Federal Research Institute for Rural Areas, Forestry and Fisheries
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THÜNEN

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FRV Walther Herwig III
Cruise 451
30.11. - 20.12.2021

Studies on Biological Effects of Contaminants in the North Sea and Baltic Sea

Scientist in Charge: Dr. Pedro Miguel Agostinho Nogueira

Summary

As part of the integrated monitoring programme of the Thünen Institute of Fisheries Ecology (FI) on contaminants and biological effects, studies were carried out in five areas in the North Sea and eleven areas in the Baltic Sea. In addition to the onboard examination of cod (*Gadus morhua*) and flounders (*Platichthys flesus*) for macroscopical externally and internally visible diseases, a large range of fish samples were taken for subsequent analysis of radioactive contaminants. Water samples were taken for eDNA analysis and quantification of the amount of adsorbed chemicals, more specifically TNT. Additionally, 611 flounders caught from selected areas were transported alive to Estonia, where they were used in a Common Garden experiment to study the natural mechanisms protecting against cancer. Furthermore, hydrographical measurements were carried out (water temperature, salinity, oxygen content and turbidity).

Objectives of the Cruise

1. Obtaining fish samples for the analysis of radioactive substances;
2. Determination of externally visible fish diseases and tissue sampling of livers and other organs for subsequent histological and biochemical analyses;
3. Hydrographical measurements (salinity, temperature, oxygen, turbidity);
4. Documentation of marine litter fished during the trawling;
5. Video and photos from marine litter on the Sea bottom, using an Epibenthos Sledge equipped with a Gopro camera and a light system;
6. Catch and transport of living flounders (*Platichthys flesus*) from selected Baltic Sea areas to Estonia;
7. Collection of water samples for eDNA and TNT quantification.

Dates of the Cruise

The RV "Walther Herwig III" departed from Bremerhaven on 01.12.2021 in the direction of the reference area GB1 and N01, where on the morning of 02.12. our work started with fisheries using the fishing gear GOV. After gathering the required samples for the radioactive monitoring of the North Sea, we proceeded to the Baltic Sea, through the

Skagerrak. On the way, water samples were collected in the N11 and SK2 areas for TNT quantification.

In the morning of 04.12. we started our work in the Baltic Sea in the area B01 using the 140er fishing gear.
The work program continued on the next day in the area B12 and after this in the areas B11, B09, B25, B26 and B27. On day 11.12. Dr. Randel Kreitsberg and Ms. Ciara Baines were transported to Tallin together with their samples and 611 living founders.

On day 12.12. the survey continued on the areas B23 and B22, B14 and B13. On this last area the pelagic net PSN was used.
On day 16.12. we returned to the North Sea through the Skagerrak, and the work continued in the area GB3. To study the differences in catchability of marine litter the 140r fishing gear was used. Additionally, an Epibenthos sledge equipped with a Gopro camera and a light system was tested for the recording of marine litter on the seabed. The tests continued in the following day, East from Helgoland and in the area GB1.

Once the tests were completed, the Walther Herwig III 451 survey finished upon the safe return to Bremerhaven on day 18.12.

The location of the study areas and the exact travel course is shown in Fig. 1 and Tab. 1a and 1b. In the 16 study areas (Fig. 1), a total of 39 fishing hauls (trawling time, usually one hour) were carried out (Table 1a). The GOV was used in the North Sea and the 140's in the Baltic Sea. Hydrographic measurements were carried out at 46 stations (Tab. 1b). The preliminary results relative to the anthropogenic Caesium 137 (Cs-137) and natural Potassium 40 (K-40) measured in the different fish samples can be found in table 7.

