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Cruise report FRV Clupea, Cruise 313 06.07. to 03.08.2017

Ichthyoplankton and fish in the central Baltic

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Background

The objective of the first part of the cruise was to observe the abundance and distribution of fish species in the Bornholm Sea. In detail we focused on the abundance, vertical and horizontal distribution as well as the diurnal migration of fish species, especially cod.

The second part of the cruise aimed mainly at sampling stomachs of Baltic cod in the Bornholm, Arkona and the Belt Sea in summer. Particularly, demersal samples along a depth-gradient from Adlergrund into the Bornholm basin were taken to assess the feasibility issues for a more extensive sampling along this transect planned for 2018. In addition, blood samples of selected cod from each subdivision were taken as well as otoliths to determine stock affiliation (via otolith shape analysis). Moreover, tissue samples from plaice were collected from two areas with different salinities (SD 22 and SD 24) for RNA sequencing.

During the third part, the period from 24th -27th July, a pilot survey for coastal concentrations of post-larval herring was conducted with the Ringtrawl. The objective was to investigate juvenile herring habitats after the larval stages left the Greifswald Bay area in early summer. The survey period was harshly affected by storm, the available days at sea did not result in any juvenile herring samples. Catches were dominated by post-flexion sandeel, sticklebacks and pipefish.

Cruise schedule & preliminary results of Part 1

The days before the 6th of July 2017 were used to prepare the ship for the cruise to the Bornholm Basin. The preparation included the removal of the equipment of the previous cruise and the installation and storage for at least some of the equipment needed for all three parts of the cruise.

In the morning of the 6th of July, FRV Clupea was shifted to the deep water port of Rostock to perform a calibration of the hydro acoustic system of the vessel. The calibration was successfully finished at the early afternoon and the vessel returned to its regular moorage at the port of Rostock-Marienehe.

On Sunday, the 9th of July, the vessel departed from the harbour in Rostock-Marienehe heading towards the Bornholm Basin. Due to the polish restrictions, we were not able to record the southern parts of the three transects resulting in shorter transects and an overall reduction of nautical miles to sail within the next days.

Investigations and hydroacoustic records started on Monday morning (10th of July) in the south on transect 1 close to the polish border (Fig. 1). In the early evening the research on transect 1 was finished and the vessels steamed to the most eastern transect (transect 3), where we continued to fish and record acoustic signals on the next morning. A total of 2 trawls and 11 CTDs were performed on transect 1 while a total of 2 hauls and 7 CDT measurements were conducted on transect 3. Investigations on transect 3 were finished at midday of the 11th of July and FRV Clupea steamed to the central transect (transect 2) where we continued fishing and hydroacoustic recording from North to South immediately. At the late evening of the 11th transect 2 were finished as well and the vessel steamed to its first position for the 24hour observation. Additional 1 fishing haul and 5 CTD casts were realized on transect 2 on the 11th. In the middle of transect 2 (the deepest part of the Bornholm Basin) FRV Clupea started its first 24 hours observation at night of the 11th by continuous sailing North and South along a 10 nautical mile long transect. During the observation 3 fishing hauls and 3 CTD measurements were performed. After 24 hours, FRV shipped to transect 1 close to the Island of Christiansø and started the same procedure for 24 hours. Additional 4 hauls and 4 CTD stations were performed within the 24 hours. Around midnight the 24 hours observation was completed and the vessels steamed back to port Sassnitz. The first part of the cruise ended on the morning of the 14th of July when FRV Clupea moored at port Sassnitz and the scientific crew left the vessel.

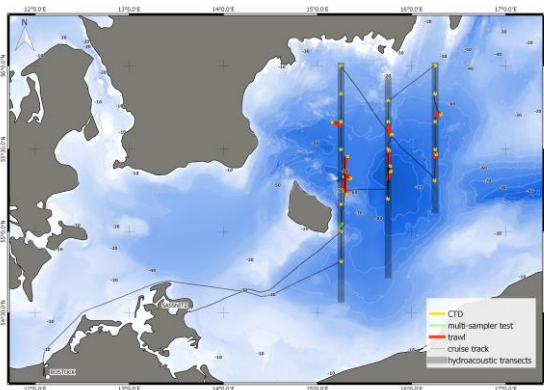


Figure 1 – Cruise map of the CLU 313 survey. Bathymetry: GEBCO 30 arc-second global grid of elevations; Coastline: Natural Earth land polygons; projection: EPSG 3857 Preliminary results of Part 1

The results of the hydrographic are not surprisingly (Fig. 2). Heavy oxygen problems started to occur in a depth of around 80 m and deeper. A strong thermocline exists in a depth of around 20 to 30 meter and at the bottom we could detect the water of high salinity.

