evaluate the characteristics of TVL and TVS standard gears used in BITS

4.5.1 4th quarter 2021 BITS.

During Autumn 2021, the level of realized valid hauls represented 100% of the total planned stations. After a few years break Russia has started BITS survey in spring 2021 in the Russian EEZ of the ICES Subdivision 26.

The coverage by depth stratum is as follows (depth stratum, coverage in %): 1, 100; 2, 97.9; 3, 96.9; 4, 105.5; 5, 97.4 and 6, 113.3).

The number of valid hauls was considered by WGBIFS as appropriate for tuning series, and it is recommended that the data are used for the assessment of the Baltic and Kattegat cod and flatfish stocks.

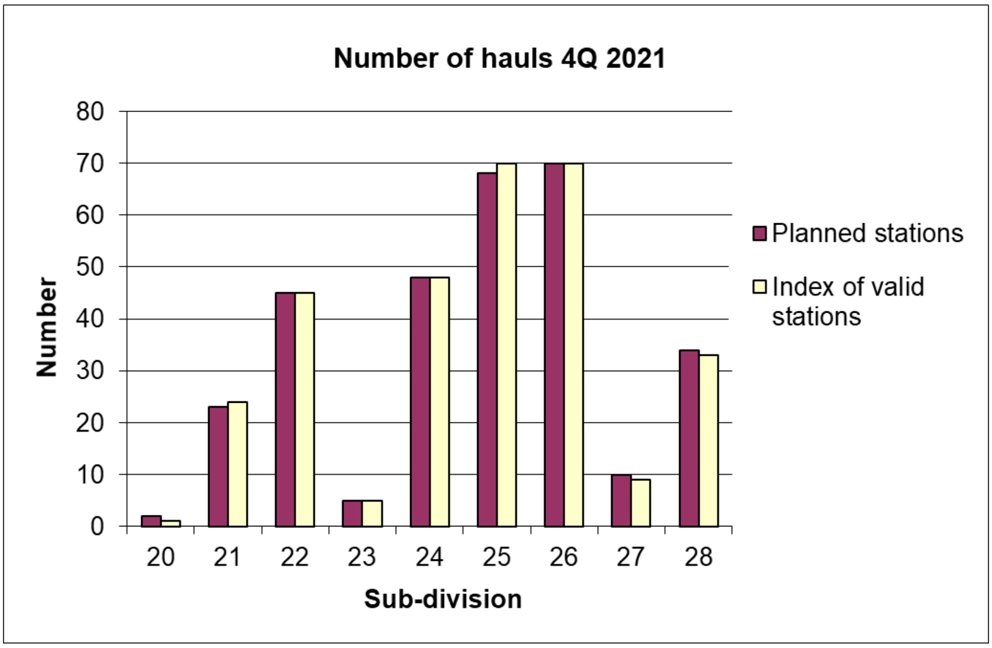


Figure 4.17. Comparison of the planned and the index-valid fishing stations by ICES Subdivisions and depth layers during BITS 4th quarter 2021.

4.5.2 1st quarter 2022 BITS.

The overall coverage in Spring 2022 was 99%. The coverage by depth stratum is as follows (depth stratum, coverage %): 1, 100; 2, 98.1; 3, 88; 4, 94.8; 5, 96; and 6, 123.1

The number of valid hauls accomplished during the BITS Q1 2022 was considered by WGBIFS 2022 as appropriate for tuning series (e.g. CPUE indices) and the data can be used for the assessment of Baltic and Kattegat cod and flatfish stocks.

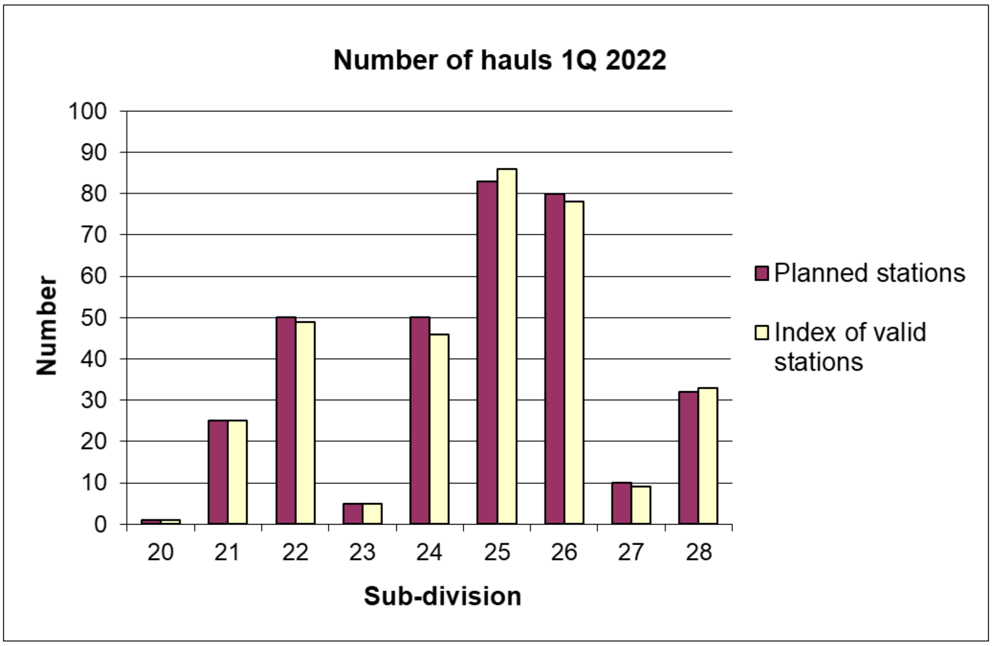


Figure 4.18. Comparison of the planned and the index-valid fishing stations by ICES Subdivisions and depth layers during BITS 1st quarter 2022.

4.5.3 CPUE in 4th quarter 2021 and 1st quarter 2022 BITS.

Figures 4.19 to 4.24 show the distribution of cod, flounder, plaice, dab, turbot and brill during the BITS surveys in Autumn 2021 and Spring 2022.

Some concentrations of cod were observed in SD23, 24, 25 and 26 in Q4 2021 with hot spots in the Sound, west and south of the Isle of Bornholm (DK), in Słupsk Furrow (PL), and East Gotland Sea (LV). In Q1 2021 cod showed a hot spot north in the Sound and weak concentrations in Bornholm Sea in SD25. Flounder showed in Q4 2021 big hot spots in SD26 in East Gotland Sea and in the Gulf of Gdańsk. Some concentrations were also found south of Sweden in SD24. In Q1 2021 hot spots of flounder were observed in in Słupsk Furrow (PL) and northeast and southwest of Bornholm in SD25. Plaice hot spots in Q4 2020 occurred in Fehmarnbelt, in SD24. Dab dense hot spots were observed in Q1 2022 in the Kiel Bight and in the Little Belt in SD22. Dab showed in Q4 2021 hot spots in Samsø Belt, the Little Belt and in the Sound in SD22 and concentrations in Kattegat and Samsø Belt in SD21 and also in the Little Belt in SD22. Turbot showed hot spots in Q4 2021 and in Q1 2022 in Darß (D) and south of Bornholm in SD24, in Hanö Bay (S) and in Słupsk Furrow (PL) in SD25 and in Fehmarnbelt in SD22. Brill concentrations were observed in Q4 2021 in Samsø Belt, Kattegat and in Little Belt in SD21 and SD22 and also in the Sound in SD23.

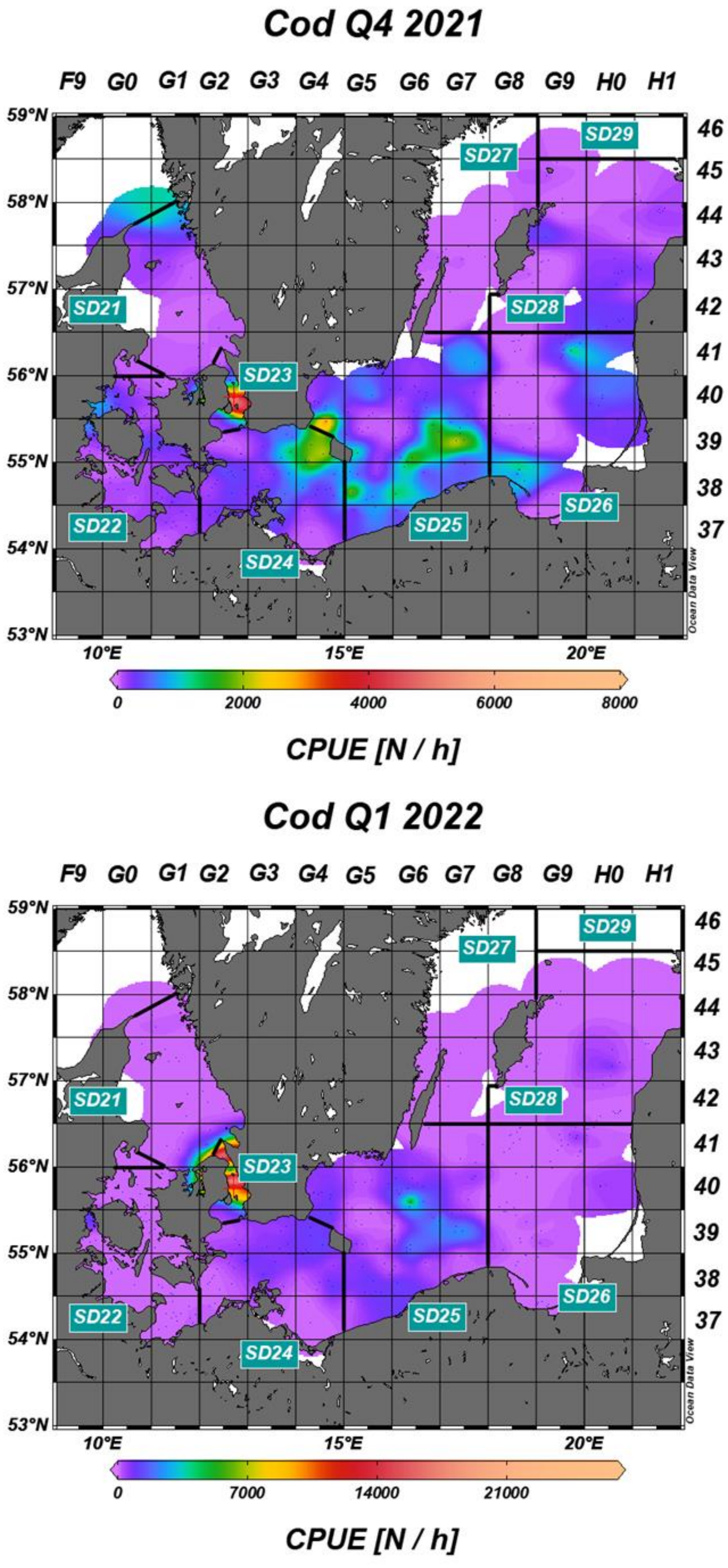


Figure 4.19. CPUE (N/per hour) for cod during BITS 4th quarter 2021 and 1st quarter 2022

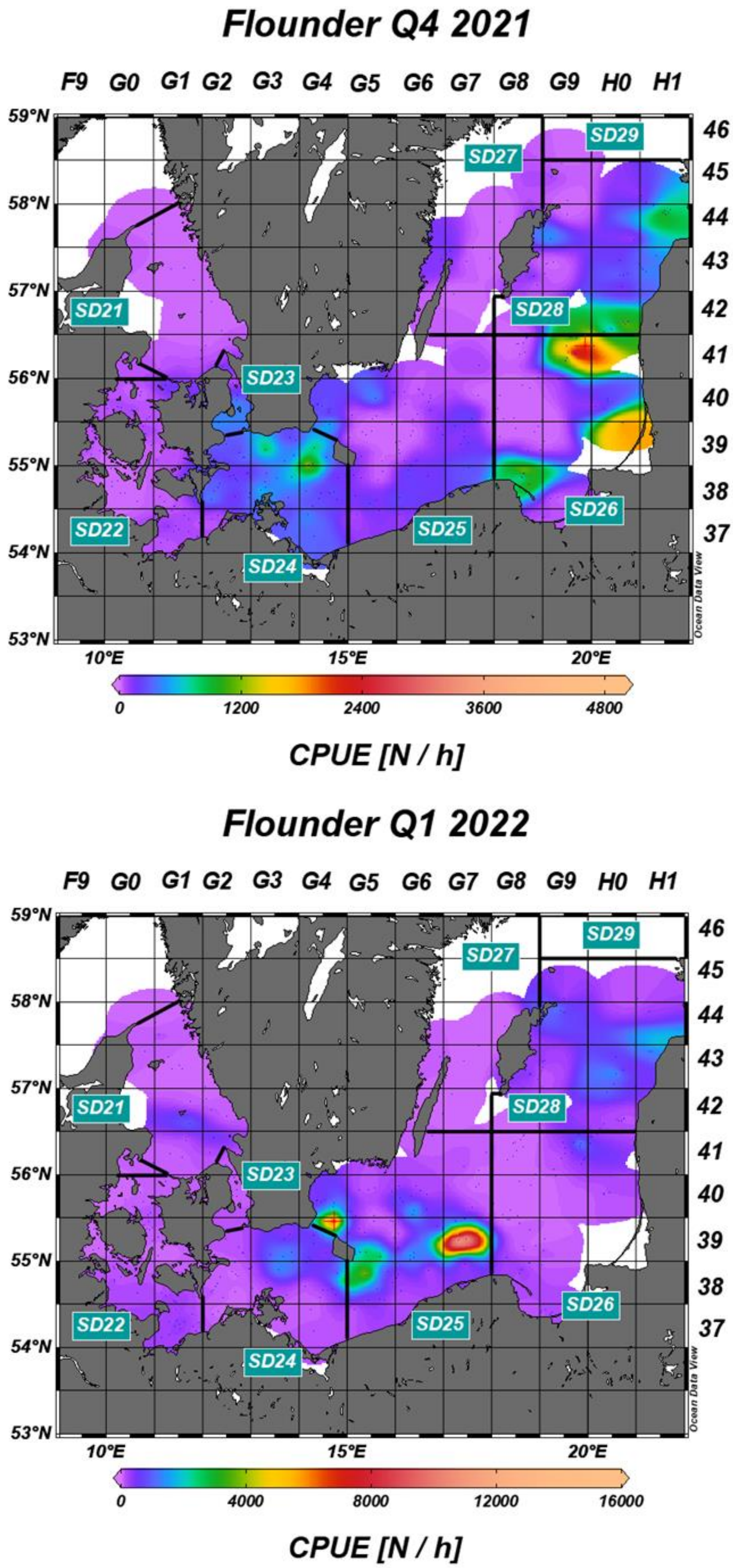
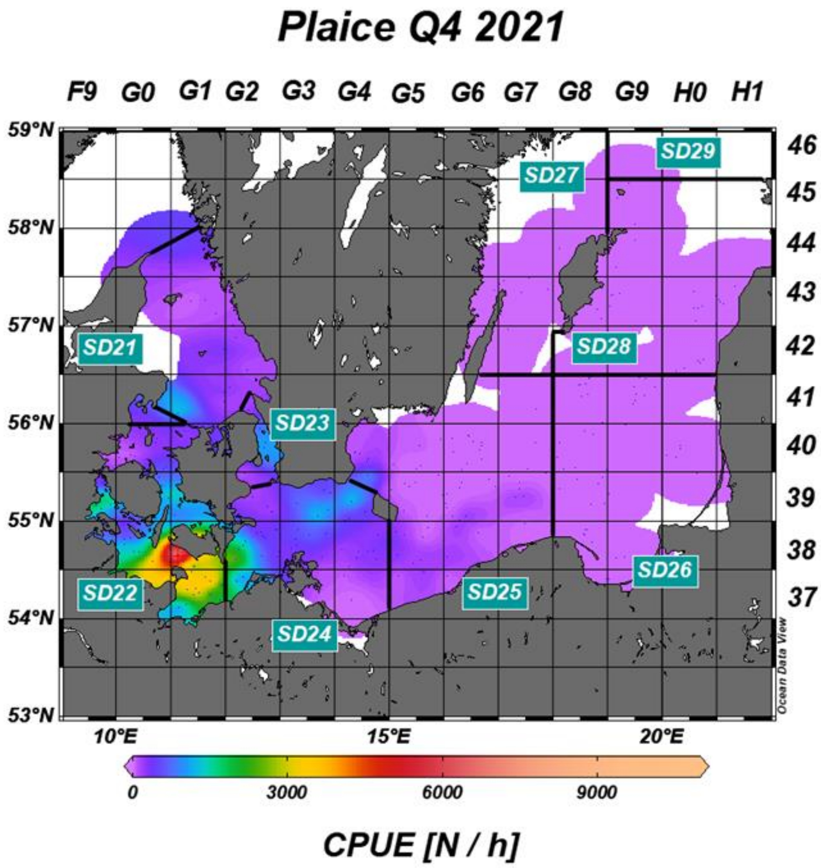


Figure 4.20. CPUE (N/per hour) for flounder during BITS 4th quarter 2021 and 1st quarter 2022.



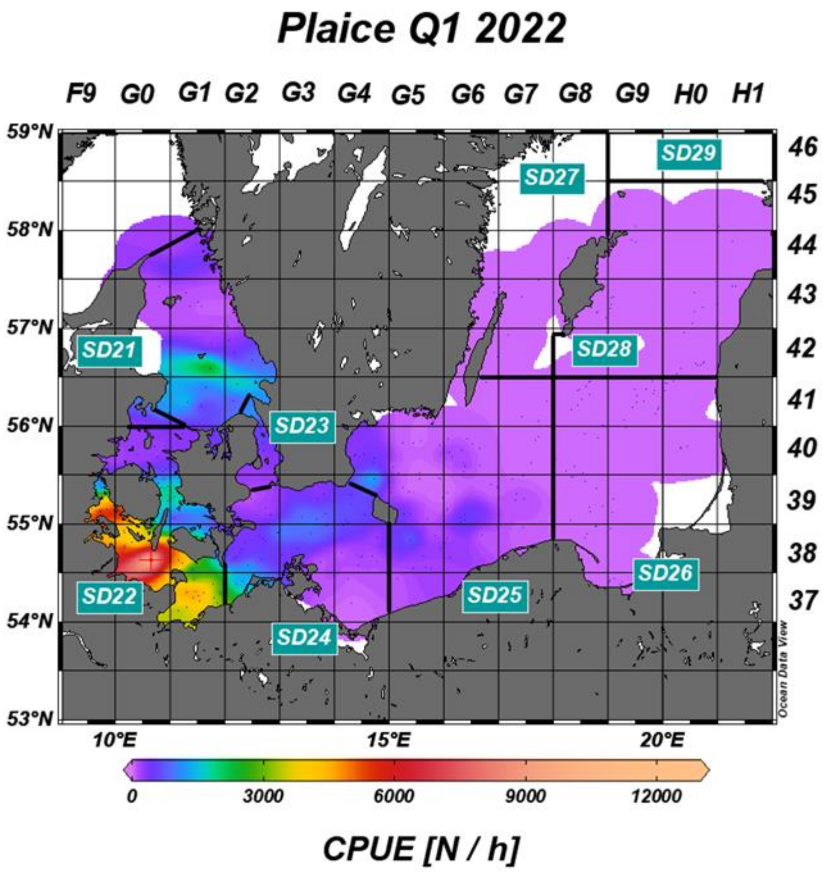
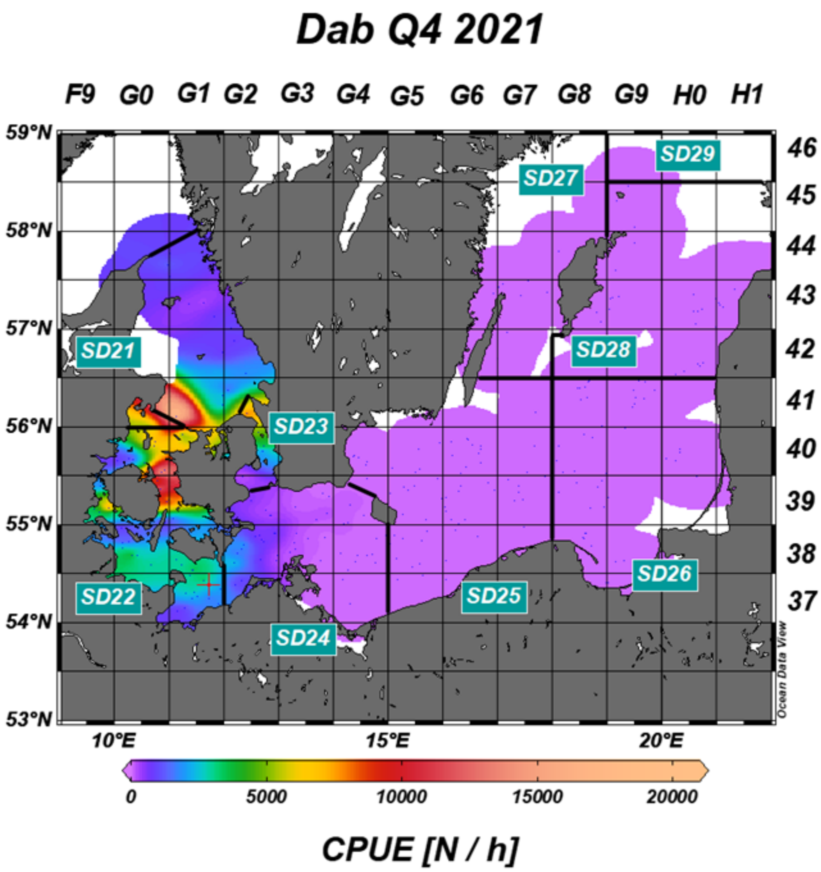


Figure 4.21. CPUE (N/per hour) for plaice during BITS 4th quarter 2021 and 1st quarter 2022.



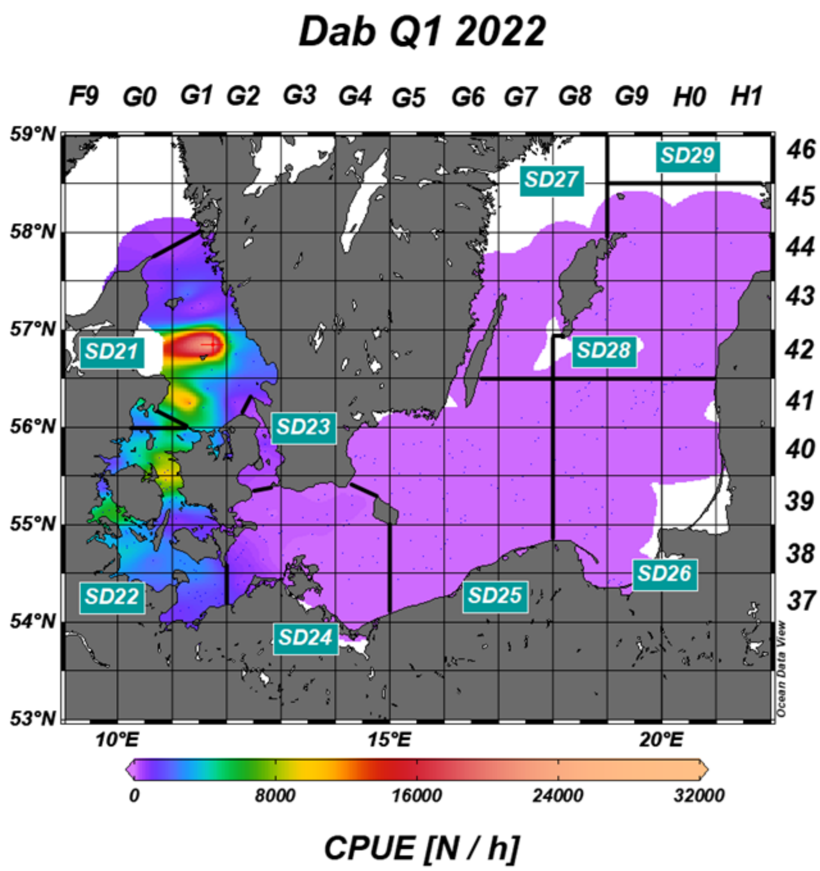
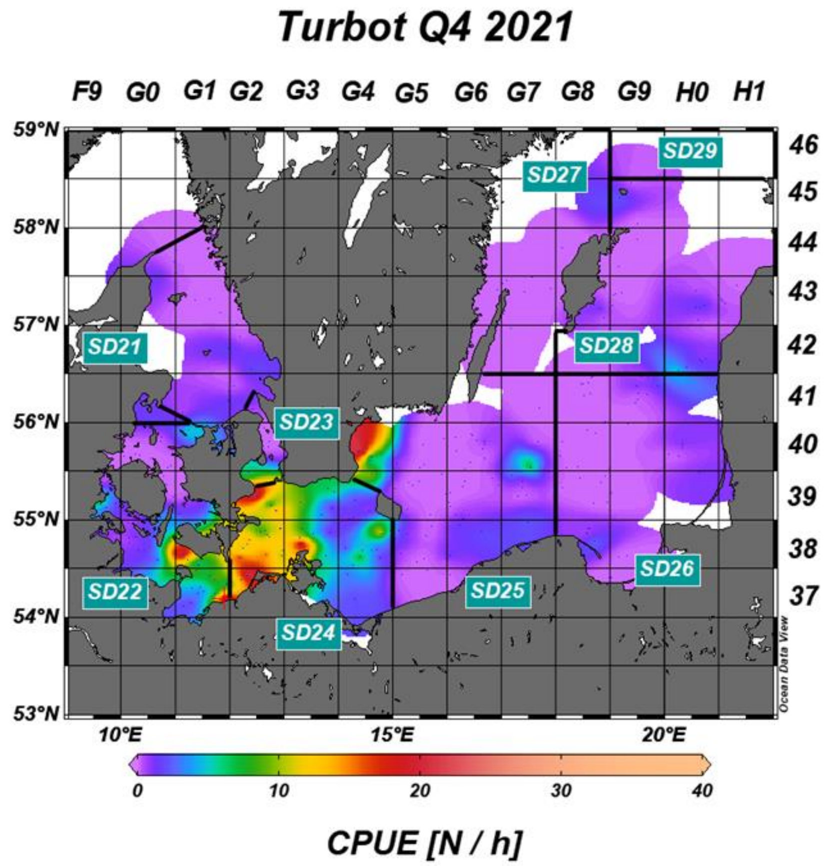


Figure 4.22. CPUE (N/per hour) for dab during BITS 4th quarter 2021 and 1st quarter 2022.



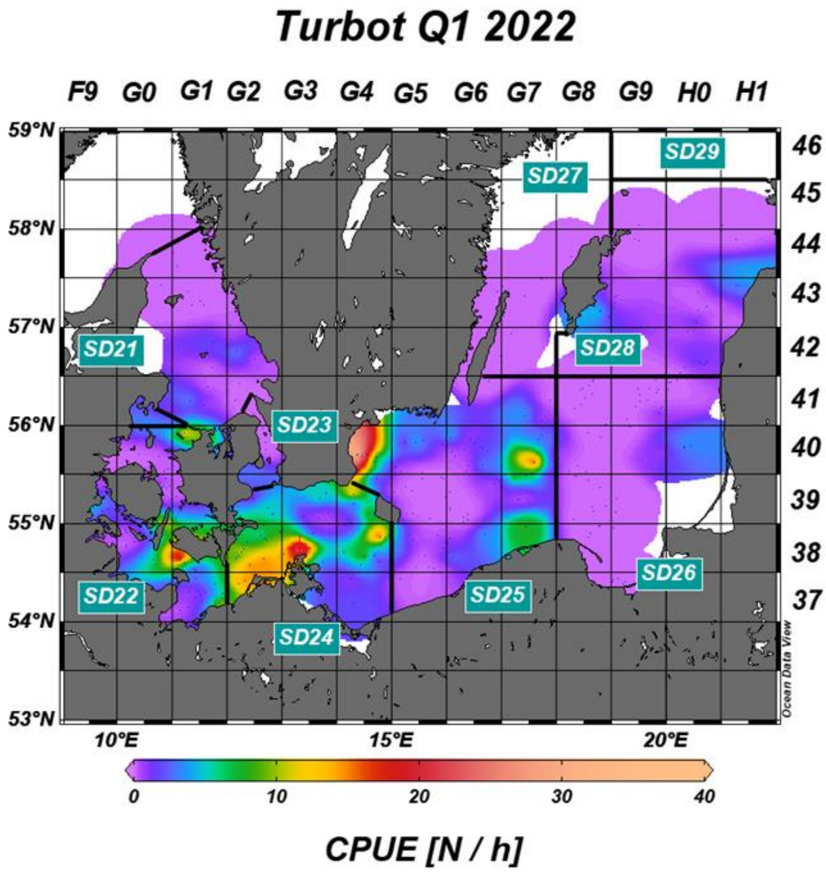


Figure 4.23. CPUE (N/per hour) for turbot during BITS 4th quarter 2021 and 1st quarter 2022.

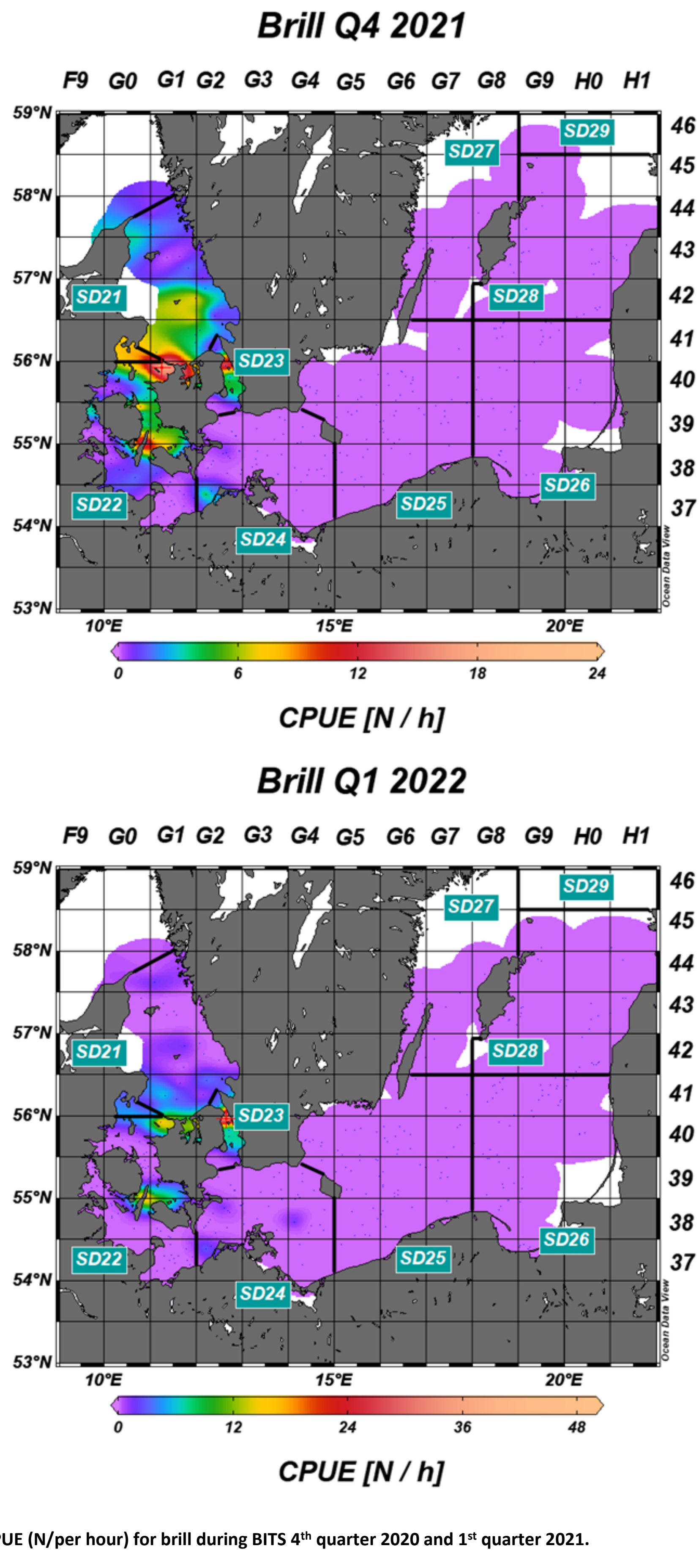


Figure 4.24. CPUE (N/per hour) for brill during BITS 4th quarter 2020 and 1st quarter 2021.

4.5.4 Standard fishing-gear checking.

WGBIFS has implemented a complete and accurate measurement of technical parameters (the geometry, mesh sizes, rope lengths of the trawl, etc.) of the exploited demersal trawls (type TV-3L and TV-3S) as a standard procedure. This procedure must be performed at least once a year for each gear used during the survey by each country involved in the BITS surveys realization. In addition, prior to each BITS survey, also a smaller scale measurement of the trawl should be made. All the measurements should follow the Manual of the construction and use of the International Standard Trawl for the Baltic Demersal Surveys. It is recommended that the measurements of TV-3L and TV-3S trawl technical parameters is done by professional experts in fishing gear technology or experienced crew members. Results of the measurements must be uploaded to the WGBIFS SharePoint using the standard protocols.

Five reports, covering the trawls type TV-3S and TV-3L, were submitted by national laboratories to WGBIFS 2022. Results of the fishing gear measurement presented in the reports did not show any values, which were outside of the acceptable percentage deviation from the standard reference values of the two trawls. The reports can be found in the Annex 6. One example of filled report of the standard bottom fishing gear-checking is given in the Table 4.22 here below.

Table 4.22. Results of the Sweden (RV "Svea") bottom, standard fishing gear-checking exercise.

Table 2. Check list for trawl and for frame ropes of trawl Tag no. TV3-930 #	Country:	Year:	Quarter:	Date:	Remarks:
Trawl no./name: No 3 Yellow bob	SWE	2021	2	31.05.2021	

Check list for trawl TV3-930#

Section	Manual TV3-930 # page 57	Standard: Measured distance [m]	Standard: Mesh size [mm]	Standard: Number of meshes	Tag no. TV3-930 # -: Measured distance [m]	Tag no. TV3-930 # -: Mesh size [mm]	Tag no. TV3-930 # -: Mesh size mean	Tag no. TV3-930 # -: Number of meshes	Relative error [%]: Mesh size [mm]	Relative error [%]: Number of meshes	Remarks
1	1B1	22.10	200	111	22	200	200	110.0	0.0	-0.5	
	1A1	22.10	200	111	21.9	200	200	109.5	0.0	-0.9	
	1A2	22.10	200	111	22.08	200	200	110.4	0.0	-0.1	
	1B2	22.10	200	111	22.13	200	200	110.7	0.0	0.1	
	1C1	22.10	120	184	22.17	120	120	184.8	0.0	0.3	
	1C2	22.10	120	184	22.02	120	120	183.5	0.0	-0.4	
2	2B1	2.96	160	19	2.98	160	160	18.6	0.0	0.7	
	2A	2.96	160	19	2.85	160	160	17.8	0.0	-3.7	
	2B2	2.96	160	19	3.03	160	160	18.9	0.0	2.4	
	2C1	3.00	120	25	3	120	120	25.0	0.0	0.0	
	2C2	3.00	120	25	3.05	120	120	25.4	0.0	1.7	
3	3B1	2.94	120	25	3.02	120	120	25.2	0.0	2.7	
	3A	2.94	120	25	2.88	120	120	24.0	0.0	-2.0	
	3B2	2.94	120	25	3	120	120	25.0	0.0	2.0	
	3C	3.00	120	25	2.9	120	120	24.2	0.0	-3.3	
4	4B1	7.92	80	99	7.84	80	80	98.0	0.0	-1.0	
	4A	7.92	80	99	7.7	80	80	96.3	0.0	-2.8	
	4B2	7.92	80	99	7.8	80	80	97.5	0.0	-1.5	
	4C	8.00	80	100	7.73	80	80	96.6	0.0	-3.4	
5	5B1	5.94	60	99	5.78	60	60	96.3	0.0	-2.7	
	5A	5.94	60	99	5.75	60	60	95.8	0.0	-3.2	
	5B2	5.94	60	99	5.83	60	60	97.2	0.0	-1.9	
	5C	6.00	60	100	5.96	60	60	99.3	0.0	-0.7	
6	6B1	11.92	40	298	11.93	40	40	298.3	0.0	0.1	
	6A	11.92	40	298	11.9	40	40	297.5	0.0	-0.2	
	6B2	11.92	40	298	11.85	40	40	296.3	0.0	-0.6	
	6C	12.00	40	300	12.02	40	40	300.5	0.0	0.2	
Codend			20			20					
			20			20					

Mean mesh opening in codend (OMEGA mesh gauge): mm (n, n, n, n, n, n, n, n, n, n)

Check list for frame ropes of trawl TV3-930 #			
Manual TV3-930 # page 59	Measured distance [m]		Remarks
	Standard	TV3-930 #	
Head line extension Port.	**4.00**	4.55	
Head line wing section Port.	**28.50**	28.65	
Head line bosom section	**2.50**	2.62	
Head line wing section Stbd.	**28.50**	28.65	
Head line extension Stbd.	**4.00**	4.5	
Fishing line extension Port.	**0.95**	1.4	
Fishing line wing section Port.	**29.94**	29.82	
Fishing line bosom section	**1.68**	1.77	
Fishing line wing section Stbd.	**29.94**	29.82	
Fishing line extension Stbd.	**0.95**	1.35	
Upper wing line Port.	**2.70**	2.5	
Upper wing line Stbd.	**2.70**	2.47	
Upper wing side Port.	**2.15**	2.65	
Upper wing side Stbd.	**2.15**	2.65	
Lower wing line Port.	**2.75**	2.8	
Lower wing line Stbd.	**2.75**	2.6	
Lower wing side Port.	**2.20**	2.85	
Lower wing side Stbd.	**2.20**	2.7	

Type of fishing gear:	TV3-930 #
Nation:	Swe
Date of measurements:	31.05.2021
Name of operators:	Olof Lövgren
Number of realized hauls:	57
Comments concerning the use:	

4.6 ToR e) Coordinate and plan demersal trawl surveys and experiments to be conducted, and update, and correct the Tow-Database

The most of the participating institutes plan the same numbers of hauls during BITS surveys in autumn 2022 and spring 2023 as in the year before.

The total number of stations planned by countries during BITS in autumn 2022 and spring 2023 is given in the following table:

Country	Vessel	Number of planned stations in autumn 2022	Number of planned stations in spring 2023
Germany	Solea	57	60
Denmark	Havfisken	27+30*	27+30*
	Total in SD 20 - 24	**84**	**87**
Denmark	Dana	55	55
Estonia	Commercial vessel	10**	0
Latvia	Chartered vessel	25	25
Lithuania	Commercial vessel	6	6
Poland	Baltica	61	69
Russia	Atlantniro/Atlantida	?	?
Sweden	Svea	30	50
	Total in SD 25 - 28	**187**	**205**
	Total in SD 20 - 28	**271**	**292**

*** Including hauls in Kattegat**

**** Only in Estonian EEZ**

There is no information available about the participation of Russia in the next two BITS surveys. Since other ICES Member Countries will not be able to get permission to work in the EEZ of Russia, these potential gaps in the dataset can affect the quality of survey results based on the BITS survey.

All countries have added data from 4th quarter 2021 and 1st quarter 2022 BITS surveys to the DATRAS.

After each survey, each country gives feedback on the information given in the Tow Database. The Tow-Database, which allows planning of the spatial distribution of hauls was updated bases on the feedbacks of the participants.

4.7 ToR f) Conduct the analyses related to the improvement of quality of acoustic indices and estimation of the uncertainty in the acoustic surveys coordinated by WGBIFS

To address the WKBALTPEL request (see chapter 5.5.) BIAS survey variance was calculated for the relative abundance indices of Central Baltic herring. Different methods have been previously discussed at WGBIFS, but in the end it was decided to use a bootstrap over the number of herring per ICES square as it was recommended at the Workshop on Sampling Design and Optimization of fisheries data (WKSDO) in Lysekil, Sweden in 2014.

The data was taken from the WGBIFS BIAS Access database "BIAS_DB_2022_11_09.accdb" from the report table "607_REPORT_N_RECT_YEAR". In the table, the number of ICES squares for each year each varied between 41-120. A bootstrap with replacement was made over the values for each year. Boot iterations was set to 100.000. The mean and standard deviation was calculated on the resampled values.

The R-code for resampling herring numbers (part of code):

```
tesd<-Hersquare$N_HER
  rows <- NROW(tesd)
    while(i<boots){
      x <- sample((A), size = rows, replace = TRUE)
      a<-sum(tesd[x])
      yrout<-c(yrout,a)
      i<-i+1
    }
```

For the mean and the standard deviation of the bootstrapped values, the R functions mean() and sd() were used on the resampled "yrout" vector.

Six different data sets were calculated on the resampled data;

- 1991-2021, SD25-29, ages 1-8+
- 1991-2021, SD25-29, age 0
- 2006-2021, SD25-29+32, ages 1-8+
- 2006-2021, SD25-29+32, age 0

Mean and sd of bootstrapped herring abundance values, ages 0 and 1-8+.

Table 4.23 and 4.24 show the mean abundance and standard deviation (sd) for the bootstrapped herring data in each year, Age 0 and ages 1-8+. In table 4.23 can be seen calculated mean abundance and SD for the years 1991-202, the values are for the area SD 25-29, age 0 and ages 1-8+ is found in different columns. In table 4.24, calculated values for mean and sd for the years 2006-2021, the area is SD 25-29+32, both age 0 and ages 1-8+ can be found in different columns.

Table 4.23. Herring abundance mean and sd of bootstrapped values 1991-2021, SD25-29.

Year	Total mean	Total sd	Age 0 mean	Age 0 sd	Age 1-8+ mean	Age 1-8+ sd
1991	54652.67	7747.09	10472.83	2992.64	44190.13	5490.70
1992	35389.18	4569.54	1302.61	884.28	34087.75	4433.10
1993	14651.09	2269.37	590.45	356.33	14081.35	2044.22
1994	52379.57	5580.90	4916.37	1416.61	47447.11	5378.11
1995	25493.55	2610.57	1212.82	290.28	24280.75	2621.21
1996	36050.22	5272.45	312.93	181.81	35738.38	5260.85
1997	14991.27	1623.61	2363.67	743.42	12632.40	1432.75
1998	21191.91	4169.59	479.34	152.65	20691.04	4212.02
1999	21855.57	2617.18	2485.13	677.38	19365.71	2377.60
2000	35013.30	8199.61	1241.17	392.63	33823.05	8173.14
2001	22838.72	2706.45	1792.82	519.49	21038.65	2626.33
2002	28961.78	4702.58	11304.79	3682.57	17673.97	2768.99
2003	49164.51	6418.71	7314.05	1640.97	41842.57	5785.75
2004	31560.67	3301.59	1545.45	378.19	30016.81	3301.23
2005	40288.19	5564.96	4474.67	1471.70	35797.37	5122.69
2006	53240.84	9638.43	1612.27	441.31	51589.20	9567.00
2007	39368.24	6549.95	11477.21	3017.38	27902.91	4392.57
2008	40350.98	6330.53	7921.02	3769.68	32444.00	3903.96
2009	39612.66	6103.88	3260.45	1210.04	36323.16	5731.54
2010	37484.86	4138.96	1143.05	290.47	36335.20	4090.06
2011	50717.83	6253.95	9205.03	1967.85	41566.01	5930.92
2012	58691.65	10459.71	10405.92	4131.73	48341.07	7302.03
2013	43475.30	4577.57	2430.82	846.33	41056.60	4452.24
2014	77655.81	10331.87	28389.25	7334.61	49241.30	6498.54
2015	86558.30	14391.47	6464.11	1936.52	80122.70	14301.01
2016	54831.74	12545.02	2438.21	1291.68	52351.11	12125.51
2017	44708.92	5843.72	6406.04	1648.65	38306.87	5677.36
2018	62274.96	12412.68	1930.66	405.72	60386.39	12213.04
2019	50144.65	9924.49	22313.45	8024.56	27817.28	5186.49
2020	34188.69	7613.01	5546.52	3498.65	28675.09	4960.19
2021	41104.43	5011.58	2755.87	1032.53	38327.93	4719.99

Table 4.24. Herring abundance mean and sd of bootstrapped values 2006-2021, SD25-29 and 32.

Year	Total mean	Total sd	Age 0 mean	Age 0 sd	Age 1-8+ mean	Age 1-8+ sd
2006	60928.65	9906.79	2126.14	461.77	58758.34	9785.11
2007	44525.25	6810.48	12214.91	3043.24	32313.80	4677.24
2008	41752.64	6300.86	8217.22	3756.74	33501.67	3895.17
2009	46955.01	6166.80	3323.51	1219.03	43604.70	5840.70
2010	42761.83	4228.13	1431.05	312.38	41325.08	4132.99
2011	52263.14	6476.50	9482.75	1990.16	42803.25	6073.29
2012	60966.14	10649.92	11136.91	4152.40	49792.31	7505.27
2013	53641.39	6491.92	2752.95	850.85	50858.79	6317.03
2014	100214.22	13416.11	38201.41	8493.15	62108.87	8161.01
2015	106298.03	15258.90	6780.25	1948.12	99570.01	15335.16
2016	81869.55	16047.02	6272.10	2777.59	75575.26	15317.15
2017	65391.44	8501.73	8393.38	1865.03	57053.17	8269.56
2018	78437.83	13626.77	2203.92	420.85	76265.24	13475.63
2019	68663.84	11477.53	30701.27	8387.16	37927.73	6601.49
2020	52321.80	9760.69	8758.97	3942.99	43534.86	7622.84
2021	45003.92	5313.19	2936.85	1035.35	42084.22	5053.28

4.8 ToR g) Update on progress in development of the StoX software and implementation of it for the calculation of WGBIFS acoustic stock estimates

Initial objective of that ToR was that WGBIFS would reach an agreement about the possibility to implement StoX as a new standard tool for the calculation of WGBIFS acoustic stock estimates. Several steps have been taken to reach the goal of this ToR. For example, in 2020 WGBIFS recalculated the whole time series of the Gulf of Bothnia herring abundance with StoX software and decided to continue this time series updates using only StoX calculations.

During the WGBIFS 2021 meeting ICES Data Centre presented 3 alternative strata files for the Baltic Sea to be used in StoX program instead of the previous one that contained several errors. WGBIFS decided to use the EMODnet_2020 strata file. After that the Group was waiting for the new updated version of StoX, which would enable testing of StoX even for the calculation of herring and sprat indices in the Baltic proper. Finally, in mid-August 2022 StoX version 3.5.0 was released and the BIAS project updated, that met all the requirements for further analyses. As a next step WGBIFS StoX task subgroup was organizing a 3 day meeting (30. August – 1. September) in Lysekil, Sweden to exchange the first experiences with StoX 3.5.0 and to present the first results to calculate abundance estimates for Central Baltic herring, Baltic sprat, and Gulf of Riga herring stocks. Totally 7 WGBIFS members participated in that subgroup meeting: Stefanie Haase (Germany), Olavi Kaljuste (Sweden), Niklas Larson (Sweden), Juha Lilja (Finland), Tiit

Raid (Estonia), Elor Sepp (Estonia),) and Beata Schmidt (Poland). Further analyses were done after the subgroup meeting and these results were presented during the WGBIFS meeting in November.

Central Baltic herring

WGBIFS calculated herring abundance estimates using the StoX software for years 2016-2021 – the years where BIAS acoustic and biotic data was available from all participating countries in the ICES database for acoustic-trawl surveys. A comparison exercise between the StoX and traditional BIAS calculation methods was done. It revealed that StoX herring total abundance estimates are somewhat higher for most of the years, but the trend of the BIAS tuning series was not so well represented in StoX estimates. This might suggest that the results are not fully comparable because StoX software is not designed to fully replicate the current IBAS calculation procedure. Additionally, different settings were tested in StoX projects for herring abundance calculation. Instead of the standard IBAS trawl assignment method the nearest haul method was used. These results showed much better agreement between the two calculation methods. Still a huge difference remained for the year 2018 results. Also, large differences in abundance estimates at the ICES Subdivision and rectangle level and in age composition existed. Additionally, some errors and differences in input data (uploaded into the ICES database) were found and therefore the further analysis was postponed until these issues are fixed.

Baltic sprat

WGBIFS calculated BASS sprat abundance estimates using the StoX software for years 2018-2021 – the years where acoustic and biotic data was available from all participating countries in the ICES database for acoustic-trawl surveys. Data for 2016 and 2017 are also available from all countries, but 2016 was excluded because of the low survey coverage and data from year 2017 gave an internal error in StoX. Sprat abundance estimates were also calculated in the StoX for the years 2016-2021. Comparison between StoX results and BIAS and BASS estimates showed no major differences in sprat total abundance estimates for most of the years and trend of the BIAS and BASS tuning series was quite well represented also in StoX estimates. However, large differences in ICES Subdivision and rectangle level and in age composition existed. Additionally, some errors and differences in input data (uploaded into the ICES database) were found and therefore the further analysis was postponed until these issues are fixed.

Gulf of Riga herring

WGBIFS calculated Gulf of Riga herring abundance estimates using the StoX software for years 2011-2021 – the years where GRAHS acoustic and biotic data were available from in the ICES database for acoustic-trawl surveys. Data for the years 1999-2010 were not available prior to the meeting. Comparison analysis, between StoX and traditional calculation method that is used so far, showed no major differences in herring total abundance estimates for most of the years. Notable differences were in the age compositions of those two methods. Some errors and differences in input data (uploaded into the ICES database) were found and therefore the further analysis was postponed until these issues are fixed.

4.9 ToR h) Coordinate the marine litter-sampling programme within the Baltic International Trawl Survey and registering the data in the ICES database

Collected and registered information about marine litter is an important source of knowledge regarding current ecological status of marine seabed in investigated areas of the Baltic. All countries, who realized the recent BITS surveys, have also submitted the collected litter materials into the DATRAS Litter database (Table 4.25).

Table 4.25. Summary overview of the marine litter data registered in the ICES database from BITS in 2021-2022 by countries and quarters.

Year	Quarter	Country	Hauls
2021	1	Germany	50
2021	1	Denmark	121
2021	1	Latvia	30
2021	1	Poland	70
2021	1	Russia	15
2021	1	Sweden	44
2021	4	Germany	53
2021	4	Denmark	119
2021	4	Estonia	7
2021	4	Latvia	29
2021	4	Poland	64
2021	4	Sweden	29
2022	1	Germany	53
2022	1	Denmark	111
2022	1	Latvia	30
2022	1	Poland	73
2022	1	Sweden	44

4.10 ToR i) Agree a standard pelagic trawl gear used in acoustic surveys

In 2016, WGBIFS requested support from WGFTFB to standardize the pelagic trawl for the international Baltic acoustic surveys (BASS and BIAS). Several meetings were held in until 2019 between the Chairs of WGBIFS and WGFTFB and between the members of these two groups to discuss this topic. Based on the discussions, the needs for the possible standard pelagic trawl gear where identified and the next steps in the gear standardization process were agreed. It was decided that the Chair of WGFTFB will present the topic at their next meeting to ask the gear technologists for their participation for addressing this ToR.

In January 2020 there was a short meeting between the Chair of WGBIFS, and the 2 new Chairs of WGFTFB (Daniel Stepputtis and Antonello Sala) to discuss the gear standardization topic. It revealed that WGFTFB has changed their position on this issue and are no longer planning to assist WGBIFS in gear standardization process. Chairs of WGFTFB recommended instead WGBIFS to launch a new EU project for the development of a new standard survey gear (as it was for example done for the TV3 type of demersal trawl for BITS surveys) and advised to search partners for cooperation within other ICES survey groups, who might have similar needs.

During the WGBIFS 2020 meeting in March this new information was discussed and the Group found that there is a lack of knowledge within our WG for launching such project alone. At the same time majority of the WG members still supported the continued search for possible solutions in this topic. Therefore, it was decided to take contact with WGIPS in this question. After the meeting the Chair of WGBIFS contacted the Chairs of WGIPS (Bram Couperus and Michael O'Malley) for possible cooperation in this matter and got a response that WGIPS will raise this question at their meeting in January 2021 to see, whether there are members in their group that would be interested in this issue and are willing to take it for-ward with the potential of getting involved in a more formal project. WGIPS discussed this question very briefly at the meeting in January 2021. Members of the group were of the opinion that this would be better dealt with as a recommendation to a gear group like WGFTFB. Also, if this question came to WGIPS as a recommendation, then it would be allocated more time at the meeting, as it was an online meeting this year, it was difficult to gauge whether there was real interest or not. Therefore, WGBIFS decided in the 2021 meeting to address this standard pelagic trawl gear question to WGIPS as a recommendation.

Based on discussions during the WGIPS 2022 meeting they replied to our recommendation the following way: "Survey sampling trawls are a key component of acoustic trawl reporting, providing biological samples used to determine age stratified abundance. Discussions within the group in response to this request included; consistency in the existing time series using the existing survey gear, gear design tailored to target species (multiple spp in some ecosystem surveys), geographical area as well as scrutiny and species partition methods used. In summary, development of new survey trawl is welcomed. However, due to the issues described above the adoption of a standard trawl design across all WGIPS survey may not be possible." After this decision it became clear to WGBIFS that we have to give up the plan to launch a new EU project for the development of a new standard survey gear. During the WGBIFS meeting in November Sweden presented an overview about their new pelagic trawl that has been used recently in BIAS and BASS surveys. Namely Sweden has changed their old traditional Fotö trawl against a new Gloria Helix pelagic trawl. Comparison of those two trawl gears has revealed that the Gloria trawl is easier to handle on deck, resulting in almost no need for a re-shooting the hauls. Also the shoot and hive time is shorter. As the catches are higher, the haul time can be shortened, and it saves some survey time. According to the manufacture's info the drawings of that gear are available for free, and the size can be scaled easily up or down. Group members were very interested in this gear and decided to discuss more about this topic during the next meeting in 2023.

4.11 ToR j) Review and update the manual for International Baltic Acoustic Surveys (IBAS; former SISP 8) and address methodological question raised at the last review of the SISP

The manual for International Baltic Acoustic Surveys (IBAS) was reviewed during the WGBIFS 2022 meeting and several suggestions about the possible changes and corrections were listed.

4.12 ToR k) Review and update the manual for Baltic International Trawl Survey (BITS; former SISP 7) and address methodological question raised at the last review of the SISP

The manual for Baltic International Trawl Survey (BITS) was reviewed during the WGBIFS 2022 meeting and minor changes and corrections were implemented.

4.13 ToR l) Conduct analyses related to the uncertainties in the Gulf of Riga Acoustic Herring Survey (GRAHS) in order to improve the quality of the GRAHS and subsequent indices

Acoustic and biotic data of GRAHS surveys from years 2011-2021 were available in the ICES database for acoustic-trawl surveys prior to the meeting. Comparison analysis based on that data gave promising results with no major differences in abundances of most year-classes which indicates to no large differences in current and StoX calculation methodologies. Some errors in uploaded data were found and further analysis was postponed until these are fixed. Notable differences were in the abundances of young herring individuals which suggests that probably the results are not fully comparable due to the fact that StoX program is not designed to fully replicate the current procedure. Further investigation into the matter is needed using full time series which will be conducted before the next meeting and results will be discussed during the 2023 meeting, if all the historic data are made available. The group is still waiting for the full time series of data to be uploaded by the responsible Latvian scientists.

4.14 ToR m) Evaluate if there are methodological and/or environmental reasons for different survey catchabilities in different ICES Sub-divisions and what may be magnitude of these differences

Jan Horbowy and Szymon Smolinski joined the WGBIFS meeting in November during the discussion of that ToR. First, they presented the background of that ToR and then answered the raised questions. It was followed by discussion about the survey catchabilities and the assessment results. Finally, WGBIFS members decided to address this ToR in the final report of WGBIFS 2023 meeting.

5 Inquiries Besides of the Fixed ToRs

5.1 Collect, count and report litter data according to the latest guidance documents produced by WGML. (WGML request)

WGML requested that bottom trawl surveys collect, count and report litter data according to the latest guidance documents produced by WGML (updated manual and QA/QC tools such as the Seafloor Litter Photo Guide). WGBIFS reviewed the manual for Baltic International Trawl Surveys and has made necessary updates there regarding the marine litter sampling.

5.2 Reporting to stock coordinators if the historical data are re-uploaded and the changes affect the calculation results (e.g. abundance, CPUE). (WGBFAS request)

Data re-uploading is a common process of database handling. BITS data re-uploaded historically represent two different types of cases. The first case concerned data on catch weight in HL records presented initially in 100 g units, which are currently not allowed. Re-uploading of that type of data neither affected abundance estimates nor the CPUE calculation results. The second cause of data re-uploading may result from updating information in already existing database from a given survey with the new data which were not available during first data upload (eg. age of fish). Additionally, possible data corrections can be the reason of database re-uploading. Any of the data uploading or re-uploading is delivered with the mandatory information on the nature of the event which is recorded in the comment field of the DATRAS database. Information on all data uploads and comments on them are available and can be downloaded from the DATRAS portal (link: https://datras.ices.dk/Data_products/Submission_Status.aspx).

5.3 Have a look at the WGDG proposals and send our comments to Adriana Villamor. (WGDG request)

The DATRAS team at ICES has presented a proposal to update the DATRAS documents webpage https://www.ices.dk/data/data-portals/Pages/DATRAS-Docs.aspx to the DATRAS governance group (WGDG). WGBIFS was requested to review and amend if needed these updates and give feedback to Adriana Villamor.

During the WGBIFS meetings in 2022 the DATRAS updates were discussed in the BITS subgroup and feedback was given to Adriana Villamor as it was requested.

5.4 Reporting to Ingeborg de Boois (WGDG) whether we collect any information on fish diseases/parasites/ulcers/.... in the survey. (WGDG request)

Ingeborg de Boois, chair of Working Group on DATRAS Governance (WGDG), has asked WGBIFS, IBTSWG and WGBEAM whether they collect any information on fish diseases/parasites/ulcers/.... in the surveys.

If yes: is that:

a. Systematically done, or more on a project basis

b. For one specific species, or multiple species

c. For one specific disease/parasite, or a broad scan

The survey on reporting information on fish diseases, parasites and ulcers during the BITS research cruises revealed that most of the Baltic countries collect such data. Type of data recorded by countries is presented in the following table.

Country	Fish diseases	Parasites	Ulcers	Liver worms
Germany	yes	yes	yes	yes
Denmark	not systematic	yes	not systematic	yes
Estonia	yes	yes	yes	yes
Latvia	yes	yes	yes	yes
Poland	yes	yes	yes	yes
Sweden	no	yes	no	yes
Lithuania	no	no	no	yes

5.5 Providing acoustic tuning indices for WKBALTPEL (WKBALTPEL request)

During the 2022 have WGBFAS stock assessors contacted chairs of WGBIFS with request that WGBIFS would provide WKBALTPEL with some alternative acoustic tuning indices (e.g. indices calculated with StoX and/or including data from Gulf of Finland). Additionally, it was requested that WGBIFS should provide number of hauls and survey variance values for Central Baltic herring tuning indices.

StoX calculated acoustic indices

Comparison exercises between the StoX and traditional BIAS, BASS and GRAHS calculation methods were done (see for more info in chapter 4.7). Main conclusion from these exercises were:

- StoX calculations produce similar Gulf of Riga herring and Baltic sprat total abundance estimates for most of the years and trend of the BIAS, BASS and GRAHS tuning series is quite well represented also in StoX estimates.
- In the case of Central Baltic herring the differences are much larger.
- Large differences exist in abundance estimates at the ICES Subdivision and rectangle level and in the age composition as well, which might suggest that the results are not fully comparable because StoX software is not designed to completely replicate the current WGBIFS calculation procedures.
- Some errors and differences in input data (uploaded into the ICES database) were found and therefore the further analyses were postponed until these issues are fixed.

Based on these results came WGBIFS to a conclusion that the new acoustic index time-series calculated with StoX cannot be used yet for the stock assessment.

Central Baltic herring stock

WGBIFS extracted a new Central Baltic herring tuning index including data from Gulf of Finland (SD 32) from BIAS_DB.mdb access-database which is presented in Table 5.1. Number of BIAS hauls are given in Table 5.2 and survey variance values in the Table 4.24.

Table 5.1. Whole time-series of tuning indices. Autumn acoustic (BIAS) tuning fleet index (numbers in millions) for the Central Baltic herring (the ICES Subdivisions 25–27, 28.2, 29 and 32, including the existing data of the ICES Subdivision 29 North).

YEAR	Age 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
1999	2 793.89	1 796.64	5 128.68	3 729.11	4 468.79	3 755.40	1 458.40	851.26	649.76
2000	2 841.22	36 324.90	6 174.65	13 325.96	8 229.94	8 308.64	4 622.07	3 609.71	2460.47
2001	2 148.63	4 100.80	8 452.87	3 475.74	4 737.98	1 598.26	1 252.46	872.16	470.55
2002									
2003	10 375.68	27 501.86	12 482.87	12 638.58	7 677.64	2 913.11	2 121.50	762.06	1270.80
2004	1 600.00	5 270.24	13 823.59	6 960.46	4 735.30	2 507.91	1 132.10	603.52	679.98
2005	6 988.63	2 138.23	10 932.54	23 334.95	14 982.24	5 202.83	2 980.71	1 095.95	1174.94
2006	2 847.01	10 307.87	10 385.19	16 353.25	23 178.09	8 093.79	3 161.37	1 718.77	1234.17
2007	13 583.07	7 507.45	8 773.00	3 207.64	4 522.07	10 112.28	1 759.80	924.52	842.92
2008	10 748.09	8 042.82	7 887.66	9 322.54	4 612.97	5 217.52	4 715.74	1 173.02	1111.91
2009	3 461.91	9 622.68	17 587.46	7 738.19	7 083.08	2 377.24	3 079.56	2 877.53	652.02
2010	1 667.00	8 599.82	9 595.07	13 496.38	5 273.11	3 879.09	1 737.81	1 923.61	1826.57
2011	10 574.66	2 633.22	6 274.17	11 531.68	13 037.34	5 605.84	3 278.16	1 495.45	2356.96
2012	12 420.12	16 760.74	3 839.23	7 847.22	9 424.79	9 274.77	2 710.75	2 270.59	2 115.43
2013	3 143.02	10 835.26	13 216.40	5 464.11	9 559.03	8 052.62	7 532.41	2 239.20	3 619.98
2014	51 137.88	6 993.54	19 548.68	21 193.95	9 355.71	7 369.99	6 583.61	4 929.26	3 885.36
2015	7 622.78	51 981.70	11 235.53	17 026.93	17 420.48	5 774.48	5 192.29	3 677.95	4 352.03
2016	8 015.84	9 117.43	42 808.25	15 589.94	8 932.27	5 680.74	2 383.89	1 756.00	1 756.17
2017	10 004.09	9 686.66	9 172.72	33 041.79	6 607.34	5 037.10	2 194.71	763.89	1 574.30
2018	2 524.33	10 512.34	15 556.02	15 017.34	32 380.35	8 092.61	6 044.92	2 267.77	1 311.15
2019	35 405.62	3 668.66	7 462.98	10 455.17	6 825.26	10 655.33	1 936.74	1 293.88	803.00
2020	10 345.59	12 953.11	5 642.06	11 332.80	7 287.18	5 091.20	6 947.98	928.75	1 282.72
2021	3 381.34	5 524.71	16 463.95	6 518.58	7 178.75	4 624.95	3 369.41	2 960.21	1 068.22

Note: In the years, 1999, 2001-2005 and 2008 the coverage was very poor. It is recommended that these data should not be used.

Table 5.2. Number of valid survey hauls used for the calculation of autumn acoustic (BIAS) tuning fleet index for the Central Baltic herring (including the existing data of the ICES Subdivision 29 North).

YEAR	SD 25–27, 28.2 and 29	SD 25–27, 28.2, 29 and 32
1991	81	
1992	75	
1993	13	
1994	94	
1995	66	
1996	143	
1997	74	
1998	123	
1999	115	125
2000	131	139
2001	137	138
2002	123	
2003	128	130
2004	143	145
2005	113	115
2006	162	169
2007	146	153
2008	125	127
2009	107	114
2010	139	150
2011	127	136
2012	123	132
2013	122	132
2014	117	136
2015	117	132
2016	127	139
2017	133	146
2018	116	126
2019	129	145
2020	116	132
2021	115	130

Note: In the years, 1999, 2001-2005 and 2008 the coverage was very poor. It is recommended that these data should not be used.

Baltic Sprat stock

BASS survey has covered only one rectangle in the Gulf of Finland (SD 32) in few recent years. Therefore, no alternative Baltic sprat index was calculated based on the BASS data. WGBIFS extracted a new Baltic sprat tuning index including data from Gulf of Finland from BIAS_DB.mdb access-database which is presented in Table 5.3.

Table 5.3. Whole time-series of tuning indices. Autumn acoustic (BIAS) tuning fleet index (numbers in millions) for the Baltic sprat (the ICES Subdivisions 22–29 and 32, including the existing data of the ICES Subdivision 29 North).

YEAR	Age 0	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8+
1999	34 353.75	4 900.96	91 682.00	16 653.69	36 135.89	39 064.00	5 274.86	3 339.33	1 754.01
2000	6 762.15	72 295.19	8 611.02	53 087.49	8 051.73	16 597.27	15 981.92	1 739.25	2 753.24
2001	12 157.26	12 989.55	38 115.62	7 766.11	30 755.81	4 305.55	10 175.27	6 480.45	2 411.90
2002									
2003	168 681.04	116 749.84	35 764.42	25 610.76	24 154.58	10 041.77	13 305.84	5 076.56	8 683.77
2004	3 673.06	170 344.88	58 119.60	11 980.71	8 018.75	4 887.39	2 518.02	2 391.23	3 560.30
2005	42 974.80	12 592.03	165 846.72	59 587.93	10 643.14	5 470.55	3 010.70	2 364.40	3 550.47
2006	86 430.50	83 119.73	24 174.80	147 487.61	52 014.07	10 142.64	5 143.43	2 278.30	3 490.68
2007	21 061.10	75 613.08	39 491.22	12 087.93	40 275.50	15 870.84	1 516.45	768.28	2 378.62
2008	131 972.40	43 599.80	62 492.07	25 533.70	6 913.34	28 473.61	8 950.54	1 383.00	3 105.28
2009	14 528.24	134 252.74	49 825.95	39 347.36	9 935.21	9 110.84	13 064.61	4 101.93	2 175.62
2010	53 561.84	15 366.59	88 034.53	14 904.19	9 019.42	2 161.49	2 966.74	3 706.65	1 560.34
2011	49 129.87	34 095.06	20 174.73	68 117.51	17 115.02	8 392.92	3 071.69	1 838.22	3 188.45
2012	34 941.34	108 250.77	28 702.72	15 212.08	43 526.49	6 639.82	3 453.07	2 134.91	4 195.79
2013	25 346.53	38 415.61	35 889.05	17 151.26	8 465.45	15 536.97	3 170.57	1 115.97	2 738.90
2014	182 073.11	19 021.35	33 427.63	22 062.19	11 956.97	5 857.15	9 165.70	1 770.63	2 026.44
2015	43 534.22	162 638.52	18 894.14	22 417.01	12 789.84	4 198.41	3 964.07	3 085.94	2 163.73
2016	32 783.70	33 849.37	119 883.58	29 659.30	11 196.42	5 440.65	2 461.37	1 506.32	1 805.15
2017	126 748.17	48 760.62	52 739.40	103 921.56	15 960.77	7 473.09	3 698.02	1 230.11	2 444.50
2018	19 371.48	41 907.25	24 556.88	16 382.70	39 840.36	11 997.43	3 293.03	1 433.91	1 905.06
2019	122 062.04	17 161.34	28 807.45	15 797.47	12 692.08	29 391.44	4 002.22	1 641.60	2 404.19
2020	111 154.70	62 658.81	19 407.85	21 467.33	9 688.96	8 401.80	17 420.51	1 225.69	1 342.80
2021	12 442.28	100 173.35	70 693.34	23 649.35	19 444.64	7 632.10	6 306.20	12 184.61	1 910.01

Note: In the years, 1999, 2001-2005 and 2008 the coverage was very poor. It is recommended that these data should not be used.

Gulf of Riga herring stock

Based on the comparison exercise results came WGBIFS to a conclusion that the new time-series of Gulf of Riga herring abundance calculated with StoX cannot be used for the stock assessment yet (see for more info in chapter 4.7 and 4.12). WGBIFS is therefore suggesting that WKBALTPEL should use the old acoustic index that has been calculated by Latvia and is presented in Table 5.4.

Table 5.4. Whole time-series of tuning indices. Gulf of Riga Acoustic Herring Survey (GRAHS) index (numbers in millions) for the Gulf of Riga herring (the ICES Subdivision 28.1).

YEAR	AGE 1	AGE 2	AGE 3	AGE 4	AGE 5	AGE 6	AGE 7	AGE 8
1999	5 292	4 363	1 343	1 165	457	319	208	61
2000	4 486	4 012	1 791	609	682	336	151	147
2001	7 567	2 004	1 447	767	206	296	56	66
2002	3 998	5 994	1 068	526	221	87	165	34
2003	12 441	1 621	2 251	411	263	269	46	137
2004	3 177	10 694	675	1 352	218	195	94	25
2005	8 190	1 564	4 532	337	691	92	75	62
2006	12 082	1 986	213	937	112	223	36	33
2007	1 478	3 662	1 265	143	968	116	103	24
2008	9 231	2 109	4 398	816	134	353	6	23
2009	6 422	4 703	870	1 713	284	28	223	10
2010	5 077	2 311	1 730	244	593	107	12	50
2011	3 162	5 289	2 503	2 949	597	865	163	58
2012	5 957	758	1 537	774	1 035	374	308	134
2013	9 435	5 552	592	1 240	479	827	187	318
2014	1 109	3 832	2 237	276	570	443	466	46
2015	3 221	539	1 899	1 110	255	346	181	197
2016	4 542	1 081	504	1 375	690	152	113	40
2017	3 231	3 442	874	402	1 632	982	137	459
2018	11 216	4 529	3 607	776	338	1 439	755	165
2019	4 912	7 007	2 237	1 335	475	228	681	148
2020	9 947	2 659	3 641	1 234	1 131	403	201	585
2021	6 171	4 891	1 054	2 161	815	670	257	139

6 Revisions to the work plan and justification

No changes in ToRs have been proposed.
No any significant revisions to the work plan were made.

7 Next meeting

There was one proposal for the venue of the next WGBIFS meeting if there will be no travel restrictions in March 2023: Cadiz, Spain. Majority of WGBIFS members supported the idea to organize the next meeting at the University of Cadiz in the period of 20 – 24. 03. 2022.

Annex 1: List of participants

Name	Institute	Country (of institute)	Email
Degel Henrik[1]	Danish Technical University, National Institute of Aquatic Resources, Section for Fisheries Advice	Denmark	hd@aqua.dtu.dk
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Goñi Nicolas	Natural Resources Institute Finland (Luke), Natural Resources and Bioproduction	Finland	nicolas.goni@luke.fi
Horbowy Jan[2]	National Marine Fisheries Research Institute	Poland	jhorbowy@mir.gdynia.pl
Haase Stefanie[1]	Thünen-Institute of Baltic Sea Fisheries	Germany	stefanie.haase@thuenen.de
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Svenson Anders[1]	Swedish University of Agricultural Sciences, Department of Aquatic Resources, Institute of Marine Research	Sweden	anders.svenson@slu.se
Velasco Andrés[1]	Thünen-Institute of Baltic Sea Fisheries	Germany	andres.velasco@thuenen.de
Villamor Adriana[2]	International Council for the Exploration of the Sea		Adriana.villamor@ices.dk

[1] Participated only in the April meeting.

[2] Participated only in the November meeting.

Annex 2: Draft resolutions for the next meeting

The Baltic International Fish Survey Working Group (WGBIFS), chaired by Elor Sepp, Estonia and Olavi Kaljuste, Sweden, will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2021	22–26 March 2021	Cadiz, Spain/ By Correspondence/Webex	Interim report by 15 May 2021 to, SCICOM and ACOM	Elor Sepp and Olavi Kaljuste appointed as chairs
Year 2022	4–6 April 2022 7–11 November 2022	Teams Copenhagen, Denmark/Teams	Interim report by 9 December 2022 to, SCICOM and ACOM	
Year 2023	20–24 March 2023	Cadiz, Spain/Teams	Final report by 15 May 2023 to, SCICOM and ACOM	

ToR descriptors

ToR	Description	Background	Science plan codes	Duration	Expected deliverables
a	Combine and analyse the results of acoustic surveys and experiments	Acoustic surveys provide important fishery-independent stock estimates for Baltic herring and sprat stocks	3.1	Annually Year 1, 2 and 3	Updated acoustic tuning indices for WGBFAS
b	Update the BIAS, BASS and GRAHS hydroacoustic databases and ICES database for acoustic-trawl surveys	The aim of BIAS, BASS and GRAHS databases is to store the aggregated data that are used for the calculation of the survey indices. The aim of ICES database is to ensure that the standardized and quality-controlled scrutinized data from the acoustic-trawl surveys will be stored centrally in a safe way and enables easy access to the data, which will facilitate usage for many different analyses by a wider range of users.	3.1	Annually Year 1, 2 and 3	Updated databases with acoustic and biotic data for WGBIFS
c	Coordinate and plan acoustic surveys including any experiments to be conducted	Acoustic surveys provide important fishery-independent stock estimates for Baltic herring and sprat stocks	3.1	Annually Year 1, 2 and 3	Finalized planning for the surveys for WGBIFS
d	Review the results of BITS surveys and evaluate the characteristics of TVL and TVS standard gears used in BITS	Demersal trawl surveys provide important fishery-independent stock estimates for Baltic cod and flatfish stocks	3.1	Annually Year 1, 2 and 3	Updated BITS data in DATRAS database for ICES Data Centre and WGBFAS

e	Coordinate and plan demersal trawl surveys and experiments to be conducted, and update and correct the Tow Database	Demersal trawl surveys provide important fishery-independent stock estimates for Baltic cod and flatfish stocks	3.1	Annually Year 1, 2 and 3	Finalized planning for the surveys for WGBIFS, updated and corrected Tow Database
f	Conduct the analyses related to the improvement of quality of acoustic indices and estimation of the uncertainty in the acoustic surveys coordinated by WGBIFS	Acoustic surveys provide important fishery-independent stock estimates for Baltic herring and sprat stocks	3.1, 3.2, 3.3	Year 1-3	Improved quality of acoustic indices with estimates of the uncertainty for WGBFAS
g	Update on progress in development of the StoX software and implementation of it for the calculation of WGBIFS acoustic stock estimates	StoX post-processing software produces fish abundance estimations in a transparent and reproducible way. Planned development of the StoX should allow implication of this software by WGBIFS using the data from ICES database. Comparisons will be performed to validate whether the StoX software provides us similar results as the current IBAS calculation method in order to allow WGBIFS to use it as a new standard tool for the calculation of annual acoustic survey estimates.	3.1, 3.2	Year 1-3	Improved quality, transparency and reproducibility of acoustic indices, improved pace of work on the level of national data compilation and verification
h	Coordinate the marine litter-sampling programme within the Baltic International Trawl Survey and registering the data in the ICES database.	Collected and registered information about the marine litter (mostly anthropogenic origin), occasionally appeared in the ground trawl fish control-catches, are additional source of data about present ecological status of marine seabed in investigated areas of the Baltic.	3.1	Annually Year 1, 2 and 3	Coordinated marine litter sampling programme within the Baltic International Trawl Survey (BITS).
i	Agree a standard pelagic trawl gear used in the acoustic surveys	Acoustic surveys provide important fishery-independent estimates for Baltic herring and sprat stocks size and possible uncertainties, which result from, e.g. different type of fishing gears applied for fish control-catches, should be eliminated.	3.1, 3.2	Year 1-3	Agreement on the standard pelagic fishing gear which will be used in the BIAS and BASS surveys
j	Review and update the manual for International Baltic Acoustic Surveys (IBAS; former SISP 8) and address methodological question raised at the last review of the SISP	Acoustic surveys provide important fishery-independent stock estimates for Baltic herring and sprat stocks	3.1, 3.2	Year 3	Updated IBAS manual for publication in TIMES
k	Review and update the manual for Baltic International Trawl Survey (BITS; former SISP 7) and address methodological question	Demersal trawl surveys provide important fishery-independent stock estimates for Baltic cod and flatfish stocks	3.1, 3.2	Year 3	Updated BITS manual for publication in TIMES

	raised at the last review of the SISP				
l	Conduct analyses related to the uncertainties in the Gulf of Riga Acoustic Herring Survey (GRAHS) in order to improve the quality of the GRAHS and subsequent indices.	Until now, the preparation of the survey data for stock assessment is the responsibility of the Latvian and Estonian national laboratories. The methodology and consistency of results of this survey should be evaluated by the wider international scientific expertise available.	3.1, 3.2	Year 1-3	Improved quality, transparency and reproducibility of acoustic indices, updated databases with acoustic and biotic data from GRAHS
m	Evaluate if there are methodological and/or environmental reasons for different survey catchabilities in different ICES Subdivisions and what may be magnitude of these differences	Within the INSPIRE project assessments of herring and sprat stocks were conducted by former assessment units (AUs) instead of currently used central Baltic herring (CBH) and sprat in the entire Baltic. It was discovered in these assess-ments that catchabilities (q) (understood as ratio between the acoustically estimated and the model assessed stock sizes in given area/AU) of acoustic surveys estimated by applied assessment models differed by AUs, and usually q's were higher in northern than in southern waters. The question is if these differences may to some extent be caused by "environmental" differences, acoustic methodologies, area coverages etc. in the surveyed areas. This information is important to have if ICES is asked to develop/evaluate a spatial management plan for sprat and herring, as has been suggested for several years in the sprat advice.	3.1, 3.2	Year 1-3	Improved quality and transparency of acoustic indices

	Summary of the Work Plan
Year 1	Compilation the survey results from 2020 and the first quarter of 2021 and reporting to WGBFAS. Coordination and planning the schedule for surveys in 2021 and first half of 2022. Review the development and validation progress of the StoX software. Conduct the analyses related to the improvement of quality of acoustic indices and estimation of the uncertainty in the acoustic surveys coordinated by WGBIFS. Uploading the data from the Gulf of Riga Acoustic Herring Survey into the ICES database for acoustic and trawl surveys and screening of the data. Conduct analyses related to the evaluation of the different survey catchabilities. Coordinate the marine litter-sampling programme in the BITS surveys and registering the data in the ICES database. Cooperate with WGIPS to find, whether there can be a joint approach for designing a standard pelagic fishing gear used in the acoustic surveys.
Year 2	Compilation the survey results from 2021 and first quarter of 2022 and reporting to WGBFAS. Coordination and planning the schedule for surveys in 2022 and first half of 2023. Review the development and validation progress of the StoX software. Conduct the analyses related to the improvement of quality of acoustic indices and estimation of the uncertainty in the acoustic surveys coordinated by WGBIFS. Conduct analyses related to the uncertainties in the Gulf of Riga Acoustic Herring Survey. Conduct analyses related to the evaluation of the different survey catchabilities. Coordinate the marine litter-sampling programme in the BITS surveys and registering the data in the ICES database. Joint approach with WGIPS, if possible, to designing the standard pelagic fishing gear used in acoustic surveys.
Year 3	Compilation the survey results from 2022 and first quarter of 2023 and reporting to WGBFAS. Coordination and planning the schedule for surveys 2023 and first half of 2024. Implementation of the StoX software linked with the ICES acoustic-trawl survey database for the calculation of stock estimates for Baltic herring and sprat. Present the results of the analyses related to the improvement of quality of acoustic indices and estimation of the uncertainty in the

	acoustic surveys coordinated by WGBIFS. Present the quality checked, transparent and reproducible acoustic indices from the Gulf of Riga Acoustic Herring Survey. Adress results of the analyses related to the evaluation of the different survey catchabilities to WGBFAS. Coordinate the marine litter-sampling programme in the BITS surveys and registering the data in the ICES database. Reviewing and updating the BITS and IBAS survey manuals, and publication in TIMES. Final decision concerning the possible implementation of the standard pelagic fishing gear for control-catches in acoustic surveys.

Supporting information	
Priority	The current activities of this Group will lead ICES into issues related to the ecosystem effects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by about 25 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	The survey data are prime inputs to the assessments of Baltic herring, sprat, cod and flatfish stocks carried out by WGBFAS. Linked to ACOM through the quality of stock assessments and management advice.
Linkages to other committees or groups	There is a very close working relationship with WGBFAS. It is also relevant to the HAPSISG, WGFAST and the working group on Marine litter (WGML).
Linkages to other organizations	No direct linkage to other organizations.

Annex 3: Agenda of WGBIFS 2022

Introduction

1. Opening of the meeting
- Welcome and introduction
- Households remarks
2. Adoption of the agenda and organization of the meeting
- Discussion and adoption of the agenda
- Allocation of tasks between participants
- Presentation of time schedule

Acoustic surveys and data

3. Combine and analyse the results of acoustic surveys and experiments. (ToR a)
- Status of BIAS and BASS standard survey reports.
4. Update the BIAS, BASS and GRAHS hydroacoustic databases and ICES database for acoustic-trawl surveys. (ToR b)
5. Coordinate and plan acoustic surveys including any experiments to be conducted. (ToR c)
6. Conduct the analyses related to the improvement of quality of acoustic indices and estimation of the uncertainty in the acoustic surveys coordinated by WGBIFS. (ToR f)
7. Update on progress in development of the StoX software and implementation of it for the calculation of WGBIFS acoustic stock estimates. (ToR g)
8. Agree a standard pelagic trawl gear used in the acoustic surveys. (ToR i)
9. Review and update the manual for International Baltic Acoustic Surveys (IBAS; former SISP 8) and address methodological question raised at the last review of the SISP. (ToR j)
10. Conduct analyses related to the uncertainties in the Gulf of Riga Acoustic Herring Survey (GRAHS) in order to improve the quality of the GRAHS and subsequent indices. (ToR l)
11. Evaluate if there are methodological and/or environmental reasons for different survey catchabilities in different ICES Sub-divisions and what may be magnitude of these differences. (ToR m)

Bottom trawl surveys and data

12. Review the results of BITS surveys and evaluate the characteristics of TVL and TVS standard gears used in BITS. (ToR d)
- Status of BITS standard and extended survey reports.

13. Coordinate and plan demersal trawl surveys and experiments to be conducted, and update and correct the Tow Database. (ToR e)
14. Coordinate the marine litter-sampling programme within the Baltic International Trawl Survey and registering the data in the ICES database. (ToR h)
15. Review and update the manual for Baltic International Trawl Survey (BITS; former SISP 7) and address methodological question raised at the last review of the SISP. (ToR k)

Inquiries besides of the fixed ToRs

16. **Recommendations from other Expert Groups**

16.1. Collect, count and report litter data according to the latest guidance documents produced by WGML. (Rec. by WGML)

16.2. Reporting to stock coordinators if the historical data are re-uploaded and the changes affect the calculation results (e.g. abundance, CPUE). (Rec. by WGBFAS)

16.3. Have a look at the WGDG proposals and send our comments to Adriana Villamor. (Req. by WGDG)

16.4. Reporting to Ingeborg de Boois (WGDG) whether we collect any information on fish diseases/parasites/ulcers/.... in the survey. (Req. by WGDG)
16.5. Providing acoustic tuning indices for WKBALTPEL (Rec. by WKBALTPEL)

Final issues

17. Selection of the venue for the next meeting

Annex 4: Recommendations

*Recommendations have been uploaded to the ICES recommendations database.

Annex 5: Action List

1. The feedback of the recent catch-stations realized in the framework of BITS surveys should be submitted to Olof Lövgren (Sweden; e-mail: olof.lovgren@slu.se), using the proposed standard format (Annex ToR e, Ch. 5.5.2.2; WGBIFS 2016 Report) not later than 20 December (autumn survey) and immediately after winter-spring survey. The above-mentioned Swedish delegate is a coordinator of the reprogrammed Tow-Database, responsible for storage old control-hauls location with remarks concern realization - and for planning new catch-stations distribution for the next BITS surveys. All problems with realization of designated single control-hauls or part (whole) of survey should be promptly transferred (by e-mail or mobile phone) to O. Lövgren with c/c to the WGBIFS chair. The updated version of the trawl database will be made available after submission the full set of data from the current BITS surveys by all countries.

2. Olavi Kaljuste (Sweden) and Beata Schmidt (Poland) were assigned as coordinators of acoustic-trawl (IBAS) surveys, responsible among-others for controlling that the acoustic surveys results are uploaded in the right format. Beata Schmidt (Poland; e-mail: bschmidt@mir.gdynia.pl) was assigned as the coordinator of BIAS and BASS national databases aggregated data uploading and compilation to international level, moreover she is responsible also for all kind of input data preparation, before and during the ongoing WGBIFS meeting. The recently collected aggregated acoustic-trawl surveys (BASS, BIAS) data (in already agreed Excel format) should be uploaded to the latest WGBIFS SharePoint site at least one month before beginning of the annual WGBIFS meeting. At the same time, the latest disaggregated acoustic and biotic data from national BASS and BIAS surveys should also be uploaded to the new database for acoustic trawl surveys at the ICES Data Centre (http://acoustic.ices.dk/submit), using the ICES acoustic data format. Each country sends the last years acoustic data to Niklas Larson one month before the meeting as specified in WGBIFS 2022 sharepoint (…/2022 Meeting Documents/06. Data/input data to Calc and quality/example files and info/) example files and info - Allitems (ices.dk)

3. Directly, after each BITS survey finalization, national submitters of data linked with monitoring of the marine litter from seabed should be uploaded to the DATRAS database (the ICES Data Centre). The upload data format is described in the manual accessible at the ICES web page: https://www.ices.dk/data/data-portals/Pages/DATRAS-Docs.aspx

4. WGBIFS suggested performing in every year, as obligatory - the technical checking of standard parameters, i.e. measurements of the TV-3 ground trawl elements. The measurements results should be reported to next WGBIFS meeting, using the agreed format of protocols.

5. It's important for precise values of the LFI and MML indicators to inspect that both doors and wingspread indices are included in DATRAS uploads. This should be analysed by all WGBIFS members involved in the BITS surveys accomplishment. This information will facilitate the ability calculate the swept area, one of the much needed parameter in calculation of the a.-m. indicators. Therefore, WGBIFS suggest that all vessels involved in the BITS surveys realization should to have possibly soon suitable equipment (sensors on the trawl wings) for measuring horizontal and vertical trawl opening during fishing.

6. WGBIFS recommends national laboratories to collect of gonad samples (images of gonads and gonads for histology) during regular sampling; the data requested by WGBIOP.

That's potential importance of the collection gonad samples (images of gonads and gonads for histology) and the benefits the other availability of such a library of samples would have for maturity exchanges and workshops. This will be followed up with an email with a protocol with instructions on how to collect the samples.

7. WGBIFS recommends that all remaining data from the GRAHS surveys will be uploaded to the ICES database for acoustic trawl surveys and the errors found in uploaded data fixed before December 2022.

8. WGBIFS recommends that, if possible, Estonia and Latvia should continue extending the BIAS survey into the Gulf of Riga due to the high uncertainty of abundance estimates of younger ages from GRAHS.

9. WGBIFS recommends that all countries that have provided BIAS and BASS data into the Access databases will check the herring and sprat mean weight data quality and provide the missing and corrected values to Beata Schmidt.

10. Based on the new calculations that may lead to an update of the indices, it is recommended that all the countries recheck their historic data so that possible changes will be made in the same update. This issue will be discussed in the 2023 meeting.

11. Each year StoX calculations are done in parallel with standard IBAS calculations and all these StoX projects shall be uploaded into the WGBIFS SharePoint.

12. During the years 2023-2028 all countries shall continue to calculate and upload the results in Bad1 file format into the WGBIFS SharePoint in the same way as it has been done so far.

13. WGBIFS will analyse the potential effect of water temperature on the catches of juvenile herring during the BIAS survey in the Bothnian Sea. Some inconsistencies identified in the Bothnian herring time-series suggest a possible environmental effect on the spatial distribution and/or catchability of juvenile individuals (ages 0, 1, 2) that would alter their representation in the catches, compared with older age classes. Such inconsistencies are particularly salient e.g. in years 2017 and 2020. To explore this hypothesis, we will analyse of the effect of local temperature parameters (SST, thermocline depth and intensity, bottom temperature) derived from CTD profiles, on the proportion of age classes 0, 1 and 2 in the hauls. Would a significant effect be identified, we should provide a corrected version of the abundance index before the next stock assessment. The results of the study will be discussed during the 2023 meeting.

Annex 6: Standard and Cruise Reports of BITS surveys at the WGBIFS 2022 annual meeting

Note: Authors are fully responsible for quality of the prepared text and all kind of presented data

List of standard reports:

- 1. BITS 2021 Quarter 4 Standard Report of Lithuania;
- 2. BITS 2021 Quarter 4 Standard Report of Germany;
- 3. BITS 2021 Quarter 4 Standard Report of Estonia;
- 4. BITS 2021 Quarter 4 Standard Report of Poland;
- 5. BITS 2021 Quarter 4 Standard Report of Latvia-Poland;
- 6. BITS 2021 Quarter 4 Standard Report of Denmark;
- 7. BITS 2021 Quarter 4 Standard Report of Sweden;
- 8. BITS 2022 Quarter 1 Standard Report of Germany;
- 9. BITS 2022 Quarter 1 Standard Report of Poland;
- 10. BITS 2022 Quarter 1 Standard Report of Latvia-Poland;
- 11. BITS 2022 Quarter 1 Standard Report of Denmark;
- 12. BITS 2022 Quarter 1 Standard Report of Sweden;
- 13. BITS 2022 Quarter 1 Standard Report of Lithuania

List of cruise reports:

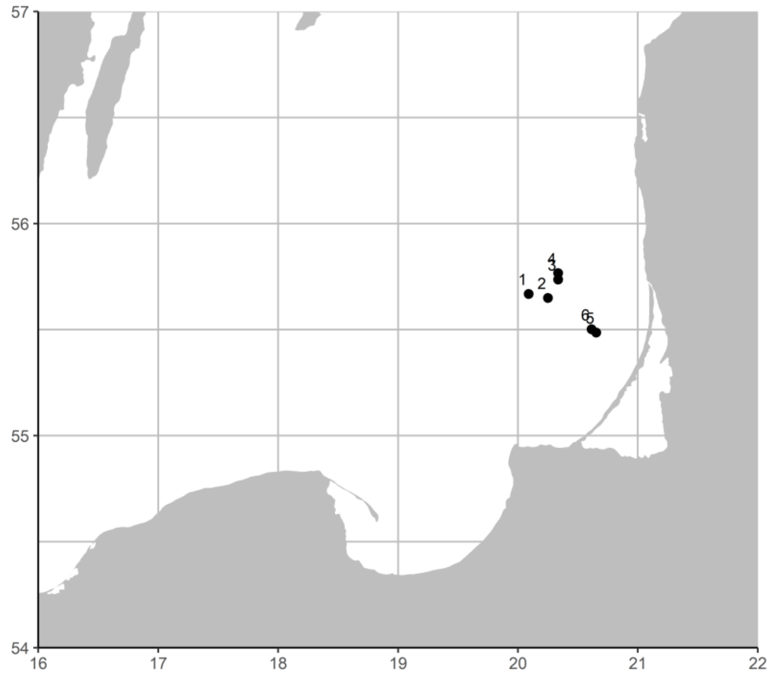
- 1. BITS 2021 Quarter 4 Cruise Report of Sweden;
- 2. BITS 2021 Quarter 4 Cruise Report of Latvia and Poland;
- 3. BITS 2021 Quarter 4 Cruise Report of Poland;
- 4. BITS 2021 Quarter 4 Cruise Report of Lithuania;
- 5. BITS 2021 Quarter 4 Cruise Report of Germany;
- 8. BITS 2021 Quarter 1 Cruise Report of Sweden;
- 9. BITS 2021 Quarter 1 Cruise Report of Poland;
- 10. BITS 2021 Quarter 1 Cruise Report of Latvia and Poland.
- 11. BITS 2021 Quarter 1 Cruise Report of Lithuania;
- 12. BITS 2021 Quarter 1 Cruise Report of Germany;

NATION:	**LITHUANIA**	**VESSEL:**	**LLB-1113**
Survey:	BITS2021Q4	Dates:	3th – 4th November 2021

Cruise	
Gear details:	The small (520#) standard TV3 trawl was used.
Notes from survey (e.g. problems, additional work etc.):	Survey made with Lithuania commercial fishery vessel LBB-1113. Total 6 fishing hauls was performed. First four hauls were made November 3 and last two trawls on November 30.
Additional comments:	

ICES Sub-Divisions	Gear (TVL, TVS)	Depth strata (2–6)	Number of hauls planed	Number of valid hauls realized using "Standard" ground gear	Number of valid hauls realized using Rock hoppers	Number of assumed zero-catch hauls	Number of replace-ment hauls	Number of invalid hauls	% stations fished
26	*TVS*	*3*	*2*	*2*	-	-	-	-	*100*
26	*TVS*	*4*	*4*	*4*	-	-	-	-	*100*

Number of biological samples (maturity and age material, *maturity only):		
Species	***Length***	***Age***
Alosa fallax	*257*	
Clupea harengus	*969*	
Gadus morhua	*791*	*333*
Myoxocephalus scorpius	*93*	
Osmerus eperlanus	*27*	
Platichthys flesus	*711*	*262*
Pleuronectes platessa	*1*	*1*
Scophthalmus maximus	*2*	*2*
Sprattus sprattus	*11*	

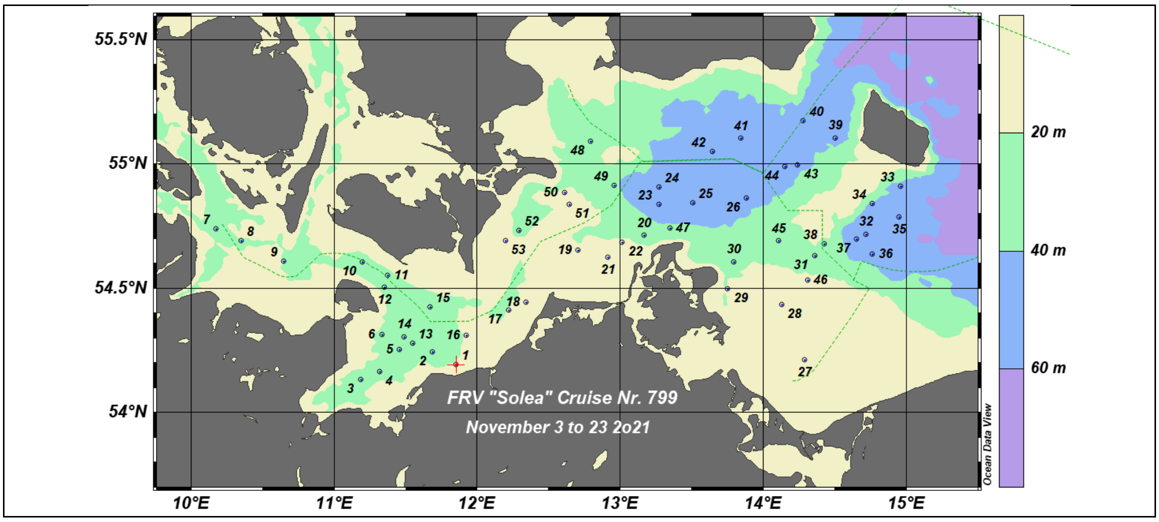


Nation:	**Germany**	**Vessel:**	**FRV "Solea"**
Survey:	BITS 2021, quarter 4	Dates:	3rd – 23rd November 2021

Cruise	
Gear details:	The small (520#) standard TV3 trawl was used. All Tow Database stations were fished without rock-hoppers. The construction of the trawl follows the specifications in the manual.
Notes from survey (e.g. problems, additional work etc.):	A total of 53 fishing hauls and 53 hydrographic stations of out of a total of 57 planned were performed. 4 stations in Polish waters were taken over by DK. Bad weather caused three days downtime.
Additional comments:	

ICES Sub-Divisions	**Gear (TVL, TVS)**	**Depth strata (1–3)**	**Number of hauls planed**	**Number of valid hauls realized using "standard" ground gear**	**Number of valid hauls realized using Rock hoppers**	**Number of assumed zero-catch hauls**	**Number of replace-ment hauls**	**Number of invalid hauls**	**% stations fished**
22	*TVS*	*1*	*1*	*1*	-		-	-	*100*
22	*TVS*	*2*	*15*	*15*	-		-	-	*100*
24	*TVS*	*1*	*6*	*6*	-		-	-	*100*
24	*TVS*	*2*	*14*	*16*	-		-	-	*88*
24	*TVS*	*3*	*17*	*17*	-		-	-	*100*

Number of biological samples (maturity and age material, *maturity only):		
Species	***Length***	***Age***
Gadus morhua	*5754*	*687*
Platichthys flesus	*2993*	*835*
Pleuronectes platessa	*7683*	*571*
Limanda limanda	*5587*	*636*
Psetta maxima	*174*	*174*
Scophthalmus rhombus	*7*	*7*
Clupea harengus	*6663*	-
Sprattus sprattus	*4444*	-

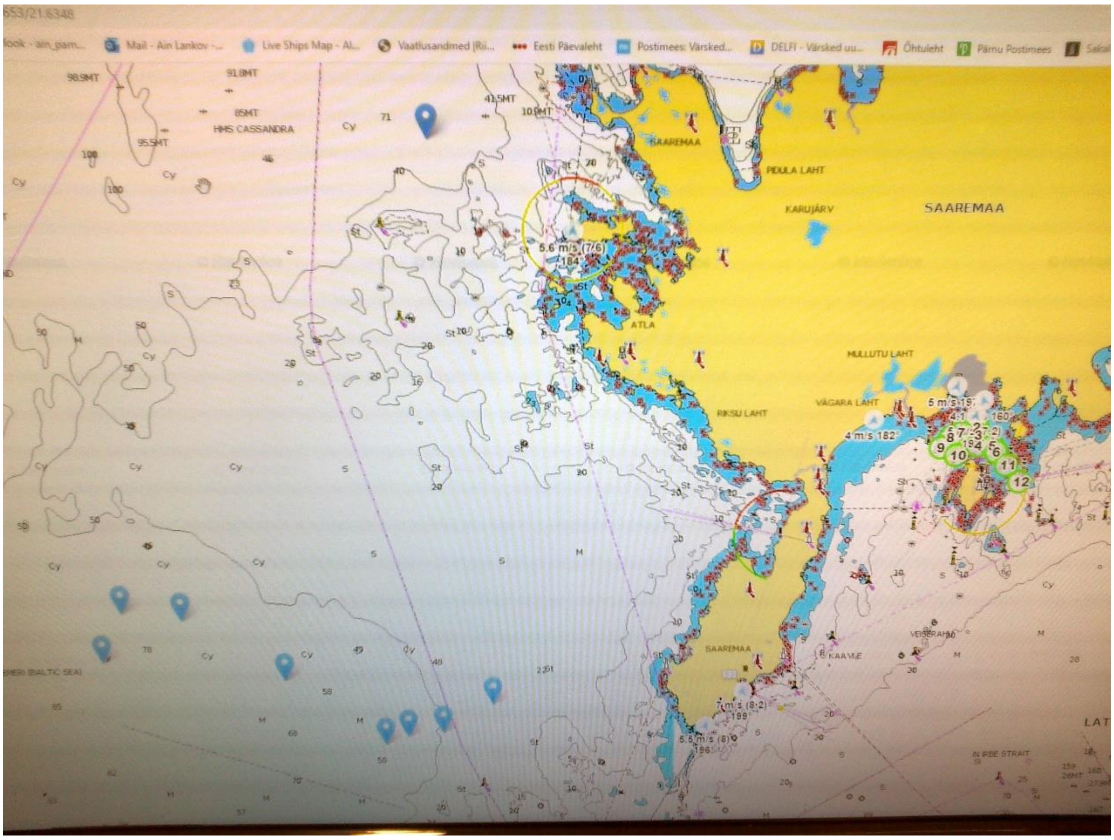


NATION:	ESTONIA	VESSEL:	CEV
Survey:	BITS21IVQRT	Dates:	14 – 16. November 2021

Cruise	
Gear details:	The TV3 (530) standard trawl was used during the survey. The construction of the trawl follows the specifications described in the BITS manual.
Notes from survey (e.g. problems, additional work etc.):	The survey was carried out onboard of the chartered FV KAIRE (Stern trawler, L= 25.5 m; 221 kW), as planned. Survey started late evening of 14 November 2021 from the Port of Haapsalu, steaming to the Sub-division 28-2. The weather conditions were initially very good for steaming to the work area: moderate NE-E wind from 6 to 9 m/s. By the time of commencing of survey hauls, the wind speed increased but still, it was possible to start working. This time Estonia was assigned for two hauls only. During the survey it was decided to carry out 7 more hauls at the positions covered also during the BITS survey of 2020. All hauls were carried out as planned and without problems. The survey was finished in the morning of hours of 16 November 2021 in the Port of Haapsalu. No technical problems were observed during the survey this year. All catches were analysed at the Pärnu Department of the Estonian Marine Institute. Overall abundance of cod and flounder was higher than during the 2020 Q4 BITS survey. The biological information collected during the survey has been uploaded to the DATRAS database.

ICES Sub-Divisions	Gear (TVL,TVS)	Depth strata (1–6)	Number of hauls planed	Number of valid hauls realized using "Standard" ground gear	Number of valid hauls realized using Rock hoppers	Number of assumed zero-catch hauls	Number of replacement hauls	Number of invalid hauls	% stations fished
28	*TVS*	*3*	*4*	*4*	*0*	*0*	*0*	*0*	*100*
28	*TVS*	*4*	*4*	*4*	*0*	*0*	*0*	*0*	*100*
28	*TVS*	*5*	*1*	*1*	*0*	*0*	*0*	*0*	*100*

Number of biological samples (maturity and age material, *maturity only):			
Species	Age	Length	Liver parasites counted
Gadus morhua	*218*	*218*	*218*
Sprattus sprattus	*0*	*233*	*0*
Clupea harengus	*0*	*496*	*0*
Scophthalmus maximus	*11*	*11*	*0*



Approximate positions of realised hauls during Estonian BITS survey in 4 QRT 2021

Estonian BITS IV Quarter 2021: Overview of catches.

BITS 2021 4. Qrt	**Catch composition, kg per 30 min haul**								
Haul no.	ID 28091	ID 28030	ID 28193	ID 28029	ID 28059	ID 28192	ID 28191	ID 28077	ID 28190
Sd	28_2	28_2	28_2	28_2	28_2	28_2	28_2	28_2	28_2
Depth, m	44	51	65	58,5	58,75	72	71	67,5	87
Date	15.11.2021	15.11.2021	15.11.2021	15.11.2021	15.11.2021	15.11.2021	15.11.2021	15.11.2021	15.11.2021
Catch, kg	34,94	19,44	127,54	82,66	82,18	5,10	4,22	0,69	0,11
Platichthys flesus	30,10	16,30	111,90	55,20	70,80	2,80	0,63	0,62	0,08
Gadus morhua	0,00	0,40	7,23	14,03	6,90	0,63	0,57	0,00	0,00
Scophthalmus maximus	0,67	0,12	1,23	0,58	0,60	0,17	0,00		
Clupea harengus	1,01	0,04	3,66	10,14	2,21	1,50	2,98	0,03	0,00
Sprattus sprattus	1,20	0,19	0,15	0,51	0,04	0,00	0,05	0,04	0,02
Osmerus eperlanus	0,08	0,32	0,21	0,20	0,00				
Triglopsis quadricornis	0,75	0,12	0,16	0,00	0,00				
Myoxocephalus scorpius	0,36	0,89	0,34	1,62	1,55				
Cyclopterus lumpus			0,00	0,00	0,00				
Zoarces viviparus	0,20	0,34	0,22	0,00	0,00				
Gobius sp.	0,53	0,18	0,16	0,20	0,08				
Pungitius pungitius			0,00	0,00	0,00				
Acerina cernua			0,00	0,00	0,00				
Gasterosteus aculeatus	0,01	0,02	2,25	0,02	0,01			0,00	0,01
Neogobius melanostomus	0,03	0,38	0,00	0,05	0,00				
Triglopsis quadricornis			0,00	0,00	0,00				
Alosa fallax		0,11	0,00	0,12	0,00				
Lumpenus lampretaeformis		0,03	0,03	0,00	0,00				
Total	34,94	19,44	127,54	82,66	82,18	5,10	4,22	0,69	0,11
									356,88

NATION:	**POLAND**	**VESSEL:**	**RV "BALTICA"**
Survey:	BITS-Q4/2021	Dates:	12/11-01/12/2021

Cruise	No. 21/2021/MIR
Gear details:	The standard rigging cod ground trawl type TV-3#930, with 10-mm mesh bar length in the codend was applied for fish control-catches realisation. The construction of the trawl follows the specifications in the manual.
Notes from survey (e.g. problems, additional work etc.):	According to the WGBIFS recent (March 2021) recommendations, the vessel "Baltica" was designated to cover in November/December 2021 survey, the Polish part of ICES Sub-divisions 25 and 26 with 9 and 43, respectively randomly selected bottom fishing hauls, as well as in Swedish and Lithuanian EEZs to cover ICES Sub-division 26 with 10 and 2 fishing hauls, respectively. The R/V Baltica realized 64 of the 64 planned hauls for this survey. Due to oxygen level on the bottom below 0.5 ml/l, hauls No 26124, 26141, 26140, 26221 and 26161 were not realized. These hauls were classified as "no oxygen". In total 64 fish catch-stations can be accepted as representative. Due to stormy weather, rocky bottom, commercial fishing activity or large fish concentrations observed in echosounder – 1, 1, 2, 5 and 21 hauls were shortened to 8, 10, 5, 15 and 20 min, respectively. Every control-haul was preceded by the seawater temperature, salinity and oxygen content measurements, made continuously from the sea-surface to a bottom. Overall, 64 fish catch-stations starting positions and 25 standard hydrographic stations were controlled by the SeaBird SBE 911 CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method.
Additional comments:	

ICES SUB-DIVISIONS	GEAR (TVL, TVS)	DEPTH STRATA (2–6)	NUMBER OF HAULS PLANED	NUMBER OF VALID HAULS REALIZED USING "STANDARD" GROUND GEAR	NUMBER OF VALID HAULS REALIZED USING ROCK HOPPERS	NUMBER OF ASSUMED ZERO-CATCH HAULS	NUMBER OF REPLACE-MENT HAULS	NUMBER OF INVALID HAULS	% STATIONS FISHED
25	*TVL*	*2*	*9*	*9*	*0*	*0*	*0*	*0*	*100*
25	*TVL*	*3*	*0*	*0*	*0*	*0*	*0*	*0*	*---*
25	*TVL*	*4*	*0*	*0*	*0*	*0*	*0*	*0*	*---*
25	*TVL*	*5*	*0*	*0*	*0*	*0*	*0*	*0*	*---*
26	*TVL*	*2*	*11*	*10*	*0*	*0*	*0*	*0*	*91*
26	*TVL*	*3*	*10*	*11*	*0*	*0*	*0*	*0*	*110*
26	*TVL*	*4*	*12*	*13*	*0*	*0*	*0*	*0*	*108*
26	*TVL*	*5*	*17*	*14*	*0*	*2*	*0*	*0*	*94*
26	*TVL*	*6*	*5*	*2*	*0*	*3*	*0*	*0*	*100*

NUMBER OF BIOLOGICAL SAMPLES (MATURITY AND AGE MATERIAL, *MATURITY ONLY):

SPECIES (LATIN NAME)	Length	Age and maturity
Gadus morhua	6062	318
Clupea harengus	8178	1003
Sprattus sprattus	6667	598
Platichthys flesus	3516	564
Pleuronectes platessa	163	161
Zoarces viviparus	13	
Enchelyopus cimbrius	4	
Perca fluviatilis	71	
Gasterosteus aculeatus	205	
Myoxocephalus scorpius	230	

Neogobius melanostomus	2	
Osmerus eperlanus	20	
Alosa fallax	236	
Scophthalmus maximus	13	13
Engraulis encrasicolus	118	
Hyperoplus lanceolatus	4	
Cyclopterus lumpus	3	
Agonus cataphractus	1	
Sander lucioperca	28	
Lampetra fluviatilis	2	
Merlangius merlangus	5	5
Anguilla anguilla	1	

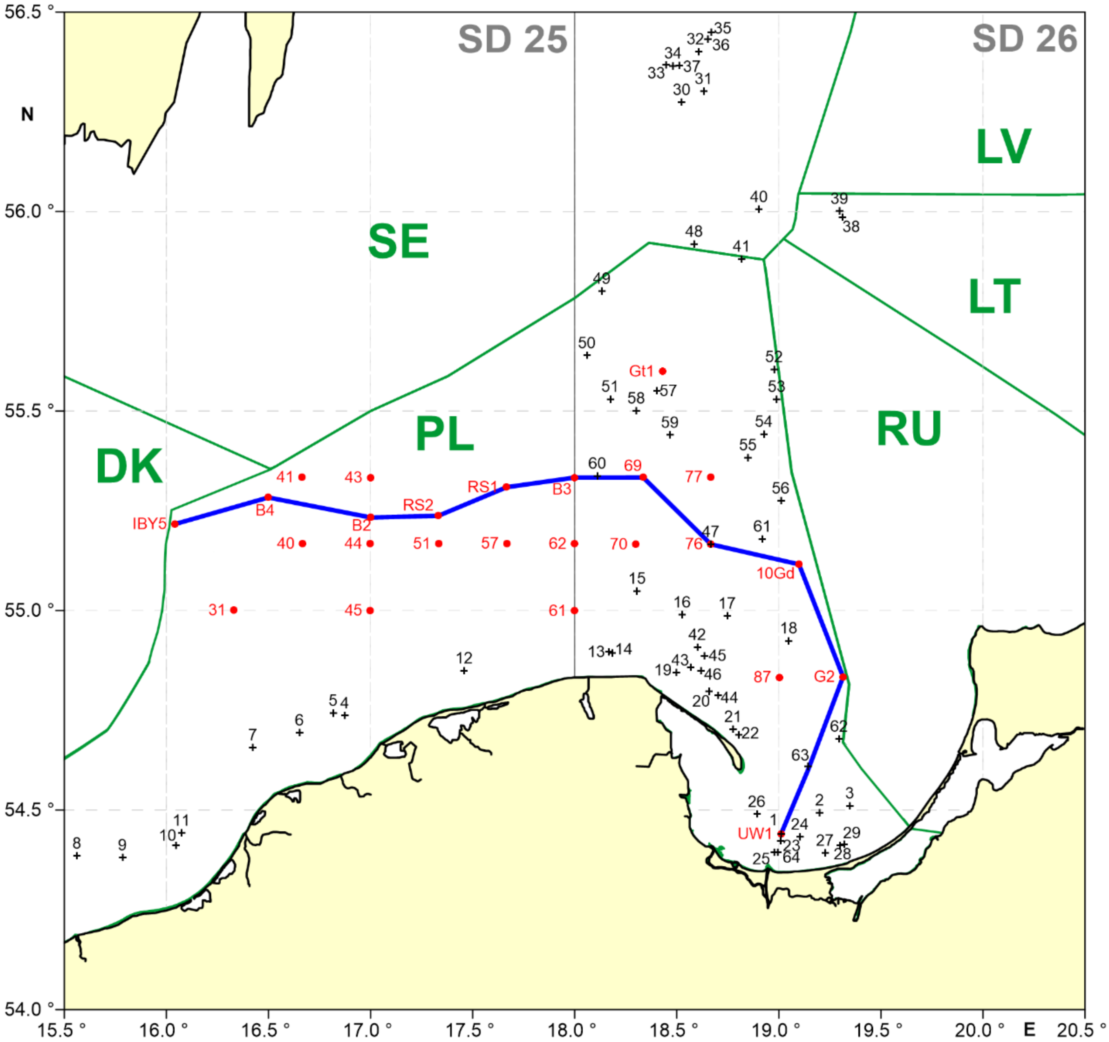


Fig. 1. Location of the bottom trawl hauls (black crosses) and the hydrological standard stations (red dots) investigated by the r.v. “Baltica” during the BITS-Q4/2021 survey (blue line – hydrological profile). (DK – Denmark, LT – Lithuania, LV – Latvia, PL – Poland, RU – Russia, SE – Sweden)

NATION:	**LATVIA**	**VESSEL:**	**RV "BALTICA"**
Survey:	BITS-Q4/2021	Dates:	08-18/12/2021

Cruise	No. 2/2021
Gear details:	The hard bottom ground-rope (rockhopper) trawl, type TV-3#930 (with 10-mm mesh bar length in the codend) was applied for fish catches. The construction of the trawl follows the specifications in the manual.
Notes from survey (e.g. problems, additional work etc.):	The original surveys plan provided that 30 control-hauls will be realized in the Latvian EEZ (9 trawls in SD 26, 21 trawls in SD 28). The r.v. "Baltica" realized 29-bottom trawl control-hauls including the Latvian territorial waters (Fig.1). Fourteen catch-stations were only initiated by hydrological parameters measurement and due to very low oxygen concentration (below 0.5 ml/l) near bottom, fishing was omitted. All trawl catches were performed in the daylight. The hard-bottom ground-rope (rockhopper) trawl, type TV-3#930 (with 10-mm mesh bar length in the codend) was applied for fish catches. The mean speed of vessel while trawling was 3.0 knots. For the 14 realized trawls, their duration was shortened to 10-20 minutes, due to dense clupeids concentrations observed on the echosounder, bad weather or hard bottom. The length measurements in the 1.0-cm classes were realised for 224 cod and 1265 flounder. Length measurements in the 0.5-cm classes were realized for 1471 herring and 1343 sprat. In total, 125 cod and 270 flounder individuals were taken for biological analysis. Stomachs from the 125 cod were taken for investigation of cod feeding. Acoustic data, i.e. the echo-integration records (SA = NASCs; Nautical Area Scattering (Strength) Coefficient) were collected with the EK-60 scientific echosounder during fishing operations and on the distances between consecutive hauls. Echo-sounding data collected during the BITS survey were delivered to the Latvian researchers for further analysis. Directly before every haul, the seawater temperature, salinity, and oxygen content were measured continuously from the sea surface to a bottom. The seawater samples were taken also at the standard HELCOM stations. Totally, 34 hydrological stations were inspected with the Neil-Brown CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method. Meteorological observations of wind velocity and directions and the sea state were realized at the actual geographic position of each control-haul.
Additional comments:	**BITS Q4 was performed on R/V Baltica with Polish scientific team. Due to Covid-19 travel restriction, Latvian team could not travel to the vessel and take part in the survey. Survey was done according to manual and supervision of Latvian team from coast.**

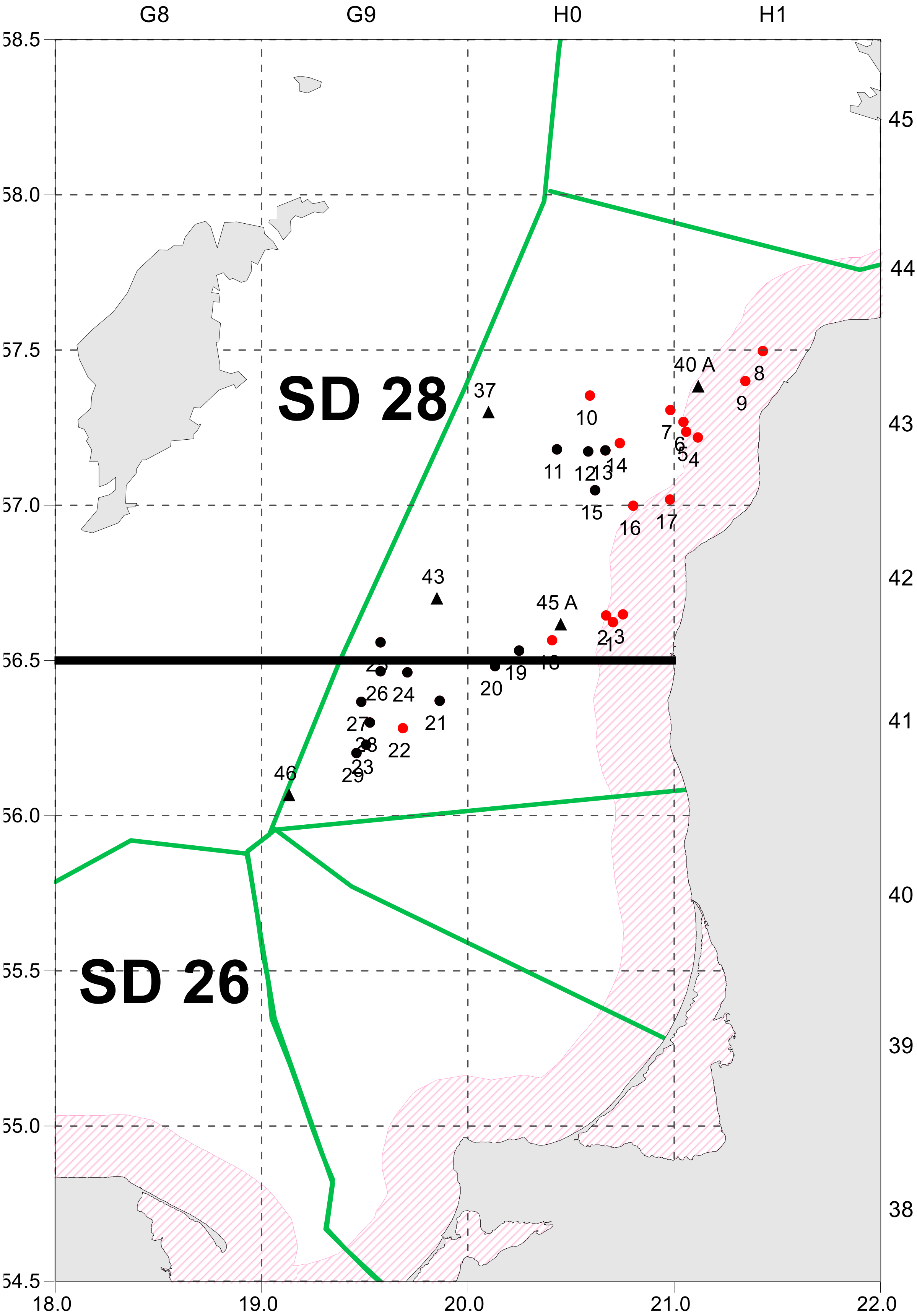


Figure 1. Location of the realized fish control-hauls (marked with red dots), hauls with low oxygen concentration (below 0.5 ml/l, marked with black dots) and the HELCOM standard hydrological stations (marked with black triangles), green lines - national fishing zone borders.

ICES Sub-Divisions	Gear (TVL, TVS)	Depth strata (2–6)	Number of hauls planed	Number of valid hauls realized using "Standard" ground gear	Number of valid hauls realized using Rock hoppers	Number of assumed zero-catch hauls	Number of replace-ment hauls	Number of invalid hauls	% stations fished
26	*TVL*	*4*	*1*	*0*	*1*	*0*	*0*	*0*	*100*
26	*TVL*	*5*	*2*	*0*	*0*	*2*	*0*	*0*	*100*
26	*TVL*	*6*	*6*	*0*	*0*	*6*	*0*	*0*	*100*
28	*TVL*	*2*	*6*	*0*	*5*	*0*	*0*	*0*	*83*
28	*TVL*	*3*	*5*	*0*	*3*	*0*	*0*	*0*	*60*
28	*TVL*	*4*	*3*	*0*	*5*	*0*	*0*	*0*	*167*
28	*TVL*	*5*	*5*	*0*	*1*	*4*	*0*	*0*	*100*
28	*TVL*	*6*	*2*	*0*	*0*	*2*	*0*	*0*	*100*

Number of biological samples (maturity and age material, *maturity only):		
Species	**Length**	**Age**
Gadus morhua	224	125
Platichthys flesus	1265	270
Clupea harengus	1471	
Sprattus sprattus	1343	
Zoarces viviparus	2	
Cyclopterus lumpus	1	
Engraulis encrasicholus	5	
Myoxocephalus scorpius	30	
Osmerus eperlanus	4	
Gasterosteus aculeatus	12	
Alosa alosa	28	

Nation:	**Denmark**	**Vessel:**	**Havfisken**
Survey:	Kasu 2-2021	Dates:	17/10-08/11/2021

Cruise	Kasu 2-2021
Gear details:	The small (#520) standard TV3 trawl is used. The construction of the trawl follows the specifications in the manual.
Notes from survey (e.g. problems, additional work etc.):	3 stations in division 22 were moved due to problems with stones or other problems at the stations.

ICES Sub-Divisions	**Gear (TVL, TVS)**	**Depth strata (2–6)**	**Number of hauls planed**	**Number of valid hauls realized using "Standard" ground gear**	**Number of valid hauls realized using Rock hoppers**	**Number of assumed zero-catch hauls**	**Number of replace-ment hauls**	**Number of invalid hauls**	**% stations fished**
20	*TVS*	*2*	*1*	*0*					*0*
20	*TVS*	*3*	*1*	*1*					*100*
21	*TVS*	*1*	*7*	*7*					*100*
21	*TVS*	*2*	*12*	*13*					*108*
21	*TVS*	*3*	*2*	*2*					*100*
21	*TVS*	*4*	*2*	*2*					*100*
22	*TVS*	*1*	*14*	*14*					*100*
22	*TVS*	*2*	*15*	*15*					*100*
23	*TVS*	*1*	*4*	*4*					*100*
23	*TVS*	*2*	*1*	*1*					*100*
24	*TVS*	*1*	*5*	*5*					*100*
24	*TVS*	*2*	*3*	*3*					*100*

Number of biological samples (maturity and age material, *maturity only):		
Species (Latin name)	**Length**	**Age**
Solea solea		259
Gadus morhua		531
Merlangius merlangus		240
Glyptocephalus cynoglossus		11
Pleuronectes platessa		1026
Pollachius virens		8
Limanda limanda		341
Melanogrammus aeglefinus		15
Scophthalmus maximus		73
Scophthalmus rhombus		74

Nation:	**Denmark**	**Vessel:**	Dana
Survey:	BITS	Dates:	1-17/11 - 2021

Cruise	BITS
Gear details:	The big (#920) standard TV3 trawl is used. The construction of the trawl follows the specifications in the manual. No rock hopper was used
Notes from survey (e.g. problems, additional work etc.):	Stomack sampling from cod, plankton fishing during night.

ICES Sub-Divisions	Gear (TVL, TVS)	Depth strata (2–6)	Number of hauls planed	Number of valid hauls realized using "Standard" ground gear	Number of valid hauls realized using Rock hoppers	Number of assumed zero-catch hauls	Number of replace-ment hauls	Number of invalid hauls	% stations fished
25	*TVL*	*2*	*2*	*2*	*0*	*0*	*0*	*0*	*100*
25	*TVL*	*3*	*19*	*19*	*0*	*0*	*0*	*0*	*100*
25	*TVL*	*4*	*18*	*16*	*0*	*2*	*0*	*0*	*100*
25	*TVL*	*5*	*10*	*8*	*0*	*2*	*0*	*0*	*100*
25	*TVL*	*6*	*0*	*0*	*0*	*1*	*1*	*2*	*-*
Total	*TVL*		*49*	*45*	*0*	*5*	*1*	*2*	

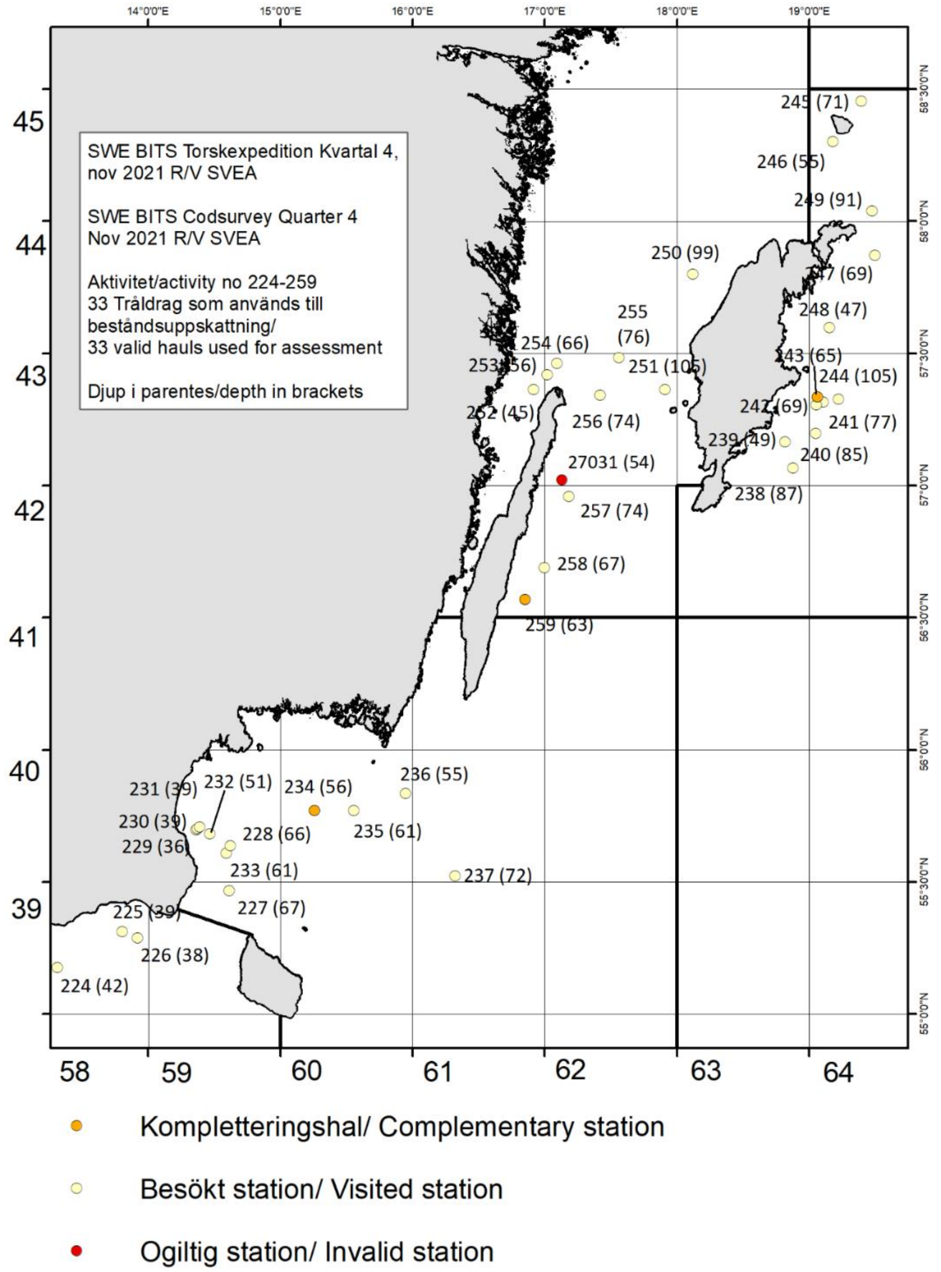
Nation:	**SWEDEN**	**Vessel:**	**RV "Svea"**
Survey:	BITS Q4 2021	Dates:	20-30 November 2021

Cruise	
Gear details:	The large (930#) standard TV3 trawl was used. No tows are done with the rock hopper ground gear on harder ground stations. The trawl construction is according to the specification in the BITS manual.
Notes from survey (e.g. problems, additional work etc.):	33 stations were allocated, 33 of these were trawled. four hauls were replaced due to duplicate stations and poor seaabed conditions. Two hauls in SD 27 and five hauls in SD 28 had oxygen deficiency.
Additional comments:	Oxygen conditions were poor but not so bad that it was not possible to fish.

ICES Sub-Divisions	Gear (TVL, TVS)	Depth strata (2–6)	Number of hauls planned	Number of valid hauls realized using "Standard" ground gear	Number of valid hauls realized using Rock hoppers	Number of assumed zero-catch hauls	Number of replace-ment hauls	Number of invalid hauls	Stations fished %
24	*TVL*	*2*	*2*	*2*	-	*0*	*0*	*0*	*100*
24	*TVL*	*3*	*1*	*1*	-	*0*	*0*	*0*	*100*
25	*TVL*	*2*	*3*	*3*	-	*0*	*0*	*0*	*100*
25	*TVL*	*3*	*2*	*2*	-	*0*	*0*	*0*	*100*
25	*TVL*	*4*	*5*	*4*		*0*	*1*	*0*	*100*
27	*TVL*	*3*	*3*	*2*	-	*0*	*0*	*0*	*66*
27	*TVL*	*4*	*5*	*5*	-	*0*	*0*	*0*	*100*
27	*TVL*	*5*	*1*	*0*	-	*1*	*0*	*0*	*100*
27	*TVL*	*6*	*1*	*0*		*1*	*0*	*0*	*100*
28	*TVL*	*3*	*3*	*3*	-	*0*	*0*	*0*	*100*
28	*TVL*	*4*	*4*	*2*	-	*1*	*1*	*0*	*100*
28	*TVL*	*5*	*3*	*0*	-	*3*	*0*	*0*	*100*
28	*TVL*	*6*	*1*	*0*	-	*1*	*0*	*0*	*100*

Remark. The % number deviates from 100 because the depth varied from before.

Number of biological samples (maturity and age material, *maturity only):			
Specname sci.	**Lenght**	**Age**	**Stomachs**
Agonus cataphractus	1		
Alosa fallax	12		
Anguilla anguilla	1		
Carcinus maenas			
Clupea harengus	4616		
Crangon			
Cyclopterus lumpus	4		
Enchelyopus cimbrius	9		
Engraulis encrasicolus	8		
Gadus morhua	1644	417	417
Gasterosteus aculeatus	128		
Limanda limanda	92		
Lumpenus lampretaeformis	1		
Macoma balthica			
Merlangius merlangus	128		
Myoxocephalus quadricornis	241		
Myoxocephalus scorpius	332		
Mytilus edulis			
Platichthys flesus	1856	395	395
Pleuronectes platessa	639		
Pomatoschistus	3		
Pungitius pungitius	2		
Saduria entomon	0		
Scomber scombrus	1		
Scophthalmus maximus	53		
Solea solea	6		
Sprattus sprattus	2441		
Zoarces viviparus	56		


14°0'0"E
15°0'0"E
16°0'0"E
17°0'0"E
18°0'0"E
19°0'0"E
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58°0'0"N
57°30'0"N
57°0'0"N
56°30'0"N
56°0'0"N
55°30'0"N
55°0'0"N
45
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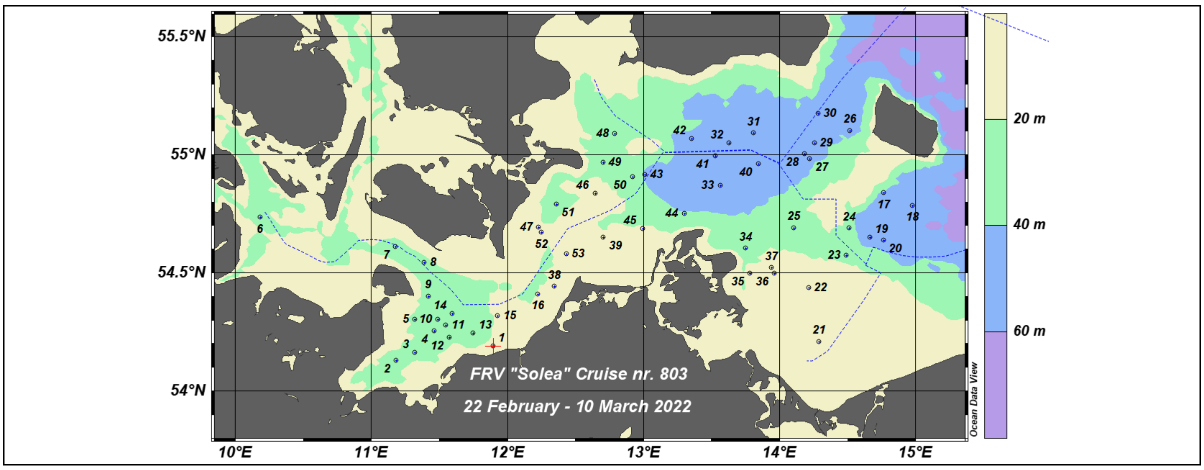
60
61
62
63
64
SWE BITS Torskexpedition Kvartal 4, nov 2021 R/V SVEA
SWE BITS Codsurvey Quarter 4 Nov 2021 R/V SVEA
Aktivitet/activity no 224-259
33 Tråldrag som används till beståndsuppskattning/
33 valid hauls used for assessment
Djup i parentes/depth in brackets
245 (71)
246 (55)
249 (91)
250 (99)
247 (69)
248 (47)
255 (76)
254 (66)
253 (56)
251 (105)
243 (65)
244 (105)
252 (45)
256 (74)
242 (69)
241 (77)
239 (49)
240 (85)
27031 (54)
238 (87)
257 (74)
258 (67)
259 (63)
236 (55)
231 (39)
232 (51)
234 (56)
230 (39)
228 (66)
235 (61)
229 (36)
233 (61)
237 (72)
225 (39)
227 (67)
226 (38)
224 (42)
Kompletteringshal/ Complementary station
Besökt station/ Visited station
Ogiltig station/ Invalid station

Nation:	**Germany**	**Vessel:**	**FRV "Solea"**
Survey:	BITS 2021, quarter 1	Dates:	22 th to 28 th February, 1st to 10th March 2022

Cruise	
Gear details:	The small (520#) standard TV3 trawl was used. All Tow Database stations were fished without rock-hoppers. The construction of the trawl follows the specifications in the manual.
Notes from survey (e.g. problems, additional work etc.):	A total of 53 fishing hauls and 53 hydrographic stations of out of a total of 57 planned were performed. 3 stations in Polish waters could not carry out due the obligatory carriage of a Polish observer. Station 22072 is currently not fishable due to Fehmarn tunnel construction activities.
Additional comments:	

ICES Sub-Divisions	**Gear (TVL, TVS)**	**Depth strata (1–3)**	**Number of hauls planed**	**Number of valid hauls realized using "Standard" ground gear**	**Number of valid hauls realized using Rock hoppers**	**Number of assumed zero-catch hauls**	**Number of replace-ment hauls**	**Number of invalid hauls**	**% stations fished**
22	TVS	1	1	1	-		-	-	100
22	TVS	2	14	14	-		-	-	100
24	TVS	1	7	7	-		-	-	100
24	TVS	2	14	14	-		-	-	82
24	TVS	3	17	14	-		-	-	100

Number of biological samples (maturity and age material, *maturity only):		
Species	**Length**	**Age**
Gadus morhua	5454	652
Platichthys flesus	*3814*	*742*
Pleuronectes platessa	*8454*	*836*
Psetta maxima	*116*	*117*
Scophthalmus rhombus	*4*	*4*
Clupea harengus	*3989*	-
Sprattus sprattus	*3272*	-



NATION:	**POLAND**	**VESSEL:**	**RV "BALTICA"**
Survey:	BITS-1Q/2022	Dates:	08/02-04/03/2022

Cruise	No. 2/2022/MIR
Gear details:	The standard rigging cod ground trawl type TV-3#930, with 10-mm mesh bar length in the codend was applied for fish control-catches realisation. The construction of the trawl follows the specifications in the manual.
Notes from survey (e.g. problems, additional work etc.):	According to the WGBIFS recent (March 2021) recommendations, the vessel "Baltica" was designated to cover in the Polish EEZ parts of the ICES Sub-divisions 25 and 26 with 10 and 39 hauls, respectively, as well as in Lithuanian, Latvian and Swedish EEZs to cover part of ICES Sub-division 26 with 2, 12 and 11 research hauls, respectively. The R/V Baltica realized 73 of the 74 planned hauls for this survey. Haul no 26107 in the Polish EEZ (SD 26) was the only one not realized. In total 6 hauls (ICES no 26138, 26140, 26141, 26144, 26209 and 28221) were not realized due to oxygen level on the bottom below 0.5 ml/l. They were classified as "no oxygen" hauls. In total, all the 73 fish catch-stations can be accepted as representative. Due to stormy weather, rocky bottom or large fish concentrations observed in echosounder – 11, 20, 12 and 24 fishing hauls were shortened to 10, 15, 20 and 30 min, respectively. Every control-haul was preceded by the seawater temperature, salinity and oxygen content measurements, made continuously from the sea-surface to a bottom. Overall, 73 fish catch-stations starting positions and 23 standard hydrographic stations were controlled by the SeaBird SBE 911 CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method.
Additional comments:	

ICES SUB-DIVISIONS	**GEAR (TVL, TVS)**	**DEPTH STRATA (2–6)**	**NUMBER OF HAULS PLANED**	**NUMBER OF VALID HAULS REALIZED USING "STANDARD" GROUND GEAR**	**NUMBER OF VALID HAULS REALIZED USING ROCK HOPPERS**	**NUMBER OF ASSUMED ZERO-CATCH HAULS**	**NUMBER OF REPLACE-MENT HAULS**	**NUMBER OF INVALID HAULS**	**% STATIONS FISHED**
25	TVL	2	9	9	0	0	0	0	100
25	TVL	3	1	1	0	0	0	0	100
25	TVL	4	0	0	0	0	0	0	---
25	TVL	5	0	0	0	0	0	0	---
26	TVL	2	12	11	0	0	0	0	92
26	TVL	3	10	11	0	0	0	0	110
26	TVL	4	15	15	0	0	0	0	100
26	TVL	5	16	15	0	0	0	0	94
26	TVL	6	11	5	0	6	0	0	100

NUMBER OF BIOLOGICAL SAMPLES (MATURITY AND AGE MATERIAL, *MATURITY ONLY):

SPECIES (LATIN NAME)	**Length**	**Age and maturity**
Gadus morhua	2005	298
Clupea harengus	6835	773
Sprattus sprattus	9480	465
Platichthys flesus	2598	543
Pleuronectes platessa	144	139
Zoarces viviparus	20	20
Enchelyopus cimbrius	9	9
Perca fluviatilis	1	1
Gasterosteus aculeatus	121	1

Myoxocephalus scorpius	166	54
Neogobius melanostomus	2	2
Osmerus eperlanus	1	1
Alosa fallax	70	15
Scophthalmus maximus	7	7
Hyperoplus lanceolatus	8	6
Cyclopterus lumpus	8	5
Agonus cataphractus	2	2
Sander lucioperca	2	2
Merlangius merlangus	1	1
Anguilla anguilla	1	0
Pomatoschistus minutus	1	0

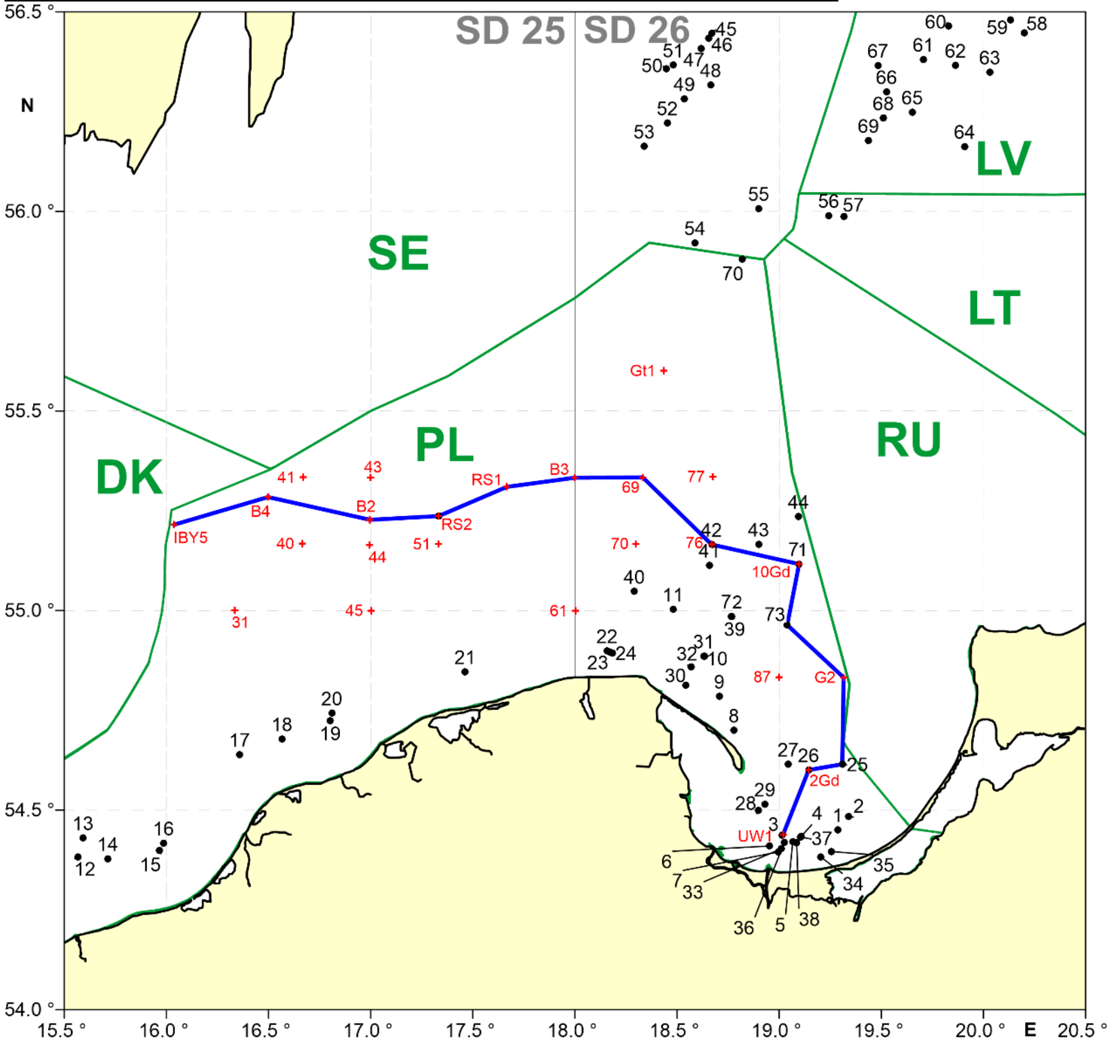


Fig. 1. Location of the bottom trawl hauls (black dots) and the hydrological standard stations (red crosses) investigated by the r.v. "Baltica" during the BITS-1Q/2022 survey (blue line – hydrological profile). (SE – Sweden, LV – Latvia, LT – Lithuania, RU – Russia, DK – Denmark, PL – Poland)

NATION:	**LATVIA**	**VESSEL:**	**RV "BALTICA"**
Survey:	BITS-Q4/2021	Dates:	08-18/12/2021

Cruise	No. 2/2021
Gear details:	The hard bottom ground-rope (rockhopper) trawl, type TV-3#930 (with 10-mm mesh bar length in the codend) was applied for fish catches. The construction of the trawl follows the specifications in the manual.
Notes from survey (e.g. problems, additional work etc.):	The original surveys plan provided that 30 control-hauls will be realized in the Latvian EEZ (9 trawls in SD 26, 21 trawls in SD 28). The r.v. "Baltica" realized 29-bottom trawl control-hauls including the Latvian territorial waters (Fig.1). Fourteen catch-stations were only initiated by hydrological parameters measurement and due to very low oxygen concentration (below 0.5 ml/l) near bottom, fishing was omitted. All trawl catches were performed in the daylight. The hard-bottom ground-rope (rockhopper) trawl, type TV-3#930 (with 10-mm mesh bar length in the codend) was applied for fish catches. The mean speed of vessel while trawling was 3.0 knots. For the 14 realized trawls, their duration was shortened to 10-20 minutes, due to dense clupeids concentrations observed on the echosounder, bad weather or hard bottom. The length measurements in the 1.0-cm classes were realised for 224 cod and 1265 flounder. Length measurements in the 0.5-cm classes were realized for 1471 herring and 1343 sprat. In total, 125 cod and 270 flounder individuals were taken for biological analysis. Stomachs from the 125 cod were taken for investigation of cod feeding. Acoustic data, i.e. the echo-integration records (SA = NASCs; Nautical Area Scattering (Strength) Coefficient) were collected with the EK-60 scientific echosounder during fishing operations and on the distances between consecutive hauls. Echo-sounding data collected during the BITS survey were delivered to the Latvian researchers for further analysis. Directly before every haul, the seawater temperature, salinity, and oxygen content were measured continuously from the sea surface to a bottom. The seawater samples were taken also at the standard HELCOM stations. Totally, 34 hydrological stations were inspected with the Neil-Brown CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method. Meteorological observations of wind velocity and directions and the sea state were realized at the actual geographic position of each control-haul.
Additional comments:	**BITS Q1 was performed on R/V Baltica with Polish scientific team. Due to Covid-19 travel restriction, Latvian team could not travel to the vessel and take part in the survey. Survey was done according to manual and supervision of Latvian team from coast.**

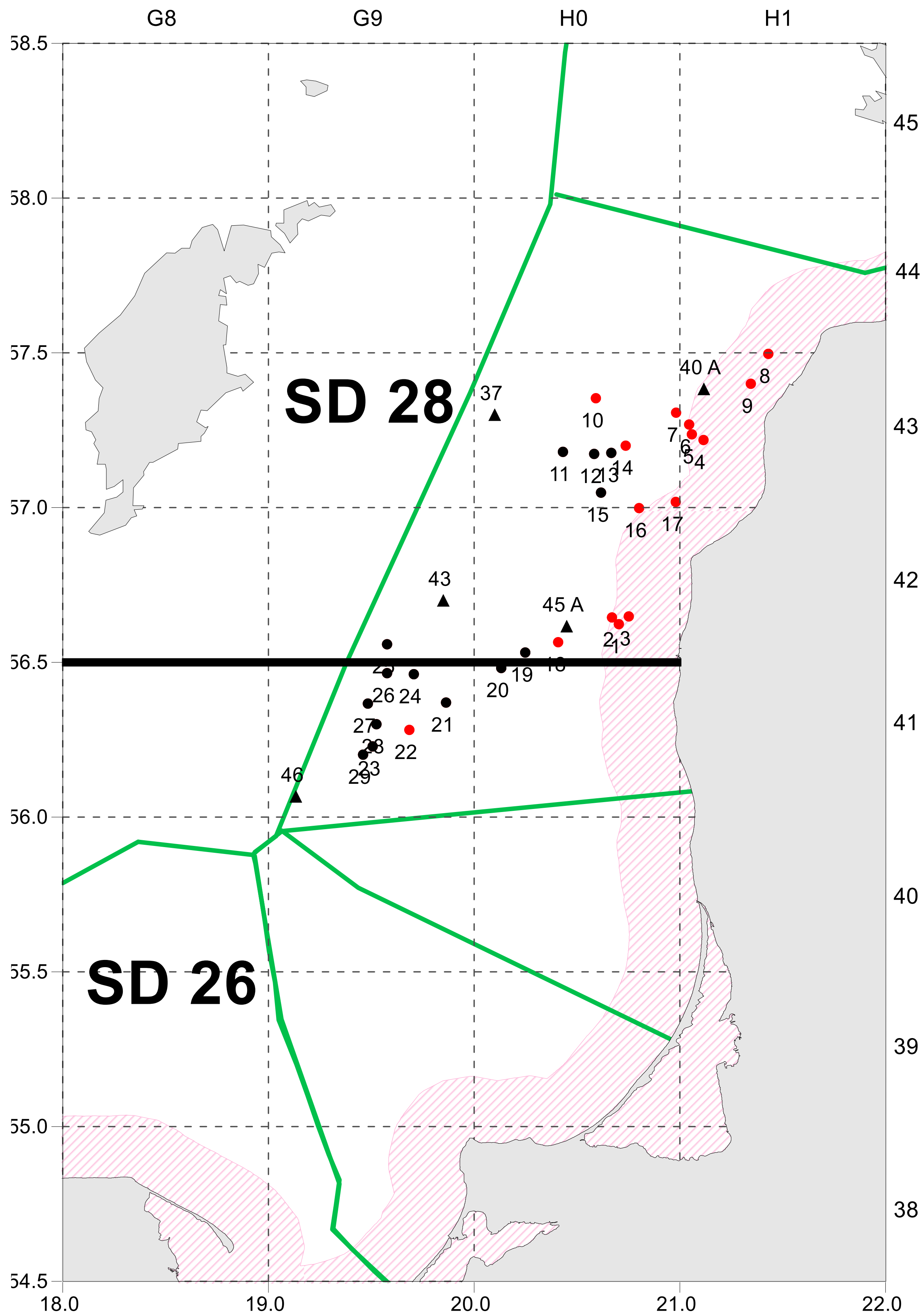


Figure 1. Location of the realized fish control-hauls (marked with red dots), hauls with low oxygen concentration (below 0.5 ml/l, marked with black dots) and the HELCOM standard hydrological stations (marked with black triangles), green lines - national fishing zone borders.

ICES Sub-Divisions	Gear (TVL, TVS)	Depth strata (2–6)	Number of hauls planed	Number of valid hauls realized using "Standard" ground gear	Number of valid hauls realized using Rock hoppers	Number of assumed zero-catch hauls	Number of replace-ment hauls	Number of invalid hauls	% stations fished
26	TVL	4	1	0	1	0	0	0	100
26	TVL	5	2	0	0	2	0	0	100
26	TVL	6	6	0	0	6	0	0	100
28	TVL	2	6	0	5	0	0	0	83
28	TVL	3	5	0	3	0	0	0	60
28	TVL	4	3	0	5	0	0	0	167
28	TVL	5	5	0	1	4	0	0	100
28	TVL	6	2	0	0	2	0	0	100

Number of biological samples (maturity and age material, *maturity only):		
Species	Length	Age
Gadus morhua	224	125
Platichthys flesus	1265	270
Clupea harengus	1471	
Sprattus sprattus	1343	
Zoarces viviparus	2	
Cyclopterus lumpus	1	
Engraulis encrasicholus	5	
Myoxocephalus scorpius	30	
Osmerus eperlanus	4	
Gasterosteus aculeatus	12	
Alosa alosa	28	

Nation:	**Denmark**	**Vessel:**	**Havfisken**
Survey:	KASU - 1	Dates:	22/02 - 15/03 2022

Cruise	Kasu 1-2022
Gear details:	The small (#520) standard TV3 trawl is used. The construction of the trawl follows the specifications in the manual.
Notes from survey (e.g. problems, additional work etc.):	5 stations in division 22 were moved due to problems with stones or other problems at the stations.

ICES Sub-Divisions	Gear (TVL, TVS)	Depth strata (2–6)	Number of hauls planed	Number of valid hauls realized using "Standard" ground gear	Number of valid hauls realized using Rock hoppers	Number of assumed zero-catch hauls	Number of replace-ment hauls	Number of invalid hauls	% stations fished
20	TVS	2	1	1					100%
21	TVS	1	7	7					100%
21	TVS	2	12	12					100%
21	TVS	3	3	3					100%
21	TVS	4	3	3					100%
22	TVS	1	12	12					100%
22	TVS	2	22	21				1	95%
22	TVS	3	1	1					100%
23	TVS	1	4	4					100%
23	TVS	2	1	1					100%
24	TVS	1	5	5					100%
24	TVS	2	3	3					100%

Number of biological samples (maturity and age material, *maturity only):		
Species (Latin name)	**Length**	**Age**
Solea solea		101
Gadus morhua		641
Merlangius merlangus		249
Glyptocephalus cynoglossus		17
Pleuronectes platessa		1283
Pollachius virens		6
Limanda limanda		379
Scophthalmus maximus		89
Scophthalmus rhombus		56

Nation:	**Denmark**	**Vessel:**	Dana
Survey:	BITS	Dates:	22/2-11/3-2022 - 2022

Cruise	BITS
Gear details:	The big (#920) standard TV3 trawl is used. The construction of the trawl follows the specifications in the manual. No rock hopper was used
Notes from survey (e.g. problems, additional work etc.):	Plankton fishing during night.

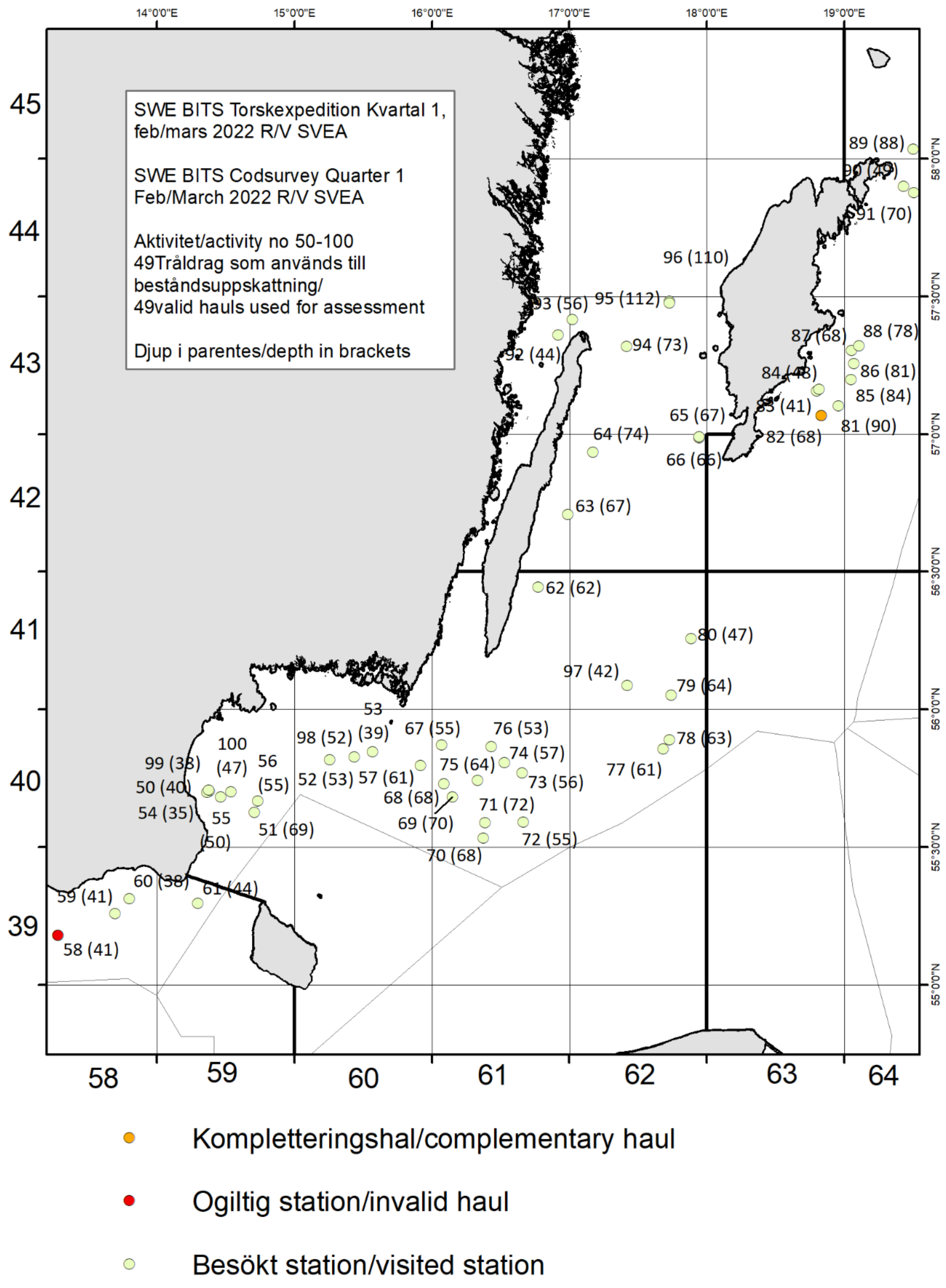
ICES Sub-Divisions	**Gear (TVL, TVS)**	**Depth strata (2–6)**	**Number of hauls planed**	**Number of valid hauls realized using "Standard" ground gear**	**Number of valid hauls realized using Rock hoppers**	**Number of assumed zero-catch hauls**	**Number of replace-ment hauls**	**Number of invalid hauls**	**% stations fished**
25	TVL	2	5	5	0	0	0	0	100
25	TVL	3	13	13	0	0	0	0	100
25	TVL	4	14	11	0	4	0	0	108
25	TVL	5	14	3	0	10	0	0	93
25	TVL	6		3	0	0	0	1	-
26	TVL	4	2	2	0	1	0	0	150
26	TVL	5	7	2	0	4	0	0	86
Total	TVL	55	55	39	0	19	0	1	

NATION:	**SWEDEN**	**VESSEL:**	**RV "DANA"**
Survey:	BITS Q1 2022	Dates:	21 February - 5 Mars 2022

Cruise	
Gear details:	The large (930#) standard TV3 trawl was used. No tows are done with the rock hopper ground gear on harder ground stations. The trawl construction is according to the specification in the BITS manual.
Notes from survey (e.g. problems, additional work etc.):	51 stations were randomly allocated, whereof 49 were trawled. four hauls in SD 27 and four hauls in SD 28 had oxygen deficiency. One haul in sd 24 were invalid, we teared a big hole in the bottom of the trawl. One haul in SD27 (Depth strata 4) were cancelled. A cable was pulled across the trawlpath.
Additional comments:	One complementary haul were made in SD 28.

ICES SUB-DIVISIONS	GEAR (TVL, TVS)	DEPTH STRATA (2–6)	NUMBER OF HAULS PLANNED	NUMBER OF VALID HAULS REALIZED USING "STANDARD" GROUND GEAR	NUMBER OF VALID HAULS REALIZED USING ROCK HOPPERS	NUMBER OF ASSUMED ZERO-CATCH HAULS	NUMBER OF REPLACE-MENT HAULS	NUMBER OF INVALID HAULS	TATIONS FISHED %
24	TVL	2	1	1	-	0	0	0	100
24	TVL	3	3	2	-	0	0	1	67
25	TVL	2	4	3	-	0	0	0	75
25	TVL	3	13	10	-	0	3	0	100
25	TVL	4	10	7	-	0	4	0	110
27	TVL	3	2	2	-	0	0	0	100
27	TVL	4	6	3	-	2	0	1	83
27	TVL	6	2	0	-	2	0	0	100
28	TVL	3	3	2	-	0	1	0	100
28	TVL	4	3	2	-	0	1	0	100
28	TVL	5	4	0	-	4	0	0	100

Number of biological samples (maturity and age material, *maturity only):			
Specname sci.	***Lenght***	***Age***	***Stomachs***
Agonus cataphractus	*4*		
Alosa fallax	*39*		
Ammodytes tobianus	*1*		
Aphia minuta	*11*		
Clupea harengus	*5075*		
Crangon crangon			
Cyclopterus lumpus	*23*		
Enchelyopus cimbrius	*39*		
Engraulis encrasicolus	*1*		
Gadus morhua	*3581*	*720*	*421*
Gasterosteus aculeatus	*77*		
Hyperoplus lanceolatus	*1*		
Limanda limanda	*230*		
Lumpenus lampretaeformis	*1*		
Merlangius merlangus	*151*		
Myoxocephalus quadricornis	*427*		
Myoxocephalus scorpius	*972*		
Osmerus eperlanus	*1*		
Pholis gunnellus	*2*		
Platichthys flesus	*4389*	*600*	*411*
Pleuronectes platessa	*1299*		
Pollachius virens	*6*		
Pomatoschistus	*2*		
Pungitius pungitius	*1*		
Saduria entomon			
Scophthalmus maximus	*94*		
Solea solea	*3*		
Sprattus sprattus	*3483*		
Trachurus trachurus	*6*		
Zoarces viviparus	*73*		


SWE BITS Torskexpedition Kvartal 1, feb/mars 2022 R/V SVEA
SWE BITS Codsurvey Quarter 1 Feb/March 2022 R/V SVEA
Aktivitet/activity no 50-100
49Tråldrag som används till beståndsuppskattning/
49valid hauls used for assessment
Djup i parentes/depth in brackets
14°0'0"E
15°0'0"E
16°0'0"E
17°0'0"E
18°0'0"E
19°0'0"E
58°0'0"N
57°30'0"N
57°0'0"N
56°30'0"N
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55°30'0"N
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62
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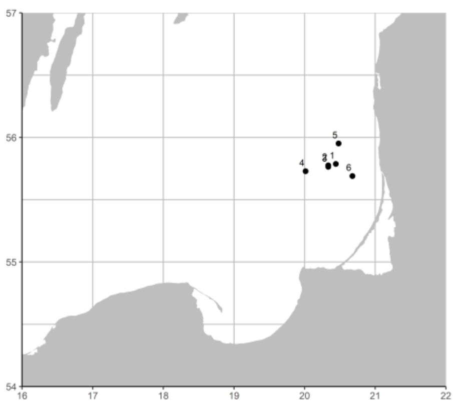
64
Kompletteringshal/complementary haul
Ogiltig station/invalid haul
Besökt station/visited station

Nation:	**Lithuania**	**Vessel:**	**652**
Survey:	BITS2022Q1	Dates:	5th – 11th March 2022

Cruise	
Gear details:	The small (520#) standard TV3 trawl was used.
Notes from survey (e.g. problems, additional work etc.):	Survey made with Lithuania commercial fishery vessel 652. The original surveys plan were 4 trawls in Lithuania EEZ (SD26) Also 2 additional trawls were planned. Total 6 fishing hauls were performed. The first haul was made on March 5 and vessel had return back due to technical issues. Other 3 trawls were made on March 10 and last two additional trawls were made on March 11.
Additional comments:	

ICES Sub-Divisions	Gear (TVL, TVS)	Depth strata (2–6)	Number of hauls planed	Number of valid hauls realized using "Standard" ground gear	Number of valid hauls realized using Rock hoppers	Number of assumed zero-catch hauls	Number of replace-ment hauls	Number of invalid hauls	% stations fished
26	*TVS*	*2*	*0*	*1*	-	-	-	-	-
26	*TVS*	*3*	*3*	*4*	-	-	-	-	*133*
26	*TVS*	*4*	*1*	*1*	-	-	-	-	*100*

Number of biological samples (maturity and age material, *maturity only):		
Species	**Length**	**Age**
Alosa fallax	*47*	
Cyclopterus lumpus	*1*	
Clupea harengus	*1876*	
Gadus morhua	*763*	*310*
Gasterosteus aculeatus	*2*	
Myoxocephalus scorpius	*34*	
Osmerus eperlanus	*23*	
Perca fluviatilis	*1*	
Platichthys flesus	*596*	*272*
Pleuronectes platessa	*1*	
Scophthalmus maximus	*6*	*6*
Sprattus sprattus	*126*	
Zoarces viviparus	*1*	



Baltic International Trawl Survey (BITS),
R/V Svea, 20 – 30 November 2021

Cruise leader : Olof Lövgren
Scientific leader : Michele Casini

Summary

The survey was conducted by the R/V Svea using the TV3L demersal trawl in accordance with the Baltic International Trawl Survey (BITS) manual (ICES. 2017). Sweden was assigned 33 randomly selected hauls.

In total 36 hauls were performed with TV3L demersal trawl including seven hauls with oxygen deficiency and three complementary hauls, one in Subdivision (SD) 28, one in SD 27 and one in SD 25. The complementary hauls were made to collect enough cod in order to perform relevant biological analyses. This year's expedition was carried out without complications. No trawls were declared invalid. A haul was not trawled because the bottom was judged to be too risky to trawl on. Sweden covered parts of the areas SD 24, 25, 27 and 28 this year.

During this survey, a total of 23 fish species were caught. Herring, sprat, cod, flounder and plaice dominated the total catch, in terms of weight.

The hydrographic conditions were measured on every station. Only the oxygen concentration at the bottom is presented in the report.

Introduction

The institute of marine research trawl expeditions in the Baltic Sea are carried out in collaboration with the countries around the Baltic Sea within the framework of one of ICES 'trawl survey programs, the Baltic International Trawl Survey, BITS. Sweden is responsible for the surveys in parts of the southern Baltic Sea SD 24 and 25, central SD 26 and is responsible for all sampling in SD 27 and the western part of SD 28. The expedition is carried out twice a year, in quarters 1 and 4 according to the BITS manual (ICES , 2017) Quarter 1 is performed in February, March and quarter 4 the last week of November.

The trawl survey is coordinated by the WGBIFS working group, which meet once a year for planning and analysis. https://www.ices.dk/community/groups/pages/wgbifs.aspx
The surveys, which in their current form have been ongoing since the early 2000s, first used the Swedish research vessel U / F Argos. U / F Argos was taken out of service in 2010 and between 2011 and 2019, Sweden chartered the Danish state vessel Dana to fulfill the Swedish commitments. Since the autumn of 2019, we have had Sweden's new research vessel R / V Svea at our disposal.
The main purpose of the expedition is to map and monitor the spatial distribution and size of the

year classes of mainly demersal species such as cod and flounder in the Baltic Sea.

The expedition in the Baltic Sea has been going on for about 40 years, which has created an unbroken time series that is very important for the stock estimation work. Due to the fact that in 2011–2019 we used another nation's vessels (U / F Dana), some of the regular stations were banned from fishing (Decision Swedish Armed Forces FM2018-22193: 6) by the Swedish Armed Forces, which resulted in a break in the time series.

All Swedish expedition data is stored in the FD2 database at the Sea Fishing Laboratory and transferred to ICES databases for international data storage; DATRAS for fish and marine litter. Hydrographic data is uploaded to Oceanography by SMHI. Data collected from this expedition are used by several working groups within ICES, mainly the Baltic Fisheries Assessment Working Group (WGBFAS). https://www.ices.dk/community/groups/Pages/default.aspx

Method

The expedition started from Lysekil on November 20th and ended in Kalmar on November 30th.

Sweden had been assigned to 33 randomly placed stations (stratified by depth from an international database that randomly selects trawl hauls to all participating countries) and was distributed as follows: three stations in the Baltic Sea subdivision, SD 24, ten stations in SD 25, ten in SD 27 and ten stations in SD 28 (see Figure 1, table 1).

Two of the randomly selected stations were replaced, entirely because the bottoms are bad at these two stations 24267, 25391, partly because two hauls were in the same position (two stations with different station numbers but located at exactly the same positions), 4 nw byxelkrok and 8 se Östergarn. The doublets were replaced with similar stations within the same depth and area. The fishing is performed with a TV3 bottom trawl with a 16 mm mesh in the codend (which is the last part of the trawl where the fish is collected before it is lifted on board). All fish species in the catch as well as some invertebrates are measured, and biological samples of the target species specified in the manual (mainly cod and flounder) are taken with respect to sexual maturity and age. http://datras.ices.dk/Documents/Manuals/Manuals.aspx.
Otoliths for age determination were collected with the goal of 1 individual per cm class and haul in the areas where there are enough stations to take samples from. In other areas, the number of sampled individuals is increased up to 2/3 per cm class and haul. On other fish species, a length distribution was made. Total weight was registered per species and haul.

Hydrography examination with CTD and oxygen probe was performed at most stations during the expedition. Oxygen-free stations are stations that are not trawled because the oxygen concentration near the bottom (measured approx. 1 m above the bottom) is less than 0.5 ml / l, an oxygen content that is considered too low for cod to stay there. However, the stations are included in calculations of stock estimates as 0-catch (Table 1).

Three supplementary halls were made in SD 25, SD 27 and one in SD 28 to collect biological samples for, among other things, age determination and other biological parameters such as liver parasites, stomachs for gastric sampling and so on.

Other sampling

At all trawled stations, the presence of debris that accumulates on the bottom and that accompanies the trawl is documented, debris is separated into different categories such as plastic, glass, metal, etc. Garbage collection was carried out in accordance with the Marine Directive's guidelines (MFSD) on behalf of the Swedish Maritime Administration.

Other surveys and provincial collections were conducted as follows:

- Collection of stomachs from cod and flounder for food selection analysis.
- Visual assessment of liver parasites in cod.
- Collection of liver and tissue samples for isotope analysis (diet analysis)
- Cod heads were collected for analysis of drug residues.
- Baltic isopod (Saduria entomon) was collected for food selection analysis.

Results

The weather during the expedition was calm and did not affect the outcome of the expedition.

A total of 33 of the 33 preselected stations could be performed, including seven oxygen-free stations (Figure 2, Table 1). Results from hydrography examination with CTD and oxygen probe are shown in Table 1. The oxygen concentration at the bottom is shown in Figure 2. Oxygen varies greatly between seasons and in November the oxygen conditions were slightly above the limit values in most of the areas. As expected, the oxygen concentration was lower in the deeper parts of SD 27 and in the deeper part of SD 28. The oxygen levels were low in other areas SD24 and 25 but were well above the limit values for trawling.

A total of 25.6 tonnes of fish were caught, of which 628 Kg were cod and corresponded to a total of 3,899 individuals. The catches of herring and sprat were 12.2 and 11.8 tonnes respectively. During the expedition, a total of 23 different fish species were caught. Captured species with weight and number distribution are reported separately in Table 2.

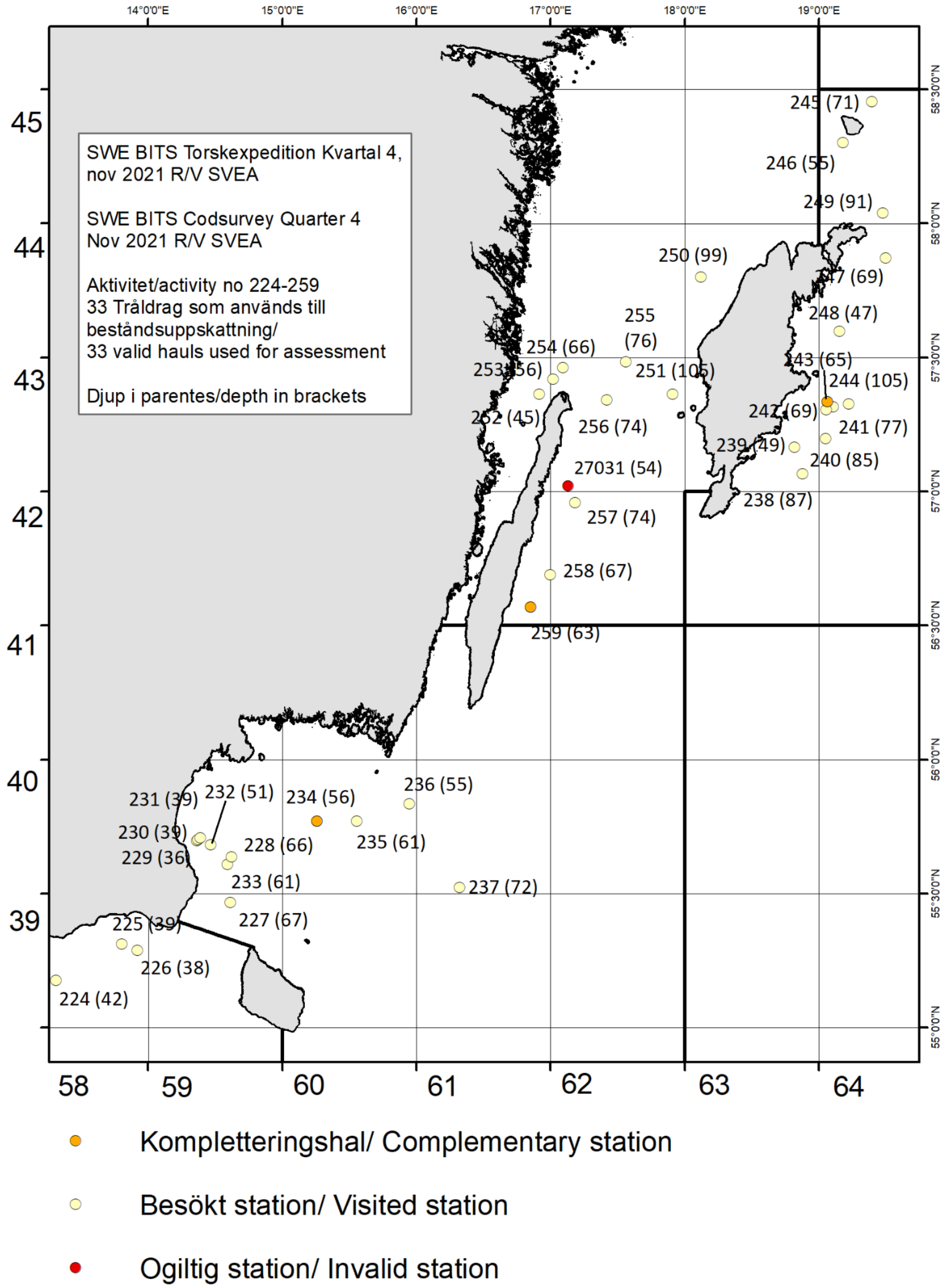


Figure 1. Map of the trawl stations performed during the Swedish BITS Quarter 4 2020. Trawled stations including three complementary haul and one invalid haul.

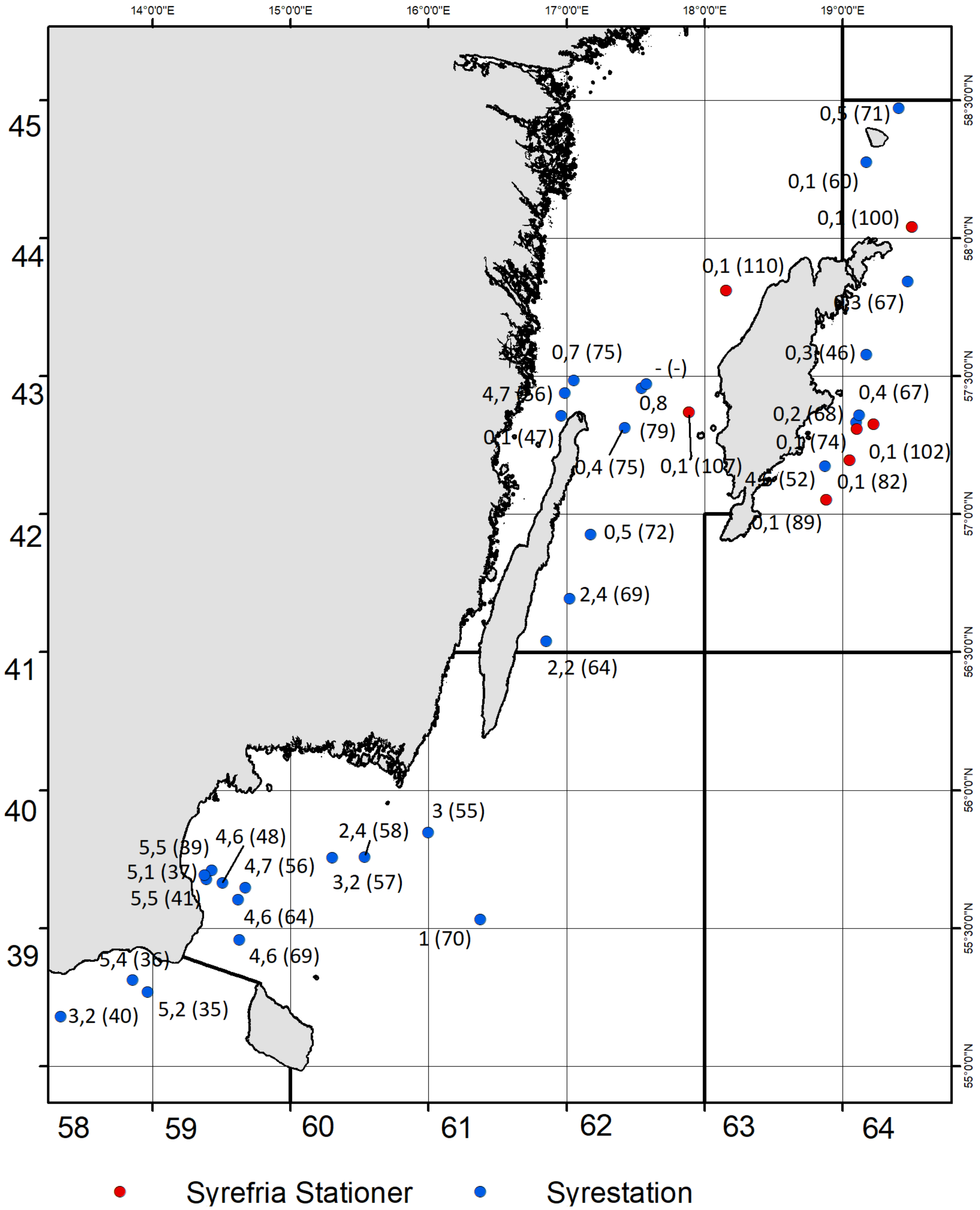


Figure 2. Oxygen concentration (ml/l) at the bottom at the trawl stations. Numbers in brackets indicate bottom depth. Swedish BITS, Quarter 4 2021.

The catch of cod is reported in kg and number per haul and SD in table 3. In the hauls where the catch of cod has been registered, the length of all cod is measured. In the case of large catches, only parts of the catch are measured (sample), which is then counted up to the total catch. Otoliths for age determination were collected with the aim of one individual per cm class, area and slippery (SD 25 divided into 3 sub-areas: 25W, 25C and 25E, see figure 1). In total, otoliths were taken from 417 cod.

Other sampling

A large part of the litter collected this year consisted of plastic. The Miscellaneous category includes clothing and shoes (see Figure 3). The information about the occurrence of rubbish is entered into a database on ices:
https://datras.ices.dk/Data_products/Download/Download_Data_public.aspx.

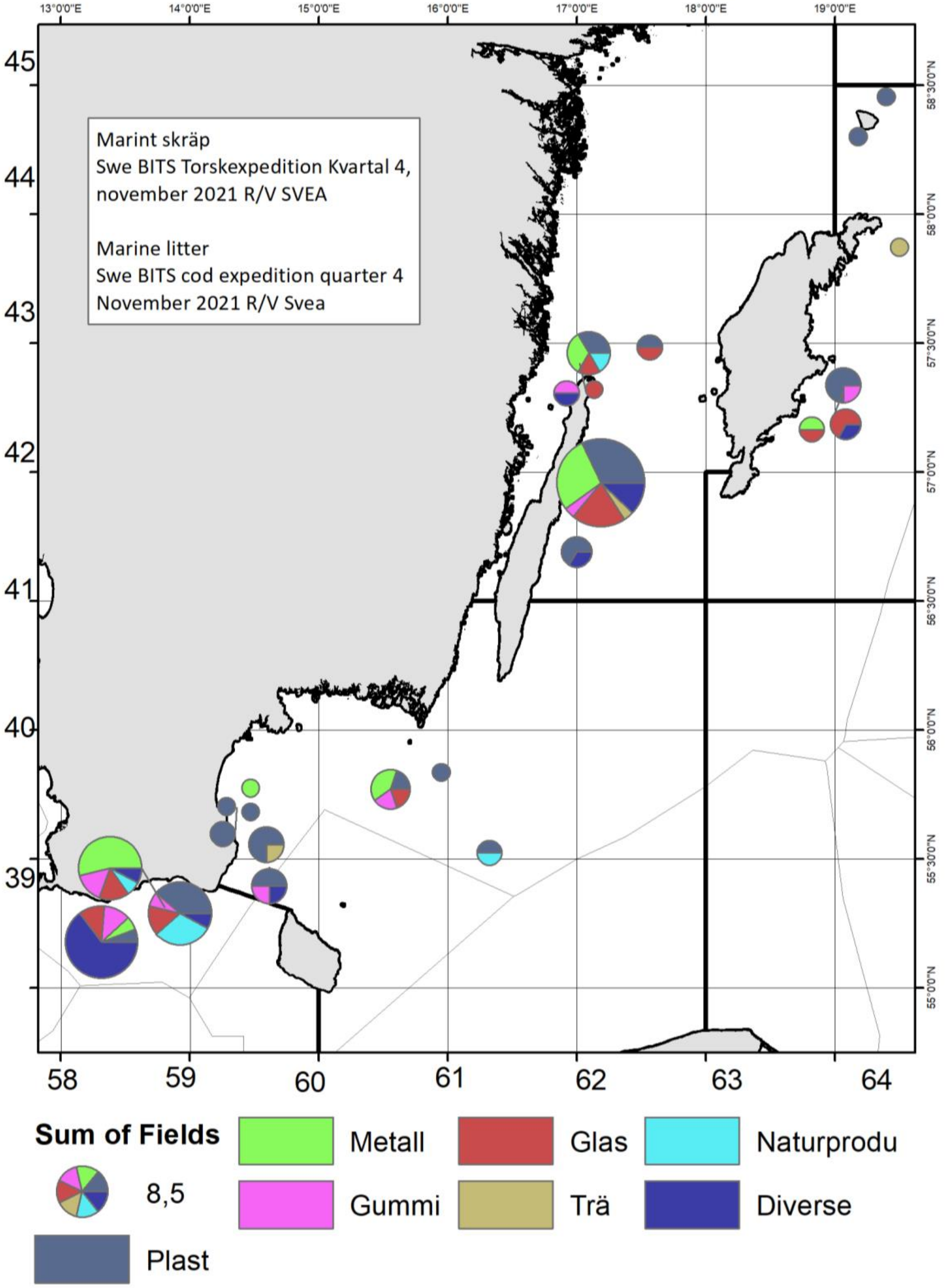
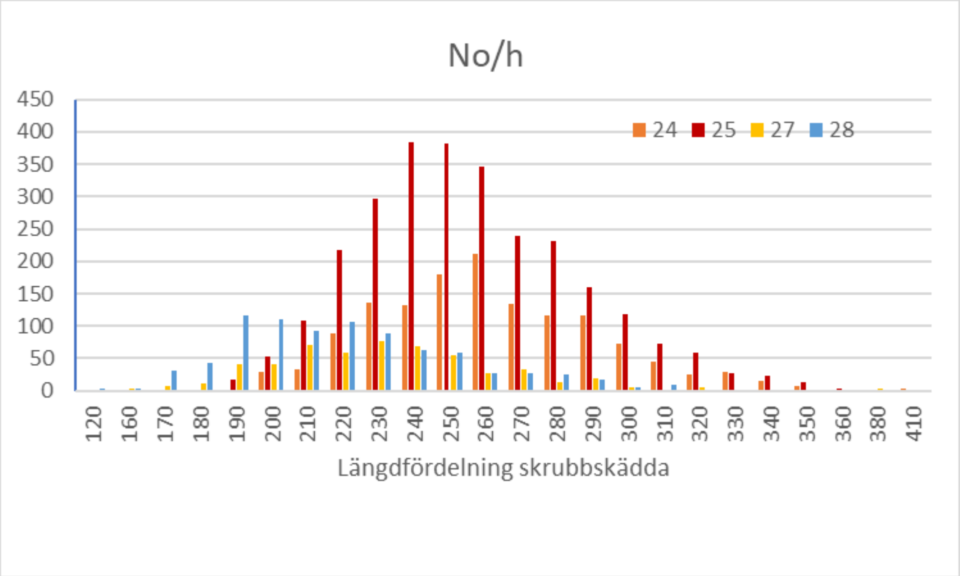


Figure 3. Marine litter presented as the number of pieces of litter per trawl haul. The size of the circles shows the total amount of litter at each station.

The length distribution of flounder per hour and area is shown in Figure 4. In total, otoliths were taken from 395 flounder.



Figur 4. Lenghtdistribution for flounder per hour and subdivision

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Table 1. Summary of all stations. Swedish BITS quarter 4 2021.

