

Institute of Sea Fisheries

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Cruise report FRV "Walther Herwig III" Cruise 391 04.01. – 18.01.2016

German Small-scale Bottom Trawl Survey and International Herring Larvae Survey in the North Sea

Scientist in charge: Dr. Norbert Rohlf

Summary

The German Small-scale Bottom Trawl Survey (GSBTS) continued the long-term investigation of winter bottom fish assemblages through sampling of the standard area "Box A" in the German Bight. The mean catch yielded per half hour trawl duration (143 kg) was well in line with the long term mean. A striking amount of spotted dogfish (*Scyliorhinus canicula*) was observed in this year's survey (0.7 kg/30 min.). As a contradiction to the increasing trend seen in most recent years, the striped red mullet (*Mullus surmuletus*) was nearly absent.

Within the 10-by-10 nautical mile area in the Box, the GOV bottom trawls were accompanied by monitoring of the benthic epifauna with a 2-m beam trawl. The epifauna in Box A was generally dominated by high numbers of the starfish *Asterias rubens*, the solenette *Buglossidium luteum* and the bivalve *Nucula nitidosa*. In contrast, high abundances of the brittle star *Ophiura ophiura* and the masked crab *Corystes cassivelaunus* disappeared.

The international herring larvae surveys in the North Sea (IHLS) are conducted annually during the autumn and winter herring spawning activity and monitor the spatial distribution and abundance of herring larvae. The survey index is used as an important estimator of herring spawning stock biomass and provides valuable information for herring stock assessment and the fixation of fishing quotas. Quantities of newly hatched larvae were much lower compared to the historic high estimates found in the English Channel in 2014 and 2013. However, conclusions for North Sea herring stock spawning biomass can only be drawn when information of larvae abundance from all spawning areas become available prior to the herring assessment working group meeting in March 2016.

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2. Research programme

2.1 Herring larvae survey

One aim of the cruise was the German contribution to the international herring larvae surveys in the North Sea in January. Parts of ICES area IVc and VIId should be sampled by double oblique tows with the "Nackthai" (modified GULF III sampler), resulting in herring larval abundance estimates and spatial distribution. In the survey area in the southern North Sea and the English Channel, 64 plankton tows were done in total. Sampling was achieved according to the manual of the herring larvae surveys. Physical measurements, e.g. temperature, salinity and conductivity, were conducted via a CTD mounted directly onto the gulf sampler. The CTD was not properly working during the last six hauls, thus no profiles are available here.

2.2 Monitoring (TI-SF)

21 GOV hauls were taken to qualitatively and quantitatively analyze the development of abundance and diversity in the bottom fish assemblages. Methods are in accordance with the International Bottom Trawl Survey, in order to allow comparison of results between the two surveys. Epibenthos sampling with a 2-m beam trawl complemented the GOV hauls in order to allow simultaneous investigations of benthic invertebrates and bottom fish (Table 2).

2.3 Epibenthos (Senckenberg Research Institute)

The 2-m beam trawl for the sampling of epibenthos had a mesh size of 20 x 20 mm in the main net and 4 x 4 mm in the cod end and was applied with 5-min towing duration at 1.5 knots. Samples were sieved over 5 mm and 2 mm mesh. The 5 mm fraction was analysed aboard, the 2 mm fraction was preserved in 70% alcohol for analysis in the laboratory ashore.

2.4 Sediments and benthic infauna (Senckenberg Research Institute)

Investigations of epibenthos were accompanied by sampling of sediments using a 0.1 m² Van Veen grab for the analysis of sediment composition and total organic carbon (TOC).

3. Narrative

FRV "Walther Herwig III" left Bremerhaven on Monday evening, 01/04/16. After some technical maintenance, the vessel steamed into the German Bight, where the fish and benthos monitoring was conducted within the next days (01/05 – 01/10) in Box A. The programme had to be interrupted several times due to strong wind forces, but could finally be completed, amounting to 21 randomly assigned GOV trawl hauls and nine beam trawls and grab samples.

The vessel steamed into the English Channel, where the herring larvae survey started Monday morning, 01/11/16. Also this part of the cruise was interrupted several times due to strong gales. The wind stress persisted over the whole cruise, but 64 stations out of 67 could be fished. The herring larvae programme was finished on the morning of 01/16/16. The vessel was back in Bremerhaven on Sunday evening, 01/17/16. Loss of working hours due to unfavourable weather conditions summed approximately to four days, but the overall available ship time was sufficient to conduct both parts of the scientific programme.

