

**Cruise Report FRV "Solea II" Cruise 747  
30.04. – 25.05.2018**

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

Scientist in charge: Paco Rodriguez-Tress (TI-OF)

## 1. Introduction

Cruise no. 747 of the FRV "Solea II" 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 2018 covered ICES subdivisions 24, 25, 26, 27, 28 and 29. Other areas in the Baltic Sea were covered by Lithuania, Latvia, Estonia and Poland.

In addition to the BASS the last days of the cruise, from the 21<sup>th</sup> to the 24<sup>th</sup> May, were used to conduct hydroacoustic experiments in the Bornholm Basin with the aim to recorded additional wideband acoustic signature of clupeids and cod and to study their diel vertical migration.

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### Distribution list:

BLE, Hamburg  
Schiffsführung FFS „SOLEA“  
BMELV, Ref. 622  
TI, Präsidialbüro (M. Welling)  
TI, Verwaltung Hamburg  
TI-FOE  
TI-OF  
TI-SF  
TI, FIZ-Fischerei  
TI, PR  
TI, Einsatzplanung Forschungsschiffe  
BFEL Hamburg, FB Fischqualität

Deutscher Fischerei-Verband e. V., Hamburg  
Leibniz Institut für Ostseeforschung  
Doggerbank GmbH  
Mecklenburger Hochseefischerei Sassnitz  
Kutter- und Küstenfisch Sassnitz  
Landesverband der Kutter- und Küstenfischer  
Sassnitzer Seefischer  
Deutsche Fischfang Union Cuxhaven  
Fahrtteilnehmer  
IFM-GEOMAR, Kiel  
LA für Landwirtschaft, Lebensmittels. u. Fischerei  
BSH, Hamburg  
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## 2. Cruise objectives

The cruise was split in two distinct parts with the following objectives:

- **Part 1 BASS**
  - Hydroacoustic measurements for the assessment of small pelagics from the Arkona Sea to Gotland Sea (ICES subdivisions 24 to 29).
  - Fishing with pelagic trawl according to hydroacoustic requirements and biological measurement of catches (species, length composition, sex, maturity and age).
  - Sampling of herring, sprat and cod (whole fish, otoliths, stomachs and gonads) for further laboratory studies at the TI-OF.
  - Hydrographic measurements with CTD probe on predetermined station and after each fishing station. In case of time constraints, only part of the hydrographic stations will be realized.
  
- **Part 2 Hydroacoustic experiments in Bornholm Basin**
  - Study of fish diel vertical migration and hydroacoustic experiments in Bornholm Basin with similar experimental design to the Solea cruise n°745 part B.
  - Night fishing with a multinet gear to identify monospecific schools of fish and gather wideband acoustic data for remote species classification.

## 3. Cruise narrative and preliminary results

### 3.1. Narrative

The scientific gear was loaded on the FRV "Solea II" the 25<sup>th</sup> April in the harbour of Rostock Marienhe. Cruise started the 30<sup>th</sup> April after the ship left Rostock in the morning. Due to good weather conditions the 30<sup>th</sup> April, the day was used to calibrate the echosounder in front of Kühlungsborn, Germany.

Acoustic recording for the BASS started in the morning of the 1<sup>st</sup> May after reaching the area of investigation in ICES subdivision 24. The Trawl-Eye sensor mounted on the haul broke down the 2<sup>nd</sup> May. Fishing operations were stopped for the day as it proved too difficult to target fish in the water column without the system. Hydroacoustic data were still gathered for the day but the ship steamed to the harbour of Sassnitz in the evening for technical assistance. The Trawl-Eye system from the FRV "Clupea" was retrieved and installed on the net the 3<sup>rd</sup> May in the morning and fishing tests were done in the afternoon in the Arkona area. The survey was resumed the 4<sup>th</sup> May in the morning and, although one of the two pelagic nets broke while fishing the 7<sup>th</sup>, it continued uninterrupted until the 16<sup>th</sup> May. Due to the long-time at sea a two days break was done the 17<sup>th</sup> and 18<sup>th</sup> May in the harbour of Visby, Gotland. The BASS ended the 20<sup>th</sup> May in the afternoon north west of Gotland in SD 27.

The last days of the cruise were then used to collect wideband echo data of monospecific schools and study their diel vertical migration in the Bornholm Basin from the 21<sup>th</sup> to the 24<sup>th</sup> in the evening, after what the ship steamed back to Rostock.

