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Survey Report
FRV "Walther Herwig III" Cruise 405
03. – 22.05.2017

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

Paco Rodriguez-Tress

1. Introduction

Cruise no. 405 of the FRV "Walther Herwig III" in 2017 was conducted as part of the annual ICES Baltic International Acoustic Spring Survey (BASS). The main objective of this hydroacoustic survey is the yearly assessment of small pelagic fishes stock, especially sprat, in the Baltic proper. BASS is co-ordinated at the international level by the ICES Baltic International Fish Survey Working Group (WGBIFS) where timing, surveying area and the principal methods of investigations are discussed and decided.

German investigation area in 2017 covered ICES subdivisions 24, 25, 26, 27, 28 and 29. Other areas in the Baltic Sea were covered by Lithuania, Latvia, Estonia and Poland.

This cruise followed a one year interruption in the usual annual survey cycle as technical problems with FRV "Walther Herwig III" previous year didn't allow monitoring this area during the BASS 2016.

Distribution list
BLE, Hamburg
Schiffsführung FFS „"W. Herwig"
BMEL, Ref. 614
Thünen-Institut - Präsidialbüro (M. Welling)
Fahrtteilnehmer
Thünen-Institut für Seefischerei
Thünen-Institut für Fischereiökologie
Thünen-Institut für Ostseefischerei
Thünen-Institut - FIZ-Fischerei
Schiffseinsatzplanung, Herr Dr. Rohlf
BFEL Hamburg, FB Fischqualität
IFM-GEOMAR, Kiel
Institut für Fischerei der Landesforschungsanstalt
LA für Landwirtschaft, Lebensmittels. u. Fischerei
BSH, Hamburg
Deutscher Fischerei-Verband e. V., Hamburg
Leibniz Institut für Ostseeforschung
Doggerbank GmbH
Mecklenburger Hochseefischerei Sassnitz
Kutter- und Küstenfisch Sassnitz
Landesverband der Kutter- und Küstenfischer
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2. Survey participants

Name	Function	Institution
P. Rodriguez-Tress	Scientist in charge	TI-OF
Dr. D. Stepputtis	Acoustics	TI-OF (03.-10.05)
Dr. E Bethke	Acoustics	TI-SF (10.-22.05)
Dr. A. Hermann	Fishery biology	TI-OF (03.-10.05)
M. Koth	Fishery biology	TI-OF
D. Stephan	Fishery biology	TI-OF
A. Müller	Fishery biology	TI-OF
M. Wolfram	Fishery biology	TI-OF (03.-10.05)
D. Enkelmann	Fishery biology	TI-OF (student assistant)
H. Heidemann	Fishery biology	TI-OF (student assistant)

3. Methods

3.1. Narrative

Scientific team and biological gear were embarked on FRV "Walther Herwig III" the 2nd May in Bremerhaven. Cruise started the 3rd May after the ship left Bremerhaven in the morning. Acoustic survey started in the morning of the 5th May after reaching the area of investigation and ended the 21th May in the afternoon. Due to optimal weather conditions the 6th May was used to calibrate the Echosounder in the Tromper Wiek. Part of the scientific staff was replaced the 10th May in the morning at the harbour of Sassnitz.
The cruise ended the 22th May after a total of 16 days of hydroacoustic monitoring when scientists disembarked in the afternoon in the harbour of Warnemünde. Good weather conditions allowed fulfilling the main objectives of the cruise.

3.2. Survey design

The acoustic and ichthyologic sampling stratification was based on ICES statistical rectangles (0.5 degree in latitude and 1 degree in longitude). The daily surveyed distance amounted to approximately 90-100 nautical miles with an objective of 60 nautical miles per statistical rectangle. In general each ICES-rectangle was covered with two parallel transects spaced by a maximum of 15-18 nm whenever possible. Survey speed remained close to 10 knots through the cruise. The standard acoustic investigations and the fishing hauls were carried out at daylight from 4:00 - 16:00 UTC (6:00 and 18:00 local time).

The survey covered the whole subdivision 24 except the rectangle 37G4 where time constraint, shallow depth restricting fishing operation and partial cover by the Polish EEZ didn't allow any investigation. With the exception of rectangle 43G8 (SD 28) -overlapping mostly land- all rectangles assigned to German investigation in subdivisions 25 to 29 were covered by hydroacoustic transects. For some rectangles, due to time or spatial constrain the total hydroacoustic track length was however lower than the recommended 60 nautical miles (see Table 1). Absence of licence delivery for some specific planned station in the Swedish EEZ by authorities forced also some track changes, especially in rectangle 42G8 (SD 28) were transect was reduced.

Most hydroacoustic recording and all fishing hauls were carried at daylight from ~4:00 to ~19:00 UTC (6:00 and 21:00 local time). One notable exception occurred on the 10th May where crew change in Sassnitz forced to extend the survey to night-time period (see Table

2). During the survey, hydroacoustic data were recorded at a standard ship speed of 10 knots and hauls done at a speed of about 3 knots.

3.3. Hydrography

A Seabird-CTD-probe with a carousel water sampler and oxygen sensor was used for hydrographical measurements. Vertical profiles were taken on a fixed station grid along the track. Additional CTD casts were done after or before each trawl if distance from the planned station was high enough (ca. 5 nm). The profiles covered the entire water column to about 2 m above the seafloor. Additionally, water samples were taken once per day from different depths to check the oxygen data by Winkler titration and to collect reference salinity samples. The hydrological raw data were aggregated to 1 m depth strata. Additional meteorological observations of air temperature, atmospheric pressure, wind speed and direction were recorded during all hydrographical investigations. Altogether 136 CTD casts were performed during the cruise following this methodology.

3.4. Calibration

Calibration of the hull mounted echosounder took place the 6th May in the coastal area of Rügen Island, the Tromper Wiek. Walther Herwig III was recently equipped with a multifrequency Simrad EK60 echosounder (18, 38, 120 and 200 kHz). Although the survey was done with a 38 kHz frequency (pulse length = 1024 µs; pingrate = 500 ms) each transducer were calibrated at pulse length of 1024, 512 and 256 µs. Calibration procedure itself was carried out as described in the “Manual for International Baltic Acoustic Surveys (IBAS)” (ICES 2015).

3.5. Acoustic data collection

The acoustic equipment used was a Simrad scientific echosounder EK60 operated at 38 kHz. Specific settings of the hydroacoustic equipment were used as described in the “Manual for the Baltic International Acoustic Survey (BIAS)” (ICES, 2015). Echo-integration, i.e. the integration and allocation of NASC values to species abundance and biomass was accomplished using Echoview 8.0 post-processing software. Mean volume back scattering values (sv) were integrated over 1 nm intervals from 10 m below the surface (or depending on surface turbulence) to ca. 0.5 m over the seafloor. Visible interferences from surface turbulence, bottom structures and scattering layers were also removed from the echogram.

3.6. Biological data – fishing stations

Trawling was done with the pelagic gear “PSN205” in the midwater as well as near the bottom to identify the echo signals. The intention was to conduct at least two hauls per ICES statistical rectangle. The trawling time lasted usually 30 minutes by using a trawling speed of about 3 knots. The trawling time was however decreased in case of abundant catch observed with the Scanmar-net-probe. In accordance to the IBAS-manual the following cod end inlets with stretched mesh sizes were used:

- 20 mm in Subdivision 24 and
- 12 mm in Subdivision 25 to 28.