4. Preliminary results

4.1 Ichthyoplankton (TI-SF)

Fish eggs and larvae were sorted from the plankton samples after the end of the cruise. Herring larvae were counted and length measured to millimetre below and their abundance per square metre estimated.

The samples yielded in total 3,235 herring larvae, which is much lower when compared to recent years (12,000-20,000 larvae). Fish larvae of other taxa amounted to 369 and 4050

fish eggs were caught, too. Species identification of the remaining fish eggs and larvae is not finished yet.

The cruise track by station number is given in Figure 1 and the spatial distribution of herring larvae in Figure 3. Abundance estimates and available physical parameters are listed in Table 4. Figure 4 depicts the distribution of near-bottom water temperature and salinity.

4.2 Bottom Fishes (TI-SF)

The mean total catch of all bottom fishes in Box A (Figure 1) amounted to 143 kg per half hour trawl duration (Figure 2). This is higher as compared to 2015 (111 kg), and in line with the long term mean (142 kg). Dab (*Limanda limanda*), herring (*Clupea harengus*) and sprat (*Sprattus sprattus*) dominated the catches with on average 79, 35 and 17 kg per half hour trawling time, respectively (Table 3). Cod (*Gadus morhua*) and plaice (*Pleuronectes platessa*) were caught with 2.9 and 1.5 kg. There was a striking amount of spotted dogfish (*Scyliorhinus canicula*) seen in this year's survey (0.7 kg/30 min.). As a contradiction to the increasing trend observed in most recent years, the striped red mullet (*Mullus surmuletus*) was nearly absent.

4.3 Epibenthos (Senckenberg Research Institute)

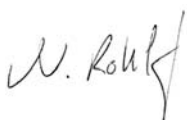
Nine beam trawl hauls and nine van Veen grab samples were taken in Box A. The sediment consisted of muddy fine sand. Three beam trawl hauls revealed very low total abundance/biomass of epifauna for unclear reasons. The epifauna in Box A was generally dominated by high numbers of the starfish *Asterias rubens*, the solenette *Buglossidium luteum* and the bivalve *Nucula nitidosa*. The trend of increasing abundance of *Buglossidium luteum* and *Nucula nitidosa* continued in 2016. In contrast, high abundances of the brittle star *Ophiura ophiura* disappeared after an increase between 2012 and 2015 following a period of rather cold winter temperatures in the German Bight. The lowest abundance of the shrimp *Crangon allmanni* and – in contrast - the second highest abundance of *Processa nouveli holthuisi* since 2000 was found this year. Compared to winter 2015, high abundances of the masked crab *Corystes cassivelaunus* disappeared.

5. Participants

Name	Institution	Function
1. Norbert Rohlf	TI-SF	Cruise leader
2. Birgit Suer	TI-SF	Technician
3. Sakis Kroupis	TI-SF	Technician
4. Christine Petersen-Frey	TI-SF	Technician
5. Michael Sasse	TI-SF	Technician
6. Inken Rottgardt	TI-SF	Student
7. Tim Dudeck	TI-SF	Student
8. Dr. Hermann Neumann	Senckenberg	Scientist
9. Anja Singer	Senckenberg	Scientist

6. Acknowledgement

Thanks to Captain Hans-Otto Janßen and FRV "Walther Herwig III" crew members for their great support and hospitality and to all participants for their reliable and responsible teamwork.



(Dr. Norbert Rohlf)

7. Tables and Figures

Table 1: Boundaries of Box A in the German EEZ

LAT		LON		Center	
From	To	From	to		
54°17.00' N	54°27.00' N	006°58.00' E	007°15.00' E	54°22.00' N	007°06.50' E

Table 2: Type and amount of samples obtained in Box A

Number of stations	GOV	2-m Beam trawl	Hydrography	Sediment + Meiofauna
9	X	X	X	X
6	X		X	
6	X			
Total sets	21	9	15	9