The cruise ended the 25<sup>th</sup> May after a total of 17 days of hydroacoustic monitoring and 3 days of experiments when scientists disembarked in the morning in the harbour of Marienhe,

Rostock. Although some technical difficulties at the beginning of the cruise the good weather conditions allowed to complete the main objectives of the survey.

## **3.2. Hydroacoustic sampling**

- **Part 1 BASS survey**

The Solea II is equipped with four Simrad EK80 wideband echosounders (18, 38, 120 and 200 kHz). Although the BASS was done with a 38 kHz frequency (pulse length = 1024  $\mu$ s; pingrate = 500 ms) each transducer were calibrated at a pulse length of 1024, 512 and 256  $\mu$ s in narrow and broadband mode in prevision of the 2<sup>nd</sup> part of the cruise. Calibration procedure itself was carried out as described in the “Manual for International Baltic Acoustic Surveys (IBAS)” (ICES 2017).

During the BASS survey the EK80 operated at 38 kHz in continuous wave (CW) mode during usual recording along the transect and in frequency modulated (FM) mode with a frequency band ranging from 35 to 45 kHz while fishing.

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. Ship's speed was 10 knots during acoustic measurements while fishing operation were conducted at 3 to 3.5 knots. The standard acoustic investigations and the fishing hauls were carried out at daylight from 4:00 - 19:00 UTC (6:00 and 21:00 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 (see Figure 1). With the exception of rectangle 43G8 (SD 28) - where fishing license were not granted- 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 also forced some track changes, especially in rectangle 42G8 (SD 28) where transect was reduced.

A map of the averaged NASC per 5 nmi based on the preliminary analysis is presented in Figure 2. The final cleaning and analysis of the hydroacoustic data will be accomplished by the end of 2018.

- **Part 2 Hydroacoustic experiments in Bornholm Basin**

Hydroacoustic recording from the 21<sup>th</sup> to the 24<sup>th</sup> May were done in frequency modulated mode (frequency range from 34 kHz to 260 kHz) on a 3 nmi per 3 nmi triangle shaped transect located above the deepest part of the Bornholm basin. This transect was followed continuously for 48h at a constant speed of 3 knots while fishing both at day and night. While clupeids and cods were found in mixed schools near the halocline at about 70m deep during the day, a clear separation of both groups was observed at night time when clupeids started

to migrate close to the surface. Due to the very good weather conditions and absence of wind it was decided to leave the ship drifting in the area from the 23<sup>rd</sup> in the afternoon the 24<sup>th</sup> in the morning in order to record some extended fish tracks inside the beam of the echosounder. The day of the 24<sup>th</sup> was then used to cover the Bornholm Basin with an hydroacoustic transect to estimate fish abundance in the area before steaming back to Rostock in the evening.

### 3.3. Biological sampling

- **Part 1 BASS survey**

Trawling was done with the pelagic gear “PSN388” in the midwater as well as near the bottom to identify the echo signals. The aim was to conduct at least two fishing hauls per ICES statistical rectangle. The trawling time lasted usually 30 minutes at a speed of 3 to 3.5 knots. The fishing time was however decreased in case of abundant catch observed with the Scanmar-net-probe. In accordance to the IBAS manual cod end inlets with stretched 20 mm mesh sizes in Subdivision 24 and 12 mm in Subdivision 25 to 28 were used. While this setting was respected for most of the survey, net damage and replacement the 6<sup>th</sup> May (station 248/59) forced to revert back to a 20 mm codend for the day although still fishing in SD 25 (stations concerned: 251/62, 254/65 and 257/68). The 12 mm codend was then available again for fishing the 7<sup>th</sup> May for the first haul of the day.

The trawling depth and the net opening were controlled by a Scanmar-net-probe. Generally the net opening was of ca. 8 m under usual operation. The trawl depth (headrope below the surface) was chosen regarding highest density of fish on the echogram and ranged from 10 m to 75 m. The bottom depth at the trawling positions varied from 21 m to 445 m.

Samples were taken from each haul in order to determine the length and weight distribution of fish. Overall, with the exception of herring in SD 24, length distribution of clupeids tended to be bigger than observed during the BASS 2017 (see Figure 3).

Sub-samples of cod, herring and sprat were done to investigate sex, maturity and age of the catches. Samples of whole fishes and parts of different organs/tissues were also taken for later investigations in the laboratory. Detailed biological analyses were made according to the standard procedure (i.e. sex, maturity, otolith dissection).