The trawling depth and the net opening were controlled by a Scanmar-net-probe. Generally the net opening was of ca 12 m under usual operation. The trawl depth (headrope below the

surface) was chosen regarding highest density of fish on the echogram and ranged from 5 m to 76 m. The bottom depth at the trawling positions varied from 28 m to 443 m.
Samples were taken from each haul in order to determine the length and weight distribution of fish. Sub-samples of cod, herring and sprat were investigated concerning sex, maturity and age. Samples of whole fishes and parts of different organs/tissues were taken for later investigations in the lab. Detailed biological analyses were made according to the standard procedure (i.e. sex, maturity, otolith dissection).

Totally 49 standard hauls were carried out on the cruise (Figure 1). One haul was conducted with a multinet gear (station 7) to sample different fish layer in the water column but the system failed to open properly, resulting in no-catch at this station. Haul 6 was carried out specifically to investigate weak echo close to the surface (consisting of sticklebacks), resulting in supposed non-representative fish composition through the water column. Finally, haul 1, 10, 18, 19, 20 resulted in low catch weight, number and non-representative species composition.

Length of hydroacoustic transects	1.545 nmi
Number of pelagic trawl hauls valid/invalid	49/1
Number of CTD vertical profiles	136

3.7. Data analysis

The pelagic target species sprat and herring are usually distributed in mixed layers and in combination with other species so that the integrator readings cannot be allocated directly to a single species. Therefore, the species composition used for the conversion of echo integrals into fish abundance, was based on trawl catch results accordingly. For each rectangle the species composition and length distribution was determined as the unweighted mean of all trawl results in this rectangle. In case of missing hauls within an individual ICES rectangle (due to gear problems or other limitations), hauls results from neighbouring rectangles was used.
From these distributions, the mean acoustic cross section σ was calculated according to the following target strength-length (TS) relations:

Clupeids	TS = 20 log L (cm) - 71.2	(ICES 1983)
Gadoids	TS = 20 log L (cm) - 67.5	(Foote et al. 1986)

The total number of fish (total N) in one rectangle was estimated as the product of the mean nautical area backscattering coefficient (i.e. echo integral, Sa in m^2) and the rectangle area (nm^2), divided by the corresponding mean cross section. The total number of fish was separated into herring, sprat and cod according to the mean catch composition. In accordance with the guidelines in the 'Manual for the Baltic International Acoustic Surveys (ICES 2015)', the further calculation was performed in the following way:

With the exception of cod, species with an overall mean contribution to all sampled hauls of less than one percent are excluded from further total species frequency calculation for abundance estimation.

Fish species considered in this report are thus (see results for catch statistics):
- *Clupea harengus*
- *Gadus morhua*
- *Gasterosteus aculeatus*
- *Hyperoplus Lanceolatus*
- *Sprattus sprattus*

Hauls with low level of catch and/or non-representative species compositions were excluded from analysis. This includes the following hauls:

- haul 1; 39G3/SD24
- haul 6; 40G5/SD25 : specifically targeting sticklebacks close to the surface
- haul 7; 39G5/SD25 (gear problem)
- haul 10; 40G5/SD25
- haul 18; 40G6/SD25
- haul 19; 40G6/SD25
- haul 20; 40G7/SD25

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

- haul 2;   38G3/SD24 for 38G2/SD24
- haul 2;   38G3/SD24 for 39G2/SD24
- haul 23; 40G7/SD25 for 40G6/SD25
- haul 49; 41G6/SD25 for 40G6/SD25

As no data is available in the German assigned area for the BASS 2016, results will be compared to those of the BASS 2015 or other previous surveys when relevant.

4. Results

4.1. Hydrographic data

Temperature, Salinity and Oxygen profile along the survey are represented in Figure 2. Seawater temperature ranged from 17.8 °C on the surface to 2.6°C (recorded at 48 m depth). At the deepest CTD recording of the survey (438.5 m) temperature was measured at 6.0°C. Only intermediate water in the Gotland Basin presented temperature below 4°C, which could be a temperature threshold limiting sprat distribution in the water column. In this regard it is noteworthy that echo density was relatively low in this water layer (see Figure 3).

Measured salinity ranged from 5 psu at the surface layer to 19 psu at the bottom of the Bornholm Basin and didn’t exceed 15 psu at the bottom of the Gotland Basin.

Regarding oxygen, concentration ranged from 5 to 10 $mL.L^{-1}$ above halocline and dropped below 1 $mL.L^{-1}$ under this layer. Overall hypoxic conditions (<1.4 $mL.L^{-1}$, ~30% atmospheric saturation) were observed below 70-80 m depth all along the survey. No fish echo is observed under these conditions (see Figure 3).

4.2. Acoustic data

The basic results are given in Table 3 (survey area, mean s_A, mean scattering cross section σ, estimated total number of fish and percentage of herring and sprat per rectangle).

The valid measured cruise track reached a distance of 1306 nautical miles. On an ICES subdivision scale the mean NASC values in SD 24, 25 and 28 were comparable to those recorded in 2015 (Figure 4). More fluctuation are observed for these 2 years in the SD 26, 27 and 29 with, for 2017, a higher recorded mean NASC in SD 26 and lower one in SD 27 and 29. Overall mean NASC appear above average in 2017 with a mean NASC of 597.6 m^2/nm^2 compared to a mean NASC of 431.0 m^2/nm^2 for all years polled together. However, due to survey track changing from one year to the other, direct comparison is not possible as fish density may well be spatially correlated to landscape.

Echo distributions along the hydroacoustic tracks (Figure 5) shows heterogeneous fish concentration in SD 24, and to a lesser extend in SD 25. Mean NASC recorded in SD 26, 27, 28, 29 appear to be more homogeneous along the transects. As noted in 2015, mean NASC is lower in SD 24 than in other Subdivisions (Figure 4).

4.3. Biological data

Catch statistics per fishing hauls are presented in Table 4 and per species in Table 5. Overall 9 fish species were recorded in 49 pelagic trawl hauls. Dismissing the hauls with low catch level, the CPUE ranged from 2.4 to 1429.3 kg/0.5h. The mean catch reached with 286.7 kg/0.5h.
In terms of weight, catch was dominated by sprat (91.1%) followed by herring (6.7%) and stickleback (1.6%). Those three species were caught on the majority of the trawls through the survey. The numbers and biomass of species other than herring, sprat and stickleback was negligible. CPUE of sprat seems to be increasing since the last 5 years with the exception of SD 25 were catches were relatively low compared to those recorded in 2013 and 2014 (203.7 vs 688.3 and 642.0 kg / 0.5 h respectively). This trend is not observed for herring with relatively average to low catches observed this year, especially in SD 24 to 26. Regarding cod, catches per subdivision were also low compared to previous years. The total CPUE calculated for cod is 1.1 kg / 0.5 h which represent, with 2012 (0.8 kg / 0.5 h) the lowest level of catch recorded during this type of survey.