Table 3: Total catch and average catch by species per 30 minutes trawl duration

STATION	1	2	3	4	5	6	7	8	9	10	11
AGONUS CATAPHRACTUS		0.048	0.032	0.036		0.003		0.029	0.011	0.056	0.019
ALLOTEUTHIS SUBULATA			0.010		0.013				0.007	0.009	0.004
ALOSA FALLAX				0.188						0.254	
AMMODYTES MARINUS											0.013
ARNOGLOSSUS LATERNA	0.063	0.032	0.026	0.018	0.004	0.101	0.049	0.002	0.002	0.037	
BUGLOSSIDIUM LUTEUM	0.080	0.187	0.461	0.042	0.034	0.094	0.224	0.244	0.291	0.381	0.165
CALLIONYMUS LYRA	0.022		0.028	0.010			0.149	0.020	0.016		
CANCER PAGURUS			1.584			0.071		0.528	1.040		
CLUPEA HARENGUS	4.974	10.000	6.550	6.590	6.000	4.485	4.525	8.685	8.195	32.040	121.982
ECHIICHTHYS VIPERA											
ENGRAULIS ENCRASICOLUS		0.003				0.003	0.009			0.004	
EUTRIGLA GURNARDUS	2.448	0.713	2.278	2.594	2.938	1.577	1.446	2.598	3.218	0.618	0.869
GADUS MORHUA		4.450	7.400	1.892			4.532		5.980	10.210	2.248
GASTEROSTEUS ACULEATUS		0.009	0.016			0.003		0.014	0.011	0.002	0.002
LIMANDA LIMANDA	50.480	112.400	183.000	49.700	50.220	82.800	126.400	76.200	112.600	44.200	132.100
LIPARIS LIPARIS											
LOLIGO VULGARIS	0.050	0.002	0.454		0.278		0.050				
MERLANGIUS MERLANGUS	3.306	2.115	1.709	4.362	6.240	1.709	2.582	1.899	1.392	0.660	3.488
MICROSTOMUS KITT							0.033				
MULLUS SURMULETUS									0.020		
MYOXOCEPHALUS SCORPIUS	0.646					0.291			0.073	0.037	0.075
PLATICHTHYS FLESUS		0.394				0.235	0.399	0.406	0.328		
PLEURONECTES PLATESSA	0.750	4.680	1.747	1.068		0.318	3.321	4.980	1.182	0.559	4.010
POMATOSCHISTUS MINUTUS	0.002	0.007	0.004	0.002		0.003	0.002	0.021	0.010	0.004	
PSETTA MAXIMA					0.295			0.238			
RAJA CLAVATA											
RHINONEMUS CIMBRIUS	0.048	0.036	0.026	0.004	0.029		0.039	0.050			0.009
SCOMBER SCOMBRUS				0.074							
SCOPHTHALMUS RHOMBUS											
SCYLIORHINUS CANICULA	2.400	1.814	0.645	0.712	2.000	0.760	1.535		0.496	0.185	
SEPIOLA ATLANTICA	0.006		0.003					0.002	0.005	0.002	
SPRATTUS SPRATTUS	1.706	2.800	1.478	0.324	1.483	0.338	0.740	1.945	1.280	1.485	38.386
SYNGNATHUS ROSTELLATUS			0.001								
TRACHURUS TRACHURUS	0.060	0.100	0.148	0.048	0.069	0.044	0.069	0.056	0.059	0.090	0.051
TRISOPTERUS LUSCUS					0.018						
Total (kg)	67.041	139.790	207.600	67.664	69.621	92.835	146.104	97.917	136.216	90.833	303.421

Table 3 continued: Total catch and average catch by species per 30 minutes trawl duration

