Annex 7: Cruise reports from the BASS and the BIAS surveys in 2016

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

REPORT FROM THE JOINT ESTONIAN-POLISH BASS 2016 CONDUCTED BY THE R.V. "BALTICA" IN THE NORTH-EASTERN BALTIC SEA (22-26 May 2016)

by
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Introduction

The recent joint Estonian-Polish Baltic Acoustic Spring Survey (BASS), marked with the number 8/2016/NMFRI/TUEMI was based on the procurement contract between the University of Tartu/Estonian Marine Institute in Tallinn and the National Marine Fisheries Research Institute in Gdynia. The survey was conducted in the Estonian EEZ (the ICES Sub-divisions 28.2, 29 and 32).

The Estonian Data Collection Programme for 2016 and the European Union (the Commission regulations Nos. 1639/2001, 1581/2004, 665/2008, 1078/2008, 199/2008) financially supported the EST-POL BASS 2016. Timing, surveying area in the North-eastern Baltic Sea and the principal methods of investigations concerns the above mentioned survey were designed and coordinated by the ICES WGBIFS (ICES 2015[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 specially for herring and sprat,
- to collect plankton samples,
- to provide hydrological monitoring (water temperature, salinity and oxygen content) at the catch locations.

Personnel

The EST-POL BASS 2016 scientific staff was composed of 8 persons:
Miroslaw Wyszynski (NMFRI, Gdynia – Poland) – survey leader
Jakub Slembarski (NMFRI, Gdynia – Poland) – acoustician
Bartosz Witalis (NMFRI, Gdynia – Poland) – hydrologist
Tiit Raid (TUEMI, Tallinn - Estonia) – Estonian scientific staff leader
Ain Lankov (TUEMI, Tallinn - Estonia) – ichthyologist
Andrus Hallang (TUEMI, Tallinn - Estonia) – ichthyologist
Timo Arula (TUEMI, Tallinn - Estonia) – biologist
Elor Sepp (TEMI, Tallinn - Estonia) – acoustician.

Narrative

The reported survey took place during the period of 22-26 May 2016. The at sea researches (echo-integration, fish control catches, hydrological and plankton stations) were conducted aboard r.v. “Baltica” within Estonian EEZ (the ICES Sub-divisions 28.2, 29 and 32 West), moreover inside the territorial waters of this country not shallower than 20 m depth.

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[1]ICES 2015. First Interim Report of the Baltic International Fish Survey Working Group (WGBIFS). ICES CM 2015/SSGIEOM: 07.

The survey started from the Ventspils port (Latvia) on 21.05.2016 after the midday and was navigated in the North-eastern direction to the entering point of planed acoustic transect at the geographical position 59°16.5’N 022°21.3’E on May, 22 (Fig. 1). The at sea researches were ended on 25.05.2016 before the midday in the port of Ventspils (Latvia). Then the r.v. “Baltica” started its journey to the home-port in Gdynia (Poland), reaching it on 26.05.2016 late afternoon.

Survey design and realization

The r.v. “Baltica” realized 251 Nm echo-integration transect and 13 fish control-catches (Fig. 1). All planed ICES rectangles were covered with acoustic transect and control catches. All control catches were performed in the daylight (between 06:50 am. and 20:00 pm.) using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The most trawling duration was 30 minutes, however in 4 cases hauls duration was shortened to 10-15 minutes due to high fish density observed on the net-sounder monitor. The mean speed of vessel while providing echo-integration was 8.0 knots, in case of trawling was 3.0 knots. Overall, 3 hauls were conducted in SD 28.2, 8 hauls in SD 29 and 2 hauls in SD 32.

The length measurements (in 0.5 cm classes) were realized for 2979 sprat and 2757 herring individuals. Totally, 397 sprat and 687 herring individuals were taken for biological analysis.

Acoustic data were collected with the EK-60 echo-sounder equipped with “Echo-view V4.10” software for the data analysis. The acoustic equipment was calibrated before the survey according to the methodology described in the IBAS manual (ICES. 2015). The basic acoustic and biological data collected during recently carried out survey will be stored in the BASS_DB.mdb managed by ICES.

Calibration

The hydroacoustic equipment was calibrated before the survey according to the methodology described in the BIAS manual. (Anon. 2014[2])

Acoustic data collection

Acoustic data were collected during the light time with the Simrad EK60 echosounder equipped with “Echo-view V4.10” software for the data analysis. Data from two frequencies (38 and 120 kHz) were recorded simultaneously, but for the standard analyses only the information collected with 38 kHz was used. The specific settings of the equipment were used as

described in the BIAS manual. (Anon. 2014[2]) The basic acoustic and biological data collected during recently carried out survey will be stored in the BIAS_DB.mdb managed by ICES.

[2]Anon. 2014. Report of the Baltic International Fish Survey Working Group (WGBIFS). ICES CM 2014/SSGESST: 13.

Data analysis

The MYRIAX "EchoView v.4.10" 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:

$TS = 20 \log L - 71.2$ (Anon. 1983[3]).

Due to fortunate weather conditions, all transects and planned trawls were conducted according to the plan and no data from colleagues from nearby countries were needed.

Catch results and fish measurements

Overall, 7 fish species were recognized in hauls performed at the North-eastern Baltic Sea in May 2016. Sprat was prevailing species by mass in the total catch with the mean share amounted 63.9 % (especially high in SD 28 – 85.0%). Only in SD 32 the catch mass share of sprat and herring was at the same level – 51.5 and 48.5% respectively. The rest 5 species (with the three spine stickleback) represented only 1.0 % of the total mass in average.

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

Mean CPUE for all species in the investigated area in May 2016 amounted 670.0 kg/h. The most valueable CPUEs for sprat was noted in SD 28.2, but for herring – in SD 32. The mean CPUEs of sprat were: 1493.2 kg/h in ICES SD 28.2, 184.9 kg/h in SD 29 and 278.9 kg/h in SD 32. The mean CPUEs in case of herring were as follow: 186.7, 149.3 and 207.9 kg/h in SDs 28.2, 29 and 32 respectively.

The length distributions of sprat and herring according to the ICES Sub-divisions 28.2, 29 and 32 are shown on Fig. 3 and 4 respectively. The sprat length distribution curves represent similar character in three investigated SDs. First frequency pick representing sprat generation born in 2015 take place on 7.5-8.0 cm length class shows a small quantity in all investigated Sub-divisions. The second one representing adult sprat placed on 9.5 cm length class. The length distribution curves by Sub-divisions in case of herring show generally two frequency picks – first one on 11.0-12.5 cm length classes and second one on 15.0-18.0 cm length classes. The first pick shows good quantity of herring generation born in 2015, especially in SD 32.

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. Fish concentrations were similar throughout the survey.

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 concentration was found highest in Central Baltic and slightly decreased towards Gulf of Finland. Average weights were similar throughout the survey. Biomass of herring increased heavily towards Gulf of Finland, but sprats biomass remained on more or less stable high level.

Meteorological and hydrological characteristics.

The 13 hydrological stations at the control catch positions (Fig.1) were inspected with the IDRONAUT CTD-probe combined with the rosette sampler. Hydrological parameters were measured at each catch–station location. Oxygen content was determined by the standard Winkler's method. The CTD row data aggregated to the 1-m depth stratum. The oxygen probes ware taken on every 10 meters, and at the catch depth.

The most frequently wind was ESE (Fig. 5). The wind force varied from 0,6 m/s to 8,4 m/s, and average force was 4,5 m/s. The air temperature ranged from 9,3 °C to 17,1 °C, and average temperature was 12,2 °C.

The seawater temperature in the surface layers varied from10.00 to 14.74°C (the mean was 11.50°C).The lowest surface temperatures were recorded at the haul station 5. The highest ones were noted at the haul 11. The minimum value of salinity in Practical Salinity Unit (PSU) was 5,05 at the haul station 4 in the surface layer. The maximum was 6,78 PSU at the haul station 12. The mean value of salinity was 6,07 PSU. The oxygen content in the surface layers of investigated the research area varied in the range of 6.52 ml/l (haul 10) - 9.87 ml/l (haul 4). The mean value of surface water oxygen content was 8.45 ml/l.

The temperature of near bottom layer was changing in the range of 4.05 (haul 7) to 6.17 °C (haul 9), the mean was 5.54 °C. Salinity of near bottom waters varied from7.47 (haul 7) to 11.61 PSU (haul 9), and the mean was 10.30 PSU. Oxygen content varied from 0.37 ml/l (haul 6) to 6.61 ml/l (haul 7), the mean was 1.77 ml/l.

The depth profiles of three basic hydrological parameters (Fig. 6) measured at the deepest sampling station show a thermocline starting from about 20 m depth and oxycline starting from about 60 m depth with the oxygen value 6 ml/l to below 0,5 ml/l below the depth of 80 m.

The temperature at the trawl towing layer was changing in the range of 4.10 (haul 13)- 5.35 °C (haul 2), the mean value was 4.76 °C. Salinity at the

haul depth varied from 6,93 (haul 6) to 9.72 PSU (haul 8), and the mean was 8.44 PSU. Oxygen content varied from 1.21 ml/l (haul 10) to 7.47 ml/l (haul 7), and the mean was 3.68 ml/l (Table 3).

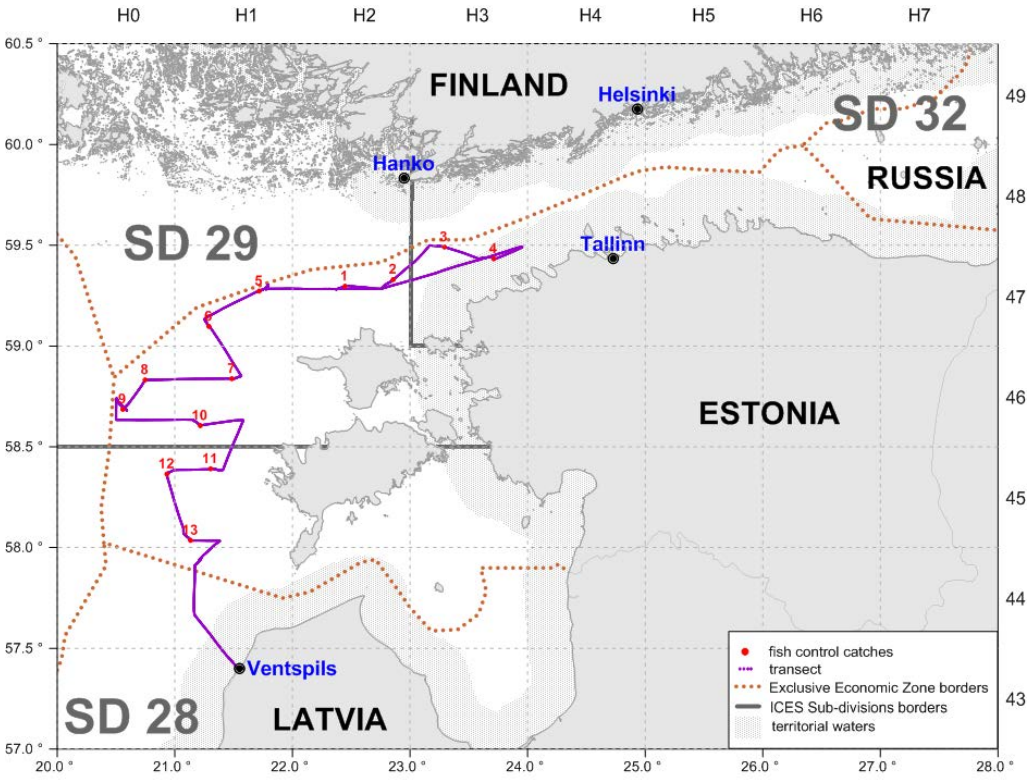


Fig. 1. Acoustic transects and pelagic fish control catches with connected hydrological stations realised during joint EST-POL BASS (May 2016).

Table 1. Catch results during joint Estonian-Polish BASS conducted by r.v. “Baltica” in Estonian EEZ in May 2016.

Gear: pelagic trawl type WP53/64x4 with 6 mm bar length in the codend

Haul no	Date	ICES rectangle	ICES Sub-division (SD)	Geographical position start latitude 00°00.0'N	Geographical position start longitude 00°00.0'E	Geographical position end latitude 00°00.0'N	Geographical position end longitude 00°00.0'E	Time start	Time end	Haul duration [min]	Total catch [kg]	CPUE* [kg/h]	Catch per species [kg] sprat	herring	cod	flounder	lumpfish	eelpout	three-spined stickleback
1	2016-05-22	47H2	29	59°16.9'	22°22.8'	59°17.5'	22°25.5'	06:55	07:25	30	160,740	321,480	74,969	85,562					0,209
2	2016-05-22	47H2	29	59°18.3'	22°47.7'	59°19.1'	22°50.0'	09:55	10:25	30	239,408	478,816	139,380	99,016	0,988				0,024
3	2016-05-22	47H3	32	59°29.7'	23°14.7'	59°29.6'	23°15.9'	13:15	13:30	15	152,990	611,960	113,320	39,640					0,030
4	2016-05-22	47H3	32	59°26.3'	23°38.6'	59°26.4'	23°41.5'	15:50	16:20	30	180,960	361,920	52,243	128,572					0,145
5	2016-05-23	47H1	29	59°17.1'	21°46.2'	59°16.6'	21°44.0'	06:50	07:20	30	399,123	798,246	208,153	189,038	1,658		0,075		0,199
6	2016-05-23	47H1	29	59°07.4'	21°15.6'	59°06.2'	21°17.0'	10:15	10:45	30	23,925	47,850	16,480	6,580					0,865
7	2016-05-23	46H1	29	58°50.8'	21°32.7'	58°50.2'	21°30.2'	13:40	14:10	30	19,084	38,168	15,180	3,040					0,864
8	2016-05-23	46H0	29	58°49.9'	20°49.0'	58°49.8'	20°46.1'	17:15	17:45	30	123,127	246,254	58,584	63,986	0,442	0,115			
9	2016-05-23	46H0	29	58°42.2'	20°35.3'	58°41.5'	20°34.1'	19:35	19:50	15	72,800	291,200	44,300	26,919	1,325	0,171		0,014	0,071
10	2016-05-24	46H1	29	58°37.6'	21°10.1'	58°36.8'	21°12.2'	09:10	09:40	30	235,322	470,643	138,120	96,136	0,767	0,132		0,003	0,164
11	2016-05-24	45H1	28	58°23.2'	21°20.2'	58°23.5'	21°19.4'	13:55	14:10	15	366,580	1466,320	236,297	129,439					0,844
12	2016-05-24	45H0	28	58°22.5'	20°57.6'	58°22.3'	20°56.7'	16:25	16:35	10	559,360	3356,160	555,444	3,804					0,112
13	2016-05-24	45H1	28	58°03.7'	21°05.3'	58°02.8'	21°07.1'	19:30	20:00	30	110,759	221,518	100,893	9,703			0,119		0,044
									Total catch [kg]	28	1036,699	1681,333	892,634	142,946			0,119		1,000
										29	1273,529	336,582	695,166	570,277	5,180	0,418	0,075	0,017	2,396
										32	333,950	486,940	165,563	168,212					0,175
										Sum	2533,419	670,041	1652,470	871,732	5,180	0,418	0,075	0,017	3,527

*mean CPUE for sum haul numbers

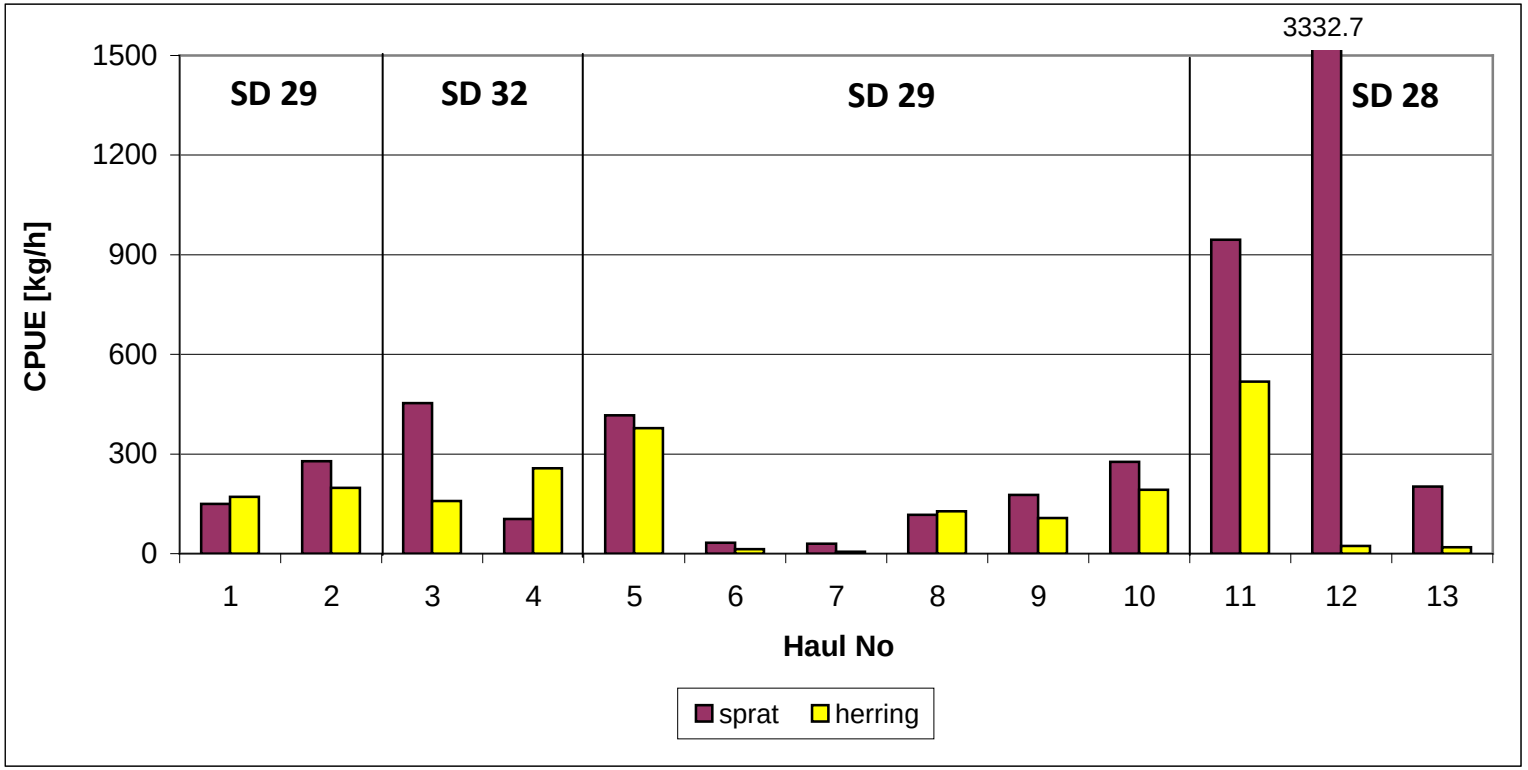


Fig. 2. CPUE values (kg/h) of sprat and herring in particular pelagic fish control catches during joint EST-POL BASS in the North-eastern Baltic Sea (Sub-divisions 28.2, 29 and 32), May 2016.

Table. 2. Biological sampling in the r.v."Baltica" joint EST-POL BASS in May 2016.

Fish samples

SD 28		SPRAT	HERRING	COD	FLOUNDER	LUMPFISH	THREE SPINED STICKLEBACK	EELPOUT	TOTAL
Samples taken	measurements	3	3			1	3		10
	analyses	3	3			0	0		6
Fish measured		746	296			1	36		1079
Fish analysed		124	182			0	0		306

SD 29		SPRAT	HERRING	COD	FLOUNDER	LUMPFISH	THREE SPINED STICKLEBACK	EELPOUT	TOTAL
Samples taken	measurements	8	8	5	3	1	7	2	34
	analyses	8	8	0		0	0	0	16
Fish measured		1798	1920	13	4	1	197	2	3935
Fish analysed		177	333	0	0	0	0	0	510

SD 32		SPRAT	HERRING	COD	FLOUNDER	LUMPFISH	THREE SPINED STICKLEBACK	EELPOUT	TOTAL
Samples taken	measurements	2	2				2		6
	analyses	2	2				0		4
Fish measured		435	541				12		988
Fish analysed		96	172				0		268

SUM		SPRAT	HERRING	COD	FLOUNDER	LUMPFISH	THREE SPINED STICKLEBACK	EELPOUT	TOTAL
Samples taken	measurements	13	13	5	3	2	12	2	50
	analyses	13	13	0	0	0	0	0	26
Fish measured		2979	2757	13	4	2	245	2	6002
Fish analysed		397	687	0	0	0	0	0	1084

Type of fishing net used: pelagic trawl WP53/64x4 with 6mm mesh size in the codend

Zooplankton samples

Sub-division	stations	samples
28	3	6
29	6	12
32	1	2
Sum	10	20

Type of plankton net used: Juday net + Bongo net

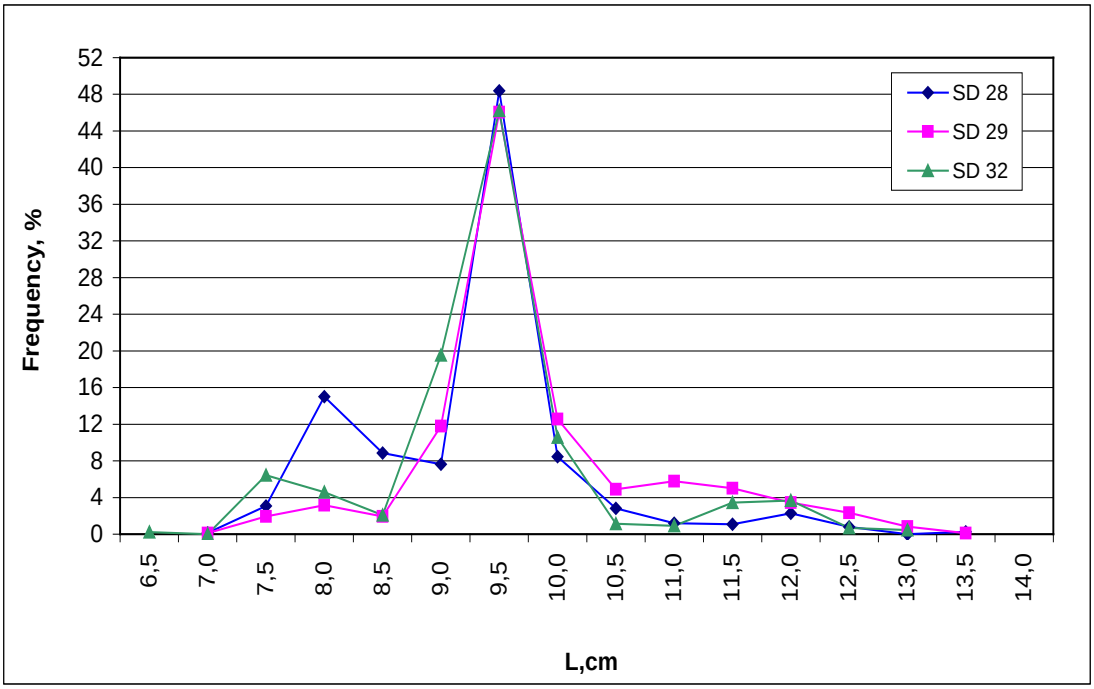


Fig. 3. Sprat length distributions from the control catches conducted by the rv. “Baltica” during joint EST-POL BASS in the SDs 28.2, 29 and 32 (May 2016).

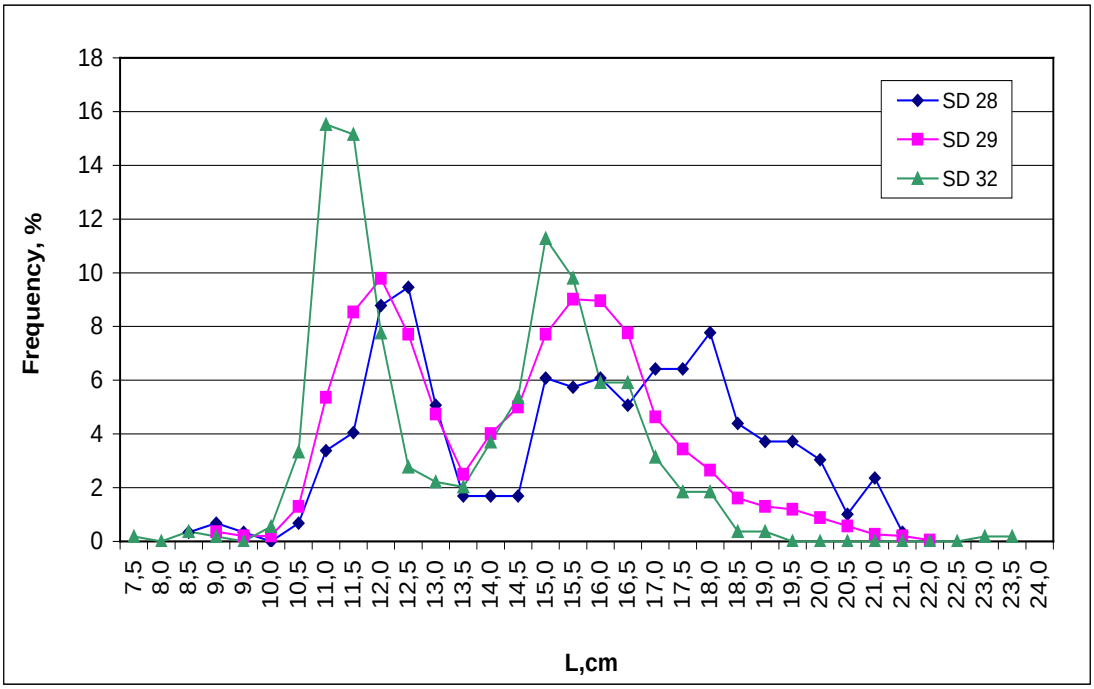


Fig. 4. Herring length distributions from the control catches conducted by the rv. “Baltica” during joint EST-POL BASS in the SDs 28.2, 29 and 32 (May 2016).

Table 3. The BASS survey basic biological and acoustic data concerning the clupeid stocks inhabiting the north- eastern Baltic Sea in May 2016.

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 [cm^2]
			herring	sprat				
28	45H0	947.2	0,3	99,7	8861,17	9,355	785,3	0,839
28	45H1	827.1	6,4	87,5	4184,93	5,060	483,7	0,956
29	46H0	933.8	19,6	80,0	4233,51	4,534	564,2	1,244
29	46H1	921.5	11,4	81,7	2870,94	3,116	325,4	1,044
29	47H1	920.3	17,5	76,3	8196,44	8,906	982,1	1,103
29	47H2	793.9	24,9	74,7	3131,27	3,944	497,1	1,260
32	47H3	536.2	29,0	70,7	3265,36	6,090	722,0	1,186
Average			**15,6**	**81,5**		**5,858**	**622,8**	**1,090**
Total		**5880**			**34743**			

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 2016.

ICES Sub-div.	ICES rectangle	HERRING – age groups								
		1	2	3	4	5	6	7	8+	total
28	45H0		21,86	0,36	1,82	1,09	0,36			25,50
28	45H1	4,56	68,16	8,17	43,29	43,48	18,89	25,54	57,13	269,21
total		4,56	90,01	8,53	45,12	44,57	19,25	25,54	57,13	294,71
29	46H0	14,20	239,14	56,67	181,84	112,34	40,36	51,33	134,3	830,17
29	46H1	6,21	112,43	20,04	67,24	42,78	14,38	19,10	45,65	327,83
29	47H1	29,44	591,56	148,97	325,03	140,22	51,72	41,96	104,23	1433,12
29	47H2	15,16	275,36	60,42	200,86	104,25	31,19	28,00	63,94	779,16
total		65,02	1218,49	286,09	774,96	399,58	137,65	140,38	348,12	3370,28
32	47H3	6,39	444,31	135,64	137,04	121,76	39,87	27,74	35,79	948,55
total		6,39	444,31	135,64	137,04	121,76	39,87	27,74	35,79	948,55
Grand total		75,97	1752,81	430,26	957,12	565,91	196,77	193,67	441,04	4613,55

Table 4. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups								
		1	2	3	4	5	6	7	8+	total
28	45H0	2825	5730	109	57	48	26	6	32	8834
28	45H1	910	2485	92	63	49	34	6	22	3661
total		3734	8216	202	119	98	60	12	54	12495
29	46H0	183	2467	150	246	135	37	60	111	3388
29	46H1	290	1680	68	127	81	20	24	56	2344
29	47H1	510	4948	109	246	185	59	57	137	6252
29	47H2	18	1852	60	157	101	34	36	84	2341
total		1001	10947	386	776	502	150	177	387	14325
32	47H3	175	1889	35	64	57	0	14	75	2309
total		175	1889	35	64	57	0	14	75	2309
Grand total		4910	21052	622	960	657	210	203	516	29129

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 2016.

ICES Sub-div.	ICES rectangle	HERRING – age groups								
		1	2	3	4	5	6	7	8+	total
28	45H0		225	6	30	18	6			285
28	45H1	23	688	118	828	1013	434	651	1806	5563
total		23	913	124	858	1031	440	651	1806	5848
29	46H0	90	2449	836	3275	2563	1314	1620	3085	12148
29	46H1	40	1132	298	1308	962	431	601	900	5672
29	47H1	82	6474	2219	5985	3354	1507	1323	1692	22635
29	47H2	112	2503	876	3717	2041	963	951	749	11913
total		324	12558	4229	14285	8920	4216	4495	6425	52368
32	47H3	256	3566	1018	3607	2143	964	852	464	12870
total		256	3566	1018	3607	2143	964	852	464	12870
Grand total		603	17037	5371	18750	12095	5620	5999	8696	71086

Table 5. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups								
		1	2	3	4	5	6	7	8+	total
28	45H0	9215	29898	866	538	469	257	61	347	41650
28	45H1	2866	13345	743	587	518	362	55	225	18701
total		12081	43242	1609	1125	987	618	116	572	60351
29	46H0	546	13408	742	1666	1079	359	496	957	19254
29	46H1	889	9023	553	1126	722	186	245	527	13271
29	47H1	1565	26662	850	2147	1579	565	595	1297	35259
29	47H2	59	9221	450	1311	852	316	354	753	13316
total		3060	58314	2596	6250	4232	1426	1690	3533	81100
32	47H3	411	8872	265	535	478	0	154	675	11389
total		411	8872	265	535	478	0	154	675	11389
Grand total		15551	110428	4469	7910	5697	2044	1960	4780	152841

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 2016.

ICES Sub-div.	ICES rectangle	HERRING – age groups								
		1	2	3	4	5	6	7	8+	avg.
28	45H0		10,30	16,50	16,50	16,50	16,50			11,19
28	45H1	5,10	10,10	14,42	19,14	23,31	22,99	25,51	31,62	20,66
29	46H0	6,33	10,24	14,75	18,01	22,81	32,57	31,56	22,97	14,63
29	46H1	6,40	10,07	14,88	19,46	22,49	30,00	31,46	19,71	17,30
29	47H1	2,78	10,94	14,90	18,41	23,92	29,13	31,53	16,23	15,79
29	47H2	7,42	9,09	14,50	18,50	19,58	30,89	33,98	11,71	15,29
32	47H3	40,01	8,03	7,50	26,32	17,60	24,18	30,72	12,96	13,57

Table 6. Continue

ICES Sub-div.	ICES rectangle	SPRAT – age groups								
		1	2	3	4	5	6	7	8+	avg.
28	45H0	3,26	5,22	7,91	9,53	9,68	9,78	9,48	10,75	4,71
28	45H1	3,15	5,37	8,05	9,34	10,52	10,62	9,87	10,45	5,11
29	46H0	2,99	5,43	4,95	6,78	8,02	9,84	8,24	8,62	5,68
29	46H1	3,07	5,37	8,18	8,88	8,89	9,52	10,23	9,48	5,66
29	47H1	3,07	5,39	7,81	8,71	8,52	9,50	10,46	9,47	5,64
29	47H2	3,27	4,98	7,54	8,35	8,47	9,19	9,96	9,01	5,69
32	47H3	2,35	4,70	7,64	8,34	8,36		11,07	9,02	4,93

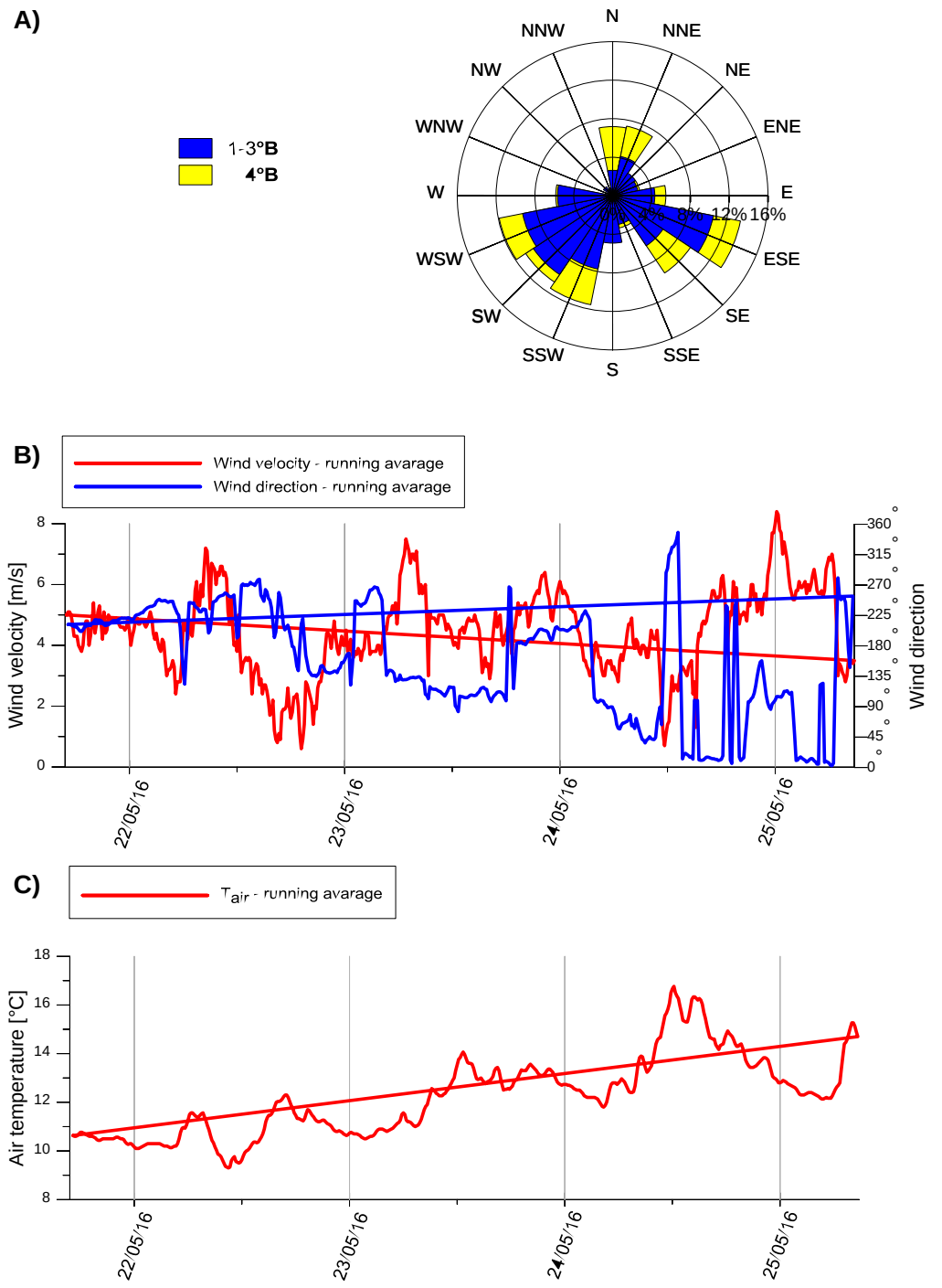


Fig. 5. Changes of the main meteorological parameters during joint EST-POL BASS conducted in May 2016 (A and B – wind direction and velocity, C – air temperature).

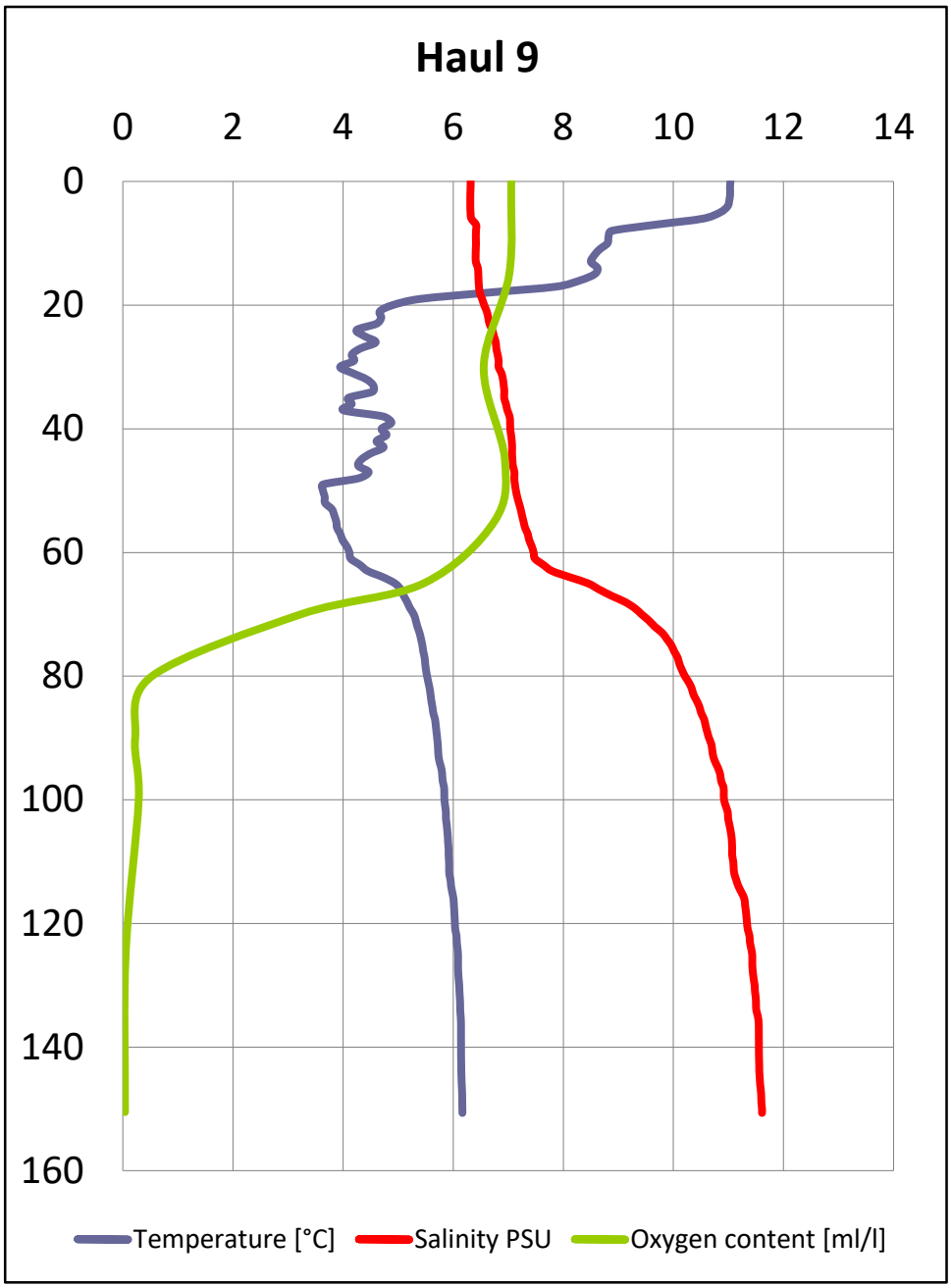


Fig.6. Temperature, salinity and oxygen depth [m] profiles at the deepest sampling station (haul No. 9) during the joint EST-POL BIAS, May 2016.

Table 3. Values of the basic meteorological and hydrological parameters recorded in May 2016 at the positions of the r.v. “Baltica” fish control catches during EST-POL BASS.

Haul number	Date of catch	Meteorological parameters					Hydrological parameters*		
		wind direction	wind force [°B]	sea state	air temper. [°C]	atmospheric pressure [hP]	temperature [°C]	salinity [PSU]	oxygen [ml/l]
1	22-05-2016	W	3	1	8	1015	4,86	8,42	2,92
2	22-05-2016	WSW	3	2	11	1016	5,35	9,66	3,59
3	22-05-2016	W	3	2	9	1019	4,32	7,64	4,44
4	22-05-2016	W	2	1	9	1019	5,11	8,95	2,64
5	23-05-2016	SE	2	1	8	1015	5,19	9,31	1,70
6	23-05-2016	SE	4	2	10	1016	4,16	6,93	7,07
7	23-05-2016	SE	2	1	11	1018	4,13/3,93	6,97/7,05	7,47
8	23-05-2016	SE	2	1	11	1018	5,32	9,72	1,37
9	23-05-2016	SE	2	1	10	1018	5,28	9,42	2,07
10	24-05-2016	SE	3	1	12	1015	5,25	9,49	1,21
11	24-05-2016	changeable	2	1	13	1017	4,98	8,84	3,78
12	24-05-2016	changeable	2	1	14	1017	4,73	8,40	3,06
13	24-05-2016	changeable	2	1	14	1017	4,10	7,30	6,55
* data at the mean depth of the fish control catch						Mean >	4,76	8,44	3,68

Fisheries Service under the Ministry of Agriculture of Republic of Lithuania,
Fishery Research and Science State

RESEARCH REPORT FROM THE BALTIC INTERNATIONAL ACOUSTIC SURVEY (BASS) IN THE ICES SUBDIVISION 26 (LITHUANIAN ESPECIAL ECONOMIC ZONE) OF THE BALTIC SEA

(R/V “DARIUS”; 03.05 - 04.05.2016)

Working paper on the WGBIFS meeting in Riga, Latvia, 27.03-31.03.2017

Klaipeda, May, 2016
Lithuania

1 INTRODUCTION

The Lithuanian survey is coordinated within the frame of the **Baltic International Sprat Survey (BASS).** The reported acoustic survey is conducted to supply the ICES Baltic Fisheries Assessment Working Group (WGBFAS) and the Fisheries Service under the Ministry of Agriculture of Republic of Lithuania with an index value for the stock size of herring and sprat in parts of the ICES subdivision (SD) 26 (Lithuanian Exclusive Economic Zone). 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 main aims were:

- to collect the echo-integration data for the estimation of the clupeids stocks biomass and abundance in the south-central Baltic.

2 METHODS

2.1 Personnel

The scientific staff was composed of four persons:

M. Špegys	Fisheries Service under the Ministry of Agriculture of The Republic of Lithuania; Division of Fishery Research and Science, Klaipeda – cruise leader and acoustics;
J. Fedotova	Fisheries Service under the Ministry of Agriculture of The Republic of Lithuania; Division of Fishery Research and Science, Klaipeda - scientific leader and fish sampling
D. Tarvydiene	Fisheries Service under the Ministry of Agriculture of The Republic of Lithuania; Division of Fishery Research and Science, Klaipeda - fish sampling

2.2 Narrative

The scientist cruise of RV “Darius” took place from 3-th to 4-th of May 2016. The cruise was intended to cover parts of ICES subdivisions (SD) 26, constituting the Lithuanian Exclusive Economic zones.

2.3 Survey design

The statistical rectangles were used as strata (ICES 2003). 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 3 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 2025 nm^2 and the distance used for acoustic estimates was 123 nm. The entire cruise track with positions of the trawling is shown in Fig. 1.

2.4 Calibration

The SIMRAD EK60 echo sounder with split beam transducer ES38 - 12 was calibrated (28 of April 2013) at the site of 30 m depth, located 3.5 nm northwest of Klaipeda harbour according to the BIAS manual (ICES 2011). S_v correction after calibration was set to 21.94 dB.

THE RESULTS OF CALIBRATION PROCEDURE FOR EK60 SCIENTIFIC ECHOSOUNDER	
Date: 28.04.2014	Place : near Klaipeda port
Type of transducer	Split – beam for 38 kHz
Gain (38 kHz)	21.94 dB
Athw. Angle Sens	12.5
Along. Angle Sens	12.5
Athw. Beam Angle	12.06
Along. Beam Angle	11.96
Athw. Offset Angle	0.08
Along. Offset Angle	-0.15
SA Correction (38 kHz)	-0.18 dB

2.5 Acoustic data collection

The acoustic sampling was performed around the clock. The main pelagic species of interest were herring and sprat. The SIMRAD EK60 echo sounder with hull mounted 38 kHz transducer ES38-12 was used during the cruise. The specific settings of the hydro acoustic equipment were used as described in the BIAS manual (ICES 2011). The post-processing of the stored echo signals was made using the Sonar4 (Balk & Lindem, 2005). The mean volume back scattering values S_v, were integrated over 1 nm intervals, from 10 m below the surface to the bottom. Contributions from air bubbles, bottom structures and noise scattering layers were removed from the echogram using Sonar4.

2.6 Biological data – fishing stations

All trawling was done with the pelagic gear „OTM“ in the midwater as well as near the bottom. The mesh size in the codend 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. From each haul, sub-samples were taken to determine length and weight composition of fish. The samples of sprat and herring were taken from each catch station to determine the species proportion, length-mass relationship, sex, maturity and age-length relationship.

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 σ 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 (S_a) 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

In total 7 trawl hauls (Fig.1) were carried out: 574 herrings and 1634 sprats were measured and 327 herrings and 639 sprats were aged.

The results of the catch composition are presented in Table 1. In all catch compositions sprat dominated (>90%).

The length distributions of herring and sprat of the May 2016 presented in Fig. 2 and Fig. 3. In 40H0 ICES rectangle were almost no herrings and most of its (more than 77%) were 12.0-17.0 cm length, but 62% of these fishes were oldest than 2 years old. The biggest part of catching herring was in the rectangle 40G9 (85.99%). In both rectangles sprats length were from 8cm to 14 cm. In 40H0 ICES rectangle sprat dominated in 8.0 – 11.0 cm length classes (94.5%) and in 40G9 rectangle more than 89% were fishes in 9.0 – 11.5 length classes.

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 fish, the percentages of herring, sprat per rectangle are show in Table 2-14. Nautical area scattering coefficient distribution during survey is show in Figure 2.

3.3 Abundance estimates

R/V “Darius” survey statistics (aggregated data for herring and sprat), included the total abundance of herrings and sprats are presented in Tables 2-4. The estimated age composition of sprat and herring are given in table 5 and table 10. The abundance estimates of sprat were dominated by 1 age fish in both rectangles. The estimated number sprat and herring by age group and rectangle are given in table 6 and table 11. The estimates of sprat and herring biomass by age group and rectangle are summarised in table 7 and table 12. The corresponding mean weights and mean length by age group and rectangle for each species are shown in tables 8-9 and tables 13-14.
The herring stock was estimated to be $364.7 \cdot 10^6$ fishes or about 6829.0 tonnes.
The estimated sprat stock was $12743.2 \cdot 10^6$ fish or 80207 tonnes. Length distribution of herring show in Fig. 3 and sprat length distribution show in Fig. 4.

3.4. Hydrographic data

The basic hydrological parameters (seawater temperature, salinity and oxygen contents) were measured from the surface to the bottom after every haul. The survey hydrographic data by hauls presented in the Figure7. The seawater temperature was 6-7 in the surface layer and and 9 ºC near in the closest coastal zone stations in rectangle 40H0. Temperature near bottom was about 10 ºC. Water temperature in hauls was from 6 to 9 ºC. There was no halocline in 2015 of May. Salinity was about 7.8 ‰ in all hauls and depts. The oxygen-condition was excellent in all hauls and depts.

4 REFERENCES

Balk, H. & Lindem, T. 2005. Sonar4, Sonar5 and Sonar6 post processing systems, operator manual version 5.9.6. Norway: Balk and Lindem. pp. 1-381

ICES 1983. Report of the Planning Group on ICES co-ordinated herring and sprat acoustic surveys. ICES CM 1983/H:12.

ICES 2011. Manual for the international acoustic survey (BIFS). CM2003/G:05 Ref.: D, H; Appendix 9, Annex 3

Foote, K.G., Aglen, A. & Nakken, O. 1986. Measurement of fish target strength with a split-beam echosounder. J.Acoust.Soc.Am. 80(2):612-621.

Figure 1 The survey grid ant trawl hauls position of R/V “Darius” 03-04 May 2016

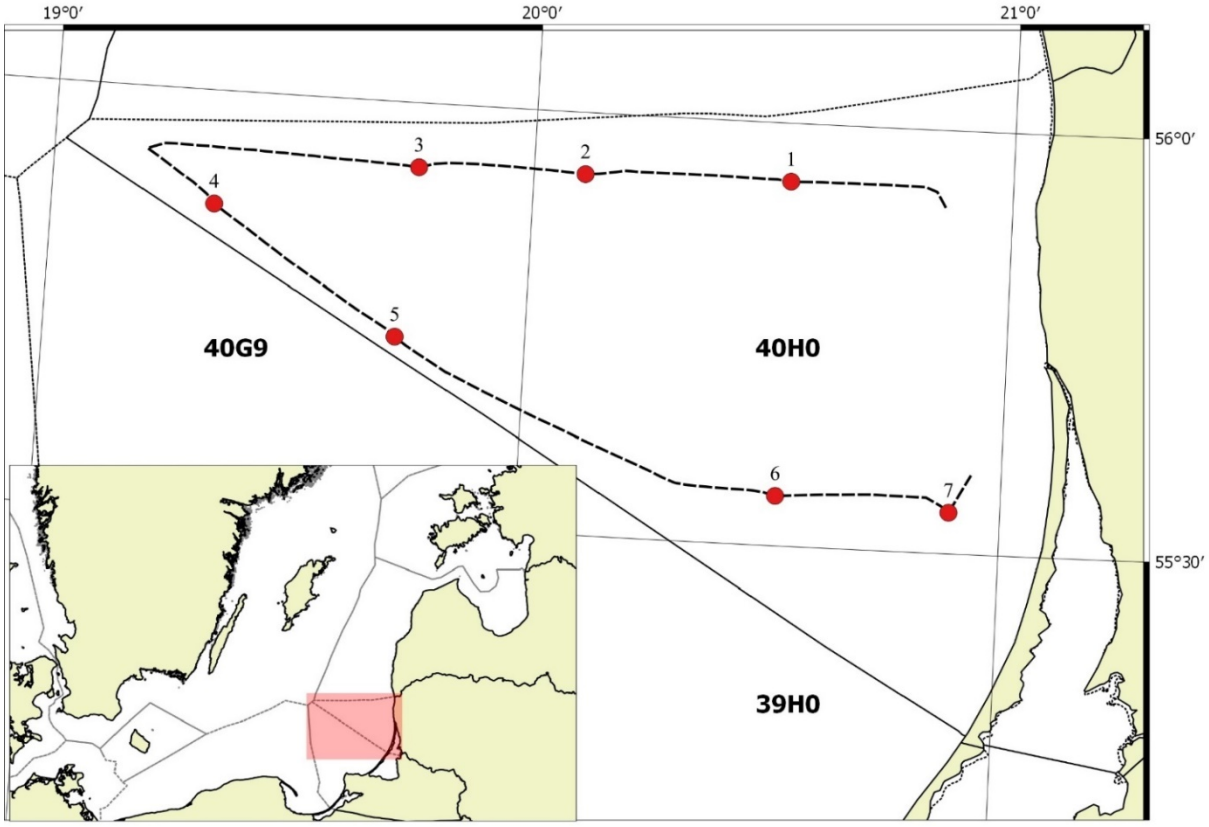


Figure 2. Mean nautical area scattering coefficient (NASC) per 3nmi of R/V “Darius” 03-04 May 2016 BASS survey

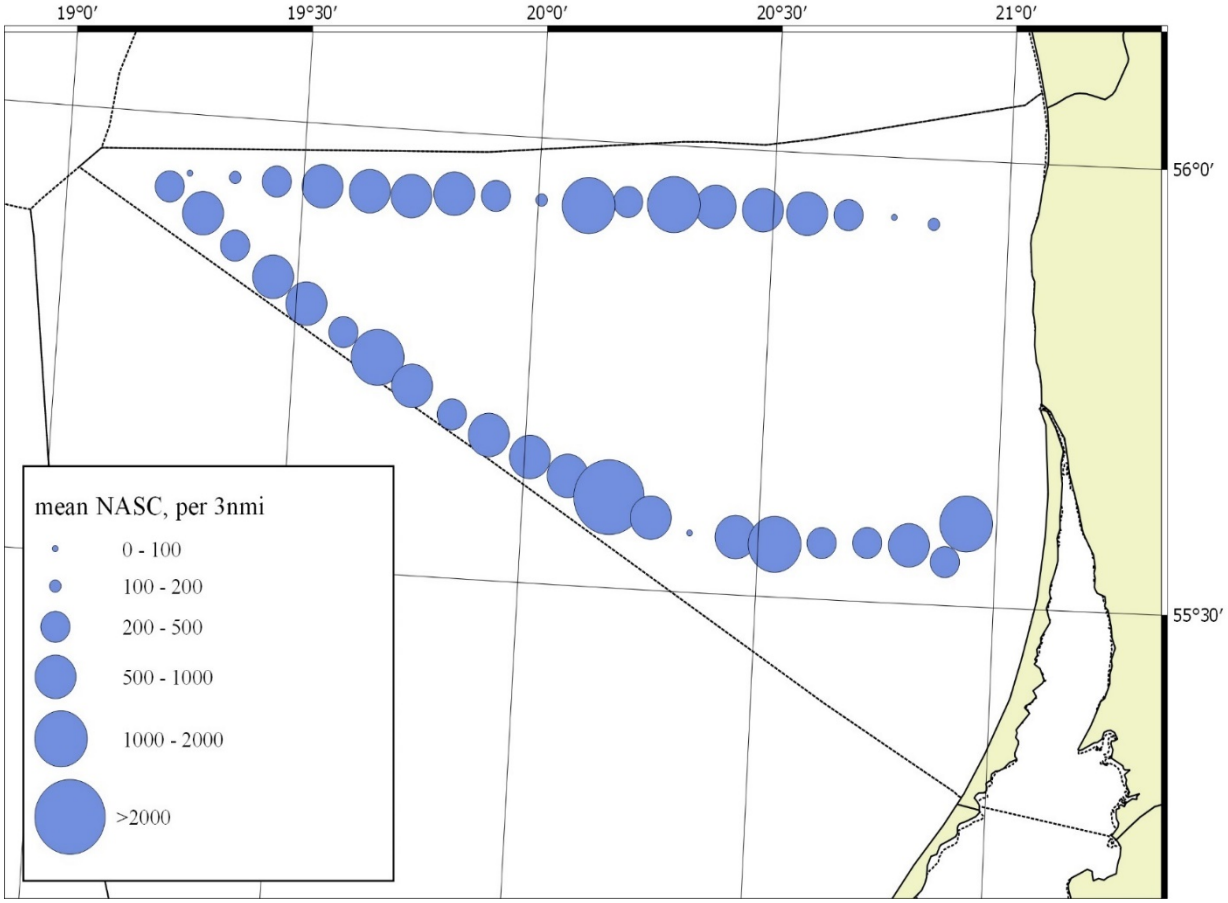


Table 1 Catch composition (kg/1hour) per haul (R/V "Darius", 03-04.05.2016)

ICES subdivision 26							
Haul No	1	2	3	4	5	6	7
Date	2016.05.03	2016.05.03	2016.05.03	201.05.04	2016.05.04	2016.05.04	2016.05.04
Validity	Valid	Valid	Valid	Valid	Valid	Valid	Valid
Species/ICES rectangle	40H0	40H0	40G9	40G9	40G9	40H0	40H0
Clupea hrengus		0.45	0.42	0.17	85.6	15.96	
Sprattus spratus	60.00	660.00	240.00	100.00	154.40	224.04	500.00
Gadus morhua		1.02		0.88			
Total	60.00	661.47	240.42	101.05	240.00	240.00	500.00

Figure 3. Length composition of herring (%) (R/V "Darius", 03-04.05.2016)

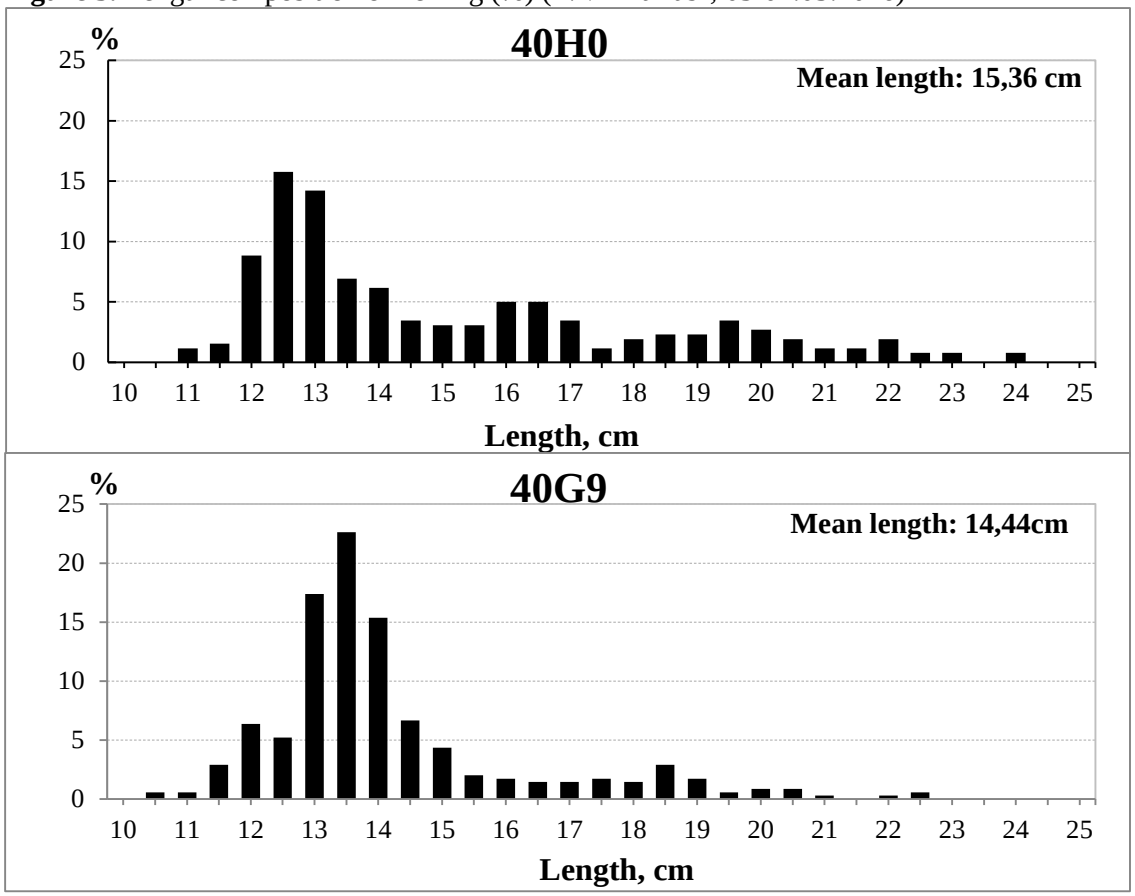


Figure 4. Length distribution of sprat (%) (R/V "Darius", 03-04.05.2016)

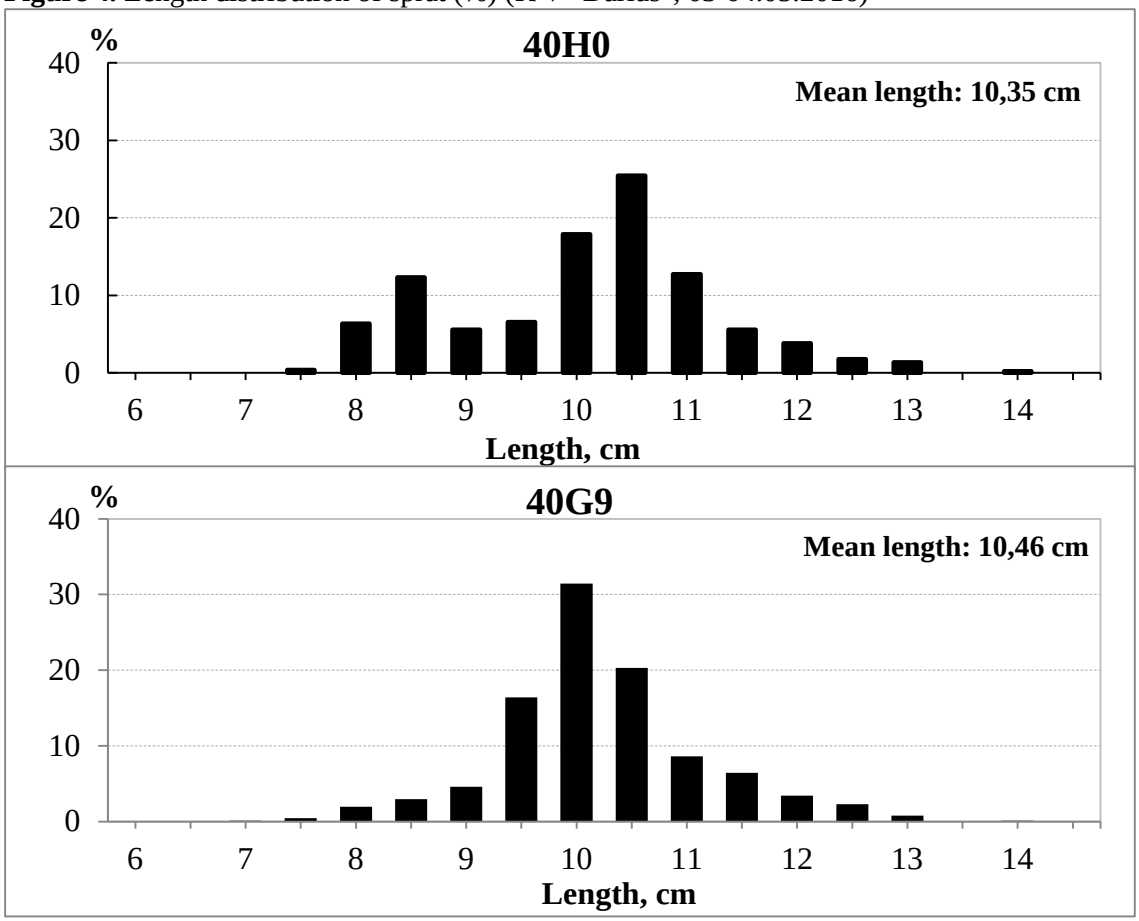


Table 2 R/V "DARIUS" survey statistics (abundance of herring and sprat),), 03-04.05.2016

ICES SD 26	ICES Rect.	Area nm^2	ρ mln/nm^2	Abundance, mln			Biomass, tonn		
				N sum	N her	N spr	W sum	W her	W spr
	40H0	1012.1	5,31	5371,0	1089,3	4281,7	52358	23883	28475
	40G9	1013.0	4,39	4444,1	1260,9	3183,2	45293	22685	22609

Table 3 R/V "DARIUS" survey statistics (aggregated data of herring and sprat),), 03-04.05.2016

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	15,36	21,93	20,28	10,35	6,65	79,72	688,9	-49,9
	40G9	3,4,5	14,44	17,99	28,37	10,46	7,10	71,63	583,0	-49,8

Table 4 R/V "DARIUS" survey statistics (herring and sprat), 03-04.05.2016

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	688,9	1,29806	5371,0	20,28	79,72
	40G9	1013	583,0	1,32896	4444,1	28,37	71,63

Table 5 R/V "Darius" estimated age composition (%) of sprat, 03-04.05.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	100,0		24,2	37,5	24,5	7,6	3,1	1,5	1,4	0,3
	40G9	100,0		6,0	57,4	23,4	6,9	2,4	2,4	0,7	0,8

Table 6 R/V "Darius" estimated number (millions) of sprat, 03-04.05.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	4281,7		1035,2	1603,8	1047,5	323,9	134,8	62,1	60,5	14,0
	40G9	3183,2		190,5	1828,4	744,7	220,8	76,1	76,1	20,7	25,9

Table 7 R/V "Darius" estimated biomass (in tons) of sprat, 03-04.05.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	28475		4164	10899	7853	2783	1240	661	732	142
	40G9	22609		694	12057	5575	2089	814	862	205	311

Table 8 R/V "Darius" estimated mean weights (g) of sprat, -03-04.05.2016

SD	Rect.	Age									
		Mean	0	1	2	3	4	5	6	7	8
26	40H0	6,65		4,0	6,8	7,5	8,6	9,2	10,6	12,1	10,2
	40G9	7,10		3,64	6,59	7,49	9,46	10,70	11,34	9,91	11,98

Table 9 R/V "Darius" estimated mean length (cm) of sprat, 03-04.05.2016

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

Table 10 R/V "Darius" estimated age composition (%) of herring, 03-04.05.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	100,0		38,7	29,0	9,9	7,7	4,4	2,4	4,0	3,9
	40G9	100,0		15,3	59,6	5,2	9,4	3,9	3,1	1,3	2,3

Table 11 R/V "Darius" estimated number (millions) of herring, 03-04.05.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	1089,3		421,8	315,6	107,5	84,1	48,2	26,0	43,4	42,6
	40G9	1260,9		192,5	751,6	65,5	118,1	48,7	39,3	16,1	28,9

Table 12 R/V "Darius" estimated biomass (in tons) of herring, 03-04.05.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	23883		5496,3	6038,4	2908,6	3003,9	1933,7	953,9	1842,0	1705,9
	40G9	22685		2537,2	11110,0	1239,8	2923,1	1459,7	1444,1	601,1	1369,8

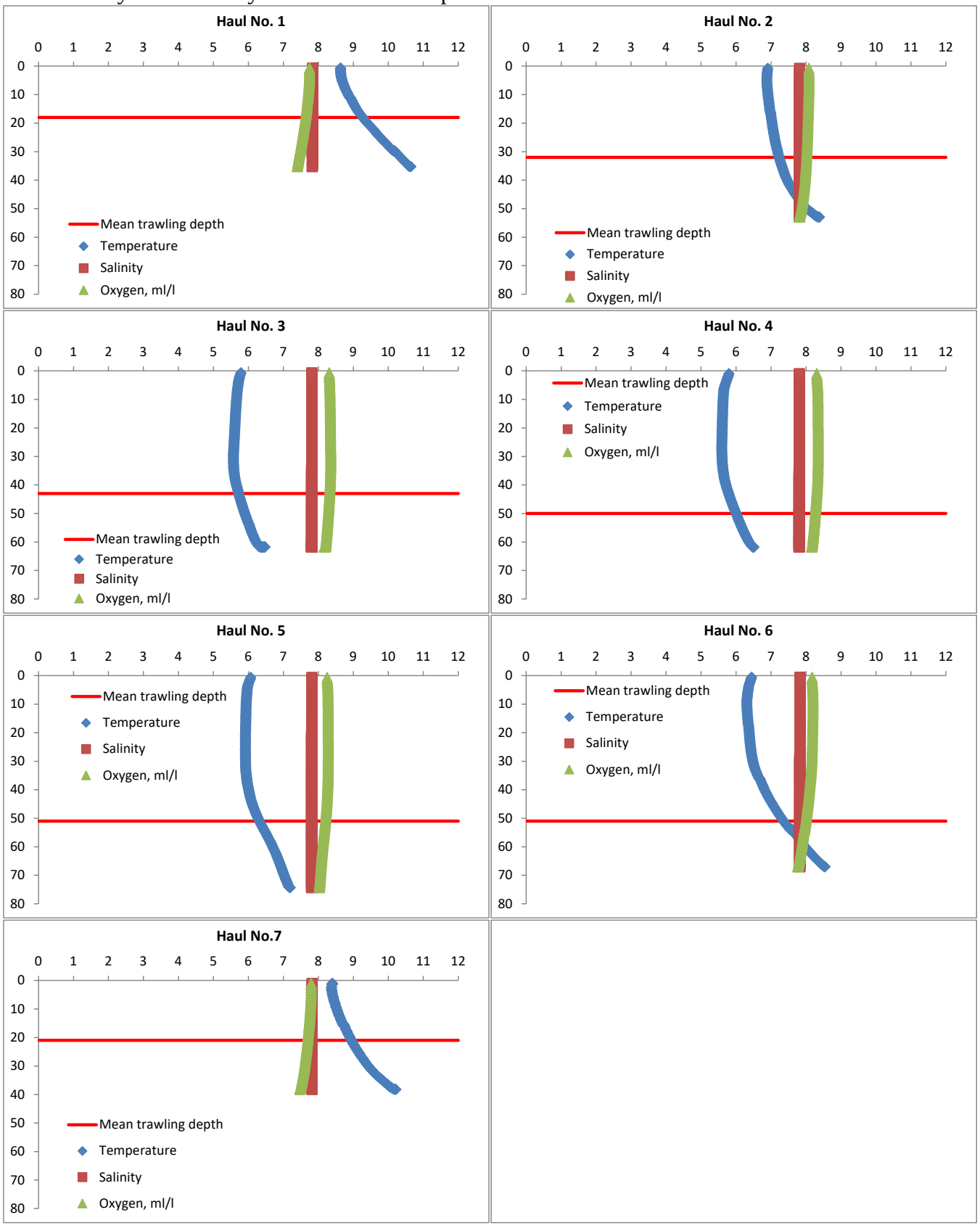
Table 13 R/V "Darius" estimated mean weights (g) of herring, 03-04.05.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	21,9		13,03	19,13	27,05	35,72	40,10	36,72	42,41	40,05
	40G9	18,0		13,18	14,78	18,92	24,75	29,96	36,76	37,24	47,34

Table 14 R/V "Darius" estimated mean length (cm) of herring, 03-04.05.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	15,4	0	12,9	14,6	16,5	18,3	19,0	19,1	19,9	19,0
	40G9	14,4	0	12,8	13,4	14,5	16,1	17,4	18,8	19,0	20,7

Figure 4. Hydrological parameters registered at the hydrological station from the Lithuanian BIAS BASS survey conducted by r/v "Darius" in the period of 03-04.05.2016.



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 2016 ON THE R/V "BALTICA" IN THE ICES SUBDIVISIONS 26N AND 28.2 OF THE BALTIC SEA (12-21 MAY 2016)

Working paper on the WGBIFS meeting in Riga, Latvia, 27-31.03.2017

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•ANDREJS MAKARCUKS•ALLA VINGOVATOVA•GUNTA RUBENE•IVARS PUTNIS•VADIMS CERVONCEVS•

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Riga – Gdynia, March 2017

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 5th 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 2016. 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 National Marine Fisheries Research Institute (NMFRI) from Gdynia. The vessel was operated within the Latvian, Estonian and Swedish EEZs (ICES Sub-divisions 26N and 28.2). The "Latvian National Program for Collection of Fisheries Data 2011-2013" in accordance with the EU Council Regulation No. 199/2008 and EU Commission Regulation No.605/2008, EU Commission Decisions 2008/605/EC, 2009/10121/EC, C (2013) 5568, with European Commission implementing decision of 30.08.2013 that extends the national program for the period 2011-2013 to the period 2014-2016, was partly subsidized this cruise. It was coordinated by the ICES Baltic International Fish Survey Working Group (WGBIFS) [ICES 2015].

Pelagic research catches carried out during an acoustic survey are the information source, independent from topical preferences in fishery, about quantitative changes in a process of clupeids geographical and bathymetrical distribution in the Baltic Sea. The data from hydrological measurements are the information source about abiotic environmental factors (seawater temperature, salinity, oxygen content) influencing sprat and herring spatial distribution. Echo-integration results along the pre-selected tracks are the basic materials for fish stock biomass calculations.

The ICES Baltic Fisheries Assessment Working Group (WGBFAS) applies the BASS data for clupeids (sprat and herring) stock biomass assessment and spatial distribution updating. The basic acoustic and biological data collected during recently carried out survey are stored in the BASS_DB and BIAS_DB in BAD1 format and till the 2012 were stored in FishFrame Acoustic (former BAD2 format) international databases, managed by the ICES Secretariat. In recent years work is underway to create a new useful acoustic database.

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 – seven persons:

F. Svecovs, (BIOR, Riga – Latvia) – scientific staff leader, acoustic team;
M. Wyszynski (NMFRI, Gdynia – Poland) – cruise leader, fish sampling team;
B. Witalis (NMFRI, Gdynia – Poland) – hydrologist, hydrology team;
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1.2. Survey description

The reported BASS survey on the r/v “Baltica” took place during the period of 12-21 May 2016 (10 working days at sea: 8 days in accordance with Latvian-Polish survey plan and additionally 2 days according to German vessel technical problems, which one should operate in the same region simultaneously). The at sea researches were conducted within Latvian, Swedish and Estonian EEZs (the ICES Sub-divisions 26N and 28.2), moreover inside the Latvian territorial waters not shallower than 20 m.

The vessel left the Gdynia port (Poland) on 12.05.2016 at 00:01 o’clock and was navigated in the north direction to the echo-integration start point at the geographical position 56°07’N 019°00’E. The direct at sea researches began on 12.05.2016 after midday. The survey ended on 21.05.2016 before midday in the port Ventspils (Latvia).

1.3. Survey methods and performance

1.3.1. Acoustical and trawling methods

Acoustic data were collected with the SIMRAD EK-60 38 kHz and 120 kHz two frequency split beam scientific echo-sounder equipped with “EchoView Version 7.10” software for the data analysis. These data collected during the described here BASS were delivered to the Latvian researchers for further elaboration. The survey echo-integration tracks were planned in the similar pattern as in the previous years, due to historical comparability of the data. Overall 645 nautical miles long survey tracks was observed and recorded with hydroacoustic equipment. The final pattern of transects was covered with a relatively good density. The area covered in May 2016 was 1953.3 nm^2 in the northern part of the ICES Sub-division 26 and 7874.9 nm^2 in Sub-division 28.2, totally 9828.2 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 2014]. The r/v “Baltica” realized 25 fish control-catches (Tab. 1). All catches were

performed in the daylight between 07:00 am and 18:30 pm (GMT+01:00) using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The standard trawling duration was 30 minutes. The mean speed of vessel while trawling was 3.0 knots. Overall, 6 hauls were conducted in SD 26N and 19 hauls in SD 28.2. Totally 14 hauls were performed in the Latvian EEZ, 10 hauls in Swedish EEZ and 1 haul in Estonian EEZ (see text-table below).

1.3.2. Biological sampling

The length measurements (in 0.5 cm length classes) were realized for 4083 herring and 5072 sprat individuals. In total, 1987 herring and 2498 sprat individuals were taken for biological analysis. Moreover, 485 individuals of other species such as threespine stickleback, ninespine stickleback, cod, flounder and lumpfish were measured (Tab. 2). Detailed ichthyologic analyses were made according to standard procedures, directly on board of surveying vessel.

Due to herring and sprat normally cannot be distinguished from other species by visual inspection of the echogram species composition and fish length distributions were based on trawl catch results. Mean target strength of fish was calculated according to the following formulas [Foote et al. 1986, ICES 1983, 2014]:

for clupeids: TS = 20logL-71.2;
for gadoids: TS = 20logL-67.5;
cross section $\sigma = 4\pi 10^{a/10} \times L^{b/10}$.

The total number of fish in each ICES rectangle was estimated as a product of the mean area scattering cross-section – NASC (S_A) and the rectangle area, divided by corresponding mean acoustic cross-section. Fish abundance was separated into different species according to the mean catch composition in the given rectangle.

Ichthyoplankton and zooplankton samples were collected at the positions of the hydrological stations or after trawling. Totally 26 ichthyoplankton and zooplankton stations were realized (Fig. 2) and 52 and 41 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 12-20 May 2015, totally at 26 stations, int. al. at 25 fish catch-station and 1 independent station named Hydro 1 (Fig. 2). Hydrological stations were inspected with the IDRONAUT CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method. The hydrological row data, originated from measuring realized from the sea surface layer up to the bottom, were aggregated to the 1-m depth stratums, were information source about the abiotic factors potentially influencing fishes spatial distribution. The oxygen probes ware taken on every 10 meters. The salinity parameter was presented in Practical Salinity Unit (PSU).

Meteorological observations of air temperature, wind velocity and directions and atmospheric pressure were realized at the actual geographic position of each control-haul and in every 10 minutes interval over the whole survey. The automatic meteorological station type "Milosz" was applied for measurements of the above-mentioned parameters. The values of meteorological and hydrological parameters registered at trawling stations are aggregated in Table 3.

2. RESULTS

2.1. Biological data

2.1.1. Catch statistics

Total number of realized hauls and total catches (in kg) of fish in Latvian, Swedish and Estonian EEZs during reported BASS 2Q 2016 are presented in the Table 4. Overall, 7 fish species were recognized in hauls performed in the Central-eastern Baltic Sea in May 2016. Sprat was dominating species by mass in the both ICES Sub-divisions 26N and 28.2 (88.3 and 71.9% respectively). The rest 5 species represented 0.6 % (in this 0.4% belonging to cod) of the total mass in average for all investigated area. The geographical catch distribution by fish species shown in Figure 3.

Mean CPUE for all species in the investigated area amounted 1404.7 kg/h. The mean CPUEs of sprat were: 4183.7 kg/h in ICES SD 26N, and 9219.8 kg/h in SD 28.2. The mean CPUEs of herring were as follow: in SD 26N – 538.1 kg/h and 3521.0 kg/h in SD 28.2. The CPUE values by particular haul for herring, sprat and others are presented at the Figure 4. The highest CPUE values for sprat were noted from the Northern part of SD 26 do the Southern part of SD 28.2. The good CPUEs for herring were distributed more in Northern part of SD 28.2.

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 2016, are given in Table 5, for third dominant species – cod in Table 6. The characteristics of the pelagic fish stock are aggregated in Table 7 for sprat and Table 8 for herring. The geographical distributions of NASC, sprat and herring stock densities in the central-eastern Baltic Sea in May 2016 are shown in Figures 6, 7 and 8 respectively.

The pelagic fish stock was represented mostly by sprat – 92.9 %, in comparison – 71.5% in 2013, 86.8 % in 2014 and 88.2 % in 2015. Herring was represented as 7.1 %, 28.5 % in 2013, 13.2 % in 2014 and 11.8 % in 2015. The highest sprat stock density according to acoustic estimates (199.3 $n\times10^6/nm^2$) were recorded in ICES rectangle 42G9 of the ICES Sub-division 28.2. The highest average abundance per nm^2 and biomass of the sprat stock were recorded in the central and southern part of investigated area in ICES rectangles 42G9 and 41G8. The distribution of the high density sprat concentrations in May 2016 had similar pattern as in May 2010 and 2013, but totally differed comparing with that from May 2005-2008, 2011, 2012, 2014 and 2015, when high density sprat concentrations had found mostly in the central and northern parts of the investigated area. In 2015 sprat distribution pattern more-less was emulating pattern observed in years till 1992 [Hoziosky et al. 1988, Shvetsov et al. 1988, 1989, 1992, 2002], but not so evident as it was in 2010. In 2014 sprat had scattered distribution of concentrations mostly made from specimens of new generation. In 2015 distribution was scattered too, but with relatively high rate of concentrations in separate points and in 2016 sprat made high concentrations in two points and distribution of concentrations was not so scattered as in previous years.

The herring stock density was significantly lower in comparison to sprat stock density. The highest density value was 18.1 $n\times10^6/nm^2$ and noted in ICES rectangle 42G9 in central part of the investigated area in Sub-division 28.2 in comparison to 2015 were highest density values was not over 10.2 $n\times10^6/nm^2$ in rectangle 44H0, in 2013 it was 8.8 $n\times10^6/nm^2$ in rectangle 44H0, but in 2014 values over 10.0 $n\times10^6/nm^2$ were recorded in two rectangles 43H0 and 45H0.

Comparison of the acoustic results from May of 2005-2016 indicated that investigated sprat stock abundance and biomass had decreasing tendency, but herring stock had a slight increase. In 2016 both of sprat and herring stocks had increased in numbers and biomass. The geographical distribution of main sprat stock shows different pattern as in years 2005-2015 and is less scattered

with two concentration points of high abundance [Svecovs et al. 2010, 2011, 2012, 2013, 2014, 2015].

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

- sprat – 7.0÷14.0 cm (average TL = 10.5 cm), 2.4÷16.6 g (average W = 6.4 g);
- herring – 10.0÷24.5 cm (average TL = 16.8 cm), 6.2÷87.3 g (average W = 28.4 g);
- cod – 19.5÷62.0 cm (average TL = 29.8 cm), 59.0÷2315.0 g (average W = 284.2 g).

The sprat length distribution curves have a bimodal character for both Sub-divisions 26 and 28.2. First length frequency pick takes place at 8.5 cm length class and represent very low frequency values 4.8 and 5.4% respectively. The second higher one at length classes 10-10.5 cm represent adult sprat. The fish generation born in 2015 (ranged from 7.0 to 9.0 cm of total length) characterized by low total frequency in both Sub-divisions.

The herring length distribution curves have a similar multimodal character in both Sub-divisions 26N and 28.2. The highest picks of frequency belong to length classes 20.0 and 12.5 cm respectively. The fish representing 10.0-14.0 cm length range belonging to the generation born in 2015 have relatively high frequency in Sub-division 28.2, only.

2.1.3. Ichthyoplankton estimates

Totally 52 ichthyoplankton samples collected at 26 station positions during BASS on RV “Baltica”, including 26 samples collected in vertical hauls with IKS-80 net and 26 samples from horizontal hauls on water surface during 10 minutes. The number of sprat eggs and larvae in ICES SD 26 and 28 are aggregated in Table 9.