Figure 6 show the length frequency distribution for sprat and herring per subdivision in 2015 and 2017. Age distribution per length class is presented in Figure 7. Missing length class for the age distribution were reconstructed by calculating a weighted mean of adjacent upper and lower classes. Final age distribution by subdivision for 2015 and 2017 (Figure 8 and Figure 9 respectively) was calculated according to the minimum effort method by multiplying the length frequency distribution with the age distribution per length class as recommended in the IBAS Manual (2015: eq 5.3.1).

As shown by the last figures, proportion of incoming year class in both herring and sprat population was notably lower in 2017 compared to 2015 in almost all subdivision (the exception being SD 24 for sprat). The large incoming year class observed in 2015 for both sprat and herring can still been seen as the well represented 3 year old class in Figure 9. Two years age class was also relatively low compared to the 3 years age class, especially for herring. Overall proportion of 1 year old sprat and herring was lower in SD 25 and 26 compared to other subdivisions in 2017.

4.4. Abundance estimates

The calculated abundance in number and weight of sprat and herring per rectangle and subdivision is presented in Table 6.

As the covered area is not exactly the same between the cruise of 2015 and 2017, following comparison of estimated biomass of sprat and herring for the two year is done only for statistical rectangles monitored both years.

Estimated abundances in all overlapping rectangle for herring and sprat are lower in 2017 compared to 2015 with respectively $5.6*10^9$ versus $18.2*10^9$ herrings (- 69%) and $92.5*10^9$ versus $77.3*10^9$ sprats (- 19%). Estimated biomass is also lower in 2017 for herring with $146.7*10^3$ tonnes versus $264.2*10^3$ tonnes estimated in 2015 (- 44%) for the same rectangles. Despite lower calculated number of sprat in 2017, estimated biomass was slightly higher in 2017 with 669.6*10^3 tonnes versus 656.8*10^3 tonnes in 2015 (+ 2%). This result is explained by a higher proportion of the larger sprat compared to 2015 (see section 3.2).

Year	Species	n total (million)	total biomass (tonne)
2015	*Clupea harengus*	18165.6	264159.9
2017		5584.8	146653.8
2015	*Sprattus sprattus*	92477.0	656751.9
2017		77331.3	669594.4

5. Discussion

Although this cruise can be considered a success regarding assigned objectives, absence of data for 2016 doesn't allow evaluation the abundance index evolution between 2016 and 2017. Proportion of incoming year class in 2017 however point toward a lower recruitment process for both herring and sprat relatively to 2015. Low proportion of 2 years old class in 2017 for herring would also suggest a similar pattern in 2016. Although estimated biomass of herring was lower (- 44%) biomass of sprats was however slightly higher than in 2015 in similar area due to the higher proportion of larger sprat in the population.

6. Acknowledgements

We are grateful to Captain Jürgen Vandrei and to the vessel's crew for their continuous support during the cruise.

7. References

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

ICES 2015. Report of the Baltic International Fish Survey Working Group (WGBIFS). ICES Document CM 2014/SSGESST:13, Addendum 2: SISP Manual of International Baltic Acoustic Surveys (IBAS),Version 0.82

Foote, K.G., Aglen, A. and Nakken, O. 1986. Measurement of fish target strength with a split-beam echosounder. Journal of the Acoustical Society of America, 80(2): 612-621.

8. Tables

Table 1: FRV "W. Herwig" cruise 405/2017. Hydroacoustic track length per ICES rectangle.

ICES rectangle	hydroacoustic track length (nmi)		ICES rectangle	hydroacoustic track length (nmi)
37G4	0		41G7	82
38G2	21		41G8	88
38G3	90		42G7*	14
38G4	59		42G8	28
38G5*	12		42G9	56
39G2	20		43G8	0
39G3	80		43G9	77
39G4	61		44G9	69
39G5	88		45G8	45
39G6*	34		45G9	72
40G4	54		46G8	54
40G5	69		46G9	61
40G6	69		46H0	41
40G7	65		47G9	30
40G8*	22		47H0	12
41G6	72			

* ICES rectangle not assigned to German investigation

Table 2: FRV "W. Herwig" cruise 405/2017. Start and end time of hydroacoustic recording during the cruise.

day	start time (UTC)	end time (UTC)		day	start time (UTC)	end time (UTC)
05.05.2017	04:03	17:48		14.05.2017	04:02	15:28
07.05.2017	03:40	16:52		15.05.2017	04:05	16:10
08.05.2017	03:38	18:46		16.05.2017	03:53	17:14
09.05.2017	03:48	15:36		17.05.2017	04:04	16:11
10.05.2017	08:59	21:26		18.05.2017	04:03	16:18
11.05.2017	04:03	14:48		19.05.2017	04:02	16:59
12.05.2017	04:02	17:42		20.05.2017	04:05	15:17
13.05.2017	03:58	16:40		21.05.2017	04:01	15:02

Table 3: FRV “W. Herwig” cruise 405/2017. Survey statistics of the Cruise.

subdivision	rectangle	area (nm²)	sa (m²/nm²)	sigma (m²) (*10e-4)	n total (million)	*Clupea harengus* (%)	*Sprattus sprattus* (%)	*Gadus morhua* (%)
24	38G2	832,9	50,6	1,177	358,07	0,97	99,02	0
24	38G3	865,7	402,4	1,583	2200,62	5,53	94,46	0
24	38G4	1034,8	290,1	1,671	1796,5	0,5	99,49	0
24	39G2	406,1	175,9	1,177	606,91	0,97	99,02	0
24	39G3	765	133,1	3,873	262,9	88,54	11,36	0,1
24	39G4	524,8	213,6	1,899	590,3	2,38	97,62	0
25	39G4	287,3	446,4	2,192	585,09	24,01	75,99	0
25	39G5	979	753,9	1,462	5048,35	0,96	98,98	0,06
25	40G4	677,2	471,8	1,738	1838,34	26,58	49,04	0
25	40G5	1012,9	630,8	2,309	2767,16	56,88	41,74	0
25	40G6	1013	834,9	1,332	6349,5	0,14	99,81	0
25	40G7	1013	598,5	1,178	5146,69	0,17	99,82	0
25	41G6	764,4	626,9	1,317	3638,59	0,78	94,71	0
25	41G7	1000	599,2	1,24	4832,26	0,27	99,22	0
26	41G8	1000	762,4	1,199	6358,63	0,34	99,62	0
27	45G8	947,2	322,4	1,018	2999,78	3,03	86,83	0
27	46G8	884,8	694,6	0,772	7960,91	4,04	44,71	0
28	42G8	945,4	636,2	1,113	5403,98	0,24	98,59	0
28	42G9	986,9	930,1	1,176	7805,41	1,1	98,58	0
28	43G9	973,7	548,8	1,087	4915,98	3,27	81,41	0,01
28	44G9	876,6	554,6	1,15	4227,5	2,8	92,16	0,01
28	45G9	924,5	746	0,875	7882,02	9,39	46,35	0
29	46G9	933,8	647,8	1,097	5514,27	6,69	89,39	0,01
29	46H0	933,8	835,1	1,123	6944,05	9,99	88,66	0,01
29	47G9	876,2	656,4	1,016	5660,8	17,07	48,06	0
29	47H0	920,3	422,4	1,25	3109,88	26,64	60,93	0

Table 4: FRV "W. Herwig" cruise 405/2017. Catch statistics per fishing haul.