Tråldrag som används för beståndsuppskattning/Valid hauls used for assessment	**31**	Tråldrag som används för beståndsuppskattning/ Valid hauls used for assessment		
Slumpade trålade stationer/Randomized trawled hauls	**25**	Slumpade tilldelade drag/	SD28	**12**
Ersättningsdrag/Replacement hauls	**6**	Randomized allocated hauls	SD27	**10**
			SD25	**6**
Slumpade syrefria drag/Random anoxic hauls	**11**		SD24	**3**
		Tråldrag som används för	SD28	**12**
Kompletteringsdrag/additional hauls	**2**	beståndsuppskattning/ Valid hauls	SD27	**10**
Ogiltiga drag/invalid hauls	**1**	used for assessment	SD25	**6**
Slumpade stationer, ej trålade/random stations, not trawled	**5**		SD24	**3**

(light yellow)	TV3 trawl station
(light green)	Fictitious haul/oxygen deficiency
(white)	Hydrographic station (CTD)
(red)	Invalid stations

Datum Date	**Akt. nr** Act. no	**Om-råde** Area SD	**Ruta** Rect.	**Position N** Latitude	**Position E** Longitude	**Stat. nr** Haul No	**Stationsnamn** Station name	**Trål-ning** Gear	**Trål-tid** Duration min	**Trål-djup** Trawl depth	**Hydro Djup** Depth m	**Hydro O2** Oxygen ml/l	**Anmärkningar**	**Remarks**
2020-11-20	483	27	43G6	57 21,475	16 55,446	27020	4 nw Byxelkrok	CTD			41	4,5		
2020-11-20	212	27	43G6	57 21,879	16 54,988	27020	4 nw Byxelkrok	TV3	00:30:01	43		4,5		
2020-11-20	213	27	43G7	57 24,864	17 01,444	27003	5 n Byxelkrok	TV3	00:30:00	55		3,4		
2020-11-20	484	27	43G6	57 28,217	16 58,683	27003	5 n Byxelkrok	CTD			59	1,4		
2020-11-20	214	27	43G7	57 27,730	17 05,474	27025	3 SW Ölands norra grund	TV3	00:28:29	66		0,2		
2020-11-20	485	27	43G7	57 29,215	17 03,420	27025	3 SW Ölands norra grund	CTD			69	0,1		
2020-11-20	486	27	44G7	57 36,997	17 05,841	27014	9 se Kungsgrundet	CTD			74	0,1		
2020-11-20	215	27	44G7	57 37,049	17 05,863	27014	9 se Kungsgrundet	TV3	00:03:08	79		0,1	Syrefritt	Oxygen free
2020-11-20	487	27	43G7	57 27,489	17 33,314	27011	5 sse Knolls grund	CTD			77	0,9		
2020-11-20	488	27	44G8	57 46,733	18 07,183	27015	10 nw Visby	CTD			97	0,4		
2020-11-20	216	27	44G8	57 46,826	18 07,178	27015	10 nw Visby	TV3	00:04:01	102		0,3	Syrefritt	Oxygen free
2020-11-21	489	27	43G7	57 29,822	17 35,723	27011	5 sse Knolls grund	CTD			78	1,1		
2020-11-21	217	27	43G7	57 28,965	17 33,694	27011	5 sse Knolls grund	TV3	00:30:01	77		2		
2020-11-22	490	28	44G9	57 35,302	19 10,573	28188	9 se Grauten	CTD			47	6,1		
2020-11-22	218	28	44G9	57 36,812	19 10,090	28188	9 se Grauten	TV3	00:15:41	46		6,1		
2020-11-22	491	28	44G9	57 40,032	19 23,642	28183	11 se Bungeör	CTD			74	0,1		
2020-11-22	219	28	44G9	57 41,310	19 22,611	28183	11 se Bungeör	TV3	00:05:09	74		0,1	Syrefritt	Oxygen free
2020-11-22	492	28	44G9	57 45,277	19 28,972	28182	13 sse Fårö	CTD			78	3,3		
2020-11-22	220	28	44G9	57 46,107	19 28,840	28182	13 sse Fårö	TV3	00:03:03	80		0,1	Syrefritt	Oxygen free
2020-11-22	221	28	44G9	57 52,785	19 25,398	28097	5 se Fårö	TV3	00:25:37	48		5,4	Ogiltigt	Invalid
2020-11-22	493	28	44G9	57 54,163	19 27,324	28097	5 se Fårö	CTD			51	0,1		
2020-11-22	494	28	45G9	58 02,422	19 30,673	28078	E Salvorev	CTD			100	0,1		
2020-11-22	222	28	45G9	58 02,122	19 29,348	28078	E Salvorev	TV3	00:10:08	92		0,1	Syrefritt	Oxygen free
2020-11-23	495	28	45G9	58 05,157	19 27,462	28106	2 e Salvorev	CTD			84	0,5		
2020-11-23	223	28	45G9	58 04,478	19 26,343	28106	2 e Salvorev	TV3	00:30:00	75		0,2		
2020-11-23	496	28	45G9	57 52,894	19 31,622	28104	6,5 se Fårö	CTD			68	0,1		
2020-11-23	224	28	44G9	57 52,560	19 30,263	28104	6,5 se Fårö	TV3	00:23:09	69		0,5		
2020-11-23	497	28	43G9	57 20,093	19 14,055	28109	10 se Östergarn	CTD			97	0,1		
2020-11-23	225	28	43G9	57 20,166	19 14,119	28109	10 se Östergarn	TV3	00:03:03	103		0,1	Syrefritt	Oxygen free
2020-11-23	498	28	43G8	57 05,342	18 55,573	28107	12 se När	CTD			85	4,6		
2020-11-23	226	28	43G8	57 05,337	18 54,453	28107	12 se När	TV3	00:03:04	84		0,1	Syrefritt	Oxygen free
2020-11-24	499	28	43G8	57 10,650	18 53,303	28016	5 se När	CTD			51	0,1		
2020-11-24	227	28	43G8	57 10,519	18 51,816	28016	5 se När	TV3	00:30:00	48		4,7		
2020-11-24	500	28	43G9	57 14,599	19 03,921	28072	13 e Ljugarn	CTD			78	0,3		
2020-11-24	228	28	43G9	57 14,978	19 04,011	28072	13 e Ljugarn	TV3	00:03:21	81		0,1	Syrefritt	Oxygen free
2020-11-24	229	28	43G9	57 18,434	19 03,544	28103	12 e Ljugarn	TV3	00:22:01	68		0,6		
2020-11-24	501	28	43G9	57 18,060	19 06,166	28103	12 e Ljugarn	CTD			73	0,3		
2020-11-24	230	28	43G9	57 19,142	19 06,510	28051	8 se Östergarn syd	TV3	00:30:01	77		0,3		
2020-11-25	502	27	42G7	56 59,274	17 55,540	27007	8 nw Hoburg	CTD			66	0,1		
2020-11-25	231	27	42G7	56 59,737	17 57,053	27007	8 nw Hoburg	TV3	00:03:20	64		0,1	Syrefritt	Oxygen free
2020-11-25	232	27	43G7	57 03,193	17 55,000	27023	9 nw Hoburg	TV3	00:03:08	75		0,1	Syrefritt	Oxygen free
2020-11-25	503	27	43G7	57 15,891	17 25,757	27030	11 e Böda	CTD			75	0,1		
2020-11-25	233	27	43G7	57 16,831	17 24,877	27030	11 e Böda	TV3	00:03:59	75		0,1	Syrefritt	Oxygen free
2020-11-25	504	27	42G7	56 58,742	17 12,353	27005	10 e Kårehamn	CTD			68	0,1		
2020-11-25	234	27	42G7	56 57,503	17 11,041	27005	10 e Kårehamn	TV3	00:30:07	73		0,1	Kompletteringshal!	Complementary haul
2020-11-25	505	27	42G7	56 42,962	17 01,245	27028	10 sse Kapelludden	CTD			64	0,1		
2020-11-26	506	27	42G7	56 43,377	17 00,218	27028	10 sse Kapelludden	CTD			64	0,1		
2020-11-26	235	27	42G6	56 43,534	16 59,635	27028	10 sse Kapelludden	TV3	00:30:01	66		0,1		
2020-11-26	236	27	42G6	56 33,928	16 51,002	27021	6 se Bläsinge	TV3	00:30:00	63		0,1	Kompletteringshal!	Complementary haul
2020-11-26	507	27	42G6	56 31,383	16 50,365	27021	6 se Bläsinge	CTD			59	0,1		
2020-11-27	508	24	39G3	55 11,927	13 35,042	24263	Ystadkroken	CTD			40	4,3		
2020-11-27	237	24	39G3	55 12,749	13 36,097	24263	Ystadkroken	TV3	00:30:01	43		4,3		
2020-11-27	238	24	39G3	55 17,157	13 55,499	24130	E Ystadkroken	TV3	00:30:01	37		6,5		
2020-11-27	509	24	39G3	55 15,787	13 54,935	24130	E Ystadkroken	CTD			37	6,5		
2020-11-27	239	24	39G3	55 15,603	13 57,109	24125	8,9 se Klostergrundet	TV3	00:30:01	38		6,5		
2020-11-27	240	25	39G4	55 27,534	14 28,793	25502	8 e Skillinge	TV3	00:30:01	56		2,6		
2020-11-27	510	25	39G4	55 27,892	14 34,223	25502	8 e Skillinge	CTD			58	2,6		
2020-11-28	511	25	40G4	55 40,312	14 30,312	25353	Rackaputt Nord	CTD			46	3,1		
2020-11-28	241	25	40G4	55 41,259	14 30,572	25353	Rackaputt Nord	TV3	00:30:01	46		3,1		
2020-11-28	512	25	40G4	55 41,002	14 22,917	25419	3,5 ne Stens Huvud	CTD			40	5,4		
2020-11-28	242	25	40G4	55 41,917	14 21,794	25419	3,5 ne Stens Huvud	TV3	00:29:23	34		6,9		
2020-11-28	243	25	40G4	55 42,222	14 22,772	25401	5 ne Stens Huvud	TV3	00:26:01	38		6,9		
2020-11-28	513	25	40G4	55 42,203	14 25,304	25401	5 ne Stens Huvud	CTD			36	6,8		
2020-11-29	514	25	40G5	55 54,990	15 36,099	25142	5 ssw Utklippan	CTD			48	3,7		
2020-11-29	244	25	40G5	55 52,978	15 34,001	25142	5 ssw Utklippan	TV3	00:30:01	50		3,7		
2020-11-29	245	25	40G5	55 50,813	15 34,216	25140	Klippebank	TV3	00:30:03	37		6,1		
2020-11-29	515	25	40G5	55 49,827	15 30,271	25140	Klippebank	CTD			46	2,9		

Table 2. Summary of the species in the catches. Swedish BITS, Q4 2021.

Species	SD 24		SD 25W		25 C		SD 27		SD 28		Total	
	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight
Gadus morhua	1 108	280,9	1 851	288,8	164	17,6	1	0,1	105	10,9	3 229	598,4
Clupea harengus	6 790	169,0	7 901	377,4	2 479	75,5	82 217	1 866,4	89 602	2 522,2	188 989	5 010,4
Sprattus sprattus	15 972	256,8	32 002	511,4	75 494	957,9	102 904	493,7	49 975	347,2	276 346	2 566,9
Enchelyopus cimbrius	1	0,1	3	0,1					1	0,1	5	0,3
Myoxocephalus quadricornis							153	15,4	728	107,3	881	122,7
Eutrigla gurnardus			1	0,1							1	0,1
Melanogrammus aeglefinus	3	0,3									3	0,3
Osmerus eperlanus							1	0,1			1	0,1
Scophthalmus maximus	10	4,0	69	27,7	3	0,7					82	32,4
Pomatoschistus	11	0,01	10	0,01					10	0,0	31	0,02
Pleuronectes platessa	1 126	218,7	1 020	155,0	18	4,1	1	0,1	1	0,3	2 167	378,3
Myoxocephalus scorpius	2	0,1	12	1,1	48	7,8	28	3,3	80	10,1	170	22,4
Limanda limanda	85	7,9	39	4,7	12	1,2					136	13,8
Cyclopterus lumpus									1	0,2	1	0,2
Platichthys flesus	500	109,0	944	187,3	247	42,2	76	12,8	248	40,2	2 014	391,5
Agonus cataphractus			1	0,04	4	0,1					5	0,1
Scophthalmus rhombus			1	0,3	1	0,2					2	0,5
Lumpenus lampretaeformis									2	0,1	2	0,1
Gasterosteus aculeatus							2 453	4,3	169	0,3	2 622	4,7
Trachurus trachurus	4	0,1									4	0,1
Arnoglossus laterna	1	0,02									1	0,02
Merlangius merlangus	224	44,7	39	5,8							263	50,5
Zoarces viviparus					1	0,04	2	0,1	78	3,3	81	3,4
Solea solea	32	3,7			1	0,1					33	3,8
	25 870	1 165,7	43 893	1 619,7	78 472	1 110,9	187 836	2 396,2	141 013	3 043,9	477 084	9 336,4

Table 3 Cod catch in kg and numbers/haul in SDs 24-28

	(orange)	Kompletteringsdrag/complemetary haul			TV3 trålstation/TV3 trawl station				
				(green)	Syrefattig trålstation/oxygen deficiency station				
Akt. nr Act. no	**Position N** Latitude	**Position E** Longitude	**Stationsnamn** Station name	**Trål-tid** Dur min	**Trål-djup** Trawl depth	**Hydro O2** Oxygen ml/l	**Totalfångst** alla arter (kg) Total catch all species (kg)	**Torskfångst** Cod catch kg	antal/nos.
SD 24									
224	55 10,605	13 18,659	S Trelleborg	25	42	3,2	307,9	15,2	56
225	55 18,752	13 48,230	5S Klostergrundet	25	39	5,4	654,9	67,5	225
226	55 17,293	13 55,226	E Ystadkroken	30	38	5,2	592,1	47,3	174
SD 25									
227	55 28,039	14 36,903	11 E Skillinge	16	67	4,6	1254,2	150,7	1071
228	55 36,551	14 35,565	8 ENE Simrishamn	25	66	4,6	2030,6	15,3	85
229	55 41,911	14 21,796	3,5 NE Stens Huvud	20	36	5,4	93,4	1,1	6
230	55 42,178	14 22,434	5 NE Stens Huvud	30	39	5,5	130,5	1,0	12
231	55 42,553	14 23,425	Rackaputt 38M	21	39	5,1	185,9	2,4	14
232	55 40,917	14 28,086	Rackaputt C	30	51	4,6	474,7	23,8	135
233	55 38,241	14 37,174	11 E Stens Huvud	30	61	4,7	805,2	77,3	515
234	55 46,227	15 15,623	1 WNW Västra Nabben	20	56	3,2	4489,6	100,5	722
235	55 46,209	15 33,251	8 NW Tången	30	61	2,4	470,8	57,1	407
236	55 50,117	15 56,759	11 SE Utklippan	30	55	3	991,0	21,5	140
237	55 31,422	16 19,228	10 S Holgers sten	30	72	1	65,2	8,6	33
SD 27									
250	57 48,072	18 07,336	10 NW Visby	30	99	0,1			
251	57 21,819	17 54,524	4 NW Stora Karlsö	30	105	0,1			
252	57 21,794	16 55,086	4 NW Byxelkrok	30	45	4,8	985,0	3,4	17
253	57 25,207	17 01,121	5 N Byxelkrok	25	56	4,8	1938,5	2,6	11
254	57 27,724	17 05,486	3 SW Ölands Norra Grund	21	66	4,8	67,9	1,0	7
255	57 29,037	17 33,763	5 SSE Knolls Grund	15	76	1,5	1590,0		
256	57 20,572	17 25,213	11 ESE Ölands Norra Udde	25	74	0,5	849,2	2,3	16
257	56 57,505	17 11,036	10 E Kårehamn	30	74	0,5	530,4		
258	56 41,419	16 59,828	10 SSE Kapelludden	30	67	2,6	1092,6	0,4	2
259	56 34,113	16 51,095	6 SE Bläsinge	26	63	3,6	1756,6	1,9	16
SD 28									
238	57 04,040	18 52,843	12 SE När	30	87	0,1			
239	57 09,903	18 49,178	5 SE När	30	49	4,9	756,7	4,4	33
240	57 11,907	19 03,025	12 E När	30	85	0,1			
241	57 18,971	19 06,396	8 SE Östergarn	30	77	0,1			
242	57 18,350	19 03,448	12 E Ljugarn	30	69	0,2	68,2	0,05	1
243	57 20,193	19 03,865	6 SE Östergarn	30	65	0,6	411,6	4,3	26
244	57 19,704	19 13,565	10 SE Östergarn	30	105	0,1			
245	58 27,352	19 23,853	4 E Gotska Sandön	30	71	0,5	232,3	1,1	9
246	58 18,104	19 10,746	4 SW Gotska Sandön	26	55	0,1	1873,9	2,4	30
247	57 52,342	19 29,918	6,5 SE Fårö	27	69	0,3	205,1		
248	57 35,916	19 09,351	9 SSE Grauten	20	47	6	717,3	14,7	137
249	58 02,438	19 28,638	E Salvorev	30	91	0,1			
Catch, weight (kg) and numbers							25 621	627,8	3 899

Institute of Food Safety, Animal Health and Environment “BIOR” Riga (Latvia)
National Marine Fisheries Research Institute, Gdynia (Poland)

THE CRUISE REPORT

FROM THE JOINT LATVIAN-POLISH BITS 4Q SURVEY ON THE POLISH R.V. “BALTICA” IN THE CENTRAL-EASTERN BALTIC (08-18 December 2021)

by
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Gdynia - Riga, January 2022

Introduction

The joint Latvian-Polish BITS survey, conducted in the period of 08.-18.12.2021 on the r/v. “Baltica”, was based on the agreement between the Institute of Food Safety, Animal Health and Environment “BIOR” in Riga and the National Marine Fisheries Research Institute (“NMFRI”) in Gdynia. The joint Latvian-Polish BITS 4Q survey was conducted in the Latvian EEZs (the ICES Sub-divisions 26 and 28). It was part of the Baltic International Trawl Survey (BITS), which was coordinated by the ICES Baltic International Fish Survey Working Group [WGBIFS] (Anon. 2021).

The main aims of reported cruise were:

1. Collecting materials to investigate the distribution, abundance, and biological structure of cod stock.
2. Determine distribution and abundance of cod recruits. Estimates of year – class strength of cod.
3. Collecting materials to investigate the distribution abundance and biological structure of flounder stock.
4. Collect data on cod feeding.
5. Analysis of the hydro-meteorological conditions (seawater temperature, salinity, oxygen content, air temperature, atmospheric pressure, wind velocity and directions) in the ICES Sub-divisions 26N and 28.
6. Acoustical data recording during trawling and on the distance between consecutive catch-stations.
7. A collection of information about marine litter.

MATERIALS AND METHODS

Personnel

The BITS Q1 - 2021 survey scientific staff was composed of nine persons, i.e.:
Radosław Zaporowski, NMFRI, Poland - cruise leader,
Krzysztof Radtke, NMFRI, Poland - ichthyologist.
Beata Schmidt, NMFRI, Poland - hydrologist,
Władysław Gaweł, NMFRI, Poland - ichthyologist,
Wojciech Deluga, NMFRI Poland – ichthyologist,
Ireneusz Wybierała, NMFRI Poland – ichthyologist,
Stanisław Trella , NMFRI Poland – ichthyologist,
Maciej Bielak , NMFRI, Poland – acoustician.

Narrative

BITS Q4 was performed on R/V Baltica with Polish scientific team. Due to Covid-19 travel restriction, Latvian team could not travel to the vessel and take part in the survey. Survey was done according to manual and supervision of Latvian team from coast.

The reported survey research tasks realisation took place during the period of 08-18 December 2021 and overall, eleven full days was devoted to survey plan accomplishment. The at sea research were conducted within the Latvian EEZ (the ICES Sub-divisions 26 and 28) moreover, inside the Latvian territorial waters not shallower than 20 m (the ICES Sub-division 28).

The vessel left the Gdynia port (Poland) on 08.12.2021 and was navigated towards the south-western corner of the Latvian EEZs (Fig. 1). The direct at sea research begins on 08.12.2021 and was ended on 14.12.2021. On 18.12.2021 r/v "Baltica" returned to the homeport. Due to the very bad weather conditions, 3 working days during the survey was lost.

Survey design and realization

The original surveys plan provided that 30 control-hauls will be realized in the Latvian EEZ (9 trawls in SD 26, 21 trawls in SD 28).

The r.v. "Baltica" realized 29-bottom trawl control-hauls including the Latvian territorial waters (Fig.1). Fourteen catch-stations were only initiated by hydrological parameters measurement and due to very low oxygen concentration (below 0.5 ml/l) near bottom, fishing was omitted.

All trawl catches were performed in the daylight. The hard-bottom ground-rope (rockhopper) trawl, type TV-3#930 (with 10-mm mesh bar length in the codend) was applied for fish catches. The mean speed of vessel while trawling was 3.0 knots. For the 14 realized trawls, their duration was shortened to 10-20 minutes, due to dense clupeids concentrations observed on the echosounder, bad weather or hard bottom.

The length measurements in the 1.0-cm classes were realised for 224 cod and 1265 flounder. Length measurements in the 0.5-cm classes were realized for 1471 herring and 1343 sprat. In total, 125 cod and 270 flounder individuals were taken for biological analysis. Stomachs from the 125 cod were taken for investigation of cod feeding.

Acoustic data, i.e. the echo-integration records (SA = NASCs; Nautical Area Scattering (Strength) Coefficient) were collected with the EK-60 scientific echosounder during fishing operations and on the distances between consecutive hauls. Echo-sounding data collected during the BITS survey were delivered to the Latvian researchers for further analysis.

Directly before every haul, the seawater temperature, salinity, and oxygen content were measured continuously from the sea surface to a bottom. The seawater samples were taken also at the standard HELCOM stations. Totally, 34 hydrological stations were inspected with the Neil-Brown CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method.

Meteorological observations of wind velocity and directions and the sea state were realized at the actual geographic position of each control-haul.

Results

Fish catches and biological data

The control-catches basic results collected in December 2021 during the Latvian-Polish BITS-4Q survey are presented in Table 1. Fifteen hauls were realized during the survey, 14 hauls in Sub - division 28, 1 haul in Sub - division 26 with total catch 0.106 kg. Overall, 11 fish species were recognised in hauls performed in the central-eastern Baltic. Herring, sprat, flounder, and cod were the most frequently occurring fish species in the catches - 100%, 93%, 87% and 87% of realized hauls, respectively (Table 1.). Herring, sprat, flounder, and cod dominated also with respect to mass of the catch (kg) and efficiency (CPUE) in Sub - division 28 (Fig. 2.A.). By-catch of other fish species was insignificant.

Herring dominated by mass in the ICES Sub - division 28 with the average share of 52.2% respectively. Sprat was the next species most frequently represented in terms of mass, i.e., 40.9%. The share of flounder and cod in control-catches made out in the ICES SD 28 was 5.8 and 0.9 %, respectively. By-catch of other fishes was insignificant. The mean CPUE for all species in SD 28 amounted 948.2 kg/h, and in this 495.6, 396.9, 49.2 and 9.9 kg/h were for herring, sprat, flounder, and cod, respectively (Fig. 2.A.).

Total catch of fishes and the number of realized hauls in the Latvian EEZ, during reported BITS survey is presented in the text-table below:

SD	Number of hauls	Total catch (kg)				
		Cod	Herring	Sprat	Flounder	Others
26	1	0.002	0.1	0	0	0
28	14	29.8	1756.5	1375.7	193.7	6.5

The length distribution of cod, flounder, herring, and sprat, according to the ICES Sub-divisions are illustrated in Figures 2-5 and Tables 3-6.

Cod

The total length of cod in scrutinized samples ranged from 7 to 52 cm and specimens from the length classes of 20-24 dominated in samples from the ICES Sub-division 28, respectively (Fig.3, Table 3). Totally 222 cod from hauls in Sub-division 28.

The only 1 haul was realized in Sub-division 26 with 2 cod less than 7 cm.

A very low number of small cod (< 19 cm) was observed generally, and they occurred in some hauls only.

Flounder

The total length of flounder in scrutinized samples ranged from 13 to 32 cm and specimens from the length classes of 19 - 25 cm dominated in samples from the ICES Sub-division 28, respectively (Fig.4, Table 4).

The only 1 haul was realized in Sub-division 26 without flounder catch.

Herring

The length range of collected herring was 11.0-23.0 cm, and specimens from the length classes of 15.0-18.0 cm were most frequently represented in samples from the ICES Sub-divisions 28 (Fig. 5, Table 5).

The only 1 haul was realized in Sub-division 26 with 4 herring.

Sprat

Sprat length distribution curves in SD 28 indicated the existence of two length fractions. First fraction of sprat in SD 28 was created by the smaller size fish - 8.5-9.0 cm, while the second fraction of the larger fish included length classes 10.5-12.0 cm. (Fig. 6. Table 6).
The only 1 haul was realized in Sub-division 26 without sprat catch.

Hydrological Situation in December 2021

Hydrological parameters were measured at each trawling (29) and hydrological stations (5) (Fig. 1). Measurements were conducted with the CTD SeaBird 911-probe combined with the rosette sampler. Oxygen content was determined by the standard Winkler's method. The STD data were aggregated to the 1-m depth strata. The salinity parameter was presented in Practical Salinity

Unit (PSU). Meteorological parameters were measured by MicroStep-MIS AMS 111 automatic weather station.

The most frequent winds (Fig. 7.) were from direction W. The average (10 min) wind speed varied from 0.4 m/s to 15.2 m/s (up to 25.7 m/s). The air temperature ranged from -7.4 °C to 8.7 °C, and average temperature was 3.1°C.

The lowest value of temperature at the surface layer was observed at the trawl 4 (4.76 °C), while the warmest (7.58 °C) surface water was at the trawl 2. The average value was 6.72 °C. The average surface salinity was 7.40 PSU. The minimum value was 7.20 PSU at the trawl 8 and maximum 7.46 at the trawls 10 and 21 and at the station 40A. The highest oxygen content in surface water layer was 8.23 ml/l at the trawl 8 while the lowest one 7.51 ml/l at the trawl 12. Mean value of dissolved oxygen equalled 7.78 ml/l.

Near - bottom layer conditions are presented in the (Fig. 8.). Water temperature varied from 7.60 °C (trawl 2) to 5.08 °C (trawl 9). The mean value calculated for the whole area covered during the cruise was 6.70 °C. The average salinity in the close-to-the-bottom water layers was 10.01 PSU. The highest value was measured at the hydrological station 37 (12.97 PSU). The lowest one was 7.26 PSU (haul 8). The dissolved oxygen highest value was measured at the trawl 9 and it was 7.27 ml/l. The 0 ml/l was found on the stations 46, 43, 37 and trawls 11, 25, 36, 27, 28, 29. The mean value was 3.81 ml/l.

The comparison of the hydrological profiles at the station 37 (Fig. 9.) shows that salinity was higher in the whole water column than the average for December 2010/2020. The temperature in the isohaline layer of water was lower than average, and below the thermocline it was higher. The content of oxygen dissolved in water in the isohaline layer was close to the average, and in the isothermal water layer it was lower than the average.

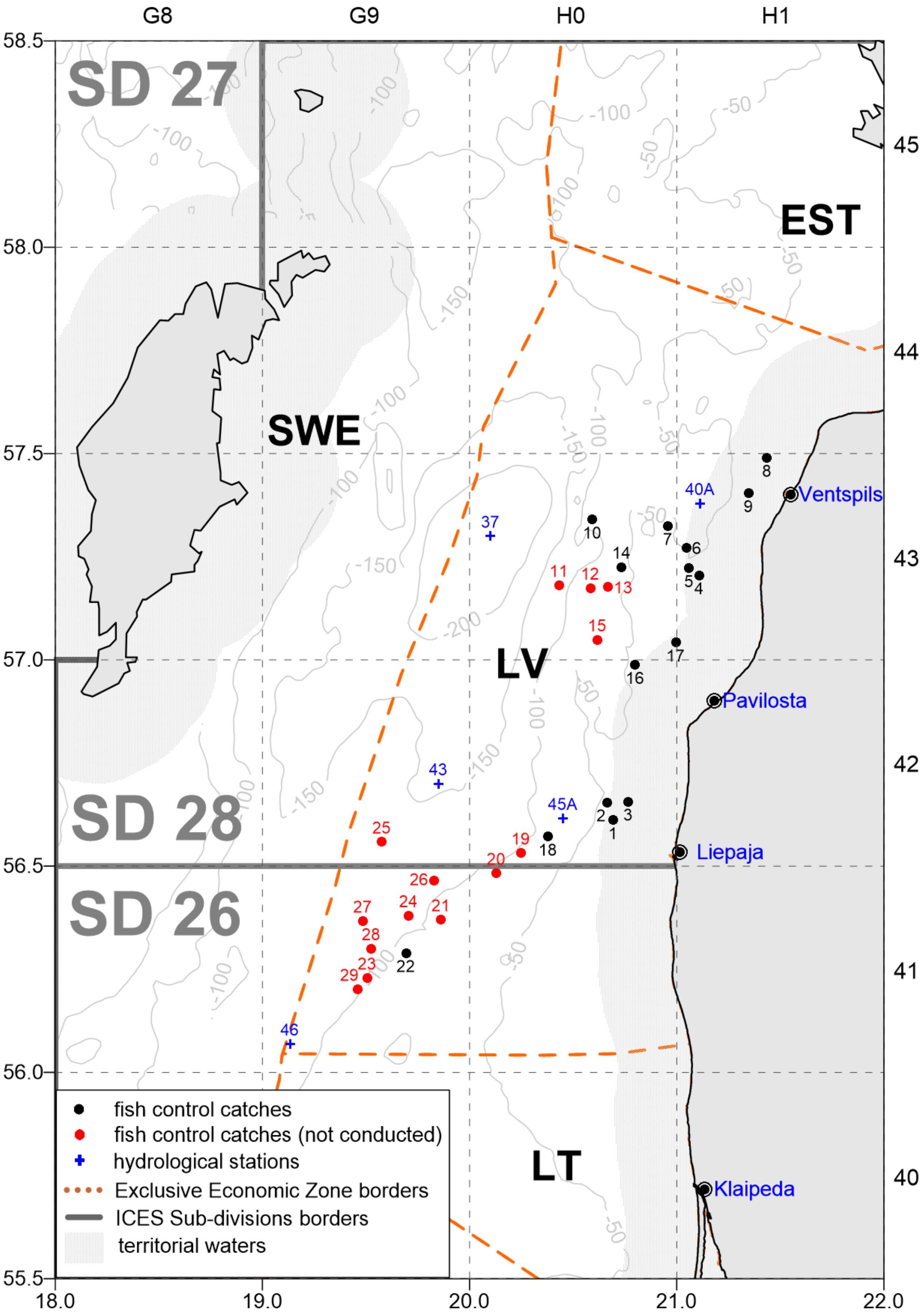


Figure 1. Locations of the fish bottom control catches and hydrological stations during the survey (December 2021)

Table 1. Catch results from the Latvian-Polish BITS 4Q survey; r/v "Baltica", 08-18 December 2021

Haul number	Date of catch	EEZ	ICES rectangle	ICES SD	Depth to the bottom [m]	The ship's course during fishing [°]	Geographical position of the catch station				Time of		Haul duration [min.]	Total catch	all species CPUE [kg/0.5h]	CATCH of particular fish species [kg]				
							start		end											
							latitude 00°00' N	longitude 00°00' E	latitude 00°00' N	longitude 00°00'E	shutting net	pulling up net				Sprat	Herring	Cod	Flounder	Others
1	09/12/2021	LAT	42H0	28	39	050	56°37.4	20°42.2	56°37.8	20°42.9	08:20	08:35	15	274.635	549.27	171.543	79.817	7.06	15.78	0.435
2	09/12/2021	LAT	42H0	28	49	215	56°38.7	20°40.2	56°38.2	20°39.4	10:05	10:20	15	562.22	1124.44	138.377	385.913	10.09	26.88	0.96
3	09/12/2021	LAT	42H0	28	39	215	56°38.9	20°45.1	56°37.9	20°43.4	12:10	12:40	30	225.173	225.173	13.301	189.177	1.865	20.12	0.71
4	10/12/2021	LAT	43H1	28	47	035	57°13.1	21°06.9	57°13.9	21°07.8	09:40	10:00	20	136.257	204.3855	6.759	63.472	0.348	63.28	2.398
5	10/12/2021	LAT	43H1	28	56	005	57°14.2	21°03.5	57°14.8	21°03.5	11:30	11:40	10	58.121	174.363	19.758	34.838	1.902	1.352	0.271
6	10/12/2021	LAT	43H1	28	62	325	57°16.1	21°02.7	57°16.7	21°02.0	12:35	12:50	15	155.017	310.034	74.021	63.31	4.12	13.21	0.356
7	10/12/2021	LAT	43H0	28	64	315	57°18.4	20°58.9	57°18.8	20°58.1	13:30	13:45	15	317.45	634.9	250.204	61.456	1.405	4.385	0
8	11/12/2021	LAT	43H1	28	24	340	57°29.8	21°25.8	57°30.8	21°25.2	08:10	08:30	20	178.121	267.1815	8.998	147.446	1.253	19.65	0.774
9	11/12/2021	LAT	43H1	28	30	350	57°24.0	21°20.7	57°24.8	21°20.5	10:10	10:25	15	77.134	154.268	1.615	64.892	0	10.28	0.347
10	11/12/2021	LAT	43H0	28	89	330	57°21.2	20°35.5	57°21.7	20°35.1	14:15	14:30	15	10.478	20.956	4.27	5.5	0.07	0.636	0.002
11	12/12/2021	LAT	43H0	28	133	-9	57°10.8	20°25.9	57°10.8	20°25.9	06:50	06:50	0	0	0	0	0	0	0	0
12	12/12/2021	LAT	43H0	28	95	-9	57°10.4	20°35.0	57°10.4	20°35.0	07:50	07:50	0	0	0	0	0	0	0	0
13	12/12/2021	LAT	43H0	28	85	-9	57°10.6	20°40.0	57°10.6	20°40.0	08:30	08:30	0	0	0	0	0	0	0	0
14	12/12/2021	LAT	43H0	28	68	360	57°12.0	20°44.2	57°12.8	20°44.1	09:15	09:30	15	684.486	1368.972	483.569	200.081	0.836	0	0
15	12/12/2021	LAT	43H0	28	88	-9	57°02.9	20°37.0	57°02.9	20°37.0	11:30	11:30	0	0	0	0	0	0	0	0
16	12/12/2021	LAT	42H0	28	70	340	56°59.9	20°48.1	57°00.5	20°47.9	13:05	13:15	10	249.874	749.622	28.226	219.894	0.735	1.019	0
17	12/12/2021	LAT	43H0	28	29	025	57°01.1	20°58.8	57°02.0	20°59.6	14:25	14:45	20	24.785	37.1775	0.112	7.98	0	16.55	0.143
18	13/12/2021	LAT	42H0	28	76	275	56°33.9	20°24.5	56°34.1	20°23.5	08:20	08:35	15	408.426	816.852	174.987	232.753	0.086	0.6	0
19	13/12/2021	LAT	42H0	28	91	-9	56°31.9	20°14.9	56°31.9	20°14.9	09:45	09:45	0	0	0	0	0	0	0	0
20	13/12/2021	LAT	41H0	26	85	-9	56°28.9	20°07.9	56°28.9	20°07.9	10:35	10:35	0	0	0	0	0	0	0	0
21	13/12/2021	LAT	41G9	26	88	-9	56°22.2	19°51.8	56°22.2	19°51.8	12:20	12:20	0	0	0	0	0	0	0	0
22	13/12/2021	LAT	41G9	26	74	220	56°16.9	19°41.1	56°16.4	19°40.3	14:00	14:15	15	0.106	0.212	0	0.104	0.002	0	0
23	13/12/2021	LAT	41G9	26	105	-9	56°13.7	19°30.4	56°13.7	19°30.4	15:30	15:30	0	0	0	0	0	0	0	0
24	13/12/2021	LAT	41G9	26	111	-9	56°27.7	19°42.4	56°27.7	19°42.4	16:50	16:50	0	0	0	0	0	0	0	0
25	13/12/2021	LAT	42G9	28	149	-9	56°33.5	19°34.6	56°33.5	19°34.6	18:35	18:35	0	0	0	0	0	0	0	0
26	14/12/2021	LAT	41G9	26	109	-9	56°27.9	19°34.6	56°27.9	19°34.6	07:25	07:25	0	0	0	0	0	0	0	0
27	14/12/2021	LAT	41G9	26	142	-9	56°22.0	19°29.0	56°22.0	19°29.0	09:40	09:40	0	0	0	0	0	0	0	0
28	14/12/2021	LAT	41G9	26	117	-9	56°18.0	19°31.5	56°18.0	19°31.5	10:45	10:45	0	0	0	0	0	0	0	0
29	14/12/2021	LAT	41G9	26	103	-9	56°12.1	19°27.6	56°12.1	19°27.6	12:10	12:10	0	0	0	0	0	0	0	0

44

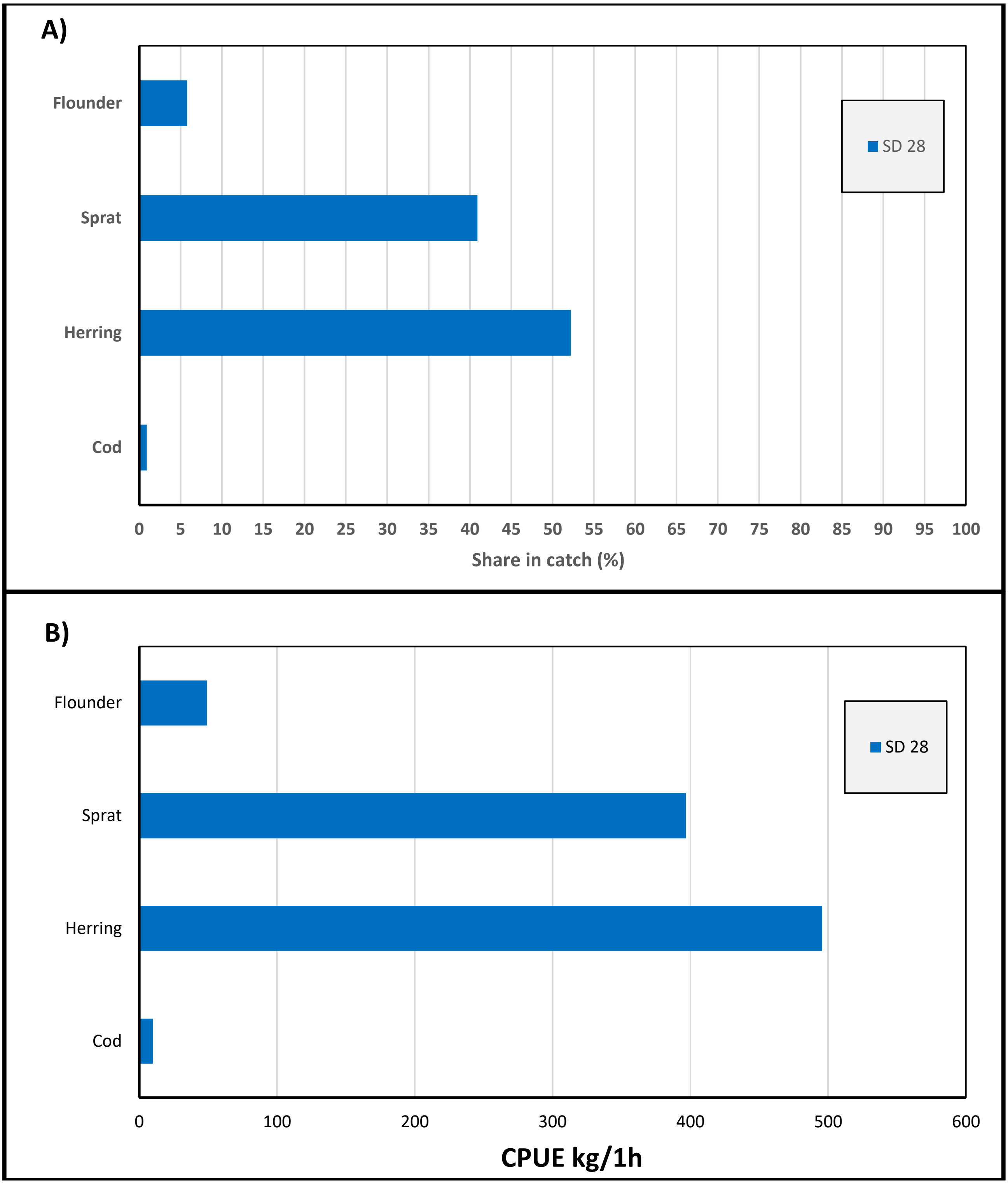


Fig. 2A. Mean share in mass of control hauls (A), and mean CPUE (B) of dominant fish species in
catches conducted during the BITS 4Q survey; r.v. "Baltica" (08-18 December 2021).

Table 2. Numbers of fish biologically analysed during the BITS 4Q survey; r.v. "Baltica" (08-18 December 2021).

Species	**Number of samples**			**Number of fish**								
				measured			**analyzed**			**stomach samples**		
	SD 26	**SD 28**	**Total**	**SD 26**	**SD 28**	**Total**	**SD 26**	**SD 28**	**Total**	**SD 26**	**SD 28**	**Total**
Cod	1	12	13	0	99	99	2	123	125	2	123	125
Flounder	0	13	13	0	995	995	0	270	270			
Herring	1	14	15	4	1467	1471						
Sprat	0	14	14	0	1343	1343						
Eelpout	0	1	1	0	2	2						
Smelt	0	3	3	0	4	4						
Three-spined Stickleback	0	4	4	0	12	12						
Lumpfish	0	1	1	0	1	1						
Sea Scorpion	0	8	8	0	30	30						
Twaite Shad	0	2	2	0	28	28						
Anchovy	0	2	2	0	5	5						
Total	2	74	76	4	3986	3990	2	393	395	2	123	125

Fig. 3. Length frequency of cod from Sub-Division 28 in the control catches during the r/v "Baltica" BITS survey, 08-18 December 2021

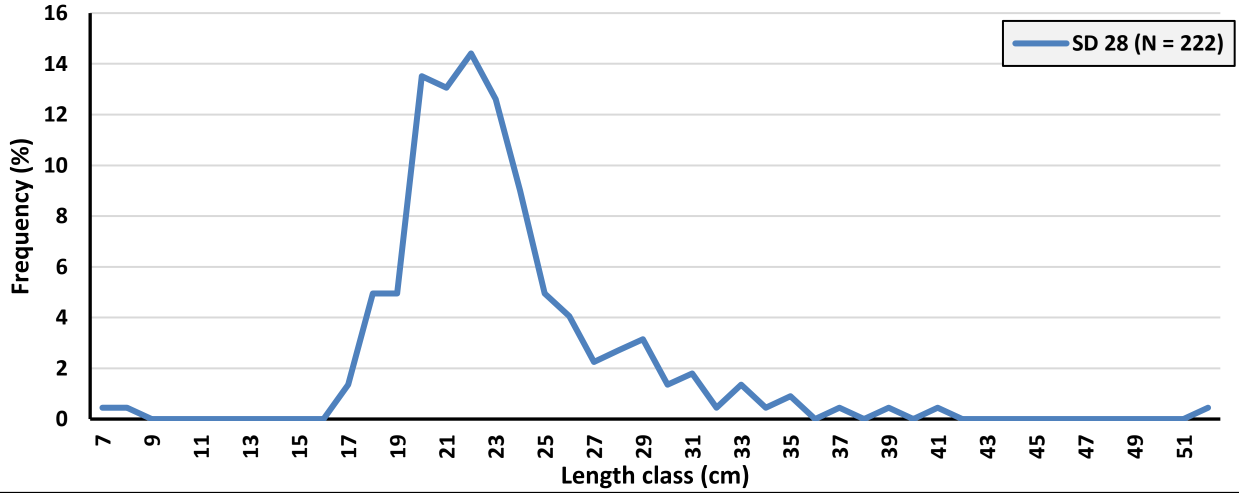


Fig. 4. Length frequency of flounder from Sub-Division 28 in the control catches during the r/v "Baltica" BITS survey, 08-18 December 2021

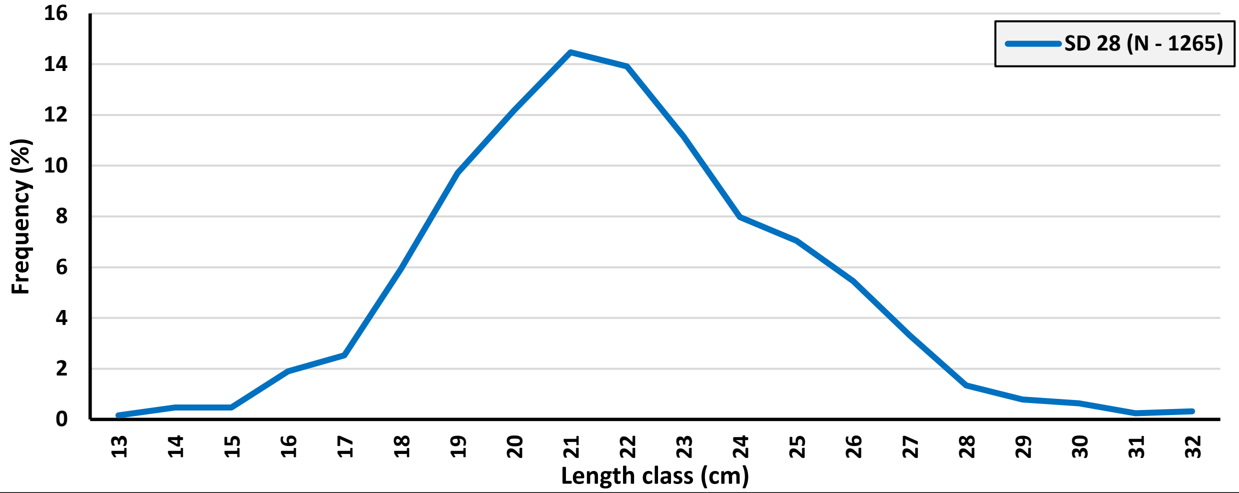


Fig. 5. Length frequency of herring from Sub-Division 28 in the control catches during the r/v "Baltica" BITS survey, 08-18 December 2021

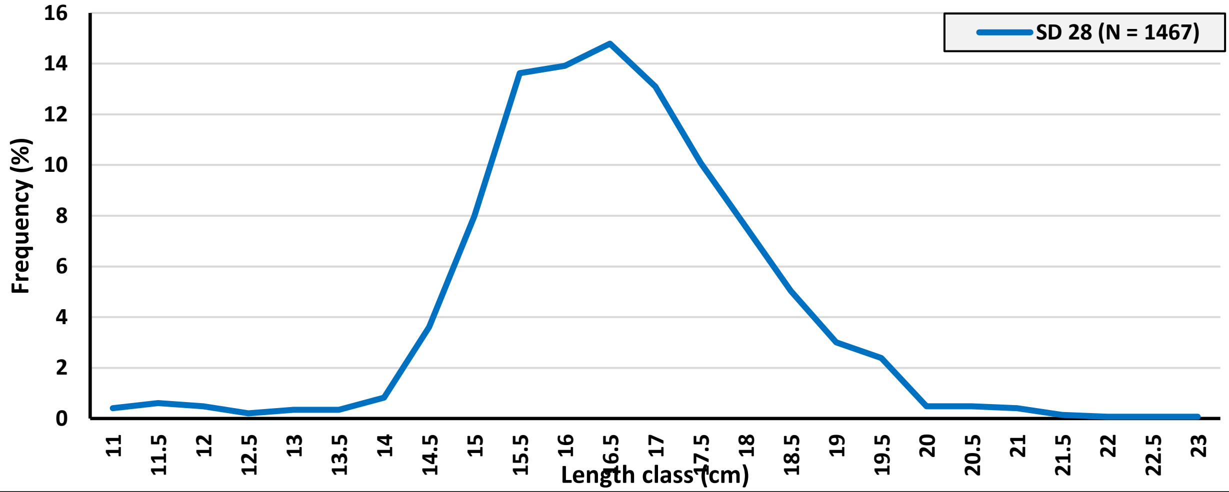
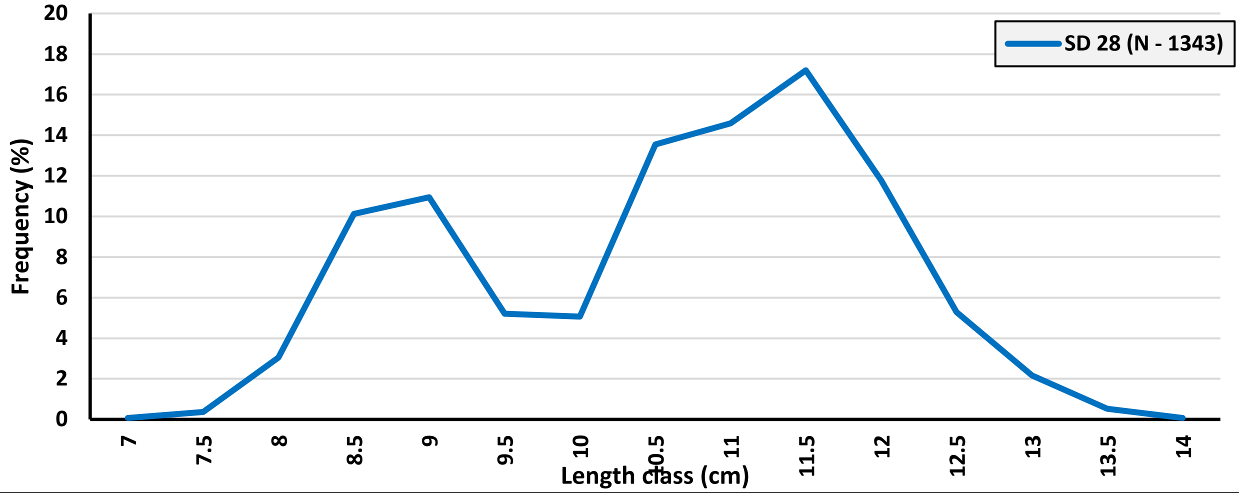


Fig. 6. Length frequency of sprat from Sub-Division 28 in the control catches during the r/v "Baltica" BITS survey, 08-18 December 2021



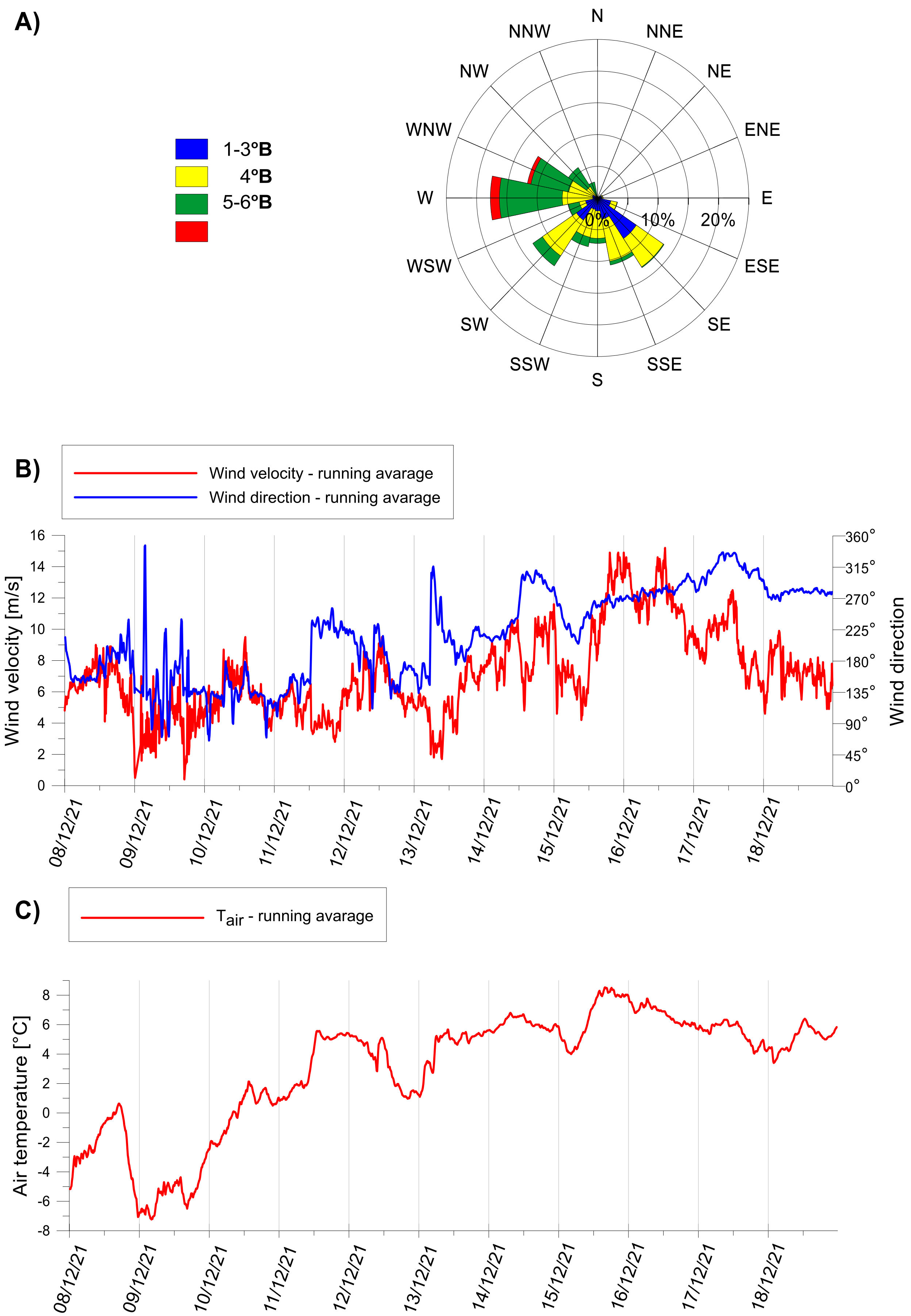
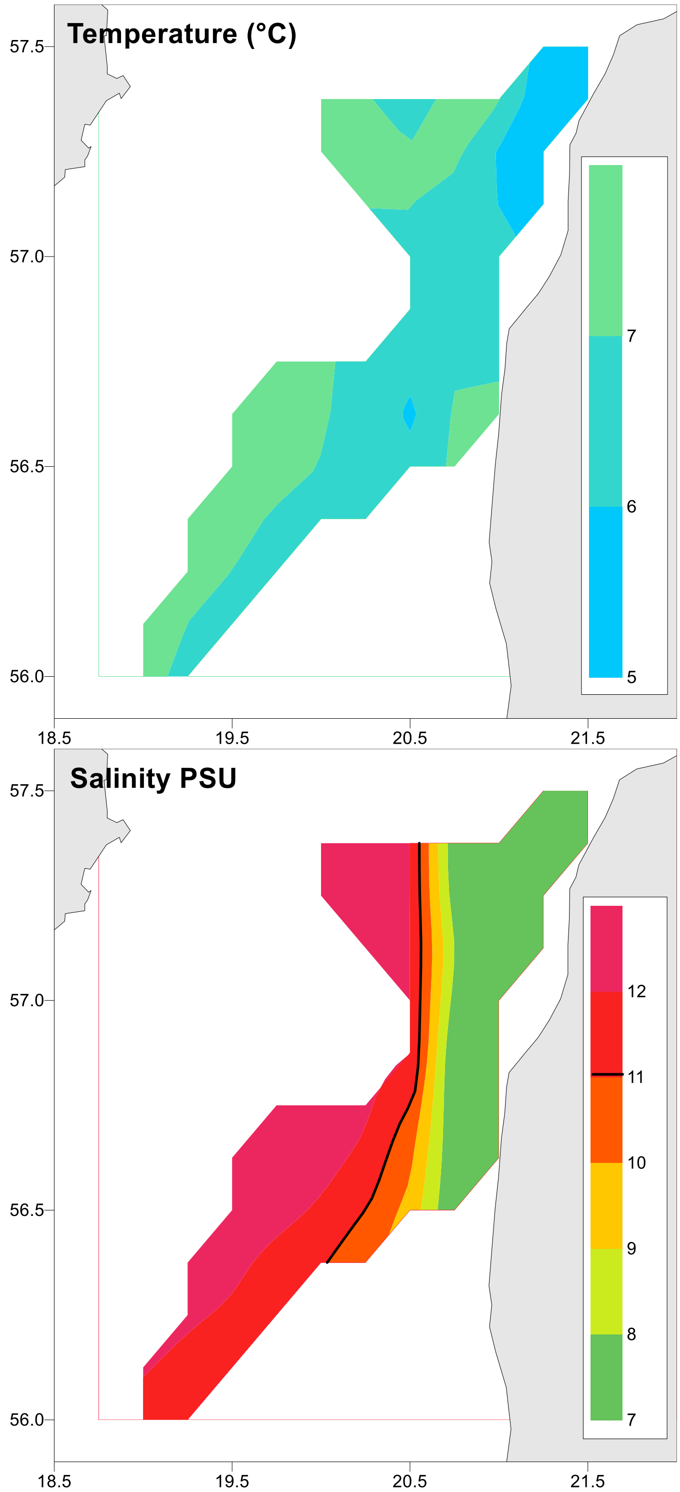


Figure 7. Changes of the main meteorological parameters (December 2021)


Temperature (°C)
57.5
57.0
56.5
56.0
18.5
19.5
20.5
21.5
7
6
5
Salinity PSU
12
11
10
9
8
7

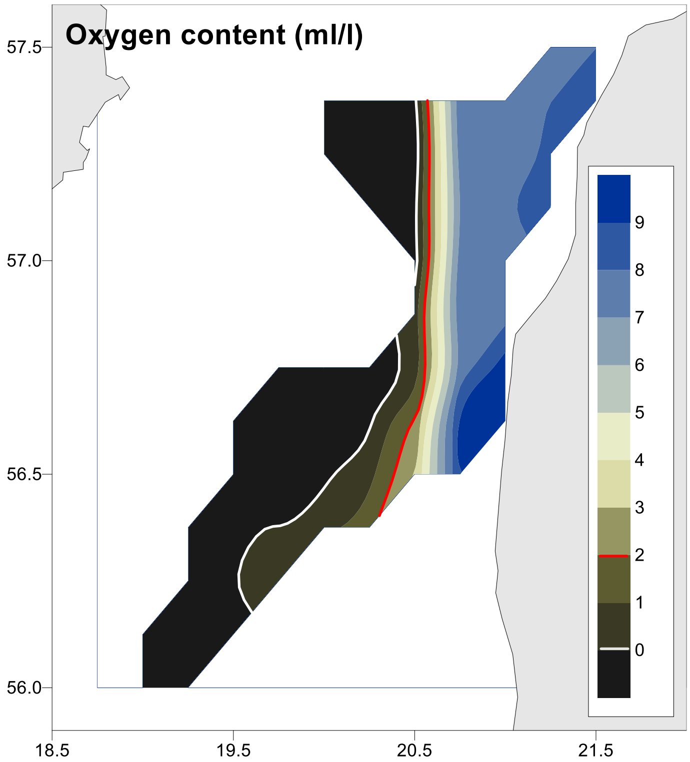


Figure 8. Distribution of the seawater temperature, salinity and oxygen content in the near bottom waters (December 2021)

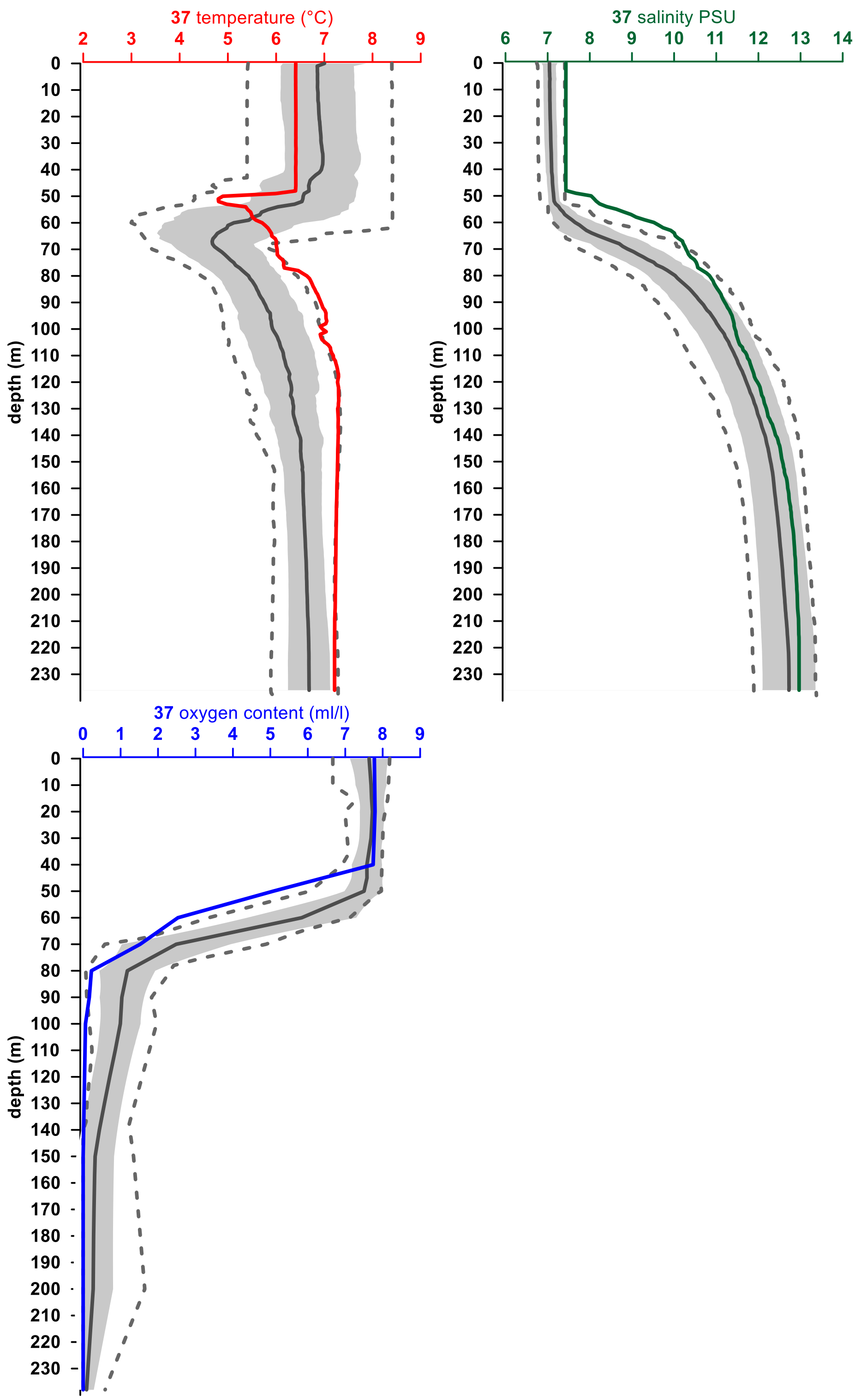


Figure 9. Comparison of the profiles of temperature, salinity and dissolved oxygen in water at the hydrological station 37. Black lines - long-term average 2010/2020, dashed line - maximum and minimum measurements 2010/2020.

Table 3. Cod length measurements by consecutive hauls in the r/v "Baltica" Latvian - Polish BITS survey (08-18 December 2021); specimens grouped by 1 cm length classes.

		cm_group																										
Haul no	SD	4	6	7	8	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	37	39	41	52	Sum
1	28						1	2	4	5	5	6	7	4	5	3	3	1		2		1				1			50
2	28				1	2	4	7	16	13	17	13	9	4	3		1	2	1			2							95
3	28						2	1		2		2	2	1						1	1		1						13
4	28			1							1							1											3
5	28							1	2	1		1		1														1	7
6	28					1	3		3	4	7	5	2	1			1	2	1	1				1					32
7	28						1		2	2	1					2									1				9
8	28										1								1					1					3
10	28								1																				1
14	28								1	1																	1		3
16	28								1			1			1		1	1											5
18	28									1																			1
22	26	1	1																										2
SD 26		1	1																										2
SD 28				1	1	3	11	11	30	29	32	28	20	11	9	5	6	7	3	4	1	3	1	2	1	1	1	1	222
Total		1	1	1	1	3	11	11	30	29	32	28	20	11	9	5	6	7	3	4	1	3	1	2	1	1	1	1	224

Table 4. Flounder length measurements by consecutive hauls in the r/v "Baltica" Latvian - Polish BITS survey (08-18 December 2021); specimens grouped by 1 cm length classes.

		cm_group																			
Haul no	SD	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Sum
1	28				1	1	2	7	19	17	20	15	15	9	10	3		2	1		1	123
2	28			1		1	10	11	20	31	37	26	22	18	14	10	2		1		1	205
3	28				2	2	10	12	16	27	21	17	13	14	14	7	1	3				159
4	28		1	1	2	4	9	30	30	37	29	20	12	15	4	4	3	1	1		1	204
5	28				1			1	1	3		2	2		1							11
6	28			1	3	3	8	18	15	11	12	10	9	6	3	6	1	2	2			110
7	28					2	1	1	4	2	3	6	3	3	3		2			1		31
8	28		4	2	7	12	17	25	17	21	23	13	11	9	11	4	3	1				180
9	28	1			4	4	9	9	12	15	9	13	3	4	2	4	2		1			92
10	28									1		1		1	1							4
16	28								1		2								1		1	5
17	28	1	1	1	4	3	9	9	19	18	20	17	11	10	6	3	3		1	2		138
18	28											1				1		1				3
Total		2	6	6	24	32	75	123	154	183	176	141	101	89	69	42	17	10	8	3	4	1265

Table 5. Herring length measurements by consecutive hauls in the r/v “Baltica” Latvian - Polish BITS survey (08-18 December 2021); specimens grouped by 0.5 cm length classes.

		cm_group																									
Haul no	SD	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	23	Sum
1	28	1	4	1				4	6	7	16	20	8	16	12	4	4	2			1						106
2	28			1	1	1		1	4	6	8	16	12	18	11	9	8	3	5		1						105
3	28			4	2	3	2	2	5	8	19	15	11	12	9	1	3	3	3	1	2						105
4	28	3	2	1		1		1	5	7	17	16	16	10	4	9	5	2	2	2	1		1				105
5	28	1	2						4	6	18	12	16	12	16	6	6	4	2								105
6	28								2	5	12	16	20	16	14	9	7	4									105
7	28							1	4	11	17	14	12	3	14	10	6	1	6	1			1				101
8	28	1					1		7	23	19	21	3	18	3	5	1	1	2								105
9	28		1						6	13	26	20	12	9	3	8	3	1	1			1			1		105
10	28						1	1	3	9	11	15	26	17	8	8	1	4		1							105
14	28								5	9	11	9	16	10	17	12	7	5	1		1	1				1	105
16	28						1		1	3	8	7	20	13	14	9	12	6	9		1	1					105
17	28							1	1	2	10	11	21	21	13	9	6	4	2	1		3					105
18	28							1		8	8	12	24	17	10	12	5	4	2	1				1			105
22	26											1		2	1												4
SD 26												1		2	1												4
SD 28		6	9	7	3	5	5	12	53	117	200	204	217	192	148	111	74	44	35	7	7	6	2	1	1	1	1467
Total		6	9	7	3	5	5	12	53	117	200	205	217	194	149	111	74	44	35	7	7	6	2	1	1	1	1471

Table 6. Sprat length measurements by consecutive hauls in the r/v “Baltica” Latvian - Polish BITS survey (08-18 December 2021); specimens grouped by 0.5 cm length classes.

		cm_group														
Haul no	SD	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	Sum
1	28				9	16	9	10	15	16	19	8	2	1			105
2	28				6	13	10	8	17	22	17	6	3	3			105
3	28				21	30	14	9	9	11	8	2	1				105
4	28			7	25	21	8	5	9	10	5	9	4	1	1		105
5	28			1	15	7	3	4	18	16	20	12	8	1			105
6	28			3	9	8	7	6	21	13	17	17	4				105
7	28				1		2	3	17	25	31	17	6	3			105
8	28	1	4	22	36	12	6	2	3	5	6	4		3	1		105
9	28			5	4	4	1			1	11	15	11	9	5	1	67
10	28				1	11	4	5	21	15	19	21	5	3			105
14	28				2	4		5	12	21	33	21	5	2			105
16	28			2	4	14	5	2	19	24	16	11	8				105
17	28		1	1	1	3			4	2	1	2	1				16
18	28				2	4	1	9	17	15	28	13	13	3			105
Total		1	5	41	136	147	70	68	182	196	231	158	71	29	7	1	1343

Working Document
ICES Baltic International Fish Survey
Working Group
Meeting on-line, 4-6.04.2022

RESEARCH REPORT
FROM THE POLISH R/V BALTICA BITS Q4 2021 SURVEY
IN THE SOUTHERN BALTIC
(12 November - 01 December 2021)

by

Krzysztof Radtke and Tycjan Wodzinowski

Gdynia, 5 January 2022

INTRODUCTION

Since 1995, the permanent participation of Polish R/V Baltica operated by the National Marine Fisheries Research Institute (NMFRI) in Gdynia, has taken place in autumn and winter Baltic International Trawl Surveys (BITS-Q4 and BITS-Q1) realised in the southern Baltic. In March 2000 when the research standard fishing gear in the Baltic Sea - the cod bottom trawl type TV-3, has been applied by the vessels assigned to the BITS surveys realization, the principal methods of investigations within BITS-Q4 ground-trawl surveys designated to particular national laboratories, including the NMFRI were designed and co-ordinated by the Baltic International Fish Survey Working Group (WGBIFS; ICES 2021). The main aim of the BITS-Q4 survey planned in autumn 2021 was to monitor abundance and spatial distribution of the main demersal fish species and to some extent also clupeids in the bottom zone of the Baltic, taking into account hydrological parameters. The R/V Baltica BITS-Q4 2021 survey, which was realized in the Polish part of the ICES Sub-divisions 25 and 26 and Swedish as well as Lithuanian part of the ICES Sub-division 26, was aimed at:

- determination of the spatial distribution of cod, flounder, herring and sprat in the near bottom zone of the southern and central Baltic during autumn 2021 applying method of
- random selection of research hauls, estimation of the fishing efficiency, i.e. catch per unit effort (CPUE), the share of particular species in total mass of bottom research catches,
- collecting biological samples of dominated fish for the determination of the age-length-mass relationship, sex, sexual maturation, feeding conditions and externally visible diseases analysis of the vertical and horizontal changes of the basic hydrological parameters (temperature, salinity, oxygen content) in the areas of fish catches and in neighbouring standard hydrological stations,
- collect and identify the abundance of marine litter present in the fishing hauls.

MATERIAL AND METHODS

The above purposes of the November/December BITS Q4 2021 cruise aboard of R/V Baltica were realized by the NMFRI nine members of scientific team, with Krzysztof Radtke as a cruise leader. The scientific team was composed of seven ichthyologists including technicians, responsible for determination of fish species composition of catches, fish biological analyses and data processing and one hydrologist, responsible for seawater sampling and analysing as well as for meteorological monitoring.

Narrative

The reported Polish ground-trawl survey on board of R/V Baltica, marked with the number 21/2021/MIR took place during the period of 12.11-01.12. 2021 within the framework of the ICES Baltic International Trawl Surveys (BITS) long-term programme (ICES 2021) and the Polish Fisheries Data Collection Programme for 2021. The vessel left the port of Gdynia on 12.11.2021 in the morning and during the same day, the at sea investigations began in the Bay of Gdańsk in the Polish EEZ (Fig. 1, Tab. 2). During the period of 22-24.11.2021 and on 27.11. 2021, the investigations were conducted in Swedish waters, while on 24.11.2021 the vessel operated in Lithuanian EEZ. The survey ended on 01.12.2021 in the morning in Gdynia harbour. The R/V Baltica operated mostly in the Polish EEZ. Overall, 20 days were utilized for fulfilling the BITS Q4 2021 survey, including one day spent at heavy weather conditions and including time spent for the vessel translocation from the Gdynia port to research area and in the final phase of the survey, a return way to the vessel home-port.

Survey design and realization – sampling description

According to the WGBIFS plan, the Polish vessel was recommended to cover during BITS Q4 2021 survey, the Polish part of ICES Sub-divisions 25 and 26 with 9 and 43, respectively randomly selected bottom research hauls, and also in the Swedish EEZ to cover Swedish part of ICES Sub-division 26 with 10 research hauls as well as in the Lithuanian EEZ in the ICES Sub-division 26 to conduct two research hauls. The R/V Baltica realized 64 of the 64 planned hauls for this survey. In total, 5 hauls were not realized due to oxygen level near the bottom below 0.5 ml/l (Tab. 2). The hauls were classified as „No oxygen" and the catch result was considered as „zero catch haul". Finally, it can be concluded that the hauls realized during the survey corresponded to the plan and could be therefore accepted as fully representative from the technical point of view (Fig. 1, Tab. 2) taking into account gear performance during hauls.

Trawling was done with the standard rigging- ground trawl type TV-3#930 (without bobbins and additional chains connected to the footrope), with 10-mm mesh bar length in the codend. A standard vertical fish-sounder was used to monitor the trawling depth. Usually a 6-7 m vertical net opening was achieved, which was monitored by the net echosounder. The catch stations were located on the depth range from 20 to 121 m (including no-oxygen hauls). Fish research hauls were conducted at the daylight only, lasting maximum 30 minutes, at approximately 3.0 knots vessel speed.

Each research catch was sorted out for the determination of the fish species composition. Mean CPUE of each fish species and their average share in mass of catches was calculated. From each catch station, representative samples of dominated fishes were collected to determine age-length-mass relationships, sex, sexual maturation, feeding conditions, externally visible diseases and additionally stomach samples for food composition estimation of cod were collected for further examinations in the Institute. The length of all the fish species represented in the catches was determined.

In the case of cod, turbot and plaice all the caught specimens were taken for total length and mass measurements. In the case of clupeids and flounder, the representative sub-samples of these fish species were investigated. Overall, 6062 cod, 3516 flounder, 163 plaice, 13 turbot, 6667 sprat and 8178 herring were taken for the length and mass determination. In total, 318, 564, 161, 13, 598 and 1003 individuals of the above-mentioned species were aged. Biological analyses of fishes were performed directly on board of surveying vessel, according to standard methodological procedures. The length of 35 cm, 23 cm (ICES SD 25) and 21 cm (ICES SD 26), 16 cm and 10 cm was taken into account as a separation (protective) length between juvenile and commercial size of cod, flounder (differed by the ICES Sub-divisions), herring and sprat, respectively.

Externally visible diseases of fish's skin and their vertebral column anomalies were monitored for 6062 cod, 3516 flounder, 6667 sprat and 8178 herring. Data on pathological symptoms were registered based on the visual inspection of fish taken for length measurements.

Every research haul was preceded by the measurements of basic hydrological parameters continuously from the sea surface to the bottom. Overall, 89 hydrological stations (including hydrographic standard stations) were inspected with the automatic CTD probe SeaBird 911 combined with the rosette sampler (the bathometer rosette). Oxygen content was determined using the standard Winkler's method. The seawater temperature and salinity row data was aggregated to the 1-m depth stratum while oxygen content was aggregated to the 10-m intervals. Temperature, salinity and oxygen content was the source of information on abiotic factors potentially influencing fish spatial distribution. Distribution of all hydrological stations inspected by the R/V Baltica cruise conducted in November/December 2021 is presented in Figure 1.

RESULTS

Fish catches and biological data

Hauls no. 30-31, 40, 48 and 58 were not conducted due to oxygen defficiency (< 0.5 ml/l) observed in the near bottom zone (Tab. 2). Oxygen level below 0.5 ml indicates lack of fish occurrence. It is therefore assumed that fishing result would be “zero”, haul is not conducted and “zero” catch is accepted in catch calculations.

In total, twenty two different fish species were recognized in 64 scrutinized valid bottom catches (Tab. 2). Only European anchovy represented fish species permanently inhabiting Atlantic Ocean. The European anchovy was present in eight hauls in both of the ICES SDs.

The frequency of the most important commercial fish species occurrence in the hauls - herring, sprat, cod and flounder was - 91%, 81%, 69% and 63%, respectively (Tab. 2).

The average CPUE of cod in ICES SD 25 (31,6 kg/1h) was very similar to flounder average CPUE in the same ICES SD – 31,2 kg/1h. The CPUE of cod in ICES SD 25 was the highest among all the fish species exceeding considerably the average CPUE of herring (12.9 kg/1h) and in particular sprat – 3.1 kg/1h (Fig. 2). Whereas, CPUE of cod in ICES SD 26 (52.0 kg/1h) was the lowest, comparing the CPUE of sprat (734.3 kg/1h), herring (168.6 kg/1h) and flounder (58.4 kg/1h).

Higher CPUE of cod obtained in ICES SD 26 than in ICES SD 25 is explained by a low oxygen content in the near bottom zone observed in a large part of the ICES SD 26 (Fig. 7). The area of low oxygen content (below 2 ml/l and also below 0.5 ml/l) occupied extended areas during the described survey, and following that cod made quite dense concentrations on the slopes of the Hel Peninsula (patchy distribution), where oxygen concentration was suitable (Fig. 6). It resulted in higher cod CPUE in ICES SD 26. Similar hydrological situation was found during the same type survey conducted in autumn 2019 and also in 2020. The average CPUE of cod, in analogous survey in November/December 2020 r., was much higher (159.6 kg/1h) in ICES SD 25, while in ICES SD 26 in November/December 2020 it was slightly lower (49.6 kg/1h) than in November/December 2021.

The average CPUE of herring in ICES SD 26 was 168,6 kg/1h. Markedly lower CPUE of herring was obtained in ICES SDs 25 – 12,9 kg/1h. The average CPUEs of herring obtained in November 2020 were higher in ICES SDs 26 and 25 – 195.8 and 50.5 kg/1h, respectively.

The average CPUEs of sprat in ICES SDs 25 and 26 differed considerably and amounted to 3.1 and 734.3 kg/1h, respectively. In addition the CPUE of sprat in ICES SD 26 was the highest out of all the fish species in the cruise. However, in ICES SD 25, the average CPUE of sprat was the lowest as compared to the other three species CPUEs described in the report. In the same type of survey from November/December 2020 the CPUEs of sprat in ICES SD 25 was 12.3 kg/1h, while in ICES SD 26 the average CPUE of sprat was 640.9 kg/1h.

The average CPUE of flounder in ICES SDs 25 and 26 was 31.2 and 58.4 kg/1h, respectively. Flounder CPUEs are the third in row as compared to the other three fish species CPUEs described in the report. The average CPUEs of flounder in November/December 2020 cruise were also low in ICES SDs 25 and 26, amounting to 29.1 and 70.3 kg/1h, respectively.

Length distributions of the main fish species according to the ICES Sub-divisions are illustrated in Figure 3. The curves of cod length distributions for both of the ICES SDs were similar, like in November/December 2019 and also in 2020, what indicates for a very low cod length diversity inhabiting in the two ICES SDs, in the area of investigations. The length distribution clearly demonstrate a prevalence of cod from the length classes 25-41 cm in the ICES SD 25, while in the ICES SD 26 cod from length classes 22-24 dominated. The numerical share of the cod 25-41 cm and 22-24 was 96.8% and 96.5%, respectively. Cod smaller than 20 cm was very seldom represented in the hauls, and also the abundance of that size of cod was very low in the catches. The highest number of that size of cod was observed in ICES SD 26 – 37 individuals, while in the ICES SD 25, only one cod below 20 cm was represented. In the length distribution curves of cod in ICES SD 25 and SD 26 a singled peaks occurred which corresponded to the length classes 31 cm and 28 cm. The numerical share which corresponded to the above mentioned length classes was 12.4% and 9.6%, respectively.

Two herring length fractions in the length distribution curves from ICES SD 25 and 26 were clearly distinguished. In the ICES SD 25, the first fraction - small size herring (10.5-15.0 cm) and second fraction - larger ones (15.5-29.5 cm). In the ICES SD 26 the first fraction of small size herring (9.0-14.0 cm) and second fraction of larger ones (14.5-28.0 cm). The numerical share of the herring in the smaller fraction was higher in ICES SD 25 (30.7%) than in the ICES SD 26 – 11.4%. Sprat length distribution curves in both ICES SD 25 and SD 26 indicated that two sprat length fractions inhabited the ICES SDs, similarly as in the case of herring. In ICES SD 25 and in SD 26, the first length fraction - smaller size sprat was – 8.0-11.0 cm and 8.0-10.0 cm. The second length fraction - larger sprat in ICES SD 25 and in SD 26 was 11.5-16.0 cm and 10.5-15.0 cm, respectively. Smaller length fraction of sprat in both ICES SDs was much more numerous in the ICES SD 25 (58.5%) than in the ICES SD 26 – 6.9%. Sprat of more favourable length size for commercial fishery was observed in ICES SD 25, similarly like in the former BITS surveys.

Flounder length distributions indicated large differences of flounder size depending on the ICES SD they inhabited. In respect of flounder length distribution in ICES SD 26, a marked shift of the length distribution curve to the left along the horizontal axis was noted as compared to length distribution curve from ICES SD 25, what indicated that much higher share of smaller flounder inhabited ICES SD 26. Flounder length distribution in ICES SD 26 covered length range 11-39 cm, while in ICES SD 25 the length range was 19-37 cm. Two peaks in length distribution of flounder from ICES SD 25 were visible, having both the same numerical share of frequency – 11.6%, which corresponded to length classes 26 and 28 cm. A clearly distinguished single peak of frequency was visible in the length distribution of flounder from ICES SD 26. It represented frequency of 12.8% of the numerical share at the length of 23 cm.

Figure 4 shows the numerical shares of the undersized fish fractions of cod, herring, sprat and flounder. In cod catches from ICES SDs 25 and 26 the undersized fraction of cod prevailed. Their numerical share in the above-mentioned ICES SDs was significant - 79,0% and 83,9%, respectively. In the same cruise from November/December 2020, the share of undersized cod was smaller and amounted to 66.5% and 72.9%, respectively. The share of the undersized fraction of herring in ICES SD 25 and 26 amounted to 32.9% and 27.4%, respectively. The largest share of undersized sprat was observed in samples from ICES SD 26 (46.8%), while the share in ICES SD 25 was only 5.6%. Flounder undersized share was much higher in the ICES SD 26 (26.9%), than the share of undersized flounder in the ICES SD 25 –5.2%.

Mean length (l.t.) and mean mass of sprat, herring, cod and flounder calculated for the whole cruise and separately for ICES SDs 25 and 26 are presented in the text table below (in parenthesis are shown parameters from November/December 2020 cruise):

ICES Sub-division	para-meter	sprat	herring	cod	flounder
24	mean length [cm]				
25		11.2 (12.3)	18.0 (18.7)	32.0 (33.0)	28.1 (27.7)
26		11.9 (10.9)	17.5 (17.6)	30.4 (31.5)	23.1 (22.4)

whole cruise		11.9 (11.2)	17.6 (18.0)	30.5 (32.3)	23.7 (23.5)
24	mean mass [g]				
25		8.4 (11.0)	40.8 (43.2)	321.3 (343.3)	255.5 (242.7)
26		10.6 (8.2)	34.6 (34.1)	246.2 (287.3)	141.9 (131.8)
whole cruise		10.3 (8.8)	35.9 (37.3)	251.7 (317.1)	155.0 (154.7)

The measurement of the length of the main fish species was accompanied by a macroscopic analysis of the presence of symptoms of visible diseases of fish's skin. i.e. anatomopathological changes (Fig. 5). The highest prevalence of fish with externally visible pathological changes was recorded for flounder (7.0%) and for cod (0.7%). The share of cod with externally visible diseases was slightly higher (1.4%) in November/December 2021. The share of herring and sprat with observed pathological symptoms was very low and amounted to 0.21% and 0.03%, respectively in the whole area investigated.

Hydrological situation in the southern Baltic

In the near-bottom water layer (Fig. 6) temperatures in the range from 10.87°C to 4.85°C were noted. The lowest temperature was observed in the fishing haul no 37 at the depth of 52 m, while the highest in fishing haul no 7 at the depth of 30 m. The highest salinity was recorded in hydrological station no IBY5 (Bornholm Deep) (15.79 on the PSU scale). The station IBY5 is monitored permanently during BITS surveys in Bornholm Basin. The salinity measured at the deepest hydrological station in Słupsk Furrow (RS2 was 13.56 near the bottom. Salinity measured in Gdańsk Deep amounted to 11.86 in hydrological station (G2), while in Gotland Deep in Polish EEZ (Gt1) salinity was 11.02 on the PSU scale. At the deepest hydrological station in Gotland deep in the haul no 40 in Swedish EEZ the salinity near the bottom was 11.80 on the PSU scale. In that location no oxygen was observed. The hydrological situation with regard to oxygen content is generally considered as very unfavourable. The range of hypoxic waters was very extended (Fig 7). It is the third year in row since 2019, when large area of hypoxia is observed in autumn.

CONCLUSIONS

The data collected during Polish BITS-Q4 2021 cruise is considered as representative. taking into account the degree of the survey plan realization. Therefore the data can be used by the ICES Baltic International Fish Survey Working Group (WGBIFS) and the Baltic Fisheries Assessment Working Group (WGBFAS) for evaluation of fish species abundance and their distribution. The survey data collected during the survey is stored in the international DATRAS database publicly available and managed by the ICES Secretariat.

References:

References:

ICES. 2021. ICES Working Group on Baltic International Fish Survey (WGBIFS). ICES Scientific Reports. 3:80. 490 pp. https://doi.org/10.17895/ices.pub.8248

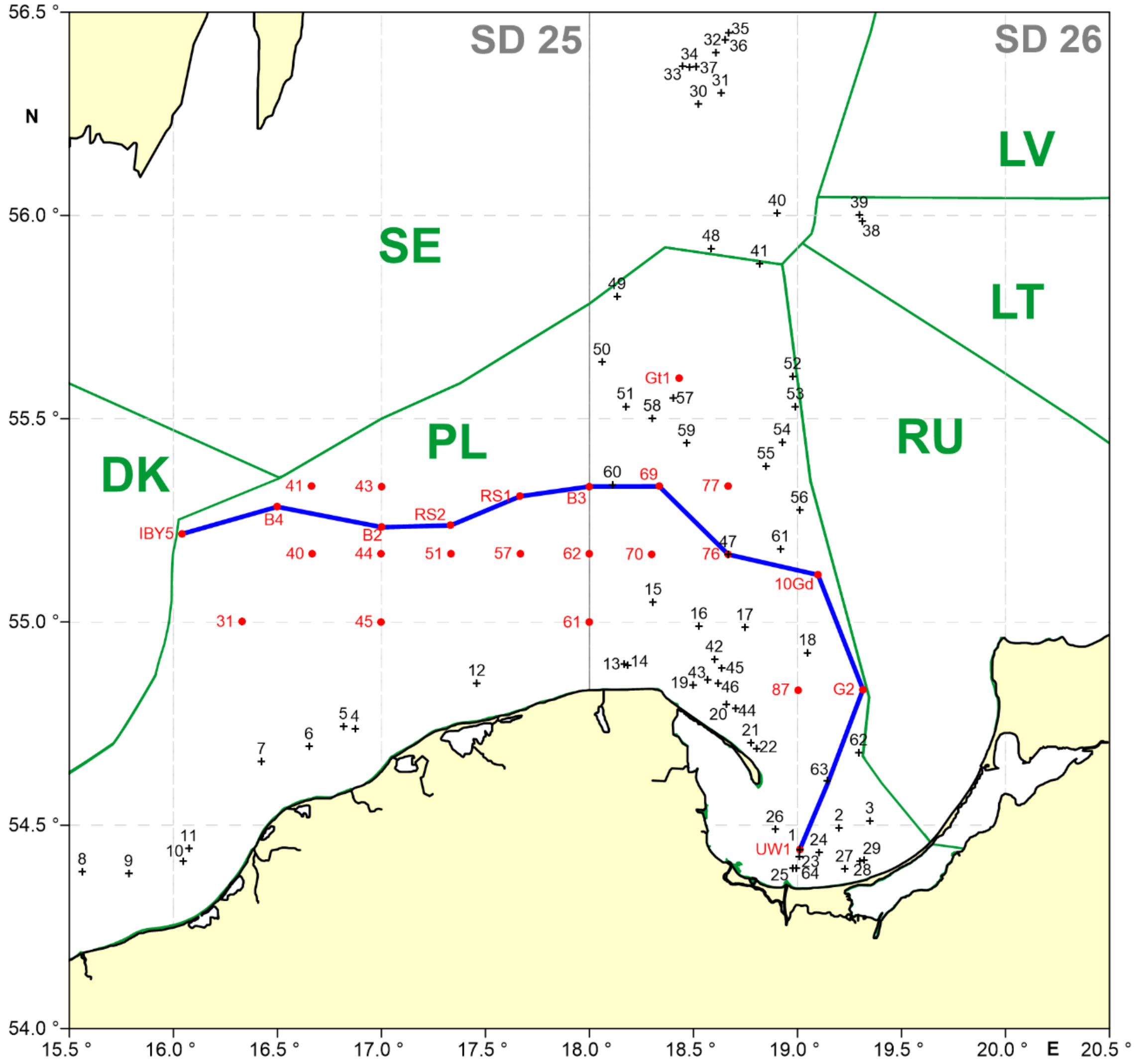


Fig. 1. Location of fish research hauls (black crosses) and hydrological standard stations (red dots) realised during the r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021). (blue solid line indicates hydrological research profile).

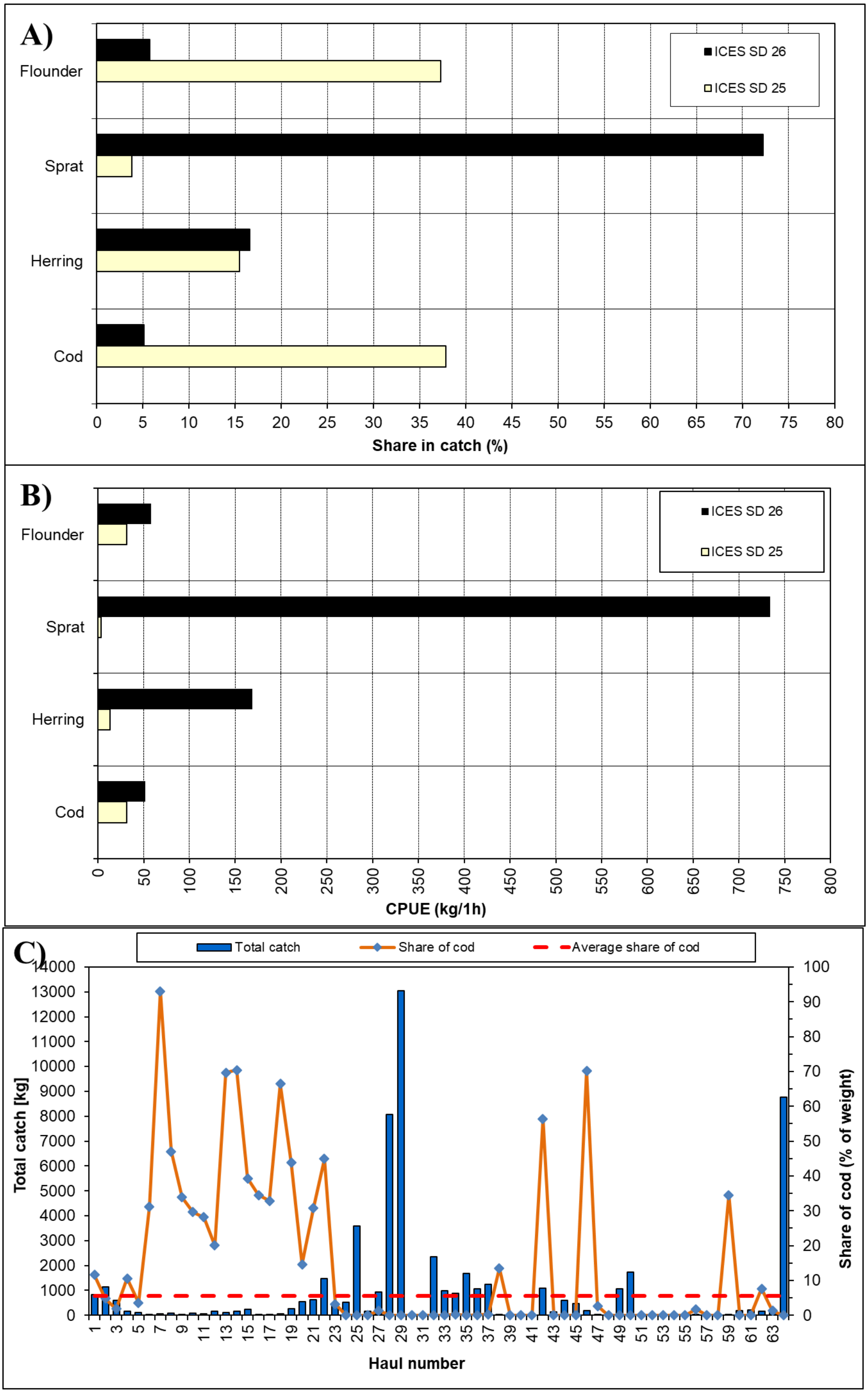


Fig. 2. Mean share in mass of research hauls (A). and mean CPUE (B) of dominant fish species. and share of cod (C) in particular catches conducted during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021).

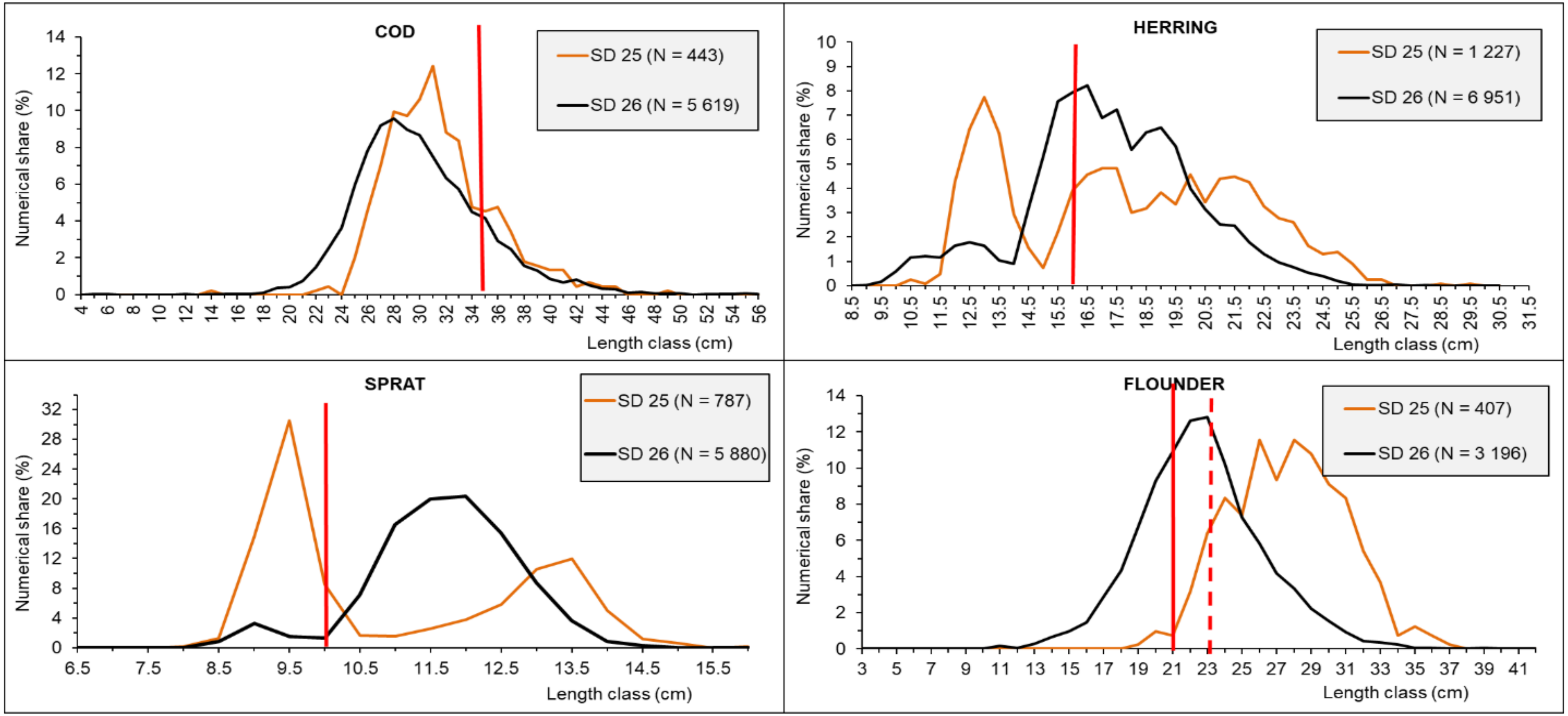


Fig. 3. Length distributions of cod. herring. sprat and flounder in samples from fish research hauls conducted during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021). (red vertical lines indicate minimum landing size).

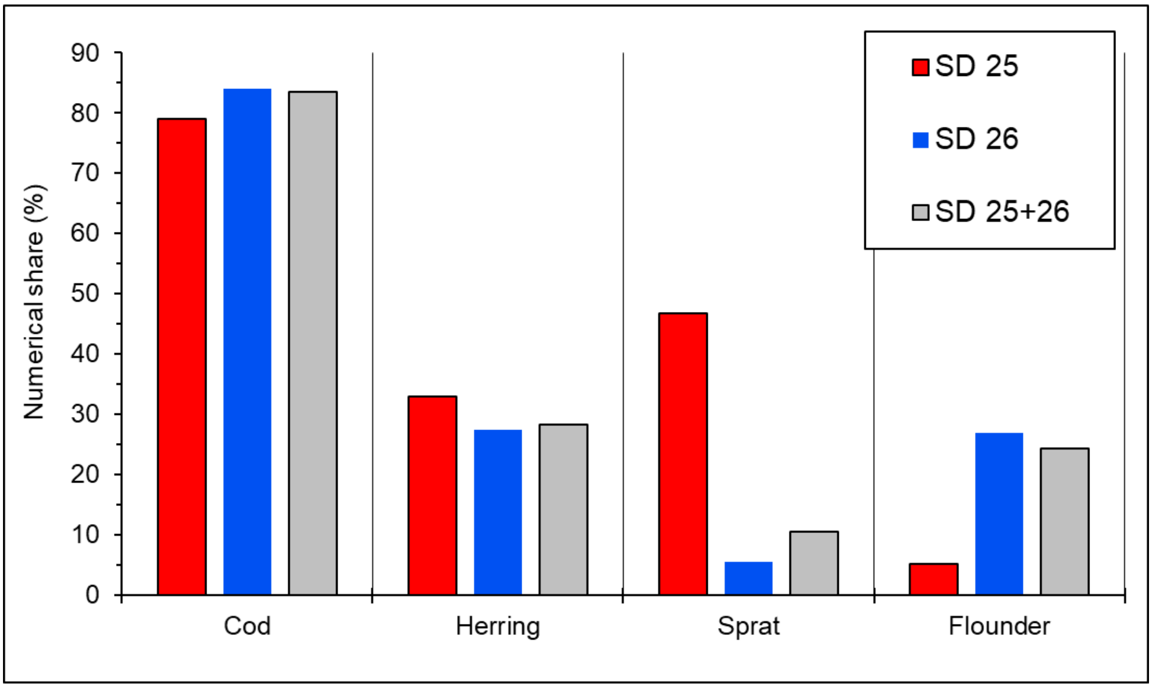


Fig. 4. Mean numerical share (in %) of undersized fish species in samples from fish research hauls conducted during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021).

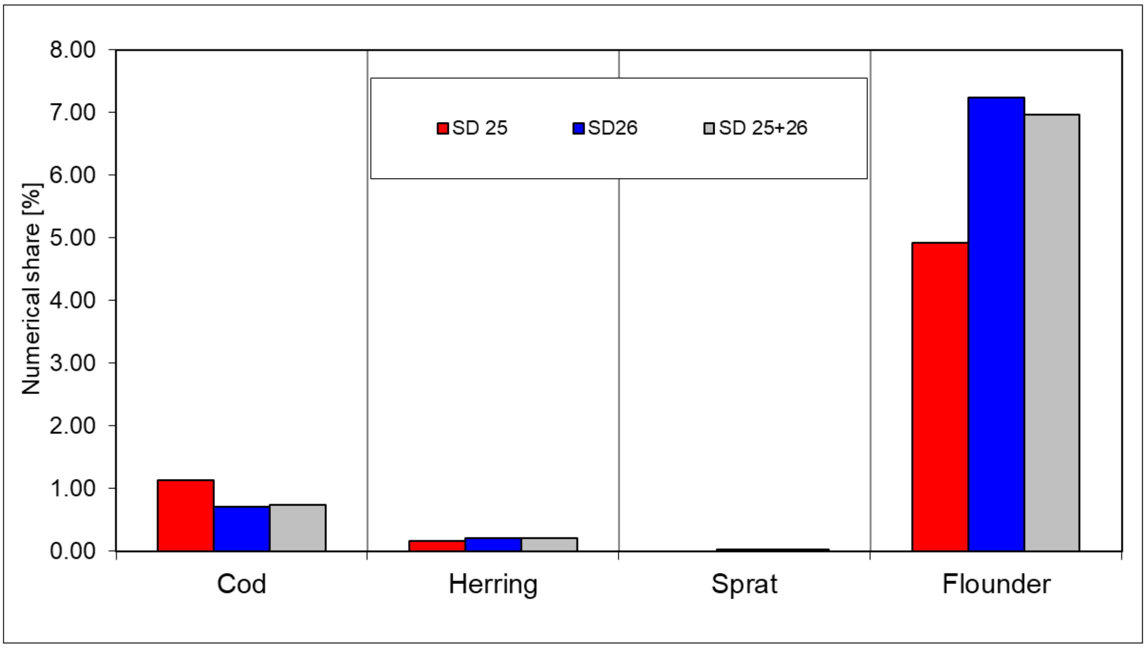


Fig. 5. Mean prevalence (in %-indiv.) of fish with externally visible diseases in samples from fish research hauls conducted during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021).

Tab. 1. Number of fish species individuals measured and aged during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021).

Species name	Number of fish mesured (l.t)			Numer of fish aged and weighed (g)		
	25 ICES Sub-division	26 ICES Sub-division	total	25 ICES Sub-division	26 ICES Sub-division	total
Cod	443	5619	6062	110	208	318
Baltic herring	1227	6951	8178	294	709	1003
Sprat	787	5880	6667	175	423	598
Flounder	407	3109	3516	205	359	564
Plaice	68	95	163	68	93	161
Eelpout	0	13	13	0	0	0
Fourbeard rockling	0	4	4	0	0	0
European perch	0	71	71	0	0	0
Three-spined stickleback	0	205	205	0	0	0
Short-horn scorpion	57	173	230	0	0	0
Round goby	0	2	2	0	0	0
Smelt	0	20	20	0	0	0
Twaite shad	3	233	236	0	0	0
Turbot	0	13	13	0	13	13
European anchovy	106	12	118	0	0	0
Greater sandeel	2	2	4	0	0	0
Lumpfish	0	3	3	0	0	0
Hooknose	1	0	1	0	0	0
Pike-perch	0	28	28	0	0	0
River lamprey	0	2	2	0	0	0
Whiting	3	2	5	3	2	5
Eel	0	1	1	0	0	0
TOTAL	**3104**	**22438**	**25542**	**855**	**1807**	**2662**

Tab. 2. Fish research hauls data obtained during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021) (**Hauls no. 1-32**)

Haul number according to survey order	Haul number according to ICES database	Catch date	ICES rectangle	ICES Sub-division	Trawling depth [m]	Geographical position of the catch-station: start/shoot latitude (N)	start/shoot longitude (E)	end latitude (N)	end longitude (E)	Time of shooting net	Time of hauling up net	Trawling duration [min]	Total catch [kg]	Weight of the catch by fish species [kg]: Cod	Baltic herring	Sprat	Flounder	Plaice	Eelpout	Fourbeard rockling	European perch	Three-spined stickleback	Short-horn scorpion	Round goby	Smelt	Twaite shad	Turbot	European anchovy	Greater sandeel	Lumpfish	Hooknose	Pike-perch	River lamprey	Whiting	Eel
1	26281	2021-11-12	37G9	26	56	54°26.4'	19°2.1'	54°26.4'	19°3.7'	10:37	10:57	20	279.198	8.820	101.837	83.188	73.220	2.346	0.500						0.314	8.345	0.150	0.041				0.267	0.170		
2	26218	2021-11-12	37G9	26	71	54°29.6'	19°13.4'	54°29.9'	19°14.9'	12:41	13:01	20	382.455	5.339	228.649	144.281	4.186																		
3	26211	2021-11-12	38G9	26	72	54°30.6'	19°20.9'	54°30.3'	19°18.6'	14:30	15:00	30	296.437	16.110	244.148	24.456	11.560	0.060			0.103														
4	25017	2021-11-13	38G6	25	28	54°44.4'	16°52'	54°43.8'	16°49.6'	07:35	08:05	30	77.287	48.630	14.677	0.681	11.851	1.144								0.013		0.012						0.279	
5	25016	2021-11-13	38G6	25	30	54°46.4'	16°51.7'	54°45.3'	16°50.3'	09:52	10:22	30	51.532	27.570	7.797	1.073	12.650	2.111					0.186			0.020		0.125							
6	25014	2021-11-13	38G6	25	29	54°41.5'	16°38.5'	54°41.1'	16°36'	11:54	12:24	30	17.976	5.459	5.731	3.431	2.432	0.080					0.084					0.759							
7	25013	2021-11-13	38G6	25	32	54°39.2'	16°24.8'	54°38.5'	16°22.5'	13:49	14:19	30	24.712	8.170	9.553	0.225	5.948	0.542										0.047						0.227	
8	25008	2021-11-14	37G5	25	30	54°23.1'	15°34.3'	54°23'	15°36.5'	07:33	08:03	30	35.290	1.870	9.770	2.110	14.624	3.233					3.060					0.601			0.022				
9	25009	2021-11-14	37G5	25	30	54°22.9'	15°46.1'	54°22.8'	15°43.2'	09:26	09:56	30	16.158	5.603	0.057		6.580	2.595					1.300					0.023							
10	25011	2021-11-14	37G6	25	26	54°24.6'	16°1.8'	54°24.3'	15°59.2'	12:07	12:37	30	44.636	23.000	0.820	6.300	13.090	0.761					0.626					0.020						0.019	
11	25010	2021-11-14	37G6	25	27	54°26.3'	16°3.5'	54°25.5'	16°1.1'	13:45	14:15	30	28.454	16.580	1.819	0.327	7.890	1.203					0.622					0.013							
12	25024	2021-11-16	38G7	25	23	54°51'	17°28.3'	54°51.1'	17°30.8'	07:31	08:01	30	80.245	5.466	7.936		65.270	1.214					0.310			0.017			0.032						
13	26274	2021-11-16	38G8	26	23	54°53.9'	18°10.9'	54°54.1'	18°13.5'	11:27	11:57	30	52.186	36.340	2.919	0.008	11.860	1.026								0.033									
14	26005	2021-11-16	38G8	26	23	54°53.8'	18°12.1'	54°54.1'	18°14.5'	13:03	13:33	30	84.762	59.630	8.582		14.660	1.414	0.430										0.046						
15	26182	2021-11-17	39G8	26	68	55°2.9'	18°20.1'	55°2.3'	18°22.3'	07:37	08:07	30	118.924	46.720	67.588	1.533	3.083																		
16	26268	2021-11-17	38G8	26	70	54°59.7'	18°30.7'	54°58.8'	18°32.6'	09:46	10:16	30	4.872	1.680	1.143	0.493	1.556																		
17	26086	2021-11-17	38G8	26	94	54°59'	18°46.2'	54°58.8'	18°46.8'	11:47	11:55	8	2.000	0.657	1.116	0.154		0.073																	
18	26257	2021-11-17	38G9	26	101	54°56.4'	19°2.8'	54°57.7'	19°2.5'	14:10	14:40	30	27.400	18.200	0.234	8.480	0.486																		
19	26266	2021-11-18	38G8	26	22	54°50.2'	18°30.7'	54°49.3'	18°31.7'	07:42	08:02	20	89.330	39.240	21.220	1.517	25.900		1.276							0.060		0.037	0.080						
20	26169	2021-11-18	38G8	26	32	54°47.2'	18°40.5'	54°45.9'	18°42.1'	09:22	09:52	30	279.432	40.850	96.425	1.517	137.710	1.439	0.290				1.086			0.115									
21	26133	2021-11-18	38G8	26	52	54°43.7'	18°45'	54°42.4'	18°46.4'	11:46	12:16	30	317.013	97.620	28.080	2.870	181.370	0.676	0.190	0.560			4.091			1.374	0.020	0.012						0.150	
22	26168	2021-11-18	38G8	26	66	54°40.6'	18°49'	54°39.3'	18°50'	14:06	14:36	30	731.275	328.660	67.649	0.770	333.580	0.301			0.127					0.188									
23	26264	2021-11-20	37G9	26	41	54°25.2'	19°1.8'	54°25.1'	19°3.5'	08:07	08:27	20	131.917	4.231	110.315	4.913	11.260	0.068					0.096		0.169	0.276	0.045	0.058				0.486			
24	26265	2021-11-20	37G9	26	49	54°26'	19°5'	54°26.1'	19°6.8'	09:31	09:51	20	169.653	1.919	114.422	23.156	25.480	0.171					0.707	0.030	1.899	1.583	0.054	0.167				0.065			
25	26263	2021-11-20	37G9	26	31	54°24'	19°1.2'	54°24.2'	19°2.9'	11:24	11:44	20	1193.103		15.547	1174.767	2.044	0.144					0.060				0.541								
26	26280	2021-11-20	37G8	26	62	54°28.7'	18°54.5'	54°27.9'	18°56'	13:29	13:49	20	53.288		33.260	0.139	18.740									0.150							0.117		0.882
27	26216	2021-11-21	37G9	26	32	54°23.7'	19°14.7'	54°24.1'	19°17.2'	07:57	08:27	30	472.557	6.652	92.726	287.578	82.340	0.592	0.645	0.039		0.013	1.516	0.013			0.288	0.155							
28	26217	2021-11-21	37G9	26	42	54°24.5'	19°14.7'	54°24.6'	19°15.6'	10:09	10:19	10	1345.479	1.136	13.047	1293.006	37.480	0.339		0.070			0.182				0.037					0.182			
29	26163	2021-11-21	37G9	26	41	54°24.7'	19°17.6'	54°24.7'	19°18'	11:51	11:56	5	1087.039	0.711	5.208	1070.720	9.950						0.417				0.033								
30	26124	2021-11-22	41G8	26	83	56°16.3'	18°31.4'			07:34				no oxygen -> haul not conducted																					
31	26141	2021-11-22	41G8	26	109	56°18'	18°37.9'			08:24				no oxygen -> haul not conducted																					
32	26125	2021-11-22	41G8	26	75	56°24.2'	18°36.6'	56°23'	18°35.2'	09:57	10:27	30	1175.685	0.265	509.606	665.814																			

Tab. 2. Fish research hauls data obtained during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021) (**Hauls no. 33-64**)

Haul number according to survey order	Haul number according to ICES database	Catch date	ICES rectangle	ICES Sub-division	Trawling depth [m]	Geographical position of the catch-station				Time of		Trawling duration [min]	Total catch [kg]	Weight of the catch by fish species [kg]																					
						start/shoot		end																											
						latitude (N)	longitude (E)	latitude (N)	longitude (E)	shooting net	hauling up net			Cod	Baltic herring	Sprat	Flounder	Plaice	Eelpout	Fourbeard rockling	European perch	Three-spined stickleback	Short-horn scorpion	Round goby	Smelt	Twaite shad	Turbot	European anchovy	Greater sandeel	Lumpfish	Hooknose	Pike-perch	River lamprey	Whiting	Eel
33	26224	2021-11-22	41G8	26	37	56°23.5'	18°28.5'	56°22.1'	18°27.3'	12:22	12:52	30	496.046		489.604	1.891	0.751						3.800												
34	26013	2021-11-22	41G8	26	44	56°23.5'	18°30.6'	56°22.2'	18°29.3'	14:20	14:50	30	434.749	1.014	412.559	6.658	3.238						11.280												
35	26077	2021-11-23	41G8	26	77	56°28'	18°40.9'	56°27.3'	18°40.3'	08:21	08:36	15	420.385		159.429	260.884						0.072													
36	26076	2021-11-23	41G8	26	75	56°27.6'	18°40'	56°26.8'	18°39.7'	09:56	10:11	15	263.631	0.188	100.894	162.433						0.116													
37	26032	2021-11-23	41G8	26	45	56°23.4'	18°30.7'	56°22.4'	18°30.1'	11:59	12:19	20	410.575	1.018	400.921	4.997	0.386					0.032	3.200			0.021									
38	26060	2021-11-24	40G9	26	73	55°59.2'	19°20.2'	55°59.3'	19°21.5'	07:44	07:59	15	6.665	0.904	2.769	0.119						2.808								0.065					
39	26122	2021-11-24	40G9	26	84	55°59.5'	19°15.6'	55°59.9'	19°17.3'	09:26	09:46	20	2.552		2.088	0.322						0.142													
40	26140	2021-11-24	41G8	26	121	56°0.3'	18°54.3'			12:05				no oxygen -> haul not conducted																					
41	26138	2021-11-24	40G8	26	114	55°53.5'	18°43.7'	55°53.3'	18°46'	14:20	14:50	30																							
42	26267	2021-11-25	38G8	26	48	54°54.7'	18°36.7'	54°53.4'	18°38.1'	07:56	08:26	30	539.825	304.620	34.127	35.523	163.360	1.723								0.472									
43	26007	2021-11-25	38G8	26	30	54°51.5'	18°34.7'	54°50.2'	18°36.4'	11:13	11:43	30	65.558	41.170	6.645	2.330	14.380	0.455					0.057			0.028		0.011		0.482					
44	26020	2021-11-25	38G8	26	46	54°46.7'	18°42.8'	54°45.2'	18°43.6'	12:49	13:19	30	293.589	139.020	35.500	8.040	106.821	1.605	0.977				1.170			0.139		0.017						0.300	
45	26019	2021-11-26	38G8	26	47	54°54.6'	18°36.3'	54°53.4'	18°38'	08:48	09:18	30	231.415	96.840	28.560		104.160	0.982	0.348				0.090			0.153				0.282					
46	26183	2021-11-26	38G8	26	31	54°51.8'	18°34.1'	54°50.6'	18°36'	11:11	11:41	30	91.936	64.540	9.561	0.121	17.410	0.158					0.115			0.031									
47	26093	2021-11-26	39G8	26	92	55°10.3'	18°41.6'	55°10.7'	18°43.1'	14:57	15:17	20	8.040	0.213	6.036	0.768	1.023																		
48	26221	2021-11-27	40G8	26	113	55°55'	18°35'			07:45				no oxygen -> haul not conducted																					
49	26055	2021-11-27	40G8	26	66	55°48.1'	18°6.9'	55°47.4'	18°5.6'	10:10	10:30	20	351.477		72.510	278.682						0.285													
50	26050	2021-11-27	40G8	26	72	55°38.8'	18°5.3'	55°38.3'	18°3.8'	12:23	12:43	20	578.212	0.061	14.453	563.698																			
51	26172	2021-11-27	40G8	26	82	55°31.7'	18°11.5'	55°31.6'	18°13.4'	14:20	14:40	20	3.103		2.831	0.268						0.004													
52	26290	2021-11-28	40G8	26	88	55°36.1'	18°58.7'	55°35.1'	18°58.9'	07:56	08:16	20	0.338		0.335							0.003													
53	26107	2021-11-28	40G8	26	88	55°31.3'	18°59.6'	55°30.3'	18°59.7'	09:24	09:44	20	5.642		0.949	4.688						0.005													
54	26106	2021-11-28	39G8	26	90	55°26.5'	18°54.7'	55°26.2'	18°53.1'	11:11	11:31	20	1.955		1.385	0.570																			
55	26105	2021-11-28	39G8	26	90	55°22.6'	18°50.1'	55°21.9'	18°49'	12:39	12:59	20	10.581	8.878	1.575	0.128																			
56	26045	2021-11-28	39G9	26	81	55°16.6'	19°1.6'	55°16.6'	19°3.3'	14:44	15:04	20	14.210	0.254	7.87	6.086																			
57	26212	2021-11-29	40G8	26	91	55°32.3'	18°24.9'	55°31.3'	18°25.5'	07:52	08:12	20	0.642		0.606							0.036													
58	26161	2021-11-29	39G8	26	88	55°29.9'	18°18.1'			09:15				no oxygen -> haul not conducted																					
59	26101	2021-11-29	39G8	26	87	55°25.8'	18°26.8'	55°25.1'	18°24.6'	10:41	11:11	30	15.911	5.493	9.69	0.721						0.007													
60	26046	2021-11-29	39G8	26	79	55°19.7'	18°7.2'	55°19.1'	18°8.2'	13:33	13:48	15	48.976		18.206	30.77																			
61	26094	2021-11-30	39G8	26	89	55°10.8'	18°56.7'	55°11'	18°58.3'	07:53	08:13	20	72.652		8.104	64.548																			
62	26191	2021-11-30	38G9	26	88	54°37.7'	19°18.6'	54°38.7'	19°18.3'	13:54	14:14	20	49.559	3.776	43.406	1.69	0.599				0.088														
63	26288	2021-12-1	38G9	26	85	54°36.8'	19°9.4'	54°37.2'	19°10.5'	07:48	08:03	15	44.579	0.554	33.641	10.119	0.124				0.141														
64	26219	2021-12-1	37G8	26	29	54°24'	18°59.6'	54°24.1'	18°59.9'	10:42	10:47	5	730.009		0.848	729.085	0.062										0.014								

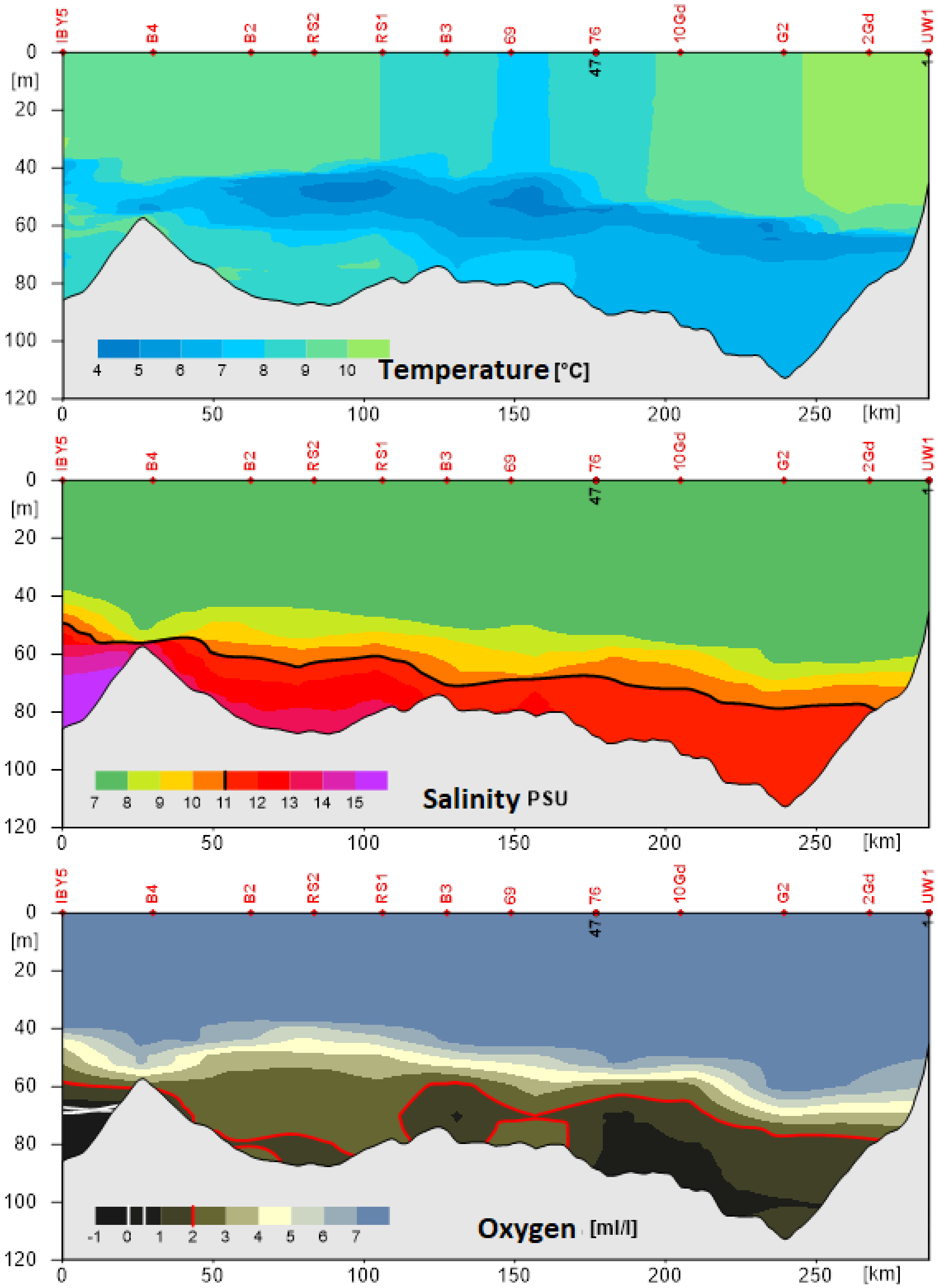


Fig. 6. Vertical distribution of the seawater temperature. salinity and oxygen content along the hydrological research profile during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021).

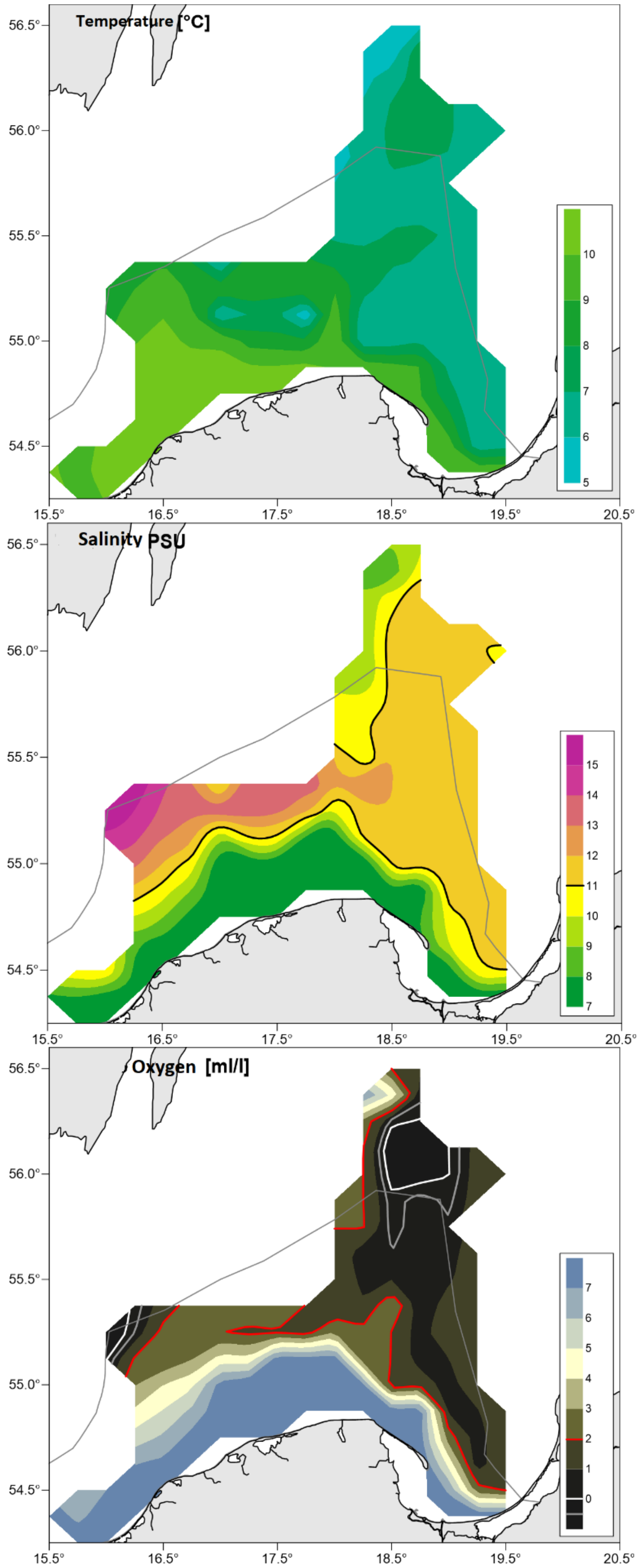


Fig. 7. Horizontal distribution of the seawater temperature. salinity and oxygen content in the near bottom layer during r/v Baltica BITS-Q4 cruise (12.11-01.12. 2021).

Lithuania BITS Q4 2021 report

Marijus Špėgys

1. INTRODUCTION

The cruise of the FV "LBB-1113" was part of the Baltic International Trawl Survey (BITS) which is coordinated by ICES WGBIFS. The main objective of the survey is the estimation of fishery independent stock indices of both Baltic cod stocks, of flounder and other flat fish.

The following further objectives were covered during the survey:

Collecting data for assessing stock indices, the structure and recruitment of the stocks especially for cod and flatfish.

Monitoring the composition of fish species in the South-Eastern Baltic Sea

Collecting length samples for all species.

Collecting samples of cod and flounder for biological investigations (i.e., sex, maturity, age).

Collecting litters from trawl.

2 METHODS

2.1 Personnel

Marijus Špegys, Marine research institute, Klaipeda University - cruise leader;
Žilvinas Kregždtys, Marine research institute, Klaipeda University –fish sampling.

2.2 Description

The cruise took place two days (03-04 November 2021). FV "LBB-1113" has covered the Sub-division 26 in Lithuanian EEZ.

2.3 Survey design and realization

The international coordinate trawl survey is planned as Stratified Random Survey where ICES subdivisions and depth layers are used as strata. A total of 6 stations were planned for the Lithuania part of the survey, which realize complete accordance with the agreements of WGBIFS during the meeting in 2017. The hauls' positions were selected from the TOW Database by the coordinator of the BITS surveys (ICES 2017, WGBIFS report as reference). All 6 fishing stations were successfully realized. The fishing hauls were realized in the daylight, between 8:15 and 16:50 local time.

Trawling was done with the standard trawl "TV3/520#". The stretched mesh size in the codend was 20 mm. The duration of the hauls was 30 minutes and the velocity was 3 knots. The total catch of each haul was analysed to determine the species' composition in weight and number as well as the distribution of length among all species. Sub-samples of cod, flounder were investigated concerning sex, maturity and age. Surface temperature and salinity were immediately sampled after every fishing hauls.

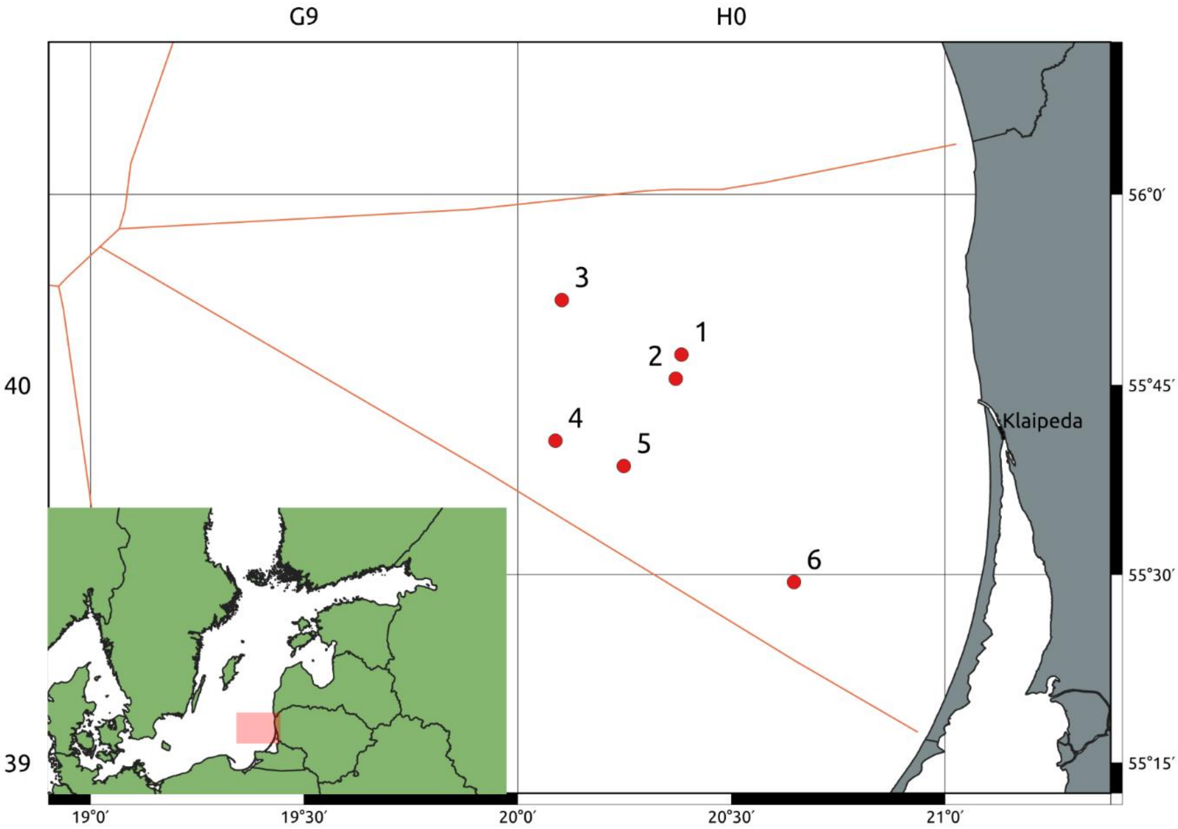


Figure 1. Trawl hauls position of F/V "LBB -1010" in BITS 2021 m. Q4 survey

The length measurements in the 1.0 cm classes was realised for cod, flounder and turbot, subsample were taken for biological analysis to laboratory. The length measurements in the 0.5 cm classes was realised of herring and sprat.

All information about haul and catches are shown in table 1 and table 2.

Table 1. Haul information from the Lithuania BITS Q4 survey with the TV3/520# bottom trawl

Haul number according to TD data	The ICES rectangle (subdivision)	Trawling depth (m)	Geographical position of catch station				Surface temperature	Surface salinity	Bot. Tempe-rature	Bot. salinity
			00.00 N	00.00 E	00.00 E	00.00 N				
26214	40H0 (26)	76	55.67	20.09	55.67	20.13	7,7	6,4	7,3	7,3
26193	40H0 (26)	72	55.65	20.25	55.66	20.28	6,6	6,7	7,3	7,3
26206	40H0 (26)	57	55.74	20.34	55.76	20.34	6,5	6,1	7,3	7,3
26205	40H0 (26)	53	55.77	20.34	55.75	20.37	7,0	6,8	7,3	7,3
26153	39H9 (26)	60	55.49	20.65	55.50	20.62	7,8	7,6	7,3	7,3
26052	40H0 (26)	62	55.50	20.61	55.49	20.65	8,0	7,2	7,3	7,3

Table 2 Fish catches results from the Lithuania BITS 2021 4Q survey with the TV3/520# bottom trawl

Haul number according to TD data	Catch date	The ICES rectangle (subdivision)	Trawling depth (m)	Total CPUE (kg/h)	CPUE per species (kg/h)					
					Cod	Flounder	Place	Turbot	Herring	Others
26214	2018-11-03	40H0(26)	76	52.7	8.4	4.6	0	0	8.4	31.3
26193	2018-11-03	40H0(26)	72	134.1	23.0	8.7	0	0	23	79.4
26206	2018-11-03	40H0(26)	57	75.9	9.5	32.8	0	0	9.5	24.1
26205	2018-11-03	40H0(26)	53	266.6	14.0	60.0	0	0.8	14	177.8
26153	2018-11-04	39H0(26)	60	456.2	21.6	360.0	0.1	0.6	21.6	52.3
26052	2018-11-04	40H0(26)	62	223.7	3.9	200.0	0	0	3.9	15.9
Mean					13.4	111.0	0.0	0.2	13.4	63.5

3. RESULTS

In total 791 cods, 711 flounders, 1 place, 2 turbot 969 herrings and 388 other species were collected for measuring and from that measurement sample 333 cods and 262 flounders 2 turbots and 1 place were collected for weight, sex, maturity and age. Numbers of biological samples by haul given in Table 3.

Cod from the length classes range of 24-36 dominated in samples. The fish with this length range constituted about 80.9% of all measured cod (Fig. 1). Moreover, 81.9% of all measured cods were undersized individuals (less than 35 cm).

The total length of flounder ranged from 16 to 36 cm, with dominating length classes of 20-30 cm. The fish with this length range constituted about 91.1% of all measured flounder.

The total length of herring ranged from 14 to 27 cm. Herring from the length classes of 15-21 cm was dominated in samples and constituted about 92.4% of all measured herring (Fig. 3).

The length distributions of cod, flounder, herring and sprat, according to the ICES Sub-divisions 26 are shown in Figures 1-3.

Table 3. Biological samples of all hauls from the Lithuania BITS 2021 Q4 survey

Haul number	Numbers of biological samples									
	Length						Age, sex, maturity			
	Cod	Flounder	Place	Turbot	Herring	Other	Cod	Flounder	Place	Turbot
1	55	9			84		55	9		
2	146	18			238	5	146	18		
3	77	71			156	37	41	71		
4	373	149		1	231	265	77	101		1
5	121	242	1	1	199	46	11	44	1	
6	19	222			61	35	19	20		
Sum	791	711	1	2	791	388	287	229		

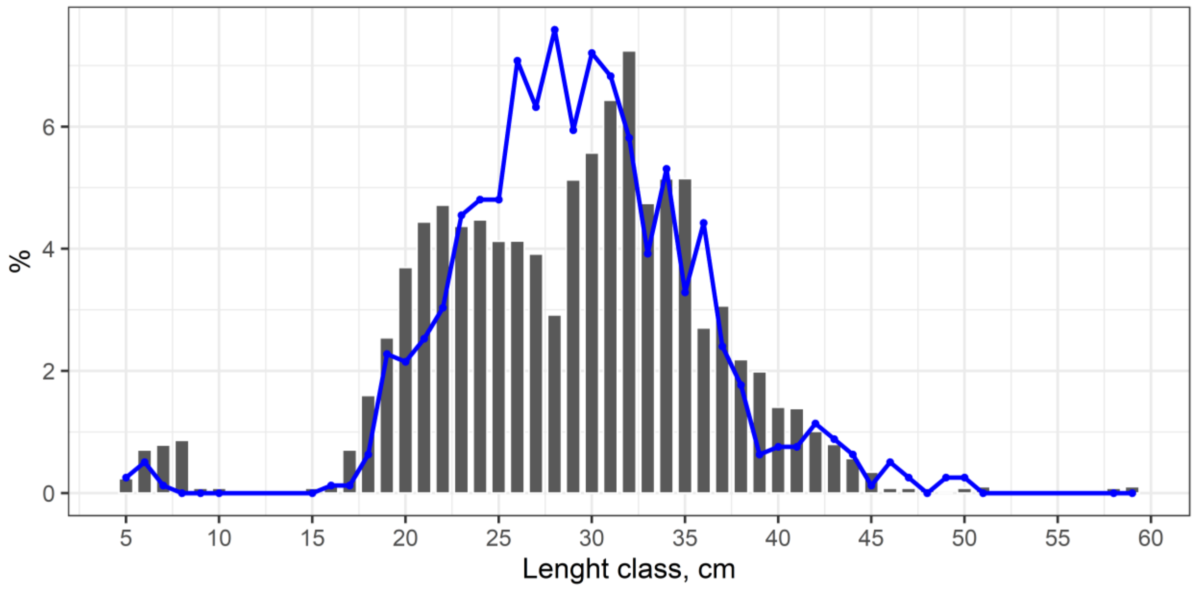


Figure 2. Cod length distribution from Lithuania BITS 2021 Q4 survey (line) and BITS 2020 Q4 (bars)

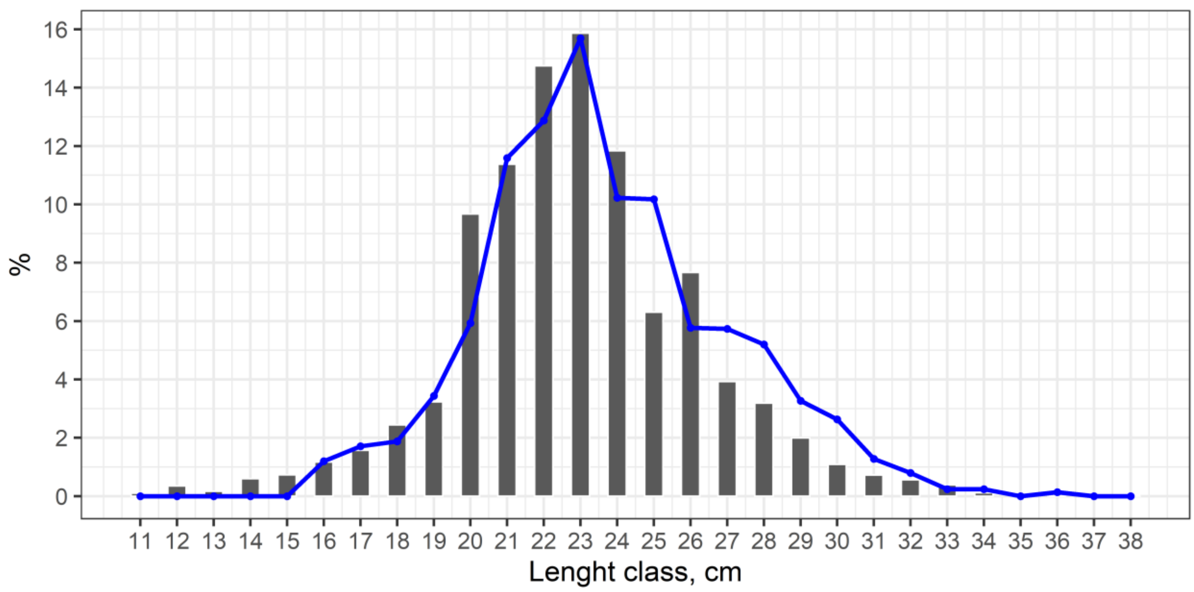


Figure 3. Flounder length distribution from Lithuania BITS 2021 Q4 survey (line) and BITS 2020 Q4 (bars)

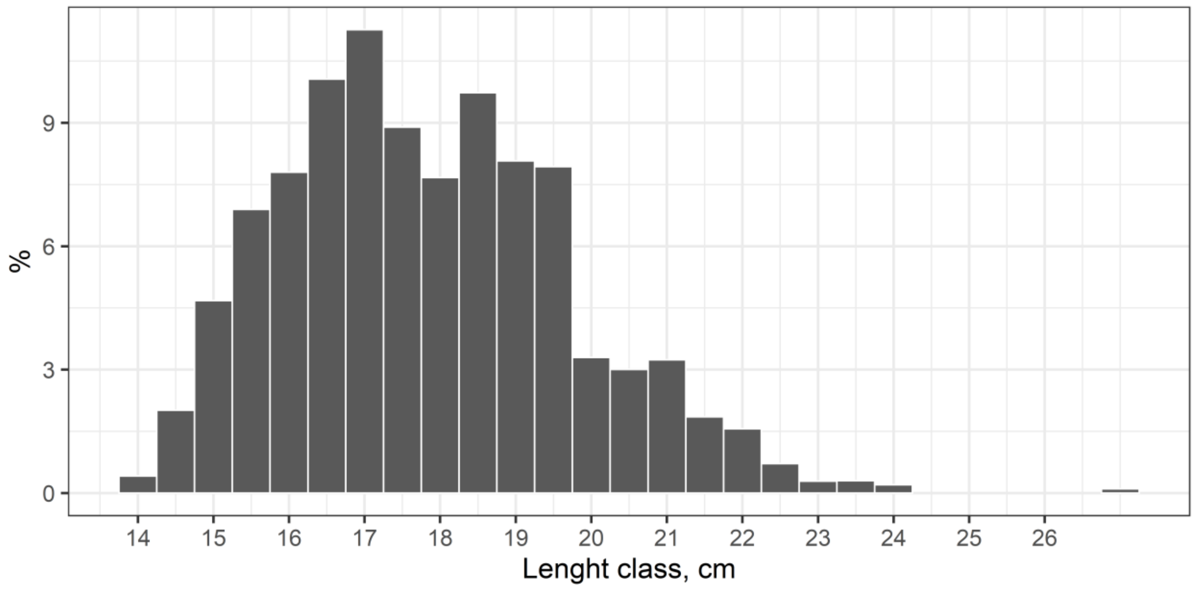


Figure 4. Herring length distribution from Lithuania BITS 2021 m. Q4 survey

THÜNEN **Institute of Baltic Sea Fisheries (OF)**

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Cruise Report
FRV „SOLEA" Cruise 799
03. – 23.11.2021

Baltic International Trawl Autumn Survey (BITS) in the Arkona Sea, Mecklenburg- and Kiel Bight (ICES SD 24+22)

Scientist in charge: **Dr. A Velasco** (Thünen-OF)

1. In a nutshell

The 799th cruise of the FRV "SOLEA" is the 40th November survey since 1981. It was part of the Baltic International Trawl Survey (BITS) which is coordinated by ICES WGBIFS. The main objective of the survey was the estimation of fishery independent stock indices for both Baltic cod stocks, flounder and other flat fish.

In total 53 fishery and 53 hydrography stations were carried out.

A preliminary analysis of the survey results suggests a similar year class of cod in 2021 as compared with the previous weak year class 2020 (recruits at length range 10-25 cm). The proportion of cod between 26-40 cm was higher in all depth layers as compared to the previous year, with the exception of the depth layer of 20–39 meters in subdivision 24.

The abundance of flounder as compared to the previous year decreased in SD 22 and increased in SD 24.

The oxygen concentration close to the bottom was between 1.2-6.7 ml/l

Distribution list:

Ship management FFS „SOLEA"
BA für Landwirtschaft und Ernährung (BLE) Fischereiforschung
BM für Ernährung und Landwirtschaft (BMEL), Ref. 614
BA für Seeschifffahrt und Hydrographie (BSH), Hamburg
Deutscher Angelfischerverband e.V.
Deutsche Fischfang-Union, Cuxhaven
Deutscher Fischereiverband Hamburg
Doggerbank Seefischerei GmbH, Bremerhaven
Erzeugergemeinschaft der Deutschen Krabbenfischer GmbH
Euro-Baltic Mukran
Kutter- und Küstenfisch Sassnitz
LA für Landwirtschaft, Lebensmittels. und Fischerei (LALLF)
LA für Landwirtschaft und Fischerei MV (LFA)
Leibniz-Institut für Ostseeforschung Warnemünde
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
Thünen-Institute - Institute of Fisheries Ecology
Thünen-Institute - Institute of Sea Fisheries
Thünen-Institute – Institute of Baltic Sea Fisheries
Thünen-Institute – Press office, Dr. Welling
Thünen-Institute – Presidential office
Thünen-Institute – Scheduling research vessels, Dr. Rohlf
Participants

2. Cruise objectives

The cruise took place from 3rd until 23rd November 2021. Corresponding to the recommendations of the WGBIFS in 2007, the survey of the FRV "SOLEA" covered the subdivisions 22 and 24 (Figure 1).

The following stock assessment objectives were covered during the survey:

- Collecting data for assessing stock indices, the structure and recruitment of the stocks, especially for cod and flatfish
- Monitoring the composition of fish species in the western Baltic Sea
- Collecting samples of cod, flounder, plaice, dab and turbot for biological investigations (i.e. sex, maturity, fecundity, age)
- Monitoring the actual hydrographical situation in the survey area

3. Cruise narrative

The internationally coordinated trawl survey is planned as a Stratified Random Survey where ICES subdivisions and depth layers are used as strata. A total of 53 stations (37 in subdivision 24 and 16 in subdivision 22) were planned for the German part of the survey which covered the southern part of ICES subdivision 22 and subdivision 24. The haul positions were selected from the TOW Database by the coordinator of the BITS surveys (ICES 2008, WGBIFS report as reference). 53 fishing stations were realized and can be used for stock assessment. The fishing hauls were carried out between 7:00 and 15:00 UTC (8:00 and 16:00 local time).

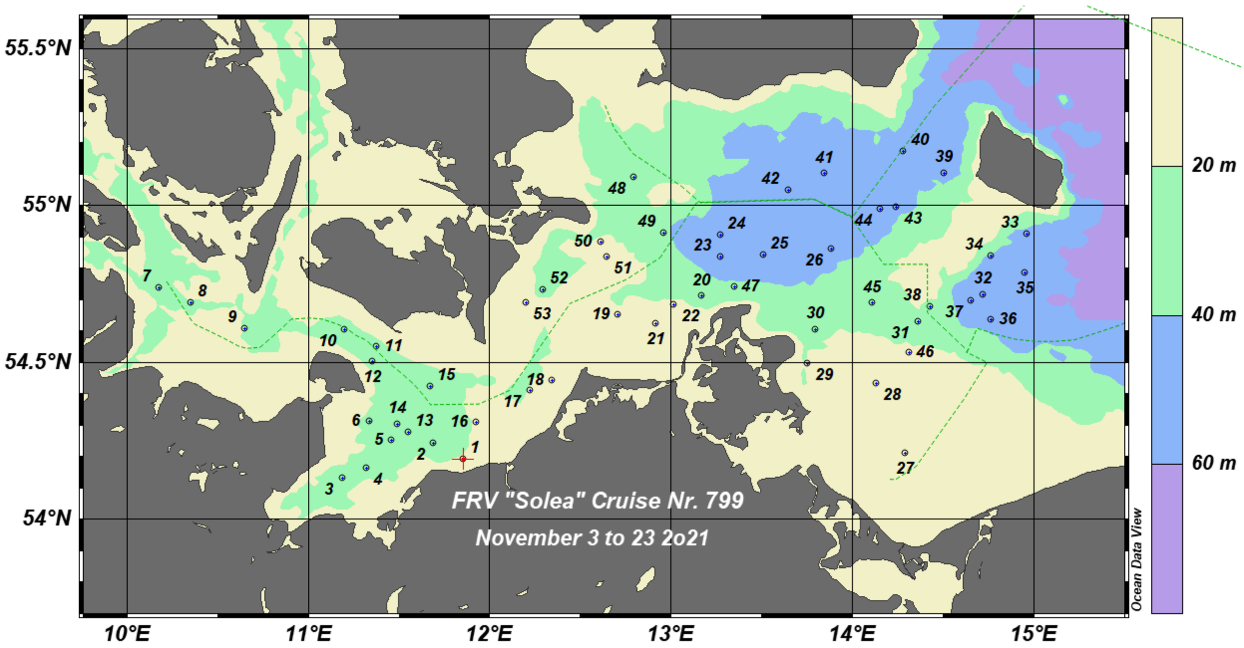


Fig. 1 Stations of the 799th FRV "SOLEA" cruise (Ocean Data View, R. Schlitzer, www.awi-bremerhaven.de/GEO/ODV)

The positions of the trawl hauls are shown in Figure 1. 16 fishing hauls and 16 hydrographic stations were conducted in subdivision 22, and 37 fishing hauls and 37 hydrographical stations were realized in subdivision 24.
The numbers of fishing hauls and hydrographic stations by subdivision and 10 m depth layers are given in Table 1. The 15 hauls in subdivision 22 were located at depths of 20–29 m and 17 of 37 hauls in subdivision 24 at 40–59 m.

Tab. 1 Sampling intensity (evaluated fishing stations)

Area		Stations		
Subdivision	**Stratum Depth [m]**	**Total trawl distance [sm]**	**Fishing [n]**	**Hydrography [n]**
22	**1 [10-19]**	1.5	1	1
	2 [20-29]	24.4	15	15
24	**1 [10-19]**	9.0	6	6
	2 [20-39]	21.1	14	15
	3 [40-59]	25.6	17	17

Trawling was done with the standard BITS trawl "TV3 520 #". The stretched mesh size in the codend was 20 mm. The duration of each haul was 30 minutes at a velocity of 3 kn as required in the BITS manual. The total catch of a haul was analysed to determine species composition in weight and number as well as the length distribution of all species. Subsamples of cod, flounder, plaice, dab and turbot were investigated concerning sex, maturity and age.
Vertical profiles of the hydrographical parameters temperature, salinity and oxygen were sampled from the surface to the bottom immediately before every fishing haul with a CTDO probe (Sea Bird SBE 19+ 6434).

4. Preliminary results

4.1. Biological data

In total 687 cod, 571 flounder, 835 plaice, 636 dab, 174 turbot and 7 brill were collected for measuring length, weight, sex, maturity and age. The total catches and numbers of length samples of cod and flounder are given in Table 2 by subdivision and depth stratum.

Tab. 2 Numbers of length measurements of cod, flounder, plaice and dab by ICES subdivision and depth stratum

Area		Sample			
		Cod		Flounder	
Subdivision	**Depth [m]**	**Weight [kg]**	**Number [n]**	**Weight [kg]**	**Number [n]**
22	**10-29**	40.6	785	81.2	355
24	**10-19**	65.3	529	178.2	725
	20-39	221.8	1565	352.8	1859
	40-59	1406.5	5379	833.9	3678

Area		Sample			
		Plaice		Dab	
Subdivision	Depth [m]	Weight [kg]	Number [n]	Weight [kg]	Number [n]
22	10-29	1640.0	19928	1570.6	20776
24	10-19	83.0	863	61.8	586
	20-39	366.2	2867	168.2	1941
	40-59	810.6	5216	100.0	771

The mean catch per hour (CPUE) was 43.3 kg of cod and 72.4 kg of plaice. In general the catch composition was dominated by cod and plaice. However, flounder and dab were also abundant in the catches. The mean fraction of cod biomass in the hauls was 17.7 % and the mean fraction of plaice, flounder and dab was 29.5 %, 14.7 % and 19.4 %, respectively. sprat and herring represented 11.0 % of the total biomass in mean.
The highest abundances in weight and number of cod, and flounder were observed in subdivision 24 in depths between 20 - 59 m and of plaice and dab between 10-29 m in subdivision 22.
Mean CPUE are given in Table 3 by subdivision and depth stratum.

Tab. 3 Mean CPUE of cod, flounder, plaice and dab and average individual weights by ICES sub-division and depth stratum

Area		Catch							
		Cod				Flounder			
Subdivision	Depth [m]	Weight [kg/sm]	Number [n/sm]	Average Weight [g]	Stations [n]	Weight [kg/sm]	Number [n/sm]	Average Weight [g]	Stations [n]
22	10-29	1.7	32	51.7	26	3.3	15	228.8	26
24	10-19	7.2	59	123.4	9	19.8	80	245.8	9
	20-39	10.5	74	141.7	21	16.7	88	189.8	21
	40-59	54.9	210	261.5	26	32.5	144	226.7	26

Area		Catch							
		Plaice				Dab			
Subdivision	Depth [m]	Weight [kg/sm]	Number [n/sm]	Average Weight [g]	Stations [n]	Weight [kg/sm]	Number [n/sm]	Average Weight [g]	Stations [n]
22	10-29	67.3	818	82.3	26	64.4	852	75.6	26
24	10-19	9.2	96	96.2	9	6.9	65	105.4	9
	20-39	17.3	136	127.7	21	8.0	92	86.7	21
	40-59	31.6	203.6	155.4	26	3.9	30	129.7	26

The frequencies of cod grouped by subdivision and depth strata are presented in Figures 2 to 4. The length range 10–25 cm of young cod compared to the previous year has slightly increased in all depths layers with the exception of the depth layer of 20–39 meters in subdivision 24. The length range 26–40 cm of cod recruits compared to the previous year was higher in all depths layers in the subdivisions 24 and 22, with the exception of the depth layer of 20–39 meters in subdivision 24 (Table 4 and Figures 2 to 4).

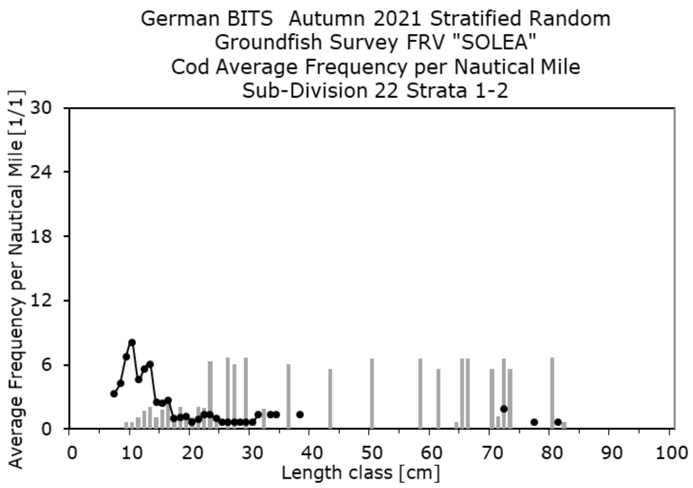


Fig. 2 Length frequencies of cod in number per mile in depth strata 10 m to 29 m in SD 22 2021 (line) and 2020 (bars), (16 Hauls)

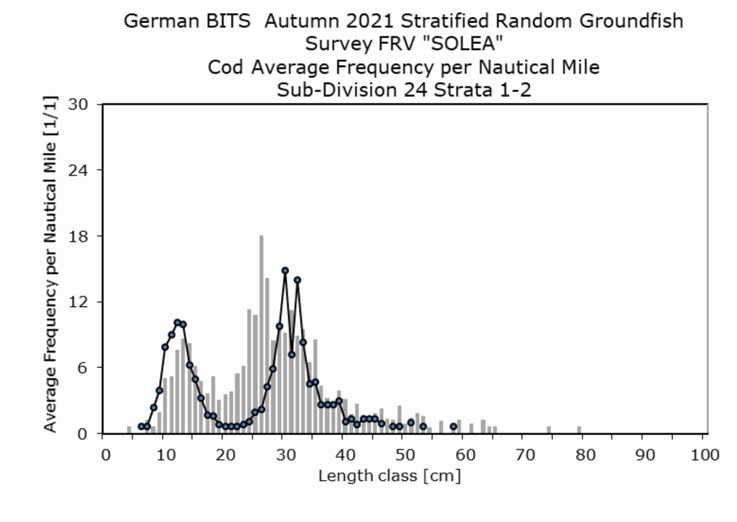


Fig. 3 Length frequencies of cod in number per mile in depth strata 10 m to 39 m in SD 24 2021 (line) and 2020 (bars), (20 Hauls)

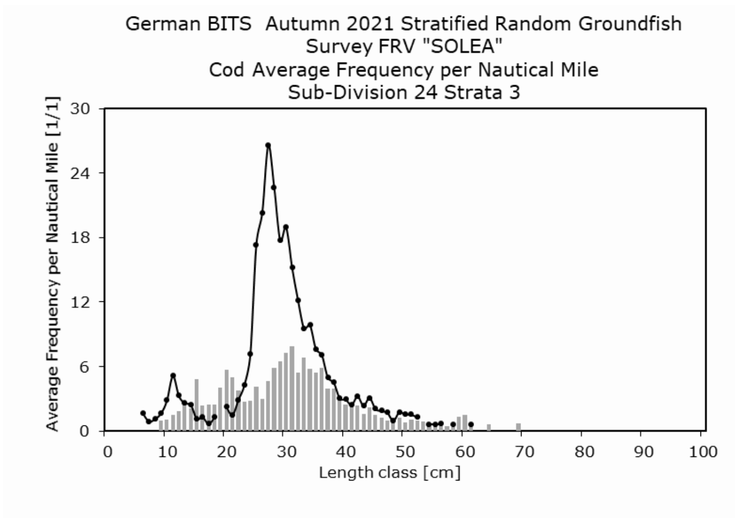


Fig. 4 Length frequencies of cod in number per mile in depth strata 40 m to 59 m in SD 24 2021 (line) and 2020 (bars), (17 Hauls)

Tab. 4 Recruitment of length groups of the year 2021 in comparison to the previous year

Area		Catch	2021		
Subdivision	Depth [m]	Length range [cm]	Number [n]	Number/ Mile [n/sm]	Trawl distance [sm]
22	10-29	26 - 40	19	1	24.4
24	10-19		154	17	9.0
	20-39		586	28	21.1
	40-59		4186	163	25.6
22 - 24	10-59		4945	62	80.1
22	10-29	10 - 25	542	22	24.4
24	10-19		329	37	9.0
	20-39		901	43	21.1
	40-59		930	36	25.6
22 - 24	10-59		2702	34	80.1

Area		Catch	2020		
Subdivision	Depth [m]	Length range [cm]	Number [n]	Number/ Mile [n/sm]	Trawl distance [sm]
22	10-29	26 - 40	7	0.4	19.1
24	10-19		98	7	13.9
	20-39		1125	70	16.0
	40-59		2018	62	32.8
22 - 24	10-59		3248	40	81.8
22	10-29	10 - 25	114	6	19.1
24	10-19		420	30	13.9
	20-39		870	54	16.0
	40-59		709	22	32.8
22 - 24	10-59		2113	26	81.8

Under the assumption that the survey covered all nursery grounds of cod, a similar weak year class 2021 (table above) compared to the year class 2020 (table below) can be assumed.

4.2 Hydrographical data

Figure 5 shows the distribution of temperature, salinity and oxygen near the bottom and at the surface in the area covered.
The hydrography was characterised by atypical autumn conditions with surface temperatures between 9.3 °C and 11.3 °C. The salinity of the surface water decreased from 18.4 to 7.4 from west to east. The lowest temperature value was found South of Adlergrund at 8.9 °C. The lowest salinity value was also South of Bornholm at a water depth of 54.0 m 7.4 The salinity increased below the halocline at a depth of 25 m South of Little Belt up to 23.3.
The oxygen concentration close to the bottom was between 2.8-7.7 ml/l.

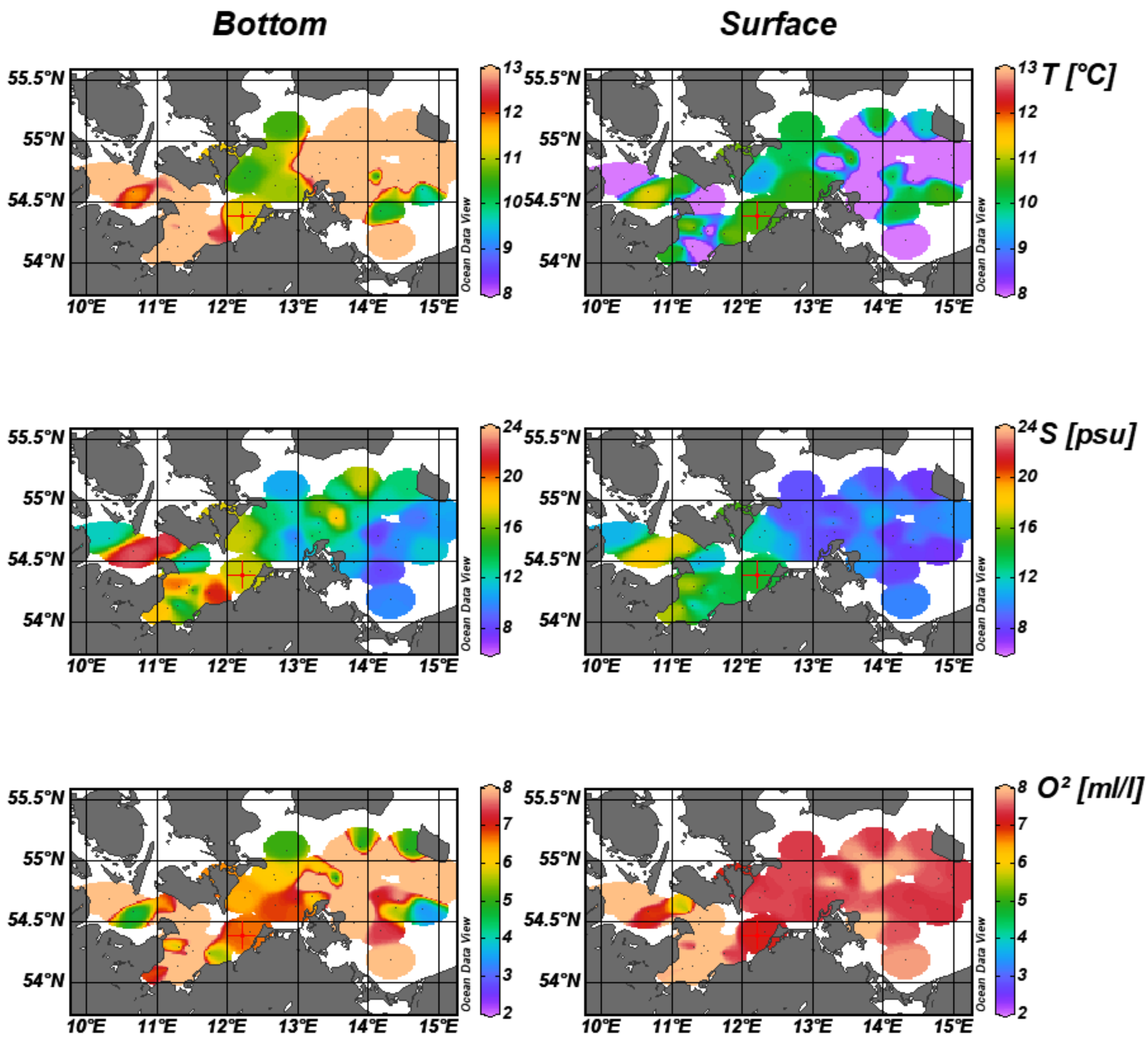


Fig. 5 Hydrography of the survey near the bottom (left) and at the surface (right)

5. Cruise Participants

A. Velasco	Thünen-OF	Scientist in charge
C. Albrecht	Thünen-OF	Technician
T. Jankiewicz	Thünen-OF	Technician
S. Dressler	Thünen-OF	Technician
R. Wiechert	Thünen-OF	Technician
N. Gerull	Uni Hamburg	Student helper
M. Bächtiger	Uni Hamburg	Student helper

6. Acknowledgements

I would like to express my gratitude to Captain Koops and his crew on the FRV "Solea" for their good cooperation under the Corona conditions.

sgd. Scientist in charge

Baltic International Trawl Survey (BITS),
R/V Svea, 21 February – 5 March 2022

Cruise leader : Olof Lövgren
Scientific leader : Michele Casini

Summary

Summary

The survey was conducted by the R/V Svea using the TV3L demersal trawl according to the Baltic International Trawl Survey (BITS) manual (ICES. 2017). Sweden was assigned 51 randomly selected hauls.

In total 50 hauls were performed with TV3L demersal trawl including eight hauls with oxygen deficiency (which were not trawled because the oxygen concentration close to the bottom was almost zero) In addition, one complementary haul in SD 28 were made. The complementary haul was made to get enough cod and flounder (target species) to be able to perform all biological analysis in a conventional manner. One station was declared invalid due to the trawl being torn. One haul could not be made due to a submarine cable being pulled straight over the trawl track. We covered parts of the areas SD 24, 25, 27 and 28 this year. During the whole survey, acoustic data were continuously recorded.

During this survey a total of 28 fish species were caught. Sprat, herring, cod and flounder dominated the total catch, in terms of weight.

The hydrographic conditions were observed and measured on every station. Only the oxygen concentration at the bottom is presented in the report.

Introduction

The institute of marine research trawl expeditions in the Baltic Sea are carried out in collaboration with the countries around the Baltic Sea within the framework of one of ICES 'trawl survey programs, the Baltic International Trawl Survey, BITS. Sweden is responsible for the surveys in parts of the southern Baltic Sea SD 24 and 25, central SD 26 and is responsible for all sampling in SD 27 and the western part of SD 28. The expedition is carried out twice a year, in quarters 1 and 4 according to the BITS manual (ICES, 2017) Quarter 1 is performed in February, March and quarter 4 the last week of November.

The trawl survey is coordinated by the WGBIFS working group, which meet once a year for planning and analysis. https://www.ices.dk/community/groups/pages/wgbifs.aspx
The surveys, which in their current form have been ongoing since the early 1990s, first used the Swedish research vessel U / F Argos. U / F Argos was taken out of service in 2010 and between 2011 and 2019, Sweden chartered the Danish state vessel Dana to fulfil the Swedish commitments. Because in 2011–2019 we used another nation's vessels (U / F Dana), some of the regular stations were banned from fishing (Decision Swedish Armed Forces FM2018-22193: 6) by the Swedish Armed Forces, which led to interruptions in the long time series. Since Autumn 2019, we

have had Sweden's new research vessel R / V Svea at our disposal.

All Swedish expedition data is stored in the FD2 database at the Sea Fishing Laboratory and transferred to ICES databases for international data storage; DATRAS for fish and marine litter. Hydrographic data is uploaded to Oceanography by SMHI. Data collected from this expedition are used by several working groups within ICES, mainly the Baltic Fisheries Assessment Working Group (WGBFAS).
https://www.ices.dk/community/groups/Pages/default.aspx

Method

The expedition started from Kalmar on February 21st and ended in Kalmar on March 5th.

Sweden had been assigned to 51 randomly placed stations (stratified by depth from an international database that randomly selects trawl hauls to all participating countries) and was distributed as follows: Four stations in the Baltic Sea subdivision, SD 24, 27 stations in SD 25, ten in SD 27 and ten stations in SD 28 (see Figure 1, table 1).

Ten of the randomly selected stations were replaced, two stations because of duplicates in the trawl database (two stations with different station numbers but located at the same position). Two because submarine cables were drawn over the trawl path. And six because the seabed is rocky and bad at these stations. All stations were replaced with similar stations within the same depth and area. The fishing is performed with a TV3 bottom trawl with a 16 mm mesh in the codend (which is the last part of the trawl where the fish is collected before it is lifted on board). All fish species in the catch as well as some invertebrates are measured, and biological samples of the target species specified in the manual (mainly cod and flounder) are taken with respect to sexual maturity and age. http://datras.ices.dk/Documents/Manuals/Manuals.aspx.
Otoliths for age determination were collected with the goal of 1 individual per cm class and haul in the areas where there are enough stations to take samples from. In other areas, the number of sampled individuals is increased up to 2-3 per cm class and haul. A length distribution is made for all fish species. Total weight was registered per species and haul.

Hydrography examination with CTD and oxygen probe was performed at most stations during the expedition. Oxygen-free stations are stations that are not trawled because the oxygen concentration near the bottom (measured approx. 1 m above the bottom) is less than 0.5 ml / l, an oxygen content that is considered too low for cod to stay there. However, the stations are included in calculations of stock estimates as 0-catch (Table 1).

One supplementary haul were made in SD 28 to collect biological samples for, among other things, age determination and other biological parameters such as liver parasites, stomachs for gastric sampling and so on.

Other sampling

At all trawled stations, the presence of litter that accumulates on the bottom and that accompanies the trawl is documented, litter is separated into different categories such as plastic, glass, metal, etc. Marine litter collection was carried out in accordance with the Marine Directive's guidelines (MFSD) on behalf of the Swedish Maritime Administration.

Other surveys and provincial collections were conducted as follows:

- Collection of stomachs from cod and flounder for food selection analysis.
- Visual assessment of liver parasites in cod.
- Baltic isopod (Saduria entomon) was collected for food selection analysis.
- SVA (National Veterinary Institute) was collecting samples, liver, marrow, muscle etc. for analysis

Results

The weather during the expedition was rough in the beginning but the wind abated during the expedition and did not affect the outcome of the expedition.

A total of 49 of the 51 preselected stations could be performed, including eight oxygen-free stations (Figure 2, Table 1). Results from hydrography examination with CTD and oxygen probe are shown in Table 1. The oxygen concentration at the bottom is shown in Figure 2. Oxygen varies between seasons and in feb/ march the oxygen conditions were slightly above the limit values in most of the areas. As expected, the oxygen concentration was lower in the deeper parts of SD 27 and in the deeper part of SD 28. The oxygen levels were low in other areas SD24 and 25 but were well above the limit values for trawling.
A total of 39 tonnes of fish were caught, of which 2 626 Kg were cod and corresponded to a total of 11 043 individuals. The catches of herring and sprat were 15,4 and 18,4 tonnes respectively. During the expedition, a total of 28 different fish species were caught. Captured species with weight and number distribution are reported separately in Table 2.

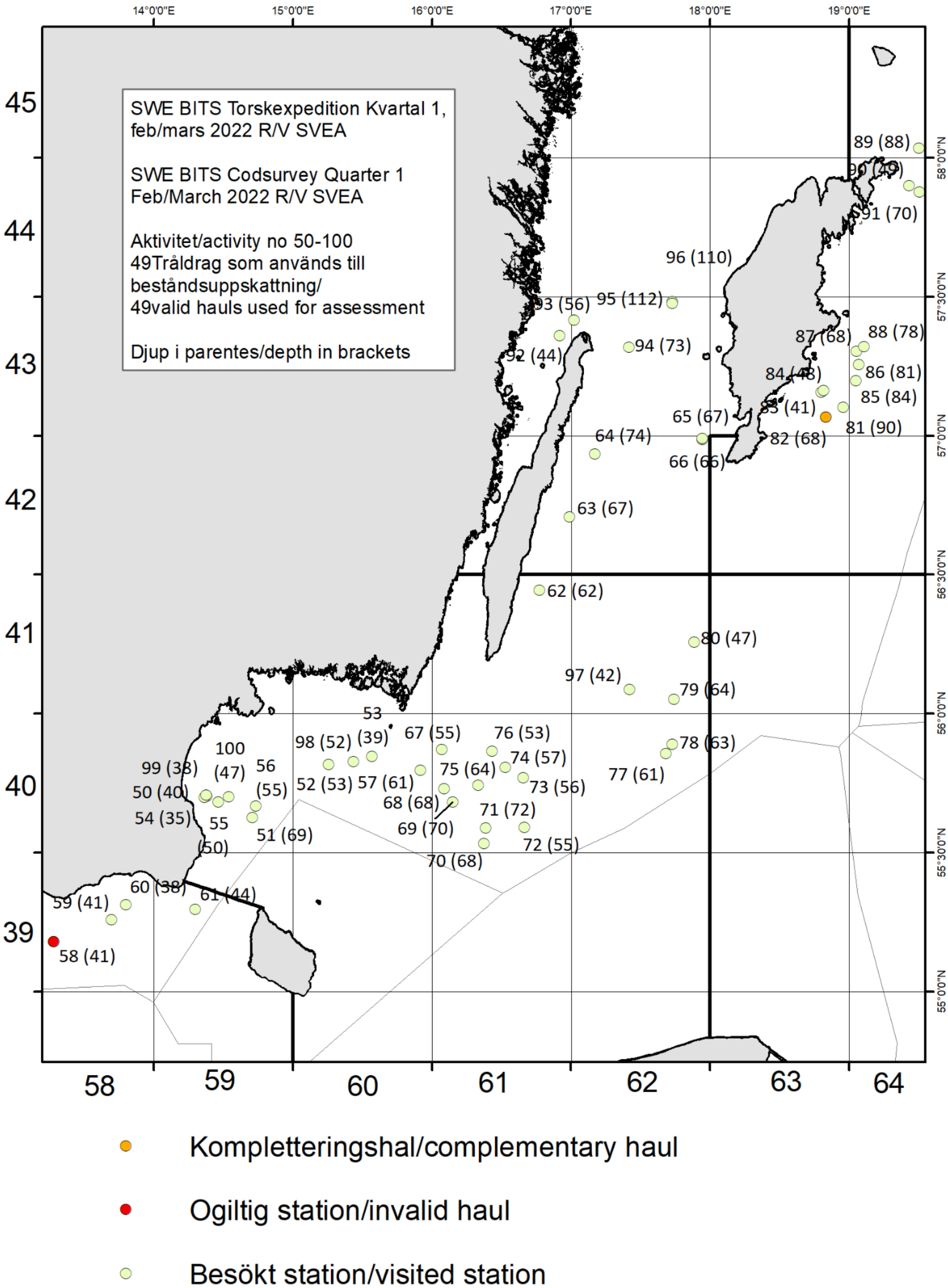


Figure 1. Map of the trawl stations performed during the Swedish BITS Quarter 1 2022. Trawled stations including one complementary haul and one invalid haul.

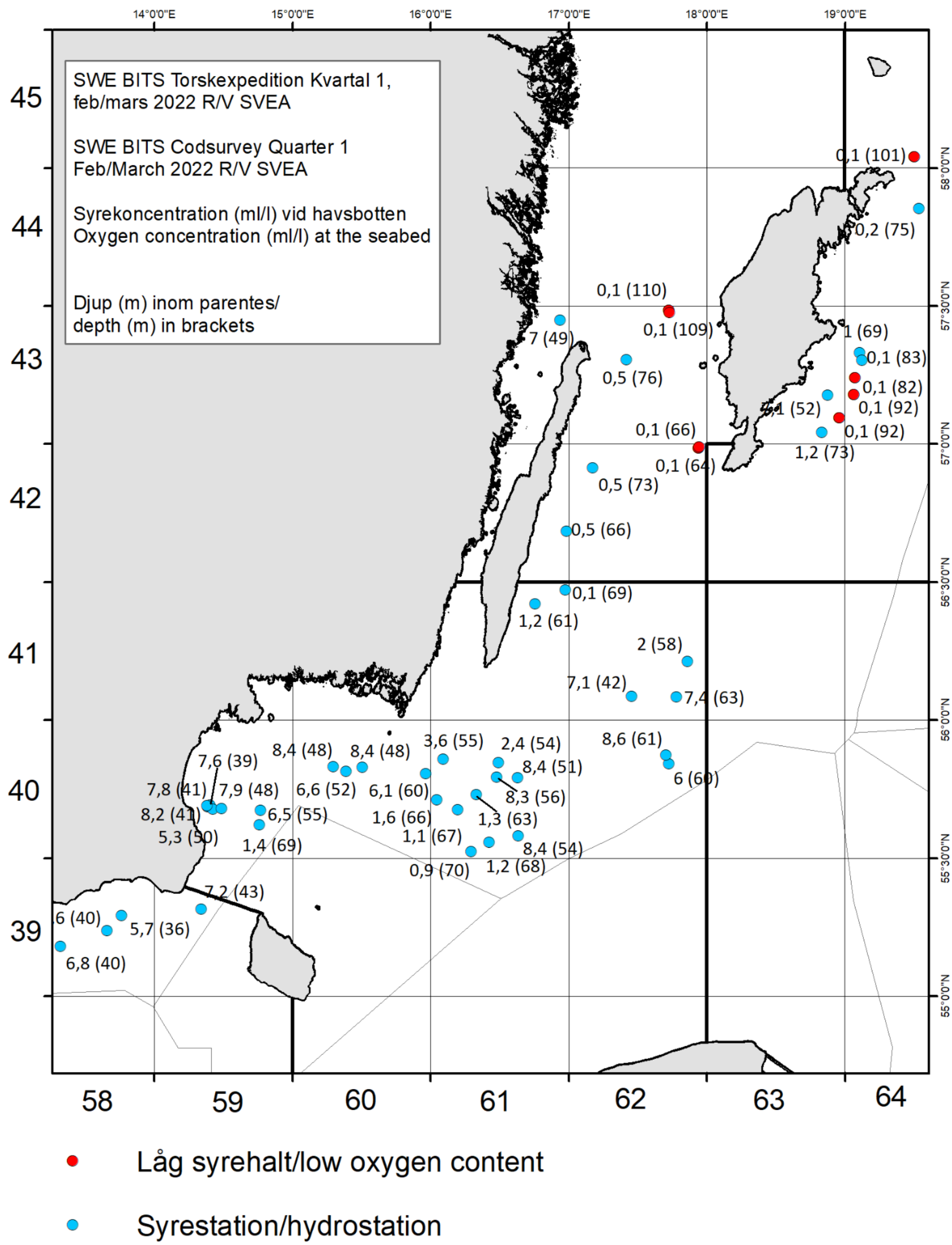


Figure 2. Oxygen concentration (ml/l) at the bottom at the trawl stations. Numbers in brackets indicate bottom depth. Swedish BITS, Quarter 1 2022.

The catch of cod is reported in kg and number per haul and SD in table 3. In the hauls where the catch of cod has been registered, the length of all cod is measured. In the case of large catches, only parts of the catch are measured (sample), which is then counted to the total catch. Otoliths for age determination were collected with the aim of one individual per cm class, area and haul (SD 25 divided into 3 sub-areas: 25W, 25C and 25E, see figure 1). In total, otoliths were taken from 720 cod.

Other sampling

A large part of the litter collected this year consisted of plastic. The Miscellaneous category includes clothing and shoes (see Figure 3). The information about the occurrence of rubbish is entered into a database on ices: https://datras.ices.dk/Data_products/Download/Download_Data_public.aspx.

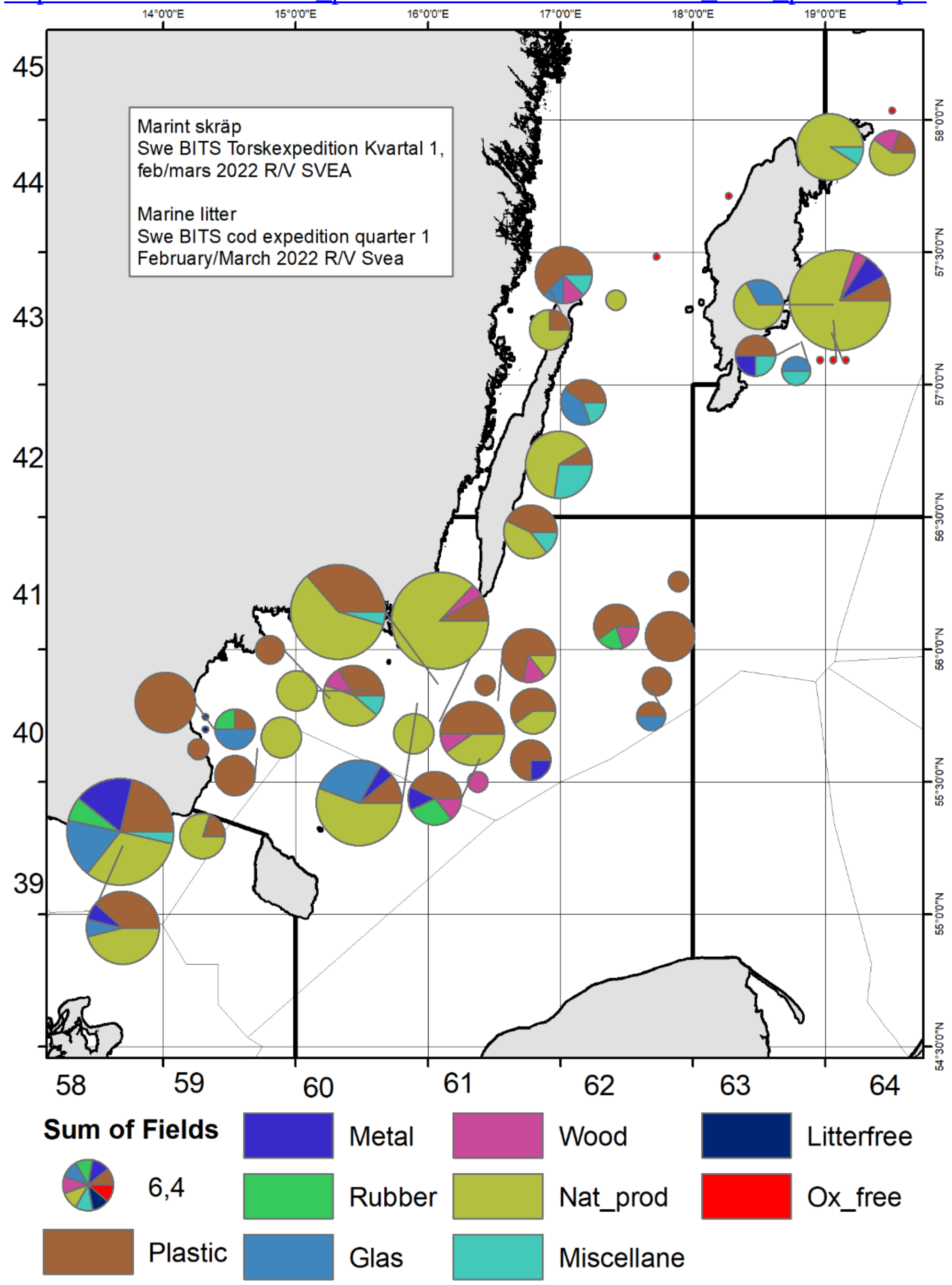
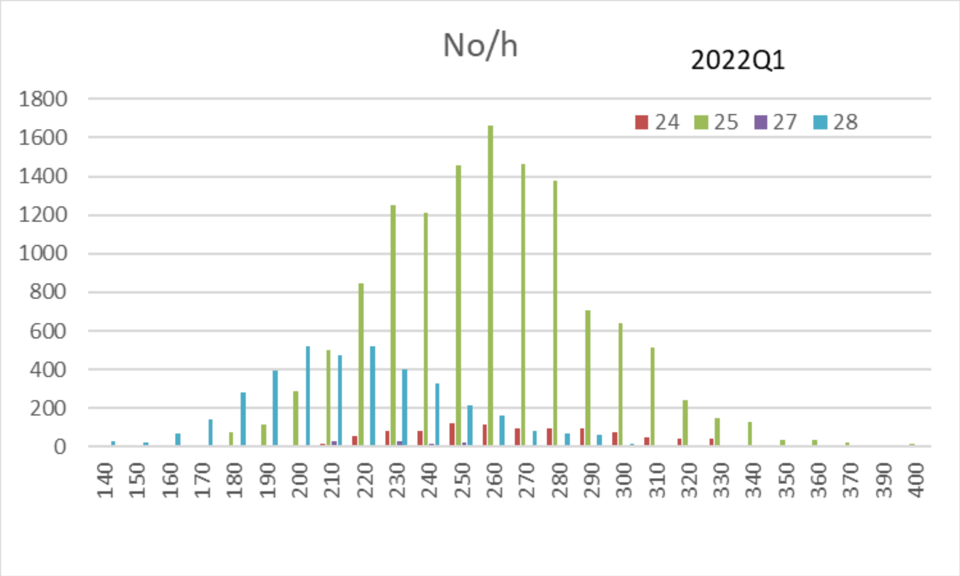


Figure 3. Marine litter presented as the number of pieces of litter per trawl haul. The size of the circles shows the total amount of litter at each station.

The length distribution of flounder per hour and area is shown in Figure 4. In total, otoliths were taken from 600 flounder.



Figur 4. Lenghtdistribution for flounder per hour and subdivision

Participants

Anders Svenson, Fisklabs chef	SLU, Havsfiskelaboratoriet
Stefan Eiler	SLU, Kustlaboratoriet
Fredrik Landfors	SLU, Kustlaboratoriet
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Axel Hjelm	SLU, Havsfiskelaboratoriet
Peter Johannesen	SLU, Havsfiskelaboratoriet
Olof Lövgren, exp.leader	SLU, Havsfiskelaboratoriet
Carina Jernberg	SLU, Havsfiskelaboratoriet

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ICES. 2018. Report of the Baltic International Fish Survey Working Group (WGBIFS). ICES WGBIFS report 2018 24-28 March 2018. Lyngby, Copenhagen, Denmark. 380 pp.

Table 1. Summary of all stations. Swedish BITS quarter 1 2022.