In total 60 standard hauls were carried out for the BASS:

Subdivision	Hauls (n)
24	8
25	19
26	4
27	8
28	13
29	8

Altogether 39813 fish were measured and 1930 additional fish (772 sprats and 1158 herrings) were sampled for further age determination

Species	Length measurements	Number of hauls
CLUPEA HARENGUS	11312	56
GADUS MORHUA	199	29
GASTEROSTEUS ACULEATUS	3297	49
HYPEROPLUS LANCEOLATUS	2	2
MERLANGIUS MERLANGUS	16	6
PLATICHTHYS FLESUS	31	18
RHINONEMUS CIMBRIUS	1	1
SCOMBER SCOMBRUS	3	1
SPRATTUS SPRATTUS	24952	56

Overall catch (kg.0.5 hr<sup>-1</sup>) during the BASS per haul and per subdivision is represented in Table 1 to Table 6.

- **Part 2 Hydroacoustic experiments in Bornholm Basin**

Fourteen additional hauls were carried out during the last days of the cruise in Bornholm Basin (SD 25) while conducting hydroacoustic experiments. One test haul was also conducted with a multinet gear in SD 27 the 20<sup>th</sup> May in prevision of the second part of the survey but the system failed to open properly and the standard net was used for the rest of the cruise. In total, 6892 fish were measured for length distribution statistic during the second part of the cruise. Biological data for the second part of the Solea cruise n°747 are still being processed.

Species	Length measurements	Number of hauls
CLUPEA HARENGUS	706	14
CYCLOPTERUS LUMPUS	1	1
GADUS MORHUA	680	11
GASTEROSTEUS ACULEATUS	1	1
PLATICHTHYS FLESUS	4	4
RHINONEMUS CIMBRIUS	1	1
SPRATTUS SPRATTUS	5499	13

### 3.4. Hydrography

A Seabird-CTD-probe equipped 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 nmi). The profiles covered the entire water column to about 2 m above the sea bottom except on the deepest station where the cable length of the

ship was limited to ~320m. 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. Altogether 237 CTD casts were performed during the cruise following this methodology.

Measurements showed a regular stratification of the water column during the survey. Temperature, Salinity and Oxygen profile are represented in Figure 4. Seawater temperature ranged from 14.9 °C at the surface to 2.0°C (recorded at 22.5 m depth). At the deepest CTD recording of the survey (309.5 m) temperature was measured at 6.3°C. Overall intermediate water masses (depth ranging from 6.5 to 74.0 m) presented temperature below 4°C, which is considered as a temperature threshold limit for the distribution of sprat in the water column, while higher temperature were recorded above and below this stratum. Measured salinity ranged from 5.2 psu at the surface layer up to a maximum of 17.9 psu at the bottom of the Bornholm. Regarding oxygen, concentration ranged from 5 to 13 mL.L-1 in the intermediate water mass 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 m depth all along the survey. No fish echo were usually observed under these conditions.

#### 4. Survey participants

Name	Function	Institution
P. Rodriguez-Tress	Scientist in charge	TI-OF
B. Lüdke	Acoustics	TI-SF
L. Wietrzinsky	Fishery biology	TI-OF
K. Shöps	Fishery biology	TI-OF
M. Bächtiger	Fishery biology	TI-OF (student assistant)
N. Köstner	Fishery biology	TI-OF (student assistant)
S. Winning	Fishery biology	TI-OF (student assistant)

#### 5. Acknowledgement

We hereby thank all participants, the crew of FRV “Solea” and Captain V. Koops for their outstanding cooperation and commitment.

#### 6. Literature

ICES. 2017. Manual for the International Baltic Acoustic Surveys (IBAS). Series of ICES Survey Protocols SISP 8 - IBAS. 47 pp. <http://doi.org/10.17895/ices.pub.3368>

