CRUISE REPORT

R/V Aranda

Cruise 03/2020

COMBINE 2/2020

1.6.2020 – 11.6.2020

This report is based on preliminary data and is subject to changes.

Objectives of the cruise

The COMBINE 2 cruise contributed to the HELCOM Baltic Sea integrated physical, chemical and biological monitoring programme, focusing especially on long-term macrozoobenthos monitoring and near-bottom water oxygen levels in the open sea area. It also contributed to the long-term monitoring of zooplankton communities and microlitter monitoring. Water and sediment samples were taken for monitoring of radioactive substances (HELCOM MORS programme). In addition a wave buouy was installed in the Bothnian Bay and drifting floats were deployed in the Bothnian Sea and the Northern Baltic Proper. The monitoring activities were part of the Finnish marine management plan.

Table 1 The scientific crew

Name	On board	Organization
Nygård Henrik (chjief scientist)	1-11.6.2020	SYKE
Noora Haavisto	1-11.6.2020	SYKE
Jere Riikonen	1-11.6.2020	SYKE
Panu Hänninen	1-11.6.2020	SYKE
Olga Kovru	1-11.6.2020	SYKE
Tanja Kinnunen	1-11.6.2020	SYKE
Susanna Hyvärinen	1-11.6.2020	SYKE
Outi Setälä	1-11.6.2020	SYKE
Marko Jaale	1-11.6.2020	SYKE
Okko Outinen	1-11.6.2020	SYKE
Pekka Kotilainen	1-11.6.2020	SYKE
Kari Huusela	1-11.6.2020	STUK
Heini Jalli	1-11.6.2020	IL
Tuomo Roine	1-11.6.2020	IL

Cruise Route

The cruise started in Helsinki 1.6.2020 and first headed towards the easternmost sampling stations in the Gulf of Finland. After sampling in the Gulf of Finland the cruise continued through the Archipelago Sea and north in the eastern part of Bothnian Sea and Bothnian Bay, before returning south along the western parts of the Bothnian Bay and Bothnian Sea to the Åland Sea. The stations in the Northern Baltic Proper were then sampled, before returning to Helsinki 11.6.2020. A map of the cruise route is shown in Figure 1.

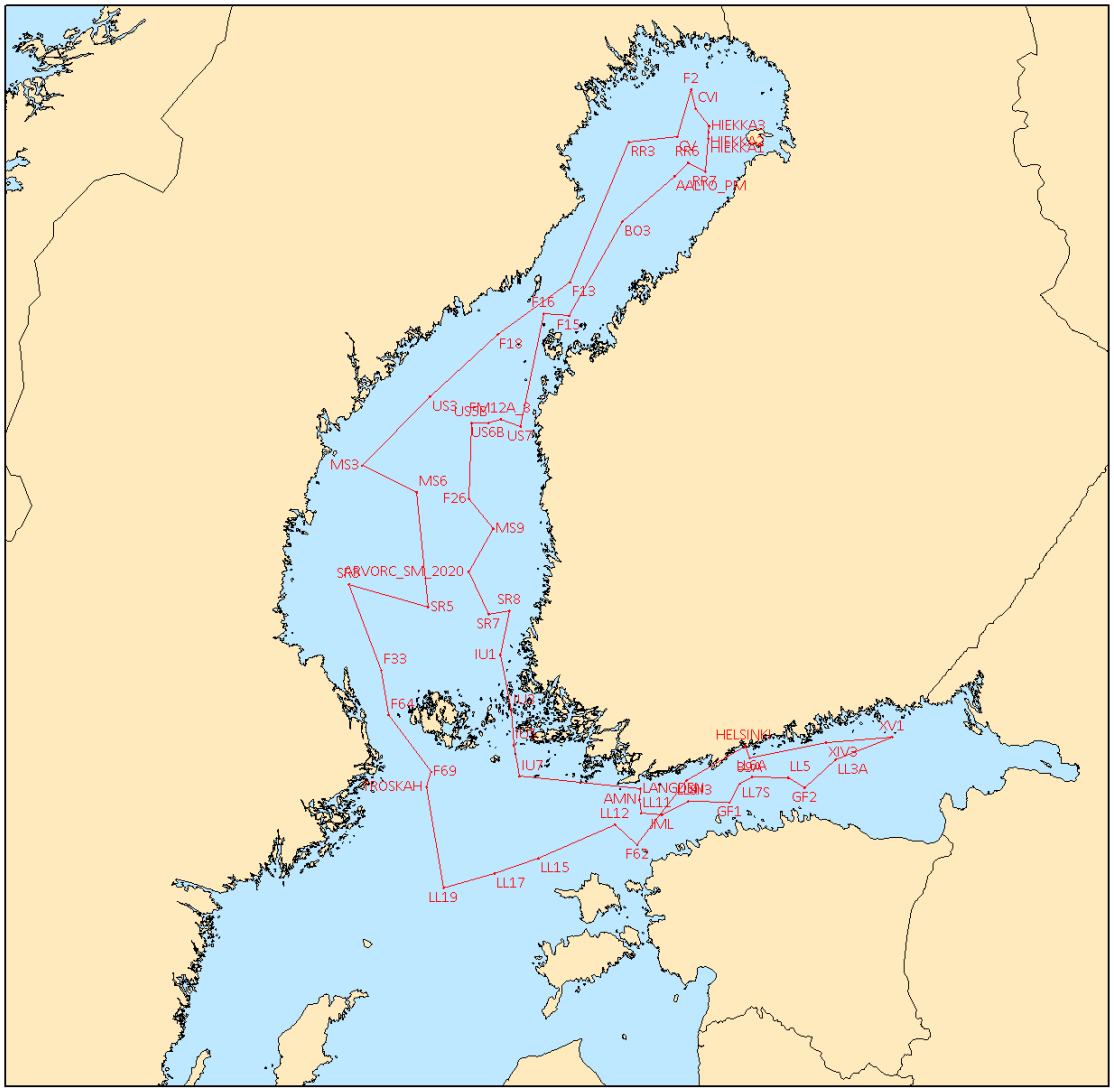

Figure 1. Cruise route

Observations

Hydrographic results
Due to the warm period prior to the cruise, the temperature in the surface water was well above the long-term (1990-2019) average in all sea areas, and a thermocline was usually observed at about 10 m depth. In the Gulf of Finland and the Northern Baltic Proper the surface temperature reached 10 °C or above, but gradually decreased to around 6 °C in the Bothnian Bay.