Participants:

1. Dr. Pedro Miguel Agostinho Nogueira (Chief Scientist), TI-FI Bremerhaven
2. Nadine Römer, TI-FI Bremerhaven
3. Sarah-Jane Reyelt, TI-FI Bremerhaven
4. Dr. Randel Kreitsberg, University of Tartu, Estonia
5. Ciara Baines, University of Tartu, Estonia
6. Wojciech Wilczyński (Polish observer) , IOPAS
7. Alexander Knorrn (Student)
8. Murielle Muesfeldt (Student)
9. Elisabeth Renk (Student)
10. Esther Wilhelm, Uni. Bremen
11. Josephine Buntrock (Trainee), Uni. Hamburg

Preliminary results:

The preliminary results of this cruise show that there is a significant higher Cs-137 activity in the North areas of the Baltic Sea, see table 5. This is in agreement with the past survey's results and values reported by HELCOM. It was also observed that the Cs-137 activity is strongly dependent of the fish species. For example, in the Area B12 the Dab contains 0.521 Bq/kg Cs-137, while Cod has 1.99 Bq/kg Cs-137.

Acknowledgements

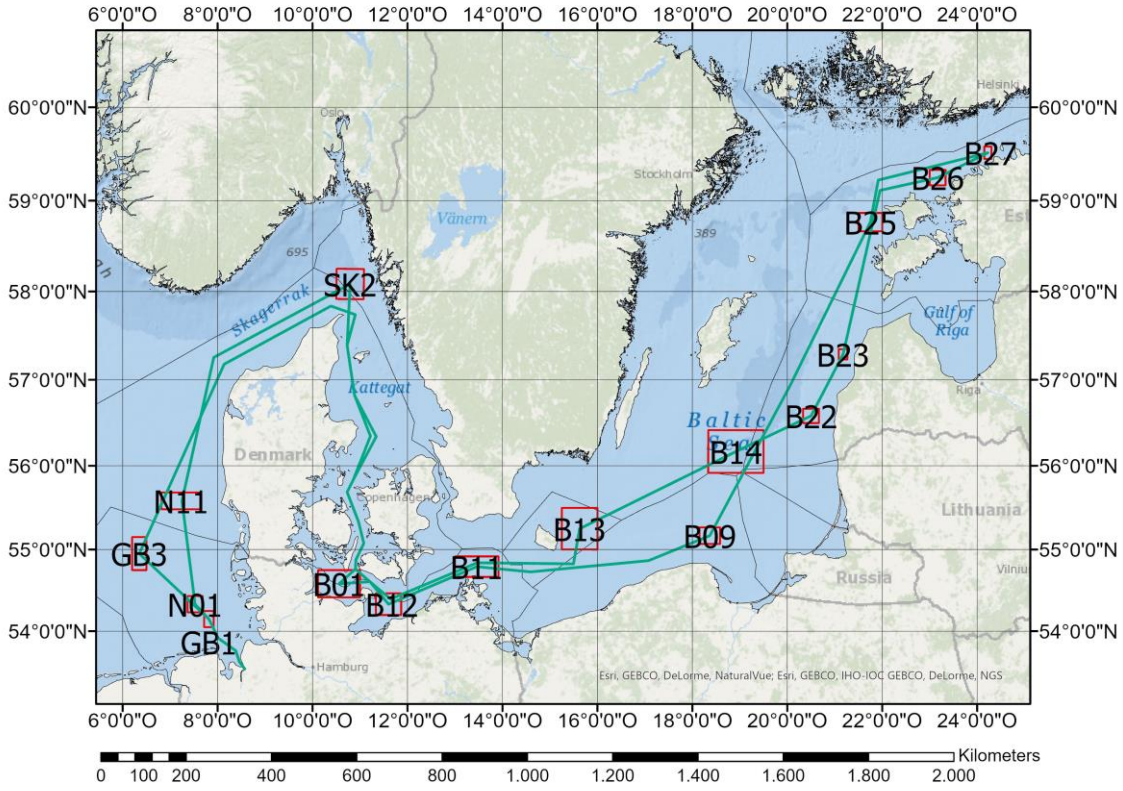
Thanks are due to Captain Janßen and his crew and to the scientific staff for constructive and hard work and a very good atmosphere on board.