Station	Catch weight (kg)	Fish number (n)	Station	Catch weight (kg)	Fish number (n)
1	0.899	22	26	255.864	34942
2	114.267	12514	27	235.497	39122
3	13.62	809	28	295.521	39064
4	150.328	12133	29	141.071	16763
5	20.476	962	30	95.876	11806
6	44.9	27662	31	110.471	16355
7	0	0	32	21.941	5721
8	570.641	52333	33	154.206	16941
9	791.854	74326	34	77.375	8647
10	0.112	12	35	4.685	897
11	25.781	1162	36	137.085	18700
12	436.425	39529	37	221.555	29309
13	10.336	496	38	182.564	25280
14	50.166	995	39	127.234	17269
15	60.268	3358	40	133.465	16927
16	355.786	21756	41	147.022	19055
17	1429.321	101415	42	60.539	23048
18	0.854	185	43	46.028	7365
19	2.25	105	44	150.479	23125
20	1.435	104	45	165.15	19164
21	207.364	22702	46	2.402	337
22	338.259	41045	47	173.298	22326
23	162.53	20376	48	156.384	17751
24	170.721	19744	49	216.146	18095
25	175.19	22866	50	57.671	7576

Table 5: FRV "W. Herwig" cruise 405/2017. Catch statistics per species.

Species	No. of trawl hauls with the species	No. of length measurements	No. of individual measurements	Total catch (kg)	Percent of total catch	Overall mean contribution to all sampled haul (%)
CLUPEA HARENGUS	47	8842	880	571.8	6.72	11.3
ENGRAULIS ENCRASICOLUS	1	3	0	0.1	< 0.001	< 0.01
GADUS MORHUA	14	112	74	44.4	0.52	< 0.01
GASTEROSTEUS ACULEATUS	41	2838	0	139.9	1.64	16.2
HYPEROPLUS LANCEOLATUS	4	57	0	0.8	0.01	1.0
MERLANGIUS MERLANGUS	2	2	0	0.6	0.01	< 0.01
MYOXOCEPHALUS SCORPIUS	1	1	0	0.1	< 0.001	< 0.01
PLATICHTHYS FLESUS	9	14	0	2.7	0.03	< 0.01
SPRATTUS SPRATTUS	46	11845	615	7743	91.06	71.5

Table 6: FRV “W. Herwig” cruise 405/2017. Total number and biomass of sprat and herring per rectangle.

Subdivision	Rectangle	n herring (million)	herring biomass (tonne)	n sprat (million)	sprat biomass (tonne)
24	38G2	3.45	147.6437	354.56	3088.7206
24	38G3	121.78	6257.9422	2078.65	25507.5286
24	38G4	9.04	484.0019	1787.3	26571.4468
24	39G2	5.86	250.496	600.96	5235.1492
24	39G3	232.79	12573.6617	29.87	478.6845
24	39G4	14.07	874.0534	576.23	9855.5534
25	39G4	140.49	6165.2192	444.6	6257.1305
25	39G5	48.54	2003.4787	4996.74	53562.1104
25	40G4	488.55	15887.1892	901.59	13027.3551
25	40G5	1574.1	48436.2735	1154.97	14108.171
25	40G6	8.81	242.1932	6337.41	61310.4714
25	40G7	8.59	249.4287	5137.58	41229.1429
25	41G6	28.43	654.6467	3446.11	34250.4451
25	41G7	12.94	371.4864	4794.47	41405.8296
26	41G8	21.88	573.3439	6334.75	49421.9127
27	45G8	90.47	1318.0367	2580.89	18001.3491
27	46G8	321.96	5329.0389	3551.63	27800.1869
28	42G8	12.92	364.0113	5327.54	38416.7613
28	42G9	85.95	2254.9033	7694.87	58493.5867
28	43G9	160.22	4507.3296	4001.94	29934.6145
28	44G9	118.43	2650.9928	3895.9	29376.6653
28	45G9	739.95	13348.9748	3653.17	27181.806
29	46G9	369.17	5309.1549	4929.05	34438.614
29	46H0	693.57	9546.5108	6156.56	42496.4549
29	47G9	966.38	16400.29	2720.53	20641.1636
29	47H0	828.47	13977.7886	1894.82	13820.1106

9. Figures

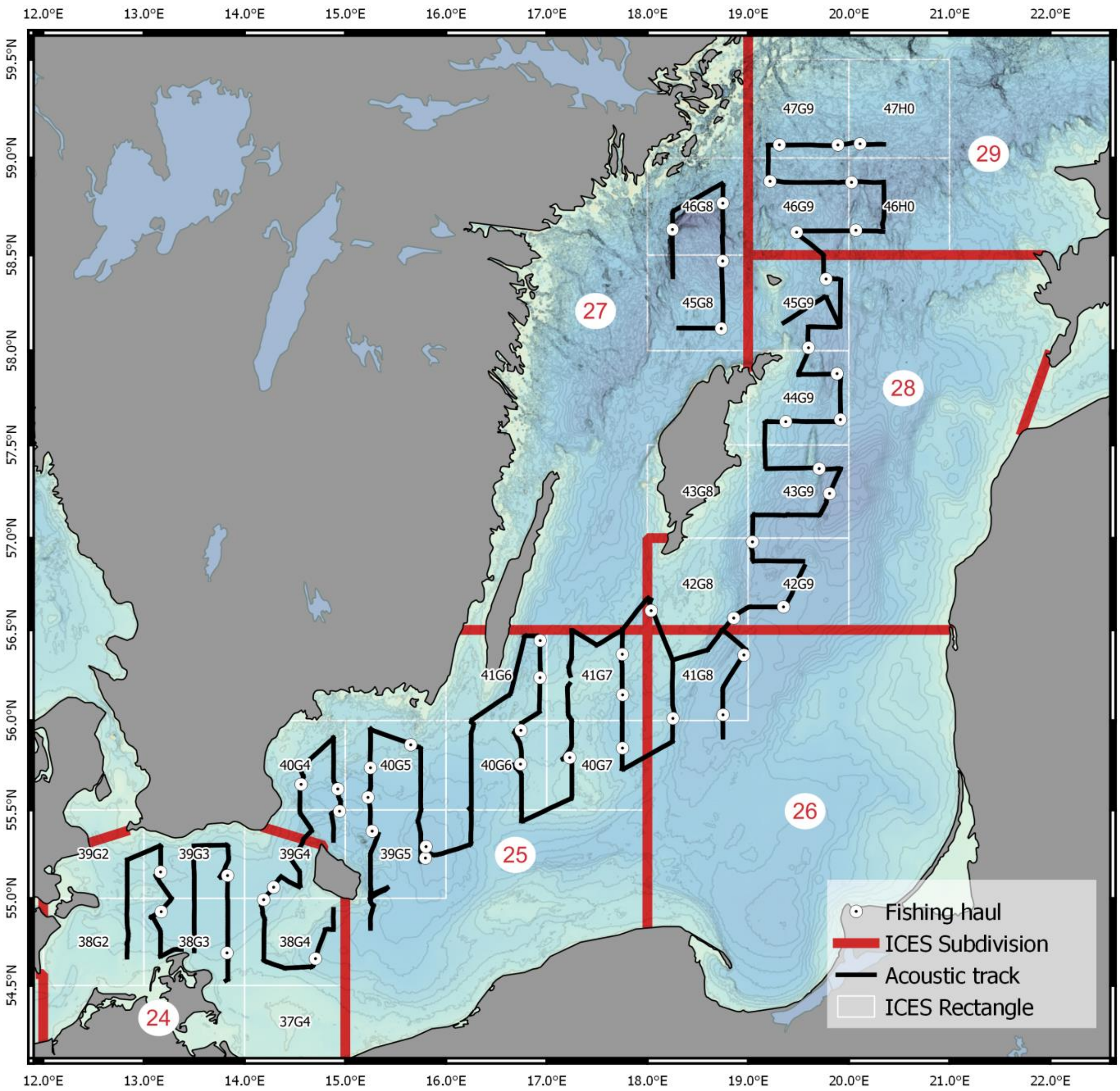

Figure 1: FRV “W. Herwig” cruise 405/2017. Hydroacoustic transect and fishing hauls.