Valid hauls used for assessment	49	Valid hauls used for assessment				
Randomized trawled hauls	39	Randomized allocated hauls	SD28	10		
Replacement hauls	10		SD27	10		
Random anoxic hauls	8		SD25	27		
Additional hauls	1		SD24	4		
Invalid hauls	1	Valid hauls used for assessment	SD28	10		Complementary haul
Random stations, not trawled	0		SD27	9		TV3 Trawl station
			SD25	27		Oxygen depleted trawl haul
			SD24	3		Hydrografic station (CTD)

Datum Date	Akt. nr Act. no	Område Area SD	Ruta Rect.	Position N Latitude	Position E Longitude	Stat. nr Haul No	Stationsnamn Station name	Trålning Gear	Trål-tid Duration min	Trål-djup Trawl depth	Hydro Djup Depth m	Hydro O2 Oxygen ml/l	Remarks
2022-02-22	114	25	40G4	55 41,566	14 24,239	25401	5 NE Stens Huvud	CTD			39	7,6	
2022-02-22	50	25	40G4	55 42,172	14 22,792	25401	5 NE Stens Huvud	Trawl	30	39		7,6	
2022-02-22	51	25	40G4	55 37,547	14 42,530	25438	12,5 ENE Simrishamn	Trawl	30	68		1,4	
2022-02-22	115	25	40G4	55 37,281	14 45,683	25438	12,5 ENE Simrishamn	CTD			69	1,4	
2022-02-22	52	25	40G5	55 49,075	15 15,406	25426	3 NW Västra Nabben	Trawl	25	52		8,4	
2022-02-22	116	25	40G5	55 49,913	15 17,850	25426	3 NW Västra Nabben	CTD			48	8,4	
2022-02-22	53	25	40G5	55 50,740	15 34,110	25140	Klippebank	Trawl	30	39		8,4	
2022-02-22	117	25	40G5	55 49,812	15 30,532	25140	Klippebank	CTD			48	8,4	
2022-02-23	118	25	40G4	55 41,217	14 23,249	25419	3,5 NE Stens Huvud	CTD			0	8,2	
2022-02-23	54	25	40G4	55 41,903	14 21,798	25419	3,5 NE Stens Huvud	Trawl	25	35		8,3	
2022-02-23	119	25	40G4	55 40,675	14 25,381	25421	Rackaputt C	CTD			50	5,3	
2022-02-23	55	25	40G4	55 40,981	14 27,909	25421	Rackaputt C	Trawl	30	50		5,3	
2022-02-23	56	25	40G4	55 40,117	14 44,023	25391	11,8 SE Botildas Knall	Trawl	20	55		6,5	
2022-02-23	120	25	40G4	55 40,417	14 46,195	25391	11,8 SE Botildas Knall	CTD			55	6,5	
2022-02-23	57	25	40G5	55 47,834	15 55,033	25409	Inre U 10	Trawl	20	61		6,1	
2022-02-23	121	25	40G5	55 48,412	15 58,088	25409	Inre U 10	CTD			60	6,1	
2022-02-24	122	24	39G3	55 10,831	13 19,255	24252	S Trelleborg	CTD			40	6,8	
2022-02-24	58	24	39G3	55 10,727	13 16,709	24252	S Trelleborg	Trawl	18	41		6,8	Invalid haul, filled the trawl with clay
2022-02-24	123	24	39G3	55 14,305	13 39,589	24107	Ystadkroken	CTD			40	5,6	
2022-02-24	59	24	39G3	55 15,459	13 41,628	24107	Ystadkroken	Trawl	25	41		5,6	
2022-02-24	124	24	39G3	55 17,541	13 45,764	24303	5 S Klostergrundet	CTD			36	5,7	
2022-02-24	60	24	39G3	55 18,709	13 47,901	24303	5 S Klostergrundet	Trawl	30	38		5,7	
2022-02-24	61	24	39G4	55 17,776	14 17,814	24142	NE Svartegrund	Trawl	30	44		7,2	
2022-02-24	125	24	39G4	55 19,022	14 20,464	24142	NE Svartegrund	CTD			43	7,2	
2022-02-25	126	25	41G6	56 28,365	16 58,694	25315	15 NE Segerstad	CTD			69	0,1	
2022-02-25	62	25	41G6	56 26,709	16 46,318	25169	6,5 NE Segerstad	Trawl	24	62		1,2	
2022-02-25	127	25	41G6	56 25,291	16 45,528	25169	6,5 NE Segerstad	CTD			61	1,2	
2022-02-25	128	27	42G6	56 41,104	16 59,100	27022	9 SE Kapelludden	CTD			66	0,5	
2022-02-25	63	27	42G6	56 42,479	16 59,247	27022	9 SE Kapelludden	Trawl	17	67		0,5	
2022-02-25	129	27	42G7	56 54,823	17 10,529	27005	10 E Kårehamn	CTD			73	0,5	
2022-02-25	64	27	42G7	56 56,073	17 10,233	27005	10 E Kårehamn	Trawl	17	74		0,5	
2022-02-25	130	27	42G7	56 59,137	17 56,574	27007/27	8 NW Hoburg	CTD			64	0,1	
2022-02-25	65	27	42G7	56 59,228	17 56,607	27007/27	8 NW Hoburg	Trawl	30	66		0,1	Oxygen free
2022-02-25	66	27	42G7	56 59,469	17 56,734	27009/27	9 NW Hoburg	Trawl	30	66		0,1	Oxygen free
2022-02-26	131	25	40G6	55 51,595	16 05,486	25431	Argos track	CTD			55	3,6	
2022-02-26	67	25	40G6	55 52,246	16 04,308	25431	Argos track	Trawl	30	55		3,6	
2022-02-26	68	25	40G6	55 43,844	16 05,310	25300	17 SE Utklippan	Trawl	30	68		1,6	
2022-02-26	132	25	40G6	55 42,716	16 02,715	25300	17 SE Utklippan	CTD			66	1,6	
2022-02-26	69	25	40G6	55 40,949	16 09,017	25301	11 E Tången	Trawl	30	70		1,1	
2022-02-26	133	25	40G6	55 40,575	16 11,831	25301	11 E Tången	CTD			67	1,1	
2022-02-26	70	25	40G6	55 35,277	16 23,288	25286	4 SW Holgers Sten	Trawl	20	68		1,2	
2022-02-26	134	25	40G6	55 33,526	16 25,525	25286	4 SW Holgers Sten	CTD			68	1,2	
2022-02-26	71	25	40G6	55 31,983	16 22,555	25511	10 S Holgers Sten	Trawl	30	72		0,9	
2022-02-26	135	25	40G6	55 31,521	16 17,578	25511	10 S Holgers Sten	CTD			70	0,9	
2022-02-27	136	25	40G6	55 34,908	16 38,071	25389	4 SE Holgers Sten	CTD			54	8,4	
2022-02-27	72	25	40G6	55 35,505	16 39,836	25389	4 SE Holgers Sten	Trawl	30	55		8,4	
2022-02-27	73	25	40G6	55 46,118	16 39,442	25509	1 S Teneriffa	Trawl	30	56		8,4	
2022-02-27	137	25	40G6	55 47,535	16 37,862	25509	1 S Teneriffa	CTD			51	8,4	
2022-02-27	74	25	40G6	55 48,439	16 31,593	25359	3 W Teneriffa	Trawl	30	57		8,3	
2022-02-27	138	25	40G6	55 47,717	16 28,783	25359	3 W Teneriffa	CTD			56	8,3	
2022-02-27	75	25	40G6	55 44,612	16 20,008	25305	5 NW Holger Sten	Trawl	25	63		1,3	
2022-02-27	139	25	40G6	55 43,870	16 19,858	25305	5 NW Holger Sten	CTD			63	1,3	
2022-02-27	76	25	40G6	55 51,937	16 25,938	25403	7 NW Teneriffa	Trawl	30	53		2,4	
2022-02-27	140	25	40G6	55 50,791	16 29,584	25403	7 NW Teneriffa	CTD			54	2,4	
2022-02-28	141	25	40G7	55 50,552	17 43,618	25309	15 NE Södra Midsjöbank	CTD			60	6	
2022-02-28	77	25	40G7	55 51,414	17 41,052	25309	15 NE Södra Midsjöbank	Trawl	16	60		6	
2022-02-28	142	25	40G7	55 52,399	17 42,314	25161	18 NE Södra Midsjöbanken	CTD			61	8,6	
2022-02-28	78	25	40G7	55 53,394	17 43,653	25161	18 NE Södra Midsjöbanken	Trawl	30	63		8,6	
2022-02-28	79	25	41G7	56 03,094	17 44,464	25410	SE Norra Midsjöbanken	Trawl	30	64		7,4	
2022-02-28	143	25	41G7	56 05,064	17 46,815	25410	SE Norra Midsjöbanken	CTD			63	7,4	
2022-02-28	80	25	41G7	56 15,454	17 53,273	25167	18 ENE Norra Midsjöbank	Trawl	30	47		2,5	
2022-02-28	144	25	41G7	56 12,843	17 51,671	25167	18 ENE Norra Midsjöbank	CTD			58	2	
2022-03-01	145	28	43G8	57 05,724	18 57,675	28067	11 ESE När	CTD			92	0,1	
2022-03-01	81	28	43G8	57 06,193	18 57,534	28067	11 ESE När	Trawl	30	90		0,1	Oxygen free

Datum Date	Akt. nr Act. no	Område Area SD	Ruta Rect.	Position N Latitude	Position E Longitude	Stat. nr Haul No	Stationsnamn Station name	Trålning Gear	Tråltid Duration min	Tråldjup Trawl depth	Hydro Djup Depth m	Hydro O2 Oxygen ml/l	Remarks
2022-03-01	82	28	43G8	57 03,996	18 50,071	28101	10 SE När	Trawl	30	68		2,1	Additional haul, not used for index calculation
2022-03-01	146	28	43G8	57 02,546	18 50,012	28101	10 SE När	CTD			73	1,2	
2022-03-01	83	28	43G8	57 09,377	18 48,021	28177	4,5 SE När	Trawl	30	41		8,4	
2022-03-01	84	28	43G8	57 09,775	18 49,073	28016	5 SE När	Trawl	30	48		7,5	
2022-03-01	147	28	43G8	57 10,636	18 52,621	28016	5 SE När	CTD			52	7,1	
2022-03-01	148	28	43G9	57 10,764	19 04,039	28071	12 E När	CTD			92	0,1	
2022-03-01	85	28	43G9	57 11,930	19 03,007	28071	12 E När	Trawl	30	84		0,2	Oxygen free
2022-03-01	149	28	43G9	57 14,502	19 04,521	28072	13 E Ljugarn	CTD			82	0,1	
2022-03-01	86	28	43G9	57 15,379	19 04,245	28072	13 E Ljugarn	Trawl	30	81		0,1	Oxygen free
2022-03-01	87	28	43G9	57 18,222	19 03,288	28103	12 E Ljugarn	Trawl	30	68		1,1	
2022-03-01	150	28	43G9	57 19,821	19 06,347	28103	12 E Ljugarn	CTD			69	1	
2022-03-02	151	28	43G9	57 18,288	19 07,528	28051	8 SE Östergarn Syd	CTD			83	0,1	
2022-03-02	88	28	43G9	57 19,208	19 06,556	28051	8 SE Östergarn Syd	Trawl	30	78		0,3	
2022-03-02	152	28	45G9	58 02,442	19 30,301	28078	E Salvorev	CTD			101	0,1	
2022-03-02	89	28	45G9	58 02,164	19 30,133	28078	E Salvorev	Trawl	30	88		0,1	Oxygen free
2022-03-02	90	28	44G9	57 53,968	19 25,988	28097	5 SE Fårö	Trawl	30	49		8,2	
2022-03-02	153	28	44G9	57 51,269	19 32,288	28104	5 SE Fårö	CTD			75	0,2	
2022-03-02	91	28	44G9	57 52,640	19 30,333	28104	6,5 SE Fårö	Trawl	30	70		0,9	
2022-03-03	92	27	43G6	57 21,681	16 55,113	27020	4 NW Byxelkrok	Trawl	25	44		7,4	
2022-03-03	154	27	43G6	57 26,895	16 56,326	27020	4 NW Byxelkrok	CTD			49	7	
2022-03-03	93	27	43G7	57 24,939	17 01,374	27003	5 N Byxelkrok	Trawl	30	56		6,8	
2022-03-03	155	27	43G7	57 18,422	17 25,237	27029	11 ESE Ölands Norra Udde	CTD			76	0,5	
2022-03-03	94	27	43G7	57 19,159	17 25,091	27029	11 ESE Ölands Norra Udde	Trawl	15	73		0,8	
2022-03-03	156	27	43G7	57 29,074	17 43,548	27017	10 SE Knolls Grund	CTD			109	0,1	
2022-03-03	95	27	43G7	57 29,032	17 43,630	27017	10 SE Knolls Grund	Trawl	30	111		0,1	Oxygen free
2022-03-03	96	27	43G7	57 28,623	17 43,710	27019	6 N Visby	Trawl	30	110		0,1	Oxygen free
2022-03-04	157	25	41G7	56 05,153	17 27,454	25461	4 SE Norra Midsjöbank	CTD			42	7,1	
2022-03-04	97	25	41G7	56 05,272	17 25,243	25461	4 SE Norra Midsjöbank	Trawl	30	42		7,1	
2022-03-04	98	25	40G5	55 49,607	15 26,200	25404	Yttertorpet	Trawl	30	51		7,4	
2022-03-04	158	25	40G5	55 48,865	15 23,327	25404	Yttertorpet	CTD			52	6,6	
2022-03-05	159	25	40G4	55 41,509	14 22,892	25418	Rackaputt 38	CTD			41	7,8	
2022-03-05	99	25	40G4	55 42,442	14 22,722	25418	Rackaputt 38	Trawl	16	38		8	
2022-03-05	160	25	40G4	55 40,812	14 29,164	25353	Rackaputt Nord	CTD			48	7,9	
2022-03-05	100	25	40G4	55 42,046	14 32,427	25353	Rackaputt Nord	Trawl	20	47		8	

Table 2. Summary of the species in the catches. Swedish BITS, Q1 2022.

Namn	Latinskt namn	24		25W		25C		25E		27		28		Total	
		Antal	Vikt	Antal	Vikt	Antal	Vikt	Antal	Vikt	Antal	Vikt	Antal	Vikt	Antal	Vikt
Local name	Species	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight	No.	Weight
Torsk	Gadus morhua	994	218,6	1782	455,8	438	71,4	7582	1849,6	4	1,4	242	29,7	11043	2626,5
Sill / strömming	Clupea harengus	13555	489,5	49121	1442,6	53325	1401,3	256539	7687,6	104619	2399,8	71985	2008,9	549143	15429,8
Skarpsill / brisling / vassbuk	Sprattus sprattus	79380	1224,8	26572	293,0	135402	1422,7	979358	8268,5	883434	6786,7	48718	379,3	2152864	18375,1
Ansjovis	Engraulis encrasicolus							7	0,1					7	0,1
Fyrtömmad skärlånga	Enchelyopus cimbrius			1	0,04	1	0,04	33	1,3	3	0,1	1	0,0	39	1,5
Gråsej	Pollachius virens	5	0,5	1	0,1									6	0,5
Hornsimpa	Myoxocephalus quadricornis							1	0,2	358	35,8	2936	292,6	3295	328,7
Klarbult	Aphia minuta	8	0,003					6	0,01					14	0,01
Nors	Osmerus eperlanus											1	0,03	1	0,03
Piggvar	Scophthalmus maximus	13	5,3	45	20,7	4	1,2	26	11,6			6	1,8	94	40,5
Sandstubbar	Pomatoschistus sp.							2	0,0					2	0,003
Rödspätta	Pleuronectes platessa	479	54,9	879	108,9	59	8,6	764	85,9	2	0,1	5	0,5	2188	259,0
Rötsimpa	Myoxocephalus scorpius	12	1,3	32	3,7	168	28,1	583	102,4	39	4,6	1344	187,9	2178	328,0
Sandskädda	Limanda limanda	99	11,0	76	10,7	15	2,4	40	5,4					230	29,5
Sjurygg (stenbit och kvabbso)	Cyclopterus lumpus	1	0,5	2	0,7	5	1,4	12	3,0	1	0,4	2	0,4	23	6,3
Skrubbskädda	Platichthys flesus	471	101,6	2265	467,4	198	31,6	3196	615,0	73	10,7	2098	268,7	8301	1495,0
Skäggsimpa	Agonus cataphractus	1	0,02			1	0,02	2	0,1					4	0,1
Småspigg	Pungitius pungitius							1	0,0					1	0,001
Spetslångebarn	Lumpenus lampretaeformis											1	0,03	1	0,03
Staksill	Alosa fallax			9	0,4			30	0,7					39	1,2
Storspigg	Gasterosteus aculeatus			3	0,01	23	0,03	476	0,8	708	0,8	175	0,4	1384	2,0
Taggmakrill	Trachurus trachurus			6	0,1									6	0,1
Tejstefisk	Pholis gunnellus	2	0,0											2	0,002
Tobis, kusttobis	Ammodytes tobianus							1	0,01					1	0,01
Tobiskung	Hyperoplus lanceolatus									1	0,01			1	0,01
Vitling	Merlangius merlangus	87	9,1	61	7,3			3	0,5					151	16,9
Tånglake	Zoarces viviparus					3	0,04	27	0,3	30	1,1	13	0,6	73	2,0
Äkta tunga	Solea solea	3	0,7											3	0,7
Totalsumma		95109,5	2160,976	80855,6	2838,26	189641,1	2972,236	1248689,6	18640,68	989270,7	9241,614	127526,1	3171,931	2731092,6	39025,697

Table 3 Cod catch in kg and numbers/haul in SDs 24-28

	(orange)	Kompletteringsdrag/complemetary haul		(white)	TV3 trålstation/TV3 trawl station				
	(red)	Ogiltigt drag/invalid haul		(green)	Fiktivt drag/oxygen deficiency station				
Akt.	**Position**	**Position**	**Stationsnamn**	**Trål-**	**Trål-**	**Hydro**	**Totalfångst**	**Torskfångst**	
nr	N	E		**tid**	**djup**	**O2**	alla arter (kg)		
Act.	Latitude	Longitude	Station name	Duration		Oxygen	Total catch	Cod catch	
no				min	Trawldepth	ml/l	all species (kg)	kg	antal/nos.
SD 24									
58	55 10,727	13 16,709	S Trelleborg	18	41,4	6,8			
59	55 15,459	13 41,628	Ystadkroken	25	41,1	5,6	1003,831	26,48	129
60	55 18,709	13 47,901	5 S Klostergrundet	30	37,9	5,7	868,949	70,738	348,5
61	55 17,776	14 17,814	NE Svartegrund	30	44,2	7,2	244,891	121,36	516,8
SD 25									
50	55 42,172	14 22,792	5 NE Stens Huvud	30	39,5	7,6	293,088	68,098	253,6
51	55 37,547	14 42,530	12,5 ENE Simrishamn	30	68,5	1,4	797,184	176,82	626,7
52	55 49,075	15 15,406	3 NW Västra Nabben	25	52,5	8,4	1148,365	26,318	117
53	55 50,740	15 34,110	Klippebank	30	39,0	8,4	541,865	8,744	97
54	55 41,903	14 21,798	3,5 NE Stens Huvud	25	35,3	8,3	520,616	62,56	217,5
55	55 40,981	14 27,909	Rackaputt C	30	50,2	5,3	1013,061	82,206	395,9
56	55 40,117	14 44,023	11,8 SE Botildas Knall	20	55,2	6,5	187,489	66,122	288,7
57	55 47,834	15 55,033	Inre U 10	20	61,3	6,1	69,67	19,414	144
67	55 52,246	16 04,308	Argos track	30	54,9	3,6	395,052	27,498	417,8
68	55 43,844	16 05,310	17 SE Utklippan	30	67,9	1,6	590,594	317,38	1109,6
69	55 40,949	16 09,017	11 E Tången	30	69,9	1,1	593,819	4,12	16
70	55 35,277	16 23,288	4 SW Holgers Sten	20	68,3	1,2	1670,458	1000,7	3659
71	55 31,983	16 22,555	10 S Holgers Sten	30	71,9	0,9	327,305	23,824	88
72	55 35,505	16 39,836	4 SE Holgers Sten	30	54,5	8,4	1010,354	88,492	388,3
73	55 46,118	16 39,442	1 S Teneriffa	30	55,6	8,4	1538,291	98,906	435,6
74	55 48,439	16 31,593	3 W Teneriffa	30	56,9	8,3	1694,138	14,214	67
75	55 44,612	16 20,008	5 NW Holger Sten	25	63,5	1,3	1780,844	73,39	389,7
76	55 51,937	16 25,938	7 NW Teneriffa	30	53,3	2,4	1680,674	9,96	64
77	55 51,414	17 41,052	15 NE Södra Midsjöbank	16	60,5	6	2244,539	25,108	137
78	55 53,394	17 43,653	18 NE Södra Midsjöbanken	30	62,5	8,6	1899,064	50,908	292,1
79	56 03,094	17 44,464	SE Norra Midsjöbanken	30	64,3	7,4	1998,344	10,98	56
80	56 15,454	17 53,273	18 ENE Norra Midsjöbank	30	46,5	2,5	399,034	13,308	62
97	56 05,272	17 25,243	4 SE Norra Midsjöbank	30	41,8	7,1	160,991	3,34	6
98	55 49,607	15 26,200	Yttertorpet	30	51,5	7,4	1208,896	16,894	80
99	55 42,442	14 22,722	Rackaputt 38	16	37,5	8	73,008	22,5	79
100	55 42,046	14 32,427	Rackaputt Nord	20	47,0	8	203,959	64,3	310,8
SD 27									
63	56 42,479	16 59,247	9 SE Kapelludden	17	66,6	0,5	744,462		
64	56 56,073	17 10,233	10 E Kårehamn	17	73,9	0,5	603,662		
65	56 59,228	17 56,607	8 NW Hoburg	30	66,5	0,1			
66	56 59,469	17 56,734	9 NW Hoburg	30	65,9	0,1			
92	57 21,681	16 55,113	4 NW Byxelkrok	25	44,4	7,4	1196,9		
93	57 24,939	17 01,374	5 N Byxelkrok	30	55,9	6,8	1522,157	1,44	4
94	57 19,159	17 25,091	11 ESE Ölands Norra Udde	15	72,8	0,8	5174,345		
95	57 29,032	17 43,630	10 SE Knolls Grund	30	111	0,1			
96	57 28,623	17 43,710	6 N Visby	30	110	0,1			
SD 28									
81	57 06,193	18 57,534	11 ESE När	30	90	0,1			
82	57 03,996	18 50,071	10 SE När	30	67,8	2,1	367,693	6,9	60
83	57 09,377	18 48,021	4,5 SE När	30	40,8	8,4	551,62	2,032	17
84	57 09,775	18 49,073	5 SE När	30	48,1	7,5	998,562	2,72	22
85	57 11,930	19 03,007	12 E När	30	84	0,2			
86	57 15,379	19 04,245	13 E Ljugarn	30	81	0,1			
87	57 18,222	19 03,288	12 E Ljugarn	30	68,2	1,1	310,121	13,522	91
88	57 19,208	19 06,556	8 SE Östergarn Syd	30	77,5	0,3	46,232		
89	58 02,164	19 30,133	E Salvorev	30	88	0,1			
90	57 53,968	19 25,988	5 SE Fårö	30	49,4	8,2	646,287	4,04	49
91	57 52,640	19 30,333	6,5 SE Fårö	30	69,7	0,9	250,43	0,512	3
Catch, weight (kg) and numbers							38 571	2 626	11 039

Working Document
ICES Baltic International Fish Survey
Working Group
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RESEARCH REPORT

FROM THE POLISH R/V BALTICA BITS 1Q 2022 SURVEY
IN THE SOUTHERN BALTIC
(08 February - 04 March 2022)

by

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INTRODUCTION

Since 1995, the permanent participation of Polish R/V Baltica operated by the National Marine Fisheries Research Institute (NMFRI) in Gdynia, has taken place in autumn and winter Baltic International Trawl Surveys (BITS-4Q and BITS-1Q) realised in the southern Baltic. In March 2000 when the research standard fishing gear in the Baltic Sea - the cod bottom trawl type TV-3, has been applied by the vessels assigned to the BITS surveys realization, the principal methods of investigations within BITS-1Q ground-trawl surveys designated to particular national laboratories, including the NMFRI were designed and co-ordinated by the Baltic International Fish Survey Working Group (ICES, 2001). The main aim of the BITS-1Q survey planned in winter 2022 was to monitor abundance and spatial distribution of the main demersal fish species and to some extent also clupeids in the bottom zone of the Baltic, taking into account hydrological parameters. The R/V Baltica BITS-1Q 2022 survey, which was realized in the Polish part of the ICES Sub-divisions 25 and 26, Latvian, Lithuanian and Swedish part of the ICES Sub-division 26, was aimed at:

- determination of the spatial distribution of cod, flounder, herring and sprat in the near bottom zone of the southern and central Baltic during winter 2022 applying method of random selection of research hauls, estimation of the fishing efficiency, i.e. catch per unit effort (CPUE), the share of particular species in total mass of bottom control-catches,
- collecting biological samples of dominated fish for the determination of the age-length-mass relationship, sex, sexual maturation, feeding conditions and externally visible diseases,
- analysis of the vertical and horizontal changes of the basic hydrological parameters (temperature, salinity, oxygen content) in the areas of fish catches and in neighbouring standard hydrological stations,
- collecting and identifying the abundance of marine litter present in the fishing hauls.

MATERIAL AND METHODS

The above purposes of the February/March 2022 BITS 1Q survey aboard of R/V Baltica were realized by the NMFRI nine members of the scientific team, with Krzysztof Radtke as a cruise leader. The scientific team was also composed of seven ichthyologists including technicians, responsible for determination of fish species composition of catches, fish biological analyses and data processing and one hydrologist, responsible for seawater sampling and analysing as well as for meteorological monitoring.

Narrative

The reported Polish ground-trawl survey on board of R/V Baltica, marked with the number 2/2022/MIR took place during the period of 08.02-04.03.2022 within the framework of the ICES Baltic International Trawl Surveys (BITS) long-term programme (ICES, 2021) and the Polish Fisheries Data Collection Programme for 2022. The vessel left the port of Gdynia on 08.02.2022 in the morning and at sea investigations began in the southern part of the Gulf of Gdańsk (Fig. 1,

Tab. 1). During the period of 26-27.02.2022, the investigations were conducted in Swedish waters while in the period of 28.02-01.03.2022 the researches were realized in Latvian fishing zone. Two hauls planned in Lithuanian waters were performed on 27.02.2022. The survey ended on 04.03.2022 (morning) in Gdynia harbour. The R/V Baltica operated mostly in the Polish EEZ. Overall, 25 days were utilized for fulfilling the tasks of the BITS 1Q 2022 survey, including six days spent at sea without investigations due to heavy weather conditions and including also time spent for the vessel translocation from the Gdynia port to research area and a return way to the vessel home-port.

Survey design and realization – sampling description

According to the WGBIFS plan, the Polish vessel was recommended to cover in February/March 2022 survey, the Polish part of ICES Sub-divisions 25 and 26 with 10 and 39, respectively randomly selected bottom research hauls, as well as in Lithuanian, Latvian and Swedish EEZs to cover part of ICES Sub-division 26 with 2, 12 and 11 research hauls. The R/V Baltica realized 73 out of the 74 planned hauls for this survey. All the hauls realized were considered as „Valid" from the technical point of view. In total 6 hauls (ICES no 26138, 26140, 26141, 26144, 26209 and 28221) were not realized due to oxygen content below 0.5 ml/l near the bottom. These hauls were classified as „No oxygen" and the catch results were considered as „zero catch haul". Finally, it can be concluded that the hauls realized during the survey corresponded to the plan and could be therefore accepted as fully representative from the technical point of view, (Fig. 1, Table 1) taking into account gear performance observed during trawling.

Trawling was done with the standard rigging ground trawl type TV-3#930 (without bobbins and additional chains connected to the footrope). In the codend 10-mm mesh bar length was used. A standard vertical fish-sounder was used to monitor the trawling depth. Usually a 6-7 m vertical net opening was achieved, which was monitored by the net echosounder. The catch stations were located on the depth range from 23 to 143 m. Fish research hauls were conducted at the daylight only (starting trawling 15 minutes after sunrise and ending trawling not later than 15 minutes before sunset), lasting maximum 30 minutes, at 3.0 knots vessel speed.

Each research catch was sorted out for the determination of the species composition. Mean CPUE of each fish species and their average share in mass of catches was calculated. From each catch station, representative samples of dominated fishes were collected to determine age-length-mass relationships, sex, sexual maturation, feeding conditions, externally visible diseases and additionally stomach samples for food composition estimation of cod were collected for further examinations in the Institute.

In the case of cod, turbot and plaice all the caught specimens were taken for total length and mass measurements. In the case of clupeids and flounder, the representative sub-samples of these fish species were investigated. Overall, 2005 cod, 2598 flounder, 144 plaice, 7 turbot, 9480 sprat and 6835 herring were taken for the length and mass determination. In total, 298, 543, 139, 7, 465 and 773 individuals of the above-mentioned species were aged. Biological analyses of fishes were performed directly on board of the surveying vessel, according to standard methodological procedures. The length of 35 cm, 23 cm (ICES SD 25) and 21 cm (ICES SD 26), 16 cm and 10 cm was taken into account as a separation (protective) length between juvenile and commercial size of cod, flounder (differed by the ICES Sub-divisions), herring and sprat, respectively.

Externally visible diseases of fish's skin and their skeletal anomalies were monitored for 2005 cod, 2598 flounder, 9480 sprat and 6835 herring. Data on pathological symptoms were registered based on the visual inspection of fish taken for length measurements.

Every control-haul was preceded by the measurements of basic hydrological parameters continuously from the sea surface to the bottom. Overall, 96 hydrological stations (including hydrographic standard stations) were inspected with the automatic CTD probe SeaBird 911 combined with the rosette sampler (the bathometer rosette). Oxygen content was determined using the standard Winkler's method. The seawater temperature and salinity row data was aggregated to the 1-m depth stratum while oxygen content was aggregated to the 10-m intervals. Temperature, salinity and oxygen content was the source of information on abiotic factors potentially influencing fish spatial distribution. Distribution of all hydrological stations inspected by the R/V Baltica in February/March 2022 is presented in Figure 1. The results of marine litters collected in the fishing hauls are presented in Figure 8.

RESULTS

Fish catches and biological data

In total, twenty one different fish species were recognized in 73 scrutinized valid bottom catches (Table 1). None of the fish species permanently inhabiting in Atlantic Ocean occurred in the research catches.

The frequency of the occurrence of the most important commercial species in the all hauls realized – sprat, flounder, herring and cod was - 80%, 77%, 76% and 58%, respectively (Table 1). Cod, flounder, herring and sprat dominated also with respect to the mass of the catch (kg) and efficiency (CPUE – kg/1h). By-catch of other fish species was insignificant.

The average CPUEs of cod in ICES SDs 25 and 26 were very low and amounted to 17,1 kg/1h and 18,7 kg/1h, respectively. Cod CPUE was the second in ICES SD25 and fourth in ICES SD 26 out of all the fish species CPUEs considered (Fig. 2). Low CPUE of cod in ICES SD 25 may result from the catches conducted mainly in shallow (20-30 m), coastal waters where the temperature was only 3 ^{0}C near the bottom. Low temperature could induce migrations of cod from coastal waters to deeper and warmer waters.

In the ICES SD 26, the low CPUE of cod can additionally be explained by the very low oxygen content in the near bottom zone (80-100 m) observed in a large part of the ICES SD 26 (Fig. 7). The area of low oxygen content (below 2 ml/l and also below 0.5 ml/l in some areas) was extended during the described survey. The average CPUE of cod, in analogous survey in February/March 2021 r., was higher in the ICES SD 25 (52.4 kg/1h) and also in the ICES SD 26 (24.2 kg/1h) than in February/March 2022 survey.

The average CPUE of herring in ICES SD 25 was 25.7 kg/1h. Markedly higher average CPUE was obtained in ICES SD 26 – 151.8 kg/1h. During the last year's survey, the CPUE of herring was higher in the ICES SD 25 – 95.2 kg/1h, while in the ICES SD 26 the CPUE was slightly lower and amounted to 146.0 kg/1h.

The average CPUE of sprat in ICES SD 25 was not calculated as the number of sprat caught was only 6 individuals. In the ICES SD 26 the sprat CPUE was very high - 728.3 kg/1h. The average CPUE of sprat in the ICES SD 26 was the highest among all the fish species CPUEs obtained during the survey. The extremely low catch of sprat observed in ICES SD 25 may most probably result from migration of sprat to deeper, warmer waters from the cold coastal areas, similarly as observed in the case of cod in ICES SD 25. In the same type of survey from February/March 2021 the CPUE of sprat in ICES SD 25 was higher - 4.8 kg/1h, while in the ICES SD 26 it was much lower - 281.6 kg/1h.

The average CPUE of flounder in ICES SDs 25 and 26 was 3.7 and 37.9 kg/1h, respectively. Thus the flounder CPUE results were the third in row CPUEs as compared to the other three species CPUEs examined. The average CPUEs of flounder in February/March 2021 in ICES SDs 25 and 26 were higher - 16.7 kg/1h, 49.2 kg/1h, respectively.

Length distributions of the main fish species according to the ICES Sub-divisions are illustrated in Figure 3. The curve of cod length distribution for the ICES SD 25 was slightly shifted to the right along the horizontal axis what indicates for a slightly larger share of bigger cod fished in that SD as compared to the ICES SD 26. Nevertheless, the shape of the curves did not differ considerably, what indicates for a low cod length variety observed between the two ICES SDs in the area of investigation. Length ranges of cod in ICES SDs were similar and in the ICES SD 25 the range was 8-52 cm, while in the ICES SD 26 it was 5-52 cm. The length distributions demonstrate a definite prevalence of cod from length classes 20-47 cm constituting 97.7% of the numerical share in the ICES SD 25 and 97.5% in the ICES SD 26. Cod smaller than 20 cm was very seldom represented in the hauls and the abundance was very low, usually a few individuals.

Two herring length fractions in the length distribution curves from ICES SD 25 and 26 were clearly distinguished. In the ICES SD 25, the first fraction of small size herring (10.5-14.5 cm) and the second fraction of larger ones (15.0-28.0 cm). In the ICES SD 26 the first fraction of small size herring constituted fish from length classes 9.5-15.0 cm, and the second fraction of larger ones was represented by herring from the range of 15.5-26.5 cm. The numerical share of the first fraction was considerably lower than the share of the larger fraction and amounted to 6.4% and 18.1% in ICES SD 25 and in ICES SD 26, respectively.

Sprat length distribution curves from ICES SD 25 and 26 were characterized by a single peak clearly visible corresponding to length class 8.5 cm (frequency 50.0%) and to 11,5 cm (frequency 23.4%), respectively. However, neither in the ICES SD 26 nor in the ICES SD 25 a fraction of smaller size sprat was clearly evident, contrary to the same type of the survey results observed in 2020-2021. It should be emphasized however that the whole catch of sprat in the ICES SD 25 was only 6 individuals.

Flounder length distributions indicated large differences of flounder size depending on the ICES SD they occupied. Analogous observations were found for previous BITS surveys. Flounder length distribution curve in the ICES SD 25 covered narrower length range (16-38 cm) than the curve from the ICES SD 26, where the length range was 9-38 cm. Flounder length ranges obtained during this survey were almost identical as the length ranges from the previous winter BITS survey (16-37 cm and 9-38 cm, in the ICES SDs 25 and 26, respectively). Numerical share of smaller flounder (<20 cm) was much bigger in the ICES SD 26 (22.2%) than in ICES SD 25 (8,1%), what indicated that more smaller flounder inhabited ICES SD 26. Single peaks of frequency in the length distribution curves of flounder from ICES SDs 25 and 26 were the same, corresponding to length class 24 cm, respectively (frequency of 10.3% and 10.0%, respectively).

Figure 4 shows the numerical shares of the undersized fish fractions of cod, herring, sprat and flounder. In cod catches from ICES SDs 25 and 26 the undersized fraction of cod prevailed markedly. Their numerical share in the above-mentioned ICES SDs was 74.3% and 80.4%, respectively. In the same type of cruise from February/March 2021, the share of undersized cod was similar in the ICES SD 25 and amounted to 71.2%, while in the ICES SD 26 it was much lower and amounted to 67.3%. The total share of undersized cod from the February/March 2022 survey was also high and amounted to 79.6%. The share of the undersized fraction of herring in ICES SD 25 and 26 amounted to 7.2% and 20.1%, respectively. The largest share of undersized sprat was observed in samples from ICES SD 26 (8.1%). The share of undersized sprat in the ICES SD 25 was not calculated as the catch in that SD was only 6 individuals. Flounder undersized share was higher in the ICES SD 26 (29.5%) than in the ICES SD 25 - 21.8%.

Mean length (l.t.) and mean mass of sprat, herring, cod and flounder calculated for the whole cruise and separately for ICES SDs 25 and 26 are presented in the text table below (in parenthesis are shown parameters from February/March 2022 cruise):

ICES Sub-division	Parametr	szprot	śledź	dorsz	stornia
25	mean length [cm]	8.8 (12.3)	20.6 (20.3)	32.2 (32.1)	26.7 (26.7)
26		11.6 (10.7)	18.0 (18.0)	30.2 (32.6)	23.4 (21.9)
whole cruise		11.6 (10.7)	18.3 (18.5)	30.5 (32.4)	23.5 (22.3)
25	mean mass [g]	4.0 (10.3)	54.9 (50.9)	328.0 (326.7)	210.2 (201.5)
26		9.4 (7.2)	37.2 (34.8)	269.3 (340.3)	147.1 (127.9)
whole cruise		9.4 (7.3)	38.3 (35.3)	276.9 (334.7)	149.2 (133.5)

The measurement of the length of the main fish species was accompanied by a macroscopic analysis of the presence of symptoms of visible diseases of fish's skin. i.e. anatomopathological changes (Fig. 5). The highest prevalence of fish with externally visible pathological changes was recorded for flounder (5.6% on average) and next for cod (1.8%). The share of sprat with observed pathological symptoms was very low and amounted to 0.03%. In case of herring, no externally visible diseases were found.

Hydrological situation in the southern Baltic

In the near-bottom water layer (Fig. 6) temperatures in the range from 8.85°C to 2.76°C were noted. The lowest temperature was noted in the control haul no 22 at the depth 23 m, while the highest in hydrological station B2, at the depth 88 m. The highest salinity was recorded in hydrological station no IBY5 (Bornholm Deep) (15.38 on the PSU scale). At the deepest place in Słupsk Furrow (hydrological station RS2) the salinity was 11.85. Salinity measured in Gdańsk Deep amounted to 11.51 in hydrological station (G2), while in Gotland Deep in the Polish EEZ – 11.35 at the hydrological station Gt1. In the deepest station examined in Gotland Deep (haul no 67), in Latvian EEZ the salinity was 12.14. It was the only station where no oxygen was detected in the near bottom layer. In general the deepest parts of the bottom were to large extent poorly oxygenated (Fig 7). Areas of oxygen content below 2 ml/l covered Gdańsk and Gotland Deep and partially also Słupsk Furrow. Limited hydrological data collected in the Bornholm Basin also suggest poor oxygen conditions near the bottom in that area.

During the survey, heavy storms occurred which induced very deep vertical mixing of the water masses. In Gdańsk Deep, in particular, the range of water column mixing ranged up to 85 m (Fig. 6). Well oxygenated and cold water masses penetrated water column very deep causing the decrease of salinity in the deeper parts of the Baltic. The processes described did not positively affect the reproduction of cold as the salinity sufficient for cod eggs buoyancy was moved toward deeper parts of the sea. There were no indications of fresh waters inflow from the North Sea in the area investigated.

CONCLUSIONS

The data collected during Polish BITS-1Q 2022 cruise is considered as representative. taking into account the degree of the survey plan realization. and therefore can be used by the ICES Baltic International Fish Survey Working Group (WGBIFS) and the Baltic Fisheries Assessment Working Group (WGBFAS) for evaluation of fish species abundance and their distribution. The survey data collected during the cruise is stored in the international DATRAS database publicly available and managed by the ICES Secretariat.

References:

ICES. 2001. Report of the Baltic International Fish Survey Working Group. Baltic Committee. ICES CM 2001/H:02. Ref.: D. Kaliningrad. Russia. 5-9 February 2001. 249 pp.

ICES. 2021. ICES Working Group on Baltic International Fish Survey (WGBIFS; outputs from 2020 meeting). ICES Scientific Reports. 3:02. 539pp. http://doi.org/10.17895/ices.pub.7679

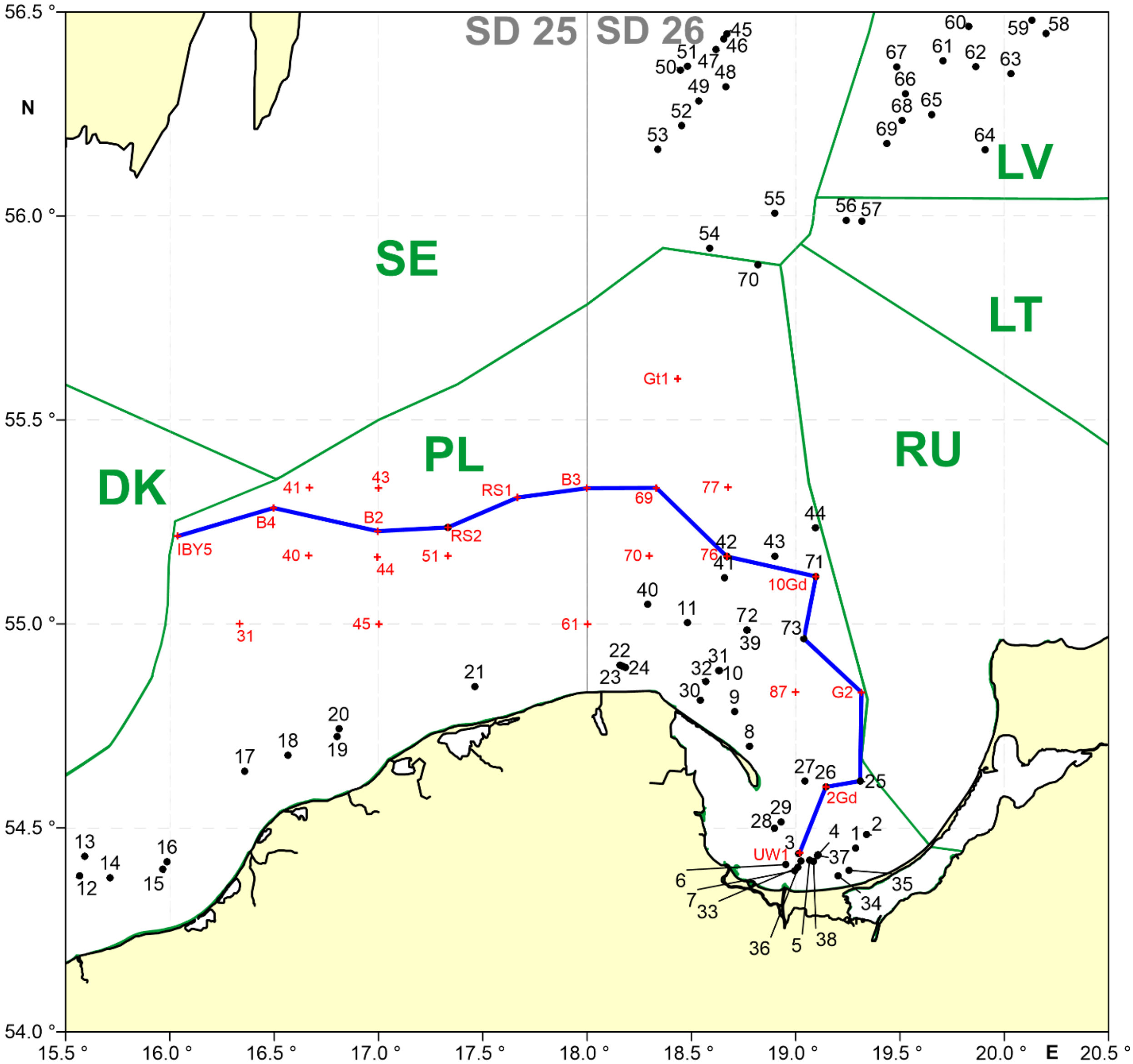

Fig. 1. Location of fish control-hauls (black crosses) and hydrological standard stations (red dots) realised during the r/v Baltica BITS-1Q cruise (08.02-04.03. 2022). (blue solid line indicates hydrological research profile).

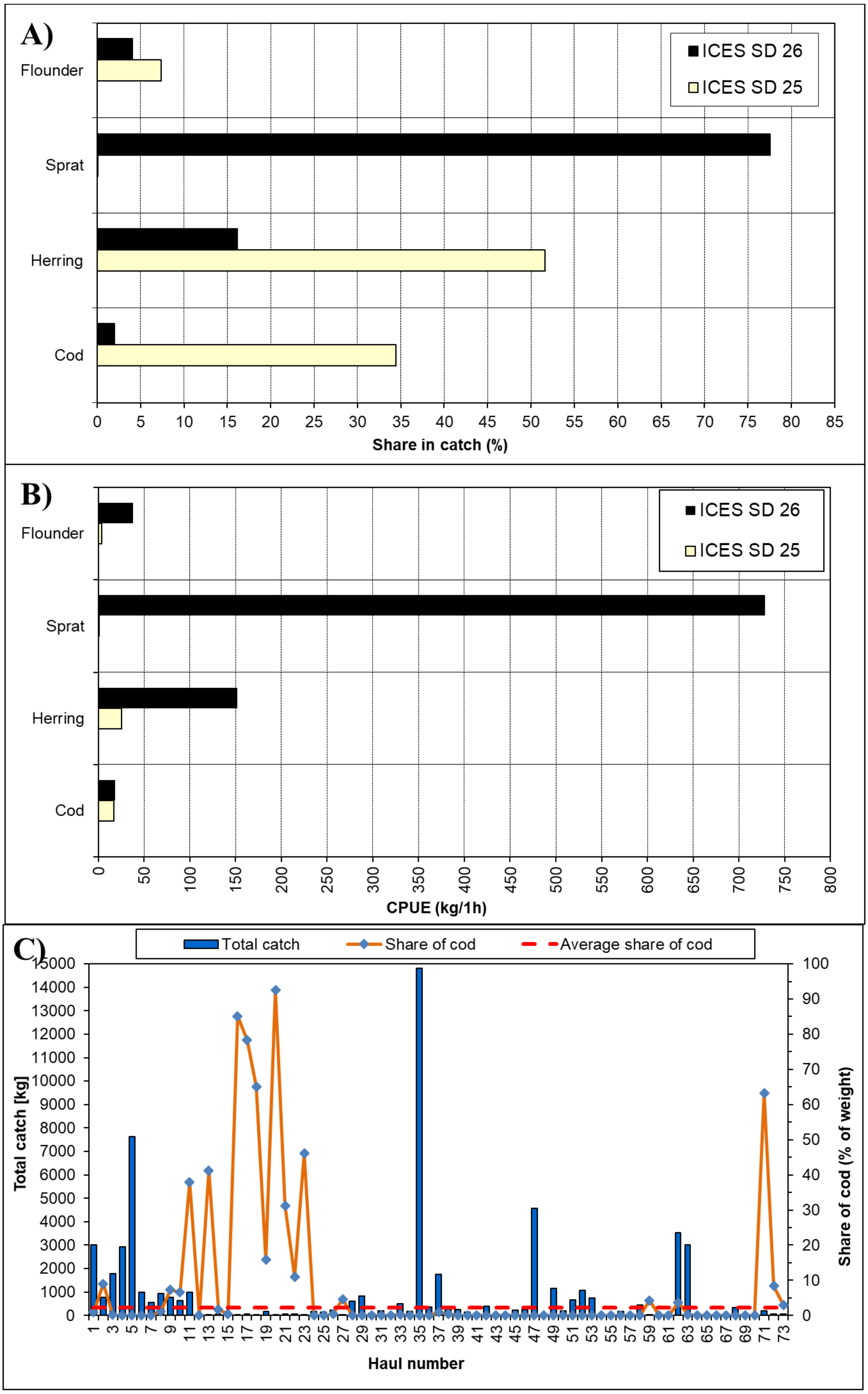

Fig. 2. Mean share in mass of control hauls (A). and mean CPUE (B) of dominant fish species. and share of cod (C) in particular catches conducted during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022).

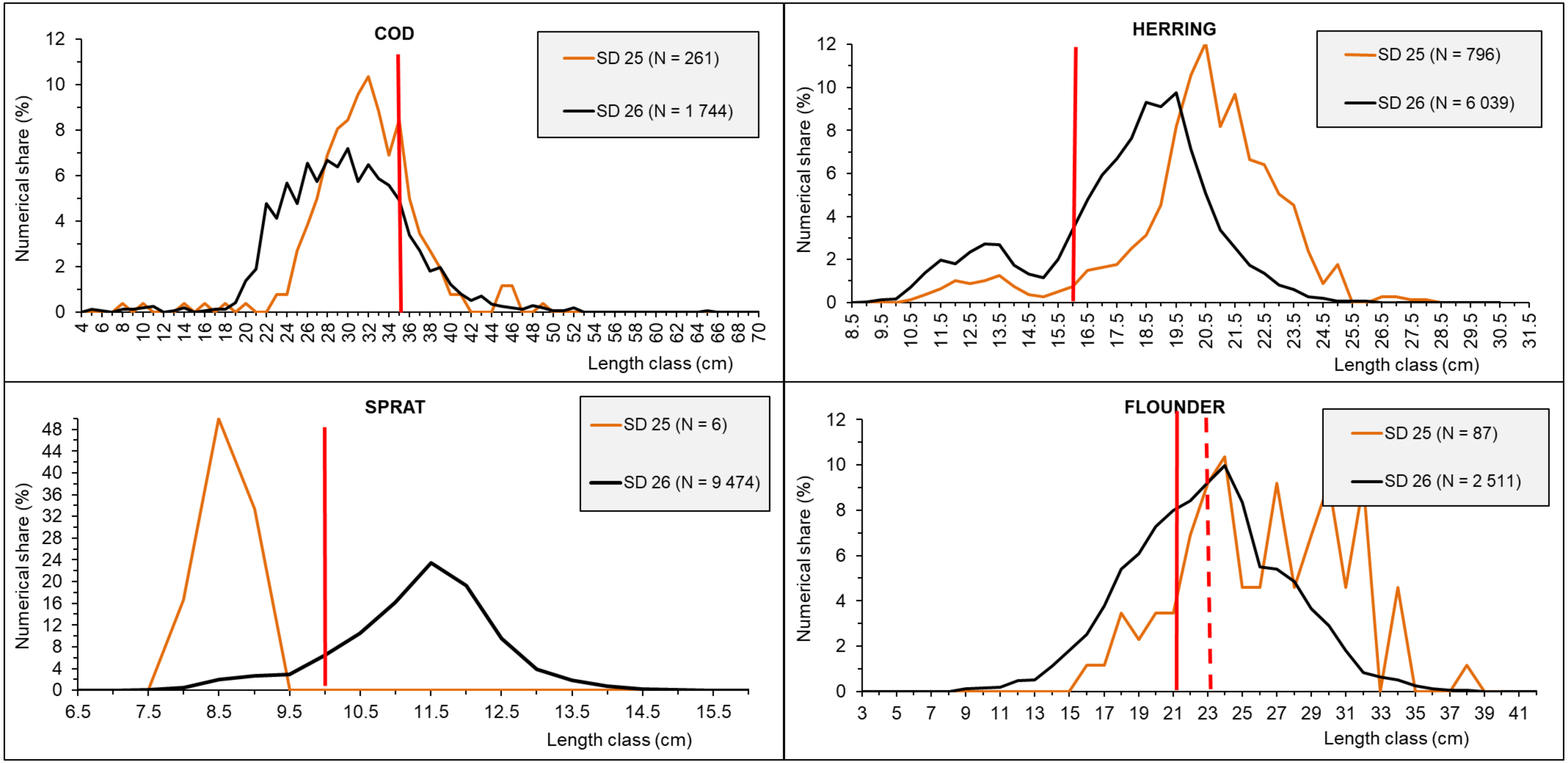

Fig. 3. Length distributions of cod. herring. sprat and flounder in samples from fish control hauls conducted during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022). (red vertical lines indicate minimum landing size).

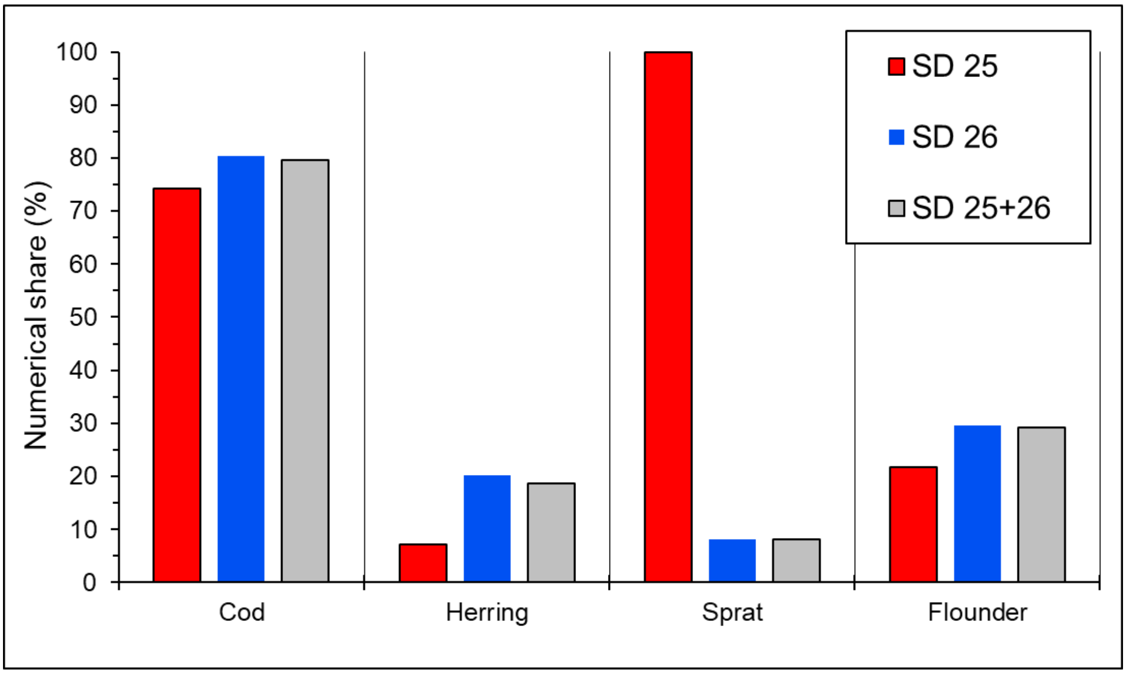

Fig. 4. Mean numerical share (in %) of undersized fish species in samples from fish control hauls conducted during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022).

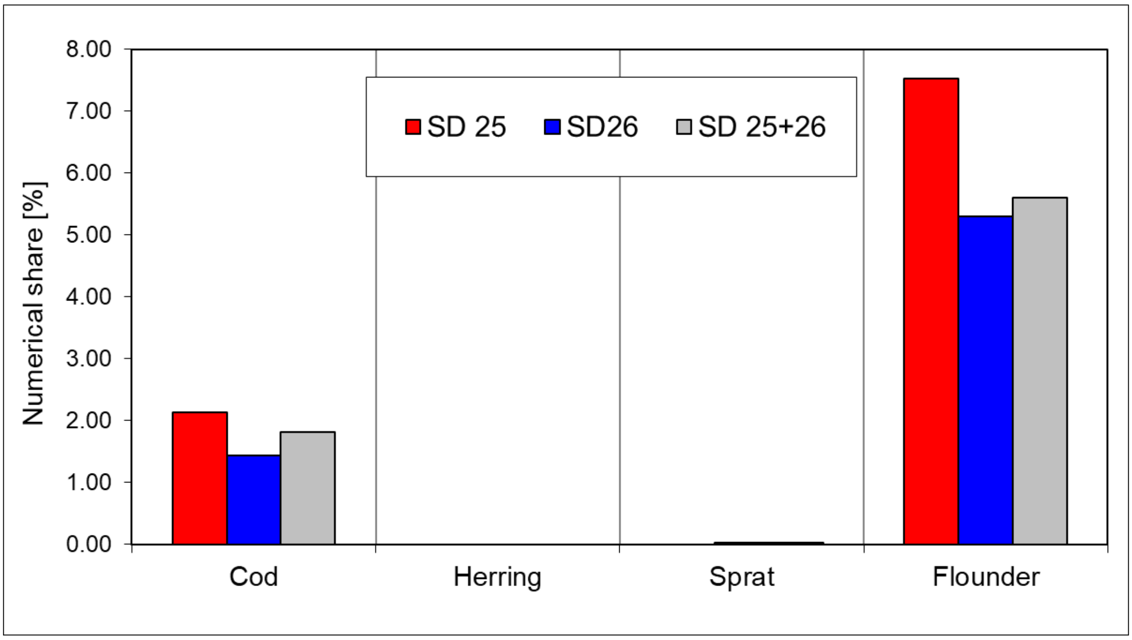

Fig. 5. Mean prevalence (in %-indiv.) of fish with externally visible diseases in samples from fish control hauls conducted during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022).

Tab. 1. Number of fish species individuals measured and aged during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022).

Species name	Number of fish mesured (l.t)			Numer of fish aged and weighed (g)		
	25 ICES Sub-division	26 ICES Sub-division	total	25 ICES Sub-division	26 ICES Sub-division	total
Cod	261	1744	2005	112	186	298
Baltic herring	796	6039	6835	223	550	773
Sprat	6	9474	9480	0	465	465
Flounder	87	2511	2598	87	456	543
Plaice	63	81	144	58	81	139
Eelpout	0	20	20	0	20	20
Fourbeard rockling	0	9	9	0	9	9
European perch	0	1	1	0	1	1
Three-spined stickleback	0	121	121	0	1	1
Short-horn scorpion	45	121	166	20	34	54
Round goby	0	2	2	0	2	2
Smelt	0	1	1	0	1	1
Twaite shad	0	70	70	0	15	15
Turbot	2	5	7	2	5	7
Greater sandeel	6	2	8	4	2	6
Lumpfish	0	8	8	0	5	5
Hooknose	0	2	2	0	2	2
Pike-perch	0	2	2	0	2	2
Whiting	0	1	1	0	1	1
Eel	0	1	1	0	0	0
Sand goby	0	1	1	0	0	0
TOTAL	1266	20216	21482	506	1838	2344

Tab. 2. Fish control-hauls data obtained during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022) (**Hauls no. 1-38**)

Haul number according to survey order	Haul number according to ICES database	Catch date	ICES rectangle	ICES Sub-division	Trawling depth [m]	Geographical position of the catch-station: start/shoot latitude (N)	start/shoot longitude (E)	end latitude (N)	end longitude (E)	Time of shooting net	Trawling duration [min]	Total catch [kg]	Weight of the catch by fish species [kg]: Cod	Baltic herring	Sprat	Flounder	Plaice	Eelpout	Fourbeard rockling	European perch	Three-spined stickleback	Short-horn scorpion	Round goby	Smelt	Twaite shad	Perch	Greater sandeel	Lumpfish	Hooknose	Pike-perch	Whiting	Eel	Sand goby
1	26258	2022-2-8	37G9	26	62	54°26.8'	19°18.5'	54°27.2'	19°20.2'	1145	20	1006.876	9.567	59.877	934.925	1.706						0.173						0.628					
2	26211	2022-2-8	37G9	26	70	54°29.1'	19°20.6'	54°29.6'	19°21.5'	1413	15	196.372	17.730	113.017	58.604	6.650									0.371								
3	26281	2022-2-9	37G9	26	56	54°26.3'	19°2'	54°26.4'	19°3.7'	0736	20	595.881	1.179	262.717	328.303	3.334	0.214	0.035	0.007			0.050	0.042										
4	26289	2022-2-9	37G9	26	54	54°26.2'	19°6.7'	54°26.2'	19°8.3'	0924	20	973.693	0.388	77.395	891.734	3.542		0.139				0.495											
5	26282	2022-2-9	37G9	26	40	54°25.2'	19°1.6'	54°25.2'	19°2.5'	1122	10	1270.563		39.084	1231.169	0.266											0.044						
6	26219	2022-2-9	37G8	26	31	54°24.6'	18°58'	54°24.4'	18°59.7'	1251	20	329.220		231.181	97.569	0.456					0.002					0.012							
7	26263	2022-2-9	37G8	26	27	54°23.9'	18°59.7'	54°23.9'	19°1.3'	1417	20	182.050		151.952	28.784	0.845					0.194			0.234						0.041			
8	26133	2022-2-10	38G8	26	53	54°42.3'	18°46.5'	54°43.4'	18°45.4'	0742	30	467.508	5.600	280.065	28.370	149.720	0.252	0.170	0.328		0.021	2.726						0.237	0.019				
9	26020	2022-2-10	38G8	26	50	54°47.5'	18°42.5'	54°46'	18°43.3'	1012	30	392.811	28.900	302.455	4.724	54.240	0.044					2.250						0.198					
10	26019	2022-2-10	38G8	26	49	54°55.1'	18°36.4'	54°53.7'	18°37.6'	1253	30	312.094	20.510	194.093	33.037	60.130	0.706	0.183				3.246						0.189					
11	26268	2022-2-10	38G8	26	71	54°59.8'	18°30.2'	54°59'	18°32.4'	1518	30	498.663	189.170	50.593	0.832	251.550	4.546			0.090		1.396			0.022			0.284			0.180		
12	25008	2022-2-11	37G5	25	29	54°22.9'	15°34.9'	54°22.9'	15°37.3'	0803	30	3.902				1.254	0.857					1.770					0.021						
13	25041	2022-2-11	37G5	25	45	54°25.7'	15°36.4'	54°25.3'	15°38.8'	0933	30	20.297	8.375	2.431		5.056	3.607					0.828											
14	25009	2022-2-11	37G5	25	30	54°22.6'	15°43.3'	54°22.9'	15°45.8'	1145	30	35.027	0.609	25.400		4.024	2.635					2.295					0.064						
15	25011	2022-2-11	37G5	25	27	54°24'	15°58.9'	54°24.4'	16°1.6'	1337	30	6.233	0.022	3.570	0.009	1.404	0.448					0.766					0.014						
16	25010	2022-2-11	37G5	25	28	54°25.2'	16°0'	54°25.9'	16°2.2'	1510	30	14.724	12.530			0.967	0.738	0.341				0.148											
17	25013	2022-2-12	38G6	25	32	54°38.5'	16°22.6'	54°39.2'	16°24.8'	0739	30	25.135	19.680	3.325	0.004	1.861	0.120					0.145											
18	25014	2022-2-12	38G6	25	29	54°41'	16°35.2'	54°41.4'	16°37.7'	0955	30	6.932	4.510	0.163		1.133	0.739	0.387															
19	25017	2022-2-12	38G6	25	29	54°43.6'	16°49.1'	54°44.3'	16°51.6'	1146	30	91.747	14.540	76.480	0.007	0.720																	
20	25016	2022-2-12	38G6	25	31	54°44.9'	16°49.5'	54°46'	16°51.7'	1400	30	18.485	17.117	1.364	0.004																		
21	25024	2022-2-14	38G7	25	24	54°50.9'	17°28.7'	54°51.2'	17°31.1'	0737	30	26.321	8.230	15.660		1.867	0.141					0.423											
22	26177	2022-2-14	38G8	26	24	54°54'	18°10.2'	54°54'	18°12.9'	1123	30	35.373	3.887	26.920	1.742	1.995	0.829																
23	26274	2022-2-14	38G8	26	23	54°53.9'	18°11.2'	54°54'	18°13.7'	1247	30	20.054	9.267	4.854	2.080	3.515						0.324					0.014						
24	26005	2022-2-14	38G8	26	23	54°53.8'	18°10.8'	54°53.9'	18°13.4'	1420	30	91.035	55.260	25.150	7.200	2.789	0.631				0.005												
25	26191	2022-2-15	38G9	26	86	54°37.4'	19°18.4'	54°38.8'	19°18.4'	0753	30	67.091		0.621	53.935	11.350									1.185								
26	26269	2022-2-15	38G9	26	86	54°37'	19°9.5'	54°38.3'	19°10.8'	1010	30	119.393	0.422	5.593	109.747	3.594				0.037													
27	26287	2022-2-15	38G9	26	85	54°37.7'	19°2.4'	54°39.1'	19°1.6'	1205	30	14.963	0.694	0.827	11.060	2.382																	
28	26280	2022-2-15	38G8	26	66	54°30.6'	18°54.4'	54°31.3'	18°54.9'	1440	15	152.834	2.959	47.126	78.757	19.460	0.106		0.198			0.115	0.027		4.086								
29	26279	2022-2-15	38G8	26	67	54°31.6'	18°56.1'	54°32.3'	18°56.4'	1556	15	207.409	1.224	75.400	98.019	27.550	0.268		0.065	0.178					4.705								
30	26266	2022-2-16	38G8	26	23	54°49.2'	18°31.9'	54°50.5'	18°30.4'	0740	30	38.547	7.751	22.640	0.412	6.690		1.054															
31	26267	2022-2-16	38G8	26	48	54°53.7'	18°37.6'	54°55'	18°36.3'	0920	30	106.489	8.638	24.313	12.557	57.480	1.948					1.190						0.228	0.134				0.001
32	26007	2022-2-16	38G8	26	31	54°51.3'	18°34.7'	54°50.4'	18°36.4'	1113	30	18.305	0.767	12.280	0.792	3.788	0.386					0.292											
33	26131	2022-2-20	37G9	26	34	54°24.3'	19°1.9'	54°24.4'	19°3.6'	0734	20	164.039	0.395	158.842	1.388	2.668	0.169				0.148	0.287						0.110		0.032			
34	26001	2022-2-20	37G9	26	26	54°23.1'	19°13.4'	54°23.4'	19°15.2'	0902	20	53.234		26.833	23.687	2.712					0.002												
35	26216	2022-2-20	37G9	26	34	54°24'	19°15.9'	54°24.1'	19°16.7'	1010	10	2467.907		253.150	2212.326	2.280						0.151											
36	26264	2022-2-20	37G9	26	43	54°25.2'	19°2.5'	54°25.3'	19°3.7'	1214	15	90.421		40.130	48.970	1.140	0.077		0.062		0.042												
37	26265	2022-2-20	37G9	26	55	54°26'	19°7.2'	54°26.2'	19°8.9'	1324	20	589.337	5.252	138.736	431.988	10.960			0.137		0.064	0.710			1.345							0.145	
38	26220	2022-2-20	37G9	26	42	54°25.2'	19°2.4'	54°25.2'	19°4'	1516	20	103.301	0.467	67.798	30.877	3.825					0.049	0.285											

Tab. 2. Fish control-hauls data obtained during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022) (**Hauls no. 39-73**)

number according to survey order	number according to ICES database	Catch date	rectangle	Sub-division	depth [m]	start/shoot latitude (N)	start/shoot longitude (E)	end latitude (N)	end longitude (E)	shooting net	duration [min]	Total catch [kg]	Cod	Baltic herring	Sprat	Flounder	Plaice	Eelpout	Fourbeard rockling	European perch	Three-spined stickleback	Short-horn scorpion	Round goby	Smelt	Twaite shad	Perch	Greater sandeel	Lumpfish	Hooknose	Pike-perch	Whiting	Eel	Sand goby
39	26086	2022-2-22	38G8	26	97	54°58.6'	18°47.3'	54°58.4'	18°48.3'	1542	15	63.532			61.300	2.232																	
40	26182	2022-2-24	39G8	26	62	55°2.5'	18°18.3'	55°2.3'	18°20.8'	0744	30	77.203	33.830	19.300	0.043	22.520	0.927					0.583											
41	26273	2022-2-24	39G8	26	93	55°7.3'	18°40.7'	55°7.7'	18°42'	1029	20	27.181			24.120	2.636	0.371			0.054													
42	26093	2022-2-24	39G8	26	89	55°10.3'	18°39.1'	55°10.9'	18°38.2'	1157	15	97.428			95.810	1.543				0.075													
43	26094	2022-2-24	39G8	26	88	55°10.6'	18°55.1'	55°11.1'	18°56'	1415	15	16.077	4.045	0.565	10.920	0.491									0.056								
44	26045	2022-2-24	39G9	26	83	55°14.9'	19°5.7'	55°15.7'	19°5.4'	1559	15	12.522		0.261	12.260						0.001												
45	26077	2022-2-26	41G8	26	77	56°27.2'	18°40.2'	56°27.8'	18°40.8'	0742	15	58.577		0.628	57.818						0.131												
46	26076	2022-2-26	41G8	26	79	56°26.6'	18°39.8'	56°27.2'	18°40.2'	0905	15	64.823	0.002	0.914	63.819						0.088												
47	26125	2022-2-26	41G8	26	76	56°24'	18°36.5'	56°23.4'	18°35.6'	1027	15	1140.109			1139.188	0.921																	
48	**26141**	**2022-2-26**	**41G8**	**26**	**111**	**56°18.9'**	**18°39.9'**			1153			**no oxygen --> haul not conducted**																				
49	26124	2022-2-26	41G8	26	84	56°16.2'	18°31.6'	56°15.7'	18°31.1'	1259	10	193.752			193.608	0.130					0.014												
50	26224	2022-2-26	41G8	26	39	56°21.8'	18°27.1'	56°22.7'	18°27.8'	1433	20	64.193	3.567	53.790	0.365	2.656					0.035	3.780											
51	26013	2022-2-26	41G8	26	45	56°22.4'	18°29.4'	56°23'	18°30.1'	1537	15	162.894	0.263	157.500	0.192	1.654					0.005	3.280											
52	26069	2022-2-27	41G8	26	75	56°12.8'	18°26.7'	56°12.4'	18°26.3'	0735	10	177.354		5.097	171.606	0.651																	
53	26170	2022-2-27	41G8	26	75	56°9.9'	18°20.3'	56°10.4'	18°21.2'	0902	15	184.556		12.658	170.934	0.964																	
54	**26221**	**2022-2-27**	**40G8**	**26**	**113**	**55°55.2'**	**18°35.3'**			1158			**no oxygen --> haul not conducted**																				
55	**26140**	**2022-2-27**	**41G8**	**26**	**122**	**56°0.4'**	**18°54'**			1343			**no oxygen --> haul not conducted**																				
56	26122	2022-2-27	40G9	26	86	55°59.5'	19°15.6'	55°59.8'	19°16.3'	1532	10	29.786		7.093	22.080	0.612					0.001												
57	26060	2022-2-27	40G9	26	73	55°59.2'	19°20'	55°59.3'	19°21.3'	1632	15	3.757		0.197	3.560																		
58	26081	2022-2-28	41H0	26	80	56°27.4'	20°12.5'	56°27.8'	20°12.7'	0735	10	75.444	1.177	13.222	59.094	1.828									0.123								
59	26160	2022-2-28	41H0	26	90	56°29.1'	20°8.8'	56°29.7'	20°9.9'	0850	20	13.716	0.587	0.241	11.520	1.323				0.043	0.002												
60	26145	2022-2-28	41G9	26	113	56°27.5'	19°49.2'	56°27.1'	19°48.3'	1124	15	2.059			2.058						0.001												
61	26199	2022-2-28	41G9	26	117	56°22.5'	19°41.5'	56°22.2'	19°40.9'	1312	10	0.457		0.190	0.265						0.002												
62	26259	2022-2-28	41G9	26	83	56°21.5'	19°51.5'	56°21'	19°51'	1452	10	587.467	22.170	21.069	441.155	101.760									1.313								
63	26078	2022-2-28	41H0	26	74	56°21.4'	20°2.6'	56°21.8'	20°2.9'	1624	10	503.693	1.221	8.989	489.991	3.332						0.160											
64	26031	2022-3-1	41G9	26	62	56°10.2'	19°54.9'	56°10.9'	19°55.1'	0734	15	7.644		6.846	0.788						0.010												
65	26073	2022-3-1	41G9	26	73	56°15.4'	19°39.5'	56°16.1'	19°39.8'	0943	15																						
66	**26209**	**2022-3-1**	**41G9**	**26**	**118**	**56°18.1'**	**19°31.8'**			1111			**no oxygen --> haul not conducted**																				
67	**26144**	**2022-3-1**	**41G9**	**26**	**143**	**56°22'**	**19°29.2'**			1159			**no oxygen --> haul not conducted**																				
68	26071	2022-3-1	41G9	26	112	56°14.7'	19°31.2'	56°15.1'	19°31.4'	1352	10	55.28			54.250	1.030																	
69	26142	2022-3-1	41G9	26	103	56°11.3'	19°27'	56°11.7'	19°27.4'	1535	10	0.412		0.012	0.279	0.116					0.005												
70	**26138**	**2022-3-1**	**40G8**	**26**	**115**	**55°52.8'**	**18°49.2'**			1956			**no oxygen --> haul not conducted**																				
71	26091	2022-3-3	39G9	26	95	55°6.9'	19°4.8'	55°6.9'	19°3.6'	0740	15	49.194	31.140	6.089	0.165	11.800																	
72	26278	2022-3-3	38G8	26	96	54°58.7'	18°47'	54°58.5'	18°48.1'	1011	15	12.871	1.081	0.230	4.260	7.262					0.002				0.036								
73	26257	2022-3-3	38G9	26	103	54°57'	19°2.6'	54°56.3'	19°2.8'	1216	15	16.626	0.508	0.179	11.6	4.302									0.037								

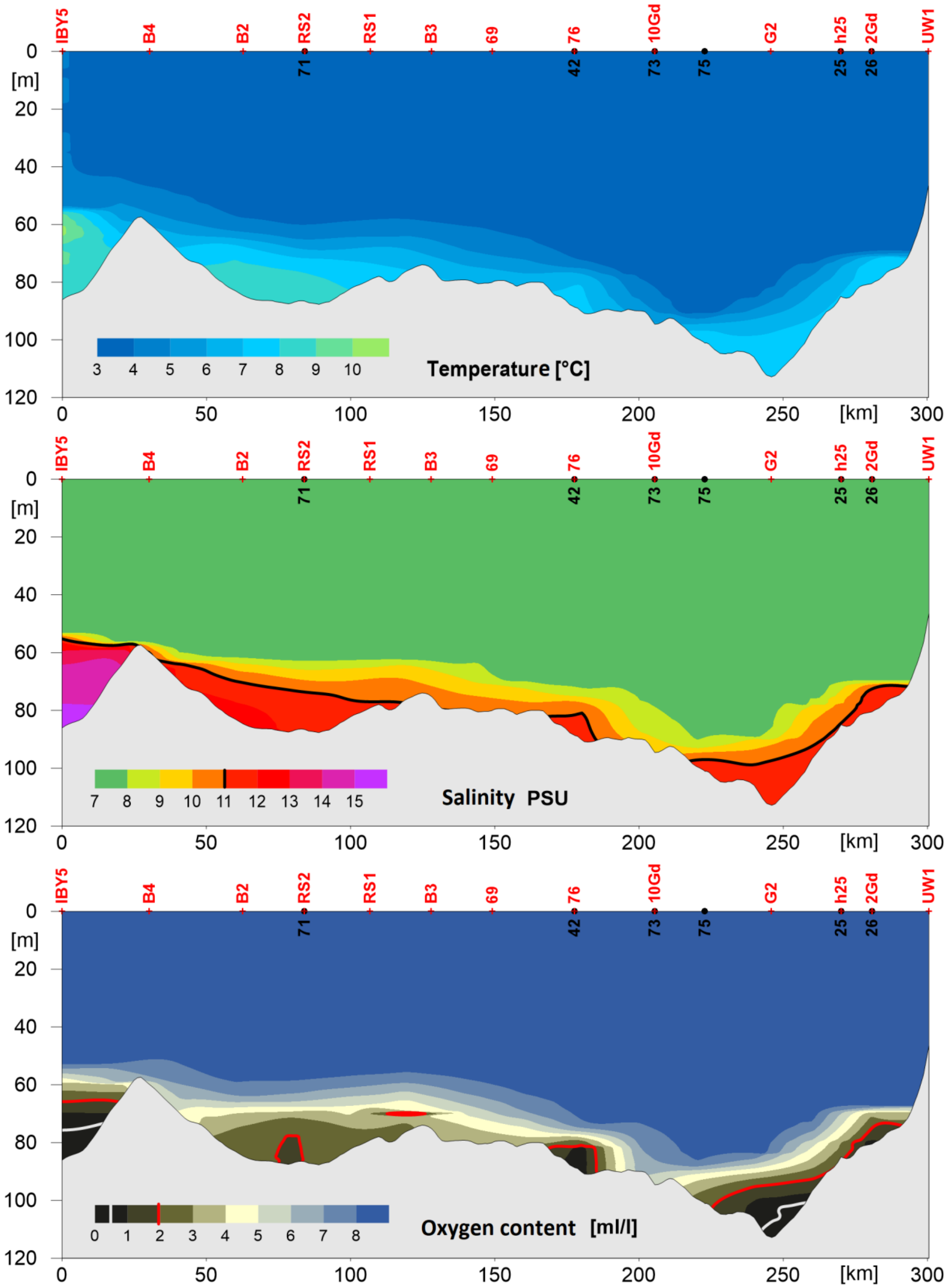

Fig. 6. Vertical distribution of the seawater temperature. salinity and oxygen content along the hydrological research profile during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022).

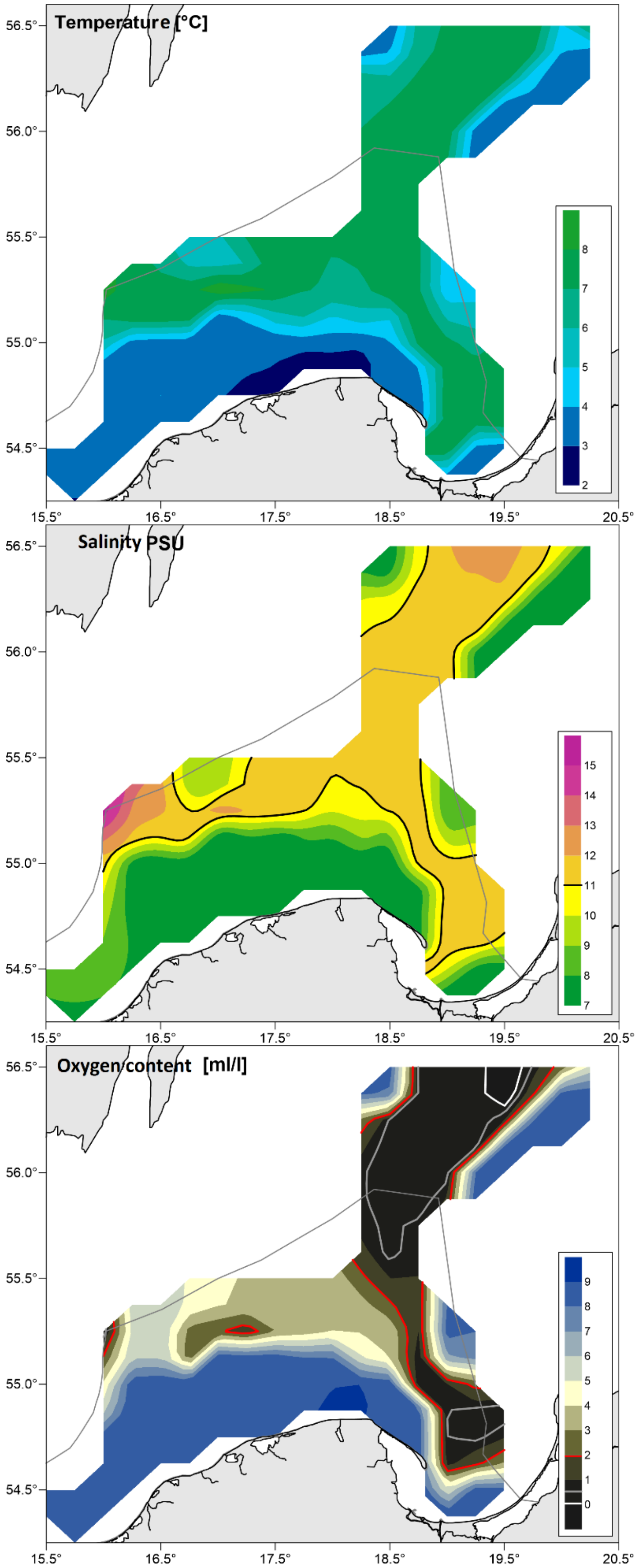

Fig. 7. Horizontal distribution of the seawater temperature. salinity and oxygen content in the near bottom layer during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022).

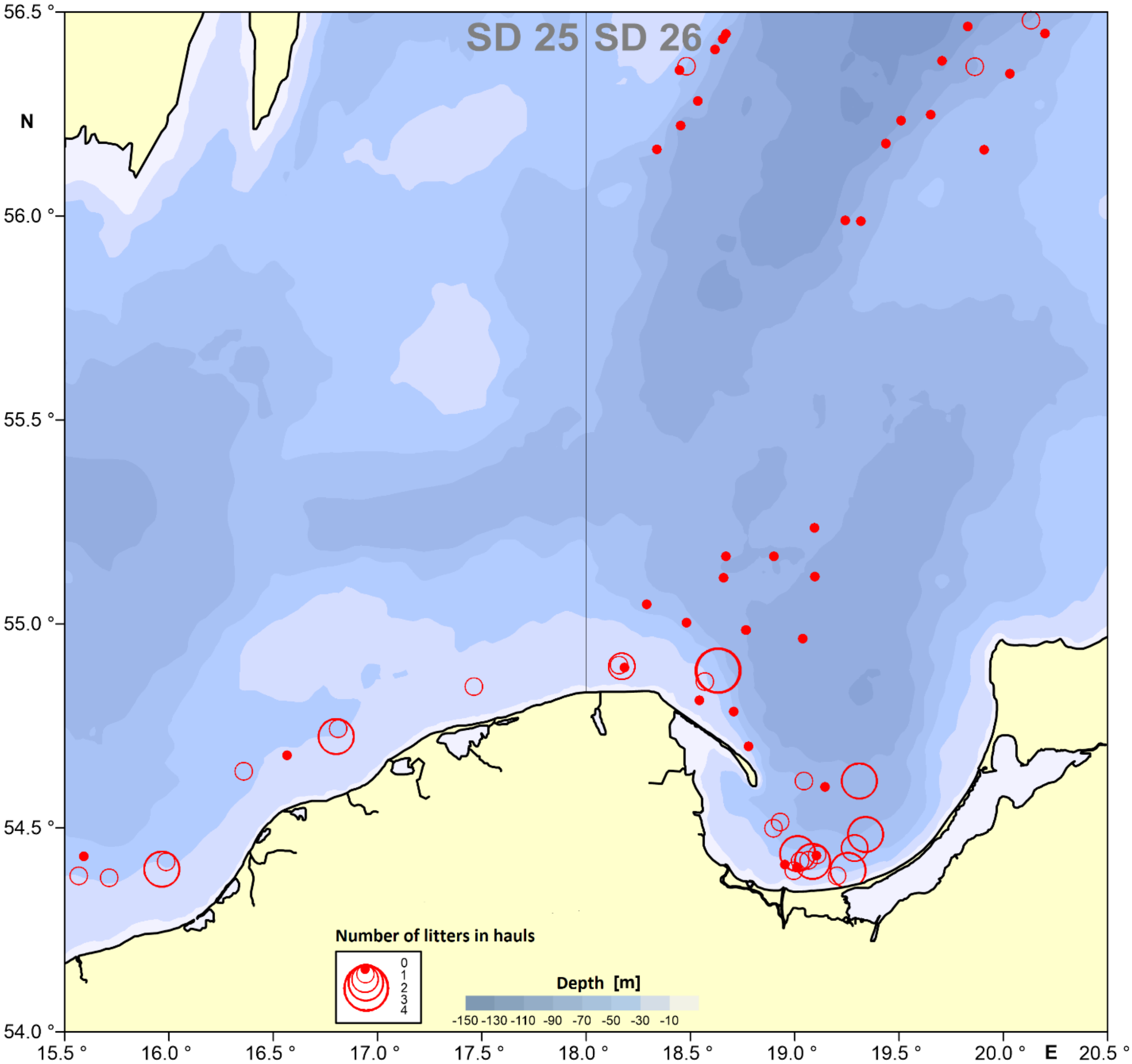

Fig. 8. Marine litter collected during r/v Baltica BITS-1Q cruise (08.02-04.03. 2022).

Institute of Food Safety, Animal Health and Environment (BIOR), Riga (Latvia)

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THE CRUISE REPORT

FROM THE JOINT LATVIAN-POLISH BITS 1Q SURVEY ON THE POLISH R.V. "BALTICA" IN THE CENTRAL-EASTERN BALTIC (06-14 March 2022)

by

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Gdynia - Riga, April 2022

Introduction

The joint Latvian-Polish BITS survey, conducted in the period of 06-14.03.2022 on the r.v. “Baltica”, was based on the agreement between the Institute of Food Safety, Animal Health and Environment (BIOR) in Riga and the National Marine Fisheries Research Institute (NMFRI) in Gdynia. The joint Latvian-Polish BITS 1Q survey was conducted in the Latvian and Estonian EEZs (the ICES Sub-divisions 26 and 28). It was part of the Baltic International Trawl Survey (BITS), which was coordinated by the ICES Baltic International Fish Survey Working Group [WGBIFS] (Anon. 2021).

The main aims of reported cruise were:

1. Collecting materials to investigate the distribution, abundance, and biological structure of cod stock.
2. Determine distribution and abundance of cod recruits. Estimates of year – class strength of cod.
3. Collecting materials to investigate the distribution abundance and biological structure of flounder stock.
4. Collect data on cod feeding.
5. Analysis of the hydro-meteorological conditions (seawater temperature, salinity, oxygen content, air temperature, atmospheric pressure, wind velocity and directions) in the ICES Sub-divisions 26N and 28.
6. Acoustic data recording during trawling and on the distance between consecutive catch-stations.
7. Collecting information about marine litter.
8. Collecting ichthyoplankton samples.

MATERIALS AND METHODS

Personnel

The BITS 1Q - 2022 survey scientific staff was composed of eight persons, i.e.:
Radosław Zaporowski, NMFRI, Poland - cruise leader,
Krzysztof Radtke, NMFRI, Poland - ichthyologist,
Bartosz Witalis, NMFRI, Poland - hydrologist,
Władysław Gaweł, NMFRI, Poland - ichthyologist,
Łukasz Dziemian, NMFRI, Poland - ichthyologist,
Karina Choma-Stolarek, NMFRI, Poland - ichthyologist,
Michał Zimak, NMFRI, Poland - ichthyologist,
Maciej Bielak, NMFRI, Poland – acoustician.

Narrative

BITS 1Q was performed on R.V. “Baltica” with Polish scientific team. Due to Covid-19 travel restriction, Latvian team could not travel to the vessel and take part in the survey. Survey was done according to manual and supervision of Latvian team from coast.

The reported survey research tasks realisation took place during the period of 06-14 March 2022 and overall, nine days was devoted to survey plan accomplishment. The at sea researches were conducted within the Latvian and Estonian EEZs (the ICES Sub-divisions 26 and 28) moreover, inside the Latvian territorial waters, not shallower than 20 m (the ICES Sub-division 28).

The vessel left the Gdynia port (Poland) on 06.03.2022 and was navigated towards the southwestern corner of the Latvian EEZ (Figure 1). The direct at sea research began on 06.03.2022 and ended on 13.03.2022. On 14.03.2022 r.v. "Baltica" returned to the homeport.

Survey design and realization

The original surveys plan provided that 22 control-hauls will be realized in the Latvian EEZ (3 trawls in ICES Sub-division 26, 19 trawls in ICES Sub-division 28) and 3 control-hauls will be realized in the Estonian EEZ in ICES Sub-division 28. Totally – 25 randomly selected hauls. Five additional trawls were planned in ICES Sub-division 26, in the Latvian EEZ.

The r.v. "Baltica" realized 30 bottom trawl control-hauls including the Latvian territorial waters (Figure 1). One catch-station was only initiated by hydrological parameters measurement and due to very low oxygen concentration (below 0.5 ml/l) near the bottom, fishing was omitted.

All trawl catches were performed in the daylight. The hard-bottom ground-rope (rockhopper) trawl, type TV-3#930 (with 10-mm mesh bar length in the codend) was applied for fish catches. The mean speed of vessel while trawling was 3.0 knots. For all realized trawls, their duration was shortened to 15-20 minutes, due to dense clupeids concentrations observed on the echosounder or hard bottom.

The length measurements in the 1.0-cm classes were realised for 708 cod and 2266 flounder. Length measurements in the 0.5-cm classes were realized for 1557 herring and 2621 sprat. In total, 155 cod and 519 flounder individuals were taken for biological analysis. Stomachs from 155 cod were taken for investigation of cod feeding.

Acoustic data, i.e. the echo-integration records (SA = NASCs; Nautical Area Scattering (Strength) Coefficient) were collected with the EK-60 scientific echosounder during fishing operations and on the distances between consecutive hauls. Echo-sounding data collected during the BITS survey were delivered to the Latvian researchers for further analysis.

Directly before every haul, the seawater temperature, salinity and oxygen content were measured continuously from the sea surface to the bottom. The seawater samples were taken also at the standard HELCOM stations. Totally, 35 hydrological stations were inspected with the Neil-Brown CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method.

Meteorological observations of wind velocity and directions and the sea state were realized at the actual geographic position of each control-haul.

Ichthyoplankton samples were collected at 14 stations.

Results

Fish catches and biological data

The control-catches basic results collected in March 2022 during the Latvian-Polish BITS-1Q survey are presented in Table 1. Thirty hauls were realized during the survey, 23 hauls in Sub - division 28, 7 hauls in Sub - division 26. Overall, 14 fish species were recognised in hauls performed in the central-eastern Baltic.

Sprat, herring, flounder and cod were the most frequently occurring fish species in the catches in Sub-division 26 - 100%, 100%, 86% and 57% of realized hauls, respectively (Table 1). Sprat dominated by mass in the ICES Sub- division 26 with the average share of 56.3%. Herring was the next species most frequently represented in terms of mass, i.e. 20.3%. The share of cod and flounder in control-catches made out in the ICES SD 26 was 14 and 9.2%, respectively. The mean CPUE for all species in SD 26 amounted 395.3 kg/h, and in this 234.6, 86.6, 73.7 and 42.9 kg/h were for sprat, cod, herring and flounder respectively (Figure 2). By-catch of other fish species was insignificant.

Flounder, sprat, herring and cod were the most frequently occurring fish species in the catches in Sub-division 28 - 96%, 91%, 83% and 43% of realized hauls, respectively (Table 1.).
Herring dominated by mass in the ICES Sub-division 28 with the average share of 48.0%. Sprat was the next species most frequently represented in terms of mass, i.e. 40.9%. Flounder was the third species most frequently represented in terms of mass in the ICES SD 28 (9.9%). The share of cod in control-catches made out in the ICES SD 28 was 0.9 %. The mean CPUE for all species in SD 28 amounted 331.8 kg/h, and in this 191.0, 137.5, 31.9 and 6.7 kg/h were for herring, sprat, flounder and cod, respectively (Figure 2). By-catch of other fishes was insignificant.

Total catch of fishes and the number of realized hauls in the Latvian and Estonian EEZs, during reported BITS survey is presented in the text-table below:

EEZ	Number of hauls	Total catch kg				
		Cod	Herring	Sprat	Flounder	Others
Latvian	26	132.7	688.4	1107.5	273.3	4.9
Estonian	3	2.9	515.1	239.3	16.8	0.9

Total catch of fishes and the number of realized hauls by Sub-divisions, during reported BITS survey is presented in the text-table below:

SD	Number of hauls	Total catch kg				
		Cod	Herring	Sprat	Flounder	Others
26	7	115.098	167	464	75.8	1.6
28	22	20.5	1036.5	882.9	214.3	4.1

The distribution of cod and flounder during the survey in kg/h are presented in Figure 3 and Figure 4. The length distributions of cod, flounder, herring and sprat, according to the ICES Sub-divisions are illustrated in Figures 6-9 and Tables 3-6.

Cod

The total length of cod in scrutinized samples ranged from 6 to 47 cm and specimens from the length classes of 21 - 35 cm dominated in samples from the ICES Sub-division 26. Totally 620 cod from hauls in Sub-division 26 was measure and from that number 612 cod occurred in haul number 28.

The total length of cod in scrutinized samples ranged from 5 to 49 cm and specimens from the length classes of 18 - 34 cm dominated in samples from the ICES Sub-division 28 (Figure 6, Table 3). Totally in the hauls in Sub-division 28 occurred 88 cod.

A very low number of small cod (< 19 cm) was observed and they occurred in some hauls only. Almost all cod were less than minimal industrial fishing size 35 cm, 91.8% in Sub-division 26 and 84.9% in Sub-division 28 (Figure 5.).

Flounder

The total length of flounder in scrutinized samples ranged from 17 to 33 cm and specimens from the length classes of 19 - 28 cm dominated in samples from the ICES Sub-division 26. Totally 494 flounder occurred in hauls in Sub-division 26.

The total length of flounder in scrutinized samples ranged from 9 to 41 cm and specimens from the length classes of 16 - 26 cm dominated in samples from the ICES Sub-division 28 (Figure 7, Table 4). Totally 1772 flounder occurred in hauls in Sub-division 28.

The share of flounder less than minimal industrial fishing size - 21 cm was 16.6% in Sub-division 26 and 45.4% in Sub-division 28 (Figure 5).

Herring

The length range of collected herring was 12.5-22.0 cm, and specimens from the length classes of 15.0-20.0 cm were most frequently represented in samples from the ICES Sub-division 26. Totally 218 herring occurred in hauls in Sub-division 26.

The length range of collected herring was 10.5-24.0 cm, and specimens from the length classes of 15.0-19.5 cm were most frequently represented in samples from the ICES Sub-division 28 (Figure 8, Table 5). Totally 1339 herring occurred in hauls in Sub-division 28

Sprat

The length range of collected sprat was 9.5-13.5 cm, and specimens from the length classes of 10.0-13.0 cm were most frequently represented in samples from the ICES Sub-division 26. Totally 648 sprat occurred in hauls in Sub-division 26.

The length range of collected sprat was 7.5-15.5 cm, and specimens from the length classes of 8.5-13.0 cm were most frequently represented in samples from the ICES Sub-division 28 (Figure 9, Table 6). Totally 1973 sprat occurred in hauls in Sub-division 28.

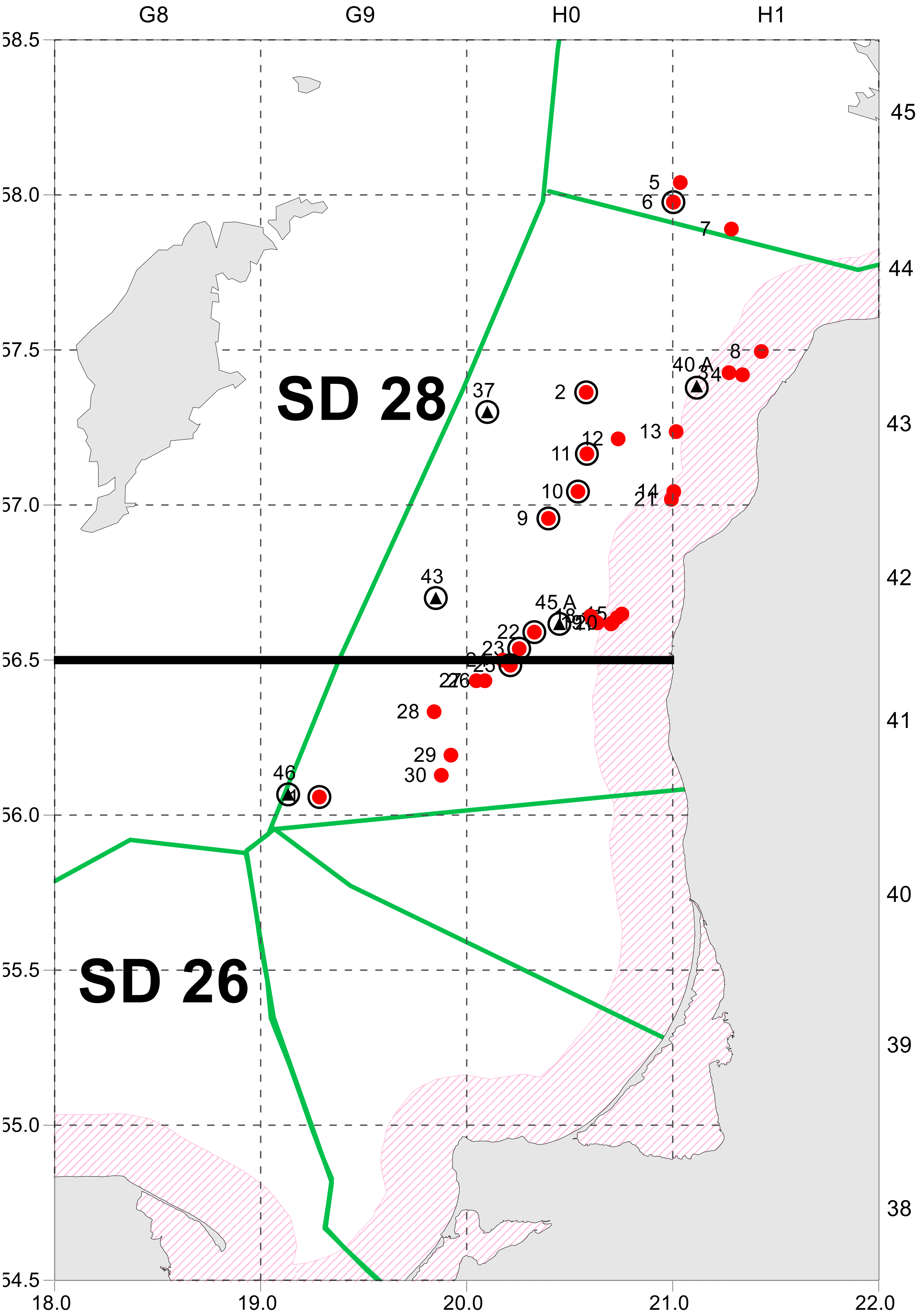
Hydrological situation in March 2022

The main hydrological parameters were measured at each trawling (30) and hydrological stations (5) (Fig. 1). Measurements were conducted with the CTD SeaBird 911-probe combined with the rosette sampler. Oxygen content was determined by the standard Winkler’s method. The STD data were aggregated to the 1-m depth strata. The salinity parameter was presented in Practical Salinity Unit (PSU). Meteorological parameters were measured by MicroStep-MIS AMS 111 automatic weather station.

The most frequent winds (Fig. 10) were from direction WNW. The average (10 min) wind speed varied from 1.3 m/s to 9.3 m/s (up to 19.2 m/s). The air temperature ranged from --2.2 °C to 5.2 °C, and average temperature was 2.2 °C.

The lowest value of temperature at the surface layer was observed at the trawl 5, while the warmest surface water was at the trawl 23. The temperature varied from 2.17 °C to 3.64 °C, while the average value was 3.18 °C. The average surface salinity was 7.37 in the PSU. The minimum value was 6.59 at the trawl 8 and maximum 7.70 at the trawl 23. The highest oxygen content in surface water layer was 9.64 ml/l at the hydrographic station 46 while the lowest one 7.00 ml/l at the trawl 27. Mean value of dissolved oxygen equaled 8.40 ml/l.

Near - bottom layer conditions are presented in the (Fig. 11). Water temperature varied from 7.82 °C (station 46) to 3.54 °C (trawl 8). The mean value calculated for the whole area covered during the cruise was 5.35 °C. The average salinity in the close-to-the-bottom water layers was 9.49 PSU. The highest value was measured at the hydrological station 37 (12.92). The lowest one was 7.57 (haul 14). The dissolved oxygen varied from 0.00 ml/l (hydrological stations 37 & 43) to 8.74 ml/l (trawl 3). The mean value was 4.61 ml/l. In Fig. 12 it is presented Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological transect of the Gotland Deep (March 2022)



G8
G9
H0
H1
SD 28
SD 26
58.5
58.0
57.5
57.0
56.5
56.0
55.5
55.0
54.5
18.0
19.0
20.0
21.0
22.0
45
44
43
42
41
40
39
38

Figure 1. Location of the realized fish control-hauls (marked with red dots) and the HELCOM standard hydrological stations (marked with black triangles), ichthyoplankton stations marked with black circles, green lines - national fishing zone borders, coloured area in pink - territorial waters.

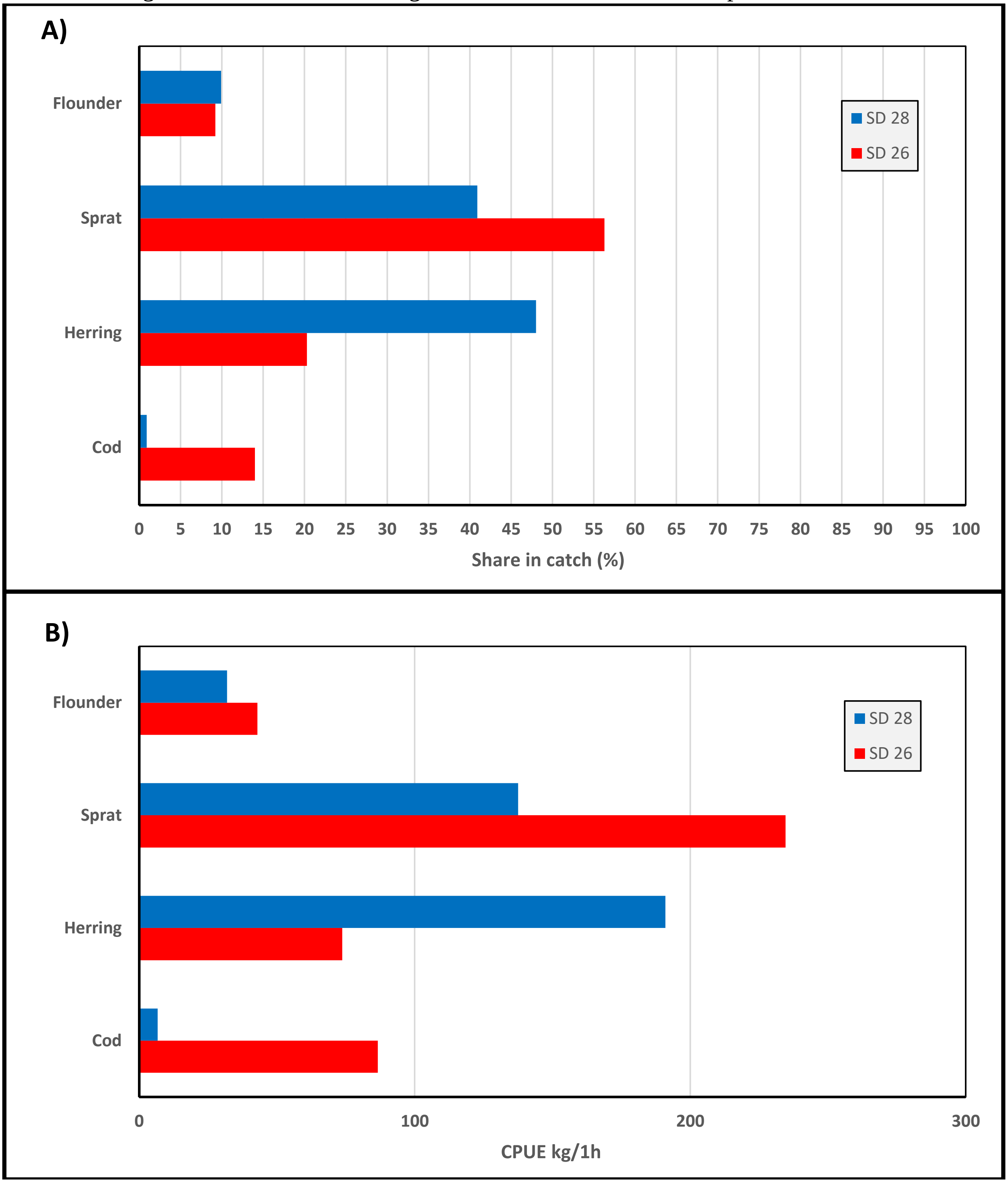


Figure 2. Mean share in mass of control hauls (A) and mean CPUE (B) of dominant fish species in catches conducted during the BITS 1Q survey; r.v. "Baltica" (06-14 March 2022).

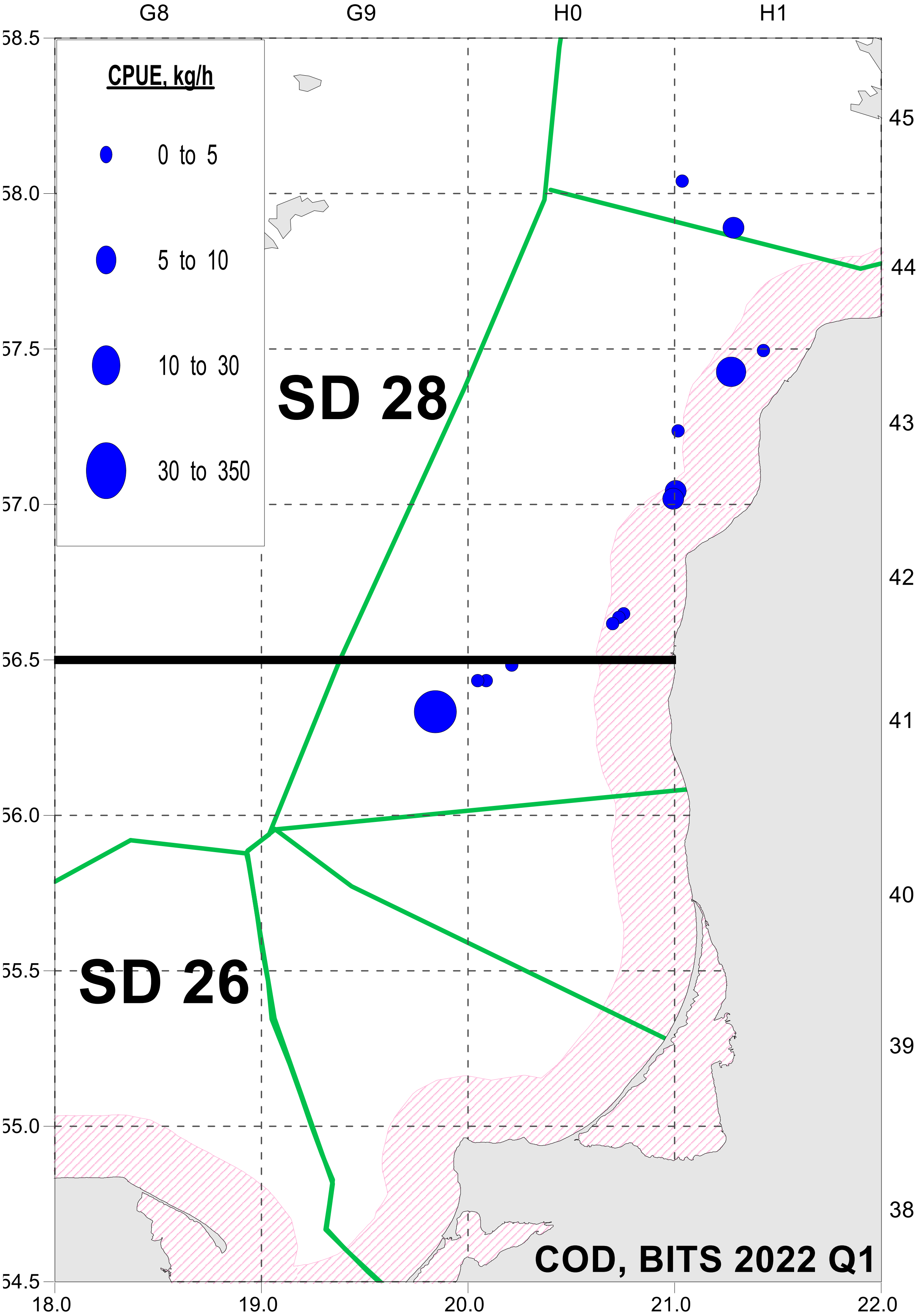


Figure 3. Distribution of cod during the BITS 2022 1Q survey.

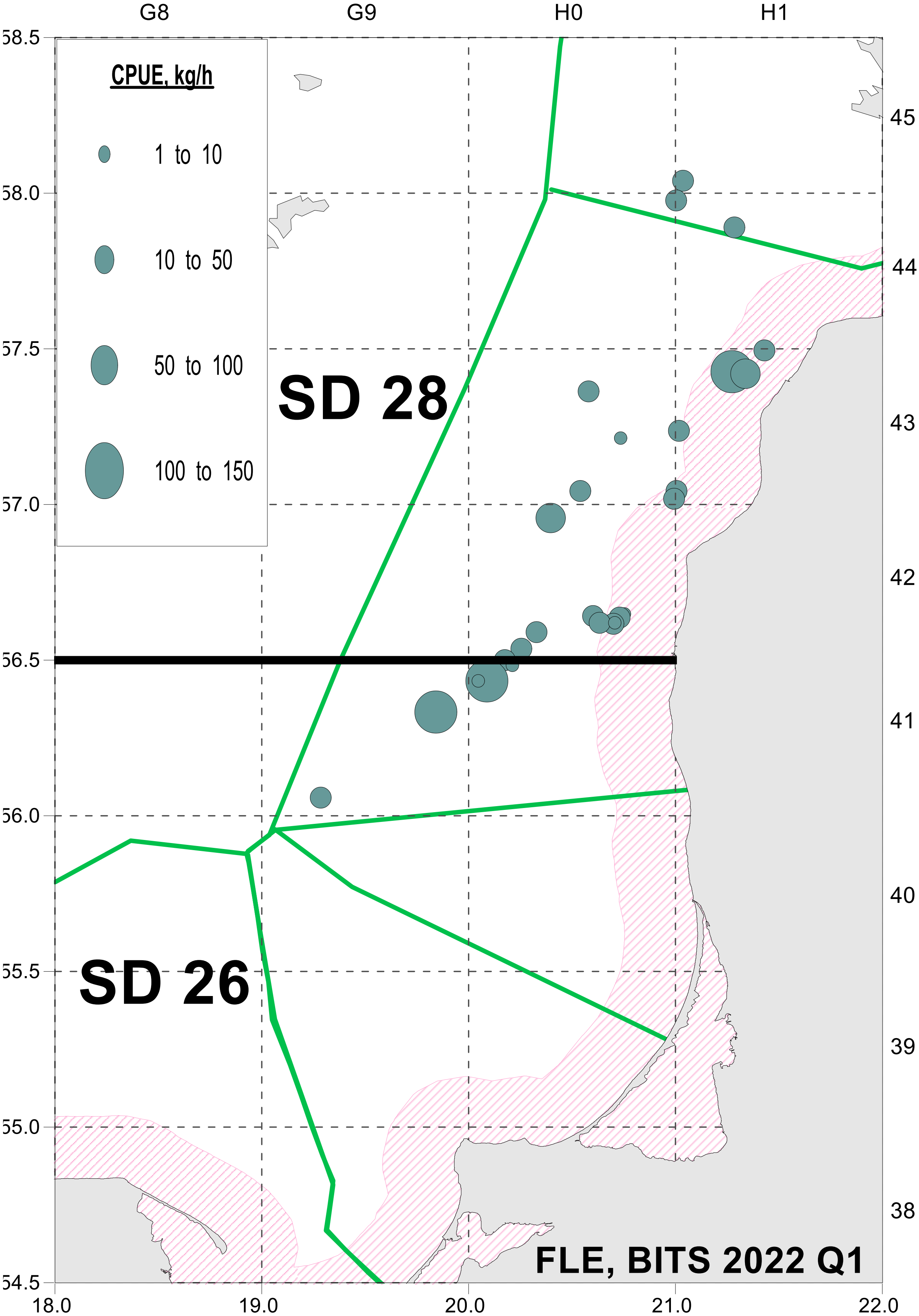


Figure 4. Distribution of flounder during the BITS 2022 1Q survey.

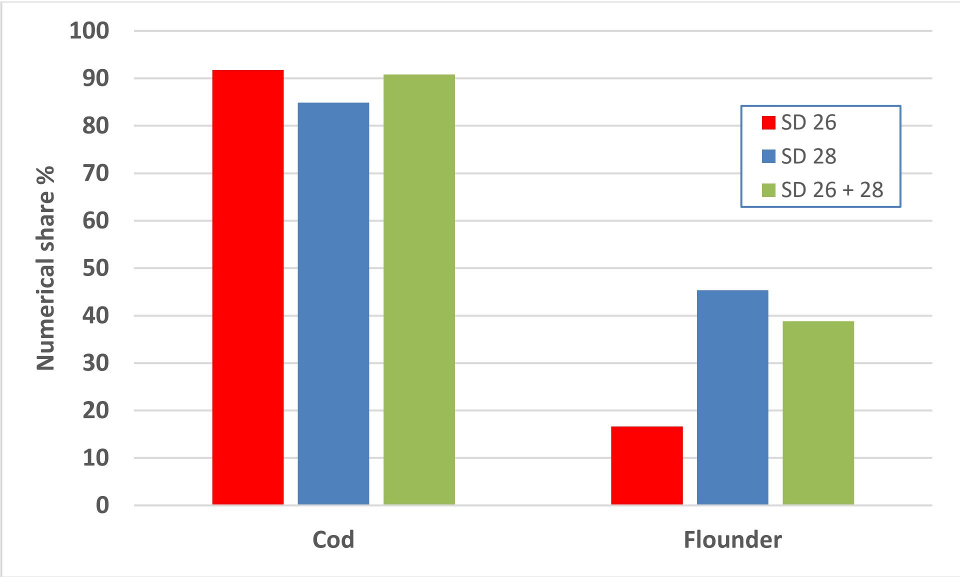


Figure 5. Fraction of undersized cod and flounder during the BITS 1Q survey; r.v. "Baltica" (06-14 March 2022).

Table 1. Catch results from the Latvian-Polish BITS 1Q survey; r.v. "Baltica", 06-14 March 2022

Haul number	Date of catch	EEZ	ICES rectangle	ICES SD	Depth to the bottom [m]	The ship's course during fishing [°]	Geographical position of the catch station				Time of		Haul duration [min.]	Total catch	all species CPUE [kg/0.5h]	CATCH of particular fish species [kg]				
							start		end											
							latitude 00°00' N	longitude 00°00' E	latitude 00°00' N	longitude 00°00'E	shutting net	pulling up net				Sprat	Herring	Cod	Flounder	Others
1	06/03/2022	LAT	41G9	26	96	015	56°03.5	19°17.1	56°04.5	19°17.7	15:35	15:55	20	148.48	222.72	137.983	0.217	0	10.28	0
2	07/03/2022	LAT	43H0	28	98	170	57°21.8	20°34.8	57°20.9	20°34.9	09:15	09:35	20	28.48	42.72	15.793	0.303	0	12.38	0.004
3	07/03/2022	LAT	43H1	28	64	190	57°25.6	21°16.4	57°24.6	21°15.9	13:50	14:10	20	99.79	149.685	0.648	41.582	9.78	47.51	0.27
4	07/03/2022	LAT	43H1	28	33	170	57°25.2	21°20.3	57°25.3	21°20.5	16:00	16:20	20	53.668	80.502	2.985	24.565	0	25.64	0.478
5	08/03/2022	EST	45H1	28	75	135	58°02.4	21°02.2	58°01.8	21°03.2	07:40	07:55	15	300.498	600.996	8.759	287.007	0.531	3.829	0.372
6	08/03/2022	EST	44H1	28	88	100	57°58.6	21°00.2	57°58.4	21°02.1	09:20	09:40	20	137.12	205.68	132.589	1.146	0	3.37	0.015
7	08/03/2022	EST	44H1	28	73	310	57°53.4	21°17.1	57°53.7	21°16.2	11:30	11:45	15	337.35	674.7	97.992	226.9	2.373	9.625	0.46
8	08/03/2022	LAT	43H1	28	25	345	57°29.7	21°25.8	57°30.7	21°25.2	15:30	15:50	20	27.533	41.2995	2.06	13.12	0.58	11.58	0.193
9	09/03/2022	LAT	42H0	28	87	030	56°57.4	20°23.8	56°58.1	20°24.4	07:50	08:05	15	18.477	36.954	5.07	0.543	0	12.86	0.004
10	09/03/2022	LAT	43H0	28	90	030	57°02.6	20°32.4	57°03.3	20°32.9	09:30	09:45	15	10.046	20.092	1.8	0.214	0	7.98	0.052
11	09/03/2022	LAT	43H0	28	98	-9	57°09.9	20°35.0	57°09.9	20°35.0	10:55	11:00	5	0	0	0	0	0	0	0
12	09/03/2022	LAT	43H0	28	68	175	57°12.8	20°44.1	57°12.1	20°44.2	12:20	12:35	15	0.363	0.726	0	0	0	0.351	0.012
13	09/03/2022	LAT	43H1	28	51	355	57°14.2	21°01.0	57°14.8	21°01.0	14:20	14:35	15	12.465	24.93	4.35	3.106	0.799	3.693	0.517
14	09/03/2022	LAT	43H1	28	30	200	57°02.6	21°00.3	57°01.9	20°59.7	16:25	16:45	20	17.274	25.911	1.028	0.395	3.059	12.76	0.032
15	10/03/2022	LAT	42H0	28	39	225	56°38.9	20°45.2	56°38.2	20°43.9	07:35	07:55	20	163.245	244.8675	4.035	156.389	0.833	1.859	0.129
16	10/03/2022	LAT	42H0	28	40	215	56°38.2	20°43.8	56°37.4	20°42.7	08:45	09:05	20	134.713	202.0695	17.518	110.492	0.244	6.27	0.189
17	10/03/2022	LAT	42H0	28	39	030	56°37.0	20°42.0	56°38.0	20°43.0	09:50	10:10	20	43.114	64.671	5.856	32.663	0.266	4.206	0.123
18	10/03/2022	LAT	42H0	28	59	025	56°38.5	20°36.1	56°39.5	20°36.7	11:45	12:05	20	314.414	471.621	193.497	109.02	0	11.42	0.477
19	10/03/2022	LAT	42H0	28	46	040	56°37.2	20°38.0	56°38.0	20°39.2	13:15	13:35	20	18.118	27.177	2.49	7.08	0	8.17	0.378
20	10/03/2022	LAT	42H0	28	39	045	56°37.2	20°42.4	56°38.0	20°43.7	15:10	15:30	20	43.734	65.601	20.74	20.42	0	2.168	0.406
21	11/03/2022	LAT	43H0	28	30	035	57°01.1	20°59.6	57°01.7	21°00.3	07:30	07:45	15	13.89	27.78	0.135	1.437	2.042	10.24	0.036
22	11/03/2022	LAT	42H0	28	91	215	56°35.4	20°19.7	56°34.8	20°19.1	13:15	13:30	15	62.983	125.966	58.79	0	0	4.193	0
23	11/03/2022	LAT	42H0	28	91	220	56°32.2	20°15.3	56°31.5	20°14.4	14:30	14:50	20	252.69	379.035	244.72	0	0	7.97	0
24	11/03/2022	LAT	42H0	28	90	220	56°30.0	20°10.5	56°29.4	20°09.6	15:50	16:05	15	68.345	136.69	61.997	0.143	0	6.205	0
25	11/03/2022	LAT	41H0	26	82	190	56°29.0	20°12.7	56°28.4	20°12.6	16:50	17:05	15	25.543	51.086	23.32	0.072	0.009	2.135	0.007
26	12/03/2022	LAT	41H0	26	83	030	56°26.0	20°05.3	56°26.7	20°06.3	07:35	07:50	15	126.406	252.812	96.428	1.697	1.016	26.6	0.665
27	12/03/2022	LAT	41H0	26	73	020	56°26.0	20°02.8	56°22.3	20°03.3	09:20	09:35	15	131.581	263.162	118.538	12.002	0.173	0.868	0
28	12/03/2022	LAT	41G9	26	78	020	56°20.0	19°50.5	56°20.8	19°51.1	11:20	11:40	20	377.9	566.85	75.399	152.001	113.9	35.74	0.86
29	12/03/2022	LAT	41G9	26	61	195	56°11.6	19°55.4	56°10.8	19°54.0	13:25	13:40	15	13.249	26.498	12.09	0.945	0	0.214	0
30	12/03/2022	LAT	41G9	26	63	085	56°07.7	19°52.6	56°07.8	19°52.7	14:35	14:55	20	0.293	0.4395	0.244	0.039	0	0	0.01

Table 2. Numbers of fish biologically analysed during the BITS 1Q survey; r.v. "Baltica" (06-14 March 2022).

Species	Number of samples			Number of fish								
				measured			analyzed			stomach samples		
	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total	SD 26	SD 28	Total
Cod	4	10	14	542	11	553	78	77	155	78	77	155
Flounder	6	22	28	333	1414	1747	161	358	519			
Herring	7	19	26	218	1339	1557						
Sprat	7	21	28	648	1973	2621						
Turbot	0	2	2	0	2	2						
Four Bearded Rockling	0	1	1	0	1	1						
Eelpout	0	5	5	0	13	13						
Smelt	0	2	2	0	3	3						
Three-spined Stickleback	2	17	19	7	114	121						
Sea Scorpion	0	10	10	0	19	19						
Plaice	0	1	1	0	1	1						
Sand Goby	0	1	1	0	1	1						
Nine-spined Stickleback	0	1	1	0	1	1						
Lesser sandeel	0	1	1	0	1	1						
Total	26	113	139	1748	4893	6641	239	435	674	78	77	155

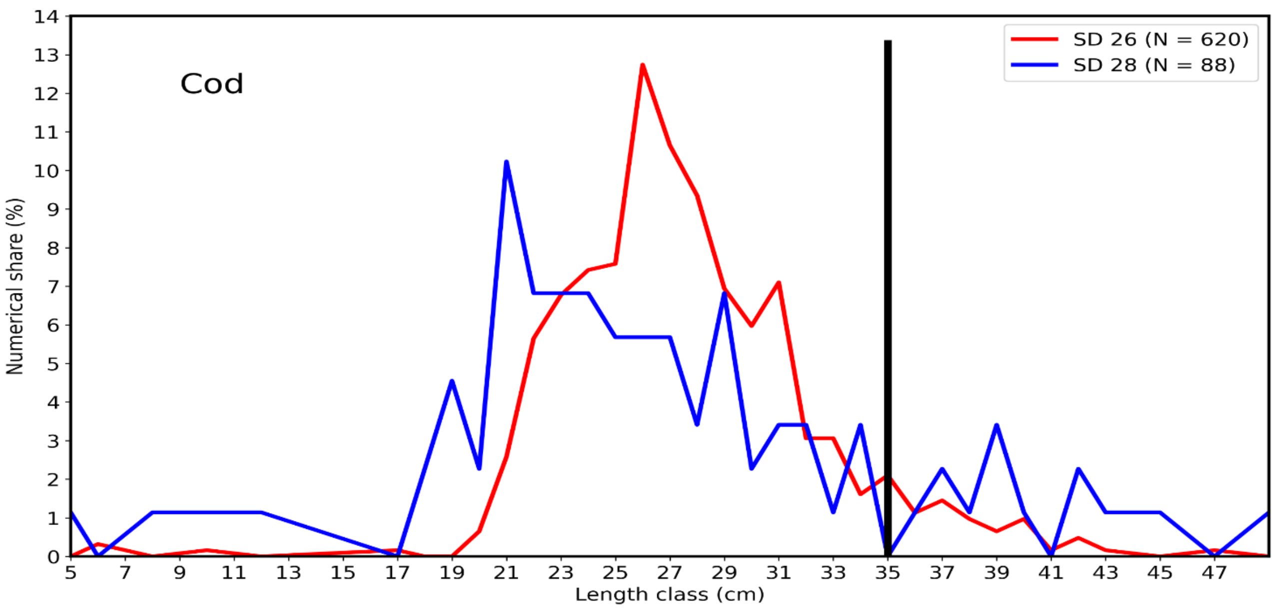


Figure 6. Length frequency of cod from Sub-Divisions 26 and 28 in the control catches.

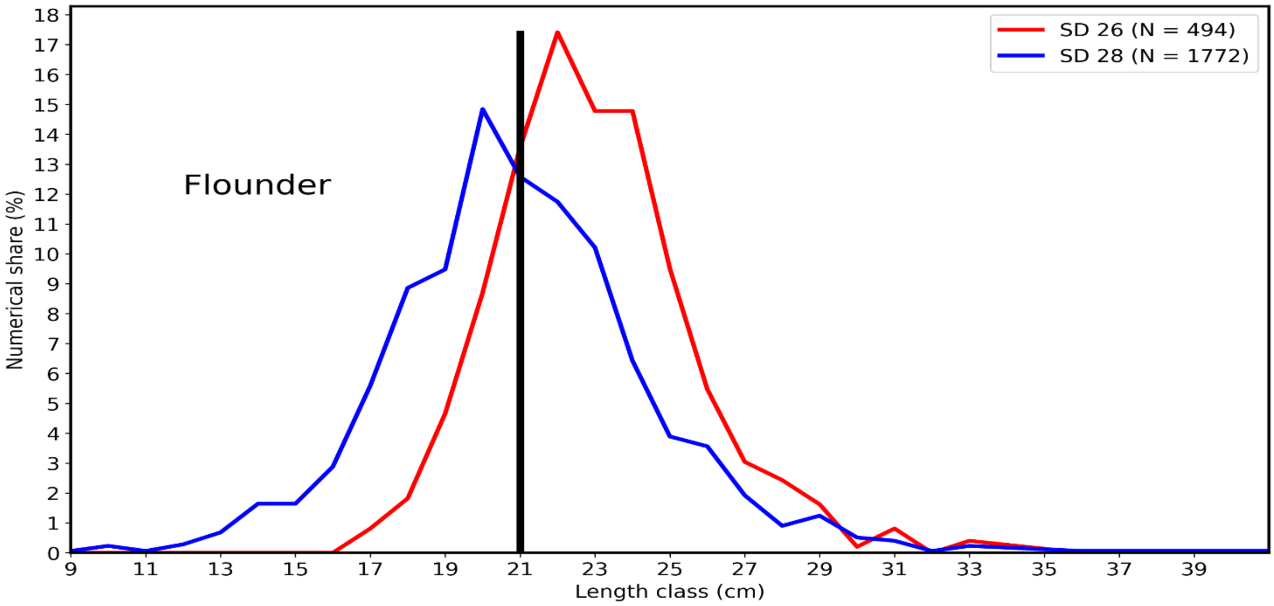


Figure 7. Length frequency of flounder from Sub-Divisions 26 and 28 in the control catches.

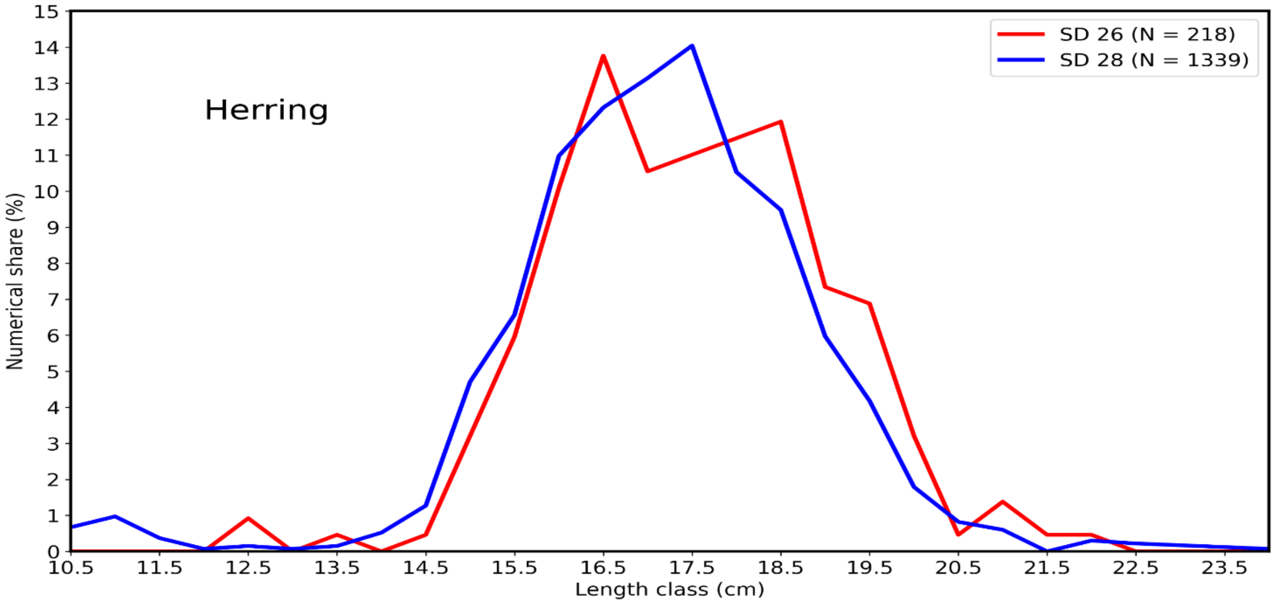


Figure 8. Length frequency of herring from Sub-Divisions 26 and 28 in the control catches.

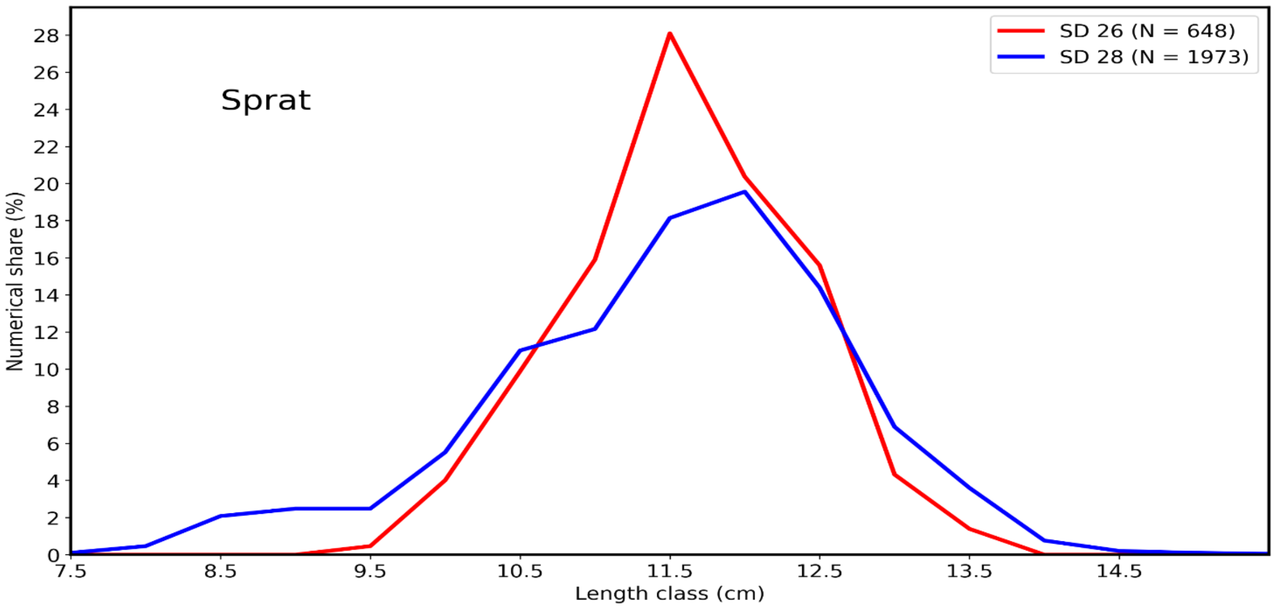


Figure 9. Length frequency of sprat from Sub-Divisions 26 and 28 in the control catches.

Table 3. Cod length measurements by consecutive hauls in the r.v. "Baltica" Latvian - Polish BITS survey (06-14 March 2022); specimens grouped by 1 cm length classes.

		cm_group																																		
Haul no	SD	5	6	8	10	12	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	45	47	49	Sum
3	28	1			1	1		1	2	1	4	6	5	5	3	4	5	3	1	1	2	2	1	1			1	1	1			1					54
5	28							1			3								1																		5
7	28								2	1	1								1		1	1		1										1			9
8	28																												1								1
13	28																																1				1
14	28										1		1		1				1							1				1						1	7
15	28																		1										1								2
16	28																			1																	1
17	28													1	1																						2
21	28			1												1			1					1			1					1					6
25	26		2		1																																3
26	26													1					1			1					1										4
27	26																1																				1
28	26						1			4	16	35	42	45	47	79	65	58	42	37	44	18	19	10	13	7	8	6	4	6	1	3	1		1		612
SD 26			2		1		1			4	16	35	42	46	47	79	66	58	43	37	44	19	19	10	13	7	9	6	4	6	1	3	1		1		620
SD 28		1		1	1	1		2	4	2	9	6	6	6	5	5	5	3	6	2	3	3	1	3		1	2	1	3	1		2	1	1		1	88
Total		1	2	1	2	1	1	2	4	6	25	41	48	52	52	84	71	61	49	39	47	22	20	13	13	8	11	7	7	7	1	5	2	1	1	1	708

Table 4. Flounder length measurements by consecutive hauls in the r.v. "Baltica" Latvian - Polish BITS survey (06-14 March 2022); specimens grouped by 1 cm length classes.

		cm_group																										
Haul no	SD	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	36	41	Sum
1	26										1	3	5	4	15	12	15	8	5		1	4		1					74
2	28								1	6	11	15	20	26	12	11	14	3	2	2			1						124
3	28						2	2	7	10	18	27	38	25	27	34	17	8	9	8	1	3			1	1			238
4	28		1		5	5	4	15	11	23	27	24	34	25	30	21	11	6	7	3	3	4	2			1			262
5	28									2	2	1	4	3	3	6	3		2	1		2							29
6	28										1		5	5		6	2	3	2	1		1							26
7	28							1	2	1	6	4	10	3	10	5	5	3	4	6	1	2	2	2					67
8	28	1	3	1		4	16	6	9	20	19	16	10	13	7	4	3	2	2	2			1	3					142
9	28					1	1			2	5	8	13	24	16	13	17	3	3	1	2					1			110
10	28								1		4	8	12	8	11	6	3	8	4	1	1	1							68
12	28											1	2			1													4
13	28							1		1	2	2	9	2	5	5	3	1			1								32
14	28					1	3	1	8	9	13	16	20	17	7	10	5	3	5		1	2	1						122
15	28								2	1	3	1	2	3	4	3	1												20
16	28								1	5	6	3	11	7	8	7	4	3	1		1		1						58
17	28						1			3	6	3	4	6	7	5	1	2	2										40
18	28								1	4	7	11	17	14	11	11	4	7	6	3	1					1			98
19	28									3	14	5	12	4	15	5	5	1	3		1		1					1	70
20	28										4	5	5	2	2	3						1							22
21	28					1	2	3	6	7	7	11	20	12	9	6	6	4	3	1	2	1							101
22	28								1	1	2	3	3	10	7	4	4	1	1			2							39
23	28								1	1		3	8	10	8	8	2	4	4	5	1	2		1					58
24	28											1	4	4	9	7	4	7	3			1		1			1		42
25	26									1			1		2	4	4	1	1	1									15
26	26									2	5	13	24	28	36	25	26	18	11	7	5	3		3		2			208
27	26									1					1		1	2			1								6
28	26										3	7	12	35	32	31	27	18	10	7	5	1	1						189
29	26												1			1													2
SD 26										4	9	23	43	67	86	73	73	47	27	15	12	8	1	4		2			494
SD 28		1	4	1	5	12	29	29	51	99	157	168	263	223	208	181	114	69	63	34	16	22	9	7	1	4	1	1	1772
Total		1	4	1	5	12	29	29	51	103	166	191	306	290	294	254	187	116	90	49	28	30	10	11	1	6	1	1	2266

Table 5. Herring length measurements by consecutive hauls in the r.v. "Baltica" Latvian - Polish BITS survey (06-14 March 2022); specimens grouped by 0.5 cm length classes.

		cm_group																									
Haul no	SD	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22	22.5	24	Sum
1	26														1													1
2	28											3	2	2	1	2	1			1								12
3	28										5	4	8	10	14	16	12	11	12	6	2	2	2					104
4	28								3	2	2	2	11	19	15	22	6	8	9	3	1	1				1		105
5	28										4	11	15	17	15	15	8	13	4	1								103
6	28									1	2	1	2		1	1	1											9
7	28									1	2	8	11	12	21	18	15	6	3	2	3		1					103
8	28						1	2	1	4	12	9	10	12	9	17	12	8	4	3					1			105
9	28										1	2	4	3	1	3	2		1									17
10	28														2	1	2	1		1								7
13	28								1		2	6	3	13	15	9	14	16	5	4	1	1			2			92
14	28										1		2		1			1	1		1		1		1			9
15	28									1	8	13	11	18	10	16	9	10	5	1	2							104
16	28								1	2	2	8	8	5	12	16	17	14	10	4	2	2						103
17	28								1	2	3	7	20	8	15	12	13	11	5	2	3	1					1	104
18	28										6	4	16	17	18	17	6	9	4	3								100
19	28										1	4	6	11	6	10	15	7	11	19	6	2	1			1		100
20	28			1		1				4	10	3	12	17	14	11	8	9	4	4	2							100
21	28	9	13	4	1	1					2	3	4	1	6	2		3	2	2	1	2	3			1		60
24	28												2															2
25	26													1							1							2
26	26										2			1		4		1		1	1							10
27	26							1		1	3	4	8	9	9	5	10	4	5	6	1		2					68
28	26											7	11	11	9	11	14	19	10	5	4	1	1	1	1			105
29	26					1					2	2	3	8	4	3	1	2	1	3								30
30	26					1										1												2
SD 26						2		1		1	7	13	22	30	23	24	25	26	16	15	7	1	3	1	1			218
SD 28		9	13	5	1	2	1	2	7	17	63	88	147	165	176	188	141	127	80	56	24	11	8		4	3	1	1339
Total		9	13	5	1	4	1	3	7	18	70	101	169	195	199	212	166	153	96	71	31	12	11	1	5	3	1	1557

Table 6. Sprat length measurements by consecutive hauls in the r.v. "Baltica" Latvian - Polish BITS survey (06-14 March 2022); specimens grouped by 0.5 cm length classes.

		cm_group																	
Haul no	SD	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	Sum
1	26						8	15	18	31	25	7	1	2					107
2	28					1	5	11	21	22	26	12	3	3					104
3	28		2	5	7	2	1	6	7	4	6	4		1					45
4	28	1	1	4	5	2	3	12	12	18	15	18	6	7	1				105
5	28		1				2	5	7	11	22	16	6	1	1				72
6	28				1	2	6	15	19	16	24	16	3						102
7	28		1	4	6	3	3	8	8	21	24	15	9	1					103
8	28			8	5	5	12	16	8	9	17	11	9	3	1	1			105
9	28			2			6	12	12	33	22	18	1						106
10	28						14	19	8	16	20	16	8	2					103
13	28				2	4	3	15	16	16	26	12	9	1					104
14	28				2	1	4		2	16	22	31	14	5	2				99
15	28			1	5	7			1	8	8	12	12	7	2	2			65
16	28		3	11	8	4	4	7	6	11	18	16	10	6	2			1	107
17	28			3		3	1	2	1	10	15	29	25	12	2	1			104
18	28				1	12	10	18	21	17	19	4	4	3					109
19	28					1	5	5	1	24	29	18	11	9	2				105
20	28		1		5	2	3	8	7	28	18	17	4	9	1		1		104
21	28	1		3	2				2	3	3		1		1		1		17
22	28						8	21	31	23	17	5							105
23	28						12	19	28	24	13	9							105
24	28						7	18	22	28	22	5	1	1					104
25	26						6	22	20	26	14	14	1	1					104
26	26						4	12	16	27	25	15	3	1					103
27	26						1	5	9	29	24	24	10	1					103
28	26					3	3	4	13	26	20	24	6	4					103
29	26						3	6	23	38	19	13	3						105
30	26						1		4	5	5	4	4						23
SD 26						3	26	64	103	182	132	101	28	9					648
SD 28		2	9	41	49	49	109	217	240	358	386	284	136	71	15	4	2	1	1973
Total		2	9	41	49	52	135	281	343	540	518	385	164	80	15	4	2	1	2621

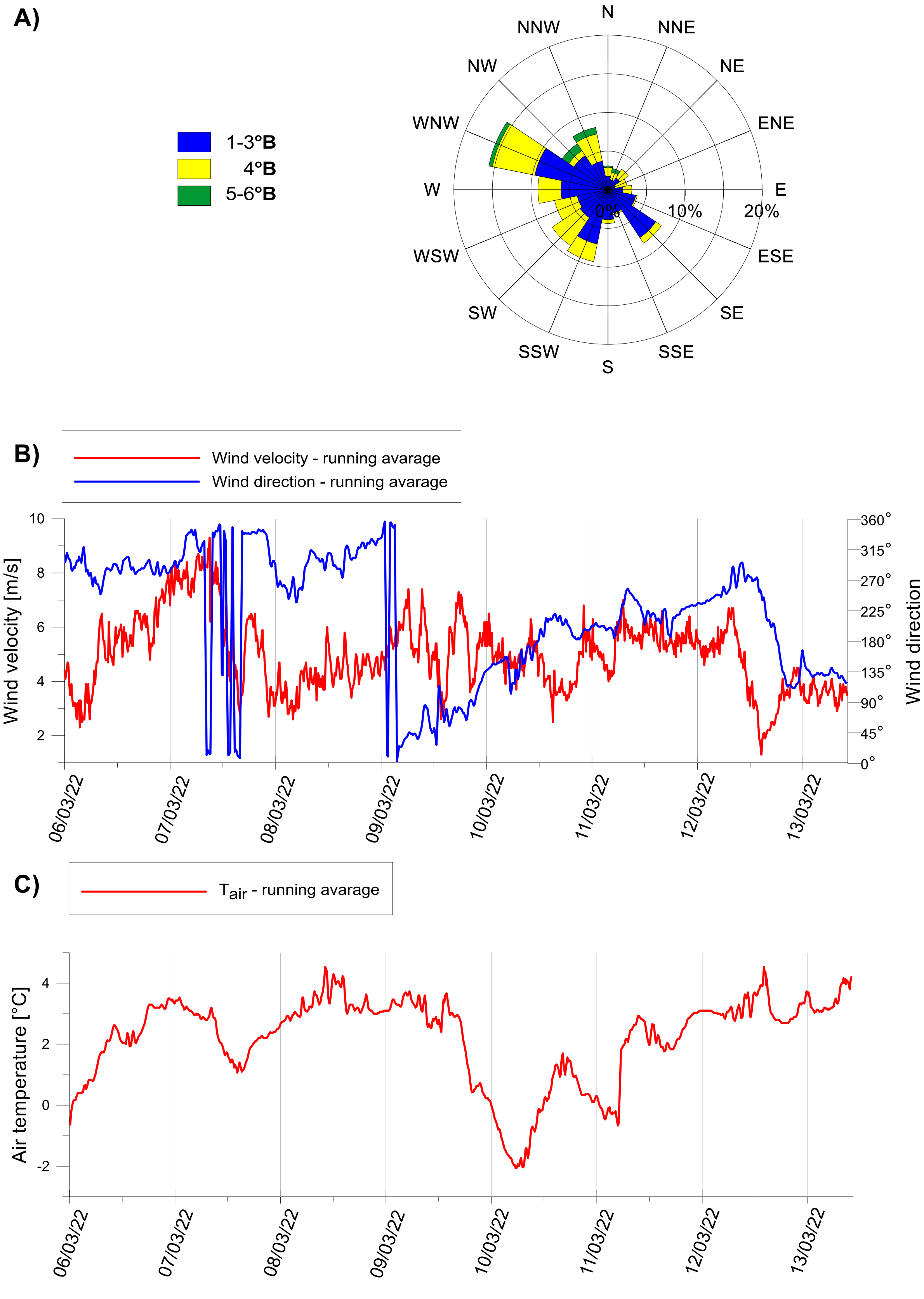


Figure 10. Changes of the main meteorological parameters (March 2022)

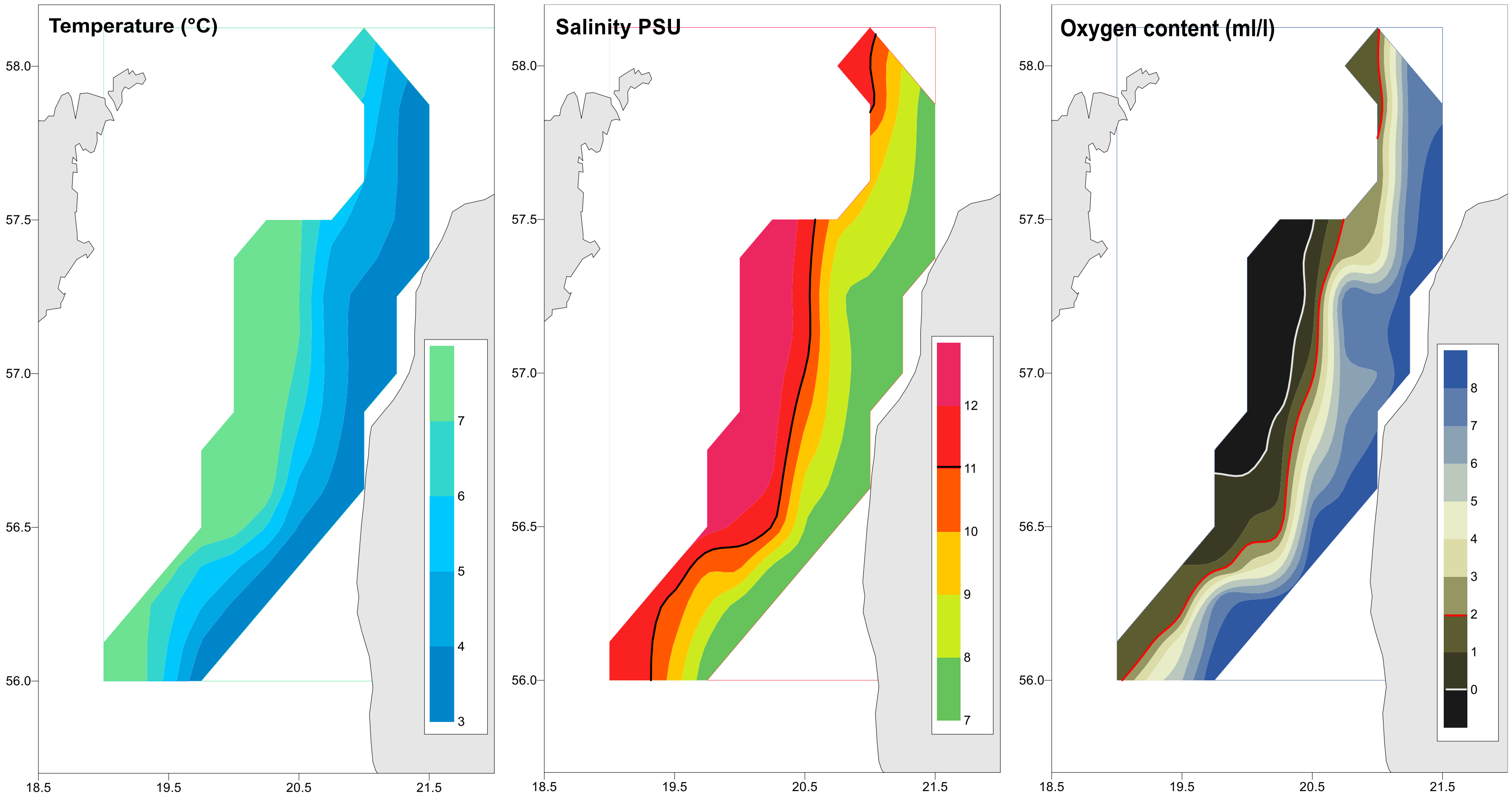


Figure 11. Distribution of the seawater temperature, salinity and oxygen content in the near bottom waters (March 2022)

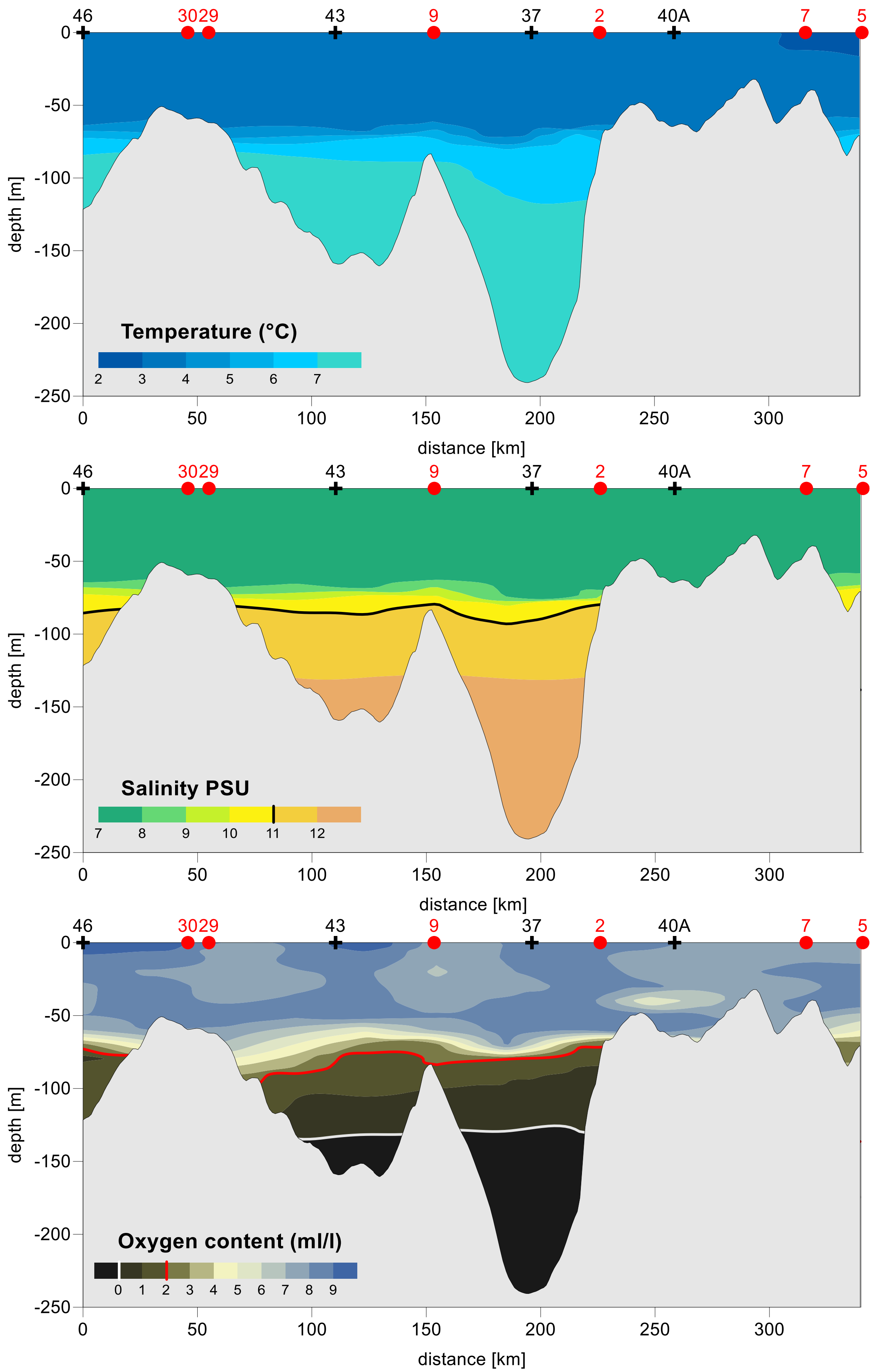


Figure 12. Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological transect of the Gotland Deep (March 2022)

Lithuania BITS Q1 2022 report

Marijus Špėgys

1. INTRODUCTION

The cruise of the FV "652" was part of the Baltic International Trawl Survey (BITS) which is coordinated by ICES WGBIFS. The main objective of the survey is the estimation of fishery independent stock indices of both Baltic cod stocks, of flounder and other flat fish.

The following further objectives were covered during the survey:

Collecting data for assessing stock indices, the structure and recruitment of the stocks especially for cod and flatfish.

Monitoring the composition of fish species in the South-Eastern Baltic Sea

Collecting length samples for all species.

Collecting samples of cod and flounder for biological investigations (i.e., sex, maturity, age).

Collecting litters from trawl.

2 METHODS

2.1 Personnel

Marijus Špegys, Marine research institute, Klaipeda University - cruise leader;
Žilvinas Kregždtys, Marine research institute, Klaipeda University –fish sampling.

2.2 Description

The cruise took place two days (05-11 March 2022). FV "652" has covered the Sub-division 26 in Lithuanian EEZ.

2.3 Survey design and realization

The international coordinate trawl survey is planned as Stratified Random Survey where ICES subdivisions and depth layers are used as strata. A total of 6 stations were planned for the Lithuania part of the survey, which realize complete accordance with the agreements of WGBIFS during the meeting in 2020. The hauls' positions were selected from the TOW Database by the coordinator of the BITS surveys (ICES 2020, WGBIFS report as reference). All 6 fishing stations were successfully realized. The fishing hauls were realized in the daylight, between 8:15 and 16:50 local time.

Trawling was done with the standard trawl "TV3/520#". The stretched mesh size in the codend was 20 mm. The duration of the hauls was 30 minutes and the velocity was 3 knots. The total catch of each haul was analysed to determine the species' composition in weight and number as well as the distribution of length among all species. Sub-samples of cod, flounder were investigated concerning sex, maturity and age. Surface temperature and salinity were immediately sampled after every fishing hauls.

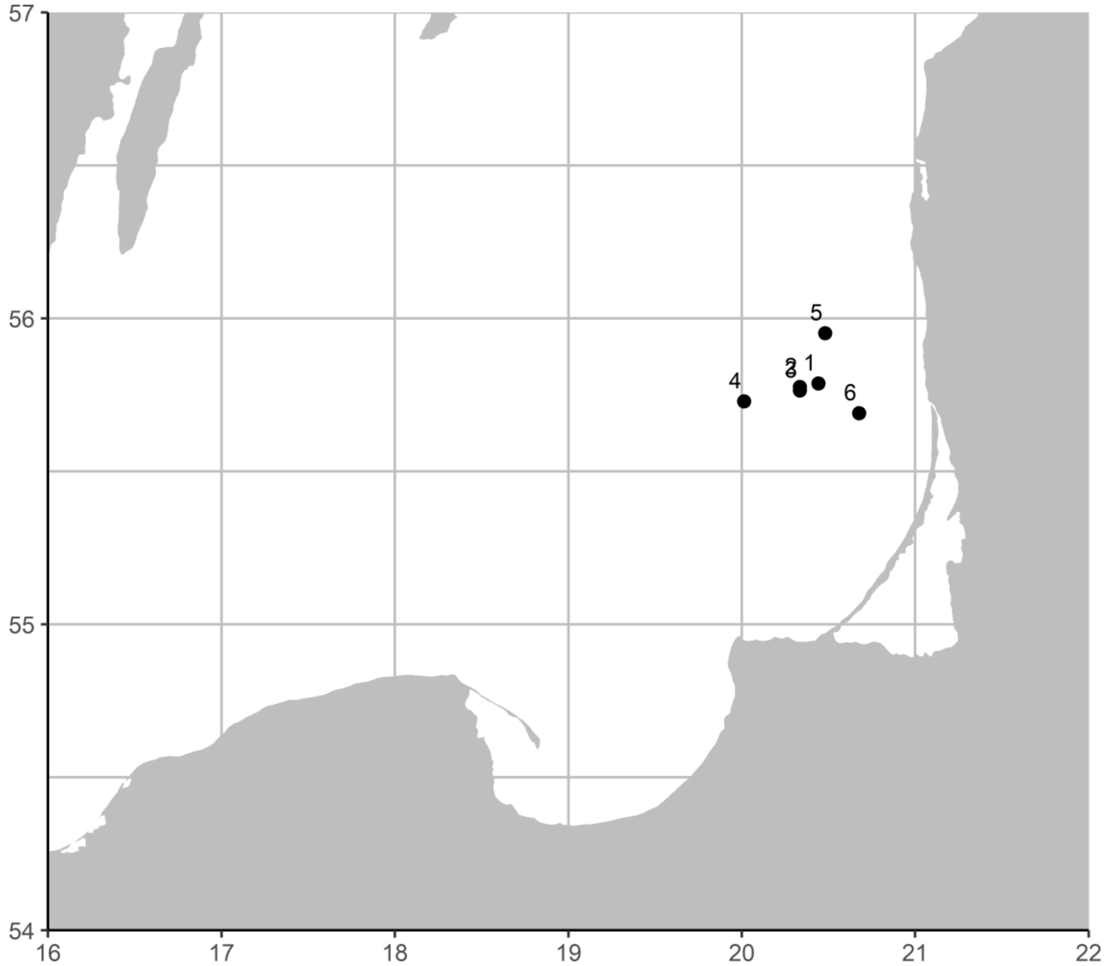


Figure 1. Trawl hauls position of F/V "652" in BITS 2022 m. Q1 survey

The length measurements in the 1.0 cm classes was realised for cod, flounder and turbot, subsample were taken for biological analysis to laboratory. The length measurements in the 0.5 cm classes was realised of herring and sprat.

All information about haul and catches are shown in table 1 and table 2.

Table 1. Haul information from the Lithuania BITS Q1 survey with the TV3/520# bottom trawl

Haul number according to TD data	The ICES rectangle (subdivision)	Trawling depth (m)	Geographical position of catch station				Surface temperature	Surface salinity	Bot. Tempe-rature	Bot. salinity
			00.00 N	00.00 E	00.00 E	00.00 N				
26027	40H0 (26)	51	55.79	20.44	55.79	20.39	6,7	6,4	6,3	6,7
26205	40H0 (26)	54	55.78	20.34	55.76	20.37	6,6	6,7	6,3	6,9
26206	40H0 (26)	55	55.76	20.33	55.74	20.34	6,8	6,1	6,5	6,6
26057	40H0 (26)	75	55.73	20.01	55.72	19.97	7,0	6,8	6,3	7,3
26134	40H0 (26)	37	55.95	20.48	55.95	20.43	7,0	6,6	6,4	6,3
26028	40H0 (26)	47	55.69	20.68	55.70	20.63	7,0	6,2	6,4	6,3

Table 2 Fish catches results from the Lithuania BITS 2022 1Q survey with the TV3/520# bottom trawl

Haul number according to TD data	Catch date	The ICES rectangle (subdivision)	Trawling depth (m)	Total CPUE (kg/h)	CPUE per species (kg/h)					
					Cod	Flounder	Place	Turbot	Herring	Others
26214	2018-11-03	40H0(26)	76	127.4	68.1	33.1		2.8	21.2	2.2
26193	2018-11-03	40H0(26)	72	183.8	91.6	33.3		3.1	54.0	1.8
26206	2018-11-03	40H0(26)	57	196.5	79.4	21.6			94.2	1.3
26205	2018-11-03	40H0(26)	53	160.6	10.7	7.5	0.3		140.0	2.1
26153	2018-11-04	39H0(26)	60	89.8	8.0	47.2		0.3	24.2	10.1
26052	2018-11-04	40H0(26)	62	142.2	74.9	42.5			22.3	2.5
Mean					55.5	30.9	0.05	1.0	59.3	63.5

3. RESULTS

In total 763 cods, 596 flounders, 1 place, 6 turbot 1876 herrings and 232 other species were collected for measuring and from that measurement sample 311 cods and 272 flounders 6 turbots and 0 place were collected for weight, sex, maturity and age. In addition to these listed indicators, liver worms were evaluated for cod. Also collect 50 cod stomach samples. Numbers of biological samples by haul given in Table 3.

Cod from the length classes range of 21-34 dominated in samples. The fish with this length range constituted about 66.6% of all measured cod (Fig. 1). Moreover, 86.1% of all measured cods were undersized individuals (less than 35 cm).

The total length of flounder ranged from 12 to 41 cm, with dominating length classes of 20-30 cm. The fish with this length range constituted about 92.1% of all measured flounder.

The total length of herring ranged from 10.5 to 26 cm. Herring from the length classes of 14.5-20 cm was dominated in samples and constituted about 83.5% of all measured herring (Fig. 3).

The length distributions of cod, flounder, herring and sprat, according to the ICES Sub-divisions 26 are shown in Figures 1-3.

Table 3. Biological samples of all hauls from the Lithuania BITS 2022 Q1 survey

Haul number	Numbers of biological samples								
	Length						Age, sex, maturity		
	Cod	Flounder	Place	Turbot	Herring	Other	Cod	Flounder	Turbot
1	167	94		2	360	57	119	94	2
2	199	105		3	321	35	97	96	3
3	173	55			266	8	46	22	
4	40	16	1		238	41	4	10	
5	57	170		1	336	55	4	23	1
6	127	156			355	36	41	27	
Sum	763	596	1	6	1876	232	311	272	6

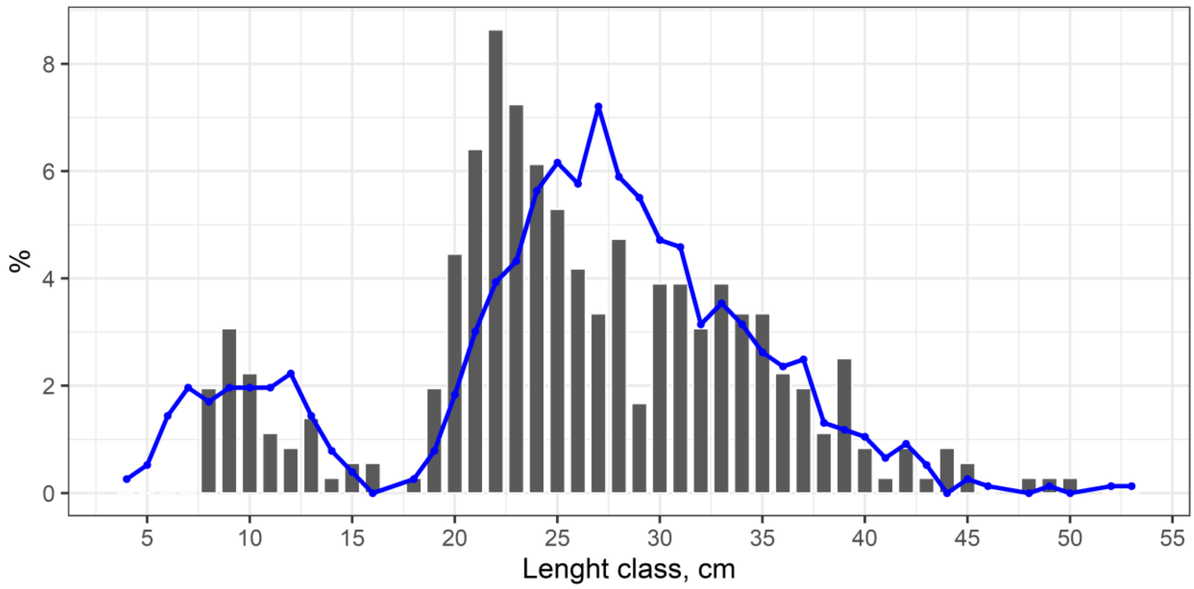


Figure 2. Cod length distribution from Lithuania BITS 2022 Q1 survey (line) and BITS 2021 Q1 (bars)

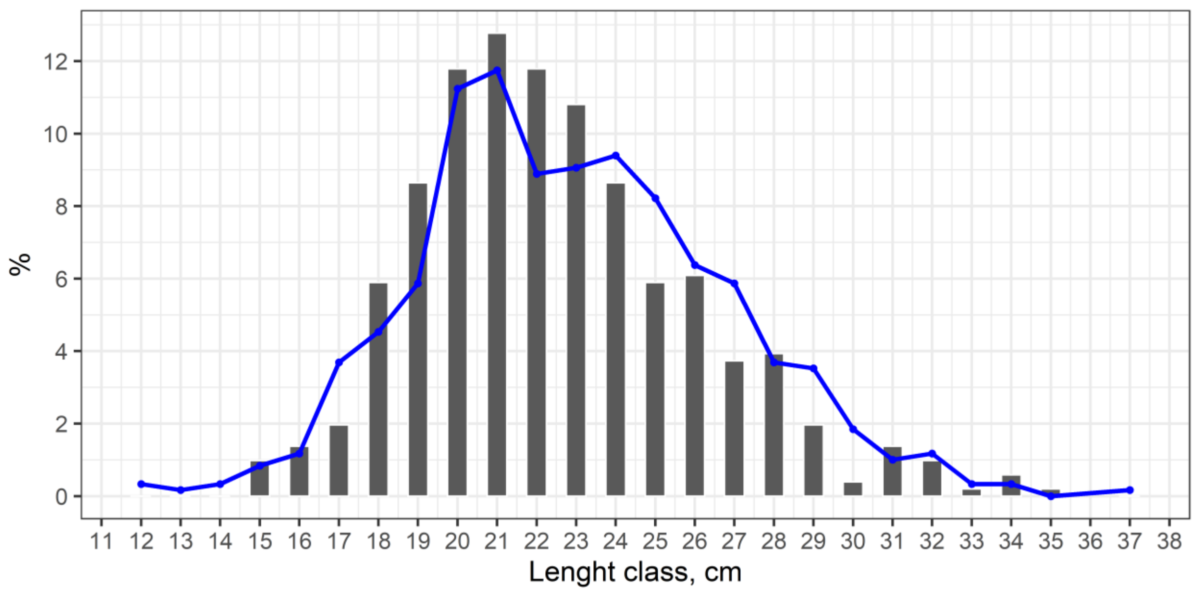


Figure 3. Flounder length distribution from Lithuania BITS 2022 Q1 survey (line) and BITS 2021 Q1 (bars)

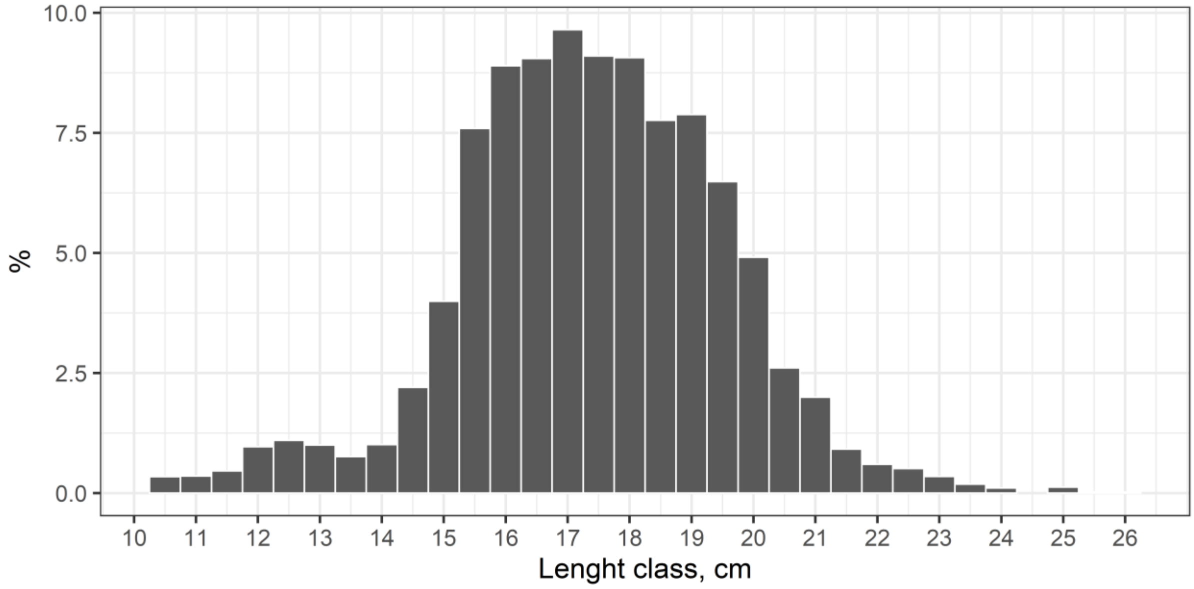


Figure 4. Herring length distribution from Lithuania BITS 2022 m. Q1 survey

Institute of
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THÜNEN

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Cruise report
Cruise number 803 FRV „Solea"
22/02 –10/03/2022

Baltic International Trawl Spring Survey (BITS) in the Arkona Sea, Mecklenburg and Kiel Bight (ICES SD 24 & 22)

Scientists in charge: **M Bleil and A Velasco**

1. Summary

The 803rd cruise of the FRV "Solea" is the 41th German Spring survey since 1981. It was part of the Baltic International Trawl Survey (BITS), which is coordinated by ICES (WGBIFS). The main objective of the survey was to estimate fishery independent stock indices for the two Baltic cod stocks, flounder and plaice.
In total, 53 fishery hauls and 53 hydrography stations were carried out.
A first evaluation of the survey results suggests that the cod year-class 2021 (recruits at length range 10 - 25 cm) is not as weak as the year-class 2020. The recruitment by length group 10 - 25 cm TL was, with exception of water depth layer 10 - 19 m in SD 24 and 10 - 29 m in SD22, higher in all depth layers between 20 - 59 m in SD 24 compared to the previous year. The recruitment by length group 26 - 40 cm TL was, with exception of depth layers between 40 - 59 m in SD 24, in all other depth layers in SD 24 lower compared to the previous year.
The abundance of flounder increased in the depth layers between 40 - 59 m in SD 24 and 10 – 29 m in SD 22 and decreased in the depth layers between 10 - 39 m in SD 24 compared to the previous year.
The maturity development of cod during the BITS survey in ICES SD 24 corresponded to the long-term average. In the middle of the main spawning season, numbers of spawning cod in SD 22 were very low. Only 12% of the females spawned. During the survey habitual salinity-gradients were observed. The oxygen concentration was sufficient down to the bottom at the stations in subdivisions 22 and 24.

Verteiler:

Schiffsführung FFS „Solea"
BA für Landwirtschaft und Ernährung (BLE) Fischereiforschung
BM für Ernährung und Landwirtschaft (BMEL), Ref. 614
BA für Seeschifffahrt und Hydrographie (BSH), Hamburg
Deutscher Angelfischerverband e.V.
Deutsche Fischfang-Union, Cuxhaven
Deutscher Fischereiverband Hamburg
Doggerbank Seefischerei GmbH, Bremerhaven
Erzeugergemeinschaft der Deutschen Krabbenfischer GmbH
Euro-Baltic Mukran
Kutter- und Küstenfisch Sassnitz
GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
LA für Landwirtschaft, Lebensmittels. und Fischerei (LALLF)
LFA für Landwirtschaft und Fischerei MV (LFA)
Leibniz-Institut für Ostseeforschung Warnemünde
Thünen-Institut - Institut für Fischereiökologie
Thünen-Institut - Institut für Seefischerei
Thünen-Institut - Institut für Ostseefischerei
Thünen-Institut - Pressestelle, Dr. Welling
Thünen-Institut - Präsidialbüro
Thünen-Institut - Reiseplanung Forschungsschiffe, Dr. Rohlf
Fahrtteilnehmer*innen

2. Research program

The cruise took place from the 22sd February to the 10th March 2021. Corresponding to the recommendations of the WGBIFS in 2007, the survey of the FRV "Solea" covered the subdivisions 22 and 24 (Figure 1).

The following stock assessment objectives were covered during the survey:

- Collecting data for assessing stock indices, the structure and recruitment of the stocks, especially for cod and flatfish
- Monitoring the composition of fish species in the western Baltic Sea
- Collecting samples of cod and flounder for biological investigations (i.e. sex, maturity, fecundity, age)
- Monitoring the actual hydrographical situation in the survey area

3. Narrative

The internationally coordinated trawl survey is planned as a Stratified Random Survey where ICES subdivisions and depth layers are used as strata. A total of 54 stations (39 in subdivision 24 and 15 in subdivision 22) were planned for the German part of the survey, which covered the southern part of ICES subdivision 22 and subdivision 24 in total. The haul positions were selected from the TOW Database by the coordinator of the BITS surveys (ICES 2008, WGBIFS report). 53 fishing stations were covered and can be used for stock assessment. The fishing hauls were carried out between 7:00 and 15:00 UTC (8:00 and 16:00 local time).
The positions of the trawl hauls are shown in Figure 1. 13 fishing hauls and 15 hydrographic stations were done in subdivision 22, and 38 fishing hauls and 39 hydrographical stations were realized in subdivision 24.

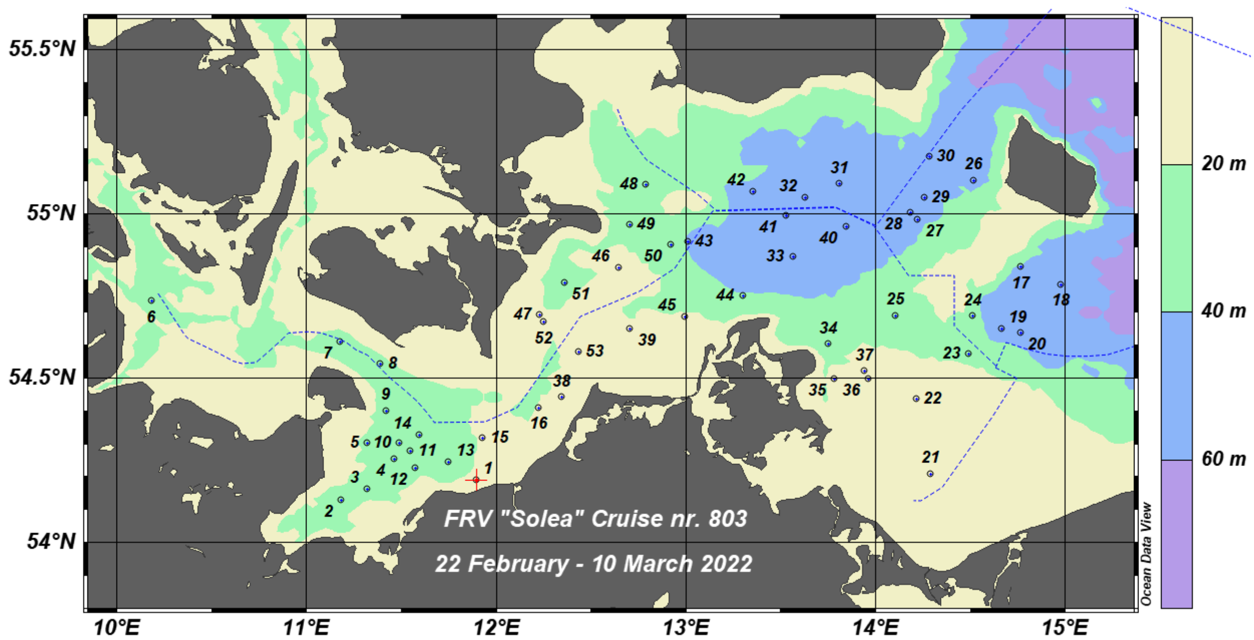

Figure 1: BITS Stations of the 803rd FRV "SOLEA" cruise (Ocean Data View, R. Schlitzer, www.awi-bremerhaven.de/GEO/ODV)

The numbers of fishing hauls and hydrographic stations by subdivision and 20 m depth layers are given in Table 1. Most hauls in subdivision 22 were located at depths from 10 m to 29 m and 21 of 38 hauls in subdivision 24 between 40 and 59 m.

Table 1: Sampling intensity (evaluated fishing stations) of BITS and additional hauls

Area		Stations		
Subdivision	**Stratum Depth [m]**	**Total trawl distance [nm]**	**Fishing [n]**	**Hydrography [n]**
22	**1 [10-19]**	1.5	1	1
	2 [20-29]	20.4	14	14
24	**1 [10-19]**	10.1	7	7
	2 [20-39]	19.5	14	14
	3 [40-59]	24.3	17	18

Trawling was done following the standard BITS trawl “TV3 520#“. The stretched mesh size in the codend was 20 mm. The duration of each haul was 30 minutes at a velocity of 3 kn as required in the BITS manual. The total catch of each haul was analysed to determine species composition in weight and number as well as the length distribution of all species. Subsamples of cod, flounder, plaice, dab and turbot were investigated concerning sex, maturity and age.

Vertical profiles of the hydrographical parameters temperature, salinity and oxygen were sampled from the surface to the bottom immediately after every fishing haul with a CTDO probe (Sea Bird 19+ s/n 8024).

4. Preliminary results

4.1 Biological data

In total 652 cod, 742 flounder, 836 plaice, 599 dab, 117 turbot and 4 brill were collected for measuring length, weight, sex, maturity and age. The total catches and numbers of length samples of cod, flounder, plaice and dab are given in Table 2 by subdivision and depth stratum.

The mean catch per hour (CPUE) was 41.8 kg of cod and 76.4 kg of plaice. In general the catch composition was dominated by plaice. However, cod, flounder and dab were also abundant in the catches. The mean fraction of cod biomass in the hauls was 16.7 % and mean fraction of plaice, flounder and dab was 30.6 %, 21.4 % and 13.6 %, respectively. Sprat and herring represented 25.8 % of the total biomass in mean.

Table 2: Numbers of length measurements of cod, flounder, plaice and dab by depth stratum and ICES subdivision

Area		Sample			
		Cod		Flounder	
Subdivision	Depth [m]	Weight [kg]	Number [n]	Weight [kg]	Number [n]
22	10-29	30.3	398	391.4	1726
24	10-19	19.7	198	29.1	208
	20-39	243.2	1096	73.5	345
	40-59	1289.3	5276	1533.5	7962

Area		Sample			
		Plaice		Dab	
Subdivision	Depth [m]	Weight [kg]	Number [n]	Weight [kg]	Number [n]
22	10-29	2004.9	27965	1017.4	13813
24	10-19	110.7	1069	40.4	413
	20-39	229.3	2364	113.1	1114
	40-59	549.9	5155	112.4	875

The highest abundances in weight and number of cod and flounder were observed in subdivision 24 in depths between 40 - 59 m. The highest abundances in weight and number of plaice and dab were observed in 22 in depths between 10 - 29 m.

Mean CPUE of cod and flounder are given in Table 3 by subdivision and depth stratum.

Table 3: Mean CPUE of cod and flounder and average individual weights by sub-division and depth

Area		Catch							
		Cod				Flounder			
Subdivision	Depth [m]	Weight [kg/nm]	Number [n/nm]	Average Weight [g]	Stations [n]	Weight [kg/nm]	Number [n/nm]	Average Weight [g]	Stations [n]
22	10-29	1.4	18	76.2	15	17.9	79	226.8	15
24	10-19	1.9	20	99.3	7	2.9	21	139.8	7
	20-39	12.5	56	221.9	14	3.8	18	213.1	14
	40-59	53.1	217	244.4	17	63.2	328	192.6	17

Area		Catch							
		Plaice				Dab			
Subdivision	Depth [m]	Weight [kg/nm]	Number [n/nm]	Average Weight [g]	Stations [n]	Weight [kg/nm]	Number [n/nm]	Average Weight [g]	Stations [n]
22	10-29	91.6	1277	71.7	15	46.5	631	73.7	15
24	10-19	10.9	105	103.5	7	4.0	41	97.7	7
	20-39	11.8	121	97.0	14	5.8	57	101.5	14
	40-59	22.7	212	106.7	17	4.6	36	128.5	17

The frequencies of cod grouped by subdivision and depth strata are presented in figures 2 to 4. Noteworthy is the abundance of cod ranging in length from 26 to 40 cm in subdivision 24. Compared to last year, the frequency of cod in the length range 26–40 increased in depth layers between 40 – 59 m in subdivision 24 (Table 4 and Figures 2 to 4).

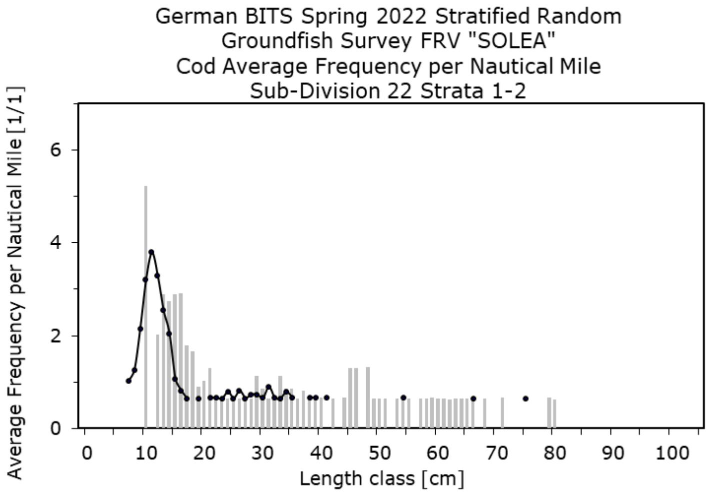

Figure 2: Length frequencies of cod in number per mile in depth strata 10 m to 29 m in SD 22 2022 (line) and 2021 (bars), (15 Hauls)

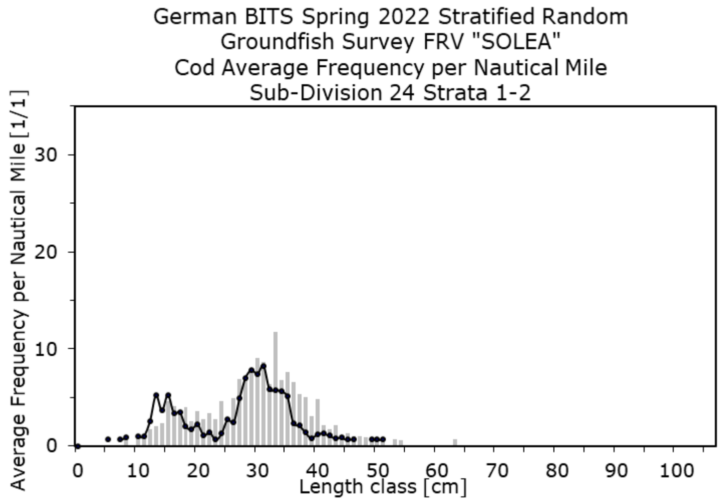

Figure 3: Length frequencies of cod in number per mile in depth strata 10 m to 39 m in SD 24 2022 (line) and 2021 (bars), (21 Hauls)

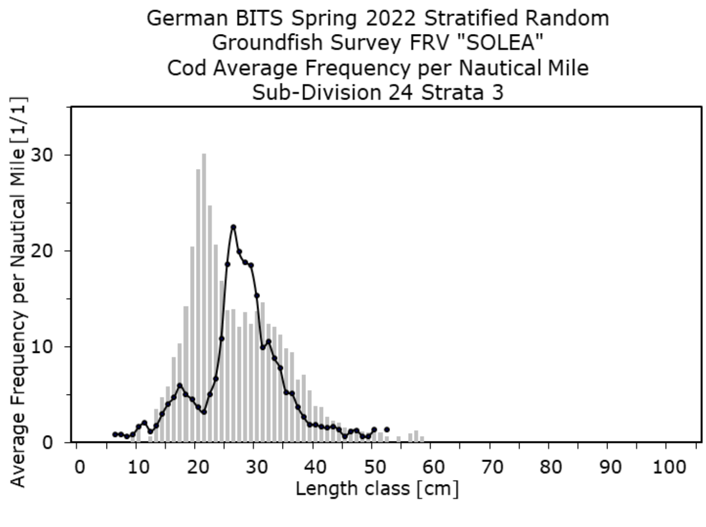

Figure 4: Length frequencies of cod in number per mile in depth strata 40 m to 59 m in SD 24 2022 (line) and 2021 (bars), (17 Hauls)

Table 4: Recruitment by length group of the year 2022 in comparison to the previous year

Area		Catch	2022		
Subdivision	**Depth [m]**	**Length range [cm]**	**Number [n]**	**Number/ Mile [n/nm]**	**Trawl distance [nm]**
22	**10-29**	**26 - 40**	50	2	21.9
24	**10-19**	**26 - 40**	45	4	10.1
	20-39	**26 - 40**	762	39	19.5
	40-59	**26 - 40**	4003	165	24.3
22 - 24	**10-59**	**26 - 40**	4860	64	75.8
22	**10-29**	**10 - 25**	57	3	21.9
24	**10-19**	**10 - 25**	58	6	10.1
	20-39	**10 - 25**	811	42	19.5
	40-59	**10 - 25**	4714	194	24.3
22 - 24	**10-59**	**10 - 25**	5640	74	75.8

Area		Catch	2021		
Subdivision	**Depth [m]**	**Length range [cm]**	**Number [n]**	**Number/ Mile [n/nm]**	**Trawl distance [nm]**
22	**10-29**	**26 - 40**	57	2	23.4
24	**10-19**	**26 - 40**	105	8	12.7
	20-39	**26 - 40**	1444	102	14.1
	40-59	**26 - 40**	4127	128	32.2
22 - 24	**10-59**	**26 - 40**	5733	70	82.4
22	**10-29**	**10 - 25**	220	9	23.4
24	**10-19**	**10 - 25**	171	13	12.7
	20-39	**10 - 25**	474	34	14.1
	40-59	**10 - 25**	4803	149	32.2
22 - 24	**10-59**	**10 - 25**	5668	33	82.4

Under the assumption that the survey covered the entire nursery ground of one-year old cod, a less weak year class 2021 to the previous year class 2020 can be assumed.

4.2. Spawning of cod in SD 24

The maturity development of the cod during the BITS survey in ICES SD 24 corresponded to the long-term average. Overall, 22 % of captured male cod spawned, but only 3.8 % of females (ICES maturity key, stage 63). The majority of spawning female cod were surprisingly observed at the far western edge of Arkona Basin. Most of the females (50 %) were in pre-spawning conditions.

4.3. Spawning of cod in SD 22

In total, only 114 cod were caught in the whole area. Of these, 55 were juvenile (<21 cm) in SD 22. Of the 59 adult cod, 16 were females, of these 16 females, 2 individuals spawned (12%). This describes the catastrophic situation of the western Baltic cod, in the south area of ICES SD22 only 2 spawned female cod were observed in the main spawning season.

4.4. Hydrographical data

Figure 5 shows the distribution of temperature, salinity and oxygen near the bottom and at the surface in the covered area.

The hydrography was characterised by atypical winter conditions with surface temperatures between 3.8 °C and 4.6 °C. The salinity of the surface water decreased from 20.9 to 7.7 from west to east. The lowest temperature was found at Oderbank 3.9 °C (at 12 m water depth).

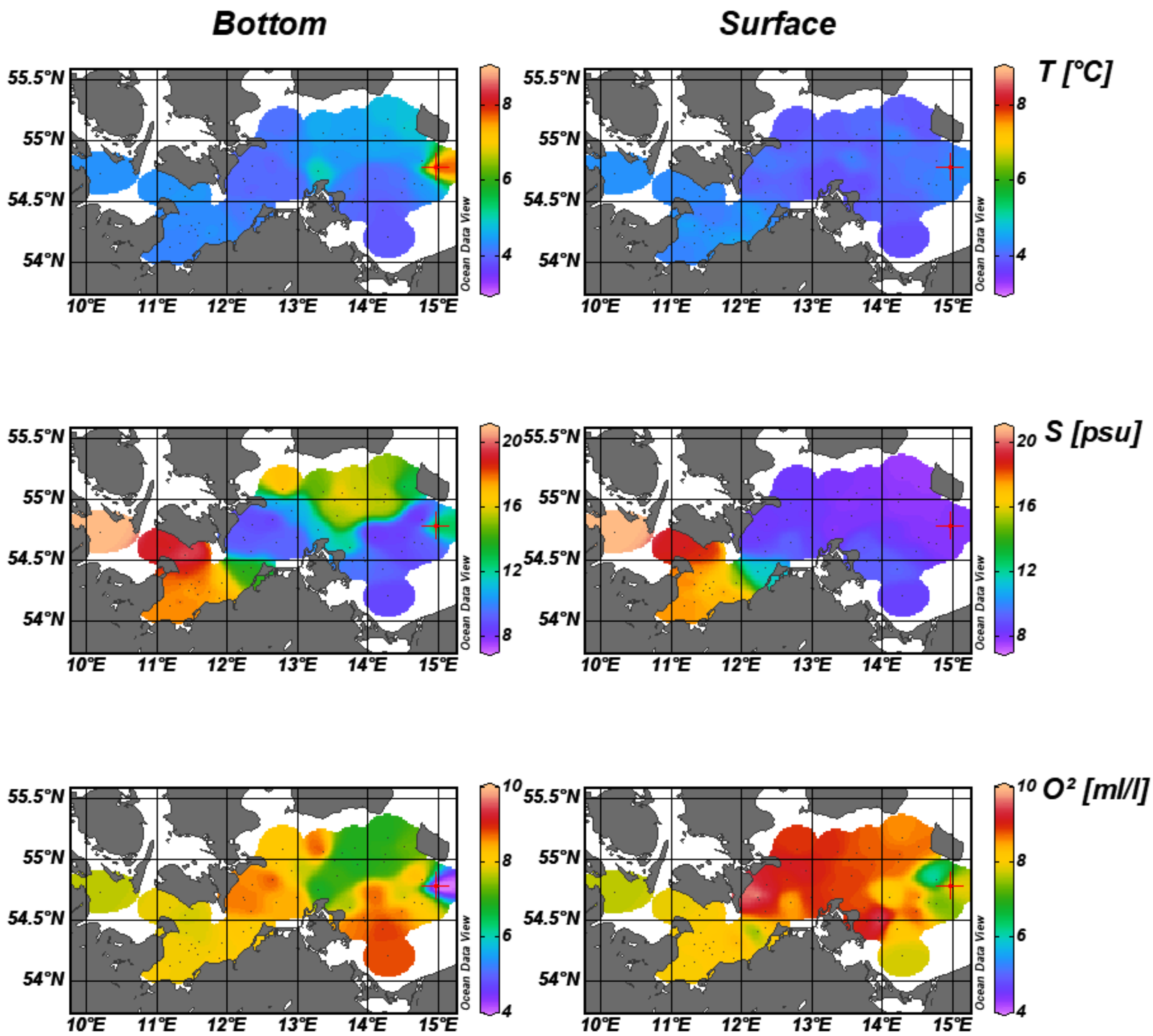

Figure 5: Hydrography of the survey near the bottom (left) and at the surface (right)

The salinity above the permanent halocline at a depth of 35.3 m in the Arkona Basin was approximately 9. The salinity in the Kiel Bight increased below the halocline up to 20.9 at a depth of 21.4 m (Figure 5). The oxygen concentration close to the bottom was high (3.6 – 8.9 ml*L-1) at all stations in the Belt Sea and Arkona Sea.

5. Participants

Participant	Function	Institution
M. Bleil	Cruise leader	Thünen-OF
T. Hogh	Head Technician	Thünen-OF
C. Albrecht	Technician	Thünen-OF
T. Jankiewicz	Technician	Thünen-OF
R. Stechert	Technician	Thünen-OF
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6. Acknowdgelements

We would like to express our gratitude to Cpt. Koops and his crew on the FRV "Solea" for their good cooperation. Many thanks to the scientific team for their reliable processing of catches.

sgd. scientists in charge

Annex 7: Cruise reports of BASS and BIAS surveys at the WGBIFS 2022 meeting

Note: Authors are fully responsible for quality of the prepared text and all kind of presented data.

List of cruise reports:

1. Cruise Report of Estonia-Poland joint BASS 2021;
2. Cruise Report of Germany BASS 2021;
3. Cruise Report of Latvia-Poland joint BASS 2021;
4. Cruise Report of Poland BASS 2021;
5. Cruise Report of Sweden BASS 2021;
6. Cruise Report of Estonia-Poland joint BIAS 2021;
7. Cruise Report of Finland BIAS 2021;
8. Cruise Report of Germany BIAS 2021;
9. Cruise Report of Germany BIAS 2021 (Summary Table);
10. Cruise Report of Latvia-Poland joint BIAS 2021;
11. Cruise Report of Lithuania BIAS 2021;
12. Cruise Report of Poland BIAS 2021;
13. Cruise Report of Sweden BIAS 2021;
14. Cruise Report of Latvia-Estonia joint GRAHS 2021.

REPORT
FROM THE JOINT ESTONIAN-POLISH SPRAS 2021
CONDUCTED BY THE R/V "BALTICA" IN THE NORTH-EASTERN BALTIC SEA
(27.05 – 1.06.2021)

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Introduction

The recent joint Estonian-Polish Sprat Acoustic Survey (SPRAS), marked with the number 9/2021/MIR-PIB/EMIUT was based on the procurement contract between the University of Tartu/Estonian Marine Institute in Tallinn and the National Marine Fisheries Research Institute in Gdynia. The survey was conducted in the Estonian EEZ (the ICES subdivisions 28.2, 29 and 32 West).

The Estonian Data Collection Program for 2021 and the European Union (the Commission regulations EC 1004/2017 and decision 2016/1251) financially supported the EST-POL SPRAS 2021 survey. Timing, surveying area in the North-eastern Baltic Sea and the principal methods of investigations concerning the above-mentioned survey were designed and coordinated by the ICES WGBIFS (ICES 2020[1]).

The main aims of the reported cruise were:

- to provide the echo-integration and to collect the acoustic data along the planned transects in the north-eastern Baltic Sea,
- to conduct the fish pelagic control-catches in the fish concentration locations,
- to collect ichthyological samples especially for herring and sprat,
- to provide hydrological monitoring (water temperature, salinity and oxygen content) at the catch locations.

