This is Supplementary Document 2 to ICES 2023 Report of The Baltic International Fish Survey Working Group (WGBIFS)
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Cruise reports of pelagic fish acoustic surveys at the WGBIFS 2023 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 2022.
2. Cruise Report of Germany BASS 2022.
3. Cruise Report of Latvia-Poland joint BASS 2022.
4. Cruise Report of Poland BASS 2022.
5. Cruise Report of Sweden BASS 2022.
6. Cruise Report of Estonia-Poland joint BIAS 2022.
7. Cruise Report of Finland BIAS 2022.
8. Cruise Report of Germany BIAS 2022.
9. Cruise Report of Latvia-Poland joint BIAS 2022.
10. Cruise Report of Lithuania BIAS 2022.
11. Cruise Report of Poland BIAS 2022.
12. Cruise Report of Sweden BIAS 2022.
13. Cruise Report of Latvia-Estonia joint GRAHS 2022.

REPORT
FROM THE JOINT ESTONIAN-POLISH SPRAS 2022
CONDUCTED BY THE R/V "BALTICA" IN THE NORTH-EASTERN BALTIC SEA
(28.05 – 02.06.2022)

by

Krzysztof Koszarowski *, Elor Sepp**, Tiit Raid**, Radosław Zaporowski * and Tycjan Wodzinowski*

* National Marine Fisheries Research Institute, Gdynia (Poland)

** University of Tartu, Estonian Marine Institute, Tallinn (Estonia)

Introduction

The joint Estonian-Polish Sprat Acoustic Survey (SPRAS), marked with the number 8/2022/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 and Finnish EEZ (the ICES subdivisions 29 and 32 West).

The Estonian Data Collection Program for 2022 in accordance with the EU Commission by the European Union (EU) Fisheries Data Collection Programme for 2022 (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. 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[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 2022 survey scientific staff was composed of 8 persons:
K. Koszarowski (NMFRI, Gdynia – Poland) – survey leader, ichthyologist,
M. Bielak (NMFRI, Gdynia – Poland) – acoustician,
T. Wodzinowski (NMFRI, Gdynia – Poland) – hydrologist,
R. Zaporowski (NMFRI, Gdynia – Poland) – ichthyologist,
M. Szymański (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 28.05 – 02.06.2022. The at sea investigations (echo-integration, fish control catches and hydrological stations) were conducted aboard r/v “Baltica” within Estonian and Finnish EEZ (the ICES subdivisions 29 and 32 West), moreover inside the territorial waters of Estonia not shallower than 20 m depth.

The survey started from the Estonian EEZs on 28.05.2022 after the midnight and was navigated in the direction to the entering point of planned acoustic transect (Fig. 1). The at sea investigations ended on 31.05.2022 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 02.06.2022.

Survey design and realization

The r/v “Baltica” realized 369,6 Nm echo-integration transect and 11 fish control-catches (Fig. 1). All planned ICES rectangles were covered with acoustic transect. One ICES rectangle was not covered with control catches (48H1). All control catches were performed in the daylight (between 04:42 and 16:35 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 15 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 7 hauls were conducted in SD 29 and 4 in SD 32.

The length measurements (in 0.5 cm classes) were realized for totally 2210 sprat and 2218 herring individuals. Totally, 808 sprat and 1156 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 were 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 29 and 32 West) in May – June 2022. Sprat and herring dominated in all catches in the Estonian and Finnish EEZ. Sprat dominated in the total biomass with the mean share amounted for 71.5% (in SD 29 – 73.4%; in SD 32 – 63.3%). Mean share of herring in the total biomass was 27.5% (in SD 29 – 26.0%; in SD 32 – 34.2%). The other 6 fish species (cod, flounder, three-spined stickleback, smelt, ninespine stickleback and garfish) represented only 1.0% 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 2022 amounted for 1240.6 kg h^{-1} (comparing to 760.1 kg h^{-1} in the same period in 2021).

The highest value of CPUE for sprat and herring was noted in SD 29. The mean values of CPUE for sprat was 1224.1 kg h^{-1} in SD 29 and 311.6 kg h^{-1} in SD 32. The mean CPUE values for herring was 433.2 kg h^{-1} in SD 29 and 168.1 kg h^{-1} in SD 32. Cod and three-spine stickleback prevailed among other species in bycatch with mean CPUE values 1.6 and 10.4 kg h^{-1} for the whole investigated area.

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

The sprat length distribution curves represent similar pattern in the two investigated subdivisions. Length distribution was in range of 8.0 – 13.5 cm. In SD 29 and 32 the length distribution was unimodal, with the frequency peak observed at 10.5 – 12.0 cm length classes (73.5% and 71.7% respectively).

The herring length distribution curves represent different pattern in the investigated area. In SD 29 the length distribution is unimodal, with the frequency peak at 14.5 – 16.0 cm length classes (61.6% of measured herrings). In SD 32 the length distribution was bimodal, with the firs frequency pike at 14.0 – 14.5 cm length classes (29.9%). Second frequency peak in SD 32 and was observed at 16.0 cm length class, that amount for 10.9% of measured herrings.

The length distribution of three spine-stickleback was in range of 3.0 – 7.5 cm, taking into account the whole investigated area. The length distribution curves represent similar pattern in the two investigated subdivisions. In SD 29 the length distribution is bimodal, with the first frequency peak at 4.0 cm length classes and amounted for 13.9%. The second frequency peak was observed at 5.5 – 6.0 cm length classes and amounted for 56.4%. In SD 32 first frequency peak was observed at 3.5 – 4.0 length classes and amounted for 40.5% of measured sticklebacks. Second frequency peak was observed at 5.5 – 6.0 cm length class and amounted for 30.5%.

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.

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.

The survey plan was changed during the ICES WGBIFS meeting to cover the northern area of SD29 in Finnish zone also. In rectangles covered in 2021 and 2022 surveys, the abundances of both herring and sprat showed slight decline. Mean weights of sprat were also somewhat higher compared to previous survey.

The final report from the EST-POL SPRAS 2022 will be presented at the meeting of the ICES Baltic International Fish Survey Working Group (WGBIFS) in March 2023.

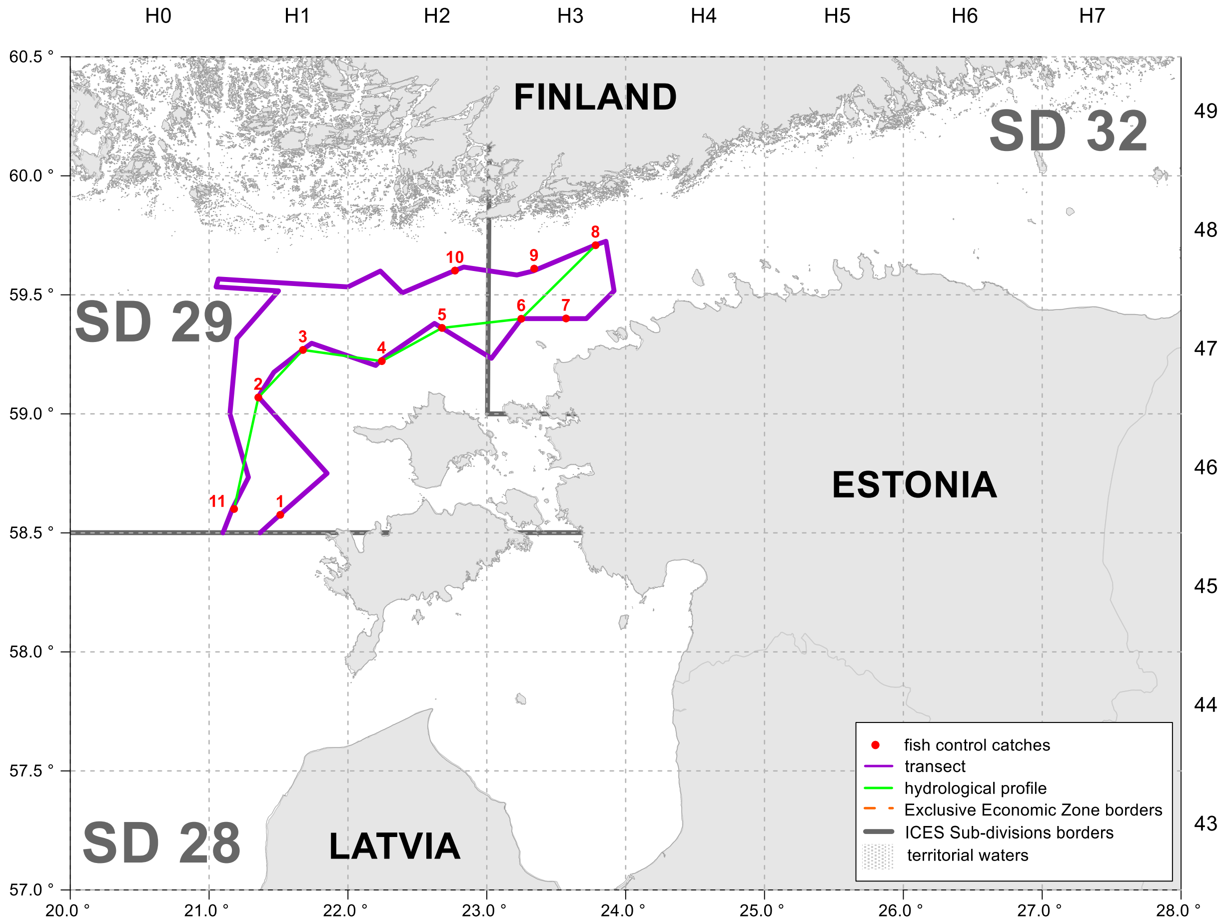

Figure 1. Acoustic transects and pelagic fish control catches with connected hydrological stations realised during the joint EST-POL SPRAS (May – June 2022)

Table 1. Catch results during joint Estonian-Polish SPRAS conducted by r/v “Baltica” in the Estonian and Finnish EEZ in May – June 2022.

Haul number	Date of catch	ICES rectangle	ICES subdivision	Depth to fishing trawl [m]	Depth to the bottom [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	Garfish	Ninespined stickleback	Smelt
Estonian EEZ																							
1	28.05.2022	46H1	29	60-80	86	260°	58°34'4	021°29'5	58°34'4	021°28'8	06:42	06:52	10	407,753	2446,518	355,172	48,085	0,983		3,513			
2	28.05.2022	47H1	29	70-90	140	020°	59°04'8	021°21'9	59°05'3	021°22'2	12:37	14:47	10	393,465	2360,790	295,585	96,525	0,236		1,119			
3	28.05.2022	47H1	29	65-85	106	045°	59°16'6	021°41'7	59°16'9	021°42'4	15:20	15:30	10	93,208	559,248	38,55	51,688	0,438	0,111	2,421			
4	28.05.2022	47H2	29	70-90	113	075°	59°13'5	022°16'3	59°13'5	022°17'4	18:25	18:35	10	208,632	1251,792	117,066	88,804	0,228		2,172	0,362		
5	29.05.2022	47H2	29	60-80	95	075°	59°21'3	022°42'0	59°21'0	022°42'8	08:10	08:20	10	448,675	2692,050	337,614	109,41	0,566		1,085			
6	29.05.2022	47H3	32	60-80	112	080°	59°24'0	023°16'4	59°24'1	023°17'8	12:02	12:17	15	183,917	735,668	140,062	42,834			1,021			
7	29.05.2022	47H3	32	65	93	060°	59°24'4	023°35'5	59°24'6	023°36'7	14:02	14:17	15	184,931	739,724	115,008	59,392	0,556		9,912		0,011	0,052
11	31.05.2022	46H1	29	65-85	93	200°	58°35'1	021°10'0	58°34'6	021°09'4	11:35	11:50	15	471,762	1887,048	396,1	74,914	0,368	0,215	0,165			
													Total	2392,343	1584,105	1795,157	571,652	3,375	0,326	21,408	0,362	0,011	0,052
Finnish EEZ																							
8	29.05.2022	48H3	32	25-40	61	240°	59°42'1	023°45'7	59°41'9	023°47'7	18:25	18:35	10	23,208	139,248	5	17,78			0,426		0,002	
9	30.05.2022	48H3	32	20-43	68	250°	59°36'3	023°19'3	59°36'0	023°17'7	06:50	07:05	15	88,503	354,012	44,207	44,144			0,152			
10	30.05.2022	48H2	29	45-48	63	240°	59°35'8	022°45'1	59°35'5	022°43'8	09:52	10:07	15	120,012	480,048	32,747	87,238			0,027			
													Total	231,723	324,436	81,954	149,162			0,605		0,002	
											SD 29			2143,507	1668,213	1572,834	556,664	2,819	0,326	10,502	0,362		
											SD 32			480,559	492,163	304,277	164,15	0,556		11,511		0,013	0,052
											Total			2624,066	1240,559	1877,111	720,814	3,375	0,326	22,013	0,362	0,013	0,052

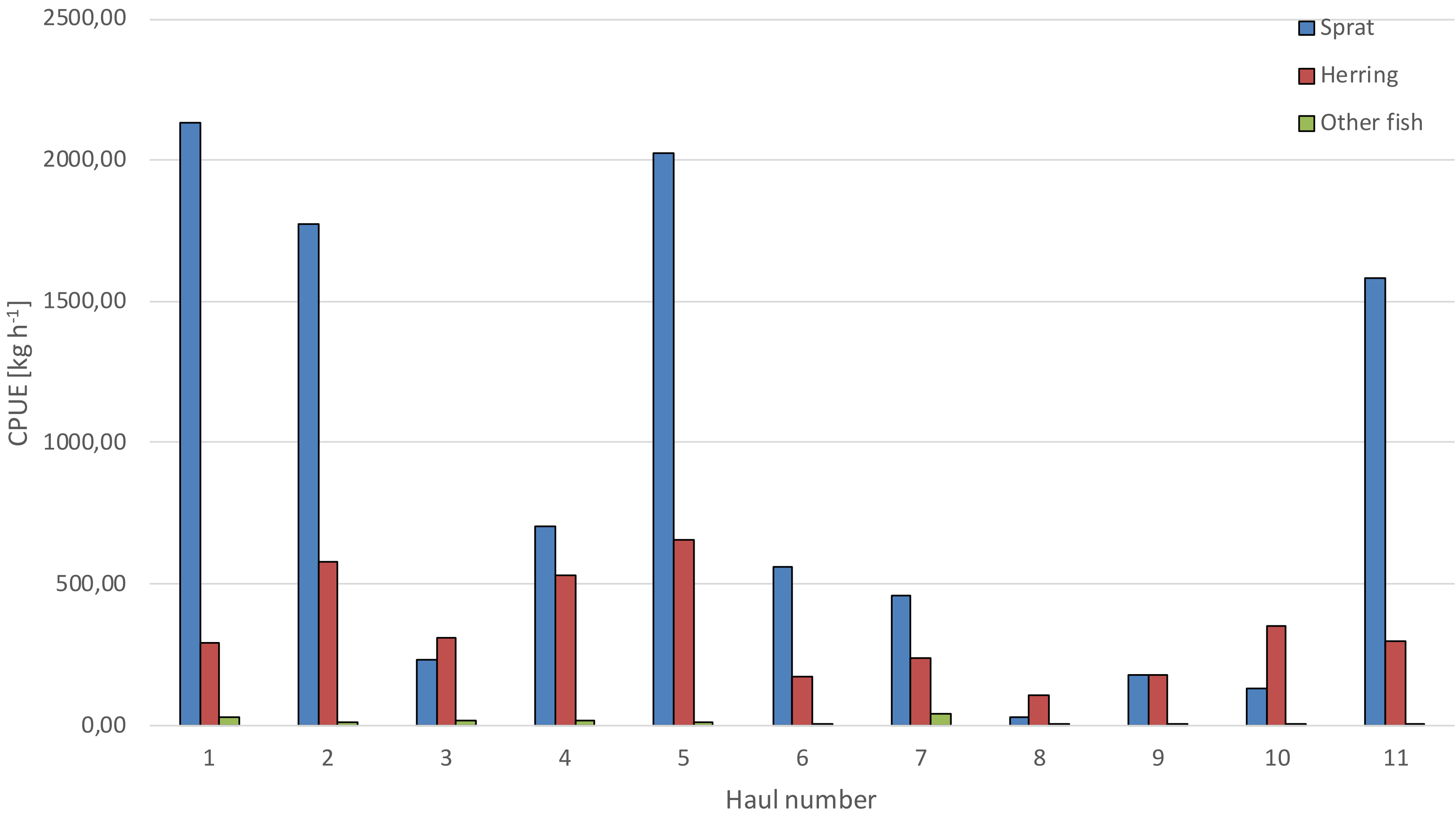

Figure 2. CPUE values (kg h^{-1}) of sprat and herring in particular pelagic fish control catches during the joint EST-POL SPRAS in the North-eastern Baltic Sea (SD 29 and 32), May – June 2022.

Table. 2. Biological sampling in the r/v "Baltica" joint EST-POL SPRAS in May – June 2022.

SD 29		Sprat	Herring	Cod	Flounder	Threespine Stickleback	Garfish	Ninespined stickleback	Smelt	Total
Samples taken	Measurements	7	7	6	2	7	1	1		31
	Analyses	7	7							14
Fish measured		1407	1409	11	2	381	1			3211
Fish analyzed		506	730							1236

SD 32		Sprat	Herring	Cod	Flounder	Threespine Stickleback	Garfish	Ninespined stickleback	Smelt	Total
Samples taken	Measurements	4	4	1		4		2	1	16
	Analyses	4	4							8
Fish measured		803	809	2		279		4	1	1898
Fish analyzed		302	426							728

TOTAL		Sprat	Herring	Cod	Flounder	Threespine Stickleback	Garfish	Ninespined stickleback	Smelt	Total
Samples taken	Measurements	11	11	7	2	11	1	3	1	47
	Analyses	11	11							22
Fish measured		2210	2218	13	2	660	1	4	1	5109
Fish analyzed		808	1156							1964

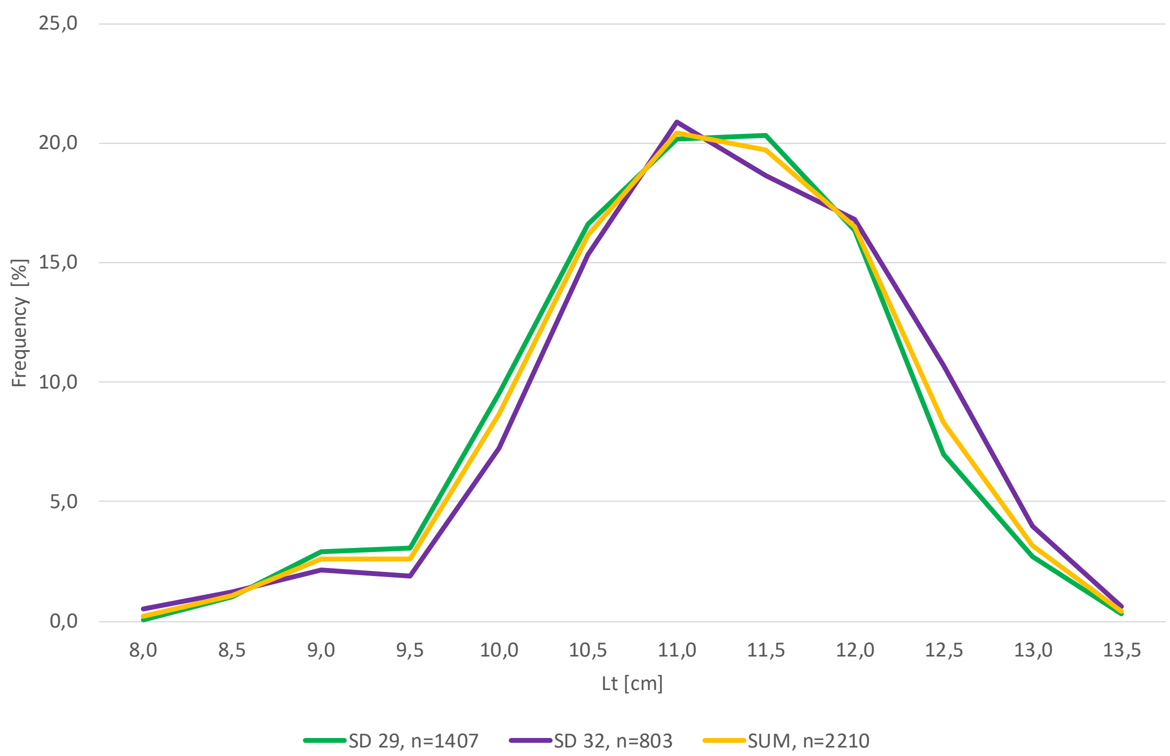

Figure 3. Sprat length distributions from the control catches conducted by the r/v "Baltica" during joint EST-POL SPRAS in the SD 29 and 32 (May – June 2022).

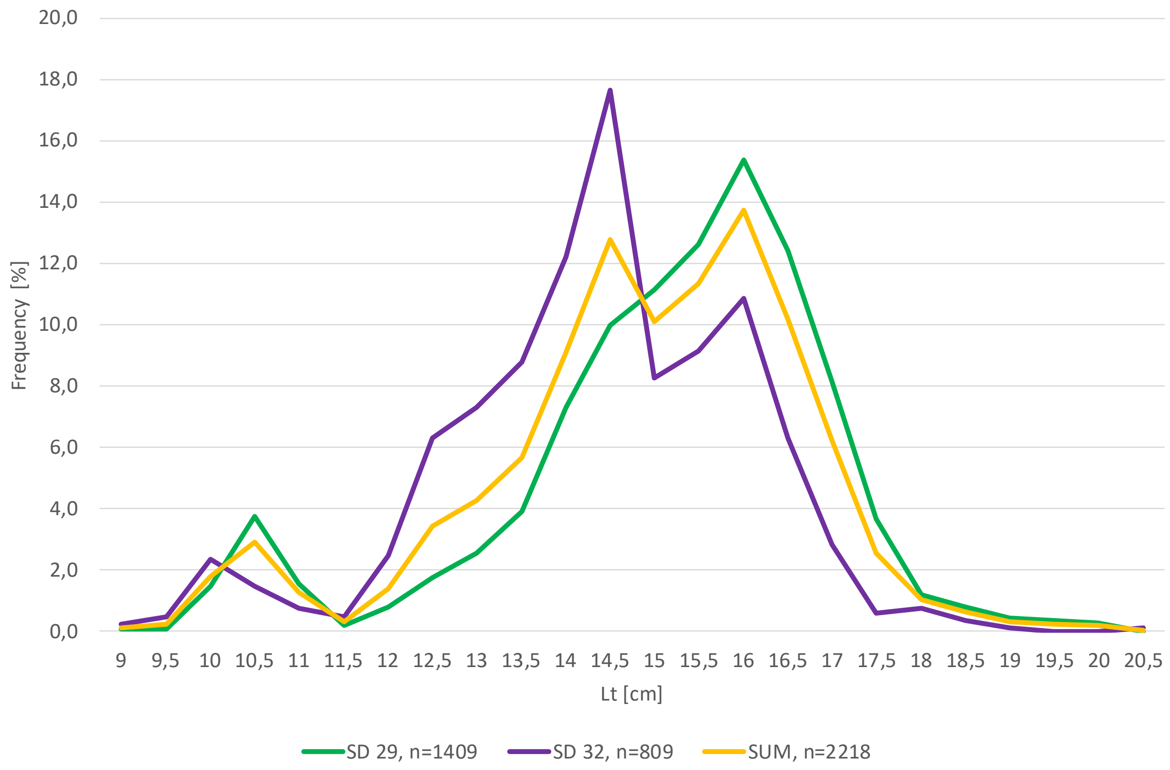

Figure 4. Herring length distributions from the control catches conducted by the r/v "Baltica" during joint EST-POL SPRAS in the SD 29 and 32 (May – June 2022).

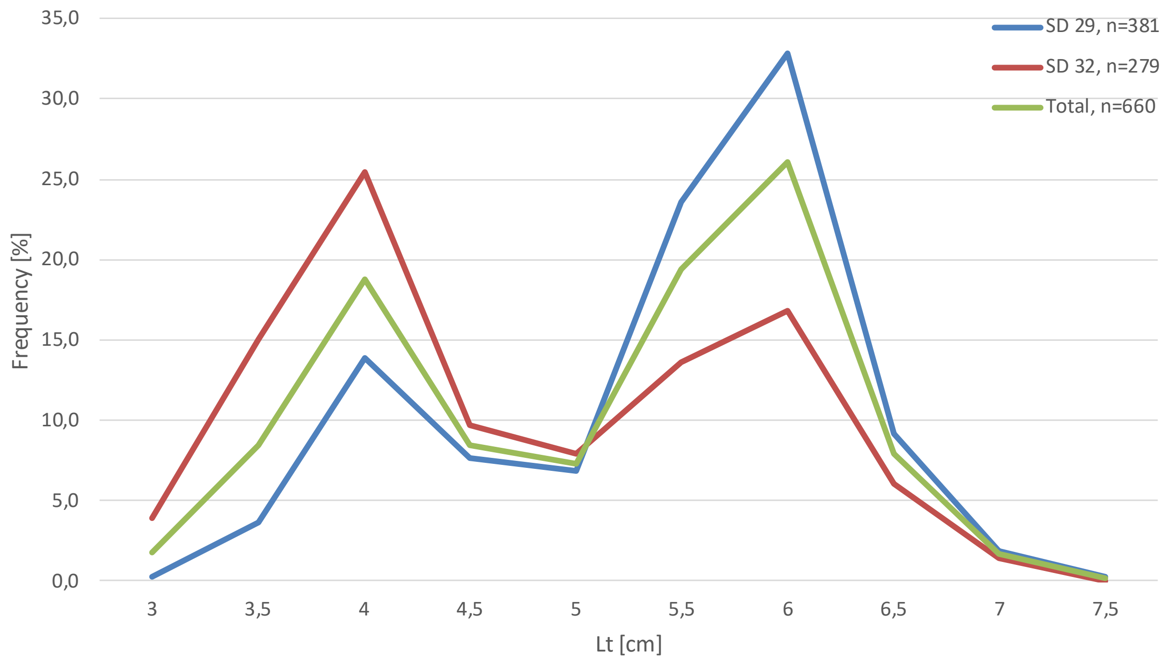

Figure 5. Three spined stickleback length distributions from the control catches conducted by the r/v "Baltica" during joint EST-POL SPRAS in the SD 29 and 32 (May – June 2022).

Table 3. The BASS survey basic biological and acoustic data concerning the clupeid stocks inhabiting the north- eastern Baltic Sea in May 2022.

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	46H1	921.5	4.7	91.9	3546.17	3.848	476.9	1.239
28	47H1	920.3	21.3	71.4	5827.37	6.332	857.7	1.355
29	47H2	793.9	16.9	79.6	3797.13	4.783	663.7	1.388
32	47H3	536.2	59.5	40.4	1869.16	2.150	402.0	1.153
29	48H1	544.0	59.5	40.4	1169.78	1.765	362.4	1.686
29	48H2	597.0	11.5	70.8	1053.82	3.486	297.5	1.686
32	48H3	615.7	47.4	45.2	2129.30	3.458347	520.5	1.505
Average			**31.5**	**62.8**		**3.727**	**511.5**	**1.430**
Total		**4929**			**19393**			

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 2022.

ICES	ICES rectangle	HERRING – age groups								
Sub-div.		1	2	3	4	5	6	7	8+	total
29	46H1	1	4	45	33	27	22	27	9	167
29	47H1	191	62	327	198	144	127	146	43	1240
29	47H2	30	28	221	121	85	62	74	19	641
32	47H3	11	34	55	35	33	17	18	14	216
29	48H1	24	215	323	62	29	21	17	4	695
29	48H2	21	194	291	56	26	19	16	4	627
32	48H3	83	359	376	100	47	18	18	7	1008
Grand total		361	896	1637	605	392	286	316	100	4594

Table 4. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups								
		1	2	3	4	5	6	7	8+	total
29	46H1	209	1258	984	180	184	123	195	125	3257
29	47H1	387	1584	1202	229	223	140	247	150	4162
29	47H2	291	856	953	210	208	125	235	144	3023
32	47H3	89	570	352	104	61	41	68	38	1323
29	48H1	11	117	160	37	44	30	45	28	472
29	48H2	10	106	144	33	39	27	41	25	426
32	48H3	29	295	253	100	77	61	76	72	963
Grand total		1026	4786	4048	894	836	546	908	583	13627

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 2022.

ICES	ICES rectangle	HERRING – age groups								
Sub-div.		1	2	3	4	5	6	7	8+	total
29	46H1	5	57	964	834	740	617	763	307	4287
29	47H1	1338	869	6155	4455	3422	3183	3726	1205	24353
29	47H2	212	402	4057	2588	1953	1453	1770	519	12955
32	47H3	72	502	970	745	764	424	431	401	4308
29	48H1	167	2763	5475	1236	591	464	383	90	11080
29	48H2	151	2489	4933	1114	533	418	345	81	10063
32	48H3	560	4847	6021	1896	990	402	402	158	15276
Grand total		2505	11930	28574	12866	8994	6960	7821	2760	82322

Table 5. Continued

ICES	ICES	SPRAT – age groups								
Sub-div.	rectangle	1	2	3	4	5	6	7	8+	total
29	46H1	1031	8758	8596	1760	1802	1218	1971	1245	26382
29	47H1	1854	11267	10484	2273	2178	1356	2517	1497	33426
29	47H2	1249	5971	8180	2044	2045	1200	2373	1418	24479
32	47H3	398	4188	3080	1012	618	427	679	405	10806
29	48H1	59	869	1408	363	443	305	462	284	4193
29	48H2	53	783	1269	327	399	275	416	256	3777
32	48H3	108	2169	2221	977	799	647	772	778	8472
Grand total		4753	34005	35239	8755	8285	5426	9190	5883	111535

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 2022.

ICES Sub-div.	ICES rectangle	HERRING – age groups								
		1	2	3	4	5	6	7	8+	avg.
29	46H1	6.08	16.03	21.51	25.26	27.37	28.09	28.57	32.64	25.63
29	47H1	7.00	13.94	18.83	22.49	23.71	25.07	25.48	27.78	19.65
29	47H2	7.01	14.19	18.32	21.33	22.89	23.56	24.06	27.31	20.21
32	47H3	6.42	14.74	17.67	21.49	23.48	25.65	24.16	28.54	19.96
29	48H1	7.07	12.84	16.97	19.98	20.12	21.77	21.99	22.66	15.93
29	48H2	7.07	12.84	16.97	19.98	20.12	21.77	21.99	22.66	16.06
32	48H3	6.77	13.50	16.01	18.96	21.05	21.73	21.80	23.06	15.15

Table 6, Continue

ICES Sub-div,	ICES rectangle	SPRAT – age groups								
		1	2	3	4	5	6	7	8+	avg.
29	46H1	4.95	6.96	8.74	9.79	9.80	9.93	10.08	9.92	8.10
29	47H1	4.79	7.11	8.72	9.94	9.75	9.71	10.20	9.97	8.03
29	47H2	4.29	6.97	8.58	9.71	9.85	9.57	10.08	9.88	8.10
32	47H3	4.48	7.34	8.75	9.71	10.14	10.48	9.94	10.55	8.16
29	48H1	5.17	7.42	8.80	9.79	10.17	10.23	10.20	10.10	8.88
29	48H2	5.17	7.42	8.80	9.79	10.17	10.23	10.20	10.10	8.88
32	48H3	3.79	7.36	8.79	9.72	10.34	10.58	10.12	10.81	8.80

Meteorological and hydrological characteristics.

The 11 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 row 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 0.7 m/s to 12.9 m/s (up to 17.8 m/s) and average speed was 5.4 m/s The most often wind direction was NNE. The air temperature ranged from 7.7 °C to 11.4 °C, and average temperature was 9.5 °C.

The seawater temperature in the surface layers (Fig. 7.) varied from 7,45 to 9.89°C and the mean was 8.86 °C. The lowest surface temperatures were recorded at the haul 6. The highest ones were noticed at the haul 3. The minimum value of salinity in Practical Salinity Unit (PSU) was 6,05 at the haul 8. The maximum was 6,93 at the haul 11. The mean value of salinity was 6,47. The oxygen content in the surface layers of investigated the research area varied in the range of 8.37 ml/l at the haul 2 to 8.75 ml/l at the haul 6. The mean value of surface water oxygen content was 8.60 ml/l.

The temperature of near bottom (Fig.8.) layer was changing in the range of 2.98 °C at the haul 8 to 6.66 °C at the haul 2, the mean was 5.52 °C . Salinity in the bottom waters varied from 7.24 at the haul 8 to 11.04 at the haul 2, and the mean was 9.77 in the PSU. Oxygen content varied from 0.00 ml/l to 7.42 ml/l and the mean was 2.26 ml/l. The zero values of this parameter were noticed at the hauls: 2, 3, 4, 6 and 7.

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.

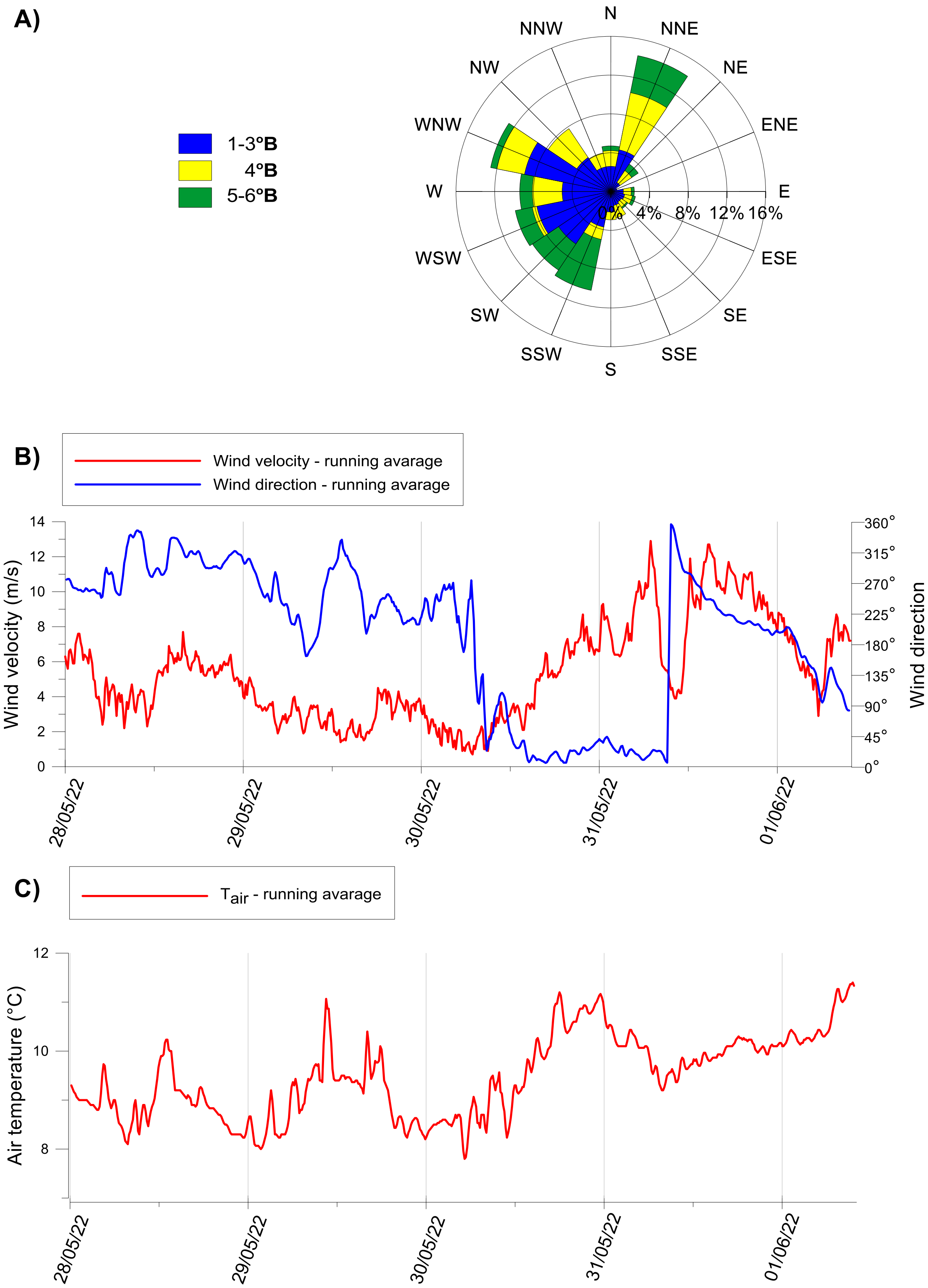

Figure 6. Changes of the main meteorological parameters (May – June 2022).

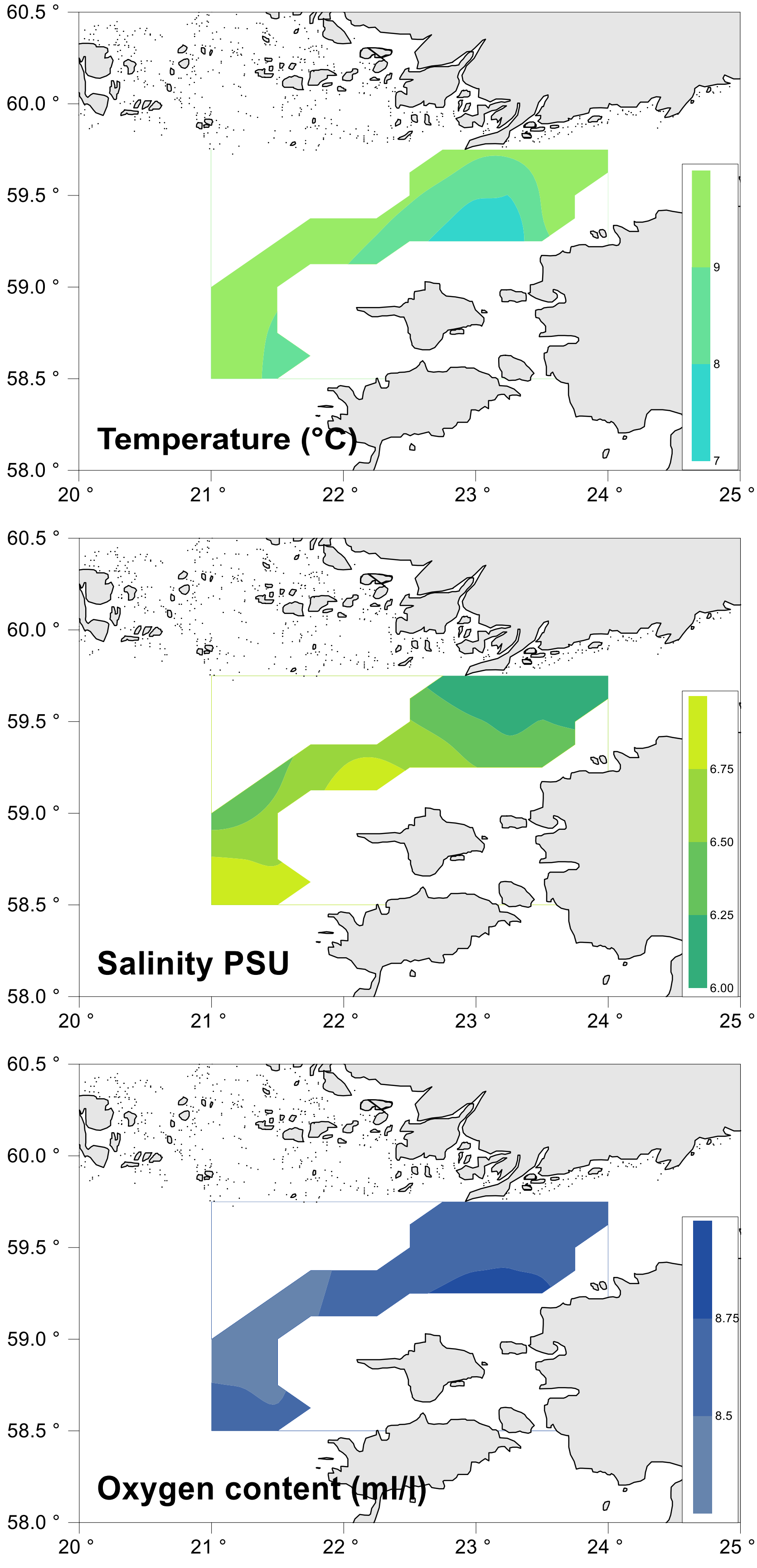

Figure 7. Distribution of the seawater temperature, salinity and oxygen content in the surface waters (May – June 2022).

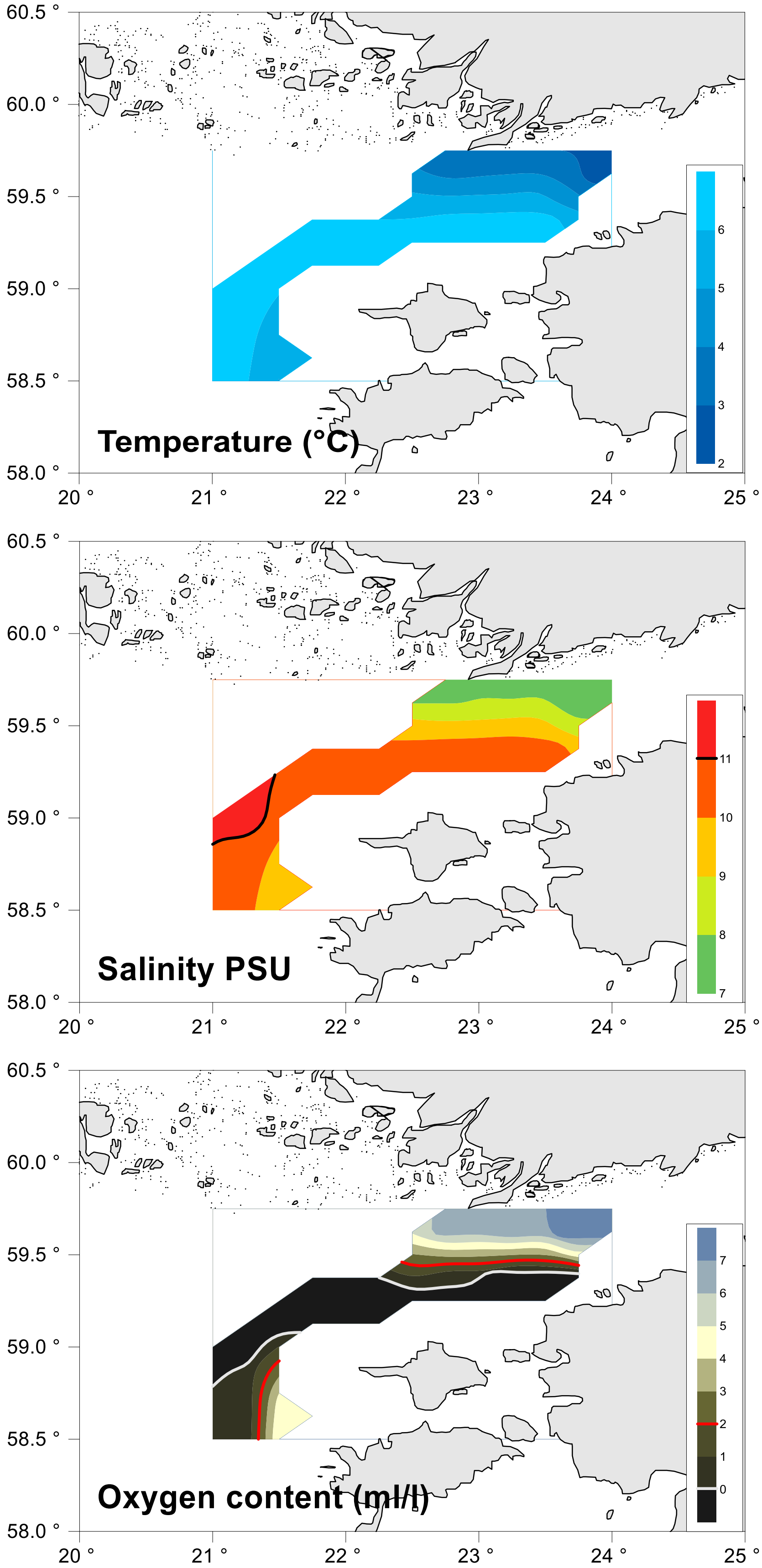

Figure 8. Distribution of the seawater temperature, salinity and oxygen content in the near bottom waters (May – June 2022).

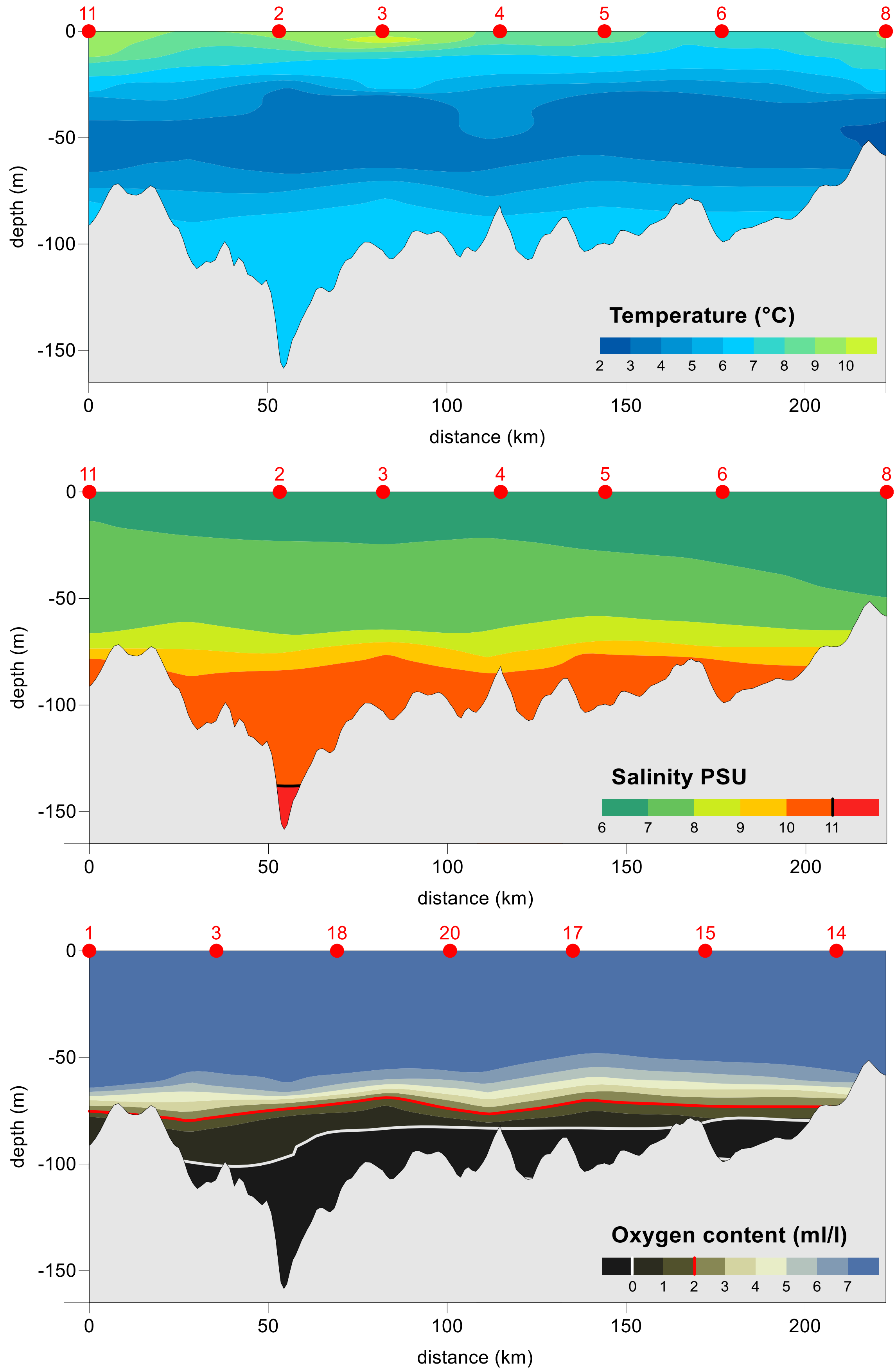

Figure 9.Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological profile (May – June 2022).

Federal Research Institute for Rural Areas, Forestry and Fisheries

Thünen-Institute of Baltic Sea Fisheries

Alter Hafen Süd 2, 18069 Rostock 16.12.2022 E-Mail: stefanie.haase@thuenen.de

Cruise Report FRV "Walther Herwig III" Cruise 456

03.05. – 26.05.2022

Hydroacoustic survey for the assessment of small pelagics in the Baltic Sea

Scientist in charge: Dr. Stefanie Haase (Thünen-OF)

1. Introduction

Cruise no. 456 of the FRV "Walther Herwig III" was conducted as part of the international Baltic Acoustic Spring Survey (BASS). The main objective of this hydroacoustic survey is the annual assessment of the small pelagic fish stocks, especially sprat, in the Baltic Sea. The BASS is coordinated by the ICES Working Group on Baltic International Fish Surveys (WGBIFS) where timing, survey area and the principal methods of investigation are discussed and decided. The survey has been conducted annually since 2001 and delivers the most important fisheries-independent abundance index for the annual ICES stock assessment of Baltic sprat. The German investigation area in 2022 covered ICES subdivisions (SDs) 24, 25, 26, 28, and 29. Other areas in the Baltic Sea were covered by Sweden, Lithuania, Latvia, Estonia, and Poland.

2. Cruise narrative and methods

2.1. Narrative

"Walther Herwig III" departed from the harbour of Bremerhaven on May 3rd. The vessel arrived in Warnemünde in the evening of the 5th where scientist boarded, and equipment was loaded.

Acoustic recordings for the BASS started in the morning of May 6th after reaching the area of investigation in ICES SD 24. Acoustic recordings were continued until all 17 transects were surveyed on the 21st of May. The scientific echosounder equipment was calibrated on May 15th. A map summarizing all daily transects is presented in Fig. 1.

May 22nd and 23rd were used to conduct an acoustic intercalibration between the research vessel "Walther Herwig III" and the commercial fishing vessel "Kristin" with which the survey was conducted in 2021. Both vessels sailed in formation on hydroacoustic transects while the acoustic instruments on both vessels operated in the same way as during the survey. Vessels took the lead in turns to investigate the influence of both vessels on the detectability of fish schools.

Scientists disembarked in the harbour of Warnemünde on the 24th and the vessel arrived in Bremerhaven on the 26th.

2.1. Hydrography

A Seabird-CTD-probe (SE911) 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 sufficient (ca. 5 nmi). The profiles covered the entire water column to about 2 m above the seafloor. Three water samples from different depth were taken per day to validate the oxygen data by Winkler titration, and to collect reference salinity samples. The hydrological raw data were aggregated to 1 m depth strata. Altogether 105 CTD casts were performed during the BASS cruise.

2.2. Echosounder calibration and hydroacoustic sampling

The "Walther Herwig III" is equipped with four Simrad EK60 narrowband 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) but all frequencies were recorded. Each echosounder was calibrated. Calibration procedure itself was carried out as described in the "Manual for International Baltic Acoustic Surveys (IBAS)" (ICES 2017).

The acoustic and ichthyological 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 to cover 60 nautical miles per statistical rectangle. In general, each ICES 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 operations were conducted at 3 to 4 knots. The standard acoustic investigations and the fishing hauls were carried out at daylight from 4:00 - 20:00 UTC (6:00 - 22:00 local time, Tab. 1).

All rectangles assigned to the German investigation area in SDs 24 to 26, 28 and 29 were covered by hydroacoustic transects. For some rectangles, due to spatial constraints, the total hydroacoustic track length was however lower than the recommended 60 nautical miles (see Fig. 1). The lack of a granted research licence for planned stations in the Swedish EEZ caused significant track changes. Hydroacoustic track lengths less than 60 nautical miles were conducted in 21 of the 26 rectangles assigned to the German investigation area (Tab. 2). In total, out of 1391 nmi of acoustic track 1146 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. In accordance with the IBAS manual, codend inlets with 20 mm stretched mesh size in SD 24 and 12 mm in SD 25 to 29 were used. 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. However, the fishing time was in some cases reduced because of abundant fish echoes observed with the Marport-net-probe.

The trawling depth and the vertical net opening were controlled by the Marport-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 11.4 m to 155.2 m. Trawl depth could vary within a haul when more than one layer of fish was sampled. The bottom depth at the trawling positions ranged from 26.7 m to 190.6 m.

Samples were taken from each haul in order to determine the length and weight distribution of fish. A comparison of length distribution of herring and sprat between BASS 2021 and BASS 2022 is presented in Fig. 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 48 standard hauls were (47 valid) carried out for the BASS:

subdivision	Hauls (n)
24	10 (8)
25	17
26	3
28	8
29	10

Altogether 28,012 fish were measured and 1,579 additional fish (545 sprat and 1,034 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 1; 39G2/SD24; only 0.7 kg catch
- Haul 9; 38G4/SD24; only 0.2 kg catch

Usage of neighbouring trawl information for investigated rectangles which contain only one or no haul (i.e. due to shallow water depth):

- Haul 3: 39G3/SD24 for 39G2/SD24
- Haul 4: 37G3/SD24 for 37G3/SD24*, 37G4/SD24 and 38G2
- Haul 7: 37G3/SD24 for 37G3/SD24*, 37G4/SD24 and 38G2
- Haul 8: 38G4/SD24 for 38G5/SD25*
- Haul 11: 48H0/SD29 for 48G9/SD29
- Haul 12: 48H0/SD29 for 48G9/SD29
- Haul 27: 42G9/SD28-2 for 40G8/SD26*
- Haul 28: 42G9/SD28-2 for 42G8/SD26
- Haul 30: 41G8/SD26 for 42G8/SD28-2
- Haul 31: 41G8/SD25 for 40G8/SD26*
- Haul 34: 41G7/ SD25 for 40G8/SD26*
- Haul 36: 40G6/SD25 for 39G6/SD25*
- Haul 41: 39G5/SD25 for 39G6/SD25*
- Haul 44: 39G5/SD25 for 38G5/SD25*

Rectangles marked with ‘*’ are not assigned to German investigation and are not included in the total abundance and biomass estimates.

Results will be compared to those of the BASS 2021 and other previous surveys when relevant.

3. Survey results

3.1. Hydrographic data

Measurements showed a regular stratification of the water column during the survey. Temperature, salinity and oxygen profiles are presented in Fig. 3. Seawater temperature ranged from 13.4°C (at the surface) to 3.1°C (recorded at 45.7 m). At the deepest CTD cast of the survey (204.1 m) the bottom temperature was 7.2°C. Overall, intermediate water masses (depth ranging from ~ 23 to 77 m) contained temperatures below 4°C, which is considered as a temperature threshold limit for the distribution of sprat in the water column. Higher temperatures were recorded above and below the midwater stratum. The water column was less stratified in rectangles 48G9 and 48H0 with temperatures between 3.4°C and 7.8°C. Measured salinity ranged from 5.5 at the surface layer up to a maximum of 17.4 at the bottom of the Arkona and Bornholm Basin. Oxygen concentrations ranged from 0.05 ml l^{-1} at the bottom to 15.4 ml l^{-1} (recorded at 11.4 m). Apart from the rectangles 48G9 and 48H0, were the whole water column was well oxygenated, hypoxic conditions (<1.4 ml l-1) were observed approximately below 63 m depth. No fish echo was usually observed under these conditions (Fig. 4).

3.2. Acoustic data

The basic hydroacoustic results are given in Tab. 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 1146 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 518.3 m²/nm² versus 432.3 m²/nm² in 2021 where similar ICES rectangles were covered. On an ICES SD scale the mean NASC per SD were relatively comparable to those recorded in the past 12 years with a larger increase in SD 25 and 26 and slight decreases in SD 24 and 28 and a larger decrease in SD 29 compared to the previous year (Fig. 5). A map of the echo distributions is shown in Fig. 6.

3.3. Biological data

Catch statistics per fishing hauls and species and SD are presented in Tab. 4 and Tab. 5 respectively. Overall 11 fish species were recorded in 48 pelagic trawl hauls. The CPUE ranged from 0.2 to 4694.1 kg/0.5h. The mean CPUE reached 451.7 kg/0.5h, which is higher than the value calculated in the 2021 survey (257.6 kg/0.5h). In terms of weight, catches were dominated by sprat (87.1%) followed by herring (10.7%), stickleback (1.4%) and cod (0.6%). Those four species were caught in the majority of the hauls during the survey, respectively in 46, 48, 26 and 27 hauls. The numbers and biomass of species other than sprat, herring, stickleback and cod were negligible.

Fig. 2 shows the length frequency distribution for sprat and herring per SD in 2021 and 2022. The length structure of herring looks more truncated in 2022 compared to the BASS 2021 with fewer larger individuals in SDs 24, 26, 28, and 29. Compared to 2021, there are more smaller herring in SD 29. Larger proportions of smaller sprats are missing from all SDs and the length distribution is truncated compared to 2021. There is a higher amount of larger sprat (>12 cm) in SD 26 compared to 2021. Age distribution per length class is presented in Fig. 7. Final age distribution by SD for 2022 (Fig. 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 and had a generally higher proportions of older herring in SDs 25, 26 and 28 (Fig. 8). The incoming year class, represented by 1-year old individuals, was mostly present in SD 24 and rather week in all other SDs, which is similar to the BASS 2021. 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 2-6.

3.4. Abundance Estimate

The calculated abundance in number and weight of sprat and herring per rectangle and SD is presented in Tab. 6. Note that contrary to previous years, rectangles 48G9 and 48H0 have been covered for the first time. Overall estimated abundances for herring and sprat in rectangles assigned to German investigation are higher in 2022 compared to 2021 with respectively $7.70*10^9$ versus $6.47*10^9$ herrings (+19%) and $71.14*10^9$ versus $67.19*10^9$ sprats (+6%). Estimated biomass is also higher in 2022 for herring with $216.26*10^3$ tonnes versus $183.50*10^3$ tonnes estimated in 2021 (+18%). Estimated biomass of sprat was higher in 2022 with $683.96*10^3$ tonnes compared to $535.99*10^3$ tonnes in 2021 (+28%).

Year	Species	n total (million)	total biomass (tonne)
2022*	*Clupea harengus*	7,466.10	211,247.3
2022		7,701.6	216,263.1
2021		6,467.9	183,503.1
2022*	*Sprattus sprattus*	6,9351.8	667,302.5
2022		71,142.6	683,956.8
2021		67,191.2	535,987.8

*excluding rectangles 48G9 and 48H0

4. Survey participants

Name	Function	Institution
Dr. S. Haase	Cruise leader	Thünen-OF
M. Koth	Fishery biology	Thünen-OF
D. Schneider	Fishery biology	Thünen-OF
M. Golovaneva	Fishery biology	Thünen-OF (student assistant)
M. Bächtiger	Fishery biology	Thünen-OF (student assistant)
A. Fiek	Fishery biology	Thünen-OF (student assistant)
M. Muesfeldt	Fishery biology	Thünen-OF (student assistant)
A. Labrière	Fishery biology	Thünen-OF (student intern)
G. Gedara	Fishery biology	Thünen-OF (student intern)

5. Acknowledgement

We hereby thank all participants, the crew of FRV “Walther Herwig III” and Captain S. Meier for their outstanding cooperation and commitment.

6. 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: FRV "Walther Herwig III" cruise 456/2022 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)
06.05.2021	04:35	18:17	14.05.2021	04:00	17:28
07.05.2021	04:06	19:05	15.05.2021	12:10	17:28
08.05.2021	04:09	19:03	16.05.2021	04:06	17:48
09.05.2021	04:29	17:12	17.05.2021	03:58	18:26
10.05.2021	04:29	16:40	18.05.2021	04:00	18:53
11.05.2021	04:13	17:35	19.05.2021	04:08	18:52
12.05.2021	04:03	19:05	20.05.2021	03:56	17:09
13.05.2021	04:04	19:03	21.05.2021	04:03	15:53

Table 2: FRV "Walther Herwig III" cruise 456/2022 BASS: Hydroacoustic track length per ICES rectangle.

SD	ICES rectangle	Valid acoustic track length (nmi)	SD	ICES rectangle	Valid acoustic track length (nmi)
24	37G3*	5	25	41G6	64
24	37G4	3	25	41G7	73
24	38G2	20	26	40G8*	21
24	38G3	64	26	41G8	66
24	38G4	55	28	42G8	9
24	39G2	19	28	42G9	53
24	39G3	55	28	43G9	65
24	39G4	24	28	44G9	58
25	38G5*	51	28	45G9	41
25	39G4	14	29	46G9	53
25	39G5	51	29	46H0	33
25	39G6*	30	29	47G9	30
25	40G4	36	29	47H0	30
25	40G5	15	29	48G9	24
25	40G6	56	29	48H0	55
25	40G7	55			

*ICES rectangle not assigned to German investigation

Table 3: FRV "Walther Herwig III" cruise 456/2022 BASS: Survey statistics of the cruise

Sub-division	Rec-tangle	area (nmi²)	Sa (m²/nmi²)	sigma (m²)(*10e-4)	n total (million)	*Clupea harengus* (%)	*Sprattus sprattus* (%)	*Gadus morhua (%)*	*Gasterosteus aculeatus (%)*
24	37G3*	167.7	83.7	2.0	71.11	24.77	74.87	0.36	0.00
24	37G4	875.1	0	2.0	0.01	24.77	74.87	0.36	0.00
24	38G2	832.9	4.0	2.0	16.69	24.77	74.87	0.36	0.00
24	38G3	865.7	104.4	2.0	457.71	24.77	74.87	0.36	0.00
24	38G4	1034.8	70.0	2.8	263.60	67.35	32.58	0.07	0.00
24	39G2	406.1	37.3	4.1	37.09	79.89	1.72	0.00	0.00
24	39G3	765.0	274.5	3.5	593.26	93.75	6.19	0.00	18.39
24	39G4	524.8	151.3	1.7	477.75	0.74	99.25	0.05	0.02
25	38G5*	1035.7	303.5	2.4	1335.87	50.11	49.89	0.01	0.00
25	39G4	287.3	637.6	1.7	1102.17	0.74	99.25	0.01	0.00
25	39G5	979.0	1042.3	1.5	7027.87	0.27	99.73	0.01	0.00
25	39G6*	1026.0	1104.3	1.9	6131.00	20.69	79.28	0.03	0.00
25	40G4	677.2	1247.5	1.5	5712.11	0.54	99.45	0.01	0.00
25	40G5	1012.9	827.8	1.7	5017.73	16.35	83.57	0.07	0.01
25	40G6	1013.0	495.8	1.8	2812.26	21.44	78.52	0.04	0.00
25	40G7	1013.0	221.0	1.6	1419.00	7.39	92.61	0.00	0.00
25	41G6	764.4	901.0	2.0	3539.02	45.91	47.99	0.01	3.60
25	41G7	1000.0	172.2	1.3	1322.03	1.45	93.23	0.00	6.10
26	40G8*	1013.0	560.8	1.4	4107.41	1.13	95.25	0.00	5.32
26	41G8	1000.0	669.2	1.3	4800.45	1.17	98.75	0.03	0.05
28	42G8	945.4	714.8	1.3	5312.75	0.89	99.10	0.01	0.00
28	42G9	986.9	799.5	1.2	6362.95	0.61	99.35	0.02	0.01
28	43G9	973.7	780.1	1.2	6130.98	0.60	98.26	0.01	1.14
28	44G9	876.6	560.1	1.4	3565.85	17.38	65.58	0.02	17.02
28	45G9	924.5	786.1	0.9	8580.14	1.34	56.22	0.00	42.44
29	46G9	933.8	904.3	1.0	8573.35	4.62	66.52	0.00	28.86
29	46H0	933.8	613.5	0.9	6094.53	5.49	58.50	0.01	35.99
29	47G9	876.2	602.0	1.1	4791.18	15.41	60.48	0.00	24.10
29	47H0	920.3	601.2	1.1	5080.43	19.04	45.06	0.00	35.90
29	48G9	772.8	398.9	0.5	5605.43	2.22	16.86	0.04	80.88
29	48H0	730.3	377.7	0.5	5014.56	2.22	16.86	0.04	80.88

*ICES rectangle not assigned to German investigation

Table 4: FRV "Walther Herwig III" cruise 456/2022 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*	0.7	35	0.7	25	265.4	31,838	398.1
2	30.5	1,561	30.5	26	414.1	43,524	1241.3
3	18.8	565	18.8	27	255.8	29,903	767.5
4	194.2	10,224	291.3	28	305.9	34,730	611.9
5	340.2	8,958	340.2	29	195.6	21,779	586.8
6	184.0	4,243	184.0	30	329.8	34,722	659.7
7	121.4	5,155	121.4	31	1077.9	81,920	1077.9
8	2.4	63	2.4	32	667.3	56,151	1000.9
9*	0.2	10	0.2	33	281.3	28,704	562.5
10	83.2	3,074	83.2	34	111.7	11,132	111.7
11	32.3	22,371	64.6	35	111.5	7,466	167.2
12	32.9	5,152	22.9	36	49.1	2,007	49.1
13	247.6	22,627	247.6	37	146.3	5,005	292.6
14	159.6	29,872	159.6	38	737.2	107,237	737.2
15	175.3	24,508	175.3	39	47.9	2,421	47.9
16	320.2	35,349	480.3	40	489.8	47,794	979.6
17	84.6	12,085	84.6	41	692.9	62,801	831.5
18	139.8	21,043	139.8	42	240.5	22,291	720.7
19	93.7	14,342	93.7	43	264.4	20,006	793.1
20	85.2	13,259	85.2	44	274.5	25,116	587.7
21	217.7	55,349	261.3	45	172.3	11,026	172.3
22	152.2	20,881	152.2	46	782.4	71,593	4694.1
23	62.3	5,015	62.3	47	348.3	29,059	1045.0
24	106.7	10,950	160.0	48	284.2	22,226	284.2

***invalid hauls**

Table 5: FRV "Walther Herwig III" cruise 456/2022 BASS: Catch statistics per. Percentages are standardized to 30 min hauls. 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 numbers	Percent of total catch weight
Ammodytes marinus	2	153	0	4.99	0.01	0.02
Clupea harengus	48	11,768	1,034	1,732.44	3.72	10.69
Cyclopterus lumpus	3	4	0	1.14	-	-
Gadus morhua	27	195	72	65.71	0.02	0.56
Gasterosteus aculeatus	26	1,876	0	249.88	8.13	1.41
Hyperoplus lanceolatus	4	224	0	30.29	0.08	0.14
Merlangius merlangus	4	40	0	9.81	-	0.06
Myoxocephalus scorpius	5	11	0	1.59	-	-
Platichthys flesus	17	26	0	3.55	-	0.03
Engraulis encrasicolus	4	14	0	0.55	-	-
Sprattus sprattus	46	13,701	545	9,331.3	88.03	87.07

Table 6: FRV "Walther Herwig III" cruise 456/2022 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	37G3*	17.62	462.59	53.25	830.14
24	37G4	0.00	0.00	0.00	0.00
24	38G2	4.14	108.72	12.50	194.83
24	38G3	113.38	2,975.8	342.70	5,342.34
24	38G4	177.54	5,512.26	85.90	1,653.79
24	39G2	31.09	2.054.92	0.63	12.01
24	39G3	556.16	22,029.11	36.73	713.96
24	39G4	3.53	144.96	474.18	7,534.32
25	38G5*	669.34	25,699.58	666.51	7,727.67
25	39G4	8.16	396.4	1,093.92	14,955.28
25	39G5	18.72	762.10	7,008.74	78,865.96
25	39G6*	1,268.80	50,633.89	4,860.44	54,836.31
25	40G4	30.65	1,278.49	5,680.94	65,245.63
25	40G5	820.26	28,534.24	4,193.18	44,248.76
25	40G6	602.83	22,601.14	2,208.32	23,383.77
25	40G7	104.93	3,557.62	1,314.07	15,028.12
25	41G6	1,624.88	50,874.97	1,698.22	17,020.82
25	41G7	19.12	607.25	1,232.59	12,337.12
26	40G8*	45.77	1,399.54	3,912.42	41,225.52
26	41G8	56.21	1,891.84	4,740.47	48,352.82
28	42G8	47.27	1,549.11	5,264.78	46,285.72
28	42G9	39.02	1,213.92	6,321.78	54,087.23
28	43G9	36.49	1,070.37	6,024.28	52,205.00
28	44G9	619.88	15,885.59	2,338.54	22,172.62
28	45G9	115.05	2,976.32	4,823.66	39,763.80
29	46G9	396.16	7,468.36	5,702.92	45,666.84
29	46H0	334.84	6,430.12	3,565.57	29,142.19
29	47G9	738.48	12,421.13	2,897.86	23,203.59
29	47H0	967.28	18,902.53	2,289.34	19,886.02
29	48G9	124.27	2,647.35	945.19	8,790.49
29	48H0	111.18	2,368.46	845.55	7,863.76
Total		**9,703.08**	**294,458.68**	**80,635.17**	**788,576.43**

*ICES rectangle not assigned to German investigation

8. Figures

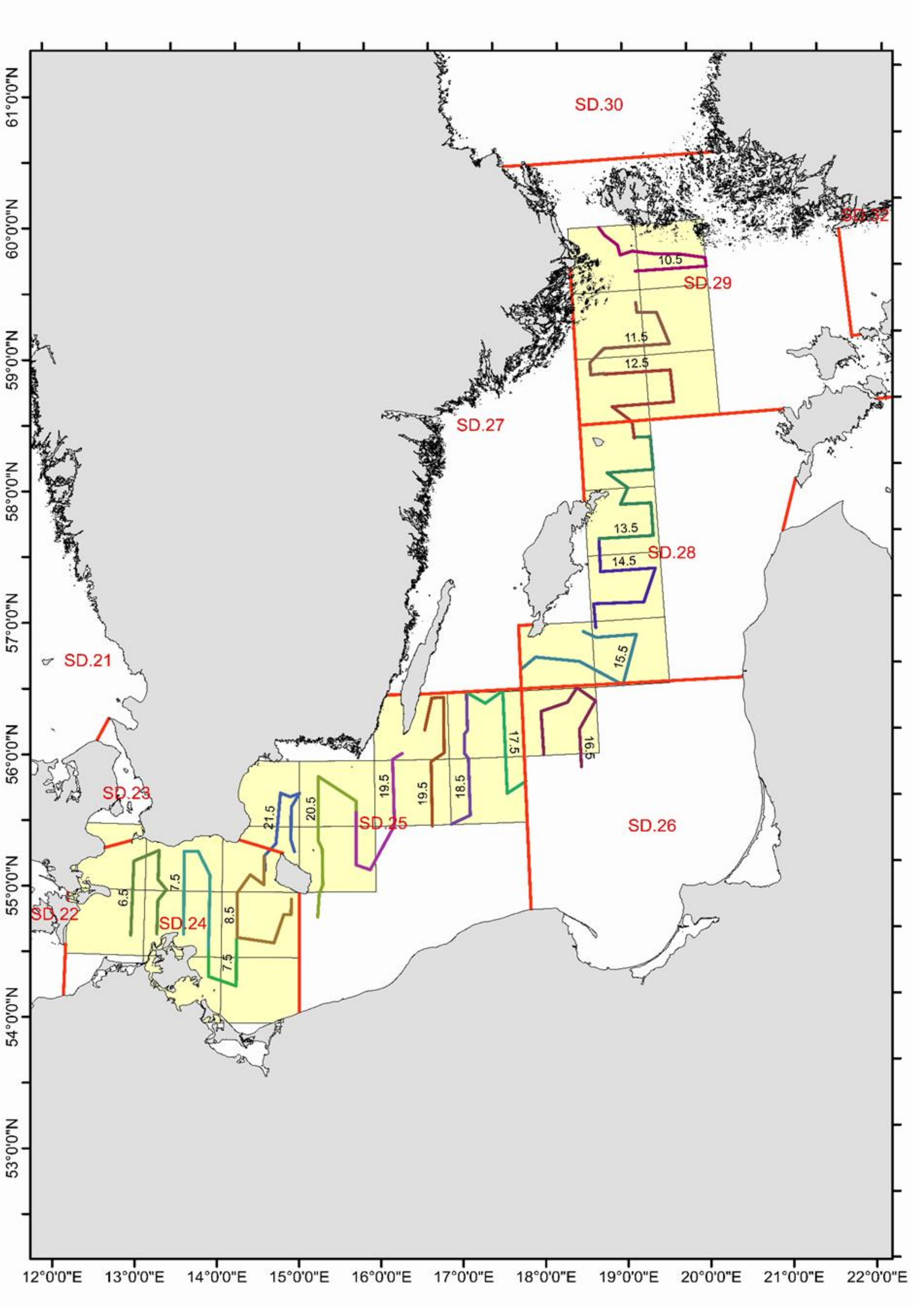

Figure 1: FRV "Walther Herwig III" cruise 456/2022 BASS: Daily hydroacoustic track done during the BASS survey 2022.

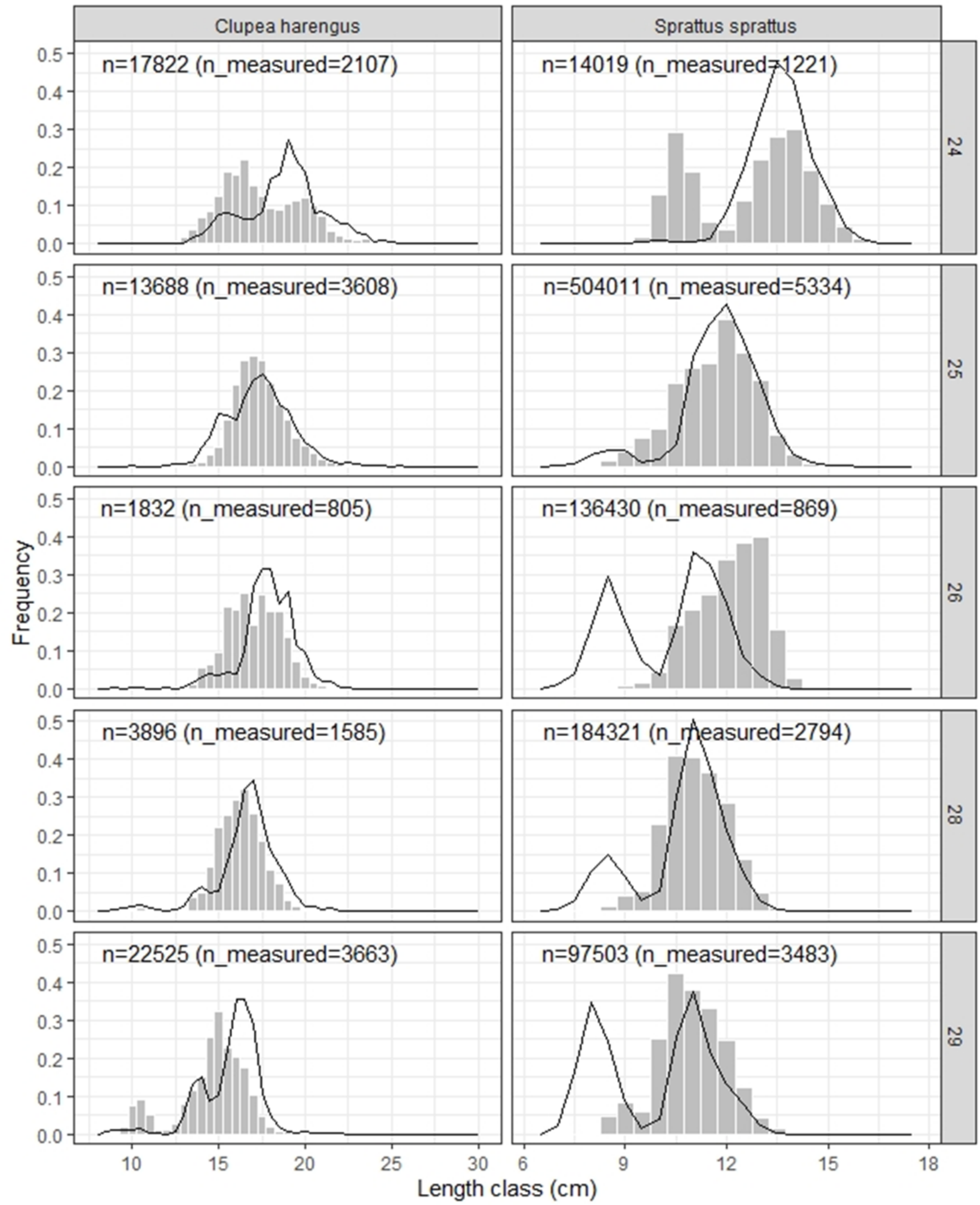

Figure 2: FRV "Walther Herwig III" cruise 456/2022 BASS: Herring and sprat length distribution measured per ICES SD during BASS 2021 (black line) and BASS 2022 (grey bars).

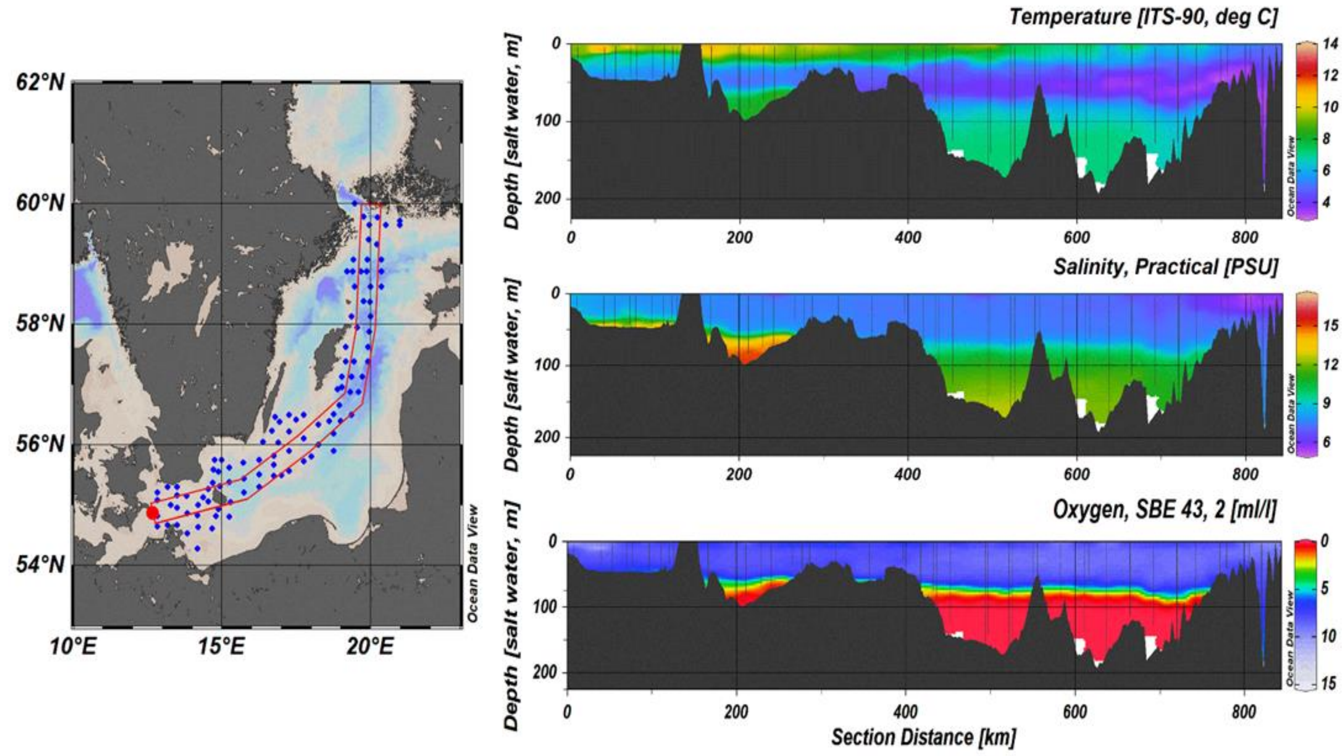

Figure 3: FRV "Walther Herwig III" cruise 456/2022 BASS: Temperature (upper right panel), salinity (middle right panel) and oxygen (lower right panel) interpolated from CTD casts along a south/west - north/east transect as shown in the left panel (red line). CTD casts coordinates are display as blue dots on the map in the left panel.

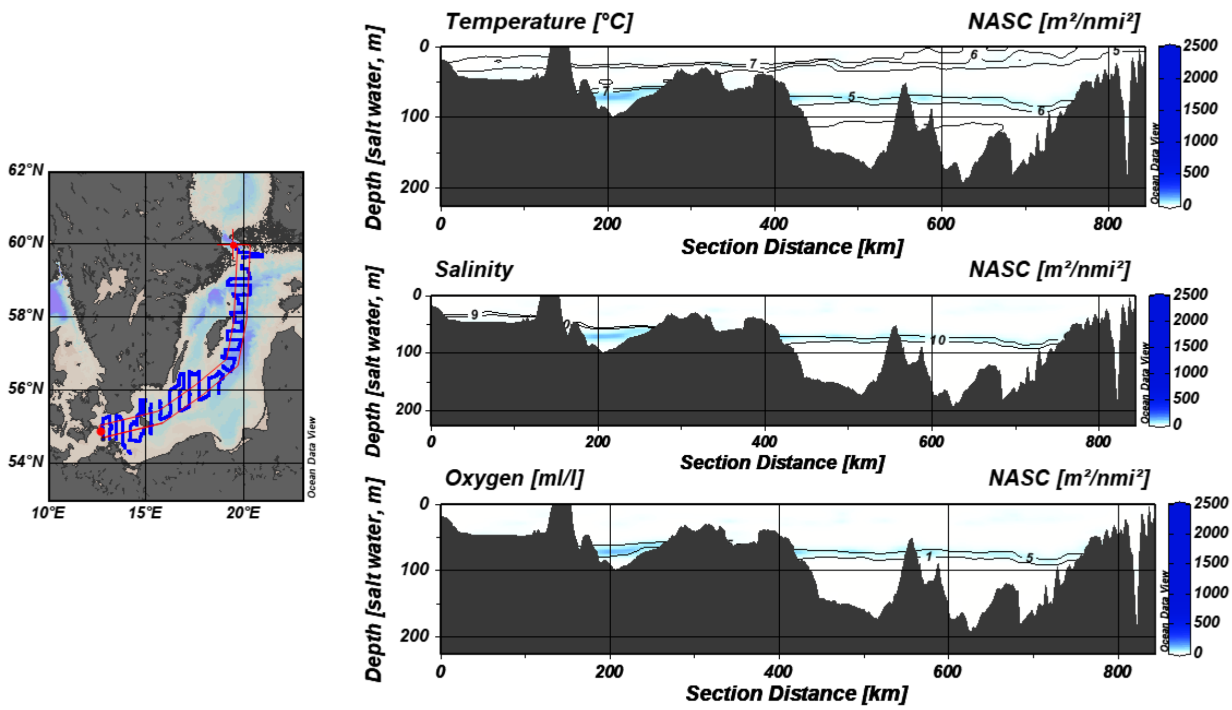

Figure 4: FRV "Walther Herwig III" cruise 456/2022 BASS: Vertical distribution of temperature, salinity and oxygen related to the echogram of fish (blue clouds).

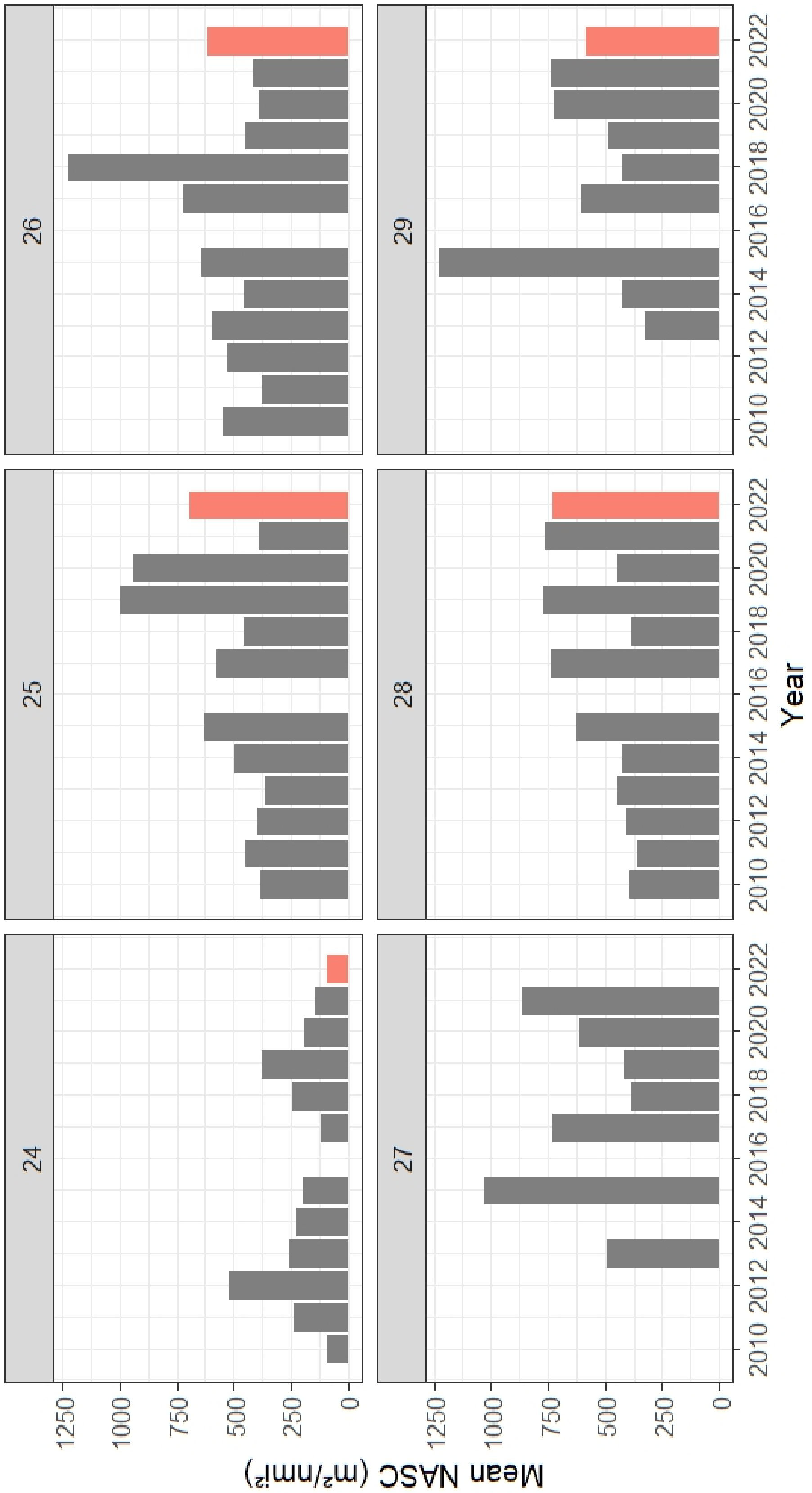

Figure 5: FRV “Walther Herwig III” cruise 456/2022 BASS: Mean NASC calculated per year and per SD (red bar corresponds to 2022). SD 27 was not covered in 2022 because this area was allocated to Sweden.

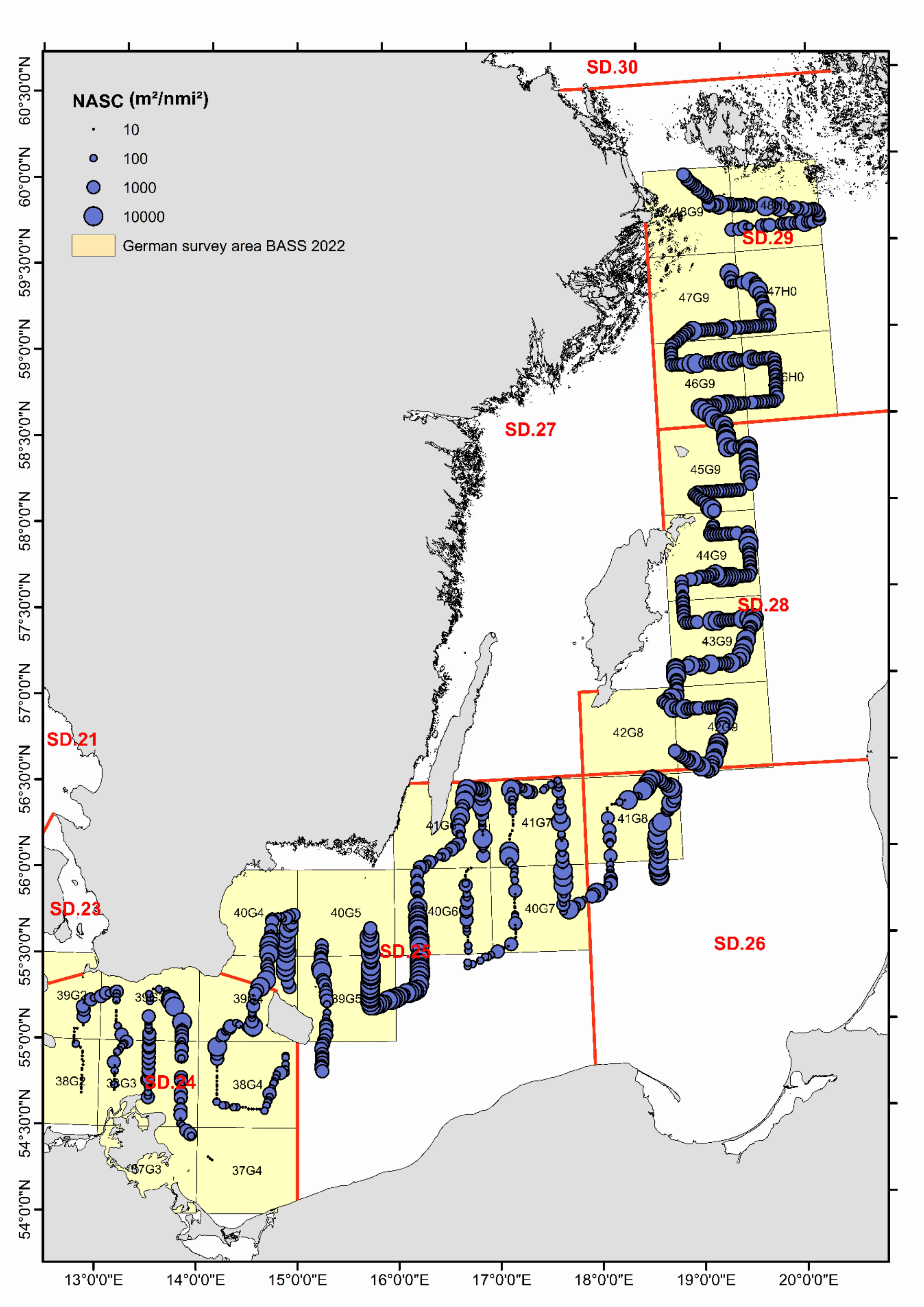

Figure 6: FRV "Walther Herwig III" cruise 456/2022 BASS: hydroacoustic results: NASC (m²/nm²) per 1 nmi recorded during the survey.

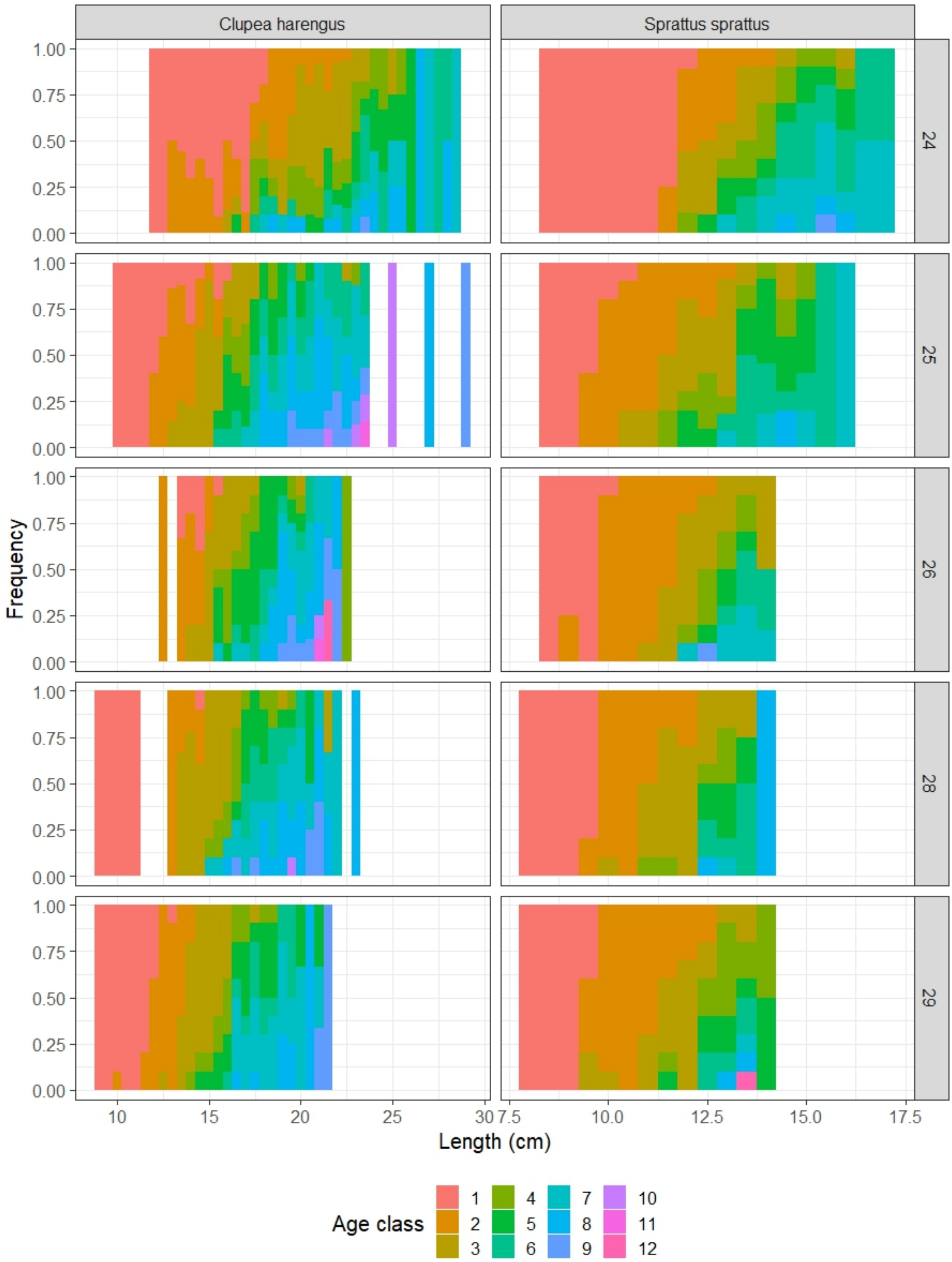

Figure 7: FRV "Walther Herwig III" cruise 456/2022 BASS: Age distribution per length class, species and SD for 2022.

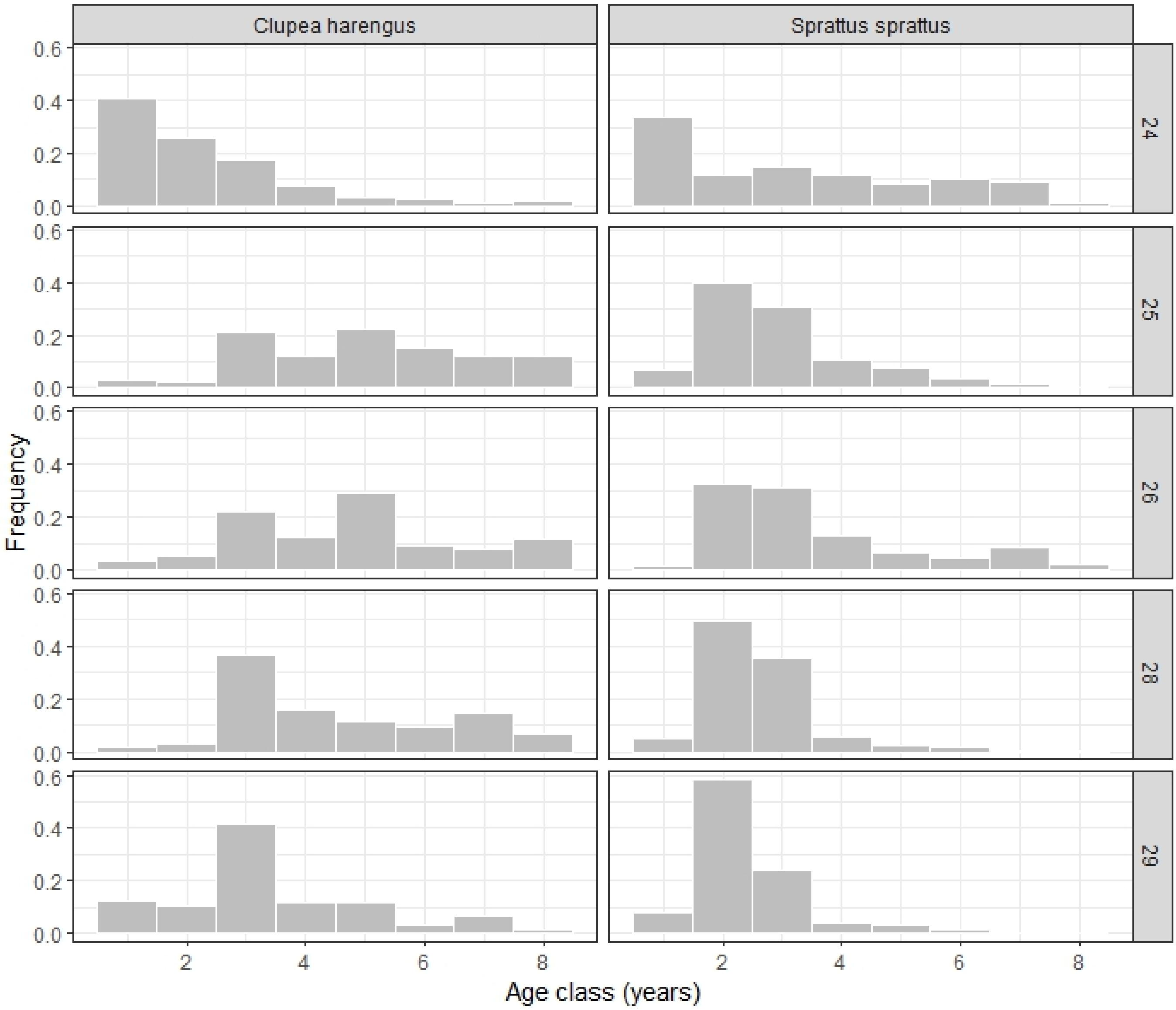

Figure 8: FRV "Walther Herwig III" cruise 456/2022 BASS: Calculated age class distribution per species and SD in 2022.