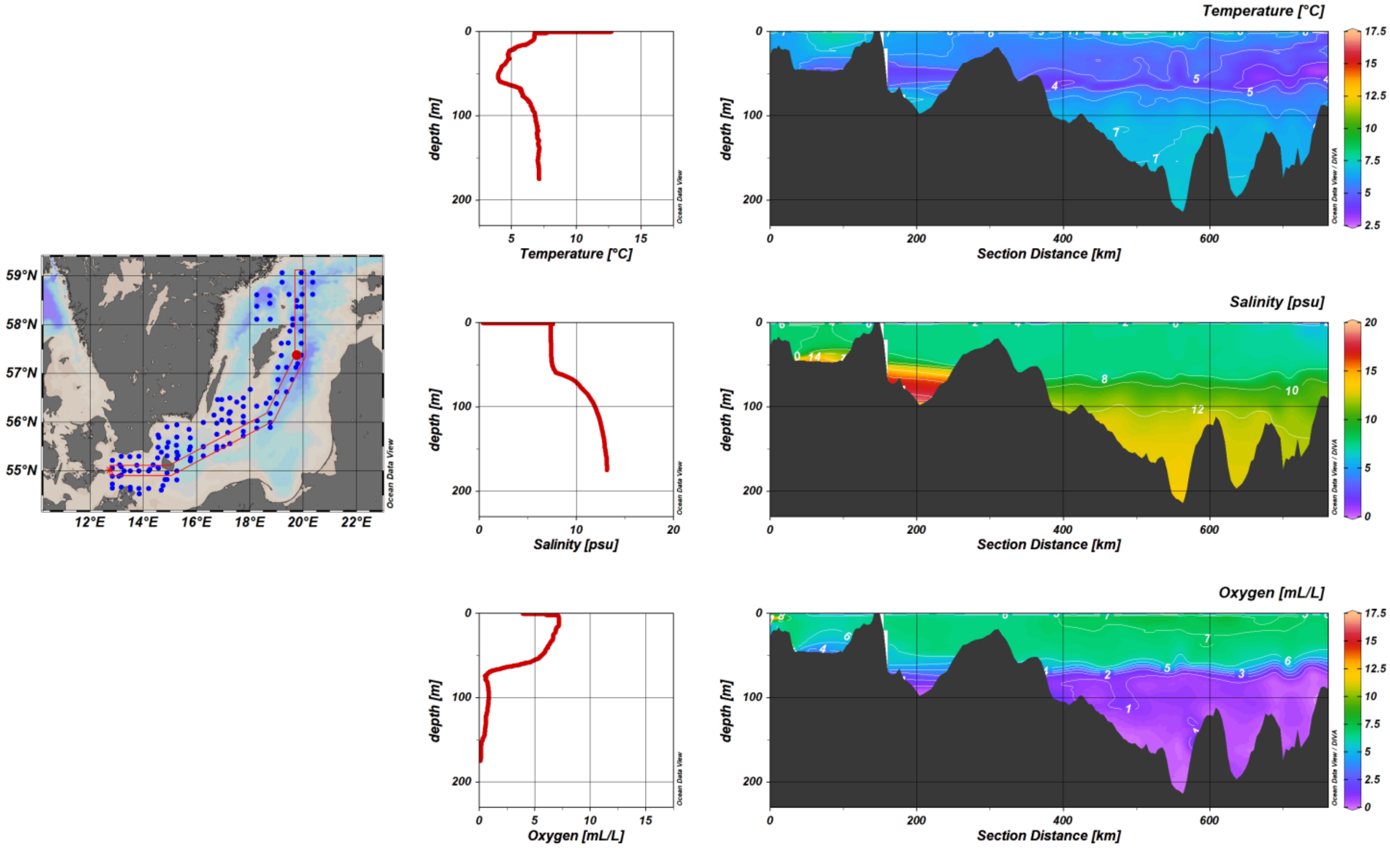

Figure 2: FRV "W. Herwig" cruise 405/2017. Water temperature, salinity and oxygen interpolated from CTD casts along a SW-NE section shown on the left map.