Sprat eggs and larvae prevailed in the ichthyoplankton in May 2016. The average numbers of sprat eggs and larvae in the investigated region were above the corresponding average values for the previous years. The number of eggs increased with the depth. Sprat eggs were more abundant in the southern and central parts of the Gotland Basin. Amount of eggs of sprat as usual increased towards the greater depths near the centre of the basin. Sprat larvae also were more numerous over the bigger depths and in the southern part of the Gotland Basin. There amount gradually decreased towards the northern areas.

Sprat eggs in the water surface layer were numerous only in the southern and central parts of the Gotland Basin, but their numbers were low in the northern region. This must be the evidence that the spawning of sprat has started not long time ago.

This year larvae of flounder were more abundant in the central part of the Gotland Basin. In general, the amount of flounder larvae was at the same level as in 2015, but most of them were collected on the water surface.

There was a major inflow from the North Sea in 2015, and the hydrological conditions in the Gotland Basin were favorable for the spawning of cod and four beard rockling also in May 2016. We observed rather sharp increase in the abundance of cod egg in the southern and central parts of the Gotland basin. All the cod eggs were found in the deepest area of the Gotland Basin. Two cod larvae were sampled in the central and southern parts of the Gotland Basin.

Biodiversity in the ichthyoplankton was on the medium level – several eggs of flounder and rockling and also some larvae of sand eel and rockling were found in May, apart from those of sprat, cod and flounder.

2.1.4. Zooplankton estimates

The calculated average number and average biomass of zooplankton organisms in 0-100 m water column per volume unit from 41 samples taken in 26 stations are aggregated in Table 10.

In May 2016 in the Baltic Sea the estimated zooplankton biomass was generally equal to 2013 and 2014. Total zooplankton biomass in 2016 was 164.55 mg/m^3. The most part of the biomass (60.14 %) was made from larger copepods, the residual part was made from small rotatorians (15.96 %), cladocerans (12.20 %) and other planktonic organisms (11.70 %). The dominance of copepods in the spring season in the Baltic Sea creates favorable feeding conditions for pelagic fish species. Amount of them in 2016 on average was 3.01 times higher than in 2014 and 1.30 times higher the long-term average. Overall, the biomass of *Acartia* spp., taking the top rank among copepods, has exceeded biomass more evident – by 7.16 times in comparison with May 2014, but the long-term average only by 1.34 times. Higher biomass of *Pseudocalanus* sp., the next largest group of copepods was detected in the deep stations of the investigated aquatory. The same was detected for *Acartia* spp. and *Temora longicornis*. The biomass of *T. longicornis* has increased for 3.17 times since 2014. In 2016 decreased average biomass of rotatorians *Synchaeta* spp. and *Polychaeta* worms. In 2016 had increased the role of above mentioned copepods in all aquatory. In deep stations has dramatically increased estimated quantity and biomass of *Centropages hamatus* – approximately by 20 times than was stated in 2014. In the upper layer (0-50 m) of water column after copepods the next dominant object of zooplankton was rotatorians *Synchaeta* spp. and cladocerans *Evadne* spp. Biomass of *Evadne* spp. was at higher level than in 2014 and almost higher to the level of long-term average. Overall, the favorable feeding conditions in May 2016 formed in the deepest part of the investigated area.

2.2. Meteorological and hydrological data

2.2.1. Weather conditions

The most frequently wind was SE (Fig. 11). The wind force varied from 16.5 m/s to 0 m/s and average force was 4.7 m/s. The air temperature ranged from 6.6°C to 13.5°C, and average temperature value was 9.3°C.

2.2.2. Hydrology of the Gotland Deep

The seawater temperature in the surface layers varied from 7.86 to 12.14°C (the mean was 9.12°C).The lowest surface temperature was recorded at the haul station 16. The highest one was noted at the haul 25. The minimum value of salinity in Practical Salinity Unit (PSU) was 6.36 at the haul station 24 in the surface layer. The maximum was 8.70 PSU at the haul station 11. The mean value of salinity was 7.10 PSU. The oxygen content in the surface layers of investigated research area varied in the range of 8.05 ml/l (haul 20) – 9.95 ml/l (haul 7). The mean value of surface water oxygen content was 9.22 ml/l.

The temperature of near bottom layer was changing in the range of 4.26 (haul 20) to 7.23°C (haul 14), the mean was 6.14°C (Fig. 12). Salinity of near bottom waters varied from 7.47 (haul 20) to 13.51 PSU (haul 14), and the mean was 6.14 PSU. Oxygen content varied from 0.45 ml/l (haul 6) to 7.42 ml/l (haul 20), the mean value was 2.72 ml/l.

The Figure 13 shows comparison of the values of three main hydrological parameters vertical distributions at the hydrological station H1 situated at the Southern Gotland Deep slope investigated in May 2016. The increasing temperature was observed above 20 m depth to the surface, to the maximum value about 10°C. The cold winter water (about 4°C) was noted in the water layer ranged 20-70 m depth. The surface water layer (0 to about 5 m depth) had a very low salinity – about 5.5 PSU. The salinity values about 11 PSU were noted below 80 m depth. The oxygen content below 2 ml/l (the border value generally recognized as a minimum for fish) started from about 73 m depth to the bottom.

The temperature at the mean depth of trawling layer was changing in the range of 7.92 (haul 20) – 4.24°C (haul 4), the mean value was 5.14°C. Salinity in the haul waters varied from 7.21 (haul 20) to 10.37 PSU (haul 7), and the mean was 8.88 PSU. Oxygen content varied from 1.30 ml/l (haul 7) to 9.71 ml/l (haul 4), the mean was 4.33 ml/l (Table 3).

3. DISCUSSION

The data of the Latvian-Polish BASS in the 2nd quarter of 2016 were considered by the ICES BIFS Working Group (Rostock, Germany, 30.03-03.04.2016) 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 since 2015 is increasing due to very abundant sprat generation of 2014. The mean length and weight of adult sprat had the same tendency to abundance. The geographical distribution of sprat densities in the May 2016 had different pattern as in 2015 and copy pattern as it was in 2010 and before 1992. The overall estimated better feeding conditions should ensure biomass increasing 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 12-21.05.2016

Haul number	Date	ICES rectangle	ICES SD	Mean bottom depth [m]	Headrope depth [m]	Vertical opening [m]	Trawling speed [knt]	Trawling direction [°]	Geographical position				Time Start	Haul duration [min]	Total cactch [kg]
									Start		End				
									Latitude 00°00.0'N	Longitude 00°00.0'E	Latitude 00°00.0'N	Longitude 00°00.0'E			
1	2016-05-12	41G8	26	98	64	19	3.0	270	56°07.1'	18°45.0'	56°07.2'	18°42.4'	18:00	30	1291.154
2	2016-05-13	41G9	26	124	35/65	20/18	3.0	87	56°07.0'	19°13.0'	56°07.1'	19°16.1'	07:35	30	955.237
3	2016-05-13	41G9	26	62	35	18	3.2	90	56°06.9'	19°52.9'	56°06.8'	19°55.8'	11:50	30	250.620
4	2016-05-13	41H0	26	66	37/43	19/18	3.2	270	56°21.9'	20°10.6'	56°21.9'	20°07.6'	17:30	30	500.672
5	2016-05-14	41G9	26	121	60/66	20/18	3.2	270	56°22.1'	19°39.0'	56°22.1'	19°36.2'	07:10	30	366.779
6	2016-05-14	41G8	26	109	65	18	3.0	6	56°22.7'	18°58.4'	56°24.1'	18°58.7'	10:50	30	1374.457
7	2016-05-14	42G8	28	103	55/70	18	2.9	99	56°36.8'	18°52.9'	56°36.6'	18°55.5'	14:30	30	1793.357
8	2016-05-14	42G9	28	130	65	19	2.9	81	56°36.5'	19°17.8'	56°36.7'	19°20.5'	17:40	30	913.394
9	2016-05-15	42G9/H0	28	134	60	20	3.0	90	56°37.0'	19°58.1'	56°37.0'	20°00.9'	07:15	30	842.007
10	2016-05-15	42H0	28	136	65	19	3.0	270	56°53.0'	20°16.7'	56°53.1'	20°14.1'	14:05	30	1068.872
11	2016-05-15	42G9	28	164	70	20	2.9	265	56°52.8'	19°46.1'	56°52.7'	19°43.1'	17:45	30	96.735
12	2016-05-16	42G8	28	139	65	20	3.0	270	56°53.0'	18°58.6'	56°53.0'	18°56.0'	07:00	30	304.421
13	2016-05-16	43G9	28	135	65	19	3.1	12	57°08.0'	19°10.6'	57°09.4'	19°11.2'	10:55	30	619.365
14	2016-05-16	43G9/H0	28	201	60	18	3.0	90	57°06.9'	19°57.4'	57°06.8'	20°00.2'	15:45	30	1121.974
15	2016-05-17	43H0	28	85	62	19	3.5	360	57°08.2'	20°39.3'	57°10.0'	20°39.4'	07:05	30	513.576
16	2016-05-17	43H0	28	167	65	19	3.3	357	57°22.9'	20°29.4'	57°24.7'	20°29.1'	10:55	30	441.087
17	2016-05-17	43G9	28	179	65	19	2.9	7	57°23.8'	19°50.8'	57°25.2'	19°51.2'	15:20	30	494.920
18	2016-05-18	44G9	28	101	65	19	3.0	93	57°36.9'	19°32.9'	57°36.8'	19°35.7'	07:05	30	1113.621
19	2016-05-18	44H0	28	133	65	18	3.3	11	57°36.9'	20°31.3'	57°38.6'	20°31.9'	12:30	30	742.231
20	2016-05-18	44H1	28	68	40	20	2.9	360	57°47.2'	21°06.1'	57°48.6'	21°06.2'	17:15	30	79.472
21	2016-05-19	44H0	28	102	65	20	3.0	265	57°53.0'	20°29.1'	57°52.9'	20°26.6'	07:00	30	237.929
22	2016-05-19	44/45G9	28	192	65	20	2.9	357	57°59.5'	19°53.8'	58°00.9'	19°53.7'	11:05	30	875.279
23	2016-05-19	45H0	28	160	68	19	3.1	95	58°09.9'	20°02.1'	58°09.7'	20°05.5'	14:15	30	968.869
24	2016-05-20	45H0	28	80	55	20	2.9	193	58°06.5'	20°47.5'	58°05.1'	20°46.9'	07:05	30	413.274
25	2016-05-20	43H1	28	70	45	21	2.9	18	57°27.0'	21°10.8'	57°28.3'	21°11.6'	14:20	30	179.290
												SD26			4738.919
												SD28			12819.672
												SD26+28			17558.591

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 12-21.05.2016

Fish species	Number of measured individuals			Number of aged individuals		
	SD 26	SD 28	SD 26+28	SD 26	SD 28	SD 26+28
Sprat (Total)	1220	3852	5072	594	1904	2498
Sprat (Age 1)	126	447	573	83	262	345
Herring (Total)	717	3366	4083	287	1700	1987
Herring (Open sea herring)	632	3024	3656	252	1527	1779
Herring (Gulf herring)	15	293	308	6	144	150
Herring (Southern Baltic herring)	70	49	119	29	29	58
Cod	52	220	272			
Flounder	13	76	89			
Lumpfish	1		1			
Stickleback, threespine		122	122			
Stickleback, ninespine		1	1			
Total	2003	5322	9640	881	3604	4485

Table 3. The values of meteorological and hydrological parameters registered at the trawling position and depth in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016

Haul number	Date of catch	Meteorological parameters					Trawling depth		Hydrological parameters		
		wind direction	wind force [°B]	sea state [Degrees]	air temper. [°C]	atmospheric pressure [hP]	Headrope [m]	Footrope [m]	temperature [°C]	salinity [PSU]	oxygen [ml/l]
1	2016-05-12	NE	5	3	10	1006	64	83	5.26	9.32	5.18
2	2016-05-13	NW	3	2	7	1000	35/65	55/83	4.32/5.45	7.54/9.81	9.56/5.04
3	2016-05-13	N	3	2	10	1000	35	53	4.30	7.57	8.41
4	2016-05-13	N	2	1	10	1000	37/43	56/61	4.24/4.25	7.53/7.38	8.16/9.71
5	2016-05-14	C	2	1	7	996	60/66	80/84	4.87/5.22	8.72/9.35	5.05/2.44
6	2016-05-14	NW	3	2	10	997	65	83	5.55	10.00	2.65
7	2016-05-14	NW	3	2	9	998	55/70	73/88	4.82/5.69	8.64/10.37	5.69/1.30
8	2016-05-14	W	2	1	11	1000	65	84	5.50	9.98	2.12
9	2016-05-15	N	4	2	7	998	60	80	5.00	8.69	4.24
10	2016-05-15	W	3	2	8	1001	65	84	5.42	9.74	3.29
11	2016-05-15	W	3	2	8	1001	70	90	5.30	9.34	2.23
12	2016-05-16	SW	5	3	8	993	65	85	5.12	9.05	5.88
13	2016-05-16	SE	5	3	9	998	65	84	5.26	9.32	2.41
14	2016-05-16	SE	4	2	10	1000	60	78	5.29	9.29	2.26
15	2016-05-17	S	5	3	7	999	62	81	4.39	7.72	7.45
16	2016-05-17	SE	4	2	8	1004	65	84	5.29	9.43	2.73
17	2016-05-17	SE	3	2	10	1007	65	84	5.36	9.72	2.54
18	2016-05-18	S	3	2	7	1006	65	84	5.32	9.48	2.10
19	2016-05-18	S	5	3	8	1011	65	83	5.29	9.46	2.16
20	2016-05-18	S	4	2	7	1011	40	60	7.92	7.21	7.85
21	2016-05-19	SW	4	3	6	1011	65	85	5.17	9.03	2.56
22	2016-05-19	SW	4	2	9	1011	65	85	4.95	8.61	1.58
23	2016-05-19	SW	3	2	9	1011	68	87	5.15	8.97	1.66
24	2016-05-20	C	1	1	7	1014	55	75	5.07	8.96	1.87
25	2016-05-20	C	2	1	9	1016	45	66	4.33	7.25	7.47
						Mean	59	78	5.14	8.88	4.33

Table 4. Fish control-catch results by species in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016

Haul number	Date	ICES rectangle	ICES SD	Total Cactch [kg]	Catch per species [kg]						
					sprat	herring	cod	flounder	lumpfish	threespine stickleback	ninespine stickleback
					161789	161722	164712	172894	167612	166365	166365
1	2016-05-12	41G8	26	1291.154	1280.880	6.440	3.544	0.290			
2	2016-05-13	41G9	26	955.237	643.180	309.680	1.606	0.771			
3	2016-05-13	41G9	26	250.620	250.620						
4	2016-05-13	41H0	26	500.672	488.960	11.000	0.462		0.250		
5	2016-05-14	41G9	26	366.779	245.718	115.102	5.586	0.373			
6	2016-05-14	41G8	26	1374.457	1274.314	95.916	3.869	0.358			
7	2016-05-14	42G8	28	1793.357	1663.570	127.140	2.486	0.161			
8	2016-05-14	42G9	28	913.394	807.090	102.820	1.995	1.489			
9	2016-05-15	42G9/H0	28	842.007	568.042	269.778	3.621	0.566			
10	2016-05-15	42H0	28	1068.872	906.281	157.429	3.925	1.237			
11	2016-05-15	42G9	28	96.735	29.366	64.454	2.242	0.673			
12	2016-05-16	42G8	28	304.421	156.105	141.805	6.245	0.266			
13	2016-05-16	43G9	28	619.365	413.844	196.996	7.857	0.668			
14	2016-05-16	43G9/H0	28	1121.974	685.267	429.602	6.017	0.977		0.111	
15	2016-05-17	43H0	28	513.576	387.601	125.099	0.322	0.554			
16	2016-05-17	43H0	28	441.087	243.756	189.204	6.982	1.145			
17	2016-05-17	43G9	28	494.920	369.252	120.148	4.931	0.552		0.037	
18	2016-05-18	44G9	28	1113.621	714.497	396.940	1.165	0.986		0.033	
19	2016-05-18	44H0	28	742.231	550.464	185.330	5.171	0.160		1.106	
20	2016-05-18	44H1	28	79.472	72.461	4.522				2.487	0.002
21	2016-05-19	44H0	28	237.929	147.751	89.338	0.658	0.111		0.071	
22	2016-05-19	44/45G9	28	875.279	353.237	511.713	8.376	0.913		1.040	
23	2016-05-19	45H0	28	968.869	707.093	261.527	0.249				
24	2016-05-20	45H0	28	413.274	266.275	145.729		0.444		0.826	
25	2016-05-20	43H1	28	179.290	177.874	1.398				0.018	
SD26				4738.919	4183.672	538.138	15.067	1.792	0.250		
SD28				12819.672	9219.826	3520.972	62.241	10.902	0.000	5.729	0.002
SD26+28				17558.591	13403.498	4059.110	77.308	12.694	0.250	5.729	0.002

Table 5. BASS statistics of pelagic fish species from the Latvian-Polish BASS in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 12-21.05.2016

Table 5A

ICES	ICES	Trawl	Herring			Sprat			NASC	$\sigma \times 10^4$	TS calc.
SD	Rect.	No	L, cm	w, g	n, %	L, cm	w, g	n, %	m^2/nm^2	m^2	dB
28	45H0	24,23,22	15.32	20.29	17.17	10.40	6.07	82.83	640.17	1.25971	-49.99
	44H1	20,25	12.68	12.30	1.16	10.64	6.77	98.84	399.38	1.09687	-50.59
	44H0	19,20,21,22	15.90	22.41	15.84	10.32	5.99	84.16	527.43	1.25549	-50.00
	44G9	18,22	15.56	21.87	19.23	10.33	6.12	80.77	658.68	1.28836	-49.89
	43H1	25	15.55	20.88	0.25	10.63	6.79	99.75	323.65	1.09243	-50.61
	43H0	14,15,16	15.72	22.75	13.08	10.34	6.06	86.92	599.20	1.21069	-50.16
	43G9	13,14,17	16.24	25.34	11.55	10.57	6.51	88.45	635.35	1.24950	-50.02
	42H0	9,10	16.77	27.50	5.98	10.24	6.04	94.02	536.35	1.11600	-50.52
	42G9	7,8,9,11,12	17.50	31.60	4.25	10.48	6.40	95.75	1110.09	1.14051	-50.42
	42G8	7,12	18.21	35.47	2.65	10.54	6.54	97.35	766.11	1.12625	-50.48
26	41H0	3,4	14.77	19.11	0.54	10.74	7.04	99.46	425.37	1.11780	-50.51
	41G9	2,3,5,6	19.77	44.72	3.11	10.58	6.65	96.89	573.31	1.15855	-50.35
	41G8	1,6	18.47	37.30	0.72	10.76	6.88	99.28	980.38	1.12741	-50.47
26		1-6	19.02	40.65	1.34	10.71	6.85	98.66	659.68	1.13459	-50.44
28		7-25	16.01	23.94	9.20	10.44	6.31	90.79	619.64	1.18358	-50.27
26+28		1-25	16.16	24.78	7.11	10.52	6.46	92.88	628.88	1.17227	-50.31

Table 5B

ICES	ICES	Area	ρ	Abundance, $n \times 10^6$			n, %		Biomass, $kg \times 10^3$		
SD	Rect.	nm^2	$n \times 10^6/nm^2$	ΣN	$N_{HERRING}$	N_{SPRAT}	herring	sprat	ΣW	$W_{HERRING}$	W_{SPRAT}
28	45H0	947.2	5.08186	4813.54	826.61	3986.93	17.17	82.83	40979.28	16770.18	24209.10
	44H1	824.6	3.64109	2997.18	29.60	2967.59	1.16	98.84	20443.11	364.12	20078.99
	44H0	960.5	4.20097	4035.03	639.06	3395.97	15.84	84.16	34668.63	14319.66	20348.96
	44G9	876.6	5.11255	4481.66	861.70	3619.96	19.23	80.77	40990.08	18845.38	22144.70
	43H1	412.7	2.96267	1222.69	3.12	1219.58	0.25	99.75	8347.62	65.10	8282.52
	43H0	973.7	4.94927	4819.11	630.51	4188.60	13.08	86.92	39737.45	14346.26	25391.19
	43G9	973.7	5.08486	4951.13	572.04	4379.09	11.55	88.45	43005.70	14497.86	28507.84
	42H0	968.5	4.80601	4654.62	278.47	4376.15	5.98	94.02	34090.71	7658.98	26431.72
	42G9	986.9	9.73326	9605.75	407.78	9197.97	4.25	95.75	71735.27	12886.18	58849.09
	42G8	945.4	6.80233	6430.92	170.61	6260.30	2.65	97.35	46998.61	6051.86	40946.74
26	41H0	953.3	3.80541	3627.69	19.76	3607.94	0.54	99.46	25764.39	377.59	25386.80
	41G9	1000.0	4.94848	4948.48	153.90	4794.57	3.11	96.89	38788.38	6882.54	31905.83
	41G8	1012.1	8.69588	8797.33	59.83	8737.50	0.72	99.28	62321.84	2231.48	60090.35
26		2965.4	5.85874	17373.50	233.49	17140.01	1.34	98.66	380996.45	9491.61	117382.99
28		8869.8	5.41293	48011.64	4416.38	43592.14	9.20	90.79	126874.60	105740.50	275190.86
26+28		11835.2	5.52463	65385.14	4649.87	60732.16	7.11	92.88	507871.05	115232.11	392573.85

Table 6. BASS statistics of 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 12-21.05.2016

ICES	ICES	Trawl	Area	Cod		NAS	TS	$\sigma \times 10^4$	ρ	Abundance	Biomas
SD	Rect.	No	nm^2	L, cm	w, g	L, cm	dB	m^2	$n \times 10^3/nm^2$	$n \times 10^3$	$kg \times 10^3$
28	45H0	24,23,22	947.2	32.50	418.80	1.01	-36.79	26.31414	0.38532	364.98	152.85
	44H0	19,20,21,22	960.5	33.67	451.57	1.58	-36.54	27.89553	0.56550	543.16	245.27
	44G9	18,22	876.6	32.19	366.96	1.58	-36.90	25.65423	0.61515	539.24	197.88
	43H0	14,15,16	973.7	30.32	288.87	1.94	-37.61	21.79493	0.89127	867.83	250.69
	43G9	13,14,17	973.7	29.45	257.60	2.97	-37.90	20.37888	1.45556	1417.27	365.09
	42H0	9,10	968.5	31.91	343.00	0.98	-37.16	24.15405	0.40725	394.42	135.28
	42G9	7,8,9,11,12	986.9	30.27	259.20	2.53	-37.69	21.39120	1.18366	1168.16	302.79
	42G8	7,12	945.4	29.61	242.53	1.74	-37.92	20.29871	0.85687	810.08	196.47
26	41G9	2,3,5,6	1000.0	30.70	276.53	1.16	-37.59	21.90629	0.52872	528.72	146.20
26		2,3,5,6	1000.0	30.70	276.53	1.16	-37.59	21.90629	0.52872	528.72	146.20
28		7-24	7632.5	31.24	328.57	1.79	-37.31	23.48521	0.79989	6105.14	1846.33
26+28		2,3,5-24	8632.5	31.18	322.78	1.72	-37.34	23.30977	0.76847	6633.85	1992.53

Table 7. 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 12-21.05.2016

Table 7A CANUM		Age group								Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
28	45H0	23461	164760	11273	9881	3984	1551		3564	218475
	44H1	5315	25855	2548	1686	837	415	127	216	36998
	44H0	19998	142890	11905	5686	2480	1354		3255	187566
	44G9	20440	138306	7201	3136	3169	863		1427	174541
	43H1	4774	17587	2008	1038	405	253	127		26191
	43H0	29583	160770	13288	7429	2259	2152	381	1330	217194
	43G9	16623	172314	14857	12912	5054	2869		925	225555
	42H0	52826	172222	10071	4143	1899	1553		1382	244095
	42G9	83801	358118	26566	16929	9543	5039	1893	2040	503930
	42G8	40665	200129	18318	8686	6314	2507	1253	336	278208
26	41H0	13744	75291	8137	3842	2245	144	288	1418	105108
	41G9	40802	285848	16823	11438	5425	607	1262	528	362733
	41G8	27595	293131	28329	10425	5525		3812	2724	371541
26		82141	654270	53289	25705	13194	750	5362	4669	839382
28		297487	1552952	118034	71526	35944	18556	3781	14475	2112755
26+28		379628	2207222	171323	97232	49139	19306	9143	19145	2952137

Table 7B n × 10^6		Age group								Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
28	45H0	428.15	3006.69	205.72	180.32	72.71	28.31		65.04	3986.93
	44H1	426.28	2073.78	204.37	135.23	67.15	33.30	10.15	17.34	2967.59
	44H0	362.07	2587.08	215.54	102.95	44.90	24.51		58.93	3395.97
	44G9	423.92	2868.45	149.34	65.04	65.72	17.89		29.59	3619.96
	43H1	222.31	818.94	93.48	48.31	18.85	11.78	5.89		1219.58
	43H0	570.52	3100.46	256.27	143.27	43.56	41.51	7.35	25.65	4188.60
	43G9	322.73	3345.43	288.45	250.68	98.13	55.70		17.96	4379.09
	42H0	947.07	3087.61	180.55	74.27	34.05	27.84		24.77	4376.15
	42G9	1529.58	6536.54	484.90	309.00	174.18	91.98	34.55	37.23	9197.97
	42G8	915.05	4503.35	412.20	195.45	142.08	56.40	28.20	7.57	6260.30
26	41H0	471.79	2584.43	279.31	131.88	77.06	4.93	9.87	48.67	3607.94
	41G9	539.32	3778.31	222.36	151.19	71.70	8.02	16.69	6.98	4794.57
	41G8	648.95	6893.56	666.21	245.17	129.92		89.65	64.05	8737.50
28		1660.06	13256.30	1167.88	528.23	278.69	12.95	116.20	119.70	17140.01
26		6147.68	31928.33	2490.80	1504.54	761.33	389.22	86.15	284.09	43592.14
26+28		7807.74	45184.63	3658.68	2032.77	1040.02	402.18	202.35	403.78	60732.16

Table 7C n, %		Age group								Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
28	45H0	10.74	75.41	5.16	4.52	1.82	0.71		1.63	100.00
	44H1	14.36	69.88	6.89	4.56	2.26	1.12	0.34	0.58	100.00
	44H0	10.66	76.18	6.35	3.03	1.32	0.72		1.74	100.00
	44G9	11.71	79.24	4.13	1.80	1.82	0.49		0.82	100.00
	43H1	18.23	67.15	7.67	3.96	1.55	0.97	0.48		100.00
	43H0	13.62	74.02	6.12	3.42	1.04	0.99	0.18	0.61	100.00
	43G9	7.37	76.40	6.59	5.72	2.24	1.27		0.41	100.00
	42H0	21.64	70.56	4.13	1.70	0.78	0.64		0.57	100.00
	42G9	16.63	71.07	5.27	3.36	1.89	1.00	0.38	0.40	100.00
	42G8	14.62	71.93	6.58	3.12	2.27	0.90	0.45	0.12	100.00
26	41H0	13.08	71.63	7.74	3.66	2.14	0.14	0.27	1.35	100.00
	41G9	11.25	78.80	4.64	3.15	1.50	0.17	0.35	0.15	100.00
	41G8	7.43	78.90	7.62	2.81	1.49		1.03	0.73	100.00
28		9.69	77.34	6.81	3.08	1.63	0.08	0.68	0.70	100.00
26		14.10	73.24	5.71	3.45	1.75	0.89	0.20	0.65	100.00
26+28		12.86	74.40	6.02	3.35	1.71	0.66	0.33	0.66	100.00

Table 7D W, kg × 10^3		Age group								Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
28	45H0	1452.64	17678.46	1703.39	1793.91	716.87	178.34		685.49	24209.10
	44H1	1587.01	13822.38	1810.63	1476.11	677.84	388.13	139.04	177.85	20078.99
	44H0	1195.28	15203.95	1644.28	1007.47	437.14	230.90		629.94	20348.96
	44G9	1578.69	17372.17	1354.39	640.83	678.65	186.50		333.47	22144.70
	43H1	823.29	5698.93	811.81	548.48	185.05	134.24	80.72		8282.52
	43H0	1993.38	18870.46	1907.17	1509.03	412.87	379.95	49.06	269.27	25391.19
	43G9	1126.14	20790.38	2382.58	2572.73	926.11	537.18		172.71	28507.84
	42H0	3267.31	19755.88	1736.60	748.28	368.51	310.85		244.27	26431.72
	42G9	5324.53	42734.84	4356.01	2980.35	1715.53	974.72	357.78	405.32	58849.09
	42G8	3231.15	29905.87	3656.53	1831.13	1381.02	567.15	288.59	85.31	40946.74
26	41H0	1674.66	17979.74	2612.08	1430.67	910.22	65.51	143.11	570.81	25386.80
	41G9	1976.60	25310.32	1977.29	1538.84	731.22	98.66	189.13	83.78	31905.83
	41G8	2392.33	46610.66	5624.95	2449.90	1429.52		883.50	699.50	60090.35
28		6043.59	89900.72	10214.32	5419.41	3070.96	164.17	1215.73	1354.09	117382.99
26		21579.44	201833.32	21363.39	15108.31	7499.60	3887.97	915.18	3003.64	275190.86
26+28		27623.04	291734.04	31577.71	20527.73	10570.55	4052.14	2130.92	4357.73	392573.85

Table 7E W, %		Age group								Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
28	45H0	6.00	73.02	7.04	7.41	2.96	0.74		2.83	100.00
	44H1	7.90	68.84	9.02	7.35	3.38	1.93	0.69	0.89	100.00
	44H0	5.87	74.72	8.08	4.95	2.15	1.13		3.10	100.00
	44G9	7.13	78.45	6.12	2.89	3.06	0.84		1.51	100.00
	43H1	9.94	68.81	9.80	6.62	2.23	1.62	0.97		100.00
	43H0	7.85	74.32	7.51	5.94	1.63	1.50	0.19	1.06	100.00
	43G9	3.95	72.93	8.36	9.02	3.25	1.88		0.61	100.00
	42H0	12.36	74.74	6.57	2.83	1.39	1.18		0.92	100.00
	42G9	9.05	72.62	7.40	5.06	2.92	1.66	0.61	0.69	100.00
	42G8	7.89	73.04	8.93	4.47	3.37	1.39	0.70	0.21	100.00
26	41H0	6.60	70.82	10.29	5.64	3.59	0.26	0.56	2.25	100.00
	41G9	6.20	79.33	6.20	4.82	2.29	0.31	0.59	0.26	100.00
	41G8	3.98	77.57	9.36	4.08	2.38		1.47	1.16	100.00
28		5.15	76.59	8.70	4.62	2.62	0.14	1.04	1.15	100.00
26		7.84	73.34	7.76	5.49	2.73	1.41	0.33	1.09	100.00
26+28		7.04	74.31	8.04	5.23	2.69	1.03	0.54	1.11	100.00

Table 7F w, g		Age group								Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
28	45H0	3.39	5.88	8.28	9.95	9.86	6.30		10.54	6.07
	44H1	3.72	6.67	8.86	10.92	10.09	11.66	13.70	10.26	6.77
	44H0	3.30	5.88	7.63	9.79	9.74	9.42		10.69	5.99
	44G9	3.72	6.06	9.07	9.85	10.33	10.42		11.27	6.12
	43H1	3.70	6.96	8.68	11.35	9.82	11.39	13.70		6.79
	43H0	3.49	6.09	7.44	10.53	9.48	9.15	6.68	10.50	6.06
	43G9	3.49	6.21	8.26	10.26	9.44	9.64		9.61	6.51
	42H0	3.45	6.40	9.62	10.07	10.82	11.17		9.86	6.04
	42G9	3.48	6.54	8.98	9.65	9.85	10.60	10.35	10.89	6.40
	42G8	3.53	6.64	8.87	9.37	9.72	10.06	10.23	11.27	6.54
26	41H0	3.55	6.96	9.35	10.85	11.81	13.28	14.50	11.73	7.04
	41G9	3.66	6.70	8.89	10.18	10.20	12.30	11.33	12.00	6.65
	41G8	3.69	6.76	8.44	9.99	11.00		9.86	10.92	6.88
28		3.64	6.78	8.75	10.26	11.02	12.67	10.46	11.31	6.85
26		3.51	6.32	8.58	10.04	9.85	9.99	10.62	10.57	6.31
26+28		3.54	6.46	8.63	10.10	10.16	10.08	10.53	10.79	6.46

Table 7G L, g		Age group								Σ
ICES SD	ICES Rect.	1	2	3	4	5	6	7	8+	
28	45H0	8.63	10.34	11.66	12.47	12.48	10.68		12.75	10.40
	44H1	8.95	10.65	11.61	12.53	12.32	12.73	13.75	12.38	10.64
	44H0	8.60	10.31	11.13	12.36	12.32	12.08		12.69	10.32
	44G9	8.76	10.35	11.81	12.29	12.52	12.76		12.95	10.33
	43H1	8.96	10.80	11.49	12.54	12.06	12.50	13.75		10.63
	43H0	8.73	10.40	11.10	12.49	12.24	12.08	10.75	12.75	10.34
	43G9	8.65	10.45	11.52	12.41	12.19	12.26		12.38	10.57
	42H0	8.68	10.49	12.07	12.35	12.57	12.75		12.25	10.24
	42G9	8.65	10.61	11.91	12.26	12.38	12.73	12.75	12.72	10.48
	42G8	8.62	10.63	11.86	12.18	12.36	12.75	12.75	12.92	10.54
26	41H0	8.78	10.78	11.82	12.42	12.96	13.25	14.00	13.06	10.74
	41G9	8.79	10.65	11.69	12.37	12.33	12.87	13.03	12.89	10.58
	41G8	8.82	10.72	11.64	12.36	12.79		12.36	12.72	10.76
28		8.80	10.71	11.69	12.38	12.72	13.01	12.60	12.87	10.71
26		8.69	10.50	11.65	12.37	12.36	12.40	12.77	12.67	10.44
26+28		8.72	10.56	11.66	12.37	12.46	12.42	12.67	12.73	10.52

Table 8. 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 12-21.05.2016

Table 8A CANUM		Age group								Σ
ICES SD	ICES Rect.	2	3	4	5	6	7	8	9+	
28	45H0	20163.77	3840.80	9163.49	3982.41	3230.53	2268.72	1313.68	1332.94	45296.33
	44H1	323.60	11.99	7.99	4.00	7.99		7.99	4.00	367.54
	44H0	12194.75	3788.56	6354.77	5489.59	3232.52	1475.48	1702.50	1058.48	35296.65
	44G9	17874.13	3880.49	6827.47	5458.98	2523.41	1692.85	2243.34	1047.19	41547.85
	43H0	13842.88	2120.31	5915.43	4327.13	1646.67	2518.45	1483.50	839.79	32694.16
	43G9	10429.32	2481.11	4773.77	4736.32	1686.17	2324.89	2086.11	946.70	29464.38
	42H0	5515.70	640.76	2144.22	2450.76	989.86	1387.32	1182.52	1221.28	15532.41
	42G9	5664.00	1766.57	3719.79	4195.95	1712.30	1249.66	1944.83	2088.18	22341.28
	42G8	1056.87	753.25	1583.11	1569.00	617.87	353.57	885.24	763.23	7582.13
26	41H0	364.49	57.55	19.18	57.55	38.37	19.18	19.18		575.51
	41G9	431.01	1025.94	2085.36	2350.31	676.05	1395.16	1714.29	1965.42	11643.54
	41G8	306.28	259.83	650.28	178.66	246.81	413.34	385.31	131.04	2571.55
28		1101.78	1343.32	2754.82	2586.52	961.23	1827.69	2118.78	2096.47	14790.61
26		87065.02	19283.83	40490.03	32214.12	15647.31	13270.94	12849.70	9301.77	230122.73
26+28		88166.80	20627.15	43244.85	34800.64	16608.54	15098.63	14968.48	11398.24	244913.34

Table 8B n × 10^6		Age group								Σ
ICES SD	ICES Rect.	2	3	4	5	6	7	8	9+	
28	45H0	367.97	70.09	167.22	72.67	58.95	41.40	23.97	24.32	826.61
	44H1	26.06	0.97	0.64	0.32	0.64		0.64	0.32	29.60
	44H0	220.79	68.59	115.06	99.39	58.53	26.71	30.82	19.16	639.06
	44G9	370.71	80.48	141.60	113.22	52.34	35.11	46.53	21.72	861.70
	43H0	266.96	40.89	114.08	83.45	31.76	48.57	28.61	16.20	630.51
	43G9	202.48	48.17	92.68	91.95	32.74	45.14	40.50	18.38	572.04
	42H0	98.89	11.49	38.44	43.94	17.75	24.87	21.20	21.90	278.47
	42G9	103.38	32.24	67.90	76.59	31.25	22.81	35.50	38.11	407.78
	42G8	23.78	16.95	35.62	35.31	13.90	7.96	19.92	17.17	170.61
26	41H0	12.51	1.98	0.66	1.98	1.32	0.66	0.66		19.76
	41G9	5.70	13.56	27.56	31.07	8.94	18.44	22.66	25.98	153.90
	41G8	7.13	6.04	15.13	4.16	5.74	9.62	8.96	3.05	59.83
28		25.33	21.58	43.35	37.20	16.00	28.72	32.28	29.03	233.49
26		1681.02	369.87	773.25	616.84	297.85	252.57	247.70	177.29	4416.38
26+28		1706.35	391.45	816.60	654.04	313.85	281.28	279.98	206.32	4649.87

Table 8C n, %		Age group								Σ
ICES SD	ICES Rect.	2	3	4	5	6	7	8	9+	
28	45H0	44.52	8.48	20.23	8.79	7.13	5.01	2.90	2.94	100.00
	44H1	88.04	3.26	2.17	1.09	2.17		2.17	1.09	100.00
	44H0	34.55	10.73	18.00	15.55	9.16	4.18	4.82	3.00	100.00
	44G9	43.02	9.34	16.43	13.14	6.07	4.07	5.40	2.52	100.00
	43H0	42.34	6.49	18.09	13.24	5.04	7.70	4.54	2.57	100.00
	43G9	35.40	8.42	16.20	16.07	5.72	7.89	7.08	3.21	100.00
	42H0	35.51	4.13	13.80	15.78	6.37	8.93	7.61	7.86	100.00
	42G9	25.35	7.91	16.65	18.78	7.66	5.59	8.71	9.35	100.00
	42G8	13.94	9.93	20.88	20.69	8.15	4.66	11.68	10.07	100.00
26	41H0	63.33	10.00	3.33	10.00	6.67	3.33	3.33		100.00
	41G9	3.70	8.81	17.91	20.19	5.81	11.98	14.72	16.88	100.00
	41G8	11.91	10.10	25.29	6.95	9.60	16.07	14.98	5.10	100.00
28		10.85	9.24	18.57	15.93	6.85	12.30	13.83	12.43	100.00
26		38.06	8.38	17.51	13.97	6.74	5.72	5.61	4.01	100.00
26+28		36.70	8.42	17.56	14.07	6.75	6.05	6.02	4.44	100.00

Table 8D W, kg × 10^3		Age group								Σ
ICES SD	ICES Rect.	2	3	4	5	6	7	8	9+	
28	45H0	4173.46	1434.57	4054.97	2039.39	1832.76	1322.52	955.79	956.74	16770.18
	44H1	277.27	17.48	15.01	7.08	13.64		21.42	12.22	364.12
	44H0	2603.06	1436.35	2847.09	2868.28	1773.02	930.18	1132.92	728.77	14319.66
	44G9	4434.36	1695.78	3694.39	3355.65	1640.03	1275.24	1848.62	901.31	18845.38
	43H0	3376.56	852.17	2935.36	2607.15	1097.70	1749.68	1072.92	654.73	14346.26
	43G9	2615.65	1134.81	2442.54	3029.11	1148.70	1772.71	1573.69	780.65	14497.86
	42H0	1398.17	276.19	1041.76	1463.37	623.40	956.73	910.28	989.09	7658.98
	42G9	1570.41	850.76	2103.48	2767.30	1227.63	949.50	1571.09	1846.01	12886.18
	42G8	430.46	470.57	1142.61	1348.35	547.94	354.45	921.35	836.12	6051.86
26	41H0	177.01	38.19	18.96	61.77	42.54	15.15	23.97		377.59
	41G9	129.96	476.56	1072.79	1324.55	401.98	821.58	1132.17	1522.95	6882.54
	41G8	136.92	161.89	539.60	175.37	246.22	372.58	423.70	175.19	2231.48
28		443.89	676.64	1631.35	1561.70	690.73	1209.31	1579.84	1698.15	9491.61
26		20879.40	8168.67	20277.20	19485.67	9904.81	9311.01	10008.08	7705.64	105740.50
26+28		21323.29	8845.31	21908.55	21047.37	10595.55	10520.32	11587.93	9403.79	115232.11

Table 8E W, %		Age group								Σ
ICES SD	ICES Rect.	2	3	4	5	6	7	8	9+	
28	45H0	24.89	8.55	24.18	12.16	10.93	7.89	5.70	5.70	100.00
	44H1	76.15	4.80	4.12	1.94	3.75		5.88	3.36	100.00
	44H0	18.18	10.03	19.88	20.03	12.38	6.50	7.91	5.09	100.00
	44G9	23.53	9.00	19.60	17.81	8.70	6.77	9.81	4.78	100.00
	43H0	23.54	5.94	20.46	18.17	7.65	12.20	7.48	4.56	100.00
	43G9	18.04	7.83	16.85	20.89	7.92	12.23	10.85	5.38	100.00
	42H0	18.26	3.61	13.60	19.11	8.14	12.49	11.89	12.91	100.00
	42G9	12.19	6.60	16.32	21.47	9.53	7.37	12.19	14.33	100.00
	42G8	7.11	7.78	18.88	22.28	9.05	5.86	15.22	13.82	100.00
26	41H0	46.88	10.12	5.02	16.36	11.27	4.01	6.35		100.00
	41G9	1.89	6.92	15.59	19.25	5.84	11.94	16.45	22.13	100.00
	41G8	6.14	7.25	24.18	7.86	11.03	16.70	18.99	7.85	100.00
28		4.68	7.13	17.19	16.45	7.28	12.74	16.64	17.89	100.00
26		19.75	7.73	19.18	18.43	9.37	8.81	9.46	7.29	100.00
26+28		18.50	7.68	19.01	18.27	9.19	9.13	10.06	8.16	100.00

Table 8F w, g		Age group								Σ
ICES SD	ICES Rect.	2	3	4	5	6	7	8	9+	
28	45H0	11.34	20.47	24.25	28.06	31.09	31.94	39.87	39.33	20.29
	44H1	10.64	18.11	23.33	22.00	21.20		33.30	38.00	12.30
	44H0	11.79	20.94	24.75	28.86	30.29	34.82	36.75	38.03	22.41
	44G9	11.96	21.07	26.09	29.64	31.34	36.32	39.73	41.50	21.87
	43H0	12.65	20.84	25.73	31.24	34.57	36.02	37.50	40.43	22.75
	43G9	12.92	23.56	26.35	32.94	35.09	39.27	38.86	42.47	25.34
	42H0	14.14	24.04	27.10	33.31	35.13	38.47	42.94	45.17	27.50
	42G9	15.19	26.38	30.98	36.13	39.28	41.63	44.26	48.43	31.60
	42G8	18.10	27.76	32.07	38.19	39.41	44.55	46.25	48.68	35.47
26	41H0	14.15	19.33	28.80	31.27	32.30	23.00	36.40		19.11
	41G9	22.81	35.14	38.92	42.64	44.98	44.55	49.97	58.62	44.72
	41G8	19.22	26.78	35.67	42.19	42.88	38.74	47.27	57.47	37.30
28		17.52	31.35	37.63	41.98	43.18	42.11	48.94	58.50	40.65
26		12.42	22.09	26.22	31.59	33.25	36.87	40.40	43.46	23.94
26+28		12.50	22.60	26.83	32.18	33.76	37.40	41.39	45.58	24.78

Table 8G L, g		Age group								Σ
ICES SD	ICES Rect.	2	3	4	5	6	7	8	9+	
28	45H0	12.54	15.84	16.81	17.72	18.37	18.85	20.05	20.24	15.32
	44H1	12.09	14.92	16.25	16.75	16.50		19.75	21.25	12.68
	44H0	12.66	15.94	16.89	17.86	18.14	19.19	19.49	19.83	15.90
	44G9	12.64	15.85	17.06	17.84	18.35	19.34	19.87	20.40	15.56
	43H0	12.89	15.66	16.95	18.07	18.89	18.98	19.23	19.57	15.72
	43G9	12.93	16.12	16.98	18.31	18.78	19.50	19.36	19.65	16.24
	42H0	13.35	16.51	17.14	18.48	18.68	19.27	20.31	20.51	16.77
	42G9	13.62	16.73	17.68	18.78	19.20	19.57	20.14	20.75	17.50
	42G8	14.31	16.90	17.72	18.88	19.12	19.91	20.29	20.58	18.21
26	41H0	13.41	14.75	17.25	17.92	18.25	16.25	20.25		14.77
	41G9	15.46	18.09	18.91	19.51	20.03	19.79	20.73	21.88	19.77
	41G8	14.74	16.68	18.27	19.75	19.74	18.59	20.33	21.82	18.47
28		14.24	17.39	18.66	19.45	19.78	19.31	20.61	21.87	19.02
26		12.81	16.02	17.04	18.15	18.56	19.24	19.79	20.27	16.01
26+28		12.83	16.10	17.13	18.23	18.62	19.24	19.89	20.50	16.16

Table 9. Number of sprat eggs and larvae per 1 m^2 or per 10 minutes of sampling on water surface in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016

Aquatory	Northern part		Central part		Southern part	
Depth strata	>70m	<70m	>70m	<70m	>70m	<70m
Eggs (per $1m^2$)	116	-	416	31	591	31
Larvae (per $1m^2$)	1.2	-	18.2	0	130	11.4
Eggs (per 10 min. of haul on the water surface)	5.3	-	123	51	82	31
Larvae (per 10 min. of haul on the water surface)	0.4	-	3.1	0	1.5	0

Northern part of the Gotland Basin – to the north from 57°30'N
Central part of the Gotland Basin – between 56°30'N and 57°30'N
Southern part of the Gotland Basin – to the south from 56°30'N.

Table 10. The average number and average biomass of zooplankton organisms in 0-100m water column per volume unit in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016

Species or group	Whole aquatory All stations (26) [0-100 layer]		Stations (13) with depth more than 100m [0-50 layer]		Stations (19) with depth more than 100m [0-100 layer]		Stations (7) with depth less than 100m [0-bottom layer]	
	n\m^3	mg\m^3	n\m^3	mg\m^3	n\m^3	mg\m^3	n\m^3	mg\m^3
Acartia spp.	2870	33.43	3524	35.78	3014	35.17	2331	26.95
Eurytemora affinis	3	0.09	5	0.13	1	0.05	7	0.24
Temora longicornis	1330	24.69	1314	16.25	1391	26.10	1100	19.43
Centropages	1658	14.46	2071	15.09	1811	15.59	1088	10.26
Pseudocalanus sp.	2843	26.27	2459	14.05	3354	31.72	937	5.96
Oithona sp.	3	0.02			4	0.02		
Bosmina spp.	3	0.02	5	0.05	3	0.02	3	0.02
Evadne spp.	663	19.59	731	20.68	659	19.21	678	20.98
Podon spp.	47	0.47	69	0.62	44	0.43	58	0.62
Synchaeta spp.	4377	26.26	6028	36.17	3817	22.90	6466	38.80
Polychaeta sp.	99	2.96	28	0.84	94	2.82	116	3.48
Bivalvia larvae	96	0.10	113	0.11	88	0.09	126	0.13
Fritillaria borealis	1619	16.19	1518	15.18	1562	15.62	1831	18.31
Copepoda	8705	98.96	9374	81.29	9576	108.65	5463	62.85
Cladocera	713	20.08	805	21.34	706	19.67	739	21.61
Rotatoria	4377	26.26	6028	36.17	3817	22.90	6466	38.80
Varia	1813	19.25	1659	16.13	1744	18.53	2073	21.91
Total	15609	164.55	17866	154.93	15842	169.75	14741	145.17

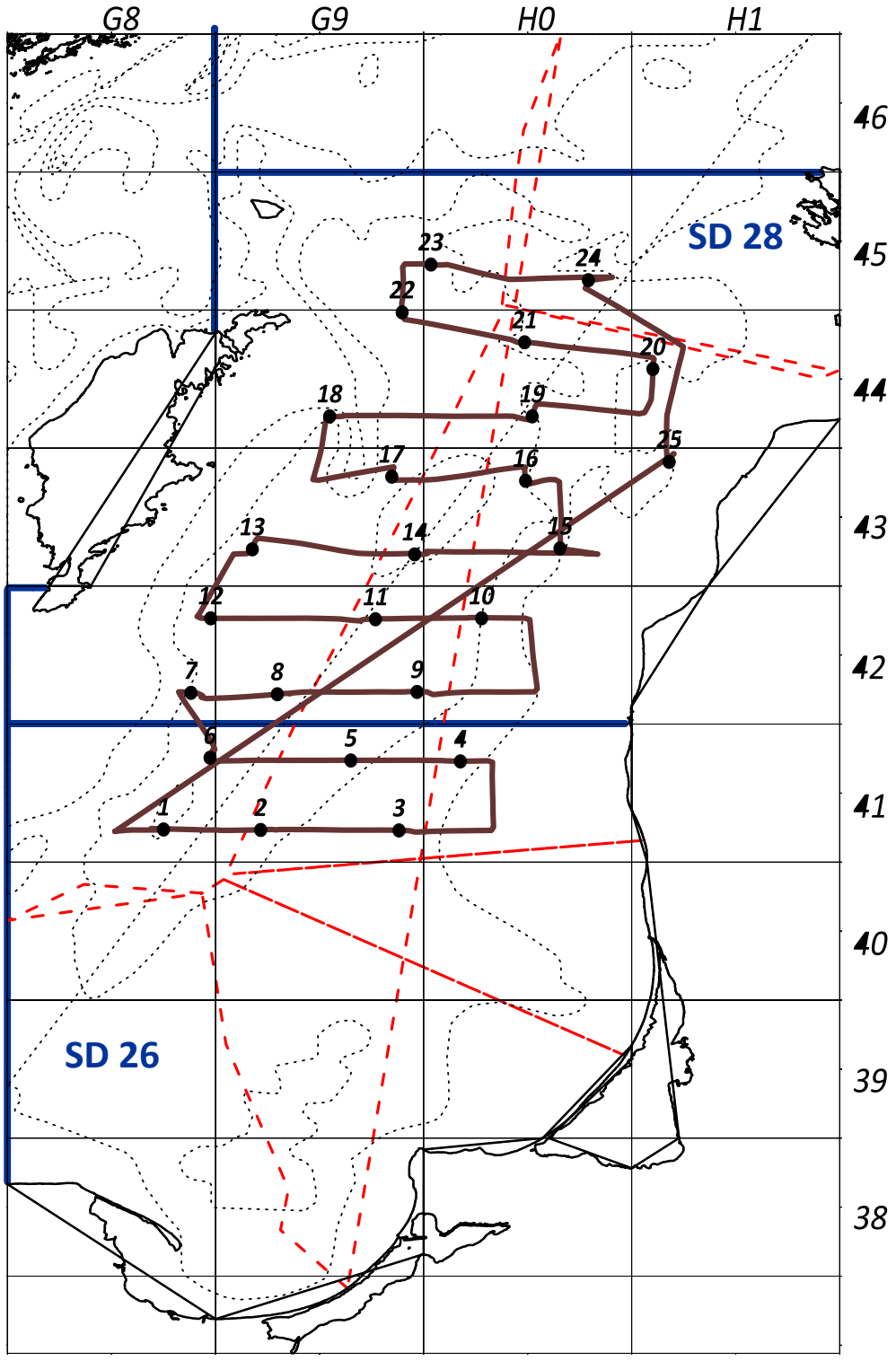

Figure 1: Cruise track design and trawling positions of the Latvian-Polish BASS on the r/v "Baltica" in the period of 12-21.05.2016.

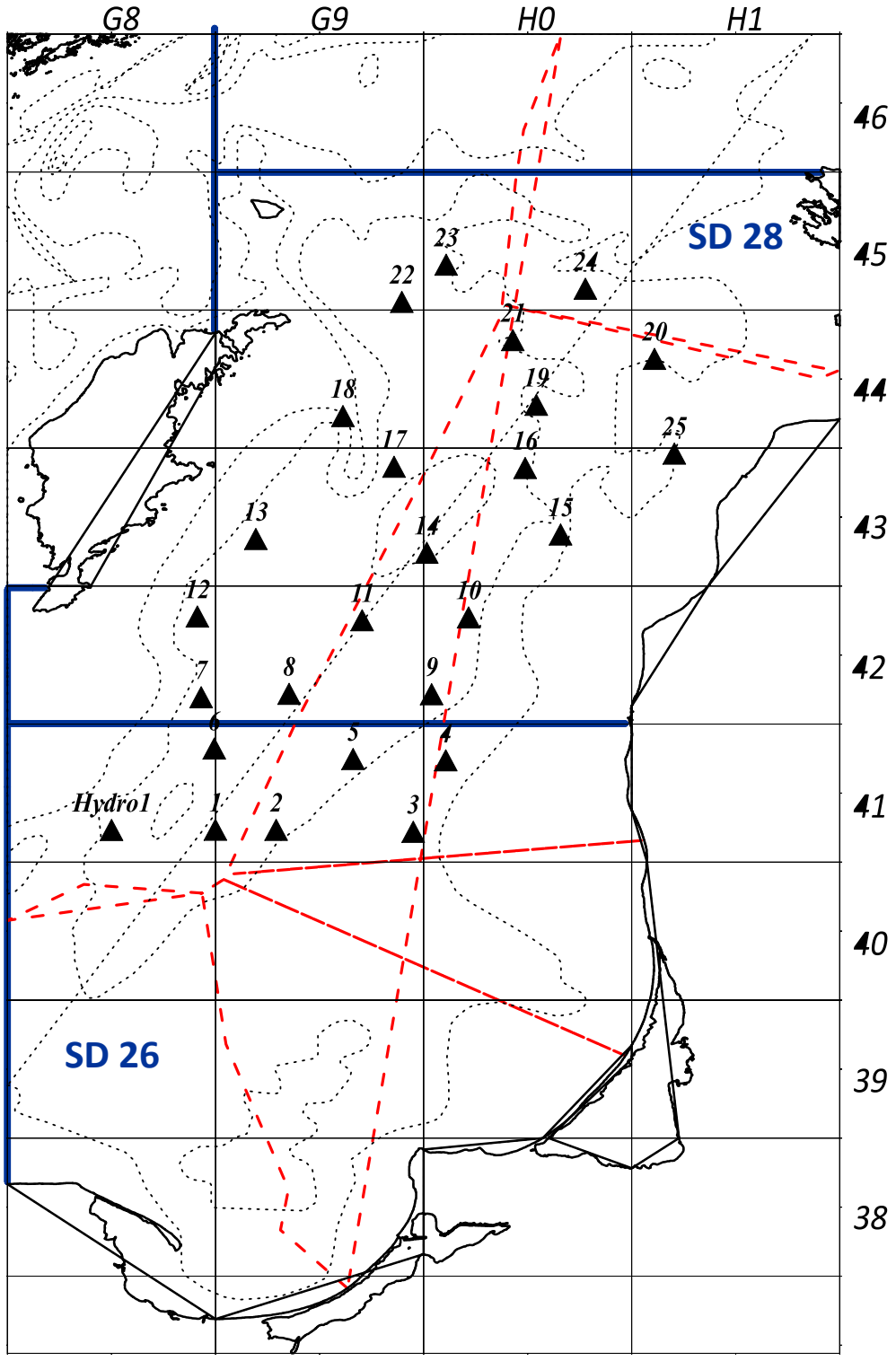

Figure 2: Locations of the hydrological, ichthyoplankton and zooplankton stations performed during the Latvian-Polish BASS on the r/v "Baltica" in the period of 12-21.05.2016.

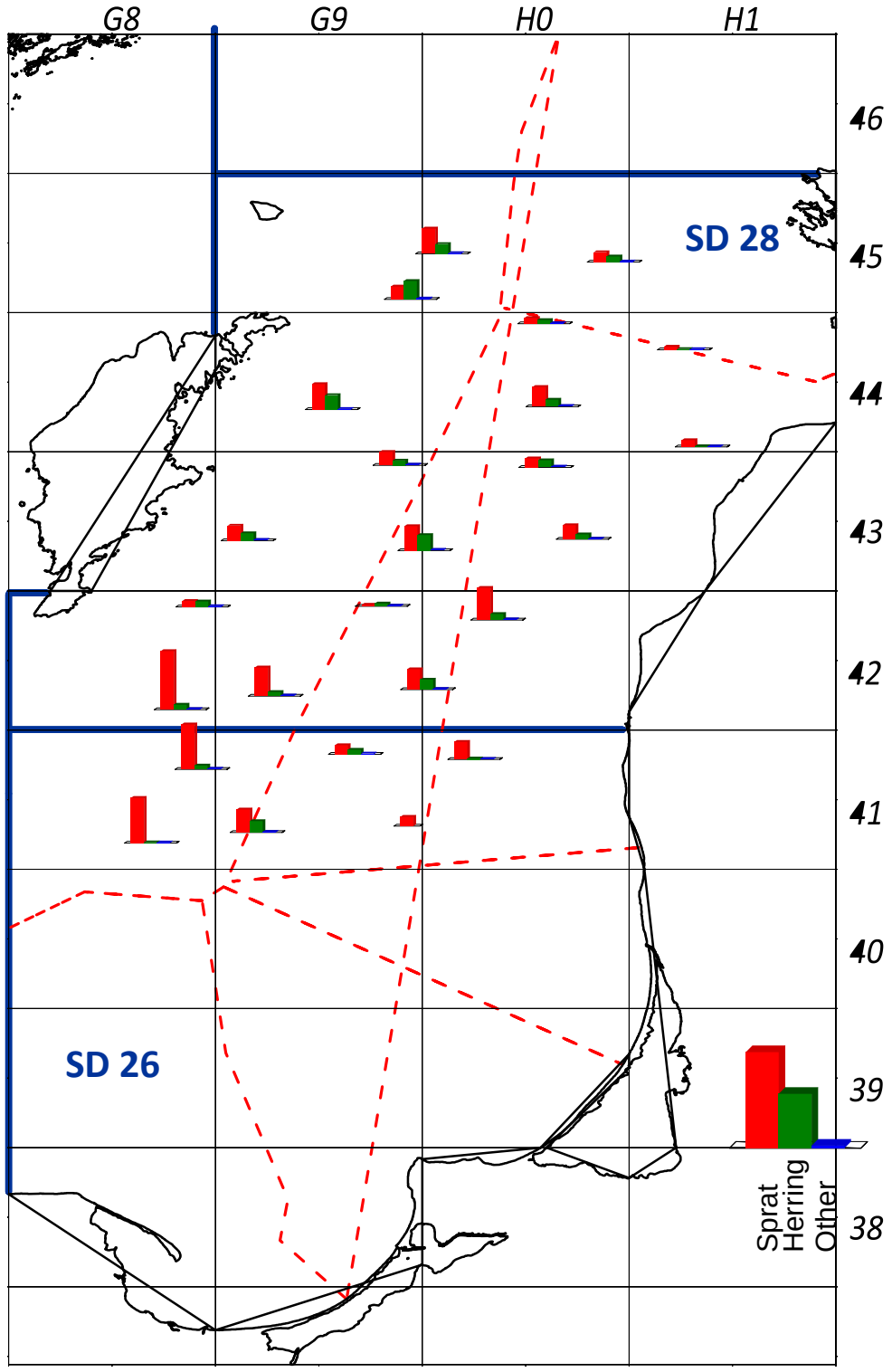

Figure 3: Catch [kg] distribution by fish species in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica"in the period of 12-21.05.2016.

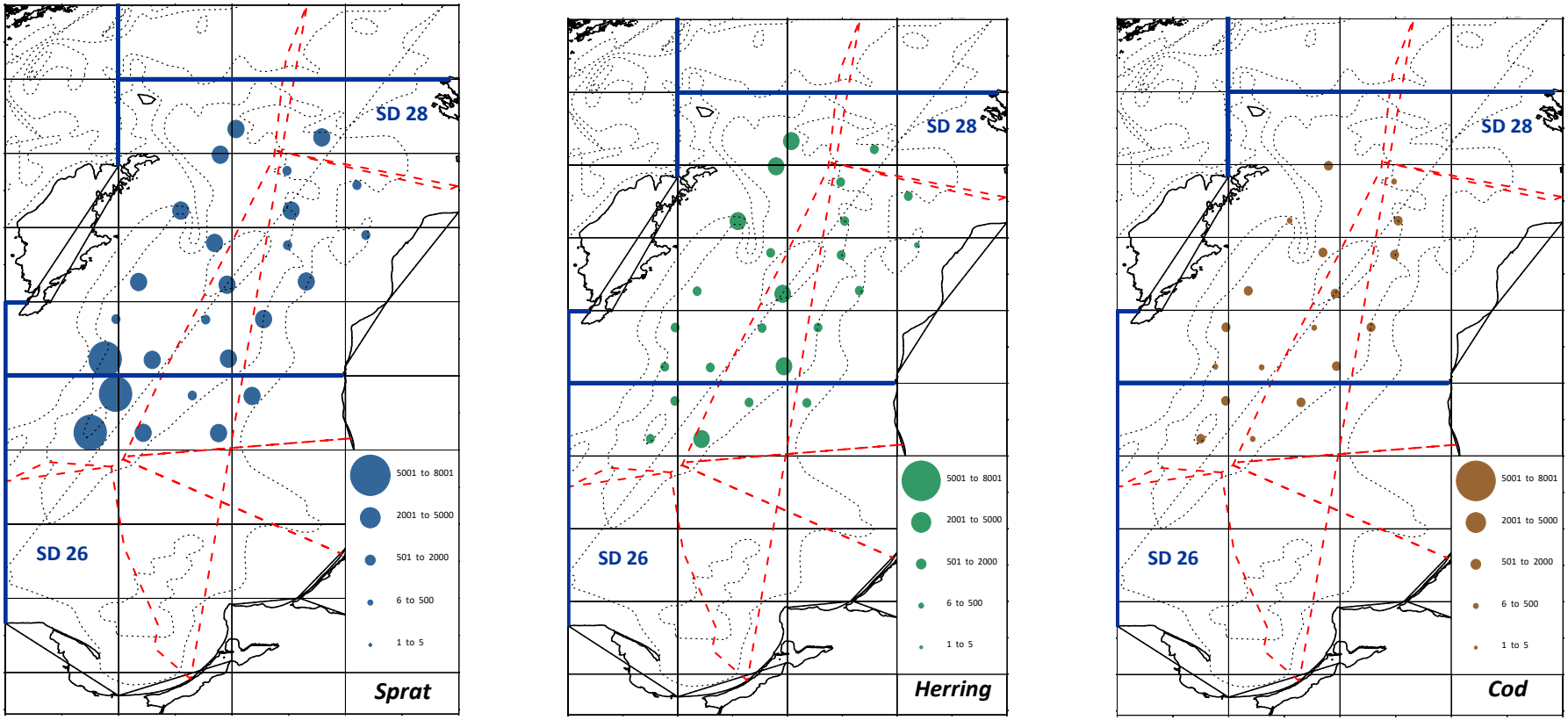

Figure 4: CPUE [kg/h] ranges distribution of dominant fish in the catch hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica"in the period of 12-21.05.2016.

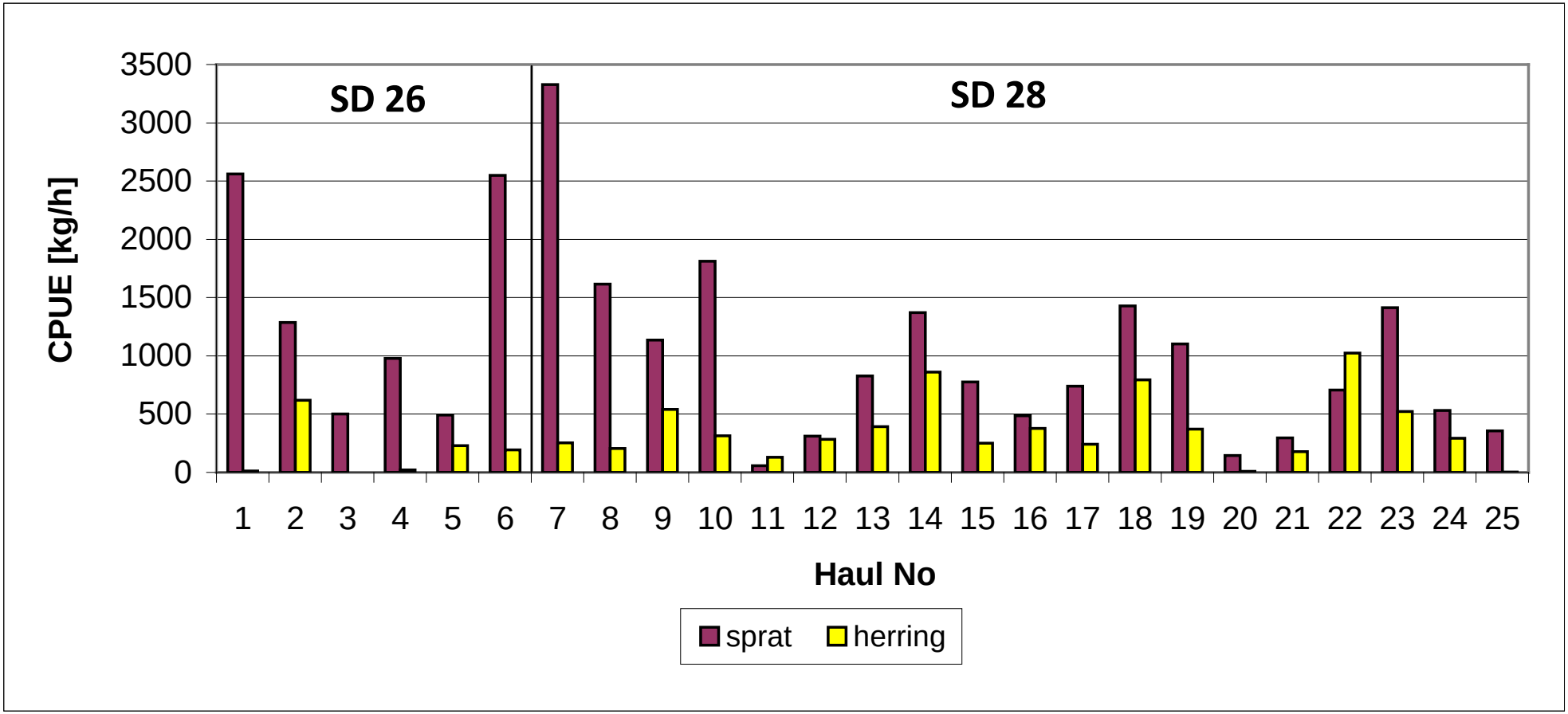

Figure 5: CPUE [kg/h] of dominant pelagic fish in the catch hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica"
in the period of 12-21.05.2016.

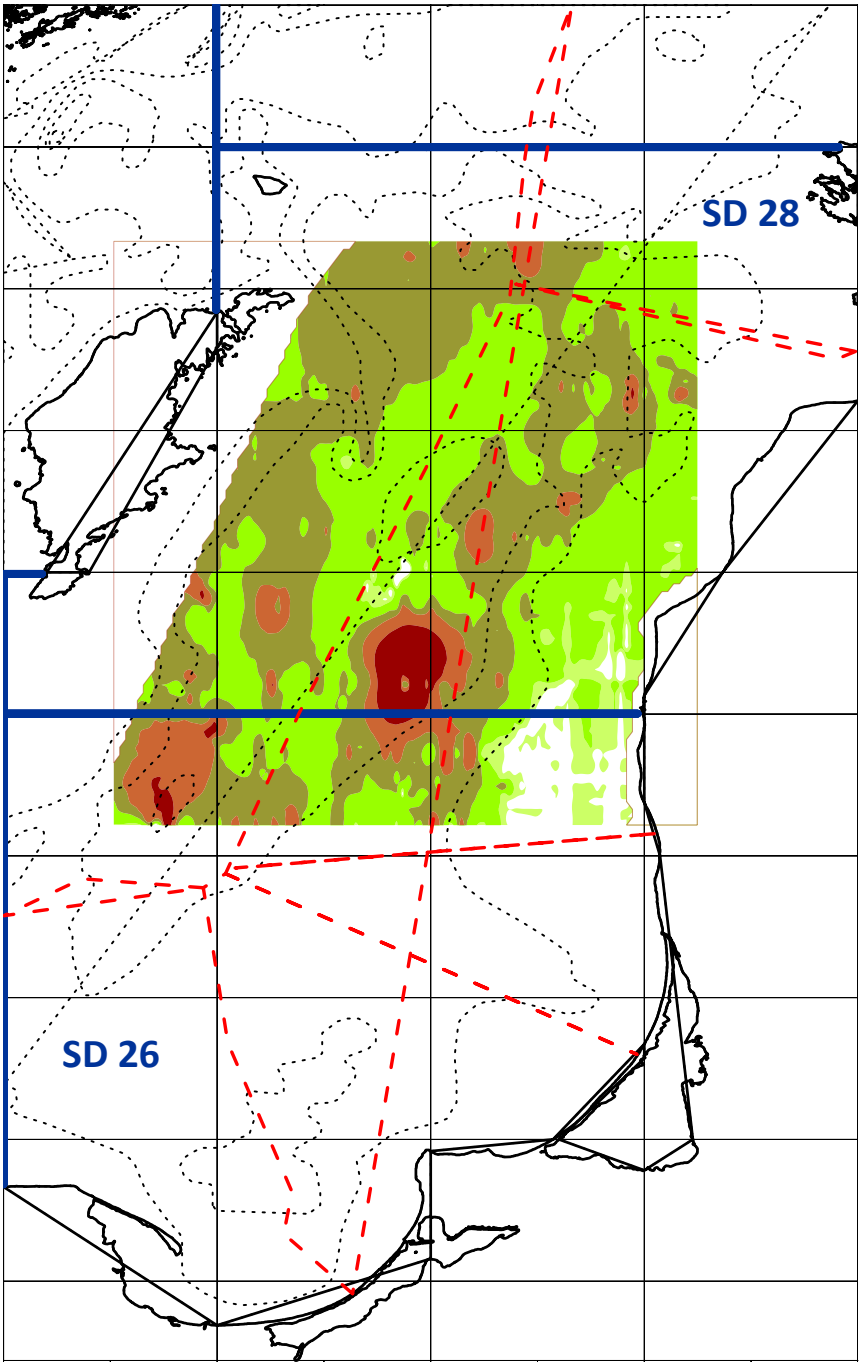

Figure 6: Acoustic parameter NASC distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016.

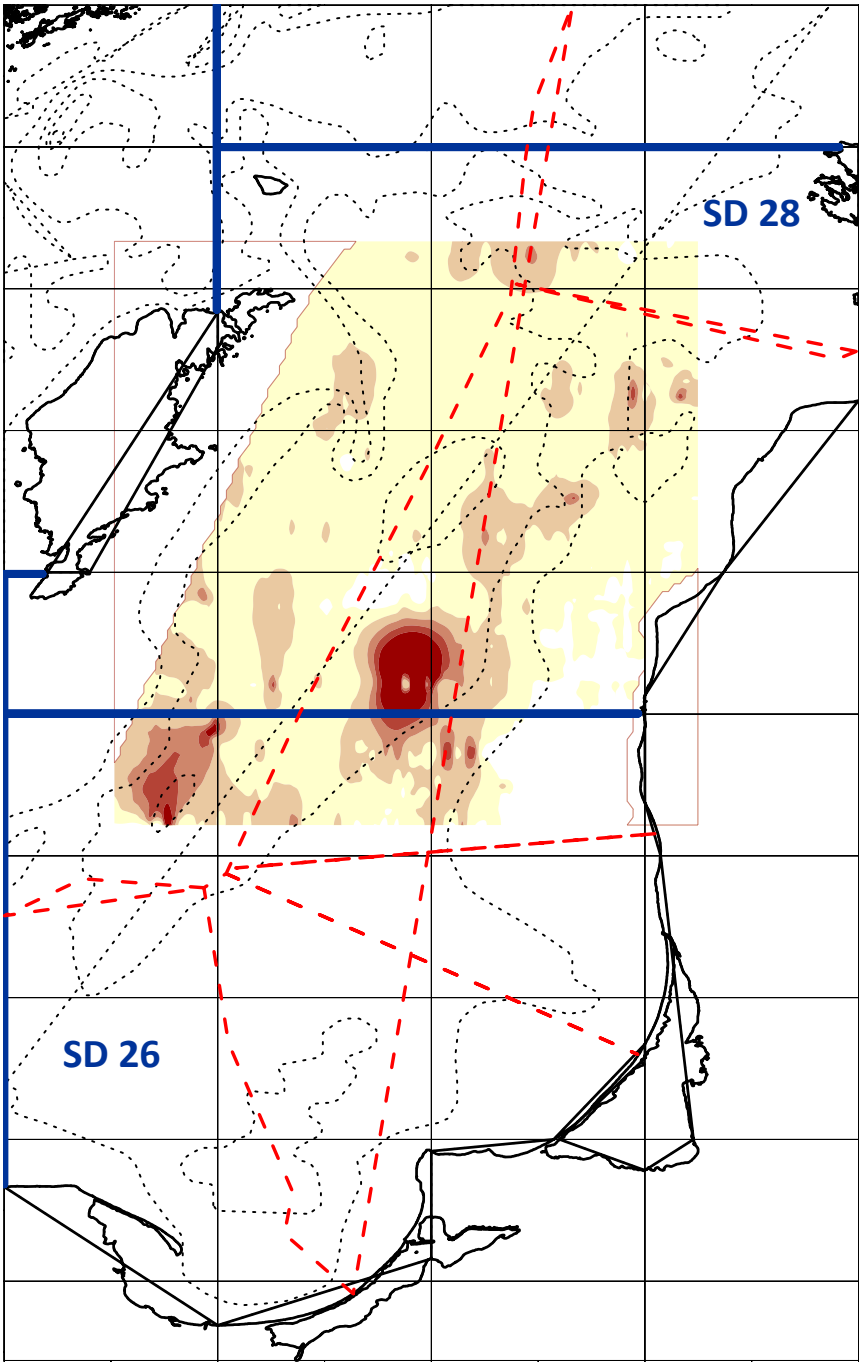

Figure 7: Sprat distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016.

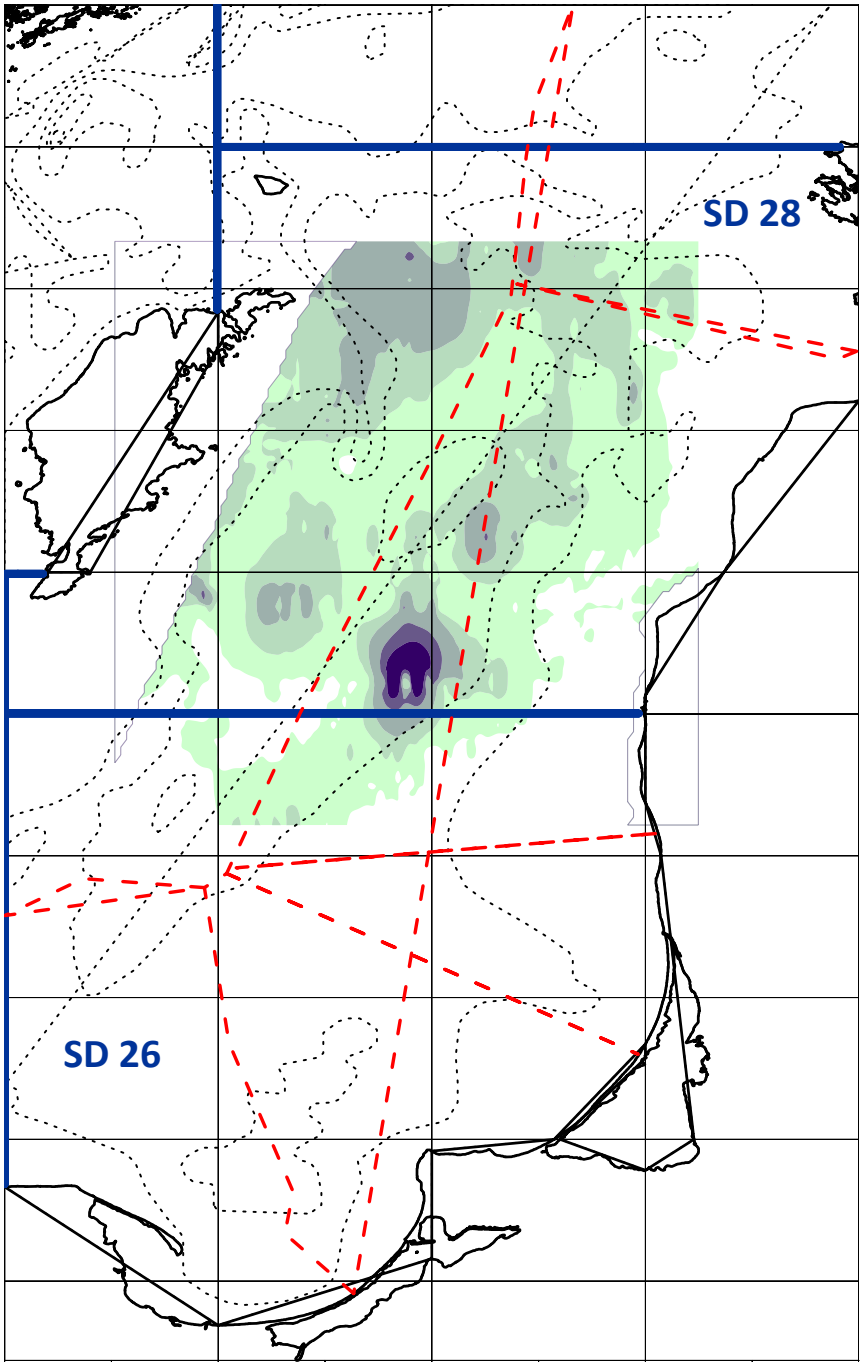

Figure 8: Herring distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016.

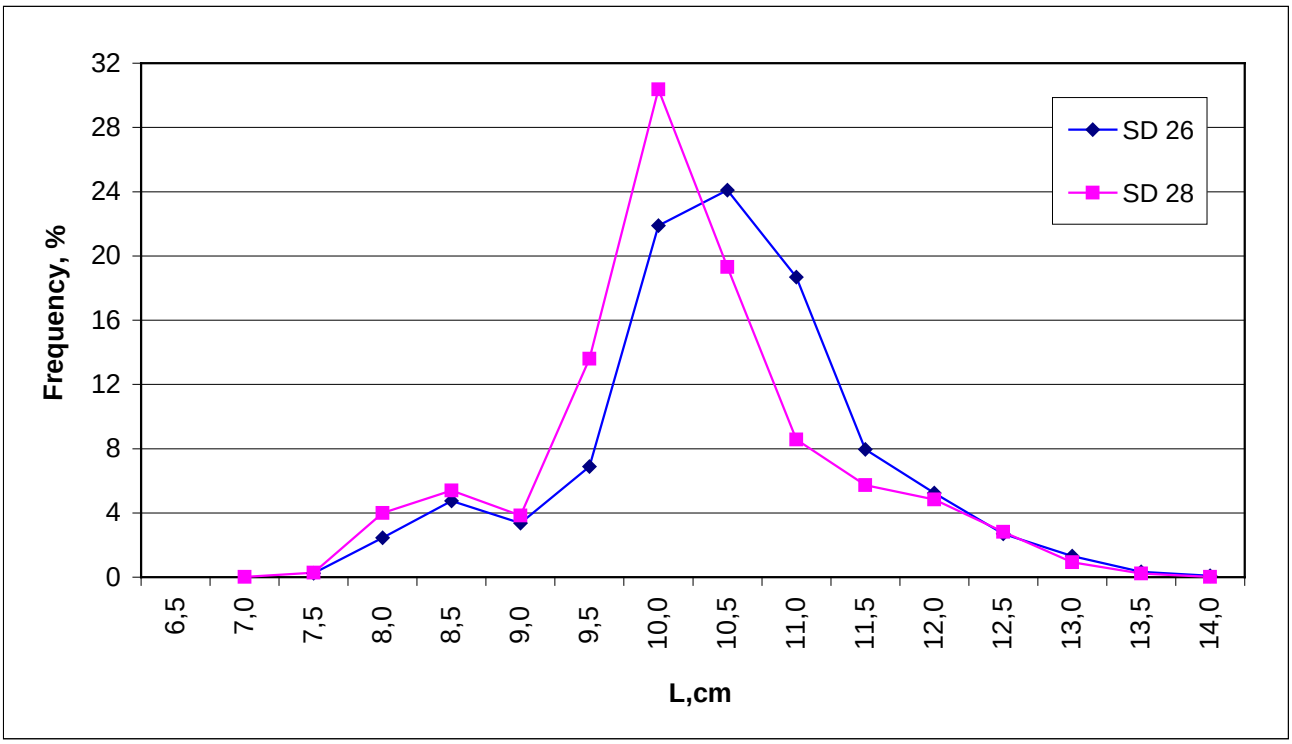

Figure 9: Sprat length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016.