Personnel

The SPRAS 2021 survey scientific staff was composed of 8 persons:
K. Koszarowski (NMFRI, Gdynia – Poland) – survey leader, ichthyologist,
M. Bielak (NMFRI, Gdynia – Poland) – acoustician,
B. Witalis (NMFRI, Gdynia – Poland) – hydrologist,
R. Zaporowski (NMFRI, Gdynia – Poland) – ichthyologist,
W. Deluga (NMFRI, Gdynia – Poland) – ichthyologist,
K. Choma-Stolarek (NMFRI, Gdynia – Poland) – ichthyologist,
W. Gaweł (NMFRI, Gdynia – Poland) – ichthyologist,
S. Trella (NMFRI, Gdynia – Poland) – ichthyologist.

[1)] ICES. 2021. ICES Working Group on Baltic International Fish Survey (WGBIFS; outputs from 2020 meeting).

Narrative

The reported survey took place during the period of 27.05 – 1.06.2021. The at sea investigations (echo-integration, fish control catches and hydrological stations) were conducted aboard r/v “Baltica” within Estonian EEZ (the ICES subdivisions 28.2, 29 and 32 West), moreover inside the territorial waters of this country not shallower than 20 m depth.

The survey started from the Estonian EEZs on 27.05.2021 after the midnight and was navigated in the North-eastern direction to the entering point of planned acoustic transect (Fig. 1). The at sea investigations ended on 30.05.2021 after midday in the Estonian EEZs. Then the r/v “Baltica” started its journey to the home-port in Gdynia (Poland), arriving in the morning on 1.06.2020.

Survey design and realization

The r/v “Baltica” realized 499 Nm echo-integration transect and 14 fish control-catches (Fig. 1). All planned ICES rectangles were covered with acoustic transect and control catches. All control catches were performed in the daylight (between 06:10 am. and 16:15 p.m. UTC) using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The hauls trawling duration varied from 10 to 30 minutes due to different fish densities observed on the net-sounder monitor. The mean speed of vessel while providing echo-integration was 8.0 knots, but 3.0 knots in case of trawling. Overall, 4, 8 and 2 hauls were conducted in SDs 28.2, 29, and 32, respectively.

The length measurements (in 0.5 cm classes) were realized for totally 2839 sprat and 2343 herring individuals. Totally, 967 sprat and 1416 herring individuals were taken for biological analysis.

Acoustic data were collected using the EK-60 echo-sounder equipped with “Echo-view V4.10” software for the data analysis. The acoustic equipment was calibrated at sea in the Gulf of Gdańsk before the survey, according to the methodology described in the IBAS manual (ICES, 2017). The basic acoustic and biological data collected during recently carried out SPRAS were delivered to the EMIUT laboratories for further elaboration. Next, they will be stored in the BASS_DB.mdb and the new acoustic data base WKBIFS-ACOU in the accepted CSV or XML formats, managed by ICES.

The rosette sampler with connected CTD Seabird 911+ probe was used for hydrological sampling,

Data analysis

The MYRIAX “EchoView v.11.0” software was used for the analysis of the acoustic data.

The total number of fishes in each the ICES rectangle was estimated as a product of the mean NASCs from scrutinized acoustic data and a rectangle area, divided by corresponding mean acoustic cross-section (σ) which is based on the trawl catch results. The abundance of clupeids was separated into sprat and herring according to the mean catch composition.

Mean target strength (TS) – one of the principal acoustic parameter – of clupeids was calculated according to following formula:

$$TS = 20 \log L - 71.2$$

Catch results and fish measurements

Overall, 8 fish species were identified in catches performed at the North-eastern Baltic Sea (SDs 28.2, 29 and 32 West) in May – June 2021. Sprat and herring dominated in all catches in the Estonian EEZ. Sprat dominated in the total biomass with the mean share amounted for 68.6% (in SD 28.2 – 68.7%; in SD 29 – 71.3%; in SD 32 – 54.9%). Mean share of herring in the total biomass was 30.9% (in SD 28.2 – 30.9%; in SD 29 – 28.2%; in SD 32 – 44.2%). The other 6 fish species (cod, flounder, three-spined stickleback, smelt, lumpfish and greater sandeel) represented only 0.5% of the total biomass.

The detailed catch and CPUE results are presented in the table 1 and figure 2. The biological sampling is shown in table 2.

Mean CPUE for all species in the investigated area in May – June 2021 amounted for 760.1 kg h^{-1} (comparing to 726.2kg h^{-1} in the same period in 2020).

The highest value of CPUE for sprat and herring was noted in SD 29. The mean values of CPUEs for sprat were as follow: 410.0 kg h^{-1} in ICES SD 28.2, 587.8 kg h^{-1} in SD 29 and 398.5 kg h^{-1} in SD 32. The mean CPUEs values for herring were: 173.9, 263.8 and 321.2 kg h^{-1} in SDs 28.2, 29 and 32, respectively. Cod and three-spine stickleback prevailed among other species in bycatch with mean CPUEs values 1.2 and 2.3 kg h^{-1} for the whole investigated area.

The length distributions of sprat, herring and three-spine stickleback according to the ICES subdivisions 28.2, 29 and 32 are shown on figures 3 – 5.

The sprat length distribution curves represent similar pattern in the three investigated subdivisions. First frequency peak, representing sprat generation born in 2020, was observed at 8.0 cm length class in subdivisions 28.2 and 29 (11.8 and 14.2% respectively) and at 7.5 cm length class in subdivision 32 (9.7%). Second frequency peak for all three subdivisions was observed at 11.0 cm length class and amounted for 19.1% in SD 28.2, 17.5% in SD 29 and 23.4% in SD 32.

The herring length distribution curves represent different pattern in the investigated area. In SD 28.2 the length distribution is unimodal, with the frequency peak at 15.5 – 17 length classes (59.7% of measured herrings). In SD 29 the length distribution is bimodal, with the first frequency pike at 14.0 cm length class (11.4%). Second frequency peak in SD 29 and was observed at 15.5 – 16.5 cm length classes, that amount for 43.7% of measured herrings. The herring length distribution curve for SD 32 is bimodal with main frequency peak at 13.5 – 14.5 cm length classes (47.4%) and a small peak for 16.0 cm length class (11.2%).

The length distribution of three spine-stickleback was in range of 2.5 – 7.5 cm, considering the whole investigated area. In SD 28.2 the length distribution is unimodal, with the frequency peak at 5.5 – 6.5 cm length classes (76.1%). In SD 29 and 32 length distribution curves represent similar bimodal pattern. First frequency peak was observed at 3.5 – 4.0 length classes and amounted for 39.4% of measured sticklebacks in SD 29 and 53.2% in SD

32. Second frequency peak was observed at 6.0 cm length class and amounted for 18.6% of measured sticklebacks in SD 29 and 13.9% in SD 32. The length range of cod was between 8.0 and 58.0 cm, without marked modal frequency at any length class.

Acoustic results

The survey statistics concerning the survey area, the mean NASC, the mean sigma, the estimated total number of fishes, the percentages of herring and sprat per ICES statistical rectangles are presented in Table 3. Overall fish abundances were higher than in previous year due to increase in sprat abundance.

Abundance and biomass estimates

The estimated abundances of herring and sprat by age group and Sub-division/ICES statistical rectangle are given in Table 4. The estimated biomass by age group and Sub-division/ICES statistical rectangle is shown in Table 5. Corresponding mean weights by age group and Sub-division/ICES statistical rectangle are summarized in Table 6.

Sprat abundance was about 20% higher compared to previous year and concentrations were mainly in the open part of Baltic Sea. Average weight of sprat was lower than in 2020. Abundance of herring was about 25% lower and average weight slightly higher than in the previous year.

The final report from the EST-POL SPRAS 2021 will be presented at the meeting of the ICES Baltic International Fish Survey Working Group (WGBIFS) in March 2022.

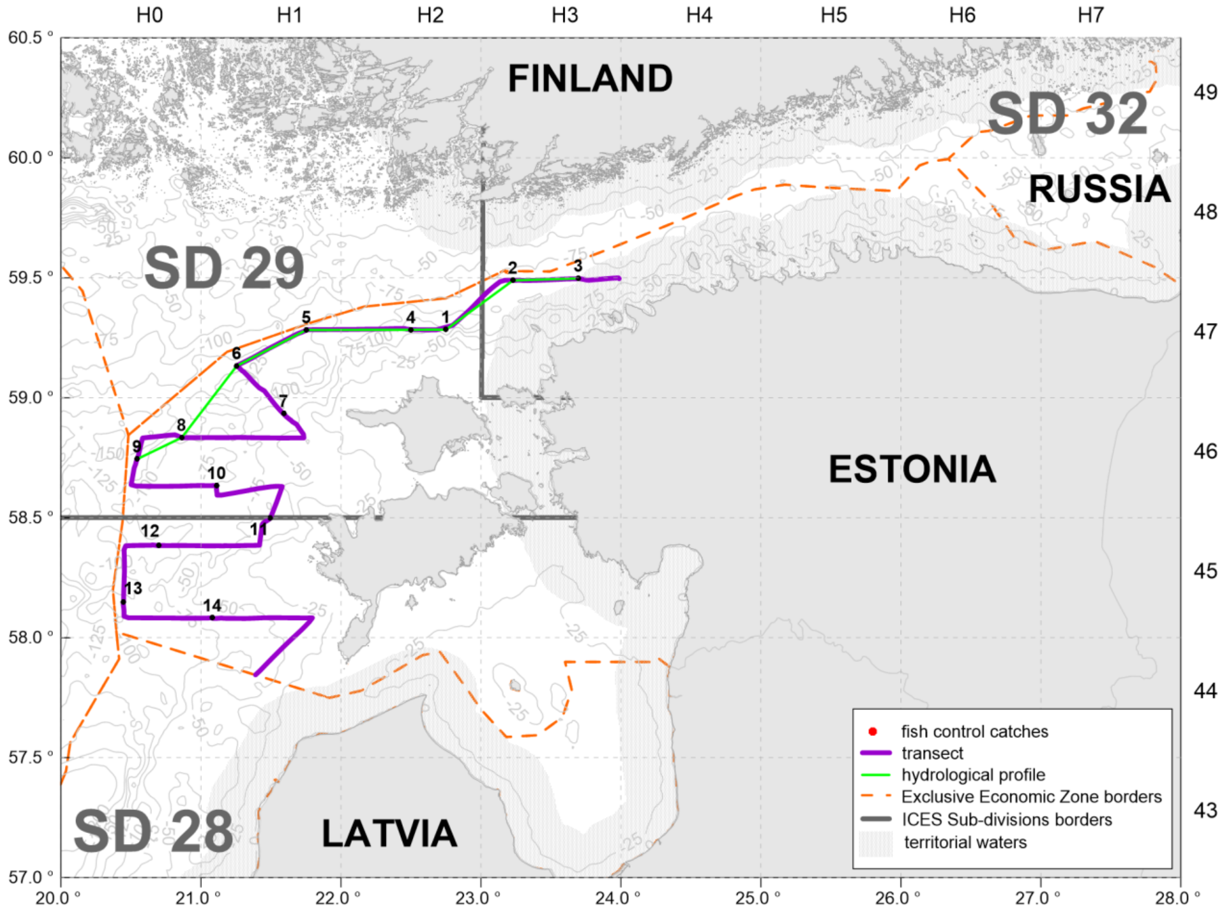

Figure 1. Acoustic transects and pelagic fish control catches with connected hydrological stations realised during the joint EST-POL SPRAS (May – June 2021)

Table 1. Catch results during joint Estonian-Polish SPRAS conducted by r/v "Baltica" in the Estonian EEZ in May – June 2021.

Haul number	Date of catch	ICES rectangle	ICES subdivision	Depth to the bottom [m]	Głębokość do dna [m]	The ships course during fishing [°]	Geographical position of the catch station				Time of		Haul duration [min.]	Total catch [kg]	CPUE [kg h^{-1}]	Catch of particular fish species [kg]							
							Start		End														
							Latitude 00°00' N	Longitude 00°00'E	Latitude 00°00' N	Longitude 00°00'E	Shutting net	Pulling net				Sprat	Herring	Cod	Flounder	Threespine stickleback	Greater sandeel	Lumpfish	Smelt
1	27.05.2021	47H2	29	65-90	138	060°	59°17'6	022°46'5	59°18'0	022°47'6	08:10	08:25	15	60,731	242,924	34,058	23,507	0,005		3,161			
2	27.05.2021	47H3	32	60-90	101	080°	59°29'4	023°15'3	59°29'4	023°16'6	11:40	11:55	15	220,556	882,224	106,982	112,026	1,028		0,107			0,413
3	27.05.2021	47H3	32	55-77	83	100°	59°29'6	023°43'1	59°29'5	023°44'4	14:30	14:45	15	142,397	569,588	92,282	48,575			1,38			0,16
4	28.05.2021	47H2	29	70-90	113	270°	59°17'1	022°29'0	59°17'2	022°28'0	07:20	07:35	15	112,733	450,932	35,237	77,041			0,455			
5	28.05.2021	47H1	29	60-85	105	240°	59°16'6	021°44'1	59°16'3	021°43'1	11:05	11:15	10	251,391	1508,346	121,021	129,73			0,64			
6	28.05.2021	47H1	29	65-87	141	145°	59°07'4	021°16'4	59°06'8	021°17'5	14:00	14:20	20	416,928	1250,784	295,922	120,870			0,136			
7	28.05.2021	46H1	29	35-60	67	140°	58°55'5	021°36'2	58°54'5	021°38'3	16:40	17:10	30	9,47	18,940	8,12	0,861			0,466	0,023		
8	29.05.2021	46H0	29	60-80	115	305°	58°50'4	020°50'2	58°50'8	020°49'0	07:30	07:45	15	477,627	1910,508	405,509	69,509	2,151	0,098	0,36			
9	29.05.2021	46H0	29	55-80	163	190°	58°43'9	020°32'2	58°43'2	020°31'9	10:00	10:15	15	139,505	558,020	83,924	55,308	0,092	0,153	0,028			
10	29.05.2021	46H1	29	60-82	87	175°	58°37'2	021°06'6	58°36'1	021°06'8	14:00	14:20	20	301,903	905,709	279,059	22,189	0,176		0,479			
11	29.05.2021	45H1	28.2	50-70	78	235°	58°29'4	021°28'6	58°28'8	021°27'2	17:55	18:15	20	33,82	101,460	31,6	1,464			0,756			
12	30.05.2021	45H0	28.2	60-78	111	275°	58°23'1	020°40'5	58°23'2	020°39'3	08:00	08:15	15	333,704	1334,816	266,281	67,238	0,163		0,022			
13	30.05.2021	45H0	28.2	55-80	90	175°	58°08'1	020°26'7	58°07'9	020°26'9	11:25	11:45	20	281,395	844,185	141,709	138,724	0,843		0,119			
14	30.05.2021	45H1	28.2	38-58	61	085°	58°04'1	021°06'1	58°05'0	021°08'8	15:10	15:40	30	31,557	63,114	27,56	3,092			0,587		0,318	
												Total catch [kg]	SD 28.2	680,476	585,894	467,15	210,518	1,006		1,484		0,318	
													SD 29	1770,288	855,770	1262,85	499,015	2,424	0,251	5,725	0,023		
													SD 32	362,953	725,906	199,264	160,601	1,028		1,487			0,573
													SUM	2813,717	760,111	1929,264	870,134	4,458	0,251	8,696	0,023	0,318	0,573

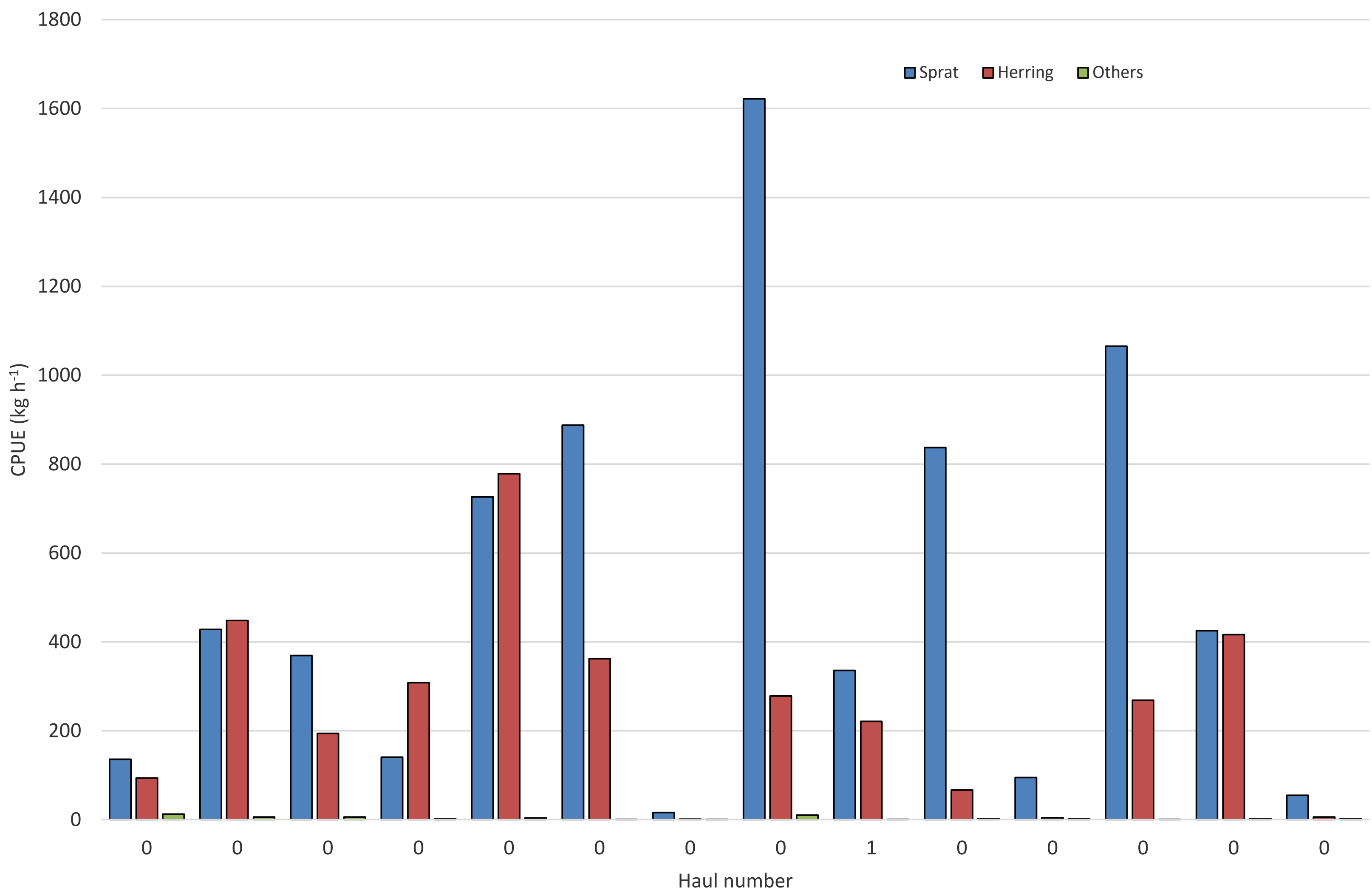

Figure 2. CPUE values (kg h^{-1}) of sprat and herring in particular pelagic fish control catches during the joint EST-POL SPRAS in the North-eastern Baltic Sea (subdivisions 28.2, 29 and 32), May – June 2021.

Table. 2. Biological sampling in the r/v "Baltica" joint EST-POL SPRAS in May – June 2021.

SD 28.2		Sprat	Herring	Cod	Flounder	Lumpfish	Threespine Stickleback	Greater sandeel	Smelt	Total
Samples taken	Measurements	4	4	2		1	4			15
	Analyses	4	4	2						10
Fish measured		817	621	6		2	117			1563
Fish analysed		311	354	6						671

SD 29		Sprat	Herring	Cod	Flounder	Lumpfish	Threespine Stickleback	Greater sandeel	Smelt	Total
Samples taken	Measurements	8	8	4	2		8	1		31
	Analyses	8	8	4						20
Fish measured			1319	6	2		345	2		3295
Fish analysed			919	6						1444

SD 32		Sprat	Herring	Cod	Flounder	Lumpfish	Threespine Stickleback	Greater sandeel	Smelt	Total
Samples taken	Measurements	2	2	1			2		2	9
	Analyses	2	2	1						5
Fish measured			403	2			79		3	888
Fish analysed			202	6						345

TOTAL		Sprat	Herring	Cod	Flounder	Lumpfish	Threespine Stickleback	Greater sandeel	Smelt	Total
Samples taken	Measurements	14	14	7	2	1	14	1	2	55
	Analyses	14	14	7						35
Fish measured			2343	14	2	2	541	2	3	5746
Fish analysed			1416	14						2397

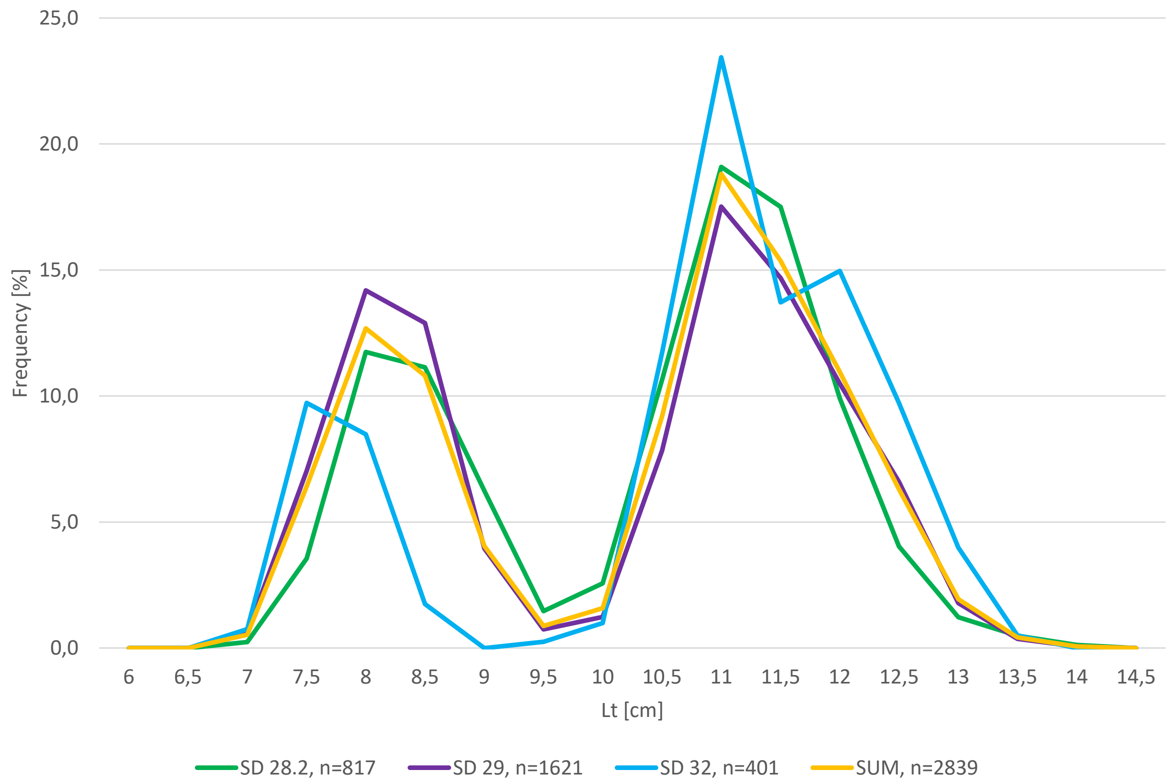

Figure 3. Sprat length distributions from the control catches conducted by the r/v "Baltica" during joint EST-POL SPRAS in the SDs 28.2, 29 and 32 (May – June 2021).

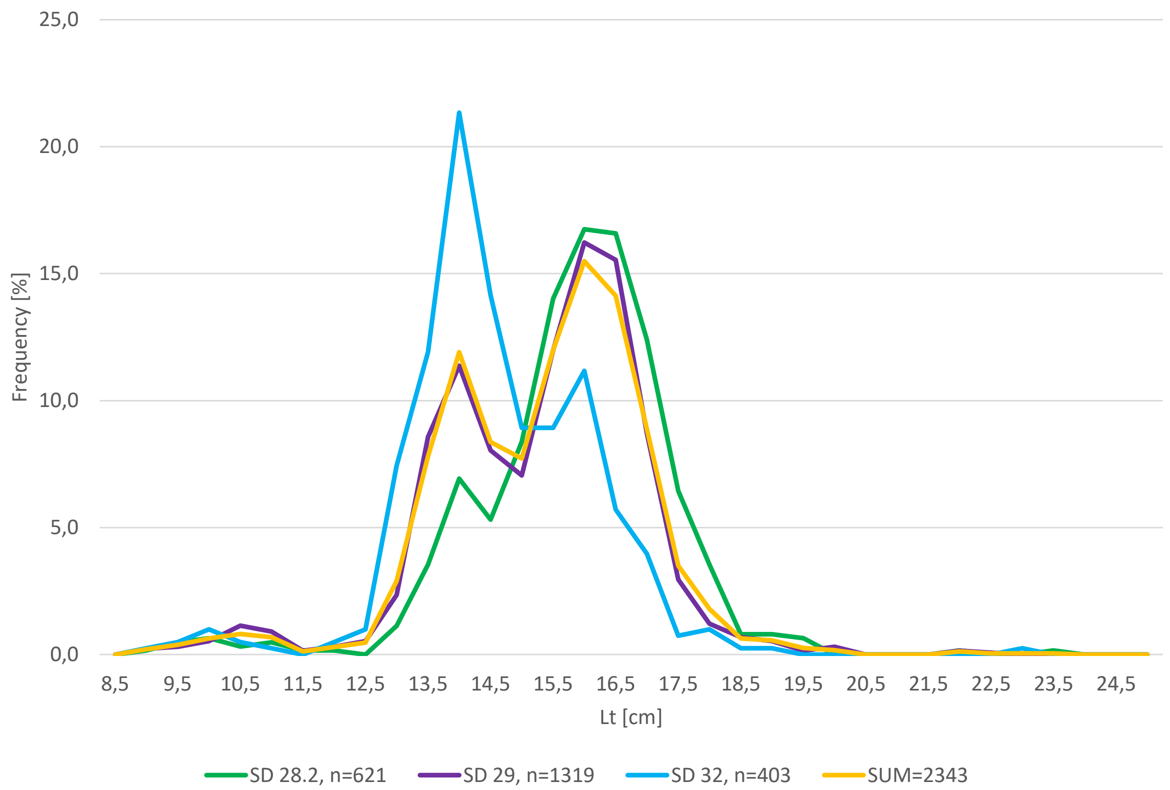

Figure 4. Herring length distributions from the control catches conducted by the r/v "Baltica" during joint EST-POL SPRAS in the SDs 28.2, 29 and 32 (May – June 2021).

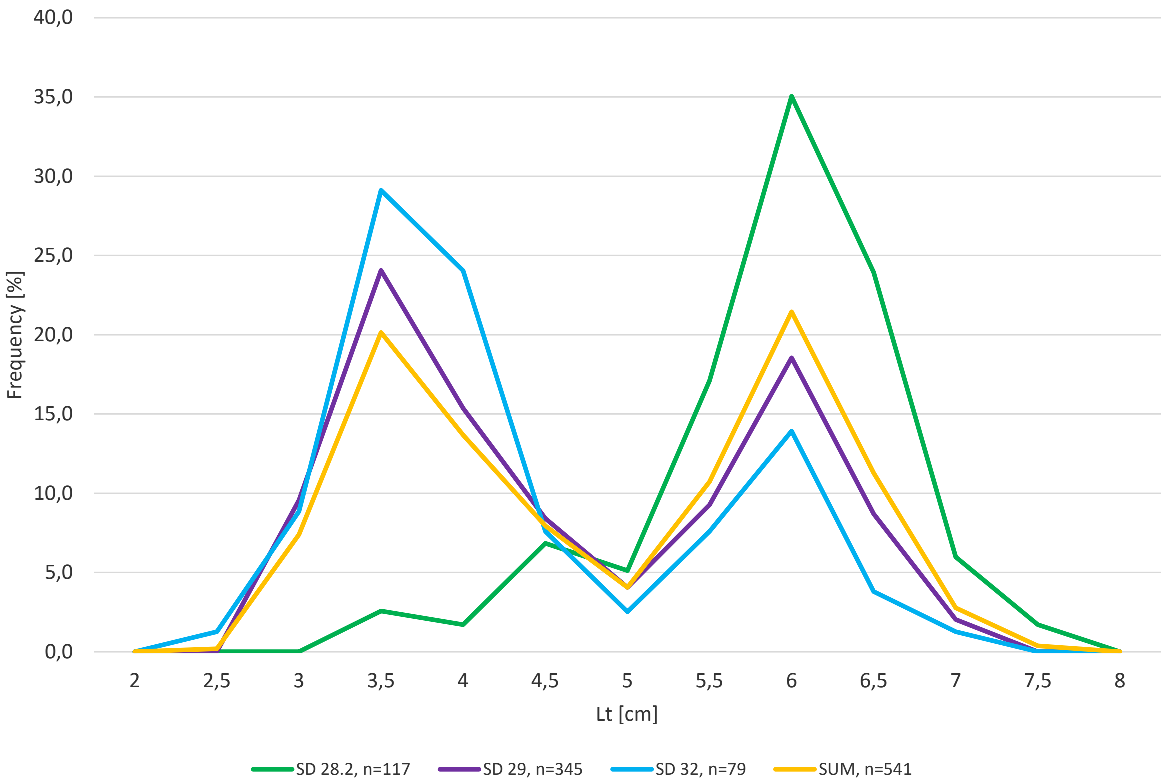

Figure 5. Three spined stickleback length distributions from the control catches conducted by the r/v "Baltica" during joint EST-POL SPRAS in the SDs 28.2, 29 and 32 (May – June 2021).

Table 3. The BASS survey basic biological and acoustic data concerning the clupeid stocks inhabiting the north- eastern Baltic Sea in May 2021.

ICES Sub-div.	ICES rectangle	Area [NM^2]	Share [%-indiv.]		Total abundance [x10^6]	Abundance density [10^6/NM^2]	NASC [m^2/NM^2]	σ [cm²]
			herring	sprat				
28	45H0	947.2	14.7	85.2	3974.19	4.196	525.9	1.253
28	45H1	827.1	2.6	90.3	4377.36	5.292	573.8	1.084
29	46H0	933.8	10.0	89.8	4996.28	5.350	585.7	1.095
29	46H1	921.5	2.4	92.5	4758.21	5.164	495.6	0.960
29	47H1	920.3	23.3	75.1	2514.27	2.732	409.9	1.500
29	47H2	793.9	27.5	54.2	3378.41	4.255	513.5	1.207
32	47H3	536.2	25.4	69.9	1273.69	2.375	321.9	1.355
Average			**15.1**	**79.6**		**4.195**	**489.5**	**1.208**
Total		**5880**			**25272**			

Table 4. Abundance (in 10^6 indiv.) of herring and sprat per age groups according to the ICES rectangles and Sub-divisions of the north-eastern Baltic in May 2021.

ICES	ICES rectangle	HERRING – age groups								
Sub-div.		1	2	3	4	5	6	7	8+	total
28	45H0	16	93	101	94	91	158	1	29	583
28	45H1	4	18	32	18	14	21	0	4	113
total		20	111	134	112	105	179	1	33	696
29	46H0	30	147	53	65	64	63	46	32	500
29	46H1	3	35	11	14	15	15	11	9	113
29	47H1	3	173	76	91	87	66	55	35	585
29	47H2	22	255	115	137	134	110	91	63	928
total		59	610	256	308	299	254	203	139	2127
32	47H3	5	188	17	42	14	25	25	8	324
total		5	188	17	42	14	25	25	8	324
Grand total		85	909	407	462	418	457	229	180	3146

Table 4. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups								
		1	2	3	4	5	6	7	8+	total
28	45H0	1243	1264	335	198	62	64	206	14	3386
28	45H1	1287	1397	385	287	115	137	279	64	3951
total		2530	2661	721	485	177	201	485	78	7338
29	46H0	2320	1120	300	254	89	87	284	33	4487
29	46H1	2295	1138	277	264	73	78	252	24	4401
29	47H1	130	741	247	257	99	100	272	43	1889
29	47H2	925	318	126	150	60	63	159	30	1830
total		5669	3317	950	925	321	328	967	130	12607
32	47H3	205	294	101	90	36	27	123	14	891
total		205	294	101	90	36	27	123	14	891
Grand total		8403	6272	1772	1500	535	557	1574	222	20835

Table 5. Biomass (in tons) of herring and sprat per age groups according to the ICES rectangles and Sub-divisions of the north-eastern Baltic in May 2021.

ICES Sub-div.	ICES rectangle	HERRING – age groups								
		1	2	3	4	5	6	7	8+	total
28	45H0	127	1440	1981	2139	2194	3919	42	799	12641
28	45H1	32	309	624	399	318	482	1	150	2315
total		159	1749	2605	2538	2512	4401	43	949	14957
29	46H0	189	2235	989	1388	1428	1529	1065	806	9629
29	46H1	25	524	210	314	347	402	286	234	2342
29	47H1	32	2606	1426	1856	1850	1514	1246	841	11371
29	47H2	143	3773	2174	2816	2882	2548	2051	1556	17943
total		390	9138	4799	6374	6507	5994	4647	3437	41286
32	47H3	31	2748	307	823	290	540	551	222	5514
total		31	2748	307	823	290	540	551	222	5514
Grand total		579	13636	7712	9735	9310	10934	5241	4609	61756

Table 5. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups								
		1	2	3	4	5	6	7	8+	total
28	45H0	4386	10032	2917	1923	628	686	1964	142	22677
28	45H1	4900	11460	3559	3110	1286	1593	2918	783	29607
total		9285	21491	6475	5033	1914	2279	4882	925	52284
29	46H0	7684	8722	2574	2383	871	863	2667	371	26135
29	46H1	8262	8527	2410	2485	696	756	2358	263	25756
29	47H1	455	5880	2185	2428	1032	1034	2611	475	16099
29	47H2	2741	2453	1118	1442	647	671	1575	338	10985
total		19142	25582	8288	8738	3245	3323	9210	1447	78976
32	47H3	581	2274	937	877	377	265	1276	161	6748
total		581	2274	937	877	377	265	1276	161	6748
Grand total		29008	49348	15700	14648	5535	5867	15369	2533	138008

Table 6. Mean weight (in grams) of herring and sprat per age groups, according to the ICES rectangles of the north-eastern Baltic in May 2021.

ICES Sub-div.	ICES rectangle	HERRING – age groups								
		1	2	3	4	5	6	7	8+	avg.
28	45H0	7.83	15.57	19.56	22.85	24.09	24.84	28.73	27.94	21.43
28	45H1	7.41	16.89	19.26	21.68	22.44	23.05	35.50	33.91	22.52
29	46H0	6.38	15.16	18.59	21.23	22.42	24.41	23.39	24.90	19.56
29	46H1	7.52	15.10	19.04	22.24	23.68	26.04	25.11	27.18	20.74
29	47H1	9.36	15.04	18.71	20.48	21.37	23.01	22.74	24.28	19.37
29	47H2	6.41	14.80	18.86	20.48	21.54	23.14	22.52	24.56	19.04
32	47H3	5.68	14.65	17.63	19.65	20.62	21.86	22.11	29.42	18.95

Table 6, Continue

ICES Sub-div,	ICES rectangle	SPRAT – age groups								
		1	2	3	4	5	6	7	8+	avg.
28	45H0	3.53	7.94	8.69	9.72	10.05	10.73	9.53	10.54	8.84
28	45H1	3.81	8.20	9.24	10.83	11.18	11.59	10.47	12.18	9.69
29	46H0	3.31	7.79	8.59	9.38	9.75	9.92	9.39	11.25	8.67
29	46H1	3.60	7.49	8.69	9.42	9.56	9.68	9.35	10.74	8.57
29	47H1	3.51	7.94	8.83	9.46	10.40	10.33	9.60	11.09	8.89
29	47H2	2.96	7.72	8.90	9.59	10.75	10.67	9.93	11.29	8.98
32	47H3	2.84	7.73	9.25	9.72	10.40	9.66	10.39	11.53	8.94

Meteorological and hydrological characteristics.

Hydrological parameters were measured at 14 trawling stations (Fig. 1). Measurements were conducted with the CTD SeaBird 911-probe combined with the rosette sampler. Oxygen content was determined by the standard Winkler's method. The STD data were aggregated to the 1-m depth strata. The salinity parameter was presented in Practical Salinity Unit (PSU). Meteorological parameters were measured by MicroStep-MIS AMS 111 automatic weather station.

The most frequent winds (Fig. 6) were from N direction. The average (10 min) wind speed varied from 0.3 m/s to 13.2 m/s. The air temperature ranged from 5.2°C to 12.9°C, and average temperature was 9.1°C.

At the surface layer (Fig. 7) the lowest value of temperature was observed at the trawl 5 and it was 6.23°C, while the warmest (9.57°C) surface water was at the trawl 14. The average value was 7.57°C. The average surface salinity was 6.79 PSU. The minimum value was 6.25 PSU at the trawl 2 and maximum 7.31 at the trawl 14. The highest oxygen content in surface water layer was 8.72 ml/l at the trawl 5 while the lowest one 6.88 ml/l at the trawl 8. Mean value of dissolved oxygen equaled 8.09 ml/l.

The near – bottom layer conditions are presented in the figure 8. Water temperature varied from 4.35°C on the trawl 14 to 6.86°C (trawl 12). The mean value calculated for the whole area covered during the cruise was 6.33 °C. The average salinity in the close-to-the-bottom water layers was 10.49 PSU. The highest value was measured on the trawl 9 (11.44 PSU). The lowest one was 7.71 PSU (trawl 14). The 0.00 ml/l of the dissolved oxygen was on trawls: 4, 6 and 9. The maximum dissolved oxygen was 6.73 ml/l on the trawl 11. The mean value was 1.44 ml/l. The vertical distribution of the seawater temperature salinity and oxygen content along the hydrological transect is presented on the figure 9. The analysis of the drawing shows that there were not the optimal water conditions for the successful spawning of cod.

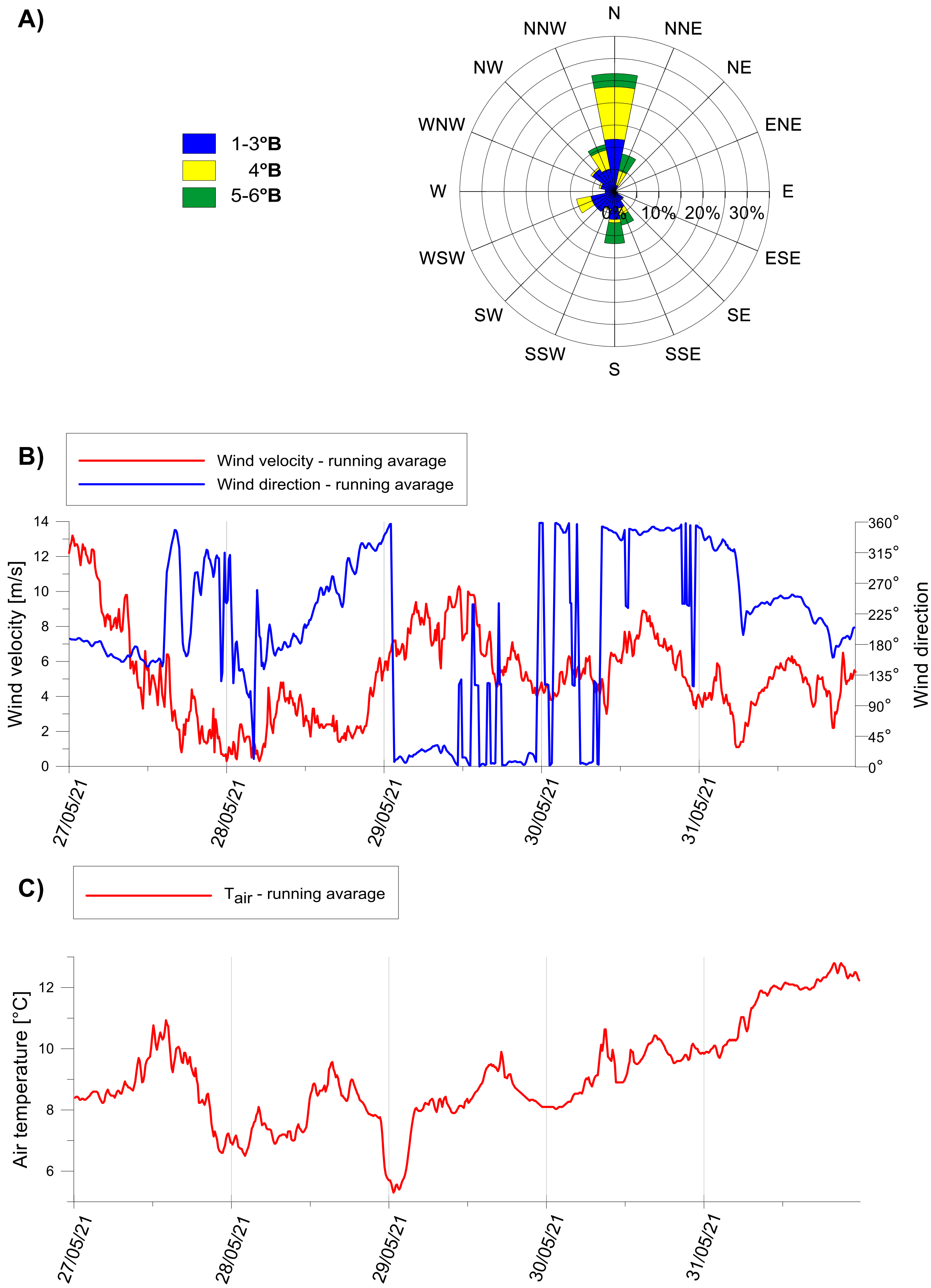

Figure 6. Changes of the main meteorological parameters (May – June 2021).

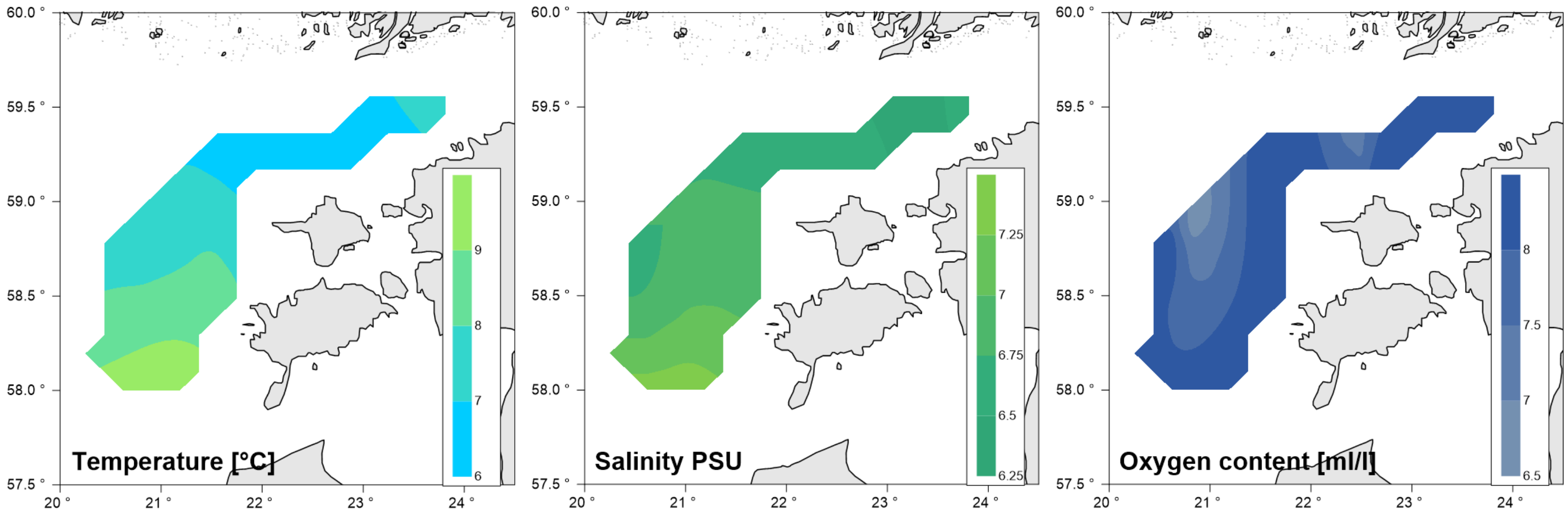

Figure 7. Distribution of the seawater temperature, salinity and oxygen content in the surface waters (May – June 2021).

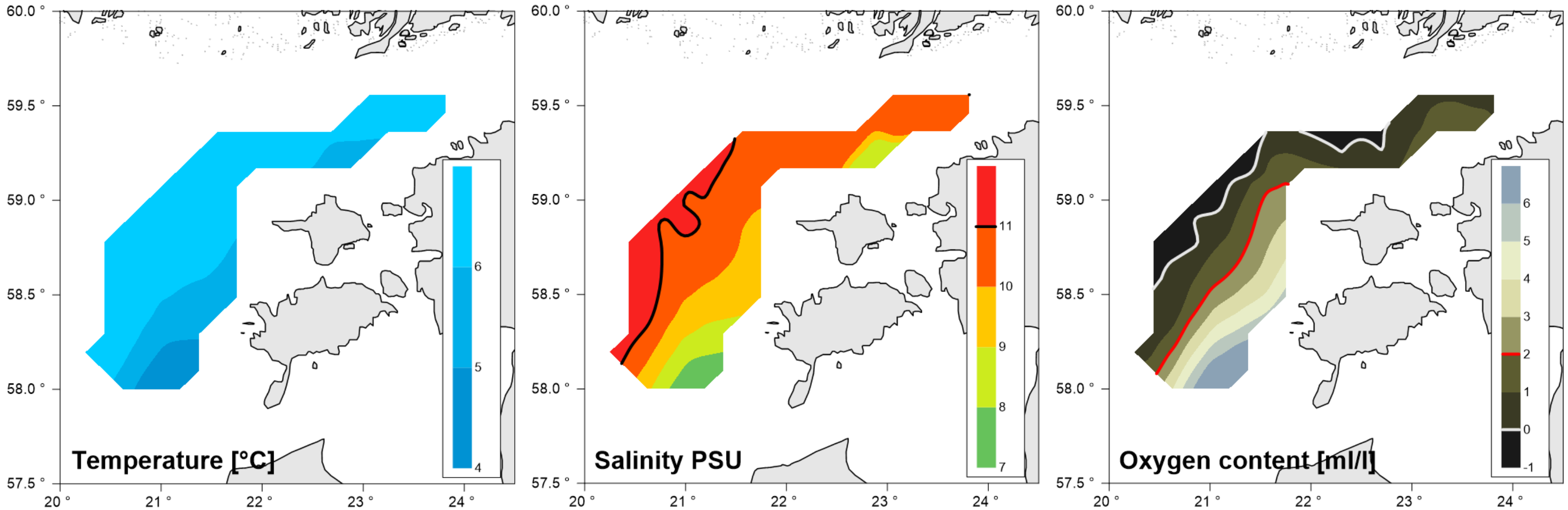

Figure 8. Distribution of the seawater temperature, salinity and oxygen content in the near bottom waters (May – June 2021).

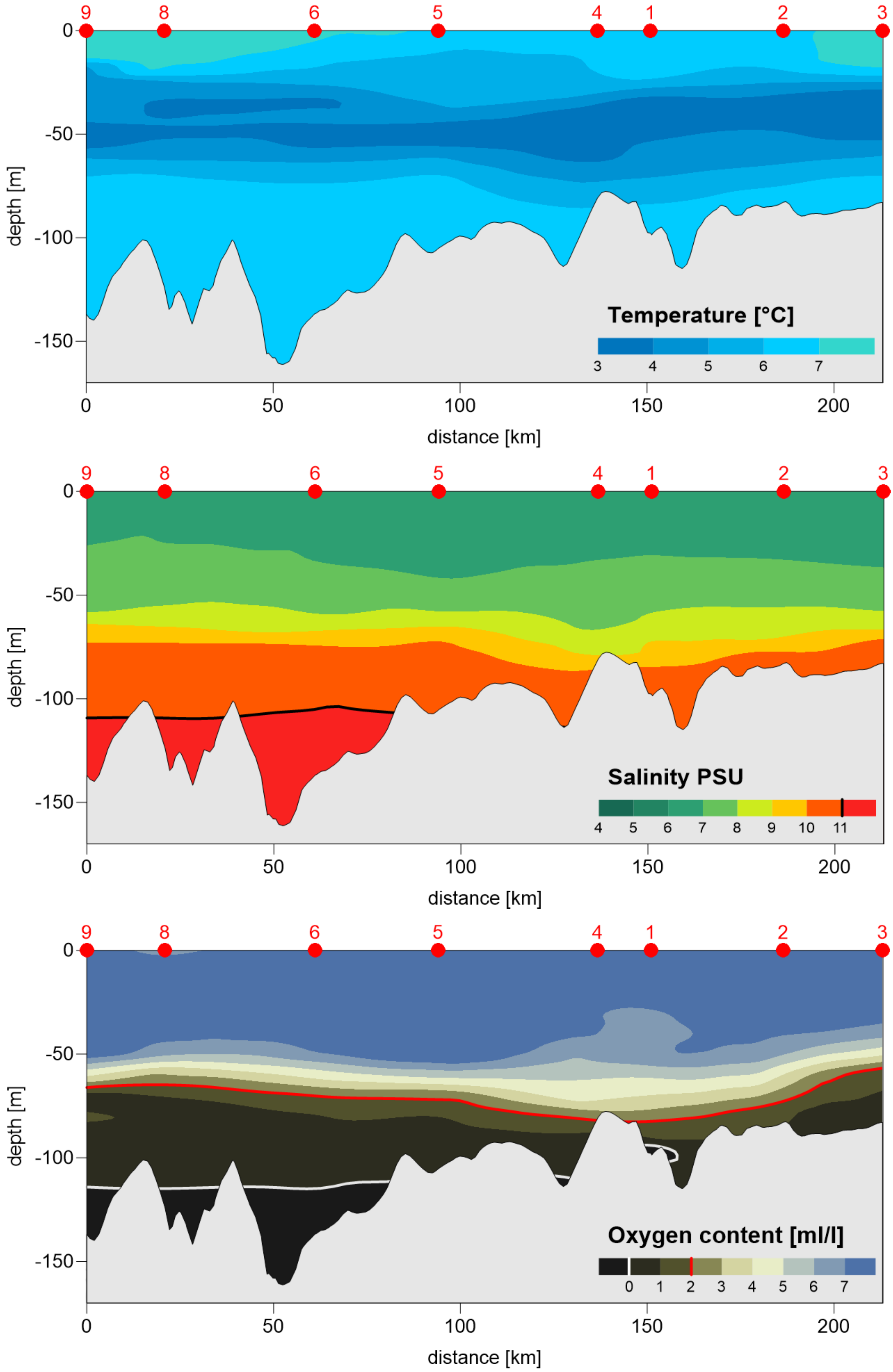

Figure 9. Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological profile (May – June 2021).

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Forestry and Fisheries**

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Cruise Report "Kristin NC336" Cruise 001

07.05. – 28.05.2021

Hydroacoustic survey for the assessment of small pelagics in the Baltic Sea

Scientist in charge: Dr. Stefanie Haase (Thünen-OF)

1. Introduction

Due to a technical defect, FRV "Walther Herwig III" was not available for this cruise and we chartered the commercial fishing vessel "Kristin" NC336" to conduct the German part of the annual ICES Baltic International Acoustic Spring Survey (BASS). The main objective of this hydroacoustic survey is the yearly assessment of the small pelagic fish stocks, especially sprat, in the Baltic proper. BASS is coordinated at the international level by the ICES Baltic International Fish Survey Working Group (WGBIFS) where timing, surveying area and the principal methods of investigations are discussed and decided. The German investigation area in 2021 covered ICES subdivisions 24, 25, 26, 27, 28, and 29. Other areas in the Baltic Sea were covered by Sweden, Lithuania, Latvia, Estonia, Russia, and Poland.

2. Cruise narrative and methods

2.1. Narrative

"Kristin NC336" departed from the habour of Marienehe, Rostock, on May 7th in the evening. The scientific echosounder equipment was calibrated immediately prior to the start of the cruise.

Acoustic recordings for the BASS started in the morning of May 8th after reaching the area of investigation in ICES subdivision 24. Acoustic recordings were continued until all 17 transects were surveyed on the 24th of May. May 17th was used for a crew change in Karlskrona. No scientific monitoring took place on that day. A map summarizing all daily transects is presented in Figure 1. May 26th and 27th was used to test equipment such as the multi-sampler onboard of "Kristin NC336", departing from Mukran.

The cruise ended in the afternoon of the 28th of May when scientists disembarked in the harbour of Marienehe, Rostock.

2.1. Hydrography

A Seabird-CTD-probe equipped with a water sampler and oxygen sensor was used for hydrographical measurements. Vertical profiles were taken on a fixed station grid along the track. Additional CTD-casts were done after or before each trawl if distance from the planned station was high enough (ca. 5 nmi). The profiles covered the entire water column to about 2 m above the sea bottom. Water samples were taken from different depths to check the oxygen data by Winkler titration and to collect reference salinity samples. The hydrological raw data were aggregated to 1 m depth strata. Altogether 119 CTD casts were performed during the BASS cruise.

2.2. Echosounder calibration and hydroacoustic sampling

The "Kristin NC336" is equipped with four Simrad EK80 wideband echosounders (18, 38, 120 and 200 kHz). The BASS was conducted with the 38 kHz frequency narrow band mode (pulse length = 1024 µs; pingrate = 500 ms) and fishing operations were recorded in broadband (38kHz) whenever possible. Each transducer was calibrated in narrowband and broadband. Calibration procedure itself was carried out as described in the "Manual for International Baltic Acoustic Surveys (IBAS)" (ICES 2017).

The acoustic and ichthyologic sampling stratification was based on ICES statistical rectangles (0.5 degree in latitude and 1 degree in longitude). The daily surveyed distance amounted to approximately 70-90 nautical miles with an objective of 60 nautical miles per statistical rectangle. In general, each ICES statistical rectangle was covered with two parallel transects spaced by a maximum of 15-18 nm whenever possible. Ship's speed was 10 knots during acoustic measurements while fishing operation were conducted at 3 to 3.5 knots. The standard acoustic investigations and the fishing hauls were carried out at daylight from 4:00 - 20:00 UTC (6:00 and 22:00 local time).

Except for rectangle 37G4 (SD24) where shallow water depth limits acoustic recording and fishing operations and 43G8 (SD 28) where a fishing license was not granted, all rectangles assigned to German investigation in SDs 24 to 29 were covered by hydroacoustic transects. For some rectangles, due to spatial constrains the total hydroacoustic track length was however lower than the recommended 60 nautical miles (see Figure 1). The lack of a research licence for all specific planned station within the Swedish EEZ caused significant track changes. This resulted in total hydroacoustic track lengths below 60 nautical miles in 24 of the 27 rectangles assigned as German investigation area.

In total, out of 1090 nmi of acoustic track 1053 nmi laying in the survey area were deemed valid and used in the further biomass estimation analysis.

2.3. Biological sampling

Trawling was conducted with the pelagic gear "PSN205" in the midwater as well as near the bottom to identify the echo signals. This is the identical gear as used by FRV "Walther Herwig III". The aim was to conduct at least two fishing hauls per ICES statistical rectangle. The trawling time lasted usually 30 minutes at a speed of 3 to 4 knots. The fishing time was however in most cases decreased because of abundant echo observed with the Scanmar-net-probe. In accordance to the IBAS manual codend inlets with stretched 20 mm mesh sizes in Subdivision 24 and 12 mm in Subdivision 25 to 29 were used.

The trawling depth and the vertical net opening were controlled by a Scanmar-net-probe. Generally, the vertical net opening was around 12 m when deployed. The trawl depth (headrope below the surface) was chosen regarding the highest density of fish on the echogram and ranged from 18.5 m to 76 m. The bottom depth at the trawling positions varied from 25 m to 264 m.

Samples were taken from each haul to determine the length and weight distribution of fish. Comparison of length distribution of herring and sprat between BASS 2020 and BASS 2021 is presented in Figure 2. Sub-samples of cod, herring and sprat were taken to investigate the distribution of sex, maturity and age of the catches. Samples of whole fish and parts of different organs/tissues were also taken for later investigations in the laboratory. Detailed biological analyses were made according to the standard procedure (i.e. sex, maturity, otolith dissection).

In total 52 standard hauls were (51 valid) carried out for the BASS:

Subdivision	Hauls (n)
24	9 (8)
25	18 (17)
26	3
27	4
28	10
29	8

Altogether 27,820 fish were measured and 1,874 additional fish (672 sprat and 1,202 herring) were sampled for further age determination.

2.1. Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers and in combination with other species so that the echo integration readings cannot be allocated directly to a single species. Therefore, the species composition used for the conversion of echo integrals into fish abundance was based on trawl catches accordingly. For each rectangle the species composition and length distribution was determined as the unweighted mean of all trawl results in this rectangle. In case of missing hauls within an individual ICES rectangle (due to shallow water depth or other limitations), haul results from neighbouring rectangles were used.

From these distributions, the mean acoustic cross section σ was calculated according to the following target strength-length (TS) relations:

- Clupeids/Gasterosteus aculeatus: TS = 20 log L (cm) - 71.2 (ICES 1983)
- Gadoids: TS = 20 log L (cm) - 67.5 (Foote et al. 1986)

The total number of fish (total N) in one rectangle was estimated as the product of the mean nautical area backscattering coefficient (i.e. echo integral) (Sa in m^2/nmi^2) and the rectangle area (nmi^2), divided by the corresponding mean cross section. The total number of fish was separated into herring, sprat, stickleback and cod as these species contributed more than one percent to all sampled hauls (in accordance with the guidelines in the 'Manual for the Baltic International Acoustic Surveys' (ICES 2017). Species with an overall mean contribution to all sampled hauls of less than one percent are excluded from further total species frequency calculation. Fish species considered in this report are thus (see results for catch statistics):

- *Clupea harengus*
- *Gadus morhua*
- *Gasterosteus aculeatus*
- *Sprattus sprattus*

Hauls with low levels of catch and thus non-representative species composition were excluded from the analysis. This includes the following haul:

- Haul 26; 38G4/SD24; only 0.16 kg catch (one flounder)
- Haul 89; 41G7/SD25; only 6.9 kg catch and a very high proportion of stickleback

Usage of neighbouring trawl information for investigated rectangles which contain only one or no haul (i.e. due to shallow water depth):

- Haul 4: 39G2/SD24 for 38G2/SD24
- Haul 11: 39G3/SD24 for 38G2/SD24
- Haul 29: 38G4/SD24 for 38G5/SD25*
- Haul 50: 39G5/SD25 for 38G5/SD25* and 39G6/SD25*
- Haul 63: 40G6/SD25 for 39G6/SD25*
- Haul 70: 40G6/SD25 for 40G7/SD25
- Haul 80: 40G7/SD25 for 40G8/SD26*

- Haul 97: 41G8/SD26 for 40G8/SD26*
- Haul 108: 42G8/SD28 for 42G8/SD27
- Haul 110: 42G8/SD25 for 42G8/SD27

Rectangles marked with '*' are not assigned to German investigation and are not included in the total abundance and biomass estimates.

Final results will be compared to those of the BASS 2020 and other previous surveys when relevant.

3. Survey results

3.1. Hydrographic data

CTD casts showed a regular stratification of the water column during the survey as shown in the temperature, salinity and oxygen profiles shown in Figure 4. Seawater temperature ranged from 10.8°C at the surface to 3.4°C (recorded at 37.4 m depth). At the deepest CTD cast of the survey (298.2 m) temperature was measured as 6.7°C. Overall intermediate water masses (depth ranging from 26.5 to 65.7 m) presented temperature below 4°C, which is higher than in previous years where temperatures below 4°C were recorded which is considered as a temperature threshold limit for the distribution of sprat in the water column. Higher temperatures were recorded above and below this stratum. Measured salinity ranged from 4.5 at the surface layer up to a maximum of 18.3 at the bottom of the Bornholm Basin. Oxygen concentrations ranged from 0.06 to 9.9 ml l^{-1}. Overall hypoxic conditions (<1.4 ml l^{-1}) were observed below 58 m depth throughout the surveyed area. No fish echo was usually observed under these conditions.

3.2. Acoustic data

The basic hydroacoustic results are given in Table 3 (survey area, mean Sa, mean scattering cross section σ, estimated total number of fish and percentage of herring and sprat per rectangle). The valid measured cruise track within ICES rectangles assigned to German investigation reached a distance of 1053 nautical miles. Overall mean NASC recorded through the survey is slightly lower compared to the previous year with a mean NASC across the water column of 432.3 m²/nm² versus 595.2 m²/nm² in 2020 where similar ICES rectangles were covered. On an ICES subdivision scale the mean NASC per subdivision were relatively comparable to those recorded in the past 11 years with a larger decrease in SD 25 and a slight decrease in 24 compared to the previous two years (Figure 4). Mean NASC increased in SD 27 and 28 compared to the previous year. A map of the echo distributions is shown in Figure 5.

3.3. Biological data

Catch statistics per fishing hauls and species and subdivision are presented in Table 4 and Table 5 respectively. Overall 12 fish species were recorded in 52 pelagic trawl hauls. The CPUE ranged from 4.1 to 2271.7 kg/0.5h. The mean CPUE reached 257.6 kg/0.5h, which is slightly lower than the value calculated in the 2020 survey (279.5 kg/0.5h). In terms of weight, catch was dominated by sprat (84.0%) followed by herring (12.9%), stickleback (1.4%) and cod (1.4%). Those four species were caught on the majority of the trawls through the survey, in respectively 51, 50, 31 and 32 hauls. The numbers and biomass of species other than sprat, herring, stickleback and cod were negligible.

Figure 6 shows the length frequency distribution for sprat and herring per subdivision in 2020 and 2021. The length structure of herring looks more truncated in 2021 compared to the BASS 2020 with fewer smaller and larger individuals in all subdivisions. Smaller sprats are missing from SD 24 but SDs 26-29 show a higher proportion of smaller sprat compared to the BASS 2020. Age distribution per length class is presented in Figure 7. Final age distribution by subdivision for 2021 (Figure 8) was calculated according to the minimum effort method by multiplying the length frequency distribution with the age distribution per length class as recommended in the IBAS Manual (2017: eq 5.3.1).

The age distribution of herring varied between SDs which generally higher proportions of older herring in SDs 25-29 (Figure 8). The incoming year class, represented by 1-year old individuals, was mostly present in SD 24 and rather week in all other SDs compared to the BASS 2020. In contrast, the age distribution for sprat was dominated by the 1- and 2-year old individuals in SDs 26-29 and 2-year old in SD 25. There were only few age-1 sprat present in the distribution of SD 24 and this SD was dominated by age 3-6.

3.4. Abundance Estimate

The calculated abundance in number and weight of sprat and herring per rectangle and subdivision is presented in Table 6. Note that contrary to previous years rectangle 37G4 has not been covered this year. Overall estimated abundances in all overlapping rectangle for herring and sprat are lower in 2021 compared to 2020 with respectively $6.48*10^9$ versus $7.84*10^9$ herrings (-18%) and $67.19*10^9$ versus $91.51*10^9$ sprats (-27%). Estimated biomass is also lower in 2021 for herring with $183.50*10^3$ tonnes versus $217.87*10^3$ tonnes estimated in 2020 (-16%). Estimated biomass of sprat was again lower in 2021 with $535.99*10^3$ tonnes versus $866.06*10^3$ tonnes in 2020 (-38%).

Year	Species	n total (million)	total biomass (tonne)
2020*	*Clupea harengus*	8,347.4	240,400.6
2020		7,842.2	217,873.2
2021		6,467.9	183,503.1
2020*	*Sprattus sprattus*	92,361.8	879,005.4
2020		91,513.3	866,064.7
2021		67,191.2	535,987.8

*including rectangle 37G4

4. Survey participants

Name	Function	Institution
Dr. S. Haase	Cruise leader	Thünen-OF
M. Koth	Fishery biology	Thünen-OF
S. Winning	Acoustics	Thünen-SF
M. Bächtiger	Fishery biology	Thünen-OF (student assistant)
Dr. D. Stepputtis	Fishery biology	Thünen-OF
Dr. A. Hermann	Engineer	Thünen-OF

5. Acknowledgement

We hereby thank all participants and the crew of “Kristin NC336” for their outstanding cooperation and commitment.

6. commitment. Literature

ICES 1983: Report of the Planning Group on ICES co-ordinated herring and sprat acoustic surveys. ICES CM 1983/H:12.

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7. Tables

Table 1: "Kristin NC336" cruise 001/2021 BASS: Start and end time of hydroacoustic recording during the cruise.

Date	Recording start time (UTC)	Recording end time (UTC)	Date	Recording start time (UTC)	Recording end time (UTC)
08.05.2021	04:49	18:05	16.05.2021	04:32	15:21
09.05.2021	04:55	17:39	18.05.2021	04:36	18:25
10.05.2021	04:21	18:03	19.05.2021	04:43	18:45
11.05.2021	04:35	17:12	20.05.2021	04:53	17:21
12.05.2021	04:18	18:24	21.05.2021	04:39	16:40
13.05.2021	04:30	17:30	22.05.2021	04:37	19:20
14.05.2021	05:58	14:28	23.05.2021	04:36	18:09
15.05.2021	04:11	17:48	24.05.2021	04:27	19:42

Table 2: "Kristin NC336" cruise 001/2021 BASS: Hydroacoustic track length per ICES rectangle.

Subdivision	ICES rectangle	Valid acoustic track length (nmi)	Subdivision	ICES rectangle	Valid acoustic track length (nmi)
24	37G4	0	25	41G6	16
24	38G2	21	25	41G7	69
24	38G3	64	26	40G8*	19
24	38G4	51	26	41G8	70
24	39G2	16	27	45G8	53
24	39G3	35	27	46G8	26
24	39G4	33	28	42G8	19
25	38G5*	12	28	42G9	53
25	39G4	14	28	43G9	52
25	39G5	49	28	44G9	38
25	39G6*	26	28	45G9	41
25	40G4	30	29	46G9	51
25	40G5	43	29	46H0	35
25	40G6	57	29	47G9	23
25	40G7	56	29	47H0	26

*ICES rectangle not assigned to German investigation

Table 3: "Kristin NC336" cruise 001/2021 BASS: Survey statistics of the cruise

Sub-division	Rec-tangle	area (nmi^2)	Sa (m^2/nmi^2)	sigma (m^2)(*10e-4)	n total (million)	*Clupea harengus* (%)	*Sprattus sprattus* (%)	*Gadus morhua (%)*	*Gasterosteus aculeatus (%)*
24	38G2	832.9	27.8	2.8	82.34	81.50	18.44	0.06	0.00
24	38G3	865.7	165.2	2.7	534.53	56.37	43.54	0.09	0.00
24	38G4	1034.8	80.1	2.8	294.04	52.80	47.09	0.11	0.00
24	39G2	406.1	152.4	2.8	222.73	88.45	11.55	0.00	0.00
24	39G3	765.0	279.8	3.2	658.99	77.48	22.46	0.06	0.00
24	39G4	524.8	144.2	1.7	444.66	2.36	97.23	0.41	0.00
25	38G5*	1035.7	93	2.7	359.33	42.37	57.27	0.36	0.00
25	39G4	287.3	125	1.7	211.07	2.36	97.23	0.41	0.00
25	39G5	979.0	877.3	1.6	5317.82	1.63	98.13	0.24	0.00
25	39G6*	1026.0	910	1.6	5875.84	2.31	97.40	0.29	0.00
25	40G4	677.2	465.8	1.8	1707.57	15.12	84.05	0.32	0.51
25	40G5	1012.9	556.2	1.1	3271.2	4.12	58.78	0.10	37.00
25	40G6	1013.0	286	1.8	1576.63	22.37	77.46	0.04	0.13
25	40G7	1013.0	151.2	2.1	737.04	31.20	68.44	0.02	0.34
25	41G6	764.4	238.4	0.6	488.49	5.70	11.40	0.00	82.90
25	41G7	1000.0	205	1.2	1411.73	0.30	84.21	0.00	15.49
26	40G8*	1013.0	515.6	1.5	3516.79	5.74	94.09	0.02	0.15
26	41G8	1000.0	317.7	1.3	2508.54	5.34	94.36	0.03	0.27
27	45G8	947.2	668	0.8	4193.11	6.90	49.16	0.01	43.93
27	46G8	884.8	612.3	0.7	4272.38	4.40	53.00	0.00	42.60
28	42G8	945.4	226.9	1.2	1242.21	5.68	63.41	0.01	30.90
28	42G9	986.9	933	1.2	7443.64	0.60	99.36	0.05	0.00
28	43G9	973.7	623.2	1.1	5266.55	1.87	97.07	0.01	1.05
28	44G9	876.6	830.8	1.1	6482.56	1.22	93.58	0.00	5.20
28	45G9	924.5	656.1	1.1	4857.86	3.48	85.41	0.01	11.10
29	46G9	933.8	625.1	0.8	4057.01	5.71	51.42	0.00	42.87
29	46H0	933.8	629.7	1.1	4520.79	6.48	74.56	0.00	18.96
29	47G9	876.2	861.4	1.2	5298.34	16.45	71.15	0.01	12.39
29	47H0	920.3	841.1	1.1	6593.39	9.06	82.84	0.01	8.09

*ICES rectangle not assigned to German investigation

Table 4: “Kristin NC336” cruise 001/2021 BASS: Overall catch statistics per fishing haul.

Haul	Catch weight (kg)	Fish number (n)	CPUE (kg/0.5 hr)	Haul	Catch weight (kg)	Fish number (n)	CPUE (kg/0.5 hr)
1	4.2	145	4.1	27*	6.8	3,439	6.8
2	12.8	368	10.9	28	94.5	7,525	94.5
3	153.5	4,173	153.5	29	246.0	35,850	369.0
4	51.6	1,980	51.6	30	23.2	3,087	34.7
5	33.1	744	33.1	31	24.4	3,454	24.4
6	426.8	11,758	426.8	32	39.5	3,887	39.5
7*	0.2	1	0.2	33	389.4	48,341	778.8
8	71.3	1,511	71.3	34	204.1	23,663	306.1
9	87.2	3,804	87.2	35	125.6	16,201	188.4
10	298.7	19,145	298.7	36	127.9	18,542	191.9
11	152.7	8,906	458.2	37	119.5	19,291	143.4
12	307.3	21,757	461.0	38	110.5	14,483	165.8
13	584.6	50,948	1,753.7	39	93.1	11,319	93.1
14	89.5	6,332	89.5	40	94.8	14,165	142.2
15	217.5	19,900	652.6	41	118.5	22,329	118.5
16	757.2	76,059	2,271.7	42	33.2	4,534	33.2
17	119.3	19,571	119.3	43	42.2	5,934	42.2
18	181.4	15,499	544.2	44	50.1	10,710	50.1
19	115.2	11,164	230.4	45	68.9	8,880	68.9
20	595.5	56,565	595.5	46	81.5	8,403	81.5
21	70.2	2,559	70.2	47	113.3	19,940	169.9
22	59.1	11,215	88.7	48	67.9	8,028	67.9
23	24.8	5,474	37.2	49	85.2	16,790	85.2
24	109.3	10,526	109.3	50	55.5	12,859	55.5
25	667.3	88,784	667.3	51	102.7	20,896	102.7
26	40.4	4,397	40.4	52	69.4	11,482	104.1

*****invalid hauls

Table 5: "Kristin NC336" cruise 001/2021 BASS: Catch statistics per species. Values < 0.01 are indicated by a "-".

Species	No. of hauls with the species	No. Of length measurements	No. Of individual measurements	Total catch (kg)	Percent of total catch weight	Percent of total catch weight
Ammodytes	2	2	0	0.01	-	-
Clupea harengus	50	11,406	1,202	1660.5	12.89	5.10
Cyclopterus lumpus	2	2	0	0.55	-	-
Gadus morhua	32	475	0	184.65	1.43	0.06
Gasterosteus aculeatus	31	2,070	0	184.79	1.43	10.05
Hyperoplus lanceolatus	2	3	0	0.07	-	-
Melanogrammus aeglefinus	1	1	0	0.20	-	-
Merlangius merlangus	11	84	0	18.84	0.15	0.01
Myoxocephalus scorpius	2	2	0	0.23	-	-
Platichthys flesus	17	32	0	10.94	0.09	-
Salmo salar	1	1	0	7.24	0.06	-
Sprattus sprattus	51	13,739	672	10816.95	83.95	84.76

Table 6: "Kristin NC336" cruise 001/2021 BASS: Total number and biomass of sprat and herring per rectangle.

Subdivision	ICES rectangle	n herring (million)	Herring biomass (tonne)	n sprat (million)	Sprat biomass (tonne)
24	38G2	67.11	2,433.88	15.18	222.48
24	38G3	301.33	12,129.13	232.72	3,912.00
24	38G4	155.25	7,130.70	138.46	2,385.80
24	39G2	197.01	6,630.81	25.72	362.08
24	39G3	510.59	23,473.99	148.00	2,623.18
24	39G4	10.50	488.65	432.34	5,887.59
25	38G5*	152.24	6,867.50	205.80	2,837.44
25	39G4	4.99	218.68	205.22	2,419.32
25	39G5	86.71	3,454.56	5,218.50	60,730.53
25	39G6*	135.49	4,978.29	5,723.19	63,881.86
25	40G4	259.53	8,525.05	1,442.50	17,164.22
25	40G5	213.80	7,506.51	3,052.20	31,096.92
25	40G6	353.08	12,043.79	1,222.88	13,208.49
25	40G7	230.73	8,437.06	506.17	5,808.72
25	41G6	162.94	5,069.48	325.55	3,508.16
25	41G7	5.07	130.05	1,406.65	14,009.31
26	40G8*	202.23	6,628.51	3,313.86	32,624.09
26	41G8	134.34	4,403.14	2,373.32	18,113.05
27	45G8	515.98	10,800.18	3,676.48	24,815.00
27	46G8	327.80	6,783.18	3,944.22	20,390.40
28	42G8	102.07	2,864.11	1,139.91	11,625.22
28	42G9	44.40	1,350.67	7,395.87	59,759.84
28	43G9	99.45	2,650.97	5,166.81	37,049.49
28	44G9	83.55	1,992.34	6,399.01	44,246.30
28	45G9	190.06	4,586.95	4,667.17	34,652.39
29	46G9	405.64	8,865.76	3,651.37	24,065.61
29	46H0	361.35	7,651.76	4,159.44	29,480.55
29	47G9	994.93	20,002.66	4,302.71	32,030.25
29	47H0	649.67	13,879.07	5,942.73	36,420.91
Total		6,957.84	201,977.43	76,433.98	635,331.20

*ICES rectangle not assigned to German investigation

8. Figures

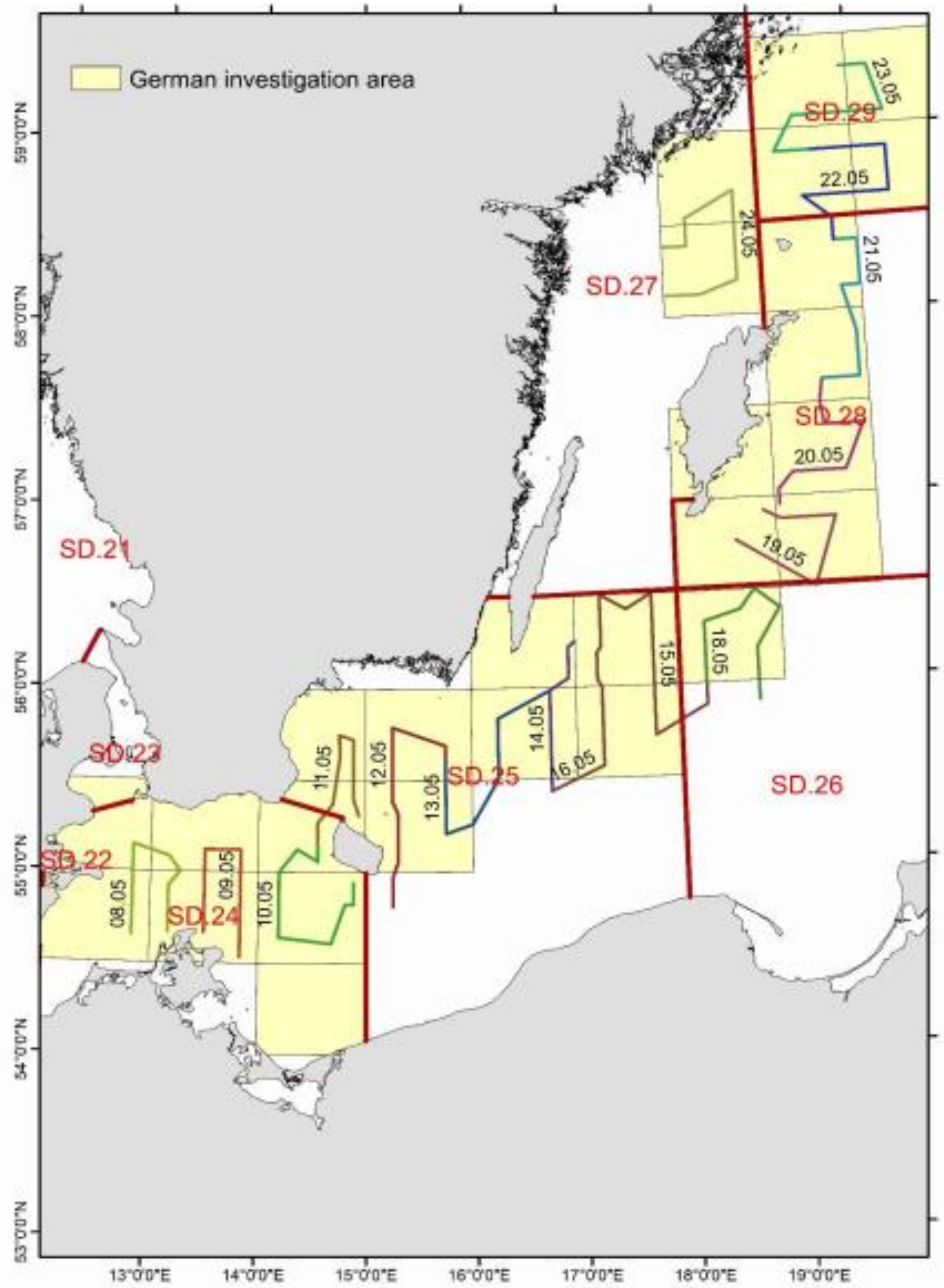

Figure 1: "Kristin NC336" cruise 001/2021 BASS: Daily hydroacoustic track done during the BASS survey 2021.

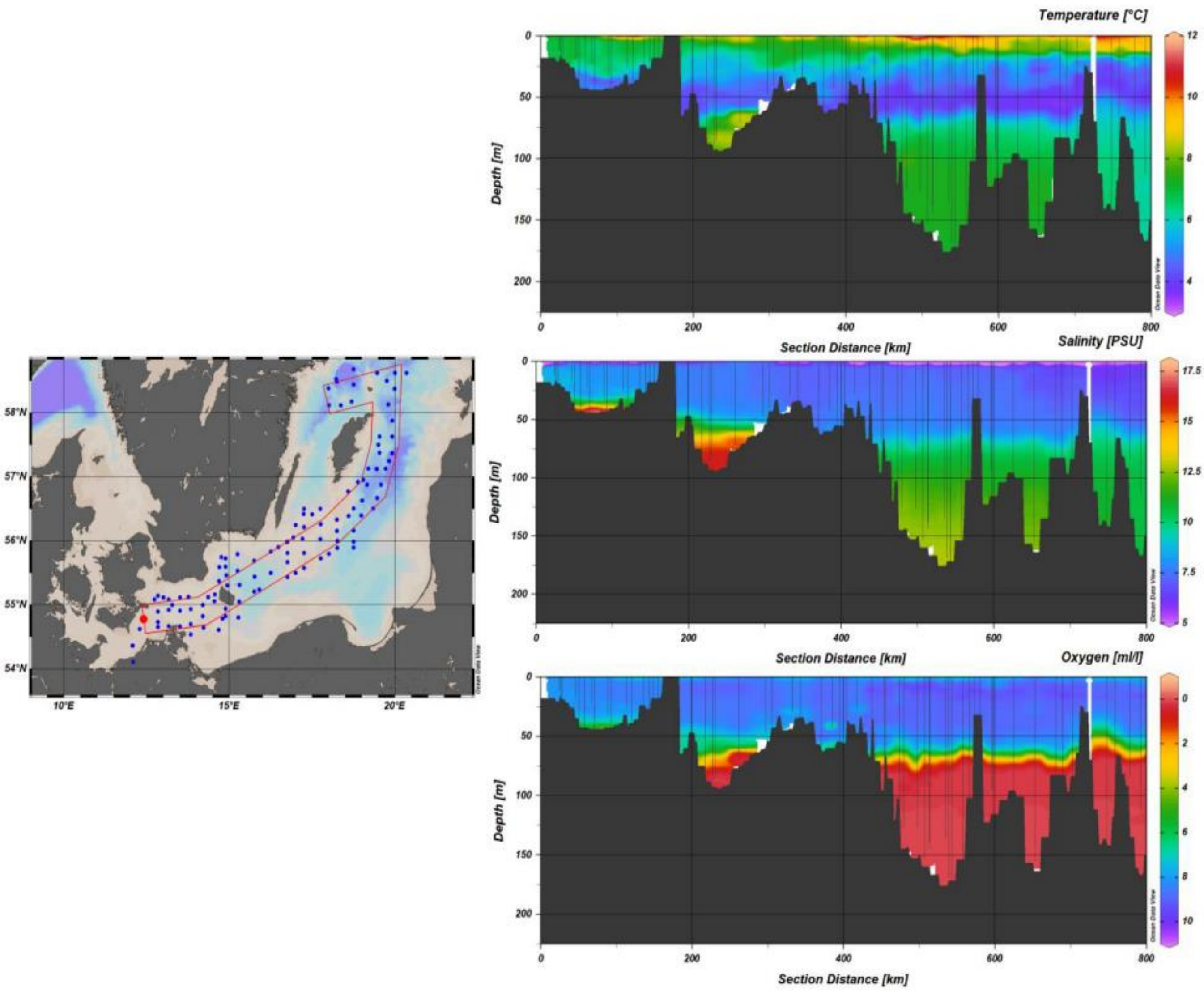

Figure 2: "Kristin NC336" cruise 001/2021 BASS: Temperature (upper right panel), oxygen (middle right panel) and salinity (lower right panel) interpolated from CTD casts along a south/west - north/east transect as shown in the left panel (red line). CTD casts coordinates are display as blue dots on the map in the left panel.

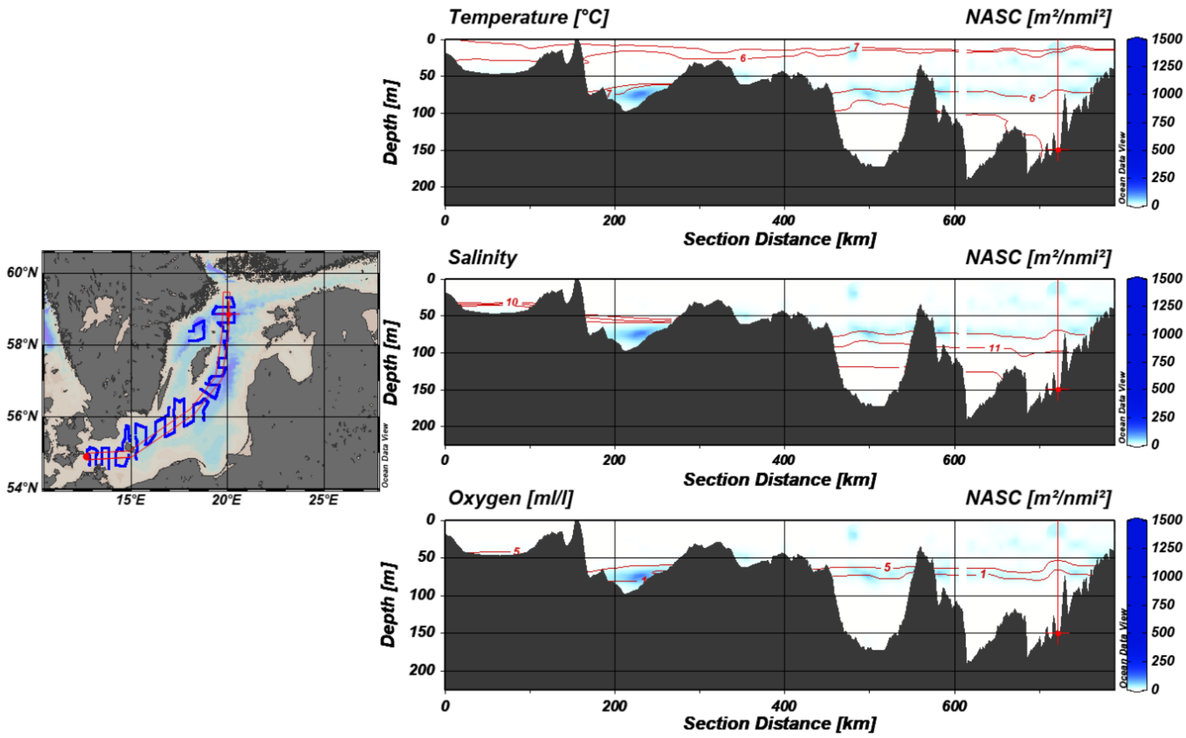

Figure 3: "Kristin NC336" cruise 001/2021 BASS: Vertical distribution of temperature, salinity and oxygen related to the echogram of fish (blue clouds).

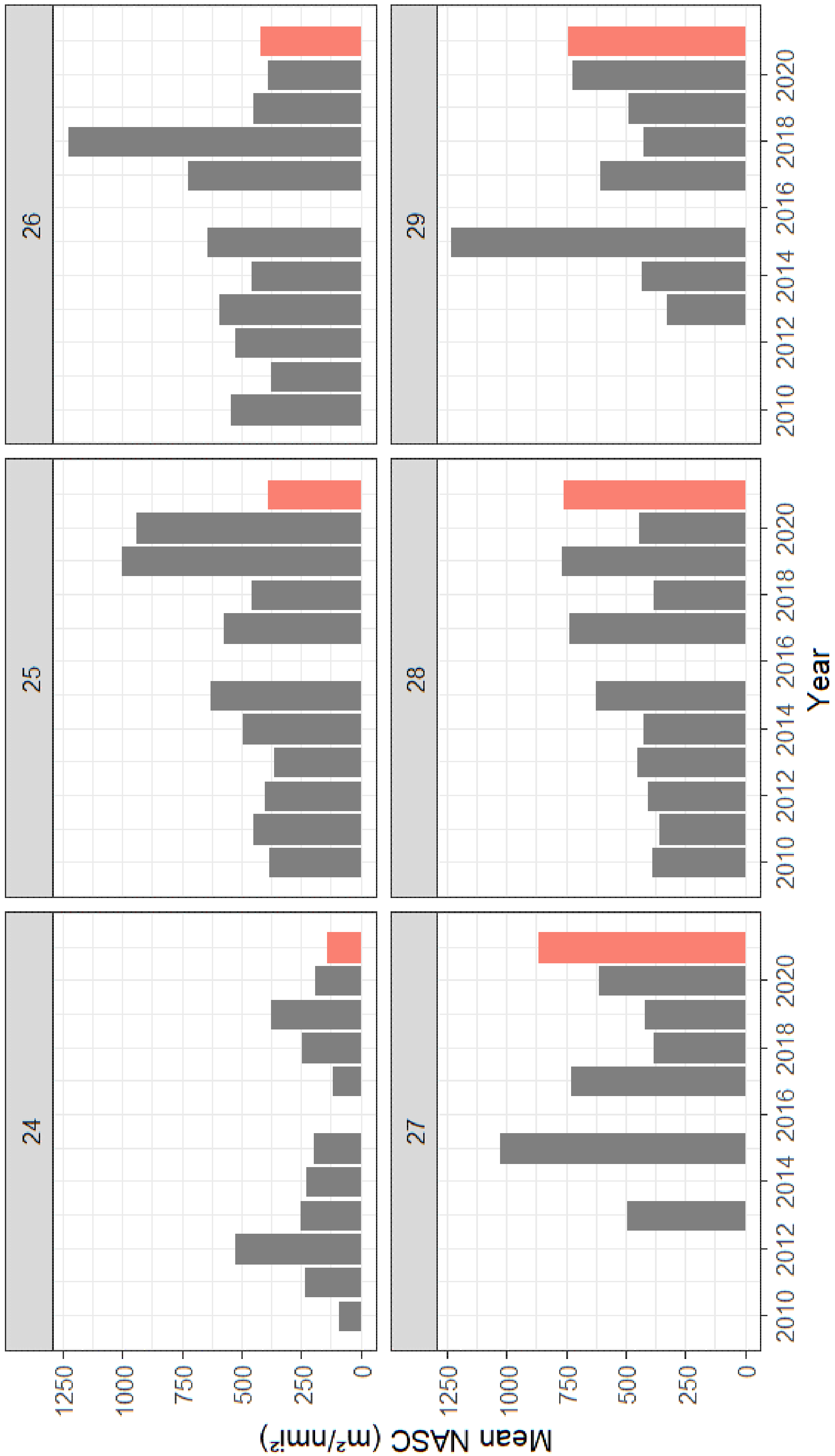

Figure 4: "Kristin NC336" cruise 001/2021 BASS: Mean NASC calculated per year and per subdivision (red bar corresponds to 2021).

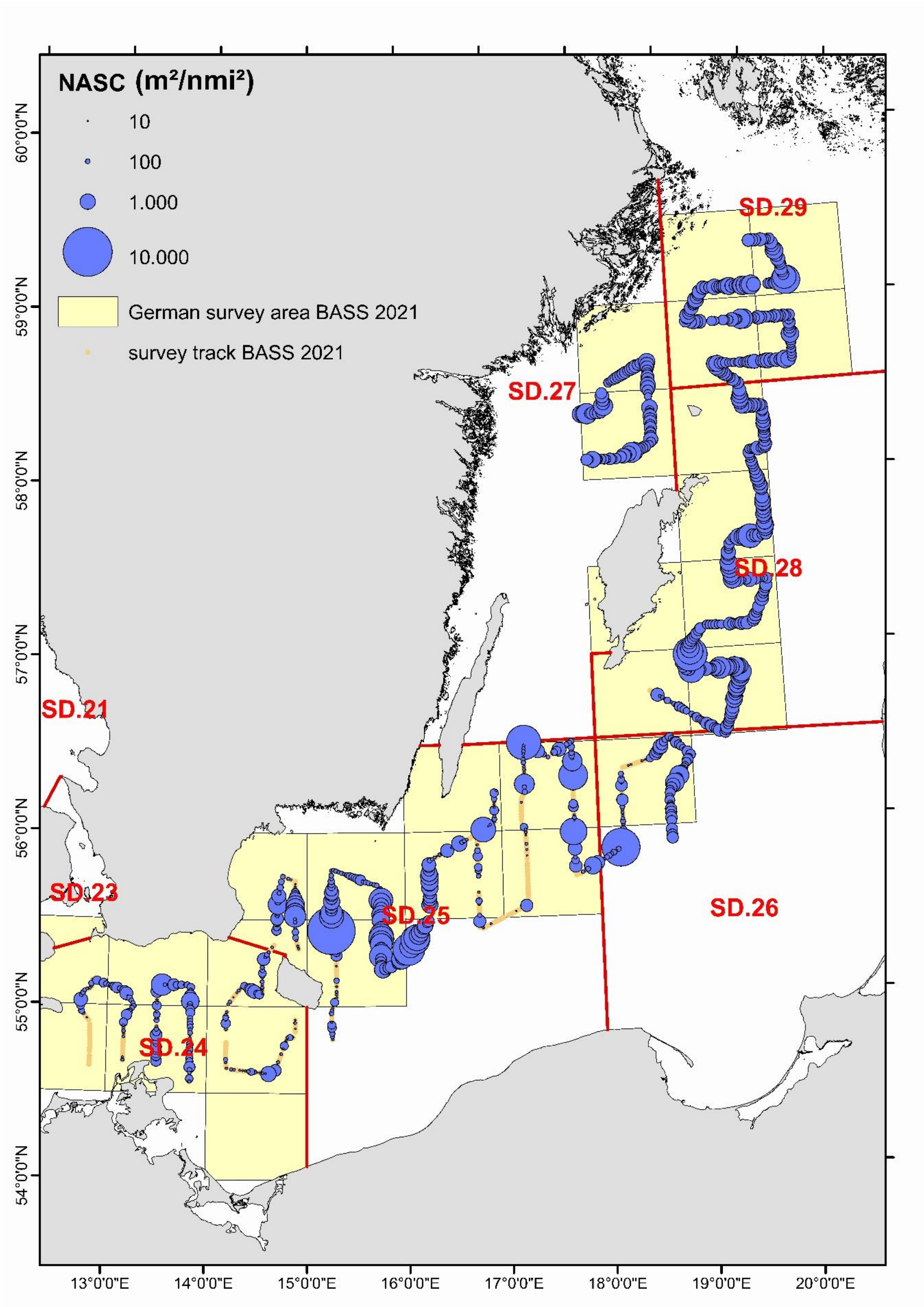

Figure 5: "Kristin NC336" cruise 001/2021 BASS: hydroacoustic results: NASC (m^2/nm^2) per 1 nmi recorded during the survey.

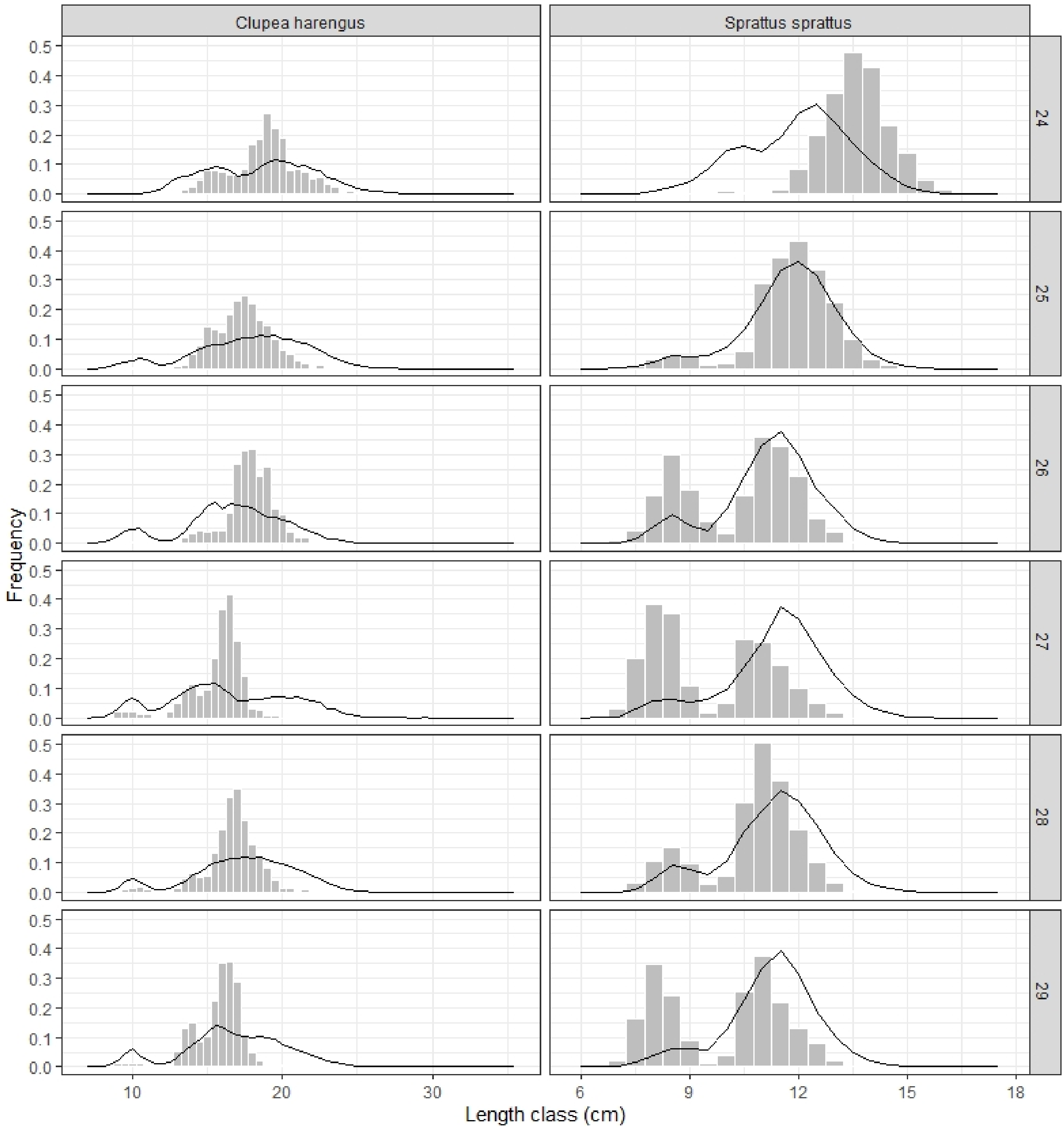

Figure 6: "Kristin NC336" cruise 001/2021 BASS: Herring and sprat length distribution measured per ICES subdivision during BASS 2020 (black line) and BASS 2021 (bars).

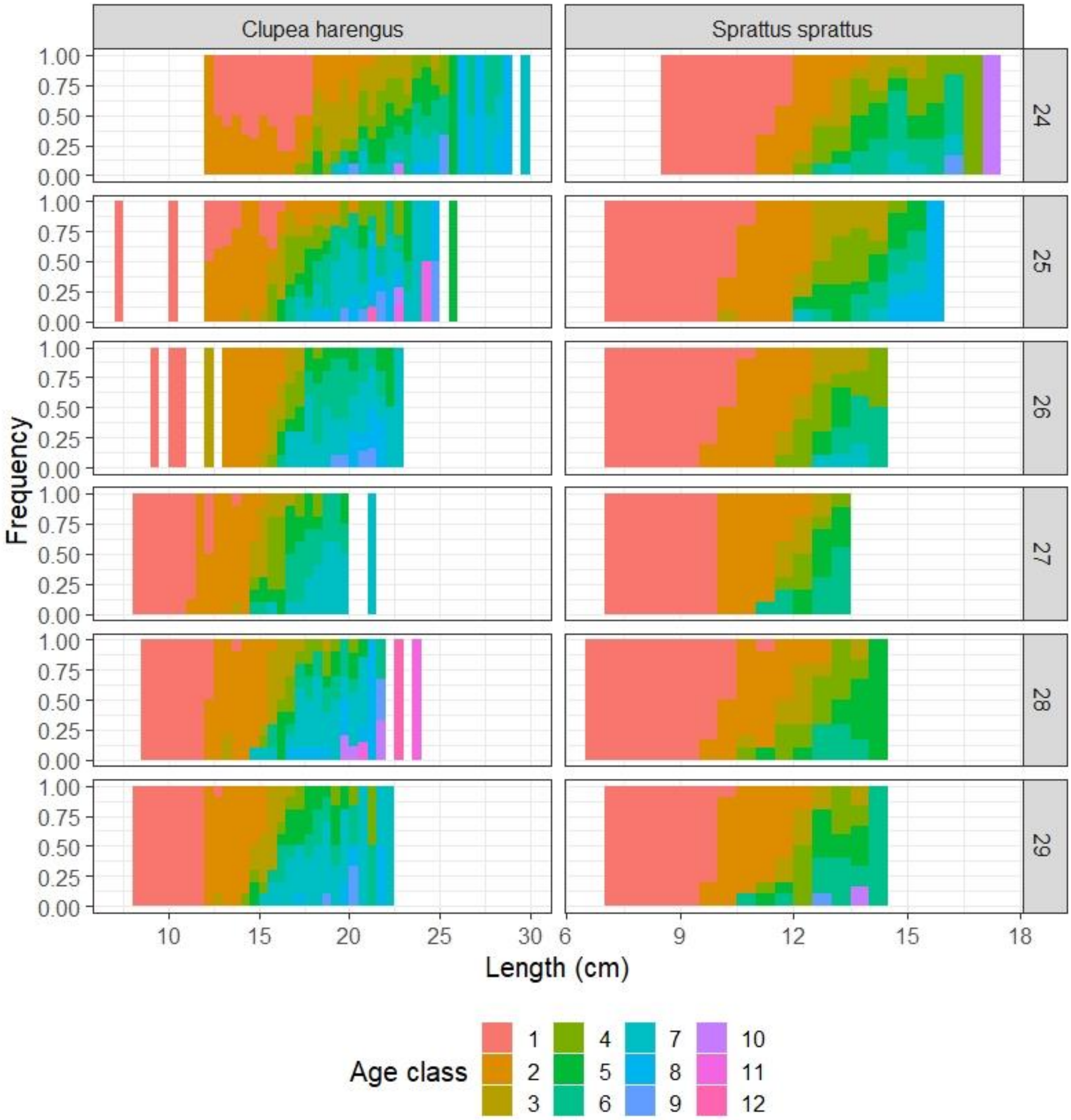

Figure 7: "Kristin NC336" cruise 001/2021 BASS: Age distribution per length class, species and subdivision for 2021.

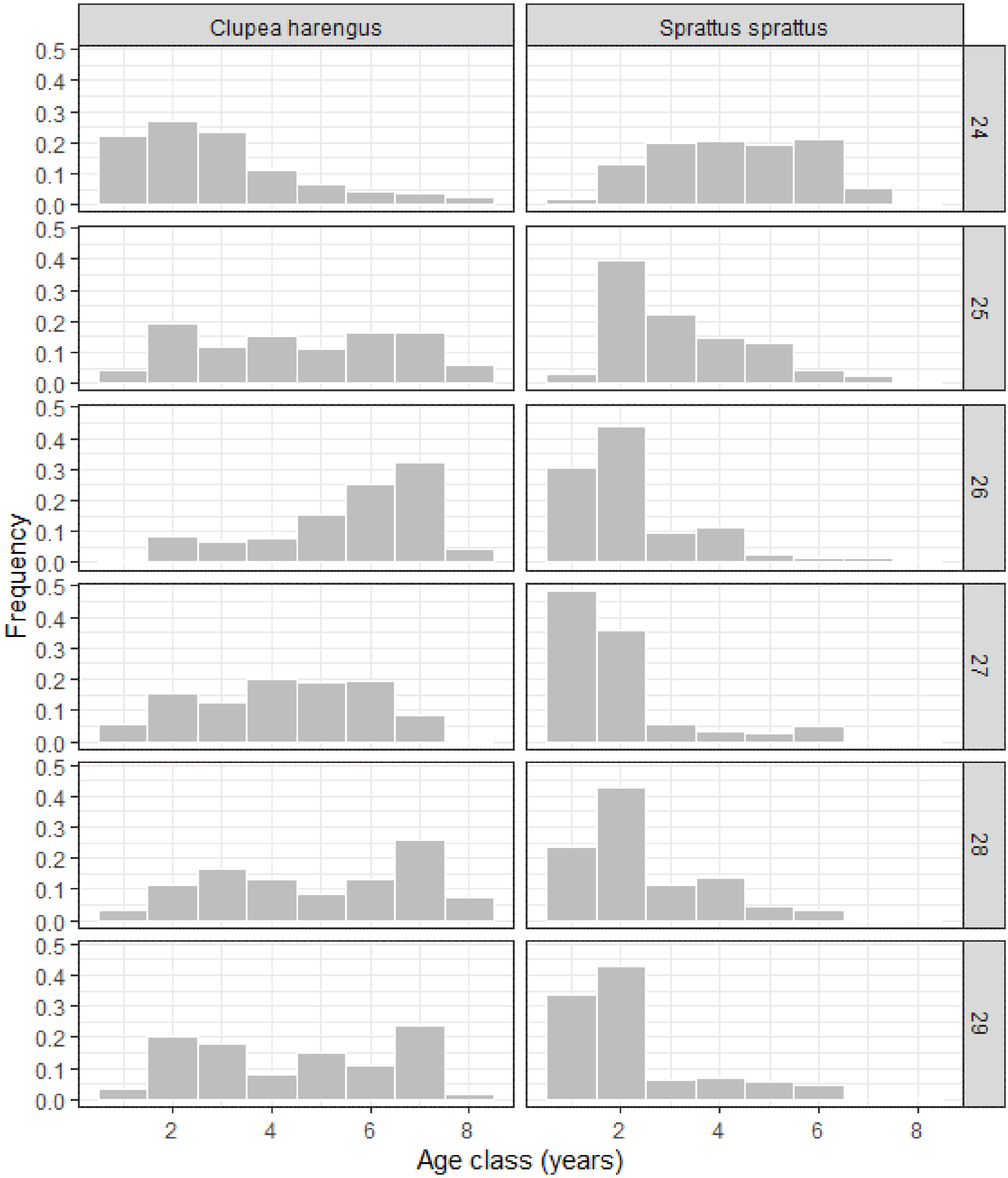

Figure 8: "Kristin NC336" cruise 001/2021 BASS: Calculated age class distribution per species and subdivision in 2021.

Institute of Food Safety, Animal Health and Environment – BIOR, Riga (Latvia)

National Marine Fisheries Research Institute – NMFRI, Gdynia (Poland)

THE CRUISE REPORT

FROM THE JOINT LATVIAN-POLISH BALTIC ACOUSTIC SPRING SURVEY – BASS 2019 ON THE R/V "BALTICA" IN THE ICES SUBDIVISIONS 26N AND 28.2 OF THE BALTIC SEA (18-25 MAY 2019)

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Riga – Gdynia, March 2020

CONTENTS

INTRODUCTION

More less regular acoustic estimations of pelagic fish stocks in the Baltic Sea initiated by BaltNIIRH (now BIOR) and Institute für Hochseefischerei in Rostock (GDR) was performed since 1983, but the first scattered surveys was made since 1977 [Shvetsov 1983, Hoziosky et al. 1987, Shvetsov et al. 1988]. Several years in May (2005-2008) BIOR as assignee of BaltNIIRH, LatFRI and LatFRA cooperated with Polish NMFRI (former SFI) in Gdynia, but before – in 2003-2004 with AtlantNIRO in Kaliningrad, Russia. In 2009 due to collapse of Latvian economy the survey was not performed. In 2010 we resumed our international cooperation in the fisheries research, but this time on the Lithuanian r/v "Darius" board. The collaboration lasted for three years till the 2012. In May 2013 The Latvian Baltic Acoustic Spring Survey (BASS) in the ICES Sub-divisions 26N and 28 was conducted on Latvian commercial fishing vessel "Ulrika" with which crew and the owners cooperation in research for pelagic fish distribution and feeding conditions in the recent decade has developed a very close and productive. Due to BONUS EEIG project INSPIRE (INSPIRE) funding historically the first Latvian-Estonian joint BASS in the ICES Sub-divisions 26N, 28 29 and 32W in May 2014 was conducted on the Latvian commercial fishing vessel "Ulrika" and in May 2015 the same survey was performed, too [Svecovs et al., 2015, 2016]. In May 2016 we renew cooperation with Polish NMFRI.

This was the 8th joint Latvian-Polish Baltic Acoustic Spring Survey (BASS) in the ICES Sub-divisions 26N and 28.2 conducted by the r/v "Baltica" in May 2019. The reported survey was organized on the basis of the public procurement contract No. BIOR 2019/2/AK/EJZF from 6th March 2019 between the Institute of Food Safety, Animal Health and Environment (BIOR) from Riga and the National Marine Fisheries Research Institute (NMFRI) from Gdynia. The vessel was operated within the Latvian and Swedish EEZs (ICES Sub-divisions 26N and 28.2). The "Latvian National Fisheries Data Collection Program, 2019" in accordance with the EU Commission Regulations No. 1639/2001, 1581/2004, 665/2008, 1078/2008 and 199/2008 was partly subsidized this survey. These investigations were coordinated by the ICES Baltic International Fish Survey Working Group (WGBIFS) [ICES 2019].

Pelagic research catches carried out during the acoustic survey are the information source, independent from topical preferences in fishery, about quantitative changes in a process of clupeids geographical and bathymetrical distribution in the Baltic Sea. The data from hydrological measurements are the information source about abiotic environmental factors (seawater temperature, salinity, oxygen content) influencing sprat and herring spatial distribution. Echo-integration results along the pre-selected tracks are the basic materials for fish stock biomass calculations.

The ICES Baltic Fisheries Assessment Working Group (WGBFAS) applies the BASS data for clupeids (specially sprat and herring) stock biomass assessment and spatial distribution updating. The basic acoustic and biological data collected during recently carried out survey will be stored in the BASS_DB.mdb and the new acoustic data base WKBIFS-ACOU in the accepted CSV or XML formats, managed by ICES.

The main aims of cruise were:

- to collect the echo-integration data for the estimation of the clupeids stocks biomass and abundance in the central-eastern Baltic;
- to collect materials from the fish control catches for investigations of the Baltic sprat, and in lesser degree herring, spawning stocks spatial distribution in the offshore waters of Latvia, Estonia and Sweden, moreover for analyses of the age-length structure and recruiting year-class strength of these fishes populations;
- to collect sprat and herring stomachs samples for feeding condition and food components analyses;
- to analyze the vertical and horizontal changes of the basic hydrological parameters (temperature, salinity and oxygen content) at the trawling positions and at the standard HELCOM hydrological stations;
- to collect the zooplankton and ichthyoplankton samples at the referring area.

1. MATERIALS AND METHODS

1.1. PERSONNEL ASSIGNMENT

The scientific staff – nine persons:

R. Zaporowski (NMFRI, Gdynia – Poland) – survey leader, ichthyologist
B. Nurek (NMFRI, Gdynia – Poland) – acoustician
B. Witalis (NMFRI, Gdynia – Poland) – hydrologist
K. Koszarowski ((NMFRI, Gdynia – Poland) - ichthyologist
G. Strods (BIOR, Riga - Latvia) – Latvian scientific staff leader, acoustician
I. Briekmane (BIOR, Riga - Latvia) – ichthyologist
I. Ozolina (BIOR, Riga - Latvia) - ichthyologist
V. Cervoncevs (BIOR, Riga - Latvia) – ichthyologist
A. Makarcuks (BIOR, Riga - Latvia) – hydrobiologist.

1.2. SURVEY DESCRIPTION

The reported survey took place during the period of 18-25 May 2019 (8 working days at sea in accordance with Latvian-Polish survey plan). The at sea researches were conducted within Latvian and Swedish EEZs (the ICES Sub-divisions 26 and 28.2), moreover inside the Latvian territorial waters not shallower than 20 m.

The vessel left the Gdynia port (Poland) on 18.05.2019 at 00:05 o'clock a.m. and was navigated in the north direction to the echo-integration start point at the geographical position 56°07'N 019°00'E. The direct at sea researches began on 18.05.2019 after the midday. The survey ended on 25.05.2019 before midday in the port Ventspils (Latvia).

1.3. SURVEY METHODS AND PERFORMANCE

1.3.1. ACOUSTICAL AND TRAWLING METHODS

Acoustic data were collected with the SIMRAD EK-60 38 kHz and 120 kHz two frequency split beam scientific echo-sounder equipped with "EchoView Version 7.10" software for the data analysis. These data collected during the described here BASS were delivered to the Latvian researchers for further elaboration. The survey echo-integration tracks were planned in the similar pattern as in the previous years, due to historical comparability of the data. Overall 611 nautical miles long survey tracks was observed and recorded with hydroacoustic equipment. The final pattern of transects was covered with a relatively good density. The area covered in May 2019 was 1953.3 nm^2 in the northern part of the ICES Sub-division 26 and 6977.2 nm^2 in Sub-division 28.2, totally 8930.5 nm^2 (Fig. 1).

The pre-selection of the pelagic fish catches based on the ICES statistical rectangle area (with range of 0.5 degree in latitude and 1 degree in longitude) and the present density pattern of vertical distribution of clupeids along a transect. The intention was to carry out at least two control hauls per the ICES statistical rectangle [ICES 2003]. The water depth range-layer with sufficient for fish oxygen content (minimum 1.0÷2.0 ml/l) were taken into account in the process of the hauls distribution.

Survey was performed in accordance to "SISP Manual of International Baltic Acoustic Surveys (IBAS)" [ICES 2017]. The r/v "Baltica" realized 19 fish control-catches (Tab. 1). All catches were performed in the daylight between 07:45 and 17:50 (GMT+01:00; UTC+02:00) using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The standard trawling duration was 30 minutes, but 8 hauls was shortened to 20 minutes and 2 hauls to 15 minutes, according to higher power of the echo-integration. The mean speed of vessel while trawling was 3.0 knots. Overall, 4 hauls were conducted in SD 26N and 15 hauls in SD 28.2. Totally 15 hauls were performed in the Latvian EEZ and 4 hauls in Swedish EEZ

1.3.2. BIOLOGICAL SAMPLING

All biological material of fish collected in the survey is presented in Table 2.

The length measurements in 0.5 cm length classes were realized for 4113 sprat, 2185 herring and 41 three-spine sticklebacks, the length measurements in 1.0 cm length classes were realized for 404 cod, 116 flounder and 1 lumpfish individuals. In total, 2018 sprat and 1276 herring individuals were taken for biological analysis.

Due to herring and sprat normally cannot be distinguished from other species by visual inspection of the echogram species composition and fish length distributions were based on trawl catch results. Mean target strength of fish was calculated according to the following formulas [Foote et al. 1986, ICES 1983, 2017]:

for clupeids: $TS = 20\log L - 71.2$;
for gadoids: $TS = 20\log L - 67.5$;
cross-section $\sigma = 4\pi 10^{a/10} \times L^{b/10}$.

The total number of fish in each ICES rectangle was estimated as a product of the mean area scattering cross-section – NASC (S_A) and the rectangle area, divided by corresponding mean acoustic cross-section. Fish abundance was separated into different species according to the mean catch composition in the given rectangle.

Ichthyoplankton and zooplankton samples were collected at the positions of the hydrological stations or after trawling. Totally 22 ichthyoplankton and zooplankton stations were realized (Fig. 2) and 44 and 37 samples were taken accordingly. Ichthyoplankton was collected with IKS-80 net (mouth opening 0.5 m^2, mesh size 500 µm). This net was towed vertically from the depths 150 or from the bottom in case of lesser depth, to the water surface with speed of 0.4 m/s. Zooplankton was collected with Judday net (mouth opening 0.1 m^2, mesh size 160 µm). This net was towed vertically from the depths 50 and 100, or from the bottom in case of lesser depth, to the water surface with speed of 0.4 m/s. Low speed of lifting allowed preventing all plankton objects from destroying by mechanic forces. All samples were conserved in 2.5% unbuffered formaldehyde solution with sea water and processed during the year.

1.3.2. HYDROLOGICAL AND METEOROLOGICAL OBSERVATIONS

The measurements of the basic hydrological parameters were realized in the period of 18-25 May 2019, totally at 22 stations, int. al. at 19 fish catch-station (Fig. 2). Hydrological stations were inspected with the IDRONAUT CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method. The hydrological row data, originated from measuring realized from the sea surface layer up to the bottom, were aggregated to the 1-m depth stratums, were information source about the abiotic factors potentially influencing fishes spatial distribution. The oxygen probes ware taken on every 10 meters. The salinity parameter was presented in Practical Salinity Unit (PSU).

Meteorological observations of air temperature, wind velocity and directions and atmospheric pressure were realized at the actual geographic position of each control-haul and in every 10 minutes interval over the whole survey. The automatic meteorological station type "Milosz" was applied for measurements of the above-mentioned parameters. The values of meteorological and hydrological parameters registered at trawling stations are aggregated in Table 3.

2. RESULTS

2.1. BIOLOGICAL DATA

2.1.1. CATCH STATISTICS

Overall, 6 fish species were identified in hauls performed in the Central-eastern Baltic Sea in May 2019. Sprat was the dominating species by mass in the both ICES Sub-divisions 26 and 28.2 (97.6% and 78.4% respectively). The share of the herring was 1.5% and 20.0% respectively. The other 4 fish species represented 1.4% (in which 1.2% belonging to cod) of the average total mass in all investigated areas.

Mean CPUE in BASS 2019 for all species in the investigated area amounted for 974.1 kg/h (comparing to 1253.7 and 1436.4 kg/h in 2018 and 2017 respectively). The mean CPUEs for sprat was: 1436.3 kg/h in ICES SD 26, and 721,3 kg/h in SD 28.2. The mean CPUEs for herring was as follows: in SD 26 – 28.0 kg/h and 170.6 kg/h in SD 28.2. The particular values of CPUE for each haul for herring and sprat are presented at the Fig. 2. The highest CPUE values for sprat were observed from the Central-western part of SD 28.2 to the Northern part of SD 26. The highest CPUEs values for herring were distributed in Central part of SD 28.2 and partly in Northern SD 26.

2.1.2. ACOUSTICAL AND BIOLOGICAL ESTIMATES

The basic acoustic and biological data (surveyed area statistics, mean NASC, the mean scattering cross-section, the total number of fish, percentages of herring and sprat) per ICES rectangles and the estimated abundance and biomass of sprat and herring per above mentioned rectangles, collected in May 2019, are given in Table 5. The characteristics of the pelagic fish stock are aggregated in Table 6 for sprat and Table 7 for herring. The geographical distributions of NASC, sprat and herring stock densities in the central-eastern Baltic Sea in May 2019 are shown in Figures 5, 6 and 7 respectively.

The pelagic fish stock was represented mostly by sprat – 94.0 %, in comparison – 71.5% in 2013, 86.8 % in 2014, 88.2 % in 2015 and 92.9 % in 2016, 94.1 % in 2017, and 93.8 % in 2018. Herring was represented as 5.9 %, 28.5 % in 2013, 13.2 % in 2014, 11.8 % in 2015, 7.1 % in 2016 and 5.9 % in 2017, 6.2 % in 2018. The highest sprat stock density 77.7 n×10^6/nm^2 according to acoustic estimates were recorded in ICES rectangle 41G9 of the ICES Sub-division 26. The highest average abundance 4.3 n×10^6/nm^2 and biomass of the sprat stock were recorded in the southern part of investigated area in ICES rectangle 41G9. The distribution of the high density sprat concentrations in May 2019 were significantly smaller compared to recent years and had different pattern as in May 2017 and more-less copy distribution in previous year [Hoziosky et al. 1988, Shvetsov et al. 1988, 1989, 1992, 2002, Svecovs 2016].

The herring stock density was significantly lower in comparison to sprat stock density. The highest density value was 1.3 n×10^6/nm^2 and noted in ICES rectangle 43H0 in central part of the investigated area in Sub-division 28.2 and was the lowest recorded since 2005. in 2013 it was 8.8 n×10^6/nm^2 in rectangle 44H0, in 2014 values over 10.0 n×10^6/nm^2 were recorded in two rectangles 43H0 and 45H0, in 2015 highest density values were not over 10.2 n×10^6/nm^2 and noted in rectangle 44H0, in 2016 the highest density 18.1 n×10^6/nm^2 was recorded in rectangle 42G9 in central part of estimated aquatory and in May 2017 the highest density 26.1 n×10^6/nm^2 was recorded in rectangle 44H0 in northern part of estimated aquatory.

Comparison of the acoustic results from May of 2005-2014 indicated that investigated sprat stock abundance and biomass had decreasing tendency, but herring stock had a slight increase. In 2015-2016 sprat stock abundance increased due to highly abundant generation of sprat in 2014. In 2017 both of sprat and herring stocks had decreased in numbers, but in biomass herring stock had significantly increased. In 2018-2019 sprat stock had significant decrease, but herring stock significant increase in abundance. The geographical distribution of main sprat stock shows different pattern as in years 2005-2016 and 2018 and 2017 when stock was less scattered with two large and dense concentrations of high abundance [Svecovs et al. 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018]. In 2019 sprat made weak aggregations.

The mean length and mean weight distributions of dominant fish species (sprat and herring) by hauls and rectangles in the ICES Sub-divisions 26 and 28 are shown in Figures 8 and 9 respectively. The total length and mean weight in control hauls of sprat, herring and cod ranged as follows:

- sprat – 7.0÷14.0 cm (average TL = 11.3 cm), 2.6÷17.0 g (average W = 8.5 g);
- herring – 10.5÷23.0 cm (average TL = 16.9 cm), 9.0÷68.0 g (average W = 28.5 g);

The sprat length distribution curves have a bimodal character for both Sub-divisions mentioned above. First length frequency peak takes place at 9 cm length class in SDs 26 and 28.2 respectively, with considerably low frequency values in SD 28.2 comparing to data from 2018. The second peak can be observed at 11 cm length class (SD 26) and 11,5 cm length class (SD 28.2), which represents adult sprat.

The herring length distribution curves have a similar multimodal character in both Sub-divisions 26 and 28.2. In subdivision 26 the highest peaks were observed for 18,5 cm, 17 cm and 16 cm length classes, respectively. In subdivision 28.2 the highest peak was observed for 16 cm length class.

The cod and flounder abundance in the pelagic control catches was on similar level, comparing to the data from the last few years. Cod from SD 26 characterized by fish length range 21-39 cm, with modal length frequency value at 28 cm length class. But in SD 28.2 its length range was 17-51 cm, and modal length frequency values at 26 cm length classes. Flounder occurrence was more abundant in the catches in SD 28.2. Its length ranged from 16 to 33 cm, with modal length frequency values at 22-25 cm length classes.

2.1.3. ICHTHYOPLANKTON ESTIMATES

Totally 44 ichthyoplankton samples collected at 22 station positions during BASS on RV "Baltica", including 22 samples collected in vertical hauls with IKS-80 net and 22 samples from horizontal hauls on water surface during 10 minutes. The number of sprat eggs and larvae in ICES SD 26 and 28 are aggregated in Table 9.

Sprat eggs and larvae prevailed in the ichthyoplankton in May 2019. The average numbers of sprat eggs in the investigated region were above the corresponding average values for the previous years. Sprat eggs were more abundant in the southern and central parts of the Gotland Basin. Amount of eggs of sprat as usual increased towards the greater depths near the center of the basin. Amount of sprat larvae was approximately at the average level for the previous years. Most of the larvae were sampled in the vertical hauls. They were distributed very unevenly: lot of them in the southern part of the Gotland Basin, less in the central part, and almost no larvae in the northern part of it (actually only in the hauls at the water surface). They also were more numerous over the bigger depths.

Sprat larvae in the water surface layer were not numerous in all the parts of the Gotland Basin with maximal abundance in the southern and central parts of the Gotland Basin. This must be the evidence that the spawning of sprat this year has started moderately early.

This year there were fewer larvae of flounder compared with the years 2015 – 2018. More larvae were collected on the water surface than during vertical hauls. They were more abundant in the southern part of the Gotland Basin (Last year there were more larvae in the central part).

The hydrological conditions in the Gotland Basin in 2019 improved compared with 2018, which was beneficial for the survival of pelagic fish eggs, and especially for those of cod and four-bearded rockling. As a result average amount of the cod eggs amounted to 7.14 eggs *m-2 in the southern part of the Gotland Basin (depth>70 m). As usual in the last years, number of cod eggs rapidly decreased in the northern direction, dropping to 0.8 eggs *m-2 in the central part of the basin, and to 0 in the northern part of it. No larvae of cod were found. Number of rockling eggs was rather low, but they are usually more abundant later in the year.

Biodiversity in the ichthyoplankton was below the medium level – several eggs of cod, flounder, and four-bearded rockling, and also some larvae of flounder and sand-eel were found in May, apart from those of sprat.

2.1.4. ZOOPLANKTON ESTIMATES

The calculated average number and average biomass of zooplankton organisms in 0-100 m water column per volume unit from 37 samples taken in 22 stations are aggregated in Table 10.

In May 2019 in the Baltic Sea the estimated zooplankton biomass was significantly higher in comparison to 2018. Total zooplankton biomass in 2018 was 194.20 mg/m^3, but in May 2019 306.48 mg/m3. The most part of the biomass (44.79 %) was made from small rotatories and copepods (41.43 %), the residual part was made from cladocers (7.33 %) and other planktonic organisms (6.44 %). The dominance of rotatorians in the spring season in the Baltic Sea creates favorable feeding conditions for larvae and smaller groups of pelagic fish species. Amount of them in 2019 on average was significantly higher than in 2018 and the long-term average, too. Overall, the biomass of *Temora longicornis*, taking the top rank among copepods, has the highest biomass recorded since May 1960. *Acartia* spp. biomass had increased and reach level of 2007-2009. *Pseudocalanus* sp. had decreased in comparison to 2018 and is on the lovest level since 2000. In 2019 increased average biomass of rotatorians *Synchaeta* spp. and *Polychaeta* worms enhancing the role of above mentioned copepods in all aquatory. In deep stations has remarkably increased estimated quantity and biomass of *Centropages hamatus* reaching the highest level since 1960. In the upper layer (0-50 m) of water column the dominant object of zooplankton was rotatorians *Synchaeta* spp. and cladocerans *Evadne* spp. Biomass of *Evadne* spp. was highest since 2013 and two times higher than the level of long-term average. Overall, the favorable feeding conditions in May 2019 as in 2018 formed in the upper water column of the investigated area.

2.2. METEOROLOGICAL AND HYDROLOGICAL DATA

2.2.1. WEATHER CONDITIONS

Changes of the main meteorological parameters during joint LAT-POL BASS in May 2019 are shown at the Figure 12. The wind force varied from 0,4 m/s to 12,8 m/s and average was 5,7 m/s. The most often wind direction was NE and ESE. The air temperature ranged from 8,1°C to 20,9 °C, and average temperature was 12,2 °C

2.2.2. HYDROLOGY OF THE GOTLAND DEEP

Changes of the main hydrological parameters of seawater during joint LAT-POL BASS in May 2019 are shown at the Figures 13-15.

The seawater temperature in the surface layers varied from 7.19 to 10.96 °C (the mean was 9.40 °C). The lowest surface temperature was recorded at the haul station No 1. The highest one was noticed at the haul 18. The minimum value of salinity in Practical Salinity Unit (PSU) was 7.01 at the hydrological station 15 in the surface layer. The maximum was 7.39 PSU at the haul station No 1. The mean value of salinity was 7.24 PSU. The oxygen content in the surface layers of the investigated area varied in the range of 7.29 ml/l (haul No 10) - 9.50 ml/l (haul No 16). The mean value of surface water oxygen content was 8.50 ml/l.

The temperature of near bottom zone was in the range from 4.51 (haul No 2) to 7.42 °C (haul No 17), the mean was 6.62 °C. Salinity in the bottom waters varied from 7.47 (haul No 2) to 13.28 PSU (haul No 14), and the mean was 11.65 PSU. Oxygen content varied from 0.00 ml/l (haul Nos. 5, 9, 10, 11, 15 and hydrological station No 37) to 6.13 ml/l (haul No 2), the mean was 1.60 ml/l.

3. DISCUSSION

The data of the Latvian-Polish BASS in the 2nd quarter of 2019 were considered by the ICES BIFS Working Group as representative for the central-eastern Baltic for the estimation of abundance and spatial distribution of pelagic fishes (herring and sprat) recruiting year classes and were provided to the Baltic Fisheries Assessment Working Group (WGBFAS) as the input data for fish stocks resources calculation. The acoustic, catch, biological and hydrological data, collected during reported survey were uploaded to the BAD1 and to the emerging international databases managed by the ICES Secretariat.

The collected data shows that sprat population in ICES SD 26N and 28.2 till the 2014 had overall decreasing tendency of abundance, but in 2015 had increased due to very abundant sprat generation of 2014. The next recent generations of sprat was on low abundance level and stock abundance in both SDs had decreased evidently. The mean length and weight of adult sprat had minor increasing tendency in 2019 compared to previous years. The geographical distribution of sprat densities in the May 2019 had different pattern as in recent years before and shows weak aggregations with densities on low level. The overall estimated good feeding conditions should ensure increasing of individual fish body condition and young fish surviving of pelagic fish species in future.

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ANNEX. TABLES AND FIGURES

Table 1. Fish control-catch statistics in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019

Haul number	Date	ICES rectangle	ICES SD	Mean bottom depth [m]	Headrope depth [m]	Vertical opening [m]	Trawling speed [knt]	Trawling direction [°]	Geographical position				Time Start	Haul duration [min]	Total catch [kg]
									Start		End				
									Latitude 00°00.0'N	Longitude 00°00.0'E	Latitude 00°00.0'N	Longitude 00°00.0'E			
1	2019-05-18	41G9	26	124	60	19	3	80	56°05.0'	19°10.2'	56°05.3'	19°11.3'	15:45	15	233.415
2	2019-05-19	41H0	26	41	22	16	3.2	180	56°09.9'	20°38.1'	56°08.4'	20°38.0'	07:45	30	656.630
3	2019-05-19	41H0	26	75	50	20	3	275	56°22.4'	20°03.4'	56°22.5'	20°01.6'	13:00	20	715.270
4	2019-05-19	41G9	26	107	60	20	3	90	56°22.9'	19°42.7'	56°22.9'	19°44.1'	15:45	15	383.349
5	2019-05-20	42G9	28.2	145	60	20	3	95	56°37.2'	19°08.1'	56°37.1'	19°09.7'	07:50	20	239.483
6	2019-05-20	42G9	28.2	156	60	20	3	105	56°42.0'	19°52.1'	56°41.8'	19°53.7'	12:10	20	267.741
7	2019-05-20	42H0	28.2	75	50	20	3	285	56°37.3'	20°25.9'	56°37.8'	20°23.3'	15:50	30	356.056
8	2019-05-21	42H0	28.2	117	60	20	3	270	56°52.9'	20°16.5'	56°52.9'	20°14.7'	09:30	20	536.130
9	2019-05-21	42G9	28.2	135	65	19	3	270	56°52.9'	19°42.3'	56°52.9'	19°40.5'	13:00	20	545.133
10	2019-05-21	43G9	28.2	173	70	20	3	30	57°02.6'	19°19.8'	57°03.8'	19°21.2'	17:50	30	220.682
11	2019-05-22	43H0	28.2	202	55	19	3	90	57°06.9'	20°03.9'	57°06.9'	20°05.6'	08:00	20	92.556
12	2019-05-22	43H0	28.2	89	60	19	3	130	57°07.2'	20°36.3'	57°06.3'	20°38.3'	11:25	30	735.173
13	2019-05-22	43H1	28.2	69	44	19	3	30	57°23.1'	21°07.6'	57°24.3'	21°08.9'	17:15	30	132.880
14	2019-05-23	43H0	28.2	127	58	19	3	270	57°22.2'	20°33.2'	57°22.2'	20°30.4'	07:40	30	569.790
15	2019-05-23	43G9	28.2	101	63	16	3	265	57°19.5'	19°41.9'	57°19.1'	19°40.4'	13:05	20	370.583
16	2019-05-23	44G9	28.2	107	55	20	3	355	57°32.4'	19°32.5'	57°33.9'	19°32.4'	16:40	30	279.611
17	2019-05-24	44H0	28.2	129	60	19	3	80	57°36.7'	20°28.7'	57°36.9'	20°31.3'	07:45	30	178.579
18	2019-05-24	44H1	28.2	78	57	19	3	280	57°51.5'	21°13.1'	57°51.7'	21°11.3'	14:20	20	573.701
19	2019-05-24	44H0	28.2	100	62	19	3	340	57°53.1'	20°47.1'	57°54.6'	20°47.7'	17:15	30	380.928
												SD26			1988.664
												SD28.2			5479.026
												SD26+28.2			7467.690

Table 2. Number of measured and aged fish individuals in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019

SD 26		Sprat	Herring	Cod	Flounder	Three spined stickleback	Lumpfish	Total
Samples taken	Measurements	4	4	3	2			13
	analyses	4						4
Fish measured		878	103	66	19			1066
Fish analysed		413						413
SD 28.2		Sprat	Herring	Cod	Flounder	Three spined stickleback	Lumpfish	Total
Samples taken	Measurements	15	15	14	13	6	1	64
	analyses	15	14					29
Fish measured		3235	2082	338	97	41	1	5794
Fish analysed		1605	1276					2881
SUM		Sprat	Herring	Cod	Flounder	Three spined stickleback	Lumpfish	Total
Samples taken	Measurements	19	19	17	15	6	1	77
	analyses	19	14					33
Fish measured		4113	2185	404	116	41	1	6860
Fish analysed		2018	1276					3294

Table 3. The values of meteorological and hydrological parameters registered at the trawling position and depth in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019

Haul number	Date of catch	Meteorological parameters			Trawling depth		Hydrological parameters		
		wind direction	wind force [°B]	sea state [Degrees]	Headrope [m]	Footrope [m]	temperature [°C]	salinity [PSU]	oxygen [ml/l]
1	2019-05-18	E	3	1	60	79	5.39	9.36	1.49
2	2019-05-19	Changeable	2	1	22	38	4.51	7.47	6.13
3	2019-05-19	Changeable	2	1	50	70	4.26	7.61	7.25
4	2019-05-19	Changeable	2	1	60	80	3.70	7.59	6.49
5	2019-05-20	SE	4	2	60	80	4.11	7.87	3.37
6	2019-05-20	SE	3	2	60	80	4.20	7.92	5.08
7	2019-05-20	E	4	2	50	70	4.24	7.60	5.78
8	2019-05-21	E	4	2	60	80	4.67	8.52	2.28
9	2019-05-21	E	4	2	65	84	4.89	8.79	1.34
10	2019-05-21	Changeable	2	1	70	90	3.63	7.55	6.05
11	2019-05-22	NE	4	2	55	74	4.55	8.39	4.40
12	2019-05-22	Changeable	1	1	60	79	4.00	7.80	3.62
13	2019-05-22	Changeable	1	1	44	63	3.64	7.50	7.56
14	2019-05-23	N	3	1	58	77	4.57	8.49	4.30
15	2019-05-23	N	4	2	63	79	3.79	7.58	2.00
16	2019-05-23	N	4	2	55	75	3.60	7.43	8.54
17	2019-05-24	W	4	2	60	79	3.97	7.83	4.94
18	2019-05-24	Changeable	2	1	57	76	3.61	7.47	7.71
19	2019-05-24	Changeable	2	1	62	81	3.62	7.59	6.60

Table 4. Fish control-catch results by species in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019

Haul number	Date	ICES rectangle	ICES SD	Total Cactch [kg]	Catch per species [kg]					
					sprat	herring	cod	flounder	threespine stickleback	Lumpfish
					161789	161722	164712	172894	166365	127214
1	2019-05-18	41G9	26	233.415	213.130	15.340	3.185	1.760		
2	2019-05-19	41H0	26	656.630	653.540	2.770	0.320			
3	2019-05-19	41H0	26	715.270	711.840	3.430				
4	2019-05-19	41G9	26	383.349	362.530	8.730	11.340	0.749		
5	2019-05-20	42G9	28.2	239.483	217.890	17.680	3.535	0.378		
6	2019-05-20	42G9	28.2	267.741	252.720	11.710	1.798	1.513		
7	2019-05-20	42H0	28.2	356.056	325.670	29.720	0.236	0.428	0.002	
8	2019-05-21	42H0	28.2	536.130	487.290	34.670	10.710	3.460		
9	2019-05-21	42G9	28.2	545.133	522.380	17.458	4.460	0.784	0.051	
10	2019-05-21	43G9	28.2	220.682	182.845	24.295	12.850	0.692		
11	2019-05-22	43H0	28.2	92.556	53.652	36.094	1.944	0.861	0.005	
12	2019-05-22	43H0	28.2	735.173	493.400	230.780	9.729	1.109		0.155
13	2019-05-22	43H1	28.2	132.880	64.030	68.850				
14	2019-05-23	43H0	28.2	569.790	418.780	146.930	3.526	0.554		
15	2019-05-23	43G9	28.2	370.583	325.640	40.740	4.203			
16	2019-05-23	44G9	28.2	279.611	226.330	48.877	4.090	0.288	0.026	
17	2019-05-24	44H0	28.2	178.579	112.480	60.990	3.623	0.868	0.618	
18	2019-05-24	44H1	28.2	573.701	369.430	202.360	1.808	0.103		
19	2019-05-24	44H0	28.2	380.928	243.191	128.089	9.080	0.538	0.030	
SD26				1988.664	1941.040	30.270	14.845	2.509		
SD28.2				5479.026	4295.728	1099.243	71.592	11.576	0.732	0.155
SD26+28.2				7467.690	6236.768	1129.513	86.437	14.085	0.732	0.155

Table 5. BASS statistics of pelagic fish species from the Latvian-Polish BASS in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 18-25.05.2019

Table 5A

ICES SD	ICES Rect.	Hauls No	NASC Pel m^2nm^{-2}	σ $m^2 10^4$	ρ $n10^6nm^{-2}$	TS db	Sprat n, %	Herring n, %	Stickleback n, %
26	41G9	1,3,4,5	547.19	1.30	4.22	0.08	99.23	0.77	
	41H0	2,3,7	113.73	1.17	0.97	-0.38	99.59	0.41	0.0004
28	42G9	5,6,9,10	394.23	1.27	3.10	-0.01	98.51	1.48	0.0128
	42H0	6,7,8	294.59	1.27	2.32	-0.02	98.27	1.73	0.0006
	43G9	10,11,15,16	260.83	1.34	1.95	0.21	94.45	5.53	0.0138
	43H0	11,12,13,14	271.19	1.41	1.92	0.45	87.55	12.44	0.0052
	43H1	12,13	100.77	1.43	0.71	0.49	86.09	13.91	
	44G9	15,16,17	213.02	1.36	1.57	0.28	93.12	6.60	0.2817
	44H0	13,17,19	334.80	1.53	2.19	0.79	81.74	17.75	0.5077
	44H1	13,18	164.99	1.33	1.24	0.19	84.25	15.75	

Table 5B

ICES	ICES	Abundance, $n10^6$				Biomass, $kg10^3$			
SD	Rect.	∑	Sprat	Herring	Stickleback	∑	Sprat	Herring	Stickleback
26	41G9	4222.015	4189.650	32.365		37205.194	36074.395	1130.799	
	41H0	928.691	924.863	3.825	0.004	7310.156	7178.174	131.976	0.007
28	42G9	3061.947	3016.299	45.257	0.392	27140.351	25686.646	1452.530	1.175
	42H0	2248.914	2210.051	38.850	0.013	19840.489	18557.081	1283.382	0.026
	43G9	1899.312	1793.945	105.105	0.262	18892.403	15840.381	3051.480	0.543
	43H0	1868.789	1636.207	232.484	0.098	20305.792	13777.408	6528.286	0.098
	43H1	291.568	251.009	40.559		3205.841	2085.072	1120.769	
	44G9	1375.051	1280.422	90.755	3.874	13983.702	11581.141	2393.546	9.016
	44H0	2107.358	1722.520	374.140	10.698	25637.061	15863.555	9749.014	24.493
	44H1	1023.596	862.363	161.233		10260.742	6403.350	3857.392	

Table 5C

ICES	ICES	Sprat		Herring		Stickleback	
SD	Rect.	L, cm	w, g	L, cm	w, g	L, cm	w, g
26	41G9	11.56	8.61	17.98	34.94		
	41H0	10.95	7.76	18.22	34.51	6.25	2.00
28	42G9	11.40	8.52	17.41	32.10	6.25	3.00
	42H0	11.36	8.40	17.79	33.03	6.25	2.00
	43G9	11.44	8.83	16.90	29.03	5.79	2.07
	43H0	11.27	8.42	16.89	28.08	5.25	1.00
	43H1	11.22	8.31	16.84	27.63		
	44G9	11.53	9.04	16.45	26.37	6.12	2.33
	44H0	11.65	9.21	16.45	26.06	6.07	2.29
	44H1	10.73	7.43	16.00	23.92		

Table 6. Sprat stock characteristics in the Baltic Sea ICES SD 26N and 28.2
from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019

Table 6A CANUM					Age group					Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9	43169.59	159473.89	54797.90	78302.18	227364.20	9200.51	13930.91	5121.69	591360.88
	41H0	180116.56	117801.59	27418.23	55199.31	132138.20	3274.90	10571.21	958.80	527478.78
28	42G9	29884.21	132837.35	47432.34	36767.91	125372.43	11404.86	4669.49	4383.85	392752.45
	42H0	28141.97	127534.29	32177.11	29819.94	108444.44	7871.78	1531.17	6444.40	341965.10
	43G9	15205.69	69306.60	26731.23	19846.83	81811.27	2810.02	3371.79	2461.83	221545.26
	43H0	49041.14	62526.55	15840.31	28876.80	79932.51	4191.70	6771.36	3804.41	250984.80
	43H1	32722.46	30963.76	7336.93	13248.71	40148.41	3450.36	3250.20	3090.11	134210.94
	44G9	8253.31	58320.42	21788.00	19708.80	66783.42	2863.83	2548.63	2661.05	182927.47
	44H0	5030.08	21174.89	10180.04	15383.38	33766.51	1993.59	1730.41	1886.28	91145.19
	44H1	72383.17	27901.01	13269.25	11756.63	36931.53	3726.08	348.18	188.10	166503.95

Table 6B n10^6					Age group					Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9	305.85	1129.83	388.23	554.75	1610.82	65.18	98.70	36.29	4189.65
	41H0	315.81	206.55	48.07	96.78	231.69	5.74	18.54	1.68	924.86
28	42G9	229.51	1020.18	364.28	282.37	962.85	87.59	35.86	33.67	3016.30
	42H0	181.88	824.23	207.95	192.72	700.85	50.87	9.90	41.65	2210.05
	43G9	123.13	561.20	216.45	160.71	662.46	22.75	27.30	19.93	1793.94
	43H0	319.71	407.62	103.27	188.25	521.09	27.33	44.14	24.80	1636.21
	43H1	61.20	57.91	13.72	24.78	75.09	6.45	6.08	5.78	251.01
	44G9	57.77	408.22	152.51	137.95	467.46	20.05	17.84	18.63	1280.42
	44H0	95.06	400.18	192.39	290.72	638.14	37.68	32.70	35.65	1722.52
	44H1	374.89	144.51	68.72	60.89	191.28	19.30	1.80	0.97	862.36

Table 6C n, %					Age group					Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9	7.30	26.97	9.27	13.24	38.45	1.56	2.36	0.87	100.00
	41H0	34.15	22.33	5.20	10.46	25.05	0.62	2.00	0.18	100.00
28	42G9	7.61	33.82	12.08	9.36	31.92	2.90	1.19	1.12	100.00
	42H0	8.23	37.29	9.41	8.72	31.71	2.30	0.45	1.88	100.00
	43G9	6.86	31.28	12.07	8.96	36.93	1.27	1.52	1.11	100.00
	43H0	19.54	24.91	6.31	11.51	31.85	1.67	2.70	1.52	100.00
	43H1	24.38	23.07	5.47	9.87	29.91	2.57	2.42	2.30	100.00
	44G9	4.51	31.88	11.91	10.77	36.51	1.57	1.39	1.45	100.00
	44H0	5.52	23.23	11.17	16.88	37.05	2.19	1.90	2.07	100.00
	44H1	43.47	16.76	7.97	7.06	22.18	2.24	0.21	0.11	100.00

Table 6D W, kg10^3					Age group					Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9	1608.98	8334.81	3380.15	5362.73	15051.26	705.42	1190.97	440.07	36074.40
	41H0	1525.72	1559.84	438.59	988.39	2337.76	75.17	232.12	20.58	7178.17
28	42G9	1102.28	7637.09	3239.24	2727.58	9211.87	893.74	433.93	440.91	25686.65
	42H0	883.78	6112.33	1917.37	1858.50	6651.19	525.33	105.39	503.20	18557.08
	43G9	593.15	4318.96	2101.68	1544.69	6482.02	259.84	309.58	230.47	15840.38
	43H0	1490.90	3237.00	974.64	1818.77	5103.45	305.89	536.33	310.44	13777.41
	43H1	277.40	465.14	124.56	251.18	745.44	71.48	77.79	72.08	2085.07
	44G9	281.47	3186.87	1502.89	1340.99	4633.76	232.84	199.54	202.78	11581.14
	44H0	464.96	3161.55	1736.54	2864.32	6383.16	443.24	396.12	413.66	15863.55
	44H1	1665.32	1122.62	663.34	673.37	1992.73	248.46	25.41	12.10	6403.35

Table 6E W, %		Age group								∑
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9	4.46	23.10	9.37	14.87	41.72	1.96	3.30	1.22	100.00
	41H0	21.26	21.73	6.11	13.77	32.57	1.05	3.23	0.29	100.00
28	42G9	4.29	29.73	12.61	10.62	35.86	3.48	1.69	1.72	100.00
	42H0	4.76	32.94	10.33	10.02	35.84	2.83	0.57	2.71	100.00
	43G9	3.74	27.27	13.27	9.75	40.92	1.64	1.95	1.45	100.00
	43H0	10.82	23.49	7.07	13.20	37.04	2.22	3.89	2.25	100.00
	43H1	13.30	22.31	5.97	12.05	35.75	3.43	3.73	3.46	100.00
	44G9	2.43	27.52	12.98	11.58	40.01	2.01	1.72	1.75	100.00
	44H0	2.93	19.93	10.95	18.06	40.24	2.79	2.50	2.61	100.00
	44H1	26.01	17.53	10.36	10.52	31.12	3.88	0.40	0.19	100.00

Table 6F w, g		Age group								∑
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9	5.26	7.38	8.71	9.67	9.34	10.82	12.07	12.13	8.61
	41H0	4.83	7.55	9.12	10.21	10.09	13.09	12.52	12.24	7.76
28	42G9	4.80	7.49	8.89	9.66	9.57	10.20	12.10	13.10	8.52
	42H0	4.86	7.42	9.22	9.64	9.49	10.33	10.65	12.08	8.40
	43G9	4.82	7.70	9.71	9.61	9.78	11.42	11.34	11.56	8.83
	43H0	4.66	7.94	9.44	9.66	9.79	11.19	12.15	12.52	8.42
	43H1	4.53	8.03	9.08	10.14	9.93	11.08	12.80	12.47	8.31
	44G9	4.87	7.81	9.85	9.72	9.91	11.62	11.19	10.89	9.04
	44H0	4.89	7.90	9.03	9.85	10.00	11.76	12.11	11.60	9.21
	44H1	4.44	7.77	9.65	11.06	10.42	12.87	14.09	12.42	7.43

Table 6G L, g		Age group								∑
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9	9.72	11.02	11.67	12.06	11.94	12.60	12.89	13.14	11.56
	41H0	9.41	10.97	11.70	12.20	12.11	13.16	12.91	12.75	10.95
28	42G9	9.50	10.89	11.63	11.95	11.94	12.18	13.06	13.43	11.40
	42H0	9.50	10.86	11.84	12.02	11.92	12.30	12.43	12.99	11.36
	43G9	9.40	10.95	11.86	11.80	11.88	12.56	12.63	12.79	11.44
	43H0	9.33	11.10	11.82	11.90	11.95	12.55	12.97	13.22	11.27
	43H1	9.25	11.17	11.68	12.13	12.04	12.54	13.28	13.23	11.22
	44G9	9.39	10.99	11.90	11.85	11.91	12.63	12.65	12.52	11.53
	44H0	9.38	11.06	11.66	11.96	12.02	12.70	12.81	12.81	11.65
	44H1	9.25	11.00	11.85	12.47	12.19	13.01	13.53	12.96	10.73

Table 7. Herring stock characteristics in the Baltic Sea ICES SD 26N and 28.2
from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019

Table 7A CANUM		Age group								∑
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9		282.90	279.44	322.01	1676.16	346.63	806.58	854.58	4568.29
	41H0			26.40	305.22	855.79	359.62	287.50	346.81	2181.34
28	42G9		528.95	394.76	502.23	2575.77	319.50	854.31	717.35	5892.86
	42H0		169.80	153.48	1080.75	2034.68	686.92	1189.84	695.91	6011.38
	43G9		870.83	1148.43	2050.76	5578.19	1095.13	1381.62	855.12	12980.09
	43H0		2086.35	3983.03	8984.56	9977.41	3323.48	5159.23	2147.67	35661.74
	43H1		1130.78	2717.37	6018.50	5771.19	1873.34	3091.02	1084.39	21686.59
	44G9		1067.31	1455.13	2359.89	5363.81	919.46	1125.46	674.68	12965.74
	44H0		1081.47	1465.48	5239.91	6790.05	1254.01	2372.03	1594.23	19797.18
	44H1	129.72	2639.58	2159.87	10393.71	9709.05	2360.08	2654.93	1083.64	31130.57

Table 7B n10^{6}		Age group								∑
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9		2.00	1.98	2.28	11.88	2.46	5.71	6.05	32.37
	41H0			0.05	0.54	1.50	0.63	0.50	0.61	3.82
28	42G9		4.06	3.03	3.86	19.78	2.45	6.56	5.51	45.26
	42H0		1.10	0.99	6.98	13.15	4.44	7.69	4.50	38.85
	43G9		7.05	9.30	16.61	45.17	8.87	11.19	6.92	105.11
	43H0		13.60	25.97	58.57	65.04	21.67	33.63	14.00	232.48
	43H1		2.11	5.08	11.26	10.79	3.50	5.78	2.03	40.56
	44G9		7.47	10.19	16.52	37.54	6.44	7.88	4.72	90.76
	44H0		20.44	27.70	99.03	128.32	23.70	44.83	30.13	374.14
	44H1	0.67	13.67	11.19	53.83	50.29	12.22	13.75	5.61	161.23

Table 7C n, %		Age group								∑
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9		6.19	6.12	7.05	36.69	7.59	17.66	18.71	100.00
	41H0			1.21	13.99	39.23	16.49	13.18	15.90	100.00
28	42G9		8.98	6.70	8.52	43.71	5.42	14.50	12.17	100.00
	42H0		2.82	2.55	17.98	33.85	11.43	19.79	11.58	100.00
	43G9		6.71	8.85	15.80	42.97	8.44	10.64	6.59	100.00
	43H0		5.85	11.17	25.19	27.98	9.32	14.47	6.02	100.00
	43H1		5.21	12.53	27.75	26.61	8.64	14.25	5.00	100.00
	44G9		8.23	11.22	18.20	41.37	7.09	8.68	5.20	100.00
	44H0		5.46	7.40	26.47	34.30	6.33	11.98	8.05	100.00
	44H1	0.42	8.48	6.94	33.39	31.19	7.58	8.53	3.48	100.00

Table 7D W, kg10^{3}		Age group								∑
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
26	41G9		41.99	55.25	69.81	365.04	93.34	222.72	282.65	1130.80
	41H0			0.90	15.70	46.86	23.17	18.76	26.58	131.98
28	42G9		87.13	78.34	106.31	603.20	88.38	248.09	241.08	1452.53
	42H0		25.97	25.27	195.85	404.72	162.89	279.84	188.85	1283.38
	43G9		119.89	217.89	443.05	1310.88	290.77	382.12	286.89	3051.48
	43H0		244.61	601.82	1470.95	1828.34	700.26	1143.92	538.38	6528.29
	43H1		39.51	116.97	279.11	300.99	112.82	195.48	75.88	1120.77
	44G9		127.01	231.26	410.96	1024.98	191.12	247.42	160.79	2393.55
	44H0		352.19	579.38	2325.28	3307.80	762.31	1425.47	996.59	9749.01
	44H1	6.05	220.87	224.43	1277.62	1241.46	340.92	377.91	168.14	3857.39

Table 7E W, %		Age group								
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	∑
26	41G9		3.71	4.89	6.17	32.28	8.25	19.70	25.00	100.00
	41H0			0.68	11.90	35.50	17.55	14.22	20.14	100.00
28	42G9		6.00	5.39	7.32	41.53	6.08	17.08	16.60	100.00
	42H0		2.02	1.97	15.26	31.54	12.69	21.80	14.71	100.00
	43G9		3.93	7.14	14.52	42.96	9.53	12.52	9.40	100.00
	43H0		3.75	9.22	22.53	28.01	10.73	17.52	8.25	100.00
	43H1		3.53	10.44	24.90	26.86	10.07	17.44	6.77	100.00
	44G9		5.31	9.66	17.17	42.82	7.98	10.34	6.72	100.00
	44H0		3.61	5.94	23.85	33.93	7.82	14.62	10.22	100.00
	44H1	0.16	5.73	5.82	33.12	32.18	8.84	9.80	4.36	100.00

Table 7F w, g		Age group								
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	∑
26	41G9		20.95	27.91	30.60	30.74	38.01	38.97	46.68	34.94
	41H0			19.50	29.34	31.23	36.74	37.22	43.71	34.51
28	42G9		21.45	25.84	27.56	30.49	36.02	37.81	43.76	32.10
	42H0		23.67	25.48	28.04	30.78	36.69	36.39	41.99	33.03
	43G9		17.00	23.43	26.68	29.02	32.79	34.16	41.43	29.03
	43H0		17.98	23.18	25.11	28.11	32.32	34.01	38.45	28.08
	43H1		18.68	23.02	24.80	27.89	32.20	33.81	37.42	27.63
	44G9		17.00	22.71	24.88	27.30	29.70	31.41	34.05	26.37
	44H0		17.23	20.92	23.48	25.78	32.17	31.80	33.08	26.06
	44H1	9.00	16.16	20.06	23.73	24.69	27.89	27.48	29.96	23.92

Table 7G L, g		Age group								
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	∑
26	41G9		15.02	16.60	17.29	17.19	18.62	18.87	20.13	17.98
	41H0			15.25	17.22	17.56	18.58	18.56	20.28	18.22
28	42G9		14.90	16.19	16.70	17.17	18.33	18.61	19.45	17.41
	42H0		15.57	16.26	16.84	17.36	18.54	18.38	19.63	17.79
	43G9		13.97	15.71	16.41	16.93	17.77	18.08	19.34	16.90
	43H0		14.25	15.78	16.29	16.95	17.89	18.19	19.04	16.89
	43H1		14.46	15.74	16.24	16.96	17.89	18.19	19.04	16.84
	44G9		13.98	15.53	16.11	16.69	17.32	17.76	18.27	16.45
	44H0		14.07	15.16	15.92	16.43	17.81	17.79	17.99	16.45
	44H1	10.75	13.80	15.06	16.01	16.22	16.99	16.84	17.59	16.00

Table 8. BASS statistics related to cod from the Latvian-Polish BASS
in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 18-25.05.2019

Table 5A									
ICES SD	ICES Rect.	L, cm	w, g	$NASC_{PEL}$ m^2nm^{-2}	σ 10^4 m^2	TS calc. dB	ρ $n10^6nm^{-2}$	Abundance $n10^6$	Biomass $kg10^3$
26	41G9	28.19	225.15	0.283	18.20	-28.45	155.36	155364.74	34.98
	41H0	27.17	185.33	0.001	16.87	-28.78	0.76	728.04	0.13
28	42G9	27.47	208.63	0.261	17.42	-28.64	149.82	147856.70	30.85
	42H0	27.72	217.12	0.148	17.88	-28.53	82.85	80242.07	17.42
	43G9	27.64	211.83	0.275	17.67	-28.58	155.46	151368.83	32.06
	43H0	27.43	197.21	0.155	17.31	-28.67	89.64	87283.33	17.21
	43H1	27.42	190.76	0.066	17.23	-28.69	38.26	15791.94	3.01
	44G9	27.18	198.83	0.065	17.14	-28.71	37.97	33283.52	6.62
	44H0	28.96	244.29	0.255	19.45	-28.16	131.24	126056.68	30.79
	44H1	27.00	180.80	0.025	16.51	-28.87	15.17	12511.91	2.26

Table 9. Number of sprat eggs and larvae per 1 m^2 or per 10 minutes of sampling on water surface in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019

Aquatory	Northern part		Central part		Southern part	
Depth strata	>70m	<70m	>70m	<70m	>70m	<70m
Eggs (per $1m^2$)	74	–	158	0	246	11.4
Larvae (per $1m^2$)	0	–	6	0	23.6	0
Eggs (per 10 min. of haul on the water surface)	0	–	2.7	7	8.5	8
Larvae (per 10 min. of haul on the water surface)	0.3	–	0.7	2.25	2.3	1

Northern part of the Gotland Basin – to the north from 57°30’N
Central part of the Gotland Basin – between 56°30’N and 57°30’N
Southern part of the Gotland Basin – to the south from 56°30’N.

Table 10. The average number and average biomass of zooplankton organisms in 0-100m water column per volume unit in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019

Species	2019		Long term average (1960-2018)	
	Biomass (mg/m^3)	Biomass (%)	Biomass (mg/m^3)	Biomass (%)
Acartia spp.	43.6200	14.2324	18.1156	11.5366
Centropages hamatus	16.3000	5.3184	2.6632	1.6960
Cyclops spp.			0.0519	0.0331
Eurytemora affinis	0.8400	0.2741	0.2936	0.1870
Limnocalanus macrurus			0.3199	0.2037
Mesochra rapiens			0.0005	0.0003
Oithona sp.	0.0100	0.0033	0.1181	0.0752
Pseudocalanus sp.	10.7200	3.4977	31.4565	20.0325
Temora longicornis	55.5000	18.1087	11.5951	7.3842
Bosmina spp.	0.0800	0.0261	0.0912	0.0581
Evadne spp.	22.1100	7.2141	11.7479	7.4814
Podon spp.	0.2900	0.0946	1.5285	0.9734
Keratella spp.	0.0030	0.0010	0.0004	0.0002
Synchaeta spp.	137.2700	44.7888	58.6496	37.3500
Amphibalanus improvisus larvae			0.0012	0.0007
Bivalvia larvae	0.3100	0.1011	0.0959	0.0611
Fritillaria borealis	13.0700	4.2645	14.3987	9.1696
Pleurobrachia pileus			0.1276	0.0812
Polychaeta larvae	6.3600	2.0752	5.7692	3.6740
Copepoda	126.9900	41.4346	64.6144	41.1486
Cladocera	22.4800	7.3348	13.3675	8.5129
Eurotatoria	137.2730	44.7898	58.6500	37.3502
Varia	19.7400	6.4408	20.3953	12.9884
Total	306.4830	100.0000	157.0273	100.0000

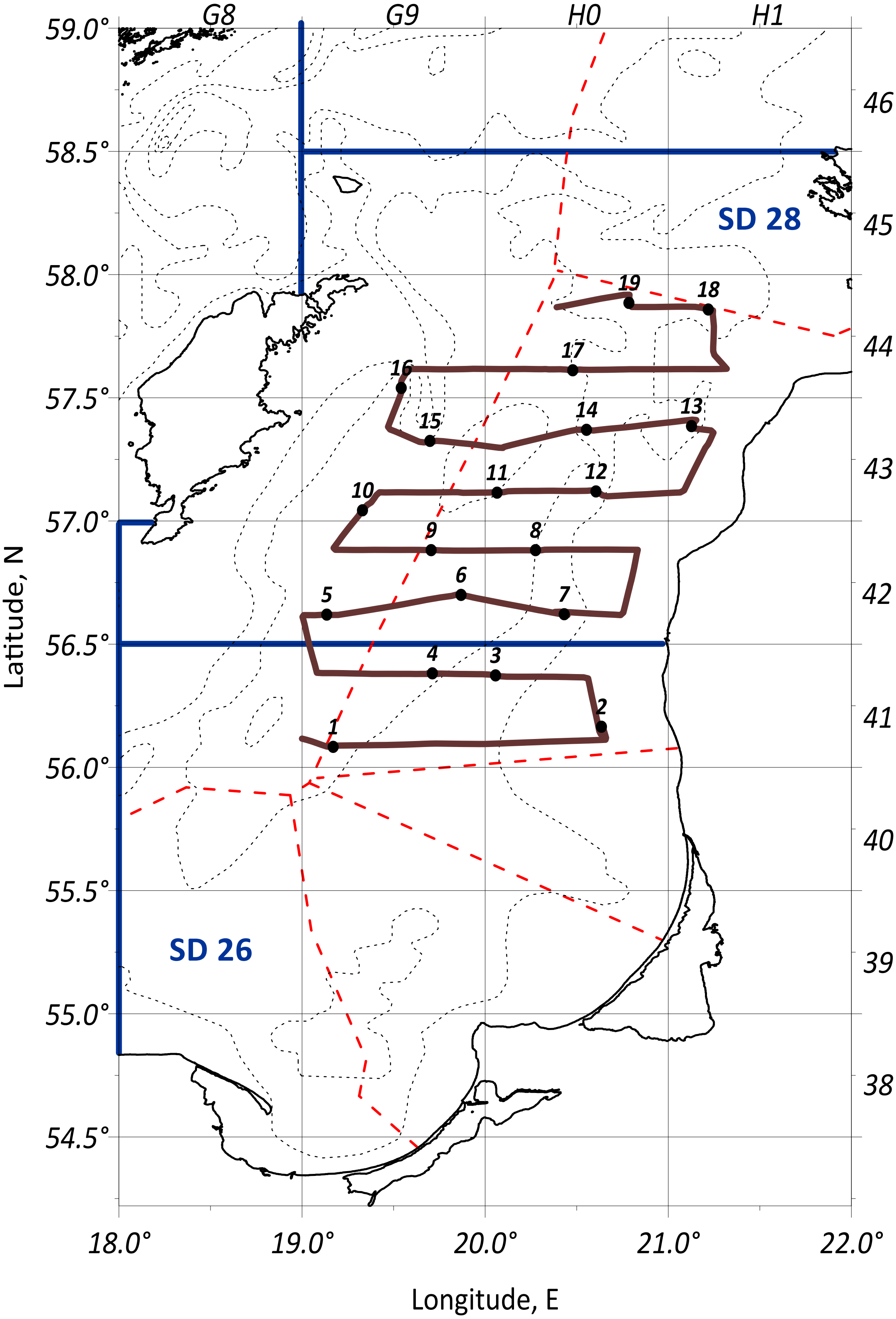

Figure 1: Cruise track design and trawling positions of the Latvian-Polish BASS on the r/v "Baltica" in the period of 18-25.05.2019.

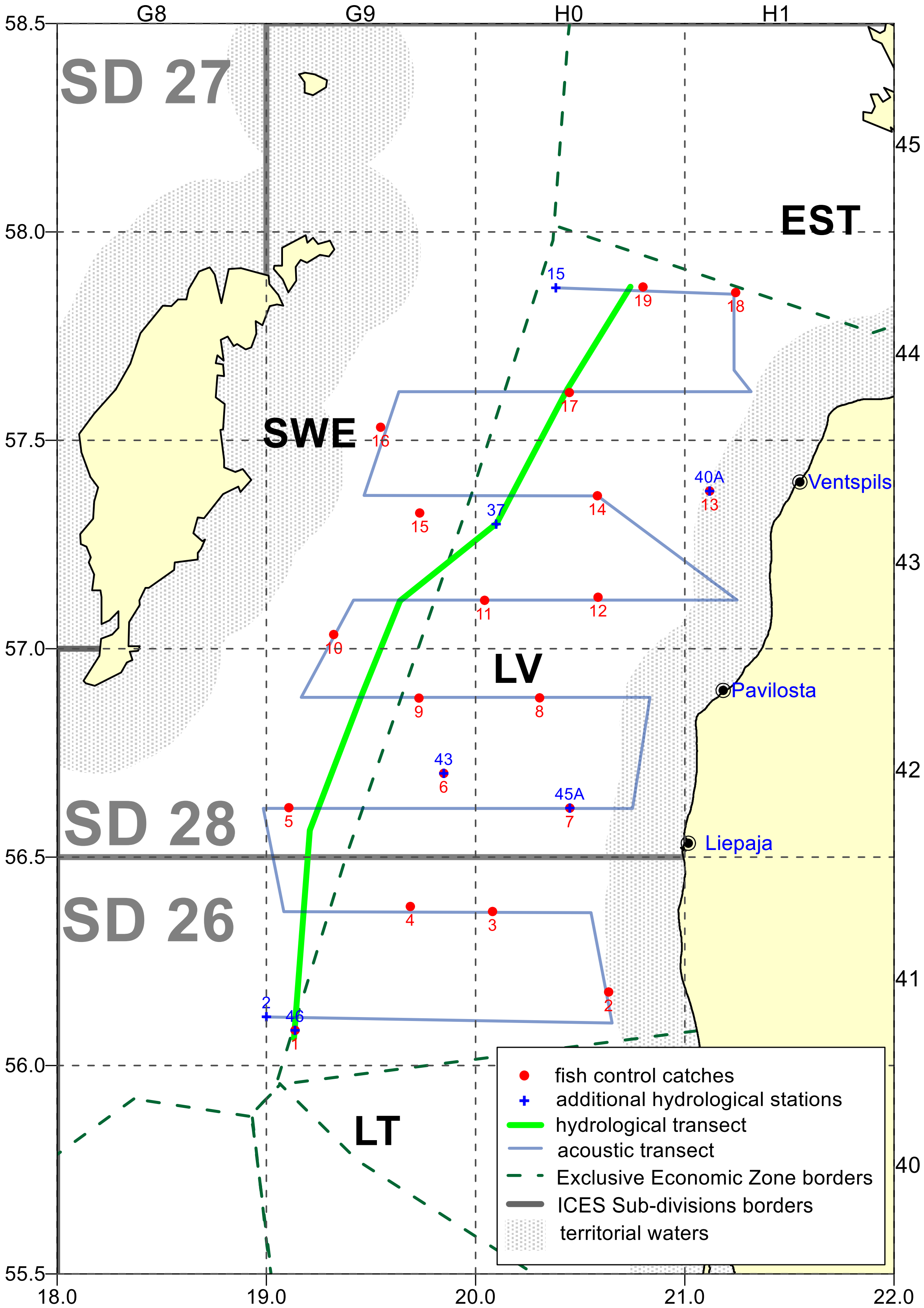

Figure 2: Locations of the hydrological, ichthyoplankton and zooplankton stations performed during the Latvian-Polish BASS on the r/v "Baltica" in the period of 18-25.05.2019.

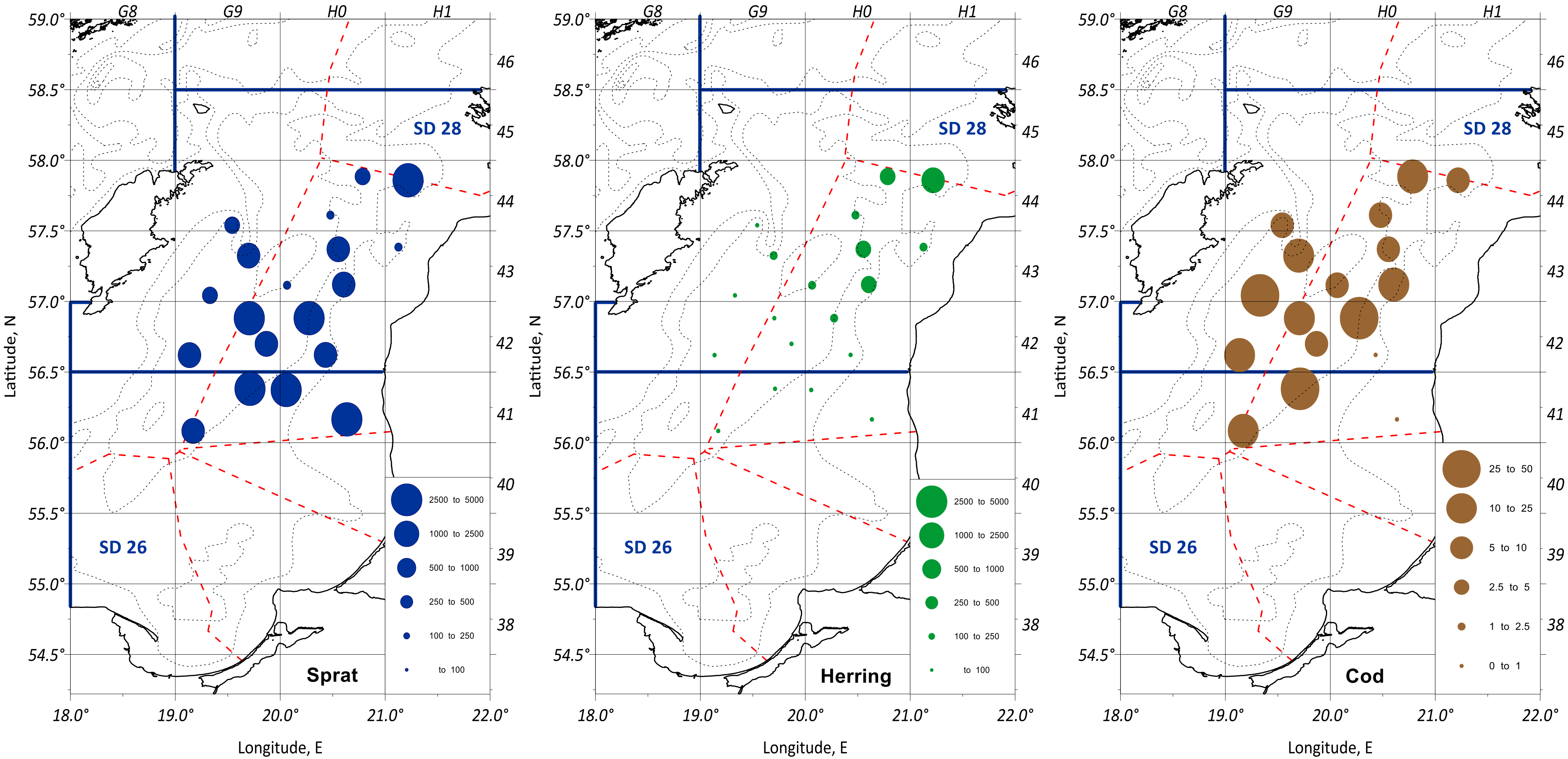

Figure 3: CPUE [kg/h] ranges distribution of dominant fish in the catch hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

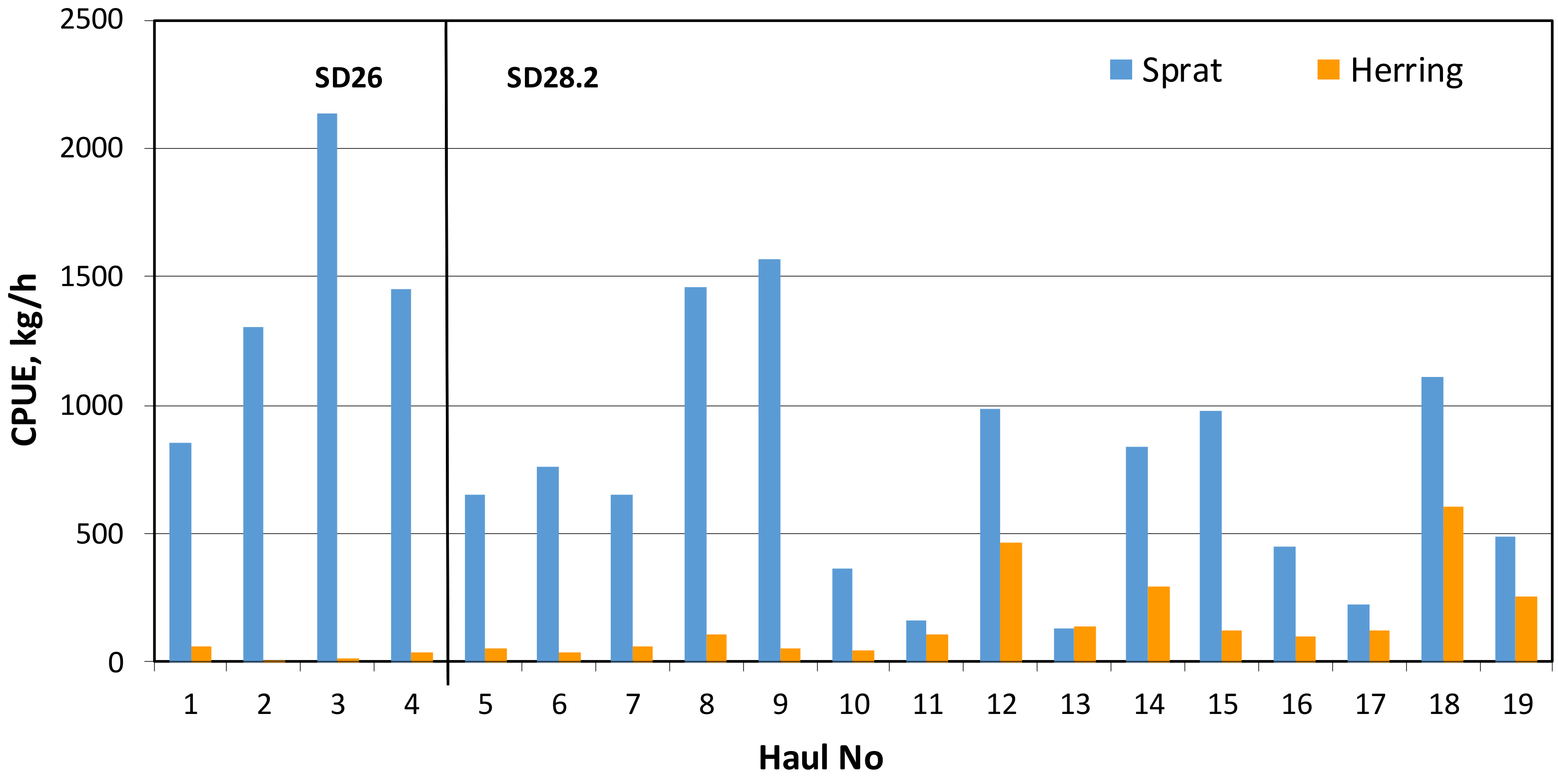

Figure 4: CPUE [kg/h] of dominant pelagic fish in the catch hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

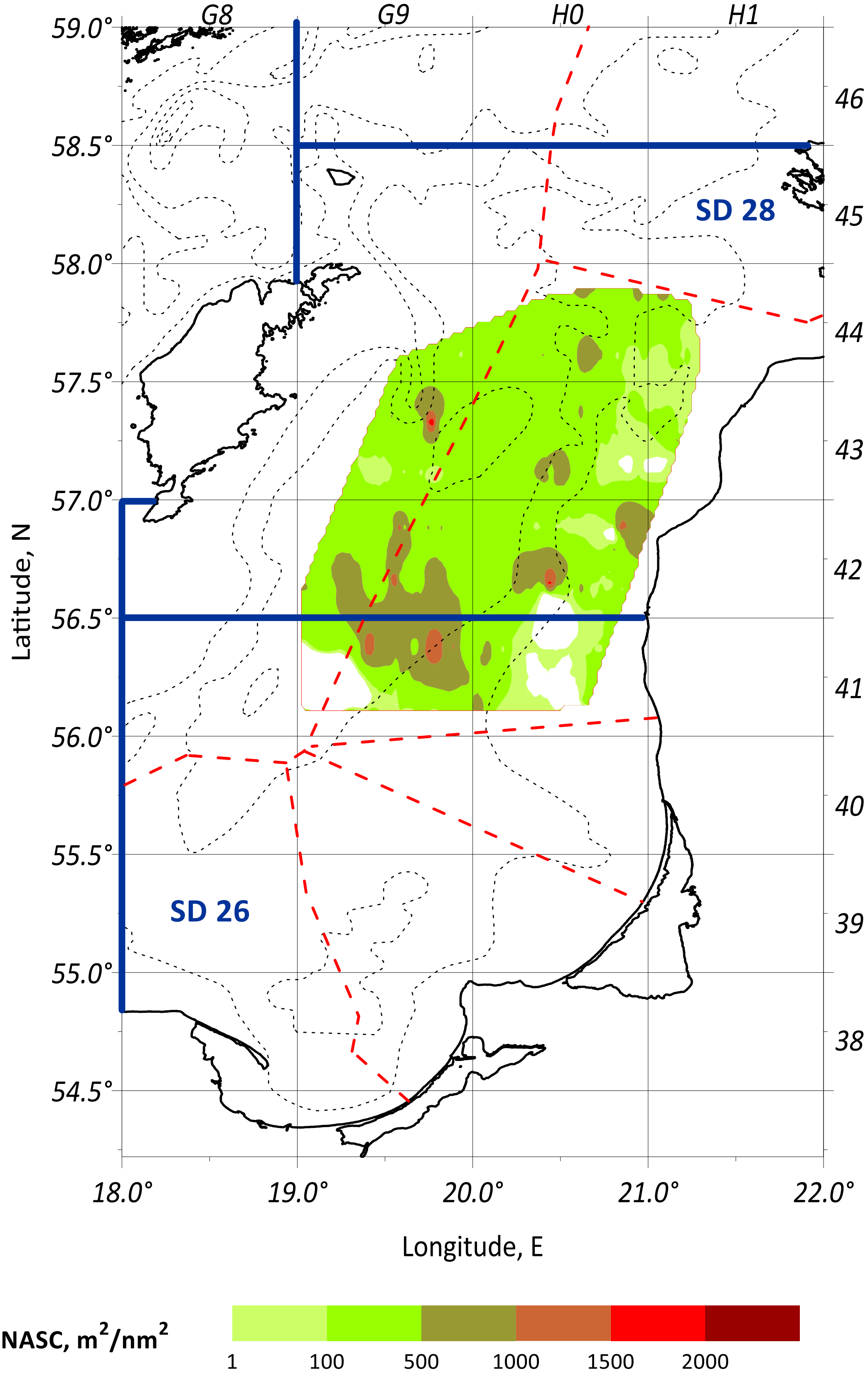

Figure 5: Acoustic parameter NASC distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

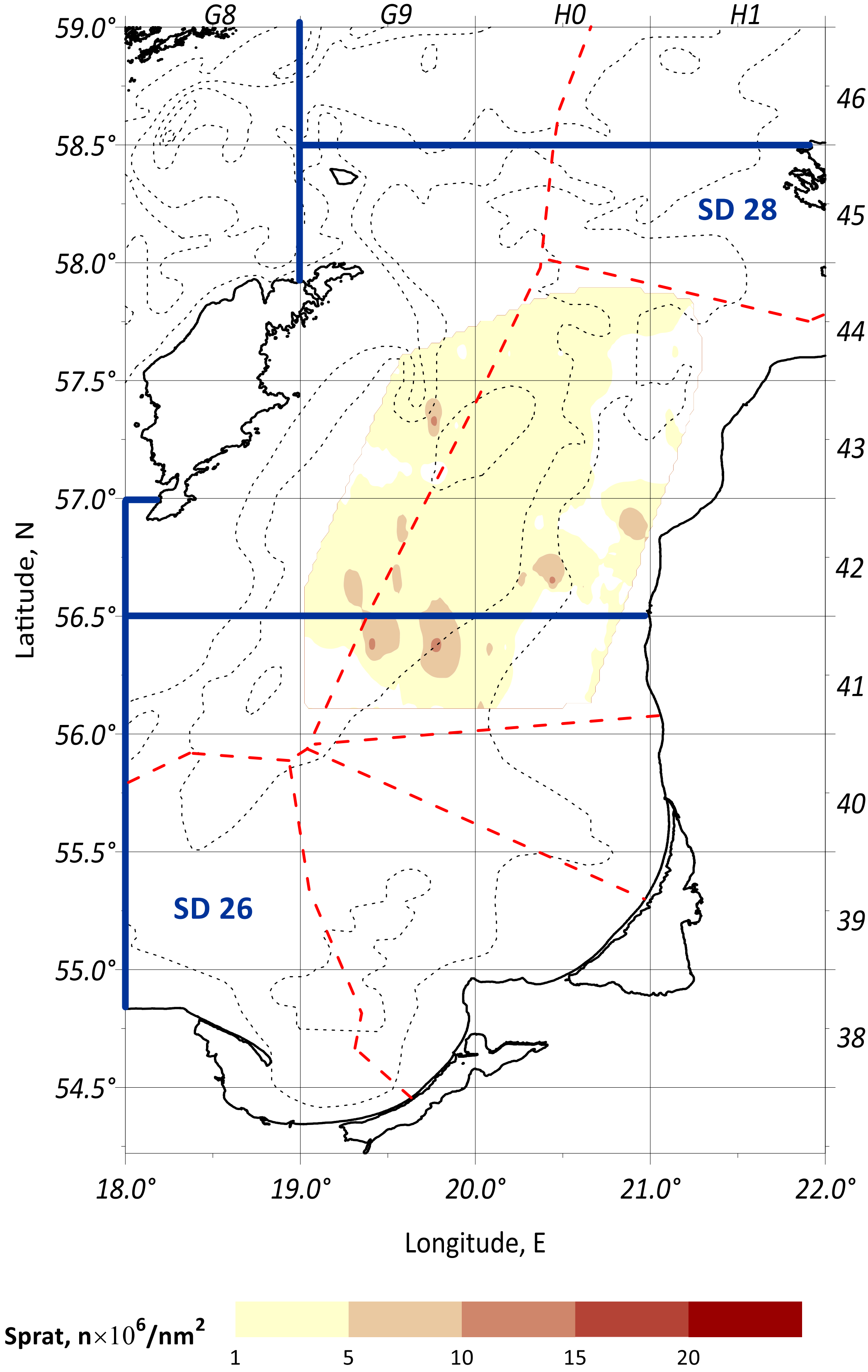

Figure 6: Sprat distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

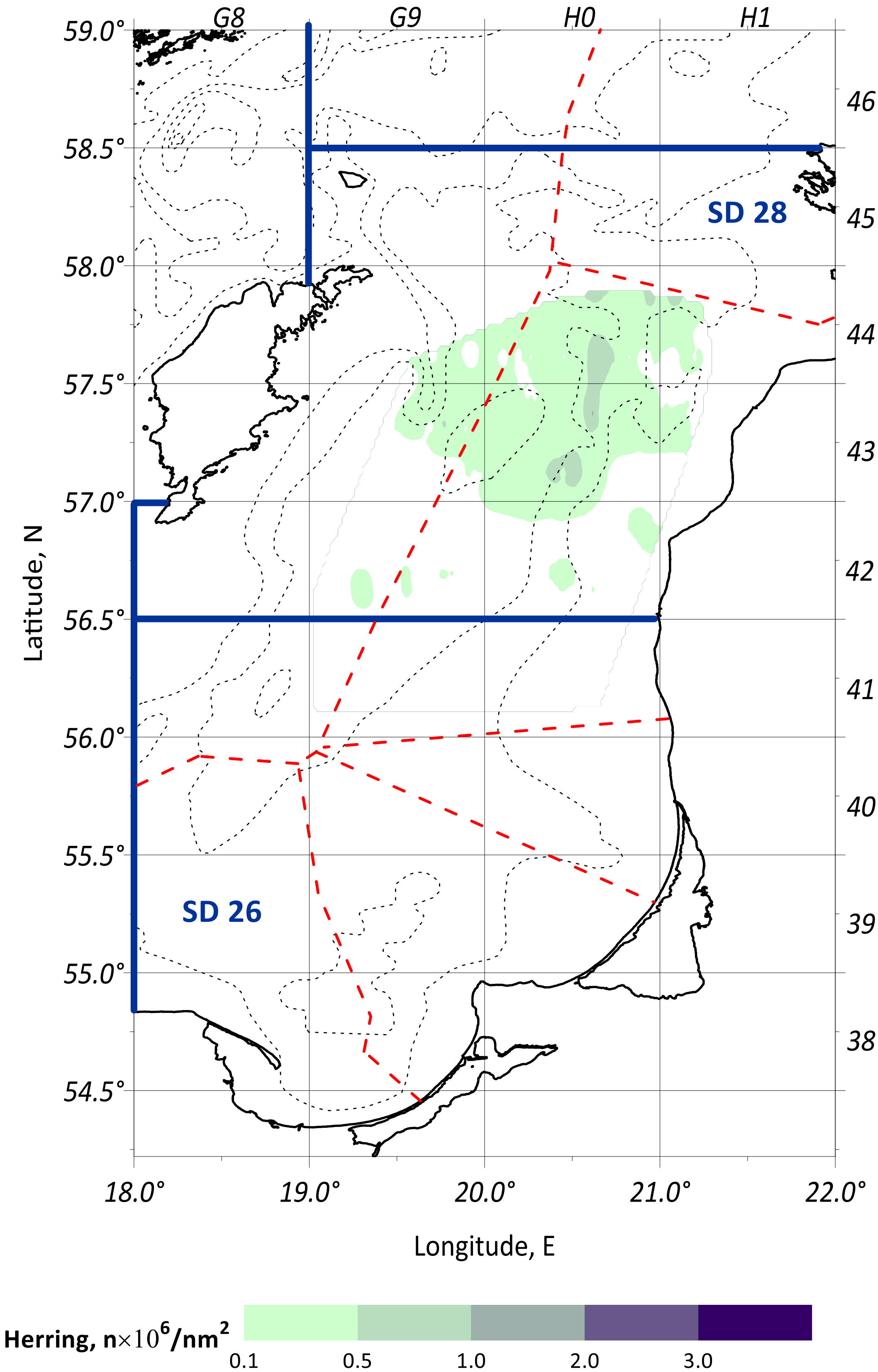

Figure 7: Herring distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

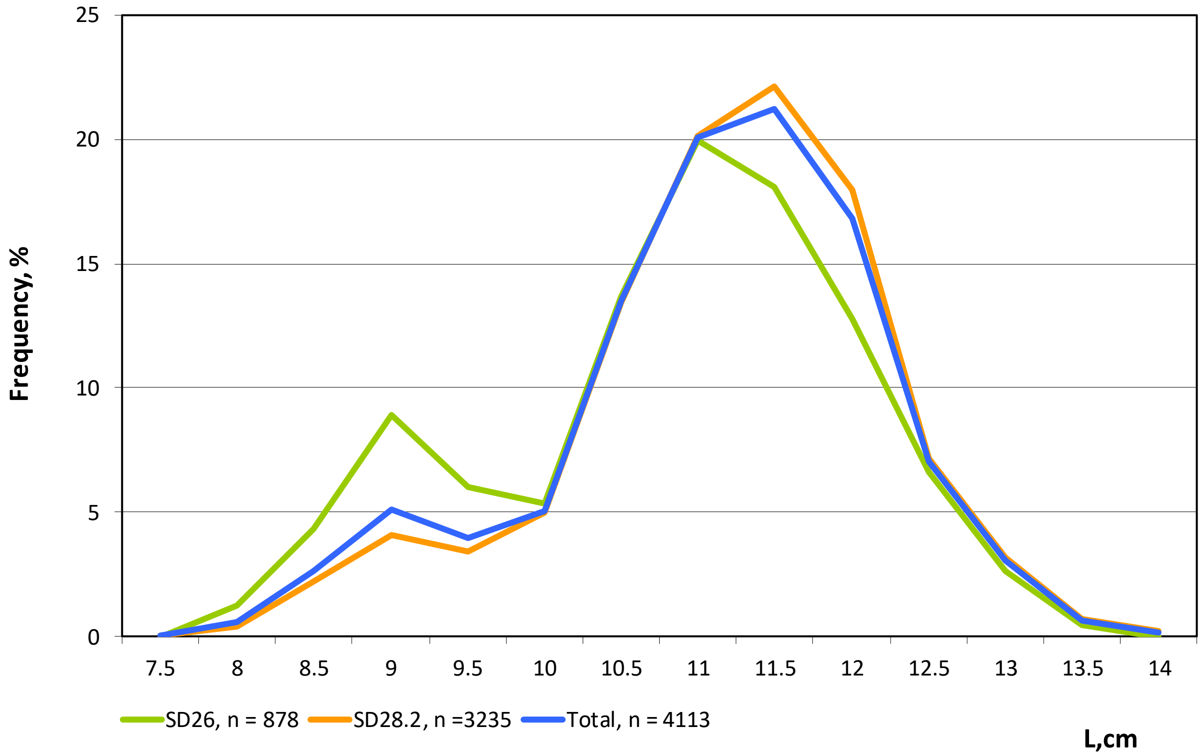

Figure 8: Sprat length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

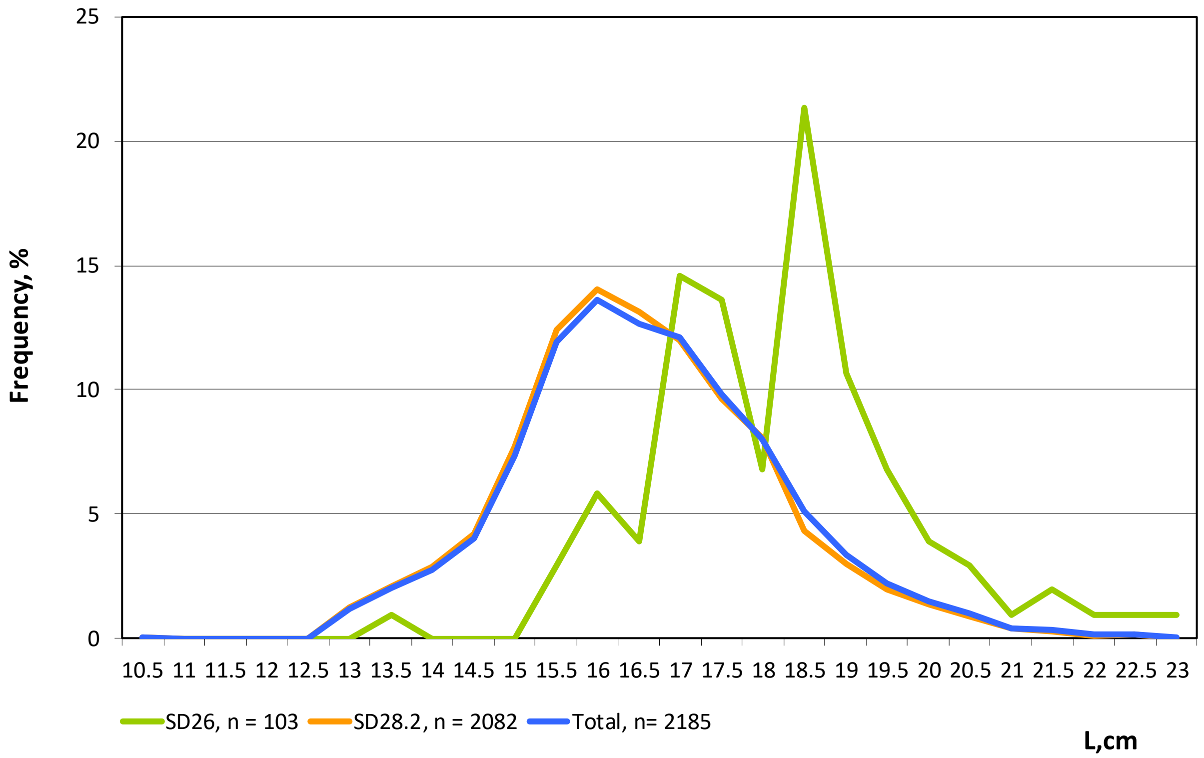

Figure 9: Herring length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

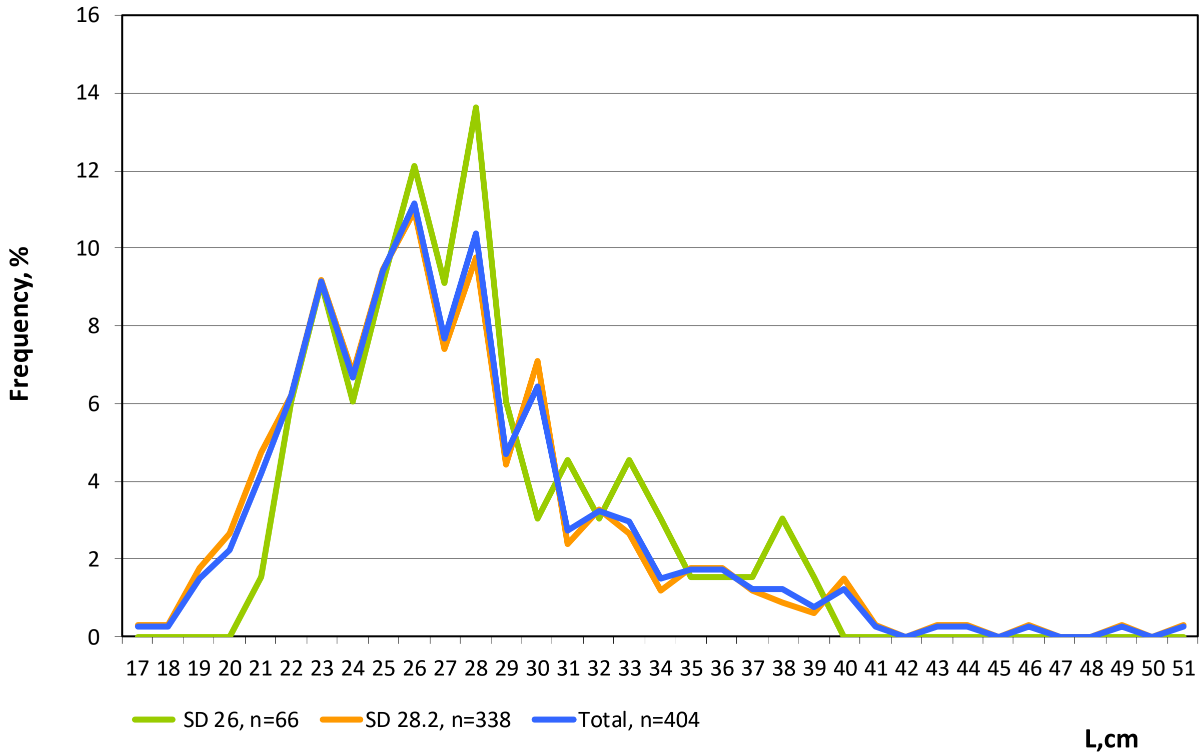

Figure 10: Cod length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

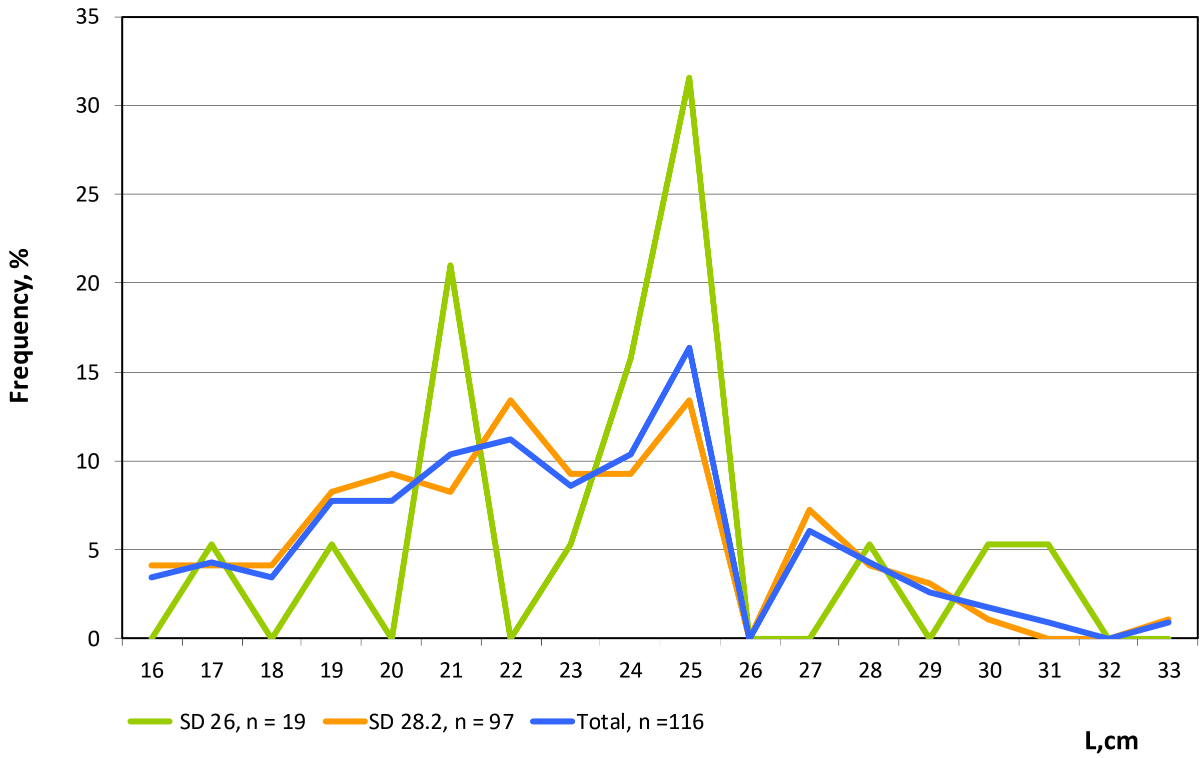

Figure 11: Flounder length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

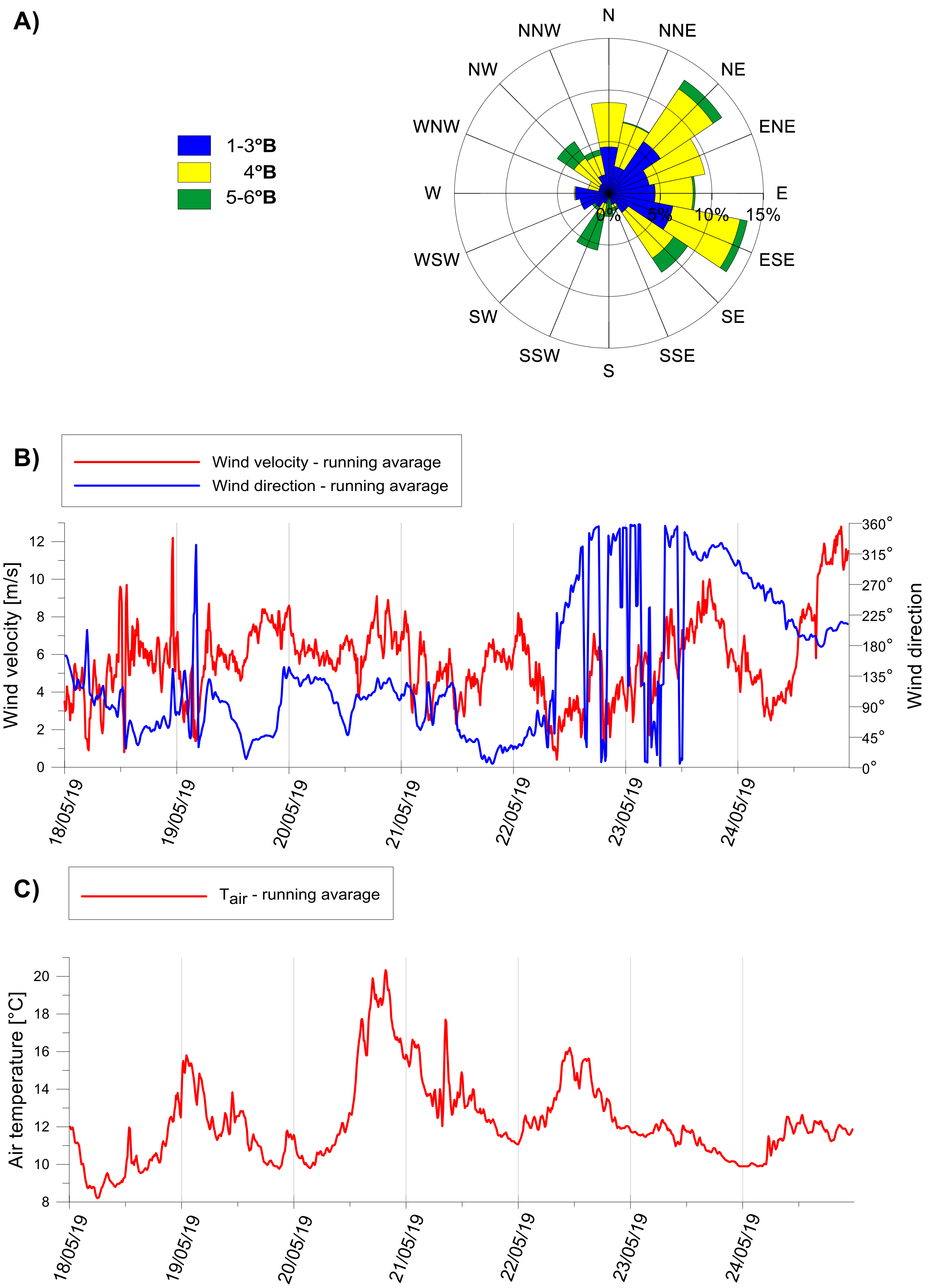

Figure 12: Changes of the main meteorological parameters (wind force, direction and the daily air temperature) during the Latvian-Polish BASS in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 18-25.05.2019.