Figures

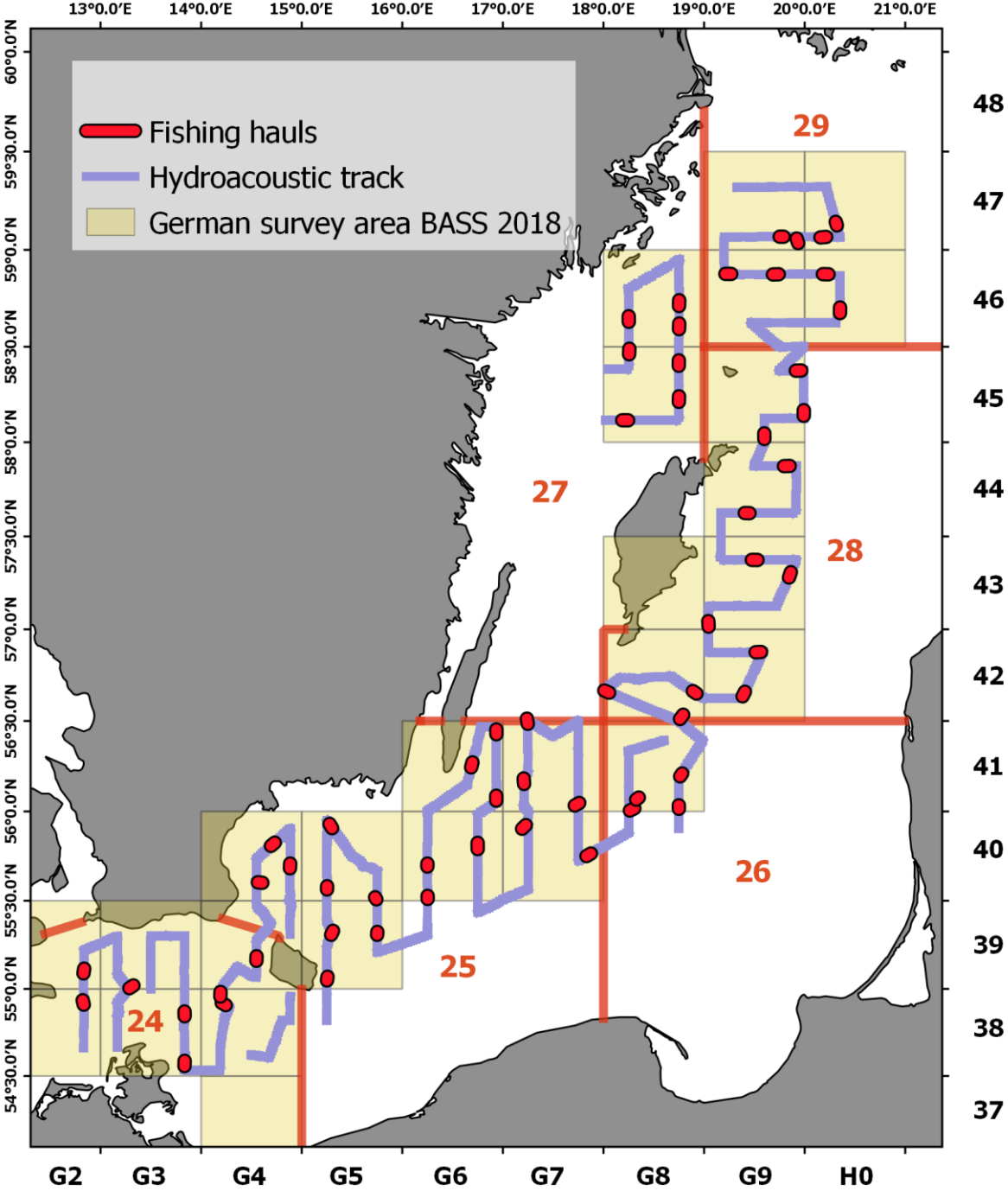


Figure 1: FRV "Solea" cruise 747/2018 BASS: Hydroacoustic track (purple line) and fishing hauls (red line) done during the BASS survey 2018.