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 2021 ON THE R/V "BALTICA" IN THE ICES SUBDIVISIONS 26N AND 28.2 OF THE BALTIC SEA (20-27 MAY 2022)

•KRZYSZTOF KOSZAROWSKI•RADOSLAW ZAPOROWSKI•TYCJAN WODZINOWSKI•
•GUNTARS STRODS•ALLA VINGOVATOVA•IVARS PUTNIS•

BIOR: Guntars Strods, Alla Vingovatova, Ivars Putnis
guntars.strods@bior.lv
NMFRI: Krzysztof Koszarowski, Radoslaw Zaporowski, Tycjan Wodzinowski
kkoszarowski@mir.gdynia.pl

Riga – Gdynia, March 2023

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 11th 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 2022 signed No. 7/2022/NMFRI/BIOR continued this cooperation. The reported survey was organized on the basis of the public procurement contract Id. No. BIOR 2022/3/AK/EJZF from 18 February 2022 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 operated within the Latvian and Swedish EEZ (ICES subdivisions 26N and 28.2). The "Latvian National Fisheries Data Collection Program, 2022" in accordance with the EU Commission by the European Union (EU) Fisheries Data Collection Programme for 2022 (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 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 acoustic data base 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 – eight persons:

K. Koszarowski (NMFRI, Gdynia – Poland) – survey leader, ichthyologist,
M. Bielak (NMFRI, Gdynia – Poland) – acoustician,
T. Wodzinowski (NMFRI, Gdynia – Poland) – hydrologist,
R. Zaporowski (NMFRI, Gdynia – Poland) – ichthyologist,
M. Szymański (NMFRI, Gdynia – Poland) – ichthyologist,
K. Choma-Stolarek (NMFRI, Gdynia – Poland) – ichthyologist,
W. Gaweł (NMFRI, Gdynia – Poland) – ichthyologist,
S. Trella (NMFRI, Gdynia – Poland) – ichthyologist.

1.2. SURVEY DESCRIPTION

The reported survey took place during the period of 20 – 27 May 2022 (8 working days at sea in accordance with Latvian – Polish survey plan). The at sea research were conducted within Latvian and Swedish EEZ (the ICES subdivisions 26N and 28.2), moreover inside the Latvian territorial waters not shallower than 20 m.

The vessel left the Gdynia port (Poland) on 20.05.2022 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 research began on 20.05.2022 after midday. The survey ended on 27.05.2022 in the Latvian EEZ's.

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 13.0.378" 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 638 nautical miles long survey tracks were observed and recorded with hydroacoustic equipment. The final pattern of transects was covered with a relatively good density. The area covered in May 2022 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 17 fish control-catches (Tab. 1). All catches were performed during the daylight (between 05:55 a.m. and 6:15 p.m. UTC) using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The mean speed of vessel while trawling was 3 knots. Overall, 4 hauls were conducted in SD 26 and 13 hauls in SD 28.2. Totally 12 hauls were performed in the Latvian EEZ and 5 hauls in Swedish EEZ (see text-table below).

1.3.2. BIOLOGICAL SAMPLING

All biological material of fish, 6 species as a whole, collected in the survey is presented in Table 2.

The length measurements (in 0.5 cm length classes) were realized for 3416 sprats, 1852 herrings, 260 cods and 43 flounders. In total, 1644 sprat, 1071 herring and 260 cod 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 = 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.

Ichthyoplankton and zooplankton samples were collected at the positions of the hydrological stations or after trawling. Totally 18 ichthyoplankton and zooplankton stations were realized (Fig. 2) and 35 and 34 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 20-27 May 2022, totally at 18 stations, int. al. at 17 fish catch-station (Fig. 2). Hydrological stations were inspected with the rosette sampler with connected CTD SeaBird 911+ probe. 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 15 minutes interval over the whole survey. The automatic meteorological station type MicroStep MIS–AMS 111 was applied for measurements of the above-mentioned parameters.

2. RESULTS

2.1. BIOLOGICAL DATA

2.1.1. CATCH STATISTICS

Overall, 5 fish species were identified in hauls performed in the Central-eastern Baltic Sea in May 2022. Sprat was the dominating species by mass in the both ICES subdivisions 26N and 28.2 (92.4% and 91.0% respectively). The share of the herring was 5.8% and 8.5% respectively. The 4 other fish species represented 0.6% (mostly cod) of the total mass in all investigated areas.

Mean CPUE in SPRAS 2022 for all species in the investigated area amounted for 1990.9 kg h-1 (comparing to 1771.0, 940.5, 974.1 and 1253.7 kg h-1 in 2021, 2020, 2019 and 2018 respectively). The mean CPUEs for sprat was: 1044.9 kg h-1 in ICES SD 26N, and 2053.3 kg h-1 in SD 28.2. The mean CPUEs for herring was as follows: in SD 26N – 57.7 kg h-1 and 192.6 kg h-1 in SD 28.2. The values of CPUE for each haul for herring and sprat are presented at the Fig. 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 May 2022, are given in Table 3. The characteristics of the pelagic fish stock are aggregated in Table 4 for sprat, Table 5 for herring and Table 6 related to cod. The geographical distributions of NASC, sprat, herring and cod stocks densities in the central-eastern Baltic Sea in May 2022 are shown in Figures 4, 5, 6 and 7 respectively.

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, for cod in Fig. 10. The total length and mean weight in control hauls of sprat, herring and cod ranged as follows:

The sprat length distribution curves represent similar pattern in the both investigated areas. Only one frequency peak at the length range from 10.5 cm to 12 cm was observed and amounted for 78.9%.

The herring length distribution curves have a similar character in both investigated areas, with only one frequency peak. In SD 26 the frequency peak was observed at the length range from 17.0 cm to 19.5 cm and amounted for 72.3%. In SD 28.2 the frequency peak was observed at the length range from 15.5 cm to 17.5 cm and amounted for 71.5% of all measured herrings.

Cod prevailed among other species in bycatch with mean CPUE 10.3 kg h-1 for the whole investigated area. Length range was similar in both SD 26 and SD 28.2 (19 cm – 58 cm and 17 cm – 52 cm respectively).

2.2. METEOROLOGICAL AND HYDROLOGICAL DATA

2.2.1. WEATHER CONDITIONS

Changes of the main meteorological parameters during joint LAT-POL BASS in May 2022 are shown at the Figure 11.

The most frequent winds (Fig. 6) were from the WSW sector. The average (10 min) wind speed varied from 0.3 m/s to 14.0 m/s (up to 20.9 m/s). The air temperature ranged from 7.7 °C to 27.7 °C, and average temperature was 11.1 °C.

2.2.2. HYDROLOGY OF THE GOTLAND DEEP

Changes of the main hydrological parameters of seawater during joint LAT-POL BASS in May 2022 are shown at the Figures 12-14.

The lowest value of temperature at the surface layer (Fig. 7) was observed at the trawl 4 and it was 8.22 °C, while the warmest surface water was at the trawl 15 and it was 9.64 °C. The average value was 8.85 °C. The average surface salinity was 7.39 in the PSU. The minimum value was 7.14 at the trawl 15 and maximum 7.53 at the trawl 1 / station 46/J52. The highest oxygen content in surface water layer was 9.10 ml/l at the station K2 while the lowest one was 8.38 ml/l at the trawl 15. Mean value of dissolved oxygen equalled 8.66 ml/l.

The near - bottom layer conditions are presented in the figure 8. Water temperature varied from 4.00 °C at the trawl 15 to 7.36 °C at the station K2. The mean value calculated for the whole area covered during the cruise was 6.47 °C. The average salinity in the close-to-the-bottom water layers was 11.03. The highest value was measured at the trawl 11 / station 37/J1 and it was 12.89 PSU. The lowest one was 7.77 at the trawl 15. The 0.00 ml/l of the dissolved oxygen was on trawls: 4, 5 (43/J37), 8, 9, 11 (37/J1), 12, 14, 16. The maximum dissolved oxygen was 6.51 ml/l on the trawl 2. The mean value was 1.45 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 was not the water optimal conditions for the successful spawning of cod.

3. DISCUSSION

The data of the Latvian-Polish BASS in the 2nd quarter of 2022 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. The geographical distribution of sprat densities in the May 2021 had almost similar pattern as in 2019 and shows higher aggregations with densities on medium 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 20-27.05.2022

Haul number	Date of catch	ICES rectangle	ICES subdivision	Depth to fishing trawl [m]	Depth to the bottom [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		Shutting net	Pulling net								
							Latitude 00°00' N	Longitude 00°00'E	Latitude 00°00' N	Longitude 00°00'E						Sprat	Herring	Cod	Flounder	Threespine stickleback
Latvian EEZ																				
1	20.05.2022	41G9	26	70-90	124	070°	56°04'2	019°09'3	56°04'4	019°10'9	15:55	16:15	20	346,870	1040,610	283,425	49,785	12,320	1,340	
2	21.05.2022	41H1	26	53-35	58	175°	56°06'4	020°01'2	56°04'9	020°01'4	08:12	08:42	30	92,060	184,120	92,060				
3	21.05.2022	41H0	26	50-68	71	110°	56°21'5	020°06'8	56°21'3	020°07'5	17:23	17:33	10	181,718	1090,308	179,521	2,197			
4	22.05.2022	41G9	26	70-88	131	180°	56°20'9	019°19'9	56°20'3	019°20'9	07:55	08:05	10	368,286	2209,716	358,533	5,723	4,030		
5	22.05.2022	42G9	28.2	60-80	155	115°	56°41'6	019°52'3	56°41'3	019°53'7	16:25	16:45	20	521,691	1565,073	510,085	3,094	7,760	0,752	
6	22.05.2022	42H0	28.2	63-45	73	090°	56°36'7	020°28'1	56°36'7	020°29'3	20:00	20:15	15	119,596	478,384	117,993	1,405		0,198	
7	23.05.2022	42H0	28.2	70-90	134	270°	56°52'1	020°16'3	56°52'1	020°15'0	11:26	11:41	15	1194,317	4777,268	1088,505	102,602	2,395	0,815	
10	24.05.2022	43H0	28.2	65-85	115	090°	57°07'2	020°26'7	57°07'2	020°27'9	13:11	13:26	15	690,128	2760,512	548,390	139,350	2,185	0,203	
11	25.05.2022	43H0	28.2	70-90	242	360°	57°18'9	020°05'9	57°19'5	020°05'9	12:22	12:37	15	815,939	3263,756	789,165	25,021	1,270	0,483	
14	26.05.2022	44H0	28.2	70-90	144	080°	57°37'0	020°36'7	57°37'1	020°38'0	11:48	12:03	15	383,182	1532,728	307,941	74,419	0,647	0,175	
15	26.05.2022	44H1	28.2	70-58	64	345°	57°35'5	021°10'2	57°36'4	021°09'9	15:20	15:40	20	617,571	1852,713	587,681	29,890			
17	27.05.2022	44H0	28.2	65-85	98	080°	57°52'2	020°33'0	57°52'3	020°34'3	12:18	12:33	15	1506,492	6025,968	1446,350	59,682	0,265	0,195	
													Total	6837,850	2231,763	6309,649	493,168	30,872	4,161	
Swedish EEZ																				
8	23.05.2022	42G0	28.2	70-90	155	270°	56°51'8	019°28'9	56°51'7	019°27'6	15:50	16:05	15	401,953	1607,812	359,251	32,678	9,120	0,904	
9	24.05.2022	43G9	28.2	70-90	200	090°	57°07'2	019°41'8	57°07'2	019°43'1	09:05	09:20	15	547,195	2188,78	527,245	19,104	0,578	0,268	
12	25.05.2022	43G9	28.2	70-90	122	020°	57°23'1	019°25'9	57°23'9	019°26'5	16:37	16:57	20	140,993	422,979	91,402	47,758	1,720	0,113	
13	26.05.2022	44G9	28.2	60-80	119	090°	57°37'0	019°46'5	57°37'1	019°47'9	07:15	07:30	15	586,753	2347,012	520,863	63,693	2,040	0,119	0,038
16	27.05.2022	44G9	28.2	70-90	175	080°	57°52'0	019°47'0	57°52'0	019°48'4	08:02	08:17	15	124,284	497,136	69,572	54,48	0,218		0,014
													Total	1801,178	1412,7438	1568,333	217,713	13,676	1,404	0,052
													SD 26	988,934	1131,189	913,539	57,705	16,350	1,340	
													SD28.2	7650,094	2255,394	6964,443	653,176	28,198	4,225	0,052
													Total	8639,028	1990,875	7877,982	710,881	44,548	5,565	0,052

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 20-27.05.2022

SD 26		Sprat	Herring	Cod	Flounder	Threespine Stickleback	Total
Samples taken	Measurements	4	3	2	1		10
	Analyses	4	3				7
Fish measured		804	235	64	8		1111
Fish analysed		384	146				530

SD 28.2		Sprat	Herring	Cod	Flounder	Threespine Stickleback	Total
Samples taken	Measurements	13	13	11	11	2	50
	Analyses	13	13				26
Fish measured		2612	1617	196	38	3	4466
Fish analysed		1260	925				2185

TOTAL		Sprat	Herring	Cod	Flounder	Threespine Stickleback	Total
Samples taken	Measurements	17	16	13	12	2	60
	Analyses	17	16				33
Fish measured		3416	1852	260	46	3	5577
Fish analysed		1644	1071				2715

Table 3. 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 20-27.05.2022

Rectangle	Area nm^2	PEL NASC m^2/nm^2	PE %	Σ $m^2/m^2 \times 10^4$	TS db	P $n \times 10^6/nm^2$	Total n*10^6	HER%	SPR%	GTA%
41G9	1000.0	627.81	99.95	1.2992	-49.86	4.83	4832.29	0.91	99.09	
41H0	953.3	487.85	100.00	1.2962	-49.87	3.76	3588.01	0.02	99.98	
42G9	986.9	641.04	99.88	1.2983	-49.86	4.94	4873.01	1.56	98.44	
42H0	968.5	237.74	99.97	1.3009	-49.85	1.83	1769.94	1.32	98.68	
43G9	973.7	513.37	99.93	1.3313	-49.75	3.86	3754.70	3.57	96.43	
43H0	973.7	387.32	99.98	1.3428	-49.71	2.88	2808.61	4.38	95.62	
43H1	412.7	43.81	100.00	1.3756	-49.61	0.32	131.43	2.28	97.72	
44G9	876.6	792.64	99.97	1.3857	-49.58	5.72	5014.14	6.72	93.25	0.03
44H0	960.5	655.91	99.99	1.3688	-49.63	4.79	4602.49	5.75	94.24	0.01
44H1	824.6	219.56	100.00	1.3739	-49.61	1.60	1317.75	2.17	97.83	
SD26	1953.3	557.83	99.97	1.2940	-49.87	4.31	8420.30	0.53	99.47	
SD28.2	6977.2	436.42	99.95	1.2545	-50.01	3.48	24272.07	4.08	95.92	0.01
Total	8930.5	485.51	99.95	1.3263	-49.77	3.66	32692.37	3.16	96.83	0.01

Rectangle	Total $n \times 10^6$	HER	SPR	GTA	Total $kg \times 10^3$	HER	SPR	GTA
41G9	4832.29	43.95	4788.34		45742.57	1648.47	44094.10	
41H0	3588.01	0.56	3587.45		34540.06	15.60	34524.47	
42G9	4873.01	76.04	4796.97		44580.57	2388.37	42192.20	
42H0	1769.94	23.39	1746.55		16276.28	710.22	15566.06	
43G9	3754.70	134.15	3620.55		36363.57	3873.00	32490.57	
43H0	2808.61	122.88	2685.73		27681.24	3703.84	23977.40	
43H1	131.43	3.00	128.43		1406.46	72.80	1333.66	
44G9	5014.14	336.95	4675.91	1.28	53831.65	10017.03	43810.61	4.01
44H0	4602.49	264.62	4337.47	0.41	44810.96	7779.69	37030.03	1.24
44H1	1317.75	28.54	1289.20		14076.56	680.88	13395.68	
SD26	8420.30	44.51	8375.79		80282.63	1664.07	78618.56	
SD28.2	24272.07	989.55	23280.83	1.69	239027.30	29225.84	209796.20	5.26
Total	32692.37	1034.06	31656.62	1.69	319309.93	30889.91	288414.77	5.26

Table 4. 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 20-27.05.2022

CANUM	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	35046	242452	107406	26392	19375	13786	6926	43402	494786
41H0	25518	130542	30484	8967	5648	4511	720	11800	218190
42G9	35015	384559	299739	67519	43880	43571	22052	149632	1045968
42H0	24651	234631	190746	50275	39075	38348	12167	109746	699640
43G9	22625	373772	217531	43783	60242	21794	14778	61487	816012
43H0	30356	483400	328906	74302	111880	37434	19448	75503	1161228
43H1	6526	118103	122169	34064	48127	16394	13790	41332	400505
44G9	5067	100944	97233	8557	20435	6079	8212	35501	282026
44H0	29684	537747	433980	57878	95189	21551	21181	103899	1301109
44H1	25557	384016	281490	64267	78119	14878	17836	45985	912148
SD26	60564	372994	137890	35359	25023	18297	7646	55202	712976
SD28.2	179481	2617170	1971795	400644	496947	200049	129464	623087	6618637
Total	240045	2990164	2109685	436003	521970	218346	137110	678289	7331612

n, %	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	7.08	49.00	21.71	5.33	3.92	2.79	1.40	8.77	100.00
41H0	11.70	59.83	13.97	4.11	2.59	2.07	0.33	5.41	100.00
42G9	3.35	36.77	28.66	6.46	4.20	4.17	2.11	14.31	100.00
42H0	3.52	33.54	27.26	7.19	5.58	5.48	1.74	15.69	100.00
43G9	2.77	45.80	26.66	5.37	7.38	2.67	1.81	7.54	100.00
43H0	2.61	41.63	28.32	6.40	9.63	3.22	1.67	6.50	100.00
43H1	1.63	29.49	30.50	8.51	12.02	4.09	3.44	10.32	100.00
44G9	1.80	35.79	34.48	3.03	7.25	2.16	2.91	12.59	100.00
44H0	2.28	41.33	33.35	4.45	7.32	1.66	1.63	7.99	100.00
44H1	2.80	42.10	30.86	7.05	8.56	1.63	1.96	5.04	100.00
SD26	9.06	53.64	18.39	4.81	3.35	2.48	0.94	7.33	100.00
SD28.2	2.64	39.40	30.38	5.32	6.90	2.91	2.06	10.40	100.00
Total	4.34	43.17	27.21	5.18	5.96	2.80	1.76	9.59	100.00

n, 10^6	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	339.165	2346.355	1039.436	255.410	187.505	133.414	67.029	420.027	4788.342
41H0	419.563	2146.358	501.210	147.439	92.859	74.171	11.831	194.018	3587.449
42G9	160.586	1763.648	1374.652	309.651	201.241	199.823	101.136	686.236	4796.972
42H0	61.537	585.725	476.171	125.505	97.545	95.731	30.373	273.967	1746.554
43G9	100.386	1658.383	965.162	194.259	267.287	96.696	65.568	272.812	3620.554
43H0	70.207	1118.025	760.706	171.849	258.761	86.579	44.980	174.626	2685.734
43H1	2.093	37.872	39.176	10.923	15.433	5.257	4.422	13.254	128.430
44G9	84.009	1673.618	1612.088	141.867	338.800	100.785	136.148	588.597	4675.912
44H0	98.957	1792.669	1446.746	192.945	317.329	71.845	70.611	346.366	4337.468
44H1	36.121	542.756	397.850	90.833	110.412	21.029	25.208	64.994	1289.203
SD26	758.728	4492.713	1540.647	402.849	280.364	207.584	78.861	614.045	8375.790
SD28.2	613.896	9172.696	7072.551	1237.832	1606.807	677.745	478.446	2420.852	23280.828
Total	1372.624	13665.409	8613.198	1640.682	1887.171	885.330	557.307	3034.898	31656.618

<w>, g	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	5.27	7.61	9.47	11.01	10.69	11.16	11.19	11.20	8.62
41H0	5.49	7.38	9.27	10.53	10.98	10.42	13.04	11.39	7.94
42G9	5.02	7.70	9.30	10.64	10.64	11.53	10.80	10.82	9.06
42H0	5.37	7.57	9.35	10.25	10.39	10.51	10.57	11.04	9.09
43G9	5.20	7.41	9.05	9.82	10.40	10.58	10.94	10.93	8.55
43H0	5.57	7.66	9.61	10.40	10.44	10.09	11.52	11.64	9.00
43H1	5.73	8.24	9.93	11.14	11.13	9.85	11.42	12.05	9.88
44G9	5.09	7.85	9.56	10.61	11.35	11.03	11.87	11.31	9.35
44H0	5.60	7.99	8.65	9.28	9.07	9.84	11.05	10.37	8.56
44H1	5.77	8.07	8.13	7.93	9.09	8.60	8.02	11.35	8.28
SD26	5.39	7.50	9.40	10.84	10.78	10.90	11.47	11.26	8.33
SD28.2	5.30	7.74	9.17	10.03	10.29	10.71	11.07	10.99	8.90
Total	5.35	7.66	9.21	10.23	10.36	10.75	11.13	11.05	8.75

w, kg*10^3									
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	1785.943	17867.173	9839.777	2812.578	2004.172	1489.313	750.254	4703.688	41252.898
41H0	2304.781	15836.907	4647.165	1553.002	1019.173	772.644	154.271	2209.441	28497.383
42G9	806.204	13586.919	12786.852	3295.866	2141.709	2304.030	1092.688	7427.980	43442.247
42H0	330.305	4432.546	4452.889	1286.294	1013.265	1005.793	321.161	3025.236	15867.490
43G9	522.028	12290.104	8731.986	1908.453	2780.490	1022.585	717.121	2982.749	30955.517
43H0	390.856	8560.385	7313.713	1787.294	2701.425	873.683	518.373	2032.701	24178.430
43H1	11.998	312.160	389.142	121.643	171.814	51.805	50.486	159.723	1268.770
44G9	427.348	13133.697	15409.447	1505.242	3844.376	1111.493	1615.626	6655.950	43703.177
44H0	554.095	14326.909	12513.703	1790.750	2878.865	707.071	780.494	3591.678	37143.565
44H1	208.411	4379.646	3236.247	719.989	1003.975	180.744	202.128	737.608	10668.747
SD26	4090.724	33704.080	14486.942	4365.580	3023.344	2261.957	904.525	6913.129	69750.281
SD28.2	3251.246	71022.365	64833.979	12415.531	16535.918	7257.203	5298.076	26613.625	207227.943
Total	7341.970	104726.445	79320.920	16781.110	19559.263	9519.160	6202.601	33526.754	276978.223

w, %									
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	4.33	43.31	23.85	6.82	4.86	3.61	1.82	11.40	100.00
41H0	8.09	55.57	16.31	5.45	3.58	2.71	0.54	7.75	100.00
42G9	1.86	31.28	29.43	7.59	4.93	5.30	2.52	17.10	100.00
42H0	2.08	27.93	28.06	8.11	6.39	6.34	2.02	19.07	100.00
43G9	1.69	39.70	28.21	6.17	8.98	3.30	2.32	9.64	100.00
43H0	1.62	35.41	30.25	7.39	11.17	3.61	2.14	8.41	100.00
43H1	0.95	24.60	30.67	9.59	13.54	4.08	3.98	12.59	100.00
44G9	0.98	30.05	35.26	3.44	8.80	2.54	3.70	15.23	100.00
44H0	1.49	38.57	33.69	4.82	7.75	1.90	2.10	9.67	100.00
44H1	1.95	41.05	30.33	6.75	9.41	1.69	1.89	6.91	100.00
SD26	5.86	48.32	20.77	6.26	4.33	3.24	1.30	9.91	100.00
SD28.2	1.57	34.27	31.29	5.99	7.98	3.50	2.56	12.84	100.00
Total	2.65	37.81	28.64	6.06	7.06	3.44	2.24	12.10	100.00

<L>, cm	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	9.70	10.94	11.79	12.34	12.26	12.40	12.40	12.42	11.36
41H0	9.84	10.85	11.69	12.12	12.28	12.08	12.97	12.42	11.06
42G9	9.61	11.01	11.75	12.28	12.26	12.63	12.36	12.33	11.59
42H0	9.86	10.99	11.79	12.17	12.21	12.28	12.34	12.43	11.64
43G9	9.72	10.89	11.68	12.01	12.20	12.30	12.37	12.37	11.40
43H0	9.93	10.97	11.82	12.17	12.17	12.01	12.52	12.68	11.54
43H1	10.04	11.12	11.83	12.30	12.30	11.78	12.43	12.64	11.79
44G9	9.58	10.94	11.72	12.15	12.43	12.33	12.63	12.41	11.59
44H0	9.87	10.98	11.79	12.41	12.30	12.70	12.76	12.65	11.58
44H1	9.96	11.00	11.73	12.41	12.20	12.77	12.49	12.93	11.56
SD26	9.78	10.90	11.76	12.26	12.26	12.29	12.49	12.42	11.23
SD28.2	9.75	10.96	11.75	12.23	12.27	12.41	12.52	12.45	11.56
Total	9.77	10.94	11.75	12.24	12.27	12.38	12.52	12.45	11.47

Table 5. 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 20-27.05.2022

CANUM	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	93	39	422	370	951	343	762	2354	5334
41H0	61	23	165	114	118	0	73	126	679
42G9	40	173	2341	4106	4175	1714	3251	3075	18874
42H0	10	91	1555	3280	3483	1181	2194	2096	13891
43G9	0	118	3523	2191	2423	1790	2781	2281	15107
43H0	95	339	9238	6055	6914	5630	5058	5009	38337
43H1	105	196	4643	3346	3322	3294	3604	3613	22122
44G9	0	140	5225	2512	3100	2189	4596	3231	20994
44H0	196	497	9363	5559	6655	4745	6594	4855	38462
44H1	211	319	3170	1943	1925	1474	1862	1298	12204
SD26	154	61	587	484	1069	343	835	2480	6013
SD28.2	656	1874	39056	28991	31998	22017	29940	25458	179990
Total	810	1935	39643	29475	33067	22359	30775	27938	186004

n, %	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	1.74	0.73	7.91	6.95	17.83	6.42	14.29	44.13	100.00
41H0	9.00	3.32	24.24	16.76	17.40	0.00	10.76	18.51	100.00
42G9	0.21	0.92	12.40	21.76	22.12	9.08	17.23	16.29	100.00
42H0	0.07	0.66	11.20	23.61	25.08	8.50	15.80	15.09	100.00
43G9	0.00	0.78	23.32	14.50	16.04	11.85	18.41	15.10	100.00
43H0	0.25	0.88	24.10	15.79	18.04	14.69	13.19	13.07	100.00
43H1	0.48	0.89	20.99	15.12	15.02	14.89	16.29	16.33	100.00
44G9	0.00	0.67	24.89	11.97	14.77	10.43	21.89	15.39	100.00
44H0	0.51	1.29	24.34	14.45	17.30	12.34	17.14	12.62	100.00
44H1	1.73	2.62	25.97	15.92	15.77	12.08	15.26	10.64	100.00
SD26	1.83	0.76	8.12	7.07	17.82	6.34	14.25	43.81	100.00
SD28.2	0.24	0.95	23.17	14.60	16.86	11.57	18.36	14.25	100.00
Total	0.30	0.94	22.52	14.28	16.90	11.35	18.18	15.52	100.00

n, 10^6	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	0.764	0.321	3.477	3.052	7.834	2.823	6.280	19.396	43.948
41H0	0.051	0.019	0.136	0.094	0.098	0.000	0.060	0.104	0.561
42G9	0.160	0.698	9.430	16.543	16.818	6.903	13.097	12.386	76.035
42H0	0.016	0.154	2.618	5.522	5.865	1.988	3.694	3.530	23.387
43G9	0.000	1.049	31.283	19.452	21.518	15.896	24.695	20.252	134.146
43H0	0.303	1.086	29.608	19.406	22.162	18.045	16.211	16.054	122.877
43H1	0.014	0.027	0.629	0.453	0.450	0.446	0.488	0.489	2.997
44G9	0.000	2.252	83.855	40.318	49.757	35.135	73.767	51.864	336.947
44H0	1.349	3.416	64.413	38.242	45.783	32.646	45.364	33.402	264.616
44H1	0.493	0.747	7.414	4.545	4.502	3.448	4.356	3.037	28.545
SD26	0.815	0.339	3.613	3.146	7.932	2.823	6.341	19.500	44.509
SD28.2	2.336	9.429	229.251	144.482	166.857	114.509	181.672	141.014	989.550
Total	3.151	9.768	232.864	147.629	174.788	117.332	188.013	160.514	1034.059

<w>, g

Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	12.66	23.39	29.62	30.64	33.45	38.96	36.79	41.51	36.91
41H0	13.53	18.20	24.96	25.79	26.25	0.00	33.06	39.79	27.69
42G9	11.00	19.41	26.39	28.23	30.54	32.31	33.09	36.69	30.98
42H0	13.50	22.33	26.52	27.51	29.37	33.04	33.32	36.83	30.62
43G9	0.00	21.10	24.88	27.49	29.67	31.03	31.99	36.70	29.82
43H0	12.68	21.56	25.11	27.07	29.80	30.50	32.12	35.27	29.25
43H1	12.50	19.21	25.17	26.46	28.95	30.83	30.99	35.22	29.25
44G9	0.00	20.22	24.15	27.41	29.37	30.92	30.64	36.69	29.34
44H0	10.08	19.81	23.84	27.02	30.21	30.34	30.78	34.11	28.57
44H1	10.25	18.94	23.57	26.20	29.58	29.31	29.46	30.45	26.91
SD26	12.71	23.11	29.44	30.49	33.36	38.96	36.76	41.50	36.79
SD28.2	10.56	20.19	24.39	27.33	29.82	30.78	31.19	35.78	29.27
Total	11.11	20.30	24.47	27.39	29.98	30.97	31.38	36.48	29.60

Age

w, kg*10^3

Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	9.675	7.500	102.982	93.508	262.062	109.990	231.086	805.171	1621.974
41H0	0.684	0.339	3.394	2.425	2.563	0.000	1.997	4.133	15.534
42G9	1.756	13.550	248.861	466.967	513.672	223.048	433.396	454.439	2355.690
42H0	0.222	3.428	69.446	151.918	172.263	65.679	123.106	130.011	716.073
43G9	0.000	22.145	778.441	534.666	638.440	493.220	789.880	743.314	4000.106
43H0	3.848	23.428	743.577	525.282	660.480	550.406	520.642	566.179	3593.845
43H1	0.179	0.510	15.831	11.994	13.029	13.758	15.133	17.240	87.674
44G9	0.000	45.532	2024.712	1104.991	1461.451	1086.508	2259.885	1903.116	9886.196
44H0	13.592	67.666	1535.925	1033.316	1382.902	990.428	1396.178	1139.372	7559.380
44H1	5.058	14.152	174.759	119.097	133.183	101.087	128.329	92.469	768.133
SD26	10.358	7.839	106.377	95.933	264.625	109.990	233.083	809.304	1637.508
SD28.2	24.655	190.412	5591.553	3948.231	4975.422	3524.134	5666.549	5046.142	28967.097
Total	35.013	198.251	5697.929	4044.164	5240.046	3634.124	5899.632	5855.446	30604.605

w, %

Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	0.60	0.46	6.35	5.77	16.16	6.78	14.25	49.64	100.00
41H0	4.40	2.18	21.85	15.61	16.50	0.00	12.85	26.61	100.00
42G9	0.07	0.58	10.56	19.82	21.81	9.47	18.40	19.29	100.00
42H0	0.03	0.48	9.70	21.22	24.06	9.17	17.19	18.16	100.00
43G9	0.00	0.55	19.46	13.37	15.96	12.33	19.75	18.58	100.00
43H0	0.11	0.65	20.69	14.62	18.38	15.32	14.49	15.75	100.00
43H1	0.20	0.58	18.06	13.68	14.86	15.69	17.26	19.66	100.00
44G9	0.00	0.46	20.48	11.18	14.78	10.99	22.86	19.25	100.00
44H0	0.18	0.90	20.32	13.67	18.29	13.10	18.47	15.07	100.00
44H1	0.66	1.84	22.75	15.50	17.34	13.16	16.71	12.04	100.00
SD26	0.63	0.48	6.50	5.86	16.16	6.72	14.23	49.42	100.00
SD28.2	0.09	0.66	19.30	13.63	17.18	12.17	19.56	17.42	100.00
Total	0.11	0.65	18.62	13.21	17.12	11.87	19.28	19.13	100.00

<L>, cm	Age								
Rectangle	1	2	3	4	5	6	7	8+	Total
41G9	12.15	15.55	16.75	16.92	17.47	18.44	18.16	18.98	18.10
41H0	13.33	14.50	15.87	16.13	16.42	0.00	17.40	18.85	16.45
42G9	10.50	14.77	16.23	16.63	17.07	17.53	17.60	18.28	17.16
42H0	13.50	15.50	16.36	16.56	16.93	17.74	17.80	18.32	17.18
43G9	0.00	14.74	15.88	16.66	17.00	17.36	17.44	18.24	16.98
43H0	12.94	15.06	15.91	16.37	16.97	17.15	17.49	18.04	16.83
43H1	13.00	14.54	16.01	16.30	16.84	17.27	17.30	18.06	16.88
44G9	0.00	14.15	15.41	16.40	16.85	17.22	17.11	18.27	16.73
44H0	11.62	14.45	15.47	16.27	16.95	16.97	17.07	17.72	16.55
44H1	11.75	14.73	15.64	16.23	16.94	16.90	16.93	17.21	16.36
SD26	12.22	15.49	16.72	16.90	17.45	18.44	18.15	18.98	18.08
SD28.2	11.76	14.55	15.61	16.42	16.94	17.18	17.22	18.09	16.76
Total	11.88	14.58	15.62	16.43	16.96	17.21	17.25	18.20	16.82

Table 6. 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 20-27.05.2022

Rectangle	COD NASC m^2/nm^2	COD %	Σ $m^2/m^2 \times 10^4$	TS db	P $n \times 10^6/nm^2$	COD n	$kg \times 10^3$
41G9	0.29297	0.04664	19.67374	-38.05	148.91	148912.76	45781.46
41H0							
42G9	0.69650	0.10852	14.72262	-39.31	473.08	466881.27	44655.94
42H0	0.04532	0.01906	17.13191	-38.65	26.45	25617.82	16281.94
43G9	0.32883	0.06401	12.89370	-39.89	255.03	248320.70	36384.47
43H0	0.07231	0.01867	15.30205	-39.14	47.26	46015.28	27686.67
43H1	0.00017	0.00039	18.80917	-38.25	0.09	37.35	1406.47
44G9	0.20230	0.02552	13.53531	-39.68	149.46	131018.84	53849.23
44H0	0.06638	0.01012	13.01927	-39.85	50.99	48974.01	44817.32
44H1	0.00002	0.00001	8.75425	-41.57	0.02	18.37	14076.56
SD26	0.14648	0.02625	19.21435	-38.16	76.24	148912.76	80321.52
SD28.2	0.17648	0.04042	12.73498	-39.94	138.58	966883.64	239158.59
Total	0.19796	0.04075	15.84389	-38.99	124.94	1115796.40	319480.12

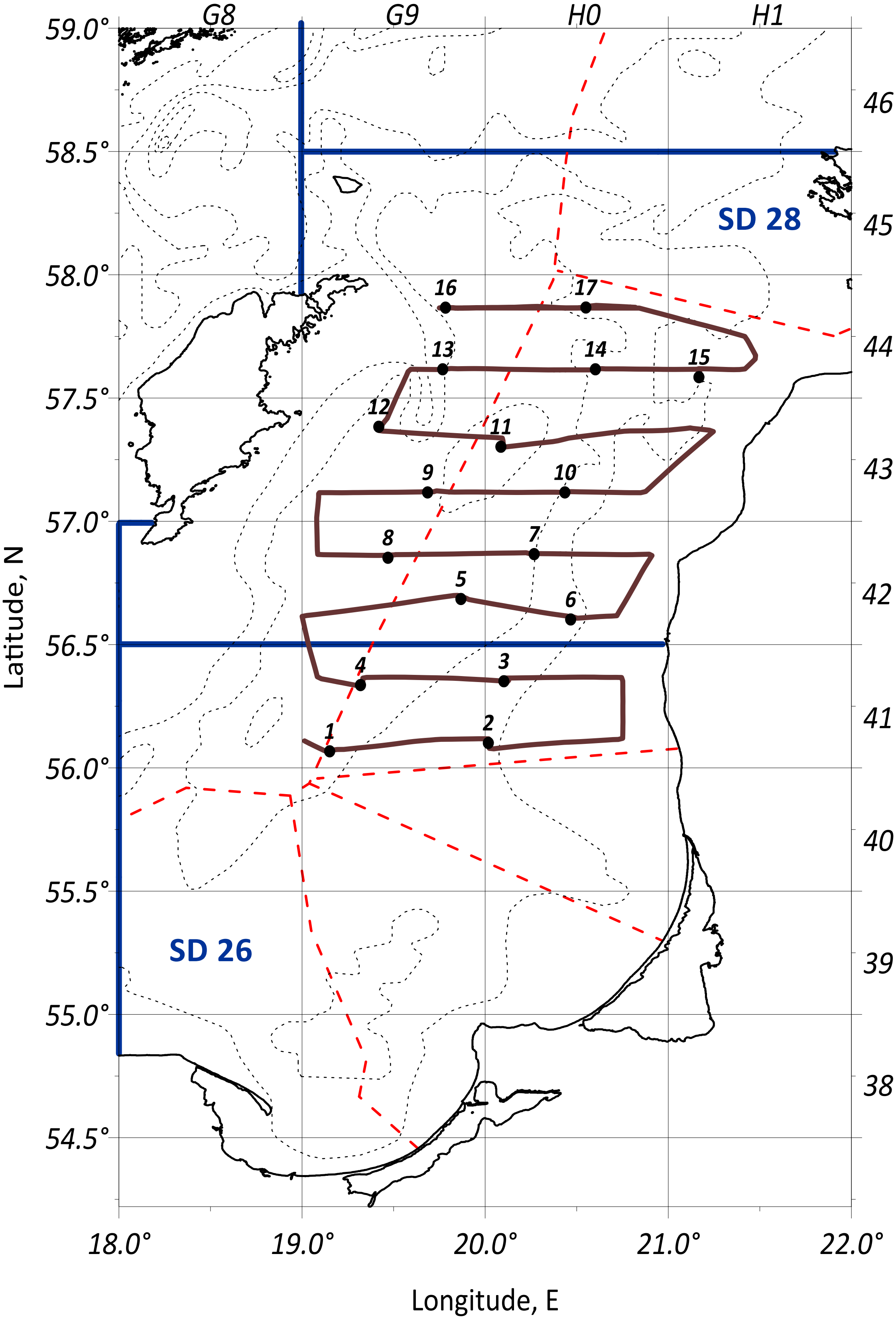

Figure 1: Cruise track design and trawling positions of the Latvian-Polish BASS on the r/v "Baltica" in the period of 20-27.05.2022.

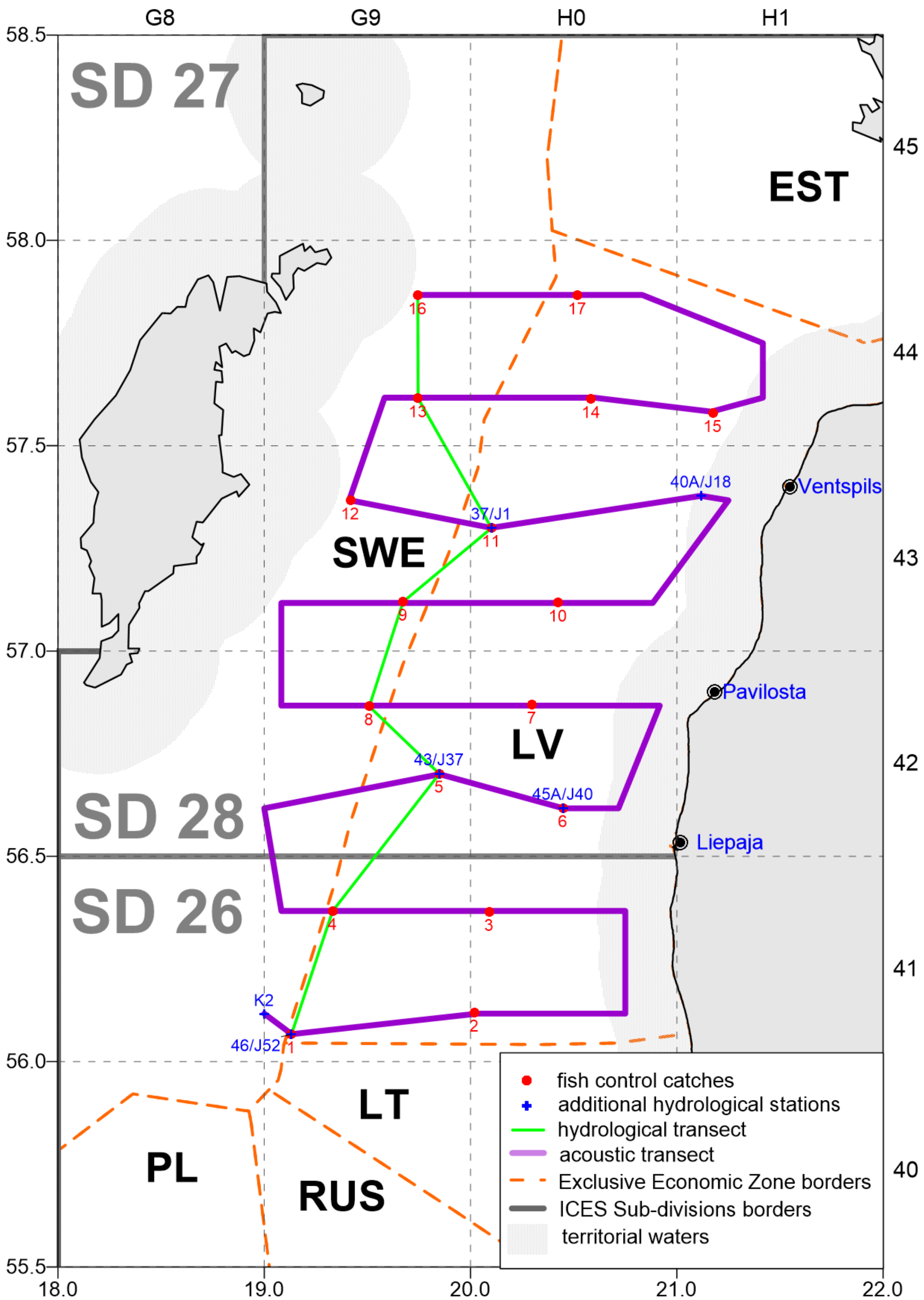

Figure 2: Locations of the hydrological, ichthyoplankton and zooplankton stations performed during the Latvian-Polish BASS on the r/v "Baltica" in the period of 20-27.05.2022.

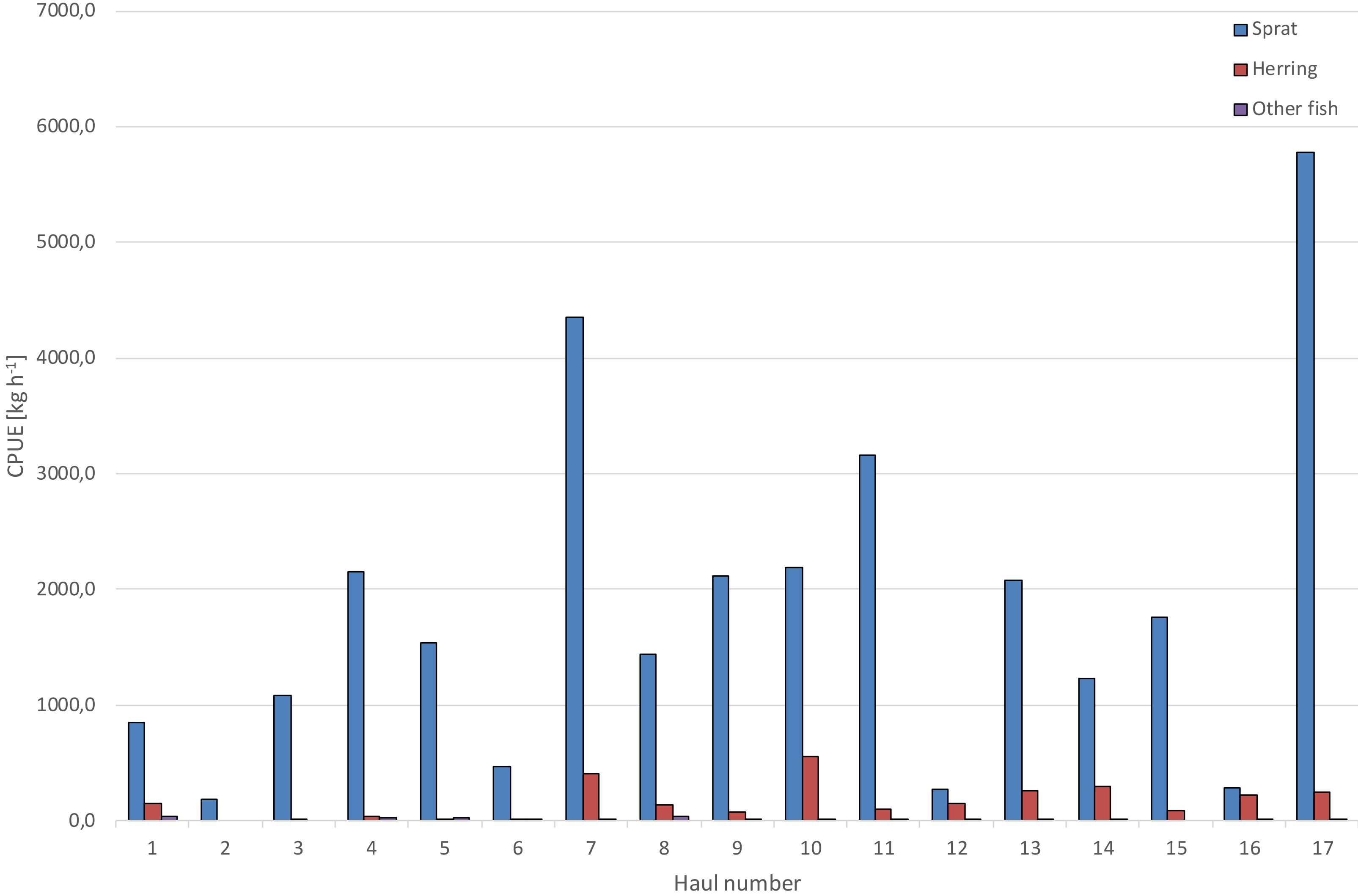

Figure 3: CPUE [kg/h] ranges distribution of dominant fish in the catch hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

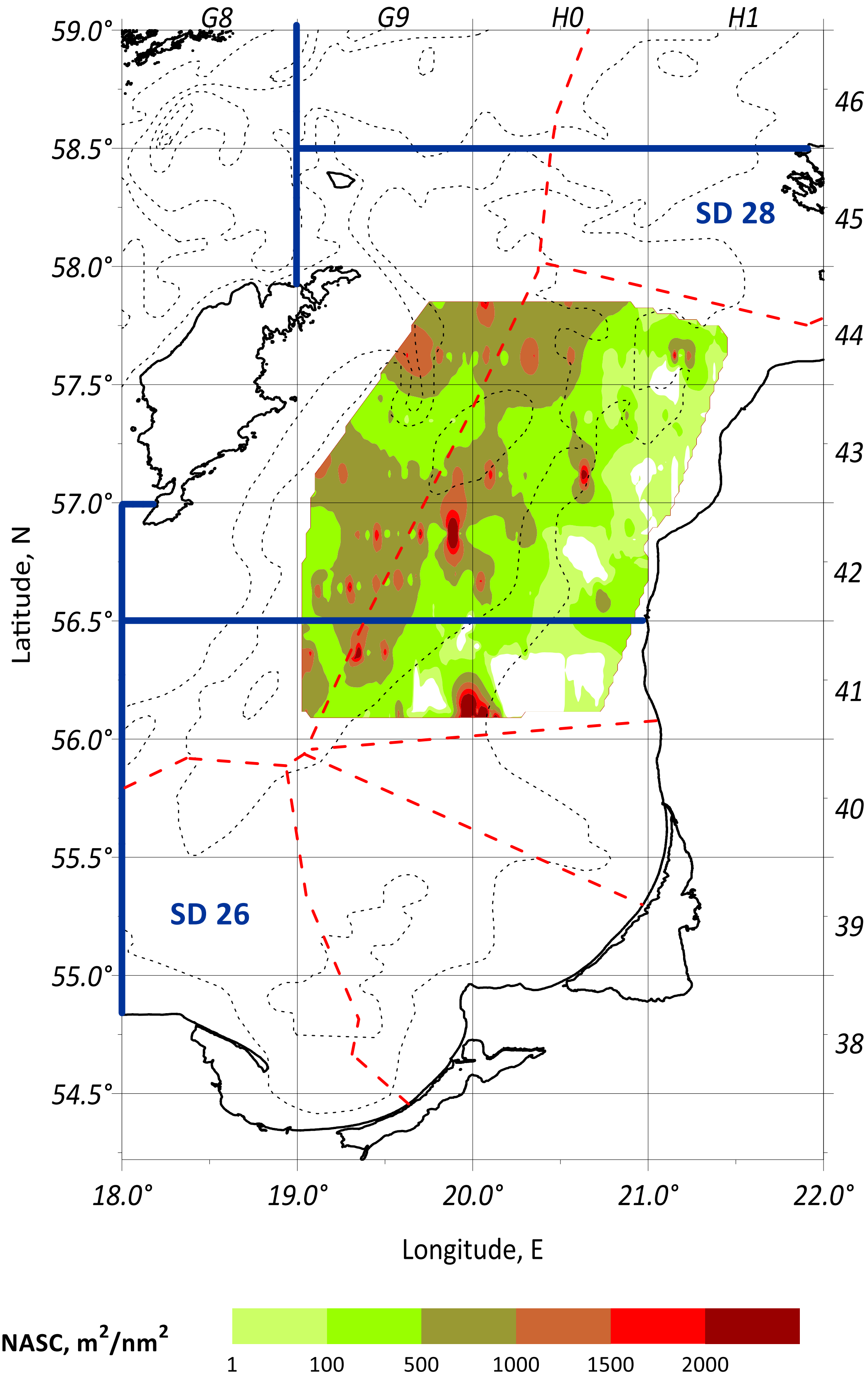

Figure 4: Acoustic parameter NASC distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

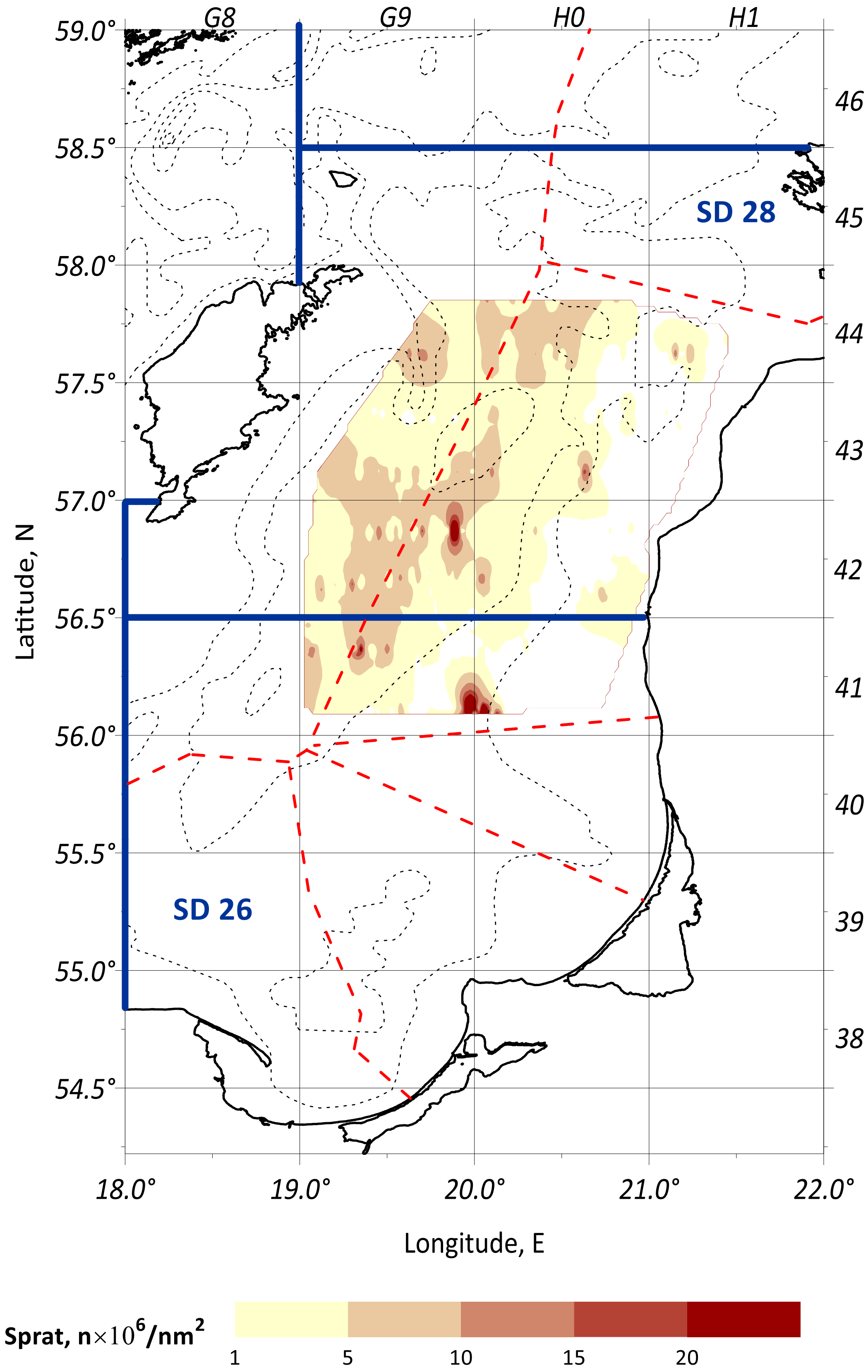

Figure 5: Sprat distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

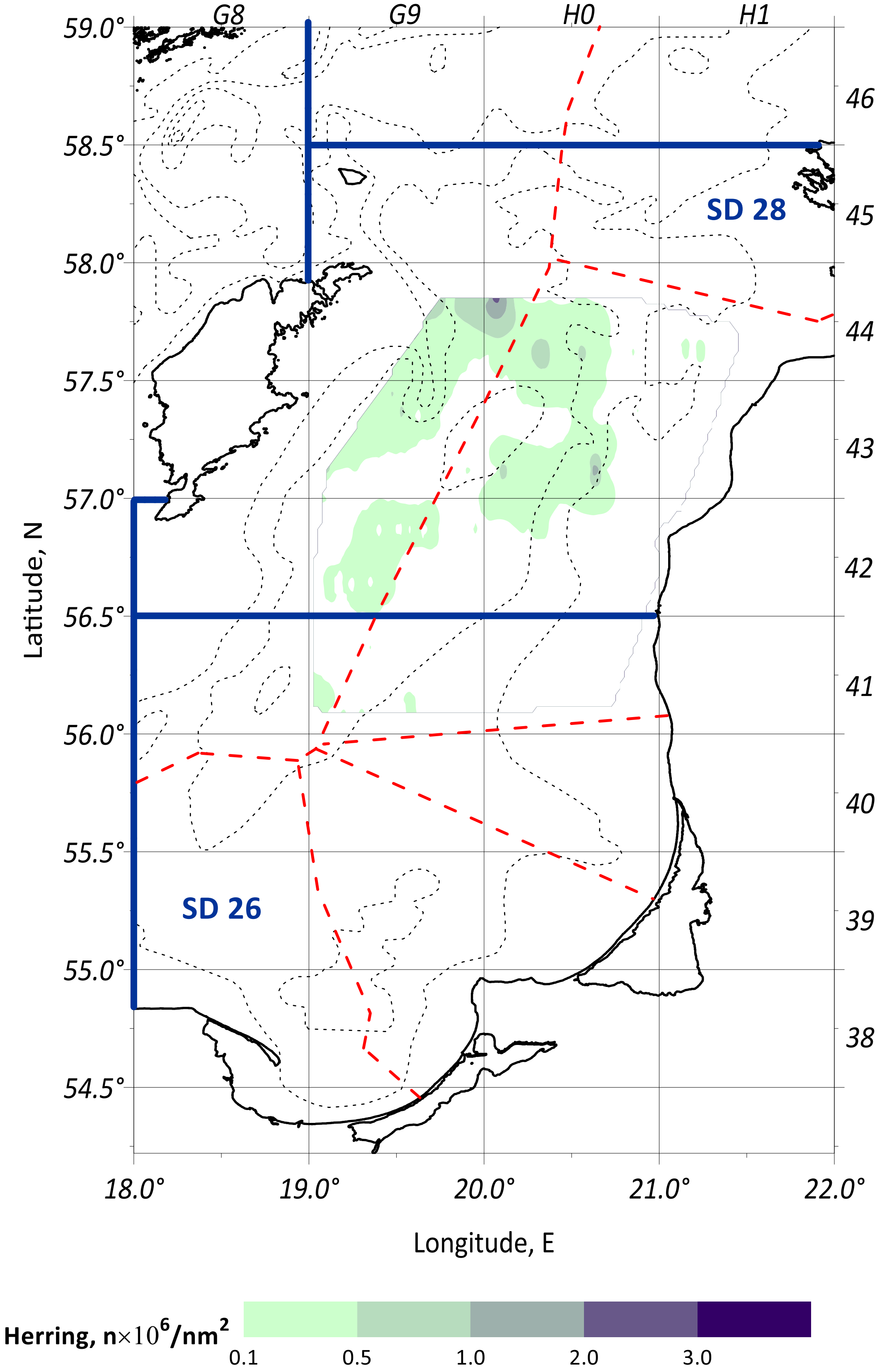

Figure 6: Herring distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

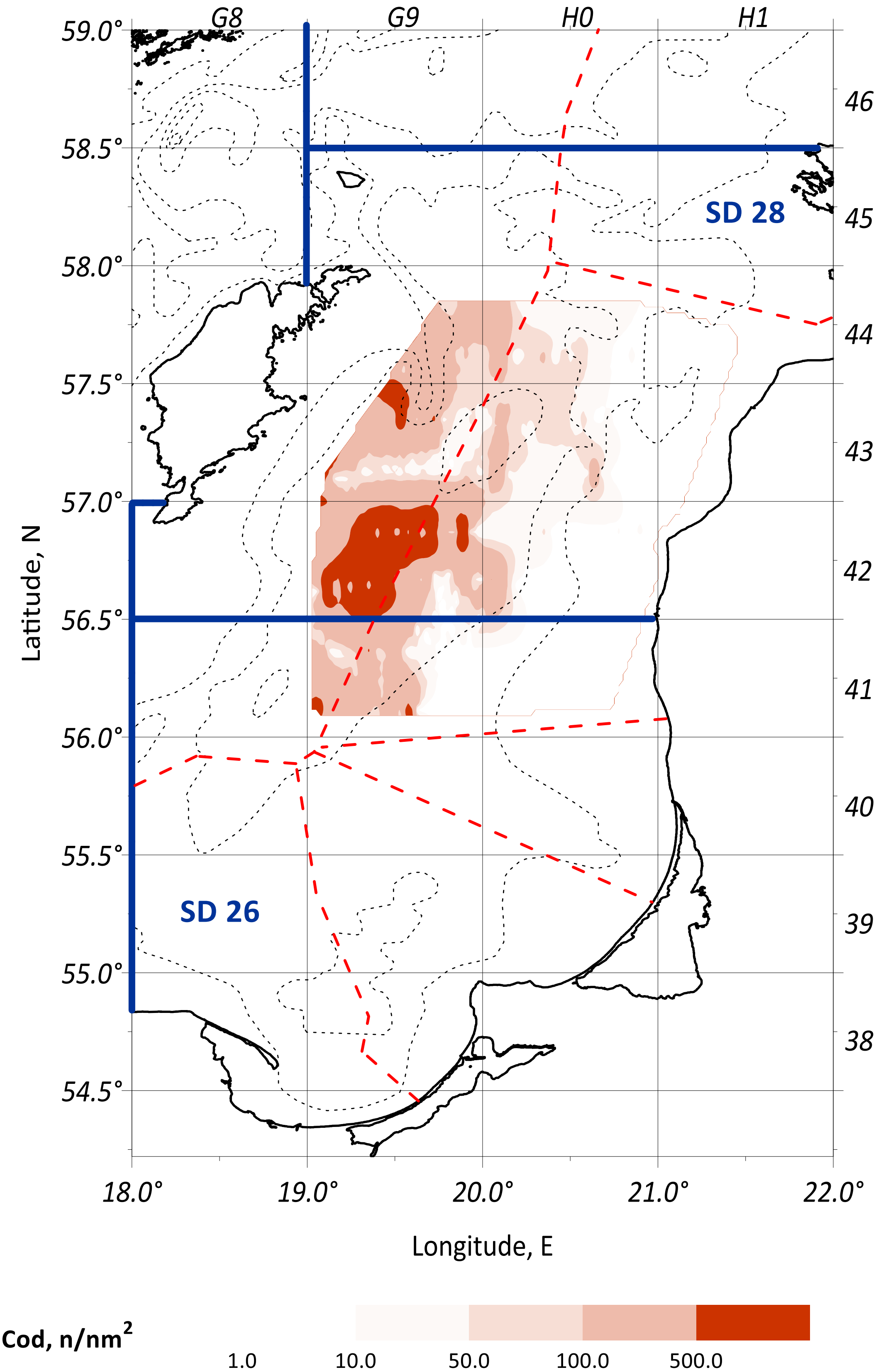

Figure 7: Cod distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

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 20-27.05.2022.

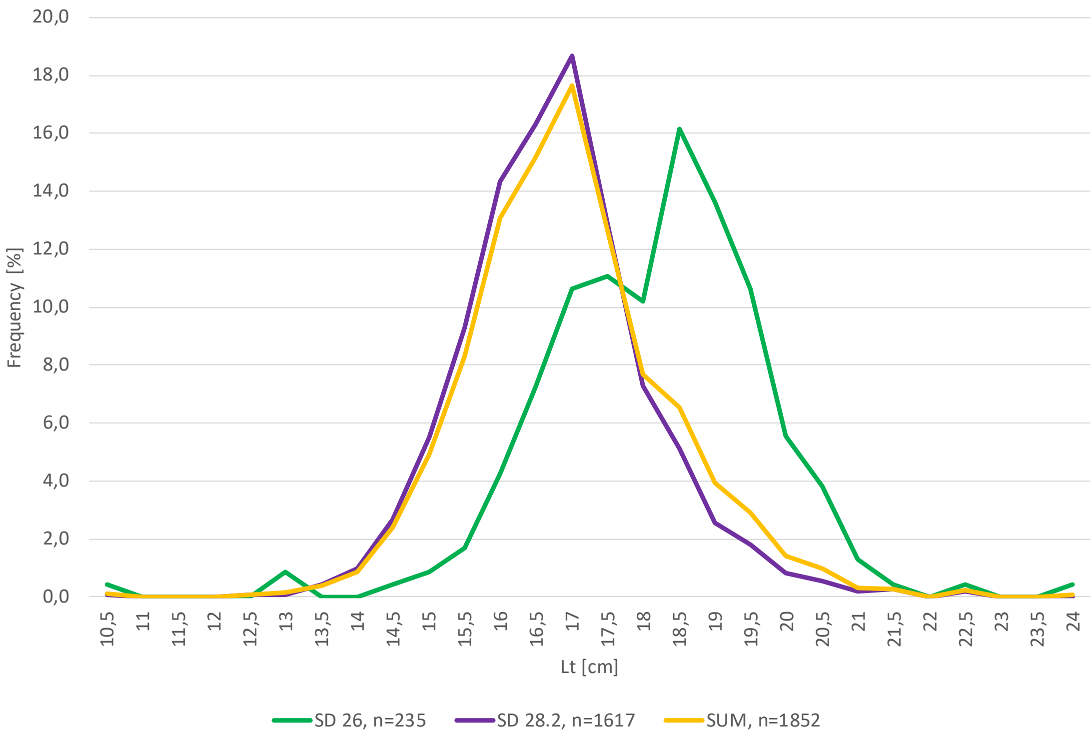

Figure 9: Herring length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

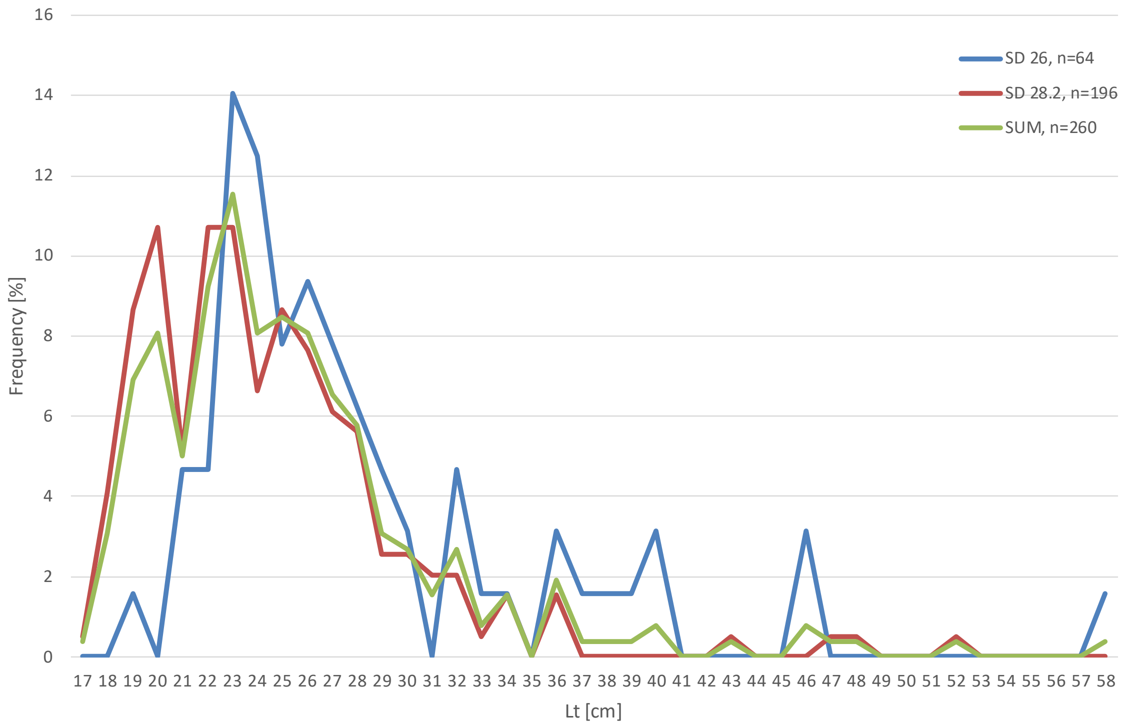

Figure 10: Cod length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

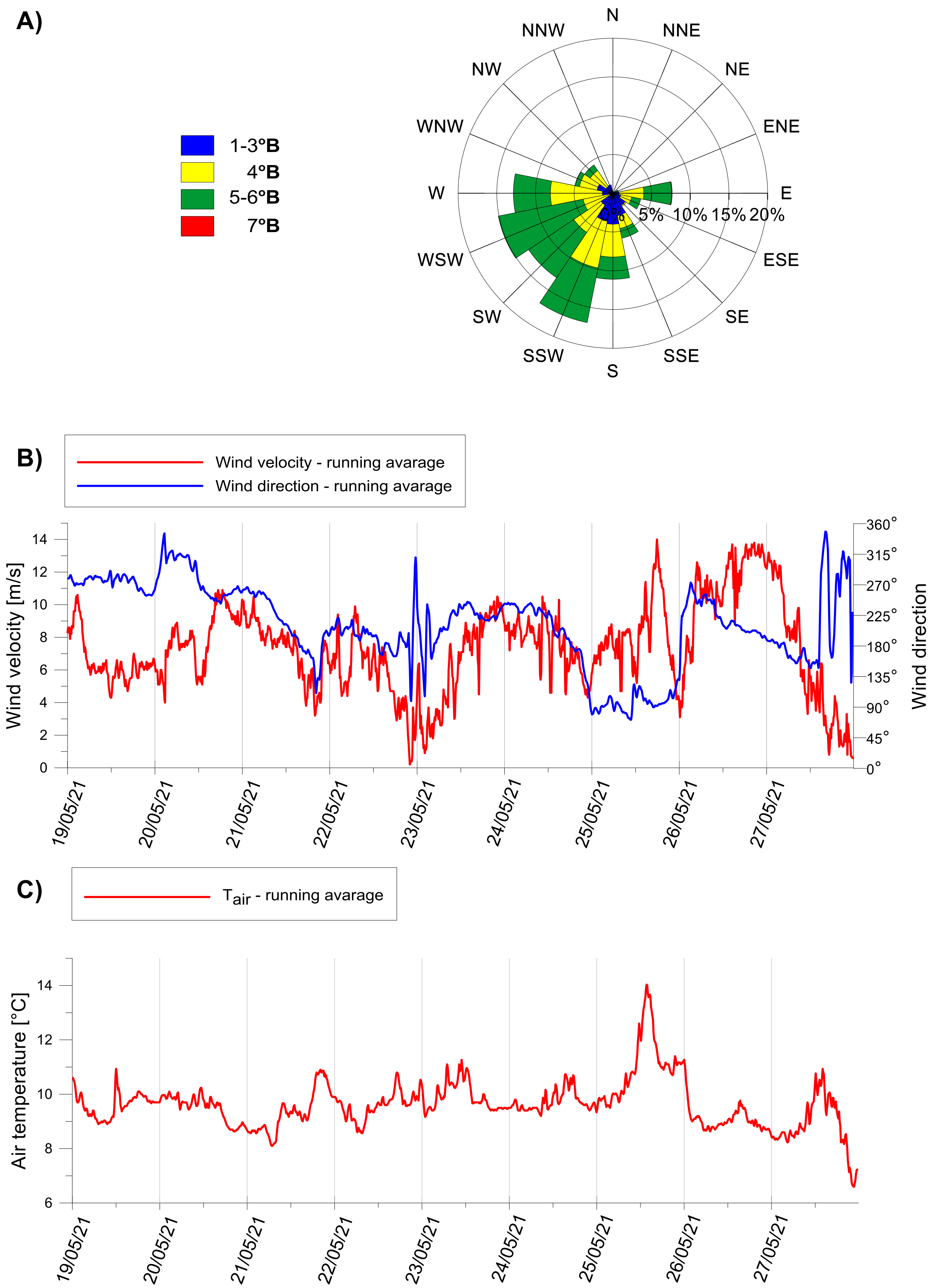

Figure 11: Changes of the main meteorological parameters (wind force, direction and the daily air temperature) during the Latvian-Polish BASS in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 20-27.05.2022.

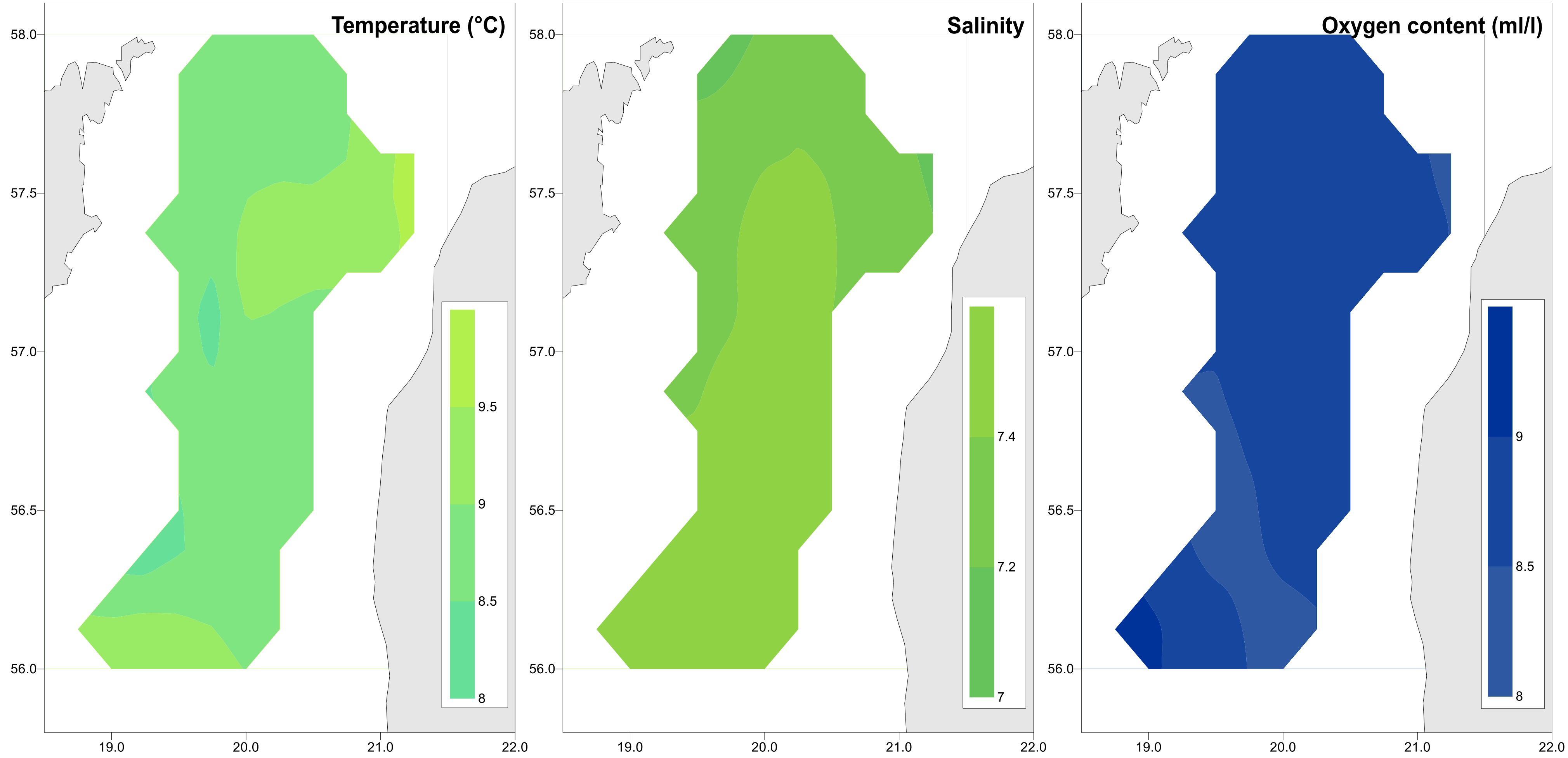

Figure 12: Horizontal distribution of the main hydrological parameters (temperature, salinity, oxygen content) measured in the surface water layer of the Gotland Deep in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

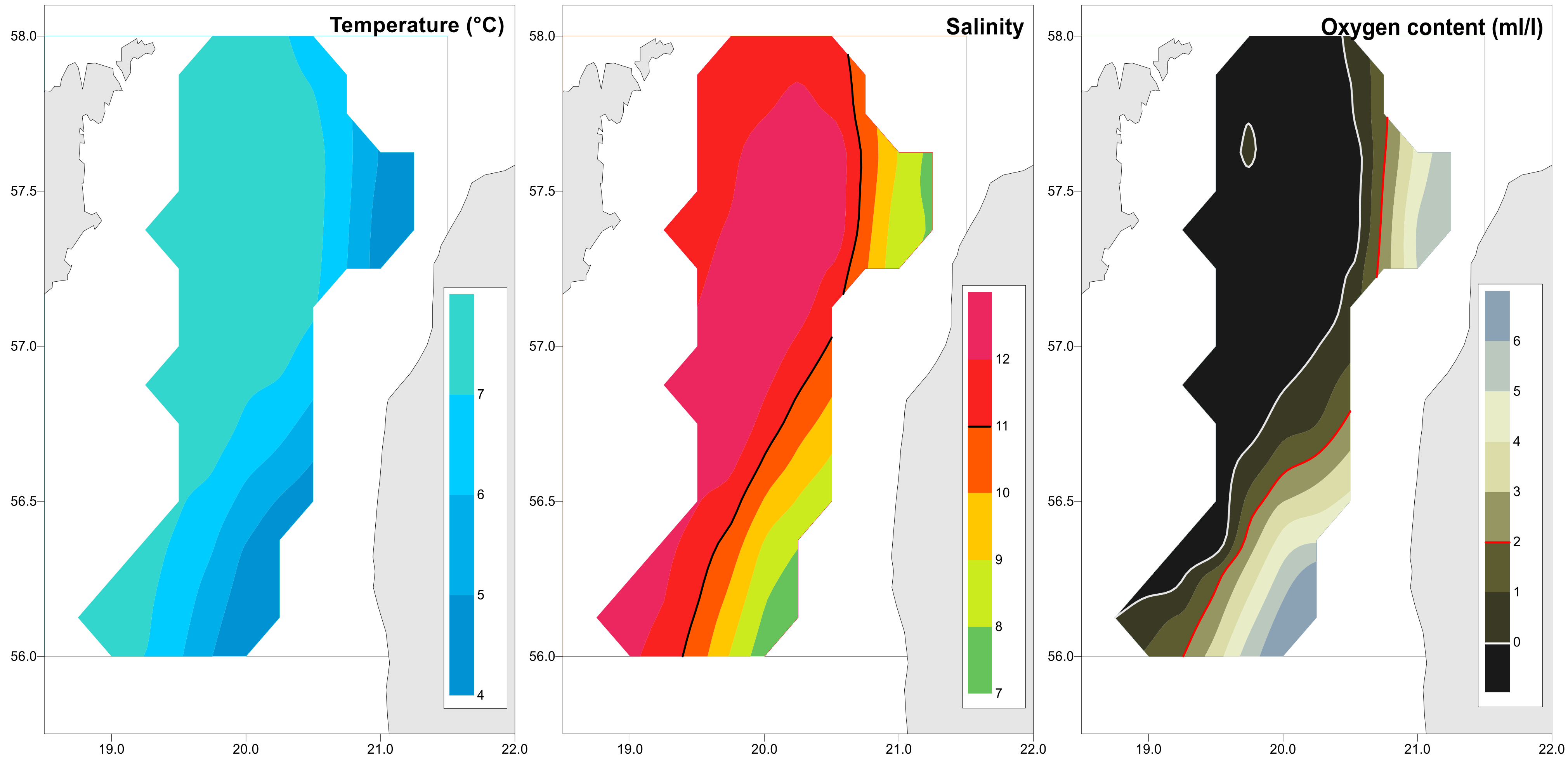

Figure 13: Horizontal distribution of the main hydrological parameters (temperature, salinity, oxygen content) measured in the bottom water layer of the Gotland Deep in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 20-27.05.2022.

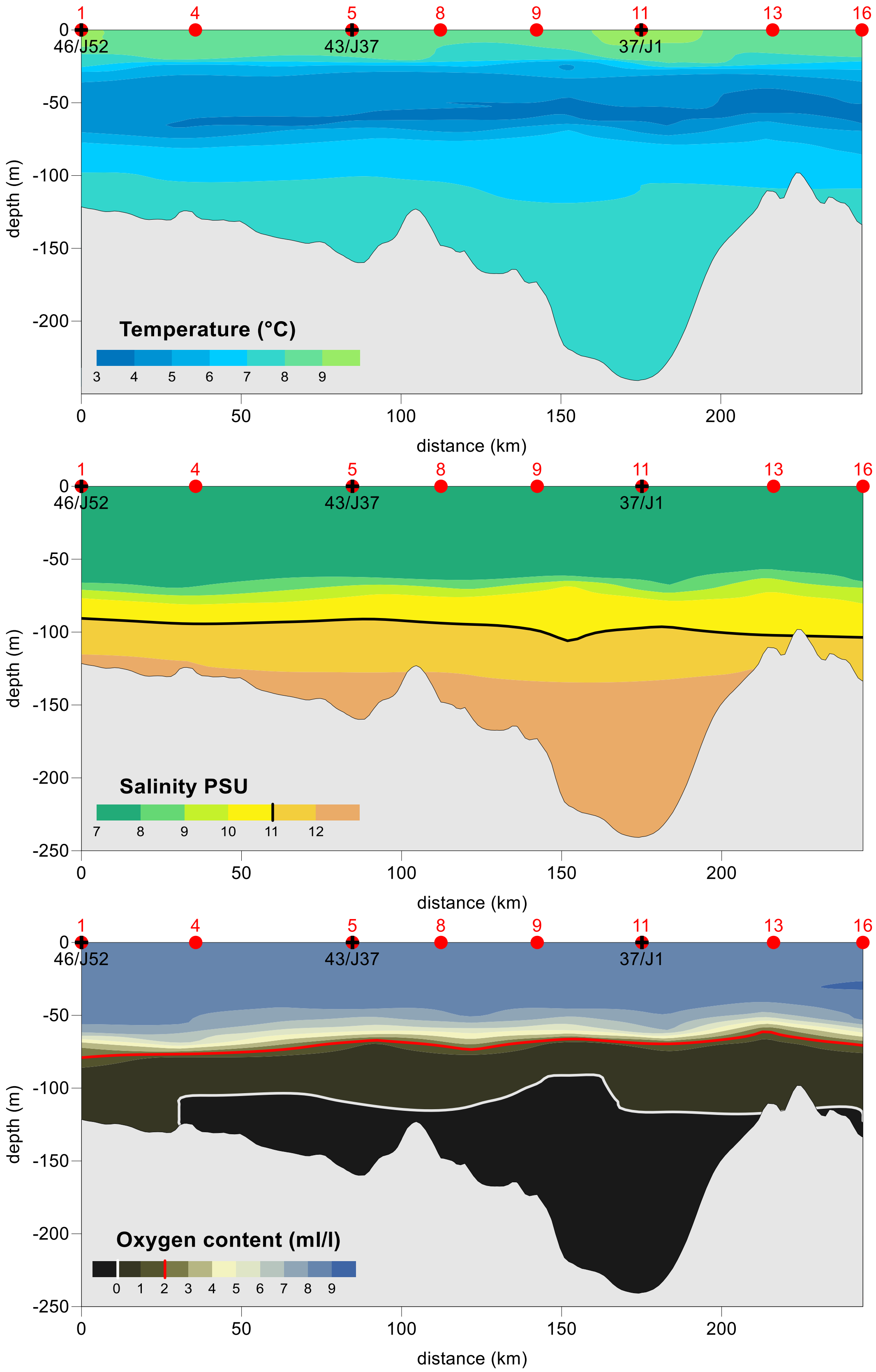

Figure 14: Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological profile in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS survey conducted by r/v "Baltica" in the period of 20-27.05.2022.

Research report from the Polish part of the SPRat Acoustic Survey (SPRAS) on board of the r.v. "Baltica" (03-15.05.2022)

Beata Schmidt and Krzysztof Radtke
National Marine Fisheries Research Institute, Gdynia (Poland)

INTRODUCTION

The Polish SPRAS/2022 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 survey investigations, as well as spatial allocation of vessels and the timing of regarding SPRAS and BIAS acoustic surveys. 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 3-15 May 2022, the SPRAS survey was conducted on board of the r.v. "Baltica" inside of the Polish, and partly, the Danish EEZs. The Polish Fisheries Data Collection Programme for 2022 and the European Union (the European Parliament and the Council Regulation (EU) 2017/1004 of 17 May 2017 and the Commission Implementing Decision (EU) 2021/1168 of 27 April 2021) financially supported the Polish SPRAS survey marked with internal No. 6/2022/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 its distribution. The SPRAS survey was carried out in the season of herring initial phase of intensive feeding and spawning time of sprat and cod 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 within investigated part of the southern Baltic in spring 2022. Moreover, the paper contains a description of sprat, herring and cod biological parameters variation. Horizontal and vertical distributions of the principal hydrological parameters in the southern Baltic are also described.

MATERIAL AND METHODS

Research team personnel

The main research tasks of the Polish SPRAS/2022 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,
Zuzanna Celmer – ichthyologist, sprat analyses,
Grzegorz Modrzejewski – technician, sprat analyses,
Katarzyna Nadolna-Ałtyn – 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,
Bartosz Witalis – hydrologist.

The course of the cruise

The r.v. “Baltica” left Gdynia port on the 3rd of May 2022 at 07:00 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 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 the ICES Subdivision 26. On the 8th of May at 05:30 p.m. measurements were completed at the position λ = 017°40,0’E, ϕ = 55°00,0’N. During the night r.v. “Baltica” sailed west where on the 9th 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 14th of May at 08:40 a.m. The r.v. “Baltica” returned to the Gdynia port on the 15th of May 2022 at 06:30 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, 2023). 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 (Figure 2).

As in the previous years, the SIMRAD EK60 version 2.2.0, a split-beam scientific echosounder was used in the Polish SPRAS 2022 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 3rd of May 2022 at the following location: λ = 019°01.7'E and φ = 54°26.1' N over seabed depth of 54 m (Figure 2). The echosounder calibration was performed as described in Simrad Manual (2012) using copper spheres as reference targets of diameters 60 mm and 23 mm for 38 kHz and 120 kHz frequency, respectively. Calibration results were considered good based on calculated RMS values which were 0.13 dB and 0.27 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 Figure 1.

The acoustic sampling was performed along the pre-selected acoustic transects at the distance of 772 NM. The echo-integration data were collected in a daytime regime at the vessel 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 similar to previous years.

The settings of the hydroacoustic equipment were as described in the IBAS Manual (ICES, 2017). The post-processing of the raw data recorded at 38 kHz frequency was done using the Echoview software (www.echoview.com). 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^2/NM^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 26 catch-stations (12 and 14 in ICES Subdivision 25 and 26, respectively) were conducted by the r.v. "Baltica" in spring 2022 (Figure 2, Table 2), 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. Due to 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 ranged from 2.8 to 3.2 knots. Fish catches were distributed at the depth ranged from 18 to 76 m from the sea surface (position of the headrope). Depth to the bottom at trawling positions varied from 39 to 107 m.

Fish caught in each haul were separated by species and weighted. The samples for sprat, herring and cod were taken for length and mass measurements, and ageing. Fish total length distributions 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 based on the results of fish length distributions. 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, 26, 20 and 18 samples were taken for the length and mass determination of sprat, herring and cod, respectively. Altogether, the length and mass were measured for 5390 sprat, 1241 herring, and 354 cod individuals. Respectively, 473, 495 and 235 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, 37 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, represented source information 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 support acoustic identification of fish species. Such data analysis is sectioned according to ICES statistical rectangles. Based on catch results, for each rectangle, the share of number and length distribution of all species were calculated as the unweighted mean. We intended to carry out at least two pelagic hauls per ICES rectangle, following 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 adjacent rectangles were used. This concerns the ICES rectangle 38G7 where no hauls were carried out due to very low acoustic signal recorded during echo-sounding (see Table 1). The assignment of hauls carried out during SPRAS 2022 cruise to the ICES Subdivisions and rectangles are presented below:

Subdivision (SD)	ICES rectangle	Haul no.
25	37G5	18
25	38G5	16,17
25	38G6	19
25	38G7	11*,19*
25	39G6	20,21,22
25	39G7	15,23,24,26
26	37G8	3
26	37G9	1,2
26	38G8	4,11
26	38G9	6,7
26	39G8	10,12
26	39G9	5
26	40G8	8,9,13,14

* haul performed in adjacent 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 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*. *Platichthys flesus* was included into analysis only in the ICES rectangle 38G9.

RESULTS

Acoustic results

The survey statistic including basic hydroacoustic results are given in Table 1. The total area covered by the Polish SPRAS/2022 survey was 9987.2 NM^2 overlaying 13 ICES rectangles. In total 748 NM of acoustic recording were used for acoustic biomass estimation. The spatial distribution of mean NASC values (5 NM intervals), predominantly derived from clupeids, measured on hydroacoustic transects during the SPRAS/2022 survey is presented in Figure 3. The highest NASC values were recorded, as in the previous year, in the Bornholm Deep and Słupsk Furrow (ICES Subdivision 25), and in the middle and east part of the Polish EEZ in the ICES Subdivision 26. The overall mean NASC value recorded over survey was lower compared to the previous year with a mean NASC across the water column of 591.6 versus 743.5 in 2021 where the same rectangles were covered. On the ICES Subdivision scale, similarly to the previous years, the ICES Subdivision 26 was characterized by a higher average value of NASC, which was almost twice as high as the average NASC value in the ICES Subdivision 25 - 741.2 m^2/NM^2 versus 384.0 m^2/NM^2. However, comparing to May 2021, a decrease by 22% and 27% in mean NASC was observed in Subdivisions 25 and 26, respectively. Furthermore, in the ICES Subdivision 26 the continuous decrease in mean NASC value has been observed since 2017, whereas in the ICES Subdivision 25 the mean NASC values stay on comparable level between years (Figure 4). On the rectangle scale, only in rectangle 37G9 located in Gdańsk Basin (ICES Subdivision 26), the mean NASC was higher than observed in May 2021. The highest average NASC value was recorded in rectangle 40G8 (Gotland Basin, ICES Subdivision 26), reaching the value of 1179.6 m^2/NM^2. The highest mean NASC values in the ICES Subdivision 25, were obtained for rectangles 39G6, 39G7 and 40G7 covering the area of the Słupsk Furrow.

Fish catches, biological parameters and stocks size

In May 2022, overall, 8 fish species were recorded in 26 scrutinized pelagic research hauls taking place in surveyed parts of the ICES Subdivisions 25 and 26 (Table 2, Figure 5). Totally, 14666.4 kg of fish were caught. Sprat distinctly dominated by mass in pelagic hauls (90.8%) whereas herring (6.5%) and cod (1.6%) can be considered as a significant bycatch in accomplished hauls (Table 2). From the remaining fish species, only flounder with a total catch of 21.4 kg in the entire study area was a remarkable component of bycatch (1.03%). Sprat occurred in each pelagic haul, herring was missing in one haul only and cod occurred in 69% of hauls performed. Neither marine mammals nor any seabirds were detected in the catches.

The CPUE ranged from 43 to 6777 kg/h. The mean CPUE for all species was 2222.0 kg/h, and it was higher value compared to the corresponding SPRAS survey in May 2021 (1601.0 kg/h). For sprat, the mean CPUEs were 2266.0 and 1682.7 kg/h for the ICES Subdivision 25 and 26, respectively, and were higher than obtained in May 2021 (1888.3 and 1231.4 kg/h, respectively). The CPUE of herring was generally low in all hauls performed, except one haul only, which was conducted in the northern part of the Slupsk Furrow, reaching herring CPUE 5883.0 kg/h.

Figure 6 presents the relative length-frequency distribution of sprat, herring and cod per Subdivision in 2021 and 2022. The total length of species dominated in pelagic hauls conducted in the all investigated areas in May 2022 ranged as follows:

- sprat – 8.5 ÷ 15.5 cm (avg. l.t. = 12.2 cm, avg. W = 10.7 g),
- herring – 10.0 ÷ 25.5 cm (avg. l.t. = 17.9 cm, avg. W = 36.6 g),
- cod – 19.0 ÷ 50.0 cm (avg. l.t. = 31.1 cm, avg. W = 286.2 g).

In May 2022 catches were dominated by sprat larger than 10 cm with a mode at 12 and 11.5 cm for the ICES Subdisvision 25 and 26, respectively. In both ICES Subdivisions the contribution of young, undersized specimens was minor. This is in contrast to the results obtained in 2021, when the second minor frequency apex from the length class of 9.0 cm existed, especially in Subdivision 26. It resulted in that the overall mean numerical share of undersized sprat (<10.0 cm length) was much lower comparing to May 2021, and amounted to 0.6% (Table 3).

For herring, in May 2022 two length fractions were evident in length distribution curve obtained for the ICES Subdivision 26. The first fraction, consisted of smaller size herring (10-15 cm), and the second fraction, of larger herring consisted of fish from length classes 15.5-25.5 cm. The first fraction of herring clearly represented undersized individuals. Length distribution of herring from the ICES Subdivision 25 was uniform, without any distinctive length fractions. Multimodal shape of herring length curves was characteristic for the both Subdivisions. In May 2021, the shape of length distribution for both ICES Subdivisions were quite similar to this obtained for ICES Subdivision 25 in May 2022. In May 2022, the numerical share of undersized herring (<16.0 cm length) in the ICES Subdivisions 25 was 15.3% and in the ICES Subdivision 26 the share was much higher – 30.5%. Undersized herring mean numerical share in the entire area in May 2022 was much higher (24.2%) than in May 2021 – 8.0% (Table 3).

Cod length distributions in May 2022 and in 2021 for both ICES Subdivisions investigated were marked by a quite large fluctuations in numerical share in length classes resulting from relatively low number of cod occurring in the surveys (Figure 6). Therefore, all the cod length distribution curves are multimodal. Length range of cod in May 2022 was very similar in the ICES Subdivision 25 and 26, ranging from 21 cm to 50 cm and from 19 cm to 50 cm, respectively. The mean bycatch of undersized cod (<35 cm length) was very high in samples collected in May 2022 – 85.0% and 70.1% in Subdivision 25 and 26, respectively. In May 2021 the share of undersized cod was of similar magnitude in Subdivision 25 – 75.5%, whereas in the ICES Subdivision 26 it was lesser – 53.6%.

The basic data evaluated in May 2022, including data on Baltic sprat, herring and cod stocks total abundance per ICES rectangle and Subdivision adequately to echosounding under the frequency of 38 kHz, are given in Table 1. Estimated numbers of sprat herring and cod by age group and ICES statistical rectangle/Subdivision is presented in Tables 4, 7 and 10. Corresponding mean weights by age group and ICES rectangle/Subdivision are provided in Tables 5, 8 and 11. Estimates of sprat, herring and cod biomass by age group and ICES rectangle/Subdivision are summarized in Tables 6, 9 and 12.

The total estimated sprat abundance and biomass reached the values of $38128.4 \cdot 10^6$ individuals and 397126.4 tones which about 65% of its abundance and 62% of its biomass allocated in the ICES Subdivision 26. In case of herring 78% of total estimated abundance ($297 \cdot 10^6$ individuals) and 81% of its total biomass (12464.2 tonnes) were allocated in the ICES Subdivision 26. Also total cod abundance ($27.3 \cdot 10^6$ individuals) and biomass (8349.7 tonnes) estimated in the scrutinized part of the southern Baltic were in 80% allocated in the ICES Subdivision 26.

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 2022 are illustrated in Figure 11. The air temperature during the reported survey varied from 6.0 to 13.0°C (avg. was 9.1°C). The wind force changed from 3 to 7°B, and winds from the west direction prevailed.

The main hydrological parameters at the depths of fish pelagic catches (Table 13), i.e. in the range of 27-85 m (with 20 m vertical net opening on average) changed in the relatively broad ranges. The seawater temperature fluctuated from 4.2 to 8.1°C, salinity from 7.6 to 14.1 PSU and oxygen content from 1.3 to 8.2 ml/l.

The surface water hydrological parameters changed in relatively narrow ranges: 6.7-10.1°C, 5.0-7.7 PSU and 7.7-9.6 ml/l for temperature, salinity and oxygen content respectively. The temperature in near bottom layer was changing horizontally within the range of 4.3-8.2°C. Salinity in the bottom waters varied from 7.6 PSU to the maximum of 15.2 PSU - appeared at the hydrological station no. IBY5b (the Bornholm Basin). Oxygen content near the bottom of deep waters varied from 0.75 ml/l – measured at the catch-station no. 2 (the Gdańsk Deep) to the maximum of 7.76 ml/l. During the period surveyed, the near-bottom waters with oxygen content below 2 ml/l occurred at the areas of the Bornholm Basin, the Słupsk Furrow, the Gdańsk Deep and the Gotland Basic. The horizontal distribution of these parameters in the near bottom zone of the southern Baltic is illustrated in Figure 12.

The vertical distribution of the seawater temperature, salinity and oxygen content, along the hydrological research profile determined in the southern Baltic in May 2022 is presented in Figure 13. During the period surveyed, the waters with hypoxic condition (< 2 ml/l) occurred mainly in the Gdańsk Deep at the depth bellow 70 m, having a patchy structure.

DISCUSSION

The above-results presented indicate that the centre of sprat, herring and cod temporal resources distribution in the scrutinized part of the southern Baltic in May 2022, was located mostly in the ICES Subdivision 26, similarly as in the previous year. Nevertheless, compared to May 2021, the present estimates show a significant decrease in total sprat and herring abundance (-26,9% and -64,4%, respectively) and biomass (-21.2% and -64.0%, respectively). In the case of cod, a slight increase in total abundance (+3.2%) and decrease in biomass (-14.9%) was observed (Schmidt *et al.*, 2022a). However, these changes differ between the ICES Subdivisions.