The sampling stations in the coastal parts of Gulf of Finland all situated shallower then the halocline and the bottom water was well-oxygenated. In the open areas of the Gulf of Finland, the water column was now stratified again after the mixing observed in winter. The halocline was situated around 60-65 m depth and in the bottom water the salinity was above the long-term average, reaching above 10 ppm, indicating an inflow of bottom water from the Northern Baltic Proper. The oxygen conditions in the near-bottom waters were poor and close to anoxic at many sampling stations. However, hydrogen sulphide was only observed at the deepest stations in the western part of the Gulf of Finland.

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FI-00101 Helsinki
Finland
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In the Bothnian Sea, the salinity in the water below ~80 m was elevated compared to the long-term average and reached above 6.5 ppm. Oxygen levels were close to the long-term average in the Bothnian Sea. In the Bothnian Bay, both salinity and oxygen levels were close to the long-term average.

In the Åland Sea the salinity was slightly above the long-term average throughout the water column. Also in the Northern Baltic Proper, the salinity both in the surface and bottom water was slightly above the long-term average. The halocline situated around 70 m depth and below 80 m the water column was anoxic. Hydrogen sulphide occurred in the bottom water.

Depth profiles on temperature, salinity and oxygen for selected sampling stations are presented in Annex 1.

Chemical results
In the eastern and middle parts of the Gulf of Finland the surface water was almost completely depleted for dissolved nutrients. In the western part of the Gulf of Finland elevated concentrations of phosphate, reaching up to 0.4-0.6 µmol/l, were observed in the surface water. Also in the southern parts of the Bothnian Sea, the phosphate levels were elevated in the surface waters. In the northern parts of the Bothnian Sea, the Quark, Bothnian Bay and the Northern Baltic Proper, the surface water was almost completely depleted for phosphate. Nitrate levels in the surface water were close to 0 µmol/l in the whole sea area.

Results for total nitrogen and total phosphorus are not available, as the samples were not analysed during the cruise. These samples will be analysed within a few weeks after the cruise ended.

Depth profiles on phosphate and nitrate-nitrite concentrations for selected sampling stations are presented in Annex 1.

Biological results
Although the oxygen conditions had improved in the Gulf of Finland compared to the latest years, no recovery in the benthic community was observed. Based on the preliminary results, only polychaetes, mainly *Marenzelleria* spp., were observed in low numbers in the Gulf of Finland. In the Bothnian Sea, the abundances of benthic macrofauna had increased or were similar to the latest years, whereas in the Bothnian Bay the abundances seem to have decreased slightly, according to the preliminary results. In the Northern Baltic Proper, no benthic samples were taken due to the occurrence of hydrogen sulphide and the bottoms were considered azoic.

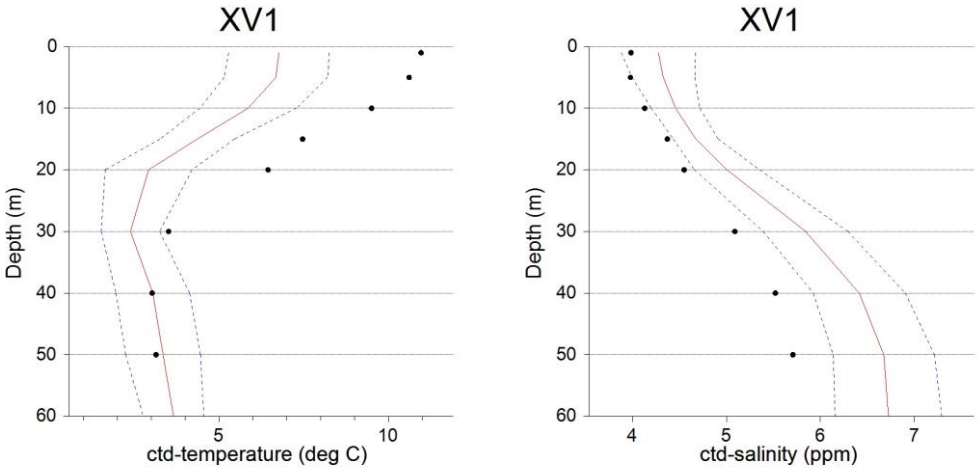
No results on the zooplankton community are yet available.

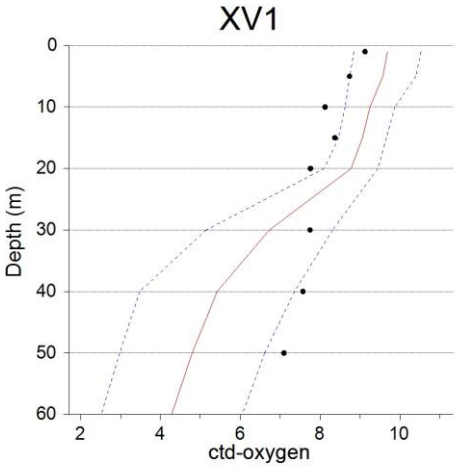
Conclusions

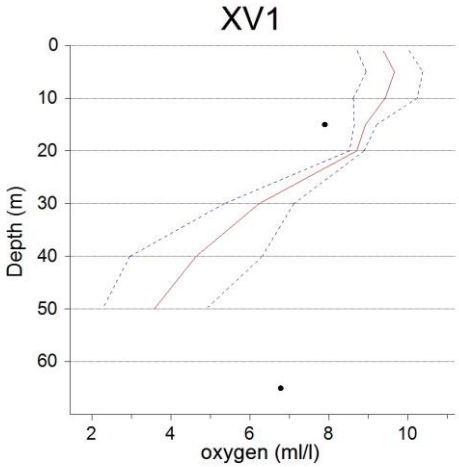
In the Gulf of Finland, the changes in the bottom water oxygen conditions seem to be part of the natural fluctuations and water exchange between the Northern Baltic Proper and the Gulf of Finland. After the mixing event during winter, letting oxygenated surface water reach the bottom, inflow of water from the Northern Baltic Proper has re-formed the stratification and the oxygen levels are declining again. Excess phophate in the surface waters in the western parts of the Gulf of Finland increase the potential for cyanbacterial blooms during the coming summer.