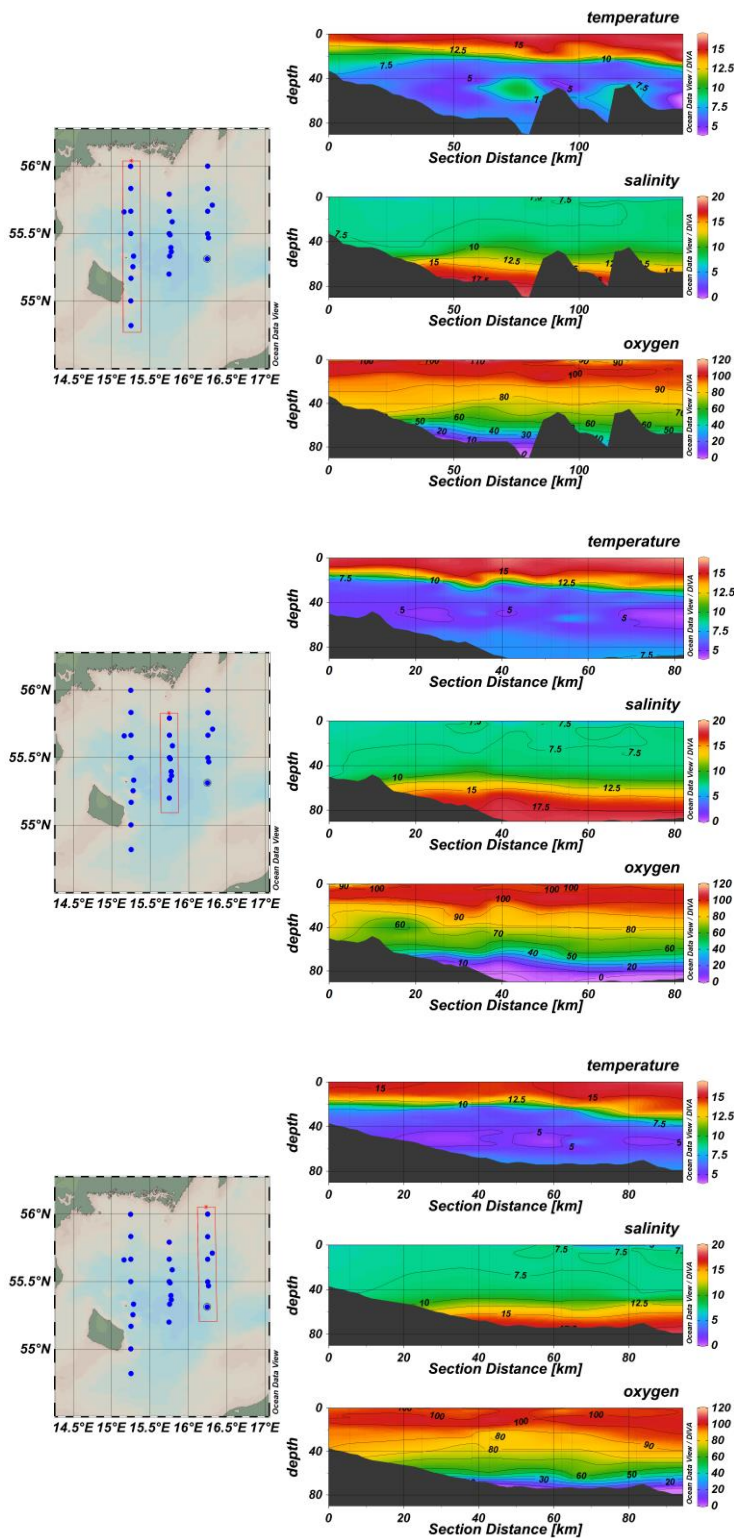


Figure 2 - Hydrography profiles (temperature, salinity and oxygen) on the acoustic transect investigated during the CLU 313 cruise.

NASC results show higher mean values on transect 1 and 2 compared to transect 3 (Fig. 3), and higher values in the shallower parts compared to the deeper parts of the Bornholm Basin.

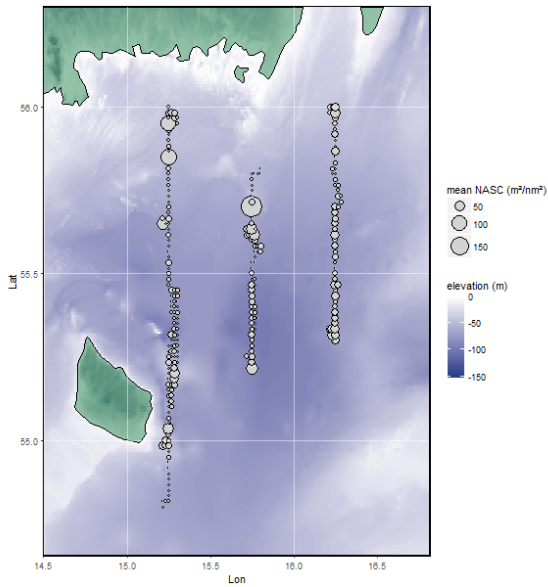


Figure 3– Mean Nasc (m^2/nm^2) recorded on the acoustic transects

An interpolation of the Nasc values underpin the interpretation that the biomass in the shallower areas of the Bornholm Basin is higher compared to the deeper parts, which may be reflect the insufficient oxygen situation in the deeper parts of the basin (Fig. 4).