STATION	12	13	14	15	16	17	18	19	20	21	Mittel
AGONUS CATAPHRACTUS	0.008	0.026			0.046	0.011	0.012		0.023	0.025	0.018
ALLOTEUTHIS SUBULATA	0.058	0.073	0.056	0.103	0.123	0.095	0.035	0.098	0.037	0.068	0.038
ALOSA FALLAX	0.214			0.359	0.508	0.691			0.235	0.230	0.128
AMMODYTES MARINUS									0.019	0.015	0.002
ARNOGLOSSUS LATERNA	0.021	0.026	0.025	0.018	0.027	0.006	0.022	0.011		0.011	0.024
BUGLOSSIDIUM LUTEUM	0.026	0.020	0.018	0.027	0.028	0.042	0.306	0.055	0.032	0.030	0.133
CALLIONYMUS LYRA	0.024	0.006	0.098	0.046	0.035			0.025	0.118		0.028
CANCER PAGURUS	1.622		0.615				2.518	1.575	1.400	0.940	0.566
CLUPEA HARENGUS	126.865	22.115	28.566	47.573	130.997	49.369	42.719	39.345	23.448	10.812	35.040
ECHIICHTHYS VIPERA	0.005										0.000
ENGRAULIS ENCRASICOLUS		0.004	0.002	0.020	0.002	0.005		0.003			0.003
EUTRIGLA GURNARDUS	2.078	1.038	2.341	0.278	1.226	1.690	1.842	1.373	0.989	2.721	1.756
GADUS MORHUA	4.161		4.304		1.845		7.520	3.030		2.726	2.871
GASTEROSTEUS ACULEATUS								0.004	0.010	0.002	0.003
LIMANDA LIMANDA	42.860	31.580	25.500	43.140	59.820	92.200	136.693	77.778	48.700	83.237	79.124
LIPARIS LIPARIS							0.011				0.001
LOLIGO VULGARIS				0.298	0.037			0.032	0.242	0.074	0.072
MERLANGIUS MERLANGUS	3.742	4.156	4.298	6.200	5.970	6.250	1.420	5.546	4.940	4.590	3.646
MICROSTOMUS KITT						0.056					0.004
MULLUS SURMULETUS										0.025	0.002
MYOXOCEPHALUS SCORPIUS		0.136	0.036				0.265		0.340		0.090
PLATICHTHYS FLESUS			0.561			0.284				0.304	0.139
PLEURONECTES PLATESSA	0.372	0.531	0.082	0.624	0.650	0.862	2.752	1.675	0.284	0.518	1.475
POMATOSCHISTUS MINUTUS	0.005			0.003	0.001	0.005	0.002	0.004		0.001	0.004
PSETTA MAXIMA											0.025
RAJA CLAVATA						3.082					0.147
RHINONEMUS CIMBRIUS	0.055		0.024				0.035			0.014	0.018
SCOMBER SCOMBRUS											0.004
SCOPHTHALMUS RHOMBUS	0.885	0.337		0.420							0.078
SCYLIORHINUS CANICULA		0.587	1.021					0.780	0.707	1.051	0.700
SEPIOLA ATLANTICA	0.003	0.004	0.002	0.002		0.003	0.002				0.002
SPRATTUS SPRATTUS	74.733	8.335	2.934	62.427	43.003	39.131	28.088	24.778	14.767	12.051	17.248
SYNGNATHUS ROSTELLATUS											0.000