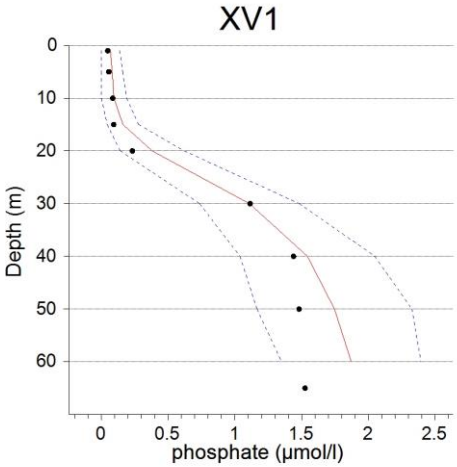
In the Bothnian Sea, the increased salinity in bottom waters can lead to a stronger stratification of the water column. This might affect the mixing of the water column with reduced replenishment of oxygen concentrations in the bottom water as a consequence.

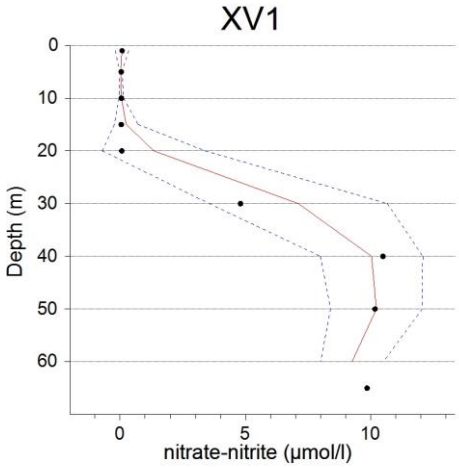
Annex 1. Selected variables at the stations XV1, LL7S, US5B, BO3, SR5, F64 and LL15. Mean (red solid line) and standard deviation (blue dotted lines) represent the data collected at the same time of season since the year 1990.

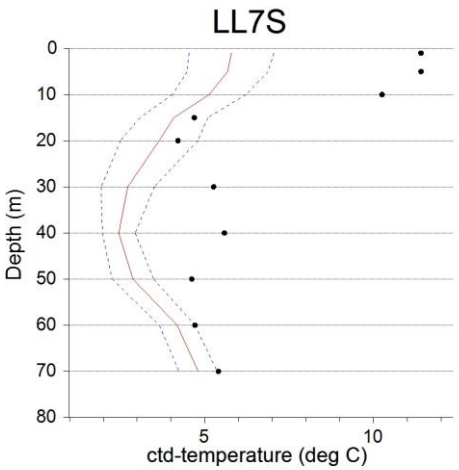


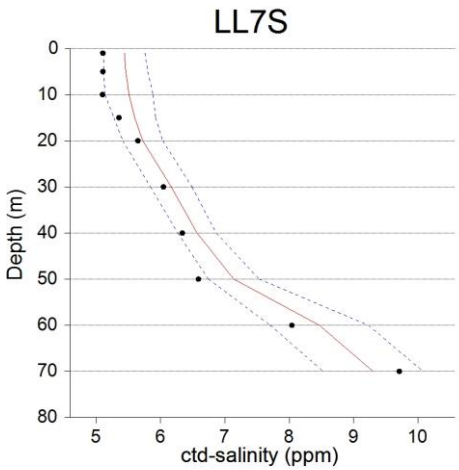


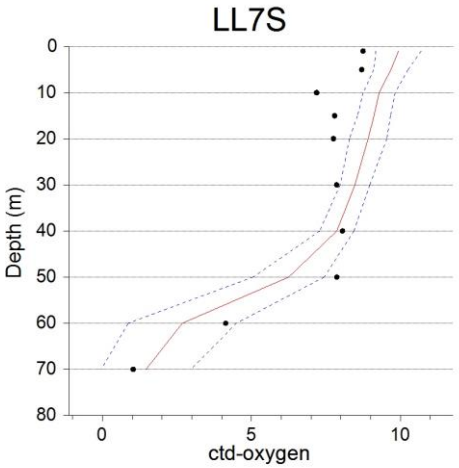


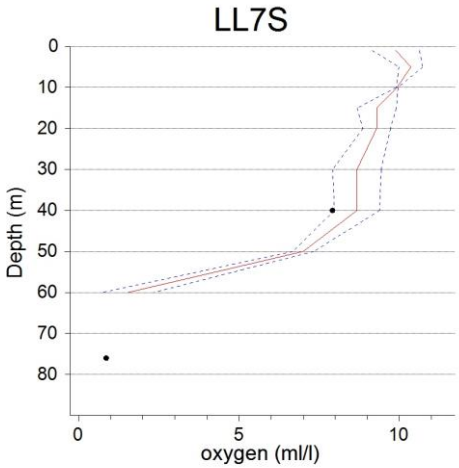


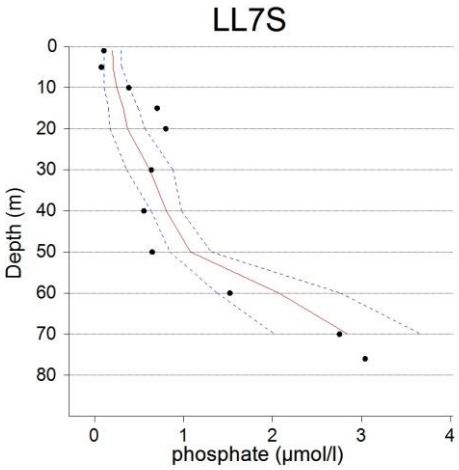


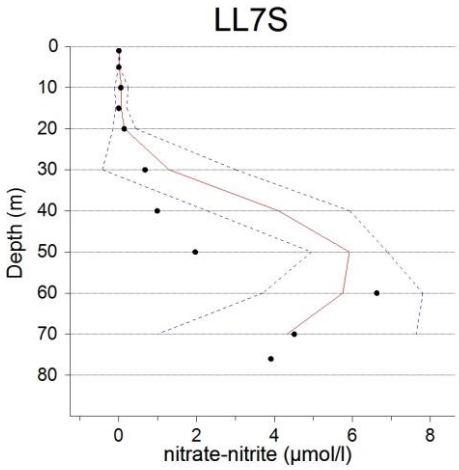

LL7S
Depth (m)
0
10
20
30
40
50
60
70
80
5
10
ctd-temperature (deg C)

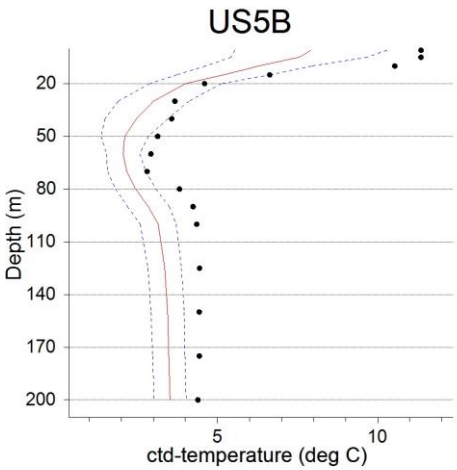

LL7S
Depth (m)
0
10
20
30
40
50
60
70
80
5
6
7
8
9
10
ctd-salinity (ppm)