ICES SD	Difference comparing to May 2021					
	abundance [%]			biomass [%]		
	sprat	herring	cod	sprat	herring	cod
SD25	-18.1	-87.0	+515.3	-17.5	-89.0	+513.5
SD26	-30.8	-30.9	-16.5	-23.2	-22.6	-30.2
SD25-26	-26.9	-64.4	+3.2	-21.2	-64.0	-14.9

Compared to May 2021, the abundance of sprat in May 2022 decreased considerably in the ICES Subdivision 26 (-30.8%). In particular, the number of individuals of sprat from age group 2 (year-class 2020) decreased markedly, by -56.1%, from ca. $11225.2 \cdot 10^6$ to ca. $6299.3 \cdot 10^6$ individuals (Table 4, Figure 7). The abundance of year-class 2016 also decreased significantly (by -64.1%). The abundance of the sprat declined also in the ICES Subdivision 25 (by -18.1%). A marked decrease was observed for sprat age group 4 (year-class 2018), by -53.1% and also, as in the Subdivision 26, for the age group 6 (year-class 2016), by the same level as for year-class 2018 in the ICES Subdivision 25, by -53.1%. Moreover, in May 2022, in the sprat catches, over 89% of males and 90.5% of females participated in the spawning, which indicated that spawning took place in the research area.

In May 2022, the mean biomass density of sprat per ICES rectangle was lower in all rectangles, except one, compared to previous year. This resulted in lower biomass density in May 2022 in both Subdivisions: 29.0 and 51.1 t/NM^2 in the ICES Subdivisions 25 and 26 compared to May 2021: 35.2 and 66.6 t/NM^2 respectively. In May 2022 the maximum sprat surface biomass density was observed in the southern part of the Gotland Basin (the ICES rectangle 40G8). Contrary to SPRAS 2021, the high sprat biomass density in May 2022 did not occur in waters in Gdansk Buy in the ICES rectangle 37G8 (Figure 8).

The decreasing tendency (with some fluctuations) in biomass density of sprat in the ICES Subdivision 26, has been observed since 2017 (before 2017 the investigated area covered only partwithout large part of ICES Subdivision 26) – Figure 10. Comparing to May 2017, its present value dropped by almost three times from 134.4 t/NM^2 to 51.1 t/NM^2. While in the ICES Subdivision 25 the biomass density of sprat stay on similar level through the last 6 years.

During the SPRAS in 2022, the abundance and biomass of herring in the ICES Subdivision 26 were bigger than during the previous SPRAS survey in 2021, opposite to May 2020. The herring abundance, combined for both ICES Subdivisions, increased in May 2022 only for age groups 1 and 3 (Table 7, Figure 7). Compared to the results from the survey in May

2021, the abundance in May 2022 of an age group 2 (year-class 2020) decreased considerably in the ICES Subdivision 25 (from $149.9 \cdot 10^6$ individuals to $2.5 \cdot 10^6$). The decline of an age group 2 was also evident for Subdivision 26 (from $110.9 \cdot 10^6$ individuals to $18.2 \cdot 10^6$). The reduction in number of all the age groups 4+ which contribute the most in terms of mean mass of age groups contributed markedly to the observed decline of biomass in 2022 as compared to 2021 (by - 64%). Moreover, low level of gonadal development of herring (most of the fish were in preparatory stage) has also contributed to low individual mass of the fish in the study area.

The drop in herring biomass comparing to May 2021 is reflected in decrease in the mean biomass density in both ICES Subdivisions, especially in the ICES Subdivision 25: 0.5 t/NM^2 in May 2022 versus 4.2 t/NM^2 in May 2021. In this ICES Subdivision 25 in May 2022 in almost all rectangles the mean biomass density were less below 1 t/NM^2, and opposite to May 2021 no herring concentrations were observed in its offshore, west part (Figure 8). In ICES Subdivision 26 the decrease in mean biomass density was also observed but in less degree: from 2.7 t/NM^2 in May 2021 to 2.1 t/NM^2 in May 2022. Similarly to previous year, in May 2022 the highest mean surface biomass density of herring stock was estimated for the ICES rectangles 37G9 and 38G9 located in the Gdańsk Bay (Fig. 8). The biomass density of herring shows some fluctuation between 2017 and 2022 in both ICES subdivisions (Figure 10).

Compared to May 2021, the abundance of cod in May 2022 increased over 3% and the biomass decreased by -14.9% in both the ICES combined. The abundance and biomass of cod declined in Subdivision 26, whereas the opposite trend was observed in the ICES Subdivision 25. A high share of males with gonads at maturity stage VI (Maier's scale) indicates that cod spawning took place also in May 2022.

In May 2022, the mean biomass surface density per rectangle reached 6.1 t/NM^2, whereas in 2021 the highest value was 4.2 t/NM^2 (Figure 9). Cod resources were patchy distributed inside the Polish waters and in two ICES rectangles, its biomass was over 1.0 t/NM^2: 38G5 (1.1 t/NM^2), and 38G9 (6.1 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 1.4 and 0.3 $t \cdot NM^{-2}$. The mean biomass density of cod in years 2017-2022 stay below 1 t/NM^2 (with some fluctuations) in the ICES Subdivision 25, however in the ICES Subdivision 26 the decreasing tendency is observed (Figure 10).

CONCLUSION

The ICES Baltic International Fish Survey Working Group and the Baltic Fisheries Assessment Working Group can apply Polish SPRAS-2022 survey data for the Baltic clupeids and cod stocks size analysis and their spatial distribution. Results presented in this paper are 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 international database, managed by the ICES Secretariat and designated experts from WGBIFS.

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Table 1. Cruise statistics of the Polish SPRAS survey on board of the r.v. “Baltica”, 03-15.05.2022.

ICES SDs	ICES rectangles	EDSU [NM]	$\langle\sigma\rangle$ $[m^2 \cdot 10^{-4}]$	$\langle S_A \rangle$ $[m^2 \cdot NM^{-2}]$	Area $[NM^2]$	species composition [%]			Abundance $\cdot 10^6$			
						sprat	herring	cod	total	sprat	herring	cod
25	37G5	44	1.81	91.1	642.2	95.78	3.89	0.33	323.1	309.5	12.6	1.1
25	38G5	78	1.63	356.7	1035.7	99.17	0.66	0.17	2265.6	2246.8	14.9	3.9
25	38G6	67	1.65	197.0	940.2	99.42	0.58	0.01	1119.5	1113.0	6.5	0.1
25	38G7	29	1.54	7.7	471.7	99.34	0.66	0.00	23.5	23.3	0.2	0.0
25	39G6	89	1.48	656.8	1026	99.51	0.49	0.00	4538.1	4515.7	22.2	0.2
25	39G7	97	1.38	666.3	1026	99.81	0.17	0.02	4938.8	4929.4	8.6	0.8
Sum SD25		**404**							**13208.6**	**13137.7**	**64.9**	**6.0**
26	37G8	8	1.25	123.2	86	99.94	0.06	0.00	85.0	85.0	0.1	0.0
26	37G9	33	1.41	542.3	151.6	94.49	5.46	0.05	583.2	551.0	31.9	0.3
26	38G8	57	1.42	509.5	624.6	99.45	0.54	0.01	2247.8	2235.4	12.2	0.3
26	38G9	40	1.68	538.5	918.2	91.82	5.55	0.61	2945.8	2704.8	163.4	17.8
26	39G8	84	1.40	918.2	1026	99.97	0.03	0.00	6711.9	6710.0	1.8	0.1
26	39G9	30	1.49	534.8	1026	99.92	0.02	0.06	3688.9	3686.1	0.8	2.0
26	40G8	92	1.32	1179.6	1013	99.75	0.24	0.01	9041.3	9018.5	22.0	0.8
Sum SD26		**344**							**25303.8**	**24990.7**	**232.1**	**21.3**

Table 2. Fish catches data from the Polish SPRAS survey conducted on board of the r.v. “Baltica” in May 2022.

Haul number	Date of catch	ICES rectangles	ICES SDs	Geographical position of the catch				Mean depth to the bottom [m]	Headrope depth from the sea surface [m]	Vertical net opening [m]	Trawling speed [w]	The sip'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]							
				start		end																		
				latitude N	longitude E	latitude N	longitude E										sprat	herring	cod	flounder	whiting	European anchovy	Atlantic mackerel	twait shade
1	2022.05.03	37G9	26	54°25.1'	019°11.7'	54°25.2'	019°13.5'	49	28	18	3,0	080	14:45	20	244.77	734.30	237.013	6.443	0.953					0.359
2	2022.05.03	37G9	26	54°27.5'	019°28.0'	54°28.2'	019°27.9'	53	32	18	3,0	360	17:30	15	100.09	400.34	79.090	17.842	3.051					0.103
3	2022.05.04	37G8	26	54°28.0'	018°54.8'	54°28.5'	018°55.2'	60	38	18	3.0	020	07:50	15	180.97	723.90	180.620	0.354						
4	2022.05.04	38G8	26	54°41.3'	018°59.6'	54°42.0'	018°59.3'	88	63	18	3.0	345	11:25	15	387.05	1548.19	375.148	5.945	4.375	1.580				
5	2022.05.04	39G9	26	55°06.9'	019°04.5'	55°06.8'	019°03.3'	93	72	20	2,8	260	16:40	20	659.64	1978.93	647.470	0.596	10.565	1.012				
6	2022.05.05	38G9	26	54°35.9'	019°09.7'	54°35.9'	019°11.2'	82	61	17	3,0	085	07:35	20	233.56	700.69	178.108	49.342	4.878	1.236				
7	2022.05.05	38G9	26	54°50.1'	019°16.3'	54°50.2'	019°13.7'	107	76	19	3,0	270	11:20	30	52.99	105.99	23.280	6.730	9.743	13.241				
8	2022.05.06	40G8	26	55°51.2'	018°55.0'	55°50.5'	018°55.0'	104	69	20	2,9	180	07:45	15	574.61	2298.43	565.102	5.534	2.088	1.884				
9	2022.05.06	40G8	26	55°40.7'	018°40.3'	55°41.4'	018°40.3'	95	70	20	3,0	360	11:35	15	1214.36	4857.42	1207.182	4.310	2.501	0.362				
10	2022.05.06	39G8	26	55°19.7'	018°41.1'	55°19.6'	018°42.6'	85	60	20	2,8	095	15:25	20	990.43	2971.29	987.683	1.636	0.581	0.531				
11	2022.05.07	38G8	26	54°51.8'	018°40.4'	54°51.3'	018°41.0'	61	40	18	2.9	150	06:50	15	446.82	1787.29	442.239	4.583						
12	2022.05.07	39G8	26	55°11.5'	018°21.6'	55°11.6'	018°22.9'	79	55	20	3,0	085	12:00	15	481.10	1924.40	481.100							
13	2022.05.07	40G8	26	55°36.1'	018°27.6'	55°36.3'	018°28.5'	93	65	20	3,0	075	16:45	10	586.13	3516.80	580.745	2.888	1.515	0.986				
14	2022.05.08	40G8	26	55°32.9'	018°00.2'	55°34.3'	018°00.1'	75	48	20	3,0	360	08:50	30	282.01	564.01	276.975	5.031						
15	2022.05.08	39G7	25	55°17.3'	017°59.5'	55°18.2'	017°59.3'	76	50	20	3,0	360	13:00	20	14.52	43.57	14.440	0.082						
16	2022.05.09	38G5	25	54°46.1'	015°20.0'	54°44.6'	015°20.0'	69	47	20	3,1	180	11:10	30	381.43	762.86	347.286	7.327	26.427		0.235	0.097	0.058	
17	2022.05.09	38G5	25	54°57.9'	015°37.8'	54°57.9'	015°36.3'	79	55	20	2,9	270	15:30	15	711.65	2846.58	697.689	13.176	0.781					
18	2022.05.10	37G5	25	54°27.7'	015°39.9'	54°29.0'	015°39.8'	53	33	18	2,9	360	06:30	30	444.33	888.65	388.839	33.056	21.265		0.508			0.658
19	2022.05.10	38G6	25	54°54.8'	016°00.6'	54°54.0'	016°00.4'	67	45	18	3,0	185	13:30	15	266.73	1066.91	262.744	3.709	0.162			0.113		
20	2022.05.10	39G6	25	55°13.2'	016°03.5'	55°13.2'	016°04.7'	86	60	20	2,9	095	17:00	15	1065.61	4262.43	1052.430	10.127	2.656			0.394		
21	2022.05.11	39G6	25	55°08.8'	016°17.1'	55°08.9'	016°18.6'	72	50	20	2,9	080	07:40	20	457.25	1371.75	451.968	4.291	0.511	0.229		0.175	0.077	
22	2022.05.11	39G6	25	55°11.6'	016°41.4'	55°11.7'	016°42.6'	75	51	20	3,0	075	17:40	15	940.27	3761.10	909.486	30.587		0.201				
23	2022.05.12	39G7	25	55°14.0'	017°01.5'	55°14.0'	017°02.8'	88	63	20	3,0	080	11:00	15	828.31	3313.22	825.950	2.355						
24	2022.05.13	39G7	25	55°14.1'	017°21.5'	55°14.2'	017°22.4'	89	65	20	3,0	075	09:05	10	953.64	5721.82	946.080	5.899	1.529	0.128				
25	2022.05.13	40G7	25	55°32.2'	017°32.0'	55°32.4'	017°33.3'	39	18	18	2,9	065	13:50	15	1694.26	6777.04	223.514	1470.746						
26	2022.05.13	39G7	25	55°18.1'	017°41.3'	55°18.4'	017°42.0'	81	58	20	2.9	050	17:25	10	473.89	2843.34	459.386	6.768	7.736					

Table 3. The mean numerical share of young, undersized fishes per ICES SDs (the Polish SPRAS/2021 and SPRAS/2022).

Species	Fish length	SPRAS 2021			SPRAS 2022		
		Mean share in % numbers			Mean share in % numbers		
		SD25	SD26	Mean	SD25	SD26	Mean
sprat	< 10 cm	1.9	15.1	8.5	0.2	0.9	0.6
herring	< 16 cm	8.7	5.8	8.0	15.3	30.5	24.2
cod	< 35 cm	75.5	53.6	57.9	85.0	70.1	79.7

Table 4. 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", 03-15.05.2022.

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	10.7	39.2	47.6	56.9	58.3	37.1	48.1	11.5	309.5
25	38G5	13.1	399.2	632.2	387.3	390.5	188.5	204.7	31.3	2246.8
25	38G6	0.8	152.5	245.8	220.8	224.8	116.2	131.7	20.4	1113.0
25	38G7	0.2	5.3	7.3	3.7	3.3	1.7	1.6	0.2	23.3
25	39G6	77.8	1230.0	1532.1	624.0	557.8	261.9	212.3	19.8	4515.7
25	39G7	237.7	1808.0	1827.0	485.1	309.8	174.9	82.7	4.2	4929.4
Sum SD25		**340.2**	**3634.3**	**4291.9**	**1777.8**	**1544.5**	**780.4**	**681.1**	**87.5**	**13137.7**
26	37G8	3.2	34.9	26.6	11.4	4.8	2.6	1.3	0.1	85.0
26	37G9	12.1	159.1	162.5	101.7	59.1	23.5	26.2	6.9	551.0
26	38G8	5.8	489.8	665.0	513.2	292.3	90.1	149.1	30.2	2235.4
26	38G9	7.6	518.7	782.5	636.9	387.2	140.7	186.8	44.5	2704.8
26	39G8	23.0	1528.4	1970.6	1489.9	882.8	337.1	383.8	94.4	6710.0
26	39G9	1.5	573.8	987.5	899.0	599.2	248.8	275.6	100.7	3686.1
26	40G8	193.7	2994.6	2711.7	1563.3	825.6	329.9	330.6	69.1	9018.5
Sum SD26		**246.9**	**6299.3**	**7306.3**	**5215.3**	**3051.1**	**1172.8**	**1353.3**	**345.8**	**24990.7**

Table 5. 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", 03-15.05.2022.

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	66.3	423.3	626.0	860.9	898.0	588.3	786.3	211.0	4460.1
25	38G5	95.2	4388.3	7222.3	5165.7	5247.2	2699.5	3100.0	525.2	28443.4
25	38G6	6.6	1807.1	2937.3	3065.6	3117.8	1690.4	2007.0	343.4	14975.1
25	38G7	1.3	55.8	79.7	48.0	44.9	23.6	24.4	3.8	281.5
25	39G6	609.1	12326.6	16409.4	7729.3	7235.8	3441.8	3065.8	311.7	51129.5
25	39G7	1716.3	16886.3	18697.4	5533.4	3937.9	2059.8	1132.7	65.1	50028.8
Sum SD25		**2494.7**	**35887.3**	**45972.2**	**22402.9**	**20481.5**	**10503.4**	**10116.1**	**1460.2**	**149318.4**
26	37G8	17.8	272.1	225.4	106.0	47.4	24.1	14.1	1.6	708.5
26	37G9	64.8	1317.4	1533.7	1048.4	657.2	249.4	304.9	88.1	5264.0
26	38G8	38.9	4437.3	6603.8	5355.3	3214.1	972.8	1698.8	386.0	22707.1
26	38G9	32.4	4859.2	7928.8	6765.8	4360.7	1617.0	2140.1	568.4	28272.3
26	39G8	156.0	13665.4	19382.3	15621.2	9831.6	3740.7	4372.3	1197.7	67967.2
26	39G9	9.9	5575.8	10434.7	9811.1	6976.9	3004.5	3209.3	1489.3	40511.4
26	40G8	1083.8	24171.8	24817.8	15609.2	8749.9	3316.6	3752.4	876.1	82377.5
Sum SD26		**1403.4**	**54298.9**	**70926.6**	**54317.0**	**33837.7**	**12925.1**	**15491.9**	**4607.3**	**247808.0**

Table 6. 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", 03-15.05.2022.

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	6.2	10.8	13.1	15.1	15.4	15.9	16.3	18.3	14.4
25	38G5	7.3	11.0	11.4	13.3	13.4	14.3	15.1	16.8	12.7
25	38G6	8.2	11.8	11.9	13.9	13.9	14.5	15.2	16.9	13.5
25	38G7	8.2	10.5	11.0	13.0	13.5	13.8	15.0	16.8	12.1
25	39G6	7.8	10.0	10.7	12.4	13.0	13.1	14.4	15.7	11.3
25	39G7	7.2	9.3	10.2	11.4	12.7	11.8	13.7	15.6	10.1
MW SD25		**7.3**	**9.9**	**10.7**	**12.6**	**13.3**	**13.5**	**14.9**	**16.7**	**11.4**
26	37G8	5.5	7.8	8.5	9.3	9.8	9.1	10.6	11.9	8.3
26	37G9	5.4	8.3	9.4	10.3	11.1	10.6	11.6	12.8	9.6
26	38G8	6.7	9.1	9.9	10.4	11.0	10.8	11.4	12.8	10.2
26	38G9	4.3	9.4	10.1	10.6	11.3	11.5	11.5	12.8	10.5
26	39G8	6.8	8.9	9.8	10.5	11.1	11.1	11.4	12.7	10.1
26	39G9	6.8	9.7	10.6	10.9	11.6	12.1	11.6	14.8	11.0
26	40G8	5.6	8.1	9.2	10.0	10.6	10.1	11.4	12.7	9.1
MW SD26		**5.7**	**8.6**	**9.7**	**10.4**	**11.1**	**11.0**	**11.4**	**13.3**	**9.9**

Table 7. 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", 03-15.05.2022.

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	5.1	0.6	2.5	1.7	0.9	0.9	0.5	0.4	12.6
25	38G5	3.6	0.4	3.7	2.2	1.8	1.1	1.0	1.2	14.9
25	38G6	2.0	0.2	1.6	1.1	0.6	0.4	0.4	0.1	6.5
25	38G7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
25	39G6	2.7	0.8	5.4	2.4	3.3	3.9	2.4	1.4	22.2
25	39G7	1.4	0.4	2.6	0.9	0.8	0.7	1.0	0.6	8.6
Sum SD25		**14.8**	**2.5**	**15.9**	**8.3**	**7.4**	**7.0**	**5.3**	**3.7**	**64.9**
26	37G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
26	37G9	19.8	2.2	4.0	1.4	1.3	1.0	1.6	0.5	31.9
26	38G8	5.6	0.9	2.2	0.7	0.8	0.6	1.0	0.4	12.2
26	38G9	0.4	10.6	40.8	14.3	25.2	22.2	29.1	20.9	163.4
26	39G8	0.0	0.4	0.6	0.1	0.3	0.1	0.2	0.0	1.8
26	39G9	0.0	0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.8
26	40G8	0.3	3.9	7.1	2.5	2.2	1.8	3.4	0.9	22.0
Sum SD26		**26.2**	**18.2**	**54.9**	**19.0**	**29.9**	**25.8**	**35.4**	**22.7**	**232.1**

Table 8. 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”, 03-15.05.2022.

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	112.4	15.1	81.8	54.9	36.0	35.0	19.4	20.9	375.5
25	38G5	77.0	12.2	149.4	78.4	85.8	45.9	46.0	75.3	570.1
25	38G6	47.6	7.0	56.6	33.4	22.9	18.3	19.1	5.3	210.2
25	38G7	1.7	0.1	0.7	0.4	0.3	0.2	0.2	0.1	3.7
25	39G6	69.1	27.6	211.7	81.5	137.2	160.4	99.1	69.5	856.0
25	39G7	34.8	14.4	113.7	37.3	39.1	33.5	50.9	32.9	356.6
Sum SD25		**342.6**	**76.4**	**613.9**	**285.8**	**321.3**	**293.4**	**234.8**	**204.0**	**2372.1**
26	37G8	0.2	0.2	0.4	0.2	0.1	0.0	0.1	0.0	1.3
26	37G9	234.1	68.2	146.2	49.9	52.4	42.9	64.9	21.0	679.5
26	38G8	79.6	26.9	84.5	28.9	37.9	28.5	45.1	19.8	351.2
26	38G9	6.2	408.2	1832.6	655.6	1302.1	1144.9	1437.8	1343.8	8131.4
26	39G8	0.0	13.4	19.8	2.9	9.9	3.5	7.0	0.0	56.4
26	39G9	0.0	4.9	9.8	2.4	2.4	7.3	7.3	2.4	36.6
26	40G8	6.0	132.7	258.8	88.1	89.6	80.4	140.5	39.7	835.7
Sum SD26		**326.1**	**654.4**	**2352.1**	**828.2**	**1494.4**	**1307.5**	**1702.7**	**1426.7**	**10092.1**

Table 9. 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”, 03-15.05.2022.

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	21.9	25.3	33.0	32.3	38.4	40.3	41.5	52.4	29.9
25	38G5	21.5	30.1	40.6	36.1	46.8	43.4	46.8	61.3	38.2
25	38G6	24.2	30.5	34.6	30.7	40.3	42.0	45.9	46.4	32.6
25	38G7	17.3	27.2	34.0	30.6	39.2	41.7	45.9	46.4	24.1
25	39G6	26.1	34.5	38.9	34.0	41.6	41.2	42.0	49.8	38.5
25	39G7	25.0	32.1	43.3	39.8	48.5	45.3	49.0	58.2	41.7
MW SD25		**23.1**	**30.8**	**38.7**	**34.4**	**43.2**	**41.9**	**44.6**	**55.1**	**36.5**
26	37G8	12.8	28.3	27.5	28.9	27.9		31.1	32.6	24.5
26	37G9	11.8	30.6	36.2	36.5	38.9	43.9	40.7	43.5	21.3
26	38G8	14.1	30.3	39.2	40.0	47.3	48.7	46.5	51.1	28.9
26	38G9	15.5	38.4	45.0	45.9	51.7	51.6	49.5	64.4	49.8
26	39G8	-	32.2	31.3	24.8	31.3	35.2	35.2	-	31.7
26	39G9	-	45.4	45.4	45.4	45.4	45.4	45.4	45.4	45.4
26	40G8	19.0	33.9	36.5	35.9	41.0	45.1	41.9	43.3	38.0
MW SD26		**12.4**	**36.0**	**42.8**	**43.5**	**50.0**	**50.7**	**48.2**	**62.9**	**43.5**

Table 10. 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”, 03-15.05.2022.

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	0.0	0.9	0.2	0.0	0.0	0.0	0.0	0.0	1.1
25	38G5	0.0	2.9	1.0	0.0	0.0	0.0	0.0	0.0	3.9
25	38G6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
25	38G7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	39G6	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2
25	39G7	0.0	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.8
Sum SD25		**0.0**	**4.5**	**1.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**6.0**
26	37G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	37G9	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.3
26	38G8	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.3
26	38G9	0.8	8.1	8.1	0.8	0.0	0.0	0.0	0.0	17.8
26	39G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
26	39G9	0.0	1.2	0.8	0.1	0.0	0.0	0.0	0.0	2.0
26	40G8	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.8
Sum SD26		**0.8**	**10.1**	**9.4**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**21.3**

Table 11. 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”, 03-15.05.2022.

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	0.0	178.2	61.1	0.0	12.4	0.0	0.0	0.0	251.7
25	38G5	0.0	623.7	535.1	8.6	0.0	0.0	0.0	0.0	1167.3
25	38G6	0.0	12.7	0.0	0.0	0.0	0.0	0.0	0.0	12.7
25	38G7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
25	39G6	0.0	11.8	54.7	0.0	0.0	0.0	0.0	0.0	66.5
25	39G7	0.0	130.7	58.4	5.7	0.0	0.0	0.0	0.0	194.9
Sum SD25		**0.0**	**957.2**	**709.4**	**14.3**	**12.4**	**0.0**	**0.0**	**0.0**	**1693.2**
26	37G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	37G9	0.0	38.8	39.4	29.1	0.0	0.0	0.0	0.0	107.2
26	38G8	0.0	25.6	58.9	41.5	0.0	0.0	0.0	0.0	125.9
26	38G9	54.8	1625.2	3451.8	430.0	0.0	0.0	0.0	0.0	5561.9
26	39G8	0.0	6.2	9.7	1.1	0.0	0.0	0.0	0.0	17.0
26	39G9	0.0	293.4	328.7	29.6	0.0	0.0	0.0	0.0	651.8
26	40G8	1.4	90.3	92.3	8.7	0.0	0.0	0.0	0.0	192.7
Sum SD26		**56.2**	**2079.5**	**3980.8**	**540.0**	**0.0**	**0.0**	**0.0**	**0.0**	**6656.5**

Table 12. 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”, 03-15.05.2022.

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	-	205.9	328.0	-	1057.0	-	-	-	236.7
25	38G5	-	214.0	537.1	779.5	-	-	-	-	297.7
25	38G6	-	222.3	-	-	-	-	-	-	222.3
25	38G7	-	222.3	-	-	-	-	-	-	222.3
25	39G6	-	265.8	507.5	-	-	-	-	-	437.1
25	39G7	-	201.5	344.6	779.5	-	-	-	-	236.0
MW SD25		**-**	**211.3**	**485.8**	**779.5**	**1057.0**	**-**	**-**	**-**	**281.3**
26	37G8	-	-	-	-	-	-	-	-	-
26	37G9	-	226.0	467.6	765.3	-	-	-	-	365.0
26	38G8	-	268.4	433.0	782.4	-	-	-	-	443.1
26	38G9	66.4	201.0	425.9	529.6	-	-	-	-	312.0
26	39G8	-	196.7	323.0	345.4	-	-	-	-	262.6
26	39G9	-	249.3	407.5	496.6	-	-	-	-	319.0
26	40G8	64.0	164.9	465.3	509.3	-	-	-	-	245.5
MW SD26		**66.3**	**300.4**	**501.1**	**564.0**	**-**	**-**	**-**	**-**	**392.1**

Table 13. Values of the basic meteorological and hydrological parameters recorded in May 2022 at the positions of the r.v. "Baltica" fish 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	2022-05-03	12:45	1016.3	8.7	NNW	3	1	4.6	7.6	7.7	37
2	2022-05-03	15:30	1017.2	8.3	NNW	4	2	4.2	7.6	7.4	41
3	2022-05-04	05:50	1022.2	7.9	E	3	1	4.6	7.7	7.4	47
4	2022-05-04	09:25	1023.1	8.8	ESE	3	1	6.0	10.0	2.0	72
5	2022-05-04	14:40	1022.1	8.5	E	3	2	6.8	10.9	2.5	82
6	2022-05-05	05:35	1020.0	8.8	S	3/4	3/2	5.0	8.8	1.4	70
7	2022-05-05	09:20	1020.1	7.8	S	4	2	6.8	10.9	1.3	85
8	2022-05-06	05:45	1021.3	7.4	SW	3	2	6.5	10.6	1.3	79
9	2022-05-06	09:35	1022.5	7.8	W	4	1	6.0	10.0	2.2	80
10	2022-05-06	13:25	1022.8	8.4	W	3/2	1	6.2	10.3	1.9	70
11	2022-05-07	05:50	1020.5	9.1	SW	3	2	4.3	7.7	7.6	49
12	2022-05-07	10:00	1020.0	9.1	WSW	4	2	5.8	9.9	4.9	65
13	2022-05-07	14:45	1019.0	8.6	WSW	4	2	5.6	9.6	3.4	75
14	2022-05-08	06:50	1022.8	6.7	ENE	4	2	4.3	7.7	6.1	58
15	2022-05-08	11:00	1025.3	6.9	NE	4	2	4.2	7.6	7.4	60
16	2022-05-09	09:10	1032.4	8.7	E	4	2	6.0	11.2	3.9	57
17	2022-05-09	13:30	1031.1	8.9	E	4	2	7.8	14.1	2.3	65
18	2022-05-10	04:30	1023.1	9.4	SE	4	2	4.9	7.9	6.3	42
19	2022-05-10	11:30	1019.3	11.6	SE	4	2	6.6	12.0	3.4	54
20	2022-05-10	15:00	1015.5	11.7	SE	4	2	7.8	11.1	1.5	70
21	2022-05-11	05:40	1011.5	9.6	W	4/5	2/3	8.1	13.1	2.5	60
22	2022-05-11	15:40	1007.9	10.8	SSW	3/4	2	7.2	12.2	3.1	61
23	2022-05-12	09:00	1008.3	9.7	W	5/6	3	7.4	12.5	4.6	73
24	2022-05-13	07:05	1013.5	8.8	W	4	3	7.7	12.8	2.7	75
25	2022-05-13	11:50	1012.7	9.9	WSW	4	3/2	7.9	7.6	8.2	27
26	2022-05-13	15:25	1012.8	9.2	WSW	4	3/2	7.0	11.7	3.2	68

*date of the mean of the catches (in the middle of trawl vertical opening)

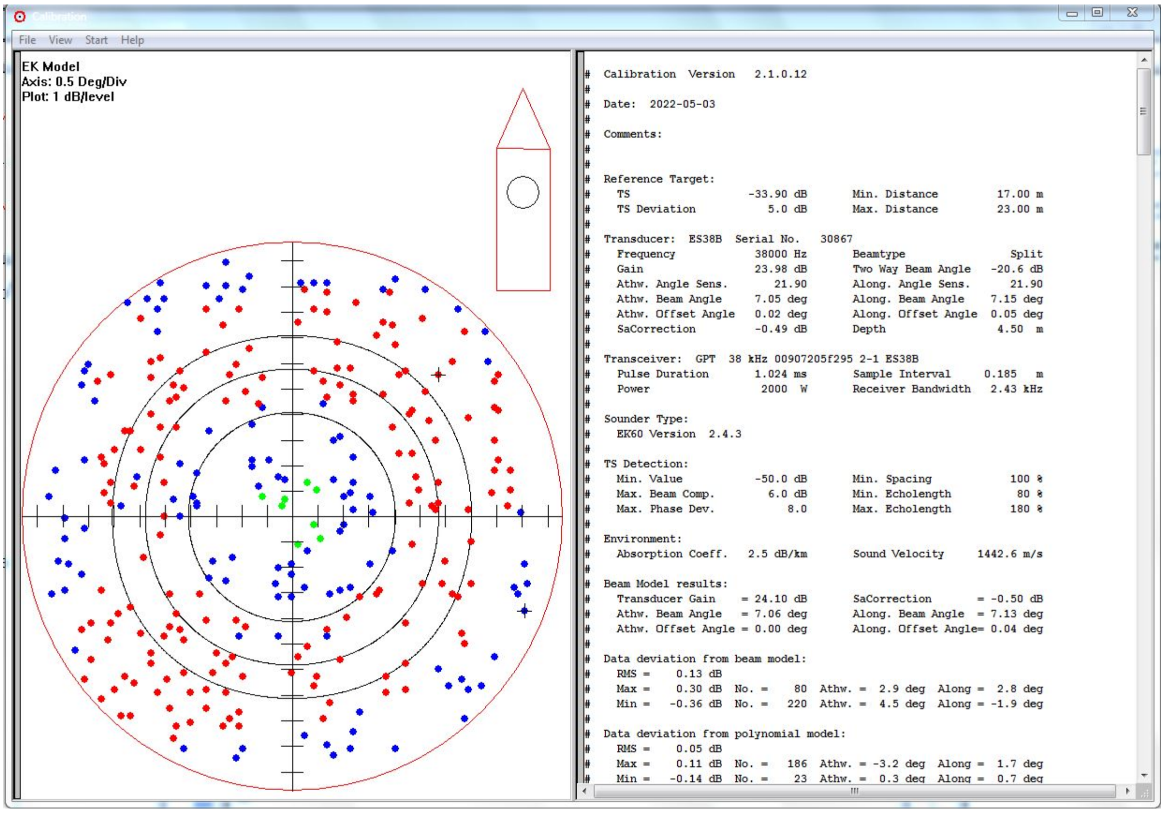

Figure 1. Simrad EK60 calibration report (38 kHz transducer) R.v. “Baltica” cruise SPRAS 2022.

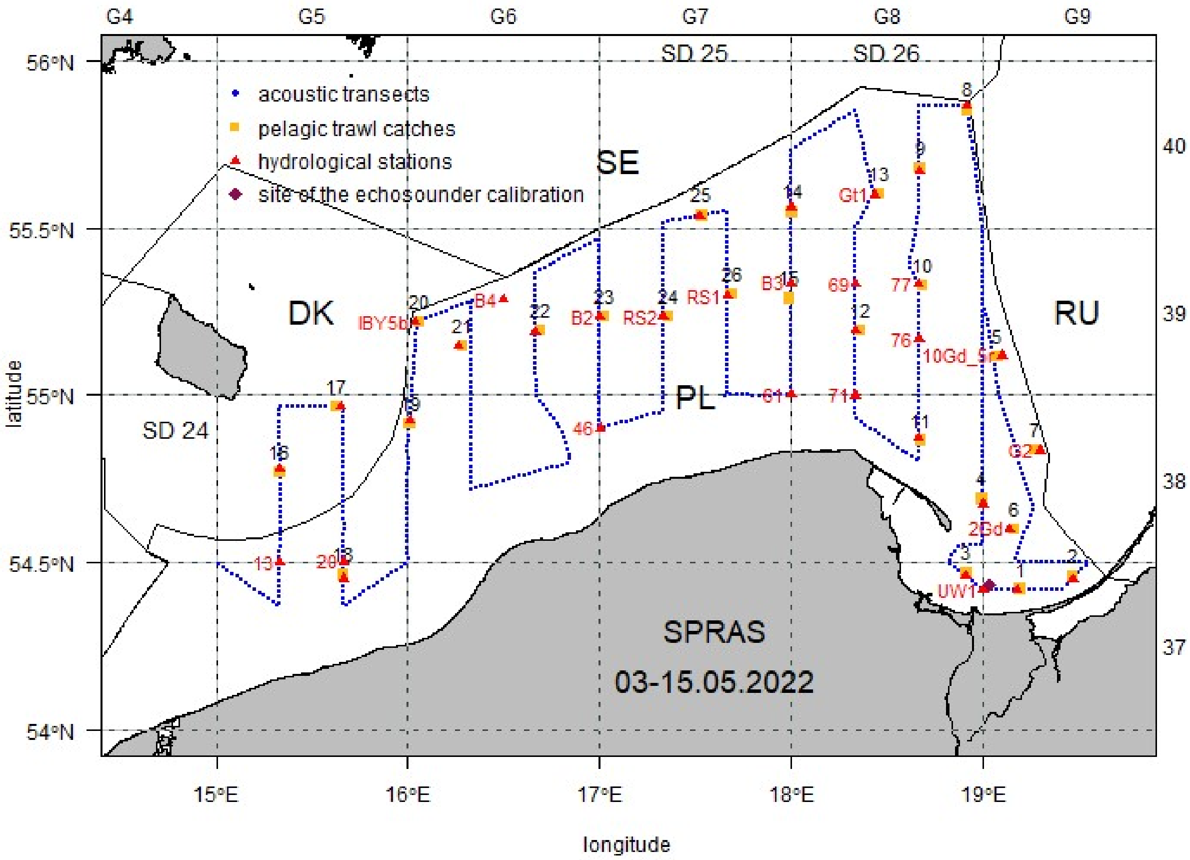

Figure 2. Location of realized investigations during the Polish SPRAS survey on board of the r.v. “Baltica”, 03-15.05.2022.

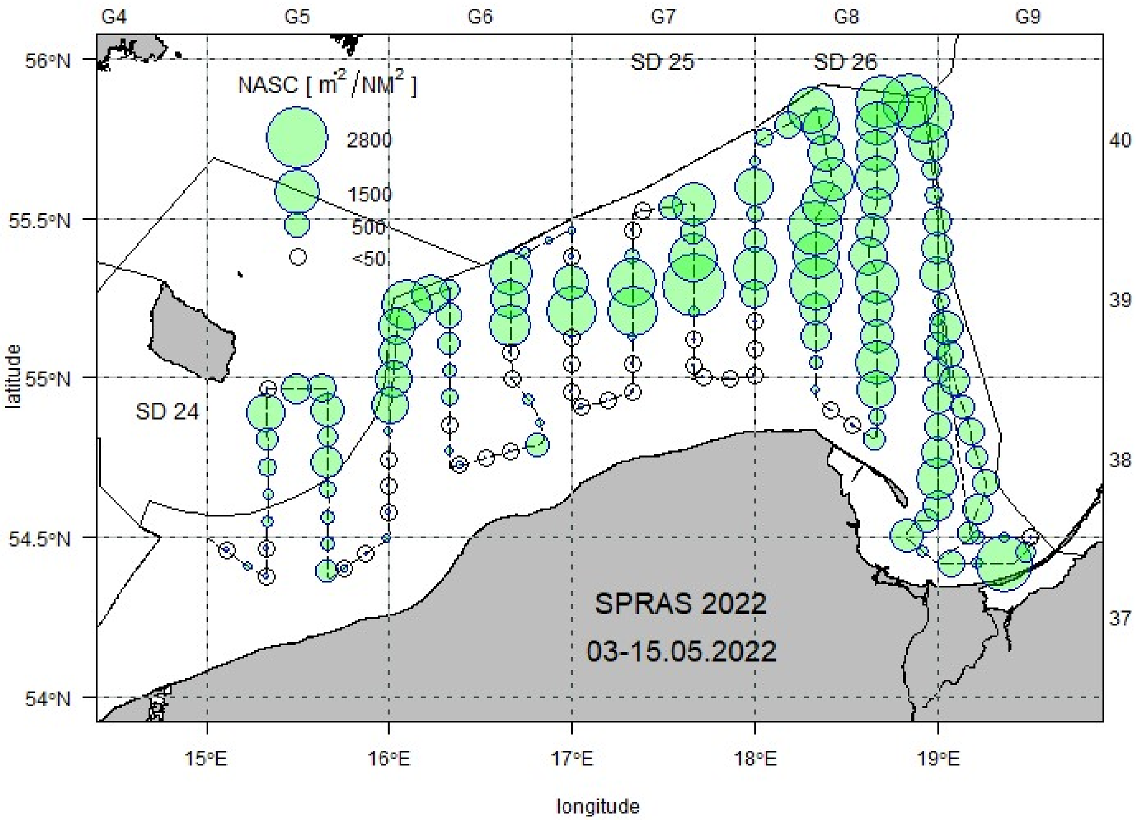

Figure 3. Cruise track (thin dashed line) and the mean NASC (5 NM intervals, bubbles) recorded during Polish SPRAS survey on board of the r.v. "Baltica", 03-15.05.2022.

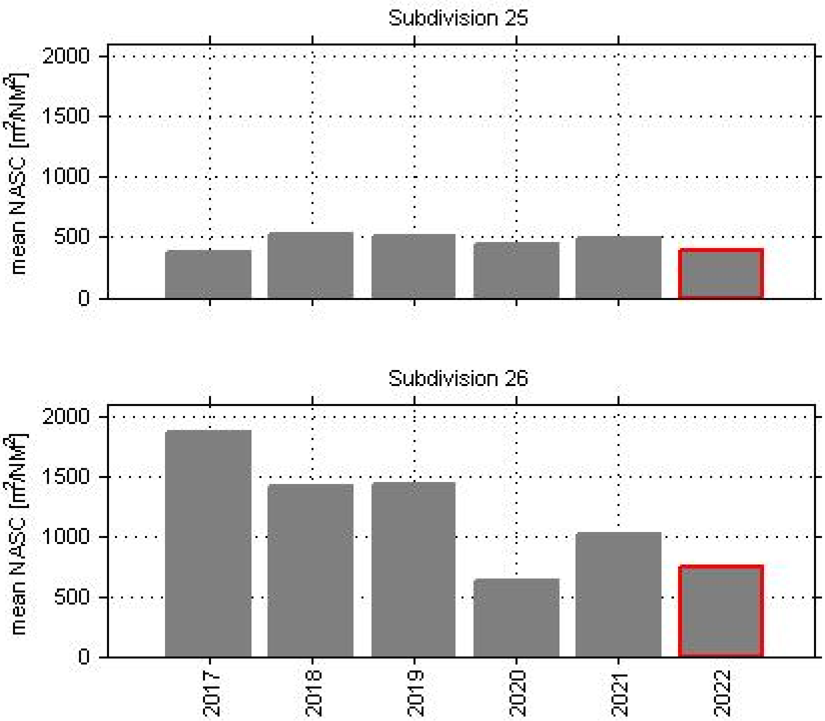

Figure 4. Weighted mean NASC values (m2/NM^2) for investigated parts of the ICES Subdivisions 25 and 26 during Polish SPRAS surveys for years 2017-2022 (the mean NASC values were calculated with the use of areas of ICES rectangles as weight).

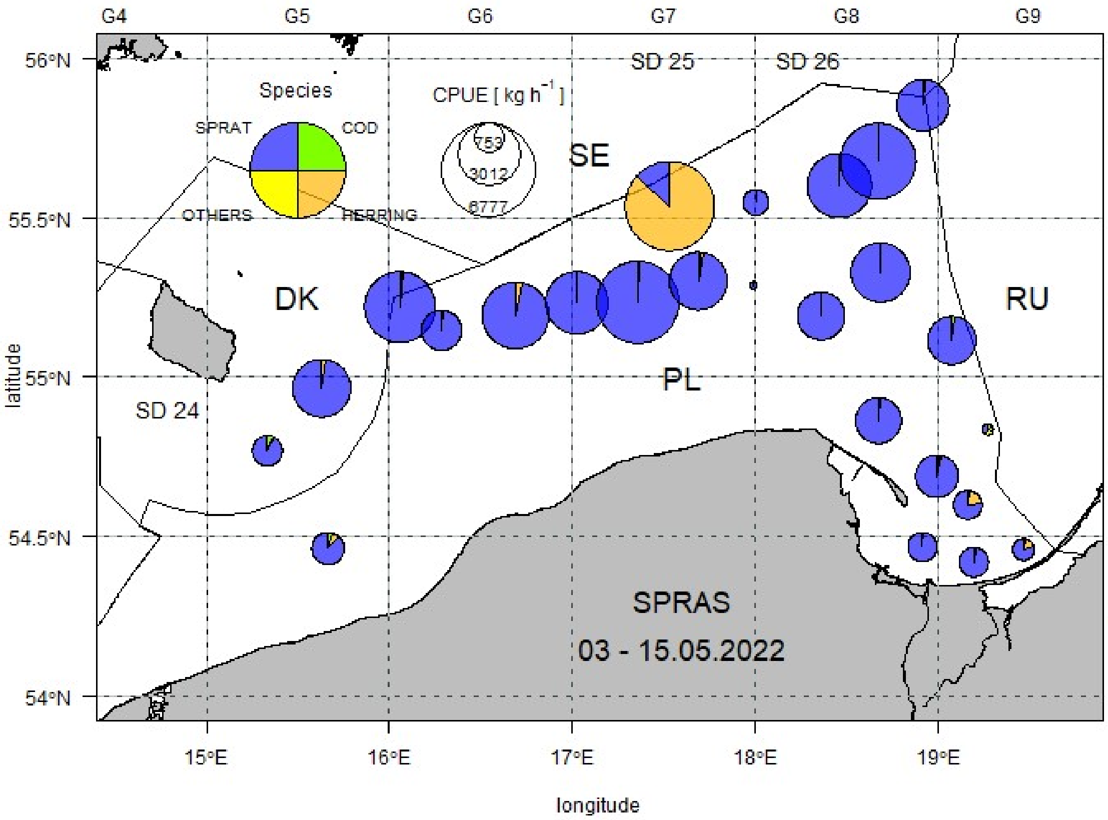

Figure 5. CPUE [kg/h] of fish species per single pelagic hauls conducted in the Polish SPRAS survey on board of the r.v. “Baltica”, 03-15.05.2022

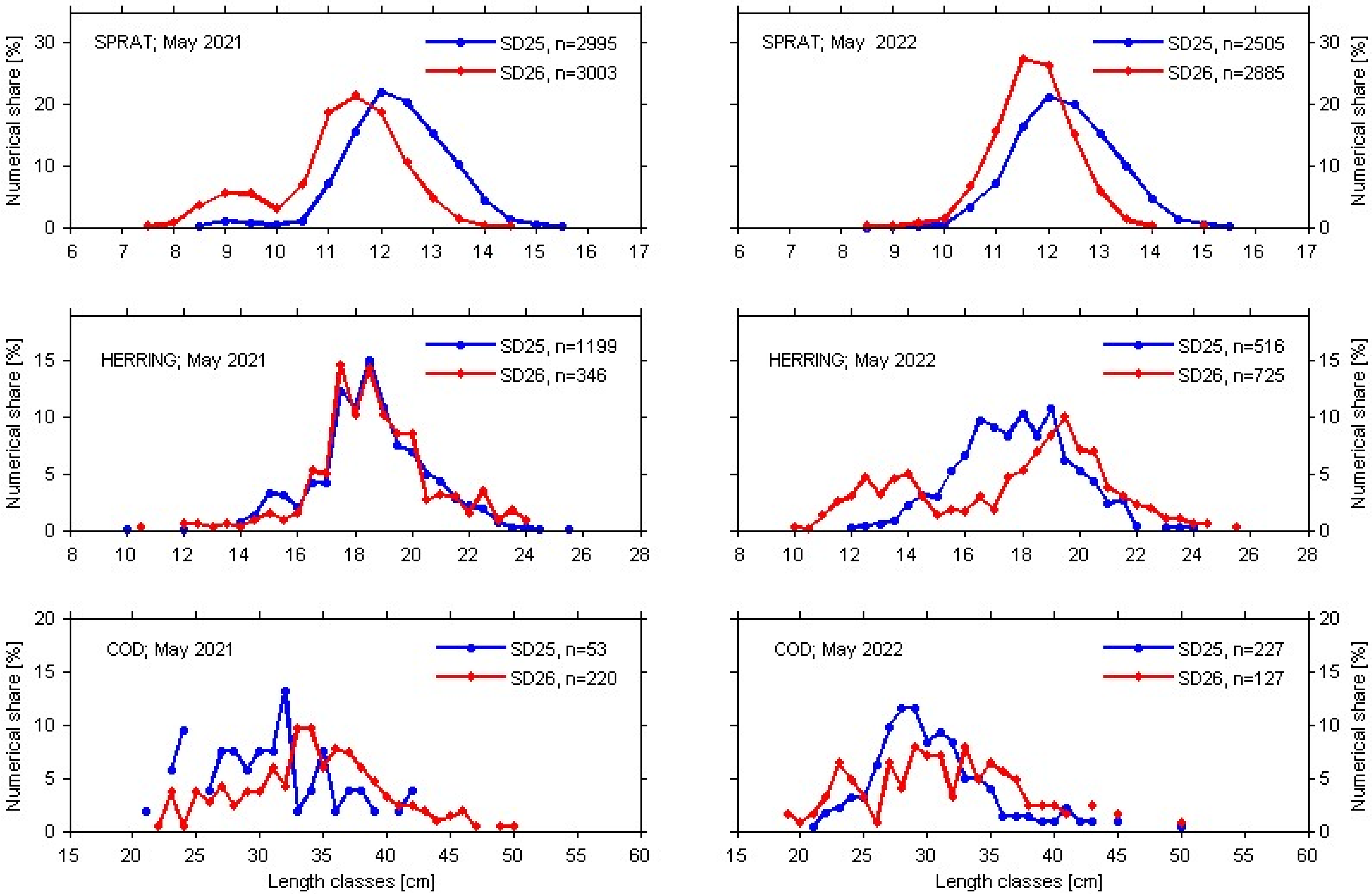

Figure 6. Length distribution of sprat, herring and cod in samples taken from the catches conducted during the Polish SPRAS/2021 and SPRAS/2022 surveys (the length distribution of sprat, herring and cod from 2021 from Schmidt *et al.,* 2022a).

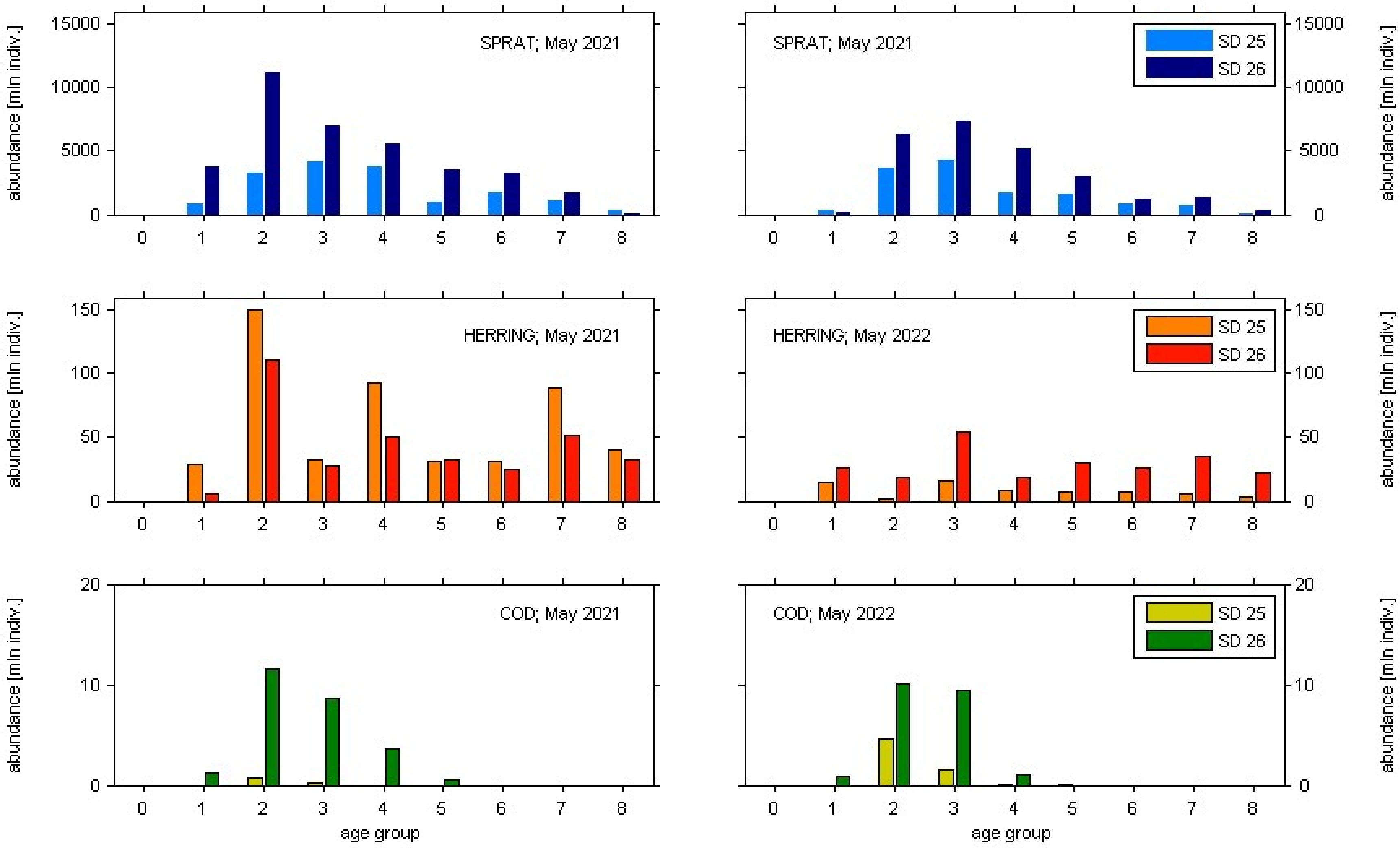

Figure 7. Estimated abundance of sprat, herring and cod stocks per age groups, according to the ICES Subdivisions 25 and 26, based on data from the Polish SPRAS surveys in 2021 and 2022 (the abundance data for fish species from 2020 from Schmidt *et al.,* 2022a).

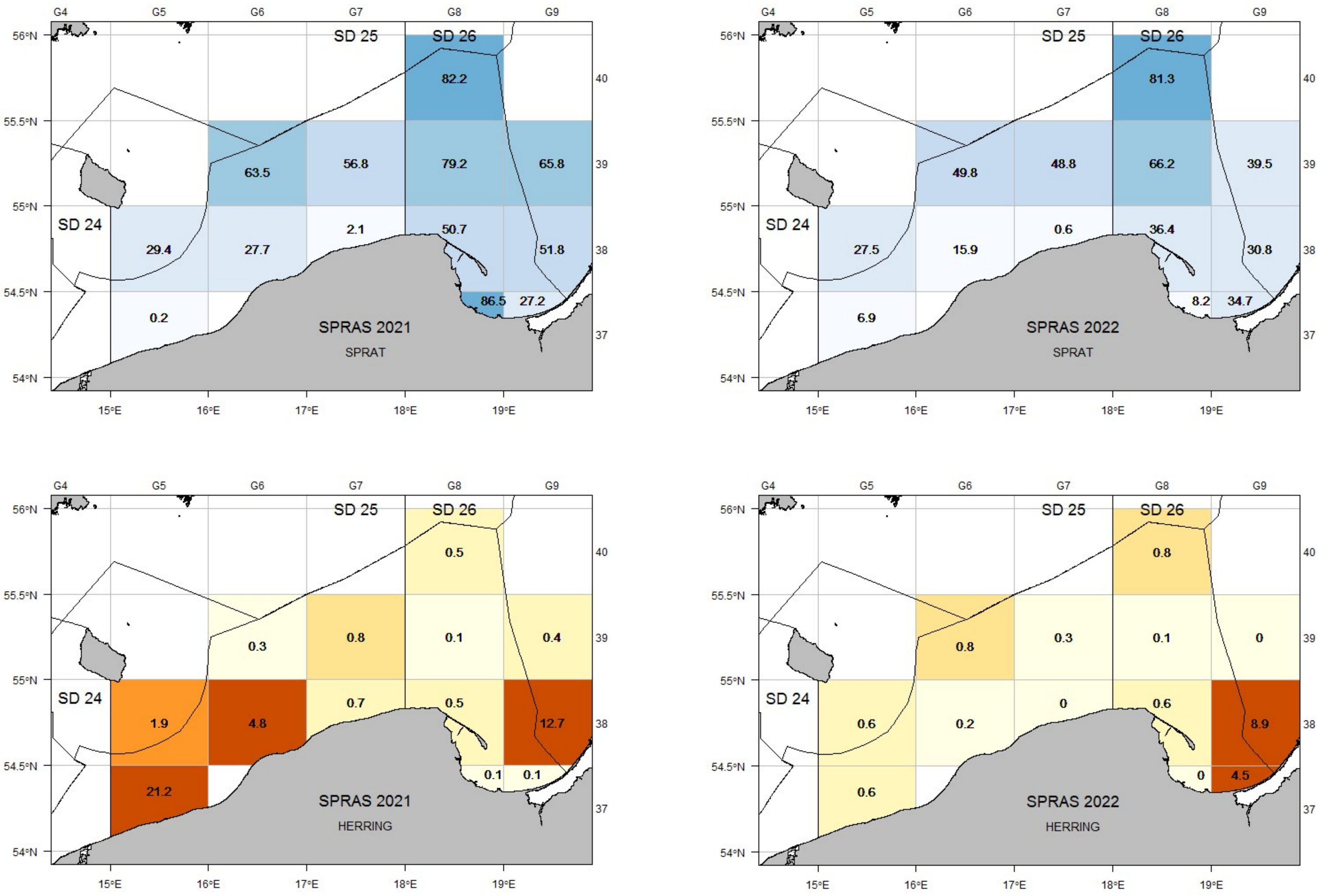

Figure 8. Biomass surface density of sprat and herring [$t \cdot NM^{-2}$] in ICES rectangles, estimated using the acoustic method, and based on data collected during the Polish SPRAS 2021 and 2022 surveys (the fish species biomass density data from 2021 from Schmidt *et al.,* 2022a).

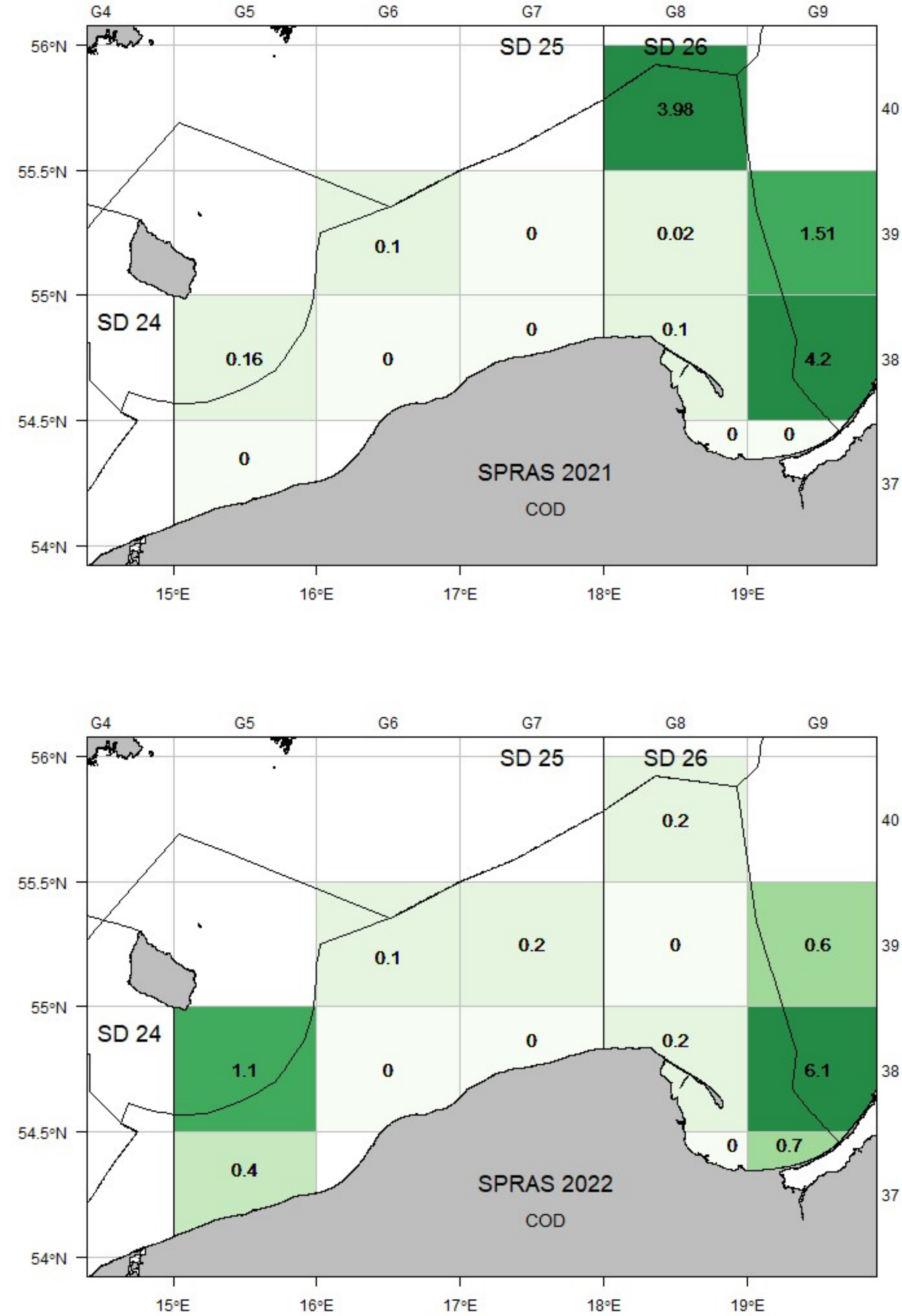

Figure 9. Biomass surface density of cod [t·NM^{-2}] in ICES rectangles, estimated using the acoustic method, and based on data collected during the Polish SPRAS 2021 and 2022 surveys (the biomass surface density of cod from 2021 from Schmidt *et al.,* 2022a).

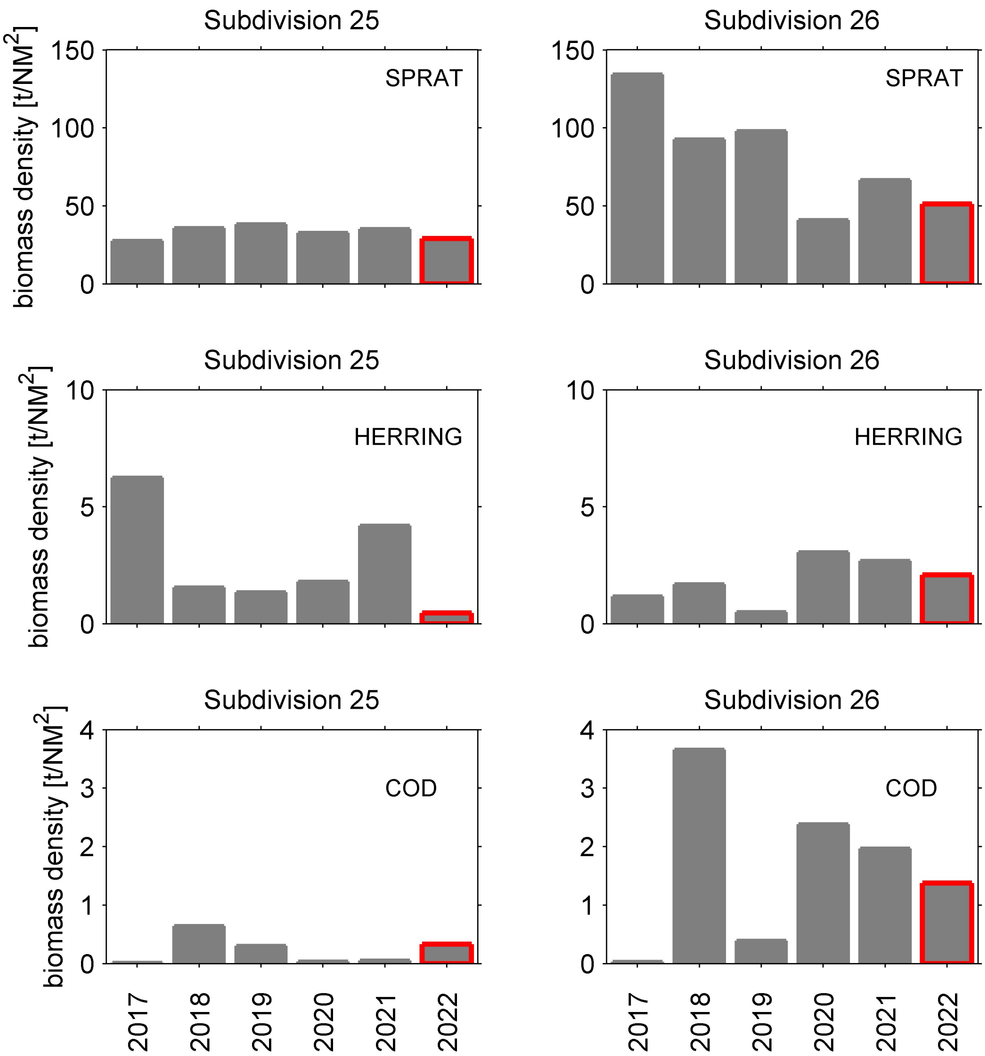

Figure 10. Mean biomass surface density [t/NM^2] of sprat, herring and cod calculated for investigated parts of the ICES Subdivisions 25 and 26 during Polish SPRAS surveys for years 2017-2022.

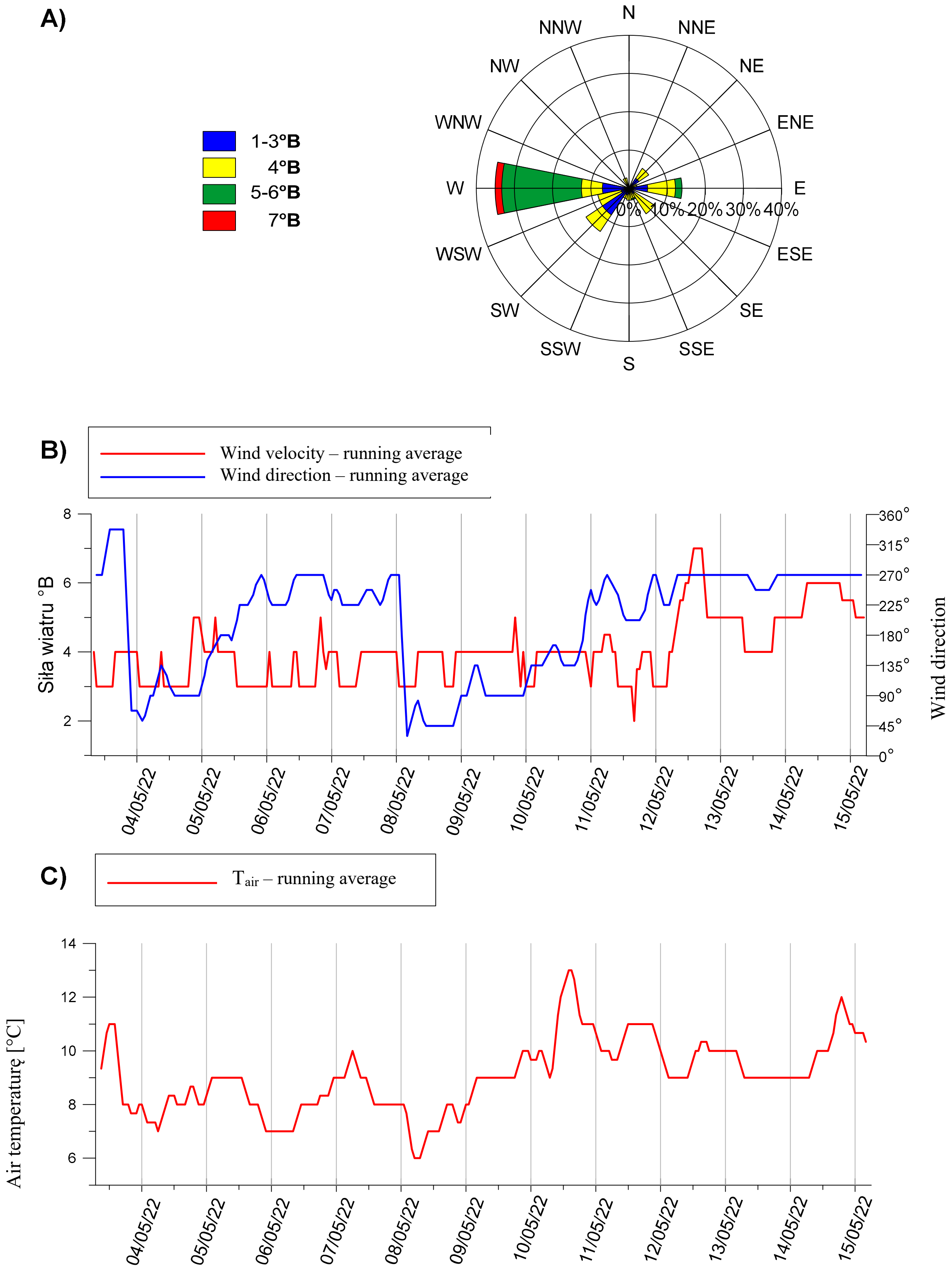

Figure 11. Changes of meteorological parameters during consecutive days of the Polish SPRAS survey in May 2022 (fig. Wodzinowski cit. in Schmidt *et al.,* 2022b).

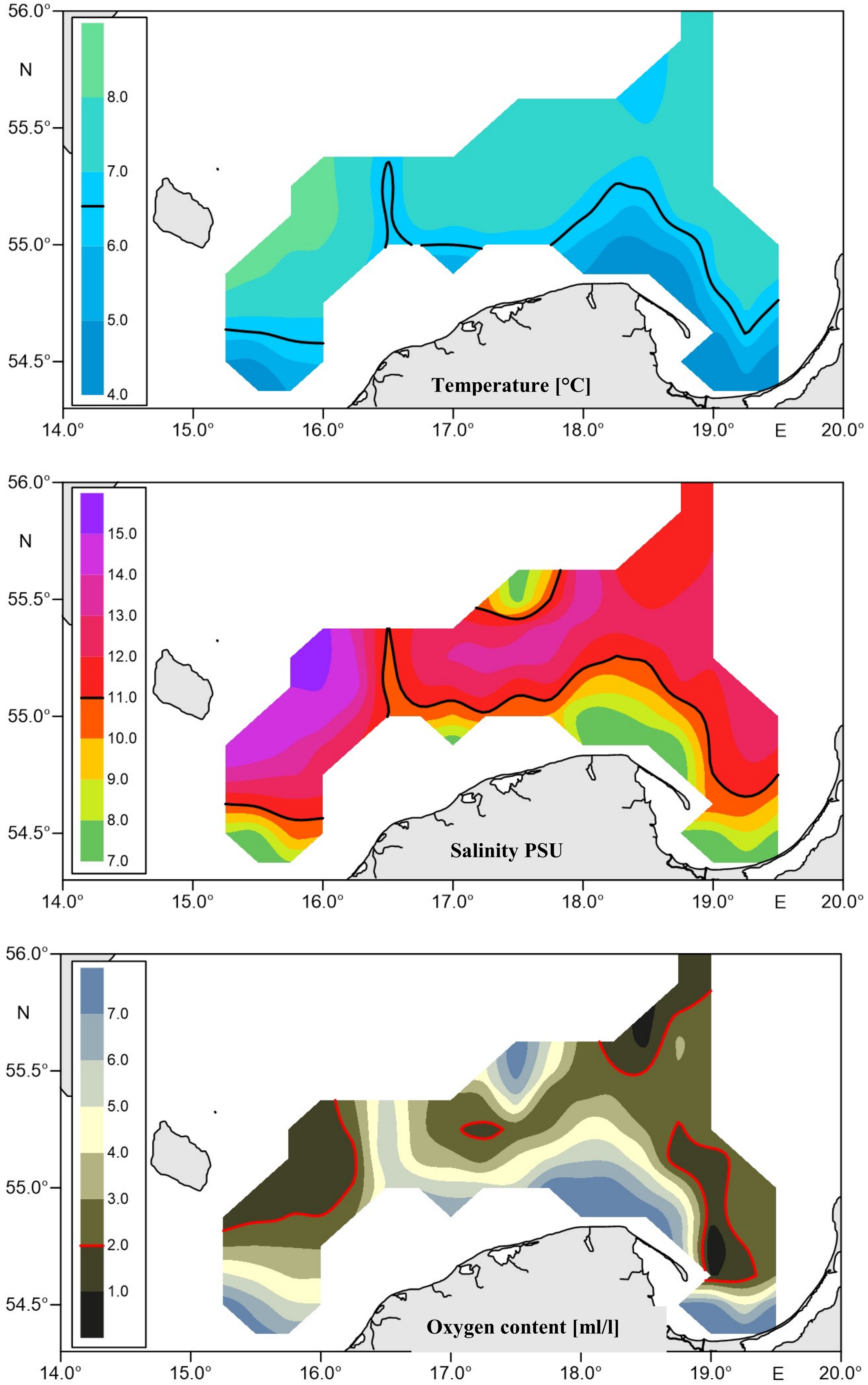

Figure 12. Horizontal distribution of the seawater temperature, salinity and oxygen content in the near seabed layer of the southern Baltic in May 2022 (fig. Wodzinowski cit. in Schmidt *et al.,* 2022b).

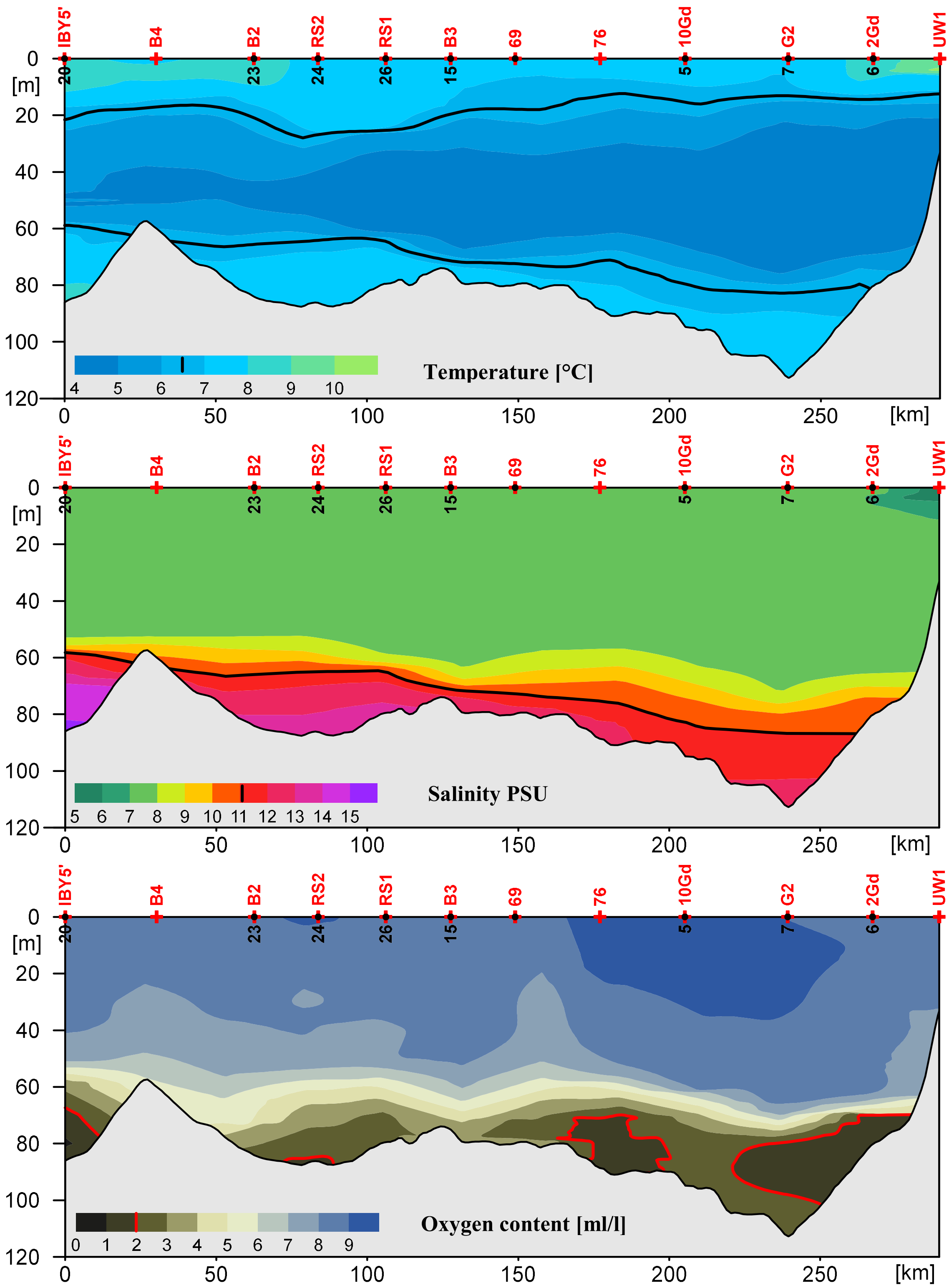

Figure 13. Vertical distribution of the seawater temperature, salinity and oxygen content, along the hydrological research profile determined in the southern Baltic (May 2022); X- and Y-axes reflects distance (in kilometres) and depth (in meters) from the sea surface to the seabed, respectively (fig. Wodzinowski cit. in Schmidt *et al.,* 2022b).

Baltic Acoustic Spring Survey Report for Sweden

2022-05-10 - 2022-05-16

Anders Svenson, Niklas Larson and Jonas Hentati Sundberg
Institute of Marine Research, Department of Aquatic Resources (SLU Aqua), Swedish University of Agricultural Sciences, 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 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).

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 2022 was the third year Sweden participated in BASS. The survey started 2022-05-10 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)

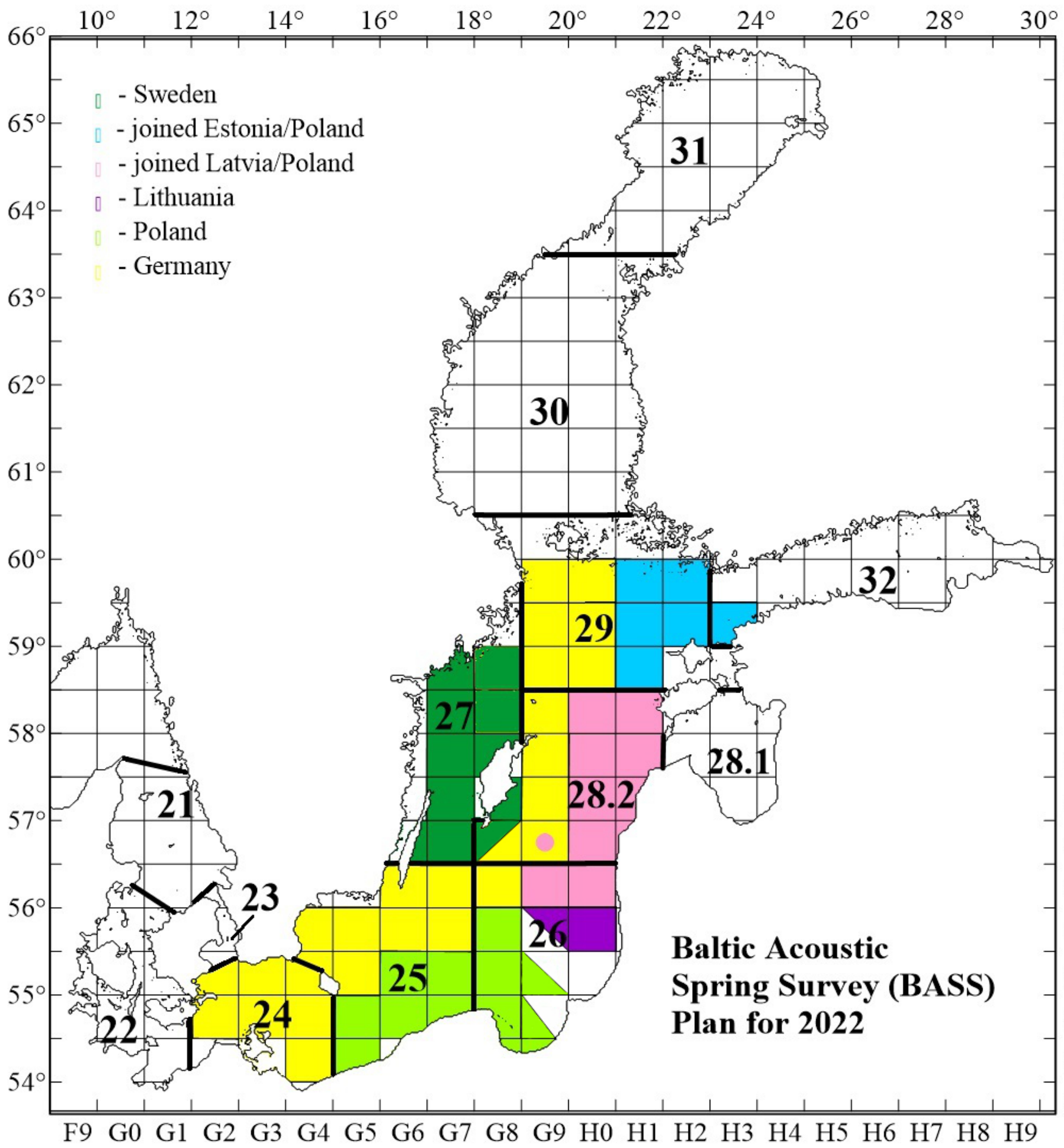

Figure 1. Map with ICES squares allocated to each country in the BASS survey 2022 (On axes: longitude, latitude and ICES name of square eg:41G8)

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).

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 (ICES CM 2012). 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 7566 square nautical miles and the distance used for acoustic estimates was 533 nautical miles. The cruise track and positions of trawl hauls are shown in figure 2.

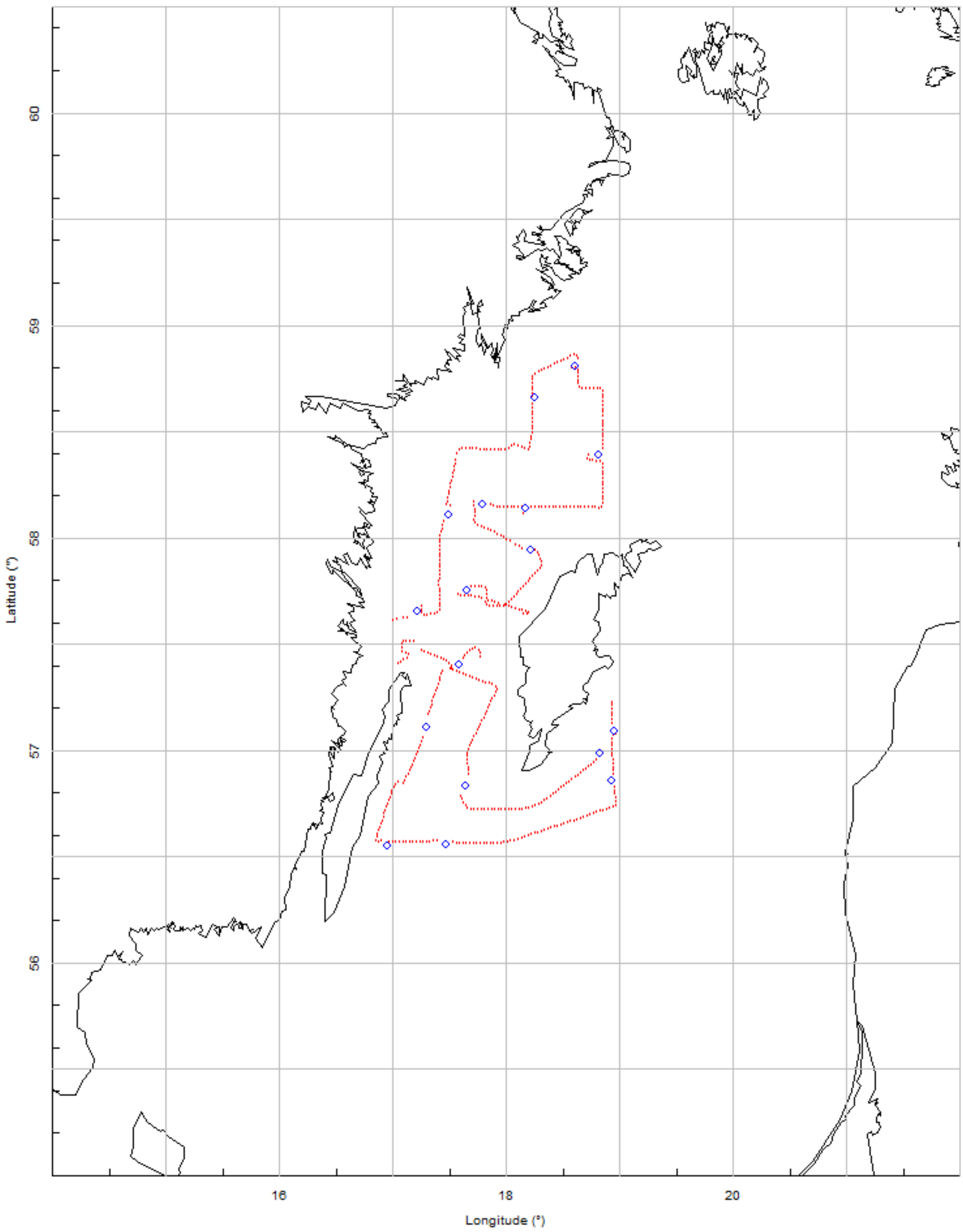

Figure 2. Cruise track in red for BASS 2022. Positions of trawl hauls in blue and survey grid (ICES squares) in grey.

2.2 Calibration

The SIMRAD EK80 echo sounder with the 38kHz transducer was calibrated at Gåsfjärden south of Västervik on 2022-05-10 according to the IBAS manual. Values from the calibration were within required accuracy.

2.3 Acoustic data collection

The acoustic sampling was performed in daytime between 04:30 o'clock in the morning and 21:30 o'clock in the evening. A SIMRAD EK80 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. The post processing of the stored raw data was made using the software LSSS (www.mareco.no). 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 Peña, 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.

2.5 Hydrographic data

CTD casts were made with a SeaBird (SBE 19) CTD when calibrating the acoustic instruments and whenever a haul was conducted.

2.6 Personnel

The participating scientific crew can be seen in table 2.

Table 2: Participating scientific crew

Sundberg Hentati, Jonas	IMR, Lysekil, Sweden	Scientific leader
Svenson, Anders	IMR, Lysekil, Sweden	Expedition leader/Acoustics
Larson Niklas	IMR, Lysekil Sweden	Acoustic / Analyse
Nilsson, Hans	IMR, Lysekil, Sweden	Acoustics
Sjöberg, Rajlie	IMR, Lysekil, Sweden	Fish sampling
Hilvarsson, Annelie	IMR, Lysekil, Sweden	Fish sampling
Ronja Risberg	IMR, Lysekil, Sweden	Fish sampling
Lövgren, Olof˙	IMR, Lysekil, Sweden	Fish sampling

3 Results

3.1 Biological data

In total 17 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 3 Length distributions for herring and sprat by ICES subdivision are shown in figures 3 to 6.

Table 3: Catch composition per haul.

	Species	111	112	113	115	116	117	119	120	121
1	Clupea harengus	145.41	155.42	148.17	177.87	86.97	23.88	126.93	33.95	
2	Cyclopterus lumpus									
3	Gadus morhua		0.45	0.08	0.45		0.14	0.12		
4	Gasterosteus aculeatus	37.61	114.22	5.51	5.01	46.38	1.79	144.52	1.94	113.26
5	Hyperoplus lanceolatus									
6	Platichthys flesus		0.09		0.26			0.14		
7	Sprattus sprattus	588.22	316.61	198.37	223.49	278.62	120.31	386.74	305.67	

Table 3 (continued): Catch composition per haul

	Species	122	123	124	126	127	128	129	132
1	Clupea harengus	404.39	108.03	26.43	79.92	58.08	16.23	5.65	709
2	Cyclopterus lumpus						0.2		
3	Gadus morhua	1.53	0.10	0.29	0.23	1.34		0.8	0.2
4	Gasterosteus aculeatus	37.35	27.92	2.95	0.46		0.2	25.04	40.94
5	Hyperoplus lanceolatus								
6	Platichthys flesus	0.13	0.29	0.10	0.12	0.19			
7	Sprattus sprattus	35.42	132.23	471.25	415.78	236.28	123.78	79.26	532.53

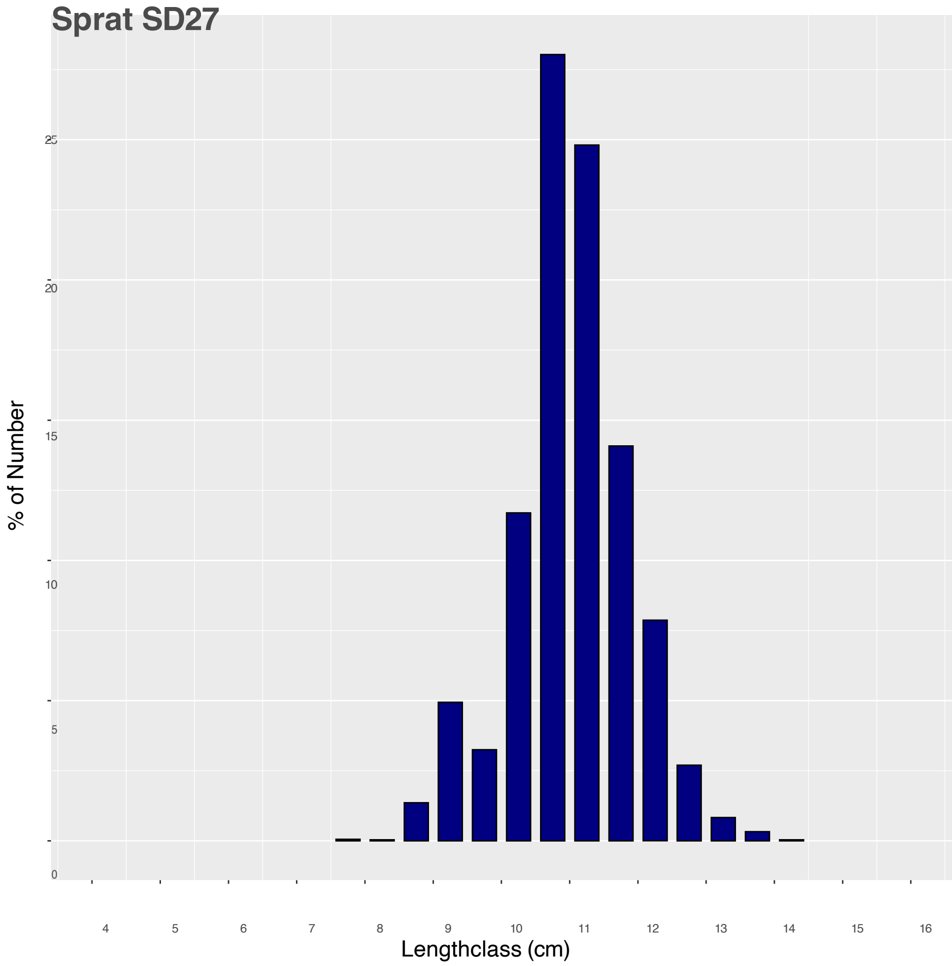

Figure 3: Length distribution of sprat from subdivision 27 for BASS 2022

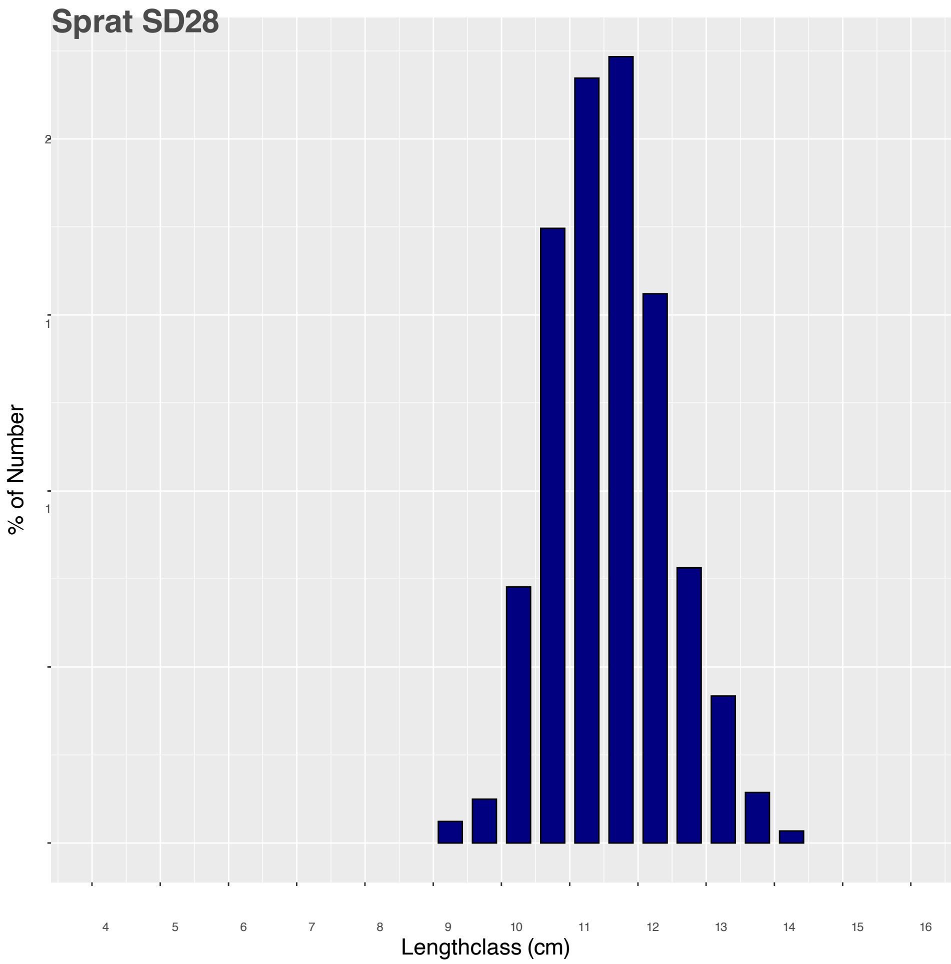

Figure 4: Length distribution of sprat from subdivision 28 for BASS 2022

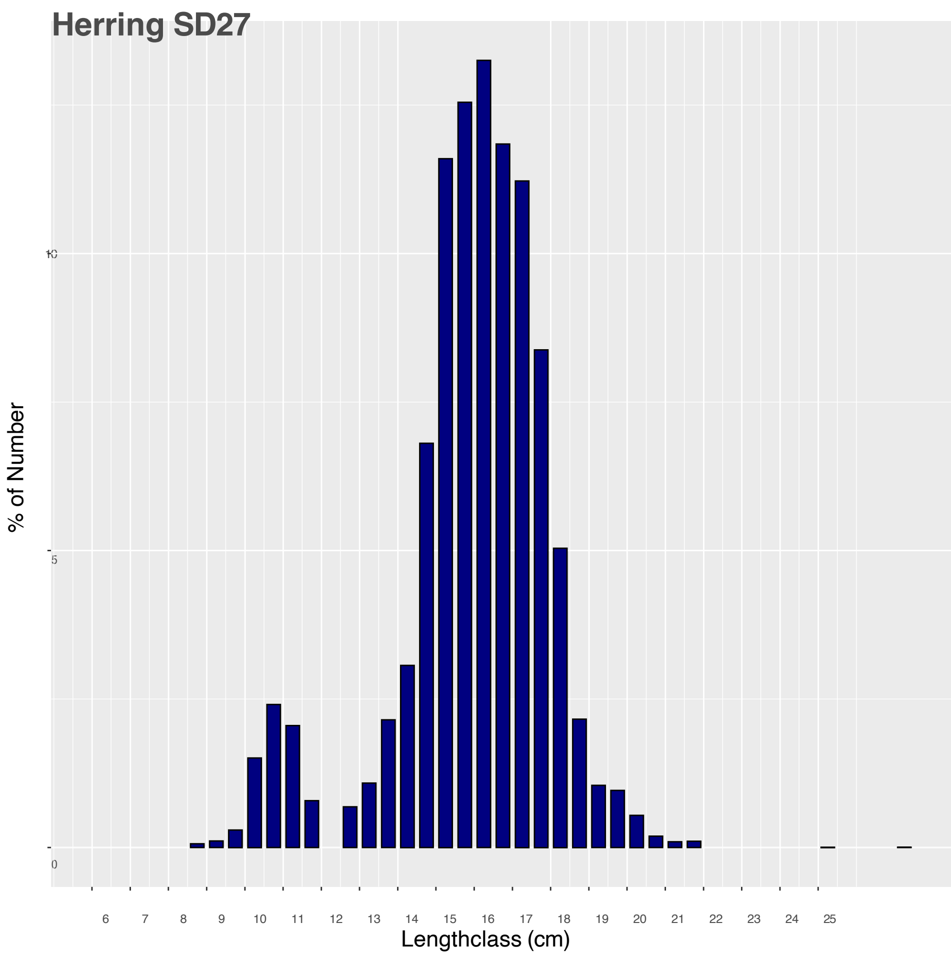

Figure 5 Length distribution of herring from subdivision 27 for BASS 2022

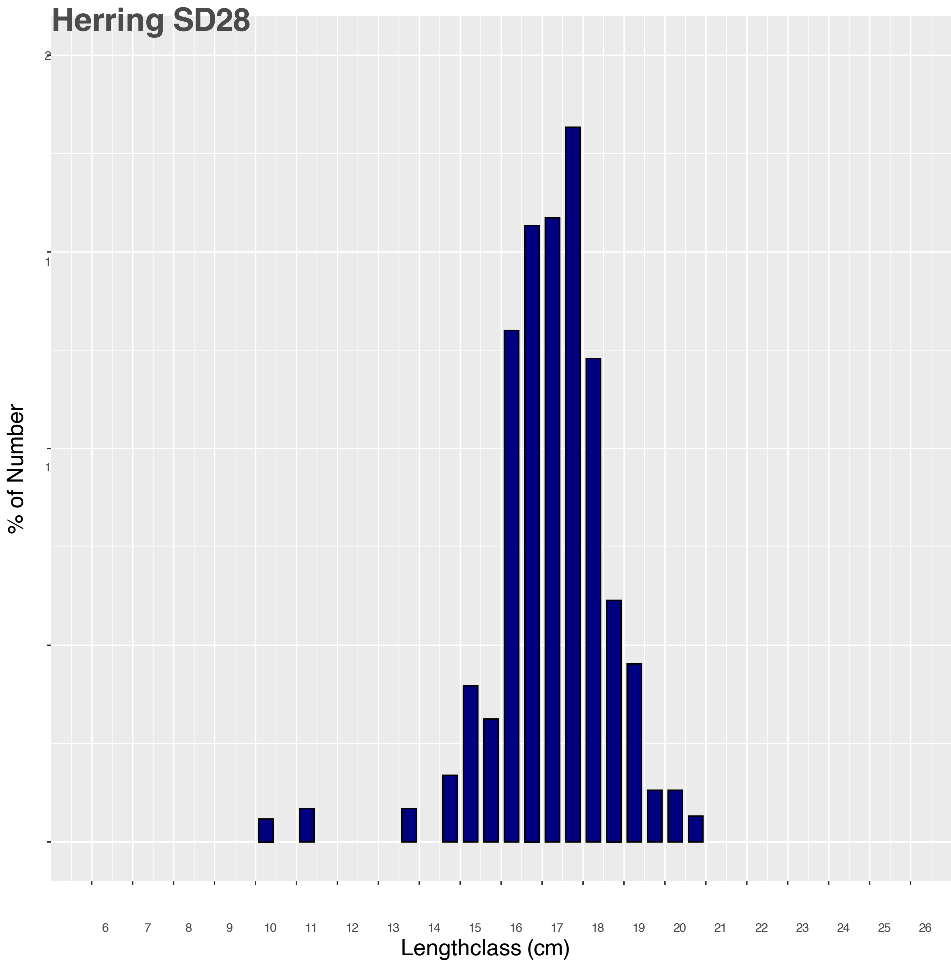

Figure 6: Length distribution of herring from subdivision 28 for BASS 2022

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 4.