Dr. Pedro Miguel Agostinho Nogueira

(Scientist in Charge)

Annex: 1 Figure and 7 Tables

Fig. 1: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021:
Location of sampling sites and travel route in the North Sea and Baltic Sea



Tab. 1: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021:
Geographical coordinates of trawling stations in the North Sea and Baltic Sea

Date	LOG-Station	Station	Area	Latitude	Longitude	Duration (min)	Net
01.12.21	286	1	GB1	54°04,502N	007°54,030E	60	GOV, 50m Stander
01.12.21	287	2	N01	54°16,446N	007°30,725E	60	GOV, 50m Stander
04.12.21	290	5	B01	54°32,881N	010°46,398E	60	140 Fuß-Netz
04.12.21	291	6	B01	54°32,049N	010°37,515E	60	140 Fuß-Netz
04.12.21	292	7	B01	54°32,944N	010°46,842E	60	140 Fuß-Netz
04.12.21	293	8	B01	54°33,908N	010°30,463E	60	140 Fuß-Netz
04.12.21	294	9	B01	54°31,889N	010°36,567E	60	140 Fuß-Netz
04.12.21	295	10	B01	54°32,881N	010°46,398E	60	140 Fuß-Netz
05.12.21	296	11	B12	54°23,142N	011°25,328E	60	140 Fuß-Netz
05.12.21	297	12	B12	54°17,797N	011°34,886E	60	140 Fuß-Netz
05.12.21	299	14	B12	54°20,155N	011°42,525E	60	140 Fuß-Netz
05.12.21	299	14	B12	54°16,440N	011°37,927E	60	140 Fuß-Netz
05.12.21	300	15	B12	54°15,052N	011°39,854E	60	140 Fuß-Netz
05.12.21	301	16	B12	54°12,694N	011°39,813E	60	140 Fuß-Netz
06.12.21	302	17	B11	54°43,253N	013°17,999E	60	140 Fuß-Netz
07.12.21	303	18	B09	55°09,667N	018°13,934E	60	140 Fuß-Netz
07.12.21	304	19	B09	55°14,659N	018°10,232E	60	140 Fuß-Netz
07.12.21	305	20	B09	55°12,572N	018°21,624E	60	140 Fuß-Netz
07.12.21	306	21	B09	55°08,227N	018°19,266E	60	140 Fuß-Netz
07.12.21	307	22	B09	55°07,438N	018°11,060E	60	140 Fuß-Netz
07.12.21	308	23	B09	55°13,991N	018°10,560E	60	140 Fuß-Netz
08.12.21	309	24	B 09	55°07,291N	018°15,753E	60	140 Fuß-Netz
09.12.21	310	25	B25	58°40,361N	021°40,286E	60	140 Fuß-Netz
09.12.21	311	26	B25	58°41,234N	021°47,910E	60	140 Fuß-Netz
09.12.21	312	27	B25	58°45,630N	021°48,419E	60	140 Fuß-Netz
09.12.21	313	28	B25	58°41,104N	021°47,858E	60	140 Fuß-Netz
09.12.21	314	29	B25	58°45,492N	021°48,132E	60	140 Fuß-Netz
10.12.21	315	30	B27	59°30,937N	024°10,548E	60	140 Fuß-Netz
10.12.21	316	31	B27	59°32,730N	024°08,121E	60	140 Fuß-Netz
10.12.21	317	32	B27	59°36,246N	024°11,407E	120	140 Fuß-Netz
12.12.21	319	34	B23	57°20,211N	021°14,836E	60	140 Fuß-Netz
12.12.21	320	35	B23	57°17,849N	021°10,678E	60	140 Fuß-Netz
13.12.21	324	39	B13	55°09,080N	015°53,292E	60	PSN 205
13.12.21	325	40	B13	55°14,839N	015°53,989E	120	PSN 205
16.12.21	327	42	GB3	55°01,207N	006°18,586E	60	140 Fuß-Netz
16.12.21	328	43	GB3	54°55,804N	006°16,879E	60	140 Fuß-Netz
16.12.21	328	43	GB3	54°58,766N	006°23,276E	60	140 Fuß-Netz
16.12.21	330	45	GB3	54°56,425N	006°16,276E	60	140 Fuß-Netz
16.12.21	331	46	GB3	54°58,729N	006°21,454E	60	140 Fuß-Netz