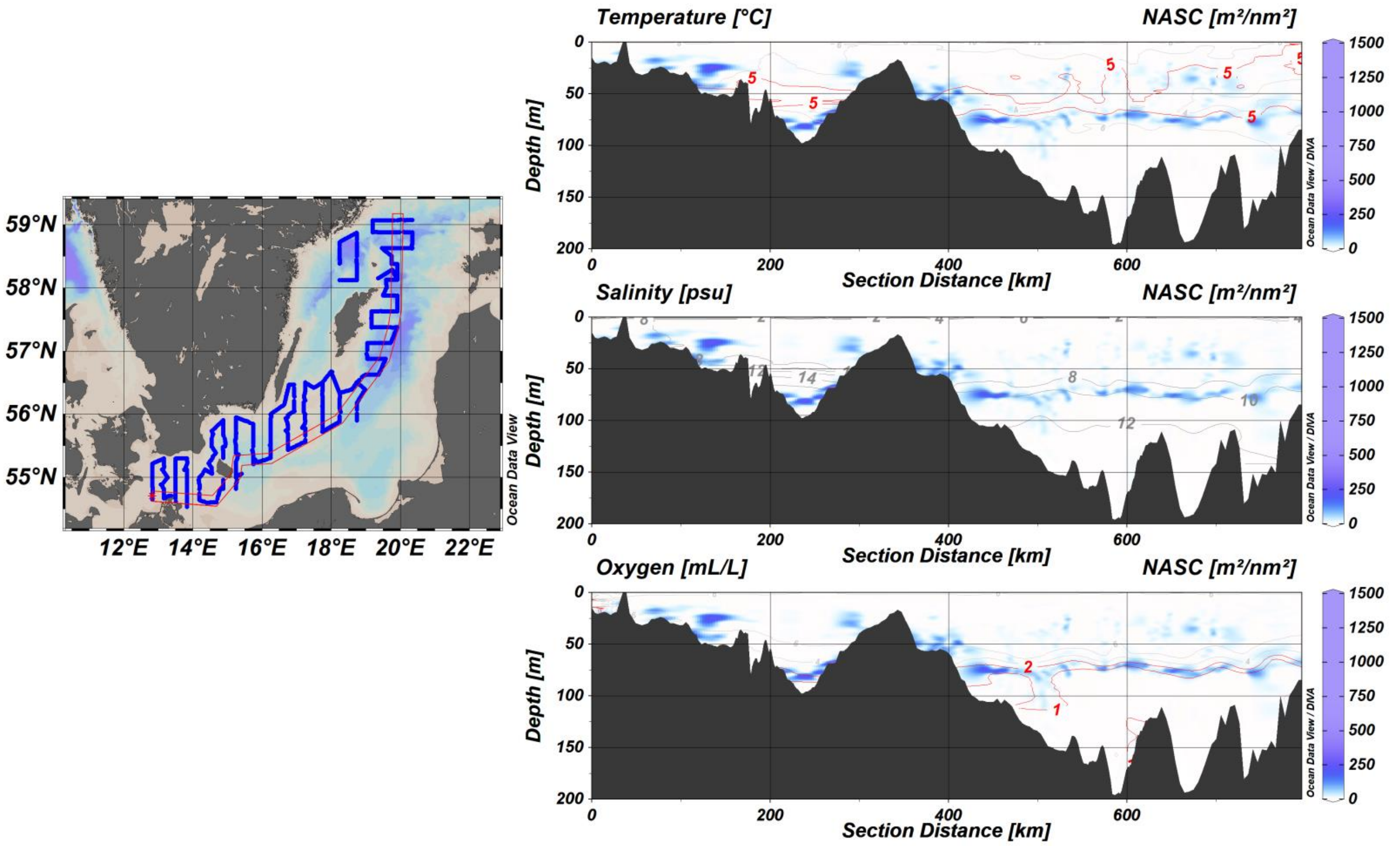

Figure 3: FRV “W. Herwig” cruise 405/2017. Vertical distribution of salinity, temperature and oxygen related to the echogram of fish (blue clouds).

Figure 4: FRV “W. Herwig” cruise 405/2017. Mean NASC calculated per year and per subdivision

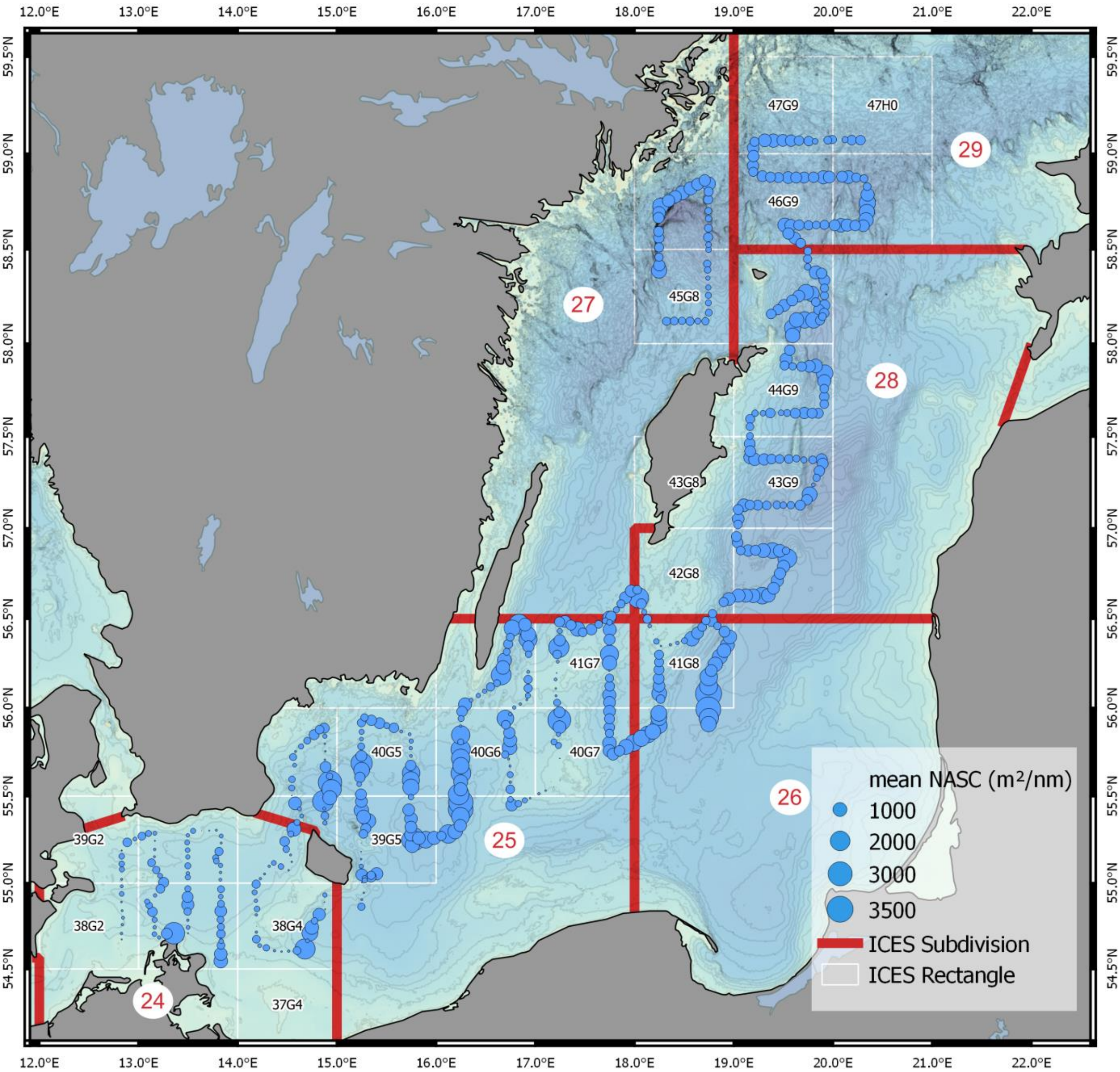

Figure 5: FRV “W. Herwig” cruise 405/2017. Mean NASC calculated per 5nm of transect