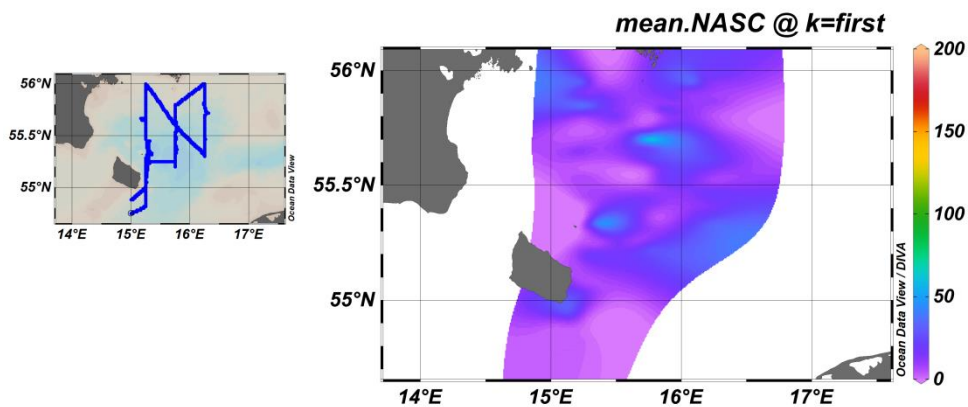


Figure 4– Nasc interpolation

The 24 hours observation shows a clear picture of the diurnal migration pattern of the fish biomass recorded with the acoustic device (Fig. 5-6). While on transect 1 the Nasc values concentrate at the shallower water column during night, the values increase at the deeper water column during day. However, a similar trend but not so strong is also observable on transect 2.

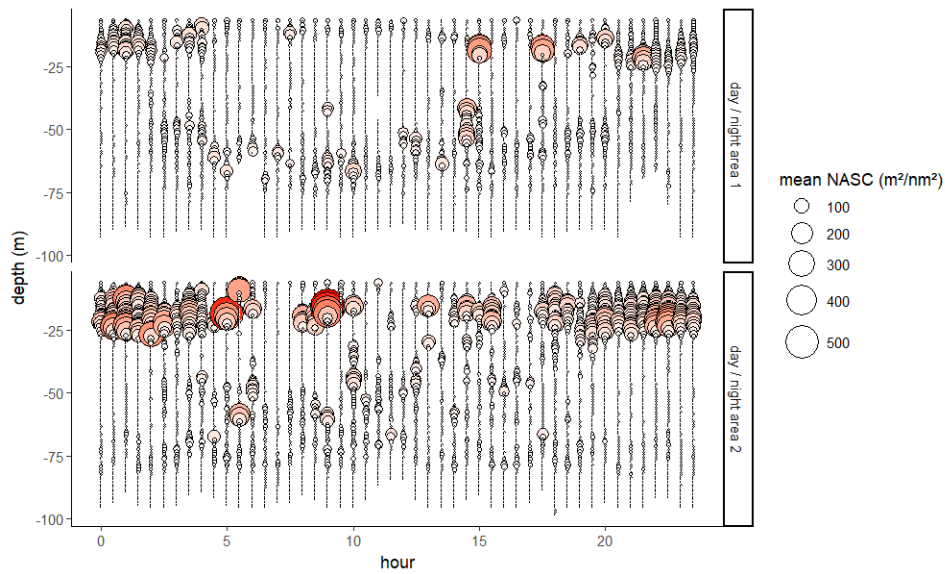


Figure 5– Mean NASC per depth and hour recorded on the 24h transects

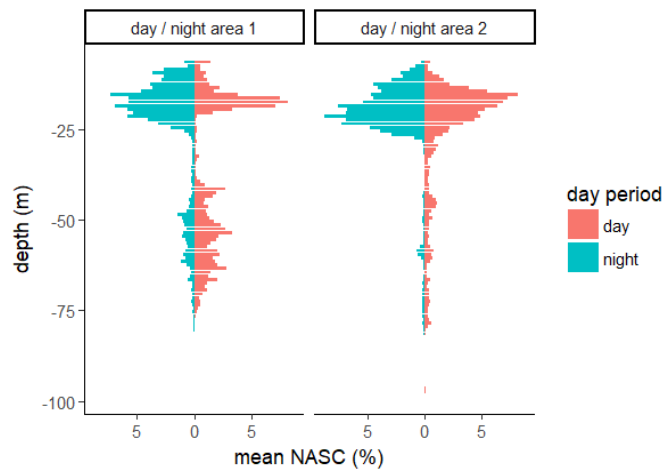


Figure 6– NASC percentage per depth for day/night period recorded on the 24h transects