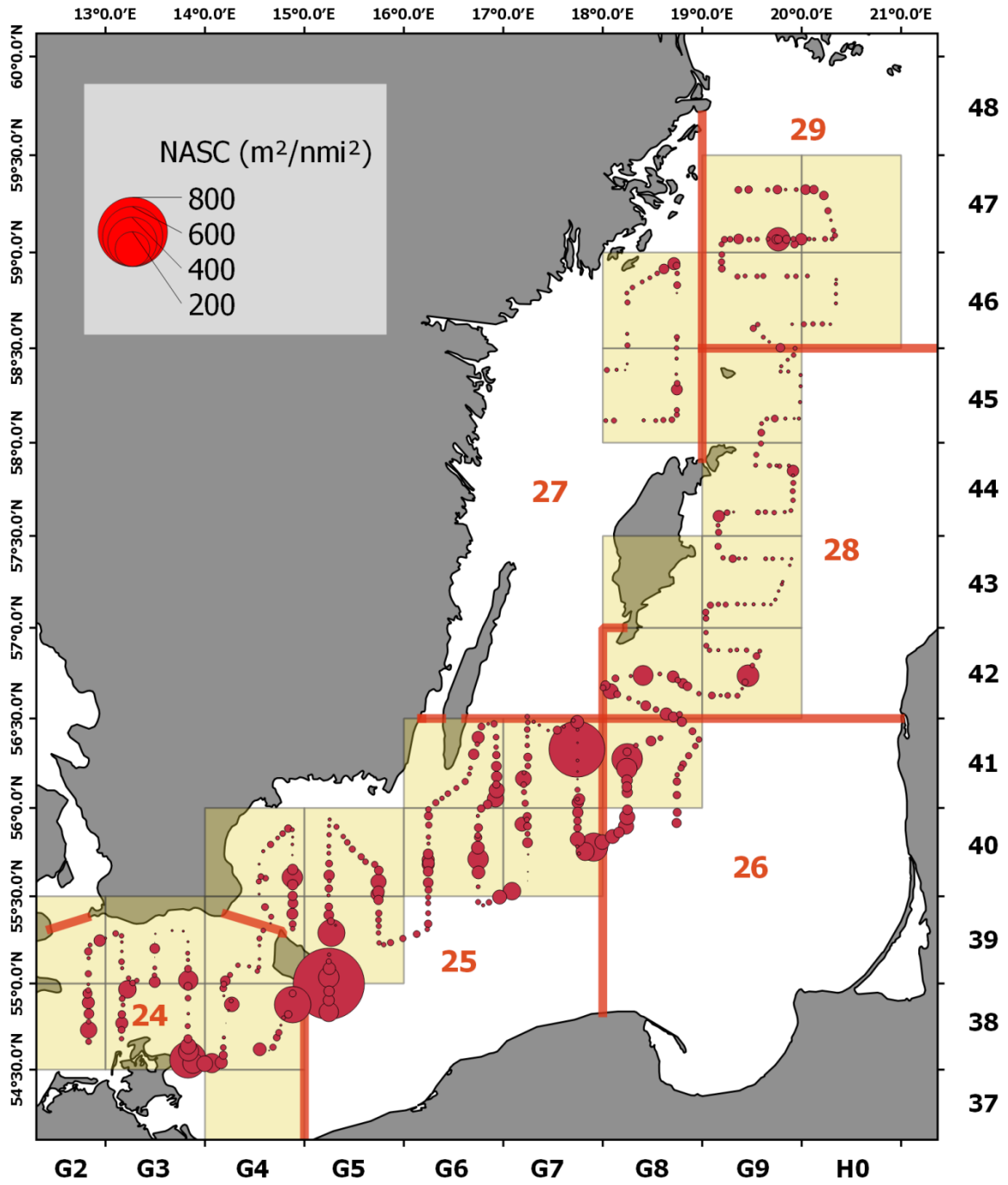