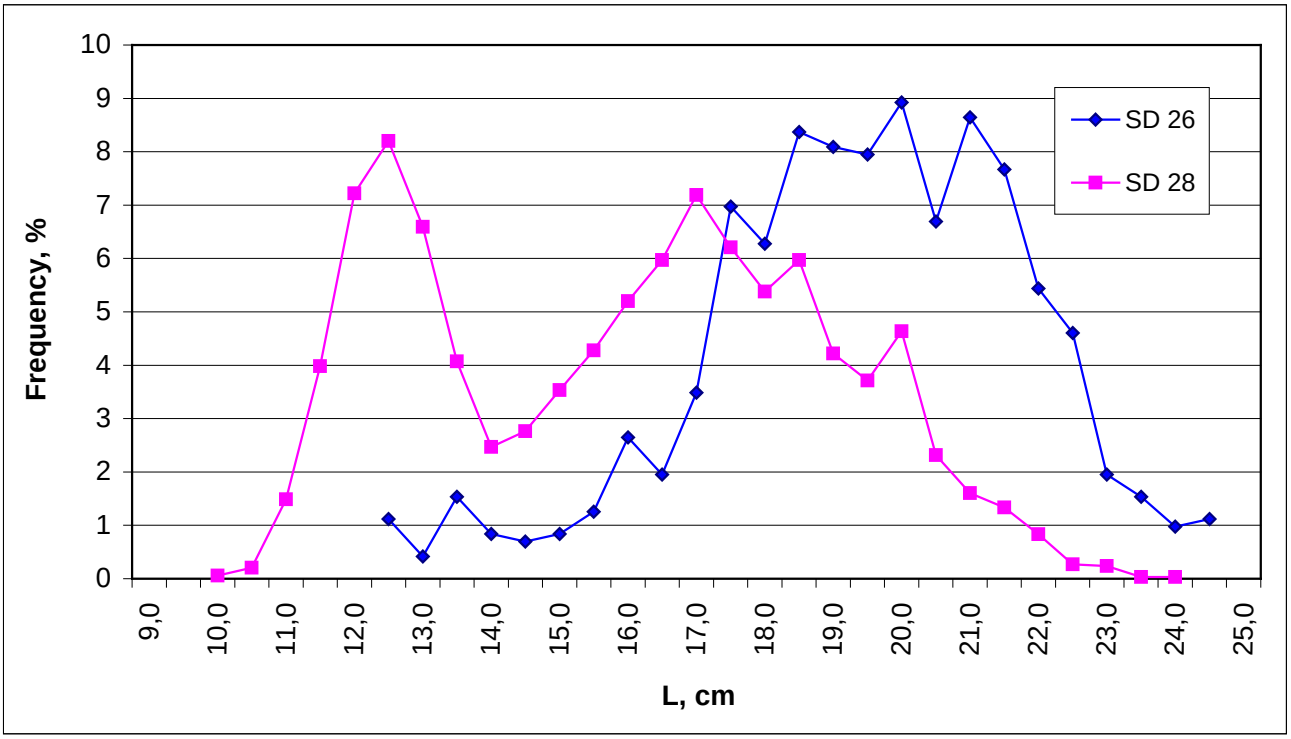

Figure 10: Herring length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016.

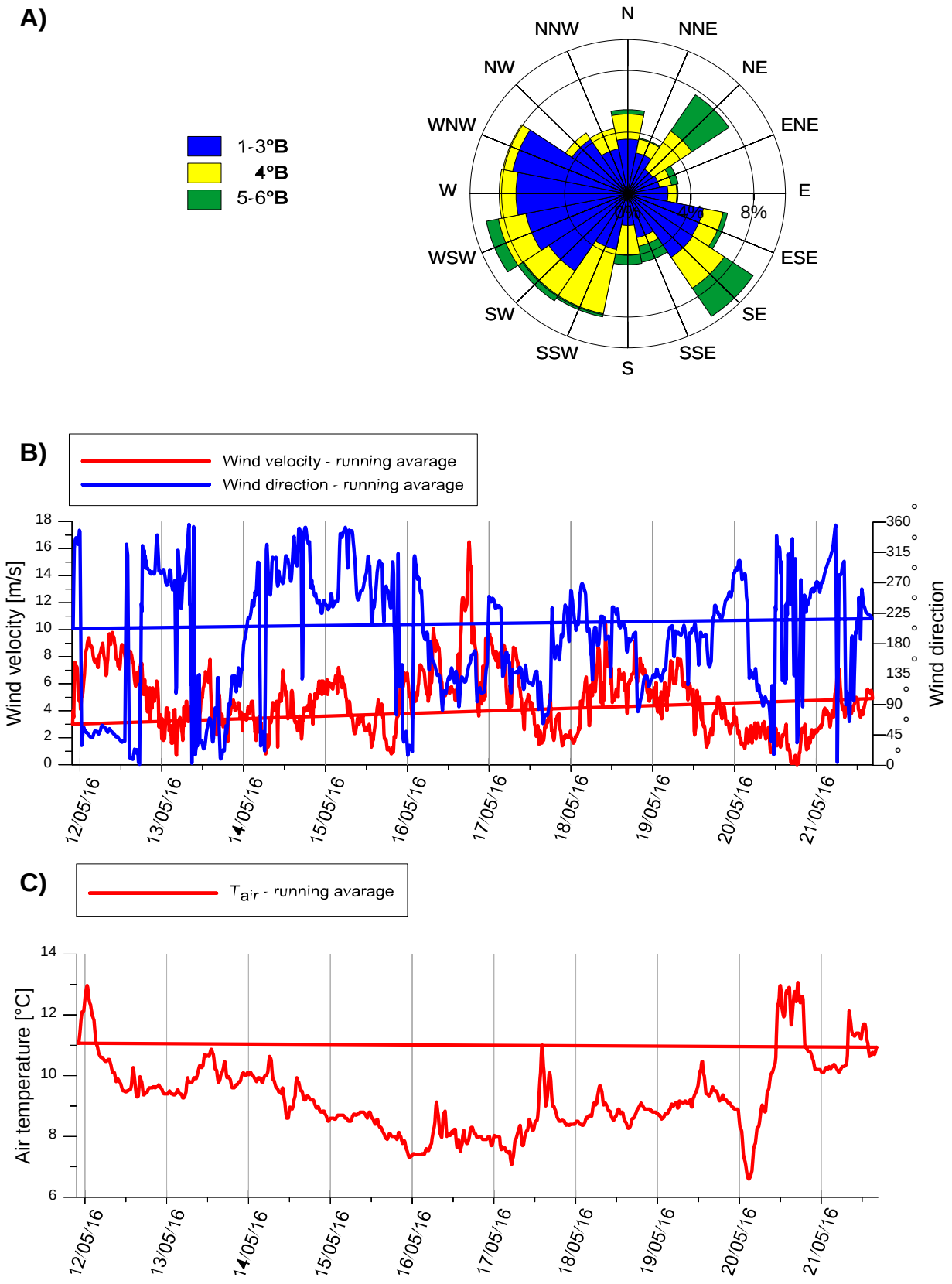

Figure 11: Changes of the main meteorological parameters (wind force, direction and the daily air temperature) during the Latvian-Polish BASS in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 12-21.05.2016

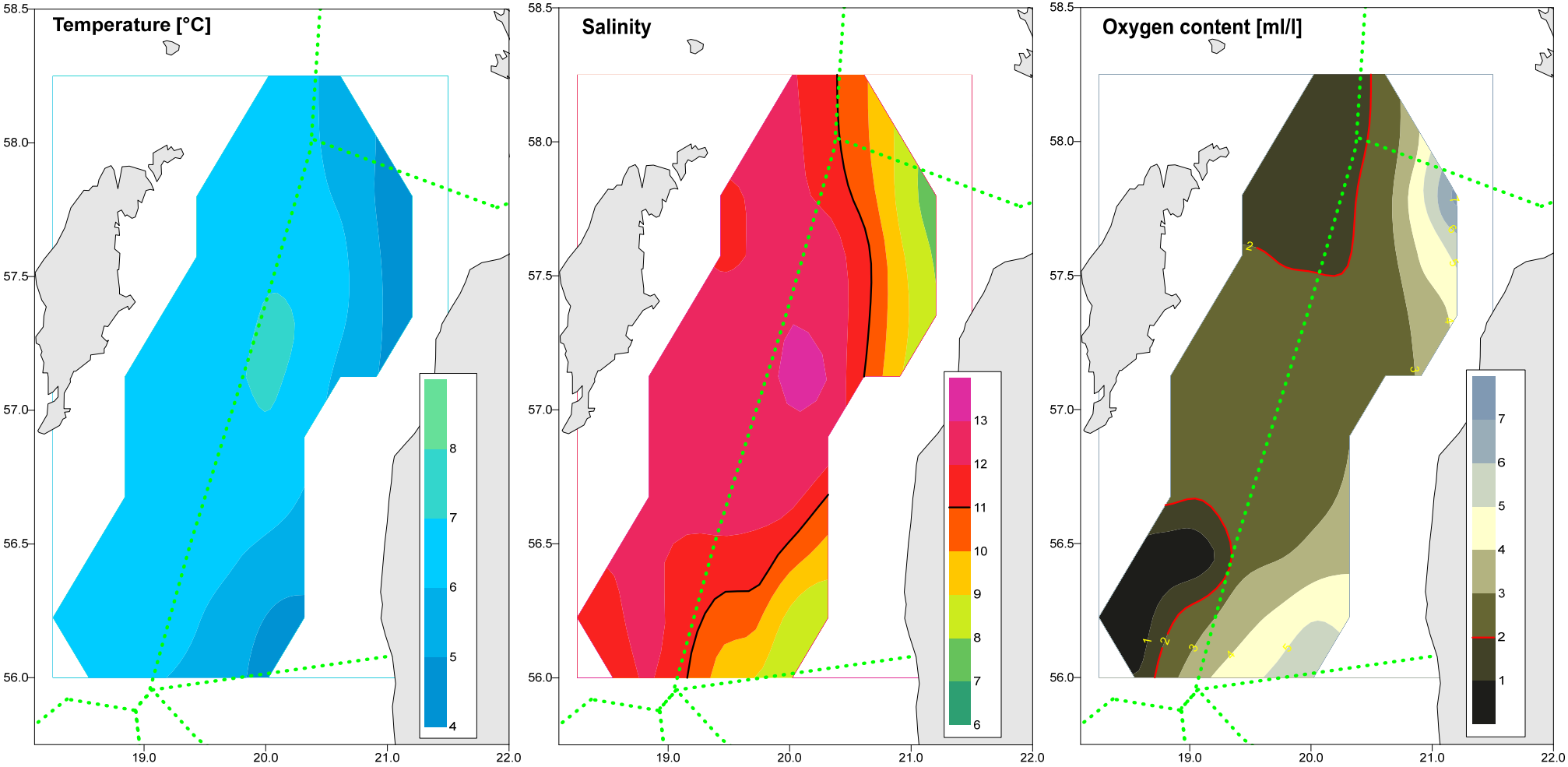

Figure 12: Horizontal distribution of the main hydrological parameters (temperature, salinity, oxygen content) measured in the bottom water layer of the Gotland Deep in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in the period of 12-21.05.2016.

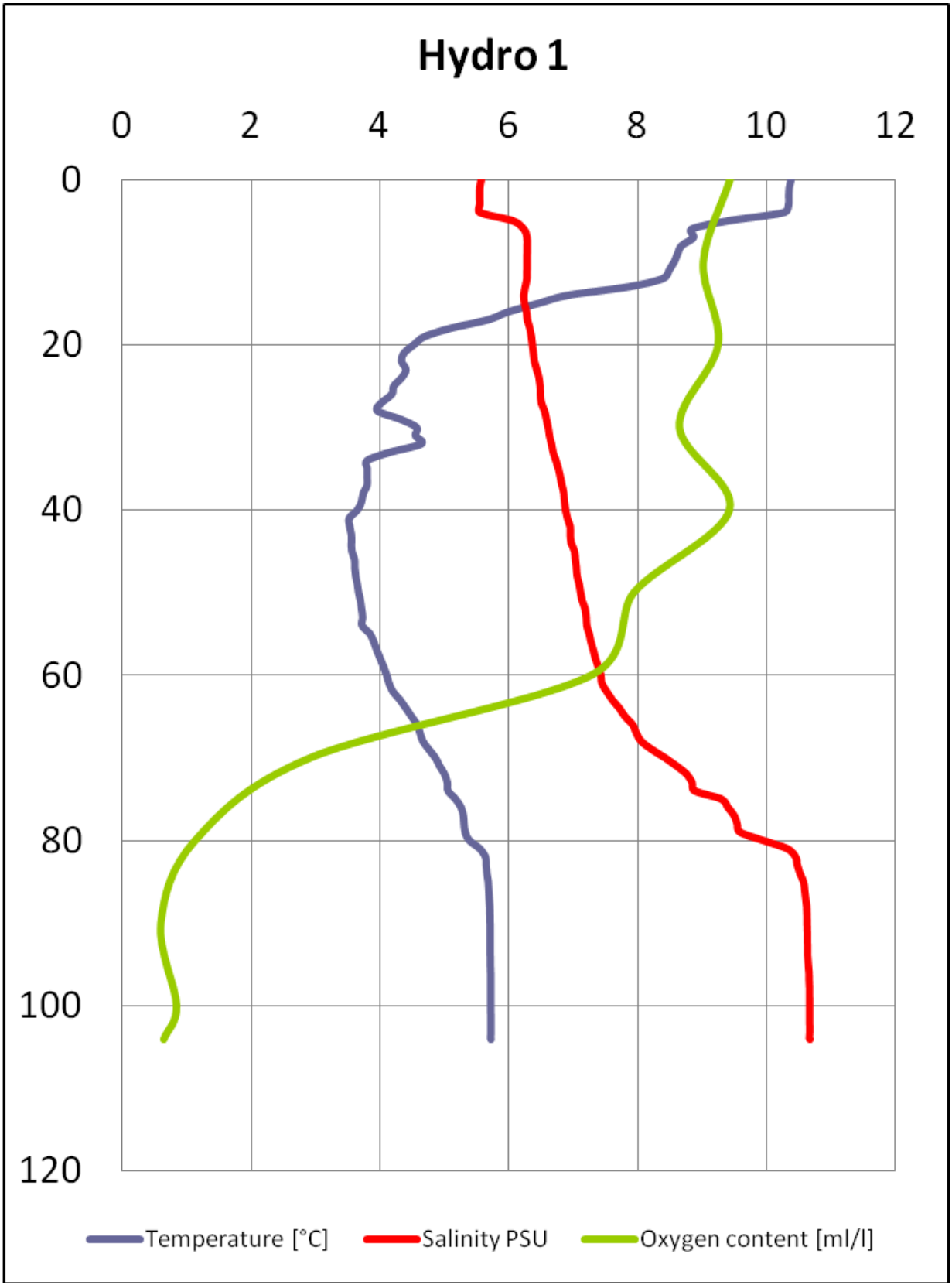

Figure 12: Vertical distribution of the seawater temperature, salinity and oxygen content at the independent hydrological station in the southern part of the Gotland Basin in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BASS conducted by r/v "Baltica" in October in the period of 12-21.05.2016.

REPORT FROM THE JOINT ESTONIAN-POLISH BIAS CONDUCTED BY THE R.V. "BALTICA" IN THE NORTH-EASTERN BALTIC SEA (21-28 October 2016)

by
Miroslaw Wyszynski*, Ain Lankov**, Elor Sepp** and Tycjan Wodzinowski*

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Introduction

The permanent participation of the Polish r.v. "Baltica" in the autumn Baltic International Acoustic Surveys (BIAS) within the Polish EEZ has taken place since 1994 in the framework of long-term ICES Baltic International Acoustic Surveys Program, coordinated by the ICES Baltic International Fish Survey Working Group [WGBIFS].

The first joint Estonian-Finnish-Polish BIAS survey was conducted on the r.v. "Baltica" in October 2006 in the ICES Sub-divisions 28.2, 29 and 32. The recent joint survey, marked with the number 5/2016/NMFRI/TUEMI based on the procurement contract between the University of Tartu/Estonian Marine Institute in Tallinn and the National Marine Fisheries Research Institute in Gdynia. This Estonian-Polish BIAS 4Q 2016 survey was conducted in the Estonian EEZ only (the ICES Sub-divisions 28.2, 29 and 32).

The Estonian Data Collection Program for 2016 and the European Union (the Commission regulations Nos. 665/2008, 199/2008, 2010/93/EU) financially supported the mentioned above BIAS-2016 survey. Timing, surveying area in the north-eastern Baltic and the principal methods of investigations concerns the survey were designed and coordinated by the WGBIFS (Anon. 2012[1], Anon. 2016[2]).

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 specially for herring and sprat,
- to collect plankton samples,
- to provide hydrological monitoring (temperature, salinity and oxygen content) at the catch locations.

Personnel

The BIAS 4Q 2016 scientific staff was composed of 9 persons:
Miroslaw Wyszynski (NMFRI, Gdynia – Poland) – survey leader
Jakub Slembarski (NMFRI, Gdynia – Poland) – acoustician
Tycjan Wodzinowski (NMFRI, Gdynia – Poland) – hydrologist
Grzegorz Kruk (NMFRI, Gdynia – Poland) – acoustician
Ain Lankov (TUEMI, Tallinn - Estonia) – Estonian scientific staff leader
Andrus Hallang (TUEMI, Tallinn - Estonia) – ichthyologist
Timo Arula (TUEMI, Tallinn - Estonia) – ichthyologist
Viktor Kajalainen (TUEMI, Tallinn - Estonia) – ichthyologist
Elor Sepp (TUEMI, Tallinn - Estonia) – acoustician.

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[1]Anon. 2012. Manual For International Balic Acoustic Surveys (IBAS). Version 1.01. Addendum 2: ICES WGBIFS BIAS Manual 2012.
[2]Anon. 2016. Anon. 2016. Second Interim Report of the Baltic International Fish Survey Working Group (WGBIFS). ICES CM 2016/SSGIEOM: 07.

Narrative

The reported survey took place during the period of 21-28 October 2016. The at sea researches (echo-integration, fish control catches, hydrological and plankton stations) were conducted within Estonian EEZ (the ICES Sub-divisions 28.2, 29 and 32), moreover inside the territorial waters of this country not shallower than 20 m.

The vessel left the Ventspils port (Latvia) on 20.10.2016 at 15:40 o'clock and was navigated in the north-western direction to the geographical position 58°05'N 020°27'E in north-western part of Sub-division (SD) 28.2 (Fig. 1) where the vessel started investigations at the acoustic transect. The at sea researches were ended on 26.10.2016 after midday in the Ventspils harbour (Latvia). Then the r.v. "Baltica" started its journey to the home-port in Gdynia (Poland), reaching it on 28.10.2016 morning. The researches were shortened by 2 days at sea (according to contracted time of research) due to vessel technical problems making the catches impossible.

Survey design and realization

The r.v. "Baltica" realized 612 Nm echo-integration tracks and 9 fish control-catches/hauls (Fig. 1). Due to technical problems of the vessel the ICES rectangles 45H0, 47H1, 47H2 and 48H4 were not covered with control catches. Three rectangles (44H1, 45H0 and 45H1) in SD 28.2 were covered with investigations during the gone before Latvian-Polish BIAS in October 2016. All catches were performed in the daylight (between 08:05 am. and 16:30 pm.) using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The standard trawling duration (30 minutes) was shortened in 7 cases to 15 or 20 minutes due to high fish density observed on the net-sounder monitor. The mean speed of vessel while trawling was 3.1 knots. Overall, 1 haul was conducted in SD 28.2, 2 hauls in SD 29 and 6 hauls in SD 32.

The length measurements (in 0.5 cm classes) were realized for 1919 sprat and 2259 herring. Totally, 420 sprat and 554 herring individuals were taken for biological analysis.

The acoustic data were collected with the EK-60 echo-sounder equipped with "Echo-view V4.10" software for the data analysis. The acoustic system was calibrated before the survey according to the methodology described in the BIAS manual (Anon. 2012). The basic acoustic and biological data collected during recently carried out survey will be stored in the acoustic database, managed by ICES Secretariat. The acoustic data collected during the survey were delivered to the Estonian Marine Institutes laboratories for further elaboration.

Calibration

The hydroacoustic equipment was calibrated before the survey according to the methodology described in the BIAS manual. (Anon. 2014[2])

Acoustic data collection

Acoustic data were collected during the light time with the Simrad EK60 echosounder equipped with "Echo-view V4.10" software for the data analysis. Data from two frequencies (38 and 120 kHz) were recorded simultaneously, but for the standard analyses only the information collected with 38 kHz was used. The specific settings of the equipment were used as described in the BIAS manual. (Anon. 2014[2]) The basic acoustic and biological data collected during recently carried out survey will be stored in the BIAS_DB.mdb managed by ICES.

Data analysis

The MYRIAX "EchoView v.4.10" 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:

$TS = 20 \log L - 71.2$ (Anon. 1983[3]).

Due to fortunate weather conditions, all transects and planned trawls were conducted according to the plan and no data from colleagues from nearby countries were needed.

Catch results and fish measurements

Overall, 10 fish species were recognized in hauls performed in the north-eastern Baltic Sea in October 2016. Sprat was prevailing species by mass in each of the ICES Sub-divisions 28.2, 29 and 32 with the mean share amounted 69 % of the total catch (mostly in SD 29 – 97.2%). Herring dominated in 4 from all 9 hauls performed. Its most share in the total catch mass was in the Sub-division 32 with mean share about 38 %. The rest 8 species (with smelt and three-spine stickleback predominance) represented only 1,6 % of the total mass in average.

The detailed catch and CPUE results and distribution are presented in the Table 1 and Fig. 2-3. The biological sampling is shown in Table 4. Mean CPUE for all species in the investigated area in 2016 amounted 729.5 kg/h comparing to 845.5 kg/h in the previous year (2015) – about 14 % decrease has been noted. The mean CPUE value for all species was similar in SD 29 and 32, respectively 729.6 and 772.5 kg/h in the investigated year. It was lower in SD 28.2 – 471.8 kg/h, however 1 haul only was performed in this SD.

The mean CPUEs of sprat in SDs 28.2, 29 and 32 were as follow: 297.5, 708.9 and 469,1 kg/h respectively. The mean CPUEs in case of herring were: 156.3, 10.0 and 292.3 kg/h in above mentioned SDs.

The length distributions of sprat, herring, three-spine stickleback, nine-spine stickleback and smelt according to the ICES Sub-divisions 28.2, 29 and 32 are shown on Fig. 4-8 respectively. Generally, sprat was caught in length range 6.5-14.0 cm. The modal value of sprat length frequency belonged to 10.5 cm length class in all SDs. A little frequency pick only at 8.0 cm length class represented 2016 generation of this species. The length range of herring from all control catches was 6,0-19,5 cm. The modal values of herring length frequency from SDs 28.2, 29 and 32 were 14.5, 13.5 and 13.0 cm respectively. This species generation born in 2016 (with modal frequency value 9.0 cm) was noted numerously only in SD 32. This herring generation was not found in SD 28.2. The total length range of three-spine stickleback was 3-7 cm. Its length frequency curves had bimodal character in all investigated SDs, with small pick at 3.5-4 cm length classes and main one at 5.5-6 cm length classes. The length frequency curves of nine-spine stickleback caught in SDs 29 and 32 had one mode character in length range 4-6 cm and frequency pick at 4.5 cm length class. Smelt was caught in SD 32 only. It existed in catches in wide length range 5-21 cm, with modal value of length frequency at 8 cm length class.

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. Fish concentrations were found to be higher in western part of Gulf of Finland as in previous years.

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 spatial distribution of sprat biomass and abundance differed considerably within the investigated area, abundance being highest near island Hiiumaa. The abundance and biomass of herring was highest in the western part of Gulf of Finland and lowest in the Baltic Proper. The average weight of individuals from both species was lower than in the previous survey, but abundance was considerably higher, especially for herring.

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[2]Anon. 2014. Report of the Baltic International Fish Survey Working Group (WGBIFS). ICES CM 2014/SSGESST: 13.

Meteorological and hydrological characteristics.

The 9 hydrological stations connected with the control catch locations (Fig.1) were inspected with CTD-probe combined with the rosette sampler. Hydrological parameters were measured at each catch–station location. Oxygen content was determined by the standard Winkler's method. The CTD row data aggregated to the 1 m depth stratum. The Oxygen probes were taken on every 10 meters.

The most frequently wind (Fig. 9) were: SE, ESE, E and N. The wind speed varied from 3.8 m/s to 16.6 m/s and average wind speed was 11.1 m/s. The air temperature ranged from 8.0 °C to 1.7 °C, and average temperature was 5.1 °C.

The seawater temperature in the surface layers varied from 7.73 to 10.30°C (the mean was 8.74°C). The lowest surface temperatures were recorded at the haul station 7. The highest ones were noticed at the haul station 5. The minimum value of salinity in Practical Salinity Unit (PSU) was 4.23 at the haul station 6 in the surface layer. The maximum was 6.66 PSU at the hydrological haul station 3. The mean value of salinity was 5.44 PSU. The oxygen content in the surface layers of investigated the research area varied in the range of 7.31 ml/l (haul 9) - 8.26 ml/l (haul 3). The mean value of surface water oxygen content was 7.71 ml/l.

The temperature of near bottom layer was changing in the range of 6.22 - 4.81°C (the mean was 5.58°C). Salinity in the bottom waters varied from 7.73 to 10.57 PSU (the mean was 9.11 PSU). The lowest values of salinity was at the haul station 3. The highest values of salinity were noticed at the haul station 1. Oxygen content varied from 0.00 ml/l to 5.23 ml/l (the mean was 1.69 ml/l). The lowest values of this parameter were noticed at the haul stations 4 and 5. Vertical distribution of the seawater temperature, salinity and oxygen content on the four chosen haul stations are presented at Fig. 10.

Discussion

The estimated total abundance of sprat in the survey regions was almost 10% higher compared to the previous year survey results. Herring abundance in same region was almost 2 times higher. Herring abundance was found low in Baltic Proper, but much higher in Gulf of Finland compared to previous year. Mean weights of individuals from both species were slightly lower than in the previous year and much lower compared to older results.

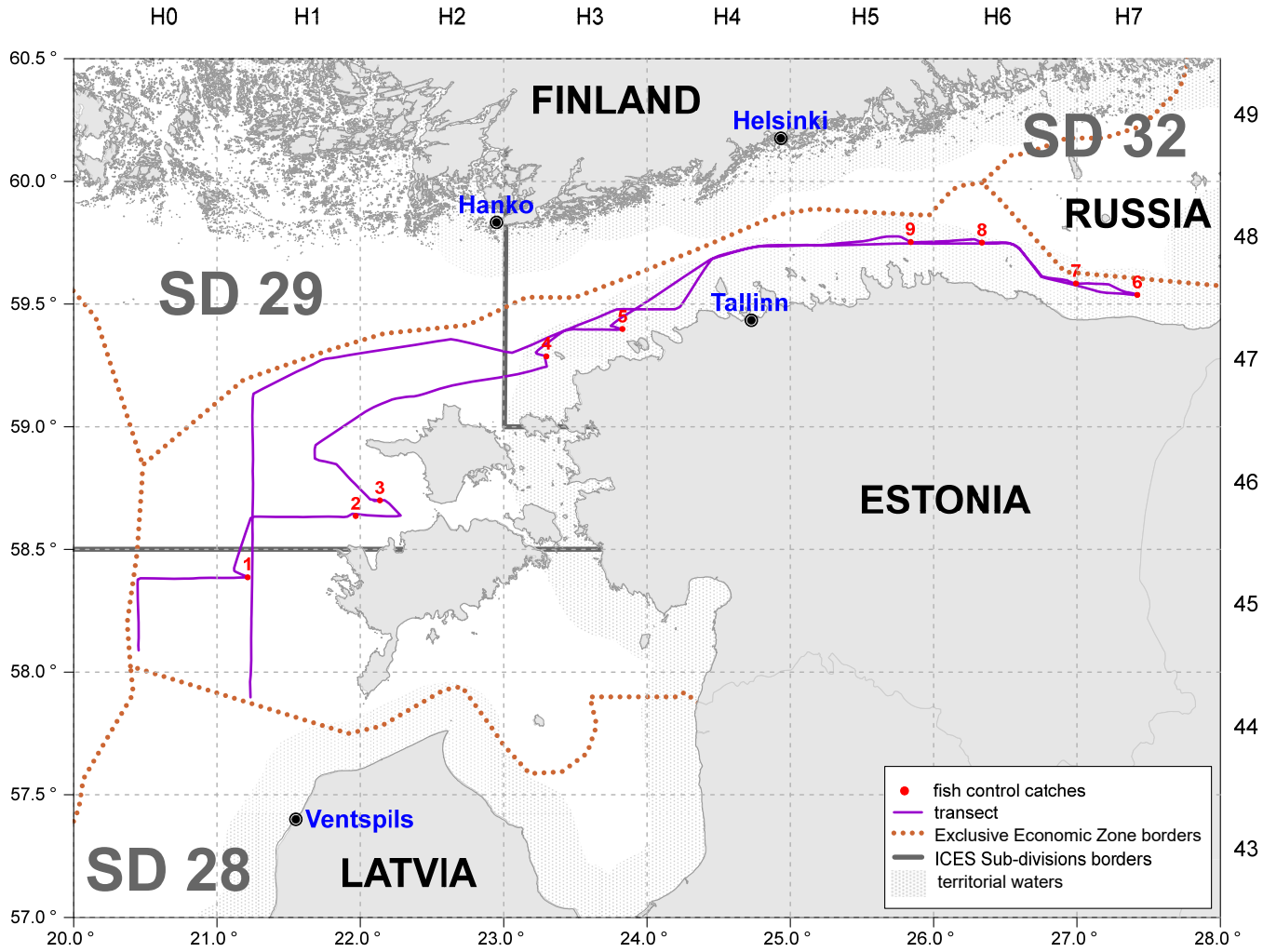


Fig. 1. Acoustic transects and pelagic fish control catches with connected hydrological stations realised during joint EST-POL BIAS 4Q 2016.

Table 1. Catch and CPUE results during joint Estonian-Polish BIAS conducted by r.v. “Baltica” in Estonian EEZ in October 2016.

Haul no	Date	ICES rectangle	ICES Sub-division (SD)	Geographical position start latitude 00°00.0'N	Geographical position start longitude 00°00.0'E	Geographical position end latitude 00°00.0'N	Geographical position end longitude 00°00.0'E	Time start	Time end	Haul duration [min]	Total catch [kg]	Catch per species [kg] sprat	herring	cod	flounder	short horn sculpin	eelpout	sand gobby	nine-spined stickleback	three-spined stickleback	smelt
1	2016-10-21	45H1	28.2	58°23.8'	21°10.5'	58°24.5'	21°07.7'	14:10	14:40	30	235,882	148,741	78,136	0,532					0,071	8,237	0,165
2	2016-10-22	46H1	29	58°38.3'	21°55.9'	58°38.6'	21°52.9'	08:05	08:35	30	650,957	643,971	0,260			0,087			0,130	6,509	
3	2016-10-22	46H2	29	58°42.0'	22°06.5'	58°42.1'	22°04.9'	12:30	12:45	15	39,300	32,462	4,873						0,362	1,603	
4	2016-10-23	47H3	32	59°17.5'	23°15.6'	59°17.7'	23°14.3'	09:35	09:50	15	151,200	68,010	81,860						0,015	0,711	0,604
5	2016-10-23	47H3	32	59°24.2'	23°47.5'	59°24.4'	23°46.3'	14:00	14:15	15	580,048	499,363	80,443						0,076	0,116	0,050
6	2016-10-24	48H7	32	59°32.6'	27°23.3'	59°32.8'	27°21.4'	08:05	08:20	15	36,940	6,738	29,792				0,052		0,052	0,218	0,089
7	2016-10-24	48H6	32	59°35.2'	26°58.4'	59°35.5'	26°56.8'	10:15	10:30	15	61,546	16,359	43,087					0,007	0,018	0,620	1,455
8	2016-10-24	48H6	32	59°45.0'	26°18.6'	59°45.7'	26°17.4'	13:45	14:00	15	171,679	93,966	73,753		0,121	0,065			0,103	0,446	3,225
9	2016-10-24	48H5	32	59°45.6'	25°48.7'	59°46.2'	25°46.9'	16:10	16:30	20	209,800	25,616	172,770						0,043	1,280	10,091
									Total	28.2	235,882	148,741	78,136	0,532					0,071	8,237	0,165
									catch	29	690,257	676,433	5,133			0,087			0,492	8,112	
									[kg]	32	1211,213	710,052	481,705		0,121	0,065	0,052	0,007	0,307	3,391	15,514
										Sum	2137,352	1535,226	564,974	0,532	0,121	0,152	0,052	0,007	0,870	19,740	15,679

Haul no	Date	ICES rectangle	ICES Sub-division (SD)	Haul duration [min.]	Total CPUE [kg/h]	CPUE per species [kg/h] sprat	herring	cod	flounder	short horn sculpin	eelpout	sand gobby	nine-spined stickleback	three-spined stickleback	smelt
1	2016-10-21	45H1	28.2	30	471,764	297,482	156,272	1,064					0,142	16,474	0,330
2	2016-10-22	46H1	29	30	1301,914	1287,942	0,520			0,174			0,260	13,018	
3	2016-10-22	46H2	29	15	157,200	129,848	19,492						1,448	6,412	
4	2016-10-23	47H3	32	15	604,800	272,040	327,440						0,060	2,844	2,416
5	2016-10-23	47H3	32	15	2320,192	1997,452	321,772						0,304	0,464	0,200
6	2016-10-24	48H7	32	15	147,760	26,952	119,168				0,206		0,206	0,872	0,356
7	2016-10-24	48H6	32	15	246,184	65,436	172,348					0,028	0,072	2,480	5,820
8	2016-10-24	48H6	32	15	686,716	375,864	295,012		0,484	0,260			0,412	1,784	12,900
9	2016-10-24	48H5	32	20	629,400	76,848	518,310						0,129	3,840	30,273
		Mean CPUE		28.2	471,764	297,482	156,272	1,064					0,142	16,474	0,330
		by SDs		29	729,557	708,895	10,006			0,087			0,854	9,715	
		[kg/h]		32	772,509	469,099	292,342		0,081	0,043	0,034	0,005	0,197	2,047	8,661
				Total	729,548	503,318	214,482	0,118	0,054	0,048	0,023	0,003	0,337	5,354	5,811

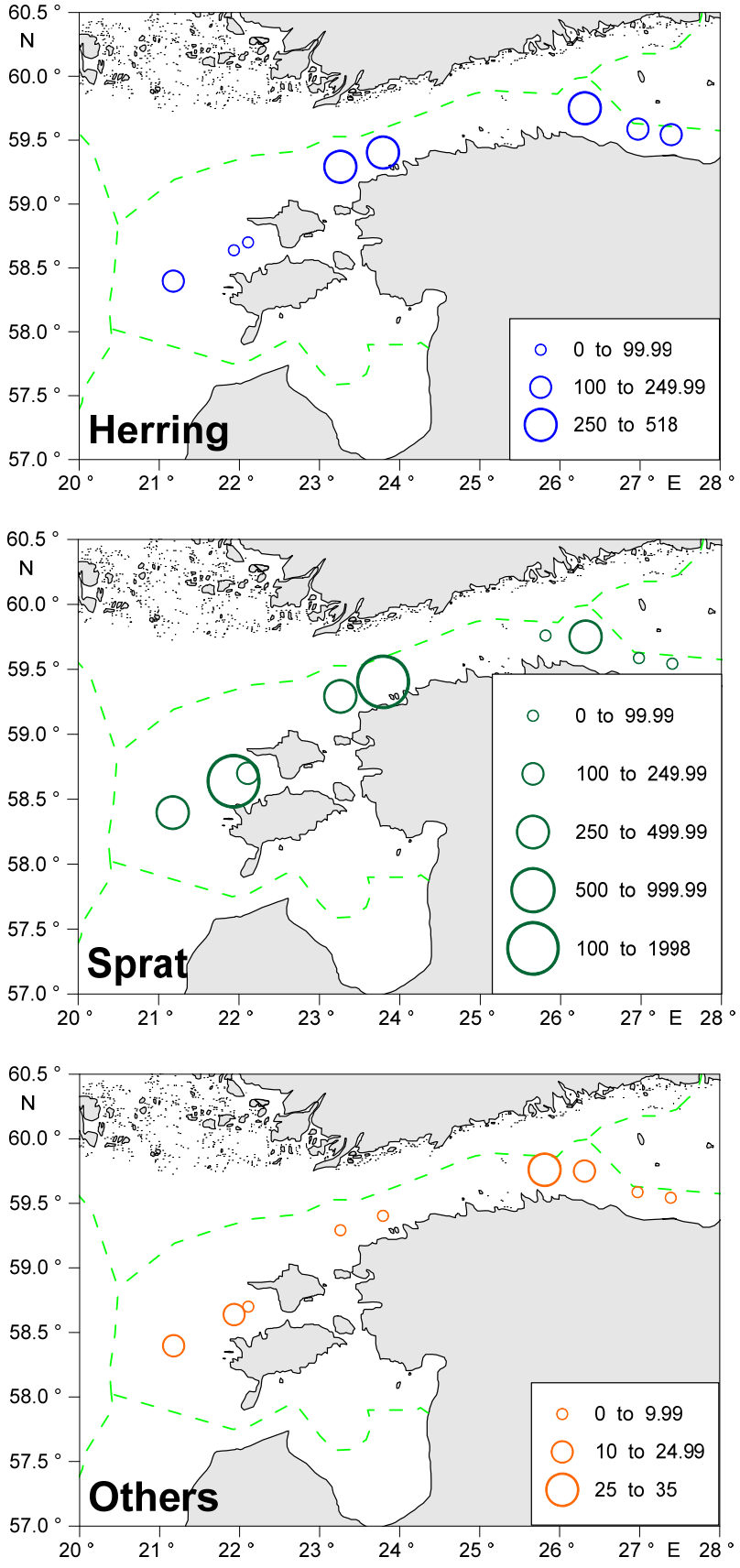


Fig. 2. Distribution of CPUE values (kg/h) for herring, sprat and other species in the pelagic fish control catches during EST-POL BIAS (October 2016).

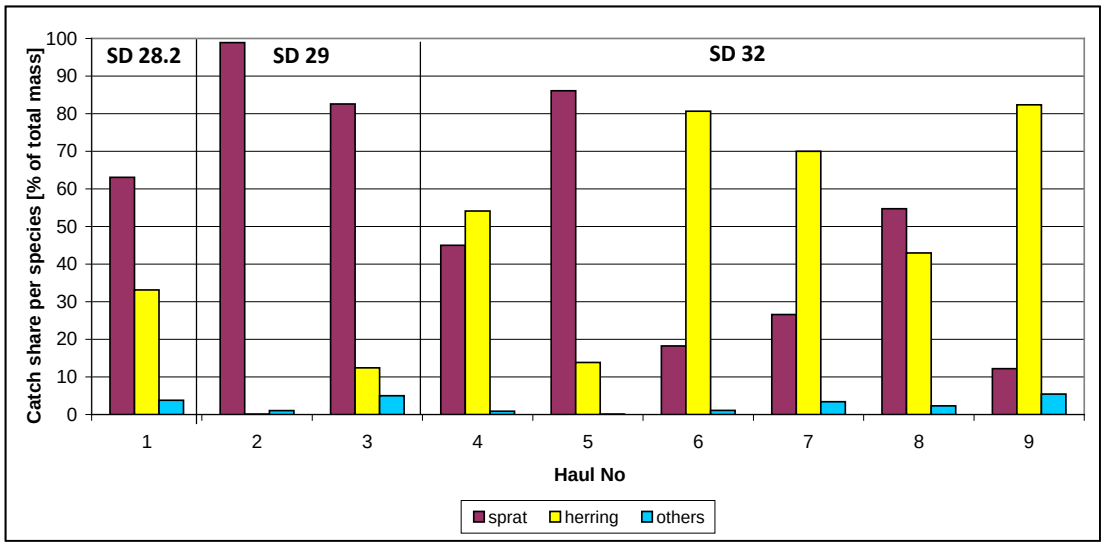


Fig. 3. Catch share per species [% of total mass] in particular control hauls during joint EST-POL BIAS (October 2016).

Table. 2. Biological sampling in the r.v."Baltica" joint EST-POL BIAS in October 2016.

Fish biological material collected during EST-POL BIAS; r/v "Baltica", October 2016.

SD 28.2		SPRAT	HERRING	THREE SPINED STICKLEBACK	NINE SPINED STICKLEBACK	SMELT	EEL POUT	TOTAL
Samples taken	measurements	1	1	1	1	1	0	5
	analyses	1	1	0	0	0	0	2
Fish measured		205	261	50	10	1	0	527
Fish analysed		117	117	0	0	0	0	234

SD 29		SPRAT	HERRING	THREE SPINED STICKLEBACK	NINE SPINED STICKLEBACK	SMELT	EEL POUT	TOTAL
Samples taken	measurements	2	2	2	2	0	0	8
	analyses	2	2	0	0	0	0	4
Fish measured		444	197	98	46	0	0	785
Fish analysed		123	98	0	0	0	0	221

SD 32		SPRAT	HERRING	THREE SPINED STICKLEBACK	NINE SPINED STICKLEBACK	SMELT	EEL POUT	TOTAL
Samples taken	measurements	6	6	6	6	6	1	31
	analyses	6	6	0	0	0	0	12
Fish measured		1270	1801	301	76	197	10	3655
Fish analysed		180	339	0	0	0	0	519

Sum SDs		SPRAT	HERRING	THREE SPINED STICKLEBACK	NINE SPINED STICKLEBACK	SMELT	EEL POUT	TOTAL
Samples taken	measurements	9	9	9	9	7	1	44
	analyses	9	9	0	0	0	0	18
Fish measured		1919	2259	449	132	198	10	4967
Fish analysed		420	554	0	0	0	0	974

Zooplankton samples collected during EST-POL BIAS; r/v "Baltica", October2016.

Sub-divisi	stations	samples
28.2	1	1
29	2	2
32	6	6
Sum	9	9

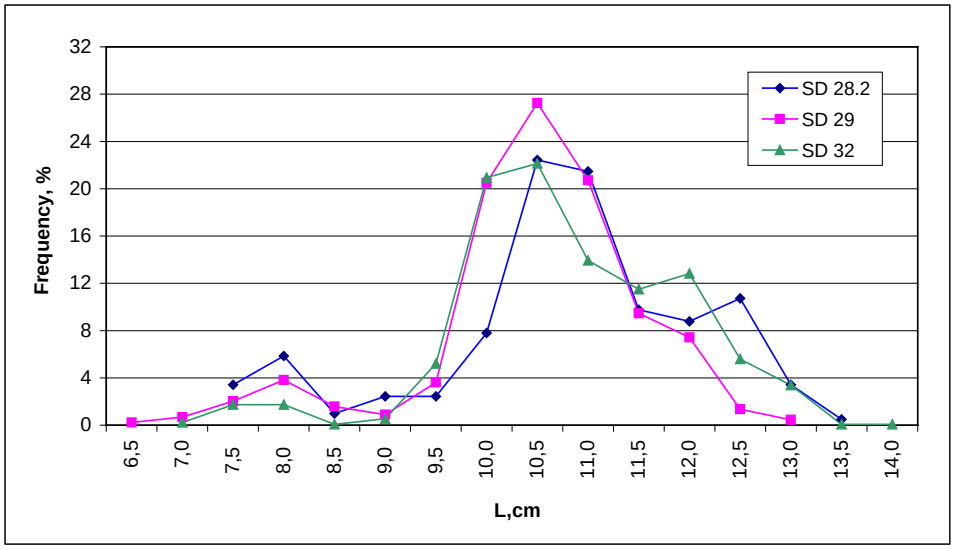


Fig. 4. Sprat length distributions from the control catches conducted by the rv. "Baltica" during joint EST-POL BIAS in the SDs 28.2, 29 and 32 (October 2016).

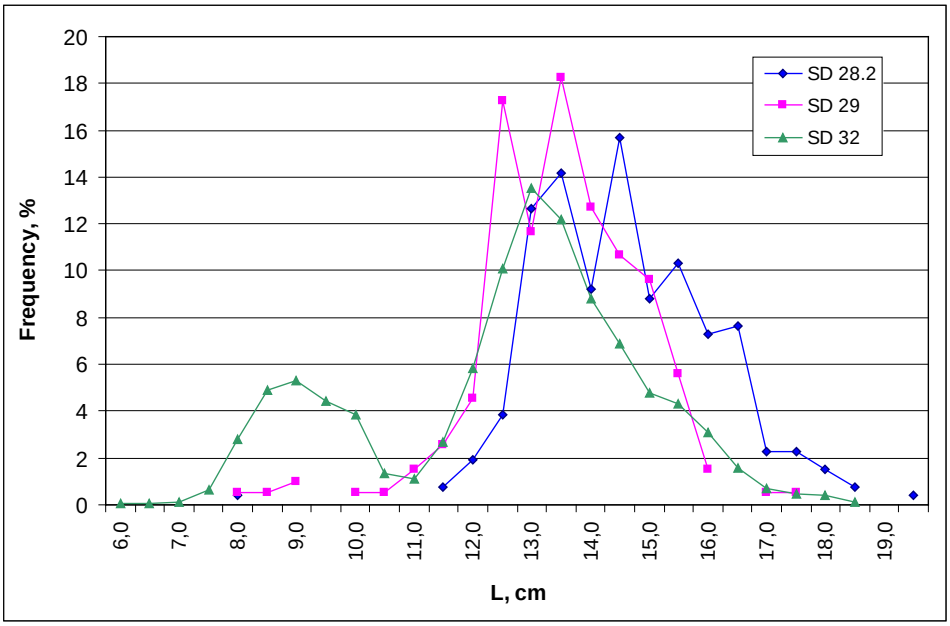


Fig. 5. Herring length distributions from the control catches conducted by the rv. "Baltica" during joint EST-POL BIAS in the SDs 28.2, 29 and 32 (October 2016).

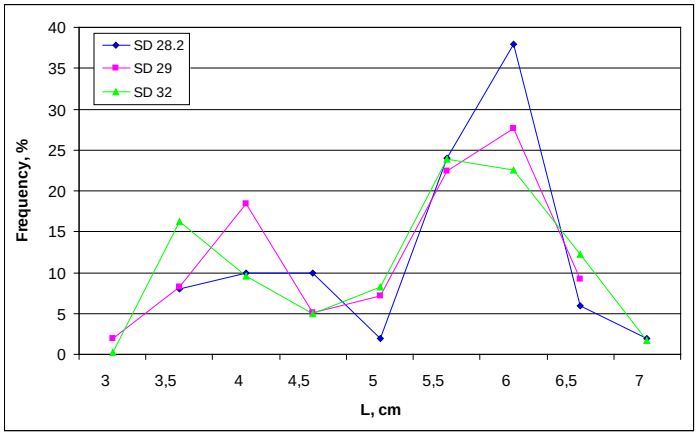


Fig. 6. Three-spined stickleback length distributions from the control catches conducted by the rv. “Baltica” during joint EST-POL BIAS in the SDs 28.2, 29 and 32 (October 2016).

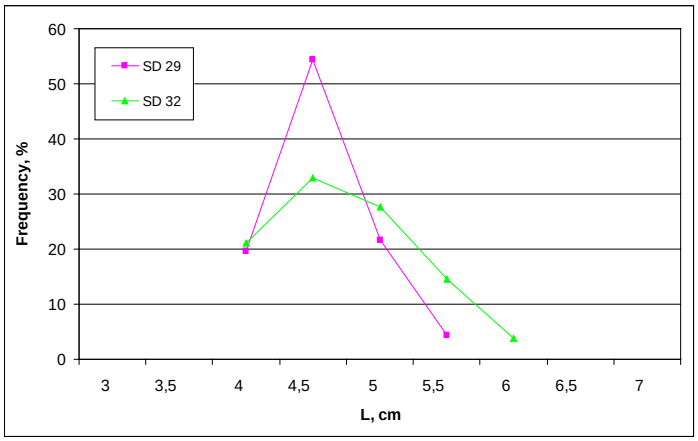


Fig. 7. Nine-spined stickleback length distributions from the control catches conducted by the rv. “Baltica” during joint EST-POL BIAS in the SDs 28.2, 29 and 32 (October 2016).

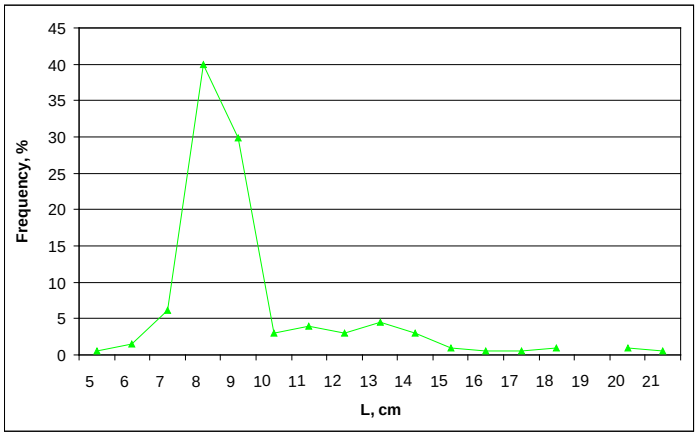


Fig. 8. Smelt length distributions from the control catches conducted by the rv. “Baltica” during joint EST-POL BIAS in the SD 32 (October 2016).

Table 3. The BIAS survey basic biological and acoustic data concerning the clupeid stocks inhabiting the north- eastern Baltic Sea in October 2016.

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 [cm^2]
			herring	sprat				
28	45H0	947.2	3,1	34,3	8917,93	9,415	618,9	0,657
28	45H1	827.1	14,4	65,0	7950,35	9,612	1082,8	1,127
29	46H1	921.5	0,1	94,2	7145,14	7,754	814,4	1,050
29	46H2	258.0	4,7	67,9	1282,29	4,970	448,7	0,903
29	47H1	920.3	30,6	53,7	9202,00	9,999	1229,2	1,229
29	47H2	793.9	32,6	62,5	32609,50	41,075	5202,4	1,267
32	47H3	536.2	19,0	78,7	7009,79	13,073	1575,0	1,205
32	48H4	835.1	66,1	19,3	19868,09	23,791	3708,8	1,559
32	48H5	767.2	66,1	19,3	20202,23	26,332	4104,9	1,559
32	48H6	776.1	46,2	44,1	7061,84	9,099	1130,5	1,242
32	48H7	851,4	70,7	20,6	5500,64	6,461	785,4	1,216
Average			**32,1**	**50,9**		**14,851**	**1881,9**	**1,183**
Total		**8434**			**126750**			

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 2016.

ICES Sub-div.	ICES rectangle	HERRING – age groups									
		0	1	2	3	4	5	6	7	8+	total
28	45H0	37,94	2,96	150,54	42,01	24,78	10,97	0,99	3,57	5,79	279,54
28	45H1	4,39	17,57	536,18	205,51	184,87	119,44	8,78	25,91	43,47	1146,13
total		42,33	20,53	686,71	247,52	209,66	130,41	9,77	29,47	49,26	1425,67
29	46H1	4,17	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,17
29	46H2	1,53	4,84	34,44	8,32	6,32	2,98	0,00	0,31	0,95	59,69
29	47H1	85,35	109,94	1654,30	377,64	263,59	227,45	0,00	38,38	59,46	2816,09
29	47H2	199,44	892,35	5787,16	1199,61	929,17	1196,68	0,00	139,17	294,79	10638,36
total		290,49	1007,12	7475,90	1585,57	1199,08	1427,11	0,0	177,85	355,20	13518,31
32	47H3	14,04	52,12	498,93	396,56	118,57	139,29	45,62	42,26	25,51	1332,92
32	48H4	230,99	1045,24	6527,01	3842,52	581,00	660,01	86,84	78,26	75,07	13126,95
32	48H5	234,88	1062,82	6636,78	3907,14	590,77	671,11	88,30	79,58	76,33	13347,72
32	48H6	1237,32	256,28	1108,28	518,81	54,81	65,55	12,00	9,22	0,00	3262,26
32	48H7	2224,89	141,05	494,62	534,77	192,89	183,95	54,71	46,63	15,64	3889,15
total		3942,12	2557,5	15265,62	9199,8	1538,05	1719,91	287,48	255,95	192,56	34959,0
Grand total		4274,94	3585,15	23428,24	11032,89	2946,78	3277,43	297,25	463,28	597,03	49902,98

Table 4. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups									
		0	1	2	3	4	5	6	7	8+	Total
28	45H0	753,84	243,67	1390,88	341,36	117,47	88,14	12,47	31,40	83,99	3063,23
28	45H1	655,53	447,87	2458,32	601,26	290,07	266,53	79,24	154,88	214,91	5168,61
total		1409,37	691,54	3849,19	942,63	407,54	354,68	91,71	186,28	298,90	8231,83
29	46H1	838,04	806,66	4130,30	797,63	38,91	53,87	29,93	38,91	0,00	6734,25
29	46H2	51,68	161,92	545,45	89,44	5,37	7,35	3,98	5,37	0,00	870,55
29	47H1	155,00	767,01	3170,23	618,57	52,53	68,65	51,81	57,91	0,00	4941,72
29	47H2	2622,20	5788,59	10117,29	1448,61	79,12	153,87	107,97	79,12	0,00	20396,77
total		3666,91	7524,19	17963,27	2954,26	175,92	283,75	193,69	181,30	0,00	32943,29
32	47H3	646,57	1191,18	3231,00	206,66	50,13	86,03	55,99	17,72	31,19	5516,49
32	48H4	40,91	554,86	1844,54	410,24	219,83	363,59	232,28	63,35	107,67	3837,27
32	48H5	41,60	564,20	1875,57	417,14	223,52	369,71	236,18	64,41	109,48	3901,81
32	48H6	3,99	427,51	1606,85	310,09	143,81	273,55	179,98	50,94	120,48	3117,20
32	48H7	5,38	141,84	591,65	128,32	50,64	90,15	62,36	20,68	44,79	1135,822
total		738,46	2879,59	9149,61	1472,45	687,93	1183,03	766,79	217,10	413,62	17508,59
Grand total		5814,74	11095,32	30962,08	5369,33	1271,39	1821,46	1052,19	584,68	712,52	58683,72

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 2016.

ICES Sub-div.	ICES rectangle	HERRING – age groups									
		0	1	2	3	4	5	6	7	8+	total
28	45H0	4,74	32,14	2270,86	740,32	505,58	259,94	24,90	95,48	151,95	4085,91
28	45H1	14,05	178,64	8204,58	3706,48	3989,72	2909,24	240,86	660,23	1145,91	21049,70
total		18,80	210,77	10475,43	4446,80	4495,29	3169,17	265,77	755,71	1297,86	25135,61
29	46H1	19,61	0	0	0	0	0	0	0	0	19,61
29	46H2	8,61	53,68	508,20	149,67	132,99	66,22	0	7,35	21,18	947,89
29	47H1	125,99	1240,29	23389,02	6280,75	5207,84	4886,85	0	829,15	1414,68	43374,57
29	47H2	422,25	9808,78	79188,97	20296,74	18541,90	26425,15	0	3006,70	7244,03	164934,52
total		576,47	11102,74	103086,19	26727,15	23882,73	31378,22	0	3843,20	8679,89	209276,59
32	47H3	34,40	553,42	6908,60	6948,45	2515,71	2948,43	1083,74	1013,35	626,53	22632,62
32	48H4	1259,90	10843,92	92405,55	71673,77	13353,98	15172,96	2306,62	1980,59	2531,01	211528,30
32	48H5	1281,09	11026,30	93959,66	72879,20	13578,57	15428,14	2345,41	2013,90	2573,58	215085,90
32	48H6	6161,85	2426,80	15754,96	9390,20	1272,20	1495,33	321,58	252,47	0	37075,39
32	48H7	10431,21	1178,32	7678,26	10762,07	4930,49	4776,47	1619,18	1442,71	568,25	42818,70
total		19168,43	26028,76	216707	171653,70	35650,96	39821,33	7676,53	6703,02	6299,38	529140,90
Grand total		19764	37342	330269	202828	64029	74369	7942	11302	16277	763553

Table 5. Continued

ICES Sub-div.	ICES rectangle	SPRAT – age groups									
		0	1	2	3	4	5	6	7	8+	total
28	45H0	2834,60	1596,13	10790,11	3019,30	1065,96	895,45	137,04	354,77	686,80	21380,16
28	45H1	2203,59	2986,65	18888,68	5421,54	2833,24	2846,41	870,92	1740,76	2278,77	40070,57
total		5038,19	4582,79	29678,80	8440,84	3899,20	3741,86	1007,96	2095,53	2965,57	61450,72
29	46H1	2621,87	5130,68	32224,53	6881,93	393,88	573,46	341,20	393,88	0,00	48561,43
29	46H2	177,69	1041,50	4090,44	763,57	56,54	80,39	47,83	56,54	0,00	6314,50
29	47H1	577,44	4676,61	23341,75	5256,49	537,53	717,04	557,79	537,53	0,00	36202,19
29	47H2	7472,95	33822,96	71418,28	12154,12	786,06	1618,29	1184,40	786,06	0,00	129243,12
total		10849,94	44671,76	131075,00	25056,11	1774,01	2989,18	2131,22	1774,01	0,00	220321,25
32	47H3	1846,29	7555,25	21838,66	1730,90	478,14	856,32	567,18	176,06	338,22	35387,01
32	48H4	175,64	3508,15	13712,36	3769,29	2150,53	3669,94	2454,12	665,28	1257,25	31362,55
32	48H5	178,59	3567,15	13942,98	3832,69	2186,70	3731,67	2495,39	676,47	1278,40	31890,02
32	48H6	14,78	3125,80	12956,32	2939,42	1466,19	2919,64	1993,66	568,09	1470,41	27454,33
32	48H7	19,38	943,92	4694,44	1222,69	518,31	957,72	683,33	224,58	548,38	9812,75
total		2234,67	18700,26	67144,76	13494,99	6799,86	12135,29	8193,68	2310,49	4892,66	135906,67
Grand total		18123	67955	227899	46992	12473	18866	11333	6180	7858	417679

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 2016.

ICES Sub-div.	ICES rectangle	HERRING – age groups									
		0	1	2	3	4	5	6	7	8+	avg.
28	45H0	0,13	10,84	15,09	17,62	20,40	23,70	25,20	26,78	26,25	14,62
28	45H1	3,20	10,17	15,30	18,04	21,58	24,36	27,43	25,48	26,36	18,37
29	46H1	4,70									4,70
29	46H2	5,63	11,10	14,76	17,99	21,04	22,20		24,00	22,24	15,88
29	47H1	1,48	11,28	14,14	16,63	19,76	21,49		21,61	23,79	15,40
29	47H2	2,12	10,99	13,68	16,92	19,96	22,08		21,61	24,57	15,50
32	47H3	2,45	10,62	13,85	17,52	21,22	21,17	23,76	23,98	24,56	16,98
32	48H4	5,45	10,37	14,16	18,65	22,98	22,99	26,56	25,31	33,71	16,11
32	48H5	5,45	10,37	14,16	18,65	22,98	22,99	26,56	25,31	33,71	16,11
32	48H6	4,98	9,47	14,22	18,10	23,21	22,81	26,79	27,39		11,36
32	48H7	4,69	8,35	15,52	20,12	25,56	25,97	29,59	30,94	36,33	11,01

Table 6. Continue

ICES Sub-div.	ICES rectangle	SPRAT – age groups									
		0	1	2	3	4	5	6	7	8+	avg.
28	45H0	3,76	6,55	7,76	8,84	9,07	10,16	10,99	11,30	8,18	6,98
28	45H1	3,36	6,67	7,68	9,02	9,77	10,68	10,99	11,24	10,60	7,75
29	46H1	3,13	6,36	7,80	8,63	10,12	10,64	11,40	10,12		7,21
29	46H2	3,44	6,43	7,50	8,54	10,54	10,93	12,03	10,54		7,25
29	47H1	3,73	6,10	7,36	8,50	10,23	10,44	10,77	9,28		7,33
29	47H2	2,85	5,84	7,06	8,39	9,94	10,52	10,97	9,94		6,34
32	47H3	2,86	6,34	6,76	8,38	9,54	9,95	10,13	9,94	10,84	6,41
32	48H4	4,29	6,32	7,43	9,19	9,78	10,09	10,57	10,50	11,68	8,17
32	48H5	4,29	6,32	7,43	9,19	9,78	10,09	10,57	10,50	11,68	8,17
32	48H6	3,70	7,31	8,06	9,48	10,20	10,67	11,08	11,15	12,20	8,81

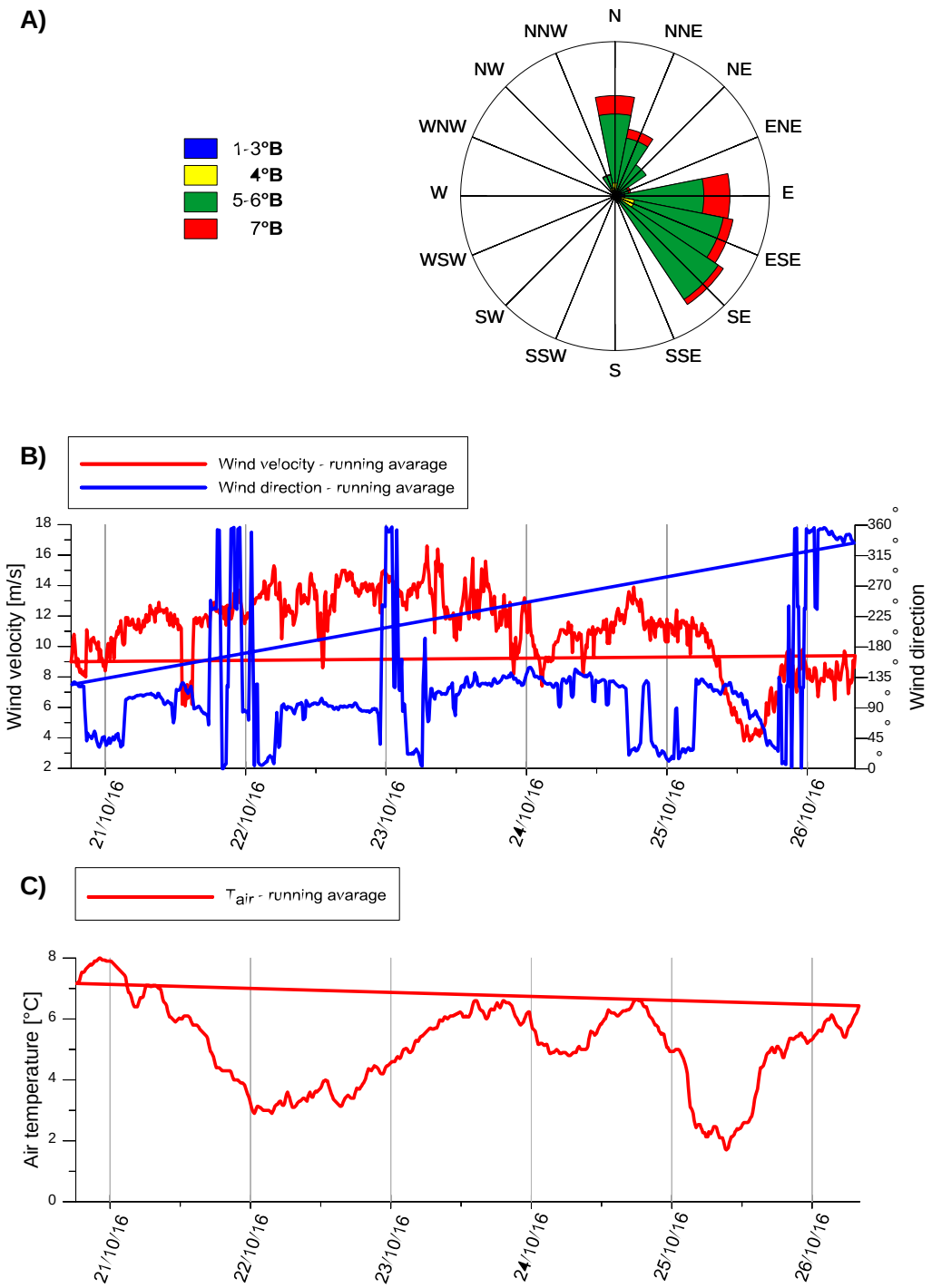


Fig. 9. Changes of the main meteorological parameters during EST-POL BIAS in October 2016.

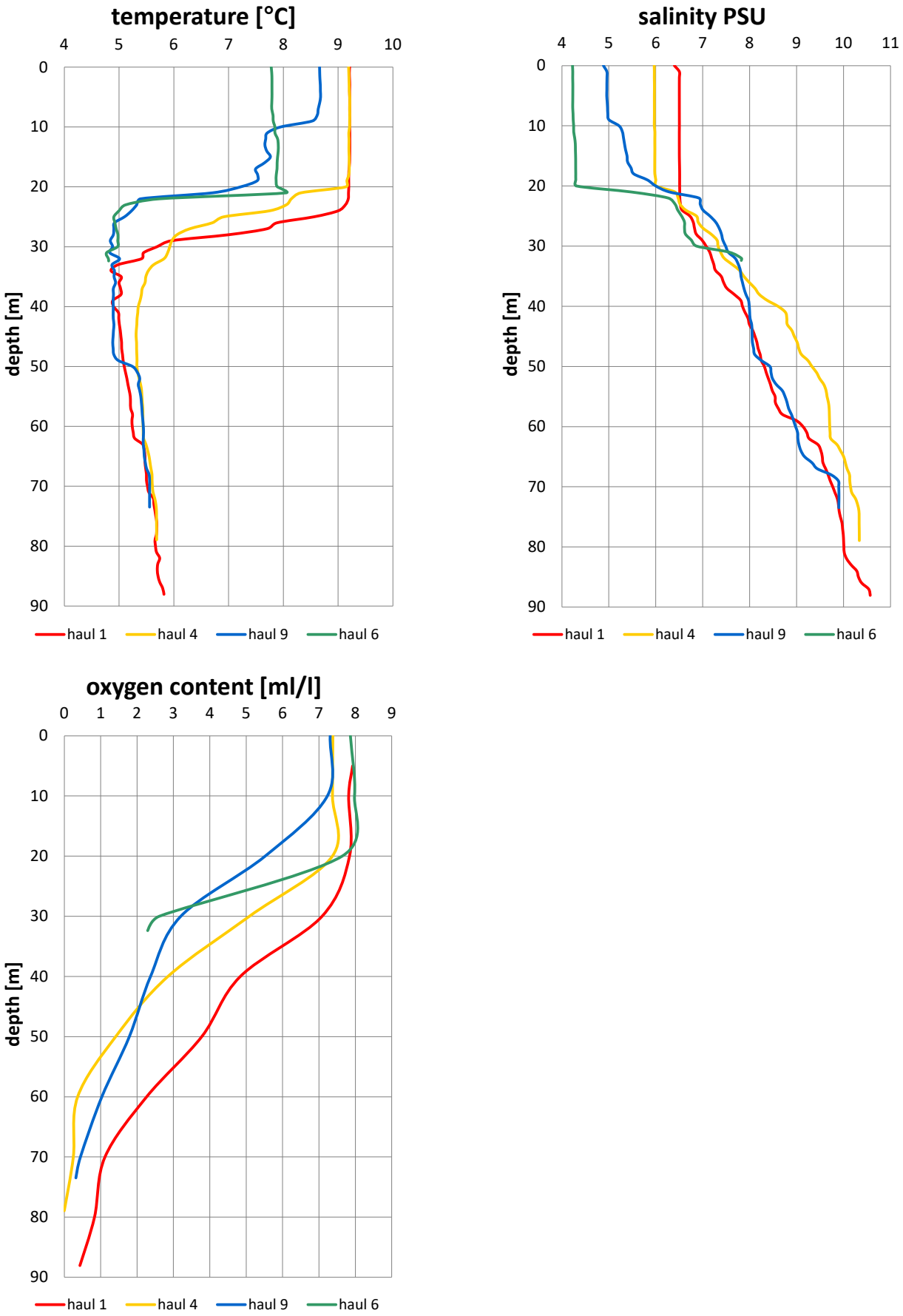


Fig. 10. Vertical distribution of the seawater temperature, salinity and oxygen content on the four chosen haul stations sampled during EST-POL BIAS (October 2016).

Fisheries Service under the Ministry of Agriculture of Republic of Lithuania,
Fishery Research and Science State

RESEARCH REPORT FROM THE BALTIC INTERNATIONAL ACOUSTIC SURVEY (BIAS) IN THE ICES SUBDIVISION 26 (LITHUANIAN ESPECIAL ECONOMIC ZONE) OF THE BALTIC SEA

(R/V “DARIUS”; 13.10. - 14.10.2016)

Working paper on the WGBIFS meeting in Riga, Latvia, 27.03-31.03.2017

Klaipeda, October, 2016
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.

The principal aims of the Lithuanian BIAS surveys organized and realized by the Division of Fishery research and science delegates on board of the R/V "Darius" were:

- annual verification of herring, sprat and cod stocks size and their spatial distribution in the pelagic zone of the Lithuanian Especial Economic Zone (LEEZ) waters with applied an acoustic method, along preselected transects on the distance of 124 nautical miles (NM),
- 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 R/V "Darius".

2 MATERIALS AND METHODS

2.1 Personnel

The main research tasks of the BIAS survey on board of the R/V "Darius" were realized by the Fishery Research and Science State (FS FRSS) two members of the scientific team. The group of researchers was composed of:

M. Spegys, FS FRSS, Klaipeda - cruise leader and acoustics;
J. Fedotova, FS FRSS, Klaipeda – scientific staff and fish sampling.
G. Macernius, FS FRSS, Klaipeda – fish sampling

2.2 Narrative

The reported BIAS survey of the R/V "Darius" took place during the period of 13-14 October in 2016. The vessel left the port of Klaipeda on 13.10.2016 early morning. On next day 14.10.2016 evening, the research activity had been stopped and the vessel returned back to the homeport. During research time was intended to cover parts of ICES subdivision (SD) 26, constituting the LEEZ.

2.3 Survey design

The area of international acoustic survey is limited by the 20 m depth line. The statistical rectangles of Subdivision 26 were used as strata (BIAS, ver. 0.82, ICES CM 2010/j: 1 Ref. Assess). The scheme of transects has been defined as the regular, of rectangular form, with the distance between transects of 15 nm. The average speed of a vessel for the all period of acoustic survey was 8.0 knots. The average speed of the vessel with a trawl was 3 knots; the trawling duration was standard 30 minutes. The survey was conducted in the daytime from 08:00 up to 17.00 of local time. All investigated area of survey constitutes the 2015 nm^2. The full cruise track with positions of the trawling is shown on Figure 1.

2.4 Calibration

The SIMRAD EK60 echo sounder with split beam transducer ES38 - 12 were calibrated in 28th of April in the Baltic Sea shore area The calibration procedure was carried out with a standard calibrated copper sphere, in accordance with the 'Manual for the Baltic International Acoustic

Surveys (BIAS) (“Manual for the Baltic International Acoustic Survey”, Version 0.3-0.82, WGBIFS 2011 ICES CM 2011/ SSGESST:07).

THE RESULTS OF CALIBRATION PROCEDURE FOR EK60 SCIENTIFIC ECHOSOUNDER	
Date: 28.04.2014	Place : near Klaipeda port
Type of transducer	Split – beam for 38 kHz
Gain (38 kHz)	21.94 dB
Athw. Angle Sens	12.5
Along. Angle Sens	12.5
Athw. Beam Angle	12.06
Along. Beam Angle	11.96
Athw. Offset Angle	0.08
Along. Offset Angle	-0.15
SA Correction (38 kHz)	-0.18 dB

2.5 Acoustic data collection

The acoustic sampling was performed around the clock. The main pelagic species of interest were herring and sprat. The SIMRAD EK60 echo sounder with hull mounted 38 kHz transducer ES38-12 was used during the cruise. The specific settings of the hydro acoustic equipment were used as described in the BIAS manual (ICES 2011). The post-processing of the stored echo signals was made using the Sonar4 (Balk & Lindem, 2005). The mean volume back scattering values Sv, were integrated over 1 nm intervals, from 10 m below the surface to the bottom. Contributions from air bubbles, bottom structures and noise scattering layers were removed from the echogram using Sonar4.

2.6 Biological data – fishing stations

All trawling were done with the pelagic gear “OTM” in the midwater as well as near the bottom. The mesh size in the codend was 20 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 of the single haul lasted for 30 minutes. On the whole, 6 catch samples were taken in the Lithuanian EEZ. 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 each rectangle was estimated as the product of the mean NASCs scrutinized acoustic data and a rectangle area, divided by corresponded the mean acoustic cross-section. Clupeids abundance was separated into herring and sprat according to the mean catch composition.

After finalization of each trawling, a hydrographic measurement was executed. The vertical profiles of hydrographical parameters, (temperature, salinity of water and the oxygen dissolved in water) were taken with a "SBE-19 plus" probe.

3. RESULTS

3.1 Biological data

Caught fishes, before the length measurements, were separated by species and weighed, and the species composition, the mean share in mass (proportion) as well as the CPUE was determined for given species from each control-haul. The sample of fish dominants from each catch-station was taken for the length-mass structure analyses. Fish sampling 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. Overall, in 6 trawl hauls was measured for 843 herring, 1140 sprat, 2 cods, 2 shorthorn sculpins, and 1 smelt. Totally, 422 individuals of sprat, 510 of herring and 2 of cod were biologically analyzed (age, sex, maturity, stomach fullness). The results of the catch composition are presented in Table 1. Ichthyological 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, 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.

The length distributions of herring and sprat of the October 2016 presented in Fig. 3 and 4. Both rectangles were represented practically by sprat. In the coastal rectangle (40H0) herring was only 37%. Most of its was fish of 15.5–21.5 cm length class. There were no young (0+ age class) fish and a little herring recruitment (age 1) – 0.8%. In 40G9 rectangle herring stock was represented 15.5–20.5 cm length class without young herring too.

Sprat was represented by two size groups in the rectangle 40H0: 7.0–8.5 cm and 10.0–12.0 cm. And more than 55% of sprat was fish of this year generation. (age 0+). In the western part of LEEZ (40G9 rectangle ICES) sprat was represented practically of adult fish 10.5-13.5 cm length classes.

3.2 Acoustic data

The survey statistics concerning the survey area, the mean S_a , the mean scattering cross-section σ, the estimated total number of fish, the percentages of herring, sprat per rectangle are shown in Table 2-12. Nautical area scattering coefficient distribution during survey is show in Figure 2.

3.3 Abundance estimates

R/V “Darius” survey statistics (aggregated data for herring and sprat), included the total abundance of herrings and sprats are presented in tables 2-4. The estimated age composition of sprat and herring are given in Table 5 and Table 10. The estimated number sprat and herring by age group and rectangle are given in Table 6 and Table 11. The estimates of sprat and herring biomass by age group and rectangle are summarised in Table 7 and Table 12. The corresponding mean weights and mean length by age group and rectangle for each species are shown in tables 8-9 and tables 13-14.

The herring stock was estimated to be $2269.8*10^6$ fish or about 102696.2 tones. The abundance estimates were dominated by 3 - 6 ages herring in rectangle 40H0 and by 2-6 ages herring in rectangle 40G9 (Fig. 2 and Table 8).

The sprat stock was estimated to be $3457.1*10^6$ fish or about 25456.9 tones. More than 55% of all aged sprats were young (0+ age class) fish in rectangle 40H0 and by ages 2-5 fish (86%) in the rectangle 40G9 (Fig. 3 and Table 5).

Comparison of the acoustic results from last five years (2010-2014) indicated that investigated herring stock abundance have decreasing tendency in ICES rectangle 40H0. In 2016 was recorded the highest average parameters of the herring stock densities in this rectangle (Fig.5). At the same time investigated sprat stock have decreasing tendency in this rectangle in 2013-2014 The distribution of the high density sprat concentrations were indicated in the northern part of the ICES rectangle 40H0 (Fig.6).

3.4 Hydrologic data

The basic hydrological parameters (seawater temperature, salinity and oxygen contents) were measured from the surface to the bottom after every haul. Totally, 6 hydrological stations were inspected during survey. The hydrological research profiles location is presented in Figure 7.
The seawater temperature varied from 7 ºC to 10 ºC in the surface layer in 40H0 and 40G9 ICES rectangles. The lowest temperature (about 2 ºC lower then in surface) was in 30 -40 m depth. Deeper temperate equable grow. The salinity is 7.5 -8 ‰ in all area and strata. There was no oxygen deficit in this survey.

4.0 REFERENCES

ICES. 1983. Report of the Planning Group on ICES co-ordinated herring and sprat acoustic surveys. ICES CM 1983/H:12;

ICES. 2001. Report of the Baltic International Fish Survey Working Group. ICES CM 2001/H:02 Ref.:D;

Foote, K.G., Aglen, A., and Nakken, O. 1986. Measurement of fish target strength with a split-beam echosounder. J.Acoust.Soc.Am. 80(2):612–621;

ICES. 2011. Report of the Baltic International Fish Survey Working Group (WGBIFS), March 2011, Kaliningrad, Russia. ICES CM 2011/SSGESST:07. 102 p.