TRACHURUS TRACHURUS	0.037	0.047	0.058	0.058	0.114	0.038	0.045	0.117	0.044	0.131	0.071
TRISOPTERUS LUSCUS											0.001
Total (kg)	257.774	69.021	70.541	161.596	244.432	193.820	224.287	156.229	96.335	119.576	143.460

Table 4: Main data of Ichthyoplankton hauls made during WH 391

Stat. No.	Haul No.	Lat. (° N)	Long.	E/ W	Date (UTC)	Time (UTC)	Duration (min)	Water depth (m)	Catch depth (m)	Flow (m³)	Hela (n/m²)	Surface		Bottom	
												T (°C)	Sal (psu)	T (°C)	Sal (psu)
22	1	52°25.46	003°30.29	E	11.01.16	06:17	3.33	29	26	20.3	144	10.47	35.30	10.47	35.36
23	2	52°25.27	309°97.00	E	11.01.16	07:29	4.34	41	38	25.4	253	10.87	35.44	10.88	35.45
24	3	52°25.16	002°49.93	E	11.01.16	08:39	4.17	40	36	23.8	10	11.34	35.53	11.35	35.54
25	4	52°14.84	002°29.44	E	11.01.16	10:12	3.56	44	41	19.6	321	11.55	35.55	11.55	35.56
26	5	52°15.26	002°50.03	E	11.01.16	11:43	4.55	39	36	26.6	7	11.28	35.52	11.29	35.52
27	6	52°15.34	003°10.10	E	11.01.16	13:13	4.20	35	32	25.3	76	10.85	35.46	10.86	35.46
28	7	52°15.22	003°30.07	E	11.01.16	14:17	3.47	27	24	19.9	102	10.35	35.30	10.36	35.30
29	8	52°15.37	003°47.57	E	11.01.16	15:19	2.47	26	22	16.3	102	9.76	35.03	9.76	35.05
30	9	52°05.32	003°49.86	E	11.01.16	16:25	2.30	25	21	12.9	62	9.61	34.89	9.61	34.90
31	10	52°04.99	003°30.25	E	11.01.16	17:39	3.09	29	25	18.8	43	10.29	35.22	10.29	35.22
32	11	52°04.91	003°10.70	E	11.01.16	18:49	3.56	32	29	22.7	161	10.74	35.34	10.76	35.36
33	12	52°04.85	002°49.95	E	11.01.16	19:57	4.09	34	30	25.9	231	11.26	35.54	11.28	35.56
34	13	52°05.03	002°30.46	E	11.01.16	21:04	5.28	40	37	34.1	169	11.52	35.55	11.53	35.57
35	14	51°54.99	002°30.59	E	11.01.16	21:57	5.08	39	36	33.2	174	11.43	35.54	11.45	35.56
36	15	51°45.04	002°10.20	E	11.01.16	23:21	6.30	49	46	40.8	131	11.57	35.58	11.58	35.59
37	16	51°34.88	002°11.26	E	12.01.16	00:39	4.42	41	38	26.4	70	11.43	35.49	11.45	35.52
38	17	51°35.03	001°50.27	E	12.01.16	02:02	4.54	39	36	27.7	11	11.43	35.49	11.45	35.57
39	18	51°25.15	001°51.34	E	12.01.16	03:09	5.08	41	37	30.2	65	11.56	35.59	11.58	35.61
40	19	51°15.18	001°50.12	E	12.01.16	04:13	4.37	40	36	27.5	71	11.59	35.58	11.60	35.59