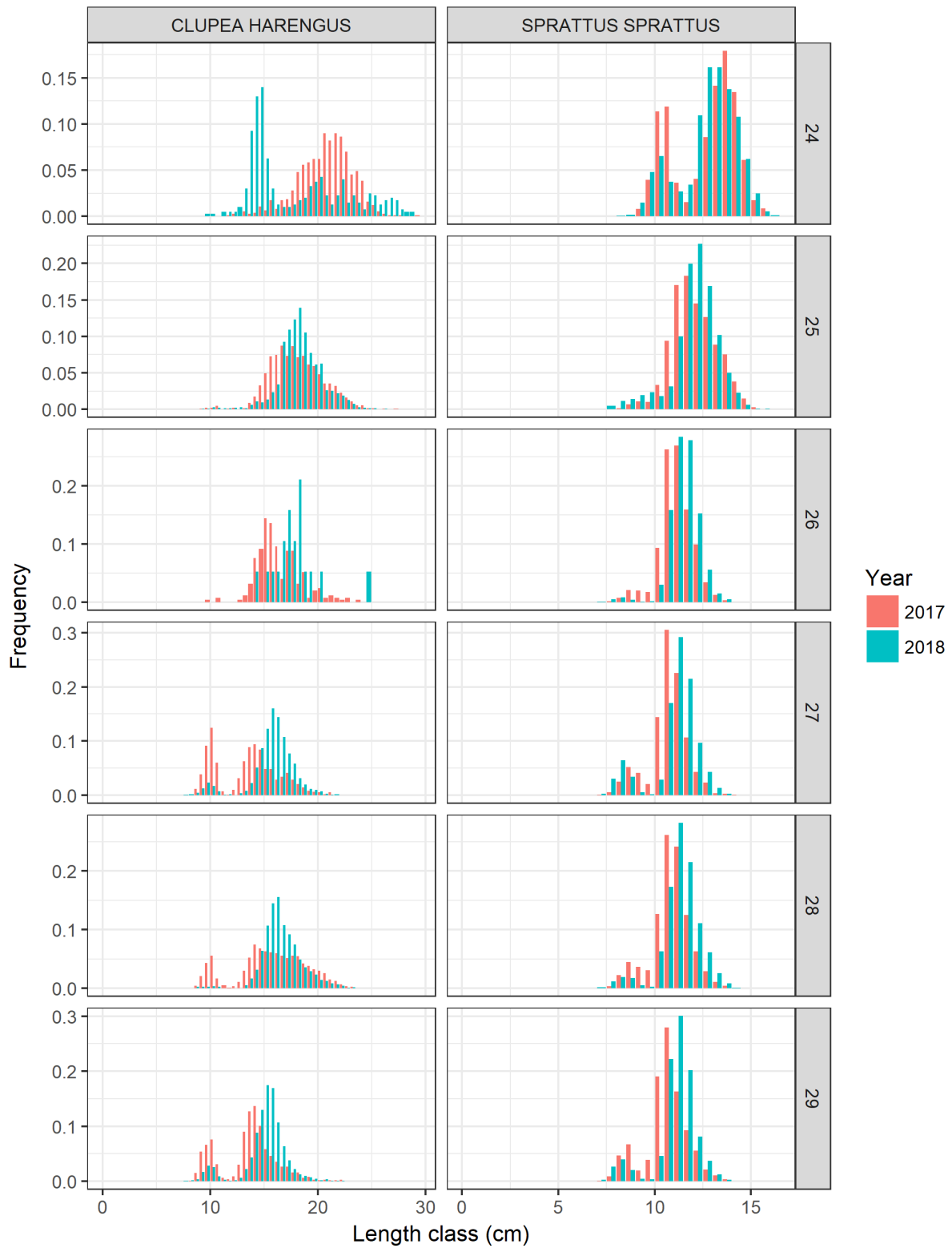