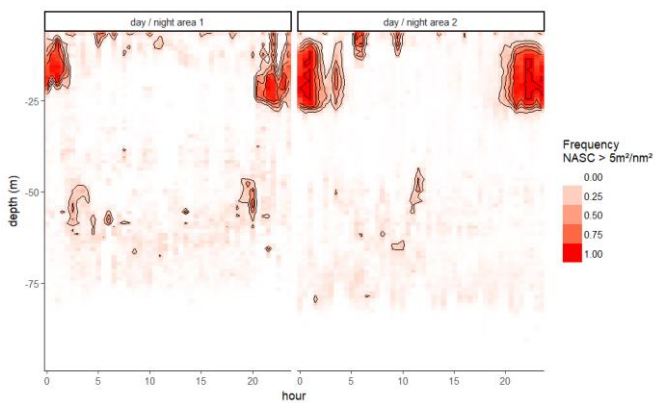


Figure 7– Frequency of recording with NASC > 5m²/nm² per hour and depth on the 24h transects

Catch composition was dominated by the three target species cod, herring and sprat and depend on the acoustic signal and depth where FRV Clupea fished (Ta. 1). In more detail, the most fished species was sprat followed by herring and cod. The total fished biomass was around 1 metric ton.

Table 1 Catch composition in kg

	<i>C. harrengus</i>	<i>S sprattus</i>	<i>G. morhua</i>	<i>M merlangus</i>	<i>C. lumpus</i>	<i>G. aculeatus</i>	<i>Ammodytidae</i>	<i>P. flesus</i>	Total
Haul 1	126.040	360.150	8.380	1.300	0.700	0.000	0.000	0.000	496.570
Haul 2	12.220	22.480	43.600	0.000	0.000	0.050	0.000	0.000	78.350
Haul 3	0.370	33.680	0.000	0.000	0.000	0.000	0.000	0.000	34.050
Haul 4	3.140	24.220	0.000	0.000	0.000	0.005	0.000	0.000	27.365
Haul 5	41.720	9.480	1.046	0.000	0.000	0.057	0.000	0.000	52.303
Haul 6	0.760	67.160	0.000	0.000	0.000	0.000	0.000	0.000	67.920
Haul 7	7.740	13.680	8.225	0.000	0.004	0.000	0.000	0.000	29.649
Haul 8	2.620	2.060	28.200	0.000	0.004	0.000	0.000	0.000	32.884
Haul 9	0.000	6.120	0.000	0.000	0.000	0.005	0.000	0.154	6.279
Haul 10	2.460	26.180	1.640	0.000	0.000	0.465	0.000	0.000	30.745
Haul 11	9.160	25.580	0.920	0.000	0.285	0.340	0.005	0.000	36.290
Haul 12	0.960	99.960	0.348	0.000	0.000	0.170	0.000	0.000	101.438
Total	207.190	690.750	92.359	1.300	0.993	1.092	0.005	0.154	993.843

Figure 8 shows the length distribution for sprat, herring, cod and stickleback.