Table 4: Survey statistics,

SD	RECT	AREA	SA	SIGMA	NTOT	HHer	HSpr	HCod
27	42G6	266.0	657.6	0.731	2392.91	0.80	44.39	0.008
27	42G7	986.9	347.3	1.151	2978.79	6.00	72.52	0.002
27	43G7	913.8	247.6	1.342	1686.05	29.33	33.34	0.016
27	44G7	960.5	579.8	0.675	8245.95	2.70	36.17	0.000
27	44G8	456.6	485.9	1.227	1807.62	3.70	93.96	0.000
27	45G7	908.7	496.5	0.710	6352.16	4.76	37.05	0.002
27	45G8	947.2	487.3	1.049	4399.87	6.62	72.85	0.003
27	46G8	884.8	432.3	1.334	2866.42	20.65	72.44	0.008
28	42G8	945.4	289.3	1.317	2076.83	3.67	95.21	0.018
28	43G8	296.2	451.9	1.416	945.57	6.13	93.50	0.004

3.3 Abundance estimates

The total abundances of herring and sprat by age group per rectangle are presented in Table 5 and 7. The corresponding mean weights by age group per rectangle are shown in Tables 6 and 8.

Table 5: Estimated number (millions) of sprat (Nspr1 stands for number of 1 year old sprat)

SD	RECT	NSprTOT	NSpr1	NSpr2	NSpr3	NSpr4	NSpr5	NSpr6	NSpr7	NSpr8	CCODE
27	42G6	1062.18	59.69	809.36	158.01	17.56	8.78	0.00	8.78	0.00	BASS Swe2022
27	42G7	2160.35	43.96	743.29	924.56	112.42	67.43	33.77	146.15	88.77	BASS Swe2022
28	42G8	1977.37	36.37	896.90	361.51	291.05	334.66	38.79	0.00	18.10	BASS Swe2022
27	43G7	562.16	5.12	270.70	178.74	13.35	24.38	28.21	13.35	28.32	BASS Swe2022
28	43G8	884.13	7.82	323.92	303.58	184.65	0.00	18.78	0.00	45.38	BASS Swe2022
27	44G7	2982.20	322.02	1803.32	383.63	117.61	260.42	30.80	16.80	47.60	BASS Swe2022
27	44G8	1698.52	97.46	902.17	242.25	370.33	27.84	30.63	0.00	27.84	BASS Swe2022
27	45G7	2353.28	461.26	1239.94	561.41	51.21	0.00	20.67	11.16	7.63	BASS Swe2022
27	45G8	3205.09	363.74	1912.70	578.70	72.75	115.44	9.50	64.29	87.98	BASS Swe2022
27	46G8	2076.41	228.58	1132.25	358.89	181.21	45.49	25.65	104.33	0.00	BASS Swe2022

Table 6: 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	4.38	7.62	8.55	10.03	9.45		10.31	
27	42G7	5.33	7.14	9.48	12.84	11.97	14.06	12.75	12.59
28	42G8	4.92	7.60	10.77	13.04	12.82	13.92		12.06
27	43G7	4.62	7.16	8.27	11.66	10.43	8.98	12.95	10.76
28	43G8	4.14	7.13	10.26	11.47		12.79		10.58
27	44G7	4.17	7.10	9.40	10.80	7.66	11.22	10.29	12.45
27	44G8	4.49	6.78	9.61	9.61	11.33	9.13		12.91
27	45G7	3.93	6.50	8.71	11.07		8.77	12.62	10.88
27	45G8	4.06	6.70	9.29	10.61	11.19	11.48	8.34	7.41
27	46G8	3.80	6.44	10.33	9.43	12.20	10.91	9.71	

Table 7: Estimated number (millions) of herring (NHer1 stands for number of 1 year old Herring)

SD	RECT	NHerTOT	NHer1	NHer2	NHer3	NHer4	NHer5	NHer6	NHer7	NHer8	CCODE
27	42G6	19.24	0.00	0.00	7.22	2.41	2.41	0.00	4.81	2.41	BASS Swe2022
27	42G7	178.81	1.86	1.40	27.28	39.23	30.44	30.48	38.76	9.35	BASS Swe2022
28	42G8	76.30	0.78	0.00	12.67	11.89	18.71	9.99	12.09	10.17	BASS Swe2022
27	43G7	494.44	3.13	7.93	150.91	116.62	128.61	47.52	6.31	33.40	BASS Swe2022
28	43G8	57.97	2.73	3.41	11.37	9.09	12.28	8.41	7.27	3.41	BASS Swe2022
27	44G7	222.74	7.51	12.51	94.60	27.53	50.55	24.03	6.01	0.00	BASS Swe2022
27	44G8	66.86	1.76	7.04	28.86	8.80	11.61	3.17	3.52	2.11	BASS Swe2022
27	45G7	302.07	19.67	21.45	132.27	45.98	43.51	21.89	8.88	8.42	BASS Swe2022
27	45G8	291.22	56.34	24.32	125.31	15.42	30.59	22.78	14.85	1.60	BASS Swe2022
27	46G8	591.98	69.05	67.05	282.48	43.39	68.63	38.58	22.80	0.00	BASS Swe2022

Table 8: Estimated mean weights (g) of herring (WHer1 stands for average weight of the 1 year old Herring)

SD	RECT	WHer1	WHer2	WHer3	WHer4	WHer5	WHer6	WHer7	WHer8
27	42G6			25.63	33.86	23.20		33.92	32.92
27	42G7	16.36	19.81	26.53	34.92	30.82	37.44	37.61	79.14
28	42G8	5.39		25.94	30.86	28.16	37.75	34.71	39.18
27	43G7	16.31	15.94	21.45	25.82	29.29	36.79	38.78	43.91
28	43G8	14.44	18.77	21.50	25.88	31.82	27.74	29.70	34.68
27	44G7	6.00	13.32	20.05	26.16	29.32	26.38	30.29	
27	44G8	7.48	14.69	22.00	27.65	30.03	24.19	25.48	23.28
27	45G7	6.93	12.99	20.32	25.02	27.84	32.79	27.52	31.28
27	45G8	6.83	14.87	22.38	30.66	31.93	31.24	31.26	78.25
27	46G8	6.62	14.18	23.04	22.59	28.67	26.59	24.88	

4 Summary

This year was the third 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 2022 for the covered area. For further information regarding the procedures of WGBIFS see the latest WGBIFS report at ICES.

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REPORT
FROM THE JOINT ESTONIAN-POLISH BIAS 2022 CONDUCTED BY THE R.V. "BALTICA" IN THE NORTH-EASTERN BALTIC SEA (10 – 23.10.2022)

by

Krzysztof Koszarowski *, Tiit Raid**, Elor Sepp**, Radosław Zaporowski * and Tycjan Wodzinowski*

* National Marine Fisheries Research Institute, Gdynia (Poland)

** University of Tartu, Estonian Marine Institute, Tallinn (Estonia)

Introduction

The recent joint Estonian-Polish Baltic International Acoustic Survey (EST-POL BIAS), marked with the number 18/2022/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 28.1, 28.2, 29 and 32).

The Estonian Data Collection Program for 2022 and the European Union (by the European Union (EU) Fisheries Data Collection Programme for 2022 (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 2022. 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 2022 survey scientific staff was composed of 9 persons:

K. Koszarowski (NMFRI – Poland) – survey leader, ichthyologist,
M. Bielak (NMFRI – Poland) – acoustician,
A. Ameryk (NMFRI – Poland) – hydrologist,
R. Zaporowski (NMFRI – Poland) – ichthyologist,
T. Raid (EMIUT – Estonia) – scientific team leader, ichthyologist,
A. Hallang (EMIUT – Estonia) – ichthyologist,
E. Sepp (EMIUT – Estonia) – acoustician,
A. Lankov (EMIUT – Estonia) – ichthyologist
T. Kaup (EMIUT – Estonia) – ichthyologist

1) ICES. 2021. ICES Working Group on Baltic International Fish Survey (WGBIFS). ICES Scientific Reports. 3:80. 497 pp. https://doi.org/10.17895/ices.pub.8248

Narrative

The reported survey took place during the period of 10 – 23.10.2022. 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 28.1, 28.2, 29 and 32), moreover inside the territorial waters of this country not shallower than 20 m depth.

The vessel set off from the port of Gdynia on October 10, 2022 at 00:05 and headed towards the port of Ventspils in Latvia, where it arrived on October 11, 2022 at 8:00. After embarking the Estonian team, the vessel set off for the most optimal point of the trasect in order to start echo-integration. The first hauls were made on October 12, 2022. and the unit was moving as planned towards the Gulf of Finland. Due to weather conditions (storm), on October 17, 2022, the unit was forced to stay in the sheltered waters of Hara Bay. Echo-integration started again on October 18, 2022 and proceeded towards the Gulf of Riga along the planned transect points. On October 21, 2022, the planned tasks were completed and the unit headed towards the port of Ventspils. On October 22, 2022, in the morning, the vessel was moored in the port of Ventspils and after the Estonian team left the ship, the unit went back to the port in Gdynia. The call to the home port took place on October 23, 2022 at around 14:00.

Survey design and realization

The r.v. “Baltica” realized 724 Nm echo-integration transect and 24 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 09:35 am. and 18:25 p.m.) 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, 6, 4, 6 and 8 hauls were conducted in SDs 28.1, 28.2, 29, and 32, respectively.

The length measurements (in 0.5 cm classes) were realized for totally 4538 sprat and 4120 herring individuals. Totally, 601 sprat and 717 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, 15 fish species were identified in catches performed at the North-eastern Baltic Sea (SDs 28.1, 28.2, 29 and 32 West) in October 2022. 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 28.1 – 19.9%, in SD 28.2 – 93.1%; in SD 29 – 87.4%; in SD 32 – 75.4%). Mean share of herring in the total biomass was 29.7% (in SD 28.1 – 76.7%, in SD 28.2 – 5.0%; in SD 29 – 11.2%; in SD 32 – 23.8%). The other 13 fish species (flounder, turbot, three-spined stickleback, ninespine stickleback, river lamprey, vendace, fourhorn sculpin, pike perch, straightnose pipefish, trout, shorthorn sculpin, lumpfish and smelt) represented only 1.7% 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 October 2022 amounted for 1060.1 kg/h (comparing to 1022.9 and 1163.6 kg/h in the same period in 2021 and 2020, respectively).

The highest value of CPUE for sprat was noted in SD 29 and for herring in SD 28.1. The mean values of CPUEs for sprat were as follow: 187.4 kg/h in SD 28.1, 872.6 kg/h in SD 28.2, 1275.0 kg/h in SD 29 and 796.8 kg/h in SD 32. The mean CPUEs values for herring were: 686.4, 39.9, 72.3 and 222.0 kg/h in SDs 28.1, 28.2, 29 and 32, respectively. Three-spined stickleback prevailed among other species in bycatch with the mean CPUE value of 11,6 kg/h for the whole investigated area.

The length distributions of sprat, herring and three-spined stickleback according to the ICES Sub-divisions 28.1, 28.2, 29 and 32 are shown on Fig. 3-5.

The sprat length distribution curves represent similar unimodal pattern in the four investigated SDs. The length distribution of sprat was in range of 7.0 – 14.5 cm with highest frequency at 11.0 – 12.5 cm length classes amounting for 79.0% of measured sprat, taking into account the whole investigated area.

The herring length distribution curves represent similar pattern in SD 28.1, SD 29 and SD 32. First frequency peak was observed at 8.5 – 10.5 cm length classes and amounted for 59.7%, 49.9% and 29.6% of all measured herring, respectively. Second frequency was observed at 13.5 – 16.5 length classes and amounted for 26.3%, 43.5% and 58.4%, respectively. The herring length distribution curve for SD 28.2 showed one frequency peak at 9.0 – 10.0 cm length classes and amounted for 86.4% of all measured herring.

The length distribution of three-spined stickleback was in range of 3.0 – 7.5 cm. The length distribution curves represent similar pattern in SD 28.1, SD 29 and SD 32. First frequency peak was observed at 3.5 – 4.0 cm length classes and amounted for 27.1%, 24.8% and 24.8%, respectively. Second frequency was observed at 5.5 – 6.5 length classes and amounted for 50.1%, 44.6% and 50.6%, respectively. The three-spined stickleback length distribution curve for SD 28.2 showed one frequency peak at 5.0 – 6.5 cm length classes and amounted for 89.8% of all measured stickleback.

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. Results concerning the pilot study in Gulf of Riga will be combined with Latvian survey results and presented separately. Overall fish abundances were considerably 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 almost two times lower compared to previous year probably due to very low recruitment for the second consecutive year. Abundance of herring was slightly higher than in the previous survey.

The final report from the EST-POL BIAS 2022 will be presented at the meeting of the ICES Baltic International Fish Survey Working Group (WGBIFS) in March 2023.

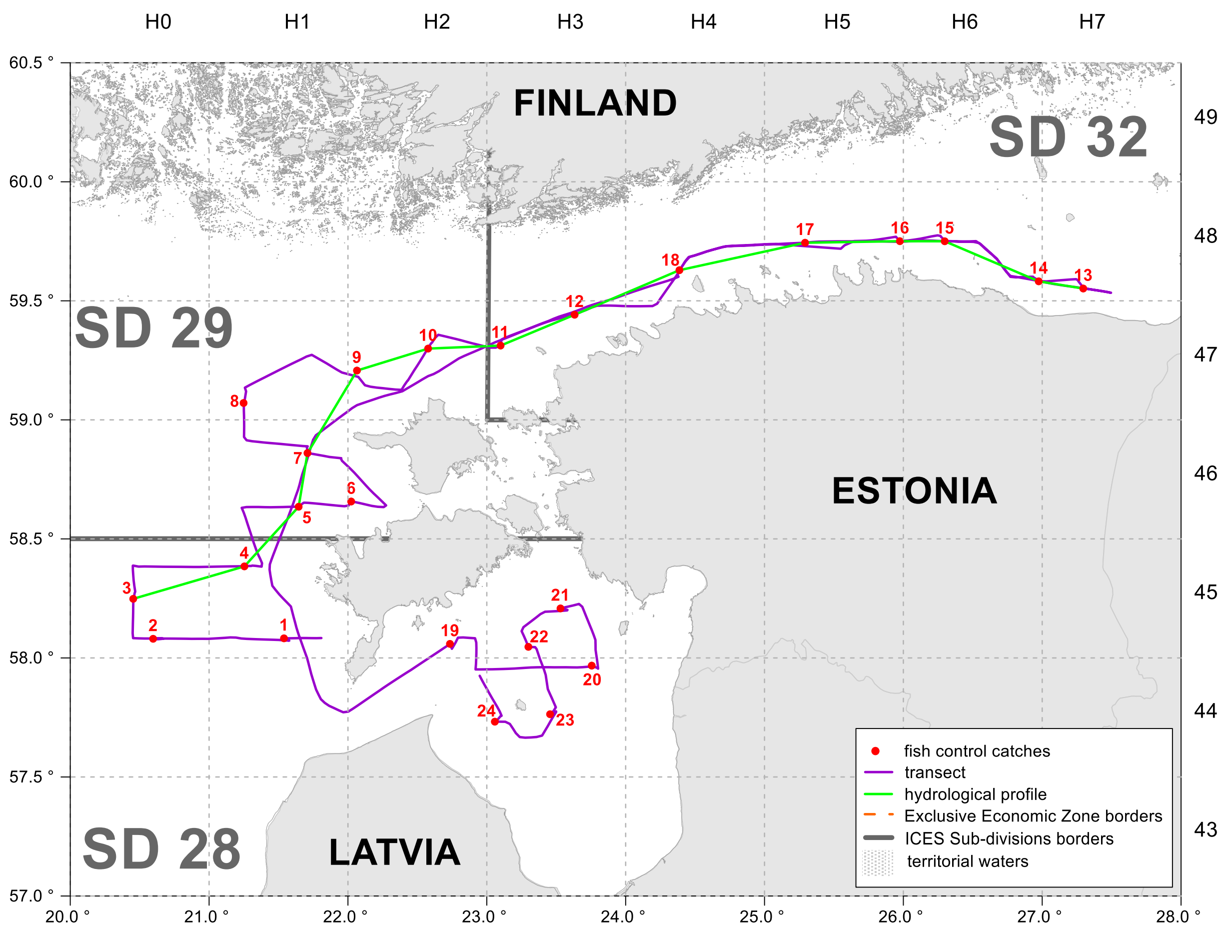

Figure 1. Locations of the fish pelagic control catches and hydrological stations during the survey (October 2022).

Table 1. Catch results during joint EST-POL BIAS conducted by r.v. “Baltica” in the Estonian EEZ in October 2022.

Haul number	Date of catch	ICES rectangle	ICES subdivision	Depth to fishing trawl [m]	Depth to the bottom [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	Flounder	Turbot	Three-spined stickleback	Ninespined stickleback	River lamprey	Vendace	Fourhorn sculpin	Pike perch	Straightnose pipefish	Trout	Shorthorn sculpin	Lumpfish	Smelt
1	12.10.2022	45H1	28.2	20-37	42	115°	58°04' 7	021°33′ 4	58°04' 5	021°34′ 1	08:35	08:45	10	456,053	2736,318	453,778	2,168			0,041	0,066									
2	12.10.2022	45H0	28.2	25-51	93	085°	58°04' 7	020°37′ 2	58°04' 8	020°39′ 7	13:45	14:15	30	163,219	326,438	156,182	0,763			1,885	0,019						4,37			
3	12.10.2022	45H0	28.2	30-46	145	360°	58°15' 4	020°27′ 5	58°16' 4	020°27′ 8	17:10	17:25	15	25,962	103,848	17,46	1,04			7,43	0,032									
4	13.10.2022	45H1	28.2	40-46	83	095°	58°23' 2	021°16′ 9	58°23' 2	021°18′ 2	10:15	10:30	15	132,410	529,640	96,378	35,276			0,612	0,031								0,113	
5	13.10.2022	46H1	29	40-59	62	045°	58°38' 6	021°39′ 8	58°39' 1	021°40′ 5	15:10	15:20	10	384,131	2304,786	381,168	2,511			0,26									0,192	
6	13.10.2022	46H2	29	20-38	41	020°	58°38' 8	022°00′ 6	58°39' 0	022°00′ 8	17:00	17:05	5	244,127	2929,524	243,111	0,577			0,252	0,028								0,159	
7	14.10.2022	46H1	29	40-57	61	335°	58°52' 5	021°42′ 5	58°52' 9	021°42′ 2	08:00	08:10	10	96,163	576,978	81,494	13,706			0,877	0,008								0,078	
8	14.10.2022	47H1	29	30-44	150	040°	59°04' 8	021°15′ 9	59°05' 6	021°17′ 3	12:10	12:30	20	39,553	118,659	20,2	8,443			10,804	0,106									
9	14.10.2022	47H2	29	30-53	108	060°	59°11' 6	022°01′ 0	59°12' 3	022°03′ 0	16:45	17:15	30	97,302	194,604	8,776	87,157			1,345	0,024									
10	15.10.2022	47H2	29	30-52	121	030°	59°18' 8	022°35′ 4	59°19' 2	022°35′ 8	08:10	08:20	10	337,263	2023,578	313,049	21,653			2,424	0,032								0,105	
11	15.10.2022	47H3	32	35-58	92	360°	59°19' 5	023°06′ 2	59°20' 0	023°06′ 2	11:10	11:20	10	403,808	2422,848	352,467	50,444			0,723	0,022								0,152	
12	15.10.2022	47H3	32	40-58	65	060°	59°26' 9	023°39′ 4	59°27' 1	023°40′ 2	14:10	14:20	10	137,075	822,450	114,971	21,325			0,76	0,019									
13	16.10.2022	48H7	32	27-44	48	320°	59°33' 8	027°17′ 2	59°35' 1	027°15′ 4	08:00	08:30	30	54,946	109,892	0,969	52,139			0,829	0,06	0,098								0,851
14	16.10.2022	48H6	32	26-37	52	300°	59°35' 4	026°57′ 7	59°35' 8	026°56′ 5	10:15	10:30	15	226,883	907,532	178,272	43,471			4,282	0,199		0,319							0,34
15	16.10.2022	48H6	32	30-48	81	320°	59°45' 5	026°17′ 3	59°46' 1	026°16′ 3	14:15	14:30	15	89,353	357,412	46,299	42,561			0,288	0,051									0,154
16	16.10.2022	48H5	32	30-47	80	320°	59°45' 5	025°57′ 8	59°45' 9	025°57′ 1	16:20	16:30	10	175,470	1052,820	54,912	119,191			0,545	0,048									0,774
17	18.10.2022	48H5	32	30-50	91	270°	59°44' 6	025°16′ 4	59°44' 6	025°15′ 6	08:30	08:40	10	78,727	472,362	58,423	19,395			0,718	0,055									0,136
18	18.10.2022	48H4	32	40-66	81	225°	59°37' 0	024°22′ 7	59°36' 5	024°22′ 4	13:10	13:20	10	343,257	2059,542	331,599	10,975			0,574	0,012							0,097		
19	19.10.2022	45H2	28.1	8-22	26	160°	58°02' 9	022°44′ 4	58°02' 5	022°44′ 7	15:35	15:45	10	353,865	2123,190	104,021	248,699			1,085	0,06									
20	20.10.2022	44H3	28.1	9-24	29	110°	57°57' 7	023°46′ 6	57°57' 5	023°47′ 4	08:40	08:50	10	274,831	1648,986	35,325	234,706			4,426	0,374									
21	20.10.2022	45H3	28.1	10-24	29	100°	58°12' 3	023°33′ 2	58°12' 1	023°34′ 6	12:20	13:35	15	120,720	482,880	46,91	73,059			0,61	0,095	0,046								
22	20.10.2022	45H3	28.1	16-25	37	090°	58°02' 7	023°19′ 2	58°02' 7	023°20′ 6	15:25	15:40	15	122,091	488,364	5,473	93,377	0,065		23,081	0,095									
23	21.10.2022	44H3	28.1	20-46	53	060°	57°46' 0	023°28′ 5	57°46' 5	023°29′ 7	08:20	08:35	15	60,705	242,820	15,06	43,823	0,044	0,078	1,055	0,03			0,123	0,033	0,001				0,458
24	21.10.2022	44H3	28.1	18-32	41	045°	57°44' 4	023°04′ 5	57°45' 7	023°05′ 7	11:50	12:10	20	135,382	406,146	6,106	125,6			3,453	0,06	0,05							0,113	
													Total (mean CPUE)	4553,296	1060,067	3122,403	1352,059	0,109	0,078	68,359	1,526	0,194	0,319	0,123	0,033	0,001	4,37	0,097	0,912	2,713
													SD 28.1	1067,594	898,731	212,895	819,264	0,109	0,078	33,71	0,714	0,096		0,123	0,033	0,001			0,113	0,458
													SD 28.2	777,644	924,061	723,798	39,247			9,968	0,148						4,37		0,113	
													SD 29	1198,539	1358,022	1047,798	134,047			15,962	0,198								0,534	
													SD 32	1509,519	1025,607	1137,912	359,501			8,719	0,466	0,098	0,319					0,097	0,152	2,255
													Total	4553,296	1060,067	3122,403	1352,059	0,109	0,078	68,359	1,526	0,194	0,319	0,123	0,033	0,001	4,37	0,097	0,912	2,713

Table 2. Biological sampling in the r.v."Baltica" joint EST-POL BIAS in October 2022.

SD 28.1		Sprat	Herring	Flounder	Turbot	Three-spined stickleback	Ninespined stickleback	River lamprey	Vendace	Fourhorn sculpin	Pike perch	Straightnose pipefish	Trout	Shorthorn sculpin	Lumpfish	Smelt	TOTAL
Samples taken	Measurements	6	6	2	1	6	6	1		1	1	1			1	1	33
	Analyses	6	6														12
Fish measured		1055	1380	2	1	561	136	2		1	1	1			1	52	3193
Fish analysed		148	230														378

SD 28.2		Sprat	Herring	Flounder	Turbot	Three-spined stickleback	Ninespined stickleback	River lamprey	Vendace	Fourhorn sculpin	Pike perch	Straightnose pipefish	Trout	Shorthorn sculpin	Lumpfish	Smelt	TOTAL
Samples taken	Measurements	4	4			4	4						1		1		18
	Analyses	4	4										1				9
Fish measured		845	391			294	44						1		1		1576
Fish analysed		159	71										1				231

SD 29		Sprat	Herring	Flounder	Turbot	Three-spined stickleback	Ninespined stickleback	River lamprey	Vendace	Fourhorn sculpin	Pike perch	Straightnose pipefish	Trout	Shorthorn sculpin	Lumpfish	Smelt	TOTAL
Samples taken	Measurements	6	6			6	5								4		27
	Analyses	6	6														12
Fish measured		1173	726			545	36								4		2484
Fish analysed		160	190														350

SD 32		Sprat	Herring	Flounder	Turbot	Three-spined stickleback	Ninespined stickleback	River lamprey	Vendace	Fourhorn sculpin	Pike perch	Straightnose pipefish	Trout	Shorthorn sculpin	Lumpfish	Smelt	TOTAL
Samples taken	Measurements	8	8			8	8	1	1					1	1	5	41
	Analyses	8	8														16
Fish measured		1465	1623			549	109	1	6					1	2	69	3825
Fish analysed		134	226														360

TOTAL		Sprat	Herring	Flounder	Turbot	Three-spined stickleback	Ninespined stickleback	River lamprey	Vendace	Fourhorn sculpin	Pike perch	Straightnose pipefish	Trout	Shorthorn sculpin	Lumpfish	Smelt	TOTAL
Samples taken	Measurements	24	24	2	1	24	23	2	1	1	1	1	1	1	7	6	119
	Analyses	24	24										1				49
Fish measured		4538	4120			1949	325	3	6	1	1	1	1	1	8	121	11075
Fish analysed		601	717														1318

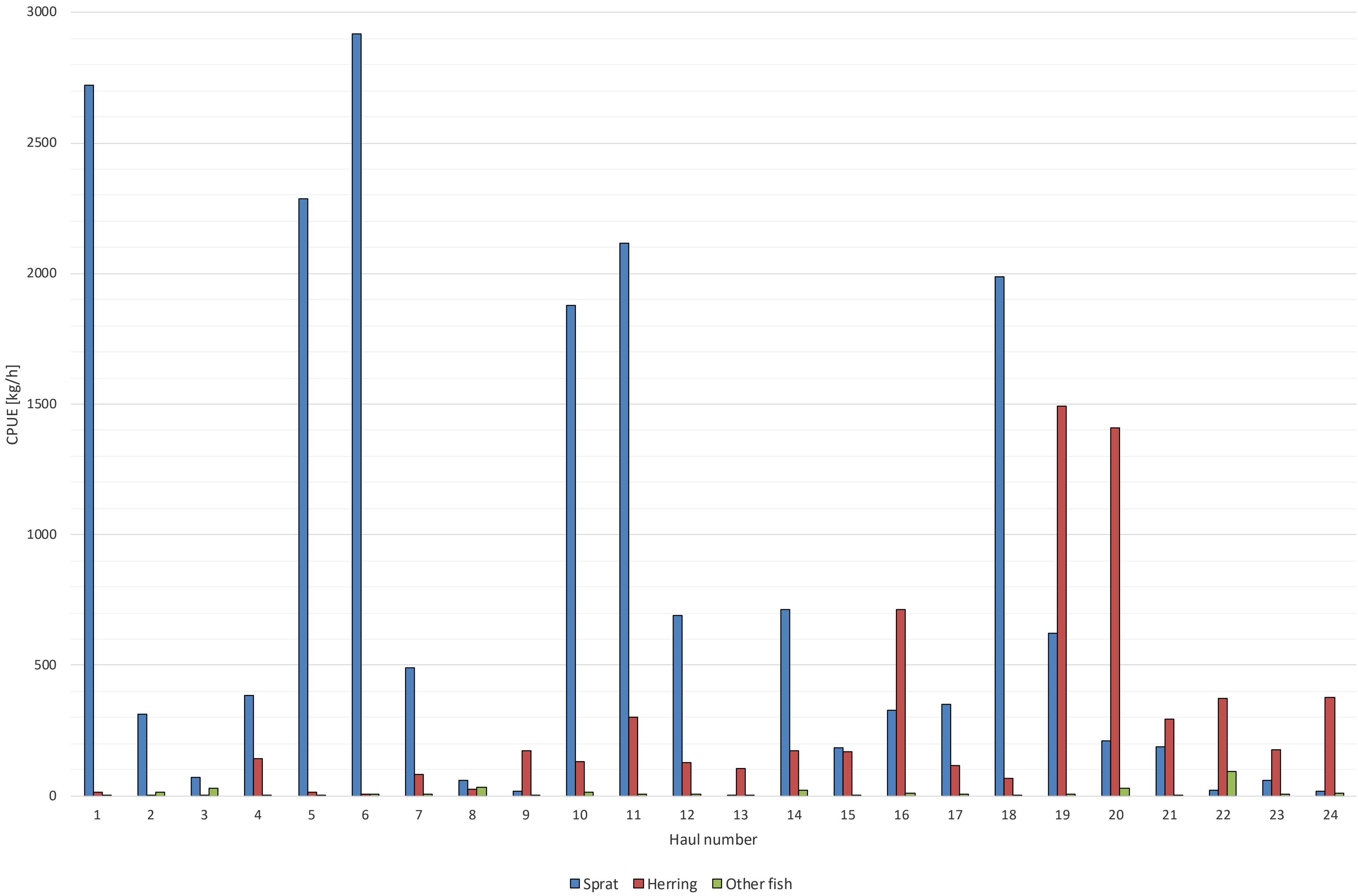

Figure 2. CPUE (kg/h) of sprat, herring and other fish species in particular pelagic fish control catches during the joint EST-POL BIAS in the north-eastern Baltic Sea (Sub-divisions 28.1, 28.2, 29 and 32), October 2022.

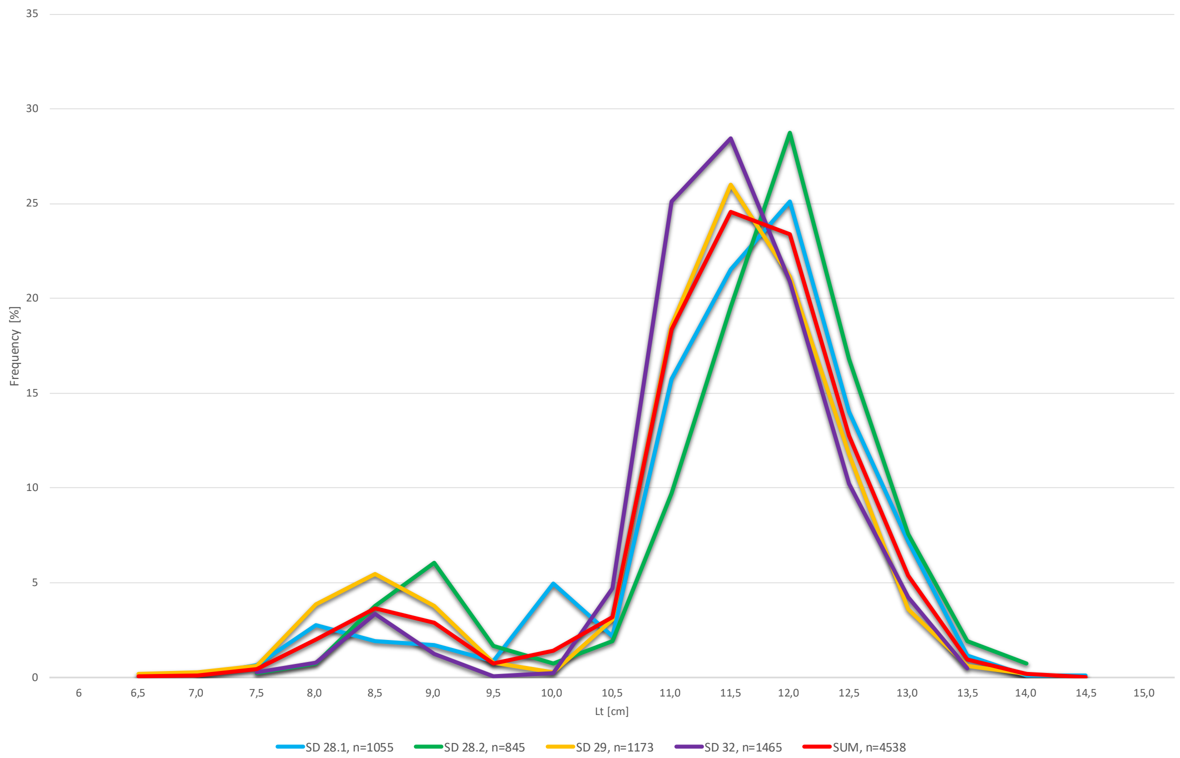

Figure 3. Sprat length distributions from the control catches conducted by the r.v. "Baltica" during joint EST-POL BIAS in the SDs 28.1, 28.2, 29 and 32 (October 2022).

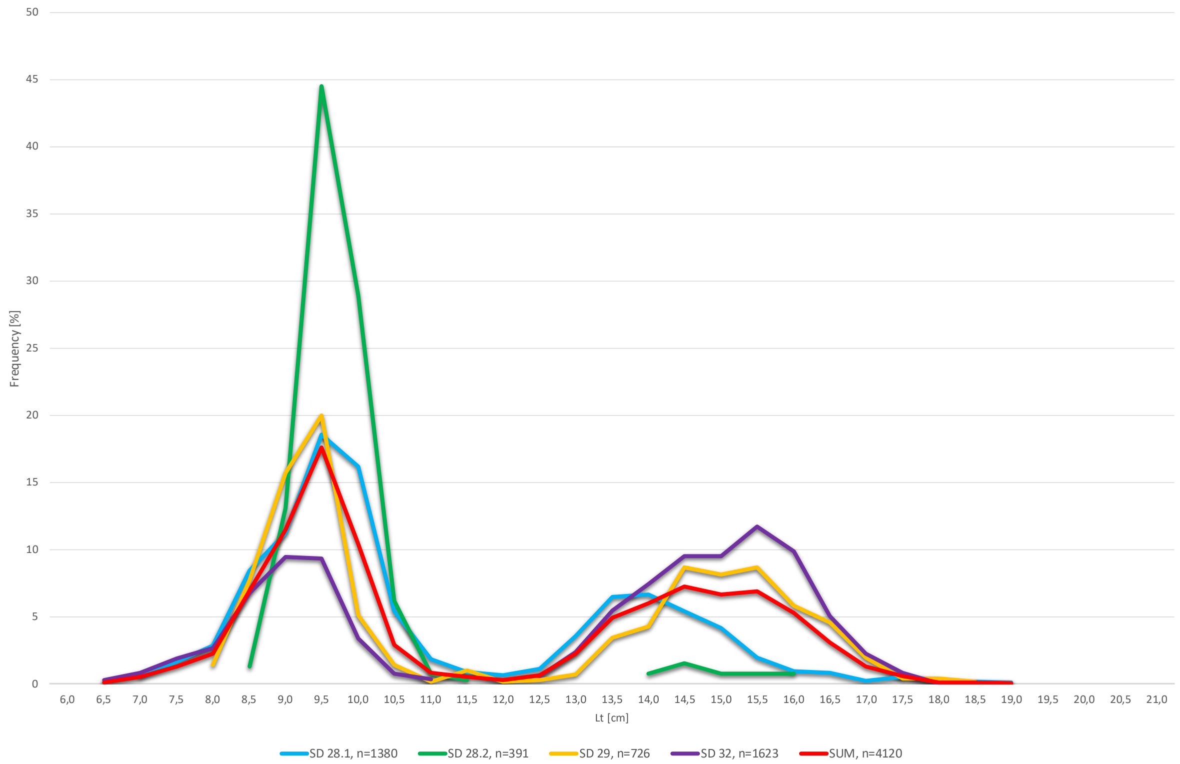

Figure 4. Herring length distributions from the control catches conducted by the r.v. "Baltica" during joint EST-POL BIAS in the SDs 28.1, 28.2, 29 and 32 (October 2022).

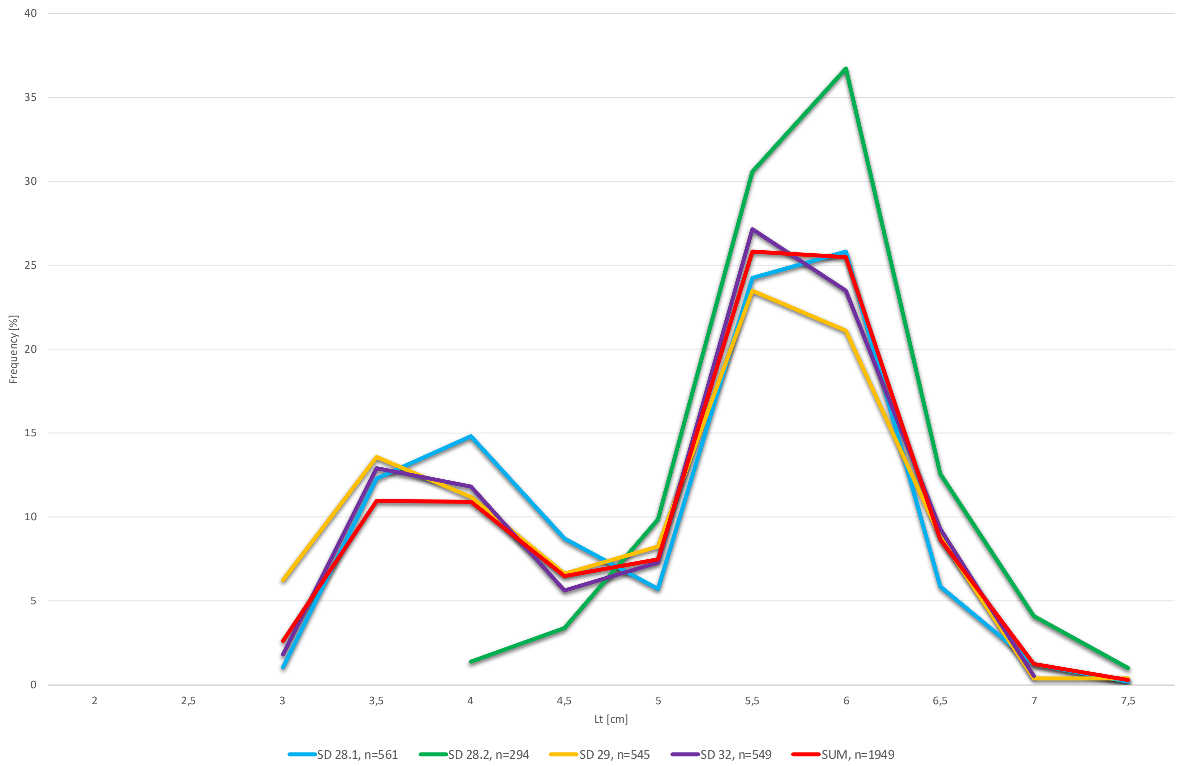

Figure 5. Three spined stickleback length distributions from the control catches conducted by the r.v. "Baltica" during joint EST-POL BIAS in the SDs 28.1, 28.2, 29 and 32 (October 2022).

Table 3. The BIAS survey basic biological and acoustic data concerning the clupeid stocks inhabiting the north- eastern Baltic Sea in October 2022.

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	1.1	60.8	2090.11	2.207	211.2	0.957
28	45H1	827.1	11.3	87.1	12348.20	14.930	1863.7	1.248
29	46H1	921.5	4.3	91.4	15421.52	16.735	2262.9	1.352
29	46H2	258.0	0.3	99.0	2707.78	10.495	1274.2	1.214
29	47H1	920.3	7.3	29.1	4881.60	5.304	290.5	0.548
29	47H2	793.9	39.6	50.5	8336.31	10.500	1535.9	1.463
32	47H3	536.2	10.6	86.6	5327.49	9.936	1291.5	1.300
32	48H4	835.1	2.2	96.8	7452.42	8.924	1130.3	1.267
32	48H5	767.2	36.8	58.6	6643.20	8.659	1281.1	1.480
32	48H6	776.1	25.0	64.6	5878.83	7.575	1005.5	1.327
32	48H7	851.4	77.3	2.9	653.22	0.767	151.6	1.976
Average			**19.6**	**66.1**		**8.730**	**1118.1**	**1.29**
Total		**8434**			**71740**			

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 2022.

ICES	ICES rectangle	HERRING – age groups									
Sub-div.		0	1	2	3	4	5	6	7	8+	total
28	45H0	21.01	1.34	0.22	0.24	0.11	0.00	0.09	0.06	0.00	23.07
28	45H1	1232.12	112.97	23.12	16.36	6.49	0.00	0.00	2.38	0.00	1393.44
total		1253.12	114.31	23.34	16.60	6.60	0.00	0.09	2.44	0.00	1416.51
29	46H1	85.78	67.99	124.10	237.71	69.77	39.70	25.31	8.24	10.70	669.31
29	46H2	6.46	2.07	0.30	0.15	0.00	0.00	0.00	0.00	0.00	8.98
29	47H1	329.95	20.44	1.24	2.22	0.76	0.22	0.32	0.00	0.00	355.14
29	47H2	679.59	184.75	696.08	1270.94	230.93	124.73	84.98	7.30	20.59	3299.89
total		1101.78	275.25	821.72	1511.02	301.45	164.65	110.62	15.54	31.29	4333.32
32	47H3	251.47	39.68	75.11	123.91	42.42	23.72	5.38	1.97	1.58	565.24
32	48H4	102.77	7.89	14.54	20.33	10.35	6.04	1.85	0.49	0.25	164.51
32	48H5	427.41	153.58	434.13	741.66	339.26	239.79	62.50	24.82	20.73	2443.87
32	48H6	381.77	78.49	191.63	417.25	206.46	129.03	41.44	14.40	9.85	1470.33
32	48H7	15.54	10.51	32.30	160.58	118.38	99.49	32.15	17.06	19.04	505.05
total		1101.78	275.25	821.72	1511.02	301.45	164.65	110.62	15.54	31.29	5149.00
Grand total		**3533.87**	**679.72**	**1592.78**	**2991.34**	**1024.92**	**662.71**	**254.02**	**76.73**	**82.75**	**10898.84**

Table 4. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups 0	1	2	3	4	5	6	7	8+	Total
28	45H0	206.78	13.21	215.56	267.95	210.57	144.92	46.19	60.57	104.17	1269.91
28	45H1	1495.97	217.34	3091.95	2290.67	1622.14	826.77	279.16	301.12	627.63	10752.75
total		1702.75	230.55	3307.51	2558.61	1832.71	971.69	325.35	361.69	731.80	12022.66
29	46H1	282.21	316.15	4391.22	4593.04	1936.13	591.78	547.84	453.74	977.03	14089.14
29	46H2	310.88	120.36	1089.14	772.12	216.24	32.55	42.18	21.65	76.19	2681.30
29	47H1	818.71	36.45	221.54	192.69	71.20	17.20	16.75	14.31	31.32	1420.17
29	47H2	122.93	146.73	1565.03	1389.30	456.41	103.60	119.39	77.31	231.00	4211.70
total		1534.72	619.68	7266.94	6947.14	2679.98	745.13	726.16	567.00	1315.54	22402.30
32	47H3	125.10	400.69	1580.87	1073.89	723.41	205.91	170.37	84.64	247.56	4612.44
32	48H4	383.27	699.18	2517.98	1540.06	1029.61	286.29	234.32	130.37	391.40	7212.48
32	48H5	488.60	281.67	1103.93	771.11	533.86	182.88	177.56	122.60	229.66	3891.86
32	48H6	172.29	324.82	1233.04	835.47	573.11	178.82	155.73	100.38	223.24	3796.90
32	48H7	0.00	0.77	3.12	3.08	2.57	1.87	2.33	2.33	2.64	18.70
total		1169.25	1707.12	6438.93	4223.61	2862.55	855.78	740.30	440.32	1094.51	19532.38
Grand total		**4406.72**	**2557.35**	**17013.38**	**13729.36**	**7375.24**	**2572.61**	**1791.82**	**1369.01**	**3141.85**	**53957.34**

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 2022.

ICES	ICES rectangle	HERRING – age groups									
Sub-div.		0	1	2	3	4	5	6	7	8+	total
28	45H0	119.27	8.81	4.56	5.22	2.63	0.00	2.56	1.50	0.00	144.54
28	45H1	6917.81	953.22	456.30	429.02	228.82	0.00	0.00	57.03	0.00	9042.21
total		7037.09	962.03	460.86	434.24	231.46	0.00	2.56	58.53	0.00	9186.75
29	46H1	430.83	839.33	2666.64	5790.45	1987.97	1138.29	802.05	301.80	370.47	14327.82
29	46H2	27.59	18.80	4.49	2.24	0.00	0.00	0.00	0.00	0.00	53.13
29	47H1	1689.97	115.53	24.59	50.41	20.62	5.59	9.44	0.00	0.00	1916.14
29	47H2	3400.01	2571.12	14127.18	27567.22	5818.93	3364.25	2097.45	215.93	605.13	59767.22
total		5548.40	3544.78	16822.90	33410.32	7827.51	4508.12	2908.94	517.73	975.60	76064.31
32	47H3	1183.95	518.76	1335.55	2546.01	951.78	566.26	146.12	55.23	42.79	7346.45
32	48H4	468.90	86.82	241.90	426.98	241.85	143.21	53.32	15.18	7.00	1685.17
32	48H5	1963.02	2321.00	7873.72	15627.95	7886.01	5811.89	1712.07	696.96	573.96	44466.57
32	48H6	1591.93	1189.54	3438.24	9082.42	5003.95	3252.70	1217.64	434.70	286.29	25497.43
32	48H7	76.97	167.63	597.44	3596.89	2928.52	2565.95	907.46	522.30	613.63	11976.79
total		5284.76	4283.76	13486.85	31280.25	17012.11	12340.02	4036.61	1724.36	1523.68	90972.41
Grand total		**17870.25**	**8790.58**	**30770.60**	**65124.81**	**25071.08**	**16848.14**	**6948.11**	**2300.62**	**2499.27**	**176223.47**

Table 5. Continued

ICES	ICES rectangle	SPRAT – age groups									
Sub-div.		0	1	2	3	4	5	6	7	8+	total
28	45H0	973.83	118.85	2325.69	3158.09	2611.08	1854.30	587.39	814.27	1390.14	13833.64
28	45H1	6595.98	1855.52	30448.18	24513.57	18061.98	9714.09	3283.03	3754.13	7549.33	105775.81
total		7569.81	1974.36	32773.86	27671.67	20673.06	11568.39	3870.42	4568.40	8939.47	119609.45
29	46H1	1116.12	3012.92	43880.50	49571.36	22217.67	7532.60	6641.37	5667.04	11671.92	151311.49
29	46H2	1104.90	1072.79	10227.71	7699.90	2275.99	399.20	489.35	259.04	873.57	24402.46
29	47H1	3325.46	281.70	2157.67	2022.17	793.01	210.46	194.20	174.49	361.43	9520.61
29	47H2	511.71	1340.21	15253.21	14327.89	4976.85	1291.58	1408.29	966.80	2738.92	42815.47
total		6058.20	5707.62	71519.10	73621.32	30263.53	9433.84	8733.21	7067.37	15645.84	228050.03
32	47H3	474.70	3657.11	15061.91	11154.33	7586.75	2360.44	2006.34	1051.10	2646.54	45999.21
32	48H4	1491.28	6230.61	23264.13	15460.26	10487.86	3163.88	2664.54	1581.07	4007.69	68351.30
32	48H5	1999.60	2531.41	10290.84	7759.12	5443.72	2030.60	2028.22	1456.34	2459.60	35999.45
32	48H6	711.88	2985.11	11726.38	8497.13	5923.34	1978.63	1782.65	1231.76	2385.21	37222.10
32	48H7	0.00	7.12	28.99	29.78	25.81	20.17	25.43	26.20	29.16	192.67
total		4677.46	15411.37	60372.26	42900.61	29467.48	9553.71	8507.17	5346.47	11528.20	187764.73
Grand total		**18305.47**	**23093.35**	**164665.22**	**144193.60**	**80404.07**	**30555.94**	**21110.81**	**16982.25**	**36113.50**	**535424.21**

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 2022.

ICES Sub-div.	ICES rectangle	HERRING – age groups									
		0	1	2	3	4	5	6	7	8+	avg.
28	45H0	5.68	6.55	20.71	22.11	23.93		27.10	23.80		6.26
28	45H1	5.61	8.44	19.73	26.22	35.25			24.00		6.49
29	46H1	5.02	12.35	21.49	24.36	28.49	28.67	31.69	36.61	34.62	21.41
29	46H2	4.27	9.08	15.00	15.00						5.92
29	47H1	5.12	5.65	19.90	22.75	27.24	25.85	29.10			5.40
29	47H2	5.00	13.92	20.30	21.69	25.20	26.97	24.68	29.59	29.39	18.11
32	47H3	4.71	13.07	17.78	20.55	22.44	23.87	27.16	28.06	27.15	13.00
32	48H4	4.56	11.01	16.64	21.00	23.37	23.72	28.85	30.80	28.40	10.24
32	48H5	4.59	15.11	18.14	21.07	23.24	24.24	27.39	28.08	27.68	18.20
32	48H6	4.17	15.16	17.94	21.77	24.24	25.21	29.38	30.18	29.05	17.34
32	48H7	4.95	15.95	18.50	22.40	24.74	25.79	28.23	30.61	32.22	23.71

Table 6, Continue

ICES Sub-div.	ICES rectangle	SPRAT – age groups									
		0	1	2	3	4	5	6	7	8+	avg.
28	45H0	4.71	9.00	10.79	11.79	12.40	12.80	12.72	13.44	13.34	10.89
28	45H1	4.41	8.54	9.85	10.70	11.13	11.75	11.76	12.47	12.03	9.84
29	46H1	3.95	9.53	9.99	10.79	11.48	12.73	12.12	12.49	11.95	10.74
29	46H2	3.55	8.91	9.39	9.97	10.53	12.26	11.60	11.97	11.47	9.10
29	47H1	4.06	7.73	9.74	10.49	11.14	12.24	11.60	12.20	11.54	6.70
29	47H2	4.16	9.13	9.75	10.31	10.90	12.47	11.80	12.51	11.86	10.17
32	47H3	3.79	9.13	9.53	10.39	10.49	11.46	11.78	12.42	10.69	9.97
32	48H4	3.89	8.91	9.24	10.04	10.19	11.05	11.37	12.13	10.24	9.48
32	48H5	4.09	8.99	9.32	10.06	10.20	11.10	11.42	11.88	10.71	9.25
32	48H6	4.13	9.19	9.51	10.17	10.34	11.06	11.45	12.27	10.68	9.80
32	48H7		9.25	9.30	9.67	10.06	10.79	10.92	11.25	11.05	10.30

Meteorological and hydrological characteristics.

The 24 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 row data aggregated to the 1-m depth stratum. Meteorological parameters were measured by MicroStep-MIS AMS 111 automatic weather station. The Secchi Disc measurements were conducted on 23 stations.

The wind speed varied from 0.2 m/s to 19.8 m/s (up to 44.4 m/s) and average speed was 8.5 m/s The most often wind direction was S. The air temperature ranged from 2.9 °C to 15.2 °C, and average temperature was 10.7 °C.

The seawater temperature in the surface layers (Fig. 3.) varied from 10.44 to 12.24°C and the mean was 11.38 °C. The lowest surface temperatures were recorded at the haul 17. The highest ones were noticed at the haul 3. The minimum value of salinity in Practical Salinity Unit (PSU) was 4.40 at the haul 14. The maximum was 7,19 at the haul 2. The mean value of salinity was 6.07. The oxygen content in the surface layers of investigated the research area varied in the range of 6.86 ml/l at the haul 19 to 7.49 ml/l at the haul 17. The mean value of surface water oxygen content was 7.19 ml/l.

The temperature of near bottom (Fig.4.) layer was changing in the range of 3.54 °C at the haul 13 to 11.74 °C at the haul 21, the mean was 6.94 °C . Salinity in the bottom waters varied from 5.98 at the haul 23 to 11.15 at the haul 3, and the mean was 8.31 in the PSU. Oxygen content varied from 0.00 ml/l to 7.10 ml/l and the mean was 3.36 ml/l. The zero values of this parameter were noticed at the hauls: 3, 8, 9, 10 and 17.

The Secchi Disc measurements shows that this water parameter changed in the range of 4.2 m up to 8.6 m and its mean was 6.4 m.

The vertical distribution of the seawater temperature salinity and oxygen content along the hydrological transect is presented on the figure 5. The analysis of the drawing shows that there was not the water optimal conditions for the successful spawning of cod.

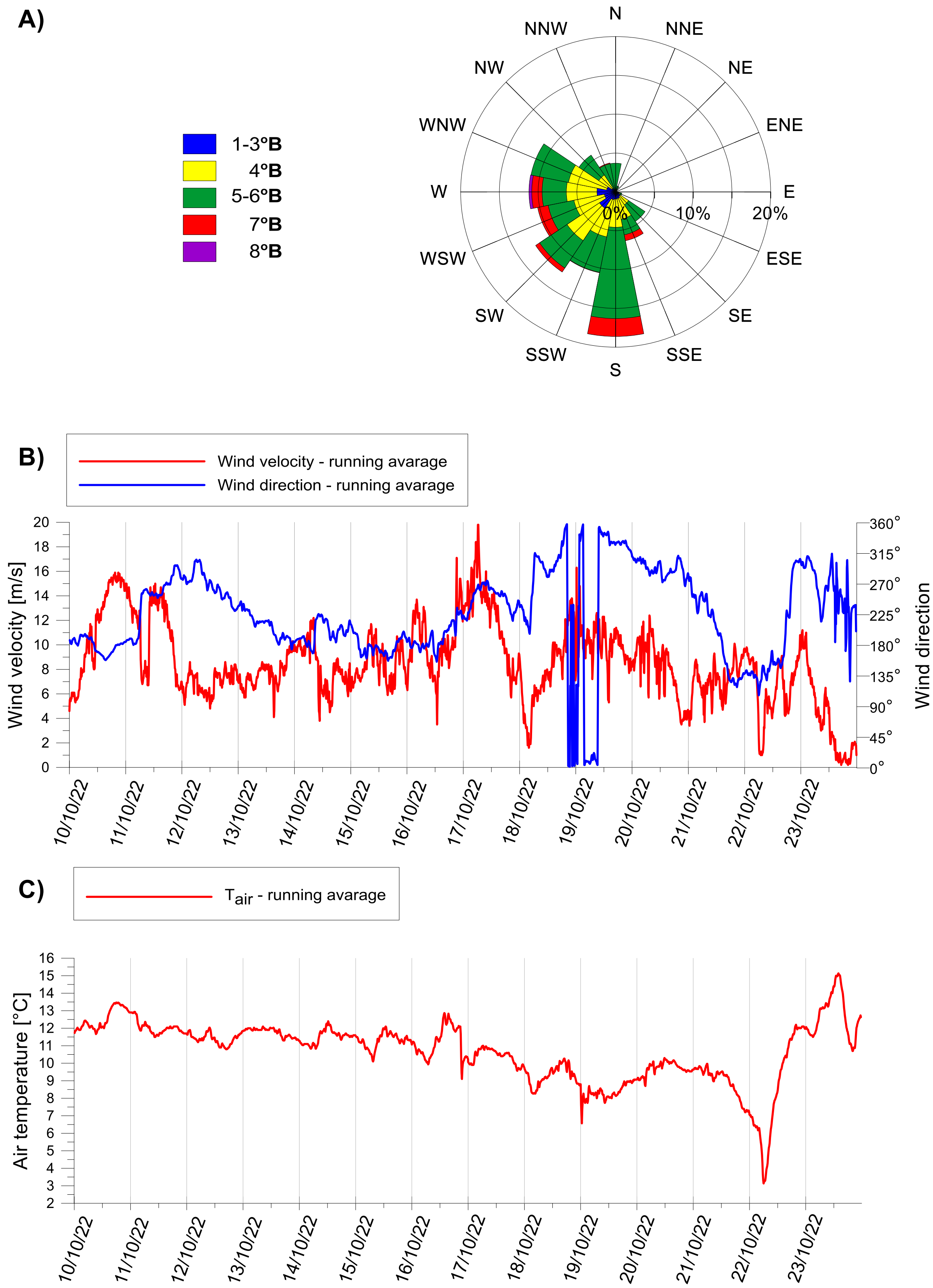

Figure 6. Changes of the main meteorological parameters (October 2022).

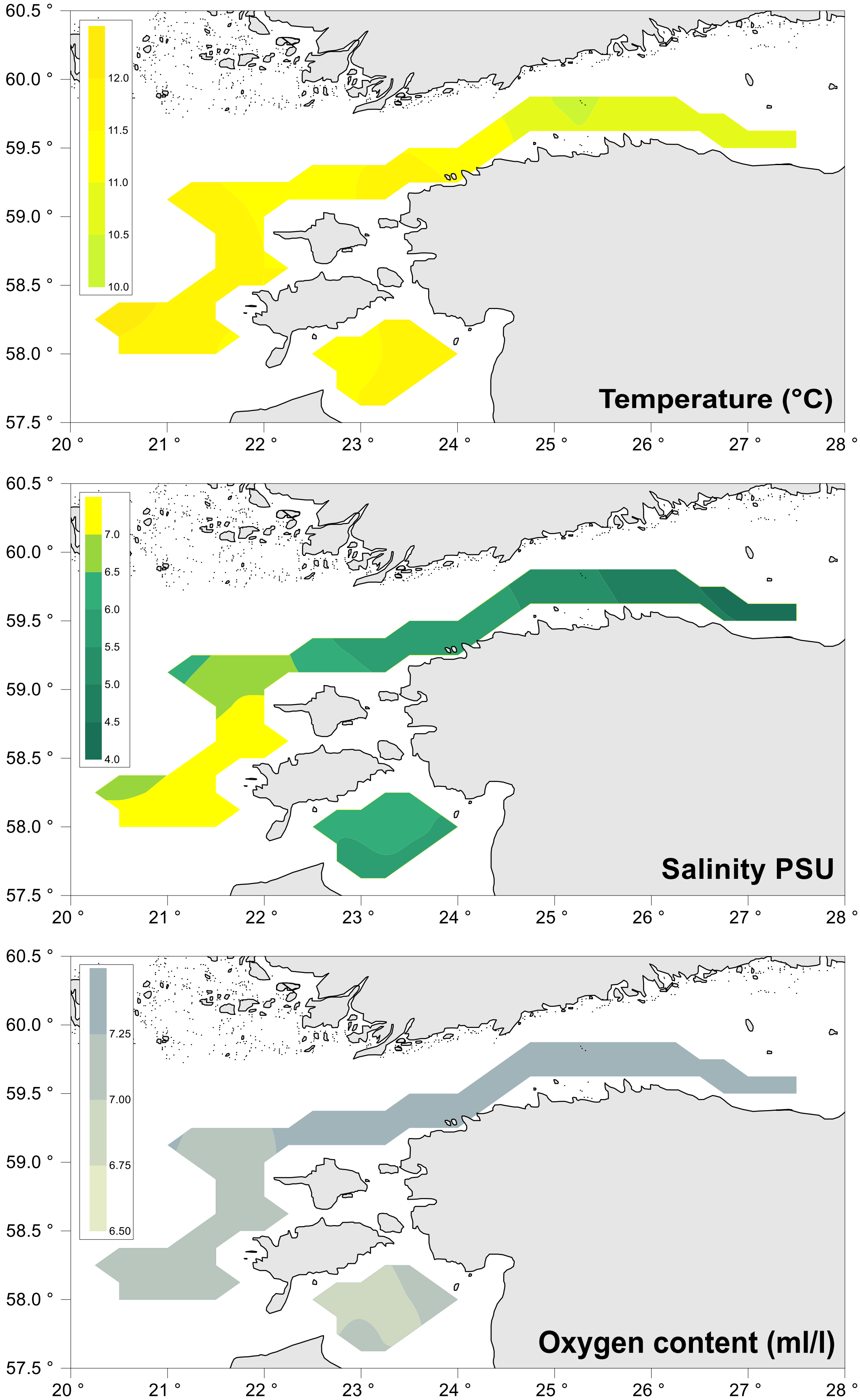

Figure 7. Distribution of the seawater temperature, salinity and oxygen content in the in the surface waters (October 2022).

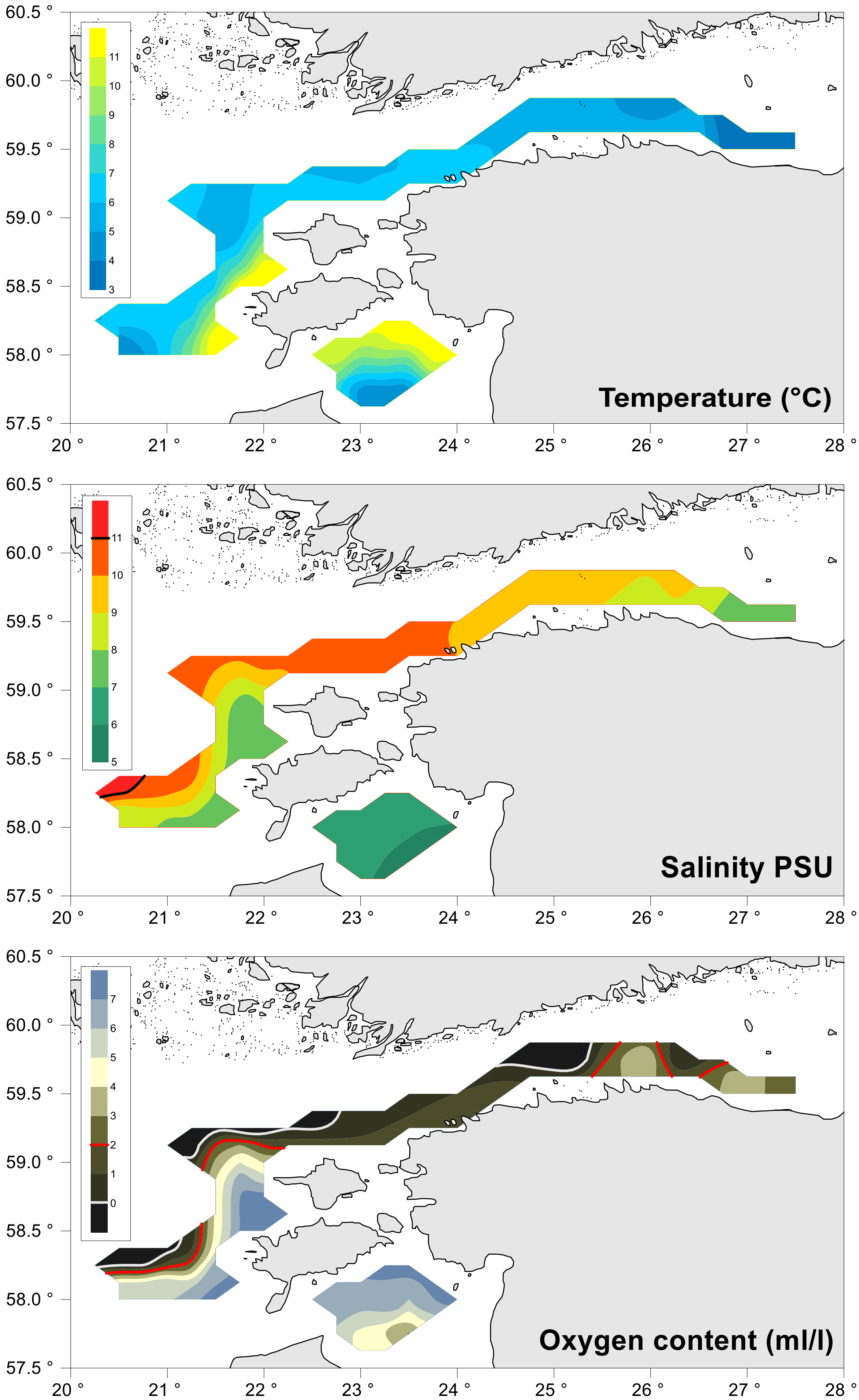

Figure 8. Distribution of the seawater temperature, salinity and oxygen content in the near bottom waters (October 2022).

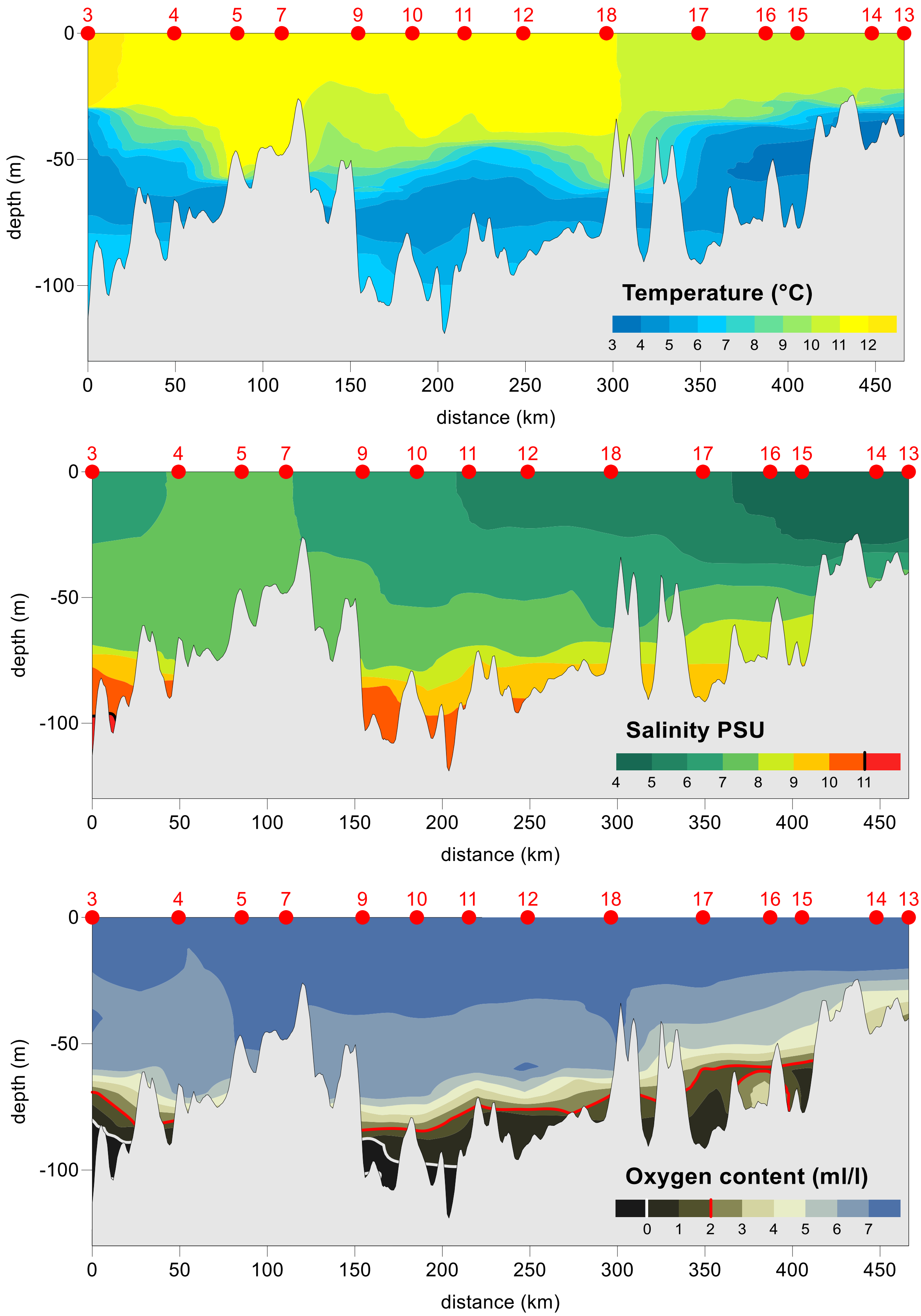

Figure 9. Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological profile (October 2022).

Baltic International Acoustic Survey

Report for R/V Aranda

Cruise 11/2022

ICES_BIAS_2022

20st September – 3rd October 2022

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 2022, 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 Tuesday 20.09.2022 at 16:55 (UTC 13:55) 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 02.10.2022 and the vessel was navigated back to the port of Helsinki.

The Finnish BIAS 2022 survey had only a slight deviation from the original plan when the trawling could not be performed due to low fish abundance or 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 15.9.2022 on (N60°06.62', E025°00.12'), 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 = 0.13 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	
IT chief:	Perttu Rantanen	LUKE	20.09.2022 - 03.10.2022
	Anna Reunamo	SYKE	27.09.2022 - 03.10.2022
	Anu Lastumäki	SYKE	20.09.2022 - 03.10.2022
	Jukka Pönni	LUKE	20.09.2022 - 03.10.2022
	Jari Raitaniemi	LUKE	20.09.2022 - 27.09.2022
	Hannu Harjunpää	LUKE	20.09.2022 - 03.10.2022
	Topi Lehtonen	LUKE	27.09.2022 - 03.10.2022
	Velimatti Leinonen	LUKE	20.09.2022 - 27.09.2022
	Erkki Jaala	LUKE	20.09.2022 - 03.10.2022
	Riku Helisevä	LUKE	20.09.2022 - 03.10.2022
	Tommi Lindroth	FISH	20.09.2022 - 03.10.2022
	Toni Nikaniemi	FISH	20.09.2022 - 03.10.2022
	Jani Helminen	LUKE	27.09.2022 - 03.10.2022
	Roope Lehmonen	LUKE	20.09.2022 - 03.10.2022
	Jukka Pohtila	LUKE	20.09.2022 - 03.10.2022
	Markku Gavrilov	LUKE	20.09.2022 - 03.10.2022
	Pia Lindberg-Lumme	LUKE	20.09.2022 - 03.10.2022
	Rickard Yngwe	SLU	20.09.2022 - 03.10.2022
	Per Andersson	SLU	20.09.2022 - 03.10.2022

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 29 and 9 in northern Baltic proper (SD 29). In addition, 6 trawl hauls were done in the northern Gulf of Finland (SD 32).

The 9009 kg combined catches (Table 1) consisted of 22 fish species (8804 kg) and mostly unidentified organic matter categorized as “waste” (179 kg), but also small amounts of common jellyfish *Aurelia aurita* (26.5 kg) and the isopod *Saduria entomon*. The most common and abundant species were herring (*Clupea harengus*) (4359 kg), sprat (*Sprattus sprattus*) (3108 kg) and three-spined stickleback (*Gasterosteus aculeatus*) (1130 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, 3923 and 1935 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 44 CTD casts were done during the entire cruise.

Abundance estimates

The total area covered by the Finnish BIAS survey was 21537 square nautical miles (nmi^2), 29 rectangles, and after the scrutinizing, the distance used for acoustic estimates was 1406 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 2022 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 2022 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 2022.

Haul number	SD	Rectangle	Ammodytes tobianus	Aurelia aurita	Clupea harengus	Coregonus albula	Cyclopterus lumpus	Gadus morhua	Gasterosteus aculeatus	Gymnocephalus cernuus	Hyperoplus lanceolatus	Lampetra fluviatilis	Liparis liparis	Myoxocephalus scorpius	Nerophis ophidion	Osmerus eperlanus	Perca fluviatilis	Platichthys flesus	Pomatoschistus minutus	Pungitius pungitius	Saduria entomon	Salmo salar	Sprattus sprattus	Syngnathus typhle	Triglopsis quadricornis	Zoarces viviparus	"Waste"	Fish Catch
1	32	47H0		4.2	112.9				27.4											0.1		0.2	112.9				34.3	253.5
2	29	47H0		3.1	56.1		0.8		55.4						0.0					0.0			49.7				11.8	162.0
3	29	48G9		2.3	124.3				54.8											1.1		0.2	127.3	0.0				307.7
4	29	48H0		2.2	32.2				38.6						0.0					0.3			343.0				3.7	414.0
5	29	48H1			100.2				10.7					0.2	0.0	0.1				0.1			188.2				8.5	299.5
6	29	48H1		10.0	44.9		0.4		30.3						0.0					0.0			53.8				2.6	129.4
7	30	48H2			16.4				5.7						0.0	0.4				0.2	0.0		340.5				0.7	363.3
8	30	48H2		4.1	2.7		0.1		3.7						0.0					0.1			499.7				2.6	506.3
9	30	48H3			131.8		0.1		1.9						0.0	0.7		0.2		0.4	0.0	10.8	155.3				5.7	301.3
10	30	48H3			9.0		10.6		9.4											0.1			452.8	0.1			16.0	482.0
11	30	48H4			147.2				1.0							0.2				0.1			234.8				8.7	383.3
12	30	48H5			130.4				3.3							0.0				0.6			46.6				1.0	181.0
13	30	49G9		0.5	112.0			0.1	34.2		0.1		0.1		0.0					0.8	0.0	0.5	38.3				0.6	185.9
14	30	49H5			118.0				0.4							1.5				0.1			146.4				4.6	266.4
15	30	49H6			47.7	0.1			2.8			0.0				107.5	0.1			0.2	0.0		113.6				7.0	272.0
16	30	50G8	0.1		54.0				4.7						0.0					0.0	0.0		18.5				2.7	77.3
17	30	50G9			137.6				6.9						0.0	0.5				0.0			6.0					151.0
18	30	50G9			45.6				3.6											0.0		0.2	1.5				0.2	50.8
19	30	50H0			154.6				12.5							7.8			0.0	0.0		0.1	3.3				25.6	178.4
20	30	51G8	0.1		95.0				1.6						0.0								0.9				4.8	97.5
21	30	51G8			261.1				113.4														2.4					377.0
22	30	51G9			23.5				18.8						0.0	0.0				0.0	0.0		22.3				0.4	64.6
23	30	51G9			55.1				58.6											0.1			39.5				11.8	153.2
24	30	51H0			109.2				2.5							3.1				0.0			1.1				5.1	115.9
25	30	51H0	0.0		55.6				2.1			0.0				0.6					0.0		2.5			0.0	0.2	60.8
26	30	52G8			137.1				58.2						0.0								2.1		0.1		1.4	197.6
27	30	52G8			60.8				32.6						0.0					0.2		0.2	5.2					99.0
28	30	52G9			6.0				184.3														0.7					191.0
29	30	52G9			61.1				11.1						0.0					0.0			22.4				1.4	94.6
30	30	52H0			76.4				19.6													0.3	15.6				2.1	111.9
31	30	52H0			136.9				3.6			0.1			0.0				0.0	0.0		0.2	8.3				0.9	149.1
32	30	53G8			69.0				25.9														3.2				0.4	98.1
33	30	53G8			58.7				77.6														1.2				0.5	137.5
34	30	53G9			110.1				133.2												0.1		0.4				0.2	243.7
35	30	53G9	0.0		67.3				9.0											0.0			2.5				0.2	78.8
36	29	53H0			167.2				24.3							1.6					0.0		23.9				1.0	217.0
37	29	53H0			167.4				6.4						0.0							0.2	8.3				0.7	182.3
38	29	54G8			52.3				14.9						0.0						0.0						1.8	67.2
39	29	54G9			257.2				3.5																		4.3	260.7
40	32	54G9			44.0				2.3			0.0								0.0			1.4				2.3	47.7
41	32	54H0			162.0				3.2							39.4							0.8				3.1	205.4
42	32	54H0	0.1		205.5				0.8							11.5							1.1					219.0
43	32	55G9			242.6				7.1												0.0		5.3					255.0
44	32	55H0			100.4				8.4	0.0										0.0	0.1		5.1					113.9
Total			**0.2**	**26.5**	**4359.1**	**0.1**	**12.0**	**0.1**	**1130.2**	**0.0**	**0.1**	**0.1**	**0.1**	**0.2**	**0.2**	**174.9**	**0.1**	**0.2**	**0.0**	**4.6**	**0.3**	**12.8**	**3108.4**	**0.1**	**0.1**	**0.0**	**178.9**	**8803.6**

Table 2. English, scientific, and Finnish names of observed species in Finnish 2022 BIAS-survey.

Fishnames		
English	**Scientific**	**Finnish**
Atlantic Salmon	Salmo salar	Lohi
Brown Trout	Salmo trutta	Meritaimen
Cod	Gadus morhua	Turska
Common Goby	Pomatoschistus microps	Liejutokko
Common Seasnail	Liparis liparis	Imukala
European Whitefish	Coregonus lavaretus	Siika
Flounder	Platichthys flesus	Kampela
Fourhorn Sculpin	Triglopsis quadricornis	Härkäsimppu
Great Sandeel	Hyperoplus lanceolatus	Isotuulenkala
Herring	Clupea harengus	Silakka
Lamprey	Lampetra fluviatilis	Nahkiainen
Lesser Sandeel	Ammodytes tobianus	Pikkutuulenkala
Lumpsucker	Cyclopterus lumpus	Rasvakala
Nine-spined Stickleback	Pungitius pungitius	Kymmenpiikki
Perch	Perca fluviatilis	Ahven
Pipefish	Syngnathus typhle	Särmäneula
Rock Gunnel	Pholis gunnellus	Teisti
Round Goby	Neogobius melanostomus	Mustatäplätokko
Ruffe	Gymnocephalus cernuus	Kiiski
Sand Goby	Pomatoschistus minutus	Hietatokko
Shorthorn Sculpin	Myoxocephalus scorpius	Isosimppu
Smelt	Osmerus eperlanus	Kuore
Snake bBlenny	Lumpenus lampretaeformis	Elaska
Snake blenny	Zoarces viviparus	Kivinilkka
Sprat	Sprattus sprattus	Kilohaili
Straightnose Pipefish	Nerophis ophidion	Siloneula
Three-spined Stickleback	Gasterosteus aculeatus	Kolmipiikki
Turbot	Scophthalmus maximus	Piikkikampela
Vendace	Coregonus albula	Muikku

Table 3. Number of length measurements /species and Sub-Division in Finnish 2022 BIAS-survey.

Species	ICES SD			Total
	29	30	32	
Ammodytes tobianus		9		9
Clupea harengus	2356	8592	1560	12508
Coregonus albula			1	1
Cyclopterus lumpus	13		6	19
Gadus morhua	1			1
Gasterosteus aculeatus	502	1740	288	2530
Gymnocephalus cernuus		1		1
Hyperoplus lanceolatus	4			4
Lampetra fluviatilis		3	1	4
Liparis liparis	1			1
Myoxocephalus scorpius	1			1
Nerophis ophidion	38	15	1	54
Osmerus eperlanus	4	163	45	212
Perca fluviatilis			1	1
Platichthys flesus			1	1
Pomatoschistus minutus		2		2
Pungitius pungitius	98	49	199	346
Salmo salar	6	5	1	12
Sprattus sprattus	1664	2011	989	4664
Syngnathus typhle	2		2	4
Triglopsis quadricornis		1		1
Zoarces viviparus		1		1
Total	**4690**	**12592**	**3095**	**20377**

Table 4. Individual samples of herring and sprat (for age determination) per SD in 2022.

Length class	Species							
	Sprat			Sprat Total	Herring			Herring Total
	29	30	32		29	30	32	
45						2		2
50						5		5
55						20	1	21
60					1	21	2	24
65	7	1		8	3	50	5	58
70	29	3	1	33	20	47	16	83
75	61	17	7	85	62	75	27	164
80	76	21	14	111	68	69	40	177
85	81	40	22	143	86	93	45	224
90	16	13	2	31	20	32	16	68
95	4	12	1	17	21	29	12	62
100	14	4	9	27	18	20	13	51
105	61	35	49	145	7	21	6	34
110	63	91	49	203	3	10	3	16
115	63	115	51	229	4	10	3	17
120	61	135	51	247	2	8	6	16
125	52	141	51	244	15	20	20	55
130	33	133	39	205	28	66	42	136
135	3	109	11	123	40	129	50	219
140	1	58	2	61	39	159	50	248
145		21		21	44	171	50	265
150		2		2	41	181	49	271
155					38	181	50	269
160					32	176	50	258
165					25	165	46	236
170					19	165	28	212
175					7	158	9	174
180					3	134	1	138
185						120		120
190						98	1	99
195						79		79
200						50		50
205						28		28
210						18		18
215					1	7		8
220						12		12
230						2		2
235						1	1	2
265						1		1
295							1	1
Total	**625**	**951**	**359**	**1935**	**647**	**2633**	**643**	**3923**

Table 5. Numbers and locations of fishing stations (WGS-84) during Finnish BIAS-survey in 2022.

HaulNumber	HaulStationName	SD	HaulStartTime	HaulDuration (min)	HaulStartLatitude	HaulStartLongitude	HaulStopLatitude	HaulStopLongitude	HaulTrawlHeadrope	HaulBottomDepth	HaulDistance	HaulNetopening
1	48H3-1	32	2022-09-20T22:01	30	59.67350	23.15650	59.69433	23.18267	23	60	2778	12.3
2	48H2-1	29	2022-09-21T02:15	15	59.65333	22.57650	59.66333	22.55167	17	60	1389	20
3	48H1-1	29	2022-09-21T08:00	80	59.69967	21.06250	59.74550	20.97600	15	135	6914	17
4	48H0-1	29	2022-09-21T11:41	60	59.66667	20.89483	59.71633	20.82550	15.8	70	5556	18
5	48G9-1	29	2022-09-21T17:00	45	59.78883	19.94250	59.78983	19.87917	15.8	200	4167	17.6
6	49G9-1	29	2022-09-21T21:11	45	60.02650	19.43100	60.05734	19.38233	15.8	170	4306	20
7	50G8-1	30	2022-09-22T03:16	90	60.77934	18.83133	60.85567	18.82183	14.3	70	8334	16.8
8	51G8-1	30	2022-09-22T17:55	60	61.32784	18.89583	61.27883	18.88650	15.8	70	5371	17
9	51G8-2	30	2022-09-22T22:10	60	61.28750	18.12050	61.28817	18.08217	14.3	70	5556	17.1
10	52G8-1	30	2022-09-23T02:02	50	61.49133	18.07467	61.57084	18.07867	14.3	65	4630	16.9
11	52G9-1	30	2022-09-23T07:59	60	61.68600	19.15683	61.63583	19.14400	12.7	80	5556	15.9
12	52G8-2	30	2022-09-23T14:11	82	61.85267	18.22900	61.79133	18.18950	11.1	90	7593	15
13	53G8-1	30	2022-09-23T19:01	60	62.07167	18.15050	62.10717	18.22300	9.5	85	5556	15.4
14	53G8-2	30	2022-09-23T22:49	45	62.12734	18.60650	62.08967	18.59400	12.7	90	4167	17.5
15	53G9-1	30	2022-09-24T01:45	75	62.11517	19.15150	62.05267	19.08183	12.7	87	6945	17.3
16	54G8-1	30	2022-09-24T12:22	90	62.62900	18.80233	62.68817	18.80633	85.5	120	6667	19.6
17	54G9-1	30	2022-09-24T18:00	60	62.64517	19.33433	62.69333	19.34000	15.8	160	5371	16.2
18	55G9-1	30	2022-09-24T22:13	67	63.03617	19.41083	63.05734	19.52883	14.3	150	6204	16.5
19	55H0-1	30	2022-09-25T01:58	70	63.14367	20.06500	63.16033	20.18900	12.7	90	6482	16.4
20	54G9-2	30	2022-09-25T09:08	108	62.68067	19.53617	62.59667	19.53500	15.8	125	9001	16.8
21	54H0-1	30	2022-09-25T17:50	60	62.69000	20.22950	62.73417	20.18200	12.7	80	5556	16.3
22	54H0-2	30	2022-09-25T20:09	90	62.81583	20.43500	62.86633	20.33650	7.9	70	7223	21.1
23	53H0-1	30	2022-09-26T02:04	45	62.47867	20.35017	62.45417	20.41650	12.7	80	4167	16.7
24	53G9-2	30	2022-09-26T06:13	100	62.17617	19.84817	62.11033	19.93250	12.7	130	8334	14.7
25	52G9-2	30	2022-09-26T11:01	105	61.98450	19.89567	61.90917	19.97400	12.7	110	9723	18.5
26	52H0-1	30	2022-09-26T18:52	45	61.60600	20.15283	61.58967	20.21733	15.8	130	4028	16.3
27	52H0-2	30	2022-09-26T22:37	60	61.86550	20.23450	61.83767	20.31700	15.8	120	5556	18.8
28	53H0-2	30	2022-09-27T02:38	60	62.06600	20.35533	62.04083	20.44350	15.8	110	5556	17.1
29	51H0-1	30	2022-09-27T19:46	60	61.47750	20.78683	61.45750	20.88067	12.7	70	5556	15
30	51H0-2	30	2022-09-27T23:42	60	61.33300	20.52367	61.30983	20.61633	15.8	100	5186	18.4
31	51G9-1	30	2022-09-28T04:50	55	61.33484	19.78700	61.32267	19.90517	12.7	110	5093	16.3
32	51G9-2	30	2022-09-28T10:12	60	61.10900	19.72517	61.10883	19.82667	15.8	120	5371	16.5
33	50H0-1	30	2022-09-28T19:13	60	60.85483	20.45967	60.87117	20.55083	12.7	75	5556	16.2
34	50G9-1	30	2022-09-28T22:30	60	60.87667	19.83983	60.88217	19.93867	14.3	95	5556	17.8
35	50G9-2	30	2022-09-29T02:15	60	60.89400	19.50467	60.90800	19.59133	11.1	100	5371	11
36	47H0-1	29	2022-09-29T18:55	30	59.31033	20.27033	59.32650	20.30483	12.7	65	2778	16.4
37	47H0-2	29	2022-09-29T23:25	45	59.18300	20.90200	59.21533	20.87567	15.8	100	4167	17.1
38	48H1-2	29	2022-09-30T04:14	30	59.52117	21.12450	59.53083	21.16917	15.8	75	2778	16.8
39	48H2-2	29	2022-09-30T08:34	60	59.52984	22.15817	59.54433	22.24450	11.1	70	5556	17
40	48H3-2	32	2022-09-30T14:32	45	59.54217	23.38550	59.55383	23.45700	15.8	90	4167	17.2
41	48H4-1	32	2022-09-30T21:13	45	59.86533	24.75133	59.87200	24.82283	12.7	65	4167	15.7
42	48H5-1	32	2022-09-30T23:55	60	59.92750	25.09917	59.92733	25.19200	12.7	60	5556	15.5
43	49H6-1	32	2022-10-01T18:40	45	60.13183	26.33167	60.09483	26.33767	14.3	65	4167	16.7
44	49H5-1	32	2022-10-02T00:53	60	60.01317	25.04117	60.06067	25.05800	14.3	60	5556	16.7

Table 6. Survey statistics by area in SDs 29, 30 and 32 (r/v Aranda in 2022).

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	11.3286	920.3	780.674	0.68912	10425.68	34.03	14.44	0.00	51.41
29	48G9	51	10.5764	772.8	722.397	0.683027	8173.445	27.06	25.20	0.00	47.50
29	48H0	44	11.0033	730.3	828.577	0.753027	8035.701	10.71	60.51	0.00	28.51
29	48H1	56	15.2937	544	1207.142	0.789308	8319.761	21.81	42.10	0.00	35.83
29	48H2	61	10.7803	597	1172.075	1.087238	6435.84	3.61	93.87	0.00	2.37
32	48H3	64	7.4899	615.7	965.893	1.289597	4611.518	14.13	77.34	0.00	7.23
32	48H4	58	7.5161	835.1	1085.989	1.444885	6276.688	31.60	66.48	0.00	1.50
32	48H5	28	5.9261	767.2	917.216	1.547768	4546.468	48.99	33.39	0.00	12.68
29	49G9	35	7.2060	564.2	575.519	0.79867	4065.609	21.29	14.54	0.00	62.86
32	49H5	28	8.5202	306.9	1204.485	1.413682	2614.849	35.10	62.62	0.00	0.99
32	49H6	44	5.3231	586.5	846.433	1.590106	3122.011	16.95	49.90	0.00	7.53
30	50G8	27	2.5570	833.4	301.887	1.180624	2131.015	49.68	20.59	0.00	28.87
30	50G9	70	1.3166	879.5	224.474	1.704891	1157.99	66.01	4.79	0.00	28.95
30	50H0	37	3.1072	795.1	452.527	1.456373	2470.552	55.09	1.89	0.00	40.92
30	51G7	13	1.4247	614.5	350.231	2.458208	875.5029	83.40	1.30	0.00	15.15
30	51G8	76	2.4636	863.7	400.691	1.626418	2127.844	50.98	0.79	0.00	48.16
30	51G9	59	2.9932	865.8	194.550	0.649964	2591.555	21.31	12.07	0.00	66.47
30	51H0	65	0.7251	865.7	146.224	2.016611	627.7166	74.48	3.61	0.00	20.56
30	52G8	65	3.7635	852	281.864	0.74894	3206.512	16.81	1.29	0.00	81.83
30	52G9	69	2.3183	852	150.922	0.650992	1975.221	27.04	6.64	0.00	66.23
30	52H0	62	1.2736	852	184.432	1.448165	1085.068	48.54	8.16	0.00	43.19
30	53G8	55	4.2678	838.1	302.409	0.708578	3576.867	13.97	0.90	0.00	85.12
30	53G9	59	2.3464	838.1	193.356	0.824072	1966.479	27.42	1.26	0.00	71.29
30	53H0	71	2.1338	838.1	299.093	1.401726	1788.296	49.88	7.30	0.00	42.57
30	54G8	13	3.2360	642.2	322.810	0.99756	2078.159	25.08	0.00	0.00	74.82
30	54G9	43	1.2984	824.2	261.189	2.011556	1070.176	70.01	1.55	0.00	28.26
30	54H0	60	1.4286	727.9	319.880	2.239173	1039.851	76.29	0.80	0.00	8.65
30	55G9	16	1.4525	625.6	260.312	1.792129	908.7008	72.17	2.55	0.00	25.28
30	55H0	18	2.5678	688.6	191.520	0.745864	1768.157	25.14	2.31	0.00	72.49

Table 7. Numbers (millions) of herring by age in SDs 29 and 32 (r/v Aranda 2022).

SD	Rect	0	1	2	3	4	5	6	7	8+	Total
29	47H0	2853.87	51.49	190.40	229.86	76.34	50.30	22.01	49.72	23.58	3547.59
29	48G9	1879.27	68.24	116.38	98.76	25.25	10.83	2.41	4.10	6.51	2211.75
29	48H0	860.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	860.57
29	48H1	1340.84	117.41	151.93	108.93	33.76	21.08	8.25	20.51	11.84	1814.54
29	48H2	217.98	4.53	4.74	3.28	0.58	0.36	0.09	0.35	0.19	232.10
32	48H3	328.51	9.52	107.01	53.71	58.17	30.66	6.52	27.86	29.57	651.53
32	48H4	451.18	170.82	757.28	212.92	141.27	77.61	16.28	72.92	83.36	1983.64
32	48H5	102.92	102.33	927.34	343.48	290.28	152.59	33.89	133.23	141.38	2227.44
29	49G9	141.31	168.49	224.75	171.27	57.23	32.98	13.83	31.81	23.93	865.60
32	49H5	270.42	61.91	335.32	94.83	62.51	35.87	6.95	27.01	23.06	917.87
32	49H6	250.00	22.59	126.98	43.61	32.47	18.13	3.68	17.42	14.37	529.24

Table 8. Mean weight (g) of herring by age in SDs 29 and 32 (r/v Aranda 2022).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Average (g)
29	47H0	8.07	18.03	19.58	20.62	22.00	22.63	25.14	24.59	24.48	10.59
29	48G9	4.35	16.61	18.95	20.26	22.71	21.02	34.33	22.91	27.14	6.63
29	48H0	3.89									3.89
29	48H1	4.67	15.89	18.14	20.23	23.24	23.11	25.54	25.41	25.88	8.48
29	48H2	4.19	15.98	18.06	19.34	20.23	22.35	29.97	22.68	29.47	5.04
32	48H3	7.60	14.50	19.16	20.77	22.57	23.13	22.91	23.37	31.98	14.69
32	48H4	7.21	14.20	17.65	19.71	22.66	23.24	23.27	22.97	25.40	16.34
32	48H5	6.30	14.97	18.53	20.11	22.49	22.99	23.15	23.23	25.27	19.65
29	49G9	4.09	15.87	18.34	20.34	23.07	23.10	27.57	24.81	32.18	17.19
32	49H5	6.31	14.53	17.88	19.62	22.14	25.47	22.55	22.73	24.49	15.36
32	49H6	6.02	14.28	18.12	21.05	22.41	22.59	23.09	23.29	24.36	13.27

Table 9. Total biomass (ton) of herring by age in SDs 29 and 32 (r/v Aranda 2022).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Total
29	47H0	23019	928	3728	4739	1680	1138	553	1223	577	37585
29	48G9	8175	1133	2205	2001	574	228	83	94	177	14669
29	48H0	3352	0	0	0	0	0	0	0	0	3352
29	48H1	6256	1865	2757	2204	785	487	211	521	306	15391
29	48H2	912	72	86	63	12	8	3	8	6	1170
32	48H3	2497	138	2051	1115	1313	709	149	651	946	9569
32	48H4	3253	2425	13367	4196	3201	1803	379	1675	2117	32417
32	48H5	649	1532	17182	6909	6530	3508	784	3095	3572	43761
29	49G9	578	2674	4122	3483	1321	762	381	789	770	14880
32	49H5	1708	900	5997	1861	1384	914	157	614	565	14098
32	49H6	1504	322	2301	918	728	410	85	406	350	7023

Table 10. Numbers (millions) of sprat by age and area (r/v Aranda 2022).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Total
29	47H0	515.12	102.15	397.40	185.68	99.47	59.31	35.72	29.19	81.07	1505.11
29	48G9	989.00	137.27	455.00	191.20	92.92	58.22	34.73	29.64	71.90	2059.88
29	48H0	2443.15	267.03	1058.73	453.50	222.60	129.43	66.14	56.62	165.17	4862.35
29	48H1	1305.60	290.57	932.38	398.24	197.88	109.10	61.95	52.72	153.99	3502.42
29	48H2	1573.20	553.06	1903.85	822.09	409.69	238.53	124.64	107.82	308.44	6041.32
32	48H3	316.34	201.16	1334.83	569.91	221.89	264.63	96.67	179.04	381.87	3566.35
32	48H4	244.15	168.60	1278.48	648.91	315.31	441.39	182.23	279.76	613.99	4172.83
32	48H5	28.11	74.08	443.85	246.20	119.74	179.15	71.25	108.04	247.78	1518.20
29	49G9	165.28	37.72	148.23	77.74	46.08	31.10	21.66	16.96	46.25	591.04
32	49H5	47.76	84.16	615.25	282.43	115.30	139.09	50.15	88.75	214.46	1637.34
32	49H6	16.97	33.07	357.53	248.38	147.04	224.38	93.15	128.40	308.92	1557.85
30	50G8	202.96	44.88	89.30	25.32	23.08	13.58	8.90	4.45	26.36	438.83
30	50G9	13.28	6.91	13.69	4.33	5.09	3.03	2.18	1.06	5.90	55.47
30	50H0	0.00	4.64	12.61	4.13	5.69	3.64	3.33	1.78	10.91	46.72
30	51G7	0.00	0.32	1.90	0.93	1.59	1.00	1.00	0.63	4.06	11.43
30	51G8	0.00	1.20	3.07	1.43	2.38	1.45	1.36	0.84	5.02	16.74
30	51G9	56.07	43.18	76.09	24.75	30.38	17.97	14.06	7.49	42.86	312.85
30	51H0	0.67	5.29	7.16	2.05	2.06	1.14	0.86	0.51	2.93	22.66
30	52G8	0.39	1.62	6.17	2.64	4.93	3.58	4.05	2.37	15.51	41.26
30	52G9	0.00	29.36	38.22	11.13	12.83	8.15	6.70	3.19	21.61	131.18
30	52H0	0.00	14.69	25.92	8.61	10.64	6.50	5.00	2.55	14.59	88.50
30	53G8	0.00	0.10	2.62	1.79	4.14	2.87	3.46	2.16	15.22	32.35
30	53G9	0.17	2.04	4.33	1.75	2.74	1.79	2.11	1.47	8.34	24.75
30	53H0	0.00	25.85	42.85	12.69	13.64	8.07	5.92	2.97	18.56	130.56
30	54G8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	54G9	0.00	2.11	5.86	1.79	1.88	1.11	0.81	0.45	2.57	16.57
30	54H0	0.00	1.31	2.07	0.75	0.98	0.64	0.55	0.30	1.75	8.34
30	55G9	0.00	0.88	4.12	1.81	3.11	2.01	2.06	1.24	7.95	23.18
30	55H0	0.00	12.40	12.45	3.65	3.80	2.27	1.54	0.70	4.07	40.87

Table 11.Mean weight (g) of sprat by age and area (r/v Aranda 2022).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Average (g)
29	47H0	3.75	8.76	9.88	10.43	10.87	11.16	11.93	11.70	11.40	8.06
29	48G9	3.88	8.68	9.65	10.21	10.82	11.20	12.09	11.86	11.41	7.10
29	48H0	3.36	8.95	9.73	10.24	10.76	10.94	11.72	11.41	11.31	6.72
29	48H1	3.65	8.56	9.71	10.25	10.79	10.96	11.78	11.48	11.32	7.65
29	48H2	3.32	8.69	9.74	10.27	10.77	10.99	11.74	11.45	11.28	8.31
32	48H3	3.44	8.67	9.17	9.62	10.10	10.56	10.70	10.29	10.40	9.09
32	48H4	4.26	8.81	9.29	9.89	10.39	10.81	11.29	10.71	10.85	9.73
32	48H5	3.57	8.29	9.29	9.94	10.38	10.84	11.14	10.74	10.81	9.95
29	49G9	3.97	8.53	9.94	10.65	11.15	11.54	12.17	11.97	11.84	8.74
32	49H5	4.35	8.66	9.23	9.65	10.13	10.52	10.77	10.26	10.62	9.59
32	49H6	4.71	8.60	9.50	10.10	10.54	10.86	11.31	10.83	11.10	10.35
30	50G8	4.33	10.80	12.02	12.33	12.90	13.01	13.67	14.17	14.03	8.61
30	50G9	4.84	10.67	12.07	12.55	13.20	13.36	13.78	14.00	14.01	10.69
30	50H0		11.35	12.09	12.68	13.42	13.67	14.24	14.60	14.59	13.19
30	51G7		11.35	12.70	13.12	13.51	13.72	14.44	14.71	15.46	14.14
30	51G8		10.88	12.54	13.04	13.45	13.66	14.28	14.49	15.30	13.76
30	51G9	4.64	10.75	12.04	12.57	13.24	13.39	13.95	14.32	14.44	11.24
30	51H0	4.96	10.78	11.90	12.32	12.90	13.07	13.80	14.24	15.06	12.15
30	52G8	4.10	11.21	12.36	13.00	13.75	14.02	14.62	14.91	15.07	13.97
30	52G9	0.00	10.61	11.82	12.35	13.27	13.50	14.11	14.52	14.51	12.47
30	52H0		10.58	12.07	12.58	13.28	13.44	13.95	14.22	14.26	12.65
30	53G8		12.21	12.84	13.45	13.88	14.05	14.76	15.18	15.40	14.68
30	53G9	5.42	10.78	12.35	12.85	13.46	13.74	14.60	14.91	15.17	13.73
30	53H0		10.80	11.96	12.40	13.10	13.27	13.84	14.23	14.48	12.47
30	54G8										
30	54G9		10.85	12.13	12.51	13.07	13.19	13.88	14.37	14.36	12.68
30	54H0		9.94	12.23	12.64	13.38	13.56	14.21	14.45	14.49	12.83
30	55G9		11.43	12.41	13.04	13.62	13.79	14.49	14.91	15.05	13.93
30	55H0		10.32	11.73	12.24	13.12	13.24	13.70	13.93	13.89	11.89

Table 12.Total biomass (ton) of sprat by age and area (r/v Aranda 2022).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Total
29	47H0	1933	894	3926	1937	1082	662	426	342	924	12125
29	48G9	3837	1192	4390	1951	1006	652	420	351	821	14620
29	48H0	8215	2391	10303	4644	2394	1416	775	646	1868	32653
29	48H1	4771	2487	9054	4082	2135	1195	730	605	1743	26803
29	48H2	5222	4806	18546	8445	4411	2622	1463	1235	3480	50231
32	48H3	1087	1743	12240	5482	2241	2793	1035	1843	3972	32436
32	48H4	1039	1485	11881	6415	3277	4773	2057	2997	6660	40584
32	48H5	100	614	4123	2447	1243	1942	793	1160	2679	15102
29	49G9	657	322	1474	828	514	359	264	203	548	5168
32	49H5	208	729	5682	2726	1168	1464	540	911	2277	15704
32	49H6	80	284	3396	2509	1550	2438	1054	1390	3428	16129
30	50G8	878	485	1073	312	298	177	122	63	370	3777
30	50G9	64	74	165	54	67	40	30	15	83	593
30	50H0	0	53	153	52	76	50	47	26	159	616
30	51G7	0	4	24	12	22	14	14	9	63	162
30	51G8	0	13	38	19	32	20	19	12	77	230
30	51G9	260	464	916	311	402	241	196	107	619	3517
30	51H0	3	57	85	25	27	15	12	7	44	275
30	52G8	2	18	76	34	68	50	59	35	234	577
30	52G9	0	312	452	137	170	110	94	46	313	1635
30	52H0	0	155	313	108	141	87	70	36	208	1119
30	53G8	0	1	34	24	57	40	51	33	234	475
30	53G9	1	22	54	23	37	25	31	22	126	340
30	53H0	0	279	512	157	179	107	82	42	269	1628
30	54G8	0	0	0	0	0	0	0	0	0	0
30	54G9	0	23	71	22	25	15	11	6	37	210
30	54H0	0	13	25	9	13	9	8	4	25	107
30	55G9	0	10	51	24	42	28	30	19	120	323
30	55H0	0	128	146	45	50	30	21	10	56	486

Table 13. Survey statistics for Bothnian Sea herring SD 30 calculations (StoX) in 2022.