Figure 2: FRV "Solea" cruise 747/2018 BASS: Preliminary hydroacoustic results : NASC (m<sup>2</sup>/nmi<sup>2</sup>) averaged per 5 nmi recorded during the survey.





**Figure 3: FRV "Solea" cruise 747/2018 BASS: Herring and sprat length distribution measured per ICES subdivision during BASS 2017 (red bars) and BASS 2018 (blue bars).**

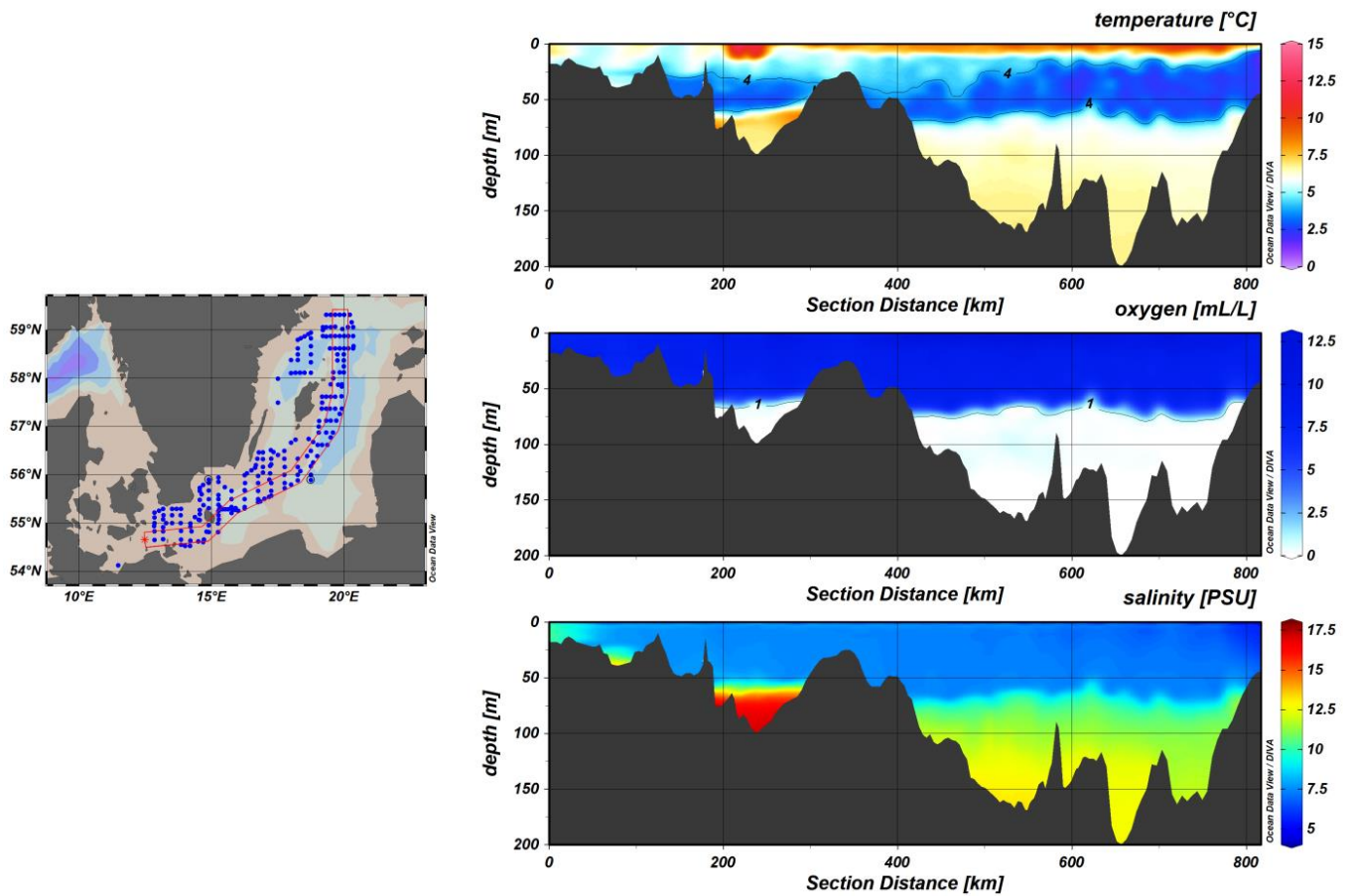


Figure 4: FRV "Solea" cruise 747/2018. Temperature (upper right panel), oxgen (middle right panel) and salinity (lower right panel) interpolated from CTD casts along a south/west - north/east transect as shown in the left panel (red line). CTD casts coordinates are display as blue dots on the map in the left panel.

## Tables

Table 1: FRV "Solea" cruise 747/2018 BASS: Catch composition (kg 0.5 h<sup>-1</sup>) by haul and species in SD 24.

Haul No.	ICES rect.	CLUPEA HARENGUS	GADUS MORHUA	GASTEROSTEUS ACULEATUS	HYPEROPLUS LANCEOLATUS	MERLANGIUS MERLANGUS	SPRATTUS SPRATTUS
1	38G2	1.474	0.348	0	0	0.304	5.829
2	39G2	1.423	0	0	0	0.461	9.06
3	39G3	4.628	0.415	0.003	0	2.164	24.273
4	38G3	2.725	0	0	0	0	84.256
5	38G3	1.863	0	0	0.017	0	76.16
6	38G4	0.443	0	0	0	0	4.866
7	38G4	5.24	0	0	0	0	134.3
8	39G4	0.846	0	0	0	0	9.898

Table 2: FRV “Solea” cruise 747/2018 BASS: Catch composition (kg 0.5 h-1) by haul and species in SD 25.