Table 4 continued: Main data of Ichthyoplankton hauls made during WH 391

Stat. No.	Haul No.	Lat. (° N)	Long.	E/ W	Date (UTC)	Time (UTC)	Duration (min)	Water depth (m)	Catch depth (m)	Flow (m ³)	Hela (n/m ²)	T (°C)	Sal (psu)	T (°C)	Sal (psu)
41	20	51°04.77	001°29.58	E	12.01.16	05:52	8.06	51	47	39.1	26	11.42	35.53	11.53	35.58
42	21	50°55.11	001°10.25	E	12.01.16	07:12	2.51	31	27	20.4	6	11.53	35.58	11.54	35.60
43	22	50°44.91	110°64.00	E	12.01.16	08:06	2.21	23	20	12.0	21	11.55	35.60	11.57	35.62
44	23	50°45.02	000°50.50	E	12.01.16	09:49	3.51	35	32	18.4	8	11.58	35.59	11.59	35.62
45	24	50°34.78	000°49.58	E	13.01.16	03:58	4.32	43	39	24.8	31	11.51	35.53	11.52	35.55
46	25	50°35.13	000°30.11	E	13.01.16	05:12	6.13	45	40	36.5	5	11.48	35.61	11.49	35.63
47	26	50°28.06	000°30.07	E	13.01.16	05:53	4.28	37	34	25.7	12	11.47	35.60	11.49	35.62
48	27	50°25.23	000°10.23	E	13.01.16	07:09	5.57	46	43	34.7	5	11.47	35.61	11.50	35.62
49	28	50°16.42	000°10.71	E	13.01.16	08:09	5.08	40	36	28.8	61	11.56	35.63	11.58	35.63
50	29	50°15.25	000°09.40	W	13.01.16	09:43	6.20	50	46	36.9	37	11.51	35.61	11.54	35.62
51	30	50°05.12	000°09.75	W	13.01.16	10:49	6.49	49	45	38.7	18	11.69	35.59	11.69	35.60
52	31	50°05.17	000°29.57	W	13.01.16	12:22	6.47	49	46	40.6	1	11.70	35.53	11.71	35.55
53	32	49°55.21	000°29.95	W	13.01.16	13:21	6.15	47	44	37.1	1	11.71	35.59	11.74	35.54
54	33	49°45.22	000°30.04	W	13.01.16	14:18	5.19	41	38	32.9	0	11.40	35.47	11.41	35.50
55	34	49°35.07	000°30.03	W	13.01.16	15:16	3.19	30	26	20.2	0	11.35	35.50	11.37	35.51
56	35	49°34.96	000°10.07	W	13.01.16	16:32	2.55	26	23	19.2	0	10.57	35.01	10.61	35.03
57	36	49°44.96	000°10.27	W	13.01.16	17:26	4.13	34	31	26.6	0	10.70	35.05	10.77	35.09
58	37	49°54.77	000°10.33	W	13.01.16	18:22	6.03	44	41	37.2	0	11.27	35.52	11.30	35.53
59	38	49°45.34	000°08.60	E	13.01.16	19:53	2.47	24	20	18.6	0	10.21	34.83	10.24	34.87
60	39	49°55.08	000°10.13	E	13.01.16	20:46	3.49	34	30	23.2	1	10.88	35.30	10.89	35.32
61	40	50°04.78	000°09.86	E	13.01.16	21:43	5.29	41	37	33.4	10	11.42	35.54	11.42	35.55
62	41	50°15.04	000°30.02	E	13.01.16	22:58	5.36	42	38	32.7	109	11.40	35.52	11.40	35.55
63	42	50°05.11	000°29.80	E	14.01.16	00:10	4.44	39	36	30.1	216	11.07	35.41	11.07	35.47
64	43	49°55.29	000°29.50	E	14.01.16	01:16	3.49	33	30	23.8	0	10.35	35.07	10.35	35.07
65	44	49°56.34	000°44.80	E	14.01.16	02:08	3.45	31	28	23.9	0	9.73	33.81	9.76	33.83
66	45	50°04.99	000°50.08	E	14.01.16	03:00	4.17	32	28	27.7	18	10.33	34.90	10.34	34.92
67	46	50°14.95	000°49.99	E	14.01.16	03:54	5.02	36	33	32.2	80	11.09	35.48	11.11	35.52
68	47	50°24.66	000°49.94	E	14.01.16	04:47	4.33	34	30	26.9	51	11.34	35.53	11.36	35.55
69	48	50°14.96	001°09.64	E	14.01.16	06:17	3.25	26	23	23.3	76	9.84	34.27	9.87	34.29
70	49	50°24.95	001°10.01	E	14.01.16	07:16	3.16	28	25	19.2	71	10.68	35.20	10.70	35.22
71	50	50°35.01	001°09.70	E	14.01.16	08:18	8.06	52	48	49.8	79	11.28	35.50	11.29	35.53
72	51	50°34.52	001°22.98	E	14.01.16	09:47	3.23	28	25	20.0	104	10.69	35.28	10.70	35.22
73	52	50°44.91	001°24.97	E	14.01.16	10:50	5.43	44	41	33.9	49	10.98	35.48	11.05	35.45
74	53	50°54.65	001°29.86	E	14.01.16	11:47	7.37	52	48	46.2	56	10.68	35.07	10.85	35.18
75	54	51°05.53	001°49.12	E	14.01.16	13:07	3.46	32	29	24.6	34	10.60	35.12	10.60	35.07
76	55	51°14.85	002°09.39	E	14.01.16	14:17	5.11	38	35	33.4	44	10.77	35.27	10.77	35.29
77	56	51°24.61	002°10.17	E	14.01.16	15:15	4.56	36	32	33.2	92	11.04	35.46	11.07	35.47
78	57	51°21.59	002°29.40	E	15.01.16	13:18	3.16	29	26	22.2	67	9.77	34.94	9.79	34.96
79	58	51°27.89	002°49.50	E	15.01.16	15:06	2.50	25	21	17.6	20	9.59	34.84	9.58	34.85
80	59	51°44.73	002°50.09	E	15.01.16	21:41	3.34	29	26	21.8	88	na	na	na	na
81	60	51°44.76	002°29.48	E	15.01.16	23:11	3.48	32	29	24.0	53	na	na	na	na
82	61	51°54.94	002°49.87	E	16.01.16	00:58	4.26	34	31	27.9	213	na	na	na	na
83	62	51°45.61	003°09.80	E	16.01.16	02:32	3.41	28	25	25.3	97	na	na	na	na
84	63	51°54.82	003°09.76	E	16.01.16	03:39	4.33	31	27	21.7	259	na	na	na	na
85	64	51°54.94	003°29.62	E	16.01.16	04:45	3.06	26	22	20.8	74	na	na	na	na