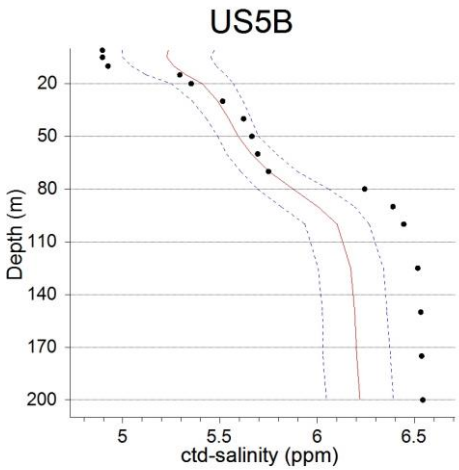

LL7S
Depth (m)
0
10
20
30
40
50
60
70
80
0
5
10
ctd-oxygen

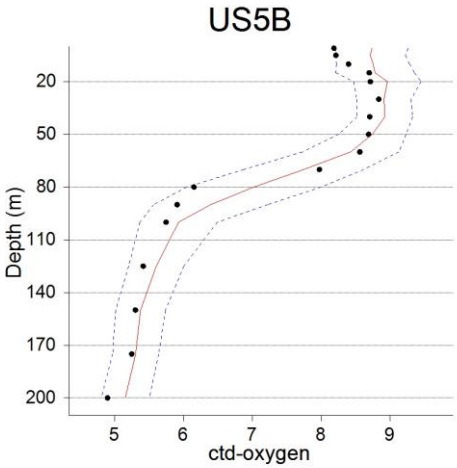

LL7S
Depth (m)
0
10
20
30
40
50
60
70
80
0
5
10
oxygen (ml/l)

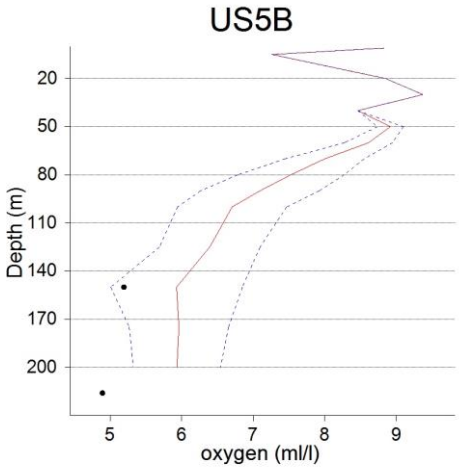

LL7S
Depth (m)
0
10
20
30
40
50
60
70
80
0
1
2
3
4
phosphate (µmol/l)

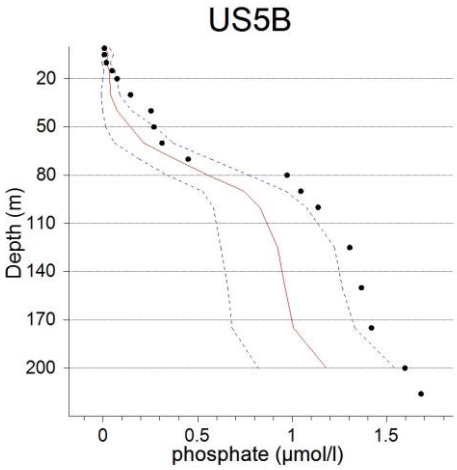

LL7S
Depth (m)
0
10
20
30
40
50
60
70
80
0
2
4
6
8
nitrate-nitrite (µmol/l)

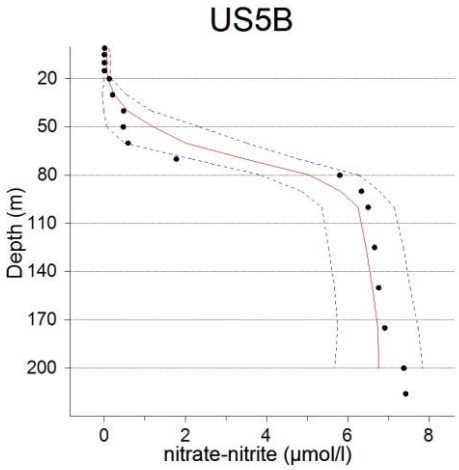

US5B
Depth (m)
20
50
80
110
140
170
200
5
10
ctd-temperature (deg C)

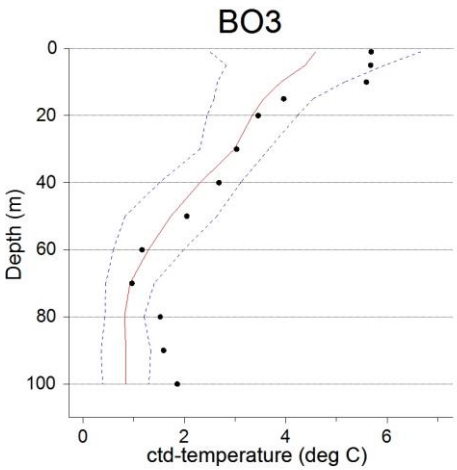

US5B
Depth (m)
20
50
80
110
140
170
200
5
5.5
6
6.5
ctd-salinity (ppm)

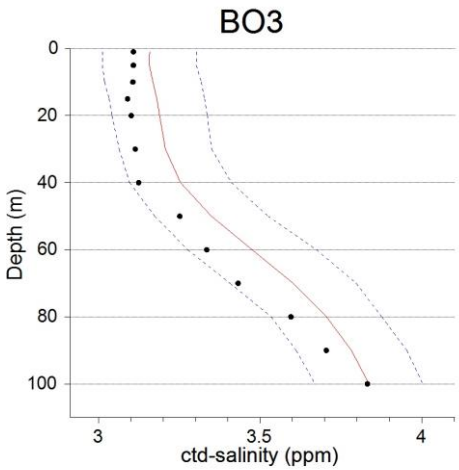

US5B
Depth (m)
20
50
80
110
140
170
200
5
6
7
8
9
ctd-oxygen

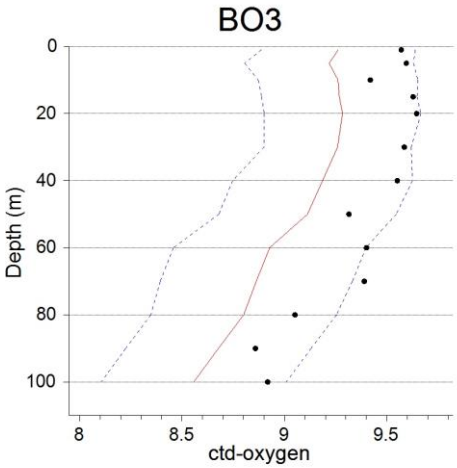

US5B
Depth (m)
20
50
80
110
140
170
200
5
6
7
8
9
oxygen (ml/l)