ICES SD	ICES Rect.	NM	Area (nm²)	Sa (m²/nm²)	Herring (%)	Sprat (%)	Cod (%)	3-spinn. (%)
30	50G8	27	860.46	301.89	49.68	20.59	0.00	28.87
30	50G9	70	885.63	224.47	66.01	4.79	0.00	28.95
30	50H0	37	839.67	452.53	55.09	1.89	0.00	40.92
30	51G7	13	670.77	350.23	83.40	1.30	0.00	15.15
30	51G8	76	871.65	400.69	50.98	0.79	0.00	48.16
30	51G9	59	871.99	194.55	21.31	12.07	0.00	66.47
30	51H0	65	871.07	146.22	74.48	3.61	0.00	20.56
30	52G8	65	858.17	281.86	16.81	1.29	0.00	81.83
30	52G9	69	858.17	150.92	27.04	6.64	0.00	66.23
30	52H0	62	858.17	184.43	48.54	8.16	0.00	43.19
30	53G8	55	844.28	302.41	13.97	0.90	0.00	85.12
30	53G9	59	844.28	193.36	27.42	1.26	0.00	71.29
30	53H0	71	844.28	299.09	49.88	7.30	0.00	42.57
30	54G8	13	660.25	322.81	25.08	0.00	0.00	74.82
30	54G9	43	830.32	261.19	70.01	1.55	0.00	28.26
30	54H0	60	733.93	319.88	76.29	0.80	0.00	8.65
30	55G9	16	659.44	260.31	72.17	2.55	0.00	25.28
30	55H0	18	744.60	191.52	25.14	2.31	0.00	72.49

Table 14.Numbers (millions) of herring by age in SD 30 (r/v Aranda 2022).

Rect.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
50G8	162.60	408.38	260.91	158.82	64.28	22.69	7.56	3.78	0.00	3.78	0.00	0.00	0.00	0.00	0.00	0.00	1092.80
50G9	16.70	92.56	255.99	158.77	87.80	91.41	24.46	22.06	2.46	6.10	3.68	0.00	4.92	1.28	0.00	1.28	769.46
50H0	103.32	145.59	389.80	544.78	140.89	42.27	28.18	9.39	14.09	14.09	4.70	0.00	0.00	0.00	0.00	0.00	1437.09
51G7	0.00	23.63	78.17	272.69	112.71	7.27	14.54	30.90	1.82	5.45	0.00	1.82	0.00	0.00	0.00	0.00	549.02
51G8	0.00	32.51	105.66	469.75	211.85	99.09	92.65	59.47	23.84	9.91	12.00	8.02	1.98	4.00	2.02	4.02	1136.78
51G9	446.08	28.24	39.52	14.99	10.09	3.43	2.61	0.00	10.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	555.45
51H0	0.84	4.78	105.01	188.25	78.51	48.32	11.01	7.84	16.40	1.56	0.77	0.75	0.75	3.14	0.00	1.53	469.46
52G8	16.08	35.81	90.56	198.16	104.84	44.75	17.00	16.11	6.26	4.48	0.00	4.47	1.79	0.00	0.00	0.89	541.20
52G9	180.62	74.29	75.64	35.57	13.10	8.22	3.14	1.27	0.00	0.64	0.00	0.00	0.00	0.63	0.00	0.00	393.12
52H0	43.08	24.63	37.04	153.88	126.29	33.25	27.62	26.64	8.57	14.27	11.46	24.67	0.00	0.94	0.00	0.95	533.30
53G8	0.83	1.65	48.82	178.78	179.65	17.39	51.32	5.80	3.31	0.83	1.66	0.00	0.83	1.66	1.66	1.66	495.84
53G9	93.00	23.12	41.47	83.76	91.81	100.60	18.39	5.58	4.77	0.79	1.57	1.60	3.95	1.59	0.00	0.00	471.99
53H0	76.77	12.81	128.04	385.38	135.33	41.35	64.16	14.28	15.69	2.85	0.00	1.42	1.42	2.86	0.00	4.31	886.67
54G8	0.00	2.01	34.12	154.56	154.56	80.29	52.19	18.07	20.07	8.03	4.01	0.00	2.01	0.00	0.00	6.02	535.95
54G9	28.82	6.16	24.98	256.53	152.88	117.67	40.20	32.49	12.98	56.08	13.19	6.41	6.47	3.91	2.62	1.18	762.60
54H0	2.62	4.10	169.20	367.94	114.21	40.98	54.68	12.58	4.37	12.96	2.86	2.88	2.95	1.47	0.00	1.47	795.27
55G9	10.13	70.90	177.25	250.68	91.16	25.32	35.45	5.06	5.06	7.60	7.60	0.00	2.53	2.53	0.00	0.00	691.27
55H0	23.36	13.35	133.49	166.87	90.11	6.67	21.69	8.34	10.01	3.34	0.00	1.67	0.00	1.67	0.00	0.00	480.58

Table 15.Total biomass (ton) of herring by age in SD 30 (r/v Aranda 2022).

Rect.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
50G8	788.4	5955.6	4977.4	3135.8	1409.7	480.6	190.2	91.9	0.0	101.3	0.0	0.0	0.0	0.0	0.0	0.0	17130.9
50G9	91.8	1483.7	5149.9	3580.7	2170.4	2368.9	646.6	654.0	73.1	176.5	105.3	0.0	173.5	53.0	0.0	53.0	16780.7
50H0	1029.9	2276.8	7754.6	11608.9	3300.6	1097.5	737.3	328.3	453.7	564.0	139.0	0.0	0.0	0.0	0.0	0.0	29290.7
51G7	0.0	378.9	1518.7	5870.7	2557.8	214.2	505.4	929.1	50.0	195.4	0.0	50.0	0.0	0.0	0.0	0.0	12270.2
51G8	0.0	534.6	2085.6	10564.0	5014.0	2764.1	2650.9	1811.1	806.1	353.3	500.2	357.1	99.8	170.7	101.1	167.9	27980.6
51G9	1885.9	489.5	816.8	339.8	238.9	87.9	70.9	0.0	220.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4149.8
51H0	0.8	77.7	2131.2	4211.3	1797.4	930.0	356.5	256.5	451.7	57.2	26.9	36.5	43.6	136.6	0.0	71.3	10585.3
52G8	57.6	586.4	1965.7	4564.0	2589.8	1351.2	557.1	495.1	216.0	211.5	0.0	175.2	111.6	0.0	0.0	54.5	12935.6
52G9	781.2	1298.4	1624.0	805.9	298.0	187.2	79.8	41.8	0.0	23.3	0.0	0.0	0.0	12.4	0.0	0.0	5151.9
52H0	173.8	432.3	765.8	3263.3	3081.6	853.0	751.5	790.2	291.8	386.8	348.3	616.8	0.0	36.3	0.0	31.8	11823.2
53G8	2.5	27.3	994.6	4217.5	4454.6	512.4	1386.1	201.5	90.1	28.8	56.4	0.0	28.8	64.9	95.2	92.7	12253.4
53G9	342.6	406.1	903.9	1850.3	2208.5	2784.6	567.5	191.0	165.0	35.6	75.8	52.5	166.1	59.7	0.0	0.0	9809.1
53H0	263.6	210.0	2922.2	8315.6	3423.2	1159.5	1744.7	442.4	550.1	99.9	0.0	69.7	74.0	121.4	0.0	324.0	19720.4
54G8	0.0	35.1	680.7	3468.0	3816.7	2144.2	1453.3	603.6	515.1	257.1	145.1	0.0	99.8	0.0	0.0	273.8	13492.4
54G9	93.4	108.4	483.4	7279.3	4109.7	3263.6	1193.2	1030.5	472.3	1563.0	464.2	202.4	224.3	173.0	113.1	47.4	20821.4
54H0	11.8	60.1	3576.8	7819.3	2704.3	1167.7	1414.0	319.3	175.7	452.4	96.5	103.7	125.9	61.6	0.0	100.1	18189.2
55G9	53.2	1163.3	3609.0	5560.3	2267.8	654.3	926.8	160.8	150.9	264.6	294.5	0.0	75.5	121.5	0.0	0.0	15302.4
55H0	98.6	216.8	2671.1	3720.3	2208.8	199.7	668.8	272.7	393.8	159.0	0.0	84.8	0.0	89.3	0.0	0.0	10783.7

Table 16. Mean weight (g) of herring by age in SD 30 (r/v Aranda 2022)

Rect.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Total
50G8	4.85	14.58	19.08	19.75	21.93	21.18	25.15	24.30		26.80							15.68
50G9	5.50	16.03	20.12	22.55	24.72	25.91	26.44	29.64	29.70	28.94	28.60		35.30	41.50		41.50	21.81
50H0	9.97	15.64	19.89	21.31	23.43	25.97	26.17	34.95	32.20	40.03	29.60						20.38
51G7		16.03	19.43	21.53	22.69	29.45	34.75	30.06	27.50	35.83		27.50					22.35
51G8		16.45	19.74	22.49	23.67	27.89	28.61	30.45	33.81	35.64	41.68	44.53	50.50	42.70	50.00	41.74	24.61
51G9	4.23	17.33	20.67	22.66	23.69	25.63	27.13		21.00								7.47
51H0	1.00	16.23	20.30	22.37	22.89	19.25	32.38	32.72	27.55	36.75	34.80	48.50	58.00	43.45		46.74	22.55
52G8	3.58	16.38	21.71	23.03	24.70	30.19	32.77	30.73	34.50	47.26		39.16	62.25			61.00	23.90
52G9	4.33	17.48	21.47	22.66	22.75	22.78	25.42	32.80		36.50				19.50			13.10
52H0	4.04	17.55	20.67	21.21	24.40	25.65	27.21	29.66	34.04	27.11	30.40	25.00		38.80		33.30	22.17
53G8	3.00	16.50	20.37	23.59	24.80	29.46	27.01	34.76	27.20	34.80	34.05		34.80	39.15	57.50	56.00	24.71
53G9	3.68	17.56	21.80	22.09	24.06	27.68	30.87	34.23	34.62	45.30	48.15	32.90	42.02	37.65			20.78
53H0	3.43	16.40	22.82	21.58	25.29	28.04	27.19	30.98	35.06	35.10		49.00	52.00	42.50		75.17	22.24
54G8		17.50	19.95	22.44	24.69	26.71	27.85	33.41	25.66	32.03	36.15		49.70			45.47	25.17
54G9	3.24	17.58	19.36	28.38	26.88	27.74	29.68	31.72	36.38	27.87	35.19	31.56	34.64	44.20	43.15	40.00	27.30
54H0	4.50	14.67	21.14	21.25	23.68	28.49	25.86	25.39	40.17	34.91	33.70	36.00	42.75	41.80		68.00	22.87
55G9	5.25	16.41	20.36	22.18	24.88	25.84	26.14	31.75	29.80	34.83	38.77		29.80	48.00			22.14
55H0	4.22	16.24	20.01	22.30	24.51	29.93	30.83	32.68	39.33	47.65		50.80		53.50			22.44

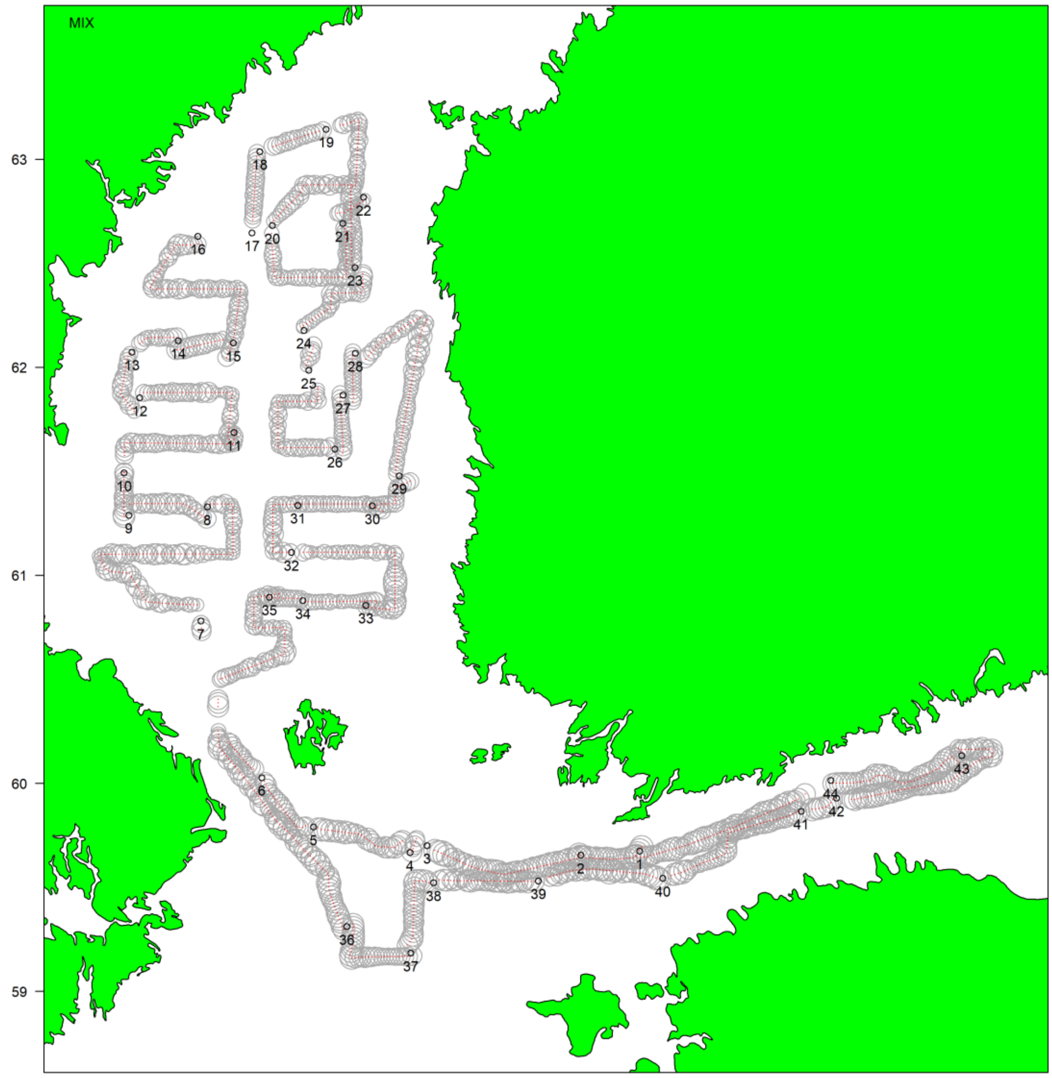

Figure 1. Cruise track and trawl stations of r/v Aranda during the Finnish BIAS-survey in 2022.

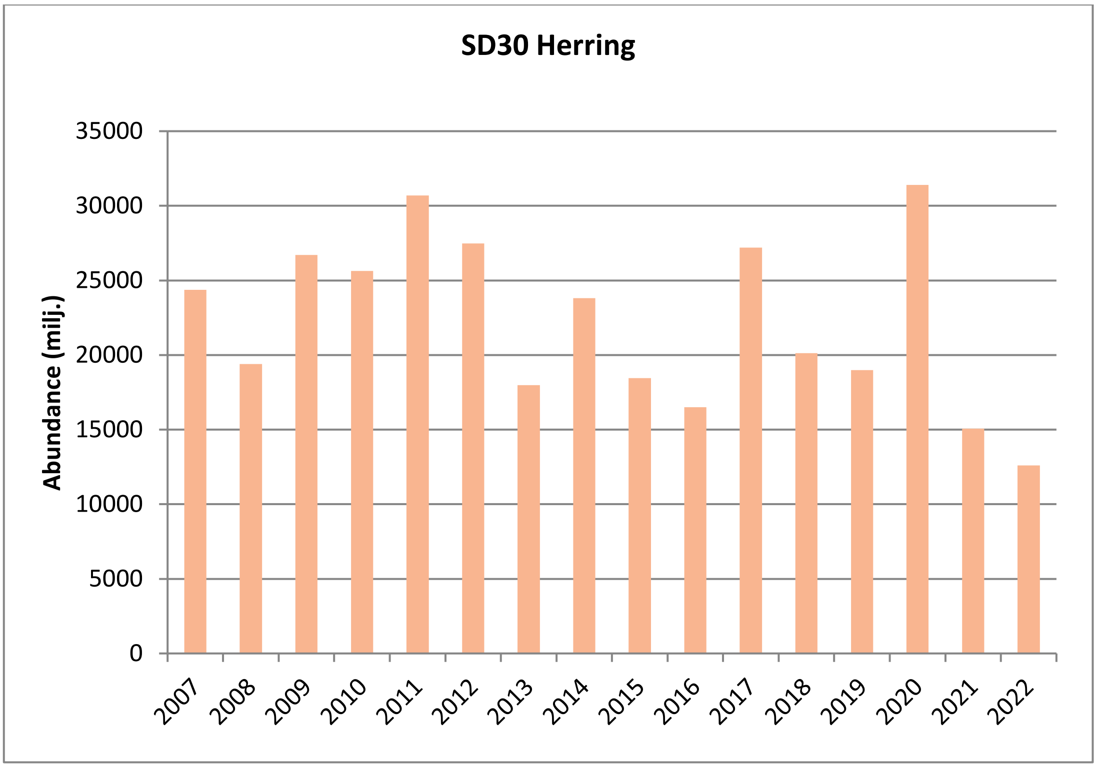

Figure 2. Abundance of herring in SD 30 from 2007 to 2022 with StoX calculations.

Federal Research Institute for Rural Areas,
Forestry and Fisheries

Thünen Institute of Sea Fisheries (Thünen-SF)[1]
Thünen Institute of Baltic Sea Fisheries (Thünen-OF)[2]

Survey Report FRV “Solea” SB812

German Acoustic Autumn Survey (GERAS)

05.10.-24.10.2022

Matthias Schaber[1] & Stefanie Haase[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 35th 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 SB812:

- 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 as planned in all of the covered ICES Subdivisions.

Altogether, 1208 nautical miles of hydroacoustic transects (plus 175 nmi daytime/repeat 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 49 fishery hauls were conducted. Vertical hydrography profiles were measured on 74 stations.

In all subdivisions covered, mean NASC values per nautical mile per ICES statistical rectangle were mostly either distinctly lower or distinctly higher than the values measured in 2021. Compared to the long-time survey mean since 1991, mean NASC values were lower in 21 out of 28 rectangles covered. On ICES subdivision scale, mean NASC values were overall distinctly higher than in the previous year in subdivisions 21 and 22, while in SD 23 and 24 lower mean NASC values were recorded.

2. SURVEY DESCRIPTION & METHODS APPLIED

2.1 Cruise narrative

The 812th cruise of FRV "Solea" represents the 35th 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 took place on October 5th in Kiel port, when also a calibration of the echosounders had been planned but had to be postponed. On October 6th, survey operations commenced in SD 22 (Belt Sea). After covering some sections of the southwestern area of SD 22 and the northeastern transects in this subdivision, survey operations commenced in SD 24 (Arkona Sea) on October 9th, with that SD fully covered on October 13th. On October 14th and 15th, the remaining transect sections in the southwestern part of SD 22 were accomplished before FRV "Solea" entered Kiel port for a short cruise break (exchange of scientific crew members) on October 16th. Later that day, the calibration of the echosounders used during the survey took place in Strande Bay. Afterwards, FRV "Solea" continued to SD 23 (the Sound), which was sampled several times during regular night transects (17. & 22.10.) as well as for comparison during daytime (18. & 23.10.). Subdivision 21 (Kattegat) was covered from Oct 18th-21st. Survey operations in SD 21 had to be interrupted for 0.5 nights due to inclement weather, which did not restrict full coverage of the transects in that SD. After accomplishing all planned transects in all SDs, another daytime comparison was conducted in SD 23. FRV "Solea" returned to Rostock harbor, where the survey ended after unloading of the scientific equipment and samples on October 25th.

Altogether, the following survey schedule was accomplished:

Belt Sea	(SD 22)	6.- 8.10. & 14.-15.10.
Arkona Sea	(SD 24)	9.-13.10.
Sound	(SD 23)	17. & 22.10. (23.10.)
Kattegat	(SD 21)	18. - 21.10.

Total survey time	16 nights (incl. 0.5 days loss due to bad weather)
Fishery hauls	49
CTD-casts	74
Hydroacoustic transects	1208 nmi (+ 175 nmi daytime/ repeated 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 covered regular cruise track length was 1208 nautical miles (2021: 1124 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 13 software (Echoview Software Pty Ltd, 2022). Mean volume backscattering values (S_v) were integrated over 1 nmi intervals from 10 m below the surface to ca. 0.5 m over the seafloor (NASC - Nautical Area Scattering Coefficient). Interferences from surface turbulence, bottom structures and scattering layers were removed from the echogram. In post-processing, no species-specific NASC values were allocated to echo registrations, but a MIX category was used for the combined acoustic backscatter per EDSU. 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 in CW and FM mode from a drifting vessel in Strande Bay (54°26.30 N, 10°11.85 E) on October 16th. Overall calibration results were considered very 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 provided 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 net monitoring sensor 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. Trawling time usually was set to 30 minutes but was shortened when echograms and monitoring sensors indicated large catches. To validate and allocate echorecordings, altogether 49 fishery hauls were conducted (Figure 1). From each haul sub-samples were taken to determine length and weight of fishes. Samples of herring, sprat, sardine and anchovy were frozen for additional investigations (e.g. determining sex, maturity, age).

2.6 Hydrographic data

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, 74 CTD casts were conducted during this survey (Figure 6).

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, an aggregated acoustic category MIX was allocated to the hydroacoustic registrations. The species composition allocated to the MIX category and used for disaggregating NASC measurements to species level 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 2020-2022 support the applicability of the SF (Oeberst et al., 2013; Oeberst et al., 2014, 2015, 2016, 2017; Gröhsler and Schaber, 2018, 2019, 2021, 2022, Haase and Schaber, 2023).

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 2022. In general, the majority of these NASC measurements can be allocated to clupeids. Altogether, 28 ICES statistical rectangles were covered in the survey 2022 (25 in 2020). In the rectangles covered in both years, the mean NASC in 2022 was higher than in 2020 (partly significantly) in 14 rectangles. In three rectangles the mean NASC was in the range of 2021. In the 8 other rectangles, mean NASC values were partly well below the already low values measured in 2021. Compared with the long-term survey mean (1991-2021), the mean NASC measured in 2022 was again lower in 21 out of 28 rectangles. On ICES subdivision scale, mean NASC values were overall distinctly higher than in the previous year in subdivisions 21 (Kattegat) and 22 (Belt Sea), while in SD 23 (the Sound) and 24 (Arkona Sea) lower mean NASC values were recorded.

In the rectangles of SD 21 covered both in 2022 and 2021, overall NASC values measured were higher than those measured in the previous year along the Swedish coast of the Kattegat (41G2, 42G2) and in the central Kattegat (42G1). In the southern Kattegat, the mean NASC per 1 nmi EDSU measured was slightly higher (41G0) or distinctly lower (41G1) than the values measured in the previous year. The three rectangles in the northern Kattegat not covered in 2021 showed lower NASC values than the long-term survey average. In general, aggregations of clupeids were mostly observed in the central and northern parts of the SD 21 survey area and along the Swedish coast.

In SD 22, the mean overall NASC values recorded were higher than in the previous years in 10 out of 11 rectangles surveyed. Highest increases were recorded in Kiel Bight (38G0), the western parts of that subdivision (39F9), in areas north of the Belt Sea adjacent to the Kattegat (40G0) as well as in the Belts (39G0, 39G1).

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 2022 to the extent observed prior to 2016. NASC values in rectangles 39G2 and 40G2 were again below the survey mean, but in the range of (40G2) or distinctly higher (39G2) than in 2021. Once again, a massive aggregation of herring was detected in rectangle 41G2 located at the narrow isthmus in the northern Sound. In the remaining areas of the rectangle, only very low NASC values were recorded.

In SD 24, mean NASC values were comparable (1) or distinctly lower (7) than the levels measured in the previous year in 8 out of 9 rectangles. Only in 37G3 (east of Rügen Island), the mean NASC values per rectangle were higher than the values measured in 2021. Mean NASC values were lower than the long-term survey average (1991-2021) in all rectangles covered in SD 24. Notable aggregations were detected around Rügen Island, the southeastern Arkona Sea bordering the Bornholm Basin (38G4) and in Faxe Bugt (39G2).

3.2 Biological data (S. Haase)

Fishery hauls according to ICES Subdivision (Figure 1):

SD	Hauls (n)
21	12
22	16
23	5
24	16

Altogether, 1 399 individual herring, 781 sprat, 352 European anchovies and 60 sardines were frozen for further investigations (e.g. determining sex, maturity, age). Results of catch compositions by Subdivision are presented in Tables 1-4. Altogether, 27 different fish species were recorded. Out of 49 hauls in total, herring were caught in 47, sprat in 42, anchovies in 39 and sardines in 5. Again, SD 23 showed amongst the highest mean herring catch rate per station (kg 0.5 h^{-1}) in the data series, which however was only caused by one exceptionally large haul in the northern part of the Sound (Haul 33). Similar to previous years, anchovies (*Engraulis encrasicolus*) were present in most parts of the survey area except from the Sound (SD 23). Sardines (*Sardina pilchardus*) were only present in catches from SD 21, albeit in low numbers. Figure 3 depicts a representation of the standardized clupeid catch per haul.

Altogether, the following fish species were sampled and processed:

Species	Length measurements (n)	Prevalence (n of hauls)
Aphia minuta	591	27
Belone belone	12	9
Clupea harengus	8 578	47
Engraulis encrasicolus	2 771	39
Gadus morhua	95	24
Gasterosteus aculeatus	899	30
Limanda limanda	24	13
Merlangius merlangus	448	33
Platichthys flesus	26	11
Pleuronectes platessa	12	7
Pomatoschistus minutus	396	28
Sardina pilchardus	83	5
Scomber scombrus	5 081	25
Sprattus sprattus	6 308	42
Squalus acanthias	53	2
Trachinus draco	228	13
Trachurus trachurus	169	28
Others	124	-

Figure 4 shows the relative length-frequency distributions of herring and sprat in ICES subdivisions 21, 22, 23 and 24 for the years 2021 and 2022. Compared to results from the previous survey in 2021, the following conclusions for **herring** can be drawn:

- In 2022 catches in SD 21 were dominated by the incoming year class at 12-17 cm length with a mode at 15 cm and only low contributions of larger herring. This is in contrast to 2021, when catches in SD 21 were dominated by herring >15 cm with a mode at 18.75 cm and minor contributions of the incoming year class (ca. ≤15 cm).
- As in the previous year, catches in SD 22 were dominated by the incoming year class (ca. ≤15 cm), but with somewhat higher contributions of small herring <10 cm.
- In SD 23 a significant contribution of herring >20 cm was again recorded. Catches showed a mode at ca. 26.75 cm (2021: 26.25 cm). Other than in the previous year, minor contributions

of very small herring (mode at ca. 7 cm) and the incoming year class (mode at ca. 15 cm) were registered.
- In 2022, catches in SD 24 showed a bimodal distribution with modes at ca. 13 cm and 18 cm, whereas catches in the previous year were characterized by a trimodal distribution with modes at 9.25 cm, 13.25-14.25 cm and 17.25 cm, with also lower contributions of fishes <15 cm than in 2022. Both in 2022 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 2021 and 2022 (Figure 4) can be characterized as follows:

- In SD 21 the incoming year class (ca. ≤10 cm) had virtually been absent from catches in 2021. In contrast, some contribution of this year class was observed in in 2022. However, both in 2021 and in 2022 catches in SD 21 were dominated by larger sprat (mode at ca. 13 cm in 2022).
- In 2021, catches in SD 22 had shown a tri-modal distribution with contributions 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) and a general length range of ca. 7.5-15 cm with only minor contributions of smaller fish. This is contrast to the results of 2022, when catches showed a unimodal distribution indicating an exclusive contribution of the incoming year class (ca. ≤10 cm) with a mode at ca. 8.5 cm and virtually no sprat measured >10.5 cm.
- In SD 23, catches of sprat resembled the observations made in 2021 with catches dominated by larger fish (>10 cm) at a mode of ca. 14.25 cm. Other than in 2021, a low but distinct contribution of the incoming year class was observed in 2022.
- In SD 24, catches of sprat also highly resembled the observations made in 2021 and showed a bimodal distribution with a distinct contribution of the incoming year class (ca. ≤10 cm, mode at 8.75 cm) and also a notable contribution of larger, older sprat (>10 cm, mode at ca. 12.75 cm).
- Altogether, the contribution of the incoming year class (ca. ≤10 cm) seemed to be higher than in 2021 and 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*)
Haddock	(*Melanogrammus aeglefinus*)
Whiting	(*Merlangius merlangus*)
European hake	(*Merluccius merluccius*)
Sardine	(*Sardina pilchardus*)
Mackerel	(*Scomber scombrus*)
Sprat	(*Sprattus sprattus*)
Greater weever	(*Trachinus draco*)
Norway pout	(*Trisopterus esmarki*)

Exclusion of trawl hauls with very low catches:

Haul No.	Rectangle	Subdivision (SD)
4	40G0	22
10	39G2	24
11	39G3	24
24	38G3	24
45	41G2	21
49	41G2	23

Usage of neighboring trawl information for rectangles which contain only acoustic investigations:

Rectangle/SD to be filled	with Haul No.	of Rectangle/SD
43G2/21	42, 43	43G1/21, 43G2/21
39F9/22	2, 3	39G0/22, 40F9/22
41G2/21	36	41G1/21
38G0/22	30	37G0/22
39G1/22	8	39G0/22

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 2022 indicated only minor contribution of fish of CBH origin. The SF was only applied in SD 24.

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 2022. Due to a minor degree of mixing of CBH/WBSSH in SDs 21, 22 and 23, results showed applying the SF for splitting of WBSSH and CBH stocks was feasible (Haase & Schaber, 2023).

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 3.3 x 10^9 fish (Table 7) or 86.1 x 10^3 tons (Table 9). For Subdivisions 22-24 the number of herring was calculated at 2.2 x 10^9 fish or 61.6 x 10^3 tons.

3.4.2 Herring excl. Central Baltic Herring (CBH) & incl./excl. large herring accumulation in SD 23

Abundance and biomass indices of herring excluding CBH in SDs 21-24 by age group and SD/rectangle are provided in tables 13-15.

Removal of the CBH fraction in SD 24 yielded the following results:

Abundance (mio)	incl. CBH	excl. CBH in SD24
SDs 21-24	3 257.6	2 822.9
Percentage of Total Difference	100.0%	86.7% - 13.3%
Biomass (mt)	incl. CBH	excl. CBH in SD24

SDs 21-24	86 116.6	69 670.9
Percentage of Total Difference	100.0%	80.9% -19.1%

Removal of the CBH fraction in SD 24 from the herring HAWG-GERAS index of the standard area (excluding 43G1/43G2 in SD 21 and 37G3/37G4 in SD 24) in 2022 resulted in biomass reductions of 19 % with corresponding reductions in numbers of 13 % (2021: -53% and 55%, 2020: - 37 % and -27 %, 2019: -36 % and -24 %, 2018: -20 % and -11 %, respectively (Figure 6).

Estimated resulting abundance and biomass estimates of herring excluding CBH in SDs 21-24 by age group and SD/rectangle as well as excluding the large aggregation of (presumed) North Sea herring (see below) for 2022 are given in Tables 16-18.

Removal of the CBH fraction in SD 24 as well as the presumed NSAS in rectangle 41G2/SD 23 yielded the following results:

Abundance (mio)	incl. CBH	excl. CBH in SD24 and excl. 41G2/SD23
SDs 21-24	3 257.6	2 744.9
Percentage of Total Difference	100.0%	84.3% - 15.7%
Biomass (mt)	incl. CBH	excl. CBH in SD24 and excl. 41G2/SD23
SDs 21-24	86 116.6	58 140.7
Percentage of Total Difference	100.0%	67.5% -32.5%

Removal of the CBH fraction in SD 24 as well as the presumed NSAS herring fraction from rectangle 41G2 in SD 23 from the herring HAWG-GERAS index of the standard area (excluding 43G1/43G2 in SD 21 and 37G3/37G4 in SD 24) in 2022 resulted in biomass reductions of 33 % with corresponding reductions in numbers of 16 %.

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 4.0 x 10^9 fish (Table 10) or 31.9 x 10^3 tons (Table 12). For the included area of Subdivisions 22-24 the number of sprat was calculated at 3.9 x 10^9 fish or 29.7 x 10^3 tons. The overall abundance estimate in 2022 was dominated by zero and three year old sprat (Figure 4 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, 74 CTD casts were conducted during this survey (Figure 7).

Surface temperatures were higher than in the previous year in some areas, ranging from > 12°C in the central Kattegat area (SD 21) to 14°C, and partly higher in the southwestern parts of the survey area

(SD 22) and the Arkona Sea (SD 24). In general, surface temperatures were highest 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 (~ 8°C). The deeper parts of the Sound and the Kattegat were comparatively warm with temperatures around 12°C. Temperatures near the seafloor were generally higher in the shallow areas of SD 21-24, but 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 > 25 PSU in the Kattegat). Surface salinities in the western parts of the survey area were comparable to the values recorded in the previous year and exceeded 15 PSU south of the Belt Sea. Salinity near the seafloor ranged from 8 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 as well as in the deep parts of the southeastern Arkona Sea (Bornholm Basin area). 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 distinct increase in abundance and stock biomass (in the standard area covered in both 2021 and 2022):

Herring (incl. CBH)	Difference compared to 2021	
Area	Numbers (%)	Biomass (%)
Subdivisions 21-24	+79	+39

The present results **incl. CBH** are mainly driven by a far higher contribution of the 0-group (+461% in numbers and +714% in biomass).

The present estimates of herring **excl. CBH** and excl. the large haul in 41G2/SD23 show a significant increase in stock biomass and abundance (in the standard area covered in both 2021 and 2022):

Herring (excl. CBH)	Difference compared to 2020	
Area	Numbers (%)	Biomass (%)
Subdivisions 21-24	+231	+98

The high number of 0-group herring together with the exclusion of a large part of 1-8+ years old CBH in the main mixing area of SD 24 (by applying SF) lead to the overall significant increase in stock biomass and abundance values (**excl. CBH** and excl. Rectangle 41G2/SD23) compared to 2021.

The application of the Separation Function (SF) to remove CBH from the index calculation again yielded robust results (Haase & Schaber, 2023 WD). Estimates of parameters of the Bertalanffy-Growth-Function (BGF) in 2022 showed a decreasing trend compared to the period 2005-2010 which can be explained by a distinctly lower contribution of older/larger herring in 2022. 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.

After over 6 years of consecutive decline, the present Western Spring Spawning Herring biomass estimate (HAWG-GERAS Index) in 2022 showed a distinct increase from the lowest recorded value in the time series in 2021 (Figure 7). This trend, however, is strongly driven by the large increase of 0-group herring.

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 2022, after several years of supposed absence, some of those fishes were present in catches from the Sound again for the third year in a row since 2020. 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, 2022) 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 again detected during a 2022 parallel survey of the inner Sound transect with FRV "Solea" and FRV "Clupea", when some large - assumed clupeid- aggregations were detected in shallower areas of SD 23 off the regular transects covered during GERAS (analysis of parallel survey CLU370 with FRV "Clupea" pending). However, the presence of large aggregations in areas not covered by the regular GERAS transects alone is not indicative of a potential shift, since herring may regularly be distributed in that regions and also have been so during years with large aggregations detected on the acoustic transects as well.

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 2022, 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 statistical rectangle 41G2 in SD 23, in the "isthmus" of the Sound between Helsingör and Helsingborg, again a large aggregation of fish was recorded on the echosounder along a ridge in less than 20 m depth. A similarly large and smaller aggregations had been recorded at the same position in 2021 and the years before, respectively. Due to navigational constraints as well as the difficult bathymetry, no targeted trawl haul could be conducted on this aggregation before 2021. 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 yielded a large amount of large herring that were all spawning (maturity 6). Genetic analysis revealed that this aggregation consisted of North Sea autumn spawning herring (NSAS). 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 in 2021. In 2022, herring sampled from that large aggregation were already finished with spawning. Accordingly, it was assumed that these again were North Sea autumn spawning herring. Genetic analysis for the 2022 samples is still ongoing. However, to indicate the effect of that large school (and associated NASC values) on the survey estimates, abundance and biomass indices for WBSSH were estimated including and excluding NASC values of this accumulation and the corresponding haul. Removing the presumed NSAS fraction from the WBSSH estimates resulted in a 3% reduction in total abundance and a 17% reduction in total biomass. However, both indices of WBSSH, i.e. those including the presumed NSAS fraction and those with the presumed NSAS fraction removed, were significantly higher than the estimates for the previous years - largely driven by the increase in 0-group herring, which however are considered not to be representatively sampled/contained within the survey area and show large interannual variation in abundance.

5. SURVEY PARTICIPANTS

Name	Function	Institute
Dr. M. Schaber (16.-24.10.)	Cruise Leader (Hydroacoustics, Hydrography)	TI-SF
L. Hartkens (5.-16.10.)	Cruise Leader (Hydroacoustics, Hydrography)	TI-SF
Dr. S. Gastauer (16.-24.10.)	Hydroacoustics, Hydrography	TI-SF
A. Georgi	Fishery biology	TI-OF
M. Koth	Fishery biology	TI-OF
N. Lyse (5.-16.10.)	Fishery biology	DTU-Aqua (DK)
S. Niemann (16.-24.10.)	Fishery biology	TI-OF
K. Paetz (5.-16.10.)	Fishery biology	TI-SF
J. Plewka (16.-24.10.)	Fishery biology	TI-SF
J. Stounberg (16.-24.10.)	Fishery biology	DTU-Aqua (DK)

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7. FIGURES

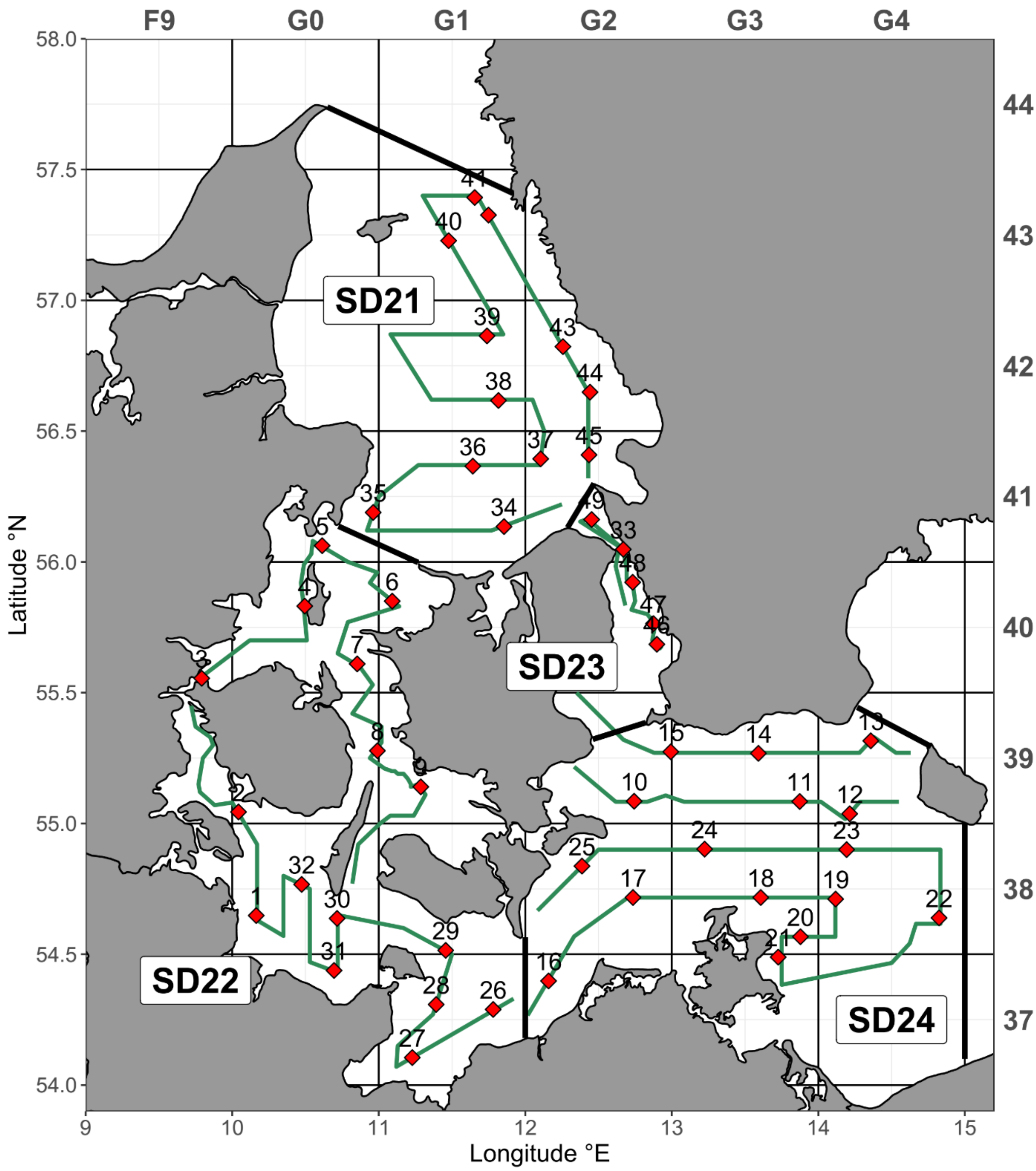

Figure 1: FRV "Solea" cruise 812/2022. Cruise track (dark green lines) and fishery hauls (red diamonds). ICES statistical rectangles are indicated in the top and right axis. Thick black lines separate ICES subdivisions (SD).

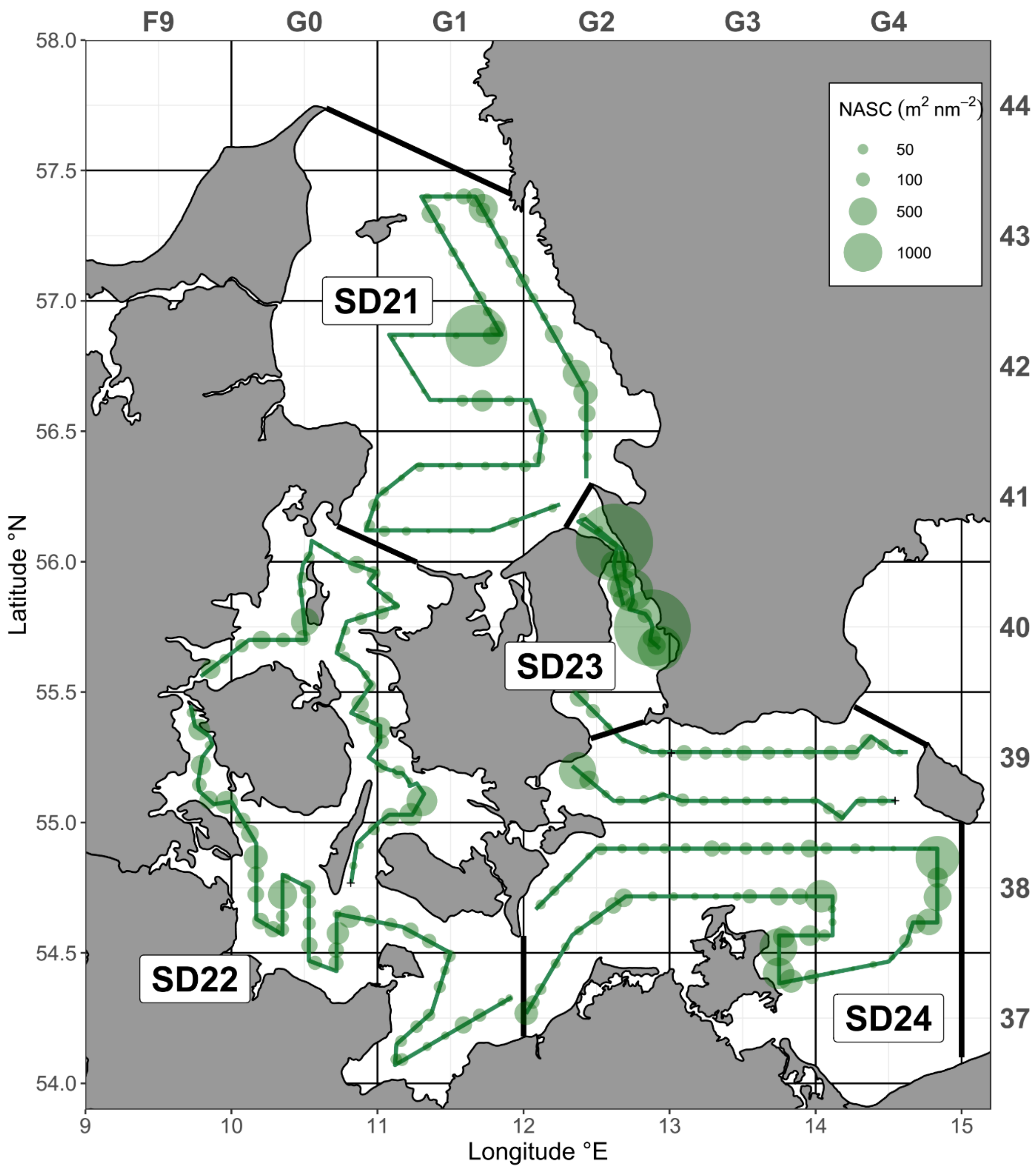

Figure 2: FRV "Solea" cruise 812/2022. Cruise track (thin grey lines) and mean NASC (5 nmi intervals, dots). ICES statistical rectangles are indicated in the top and right axis. Thick black lines separate ICES subdivisions. Note the large NASC value measured in 41G2 (SD 23) which was both included and excluded from the WBSSH estimates (see results).

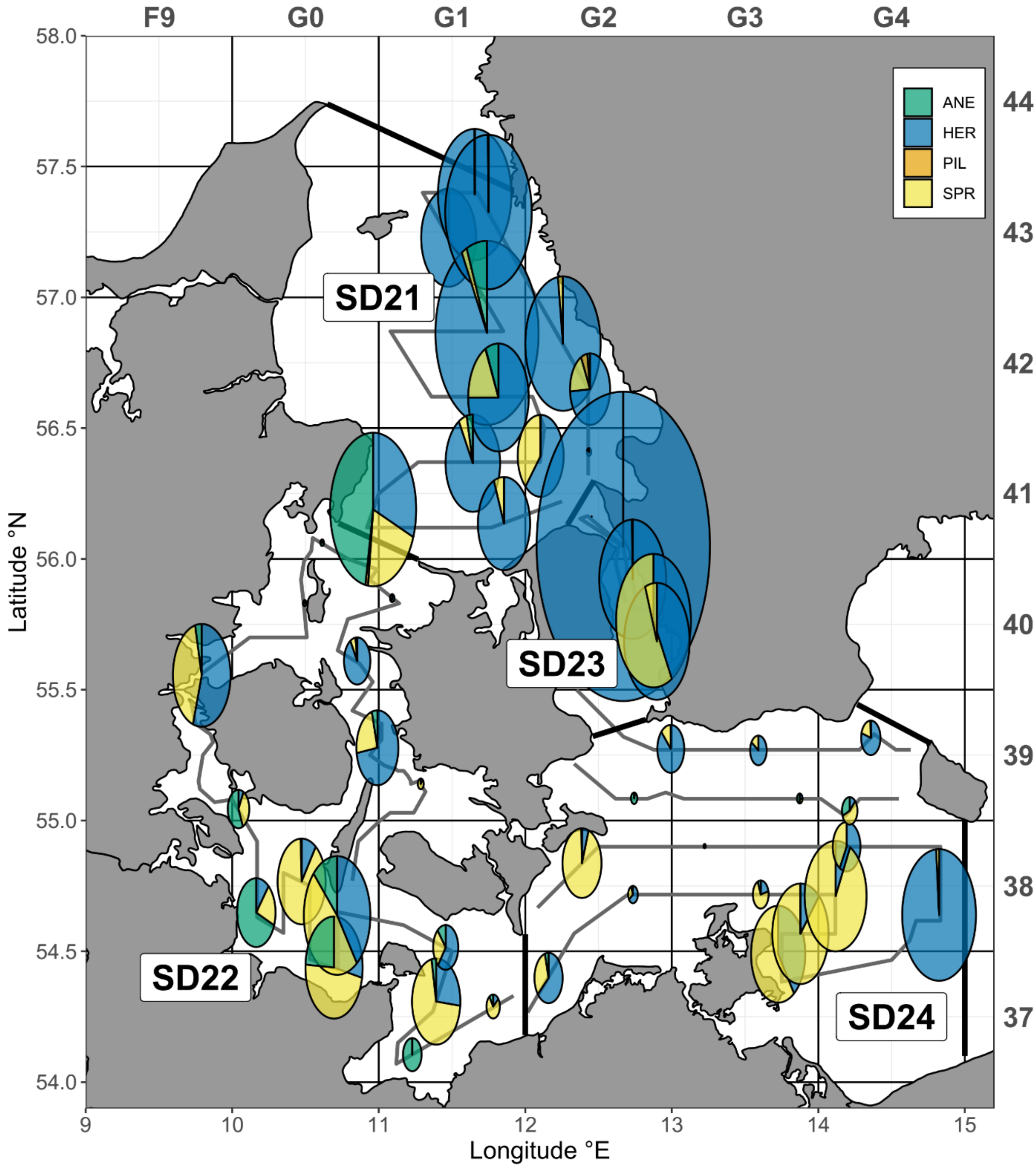

Figure 3: FRV "Solea" cruise 812/2022. Clupeid catch per haul (kg 30min[-1]). ANE = European anchovy (*Engraulis encrasicolus*), HER = Herring (*Clupea harengus*), PIL = Sardine (*Sardina pilchardus*), SPR = Sprat (*Sprattus sprattus*). ICES statistical rectangles are indicated in the top and right axis. Thick black lines separate ICES subdivisions. Thin grey lines indicate cruise track.

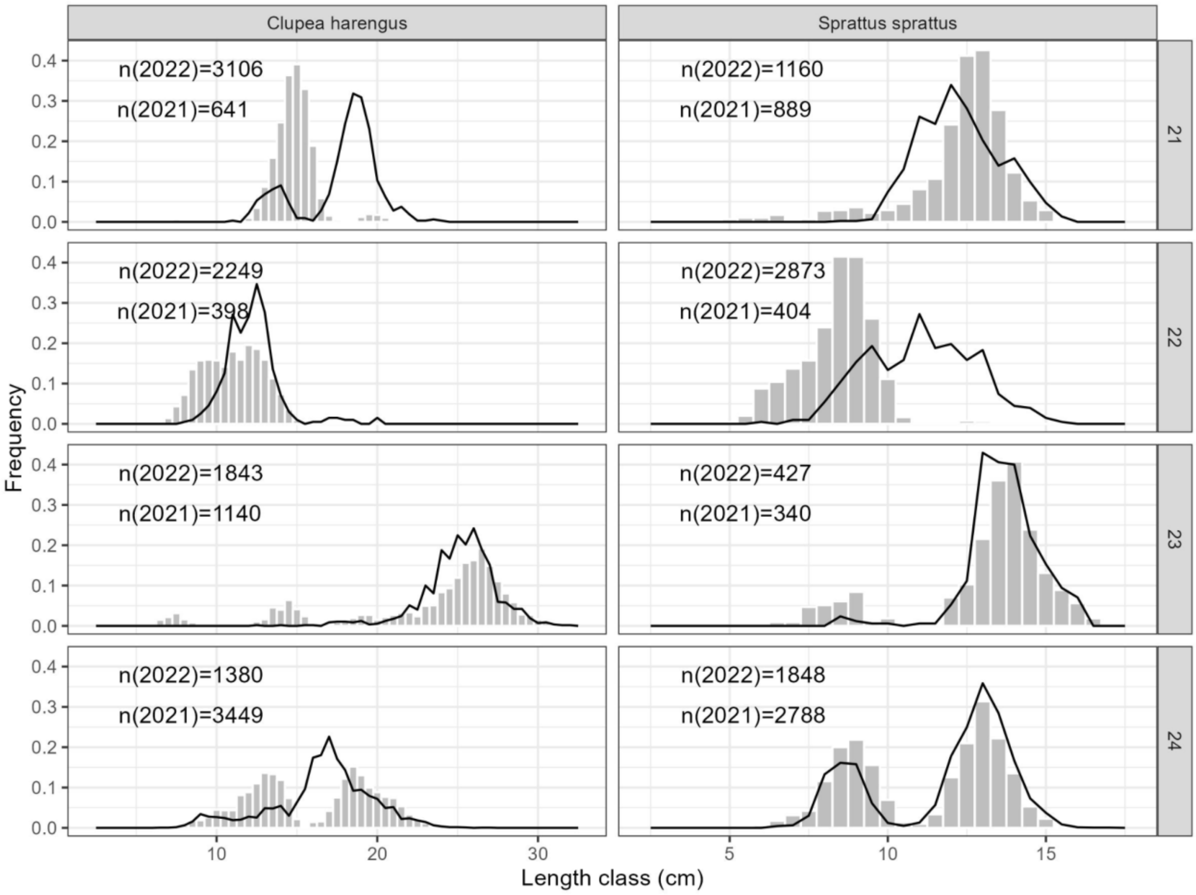

Figure 4: FRV "Solea" cruise 812/2022. Herring (Clupea harengus, left) and sprat (Sprattus sprattus, right) length-frequency distribution (bars) compared to the previous year (cruise 798/2021, lines).

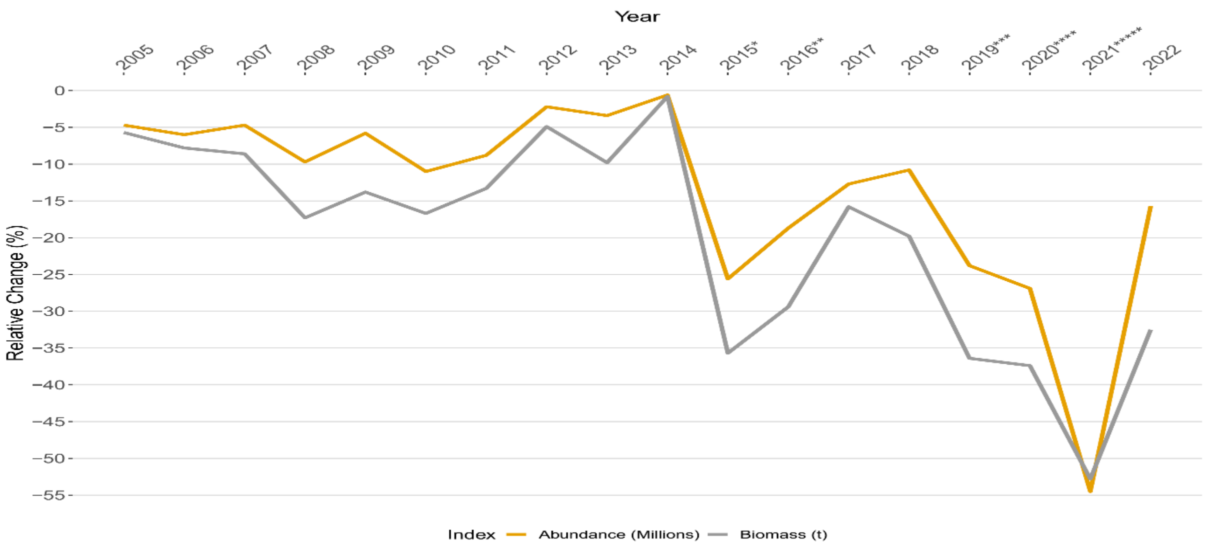

Figure 5: Relative changes in abundance and biomass of Western Baltic Spring Spawning herring in ICES Subdivisions 21-24 (2005-2022) after application of the stock Separation Function (SF, Gröhsler et al., 2013) to the abundance and biomass index generated from German acoustic survey data. In 2022, exclusion comprised CBH in SD 24 as well as rectangle 41G2 in SD 23 (haul 33). **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.

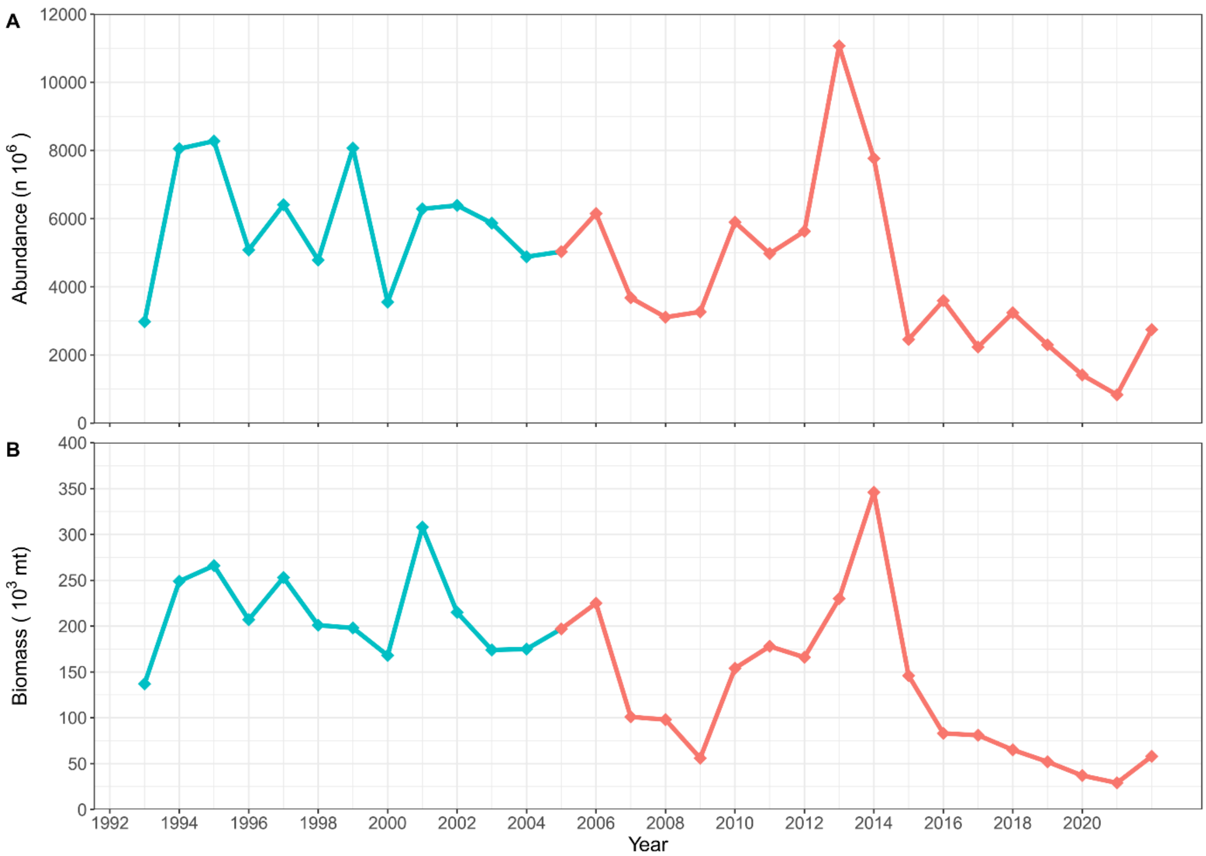

Figure 6: HAWG time series of GERAS survey indices for Western Baltic Spring Spawning Herring (WBSSH) age groups 0-8$^+$. A) Abundance and B) Biomass of herring in ICES Subdivisions 21 (Southern Kattegat, ICES statistical rectangles 41G0 - 42G2) – 24 (excl. ICES statistical rectangles 37G3 & 37G4). Blue line (until 2005): WBSSH including Central Baltic Herring fraction; Red line (from 2005): WBSSH after application of Separation Function (SF).

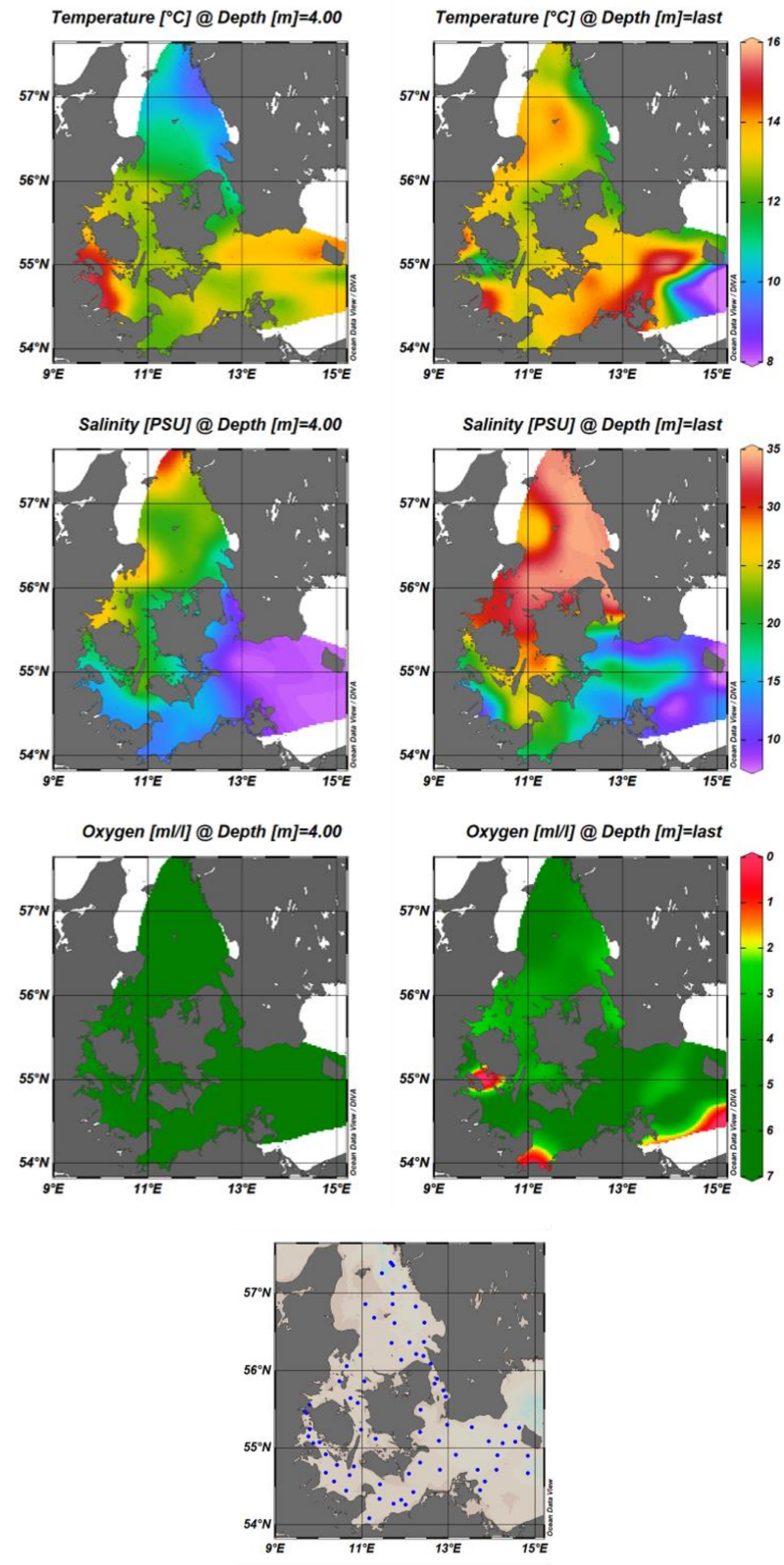

Figure 7: FRV "Solea" cruise 812/2022: Hydrography. CTD stations are depicted as blue dots in the area map. Temperature (°C, top panels), salinity (PSU, middle panels and oxygen concentration (ml/l, lower panels) at the surface (left) and near the seafloor (right). Station overview below surface plots.

8. TABLES

Table 1: FRV "Solea" cruise 812/2022: Simrad EK80 calibration report (38 kHz Transducer).

Date:	16.10.2022		
Calibration Site:	Kiel Bight/ Strande Bay (54°26.30 N, 10°11.85 E)		
Transceiver Type:	WBT		
Software Version:	EK80 21.15.1.0		
Reference Target:	Tungsten (WC-Co) 38.1 mm		
Transducer:	ES38-7 Serial No. 147		
Frequency:	38000 Hz	Beamtype:	Split/Narrow
Depth:	4.20 m		
Pulse Duration:	1.024 ms		
Power:	2000 W		
TS Detection:			
Min. Value:	-50.0 dB	Min. Spacing:	0.0
Mx. Gain Comp.:	3.0 dB	Min. Echolength:	0.8
Max. Echolength:	1.8		
Environment:			
Absorption Coeff.:	0.005521	Sound Velocity:	1487.06m/s
Temperature:	14.4 °C	Salinity:	20.0 PSU
Calibration results:			
Transducer Gain:	26.91 dB	SaCorrection:	-0.0562 dB
Beamwidth Athw.:	6.52 deg	Beamwidth Along.:	6.50 deg
Offset Athw.:	0.08 deg	Offset Along.:	-0.13 deg
RMS-Error:	0.07		

Table 2: FRV "Solea" cruise 812/2022: Catch composition (kg 0.5 h^{-1}) by haul in SD 21 (+ = <0.01 kg).

Haul No.	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Species/ICES Rectangle	**41G1**	**41G0**	**41G1**	**41G2**	**42G1**	**42G1**	**43G1**	**43G1**	**43G1**	**42G2**	**42G2**	**41G2**
APHIA MINUTA		0.01	+	0.49	0.02					0.48	0.28	+
CLUPEA HARENGUS	19.38	48.96	21.83	8.59	25.72	399.60	24.49	74.88	243.81	81.80	7.09	0.24
ENGRAULIS ENCRASICOLUS	0.01	74.34	0.86	0.03	2.39	28.09		0.02	0.37	+	0.21	0.02
EUTRIGLA GURNARDUS		0.003		+	+		0.05	+				+
GADUS MORHUA		0.06			0.02							
GASTEROSTEUS ACULEATUS	+	0.01			0.01							
LIMANDA LIMANDA		0.20	0.05					0.09			0.30	
MELANOGRAMMUS AEGLEFINUS							0.03	0.21				
MERLANGIUS MERLANGUS	0.30	0.43	0.20	0.03	1.35	0.63	0.25	0.82	0.95	0.38	1.08	0.06
MERLUCCIUS MERLUCCIUS							0.23		0.16	0.11		
PLEURONECTES PLATESSA		0.95										
POMATOSCHISTUS MINUTUS	+	+			0.01	+	+			+	+	+
SARDINA PILCHARDUS		1.54			0.06					0.02	0.50	0.01
SCOMBER SCOMBRUS	0.20	2.42	7.90	8.65	0.64	10.02	0.04	0.93	0.38	2.93	0.60	0.04
SPRATTUS SPRATTUS	1.03	33.21	1.18	5.35	6.14	7.29		0.00	0.04	1.74	1.79	0.03
SQUALUS ACANTHIAS							1.11		764.24			
TRACHINUS DRACO	25.20		3.40		2.63	0.54	0.04	0.16	0.18	0.34	0.07	0.12
TRACHURUS TRACHURUS	0.07	0.08	0.03		0.04	0.03	0.01	0.02	0.083	0.01	0.06	0.03
TRISOPTERUS ESMARKI							0.04	0.60	0.04			
Total	**46.20**	**162.22**	**35.45**	**23.13**	**39.03**	**446.20**	**26.28**	**77.73**	**1010.25**	**87.81**	**11.98**	**0.53**

Table 3: FRV "Solea" cruise 812/2022: Catch composition (kg 0.5 h^{-1}) by haul in SD 22 (+ = <0.01 kg).

Haul No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Species/ICES Rectangle	**38G0**	**39G0**	**40F9**	**40G0**	**41G0**	**40G1**	**40G0**	**39G0**	**39G1**	**37G1**	**37G1**	**37G1**	**38G1**	**38G0**	**37G0**	**38G0**
AGONUS CATAPHRACTUS													0.02			
APHIA MINUTA				+		+	0.47	+	+	+	+	0.02	+		0.02	0.01
BELONE BELONE							0.06				0.06	0.04			0.03	
CLUPEA HARENGUS	0.96	0.19	15.84	0.16	0.07	0.17	3.41	7.89	0.05	0.17		4.30	2.05	19.69	7.94	1.60
CTENOLABRUS RUPESTRIS		+		0.01					0.03							
CYCLOPTERUS LUMPUS							0.35								0.49	
ENGRAULIS ENCRASICOLUS	5.99	1.45	1.06	0.05	0.18	0.10	0.08	0.47	+	0.12	1.99	0.50	0.38	6.20	6.77	0.10
GADUS MORHUA	6.47	+		+		+		0.01	+			0.26			7.07	0.02
GASTEROSTEUS ACULEATUS	0.07	0.10			+	0.01		+	+		0.03	0.48	0.17		0.12	0.01
GOBIUS NIGER				+												
LIMANDA LIMANDA	0.39	0.11						0.04	0.06		0.25	0.03	0.07			
MERLANGIUS MERLANGUS	0.02			0.02	0.12	0.05		0.04	0.03	0.04		0.09	0.02		0.08	
PLATICHTHYS FLESUS	0.25															
PLEURONECTES PLATESSA		0.05											0.12			
POMATOSCHISTUS MINUTUS	0.01					+		+	0.01			0.01	0.03	+	+	0.01
SCOMBER SCOMBRUS			6.49				0.14				0.06	0.11		0.06	1.38	
SPRATTUS SPRATTUS	1.73	0.91	11.92	0.02		0.03	0.25	2.49	0.37	0.92		11.39	0.96	23.49	13.41	14.27
SYNGNATHUS TYPHLE											+					+
TRACHINUS DRACO					0.09	0.03	0.06									
TRACHURUS TRACHURUS	0.01			+		0.07	0.04	0.04		0.01	0.06	0.06	0.01	0.09	0.09	
Total	**15.90**	**2.82**	**35.31**	**0.26**	**0.46**	**0.47**	**4.85**	**10.99**	**0.57**	**1.26**	**2.45**	**17.29**	**3.83**	**49.52**	**37.40**	**16.03**

Table 4: FRV "Solea" cruise 812/2022: Catch composition (kg 0.5 h^{-1}) by haul in SD 23 (+ = <0.01 kg).

Haul No.	**33**	**46**	**47**	**48**	**49**
Species/ICES Rectangle	**41G2**	**40G2**	**40G2**	**40G2**	**41G2**
APHIA MINUTA			0.21	+	+
BELONE BELONE		0.03	0.06		
CLUPEA HARENGUS	27294.00	43.69	33.92	50.44	
CTENOLABRUS RUPESTRIS			0.02		
ENGRAULIS ENCRASICOLUS		0.00			0.00
EUTRIGLA GURNARDUS					0.00
GADUS MORHUA		1.10	2.96		
GASTEROSTEUS ACULEATUS			0.00		0.00
MERLANGIUS MERLANGUS			2.54	0.13	0.01
PLEURONECTES PLATESSA				0.18	
SCOMBER SCOMBRUS	6.42	0.46	1.08		
SPRATTUS SPRATTUS		2.71	47.14	0.16	
TRACHURUS TRACHURUS					0.02
TRISOPTERUS ESMARKI				0.01	
Total	**27300.42**	**47.98**	**87.94**	**50.92**	**0.03**

Table 5: FRV "Solea" cruise 812/2022: Catch composition (kg 0.5 h^{-1}) by haul in SD 24 (+ = <0.01 kg).

Haul No.	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
Species/ICES Rectangle	**39G2**	**39G3**	**39G4**	**39G4**	**39G3**	**39G2**	**37G2**	**38G2**	**38G3**	**38G4**	**38G3**	**37G3**	**38G4**	**38G4**	**38G3**	**38G2**
APHIA MINUTA			+				+	0.01	+						+	+
BELONE BELONE	0.07										0.06			0.06		
CLUPEA HARENGUS	0.02	0.10	0.19	1.69	1.40	3.38	2.72	0.50	0.33	2.91	3.06	9.40	75.26	2.40	0.09	0.50
CYCLOPTERUS LUMPUS				0.19	0.16					0.65	0.35			0.28		
ENGRAULIS ENCRASICOLUS	0.43	0.19	0.46	0.01			0.18	0.05	0.09		0.02				0.06	0.04
GADUS MORHUA	+	0.01	+	0.22	0.01		0.04	0.01	0.01			1.71	3.38			0.02
GASTEROSTEUS ACULEATUS	1.17	0.13	2.11		0.02	0.03	0.05		0.12	0.27	0.15	0.06	0.17	0.01	0.17	0.05
GOBIUS NIGER	+		+													
LIMANDA LIMANDA				0.09												0.09
MERLANGIUS MERLANGUS		+	0.01				0.05	0.01	0.01			0.13	0.09			0.05
PLATICHTHYS FLESUS		0.17	0.36	1.00	0.26				0.45	0.72	0.23		0.51		1.10	0.35
PLEURONECTES PLATESSA			0.10						0.21				0.51			
POMATOSCHISTUS MINUTUS	0.01	0.06	0.03	0.01		+		+	0.01		+		+		0.02	0.01
RHINONEMUS CIMBRIUS			0.09													
SCOMBER SCOMBRUS							0.04		0.05			0.19				0.05
SPRATTUS SPRATTUS		0.09	0.83	0.42	0.26	0.48	1.36	0.22	1.11	34.58	23.52	14.06	0.96	1.71		8.42
TRACHURUS TRACHURUS							0.22	0.02	0.01						+	0.01
Total	**1.71**	**0.76**	**4.18**	**3.63**	**2.11**	**3.90**	**4.66**	**0.81**	**2.40**	**39.14**	**27.39**	**25.55**	**80.88**	**4.46**	**1.45**	**9.58**

Table 6: FRV “Solea”, cruise 812/2022. Survey statistics by area.

Subdivision	ICES Rectangle	Area (nm²)	Sa (m²/nm²)	Sigma (cm²)	N total (million)	Herring (%)	Sprat (%)	N Herring (million)	N Sprat (million)
21	41G0	108.1	58.5	1.8	34.79	17.4	8.82	6.04	3.07
21	41G1	946.8	27.4	3.8	68.99	60.32	4.95	41.63	3.42
21	41G2	432.3	46.6	1.6	129.58	38.64	5.75	50.08	7.45
21	42G1	884.2	202	2.2	809.28	70.4	10.48	569.74	84.85
21	42G2	606.8	172.7	1	1074.88	33.26	4.32	357.5	46.49
22	37G0	209.9	109.8	1.0	242.07	21.61	50.48	52.31	122.21
22	37G1	723.3	67.9	0.8	598.75	6.21	50.23	37.2	300.75
22	38G0	735.3	152.4	0.9	1312.09	14.14	54.48	185.56	714.84
22	38G1	173.2	112.8	0.8	254.03	32.35	33.14	82.17	84.18
22	39F9	159.3	173.4	0.8	328	19.01	47.07	62.35	154.37
22	39G0	201.7	199.1	0.9	453.19	33.26	31.75	150.75	143.90
22	39G1	250	207.6	0.8	625.93	32.57	52.42	203.83	328.14
22	40F9	51.3	121.8	0.8	73.75	34.1	61.53	25.15	45.38
22	40G0	538.1	118.2	0.2	3401.83	5.59	0.46	190.15	15.67
22	40G1	174.5	55.7	1.1	86.06	25.64	5.13	22.07	4.42
22	41G0	173.1	24.6	1.8	23.37	17.4	8.82	3.96	2.07
23	40G2	164	414.6	3.2	210.55	59.9	27.44	126.11	57.77
23	41G2	72.3	819.6	6.8	86.72	99.99	-	86.72	-
24	37G2	192.4	87.9	1.1	147.65	43.33	40.37	63.98	59.61
24	38G2	832.9	60.5	0.8	643.45	17.35	68.42	111.66	440.25
24	38G3	865.7	120.4	1.1	933.05	6.71	75.16	62.64	701.28
24	38G4	1034.8	243.0	2.4	1054.81	42.09	52.38	443.92	552.49
24	39G2	406.1	60.6	1.8	136.75	72.2	14.8	98.73	20.23
24	39G3	765	63.1	1.9	249.67	61.63	19.77	153.87	49.35
24	39G4	524.8	72.0	1.3	281.93	24.64	18.88	69.46	53.23
22-24	Total	8247.7			11143.65			2232.58	3850.14
21-24	Total	11225.9			13261.17			3257.57	3995.42

Table 7: FRV "Solea", cruise 812/2022. Numbers (millions) of herring incl. CBH by age/W-rings and area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	5.88	0.05	0.04	0.05	0.02					6.04
21	**41G1**	35.62	4.22	0.94	0.32	0.18	0.35				41.63
21	**41G2**	50.02	0.03		0.02		0.01				50.08
21	**42G1**	561.77	6.45	0.09	0.65	0.25	0.53				569.74
21	**42G2**	353.81	2.83	0.19	0.39	0.09	0.19				357.50
21	**Total**	1007.10	13.58	1.26	1.43	0.54	1.08	0.00	0.00	0.00	1024.99
22	**37G0**	51.93	0.38								52.31
22	**37G1**	36.53	0.67								37.20
22	**38G0**	184.36	1.20								185.56
22	**38G1**	81.07	0.60				0.50				82.17
22	**39F9**	62.24	0.11								62.35
22	**39G0**	150.34	0.41								150.75
22	**39G1**	199.88	3.95								203.83
22	**40F9**	25.06	0.09								25.15
22	**40G0**	186.87	3.28								190.15
22	**40G1**	21.41	0.66								22.07
22	**41G0**	3.93	0.02				0.01				3.96
22	**Total**	1003.62	11.37	0.00	0.00	0.00	0.51	0.00	0.00	0.00	1015.50
23	**40G2**	38.74	13.94	43.98	13.19	8.42	3.19	3.24	1.13	0.28	126.11
23	**41G2**		0.50	48.24	18.04	7.98	4.37	5.47	1.74	0.38	86.72
23	**Total**	38.74	14.44	92.22	31.23	16.40	7.56	8.71	2.87	0.66	212.83
24	**37G2**	51.99	11.90		0.09						63.98
24	**38G2**	101.29	8.37	0.18	0.45	0.36	0.36	0.18	0.27	0.18	111.64
24	**38G3**	37.16	6.90	3.21	5.38	3.45	2.69	1.46	1.09	1.31	62.65
24	**38G4**	82.27	79.72	47.53	67.13	55.80	45.47	20.19	26.30	19.51	443.92
24	**39G2**	59.43	30.10	1.47	2.79	1.75	1.52	0.58	0.76	0.33	98.73
24	**39G3**	65.00	41.81	5.88	14.03	10.61	8.02	2.32	2.52	3.68	153.87
24	**39G4**	19.62	13.11	6.77	8.85	7.43	6.05	2.68	2.29	2.66	69.46
24	**Total**	416.76	191.91	65.04	98.72	79.40	64.11	27.41	33.23	27.67	1004.25
22-24	**Total**	1459.12	217.72	157.26	129.95	95.80	72.18	36.12	36.10	28.33	2232.58
21-24	**Total**	2466.22	231.30	158.52	131.38	96.34	73.26	36.12	36.10	28.33	3257.57

Table 8: FRV “Solea”, cruise 812/2022. Mean weight (g) of herring incl. CBH by age/W-rings and area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	14.75	47.32	101.17	123.01	135.82	44.72				16.89
21	**41G1**	21.71	49.89	60.80	56.57	48.08	46.80				26.04
21	**41G2**	22.40	35.00		35.00		35.00				22.42
21	**42G1**	23.95	41.18	51.93	37.43	44.74	39.62				24.19
21	**42G2**	23.32	44.51	51.93	43.25	44.74	39.61				23.54
21	**Total**	23.52	44.59	60.11	46.26	49.23	41.90				23.91
22	**37G0**	9.67	13.41								9.70
22	**37G1**	10.55	13.41								10.60
22	**38G0**	8.12	13.41								8.15
22	**38G1**	8.30	13.41				35.00				8.50
22	**39F9**	7.83	13.41								7.84
22	**39G0**	7.72	13.41								7.74
22	**39G1**	9.27	13.41								9.35
22	**40F9**	7.69	13.41								7.71
22	**40G0**	13.39	13.41								13.39
22	**40G1**	10.88	13.41								10.96
22	**41G0**	13.95	13.41				35.00				14.00
22	**Total**	9.51	13.41				35.00				9.56
23	**40G2**	12.50	51.61	112.67	128.74	113.45	144.43	162.40	161.42	204.72	79.60
23	**41G2**		84.96	134.68	144.81	153.22	176.22	171.20	200.35	209.40	144.25
23	**Total**	12.50	52.76	124.18	138.02	132.80	162.81	167.93	185.02	207.41	105.94
24	**37G2**	11.33	14.39		23.33						11.92
24	**38G2**	8.51	16.48	40.39	44.57	45.61	50.84	50.84	47.35	40.39	9.77
24	**38G3**	7.55	32.27	43.16	40.41	44.23	44.51	46.70	50.74	45.72	20.99
24	**38G4**	14.45	32.58	50.50	45.46	48.31	50.89	49.54	55.66	51.37	39.90
24	**39G2**	17.07	17.13	48.14	43.61	50.21	78.40	50.25	59.58	48.41	20.46
24	**39G3**	15.99	24.17	41.99	39.37	42.69	44.71	48.91	48.55	48.25	26.48
24	**39G4**	13.80	28.93	47.33	43.53	46.57	45.74	50.48	54.70	51.42	34.20
24	**Total**	12.59	26.23	48.96	44.07	47.25	50.02	49.45	54.92	50.59	29.23
21-24	**Total**	15.80	28.34	92.81	66.43	61.82	61.43	78.02	65.26	54.24	26.44

Table 9: FRV "Solea", cruise 812/2022 biomass (t) of herring incl. CBH by age/W-rings and area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	86.7	2.4	4.1	6.2	2.7	0.0	0.0	0.0	0.0	102.0
21	**41G1**	773.3	210.5	57.2	18.1	8.7	16.4	0.0	0.0	0.0	1084.1
21	**41G2**	1120.5	1.1	0.0	0.7	0.0	0.4	0.0	0.0	0.0	1122.6
21	**42G1**	13454.4	265.6	4.7	24.3	11.2	21.0	0.0	0.0	0.0	13781.2
21	**42G2**	8250.9	126.0	9.9	16.9	4.0	7.5	0.0	0.0	0.0	8415.1
21	**Total**	23685.7	605.5	75.7	66.2	26.6	45.3	0.0	0.0	0.0	24505.0
22	**37G0**	502.2	5.1								507.3
22	**37G1**	385.4	9.0								394.4
22	**38G0**	1497.0	16.1								1513.1
22	**38G1**	672.9	8.1				17.5				698.4
22	**39F9**	487.3	1.5								488.8
22	**39G0**	1160.6	5.5								1166.1
22	**39G1**	1852.9	53.0								1905.9
22	**40F9**	192.7	1.2								193.9
22	**40G0**	2502.2	44.0								2546.2
22	**40G1**	232.9	8.9								241.8
22	**41G0**	54.8	0.3				0.4				55.4
22	**Total**	9540.9	152.5	0.0	0.0	0.0	17.9	0.0	0.0	0.0	9711.3
23	**40G2**	484.3	719.4	4955.2	1698.1	955.3	460.7	526.2	182.4	57.3	10038.9
23	**41G2**		42.5	6497.0	2612.4	1222.7	770.1	936.5	348.6	79.6	12509.2
23	**Total**	484.3	761.9	11452.2	4310.5	2178.0	1230.8	1462.6	531.0	136.9	22548.1
24	**37G2**	589.1	171.2		2.1						762.4
24	**38G2**	862.0	137.9	7.3	20.1	16.4	18.3	9.2	12.8	7.3	1091.2
24	**38G3**	280.6	222.7	138.5	217.4	152.6	119.7	68.2	55.3	59.9	1314.9
24	**38G4**	1188.8	2597.3	2400.3	3051.7	2695.7	2314.0	1000.2	1463.9	1002.2	17714.0
24	**39G2**	1014.5	515.6	70.8	121.7	87.9	119.2	29.2	45.3	16.0	2020.0
24	**39G3**	1039.4	1010.6	246.9	552.4	452.9	358.6	113.5	122.4	177.6	4074.1
24	**39G4**	270.8	379.3	320.4	385.2	346.0	276.7	135.3	125.3	136.8	2375.8
24	**Total**	5245.0	5034.6	3184.2	4350.6	3751.5	3206.5	1355.5	1824.8	1399.7	29352.3
22-24	**Total**	15270.2	5949.0	14636.4	8661.0	5929.5	4455.1	2818.1	2355.9	1536.6	61611.7
21-24	**Total**	38955.9	6554.5	14712.1	8727.2	5956.1	4500.4	2818.1	2355.9	1536.6	86116.6

Table 10: FRV "Solea", cruise 812/2022. Numbers (millions) of sprat by age and area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	0.01	0.41	0.89	1.43	0.21	0.08	0.00	0.04	0.00	3.07
21	**41G1**	0.07	0.68	0.99	1.24	0.36	0.05	0.00	0.03	0.00	3.42
21	**41G2**	0.07	1.38	2.26	2.88	0.67	0.12	0.00	0.07	0.00	7.45
21	**42G1**	2.70	15.82	22.31	32.71	8.80	1.42	0.22	0.87	0.00	84.85
21	**42G2**	15.41	7.02	8.31	11.72	3.28	0.54	0.03	0.18	0.00	46.49
21	**Total**	18.26	25.31	34.76	49.98	13.32	2.21	0.25	1.19	0.00	145.28
22	**37G0**	119.76	1.53	0.28	0.55	0.09					122.21
22	**37G1**	300.09	0.37	0.18	0.11						300.75
22	**38G0**	705.38	5.89	1.09	2.14	0.34					714.84
22	**38G1**	84.18									84.18
22	**39F9**	152.10	0.93	0.67	0.56	0.03	0.08				154.37
22	**39G0**	142.69	0.47	0.17	0.47	0.06	0.04				143.90
22	**39G1**	325.39	1.07	0.39	1.07	0.13	0.09				328.14
22	**40F9**	44.05	0.54	0.39	0.33	0.02	0.05				45.38
22	**40G0**	5.15	1.83	3.62	3.74	0.25	0.33	0.75			15.67
22	**40G1**	2.21					2.21	0.00			4.42
22	**41G0**	0.02	0.36	0.65	0.82	0.08	0.09	0.05			2.07
22	**Total**	1881.02	12.99	7.44	9.79	1.00	2.89	0.80	0.00	0.00	1915.93
23	**40G2**	10.23	2.56	10.03	23.51	7.40	2.91	0.71	0.32	0.10	57.77
23	**41G2**										
23	**Total**	10.23	2.56	10.03	23.51	7.40	2.91	0.71	0.32	0.10	57.77
24	**37G2**	57.01	1.13	0.40	0.55	0.29	0.15	0.04	0.04	0.00	59.61
24	**38G2**	436.39	0.00	0.19	1.35	0.97	0.58	0.58	0.19	0.00	440.25
24	**38G3**	342.91	65.90	89.99	93.46	56.22	34.10	9.19	9.51	0.00	701.28
24	**38G4**	0.00	28.01	86.67	169.62	125.39	80.14	35.79	26.87	0.00	552.49
24	**39G2**	1.38	2.10	3.63	4.76	3.89	2.61	1.13	0.73	0.00	20.23
24	**39G3**	2.90	2.47	9.29	12.31	9.81	7.22	3.19	2.16	0.00	49.35
24	**39G4**	1.32	7.13	9.33	13.73	9.36	7.72	2.52	2.12	0.00	53.23
24	**Total**	841.91	106.74	199.50	295.78	205.93	132.52	52.44	41.62	0.00	1876.44
22-24	**Total**	2733.16	122.29	216.97	329.08	214.33	138.32	53.95	41.94	0.10	3850.14
21-24	**Total**	2751.42	147.60	251.73	379.06	227.65	140.53	54.20	43.13	0.10	3995.42

Table 11: FRV "Solea", cruise 812/2022. Mean weight (g) of sprat by age and area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	8.36	16.08	17.18	17.97	19.88	18.04	0.00	19.61		17.61
21	**41G1**	6.75	13.72	16.04	18.27	21.28	19.13	24.24	19.61		16.83
21	**41G2**	10.20	14.20	16.31	17.88	20.67	18.17	24.24	19.61		16.92
21	**42G1**	8.14	13.38	16.13	18.68	21.12	19.27	24.24	19.61		16.97
21	**42G2**	4.26	12.12	16.04	18.22	21.22	18.89	24.24	19.61		12.51
21	**Total**	4.87	13.13	16.14	18.50	21.11	19.07	24.24	19.61		15.55
22	**37G0**	5.48	10.06	13.74	14.54	16.00					5.60
22	**37G1**	4.92	9.56	13.45	13.45						4.93
22	**38G0**	4.90	10.08	13.74	14.54	16.00					4.99
22	**38G1**	3.89									3.89
22	**39F9**	3.75	12.02	13.48	14.78	16.00	15.22				3.89
22	**39G0**	4.63	10.37	15.48	14.87	16.00	15.22				4.70
22	**39G1**	3.72	10.37	15.48	14.87	16.00	15.22				3.80
22	**40F9**	3.07	12.02	13.48	14.78	16.00	15.22				3.37
22	**40G0**	5.11	13.55	14.12	14.76	16.00	15.22	19.00			11.53
22	**40G1**	1.89									10.44
22	**41G0**	8.41	13.26	14.34	15.12	16.00	15.22	19.00			14.62
22	**Total**	4.53	10.89	14.06	14.73	16.00	18.11	19.00			4.70
23	**40G2**	5.28	17.53	19.33	20.23	22.28	23.63	25.73	26.19	25.37	17.85
23	**41G2**										
23	**Total**	5.28	17.53	19.33	20.23	22.28	23.63	25.73	26.19	25.37	17.85
24	**37G2**	5.95	10.97	12.52	14.18	15.12	14.61	18.53	16.16		6.25
24	**38G2**	3.83		18.53	18.53	18.53	18.53	18.53	18.53		3.96
24	**38G3**	4.43	13.28	14.11	14.91	15.10	15.10	16.42	15.58		9.58
24	**38G4**		13.72	15.32	16.18	16.61	16.70	16.85	16.81		16.17
24	**39G2**	2.51	12.32	14.67	16.35	16.75	16.58	17.15	17.13		14.87
24	**39G3**	1.17	13.87	15.06	16.48	16.86	16.70	16.70	17.16		15.33
24	**39G4**	3.03	12.43	14.48	15.90	16.56	17.26	17.06	17.22		15.29
24	**Total**	4.21	13.31	14.71	15.79	16.22	16.32	16.80	16.58		10.47
21-24	**Total**	4.44	13.14	15.07	16.39	16.70	16.56	16.99	16.74	25.37	7.99

Table 12: FRV "Solea", cruise 812/2022. Total biomass (t) of sprat by age and area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	0.1	6.6	15.3	25.7	4.2	1.4	0.0	0.8	0.0	54.1
21	**41G1**	0.5	9.3	15.9	22.7	7.7	1.0	0.0	0.6	0.0	57.5
21	**41G2**	0.7	19.6	36.9	51.5	13.9	2.2	0.0	1.4	0.0	126.1
21	**42G1**	22.0	211.7	359.9	611.0	185.9	27.4	5.3	17.1	0.0	1440.2
21	**42G2**	65.7	85.1	133.3	213.5	69.6	10.2	0.7	3.5	0.0	581.6
21	**Total**	88.9	332.3	561.2	924.4	281.1	42.1	6.1	23.3	0.0	2259.5
22	**37G0**	656.3	15.4	3.9	8.0	1.4	0.0	0.0	0.0	0.0	685.0
22	**37G1**	1476.4	3.5	2.4	1.5	0.0	0.0	0.0	0.0	0.0	1483.9
22	**38G0**	3456.4	59.4	15.0	31.1	5.4	0.0	0.0	0.0	0.0	3567.3
22	**38G1**	327.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	327.5
22	**39F9**	570.4	11.2	9.0	8.3	0.5	1.2	0.0	0.0	0.0	600.6
22	**39G0**	660.7	4.9	2.6	7.0	1.0	0.6	0.0	0.0	0.0	676.7
22	**39G1**	1210.5	11.1	6.0	15.9	2.1	1.4	0.0	0.0	0.0	1246.9
22	**40F9**	135.2	6.5	5.3	4.9	0.3	0.8	0.0	0.0	0.0	152.9
22	**40G0**	26.3	24.8	51.1	55.2	4.0	5.0	14.3	0.0	0.0	180.7
22	**40G1**	4.2	0.0	0.0	0.0	0.0	42.0	0.0	0.0	0.0	46.2
22	**41G0**	0.2	4.8	9.3	12.4	1.3	1.4	1.0	0.0	0.0	30.3
22	**Total**	8523.9	141.5	104.6	144.3	16.0	52.3	15.2	0.0	0.0	8997.9
23	**40G2**	54.0	44.9	193.9	475.6	164.9	68.8	18.3	8.4	2.5	1031.2
23	**41G2**								0.0	0.0	0.0
23	**Total**	54.0	44.9	193.9	475.6	164.9	68.8	18.3	8.4	2.5	1031.2
24	**37G2**	339.2	12.4	5.0	7.8	4.4	2.2	0.7	0.7	0.0	372.4
24	**38G2**	1671.4	0.0	3.5	25.0	18.0	10.8	10.8	3.5	0.0	1742.9
24	**38G3**	1519.1	875.2	1269.8	1393.5	848.9	514.9	150.9	148.2	0.0	6720.4
24	**38G4**	0.0	384.3	1327.8	2744.5	2082.7	1338.3	603.1	451.7	0.0	8932.4
24	**39G2**	3.5	25.9	53.3	77.8	65.2	43.3	19.4	12.5	0.0	300.7
24	**39G3**	3.4	34.3	139.9	202.9	165.4	120.6	53.3	37.1	0.0	756.7
24	**39G4**	4.0	88.6	135.1	218.3	155.0	133.3	43.0	36.5	0.0	813.8
24	**Total**	3540.5	1420.6	2934.3	4669.8	3339.6	2163.3	881.1	690.1	0.0	19639.3
22-24	**Total**	12118.5	1607.0	3232.9	5289.6	3520.4	2284.4	914.6	698.5	2.5	29668.3
21-24	**Total**	12207.3	1939.3	3794.0	6214.0	3801.6	2326.5	920.6	721.8	2.5	31927.8

Table 13: FRV "Solea", cruise 812/2022. Numbers (m) of herring excl. CBH in SD 24 by age/W-rings & area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	5.88	0.05	0.04	0.05	0.02					6.04
21	**41G1**	35.62	4.22	0.94	0.32	0.18	0.35				41.63
21	**41G2**	50.02	0.03		0.02		0.01				50.08
21	**42G1**	561.77	6.45	0.09	0.65	0.25	0.53				569.74
21	**42G2**	353.81	2.83	0.19	0.39	0.09	0.19				357.5
21	**Total**	1007.1	13.58	1.26	1.43	0.54	1.08	0.00	0.00	0.00	1024.99
22	**37G0**	51.93	0.38								52.31
22	**37G1**	36.53	0.67								37.2
22	**38G0**	184.36	1.2								185.56
22	**38G1**	81.07	0.6				0.5				82.17
22	**39F9**	62.24	0.11								62.35
22	**39G0**	150.34	0.41								150.75
22	**39G1**	199.88	3.95								203.83
22	**40F9**	25.06	0.09								25.15
22	**40G0**	186.87	3.28								190.15
22	**40G1**	21.41	0.66								22.07
22	**41G0**	3.93	0.02				0.01				3.96
22	**Total**	1003.62	11.37	0.00	0.00	0.00	0.51	0.00	0.00	0.00	1015.5
23	**40G2**	38.74	13.94	43.98	13.19	8.42	3.19	3.24	1.13	0.28	126.11
23	**41G2**		0.5	48.24	18.04	7.98	4.37	5.47	1.74	0.38	86.72
23	**Total**	38.74	14.44	92.22	31.23	16.4	7.56	8.71	2.87	0.66	212.83
24	**37G2**	51.99									51.99
24	**38G2**	101.29	0.73								102.02
24	**38G3**	37.16	4.72	2.03	0.53	0.2					44.64
24	**38G4**	82.27	51.76	35.15	15.97	3.49	2.16			0.24	191.04
24	**39G2**	59.43	1.1	1.05	0.86	0.38	0.61				63.43
24	**39G3**	65	13.65	2.32	0.97						81.94
24	**39G4**	19.62	7.37	5.3	1.72	0.55					34.56
24	**Total**	416.76	79.33	45.85	20.05	4.62	2.77	0.00	0.00	0.24	569.62
22-24	**Total**	1459.12	105.14	138.07	51.28	21.02	10.84	8.71	2.87	0.9	1797.95
21-24	**Total**	2466.22	118.72	139.33	52.71	21.56	11.92	8.71	2.87	0.9	2822.94

Table 14: FRV "Solea", cruise 812/2022. Mean weight (g) of herring excl. CBH in SD24 by age/W-rings & area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	14.75	47.32	101.17	123.01	135.82	44.72				16.89
21	**41G1**	21.71	49.89	60.80	56.57	48.08	46.80				26.04
21	**41G2**	22.40	35.00		35.00		35.00				22.42
21	**42G1**	23.95	41.18	51.93	37.43	44.74	39.62				24.19
21	**42G2**	23.32	44.51	51.93	43.25	44.74	39.61				23.54
21	**Total**	23.52	44.59	60.11	46.26	49.23	41.90				23.91
22	**37G0**	9.67	13.41								9.70
22	**37G1**	10.55	13.41								10.60
22	**38G0**	8.12	13.41								8.15
22	**38G1**	8.30	13.41				35.00				8.50
22	**39F9**	7.83	13.41								7.84
22	**39G0**	7.72	13.41								7.74
22	**39G1**	9.27	13.41								9.35
22	**40F9**	7.69	13.41								7.71
22	**40G0**	13.39	13.41								13.39
22	**40G1**	10.88	13.41								10.96
22	**41G0**	13.95	13.41				35.00				14.00
22	**Total**	9.51	13.41				35.00				9.56
23	**40G2**	12.50	49.83	102.75	123.63	118.45	146.87	165.22	174.85	217.07	81.70
23	**41G2**	18.51	38.21	118.23	134.02	140.02	164.84	169.65	193.70	205.89	82.37
23	**Total**	13.03	49.41	103.40	124.24	119.77	148.14	165.57	175.93	216.61	81.75
24	**37G2**	11.33									11.33
24	**38G2**	8.51	44.31								8.77
24	**38G3**	7.55	40.58	47.08	66.01	71.29					13.82
24	**38G4**	14.45	41.54	55.01	65.59	74.88	84.91			115.00	35.55
24	**39G2**	17.07	37.28	54.52	65.41	71.29	124.00				20.05
24	**39G3**	15.99	40.28	47.99	62.78						21.50
24	**39G4**	13.80	39.94	50.25	64.02	71.29					28.38
24	**Total**	12.59	41.08	53.74	65.32	74.00	93.52			115.00	22.66
21-24	**Total**	15.80	28.07	65.58	56.38	57.56	58.97	78.18	62.11	53.47	23.46

Table 15: FRV “Solea”, cruise 812/2022. Total biomass (t) of herring excl. CBH in SD 24 by age/W-rings & area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	86.73	2.37	4.05	6.15	2.72	0	0	0	0	102.01
21	**41G1**	773.31	210.54	57.15	18.1	8.65	16.38	0	0	0	1084.13
21	**41G2**	1120.45	1.05	0	0.7	0	0.35	0	0	0	1122.55
21	**42G1**	13454.39	265.61	4.67	24.33	11.19	21	0	0	0	13781.19
21	**42G2**	8250.85	125.96	9.87	16.87	4.03	7.53	0	0	0	8415.1
21	**Total**	23685.73	605.53	75.74	66.15	26.59	45.26	0.00	0.00	0.00	24504.98
22	**37G0**	502.16	5.1								507.26
22	**37G1**	385.39	8.98								394.38
22	**38G0**	1497	16.09								1513.1
22	**38G1**	672.88	8.05				17.5				698.43
22	**39F9**	487.34	1.48								488.81
22	**39G0**	1160.62	5.5								1166.12
22	**39G1**	1852.89	52.97								1905.86
22	**40F9**	192.71	1.21								193.92
22	**40G0**	2502.19	43.98								2546.17
22	**40G1**	232.94	8.85								241.79
22	**41G0**	54.82	0.27				0.35				55.44
22	**Total**	9540.94	152.48	0.00	0.00	0.00	17.85	0.00	0.00	0.00	9711.28
23	**40G2**	484.25	719.44	4955.23	1698.08	955.25	460.73	526.18	182.4	57.32	10038.88
23	**41G2**		42.48	6496.96	2612.37	1222.7	770.08	936.46	348.61	79.57	12509.24
23	**Total**	484.25	761.92	11452.19	4310.45	2177.95	1230.81	1462.64	531.01	136.89	22548.12
24	**37G2**	589.05									589.05
24	**38G2**	861.98	32.35								894.32
24	**38G3**	280.56	191.54	95.57	34.99	14.26					616.91
24	**38G4**	1188.8	2150.11	1933.6	1047.47	261.33	183.41			27.6	6792.32
24	**39G2**	1014.47	41.01	57.25	56.25	27.09	75.64				1271.71
24	**39G3**	1039.35	549.82	111.34	60.9						1761.41
24	**39G4**	270.76	294.36	266.33	110.11	39.21					980.76
24	**Total**	5244.97	3259.19	2464.09	1309.72	341.89	259.05	0.00	0.00	27.6	12906.48
22-24	**Total**	15270.16	4173.59	13916.28	5620.17	2519.84	1507.71	1462.64	531.01	164.49	45165.88
21-24	**Total**	38955.89	4779.12	13992.02	5686.32	2546.43	1552.97	1462.64	531.01	164.49	69670.86

Table 16: FRV "Solea", cruise 812/2022. Numbers (m) of herring excl. CBH in SD 24 and large herring accumulation in rectangle 41G2/SD 23 by age/W-rings & area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	5.88	0.05	0.04	0.05	0.02					6.04
21	**41G1**	35.62	4.22	0.94	0.32	0.18	0.35				41.63
21	**41G2**	50.02	0.03		0.02		0.01				50.08
21	**42G1**	561.77	6.45	0.09	0.65	0.25	0.53				569.74
21	**42G2**	353.81	2.83	0.19	0.39	0.09	0.19				357.50
21	**Total**	1007.10	13.58	1.26	1.43	0.54	1.08	0.00	0.00	0.00	1024.99
22	**37G0**	51.93	0.38								52.31
22	**37G1**	36.53	0.67								37.20
22	**38G0**	184.36	1.20								185.56
22	**38G1**	81.07	0.60				0.50				82.17
22	**39F9**	62.24	0.11								62.35
22	**39G0**	150.34	0.41								150.75
22	**39G1**	199.88	3.95								203.83
22	**40F9**	25.06	0.09								25.15
22	**40G0**	186.87	3.28								190.15
22	**40G1**	21.41	0.66								22.07
22	**41G0**	3.93	0.02				0.01				3.96
22	**Total**	1003.62	11.37	0.00	0.00	0.00	0.51	0.00	0.00	0.00	1015.50
23	**40G2**	38.74	13.27	27.55	17.07	12.43	6.30	8.30	1.98	0.47	126.11
23	**41G2**	3.76	0.50	1.21	1.06	0.81	0.48	0.71	0.12	0.02	8.67
23	**Total**	42.50	13.77	28.76	18.13	13.24	6.78	9.01	2.10	0.49	134.78
24	**37G2**	51.99									51.99
24	**38G2**	101.29	0.73								102.02
24	**38G3**	37.16	4.72	2.03	0.53	0.20					44.64
24	**38G4**	82.27	51.76	35.15	15.97	3.49	2.16			0.24	191.04
24	**39G2**	59.43	1.10	1.05	0.86	0.38	0.61				63.43
24	**39G3**	65.00	13.65	2.32	0.97						81.94
24	**39G4**	19.62	7.37	5.30	1.72	0.55					34.56
24	**Total**	416.76	79.33	45.85	20.05	4.62	2.77	0.00	0.00	0.24	569.62
22-24	**Total**	1462.88	104.47	74.61	38.18	17.86	10.06	9.01	2.10	0.73	1719.90
21-24	**Total**	2469.98	118.05	75.87	39.61	18.40	11.14	9.01	2.10	0.73	2744.89

Table 17: FRV "Solea", cruise 812/2022. Mean weight (g) of herring excl. CBH in SD24 and large herring accumulation in in rectangle 41G2/SD 23 by age/W-rings & area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	14.75	47.32	101.17	123.01	135.82	44.72				16.89
21	**41G1**	21.71	49.89	60.80	56.57	48.08	46.80				26.04
21	**41G2**	22.40	35.00		35.00		35.00				22.42
21	**42G1**	23.95	41.18	51.93	37.43	44.74	39.62				24.19
21	**42G2**	23.32	44.51	51.93	43.25	44.74	39.61				23.54
21	**Total**	23.52	44.59	60.11	46.26	49.23	41.90				23.91
22	**37G0**	9.67	13.41								9.70
22	**37G1**	10.55	13.41								10.60
22	**38G0**	8.12	13.41								8.15
22	**38G1**	8.30	13.41				35.00				8.50
22	**39F9**	7.83	13.41								7.84
22	**39G0**	7.72	13.41								7.74
22	**39G1**	9.27	13.41								9.35
22	**40F9**	7.69	13.41								7.71
22	**40G0**	13.39	13.41								13.39
22	**40G1**	10.88	13.41								10.96
22	**41G0**	13.95	13.41				35.00				14.00
22	**Total**	9.51	13.41				35.00				9.56
23	**40G2**	12.50	49.83	102.75	123.63	118.45	146.87	165.22	174.85	217.07	81.70
23	**41G2**	18.51	38.21	118.23	134.02	140.02	164.84	169.65	193.70	205.89	82.37
23	**Total**	13.03	49.41	103.40	124.24	119.77	148.14	165.57	175.93	216.61	81.75
24	**37G2**	11.33									11.33
24	**38G2**	8.51	44.31								8.77
24	**38G3**	7.55	40.58	47.08	66.01	71.29					13.82
24	**38G4**	14.45	41.54	55.01	65.59	74.88	84.91			115.00	35.55
24	**39G2**	17.07	37.28	54.52	65.41	71.29	124.00				20.05
24	**39G3**	15.99	40.28	47.99	62.78						21.50
24	**39G4**	13.80	39.94	50.25	64.02	71.29					28.38
24	**Total**	12.59	41.08	53.74	65.32	74.00	93.52			115.00	22.66
21-24	**Total**	15.80	28.07	65.58	56.38	57.56	58.97	78.18	62.11	53.47	23.46

Table 18: FRV "Solea", cruise 812/2022. Total biomass (t) of herring excl. CBH in SD 24 and large herring accumulation in in rectangle 41G2/SD 23 by age/W-rings & area.