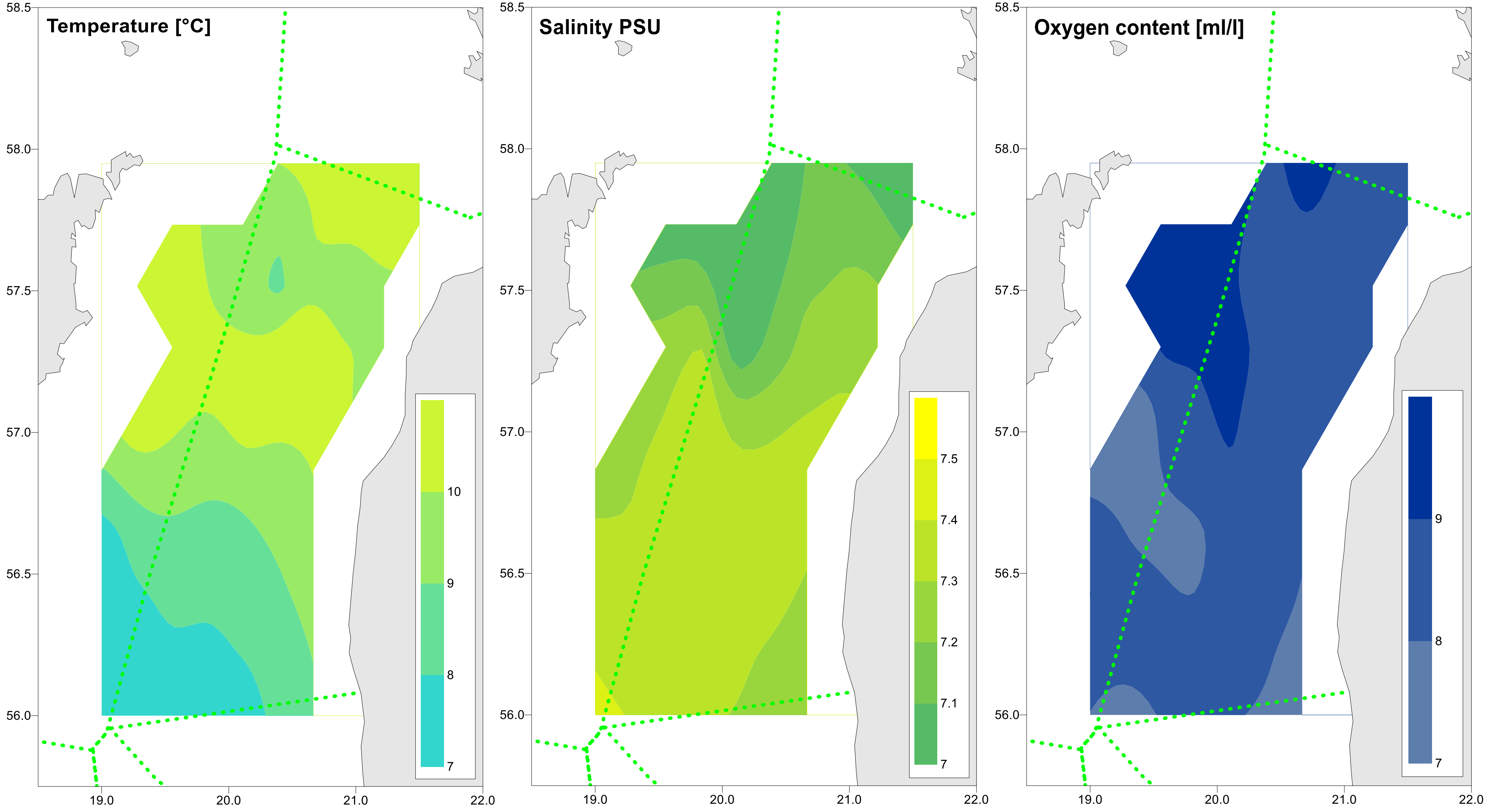

Figure 13: Horizontal distribution of the main hydrological parameters (temperature, salinity, oxygen content) measured in the surface water layer of the Gotland Deep in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

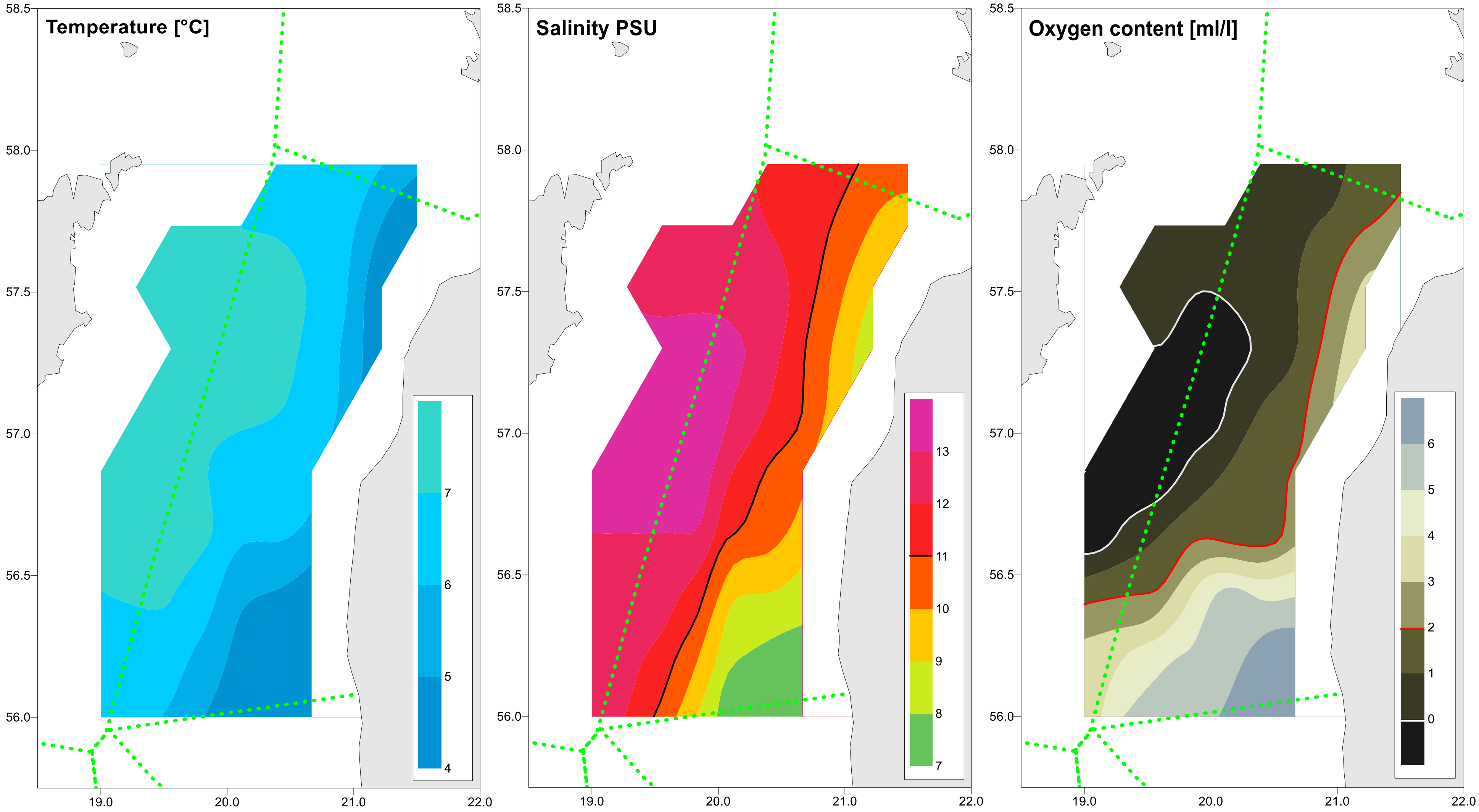

Figure 14: Horizontal distribution of the main hydrological parameters (temperature, salinity, oxygen content) measured in the bottom water layer of the Gotland Deep in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 18-25.05.2019.

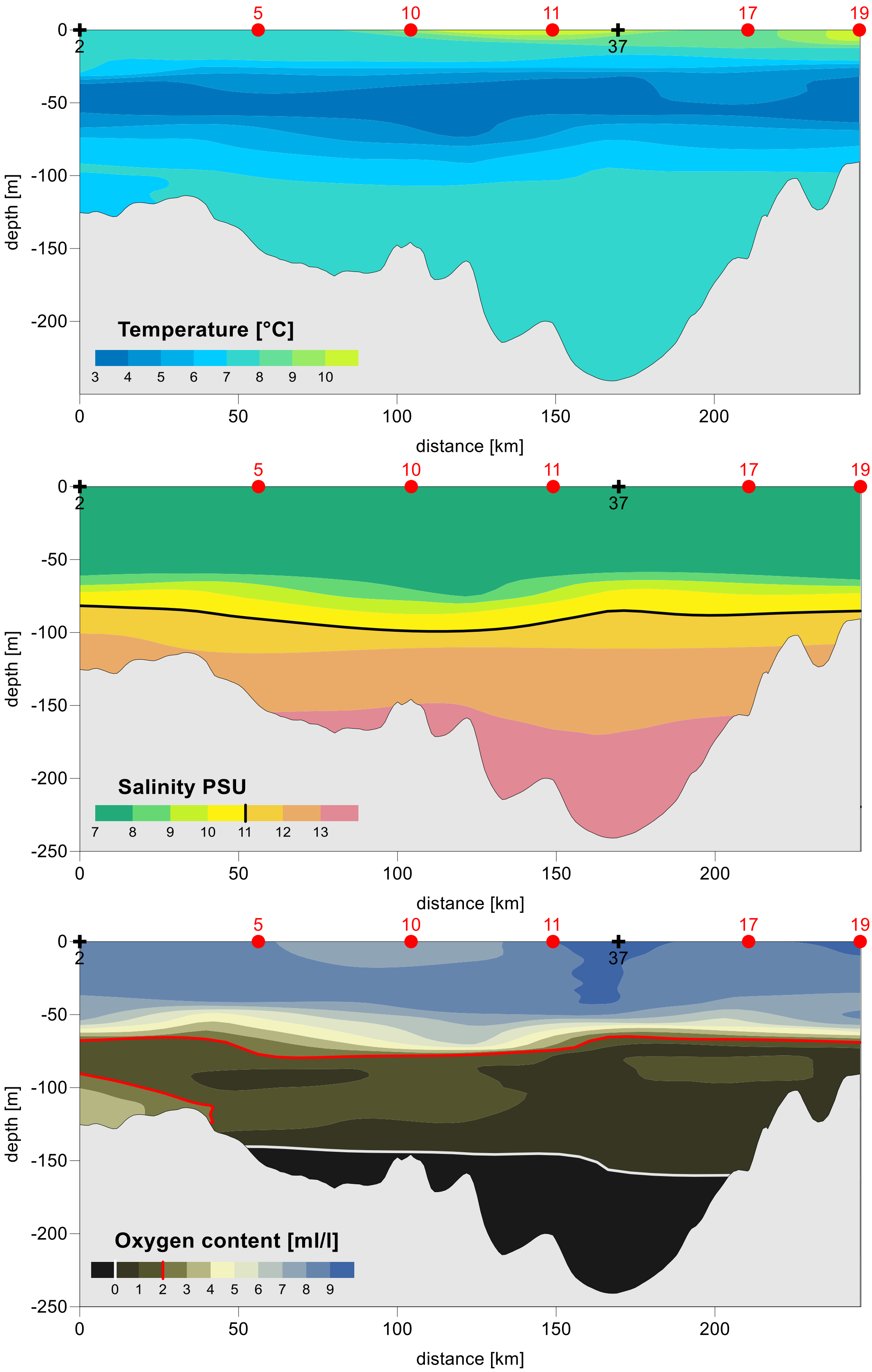

Figure 19: Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological profile in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS survey conducted by r/v "Baltica" in the period of 18-25.05.2018.

Working paper on the ICES WGBIFS on-line meeting , 04-06.04.2022

Research report from the Polish part of the SPRat Acoustic Survey (SPRAS) on board of the r.v. "Baltica" (01-14.05.2021)

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INTRODUCTION

The Polish SPRAS/2021 survey was conducted in the framework of the ICES International Baltic Acoustic Surveys (IBAS) long-term programme including spring (Sprat Acoustic Survey, SPRAS, previously named Baltic Acoustic Spring Survey, BASS) and autumn (Baltic International Acoustic Survey, BIAS) acoustic surveys. The ICES Baltic International Fish Survey Working Group (WGBIFS) coordinates methods of investigations, the timing of surveys, spatial allocation of vessels and the general pattern of pelagic control-hauls distribution in the Baltic, regarding both types of acoustic surveys, i.e. SPRAS and BIAS. The above-mentioned working group is also responsible for the compilation of international results required for the assessment of clupeids stocks size in the Baltic. The set of input data and recommendations are next transferred to the ICES Baltic Fisheries Assessment Working Group (WGBFAS) for the final evaluation of fish stocks size.

In the period of 1-14 May 2021, the SPRAS survey was conducted on board of the r.v. "Baltica" inside of the Polish, and partly, the Danish EEZ. The Polish Fisheries Data Collection Programme for 2021 and the European Union (the European Parliament and the Council Regulation (EU) 2017/1004 of 17 May 2017 and the Commission Implementing Decision (EU) 2019/909 of 18 February 2019) financially supported the Polish SPARS survey marked with internal No. 7/2021/MIR-PIB.

The survey was focused on monitoring the spatial-seasonal distribution of clupeids and cod in the pelagic zone of the southern Baltic (parts of the ICES Subdivisions 25 and 26), giving high priority to the assessment of sprat spawning stock size and distribution. The SPRAS survey was carried out in the season of herring initial phase of intensive feeding and sprat and cod spawning time in the southern Baltic. The acoustic system EK60 SIMRAD with the newly determined calibration parameters were applied to complete the SPRAS survey tasks.

The main goal of the current paper is a brief description of the results of analysis focused on sprat, herring, and cod stocks size changes and their spatial distribution as well as the CPUE variation within investigated part of the southern Baltic in spring 2021. Moreover, the paper contains a description of sprat, herring and cod biological parameters variation. The principal hydrological parameters fluctuations in the water column of the southern Baltic are also described.

MATERIAL AND METHODS

Research team personnel

The main research tasks of the Polish SPRAS/2021 survey on board of the r.v. “Baltica” were realized by the NMFRI (Gdynia) nine members of the scientific team, with Beata Schmidt as a cruise leader. The group of researchers was composed of:
Beata Schmidt – hydroacoustician,
Maciej Bielak – hydroacoustician,
Julita Gutkowska – ichthyologist, sprat analyses,
Grzegorz Modrzejewski – technician, sprat analyses,
Wojciech Deluga – technician, herring analyses,
Krzysztof Koszarowski - ichthyologist, herring analyses,
Krzysztof Radtke – ichthyologist, cod and other fish species analyses,
Ireneusz Wybierała – technician, cod and other fish species analyses,
Anetta Ameryk – hydrologist.

The course of the cruise

The r.v. “Baltica” left Gdynia port on the 1st of May 2021 at 06:30 a.m. and was navigated in the southeast direction. At the mouth of the Vistula River a successful calibration of the acoustic system SIMRAD EK60, installed on the vessel, was carried out. On the same day, acoustic integration and pelagic hauls were started on transects located in the southern part of the Gulf of Gdansk. In the following days, investigations were continued on transects in the Gulf of Gdansk and the Polish part of ICES Subdivision 26 in the west direction. Deterioration of weather conditions prevented the works to be continued on the 6th of May and they were resumed the next day. On the 9th of May at 08:00 p.m. measurements were completed at the position λ = 017°00,0’E, ϕ = 55°07,7’N. During the night r.v. “Baltica” sailed west where on the 10th of May at the most western position (λ = 015°00.0'E, ϕ = 54°30.0'N) the acoustic integration and pelagic hauls were resumed in the east direction. The scientific survey program was finished on the 13th of May at 05:40 p.m. The r.v. “Baltica” returned to the Gdynia port on the 14th of May 2021 at 06:00 a.m.

Survey design and realization – sampling description

The ICES statistical rectangles, designated by the ICES-WGBIFS as mandatory to Poland, were fully covered with the standard acoustic-biotic research (ICES, 2021). Two ICES rectangles, namely 38G9 and 39G9, which were allocated to Poland as optional, were covered with the standard research only inside the Polish EEZ (Fig. 2).

The SIMRAD EK60 version 2.2.0, a split-beam scientific echosounder, as in the previous years, was used in the recent Polish SPRAS 2021 survey. The echosounder was linked with the GPT transceivers, operating at 38 and 120 kHz frequencies. Calibration of the vessel’s acoustic system was performed on the 1st of May 2021 at the following location: λ = 019°07.2'E and φ = 54°26.5' N over seabed depth of 59 m (Fig. 2). The echosounder calibration was performed as described in Simrad (2012) using copper spheres of diameters 60 mm and 23 mm for 38 kHz and 120 kHz frequency, respectively, as reference targets. Calibration results were considered good based on calculated RMS values which were 0.13 dB and 0.26 dB for 38 and 120 kHz respectively. The resulting transducer parameters were applied for consecutive data-collection and post-processing of hydroacoustic survey data. Calibration results for the 38 kHz transducer are given in Fig. 1.

The acoustic sampling was performed along the pre-selected acoustic transects at the distance of 779 NM. The echo-integration data were collected in a daytime regime at the shipping speed of 7 kn. Because of the historical comparability of data, pre-selected echo-integration transects were planned in a similar pattern as in recent years. The survey effort was comparable to previous years.

The settings of the hydroacoustic equipment were as described in the IBAS Manual (ICES, 2017). The post-processing of the stored raw data was done using the Echoview software (www.echoview.com). Only 38 kHz transmitter's data were taken into further processing because that frequency is recommended for fish trace recording. In the first step of acoustic data checking, all visible interferences from the sea surface turbulences and bottom structures visible on an echogram were excluded from further analysis. The minimum threshold on mean volume backscattering strength S_v was set at -60 dB. Calculation of parameter S_A [m^2NM^{-2}] (hereinafter called NASC - Nautical Area Scattering Coefficient) for 1 nautical mile elementary sampling distance units (ESDUs) was carried out by integrating S_v values (in a linear domain) from 10 m below the surface to about 0.5 m over the seafloor and then averaged within 1 NM interval. Then the mean NASC per ICES rectangles were calculated.

Overall 31 catch-stations (17 in the ICES Subdivision 25 and 14 in the ICES Subdivision 26) were conducted by the r.v. "Baltica" in spring 2021 (Fig. 2, Table 3), using the herring small-meshed pelagic trawl type WP53/64x4, with 6 mm mesh bar length in the codend. All pelagic catches were accepted as representative from a technical point of view. The trawling depth was chosen in accordance with echo distribution on the echogram. Because of a relatively high vertical opening (up to 20 m) of applied pelagic trawl, the areas shallower than 25 m were not sampled with the catch-stations. The trawling time, was 10, 15, 20 or 30 minutes depending on the density of fish concentrations observed on the echogram and the net-sounder. The mean speed of the surveying vessel during trawling was ranged from 2.9 to 3.3 knots. Fish catches were localized at the depth ranged from 12 to 77 m from the sea surface (position of the headrope). Depth to the bottom at trawling positions varied from 29 to 107 m.

Fish caught in each haul were separated by species and weighted. The results of catch per unit effort of dominated fish species and their average share in the r.v. "Baltica" pelagic catches are presented in Table 3 and Figures 4-6. The samples for sprat, herring, and cod were taken for length and mass measurements and ageing. Fish total length distribution (Fig. 7) and the mean mass were determined at the 0.5-cm classes - in the case of clupeids and 1-cm classes in the case of cod. The numerical share of juvenile, undersized (below minimum landing/protective size) sprat, herring and cod in samples was determined (Table 4) based on fish length distribution results. For sprat, the minimum commercial size (the separate length) is equal to 10.0 cm, for herring is equal to 16.0 cm and for cod is 35.0 cm.

Detailed ichthyological analyses were made according to standard procedures (Anon., 2012), directly on board of surveying vessel. Overall, 30, 31 and 13 samples were taken for the length and mass determination of sprat, herring and cod, respectively. Altogether, the length and mass were measured for 5998 sprat, 1545 herring, and 273 cod individuals. Respectively, 612, 392 and 160 individuals of the above-mentioned species were biologically analysed (sex, maturity, stomach fullness and age).

Before each haul and at the standard hydrological stations located within the Polish EEZ, the seawater temperature, salinity, and oxygen content were measured continuously from the sea surface to the seabed. Totally, 39 hydrological stations were inspected using the CTD SeaBird 911+ probe combined with the rosette sampler. Oxygen content was determined by the standard Winkler's method. The hydrological row data, aggregated to the 1-m depth stratum, were information source about the abiotic factors potentially influencing fish's spatial distribution. The basic meteorological parameters i.e. air temperature, air pressure, wind direction and force, and sea state were registered at each catch-station location with the automatic station MILOS 500.

Data analysis

Distinguishing herring and sprat from other species is impossible by visual inspection of the echogram, therefore species composition and fish length distributions from trawl catch results are used to aid acoustic species identification. Such data analysis is sectioned according to the ICES statistical rectangles. Based on trawl results, for each rectangle, the share of number and length distribution of all species was calculated as the unweighted mean. We intended to carry out at least two control-hauls per ICES rectangle, according to the guidelines in the “SISP Manual of International Baltic Acoustic Surveys (IBAS)” (ICES, 2017). In the case of missing hauls within individual ICES rectangle, haul results from neighbouring rectangles were used. This concerns the ICES rectangle 38G7 where haul no. 19 was excluded from analysis due to very low catch. The assignment of hauls carried out during SPRAS 2021 cruise to the ICES Subdivisions and rectangles are presented below:

Subdivisions (SDs)	ICES rectangles	Haul no.
25	37G5	20,24
25	38G5	21,22,23
25	38G6	25,26,29
25	38G7	29*
25	39G6	27,28,30,31
25	39G7	14,16,18
26	37G8	6
26	37G9	1,2
26	38G8	7,11
26	38G9	4,5
26	39G8	10,12,15
26	39G9	3
26	40G8	8,9,13

* haul performed in neighboring ICES rectangle and included in the calculation for this rectangle

Based on species distributions the mean acoustic cross section σ was calculated according to the following target strength-length (TS) relation:

Species	TS	References
Clupeids	= 20 log L (cm) - 71.2	ICES 1983/H:12
Gadoids	= 20 log L (cm) - 67.5	Foote et al. 1986
Scomber scombrus	= 20 log L (cm) - 84.9	ICES 2017
Salmonids and 3-spined stickleback were assumed to have the same acoustic properties as Clupeids. Fish without swim bladder were assumed to have the same acoustic properties as *Scomber scombrus.*		

The total number of fish in each of the ICES rectangle was estimated as a product of the mean NASC from scrutinised acoustic data and a rectangle area, divided by the corresponding mean acoustic cross-section σ. Clupeids abundance was separated as sprat or herring according to their mean share in catches of given ICES rectangle. In case when the mean numerical share of sprat, herring and cod in the ICES rectangle exceeded 99%, then other species were excluded from further calculations. Thus, fish species considered in this report are as follows: *Clupea harengus, Sprattus sprattus* and *Gadus morhua*.

RESULTS

Acoustic results

The spatial distribution of mean NASC values (5 NM intervals), predominantly derived from clupeids, measured on hydroacoustic transects during the SPRAS/2021 survey is presented in Figure 3. The highest NASC values were recorded in the east part of the Bornholm Basin and in the Słupsk Furrow in the ICES Subdivision 25 and in the middle and east part of the Polish EEZ in the ICES Subdivision 26. The mean NASC values per ICES Subdivisions presented in Table 1 were calculated using areas of ICES rectangles as a weight. As in the previous year, the ICES Subdivision 26 was characterized by a higher average value of NASC, which was more than twice as high as the average NASC value in the ICES Subdivision 25 (Table 1). In both ICES Subdivisions, an increase in NASC values was observed, compared to the previous year. In the ICES Subdivision 25, the average NASC value increased by 13%, while in the ICES Subdivision 26, it increased by 61%. Nevertheless, the mean NASC values per ICES Subdivisions were still lower than those measured in May 2019 (Schmidt et. al., 2020). In May 2021, in three ICES rectangles in Subdivision 26 the mean NASC values exceeded 1000 $m^2 \cdot Nm^{-2}$. Such high mean NASC values were not observed in May 2020 (Table 2). The highest average NASC values were recorded in the ICES rectangles 37G8 (Gulf of Gdańsk) and 40G8 (Gotland Basin), reaching 1481.4 m^2Nm^{-2} and 1259.3 m^2Nm^{-2}, respectively. In the ICES Subdivision 25, the highest mean NASC value per the ICES rectangle was obtained in the Bornholm Basin (the ICES rectangle 39G6).

Fish catches, biological parameters and stocks size

In May 2021, overall, 9 fish species were recorded in 31 scrutinized pelagic research hauls taking place in the Polish parts of the ICES Subdivisions 25 and 26 (Table 3, Fig. 2). Totally, 14431 kg of fish were caught, and the mean share of sprat, herring, cod and all other fish species was 86.2, 12.9, 0.7 and 0.2%, respectively. Sprat is distinctly dominated by mass in pelagic hauls, and herring and cod can be considered as a significant bycatch in accomplished hauls (Table 3, Figs. 4-6). From the remaining fish species, only flounder with a total catch of 4.6 kg in the entire study area was a remarkable component of bycatch. Herring occurred in each pelagic haul, sprat was missing in one haul only and cod occurred in 42% of hauls performed. Neither marine mammals nor any seabirds were detected in the catches.

In the ICES Subdivision 26, sprat dominated by the total mass (26436.4 kg), the mean CPUE (1888.3 kg h^{-1}) and the mean share (95.5%) in 14 hauls realised inside the Polish part of the subdivision mentioned. The catch results were also the highest for sprat caught in the ICES Subdivision 25 and amounted to 20933.0 kg, 1231.4 $kg \cdot h^{-1}$ and 78.6%, respectively in 17 hauls. The highest CPUE of sprat was obtained in two research catches conducted in the eastern part of the Bornholm Deep – the ICES rectangle 39G6 (5818 and 4624 $kg \cdot h^{-1}$).

The total weight of catches, mean CPUE and a mean share of herring in hauls from the scrutinized part of the ICES Subdivision 25 was higher than in the ICES Subdivision 26. In the ICES Subdivision 25 values of the above parameters were as follow: 1750.4 kg, 103.0 $kg \cdot h^{-1}$ and 21.0%, whereas in the ICES Subdivision 26 was: 147.5 kg; 10.5 $kg \cdot h^{-1}$ and 3.0%. The CPUE of herring was generally low in most of the hauls during the survey, except for two hauls only, conducted in the southern part of the Bornholm Basin (ICES rectangle 37G5), where the CPUE was 1002.6 and 380.2 $kg \cdot h^{-1}$. The mean share of cod in the mass of the pelagic catches conducted in the ICES Subdivision 25 was a bit higher than in the ICES Subdivision 26, and amounted to 1.5 and 0.1%, respectively.

The results of some biological features of sprat, herring and cod investigated in May 2021 are presented in Figure 7 and Tables 4, 8, 11, 14. The total length of species dominated in pelagic hauls conducted in the all investigated areas ranged as follows:

- sprat – 7.5 ÷ 15.5 cm (avg. l.t. = 12.0 cm, avg. W = 10.2 g),

- herring – 10.0 ÷ 25.5 cm (avg. l.t. = 18.8 cm, avg. W = 42.1 g),
- cod – 21.0 ÷ 50.0 cm (avg. l.t. = 33.9 cm, avg. W = 373.6 g).

The bimodal shape of the length distribution curves for sprat in May 2021 is similar to the curves that originated from May 2020 (Fig. 7). The frequency apex is distinguished for adults, commercially sized fish collected in both ICES Subdivisions. In the ICES Subdivision 26, the apex was from the length class of 11.5 cm both in (May 2020 and 2021, whereas in the ICES Subdivision 25 from the length class 12.0. The second minor frequency apex represented young, undersized specimens from the length class of 9.0 cm. It is much better recognized from the data originated from May 2021, especially from the ICES Subdivision 26. It resulted in that the mean numerical share of undersized sprat (<10.0 cm length) was higher in the ICES Subdivision 26 than in the ICES Subdivision 25, and amounted to 15.1% and 1.9%, respectively (Table 4).

For herring, the bimodal shape of the length distribution curves was characteristic for both ICES Subdivisions in May 2020, but in May 2021 the multimodal shape of the length curves was evident (Fig. 7). In addition, in May 2021 the length distributions in both ICES Subdivisions 25 and 26 were very similar in shape overlapping each other to large extent. Two frequency major apices were distinguished in both ICES Subdivisions, corresponding to length classes 17.5 cm and 18.5 cm. Not in any of the ICES Subdivisions described in the report, no minor apices representing young herring were found, clearly indicating the low abundance of undersized herring. The numerical share of undersized herring (<16.0 cm length) in the ICES Subdivisions 25 was 8.7% and in the ICES Subdivision 26 was even lower – 5.8%. Undersized herring mean numerical share in the entire area in May 2021 was much lower (8.0%) than in May 2020 – 38.6% (Table 4).

The length distribution curve for cod sampled in the ICES Subdivision 25 differed between May 2020 and May 2021, mainly because of a little number of cod caught in that area during SPRAS/2020 (Fig. 7). However, in ICES Subdivision 26, the length distribution curves are very similar for both years. The mean bycatch of undersized cod (<35 cm length) in samples collected in May 2021 was 79.5 and 53.6% in the ICES Subdivisions 25 and 26, respectively (Table 4). For comparison, in May 2020 in respective Subdivisions, the bycatch of cod was lower – 50.0% and higher – 60.0%.

Changes in the mean weight of sprat, herring, and cod per age groups according to investigated rectangles of ICES are presented in Tables 8, 11 and 14.

The basic data evaluated in May 2021, including data on Baltic sprat, herring and cod stocks total abundance and biomass per age groups and the ICES rectangles, adequately to echosounding under the frequency of 38 kHz, are given in Tables 6, 7, 9, 10, 12 and 13. The above-mentioned materials are strongly linked with data from SPRAS/2021 cruise statistics and average NASC values for acoustically covered ICES rectangles during that survey (Table 5). The mean surface biomass density of sprat, herring, and cod, per the ICES rectangles, is shown in Figures 10 and 11. The abundance of the above-mentioned species per age groups, according to inspected in May 2020 and 2021 parts of the ICES Subdivisions 25 and 26 is demonstrated in Figure 9.

In May 2021, the mean biomass density of sprat in the ICES Subdivisions 25 was 35.2 $t \cdot NM^{-2}$ and was comparable to the value obtained in May 2020. Nevertheless, the mean biomass density of sprat in the ICES Subdivisions 26 obtained in May 2021 (41.6 $t \cdot NM^{-2}$) was higher than this from May 2020 (Fig. 8). In May 2021 the maximum of sprat surface biomass density was observed in the southern part of the Gotland Basin (the ICES rectangle 40G8) and west waters of Bornholm island (the ICES rectangle 39G5). In contrast, the minimum values of this parameter were noticed in the western coastal parts of the Polish waters (Fig. 10).

The mean biomass density of herring in the ICES Subdivisions 25 (4.2 $t \cdot NM^{-2}$) in May 2021 was higher than in May 2020. However, the mean biomass density of herring in the ICES Subdivisions 26 observed in May 2021 (2.7 $t \cdot NM^{-2}$) comparable to the value obtained in May 2020 (Fig. 8). In May 2021 the highest mean surface biomass density of herring stock was estimated for the ICES rectangles located in the coastal areas and the southern part of Gotland Deep (Fig. 10).

Results of the acoustic-biotic monitoring in scrutinized waters indicate comparable biomass of cod in May 2021 and in May 2020 (Schmidt *et al*., 2021a). In May 2020, the mean biomass surface density per rectangle reached 6.4 t·NM^{-2}, whereas in 2021 the highest value was 4.2 t·NM^{-2} (Fig. 11). Cod resources were patchily distributed inside the Polish waters and in three ICES rectangles, its biomass was over 1.5 t·NM^{-2}: 39G9 (1.51 t·NM^{-2}), 40G8 (3.98 t·NM^{-2}) and 38G9 (4.2 t·NM^{-2}) The biomass density of Baltic cod in scrutinized part of the ICES Subdivision 26 was on a higher level compared to this in the ICES Subdivision 25, and on average amounted 2.0 and 0.05 t·NM^{-2} (Fig. 8).

Meteorological and hydrological characteristics of the southern Baltic

Changes of the main meteorological parameters – wind velocity, direction and air temperature in consecutive days of the Polish SPRAS survey carried out in 2021 are illustrated in Figure 12. The air temperature during the reported survey varied from 1.1 to 19.7°C (avg. was 7.9°C). The wind force changed from 2 to 7°B, and winds from the west direction prevailed.

The main hydrological parameters at the depths of fish pelagic catches (Table 15), i.e. in the range of 19-87 m (with 20 m vertical net opening on average) changed in the relatively broad ranges. The seawater temperature fluctuated from 4.2 to 7.4°C (the mean was 5.7°C), salinity from 7.5 to 15.1 PSU (the mean was 9.8 PSU) and oxygen content from 1.1 to 8.6 ml·l^{-1} (the mean was 5.2 ml·l^{-1}).

The surface water hydrological parameters changed in relatively narrow ranges: 5.2-9.2°C, 6.6-7.9 PSU and 8.3-9.6 ml·l^{-1} for temperature, salinity and oxygen content respectively. The horizontal distribution of these parameters in the near bottom zone of the southern Baltic (within the Polish waters) is illustrated in Fig. 13. The temperature in near bottom layer was changing horizontally within the range of 4.5-8.3°C. The lowest near-bottom temperature was recorded at the trawl station no. 20 (south of the Bornholm Basin) and the highest at the hydrological station no. IBY5b (the Bornholm Basin). Salinity in the bottom waters varied from 7.6 PSU – noticed at the catch-stations no. 19, to the maximum of 16.0 PSU - appeared at the hydrological station no. IBY5b (the Bornholm Basin). Oxygen content near the bottom of deep waters varied from 0.0 ml·l^{-1} – measured at the hydrological station no. G2 (the Gdansk Deep) to the maximum of 8.6 ml·l^{-1} – calculated at the trawl station no. 15.

The vertical distribution of the seawater temperature, salinity and oxygen content, along with the hydrological research profile determined in the southern Baltic in May 2021 is presented in Fig. 14. During the period surveyed, the waters with oxygen content below 2 ml·l^{-1} occurred at the depth of just below 70 m in the Bornholm Basin, Słupsk Furrow, and Gdańsk Deep, with anoxic bottom condition observed below 100 m in the last area.

DISCUSSION

In May 2021, the total biomass (B1), the mean surface biomass density (B2) and abundance (A) were significantly different between fish species and the ICES Subdivisions:

	parameter	sprat	herring	cod
ICES SD25	B1 (tons)	181002.1	21588.2	276.01
	B2 (t NM^{-2})	35.2	4.2	0.05
	A (10^6 indiv.)	16032.7	497.5	0.98
ICES SD26	B1 (tons)	322855.5	13034.6	9533.02
	B2 (t NM^{-2})	66.63	2.69	1.97
	A (10^6 indiv.)	36128.8	336.0	25.49

The above-listed data indicate that the centre of temporal fish resources distribution in the scrutinized part of the southern Baltic in May 2021 in the case of sprat, was located in the northern part of the Polish EEZ, in the Gulf of Gdańsk and in waters of west of Bornholm island but in the case of herring – in the coastal waters of the southern Baltic but also the northern part of the Polish EEZ (Fig. 10). The most abundant areas of cod were in the southern parts of Gotland Basin and Gdańsk Deep (Fig. 11).

Compared to May 2020, the present estimates show an increase in total sprat and herring abundance (+36.2% and +16.8%, respectively) and biomass (+37.5% and +44.0%, respectively). In the case of cod, a slight increase in total abundance (+0.1%) and a decrease in biomass (-16.2%) is observed (Schmidt *et al.*, 2021a). However, these changes differ between the ICES Subdivisions.

Compared to May 2020, the abundance of sprat increased considerably in ICES Subdivision 26. The number of individuals of sprat from age group 2 (year-class 2019) increased over twice from ca. $4008 \cdot 10^6$ to ca. $11225 \cdot 10^6$ individuals. The abundance of year-class 2018 also increase but it was not as big as in the case of the year-class 2019. The abundance of the sprat increase also in ICES Subdivision 25. A bigger increase was observed for the same age groups as in ICES Subdivision 26 – 2 and 3. Similarly to the results from the SPRAS survey from 2020, the sprat abundance, total biomass and mean surface biomass density were lower in the ICES Subdivision 25 than in ICES Subdivision 26. Moreover, in May 2021, in the catches, over 81% of males and 74% of females were during the spawning which indicates that the spawning took place in the research area.

During the SPRAS in 2021, the abundance and biomass of herring in the ICES Subdivision 25 were bigger than during the previous SPRAS survey in 2020. The herring abundance increased in all age groups over 2. Compared to the results from the survey in May 2020, the abundance of an age group 2 (year-class 2019) decreased in the ICES Subdivision 25. However, the number of individuals was the highest out of all age groups and was ca. $149.9 \cdot 10^6$ individuals. Also, the biomass of that age group reached a very high level – 5695.9 tonnes. Moreover, in the ICES Subdivision 26, there was an opposite situation, the abundance of herring increased ca. twice for age group 2. Similar to the previous year, during the SPRAS/2021, an increase of the biomass of the herring from that age group was observed. Moreover, after ichthyological analysis, it occurred that spawning of herring did not take place during this time. Most of the fish were preparing for spawning.

Compared to May 2020, the biomass and abundance of cod increased over 61 and 162%, respectively, in the ICES Subdivision 25. The opposite trend was observed in the ICES Subdivision 26, where those two parameters dropped over 17 and 2%, respectively. A high share of males with gonads at maturity stage VI (Maier's scale) indicates that cod spawning took place also in May 2021.

CONCLUSION

The ICES Baltic International Fish Survey Working Group and the Baltic Fisheries Assessment Working Group for the Baltic clupeids and cod stocks size analysis and their spatial distribution characteristics can apply the Polish SPRAS-2021 survey data obtained by the r.v. “Baltica” scientific team. Results presented in this paper can be considered as representative for the Polish part of the southern Baltic, namely for the ICES Subdivisions 25 and 26. The basic acoustic, fisheries, biological and hydrological data collected during the reported survey will be stored in the ICES Data-Centre international databases, managed by the ICES Secretariat and designated experts from WGBIFS.

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Table 1. Weighted mean NASC values ($m^2 \cdot NM^{-2}$) for the Polish parts of the ICES SDs 25 and 26, calculated with the use of areas of ICES rectangles as weight, for SPRAS 2020 and 2021 cruises (the NASC values from 2020 from Schmidt *et al*., 2021a).

ICES SDs	< NASC > SPRAS 2020	< NASC > SPRAS 2021
25	442.6	491.1
26	625.6	1011.4

Table 2. Average NASC values ($m^2 \cdot NM^{-2}$) for the acoustically covered ICES rectangles, during Polish 2020 and 2021 SPRAS cruises (the NASC values from 2020 from Schmidt *et al*, 2021a).

ICES SDs	ICES rectangles	Area [NM^2]	< NASC > SPRAS 2020	< NASC > SPRAS 2021
25	37G5	642.2	135.6	167.9
25	38G5	1035.7	700.9	370.7
25	38G6	940.2	178.0	374.2
25	38G7	471.7	111.2	30.0
25	39G6	1026.0	583.3	843.1
25	39G7	1026.0	628.2	782.0
26	37G8	86.0	599.2	1481.4
26	37G9	151.6	438.9	437.7
26	38G8	624.6	676.6	732.7
26	38G9	918.2	383.6	903.4
26	39G8	1026.0	761.4	1106.8
26	39G9	1026.0	541.0	983.0
26	40G8	1013.0	792.0	1259.3

Table 3. Fish control-catches data from the Polish SPRAS survey conducted on board of the r.v. "Baltica" in May 2021.

Haul number	Date of catch	ICES rectangles	ICES SDs	Geographical position of the catch: start latitude N	start longitude E	end latitude N	end longitude E	Mean depth to the bottom [m]	Headrope depth from the sea surface [m]	Vertical net opening [m]	Trawling speed [w]	The ship's course during fishing [°]	Local time of shutting net	Trawling duration [min.]	Total catch [kg]	CPUE of all species [kg h^{-1}]	Catch per species [kg]: sprat	herring	cod	flounder	whiting	lumpfish	Atlantic mackerel	greater sand eel	three spined stickleback
1	2021-05-01	37G9	26	54°29,7'	019°20,6'	54°29,4'	019°19,0'	70	45	20	3,3	250	15:15	20	347.41	1042.24	346.182	1.231							
2	2021-05-01	37G9	26	54°29,2'	019°31,0'	54°28,8'	019°29,1'	55	32	19	3,3	255	17:25	20	151.63	454.90	150.816	0.817							
3	2021-05-02	39G9	26	55°07,0'	019°04,1'	55°07,0'	019°02,5'	93	68	20	3.1	265	08:40	20	302.67	908.02	293.354	1.965	7.220	0.133					0.002
4	2021-05-02	38G9	26	54°49,5'	019°16,4'	54°49,1'	019°15,0'	107	70	20	3,2	250	12:50	20	356.60	1069.79	307.881	3.323	43.652	1.740					
5	2021-05-02	38G9	26	54°36,9'	019°12,7'	54°36,3'	019°10,1'	83	50	20	3,2	225	15:45	30	54.71	109.42	34.130	19.660	0.722	0.200					
6	2021-05-03	37G8	26	54°29,6'	018°53,8'	54°28,7'	018°54,8'	61	38	20	3,2	150	10:05	20	725.86	2177.59	725.234	0.629							
7	2021-05-03	38G8	26	54°43,7'	018°58,6'	54°42,9'	018°58,6'	91	60	20	3,0	200	14:30	20	171.54	514.63	168.959	2.169	0.120	0.295					
8	2021-05-04	40G8	26	55°34,8'	018°58,5'	55°33,4'	018°58,0'	86	61	20	3,2	225	09:15	30	570.93	1141.85	567.016	2.565	0.864	0.481					
9	2021-05-04	40G8	26	55°52,2'	018°52,7'	55°52,3'	018°51,5'	106	77	20	3,0	250	13:05	15	715.21	2860.86	682.933	1.619	29.584	1.078					
10	2021-05-05	39G8	26	55°20,7'	018°39,6'	55°21,4'	018°38,4'	81	56	20	3,0	200	07:10	20	281.40	844.20	281.212	0.187							
11	2021-05-05	38G8	26	54°58,3'	018°41,6'	54°58,6'	018°42,6'	92	67	20	3,0	225	11:45	15	820.52	3282.07	816.221	3.420	0.877						
12	2021-05-07	39G8	26	55°20,5'	018°22,9'	55°20,9'	018°24,4'	81	56	20	3,1	200	09:50	20	1003.35	3010.04	1001.250	1.042	1.053						
13	2021-05-07	40G8	26	55°36,1'	018°27,6'	55°36,3'	018°28,6'	93	65	20	3,0	225	13:50	10	1547.05	9282.32	1536.029	8.094	2.931						
14	2021-05-08	39G7	25	55°19,6'	017°59,1'	55°18,6'	017°56,9'	73	49	20	3,1	175	07:45	30	506.64	1013.28	501.696	4.945							
15	2021-05-08	39G8	26	55°11,4'	018°01,6'	55°11,5'	018°04,3'	54	28	19	3,1	110	10:20	30	98.43	196.86	98.335	0.097							
16	2021-05-08	39G7	25	55°17,1'	017°40,1'	55°17,5'	017°40,1'	83	58	19	3,1	200	16:55	10	235.35	1412.10	230.586	4.556		0.208					
17	2021-05-09	40G7	25	55°30,9'	017°43,3'	55°32,4'	017°44,1'	64	41	20	3,1	150	07:55	30	472.70	945.40	470.534	2.164							
18	2021-05-09	39G7	25	55°14,8'	017°19,0'	55°15,2'	017°18,5'	90	65	19	3,0	250	12:15	10	520.22	3121.30	514.493	4.987					0.737		
19	2021-05-09	38G7	25	54°58,7'	017°21,1'	54°58,8'	017°23,7'	29	12	15	3,0	70	15:20	30	0.10	0.21		0.101							0.003
20	2021-05-10	37G5	25	54°29,9'	015°20,8'	54°29,1'	015°23,0'	47	22	20	3,1	105	09:05	30	192.00	384.01	1.928	190.076							
21	2021-05-10	38G5	25	54°45,1'	015°21,4'	54°44,9'	015°23,7'	70	47	20	3,1	175	12:25	30	260.84	521.68	212.765	43.194	3.946		0.936				
22	2021-05-10	38G5	25	54°58,3'	015°37,0'	54°58,5'	015°34,7'	80	56	20	2,9	220	16:50	30	223.25	446.50	222.040	1.208							
23	2021-05-11	38G5	25	54°35,0'	015°39,8'	54°36,5'	015°40,2'	61	38	20	3,1	160	07:20	30	6.80	13.60	6.710	0.088							
24	2021-05-11	37G5	25	54°24,7'	015°40,1'	54°26,2'	015°40,1'	44	22	20	3,2	105	10:15	30	506.67	1013.33	5.362	501.288						0.017	
25	2021-05-11	38G6	25	54°37,3'	016°00,3'	54°38,7'	016°01,2'	51	27	20	3,1	140	14:45	30	41.50	83.00	35.860	5.436				0.189		0.014	
26	2021-05-11	38G6	25	54°56,4'	016°01,0'	54°57,4'	016°01,2'	72	47	21	3,0	185	18:40	20	100.35	301.04	98.490	1.857							
27	2021-05-12	39G6	25	55°13,1'	016°03,2'	55°13,2'	016°05,0'	87	60	20	3,0	225	07:55	20	1955.49	5866.46	1937.846	9.840	7.654	0.148					
28	2021-05-12	39G6	25	55°11,4'	016°18,6'	55°11,3'	016°17,0'	73	48	19	3,1	180	11:15	20	1552.77	4658.32	1541.404	8.116	2.969	0.283					
29	2021-05-12	38G6	25	54°43,4'	016°22,4'	54°43,0'	016°20,3'	40	20	15	3,0	100	16:20	30	285.81	571.62	222.181	62.534						1.097	
30	2021-05-13	39G6	25	55°15,8'	016°39,0'	55°16,5'	016°38,2'	70	47	19	3,0	185	09:30	20	51.33	154.00	51.130	0.201							0.004
31	2021-05-13	39G6	25	55°14,2'	016°58,5'	55°14,3'	016°57,6'	86	63	19	2,9	225	16:10	10	371.87	2231.24	369.631	1.847	0.396						

Table 4. The mean numerical share of young, undersized fishes per ICES SDs (the Polish SPRAS/2020 and SPRAS/2021).

Species	Fish length	SPRAS 2020			SPRAS 2021		
		Mean share in % numbers			Mean share in % numbers		
		SD25	SD26	Mean	SD25	SD26	Mean
sprat	< 10 cm	9.0	19.4	13.8	1.9	15.1	8.5
herring	< 16 cm	59.0	19.6	38.6	8.7	5.8	8.0
cod	< 35 cm	50.0	60.0	59.7	75.5	53.6	57.9

Table 5. Cruise statistics of the Polish SPRAS survey on board of the r.v. "Baltica", 01-14.05.2021.

ICES SDs	ICES rectangles	EDSU [NM]	<σ> $[m^2 \cdot 10^{-4}]$	$< S_A >$ $[m^2 \cdot NM^{-2}]$	Area $[NM^2]$	species composition [%]			Abundance $\cdot 10^6$			
						sprat	herring	cod	total	sprat	herring	cod
25	37G5	44	3.52	167.9	642.2	3.05	96.95	0.00	306.1	9.3	296.8	0.0
25	38G5	87	1.68	370.7	1035.7	98.04	1.94	0.02	2285.8	2240.9	44.4	0.5
25	38G6	62	1.74	374.2	940.2	94.26	5.74	0.00	2024.7	1908.4	116.2	0.0
25	38G7	25	1.89	30.0	471.7	88.51	11.49	0.00	74.8	66.2	8.6	0.0
25	39G6	93	1.44	843.1	1026	99.84	0.15	0.01	6003.2	5993.7	9.1	0.4
25	39G7	79	1.37	782.0	1026	99.62	0.38	0.00	5836.5	5814.1	22.4	0.0
Sum SD25		**390**							**16531.1**	**16032.7**	**497.5**	**1.0**
26	37G8	8	0.97	1481.4	86	99.96	0.04	0.00	1317.7	1317.2	0.5	0.0
26	37G9	29	1.09	437.7	151.6	99.92	0.08	0.00	606.8	606.2	0.5	0.0
26	38G8	55	1.36	732.7	624.6	99.73	0.27	0.00	3370.0	3360.8	9.1	0.1
26	38G9	48	1.47	903.4	918.2	94.52	5.28	0.19	5646.7	5337.5	298.3	10.9
26	39G8	102	1.44	1106.8	1026	99.97	0.03	0.00	7905.8	7903.5	2.3	0.0
26	39G9	29	1.30	983.0	1026	99.81	0.14	0.04	7747.5	7733.2	11.0	3.4
26	40G8	98	1.29	1259.3	1013	99.74	0.14	0.11	9895.8	9870.5	14.2	11.1
Sum SD26		**369**							**36490.3**	**36128.8**	**336.0**	**25.5**

Table 6. Abundance of sprat (in millions of individuals) per age groups, ICES rectangles and ICES SDs, estimated using the acoustic method, based on data collected during the Polish SPRAS survey on board of the r.v. “Baltica”, 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total sprat abundance [mln indiv.]
25	37G5	0.0	0.5	1.8	2.1	1.2	1.6	1.7	0.4	9.3
25	38G5	57.6	155.8	484.8	538.4	271.2	328.5	325.4	79.2	2240.9
25	38G6	10.7	110.2	433.1	499.9	224.7	286.0	282.9	61.0	1908.4
25	38G7	0.1	1.3	12.0	14.8	10.0	11.3	14.0	2.9	66.2
25	39G6	300.9	1286.6	1657.2	1503.3	305.6	582.6	280.1	77.5	5993.7
25	39G7	437.5	1730.0	1564.6	1228.7	194.7	454.9	158.0	45.7	5814.1
Sum SD25		**806.8**	**3284.4**	**4153.5**	**3787.1**	**1007.3**	**1664.9**	**1062.1**	**266.6**	**16032.7**
26	37G8	889.0	266.0	90.7	39.7	14.6	13.2	4.0	0.0	1317.2
26	37G9	253.1	194.5	78.5	39.6	18.1	15.6	6.8	0.0	606.2
26	38G8	247.9	824.4	693.4	619.6	396.6	371.1	198.6	9.0	3360.8
26	38G9	201.5	1991.9	1290.2	848.1	428.1	392.8	184.9	0.0	5337.5
26	39G8	226.1	1639.0	1355.3	1565.2	1206.5	1197.5	651.6	62.4	7903.5
26	39G9	884.0	2406.7	1571.3	1212.4	696.3	628.6	333.8	0.0	7733.2
26	40G8	1083.3	3902.6	1934.8	1265.9	702.3	651.1	323.1	7.3	9870.5
Sum SD26		**3784.9**	**11225.2**	**7014.2**	**5590.5**	**3462.6**	**3269.9**	**1702.8**	**78.8**	**36128.8**

Table 7. Biomass of sprat (in tons) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish SPRAS survey on board of the r.v. “Baltica”, 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total sprat biomass [t]
25	37G5	0.5	5.4	23.2	27.5	19.0	25.4	28.1	7.7	136.7
25	38G5	362.3	1536.4	6145.4	6999.3	4123.8	4860.5	5085.2	1285.9	30398.7
25	38G6	111.8	1163.1	5477.8	6449.6	3357.4	4119.1	4426.9	934.8	26040.6
25	38G7	0.9	14.7	166.7	206.7	154.7	177.4	225.4	46.8	993.3
25	39G6	1972.6	11963.8	18127.8	17387.7	3948.4	6898.6	3822.8	1023.2	65144.9
25	39G7	2812.6	15495.0	16272.7	13741.7	2344.5	5092.9	1943.5	585.1	58287.9
Sum SD25		**5260.7**	**30178.4**	**46213.6**	**44812.4**	**13947.8**	**21174.0**	**15531.8**	**3883.5**	**181002.1**
26	37G8	4051.8	1934.4	771.8	368.6	141.2	128.0	41.6	0.0	7437.4
26	37G9	1176.8	1471.9	683.5	380.8	183.9	158.1	73.8	0.0	4128.9
26	38G8	1038.9	6780.9	6501.8	6443.5	4363.8	4141.5	2243.7	127.6	31641.7
26	38G9	1010.7	15970.3	11650.3	8355.3	4463.5	4115.9	2035.2	0.0	47601.3
26	39G8	1098.1	13372.5	12832.8	17090.7	14114.7	14133.7	7723.9	923.4	81289.7
26	39G9	3874.2	18950.1	14435.8	12285.8	7461.3	6746.3	3722.6	0.0	67476.1
26	40G8	4536.7	30407.8	17333.4	12733.4	7520.6	7028.9	3616.1	103.6	83280.4
Sum SD26		**16787.2**	**88887.8**	**64209.5**	**57658.2**	**38249.0**	**36452.5**	**19456.7**	**1154.6**	**322855.5**

Table 8. Mean weight of sprat (in grams) per age groups, ICES rectangles and ICES SDs, based on data collected during the Polish SPRAS survey on board of the r.v. "Baltica", 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W sprat [g]
25	37G5	10.60	10.18	12.96	13.41	16.03	15.80	16.54	17.88	14.65
25	38G5	6.29	9.86	12.68	13.00	15.21	14.79	15.63	16.24	13.57
25	38G6	10.5	10.55	12.65	12.90	14.94	14.40	15.65	15.33	13.65
25	38G7	10.60	11.51	13.86	13.99	15.54	15.72	16.12	16.30	14.99
25	39G6	6.56	9.30	10.94	11.57	12.92	11.84	13.65	13.21	10.87
25	39G7	6.43	8.96	10.40	11.18	12.04	11.20	12.30	12.80	10.03
MW SD25		**6.52**	**9.19**	**11.13**	**11.83**	**13.85**	**12.72**	**14.62**	**14.57**	**11.29**
26	37G8	4.56	7.27	8.51	9.29	9.66	9.67	10.52	-	5.65
26	37G9	4.65	7.57	8.71	9.63	10.16	10.13	10.81	-	6.81
26	38G8	4.19	8.22	9.38	10.40	11.00	11.16	11.30	14.13	9.42
26	38G9	5.02	8.02	9.03	9.85	10.43	10.48	11.01	-	8.92
26	39G8	4.86	8.16	9.47	10.92	11.70	11.80	11.85	14.80	10.29
26	39G9	4.38	7.87	9.19	10.13	10.72	10.73	11.15	-	8.73
26	40G8	4.19	7.79	8.96	10.06	10.71	10.80	11.19	14.13	8.44
MW SD26		**4.44**	**7.92**	**9.15**	**10.31**	**11.05**	**11.15**	**11.43**	**14.66**	**8.94**

Table 9. Abundance of herring (in millions of individuals) per age groups, ICES rectangles and ICES SDs, estimated using the acoustic method, based on data collected during the Polish SPRAS survey on board of the r.v. "Baltica", 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total herring abundance [mln indiv.]
25	37G5	4.1	85.7	17.8	62.5	21.3	20.5	58.7	26.2	296.8
25	38G5	2.1	10.9	3.6	10.3	2.8	3.1	5.9	5.6	44.4
25	38G6	16.5	40.3	7.7	15.2	6.0	5.6	17.9	7.0	116.2
25	38G7	2.0	2.8	0.6	1.1	0.4	0.3	1.0	0.4	8.6
25	39G6	1.7	2.8	0.8	1.1	0.5	0.5	1.5	0.3	9.1
25	39G7	2.9	7.5	2.0	2.8	1.0	1.2	4.1	1.0	22.4
Sum SD25		**29.2**	**149.9**	**32.5**	**93.0**	**31.8**	**31.3**	**89.2**	**40.6**	**497.5**
26	37G8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
26	37G9	0.1	0.2	0.0	0.1	0.1	0.0	0.1	0.0	0.5
26	38G8	1.1	3.9	0.7	1.0	0.6	0.3	0.7	0.7	9.1
26	38G9	3.6	99.0	24.2	44.5	29.2	21.8	46.0	30.0	298.3
26	39G8	0.4	0.7	0.1	0.1	0.2	0.1	0.4	0.4	2.3
26	39G9	0.0	3.0	0.5	1.8	1.3	1.0	2.1	1.3	11.0
26	40G8	0.0	4.1	1.6	3.0	1.4	1.2	2.1	0.7	14.2
Sum SD26		**5.6**	**110.9**	**27.2**	**50.4**	**32.9**	**24.4**	**51.4**	**33.1**	**336.0**

Table 10. Biomass of herring (in tons) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish SPRAS survey on board of the r.v. “Baltica”, 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total herring biomass [t]
25	37G5	121.7	3452.4	737.7	3184.1	1044.3	1004.5	2639.0	1422.7	13606.4
25	38G5	60.5	363.3	137.5	527.2	144.3	145.9	250.1	313.1	1941.8
25	38G6	396.9	1423.0	291.3	721.4	265.4	254.2	769.0	432.3	4553.5
25	38G7	47.0	89.8	20.2	51.7	18.2	15.8	43.3	23.7	309.7
25	39G6	40.0	99.7	27.3	50.8	19.9	20.9	61.6	14.4	334.6
25	39G7	69.3	267.7	71.7	123.3	40.2	47.7	172.5	49.8	842.1
Sum SD25		**735.4**	**5695.9**	**1285.7**	**4658.4**	**1532.3**	**1489.1**	**3935.4**	**2256.1**	**21588.2**
26	37G8	5.4	1.0	0.5	0.0	0.0	0.0	0.0	0.0	7.0
26	37G9	0.5	5.0	1.0	2.0	2.5	1.5	4.5	2.4	19.3
26	38G8	16.7	127.1	21.8	32.6	23.3	13.8	26.5	31.3	293.2
26	38G9	74.0	3393.0	872.8	1744.4	1287.5	947.8	1919.1	1420.5	11659.1
26	39G8	6.7	24.6	3.5	3.6	8.7	1.8	15.6	15.6	80.1
26	39G9	0.0	103.1	22.3	77.7	59.3	42.5	88.2	52.6	445.7
26	40G8	0.0	130.1	57.3	117.3	59.0	51.8	85.6	29.0	530.1
Sum SD26		**103.3**	**3784.0**	**979.1**	**1977.6**	**1440.4**	**1059.2**	**2139.6**	**1551.4**	**13034.6**

Table 11. Mean weight of herring (in grams) per age groups, ICES rectangles and ICES SDs, based on data collected during the Polish SPRAS survey on board of the r.v. “Baltica”, 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W herring [g]
25	37G5	29.49	40.30	41.37	50.99	49.13	48.96	44.95	54.22	45.85
25	38G5	28.59	33.48	37.96	51.05	51.43	46.43	42.09	56.15	43.75
25	38G6	24.11	35.29	37.63	47.41	44.46	45.29	42.90	61.75	39.17
25	38G7	23.79	31.96	35.08	48.98	47.04	45.50	43.17	53.71	36.03
25	39G6	24.00	35.98	36.30	44.78	42.71	41.42	41.74	48.03	36.89
25	39G7	24.03	35.87	36.04	44.05	41.67	40.23	41.98	49.44	37.60
MW SD25		**25.16**	**38.00**	**39.54**	**50.10**	**48.11**	**47.56**	**44.14**	**55.61**	**43.40**
26	37G8	12.84	20.40	20.40	-	-	-	-	-	13.98
26	37G9	10.03	32.74	33.45	39.38	48.15	48.66	45.87	49.22	37.74
26	38G8	14.87	32.39	30.16	32.67	37.59	43.20	38.88	42.20	32.10
26	38G9	20.40	34.28	36.03	39.24	44.06	43.54	41.68	47.36	39.08
26	39G8	17.07	35.35	41.37	31.97	39.02	31.97	40.02	40.02	34.18
26	39G9	-	34.42	43.53	42.86	44.08	42.45	42.59	41.56	40.51
26	40G8	-	31.43	35.40	39.29	41.66	42.83	41.03	40.98	37.43
MW SD26		**18.40**	**34.11**	**35.98**	**39.22**	**43.81**	**43.44**	**41.65**	**46.80**	**38.80**

Table 12. Abundance of cod (in millions of individuals) per age groups, ICES rectangles and ICES SDs, estimated using the acoustic method, based on data collected during the Polish SPRAS survey on board of the r.v. “Baltica”, 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total cod abundance [mln indiv.]
25	37G5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	38G5	0.00	0.34	0.19	0.00	0.00	0.00	0.00	0.00	0.53
25	38G6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	38G7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	39G6	0.00	0.34	0.11	0.00	0.00	0.00	0.00	0.00	0.45
25	39G7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum SD25		**0.00**	**0.68**	**0.30**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.98**
26	37G8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	37G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	38G8	0.00	0.06	0.01	0.03	0.01	0.00	0.00	0.00	0.12
26	38G9	0.08	5.87	2.70	2.21	0.01	0.00	0.00	0.00	10.87
26	39G8	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.03
26	39G9	0.00	1.42	1.33	0.34	0.28	0.00	0.00	0.00	3.37
26	40G8	1.11	4.16	4.52	1.04	0.29	0.00	0.00	0.00	11.11
Sum SD26		**1.19**	**11.51**	**8.57**	**3.62**	**0.60**	**0.00**	**0.00**	**0.00**	**25.49**

Table 13. Biomass of cod (in tons) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish SPRAS survey on board of the r.v. “Baltica”, 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total cod biomass [t]
25	37G5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	38G5	0.00	76.46	92.18	0.00	0.00	0.00	0.00	0.00	168.64
25	38G6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	38G7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	39G6	0.00	70.22	37.14	0.00	0.00	0.00	0.00	0.00	107.37
25	39G7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum SD25		**0.00**	**146.68**	**129.33**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**276.01**
26	37G8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	37G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	38G8	0.00	8.06	13.34	26.69	13.34	0.00	0.00	0.00	61.43
26	38G9	8.78	1373.46	1216.12	1251.47	10.65	0.00	0.00	0.00	3860.47
26	39G8	0.00	0.00	8.06	8.06	8.06	0.00	0.00	0.00	24.19
26	39G9	0.00	432.78	568.55	232.71	316.50	0.00	0.00	0.00	1550.55
26	40G8	116.70	895.52	2063.56	702.17	258.44	0.00	0.00	0.00	4036.38
Sum SD26		**125.47**	**2709.82**	**3869.63**	**2221.11**	**606.99**	**0.00**	**0.00**	**0.00**	**9533.02**

Table 14. Mean weight of cod (in grams) per age groups, ICES rectangles and ICES SDs, based on data collected during the Polish SPRAS survey on board of the r.v. "Baltica", 01-14.05.2021.

ICES SDs	ICES rectangles	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W cod [g]
25	37G5	-	-	-	-	-	-	-	-	
25	38G5	-	226.8	480.9	-	-	-	-	-	318.94
25	38G6	-	-	-	-	-	-	-	-	
25	38G7	-	-	-	-	-	-	-	-	
25	39G6	-	207.3	334.9	-	-	-	-	-	238.79
25	39G7	-	-	-	-	-	-	-	-	
MW SD25			**217.1**	**427.4**						
26	37G8	-	-	-	-	-	-	-	-	
26	37G9	-	-	-	-	-	-	-	-	
26	38G8	-	138.5	917.3	917.3	917.25	-	-	-	527.88
26	38G9	105.00	234.0	451.1	567.3	917.25	-	-	-	355.25
26	39G8	-	-	887.67	887.67	887.67	-	-	-	887.67
26	39G9	-	304.3	427.9	690.8	1127.5	-	-	-	460.28
26	40G8	105.00	215.2	456.7	677.8	899.6	-	-	-	363.18
MW SD26		**105.0**	**248.1**	**466.8**	**614.1**	**1006.2**				**384.8**

Table 15. Values of the basic meteorological and hydrological parameters recorded in May 2021 at the positions of the r.v. "Baltica" fish control catches.

Haul no	Date of catch	Haul start time (UTC)	Meterological parameters					Hydrological parameters*			Depth of measurement [m]
			Atmospheric pressure [hPa]	Air temperature [°C]	Wind direction	Wind force [°B]	Sea state [°B]	Temperature [°C]	Salinity [PSU]	Oxygen [ml/l]	
1	2021-05-01	13:15	1015.7	7.9	NNE	4	2/3	5.6	7.8	7.8	55
2	2021-05-01	15:25	1015.3	7.9	NNE	5	3	5.3	7.8	8.1	40
3	2021-05-02	06:40	1013.8	5.9	ENE	5	3	6.4	9.9	2.4	78
4	2021-05-02	10:50	1009.9	6.6	NE	6	3	7.1	10.5	1.5	80
5	2021-05-02	13:45	1008.1	7	NE	6	4	4.3	7.9	7.8	60
6	2021-05-03	08:05	1012.5	6.4	NW	6	3/4	5.2	7.9	7.2	48
7	2021-05-03	12:30	1013	6.1	NW	5	3	4.4	8.3	5.1	70
8	2021-05-04	07:15	1007.8	5.6	SSW	4	2	5.6	9.0	4.2	71
9	2021-05-04	11:05	1005.3	6.2	SE	5	2	6.9	10.8	2.2	87
10	2021-05-05	05:10	994.2	6.8	SW	5	3	5.3	9.2	4.4	66
11	2021-05-05	09:45	995.6	8.5	SSW	4	3	6.6	10.5	2.9	77
12	2021-05-07	05:50	1004.2	6.3	WSW	4/5	3	4.8	9.3	5.9	66
13	2021-05-07	11:50	1005.6	6	W	4	2/3	6.7	10.5	1.3	75
14	2021-05-08	05:45	1013.4	6.9	WSW	4	2	4.4	8.4	7.1	59
15	2021-05-08	08:20	1014.5	6.5	W	3/4	2	5.5	7.7	8.6	38
16	2021-05-08	14:55	1016.5	6.3	WSW	5	3	6.8	12.0	3.5	68
17	2021-05-09	05:55	1014.7	6.8	S	5	3	4.2	7.8	7.8	51
18	2021-05-09	10:15	1012	8	SSE	5	3	6.3	11.8	3.1	74
19	2021-05-09	13:20	1011.1	11.6	S	4/5	2/3	6.2	7.5	8.3	19
20	2021-05-10	07:05	1008.2	11.2	SE	5	2/3	5.6	7.9	8.1	32
21	2021-05-10	10:25	1007.6	11.8	SE	5	2	5.4	12.7	4.8	57
22	2021-05-10	14:50	1007.9	12.1	E	4	2	4.2	13.2	4.4	66
23	2021-05-11	05:20	1008.3	10.4	NWN	4	1	4.7	9.1	5.9	48
24	2021-05-11	08:15	1007.2	13.0	ESE	4	2	6.4	7.9	8.1	32
25	2021-05-11	12:45	1006.5	18.1	SE	3	1	6.0	7.9	7.2	37
26	2021-05-11	16:40	1005.2	11.5	E	4	2	5.8	13.5	3.2	58
27	2021-05-12	05:55	1004.7	9.7	SE	3/4	2	7.4	15.1	1.1	70
28	2021-05-12	09:15	1006.5	9.7	SW	2	1/2	6.2	13.4	2.9	58
29	2021-05-12	14:20	1007.7	9.2	N	4/3	2	6.3	7.9	7.9	28
30	2021-05-13	07:30	1004.8	8	ESE	3	1/2	4.5	8.7	6.3	56
31	2021-05-13	14:10	1003.1	10.2	ENE	4	2	6.6	12.4	2.4	73

*date of the mean of the catches (in the middle of trawl vertical opening)

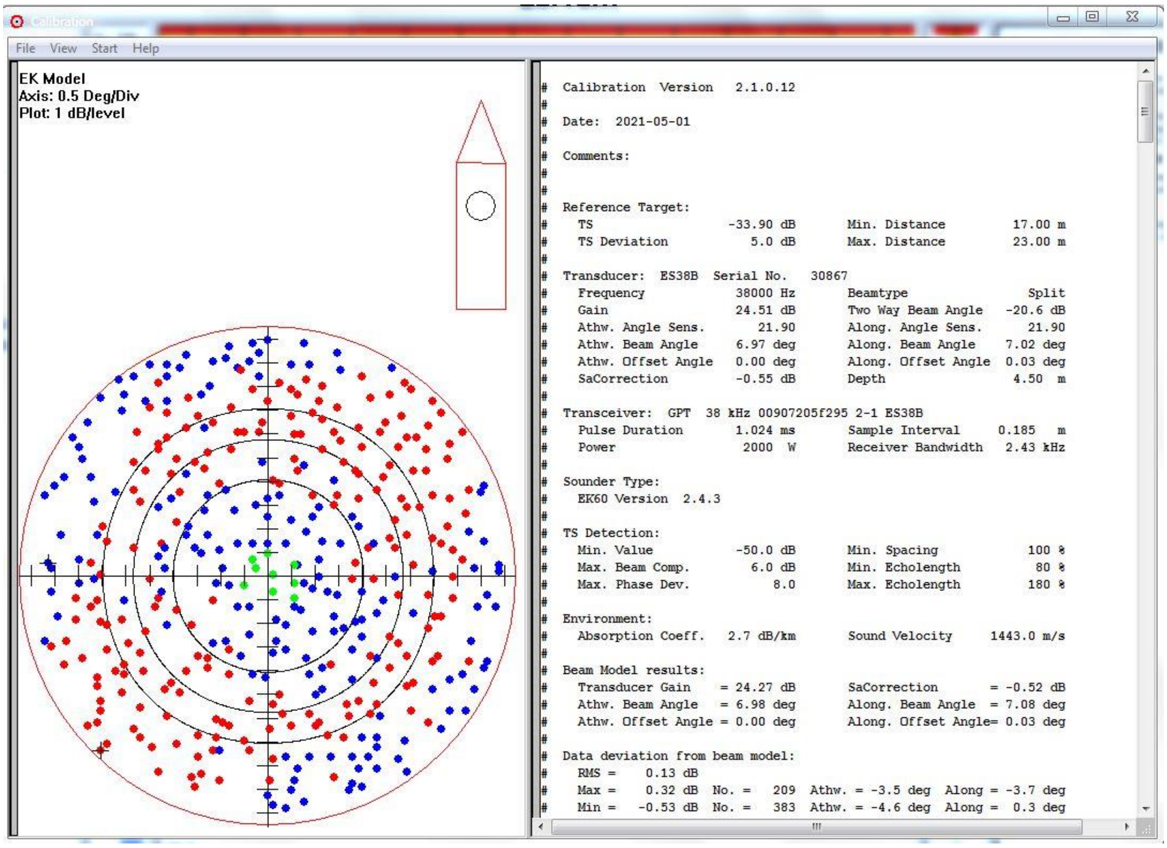

Fig. 1. R.v. "Baltica" cruise SPRAS 2021: Simrad EK60 calibration report (38 kHz transducer).

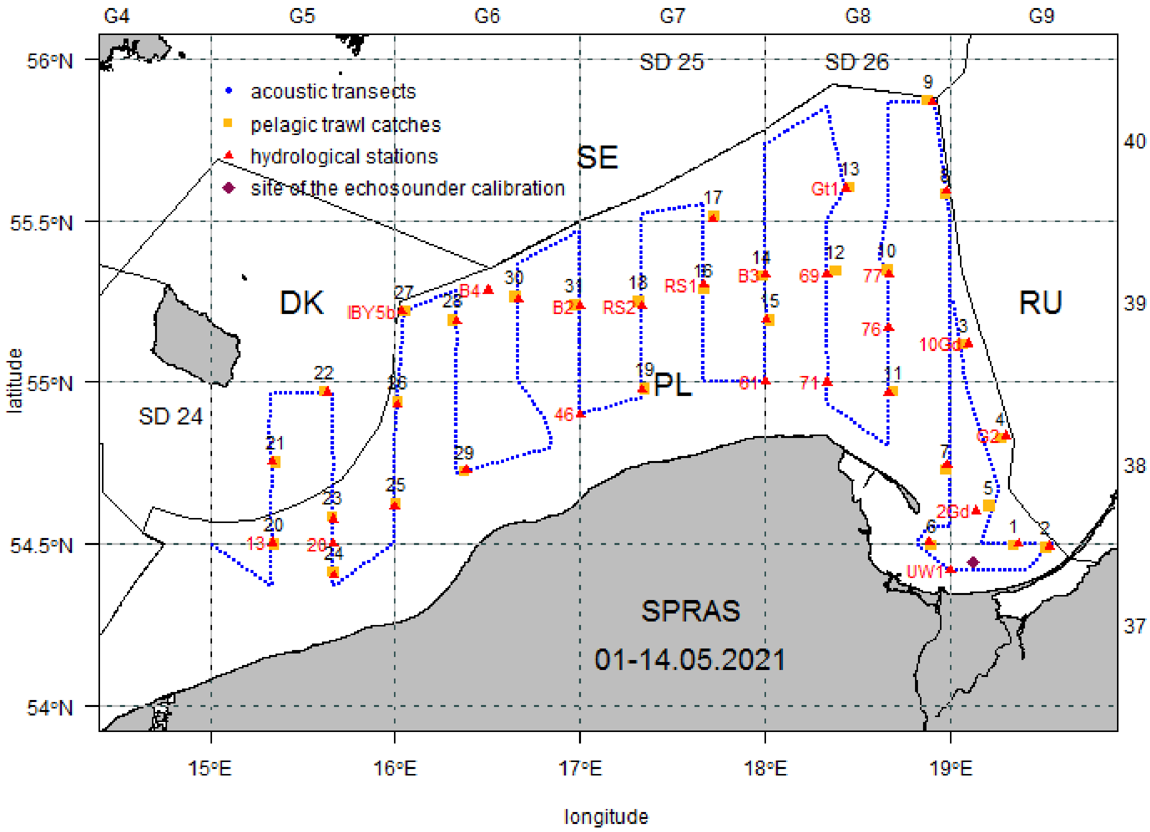

Fig. 2. Location of realized investigations during the Polish SPRAS survey on board of the r.v. "Baltica", 01–14.05.2021.

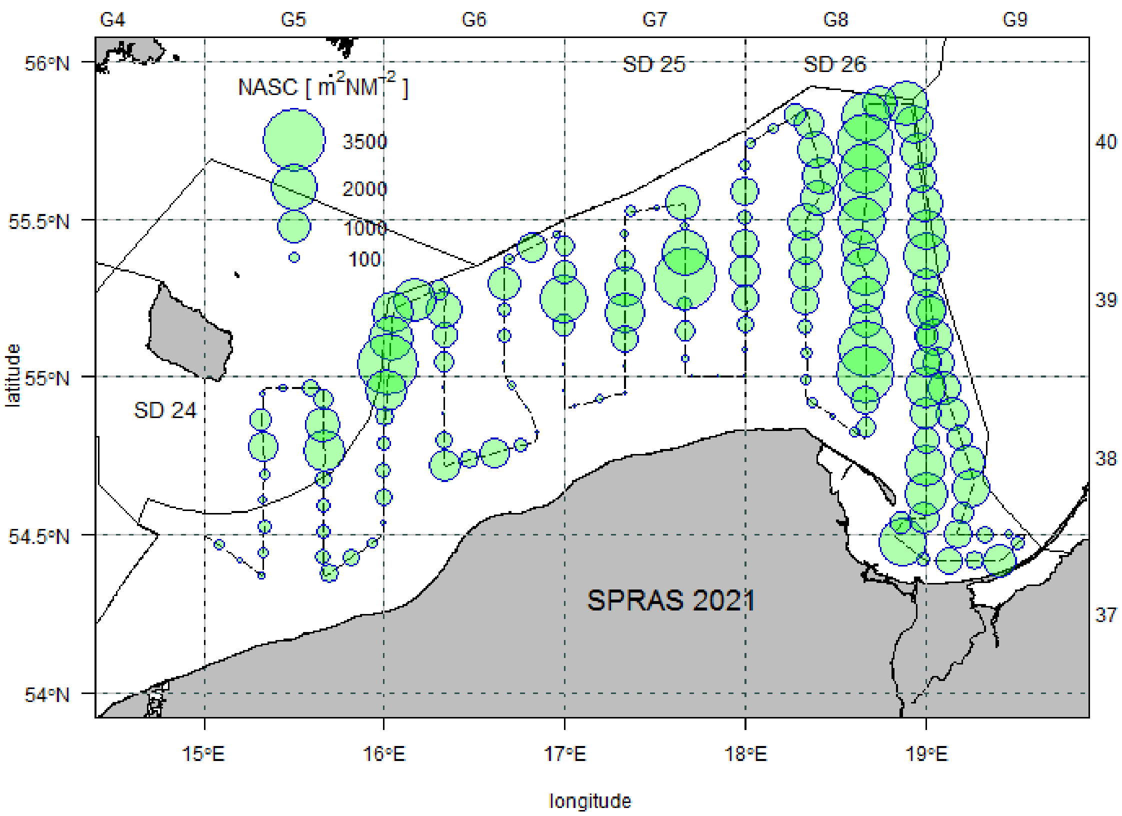

Fig. 3. Cruise track (thin dashed line) and the mean NASC (5 NM intervals, bubbles) recorded during SPRAS 2021 cruise.

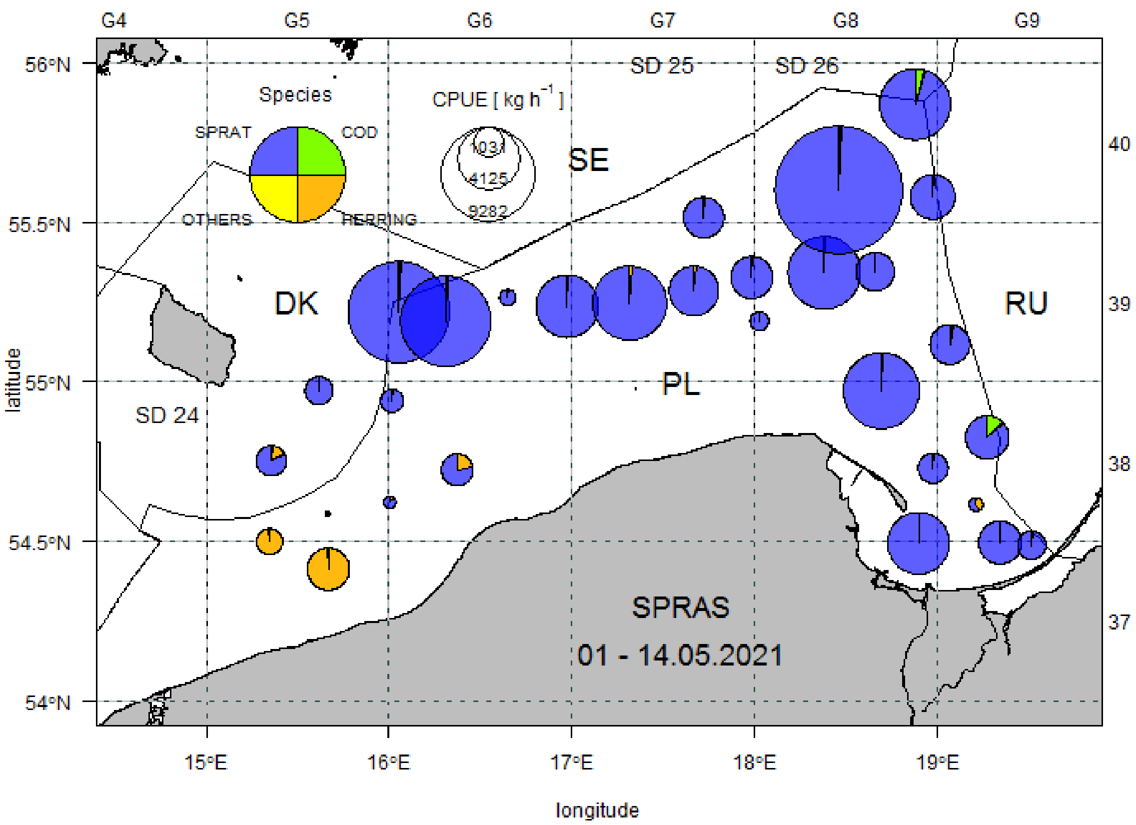

Fig. 4. CPUE [kg·h^{-1}] of fish species per single pelagic hauls conducted in the Polish EEZ (SPRAS 2021 survey).

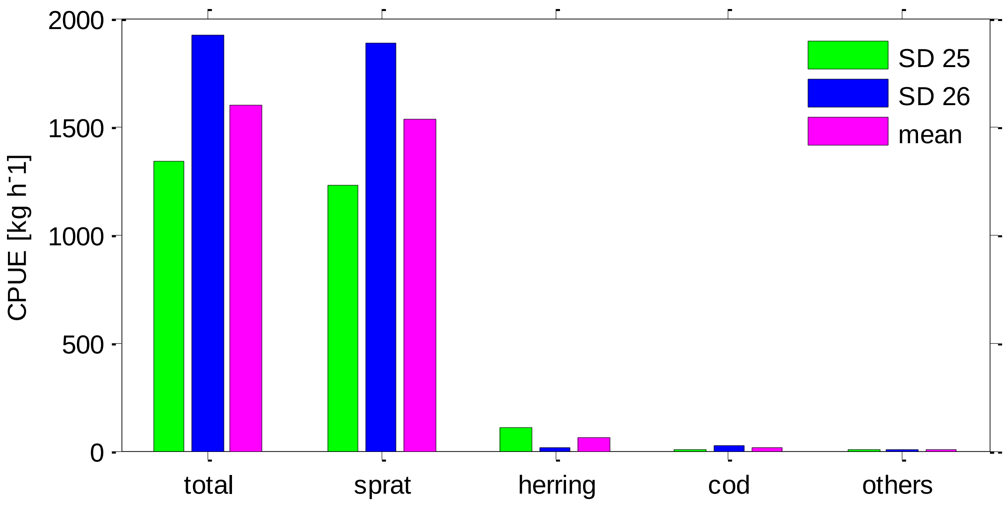

Fig. 5. Mean CPUE [kg·h^{-1}] per fish species and the ICES SDs (the Polish SPRAS/2021 survey).

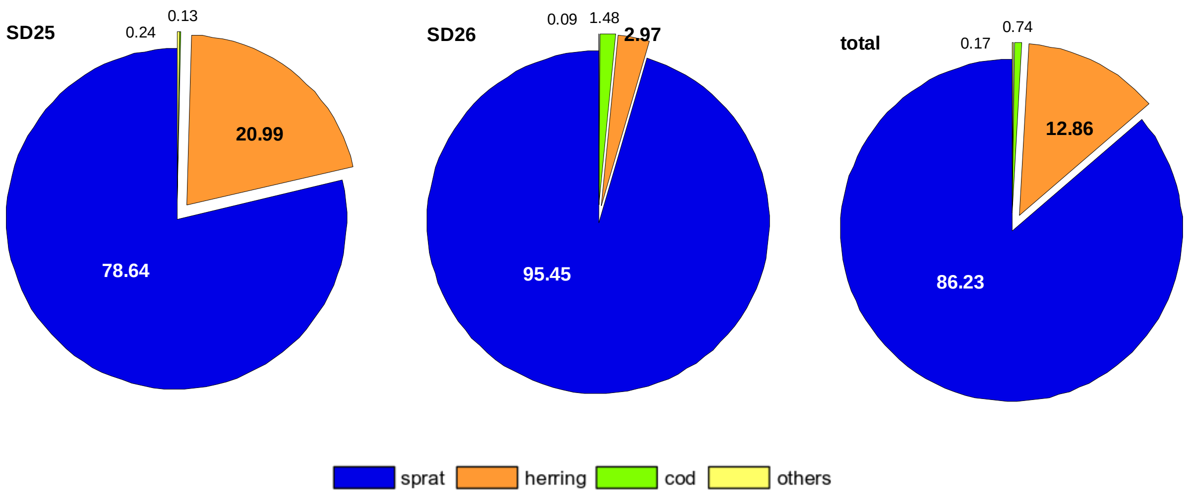

Fig. 6. Mean catch-share (%) of sprat, herring, cod and other fishes in the mass of total catches per the ICES SDs (the Polish SPRAS/2021).

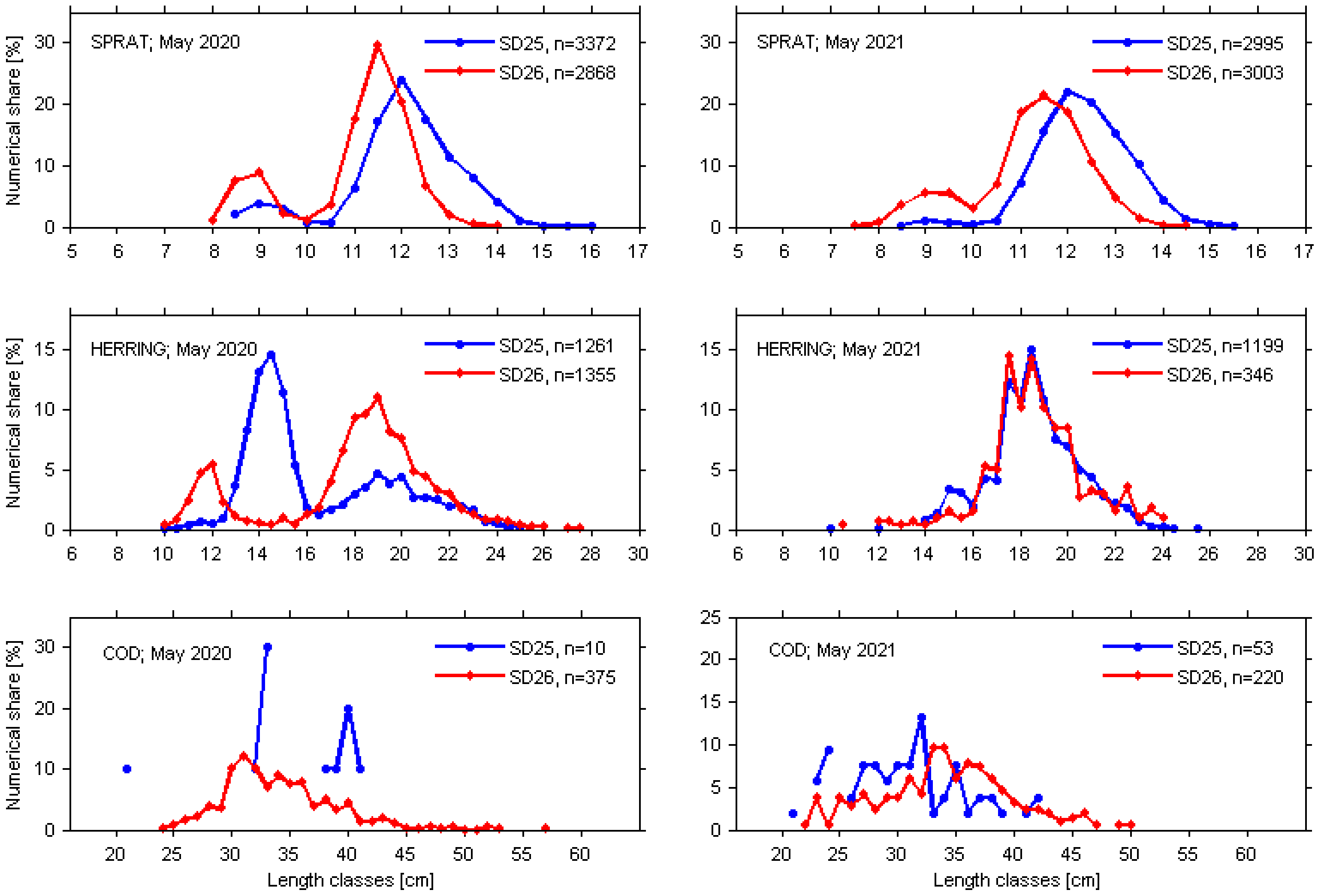

Fig. 7. Length distribution of sprat, herring and cod in samples taken from the catches conducted during the Polish SPRAS/2020 and SPRAS/2021 surveys (the length distribution of sprat, herring and cod from 2020 from Schmidt *et al.*, 2021a).

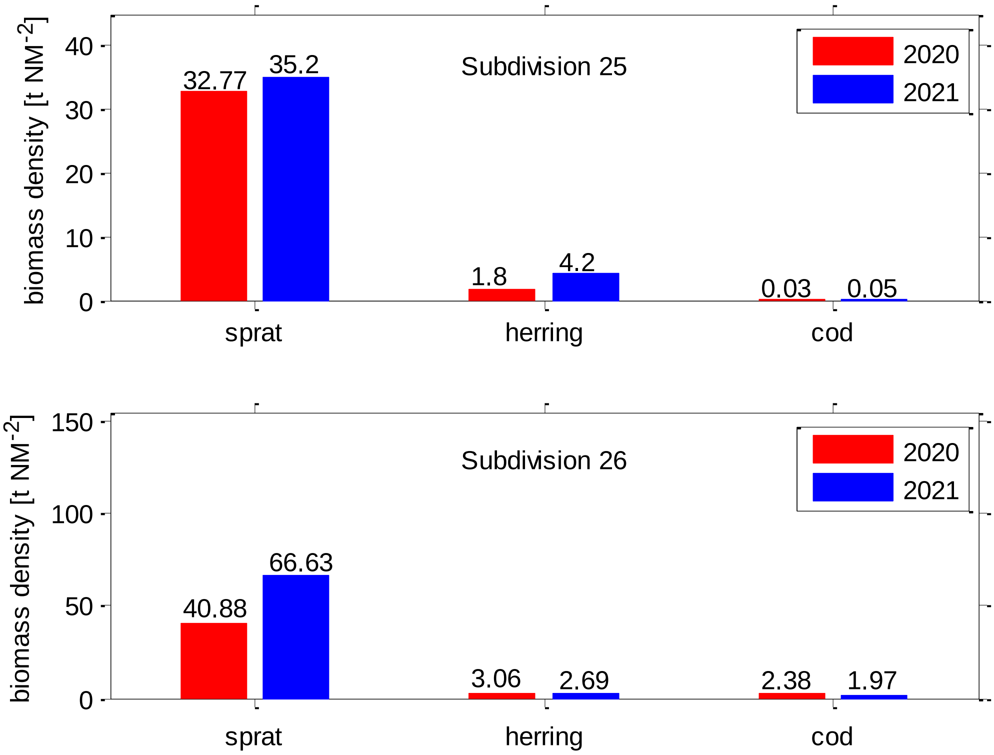

Fig. 8. Mean biomass surface density [t·NM^{-2}] of sprat, herring and cod in the ICES Subdivisions 25 and 26 in the Polish SPRAS 2020 and 2021 surveys (the biomass density data for fish species from 2020 from Schmidt *et al.*, 2021a).

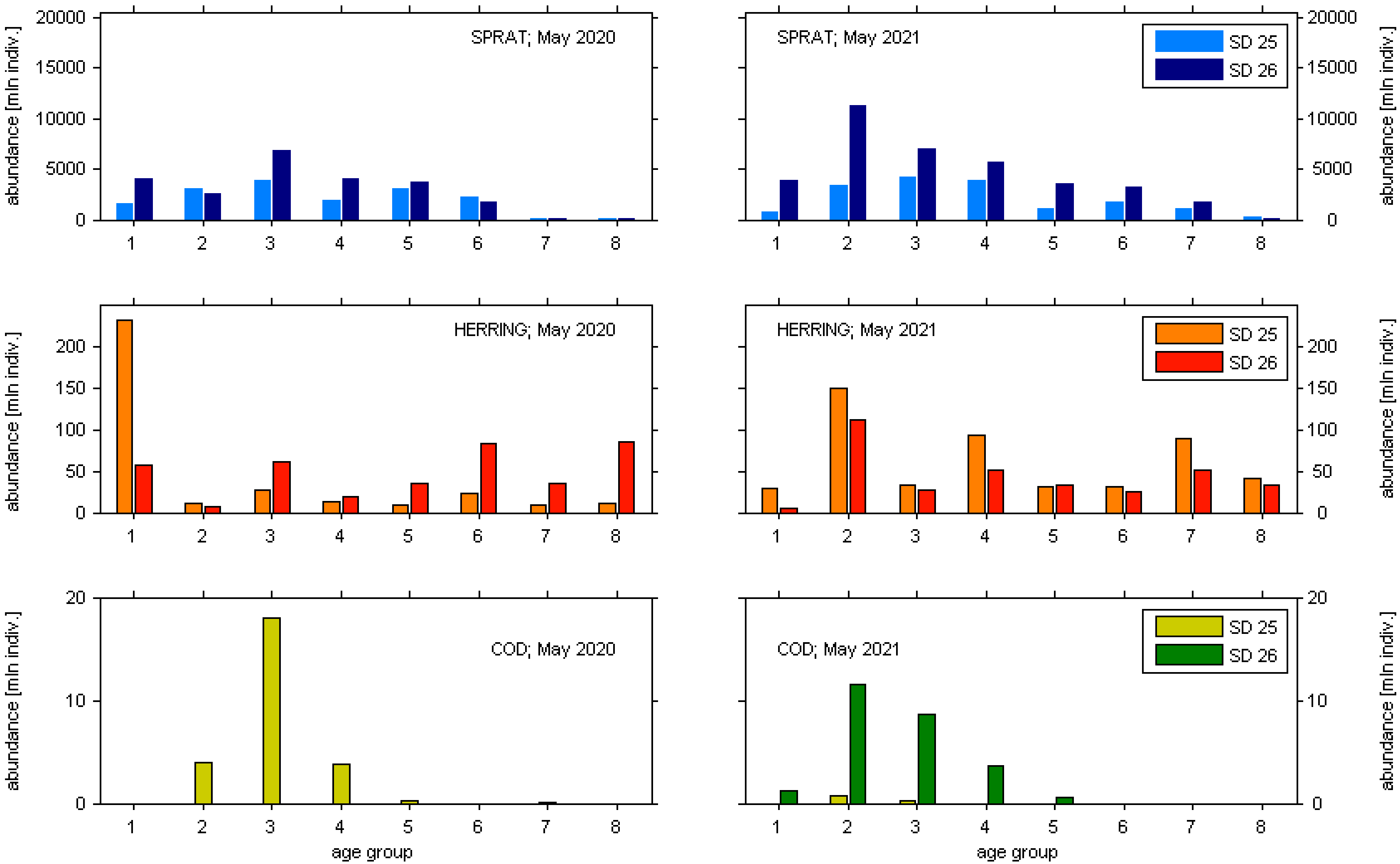

Fig. 9. Abundance of sprat, herring and cod stocks per age groups, according to the ICES Subdivisions 25 and 26, based on data from the Polish SPRAS surveys in 2020 and 2021 (the abundance data for fish species from 2020 from Schmidt *et al.*, 2021a).

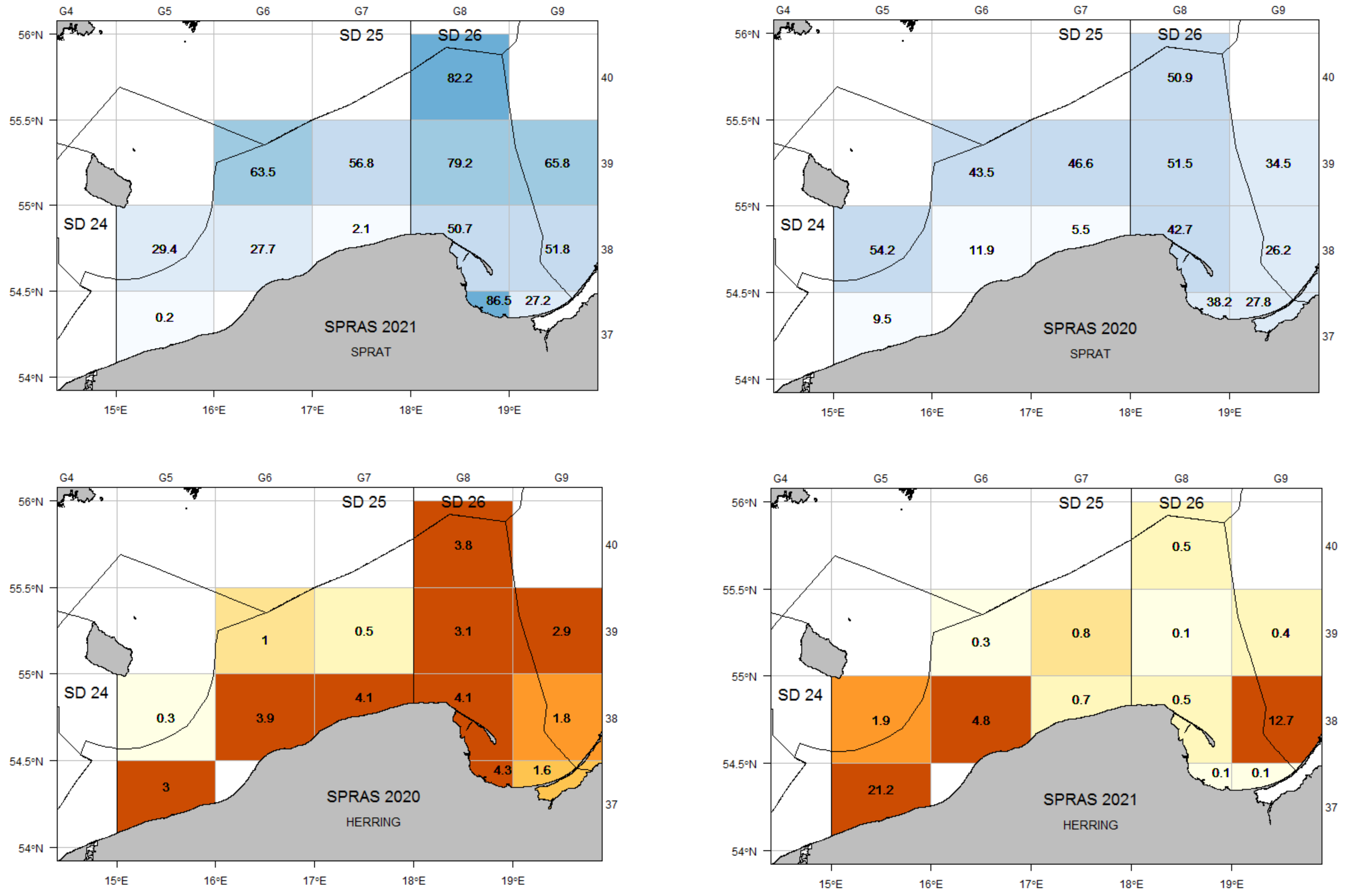

Fig. 10. Biomass surface density of sprat and herring [t·NM^{-2}] in ICES rectangles, estimated using the acoustic method, and based on data collected during the Polish SPRAS 2020 and 2021 surveys (the fish species biomass density data from 2020 from Schmidt *et al.*, 2021a).

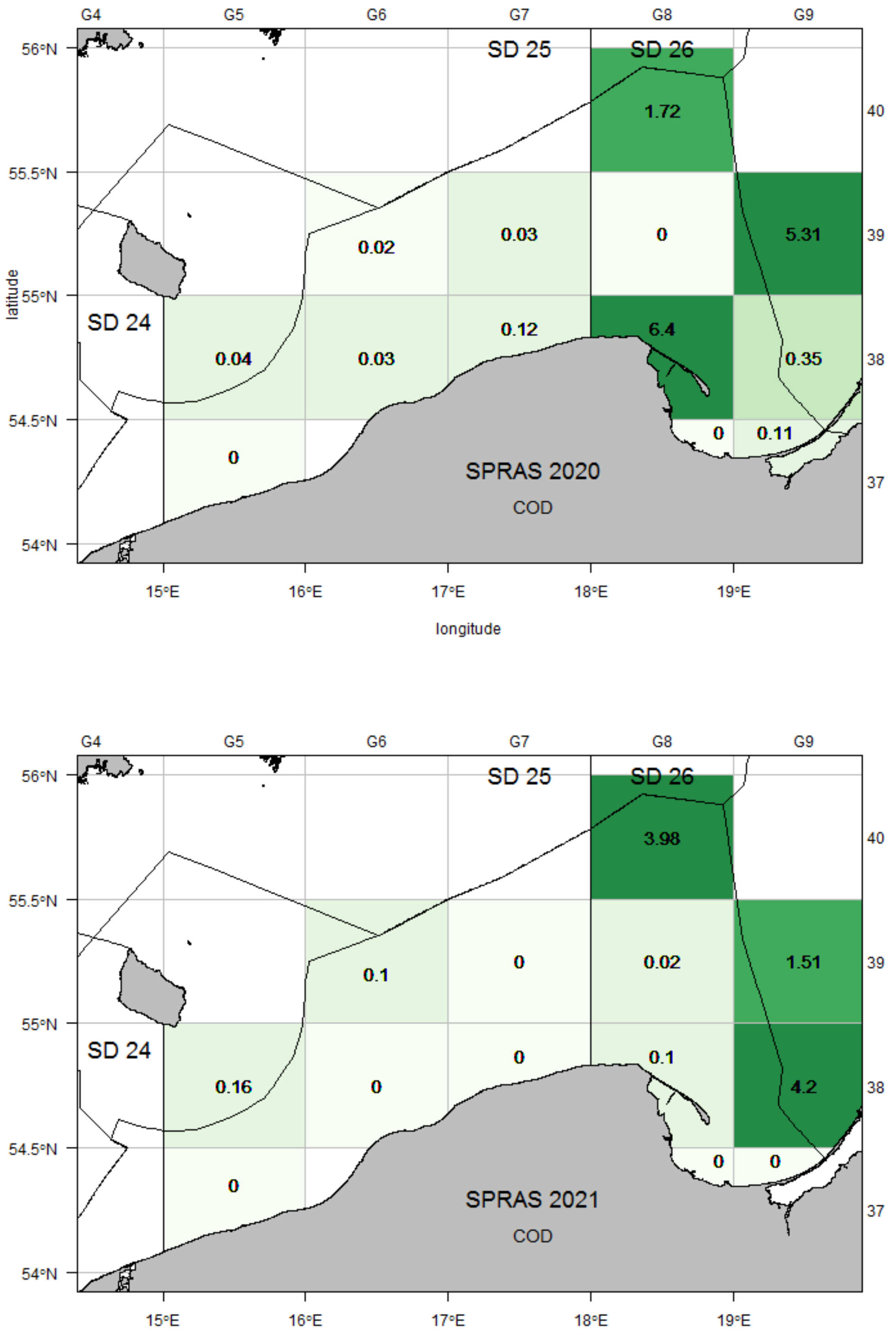

Fig. 11. Biomass surface density of cod [t·NM^{-2}] in ICES rectangles, estimated using the acoustic method, and based on data collected during the Polish SPRAS 2020 and 2021 surveys (the biomass surface density of cod from 2020 from Schmidt *et al.*, 2021a).

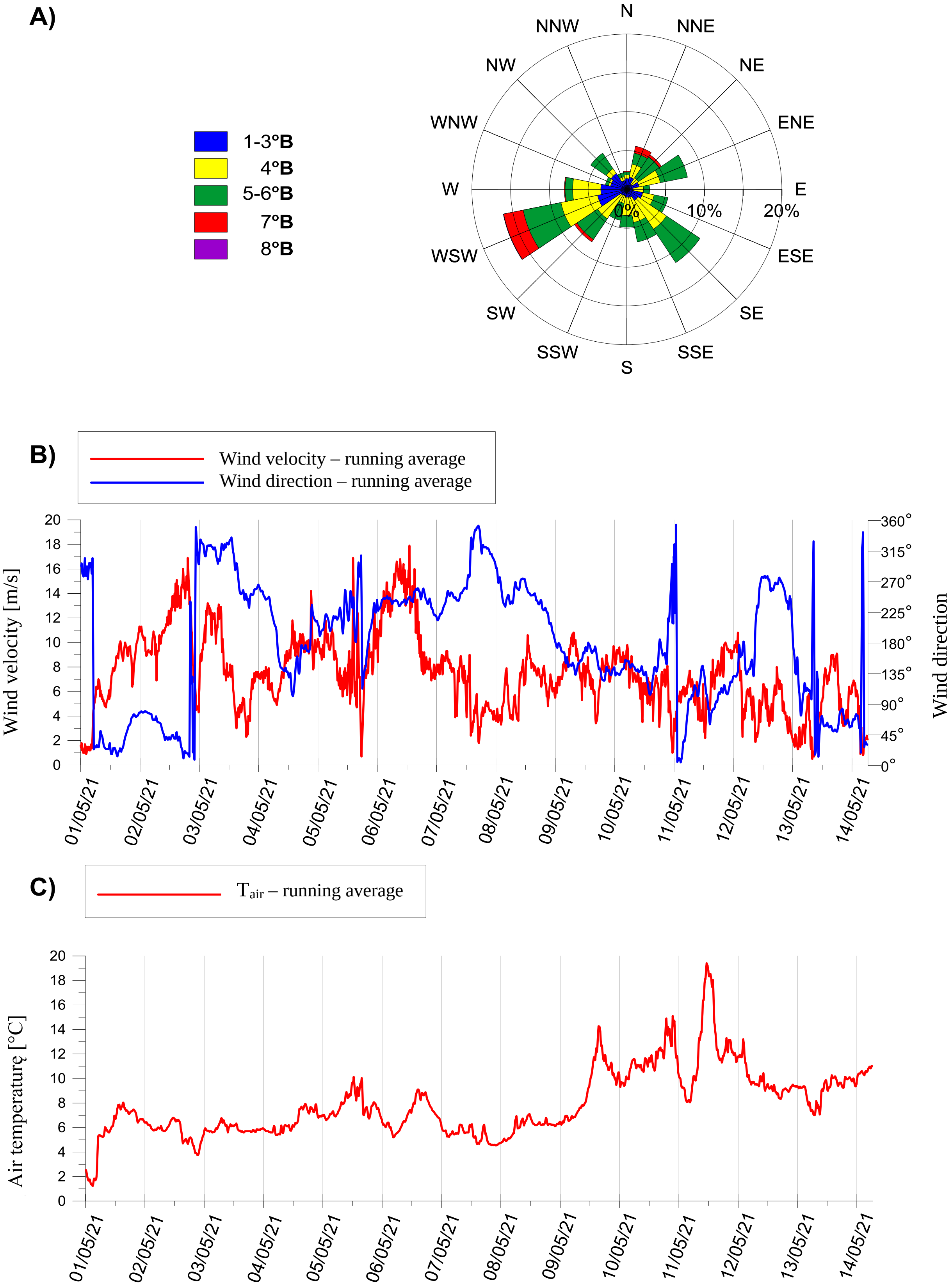

Fig. 12. Changes of meteorological parameters during consecutive days of the Polish SPRAS survey in May 2021 (fig. Wodzinowski cit. in Schmidt *et al.*, 2021b).

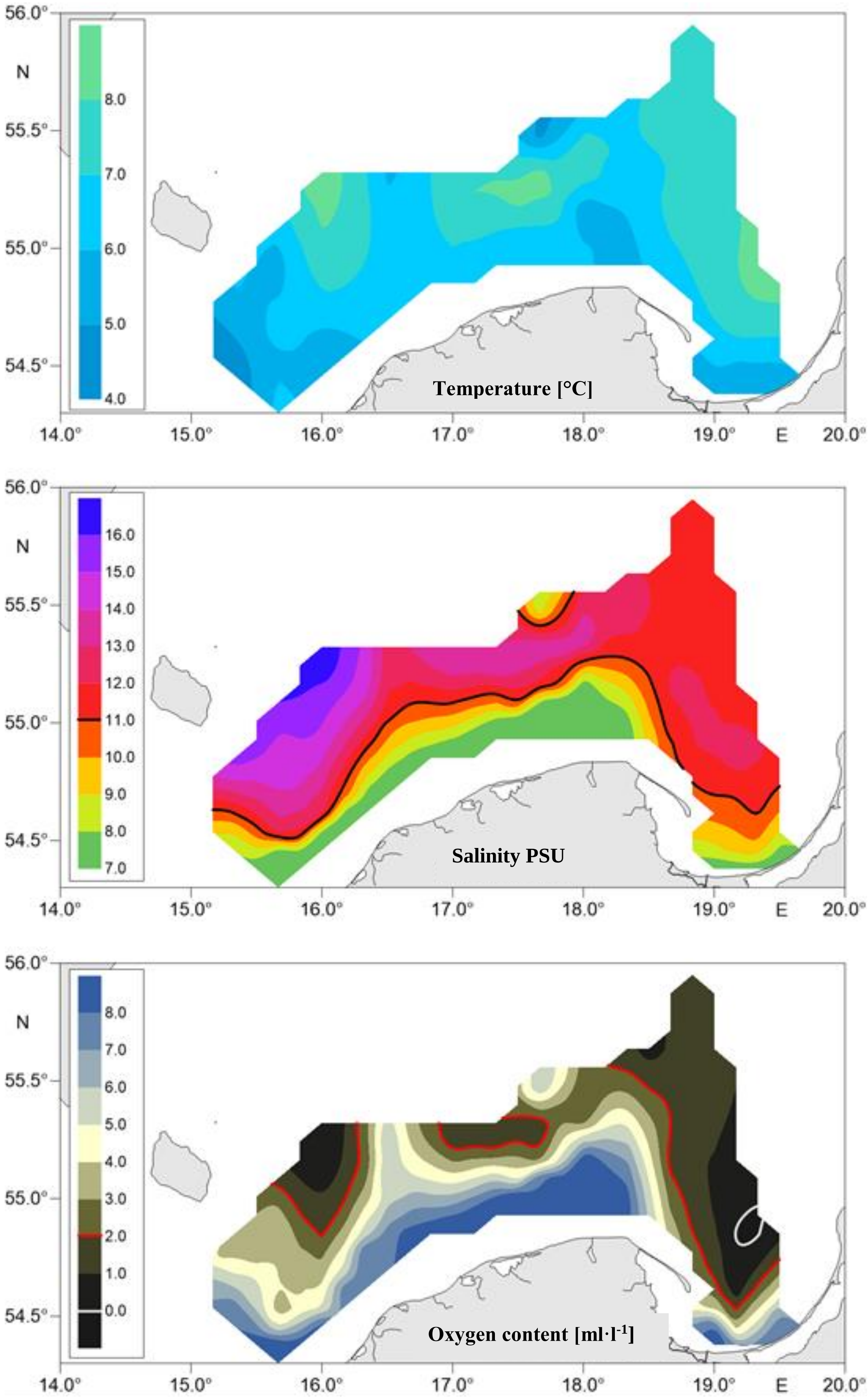

Fig. 13. Horizontal distribution of the seawater temperature, salinity and oxygen content in the near seabed layer of the southern Baltic in May 2021 (fig. Wodzinowski cit. in Schmidt *et al.*, 2021b).

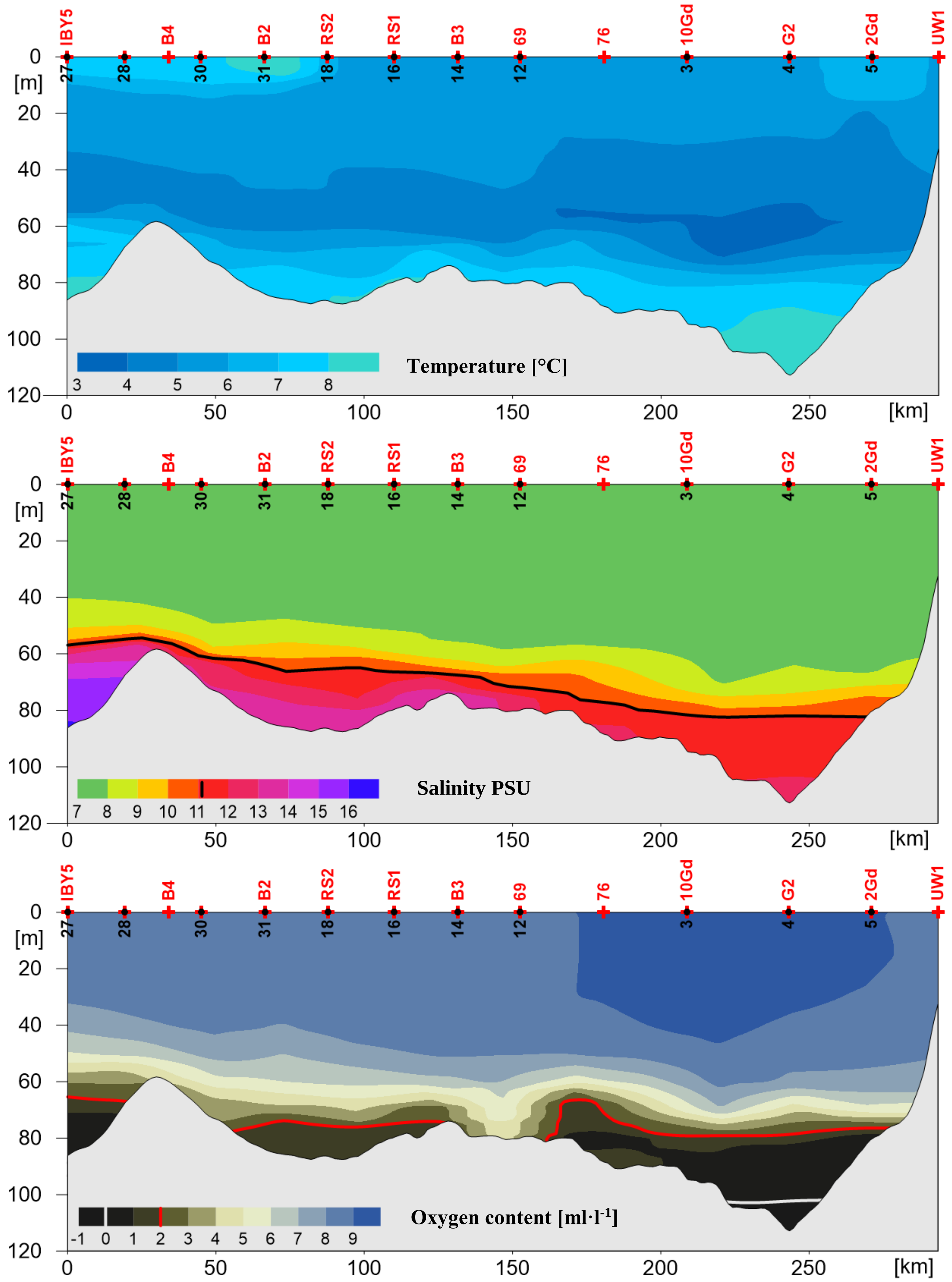

Fig. 14. Vertical distribution of the seawater temperature, salinity and oxygen content, along the hydrological research profile determined in the southern Baltic (May 2021); X- and Y-axes reflects distance (in kilometres) and depth (in meters) from the sea surface to the seabed, respectively (fig. Wodzinowski cit. in Schmidt *et al.*, 2021b).

Baltic Acoustic Spring Survey Report for Sweden

2021-05-04 - 2021-05-10

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Contents

1 Introduction

International hydroacoustic surveys have been conducted in the Baltic Sea since 1978. The starting point was the cooperation between the Institute of Marine Research (IMR) in Lysekil, Sweden, and the Institute fur Hochseefisherei und Fishverarbeitung in Rostock, German Democratic Republic, in October 1978, which produced the first acoustic estimates of total biomass of herring and sprat in the Baltic main basin (Håkansson *et al.,* 1979). Since then there has been at least one annual hydroacoustic survey for herring and sprat and results have been reported to ICES.

The Baltic International Acoustic Survey (BASS/SPRAS), is mandatory for the countries that have exclusive economic zone (EEZ) in the Baltic Sea, and is a part of the Data Collection Framework as stipulated by the European Council and the Commission (Council Regulation (EC) No 199/2008 and the Commission Data Collection Framework (DCF) web page[1]).

The Institute of Marine Research, Department of Aquatic Resources, Swedish University of Agricultural Sciences is responsible for the Swedish part of the EU DCF and surveys in the marine environment. The Institute assesses the status of the marine ecosystems, develops and provides biological advice for the sustainable use of the aquatic resources.

The year 2021 was the second year Sweden participated in BASS. The survey started 2021-05-05 outside Västervik in SD 27 (figure 2). The total cruise covered SD 27 and two squares (42G8 and 43G8) in SD 28 (see figure 1)

The BASS/SPRAS survey is co-ordinated and managed by the ICES working group WGBIFS. The main objective of BASS/SPRAS is to assess herring and sprat resources in the Baltic Sea. The survey provides data to the ICES Baltic Fisheries Assessment Working Group (WGBFAS).

[1] https://datacollection.jrc.ec.europa.eu/dcf-legislation

2 Methods

2.1 Survey design

The stratification is based on ICES statistical rectangles with a range of 0.5 degrees in latitude and 1 degree in longitude (Figure 1). The areas of all strata are limited by the 10 m depth line[2]. The aim is to use parallel transects spaced on regular rectangle basis, normally at a maximum distance of 15 nautical miles and with a transect density of about 60 nautical miles per 1000 square nautical miles. The irregular shape of the survey area assigned to Sweden and the weather conditions makes it difficult to fulfil such design. The total area covered was 6187 square nautical miles and the distance used for acoustic estimates was 432 nautical miles. The cruise track and positions of trawl hauls are shown in figure 2.

2.2 Calibration

The SIMRAD EK80 echo sounder with the 38kHz transducer was calibrated at Gåsfjärden south of Västervik on 2020-05-04 according to the IBAS manual[4]. Values from the calibration were within required accuracy.

2.3 Acoustic data collection

The acoustic sampling was performed in daytime between 5 o'clock in the morning and 9 o'clock in the evening. SIMRAD EK80[2] echo sounder with the 38 kHz transducer mounted on a drop keel is used for the acoustic transect data collection. The settings of the hydroacoustic equipment were as described in the IBAS manual[4]. The post processing of the stored raw data was made using the software LSSS[3]. The mean volume back scattering values (Sv) were integrated over 1 nautical mile elementary sampling distance units (ESDUs) from 10 m below the surface to the bottom. Contributions from air bubbles, bottom structures and scattering layers were filtered out from the echogram using LSSS.

2.4 Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers in combination with other species so that it is impossible to allocate the integrator readings to a single species. Therefor the species composition was based on the trawl catch results. For each rectangle the species composition and length distribution were determined as the unweighted mean of all trawl results in this rectangle. From these distributions the mean acoustic cross-section was calculated according to the target strength-length (TS) relationships found in table 1.

Table 1: Target strength-length (TS) relationships

Clupeoids	TS = 20 log L (cm) - 71.2	(ICES 1983/H:12)
Gadoids	TS = 20 log L (cm) - 67.5	(Foote et al. 1986)
Trachurus trachurus	TS = 20 log L (cm) - 73.0	(Misund, 1997 in Pen˜a, 2007)
Fish without swim bladder	TS = 20 log L (cm) - 84.9	ICES CM2011/SSGESST:02,Addendum 2
Salmonids and 3-spined stickleback were assumed to have the same acoustic properties as herring.		

The total number of fish (total N) in one rectangle was estimated as the product of the mean area scattering cross section s_A and the rectangle area, divided by the corresponding mean cross section σ. The total number was separated into different fish species according to the mean catch composition in the rectangle.

[2] ICES CM 2011/SSGESST:05 Addendum 2
[3] www.marec.no/english/products.htm

2.5 Hydrographic data

CTD casts were made with a SeaBird (SBE 19) CTD when calibrating the acoustic instruments and whenever a haul was conducted. Additional hydrographic data was collected on a selection of the stations.

2.6 Personnel

The participating scientific crew can be seen in table 2.

Table 2: Participating scientific crew

Hillvarsson, Annelie	IMR, Lysekil, Sweden	Fish sampling
Jernberg, Carina	IMR, Lysekil, Sweden	Fish sampling
Sundber Hentati, Jonas	IMR, Lysekil, Sweden	Scientific Acoustics
Nilsson, Hans	IMR, Lysekil, Sweden	Acoustics
Sjöberg, Rajlie	IMR, Lysekil, Sweden	Fish sampling
Svenson, Anders	IMR, Lysekil, Sweden	Expedition leader Acoustics
Björklund, Emilia	IMR, Lysekil, Sweden	Fish sampling
Lövgren, Olof˙	IMR, Lysekil, Sweden	Acoustics

3 Results

3.1 Biological data

In total 15 trawl hauls were carried out in SD 27 and in SD 28. In total 551 herrings and 449 sprats were aged. Catch compositions by trawl haul is presented in table 8. Length distributions for herring and sprat by ICES subdivision are shown in figures 3 to 12.

3.2 Acoustic data

The survey statistics concerning the survey area, the mean backscatter (SA), the mean scattering cross section (SIGMA), the estimated total number of fish (NTOT), the percentages of herring (HHer), sprat (HSpr) and cod (HCod) per Sub-division/rectangle are shown in Table 3.

3.3 Abundance estimates

The total abundances of herring and sprat by age group per rectangle are presented in Table 4 and 6.
The corresponding mean weights by age group per rectangle are shown in Tables 5 and 7.

4 Summary

This year was the second year R/V Svea was used in the BASS survey and the survey was accomplished as planned. The weather was good throughout the cruise and facilitated the operations. The data collected during the survey was accepted at the WGBIFS meeting and can be considered as representative for the abundance of the pelagic species during the BASS in 2021 for the covered area (see figure 2). For further information regarding the procedures of WGBIFS see the latest WGBIFS report at ICES. .

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Pen˜a, H. 2008. In situ target-strength measurements of Chilean jack mackerel (*Trachurus symmetricus murphyi)* collected with a scientific echosounder installed on a fishing vessel. - ICES Journal of Marine Science 65: 594-604.

ICES WGBIFS reports:
https://www.ices.dk/community/groups/Pages/WGBIFS.aspx

Council Regulation (EC) No 199/2008:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:060:0001:0012:EN:PDF

Commission DCF web page:
http://datacollection.jrc.ec.europa.eu/dcf-legislation

Table 3: Survey statistics,

SD	RECT	AREA	SA	SIGMA	NTOT	HHer	HSpr	HCod
27	42G6	266.0	879.2	0.267	8747.93	0.00	0.00	0.000
27	42G7	986.9	539.4	1.223	4351.28	4.87	85.80	0.002
27	43G7	913.8	846.3	1.073	7207.57	20.60	28.54	0.005
27	44G7	960.5	1153.6	0.920	12049.93	3.42	81.49	0.003
27	44G8	456.6	1666.5	0.885	8594.96	9.13	58.44	0.004
27	45G7	908.7	1486.7	0.963	14032.50	12.04	61.78	0.001
27	46G7	452.6	1000.5	1.381	3277.97	34.74	44.30	0.000
28	42G8	945.4	331.1	1.229	2547.80	6.34	91.10	0.004
28	43G8	296.2	801.7	1.201	1977.34	3.45	90.74	0.000

Table 4: Estimated number (millions) of sprat (Nspr0 stands for number of 0 year old sprat

SD	RECT	NSprTOT	NSpr1	NSpr2	NSpr3	NSpr4	NSpr5	NSpr6	NSpr7	NSpr8	CCODE	
27	42G6	0.25	0.00	0.13	0.04	0.04	0.00	0.00	0.00	0.04	BASS	Swe2021
27	42G7	3733.60	191.52	1820.03	735.73	664.77	0.00	290.87	0.00	30.67	BASS	Swe2021
28	42G8	2321.02	578.86	462.54	502.01	351.71	137.84	114.24	173.82	0.00	BASS	Swe2021
27	43G7	2056.86	91.79	314.43	766.28	241.81	193.99	195.51	224.09	28.98	BASS	Swe2021
28	43G8	1794.26	304.11	805.90	272.18	226.56	48.66	74.51	15.21	47.14	BASS	Swe2021
27	44G7	9819.86	4546.18	2573.73	1458.24	927.60	63.56	111.63	114.89	24.04	BASS	Swe2021
27	44G8	5023.10	2373.55	1611.81	353.27	149.04	55.20	204.24	248.40	27.60	BASS	Swe2021
27	45G7	8668.95	3564.23	2560.95	1253.67	742.29	121.18	38.18	350.27	38.18	BASS	Swe2021
27	46G7	1452.12	41.69	355.73	498.86	168.14	31.96	112.56	226.50	16.68	BASS	Swe2021

Table 5: Estimated mean weights (g) of sprat (Wspr1 stands for average weight of the 1 year old sprat)

SD	RECT	WSpr1	WSpr2	WSpr3	WSpr4	WSpr5	WSpr6	WSpr7	WSpr8
27	42G6		6.78	7.02	7.90				9.89
27	42G7	3.23	7.00	9.61	10.29		10.56		12.69
28	42G8	3.37	6.58	8.05	9.72	12.43	10.63	9.63	
27	43G7	2.96	6.95	8.31	11.61	11.23	11.79	11.89	11.19
28	43G8	3.66	7.28	8.95	10.25	10.25	11.78	13.77	12.27
27	44G7	2.95	6.62	8.99	10.43	10.43	10.55	11.16	11.61
27	44G8	3.04	7.25	9.72	10.09	8.56	9.24	10.12	10.96
27	45G7	3.46	7.26	9.36	9.91	12.25	11.74	11.50	9.26
27	46G7	3.17	8.33	8.63	9.56	11.11	12.52	11.16	11.61

Table 6: Estimated number (millions) of herring

SD	RECT	NHerTOT	NHer1	NHer2	NHer3	NHer4	NHer5	NHer6	NHer7	NHer8	CCODE	
27	42G7	211.87	4.97	18.96	27.98	27.87	32.89	25.37	62.05	11.79	BASS	Swe2021
28	42G8	161.57	3.47	16.47	13.68	31.37	2.04	36.35	53.07	5.12	BASS	Swe2021
27	43G7	1484.84	0.00	572.41	142.07	338.88	84.00	42.26	286.97	18.25	BASS	Swe2021
28	43G8	68.21	6.50	19.49	5.41	7.58	2.71	13.10	12.13	1.30	BASS	Swe2021
27	44G7	412.50	24.23	123.83	47.14	83.63	70.60	39.68	23.39	0.00	BASS	Swe2021
27	44G8	784.89	67.98	313.96	158.21	69.22	64.27	22.25	59.33	29.67	BASS	Swe2021
27	45G7	1690.01	57.07	851.84	84.74	209.55	188.04	168.76	130.00	0.00	BASS	Swe2021
27	46G7	1138.81	47.45	694.89	106.50	125.48	59.05	52.72	29.52	23.20	BASS	Swe2021

Table 7: Estimated mean weights (g) of herring

SD	RECT	WHer1	WHer2	WHer3	WHer4	WHer5	WHer6	WHer7	WHer8
27	42G7	8.06	15.47	19.71	25.61	29.43	36.93	34.73	41.78
28	42G8	5.14	17.25	23.04	27.37	45.36	32.21	31.53	57.05
27	43G7		15.84	21.11	25.89	35.32	38.48	34.59	54.49
28	43G8	5.97	16.75	20.33	26.63	25.89	28.06	25.81	36.31
27	44G7	5.94	15.09	19.88	22.65	25.24	30.38	28.79	
27	44G8	5.09	14.53	18.89	22.53	26.47	27.27	24.10	24.41
27	45G7	4.48	13.99	18.10	20.76	23.93	27.04	27.83	
27	46G7	4.89	15.13	19.90	23.76	23.95	24.13	25.98	22.76

Table 8: Catch composition per haul.

Species		112	113	114	115	116	117	118	119
1	Clupea harengus	47.35	244.31	82.53		37.12	195.20	57.33	48.60
2	Gadus morhua	0.33		0.20			0.82	0.91	
3	Gasterosteus aculeatus	14.43	19.63	9.03	300.80	3.73	6.36	1.20	7.84
4	Hyperoplus lanceolatus								
5	Myoxocephalus quadricornis								
6	Myoxocephalus scorpius						0.27		
7	Platichthys flesus	0.12		0.46		0.24	1.84	1.86	0.10
8	Pomatoschistus microps					0.04			
9	Pungitius pungitius				0.00				
10	Sprattus sprattus	531.25	126.95	429.61	0.05	187.60	453.32	591.59	468.90

Table 8 (continued): Catch composition per haul

Species		120	121	122	123	124	125
1	Clupea harengus	60.56	140.32	18.75	65.25	40.11	558.81
2	Gadus morhua	0.62	0.34	0.28	0.42	0.71	
3	Gasterosteus aculeatus	26.75	49.83	4.14	32.93	119.88	40.41
4	Hyperoplus lanceolatus					0.00	
5	Myoxocephalus quadricornis						0.19
6	Myoxocephalus scorpius						0.08
7	Platichthys flesus	0.17	0.10	0.10	0.18		
8	Pomatoschistus microps						
9	Pungitius pungitius		0.06				
10	Sprattus sprattus	38.43	298.99	90.22	417.20	638.19	379.85

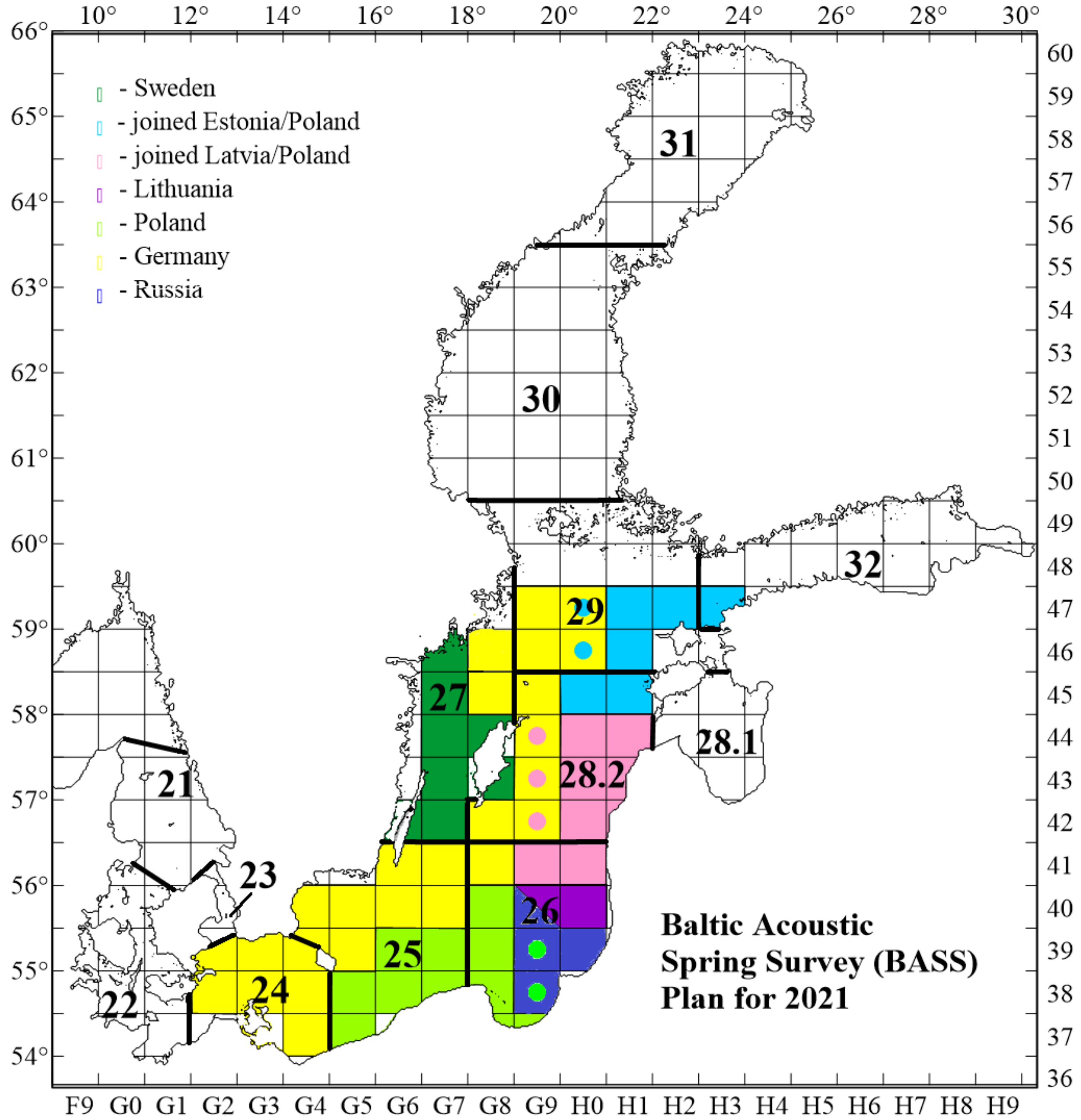

Figure 1. Map with ICES square allocated to each country in the BASS survey 2021 (On axes: longitude, latitude and ICES name of square eg:41G8)

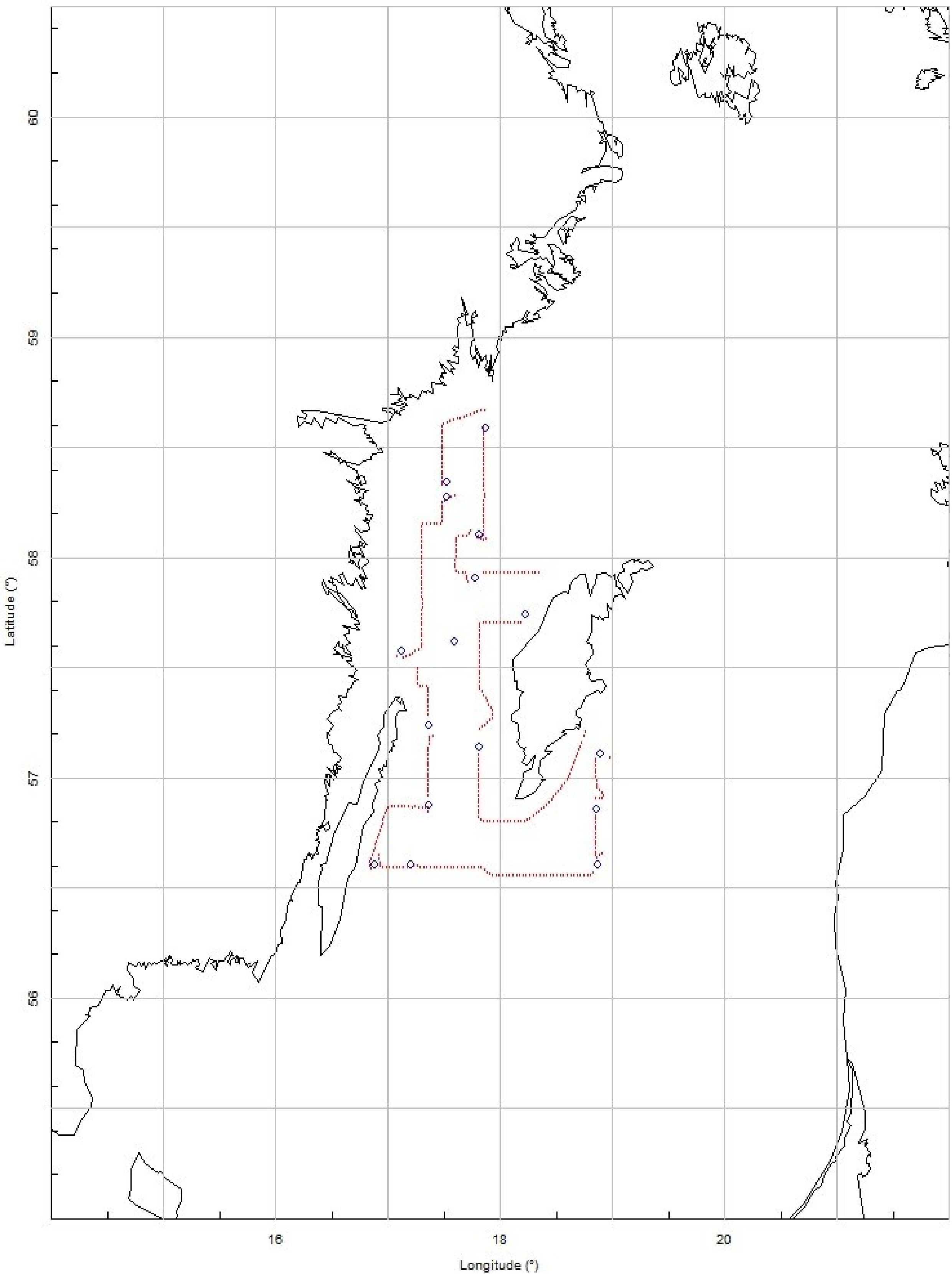

Figure 2. Cruise track in red for BASS 2021. Positions of trawl hauls in blue and survey grid(ICES squares) in grey.

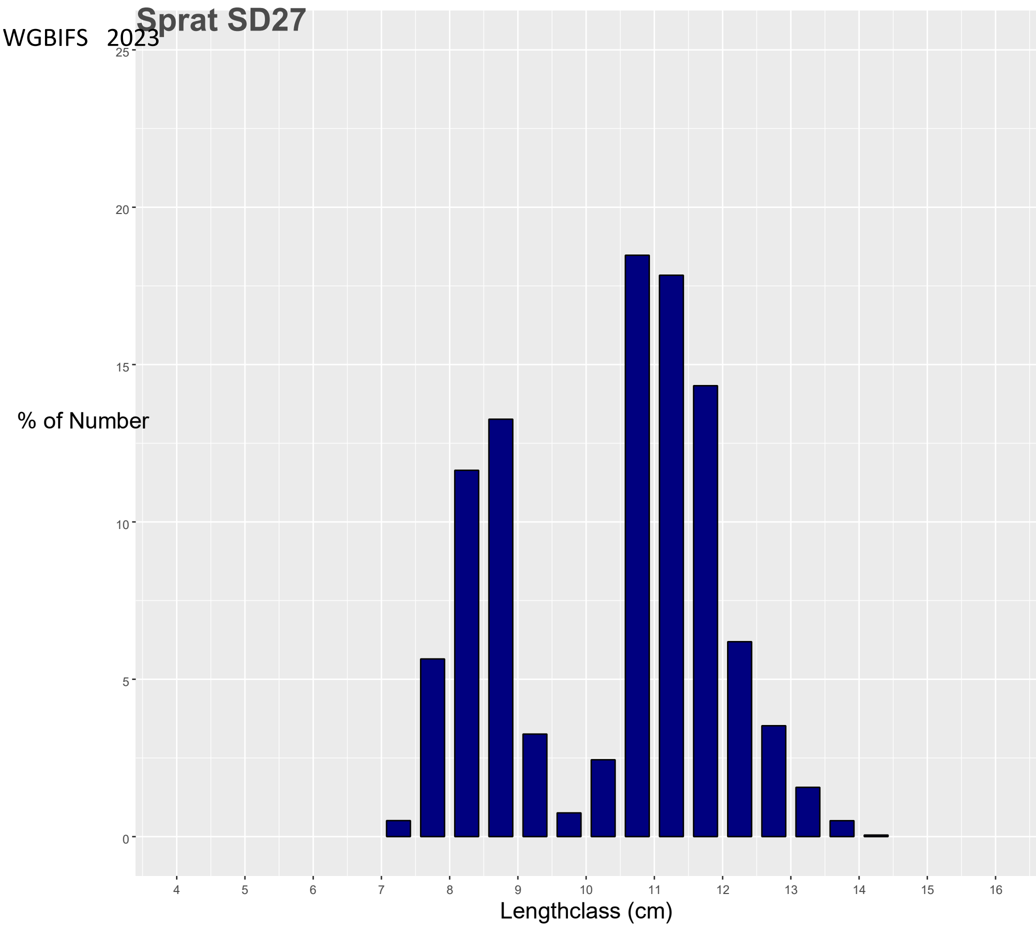

Figure 3: Length distribution of sprat from subdivision 27 for BASS 2021

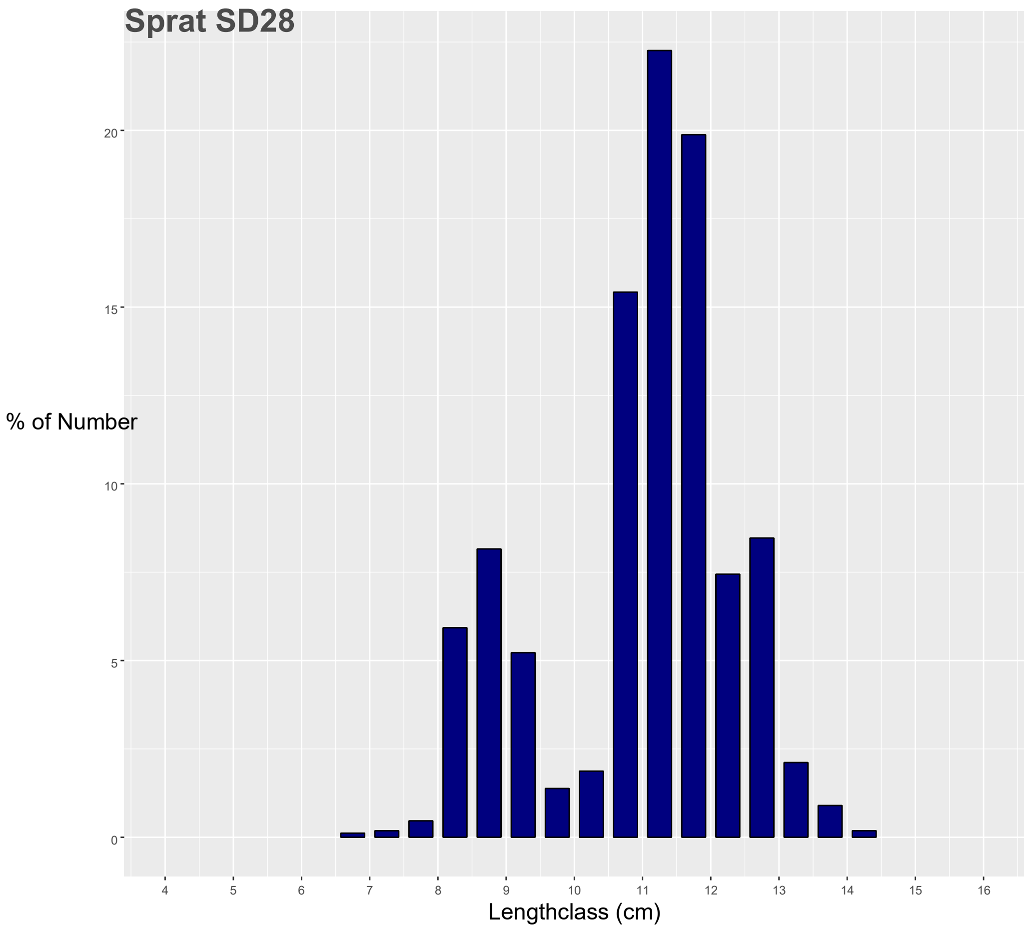

Figure 4: Length distribution of sprat from subdivision 28 for BASS 2021

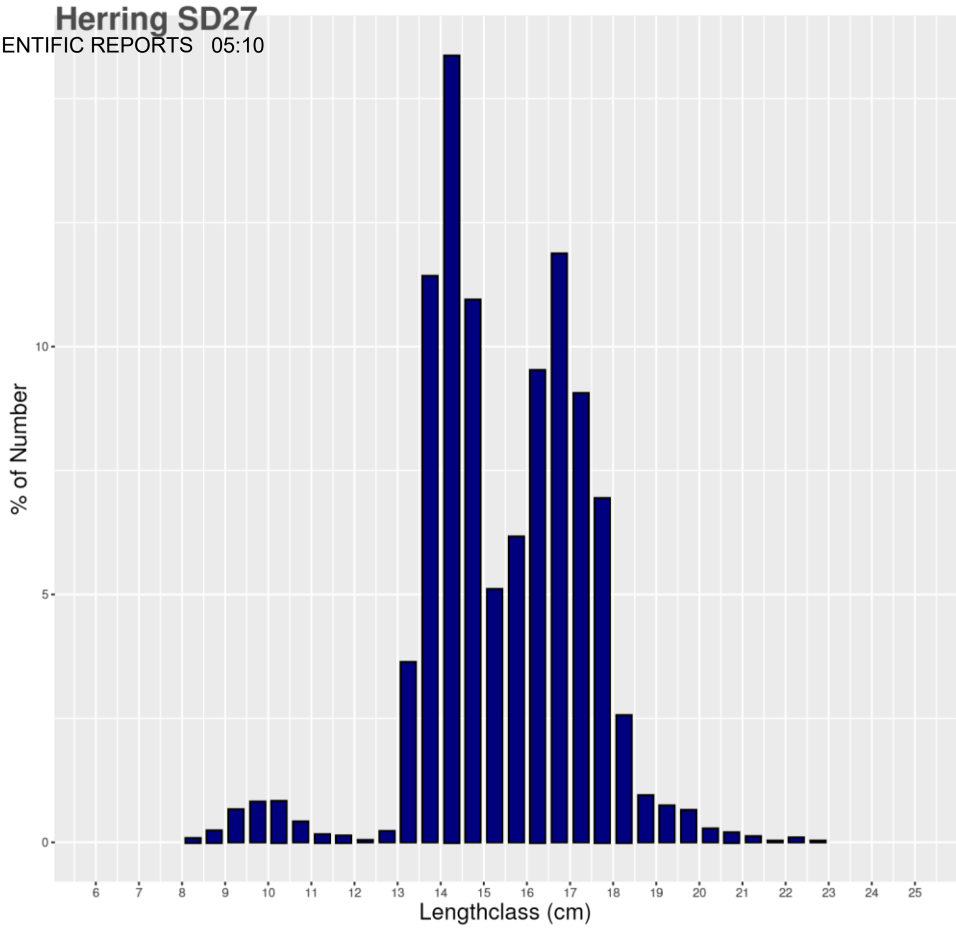

Figure 5: Length distribution of herring from subdivision 27 for BASS 2021

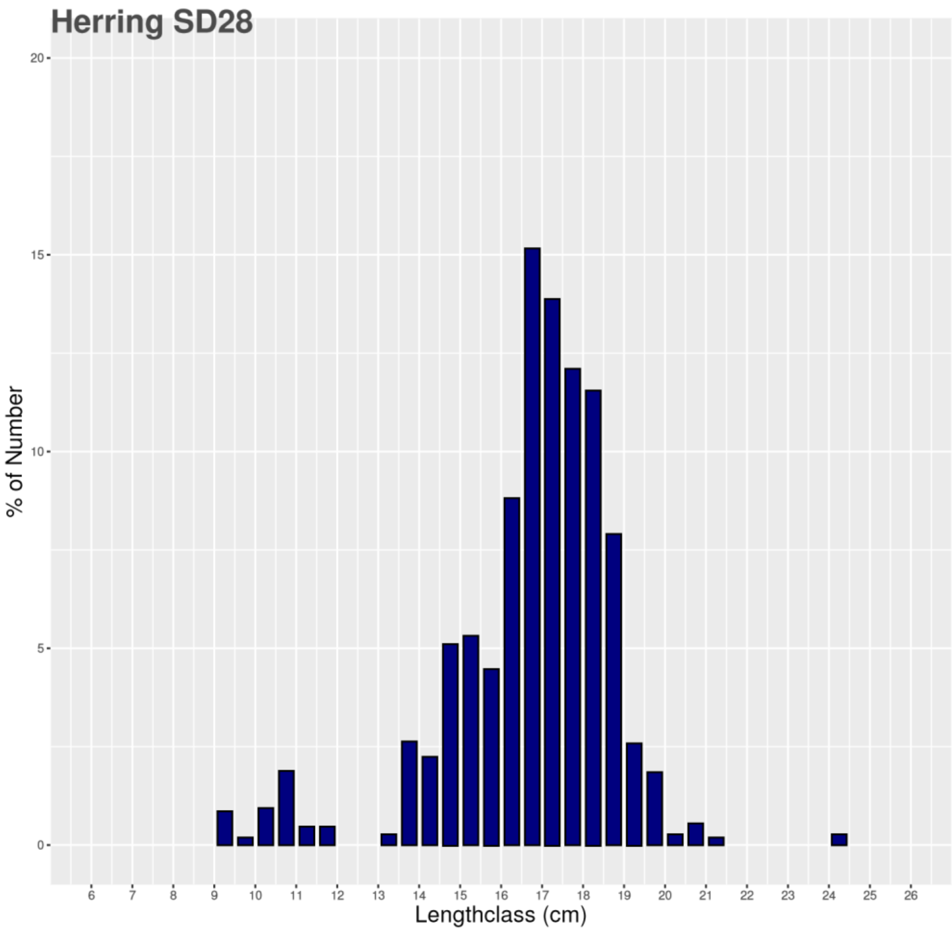

Figure 6: Length distribution of herring from subdivision 28 for BASS 2021

REPORT
FROM THE JOINT ESTONIAN-POLISH BIAS 2021 CONDUCTED BY THE R.V. "BALTICA" IN THE NORTH-EASTERN BALTIC SEA (22.10 – 01.11.2021)

by

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Introduction

The recent joint Estonian-Polish Baltic International Acoustic Survey (EST-POL BIAS), marked with the number 19/2021/MIR-PIB/EMIUT was based on the procurement contract between the University of Tartu/Estonian Marine Institute in Tallinn and the National Marine Fisheries Research Institute in Gdynia. The survey was conducted in the Estonian EEZ (the ICES Sub-divisions 28.2, 29 and 32).

The Estonian Data Collection Program for 2021 and the European Union (by the European Union (EU) Fisheries Data Collection Programme for 2021 (the Regulation (EU) 2017/1004 of the European Parliament and of the Council of 17 May 2017, and European Commission Implementing Decision (EU) 2019/909 of 18 February 2019 on the establishment of a Union Framework for the collection, management and use of the data in the fisheries sector and support for scientific advice regarding the common fisheries policy Regulations No. 2016/1251) financially supported the EST-POL BIAS 2021. Timing, surveying area in the north-eastern Baltic Sea and the principal methods of investigations concerning the above mentioned survey were designed and coordinated by the ICES WGBIFS (ICES 2021).

The main aims of the reported cruise were:

- to provide the echo-integration and to collect the acoustic data along the planned transects in the north-eastern Baltic Sea,
- to conduct the fish pelagic control-catches in the fish concentration locations,
- to collect ichthyological samples especially for herring and sprat,
- to provide hydrological monitoring (water temperature, salinity and oxygen content) at the catch locations.

Personnel

The BIAS October 2021 survey scientific staff was composed of 8 persons:

K. Koszarowski (NMFRI, Gdynia – Poland) – survey leader, ichthyologist,
M. Bielak (NMFRI, Gdynia – Poland) – acoustician,
B. Witalis (NMFRI, Gdynia – Poland) – hydrologist,
R. Zaporowski (NMFRI, Gdynia – Poland) – ichthyologist,
P. Pankowski (NMFRI, Gdynia – Poland) – ichthyologist,
K. Choma-Stolarek (NMFRI, Gdynia – Poland)- ichthyologist,
W. Deluga (NMFRI, Gdynia – Poland) – ichthyologist,
S. Trella (NMFRI, Gdynia – Poland) – ichthyologist

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1) ICES. 2021. ICES Working Group on Baltic International Fish Survey (WGBIFS). ICES Scientific Reports. 3:80. 490 pp. https://doi.org/10.17895/ices.pub.8248

Narrative

The reported survey took place during the period of 22.10 – 01.11.2021. The at sea investigations (echo-integration, fish control catches, hydrological and plankton stations) were conducted aboard r.v. "Baltica" within Estonian EEZ (the ICES Sub-divisions 28.2, 29 and 32), moreover inside the territorial waters of this country not shallower than 20 m depth. Due to weather conditions, on October 22, 2021 (evening hours), the vessel was forced to shelter (protection from bad weather) in the Gulf of Riga and started research the next day from the first planned point of the transect. Echo-integration began when the border of the Estonian EEZ was crossed. The at sea investigations ended on 30.10.2021 in the late afternoon in the Estonian EEZs. Then the r.v. "Baltica" started her journey to the home-port in Gdynia (Poland), arriving in the morning on 01.11.2021.

Survey design and realization

The r.v. "Baltica" surveyed 803,5 Nm echo-integration transect and 20 fish control-catches (Fig. 1). All planned ICES rectangles were covered with acoustic transect and control catches. All control catches were performed in the daylight using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The hauls trawling duration varied from 5 to 30 minutes due to different fish densities observed on the net-sounder monitor. The mean speed of vessel while providing echo-integration was 8.0 knots, but 3.0 knots in case of trawling. Overall, 4, 7 and 9 hauls were conducted in SDs 28.2, 29, and 32, respectively.

The length measurements (in 0.5 cm classes) were realized for totally 3755 sprat and 2181 herring individuals. Totally, 1307 sprat and 1250 herring individuals were taken for biological analysis.

Acoustic data were collected using the EK-60 echo-sounder equipped with "Echo-view V4.10" software for the data analysis. The acoustic equipment was calibrated at sea in the Gulf of Gdańsk before the survey, according to the methodology described in the IBAS manual (ICES, 2017). The basic acoustic and biological data collected during recently carried out BIAS will be delivered to the EMIUT laboratories for further elaboration. Next they will be stored in the BASS_DB.mdb and the new acoustic data base WKBIFS-ACOU in the accepted CSV or XML formats, managed by ICES.

The rosette sampler with connected CTD Seabird 911+ probe were used for hydrological sampling.

Data analysis

The MYRIAX "EchoView v.10.0" software was used for the analysis of the acoustic data.

The total number of fish in each the ICES rectangle was estimated as a product of the mean NASCs from scrutinized acoustic data and a rectangle area, divided by corresponding mean acoustic cross-section (σ) which is based on the trawl catch results. The abundance of clupeids was separated into sprat and herring according to the mean catch composition.

Mean target strength (TS) – one of the principal acoustic parameter – of clupeids was calculated according to following formula:

$TS = 20 \log L - 71.2$

Despite the rough weather conditions, all transects and planned trawls were conducted according to the plan.

Catch results and fish measurements

Overall, 12 fish species were identified in catches performed at the north-eastern Baltic Sea (SDs 28.2, 29 and 32) in October 2021. Sprat and herring dominated in 19 catches in the Estonian EEZ. Sprat dominated in 16 catches and amounted for 84.4% of the total biomass (in SD 28.2 – 35.0%; in SD 29 – 86.8%; in SD 32 – 95.2%). Mean share of herring in the total biomass was 14.2% (in SD 28.2 – 63.6%; in SD 29 – 10.5%; in SD 32 – 4.4%). Three-spined stickleback occurred in all catches and amounted for 1.3% of the total biomass share (100% in haul 16, SD 29). The other 9 fish species (cod, flounder, nine-spined stickleback, four-horned scuplin, shorthorn sculpin, vendace, broadnosed pipefish, lumpfish and smelt) represented only 0.1% of the total biomass.

The detailed catch and CPUE results are presented in the Table 1 and Fig. 2. The biological sampling is shown in Table 2.

The highest value of CPUE for sprat was noted in SD 29 and for herring in SD 28.2. The highest values of CPUEs for sprat were as follow: 591.16 kg/h in ICES SD 28.2, 4246.07 kg/h in SD 29 and 3036.32 kg/h in SD 32. The highest CPUEs values for herring were: 274,2, 281,7 and 1351,3 kg/h in SDs 28.2, 29 and 32, respectively. Three-spined stickleback prevailed among other species and amounted for 1.3% of total biomass and the highest values of CPUE were as follow: 12.95 kg/h in ICES SD 28.2, 113.36 kg/h in SD 29 and 9.67 kg/h in SD 32.

The length distributions of sprat, herring and three-spined stickleback according to the ICES Sub-divisions 28.2, 29 and 32 are shown on Fig. 3 – 5.

Sprats occurred in 19 hauls. In SD 28.2 sprats in the length classes from 7.5 to 14.5 cm occured. The length distribution in this ICES SD was bimodal. The first frequency peak was observed at 10.0 and 10.5 cm fish length – they constituted 33.8% of the measured sprats in this SD. The second largest group of sprats were individuals from 11.5 to 12.0 cm length class – 34.9% of the measured sprats. In SD 29 sprats with a length distribution from 8.0 to 13.5 cm were recorded. In this SD sprats in the length classes from 10.0 to 12.0 cm were dominating and constituted 80.4% of the measured sprats. In SD 32 sprats in the length classes from 7.5 to 13.5 cm occured. The length distribution in this ICES SD was unimodal. Sprats in the length classes from 10.0 to 11.5 cm were dominating and constituted 80.3% of measured sprats, with a visible peak for 10 cm length class (25.3%).

Herring occurred in 19 out of 20 hauls. In the SD 28.2, herrings in length classes from 10.0 to 19.5 cm were recorded. The basis for the catch in this SD were herrings in the length classes from 14.5 to 16.5 cm – they constituted 74.8% of the measured herrings. The highest frequency peak was recorded for the 16.0 cm length class – 18.5% of the measured herrings. In SD 29, herrings with a length distribution from 9.0 to 19.0 cm were recorded. The length distribution was unimodal. The basis for the catch in this SD were herrings in the length classes from 14.0 to 16.0 cm – they constituted 66.0% of the measured herrings, with the frequency peak for class 14.5 cm (16.4%). In SD 32, herrings with a length distribution from 7.5 to 22.0 cm were recorded in the measurements. The length distribution was bimodal. The first group were 12.5 cm long herrings, which constituted 15.6% of the measured fish. The second group were herrings in the length classes from 14.0 to 15.5 cm – 41.8% of all herring measurements in this SD.

The three-spined stickleback occurred in 20 hauls. During the catches individuals with a length from 3.0 to 7.0 cm were recorded. In SD 28.2, there were sticklebacks ranging from 3.5 to 7.0 cm, with the frequency peak for classes 5.5 and 6.0 cm – 75.6% of the measured fish. In the SD 29, there were three-spined sticklebacks from length classes 3.0 – 7.0 cm with the frequency peak for classes 5.5 and 6.0 cm - 66.5% of measured fish. In SD 32, the three-spined sticklebacks ranging from 3.0 to 7.0 cm were measured, with the two frequency peaks at classes 3.5 cm (19.6%) and 5.5 cm (23.5%).

Acoustic results

The survey statistics concerning the survey area, the mean NASC, the mean sigma, the estimated total number of fish, the percentages of herring and sprat per ICES statistical rectangles are presented in Table 3. Overall fish abundances were slightly lower than in previous year.

Abundance and biomass estimates

The estimated abundances of herring and sprat by age group and Sub-division/ICES statistical rectangle are given in Table 4. The estimated biomass by age group and Sub-division/ICES statistical rectangle is shown in Table 5. Corresponding mean weights by age group and Sub-division/ICES statistical rectangle are summarized in Table 6.

Sprat abundance was about slightly higher compared to previous year despite the fact that recruitment was very low. Abundance of herring was about three times lower than in the previous survey.

The final report from the EST-POL BIAS 2021 will be presented at the meeting of the ICES Baltic International Fish Survey Working Group (WGBIFS) in March 2022.

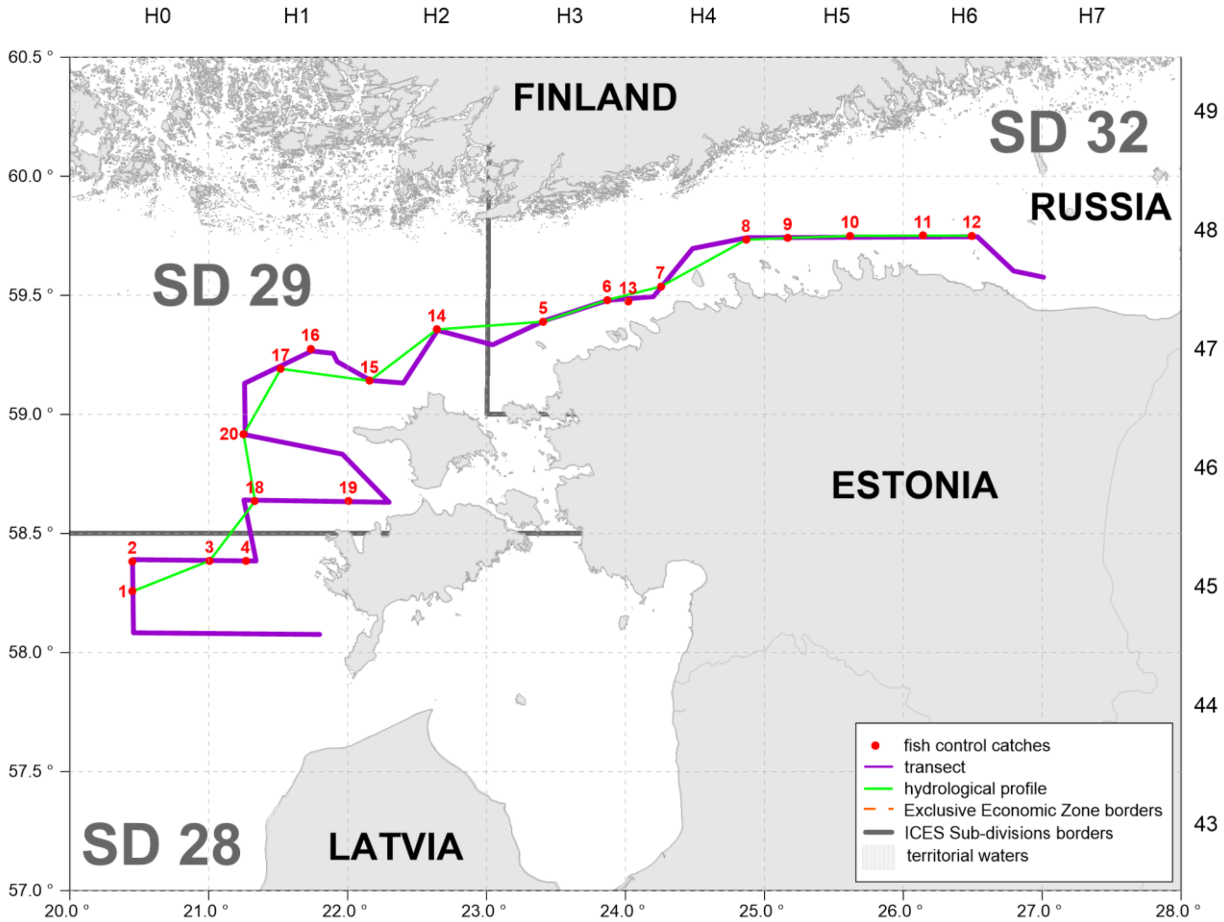

Figure 1. Locations of the fish pelagic control catches and hydrological stations during the survey (October 2021).

Table 1. Catch results during joint EST-POL BIAS conducted by r.v. “Baltica” in the Estonian EEZ in October 2021.

Haul number	Date of catch	ICES rectangle	ICES SD	Depth to fishing trawl [m]	Depth to the bottom [m]	The ship's course during fishing [°]	Geographical position of the catch station				Time of		Haul duration [min]	all species CPUE [kg/h]	Total catch	CATCH of particular fish species [kg]											
							start		end																		
							latitude 00°00' N	longitude 00°00'E	latitude 00°00' N	longitude 00°00'E	Shutting net	Pulling up net				Sprat	Herring	Cod	Flounder	Three-spined sticklebac k	Niniespine stickleback	Fourhorn scuplin	Shorthorn sculpin	Vendace	Broadnosed pipefish	Lumpfish	Smelt
1	2021-10-24	45H0	28.2	40-75	141	355°	58°16' 1	020°27′ 0	58°17′ 6	020°26′ 9	09:40	10:10	30	187,4	93,703	4,786	88,02	0,343		0,554							
2	2021-10-24	45H0	28.2	55-80	142	090°	58°23' 0	020°28′ 6	58°20' 1	020°30′ 3	11:35	11:55	20	468,5	156,151	15,55	136,131	0,138		4,316	0,016						
3	2021-10-24	45H1	28.2	60-85	100	085°	58°23' 2	021°02′ 2	58°23' 5	021°04′ 8	14:35	15:05	30	160,2	80,091	20,19	59,505			0,392	0,004						
4	2021-10-24	45H1	28.2	45-70	84	080°	58°23' 2	021°17′ 6	58°23' 4	021°18′ 8	16:25	16:40	15	835,2	208,796	147,79	59,173			1,585		0,053				0,195	
5	2021-10-25	47H3	32	30-48	104	070°	59°23' 5	023°26′ 0	59°23' 7	023°26′ 8	09:00	09:10	10	3062,6	510,426	506,053	3,601			0,537	0,062					0,173	
6	2021-10-25	47H3	32	35-52	89	070°	59°28' 6	023°53′ 3	59°28' 7	023°54′ 0	11:55	12:05	10	943,9	157,317	149,184	7,280			0,815	0,016						0,022
7	2021-10-25	48H4	32	45-68	80	040°	59°32' 6	024°15′ 0	59°33' 2	024°17' 4	15:25	15:40	15	620,8	155,189	127,974	24,349			2,418	0,057		0,074				0,317
8	2021-10-26	48H4	32	20-40	76	090°	59°44' 2	024°53′ 7	59°44' 3	024°55′ 1	07:55	08:10	15	1858,9	464,729	452,727	10,961			0,977	0,064						
9	2021-10-26	48H5	32	35-58	88	085°	59°44' 5	025°11′ 6	59°44' 6	025°12′ 4	09:40	09:50	10	2219,4	369,903	339,755	29,193			0,92	0,035						
10	2021-10-26	48H5	32	35-53	85	090°	59°45' 1	025°38′ 5	59°45' 1	025°39' 4	12:00	12:10	10	763,1	127,183	121,2	5,19			0,718	0,019						0,056
11	2021-10-26	48H6	32	25-50	77	090°	59°45' 0	026°09′ 9	59°45' 0	026°11′ 0	14:30	14:45	15	893,6	223,390	218,148	4,797			0,415	0,008						0,022
12	2021-10-26	48H6	32	20-38	79	095°	59°45' 0	026°30′ 9	59°44' 9	026°31′ 9	16:25	16:35	10	634,3	105,723	98,035	7,087			0,419	0,01			0,021			0,151
13	2021-10-27	47H4	32	40-60	85	075°	59°28' 3	024°01′ 8	59°28' 5	024°03′ 0	09:15	09:30	15	226,2	56,559	52,975	2,275			1,301	0,008						
14	2021-10-28	47H2	29	50-75	112	215°	59°20' 4	022°37′ 6	59°19' 8	022°36′ 8	09:00	09:15	15	750,3	187,571	124,624	62,096			0,736	0,007					0,108	
15	2021-10-28	47H2	29	45-65	74	275°	59°08' 7	022°08′ 3	59°08' 8	022°07′ 9	12:30	12:35	5	4257,7	354,808	353,839	0,442			0,297						0,191	0,039
16	2021-10-28	47H1	29	15-35	108	220°	59°16' 2	021°43′ 8	59°15' 7	021°42′ 1	15:10	15:25	15	113,4	28,340					28,34							
17	2021-10-28	47H1	29	40-67	108	225°	59°12' 4	021°31′ 0	59°11' 8	021°30′ 6`	16:30	16:50	20	215,1	71,710	63,783	7,137			0,787	0,003						
18	2021-10-29	46H1	29	50-75	83	055°	58°38' 6	021°21' 4	58°39' 3	021°22' 9	08:15	08:35	20	1416,0	471,996	463,115	8,578			0,255							0,048
19	2021-10-29	46H2	29	18-40	43	025°	58°38' 7	022°01′ 1	58°39' 4	022°02′ 0	11:50	12:05	15	490,8	122,705	121,368	0,614		0,235	0,358	0,128				0,002		
20	2021-10-30	46H1	29	40-91	91	360°	58°55' 8	021°15′ 3	58°57' 3	021°15′ 7	11:50	12:20	30	341,4	170,723	95,371	68,876	0,23		6,246							
													Total catch [kg]	SD 32	2170,42	2066,05	94,73	0,00	0,00	8,52	0,28	0,00	0,07	0,02	0,00	0,17	0,57
														SD 29	1407,85	1222,10	147,74	0,23	0,24	37,02	0,14	0,00	0,00	0,00	0,00	0,30	0,09
														SD 28.2	538,74	188,32	342,83	0,48	0,00	6,85	0,02	0,05	0,00	0,00	0,00	0,20	0,00
														SUM	4117,013	3476,47	585,31	0,71	0,24	52,39	0,44	0,05	0,07	0,02	0,00	0,67	0,66

Table 2. Biological sampling in the r.v.”Baltica” joint EST-POL BIAS in October 2021.

SD 28.2

		Sprat	Herring	Cod	Flounder	Three-spined stickleback	Niniespine stickleback	Fourhorn sculpin	Shorthorn sculpin	Vendace	Broadnosed pipefish	Lumpfish	Smelt	TOTAL
Samples taken	Measurments	4	4	2		4	2	1				1		18
	Analyses	4	4											8
Fish measured		731	812	4		266	3	1				1		1818
Fish analysed		298	359											657

SD 29

		Sprat	Herring	Cod	Flounder	Three-spined stickleback	Niniespine stickleback	Fourhorn sculpin	Shorthorn sculpin	Vendace	Broadnosed pipefish	Lumpfish	Smelt	TOTAL
Samples taken	Measurments	6	6	1	1	7	3				1	2	2	29
	Analyses	6	4											10
Fish measured		1209	591	2	2	340	42				1	2	2	2199
Fish analysed		429	314											743

SD 32

		Sprat	Herring	Cod	Flounder	Three-spined stickleback	Niniespine stickleback	Fourhorn sculpin	Shorthorn sculpin	Vendace	Broadnosed pipefish	Lumpfish	Smelt	TOTAL
Samples taken	Measurments	9	9			9	9		1	1		1	5	45
	Analyses	9	9											18
Fish measured		1815	778			536	43		1	1		1	24	3200
Fish analysed		580	577											1157

TOTAL

		Sprat	Herring	Cod	Flounder	Three-spined stickleback	Niniespine stickleback	Fourhorn sculpin	Shorthorn sculpin	Vendace	Broadnosed pipefish	Lumpfish	Smelt	TOTAL
Samples taken	Measurments	19	19	3	1	20	14	1	1	1	1	4	7	91
	Analyses	19	17											36
Fish measured		3755	2181	6	2	1142	88	1	1	1	1	4	26	7208
Fish analysed		1307	1250											2557

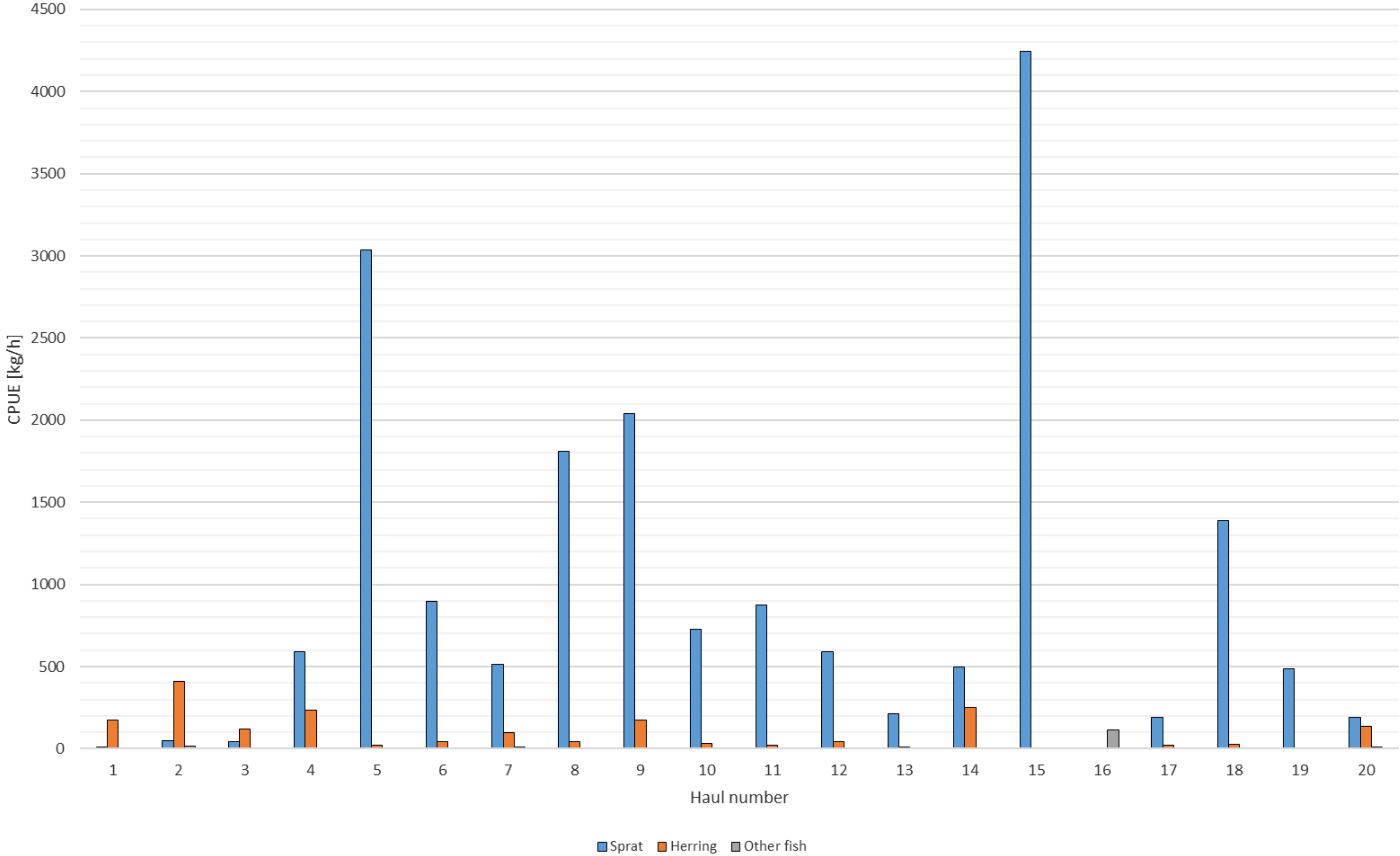

Figure 2. CPUE (kg/h) of sprat, herring and other fish species in particular pelagic fish control catches during the joint EST-POL BIAS in the north-eastern Baltic Sea (Sub-divisions 28.2, 29 and 32), October 2021

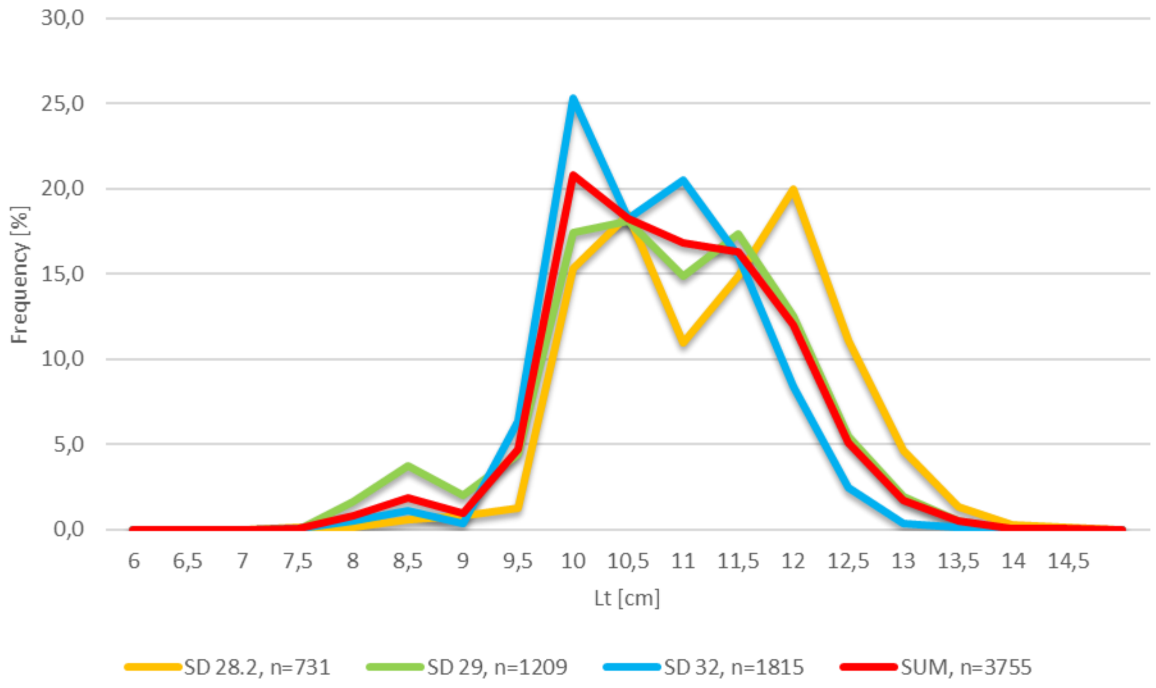

Figure 3. Sprat length distributions from the control catches conducted by the r.v. "Baltica" during joint EST-POL BIAS in the SDs 28.2, 29 and 32 (October 2021).