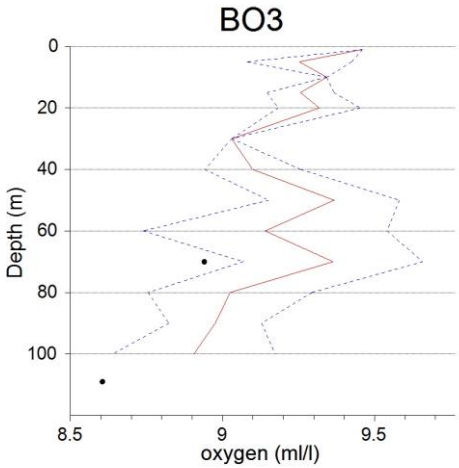

US5B
Depth (m)
20
50
80
110
140
170
200
0
0.5
1
1.5
phosphate (µmol/l)

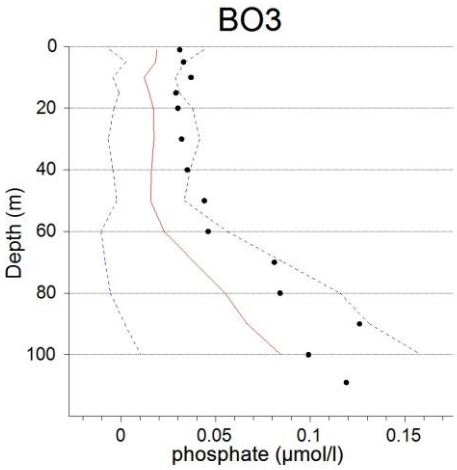

US5B
Depth (m)
20
50
80
110
140
170
200
0
2
4
6
8
nitrate-nitrite (µmol/l)

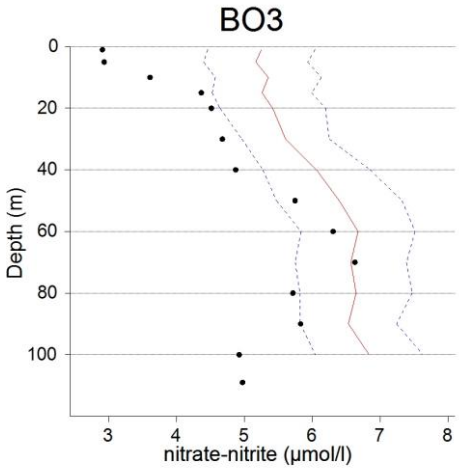

BO3
Depth (m)
0
20
40
60
80
100
0
2
4
6
ctd-temperature (deg C)

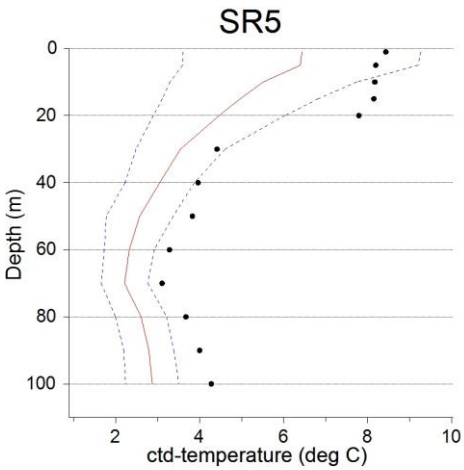

BO3
Depth (m)
0
20
40
60
80
100
3
3.5
4
ctd-salinity (ppm)

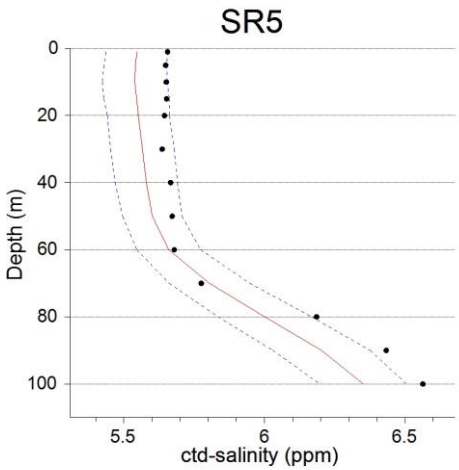

BO3
Depth (m)
0
20
40
60
80
100
8
8.5
9
9.5
ctd-oxygen

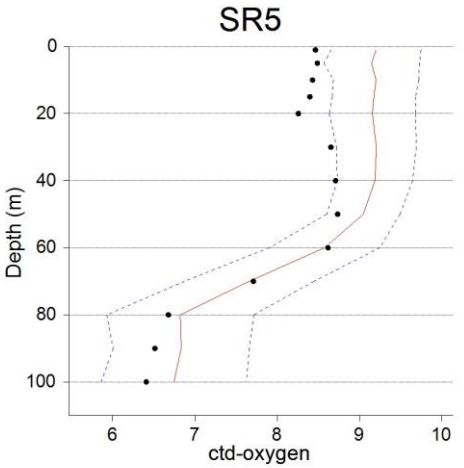

BO3
Depth (m)
0
20
40
60
80
100
8.5
9
9.5
oxygen (ml/l)

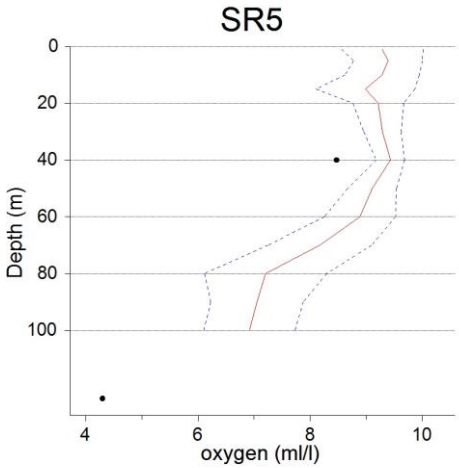

BO3
Depth (m)
0
20
40
60
80
100
0
0.05
0.1
0.15
phosphate (µmol/l)