Subdivision	Rectangle/ Age	0	1	2	3	4	5	6	7	8+	Total
21	**41G0**	86.73	2.37	4.05	6.15	2.72	0.00	0.00	0.00	0.00	102.01
21	**41G1**	773.31	210.54	57.15	18.10	8.65	16.38	0.00	0.00	0.00	1084.13
21	**41G2**	1120.45	1.05	0.00	0.70	0.00	0.35	0.00	0.00	0.00	1122.55
21	**42G1**	13454.39	265.61	4.67	24.33	11.19	21.00	0.00	0.00	0.00	13781.19
21	**42G2**	8250.85	125.96	9.87	16.87	4.03	7.53	0.00	0.00	0.00	8415.10
21	**Total**	23685.73	605.53	75.74	66.15	26.59	45.26	0.00	0.00	0.00	24504.98
22	**37G0**	502.16	5.10								507.26
22	**37G1**	385.39	8.98								394.38
22	**38G0**	1497.00	16.09								1513.10
22	**38G1**	672.88	8.05				17.50				698.43
22	**39F9**	487.34	1.48								488.81
22	**39G0**	1160.62	5.50								1166.12
22	**39G1**	1852.89	52.97								1905.86
22	**40F9**	192.71	1.21								193.92
22	**40G0**	2502.19	43.98								2546.17
22	**40G1**	232.94	8.85								241.79
22	**41G0**	54.82	0.27				0.35				55.44
22	**Total**	9540.94	152.48	0.00	0.00	0.00	17.85	0.00	0.00	0.00	9711.28
23	**40G2**	484.25	661.24	2830.76	2110.36	1472.33	925.28	1371.33	346.20	102.02	10303.79
23	**41G2**	69.60	19.11	143.06	142.06	113.42	79.12	120.45	23.24	4.12	714.17
23	**Total**	553.85	680.35	2973.82	2252.42	1585.75	1004.40	1491.78	369.44	106.14	11017.96
24	**37G2**	589.05									589.05
24	**38G2**	861.98	32.35								894.32
24	**38G3**	280.56	191.54	95.57	34.99	14.26					616.91
24	**38G4**	1188.80	2150.11	1933.60	1047.47	261.33	183.41			27.60	6792.32
24	**39G2**	1014.47	41.01	57.25	56.25	27.09	75.64				1271.71
24	**39G3**	1039.35	549.82	111.34	60.90						1761.41
24	**39G4**	270.76	294.36	266.33	110.11	39.21					980.76
24	**Total**	5244.97	3259.19	2464.09	1309.72	341.89	259.05	0.00	0.00	27.60	12906.48
22-24	**Total**	15339.76	4092.02	5437.91	3562.14	1927.64	1281.30	1491.78	369.44	133.74	33635.72
21-24	**Total**	39025.49	4697.55	5513.65	3628.29	1954.23	1326.56	1491.78	369.44	133.74	58140.70

INSTITUTE OF FOOD SAFETY, ANIMAL HEALTH AND ENVIRONMENT – BIOR, RIGA (LATVIA)

THE CRUISE REPORT

FROM THE LATVIAN BALTIC INTERNATIONAL ACOUSTIC SURVEY – BIAS 2022 ON THE F/V "ALBATROSS 3" IN THE ICES SUBDIVISIONS 26N AND 28 OF THE BALTIC SEA INCLUDING IRBE STRAIT AND GULF OF RIGA

(6-17 November 2022)

GUNTARS STRODS•MARTINS PLIKSS•JURGIS MATISS PETERSONS•KARLIS HEIMRATS•
•ALLA VINGOVATOVA•IVARS PUTNIS•

Riga, March 2023

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 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.

The Latvian Baltic International Acoustic Survey (BIAS) in the ICES Sub-divisions 26N and 28 in October 2022 was conducted on Latvian commercial fishing vessel “Albatross 3” for the first time, with which crew and the owners cooperation in research for pelagic fish distribution and feeding conditions in the recent decade has been developing a very close and productive. The reported cruise was organized on the basis of the agreement between the Institute of Food Safety, Animal Health and Environment (BIOR) from Riga and the fishing company “Balticfish” Ltd from Liepaja. The vessel was operated within the Latvian EEZ (ICES Sub-divisions 26N and 28). The “Latvian National Fisheries Data Collection Programme, 2022” in accordance with the EU Commission Regulations No.1639/2001 and No.1581/2004 was partly subsidized this cruise. It was coordinated by the ICES Baltic International Fish Survey Working Group (WGBIFS).

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. Hydrological parameters measurements are the information source about abiotic 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 calculation.

The ICES Baltic Fisheries Assessment Working Group (WGBFAS) can apply the present BASS data for clupeids (especially for sprat) stock biomass assessment and spatial distribution updating. The basic acoustic and biological data collected during recently carried out survey are stored in the BAD1 and acoustic.db international databases, managed by the ICES Secretariat.

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 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 analyse 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.

MATERIALS AND METHODS

Personnel

The scientific staff was composed of four persons:

G. Strods – scientific staff and cruise leader, acoustics, full time;

Martins Plikss – fish sampling, hydrobiology and hydrology, full time;

Jurgis Matiss Petersons – fish sampling, hydrobiology and hydrology, part time;

Karlis Heimrats – fish sampling, hydrobiology and hydrology, part time.

Survey description

The reported BIAS survey of the f/v "Albatross 3" took place during the period of 6-17 November 2022. The vessel left the port of Liepaja on 06.11.2022 at 00:05 o'clock GMT+02:00. Due to stormy weather conditions the sea researches were three times interrupted and conducted in several periods of 06.11.2022, 10.11.2022, 12-14.11.2022 and 15-17.11.2022 within Latvian EEZ (ICES Sub-divisions 26N and 28), including Irbe Strait and Gulf of Riga. The research activity had been stopped at 22:00 o'clock GMT+02:00 on 17th of November and the vessel returned back to the port of Liepaja for the scientific team disembarkation there. The almost full eight working days were utilized for fulfilling the survey purposes and three days for scientific team transfer and equipment installation and stripping.

Survey performance

The survey echo-integration tracks were planned in a similar pattern as in the previous years, due to historical comparability of the data. Overall 828 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 2022 was 9482.2 nm^2, in the northern part of the ICES Sub-division 26 – 1953.3 nm^2 , in Sub-division 28.2 – 5126.9 nm^2 and Sub-division 28.1 (Irbe Strait and Gulf of Riga) – 2402.0 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 vertical distribution of clupeids actual density pattern along the transect. The intention was to carry out at least two control hauls per the ICES statistical rectangle. The water depth range-layer with sufficient for fish oxygen content (minimum 1.5-2.0 ml/l) were taken into account in the process of the hauls distribution.

Totally 17 control haul in the pelagic offshore zone were conducted with the pelagic trawl with max. 76 m horizontal opening, max. 25 m vertical opening and 10 mm mesh bar length in the codend. The trawling depth and the net opening were controlled by the sonar type IGEK. The trawl headrope positions in particular hauls were localized on the depth range from 12 to 87 m from the sea surface (Tab. 1). Mean headrope depth location in all investigated areas was 35 m. The trawl mouth vertical opening ranged from 13 to 25 m (mean – 20 m) and horizontal opening ranged from 67 to 79 m (mean – 71 m). The mean bottom depth at trawling positions varied from 25 to 243 m (mean for all investigated area – 75 m). Totally, 4 hauls were localized in the ICES Sub-division 26, 8 hauls in the ICES Sub-division 28.2 and 5 hauls in the ICES Sub-division 28.2. The mean speed of the vessel during trawling was 2.9 knots. The trawling time of the 10 single valid hauls lasted for 20 minutes, 5 hauls with 30 minutes duration, one haul with 35 and one with 15 minutes of duration. All hauls can be accepted as representative (valid from technical point of view).

The samples of sprat, herring and cod were taken from each catch station to determine the species proportion, length-mass relationship, sex, maturity and age-length relationship. Measured and analyzed fish amount shown in Table 2. Detailed ichthyological analyses were made according to standard procedures, directly on board of surveying vessel.

Species composition and fish length distributions were based on trawl catch results. Mean target strength of clupeid fishes was calculated according to the following formula [ICES 1983, 2012]:

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.

The basic hydrological parameters (seawater temperature, salinity and oxygen contents) were measured from the surface to the bottom after every haul if weather conditions was favorable. Totally, 17 hydrological stations were inspected during survey on f/v “Albatross 3”. The location of hydrological and hydrobiological research profiles is presented in Fig. 2. The Seabird SBE 19plus was used for above-mentioned measurements. The row data were aggregated to the 10 m depth stratums.

Zooplankton samples were collected at the positions of the hydrological stations or after trawling. Totally 12 zooplankton stations were realized and 22 zooplankton samples were taken. Zooplankton has been 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. Samples from 100 m deep were conserved in 2.5% unbuffered formaldehyde solution with sea water, but samples from 50 m depth were fixed by spirit solution with sea water and both processed during the year.

RESULTS

Biological data

Catch statistics

Catch per SD and species of the survey are given in Tab. 3-6.

The total length of dominant pelagic fish species ranged as follows:

- sprat – 7.5÷14.5 cm (average TL = 11.8 cm), 2.6÷16.6 g (average W = 9.9 g);
- herring – 8.5÷21.5 cm (average TL = 16.8 cm), 4.0÷60.0 (average W = 29.2 g);

Acoustical and biological estimates

The basic acoustic and biological data (surveyed area statistics, mean NASC, the mean scattering cross-section, calculated target strength, the total number of fish, percentages of herring and sprat) per ICES rectangles, collected in November 2022, as well as the estimated abundance and biomass of sprat and herring per above mentioned rectangles are given in Tab. 4. The age structured data of sprat and herring are aggregated in Tab. 5-6. The geographical distribution of NASC, sprat and herring stock densities in the central-eastern Baltic in October 2018 are shown in Fig. 4-6. Length distribution of sprat and herring shown in Fig. 7-8.

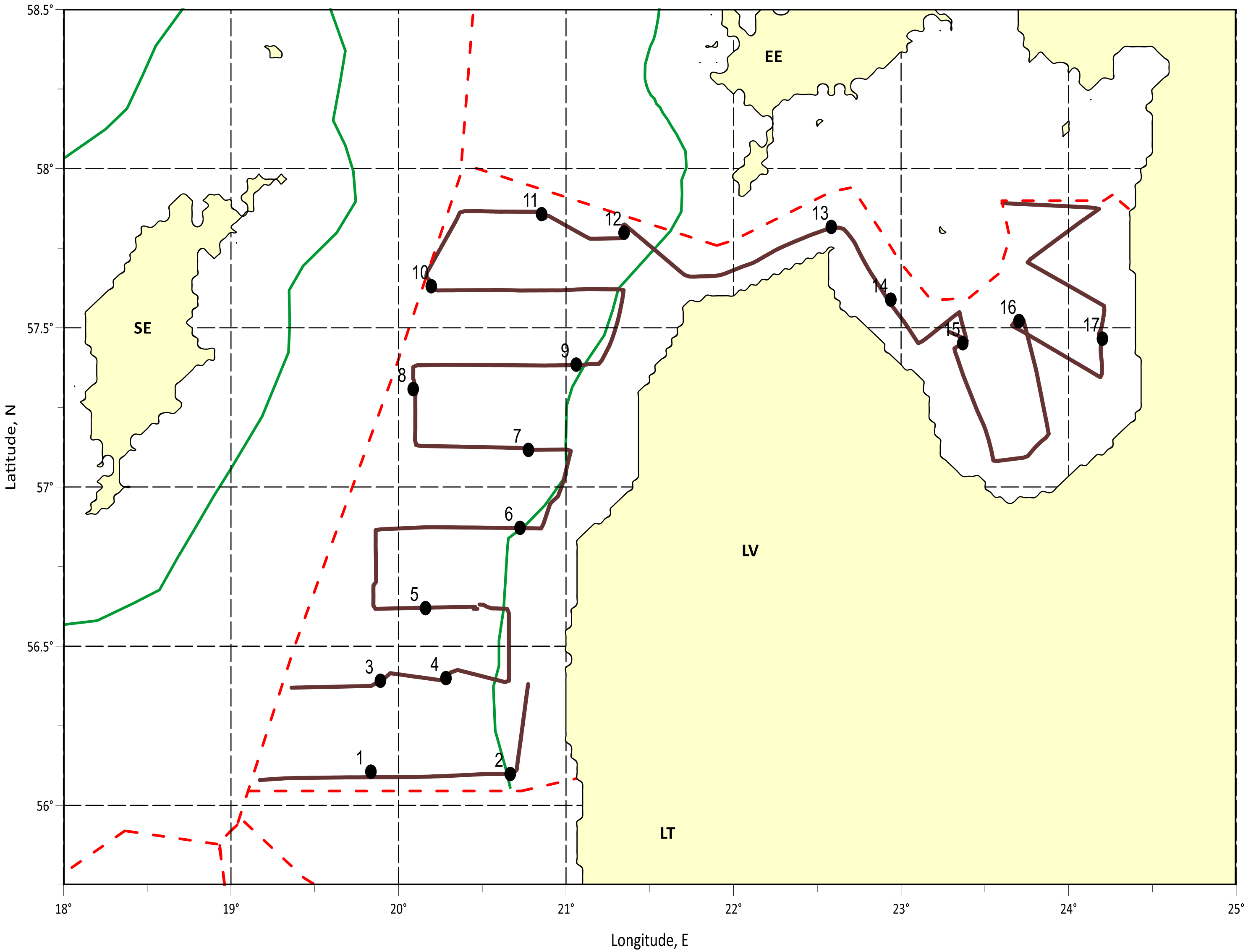

Figure 1. Cruise track design and hauls of the Latvian Baltic International Acoustic Survey on the f/v “Albatross 3”, 06-17.11.2022.

Table 1. Fish control-catch results in the Baltic Sea ICES SD 26N and 28 from the Latvian Baltic International Acoustic Survey on the f/v “Albatross 3”, 06-17.11.2022.

Haul	Date	ICES SD	ICES Rectangle	Latitude start	Longitude start	Time start, UTC	Duration, min	Trawling speed, knt	Trawling course (COG), deg	Depth, m	Headrope depth, m	Footrope depth, m	Vertical opening, m	Horizontal opening, m	Wire length, m	Total catch, kg
1	06112022	26	41G9	56°06.35′	19°50.11′	09:20	20	2.7	300	58	41	58	17	74	125	60
2	06112022	26	41H0	56°05.91′	20°40.01′	13:52	20	3	300	35	20	35	15	76	90	120.1106
3	10112022	26	41G9	56°23.48′	19°53.53′	07:30	20	3	60	88	23	47	24	67	115	41.1573
4	10112022	26	41H0	56°23.98′	20°16.99′	11:50	30	3.2	60	58	33	57	24	67	125	432
5	12112022	28.2	42H0	56°37.17′	20°09.67′	22:50	20	3	300	126	53	78	25	66	145	300
6	13112022	28.2	42H0	56°52.30′	20°43.52′	06:45	20	3	300	53	37	53	16	75	115	200
7	13112022	28.2	43H0	57°06.99′	20°46.52′	11:04	15	3.1	270	59	32	57	25	66	125	416
8	13112022	28.2	43H0	57°18.45′	20°05.26′	17:25	30	2.4	5	243	58	82	24	67	190	8
9	13112022	28.2	43H1	57°23.06′	21°03.65′	22:25	20	3.2	230	65	19	33	14	77	75	584.57
10	14112022	28.2	44H0	57°37.83′	20°11.74′	06:36	30	2.6	340	141	62	87	25	66	175	10.074
11	14112022	28.2	44H0	57°51.41′	20°51.26′	12:19	35	2.7	180	86	58	83	25	66	150	180.129
12	14112022	28.2	44H1	57°47.91′	21°20.79′	16:16	20	2.8	355	75	46	71	25	66	150	127.429
13	14112022	28.1	44H2	57°49.00′	22°35.00′	23:30	20	2.8	60	25	12	25	13	78	125	578.0152
14	15112022	28.1	44H2	57°35.29′	22°56.32′	07:28	30	3.1	335	40	22	38	16	75	100	18.077
15	16112022	28.1	43H3	57°27.09′	23°22.08′	21:02	20	2.9	250	43	25	43	18	79	100	50.9455
16	17112022	28.1	44H3	57°31.28′	23°42.23′	06:00	20	2.8	250	50	32	49	17	74	115	181.314
17	17112022	28.1	43H4	57°27.94′	24°12.11′	10:45	30	2.9	15	35	19	35	16	75	90	36.15
															SD26	653.2679
															SD28.2	1826.202
															SD28.1	864.5017
															SUM	3343.972

Table 2. Number of measured and aged fish individuals in the Baltic Sea ICES SD 26N and 28 from the Latvian Baltic International Acoustic Survey on the f/v "Albatross 3", 06-17.11.2022.

Species	Measured	Analised
Herring	1894	863
Sprat	1816	837
Cod	5	
Flounder	7	
Threespined Stickleback	524	
Ninespine stickleback	1	
Smelt	31	
Lumpfish	4	
Salmon	1	
Fourhorn sculpin	7	
Shorthorn sculpin	3	
Eelpout	7	
Striped seasnail	3	
Lamprey	4	
SUM	4307	1700

Table 3. Fish control-catch results [kg] by species in the Baltic Sea ICES SD 26N and 28 from the Latvian Baltic International Acoustic Survey on the f/v "Albatross 3", 06-17.11.2022.

Species	SD26	SD28.2	SD28.1	SUM
Herring	125.52323	406.3338	608.33179	1140.1888
Sprat	469.72627	1403.2701	242.51808	2115.5145
Cod		1.554		1.554
Flounder	0.1106	0.513	0.2565	0.8801
Threespined Stickleback	57.535806	13.396071	10.880992	81.812869
Ninespine stickleback			0.005	0.005
Smelt		0.03	0.883381	0.913381
Lumpfish	0.262	0.26		0.522
Salmon	0.11			0.11
Fourhorn sculpin		0.43	0.765	1.195
Shorthorn sculpin		0.36		0.36
Eelpout			0.581	0.581
Striped seasnail			0.037	0.037
Lamprey		0.055	0.243	0.298
SUM	653.2679	1826.202	864.50173	3343.9716

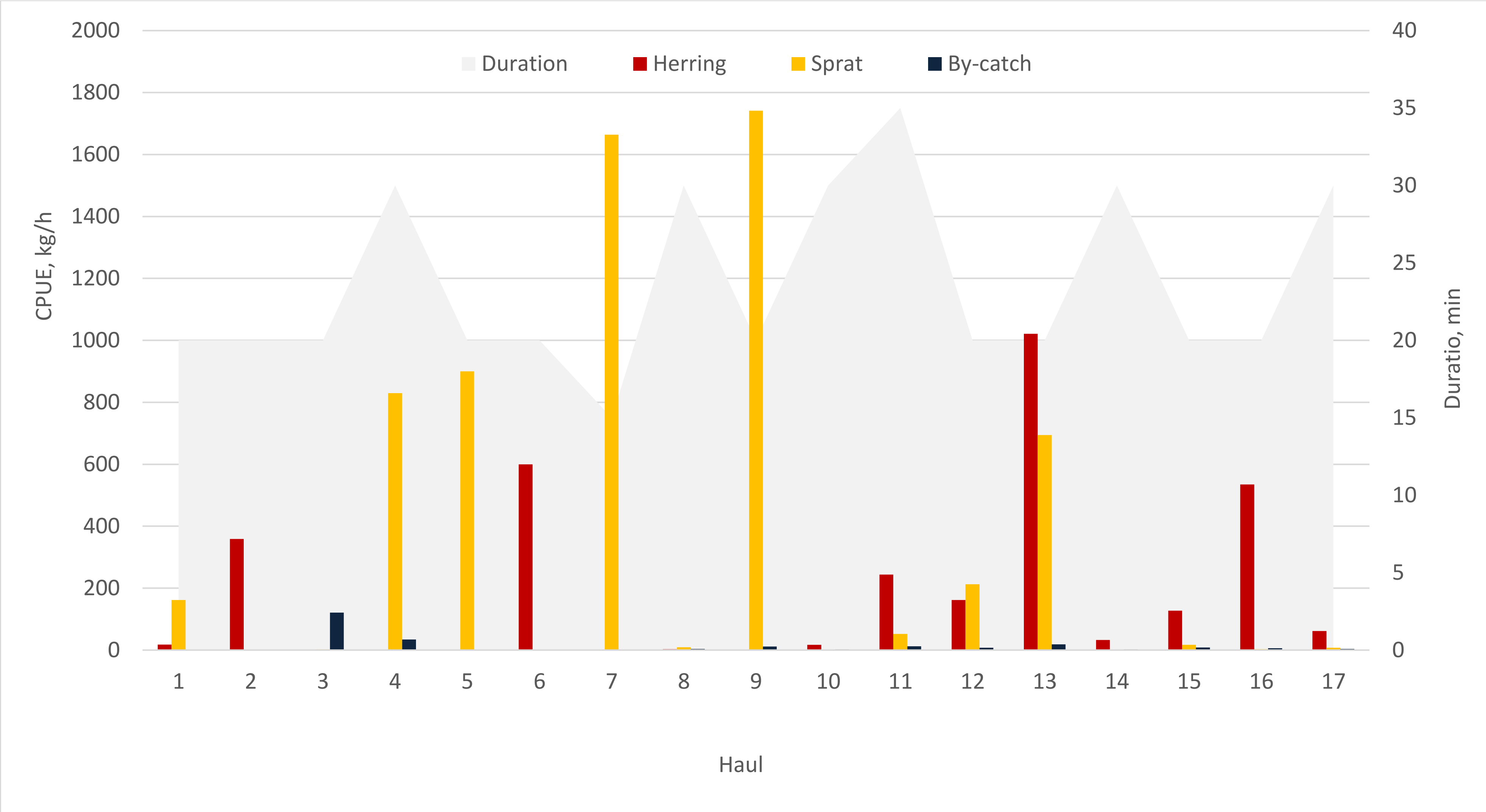

Figure 3. CPUE [kg/h] ranges distribution of sprat and herring in the catch hauls in the Baltic Sea ICES SD 26N and 28 from the Latvian Baltic International Acoustic Survey on the f/v "Albatross 3", 06-17.11.2022.

Table 4. Survey statistics of pelagic fish species from the Latvian BIAS in the Baltic Sea ICES SD 26N and 28 conducted by the f/v "Albatross 3", 06-17.11.2022.

Rectangle	Area, nm^2	PEL NASC, m^2/nm^2	PEL, %	σ, m^2/m^2*10^4	TS, db	ρ, n*10^6/nm^2	Total n*10^6	HER %	SPR%	SME%	GTA%	GPT%
41G9	1000.0	622.81	99.99	0.58216	-53.34	10.70	10698.37	1.05	21.73		77.23	
41H0	953.3	1040.58	99.99	1.16298	-50.34	8.95	8529.68	17.80	61.12		21.08	
42G9	986.9	568.16	100.00	1.43093	-49.44	3.97	3918.54		100.00			
42H0	968.5	1433.93	100.00	2.16392	-47.64	6.63	6417.80	54.04	45.84		0.12	
43H0	973.7	1102.76	99.99	1.00865	-50.95	10.93	10645.48	2.17	62.55	0.0005	35.28	
43H1	412.7	495.30	99.98	1.31781	-49.79	3.76	1551.13		96.91	0.002	3.09	
43H3	670.0	2797.67	99.90	1.44437	-49.40	19.37	12977.54	78.26	6.11	0.18	15.45	0.002
43H4	213.0	870.80	99.98	1.18014	-50.27	7.38	1571.67	69.88	8.28	0.17	21.65	0.02
44H0	960.5	1365.47	99.98	1.39721	-49.54	9.77	9386.79	63.28	14.12	0.00002	22.60	
44H1	824.6	1031.87	99.97	1.51922	-49.18	6.79	5600.78	33.97	56.96	0.03	9.04	
44H2	556.0	4358.55	99.99	1.32084	-49.78	33.00	18347.08	54.22	37.00	0.33	8.45	
44H3	963.0	2004.70	99.90	1.36194	-49.65	14.72	14174.88	80.08	5.17	0.16	14.60	
SD26	1953.3	831.70	99.99	0.84489	-51.72	9.84	19228.05	8.48	39.20		52.32	
SD28.2	5126.9	999.58	99.99	1.36585	-49.64	7.32	37520.51	30.76	52.07	0.004	17.16	
Total_OS	7080.2	915.64	99.99	1.14239	-50.41	8.02	56748.56	23.21	47.71	0.003	29.07	
SD28.1	2402.0	2507.93	99.95	1.27977	-49.92	19.60	47071.17	69.16	17.94	0.23	12.67	0.001
Total	9482.2	1474.38	99.96	1.34660	-49.70	10.95	103819.74	44.04	34.21	0.11	21.64	0.001

Table 5. Sprat stock characteristics from the Latvian BIAS
in the Baltic Sea ICES SD 26N and 28 conducted by the f/v “Albatross 3”, 06-17.11.2022.

CANUM	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	1327	1218	2733	4548	1916	1832	511	133	1285	15502
41H0	5705	6110	10165	26439	11060	11553	4917	2110	11633	89694
42G9	4169	19801	29851	5806	6526	0	794	1588	5906	74442
42H0	9619	25773	62718	110101	34623	27134	8901	6055	19473	304399
43H0	8973	34473	69016	117750	44073	17765	10397	0	9632	312079
43H1	9263	35314	64887	123061	45652	18644	10628	0	3793	311241
43H3	171	213	490	919	339	215	93	6	202	2648
43H4	65	52	112	233	89	62	27	3	36	679
44H0	2229	9225	19370	66310	22041	21461	8389	0	10314	159337
44H1	8317	20447	42127	101688	29812	18600	7015	361	13678	242044
44H2	3110	4814	12020	24015	8425	4806	2021	72	3820	63102
44H3	106	161	378	686	251	153	66	4	166	1969
SD26	7032	7328	12898	30987	12976	13385	5428	2243	12918	105196
SD28.2	42569	145034	287969	524716	182727	103603	46124	8004	62794	1403542
Total_OS	49601	152363	300868	555703	195703	116988	51552	10248	75712	1508738
SD28.1	3452	5240	13000	25852	9103	5236	2207	84	4223	68398
Total	53054	157602	313868	581555	204807	122223	53760	10332	79936	1577136

n, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	8.56	7.86	17.63	29.33	12.36	11.82	3.29	0.86	8.29	100.00
41H0	6.36	6.81	11.33	29.48	12.33	12.88	5.48	2.35	12.97	100.00
42G9	5.60	26.60	40.10	7.80	8.77	0.00	1.07	2.13	7.93	100.00
42H0	3.16	8.47	20.60	36.17	11.37	8.91	2.92	1.99	6.40	100.00
43H0	2.88	11.05	22.11	37.73	14.12	5.69	3.33	0.00	3.09	100.00
43H1	2.98	11.35	20.85	39.54	14.67	5.99	3.41	0.00	1.22	100.00
43H3	6.46	8.05	18.51	34.69	12.81	8.11	3.51	0.23	7.62	100.00
43H4	9.62	7.67	16.57	34.33	13.07	9.07	3.99	0.38	5.31	100.00
44H0	1.40	5.79	12.16	41.62	13.83	13.47	5.26	0.00	6.47	100.00
44H1	3.44	8.45	17.40	42.01	12.32	7.68	2.90	0.15	5.65	100.00
44H2	4.93	7.63	19.05	38.06	13.35	7.62	3.20	0.11	6.05	100.00
44H3	5.38	8.17	19.18	34.82	12.73	7.79	3.34	0.18	8.42	100.00
SD26	6.68	6.97	12.26	29.46	12.34	12.72	5.16	2.13	12.28	100.00
SD28.2	3.03	10.33	20.52	37.39	13.02	7.38	3.29	0.57	4.47	100.00
Total_OS	3.29	10.10	19.94	36.83	12.97	7.75	3.42	0.68	5.02	100.00
SD28.1	5.05	7.66	19.01	37.80	13.31	7.65	3.23	0.12	6.17	100.00
Total	3.36	9.99	19.90	36.87	12.99	7.75	3.41	0.66	5.07	100.00

Table 5. Continued.

n, 10^6	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	198.9	182.6	409.8	681.8	287.2	274.7	76.6	19.9	192.7	2324.3
41H0	331.6	355.1	590.8	1536.7	642.9	671.5	285.8	122.7	676.1	5213.2
42G9	219.4	1042.3	1571.3	305.6	343.5	0.0	41.8	83.6	310.9	3918.5
42H0	93.0	249.1	606.2	1064.2	334.7	262.3	86.0	58.5	188.2	2942.2
43H0	191.4	735.5	1472.5	2512.3	940.3	379.0	221.8	0.0	205.5	6658.4
43H1	44.7	170.6	313.4	594.3	220.5	90.0	51.3	0.0	18.3	1503.2
43H3	51.2	63.8	146.7	275.1	101.6	64.3	27.8	1.8	60.4	792.9
43H4	12.5	10.0	21.6	44.7	17.0	11.8	5.2	0.5	6.9	130.1
44H0	18.5	76.8	161.2	551.7	183.4	178.6	69.8	0.0	85.8	1325.7
44H1	109.6	269.5	555.3	1340.3	392.9	245.2	92.5	4.8	180.3	3190.4
44H2	334.6	517.9	1293.2	2583.7	906.4	517.1	217.5	7.7	411.0	6789.1
44H3	39.4	59.9	140.5	255.0	93.2	57.0	24.5	1.3	61.7	732.4
SD26	530.5	537.8	1000.6	2218.5	930.1	946.1	362.4	142.6	868.8	7537.5
SD28.2	676.8	2543.8	4679.9	6368.5	2415.3	1155.0	563.3	146.9	989.0	19538.4
Total_OS	1207.3	3081.6	5680.5	8587.0	3345.4	2101.2	925.6	289.5	1857.8	27075.8
SD28.1	437.7	651.5	1602.0	3158.5	1118.2	650.2	275.0	11.4	540.0	8444.5
Total	1645.0	3733.1	7282.5	11745.5	4463.6	2751.4	1200.6	300.9	2397.8	35520.3

<w>, g	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	5.00	9.99	10.44	10.96	11.09	11.55	12.37	12.08	12.42	10.54
41H0	5.15	9.97	10.77	11.24	11.54	11.87	12.38	11.95	12.60	11.09
42G9	10.92	11.58	11.83	13.26	12.62	0.00	15.56	13.55	13.35	12.09
42H0	5.08	9.80	10.88	11.23	11.80	12.15	12.19	12.37	12.90	11.15
43H0	4.97	9.84	10.74	11.21	11.46	12.44	12.38	0.00	11.96	10.94
43H1	5.00	10.10	10.67	11.17	11.53	12.48	12.07	0.00	12.75	10.94
43H3	4.07	9.74	10.43	11.14	11.51	12.57	12.33	13.50	13.02	10.79
43H4	4.60	8.92	10.51	11.49	11.96	12.95	12.77	14.17	12.71	10.79
44H0	4.27	8.87	10.79	11.18	11.66	11.96	12.00	0.00	12.40	11.20
44H1	4.76	10.43	10.84	11.38	11.65	12.17	12.17	13.83	12.49	11.16
44H2	4.41	10.21	10.87	11.38	11.58	12.24	11.98	13.40	12.47	11.03
44H3	3.75	10.00	10.41	11.02	11.35	12.42	12.15	13.00	13.09	10.79
SD26	5.10	9.97	10.63	11.15	11.40	11.78	12.38	11.97	12.56	10.92
SD28.2	6.86	10.60	11.13	11.34	11.72	12.24	12.48	13.09	12.73	11.26
Total_OS	6.09	10.49	11.04	11.29	11.63	12.03	12.44	12.54	12.65	11.16
SD28.1	4.31	10.12	10.79	11.33	11.56	12.30	12.05	13.40	12.61	10.98
Total	5.62	10.43	10.99	11.30	11.62	12.10	12.35	12.57	12.64	11.12

Table 5. Continued.

w, kg*10^3	Age								
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	995.3	1823.8	4277.3	7473.2	3185.5	3172.6	947.5	240.9	2392.7	24508.8
41H0	1708.0	3539.0	6363.7	17269.8	7419.0	7969.9	3537.9	1465.9	8520.4	57793.7
42G9	2396.9	12072.1	18585.4	4052.6	4334.7	0.0	650.5	1133.0	4150.0	47375.2
42H0	472.3	2442.5	6597.6	11950.8	3950.4	3187.1	1048.5	724.1	2428.3	32801.8
43H0	951.7	7233.9	15810.2	28173.2	10772.7	4713.6	2745.5	0.0	2457.8	72858.6
43H1	223.5	1722.1	3344.1	6640.0	2542.5	1123.3	619.3	0.0	233.5	16448.2
43H3	208.8	621.1	1531.1	3063.6	1169.0	808.7	343.0	24.8	786.7	8556.9
43H4	57.5	89.0	226.4	513.3	203.4	152.7	66.2	7.1	87.8	1403.5
44H0	79.2	680.7	1739.7	6168.5	2139.2	2135.2	837.9	0.0	1063.9	14844.3
44H1	521.9	2812.3	6016.8	15253.8	4575.9	2983.4	1125.3	65.7	2252.2	35607.3
44H2	1474.2	5285.7	14060.3	29400.1	10495.2	6327.9	2605.8	103.5	5125.4	74878.1
44H3	147.7	598.9	1462.5	2809.5	1057.5	708.1	297.6	17.1	806.9	7905.7
SD26	2703.3	5362.9	10641.0	24742.9	10604.5	11142.5	4485.4	1706.9	10913.1	82302.5
SD28.2	4645.6	26963.6	52093.8	72238.9	28315.3	14142.7	7026.9	1922.9	12585.7	219935.3
Total_OS	7348.9	32326.4	62734.8	96981.9	38919.9	25285.1	11512.4	3629.7	23498.8	302237.9
SD28.1	1888.2	6594.8	17280.3	35786.5	12925.1	7997.4	3312.7	152.4	6806.7	92744.2
Total	9237.1	38921.2	80015.1	132768.4	51845.0	33282.5	14825.1	3782.2	30305.5	394982.0

w, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	4.06	7.44	17.45	30.49	13.00	12.94	3.87	0.98	9.76	100.00
41H0	2.96	6.12	11.01	29.88	12.84	13.79	6.12	2.54	14.74	100.00
42G9	5.06	25.48	39.23	8.55	9.15	0.00	1.37	2.39	8.76	100.00
42H0	1.44	7.45	20.11	36.43	12.04	9.72	3.20	2.21	7.40	100.00
43H0	1.31	9.93	21.70	38.67	14.79	6.47	3.77	0.00	3.37	100.00
43H1	1.36	10.47	20.33	40.37	15.46	6.83	3.77	0.00	1.42	100.00
43H3	2.44	7.26	17.89	35.80	13.66	9.45	4.01	0.29	9.19	100.00
43H4	4.10	6.34	16.13	36.57	14.49	10.88	4.72	0.51	6.25	100.00
44H0	0.53	4.59	11.72	41.55	14.41	14.38	5.64	0.00	7.17	100.00
44H1	1.47	7.90	16.90	42.84	12.85	8.38	3.16	0.18	6.33	100.00
44H2	1.97	7.06	18.78	39.26	14.02	8.45	3.48	0.14	6.84	100.00
44H3	1.87	7.58	18.50	35.54	13.38	8.96	3.76	0.22	10.21	100.00
SD26	3.28	6.52	12.93	30.06	12.88	13.54	5.45	2.07	13.26	100.00
SD28.2	2.11	12.26	23.69	32.85	12.87	6.43	3.20	0.87	5.72	100.00
Total_OS	2.43	10.70	20.76	32.09	12.88	8.37	3.81	1.20	7.77	100.00
SD28.1	2.04	7.11	18.63	38.59	13.94	8.62	3.57	0.16	7.34	100.00
Total	2.34	9.85	20.26	33.61	13.13	8.43	3.75	0.96	7.67	100.00

Table 5. Continued.

<L>, cm	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	8.97	11.05	11.23	11.49	11.56	11.77	12.21	12.00	12.24	11.33
41H0	9.03	11.05	11.44	11.66	11.84	12.01	12.33	12.06	12.44	11.64
42G9	11.46	11.73	11.86	12.57	12.24	0.00	13.47	12.77	12.64	11.99
42H0	9.05	11.03	11.49	11.65	11.93	12.10	12.08	12.22	12.49	11.63
43H0	8.94	11.02	11.41	11.62	11.73	12.20	12.22	0.00	12.00	11.51
43H1	8.96	11.13	11.38	11.60	11.77	12.22	12.07	0.00	12.42	11.51
43H3	8.61	11.13	11.41	11.73	11.92	12.47	12.41	13.00	12.77	11.61
43H4	8.80	10.94	11.47	11.84	12.04	12.44	12.38	13.00	12.30	11.55
44H0	8.29	10.59	11.39	11.57	11.81	11.95	12.03	0.00	12.17	11.59
44H1	8.79	11.23	11.42	11.70	11.83	12.11	12.17	13.00	12.29	11.61
44H2	8.72	11.14	11.47	11.76	11.87	12.25	12.11	13.00	12.36	11.61
44H3	8.50	11.19	11.39	11.69	11.88	12.48	12.42	13.00	12.88	11.63
SD26	9.01	11.05	11.35	11.61	11.75	11.94	12.30	12.05	12.40	11.54
SD28.2	9.72	11.34	11.57	11.69	11.86	12.13	12.26	12.56	12.38	11.65
Total_OS	9.41	11.29	11.53	11.67	11.83	12.04	12.28	12.31	12.39	11.62
SD28.1	8.71	11.13	11.46	11.76	11.88	12.29	12.17	13.00	12.43	11.61
Total	9.22	11.26	11.51	11.69	11.84	12.10	12.25	12.33	12.40	11.62

Table 6. Herring stock characteristics from the Latvian BIAS
in the Baltic Sea ICES SD 26N and 28 conducted by the f/v “Albatross 3”, 06-17.11.2022.

CANUM	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	0	128	672	4095	4277	1269	1446	1198	321	13406
41H0	0	128	672	4095	4277	1269	1446	1198	321	13406
42G9	0	0	0	0	0	0	0	0	0	0
42H0	0	485	422	3797	2384	4799	1403	1804	1466	16559
43H0	0	0	6	25	25	25	10	19	10	121
43H1	0	0	0	0	0	0	0	0	0	0
43H3	18704	3665	4672	8972	5140	4052	1899	535	1652	49290
43H4	3236	834	537	598	208	148	60	55	55	5731
44H0	31422	2540	1402	7075	2897	2128	731	915	562	49671
44H1	61403	7051	6063	19845	8257	6445	2618	2822	2226	116730
44H2	36868	4194	5076	8928	2363	3942	1810	326	0	63507
44H3	15468	2772	3771	8285	5337	4057	1916	267	1686	43559
SD26	0	256	1345	8191	8554	2537	2892	2396	641	26813
SD28.2	92824	10076	7893	30743	13563	13398	4761	5560	4263	183082
Total_OS	92824	10333	9238	38933	22117	15935	7653	7957	4905	209895
SD28.1	74276	11465	14057	26782	13048	12199	5685	1183	3393	162087
Total	167100	21798	23295	65715	35165	28134	13338	9139	8298	371982

n, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	0.00	0.96	5.02	30.55	31.90	9.46	10.78	8.94	2.39	100.00
41H0	0.00	0.96	5.02	30.55	31.90	9.46	10.78	8.94	2.39	100.00
42G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42H0	0.00	2.93	2.55	22.93	14.39	28.98	8.47	10.89	8.85	100.00
43H0	0.00	0.00	5.26	21.05	21.05	21.05	7.89	15.79	7.89	100.00
43H1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43H3	37.95	7.44	9.48	18.20	10.43	8.22	3.85	1.08	3.35	100.00
43H4	56.46	14.55	9.38	10.43	3.64	2.58	1.05	0.96	0.96	100.00
44H0	63.26	5.11	2.82	14.24	5.83	4.28	1.47	1.84	1.13	100.00
44H1	52.60	6.04	5.19	17.00	7.07	5.52	2.24	2.42	1.91	100.00
44H2	58.05	6.60	7.99	14.06	3.72	6.21	2.85	0.51	0.00	100.00
44H3	35.51	6.36	8.66	19.02	12.25	9.31	4.40	0.61	3.87	100.00
SD26	0.00	0.96	5.02	30.55	31.90	9.46	10.78	8.94	2.39	100.00
SD28.2	50.70	5.50	4.31	16.79	7.41	7.32	2.60	3.04	2.33	100.00
Total_OS	44.22	4.92	4.40	18.55	10.54	7.59	3.65	3.79	2.34	100.00
SD28.1	45.82	7.07	8.67	16.52	8.05	7.53	3.51	0.73	2.09	100.00
Total	44.92	5.86	6.26	17.67	9.45	7.56	3.59	2.46	2.23	100.00

Table 6. Continued.

n, 10^6	Age								
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	0.0	1.1	5.6	34.2	35.7	10.6	12.1	10.0	2.7	112.0
41H0	0.0	14.5	76.2	463.8	484.4	143.7	163.7	135.7	36.3	1518.3
42G9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42H0	0.0	101.6	88.4	795.2	499.2	1005.1	293.8	377.7	307.1	3468.2
43H0	0.0	0.0	12.2	48.7	48.7	48.7	18.3	36.5	18.3	231.2
43H1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43H3	3854.0	755.2	962.7	1848.8	1059.1	835.0	391.3	110.1	340.4	10156.6
43H4	620.1	159.7	103.0	114.6	39.9	28.4	11.6	10.5	10.5	1098.3
44H0	3757.6	303.7	167.7	846.1	346.4	254.5	87.4	109.5	67.2	5940.0
44H1	1000.8	114.9	98.8	323.4	134.6	105.0	42.7	46.0	36.3	1902.5
44H2	5774.7	656.9	795.1	1398.4	370.1	617.4	283.5	51.0	0.0	9947.1
44H3	4030.8	722.4	982.7	2158.9	1390.7	1057.2	499.2	69.7	439.5	11351.1
SD26	0.0	15.6	81.8	498.0	520.1	154.3	175.8	145.7	39.0	1630.3
SD28.2	4758.4	520.2	367.0	2013.5	1028.9	1413.3	442.1	569.7	428.8	11541.9
Total_OS	4758.4	535.8	448.8	2511.5	1549.0	1567.6	617.9	715.4	467.8	13172.1
SD28.1	14279.6	2294.3	2843.5	5520.6	2859.8	2537.9	1185.6	241.4	790.4	32553.1
Total	19038.0	2830.1	3292.3	8032.1	4408.8	4105.5	1803.5	956.8	1258.2	45725.2

<w>, g	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	0.00	18.45	23.80	25.42	25.56	29.75	29.94	32.92	34.59	27.10
41H0	0.00	18.45	23.80	25.42	25.56	29.75	29.94	32.92	34.59	27.10
42G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42H0	0.00	31.67	31.53	32.37	34.17	37.34	39.28	38.42	43.24	36.23
43H0	0.00	0.00	27.22	23.80	26.38	25.93	29.08	23.70	27.64	25.67
43H1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43H3	4.68	16.22	19.18	22.02	23.34	23.28	25.71	25.40	27.78	15.35
43H4	4.70	14.45	17.09	20.49	24.60	22.07	25.18	29.23	24.15	10.74
44H0	6.65	13.68	19.47	21.29	23.10	23.28	26.59	25.15	24.55	11.96
44H1	5.98	16.74	22.90	23.60	28.38	29.48	30.10	32.17	33.40	15.08
44H2	5.14	19.31	25.08	26.84	33.58	30.71	35.07	40.90	0.00	14.41
44H3	4.67	16.83	19.41	21.74	22.80	23.44	26.95	29.77	27.67	15.96
SD26	0.00	18.45	23.80	25.42	25.56	29.75	29.94	32.92	34.59	27.10
SD28.2	6.51	17.87	23.56	26.10	29.32	33.83	35.46	34.42	38.81	20.05
Total_OS	6.51	17.89	23.60	25.97	28.06	33.43	33.89	34.12	38.46	20.92
SD28.1	4.87	17.18	20.84	23.10	24.42	25.14	28.46	30.11	27.67	15.12
Total	5.28	17.31	21.21	23.99	25.70	28.30	30.32	33.11	31.68	16.79

Table 6. Continued.

w, kg*10^3										
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	0.0	19.8	133.7	869.8	913.3	315.3	361.7	329.6	92.6	3035.7
41H0	0.0	268.0	1812.8	11790.3	12380.5	4274.3	4902.8	4467.5	1255.9	41152.1
42G9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42H0	0.0	3218.5	2785.6	25744.3	17058.2	37526.8	11539.9	14512.6	13276.2	125662.0
43H0	0.0	0.0	331.2	1158.2	1284.1	1261.9	530.8	865.0	504.4	5935.6
43H1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43H3	18022.9	12252.5	18466.8	40710.1	24718.9	19441.5	10062.3	2798.1	9458.3	155931.4
43H4	2913.1	2308.0	1760.7	2347.7	982.5	626.4	291.1	307.1	253.8	11790.4
44H0	24976.0	4154.9	3265.3	18017.1	8003.3	5923.7	2323.7	2753.1	1649.2	71066.3
44H1	5982.4	1923.3	2262.9	7631.6	3819.6	3097.2	1284.3	1479.9	1211.7	28692.9
44H2	29709.6	12687.8	19944.2	37530.3	12429.0	18959.6	9942.6	2087.2	0.0	143290.2
44H3	18831.2	12157.8	19077.5	46924.1	31707.8	24778.0	13451.5	2074.8	12162.1	181164.7
SD26	0.0	287.7	1946.6	12660.1	13293.7	4589.6	5264.5	4797.1	1348.5	44187.8
SD28.2	30958.4	9296.7	8644.9	52551.3	30165.3	47809.5	15678.7	19610.5	16641.5	231356.8
Total_OS	30958.4	9584.4	10591.4	65211.4	43459.0	52399.2	20943.2	24407.6	17990.1	275544.7
SD28.1	69476.7	39406.1	59249.2	127512.2	69838.1	63805.5	33747.5	7267.3	21874.2	492176.8
Total	100435.2	48990.5	69840.6	192723.6	113297.1	116204.6	54690.7	31674.9	39864.3	767721.5

w, %										
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	0.00	0.65	4.41	28.65	30.08	10.39	11.91	10.86	3.05	100.00
41H0	0.00	0.65	4.41	28.65	30.08	10.39	11.91	10.86	3.05	100.00
42G9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42H0	0.00	2.56	2.22	20.49	13.57	29.86	9.18	11.55	10.56	100.00
43H0	0.00	0.00	5.58	19.51	21.63	21.26	8.94	14.57	8.50	100.00
43H1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
43H3	11.56	7.86	11.84	26.11	15.85	12.47	6.45	1.79	6.07	100.00
43H4	24.71	19.58	14.93	19.91	8.33	5.31	2.47	2.61	2.15	100.00
44H0	35.14	5.85	4.59	25.35	11.26	8.34	3.27	3.87	2.32	100.00
44H1	20.85	6.70	7.89	26.60	13.31	10.79	4.48	5.16	4.22	100.00
44H2	20.73	8.85	13.92	26.19	8.67	13.23	6.94	1.46	0.00	100.00
44H3	10.39	6.71	10.53	25.90	17.50	13.68	7.43	1.15	6.71	100.00
SD26	0.00	0.65	4.41	28.65	30.08	10.39	11.91	10.86	3.05	100.00
SD28.2	13.38	4.02	3.74	22.71	13.04	20.66	6.78	8.48	7.19	100.00
Total_OS	11.24	3.48	3.84	23.67	15.77	19.02	7.60	8.86	6.53	100.00
SD28.1	14.12	8.01	12.04	25.91	14.19	12.96	6.86	1.48	4.44	100.00
Total	13.08	6.38	9.10	25.10	14.76	15.14	7.12	4.13	5.19	100.00

Table 6. Continued.

<L>, cm	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
41G9	0.00	14.50	15.78	16.26	16.31	17.15	17.24	17.60	18.20	16.59
41H0	0.00	14.50	15.78	16.26	16.31	17.15	17.24	17.60	18.20	16.59
42G9	0.00	16.02	16.15	16.26	16.51	16.98	17.32	17.16	0.00	0.00
42H0	0.00	16.02	16.15	16.26	16.51	16.98	17.32	17.16	17.93	16.83
43H0	0.00	0.00	16.00	15.44	16.19	16.06	17.00	15.58	16.33	15.97
43H1	0.00	0.00	16.00	15.44	16.19	16.06	17.00	15.58	0.00	0.00
43H3	9.52	13.57	14.29	15.06	15.41	15.60	16.17	16.33	16.36	12.96
43H4	9.64	13.27	14.07	14.93	15.59	15.06	15.41	16.25	16.50	11.68
44H0	10.72	13.25	14.72	15.22	15.72	15.69	16.33	16.05	16.18	12.35
44H1	10.31	13.88	15.17	15.30	16.12	16.32	16.43	16.75	17.03	12.79
44H2	9.81	14.24	15.32	15.59	16.31	16.27	16.86	18.00	0.00	12.24
44H3	9.50	13.67	14.33	15.01	15.32	15.66	16.26	16.47	16.36	13.12
SD26	0.00	14.50	15.78	16.26	16.31	17.15	17.24	17.60	18.20	16.59
SD28.2	10.58	14.14	15.34	15.73	16.25	16.74	17.08	16.88	17.56	14.21
Total_OS	10.58	14.15	15.43	15.84	16.27	16.79	17.13	17.04	17.64	14.56
SD28.1	9.67	13.71	14.60	15.21	15.58	15.80	16.37	16.70	16.38	12.55
Total	9.89	13.81	14.69	15.36	15.74	16.14	16.61	16.91	16.81	13.17

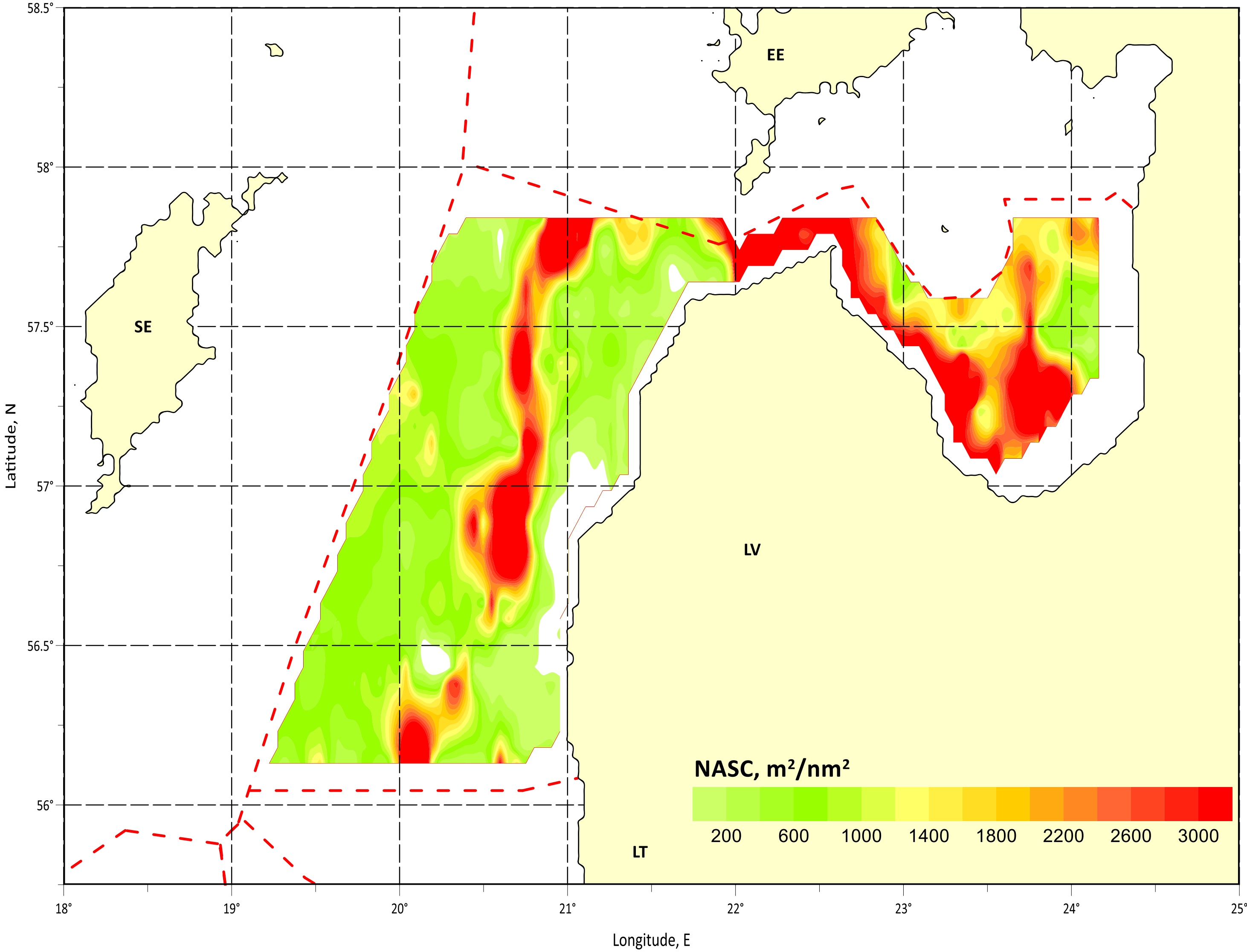

Figure 4. Acoustic parameter NASC distribution from the Latvian BIAS in the Baltic Sea ICES SD 26N and 28 conducted by the f/v "Albatross 3", 06-17.11.2022.

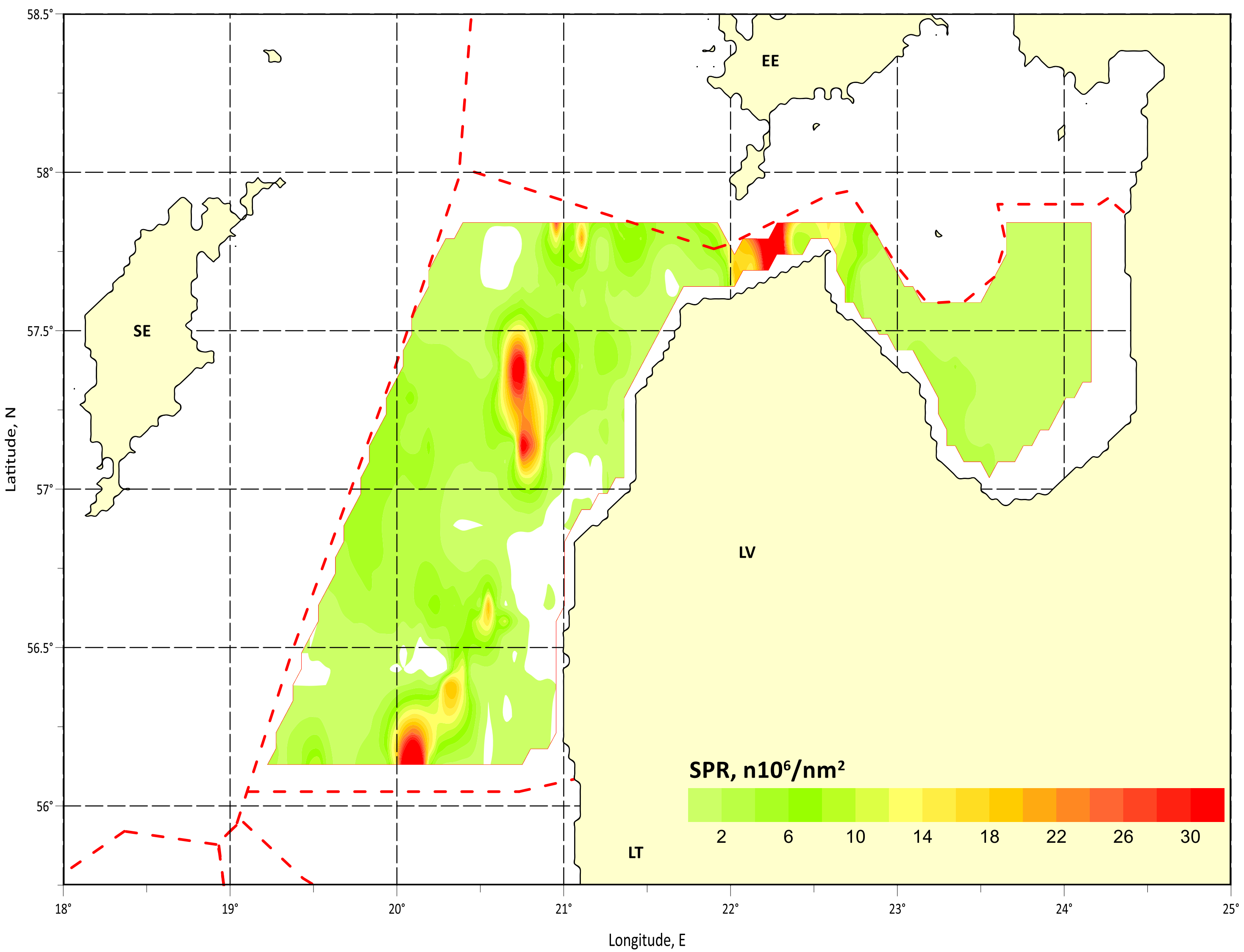

Figure 5. Sprat distribution (n×10^{6}) from the Latvian BIAS in the Baltic Sea ICES SD 26N and 28 conducted by the f/v “Albatross 3”, 06-17.11.2022.

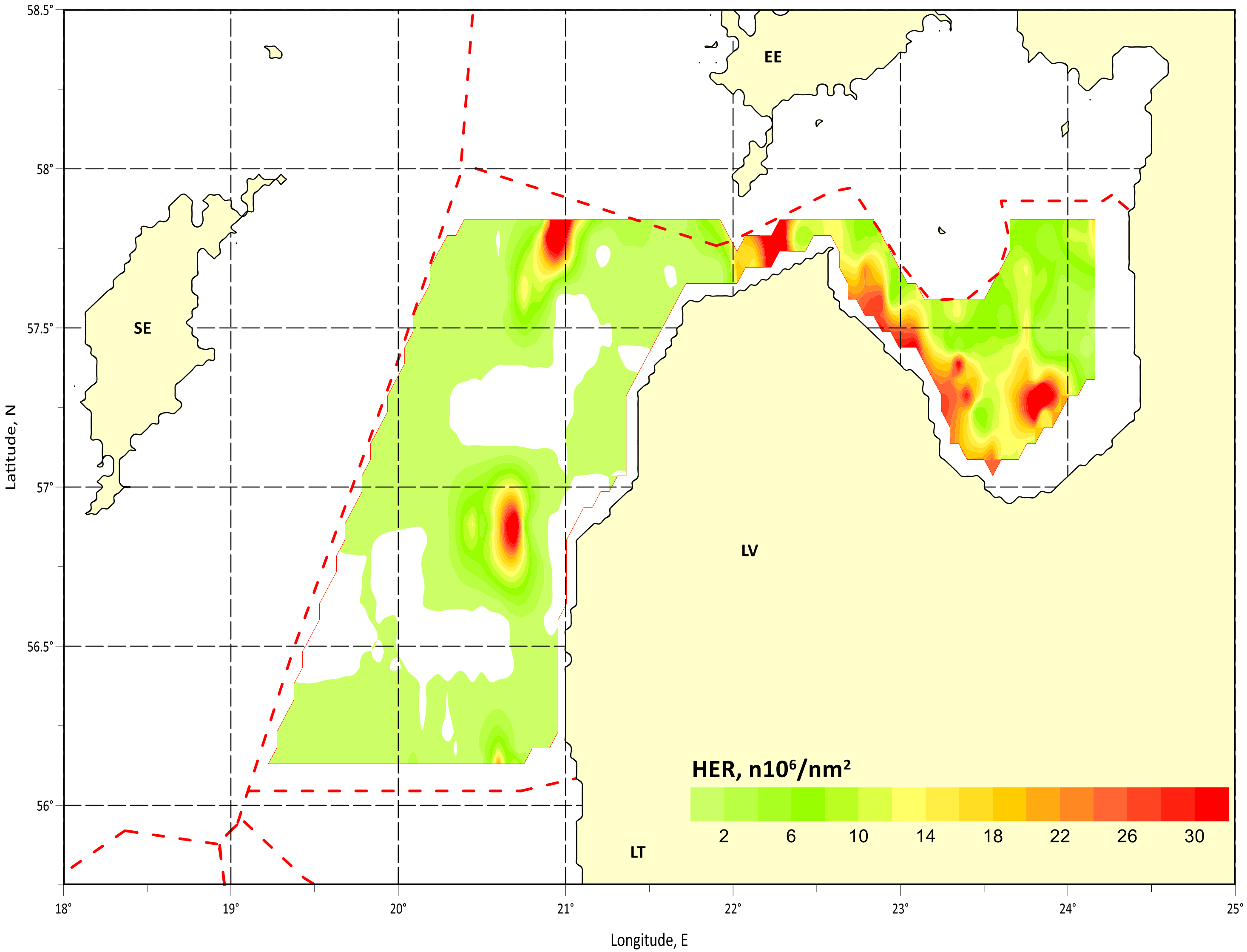

Figure 6. Herring distribution (n×10^6) from the Latvian BIAS in the Baltic Sea ICES SD 26N and 28 conducted by the f/v "Albatross 3", 06-17.11.2022.

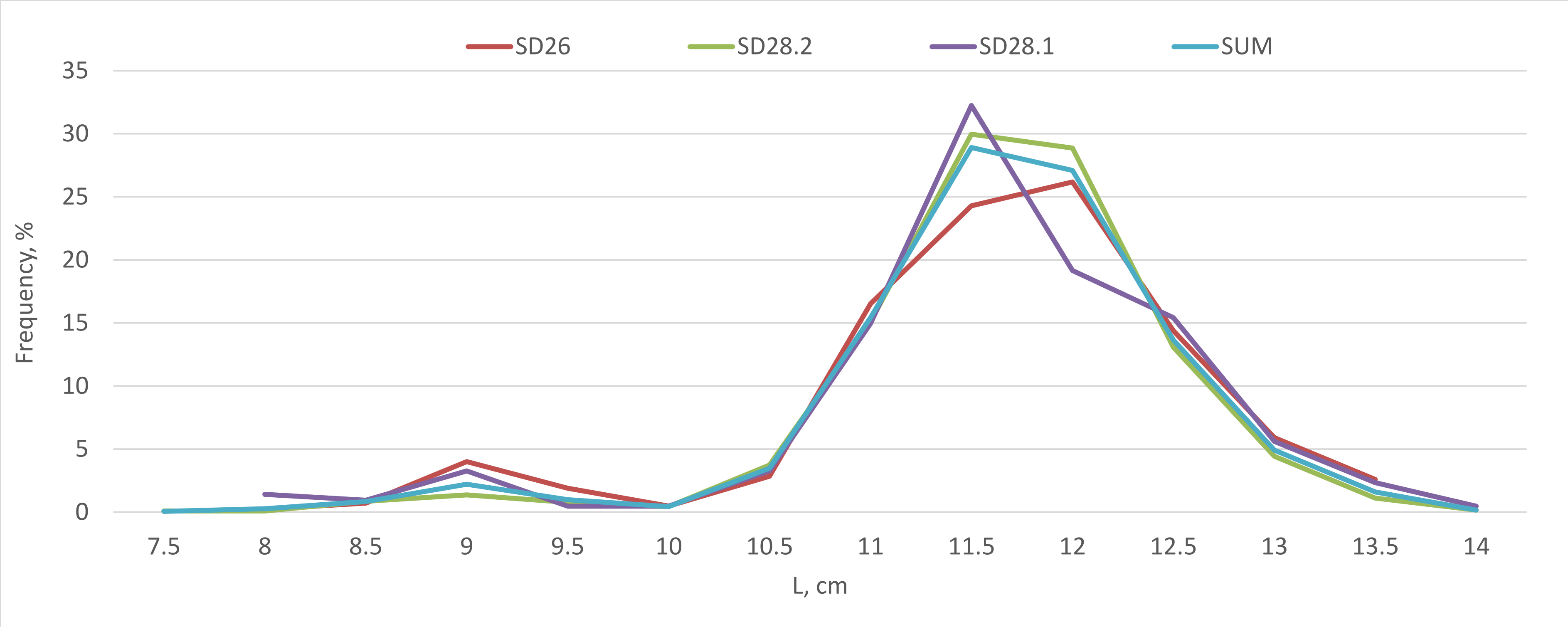

Figure 7. Sprat length distributions in control catches in the Baltic Sea ICES SD 26N and 28 from the Latvian-Polish BASS conducted by the f/v “Albatross 3”, 06-17.11.2022.

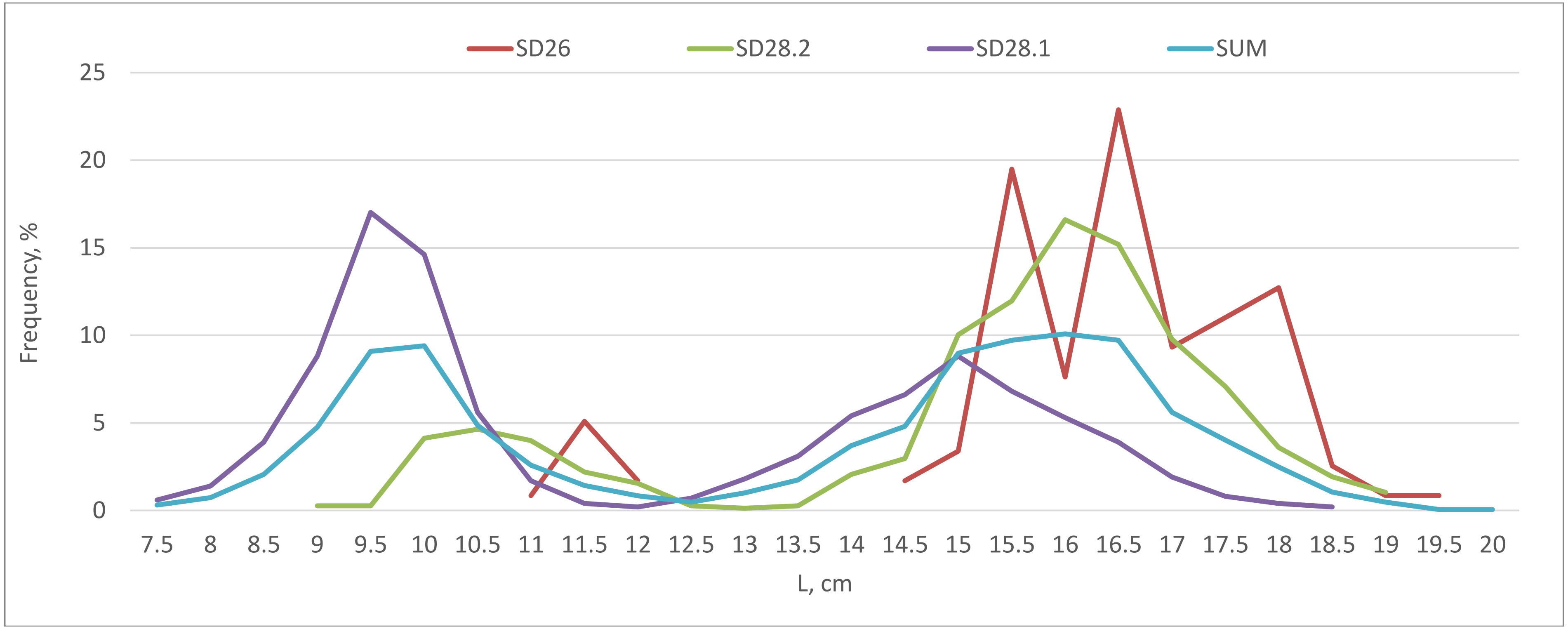

Figure 8. Herring length distributions in control catches in the Baltic Sea ICES SD 26N and 28 from the Latvian-Polish BASS conducted by the f/v “Albatross 3”, 06-17.11.2022.

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 “Palanga1”;“NZ55”; 24 - 25.10.2022)

Working paper on the WGBIFS meeting in Cadis, Spain,
19.03-24.03.2023

Vessel “Palanga1”

Vessel “NZ55”

Klaipeda, October, 2022
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 vessel “Palanga1”. 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 “NZ55”.

2. MATERIALS AND METHODS

2.1. Personnel

The main research tasks of the BIAS survey on board of the vessel "Palanga1" 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 24 to 25-th of October 2022. 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 2016). 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 111 nm. The entire cruise track with positions of the trawling is shown in Fig. 1.

2.4. Calibration

The SIMRAD EK80 echo sounder with split beam transducer ES38 - 10 was calibrated (22 of October 2022) at the site of 20 m depth, located 3. nm northwest of Klaipeda harbor according to the BIAS manual (ICES 2016). Sv correction after calibration was set to -0.104 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)	24.64 dB
Athw. Angle Sens	9.6
Along. Angle Sens	9,6
Athw. Beam Angle	9.15
Along. Beam Angle	8.87
Athw. Offset Angle	-0.01
Along. Offset Angle	-0.16
SA Correction (38 kHz)	-0.104 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 ES38-10 was used during the cruise. The specific settings of the hydro acoustic equipment were used as described in the BIAS manual (ICES 2016). The post-processing of the stored echo signals was made using the Echoview11.1.34. The mean volume back scattering values Sv, were integrated over 1 nm intervals, from 10 m below the surface 0,5 m to the bottom. Contributions from air bubbles, bottom structures and noise scattering layers were removed from the echogram using Echoview.

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 $TS = 20 \log L\ (cm) - 71.2$ (ICES 1983/H:12)

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 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

380 herrings, 703 sprats, 1 cod, 35 sticklebacks, 1 lumpfish and 1 twite-shad were measured in 7 hauls. Totally 180 individuals of sprat and 285 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 1, 2, 7 trawl catches – 77-100%. In 5 - 6 trawl catches dominated herring. Most of herring were fish 3-5 years and 16.5 -18.5 length classes in the both rectangles.

In the rectangle 40H0 0.7% of sprat was represented by fish of last year generation (0 years and 8.3 cm length class). There were no sprats in the catches in the western part of LEEZ (40G9 rectangle ICES).

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 2-12.

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 $2872.7*10^6$ fish or about 118267.1 tones. (Fig. 2 and Table 8).

The sprat stock was estimated $3768.4*10^6$ fish or about 44599.2 tones. (Fig. 3 and Table 5).

Comparison of the acoustic results from last years (1996-2022) indicated that herring stock abundance have decreasing tendency in the LEEZ. Only in 2018 was recorded the highest average parameters of the herring stock densities in the rectangle 40H0. However, starting from 2020, the stock of herring in the Lithuanian zone begin to grow again. Now, the stock is approximately at the level of 2003. (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 6.6 to 15,2 ºC. Differences between the first haul and others caused by wind direction. Wind direction was south-south-east in the begin of cruise. Later wind direction changed to south-south-west. There was no thermocline in 2022 of October. Salinity was 7.4 ‰ in all hauls and depts. The oxygen-condition was excellent in all hauls and depts.

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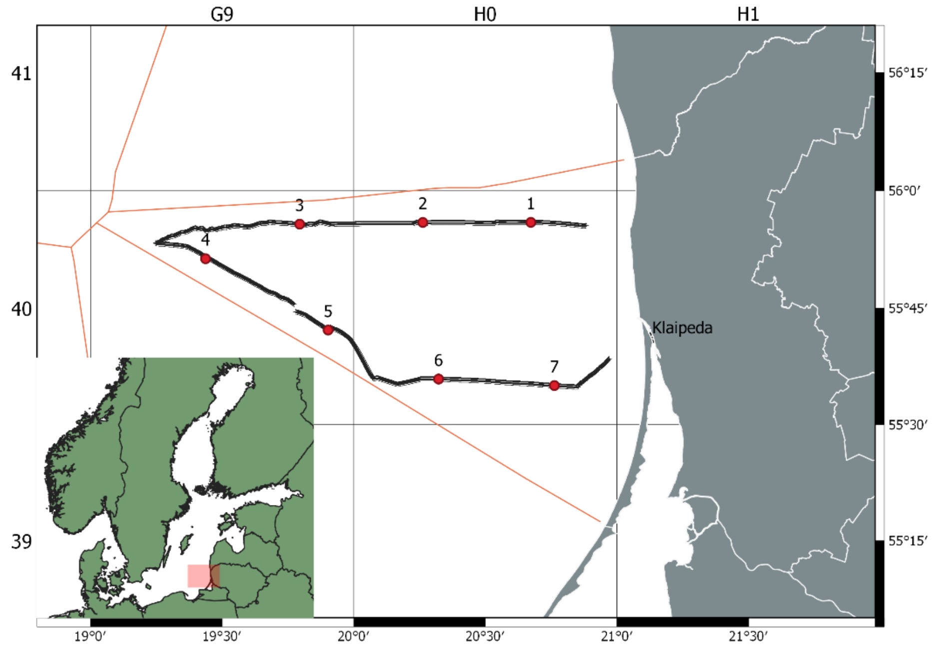

Figure 1. The survey grid and trawl hauls position of F/V “Palanga1” (24-25 October 2022)

Table 1 Catch composition (kg/1hour) per haul (F/V "Palanga1", 24-25.10.2022)

ICES Subdivision							
Haul No	1	2	3	4	5	6	7
Date	24.10.2022	24.10.2022	24.10.2022	24.10.2022	25.10.2022	25.10.2022	25.10.2022
Validity	Valid	Valid	Invalid	Invalid	Valid	Valid	Valid
Species/ICES rectangle	40H0	40H0	40G9	40G9	40G9	40H0	40H0
Clupea harengus					19.0	400.0	185.496
Sprattus sprattus	600.0	5000.0				0.798	614.504
Gadus morhua						0.486	
Gasterosteus aculeatus					0.154	0.01	
Cyclopterus lumpus					0.212		
Twite shad							0.363
Total	600.0	5000.0			19.366	401.294	800.363

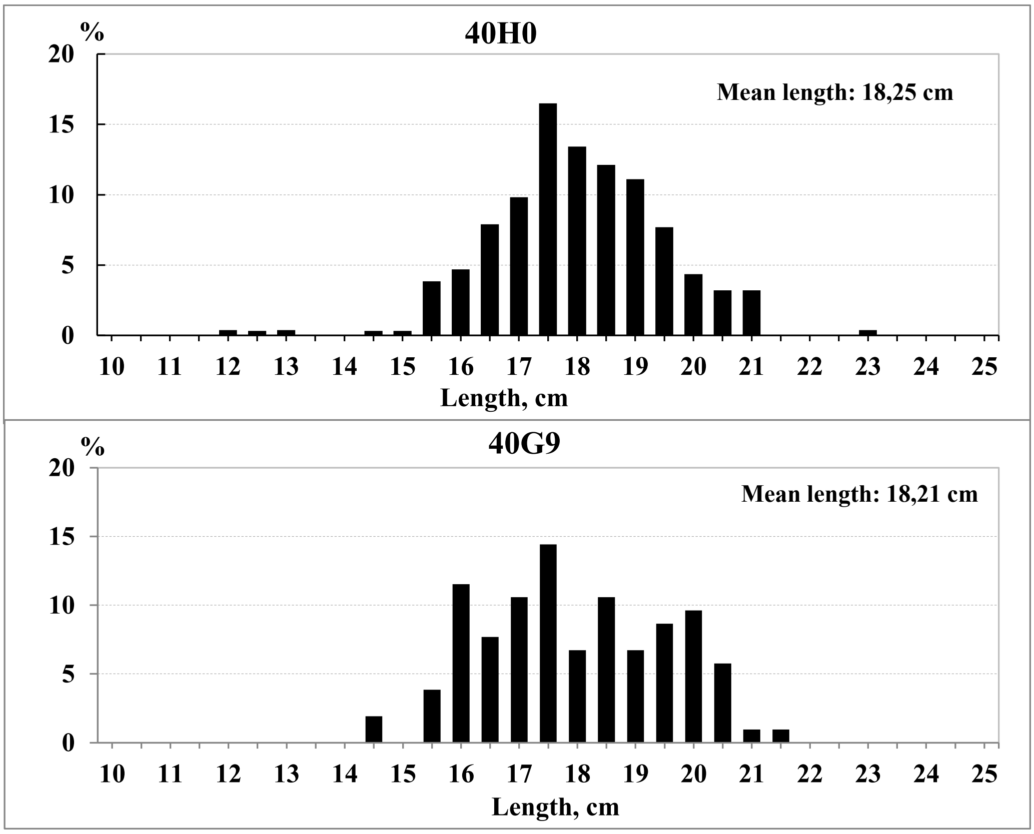

Figure 2 Length distribution of herring (%) (BIAS, 24.10- 25.10.2022)

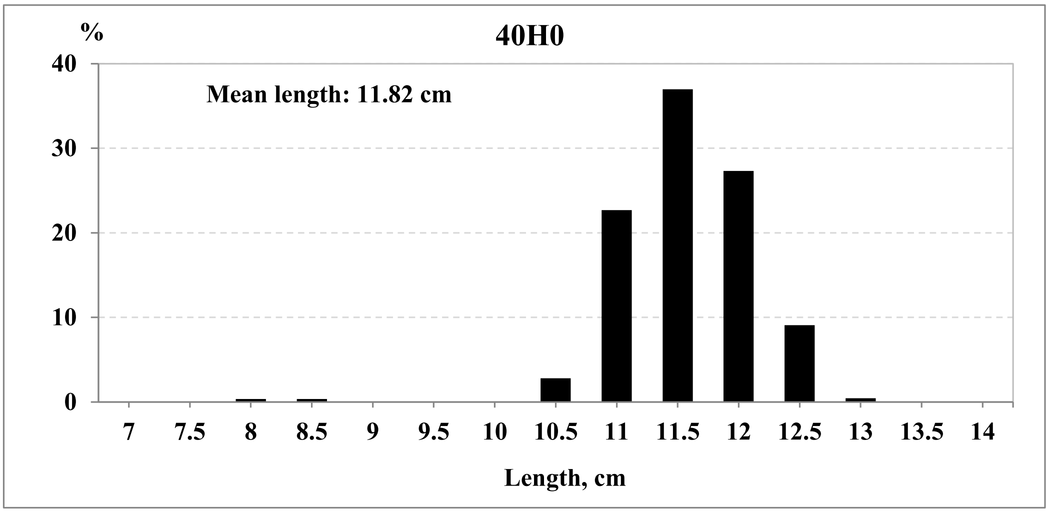

Figure 3 Length distribution of sprat in the rectangle 40H0 (%) (BIAS, 24.10- 25.10.2022)

Table 2 BIAS survey statistics (abundance of herring and sprat), 24.10- 25.10.2022

ICES SD	ICES Rect.	Area nm^2	ρ mln/nm^2	Abundance, mln N sum	N her	N spr	Biomass, tonn W sum	W her	W spr
26	40H0	1012,1	3,82	3867,3	99,0	3768,4	48801	4201	44599
	40G9	1013,0	2,74	2773,8	2773,8	0	114066	114066	0

Table 3 BIAS survey statistics (aggregated data of herring and sprat), 24.10- 25.10.2022

ICES SD 26	ICES Rect.	No trawl	Herring			Sprat			SA m^2/nm^2	TS calc. dB
			L, cm	w, g	Numb.,%	L, cm	w, g	Numb.,%		
	40H0	1,2,6,7	18,25	42,45	2,56	11,82	11,84	97,44	528,3	-49,6
	40G9	3,4,5	18,21	41,12	100,0	0	0	0	872,2	-46,0

Table 4 BIAS survey statistics (herring and sprat), 24.10- 25.10.2022

ICES SD 26	ICES Rect.	Area nm^2	SA m^2/nm^2	σ *10^4 nm^2	Abundance mln.	Species composition (%)	
						herring	sprat
	40H0	1012.1	528,3	1,383	3867,3	2,56	97,44
	40G9	1013.0	872,2	3,185	2773,8	100,00	0

Table 5 BIAS survey estimated age composition (%) of sprat, 24.10- 25.10.2022

SD 26	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
	40H0	100.0	0,7		0,4	26,4	52,6	18,7	1,1	0,1	
	40G9										

Table 6 BIAS survey estimated number (millions) of sprat, 24.10- 25.10.2022

SD 26	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
	40H0	3768,4	27,0		13,5	994,8	1981,2	705,1	41,9	4,8	
	40G9										

Table 7 BIAS survey estimated biomass (in tons) of sprat, 24.10- 25.10.2022

SD 26	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
	40H0	44599	111		130	10957	23547	9211	577	66	
	40G9										

Table 8 BIAS estimated mean weights (g) of sprat, 24.10- 25.10.2022

SD 26	Rect.	Age									
		Mean	0	1	2	3	4	5	6	7	8
	40H0	11,84	4,1		9,6	11,0	11,9	13,1	13,8	13,7	
	40G9										

Table 9 BIAS estimated mean length (cm) of sprat, 24.10- 25.10.2022

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	11,8	8,3		10,5	11,1	11,6	12,2	12,7	13,0	11,8
	40G9	0,0									0,0

Table 10 BIAS estimated age composition (%) of herring, 24.10- 25.10.2022

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	100,0	0,4	6,2	5,4	22,1	26,4	17,9	9,8	8,6	3,1
	40G9	100,0		1,0	2,9	17,3	20,2	17,3	19,2	12,5	9,6

Table 11 BIAS survey estimated number (millions) of herring, 24.10- 25.10.2022

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	99,0	0,4	6,1	5,4	21,9	26,1	17,7	9,7	8,5	3,1
	40G9	2773,8		26,7	80,0	480,1	560,1	480,1	533,4	346,7	266,7

Table 12 BIAS survey estimated biomass (in tons) of herring, 24.10- 25.10.2022

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	4201	5,1	198,0	199,3	832,1	1092,2	767,7	476,8	444,4	185,7
	40G9	114066		768,0	2657,0	14436,8	20831,5	21023,5	24740,7	16084,7	13523,3

Table 13 BIAS survey estimated mean weights (g) of herring, 24.10- 25.10.2022

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	42,4	13,3	32,2	37,1	38,0	41,8	43,4	48,9	52,4	59,7
	40G9	41,1		28,8	33,2	30,1	37,2	43,8	46,4	46,4	50,7

Table 14 BIAS survey estimated mean length (cm) of herring, 24.10- 25.10.2022

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	18,2	13	16,6	17,1	17,4	18,0	18,2	18,8	19,2	20,1
	40G9	18,2		16,0	16,7	16,2	17,2	18,3	18,7	18,8	20,1

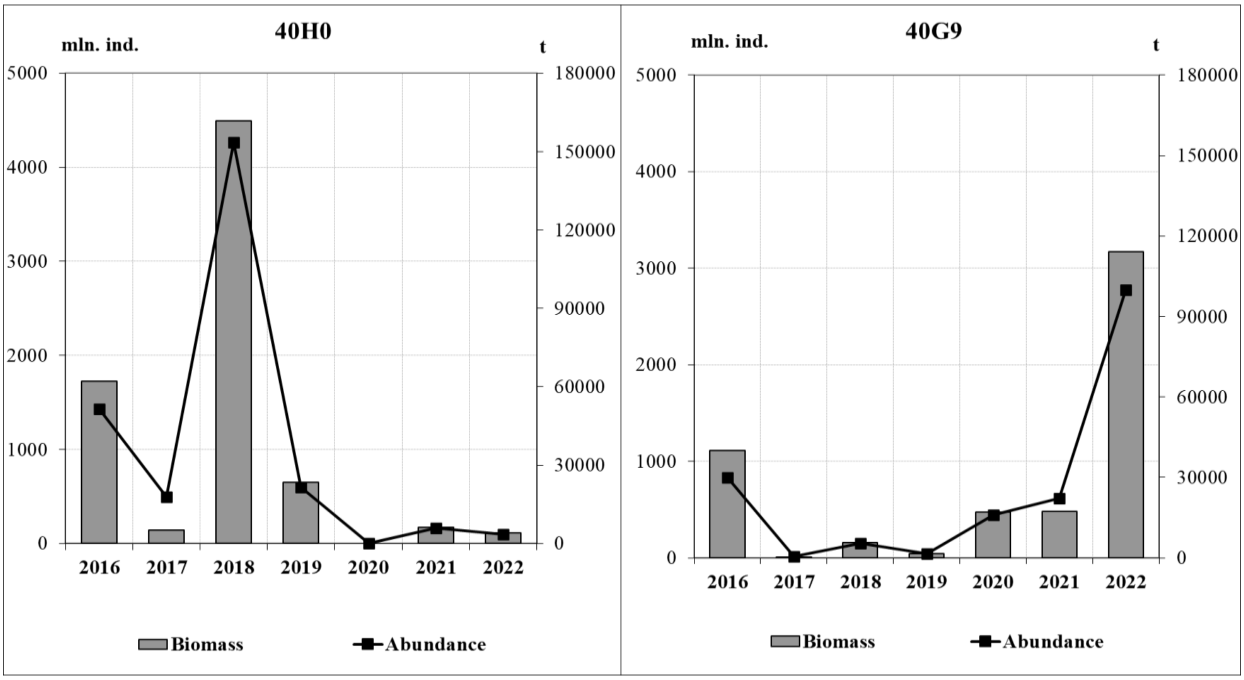

Figure 4 Biomass and abundance of herring by acoustic survey results from BIAS of 2016 – 2022 in ICES rectangles 40H0 and 40G9

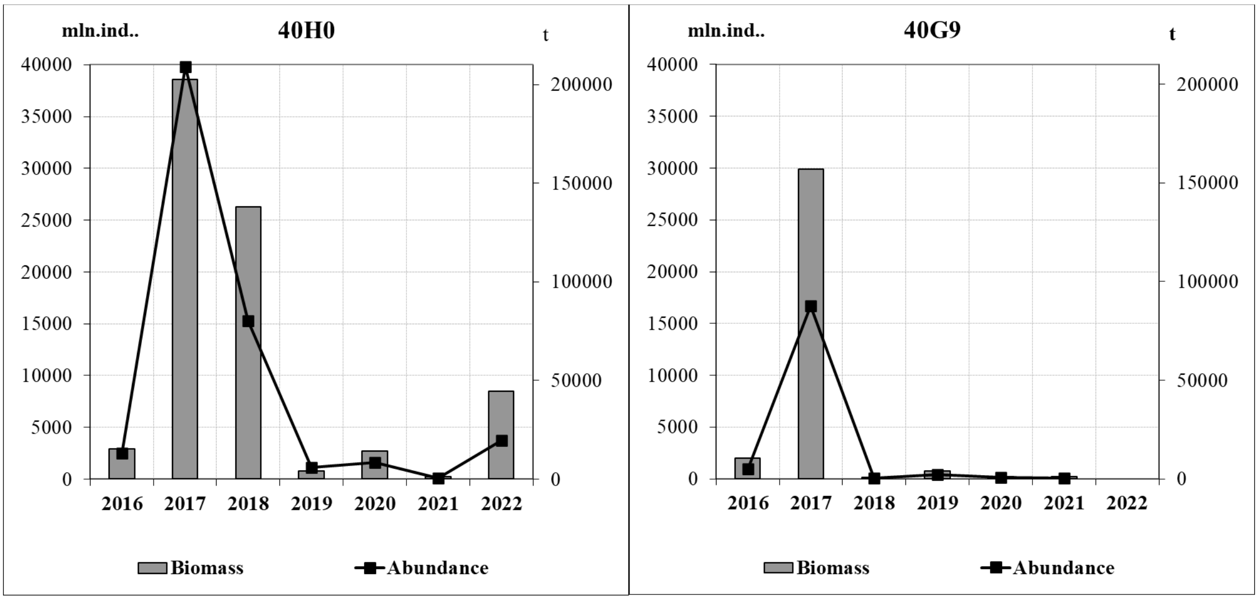

Figure 5. Biomass and abundance of sprat by acoustic survey results from BIAS of 2016 – 2022 in ICES rectangles 40H0 and 40G9

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 “Palanga1”21 (24-25 October 2022)

Haul number	Date of catch	Trawling depth, m	Hydrological parameters		
			Temperature, °C	Salinity, ‰	Oxygen, ml/l
1	24-10-2022	29-30	15.2	7.4	6.7
2	24-10-2022	33-35	12.2	7.4	7.2
3	24-10-2022	53-54	11.2	7.4	7.3
4	24-10-2022	60-61	10.3	7.4	7.5
5	25-10-2022	77	7.8	7.4	7.9
6	25-10-2022	69-70	6.6	7.4	8.2
7	25-10-2022	51	8.7	7.4	7.8
Average			10.3	7.4	7.5

Research report from the Polish part of the Baltic International Acoustic Survey on board of the r.v. "Baltica" (12-27.09.2022)

Beata Schmidt and Krzysztof Radtke
National Marine Fisheries Research Institute, Gdynia (Poland)

INTRODUCTION

The Polish BIAS/2022 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 survey investigations, as well as spatial allocation of vessels and the timing of regarding SPRAS and BIAS acoustic surveys. 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/2022 survey was conducted on board of the r.v. "Baltica" inside the Polish and partly the Danish EEZ, in the period of 12-27.09.2022. The Polish Fisheries Data Collection Programme for 2022 and the European Union (the European Parliament and the Council Regulation (EU) 2017/1004 of 17 May 2017 and the Commission Implementing Decision (EU) 2021/1168 of 27 April 2021)) financially supported the Polish BIAS survey marked with internal No. 15/2022/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), and preliminary estimation of herring and sprat 2022 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 within the surveyed part of the southern Baltic in autumn 2022. Moreover, the paper contains a description of sprat, herring and cod selected biological parameters variation. Fluctuations of the principal hydrological parameters 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/2022 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,
Marcin Nowakowski – ichthyologist, sprat analyses,
Grzegorz Modrzejewski – technician, sprat analyses,
Krzysztof Koszarowski – ichthyologist, herring analyses,
Władysław Gaweł - 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 the 12th of September 2022 at 08:00 a.m. and was navigated in the south-east direction. At the vicinity of Hel Peninsula, the attempt of calibration of the acoustic system SIMRAD EK60 was carried out. However, due to strong wind and vessel drift, the calibration failed. On the same day, acoustic integration and pelagic hauls were started on transects located in Gdańsk Basin. On the 13th of September, at the mouth of the Vistula River, a successful calibration of acoustic system was performed. In the following days, investigations were continued on transects in the Gulf of Gdansk and Gdansk Deep. On the 16th of September, the bad weather conditions prevented from carrying out research, which were resumed next day and continued in the Polish part of ICES Subdivision 26. On the 19th of September, due to bad weather conditions that prevented further research, the measurements were interrupted at the position of hydrological station B3 (λ = 018°00,0'E, ϕ = 54°30,0'N) and the ship was moved west. On the 20th of September, the acoustic integration and pelagic hauls were resumed in the area of the Bornholm Basin and continued in the following days in the area of Słupsk. The acoustic recording was completed on the 26th of September at 16:55 p.m. The r.v. "Baltica" returned to the Gdynia port on the 27th of September 2022 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, 2023), were fully covered with the standard acoustic-biotic research during BIAS 2022 cruise (Figure 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 2022 survey. Calibration of the vessel's acoustic system was performed on the 13th of September 2022 at the following location: λ = 019°01.5'E, ϕ = 54°26.1'N over seabed depth of 55 m (Figure 2). The echosounder calibration was performed as described in Simrad (2012) using the copper spheres of 60 mm diameter 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 2022 were considered good based on the calculated RMS value which was 0.14 dB (Figure 1).