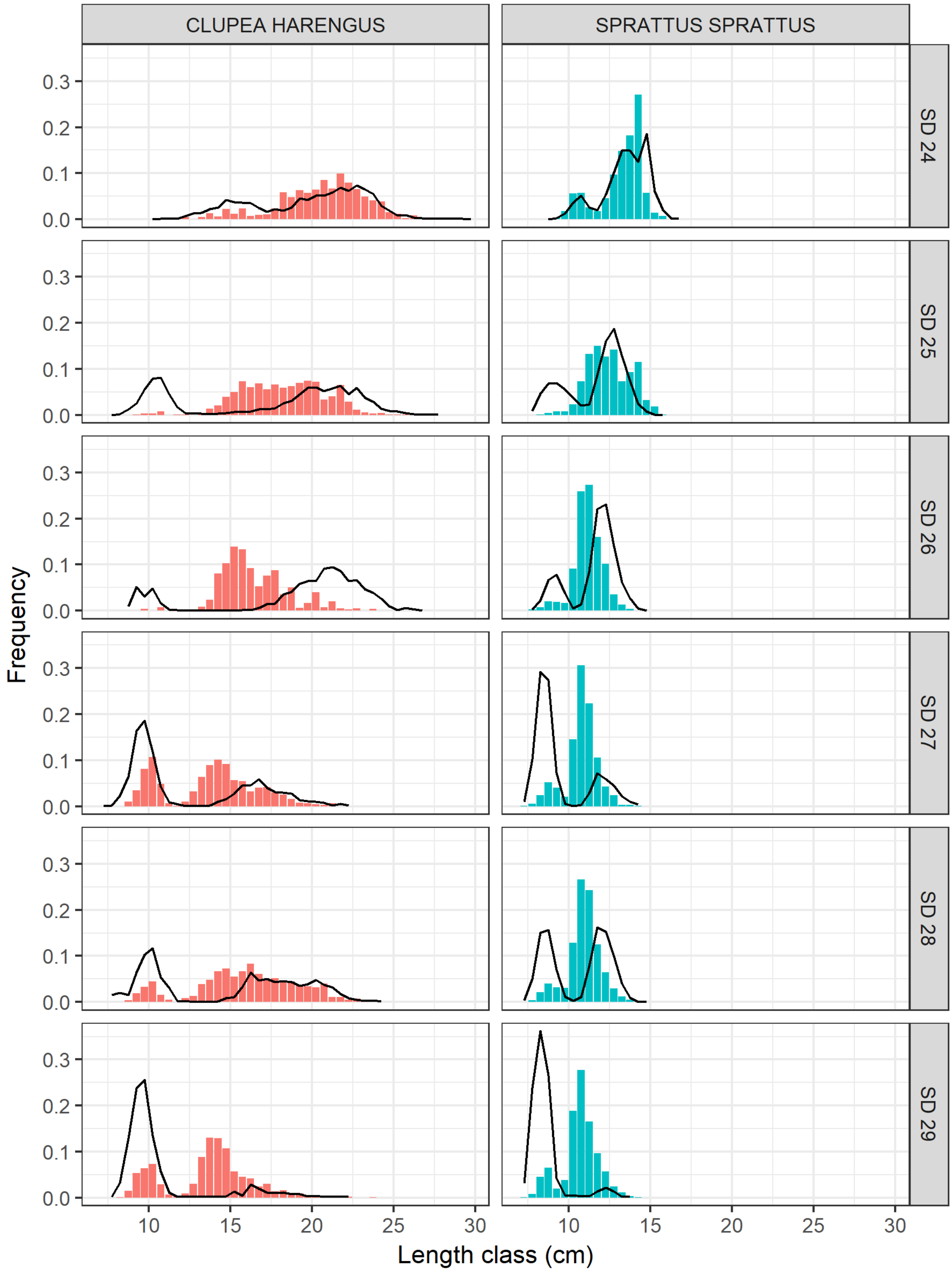

Figure 6: FRV "W. Herwig" cruise 405/2017. Length distribution per species and subdivision for 2015 (black line) and 2017 (bar).

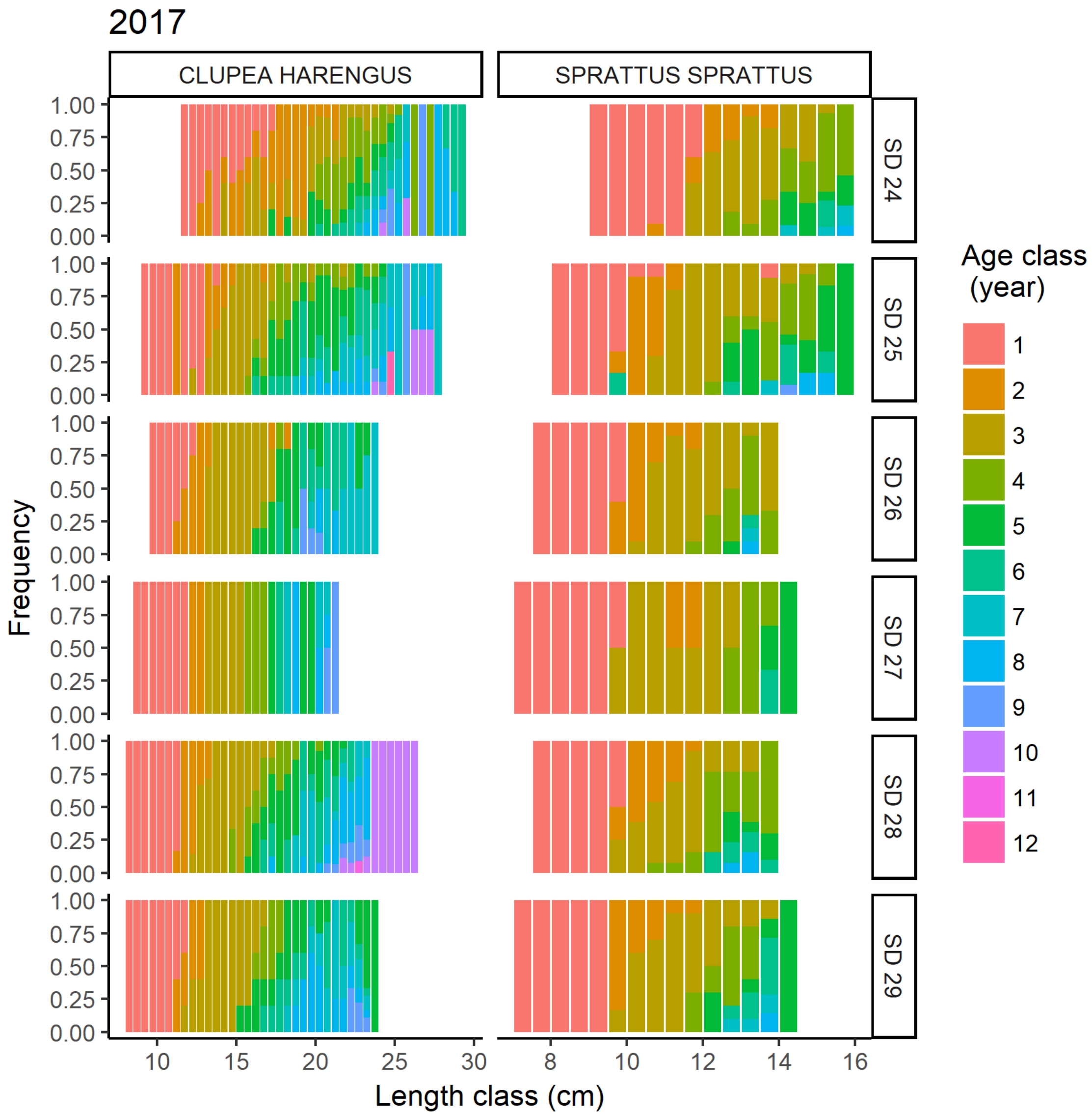

Figure 7: FRV “W. Herwig” cruise 405/2017. Age distribution per length class, species and subdivision for 2017.