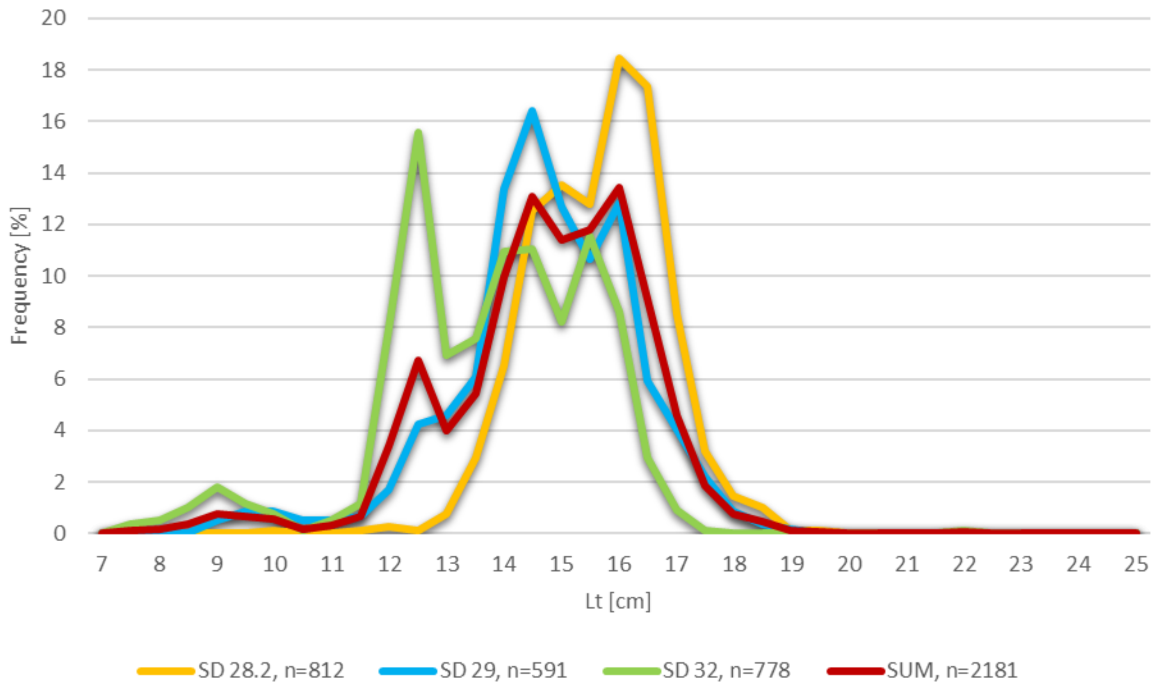

Figure 4. Herring length distributions from the control catches conducted by the r.v. "Baltica" during joint EST-POL BIAS in the SDs 28.2, 29 and 32 (October 2021).

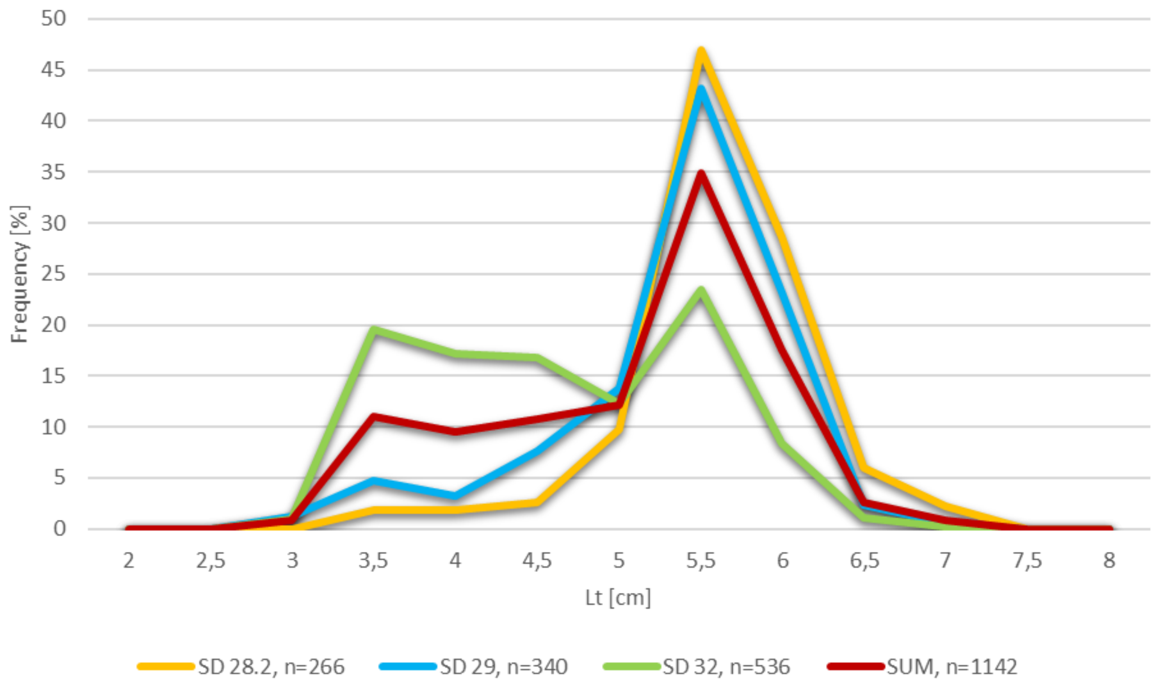

Figure 5. Three spined stickleback length distributions from the control catches conducted by the r.v. "Baltica" during joint EST-POL BIAS in the SDs 28.2, 29 and 32 (October 2021).

Table 3. The BIAS survey basic biological and acoustic data concerning the clupeid stocks inhabiting the north- eastern Baltic Sea in October 2021.

ICES Sub-div.	ICES rectangle	Area [NM^2]	Share [%-indiv.]		Total abundance [x10^6]	Abundance density [10^6/NM^2]	NASC [m^2/NM^2]	σ [cm²]
			herring	sprat				
28	45H0	947.2	70.4	14.6	3411.52	3.602	700.0	1.944
28	45H1	827.1	33.1	62.3	4694.27	5.676	926.9	1.633
29	46H1	921.5	9.9	79.5	16373.94	17.769	2282.4	1.284
29	46H2	258.0	0.2	96.5	1091.12	4.229	499.7	1.181
29	47H1	920.3	2.2	45.2	7371.04	8.009	591.7	0.739
29	47H2	793.9	8.1	90.5	13791.70	17.372	1930.7	1.111
32	47H3	536.2	1.4	96.3	26122.10	48.717	5480.9	1.125
32	48H4	835.1	4.2	89.3	11221.05	16.064	1500.2	1.117
32	48H5	767.2	3.4	93.2	12164.68	13.437	1851.3	1.168
32	48H6	776.1	2.0	95.7	19538.59	15.856	2820.7	1.120
Average			**13.5**	**76.3**		**15.991**	**1858.5**	**1.24**
Total		**8434**			**115780**			

Table 4. Abundance (in 10^6 indiv.) of herring and sprat per age groups according to the ICES rectangles and Sub-divisions of the north-eastern Baltic in October 2021.

ICES	ICES rectangle	HERRING – age groups									
Sub-div.		0	1	2	3	4	5	6	7	8+	total
28	45H0		50.41	931.86	493.03	325.02	198.60	327.64	59.89	15.06	2401.52
28	45H1	10.56	56.61	562.12	301.56	217.84	133.88	217.17	40.68	11.50	1551.93
total		10.56	107.02	1493.98	794.60	542.86	332.48	544.81	100.57	26.57	3953.45
29	46H1	27.48	56.87	731.12	261.29	153.72	119.35	204.67	43.24	19.32	1617.07
29	46H2		0.33	0.24	0.21	0.18	0.19	0.45	0.01	0.36	1.97
29	47H1	6.48	6.85	88.02	17.78	11.31	8.68	16.81	2.80	1.41	160.14
29	47H2	12.73	268.61	594.92	96.03	49.30	33.84	48.66	12.21	5.44	1121.74
total		46.69	332.65	1414.29	375.31	214.51	162.07	270.60	58.27	26.53	2900.93
32	47H3	61.89	85.07	92.45	35.40	45.46	16.95	17.54	7.14		361.91
32	48H4	14.55	114.40	168.49	52.44	61.91	24.67	20.51	11.81		468.77
32	48H5	21.62	195.47	138.65	25.27	23.05	6.11	4.39	2.25	1.90	418.71
32	48H6	12.07	85.23	116.18	50.81	61.96	27.52	23.73	15.16		392.65
total		48.24	395.10	423.32	128.52	146.93	58.30	48.62	29.21	1.90	1280.13
Grand total		**167.38**	**919.85**	**3424.04**	**1333.83**	**949.75**	**569.80**	**881.58**	**195.19**	**54.99**	**8496.42**

Table 4. Continued

ICES	ICES rectangle	SPRAT – age groups									
Sub-div.		0	1	2	3	4	5	6	7	8+	Total
28	45H0	11.01	243.71	85.79	32.66	38.84	23.38	21.33	29.51	11.04	497.27
28	45H1	19.66	897.24	642.03	270.32	326.03	203.80	200.78	255.53	110.20	2925.58
total		30.67	1140.94	727.82	302.97	364.87	227.18	222.12	285.04	121.24	3422.85
29	46H1		3917.64	3940.14	1632.42	1533.57	669.97	369.04	818.87	135.57	13017.22
29	46H2	3.93	418.30	370.84	90.63	93.33	28.28	9.79	33.70	4.15	1052.95
29	47H1	127.73	1608.85	873.74	238.57	238.66	84.12	38.80	104.06	14.69	3329.22
29	47H2	2198.03	6784.81	1977.52	531.43	498.59	186.65	67.02	211.01	22.42	12477.49
total		2329.69	12729.59	7162.25	2493.05	2364.16	969.03	484.64	1167.64	176.83	29876.88
32	47H3	1080.71	11360.13	8477.32	1328.78	1213.45	571.42	307.01	774.63	30.30	25143.75
32	48H4	284.94	4568.05	3492.10	520.26	499.39	220.28	91.17	342.86		10019.05
32	48H5	139.26	4263.09	4546.30	723.75	724.47	334.92	141.27	460.92		11333.99
32	48H6	275.65	9953.78	5891.40	795.38	735.71	322.62	169.38	522.17	23.59	18689.67
total		1780.55	30145.05	22407.13	3368.16	3173.02	1449.25	708.83	2100.58	53.89	65186.47
Grand total		4140.91	44015.58	30297.19	6164.18	5902.06	2645.46	1415.59	3553.26	351.96	98486.20

Table 5. Biomass (in tons) of herring and sprat per age groups according to the ICES rectangles and Sub-divisions of the north-eastern Baltic in October 2021.

ICES	ICES rectangle	HERRING – age groups									
Sub-div.		0	1	2	3	4	5	6	7	8+	total
28	45H0		890.11	18645.26	11611.98	8014.01	5185.92	8591.12	1660.34	443.54	55042.27
28	45H1	104.64	853.55	11094.70	7147.38	5370.35	3484.15	5640.46	1142.96	333.10	35171.30
total		104.64	1743.66	29739.96	18759.36	13384.35	8670.07	14231.58	2803.30	776.65	90213.57
29	46H1	152.71	701.84	14240.85	5877.96	3647.28	2865.45	5095.00	1108.34	473.25	34162.65
29	46H2		2.96	4.62	5.01	4.60	4.72	11.41	0.32	12.10	45.74
29	47H1	28.09	58.62	1565.86	380.30	258.49	203.38	405.66	61.48	32.14	2994.01
29	47H2	74.56	3123.31	9918.49	2021.94	1084.75	731.07	1056.61	278.86	124.59	18414.17
total		255.35	3886.73	25729.81	8285.21	4995.12	3804.62	6568.67	1448.99	642.07	55616.57
32	47H3	215.58	990.12	1509.09	718.92	955.21	366.96	416.34	156.95		5329.17
32	48H4	87.49	1346.84	2722.95	1011.89	1247.67	526.16	448.97	262.48		7654.45
32	48H5	121.87	2208.58	2161.19	463.54	444.09	125.92	93.97	49.46	137.79	5806.40
32	48H6	53.81	994.19	1877.72	1005.16	1277.13	602.38	530.83	342.32		6683.54
total		478.75	5539.73	8270.94	3199.51	3924.10	1621.42	1490.12	811.21	137.79	25473.56
Grand total		838.74	11170.12	63740.71	30244.08	22303.58	14096.11	22290.37	5063.50	1556.51	171303.70

Table 5. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups									
		0	1	2	3	4	5	6	7	8+	total
28	45H0	49.40	1788.79	814.09	335.50	403.87	252.98	249.84	324.38	130.35	4349.20
28	45H1	65.46	6796.02	6128.96	2806.44	3424.33	2235.24	2330.40	2859.40	1318.28	27964.52
total		114.86	8584.81	6943.05	3141.94	3828.19	2488.21	2580.24	3183.79	1448.63	32313.73
29	46H1		29867.64	36751.05	17031.78	15926.41	7274.08	4374.20	9028.35	1627.07	121880.59
29	46H2	15.72	3041.17	3348.80	910.94	919.15	297.06	113.00	348.06	47.90	9041.78
29	47H1	481.25	11242.97	7791.48	2358.02	2333.48	867.49	438.91	1075.13	168.60	26757.34
29	47H2	8413.12	46233.64	17460.81	5381.14	4980.13	1958.86	754.62	2208.80	256.48	87647.62
total		8910.09	90385.42	65352.14	25681.89	24159.17	10397.49	5680.74	12660.35	2100.05	245327.33
32	47H3	4122.95	77449.06	71969.58	12574.65	11971.44	5649.09	3341.61	7358.04	345.41	194781.83
32	48H4	1203.04	30954.04	29677.28	4766.00	4750.76	2077.40	931.93	3180.44		77540.89
32	48H5	635.93	29052.05	38329.54	6589.61	6820.27	3125.37	1483.28	4270.47		90306.53
32	48H6	1302.76	67892.51	49618.11	7216.89	7061.78	3032.32	1869.95	4951.18	292.50	143238.01
total		7264.69	205347.66	189594.51	31147.16	30604.25	13884.17	7626.77	19760.14	637.91	505867.26
Grand total		16289.64	304317.89	261889.71	59970.99	58591.61	26769.87	15887.76	35604.27	4186.58	783508.32

Table 6. Mean weight (in grams) of herring and sprat per age groups, according to the ICES rectangles of the north-eastern Baltic in October 2021.

ICES Sub-div.	ICES rectangle	HERRING – age groups									
		0	1	2	3	4	5	6	7	8+	avg.
28	45H0		17.66	20.01	23.55	24.66	26.11	26.22	27.72	29.44	22.92
28	45H1	9.90	15.08	19.74	23.70	24.65	26.02	25.97	28.09	28.96	22.66
29	46H1	5.56	12.34	19.48	22.50	23.73	24.01	24.89	25.63	24.50	21.13
29	46H2		9.00	19.36	23.71	25.16	25.09	25.15	26.00	33.75	23.17
29	47H1	4.34	8.56	17.79	21.39	22.85	23.42	24.13	21.96	22.78	18.70
29	47H2	5.86	11.63	16.67	21.06	22.00	21.60	21.71	22.83	22.90	16.42
32	47H3	3.48	11.64	16.32	20.31	21.01	21.65	23.73	21.97		14.73
32	48H4	6.01	11.77	16.16	19.29	20.15	21.33	21.89	22.23		16.33
32	48H5	5.64	11.30	15.59	18.34	19.27	20.60	21.42	22.02	72.60	13.87
32	48H6	4.46	11.67	16.16	19.78	20.61	21.89	22.37	22.58		17.02

Table 6, Continue

ICES Sub-div.	ICES rectangle	SPRAT – age groups									
		0	1	2	3	4	5	6	7	8+	avg.
28	45H0	4.49	7.34	9.49	10.27	10.40	10.82	11.71	10.99	11.81	8.75
28	45H1	3.33	7.57	9.55	10.38	10.50	10.97	11.61	11.19	11.96	9.56
29	46H1		7.62	9.33	10.43	10.39	10.86	11.85	11.03	12.00	9.36
29	46H2	4.00	7.27	9.03	10.05	9.85	10.50	11.55	10.33	11.55	8.59
29	47H1	3.77	6.99	8.92	9.88	9.78	10.31	11.31	10.33	11.48	8.04
29	47H2	3.83	6.81	8.83	10.13	9.99	10.49	11.26	10.47	11.44	7.02
32	47H3	3.82	6.82	8.49	9.46	9.87	9.89	10.88	9.50	11.40	7.75
32	48H4	4.22	6.78	8.50	9.16	9.51	9.43	10.22	9.28		7.74
32	48H5	4.57	6.81	8.43	9.10	9.41	9.33	10.50	9.27		7.97
32	48H6	4.73	6.82	8.42	9.07	9.60	9.40	11.04	9.48	12.40	7.66

Meteorological and hydrological characteristics.

The 20 control catches and hydrological stations were inspected with the CTD-probe combined with the rosette sampler. Oxygen content was determined by the standard Winkler's method. The CTD raw data aggregated to the 1-m depth stratum. Meteorological parameters were measured by MicroStep-MIS AMS 111 automatic weather station.
The wind speed varied from 0.5 m/s to 17.8 m/s and average speed was 9.6 m/s The most often wind direction was SW. The air temperature ranged from 5.7 °C to 14.0 °C, and average temperature was 9.7 °C.

The seawater temperature in the surface layers (Fig. 7.) varied from 8,47 to 11.10°C and the mean was 9.82°C. The lowest surface temperatures were recorded at the haul 9. The highest ones were noticed at the haul 4. The minimum value of salinity in Practical Salinity Unit (PSU) was 5,31 at the haul 12. The maximum was 7,33 at the haul 4. The mean value of salinity was 6,55. The oxygen content in the surface layers of investigated the research area varied in the range of 6.84 ml/l at the haul 4 to 7.89 ml/l at the haul 12. The mean value of surface water oxygen content was 7.30 ml/l.

The temperature of near bottom (Fig. 8) layer was changing in the range of 5.15 at the haul 12 to 10.26°C at the haul 1, the mean was 6.31°C. Salinity in the bottom waters varied from 7.09 to 11.38 PSU, and the mean was 9.17 in the PSU. The low values of salinity was at the haul 15. The highest values of salinity were noticed at the haul 1. Oxygen content varied from 0.00 ml/l to 7.25 ml/l and the mean was 2.34 ml/l. The zero values of this parameter were noticed at the hauls: 1, 2 and 17.

The vertical distribution of the seawater temperature salinity and oxygen content along the hydrological transect is presented on the figure 9. The analysis of the drawing shows that there was not the water optimal conditions for the successful spawning of cod.

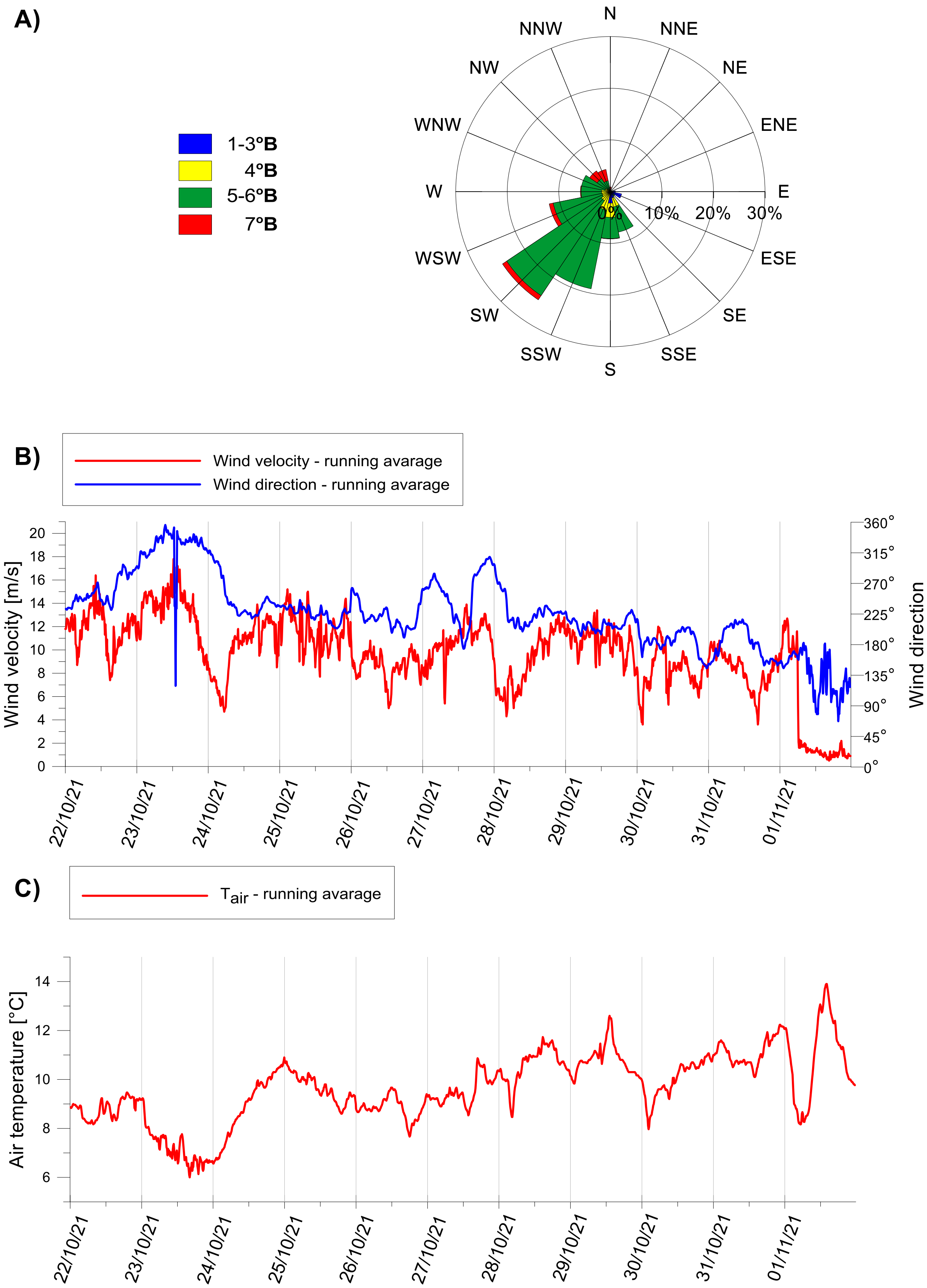

Figure 6. Changes of the main meteorological parameters (October 2021).

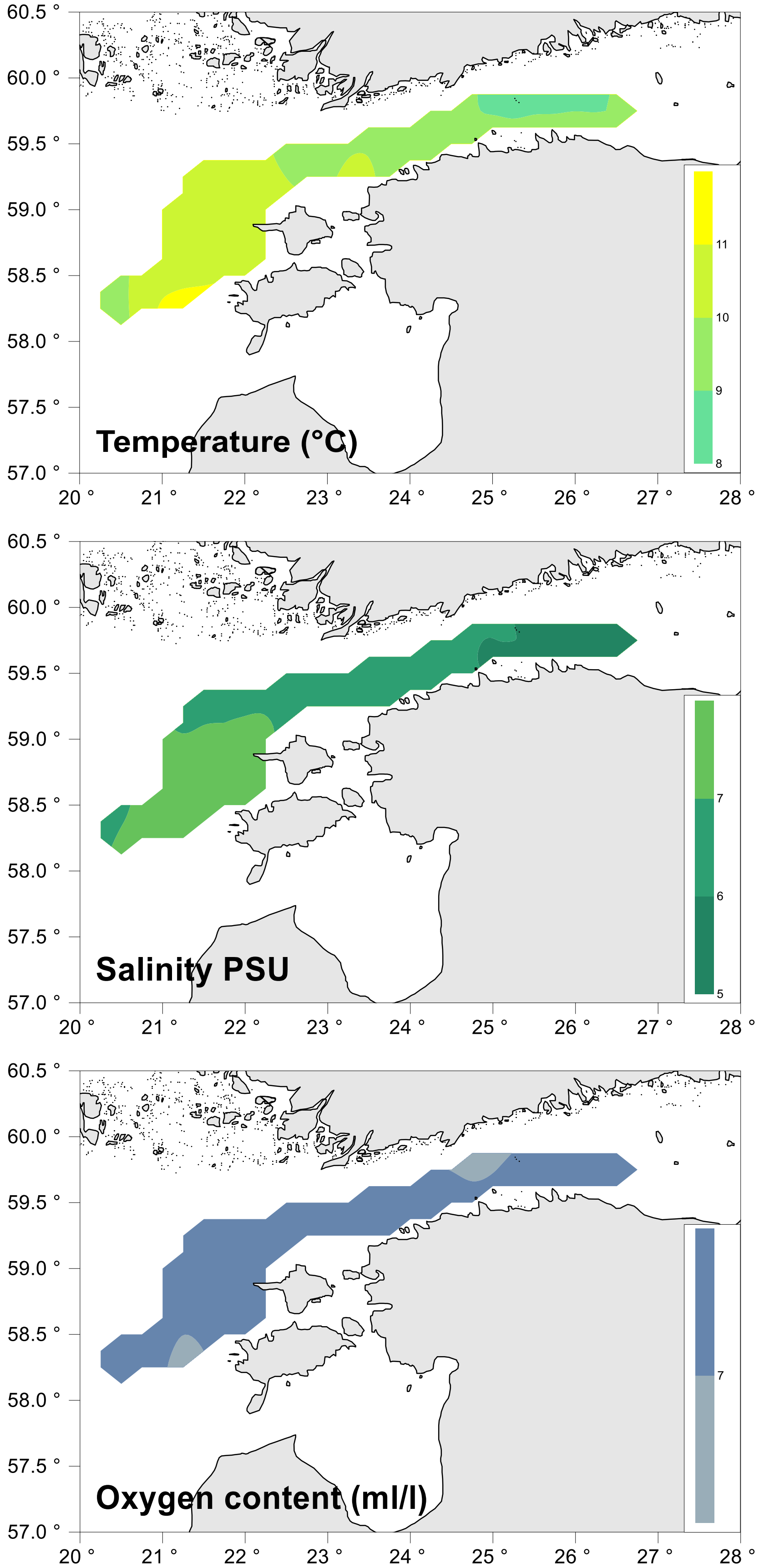

Figure 7. Distribution of the seawater temperature, salinity and oxygen content in the in the surface waters (October 2021).

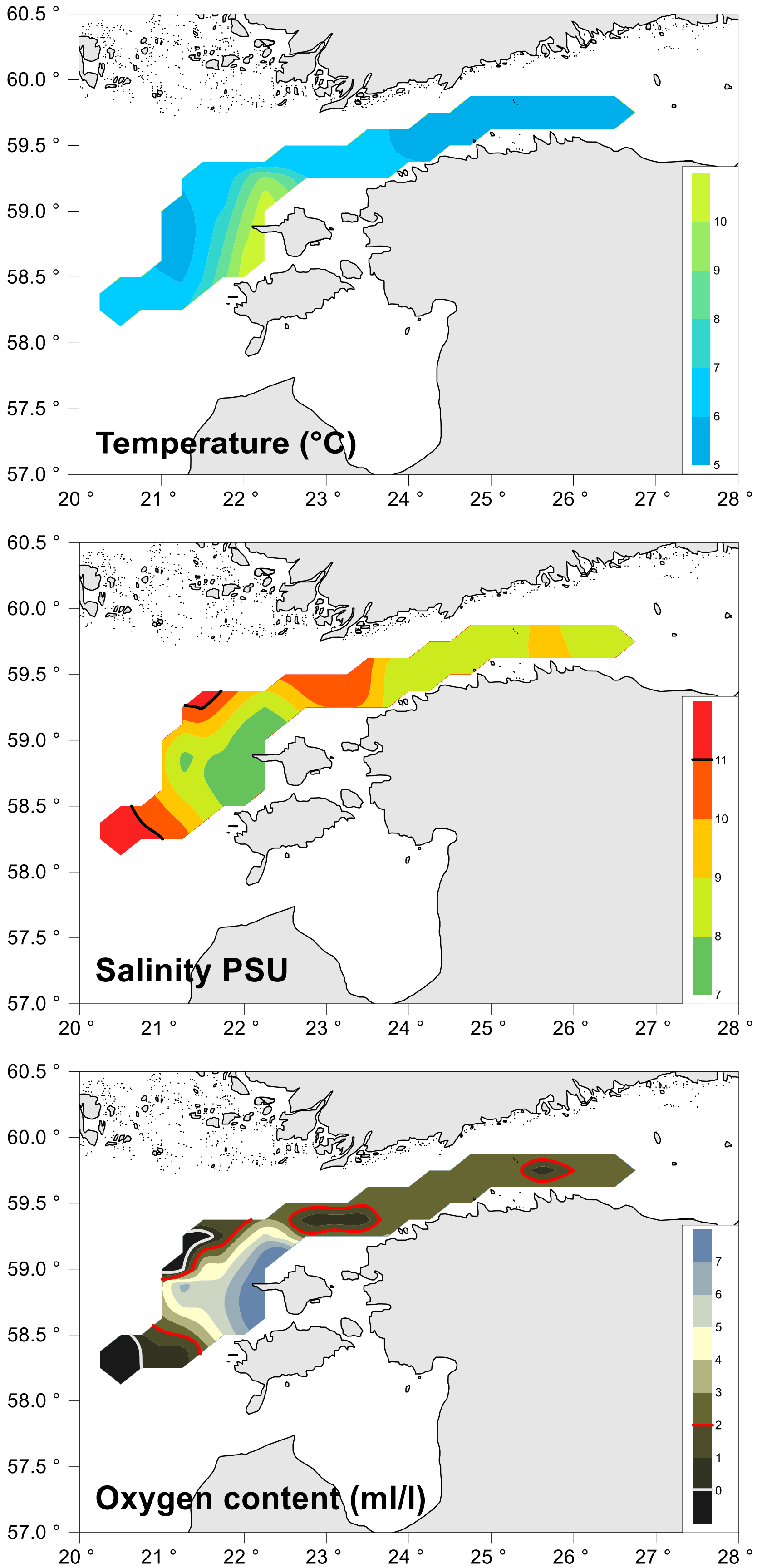

Figure 8. Distribution of the seawater temperature, salinity and oxygen content in the near bottom waters (October 2021).

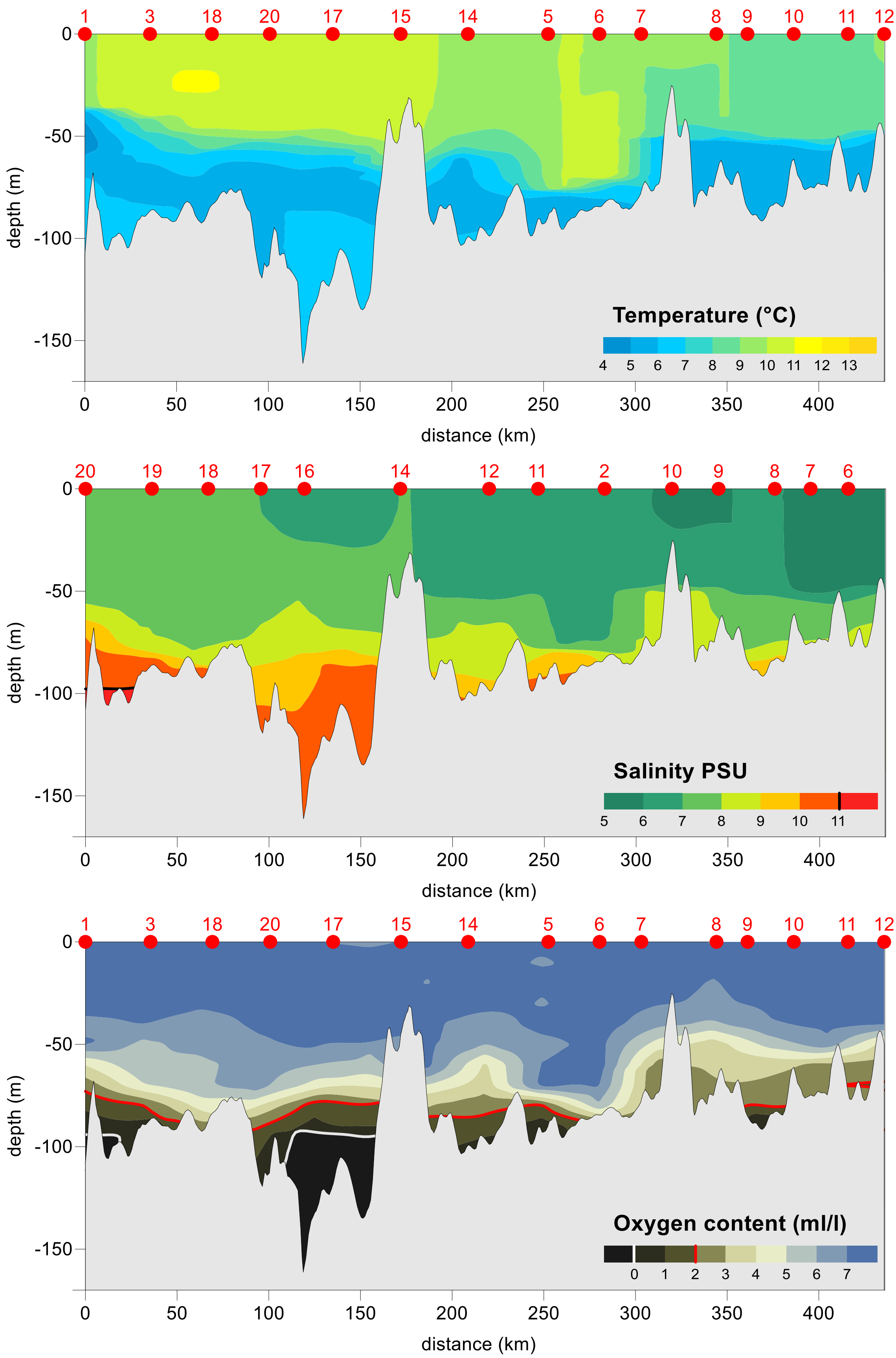

Figure 9. Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological profile (October 2021).

Baltic International Acoustic Survey

Report for R/V Aranda

Cruise 9/2021

ICES_BIAS_2021

21st September – 4th October 2021

Juha Lilja and Jukka Pönni

INTRODUCTION

International hydroacoustic surveys have been conducted in the Baltic Sea since 1978 (Håkansson et al. 1979). The initial Finnish-Estonian (FIN-EST) research survey on the R/V Baltica was realised in October 2006 (Grygiel et al. 2007), in the framework of the long-term ICES Baltic International Acoustic Surveys (BIAS) programme. The FIN-EST BIAS surveys on the R/V Baltica were continued until 2012. Since 2007, Finland and Sweden joined together to additionally cover Bothnian Sea (ICES Subdivision 30). In 2012 Sweden could not support the funding of the survey in the Bothnian Sea due to economic difficulties within the DCF program and therefore the coverage of the SD30 had to be based on Finnish funding which resulted in half the normal effort (ICES 2013). In 2013, Finland installed fishing equipment and a Simrad EK60 echo sounder into the R/V Aranda and used the vessel in order to cover ICES SDs 29N, 30, and 32N. In 2017, the R/V Aranda was in dry dock for major renovation and therefore Danish R/V Dana was hired for Finnish BIAS2017 survey. Since 2018, R/V Aranda was used again.

The Baltic International Acoustic Survey (BIAS), is mandatory for the countries that have exclusive economic zone (EEZ) in the Baltic Sea, and is a part of the Data Collection Framework. The BIAS survey in September/October are co-ordinated and managed by the ICES working group WGBIFS. The main objective of BIAS is to assess clupeoid resources in the Baltic Sea. The survey will provide data to the ICES Baltic Fisheries Assessment Working Group (WGBFAS). The aim of the cruise was to carry out Baltic International Acoustic Survey on herring and sprat covering SDs 29N, 30, and 32N during the autumn 2021, within the remit of the Natural Resources Institute Finland (Luke).

MATERIALS AND METHODS

NARRATIVE

The cruise was completed in two legs covering most of the Bothnian Sea (BS), the Northern Baltic Sea and the Gulf of Finland (GoF). Altogether 44 stations of 49 planned were completed during the survey. The research area, cruise track and trawl stations are shown in Figure 1. At every trawl station and calibration site a CTD (Conductivity Temperature Depth) cast was made.

The R/V Aranda departed from the harbour of Helsinki (Finland) on Sat 21.09.2021 at 20:00 (UTC 17:00) and the direct at sea research begun. Investigations were continued in the northern direction to SD 30. All at sea research were finalised in the morning 04.10.2020 and the vessel was navigated back to the port of Helsinki.

The Finnish BIAS 2021 survey had only a slight deviation from the original plan when the trawling could not be performed due to low fish abundance and stormy weather. In addition, Swedish authorities didn’t allow us to use scientific echo-sounder in the territorial water of Sweden. Therefore, we have not done any research investigations in the Swedish territorial areas.

SURVEY DESIGN AND HYDROGRAPHICAL DATA

During the cruise, echo-integration was performed along the survey track from ICES Sub-Divisions 29N, 30, and 32N. A SeaBird CTD instrument (SBS 19 plus) was used with state-of-the-art sensors for salinity, temperature, oxygen, connectivity and depth.

CALIBRATION

The SIMRAD EK60 echo sounder with 38 kHz transducer was calibrated on 16.9.2021 on (N60°26.39’, E022°13.15’), according to manuals (ICES 2017; Demer *et al*. 2015). The reference target strength of the 60 mm diameter copper sphere under the prevailing conditions was calculated using a web page application (https://swfscdata.nmfs.noaa.gov/AST/SphereTS/). Values from the calibration were within required accuracy (RMS = 0.08 dB)

ACOUSTIC DATA COLLECTION

The acoustic sampling was performed around the clock. SIMRAD EK60 echo sounder with the 38 kHz drop keel mounted transducer (ES38B) was used for the acoustic data collection. The settings of the hydroacoustic equipment were as described in the IBAS manual (ICES 2017). The post processing of the stored raw data was done using the Echoview software (www.echoview.com). The mean volume back scattering values (Sv) were integrated over 1 nautical mile elementary distance sampling units (ESDUs) from 10 m below the surface to the bottom at 10 m intervals.

DATA ANALYSIS

The pelagic target species sprat and herring are usually distributed in mixed layers in combination with other species so that it is impossible to allocate the integrator readings to a single species. Therefore, the species composition was based on the trawl catch results. For each rectangle the species composition and length distribution were determined as the unweighted mean of all trawl results in this rectangle. In the case of lack of sample hauls within an individual ICES rectangle (due to gear problems, bad weather conditions or other limitations) a mean from hauls from neighbouring rectangles was used. From these distributions the mean acoustic cross-section was calculated according to the target strength (TS) - length (L) relationships TS = m log L (cm) – a, where species specified constants m and a were found in list below.

AcoCat	SpecCat	m	a
ABZ	Ammodytes tobianus	20	-71.2
ELE	Anguilla anguilla	20	-67.5
GAR	Belone belone	20	-67.5
HER	Clupea harengus	20	-71.2
LUM	Cyclopterus lumpus	20	-67.5
ENC	Enchelyopus cimbrius	20	-67.5
ANE	Engraulis encrasicolus	20	-67.5
COD	Gadus morhua	20	-67.5
GTA	Gasterosteus aculeatus	20	-71.2
GSE	Hyperoplus lanceolatus	20	-71.2
LAR	Lampetra fluviatilis	20	-67.5
LEM	Leptoclinus maculatus	20	-67.5
LIL	Liparis liparis	20	-67.5
LUL	Lumpenus lampretaeformis	20	-67.5
WHG	Merlangius merlangus	20	-67.5
TGQ	Myoxocephalus quadricornis	20	-67.5
MYS	Myoxocephalus scorpius	20	-67.5
NEM	Neogobius melanostomus	20	-67.5
NRO	Nerophis ophidion	20	-67.5
SME	Osmerus eperlanus	20	-71.2
FLE	Platichthys flesus	20	-71.2
PLE	Pleuronectes platessa	20	-67.5
GOB	Pomatoschistus	20	-71.2
POM	Pomatoschistus microps	20	-67.5
GPT	Pungitius pungitius	20	-71.2
SAL	Salmo salar	20	-71.2
TRS	Salmo trutta	20	-71.2
MAC	Scomber scombrus	20	-84.9
TUR	Scophthalmus maximus	20	-67.5
SPR	Sprattus sprattus	20	-71.2
SYM	Symphodus	20	-67.5
ELP	Zoarces viviparus	20	-67.5

The total number of fish (total N) in one rectangle was estimated as the product of the mean area scattering cross section s_A and the rectangle area, divided by the corresponding mean cross section δ (sigma). The total number was separated into different fish species according to the mean catch composition in the rectangle.

PERSONNEL

Cruise leader during the survey was Juha Lilja from Natural Resources Institute Finland (Luke). The acoustic measurements were performed by Natural Resources Institute Finland (Luke) as well as fish sampling. The participating scientific crew can be seen in the list below.

Chief scientist:	Juha Lilja	LUKE	21.09.2021 - 04.10.2021
IT chief:	Perttu Rantanen	LUKE	21.09.2021 - 04.10.2021
	Marika Kirjakoff	SYKE	21.09.2021 - 04.10.2021
	Anu Lastumäki	SYKE	21.09.2021 - 04.10.2021
	Jukka Pönni	LUKE	21.09.2021 - 04.10.2021
	Jari Raitaniemi	LUKE	21.09.2021 - 04.10.2021
	Hannu Harjunpää	LUKE	21.09.2021 - 04.10.2021
	Arto Koskinen	LUKE	21.09.2021 - 04.10.2021
	Velimatti Leinonen	LUKE	21.09.2021 - 04.10.2021
	Erkki Jaala	LUKE	21.09.2021 - 04.10.2021
	Riku Helisevä	LUKE	21.09.2021 - 04.10.2021
	Tommi Lindroth	FISH	21.09.2021 - 04.10.2021
	Toni Nikaniemi	FISH	21.09.2021 - 04.10.2021
	Roope Lehmonen	LUKE	21.09.2021 - 04.10.2021
	Meri Helisevä	LUKE	21.09.2021 - 04.10.2021
	Markku Gavrilov	LUKE	21.09.2021 - 04.10.2021
	Pia Lindberg-Lumme	LUKE	21.09.2021 - 04.10.2021
	Rickard Yngwe	SLU	21.09.2021 - 04.10.2021
	Ulrika Tollerz-Bratteby	SLU	21.09.2021 - 04.10.2021

Luke: Luonnonvarakeskus / Natural Resources Institute Finland
SYKE: Suomen ympäristökeskus / Finnish Environment Institute
SLU: Sveriges lantbruksuniversitet / Swedish University of Agricultural Sciences

RESULTS

FISH CATCHES, BIOLOGICAL AND HYDRO-METEOROLOGICAL DATA

The number of planned trawling stations was 49. From these, 44 trawling stations were accomplished, and from those all were counted as “valid” (technically sound hauls and sufficient catch for a sample) (Table 1). The total number of trawling stations in Bothnian Sea (ICES SD 30) was 30 and 8 in northern Baltic proper (SD 29). In addition, 6 trawl hauls were done in the northern Gulf of Finland (SD 32).

The 8016 kg combined catches (Table 1) consisted of 19 fish species (7719 kg) and mostly unidentified organic matter categorized as “waste” (174 kg), but also small amounts of common jellyfish *Aurelia aurita* (121.9 kg) and the isopod *Saduria entomon*. The most common and abundant species were herring (*Clupea harengus*) (3748 kg), sprat (*Sprattus sprattus*) (2244 kg) and three-spined stickleback (*Gasterosteus aculeatus*) (1699 kg). All observed species are presented in Table 2. From the sub-samples of the 44 fish catches a total of 20628 measurements for species-specific length distributions (0,5 cm interval for herring and sprat, and 1 cm interval for other species) were performed according to Table 3.

Ten individual samples per statistical rectangle for age determination and maturity definitions by length-class were collected from herring and sprat, 4385 and 1950 samples respectively (Table 4). The mean weights for each length-class were also derived from these individual fish samples.
In addition, from BIAS survey on R/V Aranda 100 specimens of herring were collected from the Sea of Bothnia for contaminant analysis of Swedish Museum of Natural History (NRM).

Hydrographical data: temperature (°C), oxygen concentration (ml/l), salinity (psu), sound speed (m/s), oxygen concentration (% saturation), conductivity (mS/cm) and sound speed (m/s) were measured. Total of 48 CTD casts were done during the entire cruise.

ABUNDANCE ESTIMATES

The total area covered by the Finnish BIAS survey was 21527 square nautical miles (nmi^2), 29 rectangles, and after the scrutinizing, the distance used for acoustic estimates was 1512 nautical miles (nmi). The cruise track and positions of trawl hauls are shown in Figure 1. Abundance of Bothnian Sea herring in SD 30 from 2007 to 2021 with StoX calculations are shown in Figure 2. The survey statistics e.g., total abundance of herring and sprat are presented in Table 6. Estimated numbers of herring and sprat by age group in Subdivision 29 and 32 are given in Table 7 and Table 10, respectively. Corresponding mean weights by age group in Subdivision 29 and 32 are shown in Table 8 and Table 11, respectively. Estimates of herring and sprat biomass by age group in Subdivision 29 and 32 are summarized in Table 9 and Table 12, respectively.
Survey statistics for Bothnian Sea herring SD 30 based on StoX calculations in 2021 are given in Table 13. Estimated numbers, biomass, and mean weight of Bothnian Sea herring by age group in SD 30 were summarized in Table 14, Table 15, and Table 16, respectively.

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TABLES, MAP, AND FIGURES

Table 1.Trawl catches (kg) by species/category during the Finnish BIAS-survey in 2021.

Haul num.	ICES SD	Rectangle	Ammodytes tobianus	Aurelia aurita	Clupea harengus	Cyclopterus lumpus	Gadus morhua	Gasterosteus aculeatus	Hyperoplus lanceolatus	Lampetra fluviatilis	Liparis liparis	Lumpenus lampretaeformis	Myoxocephalus scorpius	Nerophis ophidion	Osmerus eperlanus	Platichthys flesus	Pomatoschistus minutus	Pungitius pungitius	Saduria entomon	Salmo salar	Scophthalmus maximus	Sprattus sprattus	Zoarces viviparus	Fish catch (kg)	"waste"
1	32	48H3		11,68	39,91			9,60							0,65			0,39				178,83		229,37	1,95
2	29	48H2		0,25	5,74			1,75	0,03						0,21			0,05	0,02			223,07		230,84	6,89
3	29	48H1		0,94	2,74	0,23		0,10						0,00				0,01	0,00			23,55		26,62	10,44
4	29	48G9			79,91			15,36	0,07					0,00	0,12			0,07	0,03			116,50	0,00	212,04	6,93
5	29	49G9		0,68	66,41			7,53						0,01			0,01	0,00			0,32	31,32		105,60	7,72
6	30	50G8			106,72			4,13						0,00				0,00				4,86	0,04	115,76	19,24
7	30	51G8			154,51			30,18	0,00					0,00					0,01	0,28		13,32	0,00	198,58	6,69
8	30	51G9			27,40			376,00	0,03					0,00								32,54		435,97	10,03
9	30	51G8			179,76			21,26	0,02					0,02					0,01			1,86	0,02	202,95	2,05
10	30	51G7			151,53			21,21		0,06				0,00					0,02			13,65	0,00	186,45	1,54
11	30	52G8			119,07			42,78						0,01				0,01	0,01			2,78		164,65	1,34
12	30	52G9			46,76			41,62						0,00				0,00	0,00	0,44		1,37		90,64	0,80
13	30	52G8			82,68			87,39			0,01			0,00								5,21		175,29	1,72
14	30	53G8			136,94			26,39						0,00								9,15		172,47	0,53
15	30	53G8			148,37			88,77	0,01					0,00			0,00		0,01	0,14		6,18		243,61	1,52
16	30	53G9			213,27			5,05			0,09								0,01			0,66		219,07	0,92
17	30	54G8			192,66			14,32		0,04				0,00					0,00					207,02	0,98
18	30	54G9			131,65			56,42				0,01		0,00								1,75		189,83	1,17
19	30	55G9			179,70			11,71						0,00				0,01				4,34		195,76	1,24
20	30	55H0			64,87			1,85							0,11							0,78		67,61	1,40
21	30	54G9			132,25			1,31	0,01		0,04			0,00	0,01			0,01	0,01			2,46		136,09	0,90
22	30	54H0			144,37			8,22			0,02			0,00	0,02				0,00			7,06		159,69	1,31
23	30	54H0			120,03			7,25							8,85		0,01					4,55	0,05	140,73	2,27
24	30	53H0			17,91			4,53						0,00	1,18			0,00				0,52	0,05	24,19	0,81
25	30	53G9			53,04			17,78	0,00		0,02			0,00	0,12				0,00			1,74		72,70	0,30
26	30	53H0			41,40			19,99	0,00		0,01			0,00	0,02			0,00	0,01			13,66		75,08	0,91
27	30	52H0			92,41			4,87	0,01		0,02			0,00	0,02		0,00	0,00				2,26	0,00	99,58	1,42
28	30	52H0			46,17			18,71					0,27					0,00	0,00			3,27	0,00	68,43	0,57
29	30	52G9	0,01		38,95			25,03						0,00						0,64		2,50		67,77	0,87
30	30	51G9			89,28			30,57						0,00					0,00			0,34		120,20	1,80
31	30	51H0	0,00		32,78			1,24						0,00					0,01			31,86		65,87	0,12
32	30	51H0			71,94			14,96	0,03					0,00	0,11		0,00	0,00	0,00			0,95		87,99	0,01
33	30	50G9			49,03			291,51						0,00	0,04			0,00	0,02	0,18		1,16		342,09	11,06
34	30	50H0			50,21			124,61	0,02					0,00	0,11				0,00			16,49	0,03	191,47	2,53
35	30	50G9	0,01		26,32			35,49						0,00			0,00	0,00	0,02			18,37		80,20	0,78
36	29	47H0		92,30	30,41			105,84						0,00				0,03				106,71		242,98	14,72
37	29	47H0		9,98	21,28	0,07	0,04	78,63								0,12		0,02				53,48		153,64	4,38
38	29	48H1		0,97	202,08	1,55		5,31							0,55							62,90		272,38	1,65
39	29	48H2		2,71	1,31	0,11		1,62										0,04	0,01			22,27		25,34	10,93
40	32	48H3		1,38	0,33	0,25		30,83						0,00				0,14				185,15		216,70	6,93
41	32	48H4		1,01	14,03			3,51						0,00	0,34	0,38		0,20	0,04			207,08	0,01	225,54	2,41
42	32	48H5			9,86			1,31					0,16		0,77			0,12	0,06			140,11	0,02	152,34	1,60
43	32	49H6			319,00			2,03							2,90			0,65	0,01			360,98	0,04	685,60	18,40
44	32	49H5			13,49			0,49						0,00	1,48			0,03				326,84		342,33	2,67
Total			**0,02**	**121,9**	**3748,4**	**2,2**	**0,04**	**1699,0**	**0,2**	**0,1**	**0,2**	**0,01**	**0,4**	**0,1**	**17,6**	**0,5**	**0,0**	**1,8**	**0,3**	**1,7**	**0,3**	**2244,4**	**0,3**	**7719,0**	**174,4**

Table 2.English, scientific, and Finnish names of observed species in Finnish 2021 BIAS-survey.

Fishnames		
English	**Scientific**	**Finnish**
Small Sandeel	*Ammodytes tobianus*	Pikkutuulenkala
Baltic Herring	*Clupea harengus*	Silakka
Lumpsucker	*Cyclopterus lumpus*	Rasvakala
God	*Gadus morhua*	Turska
Three-spined Stickleback	*Gasterosteus aculeatus*	Kolmipiikki
Greater Sandeel	*Hyperoplus lanceolatus*	Isotuulenkala
Lamprey	*Lampetra fluviatilis*	Nahkiainen
Striped Seasnail	*Liparis liparis*	Imukala
Snake blenny	*Lumpenus lampretaeformis*	Elaska
Shorthorn sculpin	*Myoxocephalus scorpius*	Isosimppu
Straightnose Pipefish	*Nerophis ophidion*	Siloneula
Smelt	*Osmerus eperlanus*	Kuore
Flounder	*Platichthys flesus*	Kampela
Sand goby	*Pomatoschistus minutus*	Hietatokko
Nine-spined Stickleback	*Pungitius pungitius*	Kymmenpiikki
Atlantic Salmon	*Salmo salar*	Lohi
Turbot	*Scophthalmus maximus*	Piikkikampela
Sprat	*Sprattus sprattus*	Kilohaili
Pipefish	*Syngnathus typhle*	Särmäneula
Four-horn sculpin	*Triglopsis quadricornis*	Härkäsimppu
Eelpout	*Zoarces viviparus*	Kivinilkka

Table 3. Number of length measurements /species and Sub-Division in Finnish 2021 BIAS-survey.

	ICES SD			
Species	**29**	**30**	**32**	**Total**
Ammodytes tobianus		3		3
Clupea harengus	1426	9547	781	11754
Cyclopterus lumpus	4		2	6
Gadus morhua	1			1
Gasterosteus aculeatus	597	2093	492	3182
Hyperoplus lanceolatus	6	14		20
Lampetra fluviatilis		2		2
Liparis liparis		13		13
Lumpenus lampretaeformis		1		1
Myoxocephalus scorpius		1	1	2
Nerophis ophidion	12	79	4	95
Osmerus eperlanus	8	215	35	258
Platichthys flesus	1		1	2
Pomatoschistus minutus	1	5		6
Pungitius pungitius	62	15	156	233
Salmo salar		7		7
Scophthalmus maximus	1			1
Sprattus sprattus	1633	2260	1133	5026
Zoarces viviparus	1	11	4	16
Total	3753	14263	2609	20628

Table 4.Individual samples of herring and sprat (for age determination) per SD in 2021.

	Kilohaili				Silakka			
L-class	**29**	**30**	**32**	**Sprat Tot.**	**29**	**30**	**32**	**Herring Tot.**
30						1		1
35						10		10
40						15		15
45						1		1
50						2		2
55						6		6
60						23	1	24
65	1					83	1	84
70	4	3	1	8	5	118	1	124
75	31	14	4	49	21	122	2	145
80	51	22	25	98	35	122	7	164
85	42	21	16	79	35	115	13	163
90	14	8	3	25	12	28	4	44
95	17	7	19	43	9	8	3	20
100	19	15	18	52	3	4	2	9
105	53	86	48	187	1	2		3
110	53	135	50	238	2		6	8
115	53	137	51	241	5	10	11	26
120	44	135	46	225	32	44	44	120
125	45	155	35	235	36	103	42	181
130	23	160	10	193	37	150	29	216
135	4	147	2	153	43	180	40	263
140	1	88		89	42	200	48	290
145		30		30	44	191	47	282
150		3		3	42	191	38	271
155		1		1	43	190	43	276
160					42	184	37	263
165					41	177	21	239
170					39	175	8	222
175					23	169		192
180					14	164	1	179
185					12	159	1	172
190					2	115		117
195					8	84		92
200					2	53		55
205					1	34		35
210					3	29		32
215					2	18		20
220						11		11
225						3		3
230						4		4
250						1		1
284								
302								
330								
Total	**455**	**1167**	**328**	**1950**	**636**	**3299**	**450**	**4385**

Table 5.Numbers and locations of fishing stations (WGS-84) during Finnish BIAS-survey in 2021.

HaulNumber	HaulStationName	HaulStartTime	ICES SD	HaulStartLatitude	HaulStartLongitude	HaulStopLatitude	HaulStopLongitude	HaulDuration (min)	HaulNetopening	HaulBottomDepth
1	48H3-1	2021-09-22T00:25	32	59,65434	23,22200	59,68467	23,22033	45	17,1	60
2	48H2-1	2021-09-22T05:03	29	59,65733	22,54783	59,69533	22,52467	45	14,8	62
3	48H1-1	2021-09-22T12:03	29	59,66867	21,12800	59,70833	21,04183	90	18	100
4	48G9-1	2021-09-22T20:24	29	59,91850	19,74783	59,87250	19,73700	60	11,9	125
5	49G9-1	2021-09-23T01:59	29	60,08033	19,45400	60,02050	19,46150	75	11,5	201
6	50G8-1	2021-09-23T11:20	30	60,93234	18,87567	60,87083	18,88950	75	10	80
7	51G8-1	2021-09-23T19:11	30	61,10000	18,14350	61,11250	18,04933	60	12,9	70
8	51G9-1	2021-09-24T09:05	30	61,13317	19,18467	61,13467	19,29267	60	15	75
9	51G8-2	2021-09-24T17:55	30	61,31183	18,17550	61,28800	18,12417	45	15,7	70
10	51G7-1	2021-09-24T20:11	30	61,23867	17,98217	61,17683	17,91433	90	17	75
11	52G8-1	2021-09-25T02:15	30	61,63517	18,14117	61,64000	18,06383	45	17,2	68
12	52G9-1	2021-09-25T08:19	30	61,67800	19,23350	61,66950	19,09933	81	10	65
13	52G8-2	2021-09-25T14:24	30	61,90067	18,48550	61,95317	18,39833	90	10	85
14	53G8-1	2021-09-25T20:40	30	62,15450	18,38500	62,17300	18,35300	30	16,8	90
15	53G8-2	2021-09-26T00:00	30	62,15733	18,84000	62,18150	18,80150	40	18,3	90
16	53G9-1	2021-09-26T08:20	30	62,28100	19,23250	62,32017	19,33150	75	9	95
17	54G8-1	2021-09-26T16:00	30	62,61467	18,74250	62,67433	18,83833	90	9,3	140
18	54G9-1	2021-09-26T20:30	30	62,60317	19,32867	62,63583	19,33850	45	16,7	130
19	55G9-1	2021-09-27T01:21	30	63,04400	19,53567	62,97817	19,52333	90	17,3	130
20	55H0-1	2021-09-27T07:30	30	63,16683	20,37767	63,09650	20,37567	90	10	80
21	54G9-2	2021-09-27T14:30	30	62,64667	19,68050	62,57750	19,69750	90	9,9	110
22	54H0-1	2021-09-27T18:32	30	62,60534	20,07550	62,54317	20,10983	60	17,4	97
23	54H0-2	2021-09-27T21:27	30	62,59500	20,28650	62,55017	20,34283	60	17	77
24	53H0-1	2021-09-28T02:23	30	62,40817	20,56200	62,30917	20,63767	75	15,8	80
25	53G9-2	2021-09-28T08:56	30	62,32733	19,58017	62,24883	19,64867	100	10,7	120
26	53H0-2	2021-09-28T14:20	30	62,09633	20,04067	62,02300	20,11733	95	11	140
27	52H0-1	2021-09-28T20:35	30	61,96883	20,67017	61,93167	20,73517	60	17,4	70
28	52H0-2	2021-09-29T00:22	30	61,82117	20,47800	61,77883	20,51117	60	15,7	100
29	52G9-2	2021-09-29T06:55	30	61,66100	19,62617	61,59117	19,70600	90	10,1	80
30	51G9-2	2021-09-29T17:47	30	61,32750	19,57017	61,30883	19,60367	30	16,9	80
31	51H0-1	2021-09-29T20:57	30	61,10067	20,01583	61,06133	20,08000	67	17,3	115
32	51H0-2	2021-09-30T01:30	30	61,09950	20,46800	61,09950	20,55617	75	18,5	90
33	50G9-1	2021-09-30T11:02	30	60,94717	19,28617	60,90917	19,39333	90	11,2	115
34	50H0-1	2021-09-30T17:55	30	60,81517	20,14650	60,79017	20,17567	47	17,8	70
35	50G9-2	2021-09-30T20:49	30	60,79883	19,77117	60,78117	19,80350	30	16,4	75
36	47H0-1	2021-10-01T18:13	29	59,18483	20,34133	59,14050	20,35983	30	17,8	75
37	47H0-2	2021-10-01T21:41	29	59,22217	20,84400	59,17200	20,83817	60	14	90
38	48H1-2	2021-10-02T02:29	29	59,54167	21,04833	59,52500	21,04667	24	14	80
39	48H2-2	2021-10-02T09:44	29	59,57100	22,75300	59,54833	22,77483	33	15,8	70
40	48H3-2	2021-10-02T13:42	32	59,56233	23,47817	59,50083	23,51583	90	16,9	85
41	48H4-1	2021-10-02T19:30	32	59,75633	24,04267	59,73383	24,03133	30	16,1	80
42	48H5-1	2021-10-03T01:11	32	59,97167	25,10317	59,94383	25,14900	45	16,4	70
43	49H6-1	2021-10-03T18:38	32	60,12200	26,33683	60,10067	26,35233	30	16,3	70
44	49H5-1	2021-10-04T00:10	32	60,03283	25,34300	60,02033	25,34917	15	18	70

Table 6. Survey statistics by area in SDs 29, 30 and 32 (r/v Aranda in 2021).

ICES SD	ICES Rect.	NM	N (million/nm²)	Area (nm²)	Sa (m²/nm²)	σ (cm²)	N total (million)	Herring (%)	Sprat (%)	Cod (%)	3-spinn. (%)
29	47H0	59	9,3561265	920,3	423,56	0,4527106	8610,443	2,01	10,29	0,00	87,65
29	48G9	28	6,3453261	772,8	611,68	0,9639786	4903,668	16,45	53,52	0,00	29,63
29	48H0	53	6,4129792	730,3	811,41	1,2652576	4683,399	38,72	40,66	0,00	20,38
29	48H1	76	9,1273371	544,0	1179,23	1,291977	4965,271	32,01	60,96	0,00	6,84
29	48H2	63	12,338582	597,0	1106,84	0,8970582	7366,134	3,60	82,28	0,00	13,42
32	48H3	63	9,6086429	615,7	777,70	0,8093758	5916,041	3,47	56,04	0,00	39,52
32	48H4	73	7,832607	835,1	837,07	1,0687045	6541,01	2,79	86,85	0,00	9,55
32	48H5	30	13,372846	767,2	1465,30	1,0957259	10259,65	3,21	88,79	0,00	7,40
29	49G9	39	3,9420023	564,2	428,66	1,0874058	2224,078	34,20	32,26	0,00	33,28
32	49H5	23	12,764531	306,9	1457,57	1,1418908	3917,434	2,06	96,57	0,00	1,13
32	49H6	45	11,970152	586,5	1650,08	1,3784971	7020,494	30,27	65,21	0,00	2,73
30	50G8	54	2,5525955	833,4	347,03	1,359525	2127,333	71,35	5,48	0,00	23,11
30	50G9	71	10,195432	879,5	453,88	0,4451821	8966,882	5,16	4,15	0,00	90,64
30	50H0	62	13,197395	795,1	602,92	0,4568462	10493,25	5,49	2,53	0,00	91,97
30	51G7	33	3,7349463	614,5	489,09	1,3094917	2295,124	45,40	6,55	0,00	48,01
30	51G8	60	4,9003786	863,7	561,33	1,1454902	4232,457	38,65	2,26	0,00	59,06
30	51G9	65	8,4833163	865,8	474,89	0,5597898	7344,855	11,56	0,66	0,00	87,76
30	51H0	57	1,8054937	865,7	231,93	1,2845873	1563,016	29,39	34,98	0,00	35,47
30	52G8	73	6,5523812	852,0	473,38	0,7224477	5582,629	18,96	0,89	0,00	80,09
30	52G9	57	5,4191768	852,0	300,64	0,5547701	4617,139	16,27	0,84	0,00	82,82
30	52H0	61	1,9550387	852,0	232,44	1,1889057	1665,693	43,92	2,55	0,00	53,43
30	53G8	87	4,2956439	838,1	368,60	0,8580869	3600,179	22,79	2,36	0,00	74,85
30	53G9	56	2,0888848	838,1	285,38	1,366189	1750,694	50,41	0,78	0,00	48,77
30	53H0	61	2,1900725	838,1	168,63	0,7699689	1835,5	19,58	4,89	0,00	74,11
30	54G8	17	1,8727141	642,2	294,97	1,5750824	1202,657	56,30	0,00	0,00	43,69
30	54G9	60	1,8699226	824,2	302,18	1,6160273	1541,19	55,59	1,73	0,00	42,59
30	54H0	44	1,794471	727,9	303,69	1,6923814	1306,195	59,26	4,08	0,00	34,22
30	55G9	24	1,6017519	625,6	242,51	1,514011	1002,056	55,34	2,45	0,00	42,19
30	55H0	18	1,0471734	688,6	210,86	2,0135809	721,0836	75,73	1,26	0,00	22,78

Table 7. Numbers (millions) of herring by age in SDs 29 and 32 (r/v Aranda 2021).

SD	Rect	0	1	2	3	4	5	6	7	8+	Total
29	47H0	1.44	12.13	75.35	25.62	19.25	10.77	5.24	13.24	10.13	173.16
29	48G9	93.64	226.95	272.66	54.72	47.78	26.85	14.87	29.91	39.33	806.71
29	48H0	128.72	524.61	686.74	142.74	115.53	56.92	29.88	66.57	61.72	1813.44
29	48H1	63.29	254.16	376.28	129.09	152.32	118.81	83.86	118.42	292.91	1589.14
29	48H2	226.24	13.64	8.60	2.65	2.24	1.15	0.93	1.58	7.97	264.99
32	48H3	52.96	36.28	61.62	4.22	21.61	8.22	1.75	12.31	6.21	205.17
32	48H4	40.41	20.52	43.04	5.92	23.85	12.04	3.65	18.99	14.31	182.71
32	48H5	14.69	121.87	115.79	6.58	32.95	9.75	5.71	13.99	7.66	328.99
29	49G9	95.70	210.08	243.31	50.65	49.77	27.70	17.51	32.41	33.49	760.61
32	49H5	0.00	35.81	31.69	1.30	5.26	1.61	1.23	2.17	1.52	80.58
32	49H6	6.73	544.55	687.31	66.00	321.16	134.03	43.02	201.74	120.80	2125.35

Table 8.Mean weight (g) of herring by age in SDs 29 and 32 (r/v Aranda 2021).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Average (g)
29	47H0	3.10	14.21	17.79	20.33	21.30	22.61	22.73	22.26	23.92	19.33
29	48G9	3.74	13.15	16.92	20.11	21.24	22.72	24.78	22.30	34.13	16.18
29	48H0	3.78	13.17	17.00	19.88	20.79	22.05	23.53	21.68	31.05	16.34
29	48H1	3.75	13.19	17.59	21.47	23.36	25.27	27.48	24.08	32.25	21.48
29	48H2	3.95	10.86	17.41	20.71	21.58	23.15	27.47	23.40	65.68	7.20
32	48H3	4.38	11.48	16.62	20.48	20.11	20.88	19.54	20.81	29.50	13.84
32	48H4	3.56	11.60	16.96	21.83	21.24	22.62	21.18	23.23	24.93	15.84
32	48H5	3.38	11.31	16.72	20.05	19.76	21.26	19.02	21.21	21.88	14.98
29	49G9	3.93	13.33	16.63	20.57	21.43	22.71	24.75	22.52	26.44	15.79
32	49H5	0.00	11.68	16.20	20.36	19.82	22.17	19.22	22.12	22.74	14.94
32	49H6	6.00	11.98	16.51	21.49	20.83	21.94	20.91	22.31	22.71	17.46

Table 9.Total biomass (ton) of herring by age in SDs 29 and 32 (r/v Aranda 2021).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Total
29	47H0	4.5	172.3	1340.4	520.9	410.1	243.5	119.1	294.6	242.3	3347.6
29	48G9	350.4	2983.4	4613.8	1100.6	1014.9	610.0	368.3	667.0	1342.5	13050.9
29	48H0	486.3	6909.8	11675.3	2837.9	2402.2	1255.3	703.2	1443.2	1916.7	29630.0
29	48H1	237.2	3352.9	6617.2	2771.9	3558.2	3001.8	2304.7	2851.1	9446.3	34141.5
29	48H2	894.5	148.2	149.8	55.0	48.3	26.6	25.6	36.9	523.2	1907.9
32	48H3	232.1	416.6	1024.1	86.3	434.7	171.5	34.2	256.2	183.1	2838.9
32	48H4	143.8	238.0	730.1	129.1	506.5	272.3	77.2	441.0	356.7	2894.8
32	48H5	49.6	1378.1	1936.1	132.0	651.0	207.2	108.6	296.8	167.7	4927.1
29	49G9	376.4	2799.4	4047.2	1042.1	1066.7	629.1	433.5	730.0	885.5	12009.9
32	49H5	0.0	418.1	513.4	26.4	104.2	35.7	23.7	48.0	34.6	1204.0
32	49H6	40.4	6524.3	11349.3	1418.1	6688.3	2941.1	899.6	4501.1	2743.5	37105.6

Table 10.Numbers (millions) of sprat by age and area (r/v Aranda 2021).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Total
29	47H0	39.11	179.20	289.27	102.72	125.76	19.82	22.99	96.66	10.66	886.19
29	48G9	375.30	1674.77	411.12	51.73	53.19	7.37	6.57	40.16	4.28	2624.49
29	48H0	167.68	869.99	427.68	113.73	137.72	21.30	28.90	116.91	20.21	1904.12
29	48H1	294.62	1418.31	615.37	182.71	219.18	33.92	45.19	186.19	31.34	3026.83
29	48H2	1369.19	3097.02	950.36	202.85	212.39	32.36	28.36	155.90	12.47	6060.89
32	48H3	57.58	1468.40	1009.72	199.41	202.25	60.29	52.09	254.13	11.64	3315.51
32	48H4	390.54	2054.94	1860.62	337.87	350.33	77.54	86.60	495.26	26.88	5680.59
32	48H5	682.01	3509.23	2684.45	518.16	531.80	164.86	180.88	762.77	75.51	9109.67
29	49G9	137.09	381.76	109.72	20.86	26.91	4.33	6.78	25.63	4.39	717.47
32	49H5	171.96	1605.93	1188.47	187.61	211.25	58.41	70.83	263.38	25.27	3783.10
32	49H6	57.23	1983.80	1644.12	225.01	254.23	52.04	52.48	296.15	13.08	4578.14
30	50G8	14.92	75.34	11.86	3.89	2.66	1.43	1.49	4.41	0.66	116.66
30	50G9	44.98	90.03	107.10	23.01	35.69	13.21	12.79	39.92	5.45	372.18
30	50H0	18.19	107.56	52.70	13.26	17.77	8.56	8.75	31.97	6.25	265.01
30	51G7	0.00	13.66	32.00	11.46	18.89	10.27	12.00	42.52	9.50	150.30
30	51G8	0.00	11.47	19.25	6.72	11.68	6.79	6.71	26.65	6.57	95.84
30	51G9	0.00	5.80	15.22	3.82	6.50	3.13	2.64	9.43	2.04	48.57
30	51H0	0.00	48.45	97.65	37.10	64.76	32.50	46.77	178.81	40.74	546.79
30	52G8	0.00	6.60	9.20	3.11	5.40	3.13	3.69	14.63	3.66	49.42
30	52G9	0.00	8.57	9.20	2.65	4.16	2.14	2.35	8.18	1.73	38.98
30	52H0	0.00	12.56	10.61	2.55	4.28	1.83	1.90	7.32	1.47	42.52
30	53G8	0.00	15.30	16.97	5.44	8.98	4.93	5.73	22.18	5.34	84.88
30	53G9	0.00	3.86	2.33	0.77	1.10	0.72	0.79	3.21	0.80	13.58
30	53H0	0.25	22.83	16.11	4.91	7.67	4.15	5.45	22.58	5.71	89.67
30	54G8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	54G9	1.25	3.97	4.84	1.69	2.72	1.54	1.76	7.12	1.77	26.67
30	54H0	0.00	2.12	7.67	3.62	6.66	4.00	4.63	19.48	5.06	53.24
30	55G9	0.00	9.67	3.94	1.33	1.96	1.15	1.24	4.34	0.95	24.58
30	55H0	0.00	1.19	2.20	0.70	1.16	0.64	0.58	2.09	0.49	9.05

Table 11.Mean weight (g) of sprat by age and area (r/v Aranda 2021).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Average (g)
29	47H0	3.68	7.56	9.53	10.22	10.38	10.42	11.05	10.61	11.31	9.27
29	48G9	3.69	7.17	8.50	9.90	10.23	10.17	10.78	10.26	11.25	7.07
29	48H0	3.71	7.25	9.08	10.23	10.50	10.55	11.26	10.83	12.15	8.13
29	48H1	3.45	6.79	9.27	10.20	10.48	10.54	11.26	10.80	12.18	7.86
29	48H2	3.51	6.83	9.05	9.89	10.20	10.24	10.81	10.24	11.30	6.78
32	48H3	3.22	6.16	8.11	9.22	9.11	8.09	9.58	8.12	10.27	7.32
32	48H4	3.47	6.21	8.19	9.15	8.95	8.83	9.72	8.56	10.71	7.33
32	48H5	3.52	6.26	8.12	9.31	9.15	8.84	9.97	8.74	10.52	7.31
29	49G9	3.58	7.22	8.67	10.31	10.74	10.92	11.39	10.97	11.36	7.19
32	49H5	3.44	6.35	7.98	9.24	9.10	8.74	10.02	8.30	10.27	7.30
32	49H6	3.10	6.45	8.00	9.07	8.90	8.38	9.58	8.08	10.27	7.40
30	50G8	4.00	8.49	10.61	10.07	12.16	12.00	12.45	12.60	13.37	8.54
30	50G9	3.77	9.35	11.32	11.64	11.93	12.23	12.72	12.51	13.17	10.25
30	50H0	3.91	9.00	11.14	11.53	12.29	12.58	13.06	13.29	14.01	10.31
30	51G7		9.60	11.79	12.48	12.74	12.99	13.29	13.61	14.05	12.62
30	51G8		9.08	11.93	12.54	12.78	13.02	13.44	13.77	14.27	12.59
30	51G9		9.49	11.73	12.18	12.22	12.57	13.03	13.28	14.18	12.09
30	51H0		10.14	11.41	12.55	12.95	13.37	13.48	13.76	14.10	12.82
30	52G8		9.40	11.76	12.46	12.79	13.17	13.73	14.05	14.50	12.72
30	52G9		9.40	11.53	12.12	12.48	12.79	13.30	13.51	14.04	11.91
30	52H0		9.09	11.34	11.96	12.29	12.73	13.20	13.37	14.00	11.39
30	53G8		9.32	11.60	12.35	12.69	13.06	13.48	13.86	14.40	12.33
30	53G9		9.39	11.41	12.08	12.87	13.05	13.62	14.01	14.49	12.01
30	53H0	5.08	9.38	11.25	12.08	12.74	13.22	13.66	14.06	14.62	12.09
30	54G8										
30	54G9	3.81	9.50	11.60	12.40	12.80	13.10	13.35	13.87	14.43	12.09
30	54H0		9.60	12.05	12.86	13.13	13.35	13.59	13.96	14.44	13.30
30	55G9		8.99	11.50	12.15	12.72	12.79	13.29	13.58	13.99	11.26
30	55H0		7.82	12.01	12.46	12.47	12.72	13.04	13.56	14.29	12.15

Table 12.Total biomass (ton) of sprat by age and area (r/v Aranda 2020).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Total
29	47H0	3376.1	1810.0	520.2	977.2	232.7	293.1	874.9	56.9	125.5	8266.6
29	48G9	135.6	2749.4	701.8	1227.5	291.0	310.8	1003.1	125.2	54.5	6599.1
29	48H0	177.9	33457.4	2684.4	3910.4	808.4	924.7	2808.9	221.6	262.6	45256.3
29	48H1	1491.7	12069.6	1122.5	1692.9	352.4	316.8	1163.2	61.2	41.0	18311.3
29	48H2	9136.7	30847.4	3654.0	5429.0	933.5	719.9	3287.9	160.4	34.1	54202.7
32	48H3	6120.5	30267.2	2107.0	2294.7	377.7	495.0	2467.8	0.0	194.2	44324.2
32	48H4	97.3	31691.7	8013.9	9399.0	1786.3	1726.5	8984.4	40.3	738.9	62478.4
32	48H5	102.7	10538.8	2865.7	3503.9	845.3	756.3	3979.6	103.1	564.5	23260.0
29	49G9	107.9	130.7	54.5	116.4	35.1	38.6	114.8	8.4	10.4	616.8
32	49H5	2870.3	3080.3	290.2	325.7	99.3	99.4	524.5	15.2	98.6	7403.4
32	49H6	897.3	12124.9	1436.8	1685.4	406.0	358.0	1963.4	38.7	267.3	19177.7
30	50G7	12.9	27.0	13.1	19.2	6.5	4.9	32.1	2.8	3.6	122.0
30	50G8	120.2	416.2	162.0	264.7	94.3	107.7	616.4	51.1	87.0	1919.6
30	50G9	0.0	0.0	1.8	3.8	1.4	3.2	13.8	1.6	2.8	28.5
30	50H0	0.0	16.8	24.3	62.0	22.5	35.5	211.4	15.8	43.8	432.0
30	51G7	0.0	59.7	17.1	21.3	8.8	7.6	48.7	2.6	6.9	172.8
30	51G8	4.0	37.9	27.6	72.4	31.7	59.6	341.7	21.1	86.7	682.7
30	51G9	0.9	13.9	12.5	20.3	6.1	9.4	63.4	4.0	28.2	158.7
30	51H0	0.0	0.6	6.6	19.7	7.5	14.9	76.1	6.3	13.5	145.3
30	52G7	0.0	0.0	0.0	1.3	0.5	0.7	5.7	0.2	0.7	9.0
30	52G8	0.0	10.5	1.2	2.9	1.6	1.4	10.3	0.5	2.0	30.4
30	52G9	2.2	38.8	11.7	25.1	9.2	11.4	76.9	4.2	9.9	189.3
30	52H0	0.0	0.0	4.4	17.0	8.2	16.4	106.6	5.7	37.2	195.4
30	53G8	0.0	6.6	2.7	9.5	3.8	5.1	37.9	2.0	8.3	75.9
30	53G9	0.0	0.4	4.0	7.9	2.6	5.6	23.6	2.8	4.6	51.5
30	53H0	0.0	0.3	6.3	18.5	9.2	18.8	94.1	7.5	22.2	176.9
30	54G8	0.0	0.0	0.0	0.9	0.0	4.0	19.6	1.2	10.9	36.5
30	54G9	7.3	74.7	28.8	62.8	25.6	34.3	204.1	14.4	35.7	487.8
30	54H0	1.4	78.3	63.1	181.0	77.7	150.6	803.0	57.0	198.8	1611.0
30	55G9	6.5	32.9	5.9	13.4	5.7	7.9	51.2	3.2	13.1	139.6
30	55H0	11.3	30.5	14.2	21.3	9.0	11.0	61.6	4.7	14.8	178.4

Table 13.Survey statistics for Bothnian Sea herring SD 30 calculations (StoX) in 2020.

ICES SD	ICES Rect.	NM	Area (nm²)	Sa (m²/nm²)	Herring (%)	Sprat (%)	Cod (%)	3-spinn. (%)
30	50G7	19	435.88	363.91	84.04	1.46	0.00	14.44
30	50G8	49	827.34	406.99	75.36	8.26	0.00	16.27
30	50G9	70	884.56	393.97	77.17	0.10	0.00	22.05
30	50H0	22	740.59	335.28	62.60	2.36	0.00	23.12
30	51G7	26	673.52	665.31	62.12	0.57	0.00	37.24
30	51G8	52	868.90	680.50	83.62	1.68	0.00	14.68
30	51G9	61	871.99	400.97	50.51	0.46	0.00	49.00
30	51H0	62	872.00	245.07	83.38	1.01	0.00	15.54
30	52G7	37	544.28	608.09	94.56	0.06	0.00	5.20
30	52G8	56	858.17	790.92	27.76	0.04	0.00	72.16
30	52G9	71	858.17	595.87	24.10	0.27	0.00	75.63
30	52H0	50	858.17	341.28	48.07	0.59	0.00	51.32
30	53G8	58	844.28	505.79	31.91	0.13	0.00	67.95
30	53G9	52	844.28	623.27	40.66	0.06	0.00	59.28
30	53H0	54	843.93	337.98	67.96	0.77	0.00	31.08
30	54G8	13	651.40	615.49	92.27	0.14	0.00	7.16
30	54G9	79	830.32	432.60	94.02	2.37	0.00	3.12
30	54H0	45	657.18	477.09	83.71	6.30	0.00	6.21
30	55G9	30	624.63	604.23	89.90	0.38	0.00	9.47
30	55H0	28	677.80	403.12	90.30	0.71	0.00	2.95

Table 14.Numbers (millions) of herring by age in SD 30 (r/v Aranda 2021).

Rect.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
50G8	363,42	373,11	489,41	193,82	48,46	24,23	9,69	0,00	0,00	4,85	0,00	0,00	0,00	0,00	0,00	0,00	1506,98
50G9	134,39	108,27	105,44	30,53	15,18	11,07	13,74	3,94	4,04	0,62	1,95	0,00	0,54	0,70	1,78	0,00	432,18
50H0	74,64	240,13	134,67	55,17	11,36	14,60	1,62	4,87	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	537,05
51G7	44,05	206,72	447,32	138,94	111,83	54,22	50,83	47,44	10,17	6,78	6,78	0,00	3,39	0,00	0,00	13,56	1142,02
51G8	69,77	278,43	513,90	246,78	220,45	156,53	26,49	23,88	39,72	10,57	15,89	13,22	0,00	5,28	15,85	13,23	1649,98
51G9	479,25	198,38	230,82	96,36	23,16	32,66	48,04	11,53	7,69	15,37	3,84	3,84	1,92	3,84	0,00	0,00	1156,71
51H0	51,79	91,01	174,05	82,35	23,19	12,65	5,62	4,91	4,90	2,80	1,40	1,40	2,80	2,81	0,70	0,00	462,38
52G8	3,48	114,34	454,03	259,02	39,28	59,74	70,08	5,13	13,65	10,22	5,12	3,46	0,00	1,71	0,00	1,74	1040,99
52G9	370,39	30,66	195,79	68,63	38,89	11,11	6,25	3,10	4,09	6,36	2,13	0,00	0,00	0,00	0,00	1,99	739,40
52H0	114,76	44,74	324,68	99,95	69,96	48,69	23,68	25,03	7,49	3,75	0,00	1,25	2,50	1,24	2,50	1,27	771,48
53G8	112,42	36,90	206,17	253,44	40,83	46,72	90,38	39,31	18,96	4,34	1,46	2,93	5,73	0,00	0,00	5,89	865,47
53G9	214,27	14,19	182,95	182,79	154,44	83,44	72,32	18,91	11,01	12,61	4,72	3,13	12,55	1,55	0,00	3,11	971,98
53H0	93,68	14,92	66,46	62,90	26,83	11,96	34,79	5,13	12,51	7,40	2,28	7,40	1,71	1,14	1,14	3,42	353,67
54G8	0,00	30,75	231,64	200,89	82,00	43,05	63,55	14,35	4,10	4,10	8,20	0,00	2,05	0,00	0,00	2,05	686,72
54G9	168,93	17,12	193,13	190,12	139,22	109,39	81,85	22,14	4,46	2,96	4,55	9,04	2,97	1,51	3,04	10,57	961,00
54H0	56,85	58,39	145,54	130,77	94,34	65,64	35,61	14,95	5,76	57,55	6,91	9,20	4,64	5,74	2,30	1,15	695,33
55G9	8,68	31,23	272,41	114,52	43,38	20,82	32,97	8,68	8,68	0,00	0,00	3,47	1,74	1,74	0,00	5,21	553,50
55H0	1,63	14,70	129,03	227,02	70,23	26,13	34,30	4,90	14,70	6,53	3,27	1,63	0,00	0,00	1,63	1,63	537,34
Total	2362,40	1903,97	4497,42	2633,99	1253,01	832,67	701,81	258,19	171,93	156,80	68,49	59,98	42,54	27,25	28,93	64,80	15064,17

Table 15.Total biomass (ton) of herring by age in SD 30 (r/v Aranda 2021).

Rect.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
50G8	1417	5485	8760	3973	1100	601	202	0	0	141	0	0	0	0	0	0	21678,7
50G9	470	1537	2035	638	373	285	346	106	103	17	67	0	29	28	76	0	6109,6
50H0	291	3362	2316	1054	220	308	39	131	0	0	0	0	0	0	0	0	7722,1
51G7	132	3080	8231	2932	2650	1518	1322	1404	297	279	327	0	207	0	0	552	22930,5
51G8	230	4009	9610	5528	5445	4414	850	724	1295	428	580	658	0	246	724	583	35324,5
51G9	1629	2877	4432	2101	591	839	1436	321	200	449	119	146	47	140	0	0	15326,2
51H0	104	1392	3289	1729	550	294	130	139	132	116	55	60	134	121	34	0	8280,0
52G8	9	1692	8536	5310	1057	1332	1871	156	382	429	214	128	0	88	0	68	21272,2
52G9	1185	420	3720	1482	832	293	182	85	110	177	62	0	0	0	0	81	8630,3
52H0	310	653	5844	1939	1546	1266	672	656	257	114	0	35	86	40	112	49	13579,2
53G8	236	579	3773	5221	1078	1233	2684	1195	451	154	71	125	202	0	0	326	17330,1
53G9	621	196	3458	4131	3583	2178	2083	514	377	381	180	132	507	75	0	151	18565,8
53H0	253	207	1230	1277	614	319	967	153	292	219	78	261	77	42	48	116	6153,8
54G8	0	437	4447	4299	2074	1136	1767	406	132	145	282	0	80	0	0	75	15280,8
54G9	389	276	3689	4012	3592	2724	2341	788	150	96	176	356	144	56	142	452	19381,4
54H0	188	899	2649	2642	2340	1615	954	492	200	1439	292	358	223	213	79	41	14621,3
55G9	25	503	5149	2474	1024	510	877	261	261	0	0	114	93	51	0	194	11535,4
55H0	11	234	2387	4813	1714	651	871	145	415	171	100	47	0	0	49	54	11659,9
Total	7501	27838	83554	55553	30383	21517	19596	7677	5052	4754	2604	2419	1829	1100	1264	2742	275381

Table 16. Mean weight (g) of herring by age in SD 30 (r/v Aranda 2021)

Rect.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+
50G8	3,9	14,7	17,9	20,5	22,7	24,8	20,8			29,0						
50G9	3,5	14,2	19,3	20,9	24,6	25,7	25,2	27,0	25,4	27,5	34,2		53,5	39,5	42,5	
50H0	3,9	14,0	17,2	19,1	19,4	21,1	24,3	27,0								
51G7	3,0	14,9	18,4	21,1	23,7	28,0	26,0	29,6	29,2	41,2	48,2		61,0			40,7
51G8	3,3	14,4	18,7	22,4	24,7	28,2	32,1	30,3	32,6	40,5	36,5	49,8		46,6	45,7	44,0
51G9	3,4	14,5	19,2	21,8	25,5	25,7	29,9	27,8	26,0	29,2	31,0	38,0	24,4	36,5		
51H0	2,0	15,3	18,9	21,0	23,7	23,2	23,2	28,4	26,9	41,4	39,3	43,0	48,0	43,0	49,0	
52G8	2,5	14,8	18,8	20,5	26,9	22,3	26,7	30,4	28,0	42,0	41,8	37,1		51,5		39,0
52G9	3,2	13,7	19,0	21,6	21,4	26,4	29,1	27,5	26,8	27,8	29,1					40,9
52H0	2,7	14,6	18,0	19,4	22,1	26,0	28,4	26,2	34,3	30,4		27,8	34,5	32,0	44,9	38,4
53G8	2,1	15,7	18,3	20,6	26,4	26,4	29,7	30,4	23,8	35,6	49,0	42,5	35,3			55,4
53G9	2,9	13,8	18,9	22,6	23,2	26,1	28,8	27,2	34,2	30,2	38,2	42,1	40,4	48,2		48,5
53H0	2,7	13,9	18,5	20,3	22,9	26,7	27,8	29,8	23,3	29,6	34,4	35,2	45,1	37,2	42,0	34,1
54G8		14,2	19,2	21,4	25,3	26,4	27,8	28,3	32,2	35,3	34,4		39,0			36,7
54G9	2,3	16,1	19,1	21,1	25,8	24,9	28,6	35,6	33,5	32,4	38,8	39,4	48,4	37,3	46,8	42,7
54H0	3,3	15,4	18,2	20,2	24,8	24,6	26,8	32,9	34,8	25,0	42,2	38,9	48,0	37,1	34,1	35,8
55G9	2,9	16,1	18,9	21,6	23,6	24,5	26,6	30,1	30,1			32,8	53,5	29,5		37,3
55H0	7,0	15,9	18,5	21,2	24,4	24,9	25,4	29,5	28,2	26,1	30,7	28,5			30,0	33,0

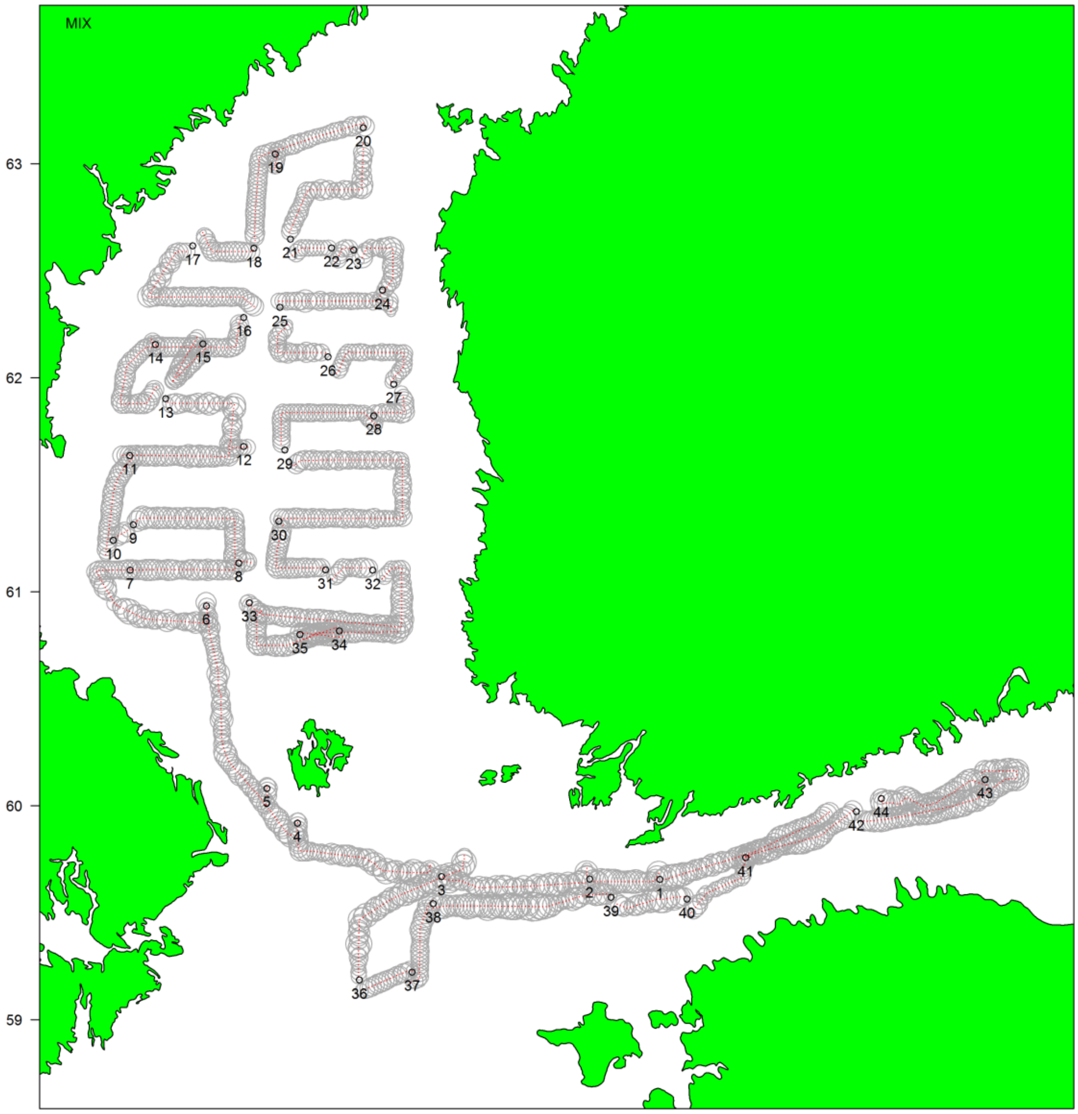

Figure 1. Cruise track and trawl stations of r/v Aranda during the Finnish BIAS-survey in 2021.

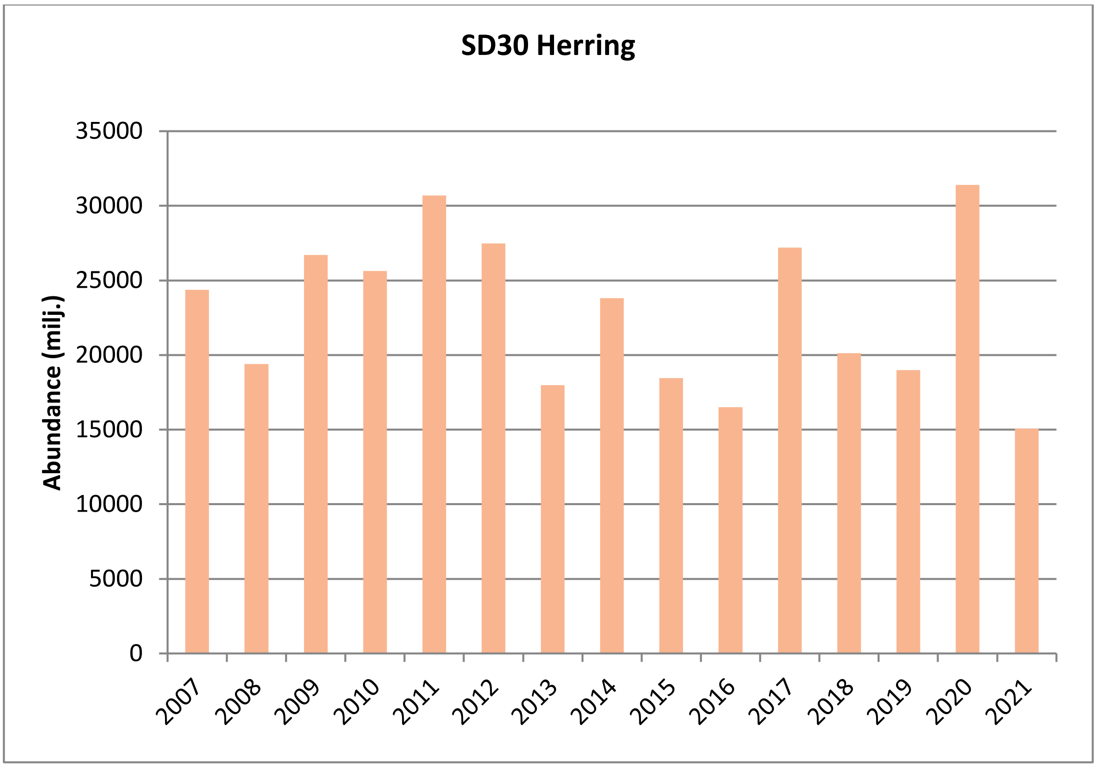

Figure 2. Abundance of herring in SD 30 from 2007 to 2021 with StoX calculations.

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Survey Report FRV "Solea" SB798

German Acoustic Autumn Survey (GERAS)

08 – 28 October 2021

Matthias Schaber[1] & Tomas Gröhsler[2]

1. INTRODUCTION

1.1 Background

The cruise was part of an international hydroacoustic survey providing information on stock parameters of small pelagics in the Baltic Sea, coordinated by the ICES Working Group of International Pelagic Surveys (WGIPS) and the ICES Baltic International Fish Survey Working Group (WGBIFS). Further WGBIFS contributors to the Baltic survey are national fisheries research institutes of Sweden, Poland, Finland, Latvia, Estonia and Lithuania. FRV "Solea" participated for the 34th time. The survey area covered the western Baltic Sea including Kattegat, Belt Sea, Sound and Arkona Sea (ICES Subdivisions (SD) 21, 22, 23 and 24).

1.2 Objectives

The survey has the main objective to annually assess the clupeid resources of herring and sprat in the Baltic Sea in autumn. It is conducted every year to supply the ICES Herring Assessment Working Group for the Area South of 62°N (HAWG) and Baltic Fisheries Assessment Working Group (WGBFAS) with an index value for the stock size of herring in the Western Baltic area (Kattegat/Subdivision 21 and Subdivisions 22, 23 and 24) and sprat in the Baltic area (Subdivisions 22-32).

The following objectives were planned for SB798:

- Hydroacoustic measurements for the assessment of small pelagics in the Kattegat and western Baltic Sea including Belt Sea, Sound and Arkona Sea (ICES Subdivisions 21, 22, 23 and 24)
- (Pelagic) trawling according to hydroacoustic registrations
- Hydrographic measurements on hydroacoustic transects and after each fishery haul
- Identification and recording of species- and length-composition of trawl catches
- Collection of biological samples of herring, sprat and additionally sardine, European anchovy and cod for further analyses

1.3 Survey summary

The objectives of the survey were carried out successfully and mostly as planned in all of the covered ICES Subdivisions.

Altogether, 1124 nautical miles of hydroacoustic transects (plus 67 nmi daytime transects for comparison) were covered. For species allocation and identification as well as to collect biological data for an age stratified abundance estimation of the target species herring and sprat, altogether 50 fishery hauls were conducted. Vertical hydrography profiles were measured on 90 stations.

In all subdivisions covered, mean NASC values per nautical mile per ICES statistical rectangle were equally either distinctly lower or distinctly higher than the values measured in 2020. However, compared to the long-time survey mean since 1991, mean NASC values were lower in all but two rectangles covered. On ICES subdivision scale, mean NASC values were overall distinctly lower than in the previous year in subdivisions 21 and 22, slightly increased in SD 24 and almost fivefold increased in SD 23 (note that the increase in SD 23 originated from large aggregations of herring that did not contribute to the WBSSH index estimate).

2. SURVEY DESCRIPTION & METHODS APPLIED

2.1 Cruise narrative

The 798th cruise of FRV "Solea" represents the 34th subsequent GERAS survey. Generally, survey operations during the GERAS/BIAS are conducted during nighttime to account for a more pelagic distribution of clupeids at that time. Equipment of the vessel as well as calibration of echosounders took place on October 8th. After leaving Rostock port, the survey commenced in ICES SD24 (Arkona Sea) on October 9th. Due to deteriorating weather and sea state, survey operations had to be interrupted for one day on October 11th, and parts of a transect in that SD had to be repeated after weather conditions had improved. After accomplishing the southern transects in SD24, the survey continued in SD22 (Mecklenburg Bight) from October 13th. On October 14th, due to again deteriorating weather conditions, the survey had to be interrupted in the Kiel Bight. FRV "Solea" steamed into Kiel port, where an exchange of scientific crew members took place. In the evening of October 15th, the survey commenced from the position where the interruption had occurred. Subdivision 22 was accomplished in the early morning of October 19th. Due to the weather forecast indicating deteriorating conditions in SD 24 the survey continued in the comparatively sheltered SD 23 (the Sound), and this subdivision was accomplished in the morning of October 20th. In the evening of that day, the survey continued in still inclement but workable conditions in the southern Kattegat (SD 21). With the weather deteriorating, survey operations had to be interrupted for another 2 days.

Since conditions in the Kattegat only improved slowly but seemed acceptable in SD 24, it was decided to steam south and accomplish the two missing transects in SD 24 (Arkona Sea) on October 23rd and 24th. Afterwards, the remaining transects in SD 21 were covered. However, the previous loss of survey time due to several days of inclement weather required shortening of the transects and omitting the two northernmost statistical rectangles in SD 21. In the early morning of October 26th, survey operations were accomplished and FRV "Solea" returned to Rostock harbor, where the survey ended on October 28th.

Altogether, the following survey schedule was accomplished:

Arkona Sea	(SD 24)	09. - 12.10. & 23.-24.10.
Belt Sea	(SD 22)	13. - 18.10.
Sound	(SD 23)	19. - 20.10.
Kattegat	(SD 21)	20. 10. & 25. - 26.10.

Total survey time	18 nights (incl. 3.5 days loss due to bad weather)
Fishery hauls	50
CTD-casts	90
Hydroacoustic transects	1124 nmi (+ 67 nmi daytime transects for comparison)

2.2 Survey design

ICES statistical rectangles were used as strata for all Subdivisions (ICES, 2017). The area was limited by the 10 m depth line. The survey area in the Western Baltic Sea is characterized by a number of islands and sounds. Consequently, parallel transects would lead to an unsuitable coverage of the survey area. Therefore a zig-zag track was adopted to cover all depth strata regularly and sufficiently. Overall, the realized cruise track length was 1124 nautical miles (2020: 1204 nmi) (Figure 1).

2.3 Acoustic data collection

All acoustic investigations were performed during night time to account for the more pelagic distribution of clupeids during that time. Hydroacoustic data were recorded with a Simrad EK80 scientific echosounder with hull-mounted 38, 70, 120 and 200 kHz transducers at a standard ship speed of 10 kn. Post-processing and analysis of hydroacoustic data were conducted with Echoview 12 software (Echoview Software Pty Ltd, 2021). Mean volume back scattering values (S_v) were integrated over 1 nmi intervals from 10 m below the surface to ca. 0.5 m over the seafloor. Interferences from surface turbulence, bottom structures and scattering layers were removed from the echogram. The transducer settings applied were in accordance with the specifications provided in ICES (2015, 2017).

2.4 Calibration

All transducers (38, 70, 120 and 200 kHz) were calibrated prior to the beginning of the survey in acceptable weather conditions from a drifting vessel in the Mecklenburg Bight (54°12.5 N, 11°45.7 E) on October 8th. Overall calibration results were considered good based on calculated RMS values. Resulting transducer parameters were applied for the post-processing of hydroacoustic survey data. Calibration results for the 38 kHz transducer are given in Table 1.

2.5 Biological data – trawl hauls

Trawl hauls were conducted with a pelagic gear “PSN388” in midwater layers as well as near the seafloor. Mesh size in the codend was 10 mm. It was planned to carry out at least two hauls per ICES statistical rectangle. Both trawling depth and net opening were continuously controlled by a netsonde during fishing operations. Trawl depth was chosen in accordance with echo distributions on the echogram. Normally, a vertical net opening of about 6-8 m was achieved. The trawling time usually lasted 30 minutes but was shortened when echograms and netsonde indicated large catches. To validate and allocate echorecordings, altogether 50 fishery hauls were conducted (Figure 1). From each haul sub-samples were taken to determine length and weight of fish. Samples of herring, sprat, sardine and anchovy were frozen for additional investigations (e.g. determining sex, maturity, age).

2.6 Hydrographic data

Hydrographic conditions were measured after each trawl haul and in regular distances on the survey transect. On each corresponding station, vertical profiles of temperature, salinity and oxygen concentration were measured using a “Seabird SBE 19 plus” CTD. Water samples for calibration purposes (salinity) were taken on every station. Altogether, 90 CTD-profiles were measured (Figure 8).

2.7 Data analysis

All data analyses were conducted using GERIBAS II software (Arivis, 2014) and Microsoft Office.

The pelagic target species sprat and herring are often distributed in mixed layers together with other species. Thus, echorecordings cannot be allocated to a single species. Therefore the species composition allocated to echorecordings was based on corresponding trawl catch results. For each rectangle, species composition and length distributions were determined as the unweighted mean of all trawl results in this rectangle. From these distributions the mean acoustic cross section σ was calculated according to the following target strength-length (TS) relation:

	TS	References
Clupeids	= 20 log L (cm) - 71.2	ICES (1983)
Gadids	= 20 log L (cm) - 67.5	Foote et al. (1986)
Scomber scombrus	= 20 log L (cm) - 84.9	ICES (2017)

All other species that were included in the analysis based on their contribution to the catches per rectangle were allocated the clupeid TS (see table above).

The total number of fish (total N) in one rectangle was estimated as the product of the mean Nautical Area Scattering Coefficient (NASC; S_A) and the rectangle area, divided by the corresponding mean cross section σ. The total number was separated into the categories mentioned above and further into herring and sprat according to the mean catch composition.

All calculations performed were in accordance with the guidelines in the “SISP Manual of International Baltic Acoustic Surveys (IBAS)” (ICES, 2017).

Hauls with very low catches in terms of numbers and biomass as well as hauls conducted with unclear fishing gear were –if applicable- rendered invalid for further analyses. Based on survey design restrictions, comprehensive sampling is not feasible in all statistical rectangles surveyed. Biological information from neighboring rectangles is used for generating estimates in these cases. This mostly applies to rectangles with low abundance as well as to rectangles where low catch hauls required to be omitted.

<u>Stock splitting / Application of the separation function (SF):</u>

In the western Baltic, the distribution areas of two stocks, the Western Baltic Spring Spawning herring (WBSSH) and the Central Baltic herring (CBH) overlap. Survey results from recent years indicated that in SD 24, which is part of the WBSSH management area, a considerable fraction of CBH is present and correspondingly erroneously allocated to WBSSH stock indices (ICES, 2013). Accordingly, a stock separation function (SF) based on growth parameters derived from 2005 to 2010 has been developed to quantify the proportion of CBH and WBSSH in the area (Gröhsler et al., 2013; Gröhsler et al., 2016). The estimates of the growth parameters from baseline samples of WBSSH and CBH in 2011-2018 and 2020 and 2021 support the applicability of the SF (Oeberst et al., 2013; Oeberst et al., 2014, 2015, 2016, 2017; Gröhsler and Schaber, 2018, 2019, 2021, 2022).

The ICES Herring Assessment Working Group for the area south of 62° N (HAWG)) is yearly supplied with an index for this survey (GERAS), which since 2005 excludes CBH and in general covers the total standard survey area, excluding ICES rectangles 43G1 and 43G2 in SD 21 and 37G3 and 37G4 in SD 24, which were not covered in 1994-2004.

3. RESULTS

3.1 Hydroacoustic data (M. Schaber)

Figure 2 depicts the spatial distribution of mean NASC values (5 nmi intervals) measured on the hydroacoustic transects covered in 2021. In general, the majority of these NASC measurements can be allocated to clupeids. Altogether, 25 ICES statistical rectangles were covered in the survey 2021 (27 in 2020). In 10 of those, the mean NASC was higher than in 2020 (partly significantly), in three rectangles the mean NASC was in the range of 2020. In the 12 other rectangles, mean NASC values were partly well below the already low values measured in 2020. In all but one rectangles, the mean NASC measured in 2021 was below the long term survey mean (1991-2020). On ICES subdivision scale, mean NASC values were distinctly lower than in the previous year in SD 21 and SD 22, but slightly higher in SD 24 - and significantly higher in SD 23 (the Sound).

In the rectangles of SD 21 covered both in 2021 and 2020, overall NASC values measured were lower than those measured in the previous year along the Swedish coast of the Kattegat (41G2, 42G2). In the central and southern Kattegat (42G1, 41G1, 41G0), the mean NASC per 1 nmi EDSU measured was higher or similar to the values measured in the previous year. As in before, aggregations were mostly patchy along the cruisetrack.

In SD 22, the mean overall NASC values recorded were lower than in the previous year in 5 out of 11 rectangles surveyed. In the southern parts of that subdivision (rectangles 37G0 and 37G1) as well as in areas north of the Belt Sea adjacent to the Kattegat (40F9, 40G1, 41G0) mean NASC was higher than in 2020, but at generally low values measured.

As in the previous years, the large aggregations of big herring that usually could be observed in the inner Sound area of SD 23 were not present in autumn 2021 to the extent observed prior to 2016. NASC values in rectangles 39G2 and 40G2 were again below the survey mean and also lower than the - slightly increased- values measured in 2020. In rectangle 41G2 however, the mean NASC measured was about 70-fold higher compared to the measurements made in 2020. This was, however, based on the detection of one massive school of fishes located at the narrow isthmus in the northern Sound in an otherwise rather “empty” rectangle. Since that school consisted of spawning herring and accordingly did not yield a NASC value considered valid for providing an WBSSH estimate, the corresponding NASC was omitted from further analyses (see below).

In SD 24, mean NASC values were comparable (1) or distinctly lower (4) than the levels measured in 2020 in 5 out of 9 rectangles. Increased NASC was measured in southern coastal areas and east of Rügen Island (37G2, 37G3) as well as in the southwestern (38G2) and southeastern Arkona Sea bordering the Bornholm Basin (38G4). As in the years before, somewhat notable aggregations were detected around Rügen Island.

3.2 Biological data (T. Gröhsler)

Fishery hauls according to ICES Subdivision (Figure 1):

SD	Hauls (n)
21	10
22	18
23	3
24	19

Altogether, 1 215 individual herring, 727 sprat, 400 European anchovies and 16 sardines were frozen for further investigations (e.g. determining sex, maturity, age). Results of catch compositions by Subdivision are presented in Tables 2-5. Altogether, 29 different species were recorded. Herring were caught in 41, sprat in 40 hauls. SD 23 showed the highest mean herring catch rate per station (kg 0.5 h^{-1}) in the data series since 2002. However, this high mean value was only caused by one haul with exceptional large herring catches in the northern part of the Sound (Haul 32). Anchovy (*Engraulis encrasicolus*), which were present last year in the whole survey area, were not caught in SD 23 in 2021 but dominated catches in other parts of the survey area (SD 22). Sardines (*Sardina pilchardus*) appeared in catches from SD 21 and SD 22, whereas they were only caught in SD 21 in 2020.

Altogether, the following fish species were sampled and processed:

Species	Length measurements (n)	Prevalence (n of hauls)
Aphia minuta	390	17
Belone belone	6	5
Clupea harengus	5,628	41
Engraulis encrasicolus	3,862	37
Gadus morhua	68	23
Gasterosteus aculeatus	1,296	35
Limanda limanda	15	8
Platichthys flesus	22	12
Pleuronectes platessa	12	12
Pomatoschistus minutus	295	18
Sardina pilchardus	16	4
Scomber scombrus	291	16
Sprattus sprattus	4,421	40
Trachinus draco	297	15
Trachurus trachurus	118	27
Others	80	-

Figures 3 and 4 show relative length-frequency distributions of herring and sprat in ICES subdivisions 21, 22, 23 and 24 for the years 2020 and 2021. Compared to results from the previous survey in 2020, the following conclusions for **herring** can be drawn (Figure 4):

- In 2021 catches in SD 21 were dominated by herring larger 15 cm with a mode at 18.75 cm and some minor contribution of the incoming year class (ca. ≤15 cm). This is in contrast to the results in 2020, which were dominated by the incoming year class (ca. ≤15 cm) with a mode at 13.75 cm and a minor contribution of larger herring (>15 cm).
- Catches in SD 22, which were dominated by larger herring >15 cm in 2020 with a mode at 22.25-22.75 cm, were in 2021 dominated by the incoming year class (ca. ≤15 cm) with a mode at 11.25-12.75 cm.
- In SD 23 the contribution of herring larger 20 cm increased in 2021 compared to 2020. Catches in 2020 showed a mode at 19.25 cm, in 2021 at 26.25 cm.
- In 2020 catches in SD 24 showed a bimodal distribution with modes at 13.25-14.25 cm and 17.75-18.75 cm, whereas catches in 2021 were characterized by a trimodal distribution with

modes at 9.25 cm, 13.25-14.25 cm and 17,25 cm. Both in 2021 as well as in the previous survey, herring larger than ca. 25 cm were almost absent.

Relative length-frequency distributions of **sprat** in the years 2020 and 2021 (Figure 5) can be characterized as follows:

- In SD 21 the incoming year class (ca. ≤10 cm) was virtually absent from catches in 2021, whereas some contribution of this year class had been observed in in 2020. The catches in 2021 were dominated by the contribution of larger sprat (mode at 14.25 cm) compared to 2020 (mode at 11.25 cm).
- Catches in SD 22 show a tri-modal distribution with a contribution of the incoming year class (ca. ≤10 cm, mode at 9.75 cm) as well as of larger sprat (>10 cm, modes at 11.25 cm and at 13.25 cm, respectively). This is contrast to the results of 2020, when catches showed a bimodal distribution with a contribution of the incoming year class (ca. ≤10 cm, mode at 6.75 cm) and of larger sprat (>10 cm, mode at 11.25 cm).
- In SD 23, the incoming year class (ca. ≤10 cm) was almost absent from the catches, as also had been observed in the previous year. In both years the catches were dominated by larger sprat (>10 cm) with modes at 11.75 cm (2020) and 13.25-14.25 cm (2021).
- While catches in SD 24 had been dominated almost exclusively by larger sprat (>10 cm, mode at 11,75 cm) in 2020, a bimodal distribution with a higher contribution of the incoming year class (ca. ≤10 cm, mode at 8.75 cm) and lower contribution of larger older sprat (>10 cm, mode at 12.75 cm) was observed in 2021 in this subdivision.
- Altogether, the present contribution of the incoming year class (ca. ≤10 cm) seemed to be as low as in 2020.

For abundance and biomass estimates, the following considerations and calculation steps were included in the analysis:

<u>Fish species considered:</u>

Herring	(*Clupea harengus*)
Transparent goby	(*Aphia minuta*)
European anchovy	(*Engraulis encrasicolus*)
Cod	(*Gadus morhua*)
Three-spined stickleback	(*Gasterosteus aculeatus*)
Whiting	(*Merlangius merlangus*)
Sand goby	(*Pomatoschistus minutus*)
Mackerel	(*Scomber scombrus*)
Sprat	(*Sprattus sprattus*)
Greater weever	(*Trachinus draco*)

<u>Exclusion of trawl hauls with very low catches:</u>

Haul No.	Rectangle	Subdivision (SD)
4	38G4	24
12, 13	37G1	22
24	40G0	22
31	40G2	23
34	41G1	21
36	39G3	24
39	39G4	24
46	42G1	21
48	42G2	21
50	41G2	21

<u>Exclusion of trawl hauls due to other reasons:</u>

Haul 32 (SD 23, 41G2) was removed from the analysis, since it consisted almost exclusively of large, old herring that all were spawning at the time of capture (maturity 6). Since it can be assumed that these herring were not WBSSH, the biological data (i.e. that haul) was removed from further analyses, as had the corresponding NASC data (see above).

Inclusion of hauls with low catches:

Despite low catches of both herring and sprat, the following hauls were not excluded from the analysis as they were the only trawl hauls conducted in the corresponding rectangles and thus provided the only available information on species composition in the following rectangles:

Haul No.	Rectangle	Subdivision (SD)
1	37G2	22
2, 10, 11	38G2	22
15	38G1	22
16, 18, 19, 29	38G0	22
17	37G0	22
20	39F9	22
23	41G0	22
26, 27	39G0	22
28	39G1	22
21	40F9	22
22, 25	40G0	22
33	41G1	21
38	39G4	24
43	41G1	21
45, 49	42G2	21

Usage of neighboring trawl information for rectangles which contain only acoustic investigations:

Rectangle/SD to be filled	with Haul No.	of Rectangle/SD
37G4/24	6, 7	37G3/24, 38G4/24
40G1/22	25	40G0/22
41G0/21	33	41G1/21
39G2/23	35, 42	39G2/24
41G2/23	30	40G2/23

3.3 Stock Splitting / Application of the Separation Function (SF)

The age-length distribution of herring in SD 21, SD 22 and in SD 23 in 2021 indicated also some contribution of fish of CBH origin. Besides the standard procedure to use the SF in SD 24 and in SD 23/39G2 (since biological samples of that rectangle were also used to raise the corresponding mean NASC values in the SD 24 area of the rectangle), the SF was accordingly also applied in SD 21 and SD 22 in 2021.

The applicability of the SF, which is checked by analyzing the growth parameters based on baseline samples of WBSSH in SDs 21 and 23 (GERAS) and SDs 27-29 (GERBASS), was also tested in 2021. Despite some degree of mixing of CBH/WBSSH in SDs 21 and 23, results showed applying the SF for splitting of WBSSH and CBH stocks was feasible (Gröhsler & Schaber, 2022).

3.4 Biomass and abundance estimates

The total abundance of herring and sprat per ICES statistical rectangle and Subdivision is presented in Table 6. Estimated numbers of herring and sprat by age group and SD/rectangle are given in Tables 7 and 10, respectively. Corresponding mean weights by age group and SD/rectangle are provided in

Tables 8 and 11. Estimates of herring and sprat biomass by age group and SD/rectangle are summarized in Tables 9 and 12.

3.4.1 Herring incl. Central Baltic Herring (CBH)

The total herring stock in Subdivisions 21-24 was estimated to be 2.0 x 10^9 fish (Table 7) or 68.8 x 10^3 tons (Table 9). For the included area of Subdivisions 22-24 the number of herring was calculated at be 1.9 x 10^9 fish or 63.5 x 10^3 tons.

3.4.2 Herring excl. Central Baltic Herring (CBH)

Estimated numbers of herring excluding CBH in SDs 21-24 by age group and SD/rectangle for 2020 are given in Table 13. Corresponding herring mean weights by age group and SD/rectangle are shown in Table 14. Estimates of herring biomass excluding CBH by age group and SD/rectangle are summarized in Table 15.

Removal of the CBH fraction in different SDs (total survey area) yielded the following results:

Numbers (millions)	Total	excluding CBH in SD:	
	incl. CBH	23(39G2) & 24	21, 22, 23 (39G2), 24
SDs 21-24	2 007.4	877.6	870.4
Percentage of Total	100.0%	43.7%	43.4%
Difference		-56.3%	-56.6%
Biomass (t)	Total	excluding CBH in SD:	
	incl. CBH	23(39G2) & 24	21, 22, 23 (39G2), 24
SDs 21-24	68 812.8	31 324	31 102
Percentage of Total	100.0%	45.5%	45.2%
Difference		-54.5%	-54.8%

Removal of the CBH fraction in SDs 21-24 from the herring HAWG-GERAS index of the standard area (excluding 43G1/43G2 in SD 21 and 37G3/37G4 in SD 24) in 2021 also resulted in biomass reductions of 53 % with corresponding reductions in numbers of 55 % (2020: - 37 % and -27 %, 2019: -36 % and -24 %, 2018: -20 % and -11 %, respectively (Figure 6).

The time series of HAWG-WBSSH-GERAS indices (standard area) is depicted in Figure 7.

3.4.3 Sprat

The estimated sprat stock in Subdivisions 21-24 was 1.9 x 10^9 fish (Table 10) or 22.5 x 10^3 tons (Table 12). For the included area of Subdivisions 22-24 the number of sprat was calculated at 1.7 x 10^9 fish or 19.8 x 10^3 tons. The overall abundance estimate in 2021 was dominated by two year old sprat (Figure 5 and Table 10).

3.5 Hydrography

Vertical profiles of temperature, salinity and oxygen concentration were measured with a SeaBird SBE CTD-probe on a station grid covering the whole survey area. Hydrography measurements were either conducted directly after a trawl haul or, in case of no fishing activity, in regular intervals along the cruise track. Altogether, 90 CTD casts were conducted during this survey (Figure 8).

Surface temperatures were lower than in the previous year ranging from ca. 11°C in the central Kattegat area (SD 21) to > 14°C in the southern Mecklenburg Bight (SD 22) and eastern Arkona Basin (SD 24). In general, surface temperatures were higher in the southern part of the survey area. Bottom temperatures showed a higher variability due to thermohaline layering and were lowest in the deep parts of the Bornholm Basin area in SD 24 (< 7°C) and the deep parts of the Sound and the Kattegat (ca. 10.5°C) but distinctly higher in the shallower areas of SD 21-24. Also in the central and eastern parts of the Arkona Sea (SD 24), bottom temperatures were relatively high at > 14 °C and exceeded surface temperatures.

As usual, due to the hydrographic nature of the western Baltic Sea, surface salinities showed a large gradient (from ca. 7.5 PSU in the southeastern Arkona Sea to > 29 PSU in the Kattegat). Surface salinities in the western parts of the survey area were higher than the values recorded in the previous years and exceeded 15 PSU south of the Belt Sea. Salinity near the seafloor ranged from 9 PSU in the Arkona Sea to ca. 34 PSU in the deep parts of the Kattegat. Especially in the Sound (SD 23), a very strong stratification with steep salinity gradients was again observed.

Surface waters were well oxygenated throughout the survey area. In contrast, pronounced oxygen depletion was measured in the inner Mecklenburg Bight (SD 22) and the western SD 22 area of the southern Little Belt. In those regions, lowest oxygen concentrations measured near the seafloor were below 0.5 ml/l and occasionally in in the anoxic range.

4. DISCUSSION

Compared to the previous year, the present estimates of herring **incl. CBH** show a slight increase in stock biomass and slight decrease in abundance values (ICES rectangles 43G1 and 43G2 in SD21 were removed in 2020 for comparison):

Herring (incl. CBH)	Difference compared to 2020	
Area	Numbers (%)	Biomass (%)
Subdivisions 21-24	-6	+3

The present results **incl. CBH** are mainly driven by a far lower contribution of the 0-group (-58 % in numbers and -63 % in biomass), together with far higher contributions of 2-4 years old herring (+136 % in numbers and +83 % in biomass).

The present estimates of herring **excl. CBH** compared to 2020 now show a significant decrease in stock biomass and abundance values (ICES rectangles 43G1 and 43G2 in SD21 were removed in 2020 for comparison):

Herring (excl. CBH)	Difference compared to 2020	
Area	Numbers (%)	Biomass (%)
Subdivisions 21-24	-41	-21

The low number of 0-group herring together with the exclusion of a large part of 2-7 years old CBH in the main mixing area of SD 24 (by applying SF) lead to the overall significant decrease in stock biomass and abundance values (**excl. CBH**) compared to 2020.

The application of the Separation Function (SF) to remove CBH from the index calculation again yielded robust results despite the “contamination” of WBSSH baseline samples with CBH in ICES SD 21 and SD 23 (Gröhsler & Schaber, 2022 WD). Estimates of parameters of the Bertalanffy-Growth-Function (BGF) in 2021 showed a decreasing trend compared to the period 2005-2010 which can be explained by a distinctly lower contribution of older/larger herring in 2021 together with some contributions of CBH in the baseline sample. However, the majority of WBSSH could be allocated to the corresponding stock using the SF established with BGF parameters from 2005-2010. Again, mean weights of different age groups that prior to removal showed somewhat untypical growth pattern for WBSSH became distinctly more realistic for older age groups after removing the CBH fraction. Additionally, a conspicuous peak of abundance of mostly 2-4 years old herring that otherwise could not be explained vanished after removing the CBH fraction.

After over 6 years of consecutive decline, the present Western Spring Spawning Herring biomass estimate (HAWG-GERAS Index) again represents the lowest recorded value in the whole time series since 1993 (Figure 7).

Prior to 2016, high numbers of large herring were usually and regularly recorded in SD 23 (the Sound), which is considered an important transition and aggregation area for the WBSSH stock during its spawning migration (Nielsen, 1996). In 2021, the second year after 2020 and several years of supposed absence, some of those fishes were present in catches from the Sound again. The reason for this re-appearance or for the previous absence in survey hauls can so far not be identified. The lack of large, adult herring in the Sound in previous years has been explained by a possibly delayed immigration of WBSSH from the feeding areas in the Skagerrak. The exceptionally low numbers of large and older herring since 2016 could also be explained by the very low recruitment, which was recorded through the N20 larval survey index during the last years. The sustained downward trend in recruitment could explain the further disappearance of older herring in time. A strong correlation of the N20 index with the 1-age group of the GERAS index (Polte and Gröhsler, 2021) supports this assumption. Methodological biases leading to presence or absence of large herring in the catches can again not be ruled out, but at least in terms of overall acoustic detections of clupeids seem not likely. Possible shifts in the spatial or diurnal distribution of herring aggregations towards shallower areas would be undetected by the current survey and cannot be disregarded. An indication for such possible shifts was detected during a 2019 parallel survey of the inner Sound transect with FRV “Solea” and FRV “Clupea”, when length distributions of herring caught differed between night- and daytime with larger herring in the daytime catches. Additionally, also in 2021 some large - assumed clupeid- aggregations were detected in shallower areas of SD 23 while steaming to the starting point of the transect.

Migrations of herring out of the sound can be triggered by hydrographic conditions in a way that barotropic inflow events in late summer and early autumn prevent deoxygenation in the Sound. This leads to prolonged aggregations of herring in the Sound (Miethe et al., 2014). In 2020, no such migration could be assumed since no older and bigger herring were detected in corresponding areas of the adjacent SD 24, nor was there an indication of according hydrographic conditions driving herring out of the Sound.

In the “isthmus” of the Sound between Helsingör and Helsingborg, a large school of fish was recorded on the echosounder along a ridge in less than 20 m depth. A similar but much smaller aggregation of fishes had been recorded at the same position in the previous year. Due to navigational constraints as well as the difficult bathymetry, no targeted trawl haul could be conducted on this aggregation before. In 2021, due to the large size of the school and the significant contribution to the overall NASC measured in the rectangle and the whole Subdivision 23, it was attempted to collect a trawl sample from that school. The catch (Haul 32) yielded a large amount of large herring that were all spawning (maturity 6). It can be assumed that the herring sampled were no WBSSH but possibly originated from an autumn spawning stock component (Western Baltic Autumn Spawning Herring, WBASH or immigrated North Sea Autumn Spawning Herring, NSASH). Accordingly, both the biological samples and the hydroacoustic records originating from that school of spawning herring were removed from the further analysis of survey indices for WBSSH. Genetic analyses on the origin of these herring are currently ongoing.

5. SURVEY PARTICIPANTS

Name	Function	Institute
Dr. M. Schaber (15.-28.10.)	Cruise Leader (Hydroacoustics, Hydrography)	TI-SF
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M. Koth	Fishery biology	TI-OF
L. Schmidt (8.-15.10.)	Fishery biology	TI-OF
S. Winning (8.-15.10.)	Fishery biology	TI-SF
A. Finke (15.-28.10.)	Fishery biology	TI-OF
P. Christiansen (8.-15.10.)	Fishery biology	DTU-Aqua (DK)
N. Kolding (15.-28.10.)	Fishery biology	DTU-Aqua (DK)

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7. FIGURES

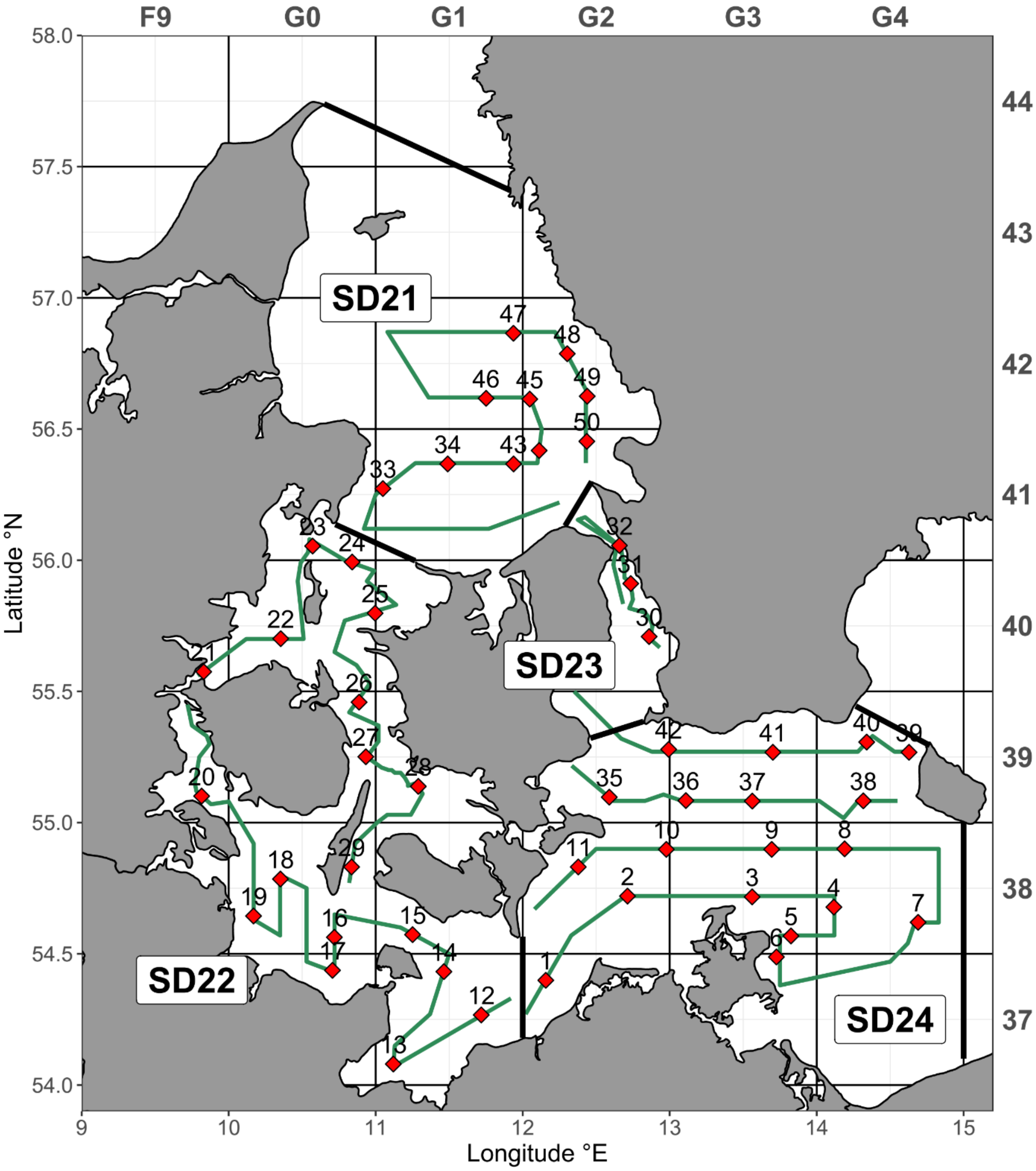

Figure 1: FRV "Solea" cruise 798/2021. Cruise track (dark green lines) and fishery hauls (red diamonds). ICES statistical rectangles are indicated in the top and right axis. Thick black lines separate ICES subdivisions (SD).

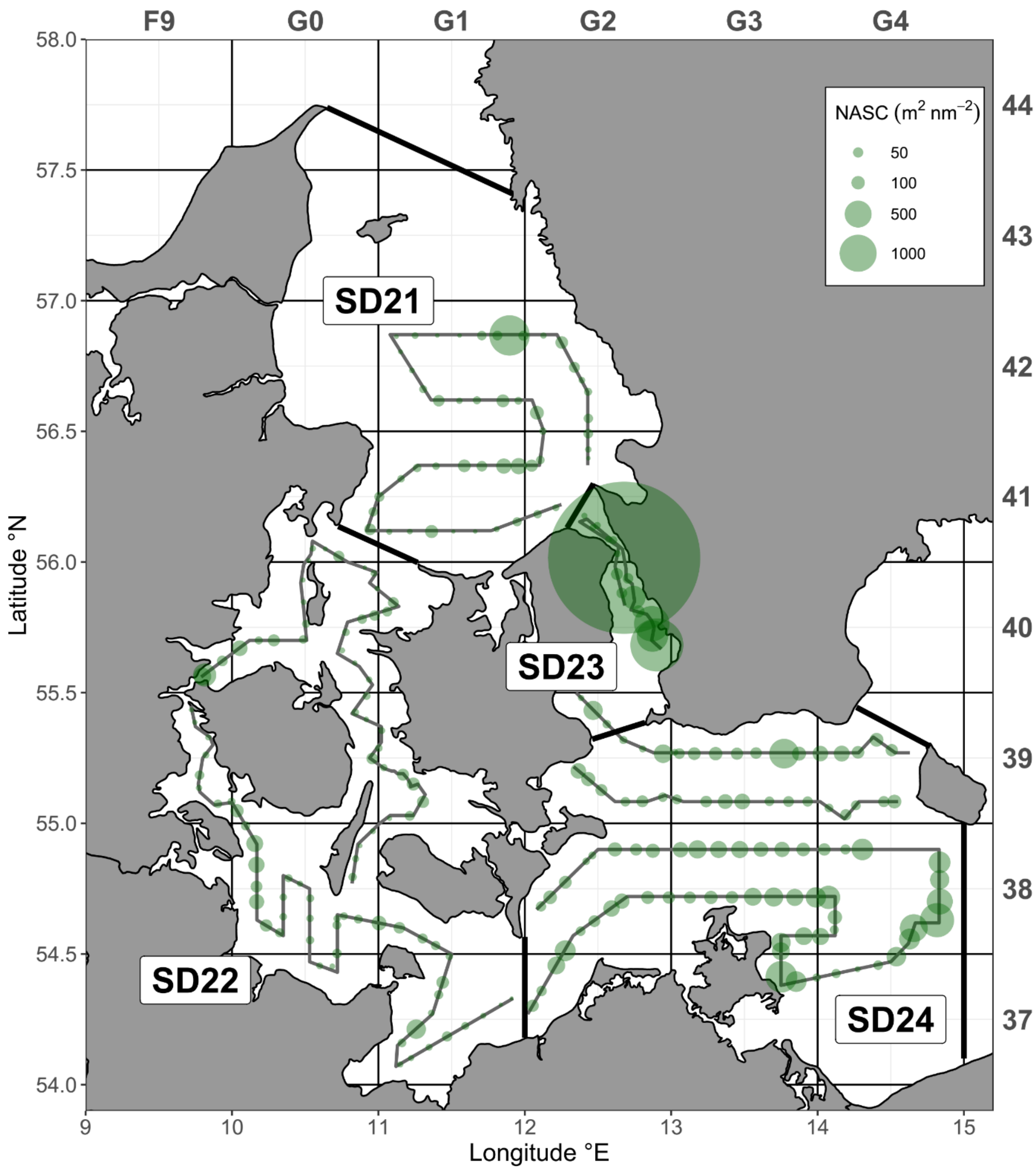

Figure 2: FRV "Solea" cruise 798/2021. Cruise track (thin grey lines) and mean NASC (5 nmi intervals, dots). ICES statistical rectangles are indicated in the top and right axis. Thick black lines separate ICES subdivisions. Note the large NASC value measured in 41G2 (SD 23) which had to be removed from the WBSSH estimate (see results).

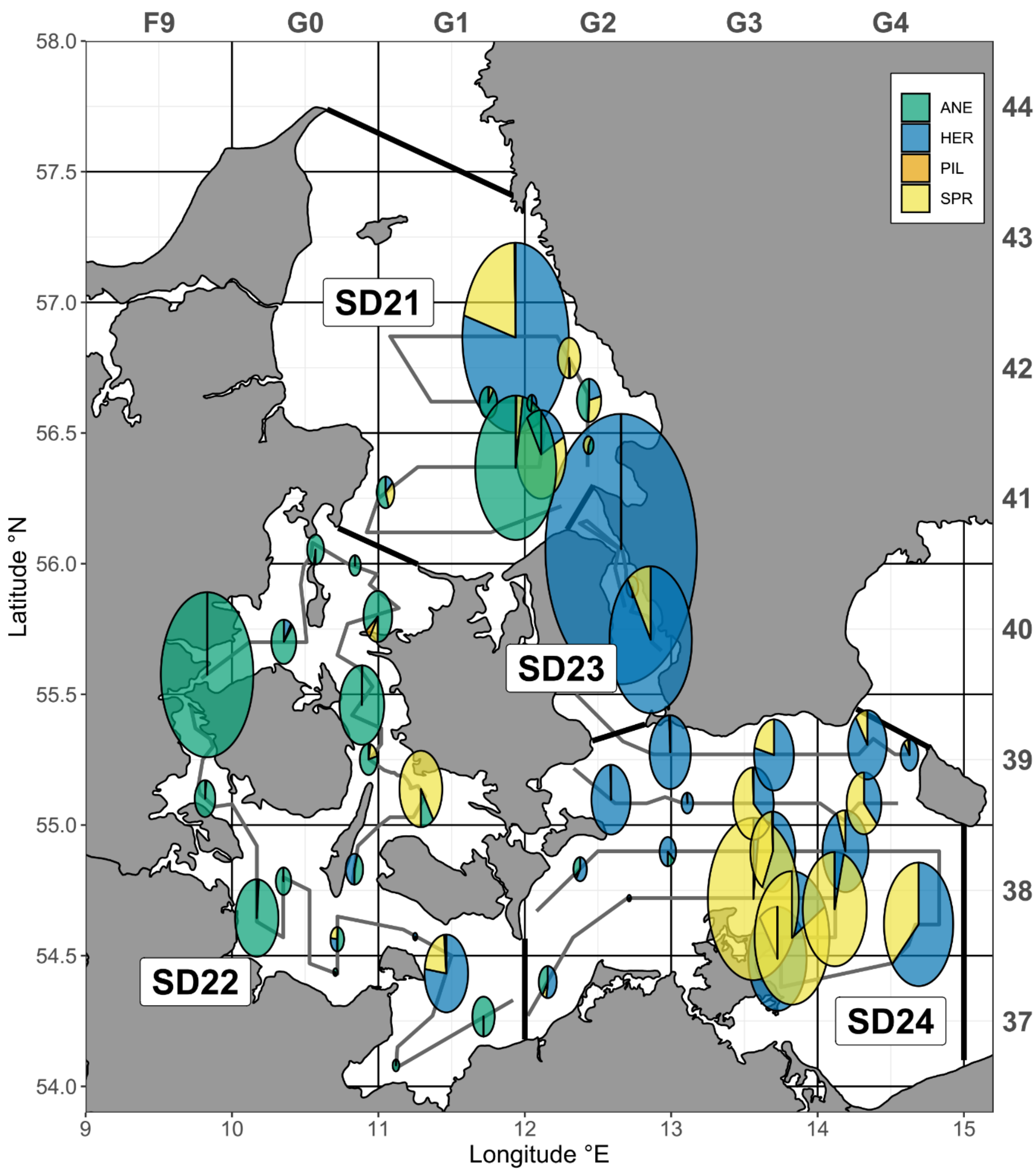

Figure 3: FRV "Solea" cruise 798/2021. Clupeid catch per haul (kg 30min^{-1}). ANE = European anchovy (*Engraulis encrasicolus*), HER = Herring (*Clupea harengus*), PIL = Sardine (*Sardina pilchardus*), SPR = Sprat (*Sprattus sprattus*). ICES statistical rectangles are indicated in the top and right axis. Thick black lines separate ICES subdivisions. Thin grey lines indicate cruise track.

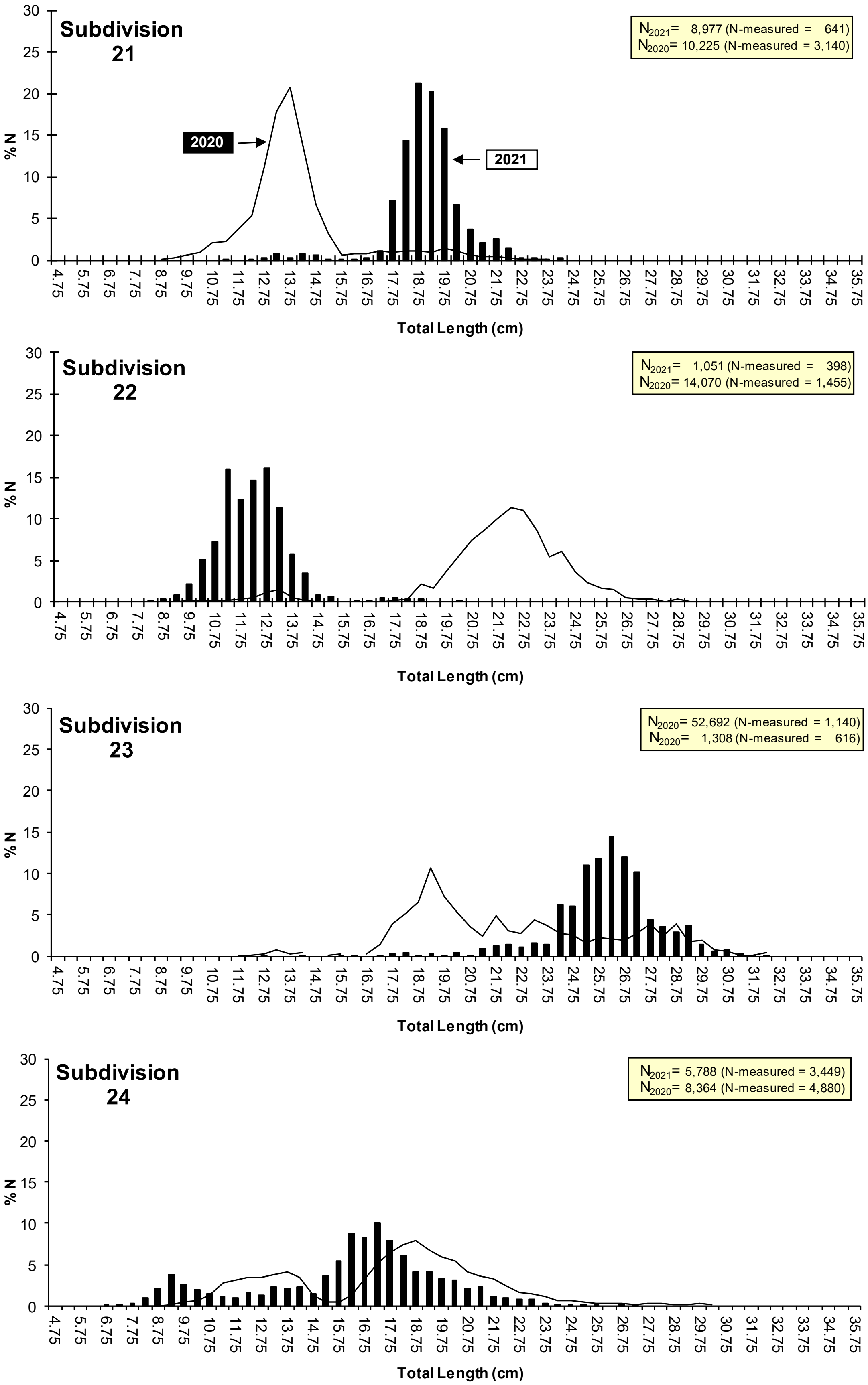

Figure 4: FRV "Solea" cruise 798/2021. Herring (*Clupea harengus*) length-frequency distribution (bars) compared to the previous year (cruise 783/2020, lines). Note that the LFD in SD 23 contains data from haul 32 which had to be removed from the calculation of WBSSH abundance/biomass indices.

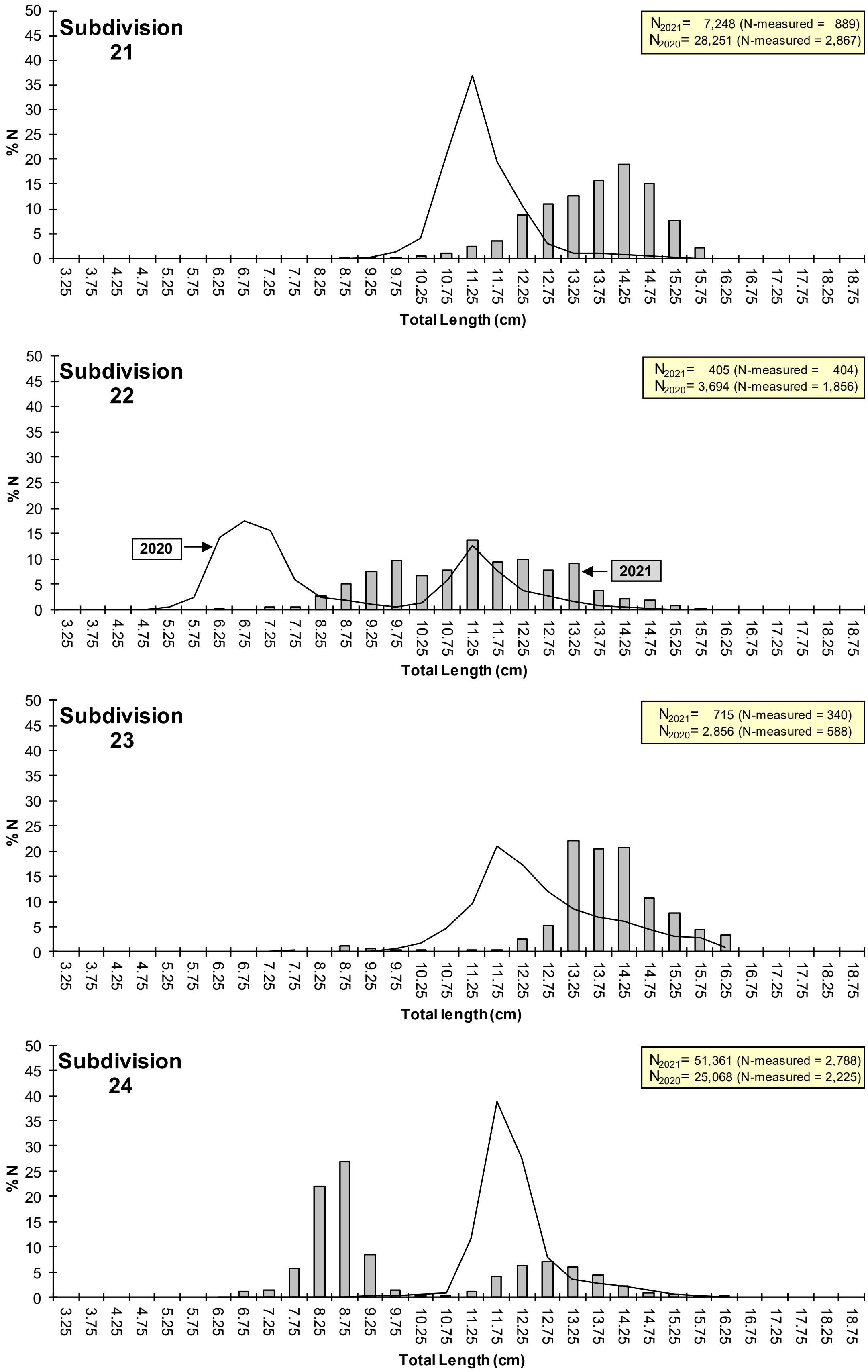

Figure 5: FRV "Solea" cruise 798/2021. Sprat (*Sprattus sprattus*) length-frequency distribution (bars) compared to the previous year (cruise 783/2020, lines).

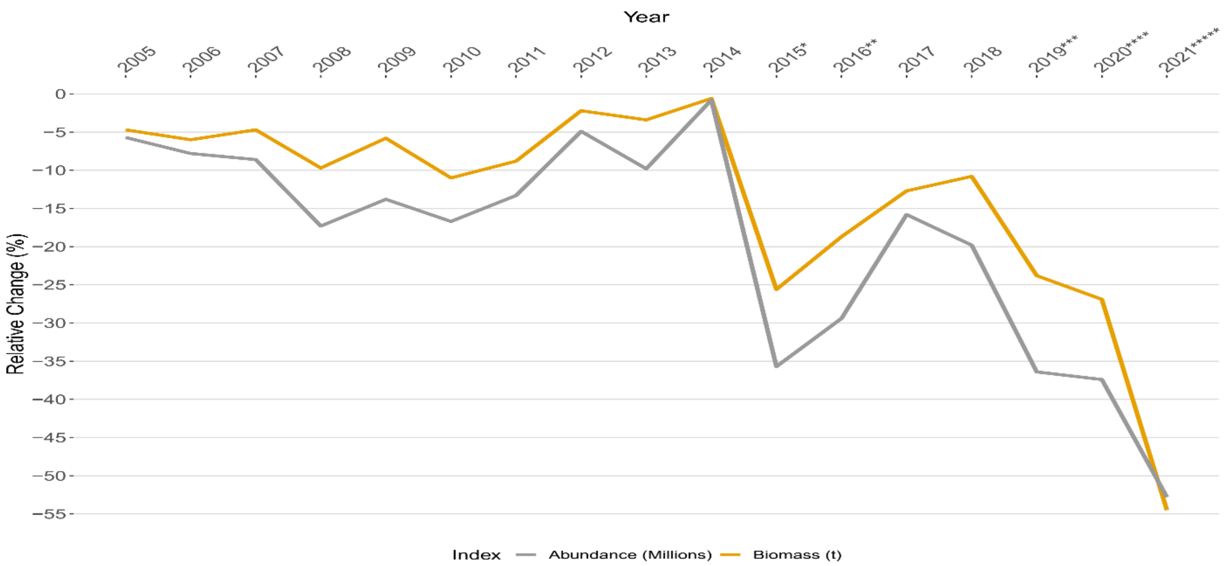

Figure 6: Relative changes in abundance and biomass of Western Baltic Spring Spawning herring in ICES Subdivisions 21-24 (2005-2021) after application of the stock Separation Function (SF, Gröhsler et al., 2013) to the abundance and biomass index generated from German acoustic survey data (GERAS) from SD24 and SD23/39G2. **excl. of CBH in SD 22 and mature herring (stages ≥6) in SD 23, **excl. of CBH in SD 22 *** excl. of CBH in SDs 21-23, ****excl. of CBH in SD 21, ******excl. of CBH in SDs 21-22 and excl. haul 32 with almost exclusively mature herring in SD 23.

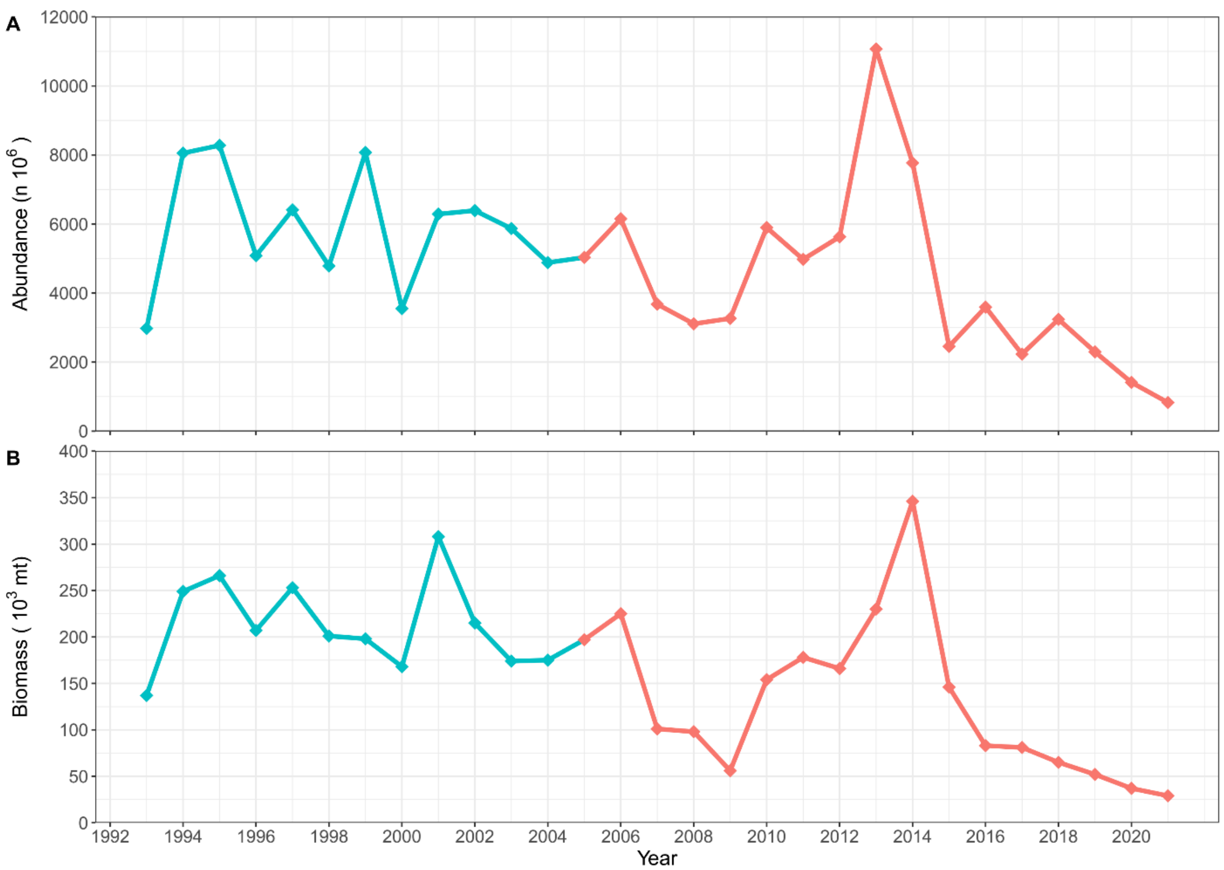

Figure 7: HAWG time series of GERAS survey indices for Western Baltic Spring Spawning Herring (WBSSH) age groups 0-8$^+$. A) Abundance and B) Biomass of herring in ICES Subdivisions 21 (Southern Kattegat, ICES statistical rectangles 41G0 - 42G2) – 24 (excl. ICES statistical rectangles 37G3 & 37G4). Blue line (until 2005): WBSSH including Central Baltic Herring fraction; Red line (from 2005): WBSSH after application of Separation Function (SF).

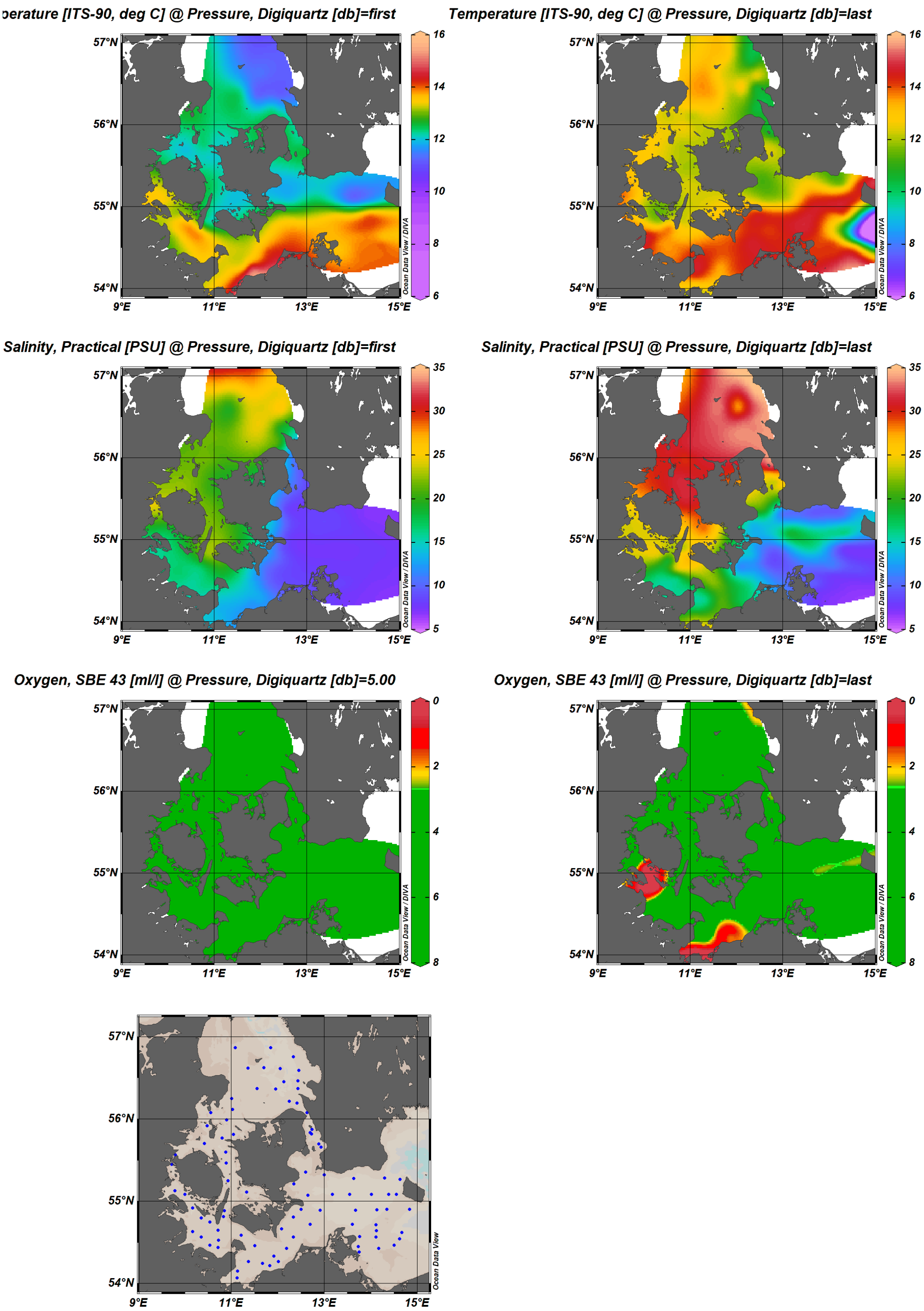

Figure 8: FRV "Solea" cruise 798/2021: Hydrography. CTD stations are depicted as blue dots in the area map. Temperature (°C, top panels), salinity (PSU, middle panels and oxygen concentration (ml/l, lower panels) at the surface (left) and near the seafloor (right).

8. TABLES

Table 1: FRV "Solea" cruise 798/2021: Simrad EK80 calibration report (38 kHz Transducer).

Date:	08.10.2021		
Calibration Site:	Mecklenburg Bight (54°12.5 N, 11°45.7 E)		
Transceiver Type:	WBT		
Software Version:	EK80 2.0.1.0		
Reference Target:	Tungsten (WC-Co) 38.1 mm		
Transducer:	ES38-7 Serial No. 147		
Frequency:	38000 Hz	Beamtype:	Split/Narrow
Gain:	26.98 dB	Equivalent Beam Angle:	-20.7 dB
Beamwidth Athw.:	6.59 deg	Beamwidth Along.:	6.67 deg
Offset Athw.:	-0.03 deg	Offset Along.:	-0.06 deg
Depth:	4.20 m		
Pulse Duration:	1.024 ms		
Power:	2000 W		
TS Detection:			
Min. Value:	-50.0 dB	Min. Spacing:	0.0
Max. Gain Comp.:	3.0 dB	Min. Echolength:	0.8
Max. Echolength:	1.8		
Environment:			
Absorption Coeff.:	0.000	Sound Velocity:	1479.95m/s
Temperature:	14.6 °C	Salinity:	13.0 PSU
Calibration results:			
Transducer Gain:	26.99 dB	SaCorrection:	-0.0618 dB
Beamwidth Athw.:	6.51 deg	Beamwidth Along.:	6.46 deg
Offset Athw.:	0.04 deg	Offset Along.:	-0.14 deg
RMS-Error:	0.05		

Table 2: FRV "Solea" cruise 798/2021: Catch composition (kg 0.5 h^{-1}) by haul in SD 21.

Haul No. / Species/ICES Rectangle	33 41G1	34 41G1	43 41G1	44 41G2	45 42G2	46 42G1	47 42G1	48 42G2	49 42G2	50 41G2	Total
ALLOTEUTHIS	+	+	0.04	0.06	0.04	0.19	0.01	0.07	0.03	0.04	**0.48**
APHIA MINUTA	+					+		0.02	0.01	+	**0.03**
CLUPEA HARENGUS	0.41		0.27	3.46	0.59	0.04	417.77		0.91	0.02	**423.47**
ELEDONE				0.01	0.01			0.02	0.01		**0.05**
ENGRAULIS ENCRASICOLUS	1.58		114.54	1.79	0.82	2.54	1.70	+	2.00	0.23	**125.20**
EUTRIGLA GURNARDUS				0.02							**0.02**
GASTEROSTEUS ACULEATUS			0.01							+	**0.01**
LIMANDA LIMANDA									0.04		**0.04**
MERLANGIUS MERLANGUS	0.01		0.15	0.10	0.01	+		0.05	0.25	0.03	**0.60**
PLEURONECTES PLATESSA						0.03		0.01			**0.04**
SARDINA PILCHARDUS									0.04		**0.04**
SCOMBER SCOMBRUS	0.78	75.58	0.08	6.14	0.31	0.52	16.12	0.04	0.05	0.07	**99.69**
SPRATTUS SPRATTUS	0.84		3.06	13.42	0.32	0.25	110.88	0.26	1.20	0.31	**130.54**
TRACHINUS DRACO	1.17	0.26	0.21	1.59	5.74	0.38	25.86	0.03	0.09	0.06	**35.39**
TRACHURUS TRACHURUS	0.06	0.01	0.05	0.01	0.01	0.01			0.01	0.03	**0.19**
Total	**4.85**	**75.85**	**118.41**	**26.60**	**7.85**	**3.96**	**572.34**	**0.50**	**4.64**	**0.79**	**815.79**
Medusae	0.24	1.09	1.43	0.08	1.11	1.83	0.00	1.38	2.36	2.68	12.20

+ = < 0.01 kg

Table 3: FRV "Solea" cruise 798/2021: Catch composition (kg 0.5 h^{-1}) by haul in SD 22.

Haul No. / Species/ICES Rectangle	12 37G1	13 37G1	14 37G1	15 38G1	16 38G0	17 37G0	18 38G0	19 38G0	20 39F9	21 40F9	22 40G0	23 41G0	24 40G0
AGONUS CATAPHRACTUS				+									
ALLOTEUTHIS											0.01	0.01	0.01
APHIA MINUTA			+			+							
BELONE BELONE		0.07		0.02	0.06	0.01	0.09						
CLUPEA HARENGUS		0.01	10.04	0.61	0.12	0.03		0.15		0.05	0.43		
CTENOLABRUS RUPESTRIS				+			+						
ENGRAULIS ENCRASICOLUS	0.27	1.47	0.21	0.17	0.22	0.55	2.48	12.70	3.31	233.44	3.81	0.36	1.97
GADUS MORHUA	+	0.01	0.02	0.13		0.02	+		0.01	0.04			
GASTEROSTEUS ACULEATUS	0.07	0.03	0.02	0.05		0.15	0.20	1.31	0.95	0.95	0.02		+
LIMANDA LIMANDA		0.15	0.47	0.32		0.07		0.20					
MERLANGIUS MERLANGUS	0.03	0.01	0.47	+		0.04	0.03	0.14	0.03	0.03	0.01		
MYOXOCEPHALUS SCORPIUS													
PLATICHTHYS FLESUS		0.45	0.22										
PLEURONECTES PLATESSA		0.17		0.06			0.16		0.11				
POMATOSCHISTUS MINUTUS	+		0.01			0.01					+		
SARDINA PILCHARDUS										0.12			0.01
SCOMBER SCOMBRUS										0.09	0.20		
SPRATTUS SPRATTUS			2.82		0.11	0.19		0.06	0.06	0.09	0.09	0.01	
TRACHINUS DRACO										0.08		0.31	0.18
TRACHURUS TRACHURUS	+	0.01	0.02	+		0.04		0.01		0.28	0.01		0.00
Total	**0.37**	**2.38**	**14.30**	**1.36**	**0.51**	**1.11**	**2.96**	**14.57**	**4.47**	**235.17**	**4.58**	**0.69**	**2.17**
Medusae	15.68	14.18	5.25	5.80	1.64	3.89	10.51	13.90	1.72	0.27	1.50	1.54	1.12

Haul No. / Species/ICES Rectangle	25 40G0	26 39G0	27 39G0	28 39G1	29 38G0	Total
AGONUS CATAPHRACTUS				+		**+**
ALLOTEUTHIS	0.02		+	0.01		**0.06**
APHIA MINUTA	0.07	+	+	4.89		**4.96**
BELONE BELONE						**0.25**
CLUPEA HARENGUS		0.05	0.10		0.30	**11.89**
CTENOLABRUS RUPESTRIS						**+**
ENGRAULIS ENCRASICOLUS	0.16	13.78	2.19	0.01	0.24	**277.34**
GADUS MORHUA					0.15	**0.38**
GASTEROSTEUS ACULEATUS		0.02		1.36	6.72	**11.85**
LIMANDA LIMANDA					0.09	**1.30**
MERLANGIUS MERLANGUS		+				**0.79**
MYOXOCEPHALUS SCORPIUS	0.06					**0.06**
PLATICHTHYS FLESUS						**0.67**
PLEURONECTES PLATESSA						**0.50**
POMATOSCHISTUS MINUTUS				0.01		**0.03**
SARDINA PILCHARDUS	0.01					**0.14**
SCOMBER SCOMBRUS	1.24					**1.53**
SPRATTUS SPRATTUS	0.02		0.51	0.07		**4.03**
TRACHINUS DRACO	0.03	0.13				**0.73**
TRACHURUS TRACHURUS	0.02	0.01	0.03	0.02		**0.45**
Total	**1.63**	**13.99**	**2.83**	**6.37**	**7.50**	**316.96**
Medusae	2.80	8.33	2.47	4.18	0.80	95.58

+ = < 0.01 kg

Table 4: FRV "Solea" cruise 798/2021: Catch composition (kg 0.5 h^{-1}) by haul in SD 23.

Haul No. **Species/ICES Rectangle**	**30** **40G2**	**31** **40G2**	**32** **41G2**	**Total**
APHIA MINUTA		+		**+**
CLUPEA HARENGUS	116.20	0.49	7565.28	**7681.97**
GADUS MORHUA	10.37	9.70		**20.07**
GASTEROSTEUS ACULEATUS	0.10	0.01		**0.11**
MERLANGIUS MERLANGUS	0.83			**0.83**
PLEURONECTES PLATESSA		0.49		**0.49**
POMATOSCHISTUS MINUTUS	+			**+**
SCOMBER SCOMBRUS			17.15	**17.15**
SPRATTUS SPRATTUS	12.05	0.01	0.98	**13.04**
TRACHURUS TRACHURUS	0.23	0.01	0.47	**0.71**
Total	**139.78**	**10.71**	**7583.88**	**7734.37**
Medusae	0.33	0.45	0.00	**0.78**

+ = < 0.01 kg

Table 5: FRV "Solea" cruise 798/2021: Catch composition (kg 0.5 h^{-1}) by haul in SD 24.

Haul No. **Species/ICES Rectangle**	**1** **37G2**	**2** **38G2**	**3** **38G3**	**4** **38G4**	**5** **38G3**	**6** **37G3**	**7** **38G4**	**8** **38G4**	**9** **38G3**	**10** **38G2**	**11** **38G2**	**35** **39G2**	**36** **39G3**
ALOSA FALLAX							0.03						
APHIA MINUTA	+	+						+			+	+	
CLUPEA HARENGUS	1.51	0.59	4.90	2.00	14.16	27.90	37.80	14.00	8.12	0.32	1.33	9.95	1.97
CRANGON CRANGON		+	+		+	+	+			+			
CYCLOPTERUS LUMPUS								0.12					
ENGRAULIS ENCRASICOLUS	1.15	0.20		0.01		0.02			0.07	0.06	0.78		0.02
GADUS MORHUA				0.19	0.02	0.07	1.70	0.58	1.06	0.02	0.02		
GASTEROSTEUS ACULEATUS	0.13	0.03	0.23	+	0.05		0.07	0.06	0.21	0.01	0.58	+	+
LIMANDA LIMANDA	0.13												
MERLANGIUS MERLANGUS	0.06		0.01		0.03	7.92	+	0.16	0.70		+	0.02	0.03
NEOGOBIUS MELANOSTOMUS										+	+		
PLATICHTHYS FLESUS		0.32	0.80		0.49	0.66	0.19	0.72				0.74	
PLEURONECTES PLATESSA	0.07		0.20					0.11					
POMATOSCHISTUS MINUTUS	0.01	0.02	0.02		+	+	0.01	+	0.03	0.05	+		
SCOMBER SCOMBRUS		0.19			0.36								
SPRATTUS SPRATTUS	0.22	0.02	208.55	41.58	67.91	3.23	21.44	0.95	5.89		0.11	0.05	
STIZOSTEDION LUCIOPERCA					0.06	3.44							
TRACHURUS TRACHURUS	0.01	0.03										0.02	
Total	**3.29**	**1.40**	**214.71**	**43.78**	**83.08**	**43.24**	**61.24**	**16.70**	**16.08**	**0.46**	**2.82**	**10.78**	**2.02**
Medusae	1.59	0.96	0.30	0.63	0.39	3.07	0.50	0.66	3.10	3.05	2.58	0.72	16.50

Haul No. **Species/ICES Rectangle**	**37** **39G3**	**38** **39G4**	**39** **39G4**	**40** **39G4**	**41** **39G3**	**42** **39G2**	**Total**
ALOSA FALLAX							**0.03**
APHIA MINUTA							**+**
CLUPEA HARENGUS	3.89	2.84	2.52	8.80	8.19	11.33	**162.12**
CRANGON CRANGON							**+**
CYCLOPTERUS LUMPUS							**0.12**
ENGRAULIS ENCRASICOLUS	0.05		0.07				**2.43**
GADUS MORHUA	1.64		0.01	0.86	0.01		**6.18**
GASTEROSTEUS ACULEATUS	0.03	+	0.01		0.03	0.02	**1.46**
LIMANDA LIMANDA							**0.13**
MERLANGIUS MERLANGUS			0.25		0.67		**9.85**
NEOGOBIUS MELANOSTOMUS							**+**
PLATICHTHYS FLESUS	0.24				0.31	0.23	**4.70**
PLEURONECTES PLATESSA				0.13	0.16		**0.67**
POMATOSCHISTUS MINUTUS					0.01	+	**0.15**
SCOMBER SCOMBRUS							**0.55**
SPRATTUS SPRATTUS	6.96	4.90	0.23	1.02	2.29	0.09	**365.44**
STIZOSTEDION LUCIOPERCA							**3.50**
TRACHURUS TRACHURUS							**0.06**
Total	**12.81**	**7.74**	**3.09**	**10.81**	**11.67**	**11.67**	**557.39**
Medusae	27.46	4.89	14.97	4.09	2.70	1.40	**89.56**

+ = < 0.01 kg

Table 6: FRV "Solea", cruise 798/2021. Survey statistics by area.

Sub-division	ICES Rectangle	Area (nm²)	Sa (m²/NM²)	Sigma (cm²)	N total (million)	Herring (%)	Sprat (%)	NHerring (million)	NSprat (million)
21	41G0	108.1	53.2	2.674	21.51	4.67	24.30	1.01	5.23
21	41G1	946.8	43.4	2.252	182.47	2.45	13.82	4.48	25.22
21	41G2	432.3	30.4	1.679	78.27	8.76	69.11	6.86	54.09
21	42G1	884.2	63.0	3.051	182.58	57.74	38.38	105.41	70.07
21	42G2	606.8	43.2	3.386	77.42	9.29	15.87	7.19	12.29
21	Total	2,978.2			542.25			124.95	166.90
22	37G0	209.9	86.1	0.696	259.66	1.22	7.76	3.18	20.14
22	37G1	723.3	42.9	1.361	227.99	72.77	22.26	165.91	50.74
22	38G0	735.3	41.7	0.949	323.10	4.83	6.08	15.60	19.65
22	38G1	173.2	60.6	1.116	94.05	39.67	0.00	37.31	0.00
22	39F9	159.3	19.7	0.718	43.71	0.00	1.49	0.00	0.65
22	39G0	201.7	38.5	1.317	58.96	1.52	5.83	0.90	3.44
22	39G1	250.0	41.8	0.138	757.25	0.00	0.07	0.00	0.52
22	40F9	51.3	118.6	1.695	35.89	0.01	0.10	0.004	0.03
22	40G0	538.1	29.0	0.770	202.66	4.22	1.07	8.55	2.18
22	40G1	174.5	44.0	0.161	476.89	0.00	0.27	0.00	1.31
22	41G0	173.1	31.7	2.624	20.91	0.00	3.03	0.00	0.63
22	Total	3,389.7			2501.07			231.45	99.29
23	39G2	130.9	110.7	2.835	51.11	92.85	1.16	47.45	0.59
23	40G2	164.0	434.7	4.501	158.39	57.99	36.87	91.85	58.40
23	41G2	72.3	19.2	4.501	3.08	57.99	36.87	1.79	1.14
23	Total	367.2			212.58			141.09	60.13
24	37G2	192.4	120.7	1.057	219.70	23.81	6.52	52.31	14.32
24	37G3	167.7	322.6	3.201	169.01	66.88	29.25	113.04	49.44
24	37G4	875.1	35.9	2.533	124.03	56.48	40.62	70.05	50.38
24	38G2	832.9	96.9	0.649	1243.57	12.56	1.07	156.20	13.32
24	38G3	865.7	134.8	1.317	886.08	17.40	77.49	154.19	686.64
24	38G4	1034.8	285.2	2.635	1120.02	58.80	33.62	658.58	376.56
24	39G2	406.1	62.4	2.835	89.38	92.85	1.16	82.99	1.04
24	39G3	765.0	113.5	1.997	434.79	31.95	62.29	138.90	270.83
24	39G4	524.8	85.1	2.603	171.57	48.80	50.06	83.73	85.89
24	Total	5,664.5			4,458.15			1509.99	1548.42
22-24	Total	9,421.4			7,171.80			1882.53	1707.84
21-24	Total	12,399.6			7,714.05			2007.48	1874.74

Table 7: FRV "Solea", cruise 798/2021. Numbers (millions) of herring incl. CBH by age/W-rings and area. ("+" indicates abundances <0.01).

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	0.37	0.30	0.16	0.16	0.01					1.00
21	41G1	3.06	0.67	0.35	0.36	0.03					4.47
21	41G2	2.70	3.71	0.14	0.17	0.11		0.03			6.86
21	42G1	1.46	93.70	6.13	2.46	0.57		1.09			105.41
21	42G2	4.56	1.98	0.42	0.15	0.06		0.01			7.18
21	Total	12.15	100.36	7.20	3.30	0.78	0.00	1.13	0.00	0.00	124.92
22	37G0	3.18									3.18
22	37G1	163.50	1.21	0.20	0.60	0.20	0.20				165.91
22	38G0	12.57	0.91	0.34	1.11	0.34	0.34				15.61
22	38G1	35.76	1.04	0.26	0.26						37.32
22	39F9										0.00
22	39G0	0.90									0.90
22	39G1										0.00
22	40F9		+	+							0.00
22	40G0	8.23	0.21	0.11							8.55
22	40G1										0.00
22	41G0										0.00
22	Total	224.14	3.37	0.91	1.97	0.54	0.54	0.00	0.00	0.00	231.47
23	39G2	2.58	3.26	9.88	13.24	11.57	3.62	1.94	1.32	0.04	47.45
23	40G2	0.35	7.07	33.16	23.83	15.7	8.42	2.42	0.65	0.24	91.84
23	41G2	0.01	0.14	0.65	0.46	0.31	0.16	0.05	0.01		1.79
23	Total	2.94	10.47	43.69	37.53	27.58	12.20	4.41	1.98	0.28	141.08
24	37G2	28.24	9.26	3.05	4.87	4.85	1.38	0.49	0.17		52.31
24	37G3	4.24	6.75	23.12	28.24	28.18	10.70	6.41	5.19	0.19	113.02
24	37G4	4.62	3.87	17.29	18.06	15.84	5.17	2.91	2.22	0.07	70.05
24	38G2	25.93	16.46	22.27	38.29	36.53	8.81	5.03	2.88		156.20
24	38G3	72.83	20.88	15.12	20.07	18.21	4.34	2.08	0.66		154.19
24	38G4	34.63	30.70	169.33	160.42	138.10	53.08	39.69	32.24	0.39	658.58
24	39G2	4.51	5.70	17.27	23.16	20.24	6.34	3.39	2.31	0.07	82.99
24	39G3	30.80	13.41	24.86	25.95	23.97	9.80	5.54	4.49	0.07	138.89
24	39G4	3.12	3.34	21.75	20.97	18.62	7.39	4.22	4.15	0.18	83.74
24	Total	208.92	110.37	314.06	340.03	304.54	107.01	69.76	54.31	0.97	1,509.97
22-24	Total	436.00	124.21	358.66	379.53	332.66	119.75	74.17	56.29	1.25	1,882.52
21-24	Total	448.15	224.57	365.86	382.83	333.44	119.75	75.30	56.29	1.25	2,007.44

Table 8: FRV "Solea", cruise 798/2021. Mean weight (g) of herring incl. CBH by age/W-rings and area.

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	18.28	37.63	78.86	69.37	32.99					42.10
21	41G1	15.69	37.63	78.86	69.37	32.99					28.36
21	41G2	16.29	38.51	40.77	28.91	33.07		45.05			29.51
21	42G1	17.33	44.59	59.64	68.69	33.87		45.05			45.60
21	42G2	15.41	40.04	56.61	41.43	32.41		45.05			25.34
21	Total	15.99	44.21	60.46	65.51	33.60		45.05			42.91
22	37G0	9.44									9.44
22	37G1	10.35	36.17	28.67	33.00	31.67	28.67				10.69
22	38G0	11.59	35.19	28.67	29.45	31.67	28.67				15.42
22	38G1	11.14	41.67	47.67	35.67						12.42
22	39F9										
22	39G0	14.33									14.33
22	39G1										
22	40F9		47.67	47.67							47.67
22	40G0	13.30	47.67	47.67							14.59
22	40G1										
22	41G0										
22	Total	10.66	38.32	36.40	31.35	31.67	28.67				11.43
23	39G2	16.37	29.41	32.89	32.66	32.96	38.67	41.62	48.36	79.17	32.97
23	40G2	14.25	70.06	104.04	109.79	122.77	128.88	125.92	112.25	156.74	108.83
23	41G2	14.25	70.06	104.04	109.79	122.77	128.88	125.92	112.25		108.48
23	Total	16.11	57.40	87.95	82.58	85.09	102.11	88.84	69.66	145.66	83.31
24	37G2	9.46	12.98	28.51	29.75	29.74	32.62	32.01	39.06		15.88
24	37G3	11.35	31.2	38.55	36.98	36.42	43.65	48.30	55.76	72.44	38.05
24	37G4	15.14	29.8	32.31	33.29	33.94	41.50	45.59	53.12	72.44	33.59
24	38G2	7.32	16.09	30.16	30.05	29.88	33.89	39.97	44.78		25.59
24	38G3	7.16	12.69	28.94	29.69	30.09	33.87	34.99	43.96		16.97
24	38G4	15.97	33.10	35.79	35.98	38.17	44.63	48.85	54.77	72.44	37.62
24	39G2	16.37	29.41	32.89	32.66	32.96	38.67	41.62	48.36	79.17	32.97
24	39G3	16.01	23.43	34.65	35.09	35.25	40.48	45.18	49.65	72.44	30.95
24	39G4	19.02	35.34	33.77	35.34	36.13	45.44	46.51	66.22	78.23	37.58
24	Total	10.89	23.48	34.61	34.46	35.48	42.23	46.71	54.27	74.00	32.49
22-24	Total	10.81	26.74	41.11	39.20	39.58	48.27	49.21	54.81	90.05	33.71
21-24	Total	10.95	34.55	41.49	39.43	39.57	48.27	49.15	54.81	90.05	34.28

Table 9: FRV “Solea”, cruise 798/2021l biomass (t) of herring incl. CBH by age/W-rings and area. (“+”indicates abundances <0.01).

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0	6.8	11.3	12.6	11.1	0.3					42.1
21	41G1	48.0	25.2	27.6	25.0	1.0					126.8
21	41G2	44.0	142.9	5.7	4.9	3.6		1.4			202.5
21	42G1	25.3	4,178.1	365.6	169.0	19.3		49.1			4,806.4
21	42G2	70.3	79.3	23.8	6.2	1.9		0.5			181.9
21	Total	194.3	4,436.7	435.3	216.2	26.2	0.0	50.9	0.0	0.0	5,359.6
22	37G0	30.0									30.0
22	37G1	1,692.2	43.8	5.7	19.8	6.3	5.7				1,773.6
22	38G0	145.7	32.0	9.8	32.7	10.8	9.8				240.7
22	38G1	398.4	43.3	12.4	9.3						463.4
22	39F9										0.0
22	39G0	12.9									12.9
22	39G1										0.0
22	40F9		+	+							0.0
22	40G0	109.5	10.0	5.2							124.7
22	40G1										0.0
22	41G0										0.0
22	Total	2,388.7	129.1	33.1	61.76	17.1	15.5	0.00	0.00	0.0	2,645.3
23	39G2	42.2	95.9	325.0	432.4	381.4	140.0	80.7	63.84	3.2	1,564.6
23	40G2	5.0	495.3	3,450.0	2,616.3	1,927.5	1,085.2	304.7	73.0	37.6	9,994.6
23	41G2	0.1	9.8	67.6	50.5	38.1	20.6	6.3	1.1		194.2
23	Total	47.4	601.0	3,842.6	3,099.2	2,346.9	1,245.8	391.8	137.9	40.8	11,753.3
24	37G2	267.2	120.2	87.0	144.9	144.2	45.0	15.7	6.6		830.8
24	37G3	48.12	210.3	891.28	1044.32	1026.32	467.05	309.60	289.39	13.76	4,300.2
24	37G4	69.95	115.4	558.64	601.22	537.61	214.56	132.67	117.93	5.07	2,353.1
24	38G2	189.8	264.8	671.7	1,150.6	1,091.5	298.6	201.1	129.0		3,997.0
24	38G3	521.5	265.0	437.6	595.9	547.9	147.0	72.8	29.0		2,616.6
24	38G4	553.0	1,016.2	6,060.3	5,771.9	5,271.3	2,369.0	1,938.9	1,765.8	28.3	24,774.6
24	39G2	73.8	167.6	568.0	756.4	667.1	245.2	141.1	111.7	5.5	2,736.5
24	39G3	493.1	314.2	861.4	910.6	844.9	396.7	250.3	222.9	5.1	4,299.2
24	39G4	59.3	118.0	734.5	741.1	672.7	335.8	196.3	274.8	14.1	3,146.7
24	Total	2,275.8	2,591.8	10,870.3	11,716.9	10,803.7	4,518.8	3,258.3	2,947.2	71.8	49,054.6
22-24	Total	4,711.8	3,322.0	14,746.0	14,877.9	13,167.7	5,780.1	3,650.1	3,085.1	112.6	63,453.2
21-24	Total	4,906.2	7,758.7	15,181.3	15,094.1	13,193.9	5,780.1	3,701.0	3,085.1	112.6	68,812.8

Table 10: FRV "Solea", cruise 798/2021. Numbers (millions) of sprat by age and area.

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0		0.15	3.89	1.02	0.11	0.05				5.22
21	41G1		7.03	15.00	2.77	0.28	0.13				25.21
21	41G2		8.08	40.85	4.74	0.29	0.13				54.09
21	42G1		0.86	30.54	31.62	5.53	1.07	0.45			70.07
21	42G2		4.74	6.31	1.12	0.08	0.04				12.29
21	Total	0.00	20.86	96.59	41.27	6.29	1.42	0.45	0.00	0.00	166.88
22	37G0	9.28	3.15	5.78	0.79	0.43	0.71				20.14
22	37G1	12.64	19.81	14.80	2.06	0.92	0.50				50.73
22	38G0	7.14	7.73	2.52	1.96	0.06	0.25				19.66
22	38G1										0.00
22	39F9	0.60		0.05							0.65
22	39G0		0.38	1.99	0.67	0.19	0.21				3.44
22	39G1	0.49	0.01	0.02							0.52
22	40F9	0.03									0.03
22	40G0		0.70	1.10	0.20	0.06	0.12				2.18
22	40G1		0.75	0.56							1.31
22	41G0			0.63							0.63
22	Total	30.18	32.53	27.45	5.68	1.66	1.79	0.00	0.00	0.00	99.29
23	39G2		0.03	0.11	0.20	0.12	0.08	0.04			0.58
23	40G2	1.42	5.01	28.84	13.02	6.97	0.93	1.86	0.18	0.18	58.41
23	41G2	0.03	0.10	0.56	0.25	0.14	0.02	0.04			1.14
23	Total	1.45	5.14	29.51	13.47	7.23	1.03	1.94	0.18	0.18	60.13
24	37G2	8.58	1.72	1.30	1.19	0.84	0.50	0.15	0.05		14.33
24	37G3	16.41	13.43	8.67	5.54	2.79	1.63	0.95	0.01		49.43
24	37G4	8.36	10.60	12.28	8.12	4.87	3.94	2.12	0.09		50.38
24	38G2	4.84	0.51	0.91	2.46	1.98	1.33	0.99	0.30		13.32
24	38G3	289.18	134.22	120.73	75.10	35.98	19.56	11.70	0.17		686.64
24	38G4	8.43	72.21	115.06	76.78	44.45	37.24	21.29	1.10		376.56
24	39G2		0.06	0.20	0.35	0.22	0.15	0.06			1.04
24	39G3	102.83	32.84	50.79	33.93	21.66	18.54	9.54	0.70		270.83
24	39G4		10.08	25.42	18.49	13.45	11.47	6.41	0.57		85.89
24	Total	438.63	275.67	335.36	221.96	126.24	94.36	53.21	2.99	0.00	1,548.42
22-24	Total	470.26	313.34	392.32	241.11	135.13	97.18	55.15	3.17	0.18	1,707.84
21-24	Total	470.26	334.20	488.91	282.38	141.42	98.60	55.60	3.17	0.18	1,874.72

Table 11: FRV "Solea", cruise 798/2021. Mean weight (g) of sprat by age and area.