Figure 1. The survey grid and trawl hauls position of R/V “DARIUS” (13-14 October 2016)

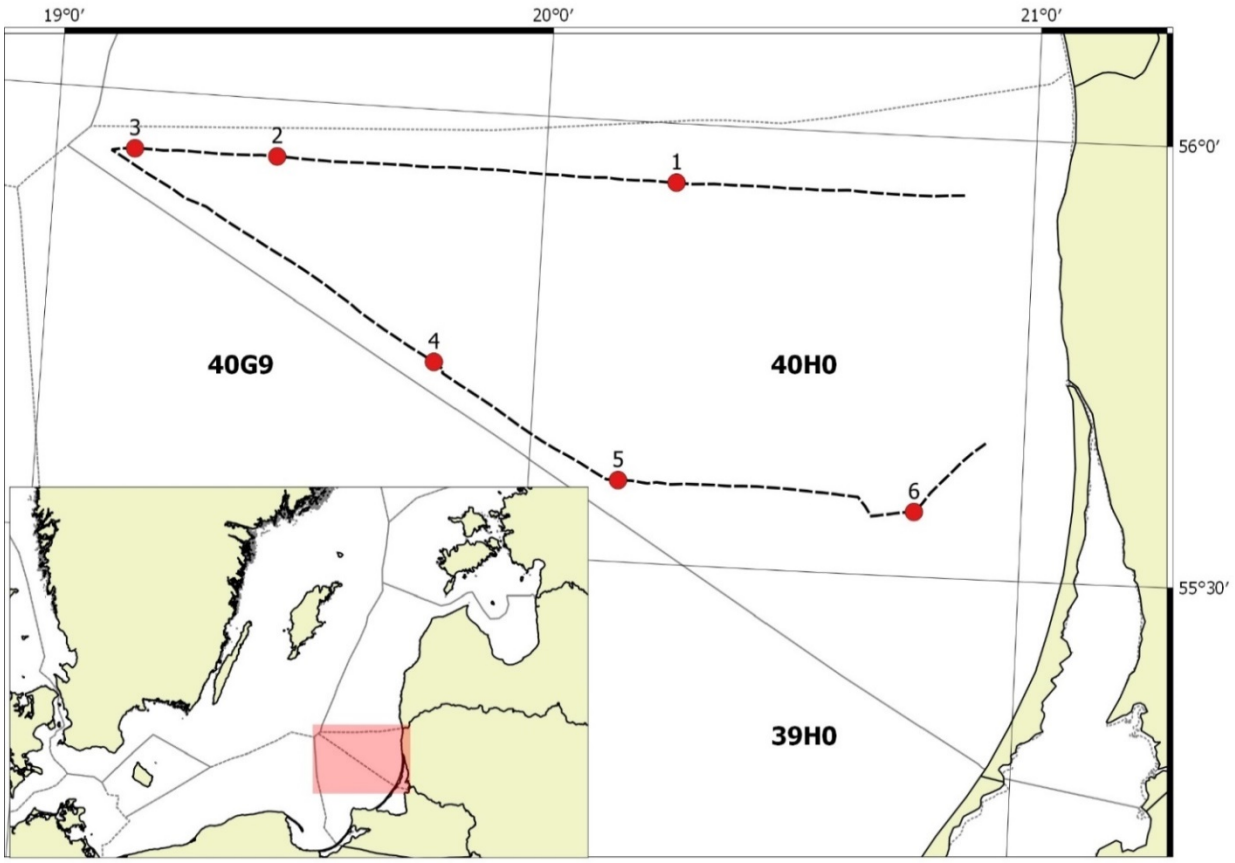


Figure 2. Mean nautical area scattering coefficient (NASC) per 3nmi of R/V “DARIUS” (13-14 October 2016)

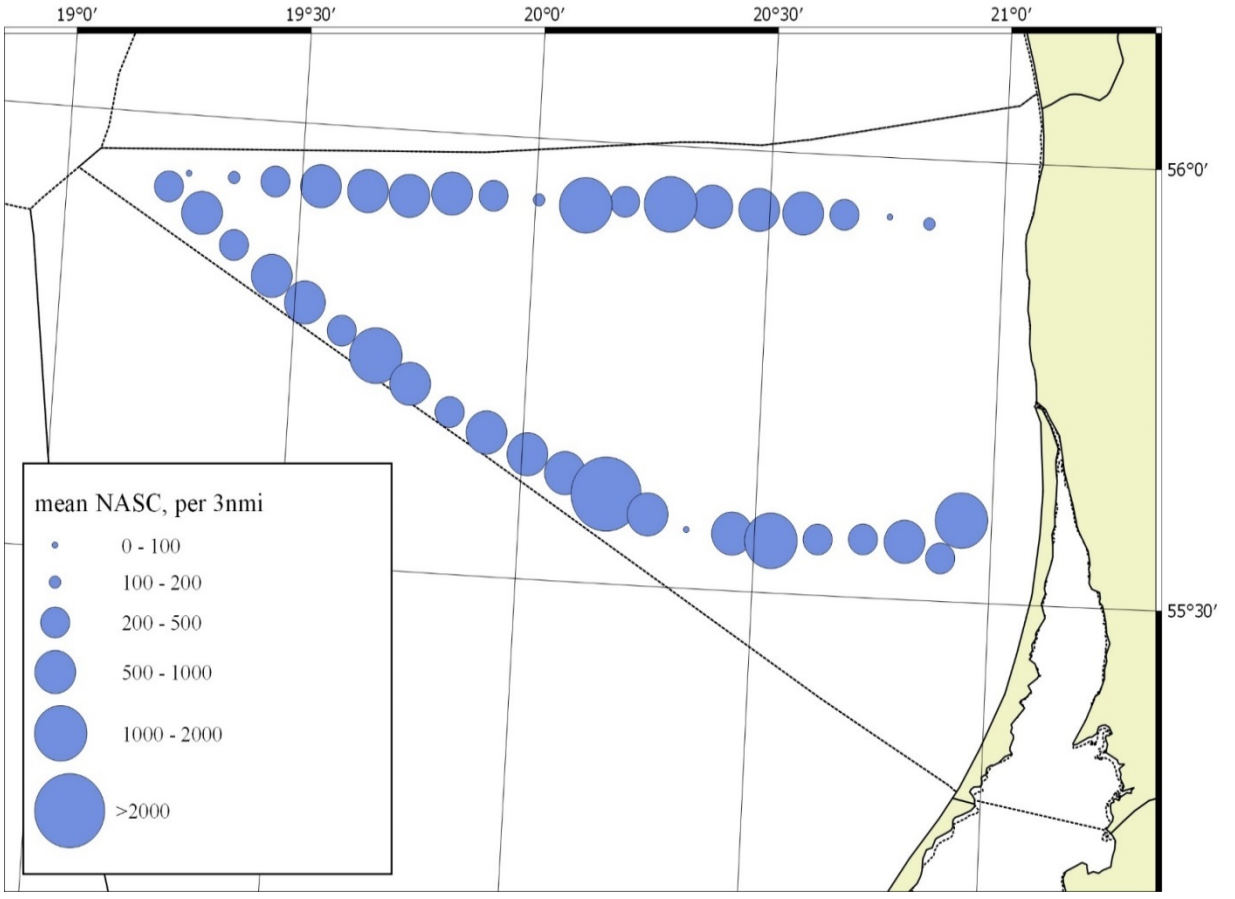


Table 1. Catch composition (kg/1hour) per haul (R/V "Darius", 13.10- 14.10.2016)

ICES subdivision 26						
Haul No	1	2	3	4	5	6
Date	13.10.2016	13.10.2016	13.10.2013	14.10.2016	14.10.2016	14.10.2016
Validity	Valid	Valid	Valid	Valid	Valid	Valid
Species/ICES rectangle	40H0	40H0	40G9	40G9	40G9	40H0
CLUPEA HARENGUS		1.75	31.944	77.3	180.00	191.056
SPRATTUS SPRATTUS	2	30	9.5	342.7		5,808.94
GADUS MORHUA				0.96		2.688
SHORTHORN SCULPIN	0.472					
SMELT	0.024					
Total	2.496	31.75	41.444	420.96	180	6002.688

Figure 3. Length composition of herring (%) (R/V "Darius", 13.10- 14.10.2016

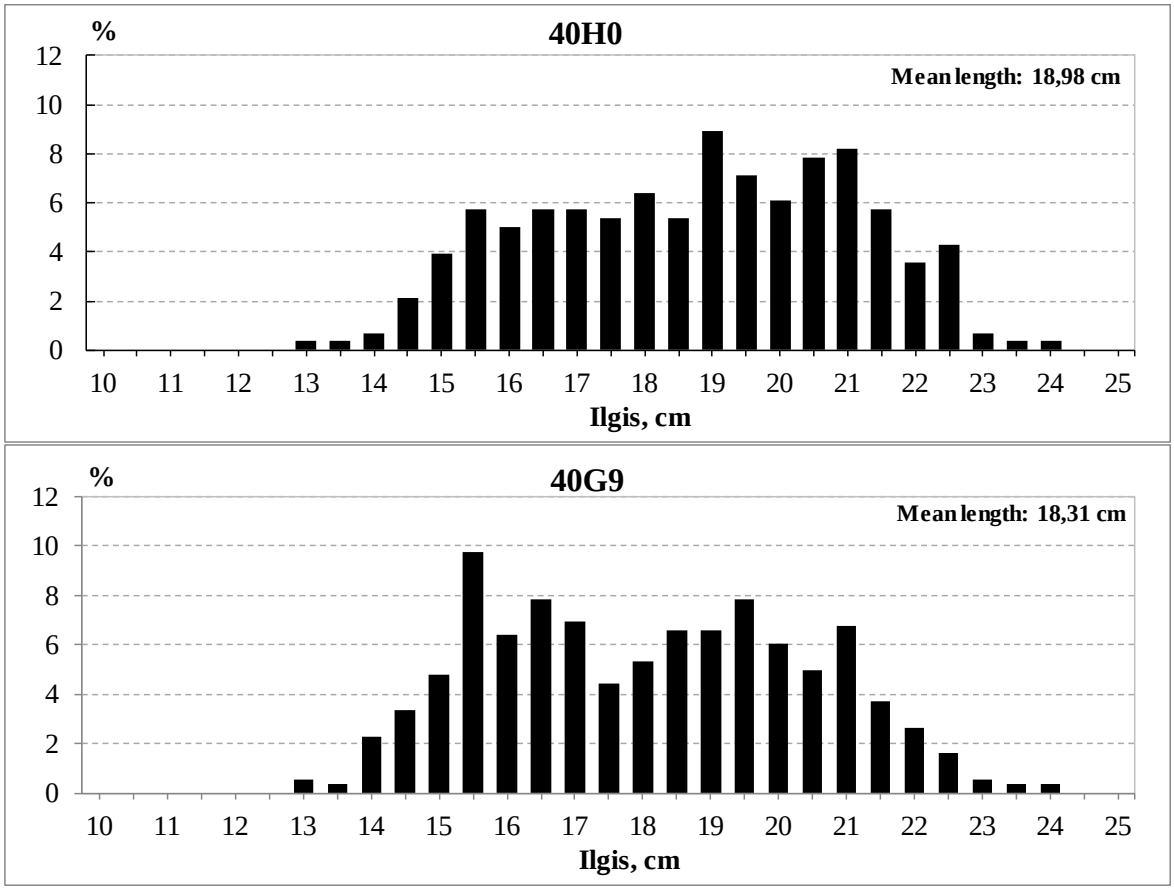


Figure 4 Length distribution of sprat (%) (R/V "Darius", 13.10- 14.10.2016)

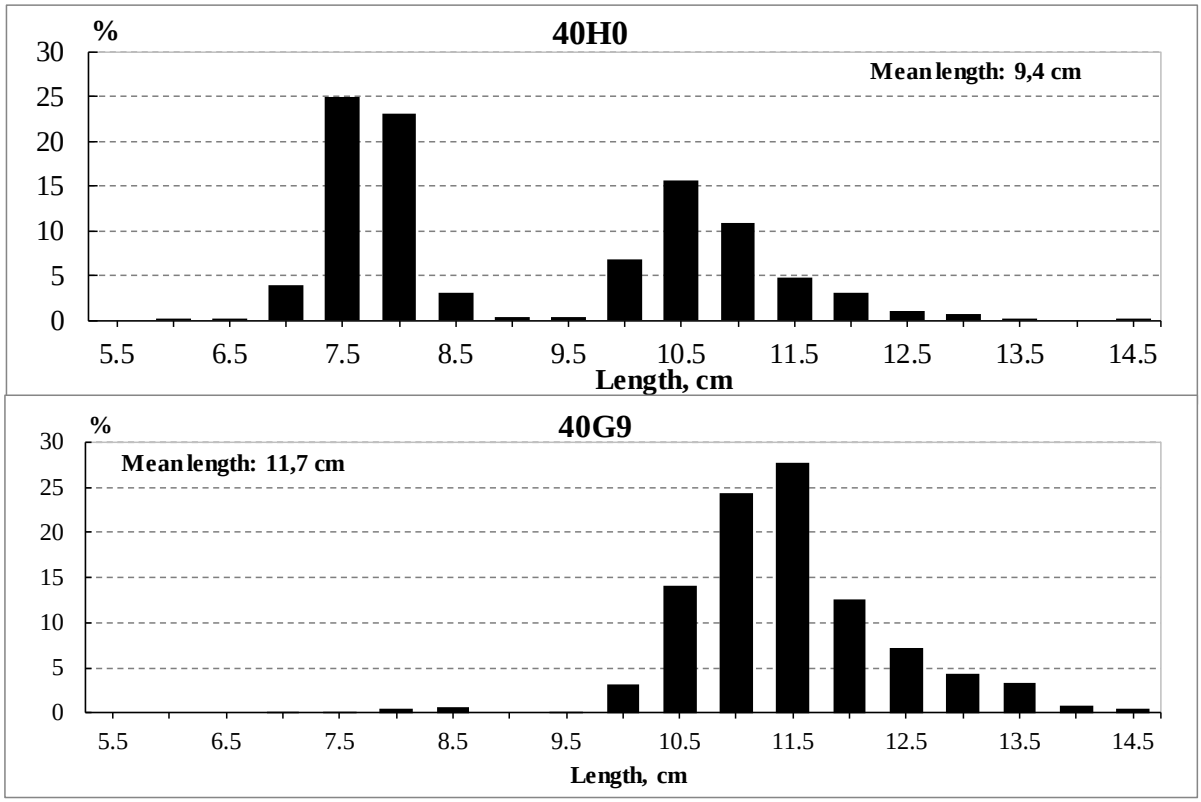


Table 2 R/V "DARIUS" survey statistics (abundance of herring and sprat), 13.10- 14.10.2016

ICES SD 26	ICES Rect.	Area nm^2	ρ mln/nm^2	Abundance, mln			Biomass, tonn		
				N sum	N her	N spr	W sum	W her	W spr
	40H0	1012,1	3.87	3917.9	1435.9	2482.0	77703	62525.7	15177.6
	40G9	1013,0	1.79	1810.0	833.9	976.1	50450	40170.5	10279.3

Table 3 R/V "DARIUS" survey statistics (aggregated data of herring and sprat), 13.10- 14.10.2016

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	1,5,6	18.98	43.55	36.65	9.36	6.12	63.35	706.1	-48.4
	40G9	2,3,4	18.31	48.17	46.07	11.69	10.53	53.93	393.9	-47.6

Table 4 R/V "DARIUS" survey statistics (herring and sprat), 13.10- 14.10.2016

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	706.1	1.82407	3917.9	36.65	63.35
	40G9	1013	393.9	2.20452	1810.0	46.07	53.93

Table 5 R/V "Darius" estimated age composition (%) of sprat, 13.10- 14.10.2016

	Rect.	Age									
SD 26		Total	0	1	2	3	4	5	6	7	8
	40H0	100,0	55.6	11.3	23.9	4.0	3.1	1.2	0.0	0.4	0.4
	40G9	100,0	1.4	3.9	33.4	29.6	16.2	6.8	4.4	2.9	1.4

Table 6 R/V "Darius" estimated number (millions) of sprat, 13.10- 14.10.2016

	Rect.	Age									
SD 26		Total	0	1	2	3	4	5	6	7	8
	40H0	2482.0	1379.5	279.9	593.0	100.2	78.1	30.8	0.0	10.3	10.3
	40G9	976.1	13.3	37.8	326.0	289.1	157.9	66.6	42.9	28.6	13.9

Table 7 R/V "Darius" estimated biomass (in tons) of sprat, 13.10- 14.10.2016

	Rect.	Age									
SD 26		Total	0	1	2	3	4	5	6	7	8
	40H0	15178	4534	2408	5558	1032	889	415	0	154	188
	40G9	10279	45	336	3134	2952	1770	855	578	412	197

Table 8 R/V "Darius" estimated mean weights (g) of sprat, 13.10- 14.10.2016

	Rect.	Age									
SD 26		Mean	0	1	2	3	4	5	6	7	8
	40H0	6.12	3.3	8.6	9.4	10.3	11.4	13.5		15.0	18.4
	40G9	10.53	3.4	8.9	9.6	10.2	11.2	12.8	13.5	14.4	14.1

Table 9 R/V "Darius" estimated mean length (cm) of sprat, 13.10- 14.10.2016

	Rect.	Age									
SD 26		Total	0	1	2	3	4	5	6	7	8
	40H0	9.4	7.7	10.3	10.7	11.3	11.9	12.7		13.0	13.8
	40G9	11.7	8.1	10.6	11.0	11.4	11.8	12.5	12.7	13.1	13.0

Table 10 R/V "Darius" estimates age composition (%) of herring, 13.10- 14.10.2016

	Rect.	Age									
SD 26		Total	0	1	2	3	4	5	6	7	8
	40H0	100,0		0.8	9.2	19.9	23.2	17.7	13.9	8.0	7.3
	40G9	100,0		2.9	16.2	22.4	26.1	13.1	12.2	5.4	1.7

Table 11 R/V "Darius" estimated number (millions) of herring, 13.10- 14.10.2016

	Rect.	Age									
SD 26		Total	0	1	2	3	4	5	6	7	8
	40H0	1435.9		11.5	131.9	285.5	333.7	254.0	200.1	114.8	104.3
	40G9	833.9		24.1	135.1	186.4	217.8	109.5	101.9	44.9	14.2

Table 12 R/V "Darius" estimated biomass (in tons) of herring, 13.10- 14.10.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	62526		227	4117	8990	13465	12007	10657	6570	6492
	40G9	40170		612	4933	9087	10177	6203	5670	2667	822

Table 13 R/V "Darius" estimated mean weights (g) of herring, 13.10- 14.10.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	43.5		19.7	31.2	31.5	40.3	47.3	53.3	57.2	62.2
	40G9	48.2		25.5	36.5	48.7	46.7	56.7	55.7	59.3	57.9

Table 14 R/V "Darius" estimated mean length (cm) of herring, 13.10- 14.10.2016

SD	Rect.	Age									
		Total	0	1	2	3	4	5	6	7	8
26	40H0	18.98		14.3	16.6	16.8	18.4	19.5	20.2	20.7	21.4
	40G9	18.31		16	15.7	17.1	18.2	18.9	20.6	20.6	21.0

Figure 5. Biomass and abundance of herring by acoustic survey results from October of 2010 – 2016 in ICES rectangles 40HO and 40G9

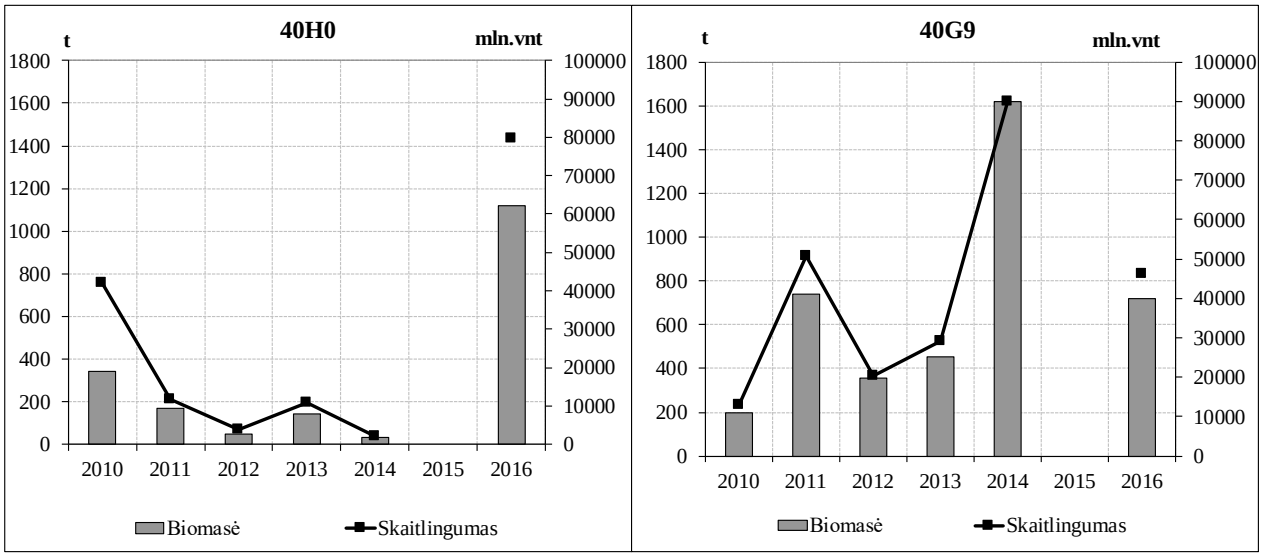


Figure 6. Biomass and abundance of sprat by acoustic survey results from October of 2010 – 2016 in ICES rectangles 40HO and 40G9

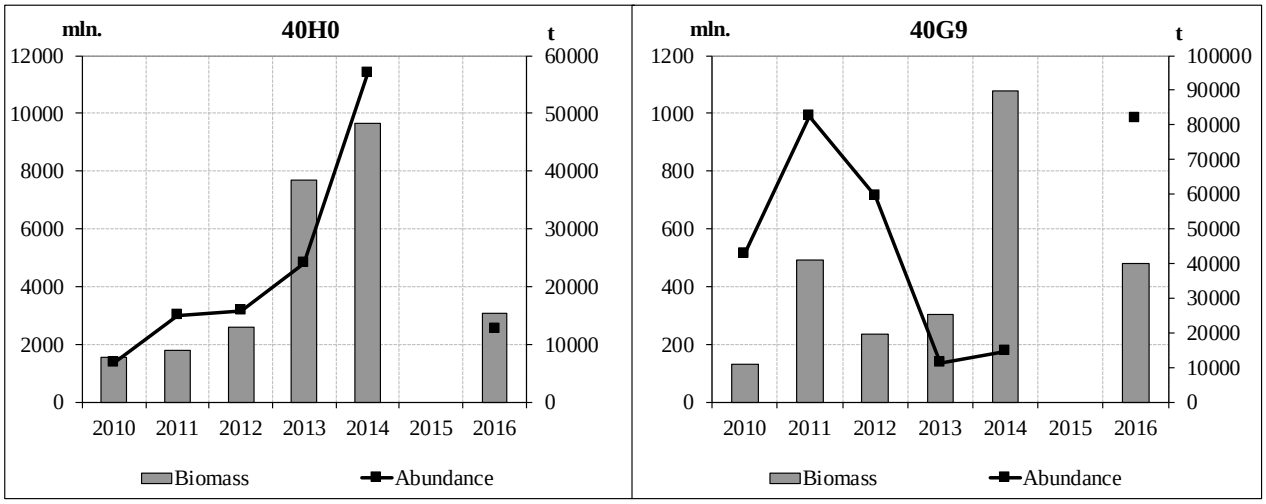
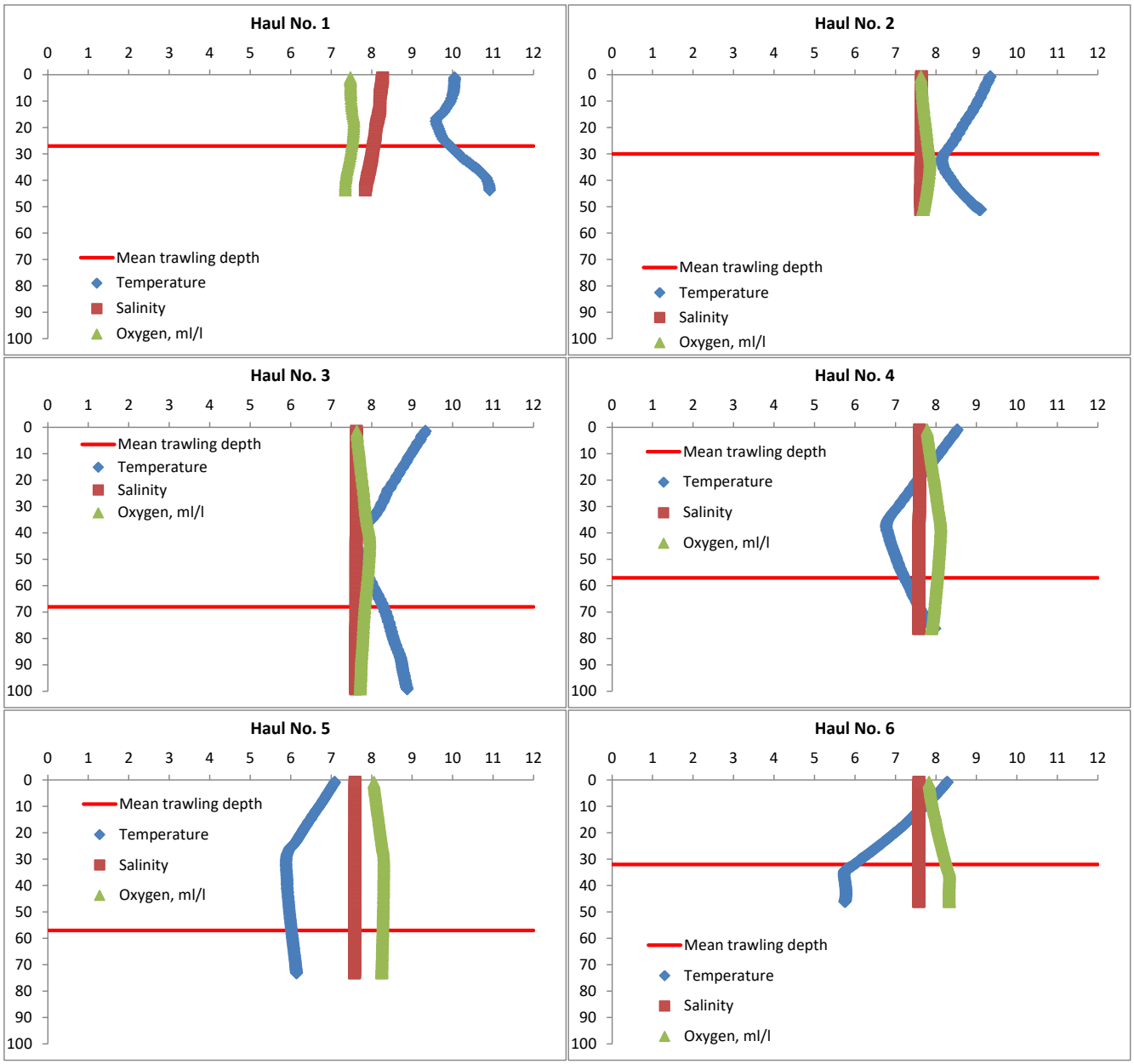


Figure 7. Hydrological parameters registered at the hydrological station from the Lithuanian BIAS survey conducted by r/v "Darius" in the period of 13.10-14.10.2016.



Research report from the Polish part of the Baltic International Acoustic Survey on board of the r.v. “Baltica” (13-30.09.2016)

Grzegorz Kruk, Mirosław Wyszyński, Bartosz Witalis and Włodzimierz Grygiel
National Marine Fisheries Research Institute, Gdynia (Poland)

INTRODUCTION

In October 1982, the Sea Fisheries Institute (SFI) in Gdynia (currently named National Marine Fisheries Research Institute – NMFRI) began the international acoustic investigations of herring and sprat stocks size and distribution, mostly in the Polish marine waters of the southern Baltic. In the 1980s, the SFI contribution to those surveys was limited to chartering of commercial stern cutter the m/t “HEL-100”, which was designated for fish control-hauls realization. Moreover, the SFI delegates participated in several acoustic surveys on board of the Swedish r.v. “Argos”. Sporadically, also the Polish r.v. “Profesor Siedlecki” participated in the Baltic acoustic surveys (May 1983 and 1985, October 1989 and 1990). Since 1994, the permanent participation of the Polish r.v. "Baltica", managed by the NMFRI in Gdynia, has took place in the framework of the ICES Baltic International Acoustic Surveys (BIAS) long-term programme, which is coordinated by the ICES Baltic International Fish Survey Working Group (WGBIFS). The WGBIFS coordinated methods of investigations and designed timing of the BIAS survey, the scheme of acoustic monitoring spatial allocation, and general pattern of pelagic control-hauls distribution in the Baltic.

The reported 23rd consecutive (1994-2016) acoustic survey in the Polish EEZ was conducted on-board of the r.v. “Baltica” between 13th and 30th of September 2016. The research was focused on monitoring of clupeids and cod spatial-temporal distribution in pelagic zone of the southern Baltic (parts of the ICES Sub-Divisions 24, 25, 26) moreover, on assessment of stocks size of the above-mentioned fishes. The BIAS survey was carried out in the season of herring and sprat an ending phase of intensive feeding and at the beginning of a new year-class, recruiting to the stocks exploited in the Polish waters of the southern Baltic.

The acoustic system EK-60 SIMRAD with the new determined calibration parameters were applied to completing the BIAS survey tasks. The Polish Fisheries Data Collection Programme for 2016 and the European Union (the Commission Regulations Nos. 665/2008 1078/2008, 2008/949/EC, 2010/93/EU) financially and logistically supported the Polish BIAS survey marked with internal No. 14/2016/MIR-PIB.

The ICES Baltic Fisheries Assessment Working Group [WGBFAS] will use the BIAS data for tuning clupeids (sprat and herring) stock biomass assessment and spatial distribution based on the data from commercial catches.

The main goal of current paper is a brief description of sprat, herring and cod stocks size changes and their spatial distribution as well as analysis of the CPUE variation within the Polish waters of the southern Baltic at autumn 2016. Moreover, the paper contains description of sprat, herring and cod some biological parameters variation. The principal hydrological parameters fluctuation in the water column of the southern Baltic is also described.

MATERIAL AND METHODS

Research team personnel

The main research tasks of September 2016 the BIAS survey on board of the r.v. "Baltica" were realized by the NMFRI (Gdynia) nine members of the scientific team, with Mirosław Wyszyński as a cruise leader. The group of researchers was composed of:
Grzegorz Kruk – hydroacoustician,
Jakub Słembarski – hydroacoustician, electronics specialist,
Zuzanna Celmer - specialist, herring analyses,
Joanna Pawlak - specialist, sprat analyses,

Krzysztof Radtke – ichthyologist, cod analyses,
Wojciech Deluga – technician, herring analyses,
Ireneusz Wybierala – technician, sprat analyses,
Bartosz Witalis – hydrologist.

The course of the cruise

The r.v. "Baltica" left the Gdynia port on 13th of September 2016 at 00:05 o'clock and was navigated in the south-eastern direction, where at the mouth of the Vistula River a successful calibration of the acoustic system, installed on the vessel, was carried out. On the same day in the evening, the ship was directed to the start point of a planned acoustic transects above the Gdansk Deep (Fig. 3). The acoustic integration started on 14th of September 2016 at 7 a.m. The researches at sea ended on 27.09.2016 in the evening at the western part of Polish EEZ, in the ICES rectangle 38G4. The r.v. "Baltica" returned to the Gdynia port on 30th of September at 08:10 a.m. One of the fish-catches planned in the vicinity of the Ustka port was impossible to realise because of stormy weather.

Survey design and realization

The SIMRAD EK-60 version 2.2.0, a split beam scientific echosounder, with the GPT transceivers operating at 38 and 120 kHz frequencies, as in the previous years, was used in the recent Polish BIAS. New values (from the above-mentioned calibration) of acoustic parameter *Sv* (transducer gain) for the transducers type ES38-B (ser. Nº 30867) and ES120-7C (ser. Nº 566) were applied:
38 kHz – 23,87 dB (reference: 23,85 dB, Fig. 1),
120 kHz – 26,45 dB (reference: 26,50 dB).

Calibration was performed at location:
Lat. 54°27.7'N, Lon. 019°07.1'E.

The depth of dropped calibration spheres: 15-24 m, as it can be seen in Figure 2 (a screenshot from the Echoview programme showing a fragment of the calibration of the 38 kHz transducer).

The integration of acoustic data was carried out between 14th and 27th of September 2016, along transects shown in Figure 3. The recorded data were analysed in the Echoview programme according to the recommendations of the recent "Manual for Baltic International Acoustic Surveys (IBAS)". Only 38 kHz transmitter's data were taken into further processing because that frequency is recommended for fish trace recording. According to the ICES advice calculation of parameter S_A [m^2/NM^2] (hereinafter called NASC) was carried out in the range from -60 dB to -24 dB by first removing noise and other wrong data type recorded. Then the average NASC for each nautical mile within overall 876 miles of integration by 10-m depth layers was calculated from exported to a CSV file data from the Echoview. After that, the average coordinates for miles were calculated and the NASC average values were assigned to the corresponding ICES statistical rectangles and Sub-divisions (SD).

The acoustic and ichthyologic sampling procedure is stratified by the ICES statistical rectangles, with the range of 0.5 degree in latitude and 1 degree in longitude in the ICES Sub-divisions 24, 25 and 26. The intention was to carry out at least minimum two control-hauls per the ICES statistical rectangle. Overall 36 catch-stations were inspected by the r.v. "Baltica" in autumn of 2016, using the herring small-meshed pelagic trawl type WP53/64x4 with 6 mm mesh bar length in the codend (Table 3). The trawling time for most hauls was 30 minutes, however duration of 16 of them was 15 and 60 minutes. The time of trawling depended on the density of fish concentration coming into the trawl mouth, observed at the net-sounder monitor. In the cases of two-layer fish concentrations appearing, the net was 15 minutes in each layer. The mean speed of vessel during trawling was slightly over 3.0 knots.

Fish catches were localized on the depth ranged from 25 to 82 m (position of the headrope from the sea surface). Depth to the bottom at trawling positions varied from 40 to 106 m. The trawl vertical opening during fishing was ranged from 15 to 20 m. The 35th and 36th hauls were localized in the Polish part of the ICES Sub-division 24, 10 hauls were realised in the ICES SD 25 and 14 hauls in the ICES SD 26 (Fig. 3, Table 3). Each haul can be accepted as representative (valid from technical point of view).

Fish caught in each control-haul was separated by species and weighted. The samples for sprat, herring and cod were taken for length and mass measurements and ageing. Detailed ichthyologic analyses were made according to standard procedures (Anon., 2012), directly on board of surveying vessel. Overall, 35, 36 and 18 samples were taken for the length and mass determination of sprat, herring and cod, respectively. Totally, the length and mass were measured for 6902 sprat, 7645 herring and 253 cod individuals. Respectively, 554, 1328 and 121 individuals of the above-mentioned species were biologically analysed (sex, maturity, stomach fullness and age).

After each haul as well as 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, 48 hydrological stations were inspected using the CTD IDRONAUT probe combined with the rosette sampler. One additional hydrological station was realized at the place selected for the acoustic system calibration. Oxygen content was determined by the standard Winkler's method. The basic meteorological parameters i.e. air temperature, air pressure, wind direction and force, and sea state were registered at the each catch-station location with the automatic station MILOS 500.

RESULTS

Acoustic results

The newest calibration results were satisfactory and comparable to those obtained in the previous year (Łączkowski and Witalis 2016); (Figures 1 and 2). Because the registered NASC values in the ICES rectangles have a direct impact on the estimation of abundance and biomass of fish, hence from the data for the ICES SDs 24, 25 and 26 (Tables 1 and 2), one can already pre-conclude, that in 2016 the total amount of clupeids in the Polish economic zone decreased, whilst comparing with 2015. In particular, a big change - about three-times decrease of the NASC appeared in the area placed to the north from the Peninsula of Hel (the ICES rectangle 38G8), and more than five-times decrease in the adjacent rectangle 38G7, located in shallow waters. Minor changes and remaining very high value integration of the clupeids can be seen in ICES rectangles 37G8 and 37G9 (the southern part of the Gulf of Gdansk). There the average NASC remained still about 3500 m^2/NM^2 in a relatively small area of 237.6 square miles. The highest value of the NASC per 1-mile reached there was 17265 m^2/NM^2 (Figs. 4 and 5).

A slight increase of the NASC was observed in the ICES rectangle 39G6 near the Danish and Swedish EEZs. In contrast, a more significant increase of the NASC was observed between the Island of Bornholm and the Kołobrzeg port (the ICES rectangle 38G5). In shallow waters, about 20 m deep, the NASC recorded for 444th mile assumed a value of 0.00 (Fig. 6).

The calculations of following parameters (the cruise statistics) have been performed according to the recent ICES IBAS Manual: mean S_A , EDSU, σ, fish species composition and abundance in millions of individuals per ICES rectangles and ICES SDs. Values of the above-mentioned parameters are listed in Table 5, while graphical distribution of fish stocks abundance is shown in Figure 14.

The changes of sprat, herring and cod total biomass surface density in the ICES sub-divisions is shown in Figure 13. Additionally, the biomass of sprat, herring and cod is presented in a form of the ArcGIS plot in Figures 15, 16 and 17.

Control catches and fish length distribution

The fish control-catches statistics and mean CPUEs by species are presented in Table 3 and Figure 7. Totally, 8354.2 kg of fish in 36 hauls were caught. The herring average share in mass was 56.5%, sprat 42.4%, cod 0.9% and other species 0.2%. Among the other eight species, the following ones were noted: flounder, salmon, sea-trout, lumpfish, lampreys, sand- eels, sticklebacks and mackerel. The herring domination in research catches was noticed in the 2010-2011 and 2013-2015. In 2009 sprat dominated (56%). In the period of 2006-2008, as well as in 2012, herring and sprat share in the total catches was similar (Grygiel et. al, 2007, 2009, 2010, 2011; Łączkowski et. al, 2012, 2013, 2014; Łączkowski and Witalis 2016).

In September 2016 the mean CPUE of all fish species for entire investigated area was 385.8 kg/h and it was lower comparing to the same period of 2015 (427.4 kg/h). The highest CPUE was noticed in the ICES SD 25 (441.7 kg/h), and it was much higher whilst comparing to this one from the ICES SDs 24 and 26 (320.4 and 323.6 kg/h, respectively). Mean CPUEs for main species in 2016 were as follow: herring – 217.9, sprat – 163.5, cod 3.5 and others – 0.9 kg/h. After Łączkowski et. al (2016), mean CPUEs for these three species in 2015 were: 318.0, 97.0 and 10.7 kg/h, respectively. Concluding, we had lower mean CPUEs of herring and cod, and higher of sprat in 2016, whilst comparing to CPUE values from 2015 in the pelagic waters of the Polish EEZ. In the early autumn of the analysed year, the mean herring CPUE in the ICES Sub-divisions 24, 25 and 26 is comparable and was as follow: 249.7, 228.1 and 200.8 kg/h, respectively (Fig. 8). The highest fishing efficiency of sprat was obtained in the ICES SD 25, i.e. 206.6 kg/h on average, while in the ICES SDs 26 and 24 was 121.4 and 69.2 kg/h, respectively.

The mean share of sprat, herring and cod in mass of catches realised in September 2016, by inspected ICES sub-divisions is presented in Figure 9. Herring was prevailed in catches performed in the ICES SDs 24, 25 and 26, where the mean share amounted, adequately: 77.9; 51.6 and 62.1%. Sprat was played the second role in realised catches with the mean share of 21.6; 46.8 and 37.5%. The share of cod in pelagic catches was marginal.

Sprat, herring and cod length distribution in samples originated from catches in the ICES SDs 24,25 and 26 in recent acoustic survey is presented in Figures 10, 11 and 12. The mean numerical share of young, undersized fishes, it is below minimum landing size (<10.0 cm for sprat, <16.0 cm for herring, <35 cm for cod) is listed in Table 4.

Sprat

The sprat length distribution in all control-catches covered the range of 7.0-16.0 cm, with the mean length of 12.7 cm and the mean weight 13.0 g. The length distribution curves had a one mode shape in each controlled ICES sub-divisions, with frequency peaks on 13.0 cm (ICES SDs 24 and 25) and 12.0 cm (ICES SD 26). In September 2016, the mean numerical share of young (undersized) sprat in analysed samples, with comparison to the data from previous years, was very low and amounted 1.7; 0.3; 1.3 and 0.8% in ICES SDs 24, 25, 26 and entire scrutinized areas, respectively (Table 4). The mean share of sprat from year-class 2016 was negligible.

Herring

The herring length distribution in all control-catches covered the range of 9.5-27.0 cm, with the mean length of 17.9 cm and the mean weight 36.0 g. The herring length frequency curve shapes were similar (with the mono modal character at length-class 16.5 cm) in the particular ICES sub-divisions. The mean numerical share of young herring (<16 cm) in entire study area was 19.2% (Table 4). The lowest and highest mean share of herring was recorded in samples originated from the ICES SDs 24 (10.8%) and 26 (21.7%). The mean share of herring below <13 cm of total length, i.e. from year-class 2016 was negligible and amounted 0.2 and 0.5% in the ICES SDs 25 and 26, respectively. Those were the lowest values in the history of Polish research surveys.

Cod

There was a small amount of cod in the ICES SD 26, where only 17 individuals were found in all catches, and only one cod with 36 cm length in the ICES SD 24. In the ICES SD 25 - 235 of cod specimens were found in all catches. The length range of cod caught in September 2016 was 21-49 cm and only one individual had length of 8 cm (Fig. 12). The mean length of sampled cod

was 31.6 cm and the mean weight was 268 g. Undersized specimens (<35 cm) established average up to 68.8% of total cod catch by numbers (Table 4).

Meteorological and hydrological characteristics of the southern Baltic

Meteorological and hydrological data at the start positions of the control-catches are presented in Table 15. The control-catches took place at the various weather conditions. The atmospheric pressure ranged from 1017 to 1027 hP. The air temperature fluctuated from 13 to 19°C, and prevailing winds were from various directions with the force from 2 to 5°B, which generated 1-3 sea state.

The seawater temperature on mean fishing depth varied from 4.81 to 13.72°C, salinity changed from 7.13 to 15.45 PSU, and oxygen content from 2.83 to 7.81 ml/l. The highest water salinity value was noticed at the position of haul No. 32, i.e. in the Bornholm Deep, on the 79 m depth. The lowest value of the oxygen content was recorded at the position of haul No. 27. In the second half of September 2016, cod spawning concentrations were recognized in the deep pelagic waters of the Bornholm Basin. In the Gdansk Deep, the hydrological conditions for cod reproduction did not appear because of salinity values were below 10 PSU, despite of quite good oxygen content.

The mean air temperature during surveying time amounted 16.8°C (ranging between 13 and 20.5°C). The dominating wind direction was from the north-east. The weak and moderate winds (below 4°B) appeared in most of the time of observation. The maximal wind speed was 12.8 m/s and minimal 0.9 m/s. Very strong winds from SW and W directions, with noticed maximum speed of 21.8 m/s, were observed in 2.3% of time of fishing operations. Fluctuation of values of meteorological parameters is shown in the Figure 18.

The horizontal distribution of hydrological parameters in the near seabed layer of the southern Baltic is presented in Figure 19, whilst vertical distribution in Figure 20.

The seawater temperature in the surface layer fluctuated from 16.68 to19.7°C. The lowest values were observed at the haul No. 25 and the highest at the haul No. 3 (Table 15). The average salinity of surface water was 7.04 PSU. A minimum salinity value (6.49 PSU) was measured at the haul No. 36 and the maximum (7.48 PSU) at the haul No. 31. The mean oxygen content in the sea upper layer was equal to 6.78 ml/l. The lowest value was 5.56 ml/l, recorded at the haul No. 35.

The seawater temperature recorded near the seabed (Fig. 19) was ranging from 5.01 to 8.75°C. The lowest temperature was recorded at position of the haul No. 4. The highest temperature was recorded at the haul No. 24. The average temperature of the water near the seabed was 6.64°C. The salinity of the water at the seabed varied in the range of 7.79 PSU at the station No. 61 to 18.38 PSU at position of the haul No. 27. The average salinity of water near the seabed was 12.75 PSU. The oxygen content in the deep-sea zone varied from 0.68 to 6.39 ml/l. The lowest values of oxygen concentration were recorded at position of the haul No. 27, the highest content of oxygen in water was recorded at the haul No. 29. The average content of oxygen near the seabed was 3.64 ml/l. During the survey period, a thermocline was observed at a depth of approx. 30 m. To the north from the Slupsk Furrow and near the Gdansk Deep at the depth of the thermocline appearance, there was a sudden decrease in the content of oxygen dissolved in water, because of the elevation to a higher layer of the "old" winter water supply through refilling at the seabed with the heavier, more saline ocean water. Salinity in the Bornholm Deep (below depth of 75 m) exceeded 18 PSU, and below 58 m of depth, there were favourable conditions for occurrence of cod eggs, at the oxygenation of 3-4 ml/l, which guaranteed the efficiency of reproduction of the cod. In the Gdansk Deep constraint on the effectiveness of spawning could be salinity and oxygen content below the threshold value of 2 ml/l, taken as a barrier to determine the thickness of the so-called "cod waters", but on the western slopes of the depth the conditions for the development of eggs were convenient. Similar conditions also existed throughout the Slupsk Furrow. Oxygen content at the seabed of the depths was not reduced below 1 ml/l (Fig. 20).

DISCUSSION

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-2016 survey data obtained by the r.v. "Baltica" scientific team. Results presented in this paper can be considered as representative for the Polish part of the southern Baltic, namely for the ICES Sub-divisions 24, 25 and 26. The basic acoustic, fisheries, biological and hydrological data collected during reported survey will be stored in the ICES Data-Center international databases, managed by the ICES Secretariat and designated experts from WGBIFS.

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TABLES AND FIGURES

Table 1. Average NASC values for the three ICES SDs in Polish EEZ in 2015 and 2016.

ICES SD	Average NASC 2016	Average NASC 2015
24	89,2	96,9
25	160,0	226,4
26	556,8	926,8

Table 2. Average NASC values for the covered ICES rectangles in Polish EEZ in 2015 and 2016.

SD	ICES Rectangles	Area [NM^2]	Average NASC 2016	Average NASC 2015
24	38G4	1034,8	89,2	96,9
25	37G5	642,2	100,7	158,2
25	38G5	1035,7	209,5	129,0
25	38G6	940,2	151,8	175,8
25	38G7	471,7	41,2	255,7
25	39G5	979,0	220,2	301,0
25	39G6	1026,0	241,1	215,8
25	39G7	1026,0	189,6	297,0
25	40G7	1013,0	125,9	279,1
26	37G8	86,0	767,5	2894,6
26	37G9	151,6	2739,7	914,1
26	38G8	624,6	336,0	997,1
26	38G9	918,2	170,9	750,9
26	39G8	1026,0	118,7	285,0
26	39G9	1026,0	57,6	393,2
26	40G8	1013,0	172,4	252,9

Table 3. Fish control-catches data from the Polish BIAS survey conducted on-board of the r.v. "Baltica" in September 2016.

Haul no	Date	ICES rectangle	ICES Sub-division (SD)	Mean bottom depth [m]	Headrope depth [m]	Vertical opening [m]	Trawling speed [w]	Trawling direction [°]	Geographical position start latitude	start longitude	end latitude	end longitude	Time start	Time end	Haul duration [min.]	Total catch [kg]	CPUE [kg/h]	Catch per species [kg] sprat	herring	cod	flounder	salmon	trout	lumpfish	mackerel	lamprey	great sand eel	three spined stickleback
									00°00.0'N	00°00.0'E	00°00.0'N	00°00.0'E																
1	14-09-2016	38G9	26	106	30	18	3.1	160	54°54.2'	19°08.0'	54°52.6'	19°08.8'	09:50	10:20	30	335.600	671.200	274.425	58.615	2.560								
2	14-09-2016	38G9	26	80	60	18	3.0	90	54°34.8'	19°13.8'	54°34.7'	19°16.6'	13:40	14:10	30	317.107	634.214	83.662	233.238	0.207								
3	14-09-2016	37G9	26	68	40	18	3.0	97	54°29.8'	19°22.2'	54°29.7'	19°23.6'	16:55	17:10	15	234.506	938.024	43.259	190.571	0.485						0.191		
4	15-09-2016	37G9	26	50	24	18	3.0	77	54°26.0'	19°04.5'	54°26.2'	19°07.1'	06:35	07:05	30	60.837	121.674	60.499	0.061		0.241						0.036	
5	15-09-2016	37G8	26	60	42	16	3.1	320	54°27.3'	18°56.1'	54°28.8'	18°54.3'	09:00	09:30	30	141.931	283.862	34.477	107.403		0.051							
6	15-09-2016	38G8	26	66	28	19	3.0	82	54°33.1'	18°55.0'	54°33.4'	18°57.4'	11:00	11:30	30	114.543	229.086	113.068	0.912	0.467	0.096							
7	15-09-2016	38G8	26	95	45	19	3.3	355	54°45.3'	18°59.8'	54°47.1'	18°59.6'	14:00	14:30	30	144.915	289.830	11.563	132.977	0.375								
8	16-09-2016	39G8	26	84	42	18	3.2	359	55°19.9'	18°59.9'	55°23.3'	18°59.8'	07:40	08:40	60	67.697	67.697		66.540	0.803				0.354				
9	16-09-2016	40G8	26	84	61	19	2.8	342	55°41.9'	18°56.9'	55°44.6'	18°55.6'	11:45	12:45	60	48.040	48.040	16.041	31.995									0.004
10	16-09-2016	40G8	26	84	32	19	3.1	181	55°34.9'	18°39.8'	55°31.8'	18°39.7'	17:40	18:40	60	163.700	163.700	25.046	138.654									
11	17-09-2016	39G8	26	80	44	18	2.9	185	55°17.6'	18°39.8'	55°16.2'	18°39.5'	07:25	07:55	30	100.279	200.558	15.717	81.903	2.590						0.069		
12	17-09-2016	38G8	26	77	58	18	3.2	336	54°53.5'	18°40.0'	54°56.6'	18°38.6'	11:55	12:55	60	157.952	157.952	63.803	93.347		0.442			0.360				
13	18-09-2016	39G8	26	85	46	18	3.2	252	55°23.7'	18°20.2'	55°23.2'	18°17.2'	08:15	08:45	30	87.130	174.260	10.368	76.762									
14	18-09-2016	40G8	26	94	63	18	3.2	322	55°36.0'	18°25.9'	55°38.0'	18°24.2'	11:45	12:15	30	325.380	650.760	157.749	166.171	1.460								
15	18-09-2016	40G7	25	68	45	17	3.1	265	55°35.7'	17°59.9'	55°35.5'	17°56.9'	17:35	18:05	30	450.180	900.360	290.816	159.364									
16	19-09-2016	39G7	25	71	37	15	3.1	236	55°26.0'	17°59.7'	55°25.3'	17°57.6'	07:20	07:50	30	117.080	234.160	18.147	98.933									
17	19-09-2016	39G8	26	75	50	20	3.1	178	55°19.4'	18°00.4'	55°16.3'	18°01.1'	10:00	11:00	60	223.140	223.140	19.860	203.280									
18	19-09-2016	39G7	25	63	30	18	3.1	341	55°12.2'	17°39.7'	55°15.1'	17°37.9'	16:55	17:55	60	191.655	191.655	13.940	174.430			3.170		0.115				
19	20-09-2016	39G7	25	77	30	19	3.1	1	55°22.7'	17°40.0'	55°25.7'	17°40.1'	08:05	09:05	60	378.770	378.770	94.883	283.137	0.491	0.140			0.119				
20	20-09-2016	39G7	25	68	50	17	3.2	181	55°22.4'	17°20.0'	55°20.6'	17°19.9'	13:25	13:55	30	291.100	582.200	104.214	186.886									
21	20-09-2016	39G7	25	81	57	18	3.0	284	55°11.7'	17°18.8'	55°12.2'	17°13.9'	16:10	17:10	60	142.843	142.843	48.267	94.113	0.223				0.240				
22	21-09-2016	39G6	25	80	50	19	3.2	342	55°14.6'	16°59.7'	55°16.1'	16°58.8'	11:40	12:10	30	502.954	1005.908	177.820	323.080	0.603				1.451				
23	21-09-2016	39G6	25	66	46	18	2.9	74	55°20.0'	16°41.0'	55°20.5'	16°43.8'	16:20	16:50	30	223.276	446.552	63.088	159.052	1.136								
24	22-09-2016	39G6	25	77	45	20	3.3	61	55°10.2'	16°40.8'	55°12.0'	16°45.9'	09:40	10:40	60	414.695	414.695	134.143	279.877		0.299			0.376				
25	23-09-2016	38G6	25	40	15	20	3.2	272	54°44.2'	16°16.3'	54°44.3'	16°13.6'	09:55	10:25	30	413.959	827.918	407.547	2.873						3.433	0.106		
26	23-09-2016	39G6	25	57	37	18	3.0	42	55°02.1'	16°20.8'	55°04.5'	16°24.5'	14:00	15:00	60	191.389	191.389	64.350	126.600					0.439				
27	24-09-2016	39G5	25	87	55	17	3.1	128	55°12.3'	15°57.8'	55°11.8'	15°59.0'	07:30	07:45	15	191.465	765.860	150.495	39.765	1.205								
28	24-09-2016	38G6	25	73	50	20	3.1	148	54°59.1'	16°00.8'	54°57.9'	16°01.7'	10:40	11:10	30	174.711	349.422	11.145	160.315	2.890				0.361				
29	24-09-2016	37G5	25	45	15	20	3.3	280	54°27.3'	15°51.5'	54°27.6'	15°46.2'	16:25	17:25	60	88.097	88.097	13.696	70.844			0.336	1.795	1.248		0.178		
30	25-09-2016	38G5	25	57	28/39	18/17	3.1	348	54°30.7'	15°39.8'	54°33.6'	15°39.0'	08:30	09:30	60	386.933	386.933	244.920	140.780					1.233				
31	25-09-2016	38/39G5	25	80	30/53	17	3.0	357	54°58.0'	15°39.9'	55°01.0'	15°39.6'	13:05	14:05	60	294.942	294.942	128.237	154.223	11.643				0.839				
32	25-09-2016	39G5	25	79	54	18	3.1	206	55°06.7'	15°37.9'	55°05.4'	15°37.2'	16:10	16:40	30	489.494	978.988	190.164	259.396	39.660	0.154			0.120				
33	26-09-2016	38G5	25	66	49	16	3.1	355	54°42.0'	15°19.7'	54°43.5'	15°19.4'	08:05	08:35	30	93.141	186.282	18.195	74.165	0.565	0.152			0.064				
34	26-09-2016	37G5	25	44	21	19	2.9	122	54°29.5'	15°20.4'	54°28.6'	15°25.3'	11:40	12:40	60	25.807	25.807	18.850	2.650				0.788	3.519				
35	26-09-2016	38G4	24	50	25	18	3.3	334	54°37.1'	14°59,3'	54°38.6'	14°58,5'	17:25	17:55	30	91.925	183.850	57.433	34.167					0.325				
36	27-09-2016	38G4	24	57	31	18	3.2	262	54°44.9'	14°55,8'	54°44.6'	14°53,1'	07:30	08:00	30	228.448	456.896	11.823	215.537	0.449				0.639				
														Total	24	320.373		69.256	249.704	0.449				0.964				
														catch	25	5062.491		2192.917	2790.483	58.416	0.745	3.506	2.583	10.124	3.433	0.284		
														by SDs	26	2522.757		929.537	1582.429	8.947	0.830			0.714		0.260	0.036	0.004
														[kg]	Sum	7905.621		3191.710	4622.616	67.812	1.575	3.506	2.583	11.802	3.433	0.544	0.036	0.004

Table 4. The mean numerical share of young, undersized fishes per ICES SDs.

Species	Fish length	Mean share in % of numbers SD 24	SD 25	SD 26	Mean
sprat	< 10 cm	1.7	0.3	1.3	0.8
herring	< 16 cm	10.8	18.5	21.7	19.2
cod	< 35 cm	0.0	72.3	23.5	68.8

Table 5. Cruise statistics of the Polish BIAS survey on-board of the r.v. "Baltica", 13.09.-30.09.2016.

SD	ICES Rectangle	EDSU [NM]	<σ> [m^2 * 10^{-4}]	<S_A> [m^2/NM^2]	Area [NM^2]	species composition [%]			Abundance *(10^6)			
						sprat	herring	cod	total	sprat	herring	cod
24	38G4	33	2.4	89.2	1034.8	44.4	55.6	0.008	379.3	168.5	210.8	0.030
Sum SD24		33		89.2	1034.8				379.3	168.5	210.8	0.030
25	37G5	61	2.2	100.7	642.2	59.7	40.3	0.000	294.0	175.6	118.4	0.000
25	38G5	73	2.2	209.5	1035.7	59.5	40.4	0.104	971.8	578.2	392.6	1.015
25	38G6	72	2.3	151.8	940.2	56.0	43.9	0.061	627.9	351.8	275.7	0.383
25	39G5	27	2.0	220.2	979.0	81.0	18.5	0.495	1066.4	864.0	197.1	5.280
25	39G6	89	2.3	241.1	1026.0	52.9	47.1	0.010	1073.1	567.8	505.2	0.107
25	39G7	112	2.5	189.6	1026.0	42.6	57.4	0.005	790.8	337.0	453.8	0.039
25	40G7	23	2.2	125.9	1013.0	57.8	42.2	0.000	572.4	330.8	241.6	0.000
Sum SD25		457		177.0	6662.1				5396.4	3205.2	2184.4	6.822
26	37G8	7	2.0	767.5	86.0	74.9	25.1	0.000	335.3	251.2	84.1	0.000
26	37G9	35	2.1	2739.7	151.6	69.2	30.8	0.005	2019.3	1397.2	621.9	0.104
26	38G8	48	2.2	336.0	624.6	62.3	37.7	0.011	969.9	603.9	365.9	0.102
26	38G9	50	1.9	170.9	918.2	76.9	23.1	0.011	808.4	621.7	186.6	0.090
26	39G8	95	2.8	118.7	1026.0	19.7	80.3	0.053	431.5	84.9	346.3	0.229
26	39G9	29	2.4	57.6	1026.0	47.1	52.8	0.075	245.0	115.4	129.4	0.185
26	40G8	101	2.3	172.4	1013.0	55.7	44.3	0.008	772.0	430.1	341.8	0.063
Sum SD26		365		623.3	4845.4				5581.2	3504.5	2075.9	0.772

Table 6. Abundance of sprat (in millions individuals) per age groups, ICES rectangles and SDs, estimated using acoustic method based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016.

SD	ICES Rectangle	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Sum sprat
24	38G4	3.3	7.7	57.2	45.9	35.6	5.6	6.5	6.7	0.0	168.49
Sum SD24		3.3	7.7	57.2	45.9	35.6	5.6	6.5	6.7	0.0	168.49
25	37G5	0.62	1.63	73.38	56.53	26.45	8.95	5.20	2.64	0.22	175.63
25	38G5	2.05	5.38	241.56	186.11	87.08	29.46	17.11	8.70	0.73	578.18
25	38G6	1.25	3.27	146.97	113.23	52.98	17.92	10.41	5.29	0.44	351.78
25	39G5	3.07	8.04	360.98	278.11	130.12	44.02	25.57	13.00	1.09	864.01
25	39G6	2.02	5.28	237.23	182.77	85.52	28.93	16.81	8.55	0.71	567.81
25	39G7	1.20	3.14	140.78	108.46	50.75	17.17	9.97	5.07	0.42	336.97
25	40G7	1.18	3.08	138.20	106.47	49.82	16.85	9.79	4.98	0.42	330.78
Sum SD25		11.39	29.83	1339.10	1031.68	482.71	163.30	94.87	48.24	4.03	3205.15
26	37G8	2.90	6.94	152.74	51.44	29.63	1.92	4.89	0.74	0	251.21
26	37G9	16.15	38.63	849.57	286.09	164.83	10.66	27.19	4.14	0	1397.25
26	38G8	6.98	16.69	367.16	123.64	71.23	4.61	11.75	1.79	0	603.86
26	38G9	7.18	17.19	378.00	127.29	73.34	4.74	12.10	1.84	0	621.68
26	39G8	0.98	2.35	51.65	17.39	10.02	0.65	1.65	0.25	0	84.95
26	39G9	1.33	3.19	70.18	23.63	13.61	0.88	2.25	0.34	0	115.41
26	40G8	4.97	11.89	261.53	88.07	50.74	3.28	8.37	1.28	0	430.13
Sum SD26		40.50	96.88	2130.82	717.56	413.41	26.74	68.19	10.39	0	3504.48

Table 7. Biomass of sprat (in tons) per age groups, ICES rectangles and SDs, estimated using acoustic method based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016.

SD	ICES Rectangle	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Sum sprat [t]
24	38G4	19.4	110.4	835.0	713.7	600.5	108.4	124.8	109.7	0.0	2621.9
Sum SD24		19.4	110.4	835.0	713.7	600.5	108.4	124.8	109.7	0.0	2621.9
25	37G5	3.0	18.0	988.9	826.3	421.3	142.3	87.9	43.6	4.2	2535.6
25	38G5	10.0	59.4	3255.7	2720.3	1387.0	468.5	289.4	143.6	13.7	8347.5
25	38G6	6.1	36.1	1980.8	1655.1	843.9	285.0	176.1	87.4	8.3	5078.8
25	39G5	15.0	88.8	4865.1	4065.1	2072.6	700.1	432.4	214.6	20.4	12474.1
25	39G6	9.9	58.3	3197.3	2671.5	1362.1	460.1	284.2	141.0	13.4	8197.7
25	39G7	5.8	34.6	1897.4	1585.4	808.3	273.0	168.6	83.7	8.0	4865.0
25	40G7	5.7	34.0	1862.6	1556.3	793.5	268.0	165.5	82.2	7.8	4775.6
Sum SD25		55.6	329.2	18047.8	15079.9	7688.7	2597.0	1604.1	796.1	75.8	46274.2
26	37G8	9.3	56.0	1612.9	658.6	400.5	30.1	70.1	12.2	0.0	2849.8
26	37G9	51.8	311.7	8971.1	3663.0	2227.8	167.7	389.8	67.8	0.0	15850.7
26	38G8	22.4	134.7	3877.1	1583.0	962.8	72.5	168.4	29.3	0.0	6850.3
26	38G9	23.0	138.7	3991.5	1629.8	991.2	74.6	173.4	30.2	0.0	7052.5
26	39G8	3.1	19.0	545.4	222.7	135.4	10.2	23.7	4.1	0.0	963.7
26	39G9	4.3	25.7	741.0	302.6	184.0	13.8	32.2	5.6	0.0	1309.3
26	40G8	15.9	96.0	2761.7	1127.6	685.8	51.6	120.0	20.9	0.0	4879.4
Sum SD26		129.8	781.9	22500.8	9187.2	5587.7	420.5	977.6	170.1	0.0	39755.5

Table 8. Mean weight of sprat (in grams) per age groups, ICES rectangles and SDs based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016.

SD	ICES Rectangle	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W sprat [g]
24	38G4	5.80	14.39	14.59	15.56	16.87	19.30	19.18	16.43		15.27
MW SD24		5.80	14.39	14.59	15.56	16.87	19.30	19.18	16.43		15.27
25	37G5	6.20	13.75	15.48	15.98	17.06	17.59	17.74	17.56	19.35	15.64
25	38G5	5.69	12.79	14.03	14.92	15.97	16.26	17.14	16.45	18.79	14.67
25	38G6	5.07	10.42	14.16	14.79	16.95	16.86	20.60	16.61		14.43
25	39G5	5.40	9.89	13.49	14.65	15.63	16.50	17.10			13.24
25	39G6	8.20	11.79	13.33	14.46	15.60	15.64	16.60	16.32	17.96	14.43
25	39G7		9.03	12.36	14.02	14.86	14.37	16.45	17.22	17.95	14.53
25	40G7		10.79	12.27	13.41	14.49	13.88	15.56	15.09	17.70	14.15
MW SD25		6.11	11.21	13.59	14.60	15.79	15.87	17.31	16.54	18.35	14.38
26	37G8	3.08	5.67	9.69	12.45	12.28	16.60	16.60			10.91
26	37G9	3.08	8.19	10.21	11.91	13.17	15.00	17.35			11.27
26	38G8	3.45	8.06	10.14	12.44	13.20	15.45	14.27	15.33		11.54
26	38G9	4.00	8.16	10.31	12.79	12.85	15.35	12.53			10.85
26	39G8		7.75	12.18	13.40	13.85	15.99	15.04	15.44		13.38
26	39G9	3.40	8.46	10.41	12.48	13.47	16.52	13.54	16.40		11.84
26	40G8		7.85	11.08	12.81	13.38	15.49	14.19	15.11		12.84
MW SD26		3.40	7.73	10.57	12.61	13.17	15.77	14.79	15.57		11.70

Table 9. Abundance of herring (in millions individuals) per age groups, ICES rectangles and SDs, estimated using acoustic method based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016.

SD	ICES Rectangle	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Sum herring
24	38G4	1.3	21.9	28.4	41.7	71.9	30.0	3.4	9.3	3.0	210.8
Sum SD24		1.3	21.9	28.4	41.7	71.9	30.0	3.4	9.3	3.0	210.8
25	37G5	0.68	5.36	31.65	24.00	28.26	12.68	4.93	5.01	5.81	118.4
25	38G5	2.25	17.78	104.96	79.59	93.70	42.05	16.34	16.62	19.27	392.6
25	38G6	1.58	12.49	73.71	55.90	65.80	29.53	11.48	11.67	13.53	275.7
25	39G5	1.13	8.93	52.69	39.96	47.04	21.11	8.20	8.34	9.68	197.1
25	39G6	2.90	22.88	135.08	102.44	120.59	54.12	21.03	21.39	24.80	505.2
25	39G7	2.60	20.55	121.33	92.01	108.31	48.61	18.89	19.21	22.28	453.8
25	40G7	1.38	10.94	64.61	48.99	57.67	25.88	10.06	10.23	11.86	241.6
Sum SD25		12.52	98.93	584.04	442.89	521.36	233.97	90.94	92.49	107.24	2184.4
26	37G8	0.42	4.21	19.48	13.94	21.60	9.07	5.01	5.42	4.90	84.1
26	37G9	3.11	31.17	144.11	103.10	159.74	67.08	37.05	40.08	36.24	621.9
26	38G8	1.83	18.34	84.79	60.66	93.99	39.47	21.80	23.58	21.32	365.9
26	38G9	0.93	9.35	43.24	30.93	47.93	20.13	11.11	12.03	10.87	186.6
26	39G8	1.73	17.36	80.24	57.41	88.95	37.35	20.63	22.32	20.18	346.3
26	39G9	0.65	6.49	29.99	21.45	33.24	13.96	7.71	8.34	7.54	129.4
26	40G8	1.71	17.13	79.19	56.66	87.79	36.86	20.36	22.03	19.91	341.8
Sum SD26		10.39	104.04	481.03	344.16	533.23	223.92	123.66	133.80	120.96	2075.9

Table 10. Biomass of herring (in tons) per age groups, ICES rectangles and SDs, estimated using acoustic method based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016.

SD	ICES Rectangle	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Sum herring [t]
24	38G4	18.0	661.4	973.6	1318.2	2558.2	1041.7	162.8	459.8	200.1	7393.9
Sum SD24		18.0	661.4	973.6	1318.2	2558.2	1041.7	162.8	459.8	200.1	7393.9
25	37G5	9.7	152.1	904.9	783.0	973.1	529.4	216.0	266.3	369.3	4203.8
25	38G5	32.1	504.2	3000.7	2596.4	3226.6	1755.4	716.4	883.2	1224.6	13939.6
25	38G6	22.6	354.1	2107.4	1823.4	2266.1	1232.8	503.1	620.3	860.0	9789.7
25	39G5	16.1	253.1	1506.5	1303.5	1619.9	881.3	359.7	443.4	614.8	6998.2
25	39G6	41.3	649.0	3861.9	3341.5	4152.7	2259.2	922.0	1136.7	1576.1	17940.4
25	39G7	37.1	582.9	3468.8	3001.4	3730.0	2029.2	828.1	1020.9	1415.6	16114.0
25	40G7	19.8	310.4	1847.1	1598.2	1986.1	1080.5	441.0	543.6	753.8	8580.5
Sum SD25		178.7	2805.8	16697.3	14447.3	17954.4	9767.9	3986.4	4914.4	6814.2	77566.3
26	37G8	4.0	101.5	519.7	443.1	755.2	359.3	225.1	290.4	358.2	3056.5
26	37G9	29.5	750.5	3844.2	3277.7	5585.6	2657.6	1664.7	2147.6	2649.7	22607.0
26	38G8	17.3	441.6	2261.8	1928.4	3286.3	1563.6	979.4	1263.6	1559.0	13301.1
26	38G9	8.8	225.2	1153.4	983.4	1675.8	797.3	499.4	644.3	795.0	6782.7
26	39G8	16.4	417.9	2140.6	1825.1	3110.3	1479.9	927.0	1195.9	1475.5	12588.4
26	39G9	6.1	156.2	799.9	682.1	1162.3	553.0	346.4	446.9	551.4	4704.3
26	40G8	16.2	412.4	2112.6	1801.2	3069.5	1460.5	914.8	1180.2	1456.1	12423.6
Sum SD26		98.3	2505.2	12832.3	10941.0	18645.0	8871.3	5556.8	7168.8	8844.9	75463.5

Table 11. Mean weight of herring (in grams) per age groups, ICES rectangles and SDs, based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016.

SD	ICES Rectangle	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W herring [g]
24	38G4	14.3	30.2	34.3	31.6	35.6	34.7	48.5	49.3	66.2	38.3
MW SD24		14.3	30.2	34.3	31.6	35.6	34.7	48.5	49.3	66.2	38.3
25	37G5	11.6	29.2	28.9	47.2	30.6	28.3	33.4		56.5	33.2
25	38G5	13.7	30.1	30.3	30.2	33.5	43.1	59.2	53.3	64.0	39.7
25	38G6		27.0	29.1	30.4	33.9	41.4	46.7	45.6	52.6	38.3
25	39G5	14.8	30.7	28.5	40.6	42.1	49.9	54.3	59.8	64.7	42.8
25	39G6	12.2	23.3	28.3	34.8	32.2	38.3	37.0	60.9	65.3	36.9
25	39G7	14.8	25.1	31.3	35.7	40.1	43.7	47.8	47.2	58.8	38.3
25	40G7			23.7	26.4	31.3	41.7	38.6	47.4	55.3	37.8
MW SD25		13.4	27.6	28.6	35.0	34.8	40.9	45.3	52.4	59.6	38.1
26	37G8	7.0	23.3	23.5	30.1	35.8	30.5	40.5	47.4	47.9	31.8
26	37G9	10.5	27.8	25.5	28.6	32.8	41.1	43.0	67.1	58.8	37.2
26	38G8	10.2	19.3	25.6	34.1	34.6	45.8	39.7	52.7	77.1	37.7
26	38G9		23.1	31.9	30.2	38.4	44.2	47.5	60.0	83.6	44.9
26	39G8		25.9	29.6	38.7	34.4	45.0	45.9	66.3	65.6	43.9
26	39G9		24.2	33.1	39.0	37.9	44.1	46.1	57.8	71.4	44.2
26	40G8		26.5	25.7	29.7	35.0	38.2	44.3	52.7	65.1	39.7
MW SD26		9.2	24.3	27.8	32.9	35.6	41.3	43.9	57.7	67.1	39.9

Table 12. Abundance of cod (in millions individuals) per age groups, ICES rectangles and SDs, estimated using acoustic method, based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016.

SD	ICES Rectangle	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Sum cod
24	38G4	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.030
Sum SD24		0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.030
25	37G5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	38G5	0.004	0.000	0.151	0.272	0.371	0.164	0.033	0.004	0.014	1.015
25	38G6	0.002	0.000	0.057	0.103	0.140	0.062	0.013	0.002	0.005	0.383
25	39G5	0.021	0.000	0.787	1.415	1.932	0.855	0.174	0.021	0.074	5.280
25	39G6	0.000	0.000	0.016	0.029	0.039	0.017	0.004	0.000	0.001	0.107
25	39G7	0.000	0.000	0.006	0.010	0.014	0.006	0.001	0.000	0.001	0.039
25	40G7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum SD25		0.027	0.000	1.016	1.828	2.497	1.105	0.225	0.027	0.096	6.822
26	37G8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	37G9	0.000	0.000	0.013	0.013	0.026	0.026	0.026	0.000	0.000	0.104
26	38G8	0.000	0.000	0.013	0.013	0.025	0.025	0.025	0.000	0.000	0.102
26	38G9	0.000	0.000	0.011	0.011	0.022	0.022	0.022	0.000	0.000	0.090
26	39G8	0.000	0.000	0.029	0.029	0.057	0.057	0.057	0.000	0.000	0.229
26	39G9	0.000	0.000	0.023	0.023	0.046	0.046	0.046	0.000	0.000	0.185
26	40G8	0.000	0.000	0.008	0.008	0.016	0.016	0.016	0.000	0.000	0.063
Sum SD26		0.000	0.000	0.096	0.096	0.193	0.193	0.193	0.000	0.000	0.772

Table 13. Biomass of cod (in tons) per age groups, ICES rectangles and SDs, estimated using acoustic method, based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016.

SD	ICES Rectangle	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Sum cod [t]
24	38G4	0.00	0.00	0.00	13.39	0.00	0.00	0.00	0.00	0.00	13.39
Sum SD24		0.00	0.00	0.00	13.39	0.00	0.00	0.00	0.00	0.00	13.39
25	37G5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	38G5	0.01	0.00	19.41	42.88	101.78	65.31	17.38	2.14	3.57	252.48
25	38G6	0.00	0.00	7.32	16.17	38.37	24.63	6.55	0.81	1.35	95.19
25	39G5	0.07	0.00	101.01	223.15	529.68	339.91	90.46	11.12	18.61	1314.01
25	39G6	0.00	0.00	2.04	4.50	10.69	6.86	1.83	0.22	0.38	26.52
25	39G7	0.00	0.00	0.74	1.63	3.88	2.49	0.66	0.08	0.14	9.62
25	40G7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum SD25		0.09	0.00	130.52	288.33	684.40	439.20	116.89	14.37	24.04	1697.83
26	37G8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	37G9	0.00	0.00	2.68	6.09	13.05	11.81	19.19	0.00	0.00	52.81
26	38G8	0.00	0.00	2.64	5.98	12.83	11.62	18.87	0.00	0.00	51.93
26	38G9	0.00	0.00	2.33	5.28	11.32	10.25	16.65	0.00	0.00	45.82
26	39G8	0.00	0.00	5.91	13.43	28.79	26.07	42.35	0.00	0.00	116.55
26	39G9	0.00	0.00	4.79	10.87	23.29	21.10	34.26	0.00	0.00	94.30
26	40G8	0.00	0.00	1.63	3.69	7.92	7.17	11.64	0.00	0.00	32.05
Sum SD26		0.00	0.00	19.97	45.34	97.19	88.02	142.96	0.00	0.00	393.47

Table 14. Mean weight of cod (in grams) per age groups and SDs, based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13.09-30.09.2016 .

SD	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+	Mean W cod [g]
24				449.00						449.00
25	3.20		128.40	157.70	274.10	397.40	519.20	526.50	251.70	282.28
26			207.00	470.00	503.75	456.25	741.00			475.60

Table 15. Values of the basic meteorological and hydrological parameters recorded in September 2016 at the positions of the r.v. "Baltica" fish control catches.

Haul	Date	Haul	Mean	Meteorological parameters					Hydrological parameters*		
No	of catch	start time	haedrope	atmospheric	air	wind	wind force	sea state	temperature	salinity	oxygen
		[hh:mm]	depth [m]	preasure [hP]	temperature [°C]	direction	[°B]		[°C]	[PSU]	[ml/l]
1	14-09-2016	09:50	30	1020	18	NE	3	2	6.06	9.40	6.46
2	14-09'2016	13:40	60	1024	19	NNE	3	2	5.60	10.30	4.17
3	14-09'2016	16:55	40	1021	18	N	4	2	5.07	9.00	4.00
4	15-09'2016	06:35	24	1020	16	S	2	1	6.15	7.27	6.47
5	15-09'2016	09:00	42	1021	16	SSE	2	1	5.10	9.07	3.89
6	15-09'2016	11:00	28	1024	19	SE	2	1	5.24	7.37	6.39
7	15-09'2016	14:00	45	1024	19	SE	2	1	5.07	7.50	6.48
8	16-09'2016	07:40	42	1018	17	NE	3	2	5.26	9.93	6.76
9	16-09'2016	11:45	61	1019	17	NE	4	2	5.16	9.34	3.23
10	16-09'2016	17:40	32	1020	17	NE	4/5	2/3	5.57	9.16	7.81
11	17-09'2016	07:25	44	1018	16	E	5	3	5.45	7.55	5.88
12	17-09'2016	11:55	58	1018	17	ENE	5	3	5.76	10.57	3.59
13	18-09'2016	08:15	46	1021	15	E	5	3	4.99	7.40	6.67
14	18-09'2016	11:45	63	1022	13	E	5	3	4.81	7.82	6.38
15	18-09'2016	17:35	45	1023	15	E	5	3	5.86	8.33	5.58
16	19-09'2016	07:20	37	1020	14	SE	3	1	6.12	7.26	6.95
17	19-09'2016	10:00	50	1020	14	ESE	2	1	5.01	7.59	6.73
18	19-09'2016	16:55	30	1020	13	N	3	1/2	5.72	7.34	6.90
19	20-09'2016	08:05	60	1017	15	N	3	2	13.72	7.13	5.20
20	20-09'2016	13:25	30	1018	16	NNW	3	2	6.47	8.96	5.98
21	20-09'2016	16:10	60	1018	16	NNW	4	2	8.41	12.54	4.45
22	21-09'2016	11:40	50	1024	16	NE	2	1	8.13	13.06	4.92
23	21-09'2016	16:10	46	1024	16	NE	3	2	6.32	8.23	6.46
24	22-09'2016	09:40	45	1023	15	NNW	4	2	6.79	6.69	4.37
25	23-09'2016	09:55	15	1022	15	W	3	2	10.88	7.46	5.88
26	23-09'2016	14:00	37	1023	16	WSW	4	3	6.51	8.93	5.24
27	24-09'2016	07:30	55	1021	16	NW	5	3	8.39	14.74	2.83
28	24-09'2016	10:40	50	1024	16	WNW	5	3	7.42	12.39	4.55
29	24-09'2016	16:25	15	1027	16	WNW	4	2	16.61	7.47	6.36
30	25-09'2016	08:30	28/39	1023	13	S	3	2	6,80/6,29	7,55/10,30	5,97/4,91
31	25-09'2016	13:05	30/53	1027	16	S	2	2	8,46/6,66	13,68/7,81	4,16/6,06
32	25-09'2016	16:10	54	1025	16	SE	3	2	11.61	15.45	4.29
33	26-09'2016	08:05	49	1023	15	SSE	4	2	8.46	12.80	3.70
34	26-09'2016	11:40	21	1025	15	SSE	4	2	7.39	7.56	6.10
35	26-09'2016	17:25	25	1027	16	E	4	2	7.98	7.58	5.57
36	27-09'2016	07:30	31	1025	14	S	4	2	6.37	8.71	5.70
37											

* data at the mean depth of the fish control catch (in the middle of trawl vertical oppening)

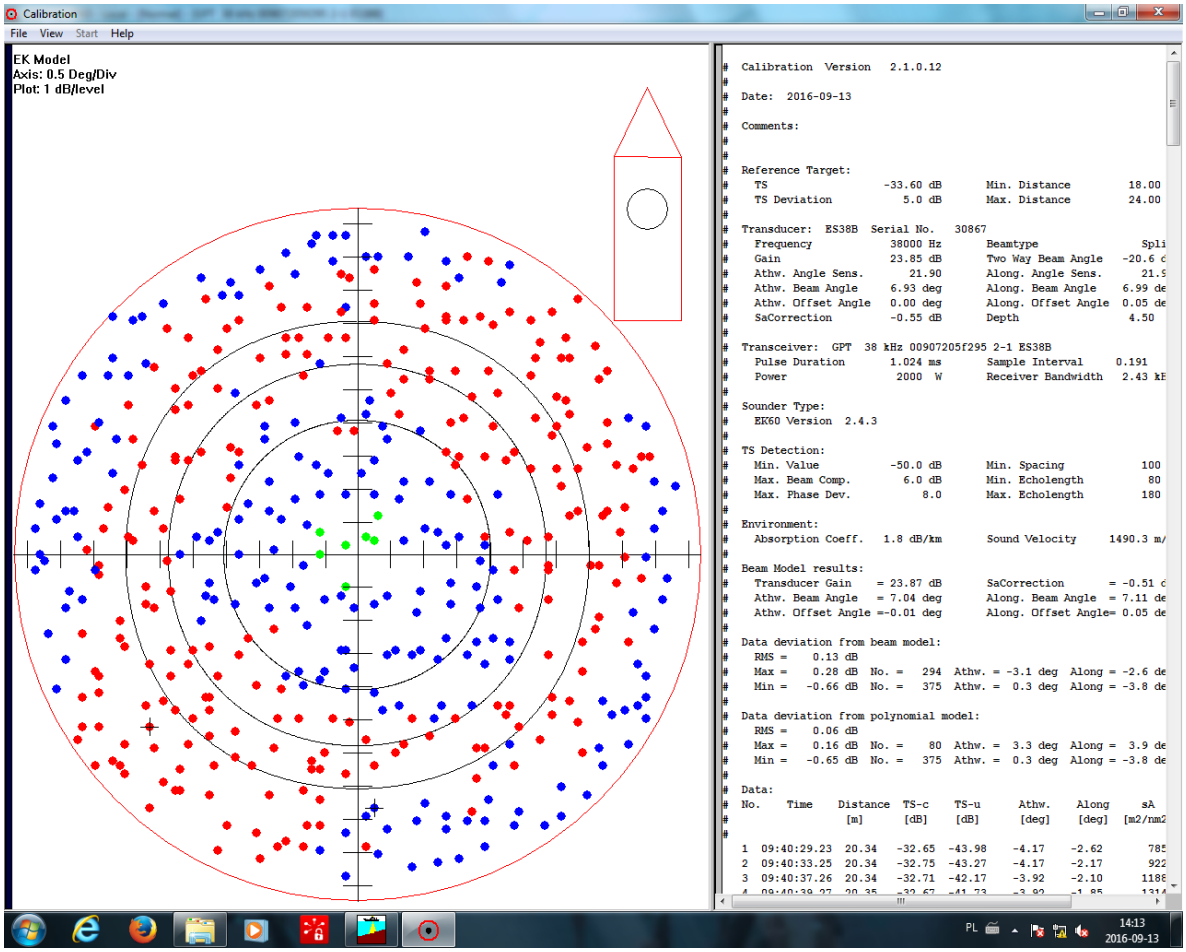

Fig.1. A screenshot after finishing calibration of the 38 kHz transducer.

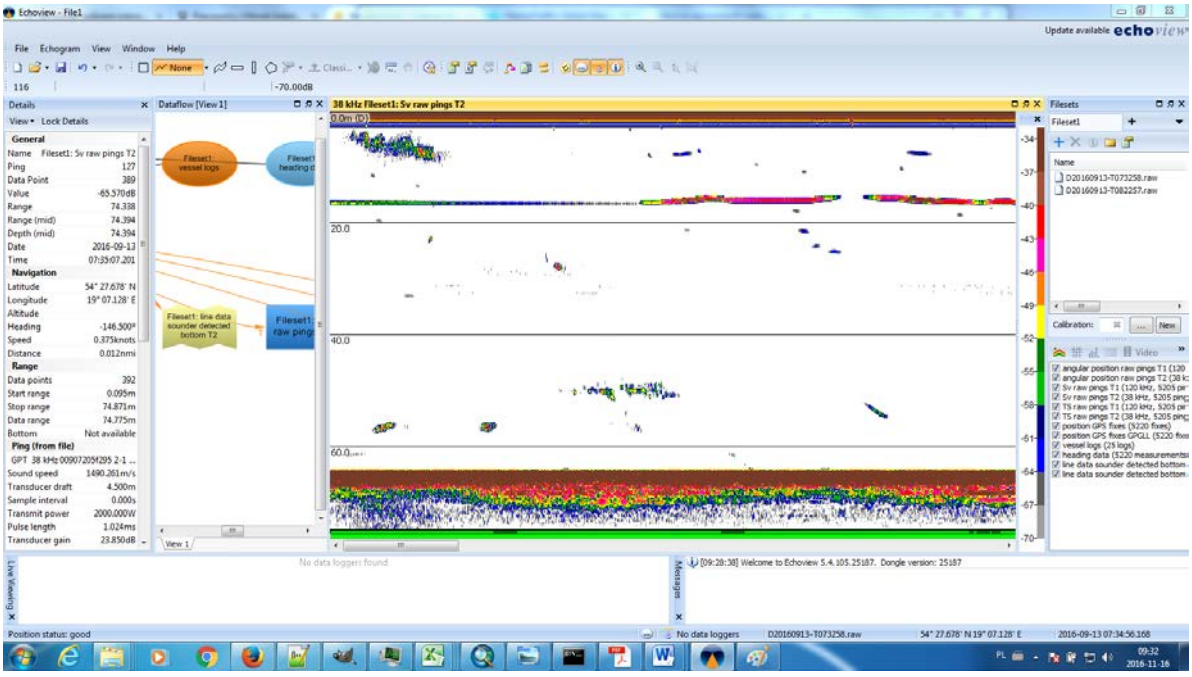

Fig. 2. Observed position of the calibration sphere for the 38 kHz transducer.