Tab. 1a: Cruise 451 RV 'Walther Herwig III',30.11. – 20.12.2021: Geographical coordinates of hydrography stations in the North Sea and Baltic Sea

Date	LOG Station	Trawling Station	Area	Latitude	Longitude
01.12.21	286	1	GB1	54°04,146N	007°54,349E
01.12.21	287	2	N01	54°16,279N	007°31,544E
02.12.21	288		N11	55°34,853N	007°19,025E
03.12.21	289		SK2	57°58,291N	010°33,741E
04.12.21	290	5	B01	54°33,143N	010°47,613E
04.12.21	291	6	B01	54°32,069N	010°37,212E
04.12.21	292	7	B01	54°33,301N	010°48,396E
04.12.21	293	8	B01	54°36,413N	010°24,494E
04.12.21	294	9	B01	54°31,802N	010°35,532E
04.12.21	295	10	B01	54°32,179N	010°39,680E
05.12.21	296	11	B12	54°23,607N	011°24,921E
05.12.21	297	12	B12	54°17,708N	011°33,896E
05.12.21	299	14	B12	54°16,080N	011°37,177E
05.12.21	300	15	B12	54°15,152N	011°39,159E
05.12.21	301	16	B12	54°12,385N	011°41,854E
06.12.21	302	17	B11	54°43,147N	013°18,918E
07.12.21	303	18	B09	55°08,776N	018°14,919E
07.12.21	304	19	B09	55°15,003N	018°09,341E
07.12.21	305	20	B09	55°12,712N	018°20,878E
07.12.21	306	21	B09	55°08,334N	018°20,435E
07.12.21	307	22	B09	55°06,965N	018°11,093E
07.12.21	308	23	B09	55°14,672N	018°10,419E
08.12.21	309	24	B09	55°06,594N	018°16,366E
09.12.21	310	25	B25	58°40,273N	021°41,844E
09.12.21	311	26	B25	58°40,639N	021°47,514E
09.12.21	313	28	B25	58°41,100N	021°47,639E
09.12.21	314	29	B25	58°45,964N	021°48,097E
09.12.21	314	29	B25	58°41,329N	021°47,236E
10.12.21	315	30	B27	59°31,159N	024°10,937E
10.12.21	316	31	B27	59°33,708N	024°08,922E
10.12.21	317	32	B27	59°36,884N	024°11,332E
11.12.21	318	33	B26	59°25,410N	023°01,510E
12.12.21	319	34	B23	57°20,220N	021°15,081E
12.12.21	320	35	B23	57°14,496N	021°06,396E
12.12.21	321		B22	56°36,163N	020°24,041E
12.12.21	322		B14	56°07,497N	019°22,549E
12.12.21	323		B14	56°05,908N	018°29,954E
13.12.21	324	39	B13	55°07,826N	015°53,101E
13.12.21	325	40	B13	55°13,520N	015°53,816E
16.12.21	326	41	GB3	55°01,605N	006°18,329E
16.12.21	327	42	GB3	54°55,353N	006°16,091E
16.12.21	329	44	GB3	54°56,345N	006°17,172E

Tab. 1a: cont.