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0		14.57	15.93	17.72	18.81	18.67				16.33
21	41G1		10.95	14.68	17.38	18.80	18.67				14.00
21	41G2		12.30	14.24	16.49	18.91	18.67				14.18
21	42G1		13.82	16.81	20.16	21.66	18.67	24.00			18.74
21	42G2		10.31	13.97	16.93	18.67	18.67				12.87
21	Total		11.47	15.17	19.40	21.32	18.67	24.00			16.04
22	37G0	4.94	9.69	12.41	17.66	17.24	18.17				9.05
22	37G1	5.93	9.91	12.86	15.76	17.29	16.80				10.22
22	38G0	5.84	9.50	13.30	16.57	13.23	16.88				9.47
22	38G1										
22	39F9	4.07		11.89							4.67
22	39G0		12.54	14.08	16.05	19.03	16.66				14.72
22	39G1	3.96	13.23	13.23							4.49
22	40F9	4.12									4.12
22	40G0		11.67	13.24	15.94	15.80	16.88				13.25
22	40G1		11.43	11.43							11.43
22	41G0			11.89							11.89
22	Total	5.53	9.90	12.86	16.34	17.28	17.34				10.01
23	39G2		13.5	15.37	21.01	21.39	16.67	16.95			18.75
23	40G2	4.63	15.63	17.67	18.91	20.57	24.71	22.35	25.58	23.69	18.1
23	41G2	4.63	15.63	17.67	18.91	20.57	24.71	22.35			18.06
23	Total	4.63	15.62	17.66	18.94	20.58	24.09	22.24	25.58	23.69	18.11
24	37G2	3.61	11.06	14.31	15.27	15.92	16.52	18.00	18.00		7.82
24	37G3	3.69	11.70	13.58	13.61	14.18	15.79	16.29	18.00		9.95
24	37G4	3.69	12.25	14.26	14.67	15.53	16.20	16.24	18.27		12.51
24	38G2	4.32	12.17	15.45	17.44	17.73	17.73	17.68	18.00		12.44
24	38G3	4.15	12.25	13.76	13.68	14.44	15.69	15.67	19.45		9.53
24	38G4	5.03	12.96	14.38	14.84	15.78	16.25	15.99	18.16		14.44
24	39G2		13.50	15.37	21.01	21.39	16.67	16.95			18.71
24	39G3	4.82	12.52	14.50	15.03	15.95	16.34	16.11	18.60		10.96
24	39G4		13.57	14.77	15.64	16.64	16.64	16.69	18.57		15.53
24	Total	4.29	12.48	14.18	14.55	15.52	16.21	16.08	18.40		11.43
22-24	Total	4.37	12.27	14.35	14.83	15.81	16.32	16.30	18.80	23.69	11.59
21-24	Total	4.37	12.22	14.51	15.50	16.05	16.35	16.36	18.80	23.69	11.98

Table 12: FRV "Solea", cruise 798/2021. Total biomass (t) of sprat by age and area.

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0		2.2	62.0	18.1	2.1	0.9				85.2
21	41G1		77.0	220.2	48.1	5.3	2.4				353.0
21	41G2		99.4	581.7	78.2	5.5	2.4				767.2
21	42G1		11.9	513.4	637.5	119.8	20.0	10.8			1,313.3
21	42G2		48.9	88.2	19.0	1.5	0.8				158.2
21	Total	0.0	239.3	1,465.4	800.8	134.1	26.5	10.8	0.0	0.0	2,676.9
22	37G0	45.8	30.5	71.7	14.0	7.4	12.9				182.4
22	37G1	75.0	196.3	190.3	32.5	15.9	8.4				518.4
22	38G0	41.7	73.4	33.5	32.5	0.8	4.2				186.2
22	38G1										0.0
22	39F9	2.4		0.6							3.0
22	39G0		4.8	28.0	10.8	3.6	3.5				50.7
22	39G1	1.9	0.1	0.3							2.3
22	40F9	0.1									0.1
22	40G0		8.2	14.6	3.2	1.0	2.0				28.9
22	40G1		8.6	6.4							15.0
22	41G0			7.5							7.5
22	Total	167.0	321.9	352.9	92.8	28.7	31.1	0.0	0.0	0.0	994.4
23	39G2		0.4	1.7	4.2	2.6	1.3	0.7			10.9
23	40G2	6.6	78.3	509.6	246.2	143.4	23.0	41.6	4.6	4.3	1,057.5
23	41G2	0.1	1.6	9.9	4.7	2.9	0.5	0.9			20.6
23	Total	6.7	80.3	521.2	255.1	148.8	24.8	43.1	4.6	4.3	1,088.9
24	37G2	31.0	19.0	18.6	18.2	13.4	8.3	2.7	0.9		112.0
24	37G3	60.6	157.1	117.7	75.4	39.6	25.7	15.5	0.2		491.8
24	37G4	30.9	129.9	175.1	119.1	75.6	63.8	34.4	1.6		630.5
24	38G2	20.9	6.2	14.1	42.9	35.1	23.6	17.5	5.4		165.7
24	38G3	1,200.1	1,644.2	1,661.2	1,027.4	519.6	306.9	183.3	3.3		6,546.0
24	38G4	42.4	935.8	1,654.6	1,139.4	701.4	605.2	340.4	20.0		5,439.2
24	39G2		0.8	3.1	7.4	4.7	2.5	1.0			19.5
24	39G3	495.6	411.2	736.5	510.0	345.5	302.9	153.7	13.0		2,968.4
24	39G4		136.8	375.5	289.2	223.8	190.9	107.0	10.6		1,333.7
24	Total	1,881.4	3,441.0	4,756.3	3,228.9	1,958.6	1,529.8	855.6	55.0	0.0	17,706.6
22-24	Total	2,055.1	3,843.2	5,630.4	3,576.9	2,136.1	1,585.6	898.7	59.6	4.3	19,789.9
21-24	Total	2,055.1	4,082.5	7,095.8	4,377.7	2,270.2	1,612.1	909.5	59.6	4.3	22,466.8

Table 13: FRV "Solea", cruise 798/2021. Numbers (m) of herring excl. CBH in SD 21, SD 22, SD 23/39G2 and SD-24 by age/W-rings & area.

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total	
21	41G0	0.37	0.30	0.14	0.11						0.93	
21	41G1	3.06	0.67	0.31	0.25						4.29	
21	41G2	2.70	3.71	0.05							6.45	excl. CBH
21	42G1	1.46	93.70	5.60	1.97						102.73	
21	42G2	4.56	1.98	0.39							6.93	
21	Total	12.15	100.36	6.49	2.33	0.00	0.00	0.00	0.00	0.00	121.34	
22	37G0	3.18									3.18	
22	37G1	163.49	1.21								164.70	
22	38G0	12.57	0.91								13.48	
22	38G1	35.76	1.04	0.26							37.05	
22	39F9										0.00	
22	39G0	0.90									0.90	excl. CBH
22	39G1										0.00	
22	40F9										0.00	
22	40G0	8.23	0.21	0.11							8.55	
22	40G1										0.00	
22	41G0										0.00	
22	Total	224.13	3.37	0.36	0.00	0.00	0.00	0.00	0.00	0.00	227.86	
23	39G2	2.58	2.24	2.88	0.54	0.24	0.03				8.51	excl. CBH
23	40G2	0.35	7.07	33.16	23.83	15.7	8.42	2.42	0.65	0.24	91.84	
23	41G2	0.01	0.14	0.65	0.46	0.31	0.16	0.05	0.01		1.79	
23	Total	2.94	9.45	36.69	24.83	16.25	8.61	2.47	0.66	0.24	102.14	
24	37G2	28.24	0.90	0.23							29.37	
24	37G3	4.24	5.04	10.61	4.37	1.31	0.13	0.19	0.13		26.02	
24	37G4	4.62	2.70	4.69	1.56	0.45	0.04	0.06	0.04		14.16	
24	38G2	25.93	5.39	2.90	0.75						34.97	
24	38G3	72.83	2.73	2.14	0.14						77.84	excl. CBH
24	38G4	34.63	24.07	73.92	17.10	4.42	0.43	0.22	1.72		156.51	
24	39G2	4.51	3.92	5.04	0.95	0.42	0.04				14.88	
24	39G3	30.80	5.08	9.30	1.93	0.70		0.09			47.90	
24	39G4	3.12	3.10	7.56	1.91	0.63	0.31		0.80		17.43	
24	Total	208.92	52.93	116.39	28.71	7.93	0.95	0.56	2.69	0.00	419.08	
22-24	Total	435.99	65.75	153.44	53.54	24.18	9.56	3.03	3.35	0.24	749.08	
21-24	Total	448.14	166.11	159.94	55.87	24.18	9.56	3.03	3.35	0.24	870.42	

Table 14: FRV "Solea", cruise 798/2021. Mean weight (g) of herring excl. CBH in SD 21, SD 22, SD 23/39G2 and SD-24 by age/W-rings & area.

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total	
21	41G0	18.25	37.98	84.97	89.76						43.48	
21	41G1	15.68	37.98	84.97	89.76						28.48	
21	41G2	16.28	38.72	57.93							29.47	excl. CBH
21	42G1	17.33	44.68	62.36	72.50						45.79	
21	42G2	15.41	40.31	59.13							25.01	
21	Total	15.99	44.31	63.71	75.15						43.10	
22	37G0	9.44									9.44	
22	37G1	10.35	36.00								10.54	
22	38G0	11.59	34.95								13.18	
22	38G1	11.14	41.58	47.67							12.25	
22	39F9											
22	39G0	14.33									14.33	excl. CBH
22	39G1											
22	40F9											
22	40G0	13.30	47.67	47.67							14.58	
22	40G1											
22	41G0											
22	Total	10.66	38.16	47.67							11.13	
23	39G2	16.37	36.76	46.80	73.02	90.69	84.00				37.96	excl. CBH
23	40G2	14.25	70.06	104.04	109.79	122.77	128.88	125.92	112.25	156.74	108.83	
23	41G2	14.25	70.06	104.04	109.79	122.77	128.88	125.92	112.25		108.48	
23	Total	16.11	62.17	99.55	108.99	122.30	128.72	125.92	112.25	156.74	102.92	
24	37G2	9.44	34.92	40.55							10.46	
24	37G3	11.35	38.98	51.01	64.57	74.96	104.00	79.20	104.00		46.44	
24	37G4	15.13	38.07	49.48	64.30	74.74	104.00	79.20	104.00		38.97	
24	38G2	7.27	31.87	48.75	55.67						15.54	
24	38G3	7.14	34.81	44.15	56.89						9.22	excl. CBH
24	38G4	15.97	38.90	48.90	63.26	74.81	104.00	79.20	102.50		43.16	
24	39G2	16.37	36.76	46.80	73.02	90.69	84.00				37.94	
24	39G3	15.96	38.58	48.53	63.65	75.45		79.20			27.59	
24	39G4	18.97	38.01	49.18	69.25	71.93	97.05		124.25		49.10	
24	Total	10.87	37.63	48.91	64.03	75.50	100.89	79.20	109.06		30.60	
22-24	Total	10.80	41.18	61.01	84.88	106.95	125.96	117.29	109.69	156.74	34.54	
21-24	Total	10.94	43.07	61.12	84.48	106.95	125.96	117.29	109.69	156.74	35.73	

Table 15: FRV "Solea", cruise 798/2021. Total biomass (t) of herring excl. CBH in SD 21, SD 22, SD 23/39G2 and SD-24 by age/W-rings & area.

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total	
21	41G0	6.8	11.5	12.0	10.0						40.3	
21	41G1	48.0	25.5	26.6	22.1						122.3	
21	41G2	44.0	143.5	2.7							190.2	excl. CBH
21	42G1	25.4	4,186.1	348.9	143.2						4,703.6	
21	42G2	70.2	79.8	23.3							173.4	
21	Total	194.4	4,446.4	413.7	175.3	0.0	0.0	0.0	0.0	0.0	5,229.7	
22	37G0	30.0									30.0	
22	37G1	1,692.8	43.5								1,736.3	
22	38G0	145.7	32.0								177.7	
22	38G1	398.4	43.1	12.3							453.9	
22	39F9										0.0	
22	39G0	12.9									12.9	excl. CBH
22	39G1										0.0	
22	40F9										0.0	
22	40G0	109.5	10.1	5.0							124.6	
22	40G1										0.0	
22	41G0										0.0	
22	Total	2,389.4	128.6	17.4	0.00	0.0	0.0	0.00	0.00	0.0	2,535.3	
23	39G2	42.2	82.3	134.8	39.4	21.8	2.5				323.1	excl. CBH
23	40G2	5.0	495.3	3,450.0	2,616.3	1,927.5	1,085.2	304.7	73.0	37.6	9,994.6	
23	41G2	0.1	9.8	67.6	50.5	38.1	20.6	6.3	1.1		194.2	
23	Total	47.4	587.5	3,652.4	2,706.2	1,987.3	1,108.3	311.0	74.1	37.6	10,511.8	
24	37G2	266.6	31.4	9.3							307.4	
24	37G3	48.1	196.5	541.2	282.2	98.2	13.5	15.1	13.5		1,208.3	
24	37G4	69.9	102.8	232.1	100.3	33.6	4.2	4.8	4.2		551.8	
24	38G2	188.5	171.8	141.4	41.8						543.4	
24	38G3	520.0	95.0	94.5	8.0						717.5	excl. CBH
24	38G4	553.0	936.3	3,614.7	1,081.8	330.7	44.7	17.4	176.3		6,754.9	
24	39G2	73.8	144.1	235.9	69.4	38.1	3.4				564.6	
24	39G3	491.6	196.0	451.3	122.8	52.8		7.1			1,321.7	
24	39G4	59.2	117.8	371.8	132.3	45.3	30.1		99.4		855.9	
24	Total	2,270.8	1,991.7	5,692.2	1,838.4	598.7	95.9	44.4	293.4	0.0	12,825.4	
22-24	Total	4,707.5	2,707.8	9,361.9	4,544.7	2,586.0	1,204.2	355.4	367.5	37.6	25,872.5	
21-24	Total	4,901.8	7,154.2	9,775.6	4,719.9	2,586.0	1,204.2	355.4	367.5	37.6	31,102.3	

Survey Summary Table WGBIFS 2022

Name of the survey (abbreviation):	GERAS / BIAS (GER) (FRV "Solea" SB798)
Target Species:	Herring (*Clupea harengus,* Western Baltic Spring Spawning Herring WBSSH; Central Baltic Herring CBH), Sprat (*Sprattus sprattus*), Anchovy (*Engraulis encrasicolus*), Sardine (*Sardina pilchardus*)
Survey dates:	08-28 Oct 2021

Summary:

The objectives of the survey were carried out successfully and mostly as planned in all of the covered ICES Subdivisions. Altogether, 1124 nautical miles of hydroacoustic transects (plus 67 nmi daytime transects for comparison) were covered. For species allocation and identification as well as to collect biological data for an age stratified abundance estimation of the target species herring and sprat, altogether 50 fishery hauls were conducted. Vertical hydrography profiles were measured on 90 stations.

In all subdivisions covered, mean NASC values per nautical mile per ICES statistical rectangle were equally either distinctly lower or distinctly higher than the values measured in 2020. However, compared to the long-time survey mean since 1991, mean NASC values were lower in all but two rectangles covered. On ICES subdivision scale, mean NASC values were overall distinctly lower than in the previous year in subdivisions 21 and 22, slightly increased in SD 24 and almost fivefold increased in SD 23 (high NASC values in SD 23 could not be allocated to WBSSH however).

After excluding the Central Baltic Herring fraction from the estimates via the Separation Function, the present Western Spring Spawning Herring biomass estimate again represents the lowest recorded value in the whole time series since 1993.

	Description
Survey design	Stratified systematic (parallel where applicable) design. Start point not randomized. ICES statistical rectangles used as strata for all ICES subdivisions
Index Calculation method	GERIBAS II Software. Index based on mean NASC per ICES statistical rectangle.
Random/systematic error issues	Survey design and transects restricted by area topography. No fully systematic coverage of survey area possible. Indications of large herring aggregations outside the surveyed transects/time period are regularly registered.
Specific survey error issues (acoustic)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Bubble sweep down	Bubble sweep down due to adverse weather conditions occurred and required interruption of survey operations (SD 21, 22, 24). Due to the continuation of the survey in improved conditions, this is not considered to affect integration results.
Extinction (shadowing)	No particular issues as targets are scattered in loose aggregations in most of the surveyed areas during the survey operations.
Blind zone	Due to the night-time distribution of clupeids also in surface layers, registrations of clupeids occur in the blind zone but are not quantified (integration start depth 10 m). In some parts of the survey area, the blind zone exclusion exceeds more than half of the total water column.
Dead zone	No particular issue as clupeids are mostly distributed pelagically and away from seafloor during night-time survey operations.
Allocation of backscatter to species	Directed trawling. Mixed species category applied throughout survey. Species allocations and splitting of NASC values based on combined trawl haul composition per ICES statistical rectangle.
Target strength	Clupeids: TS = 20 log10 (L) - 71.2 Gadids: TS = 20 log10 (L) - 67.5 Mackerel: TS = 20 log10 (L) – 84.9 see SISP Survey manual (ICES, 2017). Clupeid TS allocated to other species included in analysis (see above).

Calibration	All survey frequencies calibrated and results within recommended tolerances (Demer et al., 2015).
Specific survey error issues (biological)	*There are some bias considerations that apply to acoustic-trawl surveys only, and the respective SISP should outline how these are evaluated:*
Stock containment	Time series: It is assumed that WBSSH (primary target species) is contained within the survey area. An unquantified but assumedly low degree of mixing of WBSSH and CBH (Central Baltic Herring) can occur outside of the survey area (east of SD 24). Due to transects often determined by topography/bathymetry, aggregations of WBSSH in shallower areas not sampled by the survey may have been missed. 2021 survey: Due to adverse weather conditions, the survey area was not fully covered as planned (The two northernmost statistical rectangles in SD 21 were not covered). However, the standard area of the GERAS-Index for HAWG was covered.
Stock ID and mixing issues	Time series: WBSSH and CBH mix at varying degrees in different parts of the survey area (especially in SD 24). Separation of stocks is achieved through application of an age-growth based stock separation function (SF) (Gröhsler et al. 2013). 2021 survey: The application of the Separation Function (SF) to remove CBH from the index calculation again yielded robust results despite the “contamination” of WBSSH baseline samples with CBH in ICES SD 21 and SD 23. The majority of WBSSH could be allocated to the corresponding stock using the SF established with parameters from 2005-2010 (Gröhsler & Schaber, 2022 WD WGIPS). Mean weights of different age groups that prior to removal showed somewhat untypical growth pattern for WBSSH became distinctly more realistic for older age groups after removing the CBH fraction. A conspicuous peak of abundance of mostly 2-4 years old herring that otherwise could not be explained vanished after removing the CBH fraction. Haul 32 (41G2, SD 23) targeting a large aggregation of herring yielded a substantial sample of almost exclusively large, old herring that were spawning (maturity 6). Since the herring could not be allocated to WBSSH, both the hydroacoustic data from that aggregation as well as the biological data from haul 32 were removed from the further analysis for producing a biomass and abundance estimate for WBSSH. Genetic samples have been taken and are currently being analysed to identify stock origin of that herring.
Measures of uncertainty (CV)	*none*
Biological sampling	Time series: Based on survey design restrictions, comprehensive sampling is not feasible in all statistical rectangles surveyed. Biological information from neighboring rectangles is used for generating estimates in these cases. This mostly applies to rectangles with low abundance. 2021 survey: Biological information for ICES statistical rectangles 41G0 (SD 21), 40G1 (SD 22), 39G2, 41G2 (SD 23) and 37G4 (SD 24) used/amended from neighbouring rectangles.
Were any concerns raised during the meeting regarding the fitness of the survey for use in the assessment either for the whole times series or for individual years? (please specify)	*To be answered by Assessment Working Group*
Did the Survey Summary Table contain adequate information to allow for evaluation of the quality of the survey for use in assessment? Please identify shortfalls	*To be answered by Assessment Working Group*

Institute of Food Safety, Animal Health and Environment – BIOR, Riga (Latvia)

National Marine Fisheries Research Institute – NMFRI, Gdynia (Poland)

THE CRUISE REPORT

FROM THE JOINT LATVIAN-POLISH BALTIC INTERNATIONAL ACOUSTIC SURVEY – BIAS 2020 ON THE R/V "BALTICA" IN THE ICES SUBDIVISIONS 26N AND 28.2 OF THE BALTIC SEA (12-21 OCTOBER 2021)

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CONTENTS

INTRODUCTION

More less regular acoustic estimations of pelagic fish stocks in the Baltic Sea initiated by BaltNIIRH (now BIOR) and Institute für Hochseefischerei in Rostock (GDR) was performed since 1983, but the first scattered surveys was made since 1977 [Hoziosky et al. 1987, Shvetsov 1983, Shvetsov et al. 1988]. The first joint Latvian-Polish acoustic survey on the research vessel "Issledovatel Baltiki" (renamed on the r/v "Baltijas Petnieks") of former BaltNIRH was realised in October 1991 and was performed for the estimations of the biomas of Baltic clupeid stocks in the pelagic offshore zone of the ICES Sub-divisions 25-29 [Shvetsov et al. 1992]. The next joint acoustic survey in cooperation of scientists from Poland, Latvia and Estonia were performed on the Polish r/v "Baltica" in October 1996 [Grygiel 2006, Orłowski et al. 1997]. The permanent participation of the Polish r/v "Baltica" in the autumn Baltic International Acoustic Surveys (BIAS) within the Polish EEZ has taken place since 1994 in the framework of long-term ICES Baltic International Acoustic Surveys program, coordinated by the ICES Baltic International Fish Survey Working Group (WGBIFS). Several years in October (1994-2004) and May (2003-2004) BIOR as assignee of BaltNIIRH, LatFRI (in noted period) and LatFRA cooperated with Russian AtlantNIRO in Kaliningrad, but since 2005 the superb regular collaboration has been formed with Polish SFI (since June 2011 named as National Marine Fisheries Research Institute – NMFRI) in Gdynia and as a result we have made 8 BASS and 14 BIAS on pelagic fish stocks and 26 BITS on demersal fish stocks, 46 fish surveys totally.

This was the 16th joint Latvian-Polish Baltic International Acoustic Survey (BIAS) in the ICES Sub-divisions 26N and 28.2 signed as No. 18/2021/NMFRI/BIOR conducted by the r/v "Baltica" in October 2021. The reported cruise was organized on the basis of the agreement No. BIOR 2021/44/AK/EJZF from 11 October 2021 between the Institute of Food Safety, Animal Health and Environment (BIOR) from Riga and the National Marine Fisheries Research Institute (NMFRI) from Gdynia. The vessel was operated within the Latvian, Estonian and Swedish EEZs (ICES Sub-divisions 26N and 28.2). The "Latvian National Program for Collection of Fisheries Data 2021" in accordance with the EU Commission by the European Union (EU) Fisheries Data Collection Programme for 2021 (the Regulation (EU) 2017/1004 of the European Parliament and of the Council of 17 May 2017, and European Commission Implementing Decision (EU) 2019/909 of 18 February 2019 on the establishment of a Union Framework for the collection, management and use of the data in the fisheries sector and support for scientific advice regarding the common fisheries policy Regulations No. 2016/1251) partly subsidized this survey. These investigations were coordinated by the ICES Baltic International Fish Survey Working Group (WGBIFS) [ICES 2021].

Pelagic research catches carried out during an acoustic survey are the information source, independent from topical preferences in fishery, about quantitative changes in a process of clupeids geographical and bathymetrical distribution in the Baltic Sea. The data from hydrological measurements are the information source about abiotic environmental factors (seawater temperature, salinity, oxygen content) influencing sprat and herring spatial distribution. Echo-integration results along the pre-selected tracks are the basic materials for fish stock biomass calculations.

The ICES Baltic Fisheries Assessment Working Group (WGBFAS) applies the BIAS data for clupeids (sprat and herring) stock biomass assessment and spatial distribution updating. The basic acoustic and biological data collected during recently carried out survey will be stored in the BIAS_DB.mdb (BAD1 format) and the new Acoustic database in the accepted CSV or XML formats, managed by ICES.

The main aims of cruise were:

- to collect the echo-integration data for the estimation of the clupeids stocks biomass and abundance in the central-eastern Baltic;
- to collect materials from the fish control catches for investigations of the Baltic sprat, and in lesser degree herring, spawning stocks spatial distribution in the offshore waters of Latvia, Estonia and Sweden, moreover for analyses of the age-length structure and recruiting year-class strength of these fishes populations;
- to collect sprat and herring stomachs samples for feeding condition and food components analyses;
- to analyze the vertical and horizontal changes of the basic hydrological parameters (temperature, salinity and oxygen content) at the trawling positions and at the standard HELCOM hydrological stations;
- to collect the zooplankton and ichthyoplankton samples at the referring area.

1. MATERIALS AND METHODS

1.1. PERSONNEL ASSIGNMENT

The BIAS 4Q 2020 survey scientific staff was composed of 8 persons:

K. Koszarowski (NMFRI, Gdynia – Poland) – survey leader, ichthyologist,
M. Bielak (NMFRI, Gdynia – Poland) – acoustician,
B. Witalis (NMFRI, Gdynia – Poland) – hydrologist,
R. Zaporowski (NMFRI, Gdynia – Poland) – ichthyologist,
P. Pankowski (NMFRI, Gdynia – Poland) – ichthyologist,
K. Choma-Stolarek (NMFRI, Gdynia – Poland) – ichthyologist,
W. Deluga (NMFRI, Gdynia – Poland) – ichthyologist,
S. Trella (NMFRI, Gdynia – Poland) – ichthyologist.

1.2. SURVEY DESCRIPTION

The reported survey took place during the period of 12 – 21 October 2021 (10 working days at sea in accordance with Latvian-Polish survey plan). The at sea researches were conducted within Latvian and Swedish EEZs (the ICES Sub-divisions 26N and 28.2), moreover inside the Latvian territorial waters not shallower than 20 m.

The vessel left the Gdynia port (Poland) on 12.10.2021 at 11:00 o'clock a.m. and was navigated in the north direction to the echo-integration start point at the geographical position 56°07'N 019°00'E. The direct at sea researches began on 13.10.2021 at 5:15 a.m. UTC. The survey ended on 21.10.2021 in the afternoon in the Latvian EEZ.

1.3. SURVEY METHODS AND PERFORMANCE

1.3.1. ACOUSTICAL AND TRAWLING METHODS

Acoustic data were collected with the SIMRAD EK-60 38 kHz and 120 kHz two frequency split beam scientific echo-sounder equipped with "EchoView Version 7.10" software for the data analysis. These data collected during the described here BIAS were delivered to the Latvian researchers for further elaboration. The survey echo-integration tracks were planned in the similar pattern as in the previous years, due to historical comparability of the data. Overall 748 nautical miles long survey tracks was observed and recorded with hydroacoustic equipment. The final pattern of transects was covered with a relatively good density. The area covered in October 2021 was 2953.3 nm^2 in the northern part of the ICES Sub-division 26 and 7046 nm^2 in Sub-division 28.2, totally 9999.3 nm^2 (Fig. 1).

The pre-selection of the pelagic fish catches based on the ICES statistical rectangle area (with range of 0.5 degree in latitude and 1 degree in longitude) and the present density pattern of vertical distribution of clupeids along a transect. The intention was to carry out at least two control hauls per the ICES statistical rectangle [ICES 2003]. The water depth range-layer with sufficient for fish oxygen content (minimum 1.0÷2.0 ml/l) were taken into account in the process of the hauls distribution.

The r/v "Baltica" realized 13 fish control-catches (Tab. 1). All catches were performed in the daylight (between 08:05 am and 05:45 pm UTC+1) using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The standard trawling duration was 30 minutes, however 4 hauls duration were shortened to 20 minutes (due to very dense fish concentrations observed). The mean speed of vessel while trawling was 3.1 knots. Overall, 4 hauls were conducted in SD 26N and 9 hauls in SD 28.2. Totally 11 hauls were performed in the Latvian and 2 hauls in Swedish EEZs.

1.3.2. BIOLOGICAL SAMPLING

Totally 8 fish species were observed in hauls made by WP53/64x4 gear. The length measurements (in 0.5 cm length classes) were realized in total for 4185 fish individuals: 2579 sprats, 1083 herrings, 495 threespined sticklebacks, 8 ninespine sticklebacks, 8 cods, 5 flounders, 6 lumpfishes and 1 shorthorne sculpin. In total 1731 fish individuals: 1187 sprat, 536 herring and 8 cod individuals were taken for biological analysis (Tab. 2). Detailed ichthyologic analyses were made according to standard procedures, directly on board of surveying vessel.

Due to herring and sprat normally cannot be distinguished from other species by visual inspection of the echogram species composition and fish length distributions were based on trawl catch results. Mean target strength of fish was calculated according to the following formulas [Foote et al. 1986, ICES 1983, 2014]:

for clupeids: TS = 20logL-71.2;
for gadoids: TS = 20logL-67.5;
cross section $\sigma = 4\pi 10^{a/10} \times L^{b/10}$.

The total number of fish in each ICES rectangle was estimated as a product of the mean area scattering cross-section – NASC (S_A) and the rectangle area, divided by corresponding mean acoustic cross-section. Fish abundance was separated into different species according to the mean catch composition in the given rectangle.

Zooplankton samples were collected at the positions of the hydrological stations or after trawling. Totally 7 zooplankton stations were realized (Fig. 2) and 12 samples were taken. Zooplankton was collected with Juday net (mouth opening 0.1 m^2, mesh size 160 µm). This net was towed vertically from the depths 50 and 100, or from the bottom in case of lesser depth, to the water surface with speed of 0.4 m/s. Low speed of lifting allowed preventing all plankton objects from destroying by mechanic forces. All samples were conserved in 70% spirit solution with sea water and processed during the year.

1.3.2. HYDROLOGICAL AND METEOROLOGICAL OBSERVATIONS

The measurements of the basic hydrological parameters were realized in the period of 12-21 October 2021, totally at 17 stations, int. al. at 13 fish catch-station in association with 6 HELCOM stations (Fig. 2). Results presented in this paper are linked with sites of the standard HELCOM stations and locations of the catch-stations during pelagic trawl hauling up. Hydrological stations were inspected with the CTD SeaBird 911-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method. The hydrological row data, originated from measuring realized from the sea surface layer up to the bottom, were aggregated to the 1-m depth stratums, were information source about the abiotic factors potentially influencing fishes spatial distribution. The oxygen probes ware taken on every 10 meters. The salinity parameter was presented in Practical Salinity Unit (PSU).

Meteorological parameters were measured by MicroStep-MIS AMS 111 automatic weather station. Meteorological observations of air temperature, wind velocity and directions and atmospheric pressure were realized at the actual geographic position of each control-haul and in every 15 minutes interval over the whole survey. The values of meteorological and hydrological parameters registered at trawling stations are aggregated in Table 3.

2. RESULTS

2.1. BIOLOGICAL DATA

2.1.1. CATCH STATISTICS

Total number of realized hauls and total catches in kg of fish in Latvian and Swedish EEZs during reported BIAS 4Q 2021 are presented in the Table 4. Overall, 8 fish species were recognized in hauls performed in the Central-eastern Baltic Sea. Sprat was the dominating species by mass in the both ICES Sub-divisions 26N and 28.2 (59.46% and 89.34% respectively). The share of the herring was 40.38% and 1.48% respectively. The 6 other fish species represented 5.13% (in which 5.01% was threespined stickleback) of the total mass in all investigated areas.

The highest value of CPUE for sprat was noted in SD 28.2 and for herring in SD 26. The highest values of CPUEs for sprat were 2837.79 kg/h in ICES SD 26 and 4165.26 kg/h in SD 28.2. The highest CPUEs values for herring were: 980.32 kg/h in SD 26 and 72.12 kg/h in SD 28.2. Three-spined stickleback prevailed among other species and amounted for 5.01% of total biomass and the highest values of CPUE was 428.98 kg/h in ICES SD 28.2. In SD 26 no stickleback was caught. The CPUE values by particular haul and distributions for herring, sprat and others are presented at the Fig. 2 and 3.

2.1.2. ACOUSTICAL AND BIOLOGICAL ESTIMATES

The basic acoustic and biological data (surveyed area statistics, mean NASC, the mean scattering cross-section, the total number of fish, percentages of herring and sprat) per ICES rectangles and the estimated abundance and biomass of sprat and herring per above mentioned rectangles, collected in October 2021, are given in Table. 5, for third dominant species – threespine stickleback in Table 6. The characteristics of the pelagic fish stock are aggregated in Table 6 for sprat and Table 7 for herring. The geographical distributions of NASC and pelagic fish stock densities in the central-eastern Baltic Sea in October 2021 are shown in Fig. 5, 6 and 7.

The pelagic fish stock was represented mostly by sprat – 65.8 %, in comparison – 71.7 % in 2020, 87.2 % in 2019, 71.5 % in 2013 86.8 %, in 2014, 88.2 % in 2015, 94.4 % in 2016, 89.7 % in 2017 and 65.3 % in 2018. Herring was represented as 5.3 %, 6.0 % in 2019, 28.5 % in 2013, 13.2 % in 2014, 11.8 % in 2015, 5.6 % in 2016, 10.3 % in 2017 and 34.7 % in 2018. The highest sprat stock density 63.5 n×10^6/nm^2 (80.2 n×10^6/nm^2 in 2020, 144.4 n×10^6/nm^2 in 2019, 121.5 n×10^6/nm^2 in 2018, 55.5 n×10^6/nm^2 in 2017, 126.4 n×10^6/nm^2 in 2016 and 72.6 n×10^6/nm^2 in 2015) were recorded in ICES rectangle 43H1 of the ICES Sub-division 28.2. The highest average abundance per nm^2 and biomass of the sprat stock were recorded in the central part of investigated area in ICES rectangles 43H1. The distribution of the high density sprat concentrations in October 2021 was almost similar to October of the most of previous years 2010-2016 and 2018-2019, when sprat concentrations with high density had found mostly in the eastern and northern parts of the investigated area. In 2013 sprat distribution pattern more-less was emulating pattern observed in years till 1992 [Holiosky et al. 1988, Shvetsov et al. 1988, 1989, 1992, 2002], but not so evident as it was in 2010. In 2014 sprat had scattered distribution of concentrations mostly made from specimens of new generation and in 2015 distribution was scattered too, but with relatively high rate of concentrations in separate points. In 2016 the main sprat stock resides between 50 and 100 m depth isolines and the geographical distribution shows different pattern as it was recent two years before when it was very scattered with several concentration points of high abundance [Svecovs et al. 2010, 2011, 2012, 2013, 2014, 2015, 2016]. In October 2018 sprat stock had relatively large aggregations over 40-70m of the sea depth as in 2016 and 2018, but in 2017 sprat aggregates over different depths in northern part - <40m, over 70m and over 100m.

The herring stock density was significantly lower in comparison to sprat stock density, but evidently higher than herring densities in previous recent years. The highest density value in 2021 was 9.95 n×10^6/nm2 in the ICES rectangle 41G9 in Sub-division 26, in 2020 it was 17.0 n×10^6/nm2 in the ICES rectangle 43H0 and in 2019 it was 7.1 n×10^6/nm^2 in the ICES rectangle 42H0 in Sub-division 28.2. The highest average density value were 0.7 n×10^6/nm^2 and noted in the ICES rectangle 41G9 in Sub-division 26, in 2013 highest density values were not over 8.8 n×10^6/nm^2 and observed in rectangle 44H0, in 2014 values over 10.0 n×10^6/nm^2 were recorded in two rectangles 43H0 and 45H0, but in 2015 highest density values was 10.2 n×10^6/nm^2 and noted in ICES rectangle 44H0.

Comparison of the acoustic results from October of 2005-2016 indicated that investigated sprat stock abundance and biomass had decreasing tendency, but herring stock had a slight increase. In 2016 sprat stock has increased significantly due to very abundant generation of 2014. Herring stock remains at the same level as previous years. In October 2018 sprat stock decreased, but herring stock significantly Increased, especially biomass but in 2019 this pattern was opposite. In 2020 both stocks have decreased and sprat stock significantly. In 2021 stock abundance increased slightly, but biomass more evidently.

The mean length distributions of dominant fish species (sprat, herring and sticklebacks) by hauls in the ICES Sub-divisions 26 and 28 are shown in Figures 8, 9 and 10 respectively. The total length and mean weight in control hauls of sprat, herring and stickleback ranged as follows:

- sprat – 7.5÷14.5 cm (average TL = 11.76 cm), 2.6÷18.6 g (average W = 10.82 g)
- herring – 6.0÷21.0 cm (average TL = 15.23 cm), 1.2÷69.8 g (average W = 22.01 g)
- stickleback – 4.0÷8.0 cm (average TL = 5.79 cm), 0.4÷4.4 g (average W = 2.00 g)

Sprats occurred in 13 hauls. In SD 26 sprats in the length classes from 7.5 to 14.5 cm were measured. The length distribution in this ICES SD was unimodal. Sprats in length classes from 11.5 to 12.5 cm dominated, constituting 69.5% of the measured specimens in this SD, with the frequency peak for the 12.0 cm (27.9%) length class. In SD 28.2, sprats with a length distribution from 8.0 to 14.5 cm were recorded. The length distribution in this ICES SD was unimodal. Sprats in length classes from 11.0 to 13.0 cm dominated, constituting 86.1% of the measured specimens in this SD, with the frequency peak for the 12.0 cm (25.9%) length class.

Herring occurred in 9 out of 13 hauls. In the SD 26 herrings in length classes from 12.0 to 21.0 cm were recorded. The basis for the catch in this SD were herrings in the length classes from 14.5 to 17.0 cm – they constituted 86.9% of the measured herrings. The frequency peak was recorded for the 15.0 – 16.0 cm length classes – 56.0% of the measured herrings. In SD 28.2 herrings with a length distribution from 6.0 to 20.5 cm were recorded. Individuals from 14.5 to 17.0 cm length classes dominated (77.2%) with a frequency peak for 15.0 – 16.0 cm length classes – 50.4%.

Cod occurred in 3 hauls ranging from 6.0 cm to 42.0 cm. In SD 26 – 7 cod were caught and measured, and in SD 26 – 1.

The three-spined stickleback occurred only in SD 28.2, in 8 hauls. During the catches individuals with length from 4.0 to 8.0 cm were recorded, with the frequency peak for classes 5.5 and 6.0cm – 34.5% and 34.9% respectively.

THE 2.2. METEOROLOGICAL AND HYDROLOGICAL DATA

2.2.1. WEATHER CONDITIONS

The most frequent winds were from the western sector. The average (10 min) wind speed varied from 0.6 m/s to 19.9 m/s (up to 30.3 m/s). The air temperature ranged from 5.7°C to 14.1°C, and average temperature was 9.9°C. (Fig. 11). The weather conditions at control trawling stations are aggregated in Table 3.

2.2.2. HYDROLOGY OF THE GOTLAND DEEP

The hydrological conditions of Gotland Deep during BIAS survey in October 2021 are shown in Figures 12-14. The Seawater conditions at trawling horizon are aggregated in Table 3.

The vertical distribution of the seawater temperature salinity and oxygen content along the hydrological transect is presented on the Figure 12. The analysis of the drawing shows that there was not the water optimal conditions for the successful spawning of cod.

The lowest value of temperature at the surface layer (Fig. 13) was observed at the trawl 12 / hydrological station 38A and it was 11.53°C, while the warmest surface water was at the trawl 2 and it was 13.30 °C. The average value was 12.38°C. The average surface salinity was 7.35 PSU. The minimum value was 7.19 PSU at the trawl 12 / station 38A and maximum 7.42 at the trawl 3. The highest oxygen content in surface water layer was 7.55 ml/l at the trawl 13 while the lowest one was 6.22 ml/l at the trawl 2. Mean value of dissolved oxygen was equal to 6.93 ml/l.

The near - bottom layer conditions are presented in the Figure 14. Water temperature varied from 4.90°C at the trawl 2 to 11.76°C at the trawl 11. The mean value calculated for the whole area covered during the cruise was 6.93°C. The average salinity in the close-to-the bottom water layers was 10.52 PSU. The highest value was measured at the trawl 10 (12.91 PSU). The lowest one was 7.35 PSU (haul 11). The 0.00 ml/l of the dissolved oxygen was on trawls: 5, 7, 8, 9, 10, and station 43. The maximum dissolved oxygen was 6.79 ml/l on the trawl 11.The mean value was 2.39 ml/l.

3. DISCUSSION

The data of the Latvian-Polish BIAS in the 4th quarter of 2021 were considered by the ICES BIFS Working Group as representative for the central-eastern Baltic for the estimation of abundance and spatial distribution of pelagic fishes (herring and sprat) recruiting year classes and were provided to the Baltic Fisheries Assessment Working Group (WGBFAS) as the input data for fish stocks resources calculation. The acoustic, catch, biological and hydrological data, collected during reported survey were uploaded to the BAD1 and to the emerging international databases managed by the ICES Secretariat.

The collected data shows that sprat population in ICES SD 26N and 28.2 till the 2014 had overall decreasing tendency of abundance, but in 2015 had increased due to very abundant sprat generation of 2014. The next recent generations of sprat was on low abundance level and stock abundance in both SDs had decreased evidently. The mean length and weight of adult sprat had minor increasing tendency in 2020 compared to previous years, but in 2021 slight increase were observed. The geographical distribution of sprat densities in the October 2021 had similar pattern as in recent years before and shows dense aggregations over the 40-70m of water depth in a relatively narrow layer located 50 to 60m deep. The overall estimated good feeding conditions should ensure increasing of individual fish body condition and young fish surviving of pelagic fish species in future.

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ANNEX. TABLES AND FIGURES

Table 1. Fish control-catch statistics in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021

Haul number	Date	ICES rectangle	ICES SD	Mean bottom depth [m]	Headrope depth [m]	Vertical opening [m]	Trawling speed [knt]	Trawling direction [°]	Geographical position: Start Latitude 00°00'0N	Start Longitude 000°00'0E	End Latitude 00°00'0N	End Longitude 000°00'0E	Time Start	Haul duration [min]	Total catch [kg]
1	2021-10-13	41G9	26	120	60	20	3	90	56°03'4	019°09'0	56°03'4	019°11'7	08:40	30	335.770
2	2021-10-13	41H0	26	56	30	17	3.1	180	56°06'1	020°02'6	56°05'4	020°02'1	13:45	20	391.490
3	2021-10-14	41H0	26	47	20	18	3.1	300	56°22'3	020°19'1	56°22'9	020°17'6	09:00	20	945.930
4	2021-10-14	41G9	26	103	55	20	3	312	56°23'1	019°47'5	56°24'1	019°45'7	12:15	30	138.140
5	2021-10-16	42G9	28.2	138	15	20	3.2	90	56°36'7	019°08'8	56°36'7	019°11'5	08:55	30	306.153
6	2021-10-17	42H0	28.2	63	30	20	3.2	90	56°52'1	020°24'8	56°52'2	020°26'6	11:15	20	135.084
7	2021-10-17	42H0	28.2	136	20	20	3	90	56°51'8	020°13'0	56°51'7	020°15'8	13:50	30	70.041
8	2021-10-17	42G9	28.2	164	15	15	3.1	90	56°52'0	019°56'6	56°52'0	019°59'6	17:05	30	189.020
9	2021-10-18	43G9	28.2	169	25	18	3.1	90	57°06'8	019°18'3	57°06'7	019°21'0	11:40	30	51.759
10	2021-10-18	43H0	28.2	196	25	20	3	95	57°06'5	020°06'5	57°06'1	020°08'6	15:50	30	30.540
11	2021-10-19	43H1	28.2	54	25	18	3	250	57°15'6	021°09'9	57°15'1	021°08'2	08:05	20	1388.886
12	2021-10-19	43H0	28.2	112	40	20	3	290	57°23'2	020°34'7	57°23'8	020°32'3	12:40	30	19.512
13	2021-10-19	44H0	28.2	84	15	20	3.3	360	57°37'8	020°44'2	57°39'2	020°44'4	16:20	30	36.046
												SD26			1811.330
												SD28.2			2227.041
												SD26+28.2			4038.371

Table 2. Number of measured and aged fish individuals in the Baltic Sea ICES SD 26N and 28.2
from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021

SD 26		Sprat	Herring	Cod	Flounder	Threespine stickleback	Ninespine stickleback	Shorthorn sculpin	Lumpfish	Total
Samples taken	Measurements	4	3	2	1			1		11
	analyses	4	3	2						9
Fish measured		770	611	7	1			1		1390
Fish analysed		363	252	7						622
SD 28.2		Sprat	Herring	Cod	Flounder	Threespine stickleback	Ninespine stickleback	Shorthorn sculpin	Lumpfish	Total
Samples taken	Measurements	9	6	1	3	8	3		3	33
	analyses	9	4	1						14
Fish measured		1809	472	1	4	495	8		6	2795
Fish analysed		824	284	1						1109
SUM		Sprat	Herring	Cod	Flounder	Threespine stickleback	Ninespine stickleback	Shorthorn sculpin	Lumpfish	Total
Samples taken	Measurements	13	9	3	4	8	3	1	3	44
	analyses	13	7	3						23
Fish measured		2579	1083	8	5	495	8	1	6	4185
Fish analysed		1187	536	8						1731

Table 3. The values of meteorological and hydrological parameters registered at the trawling stations in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021

Haul number	Date of catch	Mean headrope depth, m	Meteorological parameters Wind direction	Wind force [°B]	Sea state	Water surface t° [°C]	Hydrological parameters at trawling depth Temperature [°C]	Salinity [PSU]	Oxygen [ml/l]
1	2021-10-13	60	NNW	6	4	13.29	6.32	10.37	1.16
2	2021-10-13	30	NNW	5	3	13.29	5.04	7.75	6.61
3	2021-10-14	20	SSW	4	2	13.01	7.78	7.69	5.68
4	2021-10-14	55	SSW	5	3	12.89	6.01	10.47	1.15
5	2021-10-16	15	WNW	6	4	11.89	5.55	7.69	6.54
6	2021-10-17	30	W	6	4	12.59	6.01	7.75	5.69
7	2021-10-17	20	WNW	6	4	12.46	6.13	10.14	1.28
8	2021-10-17	15	W	5	3	12.33	12.27	7.31	7.03
9	2021-10-18	25	NW	5	3	11.72	5.26	7.71	7.36
10	2021-10-18	25	NW	5	3	12.05	4.67	7.74	6.76
11	2021-10-19	25	WSW	3	2	12.04	11.88	7.33	6.93
12	2021-10-19	40	S	5	3	11.53	4.80	7.91	5.61
13	2021-10-19	15	S	6	4	11.64	11.09	7.32	7.18

Table 4. Fish control-catch results by species in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021

					Catch per							
Haul number	Date	ICES rectangle	ICES SD	Total cactch [kg]	Sprat	Herring	Cod	Flounder	Threespine stickleback	Ninespine stickleback	Shorthorne sculpin	Lumpfish
					126425	126417	126436	127141	126505	126507	127203	127214
1	2021-10-13	41G9	26	335.770	56.278	277.322	2.047				0.123	
2	2021-10-13	41H0	26	391.490	64.716	326.774						
3	2021-10-14	41H0	26	945.930	945.930							
4	2021-10-14	41G9	26	138.140	10.147	127.391	0.472	0.130				
5	2021-10-16	42G9	28.2	306.153	301.150	1.579			3.248			0.176
6	2021-10-17	42H0	28.2	135.084	130.273	2.868			1.940	0.003		
7	2021-10-17	42H0	28.2	70.041	24.372	24.041	0.010	0.396	21.222			
8	2021-10-17	42G9	28.2	189.020	46.028				142.992			
9	2021-10-18	43G9	28.2	51.759	49.346	0.115		0.300	1.607			0.391
10	2021-10-18	43H0	28.2	30.540	8.744				21.796			
11	2021-10-19	43H1	28.2	1388.886	1388.420							0.466
12	2021-10-19	43H0	28.2	19.512	7.220	4.150		0.120	8.020	0.002		
13	2021-10-19	44H0	28.2	36.046	34.078	0.269			1.698	0.001		
SD26				1811.330	1077.071	731.487	2.519	0.130			0.123	
SD28.2				2227.041	1989.631	33.022	0.010	0.816	202.523	0.006		1.033
SD26+28.2				4038.371	3066.702	764.509	2.529	0.946	202.523	0.006	0.123	1.033

Table 5. Hydroacoustic survey statistics of pelagic fish species from the Latvian-Polish BIAS survey in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 12-21.10.2021 (SPR = Sprat, HER = Herring, GTA = Threespine stickleback, GPT = Ninespine stickleback)

Table 5A

ICES SD	ICES Rect.	Area nm^2	Hauls No	NASC Pel m^{2}nm^{-2}	σ m^{2}10^4	ρ n10^{6}nm^{-2}	TS db	Abundance n10^6	Biomass kg10^3
26	41G8	1000.0	5	27.25596	1.2023	0.2267	-50.19	226.699	1983.080
	41G9	1000.0	1,2,4,5	202.7237	2.1791	0.9303	-47.61	930.297	19102.027
	41H0	953.3	2,3,4	243.6961	1.8331	1.3294	-48.36	1267.355	21263.341
28.2	42G8	945.4	5,9	117.6095	1.2023	0.9782	-50.19	924.798	8089.784
	42G9	986.9	4,5,8,9	268.281	0.7285	3.6827	-52.37	3634.407	19005.825
	42H0	968.5	3,4,6,7,8	470.5696	1.2345	3.8118	-50.08	3691.741	35181.122
	43G9	973.7	8,9,10	200.2293	0.6840	2.9274	-52.64	2850.410	14021.327
	43H0	973.7	6,10,11,12	650.1994	0.9449	6.8808	-51.24	6699.845	47651.459
	43H1	412.7	11	1595.559	1.3408	11.8996	-49.72	4910.983	51895.163
	44H0	960.5	12,13	588.7379	1.0055	5.8552	-50.97	5623.910	42371.602
	44H1	824.6	11,13	308.5517	1.2982	2.3767	-49.86	1959.815	19926.654

Table 5B

ICES	ICES	Abundance, n10^6				Abundance, %			
SD	Rect.	SPR	HER	GTA	GPT	SPR	HER	GTA	GPT
26	41G8	216.337	0.394	9.968		95.429	0.174	4.397	
	41G9	271.073	656.801	2.423		29.138	70.601	0.261	
	41H0	749.232	518.124			59.118	40.882		
28.2	42G8	882.527	1.608	40.663		95.429	0.174	4.397	
	42G9	1397.561	56.633	2180.213		38.454	1.558	59.988	
	42H0	3195.992	51.056	444.012	0.681	86.571	1.383	12.027	0.018
	43G9	924.422	0.867	1925.120		32.431	0.030	67.538	
	43H0	3652.786	137.704	2907.997	1.358	54.520	2.055	43.404	0.020
	43H1	4910.983				100.000			
	44H0	3477.759	93.912	2050.680	1.558	61.839	1.670	36.464	0.028
	44H1	1862.485	2.077	95.144	0.109	95.034	0.106	4.855	0.006

Table 5C

ICES	ICES	Biomass, kg10^3				Biomass, %			
SD	Rect.	SPR	HER	GTA	GPT	SPR	HER	GTA	GPT
26	41G8	1951.796	10.234	21.051		98.422	0.516	1.062	
	41G9	2909.962	16183.082	5.118		15.234	84.719	0.027	
	41H0	7412.450	13850.775			34.860	65.139		
28.2	42G8	7962.162	41.747	85.874		98.422	0.516	1.062	
	42G9	13033.845	1331.985	4639.527		68.578	7.008	24.411	
	42H0	33175.329	1138.857	866.286	0.408	94.299	3.237	2.462	0.001
	43G9	9959.319	19.813	4042.195		71.030	0.141	28.829	
	43H0	40000.269	2107.423	5542.598	1.169	83.943	4.423	11.632	0.002
	43H1	51895.163				100.000			
	44H0	37147.111	1365.252	3857.268	1.972	87.670	3.222	9.103	0.005
	44H1	19711.756	29.368	185.377	0.153	98.922	0.147	0.930	0.001

Table 5D

ICES	ICES	SPR		HER		GTA		GPT	
SD	Rect.	L, cm	w, g	L, cm	w, g	L, cm	w, g	L, cm	w, g
26	41G8	11.18	9.13	16.17	25.97	6.26	2.11		
	41G9	11.62	10.42	16.25	25.90	6.26	2.11		
	41H0	11.51	10.16	16.30	26.60				
28.2	42G8	11.48	10.04	16.00	24.55	6.22	2.11		
	42G9	11.53	10.18	16.00	24.39	5.98	2.13		
	42H0	11.66	10.65	15.77	23.46	5.97	1.95	4.75	0.60
	43G9	11.70	10.87	15.80	22.84	5.74	2.10		
	43H0	11.79	10.91	13.23	15.68	5.99	1.91	4.82	0.86
	43H1	11.45	10.28						
	44H0	11.83	10.56	12.82	14.32	6.07	1.88	5.08	1.27
	44H1	11.57	10.33	13.44	14.86	6.01	1.95	5.25	1.40

Table 6. Sprat stock characteristics in the Baltic Sea ICES SD 26N and 28.2
from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021

Table 6A CANUM		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8	2023	14161	5732	2023	2697	2360	1349	2360	674	33380
	41G9	1240	11903	8556	4464	5084	3348	2108	5952	2356	45010
	41H0	15696	17761	16935	11152	14457	7848	4957	15283	6196	110283
28.2	42G8	1157	13308	6750	3472	3279	2893	1736	4050	1350	37994
	42G9	1247	13493	9638	3855	3628	2721	1928	5329	1474	43315
	42H0	11201	22676	33878	13114	14753	7377	4371	12021	2732	122123
	43G9	35	2748	2609	939	1009	557	278	1252	278	9707
	43H0	4033	28228	37100	20163	20970	4436	5242	16937	6855	143964
	43H1	12664	33243	39575	18996	20579	1583		4749		131390
	44H0	77	730	749	557	384	173	250	596	327	3843
	44H1	8825	33096	36037	20593	16180	4413	2942	11032	1471	134588

Table 6B n × 10^6		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8	13.11	91.78	37.15	13.11	17.48	15.30	8.74	15.30	4.37	216.34
	41G9	7.47	71.69	51.53	26.88	30.62	20.16	12.69	35.84	14.19	271.07
	41H0	106.63	120.66	115.05	75.76	98.21	53.32	33.67	103.83	42.09	749.23
28.2	42G8	26.88	309.11	156.79	80.64	76.16	67.20	40.32	94.08	31.36	882.53
	42G9	40.24	435.37	310.98	124.39	117.07	87.80	62.20	171.95	47.56	1397.56
	42H0	293.14	593.44	886.58	343.19	386.09	193.05	114.40	314.59	71.50	3195.99
	43G9	3.31	261.75	248.50	89.46	96.09	53.01	26.51	119.28	26.51	924.42
	43H0	102.32	716.23	941.33	511.59	532.06	112.55	133.01	429.74	173.94	3652.79
	43H1	473.35	1242.54	1479.21	710.02	769.19	59.17		177.51		4910.98
	44H0	69.56	660.77	678.16	504.28	347.78	156.50	226.05	539.05	295.61	3477.76
	44H1	122.13	457.99	498.70	284.97	223.91	61.07	40.71	152.66	20.36	1862.48

Table 6C n, %		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8	6.06	42.42	17.17	6.06	8.08	7.07	4.04	7.07	2.02	100.00
	41G9	2.75	26.45	19.01	9.92	11.29	7.44	4.68	13.22	5.23	100.00
	41H0	14.23	16.10	15.36	10.11	13.11	7.12	4.49	13.86	5.62	100.00
28.2	42G8	3.05	35.03	17.77	9.14	8.63	7.61	4.57	10.66	3.55	100.00
	42G9	2.88	31.15	22.25	8.90	8.38	6.28	4.45	12.30	3.40	100.00
	42H0	9.17	18.57	27.74	10.74	12.08	6.04	3.58	9.84	2.24	100.00
	43G9	0.36	28.32	26.88	9.68	10.39	5.73	2.87	12.90	2.87	100.00
	43H0	2.80	19.61	25.77	14.01	14.57	3.08	3.64	11.76	4.76	100.00
	43H1	9.64	25.30	30.12	14.46	15.66	1.20		3.61		100.00
	44H0	2.00	19.00	19.50	14.50	10.00	4.50	6.50	15.50	8.50	100.00
	44H1	6.56	24.59	26.78	15.30	12.02	3.28	2.19	8.20	1.09	100.00

Table 6D W, kg × 10^3		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8	47.20	739.92	371.05	140.95	189.02	169.35	105.55	165.86	46.98	1975.88
	41G9	31.07	593.45	508.77	311.02	360.31	234.11	158.91	443.50	183.70	2824.83
	41H0	513.52	1053.13	1131.70	872.70	1163.69	608.08	431.02	1304.84	531.48	7610.17
28.2	42G8	96.76	2569.63	1613.64	915.23	891.04	794.27	498.61	1105.18	377.65	8862.01
	42G9	169.02	3614.63	3177.07	1437.07	1362.80	1029.51	777.44	2087.56	577.68	14232.80
	42H0	1415.67	5215.83	9673.78	4140.49	4763.96	2340.87	1474.30	4097.59	925.19	34047.69
	43G9	15.24	2322.65	2677.18	1044.37	1166.96	665.98	332.00	1485.70	338.62	10048.70
	43H0	532.06	6449.16	10217.57	5874.13	6300.80	1359.82	1591.06	5448.48	2093.45	39866.53
	43H1	2461.41	11123.67	16129.32	8271.75	9372.29	781.02		2354.91		50494.37
	44H0	295.61	5397.48	7021.60	5468.78	3994.21	1728.45	2683.09	6599.05	3526.45	36714.70
	44H1	596.40	3871.53	5394.08	3287.34	2735.72	669.68	496.66	1952.05	244.26	19247.71

Table 6E W, %						Age group					∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8	2.39	37.45	18.78	7.13	9.57	8.57	5.34	8.39	2.38	100.00
	41G9	1.10	21.01	18.01	11.01	12.76	8.29	5.63	15.70	6.50	100.00
	41H0	6.75	13.84	14.87	11.47	15.29	7.99	5.66	17.15	6.98	100.00
28.2	42G8	1.09	29.00	18.21	10.33	10.05	8.96	5.63	12.47	4.26	100.00
	42G9	1.19	25.40	22.32	10.10	9.58	7.23	5.46	14.67	4.06	100.00
	42H0	4.16	15.32	28.41	12.16	13.99	6.88	4.33	12.03	2.72	100.00
	43G9	0.15	23.11	26.64	10.39	11.61	6.63	3.30	14.79	3.37	100.00
	43H0	1.33	16.18	25.63	14.73	15.80	3.41	3.99	13.67	5.25	100.00
	43H1	4.87	22.03	31.94	16.38	18.56	1.55		4.66		100.00
	44H0	0.81	14.70	19.12	14.90	10.88	4.71	7.31	17.97	9.61	100.00
	44H1	3.10	20.11	28.02	17.08	14.21	3.48	2.58	10.14	1.27	100.00

Table 6F w, g						Age group					Total
ICES	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8	3.60	8.06	9.99	10.75	10.81	11.07	12.08	10.84	10.75	9.13
	41G9	4.16	8.28	9.87	11.57	11.77	11.61	12.52	12.37	12.95	10.42
	41H0	4.82	8.73	9.84	11.52	11.85	11.41	12.80	12.57	12.63	10.16
28.2	42G8	3.60	8.31	10.29	11.35	11.70	11.82	12.37	11.75	12.04	10.04
	42G9	4.20	8.30	10.22	11.55	11.64	11.73	12.50	12.14	12.15	10.18
	42H0	4.83	8.79	10.91	12.06	12.34	12.13	12.89	13.03	12.94	10.65
	43G9	4.60	8.87	10.77	11.67	12.14	12.56	12.53	12.46	12.78	10.87
	43H0	5.20	9.00	10.85	11.48	11.84	12.08	11.96	12.68	12.04	10.91
	43H1	5.20	8.95	10.90	11.65	12.18	13.20		13.27		10.28
	44H0	4.25	8.17	10.35	10.84	11.49	11.04	11.87	12.24	11.93	10.56
	44H1	4.88	8.45	10.82	11.54	12.22	10.97	12.20	12.79	12.00	10.33

Table 6G L, cm						Age group					Total
ICES	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8	8.33	10.52	11.50	11.92	12.00	12.43	12.75	12.36	13.50	11.18
	41G9	8.60	10.63	11.39	11.96	12.08	12.25	12.71	12.63	12.89	11.62
	41H0	8.95	10.85	11.44	11.98	12.26	12.11	12.71	12.68	12.87	11.51
28.2	42G8	8.33	10.57	11.51	12.06	12.32	12.47	12.78	12.38	12.86	11.48
	42G9	8.59	10.60	11.50	12.13	12.27	12.38	12.71	12.54	12.73	11.53
	42H0	8.95	10.82	11.71	12.26	12.47	12.37	12.81	12.88	12.85	11.66
	43G9	8.50	10.70	11.57	12.19	12.41	12.47	12.69	12.56	12.81	11.70
	43H0	9.15	10.85	11.63	12.01	12.33	12.32	12.50	12.86	12.24	11.79
	43H1	9.13	10.93	11.64	12.00	12.42	13.00		12.83		11.45
	44H0	8.75	10.64	11.49	11.83	12.25	12.06	12.54	12.89	12.88	11.83
	44H1	9.00	10.76	11.65	12.04	12.45	12.08	12.63	13.03	12.25	11.57

Table 8. Herring stock characteristics in the Baltic Sea ICES SD 26N and 28.2
from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021

Table 7A CANUM						Age group					
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	∑
26	41G8			20	10	10			20		61
	41G9		230	9679	5646	4955	3111	1613	3226	1152	29613
	41H0		211	5909	3482	3060	2005	844	1477	633	17621
28.2	42G8			24	12	12		6	12		66
	42G9		63	1898	1075	1012	443	190	633	190	5503
	42H0	187	125	2179	1183	1432	498	187	623	249	6661
	43G9			2	1	1		1			5
	43H0	176	7	105	29	51	7	10	20	7	414
	43H1										
	44H0	143	8	85	16	25	4	6	12	4	302
	44H1	5	2	11		1					19

Table 7B n × 10^6						Age group					
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	∑
26	41G8			0.13	0.07	0.07			0.13		0.39
	41G9		5.11	214.67	125.23	109.89	69.00	35.78	71.56	25.56	656.80
	41H0		6.21	173.74	102.38	89.97	58.95	24.82	43.44	18.62	518.12
28.2	42G8			0.58	0.29	0.29		0.15	0.29		1.61
	42G9		0.65	19.53	11.07	10.42	4.56	1.95	6.51	1.95	56.63
	42H0	1.43	0.95	16.70	9.07	10.97	3.82	1.43	4.77	1.91	51.06
	43G9			0.35	0.17	0.17		0.17			0.87
	43H0	58.67	2.44	35.04	9.78	17.11	2.44	3.26	6.52	2.44	137.70
	43H1										
	44H0	44.55	2.41	26.49	4.82	7.83	1.20	1.81	3.61	1.20	93.91
	44H1	0.58	0.23	1.15		0.12					2.08

Table 7C n, %						Age group					
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	∑
26	41G8			33.33	16.67	16.67			33.33		100.00
	41G9		0.78	32.68	19.07	16.73	10.51	5.45	10.89	3.89	100.00
	41H0		1.20	33.53	19.76	17.37	11.38	4.79	8.38	3.59	100.00
28.2	42G8			36.36	18.18	18.18		9.09	18.18		100.00
	42G9		1.15	34.48	19.54	18.39	8.05	3.45	11.49	3.45	100.00
	42H0	2.80	1.87	32.71	17.76	21.50	7.48	2.80	9.35	3.74	100.00
	43G9			40.00	20.00	20.00		20.00			100.00
	43H0	42.60	1.78	25.44	7.10	12.43	1.78	2.37	4.73	1.78	100.00
	43H1										
	44H0	47.44	2.56	28.21	5.13	8.33	1.28	1.92	3.85	1.28	100.00
	44H1	27.78	11.11	55.56		5.56					100.00

Table 7D W, kg × 10^3						Age group					
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	∑
26	41G8			2.61	1.38	1.89			4.35		10.23
	41G9		146.69	4510.46	3057.57	3132.20	1993.40	1075.42	2164.12	931.28	17011.14
	41H0		178.09	3719.01	2538.50	2702.93	1752.93	758.88	1371.94	761.98	13784.27
28.2	42G8			11.84	6.31	7.92		3.71	9.68		39.46
	42G9		10.68	398.65	249.71	274.96	121.34	54.81	206.22	64.84	1381.20
	42H0	14.12	11.93	335.09	208.52	284.92	100.20	41.12	141.72	60.38	1198.00
	43G9			7.15	3.85	4.41		4.41			19.81
	43H0	418.16	29.50	684.61	232.87	405.13	66.81	76.76	168.99	75.94	2158.77
	43H1										
	44H0	316.29	25.89	507.36	108.84	186.50	29.62	42.86	93.91	33.83	1345.10
	44H1	4.50	2.15	21.49		2.72					30.86

Table 7E W, %						Age group					∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8			25.55	13.48	18.49			42.49		100.00
	41G9		0.86	26.51	17.97	18.41	11.72	6.32	12.72	5.47	100.00
	41H0		1.29	26.98	18.42	19.61	12.72	5.51	9.95	5.53	100.00
28.2	42G8			30.00	16.00	20.07		9.41	24.52		100.00
	42G9		0.77	28.86	18.08	19.91	8.78	3.97	14.93	4.69	100.00
	42H0	1.18	1.00	27.97	17.41	23.78	8.36	3.43	11.83	5.04	100.00
	43G9			36.08	19.44	22.24		22.24			100.00
	43H0	19.37	1.37	31.71	10.79	18.77	3.10	3.56	7.83	3.52	100.00
	43H1										
	44H0	23.51	1.92	37.72	8.09	13.87	2.20	3.19	6.98	2.52	100.00
	44H1	14.58	6.96	69.63		8.83					100.00

Table 7F w, g						Age group					Total
ICES	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8			19.90	21.00	28.80			33.10		25.97
	41G9		28.70	21.01	24.42	28.50	28.89	30.06	30.24	36.44	25.90
	41H0		28.70	21.41	24.79	30.04	29.74	30.58	31.59	40.93	26.60
28.2	42G8			20.25	21.60	27.10		25.40	33.10		24.55
	42G9		16.40	20.41	22.56	26.40	26.63	28.07	31.68	33.20	24.39
	42H0	9.87	12.50	20.06	23.00	25.96	26.25	28.73	29.70	31.64	23.46
	43G9			20.60	22.20	25.40		25.40			22.84
	43H0	7.13	12.07	19.54	23.82	23.68	27.33	23.55	25.93	31.07	15.68
	43H1										
	44H0	7.10	10.75	19.15	22.60	23.83	24.60	23.73	26.00	28.10	14.32
	44H1	7.80	9.30	18.62		23.60					14.86

Table 7G L, cm						Age group					Total
ICES	ICES Rect.	0	1	2	3	4	5	6	7	8+	
26	41G8			14.50	15.50	17.00			17.75		16.17
	41G9		16.25	15.06	16.03	16.69	16.87	17.43	17.54	18.65	16.25
	41H0		16.25	15.14	16.11	16.90	16.92	17.19	17.57	19.08	16.30
28.2	42G8			14.75	15.75	16.75		16.50	17.75		16.00
	42G9		14.50	14.93	15.78	16.57	16.57	16.67	17.60	18.17	16.00
	42H0	11.75	12.88	14.91	15.86	16.27	16.54	16.95	17.34	18.09	15.77
	43G9			15.00	16.00	16.50		16.50			15.80
	43H0	10.25	12.33	14.67	15.96	15.98	16.67	16.50	16.81	17.67	13.23
	43H1										
	44H0	10.25	12.00	14.59	15.69	16.12	16.50	16.33	16.83	17.00	12.82
	44H1	11.00	11.75	14.75		16.00					13.44

Table 8. Survey statistics related to cod from the Latvian-Polish BIAS
in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 12-21.10.2021

Table 5A									
ICES	ICES			$NASC_{PEL}$	σ 10^4	TS calc.	ρ	Abundance	Biomass
SD	Rect.	L, cm	w, g	m^2nm^{-2}	m^2	dB	nnm^{-2}	n	$kg10^3$
26	41G8								
	41G9	36.57	292.35	0.034	26.0959	-36.83	13.22	13217.26	3.864
	41H0	31.50	317.25	0.001	22.8884	-37.40	0.38	364.21	0.116
28.2	42G8								
	42G9	22.30	290.17	0.004	22.8884	-37.40	1.64	1614.17	0.468
	42H0	23.00	13.88	0.002	1.3126	-49.81	17.98	17418.34	0.242
	43G9								
	43H0								
	43H1								
	44H0								
	44H1								

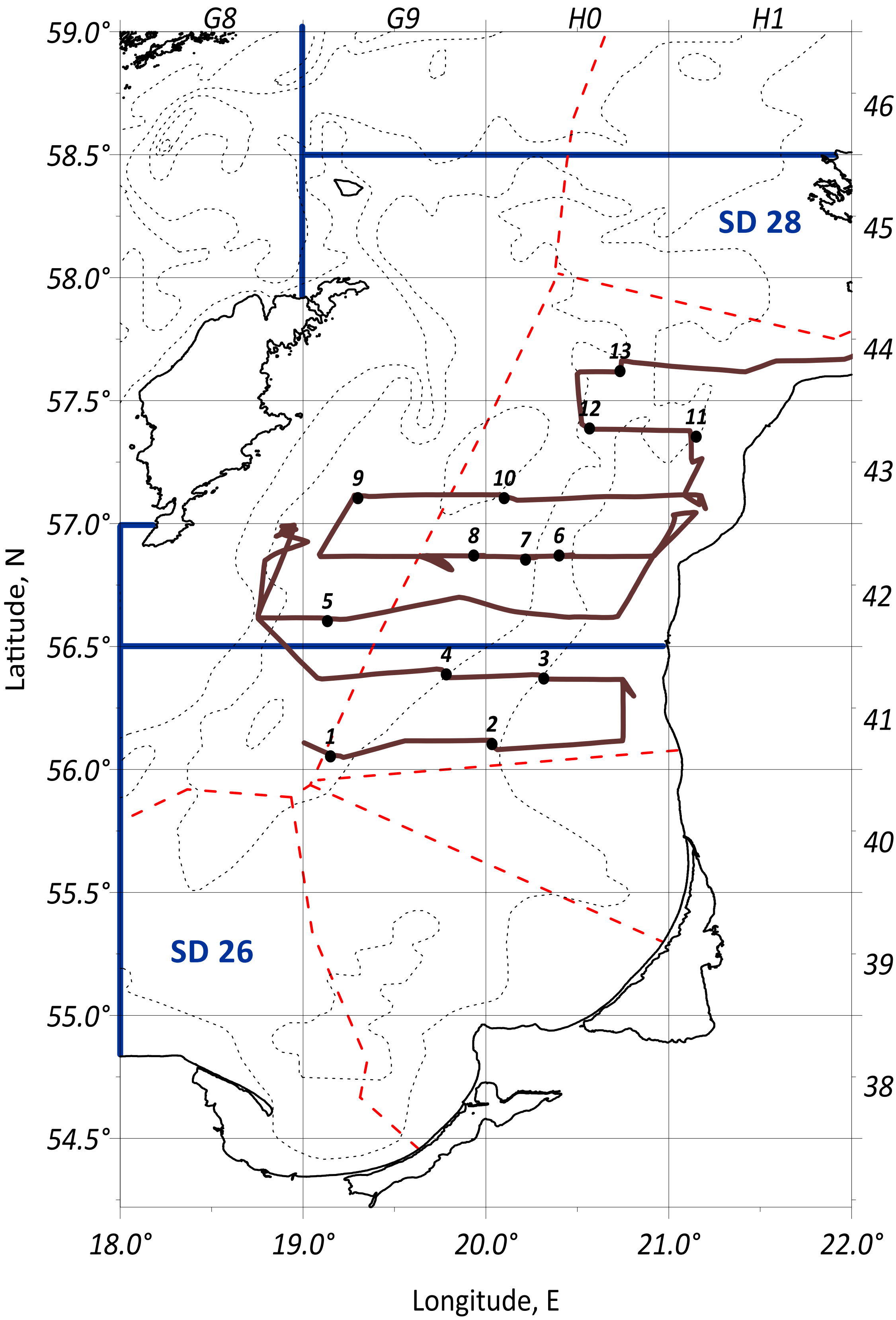

Figure 1: Cruise track design and trawling positions of the Latvian-Polish hydroacoustic survey on the r/v "Baltica" in the period of 12-21.10.2021.

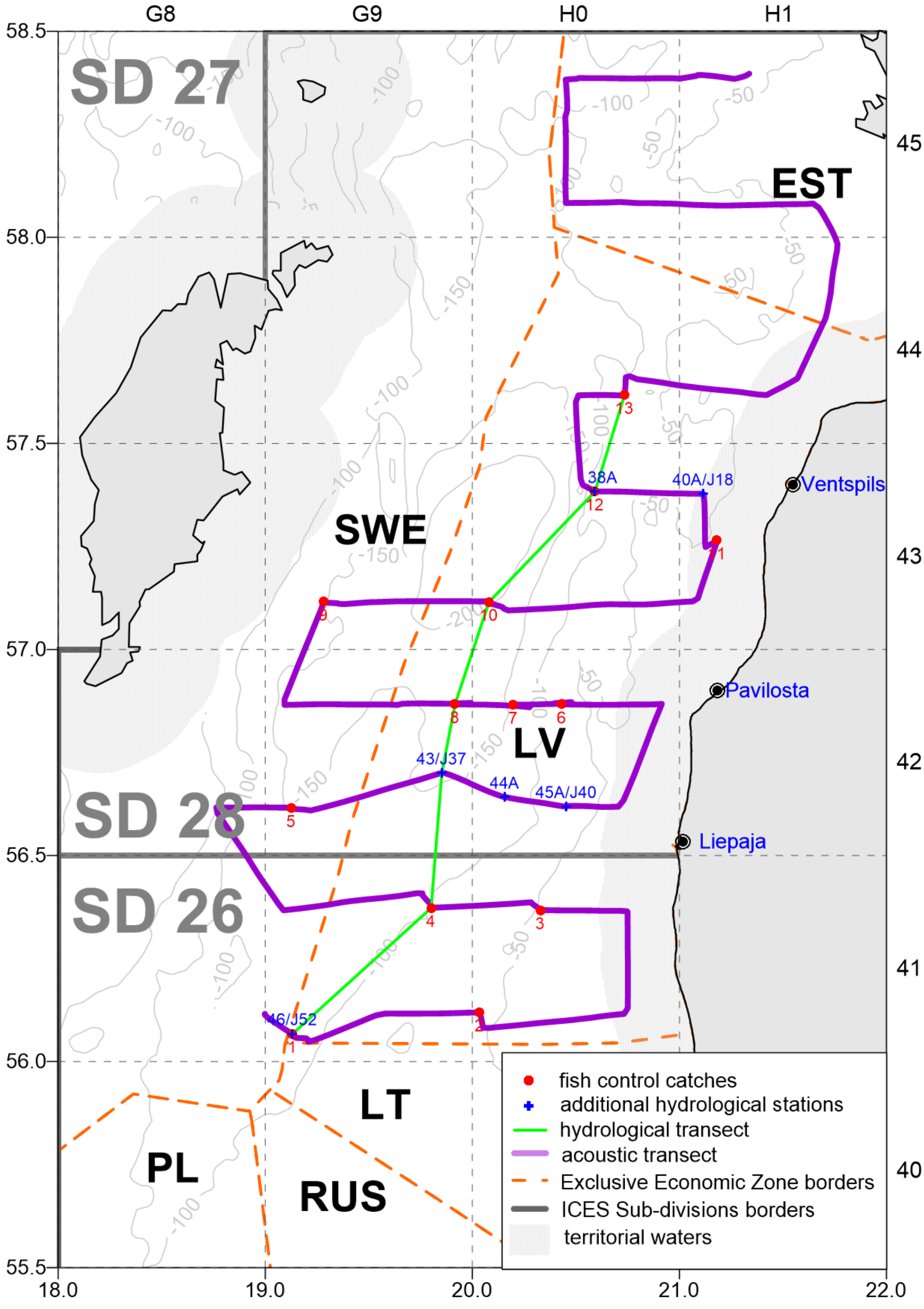

Figure 2: Locations of the hydrological stations and hydrological profile performed during the Latvian-Polish hydroacoustic survey on the r/v "Baltica" in the period of 12-21.10.2021.

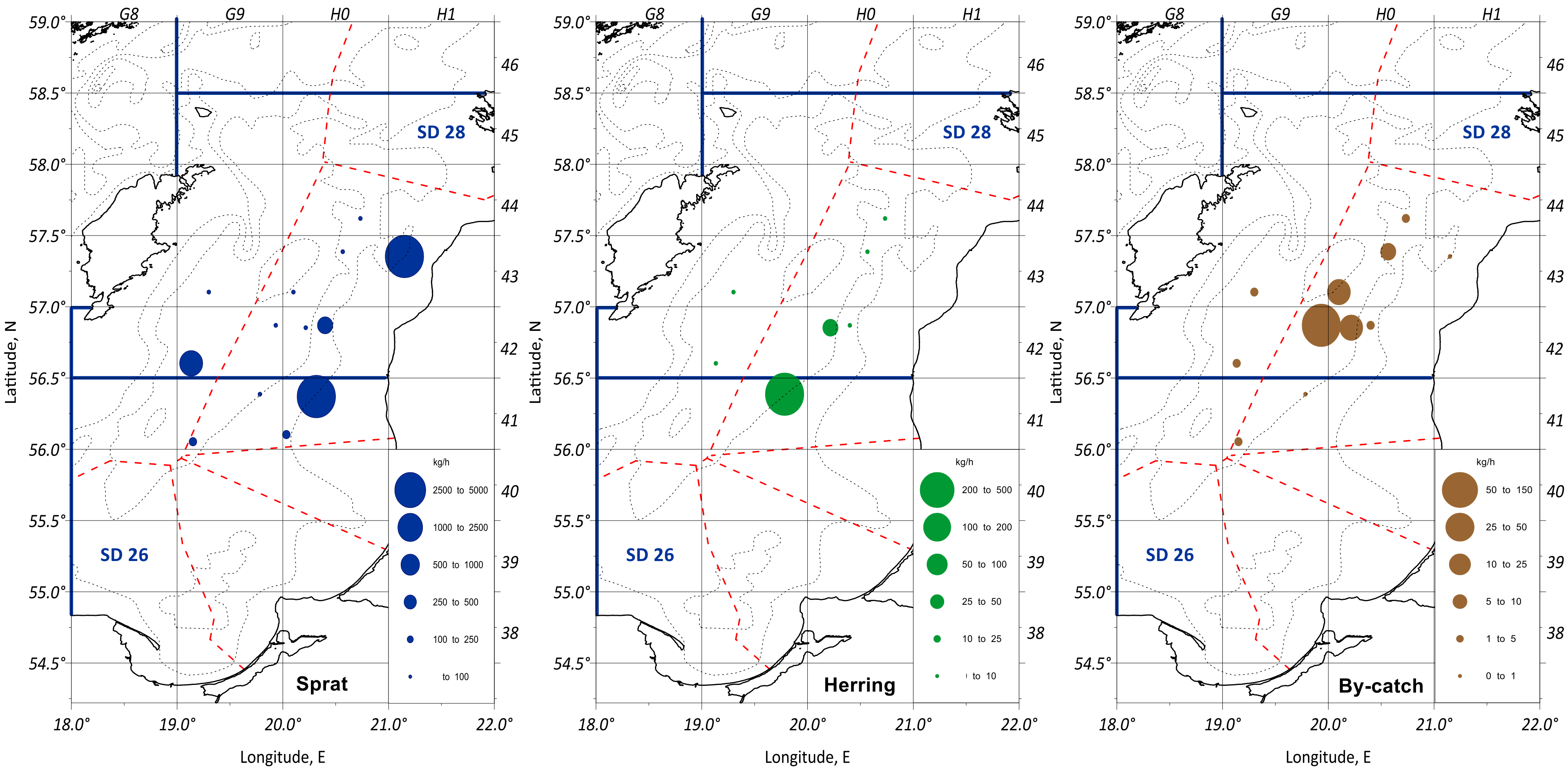

Figure 3: CPUE [kg/h] ranges distribution of fish in the catch hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

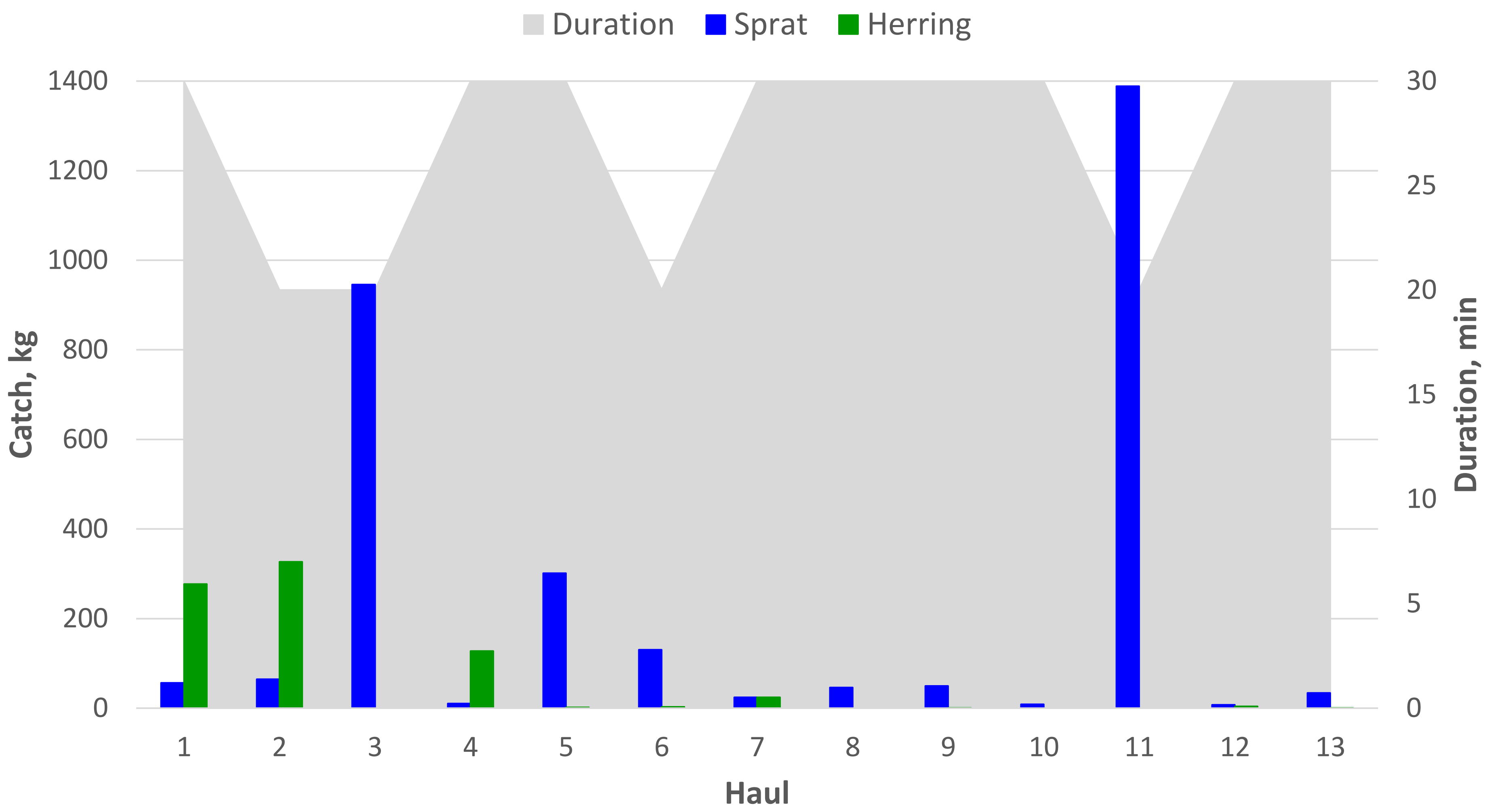

Figure 4: CPUE [kg/h] of dominant pelagic fish and by-catch in the hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

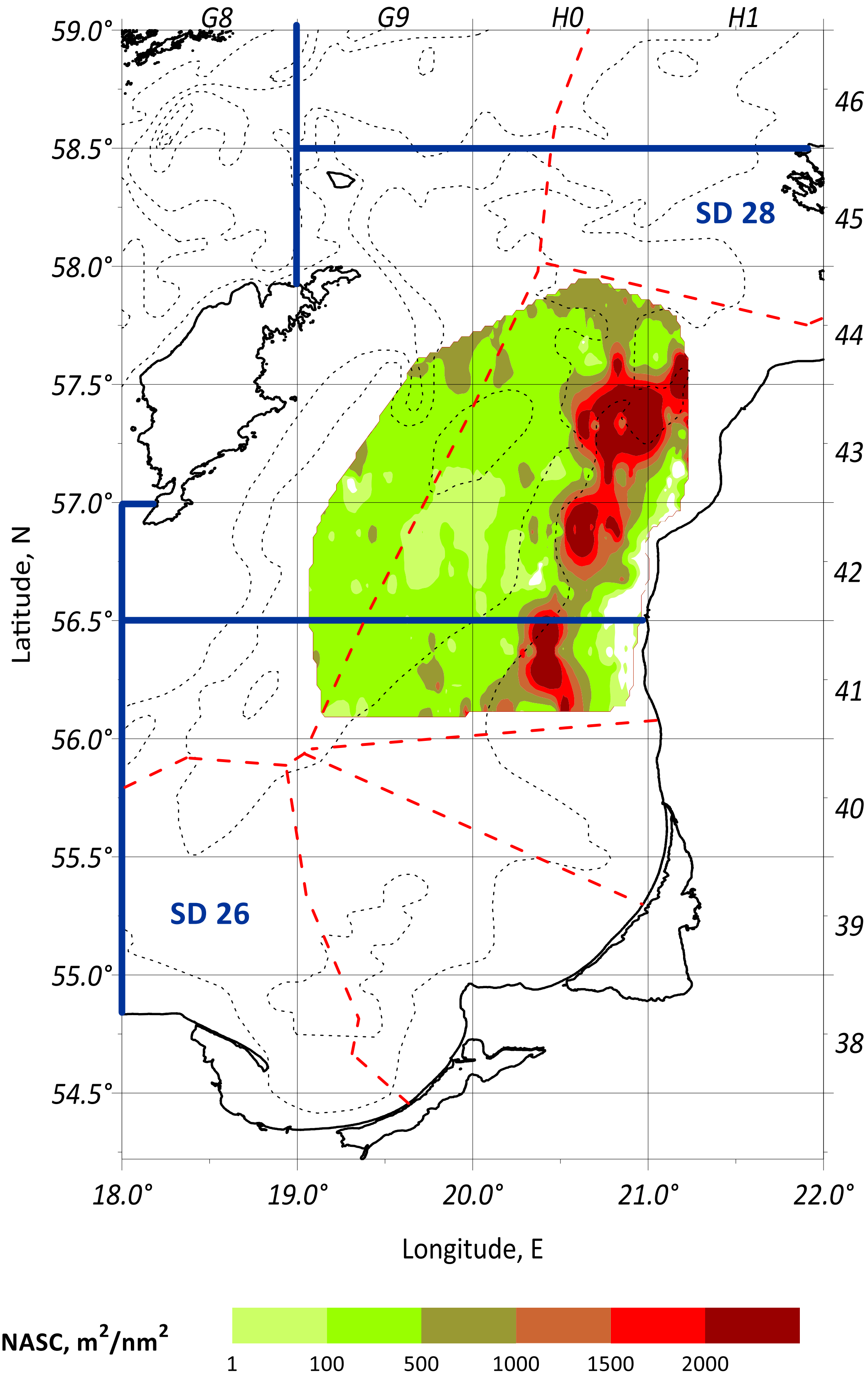

Figure 5: Acoustic parameter NASC distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

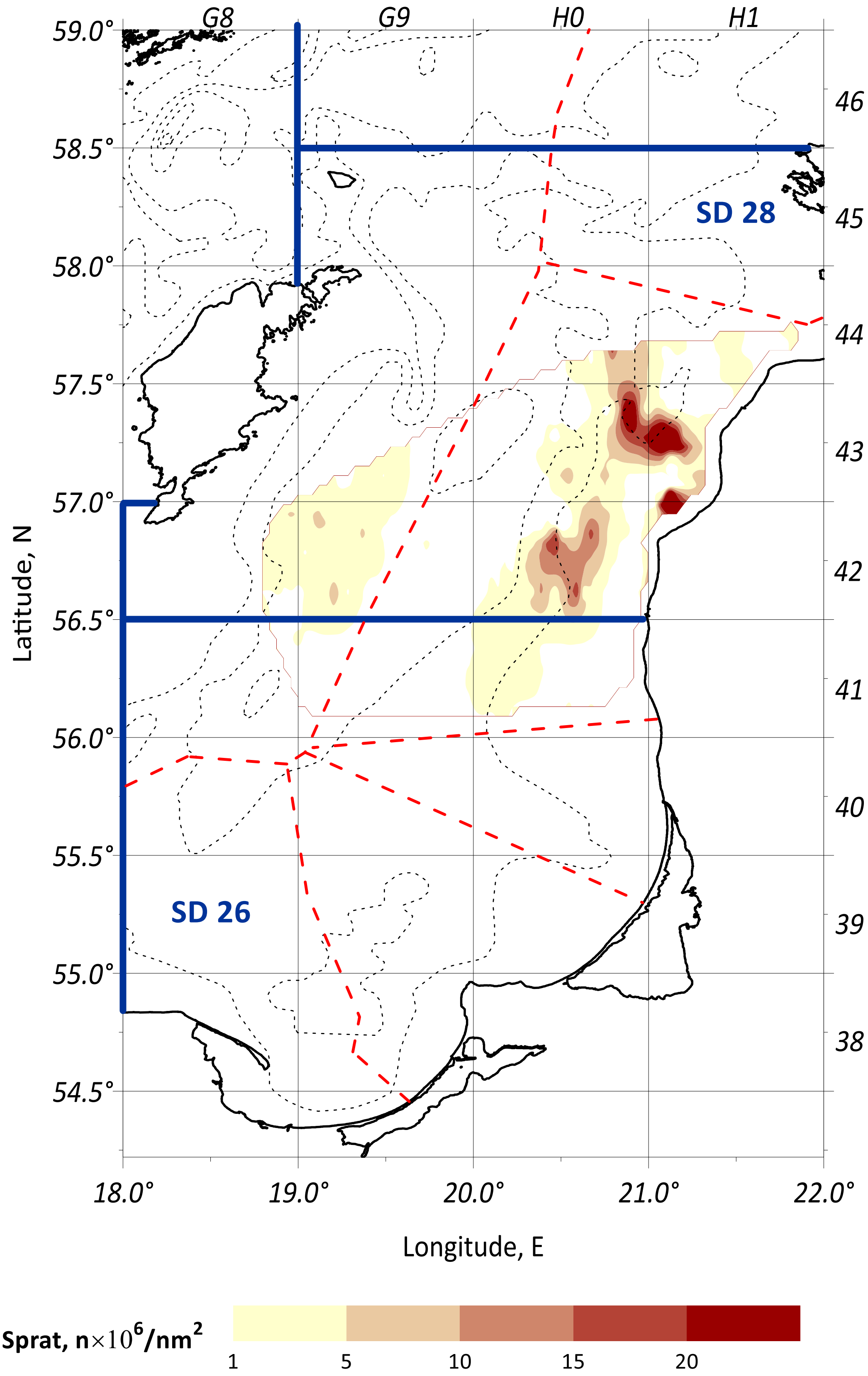

Figure 6: Sprat distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

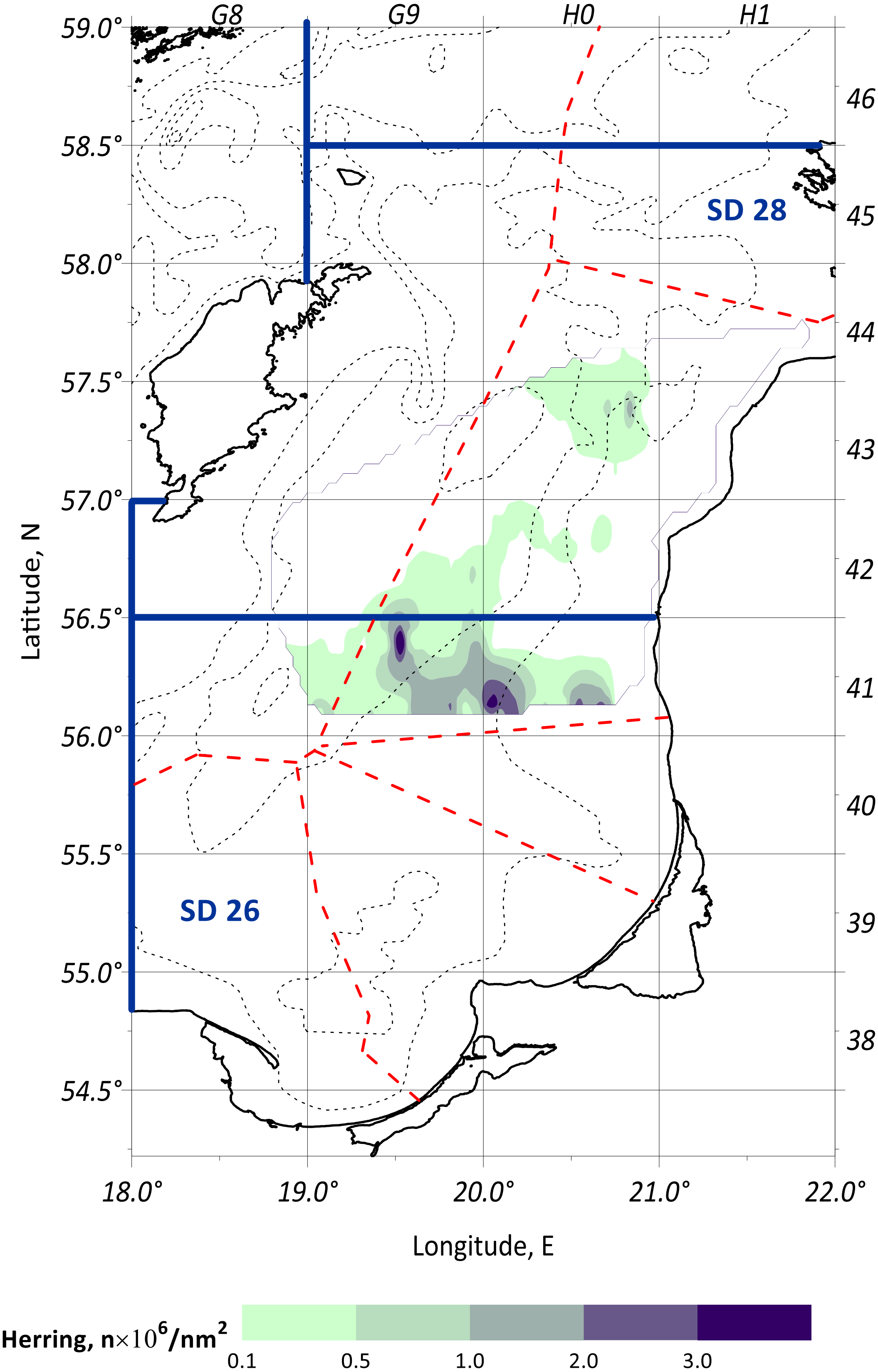

Figure 7: Herring distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

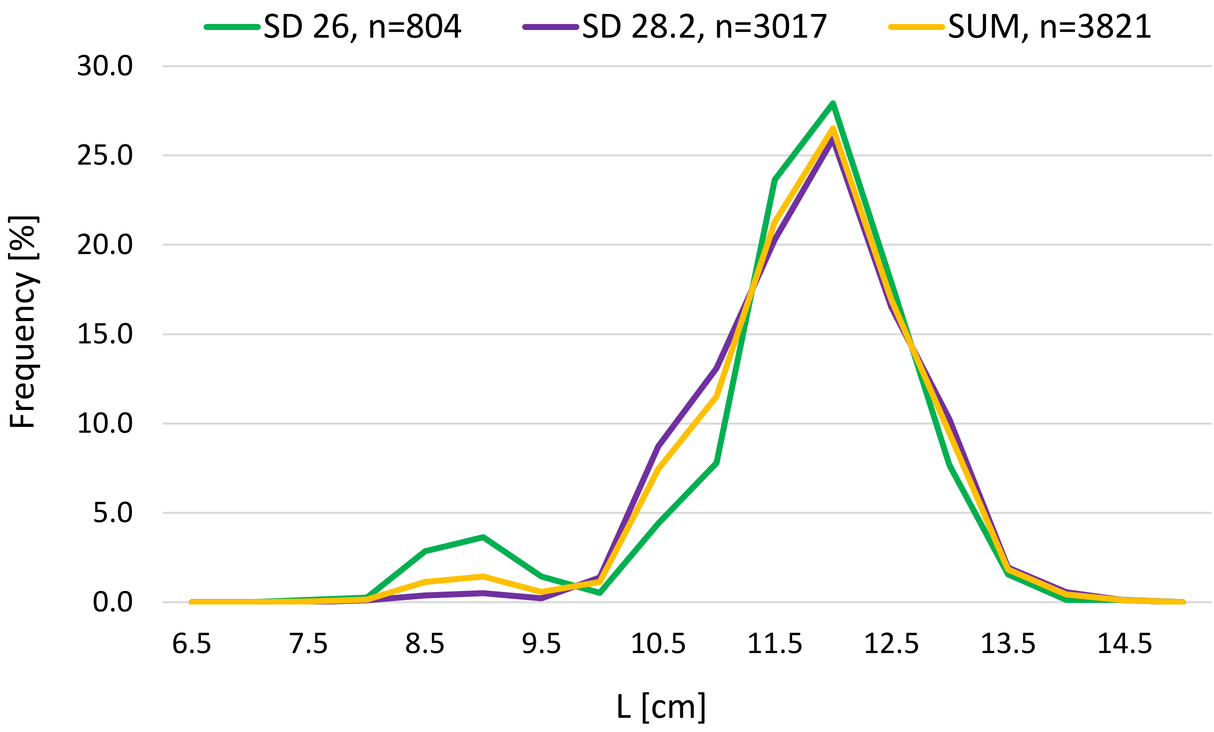

Figure 8: Sprat length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

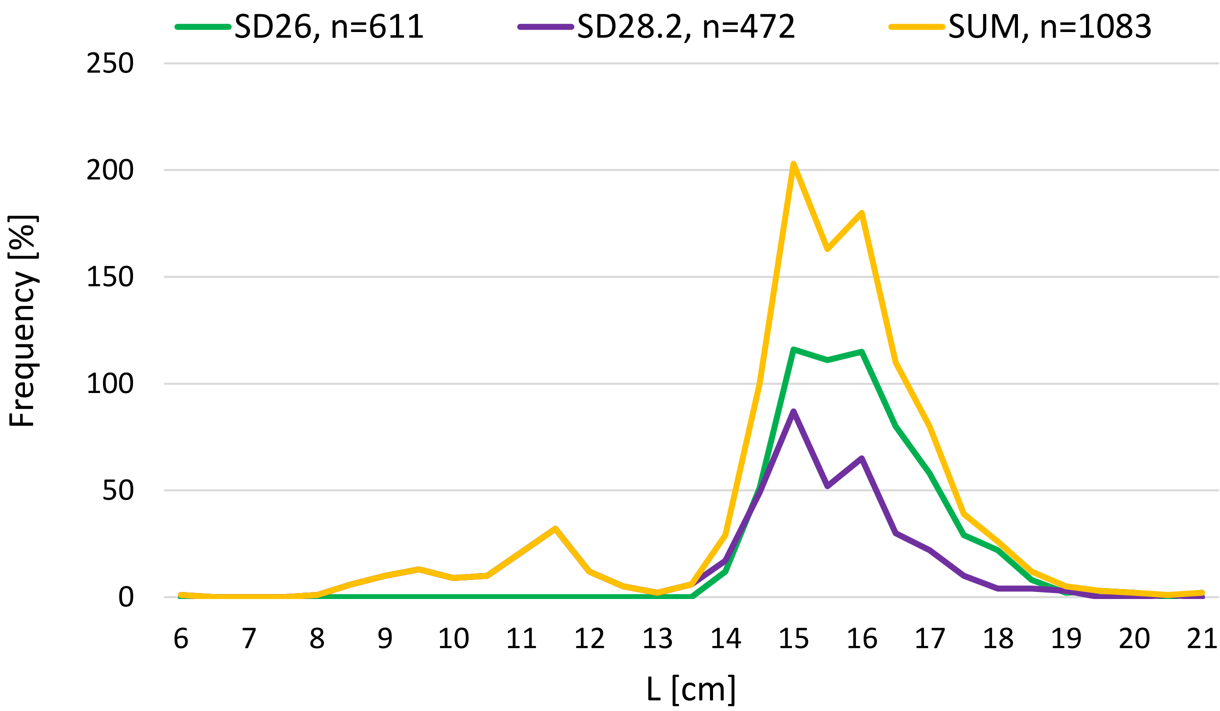

Figure 9: Herring length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

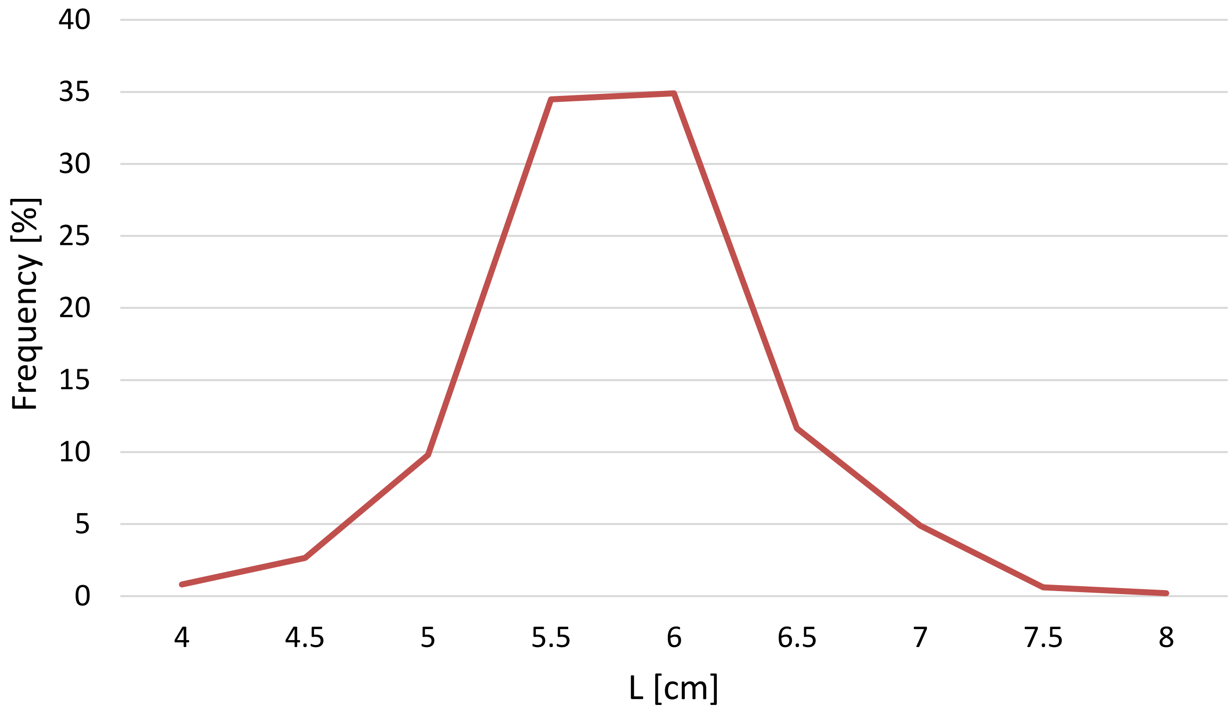

Figure 10: Stickleback length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

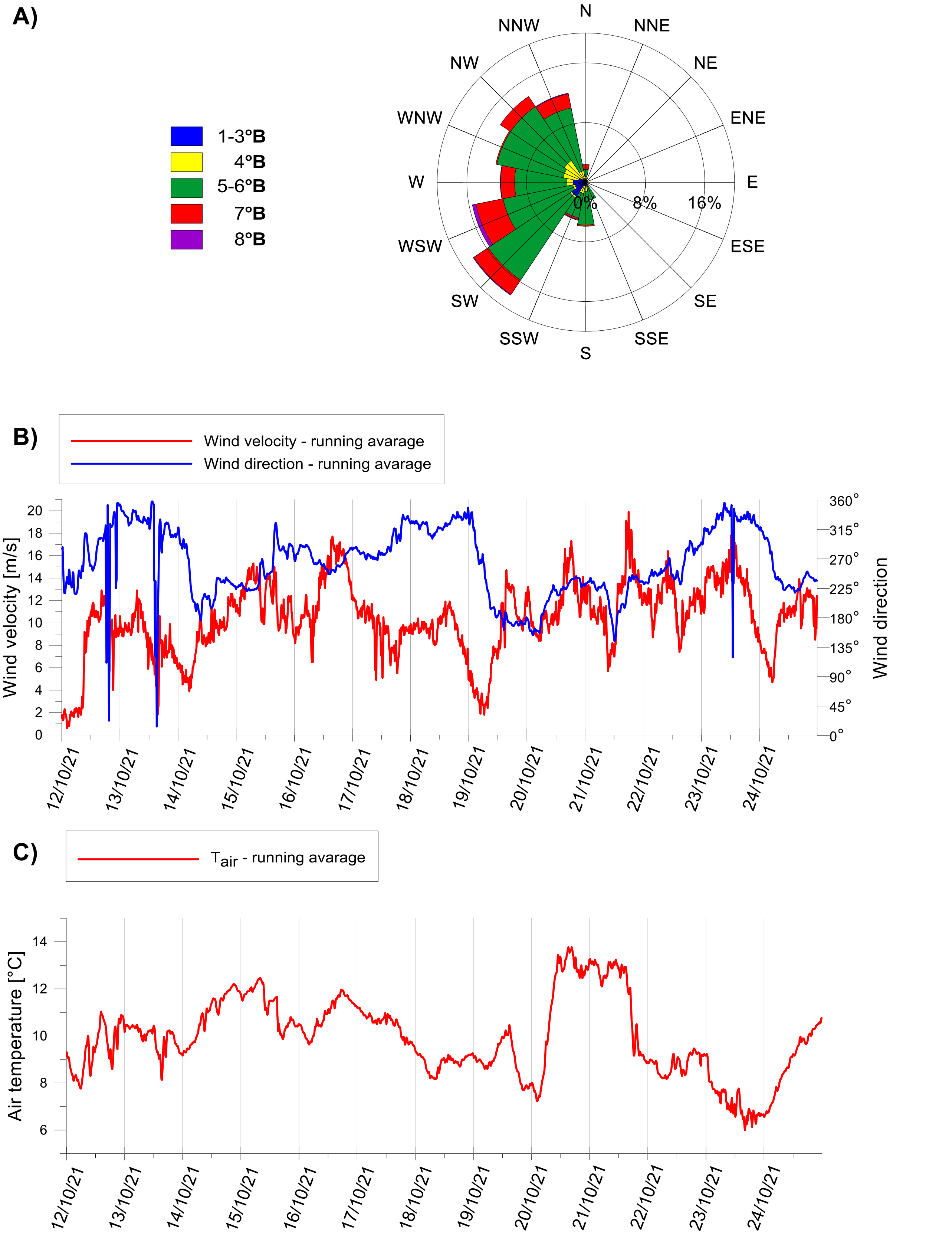

Figure 11: Changes of the main meteorological parameters (wind force, direction and the daily average air temperature) during the Latvian-Polish BIAS survey in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 12-21.10.2021.

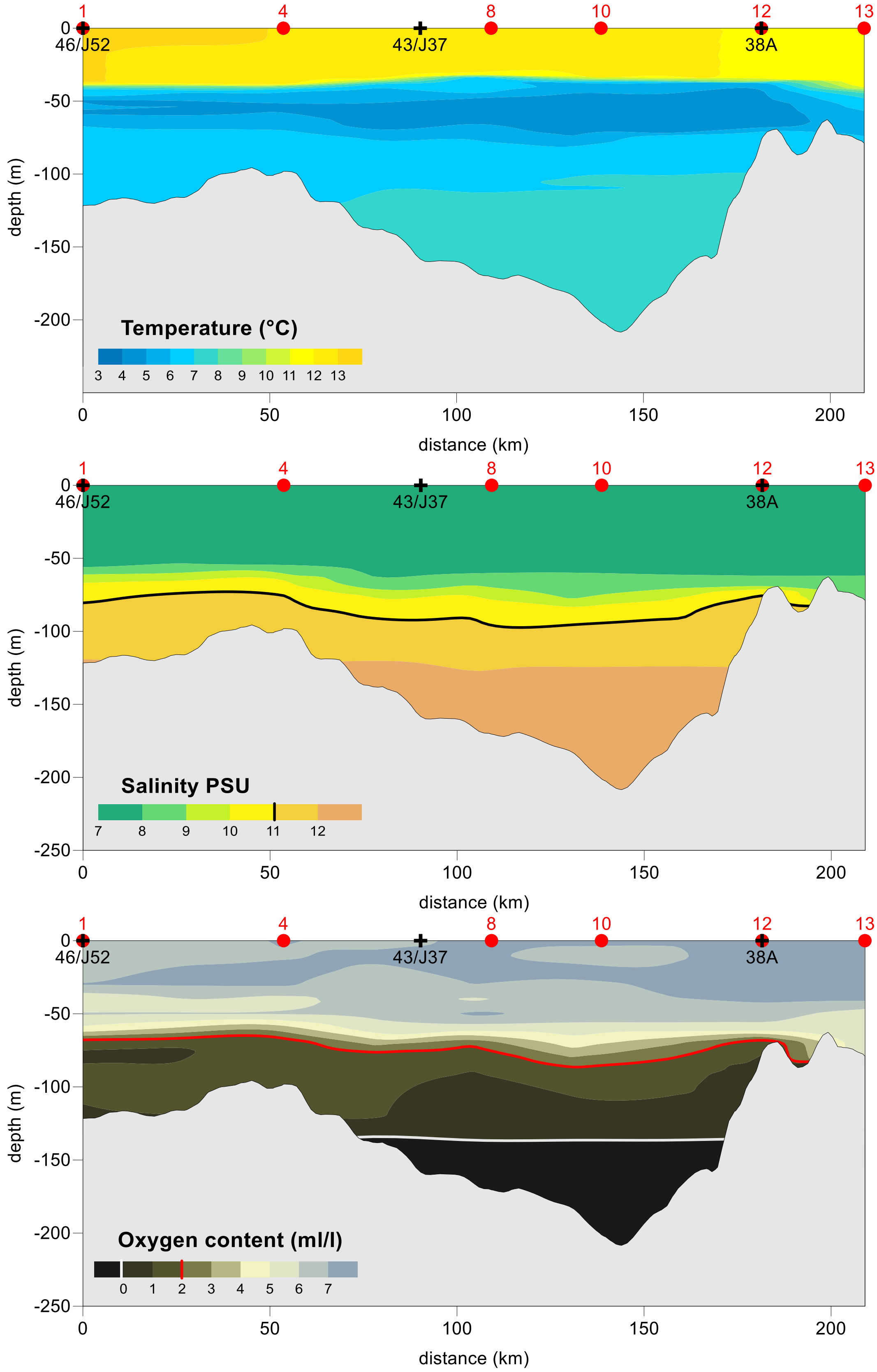

Figure 12: *Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological profile in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in October in the period of 12-21.10.2021.*

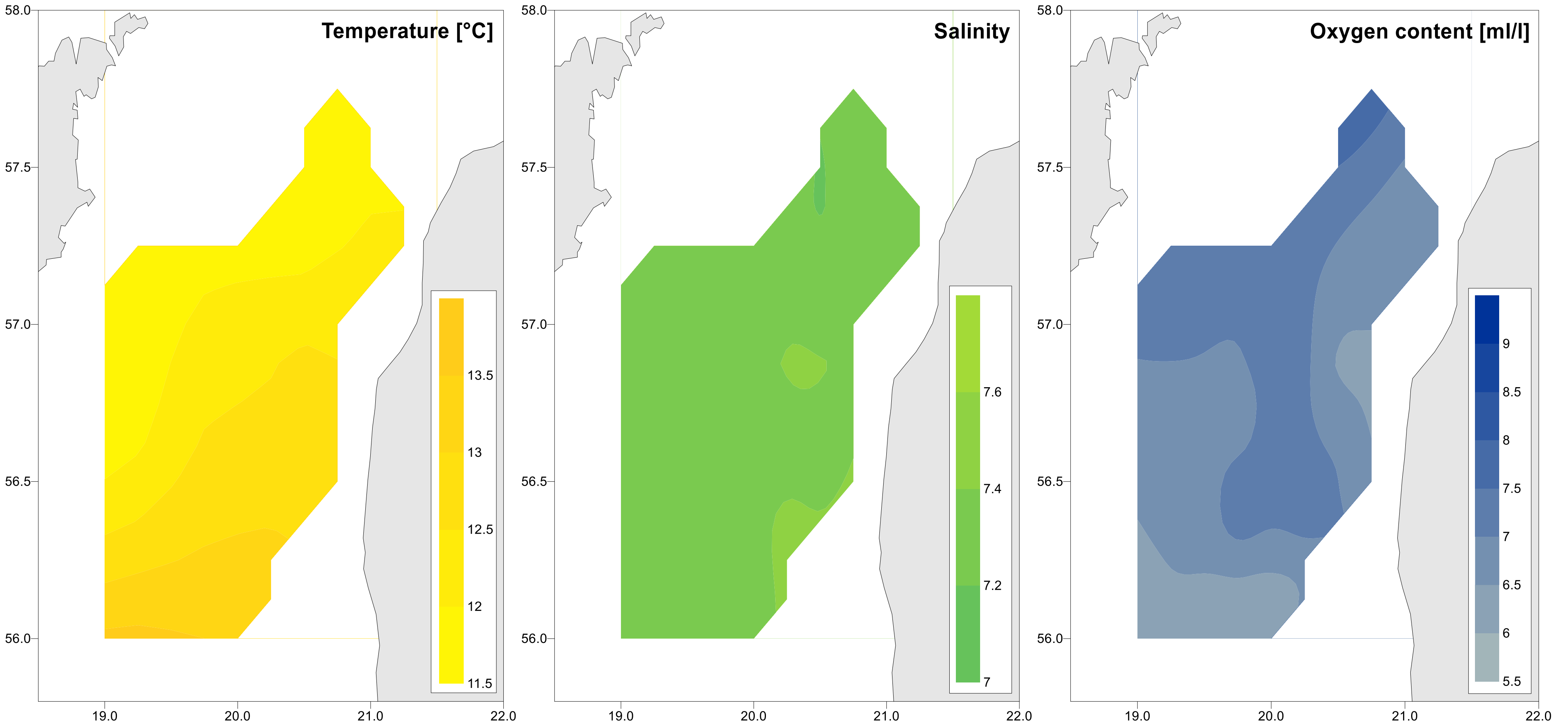

Figure 13: Horizontal distribution of the main hydrological parameters (temperature, salinity, oxygen content) measured in the surface water layer of the Gotland Deep in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

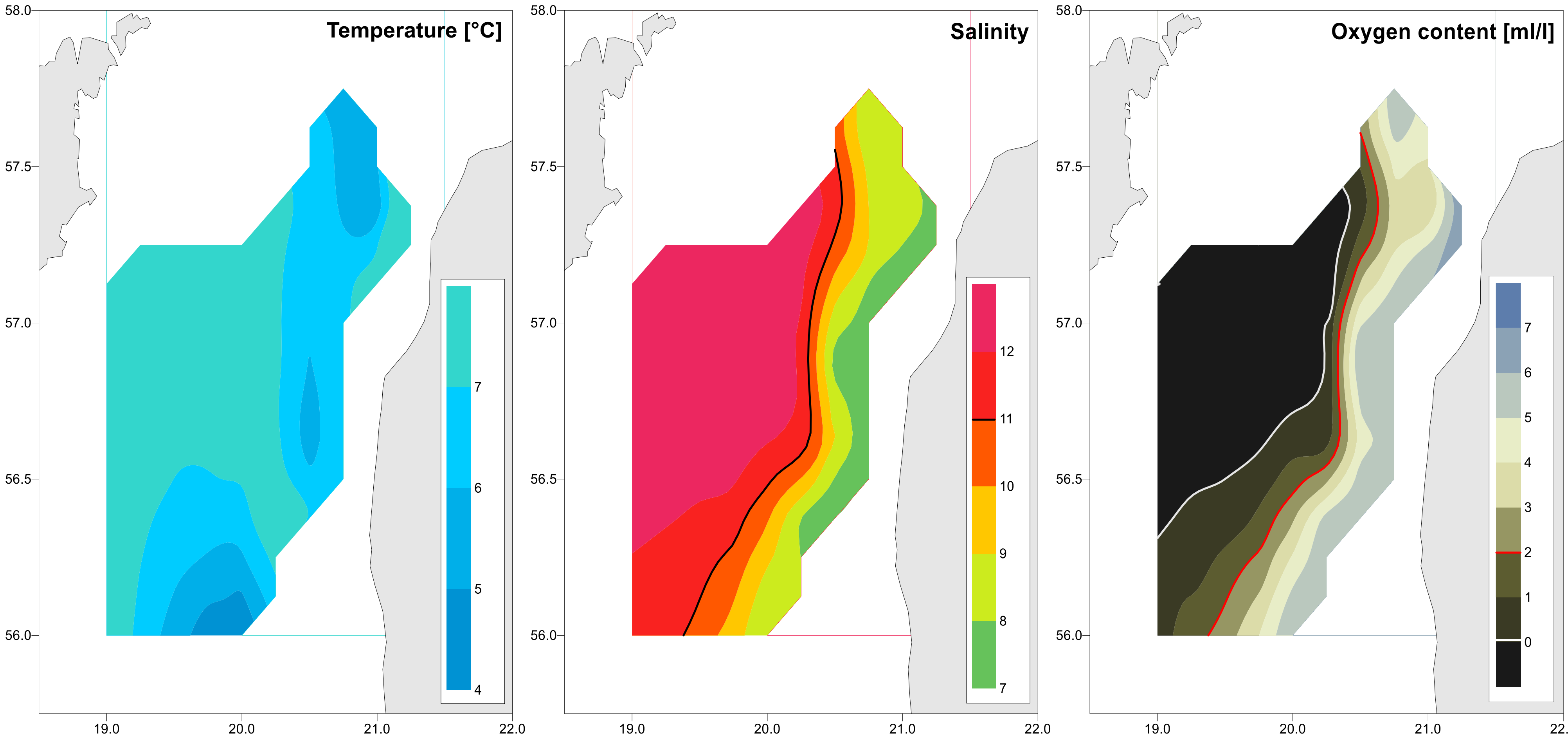

Figure 14: Horizontal distribution of the main hydrological parameters (temperature, salinity, oxygen content) measured in the bottom water layer of the Gotland Deep in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 12-21.10.2021.

MARINE RESEARCH INSTITUTE, KLAIPEDA UNIVERSITY

RESEARCH REPORT FROM THE BALTIC INTERNATIONAL ACOUSTIC SURVEY (BIAS) IN THE ICES SUBDIVISION 26 (LITHUANIAN EXCLUSIVE ECONOMIC ZONE) OF THE BALTIC SEA

(Vessel “LBB - 1113”, “NZ55”; 14 - 15.11.2021)

Working paper on the WGBIFS meeting in Cadis, Spain,
04.04-06.04.2022

Vessel “LBB- 1113”

Vessel “NZ55”

Klaipeda, November, 2021
Lithuania

1. INTRODUCTION

The main objective is to assess clupeid resources in the Baltic Sea. The international acoustic survey in October is traditionally coordinated within the frame of the **Baltic International Acoustic Survey (BIAS).** The reported acoustic survey is conducted every year to supply the ICES: Baltic Fisheries Assessment Working Group (WGBFAS) and Fisheries Service under the Ministry of Agriculture of The Republic of Lithuania (FS) with an index value for the stock size of herring, sprat and other species in the Subdivision 26 of the Baltic area.

Lithuanian BIAS surveys organized and realized by the Marine Research Institute delegates on board of the fishing vessel "LBB-1113". Annual verification of herring, sprat and cod stocks size and their spatial distribution in the pelagic zone of the Lithuanian Exclusive Economic Zone (LEEZ) waters with applied an acoustic method, along preselected:

- determination of herring, sprat and cod (usually dominants in catches) proportion by numbers and by mass in pelagic control-catches and an evaluation of their fishing efficiency, i.e., catch per unit effort (CPUE) in the investigated area,
- characteristics of dominants age-length-mass structure, sex, sexual maturation, feeding intensity,
- a preliminary evaluation of herring and sprat new recruiting year-class strength,
- analysis of the vertical and horizontal changes of the basic hydrological parameters (seawater temperature, salinity, oxygen content) in areas inspected by the vessel "LBB-1113".

2. MATERIALS AND METHODS

2.1. Personnel

The main research tasks of the BIAS survey on board of the vessel "LBB-1113" were realized by the Marine Research Institute two members of the scientific team. The group of researchers was composed of:

M. Špėgys, MRI KU, Klaipeda - cruise leader and acoustics;

J.Fedotova MRI KU, Klaipeda – scientific staff and fish sampling.

2.2. Narrative

The cruise of BIAS survey took place from 14 to 15th of November 2021. The cruise was intended to cover parts of ICES subdivisions (SD) 26, constituting the Lithuanian Exclusive Economic zone in 40H0 and 40G9 rectangles.

2.3. Survey design

The statistical rectangles were used as strata (ICES, 2017). The area is limited by the 20 m depth line. The scheme of transects is defined as the regular. The average speed of a vessel for the period of acoustic survey was 8 knots. The average speed of the vessel with a trawl was 2.8 knots. Duration of trawling was 30 minutes. The survey was conducted in the daytime from 08.00 up to 20.00. The survey area was 1520 nm2 and the distance used for acoustic estimates was 129 nm. The entire cruise track with positions of the trawling is shown in Fig. 1.

2.4. Calibration

The SIMRAD EK60 echo sounder with split beam transducer ES38 - 12 was calibrated (30 of September 2021) at the site of 30 m depth, located 3.5 nm northwest of Klaipeda harbor according to the BIAS manual (ICES, 2017). Sv correction after calibration was set to 21.94 dB.

THE RESULTS OF CALIBRATION PROCEDURE FOR EK60 SCIENTIFIC ECHOSOUNDER	
Date: 28.04.2014	Place : near Klaipeda port
Type of transducer	Split – beam for 38 kHz
Gain (38 kHz)	21.94 dB
Athw. Angle Sens	12.5
Along. Angle Sens	12.5
Athw. Beam Angle	12.06
Along. Beam Angle	11.96
Athw. Offset Angle	0.08
Along. Offset Angle	-0.15
SA Correction (38 kHz)	-0.18 dB

2.5. Acoustic data collection

The acoustic sampling was performed around the clock. The main pelagic species of interest were herring and sprat. The SIMRAD EK60 echo sounder with hull mounted 38 kHz transducer ES38-12 was used during the cruise. The specific settings of the hydro acoustic equipment were used as described in the BIAS manual (ICES, 2017). The post-processing of the stored echo signals was made using the EchoView 11 (Myriax, Hobart; 2005). The mean volume back scattering values Sv, were integrated over 1 nm intervals, from 10 m below the surface 1 m to the bottom. Contributions from air bubbles, bottom structures and noise scattering layers were removed from the echogram using EchoView 11.

2.6. Biological data – fishing stations

All trawling was done with the pelagic gear in the midwater as well as near the bottom. The mesh size in the cod end was 10 mm. The intention was to carry out at least two hauls per ICES statistical rectangle. The trawling depth was chosen by the echogram, in accordance to the characteristic of echo records from the fish. Normally, the trawl had vertical opening of about 12 m. The trawling time lasted 30 minutes. Caught fishes, before the length measurements, were separated by species and weighed, and the species catches proportion as well as the CPUE was determined for given species from each haul. The sample of fish from each catch-station was taken for the length-mass structure analyses. Fish sampling of the total length distribution and the mean mass at the 0.5-cm classes - in the case of clupeids and 1-cm classes in the case of cod were determined. From each haul sub-samples were taken to determine length and weight composition of fish. Samples of herring and sprat were analyzed for further investigations on the board of vessel (i.e., sex, maturity, age).

2.7. Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers in combination with other species, so that it is impossible to allocate the integrator readings to a single species. Therefore, the species composition was based on the trawl catch results. For each rectangle the species composition and length distribution were determined as the mean - weighted of all trawl results in this rectangle. From these distributions the mean acoustic cross section was calculated according to the following target strength-length (TS) relationships:

Clupeoids $TS = 20 \log L \text{ (cm)} - 71.2$ (ICES 1983/H:12)

Gadoids $TS = 20 \log L \text{ (cm)} - 67.5$ (Foote et al. 1986)

The total number of fish (total N) in one rectangle was estimated as the product of the mean area scattering cross section (Sa) and the rectangle area, divided by the corresponding mean cross section (σ). The total numbers were separated into herring and sprat according to the mean catch composition.

3. RESULTS

3.1. Biological data

1283 herrings, 1353 sprats, 5 flounders and 27 twite-shads were measured in 7 hauls. Totally 287 individuals of sprat and 438 of herring were biologically analyzed (age, sex, maturity, stomach fullness). The results of the catch composition are presented in Table 1. Ichthyologic analyses were performed directly on board of surveying vessel, according to the ICES WGBIFS standard procedures. The numerical share of juvenile, undersized (below minimum landing/protective size) sprat and herring in the samples was determined based on fish length distribution results. For sprat, the minimum commercial size (the separate length) is equal to 10.0 cm, for herring is equal to 16.0 cm.

The length distributions of herring and sprat in BIAS survey show in Fig. 2 and 3. Sprat dominated only in 2-3 trawl catches – 61-98%. In other catches (1, 4-7 trawls) dominated herring. Most of herring were fish 2-4 years and 15.1 -17.6 length classes in the both rectangles.

In the rectangle 40H0 25.6% of sprat was represented by fish of last year generation (0 years and 8.5 cm length class). In the western part of LEEZ (40G9 rectangle ICES) more than 60% of sprat was adult fish 11.5-12.1 cm length and 4-5 ages. In the 40G9 rectangle young fish of was only about 2.3%.

3.2. Acoustic data

The survey statistics concerning the survey area, the mean Sa, the mean scattering cross-section σ, the estimated total number of fishes, the percentages of herring, sprat per rectangle are shown in Table 2-14.

3.3. Abundance estimates

BIAS survey statistics (aggregated data for herring and sprat) of total abundance herrings and sprats are presented in Tables 2-4. The estimated age composition of sprat and herring are given in Tables 5, 10. The estimated number sprat and herring by age group and rectangle are given in Table 6, 11. The estimates of sprat and herring biomass by age group and rectangle are summarised in Table 7, 12. The corresponding mean weights and mean length by age group and rectangle for each species are shown in Table 8-9 and 13-14.

The herring stock was estimated to be $781.7*10^6$ fish or about 23547 tones. (Fig. 4 and Table 8).

The sprat stock was estimated $209,7*10^6$ fish or about 2145,3 tones. (Fig. 5 and Table 5).

Comparison of the acoustic results from last years (2010-2021) indicated that herring stock abundance have decreasing tendency in the LEEZ. And only in 2018 was recorded the highest average parameters of the herring stock densities in the rectangle 40H0 (Fig.4).

3.4 Hydrologic data

The basic hydrological parameters (seawater temperature, salinity and oxygen contents) were measured from surface to the bottom after every haul if weather conditions were favorable. Totally, 7 hydrological stations were making. The hydrological and hydrobiological profile location is presented in Table. 15.

Water temperature in hauls was from 5.7 to 10,17 ºC. Differences between the first haul and others caused by wind direction. Wind direction was west in the begin of cruise. Later wind direction changed to south-west. There was no thermocline in 2021 of November. Salinity was about 7.0 ‰ in all hauls and depts. The oxygen-condition was excellent in all hauls and depts.

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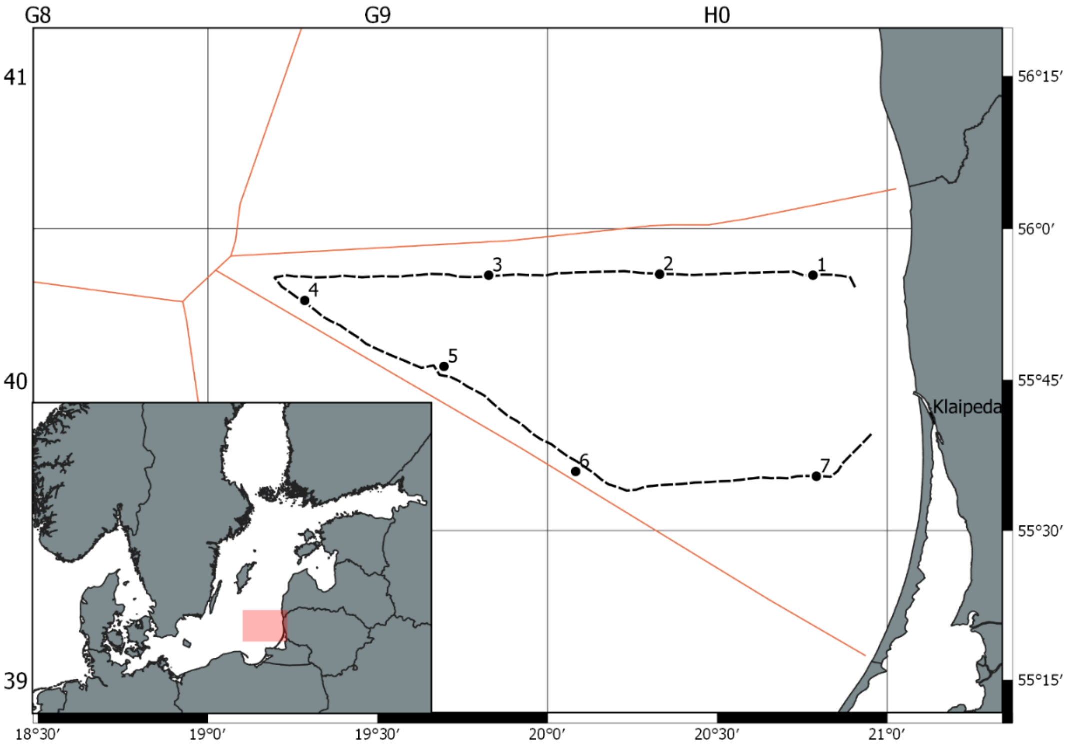

Figure 1. The survey grid and trawl hauls position of F/V “LLB-1113” (14-15 November 2021)

Table 1 Catch composition (kg/1hour) per haul (F/V "LBB-1113", 14-15.11.2021)

ICES Subdivision							
Haul No	1	2	3	4	5	6	7
Date	14.11.2021	14.11.2021	14.11.2021	14.11.2021	15.11.2021	15.11.2021	15.11.2021
Validity	Valid	Valid	Valid	Valid	Valid	Valid	Valid
Species/ICES rectangle	40H0	40H0	40G9	40G9	40G9	40H0	40H0
Clupea harengus	1,216	0.166	0.265	200.0	777.494	83.160	76.0
Sprattus sprattus	0,868	160.0	0.407		22.506	6.840	
Platichthys flesus		1.580					
Twite shad							1.778

Total	2.084	161.75	0.672	200.0	800.0	90.0	77.778

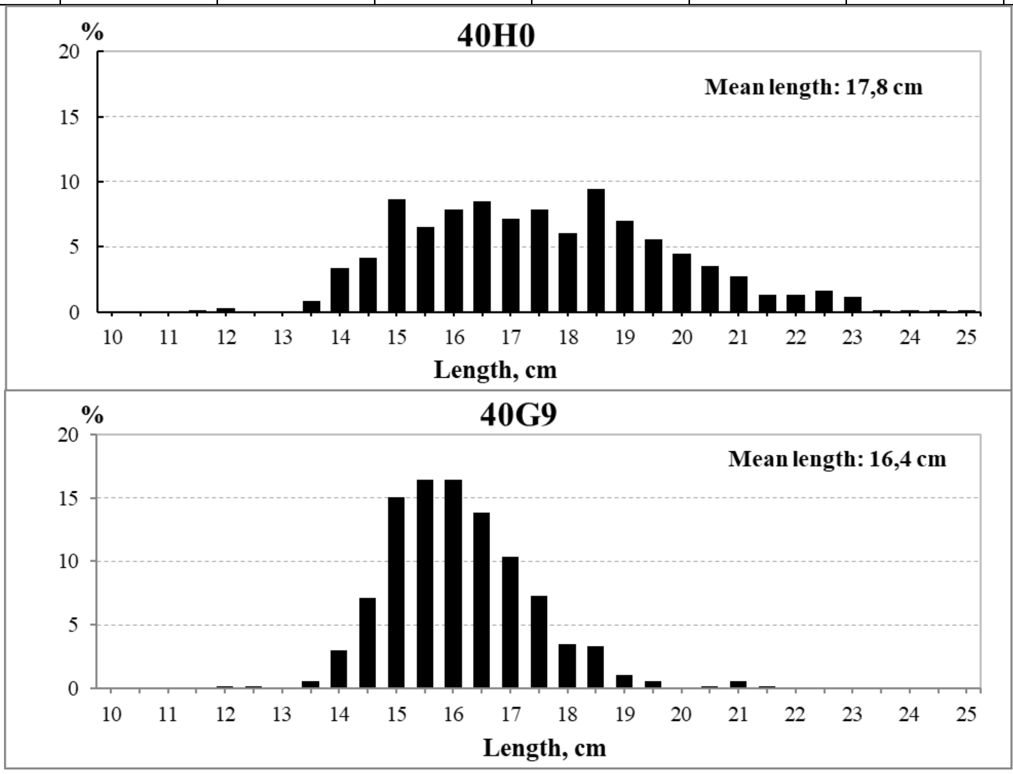

Figure 2 Length distribution of herring (%) (BIAS, 14.11- 15.11.2021)

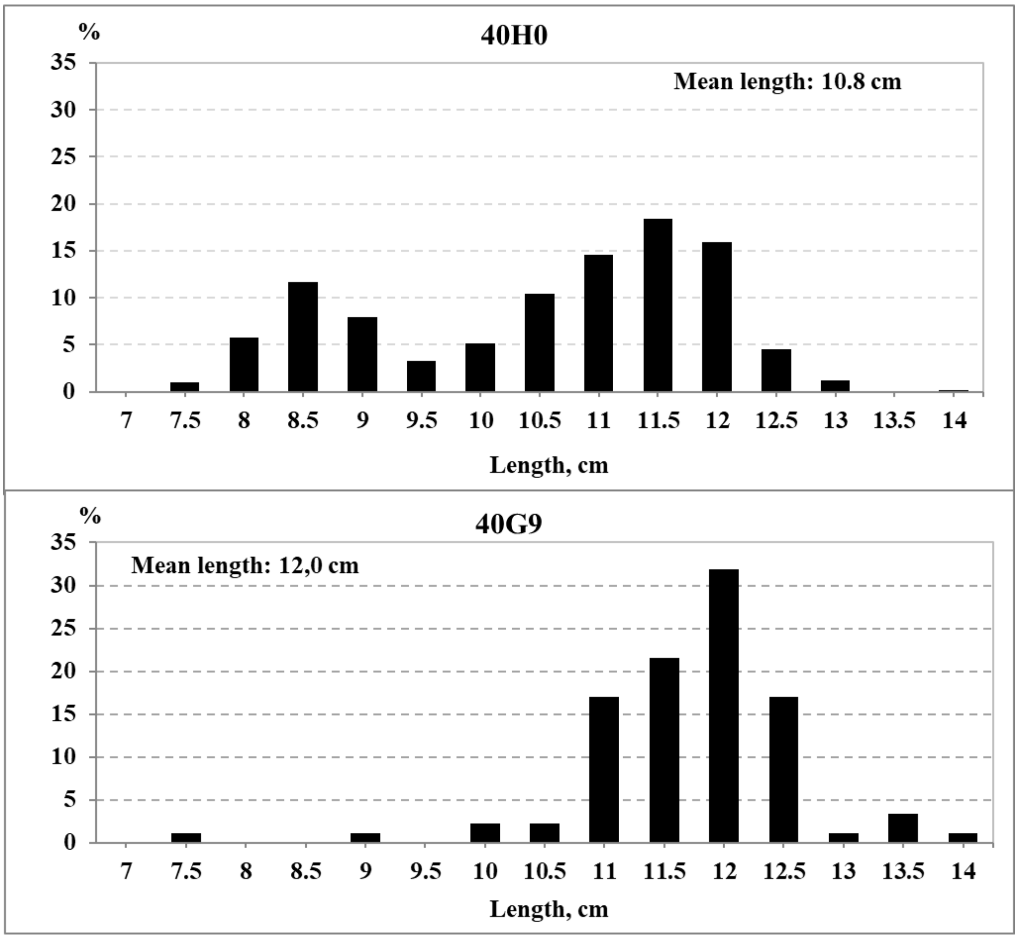

Figure 3 Length distribution of sprat (%) ((BIAS, 14.11- 15.11.2021)

Table 2 BIAS survey statistics (abundance of herring and sprat), 14.11- 15.11.2021

ICES SD	ICES Rect.	Area nm^2	ρ mln/nm^2	Abundance, mln			Biomass, tonn		
				N sum	N her	N spr	W sum	W her	W spr
26	40H0	1012.1	0.29	288.9	162.2	126.7	7310	6153	1158
	40G9	1013.0	0.69	702.5	619.5	83.0	18382	17394	988

Table 3 BIAS survey statistics (aggregated data of herring and sprat), 14.11- 15.11.2021

ICES SD	ICES Rect.	No trawl	Herring			Sprat			SA m^2/nm^2	TS calc. dB
			L, cm	w, g	Numb.,%	L, cm	w, g	Numb.,%		
26	40H0	1,2,6,7	17.81	37.94	56.14	10.79	9.14	43.86	63.4	-47.5
	40G9	3,4,5	16.36	28.08	88.19	11.98	11.90	11.81	168.2	-47.1

Table 4 BIAS survey statistics (herring and sprat), 14.11- 15.11.2021

ICES SD	ICES Rect.	Area nm^2	SA m^2/nm^2	σ *10^4 nm^2	Abundance mln.	Species composition (%)	
						herring	sprat
26	40H0	1012.1	63.4	2.21994	288.9	56.14	43.86
	40G9	1013.0	168.2	2.42512	702.5	88.19	11.81

Table 5 BIAS survey estimated age composition (%) of sprat, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	100.0	25.6	5.1	4.9	14.8	31.6	15.5	1.9	0.4	0.2
	40G9	100.0	2.3	0.0	3.4	13.6	27.3	37.5	10.2	3.4	2.3

Table 6 BIAS survey estimated number (millions) of sprat, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	126.7	32.4	6.5	6.3	18.7	40.0	19.7	2.4	0.5	0.3
	40G9	83.0	1.9	0.0	2.8	11.3	22.6	31.1	8.5	2.8	1.9

Table 7 BIAS survey estimated biomass (in tons) of sprat, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	1158	148	43	50	176	446	248	35	8	4
	40G9	988	8	0	26	115	255	390	117	46	31

Table 8 BIAS estimated mean weights (g) of sprat, 14.11- 15.11.2021

SD	Rect.	Age									
		Mean	0	1	2	3	4	5	6	7	8
26	40H0	9.14	4.6	6.6	8.1	9.4	11.1	12.6	14.7	15.7	17.0
	40G9	11.90	4.05		9.2	10.2	11.3	12.5	13.7	16.2	16.4

Table 9 BIAS estimated mean length (cm) of sprat, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	10.8	8.5	9.4	10.1	10.7	11.4	12.1	12.7	13.0	14.0
	40G9	12.0	8.3		10.5	10.9	11.5	12.1	12.5	13.3	13.8

Table 10 BIAS estimated age composition (%) of herring, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	100.0	0.5	1.8	28.3	18.2	14.2	10.7	14.3	10.5	1.4
	40G9	100.0	0.3	0.9	22.9	32.3	17.7	13.0	9.6	1.5	2.0

Table 11 BIAS survey estimated number (millions) of herring, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	162.2	0.8	2.9	45.9	29.6	23.0	17.4	23.2	17.1	2.3
	40G9	619.5	1.9	5.7	141.8	200.1	109.4	80.2	59.2	9.1	12.1

Table 12 BIAS survey estimated biomass (in tons) of herring, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	6153	9.1	71.4	1340.5	958.6	864.1	828.5	1057.5	871.4	151.3
	40G9	17394	22.4	104.6	3353.3	5387.5	3167.0	2610.2	1970.1	367.0	412.4

Table 13 BIAS survey estimated mean weights (g) of herring, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	37.9	11.8	24.3	29.2	32.4	37.5	47.7	45.6	51.1	65.4

	40G9	28.1	11.9	18.5	23.6	26.9	29.0	32.5	33.3	40.3	34.1

Table 14 BIAS survey estimated mean length (cm) of herring, 14.11- 15.11.2021

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	17.8	12	15.2	16.1	16.7	17.6	19.2	18.8	19.8	21.4
	40G9	16.4	12	13.7	15.1	15.9	16.4	17.2	17.2	18.0	17.4

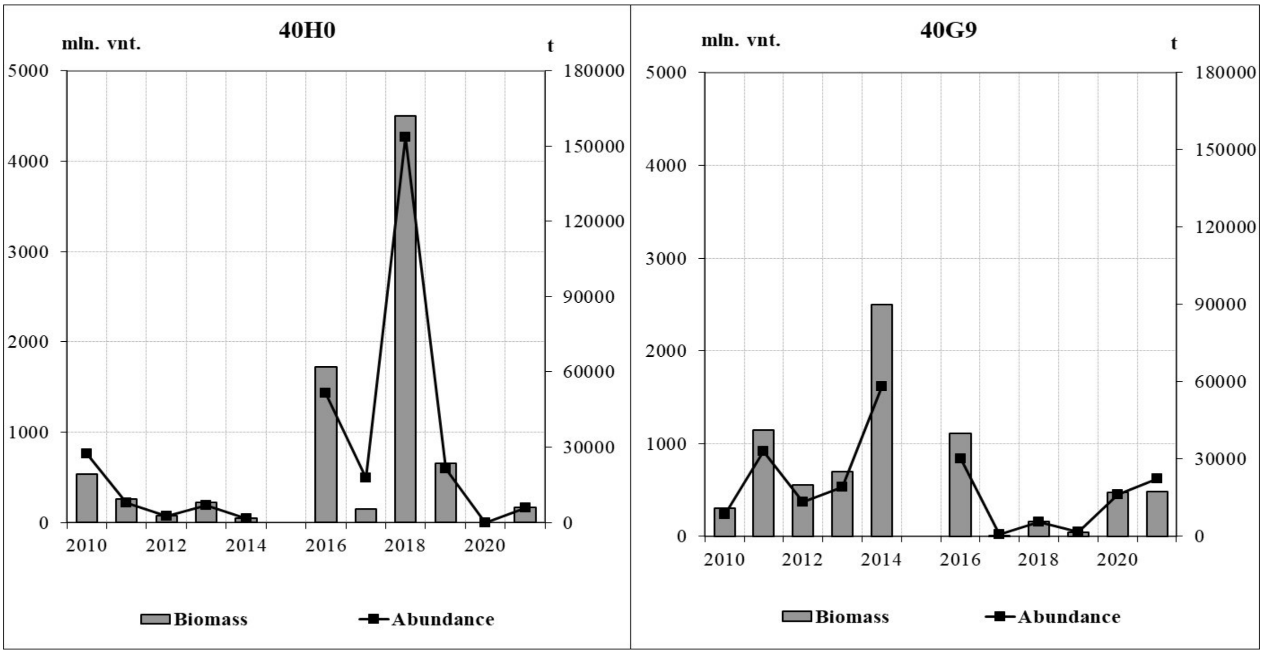

Figure 4 Biomass and abundance of herring by acoustic survey results from BIAS of 2010 – 2021 in ICES rectangles 40H0 and 40G9

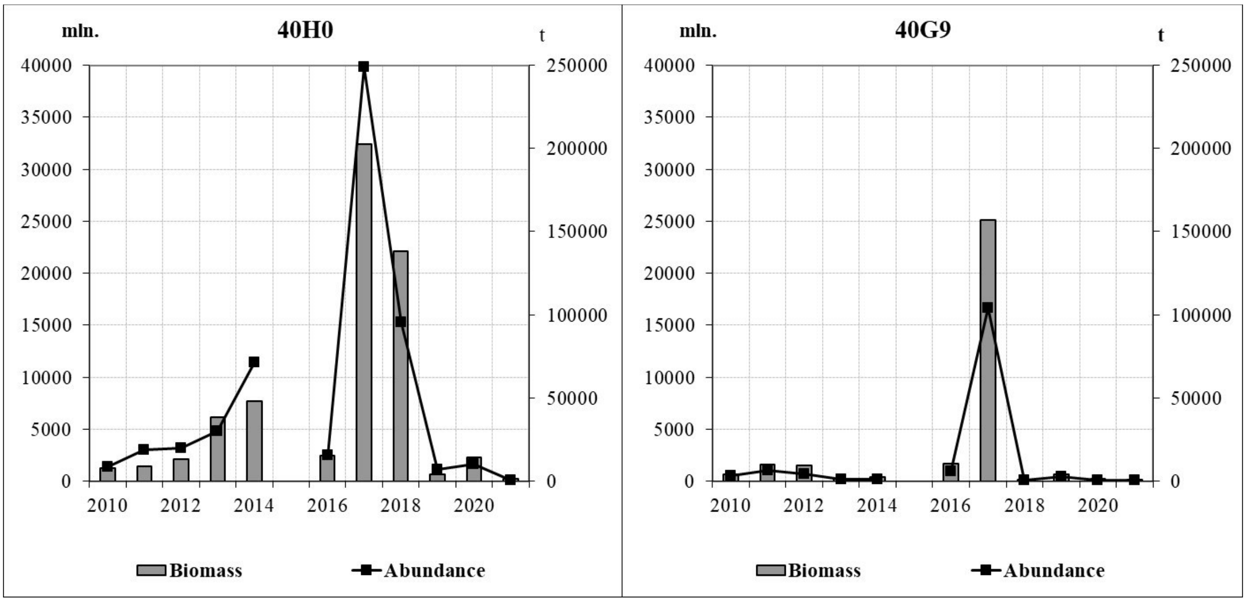

Figure 5. Biomass and abundance of sprat by acoustic survey results from BIAS of 2010 – 2021 in ICES rectangles 40H0 and 40G9

Table 15. The values of hydrological parameters registered at the catching depth in the Baltic Sea ICES SD from the Lithuanian BIAS survey conducted by f/v "LBB-1113" in the period of 14-15.11.2021

Haul number	Date of catch	Trawling depth, m	Hydrological parameters		
			Temperature, °C	Salinity, ‰	Oxygen, ml/l
1	14.11.2021	30	10.17	8.01	7.47
2	14.11.2021	44	9.97	7.63	7.52
3	14.11.2021	63	8.15	7.62	7.86
4	14.11.2021	72	6.18	7.58	8.24
5	15.11.2021	73	8.32	7.59	7.82
6	15.11.2021	78	9.12	7.6	7.68
7	15.11.2021	46	5.7	7.58	8.35
Average			8.23	7.66	7.85

Working paper on the WGBIFS on-line meeting , 04-06.04.2022

Research report from the Polish part of the Baltic International Acoustic Survey on board of the r.v. "Baltica" (13-29.09.2021)

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INTRODUCTION

The Polish BIAS/2021 survey was conducted in the framework of the ICES International Baltic Acoustic Surveys (IBAS) long-term programme including spring (Sprat Acoustic Survey SPRAS) and autumn (Baltic International Acoustic Survey BIAS) acoustic surveys. The ICES Baltic International Fish Survey Working Group (WGBIFS) coordinates methods of investigations, the timing of surveys, spatial allocation of vessels and the general pattern of pelagic hauls distribution in the Baltic, regarding both types of acoustic surveys, i.e. SPRAS and BIAS. The above-mentioned working group is also responsible for the compilation of international results needed for the assessment of clupeids stocks size in the Baltic. The set of input data and recommendations are next transferred to the ICES Baltic Fisheries Assessment Working Group (WGBFAS) for the final evaluation of fish stocks size.

The reported Polish BIAS/2021 survey was conducted on board of the r.v. "Baltica" inside the Polish and partly the Danish EEZ, in the period of 13-29.09.2021. The Polish Fisheries Data Collection Programme for 2021 and the European Union (the European Parliament and the Council Regulation (EU) 2017/1004 of 17 May 2017 and the Commission Implementing Decision (EU) 2019/909 of 18 February 2019) financially supported the Polish BIAS survey marked with internal No. 16/2021/MIR-PIB.

The survey was focused on monitoring of clupeids and cod spatial-seasonal distribution in the pelagic zone of the southern Baltic (parts of the ICES Subdivisions 25 and 26), and preliminary estimation of herring and sprat 2021 recruiting year-class abundance. The EK60 SIMRAD acoustic system with newly determined calibration parameters was applied to complete the BIAS survey tasks.

The main goal of the current paper is a brief description of results of analysis focused on sprat, herring and cod stocks size (biomass, abundance) changes and their spatial distribution as well as the CPUE variation within the surveyed part of the southern Baltic in autumn 2021. Moreover, the paper contains a description of sprat, herring and cod selected biological parameters variation. The principal hydrological parameters fluctuation in the water column of the southern Baltic are also described.

MATERIAL AND METHODS

Research team personnel

The main research tasks of the Polish BIAS/2021 survey on board of the r.v. "Baltica" were realized by the NMFRI (Gdynia) nine members of the scientific team, with Beata Schmidt as a cruise leader. The group of researchers was composed of:
Beata Schmidt – hydroacoustician,
Katarzyna Spich - hydroacoustician,
Julia Gutkowska – ichthyologist, sprat analyses,
Grzegorz Modrzejewski – technician, sprat analyses,
Krzysztof Koszarowski – ichthyologist, herring analyses,
Wojciech Deluga - technician, herring analyses,
Krzysztof Radtke - ichthyologist, cod and other fish species analyses,
Ireneusz Wybierala – technician, cod and other fish species analyses,
Bartosz Witalis – hydrologist.

The course of the cruise

The r.v. "Baltica" left Gdynia port on 13.09.2021 at 09:00 a.m. and was navigated in the south-east direction. At the mouth of the Vistula River a successful calibration of the acoustic system SIMRAD EK60, installed on the vessel, was carried out. On the same day, acoustic integration and pelagic hauls were started on transects located in the southern part of the Gulf of Gdansk which were continued on the transects in the Gdańsk Basin in the following days. On the 18th of September, due to bad weather conditions that prevented further research at the current position (λ = 016°20,0'E, ϕ = 55°11,5'N), the measurements were interrupted and the ship was moved west. On the 19th of September, at the most west position (λ = 015°00.0'E, ϕ = 54°30.0'N), the acoustic integration and pelagic hauls were resumed in the east direction. Another deterioration of weather conditions prevented the works from the 23rd to the 25th of September. Works resumed on the 26th of September and continued in the following days in the area of the Słupsk Furrow. The acoustic recording was completed on the 28th of September at 05:20 p.m. The r.v. "Baltica" returned to the Gdynia port on the 29th of September 2021 at 07:00 a.m.

Survey design and realization – sampling description

Almost all the ICES statistical rectangles, assigned by the ICES-WGBIFS as mandatory to Poland (ICES, 2021), were fully covered with the standard acoustic-biotic research during BIAS 2021 cruise (Fig. 2). The only one designated as mandatory, namely 38G6, was covered only partly due to the fact that most of the area of this rectangle was closed for fishery and research due to military exercises (red polygon in Fig. 2). Two ICES rectangles, namely 38G9 and 39G9, which were allocated to Poland as optional, were covered with the standard research only inside the Polish EEZ.

The SIMRAD EK60 version 2.2.0, a split-beam scientific echosounder, linked with the GPT transceivers, operating at 38 and 120 kHz frequencies, as in the previous years, was used in the recent Polish BIAS 2021 survey. Calibration of the vessel's acoustic system was performed on the 13th of September 2021 at the following location: λ = 019°01.6'E, ϕ = 54°26.1'N over seabed depth of 55 m (Fig. 2). The echosounder calibration was performed as described in Simrad (2012) using the copper spheres of diameters 60 mm for 38 kHz and 120 kHz frequencies respectively as reference targets. Unfortunately, due to deteriorating weather conditions, the calibration of the 120 kHz transducer was not completed. The calibration results for 38 kHz obtained in September 2021 were considered good based on the calculated RMS value which was 0.09 dB (Fig. 1).

The acoustic sampling was performed along the pre-selected acoustic transects at a distance of 715 NM. The echo-integration data were collected in a daytime regime at the shipping speed of 7-8 kn. Because of the historical comparability of data, pre-selected echo-integration transects were planned in a similar pattern as in recent years. The survey effort was comparable to previous years.

The settings of the hydroacoustic equipment were as described in the IBAS Manual (ICES, 2017). The post-processing of the stored raw data was done using the Echoview software (www.echoview.com). Only 38 kHz transmitter's data were taken into further processing because that frequency is recommended for fish trace recording. The acoustic analysis was carried out taking into account the new calibration constants determined during the calibration. In the first step of acoustic data checking, all visible interferences from the sea surface, turbulences and bottom structures visible on the echogram were excluded from further analysis. The minimum threshold on mean volume backscattering strength S_v was set to -60 dB. Calculation of parameter S_A [m^2NM^{-2}] (hereinafter called NASC - Nautical Area Scattering Coefficient) for 1 nautical mile elementary standard distance units (ESDUs) was carried out by integrating S_v values (in a linear domain) from 10 m below the sea surface to about 0.5 m over the seafloor and then averaged within 1 NM interval. Then the mean NASC per the ICES rectangles were calculated. Also, weighted mean NASC per the ICES Subdivisions were calculated with the use of the size of investigated areas as weight.

Overall 29 catch-stations (16 in the ICES Subdivision 25 and 13 in the ICES Subdivision 26) were conducted by the r.v. "Baltica" in the period of 13-29.09.2021 (Fig. 2, Table 3), using the herring small-meshed pelagic trawl type WP53/64x4, with 6 mm mesh bar length in the codend. All pelagic catches were accepted as representative from a technical point of view. The trawling depth was chosen by echo distribution, visible on the screen of the echosounder. Because of a relatively high vertical opening (up to 20 m) of applied pelagic trawl, the areas shallower than 30 m were not investigated by the trawls. The trawling time for most hauls was 30 minutes. In two cases the hauls were performed in two layers. The mean speed of the surveying vessel during trawling ranged from 2.9 to 3.3 knots. Fish catches were localized at a depth ranging from 13 to 80 m from the sea surface (position of the headrope of the trawl). At trawling positions, depth to the bottom varied from 37 to 107 m.

Fish caught in each haul were separated by species and weighted. The results of catch per unit effort (CPUE) of dominated fish species and their mean share in the r.v. "Baltica" pelagic catches are presented in Table 3 and Figs 5-7. The samples for sprat, herring, and cod were taken for length, age, and mass measurements. Fish total length distribution (Fig. 8) and the mean mass were determined in the 0.5-cm classes - in the case of clupeids and 1-cm classes in the case of cod. The numerical share of juvenile, undersized (below minimum landing/protective size) sprat, herring and cod in samples was determined (Table 4) based on fish length distribution results. For sprat, the minimum commercial size (the separate length) is equal to 10.0 cm, for herring is equal to 16.0 cm and for cod is 35.0 cm.

Detailed ichthyological analyses were made according to standard procedures (Anon., 2012), directly on board of surveying vessel. Overall, 29, 29 and 13 representative samples were taken for the length and mass determination of sprat, herring and cod, respectively. The length and mass were measured for 5138 sprat, 6453 herring and 114 cod individuals. Respectively, 564, 716 and 114 individuals of the above-mentioned species were biologically analysed (sex, maturity, stomach fullness and age).

Before each haul and at the standard hydrological stations located within the Polish EEZ, the seawater temperature, salinity, and oxygen content were measured continuously from the sea surface to the seabed. In total 39 hydrological stations were inspected using the CTD SeaBird 911+ probe combined with the rosette sampler. Oxygen content was determined by applying standard Winkler's method. The hydrological raw data, aggregated to the 1-m depth stratum, were the source of information about the abiotic factors potentially influencing the spatial distribution of fish. The basic meteorological parameters i.e. air temperature, air pressure, wind direction and force, and sea state were registered at each catch-station with the automatic station MILOS 500.

Data analysis

Due to the inability to distinguish herring and sprat from other species by visual inspection of the echogram, therefore species composition and fish length distributions from trawl catch results are used to aid acoustic species identification. Such data analysis is sectioned according to the ICES statistical rectangles. For each ICES rectangle, based on trawl results performed within, the share of all fish species numbers and its length distribution, as the unweighted mean, were calculated. Our intention was to carry out at least two pelagic hauls per ICES rectangle, according to the guidelines in the "SISP Manual of International Baltic Acoustic Surveys (IBAS)" (ICES, 2017). In the case of missing hauls within an individual ICES rectangle, haul results from neighbouring rectangles were used. This concerns the ICES rectangle 38G7 and 39G9 where no hauls were performed. Also, some hauls that were performed on the border of the two rectangles were assigned to both of them. The assignment of hauls carried out during BIAS 2021 cruise to the ICES Subdivisions and rectangles are presented below:

Subdivision (SD)	ICES rectangle	Haul no.
25	37G5	13,17,18
25	38G5	14,15,16
25	38G6	19
25	38G7	23*,26*,29*
25	39G6	20,21,22*,23*
25	39G7	22,23,25,26,27,28,29
26	37G8	3
26	37G9	1,2
26	38G8	4,11
26	38G9	5,6
26	39G8	7,9,10,12,25*,26*
26	39G9	7*
26	40G8	8,24

* haul performed in neighboring ICES rectangle and included in the calculation for that rectangle

Based on species distributions the mean acoustic cross section σ was calculated according to the following target strength-length (TS) relation:

	TS	References
Clupeids	= 20 log L (cm) - 71.2	ICES 1983/H:12
Gadoids	= 20 log L (cm) - 67.5	Foote et al. 1986
Scomber scombrus	= 20 log L (cm) - 84.9	ICES 2017
Salmonids and 3-spined stickleback were assumed to have the same acoustic properties as Clupeids. Fish without swim bladder were assumed to have the same acoustic properties as *Scomber scombrus.*		

The total number of fish in each ICES rectangle was estimated as a product of the mean NASCs from scrutinized acoustic data and a rectangle area, divided by the corresponding mean acoustic cross-section σ. Clupeids abundance was separated as sprat or herring according to their mean share in catches of given ICES rectangle. In case when the mean numerical share of sprat herring and cod in ICES rectangle exceeded 99%, then other species were excluded from further calculations. Thus, fish species considered in this report are as follows: *Clupea harengus*, *Sprattus sprattus*, *Gadus morhua*, *Gasterosteus aculeatus* and *Scomber scombrus*.

RESULTS

Acoustic results

The spatial distribution of mean NASC values (5 NM intervals), predominantly derived from clupeids, measured on hydroacoustic transects during BIAS 2021 survey is presented in Fig. 3. The highest NASC values were recorded in the southern part of the Gulf of Gdansk (ICES Subdivision 26). The mean NASC values per ICES Subdivisions and rectangles are presented in Tables 1 and 2.

As in the previous year, the average NASC value was higher in the ICES Subdivision 26, it was more than twice as high as the average NASC value for the ICES Subdivision 25. Compared to BIAS 2020, the mean value of NASC was about 50% higher in the ICES Subdivision 25, but it drop by about 10% in the ICES Subdivision 26 (Table 1). The highest mean NASC value per the ICES rectangle was recorded in the ICES Subdivision 26 in the ICES rectangles 37G9 reaching the value 5448.3 m^2NM^{-2} and it is almost twice as high as that recorded in the same rectangle in the previous year (Table 2). However, in the other rectangles of the examined part of the ICES Subdivision 26, the mean NASC values did not exceed the value of 300 m^2NM^{-2}. In the ICES Subdivision 25, the highest mean NASC value (246.4 m^2NM^{-2}) was obtained for the ICES rectangle 38G5 (Bornholm Basin).

Fish catches, biological parameters and stocks size

In September 2021 nine fish species were recorded in 29 scrutinized pelagic hauls conducted in the Polish and Danish parts of the ICES Subdivisions 25 and 26 (Table 3, Fig. 2). In total, 6265.6 kg of fish were caught, and the mean share of sprat, herring, cod and all other fish species calculated for the whole survey was 33.66, 65.29, 0.89 and 0.17%, respectively. Haul without any fish did not occur. Neither marine mammals nor any seabirds were detected in the catches.

Sprat dominated by mass in hauls and herring was the second species in terms of mass with the mean CPUE in the entire study area amounted to 329.55 and 190.69 $kg·h^{-1}$, respectively. Sprat and herring occurred in each of the pelagic hauls performed. Cod can be considered as a significant bycatch in accomplished pelagic trawl catches (Table 3, Figs. 5-7). The appearance of cod was noticed in 45% of the hauls. The mean CPUE of cod in all investigated marine waters was 2.73 $kg·h^{-1}$. In the ICES Subdivision 26, sprat dominated by the total standardised mass (6665.5 kg), the mean CPUE (512.7 $kg·h^{-1}$), while the mean share of the mass calculated from the individual shares of sprat mass in 13 hauls realised inside the Polish subdivision was 32.6%. The above-mentioned catch results were significantly lower for sprat caught in the ICES Subdivision 25 and amounted to 2891.6 kg, 180.7 $kg·h^{-1}$ and 34.5%, respectively in 16 hauls.

Sprat highest CPUE (Fig. 5) was obtained in a few single research catches conducted, e.g.: in the southern part of the Gulf of Gdańsk (1682.7 and 1592.6 $kg·h^{-1}$) and the north-eastern part of ICES Subdivision 26 (ICES rectangle 40G8) – 1454.0 $kg·h^{-1}$.

Herring was the second in a row regarding CPUE. However, in terms of the mean share of the mass calculated from the individual shares of herring mass in hauls, the species evidently dominated in the total weight of caught fishes (Figs. 5-7). The mean share of herring in the ICES Subdivisions 26 and 25 was 66.1% and 64.6%, respectively. The mean CPUE of this species in the above-mentioned areas was 170.8 and 206.9 $kg·h^{-1}$, respectively. In the ICES Subdivision 25, the largest concentration of herring was observed in the ICES rectangle 39G5 (586.9 $kg·h^{-1}$). In the ICES Subdivision 26, the highest CPUE was observed in the Polish EEZ (the ICES rectangle 40G8), where it reached 567.9 $kg·h^{-1}$.

The highest CPUE of cod, which amounted to 16.5 kg·h-1, was achieved in a haul accomplished in the most north-eastern part of the Gdańsk Deep (the ICES rectangle 38G9).

The results of some biological features of sprat, herring and cod obtained in September 2021 are presented in Figure 8 and Tables 4, 8, 11, 14. The total length of species dominated in hauls conducted in all the investigated areas ranged as follows:

- sprat – 7.0 - 15.5 cm (avg. l.t. = 12.7 cm, avg. W = 12.1 g),
- herring – 7.5 - 25.0 cm (avg. l.t. = 16.5 cm, avg. W = 28.1 g),
- cod – 7.0 - 50.0 cm (avg. l.t. = 33.9 cm, avg. W = 342.5 g).

The unimodal length distribution curve for sprat in ICES Subdivision 25 in September 2021 was similar to curve characteristic for samples from BIAS/2020 (Fig. 8). The length distribution of sprat in ICES Subdivision 26 in September 2021 was unimodal while in BIAS/2020 the length distribution was bimodal. In September 2021, a single length class dominated in the length distributions (12.5 cm and 12.0 cm in ICES Subdivisions 25 and 26, respectively) representing adult sprat, while in September 2020 the ranges of the dominated length classes were evident, corresponding to ranges 11.0-12.5 cm and 12.5-13.5 cm in the ICES Subdivision 26 and 25, respectively.

In samples from September 2021, there were no apexes evident for young undersized sprat (in Poland determined as <10.0 cm total length) in ICES Subdivisions 25 and 26. However, in September 2020, in samples from the ICES Subdivision 26, the second lower frequency apex, representing young, undersized specimens was visible for sprat from the length classes of 7.5-9.5 cm. This resulted in a higher mean numerical share of undersized sprat in the ICES Subdivision 26 than in the ICES Subdivision 25. The mean bycatch of undersized sprat in the entire study area in 2021 was very low - 0.7% and it was lower as compared to the results from BIAS/2020 – 5.% (Table 4).

For herring samples collected in September 2021, a clear bimodal length distribution occurred in ICES Subdivision 26 while in ICES Subdivision 25 the length distribution was unimodal. In September 2020, the bimodal shape of the length distribution curves was characteristic for samples originated from the ICES Subdivisions 25 and 26 (Fig. 8).

In samples from both subdivisions in September 2020, the apex for larger fish was observed for the length class 17.5 cm, representing adults, commercially sized herring. Also in BIAS 2020, there is very little frequency apex representing young, undersized specimens (length classes 12.5 and 11.0 cm in the ICES Subdivisions 25 and 26, respectively). This resulted in a significantly lower mean numerical share of undersized herring (in Poland determined as <16.0 cm total length) in September 2020 compared to the 2021 year - the mean bycatch of undersized herring in the entire study area was 12.5 and 32.4%, respectively in 2020 and 2021 (Table 4). It is worth to mention that the large share of undersized herring in September 2021 in the whole study area, resulted mainly from the contribution of small herring occurring in Subdivision 26.

The length distribution curves for cod sampled in the ICES Subdivisions 25 and 26 in both BIAS/2020 and BIAS/2021 were multimodal, without any specific length class dominated by frequency (Fig. 8). In 2021, the mean bycatch of undersized cod (determined as <35.0 cm total length) in the entire study area was 56.1% and it was very similar to the previous year – 57.5% (Table 4). However, the number of cod in 2021 was higher than in 2020.

Changes in the mean weight of sprat, herring and cod per age groups according to the ICES rectangles inspected during the BIAS/2021 survey are presented in Tables 8, 11 and 14.

The basic data evaluated in September 2021, including data on Baltic sprat, herring and cod stocks total abundance and biomass per age groups and the ICES rectangles, adequately to echosounding under the frequency of 38 kHz are given in Tables 6, 7, 9, 10, 12 and 13. The above-mentioned materials are strongly linked with data from the Polish BIAS/2021 cruise statistics and average NASC values for acoustically covered ICES rectangles (Table 5). The mean biomass surface density of sprat, herring and cod, per the ICES Subdivisions and the ICES rectangles is reflected in Figs 9, 11, 12. The abundance of the above-mentioned species per age group, according to inspected in autumn 2020 and 2021 parts of the ICES Subdivisions 25 and 26 is demonstrated in Fig. 10.

The recent pattern of sprat surface biomass density distribution per the ICES rectangles was different from the results from autumn 2020 (Fig. 11). In September 2021, the highest mean biomass surface density of sprat stock was estimated for the ICES rectangle 37G9 (located in the south-eastern part of the Gulf of Gdańsk) and amounted to 159.9 $t \cdot NM^{-2}$ (Fig. 11). The minimum value of this parameter was noticed in the central eastern parts of the investigated waters, in the

ICES rectangle 39G9 and amounted to 0.2 kg·NM^{-2}. In 2021 the mean biomass density of sprat in the ICES Subdivision 25 was higher than in 2020 (5.65 and 3.93 t·NM^{-2} in 2021 and 2020, respectively), and was lower in the ICES Subdivision 26 in 2021 (8.87 t·NM^{-2}) than in 2020 (19.11 t·NM^{-2}) (Fig. 9).

Also, the recent pattern of herring surface biomass density distribution per the ICES rectangles can be considered as different to that observed in autumn 2020 (Fig. 11). In September 2021, the highest mean biomass surface density of herring stock was estimated for the ICES rectangle 37G9 (341.3 t·NM^{-2}) which was located in the Gulf of Gdańsk close to the border of Polish and Russian EEZ. In 2021 the mean biomass density of herring in the ICES Subdivision 26 was higher than in 2020, it increased from 13.88 t·NM^{-2} in 2020 to 22.49 t·NM^{-2} in 2021. In the ICES Subdivision 25, a similar situation was observed, the mean biomass density of herring amounted to 8.72 and 12.05 t·NM^{-2} in 2020 and 2021, respectively (Fig. 9).

During the BIAS 2021 cruise, the highest mean biomass surface density of cod was estimated for the ICES rectangle 38G8 (1.45 t NM^{-2}) (Fig. 12). In other rectangles, the mean biomass surface density of cod fluctuated from 0.02 to 0.79 t NM^{-2}. However, in five ICES rectangles, namely: 37G5, 38G7, 37G8, 37G9 and 39G9, the appearance of cod was not detected (Tables 3, 13). In 2021 the biomass density of Baltic cod in the ICES Subdivision 25 was lower than in the ICES Subdivision 26 and amounted to 0.11 and 0.34 t·NM^{-2}, respectively (Fig. 9). Compared to 2020 data, in 2021 mean biomass surface density of cod was similar in both ICES Subdivisions. The differences were ca. 0.05 t·NM^{-2} in ICES Subdivision 25 and ca. 0.03 t·NM^{-2} in ICES Subdivision 26.

Meteorological and hydrological characteristics of the southern Baltic

Changes of the main meteorological parameters – wind velocity and direction, and air temperature in consecutive days of the Polish BIAS survey carried out in 2021 are illustrated in Fig. 13. The air temperature during the reported survey varied from 10.2 to 19.5°C (avg. was 14.9°C). The wind force changed from 1 to 7°B, and winds from the east and north-east direction prevailed. During fishing operations, prevailed the moderate wind (3°B) mostly from east directions (Table 15).

The main hydrological parameters at the depths of fish pelagic catches (Table 15), i.e. in the range of 22-90 m (with 18 m vertical net opening on average) changed in the relatively broad ranges. The seawater temperature fluctuated from 4.7 to 16.8°C (the mean was 6.7°C), salinity from 7.5 to 13.9 PSU (the mean was 9.0 PSU) and oxygen content from 0.2 ml l^{-1} at haul No. 6 (the Gdansk Deep) to 7.1 ml l^{-1} (the mean was 5.3).

The surface water hydrological parameters changed in relatively narrow ranges: 13.7-18.4°C, 6.3-7.5 PSU and 5.9-7.8 ml l^{-1} for temperature, salinity, and oxygen content respectively. The horizontal distribution of the seawater temperature, salinity, and oxygen content in the near bottom zone of the southern Baltic (within the Polish waters) is illustrated in Fig. 14.

The temperature in the near-bottom layer was changing horizontally within the range of 4.9-14.6°C and the mean was 6.8°C. The lowest seawater temperature was recorded at catch-station No. 4 and the highest at the hydrographical station No. 61. Salinity in the bottom waters varied from 7.4 PSU – noticed at the hydrographical station No. 61, to the maximum of 15.9 PSU - noticed at the hydrographical station No. IBY5 (the Bornholm Basin). Oxygen content near the bottom of deep waters varied from 0.00 ml l^{-1} – measured at the hydrological station No. G2 and 10GD (in the Gdansk Deep at depth 105 and 90m respectively) to the maximum of 6.9 ml l^{-1} – calculated at the hydrological station No. UW1 (at depth 35m).

The vertical distribution of the seawater temperature, salinity, and oxygen content, along with the hydrological research profile determined in the southern Baltic during BIAS 2021 survey are presented in Fig. 15. During the survey period, the waters with oxygen content below 2 ml l^{-1} occurred at depth just below 65 m at the Bornholm Basin and Gdańsk Deep (with an anoxic bottom condition in the last). The Słupsk Furrow was well-oxygenated.

DISCUSSION

In September 2021, the total biomass (B1), the mean surface biomass density (B2) and abundance (A) were significantly different between fish species and the ICES Subdivisions:

	parameter	sprat	herring	cod
ICES SD25	B1 (tons)	29051.8	61970.0	564.72
	B2 (t NM^{-2})	5.7	12.1	0.11
	A (10^6 indiv.)	2177.1	2166.8	1.81
ICES SD26	B1 (tons)	42988.9	108973.2	1652.87
	B2 (t NM^{-2})	8.9	22.5	0.34
	A (10^6 indiv.)	4417.6	4258.1	2.81

Compared to autumn 2020, the present estimates show a decrease in sprat biomass (-36.4%) and an increase in the case of herring and cod: 52.6 and 21.3%, respectively. The abundance of sprat and cod has also dropped (Schmidt *et al.,* 2021a).

Overall estimated abundances and biomass per the ICES Subdivisions for sprat, herring and cod indicate that the centre of fish resources temporal distribution during reported the BIAS/2021 survey, in the case of sprat, herring and cod, was located mostly in the ICES Subdivision 26 (Figs. 9, 11, 12).

Compared to BIAS/2020, the abundance of sprat changed in both ICES Subdivisions. In the ICES Subdivision 26, the number of individuals of sprat from year classes 2014-2020 (age groups 7-1 in 2021) decreased. The opposite situation was observed in the ICES Subdivision 25, except year classes 2016 and 2014. Similarly to the results from the BIAS survey from 2020, the sprat abundance and total biomass were higher in the ICES Subdivision 26 than in the ICES Subdivision 25. It indicates that in the ICES Subdivision 26 more sprat was concentrated compared to the ICES Subdivision 25. Considering the total biomass of sprat in each ICES Subdivision, the biomass and abundance of newborns – sprat from age group 0 (year class 2021) were not significant. However, in the ICES Subdivision 26, the biomass of the year class 2019 in 2021 was the highest among all year classes. The share of the biomass of age group 2 in 2021 was 32%. A similar situation was observed in 2020. It can be considered that this year class is abundant. Moreover, it was observed that in the catches in September 2021, in the stomachs of almost 76% of males and 75% of females contained some food, which provides the fact that this time of the year is the feeding season of sprat.

During the BIAS in 2021, the biomass of herring was higher in both ICES Subdivisions, compared to the results from BIAS/2020. One of the explanations can be the fact that in the ICES Subdivision 26 abundance of herring increased in almost all year classes – 1-7 (year classes 2020-2014) and in the ICES Subdivision 25 in the younger classes – 2- 4 (year classes 2019-2017). The biomass of the herring from age group 0 (year class 2021) was not very high in the research area but the share of abundance in the ICES Subdivision 25 was over 28%. The biomass and the abundance of the herring from the age group 2 (year class 2019) were very high in ICES Subdivision 25, however, it was not very noticeable in ICES Subdivision 25. Moreover, the abundance and the biomass of that year class was higher in autumn 2021 than in spring May 2021 (Schmidt *et al.,* 2022). A similar situation was observed in the previous year. In September 2021, year class 2021 was very abundant in the Gulf of Gdańsk (the ICES Subdivision 26). It indicates that the region constitutes nursery grounds for juveniles in autumn.

Compared to September 2020, the abundance and biomass of cod significantly increased in ICES Subdivision 25 - by 124.9 and 73.7%, respectively. Also, in the ICES Subdivision 26, it was noticed that the biomass increased by 10.0 and the abundance decreased by 29.8%. However, as already mentioned, the number of cod in 2021 was lower than in 2020.

Additionally, in the BIAS/2019, the CPUE of three-spined stickleback (*Gasterosteus aculeatus*) was almost 100 $kg \cdot h^{-1}$in one haul, while during the recent survey it was not observed in the catches (Schmidt *et al.*, 2020).

CONCLUSION

The ICES Baltic International Fish Survey Working Group and the Baltic Fisheries Assessment Working Group for the Baltic clupeids and cod stocks size analysis and their spatial distribution characteristics can apply the Polish BIAS/2021 survey data obtained by the r.v. "Baltica" scientific team for stock assessment purposes. Results presented in this paper can be considered as representative for the Polish part of the southern Baltic, namely for the ICES Subdivisions 25 and 26. The acoustic, fisheries, biological and hydrological data collected during the reported survey will be stored in the ICES Data-Centre international databases, managed by the ICES Secretariat and designated experts from WGBIFS.

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Table 1. Weighted mean NASC values (m^2 NM^{-2}) for the Polish/Danish parts of the ICES SDs 25 and 26, calculated with use of areas of ICES rectangles as weight, for BIAS 2020 and 2021 cruises (the NASC values from 2020 from Schmidt *et al.*, 2021a).

ICES SDs	< NASC > BIAS 2020	< NASC > BIAS 2021
25	123.8	186.3
26	372.9	332.7

Table 2. Average NASC values ($m^2 \cdot NM^{-2}$) for the acoustically covered ICES rectangles, during Polish 2020 and 2021 BIAS cruises (the NASC values from 2020 from Schmidt *et al.*, 2021a).

ICES SDs	ICES rectangles	Area [NM^2]	< NASC > BIAS 2020	< NASC > BIAS 2021
25	37G5	642.2	124.7	203.8
25	38G5	1035.7	117.6	246.4
25	38G6	940.2	119.3	133.8
25	38G7	471.7	7.7	194.9
25	39G6	1026.0	181.7	190.2
25	39G7	1026.0	129.0	154.8
26	37G8	86.0	1323.7	82.2
26	37G9	151.6	2830.5	5448.3
26	38G8	624.6	878.9	265.4
26	38G9	918.2	523.0	132.5
26	39G8	1026.0	116.8	128.4
26	39G9	1026.0	40.5	116.7
26	40G8	1013.0	72.7	237.3

Table 3. Fish pelagic catches data from the Polish BIAS survey conducted on board of the r.v. “Baltica” in September 2021.

Haul number	Date of catch	ICES rectangles	ICES SDs	Geographical position of the catch: start latitude N	start longitude E	end latitude N	end longitude E	Mean depth to the bottom [m]	Headrope depth from the sea surface [m]	Vertical net opening [m]	Trawling speed [w]	The ship's course during fishing [°]	Local time of shutting net	Trawling duration [min.]	Total catch [kg]	CPUE of all species [kg h^{-1}]	Catch per species [kg]: sprat	herring	cod	flounder	river lumpray	lumpfish	Atlantic mackerel	lesser sand eel	three spined stickleback
1	2021-09-13	37G9	26	54°25,3'	019°00,7'	54°25,9'	019°03,1'	45	25	18	3.1	065	14:20	30	17.13	34.25	1.506	15.62							
2	2021-09-13	37G9	26	54°25,3'	019°13,0'	54°25,7'	019°11,9'	54	33	19	3.1	305	16:55	15	895.00	3579.99	841.343	53.655							
3	2021-09-14	37G8	26	54°27,3'	018°55,7'	54°28,5'	018°55,0'	56	33	20	2.9	340	09:30	30	43.18	86.36	20.123	22.997		0.058					
4	2021-09-14	38G8	26	54°32,9'	018°55,6'	54°32,8'	018°54,2'	66	42	20	3.2	260	12:25	15	435.81	1743.25	398.155	37.565		0.093					
5	2021-09-15	38G9	26	54°36,0'	019°09,9'	54°35,9'	019°12,3'	82	60	18	3.0	100	08:15	30	74.71	149.42	27.293	46.417	1.000						
6	2021-09-15	38G9	26	54°50,6'	019°14,8'	54°50,6'	019°12,3'	107	80	20	3.0	265	12:10	30	109.70	219.40	43.727	57.643	8.239	0.089					
7	2021-09-15	39G8	26	55°15,4'	018°58,8'	55°15,9'	018°56,5'	82	25/60	18	3.0	280	17:30	30	23.87	47.74	0.442	23.430							
8	2021-09-16	40G8	26	55°44,5'	018°38,3'	55°44,8'	018°35,4'	101	37	19	3.3	290	13:10	30	301.72	603.44	17.751	283.969							
9	2021-09-16	39G8	26	55°20,0'	018°39,1'	55°19,9'	018°36,7'	82	31	18	3.0	275	18:10	30	133.11	266.22	5.789	126.953	0.222			0.147			
10	2021-09-17	39G8	26	55°09,7'	018°41.0'	55°09,0'	018°43,6'	92	28	19	3.2	115	08:10	30	31.81	63.62	0.130	31.680							
11	2021-09-17	38G8	26	54°52,1'	018°40,2'	54°50,8'	018°41,2'	60	39	18	3.0	150	11:50	30	113.64	227.28	3.961	102.977	6.701						
12	2021-09-17	39G8	26	55°11,3'	018°18,9'	55°10,8'	018°16,6'	75	28	18	3.1	250	17:55	30	72.85	145.70	6.017	66.273	0.408		0.150				
13	2021-09-19	37G5	25	54°28,3'	015°19,7'	54°26,9'	015°19,7'	37	13	18	3.1	165	10:05	30	11.51	23.01	0.152	11.340							0.015
14	2021-09-19	38G5	25	54°44,3'	015°18,7'	54°43,0'	015°17,0'	68	45	18	2.9	205	14:05	30	359.61	719.21	173.125	173.875	8.145			0.258	4.203		
15	2021-09-20	38G5	25	54°52,6'	015°38,8'	54°51,4'	015°37,7'	78	53	18	3.0	180	07:35	30	224.44	448.88	168.245	54.575	0.879				0.742		
16	2021-09-20	38G5	25	54°42,9'	015°39,0'	54°42,0'	015°36,8'	68	20/47	19	3.0	230	10:30	30	104.52	209.04	21.767	82.753							
17	2021-09-20	37G5	25	54°26,0'	015°39,0'	54°25,6'	015°36,7'	45	23	18	3.0	100	14:25	30	12.29	24.58	2.001	10.280							0.009
18	2021-09-20	37G5	25	54°24,8'	015°45,6'	54°25,0'	015°42,9'	42	20	18	3.2	90	17:05	30	75.62	151.24	10.758	64.862							
19	2021-09-21	38G6	25	54°43,8'	016°00,4'	54°42,4'	016°01,1'	50	29	18	3.0	125	09:15	30	154.81	309.63	70.989	78.431	5.394						
20	2021-09-21	39G6	25	55°14,7'	016°11,6'	55°13,9'	016°09,5'	79	54	20	3.0	175	15:30	30	177.98	355.95	112.984	59.886	4.921	0.185					
21	2021-09-22	39G6	25	55°15,0'	016°41,3'	55°14,9'	016°43,7'	73	48	20	3.0	170	08:15	30	467.34	934.69	172.919	293.471	0.954						
22	2021-09-22	39G7	25	55°24,8'	017°00,8'	55°25,6'	017°04,2'	50	25	18	3.0	100	14:40	45	19.48	25.97	2.225	16.800				0.453			
23	2021-09-22	39G7	25	55°08,7'	017°01,2'	55°09,4'	017°03,7'	51	28	18	3.1	100	16:40	30	212.06	424.12	55.256	156.804							
24	2021-09-26	40G8	26	55°38,9'	018°04,1'	55°38,4'	018°06,9'	71	49	19	3.0	135	14:25	30	877.11	1754.22	727.020	149.598	0.490						
25	2021-09-26	39G7	25	55°25,5'	017°58,6'	55°25,5'	017°56,9'	71	26	18	3.2	100	17:45	30	157.91	315.82	74.712	83.198							
26	2021-09-27	39G7	25	55°10,9'	017°59,3'	55°12,0'	017°57,6'	45	22	18	3.1	100	08:55	30	353.12	706.23	148.819	204.261						0.035	
27	2021-09-27	39G7	25	55°18,2'	017°38,3'	55°18,4'	017°36,0'	82	53	18	3.0	210	15:50	30	553.39	1106.78	392.970	159.250	0.908			0.263			
28	2021-09-28	39G7	25	55°14,4'	017°18,6'	55°14,6'	017°16,0'	91	66	20	3.0	225	10:55	30	124.93	249.87	38.721	84.859	1.353						
29	2021-09-28	39G7	25	55°07,2'	017°19,0'	55°07,3'	017°16,7'	52	31	18	3.0	110	13:25	30	126.94	253.89	0.886	126.058							

Table 4. The mean numerical share of young, undersized fishes per ICES SDs (the Polish BIAS/2020 and BIAS/2021).

Species	Fish length	BIAS 2020 Mean share in % numbers			BIAS 2021 Mean share in % numbers		
		SD25	SD26	Mean	SD25	SD26	Mean
sprat	< 10 cm	0.1	10.3	5.3	0.2	1.3	0.7
herring	< 16 cm	12.4	12.7	12.5	28.9	36.8	32.4
cod	< 35 cm	41.4	68.2	57.5	65.8	34.3	56.1

Table 5. Cruise statistics of the Polish BIAS survey on board of the r.v. “Baltica”, 13-29.09.2021.