The acoustic sampling was performed along the pre-selected acoustic transects at a distance of 774 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 raw data recorded at 38 kHz frequency was done using the Echoview software (www.echoview.com). 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 [m2/NM^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 26 catch-stations (14 in the ICES Subdivision 25 and 12 in the ICES Subdivision 26) were conducted by the r.v. “Baltica” in the period of 12-27.09.2022 (Figure 2, Table 2), 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. Due to relatively high vertical opening (up to 20 m) of applied pelagic trawl and the technical-acoustics disturbances from a set vessel-trawl, the areas shallower than 30 m were not investigated by the trawls. The trawling time for most hauls was 30 minutes. In one case, the haul covered two layers. The mean speed of the surveying vessel during trawling ranged from 2.8 to 3.4 knots. Fish catches were localized at a depth ranging from 18 to 63 m from the sea surface (position of the headrope of the trawl). At trawling positions, depth to the bottom varied from 39 to 106 m.

Fish caught in each haul were separated by species and weighted. The samples for sprat, herring, and cod were taken for length, age, and mass measurements. Fish total length distribution 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 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, 24, 26 and 16 representative samples were taken for the length and mass determination of sprat, herring and cod, respectively. The length and mass were measured for 4138 sprat, 4377 herring and 130 cod individuals. Respectively, 422, 604 and 121 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 41 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 support acoustic identification of fish species. 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 adjacent rectangles were used. This concerns the ICES rectangle 38G7 where no hauls were carried out due to very low acoustic signal recorded during echo-sounding (see Table 1). The assignment of hauls carried out during BIAS 2022 cruise to the ICES Subdivisions and rectangles are presented below:

Subdivision (SD)	ICES rectangle	Haul no.
25	37G5	15, 16
25	38G5	12, 13, 14
25	38G6	17, 19
25	38G7	26*
25	39G6	18, 20
25	39G7	21, 22, 23, 25
26	37G8	3
26	37G9	4, 5
26	38G8	2, 10
26	38G9	6, 7
26	39G8	9, 11, 26
26	39G9	1
26	40G8	8

* haul performed in adjacent 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.*

RESULTS

Acoustic results

The survey statistic including basic hydroacoustic results are given in Table 1. The total area covered by the Polish BIAS/2022 survey was 9987.2 NM^2 overlaying 13 ICES rectangles. In total 759 NM of acoustic recording were used for acoustic biomass estimation. The spatial distribution of mean NASC values (5 NM intervals), predominantly derived from clupeids, measured on hydroacoustic transects during the SPRAS/2022 survey is presented in Figure 3. The highest NASC values were recorded, as in the previous year, in the Gadńsk Bay in the ICES Subdivision 26. The overall mean NASC value recorded over survey was lower compared to the previous year with a mean NASC across the water column of 116.3 versus 257.3 in 2021 when the same rectangles were covered. On the ICES Subdivision scale, similarly to the previous years, the ICES Subdivision 26 was characterized by a higher average value of NASC than the mean NASC value in the ICES Subdivision 25 – 124.5 m^2/NM^2 versus 108.6 m^2/NM^2. However, comparing to September 2021, a decrease by 42% and 63% in mean NASC were observed in Subdivisions 25 and 26, respectively. Furthermore, in the ICES Subdivision 26 the continuous decrease in mean NASC value has been observed since 2018 attaining in 2022 the lowest value during the last 13 years. Whereas in the ICES Subdivision 25 the mean NASC values were on comparable level during these years (Figure 4). On the rectangle scale, only in two ICES rectangles namely 37G8 and 38G9, both located in Gdańsk Basin (ICES Subdivision 26), the mean NASC was higher than observed in September 2022. The highest average NASC value was recorded in rectangle 37G8 (the Gdańsk Bay, ICES Subdivision 26), reaching the value of 1248.1 m^2/NM^2. The highest mean NASC values in the ICES Subdivision 25, were obtained for rectangles 39G6, located in the area of the Słupsk Furrow.

Fish catches, biological parameters and stocks size

In September 2022 seven fish species were recorded in 26 scrutinized pelagic hauls conducted in the Polish and Danish parts of the ICES Subdivisions 25 and 26 (Table 2, Figure 5). In total 6278.6 kg of fish were caught, and the mean share (by catch mass) of sprat, herring, cod and all other fish species calculated for the whole survey was 37.4, 58.3, 4.1 and 0.2%, respectively. Haul without any fish did not occur. Herring occurred in each pelagic haul, sprat was missing in three hauls only and cod occurred in 62% of hauls performed. Neither marine mammals nor any seabirds were detected in the catches.

The CPUE ranged from 12 to 3030 kg/h. The mean CPUE for all species was 537.1 kg/h, and it was on comparable level to the corresponding BIAS survey in September 2021 (523.4 kg/h). For sprat, the mean CPUEs were 346.8 and 55.1 kg/h for Subdivision 25 and 26, respectively, and were higher in the ICES Subdivision 25 and much lower in the ICES Subdivision 26 than obtained in September 2021 (180.7 and 512.7 kg/h, respectively). The mean CPUEs of herring were 452.8 and 169.2 kg/h for the ICES Subdivision 25 and 26, respectively, and were lower and on comparable level to those obtained during BIAS 2021 (206.9 and 170.8 kg/h in the ICES Subdivisions 25 and 26 respectively). The highest CPUE of cod, which amounted to 22.8 kg/h, was achieved in a haul accomplished in the Gdańsk Deep (the ICES rectangle 39G9).

Figure 6 presents the relative length-frequency distribution of sprat, herring and cod per Subdivision in 2021 and 2022. The total length of species dominated in pelagic hauls conducted in the all investigated areas in September 2022 ranged as follows:

- sprat – 7.0 - 16.5 cm (avg. l.t. = 12.7 cm, avg. W = 13.5 g),
- herring – 9.0 - 25.0 cm (avg. l.t. = 18.7 cm, avg. W = 44.3 g),
- cod – 2.0 - 53.0 cm (avg. l.t. = 30.5 cm, avg. W = 255.2 g).

In September 2022 catches were dominated by sprat larger than 10 cm with a mode at 12.5 and 13.0 cm for the ICES Subdisvision 25 and 26, respectively. However, contrary to BIAS 2021, the second minor frequency apex for the length class of 8.5 and 8.0 cm in the ICES Subdivision 25 and 26 respectively existed. It resulted in that the overall mean numerical share of undersized sprat (<10.0 cm length) was much higher comparing to September 2021, and amounted to 7.5% (Table 3).

For herring samples collected in September 2022, a unimodal length distribution occurred in both ICES Subdivisions. Herring from length class 18.0 cm dominated in Subdivision 25, whereas in Subdivision 26 prevailed herring from 18.5 cm. Both length classes represented adults, commercially sized herring. In September 2021, an bimodal shape of the length distribution curve was characteristic for samples originated from the ICES Subdivisions 26. Smaller frequency apex represented young, undersized specimens (length classes 9.0 and 9.5 cm) and larger frequency apex (length class 17 cm) represented adult herring. In Subdivision 25 a unimodal curve for herring was observed in September 2021 (apex for length class 16.5 cm) (Figure 6).

The differences between length compositions of herring in BIAS 2021 and 2022 resulted in significantly lower mean numerical share of undersized herring (<16.0 cm total length) in the entire study area, which occurred in September 2022 (4.2%) compared to September 2021 (32.4%). Slightly higher share of undersized herring in September 2022 was observed in Subdivision 25 (5.3%) than in Subdivision 26 (3.0%) (Table 3).

The length distribution curves for cod sampled in the ICES Subdivisions 25 and 26 in both BIAS 2021 and BIAS 2022 were multimodal, without any specific length class domination, which resulted from relatively low number of cod occurring in the surveys (Figure 8). In 2022, the mean bycatch of undersized cod (determined as <35.0 cm total length) in the entire area studied was 56.1%, and it was lower than in the previous BIAS survey – 70.0% (Table 3).

The basic data evaluated in September 2022, including data on Baltic sprat, herring and cod stocks total abundance per ICES rectangle and Subdivision adequately to echosounding under the frequency of 38 kHz, are given in Table 1. Estimated numbers of sprat herring and cod by age group and ICES statistical rectangle/Subdivision are presented in Tables 4, 7 and 10. Corresponding mean weights by age group and ICES rectangle/Subdivision are provided in Tables 5, 8 and 11. Estimates of sprat, herring and cod biomass by age group and ICES rectangle/Subdivision are summarized in Tables 6, 9 and 12.

The total estimated sprat abundance and biomass reached the values of $3100.2 \cdot 10^6$ individuals and 41537.5 tones, and about 66% of its abundance and 70% of its biomass were allocated in the ICES Subdivision 25. In case of herring, 63% of total estimated abundance ($1752 \cdot 10^6$ individuals) and 65% of its total biomass (79538.1 tonnes) were allocated in the ICES Subdivision 26. Also above 90% of total cod abundance ($22.5 \cdot 10^6$ individuals) and biomass (6602.4 tonnes) estimated in the scrutinized part of the southern Baltic were allocated in the 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 2022 are illustrated in Figure 11. The air temperature during the reported survey varied from 10.9 to 17.2°C. The wind force changed from 2 to 5°B, and winds from the east and north-east direction prevailed. During fishing operations, prevailed the moderate wind (4°B) mostly from west directions (Table 13).

The main hydrological parameters at the depths of fish pelagic catches (Table 13), i.e. in the range of 25-71 m (with 18 m vertical net opening on average) changed in the relatively broad ranges. The seawater temperature fluctuated from 4.5 to 15.4°C, salinity from 6.9 to 11.8 and oxygen content from 2.4 ml/l at haul No. 1 (the Gdansk Deep) to 7.5 ml/l.

The surface water hydrological parameters changed in relatively narrow ranges: 13.8-18.2°C, 7.0-7.7 PSU and 8.8-6.9 ml/l 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 is illustrated in Figure 12.

The temperature in the near-bottom layer was changing horizontally within the range of 4.7-14.3°C. The lowest seawater temperature was recorded at hydrographical station No. UW in the Gdańsk Bay and the highest at the hydrographical station No. 46. Salinity in the bottom waters varied from 7.7 PSU to the maximum of 15.0 PSU - noticed at the hydrographical station No. IBY5 (the Bornholm Basin). Oxygen content near the bottom of deep waters varied from 0.0 ml/l – measured at the hydrological stations No. G2 and 10GD (in the Gdansk Deep at depth 105 and 90m respectively) and IBY5 (in the Bornholm Basin at depth 85m) to the maximum of 7.5 ml/l – calculated at the catch station No. 3 (in the Gdańsk Bay at depth 43m).

The vertical distribution of the seawater temperature, salinity, and oxygen content, along the hydrological research profile determined in the southern Baltic during BIAS 2022 survey are presented in Figure 13. During the survey period, the waters with oxygen content below 2 ml/l 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

The above-results presented indicate that the centre of fish resources temporal distribution in the scrutinized part of the southern Baltic in May 2022, in the case of herring and cod, was located mostly in the ICES Subdivision 26, similarly as in previous year. In the case of sprat, contrary to September 2021, its abundance and biomass were higher in the ICES Subdivision 25. Nevertheless, compared to September 2021, the present estimates show a significant decrease in total sprat and herring abundance (-53.0% and -72.7%, respectively) and biomass (-42.3% and - 53.5%, respectively). In the case of cod, a great increase in total abundance (+387.9%) and biomass (+197.7%) was observed (Schmidt *et al.*, 2022a). However, these changes differ between the ICES Subdivisions.

ICES SD	Difference comparing to 2021					
	abundance [%]			biomass [%]		
	sprat	herring	cod	sprat	herring	cod
SD25	-6.1	-70.2	+1.9	+0.4	-55.5	-81.3
SD26	-76.1	-74.0	+635.8	-70.7	-52.3	+293.1
SD25-26	-53.0	-72.7	+387.9	-42.3	-53.5	+197.7

Compared to autumn 2021, the abundance of sprat in September 2022 decreased considerably in the ICES Subdivisions 26 (-76.1%). In particular, the number of individuals of sprat from age groups 2 and 3 (year-class 2020 and 2019) decreased markedly, by -91.1% (from ca. $1287.6 \cdot 10^6$ to ca. $114.9 \cdot 10^6$ individuals) and by 82.6% (from ca. $1425.4 \cdot 10^6$ to ca. $248.6 \cdot 10^6$ individuals) for age group 2 and 3 respectively (Table 4, Figure 7). As compared to BIAS 2021, the abundance of sprat in 2022 was of similar magnitude in Subdivision 25 whereas in Subdivision 26 the abundance in 2022 was three times lower than in 2021. Total abundance in Subdivision 26 decreased in 2021-2022 from 4.4 billion individuals to only 1.1 billion. The decline in sprat abundance in 2022 in Subdivision 26 was mainly driven by ages 2 and 3 (year-classes 2020 and 2019) which occurred markedly less abundant than in 2021 survey. Year class 2019 was 248.6 million in 2022, whereas in 2021 that year class was much more numerous - 1425.4 million. Also year class 2020 was abundant in 2021 - 1287.6 million but in 2022 its abundance markedly declined to only 114.9 million. Similarly to changes in abundance estimates described above, changes in results of sprat total biomass have undergone, indicating higher values of that parameter in the ICES Subdivision 25 than in the ICES Subdivision 26. It indicates that in the ICES Subdivision 25 more sprat was concentrated (28922.6 t) compared to the ICES Subdivision 26 (12614.8 t). The differences in total sprat biomass estimates between 2021 and 2022 in ICES Subdivision 26 result to large extent from much lower contribution of age 3 sprat (year class 2019) biomass (3009.6 t) to total biomass in 2022, than the contribution of the same year class (age 2) in 2021 (13946.1 t). The share of year class 2019 biomass in 2022 total biomass in ICES Subdivision 2022 was 23.8%, whereas in 2021 the corresponding share was 32.5%.

Sprat stomachs fullness examination indicated the males contained food in 72.9% of stomachs, and females in 71.3% contained food, which provides the fact that this time of the year was the feeding season of sprat.

The drop in sprat biomass in the ICES Subdivision 26 comparing to September 2021 is reflected in decrease in the mean biomass density with 2.6 t/NM^2 in September 2022 versus 8.9 t/NM^2 in autumn 2021. As in previous year the highest sprat concentrations were observed in the Gdańsk Buy (the ICES rectangle 37G9) but in September 2021 its value was about fourth times lower than observed in September 2021: 39.7 t/NM^2 versus 159.9 t/NM^2 (Figure 8). In the ICES Subdivision 25 the mean biomass density remained on similar level: 5.6 t/NM^2 in September 2022 versus 5.7 t/NM^2 in September 2021. The changes in biomass density of sprat during last 13 years are presented in Figure 10. In the ICES Subdivisions 26 the highest biomass density of sprat were observed in years 2018-2020. The biomass density estimated in 2022 is one of the lowest since 2010 (comparable biomass density was estimated only in 2017 and 2010). In the ICES Subdivision 25 the biomass density don't exceed 10 t/NM^2 with the mean around 5 t/NM^2.

During the BIAS 2022, the abundance and biomass of herring drop significantly in both ICES Subdivisions (by 70% and 74% in the ICES Subdivision 25 and 26, respectively). It should be emphasized that the abundance estimates of all sprat age groups from 2 to 7 in BIAS 2022 in ICES Subdivision 26 were much lower than in BIAS 2021. In ICES Subdivision 25 all the sprat age groups (from zero to 8+) abundance estimates were lower in BIAS 2022 than in 2021. The overall drop in age groups abundance have significantly impacted the total abundance of the studied area in 2022. It might be concluded that it might reflect the commercial fisheries pressure on the herring resources in the Baltic. During BIAS in 2022, the biomass of herring was lower in both ICES Subdivisions, compared to the results obtained during BIAS 2021. The biomass of herring in 2022 in ICES Subdivision 25 represented only 44.5% of the herring biomass estimated in 2021. In ICES Subdivision 26, the share of herring biomass in 2022 was only 47.7% of the biomass in 2021 in that Subdivision. Remarkable drop in abundance of most of the age groups of herring represented in the catches, as described above, is the main factor explaining herring biomass decline observed between 2021 and 2022 in both Subdivisions investigated.

The drop in herring biomass comparing to September 2021 is reflected in decrease in the mean biomass density in both ICES Subdivisions: 5.4 t/NM^2 versus 12.1 t/NM^2 in the ICES Subdivision 25 and 10.7 t/NM^2 versus 22.5 t/NM^2 in the ICES Subdivision 26. In September 2022, the highest mean biomass surface density of herring stock was estimated in the Gulf of Gdansk (in the ICES rectangle 37G8) and amounted to 155.0 t/NM^2 but it was lower by half comparing the highest mean biomass density estimated in September 2021, also in the Gdansk Bay (in the ICES rectangle 37G8) - 341.3 t/NM^2 (Figure 8).

Long-time series in biomass density of herring show that the ICES Subdivision 26 characterized by greater changes in this parameter (Figure 10). However, the biomass density of herring obtained in September 2022 is the lowest one in both ICES Subdivisions since 2010.

Cod abundance estimates in ICES Subdivision 25 indicated very similar level in numbers in September 2022 (1.84 million) as in 2021 (1.81 million). However, large increase in abundance of cod was observed in 2022 in ICES Subdivision 26 (20.7 million) as compared to September 2021 – 2.81 million. Similarly, the biomass of cod significantly increased in September 2022 in ICES Subdivision 26 (by four times), as compared to September 2021. In ICES Subdivision 25, the cod biomass was lower in September 2022 than in September 2021 by five times, which can be explained by higher proportion of older age groups (and heavier) in September 2021.

During the BIAS 2022 cruise, the highest mean biomass surface density of cod was estimated for the ICES rectangle 38G9 (4.96 t/NM^2) (Figure 9). In other rectangles, the mean biomass surface density of cod fluctuated from 0.01 to 1.21 t/NM^2. However, in four ICES rectangles, namely 38G6, 38G7, 39G7 and 37G9 the appearance of cod was not detected (Table 1). In 2022 the biomass density of Baltic cod in the ICES Subdivision 25 was lower than in the ICES Subdivision 26 and amounted to 0.02 and 0.1.34 t/NM^2, respectively. In 2022 mean biomass surface density of cod was lower in the ICES Subdivision 25 comparing to 2021 (0.11 t/NM^2) and was almost four times higher in the ICES Subdivision 26 comparing to previous year (0.34 t/NM^2).

Long-term mean biomass surface density of cod indicated a very low and evenly distributed values of that parameter in ICES Subdivision 25 across years 2010-2022, with the exemption of 2010, which considerable deviated from the pattern. Larger fluctuations of that parameter, as compared to ICES Subdivision 25 were observed in ICES Subdivision 26.

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/2022 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. Cruise statistics of the Polish BIAS survey on board of the r.v. "Baltica", 12-27.09.2022.

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 $\cdot 10^6$			
						herring	sprat	cod	total	herring	sprat	cod
25	37G5	44	1.54	79.1	642.2	14.95	84.65	0.40	329.9	49.3	279.3	1.3
25	38G5	70	2.60	127.5	1035.7	44.85	55.06	0.09	508.0	227.9	279.7	0.5
25	38G6	82	1.89	97.8	940.2	13.67	86.33	0.00	486.0	66.4	419.6	0.0
25	38G7	28	3.39	6.6	471.7	98.07	1.93	0.00	9.2	9.0	0.2	0.0
25	39G6	81	1.76	161.5	1026	5.06	94.93	0.01	940.3	47.6	892.7	0.1
25	39G7	86	2.73	111.9	1026	58.56	41.43	0.01	420.0	246.0	174.0	0.0
Sum SD25		**391**							**2693.5**	**646.2**	**2045.4**	**1.8**
26	37G8	8	3.34	1248.1	86	82.11	17.83	0.05	321.7	264.2	57.4	0.2
26	37G9	26	1.39	514.6	151.6	1.46	98.54	0.00	562.2	8.2	554.0	0.0
26	38G8	46	2.37	186.7	624.6	42.61	57.36	0.02	491.4	209.4	281.9	0.1
26	38G9	60	3.88	154.2	918.2	60.08	35.91	4.01	364.8	219.2	131.0	14.6
26	39G8	93	3.50	84.2	1026	87.09	12.27	0.64	246.8	214.9	30.3	1.6
26	39G9	37	6.85	18.9	1026	84.23	1.15	14.62	28.3	23.8	0.3	4.1
26	40G8	98	3.25	53.4	1013	99.95	0.00	0.05	166.2	166.1	0.0	0.1
Sum SD26		**368**							**2181.3**	**1105.8**	**1054.8**	**20.7**

Table 2. Fish pelagic catches data from the Polish BIAS survey conducted on board of the r.v. “Baltica” in September 2022.

Haul number	Date of catch	ICES rectangles	ICES SDs	Geographical position of the catch				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]						
				start		end																	
				latitude N	longitude E	latitude N	longitude E										sprat	herring	cod	flounder	lumpfish	whiting	three spined stickleback
1	2022-09-12	39G9	26	55°08.1'	019°01.5'	55°07.4'	019°03.8'	92	63	19	3.1	115	18:05	30	21.9	43.9	0.0	10.5	11.4				
2	2022-09-13	38G8	26	54°33.0'	018°58.9'	54°33.0'	018°56.5'	68	47	18	2.9	270	07:45	30	238.6	477.2	140.9	97.4	0.2	0.2			
3	2022-09-13	37G8	26	54°28.2'	018°55.2'	54°29.8'	018°55.5'	63	36	18	3.2	015	10:10	30	81.4	162.9	3.9	77.0	0.5	0.1			
4	2022-09-13	37G9	26	54°24.6'	019°13.9'	54°26.0'	019°14.4'	50	20	17	3.1	330	17:10	30	10.1	20.3	9.7	0.4					
5	2022-09-14	37G9	26	54°28.7'	019°27.2'	54°29.3'	019°30.5'	57	34	18	3.1	070	08:20	40	30.2	45.4	28.3	1.8		0.1			
6	2022-09-14	38G9	26	54°36.1'	019°09.5'	54°36.0'	019°12.2'	82	57	19	3.1	090	12:55	30	278.1	556.2	89.5	187.6	0.6	0.2	0.1		
7	2022-09-14	38G9	26	54°50.1'	019°11.8'	54°50.1'	019°14.3'	106	58	18	2.9	085	16:10	30	14.1	28.3	0.2	8.5	5.5				
8	2022-09-17	40G8	26	55°31.7'	018°36.8'	55°31.7'	018°39.5'	85	25	19	3.0	085	17:20	30	90.0	180.1		89.3	0.4		0.3		0.0
9	2022-09-18	39G8	26	55°10.2'	018°41.8'	55°10.5'	018°45.0'	92	29/60	19	3.0	080	08:35	30	29.3	58.7	0.7	24.7	3.7	0.2			
10	2022-09-18	38G8	26	54°52.7'	018°40.4'	54°51.7'	018°41.0'	68	45	19	3.1	170	12:30	20	263.4	790.2	33.7	228.9	0.7	0.1			
11	2022-09-18	39G8	26	55°02.3'	018°21.6'	55°02.2'	018°24.6'	67	26	18	3.4	090	17:50	30	128.6	257.2	13.7	114.5		0.2	0.2		
12	2022-09-20	38G5	25	54°57.4'	015°28.7'	54°56.7'	015°31.0'	78	49	18	3.0	105	08:00	30	338.6	677.2	236.8	99.3	2.4				
13	2022-09-20	38G5	25	54°33.4'	015°19.0'	54°32.3'	015°20.9'	50	27	17	3.1	120	13:45	30	1515.0	3029.9	205.4	1309.1			0.3	0.1	
14	2022-09-21	38G5	25	54°45.3'	015°40.0'	54°43.8'	015°40.0'	71	49	18	3.0	173	09:10	30	514.0	1027.9	104.6	402.7	6.2	0.5			
15	2022-09-21	37G5	25	54°24.7'	015°39.6'	54°24.6'	015°42.1'	42	19	18	3.0	085	13:30	30	6.1	12.3	1.7	4.4	0.0				
16	2022-09-21	37G5	25	54°28.7'	015°56.3'	54°27.7'	015°54.1'	42	19	17	3.1	235	16:55	30	59.1	118.2	57.8	1.3	0.0				
17	2022-09-22	38G6	25	54°41.4'	016°00.8'	54°40.5'	016°01.4'	50	26	19	3.1	158	08:15	20	143.9	431.7	77.4	66.5					
18	2022-09-22	39G6	25	55°11.6'	016°20.0'	55°10.1'	016°20.0'	67	45	18	3.1	180	16:15	30	318.4	636.8	270.7	47.2	0.5				
19	2022-09-23	38G6	25	54°44.3'	016°28.4'	54°45.0'	016°32.1'	39	18	13	3.1	065	09:55	45	24.2	32.2	23.6	0.6					
20	2022-09-23	39G6	25	55°14.8'	016°40.6'	55°14.9'	016°42.2'	71	48	18	2.8	080	17:10	20	769.2	2307.6	693.3	75.5	0.3		0.1		
21	2022-09-24	39G7	25	55°15.7'	017°01.0'	55°17.0'	017°02.2'	80	47	18	3.1	035	10:30	30	278.5	556.9	107.1	170.6	0.6		0.1		
22	2022-09-24	39G7	25	55°08.8'	017°18.2'	55°09.6'	017°15.8'	60	29	18	3.1	295	18:25	30	114.6	229.3	8.1	105.8			0.7		
23	2022-09-25	39G7	25	55°18.8'	017°20.2'	55°20.3'	017°19.8'	76	52	18	3.0	350	09:50	30	477.8	955.7	264.4	212.8	0.3		0.3		
24	2022-09-25	40G7	25	55°32.3'	017°38.4'	55°31.3'	017°37.9'	51	25	18	3.1	200	14:15	20	362.4	1087.2		362.1			0.3		
25	2022-09-25	39G7	25	55°19.3'	017°40.0'	55°21.3'	017°40.0'	78	30	19	3.1	360	17:55	40	80.9	121.4	0.1	79.5			1.3		
26	2022-09-26	39G8	26	55°06.8'	018°00.3'	55°08.4'	018°03.4'	51	24	17	3.1	055	16:10	45	92.0	122.7	0.6	90.6			0.9		

Table 3. The mean numerical share of young, undersized fishes per ICES SDs (the Polish BIAS/2021 and BIAS/2022).

Species	Fish length	BIAS 2021			BIAS 2022		
		Mean share in % numbers			Mean share in % numbers		
		SD25	SD26	Mean	SD25	SD26	Mean
sprat	< 10 cm	0.2	1.3	0.7	8.8	5.1	7.5
herring	< 16 cm	28.9	36.8	32.4	5.3	3.0	4.2
cod	< 35 cm	65.8	34.3	56.1	81.0	61.1	70.0

Table 4. 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", 12-27.09.2022.

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	117.0	2.1	3.1	26.1	40.8	35.6	24.1	21.1	9.3	**279.3**
25	38G5	0.0	1.9	8.9	49.1	74.5	60.9	40.8	29.1	14.5	**279.7**
25	38G6	0.0	3.4	13.4	83.9	110.3	93.0	62.8	34.6	18.1	**419.6**
25	38G7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
25	39G6	0.0	12.7	51.6	197.7	240.0	182.5	128.4	50.0	29.8	**892.7**
25	39G7	0.0	2.0	7.7	35.0	43.6	34.7	25.9	17.5	7.7	**174.0**
Sum SD25		**117.0**	**22.1**	**84.7**	**391.8**	**509.3**	**406.6**	**282.0**	**152.2**	**79.5**	**2045.4**
26	37G8	1.8	4.1	9.2	13.6	18.6	4.0	3.8	2.0	0.3	**57.4**
26	37G9	89.4	43.3	61.8	146.6	149.6	19.9	31.4	11.5	0.4	**554.0**
26	38G8	0.0	10.6	26.1	47.0	101.5	50.2	30.7	14.0	1.7	**281.9**
26	38G9	1.1	10.8	15.6	38.0	42.6	9.6	10.0	3.3	0.0	**131.0**
26	39G8	0.0	0.6	2.3	3.5	9.8	7.3	3.8	2.3	0.8	**30.3**
26	39G9	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	**0.3**
26	40G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Sum SD26		**92.3**	**69.5**	**114.9**	**248.6**	**322.3**	**91.2**	**79.8**	**33.0**	**3.1**	**1054.8**

Table 5. 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", 12-27.09.2022.

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	472.7	18.1	45.2	383.5	623.2	551.8	377.4	365.3	156.7	**2994.0**
25	38G5	0.0	23.2	118.5	705.7	1113.3	924.6	623.4	498.3	244.3	**4251.3**
25	38G6	0.0	43.5	180.1	1183.1	1633.1	1393.4	939.9	591.6	295.6	**6260.3**
25	38G7	0.0	0.0	0.1	0.5	0.7	0.6	0.4	0.3	0.1	**2.7**
25	39G6	0.0	155.5	646.4	2710.1	3429.7	2678.6	1881.0	847.1	473.9	**12822.3**
25	39G7	0.0	24.6	100.5	489.9	639.2	519.7	390.4	300.4	127.3	**2592.1**
Sum SD25		**472.7**	**265.0**	**1090.7**	**5472.9**	**7439.3**	**6068.7**	**4212.4**	**2602.9**	**1298.0**	**28922.6**
26	37G8	4.9	47.6	105.2	162.7	233.0	59.7	51.9	28.6	4.6	**698.2**
26	37G9	317.9	507.1	717.2	1755.1	1868.5	289.0	404.1	157.3	6.4	**6022.5**
26	38G8	0.0	127.6	342.6	589.8	1365.0	738.0	431.3	202.4	28.6	**3825.2**
26	38G9	2.9	127.9	184.5	455.4	539.5	141.0	132.7	44.0	0.0	**1628.0**
26	39G8	0.0	7.1	32.3	46.2	136.9	109.3	55.6	35.3	13.5	**436.3**
26	39G9	0.0	0.1	0.3	0.4	1.7	1.2	0.6	0.2	0.0	**4.6**
26	40G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Sum SD26		**325.7**	**817.5**	**1382.1**	**3009.6**	**4144.6**	**1338.3**	**1076.1**	**467.8**	**53.2**	**12614.8**

Table 6. 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	4.038627	8.52	14.57	14.68	15.28	15.49	15.65	17.34	16.82	**10.72**
25	38G5	-	12.38	13.25	14.37	14.94	15.19	15.28	17.15	16.83	**15.20**
25	38G6	-	12.7	13.40	14.11	14.80	14.99	14.97	17.09	16.29	**14.92**
25	38G7	-	13.02	14.22	14.42	15.02	14.94	15.02	16.50	15.78	**15.02**
25	39G6	-	12.24	12.54	13.71	14.29	14.68	14.65	16.93	15.91	**14.36**
25	39G7	-	12.25	13.07	14.01	14.65	14.99	15.09	17.21	16.52	**14.90**
MW SD25		**4.04**	**11.97**	**12.87**	**13.97**	**14.61**	**14.92**	**14.94**	**17.10**	**16.33**	**14.14**
26	37G8	2.65	11.52	11.49	12.00	12.54	14.80	13.50	14.62	16.73	**12.17**
26	37G9	3.56	11.70	11.60	11.97	12.49	14.49	12.88	13.71	16.73	**10.87**
26	38G8	-	12.07	13.14	12.55	13.44	14.69	14.05	14.41	16.73	**13.57**
26	38G9	2.67	11.80	11.85	12.00	12.67	14.62	13.23	13.46	-	**12.43**
26	39G8	-	12.24	13.97	13.34	13.94	15.02	14.67	15.50	17.87	**14.41**
26	39G9	-	12.73	13.66	12.94	13.70	14.81	14.29	13.98	-	**13.98**
26	40G8	-	-	-	-	-	-	-	-	-	**-**
MW SD26		**3.53**	**11.76**	**12.02**	**12.11**	**12.86**	**14.67**	**13.49**	**14.16**	**17.00**	**11.96**

Table 7. 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", 12-27.09.2022.

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	19.9	3.5	1.5	12.6	4.7	4.4	1.3	1.1	0.2	**49.3**
25	38G5	0.8	23.5	15.1	100.0	33.6	35.2	9.7	7.3	2.7	**227.9**
25	38G6	26.4	4.2	3.9	17.0	5.9	5.6	1.9	1.2	0.3	**66.4**
25	38G7	0.0	1.2	0.5	4.0	1.3	1.4	0.5	0.3	0.1	**9.0**
25	39G6	1.0	6.2	1.3	24.2	6.6	5.3	1.4	1.7	0.1	**47.6**
25	39G7	1.1	30.5	12.3	111.4	34.1	36.0	10.6	8.2	1.7	**246.0**
Sum SD25		**49.1**	**69.1**	**34.5**	**269.1**	**86.1**	**87.9**	**25.4**	**19.7**	**5.2**	**646.2**
26	37G8	7.8	16.6	16.5	47.7	45.9	41.4	29.0	26.6	32.6	**264.2**
26	37G9	0.3	0.8	0.4	1.5	1.3	1.5	0.9	0.6	0.9	**8.2**
26	38G8	9.4	19.1	11.9	44.7	35.7	37.6	21.5	16.7	12.7	**209.4**
26	38G9	0.5	6.4	14.8	36.1	41.2	44.0	29.2	22.3	24.6	**219.2**
26	39G8	0.0	9.9	13.3	46.1	40.9	42.8	25.9	19.8	16.2	**214.9**
26	39G9	0.0	1.0	1.7	4.5	4.7	4.7	3.0	2.0	2.1	**23.8**
26	40G8	0.0	14.8	9.8	46.0	30.5	33.4	16.9	11.7	2.9	**166.1**
Sum SD26		**18.1**	**68.6**	**68.4**	**226.5**	**200.3**	**205.5**	**126.5**	**99.8**	**92.0**	**1105.8**

Table 8. 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", 12-27.09.2022.

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	240.0	144.0	91.4	557.4	214.6	211.1	67.8	49.2	15.3	**1590.7**
25	38G5	12.1	958.3	883.1	4435.2	1633.7	1765.2	506.5	361.7	176.2	**10732.1**
25	38G6	348.7	183.4	222.0	795.8	309.8	289.3	97.7	57.3	21.0	**2324.9**
25	38G7	0.0	48.5	24.9	164.0	52.1	63.7	24.0	10.6	3.2	**391.1**
25	39G6	13.1	235.5	63.9	895.5	256.1	223.1	64.4	66.7	6.6	**1824.9**
25	39G7	16.5	1238.5	694.9	4647.8	1477.3	1685.6	527.8	341.9	105.1	**10735.4**
Sum SD25		**630.4**	**2808.1**	**1980.1**	**11495.8**	**3943.6**	**4238.0**	**1288.2**	**887.4**	**327.4**	**27599.1**
26	37G8	86.7	448.2	854.6	2230.9	2495.7	2058.7	1557.3	1499.5	2097.1	**13328.7**
26	37G9	3.3	20.5	18.5	64.9	64.4	71.0	46.2	32.7	55.0	**376.4**
26	38G8	103.8	540.9	548.2	1807.8	1656.4	1702.5	1047.9	839.9	789.1	**9036.6**
26	38G9	9.3	201.2	754.7	1719.3	2129.3	2198.6	1498.8	1204.4	1571.0	**11286.6**
26	39G8	0.0	336.0	623.8	1922.6	1896.9	1998.4	1251.6	993.0	1056.1	**10078.3**
26	39G9	0.0	31.2	85.1	195.6	226.5	219.5	150.0	104.4	131.6	**1143.9**
26	40G8	0.0	486.9	419.6	1686.5	1263.2	1400.9	755.2	520.2	156.0	**6688.5**
Sum SD26		**203.1**	**2064.8**	**3304.5**	**9627.6**	**9732.5**	**9649.7**	**6307.0**	**5194.0**	**5856.0**	**51939.0**

Table 9. 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", 12-27.09.2022.

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	12.05	40.94	58.97	44.24	46.00	47.81	50.65	45.72	62.00	**32.25**
25	38G5	16.08	40.77	58.54	44.36	48.61	50.12	52.00	49.78	65.24	**47.10**
25	38G6	13.20	43.31	57.19	46.87	52.69	51.21	52.33	49.52	60.10	**35.00**
25	38G7	-	41.67	54.78	41.42	40.91	46.52	49.72	39.61	59.45	**43.32**
25	39G6	13.55	37.99	49.85	37.00	39.04	42.38	46.99	39.90	61.49	**38.32**
25	39G7	15.50	40.64	56.66	41.72	43.27	46.80	49.66	41.55	60.97	**43.65**
MW SD25		**12.83**	**40.64**	**57.37**	**42.71**	**45.79**	**48.19**	**50.66**	**45.12**	**63.18**	**42.71**
26	37G8	11.05	27.05	51.83	46.77	54.34	49.70	53.67	56.42	64.27	**50.45**
26	37G9	11.09	26.20	45.01	42.27	50.30	48.07	50.27	51.39	62.37	**45.82**
26	38G8	11.07	28.24	46.07	40.47	46.37	45.25	48.64	50.28	62.21	**43.16**
26	38G9	17.00	31.57	50.98	47.69	51.69	49.95	51.34	53.90	63.79	**51.50**
26	39G8	-	33.79	46.95	41.74	46.36	46.66	48.28	50.23	65.17	**46.89**
26	39G9	-	32.46	49.02	43.37	47.73	47.10	49.19	51.03	62.77	**48.05**
26	40G8	-	32.86	42.77	36.66	41.37	41.89	44.78	44.27	54.31	**40.27**
MW SD26		**11.24**	**30.10**	**48.28**	**42.50**	**48.58**	**46.96**	**49.86**	**52.03**	**63.65**	**46.97**

Table 10. 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”, 12-27.09.2022.

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	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.30**
25	38G5	0.08	0.04	0.30	0.04	0.00	0.00	0.00	0.00	0.00	**0.46**
25	38G6	0.00	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	**0.00**
25	39G6	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	**0.06**
25	39G7	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	**0.02**
Sum SD25		**1.39**	**0.04**	**0.37**	**0.05**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.84**
26	37G8	0.00	0.00	0.00	0.13	0.04	0.00	0.00	0.00	0.00	**0.17**
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	0.10	0.02	0.00	0.00	0.00	0.00	0.00	**0.12**
26	38G9	0.00	0.00	9.26	4.91	0.46	0.00	0.00	0.00	0.00	**14.62**
26	39G8	0.00	0.00	0.87	0.53	0.17	0.00	0.00	0.00	0.00	**1.58**
26	39G9	0.00	0.22	2.37	1.06	0.26	0.11	0.11	0.00	0.00	**4.13**
26	40G8	0.00	0.00	0.00	0.06	0.02	0.00	0.00	0.00	0.00	**0.08**
Sum SD26		**0.00**	**0.22**	**12.60**	**6.71**	**0.95**	**0.11**	**0.11**	**0.00**	**0.00**	**20.70**

Table 11. 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”, 12-27.09.2022.

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	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.26**
25	38G5	0.85	1.65	62.65	17.30	0.00	0.00	0.00	0.00	0.00	**82.45**
25	38G6	0.00	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	**0.00**
25	39G6	0.00	0.00	14.84	0.00	0.00	0.00	0.00	0.00	0.00	**14.84**
25	39G7	0.00	0.00	5.09	2.77	0.00	0.00	0.00	0.00	0.00	**7.86**
Sum SD25		**1.11**	**1.65**	**82.58**	**20.07**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**105.41**
26	37G8	0.00	0.00	0.00	58.75	19.58	0.00	0.00	0.00	0.00	**78.34**
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	22.46	5.85	0.00	0.00	0.00	0.00	0.00	**28.31**
26	38G9	0.00	0.00	2398.75	1923.82	228.81	0.00	0.00	0.00	0.00	**4551.38**
26	39G8	0.00	0.00	242.91	226.15	97.75	0.00	0.00	0.00	0.00	**566.82**
26	39G9	0.00	22.17	543.04	369.26	136.59	50.87	116.08	0.00	0.00	**1238.01**
26	40G8	0.00	0.00	0.00	25.58	8.53	0.00	0.00	0.00	0.00	**34.10**
Sum SD26		**0.00**	**22.17**	**3207.16**	**2609.41**	**491.26**	**50.87**	**116.08**	**0.00**	**0.00**	**6496.95**

Table 12. 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”, 12-27.09.2022.

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	0.20	-	-	-	-	-	-	-	-	**0.20**
25	38G5	10.33	45.00	210.08	420.58	-	-	-	-	-	**179.80**
25	38G6	-	-	-	-	-	-	-	-	-	**-**
25	38G7	-	-	-	-	-	-	-	-	-	**-**
25	39G6	-	-	266.94	-	-	-	-	-	-	**266.94**
25	39G7	-	-	318.24	419.86	-	-	-	-	-	**347.88**
MW SD25		**0.80**	**45.00**	**223.31**	**420.48**	**-**	**-**	**-**	**-**	**-**	**57.24**
26	37G8	-	-	-	449.25	449.25	-	-	-	-	**449.25**
26	37G9	-	-	-	-	-	-	-	-	-	**-**
26	38G8	-	-	231.90	241.62		-	-	-	-	**233.85**
26	38G9	-	-	258.99	392.20	500.67	-	-	-	-	**311.22**
26	39G8	-	-	278.56	424.14	572.54	-	-	-	-	**359.66**
26	39G9	-	102.00	229.18	347.25	520.01	468.00	1068.00	-	-	**299.74**
26	40G8	-	-	-	449.25	449.25	-	-	-	-	**449.25**
MW SD26		**-**	**102.00**	**254.53**	**388.67**	**515.50**	**468.00**	**1068.00**	**-**	**-**	**313.84**

Table 13. Values of the basic meteorological and hydrological parameters recorded in September 2022 at the positions of the r.v. "Baltica" fish pelagic catches (catch No. 9 was 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	2022-09-12	16:05	1015.7	16.3	NW	4	2	6.3	10.7	2.4	71
2	2022-09-13	05:45	1010.6	12.9	S	4/5	2	4.9	7.8	6.2	56
3	2022-09-13	08:10	1010.0	13.4	S	4	2	4.7	7.8	7.5	45
4	2022-09-13	15:10	1005.1	16.7	S	4/5	2	4.8	7.6	7.2	29
5	2022-09-14	06:20	1001.3	13.6	WSW	5	2/3	4.5	7.7	6.9	43
6	2022-09-14	10:55	1001.8	16.5	W	5	3	6.3	9.8	3.6	66
7	2022-09-14	14:10	1001.5	17.0	W	5	3	5.3	9.2	2.7	67
8	2022-09-17	15:20	999.3	15.3	WNW	5	3	7.4	7.6	7.2	34
9	2022-09-18	06:35	1000.6	15.1	WSW	4	2	6.3/6.7	7.7/10.5	6.4/3.7	38/69
10	2022-09-18	10:30	1001.4	14.8	W	4	2	10.9	7.6	6.6	54
11	2022-09-18	15:50	1002.3	14.6	W	5	3	8.8	7.7	6.2	35
12	2022-09-20	06:00	1014.6	13.9	NNW	5	3	7.6	10.5	4.1	49
13	2022-09-20	11:45	1017.7	13.8	N	4/5	2/3	9.6	7.5	6.3	36
14	2022-09-21	07:10	1024.2	13.8	N	4	2	7.8	11.5	3.9	58
15	2022-09-21	11:30	1025.0	13.6	N	3	2	13.5	7.7	6.9	28
16	2022-09-21	14:55	1024.6	14.9	N	3	2	13.1	7.7	6.6	27
17	2022-09-22	06:15	1024.9	13.3	ENE	4	2	9.1	7.9	6.6	35
18	2022-09-22	14:15	1023.7	15.2	W	2	1	8.7	11.8	3.6	54
19	2022-09-23	07:55	1020.5	12.9	SW	4	2	14.5	7.7	6.2	25
20	2022-09-23	15:10	1017.7	14.7	WSW	3/4	2	7.4	11.5	3.4	57
21	2022-09-24	08:30	1015.2	14.6	S	4	2	5.8	8.0	5.4	52
22	2022-09-24	16:25	1014.6	15.0	E	4	2	7.2	7.8	6.4	38
23	2022-09-25	07:50	1013.1	10.6	S	2	1	7.1	10.6	4.1	61
24	2022-09-25	12:15	1014.6	14.5	SSW	4	2	15.4	7.5	6.1	29
25	2022-09-25	15:55	1010.1	14.4	SW	3	1	6.3	7.7	6.5	38
26	2022-09-26	14:10	1003.5	15.0	SW	4	2	5.3	7.7	6.3	32

*date of the mean of the catches (in the middle of trawl vertical opening)

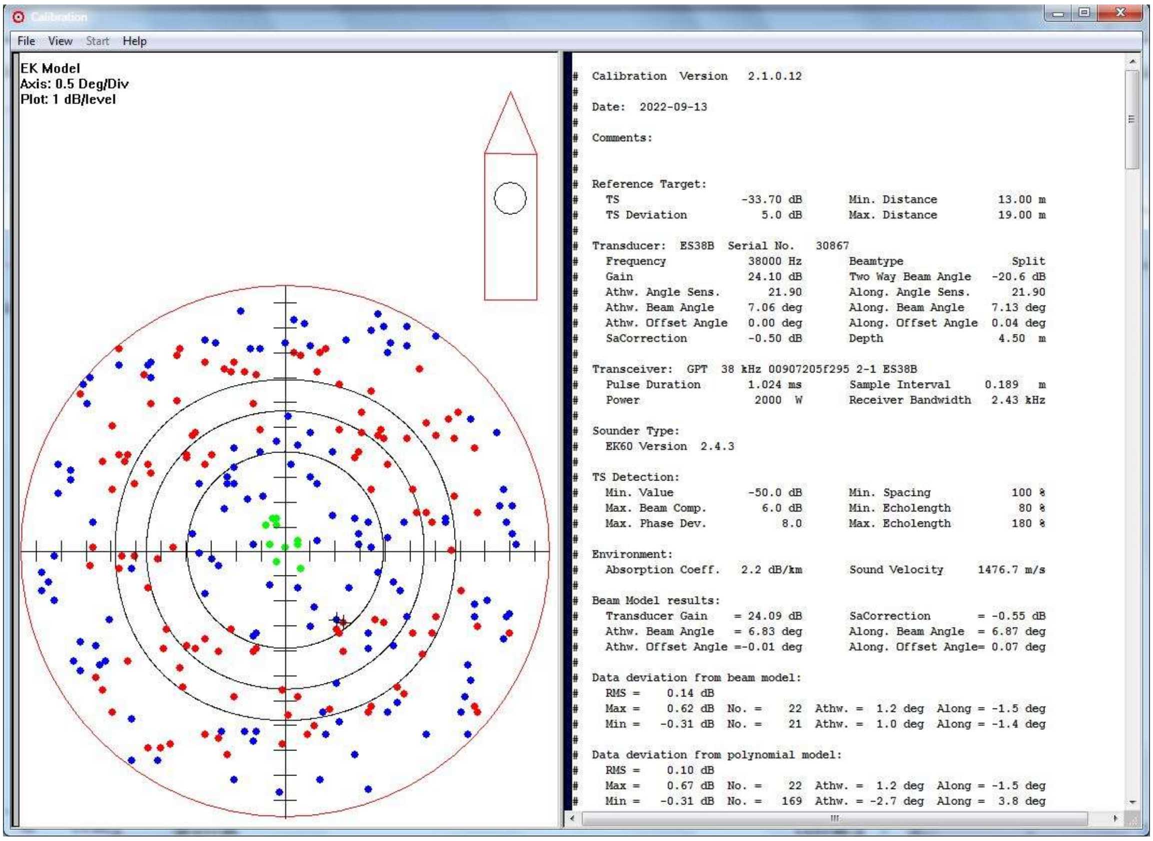


Figure 1. Simrad EK60 calibration report (38 kHz transducer) R.v. "Baltica" cruise BIAS 2022.

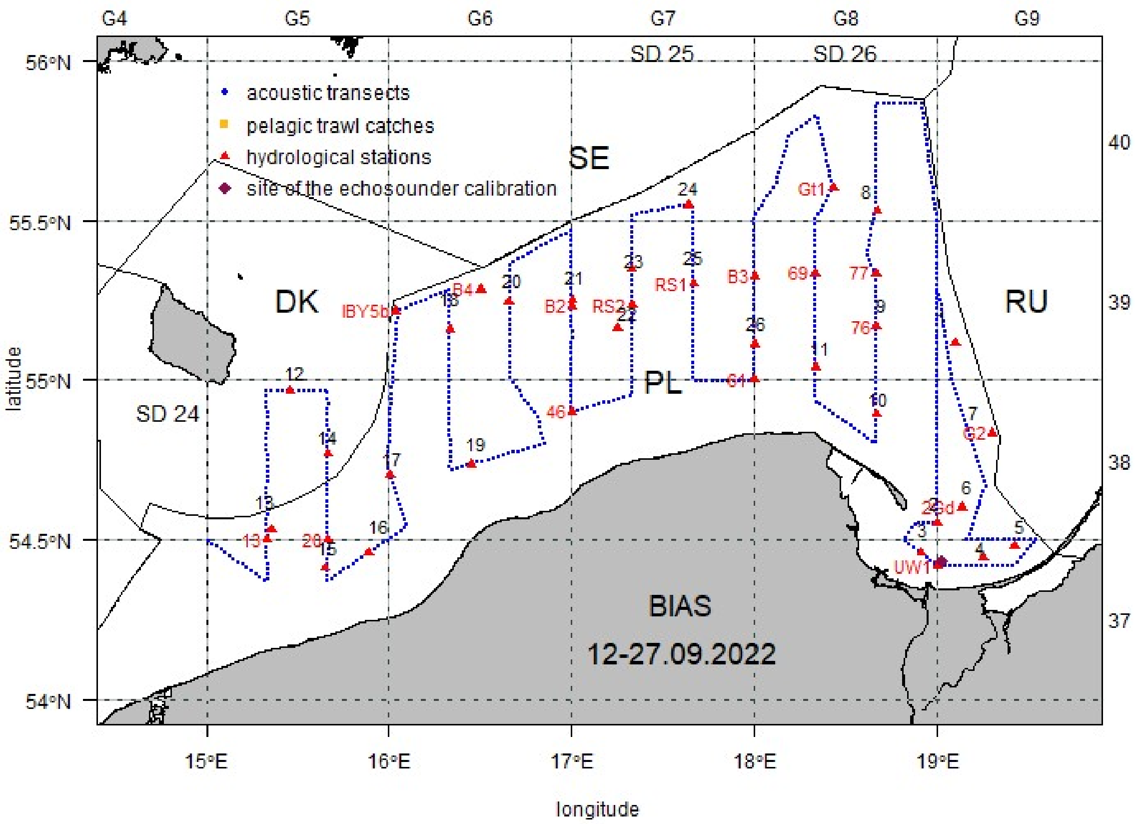


Figure 2. Location of realized investigations during the Polish BIAS survey on board of the r.v. "Baltica", 12-27.09.2022.

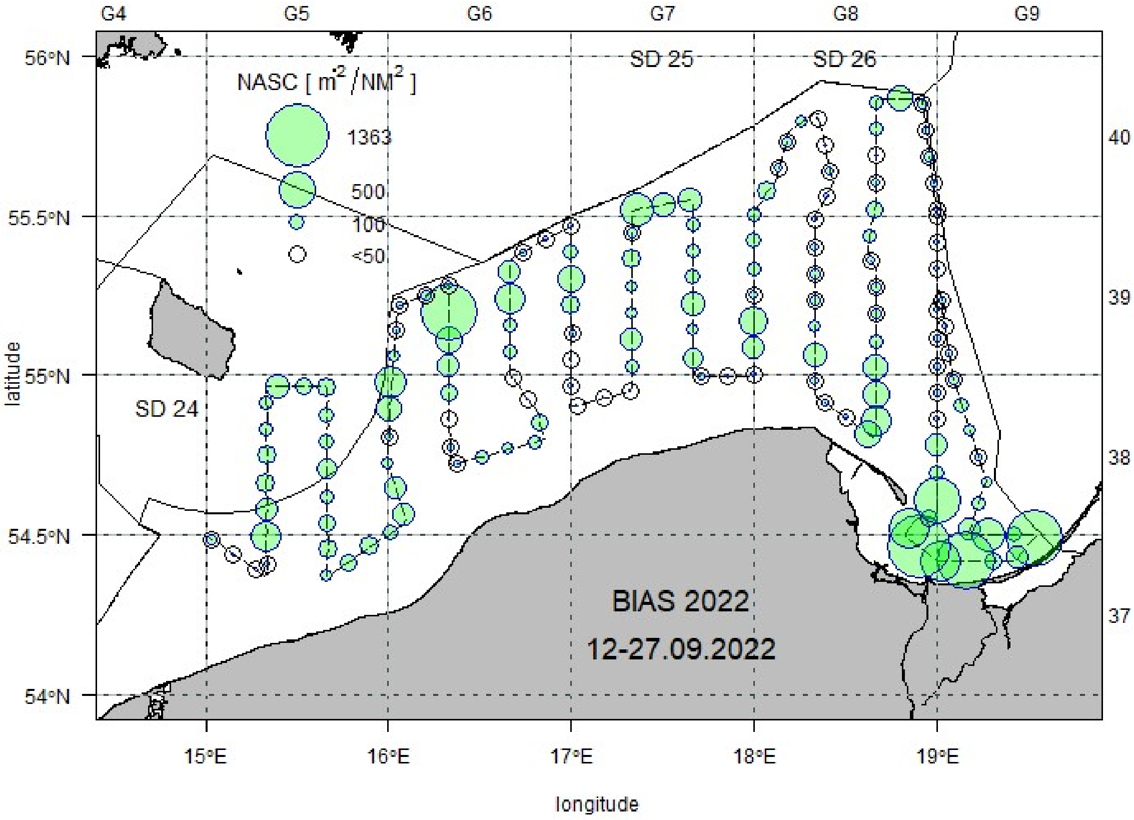


Figure 3. Cruise track (thin dashed line) and the mean NASC (5 NM intervals, bubbles) recorded during Polish BIAS survey on board of the r.v. "Baltica", 12-27.09.2022.

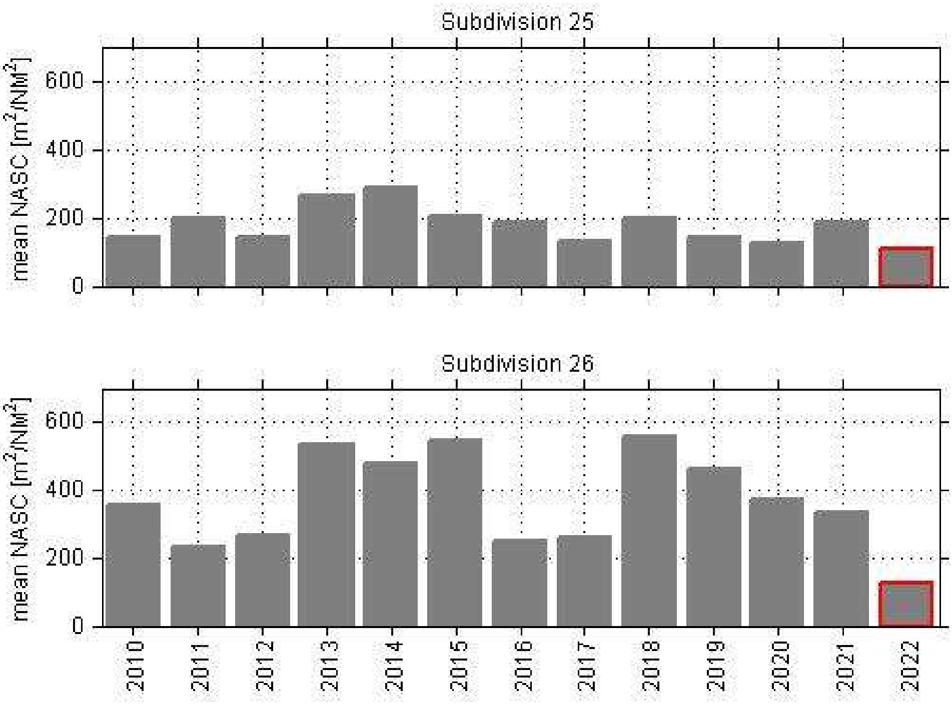


Figure 4. Weighted mean NASC values (m^2/NM^2) for investigated parts of the ICES Subdivisions 25 and 26 during Polish BIAS surveys for years 2010-2022 (the mean NASC values were calculated with the use of areas of ICES rectangles as weight).

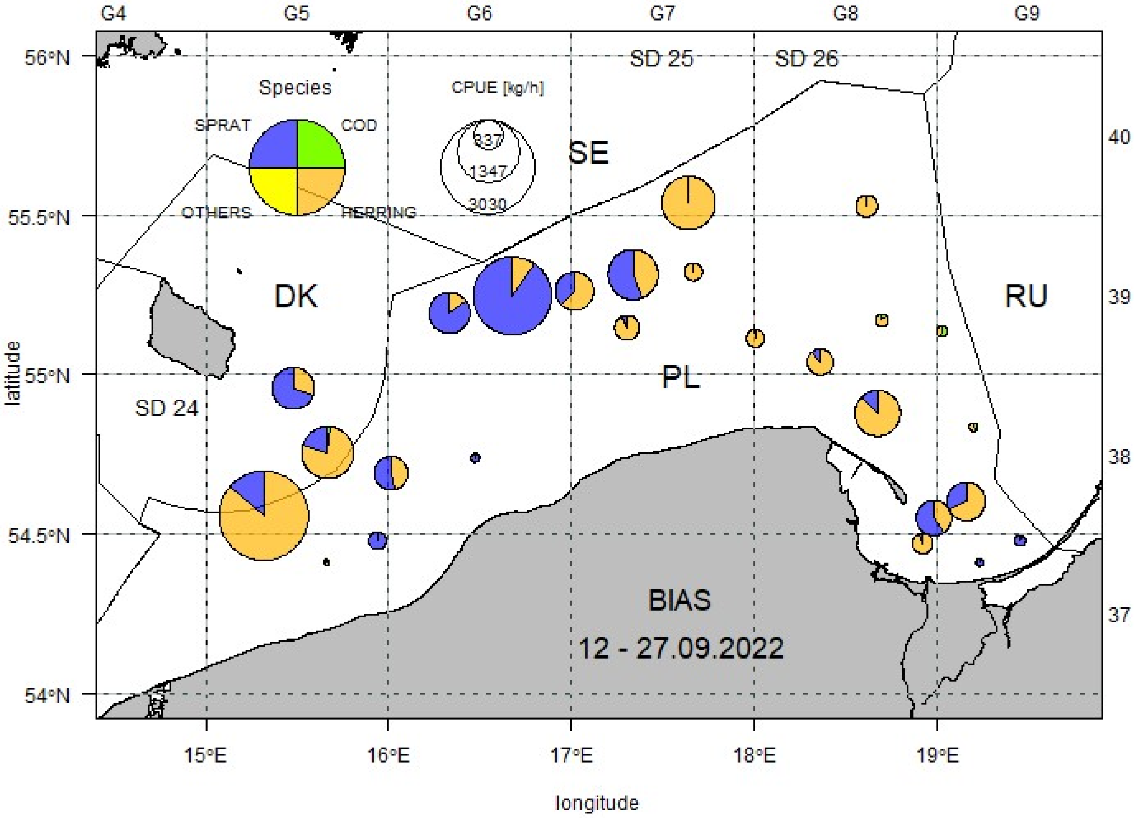


Figure 5. CPUE [kg/h] of fish species per single pelagic hauls conducted in the Polish SPRAS survey on board of the r.v. "Baltica", 12-27.09.2022.

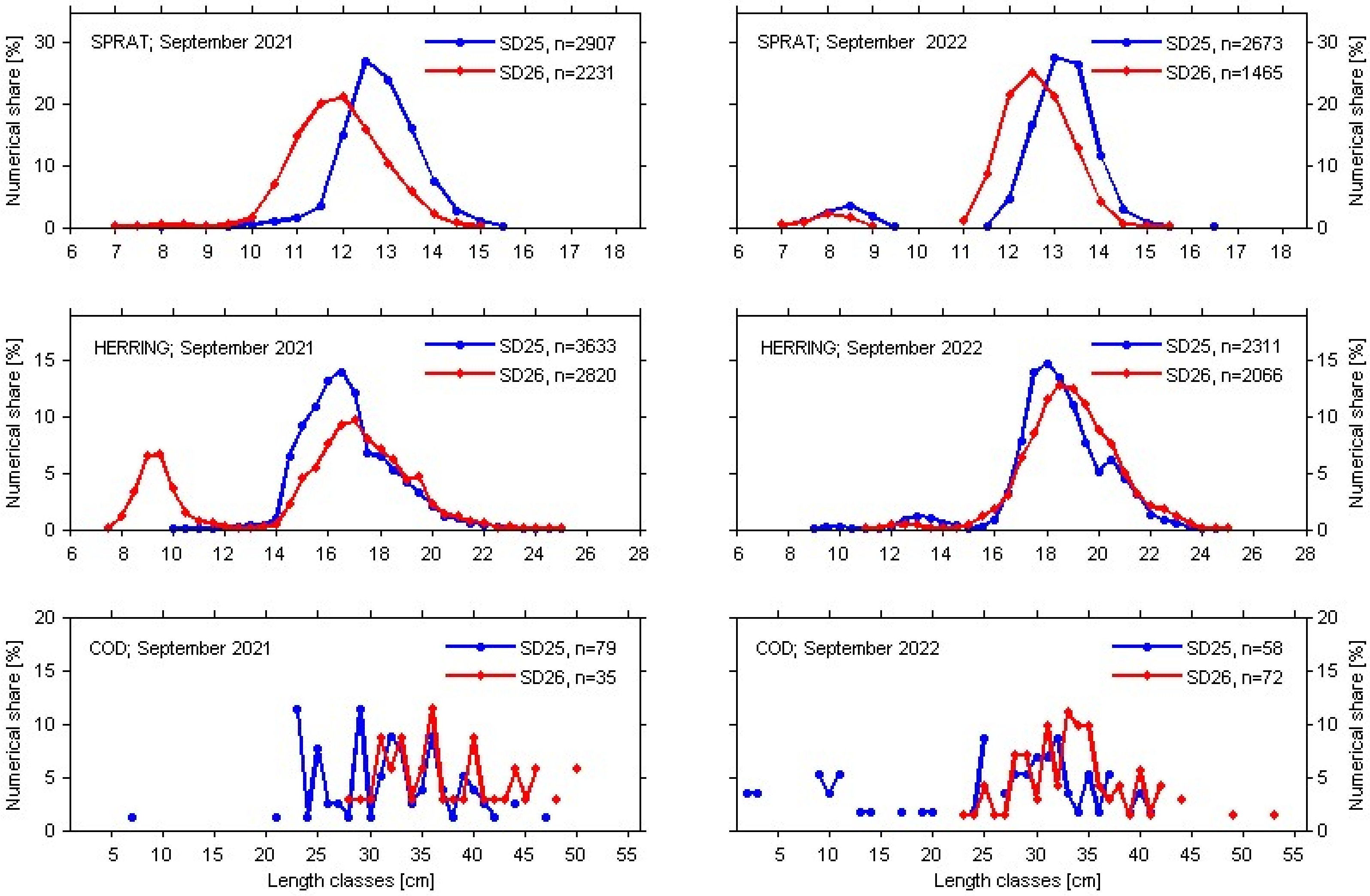


Figure 6. Length distribution of sprat, herring and cod in samples taken from the catches conducted during the Polish BIAS/2021 and BIAS/2022 surveys (the length distribution data for fish species from 2021 from Schmidt et al., 2022a).

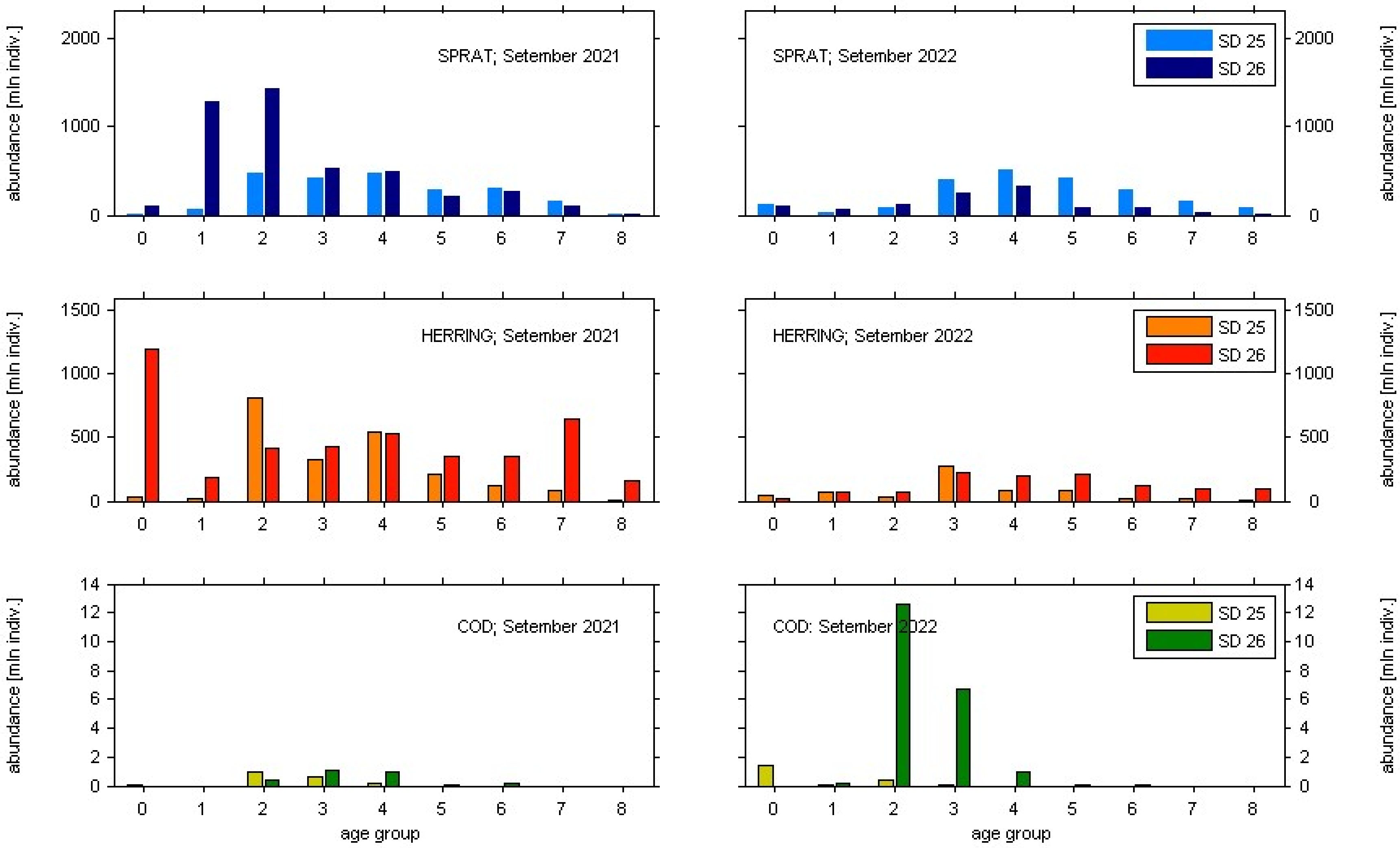


Figure 7. Abundance (in mln indiv.) of sprat, herring and cod stocks per age groups, according to the ICES Sub-divisions 25 and 26, based on data from the Polish BIAS surveys in 2021 and 2022 (the abundance data for fish species from 2021 from Schmidt et al., 2022a).

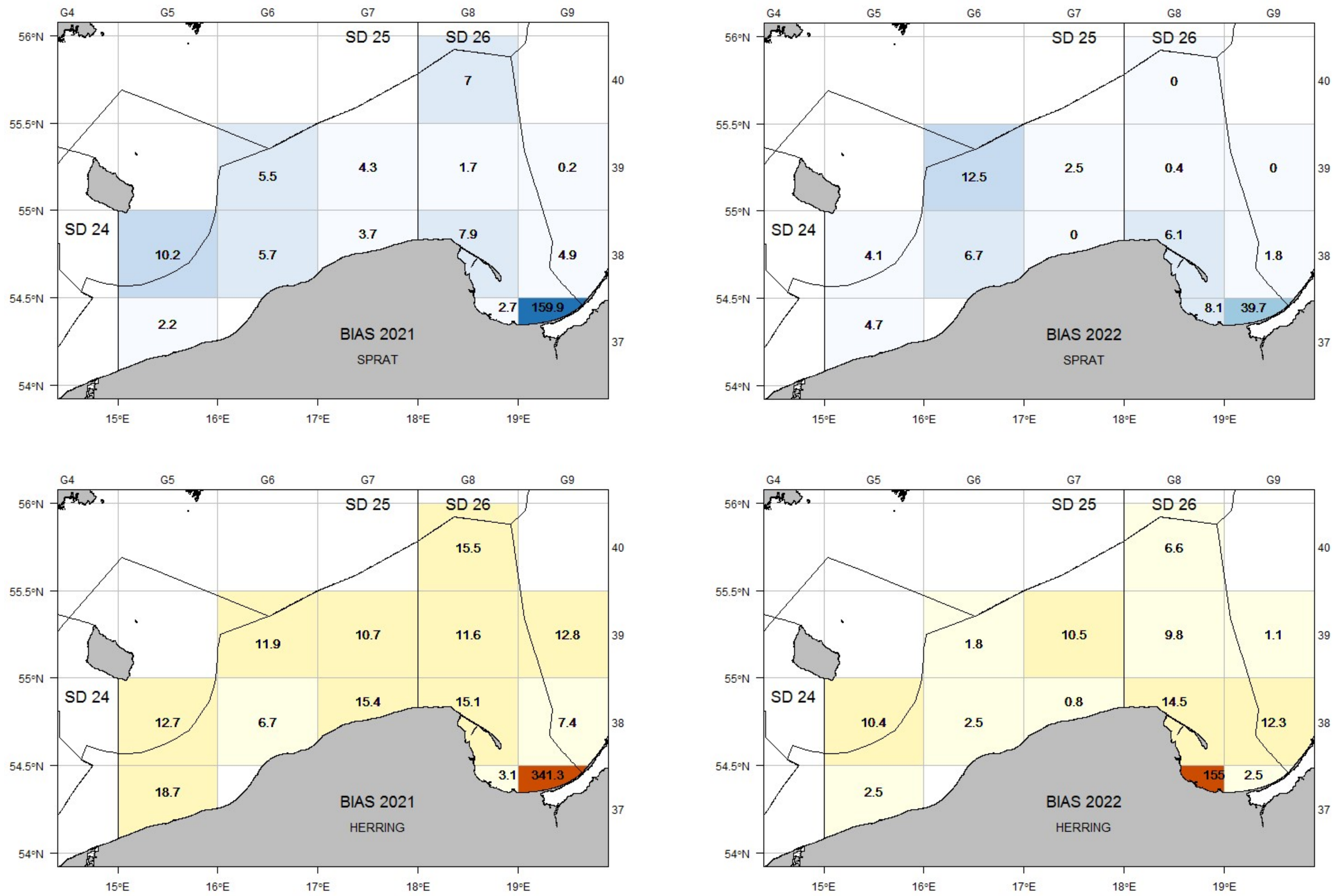
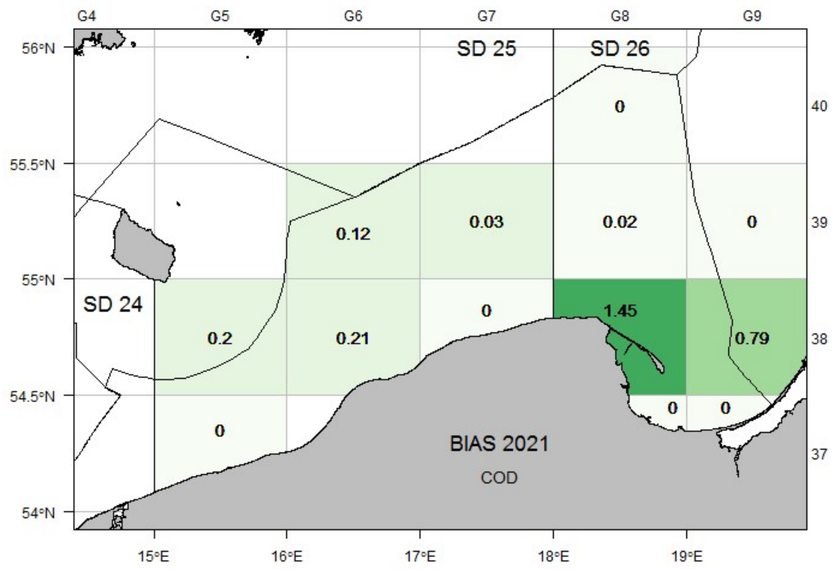


Figure 8. Biomass surface density of sprat and herring [t/NM^2] per ICES rectangles, estimated using acoustic method, and based on data collected during the Polish BIAS 2021 and 2022 surveys (the fish species biomass density data from 2021 from Schmidt et al., 2022a).



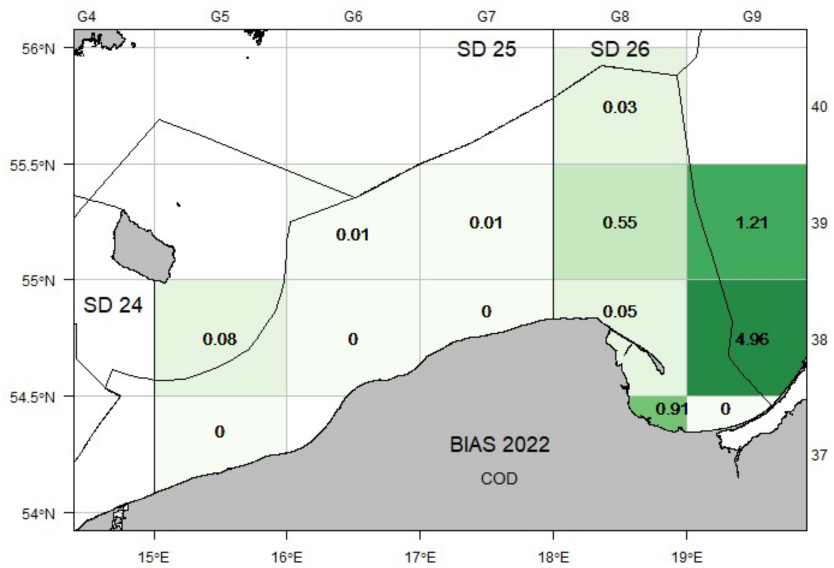


Figure 9. Biomass surface density of cod [t/NM^2] per ICES rectangles, estimated using acoustic method, and based on data collected during the Polish BIAS 2021 and 2022 surveys (the fish species biomass density data from 2021 from Schmidt et al., 2022a).

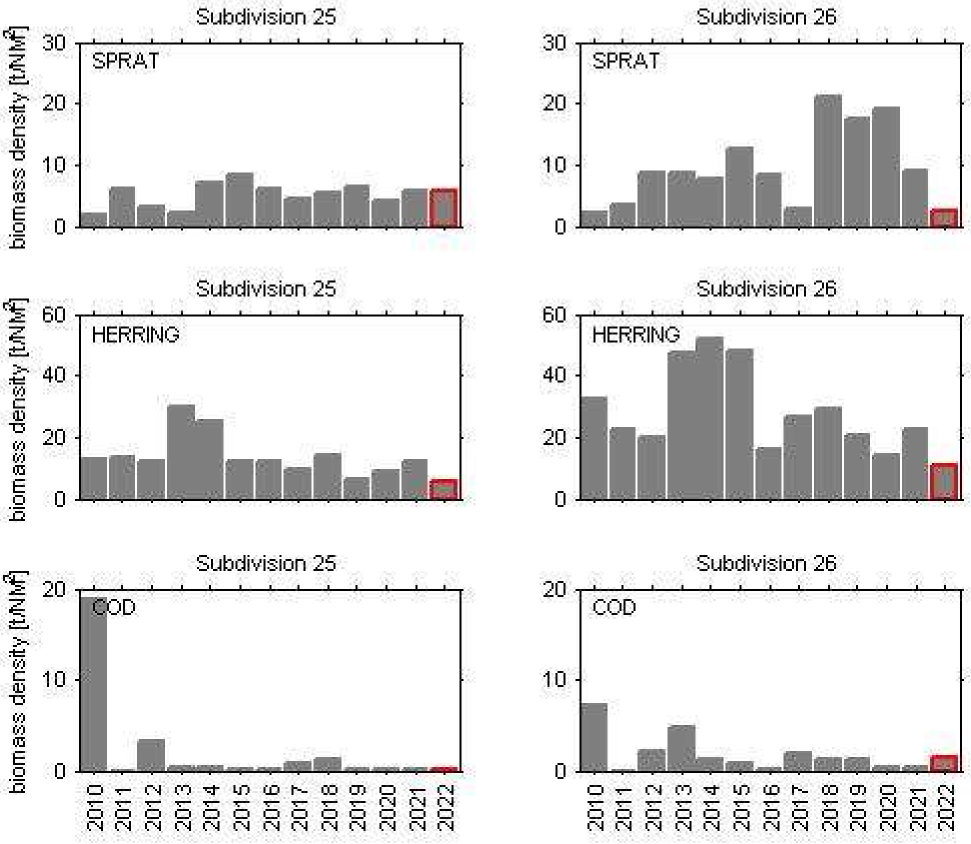


Figure 10. Mean biomass surface density [t/NM^2] of sprat, herring and cod calculated for investigated parts of the ICES Subdivisions 25 and 26 during Polish BIAS surveys for years 2010-2022.

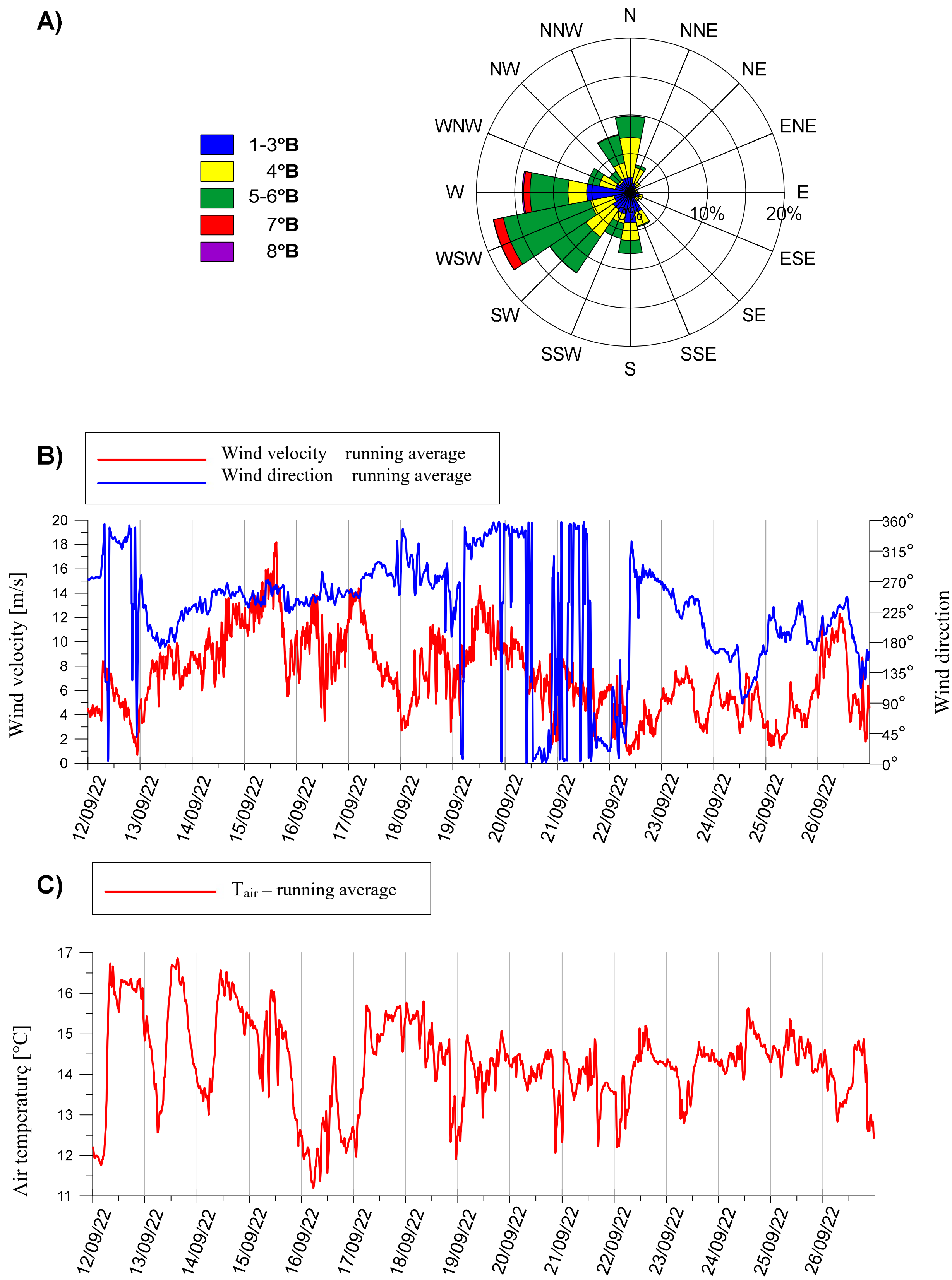


Figure 11. Changes of meteorological parameters during consecutive days of the Polish BIAS survey in September 2022 (fig. Wodzinowski after Schmidt et al., 2022b).

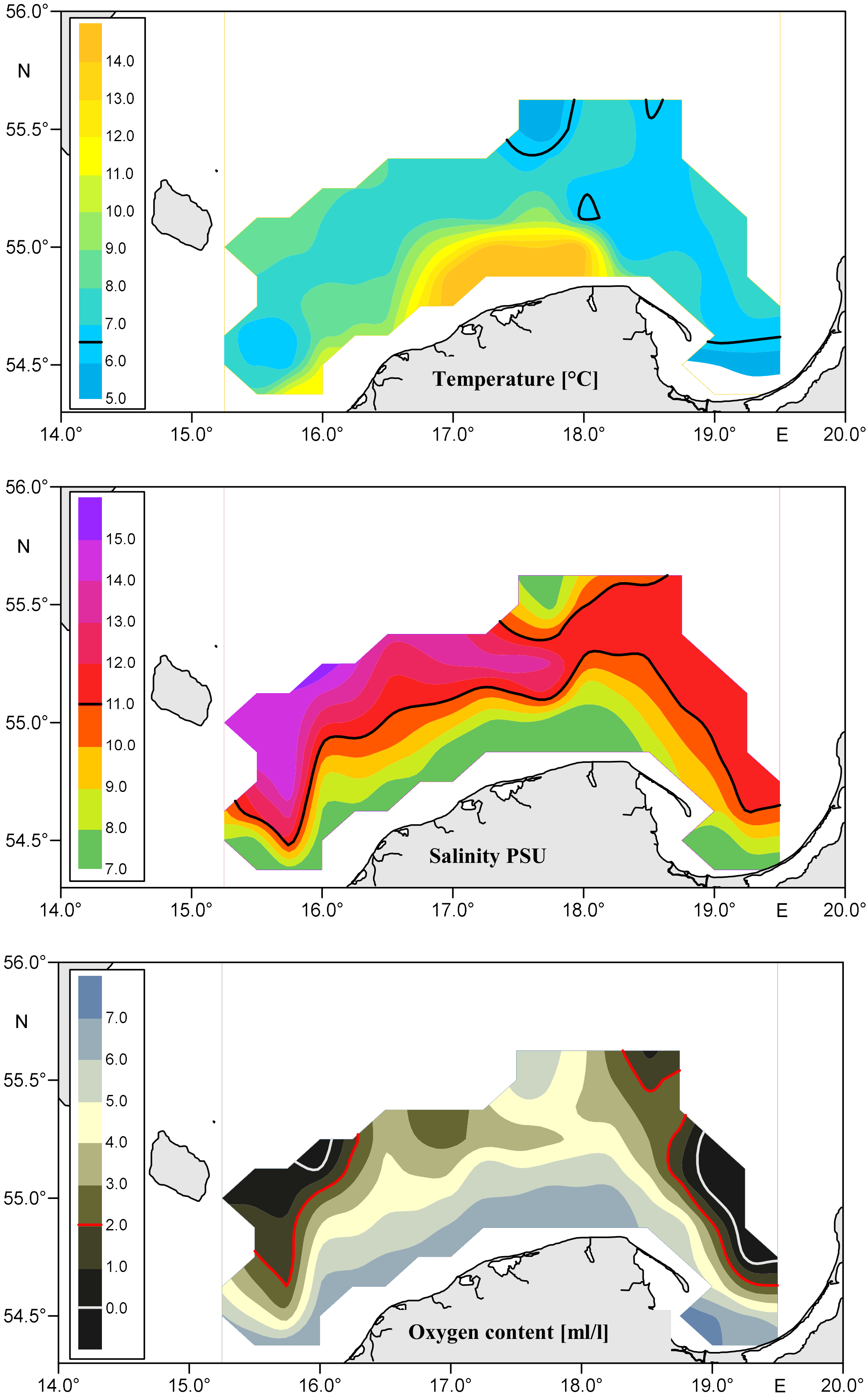


Figure 12. Horizontal distribution of the seawater temperature, salinity and oxygen content in the near seabed layer of the southern Baltic in September 2021 (fig. Wodzinowski after Schmidt et al., 2022b).

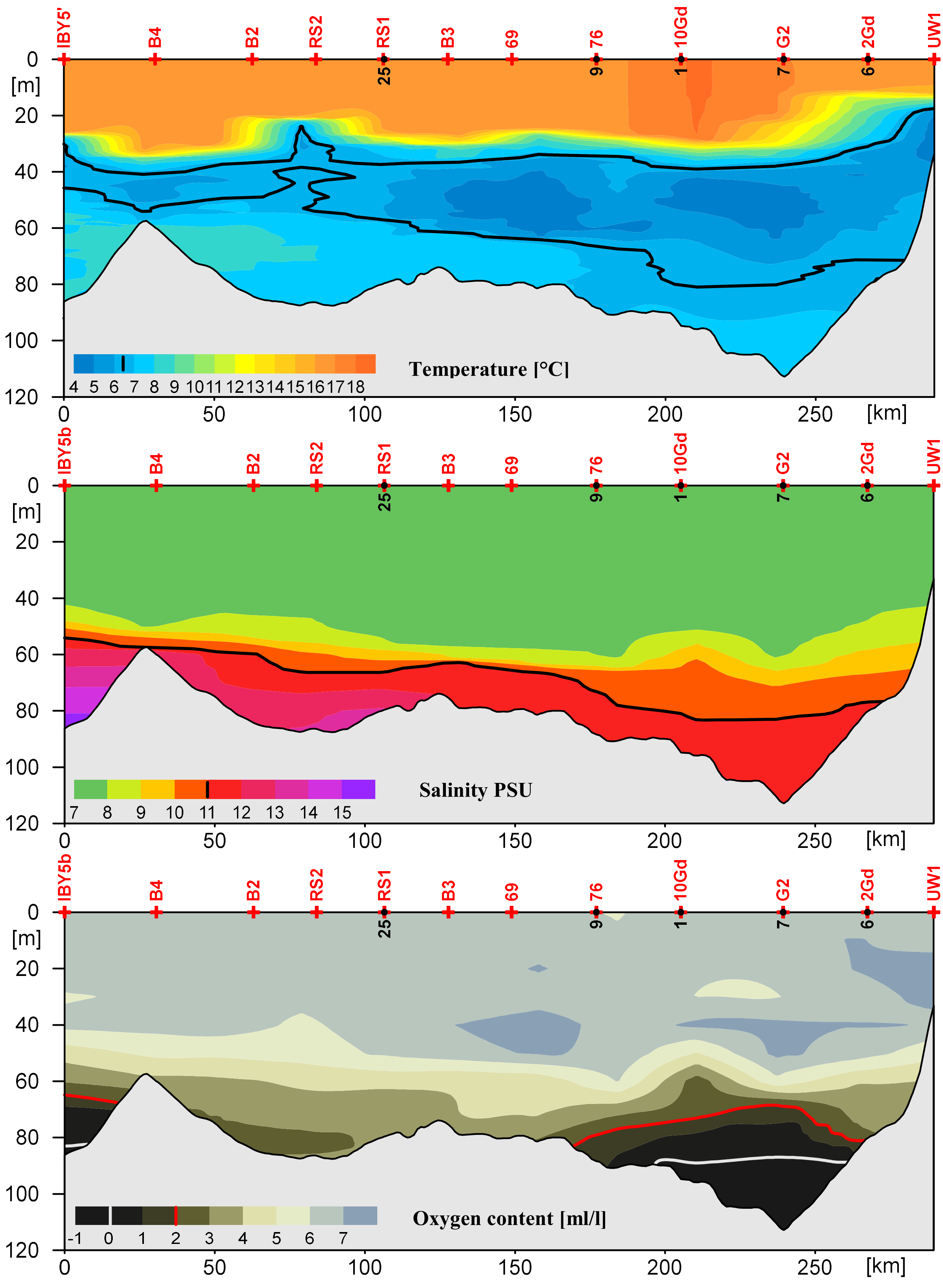


Figure 13. Vertical distribution of the seawater temperature, salinity and oxygen content, along the hydrological research profile determined in the southern Baltic (September 2022); X- and Y-axes reflects distance (in kilometres) and depth (in meters) from the sea surface to the seabed, respectively (fig. Wodzinowski after Schmidt et al., 2022b).

Baltic International Acoustic Survey Report, R/V Svea, Sweden

Survey 2022-10-02 - 2022-10-17

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 Gåsöfjärden on the Swedish east coast. The survey started 2022-10-02 east of Gåsöfjärden, and ended 2022-10-17 between Sweden and Bornholm at the border between ICES subdivision (SD) 24 and 25 (Figure 2).