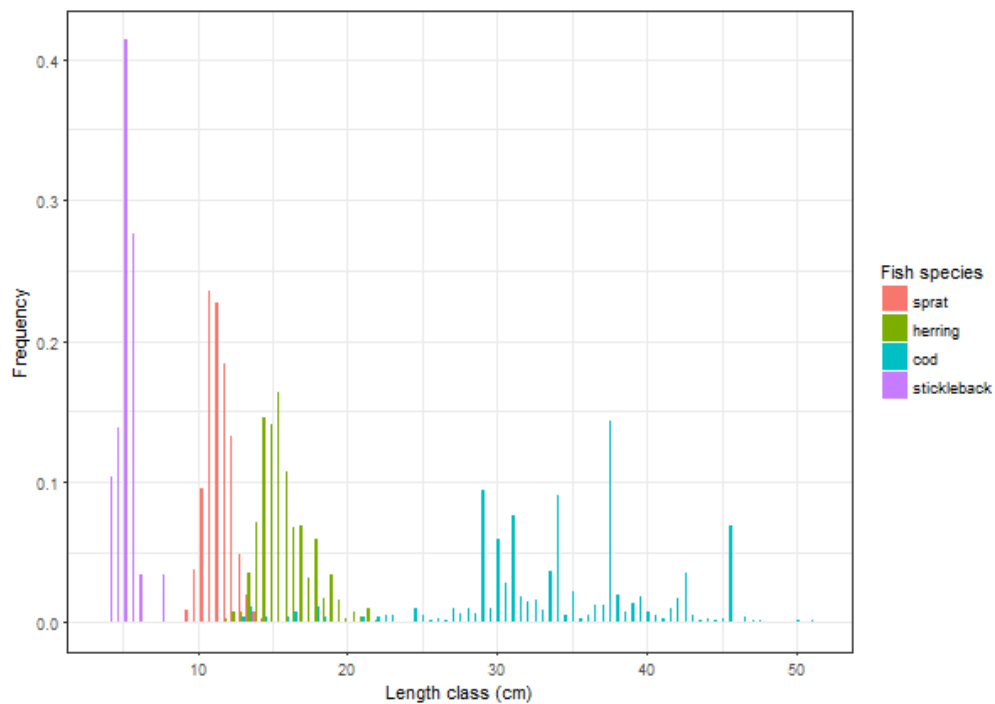


Figure 8– Unweighted length class mean frequency per species for all trawls

All cruise stations with date, position and device are summarized at the end of the cruise report in Annex 1.

Cruise schedule & preliminary results of Part 2

On Monday 17 July the vessel left the harbour of Sassnitz steaming towards Bornholm. The trawl fishery started at the easternmost sampling point in the Bornholm basin (station 15 in Fig. 1). Subsequent stations were fished in south-westerly direction. The stations were finished within three days and the vessel returned to Sassnitz on Friday, July 21st 2017.

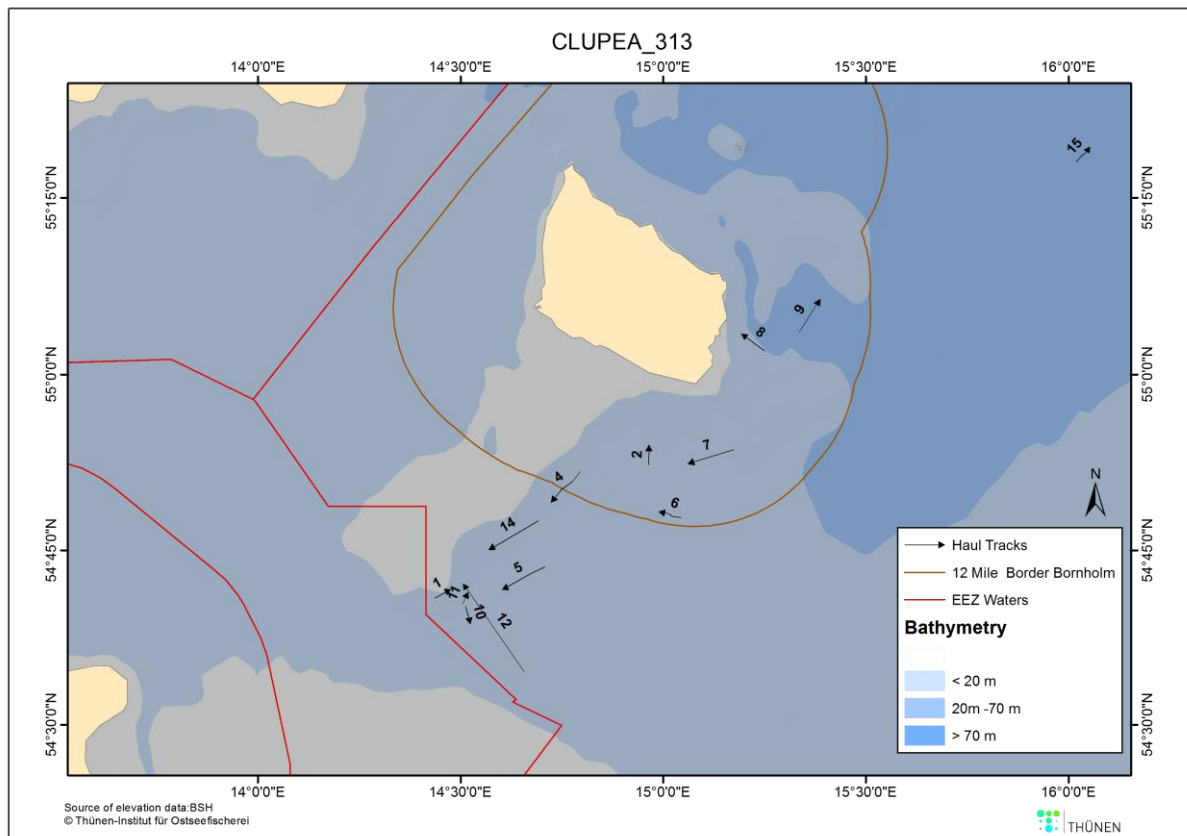


Figure 1 – Trawl stations of the depth-transect from Adlergrund to the Bornholm deep.