16.12.21	330	45	GB3	54°56,132N	006°15,675E
16.12.21	331	46	GB3	54°59,181N	006°22,021E

Tab. 2: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021: Mean catches of selected abundant fish species in the North and Baltic Sea (weight (kg) per 1 h trawling)

Area	Cod	Dab	Plaice	Herring	Sprat	Flounder	Whiting	Mackerel
GB1	2.92	23.98	1.50	11.90	15.36	0.26	170.45	0.41
N01	0.19	1.41	0.00	5.63	6.91	0.00	104.37	0.33
B01	5.60	52.26	47.48	0.26	0.05	3.02	1.03	
B12	1.62	17.98	22.05	0.22	0.09	4.81	0.53	
B11	3.25	7.41	8.59	0.24	0.14	24.73	3.63	
B09	26.41	0.11	0.24	1.98	0.67	8.55		0.11
B25	1.08			28.83	32.15	7.16		
B27				0.05	0.09	0.37		
B23	8.86			4.63	1.32	73.89		
B13	4.34		2.84	17.62	52.77	0.96		
GB3	0.01	22.57	3.15	2.27	0.36	0.08	6.32	1.05

Tab. 2a: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021: Mean catches of selected abundant fish species in the North Sea and Baltic Sea (number per 1 h trawling)

Area	Cod	Dab	Plaice	Herring	Sprat	Flounder	Whiting	Mackerel
GB1	5.00	512.00	10.00	292.00	1609.00		3207.87	5.00
N01	3.00	46.53		366.75	903.19		3360.97	3.00
B01	4.41	245.67	189.47	15.17	3.89	1.00	7.82	
B12	0.80	126.40	119.40	14.20	10.60	14.80	11.20	
B11	3.77	35.30	62.46	7.00	19.69	84.44	7.88	
B09	85.29	1.00	1.57	45.57	49.29	29.29		0.14
B25	3.81			1301.84	3358.42	5.60		
B27				2.00	11.33			
B23	28.85			134.20	147.26	0.85		
B13	7.25		20.94	521.70	3891.61	17.00		
GB3	0.20	355.00	17.20	172.00	137.40		138.60	12.00

Tab. 3: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021:
Water depth, temperature (T), salinity (S), O_2 in mg/l and O_2 saturation (%) in Baltic Sea and North Sea

Date	LOG-Station	Trawling Station	Area	Depth (m)	T (°C)	S (PSU)	O2 (mg/l)	O2 Saturation (%)
01.12.21	286	1	GB1	39	10.867	32.1536	5.99	94.83
				3	10.558	31.9132	6.01	94.51
01.12.21	287	2	N01	32	11.315	32.6493	5.95	95.46
				5	11.31	32.6533	5.95	95.5
02.12.21	288		N11	30	9.871	32.6118	6.15	95.7
				4	9.337	31.9604	6.26	95.86
03.12.21	289		SK2	127	8.241	34.969	5.22	79.49
				3	7.328	30.5987	6.51	94.35
04.12.21	290	5	B01	20	7.76	19.502	6.94	94.57
				3	7.695	17.7988	7.08	95.18
04.12.21	291	6	B01	14	7.675	18.8088	7.05	95.42
				3	7.572	18.26	7.08	95.22
04.12.21	292	7	B01	20	7.868	19.4566	6.86	93.61
				3	7.338	17.1644	7.22	95.86
04.12.21	293	8	B01	15	7.864	20.1624	6.81	93.45
				3	7.81	19.8281	6.91	94.41
04.12.21	294	9	B01	14	7.714	19.0006	7.01	95.00
				3	7.528	17.9832	7.13	95.6
04.12.21	295	10	B01	16	7.694	18.6701	6.96	94.19
				3	7.695	17.8937	7.07	95.19
05.12.21	296	11	B12	20	7.211	17.1163	7.12	94.22
				3	7.501	16.3386	7.15	94.76
05.12.21	297	12	B12	21	7.505	16.3285	7.17	95.04
				3	7.33	15.6293	7.26	95.41
05.12.21	299	14	B12	21	7.678	15.9836	7.1	94.32
				4	7.167	15.3191	7.31	95.52
05.12.21	300	15	B12	22	7.831	16.0021	7.03	93.78
				3	7.251	14.3622	7.35	95.61
05.12.21	301	16	B12	21	7.646	16.7149	7.02	93.62
				3	7.175	13.365	7.41	95.68
06.12.21	302	17	B11	29	10.236	11.2147	6.32	86.42
				3	7.847	8.9596	7.44	94.8
07.12.21	303	18	B09	67	8.533	11.8481	2.63	34.69
				3	7.723	7.4381	7.48	94.12
07.12.21	304	19	B09	61	9.127	11.9161	3.32	44.47
				3	6.722	7.2736	7.66	93.96
07.12.21	305	20	B09	72	7.933	11.6663	1.79	23.21
				4	7.679	7.446	7.48	93.95
07.12.21	306	21	B09	76	8.327	11.7699	2.52	33.02
				3	7.708	7.4542	7.53	94.75

Tab. 3: cont.