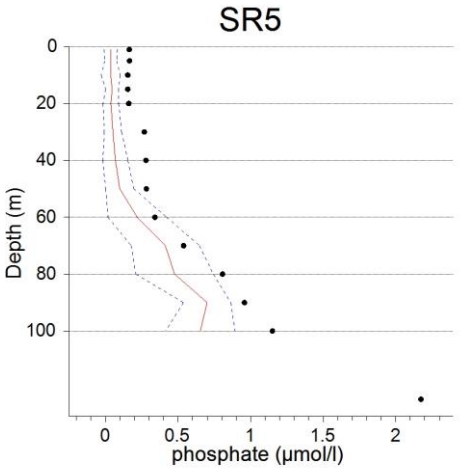

BO3
Depth (m)
0
20
40
60
80
100
3
4
5
6
7
8
nitrate-nitrite (µmol/l)

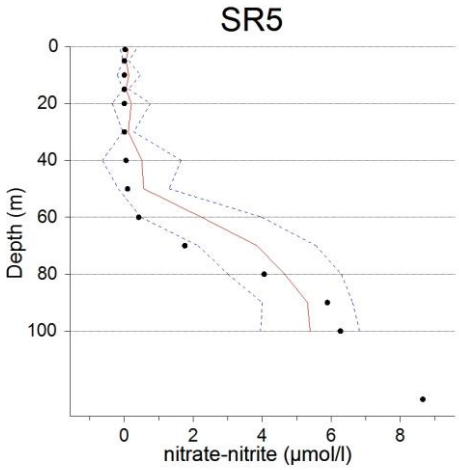

SR5
Depth (m)
0
20
40
60
80
100
2
4
6
8
10
ctd-temperature (deg C)

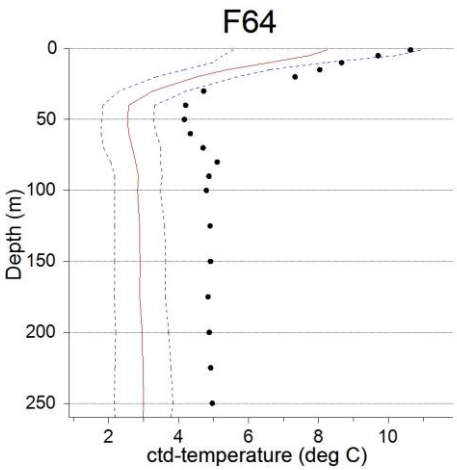

SR5
Depth (m)
0
20
40
60
80
100
5.5
6
6.5
ctd-salinity (ppm)

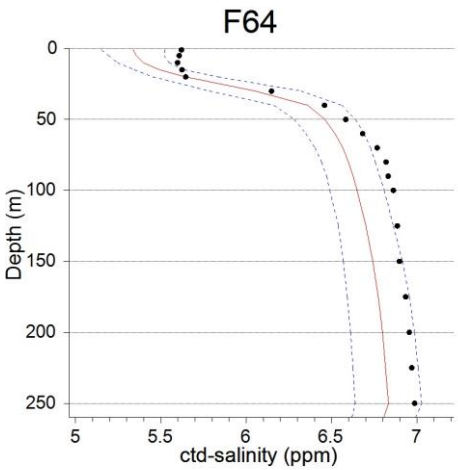

SR5
Depth (m)
0
20
40
60
80
100
6
7
8
9
10
ctd-oxygen

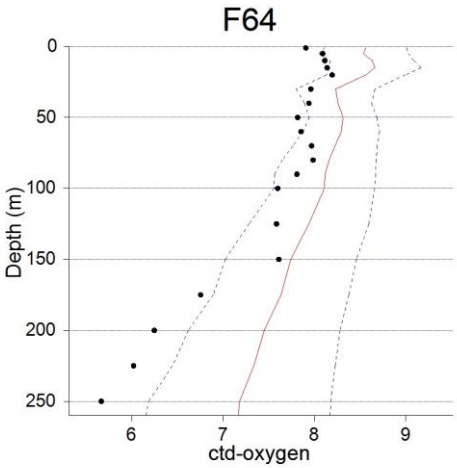

SR5
Depth (m)
0
20
40
60
80
100
4
6
8
10
oxygen (ml/l)

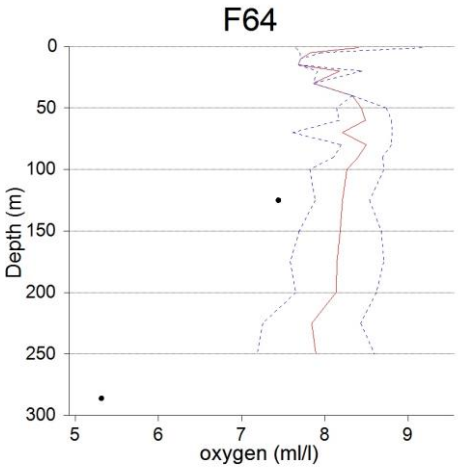

SR5
Depth (m)
0
20
40
60
80
100
0
0.5
1
1.5
2
phosphate (µmol/l)

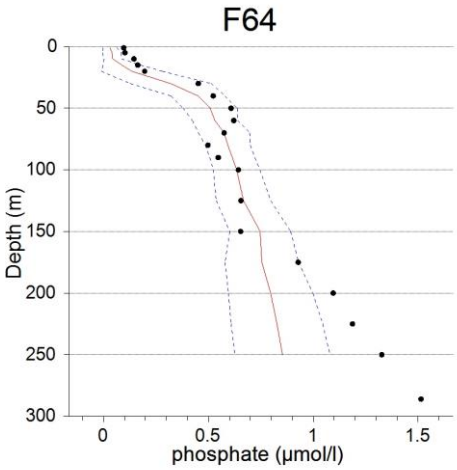

SR5
Depth (m)
0
20
40
60
80
100
0
2
4
6
8
nitrate-nitrite (µmol/l)

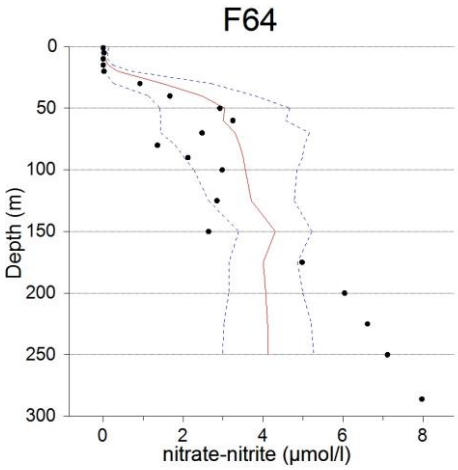

F64
Depth (m)
0
50
100
150
200
250
2
4
6
8
10
ctd-temperature (deg C)