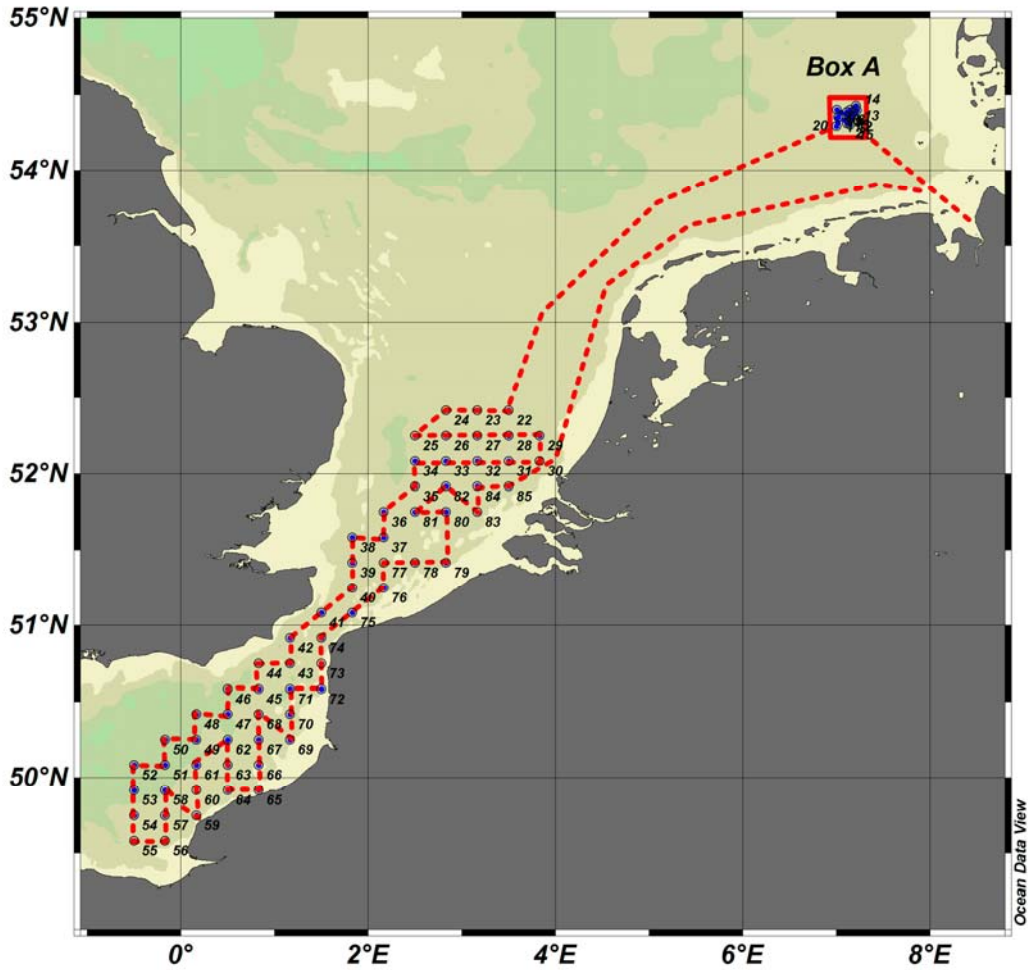


Figure 1: Location of Box A in the German Bight and positions of herring larvae stations in the southern North Sea and the English Channel.

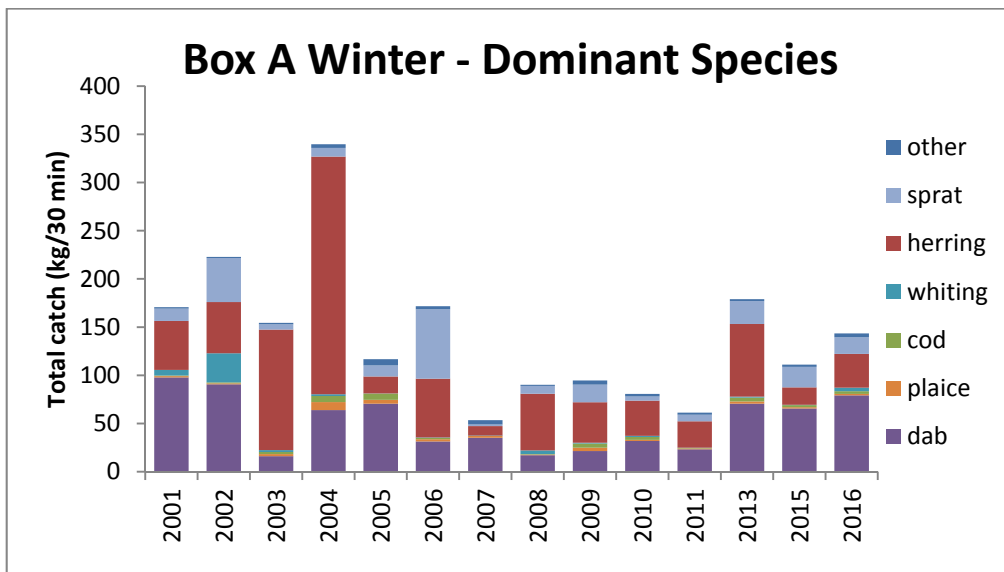


Figure 2: Catch ratios (kg/30min) in Box A in the German Bight from January 2001 to January 2016.