24 hauls were conducted during this cruise: 8 in SD25 at depths between 67-76m; 8 in SD24, with 5 at 49-54m and 3 at 25-29m; and 8 in SD22 with 7 at 14-16m and 1 at 25m (Table 1). Haul duration was always 30 minutes. 3 of the hauls in SD22 were split between the demersal and pelagic zone in an attempt to assess whether or not cod were using the upper layer of the water column. In SD25 120 cod stomach samples were collected, in SD24 147 cod stomach samples were collected and in SD22 10 cod stomach samples were collected. The cod stomachs were provided to the IHF in Hamburg for further analysis by Steffen Funk (PhD student).

Cod was the dominant species in all hauls in SD25, constituting 77-100% of the catch. Only 1 haul contained flatfish (2.1kg). Weight of cod in the catch was variable in SD25 (mean=26.5±28.96kg), with the most cod caught in the shallowest depth trawled (67m, 89.1kg) (Table 1). In general, in the Bornholm basin the oxycline was at around 70 m and despite very oxygen values at the sea floor, live cod were caught. These were, however, in poor condition, livers were heavily infested with larval anisarkid larvae but cod were spawning conditions. The crew reported that 6 to 8 dead and decomposed cod were entangled in the trawl from the haul in station 15 (water depth 76m). Whether these dead cod resulted from previous discarding of the commercial fishery (a spawning

closure for cod in SD2532 is in place from July-August), or from natural mortality is unclear. With decreasing water depth towards the Rönnebank/Adlergrund, cod became less thin, infestation of cod livers and the proportion of spawning individuals decreased, suggesting that there are clear depth-related patterns related to health of cod.

In SD24, the proportion of cod in the catch was more variable, comprising 42-100% of the catch. Flatfish contributed more to the catch in SD24 (0- 35% of the catch) compared to SD25. The highest catch of flatfish in the cruise occurred in SD 24 on 20.07.17 at 29m depth, when 40kg of plaice, 11kg of flounder and 37kg of cod were caught. The net was clogged with debris during this haul, which contributed to the high retention of flatfish. In SD24 higher catches of cod were caught at depths of 25 and 29m (mean=105.2±48kg), compared to catches at depths of 43-54m (mean=12.8±6.5kg) (Table 1).

In SD22, very few cod were caught. Out of 8 hauls, only 3 contained any cod, and only small amounts (mean=0.37±0.18kg). The total catch in SD22 ranged from 0-9.18kg, and was composed mostly of flounder, with some dab, plaice, turbot, brill and sprat (Table 1).

Table 1: Catch composition and depth distribution of 24 hauls. Missing information is denoted by a dash.

Date	Haul	Time	SD	depth (m)	total catch (kg)	cod (kg)	cod (%)	flatfish (kg)	flatfish (%)	others mix (kg)
17.07.2017	1	07:00	25	76	38	38	100	0	0	0
17.07.2017	2	10:00		76	4.4	4.4	100	0	0	0
17.07.2017	3	13:57		76	21.5	21.5	100	0	0	0
17.07.2017	4	15:00		76	0.8	0.8	100	0	0	0
17.07.2017	5	16:00		76	14	14	100	0	0	0
18.07.2017	6	07:00		72	9.2	7.1	77.17	2.1	22.82	0
18.07.2017	7	09:19		72	37.1	37.1	100	0	0	0
18.07.2017	8	13:09		67	89.1	89.1	100	0	0	0
19.07.2017	9	07:00	24	54	21	19.5	92.86	1	4.76	0.5
19.07.2017	10	08:15		54	10	6.7	67	0.3	3	3
19.07.2017	11	13:22		43	7.5	4	53.33	2.5	33.33	1
19.07.2017	12	15:00		45	5.9	3.8	64.41	2.1	35.59	0
19.07.2017	13	17:30		49	30	30	100	0	0	0
20.07.2017	14	07:00		29	88	37	42.05	51	57.95	0
21.07.2017	15	07:00		25	141.5	135	95.41	6.5	4.59	0
21.07.2017	16	10:00		25	147.8	143.7	97.23	4.1	2.77	0
31.07.2017	1	11:51	22	22	0	0	0	0	0	0
31.07.2017	2	14:10		25	4.1	0	0	4	97.56	0.1
31.07.2017	3	17:00		14	14.2	0.5	3.52	13.7	96.48	0
01.08.2017	1	09:02		16	3.76	0.5	13.3	3.26	86.7	0
01.08.2017	2	13:30		16	8	0.1	1.25	7.9	98.75	0
01.08.2017	3	15:35		15	9.18	0	-	8.84	96.3	-
01.08.2017	4	-		14	14.18	0	-	14.18	100	0
01.08.2017	5	-		14	7.86	0	-	7.86	100	0

For blood analysis, a selection of 50 cod each from SD 25 and SD 24 were obtained by a total of four hauls on the 17th of July and by a total of two hauls on the 21st of July (Tab. 2), respectively. Both sagittal otoliths and the stomachs were removed and stored individually for further processing. Between the 31st of July and 1st of August fishing in SD22 yielded only very few and immature cod, which could not be used for the blood analysis study.