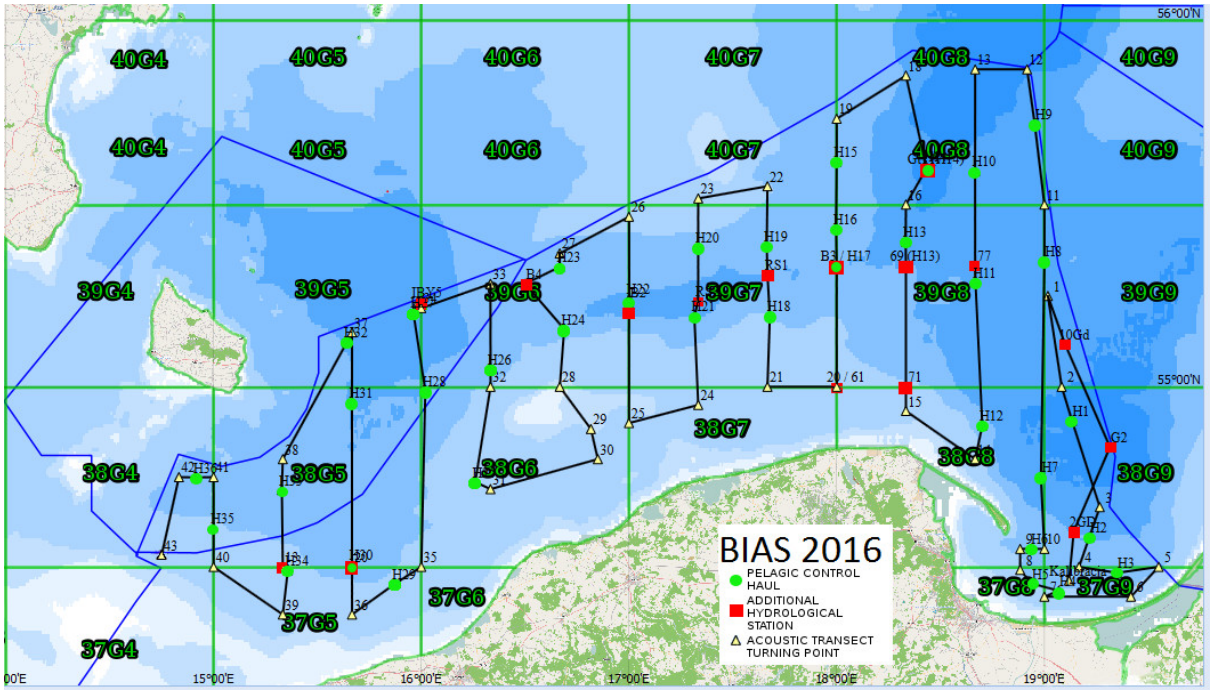

Fig. 3. A map showing realised cruise tracks.

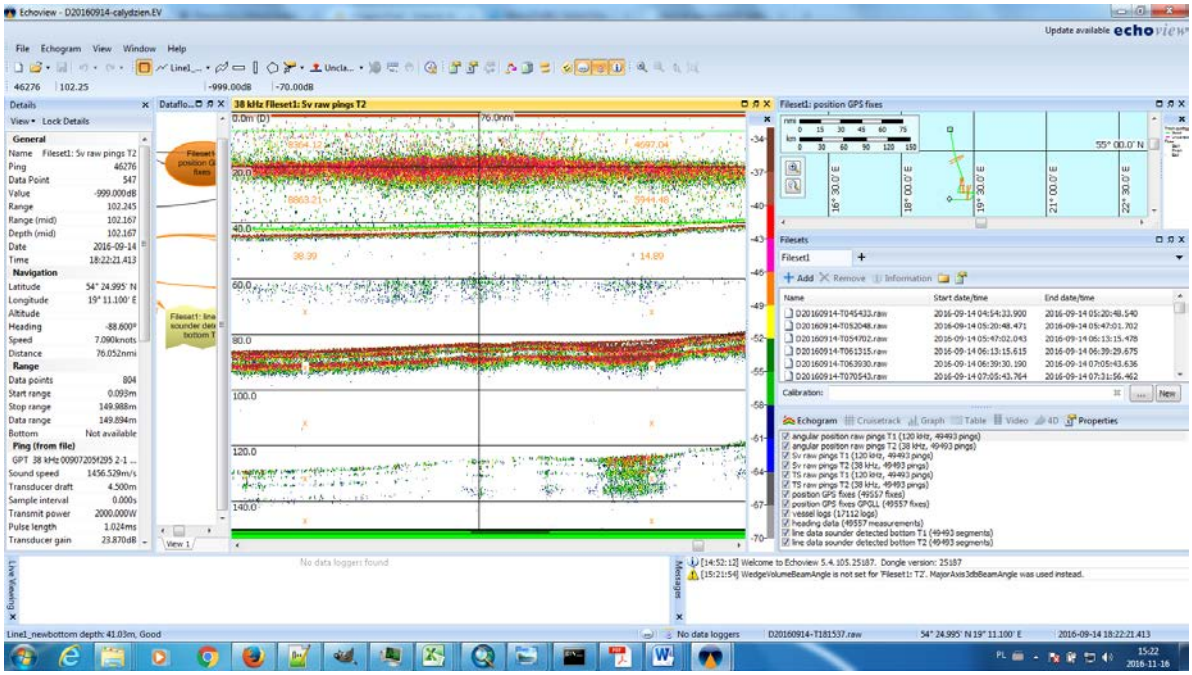

Fig. 4. An example of an echogram analysis for 76th mile of the integration NASC = 17265 (bottom depth about 40 m).

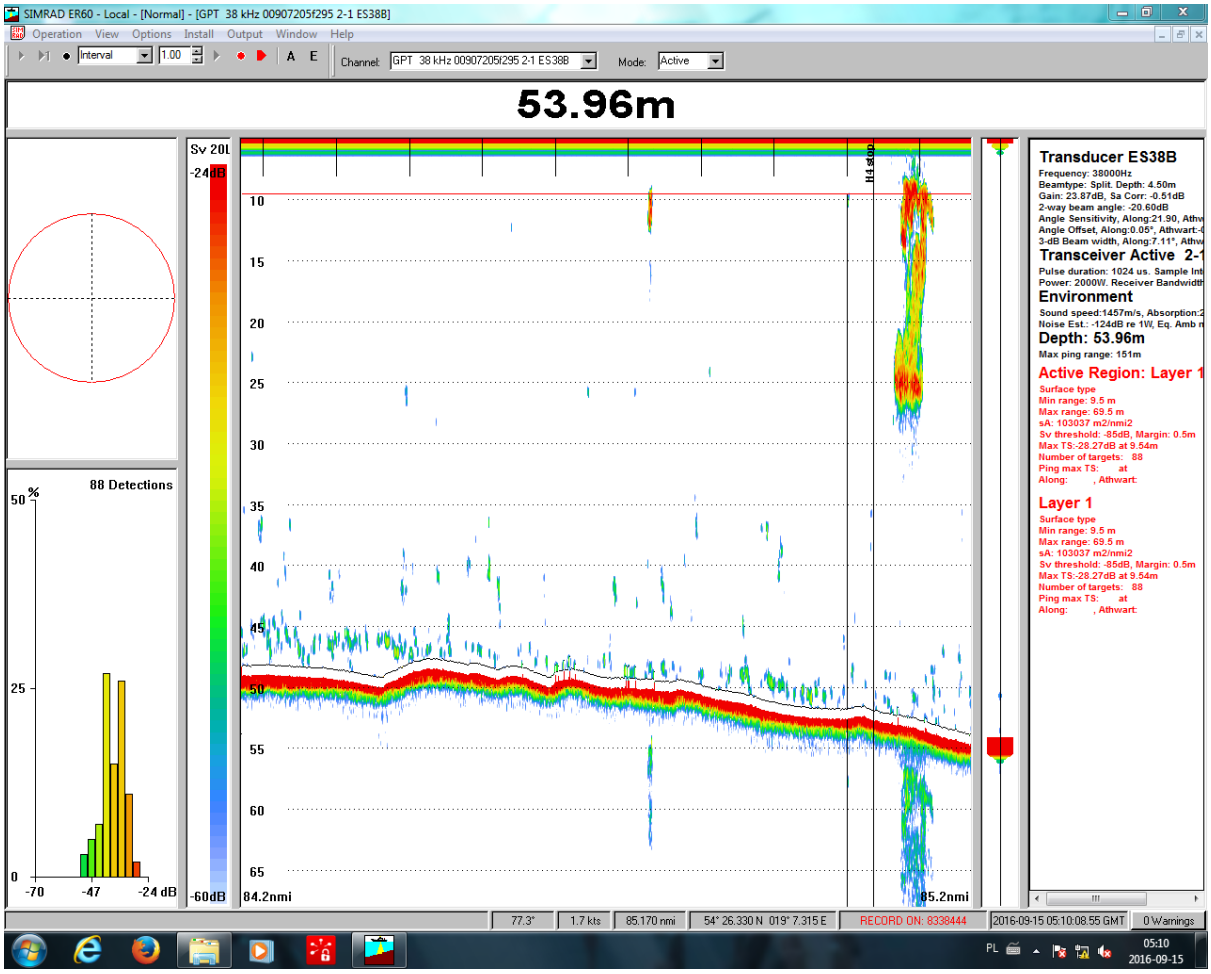

Fig. 5. A screenshot from the SIMRAD EK60 software showing a large school of clupeids with the NASC over 103000 in the ICES rectangle 37G9 near Krynica Morska (south-eastern part of the Gulf of Gdansk).

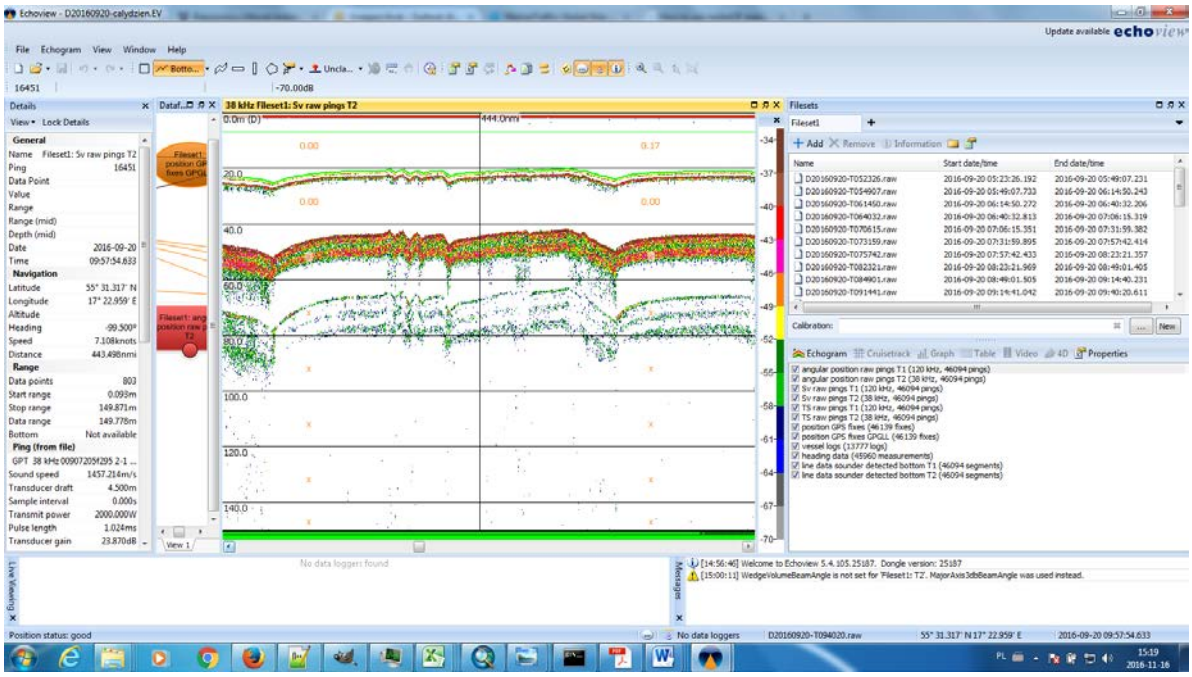

Fig. 6. An example of an echogram analysis for 444th mile of the integration NASC = 0 (bottom depth about 20 m).

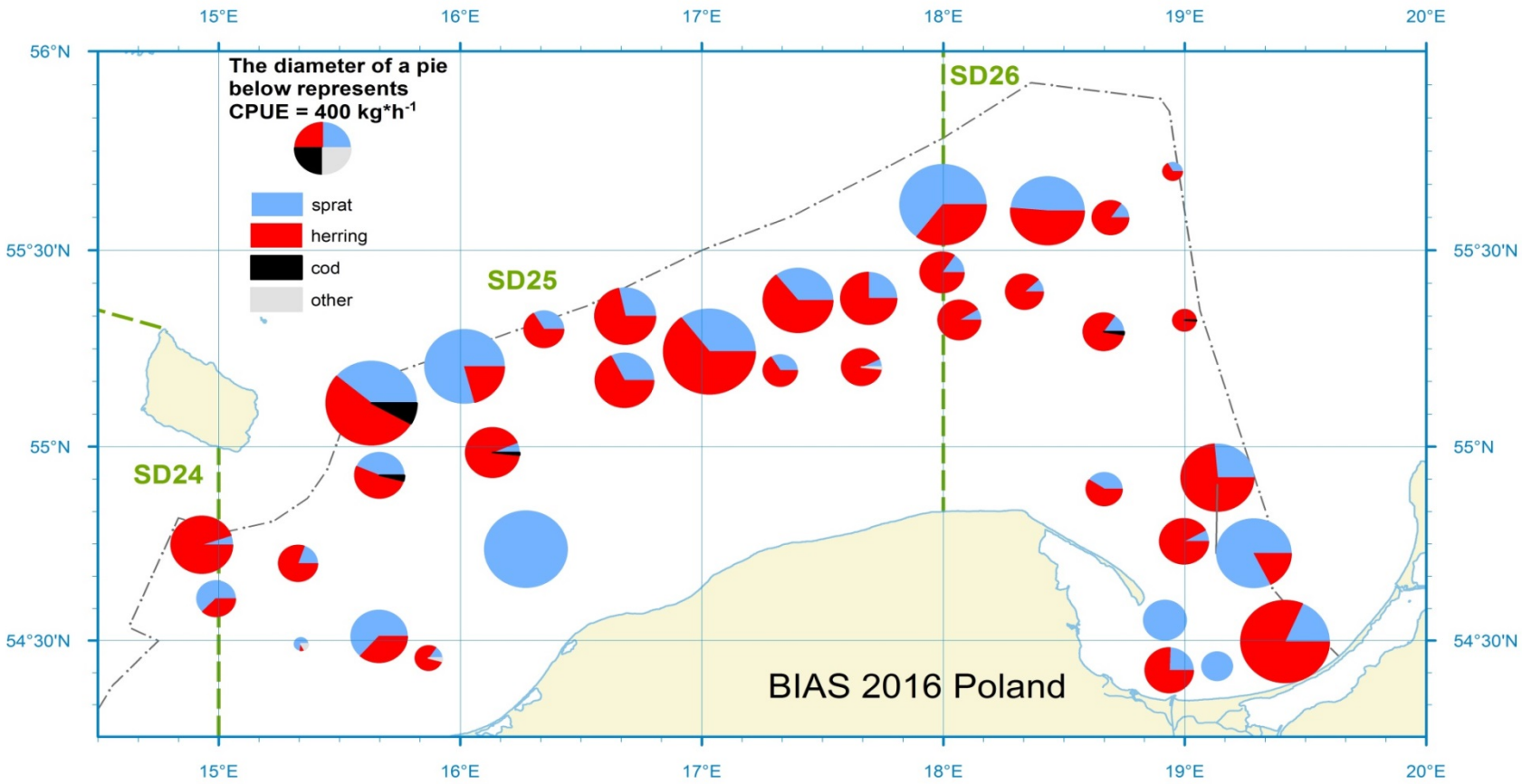

Fig. 7. Mean CPUE [kg h^{-1}] per species in Polish EEZ per single pelagic haul.

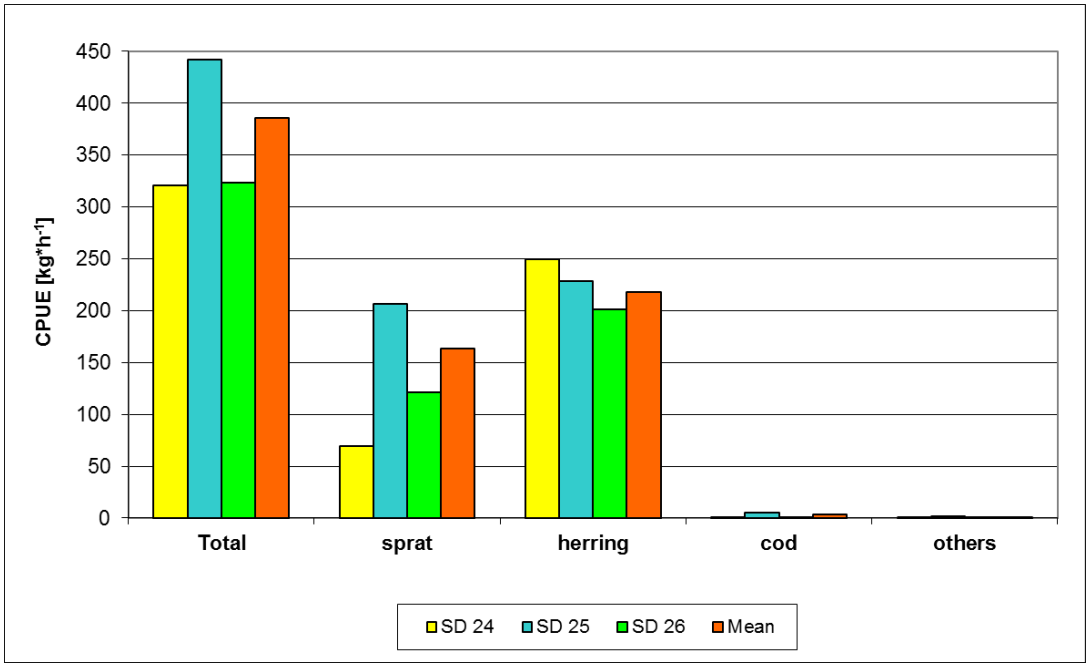

Fig. 8. Mean CPUE [kg h^{-1}] per fish species and the ICES SDs.

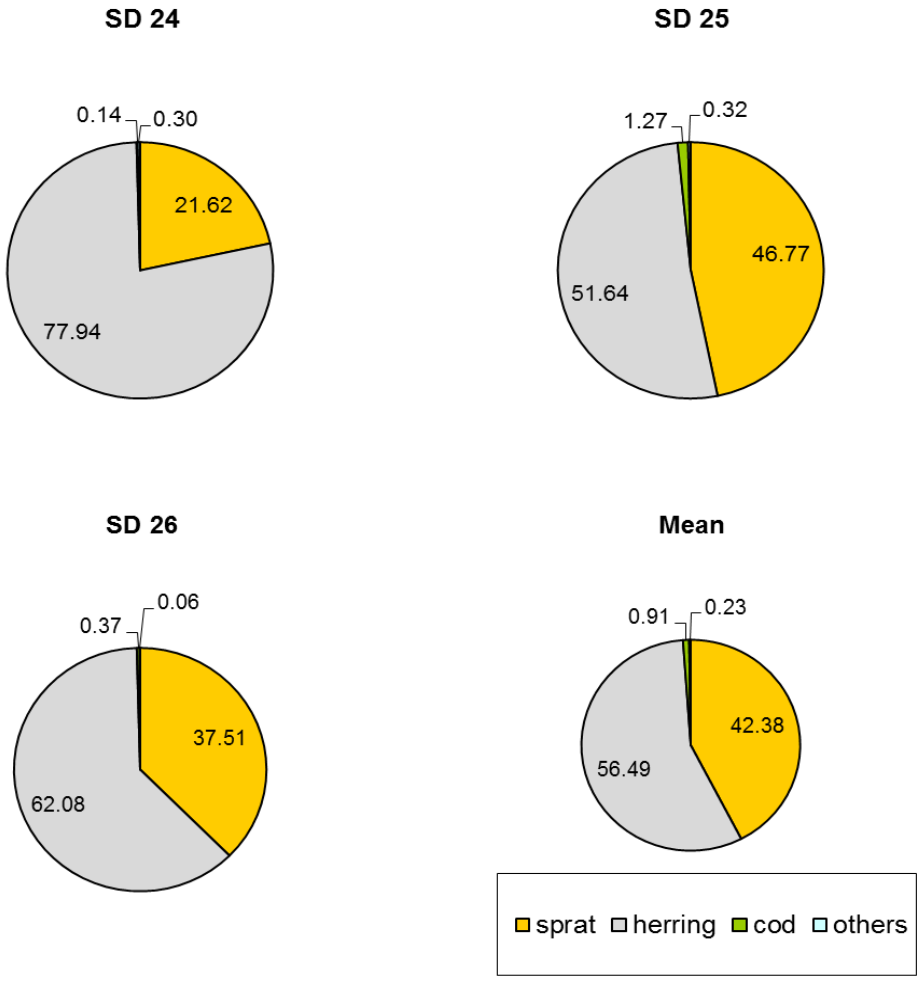

Fig. 9. Mean share (%) of sprat, herring, cod and other fishes in the mass of total catches per the ICES SDs.

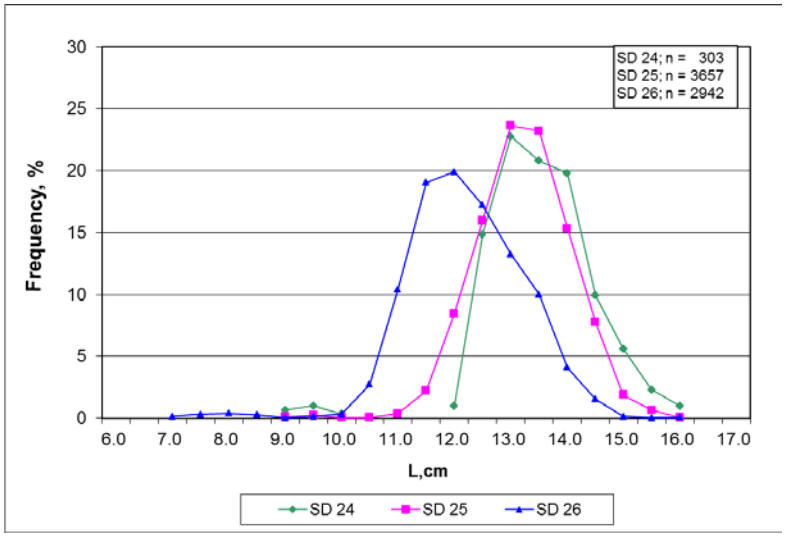

Fig. 10. Length distribution of sprat in samples taken from the control catches.

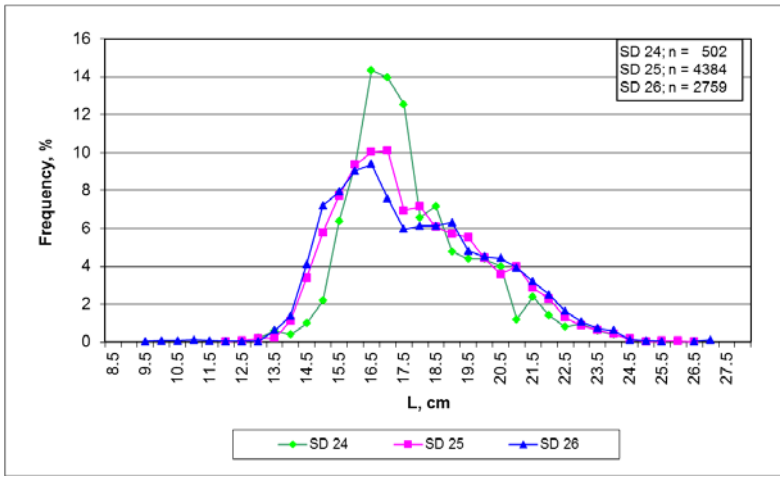

Fig. 11. Length distribution of herring in samples taken from the control catches.

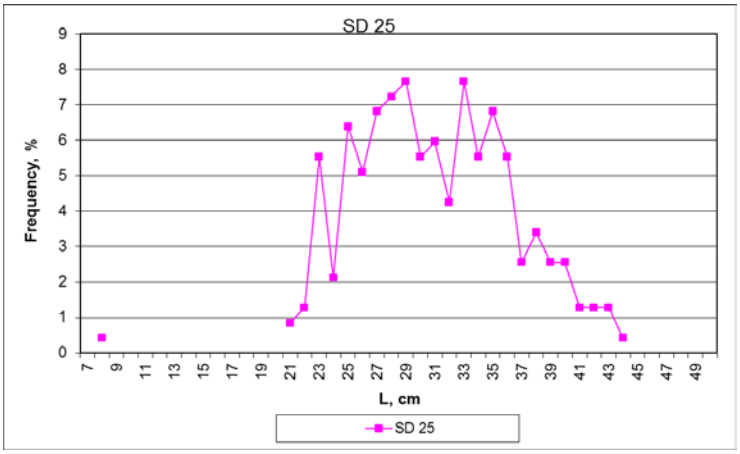

Fig. 12. Length distribution of cod in samples taken from the control catches in SD 25. The data from SDs 24 and 26 were not representative.

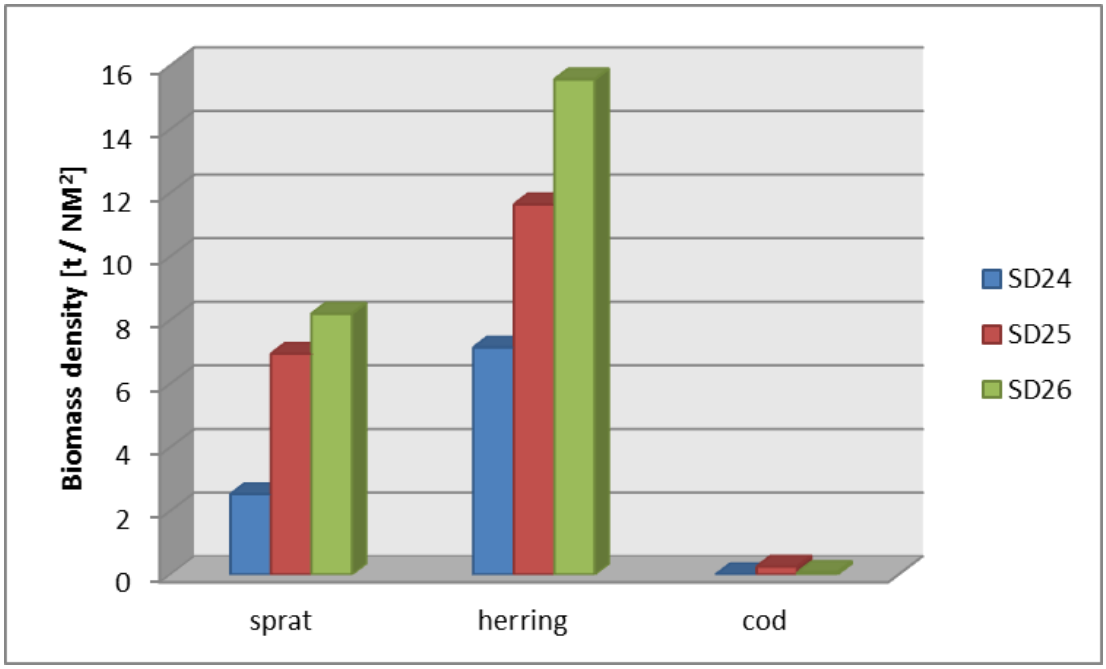

Fig. 13. Total biomass density in the ICES Sub-divisions for the three major species.

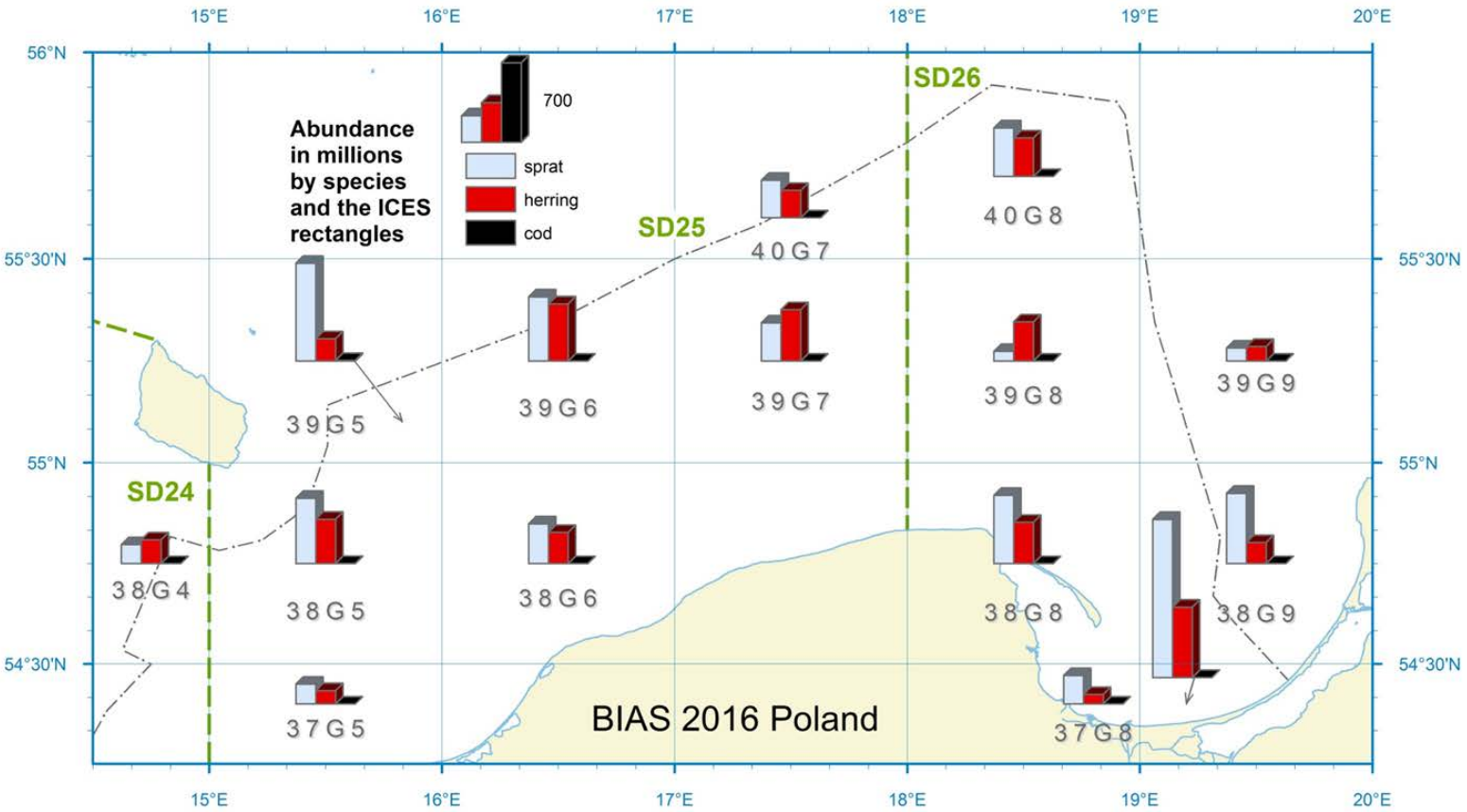

*Fig. 14. Cruise statistics (the black bar's size in a legend represents 700*10^6 of indiv.).*

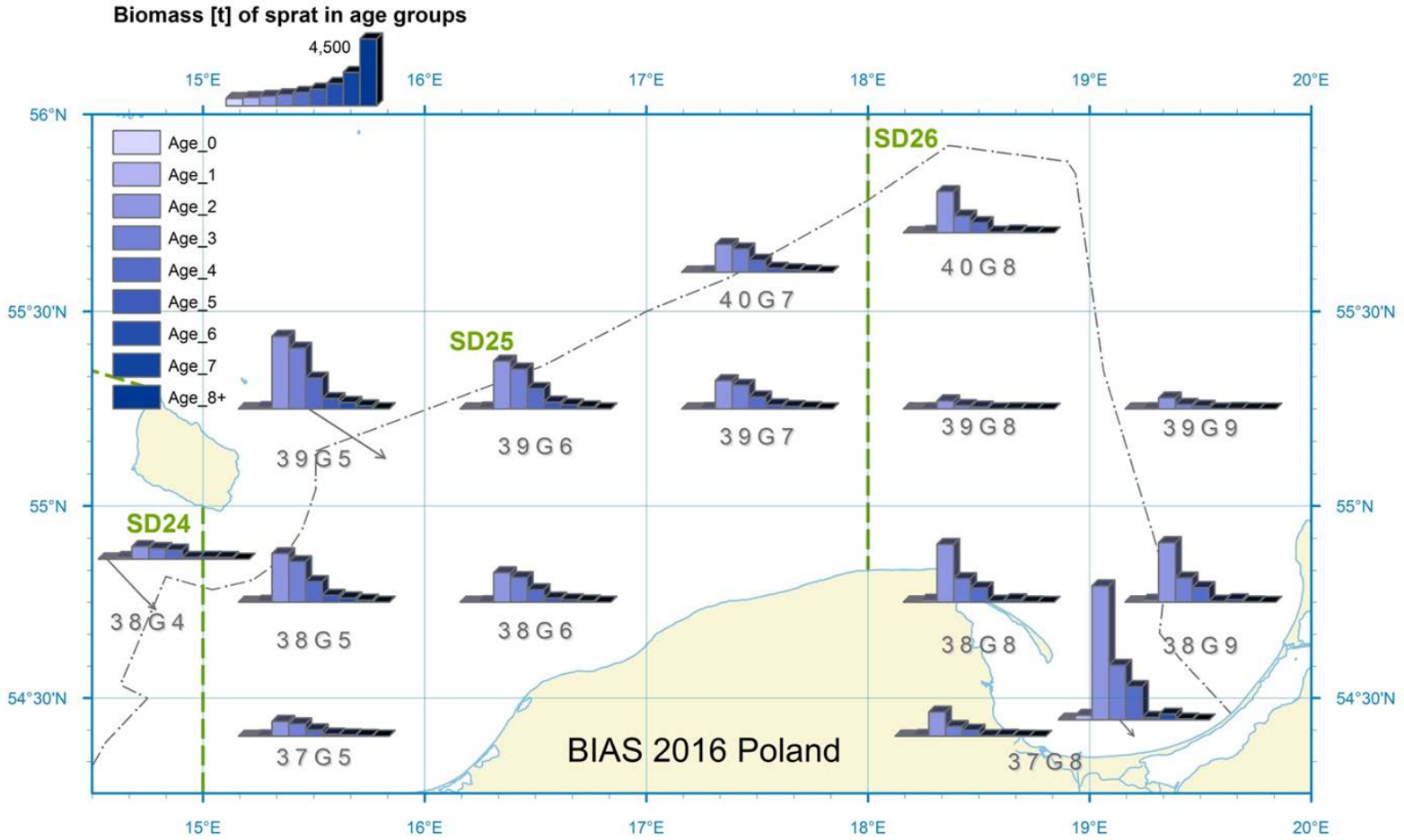

Fig. 15. Biomass of sprat (in tons) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13-30.09.2016. The largest bar's size in the legend represents 4500 t.

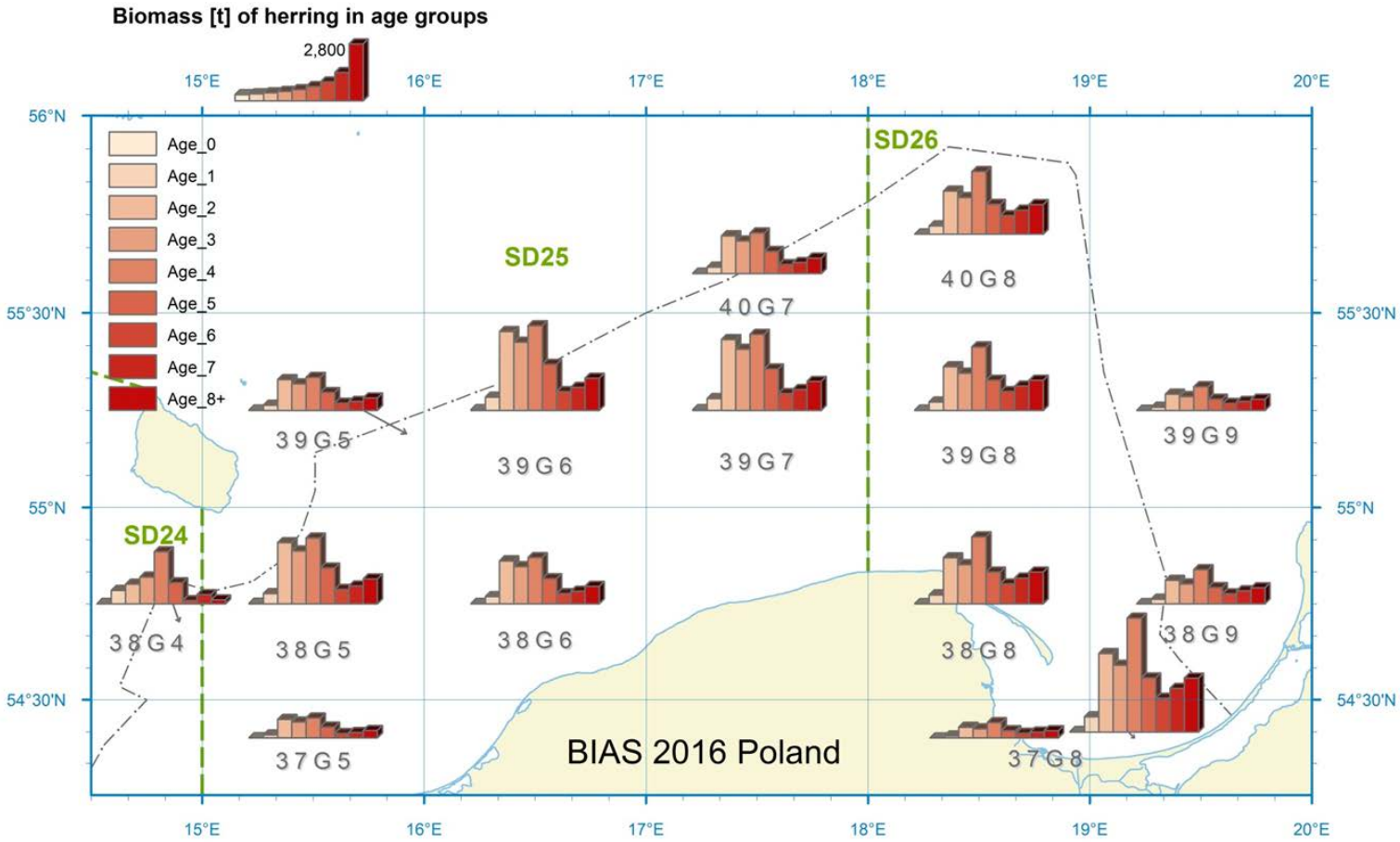

Fig. 16. Biomass of herring (in tons) per age groups, ICES rectangles and ICES SDs, estimated using acoustic method based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13-30.09.2016. The largest bar's size in the legend represents 2800 t.

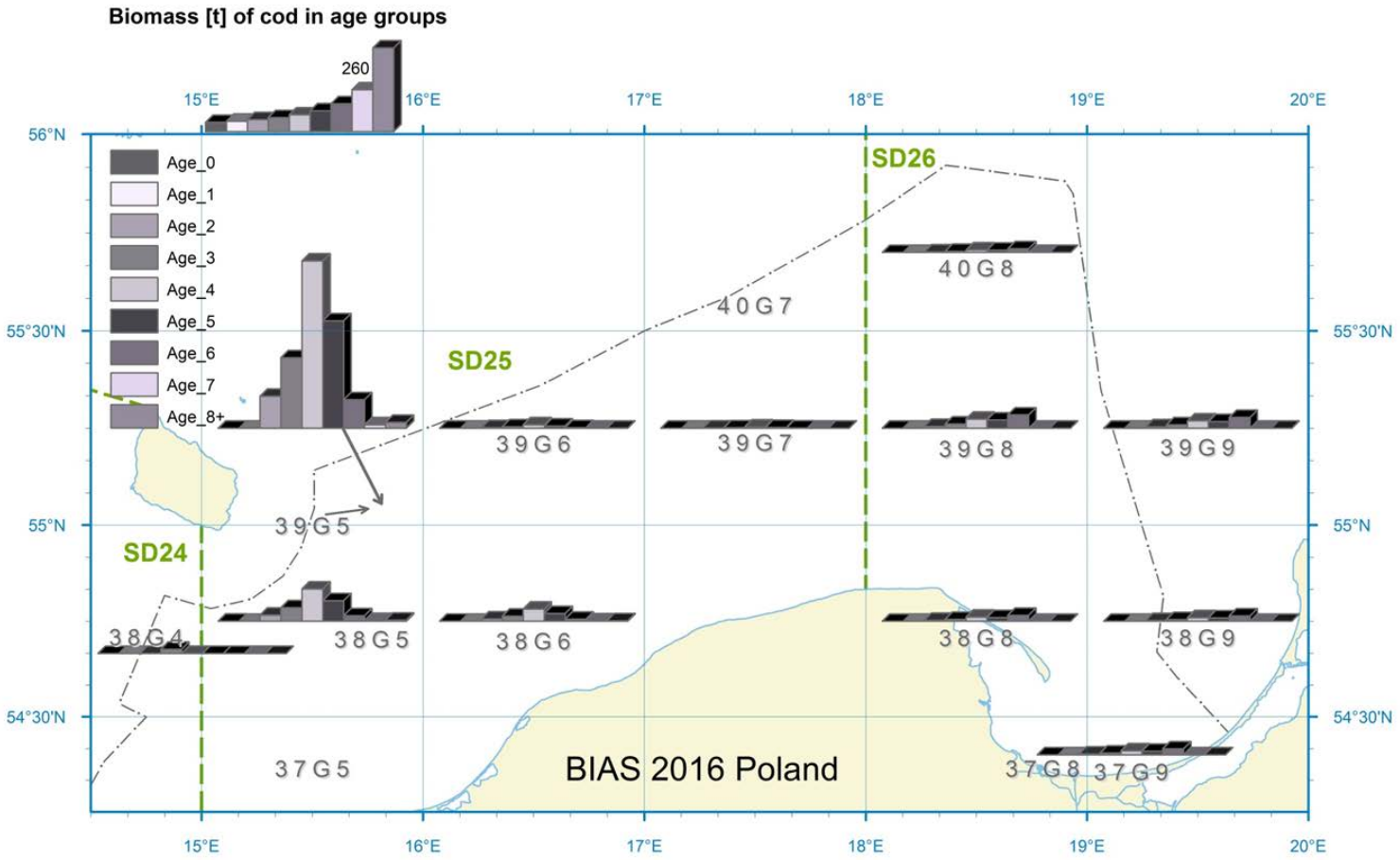

Fig. 17. Biomass of cod in tons per age groups, ICES rectangles and ICES SDs, estimated using acoustic method based on data collected during the Polish BIAS survey on board of the r.v. Baltica, 13-30.09.2016. The largest bar's size in the legend represents 260 t.

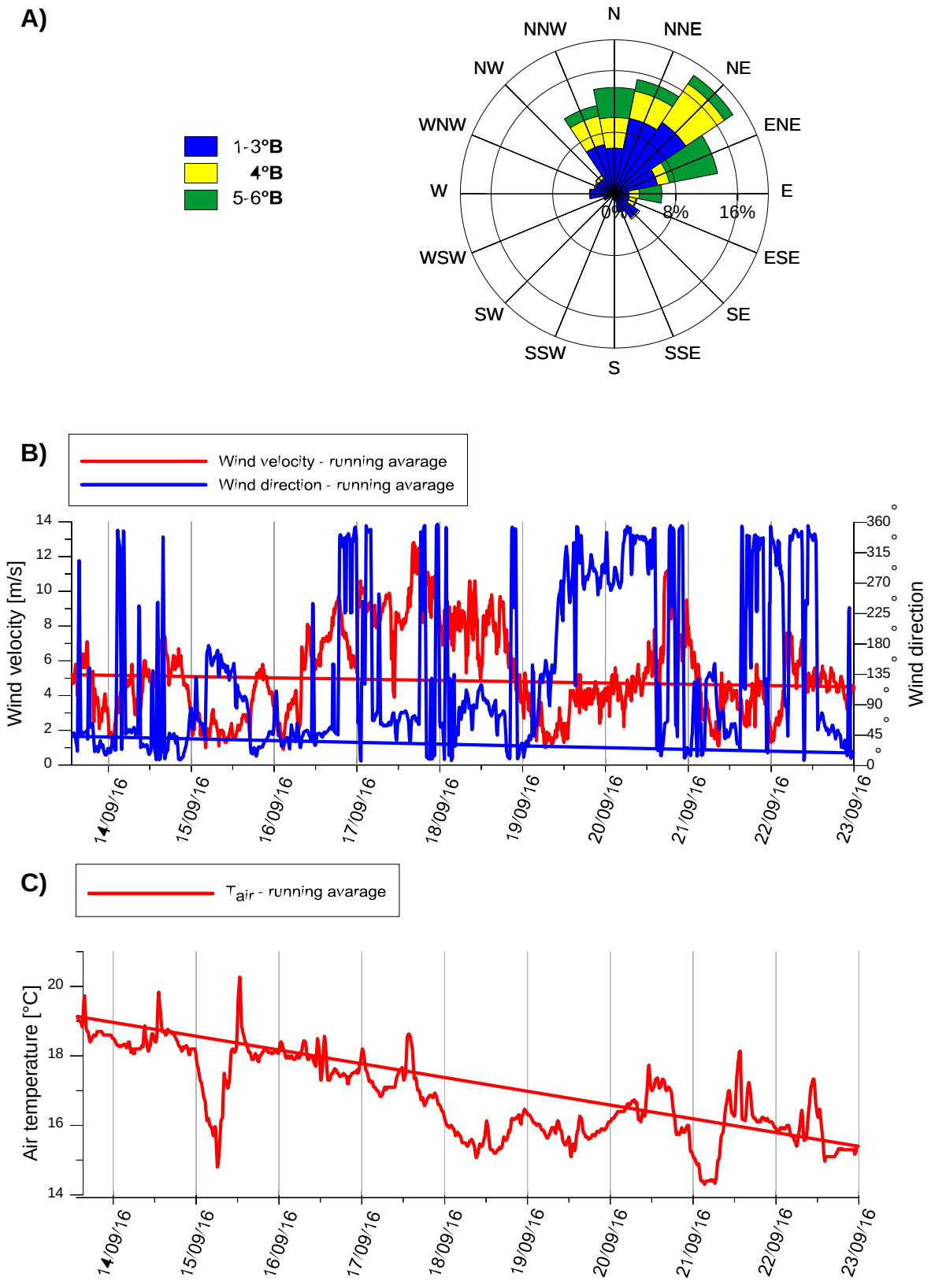

Fig. 18. Changes of meteorological parameters during consecutive days of the Polish BIAS survey (September 2016).

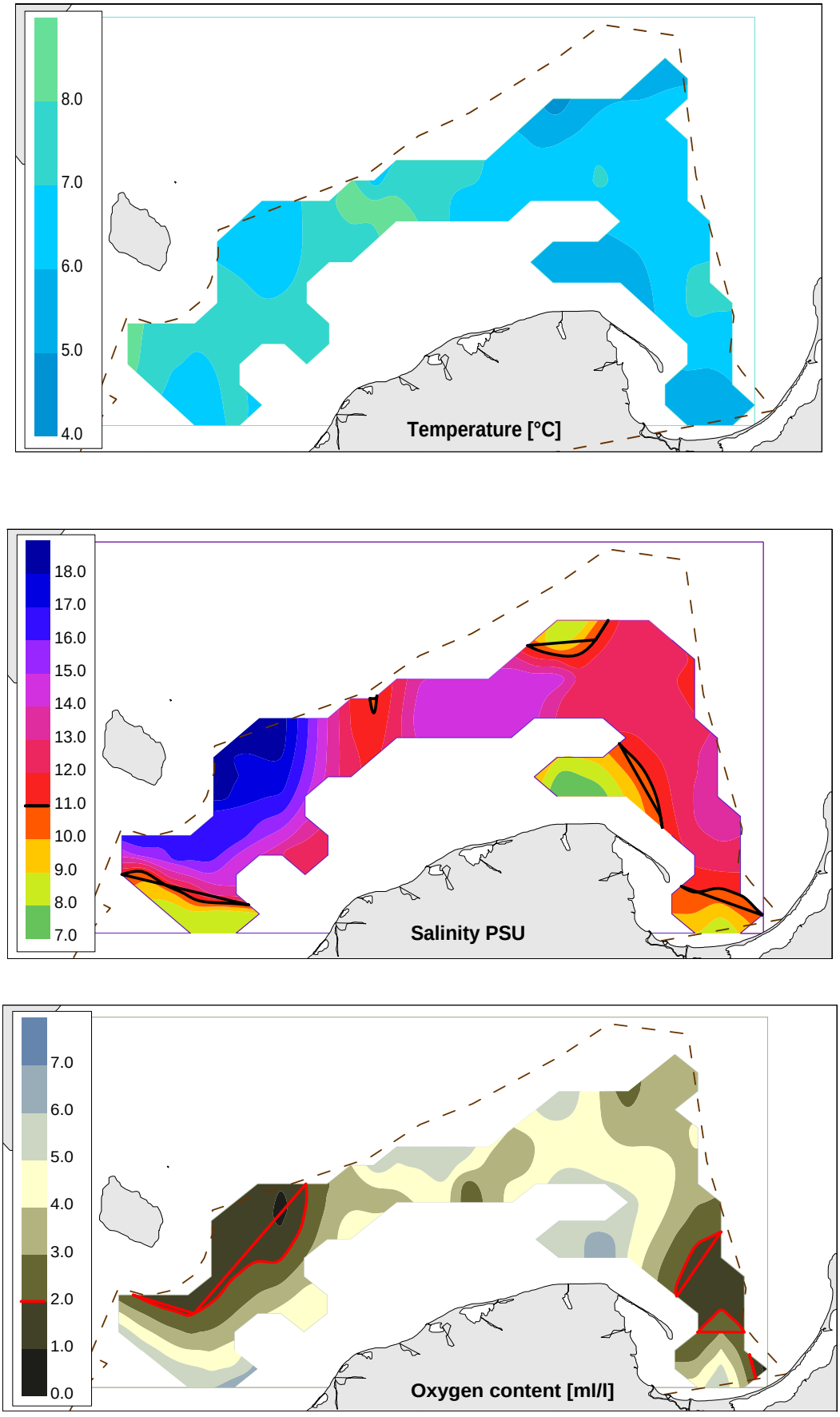

Fig. 19. Horizontal distribution of the seawater temperature, salinity and oxygen content in near the seabed layer of the southern Baltic (September 2016).

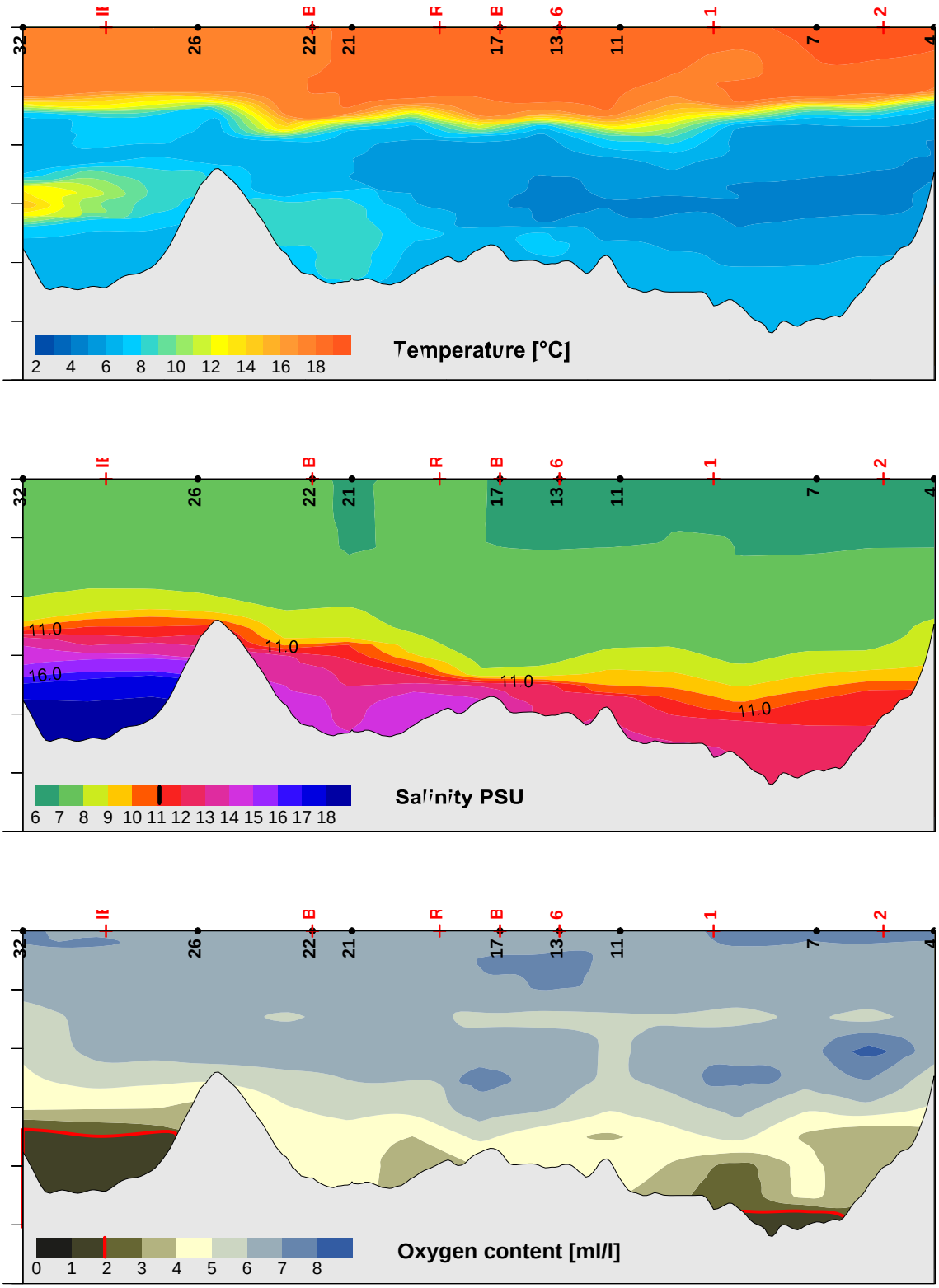

Fig. 20. Vertical distribution of the seawater temperature, salinity and oxygen content, along the research profile determined in the southern Baltic (September 2016); X- and Y-axes reflects distance (in kilometers) and depth (in meters) from the sea surface to the seabed, respectively.

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THE CRUISE REPORT

FROM THE JOINT LATVIAN-POLISH BALTIC INTERNATIONAL ACOUSTIC SURVEY – BIAS 2016 ON THE R/V "BALTICA" IN THE ICES SUBDIVISIONS 26N AND 28.2 OF THE BALTIC SEA (11-20 OCTOBER 2016)

Working paper on the WGBIFS meeting in Riga, Latvia, 27-31.03.2017

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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 (DDR) was performed since 1983, but the first scattered surveys was made since 1977 [Hoziosky et al. 1987, Shvetsov 1983, Shvetsov et al. 1988]. The first joint Latvian-Polish acoustic survey on the research vessel “Issledovatel Baltiki” (renamed on the r/v "Baltijas Petnieks") of former BaltNIRH was realised in October 1991 and was performed for the estimations of the biomas of Baltic clupeid stocks in the pelagic offshore zone of the ICES Sub-divisions 25-29 [Shvetsov et al. 1992]. The next joint acoustic survey in cooperation of scientists from Poland, Latvia and Estonia were performed on the Polish r/v "Baltica" in October 1996 [Grygiel 2006, Orłowski et al. 1997]. The permanent participation of the Polish r/v “Baltica” in the autumn Baltic International Acoustic Surveys (BIAS) within the Polish EEZ has taken place since 1994 in the framework of long-term ICES Baltic International Acoustic Surveys program, coordinated by the ICES Baltic International Fish Survey Working Group (WGBIFS). Several years in October (1994-2004) and May (2003-2004) BIOR as assignee of BaltNIIRH, LatFRI (in noted period) and LatFRA cooperated with Russian AtlantNIRO in Kaliningrad, but since 2005 the superb regular collaboration has been formed with Polish SFI (since June 2011 named as National Marine Fisheries Research Institute – NMFRI) in Gdynia and as a result we have made 5 BASS and 12 BIAS on pelagic fish stocks and 20 BITS on demersal fish stocks.

This was the 12th joint Latvian-Polish Baltic International Acoustic Survey (BIAS) in the ICES Sub-divisions 26N and 28.2 conducted by the r/v “Baltica” in October 2016. 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 National Marine Fisheries Research Institute (NMFRI) from Gdynia. The vessel was operated within the Latvian, Estonian and Swedish EEZs (ICES Sub-divisions 26N and 28.2). The “Latvian National Program for Collection of Fisheries Data 2011-2013” in accordance with the EU Council Regulation No. 199/2008 and EU Commission Regulation No.605/2008, EU Commission Decisions 2008/605/EC, 2009/10121/EC, C (2013) 5568, with European Commission implementing decision of 30.08.2013 that extends the national program for the period 2011-2013 to the period 2014-2016, was partly subsidized this cruise. It was coordinated by the ICES Baltic International Fish Survey Working Group (WGBIFS) [ICES 2016].

Pelagic research catches carried out during an acoustic survey are the information source, independent from topical preferences in fishery, about quantitative changes in a process of clupeids geographical and bathymetrical distribution in the Baltic Sea. The data from hydrological measurements are the information source about abiotic environmental factors (seawater temperature, salinity, oxygen content) influencing sprat and herring spatial distribution. Echo-integration results along the pre-selected tracks are the basic materials for fish stock biomass calculations.

The ICES Baltic Fisheries Assessment Working Group (WGBFAS) applies the BIAS data for clupeids (sprat and herring) stock biomass assessment and spatial distribution updating. The basic acoustic and biological data collected during recently carried out survey are stored in the BASS_DB and BIAS_DB in BAD1 format and till the 2012 were stored in FishFrame Acoustic (former BAD2 format) international databases, managed by the ICES Secretariat. In recent years work is underway to create a new useful acoustic database.

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 – seven persons:

F. Svecovs, (BIOR, Riga – Latvia) – scientific staff leader, acoustic team;
M. Wyszynski (NMFRI, Gdynia – Poland) – cruise leader, fish sampling team;
T. Wodzinowski (NMFRI, Gdynia – Poland) – hydrologist, hydrology team;
J. Slembarski (NMFRI, Gdynia – Poland) – acoustician, acoustic team;
G. Kruk (NMFRI, Gdynia – Poland) – acoustician, acoustic team;
G. Strods (BIOR, Riga – Latvia) – ichthyologist, acoustic and fish sampling team, hydrobiology;
V. Cervoncevs (BIOR, Riga – Latvia) – ichthyologist, fish sampling team;
J. Aizups (BIOR, Riga – Latvia) – ichthyologist, fish sampling team;
J. Gruduls (BIOR, Riga – Latvia) – ichthyologist, fish sampling team.

1.2. Survey description

The reported survey took place during the period of 11-20 October 2016 (10 working days at sea). The at sea researches were conducted within Latvian, Swedish and Estonian EEZs (the ICES Sub-divisions 26N and 28.2), moreover inside the Latvian territorial waters not shallower than 20 m.

The vessel left the Gdynia port (Poland) on 11.10.2016 at 15:55 o'clock and was navigated in the north direction to the echo-integration start point at the geographical position 56□06'N 020□10'E. The direct at sea researches began on 12.10.2016 at the midday. The survey ended on 20.10.2016 at 11:55 o'clock in the Ventspils harbor (Latvia).

1.3. Survey methods and performance

1.3.1. Acoustical and trawling methods

Acoustic data were collected with the SIMRAD EK-60 38 kHz and 120 kHz two frequency split beam scientific echo-sounder equipped with "EchoView Version 7.10" software for the data analysis. These data collected during the described here BIAS were delivered to the Latvian researchers for further elaboration. The survey echo-integration tracks were planned in the similar pattern as in the previous years, due to historical comparability of the data. Overall 628 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 2014 was 1953.3 nm^2 in the northern part of the ICES Sub-division 26 and 7874.9 nm^2 in Sub-division 28.2, totally 9828.2 nm^2 (Fig. 1).

The pre-selection of the pelagic fish catches based on the ICES statistical rectangle area (with range of 0.5 degree in latitude and 1 degree in longitude) and the present density pattern of vertical distribution of clupeids along a transect. The intention was to carry out at least two control hauls per the ICES statistical rectangle [ICES 2003]. The water depth range-layer with sufficient for fish oxygen content (minimum 1.0÷2.0 ml/l) were taken into account in the process of the hauls distribution.

The r/v "Baltica" realized 23 fish control-catches (Tab. 1). All catches were performed in the daylight (between 07:05 am and 16:55 pm) using the pelagic trawl type WP 53/64x4 (with 6 mm mesh bar length in the codend). The standard trawling duration was 30 minutes, however 5 hauls duration were shortened to 15 minutes (due to very dense fish concentrations observed). The mean

speed of vessel while trawling was 3.0 knots. Overall, 5 hauls were conducted in SD 26N and 18 hauls in SD 28.2. Totally 15 hauls were performed in the Latvian, 5 hauls in Swedish and 3 hauls in Estonian EEZs (see text-table below).

1.3.2. Biological sampling

The length measurements (in 0.5 cm length classes) were realized for 4590 sprat and 2271 herring individuals. In total, 2161 sprat and 1248 herring individuals were taken for biological analysis. Moreover, all 755 individuals of other species (683 threespine stickleback, 46 ninespine stickleback, 18 cod, 4 flounder, 2 lumpfish, 1 short horn scorpion and 1 salmon) were measured (Tab. 2). Detailed ichthyologic analyses were made according to standard procedures, directly on board of surveying vessel.

Due to herring and sprat normally cannot be distinguished from other species by visual inspection of the echogram species composition and fish length distributions were based on trawl catch results. Mean target strength of fish was calculated according to the following formulas [Foote et al. 1986, ICES 1983, 2014]:

for clupeids: TS = 20logL-71.2;
for gadoids: TS = 20logL-67.5;
cross section $\sigma = 4\pi 10^{a/10} \times L^{b/10}$.

The total number of fish in each ICES rectangle was estimated as a product of the mean area scattering cross-section – NASC (S_A) and the rectangle area, divided by corresponding mean acoustic cross-section. Fish abundance was separated into different species according to the mean catch composition in the given rectangle.

1.3.2. Hydrological and meteorological observations

The measurements of the basic hydrological parameters were realized in the period of 11-20 October 2016, totally at 25 stations, int. al. at 23 fish catch-station and 5 HELCOM stations located in the central-eastern part of the Baltic Sea (Fig. 2). Positions of the haul stations 6, 7, 13 and 14 overlapped with HELCOM stations 45, 43, 37 and 40A respectively. Results presented in this paper are linked with sites of the standard HELCOM stations and locations of the catch-stations during pelagic trawl hauling up. Hydrological stations were inspected with the IDRONAUT CTD-probe combined with the rosette sampler (the bathometer rosette). Oxygen content was determined by the standard Winkler's method. The hydrological row data, originated from measuring realized from the sea surface layer up to the bottom, were aggregated to the 1-m depth stratums, were information source about the abiotic factors potentially influencing fishes spatial distribution. The oxygen probes ware taken on every 10 meters. The salinity parameter was presented in Practical Salinity Unit (PSU).

Meteorological observations of air temperature, wind velocity and directions and atmospheric pressure were realized at the actual geographic position of each control-haul and in every 10 minutes interval over the whole survey. The automatic meteorological station type "Milosz" was applied for measurements of the above-mentioned parameters. The values of meteorological and hydrological parameters registered at trawling stations are aggregated in Table 3.

2. RESULTS
2.1. Biological data

2.1.1. Catch statistics

Total number of realized hauls and total catches in kg of fish in Latvian and Swedish EEZs during reported BIAS 4Q 2016 are presented in the Table 4. Overall, 9 fish species were recognized in hauls performed in the Central-eastern Baltic Sea. Sprat was dominating species by mass in the both ICES Sub-divisions 26N and 28.2 (92.7 and 83.3% respectively). The rest 7 species

represented as 1.9 % (in this 1.7% belonging to threespine stickleback) of the total mass in average for all investigated area.

Mean CPUE for all species in the investigated area in 2016 amounted 1387.3 kg/h and was higher comparing to the previous years (504.5 kg/h in 2013 and 751.2 kg/h in 2014, 832.6 in 2015). The mean CPUEs of sprat were: 2036.8 kg/h in ICES SD 26N, and 968.4 kg/h in SD 28.2. The mean CPUEs of herring were as follow: in SD 26N – 155.2 kg/h and 162.0 kg/h in SD 28.2. Taking into advice all investigated area, about two time increase of mean CPUE value for sprat and a little of herring was noted in 2016, comparing to previous year. The CPUE values and distributions by particular haul for herring, sprat and others are presented at the Fig. 3 and 4. Highest CPUE values for herring were noted in the North-eastern part of SD 28.2, as well as very good CPUEs for sprat were distributed more equally in all investigated area.

2.1.2. Acoustical and biological estimates

The basic acoustic and biological data (surveyed area statistics, mean NASC, the mean scattering cross-section, the total number of fish, percentages of herring and sprat) per ICES rectangles and the estimated abundance and biomass of sprat and herring per above mentioned rectangles, collected in October 2016, are given in Table. 5, for third dominant species – threespine stickleback in Table 6. The characteristics of the pelagic fish stock are aggregated in Table 7 for sprat and Table 8 for herring. The geographical distributions of NASC and pelagic fish stock densities in the central-eastern Baltic Sea in October 2016 are shown in Fig. 5, 6 and 7.

The pelagic fish stock was represented mostly by sprat – 94.4 %, in comparison – 71.5% in 2013 86.8 %, in 2014 and 88.2 % in 2015. Herring was represented as only 5.6 %, 28.5 % in 2013, 13.2 % in 2014 and 11.8 % in 2015. Tendency shows that sprat stock grows faster than herring stock. The highest sprat stock density (126.4 $n\times10^6/nm^2$, 72.6 $n\times10^6/nm^2$ in 2015) were recorded in ICES rectangle 42H0 of the ICES Sub-division 28.2. The highest average abundance per nm^2 and biomass of the sprat stock were recorded in the central and southern part of investigated area in ICES rectangles 42H0 and 41H0. The distribution of the high density sprat concentrations in October 2016 totally differed comparing with that from October of the years previous 2010-2015, when high density sprat concentrations had found mostly in the central and northern parts of the investigated area. In 2013 sprat distribution pattern more-less was emulating pattern observed in years till 1992 [Hoziosky et al. 1988, Shvetsov et al. 1988, 1989, 1992, 2002], but not so evident as it was in 2010. In 2014 sprat had scattered distribution of concentrations mostly made from specimens of new generation and in 2015 distribution was scattered too, but with relatively high rate of concentrations in separate points. In 2016 the main sprat stock resides between 50 and 100 m depth isolines and the geographical distribution shows different pattern as it was recent two years before when it was very scattered with several concentration points of high abundance [Svecovs et al. 2010, 2011, 2012, 2013, 2014, 2015]. In October 2016 sprat stock had three centers of aggregations in investigated aquatory.

The herring stock density was significantly lower in comparison to sprat stock density and densities in previous recent years. The highest density values were 5.0 and 5.2 $n\times10^6/nm^2$ and noted in ICES rectangles 43H1 and 43H0 respectively in Sub-division 28.2 in comparison to 2013 were highest density values was not over 8.8 $n\times10^6/nm^2$ in rectangle 44H0, in 2014 values over 10.0 $n\times10^6/nm^2$ were recorded in two rectangles 43H0 and 45H0, but in 2015 highest density values was 10.2 $n\times10^6/nm^2$ and noted in ICES rectangle 44H0.

Comparison of the acoustic results from October of 2005-2015 indicated that investigated sprat stock abundance and biomass had decreasing tendency, but herring stock had a slight increase. In 2016 sprat stock has increased significantly due to very abundant generation of 2014. Herring stock remains at the same level as previous year.

The mean length and mean weight distributions of dominant fish species (sprat, herring and sticklebacks) by hauls and rectangles in the ICES Sub-divisions 26 and 28 are shown in Figures 8,

9 and 10 respectively. The total length and mean weight in control hauls of sprat, herring and stickleback ranged as follows:

- sprat – 6.5÷14.5 cm (average TL = 11.36 cm), 1.7÷18.4 g (average W = 8.71 g)
- herring – 8.0÷23.0 cm (average TL = 15.38 cm), 4.0÷84.0 g (average W = 23.07 g)
- stickleback – 4.0÷7.5 cm (average TL = 6.23 cm), 0.7÷3.5 g (average W = 1.85 g)

The sprat length distribution curves have a bimodal character for both Sub-divisions 26 and 28.2. The first small length frequency pick takes place at 8.5-9 cm length classes and the second higher one at length classes 11-11.5 cm represented adult sprat. The frequency of sprat generation born in 2016 (ranged from 6.5 to 9.5 cm total length), like as 2015 generation, was scarcely notice comparing to high frequency of sprat generation born in 2014.

The modal frequency representing adult herring corresponded to 14.5 and 15.5 cm length classes in SDs 28.2 and 26 respectively. The fish representing 8.0-9.5 cm length range belonging to the generation born in 2016 had a very low frequency and was noted in SD 28.2 only.

Three and ninespine sticklebacks length distributions from SD 28.2 showed a one mode character with frequency picks at 6 and 4.5 cm length classes respectively.

Sprat at the smallest length classes had even composition of mean weights and lengths in whole area, but by increasing age the differences of mean weights appears in the investigated area – towards the south-southwest sprat became heavier, the same tendency was observed in previous years. Herring had more evident differences at length classes than it was observed at sprat. Sprat stock was composed dominantly of year class 2 specimens – 67.64 % in SD 26N, 56.82 % in SD 28.2 and 60.22 % overall. Herring stock although was composed mainly of year class 2 specimens – 33.93 % in SD 26N, 51.44 % in SD 28.2 and 49.18 % overall. The year-class 0 of sprat was represented by length-classes 8.0÷9.5 cm in SD 26N, 6.5÷10.0 cm in SD 28.2 and 8.35 cm on average with mean weights 3.3÷5.5 g, 1.7÷7.2 g and 4.27 g respectively.

2.2. Meteorological and hydrological data

2.2.1. Weather conditions

The most frequently winds (Fig. 11.) were: E and ESE. The wind speed varied from 2.8 m/s to 14.8 m/s and average wind speed was 8.1 m/s. The air temperature ranged from 9.8 °C to 2.6 °C, and average temperature was 6.6 °C.

2.2.2. Hydrology of the Gotland Deep

Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological research profile of the central-eastern Baltic for October 2016 is shown in Figure 12. The seawater temperature in the surface layers varied from 8.15 to 13.54°C (the mean was 10.81°C). The lowest surface temperatures were recorded at the haul station 23. The highest ones were noticed at the station 46. The minimum value of salinity in Practical Salinity Unit (PSU) was 6.30 at the haul station 22 in the surface layer. The maximum was 7.03 PSU at the hydrological station 46. The mean value of salinity was 6.65 PSU. The oxygen content in the surface layers of investigated the research area varied in the range of 7.06 ml/l (station 46) – 7.96 ml/l (haul 11). The mean value of surface water oxygen content was 7.61 ml/l.

The temperature of near bottom (Fig. 13) layer was changing in the range of 7.30 - 4.82°C (the mean was 6.01°C). Salinity in the bottom waters varied from 7.56 to 13.39 PSU (the mean was 10.99 PSU). The lowest values of salinity were at the haul station 2. The highest values of salinity were noticed at the haul station 13. Oxygen content varied from 0.17 ml/l to 6.96 ml/l (the mean was 1.86 ml/l). The lowest values of this parameter were noticed at the haul station 13.

3. DISCUSSION

The data of the Latvian-Polish BIAS in the 4th quarter of 2016 were considered by the ICES BIFS Working Group (Rostock, Germany, 30.03-03.04.2016) 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 in the period of 2005-2015 had overall decreasing tendency of abundance with evident increasing in 2016 due to very abundant sprat generation of 2014. The mean length and weight of adult sprat had the same tendency to abundance. The geographical distribution of sprat densities in the October 2016 had different pattern as in 2015 due to recruits of 2014 integrated in adult fish stock. The main sprat stock laid over the 50-100 m depths.