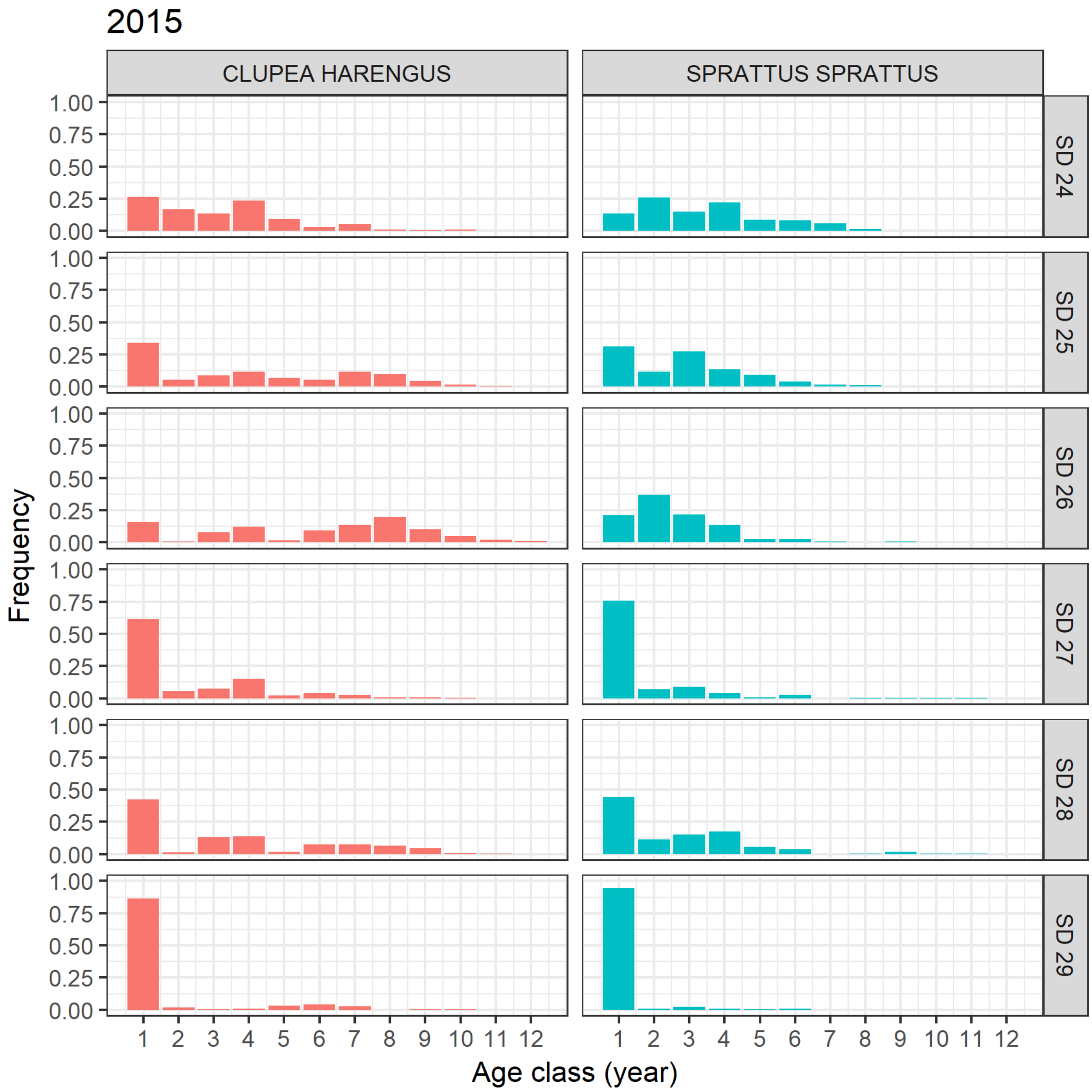

Figure 8: FRV “W. Herwig” cruise 384/2015. Calculated age class distribution per species and subdivision in 2015.

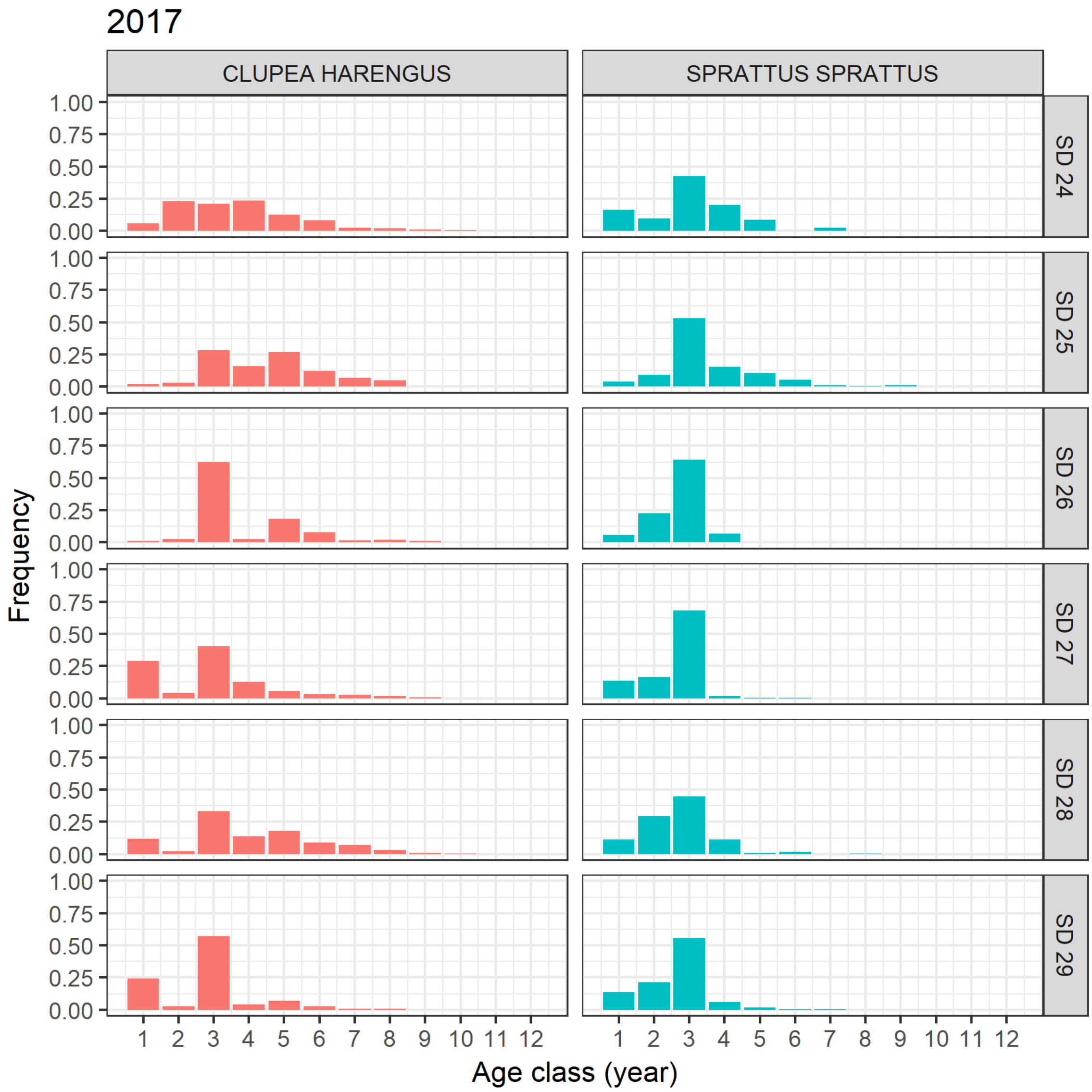

Figure 9: FRV “W. Herwig” cruise 405/2017. Calculated age class distribution per species and subdivision in 2017.