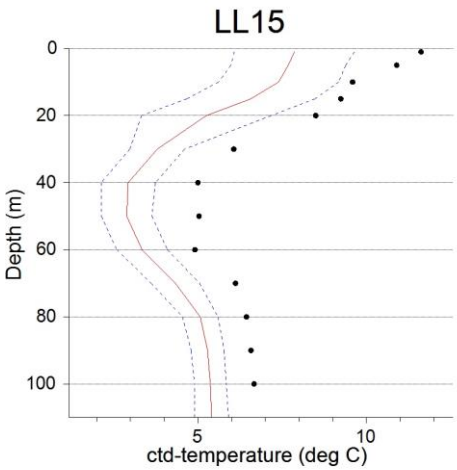

F64
Depth (m)
0
50
100
150
200
250
5
5.5
6
6.5
7
ctd-salinity (ppm)

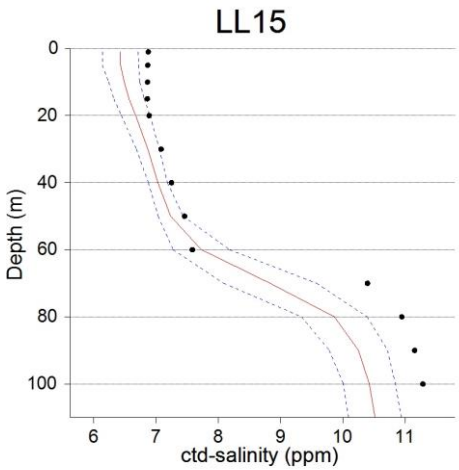

F64
Depth (m)
0
50
100
150
200
250
6
7
8
9
ctd-oxygen

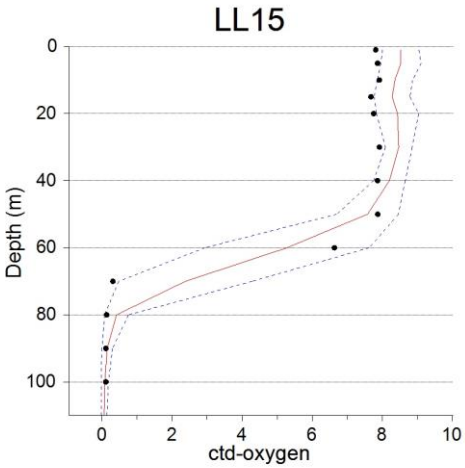

F64
Depth (m)
0
50
100
150
200
250
300
5
6
7
8
9
oxygen (ml/l)

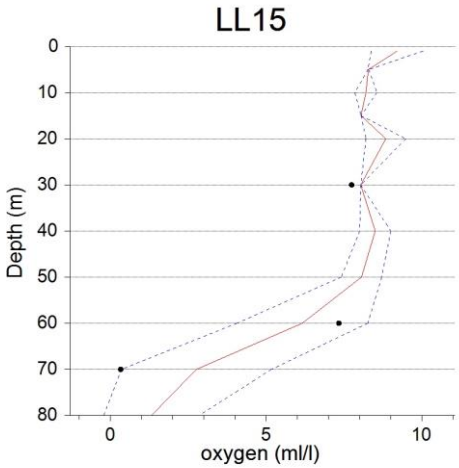

F64
Depth (m)
0
50
100
150
200
250
300
0
0.5
1
1.5
phosphate (µmol/l)

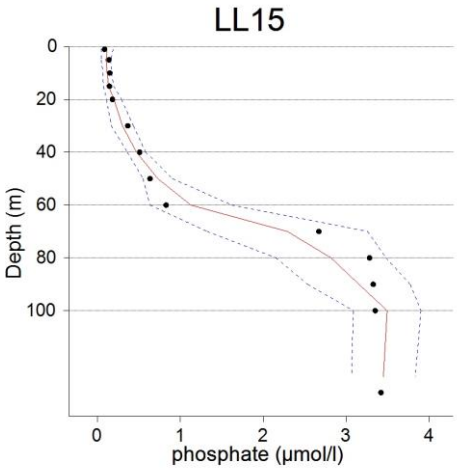

F64
Depth (m)
0
50
100
150
200
250
300
0
2
4
6
8
nitrate-nitrite (µmol/l)

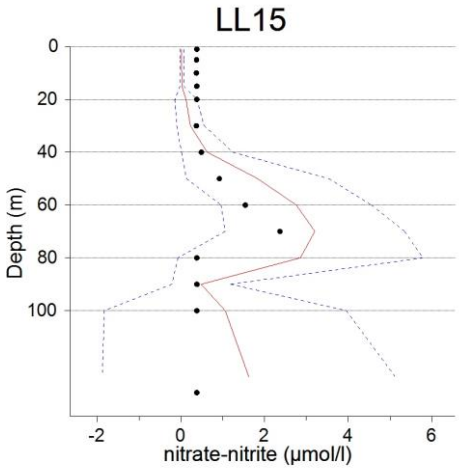

LL15
Depth (m)
0
20
40
60
80
100
5
10
ctd-temperature (deg C)


LL15
Depth (m)
0
20
40
60
80
100
6
7
8
9
10
11
ctd-salinity (ppm)


LL15
Depth (m)
0
20
40
60
80
100
0
2
4
6
8
10
ctd-oxygen


LL15
Depth (m)
0
10
20
30
40
50
60
70
80
0
5
10
oxygen (ml/l)


LL15
Depth (m)
0
20
40
60
80
100
0
1
2
3
4
phosphate (µmol/l)


LL15
Depth (m)
0
20
40
60
80
100
-2
0
2
4
6
nitrate-nitrite (µmol/l)