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Annex. Tables and Figures

Table 1. Fish control-catch statistics in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016

Haul number	Date	ICES rectangle	ICES SD	Mean bottom depth [m]	Headrope depth [m]	Vertical opening [m]	Trawling speed [knt]	Trawling direction [°]	Geographical position				Time Start	Haul duration [min]	Total catch [kg]
									Start		End				
									Latitude 00°00.0'N	Longitude 00°00.0'E	Latitude 00°00.0'N	Longitude 00°00.0'E			
1	2016-10-12	41H0/G9	26	60	37	20	3.1	277	56°06.5'	20°00.1'	56°06.7'	19°57.3'	11:45	30	239.337
2	2016-10-12	41G9	26	51	22	20	3.1	268	56°06.3'	19°37.9'	56°06.3'	19°35.1'	14:10	30	198.320
3	2016-10-13	41G9	26	128	25	20	2.9	105	56°23.0'	19°08.8'	56°22.7'	19°12.1'	07:40	30	439.608
4	2016-10-13	41G9	26	102	55	20	3.0	280	56°23.1'	19°47.0'	56°23.3'	19°44.7'	11:45	30	283.410
5	2016-10-13	41H0	26	76	50	20	3.0	280	56°23.2'	20°03.2'	56°23.3'	20°01.7'	14:50	15	2166.149
6	2016-10-14	42H0	28.2	56	27/38	20	3.0	267	56°36.9'	20°35.8'	56°36.8'	20°33.1'	07:05	30	716.380
7	2016-10-14	42G9	28.2	145	65	19	3.0	276	56°37.0'	19°53.3'	56°37.1'	19°52.1'	10:55	15	861.191
8	2016-10-14	42G9	28.2	151	70	18	3.0	18	56°40.0'	19°06.0'	56°41.4'	19°06.7'	15:25	30	379.628
9	2016-10-15	42H0/G9	28.2	160	30	20	3.1	275	56°53.1'	20°02.2'	56°53.2'	19°59.2'	08:10	30	176.630
10	2016-10-15	42H0	28.2	126	58	20	2.9	275	56°53.0'	20°17.0'	56°53.1'	20°14.1'	11:05	30	1462.576
11	2016-10-15	43H0	28.2	69	45	20	3.0	308	57°05.7'	20°44.7'	57°06.6'	20°42.8'	16:00	30	421.665
12	2016-10-16	43G9	28.2	154	35	18	2.9	304	57°23.3'	19°44.3'	57°23.7'	19°43.2'	13:35	15	338.085
13	2016-10-16	43H0	28.2	232	40/60	20	2.8	280	57°20.7'	20°04.5'	57°20.9'	20°02.0'	16:25	30	203.150
14	2016-10-17	43H1	28.2	67	46	20	3.2	26	57°23.7'	21°00.5'	57°24.6'	21°01.3'	08:25	15	946.110
15	2016-10-17	44H1	28.2	64	43	20	3.0	10	57°34.6'	21°08.4'	57°36.2'	21°09.2'	10:40	30	277.920
16	2016-10-17	44H0	28.2	103	70/40	19/20	2.9	342	57°37.3'	20°43.7'	57°38.6'	20°42.8'	14:55	30	197.671
17	2016-10-18	44G9	28.2	121	52	20	3.0	350	57°42.0'	19°59.8'	57°42.7'	19°59.6'	08:20	15	282.600
18	2016-10-18	44H0	28.2	123	56	20	2.9	346	57°54.5'	20°12.7'	57°55.8'	20°12.2'	11:55	30	306.960
19	2016-10-18	44H0	28.2	101	50/30	20/23	3.1	312	57°54.4'	20°41.9'	57°55.2'	20°40.3'	15:35	30	137.940
20	2016-10-19	44H1	28.2	67	45	20	3.1	338	57°55.5'	21°21.2'	57°56.8'	21°20.2'	07:40	30	807.460
21	2016-10-19	45H0	28.2	59	30	18	3.2	295	58°04.9'	20°57.7'	58°05.5'	20°54.8'	11:25	30	87.251
22	2016-10-19	45H0	28.2	98	41	20	2.8	309	58°07.5'	20°28.7'	58°08.4'	20°26.6'	14:30	30	99.991
23	2016-10-20	43H1	28.2	68	40	20	3.0	323	57°23.0'	21°09.2'	57°24.2'	21°08.1'	07:30	30	329.343
												SD26			3326.824
												SD28			8032.551
												SD26+28			11359.375

Table 2. Number of measured and aged fish individuals in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016

Fish species	Number of measured individuals			Number of aged individuals		
	SD 26	SD 28	SD 26+28	SD 26	SD 28	SD 26+28
Sprat (all)	1014	3576	4590	466	1695	2161
Sprat (yearclass 0)	43	381	424	43	201	244
Herring (all)	421	1850	2271	200	1048	1248
Herring (Open sea herring)	359	1460	1819	169	824	993
Spring spawners	359	1459	1818	169	823	992
Autumn spawners		1	1		1	1
Herring (Gulf herring)	4	381	385	2	219	221
Herring (Southern Baltic herring)	58	9	67	29	5	34
Cod	11	8	19			
Flounder		4	4			
Lumpfish	2		2			
Salmon	1	1	2			
Stickleback, threespine	15	668	683			
Stickleback, ninespine		46	46			
Shorthorn sculpin	1		1			
Total	1465	6153	7618	666	2743	3409

Table 3. The values of meteorological and hydrological parameters registered at the trawling depth in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016

Haul number	Date of catch	Mean headrope depth [m]	Meteorological parameters					Hydrological parameters		
			wind direction	wind force [°B]	sea state	air temper. [°C]	atmospheric pressure [hP]	temperature [°C]	salinity [PSU]	oxygen [ml/l]
1	12-10-	37	E	4	3	6	1027	5.29	7.28	6.53
2	12-10-	22	E	4	2	6	1027	13.38	7	7.27
3	13-10-	25	E	4	2	6	1027	11.6	6.7	7.36
4	13-10-	55	E	4	3	6	1029	5.07	8.58	4.65
5	13-10-	50	E	3	2	7	1030	5.04	8.6	4.11
6	14-10-	27/38	E	4	2	4	1025	4.85/4.64	7.13/7.6	6.75/4.7
7	14-10-	65	E	4	2	4	1028	5.08	8.92	2.69
8	14-10-	70	E	4	2	5	1029	5.36	9.45	2.83
9	15-10-	30	ESE	5	3	3	1027	9.15	6.81	7.31
10	15-10-	58	E	4	3	3	1028	5.08	8.83	2.18
11	15-10-	45	E	6	3	3	1031	5.26	9.25	2.59
12	16-10-	35	SE	5	3/4	5	1035	5.05	7.17	6.79
13	16-10-	40/60	SE	5	3	5	1035	5.11/5.01	8.93/7.2	2.07/6.3
14	17-10-	46	SE	4	3	5	1035	5.45	9.18	2.04
15	17-10-	43	SE	5	3	6	1037	5.85	9.58	1.75
16	17-10-	70/40	S	5	3	7	1034	4.62/4.82	7.46/8.3	5.95/3.3
17	18-10-	52	SSE	5	3	6	1026	4.67	8.04	3.96
18	18-10-	56	SSE	4	3	7	1026	5.31	9.43	1.84
19	18-10-	50/30	SE	4	3	7	1026	5.37/6.53	9.76/7.4	1.01/6.5
20	19-10-	45	SE	5	3	5	1022	5.23	8.96	2.18
21	19-10-	30	SE	5	3	7	1023	5.55	7.33	5.43
22	19-10-	41	SE	5	3	7	1023	4.59	7.54	4.6
23	20-10-	40	ESE	5	3	3	1020	5.43	9.09	2.15

Table 4. Fish control-catch results by species in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016

					Catch per species [kg]								
Haul number	Date	ICES rectangle	ICES SD	Total cactch [kg]	sprat	herring	cod	flounder	shorthorn sculpin	lumpfish	threespine stickleback	ninespine stickleback	salmon
					161789	161722	164712	172894	167318	167612	166365	166387	161996
1	2016-10-	41H0/G9	26	239.337	198.320	40.620				0.397			
2	2016-10-	41G9	26	198.320	197.328	0.992							
3	2016-10-	41G9	26	439.608	430.011	7.890	1.103		0.165		0.439		
4	2016-10-	41G9	26	283.410	28.310	251.990	3.110						
5	2016-10-	41H0	26	2166.149	2119.034	43.246	0.354						3.515
6	2016-10-	42H0	28.2	716.380	703.127	8.167					5.086		
7	2016-10-	42G9	28.2	861.191	841.569	18.070	0.691				0.861		
8	2016-10-	42G9	28.2	379.628	356.128	21.595	0.768				1.137		
9	2016-10-	42H0/G9	28.2	176.630	9.715	0.530					166.385		
10	2016-10-	42H0	28.2	1462.576	1422.233	39.775	0.276				0.292		
11	2016-10-	43H0	28.2	421.665	413.197	5.054	0.465				2.949		
12	2016-10-	43G9	28.2	338.085	332.340	1.005					1.675		3.065
13	2016-10-	43H0	28.2	203.150	173.490	18.890					10.770		
14	2016-10-	43H1	28.2	946.110	664.169	281.752					0.189		
15	2016-10-	44H1	28.2	277.920	154.690	123.146					0.084		
16	2016-10-	44H0	28.2	197.671	183.403	12.200		0.251			1.797	0.020	
17	2016-10-	44G9	28.2	282.600	243.036	33.347					6.217		
18	2016-10-	44H0	28.2	306.960	240.657	63.541					2.762		
19	2016-10-	44H0	28.2	137.940	102.972	20.001					14.911	0.056	
20	2016-10-	44H1	28.2	807.460	647.583	158.827					0.969	0.081	
21	2016-10-	45H0	28.2	87.251	58.981	1.160	0.001				26.969	0.140	
22	2016-10-	45H0	28.2	99.991	55.790	20.936					23.235	0.030	
23	2016-10-	43H1	28.2	329.343	31.508	295.958	0.549	0.244			1.051	0.033	
SD26				3326.824	9607.591	1468.692	4.567		0.165	0.397	0.439		3.515
SD28				8032.551	6634.588	1123.954	2.750	0.495			267.339	0.360	3.065
SD26+28				11359.375	9607.591	1468.692	7.317	0.495	0.165	0.397	267.778	0.360	6.580

Table 5. Hydroacoustic survey statistics of pelagic fish species from the Latvian-Polish BIAS survey in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 11.-20.10.2016

Table 5A

ICES SD	ICES Rect.	Trawl No	Herring L, cm	Herring w, g	Herring n, %	Sprat L, cm	Sprat w, g	Sprat n, %	NASC m^2/nm^2	$\sigma \times 10^4$ m^2	TS calc. dB
28	45H1	21	13.50	15.15	0.96	10.72	7.44	99.04	633.83	1.11377	-50.52
	45H0	21,22	13.69	16.13	8.03	10.66	7.32	91.97	520.53	1.15788	-50.36
	44H1	15,20	15.43	22.78	11.59	11.38	8.50	88.41	958.71	1.36654	-49.64
	44H0	16,17,18,19	14.70	19.09	6.91	11.47	8.84	93.09	473.35	1.31892	-49.79
	43H1	14,23	15.64	24.09	17.96	11.28	8.34	82.04	814.53	1.42494	-49.45
	43H0	11,13,14	15.28	22.35	10.48	11.34	8.53	89.52	874.06	1.33780	-49.73
	43G9	12,13	16.08	24.50	0.80	11.29	8.78	99.20	470.97	1.23865	-50.06
	42H0	6,7,9,10	15.65	23.07	0.85	11.57	9.03	99.15	856.76	1.29271	-49.88
	42G9	7,8,9	15.76	23.62	1.08	11.67	9.16	98.92	313.68	1.31471	-49.80
26	41H0	1,5,6	15.75	25.49	0.98	11.64	9.54	99.02	1134.30	1.30811	-49.83
	41G9	1,2,3,4	17.89	36.55	8.78	11.86	9.97	91.22	466.38	1.50449	-49.22
26		1-6	17.40	34.02	3.11	11.70	9.65	96.89	800.34	1.40630	-49.52
28		6-23	15.10	21.52	6.34	11.26	8.43	93.66	657.38	1.28510	-49.91
26+28		1-23	15.38	23.07	5.61	11.36	8.71	94.39	683.37	1.30714	-49.84

Table 5B

ICES SD	ICES Rect.	Area nm^2	ρ $n \times 10^6/nm^2$	Abundance, $n \times 10^6$ ΣN	$N_{HERRING}$	N_{SPRAT}	n, % herring	n, % sprat	Biomass, $kg \times 10^3$ ΣW	$W_{HERRING}$	W_{SPRAT}
28	45H1	827.1	5.69086	4706.91	45.03	4661.88	0.96	99.04	35372.54	682.27	34690.27
	45H0	947.2	4.49551	4258.15	341.92	3916.23	8.03	91.97	34167.85	5516.10	28651.74
	44H1	824.6	7.01564	5785.10	670.50	5114.60	11.59	88.41	58723.58	15271.87	43451.71
	44H0	960.5	3.58894	3447.17	238.34	3208.83	6.91	93.09	32926.49	4549.78	28376.71
	43H1	412.7	5.71623	2359.09	423.71	1935.37	17.96	82.04	26354.59	10206.23	16148.36
	43H0	973.7	6.53353	6361.70	666.49	5695.20	10.48	89.52	63454.08	14895.65	48558.43
	43G9	973.7	3.80230	3702.30	29.65	3672.64	0.80	99.20	32967.93	726.63	32241.30
	42H0	968.5	6.62761	6418.84	54.88	6363.97	0.85	99.15	58753.02	1265.94	57487.08
	42G9	986.9	2.38591	2354.65	25.44	2329.21	1.08	98.92	21926.25	600.89	21325.36
26	41H0	953.3	8.67126	8266.32	80.64	8185.67	0.98	99.02	80144.70	2055.42	78089.28
	41G9	1000.0	3.09990	3099.90	272.30	2827.60	8.78	91.22	38140.86	9952.01	28188.84
26		1953.3	5.88558	11366.22	352.95	11013.27	3.11	96.89	118285.56	12007.43	106278.13
28		7874.9	5.09517	39393.92	2495.98	36897.94	6.34	93.66	364646.32	53715.36	310930.96
26+28		9828.2	5.23888	50760.14	2848.92	47911.21	5.61	94.39	482931.88	65722.79	417209.09

Table 6. Hydroacoustic survey statistics of threespine stickleback from the Latvian-Polish BIAS survey
in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 11.-20.10.2016

ICES SD	ICES Rect.	Trawl No	Threespine stickleback L, cm	Threespine stickleback w, g	NASC m^2/nm^2	TS calc. dB	$\sigma \times 10^4$ m^2	ρ $n \times 10^6/nm^2$	Abundance $n \times 10^6$	Biomass $kg \times 10^3$
28	45H1	16,19,20	6.29	1.99	3.55	-51.51	0.88806	0.04000	33.08	65.69
	45H0	18,19,21,22	6.45	1.94	216.61	-51.29	0.93321	2.32110	2198.55	4267.34
	44H1	16								
	44H0	15,16,17	6.66	2.07	24.79	-51.00	0.99758	0.24852	238.71	495.17
	43H1	13,14								
	43H0	12,13,14	6.38	1.95	0.34	-51.41	0.90922	0.00369	3.59	7.00
	43G9	10,11	6.52	2.20	22.82	-51.17	0.95942	0.23781	231.55	508.74
	42H0	7,8,9	6.15	1.99	0.11	-51.69	0.85232	0.00127	1.23	2.46
	42G9	6,10	6.31	2.07	26.73	-51.46	0.89787	0.29773	293.83	609.60
26	41H0	3,4								
	41G9	1,2,5	6.28	2.23	17.42	-51.50	0.88977	0.19580	195.80	436.73
26		1-5	6.28	2.23	17.42	-51.50	0.88977	0.19580	195.80	436.73
28		6-22	6.39	2.03	42.14	-51.36	0.91967	0.45002	3000.55	5955.99
26+28		1-22	6.38	2.06	39.05	-51.38	0.91593	0.41824	3196.35	6392.72

Table 7. Sprat stock characteristics in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016

Table 7A CANUM		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	1347	1503	3963	669	115	251		38	38	7926
	45H0	3809	2136	7111	1136	587	523	200	38	147	15687
	44H1	4882	7850	55016	15543	5549	4306	971		316	94434
	44H0	5811	5659	62284	27604	5297	4930	447	245	2285	114562
	43H1	3973	24234	113613	8263	9511	3279	52		52	162977
	43H0	4806	25257	153407	22810	13261	4976			88	224605
	43G9	15066	2563	55582	9600	6246	4618		724	1078	95477
	42H0	11485	28356	218435	120074	27050	9417	4126	948	2794	422686
	42G9	3281	12095	104499	74704	19458	4681	1930	258	2889	223795
26	41H0	8728	50547	382418	69487	19467	2232	4735	348	785	538747
	41G9	4973	3625	39934	21382	6436	5640	1150	1182	1340	85661
26		13702	54171	422352	90868	25903	7872	5885	1530	2125	624408
28		54460	109654	773908	280404	87075	36982	7726	2253	9687	1362148
26+28		68162	163825	1196260	371272	112978	44854	13611	3783	11812	1986557

Table 7B n × 10^6		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	792.07	884.10	2330.94	393.77	67.89	147.85		22.63	22.63	4661.88
	45H0	950.79	533.26	1775.18	283.69	146.57	130.64	49.86	9.61	36.64	3916.23
	44H1	264.44	425.17	2979.71	841.80	300.56	233.23	52.58		17.12	5114.60
	44H0	162.78	158.52	1744.54	773.19	148.36	138.08	12.51	6.86	63.99	3208.83
	43H1	47.18	287.78	1349.17	98.12	112.95	38.94	0.62		0.62	1935.37
	43H0	121.86	640.43	3889.87	578.38	336.26	126.18			2.23	5695.20
	43G9	579.54	98.57	2138.02	369.29	240.26	177.65		27.86	41.45	3672.64
	42H0	172.92	426.93	3288.76	1807.84	407.27	141.78	62.12	14.28	42.07	6363.97
	42G9	34.14	125.88	1087.60	777.50	202.52	48.72	20.09	2.69	30.07	2329.21
26	41H0	132.62	768.00	5810.42	1055.78	295.78	33.91	71.94	5.29	11.93	8185.67
	41G9	164.17	119.64	1318.17	705.79	212.45	186.18	37.97	39.01	44.22	2827.60
26		296.79	887.65	7128.60	1761.56	508.22	220.09	109.91	44.30	56.16	11013.27
28		3125.72	3580.64	20583.78	5923.58	1962.63	1183.07	197.78	83.92	256.82	36897.94
26+28		3422.50	4468.29	27712.38	7685.14	2470.85	1403.16	307.69	128.22	312.98	47911.21

Table 7C n, %		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	16.99	18.96	50.00	8.45	1.46	3.17		0.49	0.49	100.00
	45H0	24.28	13.62	45.33	7.24	3.74	3.34	1.27	0.25	0.94	100.00
	44H1	5.17	8.31	58.26	16.46	5.88	4.56	1.03		0.33	100.00
	44H0	5.07	4.94	54.37	24.10	4.62	4.30	0.39	0.21	1.99	100.00
	43H1	2.44	14.87	69.71	5.07	5.84	2.01	0.03		0.03	100.00
	43H0	2.14	11.25	68.30	10.16	5.90	2.22			0.04	100.00
	43G9	15.78	2.68	58.21	10.06	6.54	4.84		0.76	1.13	100.00
	42H0	2.72	6.71	51.68	28.41	6.40	2.23	0.98	0.22	0.66	100.00
	42G9	1.47	5.40	46.69	33.38	8.69	2.09	0.86	0.12	1.29	100.00
26	41H0	1.62	9.38	70.98	12.90	3.61	0.41	0.88	0.06	0.15	100.00
	41G9	5.81	4.23	46.62	24.96	7.51	6.58	1.34	1.38	1.56	100.00
26		2.19	8.68	67.64	14.55	4.15	1.26	0.94	0.25	0.34	100.00
28		4.00	8.05	56.82	20.59	6.39	2.71	0.57	0.17	0.71	100.00
26+28		3.43	8.25	60.22	18.69	5.69	2.26	0.69	0.19	0.59	100.00

Table 7D W, kg × 10^3	Age group	∑

ICES	ICES	0	1	2	3	4	5	6	7	8+	
28	45H1	3043.80	6063.76	19573.56	3440.89	705.47	1398.71		222.68	241.39	34690.27
	45H0	3684.53	3578.94	14889.44	2545.54	1512.05	1367.60	546.83	94.52	432.29	28651.74
	44H1	946.38	3036.88	25066.50	7882.16	3202.36	2518.43	614.85		184.16	43451.71
	44H0	598.48	1212.86	15320.30	7101.97	1663.92	1500.86	151.81	81.11	745.41	28376.71
	43H1	131.87	2081.67	11254.27	969.01	1245.26	452.96	6.37		6.95	16148.36
	43H0	446.35	4657.12	32846.95	5520.46	3586.31	1473.39			27.84	48558.43
	43G9	2463.55	832.24	19738.78	3699.79	2588.85	2106.38		345.45	466.26	32241.30
	42H0	626.21	3422.11	29242.33	16802.9	4399.42	1567.62	772.15	159.70	494.62	57487.08
	42G9	135.88	1022.80	9642.54	7133.95	2133.98	586.11	271.57	30.67	367.85	21325.36
26	41H0	517.37	6567.77	55117.44	11137.8	3296.74	432.14	779.34	72.76	167.87	78089.28
	41G9	733.33	1063.21	12881.86	7256.01	2519.83	2177.77	516.98	452.51	587.34	28188.84
26		1250.70	7630.98	67999.31	18393.8	5816.56	2609.91	1296.3	525.27	755.21	106278.1
28		12077.0	25908.3	177574.6	55096.6	21037.6	12972.0	2363.5	934.13	2966.7	310930.9
26+28		13327.7	33539.3	245573.9	73490.5	26854.1	15581.9	3659.8	1459.4	3721.9	417209.0

Table 7E W, %		Age group									∑
ICES	ICES	0	1	2	3	4	5	6	7	8+	
28	45H1	8.77	17.48	56.42	9.92	2.03	4.03		0.64	0.70	100.00
	45H0	12.86	12.49	51.97	8.88	5.28	4.77	1.91	0.33	1.51	100.00
	44H1	2.18	6.99	57.69	18.14	7.37	5.80	1.42		0.42	100.00
	44H0	2.11	4.27	53.99	25.03	5.86	5.29	0.53	0.29	2.63	100.00
	43H1	0.82	12.89	69.69	6.00	7.71	2.80	0.04		0.04	100.00
	43H0	0.92	9.59	67.64	11.37	7.39	3.03			0.06	100.00
	43G9	7.64	2.58	61.22	11.48	8.03	6.53		1.07	1.45	100.00
	42H0	1.09	5.95	50.87	29.23	7.65	2.73	1.34	0.28	0.86	100.00
	42G9	0.64	4.80	45.22	33.45	10.01	2.75	1.27	0.14	1.72	100.00
26	41H0	0.66	8.41	70.58	14.26	4.22	0.55	1.00	0.09	0.21	100.00
	41G9	2.60	3.77	45.70	25.74	8.94	7.73	1.83	1.61	2.08	100.00
26		1.18	7.18	63.98	17.31	5.47	2.46	1.22	0.49	0.71	100.00
28		3.88	8.33	57.11	17.72	6.77	4.17	0.76	0.30	0.95	100.00
26+28		3.19	8.04	58.86	17.61	6.44	3.73	0.88	0.35	0.89	100.00

Table 7F w, g		Age group									Total
ICES	ICES	0	1	2	3	4	5	6	7	8+	
28	45H1	3.84	6.86	8.40	8.74	10.39	9.46		9.84	10.67	7.44
	45H0	3.88	6.71	8.39	8.97	10.32	10.47	10.97	9.84	11.80	7.32
	44H1	3.58	7.14	8.41	9.36	10.65	10.80	11.69		10.76	8.50
	44H0	3.68	7.65	8.78	9.19	11.22	10.87	12.13	11.82	11.65	8.84
	43H1	2.79	7.23	8.34	9.88	11.03	11.63	10.31		11.26	8.34
	43H0	3.66	7.27	8.44	9.54	10.67	11.68			12.51	8.53
	43G9	4.25	8.44	9.23	10.02	10.78	11.86		12.40	11.25	8.78
	42H0	3.62	8.02	8.89	9.29	10.80	11.06	12.43	11.19	11.76	9.03
	42G9	3.98	8.13	8.87	9.18	10.54	12.03	13.52	11.41	12.23	9.16
26	41H0	3.90	8.55	9.49	10.55	11.15	12.74	10.83	13.75	14.07	9.54
	41G9	4.47	8.89	9.77	10.28	11.86	11.70	13.62	11.60	13.28	9.97
26		4.21	8.60	9.54	10.44	11.44	11.86	11.79	11.86	13.45	9.65
28		3.86	7.24	8.63	9.30	10.72	10.96	11.95	11.13	11.55	8.43
26+28		3.89	7.51	8.86	9.56	10.87	11.10	11.89	11.38	11.89	8.71

Table 7G L, cm	Age group	Total

ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	8.72	10.37	11.23	11.46	12.58	11.94		12.25	12.75	10.72
	45H0	8.73	10.34	11.25	11.59	12.38	12.34	12.70	12.25	13.36	10.66
	44H1	8.47	10.66	11.34	11.86	12.64	12.68	13.13		12.70	11.38
	44H0	8.59	10.85	11.43	11.64	12.78	12.64	13.31	13.25	12.97	11.47
	43H1	7.92	10.69	11.29	12.12	12.73	13.06	12.75		13.00	11.28
	43H0	8.45	10.69	11.30	11.85	12.49	12.99			13.25	11.34
	43G9	8.91	11.10	11.52	11.95	12.38	12.84		13.25	12.67	11.29
	42H0	8.48	11.03	11.50	11.73	12.54	12.68	13.13	12.76	13.08	11.57
	42G9	8.80	11.13	11.50	11.71	12.43	13.15	13.34	12.78	13.23	11.67
26	41H0	8.44	11.17	11.63	12.11	12.49	13.17	12.41	13.63	13.76	11.64
	41G9	8.99	11.34	11.76	12.05	12.77	12.75	13.49	12.75	13.51	11.86
26		8.75	11.19	11.65	12.08	12.61	12.81	12.78	12.86	13.57	11.70
28		8.70	10.63	11.37	11.74	12.54	12.63	13.05	12.77	12.99	11.26
26+28		8.70	10.74	11.44	11.82	12.55	12.66	12.96	12.80	13.09	11.36

Table 8. Herring stock characteristics in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016

Table 8A CANUM		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	29		10		19		10		10	77
	45H0	188	55	862	123	76		10	5	52	1370
	44H1		750	5816	1592	2353	1118	93	395	263	12380
	44H0		531	5575	780	611	323	222	316	152	8509
	43H1			16787	5163	6226	5047	309	540	1608	35681
	43H0			14696	3705	3741	2728	60	218	1137	26285
	43G9			294	131	189	58	45	38	16	771
	42H0		106	1664	773	689	200	106	106		3645
	42G9		73	1193	550	303	172	59	94		2444
26	41H0		405	2750	1146	721	222	27	17	19	5308
	41G9		295	1850	1406	2181	909	379	623	607	8249
26			699	4600	2552	2902	1131	406	640	626	13557
28		216	1516	46897	12818	14206	9647	914	1711	3237	91161
26+28		216	2215	51497	15370	17107	10778	1320	2351	3863	104718

Table 8B n × 10^6		Age group									∑
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	16.89		5.63		11.26		5.63		5.63	45.03
	45H0	46.84	13.76	215.20	30.68	18.93		2.39	1.20	12.91	341.92
	44H1		40.63	315.01	86.23	127.44	60.57	5.01	21.38	14.24	670.50
	44H0		14.87	156.15	21.84	17.11	9.04	6.23	8.85	4.25	238.34
	43H1			199.35	61.32	73.94	59.94	3.67	6.41	19.10	423.71
	43H0			372.63	93.95	94.85	69.18	1.53	5.52	28.83	666.49
	43G9			11.29	5.06	7.26	2.24	1.75	1.46	0.61	29.65
	42H0		1.60	25.06	11.64	10.37	3.01	1.60	1.60		54.88
	42G9		0.76	12.42	5.72	3.15	1.79	0.62	0.98		25.44
26	41H0		6.15	41.78	17.42	10.96	3.38	0.41	0.25	0.29	80.64
	41G9		9.72	61.08	46.40	71.98	30.01	12.50	20.57	20.04	272.30
26			15.87	102.86	63.82	82.94	33.38	12.92	20.82	20.33	352.95
28		63.73	71.62	1312.74	316.43	364.30	205.77	28.42	47.40	85.56	2495.98
26+28		63.73	87.50	1415.60	380.26	447.24	239.16	41.34	68.22	105.89	2848.92

Table 8C n, %	Age group	∑

ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	37.50		12.50		25.00		12.50		12.50	100.00
	45H0	13.70	4.03	62.94	8.97	5.54		0.70	0.35	3.78	100.00
	44H1		6.06	46.98	12.86	19.01	9.03	0.75	3.19	2.12	100.00
	44H0		6.24	65.52	9.16	7.18	3.79	2.61	3.71	1.78	100.00
	43H1			47.05	14.47	17.45	14.15	0.87	1.51	4.51	100.00
	43H0			55.91	14.10	14.23	10.38	0.23	0.83	4.33	100.00
	43G9			38.08	17.05	24.47	7.56	5.89	4.91	2.05	100.00
	42H0		2.91	45.67	21.21	18.89	5.49	2.91	2.91		100.00
	42G9		2.99	48.82	22.50	12.38	7.03	2.42	3.85		100.00
26	41H0		7.63	51.81	21.60	13.59	4.19	0.51	0.31	0.36	100.00
	41G9		3.57	22.43	17.04	26.43	11.02	4.59	7.56	7.36	100.00
26			5.16	33.93	18.83	21.40	8.34	2.99	4.72	4.62	100.00
28		0.24	1.66	51.44	14.06	15.58	10.58	1.00	1.88	3.55	100.00
26+28		0.21	2.12	49.18	14.68	16.34	10.29	1.26	2.25	3.69	100.00

Table 8D W, kg × 10^3		Age group									Σ
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	79.94		95.70		213.91		146.36		146.36	682.27
	45H0	236.27	193.92	3572.21	645.24	418.11		62.12	29.46	358.78	5516.10
	44H1		687.60	6153.13	2013.22	3360.43	1833.12	181.16	568.41	474.80	15271.87
	44H0		214.92	2693.35	468.10	418.90	230.81	164.27	232.09	127.33	4549.78
	43H1			3720.74	1496.69	2100.28	1890.30	129.55	198.44	670.23	10206.23
	43H0			6847.05	2107.04	2643.59	2115.88	44.18	161.83	976.08	14895.65
	43G9			218.26	122.61	200.06	68.80	51.94	44.48	20.48	726.63
	42H0		33.25	475.50	295.07	252.73	98.68	55.96	54.75		1265.94
	42G9		14.29	235.04	144.80	73.54	70.51	22.78	39.94		600.89
26	41H0		141.67	908.27	481.10	307.47	161.99	19.29	14.49	21.15	2055.42
	41G9		232.16	1438.22	1433.71	2731.60	1391.88	568.78	1053.19	1102.48	9952.01
26			373.83	2346.49	1914.81	3039.07	1553.86	588.07	1067.67	1123.63	12007.43
28		316.20	1143.98	24010.98	7292.78	9681.54	6308.10	858.31	1329.40	2774.06	53715.36
26+28		316.20	1517.81	26357.47	9207.58	12720.62	7861.97	1446.38	2397.07	3897.69	65722.79

Table 8E W, %		Age group									Σ
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	11.72		14.03		31.35		21.45		21.45	100.00
	45H0	4.28	3.52	64.76	11.70	7.58		1.13	0.53	6.50	100.00
	44H1		4.50	40.29	13.18	22.00	12.00	1.19	3.72	3.11	100.00
	44H0		4.72	59.20	10.29	9.21	5.07	3.61	5.10	2.80	100.00
	43H1			36.46	14.66	20.58	18.52	1.27	1.94	6.57	100.00
	43H0			45.97	14.15	17.75	14.20	0.30	1.09	6.55	100.00
	43G9			30.04	16.87	27.53	9.47	7.15	6.12	2.82	100.00
	42H0		2.63	37.56	23.31	19.96	7.80	4.42	4.32		100.00
	42G9		2.38	39.12	24.10	12.24	11.73	3.79	6.65		100.00
26	41H0		6.89	44.19	23.41	14.96	7.88	0.94	0.70	1.03	100.00
	41G9		2.33	14.45	14.41	27.45	13.99	5.72	10.58	11.08	100.00
26			3.11	19.54	15.95	25.31	12.94	4.90	8.89	9.36	100.00
28		0.59	2.13	44.70	13.58	18.02	11.74	1.60	2.47	5.16	100.00
26+28		0.48	2.31	40.10	14.01	19.35	11.96	2.20	3.65	5.93	100.00

Table 8F w, g	Age group	Total

ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	4.73		17.00		19.00		26.00		26.00	15.15
	45H0	5.04	14.09	16.60	21.03	22.08		26.00	24.50	27.79	16.13
	44H1		16.92	19.53	23.35	26.37	30.27	36.15	26.59	33.34	22.78
	44H0		14.45	17.25	21.43	24.48	25.53	26.37	26.22	29.98	19.09
	43H1			18.66	24.41	28.41	31.54	35.34	30.94	35.10	24.09
	43H0			18.37	22.43	27.87	30.58	28.80	29.34	33.85	22.35
	43G9			19.33	24.25	27.57	30.70	29.73	30.57	33.71	24.50
	42H0		20.80	18.97	25.35	24.38	32.74	35.01	34.25		23.07
	42G9		18.77	18.92	25.29	23.34	39.41	37.00	40.77		23.62
26	41H0		23.03	21.74	27.62	28.07	47.99	46.53	57.75	72.29	25.49
	41G9		23.88	23.55	30.90	37.95	46.39	45.50	51.19	55.03	36.55
26			23.55	22.81	30.00	36.64	46.55	45.53	51.27	55.27	34.02
28		4.96	15.97	18.29	23.05	26.58	30.66	30.20	28.05	32.42	21.52
26+28		4.96	17.35	18.62	24.21	28.44	32.87	34.99	35.14	36.81	23.07

Table 8G L, cm		Age group									Total
ICES SD	ICES Rect.	0	1	2	3	4	5	6	7	8+	
28	45H1	9.25		14.25		15.25		18.75		16.75	13.50
	45H0	9.27	13.13	13.95	15.48	15.88		18.75	16.75	17.19	13.69
	44H1		13.93	14.67	15.52	16.30	17.15	18.78	16.35	18.43	15.43
	44H0		13.18	14.13	15.51	16.38	16.74	16.87	17.06	17.87	14.70
	43H1			14.44	15.76	16.64	17.22	17.87	17.13	17.93	15.64
	43H0			14.38	15.35	16.63	17.03	17.79	16.93	17.57	15.28
	43G9			14.65	16.09	17.00	17.53	17.63	17.81	17.72	16.08
	42H0		15.25	14.66	16.22	16.03	17.84	18.25	18.26		15.65
	42G9		14.77	14.68	16.19	15.86	18.97	18.25	19.92		15.76
26	41H0		15.39	14.94	16.30	16.38	20.24	19.42	21.00	22.32	15.75
	41G9		15.58	15.48	16.95	18.22	19.71	19.56	20.50	20.93	17.89
26			15.51	15.26	16.77	17.98	19.77	19.55	20.50	20.95	17.40
28		9.26	13.66	14.37	15.56	16.41	17.14	18.07	16.85	17.70	15.10
26+28		9.26	13.99	14.43	15.76	16.70	17.51	18.53	17.97	18.32	15.38

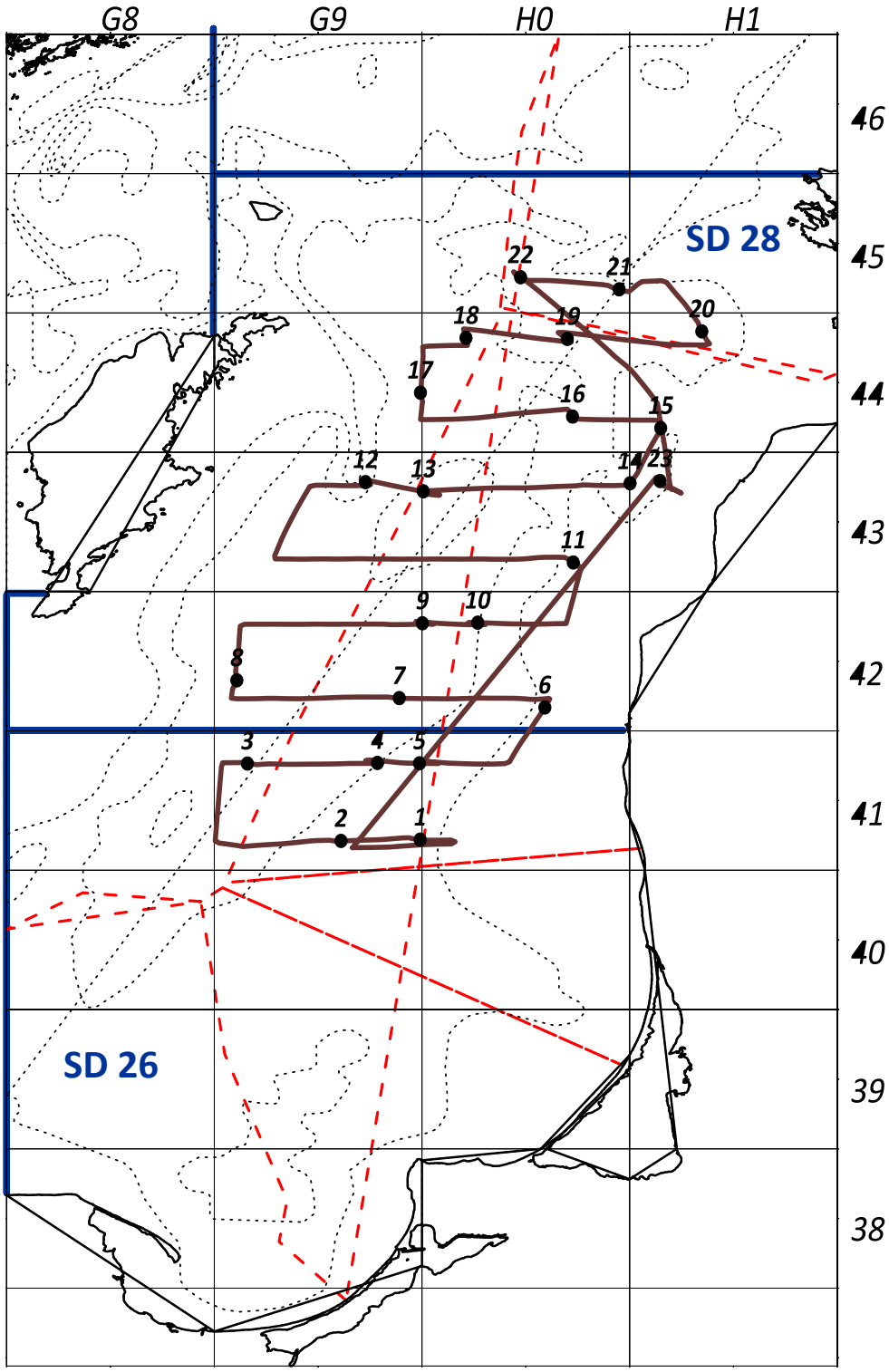

Figure 1: Cruise track design and trawling positions of the Latvian-Polish hydroacoustic survey on the r/v "Baltica" in the period of 11.-20.10.2016.

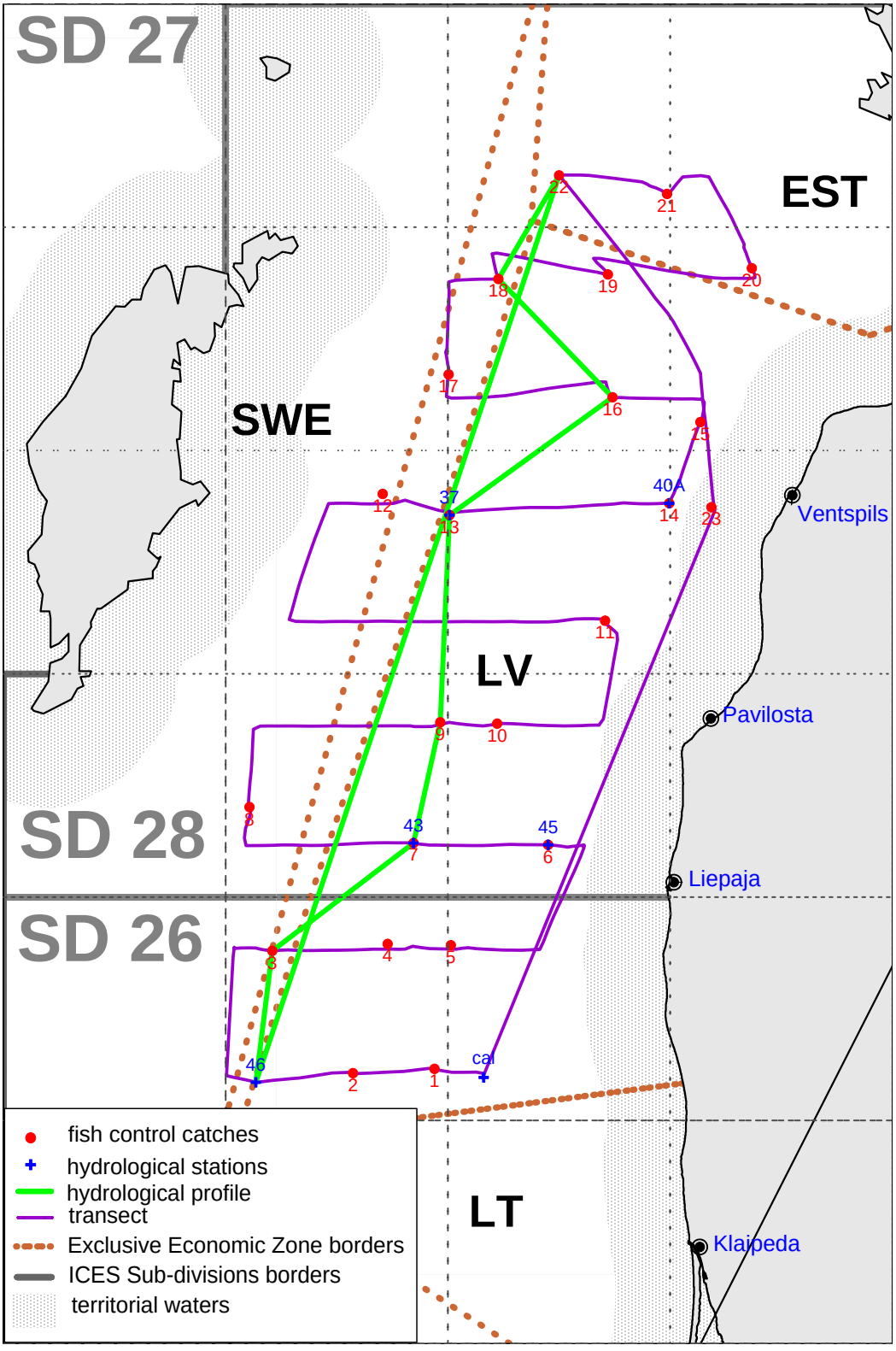

Figure 2: Locations of the hydrological stations and hydrological profile performed during the Latvian-Polish hydroacoustic survey on the r/v "Baltica" in the period of 11.-20.10.2016.

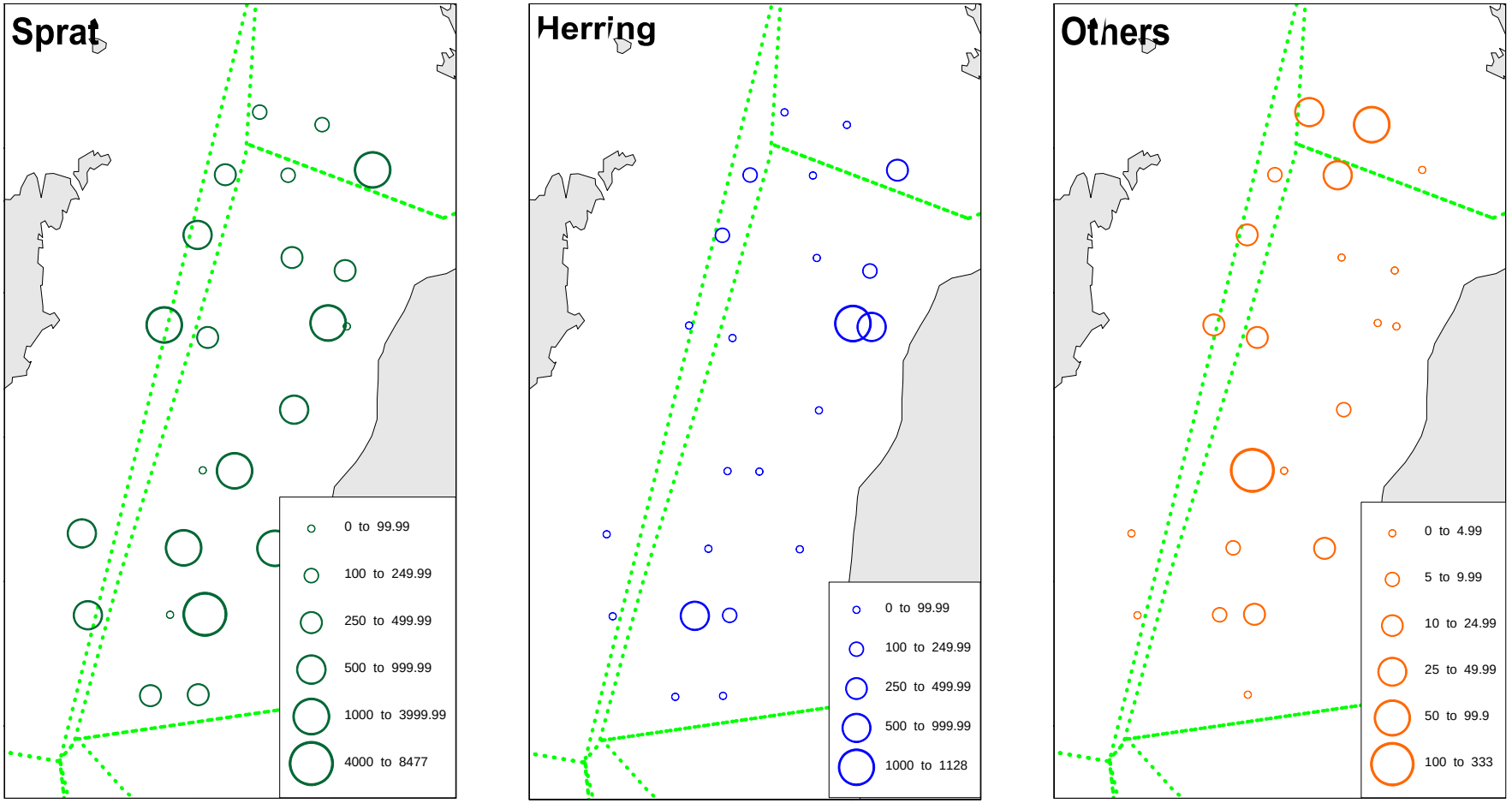

Figure 3: CPUE [kg/h] ranges distribution of fish in the catch hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica"in the period of 11.-20.10.2016.

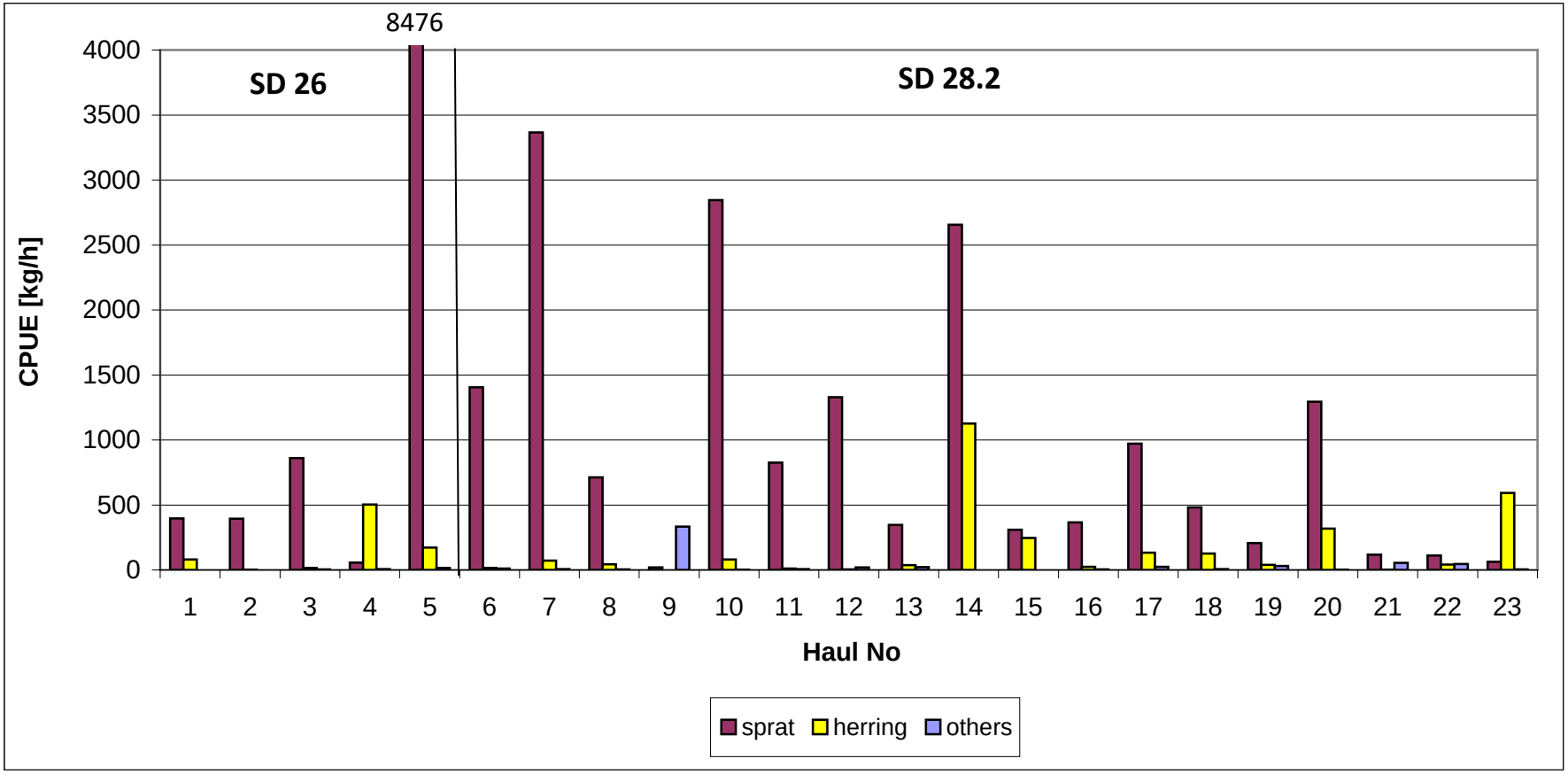

Figure 4: CPUE [kg/h] of dominant pelagic fish in the catch hauls in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica"
in the period of 11.-20.10.2016.

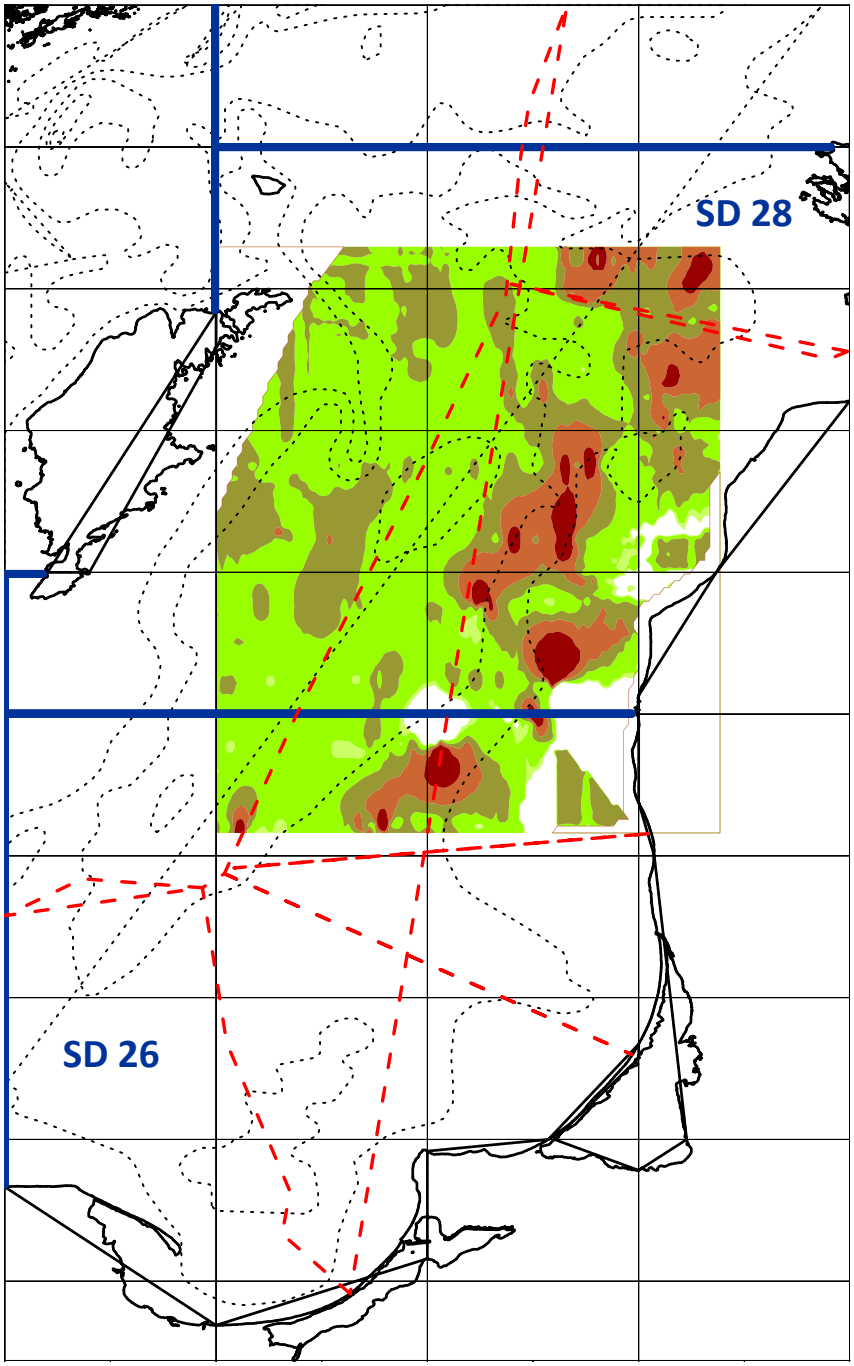

Figure 5: Acoustic parameter NASC distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016.

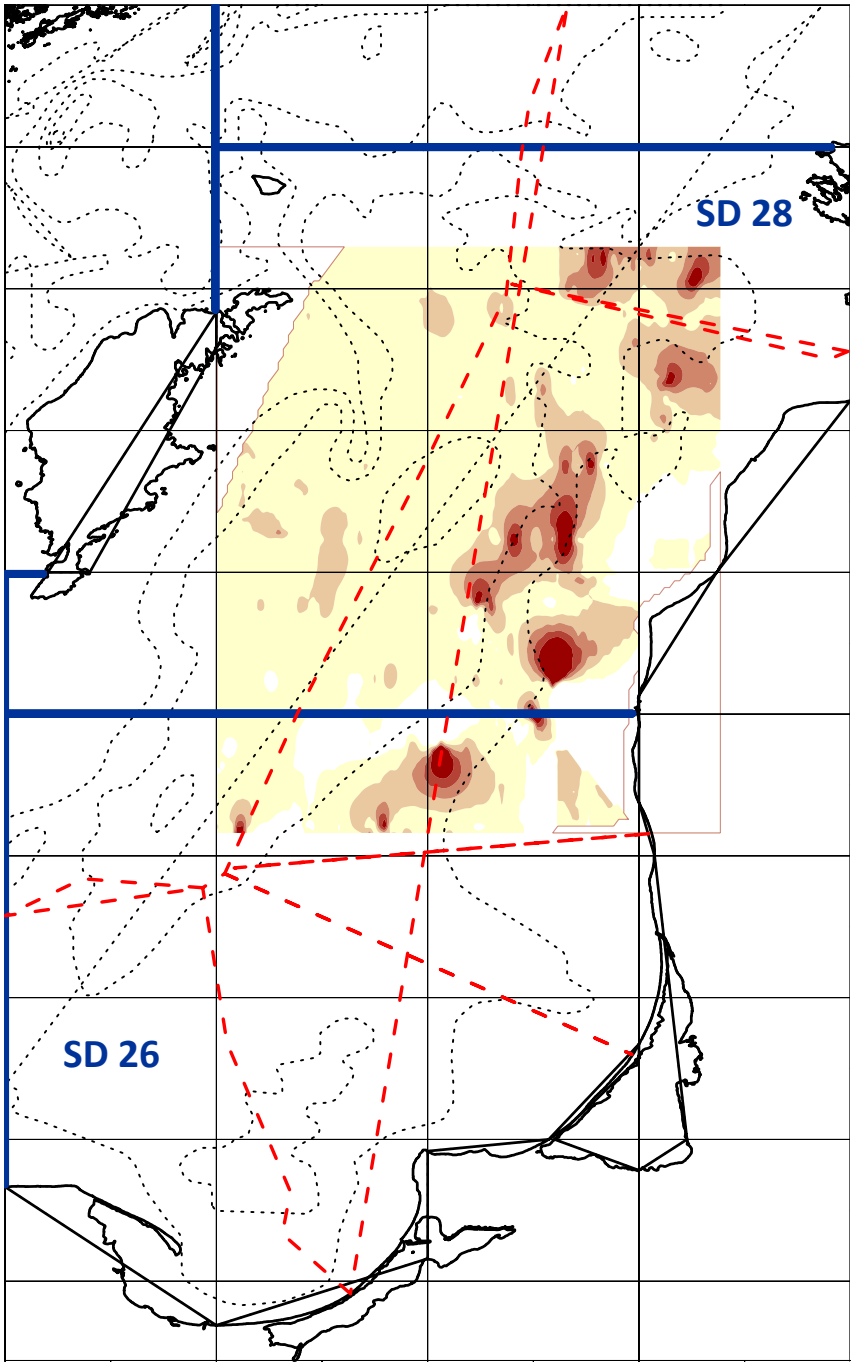

Figure 6: Sprat distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016.

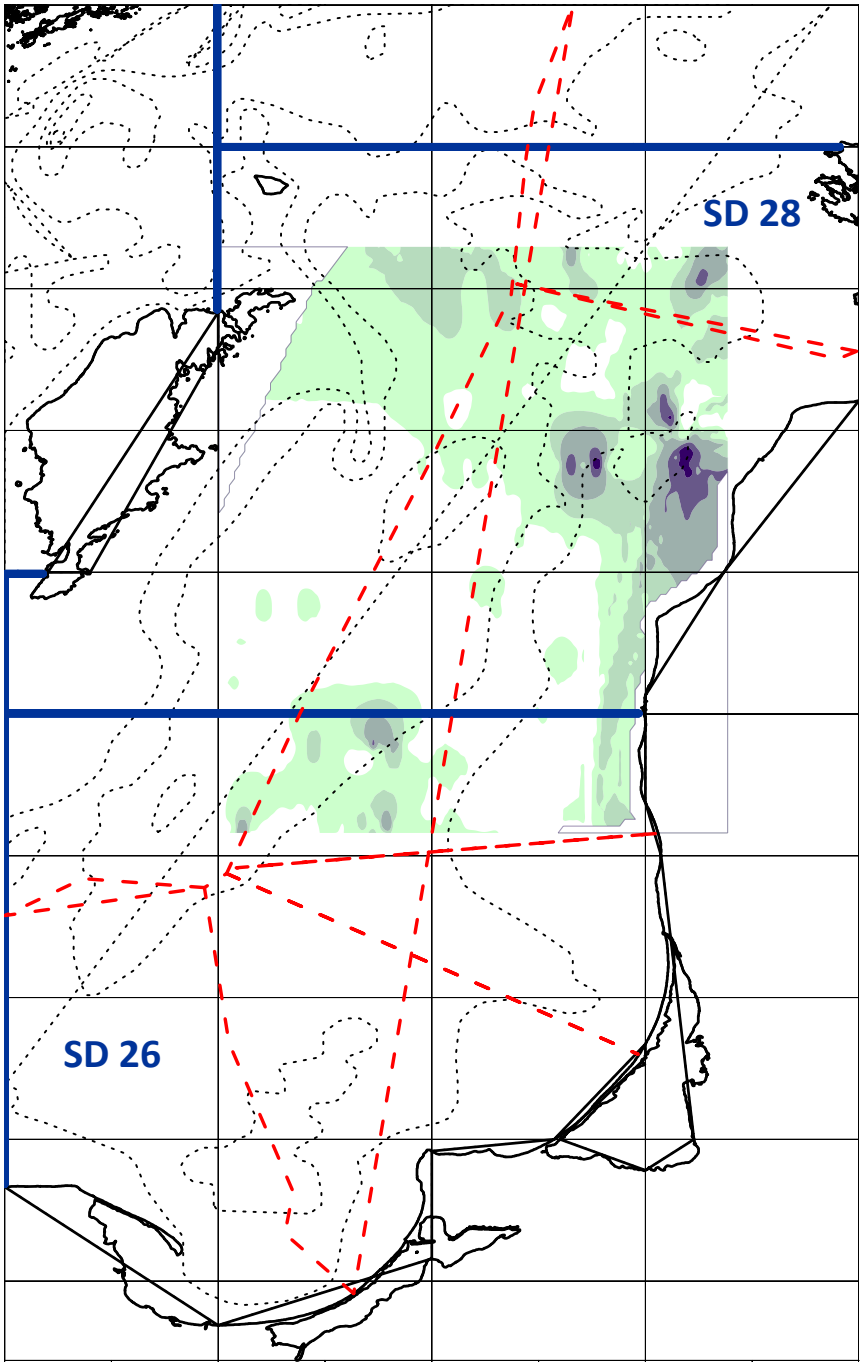

Figure 7: Herring distribution in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016.

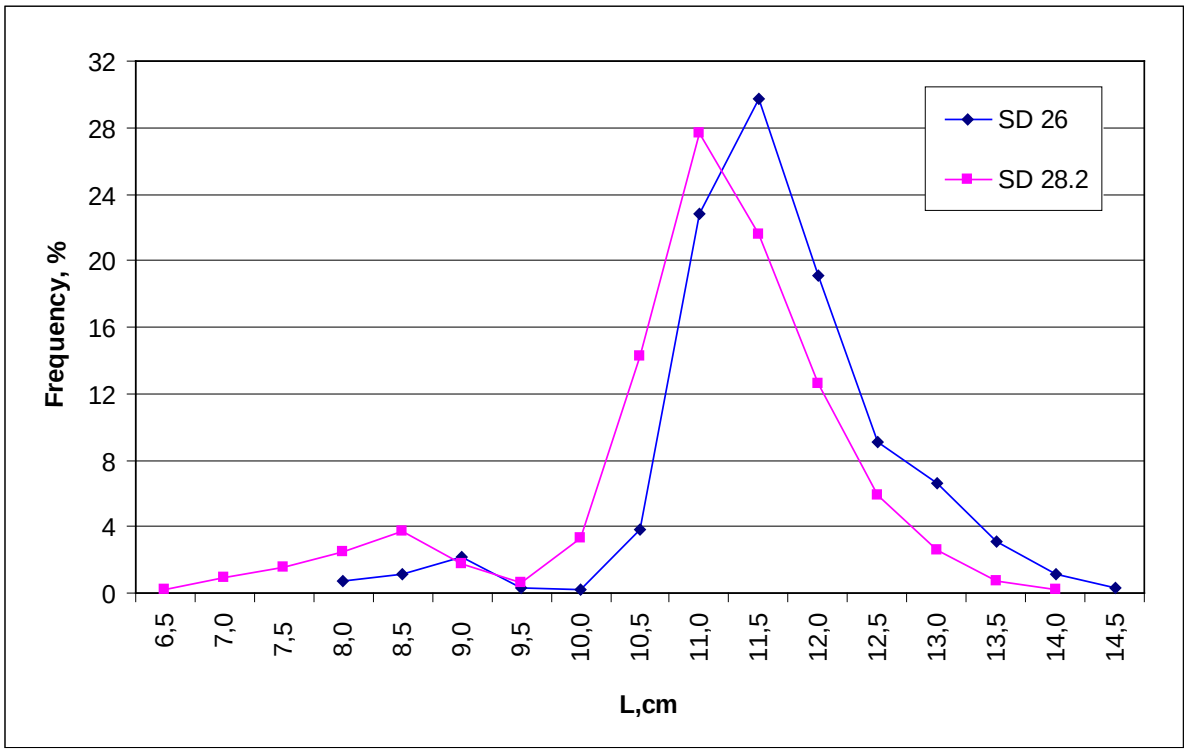

Figure 8: Sprat length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016.

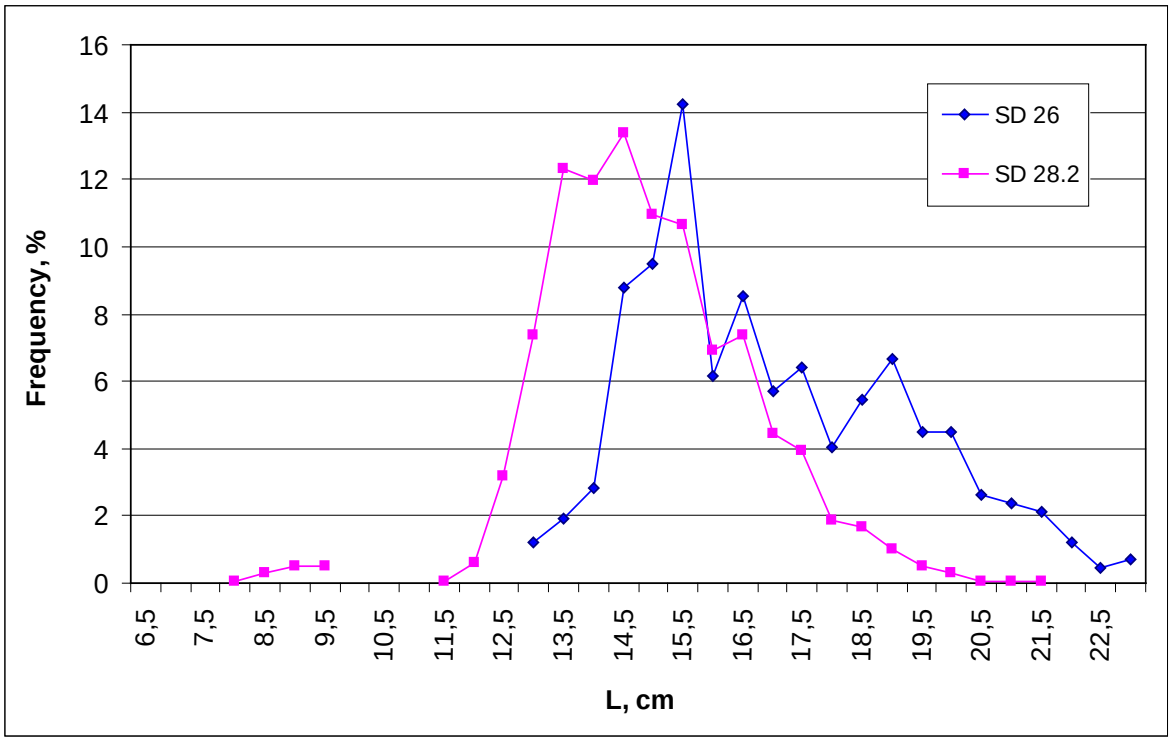

Figure 9: Herring length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016.

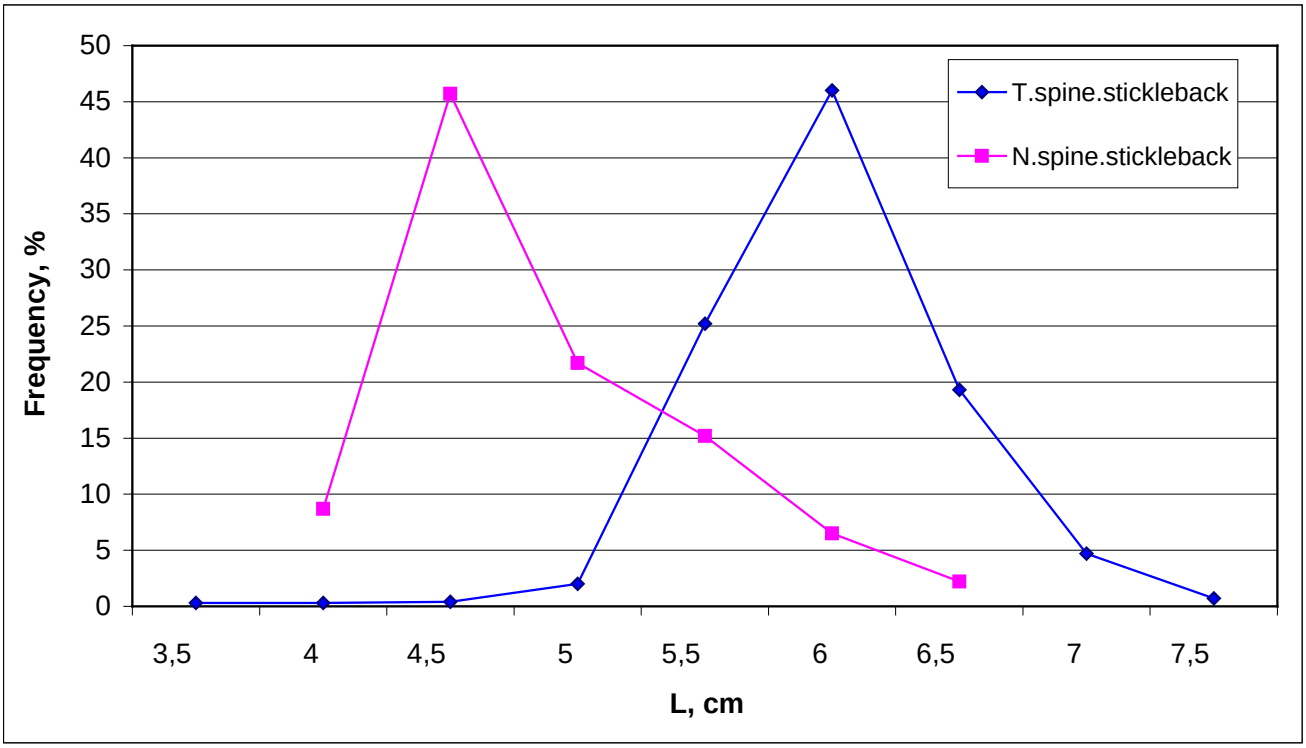

Figure 10: Stickleback length distributions in control catches in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016.

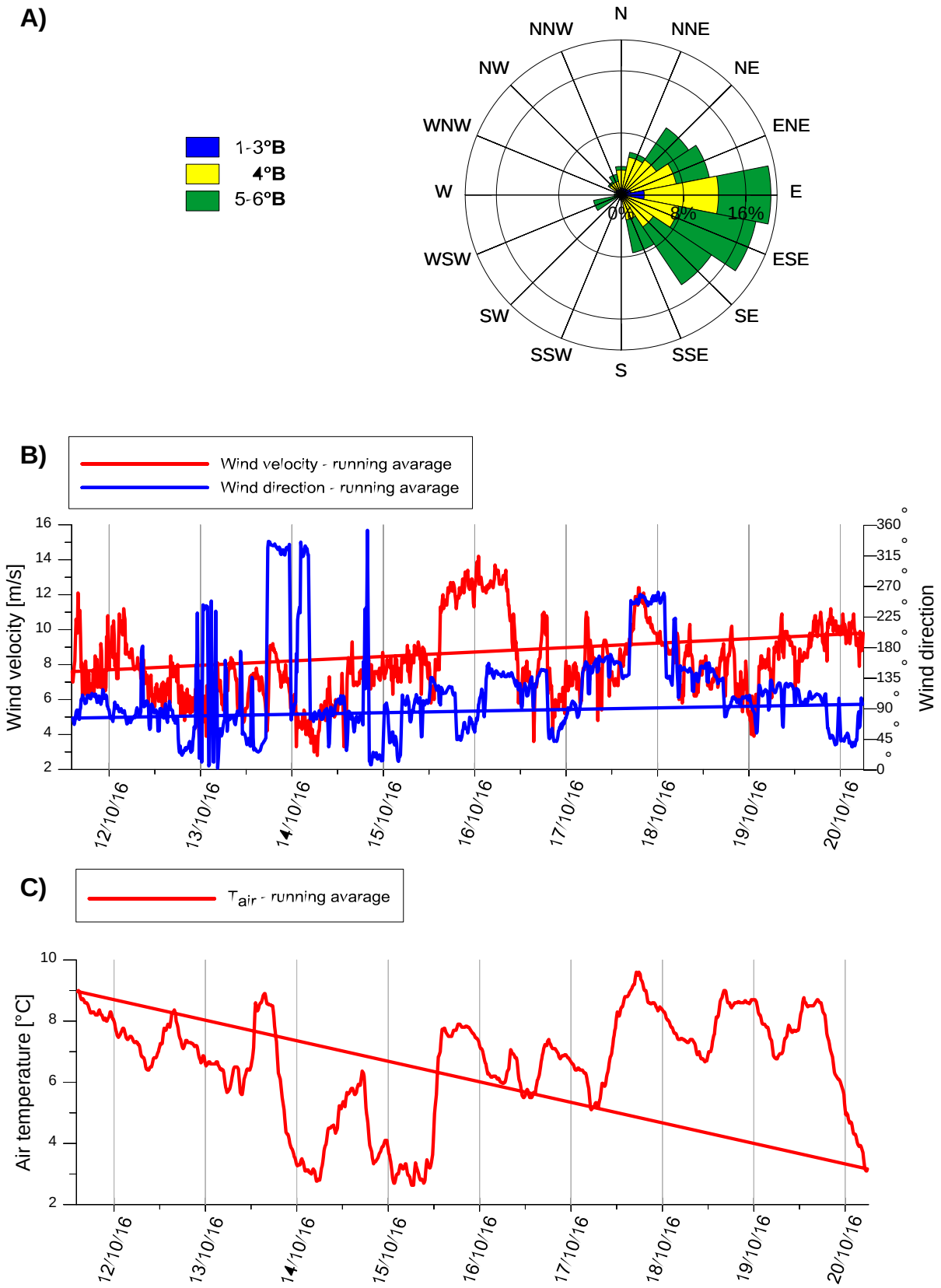

Figure 11: Changes of the main meteorological parameters (wind force, direction and the daily air temperature) during the Latvian-Polish BIAS survey in the Baltic Sea ICES SD 26N and 28.2 conducted by r/v "Baltica" in the period of 11.-20.10.2016

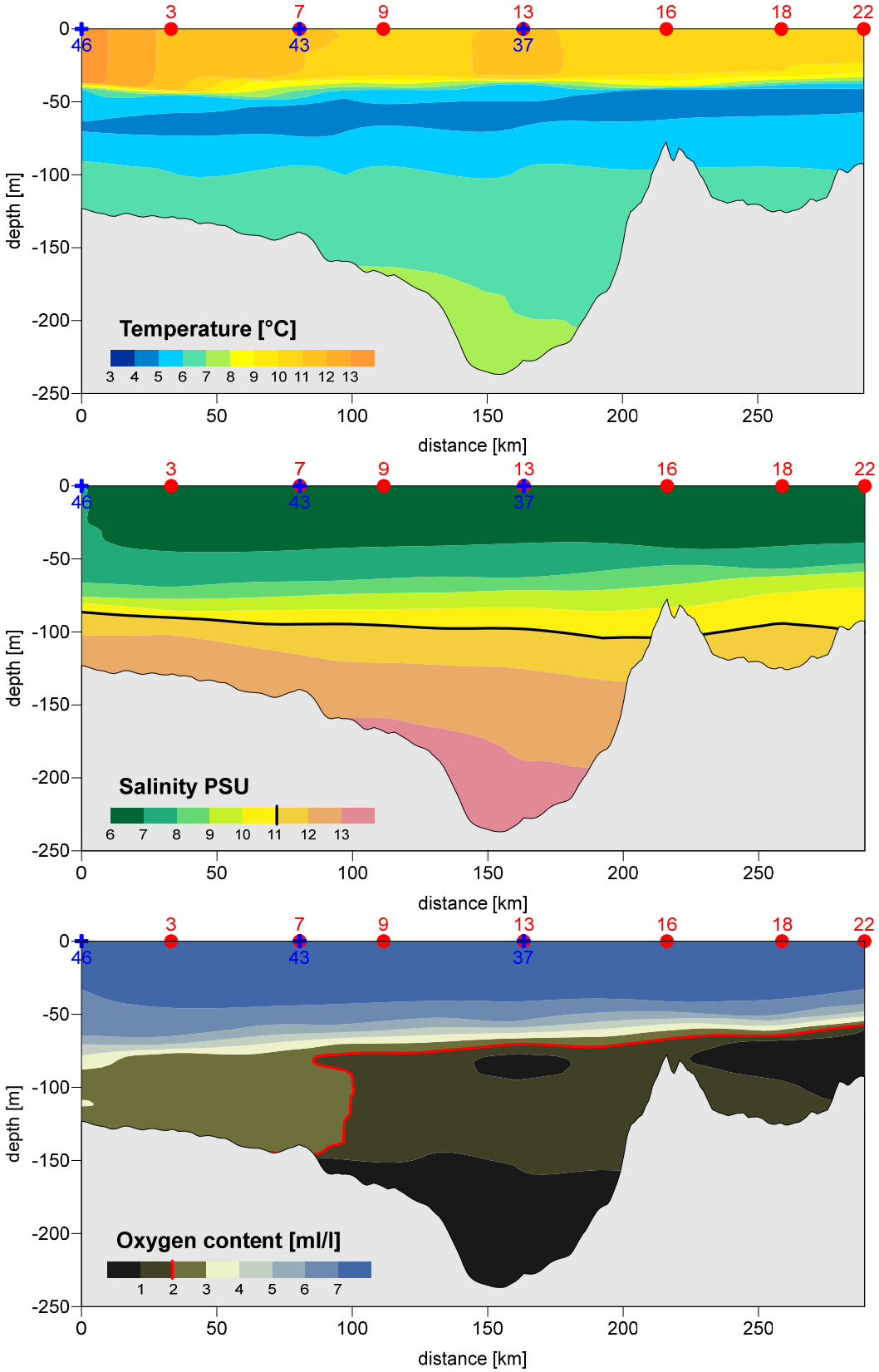

Figure 12: Vertical distribution of the seawater temperature, salinity and oxygen content along the hydrological profile in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in October in the period of 11.-20.10.2016.

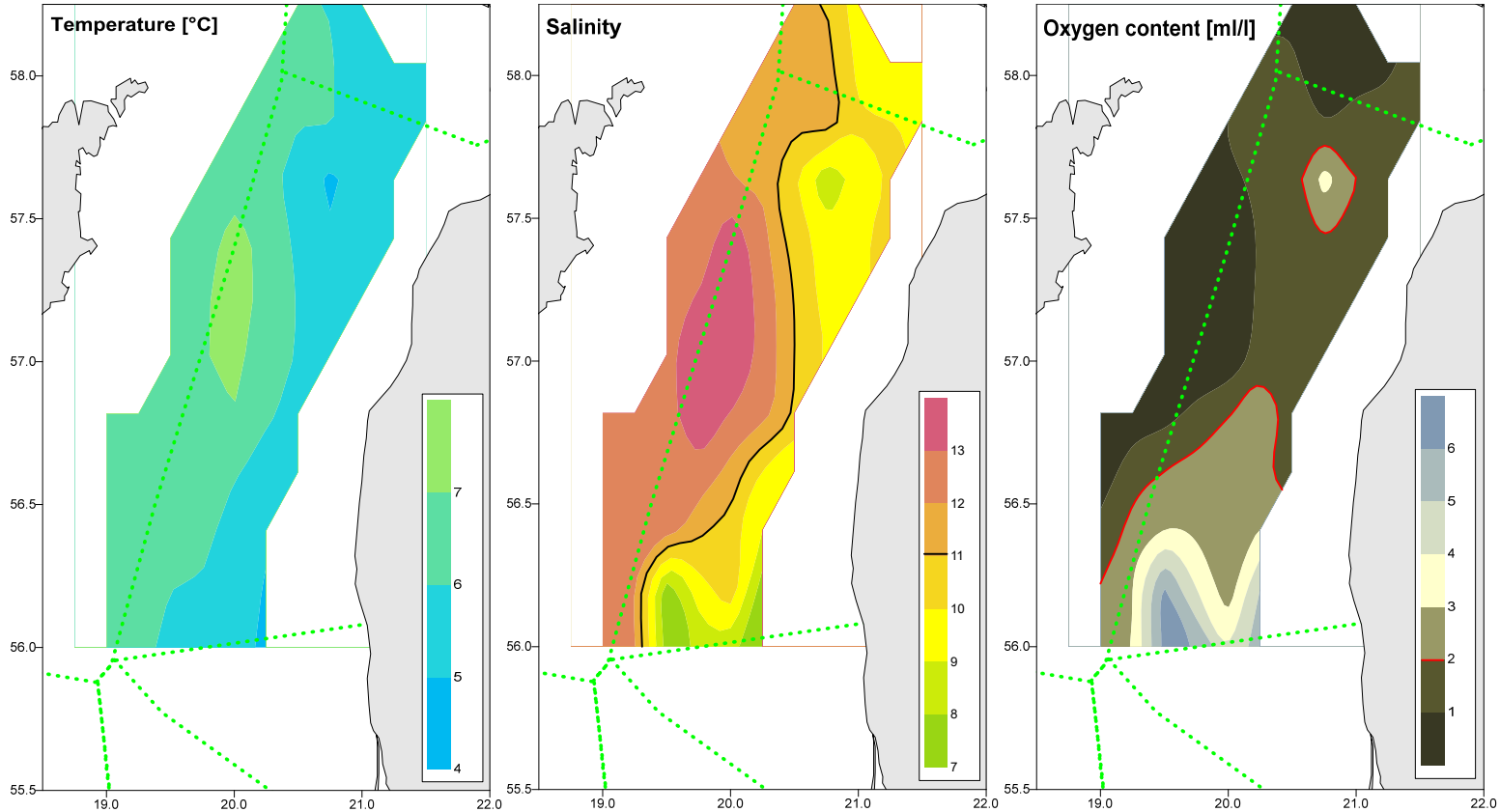

Figure 13: Horizontal distribution of the main hydrological parameters (temperature, salinity, oxygen content) measured in the bottom water layer of the Gotland Deep in the Baltic Sea ICES SD 26N and 28.2 from the Latvian-Polish BIAS survey conducted by r/v "Baltica" in the period of 11.-20.10.2016.

RUSSIAN ACOUSTIC AUTUMN SURVEY REPORT FOR THE R/V "ATLANTNIRO"

30.09-10.10.2016

by A. Karpushevskaia, A. Zezera, I. Karpushevskiy

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1 INTRODUCTION

The main objective is to assess clupeoid resources in the Baltic Sea. The autumn international acoustic survey is traditionally coordinated within the frame of the International Baltic Acoustic Survey (IBAS). The reported acoustic survey is conducted every year to estimate abundance and biomass of herring and sprat for assessment purposes of Baltic Fisheries Assessment Working Group (WGBFAS).

2 METHODS

2.2 Personnel

A. Zezera	AtlantNIRO, Kaliningrad, Russia - cruise leader
A. Karpushevskaia	AtlantNIRO, Kaliningrad, Russia - scientific leader
A. Malishko	AtlantNIRO, Kaliningrad, Russia – acoustic
M. Sokolov	AtlantNIRO, Kaliningrad, Russia – acoustic
S. Alekseev	AtlantNIRO, Kaliningrad, Russia - hydrologist
S. Ivanov	AtlantNIRO, Kaliningrad, Russia - engineer
N. Kalinina	AtlantNIRO, Kaliningrad, Russia - engineer
I. Trufanova	AtlantNIRO, Kaliningrad, Russia - engineer
N. Dyushkov	AtlantNIRO, Kaliningrad, Russia - engineer

2.2 Narrative

The RV "ATLANTNIRO" cruise number 65, 2016, was started from port Kaliningrad, the 30 September and continued to 19 October of 2016. The cruise covered the ICES Subdivision 26 and included only Russia economic zone. Calibration of acoustic equipment was carried out in 01 October 2016. Acoustic investigations were carried out from 2 October to 10 October.

2.3 Survey design

The area of international acoustic survey is limited by the 10 m depth line. The statistical rectangles of Subdivision 26 (zone of Russia), were used as strata (IBAS, ver. 0.82, ICES CM 2015/ SSGIEOM:07 Ref. Assess). The scheme of transects has been defined as the regular, of rectangular form, with the distance between transects of 15 nm. The average speed of a vessel for the all period of acoustic survey was 7.9-8.2 knots. The average speed of the vessel with a trawl was 4.0 knots; the trawling duration was standard 30 minutes. The survey was conducted in the daytime from 7.00 up to 18.00 of local time. All investigated area of survey constitutes the 3838.8 nm^2. The full cruise track with positions of the trawling is shown on Figure 1.

2.4 Calibration

The Simrad EK60 echosounder with transducers ES38B and ES120–7 were calibrated in the Baltic Sea shore area, near the port Pionerskiy (Russia), the 01.10.2016, in 55°05.31'N; 20°22.03'E. The ship was fixed on the two anchors and one trawl door on the 36.0 meters of depth. The calibration procedure was carried out with a standard calibrated copper sphere, in accordance with the 'SISP Manual of International Baltic Acoustic Surveys (IBAS) ("Manual of International Baltic Acoustic Surveys (IBAS)", Version 0.82, WGBIFS 2015 ICES CM 2015/ SSGIEOM:07).

THE RESULTS OF CALIBRATION PROCEDURE FOR EK60 SCIENTIFIC ECHOSOUNDER

Date: 01.10.2016	Place : port Pionerskiy (Russia)
Type of transducer	Split – beam for 38 and 120 kHz
Gain (38 kHz)	26.25 dB
SA Correction (38 kHz)	-0.68 dB
Gain (120 kHz)	25.90 dB
Sa Correction (120 kHz)	-0.35 dB

2.5 Acoustic data collection

The acoustic investigations have been performed during daytime only. The acoustic equipment was an echosounder EK60 with the 38/120 kHz working frequencies. Both transducers are stationary installed in the bottom of the ship, in special blister, for air bubbles noise level decreasing. The specific settings of the hydroacoustic equipment were as described in the "Manual of International Baltic Acoustic Surveys (IBAS)", (WGBIFS 2014 ICES CM 2014/ SSGIEOM:13). The post-processing of the stored echodata was done with the SonarData Echoview ver. 4.80.48.16239, Surfer 8.0 and Excel software's. Data sampling and echogram formation were implemented by SonarData Echolog_60 ver. 3.50.1.2922. The mean volume backscattering values Sv, were integrated over 1 nm intervals, from 5 m below the surface to the bottom. Contributions from air bubbles, trawlings and on oceanology stations maneuvers, bottom structures and scattering layers were removed from the echograms by using the SonarData Echoview software. The map of fish density distribution was built on base NASC values with Surfer 8.0 software.

2.6 Biological data – fishing stations

All trawlings were done with the pelagic gear "RT/TM 70/300" in the midwater as well as near the bottom. The mesh size in the codend was 6.5 mm. The intention was to carry out at least two hauls per ICES statistical rectangle. The trawling depth and the trawl opening were defined with a trawl sonar monitoring system SI-110. The trawling depth was chosen on base the echogram, in accordance to echorecords from the fish. Normally, the trawl had vertical opening of about 28 m. The trawling time lasted 30 minutes. Samples were taken from each haul in order to determine length and weight composition of fish. Sub-samples of herring and sprat were taken for further investigations in the laboratory (i.e. sex, maturity, age). In addition, stomachs of sprat and herring were sampled for further biological investigations. The positions of trawlings are shown on Figure 1. Fish control-catch results from the Russian RV'Atlantniro' IBAS survey are shown on Table 1.

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 define the integrator readings for 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 σ 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 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 different fish species according to the mean catch composition in the rectangle.

2.8 Hydrographic data

After finalization of each trawling, a hydrographic measurement was executed. The vertical profiles of hydrographical parameters, (temperature, salinity of water and the oxygen dissolved in water) were taken with a "SBE-19 plus" probe.

Samples of water on different depth were selected with the complex “SBE19+V2/SBE32/33”. Concentration of the dissolved oxygen in samples was defined on method Winkler, by means of the stand for titration "Dosimat 715" (Hydrobios, Germany).

3. RESULTS

3.1 Biological data

In total 10 trawl hauls were carried out in subdivision 26 (Russia zone). During the survey the 2006 sprat and 2381 herring were measured, 772 herring and 1000 sprat were aged. The results of the catch composition by ICES Subdivision are presented in Table 2. The average catch amounted to 260.3 kg per half hour of trawling. The average biomass fraction was 40.0% for sprat, 58.8% for herring and less than 1.0% for cod. In four trawling stations the fraction of a sprat reached more than 70%, in the remaining trawling it was from 4 to 23%. The cod catches were extremely small.

The length compositions of sprat and herring in subdivision 26 (Russia zone) of the year 2016, are presented in Figure 2.

3.2 Acoustic data

The survey statistics concerning the survey area, the mean NASC, the mean scattering cross section σ, the estimated total number of fish, the percentages of herring and sprat per Sub-division/rectangle are shown in Table 3. The maps of surface density distribution in NASC [m^2/nm^2] – values, are shown in Figure 3.