Concerning RNA sequencing of *Pleuronectes platessa*, tissue samples (gill, liver, spleen) from six plaice were collected from an area in SD 24, showing a low salinity of 8 PSU (caught on the 20th of July, Tab. 3). Tissue samples from three plaice were collected from two areas in SD 22, showing a higher salinity of 16 PSU in average (caught on the 31st of July and 1st of August, Tab. 3).

Table 2: Summary of cod used for blood analysis in SD 25 and SD 24.

Capture date	Subdivision	Capture position	Net	Haul	Station	Depth	Fish
17.07.17	25	55°20.824 N 16°14.411 E	OTB TV 300/60	1	001	76	1-12
17.07.17	25	55°20.503 N 16°14.135 E	OTB TV 300/60	2	002	76	13-24
17.07.17	25	55°21.6060 N 16°14.8102 E	OTB TV 300/60	3	003	76	25-42
17.07.17	25	55°21.7237 N 16°14.9728 E	OTB TV 300/60	4+5	004	76	43-50
21.07.17	24	54°35.4077 N 13°43.9603 E	OTB TV 300/60	15+16	115	24	1-50

Table 3: Summary of plaice used for RNA sequencing in SD 24 and SD 22.

Capture date	Subdivision	Capture position	Temp (C°)	Sal (PSU)	O2 (%)	Depth	Fish
20.07.17	24	54°41,145N 14°26,151E	7,4	8,09	71	27	1-6
31.07.17	22	54°12,056N 11°59,090E	16,1	14	81	13	1-2
01.08.17	22	54°11,777N 11°56,449E	13,7	17,7	45	15	3-6

Cruise schedule & preliminary results of Part 3

Assuming post-larval herring in the shallow shore zone of the Pommeranian Bay, the survey started with 5 stations located on the 5 m depth contour. On the 24th of July, 30 min. long hauls were conducted with the Ringtrawl (CalCofi)-net (1 m diameter, meshsize 1.5 mm) and CTD measurements were taken on each station. The vessel departed in Sassnitz/Rügen and worked it's way along the Southern Rügen coast (Binz, Sellin, Thiessower Haken) towards the Northern coast of Usedom (Karlshagen, Zinnowitz). The day ended in Peenemünde-Port.

On the 25th almost no sampling could be conducted due to harsh weather conditions with 8 Beaufort Southwesterly winds (yes, in July!). The only station that could safely be sampled was Station 600 (RügenHerringLarvaeSurvey standard station) located in the mouth of the River Peene.

5 RHLS standard station could be sampled on July 26th located in Greifswald Bay. These stations were originally defined as reference stations for the assumption that juvenile herring would leave the shallow lagoon during warm summer conditions.

Due to the lack of post-larval herring on the 5m depth contour, the last survey day was used to repeat sampling on the stations in the Pommeranian Bay on 10 m depth. This sampling also brought no juvenile herring but interestingly quite some quantities of sticklebacks that were not found earlier on 5 m depth.

Altogether the Rigtrawl net proved to be non-effective to sample post-larval herring during this part of the season. Other methods have to be applied in the future to investigate habitat utilization of the 0-group.

Table 3.1 : Mean abundance of fish larvae, juvenile fish and adult fish m⁻³ along the coastline of the Pommeranian Bay (Binz - Zinnowitz) on 5 m and 10 m depth respectively and in the Greifswalder Bodden area where only samples down to 5m depth were achieved.

Pommeranian Bay coastal zone			Greifswalder Bodden		
Abundance / m ³			Abundance / m ³		
	5 m	10 m		5 m	
Fish larvae			Fish larvae		
Sandeel	0.005	0.02	Sandeel	0.002	
Pipefish (<i>N. ophidion</i>)	0.0001	0.0002	Pipefish (<i>S. typhle</i>)	0.001	
Goby	0.001	0.001	Goby	0.0002	
Garfish		0.0002	unidentified	0.0004	
unidentified	0.0001	0.0002			
Juv. Fish			Juv. Fish		
Pipefish (<i>N. ophidion</i>)	0.0004		Pipefish (<i>S. typhle</i>)	0.0006	
Stickleback	0.007	0.029	Stickleback	0.002	
Sprat	0.0001				
Adult Fish			Adult Fish		
<i>Nerophis ophidion</i>	0.0002		<i>Syngnathus typhle</i>	0.0002	
<i>Pomatoschistus minutus</i>	0.0001				

Annex 1 (Stationlist of Cruise part 1)