ICES SDs	ICES rectangles	EDSU [NM]	<σ> $[m^2 \cdot 10^{-4}]$	< S_A > $[m^2 \cdot NM^{-2}]$	Area $[NM^2]$	species composition [%]			Abundance $\cdot 10^6$			
						sprat	herring	cod	total	sprat	herring	cod
25	37G5	44	2.62	203.8	642.2	18.14	80.63	0.00	499.4	90.6	402.7	0.0
25	38G5	76	2.13	246.4	1035.7	64.03	35.85	0.08	1198.5	767.4	429.7	0.9
25	38G6	27	2.05	133.8	940.2	63.96	35.97	0.07	613.6	392.5	220.7	0.4
25	38G7	25	2.36	194.9	471.7	34.30	65.70	0.00	389.2	133.5	255.7	0.0
25	39G6	80	2.08	190.2	1026	48.41	51.55	0.04	936.5	453.4	482.8	0.4
25	39G7	107	2.22	154.8	1026	47.51	52.47	0.01	715.1	339.8	375.2	0.1
Sum SD25		**359**							**4352.4**	**2177.1**	**2166.8**	**1.8**
26	37G8	8	1.15	82.2	86	39.68	60.32	0.00	61.7	24.5	37.2	0.0
26	37G9	27	1.65	5448.3	151.6	54.92	45.08	0.00	4995.1	2743.5	2251.6	0.0
26	38G8	48	1.77	265.4	624.6	49.83	49.99	0.19	934.4	465.6	467.0	1.7
26	38G9	54	2.04	132.5	918.2	68.92	30.91	0.17	597.6	411.9	184.7	1.0
26	39G8	88	2.53	128.4	1026	27.54	72.45	0.01	520.0	143.2	376.7	0.1
26	39G9	31	2.99	116.7	1026	5.56	94.44	0.00	400.0	22.2	377.8	0.0
26	40G8	100	2.05	237.3	1013	51.87	48.13	0.00	1169.9	606.8	563.1	0.0
Sum SD26		**356**							**8678.6**	**4417.6**	**4258.1**	**2.8**

Table 6. Abundance of sprat (in millions of individuals) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish BIAS survey on board of the r.v. "Baltica", 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total sprat abundance [mln indiv.]
25	37G5	0.0	0.5	9.4	13.5	19.2	14.5	23.2	9.1	1.2	**90.6**
25	38G5	0.0	15.3	136.9	149.3	170.5	105.2	118.2	65.4	6.5	**767.4**
25	38G6	0.0	7.9	72.1	78.7	87.1	54.8	56.4	32.6	2.8	**392.5**
25	38G7	0.0	3.7	30.1	26.7	28.8	16.9	17.4	9.2	0.7	**133.5**
25	39G6	2.5	27.0	125.8	84.8	88.2	50.5	46.3	26.5	1.7	**453.4**
25	39G7	0.0	12.5	85.8	67.7	70.9	41.1	39.0	21.4	1.4	**339.8**
Sum SD25		**2.5**	**66.8**	**460.2**	**420.8**	**464.7**	**283.0**	**300.4**	**164.2**	**14.4**	**2177.1**
26	37G8	0.7	6.7	8.8	3.1	2.7	0.9	1.1	0.4	0.0	**24.5**
26	37G9	95.7	1102.8	887.5	274.1	210.6	63.2	77.3	32.4	0.0	**2743.5**
26	38G8	0.0	95.3	156.2	63.0	63.2	27.9	41.1	16.3	2.5	**465.6**
26	38G9	0.0	42.3	147.8	65.8	68.3	32.7	40.5	14.0	0.4	**411.9**
26	39G8	0.0	3.5	37.0	23.7	28.7	15.9	23.0	10.3	1.2	**143.2**
26	39G9	0.0	1.7	6.5	3.7	3.9	2.2	2.9	1.4	0.0	**22.2**
26	40G8	0.0	35.2	181.5	97.9	110.1	62.8	81.1	35.4	2.7	**606.8**
Sum SD26		**96.4**	**1287.6**	**1425.4**	**531.3**	**487.4**	**205.5**	**267.0**	**110.2**	**6.8**	**4417.6**

Table 7. Biomass of sprat (in tons) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish BIAS survey on board of the r.v. "Baltica", 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total sprat biomass [t]
25	37G5	0.0	5.6	135.0	194.8	289.1	225.7	374.2	143.0	19.7	**1387.2**
25	38G5	0.0	180.3	1733.7	2004.1	2354.0	1471.5	1759.6	952.5	101.3	**10557.0**
25	38G6	0.0	94.7	915.8	1053.3	1186.2	754.3	818.7	463.7	42.4	**5329.2**
25	38G7	0.1	42.8	369.3	344.8	381.8	230.8	250.4	130.3	11.5	**1761.7**
25	39G6	11.5	265.1	1429.2	1087.9	1141.6	676.5	641.0	367.0	25.8	**5645.7**
25	39G7	0.2	139.2	1027.2	867.4	919.5	552.0	547.2	297.4	21.0	**4371.0**
Sum SD25		**11.8**	**727.7**	**5610.2**	**5552.2**	**6272.1**	**3910.8**	**4391.1**	**2354.0**	**221.8**	**29051.8**
26	37G8	2.5	57.8	86.2	31.2	28.1	9.2	12.7	4.4	0.0	**232.1**
26	37G9	326.8	8971.7	8282.4	2677.9	2138.1	675.8	830.7	333.9	0.0	**24237.3**
26	38G8	0.0	816.0	1557.8	698.5	723.5	342.9	528.3	211.2	41.0	**4919.2**
26	38G9	0.0	378.4	1557.8	728.4	771.2	388.8	482.6	176.0	5.9	**4489.2**
26	39G8	0.0	31.5	418.2	288.3	353.1	204.1	304.5	141.9	19.4	**1760.9**
26	39G9	0.0	15.6	70.6	42.1	46.5	26.8	36.0	18.8	0.0	**256.4**
26	40G8	0.0	312.6	1973.1	1147.9	1315.3	788.9	1037.9	474.3	43.9	**7094.0**
Sum SD26		**329.3**	**10583.6**	**13946.1**	**5614.3**	**5375.8**	**2436.5**	**3232.7**	**1360.5**	**110.2**	**42988.9**

Table 8. Mean weight of sprat (in grams) per age groups, ICES rectangles and ICES SDs, based on data collected during the Polish BIAS survey on board of the r.v. "Baltica", 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W sprat [g]
25	37G5	-	12.06	14.30	14.42	15.03	15.59	16.14	15.78	16.07	**15.31**
25	38G5	-	11.79	12.66	13.42	13.81	13.99	14.89	14.56	15.49	**13.76**
25	38G6	-	12.0	12.69	13.38	13.62	13.77	14.52	14.21	15.10	**13.58**
25	38G7	6.83	11.69	12.28	12.91	13.23	13.66	14.41	14.22	15.49	**13.20**
25	39G6	4.60	9.81	11.36	12.82	12.94	13.39	13.86	13.84	14.89	**12.45**
25	39G7	6.83	11.16	11.97	12.80	12.98	13.44	14.03	13.91	15.17	**12.87**
MW SD25		**4.65**	**10.89**	**12.19**	**13.19**	**13.50**	**13.82**	**14.62**	**14.34**	**15.36**	**13.34**
26	37G8	3.40	8.62	9.74	10.06	10.45	10.81	11.04	10.88	-	**9.48**
26	37G9	3.41	8.14	9.33	9.77	10.15	10.69	10.75	10.32	-	**8.83**
26	38G8	-	8.56	9.97	11.08	11.44	12.29	12.86	12.95	16.22	**10.57**
26	38G9	-	8.94	10.54	11.07	11.30	11.89	11.91	12.53	16.36	**10.90**
26	39G8	-	9.06	11.30	12.17	12.32	12.87	13.23	13.83	16.0	**12.30**
26	39G9	-	9.00	10.85	11.50	11.91	12.40	12.54	13.53	-	**11.54**
26	40G8	-	8.88	10.87	11.72	11.94	12.56	12.80	13.39	16.1	**11.69**
MW SD26		**3.41**	**8.22**	**9.78**	**10.57**	**11.03**	**11.86**	**12.11**	**12.35**	**16.14**	**9.73**

Table 9. Abundance of herring (in millions of individuals) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish BIAS survey on board of the r.v. "Baltica", 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total herring abundance [mln indiv.]
25	37G5	0.0	4.1	134.2	64.1	110.4	43.4	28.2	18.3	0.1	**402.7**
25	38G5	7.7	5.3	140.5	68.0	111.0	45.3	28.7	20.9	2.4	**429.7**
25	38G6	3.9	2.7	76.5	35.9	57.4	22.4	12.3	9.0	0.5	**220.7**
25	38G7	3.1	2.6	97.1	38.4	62.9	25.4	15.2	10.8	0.4	**255.7**
25	39G6	6.6	4.0	213.4	72.2	112.0	41.9	19.4	13.2	0.1	**482.8**
25	39G7	5.5	4.2	147.9	53.4	88.7	34.9	22.8	16.6	1.2	**375.2**
Sum SD25		**26.8**	**22.9**	**809.6**	**332.0**	**542.5**	**213.2**	**126.4**	**88.8**	**4.7**	**2166.8**
26	37G8	35.2	0.2	0.3	0.2	0.2	0.2	0.2	0.6	0.1	**37.2**
26	37G9	912.0	60.1	164.3	154.1	197.7	159.8	166.9	348.5	88.3	**2251.6**
26	38G8	221.4	11.0	27.9	34.6	50.7	31.4	29.3	47.2	13.4	**467.0**
26	38G9	23.4	3.2	13.1	12.8	25.3	19.5	22.4	44.3	20.8	**184.7**
26	39G8	1.1	24.3	52.9	61.6	77.2	43.1	40.8	63.3	12.5	**376.7**
26	39G9	0.0	13.5	34.6	46.1	85.4	49.2	49.9	80.3	18.8	**377.8**
26	40G8	1.6	67.9	128.4	117.8	98.6	45.8	37.4	57.4	8.2	**563.1**
Sum SD26		**1194.6**	**180.0**	**421.4**	**427.2**	**535.0**	**349.1**	**346.9**	**641.8**	**162.1**	**4258.1**

Table 10. Biomass of herring (in tons) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish BIAS survey on board of the r.v. "Baltica", 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total herring biomass [t]
25	37G5	0.0	146.4	3805.3	1788.1	3270.1	1325.7	990.6	667.7	5.6	**11999.5**
25	38G5	84.4	162.3	3979.8	1979.7	3445.7	1418.1	1095.7	804.5	200.7	**13170.9**
25	38G6	49.7	73.5	2028.6	1018.5	1671.8	668.4	453.9	329.7	32.0	**6326.0**
25	38G7	42.3	78.0	2510.7	1079.7	1825.4	776.7	526.9	399.6	27.6	**7267.0**
25	39G6	94.7	111.7	4887.2	1911.4	3010.3	1197.1	611.5	430.1	5.8	**12259.8**
25	39G7	73.0	124.8	3859.5	1542.5	2660.0	1093.0	844.0	661.2	88.9	**10946.8**
Sum SD25		**344.1**	**696.7**	**21071.1**	**9319.9**	**15883.3**	**6479.0**	**4522.5**	**3292.8**	**360.6**	**61970.0**
26	37G8	191.7	2.9	9.0	7.4	6.2	7.9	9.3	23.8	4.7	**262.9**
26	37G9	4032.0	1397.5	5087.1	4682.7	6572.5	5748.4	6308.0	13632.9	4286.6	**51747.8**
26	38G8	1142.2	278.0	829.9	965.4	1580.6	1055.7	1053.5	1832.8	713.8	**9451.9**
26	38G9	121.8	80.6	479.9	415.3	985.5	786.5	895.4	1904.8	1163.7	**6833.5**
26	39G8	11.3	591.9	1459.1	1703.4	2323.2	1408.5	1432.5	2390.6	596.8	**11917.2**
26	39G9	0.0	370.2	1126.1	1389.1	2687.3	1650.2	1755.8	3163.3	942.3	**13084.3**
26	40G8	19.5	1538.3	3071.9	3049.8	2789.0	1416.9	1268.3	2130.8	391.4	**15675.7**
Sum SD26		**5518.5**	**4259.3**	**12063.0**	**12213.0**	**16944.2**	**12073.9**	**12722.8**	**25078.9**	**8099.4**	**108973.2**

Table 11. Mean weight of herring (in grams) per age groups, ICES rectangles and ICES SDs, based on data collected during the Polish BIAS survey on board of the r.v. "Baltica", 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W herring [g]
25	37G5	-	35.94	28.36	27.90	29.61	30.57	35.13	36.51	67.20	**29.80**
25	38G5	10.95	30.59	28.33	29.13	31.04	31.33	38.23	38.53	81.96	**30.65**
25	38G6	12.68	26.98	26.51	28.36	29.11	29.80	36.98	36.51	69.20	**28.66**
25	38G7	13.72	30.22	25.85	28.12	29.03	30.63	34.76	37.13	69.35	**28.42**
25	39G6	14.40	27.62	22.90	26.47	26.87	28.60	31.59	32.49	72.37	**25.39**
25	39G7	13.29	29.63	26.10	28.87	29.99	31.30	37.07	39.87	71.88	**29.17**
MW SD25		**12.85**	**30.37**	**26.03**	**28.07**	**29.28**	**30.39**	**35.77**	**37.09**	**76.57**	**28.60**
26	37G8	5.45	18.01	30.16	30.60	38.90	34.96	39.91	37.89	50.47	**7.06**
26	37G9	4.42	23.27	30.97	30.40	33.24	35.98	37.79	39.12	48.54	**22.98**
26	38G8	5.16	25.34	29.70	27.88	31.18	33.60	35.90	38.81	53.07	**20.24**
26	38G9	5.21	25.35	36.78	32.52	38.99	40.24	39.99	42.98	56.04	**37.00**
26	39G8	10.32	24.33	27.60	27.64	30.10	32.68	35.12	37.77	47.93	**31.63**
26	39G9	-	27.48	32.52	30.14	31.48	33.51	35.21	39.37	50.22	**34.64**
26	40G8	12.40	22.66	23.93	25.88	28.29	30.91	33.95	37.11	47.47	**27.84**
MW SD26		**4.62**	**23.66**	**28.63**	**28.59**	**31.67**	**34.58**	**36.68**	**39.08**	**49.97**	**25.59**

Table 12. Abundance of cod (in millions of individuals) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish BIAS survey on board of the r.v. “Baltica”, 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total cod abundance [mln indiv.]
25	37G5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
25	38G5	0.00	0.00	0.58	0.26	0.08	0.00	0.00	0.00	0.00	**0.91**
25	38G6	0.00	0.00	0.16	0.18	0.08	0.00	0.00	0.00	0.00	**0.42**
25	38G7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
25	39G6	0.00	0.00	0.17	0.17	0.03	0.00	0.00	0.00	0.00	**0.37**
25	39G7	0.01	0.00	0.03	0.05	0.01	0.00	0.00	0.00	0.00	**0.10**
Sum SD25		**0.01**	**0.00**	**0.94**	**0.66**	**0.20**	**0.00**	**0.00**	**0.00**	**0.00**	**1.81**
26	37G8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
26	37G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
26	38G8	0.00	0.00	0.36	0.83	0.36	0.07	0.13	0.00	0.00	**1.74**
26	38G9	0.00	0.00	0.06	0.23	0.64	0.04	0.03	0.00	0.00	**1.00**
26	39G8	0.00	0.00	0.02	0.02	0.02	0.00	0.00	0.00	0.00	**0.05**
26	39G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
26	40G8	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	**0.02**
Sum SD26		**0.00**	**0.00**	**0.44**	**1.08**	**1.01**	**0.11**	**0.16**	**0.00**	**0.00**	**2.81**

Table 13. Biomass of cod (in tons) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method, based on data collected during the Polish BIAS survey on board of the r.v. “Baltica”, 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Total cod biomass [t]
25	37G5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
25	38G5	0.00	0.00	102.32	77.43	31.28	0.00	0.00	0.00	0.00	**211.03**
25	38G6	0.00	0.00	51.41	85.94	63.22	0.00	0.00	0.00	0.00	**200.56**
25	38G7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
25	39G6	0.00	0.00	44.20	64.47	12.17	0.00	0.00	0.00	0.00	**120.84**
25	39G7	0.03	0.00	7.52	19.84	4.89	0.00	0.00	0.00	0.00	**32.29**
Sum SD25		**0.03**	**0.00**	**205.45**	**247.68**	**111.56**	**0.00**	**0.00**	**0.00**	**0.00**	**564.72**
26	37G8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
26	37G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
26	38G8	0.00	0.00	186.99	316.26	229.40	55.32	118.80	0.00	0.00	**906.79**
26	38G9	0.00	0.00	15.29	73.63	583.00	25.01	26.20	0.00	0.00	**723.12**
26	39G8	0.00	0.00	6.19	3.65	8.74	0.00	0.00	0.00	0.00	**18.58**
26	39G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
26	40G8	0.00	0.00	1.02	3.36	0.00	0.00	0.00	0.00	0.00	**4.38**
Sum SD26		**0.00**	**0.00**	**209.50**	**396.90**	**821.14**	**80.33**	**145.00**	**0.00**	**0.00**	**1652.87**

Table 14. Mean weight of cod (in grams) per age groups, ICES rectangles and ICES SDs, based on data collected during the Polish BIAS survey on board of the r.v. “Baltica”, 13-29.09.2021.

ICES SDs	ICES rectangles	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W cod [g]
25	37G5	-	-	-	-	-	-	-	-	-	
25	38G5	-	-	175.49	303.32	416.93	-	-	-	-	**231.05**
25	38G6	-	-	314.18	469.91	821.00	-	-	-	-	**473.58**
25	38G7	-	-	-	-	-	-	-	-	-	
25	39G6	-	-	262.48	389.37	384.21	-	-	-	-	**330.49**
25	39G7	3.00	-	287.97	367.46	351.14	-	-	-	-	**308.97**
MW SD25		**3.00**		**218.29**	**376.57**	**564.47**					**312.52**
26	37G8	-	-	-	-	-	-	-	-	-	
26	37G9	-	-	-	-	-	-	-	-	-	
26	38G8	-	-	523.83	383.12	642.64	826.50	887.50	-	-	**521.07**
26	38G9	-	-	239.03	325.37	911.63	564.83	887.50	-	-	**720.56**
26	39G8	-	-	352.33	207.67	497.00	-	-	-	-	**352.33**
26	39G9	-	-	-	-	-	-	-	-	-	
26	40G8	-	-	244.00	266.89	-	-	-	-	-	**261.17**
MW SD26				**473.23**	**366.84**	**809.75**					**507.42**

Table 15. Values of the basic meteorological and hydrological parameters recorded in September 2021 at the positions of the r.v. "Baltica" fish pelagic catches (catches No. 7 and 16 were carried out in two depth layers).

Haul no	Date of catch	Haul start time (UTC)	Meterological parameters					Hydrological parameters*			Depth of measurement [m]
			Atmospheric pressure [hPa]	Air temperature [°C]	Wind direction	Wind force [°B]	Sea state [°B]	Temperature [°C]	Salinity [PSU]	Oxygen [ml·l⁻¹]	
1	2021-09-13	12:20	1016	17.9	NW	3	2	5.1	7.8	6.9	34
2	2021-09-13	14:55	1016.2	17.4	NW	3	2	4.9	8.0	6.4	42
3	2021-09-14	07:30	1018.8	15.9	W	3	2	5.9	7.7	5.9	42
4	2021-09-14	10:25	1019.5	17.3	W	3	1	4.7	7.8	6.6	52
5	2021-09-15	06:15	1018.8	15.7	S	3	2	5.2	9.2	3.4	69
6	2021-09-15	10:10	1018.5	16.5	S	3	1	6.6	11.3	0.2	90
7	2021-09-15	15:30	1017	16.4	E	4	2/3	6.8/5.3	7.7/8.9	6.4/5.8	34/69
8	2021-09-16	11:10	1010.8	15.6	E	6	4	6.0	8.0	6.0	46
9	2021-09-16	16:10	1010.2	17.3	W	3	3	5.0	7.7	7.1	40
10	2021-09-17	06:10	1008.9	16.9	ZM	2	1	6.8	7.7	6.7	37
11	2021-09-17	09:50	1009.3	17	ZM	1	1	5.1	8.0	5.9	48
12	2021-09-17	15:55	1010.4	15.8	ENE	4	3	5.6	7.7	7.1	37
13	2021-09-19	08:05	1019	14.1	NE	5	3	16.8	7.5	6.5	22
14	2021-09-19	12:05	1020.2	13.1	NE	6	4	6.4	10.9	4.8	54
15	2021-09-20	05:35	1021.2	14	NE	5	3	6.3	9.4	5.6	53
16	2021-09-20	08:30	1021.8	14.6	ENE	5	3	6.0/6.8	7.7/11.8	6.3/4.3	29/56
17	2021-09-20	12:25	1022	14.7	E	4	3	6.4	7.9	6.2	32
18	2021-09-20	15:05	1022.4	14.4	NE	3	3	7.7	8.0	6.1	29
19	2021-09-21	07:15	1024.9	13.3	NW	2	2	6.2	9.4	4.6	38
20	2021-09-21	13:30	1024.3	12.5	W	3	2	8.3	13.9	1.7	64
21	2021-09-22	06:15	1024.4	13.8	ZM	1	1	6.9	12.4	2.5	58
22	2021-09-22	10:40	1024.4	13.2	ZM	1	1	5.7	7.8	6.0	34
23	2021-09-22	14:40	1022.5	13.8	ZM	1	1	6.4	7.9	6.2	37
24	2021-09-26	12:25	1022.5	15.6	E	2	1	5.3	9.0	2.7	58
25	2021-09-26	15:45	1022	14.9	E	3	1	7.2	7.6	6.5	35
26	2021-09-27	06:55	1023.7	14.8	SE	5	3	12.0	7.6	6.4	31
27	2021-09-27	13:50	1022.3	14.9	E	6	3/4	7.0	10.7	4.4	62
28	2021-09-28	08:55	1022	12.8	SE	5	3	7.4	13.5	3.5	76
29	2021-09-28	11:25	1022.1	14.3	SE	5	3	6.6	7.8	6.3	40

*date of the mean of the catches (in the middle of trawl vertical opening)

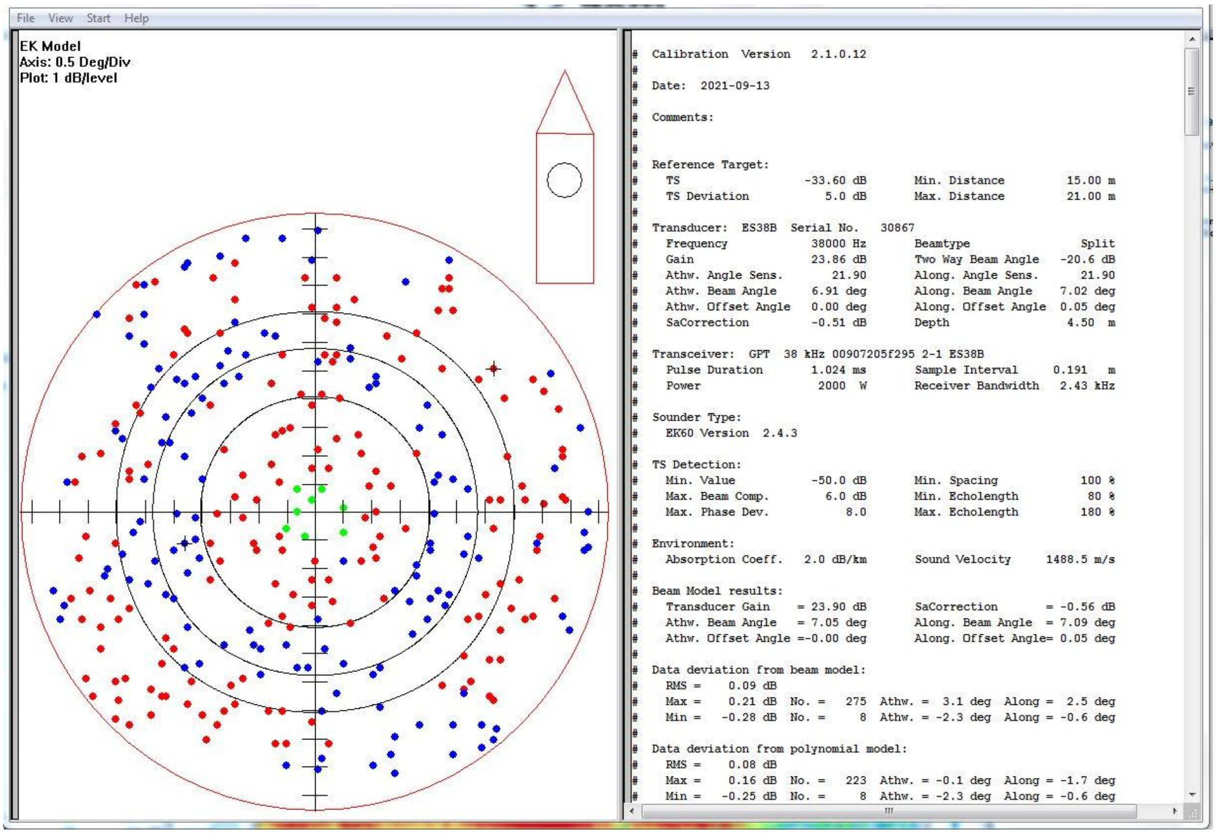


Fig. 1. R.v. “Baltica” cruise BIAS 2021: Simrad EK60 calibration report (38 kHz transducer).

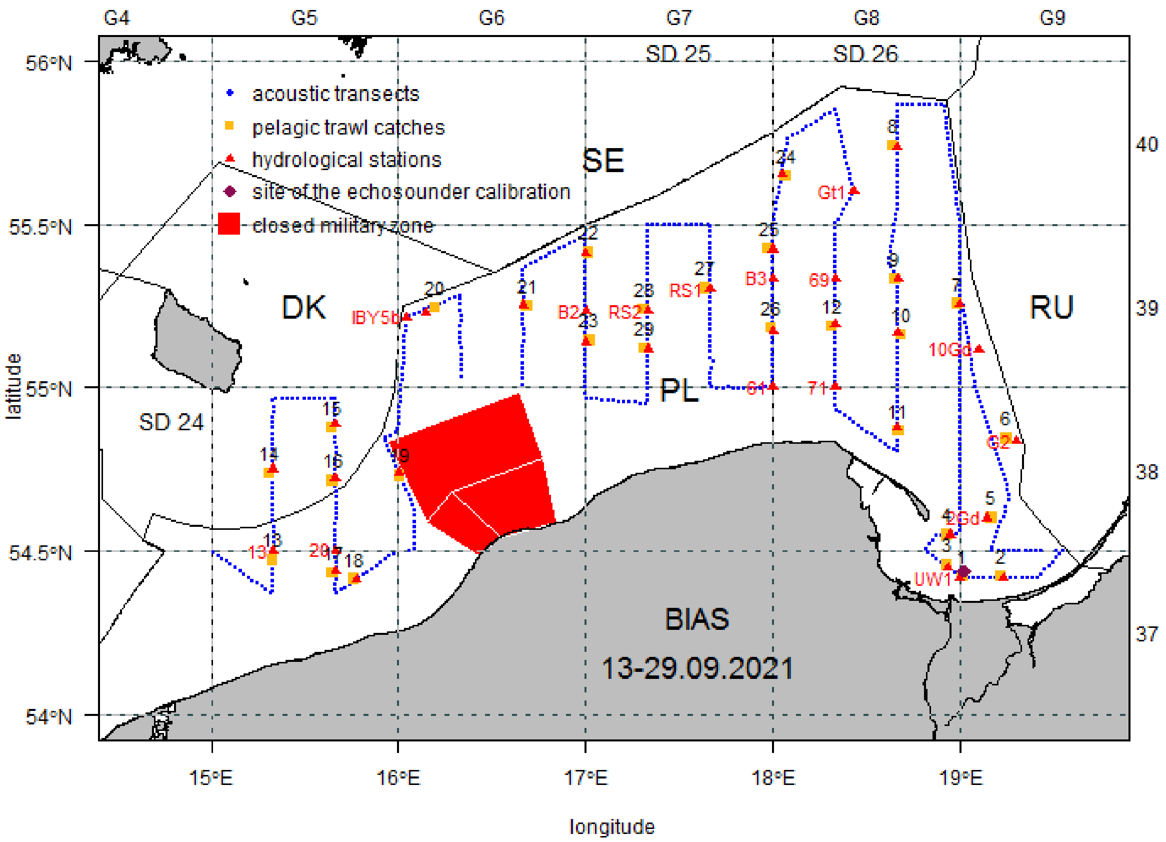


Fig. 2. Location of realized investigations during the Polish BIAS survey on board of the r.v. “Baltica”, 13-29.09.2021.

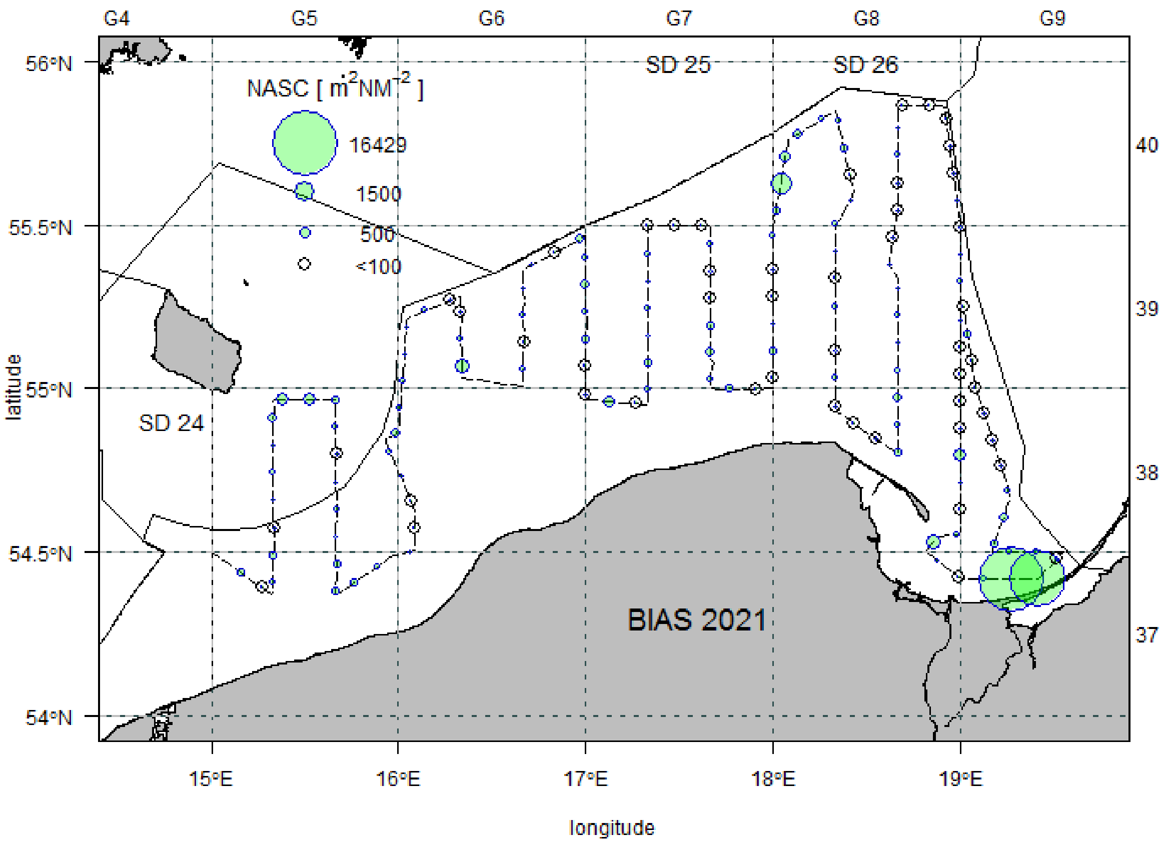


Fig. 3. Cruise track (thin dashed line) and the mean NASC (5 NM intervals, bubbles) recorded during BIAS 2021 cruise.

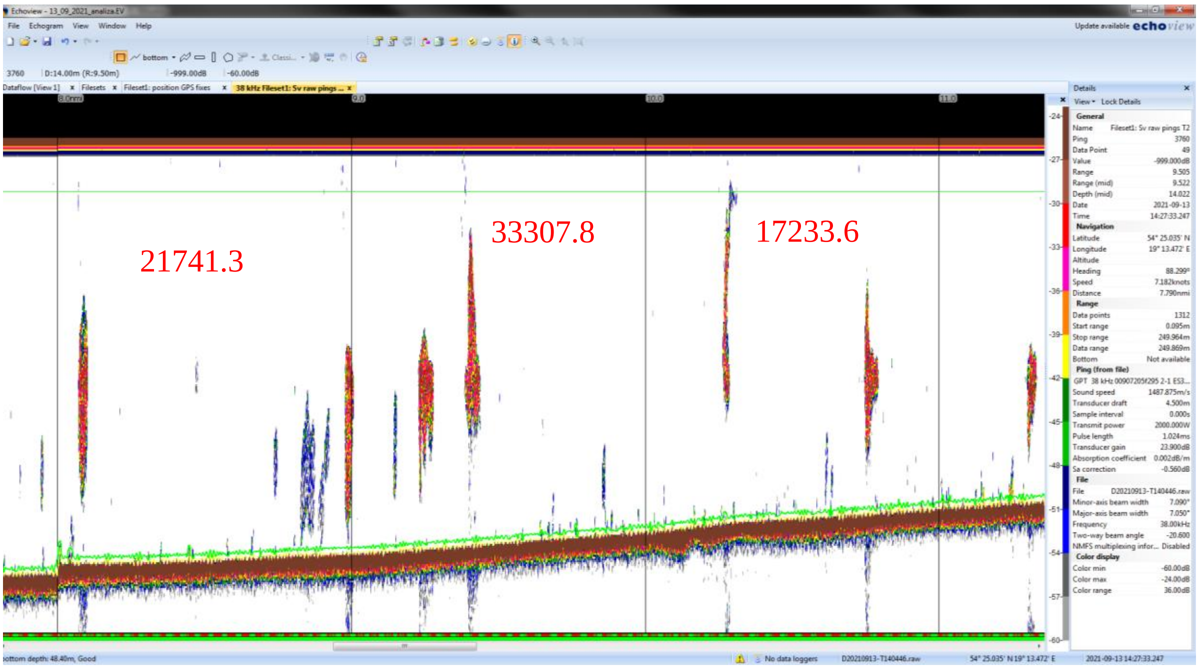


Fig. 4. An example of an echogram analysis for 10th mile of the integration, NASC = 33307.8 m^2 NM^{-2} (ICES rectangle 37G9, bottom depth 45 m; 13.09.2021).

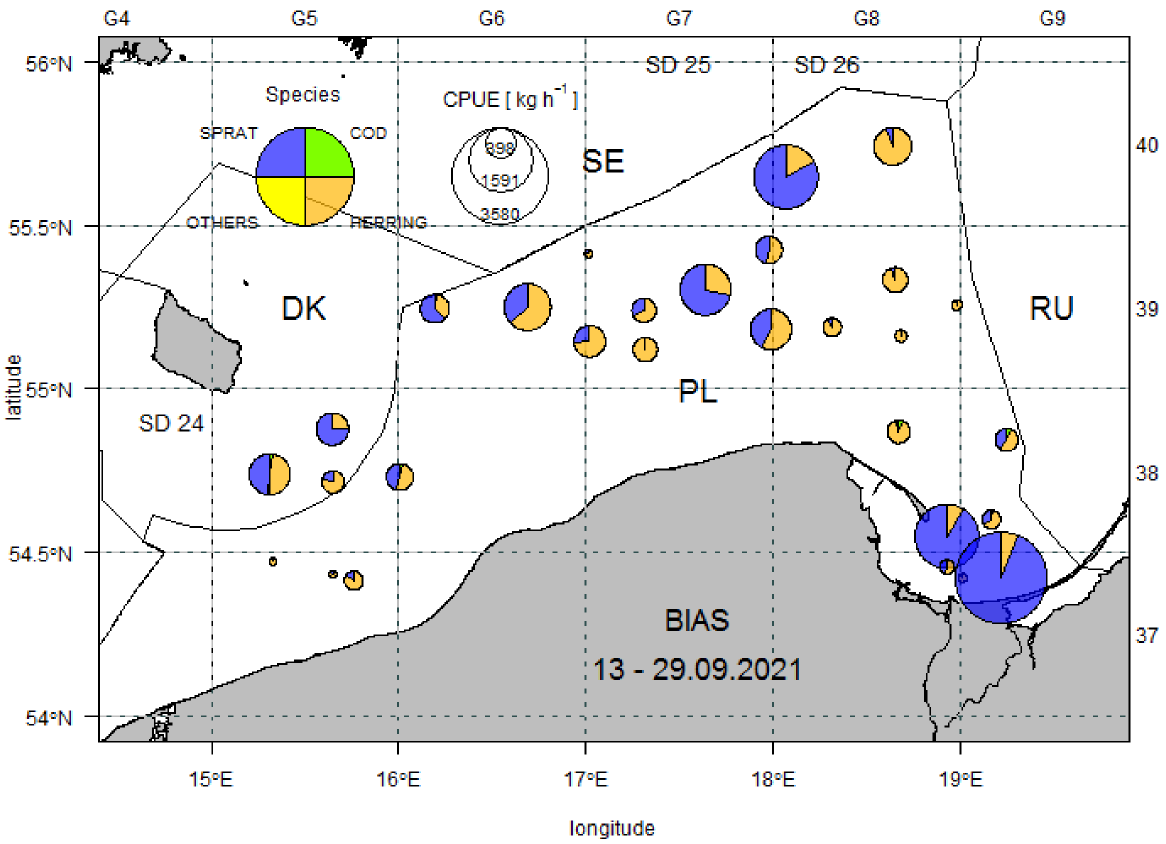


Fig. 5. CPUE [kg h-1] of fish species per single pelagic hauls conducted during the Polish BIAS 2021 survey.

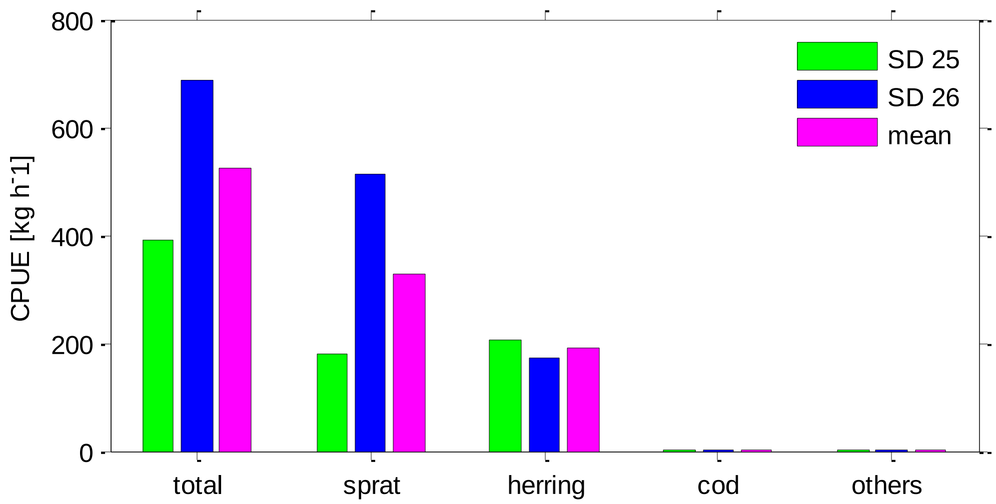


Fig. 6. Mean CPUE [kg h-1] per fish species and the ICES SDs (the Polish BIAS/2021survey).

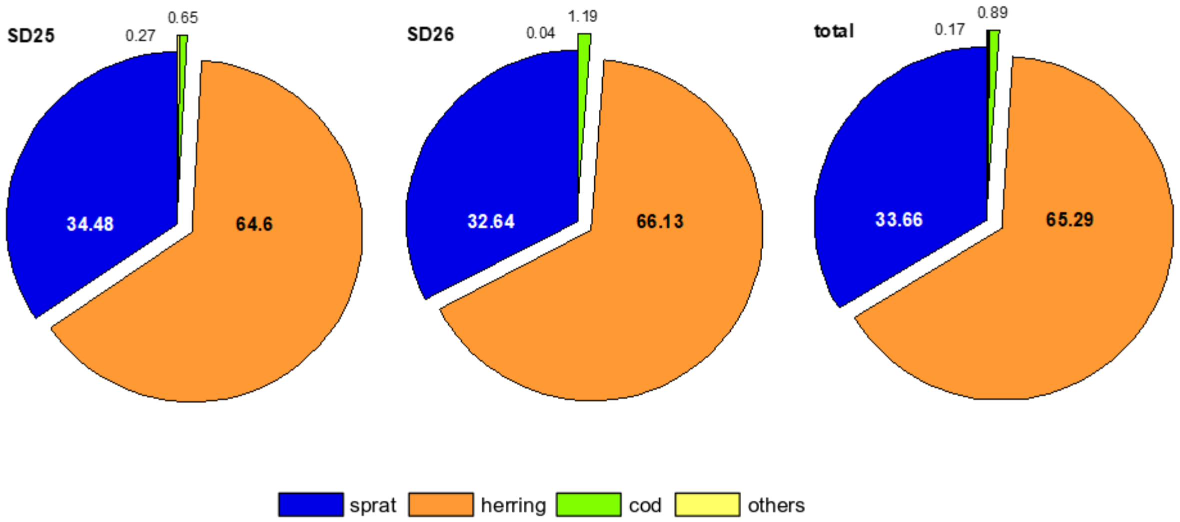


Fig. 7. Share (%) of sprat, herring, cod and other fishes in the mass of total catches per the ICES SDs (the Polish BIAS/2021).

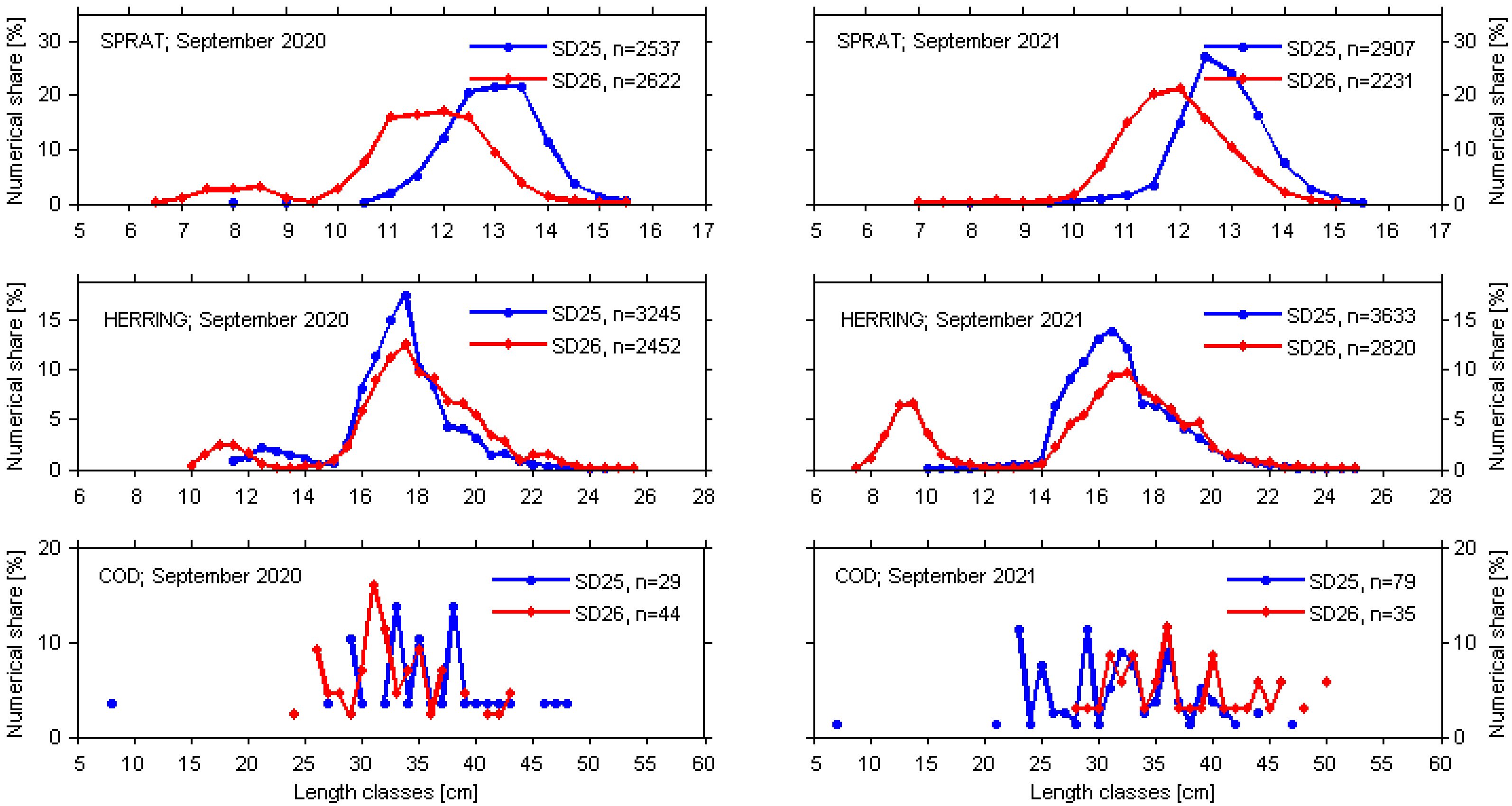


Fig. 8. Length distribution of sprat, herring and cod in samples taken from the catches conducted during the Polish BIAS/2020 and BIAS/2021 surveys (the length distribution data for fish species from 2020 from Schmidt *et al.*, 2021a).

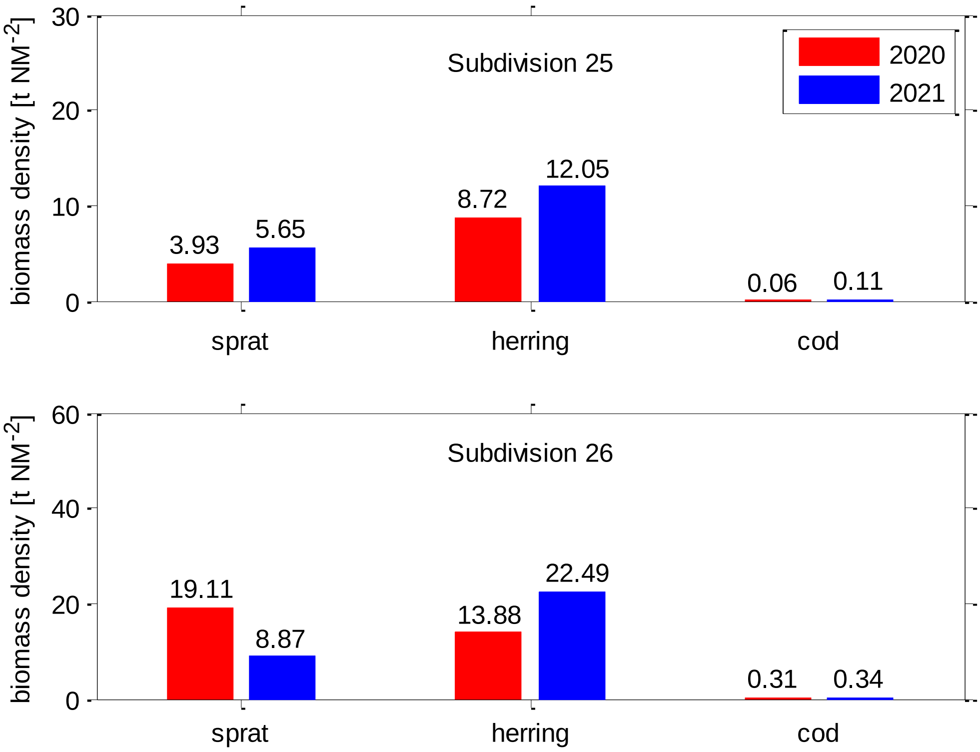


Fig. 9. Mean biomass surface density [t NM^{-2}] of sprat, herring and cod in the ICES Subdivisions 25 and 26 in the Polish BIAS 2020 and 2021 surveys (the biomass density data for fish species from 2020 from Schmidt *et al.*, 2021a).

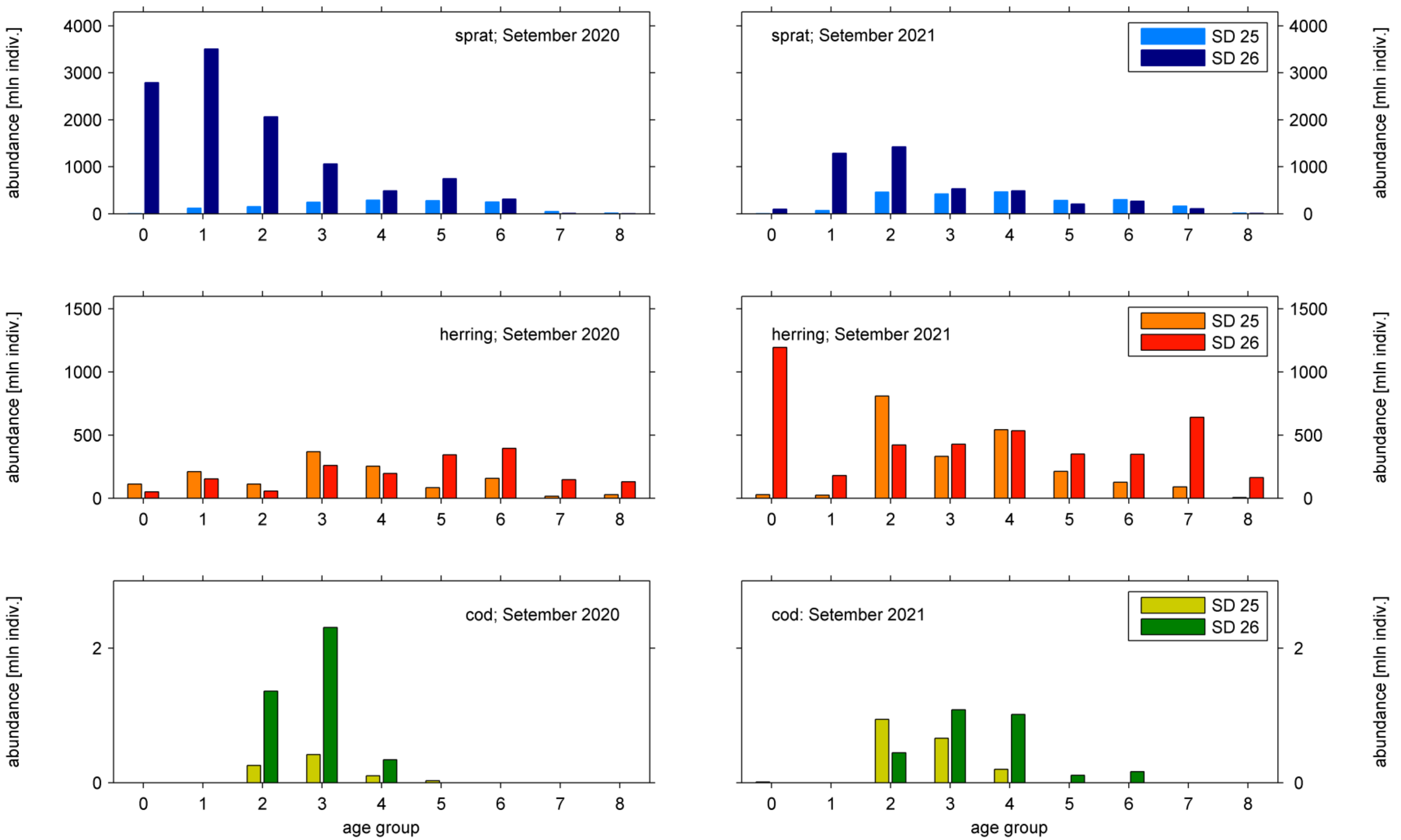


Fig. 10. Abundance (in mln indiv.) of sprat, herring and cod stocks per age groups, according to the ICES Sub-divisions 25 and 26, based on data from the Polish BIAS surveys in 2020 and 2021 (the abundance data for fish species from 2020 from Schmidt *et al.*, 2021a).

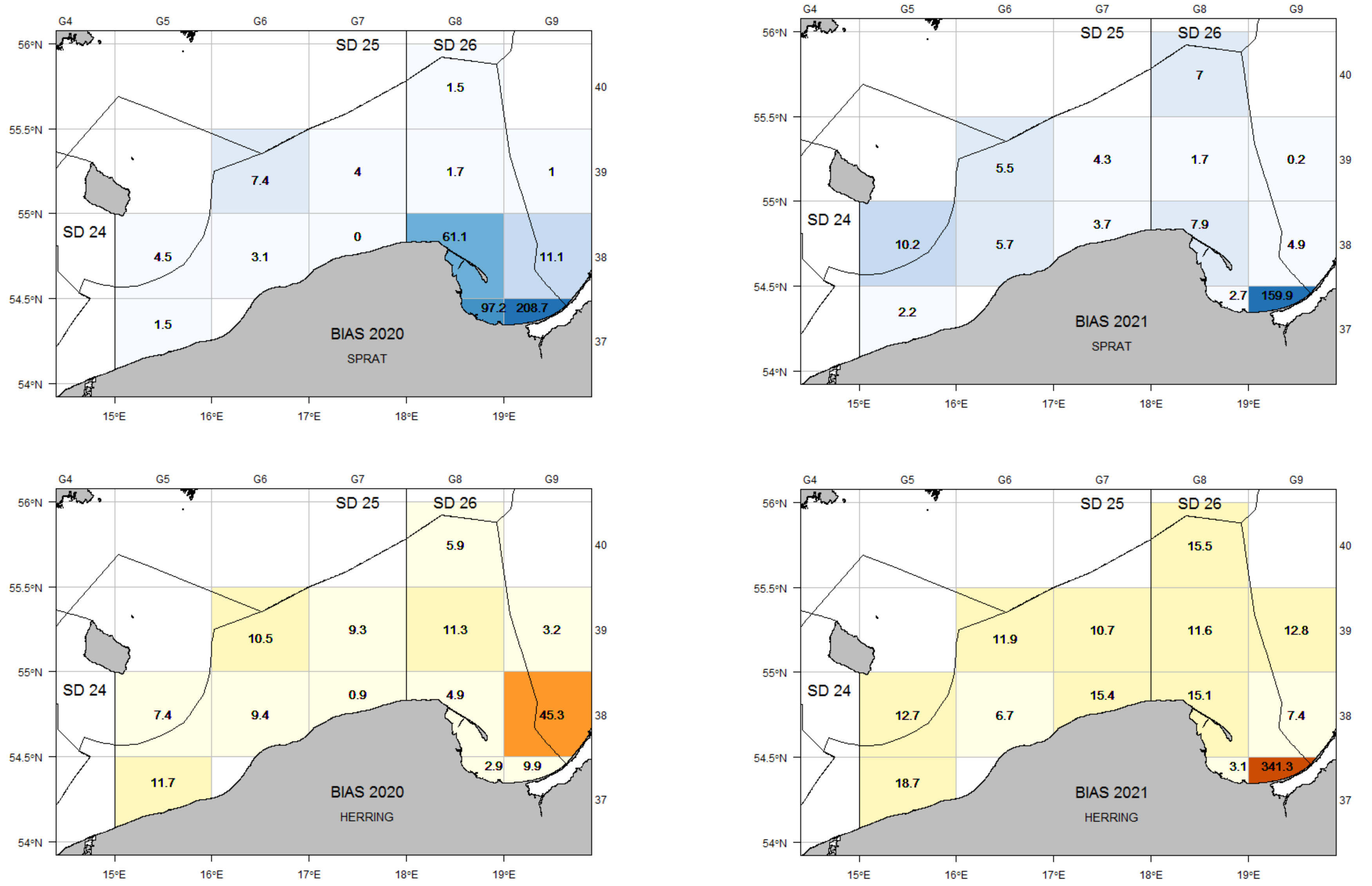
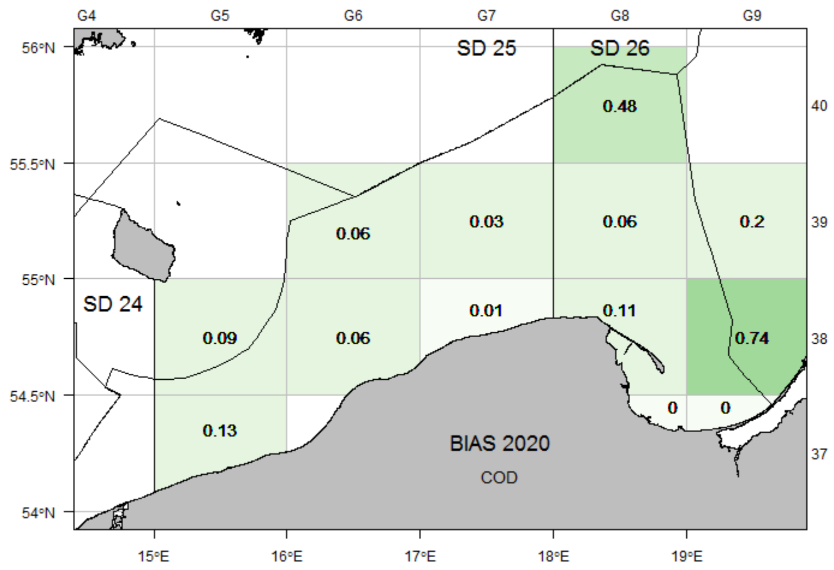


Fig. 11. Biomass surface density of sprat and herring [t NM^{-2}] per ICES rectangles, estimated using acoustic method, and based on data collected during the Polish BIAS 2020 and 2021 surveys (the fish species biomass density data from 2020 from Schmidt *et al.*, 2021a).



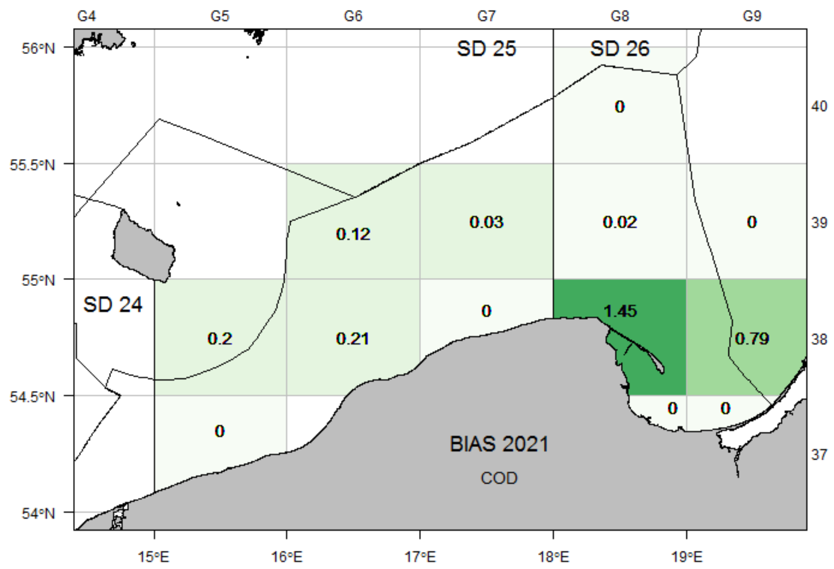


Fig. 12. Biomass surface density of cod [t NM^{-2}] per ICES rectangles, estimated using acoustic method, and based on data collected during the Polish BIAS 2020 and 2021 surveys (the fish species biomass density data from 2020 from Schmidt *et al.*, 2021a).

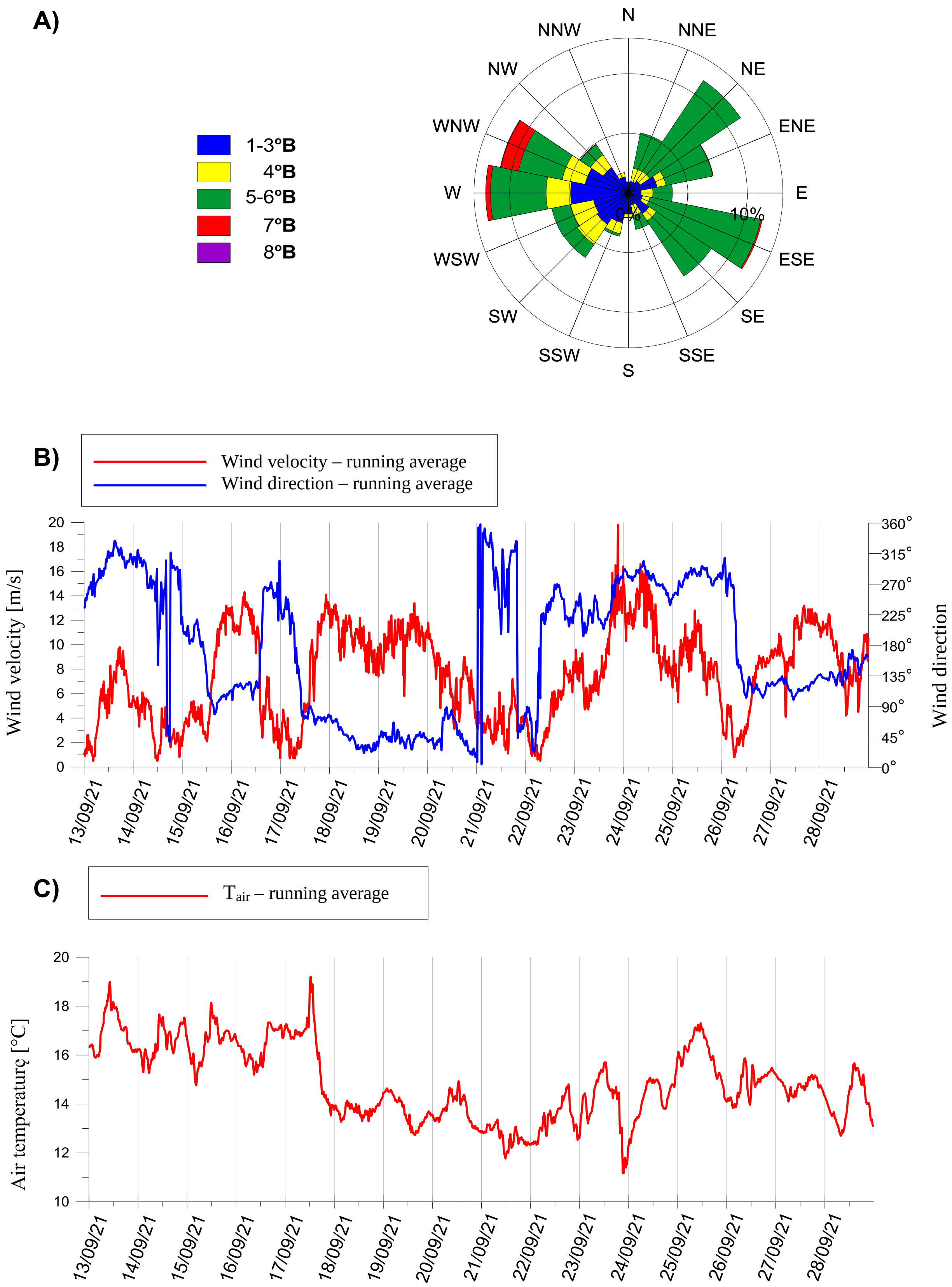


Fig. 13. Changes of meteorological parameters during consecutive days of the Polish BIAS survey in September 2021 (fig. Wodzinowski after Schmidt *et al.*, 2021b).

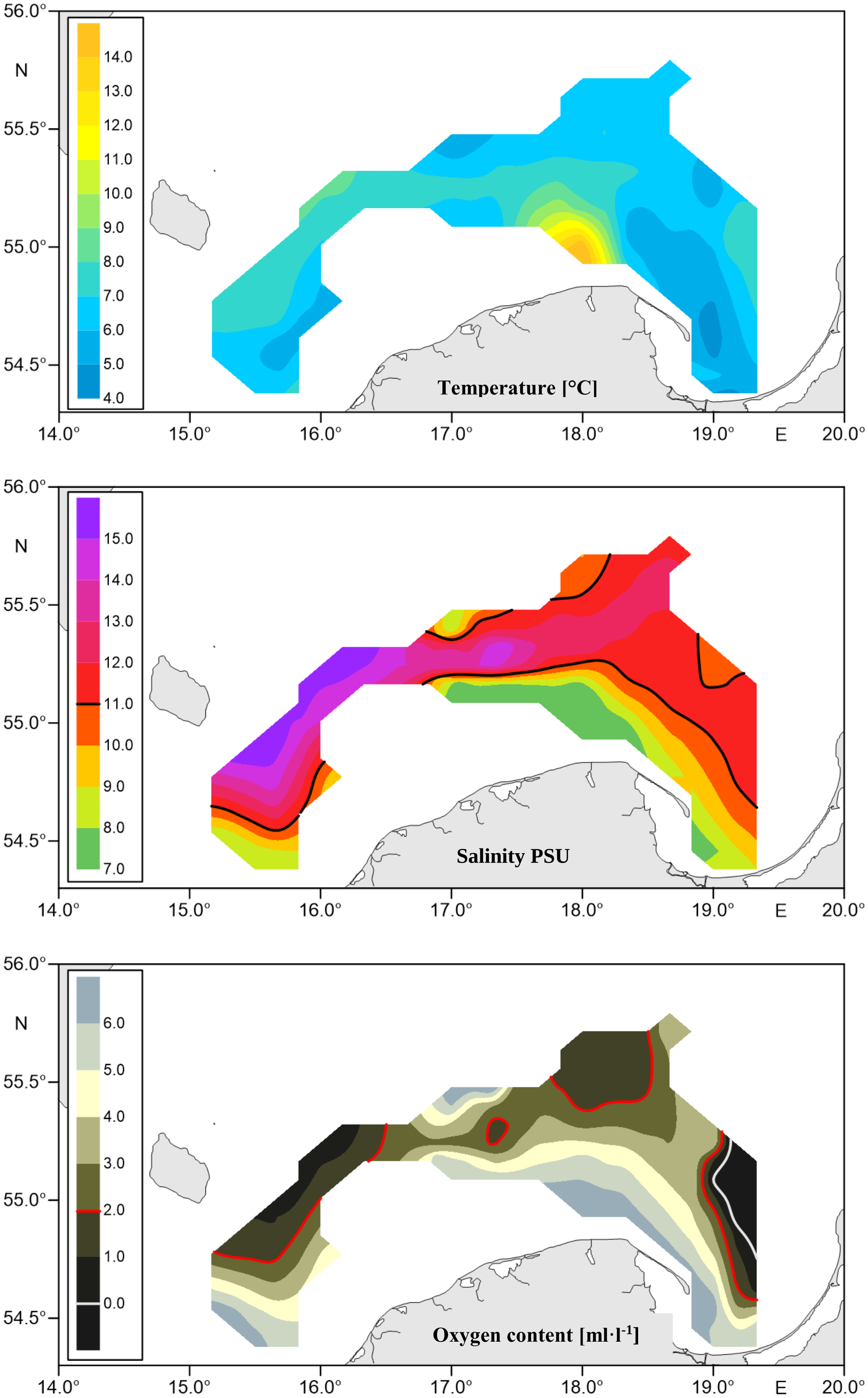


Fig. 14. Horizontal distribution of the seawater temperature, salinity and oxygen content in the near seabed layer of the southern Baltic in September 2021 (fig. Wodzinowski after Schmidt *et al.*, 2021b).

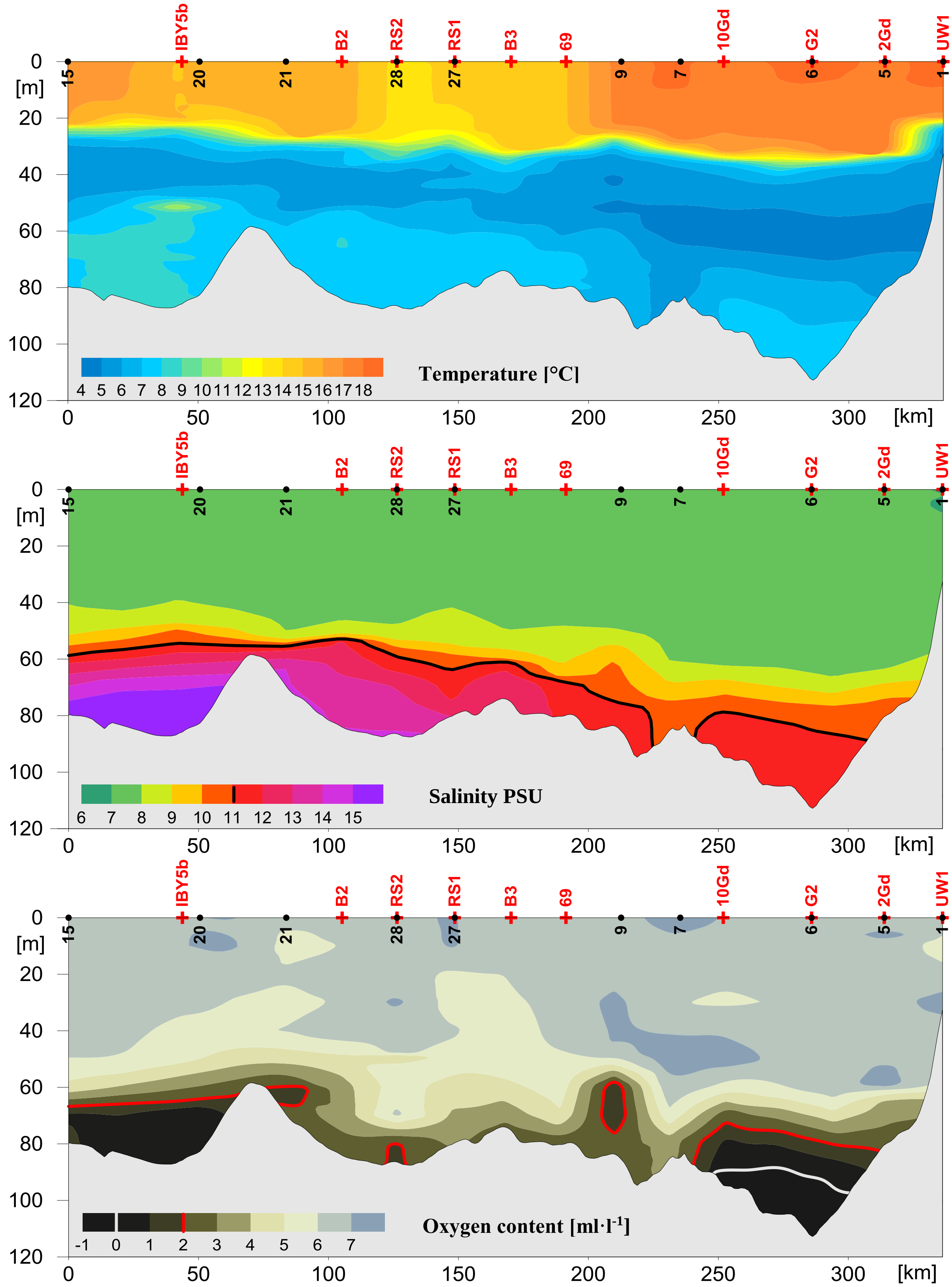


Fig. 15. Vertical distribution of the seawater temperature, salinity and oxygen content, along the hydrological research profile determined in the southern Baltic (September 2021); X- and Y-axes reflects distance (in kilometres) and depth (in meters) from the sea surface to the seabed, respectively (fig. Wodzinowski after Schmidt *et al.*, 2021b).

Baltic International Acoustic Survey Report, R/V Svea, Sweden

Survey 2021-09-25 - 2021-10-08

Niklas Larson
SLU - Institute of Marine Research, Lysekil, Sweden

Contents

1 Introduction

International hydroacoustic surveys have been conducted in the Baltic Sea since 1978. The starting point was the cooperation between the Institute of Marine Research (IMR) in Lysekil, Sweden, and the Institut für Hochseefisherei und Fishverarbeitung in Rostock, German Democratic Republic, in October 1978, which produced the first acoustic estimates of the total biomass of herring and sprat in the Baltic main basin (Håkansson *et al.,* 1979). Since then there has been at least one annual hydroacoustic survey for herring and sprat in the Baltic Sea and results have been reported to the International Council for the Exploration of the Sea (ICES).
The Baltic International Acoustic Survey (BIAS), is mandatory for the countries that have Exclusive Economic Zone (EEZ) in the Baltic Sea, and is part of the Data Collection Framework(DCF) as stipulated by the European Council and the Commission (European Council, 2017) and the Commission Data Collection Framework (The Commission, 2021).
The IMR in Lysekil is part of the Department of Aquatic Resources at the Swedish University of Agricultural Sciences and responsible for the Swedish part of the DCF and surveys in the marine environment. The IMR assesses the status of the marine ecosystems, develops and provides biological advices for the sustainable use of the aquatic resources.
The BIAS survey is coordinated and managed by the ICES working group for the Baltic International Fish Survey (WGBIFS). The main objective of BIAS is to assess herring and sprat resources in the Baltic Sea. The survey provides data to the ICES Baltic Fisheries Assessment Working Group (WGBFAS).

2 Methods

2.1 Narrative

The survey was conducted onboard the Fisheries Research Vessel, Svea that was delivered in July 2019. The total cruise covered SD 27 and parts of 25, 26, 28 and 29 (Figure 1). The calibration of the SIMRAD EK80 echo sounder was made in the Gåsöfjärden on the Swedish east coast. The survey started 2021-09-25 east of Gåsöfjärden, and ended 2021-10-08 between Sweden and Bornholm at the border between ICES subdivision (SD) 24 and 25 (Figure 2).

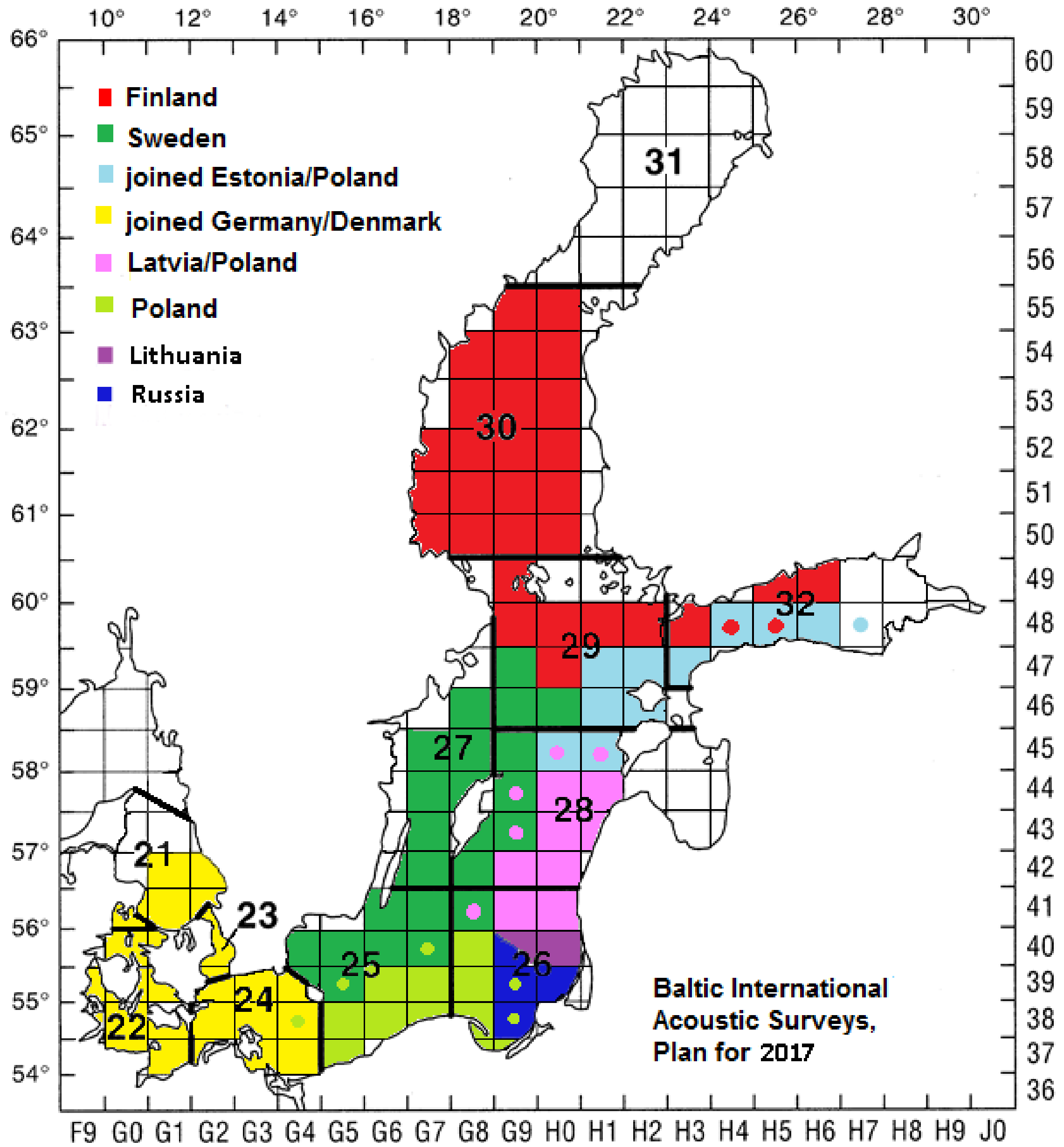


Figure 1. Allocation of ICES square to each country in the BIAS survey 2021 (On axes: longitude, latitude and ICES name of square eg:41G8).

2.2 Survey design

The survey design is based on ICES statistical rectangles with a range of 0.5 degrees in latitude and 1 degree in longitude (Figure 1). The 10 m depth line (ICES, 2017) limits the areas of all strata. The aim (ICES, 2017)is to use parallel transects spaced out on regular rectangle basis, normally at a maximum distance of 15 nautical miles and with a transect density of about 60 nautical miles per 1000 square nautical miles. Due to the irregular shape of the survey area assigned to Sweden and occational bad weather conditions during surveys the design is difficult to fulfill. The total area covered in 2021 was 20832 square nautical miles and the distance used for acoustic estimates was 1304 nautical miles. The cruise track and positions of trawl hauls are shown in Figure 2.

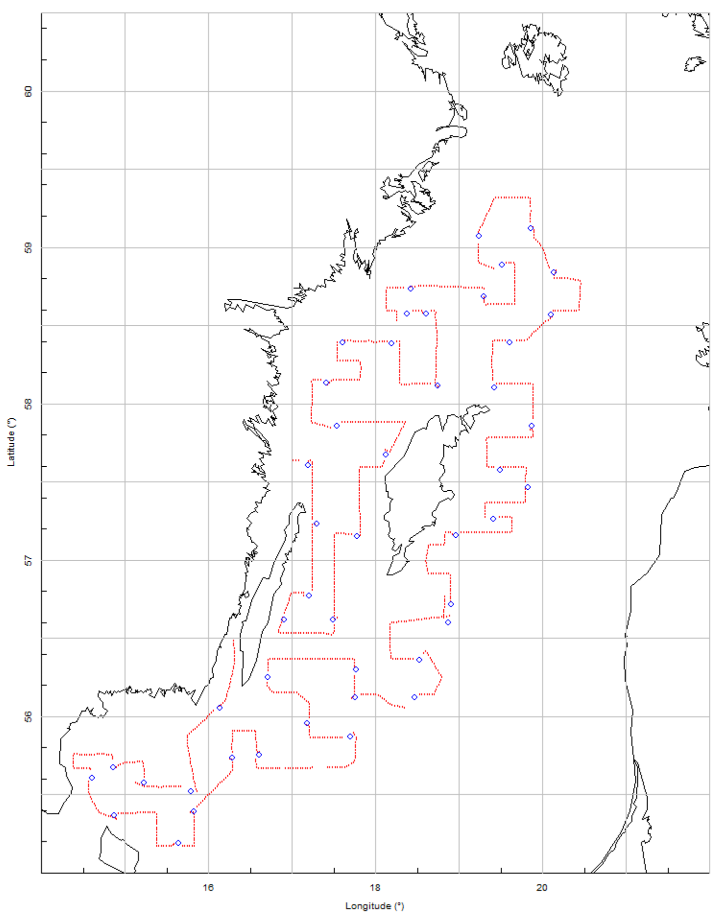


Figure 2. Cruise track(red), positions of trawl hauls (blue) and survey grid of ICES squares (grey) for BIAS 2021.

2.3 Calibration

The SIMRAD EK80 echo sounder with the 38kHz transducer was calibrated in Gåsöfjärden 2021-09-26, according to the IBAS manual (ICES, 2017). Values from the calibration were within required accuracy.

2.4 Acoustic data collection and processing

The acoustic data sampling was performed around the clock. SIMRAD EK80 (simrad.com/ek80) echo sounder with the 38 kHz transducer mounted on a drop keel was used for the acoustic data collection. The settings of the hydroacoustic equipment were as described in the IBAS manual (ICES, 2017). The post processing of the stored raw data was made using the software LSSS (Large Scale Survey System, marec.no/products.htm). The mean volume back scattering values (Sv) were integrated over 1 nautical mile (elementary sampling distance units, ESDUs) from 10 m below the surface to the bottom. Contributions from air bubbles, bottom structures and and irrelevant scattering were removed from the echogram using LSSS.

2.5 Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers in combination with other species so that it is impossible to allocate the acoustic integrator readings to a single species. Therefore the species composition was based on the catch results from the allocated trawl hauls. For each rectangle the species composition and length distribution were determined as the unweighted mean of all trawl results in this rectangle. From these data, the mean acoustic cross-section was calculated according to the target strength(TS) relationships (Table 1).

The total number of fish (total N) in one rectangle was estimated as the product of the nautical area scattering coefficient s_A and the rectangle area, divided by the corresponding backscattering cross section σ. The total number was separated into different fish species according to the mean catch composition in the rectangle.

Table 1. Target strength (TS) relationships.

Clupeoids	TS = 20 log L (cm) - 71.2	(ICES 1983/H:12)
Gadoids	TS = 20 log L (cm) - 67.5	(Foote et al. 1986)
Fish without swim bladder	TS = 20 log L (cm) - 84.9	(ICES, 2017)
Salmonids and 3-spined stickleback were given the same acoustic properties as Clupeoids.		

2.6 Hydrographic data

CTD casts were made with a "Seabird 9+" CTD when calibrating the acoustic instruments and whenever a haul was conducted. Additional hydrographic data was collected on a selection of the stations.

2.7 Personnel

The participating scientific crew are listed in Table 2.

Table 2. Participating scientific crew.

Björklund, Emilia	IMR, Lysekil	Fish sampling
Jernberg, Carina	IMR, Lysekil	Fish sampling
Larson, Niklas	IMR, Lysekil	Scientific & Exp. leader, Acoustics
Nilsson, Hans	IMR, Lysekil	Acoustics
Sjöberg, Rajlie	IMR, Lysekil	Fish sampling
Svenson, Anders	IMR, Lysekil	Acoustics
Risberg, Ronja	IMR, Lysekil	Fish sampling
Tell, Anna-Kerstin	SMHI, Gothenburg	Oceanography

3 Results

3.1 Biological data

In total 47 trawl hauls were carried out, 15 in SD 25, 2 in SD 26, 15 in SD 27, 9 in SD 28 and 6 hauls in SD 29. In total 1683 herring and 1172 sprat were selected for age analyses. Length distributions by ICES subdivision are shown for sprat in Figures 3-7 and for herring in Figures 8 to 12.

3.2 Acoustic data

The survey statistics concerning the survey area, the mean nautical area scattering coefficient (SA), the mean backscattering cross section (SIGMA), the estimated total number of fish (NTOT), the percentages of herring (HHer), sprat (HSpr) and cod (HCod) per SD/rectangle are shown in Table 3.

3.3 Abundance estimates

The total abundances of herring and sprat by age group per rectangle are presented in Table 4 and 6. The corresponding mean weights by age group per rectangle are shown in Tables 5 and 7.

4 Discussion

This year was the second year that R/V Svea was used for BIAS. For this reason some instruments were not totally up and running but as a whole the evaluation was that the survey was accomplished as planned. Some bad weather occurred and thus in some parts the planned survey track had to be changed according to the situation. The data collected during the survey was accepted at the WGBIFS meeting and thus representative for the index of abundance of the pelagic species during the BIAS in 2021 for the covered area (Figure 2). For further information regarding the procedures of WGBIFS see the WGBIFS report (ICES, 2021).

5 References

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http://data.europa.eu/eli/reg/2017/1004/oj

The Commission, 2021
https://datacollection.jrc.ec.europa.eu/legislation/current (updated 2021-06-21)

6 Tables and figures

Table 3. Survey statistics, see chapter 4.2 for more information.

SD	RECT	AREA	SA	SIGMA	NTOT	HHer	HSpr	HCod
25	39G4	287.3	455.8	1.796	729.10	4.36	95.63	0.000
25	39G5	979.0	183.8	1.766	1018.49	22.68	77.20	0.114
25	40G4	677.2	214.8	2.496	582.65	56.26	42.76	0.269
25	40G5	1012.9	141.4	1.860	769.99	37.36	59.04	0.070
25	40G6	1013.0	384.3	1.613	2413.90	12.46	83.90	0.264
25	40G7	1013.0	415.3	2.103	2000.12	63.15	33.60	0.005
25	41G6	764.4	562.9	1.433	3002.17	32.17	62.00	0.005
25	41G7	1000.0	794.8	1.584	5016.24	25.78	64.41	0.000
26	41G8	1000.0	906.8	1.844	4916.08	44.68	52.36	0.058
27	42G6	266.0	1450.5	1.387	2782.73	29.28	56.63	0.000
27	42G7	986.9	726.3	1.520	4716.77	43.90	23.39	0.000
27	43G7	913.8	655.1	1.157	5175.92	9.49	83.85	0.000
27	44G7	960.5	346.9	1.073	3106.73	23.26	41.14	0.000
27	44G8	456.6	429.5	1.131	1734.61	23.80	39.44	0.000
27	45G7	908.7	770.5	1.249	5607.77	30.19	63.87	0.000
27	45G8	947.2	466.1	1.229	3591.92	25.24	54.68	0.000
27	46G8	884.8	441.0	0.933	4182.18	12.99	45.22	0.000
28	42G8	945.4	359.5	1.637	2076.26	35.13	50.31	0.000
28	43G8	296.2	370.4	1.213	904.22	0.10	99.42	0.000
28	43G9	973.7	652.3	1.192	5327.53	17.73	41.01	0.000
28	44G9	876.6	855.1	0.864	8671.89	0.54	49.43	0.000
28	45G9	924.5	584.8	1.255	4307.78	38.32	11.79	0.004
29	46G9	933.8	327.0	0.654	4671.47	5.80	20.02	0.000
29	46H0	933.8	343.3	0.991	3236.81	10.03	47.87	0.000
29	47G9	876.2	990.3	1.244	6972.22	22.85	49.72	0.000

Table 4. Estimated number (millions) of sprat per age group and area (Number sprat two year old (NS2)).

SD	RECT	NSTOT	NS0	NS1	NS2	NS3	NS4	NS5	NS6	NS7	NS8+
25	39G4	697	6	0	94	164	134	8	131	84	76
25	39G5	786	2	38	110	157	196	88	152	7	36
25	40G4	249	4	1	16	43	26	48	59	48	1
25	40G5	455	12	38	57	144	54	56	27	55	11
25	40G6	2025	10	102	334	590	672	85	95	109	27
25	40G7	672	6	82	162	172	109	106	4	19	12
25	41G6	1861	1332	178	86	82	57	22	37	56	11
25	41G7	3231	26	726	322	782	342	207	310	500	16
26	41G8	2574	7	338	396	731	526	253	46	259	17
27	42G6	1576	14	770	402	197	7	37	14	134	0
27	42G7	1103	0	235	438	88	75	100	26	123	18
28	42G8	1044	0	120	312	268	170	18	63	77	16
27	43G7	4340	21	2431	385	1224	68	152	7	45	7
28	43G8	899	5	256	441	117	9	18	18	27	9
28	43G9	2185	17	227	209	747	424	97	127	223	114
27	44G7	1278	21	637	208	174	55	46	26	89	23
27	44G8	684	3	187	74	130	132	53	15	90	0
28	44G9	4287	2	443	1500	928	375	133	574	215	116
27	45G7	3582	277	2107	302	430	181	72	139	56	18
27	45G8	1964	68	1126	295	187	32	199	51	0	6
28	45G9	508	1	224	40	83	65	43	27	18	8
27	46G8	1891	28	643	490	76	316	3	224	109	3
29	46G9	935	10	231	193	144	240	18	49	48	2
29	46H0	1550	10	376	459	231	334	44	91	2	2
29	47G9	3467	29	614	904	849	691	99	148	99	33

Table 5. Estimated mean weights (g) of sprat per age group and area (Weight sprat (WS)).

SD	RECT	WS0	WS1	WS2	WS3	WS4	WS5	WS6	WS7	WS8+
25	39G4	4		13	14	16	20	16	16	20
25	39G5	5	8	12	11	13	15	13	15	13
25	40G4	4	9	10	13	14	15	15	16	18
25	40G5	4	8	10	12	15	13	16	13	16
25	40G6	3	8	10	13	13	12	12	14	13
25	40G7	4	8	10	11	12	13	14	14	16
25	41G6	3	7	9	9	12	11	13	13	14
25	41G7	3	8	10	11	12	11	14	12	15
26	41G8	4	8	10	12	12	12	13	12	15
27	42G6	3	7	11	11	15	12	13	10	
27	42G7		7	9	11	12	11	9	11	13
28	42G8		7	9	11	11	13	13	13	14
27	43G7	4	7	10	9	11	11	13	10	13
28	43G8	4	8	10	11	13	11	12	13	13
28	43G9	5	8	10	11	12	11	14	14	14
27	44G7	4	6	9	9	11	11	11	11	10
27	44G8	4	7	9	10	11	11	12	12	
28	44G9	4	7	10	10	12	13	12	9	11
27	45G7	4	7	9	10	10	11	10	11	13
27	45G8	4	7	9	9	12	10	12		12
28	45G9	3	7	9	10	11	11	12	9	12
27	46G8	4	7	10	9	10	13	11	11	13
29	46G9	4	7	10	10	10	13	10	12	13
29	46H0	4	7	10	11	10	12	12	13	15
29	47G9	4	7	8	9	10	10	12	10	12

Table 6. Estimated number (millions) of herring per age group and area (Number herring (NH)).

SD	RECT	NHTOT	NH0	NH1	NH2	NH3	NH4	NH5	NH6	NH7	NH8+
25	39G4	32	1	2	4	10	5	6	3	1	0
25	39G5	231	4	9	89	45	28	33	13	10	0
25	40G4	328	7	10	59	89	82	37	18	26	0
25	40G5	288	2	44	77	65	45	14	22	17	2
25	40G6	301	3	10	98	28	59	58	23	21	0
25	40G7	1263	0	45	433	225	263	82	128	87	0
25	41G6	966	7	40	155	180	150	187	98	145	4
25	41G7	1293	4	13	541	168	188	240	83	43	14
26	41G8	2196	0	23	673	411	488	291	154	150	6
27	42G6	815	17	88	341	81	87	119	56	23	3
27	42G7	2071	13	72	684	345	466	260	116	102	12
28	42G8	729	0	4	147	102	176	149	152	0	0
27	43G7	491	11	100	242	48	52	11	23	4	0
28	43G8	1	0	0	0	0	0	0	0	0	0
28	43G9	944	0	4	207	167	164	191	127	85	0
27	44G7	723	13	171	297	41	82	42	73	4	0
27	44G8	413	10	71	222	33	38	15	17	6	0
28	44G9	46	9	1	17	12	4	1	1	0	0
27	45G7	1693	438	401	451	129	101	94	42	39	0
27	45G8	906	57	90	363	122	122	98	29	22	3
28	45G9	1651	10	35	563	198	225	313	85	213	8
27	46G8	543	141	104	148	46	69	22	9	2	1
29	46G9	271	2	19	128	23	24	21	27	27	0
29	46H0	325	1	5	142	83	36	23	21	11	2
29	47G9	1593	12	121	740	253	270	116	81	0	0

Table 7. Estimated mean weights (g) of herring per age group and area. (Weight herring (NS))

SD	RECT	WH0	WH1	WH2	WH3	WH4	WH5	WH6	WH7	WH8+
25	39G4	7	32	33	37	34	30	36	28	
25	39G5	13	16	20	29	31	34	35	32	
25	40G4	13	18	26	50	52	56	46	36	
25	40G5	12	18	25	30	36	41	39	37	29
25	40G6	14	29	22	32	37	31	39	40	
25	40G7		14	22	23	30	38	38	39	
25	41G6	7	16	20	25	30	30	32	38	32
25	41G7	11	14	19	27	30	37	37	43	33
26	41G8		13	19	23	28	34	32	35	38
27	42G6	5	14	19	23	29	28	30	32	53
27	42G7	4	13	19	24	26	28	26	30	35
28	42G8		14	19	21	26	26	32		
27	43G7	4	12	17	21	24	26	25	32	
28	43G8			15	21	70				
28	43G9		15	19	23	27	26	35	30	
27	44G7	4	12	18	23	21	29	24	23	
27	44G8	4	12	18	21	24	21	27	28	
28	44G9	4	13	18	24	24	25	24		
27	45G7	5	12	17	21	22	25	22	27	
27	45G8	5	12	17	21	24	23	25	25	19
28	45G9	4	14	17	23	27	27	32	26	36
27	46G8	4	11	18	22	24	23	32	30	30
29	46G9	4	12	17	19	25	24	24	24	
29	46H0	6	13	16	22	23	27	27	26	25
29	47G9	5	13	17	20	22	24	24		

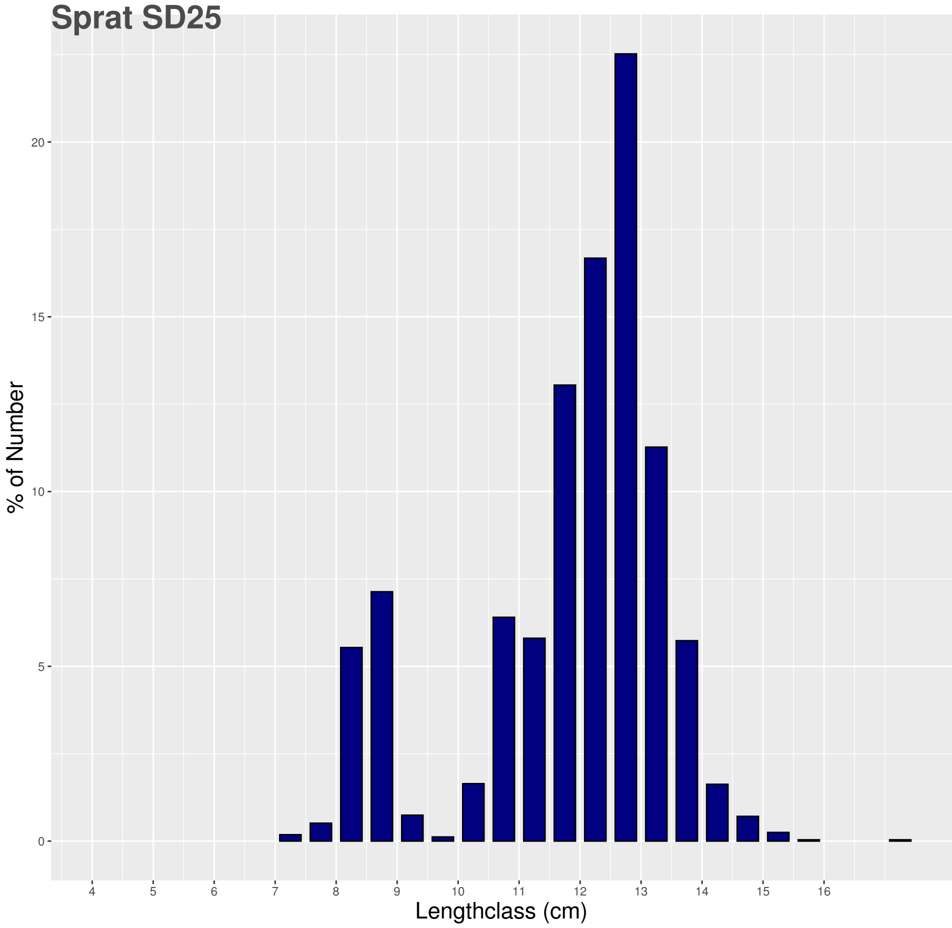

Figure 3. Length distribution of sprat from subdivision 25 for BIAS 2021.

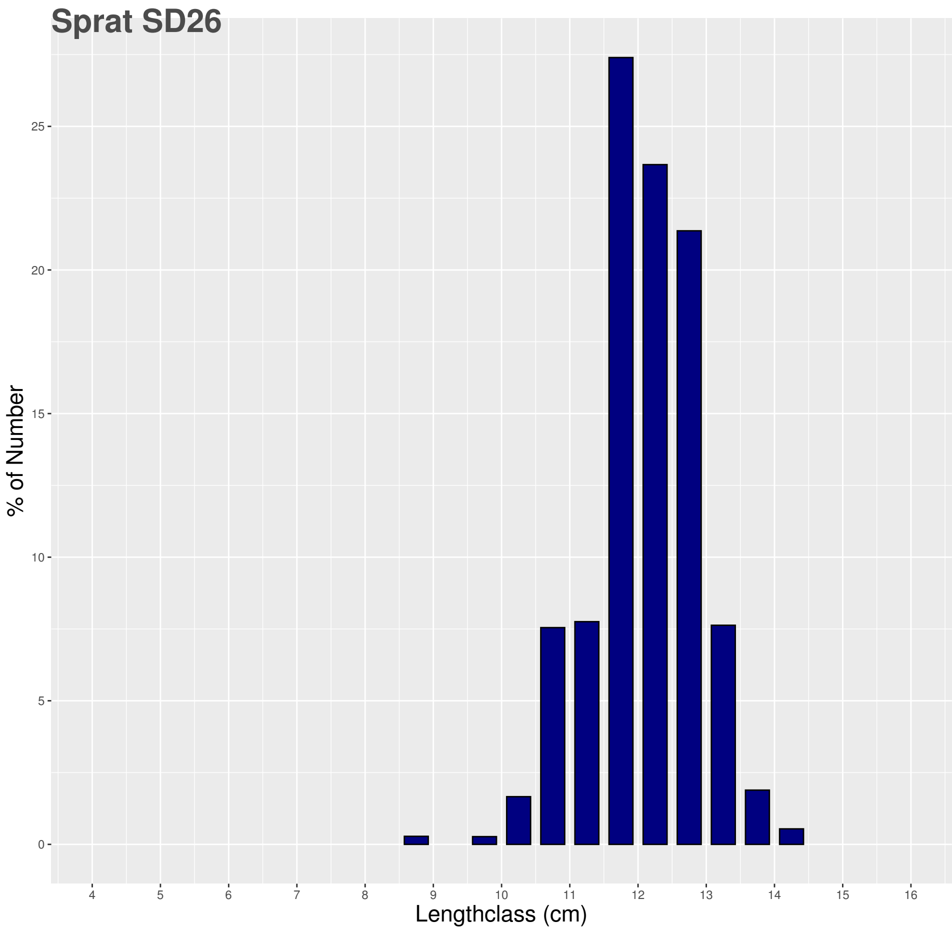

Figure 4. Length distribution of sprat from subdivision 26 for BIAS 2021.

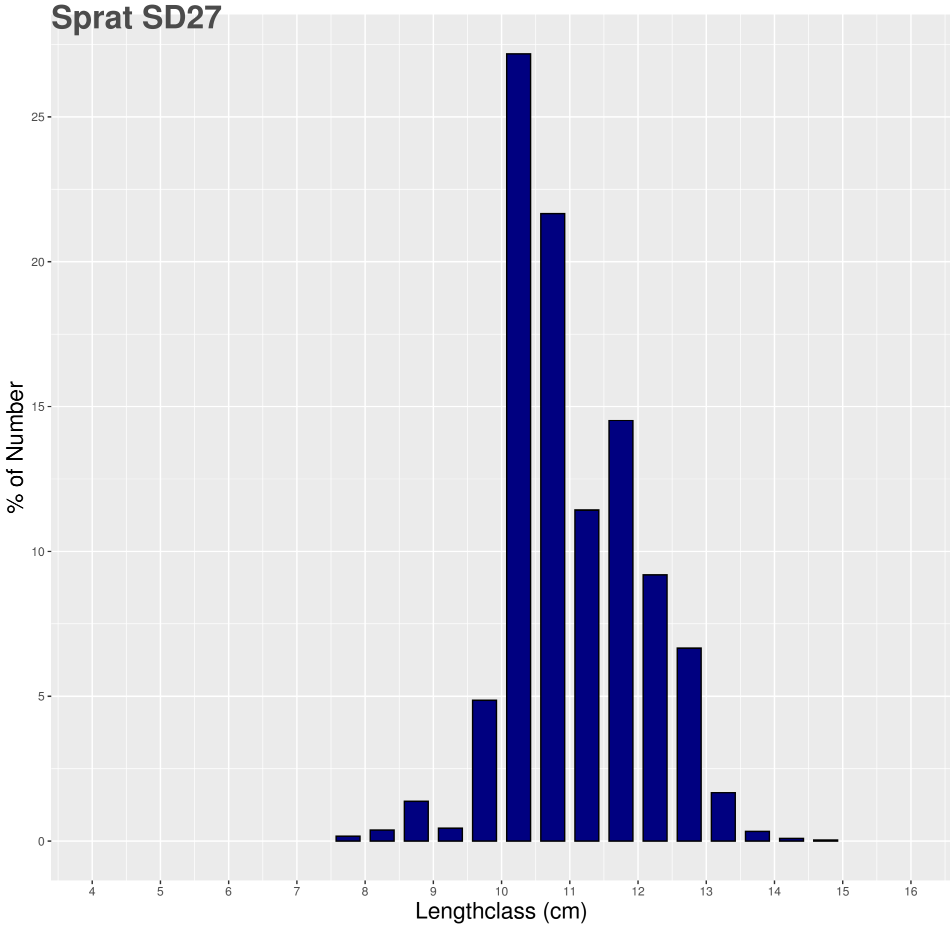

Figure 5. Length distribution of sprat from subdivision 27 for BIAS 2021.

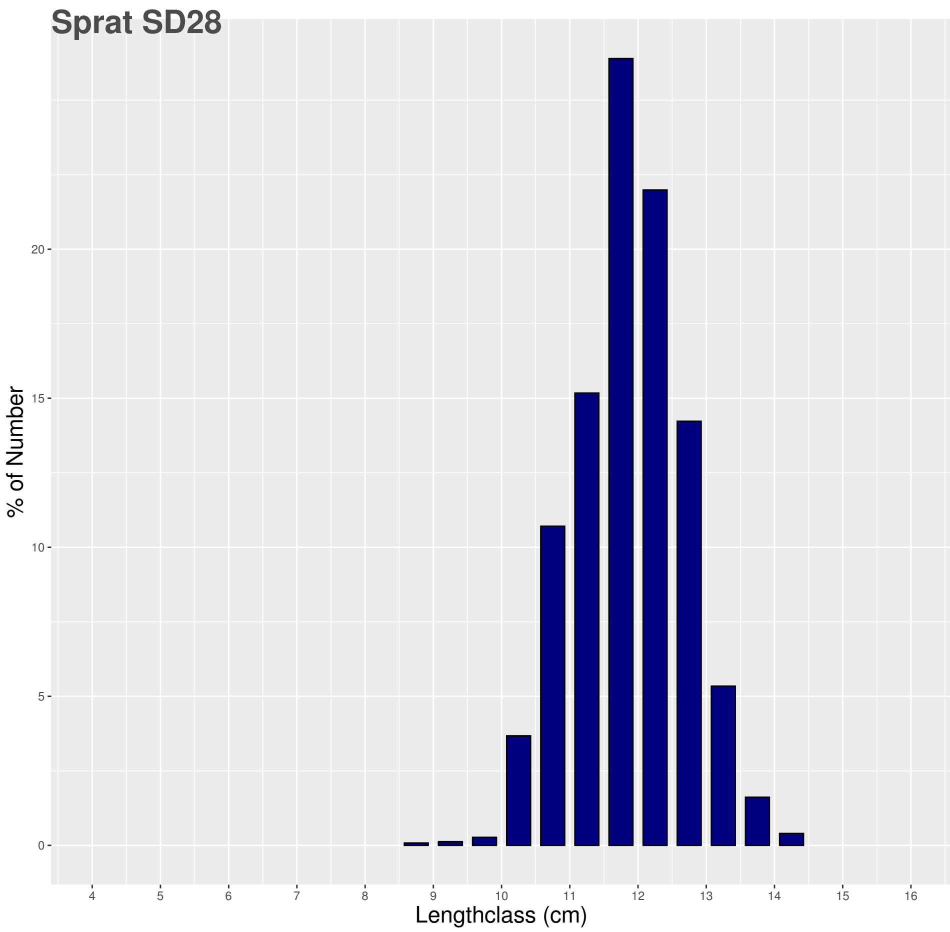

Figure 6. Length distribution of sprat from subdivision 28 for BIAS 2021.

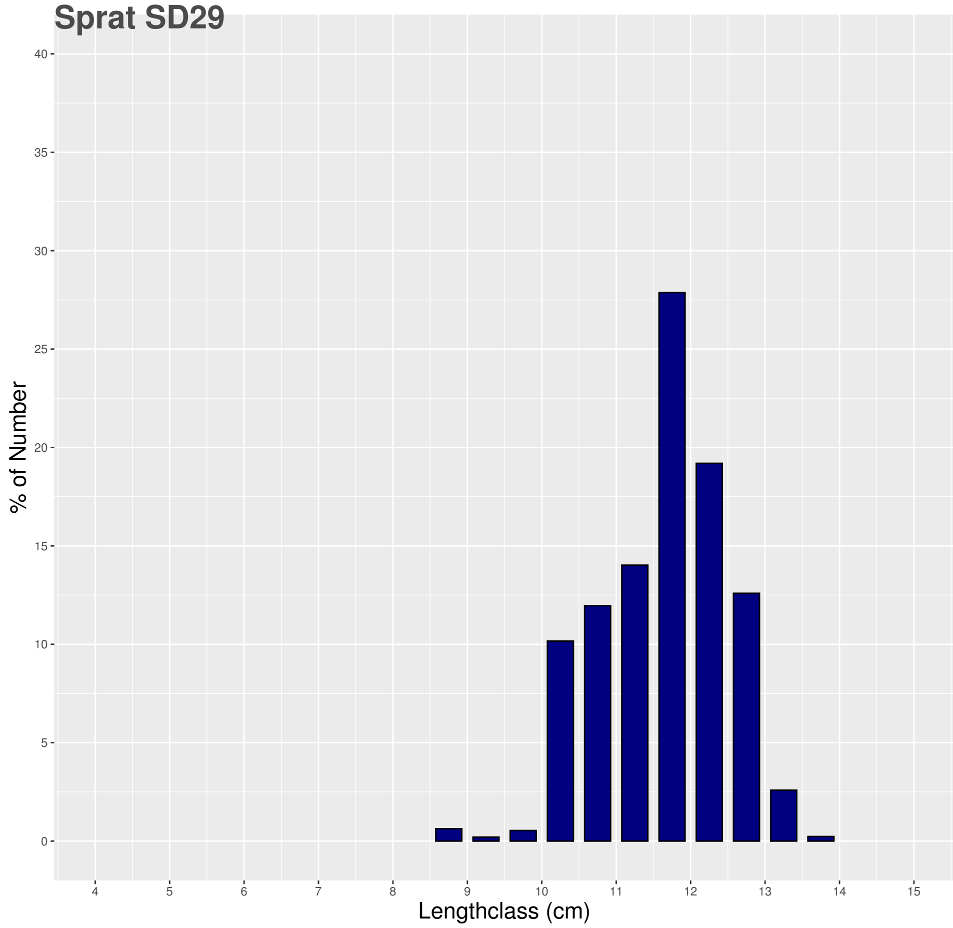

Figure 7. Length distribution of sprat from subdivision 29 for BIAS 2021.

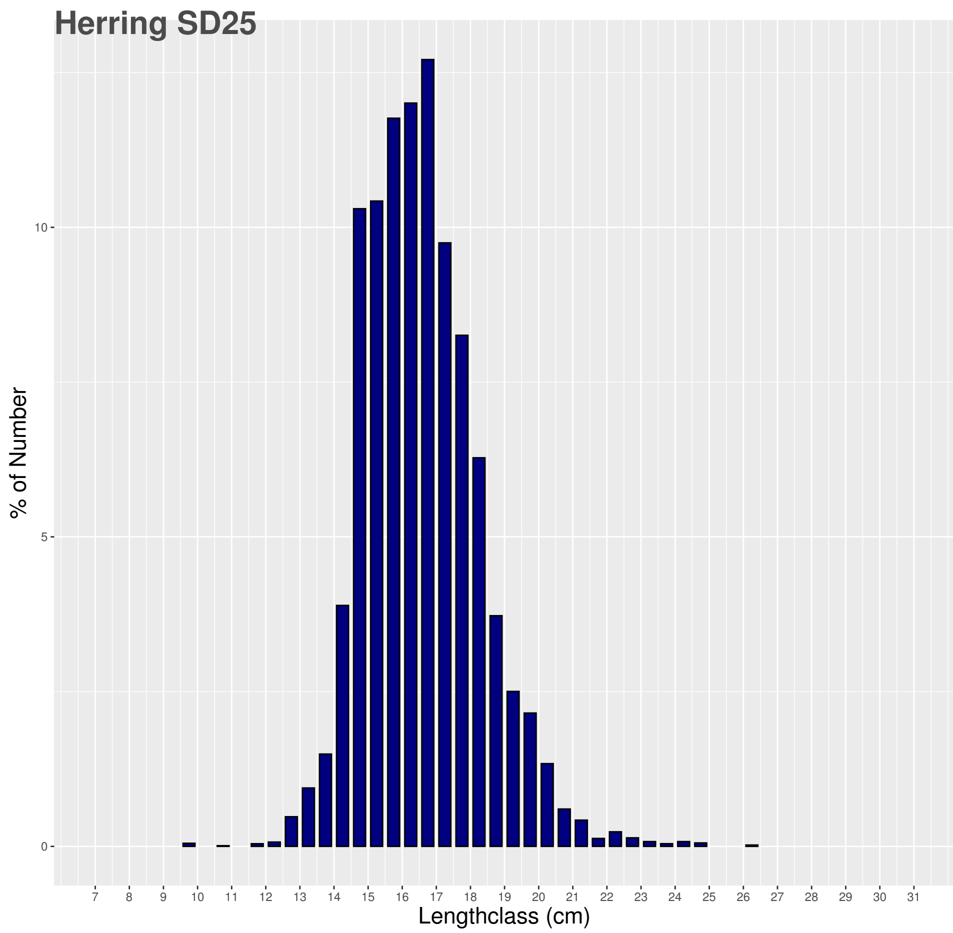

Figure 8. Length distribution of herring from subdivision 25 for BIAS 2021.

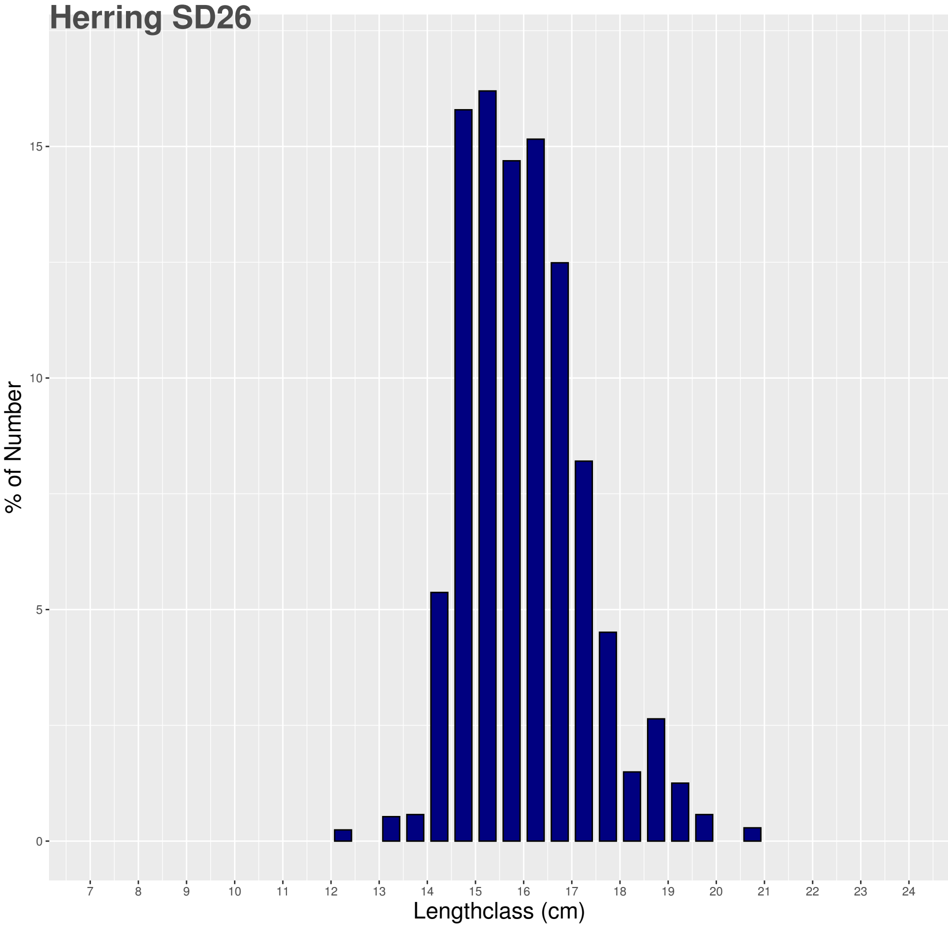

Figure 9. Length distribution of herring from subdivision 26 for BIAS 2021.

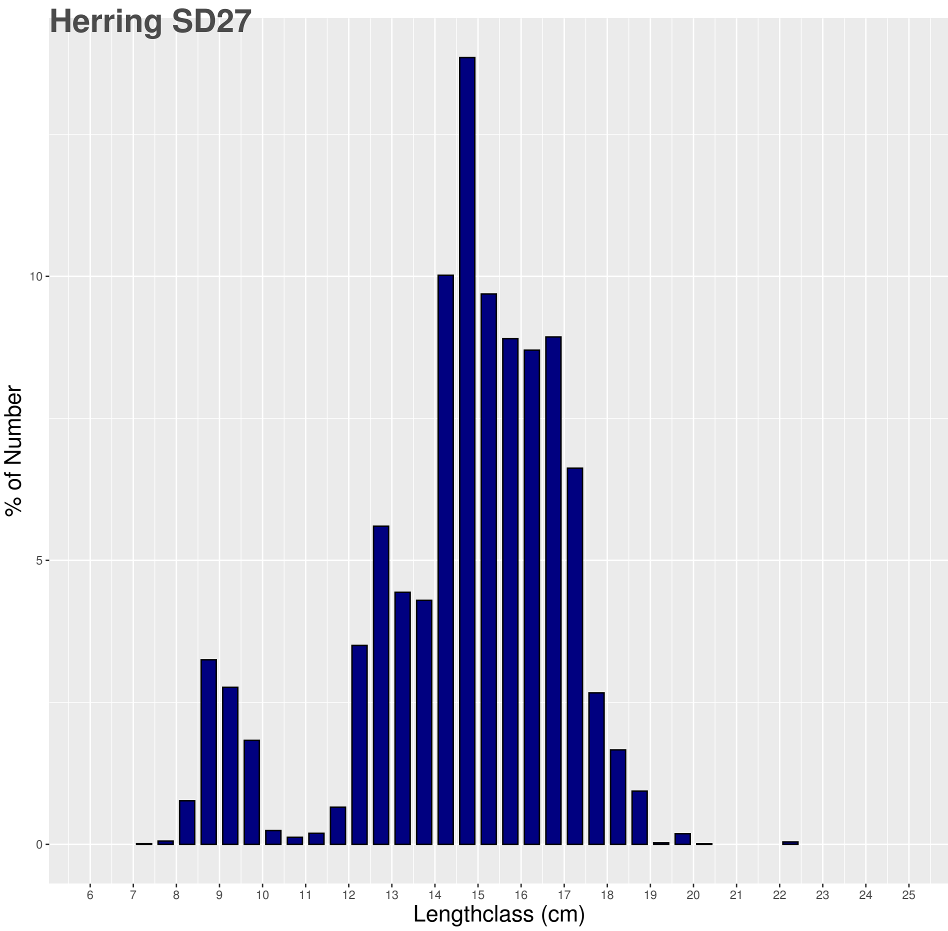

Figure 10. Length distribution of herring from subdivision 27 for BIAS 2021.

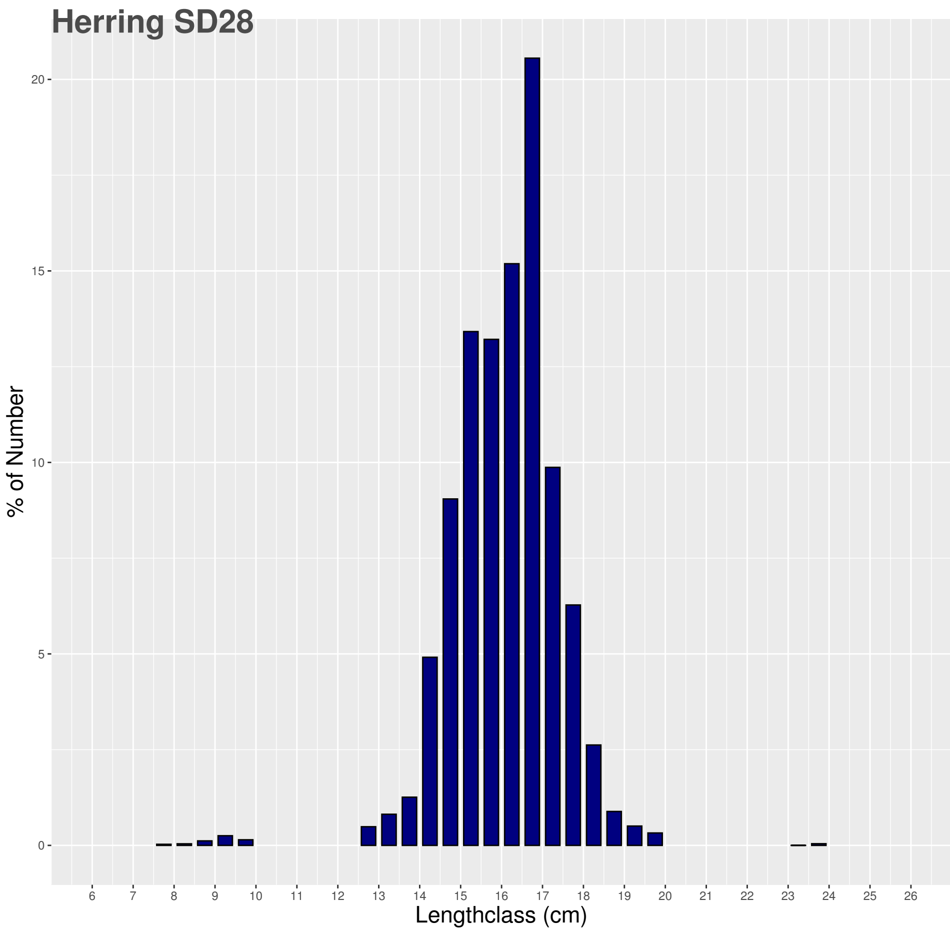

Figure 11. Length distribution of herring from subdivision 28 for BIAS 2021.

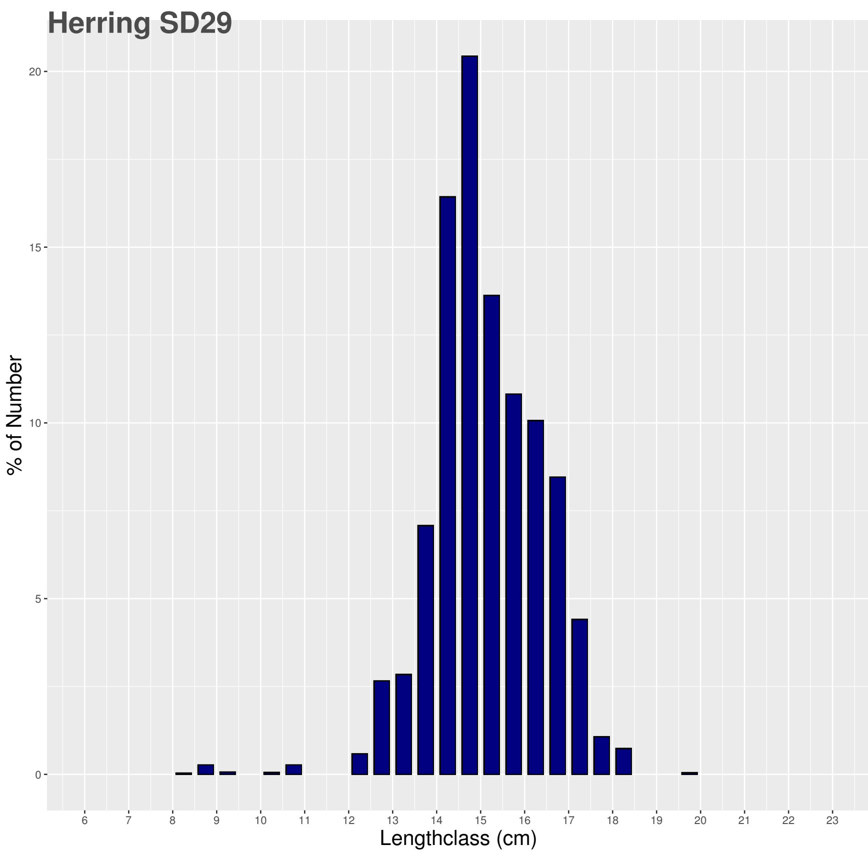

Figure 12. Length distribution of herring from subdivision 29 for BIAS 2021.

Joint Latvian-Estonian Gulf of Riga Acoustic Herring Survey (GRAHS) in the Baltic Sea ICES SD 28.1 on the f/v „ULRIKA", 28.07-03.08.2021

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Riga-Tartu-Tallinn-Pärnu
March 2022

Cruise Report

Since 1999 in July-August on rented Latvian fishing vessels a joint Latvian-Estonian Acoustic Survey in the Gulf of Riga named as „Gulf of Riga Acoustic Herring Survey or GRAHS" has been carried out. The main aim of the survey is to obtain abundance estimates of herring in the Gulf of Riga which are used for tuning VPA for the assessment of the Gulf of Riga herring (separate assessment unit). The survey is conducted in collaboration with Estonian Marine Institute within the framework of ICES. From each trawl the length, weight, sex and maturity of herring and otoliths for age determination are taken. During the survey also the basic hydrological parameters (temperature, salinity, oxygen content) were measured and zooplankton samples taken as well. Collected data are stored in the national database BIODATA as well as in the BAD1 format and ICES Acoustic_db.

In 2021 the survey was performed on period of 28th July – 3rd August on the rented Latvian commercial fisheries vessel "Ulrika" in the Gulf of Riga (ICES Sub-division 28.1). The vessel left the Ventspils port (Latvia) on 28.07.2021 at 00:05 (UTC+3:00) o'clock and was navigated in the north-east direction to the echo-integration start point at the geographical position 57°43'N 022°06'E. The direct at sea researches began on 28.07.2021 at 06:00 o'clock. The survey ended on 03.08.2021 at 15:00 o'clock in the Ventspils harbor (Latvia).

Acoustic data were collected with the SIMRAD ES80 38 kHz frequency split beam scientific echo-sounder equipped with "EchoView Version 7.10" software for the data analysis. The survey echo-integration tracks were planned in the similar pattern as in the previous years, due to historical comparability of the data. Overall, 445 nautical miles long survey tracks were observed and recorded with hydroacoustic equipment. The final pattern of transects was covered with a relatively good density. (Fig. 1).

The f/v "Ulrika" realized 14 fish control-catches. All catches were performed in the daylight, between 09:07 and 20:28 (UTC+03:00), using the pelagic trawl (with 10 mm mesh bar length in the codend). The standard trawling duration is 30 minutes, but due to bad weather conditions and relatively good acoustic records all trawlings were shortened to 10-20 minutes. The mean speed of vessel while trawling was 3.0 knots. Totally 9 hauls were performed in the Latvian and 5 hauls in Estonian EEZs.

The length measurements in 0.5 cm length classes were realized for herring, sprat, smelt and stickleback individuals, for others in the by-catch the total length was taken. In total 3499 individuals of 14 fish species were measured. Detailed ichthyologic analyses were made only for 1227 herring and according to standard procedures, directly on board of surveying vessel.

The catch weight in kg, catch numbers and share of both parameters in % are aggregated in Tab 1-4.

The Catch per unit effort values (CPUE, kg/h) of fish species by haul are aggregated in Tab 5-6 and mean weights (g) and length (cm) in Tab 7-8.

CPUE (kg/h) areal distribution of dominant pelagic fish and the mean area scattering cross-section NASC distributions during survey are shown in Figures 2-4. Herring distribution in the Gulf of Riga is shown in Fig. 5. The main Herring concentrations were observed in the Central and Central-Eastern part of Gulf of Riga over the depth more than 30 m.

Herring in the Gulf of Riga has bimodal length distribution pattern (Fig. 6). The first length frequency peak in Latvian EEZ had observed at 7.0 cm class, in Estonian EEZ at 7.5 cm, but the main part of herrings distributed in modal groups from 12.0 to 14.0 cm classes.

The annual stock changes of Herring shows decreasing tendency since 2018, but still reamains is on high abundance level. Herrings at age 0 shows great interannual changes in abundance.

Sprat distributed in northern part of Gulf of Riga, smelt in Eastern part, but sticklebacks in relatively small aquatory in Western part of gulf (Fig.9-11).

Reprt tables and figures of joint Latvian-Estonian hydroacustic survey in the Gulf of Riga on f/v "ULRIKA", 28.07-03.08.2021.

Tab1. Catch kg per species																	
Species							Haul									Total species	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	EE	LV	GoR
Eelpout										0.03					0.03		0.03
Flounder	0.10	0.04	0.20	0.17	0.06		0.10							0.39	0.39	0.66	1.04
Fourhorn sculpin					0.05											0.05	0.05
Greater sandeel											0.03				0.03		0.03
Herring	92.56	22.27	19.15	142.00	305.82	43.79	724.99	58.26	250.94	22.24	84.96	30.05	65.82	50.63	253.70	1659.77	1913.47
Lamprey	0.04					0.10			0.11	0.03	0.13			0.05	0.21	0.25	0.46
Lumpfish	0.01															0.01	0.01
Pikeperch										1.25					1.25		1.25
Salmon			0.44	0.26				0.25			0.13				0.13	0.95	1.08
Sea trout						0.13				0.14					0.14	0.13	0.27
Smelt				1.58		0.28	10.01		35.78	7.41	1.94	0.61			9.97	47.66	57.62
Sprat	52.51	1.62	2.02	40.33	2.11			4.02	10.16	83.35	36.15	157.98	1.67	79.86	359.01	112.77	471.78
Straightnose pipefish		0.0004														0.0004	0.0004
Three-spined stickleback	42.04	27.10	0.83		0.17	0.13		0.43	0.22		8.55	3.86	4.51	4.61	21.52	70.90	92.43
Total haul	187.24	51.04	22.64	184.33	308.21	44.43	735.10	62.95	297.21	114.46	131.89	192.50	72.00	135.54	646.38	1893.14	2539.52

Tab2. Catch n per species																	
Species							Haul									Total species	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	EE	LV	GoR
Eelpout										2					2	0	2
Flounder	1	1	1	4	1		1							3	3	9	12
Fourhorn sculpin					1										0	1	1
Greater sandeel											1				1	0	1
Herring	7725	2955	1529	8995	18353	3093	47502	4500	17181	2133	6488	2201	4715	5264	20802	111833	132635
Lamprey	1					2			2	1	4			1	6	5	11
Lumpfish	3														0	3	3
Pikeperch										24					24	0	24
Salmon			2	2				2			1				1	6	7
Sea trout						1				1					1	1	2
Smelt				85		13	1164		2276	711	154	51			916	3538	4454
Sprat	7208	180	217	4604	168			399	1024	8531	3686	18017	179	10577	40991	13799	54789
Straightnose pipefish		2													0	2	2
Three-spined stickleback	21849	13093	402		84	64		256	114		4612	2252	2338	2291	11493	35863	47356
Total haul	36786	16231	2152	13690	18607	3173	48667	5157	20597	11403	14945	22522	7233	18136	74239	165059	239299

Tab3. Catch weight share % per species

Species	Haul														Total species	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	EE	LV	GoR
Eelpout										0.0288					0.0051		0.0013
Flounder	0.0529	0.0823	0.8615	0.0895	0.0201		0.0129							0.2841	0.0596	0.0348	0.0411
Fourhorn sculpin					0.0162											0.0026	0.0020
Greater sandeel											0.0235				0.0048		0.0012
Herring	49.4312	43.6345	84.6137	77.0357	99.2241	98.5617	98.6250	92.5514	84.4312	19.4276	64.4198	15.6082	91.4197	37.3548	39.2488	87.6730	75.3476
Lamprey	0.0192					0.2251			0.0370	0.0297	0.0963			0.0369	0.0326	0.0130	0.0180
Lumpfish	0.0052															0.0005	0.0004
Pikeperch										1.0904					0.1931		0.0491
Salmon			1.9439	0.1411				0.3908			0.1008				0.0206	0.0500	0.0425
Sea trout						0.2926				0.1223					0.0217	0.0069	0.0106
Smelt				0.8557		0.6329	1.3621		12.0403	6.4779	1.4700	0.3191			1.5420	2.5173	2.2691
Sprat	28.0410	3.1828	8.9361	21.8780	0.6852			6.3791	3.4187	72.8233	27.4068	82.0678	2.3212	58.9257	55.5421	5.9566	18.5776
Straightnose pipefish		0.0008														0.00002	0.00002
Three-spined stickleback	22.4505	53.0997	3.6448		0.0544	0.2877		0.6786	0.0727		6.4827	2.0049	6.2591	3.3985	3.3296	3.7453	3.6395
Total haul	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

Tab4. Catch number share % per species

Species	Haul														Total species	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	EE	LV	GoR
Eelpout										0.0175					0.0027		0.0008
Flounder	0.0027	0.0062	0.0465	0.0292	0.0054		0.0021							0.0165	0.0040	0.0055	0.0050
Fourhorn sculpin					0.0054											0.0006	0.0004
Greater sandeel											0.0067				0.0013		0.0004
Herring	20.9989	18.2071	71.0618	65.7033	98.6380	97.4884	97.6056	87.2590	83.4173	18.7040	43.4140	9.7727	65.1952	29.0259	28.0201	67.7533	55.4266
Lamprey	0.0027					0.0630			0.0097	0.0088	0.0268			0.0055	0.0081	0.0030	0.0046
Lumpfish	0.0082															0.0018	0.0013
Pikeperch										0.2105					0.0323		0.0100
Salmon			0.0929	0.0146				0.0388			0.0067				0.0013	0.0036	0.0029
Sea trout						0.0315				0.0088					0.0013	0.0006	0.0008
Smelt				0.6228		0.4028	2.3923		11.0487	6.2347	1.0276	0.2273			1.2335	2.1435	1.8611
Sprat	19.5931	1.1065	10.0983	33.6301	0.9008			7.7318	4.9719	74.8158	24.6612	80.0000	2.4758	58.3205	55.2142	8.3599	22.8958
Straightnose pipefish		0.0123														0.0012	0.0008
Three-spined stickleback	59.3944	80.6679	18.7005		0.4504	2.0142		4.9704	0.5524		30.8570	10.0000	32.3290	12.6316	15.4811	21.7271	19.7893
Total haul	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000

Tab5. CPUE, kg/h per species																	
Species								Haul								Total species	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	EE	LV	GoR
Eelpout										0.1320					0.1320		0.1320
Flounder	0.3960	0.1680	0.7800	0.4950	0.1860		0.3800							2.3100	2.3100	0.4008	0.6736
Fourhorn sculpin					0.1494											0.1494	0.1494
Greater sandeel											0.1240				0.1240		0.1240
Herring	370.2294	89.0884	76.6092	425.9881	917.4615	131.3729	2899.9493	233.0297	1505.6283	88.9436	339.8556	180.2749	263.2887	303.7731	235.2272	738.8174	558.9638
Lamprey	0.1440					0.3000			0.6600	0.1360	0.5080			0.3000	0.3147	0.3680	0.3413
Lumpfish	0.0392															0.0392	0.0392
Pikeperch										4.9920					4.9920		4.9920
Salmon			1.7600	0.7800				0.9840			0.5320				0.5320	1.1747	1.0140
Sea trout						0.3900				0.5600					0.5600	0.3900	0.4750
Smelt				4.7318		0.8436	40.0507		214.7094	29.6569	7.7554	3.6853			13.6992	65.0839	43.0619
Sprat	210.0212	6.4983	8.0907	120.9801	6.3356			16.0616	60.9652	333.3995	144.5884	947.8835	6.6852	479.1898	382.3493	61.2790	195.0583
Straightnose pipefish		0.0016														0.0016	0.0016
Three-spined stickleback	168.1494	108.4134	3.3000		0.5028	0.3835		1.7087	1.2971		34.2006	23.1563	18.0261	27.6370	25.7550	40.5364	35.1613
Average haul	124.8299	40.8339	18.1080	110.5950	184.9271	26.6580	980.1267	62.9460	356.6520	65.4029	75.3663	288.7500	96.0000	162.6420	124.6767	177.4422	157.5595
Total haul	748.9792	204.1696	90.5400	552.9750	924.6354	133.2900	2940.3800	251.7840	1783.2600	457.8200	527.5640	1155.0000	288.0000	813.2100	3241.5940	7630.0132	10871.6072

Tab6. CPUE, n/h per species																	
Species								Haul								Total species	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	EE	LV	GoR
Eelpout										8					8		8
Flounder	4	4	4	12	3		4							18	18	5	7
Fourhorn sculpin					3											3	3
Greater sandeel											4				4		4
Herring	30899	11821	6117	26984	55060	9280	190008	17998	103088	8531	25954	13206	18862	31585	19628	50139	39242
Lamprey	4					6			12	4	16			6	9	7	8
Lumpfish	12															12	12
Pikeperch										96					96		96
Salmon			8	6				8			4				4	7	7
Sea trout						3				4					4	3	4
Smelt				256		38	4657		13654	2844	614	307			1255	4651	3196
Sprat	28830	718	869	13812	503			1595	6144	34126	14743	108104	716	63463	44230	7496	22802
Straightnose pipefish		8														8	8
Three-spined stickleback	87396	52374	1610		251	192		1025	683		18447	13513	9353	13745	13765	20504	18054
Average haul	125	41	18	111	185	27	980	63	357	65	75	289	96	163	125	177	158
Total haul	749	204	91	553	925	133	2940	252	1783	458	528	1155	288	813	3242	7630	10872

Tab7. Mean weight, g per species																	
Species								Haul								Total species	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	EE	LV	GoR
Eelpout										16.50					16.50		16.50
Flounder	99.00	42.00	195.00	41.25	62.00		95.00							128.33	128.33	77.58	96.22
Fourhorn sculpin					49.80											49.80	49.80
Greater sandeel											31.00				31.00		31.00
Herring	11.98	7.54	12.52	15.79	16.66	14.16	15.26	12.95	14.61	10.43	13.09	13.65	13.96	9.62	11.98	14.74	14.24
Lamprey	36.00					50.00			55.00	34.00	31.75			50.00	36.31	50.18	42.67
Lumpfish	3.27															3.27	3.27
Pikeperch										52.00					52.00		52.00
Salmon			220.00	130.00				123.00			133.00				133.00	160.18	156.00
Sea trout						130.00				140.00					140.00	130.00	135.71
Smelt				18.50		22.00	8.60		15.73	10.43	12.63	12.00			10.92	13.99	13.47
Sprat	7.28	9.05	9.31	8.76	12.60			10.07	9.92	9.77	9.81	8.77	9.33	7.55	8.64	8.17	8.55
Straightnose pipefish		0.20														0.20	0.20
Three-spined stickleback	1.92	2.07	2.05		2.00	2.00		1.67	1.90		1.85	1.71	1.93	2.01	1.87	1.98	1.95
Average haul	30.54	15.72	52.59	67.32	82.82	70.01	45.31	48.83	72.15	70.26	61.77	34.19	29.86	37.37	8.57	11.46	10.41

Tab8. Mean L, cm per species																	
Species								Haul								Total species	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	EE	LV	GoR
Eelpout										16.75					16.75		16.75
Flounder	23.75	15.75	25.25	15.38	18.75		20.75							21.25	21.25	18.42	19.13
Fourhorn sculpin					18.25											18.25	18.25
Greater sandeel											23.75				23.75		23.75
Herring	12.08	11.04	12.00	13.25	13.98	12.66	12.44	13.43	13.55	11.88	11.77	12.02	11.70	11.67	11.79	12.59	12.30
Lamprey	29.75					30.25	13.25		31.00	27.25	24.50			29.25	25.75	30.45	27.89
Lumpfish	6.25															6.25	6.25
Pikeperch										18.95					18.95		18.95
Salmon			25.50	23.75				23.25			26.25				26.25	24.17	24.46
Sea trout						23.25				24.75					24.75	23.25	24.00
Smelt				16.75		16.75			14.52	12.52	12.63	12.25			12.53	14.54	13.56
Sprat	10.66	11.00	11.11	11.50	12.50			11.35	10.89	11.79	11.75	10.75	11.88	11.00	11.44	11.13	11.27
Straightnose pipefish		11.25														11.25	11.25
Three-spined stickleback	6.38	6.25	6.00		5.25	5.50		6.25	5.25		6.25	4.75	6.13	6.00	6.03	5.99	6.01
Average haul	11.68	10.46	12.15	13.78	13.83	13.54	12.96	13.21	14.07	14.36	12.88	11.25	10.90	11.86	12.68	12.74	12.71

Tab9. Hauls per ICES statistical rectangle used in calculations

ICES Rect	Haul No
43H3	2,3,4,5,6
43H4	6,7
44H2	1,2,14
44H3	1,2,3,5,8,9,10,13
44H4	5,7,9,10
45H2	14
45H3/H4	10,11,12,13
Total	1-14

Tab10. Acoustic statistics per ICES statistical rectangle

Rectangle	Area, nm2	NASC, m2/nm2	NASC_Pel	NASC_HER	<σ>, m2*10^4	TS, dB	<ρ>, mln/nm2	PEL <ρ>, mln/n	<ρ>HER, mln/n	PEL, %	HER, %	SPR, %	SME, %	GTA, %
43H3	670	1432.72	1418.89	1319.82	1.66	-48.80	8.64	8.56	8.04	99.04	93.02	1.63	0.23	5.12
43H4	213	1660.48	1656.57	1637.05	1.71	-48.66	9.70	9.68	9.59	99.76	98.82		1.05	0.13
44H2	556	1048.52	1046.57	253.04	0.93	-51.29	11.24	11.22	2.72	99.81	24.18	37.73		38.09
44H3	963	1990.58	1972.13	928.10	1.09	-50.62	18.26	18.09	8.59	99.07	47.06	16.24	0.70	36.00
44H4	273	961.98	961.22	611.74	1.56	-49.05	6.15	6.14	3.91	99.92	63.64	26.75	9.54	0.06
45H2	73	1335.54	1331.25	127.75	1.02	-50.89	13.04	13.00	1.25	99.68	9.60	86.99		3.41
45H3/H4	394	886.45	885.11	366.82	1.43	-49.44	6.20	6.19	2.57	99.85	41.44	51.49	1.34	5.73
Total	3142	1377.03	1368.45	720.64	1.18	-50.26	11.63	11.56	6.13	99.38	52.66	21.41	0.96	24.96

Pel means "*Pelagic fish*": herring - HER, sprat - SPR, smelt - SME, three-spined stickleback - GTA, ninespine stickleback - GPT

Tab11. Pelagic fish number density ρ, mln/nm^2 per ICES statistical rectangle

Rectangle	Area, nm2	HER	SPR	SME	GTA	Tot
43H3	670	7.96	0.14	0.02	0.44	8.56
43H4	213	9.56		0.10	0.01	9.68
44H2	556	2.71	4.24		4.27	11.22
44H3	963	8.55	2.94	0.13	6.48	18.09
44H4	273	3.91	1.65	0.59	0.00	6.14
45H2	73	1.25	11.31		0.44	13.00
45H3/H4	394	2.56	3.19	0.08	0.35	6.19
Total	3142	6.09	2.48	0.11	2.89	11.56

Tab12. Pelagic fish biomass density ρ, kgx10^3/nm^2 per ICES statistical rectangle

Rectangle	Area, nm2	HER	SPR	SME	GTA	Tot
43H3	670	111.86	1.34	0.39	0.90	114.49
43H4	213	138.47		1.25	0.03	139.74
44H2	556	29.42	32.32		8.67	70.41
44H3	963	113.28	28.03	1.38	13.35	156.05
44H4	273	57.75	16.31	9.12	0.01	83.19
45H2	73	11.96	85.40		0.89	98.25
45H3/H4	394	33.33	29.76	1.02	0.65	64.76
Total	3142	82.64	21.63	1.51	5.91	111.69

Tab13. Pelagic fish mean length cm and mean weight g per hauls

	σ_Pel	HER		SPR		SME		GTA	
Haul	m2*10^4	<L>, cm	<w>, g	<L>, cm	<w>, g	<L>, cm	<w>, g	<L>, cm	<w>, g
1	1.27	12.31	11.98	10.74	7.28			5.80	1.92
2	0.95	10.04	7.54	11.34	9.05			5.77	2.07
3	1.36	12.53	12.52	11.42	9.31			5.72	2.05
4	1.70	13.77	15.79	11.31	8.60	16.75	18.50		
5	1.93	13.97	16.66	12.50	12.60			5.25	2.00
6	1.73	13.22	14.16			16.75	22.00	5.55	2.00
7	1.80	13.39	15.26			13.38	9.00		
8	1.61	13.00	12.95	12.11	10.07			5.97	1.67
9	1.82	13.47	14.61	10.86	9.92	14.73	15.73	5.25	1.90
10	1.39	11.69	10.43	11.63	9.77	11.70	10.43		
11	1.40	12.88	13.09	11.97	9.81	12.63	12.63	5.90	1.85
12	1.36	13.10	13.65	10.83	8.77	12.25	12.00	4.75	1.40
13	1.34	12.76	13.96	11.83	9.33			5.86	1.93
14	1.07	10.90	8.73	11.26	8.91			5.84	2.01
Tot	1.46	13.16	14.37	11.16	8.86	13.84	13.09	5.74	1.93

Tab14. Pelagic fish mean length cm and mean weight g per ICES rectangle

	HER		HER_GoR		HER_OS		SPR		SME		GTA		Pelagic fish total	
ICES Rect	<L>, cm	<w>, g	<L>, cm	<w>, g	<L>, cm	<w>, g	<L>, cm	<w>, g	<L>, cm	<w>, g	<L>, cm	<w>, g	<L>, cm	<w>, g
43H3	12.80	14.20	12.76	14.08	16.58	24.93	11.36	9.60	16.75	19.64	5.63	2.06	12.42	13.52
43H4	12.89	14.51	12.84	14.34	16.50	26.67	12.50		13.41	12.29	5.38	2.00	12.89	14.47
44H2	11.44	10.86	11.38	10.70	16.25	23.13	11.03	7.62			5.79	2.03	9.13	6.28
44H3	12.52	13.40	12.49	13.33	16.58	23.35	11.67	9.53	11.70	10.84	5.83	2.06	9.97	8.67
44H4	13.05	14.78	13.05	14.78			11.55	9.91	13.83	15.56	5.25	1.91	12.72	13.54
45H2	10.99	9.62	10.93	9.47	15.50	22.00	11.02	7.55	12.53		5.47	2.01	10.83	7.56
45H3/H4	12.35	13.02	12.34	12.97	17.00	28.00	11.20	9.34	11.89	12.27	5.56	1.83	11.36	10.47
Tot	12.57	13.58	12.53	13.48	16.53	24.49	11.58	8.74	12.31	13.56	5.70	2.05	10.64	9.66

Tab15. Pelagic fish number share % per ICES rectangle

ICES Rect	Area	HER	HER_GoR	HER_OS	SPR	SME	GTA	Tot
43H3	670	93.02	92.02	0.99	1.63	0.23	5.12	100.00
43H4	213	98.82	97.44	1.38		1.05	0.13	100.00
44H2	556	24.18	23.86	0.32	37.73		38.09	100.00
44H3	963	47.06	46.72	0.34	16.24	0.70	36.00	100.00
44H4	273	63.64	63.64		26.75	9.54	0.06	100.00
45H2	73	9.60	9.48	0.11	86.99		3.41	100.00
45H3/H4	394	41.44	41.32	0.13	51.49	1.34	5.73	100.00
Tot	3142	52.66	52.20	0.46	21.41	0.96	24.96	100.00

Tab16. Pelagic fish percentage by biomass per ICES rectangle

ICES Rect	HER	HER_GoR	HER_OS	SPR	SME	GTA	Tot
43H3	97.72	95.89	1.84	1.16	0.34	0.78	100.00
43H4	99.09	96.55	2.54		0.89	0.02	100.00
44H2	41.85	40.67	1.18	45.84		12.31	100.00
44H3	72.71	71.79	0.92	17.85	0.88	8.56	100.00
44H4	69.45	69.45		19.58	10.96	0.01	100.00
45H2	12.21	11.88	0.33	86.88		0.91	100.00
45H3/H4	51.52	51.17	0.34	45.92	1.57	1.00	100.00
Tot	73.99	72.82	1.17	19.37	1.35	5.29	100.00

Tab17. Pelagic fish numbers in millions per ICES rectangle

ICES Rect	Area	HER	HER_GoR	HER_OS	SPR	SME	GTA	Tot
43H3	670	5278.17	5221.72	56.45	92.35	13.23	290.62	5674.37
43H4	213	2032.13	2003.77	28.36		21.53	2.70	2056.36
44H2	556	1505.80	1485.86	19.94	2350.10		2372.05	6227.95
44H3	963	8142.37	8083.15	59.22	2809.91	121.56	6227.96	17301.81
44H4	273	1066.66	1066.66		448.41	159.89	1.07	1676.02
45H2	73	90.78	89.70	1.08	822.95		32.27	946.00
45H3/H4	394	1008.91	1005.80	3.11	1253.39	32.52	139.58	2434.41
Tot	3142	19124.82	18956.66	168.16	7777.12	348.73	9066.25	36316.92

Tab18. Pelagic fish biomass in tons per ICES rectangle

ICES Rect	HER	HER_GoR	HER_OS	SPR	SME	GTA	Tot
43H3	74945.11	73537.75	1407.36	886.89	259.80	599.80	76691.60
43H4	29493.06	28736.92	756.14		264.70	5.40	29763.16
44H2	16357.55	15896.33	461.21	17916.63		4813.50	39087.68
44H3	109090.91	107708.35	1382.56	26788.79	1317.58	12840.56	150037.85
44H4	15764.60	15764.60		4445.25	2487.90	2.05	22699.79
45H2	873.31	849.54	23.78	6213.87		64.89	7152.08
45H3/H4	13133.13	13045.94	87.19	11706.13	399.12	255.10	25493.49
Tot	259657.67	255539.44	4118.23	67957.56	4729.10	18581.30	350925.64

Tab19. Herring population abundance and number share % per ICES rectangle

ICES Rect	HER Tot $n10^6$	GoR pop. %	OS pop, %	GoR pop. n	OS pop. n
43H3	5278.17	98.93	1.07	5221.72	56.45
43H4	2032.13	98.60	1.40	2003.77	28.36
44H2	1505.80	98.68	1.32	1485.86	19.94
44H3	8142.37	99.27	0.73	8083.15	59.22
44H4	1066.66	100.00	0.00	1066.66	0.00
45H2	90.78	98.81	1.19	89.70	1.08
45H3/H4	1008.91	99.69	0.31	1005.80	3.11
Total	19124.82	99.12	0.88	18956.66	168.16

Tab20. GoR Herring stock												
n, %	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	13.33	28.29	27.57	5.05	12.07	4.68	3.78	1.80	1.08	1.08	1.26	100.00
43H4	8.49	35.85	24.53	8.02	12.26	4.25	4.25	1.42	0.94			100.00
44H2	29.53	30.87	26.85	1.68	6.38	2.35	2.01			0.34		100.00
44H3	14.41	33.46	25.40	5.01	10.74	4.40	3.30	1.22	0.61	0.98	0.49	100.00
44H4	4.51	39.52	23.34	7.16	13.00	4.51	3.45	1.86	1.06	1.33	0.27	100.00
45H2	37.35	33.73	21.69	1.20	4.82		1.20					100.00
45H3/H4	14.86	35.91	23.22	5.88	10.22	2.48	5.26	1.55	0.31	0.31		100.00
Total	14.25	32.56	25.77	5.22	11.00	4.18	3.53	1.35	0.73	0.83	0.57	100.00
n, 10^6	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	696.23	1477.13	1439.50	263.44	630.37	244.62	197.58	94.09	56.45	56.45	65.86	5221.72
43H4	170.13	718.33	491.49	160.68	245.75	85.07	85.07	28.36	18.90			2003.77
44H2	438.78	458.72	398.89	24.93	94.74	34.90	29.92			4.99		1485.86
44H3	1164.61	2704.25	2052.86	404.65	868.52	355.30	266.48	98.70	49.35	78.96	39.48	8083.15
44H4	48.10	421.57	248.98	76.39	138.64	48.10	36.78	19.81	11.32	14.15	2.83	1066.66
45H2	33.50	30.26	19.45	1.08	4.32		1.08					89.70
45H3/H4	149.47	361.22	233.54	59.16	102.76	24.91	52.94	15.57	3.11	3.11		1005.80
Total	2700.81	6171.49	4884.72	990.34	2085.09	792.90	669.84	256.51	139.13	157.65	108.17	18956.66
<w>, g	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	2.98	10.83	15.29	17.70	19.90	20.88	22.75	23.91	23.56	24.87	25.21	14.08
43H4	3.03	10.96	15.95	18.31	19.97	20.97	21.53	22.26	22.00			14.34
44H2	2.87	10.84	14.89	17.14	19.26	20.58	21.59			22.00		10.70
44H3	3.00	10.70	15.36	17.30	19.81	20.63	22.01	23.73	22.75	23.55	25.54	13.33
44H4	3.25	10.84	15.94	17.69	19.93	20.98	21.64	24.79	22.13	23.35	27.50	14.78
45H2	3.09	11.40	14.30	22.00	17.92		20.00					9.47
45H3/H4	3.42	10.67	15.21	17.37	19.41	20.82	21.40	20.80	19.20	23.00		12.97
Total	3.00	10.78	15.38	17.60	19.82	20.77	22.08	23.54	22.84	23.94	25.39	13.48
B, kg10^3	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	2072.55	16000.59	22008.84	4663.38	12547.40	5106.61	4494.79	2249.27	1329.74	1404.13	1660.46	73537.75
43H4	515.12	7869.90	7841.72	2941.41	4906.87	1783.84	1831.10	631.09	415.88			28736.92
44H2	1259.45	4973.56	5937.53	427.36	1824.56	718.33	645.87			109.69		15896.33
44H3	3489.67	28941.87	31541.40	6999.69	17207.61	7330.26	5865.30	2342.37	1122.66	1859.17	1008.34	107708.35
44H4	156.18	4570.15	3968.98	1351.40	2763.18	1009.31	795.93	490.94	250.40	330.32	77.81	15764.60
45H2	103.63	344.92	278.15	23.78	77.45		21.61					849.54
45H3/H4	511.40	3854.15	3552.18	1027.58	1994.05	518.61	1132.72	323.85	59.79	71.62		13045.94
Total	8108.00	66555.14	75128.80	17434.60	41321.12	16466.95	14787.31	6037.52	3178.46	3774.94	2746.60	255539.44
B, %	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	2.82	21.76	29.93	6.34	17.06	6.94	6.11	3.06	1.81	1.91	2.26	100.00
43H4	1.79	27.39	27.29	10.24	17.08	6.21	6.37	2.20	1.45			100.00
44H2	7.92	31.29	37.35	2.69	11.48	4.52	4.06			0.69		100.00
44H3	3.24	26.87	29.28	6.50	15.98	6.81	5.45	2.17	1.04	1.73	0.94	100.00
44H4	0.99	28.99	25.18	8.57	17.53	6.40	5.05	3.11	1.59	2.10	0.49	100.00
45H2	12.20	40.60	32.74	2.80	9.12		2.54					100.00
45H3/H4	3.92	29.54	27.23	7.88	15.28	3.98	8.68	2.48	0.46	0.55		100.00
Total	3.17	26.04	29.40	6.82	16.17	6.44	5.79	2.36	1.24	1.48	1.07	100.00
<L>, cm	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	7.45	11.73	13.47	14.34	15.07	15.48	16.00	16.35	16.33	16.67	16.93	12.76
43H4	7.17	11.84	13.58	14.38	14.83	15.39	15.61	15.67	15.75			12.84
44H2	7.47	11.82	13.42	14.10	14.87	15.36	15.83			17.00		11.38
44H3	7.39	11.72	13.51	14.21	15.09	15.49	15.72	16.40	16.10	16.56	17.13	12.49
44H4	7.06	11.72	13.54	14.20	15.02	15.41	15.69	16.43	15.75	16.40	17.00	13.05
45H2	7.76	12.13	13.19	15.50	14.38		17.00					10.93
45H3/H4	7.60	11.69	13.41	14.24	14.88	15.31	15.53	15.90	15.50	16.50		12.34
Total	7.42	11.74	13.49	14.27	15.03	15.46	15.78	16.27	16.11	16.60	17.00	12.53

Tab21. OS Herring stock												
n, %	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3				0.18	0.72	0.18						1.08
43H4					1.42							1.42
44H2			0.34	1.01								1.34
44H3				0.49	0.12	0.12						0.73
44H4												
45H2			1.20									1.20
45H3/H4						0.31						0.31
Total			0.03	0.34	0.40	0.12						0.89
n, 10^6	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3				9.41	37.63	9.41						56.45
43H4					28.36							28.36
44H2			4.99	14.96								19.94
44H3				39.48	9.87	9.87						59.22
44H4												
45H2			1.08									1.08
45H3/H4						3.11						3.11
Total			6.07	63.84	75.86	22.39						168.16
<w>, g	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3				22.92	25.83	23.33						24.93
43H4					26.67							26.67
44H2			22.00	23.50								23.13
44H3				23.35	23.33	23.33						23.35
44H4												
45H2			22.00									22.00
45H3/H4						28.00						28.00
Total			22.00	23.32	25.82	23.98						24.49
B, kg10^3	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3				215.61	972.21	219.53						1407.36
43H4					756.14							756.14
44H2			109.69	351.52								461.21
44H3				921.98	230.29	230.29						1382.56
44H4												
45H2			23.78									23.78
45H3/H4						87.19						87.19
Total			133.47	1489.11	1958.64	537.01						4118.23
B, %	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3				15.32	69.08	15.60						100.00
43H4					100.00							100.00
44H2			23.78	76.22								100.00
44H3				66.69	16.66	16.66						100.00
44H4												
45H2			100.00									100.00
45H3/H4						100.00						100.00
Total			3.24	36.16	47.56	13.04						100.00
<L>, cm	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3				16.00	16.63	17.00						16.58
43H4					16.50							16.50
44H2			15.50	16.50								16.25
44H3				16.38	17.00	17.00						16.58
44H4												
45H2			15.50									15.50
45H3/H4						17.00						17.00
Total			15.50	16.35	16.63	17.00						16.53

Tab.22 Total herring stock												
n, %	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	13.19	27.99	27.27	5.17	12.66	4.81	3.74	1.78	1.07	1.07	1.25	100.00
43H4	8.37	35.35	24.19	7.91	13.49	4.19	4.19	1.40	0.93			100.00
44H2	29.14	30.46	26.82	2.65	6.29	2.32	1.99			0.33		100.00
44H3	14.30	33.21	25.21	5.45	10.79	4.48	3.27	1.21	0.61	0.97	0.48	100.00
44H4	4.51	39.52	23.34	7.16	13.00	4.51	3.45	1.86	1.06	1.33	0.27	100.00
45H2	36.90	33.33	22.62	1.19	4.76		1.19					100.00
45H3/H4	14.81	35.80	23.15	5.86	10.19	2.78	5.25	1.54	0.31	0.31		100.00
Total	14.12	32.27	25.57	5.51	11.30	4.26	3.50	1.34	0.73	0.82	0.57	100.00
n, 10^6	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	696.23	1477.13	1439.50	272.85	668.00	254.03	197.58	94.09	56.45	56.45	65.86	5278.17
43H4	170.13	718.33	491.49	160.68	274.10	85.07	85.07	28.36	18.90			2032.13
44H2	438.78	458.72	403.87	39.89	94.74	34.90	29.92			4.99		1505.80
44H3	1164.61	2704.25	2052.86	444.13	878.39	365.17	266.48	98.70	49.35	78.96	39.48	8142.37
44H4	48.10	421.57	248.98	76.39	138.64	48.10	36.78	19.81	11.32	14.15	2.83	1066.66
45H2	33.50	30.26	20.53	1.08	4.32		1.08					90.78
45H3/H4	149.47	361.22	233.54	59.16	102.76	28.03	52.94	15.57	3.11	3.11		1008.91
Total	2700.81	6171.49	4890.79	1054.18	2160.95	815.29	669.84	256.51	139.13	157.65	108.17	19124.82
<w>, g	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	2.98	10.83	15.29	17.88	20.24	20.97	22.75	23.91	23.56	24.87	25.21	14.20
43H4	3.03	10.96	15.95	18.31	20.66	20.97	21.53	22.26	22.00			14.51
44H2	2.87	10.84	14.97	19.53	19.26	20.58	21.59			22.00		10.86
44H3	3.00	10.70	15.36	17.84	19.85	20.70	22.01	23.73	22.75	23.55	25.54	13.40
44H4	3.25	10.84	15.94	17.69	19.93	20.98	21.64	24.79	22.13	23.35	27.50	14.78
45H2	3.09	11.40	14.70	22.00	17.92		20.00					9.62
45H3/H4	3.42	10.67	15.21	17.37	19.41	21.62	21.40	20.80	19.20	23.00		13.02
Total	3.00	10.78	15.39	17.95	20.03	20.86	22.08	23.54	22.84	23.94	25.39	13.58
		10.7842933	15.38857291	17.95109055	20.02812675	20.85621224	22.07598004	23.53712296	23.95330933			13.57700128
B, kg10^3	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	2072.55	16000.59	22008.84	4878.99	13519.61	5326.14	4494.79	2249.27	1329.74	1404.13	1660.46	74945.11
43H4	515.12	7869.90	7841.72	2941.41	5663.01	1783.84	1831.10	631.09	415.88			29493.06
44H2	1259.45	4973.56	6047.22	778.88	1824.56	718.33	645.87			109.69		16357.55
44H3	3489.67	28941.87	31541.40	7921.67	17437.90	7560.55	5865.30	2342.37	1122.66	1859.17	1008.34	109090.91
44H4	156.18	4570.15	3968.98	1351.40	2763.18	1009.31	795.93	490.94	250.40	330.32	77.81	15764.60
45H2	103.63	344.92	301.92	23.78	77.45		21.61					873.31
45H3/H4	511.40	3854.15	3552.18	1027.58	1994.05	605.80	1132.72	323.85	59.79	71.62		13133.13
Total	8108.00	66555.14	75262.27	18923.71	43279.76	17003.96	14787.31	6037.52	3178.46	3774.94	2746.60	259657.67
B, %	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	2.77	21.35	29.37	6.51	18.04	7.11	6.00	3.00	1.77	1.87	2.22	100.00
43H4	1.75	26.68	26.59	9.97	19.20	6.05	6.21	2.14	1.41			100.00
44H2	7.70	30.41	36.97	4.76	11.15	4.39	3.95			0.67		100.00
44H3	3.20	26.53	28.91	7.26	15.98	6.93	5.38	2.15	1.03	1.70	0.92	100.00
44H4	0.99	28.99	25.18	8.57	17.53	6.40	5.05	3.11	1.59	2.10	0.49	100.00
45H2	11.87	39.50	34.57	2.72	8.87		2.47					100.00
45H3/H4	3.89	29.35	27.05	7.82	15.18	4.61	8.62	2.47	0.46	0.55		100.00
Total	3.12	25.63	28.99	7.29	16.67	6.55	5.69	2.33	1.22	1.45	1.06	100.00
<L>, cm	Age											
ICES Rect	0	1	2	3	4	5	6	7	8	9	10	Total
43H3	7.45	11.73	13.47	14.40	15.15	15.54	16.00	16.35	16.33	16.67	16.93	12.80
43H4	7.17	11.84	13.58	14.38	15.00	15.39	15.61	15.67	15.75			12.89
44H2	7.47	11.82	13.44	15.00	14.87	15.36	15.83			17.00		11.44
44H3	7.39	11.72	13.51	14.40	15.11	15.53	15.72	16.40	16.10	16.56	17.13	12.52
44H4	7.06	11.72	13.54	14.20	15.02	15.41	15.69	16.43	15.75	16.40	17.00	13.05
45H2	7.76	12.13	13.32	15.50	14.38		17.00					10.99
45H3/H4	7.60	11.69	13.41	14.24	14.88	15.50	15.53	15.90	15.50	16.50		12.35
Total	7.42	11.74	13.50	14.40	15.08	15.50	15.78	16.27	16.11	16.60	17.00	12.57

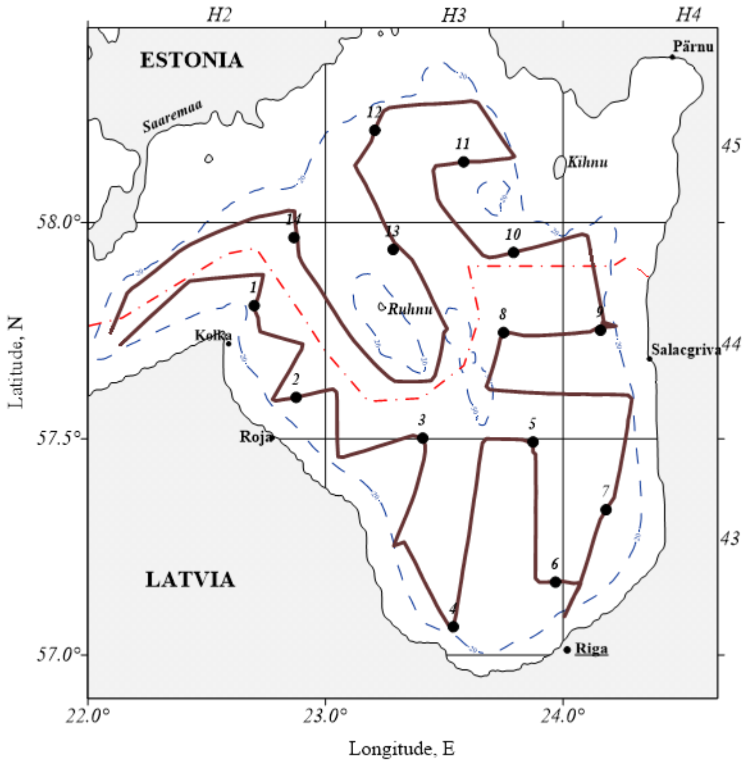

Figure 1: Cruise track design and trawling positions in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

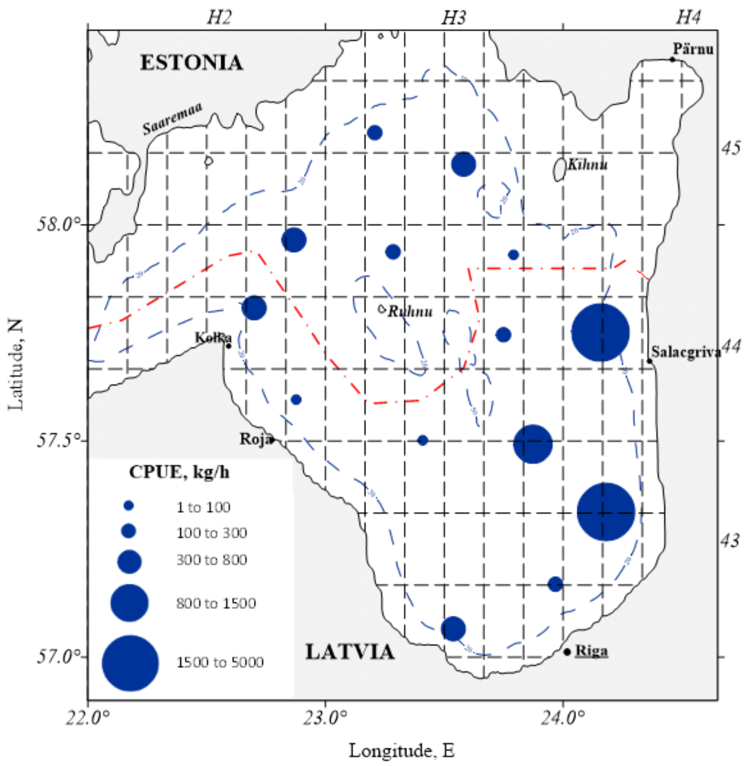

Figure 2: Herring CPUE [kg/h] of hauls in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

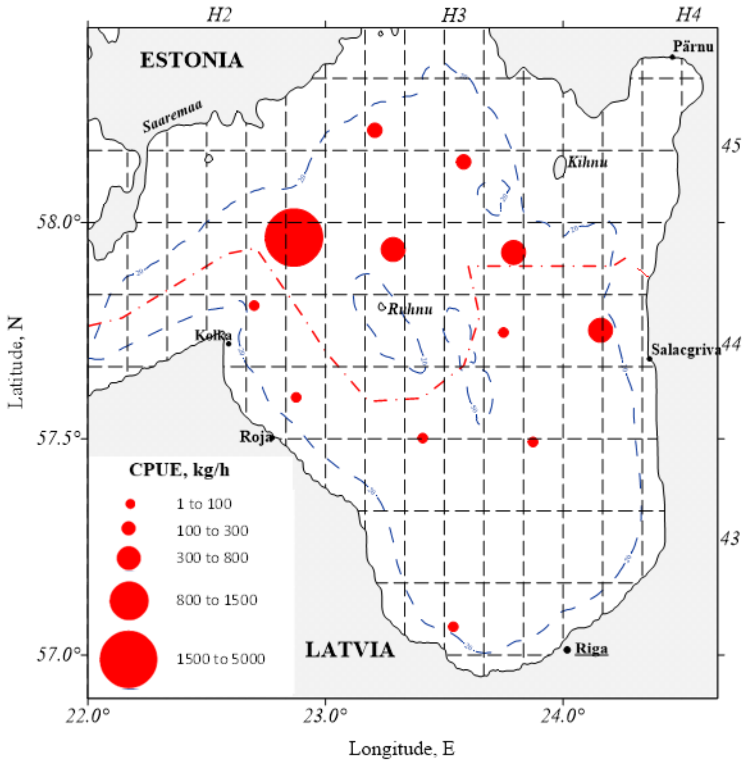

Figure 3: Sprat CPUE [kg/h] of hauls in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

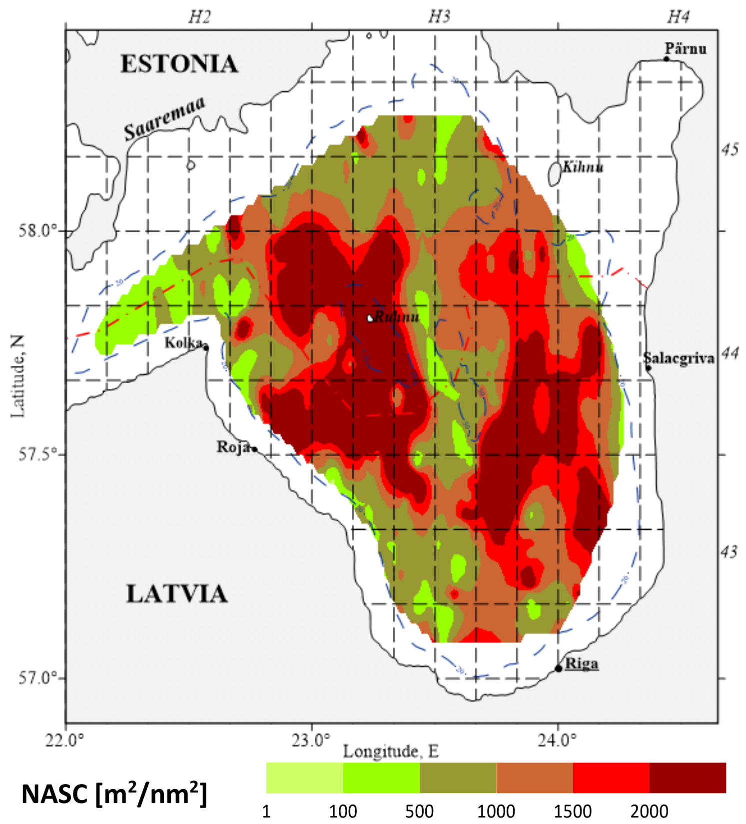

Figure 4: Acoustic parameter NASC distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

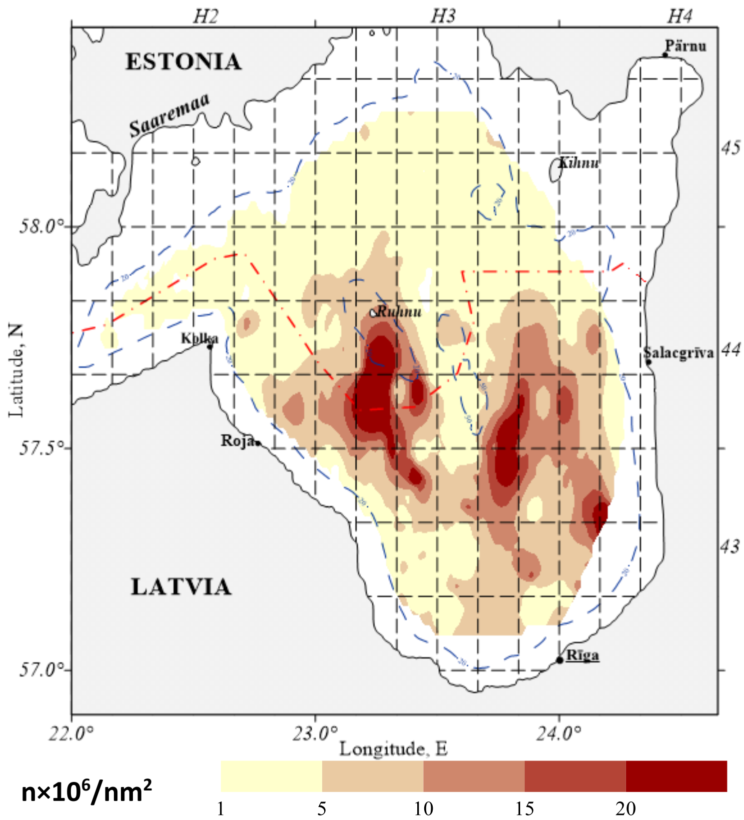

Figure 5: Herring distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

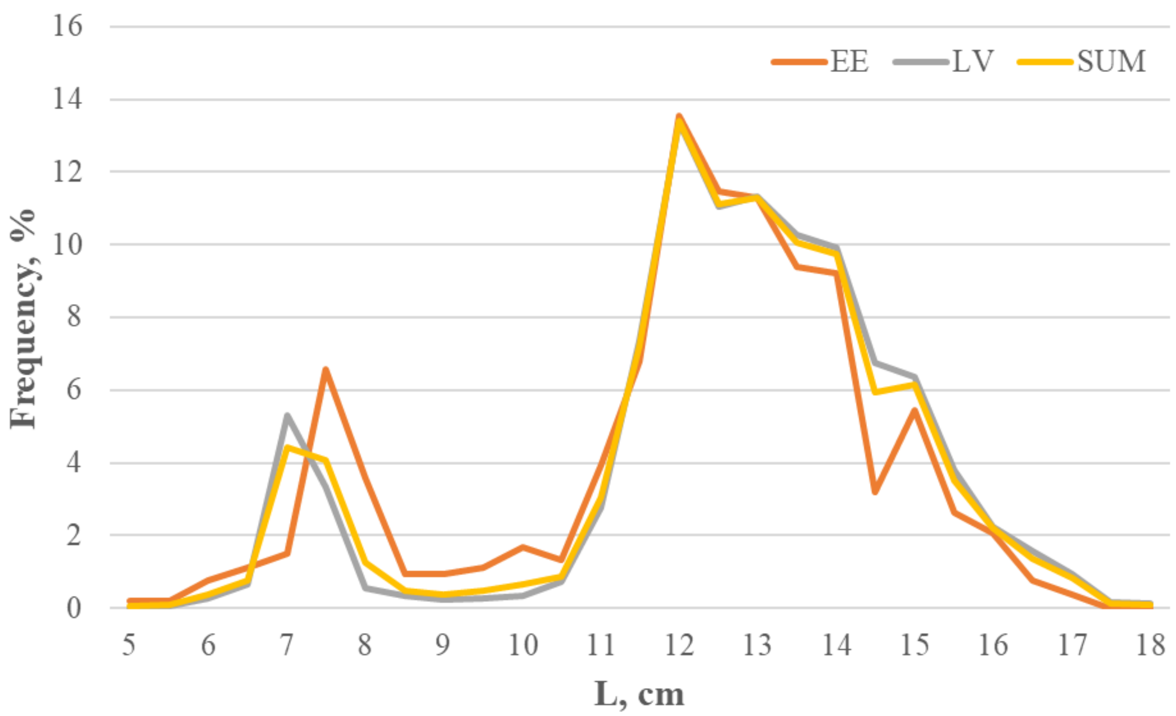

Figure 6: Length distribution of herring in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

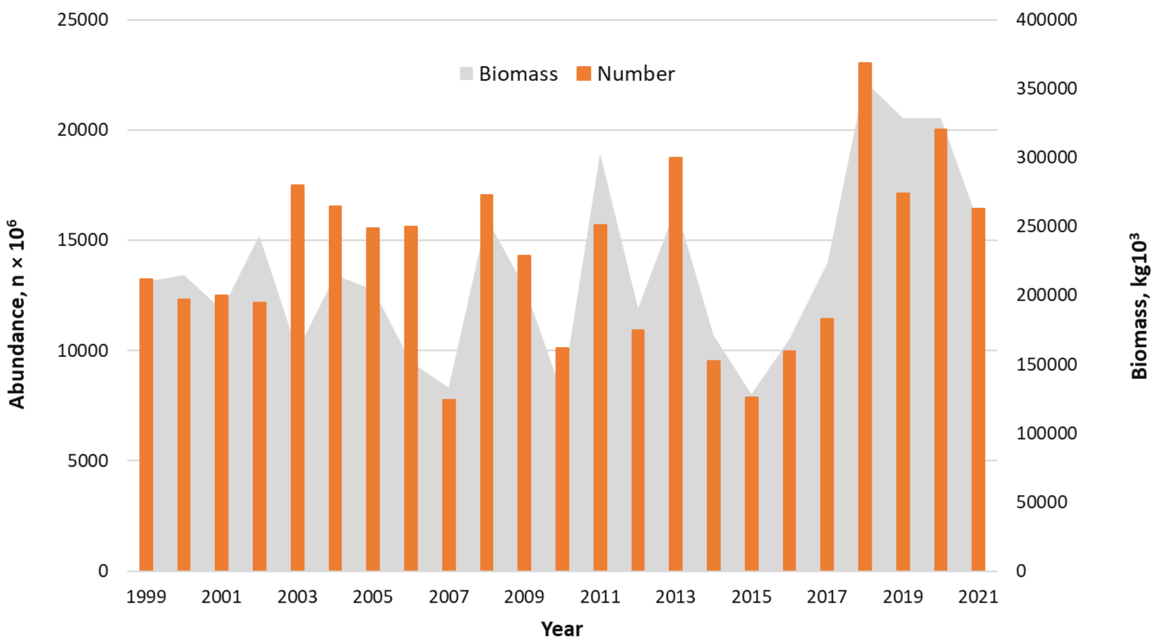

Figure 7: Annual stock changes of herring in the Gulf of Riga during GRAHS cruises.

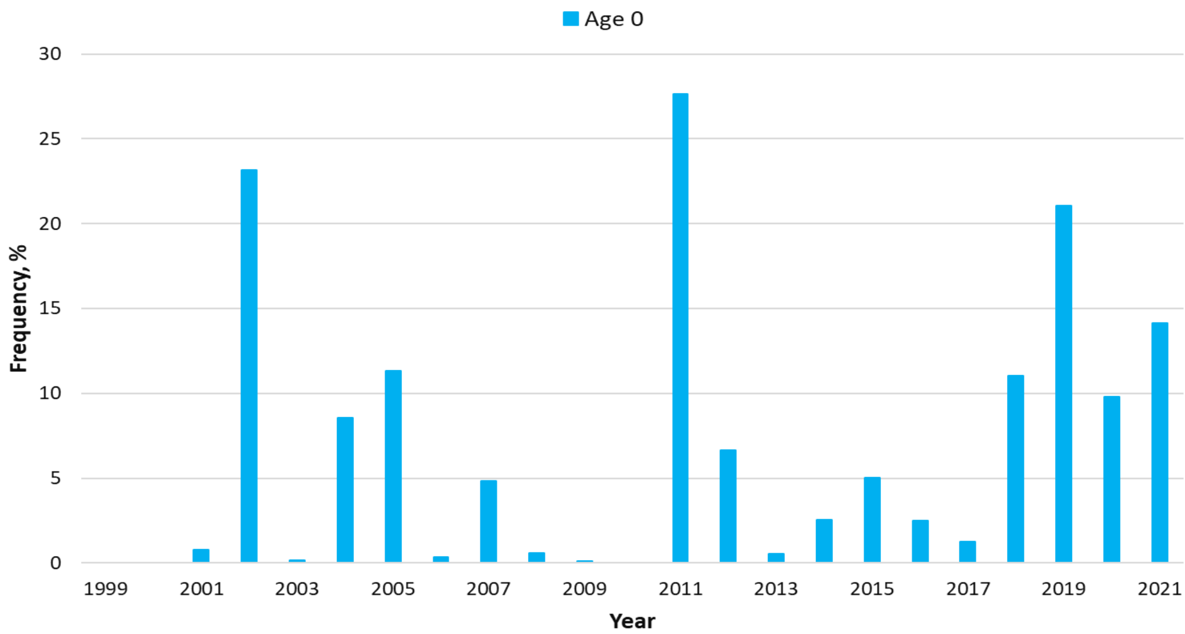

Figure 8: Annual stock changes of herring at Age 0 in the Gulf of Riga during GRAHS cruises.

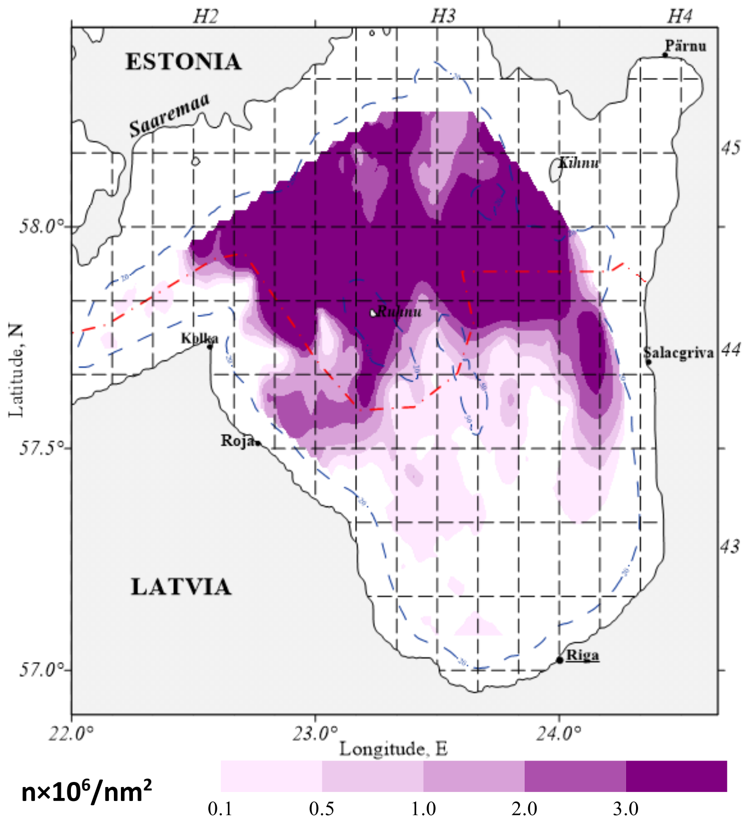

Figure 9: Sprat distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

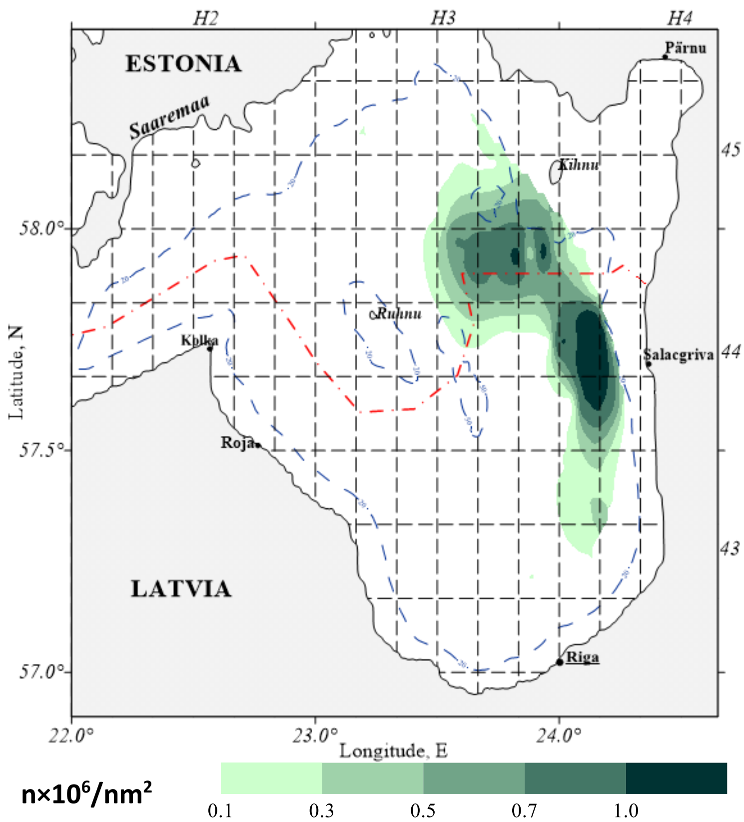

Figure 10: Smelt distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

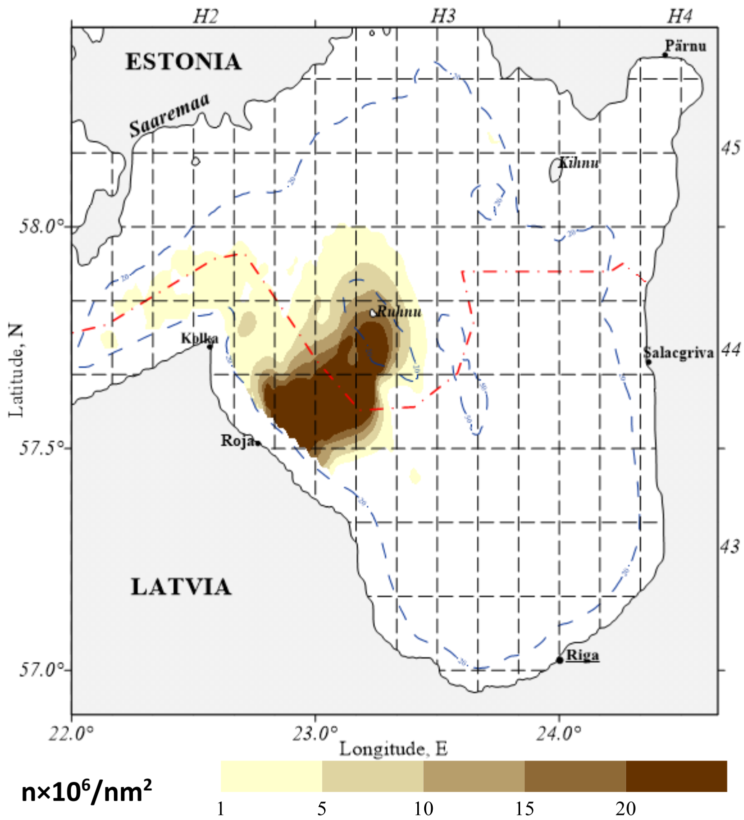

Figure 11: Three-spined stickleback distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Ulrika" in the period of 28.07-03.08.2021.

Annex 8: List of presentations made at the WGBIFS 2022 meetings

1. BASS presentation of Estonia, made by Elor Sepp (Estonia);
2. BASS presentation of Latvia, made by Guntars Strods (Latvia);
3. BASS presentation of Poland, made by Beata Schmidt (Poland);
4. BASS presentation of Germany, made by Stefanie Haase (Germany);
5. BASS presentation of Sweden, made by Anders Svenson (Sweden);
6. BIAS presentation of Finland, made by Juha Lilja (Finland);
7. BIAS presentation of Estonia, made by Elor Sepp (Estonia);
8. BIAS presentation of Latvia, made by Guntars Strods (Latvia);
9. BIAS presentation of Lithuania, made by Marijus Spegys (Lithuania);
10. BIAS presentation of Poland, made by Beata Schmidt (Poland);
11. BIAS presentation of Germany, made by Matthias Schaber (Germany);
12. BIAS presentation of Sweden, made by Niklas Larson (Sweden);
13. GRAHS presentation of Latvia, made by Guntars Strods (Latvia);
14. BITS presentation of Estonia, made by Tiit Raid (Estonia);
15. BITS presentation of Latvia, made by Ivo Sics (Latvia);
16. BITS presentation of Lithuania, made by Marijus Spegys (Lithuania);
17. BITS presentation of Poland, made by Krzysztof Radtke (Poland);
18. BITS presentation of Denmark, made by Henrik Degel (Denmark);
19. BITS presentation of Sweden, made by Olof Lövgren (Sweden);
20. BITS presentation of Germany, made by Andrés Velasco (Germany);
21. DATRAS team status and updates, made by Vaishav Soni and Adriana Villamor (ICES);
22. Presentation about ICES acoustic data portal, made by Hjalte Parner (ICES);
23. Presentation about ToR a outcomes, made by Beata Schmidt (Poland);
24. Presentation about WGBIFS 2022 acoustic tuning series, made by Olavi Kaljuste (Sweden);
25. Target strength (TS) modelling of three-spined stickleback in the Baltic Sea, made by Jonas Hentati-Sundberg (Sweden);
26. Presentation about comparison exercise between the StoX and BIAS herring abundance calculations, made by Olavi Kaljuste (Sweden);
27. Presentation about comparison exercise between the StoX and GRAHS herring abundance calculations, made by Elor Sepp (Estonia);

28. Presentation about ToR m, made by Jan Horbowy and Szymon Smolinski (Poland).
29. Presentation about Swedish new pelagic trawl “Gloria”, made by Anders Svenson and Niklas Larson (Sweden);

All these presentations are available in the folder “Presentations” in the WGBIFS 2022 SharePoint site.