3.3 Abundance estimates

The survey statistics concerning the survey area, the mean NASC, the mean scattering cross section σ, the estimated total number of fish, the percentages of herring and sprat per Sub-division/rectangle are shown in Table 3. The total abundance of herring and sprat are presented in Table 4. The estimated summary acoustic survey of sprat and herring (mean length and weights) by Sub-division/rectangle are given in Table 5. The estimates of sprat and herring number, mean weights and biomass by Sub-division/rectangle are shown in Table 6-11.

4.0 DISCUSSION

The indices of young sprat and herring (the generation of 2016) had minimal values that indicated on low recruitment of clupeids in 2016.

During trawl acoustic survey in October 2016 significant distraction of the fish accumulations on the researching water area was noted. It was caused by anomalous hydrometeorological unfavorable conditions both for the formation of dense concentrations of pelagic fish (especially sprat and its young), and, respectively, for their catching.

5.0 REFERENCES

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Foote, K.G., Aglen, A., and Nakken, O. 1986. Measurement of fish target strength with a split-beam echosounder. J.Acoust.Soc.Am. 80(2):612–621;

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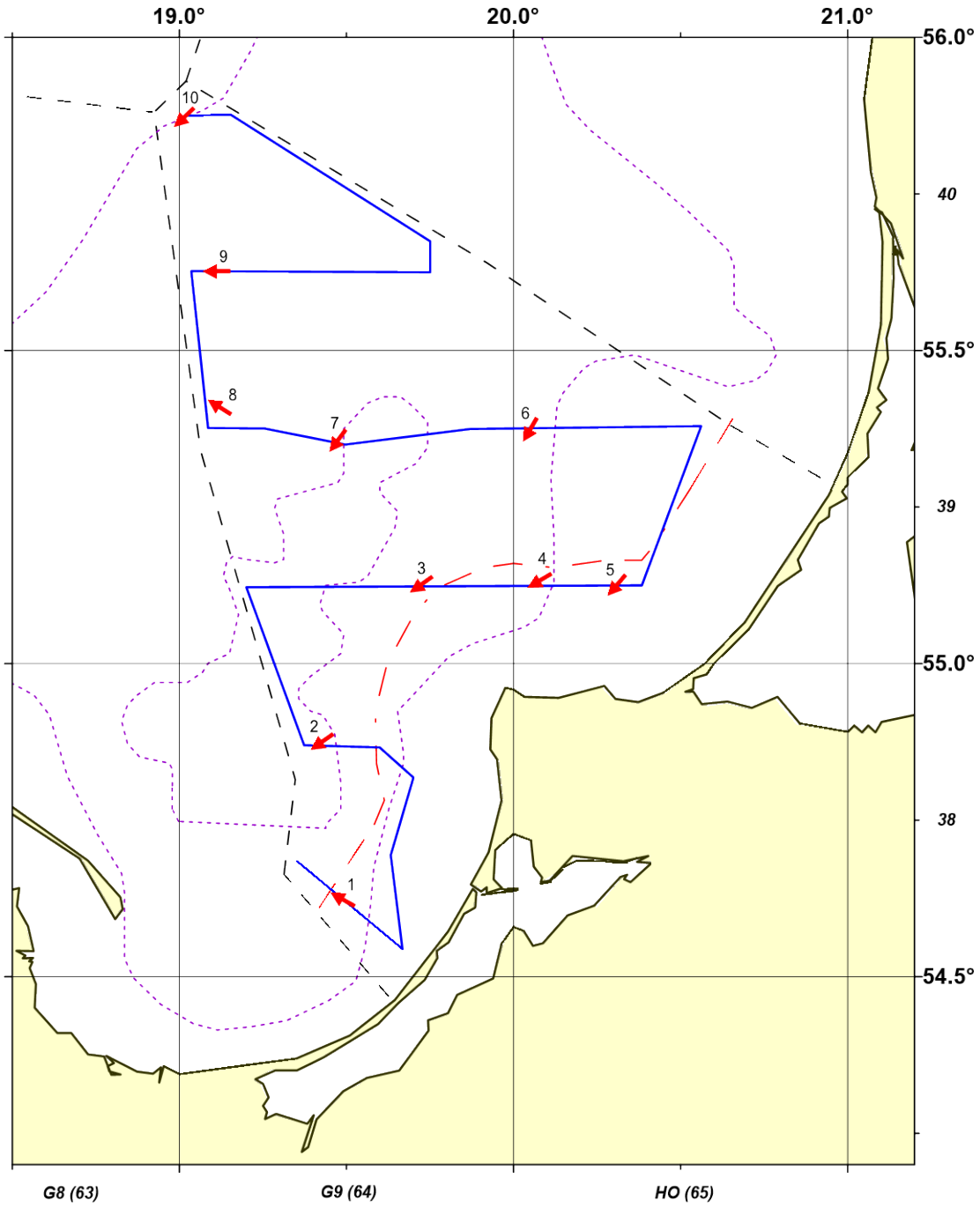

Figure 1. The scheme of cruise track and trawl stations for Russian part of survey (RV "ATLANTNIRO", 02-10.10. 2016)

Table 1. Fish control-catch results in the Baltic Sea ICES SD 26 from Russian BASS survey (RV “ATLANTNIRO”, 02–10.10.2016)

Haul number	Date	ICES rect.	ICES SD	Mean bottom depth [m]	Head-rope depth [m]	Hor. open [m]	Ver. open [m]	Trawl. speed [knt]	Trawl. direct [°]	Geographical position				Time Start	Haul dur. [min]	Total catch [kg]
										Start		End				
										Latitude 00° 00.0'N	Longitude 00° 00.0'E	Latitude 00° 00.0'N	Longitude 00° 00.0'E			
1	02.10.2016	38G9	26	80	20	97	26	4,0	300	54 37.1	19 30.1	54 37.7	19 28.2	18:08	20	345,5
2	04.10.2016	38G9	26	105	52	92	26	4,0	230	54 53.3	19 27.7	54 52.0	19 24.3	7:40	30	353,5
3	06.10.2016	39G9	26	76	37	98	28	4,1	237	55 08.2	19 45.1	55 07.0	19 42.0	12:31	30	219,5
4	07.10.2016	39HO	26	56	13	98	29	4,1	241	55 08.6	20 06.6	55 07.5	20 03.1	7:31	30	336,1
5	07.10.2016	39HO	26	43	10	91	31	4,0	220	55 08.4	20 19.8	55 06.7	20 17.3	14:42	30	149,5
6	08.10.2016	39HO	26	59	17	90	25	4,0	213	55 23.7	20 04.4	55 21.8	20 02.5	10:04	30	99,8
7	08.10.2016	39G9	26	96	43	89	28	4,0	221	55 22.3	19 29.9	55 20.5	19 27.2	15:18	30	237,1
8	09.10.2016	39G9	26	81	34	90	28	4,0	300	55 23.8	19 09.3	55 25.1	19 05.6	9:05	30	63,3
9	09.10.2016	40G9	26	87	55	95	29	3,9	270	55 37.5	19 09.0	55 37.5	19 05.3	13:39	30	419,2
10	10.10.2016	40G9	26	104	50	97	26	3,9	224	55 53.3	19 02.5	55 51.6	18 59.6	11:32	30	207,0
SD26				79	33	94	28	4,0	246							2430

Table 2. Catch composition (kg/1hour) per haul by ICES Subdivision and ICES rectangles (RV “ATLANTNIRO”, 02–10.10.2016)

ICES_subdivision	**26**	**26**	**26**	**26**	**26**	**26**	**26**
Haul_No	***1***	***2***	***3***	***4***	***5***	***6***	***7***
Date	02.10.2016	04.10.2016	06.10.2016	07.10.2016	07.10.2016	08.10.2016	08.10.2016
Validity	Valid	Valid	Valid	Valid	Valid	Valid	Valid
Species/ICES rectangle	38G9(64)	38G9(64)	39G9(64)	39HO(65)	39HO(65)	39HO(65)	39G9(64)
CLUPEA HARENGUS	282,9	523,2	386,6	8,0	1,4	11,9	431,8
SPRATTUS SPRATTUS	732,9	160,6	50,1	660,0	295,2	186,8	33,6
GADUS MORHUA	6,0	18,5	1,4	2,3	0,0	0,8	8,1
ANOTHER	14,7	4,7	0,9	1,9	2,3	0,2	0,7
Total	1036,5	707,0	439,0	672,1	298,9	199,7	474,3

ICES_subdivision	**26**	**26**	**26**
Haul_No	***8***	***9***	***10***
Date	09.10.2016	09.10.2016	10.10.2016
Validity	Valid	Valid	Valid
Species/ICES rectangle	39G9(64)	40G9(64)	40G9(64)
CLUPEA HARENGUS	119,6	803,0	385,0
SPRATTUS SPRATTUS	6,8	32,6	28,4
GADUS MORHUA	0,0	2,8	0,5
ANOTHER	0,2	0,0	0,0
Total	126,6	838,4	413,9

Table 3. Survey statistics (RV “ATLANTNIRO”, 02–10.10.2016)

ICES SD	ICES Rect.	AREA NM^2	SA M^2/NM^2	$\sigma*10^4$ M^2	N TOTAL MLN	SPECIES COMPOSITION (%)	
						HERRING	SPRAT
26	40G9	1013,0	229,3	3,12	745,4	85,78	14,22
26	39H0	881,6	630,8	1,33	4182,6	0,49	99,51
26	39G9	1026,0	154,2	2,97	533,1	74,07	25,93
26	38G9	918,2	378,3	1,95	1780,4	22,52	77,48

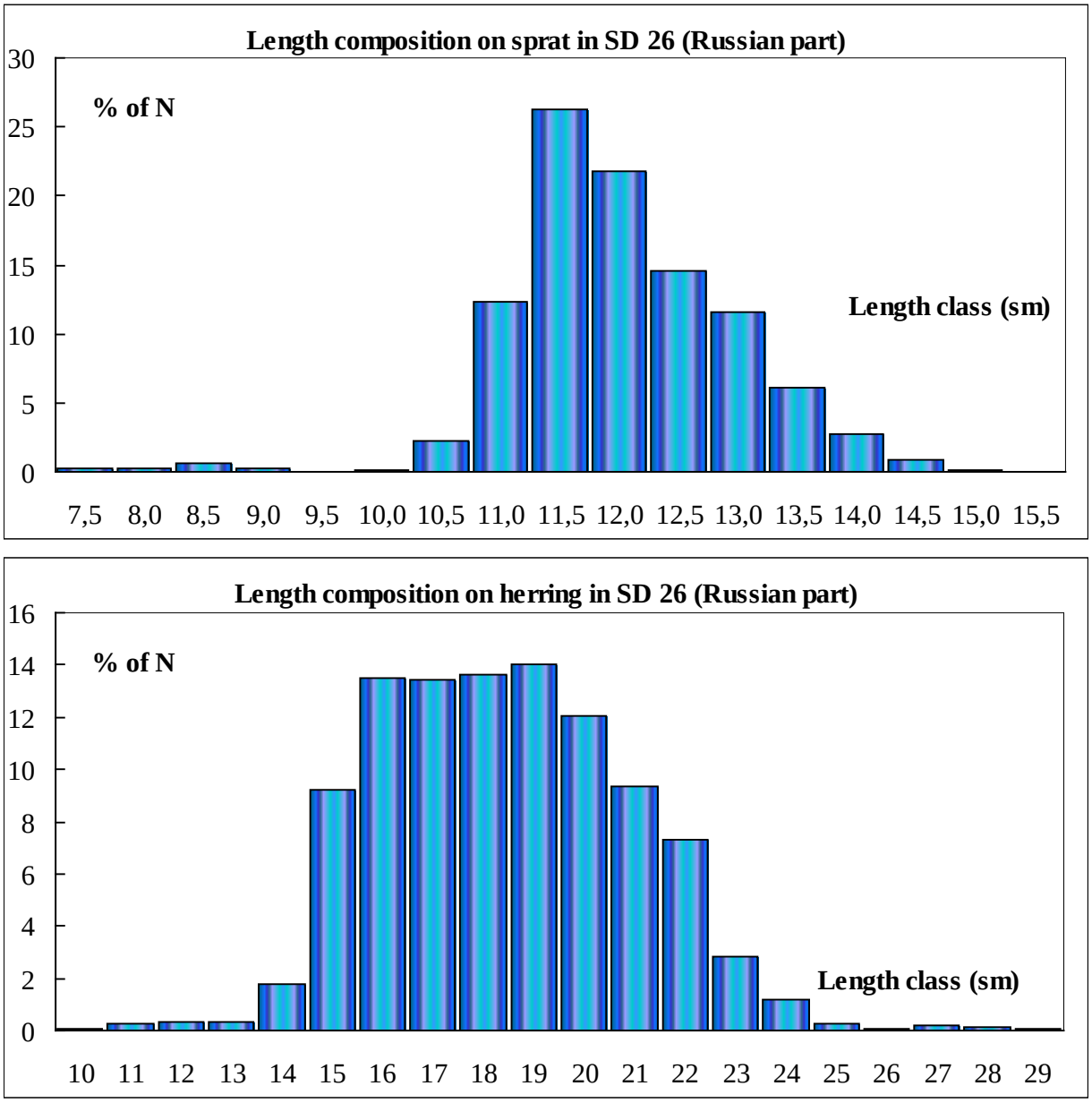

Figure 2. Length composition of sprat and herring (%) (RV “ATLANTNIRO”, 02–10.10.2016)

Table 4. Characteristics of the stock of sprat and herring acoustic survey data (RV “ATLANTNIRO”, 02–10.10.2016)

ICES	ICES	Area	ρ	Quantity, mln			Biomass, tonn		
SD	Rect.	nm^2	mln/nm^2	N sum	N her	N spr	W sum	W her	W spr
26	40G9	1013,0	0,74	745,4	639,4	106,0	26316,9	25031,6	1285,3
26	39H0	881,6	4,74	4182,6	20,5	4162,1	43786,6	799,7	42986,8
26	39G9	1026,0	0,52	533,1	394,9	138,3	17948,3	16368,6	1579,7
26	38G9	918,2	1,94	1780,4	400,9	1379,4	33058,3	17289,4	15768,9

SD26		**3 838,8**		**7 241**	**1 456**	**5 786**	**121 110**	**59 489**	**61 621**

Table 5. Summary acoustic survey of sprat and herring (RV “ATLANTNIRO”, 02–10.10.2016)

ICES SD	ICES Rect.	No trawl	HERRING			SPRAT			SA	TS CALC.
			L, cm	W, g	Numb.,%	L, cm	W, g	Numb.,%	M^2/NM^2	DB
26	40G9	9,10	18,69	39,15	85,78	12,65	12,13	14,22	229,3	-46,1
26	39H0	4,5,6	18,53	39,06	0,49	11,74	10,33	99,51	630,8	-49,8
26	39G9	3,7,8	19,01	41,45	74,07	12,29	11,43	25,93	154,2	-46,3
26	38G9	1,2	19,30	43,12	22,52	12,39	11,43	77,48	378,3	-48,1

Table 6. Estimated number (millions) of sprat (RV “ATLANTNIRO”, 02–10.10.2016)

SD	RECT	NSTOT	1	2	3	4	5	6	7	8+
26	40G9	105,99	0,29	4,98	39,33	15,38	26,76	12,91	1,73	1,75
26	39H0	4162,10	145,48	410,62	2735,36	439,54	370,11	49,18	5,91	2,95
26	39G9	138,26	0,65	7,95	68,59	20,54	26,89	7,97	1,39	1,21
26	38G9	1379,45	0,00	24,27	634,76	263,78	290,47	113,89	13,88	0,00
	Sum	5785,79	146,42	447,82	3478,05	739,23	714,22	183,95	22,91	5,91

Table 7. Estimated mean weights (g) of sprat (RV “ATLANTNIRO”, 02–10.10.2016)

SD	RECT	WSTOT	1	2	3	4	5	6	7	8+
26	40G9	12,13	3,93	8,99	10,79	11,93	13,20	14,13	16,70	15,21
26	39H0	10,33	3,90	9,04	10,32	11,58	12,14	14,36	17,24	16,79
26	39G9	11,43	4,54	8,66	10,54	12,16	12,68	14,27	16,22	12,61
26	38G9	11,43	0,00	8,02	10,39	12,36	12,19	13,61	12,90	0,00

Table 8. Estimated biomass (in tonnes) of sprat (RV “ATLANTNIRO”, 02–10.10.2016)

SD	RECT	WSTOT	1	2	3	4	5	6	7	8+
26	40G9	1285,29	1,13	44,72	424,24	183,45	353,07	182,49	28,96	26,65
26	39H0	42986,84	567,49	3712,45	28223,08	5090,96	4492,47	706,15	101,84	49,59
26	39G9	1579,69	2,97	68,89	723,03	249,85	340,82	113,73	22,55	15,24
26	38G9	15768,87	0,00	194,67	6596,11	3261,34	3541,31	1550,19	178,95	0,00
	Sum	**61620,70**	571,59	4020,73	35966,46	8785,60	8727,67	2552,56	332,30	91,48

Table 9. Estimated number (millions) of herring (RV “ATLANTNIRO”, 02–10.10.2016)

SD	RECT	NHTOT	0	1	2	3	4	5	6	7	8+
26	40G9	639,40	0,63	37,67	129,21	118,85	146,48	63,17	46,29	45,46	51,63
26	39HO	20,48	1,05	0,35	3,39	4,12	6,40	1,37	0,95	0,98	1,86
26	39G9	394,85	0,54	9,19	65,37	51,33	103,07	33,51	42,11	35,03	54,70
26	38G9	400,93	0,38	27,26	50,61	59,86	124,19	60,55	31,67	8,75	37,65
	Sum	1455,66	2,61	74,48	248,58	234,16	380,14	158,60	121,01	90,23	145,85

Table 10. Estimated mean weights (g) of herring (RV “ATLANTNIRO”, 02–10.10.2016)

SD	RECT	WHTOT	0	1	2	3	4	5	6	7	8+
26	40G9	39,15	12,05	28,76	30,89	35,29	37,35	47,14	46,52	47,72	57,76
26	39HO	39,06	11,18	18,96	30,92	33,31	38,26	43,12	61,77	46,69	70,37
26	39G9	41,45	13,96	29,16	29,65	31,86	39,19	43,74	45,74	52,24	59,57
26	38G9	43,12	9,85	26,21	29,30	42,10	41,21	45,51	53,53	60,70	65,56

Table 11. Estimated biomass (in tonnes) of herring (RV “ATLANTNIRO”, 02–10.10.2016)

SD	RECT	WHTOT	0	1	2	3	4	5	6	7	8+
26	40G9	25031,62	7,620206	1083,381	3991,107	4194,366	5471,059	2978,299	2153,536	2169,751	2982,498
26	39HO	799,7359	11,78513	6,727076	104,8264	137,3403	244,6947	59,0191	58,41273	45,84818	131,0823
26	39G9	16368,62	7,587676	267,8705	1938,146	1635,283	4039,425	1465,752	1925,884	1829,931	3258,742
26	38G9	17289,41	3,709085	714,4161	1483,027	2519,931	5117,677	2755,268	1695,348	531,3136	2468,716
	Sum	**59489,38**	30,7021	2072,394	7517,107	8486,92	14872,86	7258,338	5833,18	4576,844	8841,039

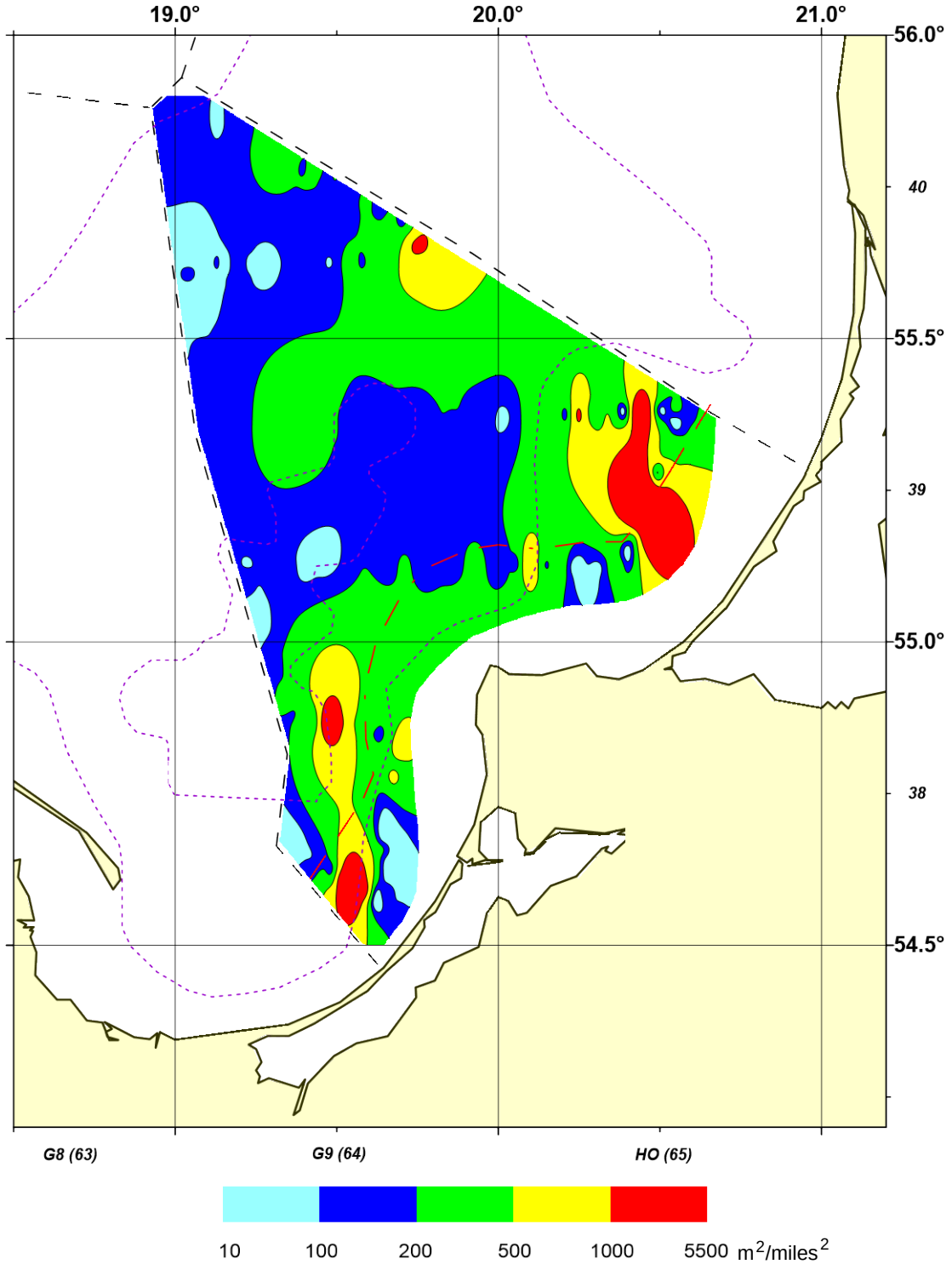

Figure 3. The map of NASC values distribution on the Russian area of international acoustic survey (RV “ATLANTNIRO”, 02-10.10.2016)

Baltic International Acoustic Survey

Report for R/V Aranda

R/V Aranda

Cruise 17/2016

ICES_BIAS2016

22th September – 4th October 2016

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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.

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 2016, within the remit of the Natural Resources Institute Finland (Luke).

MATERIALS AND METHODS

NARRATIVE

The cruise was completed in two legs, the first covering most of the Bothnian Sea (BS) and the second leg covering the Northern Baltic Sea and the Gulf of Finland (GoF). Altogether 44 stations were visited during both legs. The research area, cruise track and trawl stations are shown in Figure 1 and 2. At every station also a CTD cast was made. At one additional station the calibration of the echo sounder system was performed.

The R/V Aranda departed from HELSINKI on Thursday 28.09.2015 at 23:00 (UTC 20:00) and the direct at sea researches begun. Investigations were continued in the northern direction in to SD 30. All at sea researches were finalised on 8.10.2015 morning. The r/v Aranda arrived back to HELSINKI on Tuesday 08.10.2015 at 11:00. The harbour of Kaskinen was visited during the cruise at 01.10.2014 for change of scientific crew and repair the trawl. In addition, the harbour of Pori was visited at 03.10.2015 for fixing the vessel.

The Finnish BIAS 2015 survey had two interruptions due to technical faults and the fishing had to be stopped. The first fault was at 01.10.2015 in SD 39 when the trawl was damaged due to bottom contact. The second interruption was at between 2.-3.10.2015 due to a stormy weather, which damaged the vessel. Therefore, several fishing stations could not be realized and rectangles 55G9, 55H0, and 54H0 were not covered during the survey.

SURVEY DESIGN AND HYDROGRAPHICAL DATA

During the cruise, echo-integration was performed along the survey track from ICES Sub-Divisions 29N, 30, and 32N. The conductivity, temperature, and depth (CTD) were measured using a "RBR

XR-620" instrument. The CTD cast was done when whenever a trawl haul was conducted and also when calibrating the acoustic instrument.

CALIBRATION

The SIMRAD EK60 echo sounder with the transducer ES38B was calibrated on 30.09.2015 at the sea, according to the IBAS manual (ICES 2013, Addendum 2). Values from the calibration were within required accuracy.

ACOUSTIC DATA COLLECTION

The acoustic sampling was performed around the clock. SIMRAD EK60 echo sounder with the 38 kHz transducer (ES38B) mounted on a hull was used for the acoustic data collection. The settings of the hydroacoustic equipment were as described in the BIAS manual (ICES 2013, Addendum 2). 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 neighboring rectangles was used. From these distributions the mean acoustic cross-section was calculated according to the target strength-length (TS) relationships found below.

Clupeoids:	TS = 20 log L (cm) - 71.2	(ICES 1983/H:12)
Gadoids:	TS = 20 log L (cm) - 67.5	(Foote et al. 1986)

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 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 and fishing trawls were performed by Natural Resources Institute Finland (Luke) and fish sampling together by Luke and Swedish University of Agricultural Sciences (SLU). The participating scientist crew can be seen in the list below.

Juha Lilja	Luke	Cruise Leader, Acoustics
Ari Leskelä	Luke	Fishing
Jukka Pönni	Luke	Fish sampling
Tero Saari	Luke	Fish sampling
Hannu Harjunpää	Luke	Fish sampling
Timo Myllylä	Luke	Fish sampling
Markku Vaajala	Luke	Fish sampling
Esa Lehtonen	Luke	Fishing
Arto Koskinen	Luke	Fish sampling
Jari Raitaniemi	Luke	Fish sampling
Erkki Jaala	Luke	Acoustics
Mikko Leminen	Luke	Acoustics
Katja Ikonen	Luke	Fish sampling
Perttu Rantanen	Luke	Database maintenance
Otto Kiukkonen	Fisherman	Fishing
Peter Koskinen	Fisherman	Fishing
Jari Johansson	Fisherman	Fishing
Markku Gavrilov	Luke	Fishing
Sami Vesala	Luke	Fishing/ Fish sampling
Yvette Heimbrand	SLU	Fish sampling
Anne Odelström	SLU	Fish sampling
Harri Vehviläinen	Luke	Fish sampling
Anu Lastumäki	SYKE	Fish sampling
Tanja Kinnunen	SYKE	Fish sampling

Luke: Luonnonvarakeskus / Natural Resources Institute Finland
SLU: Sveriges lantbruksuniversitet / Swedish University of Agricultural Sciences
SYKE: Suomen ympäristökeskus / Finnish Environment Institute

RESULTS

FISH CATCHES, BIOLOGICAL AND HYDRO-METEOROLOGICAL DATA

The number of planned trawling stations was 46. From these, 44 trawling stations were accomplished, and from those 40 were counted as "valid" (technically sound hauls and sufficient catch for a sample) (Table 1 & 4). The total number of trawling stations in Bothnian Sea (ICES SD 30) was 30, in northern Baltic proper (SD 29) 7, and 7 in the northern Gulf of Finland (SD 32). Only 2 trawling stations was reduced due to stormy weather.

The 8488 kg combined catches (Table 1) consisted of 17 fish species (8349 kg) and mostly unidentified organic matter categorized as "waist" (139 kg), but also including identified common jellyfish (*Aurelia aurita*), large number of mysids and small amounts of the isopod *Saduria entomon*. The unsorted "invalid" trawlcatches add up to 115 kg, and they are also included in the total catch. The most common and abundant species were herring (*Clupea harengus*) (5134 kg) and sprat (*Sprattus sprattus*) (1870 kg) followed by three-spined stickleback (*Gasterosteus aculeatus*) (1315 kg). All observed species are presented in Table 2. From the sub-samples of the 40 fish catches a total of 18326 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, 3786 and 1183 samples respectively (Table 5). The mean weights for each length-class were also derived from these individual fish samples.
Additionally, from 10 statistical rectangles in SD 30 and 2 rectangles in SD 29 close to the Swedish coast, a 2 kg sample of herring from 17 cm to 20 cm of length was collected and frozen for dioxin analyses to be performed by Livsmedelsverket (SLV) of Sweden.

Also, in SD30, 17 dioxin samples of 25 herring individuals from the same size-category as in previous sampling were collected and frozen for Naturhistoriska Riksmuséet (NRM) of Sweden.

Hydrographical data: temperature (°C), salinity (psu), sound speed (m/s), special conductivity (µS/cm), conductivity (mS/cm) and sound speed (m/s) were measured and results are showed in Figures 5 - 8. Total of 44 CTD casts were done during the entire cruise. Here only a part of the CTD casts is presented.

ABUNDANCE ESTIMATES

The total area covered by the Finnish BIAS survey was 21629 square nautical miles (nmi^2) and after the scrutinizing, the distance used for acoustic estimates was 1703 nautical miles (nmi). The cruise track and positions of trawl hauls are shown in Figure 1. Length distributions for herring and sprat by ICES subdivision are shown in fgures 2 and 3, respectively. The total abundance of herring and sprat is presented in Table 6. Estimated numbers of herring and sprat by age group and Subdivision/rectangle are given in Table 7 and Table 10, respectively. Corresponding mean weights by age group and Subdivision/rectangle are shown in Table 8 and Table 11, respectively. Estimates of herring and sprat biomass by age group and Subdivision/rectangle are summarized in Table 9 and Table 12, respectively.

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TABLES, MAP, AND FIGURES

Table 1.Trawl catches (kg) by species/category during the Finnish BIAS-survey in 2016.

Haul no	Haul name	ICES SD	Ammodytes spp.	Clupea harengus	Clupeonella cultriventris	Gasterosteus aculeatus	Hyperoplus lanceolatus	Lampetra fluviatilis	Liparis spp.	Myoxocephalus spp.	Osmerus eperlanus	Platichthys flesus	Pomatoschistus minutus	Pomatoschistus pictus	Pungitius pungitius	Salmo salar	Salmo trutta	Sprattus sprattus	Zoarces viviparus	Weight	Total (kg)
1	6B46-1	32		24.80		4.32					9.94			0.01	0.06			654.29		0.01	654.29
2	6B49-1	32		18.48		2.82					0.68				0.06	0.01		51.80		4.96	51.80
4	6B45-1	29	0.91	3.63		2.12					0.15				0.03	0.01		61.51		1.65	61.51
5	6B49-1	29		81.00		10.87	0.12							0.01	0.02			15.62		3.00	81.00
6	5D50-1	30		186.45		20.31	0.01								0.01	0.01		3.04		6.14	186.45
7	5D50-2	30		89.80		26.28									0.00	0.01		0.14		1.78	89.80
8	5D57-1	30		508.94		7.20	0.02								0.00	0.01		8.16		3.60	508.94
9	5D58-1	30		1.24		414.25	0.08								0.04		0.04	1.16		26.04	439.25
10	5D59-1	30		54.17		14.02									0.00			0.15		0.13	54.17
11	5D58-2	30		180.94		44.05										0.01					180.94
12	5D57-1	30		77.48		30.26	0.01									0.01				0.25	77.48
13	5D57-1	30		85.80		4.45	0.01								0.01					2.65	85.80
14	5D58-1	30		180.90		13.95				0.00						0.01		0.61		0.00	180.90
15	5D58-1	30		217.74		11.72			0.01						0.03	0.14		0.08		0.24	217.74
16	5D58-2	30		67.84		10.33									0.02	0.01				0.04	67.84
17	5D59-1	30		76.60		6.08	0.01		0.07						0.01	0.04					76.60
18	5D58-1	30		57.15		0.52	0.04		0.02					0.01	0.00	0.01				2.12	57.15
19	5D59-1	30		107.22		5.52	0.15		0.05						0.01	0.01		0.81		1.23	107.22
20	5D59-1	30		127.17		8.27	0.01			0.00	0.05			0.01		0.04		9.95		6.04	127.17
21	5D40-1	30		158.56		0.68	0.00		0.11		1.10		0.00		0.00	0.04	0.28	2.04	0.02	1.13	158.56
22	5D59-2	30		105.25		0.18			0.26	0.00	0.07					0.03				1.96	105.25
23	5D40-1	30		285.34		24.27	0.02			0.02					0.06	0.03		0.08		2.28	285.34
24	5D40-1	30		106.17		20.80		0.04			0.57				0.01	0.01		0.22		5.18	106.17
25	5D40-1	30		71.51		18.95				0.00	0.07					0.01		0.09		1.56	71.51
26	5D40-2	30		76.98		21.79	0.00		0.03									0.24		6.96	76.98
28	5D40-1	30		811.78		2.45	0.00			0.00					0.02			0.29		1.43	811.78
29	5D59-1	30		10.55		182.78	0.01			0.00								0.32			182.78
31	5D40-1	30		27.47		18.42				0.00					0.01	0.01		0.02	0.04	1.02	27.47
32	5D40-2	30		71.24		100.14									0.01			0.18		0.44	100.14
33	5D40-1	30		109.93		85.49	0.00			0.00					0.00		0.41	6.78	0.02	2.37	109.93
34	5D59-1	30		140.93		41.23										0.01		11.58		1.25	140.93
35	5D59-2	30		20.08		129.80				0.00	0.01					0.01		0.44		0.17	129.80
36	6B59-1	29		159.04		13.58	0.01				0.22				0.01			186.01		1.17	159.04
37	6B40-1	29		240.11		12.76									0.01			25.58		14.51	240.11
38	6B41-2	29	3.48	897.47	0.06	9.25												96.28		7.45	897.47
39	6B42-1	29	3.09	93.91		1.33	0.02				0.09				0.02	0.02		105.52	0.04	9.34	105.52
40	6B49-2	32	0.06	2.85		0.15				2.85					0.01			946.07		1.04	946.07
41	6B46-1	32		100.97		0.97				0.00	4.76				0.01			66.88		7.91	100.97
42	6B45-1	32		165.44		3.07				0.00	1.80	0.14			0.04			156.52			165.44
44	6B45-1	32		660.46		1.18					1.91				0.01	0.01		105.17		1.52	660.46
Total			3.48	908.94	0.06	414.25	0.13	0.04	0.07	2.85	9.94	0.14	0.00	0.01	0.06	0.14	0.41	654.29	0.04	26.04	654.29

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

Fishnames		
English	**Scientific**	**Finnish**
snake blenny	Lumpenus lampretaeformis	Elaska
sand goby	Pomatoschistus minutus	Hietatokko
striped seasnail	Liparis liparis	Imukala
greater sandeel	Hyperoplus lanceolatus	Isotuulenkala
sarduria	Sarduria entomon	Kilkki
sprat	Sprattus sprattus	Kilohaili
eelpout	Zoarces viviparus	Kivinilkka
three-spined stickleback	Gasterosteus aculeatus	Kolmipiikki
jellyfish	Aurelia aurita	Korvameduusa
smelt	Osmerus eperlanus	Kuore
nine-spined stickleback	Pungitius pungitius	Kymmenpiikki
Atlantic salmon	Salmo salar	Lohi
sea lamprey	Petromyzon marinus	Meritaimen
turbot	Scophtalmus maximus	Piikkikampela
small sandeel	Ammodytes tobianus	Pikkutuulenkala
lumpsucker	Cyclopterus lumpus	Rasvakala
Baltic herring	Clupea harengus membras	Silakka
straightnose pipefish	Nerophis ophidion	Siloneula

Table 3. Number of length measurements /species and Sub-Division.

	ICES SD			
Species	**29**	**30**	**32**	**Total**
Clupea harengus	1753	8167	1408	11328
Cyclopterus lumpus	1			1
Gasterosteus aculeatus	441	1617	413	2471
Hyperoplus lanceolatus	6	96		102
Lampetra fluviatilis		1		1
Liparis liparis		51		51
Nerophis ophidion		18	5	23
Osmerus eperlanus	15	81	457	553
Platichthys flesus			1	1
Pomatoschistus minutus	1	2	1	4
Pungitius pungitius	28	65	135	228
Salmo salar		3		3
Sprattus sprattus	1382	809	1359	3550
Zoarces viviparus	2	8		10
Total	**3629**	**10918**	**3779**	**18326**

Table 4.Numbers and locations of fishing stations (WGS-84) during Finnish BIAS-survey in 2016.

Haul nro	Haul name	Date	ICES SD	Start latitude	Start longitude	End latitude	End longitude	Haul duration (min)	Haul speed (knot)	Haul distance (nmil)	Catch (kg)	Sample weight (kg)	Headrope depth (m)	Bottom depth (m)	Doors spread (m)	Trawl height (m)
1	4BH4-1	22.09.2016	32	5849693N	0242245E	5850 10N	0242375E	16	2.7	0.72	695	68.0	20	53	62.5	16
2	4BH3-1	23.09.2016	32	5838889N	0231304E	5838 95N	0231386E	10	2.5	0.42	80	26.4	25	56	62	16
3	4BH2-0(INVALID)	23.09.2016	29	5835209N	0224320E	5835 60N	0224570E	30	3	1.5	36		22	62	65	16
4	4BH1-1	23.09.2016	29	5832655N	0212500E	5833 99N	0212138E	90	2.5	3.75	70	20.75	12	120	58	16
5	4BG6-1	23.09.2016	29	6006330N	0192466E	6008 82N	0192327E	58	2.8	2.71	111.5	41.88	17	170	66.1	17
6	5DG5-1	24.09.2016	30	6051816N	0185593E	6034 61N	0185518E	62	2.6	2.69	216	39.5	17	90	64.9	17
7	5DG5-2	24.09.2016	30	6051933N	0184735E	6055 80N	0184660E	85	2.8	3.97	68	31	16	75	64.4	16
8	5DG7-1	24.09.2016	30	6046940N	0175180E	6046 48N	0175574E	75	2.4	3	528	66.6	25	55	66.2	20
9	5JG8-1	24.09.2016	30	6106622N	0181999E	6107 78N	0181738E	30	2.8	1.4	449	10.97	14	68	65.4	20
10	5JG9-1	24.09.2016	30	6106987N	0190919E	6111 31N	0190962E	30	2.9	1.45	68.5	32.16	15	70	64.2	20
11	5JG8-2	25.09.2016	30	6120016N	0185788E	6117 94N	0185447E	60	2.5	2.5	173	34.44	16	68	63.3	20
12	5JG7-1	25.09.2016	30	6118716N	0175889E	6115 81N	0175790E	69	2.8	3.22	108	31.12	15	70	66.2	20
13	5JG7-1	25.09.2016	30	6159111N	0175921E	6156 12N	0175600E	73	2.8	3.41	93	37.35	17	80	64.1	20
14	5JG8-1	26.09.2016	30	6155009N	0181234E	6152 20N	0180985E	65	2.9	3.14	196	51.64	13	85	63.2	20
15	5JG8-1	26.09.2016	30	6202846N	0181348E	6200 53N	0181031E	60	2.8	2.8	230	39.38	13	83	64.6	20
16	5JG8-2	26.09.2016	30	6206115N	0182969E	6206 47N	0183440E	49	2.8	2.29	78	35.94	13	90	65	20
17	5JG9-1	26.09.2016	30	6220857N	0191939E	6225 22N	0191988E	90	2.4	3.6	84	35.34	80	140	86.6	20
18	5AG8-1	26.09.2016	30	6240698N	0185473E	6237 19N	0185566E	93	2.3	3.57	61	61	90	210	90	17
19	5AG9-1	26.09.2016	30	6236806N	0192070E	6239 62N	0192355E	68	2.8	3.17	115	35.9	13	125	64.7	17
20	5GG9-1	27.09.2016	30	6305962N	0191760E	6308 48N	0192538E	100	2.8	4.67	152	42.94	15	185	64.3	20
21	5GH0-1	27.09.2016	30	6321016N	0202096E	6318 68N	0201742E	72	2.4	2.88	164	40.08	68	100	89.6	20
22	5AG9-2	27.09.2016	30	6240598N	0193205E	6236 98N	0192984E	90	2.4	3.6	108	48.93	80	135	98.9	20
23	5AH0-1	27.09.2016	30	6235438N	0200688E	6234 03N	0200715E	31	2.9	1.5	257	48.67	8	90	63.6	20
24	5AH0-2	28.09.2016	30	6233000N	0202093E	6231 73N	0202034E	29	2.8	1.35	136	49.24	10	70	65.2	20
25	5JH0-1	28.09.2016	30	6221679N	0203981E	6219 80N	0204128E	47	2.5	1.96	93	35.32	14	65	67	20
26	5JH0-2	28.09.2016	30	6215569N	0201988E	6214 03N	0201743E	40	2.7	1.8	106	38.32	19	120	64.7	20
27	5JG9-2(INVALID)	28.09.2016	30	6219446N	0195121E	6219 41N	0194761E	37	2.8	1.73	38.32		17	110	66.8	20
28	5JH0-1	29.09.2016	30	6155517N	0202220E	6156 73N	0201774E	60	2.7	2.7	316	65.44	15	110	62.1	20
29	5JG9-1	29.09.2016	30	6150138N	0195442E	6150 17N	0195999E	60	2.6	2.6	194	194	40	100	75	20
30	52H0-2(INVALID)	29.09.2016	30	6135620N	0200027E	6134 41N	0200003E	32	2.4	1.28			85	120	85	20
31	51H0-1	01.10.2016	30	6114879N	0202350E	6115 48N	0201806E	70	2.5	2.92	51	51	35	120	90	20
32	51H0-2	01.10.2016	30	6107736N	0200431E	6106 35N	0201464E	48	2.5	2	172	47.32	17	103	62.2	24
33	5DH0-1	02.10.2016	30	6055528N	0203207E	6056 58N	0202675E	62	2.6	2.69	205	52.44	16	70	62	20
34	5DG9-1	02.10.2016	30	6056413N	0195804E	6052 78N	0195310E	68	2.4	2.72	195	46.91	22	93	62.6	22
35	5DG9-2	02.10.2016	30	6053161N	0192088E	6055 45N	0192124E	47	2.5	1.96	150	150	20	108	62.8	20
36	4BG9-1	02.10.2016	29	5947516N	0195515E	5947 56N	0200249E	87	2.6	3.77	310	58.16	37	190	95.4	20
37	4BH0-1	02.10.2016	29	5930000N	0203001E	5929 86N	0203175E	21	2.8	0.98	301	60.54	13	90	66.3	20
38	4BH1-2	03.10.2016	29	5932469N	0210210E	5933 10N	0210293E	17	2.8	0.79	513	68.54	13	105	65	20
39	4BH2-1	03.10.2016	29	5933940N	0221711E	5933 12N	0221632E	13	2.4	0.52	213	39.8	24	66	62.1	20
40	4BH3-2	03.10.2016	32	5933288N	0233027E	5933 54N	0233186E	20	2.5	0.83	353	54.58	30	84	77	20
41	4BH5-1	03.10.2016	32	6003194N	0262278E	6003 86N	0262297E	17	2.6	0.74	178	48.91	19	75	64.2	20
42	4BH5-1(INVALID)	04.10.2016	32	5953809N	0253169E	5954 26N	0253222E	12	2.6	0.52	41		21	73	66.1	20
43	4BH5-1	04.10.2016	32	5955394N	0253359E	5956 06N	0253450E	20	2.5	0.83	330	50.06	21	68	61.3	20
44	4BH5-1	04.10.2016	32	6000510N	0252065E	6001 38N	0252069E	22	2.4	0.88	573	46.6	23	60	61.2	20

Table 5.Individual samples of herring and sprat (for age-determination) per SD.

Lenght class	Sprat			Sprat total	Herring			Herring total
	29	30	32		29	30	32	
60	2			2		1		1
65	3		3	6	1			1
70	10		6	16	3	3	4	10
75	10	1	10	21	14	6	5	25
80	11		3	14	12	11	12	35
85	6	1	1	8	13	19	2	34
90	8	1	20	29	13	28	4	45
95	47	2	50	99	10	18	4	32
100	50	10	50	110	23	11	1	35
105	50	28	50	128	3	4	5	12
110	50	33	41	124	3	1	13	17
115	45	51	36	132	19	1	43	63
120	46	72	32	150	35	9	45	89
125	41	68	15	124	47	54	50	151
130	13	62	7	82	40	85	50	175
135	3	66	1	70	40	125	50	215
140	1	38		39	40	144	50	234
145		17		17	47	181	48	276
150		12		12	41	194	48	283
155					44	199	42	285
160					35	199	24	258
165					36	195	14	245
170					17	182	2	201
175					14	179	2	195
180					5	170		175
185					4	147	1	152
190					1	127		128
195					2	123		125
200						104		104
205					1	68		69
210					1	46		47
215					1	28	1	30
220					1	20		21
225						9		9
230						3		3
235						2		2
240					1			1
250						1		1
255						1		1
265							1	1

Table 6. Survey statistics by area r/v Aranda 2015.

ICES SD	ICES Rect.	NM	N (million/nm²)	Area (nm²)	Sa (m²/nm²)	σ (cm²)	N total (million)	Herring (%)	Sprat (%)	Cod (%)
29	48G9	65	7.551482	772.8	789	1.045365	5836	58.9	30.0	0
29	48H0	61	5.550355	730.3	952	1.714755	4053	74.0	6.8	0
29	48H1	57	11.258670	544	1491	1.324108	6125	64.5	25.2	0
29	48H2	71	14.014105	597	1944	1.387496	8366	53.7	42.6	0
32	48H3	55	25.449869	615.7	2572	1.010686	15669	6.8	86.3	0
32	48H4	44	18.391186	835.1	1813	0.985664	15358	5.0	86.9	0
32	48H5	60	12.667041	767.2	1776	1.401875	9718	51.4	42.1	0
29	49G9	76	5.050568	564.2	706	1.397885	2850	59.8	10.1	0
32	49H5	19	5.190208	306.9	864	1.665052	1593	79.4	19.2	0
32	49H6	53	7.792386	586.5	1186	1.521502	4570	60.8	34.5	0
30	50G7	27	2.550247	403.1	522	2.046998	1028	93.8	1.1	0
30	50G8	61	3.104480	833.4	383	1.232636	2587	56.3	0.7	0
30	50G9	72	5.478775	879.5	381	0.695841	4819	14.2	1.1	0
30	50H0	37	3.818339	795.1	277	0.724586	3036	26.8	1.0	0
30	51G7	36	3.485320	614.5	309	0.887547	2142	23.6	0.0	0
30	51G8	61	5.656325	863.7	741	1.310854	4885	41.1	0.0	0
30	51G9	57	3.544268	865.8	483	1.361671	3069	45.6	0.1	0
30	51H0	113	4.214350	865.7	312	0.740196	3648	17.1	0.0	0
30	52G7	29	1.220099	482.6	305	2.496667	589	78.2	0.0	0
30	52G8	80	2.784527	852	553	1.986211	2372	66.3	0.2	0
30	52G9	60	1.702613	852	261	1.534196	1451	25.4	0.0	0
30	52H0	77	1.023037	852	271	2.653370	872	95.8	0.1	0
30	53G8	61	2.325741	838.1	475	2.043236	1949	74.2	0.0	0
30	53G9	61	1.129408	838.1	251	2.220022	947	73.4	0.0	0
30	53H0	62	5.492220	838.1	558	1.016509	4603	29.0	0.2	0
30	53H1	9	6.593151	126.6	621	0.942162	835	27.4	0.3	0
30	54G8	33	1.241488	642.2	381	3.071477	797	94.4	0.0	0
30	54G9	91	0.855443	824.2	220	2.569571	705	85.7	0.3	0
30	54H0	47	3.564550	727.9	722	2.024741	2595	64.8	0.0	0
30	55G9	29	1.023572	625.6	175	1.710784	640	70.5	4.9	0
30	55H0	39	1.195182	688.6	294	2.463472	823	96.6	0.9	0

Table 7.Numbers (millions) of herring by age and area (r/v Aranda 2016).

SD	Rect	0	1	2	3	4	5	6	7	8+	Total
29	48G9	1594.0	857.4	892.4	59.0	10.4	3.6	7.3	6.5	5.8	3436.4
29	48H0	7.6	360.9	1529.7	406.2	220.5	73.3	150.7	121.2	130.2	3000.3
29	48H1	52.4	882.9	2305.4	319.5	128.4	43.5	76.4	66.4	73.4	3948.4
29	48H2	89.8	1543.1	2460.1	190.9	84.2	18.2	40.9	25.5	41.9	4494.6
32	48H3	75.1	199.2	663.6	71.9	20.6	10.3	12.6	4.4	11.7	1069.4
32	48H4	31.3	118.1	463.1	79.6	28.8	13.6	12.5	9.8	15.3	772.1
32	48H5	130.6	642.0	2938.3	658.3	247.7	108.6	98.3	54.9	116.8	4995.6
29	49G9	136.6	237.5	840.3	194.5	87.0	27.3	58.7	46.0	76.2	1704.1
32	49H5	5.7	189.4	789.9	141.9	54.0	23.7	20.9	13.0	26.7	1265.2
32	49H6	42.1	315.7	1576.0	420.4	156.7	72.6	69.4	41.1	82.9	2776.9
30	50G7	7.4	293.2	450.0	127.2	45.4	20.4	5.2	3.7	11.3	963.9
30	50G8	1.4	561.5	595.2	161.5	59.7	29.5	11.8	11.2	24.9	1456.7
30	50G9	83.2	205.1	247.6	72.3	29.4	16.0	6.3	6.2	17.4	683.5
30	50H0	230.8	297.1	188.5	45.0	18.0	11.2	4.2	4.8	15.2	814.8
30	51G7	0.0	18.1	224.1	100.6	54.5	29.5	12.8	14.8	50.4	504.9
30	51G8	0.0	105.8	878.7	398.5	225.8	132.4	57.8	63.3	147.7	2010.2
30	51G9	0.0	80.8	680.2	285.7	147.6	74.9	32.4	32.9	64.5	1398.8
30	51H0	73.9	156.7	241.4	72.6	30.5	16.9	7.2	6.9	19.2	625.2
30	52G7	1.9	7.7	111.3	68.8	53.2	38.0	22.3	30.0	127.2	460.5
30	52G8	0.0	52.7	547.2	307.8	203.9	122.9	59.1	65.3	214.2	1573.1
30	52G9	1.5	16.9	129.2	66.8	45.5	29.3	14.7	16.8	47.6	368.4
30	52H0	2.8	37.3	291.2	151.3	103.5	67.0	33.8	38.6	109.4	834.8
30	53G8	3.4	64.2	512.4	276.9	183.5	112.8	55.0	61.1	176.1	1445.4
30	53G9	0.0	8.6	191.9	130.0	105.6	73.4	38.2	42.4	105.1	695.2
30	53H0	20.7	70.6	439.8	231.1	158.1	104.1	52.5	64.4	192.5	1333.8
30	53H1	3.1	18.3	82.9	39.8	25.0	15.9	7.7	9.2	26.9	228.7
30	54G8	0.0	4.1	122.6	105.6	101.5	82.7	46.2	60.3	230.1	753.0
30	54G9	7.5	41.7	200.1	97.8	65.8	44.4	23.0	29.2	95.0	604.4
30	54H0	36.1	11.7	360.6	278.5	246.9	180.8	96.3	114.8	354.7	1680.2
30	55G9	3.3	143.6	191.6	54.2	22.6	13.0	5.6	5.8	12.0	451.6
30	55H0	4.6	100.8	332.0	133.4	73.7	43.1	20.2	22.7	64.4	794.8

Table 8.Mean weight (g) of herring by age and area (r/v Aranda 2016).

SD	Rect.	0	1	2	3	4	5	6	7	8+
29	48G9	4.1	8.0	13.4	18.4	21.6	22.1	21.9	21.7	21.1
29	48H0	3.9	14.3	17.1	20.5	23.4	23.9	24.5	25.1	24.6
29	48H1	3.9	13.4	15.7	19.6	22.9	24.0	23.4	25.0	23.3
29	48H2	3.7	12.2	14.3	19.4	29.8	23.2	24.1	22.7	25.0
32	48H3	3.6	11.4	13.5	17.1	20.7	20.8	19.1	21.8	23.4
32	48H4	2.8	11.7	14.3	17.4	20.6	21.2	18.3	22.7	23.0
32	48H5	2.8	12.5	14.6	19.2	20.7	20.6	19.3	21.8	23.3
29	49G9	3.4	12.5	16.8	19.9	23.2	23.6	24.3	24.4	31.5
32	49H5	4.2	12.2	14.2	17.6	21.4	20.7	19.0	22.1	41.7
32	49H6	4.1	12.9	15.1	17.8	20.6	21.0	19.5	22.4	23.3
30	50G7	5.2	15.9	20.6	22.5	24.2	23.9	26.3	30.6	37.7
30	50G8	12.2	15.6	19.9	22.3	25.7	27.3	30.2	33.5	37.2
30	50G9	4.8	15.7	20.3	22.8	26.1	28.2	31.5	35.4	42.1
30	50H0	4.8	15.2	19.0	22.0	26.0	28.3	32.8	38.3	43.6
30	51G7	0.0	18.4	23.1	25.1	27.4	30.4	33.3	37.9	47.3
30	51G8	0.0	17.7	22.9	25.2	28.0	30.7	33.0	36.1	39.3
30	51G9	0.0	17.8	22.6	24.7	27.3	29.8	31.5	33.7	36.3
30	51H0	4.5	15.9	20.5	23.0	26.6	28.9	32.3	36.3	40.8
30	52G7	6.6	18.1	23.9	26.9	30.3	34.5	37.8	41.2	49.1
30	52G8	0.0	17.6	23.7	26.3	29.0	31.8	34.5	37.7	45.5
30	52G9	4.9	17.5	23.2	26.1	29.4	32.3	34.8	37.4	43.1
30	52H0	5.0	17.5	23.3	26.1	29.5	32.3	34.8	37.4	43.1
30	53G8	4.9	17.0	23.5	26.2	29.0	31.8	34.3	37.6	44.6
30	53G9	0.0	19.3	24.3	27.3	30.4	32.9	34.7	37.0	40.4
30	53H0	4.6	17.2	23.1	26.1	29.4	32.7	35.1	38.6	44.3
30	53H1	3.7	17.0	22.6	25.7	28.8	32.0	34.7	38.8	44.3
30	54G8	0.0	19.2	25.2	28.4	31.5	34.3	36.6	40.4	48.9
30	54G9	4.9	17.0	22.8	25.9	29.4	32.8	35.9	39.4	45.8
30	54H0	3.6	19.1	25.0	27.9	30.9	33.6	35.5	38.1	44.6
30	55G9	5.5	15.9	20.2	22.8	26.7	29.0	31.7	35.0	37.2
30	55H0	4.7	16.5	22.1	24.8	28.0	30.8	33.9	37.1	44.0

Table 9.Total biomass (ton) of herring by age and area (r/v Aranda 2016).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Total
29	48G9	6520.9	6859.2	11970.8	1085.1	225.0	78.5	159.8	141.3	123.3	27163.9
29	48H0	29.5	5165.8	26101.0	8346.2	5136.6	1752.3	3688.3	3038.8	3201.1	56479.6
29	48H1	206.0	11820.5	36084.0	6263.2	2943.2	1043.6	1789.2	1660.0	1709.5	63519.3
29	48H2	330.7	18826.1	35154.3	3701.3	2510.2	421.7	985.4	578.6	1048.0	63556.2
32	48H3	268.2	2271.5	8944.2	1228.4	425.9	214.4	240.3	96.3	275.0	13964.3
32	48H4	87.8	1385.4	6636.7	1386.1	593.6	287.9	228.4	221.2	350.4	11177.6
32	48H5	366.5	8005.5	42792.5	12654.6	5137.3	2238.7	1899.2	1196.5	2725.6	77016.3
29	49G9	459.9	2964.8	14144.9	3879.7	2018.2	644.7	1423.9	1122.2	2400.9	29059.0
32	49H5	24.2	2317.7	11250.8	2497.8	1155.5	490.8	397.0	286.3	1112.9	19533.0
32	49H6	174.0	4059.6	23833.1	7492.8	3221.6	1528.8	1351.6	920.7	1928.2	44510.3
30	50G7	38.4	4674.0	9288.8	2861.5	1097.3	488.3	137.6	114.3	427.9	19128.1
30	50G8	17.0	8736.0	11840.5	3600.7	1533.4	806.9	357.6	375.0	928.1	28195.2
30	50G9	399.0	3222.4	5031.7	1651.1	769.6	450.9	196.6	218.9	734.7	12674.8
30	50H0	1117.7	4521.0	3573.1	988.6	467.3	318.1	137.7	183.4	661.8	11968.7
30	51G7	0.0	332.8	5169.2	2521.6	1493.0	895.5	425.2	561.6	2381.3	13780.2
30	51G8	0.0	1869.2	20122.6	10028.2	6327.0	4067.2	1905.5	2289.2	5808.3	52417.2
30	51G9	0.0	1440.7	15385.8	7050.6	4035.7	2229.5	1019.4	1106.8	2340.8	34609.3
30	51H0	331.3	2496.6	4952.6	1672.5	810.8	487.4	231.8	251.5	783.0	12017.5
30	52G7	12.3	140.4	2662.7	1852.7	1613.5	1313.1	845.0	1235.6	6250.4	15925.7
30	52G8	0.0	926.7	12973.3	8080.6	5902.7	3911.5	2039.3	2462.4	9735.1	46031.8
30	52G9	7.6	295.1	3003.1	1741.7	1337.1	946.8	513.2	628.0	2051.2	10523.8
30	52H0	14.0	653.4	6772.2	3947.4	3048.5	2166.1	1177.1	1441.3	4716.1	23936.1
30	53G8	16.3	1088.7	12020.3	7240.6	5327.0	3588.4	1887.5	2295.4	7850.0	41314.3
30	53G9	0.0	166.7	4662.7	3553.0	3212.1	2414.1	1326.1	1567.9	4248.0	21150.8
30	53H0	94.5	1217.0	10171.4	6042.4	4646.6	3404.6	1845.0	2482.5	8534.0	38437.9
30	53H1	11.6	310.3	1874.0	1024.0	719.7	508.7	265.7	355.5	1192.0	6261.6
30	54G8	0.0	78.5	3086.2	3004.6	3192.0	2833.2	1689.7	2439.1	11248.7	27572.0
30	54G9	36.6	711.1	4560.5	2533.7	1932.7	1456.9	826.1	1147.3	4350.2	17555.1
30	54H0	131.2	223.3	9006.5	7755.7	7618.3	6074.3	3419.1	4372.6	15823.5	54424.6
30	55G9	18.4	2284.5	3865.8	1235.4	602.8	376.1	176.2	202.1	447.5	9208.8
30	55H0	21.6	1664.4	7323.8	3308.1	2065.0	1325.6	685.4	841.6	2832.7	20068.3

Table 10.Numbers (millions) of sprat by age and area (r/v Aranda 2016).

SD	Rect	0	1	2	3	4	5	6	7	8+	Total
29	48G9	34.1	176.9	1309.0	163.9	33.9	14.8	7.7	5.2	7.6	1753.1
29	48H0	16.0	35.2	161.0	26.1	15.2	9.2	4.5	2.9	4.2	274.4
29	48H1	33.0	130.6	952.3	202.9	98.9	59.9	27.1	15.2	24.7	1544.6
29	48H2	384.7	405.5	2055.8	359.9	189.6	92.2	30.8	13.2	28.5	3560.3
32	48H3	252.0	2828.9	8533.4	1260.9	382.2	150.8	65.3	27.2	29.6	13530.3
32	48H4	95.3	3647.5	8583.4	885.9	111.5	17.8	3.0	1.5	3.0	13348.8
32	48H5	108.2	866.6	2441.9	407.6	133.7	60.0	23.7	8.9	10.2	4060.8
29	49G9	4.8	35.0	161.1	36.2	22.4	12.9	5.7	2.9	6.0	287.0
32	49H5	2.9	53.1	157.0	38.4	24.8	16.3	6.6	3.8	2.6	305.5
32	49H6	16.8	424.4	987.4	112.4	18.3	6.8	4.3	0.9	1.8	1573.1
30	50G7	0.0	0.1	4.5	3.2	1.6	0.6	0.3	0.6	0.7	11.5
30	50G8	0.0	1.0	10.8	2.9	1.1	0.4	0.2	0.4	0.4	17.2
30	50G9	0.5	0.6	20.2	11.7	5.9	2.9	1.5	3.0	4.9	51.3
30	50H0	0.0	0.3	15.5	8.2	3.4	1.5	0.5	1.3	1.2	31.8
30	51G7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	51G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	51G9	0.0	0.0	0.5	0.4	0.3	0.2	0.2	0.3	1.2	3.1
30	51H0	0.0	0.0	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.9
30	52G7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	52G8	0.0	0.0	1.3	1.2	0.9	0.6	0.4	0.4	0.9	5.7
30	52G9	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.6
30	52H0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.7
30	53G8	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.3
30	53G9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	53H0	0.0	0.0	0.8	1.2	1.3	0.9	0.8	1.2	3.9	10.1
30	53H1	0.0	0.0	0.1	0.3	0.4	0.2	0.2	0.4	1.2	2.8
30	54G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	54G9	0.0	0.0	0.4	0.3	0.3	0.2	0.2	0.2	0.6	2.1
30	54H0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5
30	55G9	0.0	0.1	6.3	6.4	4.6	2.6	1.8	2.7	6.7	31.2
30	55H0	0.0	0.0	1.8	1.7	1.1	0.7	0.5	0.6	1.2	7.6

Table 11.Mean weight (g) of sprat by age and area (r/v Adanda 2016).

SD	Rect.	0	1	2	3	4	5	6	7	8+
29	48G9	3.0	7.0	7.9	8.6	10.1	10.5	11.6	12.1	11.5
29	48H0	2.6	6.6	7.6	9.2	10.5	10.6	11.2	11.5	11.1
29	48H1	3.1	6.8	8.0	9.2	10.3	10.4	11.2	11.5	10.9
29	48H2	2.5	6.4	7.7	9.1	10.3	10.3	10.7	11.1	10.6
32	48H3	2.5	6.4	6.8	7.4	8.5	9.6	9.0	9.8	9.4
32	48H4	2.4	6.2	6.5	6.8	7.5	8.7	9.3	9.3	9.3
32	48H5	2.7	6.5	6.9	7.6	8.6	9.3	8.8	9.7	9.3
29	49G9	3.0	6.6	7.7	9.4	10.4	10.4	11.0	11.3	11.5
32	49H5	2.6	6.6	7.0	8.2	9.5	9.9	9.6	10.1	9.8
32	49H6	2.5	6.2	6.5	7.0	8.1	9.1	8.8	9.3	9.3
30	50G7	0.0	8.3	11.0	11.8	12.2	12.5	13.8	13.0	15.1
30	50G8	0.0	7.8	9.0	10.4	11.6	12.8	14.0	12.9	14.2
30	50G9	3.8	6.8	10.6	11.7	12.6	13.1	14.2	13.8	15.4
30	50H0	0.0	8.6	10.4	11.3	12.1	12.2	13.6	12.7	14.5
30	51G7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	51G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	51G9	0.0	0.0	12.0	12.4	13.1	14.2	15.8	15.0	16.9
30	51H0	0.0	0.0	12.7	13.0	13.5	13.9	14.1	13.7	14.4
30	52G7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	52G8	0.0	0.0	11.8	12.2	12.9	14.1	14.6	13.7	14.7
30	52G9	0.0	0.0	12.4	12.9	13.8	14.3	14.7	14.8	15.2
30	52H0	0.0	0.0	12.7	13.2	14.2	14.6	14.9	15.2	15.3
30	53G8	0.0	0.0	13.5	13.5	13.5	13.5	13.5	13.5	13.5
30	53G9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	53H0	0.0	0.0	12.1	12.9	14.2	14.4	15.0	15.1	16.2
30	53H1	0.0	0.0	12.2	13.3	14.6	14.6	15.1	15.3	16.3
30	54G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	54G9	0.0	0.0	11.5	12.2	13.8	14.2	15.0	14.7	15.9
30	54H0	0.0	0.0	0.0	16.1	16.1	16.1	16.1	16.1	16.1
30	55G9	0.0	6.4	11.7	12.4	13.2	13.7	14.5	14.2	15.8
30	55H0	0.0	0.0	11.6	12.2	12.9	13.8	14.4	13.9	14.8

Table 12.Total biomass (ton) of sprat by age and area (r/v Aranda 2016).

SD	Rect.	0	1	2	3	4	5	6	7	8+	Total
29	48G9	101.0	1229.5	10351.4	1403.0	341.2	155.3	88.8	63.3	87.0	13820.5
29	48H0	41.8	232.8	1224.8	240.2	159.7	97.4	50.7	32.9	46.7	2126.9
29	48H1	101.7	883.1	7665.7	1870.4	1022.9	622.5	303.7	174.3	269.8	12914.1
29	48H2	947.9	2593.3	15911.4	3283.8	1946.8	950.1	329.4	146.8	302.0	26411.6
32	48H3	624.5	18163.1	57890.5	9373.8	3238.4	1442.9	590.0	266.2	278.0	91867.4
32	48H4	225.6	22760.7	55777.3	5997.8	838.5	155.2	27.7	13.8	27.7	85824.3
32	48H5	297.5	5658.4	16764.2	3108.9	1150.4	560.9	208.9	86.9	94.3	27930.3
29	49G9	14.8	229.7	1244.3	340.1	231.8	134.4	62.6	32.7	69.4	2359.7
32	49H5	7.5	352.3	1101.3	316.3	234.8	160.7	63.9	38.5	25.9	2301.2
32	49H6	42.5	2639.6	6399.8	791.4	149.1	62.6	37.4	8.1	16.3	10146.8
30	50G7	0.0	0.5	49.9	37.7	19.1	8.0	3.8	8.2	10.2	137.4
30	50G8	0.0	8.1	96.6	30.0	12.7	5.4	2.9	4.7	6.1	166.5
30	50G9	1.9	4.1	214.6	137.5	73.9	37.6	21.7	41.3	75.8	608.5
30	50H0	0.0	2.9	161.4	92.5	40.5	18.6	7.2	16.3	16.9	356.4
30	51G7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	51G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	51G9	0.0	0.0	5.4	5.4	3.9	3.3	3.3	3.8	19.8	45.0
30	51H0	0.0	0.0	1.5	2.7	2.1	1.7	1.1	1.2	2.5	12.8
30	52G7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	52G8	0.0	0.0	15.8	14.4	12.0	8.1	5.5	5.2	13.4	74.5
30	52G9	0.0	0.0	0.8	1.2	1.1	1.1	0.8	1.0	2.7	8.6
30	52H0	0.0	0.0	0.6	0.9	1.1	1.4	1.1	1.2	3.6	9.8
30	53G8	0.0	0.0	0.1	1.1	1.1	0.4	0.5	0.8	0.8	4.7
30	53G9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	53H0	0.0	0.0	10.1	15.5	18.8	13.4	12.2	17.4	62.4	149.7
30	53H1	0.0	0.0	1.4	3.4	5.1	3.6	3.6	5.5	20.2	42.8
30	54G8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	54G9	0.0	0.0	4.3	3.8	3.6	3.4	2.5	2.4	10.0	30.0
30	54H0	0.0	0.0	0.0	0.2	0.2	0.4	0.6	1.7	4.2	7.2
30	55G9	0.0	0.7	73.6	80.1	60.3	35.6	26.2	38.8	105.1	420.5
30	55H0	0.0	0.0	21.5	20.9	14.8	9.7	6.5	8.4	17.5	99.3

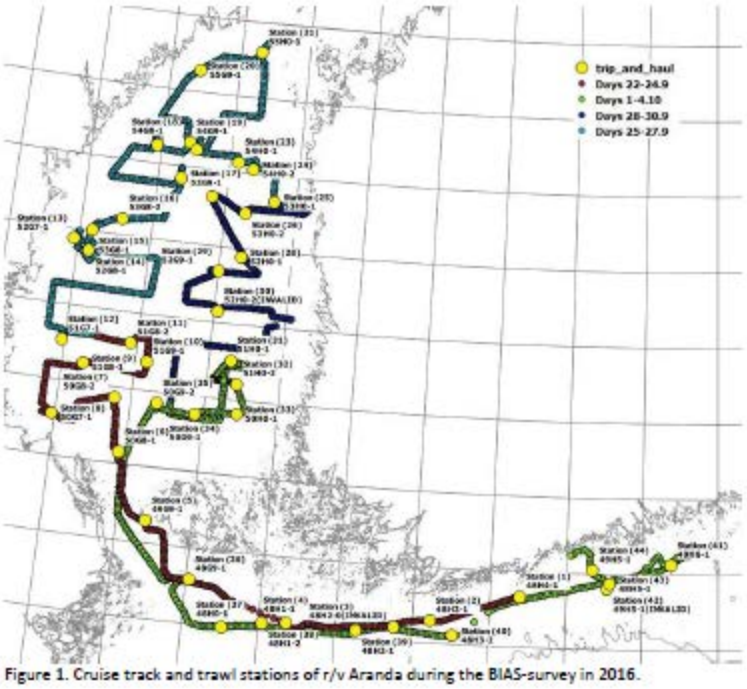

Figure 1. Cruise track and trawl stations of r/v Aranda during the BIAS-survey in 2016.

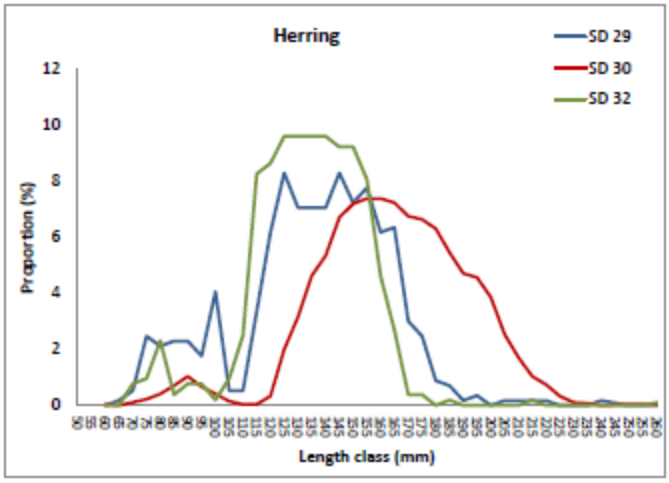

Figure 2. Length distributions of measured herring in three different Sub-Division.

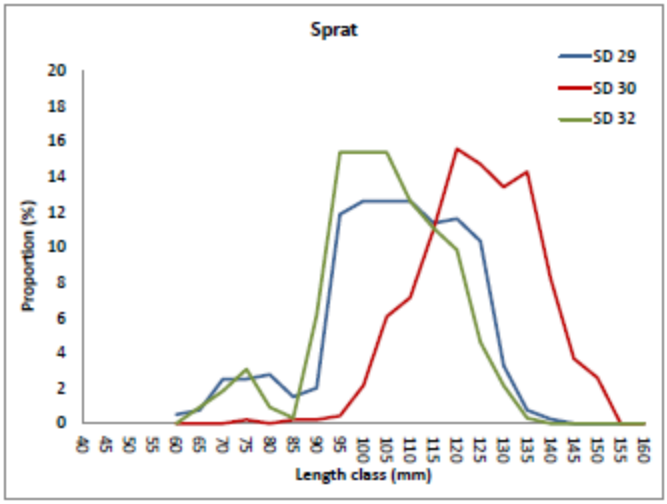

Figure 3. Length distributions of measured sprat in three different Sub-Division.

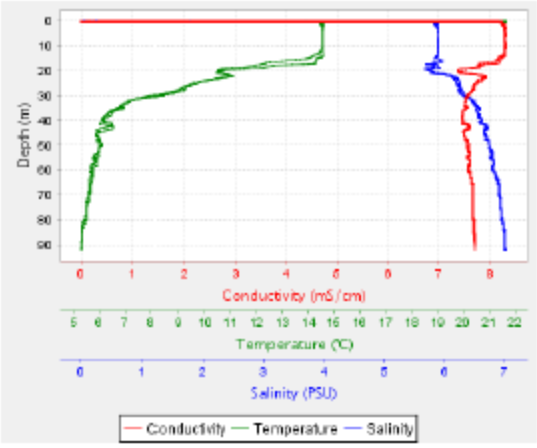

Figure 5. Vertical distribution of the connectivity, water temperature, and salinity at the trawling station 49G9-1 in SD 29.

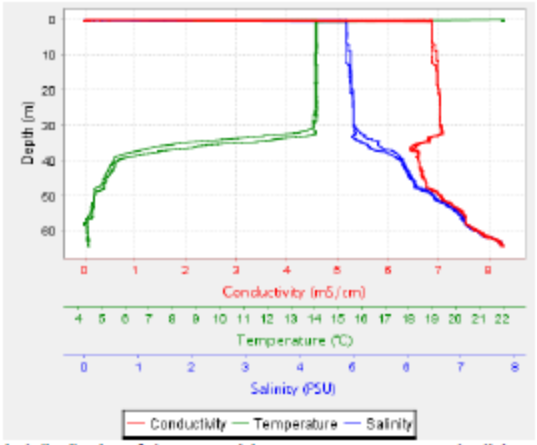

Figure 6. Vertical distribution of the connectivity, water temperature, and salinity at the trawling station 49H6-1 in SD 32.

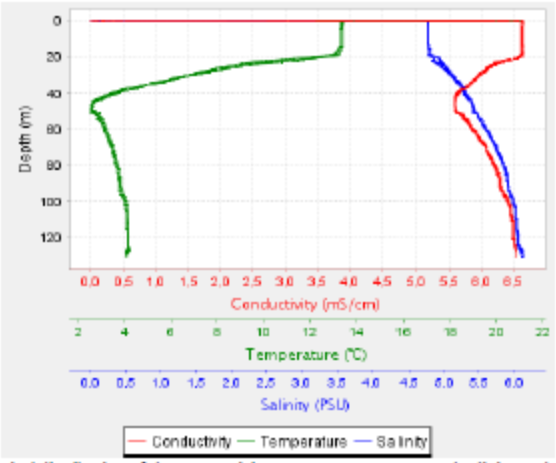

Figure 7. Vertical distribution of the connectivity, water temperature, and salinity at the trawling station 54G9-1 in SD 30.

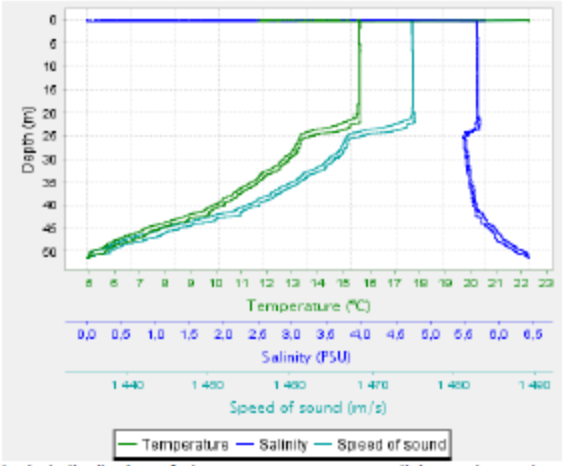

Figure 8. Vertical distribution of the water temperature, salinity, and sound speed at the calibration station of echo sounder in SD 32 (EK60 38 kHz).

Survey report for FRV "Solea"

German Acoustic Autumn Survey (GERAS)
30 September – 20 October 2016

Matthias Schaber [1] & Tomas Gröhsler [2]
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1 INTRODUCTION

Background: The joint German/Danish GERAS survey is part of the Baltic International Acoustic Survey (BIAS), which is co-ordinated by the Baltic International Fish Survey Working Group (WGBIFS) and is conducted within the scope of the ICES Working Group for International Pelagic Surveys (WGIPS). Further WGBIFS contributors to the Baltic survey are national fisheries research institutes of Sweden, Poland, Finland, Latvia, Estonia, Lithuania and Russia. FRV "Solea" participated for the 29th time. The survey area covered the western Baltic Sea including Kattegat, Belt Sea, Sound and Arkona Sea (ICES Subdivisions 21, 22, 23 and 24). The survey effort was comparable to former years.

Objectives: The survey has the main objective to annually assess the clupeoid resources of herring and sprat in the Baltic Sea in autumn. The reported acoustic survey 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 and sprat in the Western Baltic area (Kattegat/Subdivisions 21 and Subdivisions 22, 23 and 24).

2 SURVEY DESCRIPTION & METHODS

2.1 Personnel

Name	Function	Institute
30.09.-01.10.2016/Calibration of hydroacoustic equipment		
Dr. M. Schaber	Hydroacoustics, Cruise leader	TI-SF
M. Drenckow	Hydroacoustics	TI-SF
S.-E. Levinsky	Fishery biology	DTU Aqua, Charlottenlund, (DK)
B. Stefanowitsch	Student assistant	TI-SF
S. Wieser	Student assistant	TI-SF
01.-20.10.2016/Survey		
Dr. M. Schaber	Hydroacoustics, Cruise leader	TI-SF
Dr. T. Gröhsler	Hydroacoustics, Cruise leader	TI-OF (01.-08.10.)
A. Bühler	Fishery biology, Student assistant	TI-OF (09.-20.10.)
M. Koth	Fishery biology	TI-OF (01.-09.10.)
S.-E. Levinsky	Fishery biology	DTU Aqua, Charlottenlund, (DK)
B. Stefanowitsch	Student assistant	TI-SF
S. Wieser	Student assistant	TI-SF

2.2 Narrative

The 726th cruise of FRV "SOLEA" represents the 30th subsequent GERAS survey. FRV "SOLEA" left the port of Kiel harbor on 30 September 2016. The acoustic survey covered the southern part of Subdivision (SD) 21 and the whole area of SD 22, 23 and 24. The northern part of SD 21 could not be covered because of a loss of survey time due to unfavorable weather conditions. Due to varying weather conditions in the survey area the following survey schedule was accomplished:

- Arkona Sea (SD 24) 01. - 03.10.
- Belt Sea (SD 22) 03. - 07.10.
- Arkona Sea (SD 24) 09. -10.10.
- Sound (SD 23) 10. -11.10.
- Kattegat (SD 21) 11. - 13.10.
- Arkona Sea (SD 24) 16. - 17.10.
- Sound (SD 23) 18. - 19.10.

The survey ended on 20 October 2016 in Rostock/Marienehe.

2.3 Survey design

ICES statistical rectangles were used as strata for all Subdivisions (ICES, 2014). The area was limited by the 10 m depth line. The survey area in the Western Baltic Sea is characterised 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 regular cruise track length was 1 179 nmi covering a survey area of 12 400 nmi^2 (Figure 1).

2.4 Calibration

Both transducers (38 kHz and 120 kHz) were calibrated prior to the beginning of the survey in initially inclement but increasingly improving weather conditions from a drifting vessel in Strande Bay/Kiel Bight. Overall calibration results were considered good based on calculated RMS values. Resulting transducer parameters were applied for consecutive data-collection and post-processing of hydroacoustic survey data.
The calibration procedure was carried out as described in the "Manual for the Baltic International Acoustic Surveys (BIAS)" (ICES, 2014). Calibration results for the 38 kHz transducer are given in Table 1.

2.5 Acoustic data collection

All acoustic investigations were performed during night time to account for the more pelagic distribution of clupeids during that time. The main pelagic species of interest were herring and sprat. The acoustic equipment used was a Simrad scientific echosounder EK80 operated in continuous wave mode at 38 kHz (120 kHz). Specific settings of the hydroacoustic equipment were used as described in the "Manual for the Baltic International Acoustic Survey (BIAS)" (ICES, 2014). Corresponding settings are listed in Table 1. Echo-integration, i.e. the integration and allocation of NASC values to species abundance and biomass was accomplished using EchoView 7 post-processing software Echoview Software Pty Ltd (2016). Mean volume back scattering values (s_v) were integrated over 1 nmi intervals from 10 m below the surface (or depending on surface turbulence) to ca. 0.5 m over the seafloor. Interferences from surface turbulence, bottom structures and scattering layers were removed from the echogram.

2.6 Biological data – fishing trawls

Trawl hauls were conducted with a pelagic gear "PSN388" in midwater layers as well as near the seafloor. Mesh size in the codend was 10 mm. It was planned to carry out at least two hauls per ICES statistical rectangle. Both trawling depth and net opening were continuously controlled by a netsonde during fishing operations. Trawl depth was chosen in accordance with echo distributions on the

echogram. Normally, a vertical net opening of about 7-9 m was achieved. The trawling time usually lasted 30 minutes but was shortened when echograms and netsounder indicated large catches. From each haul sub-samples were taken to determine length and weight of fish. Samples of herring and sprat were frozen for additional investigations (e.g. determining sex, maturity, age).

2.7 Hydrographic data

Hydrographic conditions were measured after each trawl haul and in regular distances on the survey transect. On each corresponding station, vertical profiles of temperature, salinity and oxygen concentration were measured using a "Seabird SBE 19 plus" CTD. Water samples for calibration purposes (salinity) were taken on every station, while water samples for Winkler titration and calibration of oxygen measurements were taken and processed at least once per day. Altogether, 81 CTD-profiles were measured (Fig. 5).