Annex 2. List of sampled stations of the cruise

INDEX	STATION	latitude	longitude	depth	DATE	time	ctd	pH	ox	nu	zo	be	chl	ml	secchi
HELSINKI	HELSINKI	60.16182	24.90157		2020-06-01	06:06									
2020010062	39A	60.06680	24.97988	43	2020-06-01	08:41	x	x	x	x		x	x		x
2020010063	XIV3	60.20330	26.19265	80	2020-06-01	14:33	x	x	x	x			x		x
2020010064	XV1	60.24998	27.24672	66	2020-06-01	19:55	x	x	x	x	x	x	x	x	
2020010065	LL3A	60.06708	26.34670	68	2020-06-02	01:13	x	x	x	x	x	x	x	x	
2020010066	GF2	59.83840	25.85668	85	2020-06-02	06:31	x	x	x	x		x	x		x
2020010067	LL5	59.91678	25.59682	69	2020-06-02	09:11	x	x	x	x		x	x		x
2020010068	LL6A	59.91685	25.03028	73	2020-06-02	12:00	x	x	x	x		x	x		x
2020010069	LL7S	59.85838	24.83828	77	2020-06-02	14:02	x	x	x	x	x	x	x	x	x
2020010070	GF1	59.70495	24.68213	84	2020-06-02	17:39	x	x	x	x	x	x	x		x
2020010071	LL9	59.70012	24.03030	66	2020-06-02	21:26	x	x	x	x	x	x	x		
2020010072	JML	59.58188	23.62717	80	2020-06-03	00:40	x	x	x	x			x		
2020010073	LL11	59.58347	23.29680	67	2020-06-03	03:14	x	x	x	x		x	x		x
2020010074	AMN	59.69055	23.25718	55	2020-06-03	05:19	x	x	x	x		x	x		x
2020010075	LANGDEN	59.77687	23.26258	57	2020-06-03	07:41	x	x	x	x	x	x	x	x	x
2020010076	IU7	59.81523	21.33665	92	2020-06-03	16:15	x	x	x	x	x		x		x
2020010077	IU5	60.05808	21.19820	89	2020-06-03	19:40	x	x	x	x		x	x		
2020010078	IU3	60.33335	21.11330	49	2020-06-03	23:39	x	x	x	x		x	x	x	
2020010079	IU1	60.76688	20.84677	34	2020-06-04	03:42	x	x	x	x			x		x
2020010080	SR8	61.12647	20.92982	48	2020-06-04	07:02	x	x	x	x			x		x
2020010081	SR7	61.08337	20.59658	78	2020-06-04	09:23	x	x	x	x		x	x		x
ARVORC_SM_2020	ARVORC_SM_2020	61.40132	20.18883		2020-06-04	12:44									
2020010083	MS9	61.76693	20.53067	101	2020-06-04	15:42	x	x	x	x		x	x		x
2020010084	F26	61.98342	20.06298	137	2020-06-04	19:13	x	x	x	x		x	x		x
2020010085	US5B	62.58605	19.96873	217	2020-06-05	00:29	x	x	x	x	x	x	x		
2020010086	US6B	62.60022	20.26295	82	2020-06-05	04:54	x	x	x	x		x	x	x	x
2020010087	FM12A_8	62.64308	20.47245	39	2020-06-05	07:23	x	x	x	x		x	x		x
2020010088	US7	62.60007	20.82942	28	2020-06-05	09:48	x	x	x	x			x		x
2020010089	F16	63.51682	21.06258	49	2020-06-05	16:57	x	x	x	x	x	x	x		x
2020010090	F15	63.51685	21.51302	48	2020-06-05	19:28	x	x	x	x		x	x		
2020010091	BO3	64.30192	22.34310	110	2020-06-06	01:06	x	x	x	x	x	x	x	x	
2020010092	AALTO_PM	64.68372	23.24143	80	2020-06-06	07:16	x								x
2020010093	RR6	64.80028	23.47927	85	2020-06-06	08:36	x	x	x	x		x	x		x
2020010094	RR7	64.73368	23.81267	39	2020-06-06	10:52	x	x	x	x		x	x		x
2020010095	HIEKKA1	64.99988	23.83328	27	2020-06-	13:10	x	x	x	x		x			x

INDEX	STATION	latitude	longitude	depth	DATE	time	ctd	pH	ox	nu	zo	be	chl	ml	secchi
					06										
2020010096	HIEKKA2	65.05010	23.83322	21	2020-06-06	14:27	x	x	x	x		x			x
2020010097	HIEKKA3	65.10010	23.83313	29	2020-06-06	15:17	x	x	x	x		x	x		x
2020010098	CVI	65.23370	23.56278	69	2020-06-06	17:29	x	x	x	x		x	x	x	x
2020010099	F2	65.38365	23.46263	89	2020-06-06	20:37	x		x	x	x		x		
2020010100	CV	65.00040	23.24632	88	2020-06-07	00:13	x	x	x	x		x	x		
2020010101	RR3	64.93387	22.34592	95	2020-06-07	03:23	x	x	x	x		x	x		x
2020010102	F13	63.78353	21.47953	64	2020-06-07	16:37	x	x	x	x			x		x
2020010103	F18	63.31432	20.27278	103	2020-06-07	22:40	x	x	x	x		x	x	x	
2020010104	US3	62.75885	19.19567	176	2020-06-08	04:45	x	x	x	x		x	x		x
2020010105	MS3	62.13447	18.16302	85	2020-06-08	11:34	x	x	x	x		x	x		x
2020010106	MS6	61.98365	19.16323	73	2020-06-08	15:36	x	x	x	x		x	x		x
2020010107	SR5	61.08328	19.57968	125	2020-06-08	22:34	x	x	x	x	x	x	x	x	
2020010108	SR3	61.18320	18.22995	73	2020-06-09	05:34	x	x	x	x		x	x		x
2020010109	F33	60.53315	18.93762	134	2020-06-09	11:34	x	x	x	x			x		x
2020010110	F64	60.18895	19.14257	287	2020-06-09	14:53	x	x	x	x	x	x	x	x	x
2020010111	F69	59.78330	19.92997	190	2020-06-09	22:59	x	x	x	x		x	x		
2020010112	TROSKAH	59.65998	19.88333	37	2020-06-10	02:04	x	x	x	x			x		
2020010113	LL19	58.88062	20.31068	167	2020-06-10	07:52	x	x	x	x		x	x		x
2020010114	LL17	59.03337	21.07972	172	2020-06-10	12:23	x	x	x	x	x	x	x		x
2020010115	LL15	59.18317	21.74692	132	2020-06-10	17:59	x	x	x	x		x	x		x
2020010116	LL12	59.48345	22.89682	83	2020-06-10	23:40	x	x	x	x	x	x	x	x	
2020010117	F62	59.33352	23.26350	97	2020-06-11	02:53	x	x	x	x			x		x
2020010118	XII3	59.86412	23.98563	37	2020-06-11	08:25	x	x	x	x			x		x
HELSINKI	HELSINKI	60.16180	24.90158		2020-06-11	13:54									

Parameters: ox = oxygen, nu = nutrients, zo = zooplankton, be = benthos, chl = chlorophyll a, ml = microlitter, tox = phytotoxins.