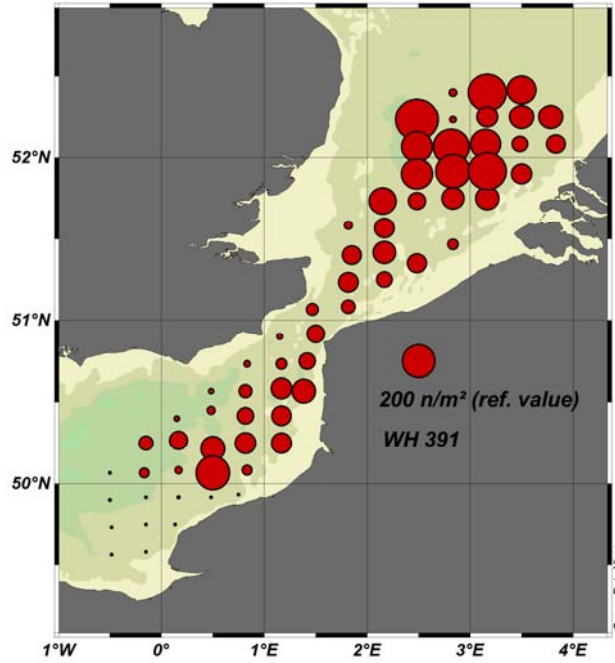


Figure 3: Distribution and abundance of herring larvae (n/m^2 , all length classes) in the southern North Sea and the English Channel. The circle size equivalent to 200 larvae per square metre is indicated.

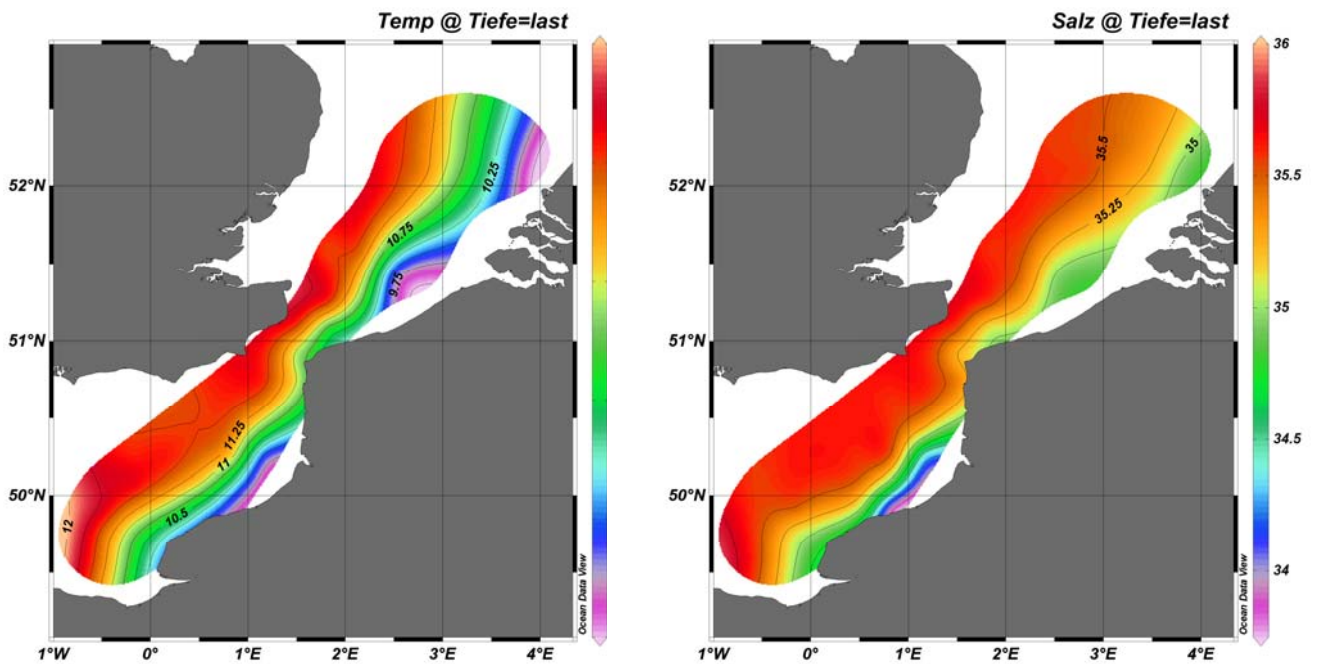


Figure 4: Distribution of near-bottom temperature ($^{\circ}C$, left panel) and salinity (psu, right panel) in the southern North Sea.