2.8 Data analysis

The pelagic target species sprat and herring are often distributed in mixed layers together with other species. Thus, echorecordings cannot be allocated to a single species. Therefore the species composition allocated to echorecordings was based on corresponding trawl catch results. For each rectangle species composition and length distributions were determined as the unweighted mean of all trawl results in this rectangle. From these distributions the mean acoustic cross section σ was calculated according to the following target strength-length (TS) relation:

	TS	**References**
Clupeoids	= 20 log L (cm) - 71.2	ICES 1983
Gadoids	= 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 (s_A) and the rectangle area, divided by the corresponding mean cross section. The total number was separated into herring and sprat according to the mean catch composition.
In accordance with the guidelines in the "Manual for the Baltic International Acoustic Surveys (BIAS)" (ICES, 2014) further calculations were performed as follows:

Fish species considered:

Clupea harengus
Engraulis encrasicolus
Gadus morhua
Gasterosteus aculeatus
Melanogrammus aeglefinus
Merlangius merlangus
Pollachuis pollachius
Pollachius virens
Sprattus sprattus
Trisopterus esmarkii

Exclusion of trawl hauls with very low catch level:

Haul No.	Rectangle	Subdivision (SD)
19, 22	40G0	22
32	41G2	23
52	39G2	24
53	40G2	23

Despite low catch levels of both herring and sprat the following hauls were not excluded from the analysis as they were the only trawl hauls conducted in the corresponding rectangles and thus provided the only available information on species composition in these rectangles:

Haul No.	Rectangle	Subdivision (SD)
20	41G0	22
42	41G0	21

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

Rectangle/SD to be filled	with Haul No.	of Rectangle/SD
40F9/22	18	40G0/22
39G2/23	45	39G2/24
37G4/24	5, 8	38G4/24

3 RESULTS

3.1 Acoustic data

Statistics on survey area, mean S_A (NASC), mean scattering cross section σ, estimated total number of fish, as well as proportion of herring and sprat per SD/rectangle are shown in Table 6.

During the survey, hydroacoustic data were recorded at a standard ship speed of 10 kn leading to daily transect lengths of roughly 90 to 100 nmi. Figure 2 depicts the spatial distribution of mean NASC values (5 nmi intervals) measured on the hydroacoustic transects covered in 2016. In almost all rectangles surveyed, mean NASC values were significantly higher than those recorded in 2015, often also higher than those recorded in 2014, and –in SD24- also above the long-time survey average. On ICES subdivision scale, mean NASC values were higher than in the previous year in SD 21, 22 and 24 while in SD 23 mean NASC values were significantly lower than in preceding years.

In SD 21, overall NASC values measured were comparatively low, but mean NASC per 1 nmi EDSU was – occasionally significantly- higher in almost all rectangles observed than in the previous year, but mostly lower than the long-time survey average in all rectangles surveyed. Rectangles with increased aggregations of clupeids (43G1 and 43G2) in the northern part could not be covered due to adverse weather conditions. Increased aggregations were instead measured in the southwestern part of SD 21.

In SD 22, mean NASC values recorded were higher than the previous year in all but one rectangles surveyed. In comparison to the long-term survey mean of rectangles in SD 22, the NASC measured was lower in the majority of rectangles. No clear aggregations of clupeids were measured, but overall NASC values were increased compared to previous years almost along the whole survey transect covered. However, in the short transect section covering rectangle 40G1, NASC values were many times higher than the values observed in the years before and also than the long-term survey mean.

The large aggregations of big herring that can be observed annually in SD 23 in the Öre Sound were not present in autumn 2016. NASC values in rectangle 40G2 covering the aggregation hotspot in this area were significantly lower than the high levels measured in 2015 (only 13% of the measured values in 2015) and also only ca. 40% of the long-time survey average. Measurements were made in inclement weather conditions with strong currents in the Sound. A replicate measurement of the transect in SD 23 in good weather conditions a few days later corroborated these findings.

3.2 Biological data

In total 55 trawl hauls were conducted:

Subdivision	No. of Hauls
21	12
22	17
23	6
24	20

Altogether, 1 501 individual herring, 749 sprat, 535 European anchovies and 42 sardines were frozen for further investigations (e.g. determining sex, maturity, age). Results of catch compositions by Subdivision are presented in Tables 2-5. Altogether, 49 different species were recorded. Herring were caught in 52, sprat in 51 hauls. SD 23, which is typically characterized by the highest mean catch rates per station (kg 0.5 h^{-1}), showed the lowest values ever recorded. In contrast to the last year where sardines (*Sardina pilchardus*) were not caught at all, this species did appear in 2016 catches in SDs 22-24. As in previous years, anchovy (*Engraulis encrasicolus*) were present in most catches. Anchovies were caught throughout the survey area in 41 out of 55 hauls, including the majority of hauls in SD 21 and SD 22.

Figures 3 and 4 show relative length-frequency distributions of herring and sprat in ICES subdivisions 21, 22, 23 and 24 for the years 2015 and 2016. Compared to results from the previous survey in 2015, the following conclusions for herring can be drawn (Fig. 3):

- As in 2015, catches in SD 21 showed a bimodal distribution characterized by the presence of the incoming year class (≤15 cm) and older herring (>15 cm). In contrast to 2015, the fraction of the incoming year class was higher in 2016.
- SD 22 showed the incoming year class with a mode at 9.75 cm while in 2015 this mode had been observed at 10.75 cm. A rather low fraction of older fishes showed in both years another comparable mode (17.25 cm in 2016 and at 16.75 cm in 2015).
- In SD 23, smaller herring (< 20 cm) dominated catches. This was in contrast to the dominant contribution of larger herring (>20 cm) in previous years.
- In SD 24, the herring length-frequency distribution was characterized by a similar contribution of the incoming year class (≤15.00 cm) and older herring (>15 cm) in both years.
- Altogether, the present contribution of the incoming year class (ca. <15 cm) seemed to be quite similar in the last two years.

Relative length-frequency distributions of **sprat** in the years 2015 and 2016 (Fig. 4) can be characterized as follows:

- In SD 21 catch numbers of the incoming year class (≤10 cm) were virtually absent in both years. The catches were dominated by the contribution of larger sprat (ca. >10 cm).
- In SD 22 and 23 catch numbers of the incoming year class (≤10 cm) dominated in 2016, whereas they were almost virtually absent in 2015. The dominant high contribution of larger sprat (ca. >10 cm) in 2015 disappeared in 2016.
- In SD 24, the sprat length-frequency distribution was rather similar compared to 2015 with a bimodal distribution of both incoming year class (< 10 cm) and older sprat.
- Altogether, the present contribution of the incoming year class (ca. <10 cm) increased compared to last year's very low value.

3.3 Biomass and abundance estimates

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 based on baseline samples of WBSSH and CBH in 2011-2015 and in 2016 support the applicability of SF (Oeberst et al., 2013, WD Oeberst et al., 2014; WD Oeberst et al., 2015; WD Oeberst et al., 2016; WD Oeberst et al., 2017). Beside in SD 24, the SF was finally also applied to ICES rectangle 39G2 (SD 23 area) since biological samples of 39G2 (SD 24 area) were used to raise the corresponding recorded Sa values.
The age-length distribution of herring in SD 22 in 2015 for the second time indicated a higher contribution of older fish of CBH origin. Thus, the SF was also applied in SD 22.
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 now excludes CBH in 2005-2016 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.

3.3.1 Estimates incl. Central Baltic herring (CBH)

The total abundance of herring and sprat is presented in Table 6. Estimated numbers of herring and sprat by age group and SD/rectangle are given in Table 7 and Table 10. Corresponding mean weights by age group and SD/rectangle are shown in Table 8 and Table 11. Estimates of herring and sprat biomass by age group and SD/rectangle are summarised in Table 9 and Table 12.
The **herring** stock in Subdivisions 21-24 was estimated to be 4.9 x 10^9 fish (Table 7) or 139.1 x 10^3 tonnes (Table 9). For the included area of Subdivisions 22-24 the number of herring was calculated to be 4.3 x 10^9 fish or 129.1 x 10^3 tonnes. Last year's higher contribution of age 2, was now recorded at age 3 (Figure 3 and Table 7).
The estimated **sprat** stock in Subdivisions 21-24 was 26.6 x 10^9 fish (Table 10) or 195.1 x 10^3 tonnes (Table 12). For the included area of Subdivisions 22-24 the number of sprat was calculated to be 22.9 x 10^9 fish or 175.1 x 10^3 tonnes. As in 2015, the overall abundance estimate was dominated by the incoming year class (Figure 4 and Table 10).

3.3.2 Estimates excl. Central Baltic herring in SDs 22&24

Estimated numbers of **herring excluding CBH** in SDs 22-24 by age group and SD/rectangle for 2016 are given in Table 13. Corresponding herring mean weights by age group and SD/rectangle are shown in Table 14. Estimates of herring biomass excluding CBH by age group and SD/rectangle are summarised in Table 15. Removal of the CBH fraction in SDs 22 and 24 from herring GERAS index in 2016 resulted in biomass reductions of 29.4 % with corresponding reductions in numbers of 18.7 % (-35.7 % and -25.6 %, respectively in 2015; Figure 5).

3.4 Hydrographic data

In addition to the trawl hauls, vertical profiles of temperature, salinity and oxygen concentration were measured on a station grid covering the whole survey area. Altogether, hydrography profiles were measured on 81 stations. CTD stations as well as horizontal gradients of temperature, salinity and oxygen concentration both at the surface and at the seafloor are displayed in Figure 6.
Surface temperatures ranged from ca. 12°C in the Kattegat, Sound and northern Arkona Sea to almost 18°C in the southern Arkona Sea and the Kiel Bight. Bottom temperatures were also comparatively and similarly high in the southern part of the survey area but decreased to less than 8 °C in the deep parts of the southeastern Arkona Sea/western Bornholm Basin.
Surface salinities showed a large gradient from ca. 7 PSU in the eastern Arkona Sea to ca. 16 PSU in the Kiel Bight and over 20 PSU in the Kattegat. Salinity near the seafloor ranged from 8 PSU in the Arkona Sea to ca. 33 PSU in the Kattegat. Especially in the Sound, a very strong stratification with steep salinity gradients was observed.
Surface waters were well oxygenated throughout the survey area, while especially in the northern parts of the Sound as well as in the inner, southeastern Mecklenburg Bight and the norther Kiel Bight

as well as in eastern parts of the Kattegat low levels, as well as in comparatively large areas anoxic conditions were observed.

4 DISCUSSION

Compared to 2015, the present estimates of **herring (incl. CBH)** show an increase in stock numbers, whereas stock biomass notably decreases:

Herring	Difference compared to 2015	
Area	Numbers (%)	Biomass (%)
Subdivisions 22-24	15	-40
Subdivisions 21-24	33	-42

The significant increase in numbers in 2016 was mainly caused by some higher numbers of the incoming year class, whereas the decrease in biomass was mainly driven by lower biomass estimates of age groups 1+ in SD 23. However, the strength of the new incoming year class in 2016, which is even assumed not to deliver an quantitative adequate index of the 0-group due to the survey design (mesh size of the gear in the codend; not covering possible inshore shallow water areas), was still far below the long-term average (2016: 2.7×10^9 million; average 1994-2015: 4.4×10^6 million).

Only very few older and bigger herring were recorded in SD 23 and SD 24 in 2016. The application of SF and the exclusion of CBH (Gröhsler et al., 2013; Gröhsler et al., 2016) in turn lead to the further decrease of older and bigger herring in 2016.

The large herring usually observed and dominant in SD 23 (the Sound), which is seen as an important transition and aggregation area for the WBSSH stock during its spawning migration (Nielsen, 1996), were in 2016 virtually absent for the first time in many years. This complete absence could be explained by delayed immigration of WBSSH from the feeding areas in the Skagerrak in 2016 (however, no large herring were observed there). The exceptionally low numbers of large and older herring could also be explained by the very low recruitment, which was recorded by the N20 during the last years. The sustained downward trend in recruitment could explain the disappearance of older herring in time. A strong correlation of N20 with the 1-age group (Annex: RHLS-Report) of GERAS supports this assumption.

As in the year before, some few older and bigger herring were detected in SD 24. However, exclusion of CBH in SD 24 led to almost elimination of older and bigger herring in this area. This was in contrast to the 2015 results, where some older and bigger herring already had started to migrate out of the Sound (SD 23) into SD 24.

In SDs 21 and 23 an increasing number of herring were observed that according to their age and length (e.g. age 3, total length 15 cm) could be allocated to CBH with a high degree of probability. Hence, CBH seem to have migrated into SD 21 and SD 23 in low numbers for the first time observed. This immigration has been observed in past years, albeit only in single individuals. Analysis of 2016 data validating the SF indicates that a further reduction of big herring together with immigration of CBH in SD 21 and SD 23, when being used as basis sample for WBSSH, can lead to problems with estimating SF parameters and their utilization.

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6 FIGURES AND TABLES

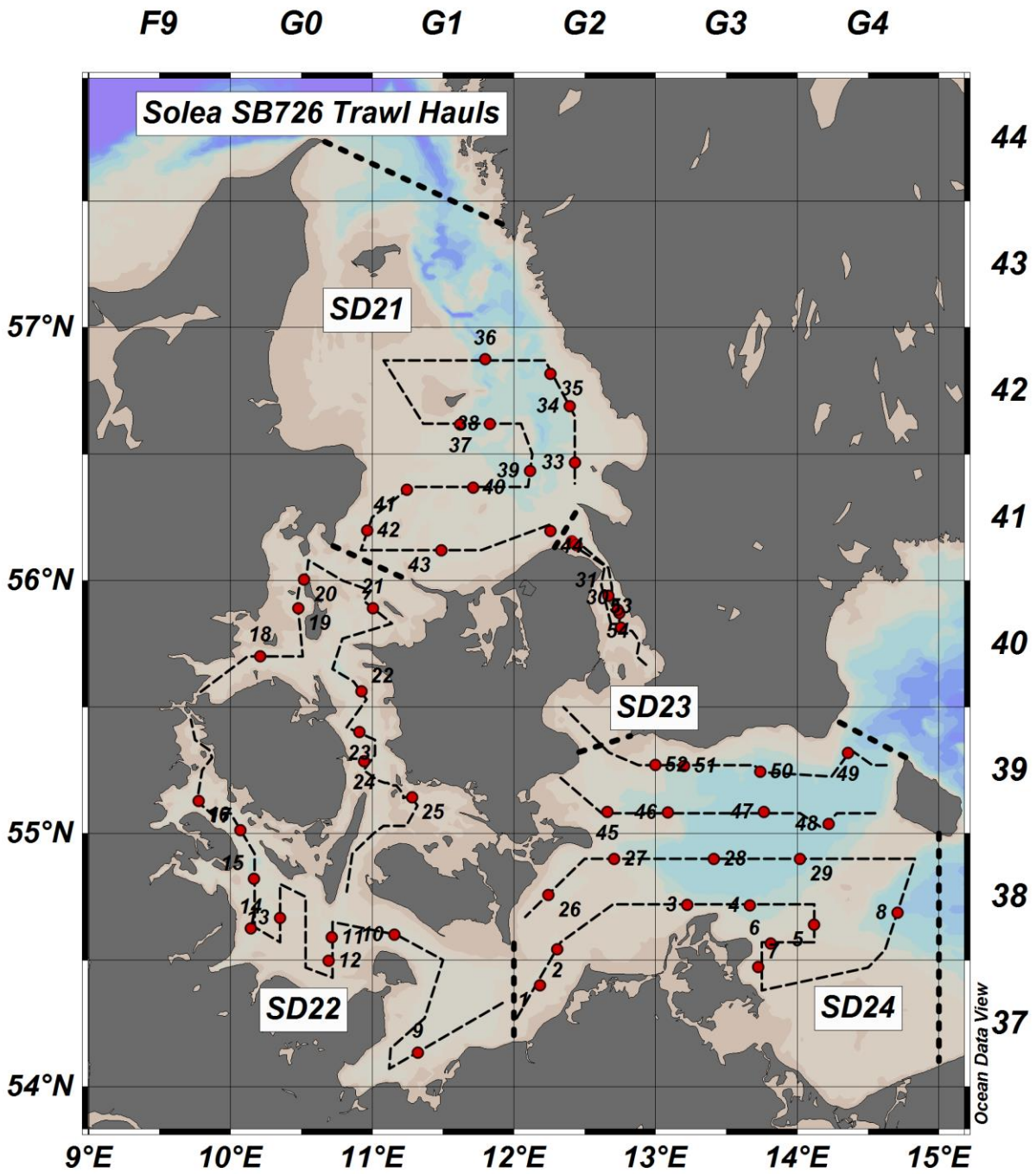

Figure 1: **FRV "Solea" cruise 726/2016. Cruisetrack (thin dashed lines) and fishery hauls (red dots). ICES statistical rectangles are indicated in the top and right axis. Thick dashed lines separate ICES subdivisions (SD).**

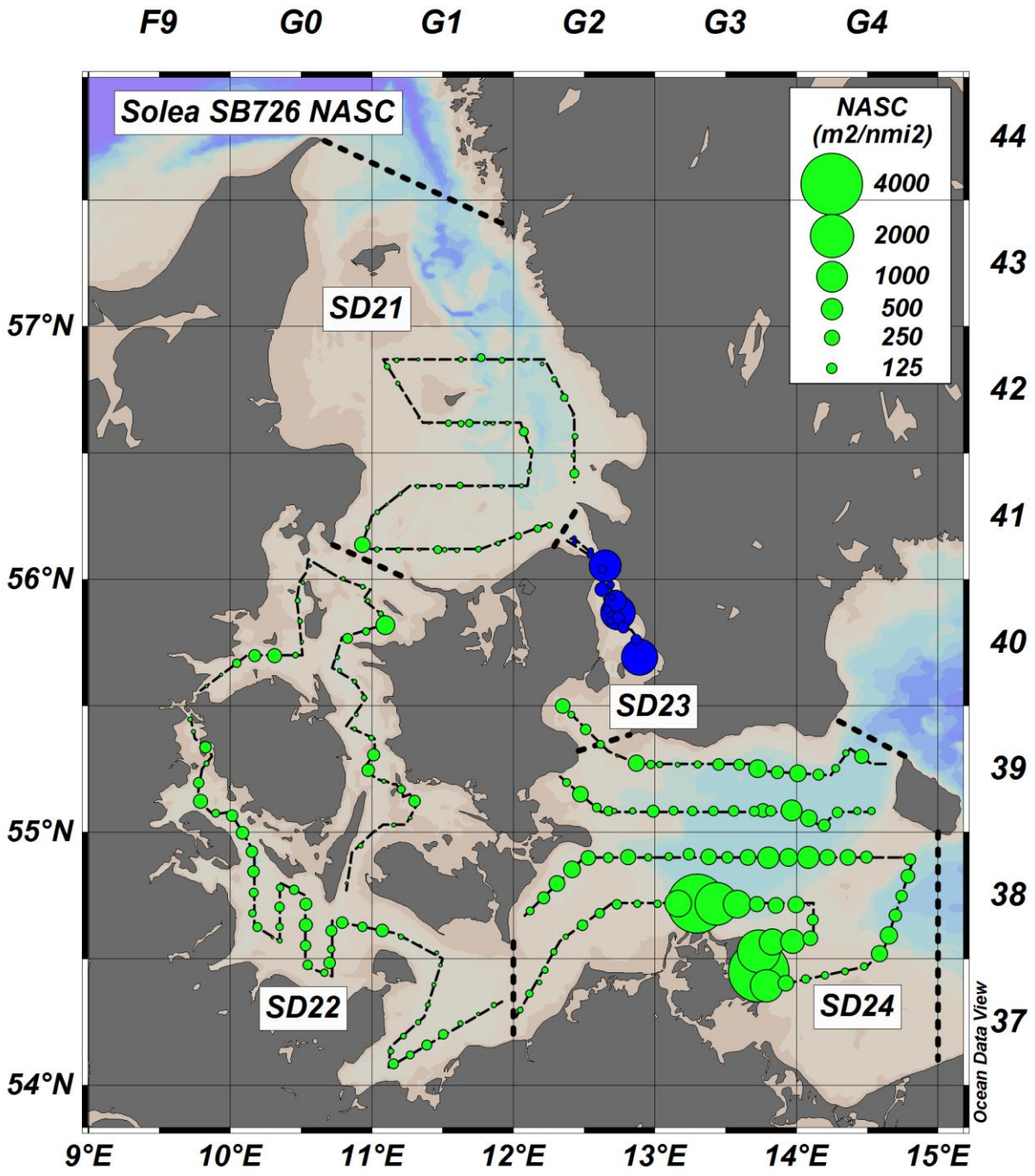

Figure 2: **FRV "Solea" cruise 726/2016. Cruisetrack (thin dashed lines) and mean NASC (5 nmi intervals, dots). ICES statistical rectangles are indicated in the top and right axis. Thick dashed lines separate ICES subdivisions (SD). Blue NASC values in Subdivision 23 (Sound) represent mean of two recordings.**

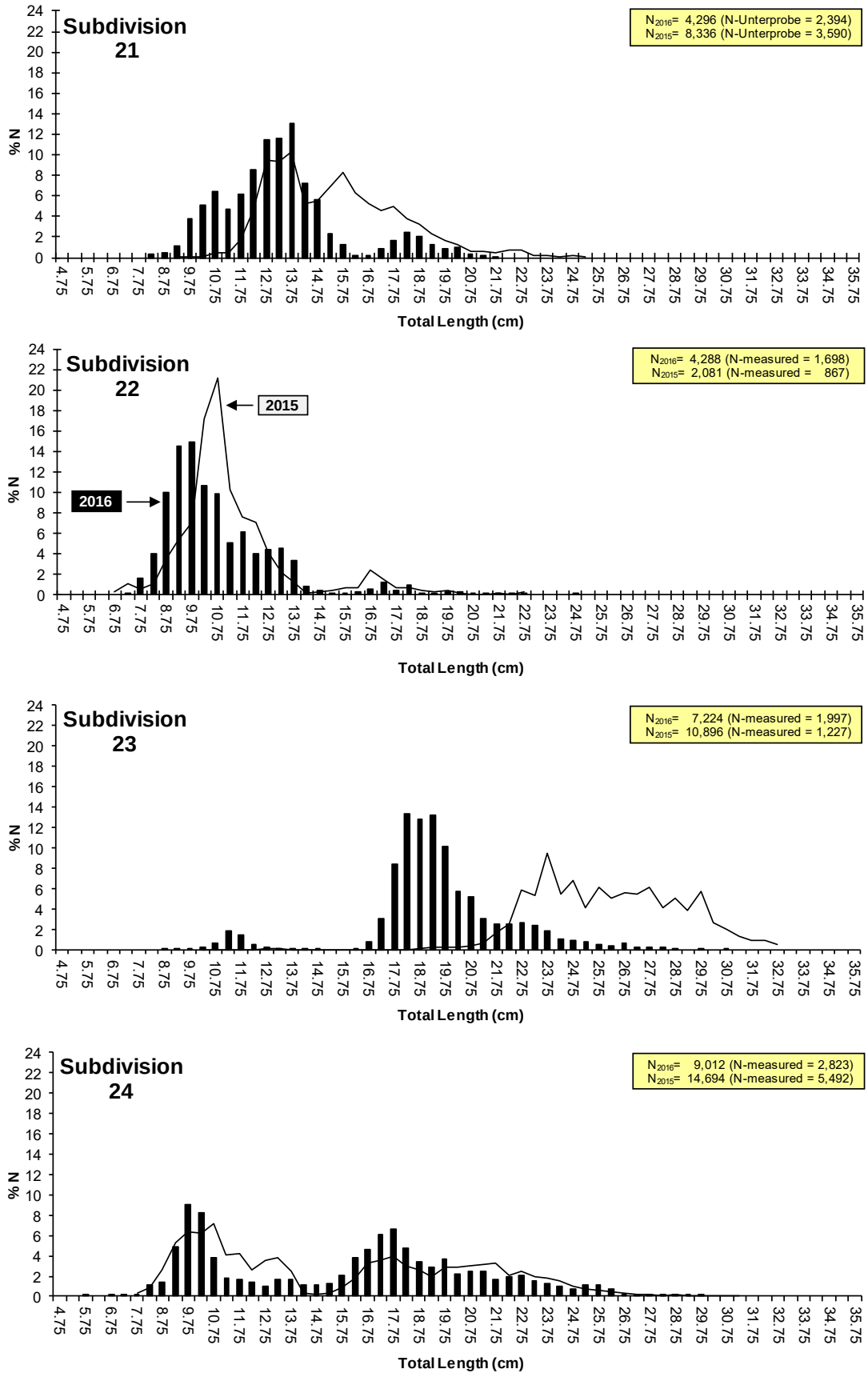

Figure 3: FRV "Solea," cruise 726/2016: Herring (*Clupea harengus*) length-frequency distribution compared to previous year (cruise 710/2015).

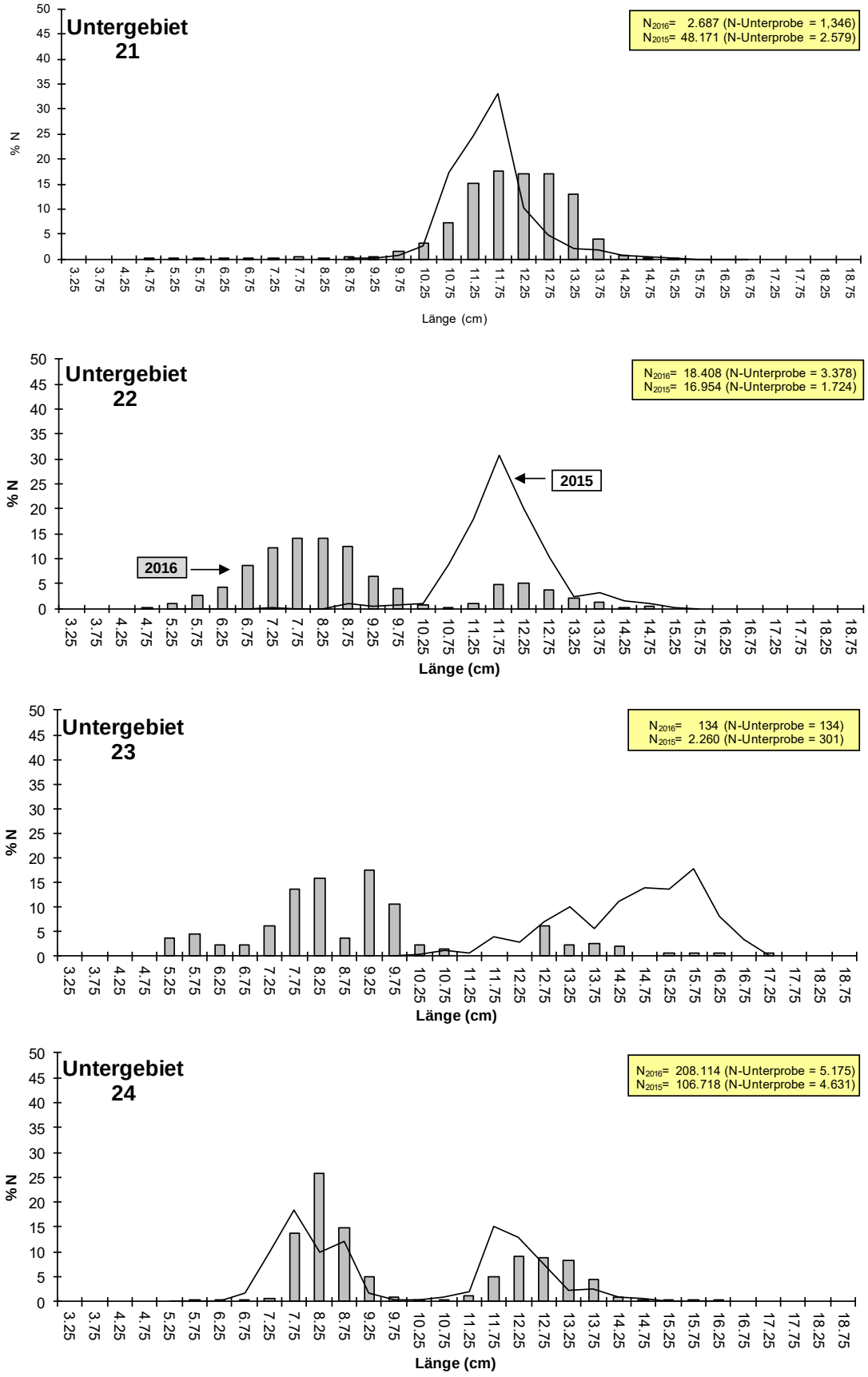

Figure 4: **FRV "Solea", cruise 726/2016: Sprat (*Sprattus sprattus*) length-frequency distribution compared to previous year (cruise 710/2015).**

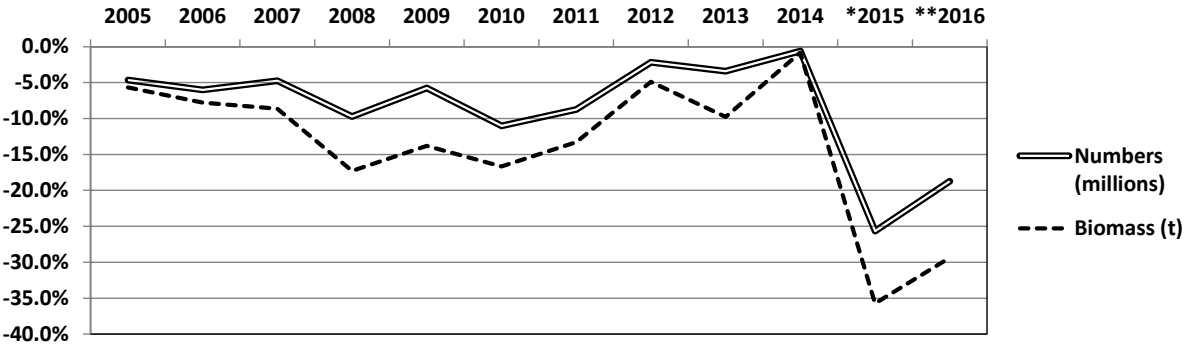

Figure 5 **Relative changes in abundance and biomass of Western Baltic Spring Spawning herring in ICES Subdivisions 21-24 (2005-2016) after application of the stock separation function (SF, Gröhsler et al., 2013) to the abundance and biomass index generated from German acoustic survey data (GERAS). *2015 = excl. CBH also in SD 22 and mature herring (stages ≥6) in SD 23; ** = . excl. CBH also in SD 22**

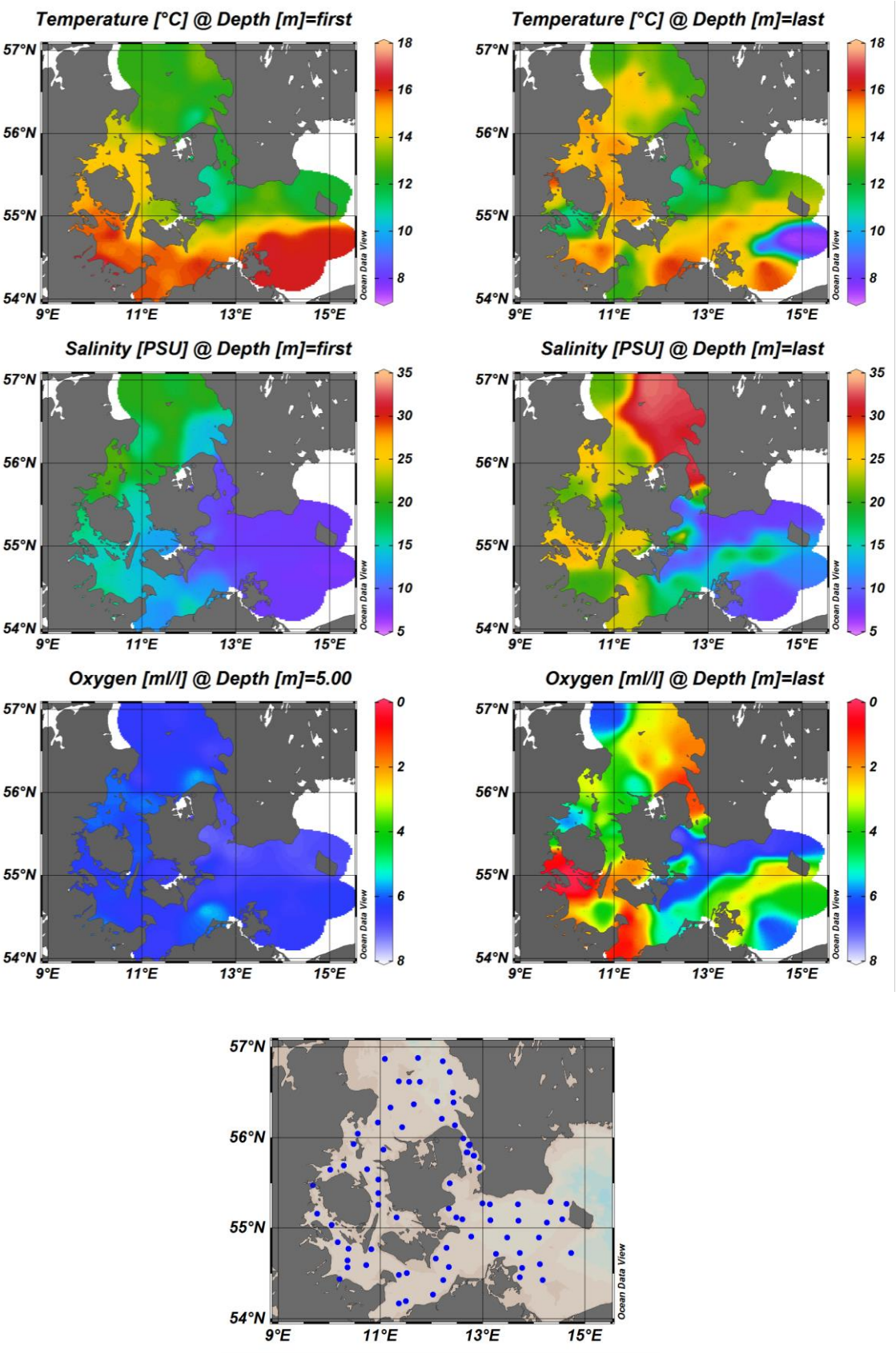

Figure 6: **FRV "Solea" cruise 726/2016: Hydrography. CTD stations are depicted as blue dots in the area map (lower panel). Temperature (°C, top panels), salinity (PSU, middle panels and oxygen concentration (ml/l, lower panels) at the surface (left) and near the seafloor (right). Surface oxygen concentration levels are displayed at 5 m depth.**

Table 1: FRV "Solea", cruise 726/2016. Simrad EK80 calibration report.

Date:	30.09.2016		
Transceiver Type:	WBT		
Software Version:	EK80 1.8.3.0		
Reference Target:	Tungsten (WC-Co) 38.1 mm		
Transducer:	ES38B Serial No. 30545		
Frequency:	38000 Hz	Beamtype:	Split
Gain:	26.04 dB	Two Way Beam Angle:	-20.6 dB
Athw. Beam Angle:	6.91 deg	Along. Beam Angle:	7.35 deg
Athw. Offset Angle:	0.10 deg	Along. Offset Angle:	-0.21 deg
Depth:	4.20 m		
Pulse Duration:	1.024 ms		
Power:	1000 W		
TS Detection:			
Min. Value:	-53.0 dB	Min. Spacing:	0.0
Max. Gain Comp.:	3.0 dB	Min. Echolength:	0.8
		Max. Echolength:	1.8
Environment:			
Absorption Coeff.:	0.005372	Sound Velocity:	1494.38 m/s
Calibration results:			
Transducer Gain:	26.21 dB	SaCorrection:	0.33 dB
Athw. Beam Angle:	7.29 deg	Along. Beam Angle:	7.32 deg
Athw. Offset Angle:	-0.11 deg	Along. Offset Angle:	0.02 deg
Ts RMS-Error:	0.0399		

Table 2: FRV "Solea", cruise 726/2016. Catch composition (kg 0.5h^{-1}) by trawl haul in SD 21.

Haul No.	33	34	35	36	37	38	39	40	41	42	43	44	Total
Species/ICES Rectangle	41G2	42G2	42G2	42G1	42G1	42G1	41G2	41G1	41G1	41G0	41G1	41G2	
BELONE BELONE											0.02		0.02
CLUPEA HARENGUS	1.67	3.53	3.19	2.66	2.26	10.86	1.46	1.84	1.08		20.29	19.23	68.07
CRANGON CRANGON				+									+
CRYSTALLOGOBIUS LINEARIS	+	0.01		+		+		+				+	0.01
CTENOLABRUS RUPESTRIS						+							+
CYCLOPTERUS LUMPUS											0.160		0.16
ENGRAULIS ENCRASICOLUS	0.01	0.01	0.09	0.11	0.10	0.92	2.19	1.05	2.42	0.43	0.110	0.060	7.50
EUTRIGLA GURNARDUS	+	0.02	0.01	0.04	0.05				1.06	0.15		+	1.33
GADUS MORHUA		6.84	2.12				5.36	2.94	2.67			0.010	19.94
GASTEROSTEUS ACULEATUS	+					+		0.01	+	+	0.08	0.01	0.10
HIPPOGLOSSOIDES PLATESSOIDES					+								+
LEANDER				+									+
LIMANDA LIMANDA		0.81	0.09	0.11	0.07			0.1	1.05	0.2		0.01	2.44
LOLIGO FORBESI	0.01	0.01	0.06	0.12	0.05	0.73	0.05	+	0.02			0.37	1.42
MELANOGRAMMUS AEGLEFINUS	0.99												0.99
MERLANGIUS MERLANGUS	0.01	1.03	0.53	0.05	0.1	0.09	0.06	0.03	0.03	0.02	0.06	0.05	2.06
MERLUCCIUS MERLUCCIUS		0.18	0.27										0.45
MYSIDACEA				0.01									0.01
PLEURONECTES PLATESSA		0.95	0.41	0.49									1.85
POMATOSCHISTUS MINUTUS		+	+	+									+
SARDINA PILCHARDUS	0.01				0.06	0.01		0.03		0.06	0.25		0.42
SCOMBER SCOMBRUS					0.68	0.43	0.43						1.54
SEPIOLA			0.01	0.03		0.01							0.05
SPRATTUS SPRATTUS	0.13	4.8	3.66		11.93	8.05	0.34	0.12	0.16		4.82	0.29	34.30
SQUALUS ACANTHIAS		0.96											0.96
SYNGNATHUS ROSTELLATUS				+									+
TRACHINUS DRACO		0.23	0.21	0.19	2.28	3.39	0.39	0.67	0.38	0.14	0.34	0.22	8.44
TRACHURUS TRACHURUS	0.01	0.02	+				0.03	0.03	0.02	0.01	0.03	0.03	0.18
TRISOPTERUS ESMARKI			0.01	0.02									0.03
Total	**2.84**	**19.40**	**10.66**	**3.83**	**17.58**	**24.49**	**10.31**	**6.82**	**8.89**	**1.01**	**26.16**	**20.28**	**152.27**
Medusae	4.16	0.02	1.86	1.95	0.27	0.23	1.77	15.18	11.05	4.12	13.67	1.99	56.26

+ = < 0.01 kg

Table 3: FRV "Solea", cruise 726/2016. Catch composition (kg 0.5h^{-1}) by trawl haul in SD 22.

Haul No.	9	10	11	12	13	14	15	16	17	18	19	20	21
Species/ICES Rectangle	37G1	38G1	38G0	37G0	38G0	38G0	38G0	39G0	39F9	40G0	40G0	41G0	40G1
AGONUS CATAPHRACTUS							+						
ANGUILLA ANGUILLA									0.05				
CALLIONYMUS LYRA			0.03										
CLUPEA HARENGUS	1.54	2.08	2.72	4.20	3.48	0.17	0.37	0.28	0.08	0.26	0.04		0.13
CRANGON CRANGON											+		+
CRYSTALLOGOBIUS LINEARIS			+								+		+
CTENOLABRUS RUPESTRIS			+						+	0.01			0.01
CYCLOPTERUS LUMPUS						0.16	1.05						
ENGRAULIS ENCRASICOLUS	0.09	0.01	0.02	0.08	0.46	0.69	1.70	0.18	0.04	0.05	3.32	0.84	0.06
EUTRIGLA GURNARDUS													
GADUS MORHUA	0.19	0.01	5.01	9.44	0.04		0.02	0.01	0.02			0.08	0.01
GASTEROSTEUS ACULEATUS	0.01	0.01	0.01		0.09		0.15	0.19	0.51	0.01	+	0.02	0.02
GOBIUS			0.01										
GOBIUS NIGER			+						0.01		+		
LIMANDA LIMANDA	0.05	0.04	20.74	3.69	1.91		0.08		0.22		0.12	0.09	0.12
LOLIGO FORBESI											0.01	+	
LUMPENUS LAMPRETAEFORMIS			0.02										
MERLANGIUS MERLANGUS	0.24	0.01	0.93	0.22	0.06	0.01	0.04	0.10	0.04		0.06	0.06	0.03
MULLUS SURMULETUS			0.03								0.02	0.08	0.03
PHOLIS GUNNELLUS													
PLATICHTHYS FLESUS			2.43	0.22	0.50								
PLEURONECTES PLATESSA			2.90					0.15	0.10				
POMATOSCHISTUS MINUTUS	+		+	+							+		+
PSETTA MAXIMA									1.78				
SARDINA PILCHARDUS											0.01	0.01	0.02
SCOMBER SCOMBRUS						0.02						0.23	
SPINACHIA SPINACHIA				+									
SPRATTUS SPRATTUS	0.39	0.31	4.56	6.03	11.11	0.33	3.74	4.62	7.17	2.55		0.19	+
SYNGNATHUS ROSTELLATUS	+		+										
SYNGNATHUS TYPHLE		+					+			+	+	+	+
TRACHINUS DRACO	0.10		0.21	0.06							0.02	0.19	0.22
TRACHURUS TRACHURUS				0.04	0.03	0.03		+			0.01	0.12	0.05
TRISOPTERUS ESMARKI												+	+
TRISOPTERUS MINUTUS													
Total	**2.61**	**2.47**	**39.62**	**23.98**	**17.68**	**1.41**	**7.15**	**5.53**	**10.02**	**2.88**	**3.61**	**1.91**	**0.70**
Medusae	37.76	6.99	4.71	4.53	33.10	53.80	48.38	47.70	7.37	11.59	32.86	9.08	6.37

Haul No.	22	23	24	25	Total
Species/ICES Rectangle	40G0	39G0	39G0	39G1	
AGONUS CATAPHRACTUS			0.01		**0.01**
ANGUILLA ANGUILLA					**0.05**
CALLIONYMUS LYRA					**0.03**
CLUPEA HARENGUS	0.12	0.96	20.93	0.74	**38.10**
CRANGON CRANGON				+	+
CRYSTALLOGOBIUS LINEARIS	0.02	0.01		0.01	**0.04**
CTENOLABRUS RUPESTRIS	+		+		**0.02**
CYCLOPTERUS LUMPUS			0.21		**1.42**
ENGRAULIS ENCRASICOLUS	+	0.02	0.03		**7.59**
EUTRIGLA GURNARDUS			+		+
GADUS MORHUA			8.48	0.05	**23.36**
GASTEROSTEUS ACULEATUS	+	0.06	0.01	5.50	**6.59**
GOBIUS					**0.01**
GOBIUS NIGER				+	**0.01**
LIMANDA LIMANDA	0.03		0.21	0.01	**27.31**
LOLIGO FORBESI			0.01		**0.02**
LUMPENUS LAMPRETAEFORMIS					**0.02**
MERLANGIUS MERLANGUS	0.01	0.19	0.14	0.10	**2.24**
MULLUS SURMULETUS					**0.16**
PHOLIS GUNNELLUS				0.02	**0.02**
PLATICHTHYS FLESUS	0.18				**3.33**
PLEURONECTES PLATESSA			0.07		**3.22**
POMATOSCHISTUS MINUTUS	+	+		0.01	**0.01**
PSETTA MAXIMA					**1.78**
SARDINA PILCHARDUS				0.02	**0.06**
SCOMBER SCOMBRUS			0.05		**0.30**
SPINACHIA SPINACHIA					+
SPRATTUS SPRATTUS	0.31	1.19	50.12	5.55	**98.17**
SYNGNATHUS ROSTELLATUS					+
SYNGNATHUS TYPHLE	+	+		+	+
TRACHINUS DRACO		0.02			**0.82**
TRACHURUS TRACHURUS	+	0.11	0.16		**0.55**
TRISOPTERUS ESMARKI				+	+
TRISOPTERUS MINUTUS	+				+
Total	**0.67**	**2.56**	**80.43**	**12.01**	**215.24**
Medusae	8.31	23.15	8.46	2.78	**346.94**

+ = < 0.01 kg

Table 4: FRV "Solea", cruise 726/2016. Catch composition (kg 0.5h^{-1}) by trawl haul in SD 23.

Haul No.	30	31	32	53	54	55	Total
Species/ICES Rectangle	40G2	40G2	41G2	40G2	40G2	41G2	
CARCINUS	0.03						**0.03**
CLUPEA HARENGUS	97.33	153.30		0.91	122.72	1.77	**376.03**
CRYSTALLOGOBIUS LINEARIS						+	+
ENGRAULIS ENCRASICOLUS			0.01	0.03		0.03	**0.07**
EUTRIGLA GURNARDUS	+		0.01				**0.01**
GADUS MORHUA	90.86	25.38	2.67	13.22	11.03		**143.16**
GASTEROSTEUS ACULEATUS	+	+	0.01	+	+	0.01	**0.02**
LIMANDA LIMANDA			0.36	0.25	0.06		**0.67**
LOLIGO FORBESI			0.01		+	0.05	**0.06**
MELANOGRAMMUS AEGLEFINUS				1.09	1.23		**2.32**
MERLANGIUS MERLANGUS	0.03		0.01		0.05	+	**0.09**
PLATICHTHYS FLESUS						0.35	**0.35**
PLEURONECTES PLATESSA	0.18				0.44		**0.62**
POLLACHIUS VIRENS	3.33			3.17			**6.50**
SARDINA PILCHARDUS					+		+
SPRATTUS SPRATTUS	0.13		0.01	0.07	0.32	0.28	**0.81**
SYNGNATHUS TYPHLE	+						+
TRACHINUS DRACO						0.02	**0.02**
TRACHURUS TRACHURUS			+			+	+
Total	**191.89**	**178.68**	**3.09**	**18.74**	**135.85**	**2.51**	**530.76**
Medusae	2.93	2.56	3.96	4.17	1.00	3.33	**17.96**

+ = < 0.01 kg

Table 5: FRV "Solea", cruise 726/2016. Catch composition (kg 0.5h^{-1}) by trawl haul in SD 24.

Haul No.	1	2	3	4	5	6	7	8	26	27	28	29	45
Species/ICES Rectangle	37G2	38G2	38G3	38G3	38G4	38G3	37G3	38G4	38G2	38G2	38G3	38G4	39G2
AMMODYTES TOBIANUS							0.04						
BELONE BELONE			0.10							0.39			
CLUPEA HARENGUS	1.47	3.23	11.57	13.75	12.20	9.56	53.66	53.96	25.05	2.41	5.29	92.66	3.11
CRANGON CRANGON											+	+	+
CRYSTALLOGOBIUS LINEARIS	+	+								+			0.01
CTENOLABRUS RUPESTRIS	+												
CYCLOPTERUS LUMPUS		0.16	0.24									0.11	
ENGRAULIS ENCRASICOLUS	0.45	0.12							0.08	0.01	0.01		0.09
GADUS MORHUA	0.02	0.10		0.02		0.81	3.84	0.54	0.01	+	1.27	0.84	0.06
GASTEROSTEUS ACULEATUS	0.01	+		0.12			0.01		0.01	0.08	0.02	+	3.44
GOBIUS NIGER				0.01						0.01			+
LEANDER													+
LIMANDA LIMANDA	+	1.99	1.02							0.03			+
MERLANGIUS MERLANGUS	0.34	1.13	0.03	0.98			0.07	0.20	0.02	0.04	4.03	2.56	
MYOXOCEPHALUS SCORPIUS		0.03											
OSMERUS EPERLANUS							0.08						
PLATICHTHYS FLESUS		1.48	0.50	0.44	0.44	1.68	0.31		0.20	0.68	0.23		
PLEURONECTES PLATESSA		0.17		0.22						0.52	0.21	0.16	
POLLACHIUS POLLACHIUS													
POMATOSCHISTUS MINUTUS	+	+	+	0.01		0.01	0.01			0.04	+	+	+
SARDINA PILCHARDUS										0.01			+
SPRATTUS SPRATTUS	0.87	1.08	753.9	24.84	2.48	59.74	324.25	6.99	22.89	12.12	61.78	81.97	9.85
STIZOSTEDION LUCIOPERCA							0.26						
SYNGNATHUS TYPHLE	+												+
TRACHURUS TRACHURUS			0.01								+	0.02	
Total	**3.16**	**9.49**	**767.37**	**40.39**	**15.12**	**71.80**	**382.53**	**61.69**	**48.26**	**16.34**	**72.84**	**178.32**	**16.56**
Medusae	2.39	13.20	0.84	5.99	42.20	18.60	4.12	9.70	11.40	3.01	3.20	7.62	1.64

Haul No.	46	47	48	49	50	51	52	Total
Species/ICES Rectangle	39G3	39G3	39G4	39G4	39G3	39G3	39G2	
AMMODYTES TOBIANUS								**0.04**
BELONE BELONE								**0.49**
CLUPEA HARENGUS	0.93	1.80	4.16	2.67	5.24	1.26	0.95	**304.93**
CRANGON CRANGON								+
CRYSTALLOGOBIUS LINEARIS								**0.01**
CTENOLABRUS RUPESTRIS								+
CYCLOPTERUS LUMPUS							0.18	**0.69**
ENGRAULIS ENCRASICOLUS	0.01	0.19	0.04			0.02		**1.02**
GADUS MORHUA	0.01	0.36	3.78	1.35	2.45		0.36	**15.82**
GASTEROSTEUS ACULEATUS	0.24	0.01		+	+	+		**3.94**
GOBIUS NIGER								**0.02**
LEANDER								+
LIMANDA LIMANDA								**3.04**
MERLANGIUS MERLANGUS	+	0.25	3.61		2.20			**15.46**
MYOXOCEPHALUS SCORPIUS								**0.03**
OSMERUS EPERLANUS								**0.08**
PLATICHTHYS FLESUS	0.20		0.19	0.37	0.32			**7.04**
PLEURONECTES PLATESSA				0.23				**1.51**
POLLACHIUS POLLACHIUS					1.60			**1.60**
POMATOSCHISTUS MINUTUS	+	+	+		+			**0.07**
SARDINA PILCHARDUS								**0.01**
SPRATTUS SPRATTUS	2.25	126.52	12.71	2.22	85.84	4.72	1.22	**1598.24**
STIZOSTEDION LUCIOPERCA								**0.26**
SYNGNATHUS TYPHLE								+
TRACHURUS TRACHURUS	0.04	0.04	0.05		0.11	+		**0.27**
Total	**3.68**	**129.17**	**24.54**	**6.84**	**97.76**	**6.00**	**2.71**	**1954.57**
Medusae	5.54	1.50	5.25	5.20	3.24	23.29	15.96	**183.89**

+ = < 0.01 kg

Table 6: FRV "Solea", cruise 726/2016. Survey statistics by area.

Sub-division	ICES Rectangle	Area (nm²)	Sa (m²/NM²)	Sigma (cm²)	N total (million)	Herring (%)	Sprat (%)	NHerring (million)	NSprat (million)
21	41G0	108.1	319.5	1.254	275.42	0.00	0.00	0.00	0.00
21	41G1	946.8	59.5	2.032	277.24	45.42	12.30	125.92	34.10
21	41G2	432.3	132.9	1.752	327.93	69.33	5.97	227.35	19.58
21	42G1	884.2	56.5	1.680	297.36	49.97	44.64	148.60	132.75
21	42G2	606.8	91.3	1.557	355.82	44.02	48.70	156.64	173.30
21	**Total**	**2,978.2**			**1533.77**			**658.51**	**359.73**
22	37G0	209.9	198.0	1.100	377.82	30.53	65.12	115.35	246.03
22	37G1	723.3	104.2	1.290	584.25	46.44	25.42	271.33	148.54
22	38G0	735.3	192.3	0.805	1756.50	14.51	71.15	254.87	1249.83
22	38G1	173.2	191.5	1.166	284.46	74.65	20.49	212.36	58.27
22	39F9	159.3	194.7	0.460	674.25	0.49	88.39	3.34	595.94
22	39G0	201.7	143.0	0.905	318.71	19.59	70.64	62.44	225.12
22	39G1	250.0	110.0	0.341	806.45	1.16	20.78	9.38	167.58
22	40F9	51.3	25.6	1.102	11.92	7.35	87.86	0.88	10.47
22	40G0	538.1	96.4	1.102	470.72	7.35	87.86	34.59	413.57
22	40G1	174.5	511.7	0.830	1075.80	25.45	1.82	273.84	19.56
22	41G0	173.1	36.4	1.453	43.36	0.00	15.65	0.00	6.79
22	**Total**	**3,389.7**			**6404.24**			**1238.38**	**3141.70**
23	39G2	130.9	208.6	0.580	470.79	4.44	38.88	20.90	183.02
23	40G2	164.0	825.0	4.530	298.68	97.12	0.64	290.08	1.91
23	41G2	72.3	123.6	1.068	83.67	70.03	25.78	58.60	21.57
23	**Total**	**367.2**			**853.14**			**369.58**	**206.50**
24	37G2	192.4	97.8	1.325	142.01	34.52	36.01	49.03	51.14
24	37G3	167.7	3085.4	0.687	7531.61	2.00	97.96	150.31	7377.79
24	37G4	875.1	186.5	2.984	546.94	64.76	35.03	354.20	191.60
24	38G2	832.9	322.7	1.239	2169.30	25.16	64.24	545.88	1393.56
24	38G3	865.7	1440.8	1.179	10579.31	4.33	94.96	457.78	10046.07
24	38G4	1034.8	441.8	2.832	1614.32	48.15	51.61	777.34	833.14
24	39G2	406.1	275.4	0.580	1928.27	4.44	38.88	85.62	749.64
24	39G3	765.0	348.1	1.426	1867.44	5.09	87.99	95.05	1643.12
24	39G4	524.8	349.9	2.455	747.97	19.15	77.19	143.26	577.35
24	**Total**	**5,664.5**			**27,127.17**			**2658.47**	**22863.41**
22-24	**Total**	**9,421.4**			**34,384.55**			**4266.43**	**26211.61**
21-24	**Total**	**12,399.6**			**35,918.32**			**4924.94**	**26571.34**

Table 7: FRV "Solea", cruise 726/2016. Numbers (millions) of herring incl. CBH by age/W-rings and area.

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0										0.00
21	41G1	94.95	27.44	2.68	0.57	0.14	0.13				125.91
21	41G2	220.63	5.85	0.77	0.07	0.03					227.35
21	42G1	132.14	15.52	0.69	0.06	0.08	0.10				148.59
21	42G2	154.58	1.97	0.07		0.01	0.01				156.64
21	Total	602.30	50.78	4.21	0.70	0.26	0.24	0.00	0.00	0.00	658.49
22	37G0	107.26	3.94	1.50	0.82	0.97	0.52	0.16	0.19		115.36
22	37G1	234.10	17.42	5.89	1.98	7.39	3.04	0.87	0.66		271.35
22	38G0	238.58	6.72	4.46	1.09	2.03	0.78	0.38	0.12	0.71	254.87
22	38G1	211.70	0.66								212.36
22	39F9	3.34									3.34
22	39G0	61.55	0.64	0.02	0.03	0.15	0.02	0.03			62.44
22	39G1	9.26	0.09			0.02	0.01				9.38
22	40F9	0.77	0.05	0.02	0.03	0.01					0.88
22	40G0	30.08	1.91	0.89	1.03	0.55		0.14			34.60
22	40G1	273.84									273.84
22	41G0										0.00
22	Total	1,170.48	31.43	12.78	4.98	11.12	4.37	1.58	0.97	0.71	1,238.42
23	39G2	16.12	1.19	0.67	0.91	1.35	0.46	0.07	0.11	0.01	20.89
23	40G2	7.76	189.69	55.82	25.32	8.58	2.15	0.56	0.2		290.08
23	41G2	58.31	0.29								58.60
23	Total	82.19	191.17	56.49	26.23	9.93	2.61	0.63	0.31	0.01	369.57
24	37G2	43.11	1.70	1.02	0.68	1.73	0.73	0.02	0.02		49.01
24	37G3	60.72	15.67	13.37	19.09	24.25	10.56	3.62	2.07	0.96	150.31
24	37G4	5.89	55.73	50.52	81.09	93.23	37.75	17.08	9.95	2.97	354.21
24	38G2	367.32	48.05	30.93	33.09	46.02	15.02	2.74	2.48	0.24	545.89
24	38G3	246.67	42.97	31.87	44.48	57.35	21.97	6.19	4.94	1.34	457.78
24	38G4	23.63	94.91	99.65	207.82	185.26	87.83	45.37	23.83	9.04	777.34
24	39G2	66.04	4.89	2.75	3.74	5.53	1.87	0.29	0.45	0.06	85.62
24	39G3	26.14	14.71	10.06	13.78	18.66	7.48	2.11	1.70	0.41	95.05
24	39G4	10.49	18.94	18.59	32.03	35.97	15.08	6.12	4.10	1.95	143.27
24	Total	850.01	297.57	258.76	435.80	468.00	198.29	83.54	49.54	16.97	2,658.48
22-24	Total	2,102.68	520.17	328.03	467.01	489.05	205.27	85.75	50.82	17.69	4,266.47
21-24	Total	2,704.98	570.95	332.24	467.71	489.31	205.51	85.75	50.82	17.69	4,924.96

Table 8: FRV "Solea", cruise 726/2016. Mean weight (g) of herring incl. CBH by age/W-rings and area.

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0										
21	41G1	14.18	40.93	55.33	54.39	31.85	45.82				21.12
21	41G2	13.18	39.69	60.19	53.48	31.85					14.04
21	42G1	14.83	38.26	40.30	49.00	31.85	45.82				17.44
21	42G2	8.94	37.74	43.82		31.85	45.82				9.32
21	Total	12.61	39.85	53.56	53.84	31.85	45.82				15.04
22	37G0	5.86	32.57	47.70	52.02	39.10	46.97	46.39	46.00		8.23
22	37G1	6.94	33.97	43.40	35.37	38.20	42.08	41.44	46.00		11.12
22	38G0	5.25	33.86	62.49	45.39	51.92	46.85	48.11	46.00	60.00	7.91
22	38G1	9.52	21.33								9.56
22	39F9	4.93									4.93
22	39G0	7.26	32.08	27.87	30.80	34.67	31.38	36.82			7.62
22	39G1	8.92	31.38			31.37	31.37				9.21
22	40F9	7.56	32.82	52.66	49.48	34.82		36.82			11.76
22	40G0	7.56	32.82	52.66	49.48	34.82		36.82			11.91
22	40G1	9.32									9.32
22	41G0										0.00
22	Total	7.56	33.39	51.20	43.28	40.55	43.44	43.05	46.00	60.00	9.34
23	39G2	9.48	32.70	34.88	40.33	36.71	39.30	49.63	45.23	45.98	15.72
23	40G2	9.94	42.63	70.05	92.15	79.86	115.41	107.38	139.40		53.19
23	41G2	8.88	29.33								8.98
23	Total	9.10	42.55	69.63	90.35	73.99	102.00	100.96	105.98	45.98	44.06
24	37G2	10.17	31.38	26.51	36.28	34.23	36.28	50.30	50.30		12.88
24	37G3	9.01	33.52	43.74	49.42	43.06	46.55	57.94	56.47	54.76	30.04
24	37G4	21.01	33.38	46.62	56.99	46.65	54.41	76.64	57.32	65.76	49.23
24	38G2	9.67	30.76	29.83	33.38	34.66	37.94	49.73	46.61	45.98	17.38
24	38G3	7.81	32.53	38.96	46.95	41.26	45.14	61.34	52.12	62.05	23.44
24	38G4	16.79	33.49	53.10	76.82	55.34	68.43	84.40	70.75	73.82	60.82
24	39G2	9.48	32.70	34.88	40.33	36.71	39.30	49.63	45.23	45.98	15.73
24	39G3	11.74	32.71	38.59	43.31	40.40	45.32	59.64	52.50	67.46	32.71
24	39G4	12.25	33.82	50.34	58.02	46.20	51.30	64.07	59.39	68.61	47.24
24	Total	9.47	32.85	45.77	62.77	47.62	57.14	76.58	62.58	69.16	38.11
22-24	Total	8.39	36.45	50.09	64.11	47.99	57.42	76.14	62.53	68.78	30.27
21-24	Total	9.33	36.75	50.13	64.09	47.98	57.40	76.14	62.53	68.78	28.23

Table 9: FRV "Solea", cruise 726/2016. Total biomass (t) of herring incl. CBH by age/W-rings and area.

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total
21	41G0										0.0
21	41G1	1,346.4	1,123.1	148.3	31.0	4.5	6.0				2,659.2
21	41G2	2,907.9	232.2	46.4	3.7	1.0					3,191.1
21	42G1	1,959.6	593.8	27.8	2.9	2.6	4.6				2,591.3
21	42G2	1,382.0	74.4	3.1		0.3	0.5				1,460.2
21	Total	7,595.9	2,023.5	225.5	37.7	8.3	11.0	0.0	0.0	0.0	9,901.8
22	37G0	628.5	128.3	71.6	42.7	37.9	24.4	7.4	8.7		949.6
22	37G1	1,624.7	591.8	255.6	70.0	282.3	127.9	36.1	30.4		3,018.7
22	38G0	1,252.6	227.5	278.7	49.5	105.4	36.5	18.3	5.5	42.6	2,016.6
22	38G1	2,015.4	14.1								2,029.5
22	39F9	16.5									16.5
22	39G0	446.9	20.5	0.6	0.9	5.2	0.6	1.1			475.8
22	39G1	82.6	2.8			0.6	0.3				86.4
22	40F9	5.8	1.6	1.1	1.5	0.4					10.3
22	40G0	227.4	62.7	46.9	51.0	19.2		5.2			412.2
22	40G1	2,552.2									2,552.2
22	41G0										0.0
22	Total	8,852.5	1,049.4	654.4	215.53	451.0	189.8	68.00	44.62	42.6	11,567.7
23	39G2	152.8	38.9	23.4	36.70	49.6	18.1	3.47	4.98	0.5	328.4
23	40G2	77.1	8,086.5	3,910.2	2,333.2	685.2	248.1	60.1	27.9		15,428.4
23	41G2	517.8	8.5								526.3
23	Total	747.7	8,133.9	3,933.6	2,369.9	734.8	266.2	63.6	32.9	0.5	16,283.0
24	37G2	438.4	53.4	27.0	24.7	59.2	26.5	1.0	1.0		631.2
24	37G3	547.1	525.3	584.8	943.4	1,044.2	491.6	209.7	116.9	52.6	4,515.6
24	37G4	123.8	1,860.3	2,355.2	4,621.3	4,349.2	2,054.0	1,309.0	570.3	195.3	17,438.4
24	38G2	3,552.0	1,478.0	922.6	1,104.5	1,595.1	569.9	136.3	115.6	11.0	9,485.0
24	38G3	1,926.5	1,397.8	1,241.7	2,088.3	2,366.3	991.7	379.7	257.5	83.2	10,732.6
24	38G4	396.8	3,178.5	5,291.4	15,964.7	10,252.3	6,010.2	3,829.2	1,686.0	667.3	47,276.5
24	39G2	626.1	159.9	95.9	150.8	203.0	73.5	14.4	20.4	2.8	1,346.7
24	39G3	306.9	481.2	388.2	596.8	753.9	339.0	125.8	89.3	27.7	3,108.7
24	39G4	128.5	640.6	935.8	1,858.4	1,661.8	773.6	392.1	243.5	133.8	6,768.1
24	Total	8,045.9	9,774.9	11,842.8	27,353.1	22,284.9	11,329.9	6,397.3	3,100.4	1,173.6	101,302.7
22-24	Total	17,646.1	18,958.2	16,430.7	29,938.5	23,470.6	11,785.9	6,528.9	3,177.8	1,216.7	129,153.4
21-24	Total	25,242.0	20,981.6	16,656.2	29,976.2	23,478.9	11,796.9	6,528.9	3,177.8	1,216.7	139,055.2

Table 10: FRV "Solea", cruise 726/2016. Numbers (millions) of sprat by age and area.

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0										0.00
21	41G1		7.53	22.27	3.81	0.49					34.10
21	41G2	3.61	11.42	4.31	0.24	0.01					19.59
21	42G1	0.26	52.84	72.75	6.48	0.42					132.75
21	42G2	9.21	134.66	28.38	1.02	0.02					173.29
21	Total	13.08	206.45	127.71	11.55	0.94	0.00	0.00	0.00	0.00	359.73
22	37G0	230.74	4.00	10.46	0.81		0.02				246.03
22	37G1	145.48	1.14	1.53	0.32		0.06				148.53
22	38G0	1,225.07	3.05	17.80	3.41	0.44	0.06				1,249.83
22	38G1	58.00	0.27								58.27
22	39F9	595.94									595.94
22	39G0	168.95	7.73	40.34	4.59	2.68	0.84				225.13
22	39G1	166.61	0.35	0.62							167.58
22	40F9	3.63	1.32	4.98	0.48	0.04	0.01				10.46
22	40G0	143.51	52.14	196.88	19.12	1.58	0.34				413.57
22	40G1	19.56									19.56
22	41G0	1.78	1.08	3.45	0.47						6.78
22	Total	2,759.27	71.08	276.06	29.20	4.74	1.33	0.00	0.00	0.00	3,141.68
23	39G2	166.28	9.03	6.13	0.73	0.33	0.28	0.24			183.02
23	40G2	0.75	0.11	0.49	0.10	0.24	0.21				1.90
23	41G2	21.08	0.23	0.16	0.03	0.06					21.56
23	Total	188.11	9.37	6.78	0.86	0.63	0.49	0.24	0.00	0.00	206.48
24	37G2	38.88	4.26	5.65	1.22	0.41	0.57	0.14			51.13
24	37G3	7,292.75	70.05	14.99							7,377.79
24	37G4	35.21	23.69	69.54	31.13	16.47	12.71	2.84			191.59
24	38G2	1,031.84	173.54	148.43	21.05	6.19	8.80	3.70			1,393.55
24	38G3	5,186.01	2,295.86	1,977.42	298.01	110.41	118.30	60.06			10,046.07
24	38G4	104.02	168.00	326.96	115.08	58.13	47.60	13.35			833.14
24	39G2	681.08	36.99	25.09	2.99	1.33	1.16	0.99			749.63
24	39G3	433.93	467.38	544.18	99.31	36.20	41.70	20.42			1,643.12
24	39G4	29.11	160.23	254.76	64.47	30.76	28.74	9.28			577.35
24	Total	14,832.83	3,400.00	3,367.02	633.26	259.90	259.58	110.78	0.00	0.00	22,863.37
22-24	Total	17,780.21	3,480.45	3,649.86	663.32	265.27	261.40	111.02	0.00	0.00	26,211.53
21-24	Total	17,793.29	3,686.90	3,777.57	674.87	266.21	261.40	111.02	0.00	0.00	26,571.26

Table 11: FRV "Solea", cruise 726/2016. Mean weight (g) of sprat by age and area.

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0										
21	41G1	0.00	12.56	16.15	18.11	18.66					15.62
21	41G2	3.05	10.84	13.75	15.43	18.07					10.11
21	42G1	8.52	11.93	15.14	17.50	18.68					13.97
21	42G2	3.38	10.34	12.74	14.28	18.07					10.39
21	Total	3.39	10.86	14.74	17.37	18.65					12.19
22	37G0	4.96	10.07	13.24	13.61		15.94				5.43
22	37G1	4.92	7.73	15.94	15.94		15.94				5.08
22	38G0	3.49	10.48	13.86	15.28	19.50	15.94				3.69
22	38G1	5.14	7.24								5.15
22	39F9	2.26									2.26
22	39G0	3.34	11.84	13.69	14.40	17.82	18.50				5.94
22	39G1	3.80	9.72	13.27							3.85
22	40F9	3.12	11.90	12.85	13.13	17.49	15.94				9.39
22	40G0	3.12	11.90	12.85	13.13	17.49	15.94				9.39
22	40G1	4.45									4.45
22	41G0	4.26	11.13	12.38	12.46						10.05
22	Total	3.45	11.62	13.06	13.61	17.86	17.56				4.61
23	39G2	5.09	12.46	13.87	15.51	15.28	16.29	14.18			5.84
23	40G2	5.01	15	15.99	16.23	20.87	27.5				13.55
23	41G2	3.52	7.97	13.78	13.78	13.78					3.69
23	Total	4.91	12.38	14.02	15.53	17.27	21.09	14.18			5.69
24	37G2	4.56	13.58	14.92	16.24	17.52	16.47	16.17			7.00
24	37G3	3.71	9.87	10.31							3.78
24	37G4	4.85	13.97	16.10	17.75	18.69	17.85	18.29			14.41
24	38G2	4.68	12.78	14.25	15.37	14.79	15.57	13.69			7.00
24	38G3	4.41	12.88	14.28	15.58	15.17	15.89	13.92			8.93
24	38G4	4.88	13.67	15.58	17.49	18.45	17.61	17.07			14.46
24	39G2	5.09	12.46	13.87	15.51	15.28	16.29	14.18			5.84
24	39G3	5.20	13.35	14.68	16.13	16.32	16.20	15.41			11.97
24	39G4	5.30	13.62	15.13	16.94	18.16	17.13	15.65			14.69
24	Total	4.15	12.96	14.55	16.25	16.64	16.48	14.83			7.66
22-24	Total	4.05	12.93	14.44	16.14	16.66	16.49	14.83			7.28
21-24	Total	4.04	12.81	14.45	16.16	16.67	16.49	14.83			7.34

Table 12: FRV "Solea", cruise 726/2016. Total biomass (t) of sprat by age and area.

Sub-division	Rectangle/ Age group	0	1	2	3	4	5	6	7	8+	Total
21	41G0										0.0
21	41G1	0.0	94.6	359.8	69.1	9.1					532.5
21	41G2	11.0	123.8	59.2	3.7	0.3					197.9
21	42G1	2.2	630.4	1,101.2	113.3	7.9					1,855.0
21	42G2	31.1	1,392.2	361.5	14.6	0.4					1,799.8
21	Total	44.3	2,241.0	1,881.6	200.7	17.6	0.0	0.0	0.0	0.0	4,385.2
22	37G0	1,145.6	40.3	138.5	11.0		0.4				1,335.7
22	37G1	715.9	8.8	24.4	5.1		1.0				755.3
22	38G0	4,270.6	31.9	246.6	52.2	8.7	0.9				4,610.9
22	38G1	298.4	2.0								300.3
22	39F9	1,345.8									1,345.8
22	39G0	564.3	91.5	552.1	66.1	47.7	15.5				1,337.1
22	39G1	633.9	3.4	8.2							645.5
22	40F9	11.3	15.7	64.0	6.4	0.7	0.1				98.3
22	40G0	447.3	620.6	2,529.8	251.1	27.6	5.4				3,881.8
22	40G1	87.0									87.0
22	41G0	7.6	12.1	42.7	5.9						68.3
22	Total	9,527.5	826.3	3,606.4	397.7	84.7	23.3	0.0	0.0	0.0	14,465.9
23	39G2	846.5	112.5	85.0	11.3	5.0	4.6	3.4			1,068.3
23	40G2	3.8	1.7	7.9	1.6	5.1	5.8				25.9
23	41G2	74.3	1.8	2.2	0.5	0.9					79.7
23	Total	924.5	116.0	95.1	13.4	11.0	10.5	3.4	0.0	0.0	1,173.9
24	37G2	177.2	57.9	84.4	19.8	7.2	9.4	2.2			358.1
24	37G3	27,042.2	691.7	154.4							27,888.3
24	37G4	170.7	330.8	1,119.7	552.6	307.9	226.9	52.0			2,760.5
24	38G2	4,824.1	2,217.2	2,115.4	323.5	91.5	137.1	50.7			9,759.4
24	38G3	22,877.5	29,575.6	28,246.1	4,643.0	1,675.1	1,879.6	835.9			89,732.7
24	38G4	507.3	2,297.0	5,093.4	2,013.2	1,072.5	838.2	227.9			12,049.4
24	39G2	3,467.1	460.9	348.1	46.3	20.3	18.9	14.1			4,375.6
24	39G3	2,256.4	6,239.3	7,988.0	1,602.2	590.8	675.4	314.7			19,666.6
24	39G4	154.2	2,182.5	3,854.6	1,092.2	558.7	492.3	145.2			8,479.7
24	Total	61,476.7	44,052.9	49,003.9	10,292.6	4,323.9	4,277.7	1,642.6	0.0	0.0	175,070.4
22-24	Total	71,928.8	44,995.2	52,705.4	10,703.7	4,419.5	4,311.5	1,646.1	0.0	0.0	190,710.1
21-24	Total	71,973.1	47,236.1	54,587.0	10,904.4	4,437.2	4,311.5	1,646.1	0.0	0.0	195,095.3

Table 13: **FRV "Solea", cruise 726/2016. Numbers (m) of herring excl. CBH by age/W-rings and area.**

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total	
21	41G0										0.00	
21	41G1	94.95	27.44	2.68	0.57	0.14	0.13				125.91	
21	41G2	220.63	5.85	0.77	0.07	0.03					227.35	
21	42G1	132.14	15.52	0.69	0.06	0.08	0.10				148.59	
21	42G2	154.58	1.97	0.07		0.01	0.01				156.64	
21	Total	602.30	50.78	4.21	0.70	0.26	0.24	0.00	0.00	0.00	658.49	
22	37G0	107.25	3.69	1.19	0.38						112.51	
22	37G1	234.10	17.42	2.97							254.48	
22	38G0	238.51	6.74	4.15		0.71					250.12	
22	38G1	211.69									211.69	
22	39F9	3.34									3.34	
22	39G0	61.55	0.59								62.14	excl. CBH
22	39G1	9.26	0.09								9.36	
22	40F9	0.77	0.05	0.02							0.83	
22	40G0	30.08	1.91	0.75							32.74	
22	40G1	273.84									273.84	
22	41G0										0.00	
22	Total	1,170.39	30.50	9.09	0.38	0.71	0.00	0.00	0.00	0.00	1,211.06	
23	39G2	16.12	1.17	0.14	0.16						17.59	excl. CBH
23	40G2	7.76	189.69	55.82	25.32	8.58	2.15	0.56	0.2		290.08	
23	41G2	58.31	0.29								58.60	
23	Total	82.19	191.15	55.96	25.48	8.58	2.15	0.56	0.20	0.00	366.27	
24	37G2	43.11	1.45	0.02							44.58	
24	37G3	60.72	15.45	7.00	7.31	1.24	0.42	0.14			92.28	
24	37G4	5.89	54.55	25.83	39.23	12.20	4.21	2.90	0.18		144.99	
24	38G2	367.32	46.76	2.39	1.88						418.35	
24	38G3	246.67	42.01	10.53	13.43	3.23	0.79	0.46			317.12	excl. CBH
24	38G4	23.63	92.93	57.80	134.41	42.43	25.58	13.38	2.98		393.14	
24	39G2	66.04	4.80	0.59	0.65						72.08	
24	39G3	26.14	14.65	3.29	2.95	0.50	0.31	0.10			47.94	
24	39G4	10.49	18.34	11.54	16.18	5.24	1.42	0.48	0.12		63.81	
24	Total	850.01	290.94	118.99	216.04	64.84	32.73	17.46	3.28	0.00	1,594.29	
22-24	Total	2,102.59	512.59	184.04	241.90	74.13	34.88	18.02	3.48	0.00	3,171.62	
21-24	Total	2,704.89	563.37	188.25	242.60	74.39	35.12	18.02	3.48	0.00	3,830.11	

Table 14: **FRV "Solea", cruise 726/2016. Mean weight (g) of herring excl. CBH by age/W-rings and area.**

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total	
21	41G0											
21	41G1	14.18	40.93	55.33	54.39	31.85	45.82				21.12	
21	41G2	13.18	39.69	60.19	53.48	31.85					14.04	
21	42G1	14.83	38.26	40.30	49.00	31.85	45.82				17.44	
21	42G2	8.94	37.74	43.82		31.85	45.82				9.32	
21	Total	12.61	39.85	53.56	53.84	31.85	45.82				15.04	
22	37G0	5.72	33.09	51.22	64.00						7.30	
22	37G1	6.73	33.85	49.51							9.08	
22	38G0	5.11	33.79	66.19		80.00					7.11	
22	38G1	9.16									9.16	
22	39F9	4.74									4.74	
22	39G0	7.01	32.69								7.25	excl. CBH
22	39G1	8.59	30.83								8.81	
22	40F9	7.28	32.93	63.00							10.06	
22	40G0	7.28	32.93	63.00							10.06	
22	40G1	8.93									8.93	
22	41G0											
22	Total	7.30	33.65	58.50	64.00	80.00					8.41	
23	39G2	9.17	32.99	56.41	62.82						11.62	excl. CBH
23	40G2	9.94	42.63	70.05	92.15	79.86	115.41	107.38	139.40		53.19	
23	41G2	8.88	29.33								8.98	
23	Total	9.04	42.55	70.02	91.97	79.86	115.41	107.38	139.40		44.12	
24	37G2	9.95	33.54	48.00							12.88	
24	37G3	8.89	34.24	60.37	69.21	80.98	88.62	87.80			30.04	
24	37G4	20.42	34.20	65.23	78.33	86.53	119.52	138.94	136.25		49.23	
24	38G2	9.42	31.03	53.93	69.05						17.38	
24	38G3	7.63	33.15	61.35	73.66	85.78	96.09	103.39			23.44	excl. CBH
24	38G4	16.39	34.36	71.71	97.14	102.97	114.02	116.70	136.25		60.82	
24	39G2	9.17	32.99	56.41	62.82						15.73	
24	39G3	11.50	33.15	60.74	71.99	88.62	88.74	87.80			32.71	
24	39G4	11.95	34.93	64.99	76.26	79.70	97.18	94.82	136.25		47.24	
24	Total	9.24	33.56	67.33	89.06	96.61	113.00	119.04	136.25		34.38	
22-24	Total	8.15	36.92	67.71	89.33	94.51	113.15	118.68	136.43		26.39	
21-24	Total	9.14	37.18	67.39	89.23	94.29	112.69	118.68	136.43		24.44	

Table 15: **FRV "Solea", cruise 726/2016. Total biomass (t) of herring excl. CBH and mature herring by age/W-rings and area.**

Sub-division	Rectangle/ W-rings	0	1	2	3	4	5	6	7	8+	Total	
21	41G0										0.0	
21	41G1	1,346.4	1,123.1	148.3	31.0	4.5	6.0				2,659.2	
21	41G2	2,907.9	232.2	46.4	3.7	1.0					3,191.1	
21	42G1	1,959.6	593.8	27.8	2.9	2.6	4.6				2,591.3	
21	42G2	1,382.0	74.4	3.1		0.3	0.5				1,460.2	
21	Total	7,595.9	2,023.5	225.5	37.7	8.3	11.0	0.0	0.0	0.0	9,901.8	
22	37G0	613.8	122.0	61.1	24.4						821.2	
22	37G1	1,575.0	589.6	147.1							2,311.7	
22	38G0	1,219.7	227.8	274.9		57.1					1,779.5	
22	38G1	1,939.1									1,939.1	
22	39F9	15.8									15.8	
22	39G0	431.2	19.4								450.5	excl. CBH
22	39G1	79.5	2.9								82.4	
22	40F9	5.6	1.6	1.2							8.4	
22	40G0	219.0	63.0	47.4							329.4	
22	40G1	2,445.1									2,445.1	
22	41G0										0.0	
22	Total	8,543.8	1,026.3	531.6	24.4	57.1	0.0	0.00	0.00	0.0	10,183.1	
23	39G2	147.8	38.6	7.9	10.1						204.4	excl. CBH
23	40G2	77.1	8,086.5	3,910.2	2,333.2	685.2	248.1	60.1	27.9		15,428.4	
23	41G2	517.8	8.5								526.3	
23	Total	742.7	8,133.6	3,918.1	2,343.3	685.2	248.1	60.1	27.9	0.0	16,159.1	
24	37G2	428.9	48.6	1.0							478.5	
24	37G3	539.8	529.0	422.6	505.9	100.4	37.2	12.3			2,147.3	
24	37G4	120.3	1,865.6	1,684.9	3,072.9	1,055.7	503.2	402.9	24.5		8,730.0	
24	38G2	3,460.2	1,451.0	128.9	129.8						5,169.8	
24	38G3	1,882.1	1,392.6	646.0	989.3	277.1	75.9	47.6			5,310.5	excl. CBH
24	38G4	387.3	3,193.1	4,144.8	13,056.6	4,369.0	2,916.6	1,561.5	406.0		30,034.9	
24	39G2	605.6	158.4	33.3	40.8						838.1	
24	39G3	300.6	485.7	199.8	212.4	44.3	27.5	8.8			1,279.1	
24	39G4	125.4	640.6	750.0	1,233.9	417.6	138.0	45.5	16.4		3,367.3	
24	Total	7,850.1	9,764.5	8,011.3	19,241.6	6,264.1	3,698.5	2,078.5	446.9	0.0	57,355.5	
22-24	Total	17,136.6	18,924.4	12,461.0	21,609.2	7,006.4	3,946.6	2,138.7	474.8	0.0	83,697.7	
21-24	Total	24,732.5	20,947.9	12,686.5	21,646.9	7,014.7	3,957.6	2,138.7	474.8	0.0	93,599.5	