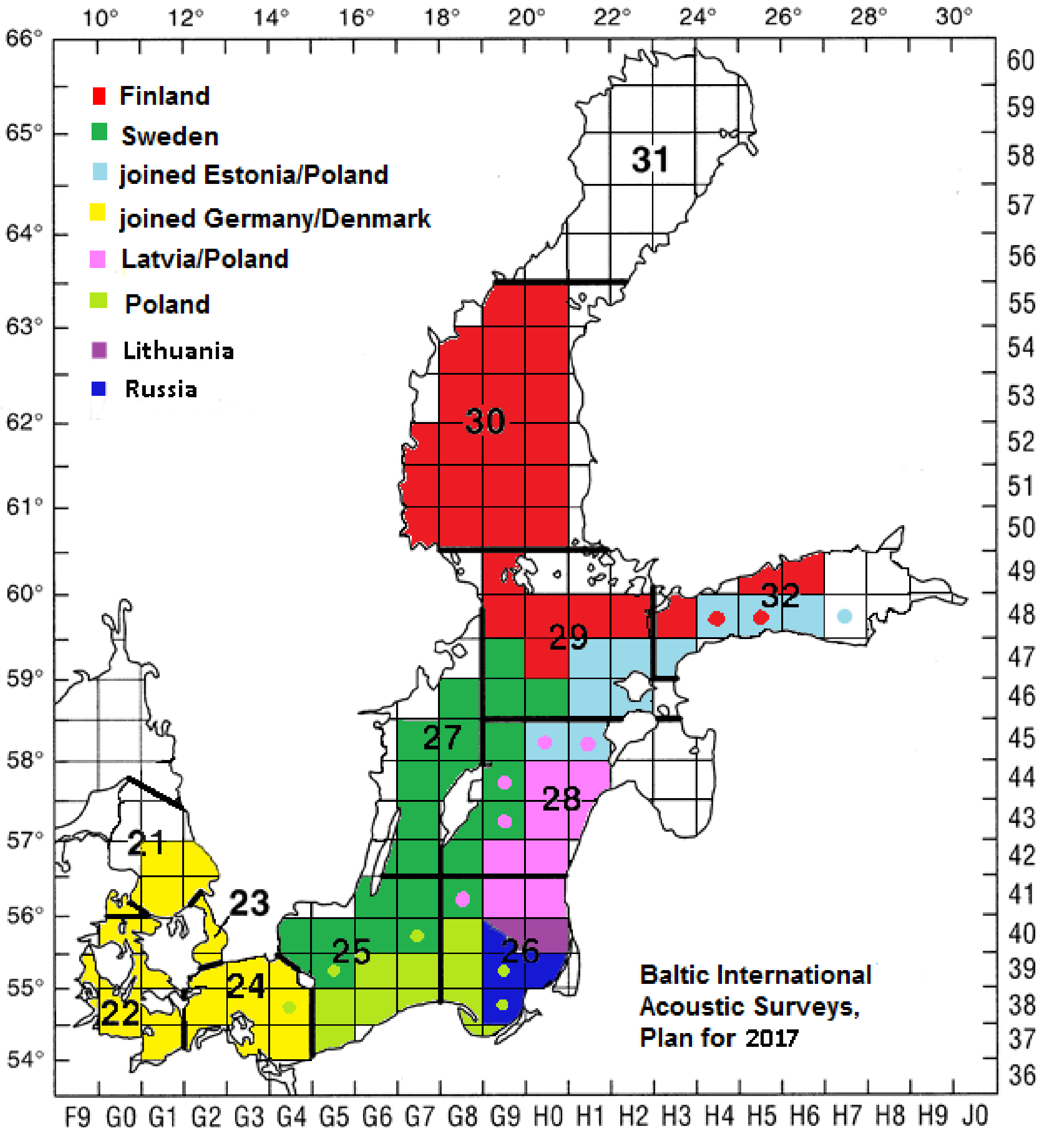


Figure 1. Allocation of ICES squares to each country in the BIAS survey 2022 (On axes: longitude, latitude and ICES name of square eg:41G8).

2.2 Survey design

The survey design is based on ICES statistical rectangles (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 2022 was 20832 square nautical miles and the distance used for acoustic estimates was 1301 nautical miles. The cruise track and positions of trawl hauls are shown in Figure 2.

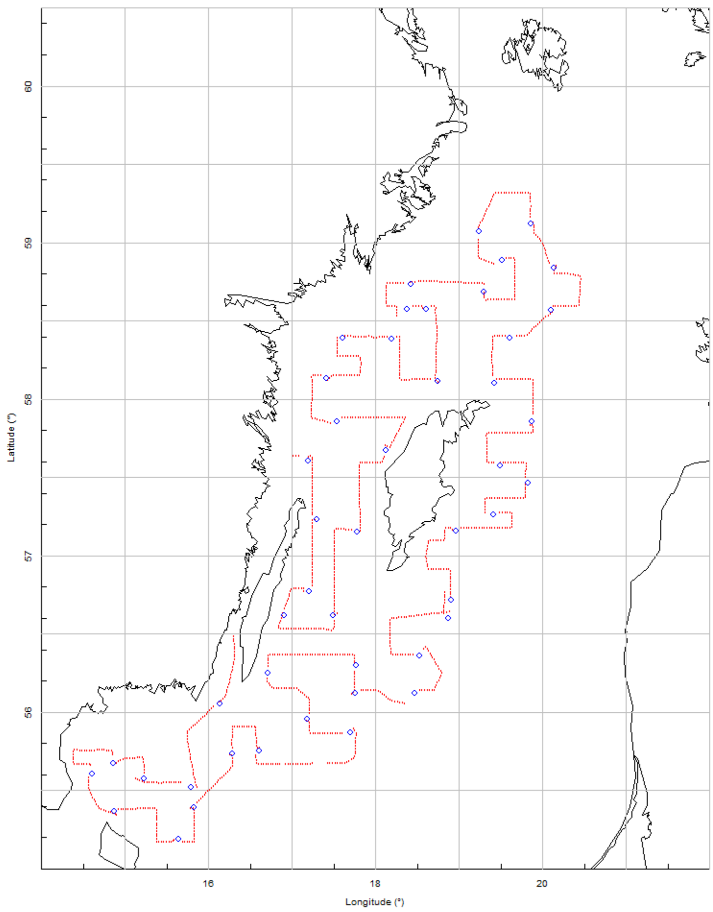


Figure 2. Cruise track(red), positions of trawl hauls (blue) and survey grid of ICES squares (grey) for BIAS 2022.

2.3 Calibration

The SIMRAD EK80 echo sounder with the 38kHz transducer was calibrated in Gåsöfjärden 2022-10-02, 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 hydro-acoustic equipment was set in accordance with 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 executed 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
Andersson, Linda	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 54 trawl hauls were carried out, 16 in SD 25, 2 in SD 26, 19 in SD 27, 9 in SD 28 and 8 hauls in SD 29. In total 1659 herring and 1250 sprat were sampled 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 fourth year that R/V Svea was used for BIAS. 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 reviewed and accepted at the WGBIFS meeting and thus representative for the index of abundance of the pelagic species during the BIAS in 2022 for the covered area (Figure 2). For further information regarding the procedures of WGBIFS see the WGBIFS report (ICES, 2022).

5 References

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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	206.2	3.096	191.34	61.99	27.26	9.517
25	39G5	979.0	116.1	2.419	469.81	45.38	53.38	0.946
25	40G4	677.2	427.9	2.660	1089.65	52.45	46.08	0.002
25	40G5	1012.9	136.9	2.095	661.70	32.89	65.81	0.238
25	40G6	1013.0	334.1	2.451	1381.22	68.17	25.60	1.305
25	40G7	1013.0	204.9	1.716	1209.40	30.19	48.60	0.109
25	41G6	764.4	508.1	1.428	2719.32	31.09	36.35	0.058
25	41G7	1000.0	360.4	0.840	4289.16	0.16	39.00	0.000
26	41G8	1000.0	275.6	0.577	4777.35	5.52	4.19	0.005
27	42G6	266.0	616.4	1.123	1459.87	12.49	41.59	0.000
27	42G7	986.9	318.7	0.917	3428.17	7.37	35.16	0.000
27	43G7	913.8	348.0	0.747	4255.13	0.84	37.73	0.000
27	44G7	960.5	367.3	0.513	6874.82	6.23	3.93	0.000
27	44G8	456.6	416.8	0.503	3784.52	4.52	6.79	0.000
27	45G7	908.7	171.9	1.128	1384.75	37.47	13.36	0.018
27	45G8	947.2	427.1	1.077	3756.97	17.44	42.99	0.014
27	46G8	884.8	256.1	0.928	2440.53	24.48	49.47	0.000
28	42G8	945.4	741.5	0.400	17513.06	0.51	0.61	0.000
28	43G8	296.2	366.4	1.915	566.64	67.83	5.34	0.096
28	43G9	973.7	458.4	0.992	4501.66	1.69	74.78	0.000
28	44G9	876.6	752.5	0.464	14222.91	2.94	2.88	0.002
28	45G9	924.5	582.3	0.566	9509.97	19.49	8.85	0.000
29	46G9	933.8	529.1	1.420	3479.73	42.33	33.62	0.004
29	46H0	933.8	372.1	0.790	4399.84	36.37	12.08	0.003
29	47G9	876.2	752.9	1.302	5065.12	68.48	15.30	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	52	0	2	3	13	12	11	6	0	5
25	39G5	251	0	5	0	81	46	33	46	2	37
25	40G4	502	3	12	31	126	52	129	64	15	71
25	40G5	435	1	5	53	134	94	72	28	2	46
25	40G6	354	0	2	3	41	81	48	19	62	98
25	40G7	588	0	53	89	196	157	23	8	10	52
25	41G6	988	37	281	167	349	40	73	33	2	7
25	41G7	1673	30	157	185	712	184	150	146	7	101
26	41G8	200	0	22	52	82	24	10	10	1	1
27	42G6	607	14	69	148	289	14	45	5	20	4
27	42G7	1205	84	82	158	259	457	29	9	30	98
28	42G8	106	3	0	20	30	17	24	2	6	2
27	43G7	1605	167	198	590	462	69	94	0	11	14
28	43G8	30	16	0	5	6	2	0	0	0	0
28	43G9	3367	1138	169	1120	570	22	125	63	43	116
27	44G7	270	37	67	46	105	3	0	9	1	2
27	44G8	257	11	35	67	45	30	25	16	9	19
28	44G9	409	46	27	48	212	42	23	8	4	0
27	45G7	185	105	8	28	20	6	2	9	4	4
27	45G8	1615	381	16	608	290	132	150	0	2	35
28	45G9	841	402	3	135	166	90	0	30	2	13
27	46G8	1207	1065	33	28	64	10	5	0	0	3
29	46G9	1170	52	9	474	388	174	9	6	6	52
29	46H0	532	138	40	78	185	43	16	11	0	21
29	47G9	775	515	72	63	54	46	2	9	13	2

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	6	13	16	15	16	17	16	23	18
25	39G5		11		14	14	16	16	18	17
25	40G4	3	12	14	16	19	16	17	12	15
25	40G5	4	9	12	12	15	14	17	18	17
25	40G6		11	11	13	14	14	16	17	15
25	40G7		11	10	12	14	15	16	18	13
25	41G6	4	6	11	13	15	14	14	16	14
25	41G7	6	12	11	13	14	15	15	17	15
26	41G8		12	10	12	12	14	13	19	15
27	42G6	5	11	11	12	13	15	15	14	16
27	42G7	4	11	11	13	13	12	16	15	15
28	42G8	5	6	9	12	13	13	14	14	15
27	43G7	5	8	10	13	14	14		13	15
28	43G8	4		9	11	12	12		16	
28	43G9	4	9	10	11	14	14	12	13	14
27	44G7	5	9	12	12	15		13	14	14
27	44G8	5	9	10	14	14	13	12	13	13
28	44G9	4	9	11	12	12	14	13	15	
27	45G7	4	8	10	11	12	12	12	12	13
27	45G8	5	8	11	12	13	14		15	14
28	45G9	4	8	9	12	11		14	14	12
27	46G8	4	8	9	10	12	13			13
29	46G9	4	8	10	13	14	14	14	15	14
29	46H0	4	9	10	11	13	12	13		13
29	47G9	4	8	10	12	10	14	13	12	15

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	119	1	5	31	12	26	24	15	1	4
25	39G5	213	0	9	17	29	85	20	28	14	12
25	40G4	572	12	44	46	59	136	59	86	69	61
25	40G5	218	8	13	8	83	50	34	13	4	5
25	40G6	942	5	42	72	82	464	86	133	38	20
25	40G7	365	0	13	20	104	138	47	11	14	17
25	41G6	846	10	17	25	61	362	263	14	47	48
25	41G7	7	2	5	0	0	0	0	0	0	0
26	41G8	264	0	2	19	35	77	56	34	21	20
27	42G6	182	1	9	10	1	87	21	23	21	10
27	42G7	253	1	1	9	63	99	30	24	25	0
28	42G8	89	2	0	3	27	39	11	4	1	1
27	43G7	36	6	5	10	1	10	1	2	0	0
28	43G8	384	0	0	29	160	66	34	39	34	23
28	43G9	76	8	0	1	17	12	26	10	3	0
27	44G7	428	140	39	33	115	65	23	2	9	3
27	44G8	171	37	16	17	27	47	17	5	4	0
28	44G9	419	40	1	39	137	108	45	20	17	11
27	45G7	519	132	33	59	45	120	12	32	85	0
27	45G8	655	114	74	58	104	129	72	55	33	16
28	45G9	1854	1693	13	10	46	40	16	14	12	10
27	46G8	597	232	80	38	16	150	24	21	25	12
29	46G9	1473	419	97	103	438	89	51	75	192	9
29	46H0	1600	1229	14	34	56	108	62	35	57	6
29	47G9	3468	1786	288	340	427	207	153	103	108	55

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	11	35	58	53	47	62	47	78	68
25	39G5		30	45	38	42	54	55	53	33
25	40G4	16	24	51	41	40	44	45	43	49
25	40G5	16	21	28	31	49	44	52	52	55
25	40G6	15	29	28	28	34	43	44	56	53
25	40G7		34	33	31	38	39	54	52	56
25	41G6	11	17	20	25	32	34	42	37	41
25	41G7	9	20				92			
26	41G8		20	25	27	28	36	33	41	41
27	42G6	7	24	23	22	30	35	35	33	43
27	42G7	7	17	26	24	29	42	36	36	43
28	42G8	6		25	26	32	34	33	41	45
27	43G7	6	18	25	22	26	39	29		
28	43G8			21	23	29	29	29	33	36
28	43G9	6		20	21	30	26	30	29	
27	44G7	6	17	22	23	29	29	38	33	31
27	44G8	6	19	25	23	27	32	34	37	
28	44G9	6	17	21	23	25	33	31	32	32
27	45G7	6	18	23	25	28	26	35	33	
27	45G8	6	18	23	23	28	32	31	33	29
28	45G9	5	17	22	23	26	26	30	28	35
27	46G8	6	16	20	18	27	25	32	30	37
29	46G9	5	18	20	23	30	33	31	29	60
29	46H0	5	17	20	22	25	27	31	27	37
29	47G9	5	17	21	22	25	30	31	32	31

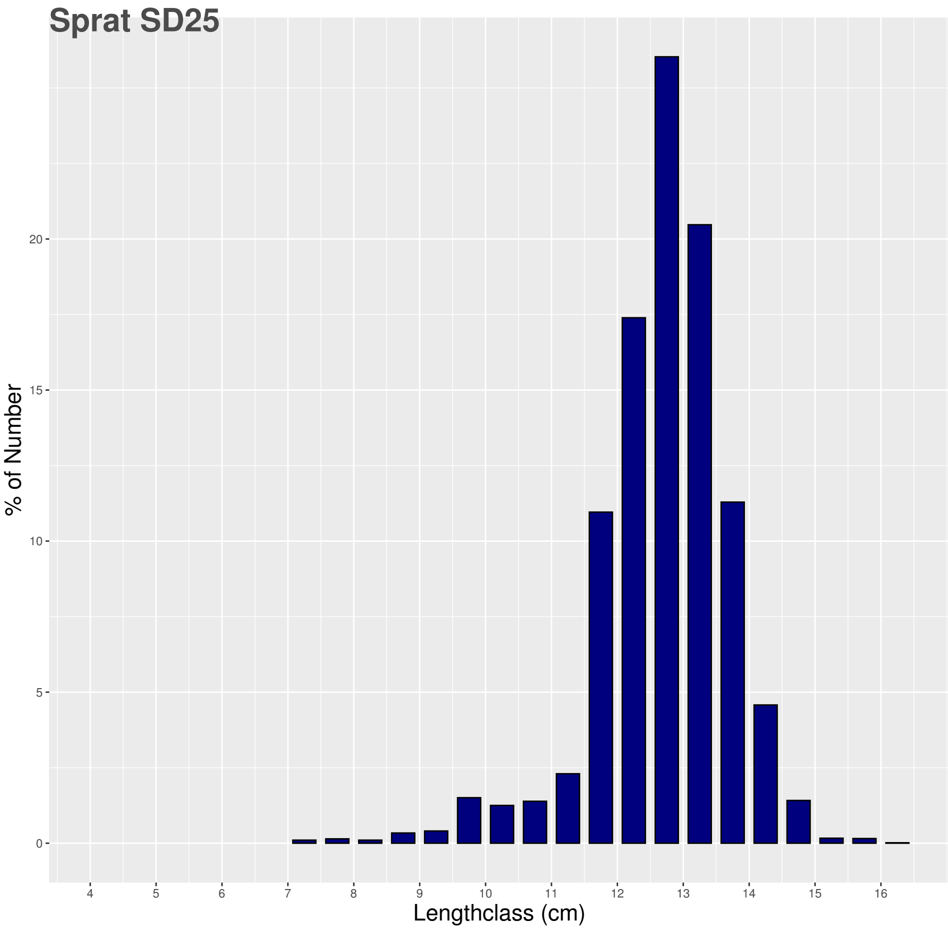

Figure 3. Length distribution of sprat from subdivision 25 for BIAS 2022.

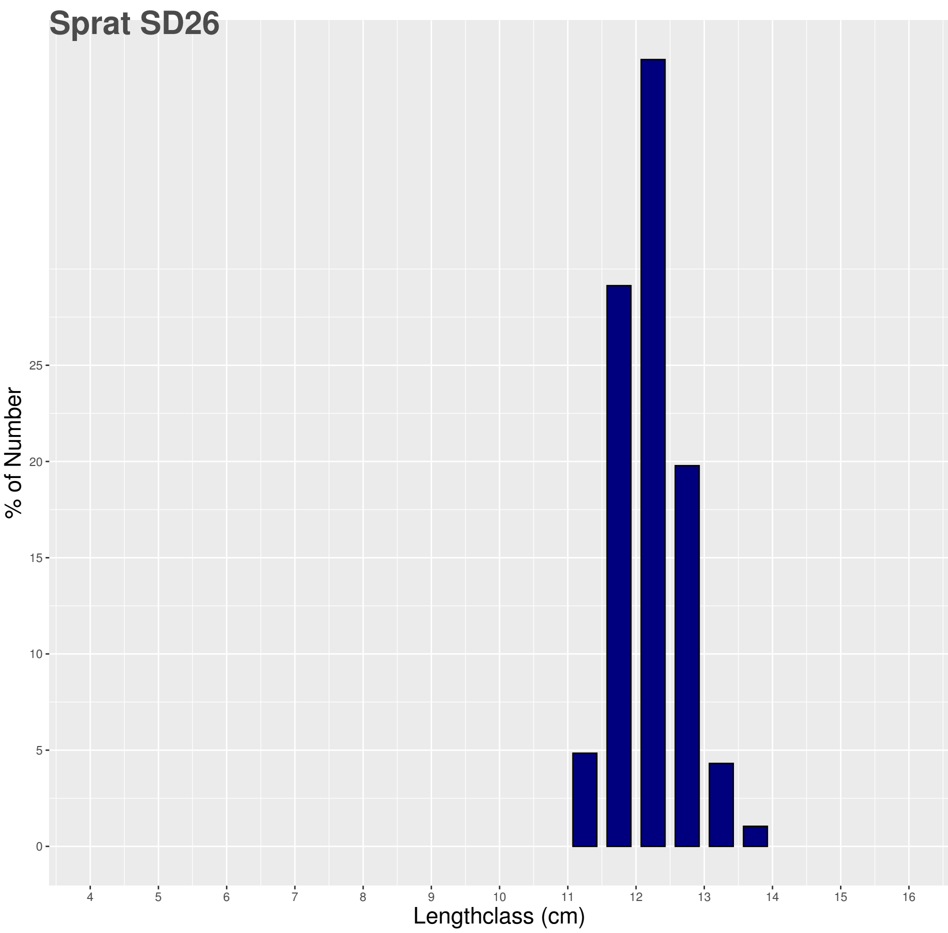

Figure 4. Length distribution of sprat from subdivision 26 for BIAS 2022.

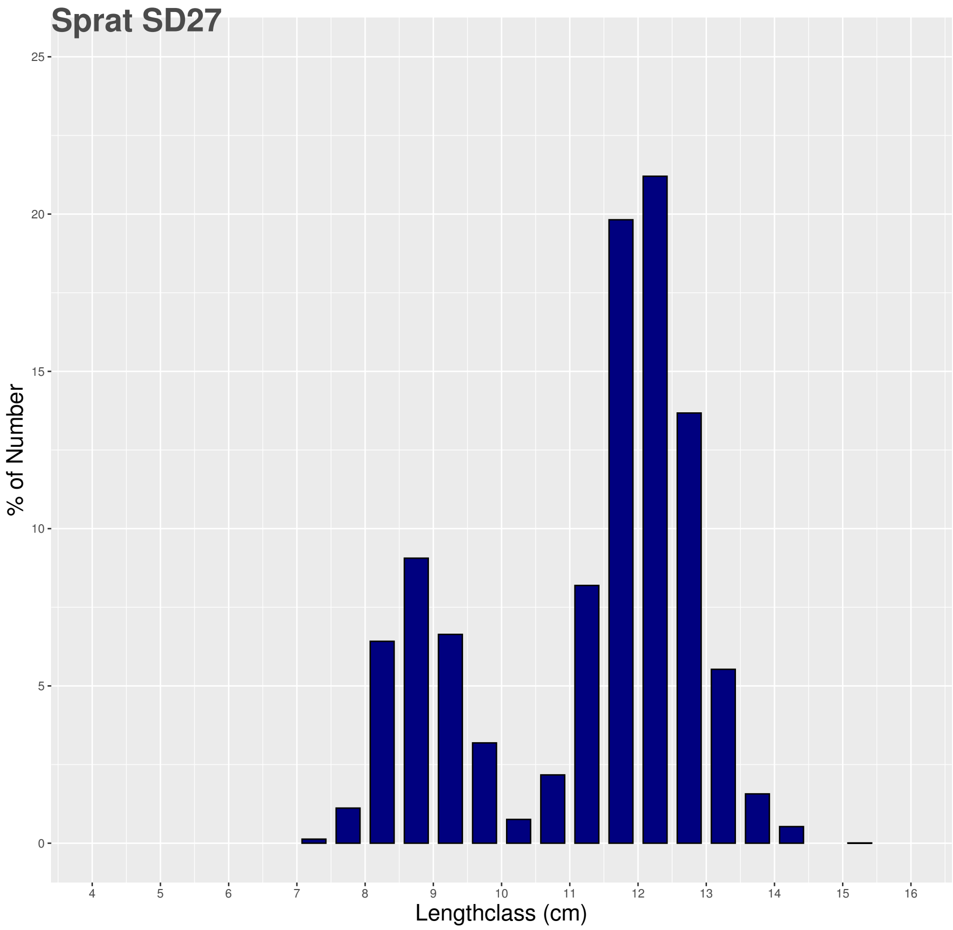

Figure 5. Length distribution of sprat from subdivision 27 for BIAS 2022.

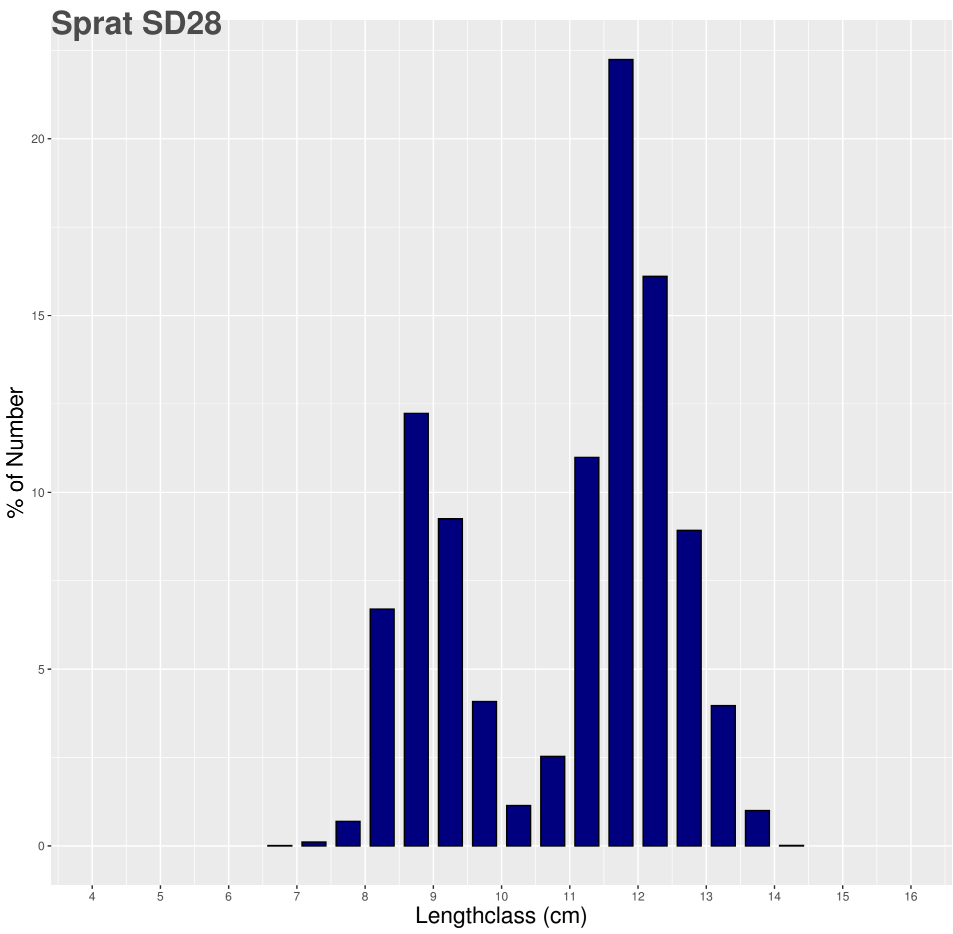

Figure 6. Length distribution of sprat from subdivision 28 for BIAS 2022.

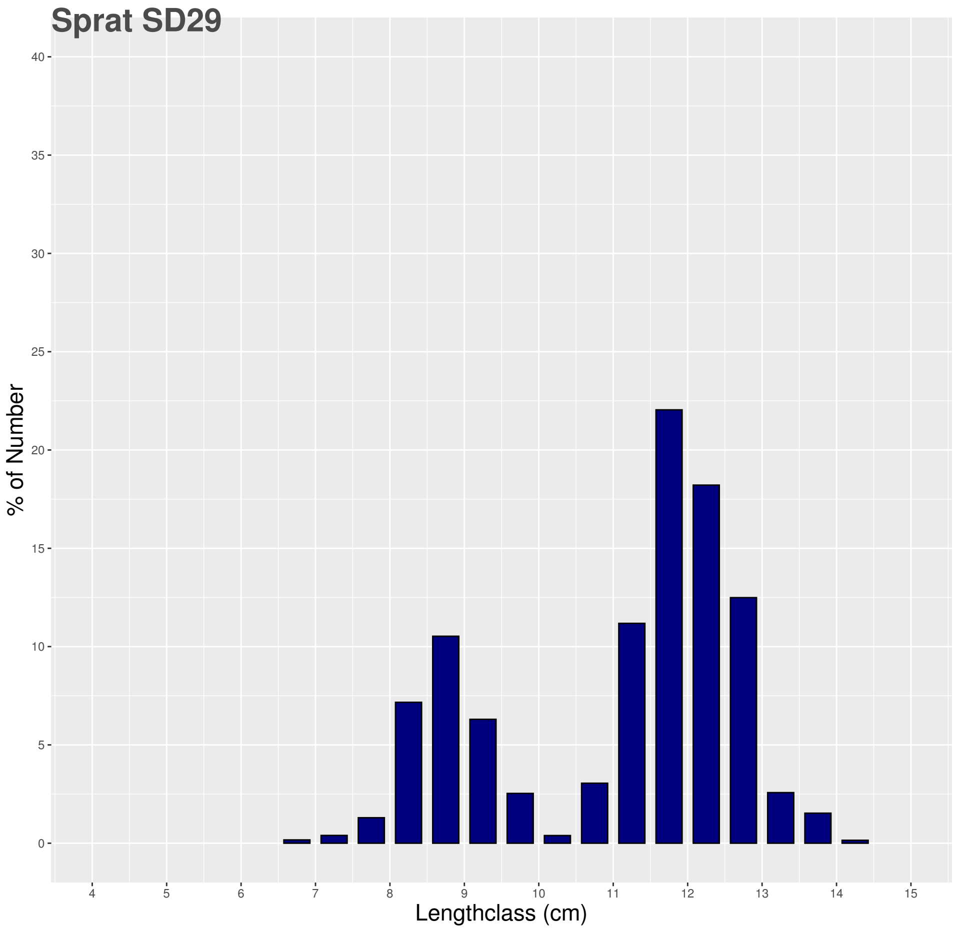

Figure 7. Length distribution of sprat from subdivision 29 for BIAS 2022.

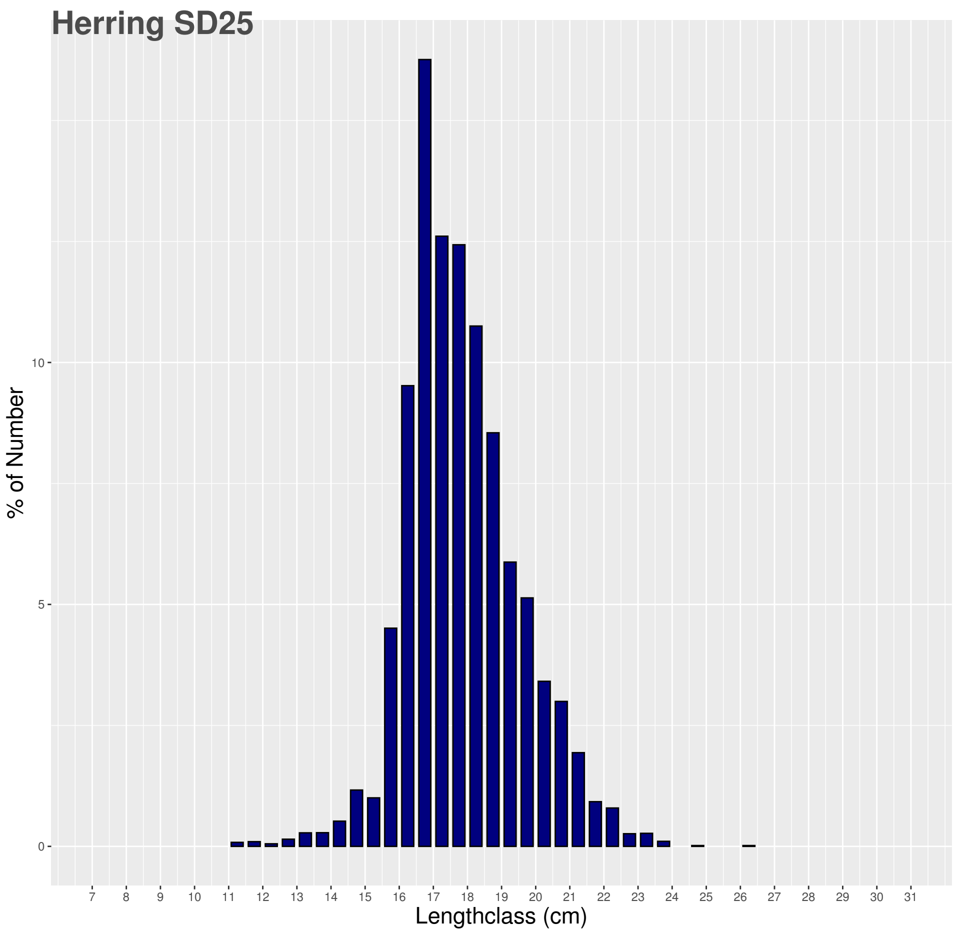

Figure 8. Length distribution of herring from subdivision 25 for BIAS 2022.

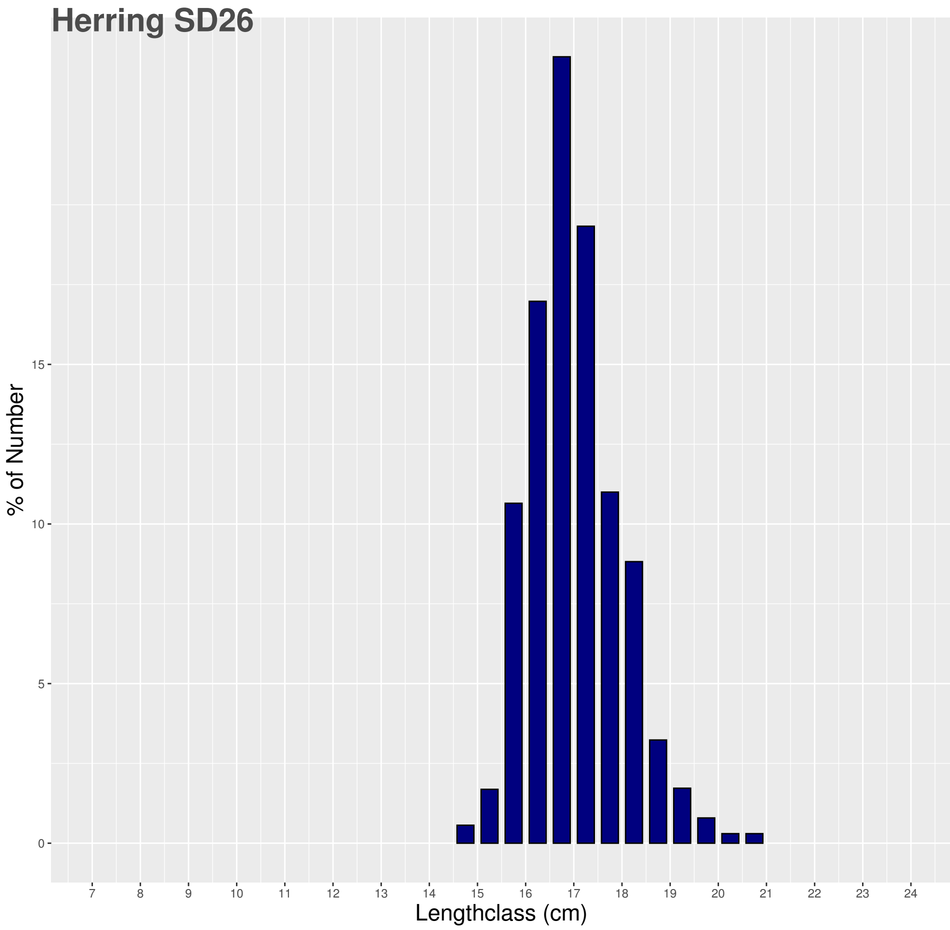

Figure 9. Length distribution of herring from subdivision 26 for BIAS 2022.

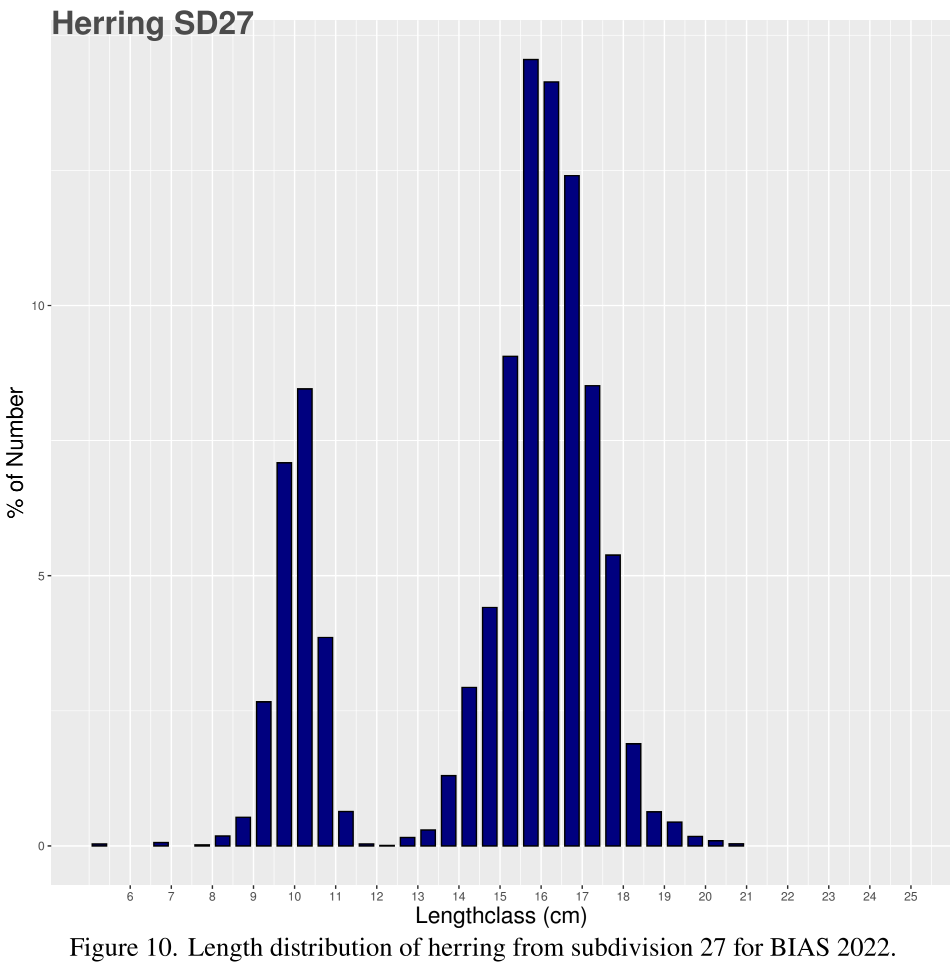

Figure 10. Length distribution of herring from subdivision 27 for BIAS 2022.

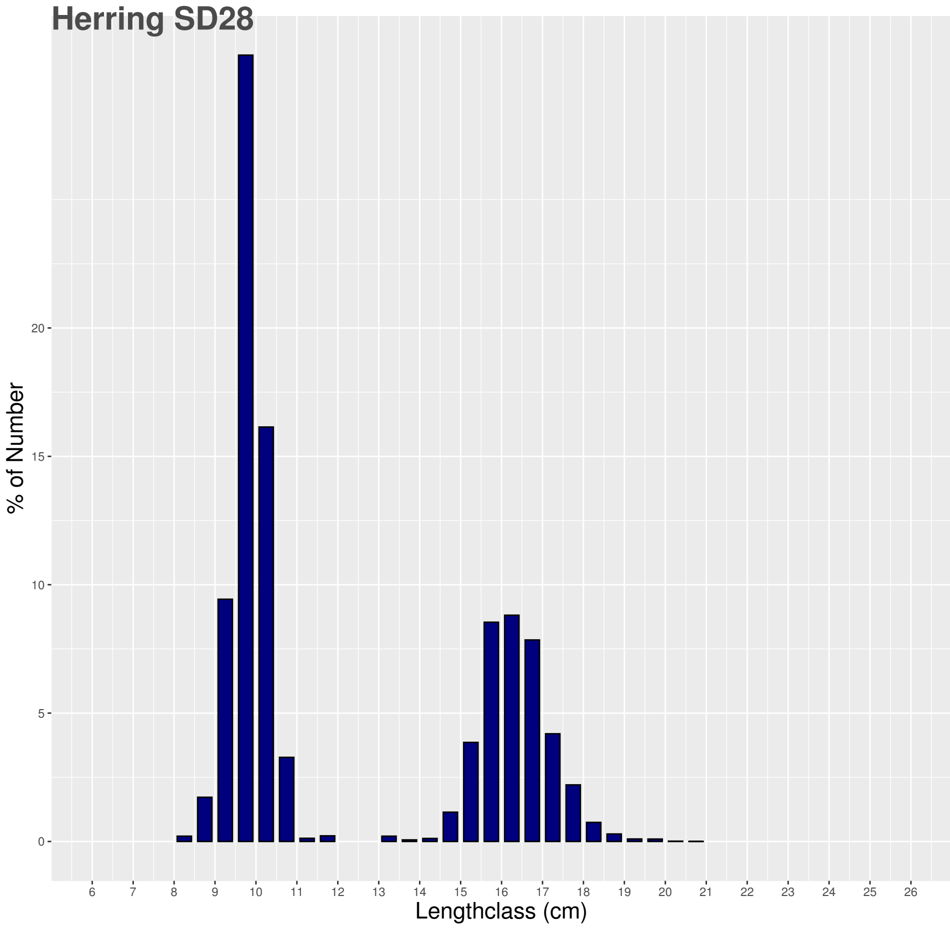

Figure 11. Length distribution of herring from subdivision 28 for BIAS 2022.

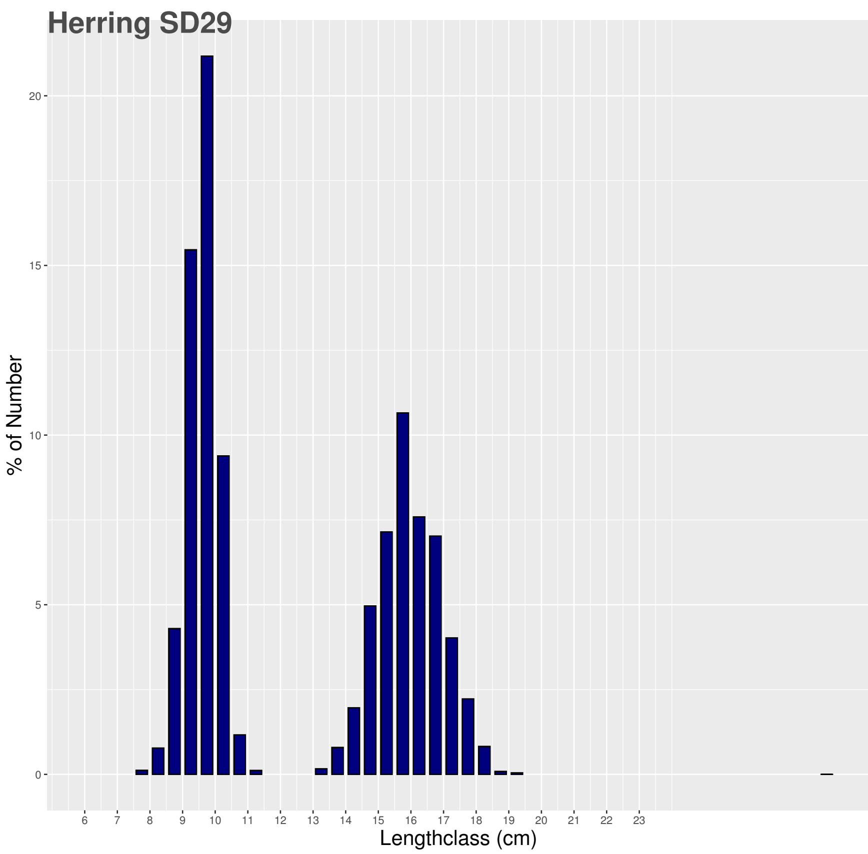

Figure 12. Length distribution of herring from subdivision 29 for BIAS 2022.

Joint Latvian-Estonian Gulf of Riga Acoustic Herring Survey (GRAHS) in the Baltic Sea ICES SD 28.1 on the f/v „URGA", 27.07-01.08.2022

Authors: Guntars Strods, Elor Sepp, Tiit Raid, Ain Lankov, Jurgis Matiss Petersons and Ivars Putnis

Riga-Tartu-Tallinn-Pärnu
March 2023

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 2022 the survey was performed on period of 27th July – 1st August on the rented Latvian commercial fisheries vessel "Urga" in the Gulf of Riga (ICES Sub-division 28.1). The vessel left the Ventspils port (Latvia) on 27.07.2022 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 01.08.2021 at 22:00 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 11.0.255" 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, 535 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 "Urga" realized 17 fish control-catches. All catches were performed in the daylight, between 08:00 and 19:23 (UTC+03:00), using the pelagic trawl (with 10 mm mesh bar length in the codend). The standard trawling duration is 30 minutes, and implemented at 7 hauls, but due to relatively good acoustic records 9 trawlings were shortened to 10-25 minutes. During one haul fish records were poor and duration was prolonged to 40 minutes. The mean speed of vessel while trawling was 3.2 knots. Totally 9 hauls were performed in the Latvian and 8 hauls in Estonian EEZs. The overall haul statistical data represented in Tab. 1.

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 4376 individuals of 12 fish species were measured (Tab. 2). Detailed ichthyologic analyses were made only for 1820 herring and according to standard procedures, directly on board of surveying vessel.

The catch weights in kg per species by haul are aggregated in Table 3.

The Catch per unit effort values (CPUE, kg/h) of fish species by haul are aggregated in Table 4.

The statistical values of acoustical estimations and pelagic fish stock are given in Tables 5-10.

The parameters related to herring stock during survey in the Gulf of Riga represented in Tables 11-13.

CPUE (kg/h) areal distribution of dominant pelagic fish and the values of mean nautical area scattering cross-section NASC (m^2/nm^2) distributions during survey are shown in Figures 2-4. Herring distribution in the Gulf of Riga is shown in Figure 5. The main Herring concentrations were observed in the Estonian EEZ in Northern part of Gulf of Riga over the depth more than 20 m.

Herring in the Gulf of Riga has bimodal length distribution pattern (Fig. 6). The first length frequency peak in had observed at 7.0 cm class, but the main part of herrings distributed in modal groups from 13.0 to 15.5 cm classes.

The annual stock changes of Herring shows decreasing tendency since 2018, but still reamains is on high biomass level (Fig. 7). Herrings at age 0 shows great interannual changes in abundance and the abundance of 2022 generation was the highest recorded ever before (Fig. 8).

Sprat distributed in northern part of Gulf of Riga, smelt in Northern part too, but on very small separated aggregations. Sticklebacks located in very dense and relatively small aquatory in Northern part of gulf and near Ruhnu island(Fig. 9-11).

Reprt tables and figures of joint Latvian-Estonian hydroacustic survey in the Gulf of Riga on f/v "URGA", 27.07-01.08.2022.

Table 1. Haul statistiscs

Haul	Rectangle	EEZ	Date	Latitude start	Longitude start	Time start	Duration, min	Trawling speed, knt	Trawling course (COG),	Depth, m	Headrope depth, m	Footrope depth, m	Vertical opening, m	Horizontal opening, m	Wire length, m
1	44H2	LV	27.07.2022	57°46.32′	22°40.93′	08:28	10	3.0	60	35	10	25	15	76	90
2	44H2	LV	27.07.2022	57°37.72′	22°46.21′	11:42	30	3.2	210	29	10	25	15	76	90
3	43H3	LV	27.07.2022	57°26.01′	23°01.90′	16:08	30	3.4	120	17	4	17	13	78	75
4	43H3	LV	28.07.2022	57°11.45′	23°19.35′	08:27	40	3.2	135	22	5	18	13	78	75
5	43H3	LV	28.07.2022	57°20.39′	23°35.56′	13:27	30	3.2	10	43	14	30	16	75	100
6	44H3	EE	28.07.2022	57°39.19′	23°29.24′	17:19	30	3.2	340	39	8	24	16	75	90
7	44H3	EE	28.07.2022	57°42.50′	23°26.00′	18:52	20	3.2	320	30	10	25	15	76	75
8	45H3	EE	29.07.2022	58°15.73′	23°12.55′	08:35	10	3.4	80	22	6	20	14	77	75
9	45H3	EE	29.07.2022	58°02.45′	23°31.35′	15:40	30	3.3	110	32	14	29	15	76	100
10	44H4	EE	29.07.2022	57°56.76′	24°05.48′	19:17	20	3.3	110	20	7	20	13	78	90
11	44H3	EE	30.07.2022	57°53.65′	23°36.67′	10:32	30	3.1	115	32	15	31	16	75	100
12	44H4	LV	30.07.2022	57°45.67′	24°09.17′	14:33	25	3.2	300	33	15	31	16	75	90
13	43H4	LV	31.07.2022	57°24.91′	24°19.08′	08:00	15	3.3	200	20	6	20	14	77	90
14	43H4	LV	31.07.2022	57°08.96′	24°05.87′	11:06	30	3.3	250	24	11	24	13	78	90
15	44H3	LV	31.07.2022	57°35.39′	23°27.32′	19:05	20	3.1	300	31	13	28	15	76	90
16	44H3	EE	01.08.2022	57°55.13′	23°00.78′	16:27	10	3.2	320	31	15	30	15	76	90
17	45H2	EE	01.08.2022	58°03.87′	22°46.88′	19:23	15	3.3	230	24	5	19	14	77	75

Table 2. Measured and analyzed individuals of fish per species

Fish species	Number of measured individuals by EEZ			Number of analyzed individuals by EEZ		
	EST	LAT	∑n	EST	LAT	∑n
Eelpout		8	8			
Flounder	2	3	5			
Fourhorn sculpin		1	1			
Herring	1617	1821	3438			
Lamprey	5	10	15			
Salmon		2	2			
Sea trout	1		1	856	964	1820
Smelt	8	14	22			
Sprat	179	308	487			
Straightnose pipefish	2	12	14			
Three-spined stickleback	193	189	382			
Whitefish		1	1			
Σn	2007	2369	4376	856	964	1820

Table 3. Catch per species, kg

Haul	EEZ	TC, kg	Herring	Sprat	Smelt	Three-spined stickle-back	Eelpout	Flounder	Fourhorn sculpin	Lamprey	Salmon	Sea trout	Straight-nose pipefish	Whitefish
1	LV	31.077	19.088	10.560		1.352		0.077						
2	LV	24.200	20.234	2.631		1.135	0.010	0.190						
3	LV	116.001	48.853	67.147									0.0013	
4	LV	92.041	92.000							0.040			0.0007	
5	LV	17.000	16.753			0.247								
6	EE	14.058	8.315	1.783		3.902				0.058				
7	EE	610.052	601.251		5.252	3.497				0.052				
8	EE	335.000	274.741	56.187		4.072								
9	EE	435.224	390.252	42.470		2.278				0.121		0.103		
10	EE	860.000	587.733	264.314	7.953								0.0002	
11	EE	162.226	159.923	1.066	0.928	0.083		0.194		0.032				
12	LV	732.931	675.383	54.617					0.165	0.216	2.550			
13	LV	245.118	225.006	15.135	4.859		0.039			0.079			0.0001	
14	LV	90.274	85.014	1.041	3.908	0.037	0.088			0.076				0.110
15	LV	118.621	109.053			2.947				0.021	6.600		0.0002	
16	EE	95.000	90.483	0.335		4.182								
17	EE	700.000	446.818	3.052	4.360	245.770								
TC, kg	GoR	4678.823	3850.901	520.339	27.260	269.500	0.137	0.461	0.165	0.695	9.150	0.103	0.0025	0.110
TC, kg	EE	3211.560	2559.517	369.207	18.493	263.783		0.194		0.263		0.103	0.0002	
TC, kg	LV	1467.262	1291.384	151.132	8.767	5.717	0.137	0.267	0.165	0.432	9.150		0.0023	0.110

Table 4. CPUE per species, kg/h

Haul	EEZ	TCPUE	Herring	Sprat	Smelt	Three-spined stickle-back	Eelpout	Flounder	Fourhorn sculpin	Lamprey	Salmon	Sea trout	Straight-nose pipefish	Whitefish
1	LV	186.462	114.528	63.360		8.112		0.462						
2	LV	48.400	40.467	5.263		2.270	0.020	0.380						
3	LV	232.003	97.706	134.294									0.0025	
4	LV	138.061	138.000							0.060			0.0011	
5	LV	34.000	33.507			0.493								
6	EE	28.116	16.629	3.566		7.805				0.116				
7	EE	1830.156	1803.752		15.756	10.492				0.156				
8	EE	2010.000	1648.448	337.122		24.431								
9	EE	870.448	780.505	84.940		4.555				0.242		0.206		
10	EE	2580.001	1763.200	792.942	23.858								0.0006	
11	EE	324.452	319.846	2.132	1.857	0.165		0.388		0.064				
12	LV	1759.034	1620.919	131.081					0.396	0.518	6.120			
13	LV	980.470	900.025	60.540	19.435		0.156			0.314			0.0004	
14	LV	180.547	170.028	2.082	7.816	0.073	0.175			0.152				0.220
15	LV	355.864	327.159			8.841				0.063	19.800		0.0006	
16	EE	570.000	542.899	2.011		25.090								
17	EE	2800.000	1787.273	12.208	17.440	983.079								
AVERAGE	GoR	878.118	712.052	125.503	14.360	89.617	0.117	0.410	0.396	0.187	12.960	0.206	0.0010	0.220
AVERAGE	EE	1376.647	1082.819	176.417	14.728	150.802		0.388		0.145		0.206	0.0006	
AVERAGE	LV	434.982	382.482	66.103	13.626	3.958	0.117	0.421	0.396	0.221	12.960		0.0011	0.220

Table 5. Hauls per ICES statistical rectangle used in calculations

ICES Rect	Haul No
43H3	3,4,5,13,14,15
43H4	13,14
44H2	1,2,16,17
44H3	2,3,5,6,7,10,11,12,15,16
44H4	10,12,13
45H2	17
45H3/H4	8,9,10,16
Total	1-17

Table 6. Acoustic statistics per ICES statistical rectangle

ICES Rect	Area, nm2	NASC, m2/nm2	NASC Pel	NASC HER	<σ>, m2*10^4	TS, dB	<ρ>, mln/nm2	PEL <ρ>, mln/nm2	<ρ>HER, mln/nm2	PEL, %	Herring, %	Sprat, %	Smelt, %	Three-spined stickle-back, %
43H3	670	673.79	673.11	588.57	1.72	-48.64	3.92	3.91	3.43	99.90	87.44	9.42	0.17	2.97
43H4	213	296.19	296.00	262.83	1.92	-48.16	1.54	1.54	1.37	99.94	88.79	9.26	1.88	0.07
44H2	556	1053.41	1053.18	421.98	0.80	-51.95	13.12	13.12	5.26	99.98	40.07	8.06	0.07	51.80
44H3	963	865.06	864.91	645.62	1.32	-49.78	6.55	6.54	4.89	99.98	74.65	3.61	0.23	21.51
44H4	273	1436.51	1436.39	1038.27	1.85	-48.32	7.76	7.76	5.61	99.99	72.28	27.33	0.39	
45H2	73	3878.29	3878.29	1004.74	0.63	-53.02	61.80	61.80	16.01	100.00	25.91	0.26	0.13	73.70
45H3/H4	394	1438.85	1438.83	1316.46	0.76	-52.19	18.98	18.98	17.37	100.00	91.49	5.58	0.01	2.92
Total	3142	1377.44	1377.24	887.48	1.41	-49.49	9.76	9.76	6.29	99.99	64.44	6.85	0.15	28.56

Pel means "*Pelagic fish*": herring, sprat, smelt, three-spined stickleback, ninespine stickleback

Table 7. Pelagic fish number density ρ, mln/nm^2
per ICES statistical rectangle

ICES Rect	Herring	Sprat	Smelt	Three-spined stickleback	Total
43H3	3.426	0.369	0.007	0.116	3.918
43H4	1.371	0.143	0.029	0.001	1.544
44H2	5.257	1.057	0.010	6.795	13.119
44H3	4.886	0.236	0.015	1.408	6.545
44H4	5.610	2.121	0.030		7.761
45H2	16.010	0.160	0.080	45.548	61.797
45H3/H4	17.365	1.060	0.001	0.553	18.979
Total	6.288	0.669	0.014	2.786	9.757

Table 8. Pelagic fish biomass density ρ, kgx10^3/nm^2
per ICES statistical rectangle

ICES Rect	Herring	Sprat	Smelt	Three-spined stickleback	Total
43H3	63.916	3.473	0.119	0.213	67.721
43H4	27.699	1.620	0.706	0.002	30.027
44H2	59.969	11.027	0.244	15.875	87.116
44H3	75.654	2.678	0.251	2.872	81.455
44H4	110.516	24.686	0.618		135.820
45H2	205.086	1.401	2.001	112.806	321.294
45H3/H4	82.506	11.669	0.021	1.100	95.296
Total	74.020	7.263	0.296	6.494	88.073

Table 9. Pelagic fish number, mln/nm^2
per ICES statistical rectangle

ICES Rect	Herring	Sprat	Smelt	Three-spined stickleback	Total
43H3	2293.282	247.046	4.361	78.011	2622.700
43H4	291.860	30.435	6.170	0.225	328.692
44H2	2922.435	587.863	5.430	3778.060	7293.788
44H3	4704.335	227.699	14.592	1355.593	6302.218
44H4	1531.436	578.950	8.271		2118.657
45H2	1168.709	11.687	5.844	3324.977	4511.216
45H3/H4	6841.797	417.509	0.412	218.066	7477.785
Total	19753.855	2101.189	45.080	8754.932	30655.057

Table 10. Pelagic fish biomass, kgx10^3/nm2
per ICES statistical rectangle

ICES Rect	HER	SPR	SME	GTA	Total
43H3	42823.874	2327.087	79.748	142.639	45373.348
43H4	5899.970	345.027	150.370	0.406	6395.773
44H2	33342.801	6131.276	135.751	8826.519	48436.348
44H3	72855.083	2579.231	241.337	2765.947	78441.597
44H4	30170.879	6739.159	168.788		37078.826
45H2	14971.272	102.262	146.089	8234.859	23454.482
45H3/H4	32507.339	4597.444	8.244	433.407	37546.434
GoR Total	232571.22	22821.49	930.33	20403.78	276726.81

Table 11. Gulf of Riga herring population stock parameters

CANUM	Age								
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	13267	29271	12364	16941	6814	4947	2002	1211	883	87699
43H4	1061	24451	7782	7177	3054	4074	1029	777	842	50247
44H2	64728	83121	22671	15146	3315	1481	288	518	504	191773
44H3	61269	99974	48686	73662	34071	23791	9686	2827	3243	357209
44H4	8289	69731	25152	37135	29372	22254	8115	1924	3734	205705
45H2	44271	67614	13818	10129	1677	671	0	0	1342	139521
45H3	528229	75232	21846	26105	11982	9217	5432	887	1631	680561
Total	721114	449394	152319	186295	90285	66435	26552	8144	12177	1712715

n, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	15.13	33.38	14.10	19.32	7.77	5.64	2.28	1.38	1.01	100.00
43H4	2.11	48.66	15.49	14.28	6.08	8.11	2.05	1.55	1.68	100.00
44H2	33.75	43.34	11.82	7.90	1.73	0.77	0.15	0.27	0.26	100.00
44H3	17.15	27.99	13.63	20.62	9.54	6.66	2.71	0.79	0.91	100.00
44H4	4.03	33.90	12.23	18.05	14.28	10.82	3.94	0.94	1.82	100.00
45H2	31.73	48.46	9.90	7.26	1.20	0.48	0.00	0.00	0.96	100.00
45H3	77.62	11.05	3.21	3.84	1.76	1.35	0.80	0.13	0.24	100.00
Total	42.10	26.24	8.89	10.88	5.27	3.88	1.55	0.48	0.71	100.00

n, 10^6	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	337.4	744.4	314.4	430.8	173.3	125.8	50.9	30.8	22.4	2230.3
43H4	5.8	134.8	42.9	39.6	16.8	22.5	5.7	4.3	4.6	277.0
44H2	985.3	1265.3	345.1	230.5	50.5	22.5	4.4	7.9	7.7	2919.2
44H3	787.7	1285.3	625.9	947.0	438.0	305.9	124.5	36.3	41.7	4592.3
44H4	59.2	498.4	179.8	265.4	210.0	159.1	58.0	13.8	26.7	1470.4
45H2	370.8	566.4	115.7	84.8	14.0	5.6	0.0	0.0	11.2	1168.7
45H3	5281.4	752.2	218.4	261.0	119.8	92.2	54.3	8.9	16.3	6804.5
Total	7827.7	5246.7	1842.3	2259.2	1022.4	733.5	297.8	101.9	130.7	19462.4

<w>, g	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	3.17	16.68	20.49	22.79	25.21	25.87	27.72	27.96	28.99	18.07
43H4	5.28	16.55	19.71	23.15	24.68	25.87	26.55	27.43	28.62	19.57
44H2	3.70	15.52	20.52	22.65	20.46	25.31	23.69	28.69	26.84	12.92
44H3	3.39	15.93	20.39	22.49	24.22	24.86	25.85	28.49	31.22	17.63
44H4	5.33	15.51	18.93	21.89	23.37	24.55	25.02	27.66	30.26	19.53
45H2	4.02	15.21	20.58	20.79	20.40	22.50	0.00	0.00	27.25	12.81
45H3	3.24	15.04	19.59	22.99	24.04	24.84	26.15	31.13	33.50	6.77
Total	3.36	15.71	20.19	22.50	23.96	24.99	26.04	28.42	30.23	13.06

Table 11 continued

W, kg×10^3	Age								
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	1067.9	12419.8	6442.1	9818.0	4367.5	3254.5	1410.8	861.0	650.7	40292.3
43H4	30.9	2230.7	845.6	916.0	415.6	581.1	150.6	117.4	132.9	5420.8
44H2	3649.1	19635.9	7080.1	5222.8	1032.5	570.5	104.0	226.3	205.8	37727.2
44H3	2670.2	20474.7	12761.3	21298.3	10610.2	7602.5	3218.7	1035.4	1301.4	80972.8
44H4	316.0	7732.1	3403.5	5811.7	4907.1	3905.0	1451.3	380.4	807.5	28714.7
45H2	1491.8	8613.6	2382.4	1764.3	286.6	126.4	0.0	0.0	306.2	14971.3
45H3	17094.7	11312.3	4279.3	6001.8	2880.6	2288.7	1420.4	276.2	546.3	46100.3
Total	26320.6	82419.1	37194.4	50832.8	24500.1	18328.7	7756.0	2896.8	3950.8	254199.3

W, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	2.65	30.82	15.99	24.37	10.84	8.08	3.50	2.14	1.61	100.00
43H4	0.57	41.15	15.60	16.90	7.67	10.72	2.78	2.17	2.45	100.00
44H2	9.67	52.05	18.77	13.84	2.74	1.51	0.28	0.60	0.55	100.00
44H3	3.30	25.29	15.76	26.30	13.10	9.39	3.98	1.28	1.61	100.00
44H4	1.10	26.93	11.85	20.24	17.09	13.60	5.05	1.32	2.81	100.00
45H2	9.96	57.53	15.91	11.78	1.91	0.84	0.00	0.00	2.05	100.00
45H3	37.08	24.54	9.28	13.02	6.25	4.96	3.08	0.60	1.18	100.00
Total	10.35	32.42	14.63	20.00	9.64	7.21	3.05	1.14	1.55	100.00

<L>, cm	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	7.71	12.96	14.27	14.81	15.34	15.50	15.96	15.99	16.22	13.18
43H4	9.30	12.94	14.08	14.87	15.22	15.49	15.72	15.92	16.10	13.82
44H2	7.78	13.08	14.27	14.73	14.22	15.35	15.00	16.01	15.64	11.61
44H3	7.96	13.13	14.28	14.79	15.22	15.42	15.71	16.20	16.89	13.22
44H4	9.49	12.91	13.92	14.67	15.03	15.34	15.50	15.87	16.59	13.98
45H2	7.79	13.03	14.44	14.50	14.40	15.00	0.00	0.00	15.75	11.66
45H3	7.73	12.89	13.95	14.69	14.95	15.19	15.64	16.55	17.29	9.09
Total	7.77	13.02	14.21	14.75	15.11	15.38	15.69	16.10	16.57	11.50

Table 12. Central Baltic Sea herring population stock parameters

CANUM	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	0	0	341	916	484	494	19	0	225	2478
43H4	0	0	429	927	460	647	0	0	225	2688
44H2	0	0	215	0	0	0	0	0	0	215
44H3	0	0	1223	1440	2959	3075	19	0	0	8717
44H4	0	0	1689	1901	1879	2846	0	0	225	8539
45H2	0	0	0	0	0	0	0	0	0	0
45H3	0	0	340	484	968	1936	0	0	0	3728
Total	0	0	4237	5668	6751	8998	38	0	674	26366

n, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	0.00	0.00	13.75	36.95	19.53	19.94	0.77	0.00	9.06	100.00
43H4	0.00	0.00	15.95	34.51	17.13	24.06	0.00	0.00	8.35	100.00
44H2	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
44H3	0.00	0.00	14.04	16.52	33.95	35.27	0.22	0.00	0.00	100.00
44H4	0.00	0.00	19.78	22.26	22.00	33.33	0.00	0.00	2.63	100.00
45H2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45H3	0.00	0.00	9.12	12.98	25.97	51.93	0.00	0.00	0.00	100.00
Total	0.00	0.00	16.07	21.50	25.60	34.13	0.14	0.00	2.55	100.00

n, 10^6	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	0.0	0.0	8.7	23.3	12.3	12.6	0.5	0.0	5.7	63.0
43H4	0.0	0.0	2.4	5.1	2.5	3.6	0.0	0.0	1.2	14.8
44H2	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	3.3
44H3	0.0	0.0	15.7	18.5	38.0	39.5	0.2	0.0	0.0	112.1
44H4	0.0	0.0	12.1	13.6	13.4	20.3	0.0	0.0	1.6	61.0
45H2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45H3	0.0	0.0	3.4	4.8	9.7	19.4	0.0	0.0	0.0	37.3
Total	0.0	0.0	45.5	65.3	76.0	95.4	0.7	0.0	8.6	291.5

<w>, g	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	0.00	0.00	27.59	28.58	30.33	31.62	35.00	0.00	69.00	33.10
43H4	0.00	0.00	26.92	27.70	30.16	31.36	0.00	0.00	69.00	32.33
44H2	0.00	0.00	31.06	0.00	0.00	0.00	0.00	0.00	0.00	31.06
44H3	0.00	0.00	26.62	29.05	29.85	33.90	35.00	0.00	0.00	30.70
44H4	0.00	0.00	26.13	30.03	30.37	32.76	0.00	0.00	69.00	31.27
45H2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45H3	0.00	0.00	27.81	33.89	33.89	33.89	0.00	0.00	0.00	33.33
Total	0.00	0.00	27.10	29.34	30.54	33.26	35.00	0.00	69.00	31.76

Table 12 continued

W, $kg \times 10^3$	Age								
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	0.0	0.0	239.1	665.5	373.3	397.3	17.0	0.0	394.0	2086.1
43H4	0.0	0.0	63.6	141.7	76.6	111.8	0.0	0.0	85.4	479.1
44H2	0.0	0.0	101.8	0.0	0.0	0.0	0.0	0.0	0.0	101.8
44H3	0.0	0.0	418.6	537.9	1135.7	1339.8	8.6	0.0	0.0	3440.6
44H4	0.0	0.0	315.5	408.0	407.9	666.6	0.0	0.0	110.7	1908.8
45H2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45H3	0.0	0.0	94.6	164.0	328.0	656.0	0.0	0.0	0.0	1242.6
Total	0.0	0.0	1233.3	1917.1	2321.4	3171.6	25.6	0.0	590.1	9259.0

W, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	0.00	0.00	11.46	31.90	17.89	19.04	0.81	0.00	18.89	100.00
43H4	0.00	0.00	13.28	29.57	15.98	23.34	0.00	0.00	17.83	100.00
44H2	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
44H3	0.00	0.00	12.17	15.63	33.01	38.94	0.25	0.00	0.00	100.00
44H4	0.00	0.00	16.53	21.38	21.37	34.92	0.00	0.00	5.80	100.00
45H2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45H3	0.00	0.00	7.61	13.20	26.40	52.79	0.00	0.00	0.00	100.00
Total	0.00	0.00	13.32	20.70	25.07	34.25	0.28	0.00	6.37	100.00

<L>, cm	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	0.00	0.00	15.87	16.12	16.64	16.87	18.00	0.00	21.00	16.79
43H4	0.00	0.00	15.68	15.88	16.61	16.82	0.00	0.00	21.00	16.62
44H2	0.00	0.00	16.50	0.00	0.00	0.00	0.00	0.00	0.00	16.50
44H3	0.00	0.00	15.98	16.44	16.75	17.16	18.00	0.00	0.00	16.74
44H4	0.00	0.00	15.71	16.53	16.72	16.94	0.00	0.00	21.00	16.66
45H2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45H3	0.00	0.00	16.50	17.00	17.00	17.00	0.00	0.00	0.00	16.95
Total	0.00	0.00	15.95	16.34	16.76	17.03	18.00	0.00	21.00	16.76

Table 13. Total herring stock parameters

CANUM	Age								
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	13267	29271	12705	17856	7298	5441	2021	1211	1107	90178
43H4	1061	24451	8210	8105	3514	4721	1029	777	1067	52934
44H2	64728	83121	22887	15146	3315	1481	288	518	504	191988
44H3	61269	99974	49909	75103	37031	26866	9705	2827	3243	365926
44H4	8289	69731	26841	39035	31251	25100	8115	1924	3958	214244
45H2	44271	67614	13818	10129	1677	671	0	0	1342	139521
45H3	528229	75232	22186	26589	12950	11153	5432	887	1631	684290
Total	721114	449394	156556	191963	97036	75433	26591	8144	12851	1739081

n, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	14.71	32.46	14.09	19.80	8.09	6.03	2.24	1.34	1.23	100.00
43H4	2.00	46.19	15.51	15.31	6.64	8.92	1.94	1.47	2.01	100.00
44H2	33.71	43.29	11.92	7.89	1.73	0.77	0.15	0.27	0.26	100.00
44H3	16.74	27.32	13.64	20.52	10.12	7.34	2.65	0.77	0.89	100.00
44H4	3.87	32.55	12.53	18.22	14.59	11.72	3.79	0.90	1.85	100.00
45H2	31.73	48.46	9.90	7.26	1.20	0.48	0.00	0.00	0.96	100.00
45H3	77.19	10.99	3.24	3.89	1.89	1.63	0.79	0.13	0.24	100.00
Total	39.63	26.56	9.56	11.77	5.56	4.20	1.51	0.52	0.70	100.00

n, 10^6	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	337.4	744.4	323.1	454.1	185.6	138.4	51.4	30.8	28.2	2293.3
43H4	5.8	134.8	45.3	44.7	19.4	26.0	5.7	4.3	5.9	291.9
44H2	985.3	1265.3	348.4	230.5	50.5	22.5	4.4	7.9	7.7	2922.4
44H3	787.7	1285.3	641.6	965.5	476.1	345.4	124.8	36.3	41.7	4704.3
44H4	59.2	498.4	191.9	279.0	223.4	179.4	58.0	13.8	28.3	1531.4
45H2	370.8	566.4	115.7	84.8	14.0	5.6	0.0	0.0	11.2	1168.7
45H3	5281.4	752.2	221.8	265.9	129.5	111.5	54.3	8.9	16.3	6841.8
Total	7827.7	5246.7	1887.8	2324.6	1098.4	828.9	298.5	101.9	139.2	19753.9

<w>, g	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	3.17	16.68	20.68	23.09	25.55	26.39	27.79	27.96	37.10	18.48
43H4	5.28	16.55	20.09	23.67	25.40	26.62	26.55	27.43	37.12	20.21
44H2	3.70	15.52	20.62	22.65	20.46	25.31	23.69	28.69	26.84	12.94
44H3	3.39	15.93	20.54	22.62	24.67	25.89	25.87	28.49	31.22	17.94
44H4	5.33	15.51	19.38	22.29	23.79	25.48	25.02	27.66	32.45	20.00
45H2	4.02	15.21	20.58	20.79	20.40	22.50	0.00	0.00	27.25	12.81
45H3	3.24	15.04	19.72	23.19	24.78	26.41	26.15	31.13	33.50	6.92
Total	3.36	15.71	20.36	22.69	24.42	25.94	26.07	28.42	32.61	13.34

Table 13 continued

W, kg×10³	Age								
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	1067.9	12419.8	6681.2	10483.5	4740.8	3651.8	1427.8	861.0	1044.6	42378.4
43H4	30.9	2230.7	909.2	1057.6	492.2	692.9	150.6	117.4	218.3	5899.9
44H2	3649.1	19635.9	7182.0	5222.8	1032.5	570.5	104.0	226.3	205.8	37829.0
44H3	2670.2	20474.7	13180.0	21836.1	11745.9	8942.4	3227.3	1035.4	1301.4	84413.3
44H4	316.0	7732.1	3719.0	6219.7	5315.1	4571.5	1451.3	380.4	918.3	30623.5
45H2	1491.8	8613.6	2382.4	1764.3	286.6	126.4	0.0	0.0	306.2	14971.3
45H3	17094.7	11312.3	4373.9	6165.8	3208.6	2944.8	1420.4	276.2	546.3	47342.9
Total	26320.6	82419.1	38427.6	52749.8	26821.5	21500.3	7781.5	2896.8	4540.9	263458.3

W, %	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	2.52	29.31	15.77	24.74	11.19	8.62	3.37	2.03	2.46	100.00
43H4	0.52	37.81	15.41	17.93	8.34	11.74	2.55	1.99	3.70	100.00
44H2	9.65	51.91	18.99	13.81	2.73	1.51	0.27	0.60	0.54	100.00
44H3	3.16	24.26	15.61	25.87	13.91	10.59	3.82	1.23	1.54	100.00
44H4	1.03	25.25	12.14	20.31	17.36	14.93	4.74	1.24	3.00	100.00
45H2	9.96	57.53	15.91	11.78	1.91	0.84	0.00	0.00	2.05	100.00
45H3	36.11	23.89	9.24	13.02	6.78	6.22	3.00	0.58	1.15	100.00
Total	9.99	31.28	14.59	20.02	10.18	8.16	2.95	1.10	1.72	100.00

<L>, cm	Age									
Rectangle	0	1	2	3	4	5	6	7	8+	Total
43H3	7.71	12.96	14.32	14.87	15.43	15.62	15.98	15.99	17.19	13.28
43H4	9.30	12.94	14.16	14.98	15.41	15.67	15.72	15.92	17.13	13.96
44H2	7.78	13.08	14.29	14.73	14.22	15.35	15.00	16.01	15.64	11.62
44H3	7.96	13.13	14.32	14.82	15.34	15.62	15.72	16.20	16.89	13.30
44H4	9.49	12.91	14.04	14.76	15.13	15.52	15.50	15.87	16.84	14.08
45H2	7.79	13.03	14.44	14.50	14.40	15.00	0.00	0.00	15.75	11.66
45H3	7.73	12.89	13.99	14.73	15.11	15.50	15.64	16.55	17.29	9.13
Total	7.77	13.02	14.25	14.79	15.22	15.57	15.70	16.10	16.84	11.58

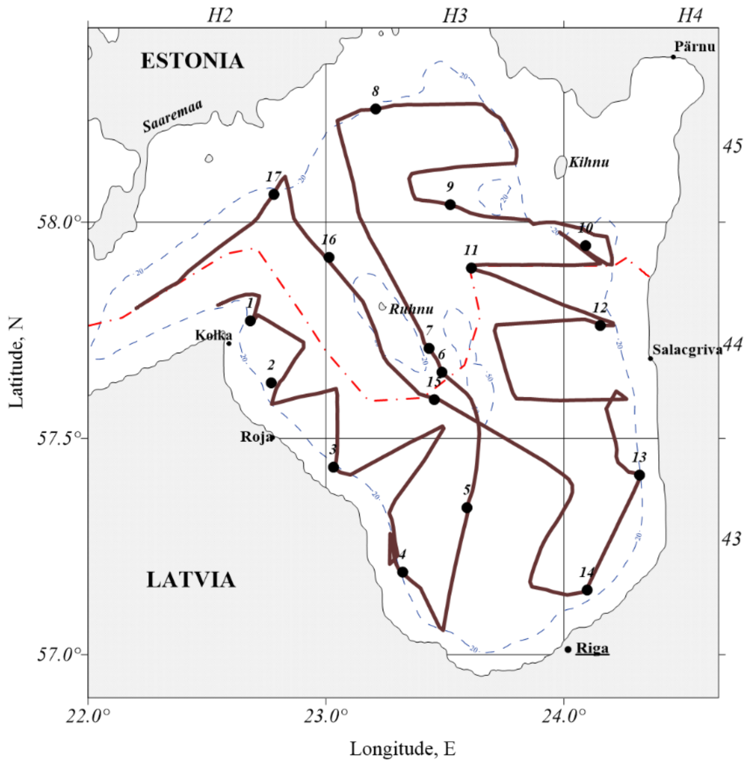

Figure 1: Cruise track design and trawling positions in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.

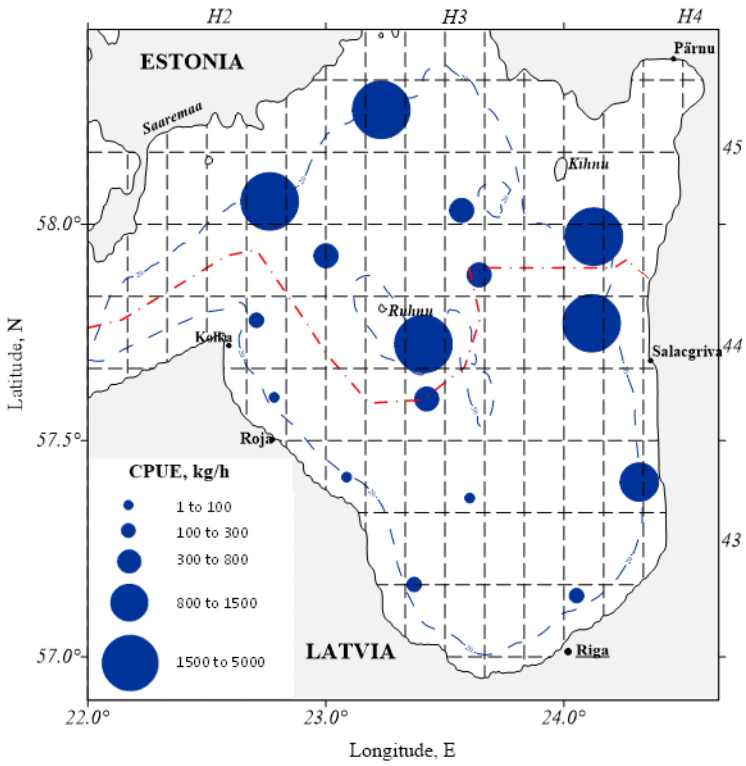

Figure 2: Herring CPUE [kg/h] of hauls in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.

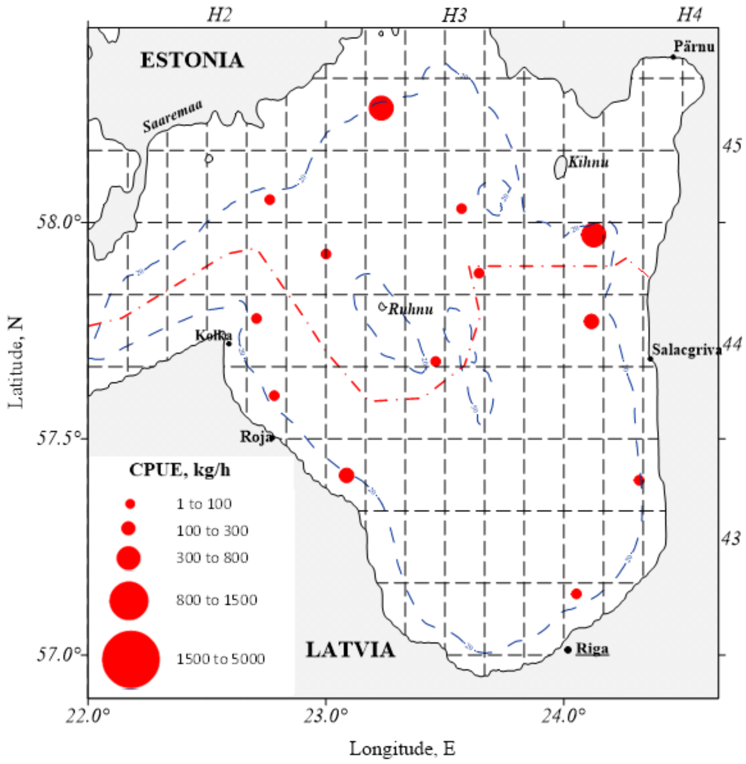

Figure 3: Sprat CPUE [kg/h] of hauls in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.

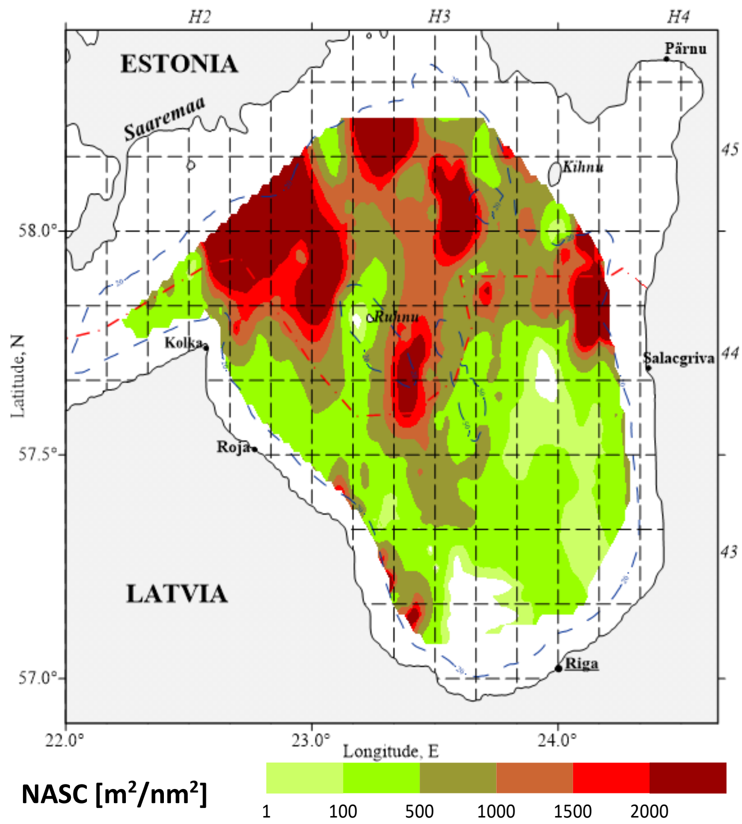

Figure 4: Acoustic parameter NASC distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.

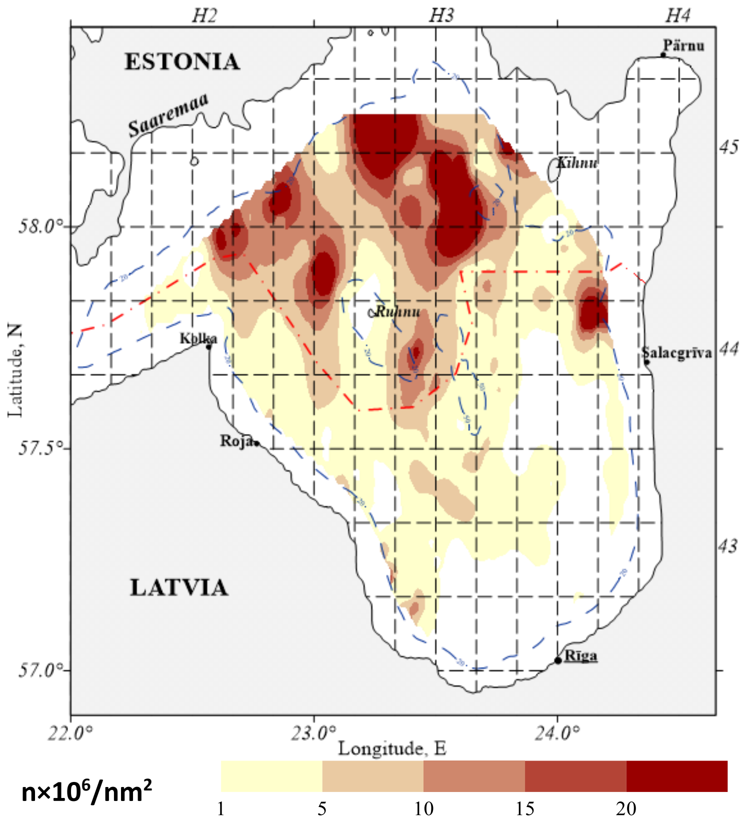

Figure 5: Herring distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.

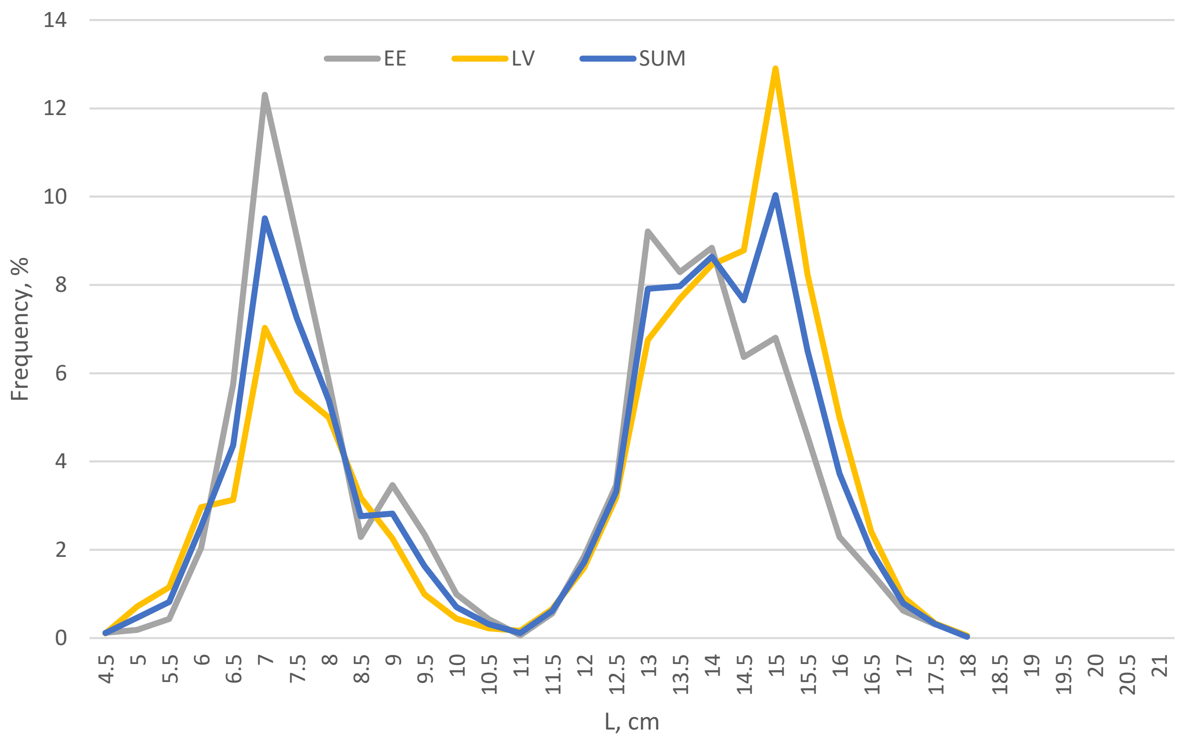

Figure 6: Length distribution of herring in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.

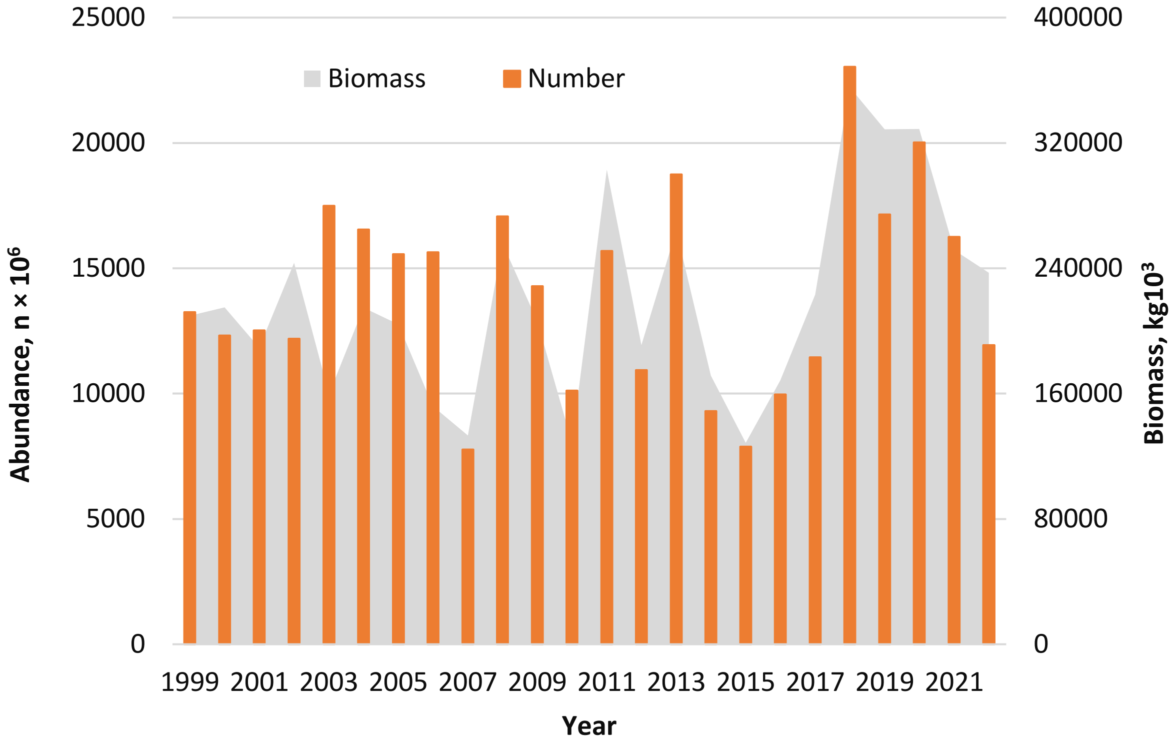

Figure 7: Annual stock changes of herring in the Gulf of Riga during GRAHS cruises.

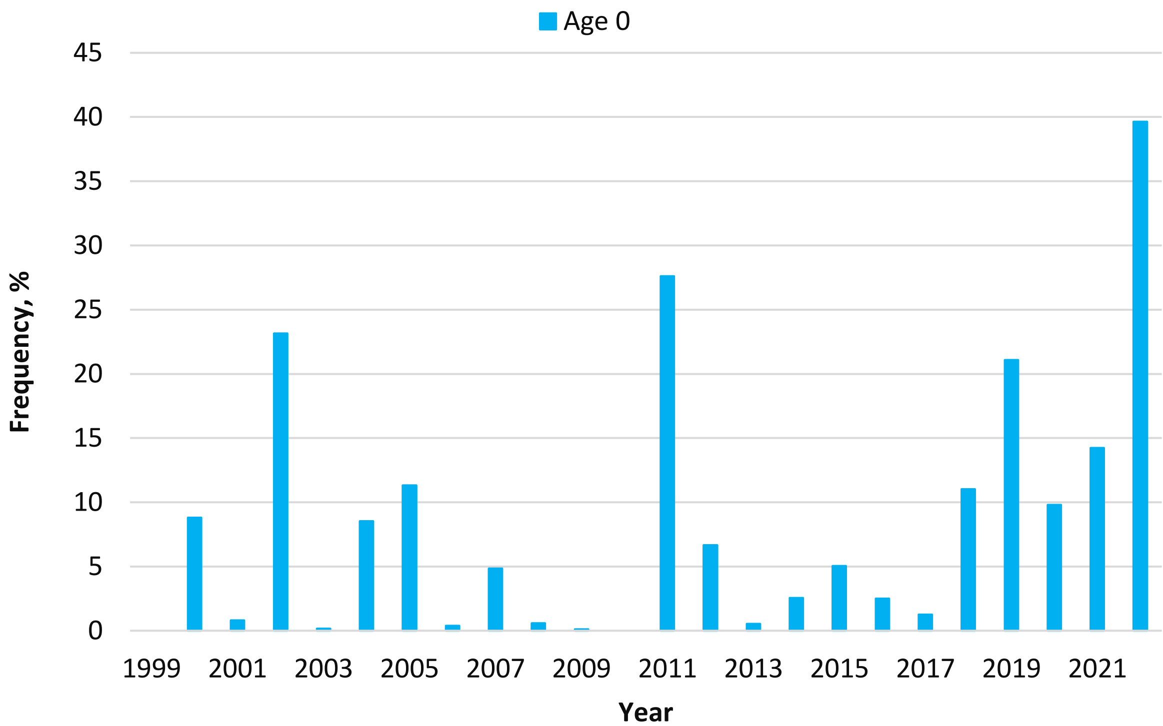

Figure 8: Annual stock changes of herring at Age 0 in the Gulf of Riga during GRAHS cruises.

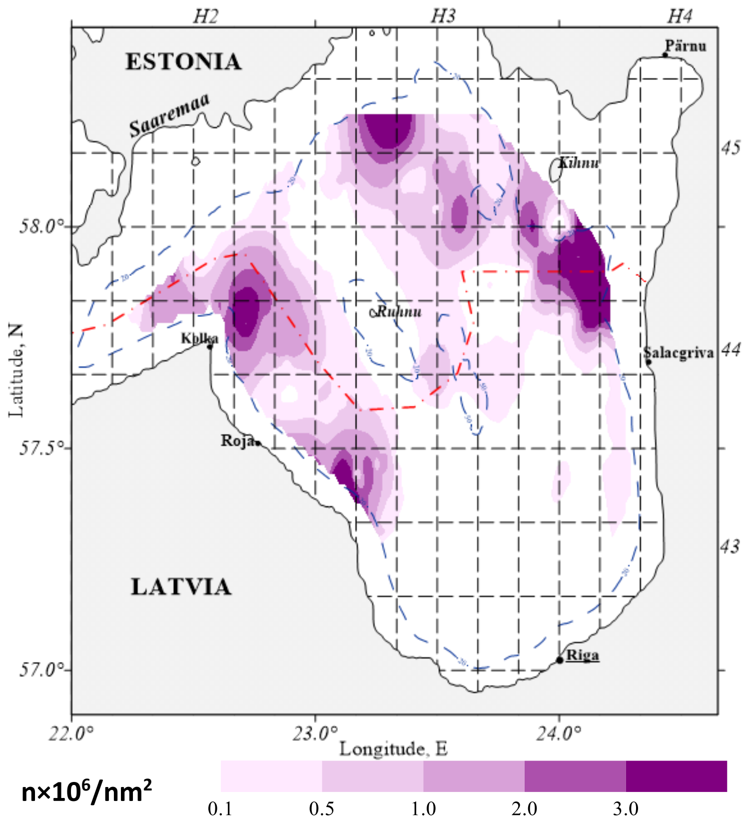

Figure 9: Sprat distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.

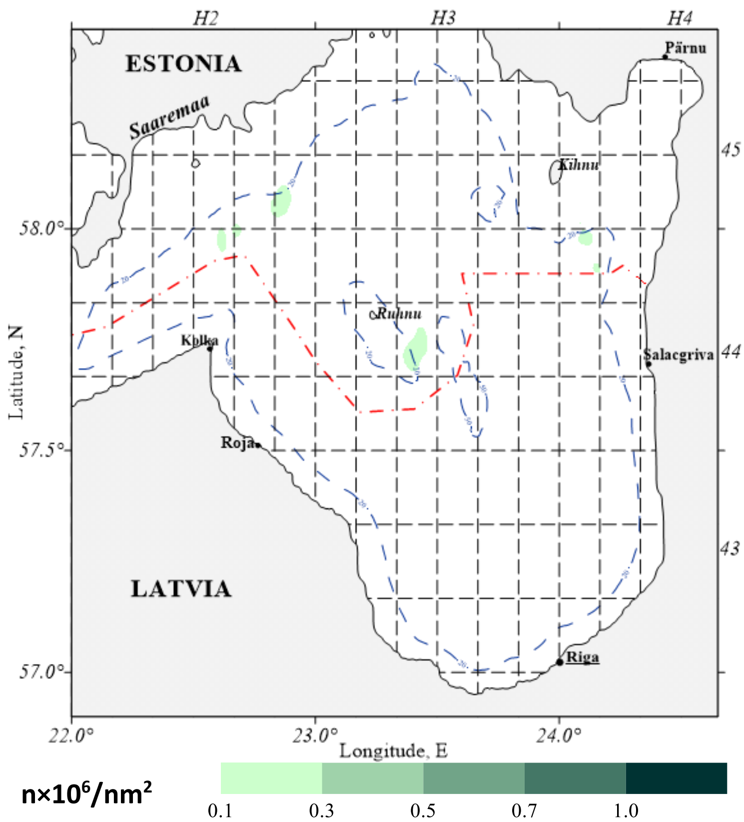

Figure 10: Smelt distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.

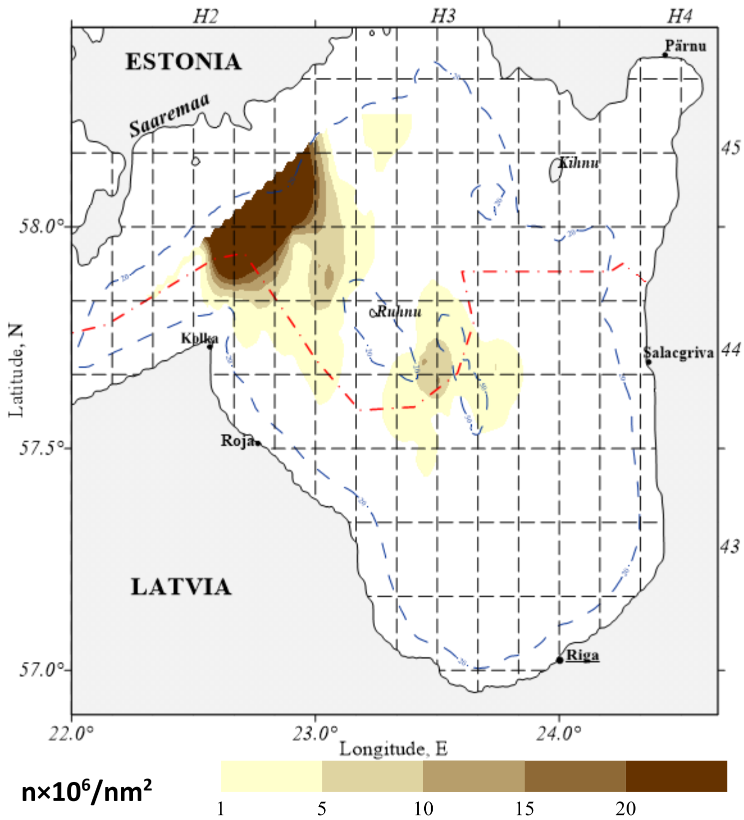

Figure 11: Three-spined stickleback distribution in the Gulf of Riga ICES SD 28.1
from the Latvian-Estonian GRAHS survey conducted by f/v "Urga" in the period of 27.07-01.08.2022.