Station	Device	Area	Transect	Date	Time	Lat	long
1452	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	03:59:21	54°49,048N	015°15,109E
1453	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	05:20:43	55°00,092N	015°14,983E
1454	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	06:57:39	55°10,084N	015°15,109E
1455	OTM PSN388 Krake	Bornholm Basin	BB T1	10.07.17	08:31:46	55°17,183N	015°16,788E
1456	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	09:42:54	55°15,261N	015°16,572E
1457	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	10:45:24	55°19,945N	015°17,029E
1458	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	12:00:36	55°29,986N	015°14,925E
1459	OTM PSN388 Krake	Bornholm Basin	BB T1	10.07.17	13:30:11	55°38,932N	015°13,312E
1460	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	14:25:48	55°39,717N	015°09,674E
1461	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	14:58:48	55°39,989N	015°14,891E
1462	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	16:11:23	55°50,055N	015°14,950E
1463	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	17:21:45	55°59,932N	015°14,855E
1463	CTD SBE19+	Bornholm Basin	BB T1	10.07.17	17:21:52	55°59,932N	015°14,852E
1464	CTD SBE19+	Bornholm Basin	BB T3	11.07.17	02:58:52	55°18,725N	016°14,685E
1465	OTM PSN388 Krake	Bornholm Basin	BB T3	11.07.17	04:10:52	55°27,410N	016°15,099E
1466	CTD SBE19+	Bornholm Basin	BB T3	11.07.17	04:45:57	55°28,133N	016°15,698E
1467	CTD SBE19+	Bornholm Basin	BB T3	11.07.17	05:08:12	55°29,919N	016°15,016E
1468	CTD SBE19+	Bornholm Basin	BB T3	11.07.17	06:21:46	55°39,995N	016°15,009E
1469	OTM PSN388 Krake	Bornholm Basin	BB T3	11.07.17	06:59:00	55°42,499N	016°16,481E
1470	CTD SBE19+	Bornholm Basin	BB T3	11.07.17	07:36:52	55°42,627N	016°18,656E
1471	CTD SBE19+	Bornholm Basin	BB T3	11.07.17	08:38:46	55°50,010N	016°15,047E
1472	CTD SBE19+	Bornholm Basin	BB T3	11.07.17	09:48:19	56°00,043N	016°15,005E
1474	CTD SBE19+	Bornholm Basin	BB T2	11.07.17	13:03:00	55°39,940N	015°45,019E
1475	OTM PSN388 Krake	Bornholm Basin	BB T2	11.07.17	13:48:43	55°37,212N	015°45,584E
1476	CTD SBE19+	Bornholm Basin	BB T2	11.07.17	14:42:51	55°35,226N	015°47,255E
1477	CTD SBE19+	Bornholm Basin	BB T2	11.07.17	15:27:05	55°29,984N	015°45,050E
1478	CTD SBE19+	Bornholm Basin	BB T2	11.07.17	16:39:38	55°19,998N	015°45,284E
1479	CTD SBE19+	Bornholm Basin	BB T2	11.07.17	17:41:41	55°11,972N	015°44,938E
1480	OTM PSN388 Krake	Bornholm Basin	BB T2	12.07.17	04:09:29	55°24,960N	015°45,332E
1481	CTD SBE19+	Bornholm Basin	BB T2	12.07.17	04:42:55	55°23,838N	015°46,274E
1482	OTM PSN388 Krake	Bornholm Basin	BB T2	12.07.17	06:16:34	55°19,829N	015°45,268E
1483	CTD SBE19+	Bornholm Basin	BB T2	12.07.17	07:13:41	55°21,956N	015°46,609E
1484	OTM PSN388 Krake	Bornholm Basin	BB T2	12.07.17	10:45:26	55°27,019N	015°45,200E
1485	CTD SBE19+	Bornholm Basin	BB T2	12.07.17	11:46:19	55°29,441N	015°45,746E
1486	OTM PSN388 Krake	Bornholm Basin	BB T1	13.07.17	05:13:25	55°15,916N	015°17,843E
1487	CTD SBE19+	Bornholm Basin	BB T1	13.07.17	06:03:01	55°13,831N	015°18,731E
1488	OTM PSN388 Krake	Bornholm Basin	BB T1	13.07.17	06:46:51	55°18,345N	015°17,681E
1489	CTD SBE19+	Bornholm Basin	BB T1	13.07.17	07:42:56	55°20,432N	015°18,341E
1490	OTM PSN388 Krake	Bornholm Basin	BB T1	13.07.17	11:03:10	55°25,023N	015°17,666E
1491	CTD SBE19+	Bornholm Basin	BB T1	13.07.17	12:02:36	55°27,333N	015°19,103E
1492	OTM PSN388 Krake	Bornholm Basin	BB T1	13.07.17	12:54:31	55°22,076N	015°17,804E
1493	CTD SBE19+	Bornholm Basin	BB T1	13.07.17	14:07:09	55°19,397N	015°20,931E