07.12.21	307	22	B09	67 3	8.98 7.758	11.998 7.4151	3.04 7.5	40.58 94.44
07.12.21	308	23	B09	58 4	9.116 6.772	11.8314 7.2766	3.38 7.66	45.16 94.07
08.12.21	309	24	B09	68 4	8.413 7.647	11.7926 7.4266	2.53 7.54	33.25 94.62
09.12.21	310	25	B25	52 3	5.919 5.831	7.2342 6.9458	7.65 7.74	91.96 92.59
09.12.21	311	26	B25	48 4	5.338 5.925	7.2047 7.0956	7.84 7.75	92.78 93.09
09.12.21	312	28	B25	48 3	6.267 5.943	7.2771 7.1011	7.55 7.74	91.58 92.97
09.12.21	313	29	B25	45 4	6.494 5.883	7.2488 7.0292	6.75 7.75	82.26 92.93
09.12.21	314	29	B25	44 4	5.301 5.881	7.1475 7.1104	7.89 7.75	93.37 93.00
10.12.21	315	30	B27	90 4	6.521 5.093	10.8104 6.7054	0.39 7.78	4.91 91.31
10.12.21	316	31	B27	83 3	6.517 5.471	10.8008 6.7266	0.43 7.78	5.42 92.19
10.12.21	317	32	B27	73 4	6.497 5.335	10.7803 6.7102	0.43 7.81	5.37 92.17
11.12.21	318	33	B26	99 3	6.631 5.948	10.9923 6.7769	0.41 7.73	5.09 92.68
12.12.21	319	34	B23	47 3	5.715 5.982	7.3983 7.3777	7.91 7.86	94.64 94.75
12.12.21	320	35	B23	49 4	7.13 7.121	7.4308 7.4308	7.57 7.56	93.81 93.68
12.12.21	321		B22	72 3	5.86 7.275	9.8801 7.4424	3.06 7.52	37.39 93.59
12.12.21	322		B14	79 3	6.563 6.409	11.1019 7.4081	0.85 7.74	10.66 94.22
12.12.21	323		B14	100 3	6.7 6.391	10.9167 7.4099	0.38 7.79	4.77 94.83
13.12.21	324	39	B13	78 4	8.179 6.895	15.3405 7.5143	0.4 7.59	5.34 93.67
13.12.21	325	40	B13	86 4	8.232 6.55	15.687 7.5288	0.4 7.71	5.33 94.3
16.12.21	326	41	GB3	43 4	10.2 10.194	34.5075 34.5079	6.07 6.08	96.2 96.34
16.12.21	327	42	GB3	40 3	10.133 10.134	34.5463 34.5414	6.08 6.07	96.21 96.14

Tab. 3: cont.

16.12.21	328	44	GB3	41	10.132	34.5442	6.08	96.22
				4	10.13	34.5378	6.08	96.29
16.12.21	329	45	GB3	40	10.14	34.5429	6.08	96.21
				3	10.141	34.5369	6.08	96.31
16.12.21	331	46	GB3	40	10.093	34.5273	6.09	96.42
				3	10.083	34.5268	6.08	96.24

Tab. 4: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021: Geographical coordinates of eDNA water samples in the North Sea and Baltic Sea.