Haul No.	ICES rect.	CLUPEA HARENGUS	GADUS MORHUA	GASTEROSTEUS ACULEATUS	MERLANGIUS MERLANGUS	PLATICHTHYS FLESUS	SCOMBER SCOMBRUS	SPRATTUS SPRATTUS
9	40G4	57.9	0	0	0	0	0	15.8
10	40G4	0.39	0	12.609	0	0	0	0.192
11	40G4	0	0	0.397	0	0	0	0
12	39G5	3.375	0	0.026	0.348	0.57	0	170.125
13	39G5	5.05	1.505	0.002	0	0.427	0	350.1
14	40G5	8.974	0.585	0	0	0.242	0	98.88
15	40G5	0	0	9.14	0	0	0	0
16	40G5	2.588	3.172	0.048	0	0	0	161.24
17	39G5	0.548	10.553	0	0.186	0.213	0	88.08
18	40G6	6.363	20.027	0.19	0.21	0.622	0	140.853
19	40G6	8.188	0	1.23	0	0	0.912	384.39
20	41G6	0	0	33.651	0	0	0	0
21	41G6	0.282	0	1.947	0	0	0	0.921
22	41G6	2.728	0	18.3	0	0	0	0.028
23	40G6	5.228	0	1.264	0	0	0	4.143
24	40G7	0.743	0	0.21	0	0	0	55.41
25	41G7	0.082	0	51.66	0	0	0	0.966
27	41G7	0.084	0	0.506	0	0	0	24.304
28	40G7	0.07	0	0.013	0	0	0	28.06

Table 3: FRV “Solea” cruise 747/2018 BASS: Catch composition (kg 0.5 h-1) by haul and species in SD 26.

Haul No.	ICES rect.	CLUPEA HARENGUS	GADUS MORHUA	GASTEROSTEUS ACULEATUS	HYPEROPLUS LANCEOLATUS	PLATICHTHYS FLESUS	SPRATTUS SPRATTUS
29	41G8	0.029	0	0.024	0	0	44.055
30	41G8	0.194	0	0.159	0	0	68.955
31	41G8	0.314	2.894	0.109	0	1.024	52.995
32	41G8	0.396	0.345	0.027	0.024	0.466	134.551

Table 4: FRV “Solea” cruise 747/2018 BASS: Catch composition (kg 0.5 h-1) by haul and species in SD 27.

Haul No.	ICES rect.	CLUPEA HARENGUS	GADUS MORHUA	GASTEROSTEUS ACULEATUS	PLATICHTHYS FLESUS	SPRATTUS SPRATTUS
26	42G7	0	0	13.251	0	0
54	45G8	14.11	0.237	2.487	0	17.503
55	45G8	35.015	0.543	0.184	0.106	86.208
56	45G8	24.197	0.072	0.864	0.07	43.05
57	46G8	14.3	0.861	0.543	0	39.323
58	46G8	54.682	0.923	0.101	0	36.334
59	46G8	110.757	0.411	0.171	0	60.653
60	45G8	25.157	0	0.203	0	64.558

**Table 5: FRV “Solea” cruise 747/2018 BASS: Catch composition (kg 0.5 h-1) by haul and species in SD 28.**

Haul No.	ICES rect.	CLUPEA HARENGUS	GADUS MORHUA	GASTEROSTEUS ACULEATUS	PLATICHTHYS FLESUS	SPRATTUS SPRATTUS
33	42G8	0.03	0	0.676	0	10.457
34	42G8	0.119	0	2.14	0	10.762
35	42G8	3.061	0.251	0.179	0.555	37.475
36	42G9	1.463	0.129	0.237	0.104	46.147
37	42G9	1.342	0.96	0.041	0	41.233
38	43G9	4.231	1.173	0.01	0.259	50.169
39	43G9	4.5	0.966	0.051	0	46.247
40	43G9	10.757	0.686	0.635	0.286	24.408
41	44G9	2.901	0	1.066	0	45.093
42	44G9	5.899	0.469	0.175	0	44.277
43	45G9	17.842	0.111	0.236	0	129.281
44	45G9	7.257	1.91	0.117	0.136	21.82
45	45G9	13.574	1.092	0.064	0.197	47.756

**Table 6: FRV “Solea” cruise 747/2018 BASS: Catch composition (kg 0.5 h-1) by haul and species in SD 29.**

Haul No.	ICES rect.	CLUPEA HARENGUS	GADUS MORHUA	GASTEROSTEUS ACULEATUS	PLATICHTHYS FLESUS	RHINONEMUS CIMBRIUS	SPRATTUS SPRATTUS
46	47H0	55.731	0.249	0.028	0	0	110.067
47	47H0	32.086	0.001	0.009	0	0	99.642
48	47G9	9.908	0.707	0.229	0	0	75.24
49	47G9	56.668	0	0.141	0	0	142.761
50	46G9	46.448	0	0.041	0	0	81.921
51	46G9	29.032	0.164	0.088	0.137	0	63.603
52	46H0	40.644	0	0	0.256	0	179.893
53	46H0	28.533	0	0.134	0.159	0.16	88.861