Date	LOG Station	Trawling Station	Area	Latitude	Longitude	Bottle's	Depth (m)
01.12.21	286	1	GB1	54°04,502N	007°54,030E	2	38.2
01.12.21	287	2	N01	54°16,446N	007°30,725E	2	31.7
04.12.21	290	5	B01	54°32,881N	010°46,398E	2	19.3
05.12.21	296	11	B12	54°23,142N	011°25,328E	2	20
06.12.21	302	17	B11	54°43,253N	013°17,999E	2	28.5
07.12.21	303	18	B 09	55°09,667N	018°13,934E	2	66
09.12.21	310	25	B25	58°40,361N	021°40,286E	2	51.5
10.12.21	315	30	B27	59°30,937N	024°10,548E	2	88

Tab. 5: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021: Geographical coordinates of TNT samples in the North Sea and Baltic Sea.

Date	LOG Station	Area	Latitude	Longitude	Depth (m)
01.12.2021	286	GB1	54°04,146N	007°54,349E	38.5
02.12.2021	288	N11	55°34,853N	007°19,025E	29
02.12.2021	288	N11	55°34,853N	007°19,025E	29
03.12.2021	289	SK 2	57°58,291N	010°33,741E	127
07.12.2021	303	B09	55°08,776N	018°14,919E	66
07.12.2021	303	B09	55°08,776N	018°14,919E	66
09.12.2021	310	B25	58°40,273N	021°41,844E	51.5
10.12.2021	315	B27	59°31,159N	024°10,937E	88
11.12.2021	318	B26	59°25,410N	023°01,510E	98
11.12.2021	318	B26	59°25,410N	023°01,510E	98
12.12.2021	319	B23	57°20,220N	021°15,081E	46
12.12.2021	321	B22	56°36,163N	020°24,041E	70
12.12.2021	322	B14	56°07,497N	019°22,549E	77
12.12.2021	322	B14	56°07,497N	019°22,549E	77
12.12.2021	323	B14	56°05,908N	018°29,954E	98
13.12.2021	324	B13	55°07,826N	015°53,101E	77
13.12.2021	325	B13	55°13,520N	015°53,816E	85

Tab. 6: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021:
Geographical coordinates of the epibenthos sledge stations in the North Sea

Date	LOG-Station	Station	Area	Latitude	Longitude	Depth (m) (min)
16.12.21	330	45	GB3	54°58,761N	006°22,829E	44.00
17.12.21	332	47		54°11,844N	008°03,346E	27.90
17.12.21	333	48		54°11,835N	008°04,300E	29.00
17.12.21	334	49		54°11,452N	008°04,966E	28.90
17.12.21	335	50		54°11,498N	008°05,041E	28.80
17.12.21	336	51		54°11,363N	008°05,340E	27.60
17.12.21	337	52	GB1	54°05,793N	007°49,340E	45.40
17.12.21	338	53	GB1	54°05,896N	007°49,069E	44.90

Tab. 7: Cruise 451 RV 'Walther Herwig III', 30.11. – 20.12.2021:
Anthropogenic Cs-137 and natural K-40 activities measured in the monitoring areas from the Baltic Sea, in Bq per Kg

			Cs-137		K-40	
Area	Species	Tissue	Activity (Bq/kg)	Uncert. (%)	Activity (Bq/kg)	Uncert. (%)
N01	Herring	Whole Fish	0.108	11.09	112	8.98
GB1	Herring	Whole Fish	0.106	11.09	113	8.98
N01	Whiting	Whole Fish	0.0571	11.51	103	8.98
GB1	Dab	Whole Fish	0.0454	12.1	94.1	8.98
B01	Dab	Whole Fish	0.389	10.86	77.7	8.98
B01	Whiting	Whole Fish	0.818	10.83	97.3	8.98
B12	Dab	Whole Fish	0.521	6.34	97.8	6.64
B12	Whiting	Whole Fish	1.07	6.2	116	6.64
B12	Cod	Whole Fish	1.99	10.82	90.4	8.98
B11	Dab	Whole Fish	1.12	6.12	93.8	6.62
B25	Flounder	Whole Fish	2.19	10.82	80	8.98